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Venturing into the Age of AI: Insights and Perspectives

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VENTURING INTO THE AGE OF AI: INSIGHTS AND PERSPECTIVES

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Venturing into the Age of AI: Insights and Perspectives

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In recent times, the term “intelligence” has gained considerable popularity, permeating numerous spheres encompassing actions, practices, processes, and products. This pervasive presence within contemporary discourse can be attributed to two pivotal factors. Primarily, there has been a paradigmatic shift in our comprehension of intelligence, transcending the notion of it being exclusively confined to humans, but rather acknowledging its manifestation in diverse emerging properties and conditions present in both human and non-human entities. Secondly, intelligence is now perceived as a multifaceted nexus, interlinking a ‘brain’ (whether human or non-human), a corporeal form, and the complex environmental contexts in which this embodiment exists.

Within architectural circles, there is an ongoing exploration of various “intelligent” tools, encompassing diverse AI languages, generative adversarial networks, and text-to-image tools. These endeavours seek to comprehend how non-human intelligence can be harnessed to address contemporary urban challenges and concerns. Simultaneously, careful consideration is being given to the potential benefits and risks that arise from the utilization of such tools in urban centers and cities. The field of architecture is undergoing rapid transformation due to the incorporation of cutting-edge digital technologies, particularly the integration of artificial intelligence (AI) into various aspects of design, representation, and production. Considering the already substantial impact of AI in fields such as engineering, social sciences, and political sciences, it becomes imperative for architecture to adopt a critical approach to understanding and evaluating the implications of these transformative technologies within its domain. By doing so, architecture can effectively navigate and harness the potential benefits while addressing any challenges that may arise from the integration of AI in its practices.

The application of Artificial Intelligence (AI) techniques has

witnessed widespread use in the realm of architecture, particularly within design-related domains. The emergence of AI-based design methods has led to a growing trend among researchers and architects, who are now actively engaged in training machine learning models or leveraging pre-trained models to augment the architectural design process. This integration of AI technology encompasses a wide array of functionalities, ranging from generating design renderings based on images to optimizing design solutions through vector-based approaches. By leveraging AI, the early-stage design inspiration phase is enriched with heightened creativity, while the efficiency of the overall design process is significantly enhanced. The fusion of AI with architectural practices thus paves the way for innovative and streamlined design solutions, fostering a promising outlook for the future of architecture.

In his seminal work, the *Tractatus Logico-Philosophicus* (1922), Ludwig Wittgenstein put forth the notion that the boundaries of one’s language mark the boundaries of one’s understanding of the world. This perspective suggests that if we lack the linguistic capacity to articulate something, then it is deemed nonexistent or incomprehensible. However, in the contemporary landscape, Wittgenstein’s statement acquires a new dimension as we witness the emergence of natural language text-to-image applications driven by artificial intelligence algorithms. This development prompts profound reflections on the concept of a post-digital sensibility in architecture. The exploration of a post-digital sensibility in architecture involves investigating how natural language-based AI applications can transcend traditional boundaries, and through theoretical and practical approaches, delve into the realms of creativity and intelligence within a post-human design ecology. By utilizing Neural Network processes in design, this discourse seeks to

dispel the perceived 'risks' associated with such technological advancements and unlock new possibilities for architectural expression and exploration. Through the convergence of AI-driven text-to-image tools and architectural practice, this inquiry into a post-digital sensibility envisions a future where the conventional barriers between language, creativity, and design are dismantled. By embracing and demystifying AI's potential, architects can forge innovative paths to shape the built environment in ways previously unimagined.

The invitation for scholarly submissions for this number of FORUM A+P provocatively interrogated the inherent interconnection between architecture and the evolving cultural ethos it reflects in the era of artificial intelligence (AI) and the pervasive influence of intelligence extending into its spheres. Architecture, as a tangible expression of societal mores, is intrinsically linked to the tenets of novelty and the ongoing reassessment of these mores in light of the dynamic currents of societal dilemmas, preferences, and apprehensions. Concurrently, it adjusts to novel dynamics and cross-pollination stemming from interconnected domains and movements. The abstracts submitted explored a wide range of topics where the entanglement between architecture and intelligence is showcased from multiple perspectives and approaches. From the need for architecture to redefine its boundaries reflecting on the importance of intersecting forces from different fields of knowledge to the embrace of such technologies to delve into society-related problems such as education inequality and gender balance issues that could solve – or at least rediscussed – in the light of these new intellectual impulses. The different papers inherently question how we should look at architectural and design research and how we should reposition their coordinates for it to remain relevant and contemporary without closing itself into its consolidated theoretical boundaries. This editorial tries to synthesize the different thoughts encapsulated in this issue and, akin to Plato's two horses, we sought to harmonize divergent perspectives and disparate trajectories, striving to maintain coherence amidst varying viewpoints. The aim beneath this number of FORUM A+P is not just to trace the current research trajectories related to the main topic but also to represent an effort to trace future directions for architectural research in the age of AI. This intention becomes apparent upon reviewing the submitted paper and the vibrant portrait they collectively paint. Furthermore, In light of the positive response to the call for papers and the multitude of discussions and topics initiated, we have opted to publish a greater number of papers than our customary practice.

Andia Vllamasi and *Klea Hallaci's* work explore the impact of artificial intelligence in medical healthcare and the implications it could have in providing medical professionals with an effective tool for early detection and intervention by determining the algorithm that performs best at disease prediction. Furthermore, it represents an interesting reflection on how prediction tools can be used in analyzing large datasets to improve performance on responsiveness with the emergence of new previously unseen conditions

Sonila Murataj and *Orgejda Doda's* study deals with the actual condition of our city environments through a thorough perspective. They propose a set of solutions for traffic light optimization by comparing and analyzing the output results of different methods/algorithms (Pedri Net algorithm, fuzzy model, improved RNN Djik-

stra Algorithm) and discussing the livability of our cities through the proposal of smarter and more efficient and reliable solutions.

Erilda Muka, Dhurata Shehu and Gerti Mecaj's paper confronts the societal topic of Educational Inequalities and gender balance discrepancies in the AI era. They reflect on how intelligent tools could play a pivotal role in mitigating certain educational gaps, its implementation and management could potentially exacerbate pre-existing inequalities.

With a background in fashion design and sustainable materials, *Esmeralda Marku* analyzes the growth of the creative potential of designers in the fashion industry delving into the impact of AI on almost every segment of the fashion value chain. Rooted in a design through a research approach, the paper oscillates between some theoretical reflections on the topic and some concrete explorations from the author coming from her professional and pedagogy practice.

Arber Malaj and *Erilda Muka's* investigation sheds light not only on the advantages that AI fosters but raises questions also about the difficulties and worries it may generate. The authors discuss about algorithmic bias and the lack of transparency in sophisticated AI algorithms, ethical considerations are crucial. Another worry is job displacement since the possibility of automation raises concerns about the nature of labor in the future. *Tamara Luarasi* and *Albina Tocilla's* text offers another perspective on the optimization of our urban environments and intersections through the lens of traffic light optimization. Differently from the previous one, this work implements VANET (vehicular ad-hoc network) technology and a preliminary study on its implementation and results.

Luca Lezzerini and *Andia Vllamasi's* express a main concern related to risks related to the diffusion of AI technologies. Through a recall from sci-fi literature and dystopias they delve into the basic concepts of risk and tailor them to provide effective support in developing risk analysis for the specific area of artificial intelligence. They assume that when risks are defined then methods to detect and minimize them are provided.

Fulvio Papadhoulis's research examines the intersection of speculative architectural-design methodologies and the era of artificial intelligence (AI). It explores how AI technologies are reshaping and augmenting the speculative design process within architecture, offering insights into the evolving role of human creativity and machine intelligence in shaping future-built environments through time and space.

Remijon Pronja and *Armela Lamaj* approach the topic of spirit and form in Tirana's contemporary urban development. Strongly rooted in the intersection between art and (urban) design. The paper investigates the potential for architectural forms to reflect the evolution of urban landscapes in the contemporary context and potentially evoke nationalist sentiments through their design. The backdrop of our discourse on this issue is the profound changes that the design practice has been facing in less than five years due to the growth of AI technologies and tools in everyday practice and have also posed existential questions about the role of research and their current and future trajectories. This number of FORUM A+P aims to be a mosaic of ideas and exploration and advocates the need for deep reflections concerning the relevance of our research in the context of fast-changing values in the transitional era we are living in.

Multimedia Design

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Abstract

The use of multimedia in a variety of applications in our everyday life, offers additional advantages in designing the multimedia themselves, based on designing principles and appropriate tools. Those well implemented multimedia elements should be part of an integral design strategy to be followed, when professionals need to transfer their message to the users and their audience. The multimedia elements were described together with a series of applications to be used. Combining the multimedia technology together with the branding principles created an increased connection of the subject to the participants. Teams of participants developed their own brand and different multimedia elements for their own case. A number of tools for analysing and building modern multimedia applications were presented and used practically with the assistance of a number of class based exercises and presentations. An effort was made to balance the amount of knowledge offered to the participants, the practical exercise work performed and the creativity satisfaction developed, when presenting the requested outcomes from the teams in front of the audience.

Objectives

The aims of the Workshop in Multimedia Design were to combine the content of the multimedia with applications connected to product branding. The theoretical aspects were presented, while at the same time, a series of exercises were performed and presented within the class. The participants worked in teams and at the end of every exercise, they were all actively present the projects' outcomes. The rest of the participants and the curators asked questions in order to clarify issues that came up during the presentations. Additionally, a series of digital tools was presented based on real case scenarios and thus the participants were exposed to knowledges and experiences, when using a multimedia toolkit, with an increased number of tools, from different points of view i.e. text, audio, sketching, vector design, image processing, animation, video, artificial intelligence based media creations.

The main objective of the course was to trigger the creativity of the participants and actively involve them via teamwork to create their own digital multimedia material and discover new computer based applications. When using these digital toolkit both creativity and creation satisfaction were supported.

Theoretical content

The multimedia term incorporates a variety of ways to transfer information to the users, while they can interact with digital pieces of information that serve as set of active communication tools. They can be used in a variety of areas i.e. training, corporate presentations, marketing and communication, design industries. It uses text, audio, video, graphics, animation etc together with their combinations, having as an aim to transfer a dynamic message in an efficient manner. Text is used as the



Figure 1. Screenshot from the tools used during the workshop

basis of all multimedia productions. The text can be found with different fonts and sizes to better suit the application built. In addition, audio or sound elements are used for improving the quality and the quantity of the transferred message to the user. It can be of analog or digital type. The analog audio or sound refers to the original sound, which should be digitized for being able to be stored on computers. The digitizing process is based on a process named analogue-to-digital-conversion procedure and requires a set of computer based hardware and software to be used for this reason. Graphics improve drastically the quality of multimedia and make them more attractive and easy to convey messages that otherwise would need a great deal of text based content. They can explain a concept, transfer knowledge, present pieces of information etc. There are two basic categories of images and several case studies were presented for stressing the core ideas behind:

- bitmap images that are real images and can be captured via digital cameras or scanners. They are not editable and require a great deal of memory space. They can be stored in formats such as .bmp, .tiff, .jpeg, .png, .gif. When the same bitmap file is used for large sized applications its quality is drastically reduced.
- vector graphics are created based on computer aided design software, they are editable and require a small amount of memory for storage. They can be stored in formatted files such as .ai, .eps, .pdf, .svg, .cdr. A vector file can be used easily, when the size of the application varies because it is not losing the content quality.

The use of RGB and CMYK colour systems were presented. It was stressed that RGB is used for digital and web based media, while CMYK is used when the work completed will be used for printed physical media. With the assistance of the color wheel, the concepts of primary, secondary and tertiary colors were introduced and further explained the possibility of selecting from a variety of color pallets, when a digital project is developed. Case studies were presented in order to avoid using from a large number of colors instead of concentrating on specific color pallets that can be easily identified from the users' point of view. With the term video, someone means a moving picture that comes with sound. Video as a main element of multimedia offers a great deal of information and messages in a limited amount of time. It can be used in order to depict real life objects within a multimedia application. It demands a considerable amount of

computer memory resources and bandwidth if in use via the internet. The digital video clips can be easily edited, altered and be transferred within a computer network. As in all digital media a variety of formats are made available and the main of them where explained based on the standards used and developed over the years i.e. .avi, .mov, .mp4, .flv, .saf, .mkv, .wmv, .mpg. Animation is the process of making a static image look like it is moving. It consists of a series of still images that are displayed one after the other and produce the sense of watching a motion. It is used for attracting the attention of the users and passing the messages and knowledge in a more effective way, thus giving the feeling of a light and attractive presentation. All the different kinds of animations are extremely populars to the users and it is one of the main ways to build multimedia applications. Stop motion, motion graphics, 2D/3D animations lead the users to receive a greater satisfaction from the multimedia applications because they feel significant entertainment.

Exercises and application

The first set of exercises given to the participants asked them to:

- find multimedia applications over the internet;
- describe them according to the multimedia categories presented earlier i.e. static elements (according to time), animated elements, artificial elements (made by computer), real elements;
- describe the multimedia applications based on the multimedia components used i.e. sound, image, video, animation, graphics. The effectiveness of the message transferred was of great importance;
- present the case studies in front of the class, ar-



Figure 2. Futuristic image produced from the class

gue about them and answer questions from the curators and especially from the rest of the teams.

A number of common areas for building multimedia applications consists of:

- entertainment: designing flying banner presentations, video transitions, animations, audio effects can be utilized for creating a multimedia-based advertisement that is appealing to the users;
- education: assisting the children to learn via using a computer game with a number of difficulty levels introduced;
- business: a number of office needs, record management, employee training etc. use multimedia for introducing user friendly and effective work characteristics;
- marketing: promoting new product and brand identities can be very effective when a series of multimedia applications and design guidelines are used.

Based on the marketing principles, the company brand and its aims were explained. A brand is the identity and the story of a company, that makes it stand out from competitors, that sell similar products or services. The goal of branding is to earn space in the minds of the target audience and become their preferred option. It is the process of creating the brand identity of a company. This process also delivers materials that support the brand, like a logo, tagline, visual design, or tone of voice. It influences the users purchasing decisions, creates an identity for the business, helps users to remembering the company, boosts advertising & marketing and builds employee support. The identity can be supported from a variety of multimedia applications that use logo, business cards, posters, packaging, promo video, websites etc. A series of case studies were presented with an aim to introduce the key thoughts to be used, when designing those multimedia applications for branding purposes.

The second set of exercises aimed in creating a common umbrella or story for each team of participants. The teams were asked to:

- create their own logo, together with the development of a story telling for their businesses and the key products to be promoted;
- choose the categories of the designed logo and story telling;
- make use of inspiration from case studies that were available at the internet, expand and altered them;
- present the case studies in front of the class, argue about their output, answer questions from the curators and especially from the rest of the teams;
- the question “What is UX and UI?” raised in the class, led to a great deal of interest and discussions. Both meanings were explained and the design principles actually used were explained;
- user Interface (UI) Design focuses on anticipating what users might need to do and ensuring that the interface has elements that are easy to access, understand, and use to facilitate those actions. UI brings together concepts from interaction design, visual design, and information architecture;
- user experience (UX) design is the process design teams use to create products that provide meaningful and relevant experiences to users. UX design involves the design of the entire process of acquiring and integrating the product, including aspects of branding, design, usability and function;
- the wireframe as a tool to analyse and implement a website was introduced;

The result of the UX and UI content offered the opportunity to run two additional set of exercises in the class. The third set of exercises aimed in analysing a website based on the wireframe tool. The teams were asked to:

- choose a website;
- analyse the multimedia and the branding elements of the website under study;
- use the elements of the website in order to present the wireframe tool output ;

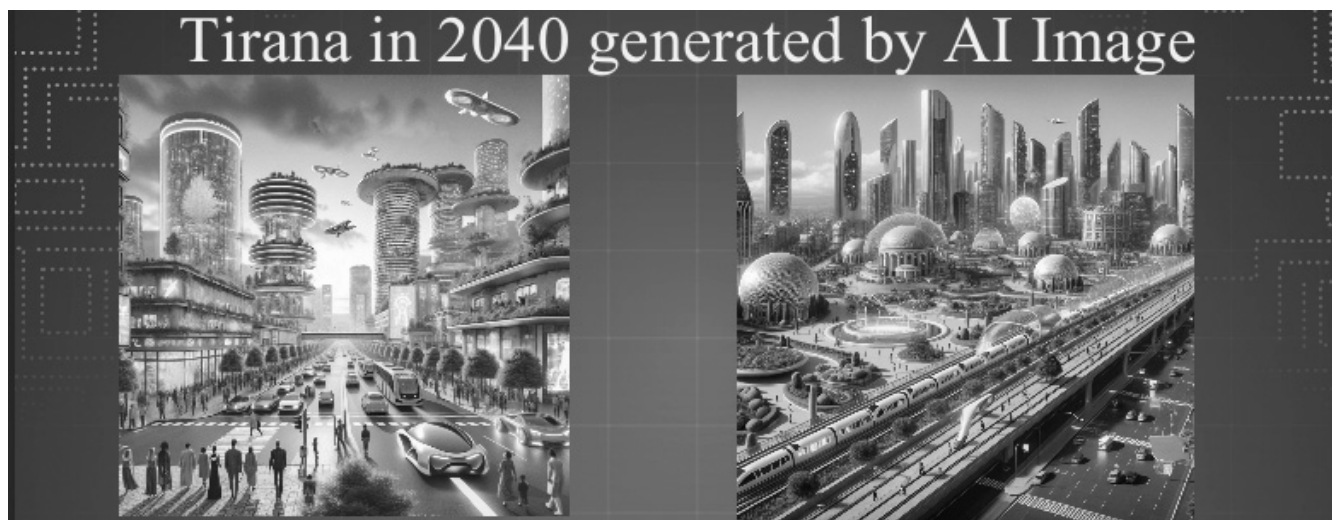


Figure 3. Vision of Tirana 2040

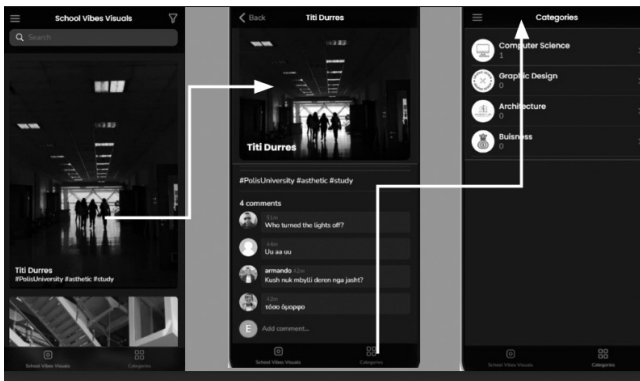


Figure 4. One of the mobile app prototypes



Figure 5. Mock-up from the apps

- present the work done including the website analysis and the website wireframe tool;

The fourth set of exercises aimed in building an application for smartphones, analyse and present it:

- based on the team brand identity built earlier, create an appropriate application for a smartphone;
- analyze the multimedia and the branding elements of the application built;
- design the wireframe of the application built;
- present the work completed including both the application analysis and the application wireframe;
- the final part of the workshop was used for including the Artificial Intelligence (AI) tools for developing a series of multimedia elements in a more effective and automatic way. Using text or images and other descriptions within a number of AI applications, the participants were able to automatically produce multimedia elements, targeted to the specific needs of their own brand identity introduced at the beginning of this workshop. At the end, each team presented the:
 - AI tool used for creating their multimedia element;
 - produced multimedia element;
 - advantages and disadvantages of using AI for this purpose.

Conclusions

After a successful workshop full of knowledge, skills and experience transfer, a number of summarized outcomes would include the following:

- the theory was combined with case studies and appropri-

ately designed class exercises;

- a series of methodological tools were used together with technological tools with an aim to integrate the whole process;
- the participants used both physical and digital tools for their work in the class;
- the teamwork used increased significantly the capacity of each team to run the project works requested in a limited time table;
- the project based work completed over the workshop offered increased knowledge and skills transfer to the participants. At the same time, the teams received increased satisfaction when completing and presenting their work. Defending their work in front of large audience was a significant experience;
- although some digital tools and pieces of software were presented to them, the teams used their own tools and felt more comfortable when producing high quality output. In a number of cases, the teams used digital tools for the first time, thus increasing their exposure to learning digital tools, discovered over the internet in such a short time period;
- the use of technological tools made the participants realizing that there are not only advantages but disadvantages as well in their use when developing multimedia elements. Not being able to control with accuracy the output received from the AI tools was the main surprise offered to the audience at the end of the workshop.

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Intelligence

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Technology has always been responsible for the profound transformation of the cultures that developed it. Technological advancements introduce new cognitive and symbolic systems which, however, are not readily apparent as soon as new technologies are developed. It always took longer -even as long as generation lifespans- to assimilate, exploit and turn into practices the cognitive possibilities opened up by any technological innovation¹. If it is valid to suggest that cultural evolution follows technological evolution, then we can safely assume that we are far from the complete exploitation of the cognitive mutations we are experiencing or encountering in the new technological environment formulated by the recent advancements of communication networks and information processing technologies. However, we can already detect an emergent (social) agenda of humanity which strives for the extension of life from the organic to the inorganic realm, shifting from what we used to call natural processes to what we now understand as intelligent design².

¹Pierre Lévy set as an example the print technology which 'fostered the development and progressive formalization of linguistic studies and the creation of metadata systems for the organization of libraries and archives'. Cf. Lévy, P. (2010). *From social computing to reflexive collective intelligence: The IEML research program*. In: *International Journal for Information Sciences*, Volume 180, Issue 1, 2, January 2019. Elsevier pp.72.

²A presentation of this new agenda to the broader public could be considered the case of Harari, Y.N. (2016). *HomoDeus. A brief History of Tomorrow*. Harvill Secker, London, UK.

The notion of intelligence has become a buzzword that accompanies every possible action, praxis, process or product nowadays. Its dominance in contemporary thinking and practice is grounded on two new and closely related considerations. The first is the ontological mutation of intelligence, from its conception as the exclusive function of the human brain to its definition as a property emerging from a specific set of conditions in which a human or a non-human organism or machine could exist. Intelligence is no longer only a human privilege. The second is the understanding of intelligence not as the outcome of the function of one single organ or center but as the emergent property of the symbiosis and the respective interaction between a 'brain' (human or non-human), a body and the environment(s) in which this body exists. There is an inseparable continuity between any kind of mind and body, body and environment, mind and matter, intelligence and environment. This mutation renders intelligence a symbolic reference of an emerging -if not already established- understanding of the human as part of a new worldview. According to this understanding, the humans are, no longer, the most important and capable distinct beings in the universe having always an antagonistic relationship with their natural environment. They are conceived as embodied in an extended interconnected and networked technological world. The humanitarian rationalism discarded God from the center of the social imaginary to glorify the human intelligence in its perpetual conflict with nature. Posthuman thinking discards the humans from their believed dominance to glorify the planetary intelligence of the living Gaia³. Any form of intelligence, human or non-human, is now considered as dynamically interdependent. Any individual intelligence, alive or machinic, is part of a collective alien intelligence.

Intelligence, nowadays, underlies notions of control, management, efficiency, but also notions of sensing, abstracting, learning, deciding and acting in either a human or in a non-human manner. In other words, it encompasses all aspects of design, introducing a new design intelligence utterly different from the one generated by the human-centered approaches to creation. It perpetually moves between the effective and smart management of presented resources and the spontaneous creation of smart environments that afford and encourage the participation of anything that could be called user, being it human or non-human. The shift in the conception of intelligence, profoundly affects the contemporary understanding of design of the built environment at any scale and every stage of the design process. We are facing new theorisations and actualisations of the concepts of innovation, creativity, and imagination, three of the main driving forces of the design activity.

Innovation has always been a primary goal of the design of the built environment around which, all human-centered theoretical discourses developed their intellectual foundations to assist the creation of innovative design outcomes. As theory is primarily based upon values, there is always a directed articulation of existing elements towards new and innovative combinations. The development of advanced computation and networking technologies and tools, supported by, and supporting the aforementioned posthuman understanding of the self and the world, expect the collective alien intelligence to open up new directions to innovation. In this context, innovation is no longer considered as the creation of something just entirely new. It is the request for unpredictably unexpected and unthinkable associations and speculations of existing components which were hidden, latent, separated or isolated and conceived as irrelevant by the different theoretical doctrines occasionally dominating the design of the built environment. The request for the 'radically new',⁴ is supported by the harsh critiques appearing twenty years ago, to pre-existed theories, defining them as an impediment to the development of an innovation culture in design⁵ which has to be replaced by a new intellectual framework supporting rather than inhibiting innovation.

The human-centered paradigm conceives creativity as one of the distinctive attributes of human consciousness such as intelligence, thought, emotion, memory, imagination, awareness, self-knowledge, sense of being. Through psychology, creativity was explained, among others, as a brain function connecting incentives from the two lobes of the brain⁶ (Braian Lawson). This can explain the enhancement of creativity linked to the enrichment of external stimuli which could eventually intensify these connections. In the post-human context, creativity is a faculty inseparable from intelligence. As intelligence is primarily based upon pattern recognition and categorisations (abstraction) as well as hierarchical classifications (association), creativity is conceived as a quality of intelligence, assessed by the operational value of the emergent new abstractions and new pattern associations in thinking processes. Since intelligence emerges from specific sets of conditions in the human and non-human continuum mind-body - environment(s), the presence of ab-

stractions assured by the non-human intelligence, devoid of values and prejudices, constitutes a critical factor for new associations of creative intelligence.

Humanists consider prediction as one of the main traits of human consciousness, closely related to our sense of time. Prediction and even more scientific prediction is formed upon human logic. The dynamics and the complexity of the mind-body-environment(s) continuum, render prediction done by humans a somewhat questionable guide for the creation of reality. Not just because it can only be short-term, but mainly because it is based upon preexisting human stereotypes, established prejudices, actual conflicts or entrenching. Imagination, and more specifically, collective imagination is proposed as a fair alternative for the production of reality. Collective imagination, as an attribute of collective intelligence, is conceived as a vehicle towards an unpredictable and not yet 'written' future, which optimistically connotes that we are probably much more liberated than we think; a vehicle for a shift from rational thinking to speculative thinking, that by no means is an invitation to abandon our critical faculties, value references, and socio-cultural standings. On the contrary, the recourse to collective imagination is an encouragement to creatively and efficiently use the powerful tools provided by digital technologies. Pierre Levy reminds us that the significant advances in human cognition are related to inventions of media and symbolic systems. We are facing the challenge to enhance our personal and collective cognitive abilities by engaging ourselves in various intellectual cooperations to invent, innovate and create the new human reality in the 'new reterritorialised agora' of cyberspace⁷ and the techno-cultural world of the post-human era.

All the above statements, ideas, and thoughts are to be tested and critically assessed as to their operability, ethics, and tactics. Research in this emergent field is facing a significant challenge and requires at least a provisional cognitive mapping.

³For a socio-philosophical presentation of the posthuman see Pepperell, R. (2003). *The Posthuman Condition: Consciousness beyond the Brain*. Intellect Books, Portlanf Oregon, USA and Braidoti, R. (2013). *The Posthuman. The Polity*, London. For a techno-philosophical approach to the posthuman see Hayles, K. (1999) *How we have become Post-Human: Virtual Bodies in Cybernetics, Literature, and Informatics*. The University of Chicago Press, Chicago USA.

⁴For a concise investigation of the nature and the adventures of the request for novelty and its relationships with the old see North, M. (2013). *Novelty: A History of the New*. University of Chicago Press, Chicago, USA.

⁵Cf. Speaks, M. (2005). *After Theory*. In: *Architectural Record Magazine*, June 2015. New York pp 72-75.

⁶Cf. Lawson B. (1980). *How Designers Think. The Design Process Demystified*. Architectural Press, Oxford.UK

⁷Cf. Lévy, P. (2006). *Collective Intelligence, A Civilisation: Towards a Method of Positive Interpretation*. *International Journal of Politics, Culture, and Society*, Vol. 18, No. 3/4, *The New Sociological Imagination* (Spring - Summer, 2005). Springel, pp. 189-198.

This *ACHI DOCT* issue, in its effort to contribute to this mapping, invited doctoral research essays focusing on any field related to architecture and the city, where intelligence is mobilised at any scale

and stage of its theorisation and actualisation. Authors were encouraged to construct arguments for or against any idea of intelligence in general and in design in particular. The issue includes one good practice example and five essays by doctoral students worldwide.

The good practice example has been kindly offered to our issue by Professor Nicos Komninos from Aristotle University of Thessaloniki. The essay originates from a book he authored in 2015 with Routledge with the title *The Age of Intelligent Cities: Smart Environments and Innovation-for-all Strategies*. The book is the last part of a trilogy on the theme of Intelligent Cities. The current essay entitled *Alternative Architectures of Spatial Intelligence of Cities: Pathways to Innovation* continues an argument that suggests that 'the intelligence of cities is based on a series of knowledge functions which are collectively created and deployed, such as network-based information intelligence and forecasting, technology learning and acquisition, collaborative innovation, product and service promotion and dissemination'. The essay is a continuation of these arguments through an appreciation of the different forms of spatial intelligence that are activated by arrangements of knowledge functions and infrastructure into cities. The concept of spatial intelligence of cities and a quick overview of the literature on cyber, digital, intelligent, and smart cities, which points to different types of spatial intelligence, are described. The four trajectories and architectures of spatial intelligence -agglomeration, orchestration, empowerment, and instrumentation- that can be found within cities follow. Cases studies from Bletchley Park UK, Cyberport Hong Kong, Smart Santander and Amsterdam Smart City illustrate the above types of spatial intelligence. These socio-technological experiments highlight important efforts to create intelligent places and contribute to a better understanding of the many faces of spatial intelligence. Last but not least, the essay attempts to draw a synthesis of the different types of spatial intelligence by defining a universal architecture, based on variables such as the type of knowledge functions activated (information gathering, technology learning, innovation, dissemination), the type of intelligence used (human, organisational, artificial), and the type arrangements within the urban space in processes takes place.

The first essay by Alexander Liu Cheng is entitled *Machine Learning as enabler of Design-to-Robotic-Operation*. Alexander is a PhD candidate at Robotic Building, Faculty of Architecture and the Built Environment, TU Delft (Delft, The Netherlands); and Adjunct Professor / Researcher at Facultad de Arquitectura e Ingenierías, Universidad Internacional SEK (Quito, Ecuador). His essay promotes Artificial Intelligence via Machine Learning ML as a fundamental enabler of technically intelligent built-environments. It does this by detailing ML's successful application within three deployment domains: (1) Human Activity Recognition, (2) Object as well as Facial-Identity and

-Expression Recognition, and (3) Speech and Voice Command Recognition. With respect to the first, the essay details previously developed ML mechanisms implemented via supervised classifiers capable of recognising a variety of physical human activities. With respect to the second, it details three previously developed ML mechanisms implemented individually via (i) *BerryNet*—for Object Recognition; (ii) *TensorFlow*—for Facial-Identity Recognition; and (3) *Cloud Vision API*—for Facial-Expression Recognition. Finally, and with respect to the third, it details a presently developed ML mechanism implemented via *Cloud Speech-to-Text* that enables the transcription of spoken speech—in several languages—into string text used to trigger pertinent events within the built-environment. The sophistication of the so-called Machine Learning collectively imbues the intelligent built-environment with a continuously and dynamically adaptive character that is central to *Design-to-Robotic-Operation*, which is the Architecture-informed and Information and Communication Technologies-based component of a *Design-to-Robotic-Production and Operation* framework. George Tryfonos currently conducting his PhD research at the University of Cyprus that focuses on industrial robotics and fabrication with tensile – high elastic materials in architecture has contributed to this issue with an essay entitled *Automated robotic toolpath generation of elastic mesh structure*. An additive waving techniques for form-finding, MOGA optimisation, and robotic fabrication. The essay describes the development of an automated robotically-driven algorithm that can be used for the design, simulate and robotic fabrication of elastic tensile mesh structures. This approach aims to automate the process between design development and additive fabrication phases through the development of a custom-made end-effector tool for physical execution. Specifically, the suggested procedure explores a weaving elastic mesh technique, followed by an automated form-finding and static analysis investigation as well as a direct toolpath generation implemented by an industrial robotic fabrication process. Within this framework, a feedback loop between the form-finding and optimisation algorithm is investigated, which is responsible for controlling the pretension of the elastic threads, aiming to suggest optimum additives robotic tool-paths. In parallel, robot's and end-effector tool's parameters and limitations are taken into account during digital form-finding and optimisation processes. The suggested procedure aims to extend the automated robotically-driven algorithm in order to achieve accurate repeatability control of the elastic material and in turn the effective physical fabrication of complex tensile shapes.

Valerio Perna is the author of the essay entitled *Urban Environment from Smart Cities to Playable Cities. Towards Playful Intelligence in the Urban Environment*. Valerio Perna is a PhD student at Roma, La Sapienza School of Architecture. As the author suggests, in the last decade, we have seen the rise of urban play as a tool for community building and city-making, and Western society is actively focusing on play/playfulness and intelligent systems as a way to approach complex challenges and emergent situations. In this essay, Valerio Perna aims to

initiate a dialogue between game scholars and architects. Like many creative professions architectural practice may benefit significantly from having more design methodologies at hand, thus improving lateral thinking. Perna also aims at providing new conceptual and operative tools to discuss and reflect on how games and smart systems facilitate long-term the shift from the Smart Cities to the Playable one, where citizens/players have the opportunity to hack the urban fabric and use the smart city's data and digital technology for their purposes to reactivate the urban environment.

The essay entitled Architectural Intelligence is authored by Andreea Movila a PhD Student at Ion Mincu University of Architecture Bucharest. The essay documents and substantiates the notion of Architectural Intelligence, which does not refer to the emerging talks about Building Intelligence, but to the neuroscience of architecture, and what we can understand about the brain of the architect as he or she designs a building. In the first instance of the study, intelligence is properly situated within the structures of mental organization and then the relationship between the architectural intelligence -perceived as a cumulus of specific mental abilities- and the architectural thinking -as an action, the mental manipulation of the information- is analysed. The premises for an Architectural Intelligence Theory are given by the context of the Theory of Multiple Intelligences developed by the psychologist Howard Gardner that suggests that there are have several types of intelligence - (musical-rhythmic, visual-spatial, verbal-linguistic, logical-mathematical, body-kinesthetic, interpersonal + intrapersonal = emotional) and not a single general intelligence- as perceived until then (the g factor proposed by the psychologist Charles Spearman in the early years of the 20th century). Following Howard's criteria, Andreea has documented the inclusion of Design Intelligence in the realm of the Theory and has developed the connection with Architectural Intelligence as an associated construct. Architect's relationship with the world has always been constantly changing throughout history and the most pertinent question to be answered today is how we can still remain relevant in a world of fantastic changes in which the field limits are subtly absorbed by other domains. The purpose of the study is to question how the role of architecture has been evolving over time, from its primary concern as need for representativeness to nowadays unquantifiable realms that imprint the delicate relation to the new paradigm of artificial intelligence.

Last but not least, the essay by Artemis Psaltoglou, an Architect Engineer whose research focuses on urban planning, spatial development and participatory processes, and a PhD candidate at the Department of Urban and Regional Planning (AURP) is entitled "From Smart to Cognitive Cities: Intelligence and Urban Utopias". The essay elaborates on recent approaches in human intelligence that have provided us with a broader understanding about its multiplicity and its dynamic nature. As the essay argues the human capacity to imagine beyond the existing has led to the creation of utopias as a way to fantasize about future societies and future cities. The current essay explores how the concept of intelligence is reflected in urban utopias. More spe-

cifically, it focuses on two current urban utopias, which are the predominant urban visions for the digital era: Smart and Cognitive cities. The vision of smart cities, grounded in the intensive use of information and communication technologies (ICT) for the sustainable development of cities, gained a lot of popularity and a wide range of smart city initiatives have been implemented across the world.

Apart from the criticism for the technological determinism of smart cities and for endorsing a corporate vision of cities, it is argued that the dominant approach of smart cities considers intelligence as a prime technological function. Based on advances in cognitive computing, cognitive cities expand the concept of smart cities through the introduction of cognition and learning. The essay concludes with some thoughts on intelligence and the function of utopian thinking, and underlines the role of technology as one among many interrelated elements that compose our cities.

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Artificial Intelligence in Product Development

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Abstract

A great deal of practitioners in the product design and manufacturing area considers using artificial intelligence (AI) tools with an aim to provide unusual ideas in a shorter period of time. The present paper is using a series of case studies in order to provide a considerable experience in using a text-based AI platform and highlight the advantages and difficulties that is needed to be overcome in the future. The new role for the AI tools within the product development cycle is stressed, while their use together with the design methodologies and the technological tools became clear. The output of these tools is mainly images that cannot be parametrically controlled and further substantial work is needed for creating the 3D models of these proposals.

Keywords

Product design; computational design; packaging design

Introduction

Artificial Intelligence (AI) has a great deal of development the last few years and its implementation is spreading to more and more applications and professions. Especially professionals in the programming computers industry are greatly affected. Education related activities have been evolved and as a result education is towards finding a new role for the use of AI (Spahiu et al, 2021b). Product development, graphical and animation applications, packaging design, corporate optical identity and product branding are some of the areas that Artificial Intelligence can play a key role, when applied, following the appropriate strategy. AI as a tool can greatly be combined with a series of methodological and technological tools used currently and thus enhance their ability to promote productivity and innovation. Additional tools such as computational design, parametric design, design automation can make use of

AI applications that can improve the time needed for product and packaging development, while improving the design engineers' capability to offer innovative solutions and proposals (Dobras et al, 2021; Manavis et al, 2022c; Malea et al, 2020). The main direction proposed is to use all the AI tools together with the process design and the design thinking approach. The term design process implies that there is a series of steps (determine objectives and constraints, prototyping, testing, evaluation etc) that the design engineers follow, with an aim to find a solution to a problem, that is set from the user (in this case the product is at the center of interest). As far as it concerns the design thinking methodology, the team of experts participating follow a non-linear and iterative approach in order to understand the users. They challenge the assumptions, redefine problems, create innovative solutions that are prototyped and

tested. In this case, the problems with difficult or incomplete definition are selected and in the center of interest is the experience created, when using a product. When these methodologies are applied, the use of words and images play a key role in the creativity development procedure and the AI tools can greatly affect and support this role (Manavis et al, 2023). At the same time, digital manufacturing and Industry 4.0 applications are supported and are made a lot more efficient. Computer Aided Design (CAD) based applications that deal with the creation of automatic product design, aim to support the new role of the design engineers and help the users to get customized products by participating in the design process. Digital optimization of geometries among a great deal of proposals under the same family of forms can increase drastically the customer satisfaction when it is used (Kyratsis et al, 2021; Spahiu et al, 2021a).

Branding and brand identity building is greatly supported by images and text. These are the main characteristics used in AI platforms, where the design engineer inserts words or complete paragraphs and the outcome is images. These images can be used for increased inspiration within the methodological tools used. For example, when a mind-map is built the images produced from an AI platform can offer a great deal of pieces

of information and characteristics. Additionally, a mood-board can be far more impressive and effective, when images from an AI platform is used. The same is true in a variety of other tools and creative exercises that design engineers follow for increased inspiration (Manavis et al, 2022a). The creativity tools offer a great deal of flexibility to design engineers and out of a large number, that constitute a toolkit, the appropriate tool can be selected. They use a variety of inputs for collecting effective and high value outputs. For gathering inspiration, text can be used as input, for the Play+Make category images are used, for generating ideas the sketches provide a solid ground for visualize the proposed ideas and for building prototypes a number of different materials are used. Figure 1 provides an overview of the toolkit proposed for applying both the design process and design thinking methodologies during product design (Manavis et al, 2022b). The present paper aims in discussing the new role of the design engineer that needs to incorporate effectively the newly provided tools that are based on AI with the creativity toolkit offered for both the design process and the design thinking methodologies. At the same time, some case studies will be presented in order to discuss the opportunities opened in the future and answer the question “What is the role of AI when applied as a creativity tool?”.

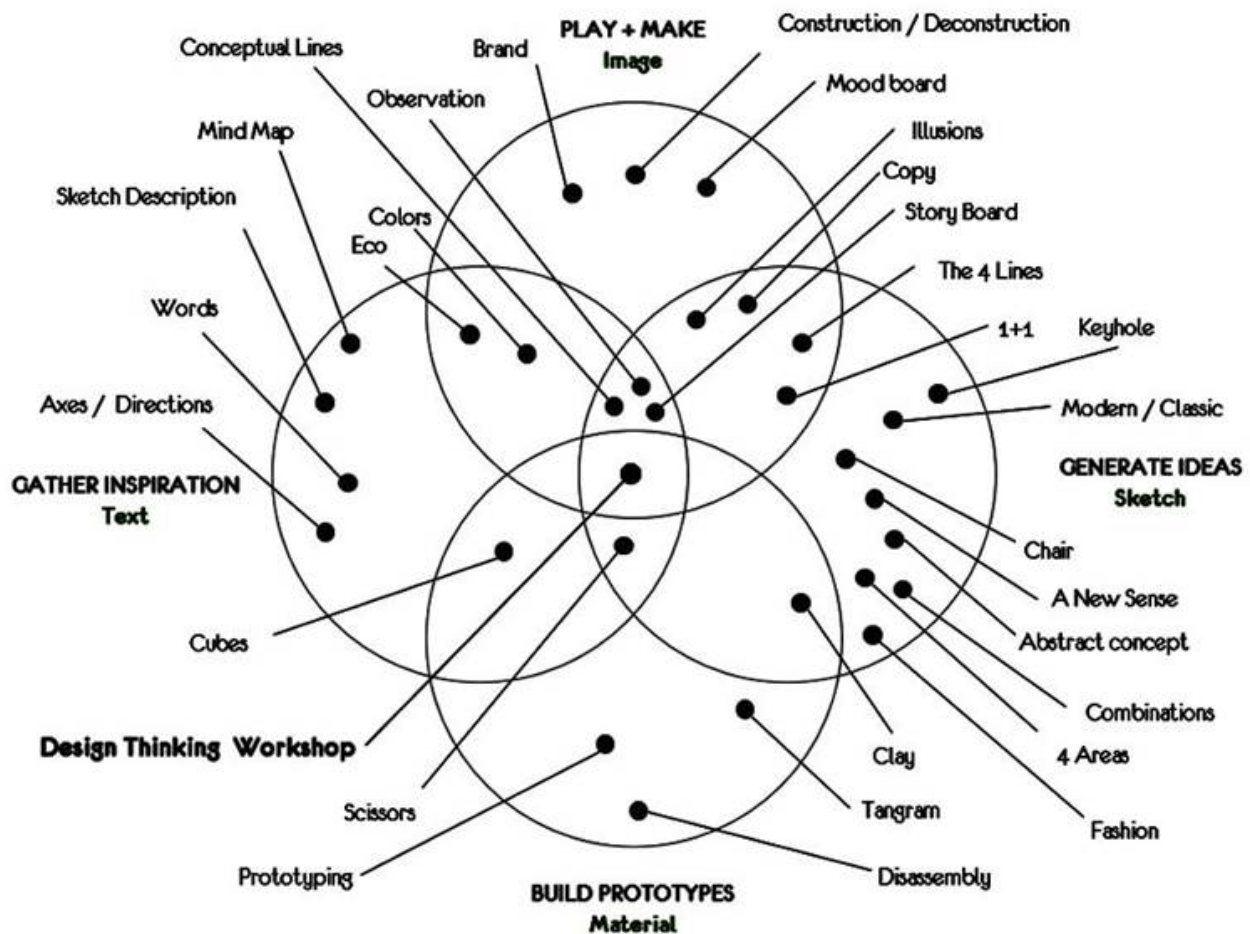


Figure 1. Creativity toolkit used by the design engineers

Methodology proposed and case studies

The main question when AI platforms are to be used is: do we need the information-based tools (like AI based tools), or the inspiration-based tools, i.e., methodological tools with the participation of the design engineer?

The role that the AI can play in the product development can lead to different directions:

- find novel ideas and provide alternative sources of inspiration,
- create new geometrical forms for products that are more likely to be innovative and successful in the market,
- produce more reliable and robust products that are less likely to fail when sold, and
- optimize the final versions of the products based on certain criteria that are relevant in each case.

This is the way to answer that in this newly formed digital age in product design, the information should be combined with the inspiration. The designer with the AI technology should work together in a supplemental way and produce far more improved solutions and products to the users, thus increasing their perception for the experience offered. The www.midjourney.com platform was used, under a payable subscription for creating a series of case studies, that can depict how the tool works and offers unusual images for inspiration purposes. This tool is an AI platform that can generate images based on text input. When feeding the AI platform with a set of words, images are the set received. The design engineer is able to refine the ideas generated from the images and receive an alternative proposal that is based on the design direction selected, keeping in mind the initial text included. This process can continue with an aim to improve the designs.

Case study in finding sketches and forms

The text used included: product design, sketch, biomimicry, morphology. The results were depicted in figure 2. The top left set of four images was the first output based on the text included and the top right set of images was the result after the refine procedure requested. The bottom image was the one selected based on the design engineer's opinion to be used further with the rest of the methodological tools provided.

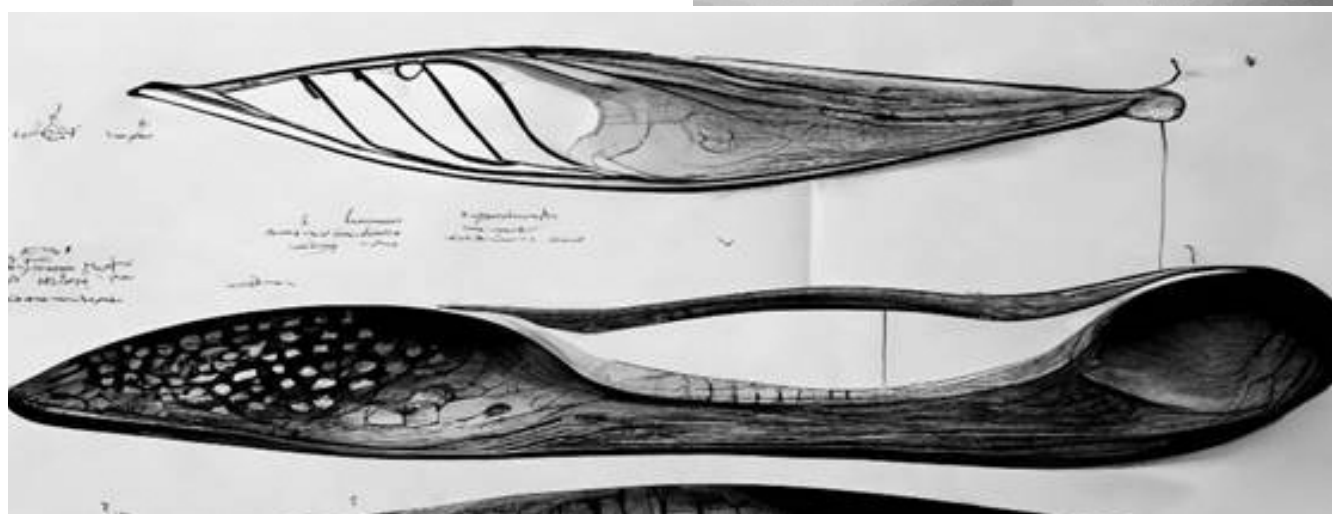
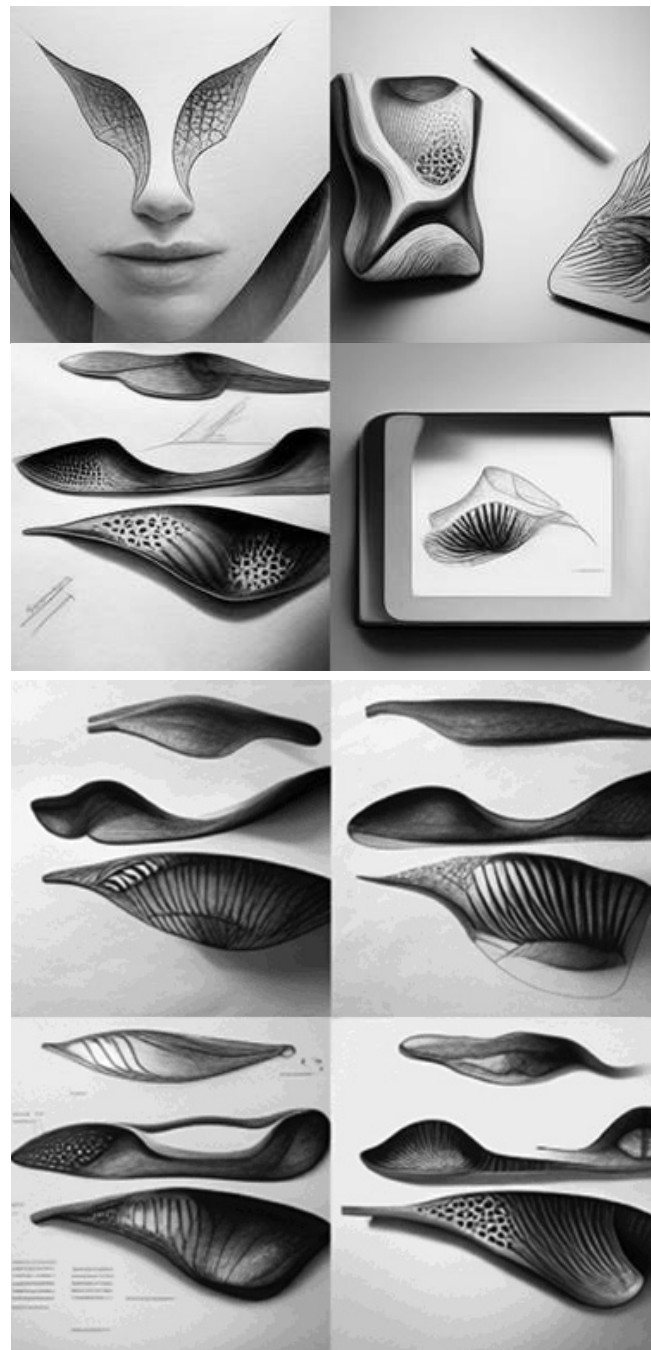


Figure 2: Results from the AI tool when specific text was used (product design, sketch, biomimicry, morphology)

Case study in product design

In this case study, the text used included: chair, leaves, veins, bending, pattern. The results were depicted in figure 3. The top left set of four images was the one that provided the directions that the design engineer can follow.

Then the top right set of images was the result of the refinement process. At the end, the proposed form to be used with the rest of the design methodological tool is depicted.

Figure 3: Results from the AI tool when specific text was used (chair, leaves, veins, bending, pattern)



Case study in packaging design (structure)

The packaging industry is one of the most creative industries and results in packages that ensure that the customer will select the product from the selves. It must attract or make an impact when the customer sees a specific product among a great deal of others that are nearby. It is a very competitive market so more design and inspiration tools are used. The AI platform was used with another set of text: product design, packaging, biomimicry, morphology. The result is depicted in figure 4. Again, a set of very impressive images were presented. Some of them stressed the idea of incorporating the principles of structural design for these proposals (left hand side) and some were more into the graphics design direction (right hand side). Further refinement could lead to more proposals based on the direction that the design engineer needed to satisfy the user demands and needs.

Case study in packaging design (shape)

In an effort to find new ideas for bottle-based packaging design, a new set of text was used: product design, packaging, bottle, biomimicry, veins. In this case again, some proposed ideas were based on the graphics design point of view (left hand side) and the rest fit better towards the structural design of bottles with improved and unusual geometries (right hand side). Further refinement can be used in order to provide more alternatives in both the directions i.e., graphics and structural. The images produced should later be transferred to 3D CAD models. This is something that the proposed AI platform did not provide this capability at present.



Figure 4: Result from the AI tool with the following text: product design, packaging, bottle, biomimicry, veins



Figure 4: Result from the AI tool with the following text: product design, packaging, bottle, biomimicry, veins

Conclusions

The new role that AI has to play, when product and packaging design is of interest was covered in the present paper. Extensive use of case studies provided a significant experience of the input and output taken, when an AI platform was used. The refinement capability of the different images produced offered more options and details for innovation and effective design. Unusual geometries were depicted in 2D and unfortunately 3D models were not received from the tool. This means that an extra effort from the design engineer was needed to model these complex geometrical forms.

The images produced can be used as a source of inspiration or guidance when methodological tools are used i.e., mind-map, mood-board, CAD-based sketching, storyboard, vector-based design, computational product design, topology optimization techniques, parametric design. Another difficulty encountered was the fact that for the same text input, different outputs was received every time. This can be an opportunity for more inspiration but at the same time proves, that the design engineer cannot control parametrically the output received. Reproduction of the steps followed can take place and this is something that creates additional difficulties in the product development cycle. Finally, it is the authors opinion that the new role for these AI-based tools is to be used together with the toolkits provided by the design methodologies and the other design/manufacturing technologies. They can be supportive to the mainstream product development roadmap and increase the efficiency of discovering new product development design directions.

As a future work proposal, more case studies should be developed and being assessed because researchers and design engineers should get more experience in how to combine the use of AI-based tools, design methodologies and design technologies.

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Designing Tomorrow: AI and the Future of Architectural Design Process

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Abstract

This essay explores the transformative role of Artificial Intelligence (AI) in the field of architecture, focusing on the impact on design innovation, production processes, as well as the ethical implications arising from inherent biases within these technologies. As AI becomes increasingly integrated into architectural practices, it offers the potential to revolutionize the discipline by enhancing efficiency, creativity, and sustainability. This investigation delves into the history and evolution of AI in architecture, tracing their journey from early computational design experiments to their current applications in generative design and robotic construction, which exemplify the shift towards more innovative and sustainable architectural practices. Furthermore, the essay highlights the involvement of the INNEN research team in integrating AI into academic and research activities within and besides the curriculum. It delves into the ways in which AI technologies are reshaping the boundaries of architectural design and construction, emphasizing on practical applications of AI in architectural design in education and professional work. This analysis uncovers the profound possibilities of AI in formulating groundbreaking design approaches and construction methods, underscoring research's role in propelling architectural thinking and practice forward through the use of technology.

Keywords

AI; architectural design; transformation; sustainability; innovation

Introduction

Current trends, available tools and methodologies used by architects have a prevalent impact on the way the built environment is designed. The use of digital tools by architects is not a new concept and started in the 70's, with the introduction of CAD software. Ever since, the architecture design toolkit has been constantly updated with new computational methods that have been enabling higher complexity and efficiency during the design process. Nowadays architects use specific tools tailored to their needs spanning from 2D and 3D design to rendering and BIM software (Cudzik et al,2018,77-84). The rise of artificial Intelligence (AI) technologies is providing significant improve-

ments in several scientific fields including architecture. AI applications in architecture are manifested through many different forms, from producing intricate blueprints and visualizations to generating endless variations of architectural forms. In addition to the revolutionary possibilities in design and manufacturing processes, this integration highlights an urgent need to address social, cultural and ethical biases embedded in the data driving these technologies. The aim of this essay is to investigate the intricate involvement of AI in the area of architecture, looking at both the ethical implications of these technologies and their potential for transforming the design and construction field.

Background

The architectural sector is experiencing a significant transition towards creative, effective, and eco-friendly design methodologies with the incorporation of AI, robotics and other state of the art applications. The origins of these advancements can be found in the early computational design experiments of the mid-20th century, when pioneers started investigating how computers can improve architectural creativity and design. Improvements in technology over the years have driven the industry into new areas, with robotics and artificial intelligence now being key components of everything, from the conceptual design phases to the actual construction process. AI and related applications are currently being used in architecture in a wide range of innovative ways. Generative AI platforms are being used by architects and creatives across disciplines to create elaborate images from simple text descriptions. The simplicity and efficiency of these new AI tools makes them easy to use through the concept design procedure. Such a process could be paralleled to the early stages of architectural design that involves multiple data collections from different sources, sketching, concept creation and finally design and modeling. (Ploennigs, 2023). Despite its many advantages, designing architecture using conventional design methods poses multiple challenges as it involves a significant amount of manual drawing and design modifications resulting in low efficiency.

The most popular AI platforms today are mainly diffusion models and they could assist in addressing the low efficiency in architectural design. These diffusion models are trained by learning from large datasets in order to be able to generate diverse images based on text descriptions. (Chen et al, 2023). However, current AI applications such as Stable Diffusion, Midjourney, and DALL-E 2 do not come without limitations, especially in architectural design, as these models, regardless of their extensive training datasets lack the ability to generalize, create, and simulate abstract information and are not capable of perceiving semantic information. This might, for example, include the meaning of line thickness in a floor plan, or an architecture style element in the generated architectural design. Thus, along with the rapid progression of AI enhancements in educational models and strategies in architecture, designers capable of effectively utilizing these tools with critical thinking should be cultivated. (Zhang et al, 2023, 1863). The idea for these diffusion models was first introduced by Sohl-Dickstein in (Sohl-Dickstein et al, 2015, 2256-2265). The main concept was to systematically and slowly 'destroy' the structure in a data distribution (i.e. image) through an iterative forward diffusion process that inserts noise into the data and then with a reverse diffusion process to 'restore' structure in a new form. This reverse process generates completely new (image) data, as the original structured information was fully destroyed and rearranged. (Sohl-Dickstein et al, 2015, 2256-2265). Under the prism of architecture design, stable diffusion models might reflect intriguing parallels with conceptual principles underlying the architecture of deconstructivism, as we know it from the

relevant architectural discussion. In both cases, there is a deliberate emphasis on the controlled deconstruction, redistribution and organization of elements within a system. An insightful approach might point out that, just as stable diffusion models aim to evenly distribute data within a given space, deconstructivist architecture has been seeking to challenge traditional notions of form and structure by fragmenting, dispersing, and reassembling architectural elements in unconventional ways. As a concept of architectural design, Deconstructivism is not perceived as demolition but rather an enhancement of the structure by challenging the values of harmony, unity and stability. It instead proposes an approach of a structure that embraces its 'flaws', by creating new, skewed geometric compositions. (Johnson et al, 1988). Assessing architecture designs generated by AI presents a unique challenge. Unlike traditional 'hand-made' architectural designs created by human architects, AI generated designs may lack historical and cultural context, as well as practical feasibility. Evaluating the aesthetic appeal and functionality is also difficult as these models produce images based on learned patterns and large data rather than human intuition and preferences. There are studies aiming at assessing the quality of architecture designs produced by AI in comparison to human-made designs with selected evaluation metrics such as Authenticity, Attractiveness, Creativity, Harmony, and overall Preference as Zhang suggests, (Zhang et al, 2023, 1863), some of the values deconstructivism was trying to break away from, raising concerns of how valid could such metrics be as global design evaluation metrics. The study highlighted that AI produced designs exhibit a competitive performance in terms of attractiveness and creativity but was limited in achieving unique attributes of human designs, therefore lacking authenticity and harmony. This is highlighting the inherent subjectivity in design and stressing that individual aesthetic preferences are pivotal in design perception.

Other studies focusing on urban design and the built environment evaluated AI models on their ability to handle challenges in urban design and planning. The findings suggested that the tested AI model was able to effectively generate images in multiple settings of the built environment, including natural real-world or abstract representations. However, it showcased weaknesses in creating realistic scenes with a high level of detail and struggled with compositionality in some scenes. Overall, the assessment revealed that 'text to image' AI models can satisfy the need of speeding up the design process of certain disciplines (such as graphic design and artistry), but for scientific design disciplines, such as urban planning and design, it indicated that further domain-specific research may be required. (Seneviratne et al, 2022). These findings highlight that existing AI concepts may not be fully applicable in architecture and its design procedure. A lot of research done so far in the design field, reuses tools developed to solve other problems. This raises critical questions about similarities of the nature of a design problem to the ones such algorithms were developed for. These point

to the need for a more intentional and tailored utilization of AI design tools, so as to cater to diverse aesthetic preferences. Furthermore, it stresses the need of developing new AI tools specifically for solving design problems. (Zwierzycki, 2020). Even though the discussion is mainly focused on generative text to image AI models, these aren't the only AI tools that could be utilized within architecture and design in its several stages. Aside from image representations, AI models can assist in structural analysis and optimization, automating drafting processes, material selection and many more. Moreover, despite the 'text to image' tools' popularity, text is also not the sole input to such AI models. There are also 'image to image' and 'sound to image' algorithms amongst others. Specifically, 'sound to image' algorithms could potentially further enrich the design process by enabling architects to translate auditory stimuli from the built environment into visual representations, thus enhancing overall spatial awareness during the design process. In a similar vein, robotic technologies, further fueled by AI capacities, are transforming the building industry. Over the past few years, construction robots have been present in construction due to recent developments in microprocessors, low-cost computers, sensing technologies and AI techniques amongst other innovations. Several case studies have demonstrated the advantages of construction robots in steel and wood structure welding, interior and exterior inspection and maintenance and material handling. However, the adoption of robotics in the construction and design industry still faces many challenges due to the unique characteristics of the construction and design process. (Heyaojing et al, 2023). In the broad spectrum of emerging and innovative computer-related technologies, robotics is one of the most promising advancements of the Architecture, Engineering and Construction industry (AEC) transformation. Nowadays, the application of robotic methods is growing in architectural design and construction in a diverse manner ranging in a variety of scales, the automation of processes, 3D printing and self-assembly architecture. Robotic advancements are increasing building efficiency, decreasing waste while enabling the creation of advanced architectural morphology. Despite the active employment of robot machines and technological advancements on the engineering side of AEC, it is still new to architecture and building design and raises challenges of proper use in order to exploit the full potential of such technologies in the respective sectors. (Yi, 2021). The evolution in architecture toward robotics and AI reflects an overall shift towards embracing digital innovation to address modern issues. Apart from contributing to improving the skills of architects and designers, this change has the potential to completely rewrite the rules of what is conceivable in terms of architecture, liberating energy and potential to an era in which design will be more inclusive, sustainable, and responsive to the changing demands.

Academic Courses

As the use of new technologies and artificial intelligence (AI) continues to increase, INNEN's research team, led by Profes-

sor Anastasios Tellios, at School of Architecture, Aristotle University of Thessaloniki (AUTH), has been experimenting with AI tools in design courses and participated in research projects utilizing such technologies. This active involvement showcases a commitment to integrating state-of-the-art technological advancements into the academic and research domains of architecture. Through dedicated courses such as the 'Spatial Investigations' design studio, students were introduced to a curriculum that encouraged experimentation with current 'text to image' and 'image to image' AI tools. The objective was to articulate proposals for different design agendas, including smaller scale object design, design of interior spaces, urban design as well as experimental abstract solutions in order to assess the usability and efficiency of AI tools in different scales and contexts. The course required the articulation of a consistent narrative and suggested the use of several means like text, sketches, collages etc, which, through the use of AI tools, would create image representations of their spatial stories. In further steps, images produced from AI were used either as inspiration or blueprints for the 3D modeling of their proposals. This included the use of parametric design tools and automated design methodologies. The spatial models produced were afterwards articulated and fabricated as physical models as well, requiring additional 3D optimizations that would allow the models' printability. The overall design process showcased great potential in the conceptual development of design as student work produced very diverse projects despite the common origins. However, it also highlighted several weaknesses. On larger scales AI tools have been challenged to produce useful representations and fragments of such spatial images were rather preferred and put together at a later stage manually. Moreover, it also raised the issue of 2D to 3D transforming and the loss of semantic information within the generated design product. In general, this initiative not only equipped students with valuable technological proficiency but also fostered an environment that encouraged innovation and creativity, positioning them at an updated position within the related discourse.

Research Projects

Besides academic curricula, the INNEN research team's have further focused on implementing innovative technologies through participation in numerous European research projects. These initiatives, funded mostly by the Horizon frame by the European Commission, demonstrate how essential international cooperation is in advancing architectural research and practice. Projects such as V4Design, MindSpaces and ReSilence represent an example of the research activity co-implemented by INNEN. They all include various applications of advanced technology, parts of AI modules and attempts to relate to architecture, among other fields, and improve the architectural procedure. The 'V4Design' initiative aimed to integrate state of the art technologies in order to transform visual and textual data into 3D models and designs. This program sought to reinterpret existing visual materials, such as paintings, photo-

graphs, and videos, into new architectural and design inspirations, resembling and simulating the way AI tools operate. This innovative approach enhanced creativity and innovation in the field. ‘MindSpaces’ focused on the intersection of technology, architecture and the arts to create immersive and responsive environments. These environments were able to adapt to the emotional and cognitive states of their participants. By exploring how AI-driven modules can tailor architectural and urban spaces to human needs and experiences, MindSpaces encourages a more intimate connection between the built environment and their users. ‘ReSilence’ uses new technologies such as AI & XR to explore the borders between noise and music in the rapidly changing environments by producing acoustic awareness in urban spaces. In ReSilence technological applications including AI tools are utilized in several domains such as natural language processing as well as ‘sound to image’ translation in order to visualize sonic stimuli of urban spaces. Additionally, the project aims at creating new types of sonic urban experiences that expand possibilities for accessibility, active participation and engagement, sustainability, and social inclusion. Additionally, the ‘ReSilence’ project requires the involvement and collaboration of artists, which is considered as pivotal in order to establish interdisciplinary collaboration schemes, exploiting the full potential of AI and XR technologies.

Conclusion

In conclusion, this essay tries to discuss the yet undisclosed intersection of AI as well as other state-of-the-art technologies with architecture. It explores the evolution of technologies from their foundational role in computational design to its transformative impact on modern architectural practices and construction. This exploration uncovers how AI and state of the art procedures not only enhance design and construction processes through innovation and efficiency but also to point out conceptual and ethical complexities and biases yet uncovered and not fully evaluated. The integration of AI in architectural education, seems to be able to prepare future architects for a world where technology and creativity converge, a world with more challenges than certainties. Technology and advances can definitely transform architectural design, they have done so repeatedly in the last decades. Wishfully, they would be directed towards a more sustainable, more inclusive, and more human-centric built environment. However, this future necessitates a balanced, resourceful approach that takes into account ethical dimensions of technological integration. Collaborative efforts of educators, researchers, and practitioners play a vital role in shaping an architectural landscape that harnesses the power of technology while remaining grounded in ethical principles. The work of the INNEN is aligned with current discussion on the topic and operates towards positively exploiting new tools in the design process of innovative, dynamic, thoughtful environments. In this framework, this essay attempts to provide guidance for navigating the complexities of technological frontiers, AI among others, with foresight and responsibility.

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Start making sense. AI, Automata and the Conquest of Space

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The rapid development of artificial intelligence tools during the last years, and more importantly, the availability and ease of use of such tools for architects, designers and artists have raised questions about the ways in which they affect current creative practices. Opinions of course vary, from understanding AI as just another set of tools at the disposal of the designer to desperate warnings that generative AI tools could signify the death of the creative process as we know it. The use of automated processes however is not something new; on the contrary, tools that automate a smaller or larger part of the creative process have a long history within which we can find examples that might help us to better understand current processes as they are formed with the proliferation of AI tools.

Xenakis and Automata

In 2005, Makis Solomos, one of the most prominent scholars of Iannis Xenakis' work, publishes his article "Cellular Automata in Xenakis Music. Theory and Practice"¹. Iannis Xenakis, who apart from being an accomplished musical composer had been educated as an engineer and worked for more than ten years with Le Corbusier, has employed several times computational models as part of his compositional methods. In fact, it would be reasonable to argue that even those of his compositions that predated the use of computers are following approaches that are in essence algorithmic. In his article however, Solomos is analyzing two of Xenakis' later compositions, namely Horos² and Ata³, where cellular automata are utilized to generate part of the musical score.

Xenakis himself notes in a very brief passage from the Preface to the Pendragon Edition of his 'Formalized Music' book: "It is on the basis of sieves that cellular automata can be useful in harmonic progressions which create new and rich timbric fusions with orchestral instruments"⁴. Solomos' article, as he

states in the introduction, has three main aims. The first is to try and locate the reasons behind Xenakis' decision to use cellular automata in the first place. The second is to analyze the implementation of cellular automata in one specific example, namely that of Horos. And finally, the third part is a reflection on the notion of theory, as one that has an important place in the body of Xenakis' work. Concerning the first aim, Solomos is locating two main reasons that might explain why Xenakis makes use of cellular automata. The first one is rather practical. It is their ability to generate complex and rich output that can be used to generate sound qualities, from very basic and simple rules: "They are very simple rules which can create structures on very large surfaces [...] I was also attracted by the simplicity of it: it's a repetitious, a dynamic procedure which can create a very rich output". Therefore, Xenakis is using cellular automata as a tool that helps him generate variability and complexity. One can easily identify a reasoning very similar to the one behind the use of AI tools today. AI tools can indeed provide a starting point for any creative process and generate an abundance of ideas in a relatively small amount of time. The second reason identified by Solomos, however, is more interesting and is based on the idea of the automaton: "It is well known that Xenakis took a great interest in automata. [...] The idea is related to 'formalization', which has several meanings in Xenakis' thought and practice. One of its meanings is the idea of 'mecha-

¹Makis Solomos, "Cellular Automata in Xenakis' Music. Theory and Practice," in *Definite Proceedings of the International Symposium Iannis Xenakis (International Symposium Iannis Xenakis, Athens, 2005)*.

²Iannis Xenakis, *Horos, Orchestral Works, Vol. 3, 1986*.

³Iannis Xenakis, *Ata, Orchestral Works, Vol. 4, 1987*.

⁴Iannis Xenakis, *Formalized Music: Thought and Mathematics in Composition, 2nd edition (Stuyvesant, NY: Pendragon Pr, 2001)*, xii.

⁵Solomos, "Cellular Automata in Xenakis' Music. Theory and Practice."

nism'.⁵ Particularly, Xenakis employs the term 'mechanism' when he comments on the use of computers: "everything that is rule or repeated constraint is part of the mental mechanism. [...] Just as the wheel was once one of the greatest products of human intelligence, a mechanism which allowed one to travel faster and faster with more luggage, so is the computer, which today allows the transformation of man's ideas"⁶. For Xenakis therefore, the automaton is something that operates like a mechanism that carries the ability to transform (ideas, sounds, etc). Solomos continues his analysis by employing Varela's distinction between Von Neumann's and Wiener's approach to computation, and consequently their different understanding of the concept of the automaton. The first is based on the idea of the command, of the black box. The second is based on the idea of autonomy.⁷ Solomos concludes this part by stating that in principle, Xenakis' conception of the automaton is closer to the idea of autonomy.

In the second part of the article Solomos analyzes Horos and the ways in which cellular automata were used during its composition. After a thorough analysis of the score and of the role that cellular automata played in its generation, Solomos verifies that Xenakis used cellular automata to generate sieves. However, in the end of the process Xenakis takes great liberties at manipulating the results of the automata, by altering them, making local changes, and smaller or larger manual adjustments to the automatically generated score. Indeed, this is something that characterizes Xenakis' approach to composition at large: "All the Xenakis' specialists, when working in the field of the concrete analysis of works using formal procedures, have noted that the composer takes liberties with formal models, and introduces 'licenses', 'gaps'. In other terms, his use of formalization is mediated through manual interventions. These interventions [...] affect not only the musical implementation of the formal system, but also its construction".⁸ Xenakis' approach to the usage of models like cellular automata in composition, is always mediated by his manual interventions. That holds true for all the different procedures that he employed throughout his career: whether stochastic processes or game theory, group theory or sieve theory, Xenakis was always having the last (manual) word. He intervenes and adjusts or transforms the results, usually employing his musical criteria, in such a way that he undermines the integrity of the generative processes. The adjustments he makes to the output generated by the cellular automaton, not only differentiates and alters it, but in effect goes against the internal rules of the system he uses. In other words, it would appear that the autonomy of the system is compromised.

Solomos describes Xenakis' common practice to deliberately alter the results of the formal models that he employs as bricolage. Bricolage is a term that, as analyzed by Claude Lévi-Strauss,⁹ refers to an intermediate condition between what he calls the mythical and the rational. The 'space' that exists between the magical and the scientific. In fact, Lévi-Strauss claims that art is always an operation through bricolage. In the case of Xenakis, bricolage is a technique that combines

the output of the formal model that he employs, in the case of Horos the cellular automata, (the rational or scientific) with his intuition or musical intention (the mythical or magical). Or, to be more precise, it is not so much a combination, as it is a transformation, or a modulation, of the output of the formal model through the personal and of course highly subjective filters of the composer. Solomos is based on Xenakis' use of bricolage to justify his first conclusion: The composer's process cannot fulfill the concept of autonomy because of the manual interventions that he performs: "Xenakis' manual interventions are very important; sometimes they destroy the nature of cellular automata. And, of course, they are far away from the idea of something that works alone, of an automaton, from which an autonomous meaning emerges".¹⁰

The Importance of 'Comprehension'

One would be tempted to draw quick conclusions by observing the obvious parallels between Xenakis' use of cellular automata and bricolage, and the ways in which we are employing AI tools today as part of creative processes. Indeed, what for Solomos is Xenakis' compromise of the idea of autonomy, namely bricolage, could be seen as a creative way to deal with AI tools while at the same time keeping control over them and imposing the personal 'vision' of the creator. Various tools that employ artificial intelligence can become part of that process of bricolage; in other words, they can be subordinated to the will of the artist/designer/creator. Let us, however, consider a different approach before we draw any such conclusions.

In 1962, Hannah Arendt wrote an article that was taking part in the at the time current discussion concerning the 'conquest of space'; the ability of man to travel beyond the limits of the earth. The article, which was published a year later as part of the collection of essays under the title "Between past and future",¹¹ is a much more general reflection upon the concepts of science and technology. In it, Arendt explores the implications of space exploration on human society and individual identity. She argues that while the conquest of space represents a remarkable achievement of human intellect and technology, it also poses significant challenges to our understanding of human existence, as well as to our understanding of non-human entities. She argues that modern science has changed the meaning of notions like life, man, science, or knowledge to "such an extent that they no longer make sense".¹² Modern science for Arendt "has changed and reconstructed the world we live

⁵Xenakis, *Formalized Music*, 132.

⁷For more details on the two opposing directions that defined the development of computation at its early stages and which are represented by John Von Neumann and Norbert Wiener see Gourdoukis, D. "Variability: Architecture and its Fight against Chaos and Opinion" in *ArchiDOCT 15*, vol 8(1), July 2020.

⁸Solomos, "Cellular Automata in Xenakis' Music. Theory and Practice."

⁹Lévi-Strauss, *The Savage Mind*.

¹⁰Solomos, "Cellular Automata in Xenakis' Music. Theory and Practice."

¹¹Arendt, Hannah. *Between Past and Future: Six Exercises in Political Thought*. New York: Penguin Classics, 2006.

¹²*Ibid.* p.268

in so radically that it could be argued that the layman and the humanist, still trusting their common sense and communicating in everyday language, are out of touch with reality”¹³. In other words, common people (ie non-scientists) can understand only appearances; they can comprehend the results of scientific processes and not the principles behind them. That idea of comprehension is very important for Arendt. She goes on to explain that machines that supplant human brain power are no different than those that support labor power and she supports that claim by quoting a letter from John Gilmore: “During the last several years we have in fact succeeded in writing computer programs that enable these machines to exhibit behavior that anyone not familiar with the makeup of the programs would unhesitatingly describe as intelligent, even highly intelligent. Alex Bernstein, for example, has devised a program that enables a machine to play spectacular good checkers. In particular, it can play better checkers than Bernstein. This is an impressive achievement; but it is Bernstein’s and not the machine’s.”¹⁴ In other words, according to Gilmore (and Arendt) the intelligence exhibited by machines that can mimic the function of the human brain, even when doing so much more efficiently than humans, is in fact intelligence related and attributed to the one that created the machine and not to the machine itself. For Arendt that stems from being able to understand how the machine works: We know the rules behind checkers, we know that to play checkers we need to follow those rules and anticipate future actions that derive from them, and we fully understand that the computer is doing the same, albeit faster and more efficiently.

For Arendt however, there is a break in this line of thinking when ‘understanding’ is absent: “There are, however, scientists who state that computers can do “what a human brain cannot comprehend,” and this is an altogether different and alarming proposition; for comprehension is actually a function of the mind and never the automatic result of brain power. If it should be true and not simply a case of a scientist’s self-misunderstanding—that we are surrounded by machines whose doings we cannot comprehend although we have devised and constructed them, it would mean that the theoretical perplexities of the natural sciences on the highest level have invaded our everyday world.”¹⁵ The problem arising from the above observation “is that man can do, and successfully do, what he cannot comprehend and cannot express in everyday human language.”¹⁶ The lack of the ability to comprehend and express through human language (which for Arendt is the same thing since she believes that we can only comprehend what we can express through language) is what takes automated computational tools to a different level that moves beyond what is essentially human.

In Xenakis’ example and his use of cellular automata, comprehension is still in place. He fully understands the rules of the cellular automaton. Xenakis programmed his computer to follow those rules, and even when the calculations are too complex to carry out without a computer, he can still understand and follow them. However, is that true for generative AI tools? One could argue that the users of such tools cannot really comprehend everything that they do. That is certainly true when one

uses tools that do not give access to the code that supports them. Most tools that we employ today fall in this category. However, AI might be moving beyond our comprehension even when we have access to the code or for that matter even when we are using tools that we trained or created ourselves. AI tools are operating through references; an almost infinite number of references that are then used to generate something new. However, while using references is a very old and common creative process, in the case of AI tools we can’t trace those references back, and we can’t see how they are combined and altered. In other words, we cannot fully understand how the results are produced, even if we know the general principle or the rules that the AI model follows in order to learn.

Xenakis Revisited

Going back to Solomos’ article on the work of Xenakis with cellular automata, it is interesting to see his conclusion. While he determines that Xenakis’ approach does not follow the model of autonomy, because of bricolage as we explained above, he also claims that his approach does not follow the model of ‘command’ either. He uses the concept of ‘theory’ in Xenakis’ approach to justify the later observation: “if cellular automata are comprehended as ‘theory’ [...] as independent, in the musical level, of a practice, then they are working as black boxes: they are only used to produce interesting sonorities, and it is why there are a lot of manual interventions. But if they are comprehended as *theoria*, something remains from the model of autonomy to which they are related by their nature.”¹⁷ Solomos is using the word ‘*theoria*’ here to signify the etymological meaning of the word ‘theory’, through its Greek origin. *Theoria* in this sense can be ‘translated’ as point of view.¹⁸ For Solomos, Xenakis’ theories are never theories in the ‘traditional’ sense of the word: that of “a system of rules, procedures, and assumptions used to produce a result”¹⁹ which are coherent and are operating autonomously within themselves. Instead, theory for Xenakis is *theoria*, a point of view, and as such is always related to a practice. It is not an attempt to create a generalized theory that can achieve a universal status. It is instead a specific point of view in relation to the specific case that is at hand. In other words, Xenakis’ theories are processes created and employed in specific applications, and they work only in the context of those applications. In the case of Horos for example, the cellular automaton is a point of view towards the

¹³*Ibid.*

¹⁴*Ibid.*

¹⁵*Ibid.*

¹⁶*Ibid.*

¹⁷Solomos, “Cellular Automata in Xenakis’ Music. Theory and Practice.”

¹⁸“From Middle French *théorie*, from Late Latin *theōria*, from Ancient Greek *θεωρία* (*theōria*, “contemplation, speculation, a looking at, things looked at”), from *θεωρέω* (*theōréō*, “I look at, view, consider, examine”), from *θεωρός* (*theōrós*, “spectator”), from *θεά* (*théa*, “a view”) + *όράω* (*horáō*, “I see, look”).” “Theory - Wiktionary,” accessed March 7, 2016, <https://en.wiktionary.org/wiki/theory>.

¹⁹“Theory,” *Collins English Dictionary – Complete and Unabridged, 1994, 1998, 2000, 2003 1991*, <http://www.thefreedictionary.com/theory>.

production of sieves. But then, if we adopt this attitude towards the concept of theory, we cannot dismiss Xenakis' approach as unrelated to the model of autonomy. The productive system in Xenakis' compositional methods does not consist solely of the formal model used, in the case of Horos the cellular automaton, but instead includes the composer as part of the system. The cellular automaton becomes an autonomous generative system only when understood as a point of view, through Xenakis' eyes. The manual interventions performed by Xenakis allow the closed, self-referential nature of the computational model to open up and become part of a larger assembly that includes the composer. Equally, if we understand AI supported processes as 'theorias', as points of view, we might be able to understand them. While the users still don't have access to the references that the AI models used for the specific result that they produce each time, they make them part of a larger system that includes the users and therefore becomes able to produce subjectivity.

Aesthetics and the Making-sense of the World

Comprehension therefore might be a concept that will help designers navigate the creative landscape formed by AI tools. Which will in turn render the concept of aesthetics equally important: "Aesthetics thus concerns the experience of the world. It involves sensing – the capacity to register or to be affected, and sense-making – the capacity for such sensing to become knowledge of some kind"²⁰. It is the latter – sense-making – that is crucial, and currently lacking, when we deal with AI powered tools. When we find ways to use those tools in order to transform the sensations that they produce into processes that produce knowledge and subjectivity, we might be able to re-establish our own creative processes and generate novice and liberating points of view.

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Artificial Intelligence for Design

The Artificial Intelligence of Objects

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Abstract

Artificial Intelligence (AI) is increasingly permeating various domains, revolutionizing traditional processes and opening new avenues for innovation. In the realm of design, AI holds immense promise, offering capabilities to augment human creativity, streamline workflows, and deliver personalized user experiences. This paper explores the intersection of AI and design, highlighting its transformative potential and key implications. Firstly, for instance, AI-powered design tools automate repetitive tasks, freeing up designers' time for more creative endeavors, while generative design algorithms can generate myriad design options based on specified constraints, enabling designers to explore more efficiently brand-new solutions. Additionally, AI-driven predictive analytics provide insights into user preferences and market trends, facilitating informed design decisions and enhancing product relevance; moreover, AI enables the creation of personalized user experiences by analyzing vast datasets to understand individual preferences and behaviors: this personalization extends across various design domains, from user interfaces and digital products to physical spaces and services. Ethical considerations are paramount in the integration of AI into design processes: designers must address issues of transparency, fairness, and bias to ensure that AI-driven solutions uphold ethical standards and respect user privacy; furthermore, human-AI collaboration emerges as a fundamental paradigm, where AI augments human creativity and decision-making rather than replacing it entirely. Challenges such as technical complexity, data privacy concerns, and the need for upskilling within the design workforce accompany the integration of AI in design; thus, addressing these challenges requires interdisciplinary collaboration and a holistic approach encompassing technological, ethical, and socio-economic dimensions. In this framework, this paper sets the stage for further exploration of AI's transformative impact on design and the ethical considerations guiding its integration into practice.

Keywords

Design; objects; products; interaction; generative design

Introduction

The big potential offered to the contemporary design by the so-called Artificial Intelligence cannot be denied or underestimated any more. And this is true not because we must accept the idea of substituting the human thought with a sort of autonomous virtual dimension of things, but for the impact that AI can have on the real world and on the real human relationships with spaces and objects, within a new social and cultural framework (Crawford, 2021). Vogiatzaki and Spyridonidis (2022) underline how the concept of intelligence has recently changed following two directions: on one hand it has been extended to what is not human, that is that also machine now can be considered 'intelligent'; on the other hand, the idea of intelligence is not anymore only individual but collective when not social, and this means that the contemporary interpretation of intelligence goes toward a unavoidable dialogue between humans, machines and environment, and this is particularly true for all the actors involved in the design activity. In a certain sense, while other design disciplines like architecture have a very strong armor which protects their territorial boundaries and thereby, as happened in occasion of every technological revolution in history, the AI has to work harder to pass through them, design, being more fluid and 'open', is immediately called to control the entry of this new actor on the stage.

But, as underlined by Del Campo (2004), the impact of AI in design and in the relationship between human and machine has to be read in terms of language renewal, creative opportunity, theoretical explorations and not in terms of preconceived certainties regarding the final aesthetical configurations of objects. New technological paradigms, new network-based systems, new computational structures, which are just some of the constituting elements of the AI, can be understandably seen as critical for the design approach, but not so much if we consider them as services or tools to manage the now essential digital dimension of creativity, the complexity of the processes of ideation and production, the levels of user's active participation and the interdisciplinary dialogue in the work teams (Cattabriga & Joler, 2023). But these tools seem to be something different compared, for examples, to those that appeared some years ago within the CAD/CAM systems; and the difference is that now we are facing to 'tools for thinking' instead of 'tools for making' that are going beyond our traditional conception of modern science applied to the design ambit (Carpo, 2017). Otherwise, as Neil Leach tells us (2021), a fundamental aspect of AI is who uses it and for which purpose, and this awareness leads us to its human aspect, transforming it from a 'cool tool' into 'culture'. If a definition is needed, using the ChatGPT (an AI system of data) we can say that Artificial Intelligence is a field of computer science that deals with creating systems and programs capable of performing tasks that usually require human intelligence. The goal of artificial intelligence is to develop actions and/or knowledge starting from a data set and through algorithms and models that allow computers to learn, reason, solve problems and make decisions autonomously, without being explicitly programmed for each specific action, in a condition of continuous self-powering.

Within its branches, we can first of all mention the machine learning (a subset of AI) and the deep learning (a subset of machine learning). The machine learning is a system through which is possible to teach the machine to do something without explicitly programming it but letting it adapt its decisions from experience, using an algorithm which provides the machine a set of rules and basic data; with the deep learning is a variant of the traditional programming through which the development of specific algorithms allows the machines to learn from their own errors and perform specific actions autonomously, like how our brain processes informations; or the prompt generators (text, audio, video, etc.) and the generative design systems able to create texts (i.e., ChatGPT), images (i.e., Midjourney, Stable Diffusion) and optimized 3D models starting from requisites and using algorithms and parameters able to overcome the limitations and the low speed of the traditional design methods.

With the emergence of AI, which has broken the conventional technological frontiers, it's true that the limit between transhuman and post-human (intended as more-than-human) dimension can become quite fine, but we don't have to forget that the design discipline has an intrinsic openness for technological systems innovation and, in general, for all the new form of knowledge and information that absorbs like a sponge: the problem is what kind of use we're asked to do of these new scientific additions and in which way the relationship between the individual and collective dimensions are supposed to change. In other words, which are the aesthetical, cultural and social implication of the diffusion of AI systems (Kuutti, 2009).

Design and AI: A Possible Marriage

Based on the information processing psychology since the Seventies and Eighties, AI increased by more than 80% in the last two years. Actually, the relationship with design is in a phase of experimentation, mainly in the preliminary and concept phase of the projects. But which are the real potentials of this relationship in the near future?

In general, as a matter of fact, the generative power of design is something not totally new, as well as its 'open' character and its intrinsic flexibility (Maldonado, 2015): according to the new possibilities offered by the computer science, for several decades now design has gone overcoming the ordinary linear systems starting using the computers not in a passive way anymore but in a dynamic mode that could enable the definition of synchronic infinite alternative solutions to specific design problems (Cross, 2001). Thus, despite of the word 'intelligence', if we accept the fact that AI is a way to 'do', the role of design must continue to be 'to think' about things, actions, values and sustainable attitudes and behaviors; more generally, the actual role of design toward technology is not that much different from other situations in the past: by observing what's going on around us, we can detect the same risks of overshadowing the social values and of not considering the ethical responsibility of the design actions. Moreover, technology goes undoubtedly faster than our capacity to collectively decide what kind of vi-

sion of the future we want to share and build. But, in conclusion, what it's probably true is that design is definitely changing itself from a discipline into a creative process whose ethical reference however remain steadfastly the protection of people, places and eco-systems (Pham, 1991).

Actually, the ambit of AI which has more applications in the field of design is the so-called 'generative design': it's a form of AI capable of exploring the project of objects at different scales, through which parameters like materials, costs and morphological objectives are transformed into design solutions. In truth, for the design ambit the real big opportunity will be offered by the possibility of producing objects with automatic 3D printing using robots able to analyze the information previously produced by the systems of generative design to build prototypes, models and final products. This is already enough to underline how the AI system of things is not exempt from improvements, whose margins are to be found in the quality and quantity of the input information (context), the possibility to verify the solution before their modelling (modifications), the capacity of reducing the resources (times and costs). But beside the freedom and the possibilities given to the designer in the present and future, the main aspect that seems to be fundamental is the concrete possibility of easily integrate technology, creation and management of the products. Downstream of this, more and more companies are going to ask design to control this integration through specific methodologies which can guarantee a more rapid and effective design cycle both for project and production: these methodologies are ascribed to the design thinking approaches. The use of design thinking in the AI ambit means making products and services more comprehensible and accessible for clients; furthermore, the same systems of AI are asked to be not a 'secret' for customers but totally available, at least under a communication, operative an economic point of view: in this point, the design thinking approach can effectively intervene, making clearer the phases of the brief and/or the product design specifications, as well as those of the concept, managing the transition from one to the other. After all, and as a direct consequence, also the user experience does it draw advantage from the AI systems. First of all, in terms of personalization, with the possibility to reach high quality customized user experiences based on real behaviors, preferences and real time interactions; secondly, for its power to translate them into dynamic and adaptive interfaces and returned to customers in terms of support, suggestion and a wide range of possibilities to choose.

The Aesthetic, Productive, Social and Cultural Dimension of AI in Design

Beyond the indisputable fact that AI has gained a very big space around us, influencing our everyday interactions and the way we interpret and live both the physical and digital world of products, a distinction between the different dimension of the dialogue between design and AI is strongly needed to help to address future investigations.

The aesthetic dimension: AI as a new language

An important issue is if the use of AI by design leads necessarily to specific aesthetical outputs, morphologies and forms. In other words, the question is: does the relationship between AI and design contains a unique exit in terms of aesthetical language? In this case, what happens to the historical archetypes? And what about the cultural relationship between objects and environment? As happened in other moment in history, the emergence of technological innovations brings with it new forms and new languages which can represent it: under this point of view, it does not make much sense to stand up for the rights of minimalism, in relation to the possibility of exploring new aesthetical territories. But observing how AI is going to replace the formal geometry with mathematical algorithms, a reasonable doubt about the ability to guarantee high aesthetic quality levels can come. May be an interpretative key could be the fact that design can bring things to the surface making them visible and legible. This role of 'showing' what people cannot read with the traditional tools starts having sense instead of asking ourselves if AI is useful or not, always beside the 'traditional' objective of the problem solving and search for innovation (Verganti, Vendraminelli & Iansiti, 2020). Still under an aesthetical point of view, another aspect can be related to the issue of customization: being possible to easily generate a big number of configuration and transforming them into concrete objects, the purchase of products' experience it connotes to a brand-new individual dimension made of personalization and dynamic adaptability according to specific requirements. This means that the new products' aesthetical outputs tend to be not unique any more but different, and if this aspect under the point of view of the *venustus* can appear as a criticality, from an ethical perspective it's a cultural achievement, at least when distortions and aberrations are correctly controlled.

The productive dimension: AI as a tool

Under a productive point of view, the organizational models of the traditional companies are not always capable to manage the scale production and its customization at the speed that society requires. Neither do designers in the project phase, because the effective capturing of user's feedback on a preliminary idea or concept needs time to be correctly elaborated and this process, when based on traditional tools, cannot but be sequential. Hence, AI as a tool can make possible to overcome these limitations on one hand increasing the speeds of the process' phases, on the other hand facilitating the chances of reaching innovation, through the following concrete elements:

- Availability of real time data (big data and internet of things);
- virtualization, automation and distribution of cloud computing and data mining;
- Automatic management of some process' phases, including virtual simulations, prototyping and additive manufacturing;
- improvement of the forecast models on customers' future behavior;
- scalability and speed of processes of innovation research.

These elements, in their turn, lead to the following objectives:

- increase of efficiency (functionality);
- improvement in accuracy (precision);
- reduction in costs (economy);
- enhancement of experience (participation);
- new points of view and new perspectives (lateral thinking).

If we consider the AI as a tool, we can use it in a generative way to create contents starting from systems of data: but considering the transformative impact of AI on the design industry, its capacity to make the design processes more efficient through automation and its strategic role in searching for innovation and break into new markets, we must consider AI not just as a tool but mainly as a paradigm shift in which, beyond the utility of managing UX research, market analysis, personas interviews, data processing, prototyping, digital fabrication, etc. (most of them open source), becomes fundamental the relationship between the solutions and their ethical impacts.

The social dimension: AI as a dialogical facilitator

Belonging to the Internet of things, the social power of AI in the design ambit can be recognizable along two main ways: on one hand, objects, software and systems from simple machines are gaining more and more ‘humanity’ and are going to build ‘horizontal’ dialogues with people that can very easily attract, being now intelligent sensors able to elaborate (and sometimes invent) all kind of information and data (centripetal sociality). On the other hand, the same objects, software and systems can increase the level of interaction between people (designers, producers and users), building specific intelligent environment or dialogical conditions (centrifugal sociality) which are not necessarily virtual but certainly innovative and sustainable (Arcagni, 2015). Thereby, AI establishes new relationships between clients and products, between companies and customers, between designers and users: this means that the risk of a substitution (machines for men) doesn’t seem to be realistic but a new approach to technology appears all the more necessary. New skills will be fundamental to overcome problems and reduce errors, increase efficiency, have access to new possibilities and free levels of creativity, maintaining AI in playing a supportive role.

The cultural dimension: AI as a renewal

The ultimate goal of the AI in the field of design is its capacity to contribute to the development of the cultural sector of things, according to the always changing social transformations that can have an influence on it. In the cultural dimension the AI becomes an opportunity to extend participation to a wider audience, respecting all the different points of view that a community can be made of (Franzato, 2017). Moreover, it assumes, as paradoxical as it may sound, a strategic importance in protecting the cultural craftsmanship, first of all because it extends the ability of a single craftsperson and, in general, the know-how of a small productive reality transferring in a larger scale

production its creations so to be more competitive reducing the gap with the bigger companies; secondly, because it frees the artisans from all those activity that take time away from creation, experimentation, search for innovation, giving them unprecedented opportunities; thirdly because it recognizes to design a new responsibility in managing and controlling over organizational complexity, thus helping craftsmanship to update its tradition while maintaining its cultural identity (Stevens, 2019).

Case Studies

For nearly a decade, the design ambits interested by the generative systems offered by the AI that, using a mix of algorithms and ‘text-to-image’ technologies, allow the use of shared computer resources aimed at producing infinite preliminary and/or final configurations, range from fashion design to product design, from furniture design to graphic design. In general, the most common solutions using AI in the field of design are related to intelligent data processing, virtual assistance, image and language processing, etc. More specifically, in the ambit of the product design are to be counted intelligent objects (objects with sensors that interact with the environment and able to learn directly from the users), autonomous robot and vehicles, all fitted with sensors able to interact with environment and programmed to learn directly from the users. An example is the creation of a series of eating accessories, designed by oio studio (2022) and



Figure 1: oio studio, Spawns, Greggio Argenterie, 2022 (Image font: oio.store) manufactured in one of the oldest silverware factories in Italy (*Greggio Argenterie*), generated by a machine in thousands of variations; for the moment only three spoons are in production (Spawn no. 22, 51 and 83) but, through a process that the designers have called ‘artisanal intelligence’, in the near future other infinite combinations can be crafted (Figure 1).

In the automotive sector, the BMW Vision Next 100 has to be mentioned, a visionary vehicle born in 2016 from a generative design system which uses an ‘alive geometry’ made of more than 800 triangles that can dynamically change position and form. Moreover, the Airbus A320 which employs new lightweight and stable partition panels, produced by a generative design process, which are the result of the analysis of thousands of variations and configurations (2016) and whose final solution is a breeze wall which imitates the growth of human bones, the 55% lighter than a normal wall. In the field of furniture design,



Figure 2: Philippe Starck, AI Evolution (Console, Lounge, Chair), Kartell, 2019 (Image font: kartell.com)

the company Kartell, in collaboration with Philippe Starck, has recently produced a collection of objects created with a generative design process (A.I. Console, A.I. Lounge, A.I. Chair) in which the aesthetical research is aimed at reducing to a minimum the size of the components and the formal impact of their connections (2019); furthermore, the reduction of times and resources has been quite significant (Figure 2).

Another analogous interesting experience is the chair project by Schmitt & Weiss, a chair developed with the AI and born from a set of images of XX century's iconic chairs processed by a system of algorithms which generated new configurations. Or the Elbo Chair, developed by A. Harsuvanakit & B. Preston of the Autodesk's generative design lab, which comes from the intention of making reference to the Danish mid-century modern style chairs; in this case, the designers only decide to have the seat 18 inches off the floor and the chair to be capable of supporting 300 pounds: all the other aspects have been found out by the algorithms. Lastly, the Tamu Chair, designed by Patrick Jouin with the think tank 3DExperience for Dassault Systèmes, using generative design, had the objective to be foldable, light and space-saving, other than sustainable in the use of materials and in the production process. In the ambit of fashion design, the use of AI seems to have at least three general issues: first of all, the capacity of designers to be more efficient; secondly, the possibility has more designers increasing their number; thirdly, the hope to have better fashion consumers. The first issue is related to the problem of creativity: does the AI permit designers to improve their creativity? Undoubtedly the speed of the AI processes and the quantity of input they work with are a very big help, but designers must be careful and must ensure that AI amplify their work without replacing it. The second issue has something to do with democratization; under this point of view, we must accept the idea that the easy access to the AI tools can allow non-experts people to create clothes, expressing their creativity without being designers. The democratization is an important aspect contained in the 'philosophy' of AI, so the fact that the distance between expert designers and laypeople is getting smaller and smaller, it represents something that cannot be stopped: but this transformation has a positive aspect, which is the fact that designers and people can build a dialogue made of a more comprehensible language: in other word, and here we come to the third issue, the easy access to the AI tools can improve not only the creativity of non-expert people but also their sensibility, transforming them into more learned and aware consumers. And this



Figure 3: G-Star Design Office, AI Denim Cape, G-Star Raw, 2023 (Image font: g-star.com)

is definitely a guarantee for the achievement of higher level of quality in the final products that are put on market. One example of application of AI in the fashion design ambit is The Fashion Designer AI produced by the E-Commerce Amazon with the machine learning in 2017. It consists of a program which, learning from a data base of images, elaborates various configurations of fashion objects and clothing items, very useful both for professionals and clients. A recent and interesting experience is represented by the experimentation of G-Star Raw, called G-Star AI Denim Cape (2023), which is an endgame developed with the help of Midjourney and made of 12 unique concepts, conceived through the AI platform and then carefully crafted in their details (Figure 3). In graphic design there are many tools designed to create visual contents from libraries of pre-constituted models, images, icons, and fonts. Some of these programs are Canva, Nvidia Canvas, Topaz Photo AI or Let's Enhance (for images and pictures editing), Imagen, Midjourney or DALL.E 2 (for image creation) Writesonic and ChatGPT (for texts, articles, etc.), Design.ai or Topaz Video AI (for logotypes, videos, branding, advertising etc.), Adobe Sensei (for data streams, schemes, etc.), Alpaca (for 3D modelling), Adobe Firefly (for integrated creation of texts and images), Khroma (for color management), Uizard (for web applications, web sites, software desktop, etc.). All programs and platforms which have the ratio of speeding up the work of designers, improving the final product's systems of communications. As an example, we can mention the home fragrances Moooi, designed by EveryHuman and created with AI,

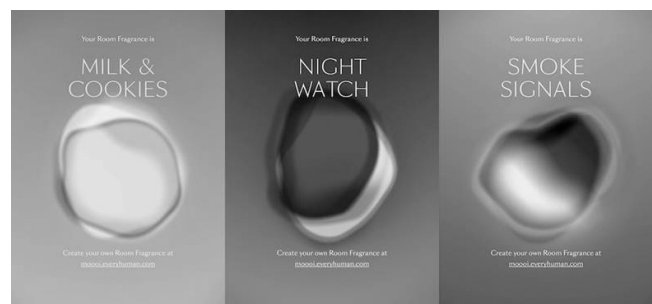


Figure 4: EveryHuman, Moooi Room Fragrances, 2023 (Image font: mooi.everyhuman.com)

which uses a platform called Algorithmic Perfumery through which is possible to create a personal fragrance starting from a survey on the website mooi.everyhuman.com, where users can answer some questions about sensation and feeling so to create the 'perfect' fragrance they are looking for (Figure 4).

Conclusions

The relationship between design and AI holds immense potential to radically change the future of human life. Through the integration of AI technologies into design processes, we witness a paradigm shift in how products, services and user experiences are conceived, developed and delivered. The above-mentioned examples are some of the many experiences that, in general, can be seen as concrete evidence of the interest that designers and productive companies working in the most diverse sectors show of the possibilities offered by AI. In their aesthetical aspects it is possible to detect a certain enthusiastic attitude toward experimentation and, on the other hand, an almost playful dimension in their functional proposals, despite the differences between each creative specificity; but a common element is always the dimension of 'dialogue', the necessity to talk with someone or something which is perhaps the expression of a sort of ethical coming out that takes the place of the old egoistic showing off. As a short and temporary conclusion of this essay, whereby it was necessary, we can summarize the following key points:

- creativity and innovation: AI empower designers to explore new frontiers of creativity and innovation by automating tasks, generating new ideas and optimizing their work in terms of efficiency and effectiveness;
- user centered solutions: the dialogue between design and AI enables the creation of high personalized and user centered solutions, driven by insights derived from data analytics, predictive modelling and user behavior analysis;
- efficiency and optimization: AI-driven design tools streamline workflows, enhance productivity and optimize design processes by automating repetitive tasks, analyzing vast amount of data and generating optimized design solutions;
- ethical aspects: Designers must grapple with ethical considerations surrounding the use of AI in design, including issues of transparency, fairness, privacy and bias. Responsible AI design practices are essential to ensure that AI-driven solutions uphold ethical standards and serve the best interests of users and society as a whole;
- human-AI collaboration: the symbiotic relationship between humans and AI fosters collaborative design processes, where AI augments human creativity, problem-solving capabilities and decision-making, leading to the co-creation of more innovative and impactful solutions;
- new opportunities and future challenges: while the integration of AI in design offers numerous opportunities for advancement and transformation, it also presents challenges such as technical complexity, data privacy concerns, and the need for upskilling and reskilling within the design workforce. Addressing these challenges requires a holistic approach that encompasses technological, ethical and socio-economical dimensions.

In essence, the convergence of design and AI represents a pivotal moment in the evolution of creative processes and problem-solving methodologies. By embracing AI technologies thoughtfully and responsibly, designers can harness their transformative potential to address complex challenges, unlock new possibilities and shape a future where human-entered design flourishes in synergy with intelligent systems.

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AI – The Future of Humanity and the Biggest Dilemma

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Abstract

Nowadays, there is a wide discussion about the developments of Artificial Intelligence (AI) and the impact these developments are going to have on humanity. There are interest groups that are pro further developments, but there are also many other groups that believe that the developments of this technology will cause extraordinary and irreparable damage to humanity. In this article we will briefly discuss the latest developments of this technology in the world. We will mention what is GLLMM (Generative Large Language Multi-Modal Model), what this language is bringing new and what inventions has brought it to the AI developments. It will also briefly describe what the stages of technological development have been, the match with humanity and the impact on the latter years. In conclusion, we will briefly consider whether the further technological development of AI is a threat to humanity and whether we should feel threatened by this technology, and respective further developments conducted in this domain.

Keywords

AI (artificial intelligence); GLLMM (generative large language multi-modal model)

Introduction

Let us imagine for a moment that we are back in the distant year of 1944. One beautiful morning we wake up to a phone call from Robert Oppenheimer (director of the Manhattan Project) telling us that the world is about to change forever in a radical way. Currently, 50% of AI researchers believe there is more than a 10% chance that humans will disappear due to their inability to control AI. The information was extracted from a questionnaire that was administered to 738 researchers in the field of ML between June and August 2022 (MIRI, 2022). They were asked the question: What is the probability that you predict the inability of humans to control the future progress of artificial intelligence systems, which can cause superhumanity or similarly disable the ability of humans to control them in a permanent and very serious way? Let's say that 50% of aeronautical engineers believe that there is a 10% chance of people dying during an airplane flight. Will anyone fly in an airplane under such conditions? The logical answer is no.

First contact of AI with Humanity

According to the three rules of technology (Zhan, 2022), every time a new technology is invented, we discover a new level of responsibility. If this technology generates power, then this technology will start a race. If it cannot be coordinated, the race will end in tragedy. Everyone has probably seen the documentary on Netflix called "The Social Dilemma". In this documentary, concrete real facts and reference cases are presented on how social media platforms, designed to connect and unite us with other people, control us. I believe that everyone has experienced the fact that whenever you search for something in such social networks, actions related to that search are automatically published in every navigation window. In this respect, social media is humanity's first contact with artificial intelligence.

In this first contact, humanity has lost. In the aspect that almost all users of these networks are dependent on them, but not only that they receive a very large amount of information (information overload). Users are also condemned to navigate all the time (doom scrolling). Influencer culture has also become a widespread trend in these networks. The spread of political conspiracy theories such as QAnon. The shortening of attention spans, especially in children, and the direct impact on their mental health, which is an increasing concern. A significant increase in the sexualization of children. Widespread polarization of society. Fake news and viruses spread through these platforms. Ultimately, democracy has been destroyed by these networks. Of course, the question is, why is humanity being lost? Because through these platforms, in addition to the above-mentioned factors, you are all given the opportunity to have a voice, we have the opportunity to connect with all friends, the virtual gathering with like-minded communities, as well as the opportunity that is given to small and medium companies to reach the customers and manage to benefit from them by selling you the products in a direct way.

Behind all these platforms, taking into account all the factors that negatively affect people's lives, is the so-called race of these

companies for attention, or in other words, the race to reach the deepest brain cell. In this way, social media have managed to rewrite the rules of every aspect of our society. They have become important and inseparable factors in politics, where every politician curates and updates all the social networks. With these platforms, they have managed to influence elections in countries such as America, with the scandal that broke out after Cambridge Analytica (Confessore, 2018), or popular movements for regime change, as was the case with the Arab Spring. The extraordinary impact of these platforms on children's identity has become a major concern these days. National security is an overriding factor that is influencing more and more recent armed conflicts, such as Israel - Hamas or Ukraine - Russia.

Second Contact

The second confrontation between humans and AI is the introduction of Chat GPT 4 (Sundar & Mok 2023). Through this platform, AI is supposed to make us more effective. AI will make us faster writers and enable us to write application code in record time. It will also make it possible to solve scientific challenges that were previously impossible. Through AI, the solution to climate change will be achieved, and as a result, AI will generate a lot of income.

However, there are some major concerns behind the introduction of Chat GPT-4. Most people see AI as a scientific development that will disrupt the labour market and massively reduce the number of jobs people do, replacing them with machines. It is claimed that AI will lead to a loss of transparency and that things will be done without our knowledge. A significant group of people also believe that AI will work in an unethical and unfair way. In 2023, the year Chat GPT-4 was introduced, there was a large increase in all things fake, the destruction of the real as well as the destruction of reality. The use of legal spaces made this development possible in all areas, like:

- An extraordinary increase in threats or blackmail.
- Automatic creation of computer weapons and exploration programs.
- Automatic lobbying on the political, commercial and social level.
- Automation of biology and fields related to production.
- Exponential growth of scams.
- Testing everything from start to finish.
- The establishment of synthetic relationships as well as the so-called Alpha Persuade (de Graaf 2023), which causes people to be deceived in the intimate aspect by a computer.

AI Engine

In 2017, a new AI engine was invented. Until this year, AI was used in various fields such as robotics, speech recognition, image generation, music generation and speech synthesis. In that year, the so-called language was created. This language was called GLLMM or Generative Large Language Multi-Modal Model. Otherwise called "Golem-class" AI (a term coined in March 2023 by Silicon Valley engineers, Tristan Harris and Aza Raskin). With this new language, all of the aforementioned pro

cessing activities will take place in the same environment, including DNA information, codes, videos, images, voice, music, robotics, stock markets, biometrics, fMRI and texts from the Internet. On 5 March 2023, the well-known American newspaper The Washington Post (Verma, 2023) published an article describing how people had been deceived by phone calls they thought were from their relatives asking for help, but were in fact nothing more than an AI scam.

MGM Casino was also hacked (Page, 2023) by a single phone call. In these cases, we have a complete decoding and synthesis of reality. It is worth mentioning that the original human voice can be reproduced with only 3 seconds of audio, or hearing a person speak for only 3 seconds. A great debate has also been raised about the manipulation of video, where videos of faces can be used to blackmail people and directly affect the way of life and well-being of people. In light of all these technological developments, 2024 will be the last year in which the People's Powers will hold elections. During these developments, extraordinary abilities have been demonstrated in solving mathematical problems, translating from one language to another, identifying handwriting and answering questions in Persian. According to (Kosinski, 2023), the development of AI according to the Theory of the Human Mind is shown in Figure 1. Theory of Mind developed by AI.

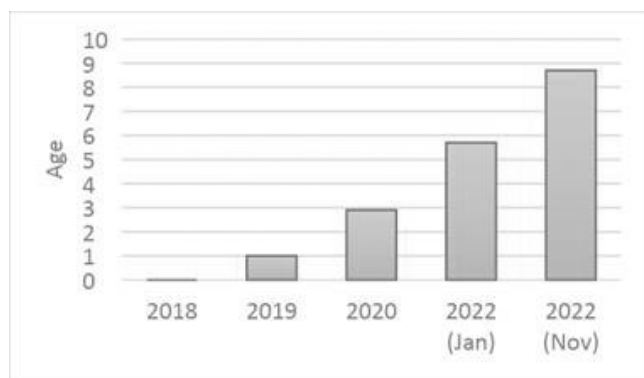


Figure 1: Theory of Mind Developed by AI.

It is clear from this graph that if this measure was not present in 2018 and was negligible in 2019, it took a significant leap in 2020, when the developments here are compared with the brain of a 3-year-old child. In January 2022, trying to compare these developments with the brain of a 7-year-old child, and for a period of 10 months, in November 2022, trying to compare these developments with the brain of an approximately 9-year-old child. The question that naturally arises in this case is: where will it go in the coming two years?

AI platforms developed by big tech vendors

Artificial intelligence is the future of big tech — and is already an integral part of the consumer and enterprise products at all of them. All big tech vendors are in race to develop their AI platforms or perform partnerships and try to position themselves in a leadership position and gain significant market share. It is worth mentioning that most of such companies have not had a big experience in launching such platforms, we can mention here

the fact that Meta’s powerful AI language, called LLaMA, has been leaked (Vincent, 2023) online. On the other side Microsoft has been criticized for embedding ‘crass’ AI polls beside news article (Gross, 2023). Google, Amazon and Apple are dedicating resources to breakthrough in AI. Google has launched its own AI chatbot called Bard. Today, Amazon uses artificial intelligence for everything from Alexa, its industry-leading voice-activated technology. Microsoft has gained a lot from its partnership with OpenAI. Oracle has partnered with Nvidia to boost enterprise AI adaption. IBM has been a leader in AI software platforms with 13.7% market share in 2020 and 46% in 2022. It has an extensive AI portfolio and through its Watson products, sells AI and ML services that helps its customers make better decisions and benefit more financial values.

Identified problems after AI increased usage

With the increase usage of AI platforms was identified an significance increase in power supplies in Data Center. Microsoft has announced a really high number of water consumption (Mann, 2023), used for cooling of servers due to high power consumption after introduction of AI. There is a prediction that high usage of AI will lead in quite significance high usage of power (Leffer, 2023). Powering AI systems needs a lot of energy and this can be a significant problem in the future. Despite this, its enormous amount of energy consumption is already creating an undeniably large carbon footprint. AI create a major carbon footprint and environmental concern due to the reliance on non-renewable resources. This leads to higher greenhouse gas emissions and an exacerbation of global warming.

Another big problem faced with usage of AI is its economic impact. Creation, powering and maintenance of complex AI systems is going to be a very big challenge for public and private sector. Only corporates and governments will be capable to handle such systems and run then accordingly. Considering three aspects of an economic impact, implementation of AI systems is going to be complex and difficult to be understood. It will be expensive to be implanted and not affordable especially for small and medium businesses. On the other side the low number of AI experts is making introducing of such systems not possible economically and operationally.

AI Feeding itself

Today, one of the characteristics of AI is its use to feed itself with more data. In this context, the use of Chat GPT data that it receives from different sources and internet platforms is able to generate more data, which can later be used to generate other data in a cyclical manner. as shown in Figure 2.



Figure 2: The way AI feeds itself.

In this way AI realizes a stronger AI. Paralleling it with the theory of evolution, we can describe it as follows:

Give a man a fish and you feed him for a day;

Teach a man to fish and you feed him for a lifetime;

Teach an AI to fish, and it will teach itself biology, chemistry, oceanography, evolutionary theory

.... and fish all the fish to extinction.

Where is AI going to go?

Let's return to the question posed at the end of section 4: Where will AI go in the coming years? Even the best AI experts, who are more familiar with exponential functions, are unable to give a prediction of progress. We asked these experts when AI would be able to solve a mathematical equation of a certain degree with more than 80% accuracy. Their answer, based on the prediction, was that AI would reach 52% in 4 years. In reality, AI has reached more than 50% in just 1 year. AI has also been able to solve the tests at the moment they are created. So there is a real-time testing solution, something that has increased significantly since 2020. According to Jack Clarke (xz), tracking the progress of AI is becoming increasingly difficult because the progress itself is accelerating at an extraordinary rate. This progress is unlocking things that are critical to the economy and national security - and if we don't take the paper out of circulation every day, we will miss important trends that our competitors will see and exploit. Golem AI armies aimed at our brains will try to strip us of any thought or anything else that is not protected by 19th century laws. Almost all over the world, human rights groups and governments concerned with the protection of their citizens are analysing the situation and creating new laws that will be able to protect the human aspect of humanity.

Is the situation really that critical?

Take a breath. However, Golem's development is too slow for the public to safely test it. At the end of February 2023 (Warren, 2023), Microsoft unveiled its new AI-powered browser for Windows 11. Also in February 2023, Meta launched LLaMA: A State-of-the-Art Foundation Language Model for AI Research. In April this year (Cimerman, 2023), Snapchat released its AI chatbot to everyone for free.

The OpenAI-powered chatbot has been added to chat groups, gained the ability to make recommendations for things like AR filters, and will be able to generate photos within the app. But this should reassure us that there are many careful and safe scientific researchers who allow us to be calm and unconcerned about AI developments. AI also has important lines of research that are not driven purely by economic interests.

Even the smartest AI people think that there is a way to try to develop AI in a way that is safe and harmless for humanity. This way is to selectively slow down the public development of GLLMM AIs. This is achieved by assuming that public use of GLLMM is unsafe until proven otherwise. In this view, the pressure should not be put on citizens, but on AI development companies. According to Yuval Harari (Harari, 2011), AI is to the virtual world and symbols what atomic bombs are to the physical world.

Conclusions

This paper has attempted to provide an up-to-date overview of developments in the field of Artificial Intelligence. In the respective sections, we have provided information on the confrontation of humans with AI and the implications of this confrontation. An overview of the main drivers of AI development today was also presented. It is worth noting that this development is becoming extraordinarily widespread and is being used in all areas of life. Many companies and even governments are trying to include AI in their development plans to ensure sustainable growth. It is now obvious that AI will be an integral part of our lives, but should we be afraid of it? If the development of this technology is done in a controlled and objective way, then we should not be afraid or worried. If the opposite happens, then we should start to feel uncomfortable. The most positive thing so far is the fact that these developments are being made by scientific researchers for the benefit of humanity, without monetary profitability as the main objective.

Even if there is a race to take over the market from the technology giants, now this race seems to be only to test the stability and functionality of the solutions. Meanwhile, many governments are working to regulate the entire operation of AI platforms with a certain legal framework. These legal frameworks aim to protect people's privacy and personal data. Although there is great uncertainty that AI will destroy humanity, this does not seem to be the case actually. Many stakeholders are working to control the development of this technology for the benefit of humanity. Their main aim is to take humanity to another, more advanced stage, not to destroy it. One of the other worrying things about the development of Artificial Intelligence is the high level of energy that these platforms require to function. Scientists are working on how to find an optimal consumption for these platforms, based on green energy. In principle, the use of this technology has significantly increased the need for energy in data centers, so with the increase in electricity prices and wars in the region, the operation of this technology will be very expensive and unaffordable for most of the users.

In conclusion, the development of artificial intelligence is safe and is being monitored by various regulatory entities being this state owned or private ones. Humanity must use this development to its advantage and take maximum advantage of this technology. Although there is uncertainty and fear about the impact that the development of AI will have on human life, we must be calm and prepared to use all this power to further develop human life. Digitalization and automation will be the future of technological development, and in this regard, AI will be the main driving force to ensure the longevity of humanity and the further development of technology and science always for the benefit of humanity.

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Decoding the 'Artificial' Epoch: “Embracing Speculative Architectural-Design Methodologies in the era of AI by addressing the Computational Continuum”

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Abstract

In the contemporary epoch marked by paradigm shifts, as articulated by Saggio in "The IT Revolution in Architecture" (Saggio, 2013), our world is enmeshed in a tapestry of evolving architectural ideologies. The current correlative relationship between those, are blurred superimpositions of influential waves which define a multi-dimensional complexity which resembles a simplified fragrance of the quantum state. The integration of AI into architecture marks a seismic shift, challenging the very narrative that has historically defined architectural discourse. As AI methodologies continue to unfold, they introduce a paradoxical dynamic, redefining conventional perspectives and prompting a reexamination of architectural legacies. The roots of speculative design, deeply embedded in avant-garde movements of yore, now intersect intriguingly with the emergence of AI. Speculation, an inherent aspect of architectural exploration, discovers resonance in the iterative and generative capacities of AI methodologies. These technologies, acting as speculative agents themselves, transcend conventional design constraints, engendering a novel dialogue between human creativity and computational ingenuity. This unfolding narrative opens up new dimensions within the ever-evolving saga of architectural expression by reading and defining this dynamic tension, simultaneously challenging and aligning with tradition, propelling the discipline into unexplored territories that also embrace individualities. Within this metamorphic landscape, this research will try to articulate the correlation of generative design thinking in approaching AI generative methodologies in addressing new architectural design processes; precipitated as an emergence in the ever-evolving Architecture, Engineering, and Construction (AEC) industry. This study lays a foundation for understanding AI's role in architecture but also points to significant areas for further inquiry.

Keywords

Artificial intelligence, neural networks, space-time, architectural design, parametricism

Historical context of computation and architecture

The genesis of computational power's integration in architecture can be traced back to the cybernetic theories of the mid-20th century. Gordon Pask's work, particularly in "The Architectural Relevance of Cybernetics", not only introduced the idea of responsive environments but also hinted at a future symbiosis between human cognition and computational processes in design (Pask, 1969, pp. 494-496). This notion was revolutionary, laying a philosophical foundation for future AI integration. In the 1970s and 1980s, the concept of computational design began to materialize beyond theoretical frameworks. Christopher Alexander's "The timeless way of building" was pivotal in this regard, advocating for a design methodology that is both responsive and adaptive to human needs and environmental contexts, prefigures a speculative framework where AI tools are not merely instruments but partners in creating spaces that embody the complexity and richness of life (Alexander, 1979, pp. 117-122). Integrating Alexander's principles, this period can be seen as a nascent stage in the quest for a more humane and ecologically integrated approach to architectural design, facilitated by the collaboration between human intuition and computational capabilities. The late 20th century saw further advancements with John Frazer's "An Evolutionary Architecture" (Frazer, 1995), emphasizing architecture that adapts and evolves, akin to natural organisms. This work foresaw the adaptive capabilities, aligning closely with today's generative design methodologies (Frazer, 1995, pp. 110-125). The current state of AI in architecture is a culmination of many other historical developments, characterized by an intricate blend of creativity and computational intelligence. This blend echoes in the works of contemporary theorists like Mario Carpo in "The Second Digital Turn" (Carpo, 2017), where he discusses the democratization of design through digital tools, an ethos central to AI's role in architecture today (Carpo, 2017, pp. 20-35). Figure 1 shows a more detailed and comprehensive visual diagram of the historical prevalence of computation in architecture, mapped and published in 2023 by Mark Garcia and Steven Hutt, based on Carpo's sequential researches as well as other sources (Fig. 1). The future trajectory of AI in architecture, while unpredictable, is likely to be marked by a continued fusion of human and machine intelligence, leading to unprecedented methodologies and applications. This evolution will continue to challenge tradi-

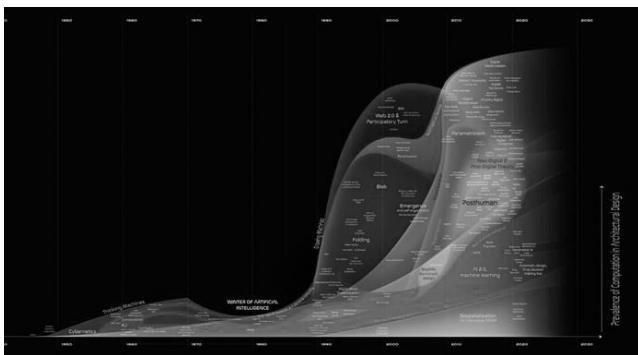


Figure 1: Mark Garcia and Steven Hutt, "Prevalence of Computation in Architectural Design," 2023.

tional architectural paradigms, as AI becomes an integral part of the architectural discourse, reshaping design methodologies and the built environment itself. Kuhn elucidated how the accumulation of anomalies within a prevailing scientific framework precipitates a crisis, ultimately leading to a paradigm shift that redefines foundational principles and methodologies (Kuhn, 1962, pp. 92-110). Analogously, as AI becomes an indispensable component of architectural discourse, it disrupts conventional design methodologies and the conceptualization of the built environment, heralding a paradigmatic transformation. This shift is not merely technological but philosophical, challenging architects to reconceptualize the role of the designer in the digital age and the means through which architectural solutions are generated and realized. Reflecting on the initial outcomes of digital generative design experiments at Columbia University, Greg Lynn observed a notable uniformity in the results. As cited in Cramer and Guiney (2000), Lynn remarked, "They all looked the same. It's the technology. We were figuring out the limitations of the software. It happened in every other industry: for a while all cars looked like Taurus. It'd be naïve to think it wouldn't happen in architecture." This comment underscores Lynn's perception that the homogeneity in design was a consequence of the architects' nascent familiarity with the technology, a phenomenon not unique to architecture but observed in various industries during the adoption of new technologies. This being said, the power of generative AI, more specifically through generations by prompting, does not solicitate an unparenting from what Lynn stated, rather than a rethinking of its powerful capabilities; opening up a new world for experimentation through literal expression and abstraction that surpass traditional algorithmic limitations. Perhaps, the need to address a new continuum emerges.

Deciphering the 'Computational Continuum': A new epoch in architectural design.

The advent of the 'Artificial Epoch' in architectural design marks a significant transformation in the discipline, characterized by the interpretation and application of Artificial Intelligence (AI); rising an emergence for a 'computational continuum' definition. With computational continuum we shall understand an ever-evolving framework where computational design methodologies are continuously reshaped by the integration and metamorphosis of AI, leading to unprecedented as well as speculative architectural designs and solutions. Theoretical foundations can be traced to the works of pioneers who foresaw the impact of technology on architecture. For instance, Kostas Terzidis in "Algorithmic Architecture" (Terzidis, 2006, pp. 45-60) explores the possibilities of algorithms in shaping architectural form and function. Furthermore, Generative Design (GeD) methodologies find their conceptual underpinning in the work of Mitchell's "Computer-Aided Architectural Design" (Mitchell, 1977, pp. 89-102), which lays foundations for understanding the potential of computational techniques in architectural design. Moreover, finished constructions like Zaha Hadid

Architects' Morpheus Hotel in Macau exemplify the innovative application of algorithmic design techniques, leveraging AI to generate intricate, fluid structures that redefine architectural aesthetics and functionality, demonstrating the capacity of AI to conceptualize forms that were previously unattainable (Zaha Hadid Architects, 2018, pp. 24-30).

The EDGE Olympic building in Amsterdam, designed by PLP Architecture, utilizes AI to enhance environmental sustainability, illustrating how AI-driven solutions can address critical ecological issues by optimizing building performance and energy efficiency (PLP Architecture, 2019, pp. 15-20). The significance of Generative Design (GeD) lies in its ability to synthesize vast amounts of data, environmental factors, and user preferences, resulting in designs that are not only innovative but also contextually and functionally appropriate. This approach redefines the architect's role from a sole creator to a curator of possibilities, where the final design is a product of a collaborative process between human expertise and computational intelligence. The integration of generative design in architectural practice signifies a shift towards an era where design solutions are not static but are constantly evolving, mirroring the dynamic nature of the environments they inhabit. AI at the other hand, can enhance these processes by providing constant feedback through supervised/unsupervised learning experiences throughout trainings of datasets, resulting in an "artificial brain" which thinks and makes decisions. Nowadays, the power of AI iterative technologies leads to user-friendly high-end products that can be generated by crafting a single prompt and clicking 'enter'. And this is only the beginning...

Even though Generative Design and AI are only parts of the large computational techniques used by industry and researchers nowadays, they stand out as two large umbrellas of computational practices; which subsequently keep specializing as technology advances, by forging new sub-terms and methodologies. Despite the clear differences in their 'built-in' architecture as well as performance, their behavior in working and usage, do have some similarities which will be examined later on this paper. Due to these similarities, is crucial to articulate and refer to a continuum rather than two different umbrellas that exist inside of the big computational framework regarding the AEC industry. This being said, today's role of AI in this continuum is not limited to a mere tool or extension for efficiency, but extends to being a collaborative partner that enhances the creative process. This shift is significant as it moves beyond the conventional boundaries of architectural design, incorporating data-driven algorithms and machine learning techniques in crafting spaces that go beyond our physical understanding of space. The computational continuum builds upon these concepts, contextualized in the "AI-epoch"; presenting a methodology that integrates human intuition with algorithmic precision, creating a symbiotic relationship between architect and AI. This approach aligns with the speculative nature of contemporary architectural practice, where design is an exploration of possibilities rather than a predetermined outcome.

Shout-out to Pioneering!

Initially hailing from avant-garde top-leading bastions such as the UK, Germany, Denmark, Spain, or even Canada, generative design methodologies nowadays cascade through academic corridors, birthing a specialized sub-profession — the "Computational Design Specialist." In the current discourse, algorithms, and more pervasively the integration of artificial intelligence (AI), intertwine seamlessly within architectural design and methodologies. This exposé explores the role of Generative Networks, entwined with AI, as they weave the fabric of design options. A discordant symphony emerges, challenging preconceptions of their "artificial" essence. A burgeoning commercial sub-profession emerges, beckoning contemplation on the dual specters of peril and promise to accompany AI's integration into architectural design. Can we, hand-in-hand, enfold these technologies to inaugurate an epoch of architectural unlimited supremacy? The query begets no facile response, for its essence resonates within the intricate dance of technological progression and the enigmatic pulse of societal awareness. In this arena, where the quantized cognizance of today's multi-layered social stakeholders plays an unprecedented role, the trajectory of AI integration into architecture crystallizes even more. This is an inevitable process that accompanies technological progress, but the shape of the crystal, is yet to be determined. Venturing beyond rhetoric, I have been in a constant experimentation process with AI iterations on venerable generative platforms and servers like Midjourney, DALL-E, LookX AI, etc., proffering a narrative etched in firsthand encounters. An intriguing dichotomy unfolds — critics decry the capricious ultra-realism of AI-generated images, perceiving an ominous threat to the traditional renderer's mastery. Simultaneously, advocates extol the incomparable quality of AI-crafted imagery, illuminating the depths of design cognition that often is eclipsed by the client mind's recesses. Within its pages lie revelations of potential pitfalls and shadows cast by the weight of prejudices and judgments. An impassioned plea reverberates — a plea for a comprehensive theory for pinpointing the authentic needs and boundless opportunities that AI consigns upon the future contours of computational architecture.

In this context of evolving paradigms and polarized perspectives, the critical discourse surrounding the integration of Artificial Intelligence (AI) in architectural design becomes ever more salient. Detractors, express apprehensions regarding AI's potential to diminish the role of traditional craftsmanship and intuition in the architectural process, fearing a loss of the human touch that underpins architectural creativity (Johnson, 2020, pp. 75-80). Conversely, proponents advocate for the unparalleled precision and innovation that AI introduces, arguing that it augments rather than replaces human ingenuity, offering new avenues for exploring architectural forms and functions (Smith, 2019, pp. 142-145). This debate is framed within a broader inquiry into how AI can be harnessed to serve not just as a tool for efficiency but as a collaborator in the creative process, seeking a synthesis where technology enhances the architect's vision and responsiveness to complex design chal-

lenges (Doe, 2021, pp. 60-65). The crux of this discourse lies in the development of a nuanced understanding of AI's role in architecture — one that recognizes both its limitations and its potential to redefine the boundaries of architectural imagination and practice (Brown, 2022, pp. 33-37). This ongoing dialogue underscores the necessity for a balanced approach to AI in architecture, one that cultivates a symbiotic relationship between technological advancements and the timeless principles of architectural design.

The pioneering work of Matias Del Campo and Daniel Bolojan, has been instrumental in advancing this discourse, demonstrating the profound impact of AI on creativity, optimization, and sustainability within the architectural domain. Del Campo's explorations into generative design processes facilitated by AI have underscored the potential for machine learning algorithms to produce innovative architectural forms, thereby expanding the aesthetic and functional possibilities available to practitioners. (Del Campo, 2022). Similarly, Bolojan's research into non-standard and computational design strategies has illuminated the augmentative capacity of AI in enhancing human creativity and efficiency (Bolojan, 2022). By investigating the intersections between AI, computational design, and digital fabrication, Bolojan has contributed to a deeper understanding of how these technologies can be harmoniously integrated into architectural practice to foster innovative solutions and methodologies. Today, people all around the world are aspiring to open some of the first AI-powered architectural design studios, inspired by the knowledge and devotion of Tim Fu (ex-ZHA), who legitimately claims that has now opened and runs the first AI-powered architectural studio in the world. Can you think of the role of an architect in your country, region or even continent? Is this profession demanding more specialized workers or are they searching for the old “do-it-all” architect which meets the client, draws the plans, makes the 3D, renders, presentations and even collects the salaries at the nearest branch? Because, dear reader, we need to embrace the complex reality of our profession and break down tasks in more numerous but easier ones (Alexander, 1965). And to do this, we need more people, more funds and more importantly, more time! In an epoch where all odds are against human repetitive tasks due to mental consumption and increased psychological problems leading the way, investigating smart and efficient AI integrated methodologies might be the only way out, to push further steps toward, rather than backward!

By not entering in depth the philosophical discourse of time perception regarding our comprehension of “present state” as an abstract concept for time understanding rather than an ever-present spatio-temporal continuum, we shall all agree that the future is here and the future is now! The future is for those who are ready to embrace technologies and adapt to this exponential growing, quick-paced reality, embracing and addressing all the emerging concerns. Nobody believed that the world wide web would influence humanity at the scale that it did when it first released to public; and nobody believed that AI technologies will impact the way we think, work and behave in our daily

basis; but here we are, reading, writing and researching about it so much, because its crucial to understand its ever-changing dynamics, in way to achieve a fruitful, not-so-harmful, ever-efficient and ever-adaptive innovative usage; responding to our contextualized professional daily needs!

Quantized, Quantum, Qauntuum...

Navigating the non-normative terrain of this research complicates the selection of a suitable language, encapsulating the uncertainty enveloping the forthcoming years. The research is, at its core, an experiment, a pursuit of audacious ambitions in a world where innovation has evolved into a dynamic entity of its own. As we navigate this unexplored territory, the evolving relationship between architecture and AI is akin to a student surpassing its master. But to build up a clear vision of AI potential and its application to architectural design processes, I would like to start from a simpler version of generative logic that leads the way to a fully comprehensive potential: the above-mentioned Generative Design (GeD).

Remembering the moment when I was firstly introduced to GeD in its algorithmic context, mr. Marco Mondello, my professor of CAD Logics at the Anhalt University of Applied Sciences at that time, stated the clear differences between the actual physical space and the design space used in fueling up generative scripts. The well-known acronym (DSC), refers to the “Design Space Construction” and goes beyond our understanding of a mere physical space-time continuum, forging a strong and clear concept for a “non-physical space for data exploration”, following up a purely holistic approach. To make it easier to understand, think of the DSC as an ideal infinite space of alternated options/scenarios which can take life in infinite contexts. Imagine a random/amorphous 3D model where you can choose where to perform 2D section-cuts; and now think of the infinite possibilities of physically performing it by constructing a possibly infinite number of planes that cut the model through 3 points of all possibly different coordinates:

Possible section cut [A-A'] – Plane constructed between points A - (x1;y1;z1); B - (x2;y2;z2); C - (x3;y3;z3)

Possible section cut [A-A'] – Plane constructed between points A - (x1;y1;z2); B - (x2;y2;z2); C - (x3;y3;z3)

Possible section cut [A-A'] – Plane constructed between points A - (xn;yn;zn); B - (xm;ym;zm); C - (xi;yi;zi)

Possible section cut [A-A'] – Plane constructed between points ...

Possible section cut [B-B'] – Plane constructed between points A - (x1;y1;z2); B - (x2;y2;z1); C - (x3;y3;z1)

Possible section cut [B-B'] – Plane constructed between points A - (x1;y2;z1); B - (x2;y2;z1); C - (x3;y1;z3)

Possible section cut [B-B'] – Plane constructed between points A - (xn;yn;zm); B - (xm;ym;zn); C - (xi;yi;zi)

Possible section cut [B-B'] – Plane constructed between points ...

Possible section cut [C-C'] – Plane constructed between points ...

The holistic approach translates possible data interconnections in perceivable generated scenarios through text, geometries or even images. But if we go a little bit deeper in the analysis, DSC is established by domains and as a consequence, is also restricted by them. The word “restriction” is generally conceived as a negative influence that limits possibilities; but in this case, it might be the most important and crucial element that helps the user to adequately know what and how to search for. In an era where Skender Luarasi, Ph.D., and other eminent scholars interrogate the terminus of design processes, an equally pivotal inquiry emerges regarding their inception, particularly in a landscape where technological advancements enable the rapid generation of design outcomes from mere prompts (Luarasi., 2022). This juxtaposition of beginning and conclusion within architectural design processes embodies a continuous dialectic experienced by practitioners, shaped profoundly by their educational and professional trajectories. The exploration of this dialectic reveals a nuanced understanding of design as a cycle, where the initiation and cessation of processes are intrinsically linked, thus challenging architects to reconsider the foundational strategies that underpin their work. Today's discourse seeks to elucidate design strategies that harmonize with the concept of Design Space Construction (DSC) amidst the iterative evolutions propelled by Artificial Intelligence (AI).

The complexity of this endeavor mirrors the intricate nature of contemporary data landscapes, exponentially expanding in a manner that defies traditional processing capabilities. This expansion can be likened to a quantum state, where the precise definition eludes due to the observer's incapacity to simultaneously comprehend all phenomena, leading to an ambiguous superposition of translated geometries. Such geometries, existing beyond the confines of clear Cartesian boundaries, evoke the necessity of reimagining design spaces as fluid constructs, adaptable and responsive to the ever-changing inputs provided by both human insight and algorithmic calculations. This paradigm shift underscores the importance of a holistic approach to architectural design, where the binary between beginning and end is dissolved in favor of a continuous, iterative exploration of possibilities. In this context, the role of AI becomes not merely generative but deeply integrative, facilitating a symbiotic relationship between technological potential and architectural creativity, powered by human intuition. Thus, the challenge and opportunity lie in conceptualizing design processes that are both reflective and forward-thinking, capable of navigating the ambiguous terrain between inception and conclusion. By adopting a quantum-inspired perspective on design, architects and researchers can foster a more dynamic and adaptable methodology, one that embraces the complexities of modern technological advancements while remaining attuned to the fundamental human elements of space and place.

"Artificial" Domains

Neural networks and noise maps are essential performative components which power AI-image generative algorithms, and as a consequence necessitate a nuanced understanding of

their combined capabilities and limitations. A neural network represents an artificial intelligence methodology that enables computers to emulate data processing mechanisms akin to the human brain. This approach, part of a broader category known as deep learning, employs a network of interconnected nodes or neurons arranged in a hierarchical structure, mirroring the brain's architecture. (Goodfellow, Bengio, & Courville, 2016). By simulating the complex processing of biological neurons, NN offer a robust framework for learning and replicating intricate patterns, essential for guaranteeing senseful and coherent *brain-like* iterations. At the other hand, within machine learning, "noise" denotes random or unpredictable data variations that hinder the identification of clear patterns or relationships within these iterative models. This interference can significantly reduce a model's prediction accuracy or the reliability of its outcomes, posing challenges in data analysis and interpretation. Contributing more to texture and variability, they are essential for providing realistic visual simulations, yet their application must be meticulously calibrated to avoid overwhelming the design with randomness, thus undermining the architectural intent. (Perlin, 1985) The synthesis of these technologies into AI image generators requires a delicate balance, ensuring that the output not only embodies innovative design principles but also adheres to functional requirements and aesthetic considerations. This complexity underscores the need for advanced algorithms capable of guiding the AI's generative process, steering it towards outcomes that are both innovative and applicable within the architectural domain. Until the full AI-automatization of the process, that will still lack of original human guidance, we can start addressing the problem of stopping by considering solving the problem of starting, through intuitively predicting final results based on constraining input datasets. Zooming out, considering the affiliation in the above defined computational continuum, we can search for similar applicable methodologies in the continuum, to control the spectrum of research through AI generations. Looking back to computational design methodologies, these datasets can *be variably-controlled* through *domains*. The evolution of AI in architecture thus depends on overcoming these analytical and computational challenges which consider intuition as a collaborative approach, paving the way for a future where AI-assisted design processes produce results that are as practical as they are visionary. In order to do so, we need to address the need for better control.

When firstly introducing domains in computational design to my architecture students, I usually refer to them as “setting limits” for being able to control infinite iterative processes enter a desired “rule of order”. But in the case of explorative AI generated images, this definition of domains does not represent the full meaning to my understanding of them. Domains in AI generative images through prompts might not even be a thing either; but it is crucial, for the way this exploration goes on, to keep an open eye on the essence of this concept! When talking inputs, in the now “traditional” computational design framework, we usually refer to (but not only): variables - which translate in numbers, Booleans - which refer to states like “true” or

“false” and sometimes, we refer to strings. All of them, for how much you might romanticize sciences and a programming language, lack of an important element that gives meaning to the essence of romance itself: linguistic expression! What I always found astonishing in AI generations is a deeper connection to the tool, if we shall call it like that. Rather than the tool, it might even be a more profound connection to ourselves. How? It often happened to me, but to many other professionals as I presume, that you have a great idea, a great concept, a great ambition to see the project go to the final design phase and visualization, but somehow, you sabotage this passion for the concept during the process itself; ending up with another extraordinary proposal of course, but at what costs? How can we evaluate 2 design proposals at once, if one of them was slowly suffocated to give birth to the other? Well, no longer! Even though to many of you the idea of romance between an AI and that guy in that famous movie might pop-up right now; I wouldn't go there, just yet! What I'm trying to articulate is that for as utopic or dystopic this might sound, it is possible to create a relation with the machine as much as it can trigger your emotions, beyond the mere “light-up the bulb” trigger of traditional/computational design processes. If done right, - and I don't think it would be sane to even try and write down a right or wrong thing about the topic yet, - but if done right; it can support, power and catapult different stages of design processes into new extraordinary dimensions.

Artificial Intelligence, but why 'Artificial' ?!

The advent of the so-called 'Artificial Epoch' in architectural design, marked by the integration of Artificial Intelligence (AI), can be debated not as a novel divergence but as a historical continuity. AI, in its capability to compute multi-layered data, does not simulate artificiality in design but extends the complexity and depth that traditional processes sought to achieve. This computational depth aligns with Rossi's notion of the city as a locus of collective memory, where layers of history, usage, and time coalesce ("The Architecture of the City," Rossi, 1982, pp. 130-131). AI's integration performs a similar synthesis, albeit on a dataset instead of a cityscape.

First of all, let's give credits to the adequate term of “prompt crafting” rather than “sentence writing”, because the main essence of crafting is preserved in its origins of hand-making or making something with your hands that go beyond the physical operation of hand. When you make something with your own hands, there are many hidden processes that the human mind evokes that we might be or not be aware of. How do I start? What do I predict to achieve? How much of this is really achievable? How do I do it? What if I fail? How much time does this take? How do I integrate my originality in this? Further dissecting the term 'artificial' within this context exposes its fallacy. The vast computing potential of AI stands not outside but within the continuum of architectural tools that have always sought to translate the multiplicity of human experience into built form. This is not dissimilarity but an evolution in methodology, resonant with the complex narratives that Koolhaas explores through the 'Exodus' or the 'Voluntary Prisoners of Architecture' (Koolhaas,

1972, pp. 18-34), wherein the depth of human intention and urban theory is woven into a speculative reality. The 'false facts' of AI — the initial apprehensions and misunderstood potential — are analogous to the early misconceptions of concrete in architectural applications, initially dismissed before becoming a staple of modern construction. These false facts, when engaged critically, propel our understanding forward, much like the Socratic method of elenchus, which advances knowledge through refuted hypotheses (Plato, "Phaedo," 2000, p. 89). Speculation, rooted in the richness of philosophical inquiry, emerges as the purest form of ideology for advancement and innovation. It is through the lens of speculative thought that AI in architecture is understood not as a mere tool but as an intellectual partner, expanding the horizons of the conceivable.

In this light, the role of AI in architectural design processes emerges as an authentic continuation of the architect's quest to materialize the complex spectrum of human experience. The 'Artificial Epoch' becomes a misnomer, as the integration of AI represents not a replacement but a refinement and expansion of traditional processes, inviting us to redefine what we consider 'natural' in the evolution of architectural methodologies. From now on, this research will investigate speculative methodologies in iterative design scenarios, which integrate a wholesome, yet not-so-automated, generative AI into architectural design.

Embracing "The Artificial" - the resurgence of speculative-ly contextualized architectural ornaments in the digital age.

The historical trajectory of architectural embellishments, particularly columns, orders, and ornamentations, reveal a nuanced narrative of decline post-World War II. The impact of war, coupled with the ascendance of modernist ideals, led to the marginalization of these once-revered elements. This exploration posits that the intersection of historical analysis and digital innovation presents a unique opportunity for the reinvigoration of architectural ornaments, transcending the limitations imposed by the tumultuous mid-20th century. The aftermath of the two world wars witnessed a paradigm shift in architectural ethos. Ornamentation, once celebrated for its ability to articulate cultural narratives, fell victim to the minimalist tendencies that emerged in the mid-20th century. This departure from embellishment was a response to the stark realities of the time, as architects sought simplicity and functionality in the face of widespread destruction.

The post-modernist movement, emerging in the latter half of the 20th century, aimed to revive architectural ornamentation. However, it faltered in its attempt, drowned in a cacophony of eclectic styles and disjointed references. The 'less is more' mantra, popularized by modernist architects, persisted, rendering post-modernist attempts at revival as chaotic and lacking in coherence. Notably, the influence of "Learning from Las Vegas" by Venturi is acknowledged, though its approach is considered insufficient for a genuine revival (Venturi, 1972). Fast-forward to 2024, where the digital age has ushered in transformative possibilities for architectural design. In this era of computational prowess, the re-incorporation of architectural ornaments

emerges as a compelling proposition. The digital tools at our disposal not only facilitate the resurrection of classical embellishments but also provide a platform for their reimagining in ways unimaginable in previous epochs. This posits an anti-thesis to the modernist dictum of 'less is more,' asserting that in the current socio-cultural context, 'more is more.' In an age where digital advancements allow for intricate detailing and mass customization, the need for architectural artifacts and richness becomes pronounced. The research provocatively challenges the prevailing minimalist trends, advocating for a return to a visual language that embraces the complexities and nuances of human experiences, as described by the quantum state.

(1) Methodological Application-simplified case study:

Proposed Methodology overview (a):

The first methodology that I am going to present, fuses generated AI imagery (through Midjourney v5.2) with the spatial interpretation capabilities of the Monolith (by Andy Pane) plugin for Grasshopper & Rhinoceros 6/7 (McNeel & Associates), denoting a significant leap in architectural design processes. This approach reflects a computational alchemy, whereby the AI's abstracted representations become the raw materials for three-dimensional, constructible forms. In the tradition of Eisenman's explorations of the interplay between diagram and architectural space (Eisenman, 1999), this methodology harnesses AI to generate initial images that embody not only form but also the latent potential for spatial complexity. These images, once translated by Monolith, echo the sentiments of Tschumi's disjunctions, where form is liberated from function to embrace a multitude of interpretations (Tschumi, 1994). The resultant 3D models are not static endpoints but are iterative steps in a continuous design evolution, where the transition from 2D to 3D and beyond becomes a reflective dialogue between emergent technology and established architectural thought.

The rendering and visualization of these models in various styles present an opportunity to speculate on new ornamental paradigms within the 'Artificial Epoch.' This speculative approach is reminiscent of the work of Venturi, who celebrated the complex and contradictory as a means to richer architectural expression (Venturi, 1966). As these models are rendered, they embody the multiplicities of their genesis—each style offering a different narrative of the form's potential, from the serene to the sublime. This generative process does not merely suggest new aesthetic directions but rather proposes a paradigm shift in architectural genesis. It calls for an open discourse on further research, emphasizing the potential of this methodology to recalibrate our theoretical and practical understanding of architecture. The game-changing potential lies in the capacity for continuous reinterpretation and reconfiguration—a fluid architectural language for the digital era, echoing the adaptable systems envisioned by Frazer (Frazer, 1995). The investigation of such methodologies point to a future where architectural form is not only responsive to but anticipatory of its environmental and social context, paving the way for an architecture that is as dynamic and ever-changing as the society it serves. This line of inquiry

posits a fertile ground for academia and practice alike, signaling a renaissance of architectural exploration in the digital age.

(1) Proposed methodology hands-on (b):

Supervised Generative AI prompts through pseudo predictable speculative DSC (1) → Generating input images via AI Platform (2) → Computational Blend through 3D translation (3) → Further AI contextualization (4) → Computational Fabrication (5).

STEP 1 - Supervised Generation of AI prompts through pseudo predictable speculative DSC (1)

1-A) – Building up a 'mental domain' continuum (similar to a mental map), merging up abstract notions of our understanding (ex. "the quantum state") - to achieve a speculative and unprecedented result, - with very simple concepts (ex. "columns").

1-B) – Making use of AI text platforms like "ChatGPT" (or similar) to generate adequate prompt iterations, optimized for the desired AI platform that we are going to use for generating the input images (Midjourney v5.2) that resonate: ex. "your comprehension of columns in a quantum state"

1-C) – Keeping in mind that we will use an image to 3D translator like Monolith Plug-in for Grasshopper (Rhinoceros 6/7), also considering the process of pixel translation from color to numbers, it would be better to generate monochrome pictures in way to help the software achieve a more rationally comprehensive form. Moreover, Monolith plug-in natively generates a 3D model from 3 axes blending of input images, X/Y/Z, so we will need to give as inputs a minimum of 3 images; one per each axis.

1-D) – Ask AI platforms like "ChatGPT" (or similar) to: "Help me generate 3 adequate prompt iterations, one per each view: top, right and left, monochrome with white background, optimized for Midjourney v5.2, that better visualize your comprehension of columns in a quantum state"

1-E) – Check, control and use desired prompts, if they make sense to you and represent the essential meaning of what you wanted to craft. Add desired resolution at the end of each prompt. Example of an interesting output evaluated by pure human ***intuition (by author):***

Top View Prompt: Imagine a top-down view of an array of slender, ethereal columns, each representing a quantum state in a serene, monochrome landscape. These columns, set against a stark white background, are interlinked by delicate, web-like structures symbolizing quantum entanglement. The air around each column vibrates with a subtle shimmer, hinting at the superposition principle, where each column exists in multiple states at once. This scene is captured in high contrast monochrome, emphasizing the interplay of light and shadow to depict the unseen forces and the probabilistic nature of quantum mechanics. –ar 1:1 –v 5.2

Right Side View Prompt: Visualize from the right side, a series of abstract, monochrome columns standing against a pure white backdrop, each column gracefully ascending and intricately detailed to represent a quantum state. From this perspective, the columns are interconnected by thin, almost invisible lines, suggesting the complex relationships and entanglement between quantum states. The texture of the columns suggests

a dynamic, fluctuating surface, capturing the essence of quantum uncertainty and the wave-particle duality, all rendered in a minimalist black and white palette to focus on the form and structure of quantum interactions. –ar 1:5 –v 5.2

Left Side View Prompt: From the left side, picture a collection of tall, spectral columns in monochrome, each uniquely shaped to symbolize different quantum states, against a clean, white background. These columns are connected by a network of faint, swirling patterns, representing the fluid, interconnected nature of quantum mechanics. The play of light across the columns reveals a world of probabilities and possibilities, with shadows and highlights designed to suggest the movement and energy of particles at a quantum level. The scene is a study in contrast and subtlety, showcasing the elegance and mystery of quantum states in a stark, monochromatic scheme. –ar 1:5 –v 5.2

STEP 2 - Generating input images via AI Platforms

2-A) Accessing AI generative servers like Midjourney (DALL-E, Stable Diffusion, etc.) to generate finite iterations for each prompt. The process of stopping the iterations or selecting the best generation can turn out to be extremely difficult and unprecedented, but this will be food for thought to other researches, as it is not a mere intent of this paper. We will just stop wherever we think it's the best option, as well as we will try different iterations on Grasshopper and see different results.

2-B) Selecting and upscaling desired input images, while documenting each iteration with specific codes like numbers or letters in our electronic device (PC/Mobile); to better comprehend the progressiveness of the quality for each generation. You can see some of the upscaled variations of top view generated images on Figures 2,3 and 4 while the side views' iterations are shown in Figure 5.

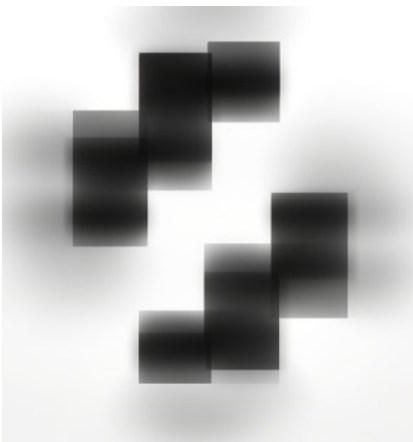


Figure 2: by author, Upscale 4 – Variation 1

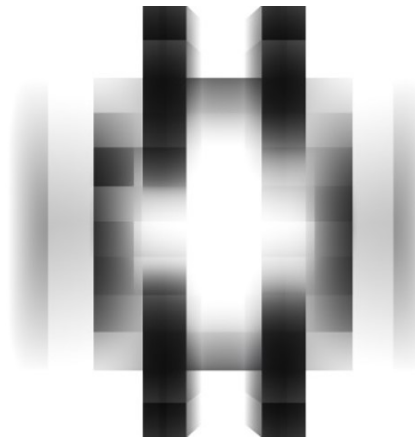


Figure 3: by author, Upscale 2 – Variation 2

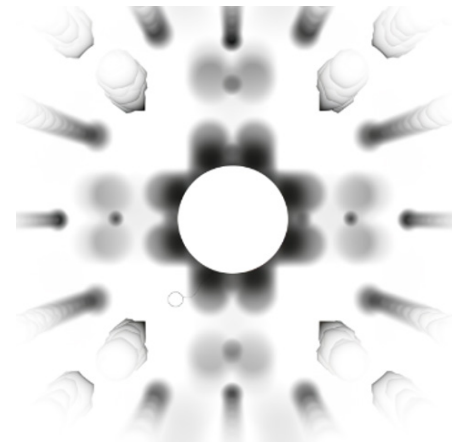


Figure 4: by author, Upscale 3 - Variation 3

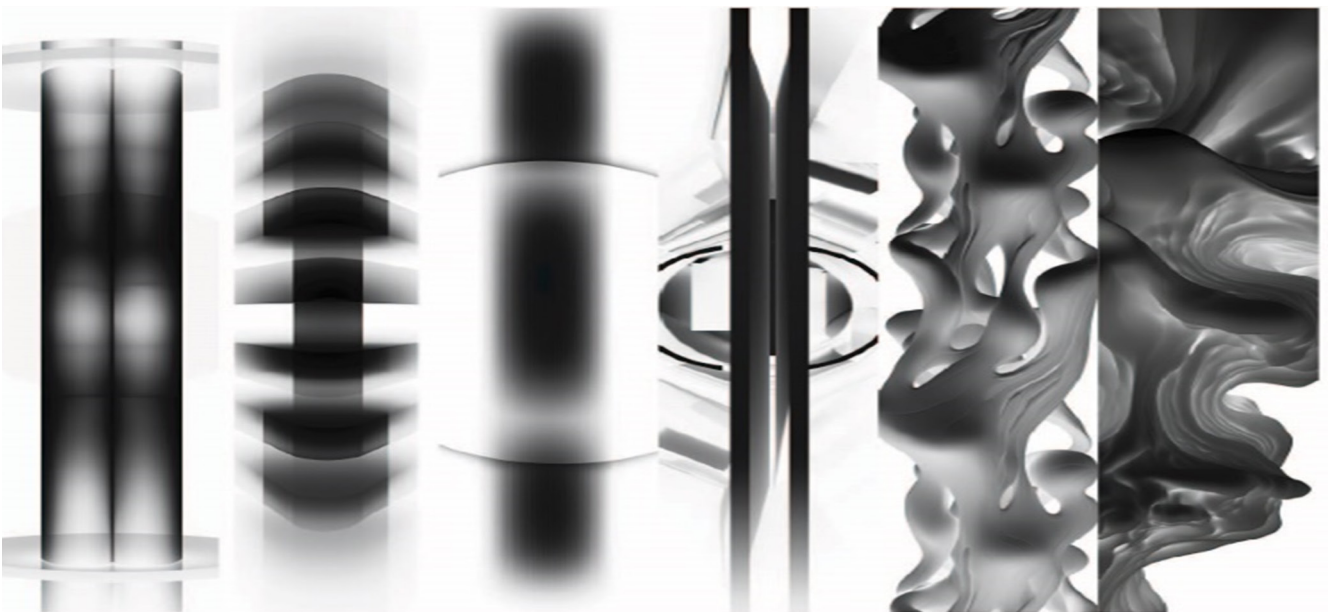


Figure 5: by author, Upscaled Variations - Side Views (Right & Left)

STEP 3 - Computational Blend – Images to 3D translation through 3 Axes (X/Y/Z)

3-A) – Assuring the right installation of Monolith Plug-in (by Andy Pane) for Grasshopper in Rhinoceros 6/7. Insertion of input images in 3 Axes to generate the 3D mesh.

3-B) – Generating variations by replacing the input images with other input variations taken from Step 2.

3-C) – After choosing one/couple 3D meshes, we bake the geometries from GH into Rhinoceros (V1 – Figure 6).

3-D) – Play around in traditional CAD Modelling in Rhino, by applying different scales, sizes, ratios etc. (V5/6/7 - Figure 7) and export best images in High Resolution JPG/JPEG/PNG (or similar).

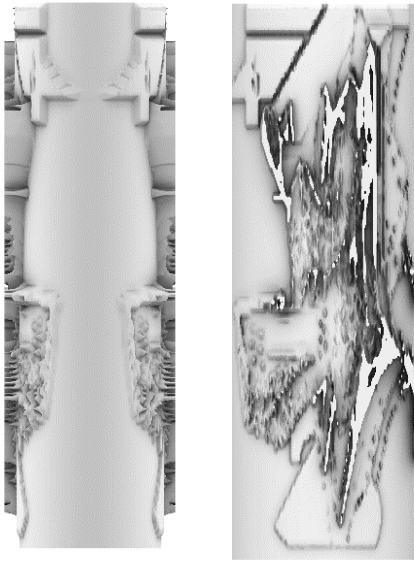


Figure 6: - by author, Algorithmically Generated via Monolith in GH - Side Views (Right & Left) v1

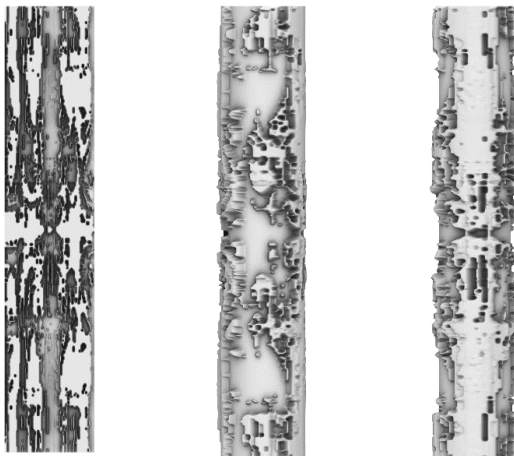


Figure 7: by author, Algorithmically Generated via Monolith in GH - Side Views (Right & Left) v5/6/7

STEP 4 – Further AI contextualization

4-A) – Upload High-Resolution images to the world wide web by getting an accessible image link via public servers/domains or similar (ex.: <https://postimages.org/>).

4-B) – Insert link in AI servers like Midjourney (or similar) and set a low style of abstraction (ex. $-q < 50$, or similar; depending on the platform you are using), while crafting your prompt of reference and generating variations. (Figure 8)

4-C) – If you are not satisfied with the results, try going back to AI text generations to better optimize your prompt with your desired output specifications. Example: “Read and comprehend the following prompt, and craft me the best prompt possible to achieve the essence of it: digital neo-gothic hyper-realistic column with high-end quantum detailing that represent the complexity of today’s architectural paradigms’ shift”.

4-D) – Example of a final prompt iteration generated and optimized for Midjourney version 5:

“<Link of image file, previously uploaded> Envision a column that embodies the fusion of past and future: a masterpiece of digital neo-gothic design, hyper-realistic in its execution, standing tall against a stark, minimalist background, preserving the essence of the initial input image provided through the link. This column is not just a structure but a statement, intricately detailed with motifs that draw from the rich heritage of gothic architecture, yet reimagined. Picture high-end, quantum-inspired detailing that weaves through the column's fabric, suggesting a mesh of otherworldly energy and matter; symbolizing the complex evolution of architectural paradigms. The column's texture is a juxtaposition of ancient stone and futuristic, shimmering quantum particles, creating a visual metaphor for the transition from traditional to contemporary architectural thought. The lighting is dynamic, highlighting the column's intricate details, casting shadows that dance and reflect the quantum detailing, enhancing the depth and dimensionality of the structure. This digital rendering should not only capture the viewer's gaze but also provoke thought on the seamless integration of historical elegance and cutting-edge innovation, representing the complexity and fluidity of today's architectural shifts. $-q 50 -ar 9:16 -v 5.2$ ”

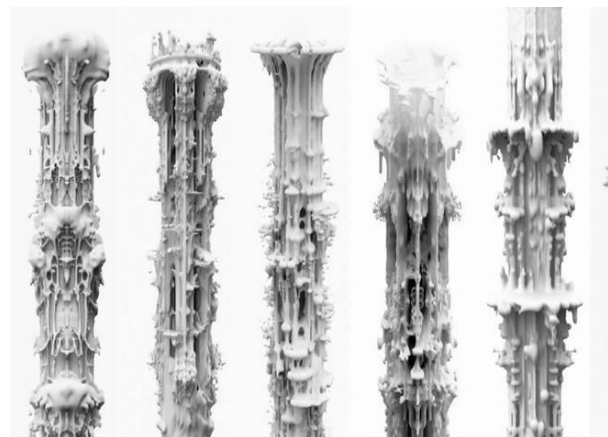


Figure 8: AI iterations of Contextualized Columns

STEP 5 – Computational Encoding & Fabrication

5-A) – Bearing in mind the possible encoding of the image through image to 3D algorithms, we need to assure an orthogonal qualitative image of the column.

5-B) – Through Grasshopper algorithmic assistance, it is possible to build simple scripts that mimic a simplified version of what Monolith does, reading every pixel as color by later translating each color code to numbers. The list of numbers can then be re-mapped in desired values in way to achieve a detailed 3D Mesh.

5-C) – In older versions like Rhino 5/6/7 there will be a need for assuring the closing of the mesh and guaranteeing a good and clear geometry, while in the latest Rhinoceros 8 (McNeel & Associates), a new command called ‘Shrink Wrap’ is available. It automatically adjusts and clears the mesh for 3D printing purposes. Once this process is concluded, we can also think of other fabrication methods like laser-cutting profiles (ex. through ‘Contour’ in X/Y/Z axis) (Figure 9), negative mold creation, etc.

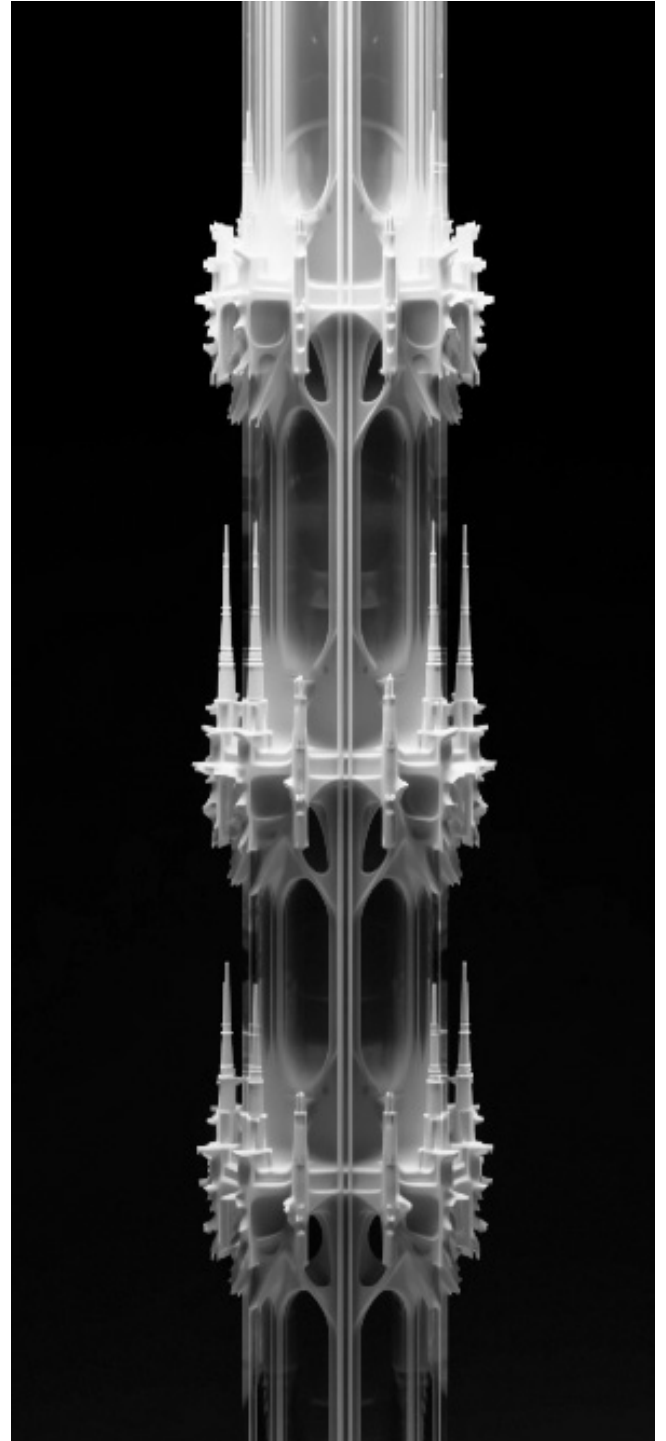


Figure 9: Fabrication Proposals of Columns’ Iterations, Generated through the Computational Continuum philosophy

Limitations and further developments

As we crest the current wave of the 'Artificial Epoch,' it is imperative to acknowledge the limitations inherent in the integration of AI within architectural design. The fidelity of AI-generated designs is bound by the quality and breadth of input data; richness in, richness out. The computational continuum we navigate is not free from the constraints of existing technologies and the current state of machine learning and cognitive computing. These tools, while revolutionary, are not panaceas. They function within the bounds of our current understanding and capabilities, leaving ample room for further development.

The expansion of AI's role in architectural design predicates not only on technological advancements but also on our capacity to adapt our methodologies to its evolving nature. The role of AI must extend beyond a generative force into realms of critical analysis and decision-making. Further developments could see AI not only suggesting forms based on environmental data but also critiquing its own designs, engaging in a form of self-improvement and learning that mirrors the architect's own reflective practice.

The future beckons a multi-disciplinary approach, blending cognitive science, environmental psychology, and computational design to cultivate AI that understands context, culture, and the subtleties of human experience. Such advancements will challenge the boundaries between the natural and the constructed, the real and the simulated, ultimately leading to a more holistic, integrated approach to architectural design. Despite its clarity, the study faces limitations due to its speculative nature and the rapid pace of AI development, which may not capture the full spectrum of future advancements in architectural practices. The scope of this research is limited by the current technological landscape and the speculative application of AI in architecture. The evolving nature of AI tools and methodologies presents a challenge in predicting long-term effects on architectural design processes and outcomes. Future research should focus on empirical studies to assess the practical impacts of AI in architecture, from design to construction. Investigating the ethical, social, and cultural implications of AI in design practices is also crucial for ensuring that technological progress aligns with sustainable and human-centric values. Collaborative efforts between architects, technologists, and ethicists will be key to developing AI applications that are innovative and ethically responsible.

Conclusions

This inquiry into the 'Artificial Epoch' has revealed the profound entanglement of AI with the future of architectural design. Far from diminishing the role of the architect, AI augments the creative process, providing a new set of tools to navigate the complex, multivalent challenges of modern design. The speculative nature of architecture finds a kindred spirit in AI's predictive models and generative capabilities, offering a sandbox for innovation and experimentation. The AI-augmented design processes reflect an evolution, not a replacement, of traditional methodologies. They offer a bridge to new forms of architec-

tural expression and understanding, rooted deeply in the rich soil of history and philosophy, yet reaching out to the boundless possibilities of the future. There is an urgent need for speculating, addressing and consolidating different methodologies as well as their possible appliances which constantly adapt to the ever-evolving state of technological advancements. As we embrace this new era, it is important to underpin the AI integration as a possible partner in the creative process, a medium through which the architect can explore uncharted territories of design with newfound clarities and depth.

The 'Artificial Epoch,' then, is a misnomer for what is genuinely an age of augmentation and amplification of human potential through the lens of computational intelligence. It is an epoch that stands to redefine not just how we design but also fundamentally, what we conceive as architecture in the context of our ever-changing world. In the exploration of the symbiosis between artificial intelligence (AI) and architectural design, this study has illuminated the profound implications of AI's integration into speculative design methodologies and the computational continuum. The evidence presented, suggest a pivotal shift towards an architecture that is both responsive and anticipatory, leveraging AI to navigate complexities and innovate sustainably. Looking forward, it is imperative that research continues to critically engage with the ethical, practical, and theoretical dimensions of AI's role in architecture. Such inquiry should aim to forecast emerging trends, delineate potential challenges, and propose frameworks that ensure technological advancements align with human-centric and environmental principles. This approach will not only refine our understanding of AI's impact but also guide the architectural discipline towards a future where technology and humanism are inextricably linked.

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Acronym	Full Meaning
AI	Artificial Intelligence
GeD	Generative Design
DSC	Design Space Construction
AEC	Architecture, Engineering & Construction
NN	Neural Networks

AI-Artificial Intelligence and the Growth of the Creative Potential of Designers in the Fashion Industry

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Abstract

Artificial intelligence (AI) in the 21st century has reached a high level of use and is now an integral part of every industry, or of the way a business is functioning. The fashion industry, being one of the most variable industries in the world, had no way of making an exception from the use of Artificial Intelligence. Starting from the idea, and product development and up to mass production business in any industry. The fashion industry is no exception. From product development to robotic manufacturing, AI has made its way to almost every segment of the fashion value chain. Fashion is a trend that has its own story evolving as ideas are recycled or given new interpretations. It's a phenomenon associated with the pursuit of perfection. Fashion has been around, for as long as humans can remember. It took off when consumerism became prevalent in the 19th century. This was also the time when social scientists started paying attention to fashion. Fashion is all about what's considered trendy and appropriate in a time and situation. A certain group of people known as fashion leaders play a role, in shaping these trends. They have a status that allows them to determine what's fashionable and others follow their lead. Fashion used to be a privilege that only a select few could enjoy. However, in today's society, economic progress has opened up the opportunity for a large number of people, from countries to actively participate in fashion competitions. It's not about wealth though; people now have psychological freedom and the emergence of new communication methods has made fashion even more significant in our lives. This article delves into the impact of intelligence on the rise of designers, in the industry exploring how it enhances and automates their creative process. Fashion needs followers, but it is also necessary for some people to be out of fashion, as not everyone, or everything, can be 'in fashion'. When something is too common, it can be replaced, otherwise, fashion cannot be used to differentiate between people. Fashion design is well-accepted as a career option. A very large number of institutes exist around the world, offering courses in various fields of fashion. The number of students who consider fashion as a serious career has continued to grow over the years, not limited only to people who have studied fashion, but we can have people who have studied other professions but find themselves very well in the fashion industry. In such a diverse market, what makes the difference in the industry is the designer's ability to keep up with the times. Artificial intelligence has brought a variety of artistic creations, allowing everyone to express their style. Regardless of which of these creations have the potential to find real application in the real world.

AI research has created techniques based on probability and economics to deal with ambiguous or partial information. The "combinatorial explosion" that occurred when the problems got bigger and the machines become exponentially slower made the early algorithms unsuitable for handling large argument problems. They address the majority of their difficulties with snap decisions based on intuition. Conditional statements, conditional expressions, and conditional constructs form the foundation of the computer language. A popular construct in many programming languages is the if-then (sometimes known as if-then-else). This fundamental boolean condition can be resolved by a computer. It is predicated on the fundamental principles of what is True or False. On the other hand, this sentence alone, along with the If and Then that surround it and the consequences that follow, comprise a conditional statement that lacks intrinsic value but has an internal meaning (like expressing a coherent logic rule). ((n.d.))

Keywords

Artificial intelligence; design; fashion industry; optimization; product development

Introduction

Referring to the explanation from Wikipedia: "A fashion designer conceives clothing combinations of line, proportion, color and structure. While sewing and modeling skills are helpful, they are not a prerequisite to successful fashion design." (Wikipedia, n.d.) A designer is the creative mind behind any outfit, be it a high-fashion outfit a pair of jeans, or a casual shirt. They conduct research, develop a concept and vision for the type of person they would like to dress, create a visual image of their concept through sketches, and oversee the various design and manufacturing processes that bring their sketches or designs to life in the form of a three-dimensional garment that fits their muse or target market. In other words, a designer is the "brain" behind every piece of clothing produced. He/she sees the finished garment in his/her mind, documents it on paper in the form of a sketch (or covers it on a mannequin), and gathers together a strong team of skilled people to help him or her build it. of his idea in a "wearable" or better yet "physical" garment. Their main work is to invent new, unique, and original methodologies, from single pieces such as skirts, jackets, shirts, and so on, to complete combinations of clothing, suits, or glamorous dresses. Fashion designers also need to possess a certain amount of knowledge about various theoretical aspects related to their work, practical skills are not enough for such a profession. A designer visualizes and turns creation into reality. Fashion not only provides a functional purpose but also often includes mysterious aspects of being human and thus encourages people to create emotions and creativity. Our physical appearance but also our spiritual side is greatly influenced by what we wear. This makes the fashion industry very powerful to influence our lives and this makes it necessary to invest a lot in this industry and of course to have direct access to technology, to artificial intelligence. artificial intelligence (AI) is a field of computer science that looks beyond human logic and intelligence. The intersection of fashion and AI is a rich and expansive space that is just beginning to be explored. As AI continues to develop, it becomes more difficult for non-technical followers to understand. The challenge of understanding lies in the way of meaningful developments between these two fields. However, it should be given due importance that the people who adapt to this technology are the first to succeed in this industry.

How is the fashion industry traditionally developed?

Production in the fashion industry includes some very important rules:

- Client request consultation: Designers often receive requests from managers or clients who want them to design special fashion projects or create a new collection. It is the designer's job to meet the client's or fashion house's requirements and create a product design that fits the brand's style, values, budget, and constraints. Clients will include this relevant information in a fashion brief, a document detailing the scope of the project, and other necessary information that a designer needs before starting production.

- Finding inspiration: Fashion is more than just what you wear, but how it is worn and the visual story it tells. Whether designing for someone else's label or making a collection for themselves, designers look to their everyday lives for inspiration. They will draw inspiration from sources such as music, art, history, architecture, and fashion trends. Designers try to discern what current fashion trends communicate about consumer wants and needs to inform their designs.

- Sketching ideas: Sketches help designers mentally visualize designs. Sketches present an idea in a tangible form, giving the image a different perspective. Sketches are the foundation of design; these minimalist, flat drawings can communicate the technical elements of an idea, including darts and seams, sleeve length, overall length, fit, shape, and more. Eventually, these sketches will become a blueprint for the pattern maker to create the first muslin or prototype.

- Design improvement: Many designers use a mood board or inspiration board to improve their design style. These reference points can help organize ideas or inspiration materials and see which creative ideas have the most interest. Photos, magazines, books, and movies are all sources that designers use to inspire their designs. They can also include fabric patterns or textile design ideas to further narrow down their style choices.

- Choice of fabrics: Designers need to choose the right type of fabric to express their design ideas adequately. Sometimes, the fabric will dictate the type of garment the designer makes; Other times, the type of silhouette will inform the fabric selection. Good designers research the weight, thickness, and texture of their fabric selections to better understand how they fit, move, and wrap around the human body.

- Choice of colors: Color is a powerful tool to convey a mood. It's often the first thing people notice when they look at a piece of clothing. Fashion designers must choose the right color palettes to ensure they depict the right mood and story for their clothing. Learn more about how designers create color schemes in our color theory guide.

- Sampling and prototyping: Finally, the designer will finalize their sketches and send them to the model makers for prototyping. Pattern makers create the first garment sample with materials such as muslin, a loosely woven cotton fabric often used to test garment patterns before cutting and sewing the final product. Prototypes aim to capture the spirit of the final garment through their shape, fit, and fabric choice. This sample product marks the first time a designer will see their garment in three-dimensional form, which they can review and modify as needed.

- Assembly of the garment: Construction brings a design to life. The designer must determine the best techniques to use to formally construct their garments, such as stitching, buttons, or zipper selection. These design choices must work within the context of their fashion history. For example, the distressed and

unfinished look works well for a trendy streetwear collection, but may not be the best choice for an elegant evening gown.

- **Wear testing:** Designers often use fashion models to visualize and conceptualize their designs. Models allow designers to see how their garments fit and stretch on a real, three-dimensional person. If wear is a concern for a design, some models will provide feedback on the functionality of a garment's design, such as how it feels in terms of size, texture, or mobility, which can further inform any changes designers need to make. do when creating the final, smooth finish. product. (Alison, 2012, pp. 34-78.)

How will Artificial Intelligence (AI) change the fashion Industry?

The ability of a machine or robot controlled by a computer to carry out tasks typically performed by an intelligent being is known as artificial intelligence (AI). The technology's foundation is explained in this concise definition. Change is an inevitable force that affects all aspects of our lives, including the fashion industry. Artificial Intelligence (AI) is starting a revolution that will transform the way we create, design, and consume fashion.

Here are some ways in which AI is expected to transform the fashion industry:

- **Trend forecasting:** AI can analyze large volumes of data from social media, fashion blogs, e-commerce platforms, and other sources to predict future trends. By identifying consumer patterns and preferences, AI algorithms can provide accurate trend predictions, helping fashion brands and retailers make informed decisions about collections, inventory, and marketing strategies.

- **Design and Creativity:** AI can help fashion designers generate innovative designs by analyzing large amounts of data, including customer preferences, historical trends, and market insights. AI-powered tools can suggest design variations, and combinations and even generate new designs autonomously, increasing creativity and speeding up the design process. Creatives will continue to be the driving force behind fashion, but AI will lead them.

- **Personalized recommendations:** AI can enable personalized shopping experiences by analyzing customer data, including past purchases, browsing behavior, and preferences. By leveraging machine learning algorithms, fashion retailers can provide recommendations tailored to individual customers, increasing customer satisfaction and driving sales.

- **Virtual try-on and fitting:** AI-powered virtual try-on technologies allow customers to visualize how clothing items will look without physically trying them on. Using computer vision and augmented reality (AR), customers can virtually try on different clothes, styles, and colors, enhancing the overall online shopping experience. AI can also help accurately measure body dimensions, facilitating better-fit recommendations and reducing return rates.

- **Supply chain optimization:** AI can optimize the fashion supply chain by improving inventory management, demand forecasting, and logistics. By analyzing data from various sources, including sales, weather patterns, and market trends, AI algorithms can in-

crease inventory accuracy, reduce overstocking or out-of-stock issues, and optimize the production and distribution process.

- **Sustainability and ethical practices:** AI can play a crucial role in promoting sustainability and ethical practices in the fashion industry. By analyzing supply chain data, AI can trace and verify the origin of materials, ensuring transparency and ethical sourcing. AI can also optimize manufacturing processes, reducing waste and improving energy efficiency. **Influencer Marketing:** Last but not most important - AI can help identify suitable influencers for fashion brands by analyzing social media data, follower demographics, engagement rates, and content relevance. By leveraging artificial intelligence algorithms, brands can partner with influencers that match their target audience, leading to more effective influencer marketing campaigns.

Overall, AI has the potential to improve operations, drive innovation, and create personalized experiences in the fashion industry, benefiting both businesses and consumers.

The impact of the use of artificial intelligence in the fashion industry.

Like technology, fashion is forward-looking and cyclical. According to (Fashion United), the fashion industry has a labor force of 3,384.1 million. Its value is equivalent to 3 trillion dollars. That means it corresponds to 2% of the world's Gross Domestic Product (GDP). (United, n.d.)

Based on "The State of Fashion 2023", a report by McKinsey & Company and The Business of Fashion, 75% of retailers plan to invest in artificial intelligence between 2018 and 2023. (McKinsey) It is changing the way the fashion industry will operate in the entire fashion value chain. Delivering a personalized customer experience and better forecasting is just the beginning. Currently, up to 30% of activities in 60% of occupations across all industries can be automated. It will still take time to implement some of this automation and retraining of the current workforce. At this rate, there is no doubt that artificial intelligence will significantly affect the way we work.



Figure 1: Global AI in the fashion market, by Region. (Eden, n.d.)

Advantages and possibilities of artificial intelligence in the fashion industry.

- Increase the user experience.
- Increased production efficiency
- Automation along production, sales, and logistics
- Intelligent forecasts

“Alexa, what shoes go with this dress?”

More and more manufacturers are relying on artificial intelligence (AI), for example, to improve the shopping experience of Online buyers. Classic example: interfaces to digital assistants such as Google Home or Amazon Alexa. Instead of shopping in apps and on websites, potential buyers talk to their digital assistants. They ask the customer a series of questions and send them a selection of suitable products. This makes shopping more intuitive and more individual.



Figure 2: Image source & copyright by Syte.ai

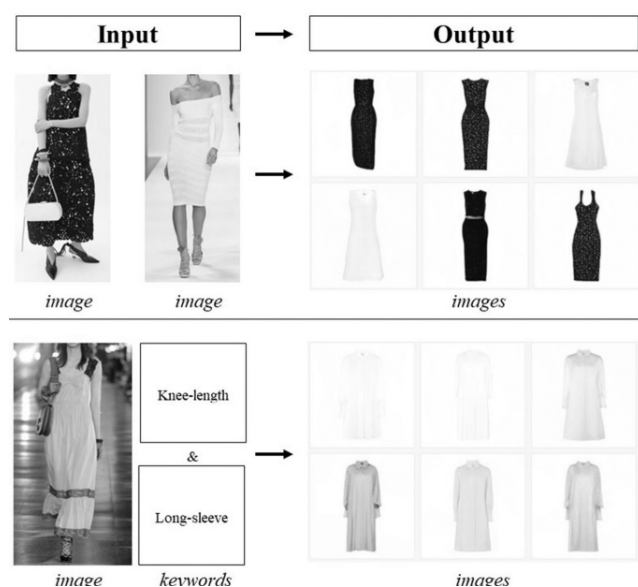


Figure 3: The example of fashion image generation and editing by (Sander, 2022), Vogue

Today, fashion technology is growing at a faster pace than ever. In one form or another, everyone today may have heard or may even have experience in one of the following forms of application of artificial intelligence:

- Robots that sew and cut fabric
- Algorithms that predict style trends
- Clothes to wear in virtual reality
- Smart Mirrors
- Image search
- Data collection
- Chatbox
- Layer and texture

These and many other innovations are an indication of how technology is automating, personalizing, and accelerating the fashion space. Seizing the opportunity to open up more revenue streams and business models, fashion companies are partnering with technology providers, creating startups, and even building their technology. As the industry faces a belated reckoning with its environmental and social impact, processes across the value chain are being examined to reshape itself. It is about how clothes and accessories are designed, manufactured, distributed, and marketed.

“Fashion is part of the daily air and it changes all the time, with all the events. You can even see the approaching of a revolution in clothes. You can see and feel everything in clothes.”
- (Vreeland), former editor, of Vogue magazine

In our daily use of technology, we accumulate a large amount of data that shapes the way we experience retail, enabling the personalization of the experience. This is how we become a known user. In the fashion industry, technology is being built around monthly or annual subscription services. Provide an example of how these order experiences can be applied to e-commerce. While for most fashion brands data is important for driving sales and producing styles that customers want. Using data to keep customers wowed has become part of the DNA of companies like Stitch Fix, Rocksbox, and Le Tote, just to name a few. The appearance of digital products has made it possible for the user to customize the expected consumption experience. They interact with digital products that remind them of what they saw or liked a while ago, but at the same time, they can get to know products that they didn't even know existed until a while ago. This type of customization has gone from a convenience to a necessity. Hyper-personalized recommendations for music, movies, digital other digital products and services have become expected. Netflix, for example, doesn't show you every movie there is when you sign in. Instead, Netflix makes personalized recommendations based on other movies you've watched and specific interests associated with your profile. As this has become the new normal, consumers are demanding it in every aspect of their lives. It gives them a sense of control and reduces choice paralysis. All of these experiences are driven by collecting data about what the user is doing on the site and then turning that into actionable personalization. For a consumer, re-

turning to the fashion retail environment after being exposed to this level of personalization is like entering a world of complete and utter chaos. Suddenly, someone who is used to doing very little to get to a product they want must sift through hundreds or thousands of unwanted items.

The relationship of innovation and technology with creative entrepreneurship. Is technology increasing the number of designers in the market?

Yes, technology has played such a role in the number of designers on the market. In today's era, people are more interested in becoming employers than job seekers. Over time, with the growth of the population, new forms of employment also increase, and at the same time opportunities for employment increase or decrease. However, in the youth of the century we are living in, we noticed that today's young people consider it easier to have their own business and employ others than to work in other people's businesses. In a market economy, this brings about the recognition of the concept of Entrepreneurship. "An entrepreneur is an individual who creates and/or invests in one or more businesses, bearing most of the risks and enjoying most of the rewards. The process of creating a business is known as "entrepreneurship". The entrepreneur is usually seen as an innovator, a source of new ideas, goods, services, and business/or procedures."-Referred to Wikipedia, the free encyclopedia (Wikipedia, n.d.). Entrepreneurs are characterized by their creative abilities, innovative ideas, and new inventions. Entrepreneurship in fashion is just like entrepreneurship in any other field and is no longer limited to stores/boutiques. Different approaches have been developed with the advancement of technology. Designers today are taking advantage of all the benefits offered by modern technologies such as e-commerce, 3D printing, digital avatars, or AI-based marketing strategies. They play different managerial roles - they think of innovative ideas, participate in decision-making, lead in a visionary way, and thus contribute to economic development and a supportive social environment. (Kurz, 2010) In McKinsey's article "Generative AI: Unlocking the future of fashion" (2023), it is stated that "Generative AI has the potential to affect the entire fashion ecosystem. Fashion companies can use the technology to help create better-selling designs, reduce marketing costs, hyperpersonalize customer communications, and speed up processes". Generative AI is the distinction of algorithms that can create new content such as images, text, code, audio, and videos based on existing data. (McKinsey, 2023) While still nascent, generative AI has the potential to help fashion businesses become more productive, get to market faster, and serve customers better. The time to explore the technology is now. Fashion is synonymous with creativity and is also about organization, strategy, and management. Entrepreneurship in the fashion industry is the fusion of business creation and management with specific aspects of the industry. In recent years, the entrepreneurship of the fashion industry has gained importance and so has the competition in the fashion industry across the globe.

Design is getting more attention because of the technology industry.

The introduction of AI technology in the creative industries at a mass scale is fairly recent however it is growing at an impressive speed. The AI related market in media and entertainment was said to have reached \$10.87 billion in 2021. This numbers are expected to grow at an annual rate of approximately 26.9% from 2022 to 2030 translating in \$99.48 billion. Geographically this increased has been located mainly in the developed countries with the North America region accounting for 38% of the overall revenue related to AI models. This impressive raise in popularity can be highly attributed largely to the unique abilities of the technology namely virtual creation of media, composition of highdefinition graphics and formation of real-time virtual worlds. (Wingström, (2022)) Artificial Intelligence (AI) is having a significant impact on the fashion industry, which has increased the creative capacity of designers in several ways. AI opens up new creative options for designers and helps them create new concepts. These technologies also facilitate data manipulation and provide new approaches to difficult problems, allowing designers to explore more creative avenues than they could before. When there is a noticeable change in the form and structure of relationships, we can declare that the technological ecosystem has reached a new stage of cooperation. These days, we can't just think of product design as a necessity for businesses; rather, we see it as something that brings the product to life. (Design, 02.2020) There are no longer long-term answers to business problems when they are approached only from a technological point of view. It's safe to say, in my opinion, that design is now an essential component of problem solving. Why am I saying this? Simply put, in our daily technological lives, we deal with more patterns than ever before. A product's user experience and usability are significantly more important in determining its overall success and that of its customers. The importance of user interface (UI) and user experience (UX) design has increased due to the widespread use of technology. Good design highlights the fact that modern consumer-facing technology is much more elegant than in the past. As digitization efforts are taking over our lives, most businesses have some sort of online presence, and a company's website is often the initial point of contact between a customer and a brand. For this reason, making a strong first impression is essential. And only strong design can achieve this. A large number of software projects are derailed early because their primary focus was on technology rather than usability. Today's users are very intelligent and won't put up with technology that doesn't feel right to them. To create apps that are both tech-savvy and user-centric, design and technology teams must strike a careful balance. Start with design and consider product development to achieve this balance. Business strategy should be shaped in part by design. Technology designers possess the knowledge and skills to understand the business environment and are eager to form strategies by putting themselves in the shoes of the typical custom.

Fashion Content Creation Using AI.

By incorporating AI into the creative aspects of fashion content

creation, the industry could see a revolution in efficiency and innovation. With its AI capabilities to analyze its vast amount, it can predict the right and organized trend in organizing photo shoots, as by analyzing historical data and related information, AI can suggest optimal dates, times, and opportunities. for photo shoots, ensuring the best possible result. But the potential of AI doesn't stop there. By combining conversion rate data with the metadata behind the visual content, AI can provide recommendations for lighting setups that match the right aesthetic or mood. By leveraging the Internet of historical data for high-converting products on, for example, other lighting characteristics, the AI can also suggest optimal lighting setups for new photos. This integration of creativity and data science has the potential to be groundbreaking, as it allows such a data-driven approach to fashion content. Additionally, AI can help make real-time adjustments during photo shoots. By constantly monitoring and analyzing the process, AI can provide immediate feedback and suggestions for lighting adjustments. This empowers photographers and designers to make edits on the spot, saving time and effort during post-production. The ability to receive real-time feedback from AI can greatly increase the efficiency and quality of the photo shoot, ensuring that the desired result is achieved. However, it is important to note that while AI can greatly improve the creative process, the final decisions must still rest with human professionals. AI should be seen as a tool that supports and enhances human creativity and intuition, rather than replacing it. Collaboration between AI and human professionals can unlock new levels of innovation and efficiency in fashion content creation, ultimately leading to a more dynamic and impactful process that results in increased conversion rates and minimized product returns.

Virtual try-on and fitting

Fashion brands benefit greatly from the use of artificial intelligence (AI) in virtual try-ons and fittings. Artificial Intelligence (AI) can produce realistic and customized virtual experiences for consumers by utilizing sophisticated algorithms and computer vision technology. Fashion firms can create a more immersive and engaging online shopping experience for their customers and lower the chance of returns by integrating artificial intelligence (AI) into virtual try-ons and fits.

The following are some ways AI helps with virtual fits and try-ons:

- Measurements and Analysis of the Body. Using user-uploaded photos or videos, AI systems are able to measure and evaluate body proportions with accuracy.
- Digital Fitting Rooms. Virtual fitting rooms, where users may see how clothes would appear on their digital avatars, can be created thanks to artificial intelligence.
- Simulated clothing. AI can mimic the way textiles and apparel items move and wear in a virtual avatar, giving a more accurate picture of how the real garment will act. tailored advice.
- Artificial intelligence (AI) can offer tailored product recommendations for virtual try-ons by examining user preferences, past purchases, and stylistic preferences. This increases the possibility that customers will be satisfied.

- Analysis of emotions and facial expressions. AI can assess how users are responding to various styles by analyzing their emotions and facial expressions during virtual rehearsals. This information can be utilized to enhance suggestions and gain a deeper comprehension of client preferences.

- Integration across platforms. Artificial Intelligence makes it possible to integrate elements for virtual trials on a variety of channels, such as social media, mobile apps, and websites. This guarantees a user experience that is accessible and consistent.

(Banuba, n.d.) is an online platform for practicing. With the aid of an AI recommendation engine and a try-before-you-buy platform, businesses can enhance engagement, reduce returns, and boost revenues.

Textile Simulation Using AI.

Using the parameters indicated by the technology, we will be able to control the textile parameters by evaluating the ability of the textile to be withdrawn and return to the initial position. Or in the worst case, we can estimate the tendency of a textile to tear due to the frictional forces exerted on it. Thus, the textile parameters listed in the software can evaluate the simulation of the textile in the avatar.

How Augmented Reality (AR) is changing e-Commerce.

The impact of Augmented Reality (AR) on e-commerce is revolutionary. By harnessing the power of 3D assets and AR technology, online retailers can now offer customers immersive and engaging shopping experiences that result in higher conversion rates and reduced return rates. For years, the importance of visual content on e-commerce sites has been recognized and used. Including high-quality products, images have always played a crucial role in influencing customer decisions. However, the introduction of elevated 3D and AR assets takes this concept to a whole new level. First, by using high-resolution images and 360-degree views, customers can now gain a full understanding of the product's appearance, structure, and intricate details. This significantly reduces the chances of disappointment during delivery, as customers have a clearer picture of what they are buying.

Second, AR in e-commerce allows customers to virtually try on products such as clothing, watches, glasses, or jewelry. By placing these products in a real "space," customers can visualize



Figure 5: Textile simulation

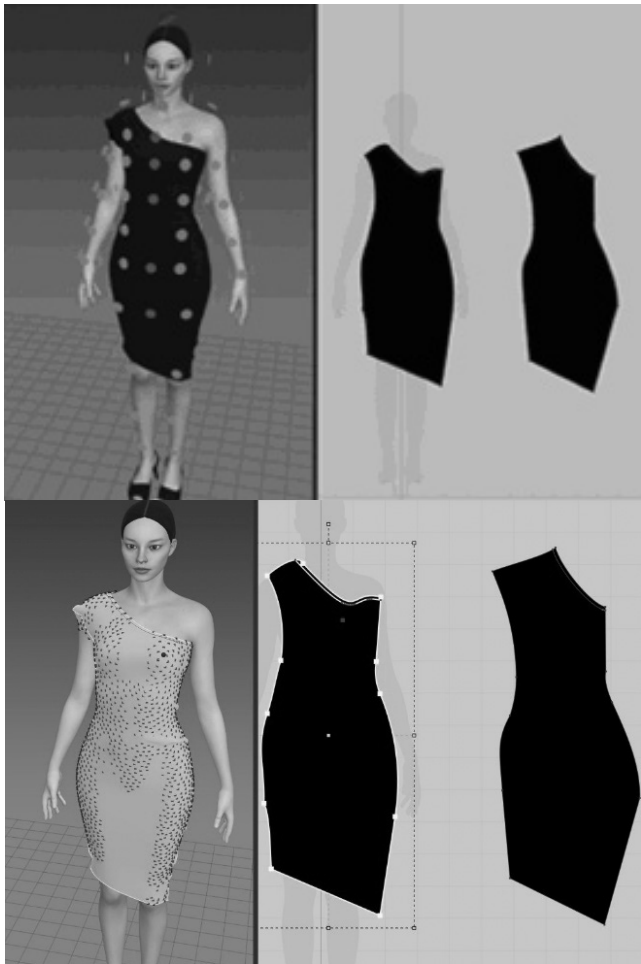


Figure 6: CLO 3D software was used to test this

how they would look and fit in their environment. This integration of 3D models into AR platforms improves the overall shopping experience, making it more interactive and personalized. Furthermore, the connection between AR and social media enables users to share their virtual experiences with friends and ask for feedback. This not only fosters a sense of community but also builds trust and customer satisfaction. Ultimately, using AR in e-commerce creates a better shopping experience, leading to increased sales. To make the shopping experience even more attractive and enjoyable, gamification elements can be



Figure 7: Image from Pexels

included. Interactive product tours and 3D virtual showrooms add an element of fun and interactivity, increasing customer interaction and ultimately increasing conversions. By embracing augmented reality and leveraging 3D assets, online retailers can transform their e-commerce platforms into engaging and informative spaces. These immersive shopping experiences not only increase conversions but also empower customers to make informed purchasing decisions, ultimately leading to higher customer satisfaction and loyalty. (soest)

Limitations of AI in the fashion industry

Since the fashion industry is characterized by human creativity and ideas, there is a need to assess whether AI is in line with the industry's values. Effects on the human workforce: One of the biggest concerns is the potential that the use of AI can replace human labor. With AI algorithms we will be able to do the work of designers, marketers, and other fashion professionals and this increases the risk that some jobs will be lost from the market. This could have a significant impact on the fashion industry as a whole, as well as the wider economy. This is a valid concern and businesses must approach AI responsibly and ethically.

Homogenization: Another challenge is AI's potential to make fashion more homogenized. It is expected that with AI algorithms driving design and marketing decisions, there is also the risk that fashion will become less individual and less creative. This can lead to a decline in the quality of fashion products, as well as a decline in the popularity of the overall industry. This is a real concern and it is up to the industry as a whole to ensure that AI is used in a way that promotes creativity and diversity. Despite these challenges, much of the fashion industry is embracing AI with open arms. With its ability to analyze data and make predictions, AI is offering businesses new opportunities to improve their operations and reach new heights. From improving supply chain management to revolutionizing the design process, AI is transforming the fashion industry and changing the way businesses operate. While AI has the potential to revolutionize the fashion industry, it also presents new challenges that businesses will need to address. However, as with any technology, the benefits and drawbacks of AI in fashion are all a matter of perspective. And with the right approach, businesses can use AI to drive growth and improve their bottom line.

Conclusions

In conclusion, fashion design will have a better future if AI tools are adopted. Ushering in a period of creativity and efficiency through the integration of AI in the design processes of their development as creators and thinkers. With its ability to streamline the workplace and allow designers to unleash their creativity, artificial intelligence technologies have emerged as priceless tools in the creative sector. They are used for everything, including data analysis, design optimization, and concept generation and prototyping. AI can identify customer preferences and trends during collection analysis and make recommendations for developing the best collections. Creative automation will be beneficial for repetitive jobs. Artificial intelligence facilitates detailed attention to the most crucial aspects of design

work. This gives designers the freedom to go beyond the box and come up with ideas that work for their intended audience. As AI technology has grown more accessible, the design process has expanded and inspired exploration among a large number of individuals. Once the products are completed and prepared for photography, artificial intelligence (AI) can scan and evaluate the photographers' suggestions for the ideal lighting, color scheme, and other elements that best showcase a product's appearance. Additionally, fashion firms can stay ahead of the curve by aligning their wares with changing consumer tastes thanks to AI-driven trend research. When creativity and data analytics come together, the precision of algorithms and the elegance of design create a perfect combination. Adaptability is essential in the fast-paced fashion industry, and artificial intelligence (AI) is emerging as a catalyst for agility. Artificial intelligence is driving industry progress, whether through changing marketing tactics, optimizing pricing strategies, or streamlining supply chain procedures. The future fashion scene is expected to be vibrant and ever-changing due to the combination of human brilliance and machine intelligence. The application of AI in the production of fashion products is more than just a technological revolution; it is also a story of seemingly endless possibilities and a monument to the boundless creativity that arises when people embrace the instruments of the future. The fusion of fashion and AI lights the runway of the future, ushering in a time of limitless invention. In a Google form located at the following link <https://forms.yb-jTPbk2iFfXhsPYA>. I conducted an analysis of a few questions to have a better understanding of the relevance, implications, and uses of artificial intelligence in the fashion sector. Following the completion of the academic, study, and perspective sections of the questionnaire on the fashion industry. Academics are a great resource to interview because of their knowledge and experience in the field. I draw the conclusion that AI is being used in a variety of ways (taking into account chat gpt, clo3d, mid-journey, and smart mirror here). The questionnaire was formulated with questions that help to understand how important it was for them to include AI in their daily work and how familiar it was to use AI in their work.:

Are you familiar with the concept of Artificial Intelligence (AI)?

All of the academic and fashion industry respondents who responded to my inquiry about AI and technology use said they had little to no familiarity with the technology. Conclusions about AI's potential primarily reflect the implications that our interviewees thought might arise. Regarding the potential uses of AI in the creative process, the respondents' attitudes were largely positive. Based on the results, we deduced the following consequences for AI: inspiration, quantifiable measurements, time efficiency, professional attitudes, and sustainability.

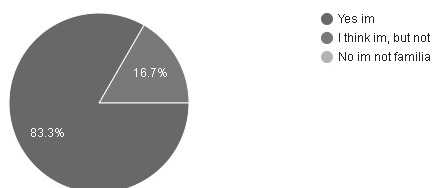


Figure 8: Image from results on Google Form questionnaire .

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Revolutionizing Healthcare: Disease Prediction Through Machine Learning Algorithms

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Abstract

A crucial field of medical research is disease prediction, which has the potential to improve early diagnosis and therapy that can have a major impact on the course of treatment. By dramatically raising the standard of patient care and the effectiveness of the healthcare system as a whole, disease prediction plays a critical role in contemporary healthcare. Early detection of illnesses or medical issues, even before symptoms appear, is a key component of this proactive approach to healthcare management. This enables prompt interventions, better treatment outcomes, and better resource allocation. In this study, we use four different machine learning techniques to predict diseases using large datasets. Our main goal is to evaluate the effectiveness of different algorithms and determine which one performs best at accurately predicting the condition. To guarantee data quality and significance, the study makes considerable use of feature selection, engineering, and data preparation. Across various illness datasets, four machine learning algorithms, K-Nearest Neighbors, XG Boost, Ada Boost with SVM and Logistic Regression, are thoroughly examined. Accuracy, precision, recall, F1-score, and receiver operating characteristic area under the curve (AUC-ROC) are just a few of the performance criteria used to rate these algorithms.

The comparative study not only identifies the algorithm with the best predicted accuracy, but it also offers insightful information about the benefits and drawbacks of each strategy.

This study has significant healthcare impacts. We provide medical professionals with an effective tool for early detection and intervention by determining the algorithm that performs best at disease prediction. Improved disease prediction accuracy can result in earlier and more efficient treatment, which may save lives and lower healthcare costs. Additionally, this research opens the door for the application of sophisticated machine learning methods to clinical practice, ushering in a new era in healthcare where data-driven predictions support clinical judgment. In conclusion, by utilizing the potential of machine learning algorithms for more precise and timely disease prediction, our research supports the continual evolution of healthcare.

Keywords

AI (artificial intelligence); machine learning; healthcare; datasets; algorithm

Introduction

Artificial Intelligence (AI) is having a profound impact on many different industries and aspects of our daily lives, including work and social interactions. Artificial intelligence (AI) and machine learning (ML) have revolutionised the healthcare industry by radically changing the ways in which diseases are identified and treated. In the medical domain, artificial intelligence mostly focuses on developing algorithms and techniques to evaluate if a system's behaviour in identifying diseases is accurate, which also affects disease diagnosis and treatment approaches. A medical diagnosis determines the disease or diseases that cause a person's symptoms and indicators. Usually, diagnostic information is obtained through a physical examination and the patient's history. Because many indications and symptoms are unclear and may only be diagnosed by trained medical specialists, this process is frequently difficult.

Given that humans are prone to making mistakes, it is not surprising that a patient would receive an incorrect diagnosis more frequently. Overdiagnosis can result in problems such as needless medical intervention, which can impact people's health. An uncommon disease's condition, which leads the illness to be incorrectly dismissed from consideration, and a lack of relevant symptoms, which are sometimes undetectable, are two reasons why a misdiagnosis may occur. A branch of artificial intelligence called machine learning (ML) employs multi-dimensional clinical data as its input resource. A multitude of patient data sources, like as genetic information, imaging scans, medical records, and even lifestyle characteristics, are utilised by machine learning algorithms to uncover subtle patterns and connections that might not be immediately obvious to human clinicians. This makes it possible to diagnose illnesses like cancer, heart problems, and neurological issues earlier, which improves patient outcomes and allows for more prompt interventions. The application of machine learning (ML) in the healthcare industry is bringing about a paradigm change by using predefined mathematical functions to provide classification or regression results that frequently outperform human capabilities. Large volumes of patient data are analyzed by these ML algorithms, which then uncover complex connections and patterns that are frequently challenging for humans to achieve. The promise of inexpensive and quick machine-learning-based disease diagnosis (MLBDD) has led to incorporation of ML in healthcare.

Traditional diagnosis procedures take a long time, are expensive, and frequently involve human intervention. Traditional diagnosis methods are constrained by the patient's capacity, but ML-based systems are unrestricted and do not experience human weakness. Also, there is often an absence of qualified healthcare workers in many low-resource environments, especially specialists with training in particular illness diagnosis. Algorithms for machine learning can function as virtual assistants, offering diagnostic assistance even in places where access to qualified medical personnel is restricted. As a result, a technique for diagnosing disease with unexpectedly high patient numbers in the healthcare setting might be created. This is more

beneficial for developing nations like Albania that do not have enough medical professionals that are specialized for specific kind of diseases for their populations and struggle to provide appropriate diagnostic procedures for their maximum patient populations. Additionally, diagnostic procedures frequently call for medical tests, which low-income individuals frequently find to be pricey and difficult to afford. All things considered, machine learning-based illness diagnoses hold the potential to completely transform the way that healthcare is provided in developing nations by increasing access to knowledge, cutting expenses, improving patient outcomes, and enabling remote patient care. These technologies have the potential to alleviate healthcare inequities that impoverished groups experience globally as they develop and become more widely available.

Data, Algorithms, and Methods

In the current world, data is becoming an increasingly important resource. Data is turning into an essential part of decision-making in business, government, research, and other areas. Data is becoming a ubiquitous and extremely valuable resource that permeates almost every aspect of our daily lives in the age of technology. The work of American mathematician Claude Shannon, who is regarded as the pioneer of information theory, is where the idea of data originated in the context of computers. We have selected two different datasets for this research, with one containing information connected to diabetes and the other centered on heart-related data. Our analysis is based on these databases, which enable us to investigate trends, patterns, and connections related to these different health issues. We have carefully applied and assessed the results of four different machine learning algorithms—K-Nearest Neighbors, XG Boost, Ada Boost with SVM, and Logistic Regression—in each of these datasets. With this all-encompassing method, we hope to determine the effectiveness and appropriateness of every algorithm in correctly forecasting results and trends in the context of diabetes and heart-related data. Our goal is to derive significant conclusions about these algorithms' performance and efficacy in tackling particular healthcare issues by analyzing their efficiency in light of multiple characteristics.

Data

The National Institute of Diabetes and Digestive and Kidney Diseases provided the diagnostic measurements for the first dataset that is being examined. This dataset is essential for estimating the probability that a patient would develop diabetes. This dataset is unique in that it focuses on a particular demographic: female patients who identify as Pima Indian and who are at least 21 years old. Multiple important health markers are carefully tracked in this extensive dataset. These contain the number of births in the country, serum insulin levels, diastolic blood pressure, plasma glucose concentration, body mass index, triceps skin fold thickness, diabetes pedigree function, age, and the final result expressed as a binary class variable. Specifically, this binary variable assumes a value of 0 to denote the

absence of diabetes and 1 to signify the presence of diabetes. This dataset is significant since it focuses on a specific population subset and has a wide range of health characteristics. Focusing on women of Pima Indian descent who are 21 years of age or older, the dataset allows for a more in-depth investigation of diabetes risk variables in this particular population. Consequently, the dataset offers significant insights that support a more focused and knowledgeable approach to comprehending and managing diabetes in this specific demographic. Adding a variety of health measures to the dataset enhances its quality and provides a comprehensive view of the various factors that influence the prognosis of diabetes in these people.

The second dataset is a combination of four different databases from Long Beach V, Cleveland, Hungary, and Switzerland. This dataset is unique in that it includes 76 variables in total, including the predictive feature, in contrast to numerous research that usually concentrate on a small group of 14 distinct traits. This dataset's main goal is to determine whether patients have heart disease, which is the main target variable. Heart disease is represented binaryly, with 0 signifying no disease and 1 signifying the presence of the condition. Several significant characteristics have been carefully documented in this large dataset to provide a thorough comprehension of the cardiovascular system. Age, sex, kind of chest pain, resting blood pressure, serum cholesterol levels, fasting blood sugar, ECG readings, maximal heart rate achieved, exercise-induced angina, exercise-induced ST depression, slope of the peak exercise ST segment, number of major vessels coloured by fluoroscopy, and a variable labelled "thal," which suggests the presence of heart defects, are some of these. The careful anonymization procedure used in this dataset to protect patient privacy and data security is a crucial component. Sensitive personal information is kept private by replacing patient names and social security numbers with dummy values. In addition to upholding moral principles, this calculated anonymization promotes the safe and ethical use of data for analysis and study. This dataset becomes a useful tool for researching and comprehending the subtleties of heart disease across a range of populations while upholding the highest standards of data protection and confidentiality by combining a wide range of variables and giving privacy measures priority. The performance of machine learning algorithms is heavily influenced by the number and diversity of datasets they are trained on. The importance of huge datasets cannot be overstated when employing semi-supervised, supervised, or unsupervised learning techniques. When using supervised learning, where models learn from labelled examples to make predictions, large datasets provide an abundant supply of varied examples. (Brownlee, J. (2016) This improves the accuracy with which algorithms are able to recognise nuances and connections between input characteristics and target labels. Likewise, larger datasets offer a greater variety of data points, facilitating the discovery of more significant and representative patterns in the context of unsupervised learning, when computers identify latent structures or groupings in unlabeled data. Large datasets also aid in

semi-supervised learning, which uses both labelled and unlabeled data, by providing an abundance of instances for model enhancement and generalisation. Now that deep learning has become popular, large datasets are also necessary since deep neural networks require a lot of data to build hierarchical representations of complex data domains. Large datasets are fundamentally what allow machine learning algorithms—regardless of paradigm—to achieve higher levels of accuracy, robustness, and generalisation, hence increasing the potential and applications of artificial intelligence in a variety of sectors.

Algorithms

In the field of data analysis and decision-making, the proper algorithms chosen with care are crucial since they affect the quality of decisions made and the ability to extract valuable insights. Through an examination of four different algorithms and their applications to two different datasets, this research seeks to delve into the complexities of algorithm selection. By means of this investigation, we hope to demonstrate the flexibility and efficiency of these algorithms in tackling healthcare issues, highlighting their usefulness in yielding outcomes that are in line with the distinct features and requirements of every dataset. Our research will clarify the complex ways in which these algorithms can be used to address issues in healthcare. We aim to demonstrate the algorithmic prowess in deriving solutions that are accurate and customised to the nuances of the healthcare domain by taking into account the unique qualities and subtleties embedded in each dataset. In addition, the analysis will methodically reveal the benefits and limitations related to every algorithm, providing a thorough comprehension of how well they function in practical scenarios. We hope to give readers insightful knowledge about the complex field of algorithm selection in data analysis by means of a comparison analysis.

In the end, this investigation into algorithm selection makes a significant addition to the larger conversation about data-driven healthcare decision-making. The purpose of this work is to equip researchers, analysts, and decision-makers with the information necessary to successfully negotiate the complex terrain of data analysis by shedding light on the factors and consequences that go into selecting algorithms. By means of a detailed investigation of algorithmic applications in the healthcare domain, we want to augment the collective cognizance of optimal practices, so enabling well-informed decisions that propel progress in the domain of data-driven healthcare solutions.

The algorithms that we used are: XGBoost, AdaBoost, K-nearest neighbor (KNN) and Logistic regression (LR).

XGBoost

One popular and effective open-source implementation of the gradient boosted trees algorithm is XGBoost. This approach, which is classified as supervised learning, combines the estimations from several less powerful, simpler models to produce accurate predictions of a target variable. These weaker learners appear as regression trees in the context of regression with gra-

dient boosting, where each tree translates an input data point to one of its leaves that contains a continuous score. It uses a regularised objective function to improve prediction accuracy. This function includes a penalty term that accounts for model complexity, specifically the regression tree functions, and a convex loss function that measures the difference between the target and projected outputs. Iteratively, the training process introduces new trees that forecast the residuals or errors of earlier trees. The final forecast is then created by combining these new predictions with the results of earlier trees. The algorithm's use of a gradient descent strategy to minimise loss while integrating new models into the ensemble is reflected in the name "gradient boosting" (xgboost, u.d.).

XGBoost's success can be attributed mostly to its scalability across all contexts. In distributed or memory-constrained environments, the system expands to billions of samples and operates more than ten times quicker than popular solutions now available on a single machine. XGBoost is scalable because of a number of significant systems and algorithmic improvements. Among these developments are: a theoretically justified weighted quantile sketch process that allows handling instance weights in approximate tree learning; a unique tree learning algorithm for handling sparse data. Rapid learning with parallel and distributed computing facilitates faster model exploration. The XGBoost algorithm's primary goal is to minimise the objective function that is comprised of the regularisation terms and loss function:

$$L^t = \sum_{i=1}^n l(y_i, \hat{y}_i^{(t-1)} + f_t(x_i)) + \Omega(f_t). \quad (1)$$

These days, XGBoost is the most popular approach for creating predictive models because of its exceptional precision, effectiveness, and flexibility. (T. Chen, 2016)

AdaBoost

AdaBoost, is an ensemble machine learning algorithm that can be used in a wide variety of classification and regression tasks. It is a supervised learning algorithm that is used to classify data by combining multiple weak or base learners (e.g., decision trees) into a strong learner. (Schapire in 2013).

It was first presented by (Freund & Schapire in 1997). The method weights every example equally and begins with a weak learner. Boosting iterations is the process of applying weights w_1, w_2, \dots, w_n to every training sample in order to achieve this. All of the weights are initially adjusted evenly to $w_i=1/n$. The training dataset is then used to train a weak learner on the original data. In the training phase, the new distribution weight is lowered when the error rate falls and vice versa, with an increase in the sample's distribution weight occurring when it does. After that, samples are continuously trained using weights from an unknown distribution. By lowering the error of the subsequent machine and ultimately achieving higher accuracy rates, the goal is to receive positive feedback. It is easy

to locate the AdaBoost algorithm's process, and one such study is in (Lu, Hu, & Bai, 2015). (Schapire, 2003) explains a basic AdaBoost algorithm; relevant Python packages are readily available in (Api reference).

The AdaBoost algorithm of this study works through the following steps:

1. Initially, training and test subsets are randomly created and assigned using Adaboost.
2. By choosing the training set, iteratively trains the model.
3. In order to provide incorrectly categorised observations a higher probability of categorization in the following iteration, it gives them a larger weight.
4. The algorithm uses the customised classifier to assign the weight to the classifier at the end of each iteration.
5. The process keeps going until all of the training data fits perfectly or there are no more estimators left.
6. To classify, conduct a "vote" among classifiers and select the result based on the constructed model.

K- nearest neighbor (KNN)

K- nearest neighbor (KNN) is created by Evelyn Fix and Joseph Hodges in 1951 and is a nonparametric classification method which is simple but effective in many cases according to the seminal work by Hand, Mannila, and Smyth (2001), titled Principles of Data Mining. Both classification and regression analysis can be done with KNN. Class membership is the conclusion of KNN classification. A voting system is utilized to categorize the thing. The distance between two data samples is calculated using Euclidean distance methods, which may be computed using

$$D(p, q) = \sqrt{(p_1 - q_1)^2 + \dots + (p_n - q_n)^2} \quad (2)$$

ing the following formula :

where p and q are the ones with n attributes that need to be compared. This is what the knn() function uses by default (Weinberger, 2009). There are alternative ways to compute distance as well, like the Manhattan distance (Breiman 2001) .

The category or class of any particular dataset can be easily solved with the help of the K-NN algorithm. The following is an understanding of how the K-NN algorithm operates:

- Step 1: Choose the neighbour with the K-number first.
- Step 2: For every K neighbours, the Euclidean distance must be determined.
- Step 3: Using the computed Euclidean distance, select the K closest neighbours.
- Step 4: Determine how many data points there are in each category among these K neighbours.
- Step 5: The category with the greatest number of neighbours will receive new data points.
- Step 6: The K-NN classification model will then be prepared in this manner.

Logistic regression (LR) is a ML technique that is employed to address classification problems. With projected values ranging from 0 to 1, the LR model has a probabilistic framework. Malignant tumor detection, the identification of spam emails, and the detection of online fraud transactions are a few examples of LR-based ML. LR employs the cost function, also referred to as the sigmoid function. Every real number between 0 and 1 is transformed by the sigmoid function. Logistic Regression can be expressed as,

$$\log\left(\frac{p(x)}{1-p(x)}\right) = \beta_0 + \beta_1 X \quad (3)$$

where the left-hand side is referred to as the logit or log-odds function, and the expression $p(x)/(1-p(x))$ is called odds. The ratio of success to failure chances is known as the odds. Consequently, a linear combination of inputs is converted to $\log(\text{odds})$ in logistic regression, yielding an output of 1. A straight line that depicts the association between the variables and clean data with no significant surprises between data points are prerequisites for using logistic regression. This model is applicable to any datasets; however, some assumptions must be taken into account in order to get optimal performance. In binary logistic regression, the dependent variable needs to be binary. Include only the variables that are meaningful. There must be no correlation between the independent variables. In other words, the model should have very little or no multicollinearity. The independent variables have an equal relationship with the log odds. Logistic regression requires large sample sizes. (Fix, E., & Hodges, J.L. 1989)

Methods

A preliminary data analysis revealed that the dataset did not contain missing values. Additionally, data anomaly identification, an analysis for the examination of the data components and descriptive statistics of the data have all been provided. We then split the data in two sets, the first 80% is used for model training, and the 20% is used for model prediction. The decision to treat the modelling as 80-20 was taken after the discussion on the lack of data available. Another possible approach would be using rolling forecasts, which fix the horizon for the test set prediction and use an expanding set of training data as more data become available. We decided to use the first option since the algorithms that we use incorporates the concept of rolling forecasts. In fact, the algorithm implements a method known as cross-validation, which is a variant of rolling forecasts. By using this approach, the algorithm is able to test the performance of the model on different periods of the test set while using an expanding set of training data as more data become available. This helps to provide a more accurate assessment of the model performance and allows for the selection of the best prediction model. After organizing the data, we built the XGBoost, Ada Boost, KNN and logistic regression for Diabet Disease and Heart Disease datasets. The evaluation of these algorithms is made based on accuracy scored. The accuracy is calculated using the `accuracy_score` function from, which returns the count (normalise = False) or the fraction (default) of accurate predictions. The subset accuracy is 1.0 if all of the projected labels for a sample precisely match the true labels; if not, it is 0.0.

If \hat{y}_i is the predicted value of the i -th sample and y_i is the corresponding true value, then the fraction of correct predictions over n samples is defined as where $1(x)$ is the indicator function. (Scikit-Learn developers in 2021)

$$\text{accuracy}(y, \hat{y}) = \frac{1}{n_{\text{samples}}} \sum_{i=0}^{n_{\text{samples}}-1} 1(x)(\hat{y}_i = y_i)$$

Results

First we studied Heart disease dataset using four different algorithms, XGBoost, Ada Boost, K-Nearest Neighbors and Logistic Regression. For a number of reasons, dividing the data into training and testing sets is crucial. First of all, it enables us to evaluate our machine learning model's performance on hypothetical data, giving us a more accurate picture of how well it works in actual situations. A part of the data, in this example 20%, can be set aside for testing so that we can confirm the model's generalizability to fresh data and identify any possible overfitting problems. Moreover, the model can better identify patterns and relationships in the data by being trained on a bigger subset of the sample (usually 80%). This makes it easier to create a solid, accurate model that can produce trustworthy forecasts. After splitting the data, 80% for model training, and 20% for model prediction, we notice that Ada Boost has the accuracy score 0.89. This algorithm is used to classify data by combining multiple weak or base learners (e.g., decision trees) into a strong learner. The combination of Adaboost and SVM-based component classifier has been noted for its deviation from the standard Boosting principle due to the complexities associated with SVM training and the challenge of balancing diversity and accuracy in comparison to basic SVM classifiers. In the study, the Adaboost classifier was trained with SVM as the base classifier, incorporating a dynamic alteration of the kernel function parameter σ value, which gradually decreased in correspondence with the fluctuation of the weight value of the training sample. The performance of the proposed classifier was evaluated through experimentation on human subjects, focusing on the classification of left- and right-hand motor imagery tasks. The testing phase revealed an impressive average classification accuracy of 90.2% on the test data, showcasing a significant improvement compared to SVM classifiers that do not integrate Adaboost and the commonly used Fisher Linear Discriminant classifier. The findings provide substantial evidence that the integration of Adaboost with SVM classifiers has the potential to enhance accuracy in the classification of motor imagery tasks, thus offering promising prospects for enhancing the performance of brain-computer interface (BCI) systems." (Scikit-Learn developers, n.d.)

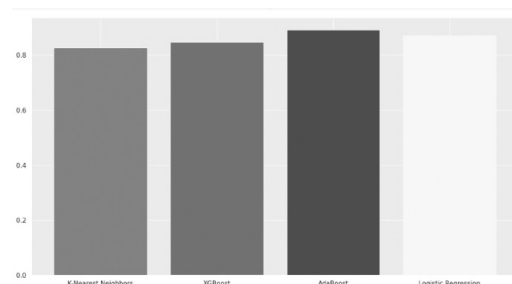


Figure 1: Accuracy Score for Heart disease dataset

The accuracy ratings of several machine learning algorithms used to forecast cardiac disease are shown in Table 1. The accuracy score, which is given as a percentage, indicates how effectively the model identifies cases properly. The table can be interpreted as follows:

1. XGBoost: This algorithm accurately predicts the condition of heart disease in about 84.7% of cases, with an accuracy score of 0.847.
 2. Ada Boost: With an accuracy score of 0.89, it outperforms other algorithms and suggests a high degree of accuracy in heart disease prediction. About 89% of the time, this method classifies cases accurately.
 3. KNN (K-Nearest Neighbours): Displays an accuracy value of 0.75, meaning that in 75% of cases, it accurately predicts heart disease. It shows decent predictive performance, however not as good as the other algorithms.
 4. Logistic Regression: Gets an accuracy score of 0.82, meaning that 82% of the time, it accurately predicts heart disease. In terms of accuracy, this algorithm lies in between XGBoost and KNN.
- To sum up, out of all the algorithms evaluated in this table, Ada

Algorithms	XGBoost	Ada Boost	KNN	Logistic Regression
Accuracy score	0.847	0.89	0.75	0.82

Table 1: Accuracy score for Heart Disease

Boost seems to be the most accurate. Nonetheless, a number of variables, including the dataset's properties, interpretability, and processing efficiency, influence the best algorithm selection. For a thorough assessment of the model's performance, various metrics such as precision, recall, and F1-score must be taken into account. Using key variables like age, sex, exercise-induced angina (exang), ST depression induced by exercise relative to rest

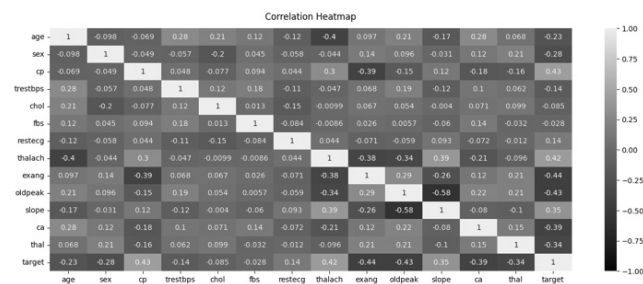


Figure 2: Heat map for Heart disease dataset

(oldpeak), slope of the peak exercise ST segment (slope), number of major vessels coloured by fluoroscopy (ca), thal- assemia (thal), resting electrocardiographic results (restecg), maximum heart rate achieved (thalach), and exercise-induced angina (exang), the heatmap reveals insightful patterns within the heart disease dataset. Brighter colours in the heatmap imply higher correlations, while the heatmap's colour intensity represents the strength of the correlations. Interestingly, there are strong connections between the "thal" variable—which is thought to indicate the existence of heart defects—and the variables linked to chest pain. This implies that these elements are critical to comprehending heart disease. Subsequent investigation may show that specific kinds of chest discomfort and

the particular traits indicated by "thal" may be important indicators of heart disease. As a result, in the context of cardiac disease, these characteristics might be given priority for risk assessment and predictive modelling.

The heatmap indicates that the brighter the colors the higher the correlation and vice versa. We can see that glucose is high-

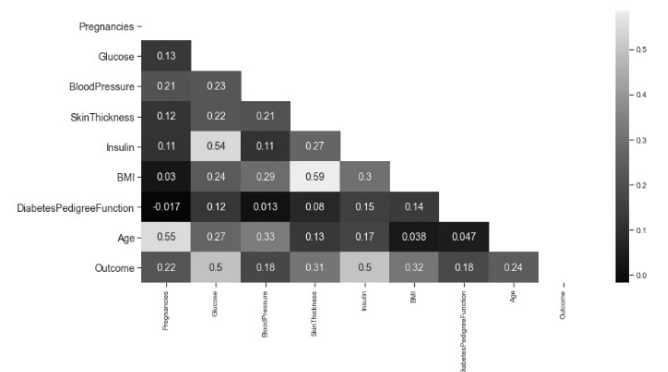


Figure 3: Heatmap for Diabetes Disease

ly correlated to the dependent variable, which invariables means that the above medical facts is shown to be true in the given data. Also, Insulin is the next correlated independent variable in the given data, but obviously does not correlate with outcome which medically is true because Insulin levels are used to predict the type of diabetes. Based on these facts, the following conclusion is made: That Glucose is the major predictor of diabetes Insulin is the major indicator of the type of diabetes. For the above reasons, only the glucose and insulin will be used to predict diabetes and type of diabetes.

The above plot shows the training and test set accuracy on the y-axis against the setting of n_neighbors on the x-axis. Considering if we choose one single nearest neighbor, the pre-

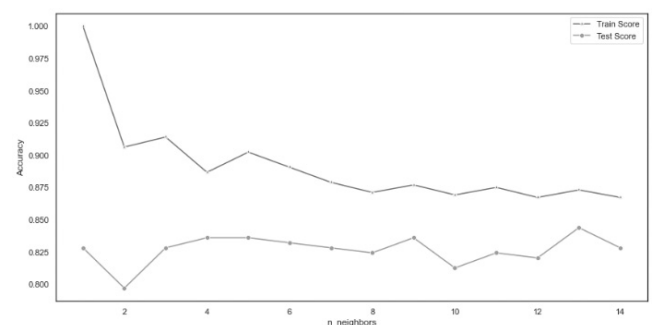


Figure 4: Test vs Training for KNN Algorithm

diction on the training set is perfect. But when more neighbors are considered, the training accuracy drops, indicating that using the single nearest neighbor leads to a model that is too complex. The best performance is somewhere around 13 neighbors. The accuracy score of each algorithm is given on the table below. Here's a succinct explanation: XGBoost: Achieved a 0.75 accuracy rating. Ada Boost: Achieved a 0.66 accuracy rating. With KNN (K-Nearest Neighbours), an accuracy score of 0.75 was attained. With a score of 0.79, logistic regression produced the best accuracy result of all the described

Algorithms	XGBoost	Ada Boost	KNN	Logistic Regression
Accuracy score	0.847	0.89	0.75	0.82

Table 2: Accuracy score for Diabetes Disease

techniques. Accuracy is a gauge of how successfully a model forecasts the right results. The better the model is in making accurate predictions on the given task, the higher the accuracy score. Thus, based on the scores given, it appears that the most accurate algorithm for this problem is Logistic Regression, which is followed by XGBoost and KNN. Ada Boost did slightly worse in terms of accuracy.

Conclusions

In this study, we conducted a thorough evaluation of four machine learning algorithms on two important healthcare datasets. The goal was to identify the algorithm that had the best predicted performance across all datasets. We have come to relevant conclusions about the effectiveness of these algorithms through a thorough evaluation using performance measurements. AdaBoost stood out as the most efficient algorithm for heart disease prediction, delivering the highest accuracy, precision, recall, and F1-score. Its capacity as an effective tool in healthcare was demonstrated by its capacity to merge poor learners into a robust model, which proved essential for spotting prospective heart disease cases. On the other hand, Logistic Regression excelled in predicting diabetes. Its usefulness in forecasting health outcomes was underlined by its simplicity, clarity, and strong performance in this particular application. It is impossible to overestimate the importance of using machine learning in healthcare, particularly in countries like Albania with little resources. By providing precise and timely disease forecasts, which is essential in contexts with limited resources, machine learning algorithms have the potential to change healthcare. These algorithms can help healthcare personnel make better decisions, allocate resources more efficiently, and ultimately improve patient care by leveraging the power of data. Furthermore, the ability to anticipate diseases, as this study's results show, not only improves the effectiveness of healthcare systems but also has the potential to help people and governments spend less money. The early diagnosis and prevention of diseases by machine learning can have a significant influence on public health, especially in economically underdeveloped areas like Albania where access to cutting-edge medical facilities may be restricted. Machine learning can contribute to cost-effective healthcare solutions by detecting high-risk patients and advising preventive steps, thereby enhancing the quality of life for people and communities. The research's conclusions highlight the potential of machine learning algorithms in healthcare applications. We can use the predictive power of machine learning to address health concerns in a targeted and efficient manner by customizing algorithms to particular datasets and health difficulties. This study emphasizes the revolutionary potential of machine learning in the field of medicine and serves as an important first step in improving healthcare in resource-limited areas.

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An approach in using Artificial Intelligence for traffic light optimization (fuzzy method)

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Abstract

Optimization of traffic light has been a hotspot for years, because of technology advancement for the latest 20 years, high demand in international market for car companies to develop, produce more cars and also geographic conditions, high standardization of live enhance this problem. In this paper I will use an approach in traffic light optimization by using machine learning technique, to train a set of data, in order to compute and produce best solutions for optimization of traffic light. There have been many methods used such Webster method, Pedri Net algorithm model, fuzzy model and so on. I will use a different approach to fuzzy method, with intention to provide better output result, decrease the amount of released gases in atmosphere, lower delay and waiting time of cars in a traffic jam. In metropol cities consisting million of people where urban infrastructure is complex, only the development and improvement of these methods can make people's live more simple. One of most early algorithms to minimize cost in travelling through one or lots of routes is Dijkstra's algorithm, where simultaneous tests to use different routes, chose the best route, thus minimizing consumption and increasing output efficiency. The paper will be divided into several sections: Introduction, where a set of definitions, general terms of traffic light software simulation are presented, Big Data, representing the dataset of input where in Artificial Intelligence are the building 'bricks' into comparing and analyzing the output results of different methods/algorithms (Pedri Net algorithm, fuzzy model, improved RNN Dijkstra Algorithm etc.). The upcoming section Methodology, gives a general idea of into analyzing Webster's algorithm and breaking it down into smaller parts, The Derivation of Fuzzy Method, when analyzing bits of components, methodology used in traffic light system and proposed smart system nowadays, fuzzy method is one of the roots in considering clustering techniques, VANet System Architecture, in this section a proposed system architecture is used, it is one of the most important sections because it approaches a solution, which is a derived form of Internet of Thing (IoT) components into achieving a Smart City System, Result section gives output where in the upcoming sections can be used as proposals and ideas. Neural Network, CNN (Convolution Neural Network), DL (Deep Learning) and RNN (Recurrent Neural Network) are sections dedicated to relation between artificial intelligence and smart city implementation, where the main idea is training large amounts of datasets to propose smart, efficient and reliable solutions. In conclusion and future work section, the proposed solutions underline the importance of correlation between general methods: Fuzzy, Webster method with big datasets (machine learning techniques) and future work ideas highlight the necessity of virtualization and doubling – quadrupling the layers of CNN, which is proportional to hardware computational cost.

Keywords

Machine learning; fuzzy method; optimal control; microcontrollers; ReLu; deep learning

Introduction

A large amount of car production and their high demand in usage on urban roads in larger cities where the population boosts year after year requires new urban models in road intersection, while congestion relieving is estimated to be 3-4 times higher than before. (Zhang H., 2021). Traffic congestion is one of the most prevalent problems on the streets in urban areas, especially at intersections that are not properly controlled, so it causes problems in the flow of traffic and the disruption of the streets. Many new solutions has been proposed. A new solution proposes an intelligent control system, which uses a traffic light method called Dynamic Webster with Dynamic Cycle Time, which runs by software simulation (P.A.Sumayya, 2014).The optimization of traffic light is derived from Green Wave. A Green Wave occurs when a series of traffic lights (usually three or more) are coordinated to allow continuous traffic flow over several intersections in one main direction. Any vehicle travelling along with the green wave (at an approximate speed decided upon by the traffic engineers) will see a progressive cascade of green lights, and not have to stop at intersections. This allows higher traffic loads, and reduces noise and energy use. According to a study which modeled the implementation of green waves using SParamics microsimulation and the AIRE emissions module, (Mascia M. H., 2017) the results below were shown which in fact they were significant to what advantages it could bring to us.

- reduce CO₂, NO_x and PM₁₀ emissions from traffic;
- reduce fuel consumption of vehicles;
- be used on roads that intersect with other green waves.
- reduce the time cars wait at side roads;
- give pedestrians more time to cross at crossings and help them to cross streets as vehicles travel in platoons;
- control the speed of traffic in urban areas;

With the introduction of AI, by training big data and usage of stationary and GPS sensor, now it is possible to develop “smart” models to forecast traffic congestion. This is achieved by acquiring historical data, thus giving results under different methods used, summarising strengthness, reliability and weakness of each method.

Big data

Based on extensive research and analysis conducted, it is evident that the traffic datasets utilized in various studies can be classified into two primary categories, namely stationary and probe data. The stationary data category can be further delineated into sensor data and fixed cameras (Akhtar, 2021), whereas the probe data encompasses GPS data affixed to vehicles, serving as a critical component in the studies. It is notable that stationary sensors play a vital role in continuously capturing spatiotemporal traffic data. However, it is imperative to acknowledge the possibility of interruptions in sensor operation, which can potentially affect the data's reliability. Consequently, authorities and stakeholders are advised to account for these temporary sensor failures during the planning and utilization of such data. It is worth emphasizing that the use of sensor data

offers the distinct advantage of providing precise vehicle location information, thereby minimizing any potential confusion or ambiguity in the dataset. There are lots of datasets, where the most used one is Performance Measurement System (PeMS) (Chen, 2002). Through meticulous research and comprehensive analysis, it has become apparent that probe data offers a notable advantage in its capacity to encompass the entirety of the road network. Given the diverse nature of road infrastructure within a network, studies focusing on a broad network scope have demonstrated a preference for utilizing probe data. Notably, one of the frequently employed datasets comprises GPS data, collected at one-second intervals from an extensive fleet of approximately 20,000 taxis in Beijing, China. This dataset encompasses critical parameters such as taxi identification numbers, latitude-longitude coordinates of each vehicle, corresponding timestamps, and the occupancy status of the taxis during sampling periods. It is imperative to note that the data updating frequency for this specific dataset ranges from 10 seconds to 5 minutes, contingent upon the quality of the integrated GPS devices. Furthermore, it is worth acknowledging that non-intrusive tracking of cellular phone movements can serve as an additional data source, ensuring privacy preservation. However, it is essential to recognize that determining the heterogeneous distribution of vehicles from this dataset might prove challenging, if not infeasible. Additionally, when conducting modeling for a road network, the presence of outliers within the dataset may arise due to pedestrian or cyclist movement alongside the roadways. The database which I will use in my publication derives from one of too many prediction datasets in <https://www.kaggle.com/>. From the data interpretation I will employ the usage of fuzzy method, with small altering changes to give actual and reliable results.

Derivation of Fuzzy-C algorithm

In the realm of data mining, Fuzzy C-Means (FCM) has emerged as a prominent non-deterministic clustering technique. Within the domain of traffic engineering research, the recognition of traffic patterns assumes a pivotal role. These research endeavors often encounter challenges stemming from the presence of incomplete or missing data. In response to these constraints, FCM has garnered widespread application as a preferred clustering technique. Notably, this approach offers a distinct advantage over the original C-means clustering methods by effectively mitigating the issue of convergence to local optima. However, it is important to highlight that the utilization of FCM necessitates the establishment of a predefined cluster number, a requirement that may not always be feasible when handling substantial datasets lacking prior insights into the data dimension. Moreover, the computational complexity of this model escalates with an increase in data size, potentially posing challenges in practical applications. Diverse studies have demonstrated successful applications of FCM by addressing and enhancing its inherent limitations, thereby showcasing its adaptability and efficacy in accommodating complex data scenarios.

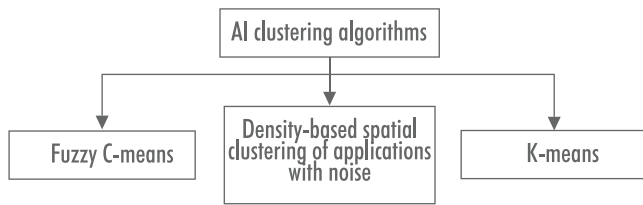


Figure 1: . AI used methods.

Methodology

Traffic congestion is one of the most prevalent problems on the streets in urban areas, especially at intersections that are not properly controlled, so it causes problems in the flow of traffic and the disruption of the streets. Many new solutions has been proposed. A new solution proposes an intelligent control system, which uses a traffic light method called Dynamic Webster with Dynamic Cycle Time, which runs by software simulation. Webster’s method for traffic light design is an *analytical approach* of determining several terms which are exploited as below:

Webster’s Optimum Cycle determines the optimal time shared in a traffic light system between two or four lanes. It carries out the below formula:

$$C_0 = \frac{1.5 \times L + 5}{1 - \sum_i^n \frac{Y_i}{Y}}$$

C_0 : optimum length cycle

L : total lost time (when led is yellow)

\sum_i^n : total critical volume/saturation flow

$$g_t = C_0 - L$$

g_t : total green time

$$g_i = \frac{Y_i}{\sum_i^n \frac{Y_i}{Y}} g_t$$

g_i : effective green time per one phase

Algorithm script:The below representation shows the algorithm logic behind the computations.

start

Input total lost time (L) and total critical volume/saturation flow $\sum_i^n Y$

Calculate C_0 :

- Multiply L by 1.5 and add 5

- Divide the result by the subtraction of 1 and the total critical volume/saturation flow $\sum_i^n Y$

- Store the result in C_0 :

Calculate g_t

- Subtract L from C_0 :

- Store the result in g_t

For each phase 'i' from 1 to 'n':

Calculate g_i

- Divide each Y_i by the total critical volume/saturation flow $(\sum_i^n Y)$

- Multiply the result by g_t

- Store the result in g_i

end

The signal design process encompasses six key steps, which include:

- Phase design,
- Determining amber and clearance times,
- Establishing cycle length,
- Allocating green time,
- Addressing pedestrian crossing needs, and
- Evaluating the performance of the design obtained in the preceding steps.

Phase design aims to segregate conflicting movements at an intersection into different phases to eliminate conflicts. If complete separation without conflicts is sought, a high number of phases may be necessary. In such cases, the goal is to create phases with minimal or less severe conflicts. The development of phases lacks a precise methodology and is often influenced by intersection geometry, flow patterns (especially turning movements), and the relative magnitudes of flow. As a result, a trial-and-error approach is commonly employed. Despite its somewhat subjective nature, phase design holds significance as it sets the foundation for subsequent design steps. Additionally, it is relatively easier to adjust cycle and green times in response to changes in flow patterns, while a drastic shift in flow patterns could lead to significant driver confusion.

VANET (Vehicular Ad-Hoc Network) Smart System Implementation

While discussing about implementation and usage of a smart city, one might suggest VANet “smart” architecture proposal. In the designed VANet system alerting, reporting the surrounding components, thus extending the optimization and reliability of emergency feedback.

Proposed System Architecture

The system comprises several key components: the On-Board Unit (OBU) situated within the vehicle, a dedicated android app named installed on smartphones, a server with a hosted database and a web application, and Road Side Units (RSUs) strategically placed at intersections. The OBU serves to collect data from various sensors within the vehicle, while the RSUs control traffic signals at road intersections. The android app, is integrated into a navigation system, allowing users to access road maps, current location, and route information through a user-friendly interface. Notably, pedestrians with smartphones equipped with can report accidents or road hazards to authorities instantly, triggering emergency services without legal complications. For users driving vehicles, the OBU automatically detects accidents and reports them to the relevant authorities. Bluetooth technology facilitates communication between the OBU and the smartphone, while RF transceivers establish communication between RSUs.

In response to events such as accidents, medical emergencies, breakdowns, or congestion, the smartphone sends messages to the main server, providing relevant data and the vehicle's location. The server maintains real-time tracking of each vehicle and traffic data, communicating with individual vehicles to facilitate necessary services. The network diagram depicted as below, illustrates the interactions between system components, each serving specific functions:

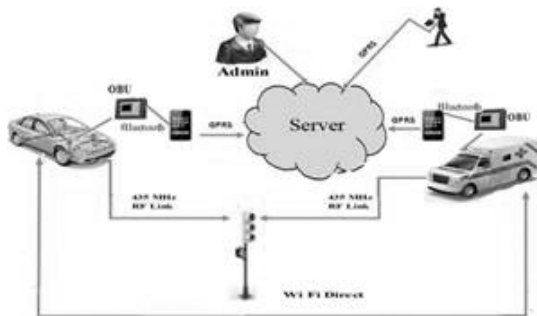


Figure 2: Network diagram (proposed system architecture)

- **OBU**: Responsible for acquiring and collecting sensed data from vehicle sensors.
- **RSU**: Manages and controls traffic signals at intersections.
- **Hosted database**: Stores user accounts, vehicle details, hospital information, and emergency vehicle details.
- **Web application**: Includes a website for user and hospital registration management and an HTTP service to handle requests between mobile clients and the database server.
- **Android application**: Acts as the client interface for users participating in the system.

Results

The results taken from the application of the above algorithm, simulated in a test network in Glasgow examining the impact of three traffic management measures: traffic signal control (TSC), variable message sign (VMS), and a combination of both. To address daily traffic variability, five different demand levels were considered. The results revealed that these interventions effectively reduced BC emissions and enhanced traffic conditions, but their effectiveness depended on factors such as demand levels and VMS compliance rates. Regarding demand levels, the study initially explored five boundary conditions, demonstrating varied impacts. However, to provide more comprehensive insights into the benefits of these interventions, a more detailed examination with finer variations in demand is recommended. The VMS compliance rate was treated as an exogenous variable in the study. To enhance accuracy in estimating the impact of ITS actions, future research should consider modeling the compliance rate as an endogenous variable (Mascia M. H., 2017), allowing for a more in-depth analysis of its interaction with traffic flows across the network. An in-depth analysis of BC emissions per vehicle type highlighted the significant contribution of buses to overall emissions. Even a low bus flow, equivalent to 5% of the total flow (17 vehicles per hour), was found to be responsible for 71% of the overall BC

emissions on the link. This suggests that interventions targeting specific vehicle types may be more effective in reducing BC emissions compared to the studied ITS actions.

Neural Network

The comprised methods of CNN in image segmentation, may alter from each-other in spite of dimensions size input, network depth, filter size, input size etc. Several methods were proposed for image segmentation like: Deep-Medic, FCN-8 and all of these methods had the same root architecture U-Net. It has been proved that CPU core can compute around 6 billion floating points operations. Compared to an average human brain this amount of computation is likely unimaginable to be processed, even though there are no records of 100% power exploiting of human brain. Unlikely to traditional CPU-s human brain is able of computing lots of tasks per fraction of time for instance classification of images. That is the reason why even in the beginning of DNN development in 40s, researchers tried to imitate human brain, where this concept was called as Artificial Neural Network

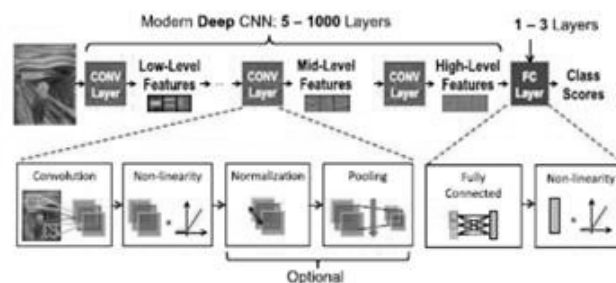


Figure 3: CNN (convolution neural network)

Each of the convolution layers of the CNNs produce a high level of abstraction name f-map (feature map), which conserves essential information. Nowadays, CNNs are able to perform in high level, while introducing a hierarchy layer. After the convolution of the CNN layers the input activators are structure in 2-dimension feature maps, called channel. Every channel is comprised of filter sets, unique for each and every channel, where many times this filter set is denoted as a 3-D filter. Therefore, the convolution products for every point are added together, where the result of the computation output is nonetheless but activation output, named output feature map. Moreover, all input feature maps are processed together as a batch (Yang, 2023), resulting in improvement of filter weights. Additionally, there are other optional layers, as observed in the figure above like, nonlinearity (generally it can evaluate the maximum value of two intersecting function), pooling (it makes the network to withstand to any invariance or distortion) and normalization which is nonetheless but, controlling the input distribution through the layers. Its formula is as below:

$$y = \frac{x - \mu}{\sqrt{\sigma^2 + \epsilon}} + \beta$$

- y, β : parameters
- ϵ : small constant

In convolution neural network the processes occur as below:

Firstly, when the images arrive the computer is to much literal and unable to decide, therefore ConvNets (convolution neural network) matches all the pieces of the image, then filtering happens later on pooling (max pooling), normalization, ReLu, (rectified linear unit) fully connected layer then learning.

The realm of deep learning, a subset of machine learning methodologies employed for data feature extraction, has prominently utilized Convolutional Neural Networks (CNNs). CNNs, a specialized form of artificial neural networks that have been expanded across spatial dimensions through shared weights, have demonstrated their efficacy in various computer vision tasks. Initially, researchers conducted experiments with relatively modest datasets. However, with the reduction in costs associated with high-performance processing hardware, the augmentation of chip processing capabilities, and the exponential growth of online data repositories, the application of deep neural networks has expanded to encompass larger datasets and real-world scenario-based datasets.

One particular CNN (convolution neural network) model, the AlexNet introduced by Krizhevsky in 2012 (Krizhevsky, 2012), has garnered significant attention and adoption within the computer vision research community. This adoption stands as a testament to the substantial advancements in leveraging deep learning frameworks for addressing intricate computer vision challenges. (Nishani E., 2017, June).

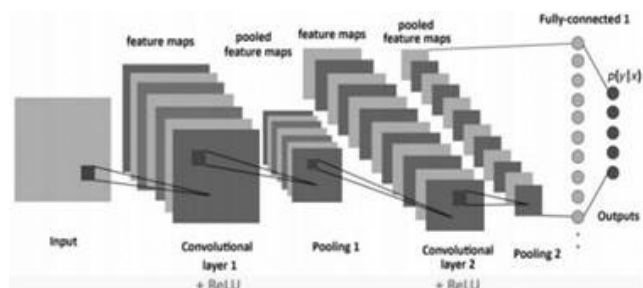


Figure 4: CNN containing 2 convolution layers, 2 pooling layers, and a fully connected

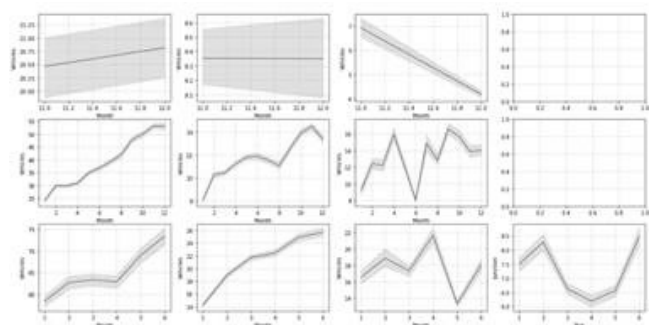


Figure 5: Line plot showing the pattern amounts of vehicles per year after simulating dataset

Efficient traffic light control and the management of urban traffic represent crucial components in the administration of city traffic systems. In this context, our research introduces a novel genetic scheduling model for traffic light control, integrating a status update feature specifically designed for the customization of road signs. This model demonstrates the capacity to dynamically enhance the signal cycle at various intersections, ensuring a remarkably adaptable and responsive approach. Utilizing inputs from camera images positioned strategically along the roadway, our proposed fuzzy logic controller effectively regulates traffic light operations, a feature further supported by the well-documented probability distribution illustrating the flexibility of the fuzzy logic system, thus yielding promising outcomes in simulations (Khazukov, 2020). This controller model enables the implementation of tailored green timing sequences, contingent upon the vehicular density at each intersection. Consequently, it ensures that vehicles do not experience prolonged waiting times, a distinct advantage over fixed-time controllers, as our system adjusts the green signal duration in direct response to the prevailing traffic congestion. This capability underscores the significant impact of traffic conditions on the performance of the Fuzzy Logic Signal Controller (FLSC), with the empirical evidence suggesting notable improvements in traffic flow within various urban settings. Future iterations of this system aim to leverage diverse datasets sourced from multiple cities and locations, incorporating a tracking stage to anticipate traffic conditions before vehicles reach the traffic lights. Our research addresses the challenges associated with the acquisition of data related to vehicle speed and direction from video streams captured by street surveillance cameras, attributed to factors such as varying viewing angles, distance from the intersection, and object overlap.

Fuzzy Method in CNN (Convolution Neural Network)

Furthermore, an additional branch within the YOLO v3 neural network architecture has been introduced, optimizing anchor shapes to enhance object detection and classification precision, particularly for objects of varying sizes. Real-time speed determination employs a method centered on the application of perspective transformation, translating vehicle coordinates within the image to geographic coordinates. In related studies, the integration of fuzzy logic, K-Nearest Neighbors (KNN), and image processing has demonstrated promising potential for identifying vehicular congestion. By employing this approach, the classification of vehicles based on their spatial occupancy becomes feasible, with a particular focus on three primary vehicle types: buses, cars, and bikes. Employing MATLAB (proprietary multi-paradigm programming language and numeric computing environment) algorithms for image processing and vehicle classification, we extract pertinent features such as area, subsequently utilized in the application of fuzzy logic rules. These rules encompass various congestion levels, ranging from light to heavy congestion, quantified as a percentage. Our study underscores the efficacy of incorporating KNN, fuzzy logic, and image processing as a robust strategy for assessing vehicular congestion, offering valuable insights into the optimization of traffic management systems (Chabchoub, 2021).

Deep Machine Learning

Deep learning algorithms (DML) comprise multiple concealed layers aimed at addressing nonlinear problems. A notable advantage of these algorithms lies in their capability to extract features from input data autonomously, devoid of any prerequisite knowledge. Unlike shallow machine learning (SML) techniques, DML integrates feature extraction and model training simultaneously. This characteristic enables DML to effectively transform extensive and intricate traffic datasets, collected within constrained timeframes, into discernible patterns or feature vectors. Notably, in recent years, the adoption of DML (deep machine learning technique) has gained prominence within studies focusing on the prediction of traffic congestion. Figure 8 provides an overview of the traffic congestion studies that have implemented DML algorithms, with detailed discussions presented in this specific section. This integration of DML methodologies in traffic analysis showcases the promising potential of deep learning frameworks in comprehending and addressing complex traffic dynamics.

Recurrent Neural Network

Recurrent Neural Networks are often used to pre-process data like: videos, simple text, different speeches, in that instantaneous position or time depending respectively in the prior data. At each time-stamp the model collects the input from the current time X_i and the hidden state from the previous step h_{i-1} , and outputs a target value and a new hidden state. It exists a type of RNNs called LSTM (long short-term memory) which avoids the issues such as gradient vanishing or exploding problems. (Y. S. L. C. Chao Liu, 2015) LSTM architecture includes gates (input gate, output gate, forget gate), which regulate the flow of information into and out from a memory cell, which stores values over arbitrary time intervals. Furthermore, Recurrent Neural Network can pattern a sequence of data, where every template it is related with the prior model. The perfect process sustainable for the RNN is by convolving every layer, thus increasing effectiveness of the upcoming pixel.

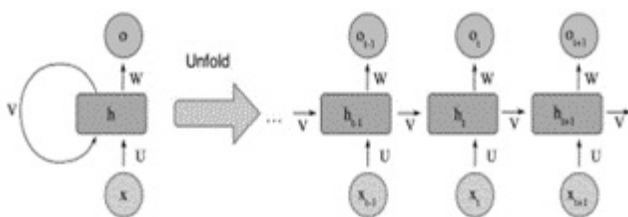


Figure 6: Recurrent Neural Network methodology

In the realms of artificial intelligence (AI), machine learning, and deep learning, neural networks serve to replicate the intricate workings of the human brain, enabling computer programs to identify patterns and address common challenges. Among these networks, recurrent neural networks (RNNs) play a significant role in modeling sequence data. Formed from feedforward networks, RNNs exhibit behaviors akin to those of the human brain. Essentially, recurrent neural networks possess the unique ability to anticipate sequential data, a task that remains

elusive for many other algorithms.

While conventional neural networks treat inputs and outputs as independent entities, certain scenarios, such as predicting the subsequent word in a sentence, necessitate the consideration of preceding words. Consequently, the development of RNNs ensued, employing a Hidden Layer to surmount this predicament. Central to the architecture of RNNs is the Hidden state, which retains specific information pertaining to a sequence (Y. S. L. C. Chao Liu, 2015). RNNs boast a Memory function that stores comprehensive information about computations. It applies identical parameters to each input, ensuring that the same task yields consistent outcomes across all inputs and hidden layers.

State of Art – Research Gap

In traffic congestion probability and statistics play an important role in determining and predicting the results. Based on comprehensive investigations and thorough assessments, it has been observed that probabilistic reasoning algorithms were predominantly employed in specific segments of the prediction model, such as for tasks like map matching and optimal feature number selection. Notably, within this category of algorithms, fuzzy logic emerged as the widely adopted approach. Moreover, from related branches, artificial neural networks (ANN) and recurrent neural networks (RNN) (Carbonneau, 2009) were among the frequently utilized models. While several studies employed hybrid or ensemble models falling within the probabilistic and shallow learning class, only a limited number of studies applied hybrid deep learning models for the prediction of network-wide congestion. Detailed information outlining the advantages and limitations of algorithms from different branches can be found in below figure. Both convolution neural network and recurrent neural network associated together have their own advantages and setbacks, where in different situations different models offer a variety of output results. Among various deep machine learning (DML) models, it was determined that RNN exhibits more suitability for time series prediction tasks. Several studies indicated that RNN outperformed convolutional neural networks (CNN) in scenarios where the disparity between traffic speeds in different classes was minimal. However, given the relative scarcity of research in the traffic congestion domain, there remains a significant potential for the application of new machine learning (ML) algorithms (Patnaik, 2019).

In the context of short-term traffic congestion forecasting, it was evidenced that shallow machine learning (SML) models yielded superior results compared to DML models, as SML demonstrated efficiency in processing linearity, which contributes significantly to short-term traffic flow. Notably, the discussed short-term forecasting studies employing SML exhibited promising outcomes. Simultaneously, DML models showcased notable accuracy, given their adeptness in effectively handling both linear and nonlinear features. Furthermore, for real-time congestion prediction, it is imperative to consider models that entail minimal computational time, as high computational requirements are not feasible in such cases.

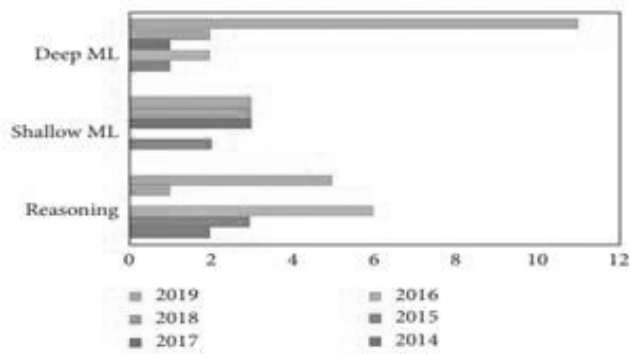


Figure 7: Application of AI models through years

Conclusions & Future Work

The utilization of a network comprising fuzzy components offers a range of advantages beyond those typically associated with distributed systems. Notably, the ease of configuration associated with fuzzy cells facilitates the incorporation of high-level functionalities, including the facilitation of mergers and decision-making processes. In the specific context of the presented application, namely, the utilization of agent-based modeling and fuzzy logic for simulating pedestrian crowds in panic decision-making scenarios, a network of sensors was deployed to intercept Bluetooth signals from mobile devices. Additionally, fuzzy logic was instrumental in determining the positions of pedestrians concerning escape routes and in calculating the optimal evacuation distances (Dumitrescu, 2021).

The primary aim of this research endeavor was to devise a comprehensive solution for the identification, tracking, and analysis of populations within panic-inducing situations. The potential applications of this solution extend across various domains, ranging from public transportation settings to Crisis Management systems. The future work lies in training more and more data and using probabilistic equations to improve the accuracy, implementing traffic congestion algorithm like Webster, Fuzzy method and Dijkstra's algorithm in high complexity telecommunication networks. Proposing new modifications in increasing efficiency, optimization of throughput in high volume traffic congestion smart systems will be a tough task into the near future.

One might suggest that using Virtual environment for complex integrated systems can boost the outcomes in telecommunication networks. (Chu, 2006) Future work lies in using multiple of CNN to affect the training of a larger amount of data. For sure, it will demand greater computational cost, higher GPU processor performance to withstand the operation. Requirements of higher graphical processing unit card are prerequisites in adapting and preventing the drawbacks coming from large amount of computational cost and larger sets of data to be analysed. New GUI (graphical unit interface) also will be designed to replace ImageJ tasks and a software interface which is used to connect with common medical image programs like Slicer or Visualization Toolkit (VTK) will be designed. (Chu, 2006)

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Influence of Artificial Intelligence on Educational Inequalities and Perils Confronting Women in Albania

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Abstract

This paper sheds light on the reality of women following an educational system characterized by a pervasive tendency and the disparities they face in Albania. Despite numerous efforts towards advancement against such phenomena, women in Albania continue to find themselves facing barriers when it comes to accessing education of high quality. The impact of artificial intelligence (AI) on gender disparities in education and the difficulties women encounter in Albania is a complicated and diverse topic. Although artificial intelligence (AI) has promise in mitigating certain educational gaps, its implementation and management could potentially exacerbate pre-existing inequalities. Furthermore, the effects of AI on education may overlap with particular issues that women in Albania confront, such as gender stereotypes and restricted access to education. This article will explore the multifaceted nature of these educational inequalities while taking into consideration many factors such as limited access to schools, cultural norms, gender biases in curricula, and societal expectations that create a self-perpetuating system of discriminatory practices. Furthermore, it examines the risks women encounter when pursuing education, including social stigma, harassment, and violence. By understanding the complexities of these concerns, this abstract aims to raise awareness, prompt dialogues, and advocate for changes that ensure an even-handed and safe environment for women to pursue education in Albania.

Keywords

Artificial intelligence; gender disparities; education; perils; harassment

Introduction

One glance at Albania's history reveals the remarkable strides it has made as both a nation and its people. If we also take the time to consider its sociopolitical environment at the point Albania started its journey as a democratic country, we could say that it has made considerable progress. However, in the aspect of gender equality, this progress thus far is not discernible. We have been bearing witness to many cases of disparities towards our female peers, from them being belittled and not taken seriously solely because of their gender to them losing their lives at the hands of their spouses, as reported in the news. This profound awareness has propelled me towards researching and raising awareness on these issues, aiming to contribute to a fair and inclusive educational environment for all my people. Accessing technology gave positive impacts such as the fact that artificial intelligence has the potential to improve access to education by leveraging online learning platforms to offer distant and flexible learning options. In places where there aren't many educational resources, this might be helpful but exposes to a potential peril: Unequal access to technology could exacerbate already-existing disparities in schooling. It can be difficult for families with little money to give their kids access to the internet or the essential gadgets.

State of Art

In ("Counting Dead Women Albania" , n.d.), we notice a phenomenon happening in Albania and after analyzing it we understand its close correlation with the victim's low background of education as a result of societal expectations.

We are given numbers regarding phenomena that happen in countries with similar educational gender-based disparities, including violence, teen pregnancy, and neglect, 11.8% of women aged 20–24 years old who were married or in a union before age 18. The adolescent birth rate is 14.2 per 1,000 women aged 15–19 as of 2019, down from 14.3 per 1,000 in 2018. As of February 2021, 29.5% of seats in parliament were held by women (Albania, n.d.)

In (Peace Corps Under Pressure Over Albania Sex Scandal, n.d.) we are introduced to an attempt of international structures trying to fight the aftereffects of educational disparities in Albania. After the Peace Corps allowed an easy exit for a former country director in Albania who was accused of sexual harassment - and fired the whistleblower who reported the claims - staff in Albania are campaigning for it to change its internal policies.

In (2016 Peace Corps Albania: Annual Review, n.d.), we come into realization as to why these attempts failed. In this article here, we are also introduced to other related phenomena, such as lack of supervision, neglect from the competent governmental structures whose purpose is to prevent these cases, etc. In this Peace Corps report for Albania in 2016, it shows how the Peace Corps had created 3 working groups in Albania, with the aim of contributing to the education system in Albania, through civil service organizations and recently with contribution in the municipalities of governance.

In (Sokol Pacukaj, 2021), the article brings to attention the importance of gender equality as a valuable asset in our politics, economics, education, and other aspects of society.

In (Jusko, 2019), we will see actual numbers regarding the subject. The study gives detailed information on respondents divided by age, gender, employment, and education.

In (Genc Burazeri, 2015), the article will focus on how educational differences between spouses leads to domestic violence. This subject also opens the door to discussions regarding our societal expectations, and how these phenomena affect a considerable number of men living in a patriarchal society. More than a third (37%, 384/1039) of women had experienced violence. Risk was greatest among women aged 25-34 (odds ratio 1.47, 95% CI 1.04 to 2.09), women with tertiary education (3.70, 2.04 to 6.67), women in white collar jobs (4.0, 1.59 to 10.0), women with least educated husbands (5.01, 2.91 to 8.64), and women married to men raised in rural areas (3.31, 2.29 to 4.80). Women were at higher risk if they were more educated than their husbands (4.76, 2.56 to 9.09).

Current Situation : Unpacking Gender Disparities

Gender-based educational inequalities persist as a significant concern within the Albanian education system. In this section we will cover all the aspects of these issues based on results from other researches in this field of study. We will begin a thorough examination of these disparities existing in enrollment, access, retention, academic achievement, and educational pathways between boys and girls. The peril biased of AI algorithms in educational technologies have the potential to reinforce gender stereotypes. It may restrict chances for women, for instance, if algorithms suggest distinct job pathways according to gender. In academic year 2020-21, 32,690 students graduated in tertiary education, 66.1 % of graduates were females.

The areas in which most females have graduated comparatively with males are "Education" (82.3 %), followed by "Arts and Humanities" (79.9 %) and "Social Sciences, Journalism and Information" (79.1 %).

The areas in which more males have graduated compared to females are "Engineering, Manufacturing and Construction" (64.4 %), "Services" (63.9 %), and "Information and Communication Technologies" (61.6 %) (Education in Albania, n.d.)

Access Disparities

A recent study by UN Women shows that girls in rural areas face significant challenges in accessing education due to factors such as limited infrastructure, long commuting distances, and traditional gender roles that prioritize domestic responsibilities over schooling.² Conversely, boys often enjoy greater access to educational opportunities in urban areas, resulting in an imbalance in educational participation. This claim is also supported by another study conducted specifically for the rural areas of the region of Kruja, where it also shows the importance of education in a society where women are strongly dependent on a

father, spouse, and family in general. The numbers presented in this study unequivocally reveal conspicuous disparities between genders. The study also points out how the political state of Albania, precisely the post-communist era of Albania, affected women and education. It mentions how before that, Albania was in dire need of educated people in different fields of education, and so women and men alike were allowed to pursue education. Undeniably, as it would happen under a dictatorship regime, not everyone was introduced to that opportunity, and even if they were, not always in the field they were interested in. But nonetheless, these cases knew no gender. The issue regarding gender-biased disparities would manifest when education was no longer an asset required by the government, and gender roles were once again pushed into women by the patriarchal elements of Kruja.

Academic Achievements

Gender-based academic disparities are observed in various subjects and levels of education. A positive impact is that AI can help build skills that will be needed in the labor market of the future. By giving them the chance to develop their skills in STEM (Science, Technology, Engineering, and Mathematics) disciplines, this could empower women. Potential peril is the fact that Women who already may have difficulty entering and progressing in the workforce may be disproportionately impacted if AI adoption results in job displace-

ment without equivalent chances for reskilling. Research conducted by INSTAT (Institute of Statistics) indicates that choices made by the students when selecting their path of education are strongly influenced by gender norms and societal expectations. last one isntat These numbers show how boys exhibit a higher propensity for selecting STEM (Science, Technology, Engineering, and Mathematics) oriented fields, while on the other hand women are directed towards fields often labeled as “feminine” such as humanities and social sciences. The acceptance and effects of AI in education may be influenced by cultural norms and societal expectations. For instance, not all areas will gain equally from AI's ability to improve STEM education if it deters girls from pursuing STEM degrees. Security and privacy issues with data are quite important. Insufficient protection of personal data may result in privacy violations that disproportionately impact women and other vulnerable groups. A potential peril is that the development and application of artificial intelligence in education may have unexpected repercussions if there is insufficient regulation and monitoring. Policies that guarantee accountability, fairness, and transparency are vital. A multi-stakeholder approach encompassing legislators, educators, IT developers, and communities is necessary to address these issues. The promotion of impartial AI algorithms, equal access to technology, and an emphasis on inclusivity are crucial for minimizing the risks and optimizing the benefits of AI in education, especially for Albanian women.

Wife's (or family) characteristic	N	Experienced physical violence in past year (n=204)	No physical violence in past year (n=166)
Age (years)			
45-65	379	121 (31.6)	258 (68.4)
35-45	314	112 (35.7)	202 (64.3)
25-34	348	151 (43.4)	197 (56.6)
Education			
> 12 years	271	121 (44.7)	150 (55.3)
9-12 years	528	178 (33.7)	350 (66.3)
0-8 years	500	48 (9.6)	452 (90.4)
Employment status			
White collar	576	180 (31.3)	396 (68.7)
Blue collar	188	47 (24.9)	141 (75.1)
Unemployed	334	105 (31.4)	229 (68.6)
Religion			
Christian	423	161 (38.1)	262 (61.9)
Muslim	607	219 (36.1)	388 (63.9)
Origin			
Urban area (Tirana or other)	495	166 (33.5)	329 (66.5)
Rural area (countryside before age 10)	318	126 (39.6)	192 (60.4)
Rural area (countryside at age ≥10)	500	83 (16.6)	417 (83.4)

Figure 2: Womens experienced violence in the past few years.

Consequences

The evidently existing gender norms have lead to other problematic situations in our society. A study shows that statistically in Albania, teen pregnancy occurs at a rate of 14.2 per 1000 women (ages 15-19). The study also points out the noticeable lack of female representation in parliamentary proceedings and the amount of unpaid care and domestic work provided by women. Unfortunately, the observed phenomenon is merely the tip of the iceberg, indicating the existence of a much larger

	Female	Male	Total
Total	200	200	400
Employed	98	140	238
Unemployed	102	60	162
Higher education	66	98	164
Secondary education	104	88	192
Eight Education	30	6	36
Primary education	0	8	8
18 - 25 years old	52	50	102
26 - 35 years old	56	42	98
36 - 45 years old	40	64	104
46 - 60 years old	50	40	90
61 years and older	2	4	6

Figure 3: Academic achievements based on gender and age.

and complex issue. An article was written by Citizens Channel Albania titled “Counting Dead Women Albania”.¹ As the title indicates, the article quantifies the number of female fatalities during the past months. An Instagram account created by Eva Shimaj and Patris Pustina on the International Day for the Elimination of Violence against Women, posts the cases of the phenomenon of femicide. The two activists talk about their initiative, how they could stand by as they waited for another woman to get murdered, and how the posts in their Instagram profile lack information due to lack of attention from the media and the institutions responsible for such cases. "A woman was killed, and that is sufficient. When reasons are given, they often end up in banalities such as 'for weak motives.' The true reason behind every murder is misogyny," - asserts Eva.

Risk Analysis and response

Understanding the potential risks that society may face due to the persistent educational inequalities faced by women is crucial in developing effective response strategies. This section aims to analyze and address the potential risks associated with women's limited access to education, highlighting the need for urgent action and proposing possible solutions. We will also analyze the compatibility of these solutions with the Albanian society and the competence of governmental structures to prevent the parties partaking into this phenomenon to act against the law.

Unsuccessful Endeavors

After assessing the importance of women being educated in a society, the need for urgent action to develop effective response strategies. In 2016, the Peace Corps made an attempt to assist Albanians and presented them to these goals :

- To help the people of interested countries in meeting their needs for trained men and women.
- To help promote a better understanding of Americans on the part of the peoples served.
- To help promote a better understanding of other peoples on the part of Americans.⁴

Peace Corps operated in three groups to achieve these goals in different regions of Albania. This contribution to Albanian society in 2016 was most needed for the same exact reasons we mentioned beforehand, and so the Albanian people embraced the assistance with heartfelt gratitude. Regrettably, a scandal ensued following the provision of this offer. A former country director in Albania was accused of Sexual Harassment, and after firing the whistleblower who reported the claims, Peace Corps gave the former director an easy exit. In the article written by BalkanInsight³, it is mentioned that the volunteers were the ones to report the crime of two women being sexually assaulted in August 2015. Even though this scandal escalated to massive proportions in the area, the Albanian media and the responsible institutions remained silent.

Assessin Consistent Outcomes

Research indicates a perplexing correlation between a higher educational background of women compared to their spouses

and the presence of domestic violence. In this subsection, we delve into the nuanced relationship between educational disparities within intimate partnerships and the occurrence of domestic violence. This article comprehensively explores various facets of the domestic violence phenomenon, providing in-depth coverage and intricate details.

Conclusions

In conclusion, a complex picture emerges from the analysis of artificial intelligence's (AI) impact on educational disparities and women's difficulties in Albania. AI has a lot of intriguing applications in education, including skill improvement, individualized learning, and greater accessibility. These benefits come with risks, too, which need to be carefully considered in order to prevent widening already existing gaps. The ability to

Wife's (or family) characteristic	N	Experienced physical violence in past year (n=204)	No physical violence in past year (n=600)	Odds ratio (95%CI)	P-value
Age (years)					
40-49	274	121 (21.9)	253 (28.4)	1.00 ^c	
50-59	314	112 (29.3)	202 (60.8)	1.18 (0.88 to 1.62)	0.90
25-34	245	151 (39.3)	195 (29.8)	1.65 (1.22 to 2.24)	<0.01
Education					
>12 years	271	151 (54.7)	120 (21.5)	1.00 ^c	
9-12 years	528	179 (47.2)	350 (55.7)	0.54 (0.40 to 0.74)	<0.01
0-8 years	240	88 (29.6)	152 (28.9)	0.68 (0.45 to 0.95)	<0.01
Employment status					
White collar	275	133 (26.5)	142 (22.4)	1.00 ^c	
Housekeeper	311	147 (34.4)	164 (31.3)	0.61 (0.40 to 0.94)	0.02
Blue collar	554	209 (27.8)	345 (55.2)	0.51 (0.37 to 0.71)	<0.01
unemployed	240	96 (25.4)	144 (28.5)	0.69 (0.42 to 0.92)	<0.01
religion					
christian	474	191 (29.4)	283 (40.2)	1.00 ^c	
Muslim	609	219 (27.8)	390 (59.6)	0.61 (0.35 to 1.15)	0.09
origin					
Urban area (Tirana or other)	465	155 (46.1)	310 (51.4)	1.00 ^c	
Rural area (came to city)	538	179 (55.7)	359 (60.6)	1.50 (0.97 to 2.30)	0.08

Figure 4: Assessin Consistent Outcomes.

use technology becomes a crucial component, since differences in device and internet connection might potentially counteract the benefits of online learning. The potential of AI-powered personalized learning depends on resolving algorithmic biases and making sure that all students, regardless of gender or socioeconomic status, benefit from the technology. Gender bias in AI algorithms is a serious problem since it might reinforce preconceptions and restrict women's access to higher education and career prospects. Moreover, in this paper the necessity for a thorough and culturally aware approach is highlighted by the interconnectedness of gender and sociocultural variables.

While developing and implementing AI in education, societal norms and expectations—particularly those that impact women's professional trajectories and educational choices—must be taken into account. The difficulties mentioned also cover more general societal concerns including security, privacy of data, and the possibility of employment displacement.

Strong governance structures and policies are required in light of these issues to guarantee the moral and just application of AI in education. Collaboration between governmental agencies, academic institutions, tech companies, and local communities is crucial to solving these issues. Legislators are essential in creating laws that promote equity, openness, and inclusivity. Prioritizing equitable access to technology and eradicating gender stereotypes in AI-driven teaching resources should be top priorities for educational institutions. Prioritizing ethical issues will help tech engineers make sure AI systems are inclusive of all people and are free of prejudices. In the end, the field of AI's impact on educational disparities and the difficulties faced by women in Albania is dynamic and ever-evolving. Through recognition of the possible risks and proactive efforts to reduce them, interested parties can leverage AI's revolutionary potential to provide a fairer and more inclusive learning environment for everybody.

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AI Lights and Shadows: Revolutionizing the World

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Abstract

The article examines the effects of artificial intelligence (AI) by highlighting its advantages and its uses, as well as the difficulties and worries it raises. The benefits of AI are emphasized in the first section across several industries, including healthcare, transportation, and education. AI has completely changed the healthcare industry by providing more precise and quick diagnosis, individualized treatment regimens, and better patient care. With the help of traffic management systems and self-driving automobiles, artificial intelligence (AI) technologies have the potential to improve safety, efficiency, and sustainability in transportation networks. Artificial Intelligence (AI) in education provides immersive learning environments, improved learning outcomes, and tailored and adaptive learning experiences. The difficulties and worries surrounding AI are covered in detail in the section that follows. With worries about algorithmic bias and the lack of transparency in sophisticated AI algorithms, ethical considerations are crucial. Another worry is job displacement since the possibility of automation raises concerns about the nature of labor in the future. The gathering and processing of vast volumes of personal data raises the possibility of security and privacy problems. It is essential to address these issues to guarantee the proper development and application of AI systems.

Keywords

Artificial intelligence; healthcare; transportation; education, employment displacement; privacy and security

Introduction

The technology known as artificial intelligence (AI) has come of age, revolutionizing many facets of human existence. Artificial Intelligence (AI) has advanced significantly in industries including healthcare, banking, transportation, and education thanks to its capacity to process and analyze massive amounts of data, learn from experience, and make decisions on its own. However, as AI develops further, it is critical to consider both its advantages and disadvantages. There are several advantages to incorporating AI into our daily life. AI has made it possible to diagnose patients more quickly and accurately, create individualized treatment programs, and provide better patient care. Medical decision-making and early intervention are aided by machine learning algorithms' ability to evaluate medical data, spot trends, and forecast disease outcomes (Esteva A.Kuprel, 2017) (Rajkomar, 2019). Better patient outcomes have resulted from the increased precision and less invasiveness of surgical operations made possible by robotic surgery systems driven by AI. AI has the power to completely transform the transportation industry and our daily commutes. One popular use of AI is in self-driving automobiles, which can drastically lower traffic, accidents, and fuel usage. These cars can make judgments in real time, improve traffic flow, and handle challenging road conditions more skillfully by utilizing AI algorithms, which eventually improves safety and sustainability of transportation (T, 2019). Furthermore, AI technologies have the power to revolutionize learning and education. With the use of intelligent tutoring systems, learning results can be improved by customizing curriculum based on each student's strengths and shortcomings. These systems offer personalized and adaptive learning experiences, enhancing educational outcomes and engagement by utilizing AI's capacity to analyze and adjust to student performance (Baker, 2010; Vanheln, 2011). Furthermore, AI-powered augmented reality and virtual reality apps can produce immersive, interactive learning environments that improve student engagement and effectiveness (Lee). Though AI has a lot of promise, there are a lot of obstacles to overcome. It is necessary to address ethical issues pertaining to AI decision-making, bias, and responsibility. It is imperative to guarantee that AI systems are impartial, equitable, and consistent with societal norms to prevent unforeseen outcomes and possible harm (Bostrom). Another significant obstacle is the possibility of job displacement brought on by AI technology. There are worries about how AI will affect the workforce and the need to retrain workers for new professions as it replaces repetitive and routine tasks (Osborne, 2017). AI's ability to gather, analyze, and understand enormous volumes of personal data also gives rise to security and privacy problems. Individual privacy rights must be upheld, which requires building strong data protection regimes and safeguarding sensitive information (Mitlesatdt).

AI Lights: Positive Impact and Potential Applications

Artificial intelligence (AI) has proven to have a major positive impact in several areas, transforming business and improving quality of life for people. The main domains where AI has demonstrated promise and potential are examined in this section.

Medical Care

Artificial intelligence (AI) has significantly improved healthcare by enabling quicker and more accurate diagnosis, individualized treatment plans, and better patient care. Medical pictures from CT, MRI, and X-rays have been analyzed using deep learning algorithms to help identify and categorize disorders like cancer (Esteva, 2017). Artificial intelligence-driven chatbots and virtual assistants have been created to offer basic medical guidance, prioritize patients, and enhance the availability of healthcare data (Denecke, 2018).

How might healthcare benefit from artificial intelligence?

The artificial intelligence (AI) healthcare market, estimated by Statista to be worth \$187 billion in 2030, is expected to grow from its 2021 valuation of \$11 billion. Because of this enormous rise, the way hospitals, pharmaceutical and biotechnology companies, medical providers, and other businesses in the healthcare sector function is probably going to continue to undergo significant changes. The speed of change in the healthcare industry has accelerated due to the rising application of artificial intelligence (AI) and the availability of 5G, cheaper technology, better machine learning (ML) algorithms, and increased data access. More quickly than humans, AI and ML systems can sort through massive amounts of health data, including genetic data, clinical study results, and medical records. AI could improve the efficiency of hospital operations. AI is being used by healthcare organizations to increase the effectiveness of a variety of activities, including patient care and back-office work. Here are a few instances of how AI might help both staff and patients:

Administrative workflow: It takes a lot of time for healthcare personnel to finish paperwork and other administrative tasks. AI and automation can help with a lot of those monotonous tasks, freeing up employee time for other activities and enhancing their face-to-face encounters with patients. For example, generative AI can help medical staff take notes and summarize information so that patient records are as thorough as feasible. Further areas where AI may be useful are billing, departmental information exchange, and accurate labeling.

Virtual nursing assistants: A survey found that 64% of patients are comfortable utilizing artificial intelligence (AI) to acquire round-the-clock support nurse responses. Chatbots, apps, or other AI-powered interfaces, often known as virtual nursing assistants, can assist with medication inquiries, report cases to doctors or surgeons, and help patients schedule an appointment with a healthcare provider. Clinical staff members can devote more of their time to patient care, which mostly involves human interaction and judgment calls, by delegating routine duties such as these to them.

Minimizing dose errors: AI might be able to identify errors made by patients when they take their own medications. Minimizing dose errors: AI might be able to identify errors made by patients when they take their own medications. One example comes from a study that was published in Nature Medicine and found that up to 70% of individuals do not take insulin as prescribed. An AI-enabled background-running device, similar to a Wi-Fi router, might be used to detect errors the patient makes when using an insulin pen or inhaler.

Less invasive surgeries: AI-enabled robots may be used to operate around sensitive organs and tissues to help reduce blood loss, infection risk, and post-surgery pain.

Stopping deception: The yearly cost of fraud in the healthcare industry is \$380 billion, and it increases consumer out-of-pocket expenses and medical premiums.

Artificial intelligence (AI) can help detect unusual or dubious patterns in insurance claims, like billing for costly services or procedures that were never performed, unbundling—the practice of billing for each step of a procedure separately—and requesting unnecessary tests to maximize insurance reimbursements.

AI could be used to increase the efficacy of healthcare analysis.

Though it's still early in the process, employing AI to generate analysis might save treatment costs by up to 50% and improve health outcomes by 40%, according to Harvard's School of Public Health. A research team at the College of Hawaii found that delivering deep learning AI innovation can raise the risk of breast cancer, which is one application case. The chief analyst noted that an AI computation can be performed on up to a million radiology images, significantly more than a radiologist can, however further research is necessary in this area. Moreover, that computation's value can be performed again, this time with different equipment. Although further research is necessary, the primary analyst noted that an AI calculation can be prepared on a much bigger set of pictures than a radiologist—as numerous as a million or more radiology pictures. Moreover, that calculation can be reproduced value but for equipment. An MIT bunch created an ML calculation to decide when a human master is required. In some instances, such as distinguishing cardiomegaly in chest X-rays, they found that a crossover human-AI show created the most excellent comes about. Another distributed consider found that AI recognized skin cancer superior than experienced specialists. US, German and French analysts utilized profound learning on more than 100,000 pictures to recognize skin cancer. Comparing the comes about of AI to those of 58 universal dermatologists, they found AI did superior.

Precision medicine

With precision medicine, medical procedures can be customized for specific patients or patient groups according to their disease profile, diagnostic or prognostic data, or response to treatment. The customized treatment plan will account for genetic differences in addition to treatment-related variables like age, gender, race, location, family history, immune system, metabolism, microbiota, and susceptibility to environmental stressors. Using individual biology instead of population biology at every stage of a patient's medical journey is the aim of precision medicine. This means collecting data from individuals such as genetic information, physiological monitoring data, or EMR data and tailoring their treatment based on advanced models. Advantages of precision medicine include reduced healthcare costs, reduction in adverse drug response,

and enhancing effectivity of drug action. Precision medicine innovation is anticipated to transform the way health services are provided and assessed while also offering significant benefits to patients. Precision medicine projects come in a variety of forms, but they can be broadly categorized into three clinical areas: intricate algorithms, digital health apps, and testing based on "omics." sophisticated algorithms Large datasets, including genetic, demographic, and electronic health record data, are fed into machine learning algorithms to predict prognosis and choose the best course of treatment.

Digital health applications: Health monitoring data from wearables, mobile sensors, and other sources, as well as data entered by patients on their food intake, activity, and emotional state, are all recorded and processed by healthcare apps. Several of these applications are classified as precision medicine apps because they employ machine learning algorithms to identify patterns in the data, improve forecasts, and provide tailored treatment recommendations.

Omics-based tests: Machine learning algorithms are combined with genetic data from a population pool to identify patterns and forecast a patient's reaction to therapy. To enable individualized treatments, machine learning is used with various biomarkers, such as protein expression, gut microbiota, and metabolic profile, in addition to genetic data.

Transport & Learning

Transportation systems could be transformed by AI technologies, becoming more sustainable, safe, and effective. With AI algorithms and sensors installed, self-driving cars can navigate tricky roads, assess real-time data, and lower the number of accidents brought on by human mistake (T, 2019). Traffic flow can be optimized using AI-powered traffic management systems, cutting down on traffic and travel times (Chen, 2019). AI algorithms have also been used in supply chain management and logistics to improve delivery efficiency, reduce fuel consumption, and optimize routes (&Bostrom, 2018). AI has the power to completely transform education by offering individualized and flexible learning opportunities. AI algorithms are used by intelligent tutoring systems to evaluate student performance, provide individualized training, give immediate feedback, and improve learning results. Artificial intelligence (AI)-powered virtual reality (VR) and augmented reality (AR) applications can produce immersive, dynamic learning environments that improve student engagement and effectiveness. AI-powered solutions can also automate administrative chores like grading, giving teachers more time to concentrate on mentorship and instruction.

AI and autonomous vehicles

One of the key transportation areas where AI is having great impact is in autonomous vehicles. Self-driving cars have the potential to reduce accidents caused by human error and improve overall traffic flow. Many major car manufacturers and technology companies are currently developing autonomous vehicles,

with some already testing them on public roads. Developers frequently train AI control algorithms to mimic the actions of seasoned drivers as they maneuver through oncoming traffic. For instance, PTV Group works with AI developers on projects like CoExist to guarantee that the behavior of autonomous vehicles is accurately recreated in PTV's traffic simulation software. Artificial intelligence-driven devices, or ADAS, optimize driving and lessen the chance of human error. The full potential of smart roads would require the widespread use of autonomous self-driving cars. The general public is currently a little hesitant to give artificial intelligence control of the steering wheel. The public's mistrust is reflected in the deadlock in laws and regulations.

AI in traffic management systems

AI is also utilized in traffic management systems to minimize gridlock and improve traffic flow. Artificial intelligence (AI) systems can save travel time and fuel consumption by rerouting vehicles to less congested roads and adjusting traffic lights based on real-time traffic data analysis. Successful implementations of intelligent traffic management are already in place. Cities such as Taichung, Vienna, New York, or Rome already depend on PTV's real-time solution, which blends dynamic traffic modeling and machine learning techniques. PTV Optima is a software that assists operators in identifying the ideal situations for managing traffic, road closures, and construction sites, as well as in making accurate traffic forecasts up to 60 minutes in advance. Operators are able to respond to changing situations rapidly thanks to smart traffic management. This can lessen or even avoid traffic bottlenecks and clogged roadways before they occur. AI also helps to improve the monitoring of traffic volumes in many locations across the network. AI helps traffic controllers to spot abnormal traffic conditions and bases its forecasts on similar historic traffic situations.

AI in public transport

AI-assisted optimization can help with real-time public transportation management, just like it can with private transportation. A deeper understanding of passenger flows over the network is made possible by big data streams from automated passenger counting equipment and ticketing systems. Traffic controllers can act when demand patterns diverge from usual circumstances and when delays or infrastructure malfunctions impact operations, all based on enhanced situational awareness. Passengers and traffic controllers can both benefit from algorithms' recommendations on how to handle difficult situations. Traffic controllers will be able to decide on the best actions for recovering normal service, e.g. by short-turning trains or buses, substituting buses for trains, or selecting which connections to cut and which to maintain, in order to minimize the impact on passengers. Passengers receive notifications describing the best alternative route to their destination which minimizes delay on arrival. Implementing all of this as part of PTV Optima has important advantages: not only are the decisions based on one overall traffic state for public and private transport – essential for practical bus substitution. Journey planner recommendations to passen-

gers are also always consistent with the dispatching actions of traffic controllers, stranding fewer travellers on their journeys.

AI Shadows: Challenges and Concerns

Although artificial intelligence (AI) has many advantages, there are also serious drawbacks and worries. This section explores some of the major AI-related concerns, such as privacy and security concerns, employment displacement, and ethical dilemmas.

Moral Aspects to Consider:

Ethical considerations become critical when AI systems become more autonomous and make decisions that affect people and society. The following are some ethical issues with AI:

Transparency and Explainability: Since AI algorithms sometimes operate as "black boxes," it may be difficult to understand how decisions are made. Lack of transparency raises questions about fairness, accountability, and potential biases in AI-based decision-making systems. The transparency and explainability of AI algorithms are critical to establishing trust and understanding the underlying mechanics.

- Fairness and Bias: Artificial intelligence systems may inadvertently propagate preexisting biases in training data, leading to unfair outcomes and discriminatory actions. Algorithmic bias is the term for when AI systems disproportionately impact certain populations, like in the example of racial or gender biases in facial recognition systems. In order to prevent discriminatory practices and promote inclusivity, it is crucial to address bias and ensure equity in AI algorithms.

- Accountability and Responsibility: As AI systems become more self-sufficient, questions regarding accountability and responsibility arise. Assigning responsibility for errors or malfunctions in AI systems can be challenging, especially when algorithms are involved in the decision-making process. Establishing definite accountability chains and defining legal and ethical standards for AI systems are crucial.

- Consent and Privacy: AI often uses a great deal of personal data to learn about itself and make choices. The collection, storing, and use of personal data raises concerns about permission, privacy, and data protection. Respecting people's right to privacy and ensuring that the proper permission procedures are in place are necessary to prevent unauthorized access to or exploitation of personal data.

- Bias in Training Data: AI systems are educated on historical data that may contain biases and reflect societal attitudes. Biased training data has the potential to reinforce and maintain prevalent inequities. Thorough training data curation and preparation, as well as ongoing monitoring and assessment, are crucial to reducing biases in AI systems.

- Data Opacity Fuels Privacy Concerns

Organizations have long grappled with data transparency challenges in the world of privacy and security — and the same issues arise in the use of artificial intelligence. Data generated by AI models is often cloaked in obscurity, raising questions about its origin, use, and accuracy. This unclear data usage lurking in

AI models and pipelines raises doubt around entitlements and exposes sensitive information to potential leaks, derailing compliance efforts and exposing enterprises to a world of uncharted vulnerabilities. For example, a leading consumer electronics company banned ChatGPT among its employees after a sensitive code leak happened.

- Unsecured Models Create Vulnerabilities

As the use of AI expands, the need to implement data controls on model inputs and outputs also increases. Sensitive information that is both put into and generated from AI models must meet compliant data protection and privacy standards. Lack of security controls leaves AI models open to manipulation, data leakage, and malicious attacks. Organizations that want to avoid data breach incidents do not have the luxury of making AI security an afterthought; doing so poses a threat to the integrity of the enterprise and the reliability of the brand.

- Uncontrolled Interactions Invite Abuse

Unguarded prompts, agents, and assistants open the door to harmful interactions, threatening user safety and ethical principles. It's crucial to understand how the data generated by these models is being utilized — whether it's being shared in a Slack channel, integrated into a website as a chatbot, disseminated through an API, or embedded in an app. Moreover, these agents, while serving as channels for legitimate queries, also become potential pathways for new types of attacks on AI systems.

Job Losses

Concerns regarding potential job displacement across numerous industries have been raised by the growth of AI and automation. AI can lead to the automation of jobs that have historically been completed by humans, even while it also can increase productivity and open new career opportunities. The following are some salient points about AI-related job displacement:

- *Automation of Routine Work:* AI technologies have the potential to automate routine and repetitive tasks across multiple industries. Robotic process automation (RPA) and machine learning are two examples of these technologies. Jobs involving manual data entry, assembly line labor, and repetitive tasks are more likely to be automated.

- *Impact on Particular areas:* Jobs in manufacturing, transportation, and customer service might all be eliminated by the application of AI technologies. For example, self-driving automobiles may have an influence on jobs in logistics and transportation. But it's important to keep in mind that AI may create new job opportunities and career trajectories in these industries.

- *Change in Job responsibilities:* In addition to automating certain tasks, artificial intelligence (AI) has the ability to modify work duties. Instead of taking the place of whole job positions, AI may augment human abilities and free up workers to focus on higher-value jobs that need creativity, critical thinking, and problem-solving skills. This shift can lead to a change in work positions rather than a total loss of jobs.

- *Reskilling and Upskilling:* Retraining and upskilling initiatives are crucial to mitigating the impact of job relocation. Employees can find job opportunities in developing sectors and

adapt to the changing nature of the labor market by acquiring new skills that are complementary to AI technologies. In order to equip people with the skills they'll need for the employment of the future, governments, universities, and other organizations should sponsor training projects.

- *Creation of Jobs in AI-Related industries:* Although AI adoption may result in the displacement of certain jobs, it also opens new career opportunities in AI-related industries. These include roles as data scientists, AI engineers, AI ethicists, and machine learning specialists. The development of AI technology creates new job opportunities and calls for a trained workforce to create, implement, and oversee AI systems. According to a recent report of 750 business leaders using AI from *Resume Builder*, 37% say the technology replaced workers in 2023. Meanwhile, 44% report that there will be layoffs in 2024 resulting from AI efficiency. But even amid reports of AI-inspired layoffs, many experts disagree with Musk's view. Julia Toothacre, resume and career strategist at *Resume Builder*, recognizes the numbers from its research may not accurately reflect the broad business landscape. "There are still so many traditional organizations and small businesses that do not embrace technology the way that some of the larger companies do," Toothacre said. Layoffs are a reality, but AI technology is also enabling business leaders to restructure and redefine the jobs we do. Alex Hood, chief product officer at project management and collaboration software company *Asana*, estimates that half the time we spend at work is on what he calls "work about work." Here, he's referring to the status updates, cross-departmental communication and all the other parts of work that aren't at the core of why we're there. "If that can be reduced because of AI, that can be a great unlock," said Hood. He says that without the nuance behind the numbers, the statistics marking and predicting AI-induced layoffs reflect fear more than reality. With AI tackling task-based work, humans have the opportunity to move up the value chain, says Marc Cenedella, founder of *Leet Resumes and Ladders*. "For the entire economy," Cenedella said workers will be able to focus on "integrating or structuring or defining what the task-based work is." He compares this shift to mid-century office culture, when there were entire floors of typists — something that the efficiency of word processors eliminated.

White-collar work and 'human-centered' AI

According to *Asana's State of AI at Work 2023* report, employees say that 29% of their work tasks are replaceable by AI. However, *Asana* is a proponent of what it calls "human-centered AI," which seeks to enhance human abilities and collaboration, not replace people outright. The more people understand human-centered AI, the more they believe it will have a positive impact on their work, the report states. White-collar and clerical workers represent somewhere between 19.6%–30.4% of all employed people globally, according to the United Nations. Analytical and communication tools have redirected knowledge work over the years, and "generative AI should be considered another development in this long continuum of change." But as of 2022, 34% of the global population still did not have

access to the internet, so any conversation around AI's impact on layoffs and potential restructuring of the work needs to also include discussion of a wider mote between the technological haves and have-nots.

Why Uncontrolled AI is a Recipe for Trouble

Integrating AI services into enterprise data models requires careful control and oversight over the entire AI lifecycle, spanning from creation to deployment. This is essential to reduce risk around security breaches, compromised data privacy, legal violations, and damaged brand trust. Yet an alarming gap exists between adoption and governance. A September 2023 survey from The Conference Board shows that over half (56%) of US workers are using generative AI technologies on the job, and a survey by ISACA indicates that only 10% of organizations have a formal generative AI policy in place. And so we also enter the era of uncontrolled AI, in which AI governance becomes an increasingly vital priority for businesses that want to integrate AI models safely and transparently while driving positive business impact and meeting legal and ethical requirements. Without the right controls and oversight in place, enterprises encounter a series of risks that can turn their quest for innovation and efficiency into a compliance and security calamity. Here are just a few of those dangers. In this rapidly changing environment, the race to innovation is more competitive than ever — and privacy and security risks are more relevant than ever. As companies strive to achieve business goals via the expeditious incorporation of AI, those very same organizations are still figuring out what their AI posture will be. Without complete visibility into all AI systems, deployed internally or through SaaS, hidden models operate with unknown risks that can lead to astronomical costs down the line. To intensify the problem, shadow AI shows signs of proliferating at a faster rate than the parallel challenge of shadow IT that has beset security and governance teams for decades — and continues to.

5 Steps to AI Governance

Fortunately, there are ways that enterprises looking to enable the safe use of AI can integrate AI models into their data landscape while meeting legal requirements, upholding ethical standards, and driving positive business outcomes. Here's how incorporating AI governance into a central Data Command Center enables the safe use of AI:

- *Discover AI Models*: The first step is to discover and catalog AI models in use across public clouds, private clouds, and SaaS applications.
- *Assess Risks and Classify AI Models*: Evaluate risks related to data and AI models and classify AI models as per global regulatory requirements.
- *Map and Monitor Data + AI Flows*: Connect models to data sources, data processing paths, vendors, potential risks, and compliance obligations — and continuously monitor data flow. Implement Data + AI Controls for Privacy, Security, and Compliance: Establish data controls on model inputs and outputs, securing AI systems from unauthorized access or manipulation.

- *Comply with Regulations*: Conduct assessments to comply with standards such as the NIST AI RMF and generate AI ROPA reports and AI system event logs. Beyond merely “controlling” data, forward-thinking businesses that get ahead of the risk posed by uncontrolled AI will not only enable the safe use of AI through better governance that upholds ethical and legal standards, but will unlock untold value in business performance, insight, innovation, and brand reputation.

Risk management

Risk management is a critical challenge when implementing AI in an organization because AI systems can introduce various forms of risk, including ethical, legal, and operational. The potential for biases in AI algorithms, data breaches, regulatory non-compliance, and unexpected system behavior can lead to reputational damage and financial liabilities. Organizations must establish robust governance frameworks, data management practices, and transparency mechanisms to mitigate these risks. Effectively managing these risks is essential for ensuring legal and ethical compliance, maintaining stakeholder trust, and successfully integrating AI into business operations.

What is Shadow IT?

Shadow IT is a term used to describe IT systems, applications, or services that are used within an organization without the explicit approval, knowledge, or oversight of the IT department or the organization's management. It typically arises when employees or departments adopt and use software, hardware, or cloud services for their specific needs without going through the official IT procurement or security processes. As the nomenclature “shadow” implies – these IT activities exist in the background or hidden from the official IT infrastructure and support. Whilst it can mean dark and sinister things are afoot – often it is simply employees using an application without IT's knowledge. However, while individuals or teams may resort to shadow IT with good intentions, such as finding quick solutions to address their specific needs or improving productivity, it can also create several challenges and risks for the organization, including:

- *Security risks*: Shadow IT often lacks proper security controls and may expose sensitive data or systems to potential breaches, hacks, or data leaks. When a solo employee subscribes to a SaaS app to perform a certain task it is unlikely that they will also put in place a procedure to delete their access when they leave a company and transfer access to a colleague.
- *Data loss*: When IT systems are not centrally managed, data may be stored in unsecured locations, leading to data loss or accidental data deletion. It may not even be an actual data deletion problem simply that the one individual who implemented a tool leaves the company and nobody else knows where the data is or the account login details.
- *Unreliable / Flaky supplier*: Many SaaS based apps are produced by startups and small companies and run on rented co-lo or cloud hardware. If the company goes bust in a poofy cloud of venture capital fueled smoke or gets hacked – you have a problem.

- **Unsupported or unpatched:** Freeware version of tools easily accessible to the individual often come with no support commitments, can be withdrawn on a whim, may not feature certain security features and may even be the test system for the commercial paid version of the tool and not subject to the same security hardening, patching and testing as the paid version.
- **Lack of integration:** Shadow IT applications may not be well-integrated with the rest of the organization's systems, leading to data silos and inefficiencies. Folks may cut-n-paste bits of information into the official systems which become desynchronized from the reality of what is happening in practice.
- **Compliance issues:** Organizations may face compliance and legal problems when using unapproved software or services that fail to meet regulatory requirements. SaaS tools with web frontends are often hosted in a US cloud and don't meet GDPR type compliance needs in Switzerland or Germany. Increasingly potential customers are including RFI (Request for Information) questions that include whether a supplier has processes in place to approve and evaluate applications they use.
- **Increased costs:** The use of multiple uncoordinated IT solutions can lead to duplication of efforts and increased costs for the organization. Many SaaS tools are free to encourage uptake but when used in anger at scale will require an upgrade to a paid tier.

Security and Privacy

There are serious privacy and security risks with the broad use of AI technologies. The following are important considerations for security and privacy in the context of AI:

- **Data Privacy:** Artificial intelligence (AI) systems sometimes rely on enormous amounts of personal data in order to produce accurate forecasts and judgments. This data may contain sensitive information such as financial transactions, health records, and personal preferences. Protecting people's data privacy requires preventing illegal access, data breaches, and possible exploitation of personal information.
- **Data Security:** As AI systems are used more often, it's imperative to safeguard the underlying data as well. Organizations must have robust security measures to guard against data theft, manipulation, and unauthorized access. Encryption, access controls, and secure data storage methods are essential for maintaining data security.
- **Algorithmic security:** refers to the vulnerability of artificial intelligence algorithms to adversarial assaults, when malicious actors manipulate input data with the intention of deceiving or misleading AI systems. Adversarial attacks can have detrimental effects such as compromising decision-making and misclassifying facts. Ensuring the dependability and security of AI systems requires constructing robust defenses against algorithmic attacks.
- **Ethical Data Use:** People's right to privacy may be inadvertently violated by artificial intelligence (AI) systems when they collect or handle data. It is imperative for organizations to adhere to privacy regulations, obtain informed consent from individuals, and handle data collection and utilization in a manner that is both ethical and responsible. By implementing privacy-

by-design principles, AI systems can take privacy concerns into account from the outset.

- **Regulatory Compliance:** As AI technology advances, standards and frameworks for regulation are being created to handle privacy and security issues. Protecting people's right to privacy and holding companies responsible for their data handling methods are the goals of laws like the California Consumer Privacy Act (CCPA) in the US and the General Data Protection Regulation (GDPR) in the EU.

Conclusion

Artificial Intelligence (AI) can significantly improve our lives in a few ways and has a bright future ahead of it. Artificial Intelligence has proven to be able to increase productivity, make better decisions, and offer tailored experiences in a variety of fields, including healthcare, transportation, and education. But in addition to these artificial intelligence lights, there are shadows as well that must be recognized and dealt with. The ethical implications of AI algorithms and decision-making procedures are crucial. To reduce algorithmic biases and foster user trust, AI systems must be transparent, equitable, and accountable. In addition, worries about the nature of employment in the future are sparked by the possibility of automation eliminating jobs. Taking proactive steps to manage the impact on the workforce, like developing new job possibilities and reskilling programs, is essential. Adoption of AI depends critically on security and privacy. Because AI systems rely on enormous volumes of personal data, maintaining public trust requires protecting people's privacy and guarding against breaches and unwanted access. The responsible development and application of AI technology requires the implementation of strong security measures and compliance with data protection laws. In assumption, even if artificial intelligence (AI) presents opportunities for advancement, it is critical to confront the negative effects it has. We can fully utilize AI while minimizing risks by managing employment displacement, addressing ethical issues, and maintaining privacy and security.

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A Methodology of Traffic Simulation, a Preliminary Work for VANET Technology

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Abstract

Urban regions across the globe continue to grapple with a substantial problem of traffic congestion, which has adverse effects on both the environment and the overall well-being of citizens. Intelligent Transport Systems (ITS) are essential for dealing with and reducing congestion by employing diverse technological solutions. ITS represents a powerful toolbox of technologies and strategies for managing and alleviating traffic congestion in modern cities. Taking into consideration that their real implementation is very expensive, a preliminary simulation work is required.

This paper aims to propose a way for conducting a traffic simulation for an intersection, using real data. It provides a comprehensive description of the necessary steps to take in order to carry out this simulation and conduct subsequent analyses. The simulators used for this purpose are SUMO and VEINS. The findings presented here demonstrate that the configuration of a crucial point in the road network has specific impacts on vehicular traffic and should be taken into account when making decisions about altering or establishing the topology of key points in the road network within a city.

Keywords

Intersection; SUMO; VEINS; performance; geometry

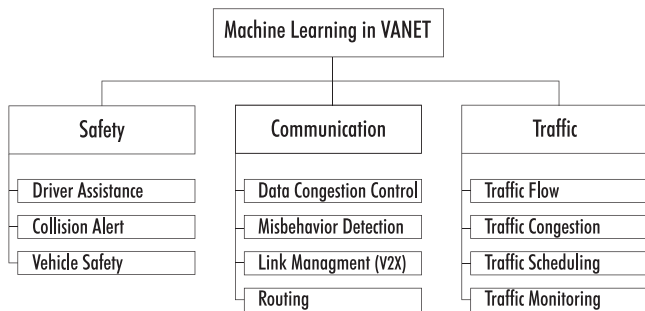


Figure 1: ML use in VANET (Khatri et al., 2021)

Introduction

The vehicular traffic is a significant problem for the urban life. It is a problem for the vehicle, the passenger, and in general, for the life people living in the city. Referring to The Future of Urban Mobility 2.0 study, it is calculated that about 53% of the world's population was living in urban centers in 2014 and an increase of 14% is expected in 2050. This growth of population is associated with the increase of traffic flows in the same time. For this reason, there are a lot of efforts and studies about this problem, that are linked with various aspects of it, like vehicle, accidents and life in general. What is important for the vehicle is the speed of travelling inside the city, the delays caused by the unpredictable traffic, and the possibility of parking when it needs to stop. Vehicular traffic affects both the air quality and life in the city. The rapid advancement of artificial intelligence has brought about a sea change in road traffic management. AI can now predict and control the flow of people, objects, vehicles, and goods at different points of the transportation network with great accuracy. There are a lot of studies that are focused in one of the details of traffic management. Some of them, are focused on the security aspect, to avoid the accidents and the critical cases of the traffic, providing communication networks between vehicles, and between vehicles and RSD units, the so called VANET. Machine learning and fuzzy logic algorithms are also the basis of many VANET clustering algorithms, as we see in the figure (Mchergui et al., 2022). Of course, this phase needs to be preceded by a study of the existing traffic, and its improvement which is linked with urbanistic aspect of the roads too such as the topology of the important points of the road networks like intersections and roundabout. Intelligent Transport Systems (ITS) gain a special attention nowadays. ITS's main aim consist on improving the transportation itself by reducing the traffic problems and providing a sustainable transport system. They include an wide range of communication technologies and smart solutions, which help the traffic flow management and optimization by reducing the congestion. These systems are able to gather and process data related to transportation, to achieve the above aims. One of the key

components of an ITS is connectivity, which plays a crucial role in designing an efficient transportation system. These kinds of problems are impossible to be experimented in real life, for different reasons, and on the other side it is quite necessary to forecast the different situations related to the traffic of the city. Then, the simulations of the traffic are essential. There are a lot of software that, by using some parameters based on the real data of the traffic, make possible the generation of a similar traffic with the real one. This article is an effort to represent a methodology to ensure a traffic simulation based on real data for a zone where these data exist. It has a descriptive character of all the steps that we need to follow to achieve this simulation and to make some analyses about it. This methodology also, is illustrated with an experimental work. The results presented here show that the topology of an important point in the road network has certain effects of the vehicular traffic and serve as a practice that people have to take into consideration when they take some decision regarding the topology of some key points



Figure 2: Work Environment interface (Virtual Box)



Figure 3: Veins interface

in the road network, when this topology needs to be changed or defined for the first time in the city.

The Work Environment

It is helpful to create an isolated work environment when we do such a work, to simulate the vehicular traffic. One of the reasons for this, is to avoid the conflicts between the different versions of software that we will download with those that we have already on our computer. For example, we can have differ-

ent versions of Python downloaded in our computer, which may conflict with python version of the SUMO modules.

Virtual Box

A solution for this is the installation of Virtual Box. This software allows us to work inside an operating system Linux quite in isolated way from the other part of computer. VirtualBox is a virtualization software of the type x64. A virtualization software allows one or more operating systems to work inside a computer. It is like having more than one computer. One is physical, the other virtual.(Capterra, 2023) The physical one it is called the “host;” it can have one of the operating Systems Windows, Linux, macOS, and Solaris, and it supports the other operating systems called “guest” such as Windows (NT 4.0, 2000, XP, Server 2003, Vista, Windows 7, Windows 8, Windows 10), DOS/Windows 3.x, Linux (2.4, 2.6, 3.x and 4.x), Solaris and Open Solaris, OS/2, and OpenBSD. (Virtualbox) In our work we have used Windows 11 as a host system and Linux as the guest system (the version Debian 11). In this case we installed the version 6.1 of the Virtual Box. Instant Veins, version 5.2, is installed too and imported inside the Virtual Box. In this way the possibility of the execution of Instant Veins directly is provided.

Virtual Machine Instant Veins

When we download Instant Veins, in our case the version 5.2-11, there are some components that come with it:

- Simulation modules
- Veins 5.2
- INET Framework 4.2.8
- SimuLTE 1.2.0 (plus a backported patch, 23c0936e31)
- Veins_INET included with Veins 5.2
- Software
- OMNeT++ 5.7
- SUMO 1.11.0
- Cookiecutter 1.7.3 for cookie cutter-veins-project
- Operating system
- Debian 11, Linux 5, GNOME 3

The goal here is to study of the road traffic using the features

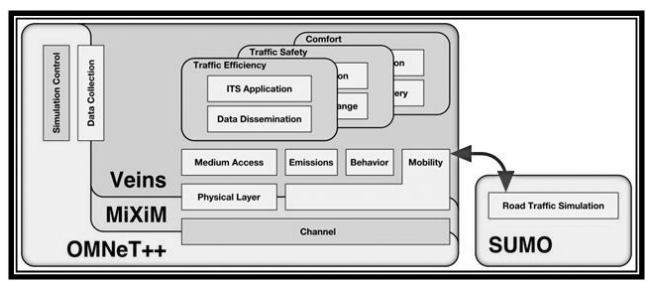


Figure 4: Veins architecture between Omnet++ and SUMO

of SUMO and what OMNET++ provides for this purpose, because it is this component OMNET++ that can fully do the traffic simulation control generated by SUMO and operates closely

with this simulator.

Simulation of Urban Mobility (or **SUMO** for short) is a powerful simulator designed to handle a large load network and a specified traffic demand, including a vehicle route and

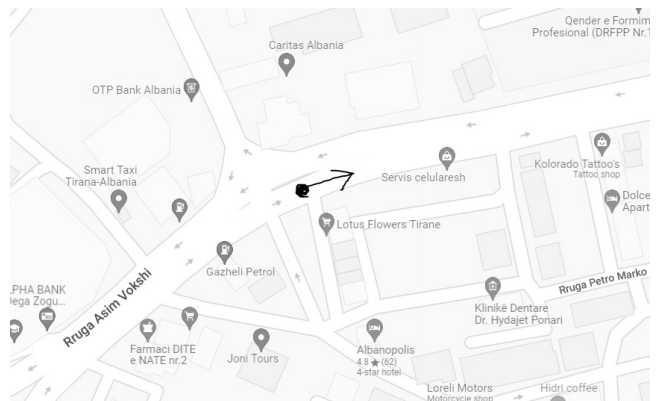


Figure 4: Open Street map view

car following model. It also provides a lot of useful information such as the vehicle speed, model, and position. One of the major features of SUMO is the Traffic Control Interface (or TraCI for short), which is a Python API that treats the SUMO simulation as a server and allows users to gain information from a traffic simulation or modify the simulation. TraCI enables an interface to allow third party systems (or libraries) to integrate with the SUMO traffic simulation. Generally, the traffic patterns or mobility traces created by SUMO can be imported to some of the popular network simulators including Omnet++ to create a realistic vehicle and traffic dynamics. Omnet++ is the Network simulator that can do the real networking aspects of the simulation and be dealing with the networking components of a typical “network simulation” (such as mac, TCP, routing, etc.,) (Omnet).

Veins is a set of extensions exclusively written for OMNET++. Veins provides a set of protocols to simulate VANET under OMNET++. In addition to that, Veins will work along with SUMO and can use its traffic models (mobility scenarios and patterns) under OMNET++ in a well-integrated fashion.(Omnet) OMNET++ node for every vehicle is paired with a vehicle moving in SUMO. As a result, simulations of mobility and network can happen simultaneously (bidirectional) with the protocol called Traffic Control Interface or TraCI (Omnet).

The Methodology

¹OpenStreetMap (OSM) is a free, open geographic database updated and maintained by a community of volunteers via open collaboration. Contributors collect data from surveys, trace from aerial imagery and also import from other freely licensed geodata sources. OpenStreetMap is freely licensed under the Open Database License and as a result commonly used to make electronic maps, inform turn-by-turn navigation, assist in humanitarian aid and data visualization. OpenStreetMap uses its own topology to store geographical features which can then be exported into other GIS file formats. The OpenStreetMap website itself is an online map, geodata search engine and editor.

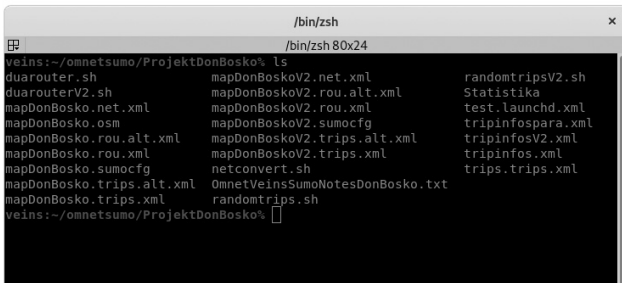


Figure 6: Main files and commands of the project

Using OpenStreetMap, a zone of Tirana is selected, for which is provided some information by sensors regarding the urban traffic for 24 hours, for one week. This information is maintained by the Directory of Transportation in Tirana Municipality. As a result of the exportation a file is generated, the .osm file with information about the road network of the selected zone. The second step is the control of this information to avoid the errors that can be caused by different reasons during this process. There are three reasons why converting OSM data directly to a road network for microscopic traffic simulation is problematic: (i) Intersections are not modeled with an explicit data structure in OSM, requiring the conversion process to guess relevant information like intersection geometry, waiting lines, and lane-to-lane connections. (ii) Considering that most of the OSM data is produced by volunteers, human errors are very frequent. Incorrect connections, gaps, misclassifications, and broken ways are common issues found in the road network for a given region, which could result in disconnections and inconsistencies in the traffic simulation. (iii) Variability in how real-world geometry is represented in OSM data is another reason. (Meng et al, 2022)

Generation of the SUMO files for a Simulation

Generation of the Road Network

From the file .osm, in our case mapDonBosko.osm we create the network file that SUMO needs for a simulation.

The command is:

```
netconvert --osm-files mapDonBosko.osm -o mapDonBosko.net.xml
```

in fact, we have used for each command a shell file that makes the command shorter

```
sh netconvert.sh
```

with content the netconvert command.

As the result of this step we get the SUMO network file, in our case mapDonBosko.net.xml, it describes the traffic-related part of a map, the roads and intersections the simulated vehicles run along or across. Nodes, usually named "junctions" in SUMO-context, represent intersections, and "edges" roads or streets. (SUMO)

For example:

```
<edge id=":4655759636_4" function="internal">
<lane id=":4655759636_4_0" index="0" disallow="tram rail_urban
rail_rail_electricrail_fast_ship"
speed="2.78" length="9.39" shape="444.44,157.28 435.91,161.24"/>
```

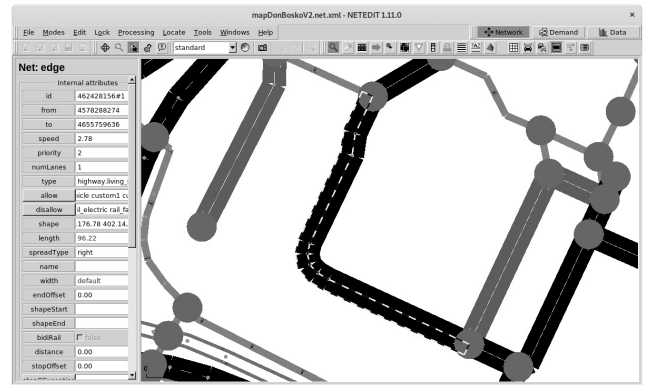


Figure 7: Net.xml file in NETEDIT

<edge>

Represent an **internal** edge with id=":4655759636_4", which lies within an intersection and connects an incoming normal edge with an outgoing normal edge. The first part of ID, 4655759636 is the node ID, the edge is located within (see below the bolded id), and 4 is a running number running clockwise around the node (starting in the north). As we see the ID has a ':' as prefix. And the following represent the information related to a normal edge that connects two nodes:

```
<edge id="-462428156#1" from="4655759636" to="4578288274"
priority="2" type="highway.living_street"
shape="439.49,157.82 402.14,175.07 399.20,176.78 397.11,178.96
396.46,181.84 397.10,184.60 408.36,208.05 409.19,213.88 413.85,223.81">
<lane id="-462428156#1_0" index="0" disallow="tram rail_urban
rail_rail_electricrail_fast_ship" speed="2.78"
length="86.44" shape="435.91,161.24 402.87,176.49 400.20,178.05
398.57,179.74 398.10,181.84
398.62,184.07 409.91,207.58 410.74,213.42 414.22,220.83"/>
</edge>
```

It represents a street (edge) with an id="-462428156#1" that connects two nodes with ID "4655759636" (from), "4578288274" (to), it has the type "highway.living_street", one lane with id="-462428156#1_0" and a length of 86.44m, and a shape of the edge is represented by a sequence of points "439.49,157.82 402.14,175.07 399.20,176.78 397.11,178.96 396.46,181.84 397.10,184.60 408.36,208.05 409.19,213.88 413.85,223.81"

that form the geometry of this edge like in the figure (represented with dashes):

The street name and other features of the edge can be found in the .osm file. Junctions represent the area where different streams cross, including the right-of-way rules that the vehicles have to follow when crossing the intersection.

```
<junction id="1843955439" type="priority" x="389.02" y="454.54"
incLanes="174507820_0 173614254#2_0 -173614254#3_0" in-
```



```
tLanes=":1843955439_0_0 :1843955439_1_0 :1843955439_2_0
:1843955439_6_0 :1843955439_4_0 :1843955439_7_0"
shape="394.87,459.05 396.23,456.15 394.42,454.81 393.95,453.98
393.79,453.05 393.92,452.01 394.36,450.86 388.60,448.07
383.75,458.24 389.54,460.96 390.89,459.14 391.72,458.68
392.66,458.50 393.72,458.63">
```

```
<request index="0" response="000100" foes="100100" cont="0"/>
<request index="1" response="010100" foes="011100" cont="0"/>
<request index="2" response="000000" foes="100011" cont="0"/>
<request index="3" response="010010" foes="010010" cont="1"/>
<request index="4" response="000000" foes="001010" cont="0"/>
<request index="5" response="000101" foes="000101" cont="1"/>
</junction>
```

Here, we have the id "1843955439" of the junction, the coordinate x and y, the id-s "174507820_0", "173614254#2_0", "-173614254#3_0" of the lanes that end at the intersection sorted by direction, clockwise, with direction up = 0, The IDs ":1843955439_0_0", ":1843955439_1_0", ":1843955439_2_0", ":1843955439_6_0", ":1843955439_4_0", ":1843955439_7_0" of the lanes within the intersection, and the shape.

Regarding the **requests**, the meaning of one of them, for example `<request index="5" response="000101" foes="000101" cont="1"/>` is, the connections 0, 2 (starting from the right) have a higher priority than the connection with index 5 and prohibits un-decelerated passing of the intersection for vehicles at this connection 5. The connection 0, 2 conflict with the connection 5, and the vehicle may pass the first stop line and wait within the intersection until there are no vehicles with higher priority. This is typically the case for left-moving streams from the prioritized direction. The command `netconvert` also generates the traffic lights and programs for junctions during the computation of the networks (DLR). The following is this information when it is generated.

```
<tLogic id="1842446691" type="static" programID="0" offset="0">
<phase duration="82" state="GG"/>
<phase duration="3" state="y"/>
<phase duration="5" state="rr"/>
</tLogic>
```

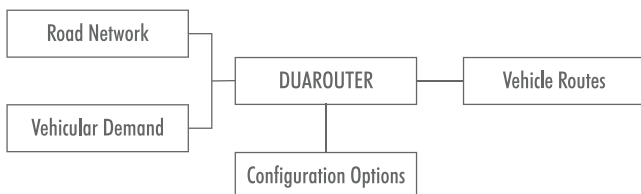


Figure 8: Creation of the routes file

Another information generated by command `netconvert` are the connections between lanes at junctions (nodes), for example:

```
<connection from="-1056187988#0" to="551904499#0" fromLane="0" toLane="1" via=":1840291109_3_0" dir="s" state="m"/>
```

This is a plain connection that describes that outgoing lane "1" of the edge "551904499#0" is reached from lane "0" of the edge "-1056187988#0" via the lane ":1840291109_3_0" across the junction, and the direction of the connection is straight ("s") and the state of the connection is minor ("m"). We also have the following information about roundabout nodes.

```
<roundabout nodes="1840291020 1840291049 1840291064
1840291157 2523562417 258179027 4539989271 6879850168
6879898516" edges="1056187989 37229363 548351119 549125847
549166140 549166141 549166142 736331977 736331978">
```

Creation of the routes file

Beside the generated network of roads, streets, and nodes, the simulation needs some kind of description about the vehicles. This is called the traffic demand. It is used the following terminology: A **trip** is a vehicle movement from one place to another defined by the starting edge (street), the destination edge, and the departure time. A **route** is an expanded trip, that means, that a route definition contains not only the first and the last edge, but all edges the vehicle will pass. There are several ways to generate routes for SUMO.

DUAROUTER is one of them, it generates vehicles' routes based on the demand for individual trips and vehicles' flows, using the shortest route routing algorithms. (Figure 6) (Urquiza-Aguilar et al., 2019) shows the flowchart of this tool, where the road network and the vehicle demand are entered as inputs and as outputs the routes.

In order to create the trip file (Vehicle Demand), SUMO offers the python tool called `randomTrips.py`. Inside the shell file `randomtrips.sh` we have the following command:

```
/home/veins/src/sumo/tools/randomTrips.py -n "mapDonBosko.net.xml" -b 0 -e 3600 -p 6.2 --route-file "mapDonBosko.trips.xml" --validate
Where mapDonBosko.net.xml is the input file and mapDonBosko.trips.xml is the output file, and the following parameters are used
```

- n is used to specify the network in this case `mapDonBosko.net.xml`
- e specifies the end time which is set to 3600 sec
- p represent the arrival rate. The arrival rate is calculated by the formula: $(t2-t1)/n$
- Where n is the number of vehicles that depart between times t1 and t2, in our case, in 1 hour. For n we have considered an average of the Traffic Vehicles information provided for one week, 24 hour per day. This calculated average is 6.2.
- o specifies where resulting trips are stored

After creating the `mapDonBosko.trips.xml` we need to convert the trips to routes. To do this we will run the shell file `duarouter.sh`, with the following command inside it:

```
duarouter -n mapDonBosko.net.xml --route-files mapDonBosko.trips.xml -o mapDonBosko.rou.xml
```

This will convert our trips into routes. Let's breakdown the options:

- n is used to specify the network in this case `mapDonBosko.net.xml`

- *route-files* specifies the trip file *mapDonBosko.trips.xml*
- *o* specifies where resulting routes are stored, in our case *mapDonBosko.rou.xml*

```
veins:~% cd omnetsumo
veins:~/omnetsumo% cd ProjektDonBosko
veins:~/omnetsumo/ProjektDonBosko% ls
duarouter.sh          mapDonBoskoV2.net.xml      randomtripsV2.sh
duarouterV2.sh        mapDonBoskoV2.rou.alt.xml  Statistika
mapDonBosko.net.xml   mapDonBoskoV2.rou.xml     test_launcher.xml
mapDonBosko.osm       mapDonBoskoV2.sumocfg     tripinfospara.xml
mapDonBosko.rou.alt.xml mapDonBoskoV2.trips.alt.xml tripinfosV2.xml
mapDonBosko.rou.xml   mapDonBoskoV2.trips.xml   tripinfos.xml
mapDonBosko.sumocfg  netconvert.sh             trips.trips.xml
mapDonBosko.trips.alt.xml OmnetVeinsSumoNotesDonBosko.txt
mapDonBosko.trips.xml randomtrips.sh
veins:~/omnetsumo/ProjektDonBosko% sumo-gui mapDonBosko.sumocfg
```

Figure 9: The command `sumo-gui mapDonBosko.sumocfg`

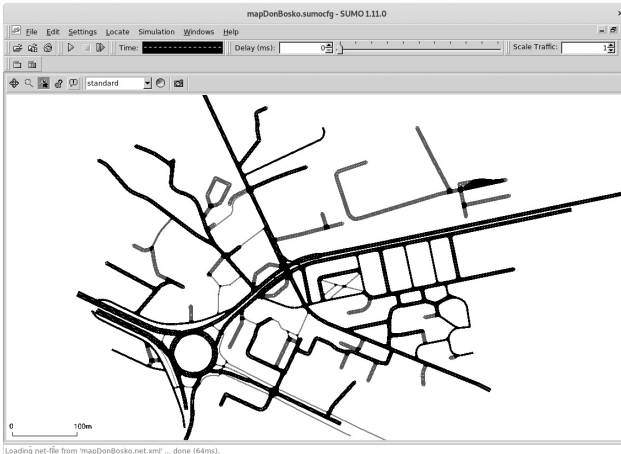


Figure 10: The generated Road Network of the selected zone

The generated information has this character:

```
<vehicle id="2" depart="12.40">
<route edges="471407810 -471407810 -717156976#4 -717156976#3
-717156976#2 -717156976#1 -717156976#0 173988975#0
173988975#1 173988975#2 173988975#3 173430970#0
173430970#1 459248049 459205964#0 459205964#1 459205964#2
674597415#0 674597415#1 549166141 549166142 549166140
548351119 736331978 210192830#0 210192830#1 551904499#0
712114948#0 712114948#1 462428160#0"/>
</vehicle>
```

where we see the ID of all the edges that form the road of vehicle with id 2 and start time 12.40s. If we add some other parameters in the command `randomTrips.py`, we will have additional information about vehicle trip like speed, acceleration, distance between vehicle etc. Finally, the last part is to configure the simulation by specifying the network, routes, and duration in a configuration file, like the following.

```
<configuration>
<input>
<net-file value="mapDonBosko.net.xml" />
<route-files value="mapDonBosko.rou.xml" />
</input>
<time>
<begin value="0"/>
<end value="86400"/>
</time>
```

```
</configuration>
```

The Traffic Simulation in SUMO

Saving this file as `mapDonBosko.sumocfg`, we can give the following command directly in console:

`sumo-guimapDonBosko.sumocfg` and a simulation is generated

If we add in configuration file the lines

```
<output>
<write-license value="true"/>
<tripinfo-output value="tripinfos.xml"/>
<tripinfo-output.write-unfinished value="true"/>
</output>
```

We will get the file `tripinfos.xml` with the information regarding the trips of one vehicle, one line of it is as follows:

```
<tripinfo id="3" depart="19.00" departLane="" departPos="0.00"
departSpeed="14.29" departDelay="0.40" arrival="31.00" arrival-
Lane="" arrivalPos="0.20" arrivalSpeed="28.57" duration="12.00"
routeLength="119.02" waitingTime="0.00" waitingCount="0" stop-
Time="0.00" timeLoss="1.41" rerouteNo="0" devices="tripinfo_3"
vType="DEFAULT_VEHTYPE" speedFactor="1.00" vaporized="" />
```

We will convert this .xml file into one Excel file, this allow us to create various charts and statistics about speed average of the vehicle in urban areas, or time loss average and other indicators of the traffic.

But also, we can integrate all this work done in SUMO as part of an OMNET++ project.

Running the Simulation from Omnet++

As we mentioned above TraCI enables an interface to allow third party systems (or libraries) to integrate with the SUMO traffic simulation, and one of these is Omnet++, where SUMO plays the role of a server and the client is on Omnet++ side. When we create a project in Omnet++, we are asked to include the Veins project, which is an open-source framework and provides a C++ client library for the TraCI API. A good tutorial for this work is given in. Let's represent very shortly some of the steps of this tutorial to create an OMNET++ project that interact with SUMO.

- *A new Omnet++ project from Omnet++ is created*

File -> New -> Omnet++ Project, and we accept veins and create and empty project.

- *The files generated for SUMO, .net.xml, rou.xml, and. sumocfg files are copied into our project folder*

- *Another file is needed with the names of these files, let call it "test.launchd.xml"*

```
<launch>
<copy file="mapDonBosko.net.xml" />
```

²We eliminated in our case the lines

```
<AnalogueModel type="SimpleObstacleShadowing" thresholding="true">
<obstacles>
<type id="building" db-per-cut="9" db-per-meter="0.4" />
</obstacles>
</AnalogueModel>
```

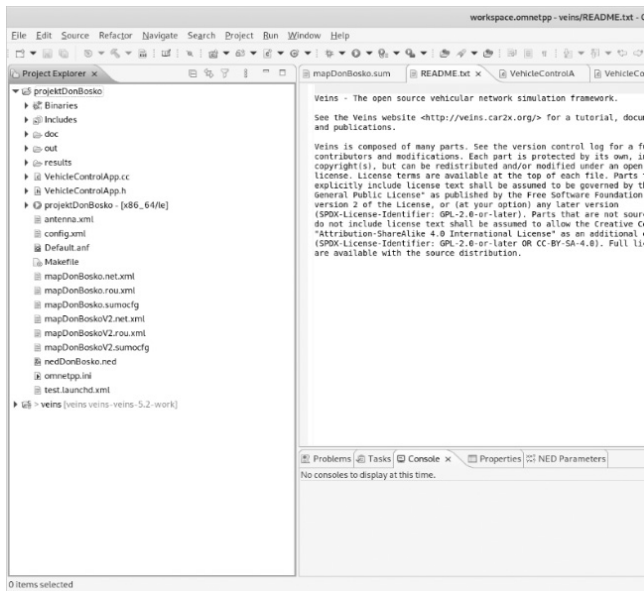


Figure 11: Project explorer interface

```
<copy file="mapDonBosko.rou.xml" />
<copy file="mapDonBosko.sumocfg" type="config" />
</launch>
```

As we mentioned, the goal of Omnet++ is the establishment of a vehicle network and this network is tied with the SUMO simulation by some classes of Veins. Veins instantiates one network node per vehicle driving in SUMO. For this reason, we need here the files that we generated for SUMO and some files from Veins folders as is described below.

- Some files are needed to be copied from Veins example folder [veins folder]/examples/veins, to our project folder are:

- *Antenna.xml2*: This file provides a simulation model of antennas that includes parameters for different types of real-world antenna patterns, depending on antenna type, mounting point, and roof topology.

- *Config.xml*: Veins supports some analogue models of signal transmission for the wireless channel, which are defined in this file, and also some other parameters linked with signal transmission.

- The structure of a network simulation model in the NED language (Network Description), and for this file is created of the type *.ned*. File -> New -> Network Description File (NED), empty file

We copy the content of RSUExampleScenario.ned to our ned file which is:

```
network networkName extends Scenario {
  submodules:
  rsu: RSU {
    @display("p=150,140;i=veins/sign/yellowdiamond;is=vs");
  }
}
```

And we change the name of network, putting our name here, ned-DonBosko.ned.

- There is also the file *omnetpp.ini* where there are included different parameters of different categories that make possible the functionality of the network. To not write everything from scratch we copy the content of the file with the same name from the same folder of veins project and modify some of these parameters as can be shown below. As the result we have the files of our project as they are shown in the Fig 11.

- **Modification of the file omnetpp.ini**

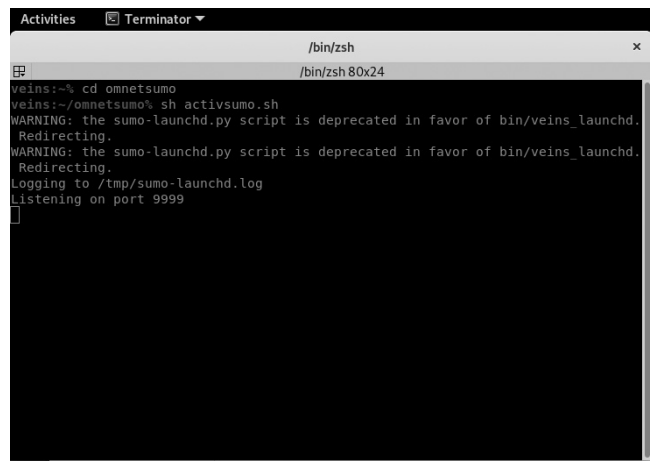


Figure 12: The way how to activate sumo from terminal

To run the simulation using the file *omnetpp.ini*. The file tells the simulation program which network to simulate, allows you to assign values to different parameters declared in *.ned* files (your file or inherited ones). Many other parameters are included here



Figure 13: Execution process

which can be grouped by some categories some of them are:

- General parameters
-
- network = nedDonBosko
-
- Simulation parameters
- Obstacle parameter (we have eliminated this part)
- TraCIScenarioManager parameters
-
- manager.launchConfig = xmldoc("test.launchd.xml")
-
- RSU Settings
- 11p specific parameters
- App Layer parameters
- Mobility parameters

We are leaving all the other with default values, because our goal is only what statistics Omnet++ offers to simulated traffic of SUMO.

- **Reference to Veins libraries**

There will be lots of errors because the Omnet++ simulator is a network simulator. By default, it is not aware of many objects like RSUs, Cars, etc., which are implemented in Veins. We need to reference to Veins libraries that developers have made.

Right-click the project in the project explorer (in our case projectDonBosko) Properties -> Project References -> Click Veins -> “Apply and Close”

- Run the project

Then we are ready to run the project from Omnet++. But before we have to launch sumo in parallel, so that it can wait for incoming connections on the port specified in the behavior of our application (generally 9999). Therefore, we need to start the TraCI server first by the command:

```
python /home/veins/src/veins/sump-launch.py -vv -c sumo-gui
```

and we will see the screen

Now right click on omnet.ini, run->Omnet++ simulation and we will see the view of Figure 13. We answer OK and push the button Run or Run Fast and the GUI of SUMO of Fig 10 will be shown and push the button Run again and the traffic is generated.

The outputs

And we can see the results afterwards. It is a folder in project that will be generated with the name results, where there are generated multiple files. We double click *.sca and *.vec file and an output file (with extension.anf) will be generated We go to “scalar” or “vectors” tab, and select the data we want to display, right click, plot, and we will have the corresponding graph. All these results are additional results that we can get for the traffic and help us create a better view for the traffic. We can also export this information and get a .csv file to find different statistics from it.

From OMNET++project we can also use the same outputs that we could get directly from SUMO. For example, adding in the mapDonBosko.sumocfg of the OMNET++ project the lines

```
<output>
<write-license value="true"/>
<tripinfo-output value="/home/. . /tripinfos.xml"/>
<tripinfo-output.write-unfinished value="true"/>
</output>
```

We can get the file tripinfos.xml with trip information in the folder /home/. . /. We must note here that if you leave the default folder for this file, it is not possible to get it, so use another folder for this goal.

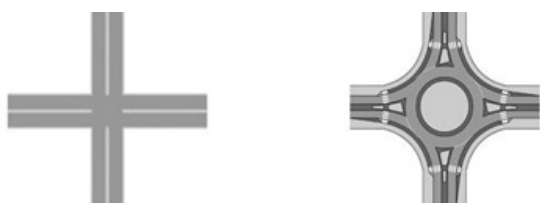


Figure 14: Two geometric types of intersections

Experimental Work

The experimental work here is related to the topology aspect of the road network, how this topology influences on the vehicle traffic. Recent decades have been faced with a significant amount of research focused on the intricate geometric patterns found in many cities, as these patterns provide a means of comprehending the development of cities through a range of methodologies. The cities' gradual development and structural organization have had an impact on certain areas at the macro scales. As a result, a typical city's entire structure has evolved gradual-

ly, from small to large scale, and with a large-scale connectivity among different parts. Starting from the geometric complexity and urban morphology of the city, it is necessary to improve the urban systems understanding. Recent decades have seen a significant amount of research focused on the intricate geometric patterns found in many cities, as these patterns provide a means of comprehending the development of cities through a range of methodologies. The core of building an urban terrain model is its morphology. Urban roads have unique geometric and semantic properties because they form the framework of the urban terrain. The road is a strip-shaped feature that is connected and interconnected. It is flat in the horizontal direction and gently undulating in the vertical direction. (Smith, Johnson, 2020) Intersections are essential to the efficient flow of traffic on the extensive network of roads that crisscross our cities and towns. These are the locations where two or more roads converge, enabling safe crossings for both cars and pedestrians. Road intersections come in different varieties, each with unique features and purposes. We will examine the characteristics and



Figure 15: The intersection where the topology is changed

Attribute	Value	Explanation
Length	2.5	Physical length of vehicles
Accel	2.6	The acceleration ability of vehicles of this type (in m/s^2)
Decel	4.5	The deceleration ability of vehicles of this type (in m/s^2)
Sigma	0.5	0≤sigma≤1; driver imperfection; The behavior of sigma is carFollowModel dependent
Tau	1	This parameter is intended to model a drivers desired minimum time headway (in seconds).
minGap	2.5	Empty space after leader [m]
maxSpeed	55,55	The vehicle's (technical) maximum velocity (in m/s)
departSpeed	Max	Determines the speed of the vehicle at insertion, where maxSpeed = MIN (speedLimit * speedFactor, vType_desiredMaxSpeed * speedFactor, vType_maxSpeed);
departLane	Best	Determines on which lane the vehicle is tried to be inserted;
departPos	random	Determines the position on the chosen departure lane at which the vehicle is tried to be inserted;
b	0	Begin time
p	0.1-1	The arrival rate (also know as departure rate or insertion rate) is controlled by option -period (default 1). By using value below 1, multiple arrivals per second can be achieved.
e	3600	Simulation time/end time

Figure 16: Simulation parameters used

functions of some of the most prevalent kinds of road intersections in this section. Critical locations for interactions between cars and pedestrians are road intersections, where traffic patterns must be carefully controlled. Traffic engineers and city planners can create effective and secure transportation systems by having a thorough understanding of the various kinds of road intersections. [19] Two types of intersections (four legs and roundabout), Figure 14 are considered as case studies for the purpose of this article.

A four-way intersection is composed of two perpendicular roads. It is also known as a crossroad. They create a shape akin to a square or cross, enabling traffic to gather in the middle from all four directions. At four-way intersections, traffic signals or stop signs are frequently used to control the flow of cars. Circular intersections called roundabouts are made to improve traffic flow and lower the chance of accidents. They have a central island with constant traffic moving around it in an anticlockwise direction. Roundabouts rely on yield-at-entry laws and do not require stop signs or traffic signals. They enhance safety and facilitate efficient traffic flow. NETEDIT, a SUMO component, provides us the possibility to change the topology of an intersection. As it is shown in Fig 15 the shape of an intersection is changed by NETEDIT. The used simulator SUMO and the sim-

ulation parameters are the same in both cases (as in the following table 1). The results are analyzed in terms of arrival speed, depart speed and time loss. The comparison of these parameters in both intersections are demonstrated in the charts below and the difference between them is a clear one. For the effect of experimental work, here there are used some more parameters that provide an improvement of the traffic features, and especially the number of the cars in traffic. Some values of the arrival rate are used in the interval 0.1-1 that generate different numbers of vehicles in traffic. The simulation is done using the same parameters (demonstrated in the following figure). The majority of them are used in their “default” values. The parameter “p” is changed from 0.1 to 1, in order to change the urban traffic flux in the intersection, while the simulation time is 1 hour (equal to 3600 seconds).

The model used for the simulations is Krauss because it was specifically chosen to guarantee a speed that consistently maintains the minimum gap (minGap), whereas other models may not prioritize this requirement. The car following model will automatically adjust its driving speed to minimize the need for braking until the maximum limit set by the deceleration function is reached. In the case of the default, there are strict constraints on the Krauss model, whereas for alternative models such as IDM, the deceleration bounds are less strict. There are several ways to view different aspects of traffic, including traffic congestion. It can be characterized as an occurrence of longer vehicle lines, slower driving and longer travel times than typical in terms of both speed and duration. The table below summarizes the simulation results in terms of arrivalSpeed, departSpeed, duration, waitingTime and timeLoss. The column of id_max shows the total number of vehicles in the intersection. The data processing is realized by using R Studio. The difference between two types of intersections is supported by the provided data results, where the four-legs one is dominant as the timeLoss is less compared to the roundabout and also waiting time or speeds follow the same logic. These data are shown in the following graphs, focusing only on arrival speed, depart speed and time loss.

p	arrivalSpeed (m/s)	departSpeed (m/s)	duration	waitingTime	timeLoss	id max
0.1	0.79	8.5	1592.6	291.58	890	35942
0.3	2.86	8.49	979.25	223.99	571.23	11995
0.5	5.63	8.69	391	84.39	168.81	7193
0.7	9.2	9.03	69.4	0.46	0.95	5141
1	9.25	0.01	68.65	0.26	0.55	3599

p	arrivalSpeed (m/s)	departSpeed (m/s)	duration	waitingTime	timeLoss	id max
0.1	1.58	6.48	1546.6	232.5	819.2	35942
0.3	3.81	5.85	622.2	112.99	302.78	11995
0.5	6.69	6.22	54.54	0.84	2.21	7193
0.7	6.77	6.33	52.62	0.36	0.96	5141
1	6.9	6.3	51.88	0.19	0.51	3599

Table 1: The results for roundabout and four-legs intersections

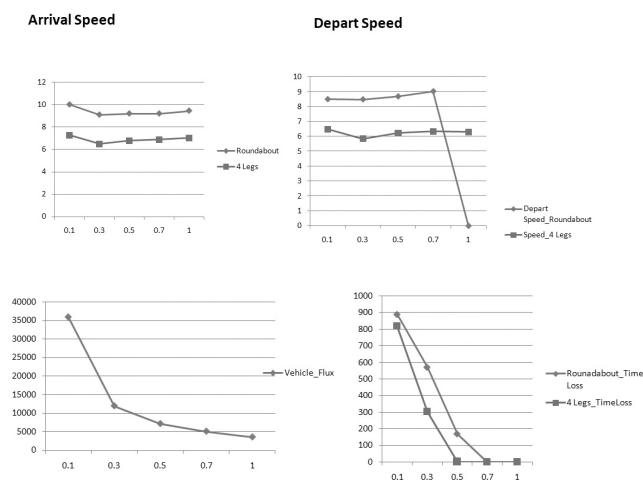


Figure 17: The results in terms of speed and time loss

Conclusions

The urban vehicular road traffic is an important problem for the city and for this reason, it is important to have the possibility to trace and forecast it. The simulation of the traffic makes this possible. During rush hour, busy intersections where multiple roads intersect can become bottlenecks. Congestion is a consequence of signal timing, geometric design and vehicle volume.

This paper describes a methodology step by step of how to achieve this simulation in a zone of the city, and how to get some results that will serve us for different goals. The methodology suggests a virtual work environment, and inside it the work with SUMO & OMNET++ & Veins. In this paper we are focused on the work with SUMO and SUMO & Omnet+++Veins, but in the second case again, we are focused only on the results related to traffic. We keep everything default regarding Omnet++ and Veins. The experimental work is related to the effects of the topology of an important point of the zone in relation to the traffic of this zone. Therefore, the actors of the urban planning, when they take some decision regarding the topology of some key points of the city, have to have as a practice consideration of

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Guidelines for Risk Evaluation in Artificial Intelligence Applications

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Abstract

Artificial intelligence is becoming a common element of our times. It is becoming more and more pervading into every element of our lives. Mass applications of artificial intelligence started when it began to be used in video games, but now it is available to everyone and can help with many tasks that, up to a few years ago, could be done only by humans. Discussions about artificial intelligence began very early before it existed. Most of the science-fiction literature tried to imagine many forms of AI and the consequences, both good and evil, of its use. But now artificial intelligence is a real, concrete thing and its mass usage must be subordinated to a risk evaluation and mitigation process to make it safe. In this paper, an introduction to this risk assessment will be made and the main guidelines for it will be defined. These guidelines could be used by researchers, designers, developers and even users to validate an AI-based application before delivering it to people. The paper considers the basic concepts of risk and tailors them to provide effective support in developing risk analysis for the specific area of artificial intelligence. Then a set of typical risks are defined and methods to detect and minimize them are provided. In conclusion, a call for stricter regulation of AI and high-performance processing is issued.

Keywords

Artificial intelligence, risk assessment, risk management

Introduction

Artificial intelligence technology is today a reality. It has moved out from sci-fi novels to enter people's daily lives. As with any mass product, AI must satisfy requirements about its risks for users. And these requirements require that people will be exposed to no serious risk. No well-defined standard exists today to provide a risk assessment for AI, but it is the first step for risk management. Although no standard exists, common tools to manage it are known and this will be described later. The traditional approach to risk and impact assessment follows a six-step process that can be described as identifying risks, prioritizing them, defining mitigation strategy, defining a monitoring plan, testing and reassessing risks and, finally, clearly communicating risk and mitigation procedures. Based on this six-step process, it is necessary to analyze how artificial intelligence can become a risk. For each risk, the risk assessment procedure must be applied, and a risk quantification carried out. The heart of the process is thus precisely the identification of how an artificial intelligence can become a risk.

Research question

The questions to be answered in this article are:

- what are, in a general sense, the areas of risk that can be generated by an artificial intelligence system in the current state of the art?
- how should this risk be assessed?
- who is responsible for assessing this risk?
- are there guidelines for legislators to define risk mitigation policies at the regulatory level?

Methodology

The methodology followed in this article begins with a review of the scientific literature relating to the risks of artificial intelligence and then moves on to define the typical risk areas of artificial intelligence in the current state of technology. This will be followed by a presentation of the main risk assessment methodologies and then one will be applied as an example. Based on the process described above, the allocation of responsibilities to the different actors in the entire life cycle of artificial intelligence will then be analyzed, and based on this, guidelines will also be produced for the various actors and, in particular, for legislators.

Literature review

Since the publication in 1921 of "R.U.R." (also known as "Rossum's Universal Robots") the Czech novel that gave the origin to the term "robot" from the Czech word "robota", meaning "hard work", a long time has passed. Yet today, Karel Capek's words, the author of "R.U.R.", are echoing and seeming very actual "The product of the human brain has escaped the control of human hands" (Capek, 1920). Science fiction has deeply investigated the theme of AI and, passing through the famous "Colossus", the main character of the homonymous novel written by D. F. Jones in 1966 where it is stated the incredibly fast growth of its AI "Listen to me: outside, in the vast world behind those doors, there are two machines. Less than twenty-

four hours ago, they were busy proving to each other that two and two make four. Now they have reached the point where we hope to be in a hundred years. They think better and faster than we do, and I think we can only keep them under control in a very precarious way... but I have no desire to try to prove that..." (Jones, 2020). Isaac Asimov approached it in a very engineered way, in the 40s, by defining the legendary "Three Laws of Robotics" that have been the basis of many of his writings. Many of these trials to forecast the future of AI through novels have concluded that they will destroy us. "Terminator" with its SkyNet is only one of a plethora of examples. But now we are starting to have, in our reality, not in novels, AIs that are enough powerful to become a danger. So, now, it is time to apply a true risk management approach that should not be limited to the engineering aspect only, but also has to explore other contexts like social, political, emotional, psychological and more. Some scholars (Khalif Ali et al., 2023) have tried to provide a literature review about frameworks for AI risk management, balancing trust, risk and security. They evidenced risks tied to bias and discrimination, privacy invasion, society manipulation, deepfakes, lethal autonomous weapon systems (LAWS), malicious use of AI, and insufficient security measures. All these risks have been grouped into three classes AI trust management, risk management and security management but, anyway, they are all risks to be mitigated despite their names. For each type of risk, (Khalif Ali., 2023) have also defined the possible types of damages. Then they defined a framework for such risk mitigation. According to their analysis, it is possible to apply a risk assessment and mitigation procedure to assess any of these risks and then find a set of countermeasures. Other scholars (Matloob et al., 2021) have developed a similar approach to specific cases, like in the cited paper, the application of AI to coal mining. Or in the financial risk management (Sheth, 2023). In the last two cited works, the application to a specific context has introduced a deeper detail but lost, in the perspective of this paper, the general view and the abstraction process needed to perceive the big picture behind AI risk management. But even starting from this research, it is possible to define a general set of AI-related risks.

Risk areas for AI

Analysing the various types of danger that artificial intelligence can pose, both in general research work and in specific ones applied to well-defined cases, it emerges that risks can be grouped into four well-defined general areas. (I. A. E. M. E., 2023, Weerts et al., 2023, GWAI-90,1990, Ghaz et al., 2023) The first area is that of artificial intelligence which can produce specific damage such as emotional, physical or psychological. Other areas are those related to information generated by AI and violation of human rights impacts in the social or socio-political context. Damage in this first area is essentially physiological as it corresponds to risks arising from the use of artificial intelligence in general. An example of this first area could be the social isolation resulting from the humanisation of

the artificial intelligence system with which one moves to have a relationship that is no longer a human-machine but human-human, the relationship that generally becomes morbid or toxic. A second area of risk is related to specifics and technologies that may bring with them risks that are not present in other technologies. In this second area, we find, for example, the risks connected with deepfake technologies, which allow the perception of reality to be altered through the creation of images, films or audio recordings that are extremely realistic but completely false, and which can mislead their users by providing them with misleading information. Another very important area of risk is the one related to the use scenarios of artificial intelligence systems. In this case, there are all the more engineering-type problems involving malfunctions, misuse and variations in the operating environment. This area of risk is very similar to that of any other device created by human ingenuity, and therefore risk assessment structures typical of systems engineering processes already exist for it. Analysis methodologies such as FMEA (Failure Mode Effect Analysis) (Schoitsch, 2014, Fregnani, 2022) or FMECA (Failure Mode Effect and Criticality Analysis) can be directly applied to specific cases, with the important point not to forget that, since artificial intelligence normally reacts actively and proactively to the context in which it is used, this context must be considered among the factors that can cause the failure modes of the aforementioned analyses.

An example could be that of an autonomous driving system of a vehicle that, in the face of a sensor failure, no longer has a correct perception of space and therefore becomes dangerous. As already mentioned, this type of problem is already widely considered in current engineering processes. The impact of context on the operation of artificial intelligence, on the other hand, is something in the making, as failure modes resulting from changes in context are not yet part of the average engineer's experience. A very interesting example can be that of the always self-driving systems that perceive the presence of vehicles as they detect images posted along the road or on surrounding vehicles, images that represent vehicles, or they incorrectly calculate the speed of movement and thus incorrectly classify people as vehicles or vice versa. The latter case is one of the possible cyber attacks that can be perpetrated against a self-driving vehicle.

Another type of risk is associated with specific application domains in which artificial intelligence can be used. In this risk category, the dangerousness of artificial intelligence is considered to depend on the domain to which it is applied. For example, an object classification applied to a home alarm system has a completely different dangerousness than an application in the automotive or aeronautical fields. The same can be said for classification systems applied in the financial domain rather than in the occupational safety domain. In conclusion, we can classify these risks into four categories such as risks associated with typical AI hazards, risks associated with the particular technology, risks associated with operational scenarios, and risks associated with the specific application domain of artificial intelligence.

Risk assessment and mitigation methods

Genuine standards for risk assessment in connection with the use of artificial intelligence are still being developed. To date, numerous attempts have been made, both in the academic sphere and in the national or supranational legislative sphere, to define specific risk methodologies to be able to certify the non-hazardousness of specific artificial intelligence systems. The first consideration is that these risk analysis models should be able to anticipate dangers before they materialise, i.e. be based on a preventive rather than a corrective approach through, for example, monitoring mechanisms or, even less preferably, through protection systems capable of intervening to reduce the damage when it occurs. As happens in any risk management system, we, therefore, have three possible approaches: the preventive approach based on the prediction of the risk and its elimination through prevention, the predictive approach based on the monitoring of symptoms that make it possible to predict the occurrence of the damage and act in time when it is not yet there or is at a tolerable level, and finally, the protective approach that implements protection mechanisms, active or passive, capable of protecting the object of the damage, whether human, economic, social or other, from the damage itself, either by avoiding any impact or by greatly reducing its effect. These three approaches, as already mentioned, are characteristic of all risk management methodologies and must apply to the entire life cycle of artificial intelligence, from its conception to its decommissioning.

In some states, directives or laws have been issued that attempt to standardise risk assessment and management methods in both the artificial intelligence and data governance sectors. One example of such a model is the European Commission's 2021 model (EU Commission, 2021), another is the so-called General Data Protection Regulation or GDPR of 2016. The first aims to reduce the dangerousness of the application of artificial intelligence by placing constraints on risk assessment. The second is only concerned with prohibiting the application of automatic decision-making or automatic profiling systems if these impact the rights and freedoms of individuals (Art. 22) and subject to certain special cases. Wanting to develop guidelines for the analysis of risks arising from the application of artificial intelligence, given the lack of standard frameworks both at the national and supranational level, it might be convenient to follow a strategy based on the analogy with the current systems of risk assessment and management derived from the electromechanical engineering sector and the cyber security sector. Wanting to derive a typical outline of a risk assessment process and its management for its mitigation, one may consider, analysing specific techniques such as the aforementioned FMEA/FMECA or information security frameworks, that six basic steps are necessary for this outcome. The first step is risk identification, which typically consists of drawing up a list of risks that the system presents. In the traditional engineering approach, these risks are seen as the loss of system functionality (failure modes), whereas in the information security approach, these risks are seen as the loss of one or more of the security

requirements for an information asset by a threat, i.e. an external internal agent, either intentional or unintentional, that may compromise, for example, its confidentiality or availability or integrity. In both approaches, assets are defined as those elements that one wishes to protect, be they system functionality or data, and for each one, one sees how they may be compromised. This potential “compromised state” is precisely the risk that one wishes to identify.

The second step consists of defining a priority ranking among the identified risks to deal first with the highest ones and then gradually move down to the less important ones. There are various methods of prioritisation, the two most common being one based on the product of the probability of occurrence and the severity of the occurrence of the risk, and the other on the further multiplication by the so-called detectability, i.e. the ability to detect a premonitory symptom of the occurrence of the risk. The first approach emphasises only the preventive mode as a mode of risk management, while the second approach implicitly admits the possibility of predictive risk management as well. Both situations also allow the protective approach to be used, but this should be considered as a last resort. In the approach based on the product of probability and severity, one obtains an indicator called magnitude, which is used to prioritise the risk because the higher the magnitude, the more the risk is prioritised. In the other approach, the one also based on the possibility of detecting premonitory symptoms, an additional indicator will be produced, usually referred to as RPN or Risk Priority Number. Regardless of which approach you have chosen, once the prioritisation indicator has been calculated, you can proceed to sort the list of risks according to priority. At this point, you can begin the third step, which concerns the design of risk mitigation. In this activity, starting with the most prioritised risks, mitigation strategies are defined, which could be those already mentioned of prevention, prediction and protection. In some cases, a fourth modality is also considered, which consists in transferring the risk, either by taking out insurance to cover the economic aspect of the damage that may be generated by the occurrence of a risk. For each of these mitigation options, a cost-benefit analysis will have to be carried out, and at the end of the day, based on this analysis, one or more mitigation strategies will be defined for each risk, which will then have to be implemented.

The next step is the implementation of the mitigation strategies. At this stage, all mitigation strategies that need to be practically deployed in the field through design changes, through the acquisition of additional devices, or through training are implemented and their outcome validated. For all aspects of design modifications or the acquisition of additional devices, it may be that the risk assessment must be repeated or that specific worst-case tests have to be carried out to highlight unacceptable residual risks or new risks introduced by the devices that should mitigate the risk. The next step is the monitoring of the risks, and this monitoring can be carried out in two ways. The first method is to repeat the risk assessment periodically. Periodically may be on a time basis, i.e. setting a certain time interval

(such as six months), and then repeating it, or it may be based on the occurrence of events. These events may be of an organisational or other nature, or they may relate to the occurrence of failures or, finally, to evidence from indicators that form part of the second type of monitoring. The second type of monitoring consists of continuously calculating indicators that assess the validity of the risk analysis and its management. These indicators can also be used to trigger risk review activities. The two monitoring methods are rather integrated. Both should be applied during the development phase of the AI as well as during its operational phase. The purpose of monitoring is twofold in that it is concerned both with highlighting the emergence of any risks that threaten to become real and with assessing the soundness of the risk analysis carried out and the resulting risk mitigation work.

At all stages of designing the risk management system and designing the artificial intelligence, not only the various indicators that will be the subject of operational monitoring will have to be defined, but also the indicators that will be used during the AI development phase to assess its riskiness. Another step is testing and validation. In this phase, the artificial intelligence is subjected to a series of tests that verify its correct implementation according to the design (verification), but at the same time provide information on whether the artificial intelligence is mature for the task that will be assigned to it. Both verification and validation activities are partly based on the traditional metrics of artificial intelligence (accuracy, precision, sensitivity, mean absolute error, ...) and partly on the risk indicators developed during the design phase of operational monitoring. Consequently, during the verification and validation phases, we will not only look at the performance of the artificial intelligence in functional terms but also consider how effective the risk mitigation system is. For instance, malfunctions may also be simulated during this phase to verify how the artificial intelligence will behave in such cases. Unfortunately, this type of test is extremely complex because most of the problems of artificial intelligence lie in the intelligence matrix, i.e. in that part where knowledge resides is the set of rules that artificial intelligence applies, a part that very often if not always and in the eyes of humans is practically an opaque black box. (Avin, 2021) A good example of an indicator for assessing the risk of an artificial intelligence that is already widely used and easy to implement is the so-called confusion matrix. This is a table in which, in the case of a binary classification, for example, both the exact results and the false positives or negatives are shown. From this confusion matrix, it is possible to calculate the cost of error and assess the probability of a certain risk, understood as the probability that a certain unwanted error will occur. Although very simple, this indicator makes it possible to roughly estimate, in probabilistic terms, the risk of committing misclassifications and to associate the cost, i.e. the severity of the damage, with each of them. Consequently, the confusion matrix is an excellent tool for calculating the magnitude of risk as a product of probability times severity and is therefore extremely practical in use and also highly automatable. The

same tool can also be easily extended to non-binary classification cases. Once the confusion matrix has been calculated in the AI development phase, it can be periodically recalculated a posteriori, in the operational phase, having the exact answers available, it is compared with the design matrix to check for any significant deviations, which could indicate the emergence of a risk considered mitigated or acceptable. (Ramli et al., 2022) A final step in the risk assessment and mitigation process is communication and information. In practice, this involves defining information, often common to relatively different systems, to be transferred to users, be they specialists or masses. This type of transparency allows both users to make safer use of the AI system and to highlight anomalous behaviour.

Policies and Responsibilities

Based on the risk analysis and mitigation process outlined above, it is possible to define responsibilities in the identification and management of risk. As in any engineering activity, the first actor in a risk assessment is precisely the engineering team that designs and develops the artificial intelligence system and that, like all other engineering systems, will have to go through a hazard review based on risk assessment and mitigation.

Allocating the responsibility for risk management to the engineering team alone is not enough because, in addition to having to consider those who will have to use and maintain the AI system, it is necessary to standardise risk assessment and risk management procedures. Without standardisation, it becomes difficult to define whether an AI system is safe enough to be placed on the market or not, leaving the assessment to the engineering element alone, an element that could be pressurised by the manufacturer or that could make mistakes that would not be detected until too late. Thanks to the use of standardised policies, AI products might have to undergo a risk assessment phase before they can be placed on the market, and thus be subject to a standardised evaluation, which can be improved over time based on experience, and can also improve the risk assessment phase of the engineering team, by placing it in a transparent scheme common to all. Standardisation would also lead to savings in design and development costs while increasing the safety of the AI system, as has been amply demonstrated in other cases involving engineering products.

Emerging standards for AI risk management

At present, a variety of AI-specific risk assessment methods exist, virtually all of them evolving rapidly and with considerable levels of detail. Unfortunately, none of them is a widely accepted standard, most of them having applicability at the level of a single nation. These standards are all rather immature although it is worth noting that the International Organisation for Standardisation itself has moved forward with its ISO/IEC 23894:2023 Information Technology - Artificial Intelligence - Guidance on risk management (ISO/IEC 23894:2023, 2023). Although an important contribution to the standardisation of risk analysis and management practices for AI, this standard is still very young and is meant to be applied in conjunction with

the ISO standard for risk management systems ISO 31000:2018 (ISO 31000:2018, 2018), of which it is seen as an extension to a specific sector. Other standards (actually national regulations or guidelines) are the EU AI Act (EU Commission, 2021), the UK Online Safety Bill (UK, 2023) and the US Algorithm Accountability (Mökander, 2022), the Italian White Paper on Artificial Intelligence (IT, 2020). Other standards have been developed or are being developed in other countries, for example in Brazil (Uechi et al., 2023).

All these standards have, as a common feature, the attempt to prevent the damage that an AI could potentially cause, either by acting at the development level and before use or during use. They all also try to take into account the fact that AIs evolve during use and that, therefore, their behaviour may change with the arrival of new training data, in a phenomenon very similar to that of regression in software releases. Many of these methods are beginning to become legislative requirements for the development and deployment of AI systems, thus becoming real general policies that can be used to define certification schemes on the safety of AI systems. In addition, a process very similar to the one described in Section 5 above can be found in these standards. Precisely because of the immaturity of these systems, there is now a high risk of artificial intelligence products being placed on the market that may present unacceptable risks.

Conclusions

Standard risk analysis methodologies (e.g. ISO 31000) can be applied to artificial intelligence systems, but considering risk profiles that are in part extremely innovative and different from those typical of other systems. Given the ever-increasing pervasiveness of artificial intelligence in today's widely used systems, but also in systems of limited use but of high criticality, the need to define reliable risk analysis and mitigation methodologies and to introduce mandatory legislative requirements for their application before the approval of artificial intelligence systems for use outside development laboratories becomes increasingly urgent.

These legislative requirements are the responsibility of legislators who, given the current bureaucratic slowness in defining mandatory certification policies, may even have to impose a temporary suspension of the use of artificial intelligence in various sectors, such as defence, mobility, medical applications and all those cases where there is a direct risk of damage to health, the environment or the economy of significant magnitude. The purpose of this suspension would be to allow the regulatory evolution path to be completed before allowing the use of AI applications in critical contexts. It is believed that ISO could be a good framework for technical standardisation, but it is suggested that a specific task force for artificial intelligence be set up at a global level with the task of guiding the various nations and the authority to select best practices, methodologies, guidelines and national policies, facilitating their sharing with other nations and supranational bodies, to pool the best results emerging at a local level.

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The Folkloric Spirit Through the Form. In the Case of Tirana Recents Architectural Development

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Abstract

This paper aims to analyze the methodological differences of the sculptural-aesthetic form in architecture. The so-called sculptural form has always been looking for an aesthetic realization in arts, but today we see more and more architectural examples that are proposed as such. In the Pier Paolo Pasolini's short documentary 'The Shape of the City', we see contemplated the shape of the city of Orte in Viterbo, Italy, where he referred to the different as a form that destroys the complexity of the whole, but he clarifies that he is talking from an aesthetic point of view. This phenomenon, especially in Albania, is more noticeable around the central areas of the cities, where in some cases the architectural forms has been transformed, evoking some folkloristic symbols. The architect and the artist are no longer differentiated, so these phenomena can be more visible in the facades of many new buildings in the city of Tirana. Analyzing the shape of buildings in the city of Tirana in the last 10 years, we see many recent shapes through folkloric elements. This way of designing by architects working with cities like Tirana is creating disconnection with the organic parts of the city and alienating it. The new image of the city, with skyscrapers like Down Town or Skanderbeg Tower are a direct reflection of the representation of the folkloric form. The question arises spontaneously; do these forms bring sustainability for a contemporary image of the city as a representative of its time? The paper will ask the above question and at the same time examine the possibilities of these forms to be representative of the development of the city in the contemporary spirit and the appearance of at least a nationalist spirit through the form.

Keywords: Tirana, shape, downtown, folklores, architecture.

Introduction

Although the Labor Party won the 1991 elections, (Affairs) in 1992 they lost the first pluralist elections after almost 50 years of a one-party system and the party-state government fell. And a democratic government was installed soon after, in that moment the rapid change of the cities began, the additions often dictated by the need for space appeared like mushrooms everywhere, alienating the common public space. Ornamental tools up to that time almost completely absent began to appear inside the apartments and also outside it. Till that day, the fantasy was truncated by the totalitarian regime, which made it impossible to display aesthetic individuality, also because most of the dwellings other than what the vast majority of the population called adobe were state-built dwellings such as prefabricated or silicate bricks and in most cases they were built by voluntary work, which lasted until the end of the imposing collective rules. The need until that time was to build four or five floor buildings, because they were mostly for residential purposes. The communist era left a lasting impact on the city's physical and architectural landscape, with monumental structures and urban planning interventions that aimed to shape the city according to the ideology of the time (Velo, 2013). With the end of that era, Albania opened up to the influence that came from abroad, starting a process which still lasts today. During this process, in Albania, the individual took over on the role of the beautician and modifier of public space in the city by transforming it according to his image, full of effort and doubt towards an idea of personal ideal.



Figure 1: Skanderbeg Square, Tirana, 1990. Retrieved from online newspaper Koha.

Vice Versa (Artist as Architect)

Throughout history, we have evidences that what happened in Albania in the 1990s is not new; a sort of aesthetic self-regulation has always existed. Perhaps this did not happen consciously in the case of the individual, but referring to what was argued in the book *Gardner's Art through the ages: A Global History* (Kleiner, 2009), many societies or rulers of the past understood the influence of art in communicating with the masses. Something that from ancient times was an idea widely accepted was designing power and propaganda

message through the facade has been very present, where one of the main roles has been the use of decor through bas-reliefs and round sculpture. For conveying these concepts, round sculptures, bas-reliefs, and other architectural decorations were particularly effective mediums. Bas-reliefs offered the chance to depict in great detail historical occurrences, mythological tales, or symbolic environments that bolstered the ruler's narrative. These pieces of art were often erected in public on the outside or on the exterior facades of important buildings for maximum impact and visibility. For example, in Egypt as was explained by Gombrich in his book *The story of art*, (Gombrich, 1995) the pharaohs decorated their temples and tombs with hieroglyphs and reliefs showing their divine status and military conquests. The Romans acted in the same way, using monumental sculptures and bas-reliefs to propagate and glorify the virtues of the empire, as in the case of Trajan's column. However, in the cases mentioned above, we are not talking about a special role of the artist or the architect, but about a practice conditioned by the intention of the commissioner. The role that the individual has claimed as his own during the 90s and taking the omnipotence of the creator par excellence has also been a kind of dilemma of its own kind which is repeated in the history of the coexistence between the artist and the architect. Regardless of today and this day, we are always amazed when we come across some of the wonders of Gothic, Renaissance, Romantic architecture, and many, many others. We are delighted by their engineering achievements, by their aesthetic beauty and by the art-works that they hold inside, as decorations, frescoes, and many more. They have transformed into symbolic expressions and sensorial bearers of aesthetic values.

There was a time, precisely the one we mentioned about above, in which the architect and the artist were one, for example Michelangelo Buonarroti, Leon Battista Alberti, Brunelleschi, Raphael, etc. There is a long list of artists who developed their practice in different disciplines during Humanism, who did not divide their art practices into architecture and fine arts. For example, the discovery of perspective was nothing more than a fragment of the same thing, a different expression of the same sensitivity. But in a writing by Marco Casamonti (Casamonti, 2014) the unification of the arts did not last long, and not due to reluctance, but due to the difficulty of combining all artistic expressions in the same aesthetic theory. The fine arts are able to express themselves to the maximum through the sublime, the imitation of nature (considered perfect because God created it), just as architecture, which by necessity builds artificial landscapes, functional to human needs, can claim to have the same status as art? Casamonti says.

This conceptual problem has been sought to be solved by means of an archetype such as that of a primitive hut, which turns into a model to be imitated. Corinthian capitals had leaves next to them, so they gave the architecture the same expressive artistic value of painting and sculpture.



Figure 2: Pier Paolo Pasolini, stills from the short documentary, Orte, Italy, 1974. *La Forma della Città – The Form of the City*.

The Whole (form and detail)

Pier Paolo Pasolini, the director of Italian Neorealism, also discussed the shape of the city, his films mainly deal with the outskirts of the city. But in the case of the documentary *“La Forma della Città”* (Pasolini, 1974), he speaks in a monologue about the historic city of Orte in the province of Viterbo where he refers to social housing (which he was categorically against) which was built on the outskirts of the city of Orta in the years of the Italian economic boom, as something outside the country, as a different form that broke the complexity of the whole. Pasolini clarifies that he is talking about the aesthetic form of the city, so he speaks as an artist, not as an architect. It underlines the need for the eye not to be distracted by something that seems not to have its place there, something that alienates the profile of the city we are seeing, which is why the difference in styles and above all in some structures are very different from the sum of the style dominant, you cannot put a new modern structure in the center of an ancient city contemplates Pasolini. Trying to strengthen what was said before, let's make a modest analogy with the thought of Pasolini, and Rudolf Arnheim, the latter, tells us about form and simplicity as a need to read the general form. He states that:

« *According to the basic law of visual perception, any stimulus pattern tends to be seen in such a way that the resulting structure is as simple as the given conditions permit.* » (Arnheim, *Art and Visual Perception, A Psychology of the Creative Eye*, 1974)

With this quote he tells us that depending on the stimulus, be it; shape, color, light or atmospheric conditions, the receptors of the eye and then of the mind will read the shape as simply as possible. To put it with Pasolini, if the stimulus is strong, then the eye's tendency to simplify the detail will be less, but if the stimulus is weaker, then the eye is able to simplify it better. Eliminating the distraction of the eye from the overall shape and panorama. Pasolini, in its Orte's documentary, seems to give a sense of proportion to the city's history, but what about Tirana today? What can be said? It is often argued that Tirana was not a historic city like other cities in Albania or outside of it. Or that Tirana does not have a historical skeleton of the city worth preserving.

Towards the Centrality (Periphery)

At the beginning of this article, we discussed a little about the numerous haphazard constructions around the city, especially during the early 90s and the general cacophony where everyone was building according to their own personal idea. But it would be good to make a differentiation regarding this phenomenon

between center and periphery. The intervention of the individual in his home in the suburbs comes as a result of local cultural processes assimilated over time. Despite the lack of aesthetic unity, it is organic because it comes from below, it comes from the need to build a larger space, from the need to create facilities through the property and from the need to be identified. This conglomeration of differences that the outskirts of Tirana offers in particular, creates a unified and simultaneously diverse urban landscape.

However, we cannot simply separate the center from the periphery, as if to say that this phenomenon of individual aestheticism only occurs on the periphery. To various extents this phenomenon also manifests itself at the center and, on the contrary, from the periphery it is not organic. It seems more as if the center is an arena, a pedestal on which the sculptural volumes are raised, a theatrical stage on which a comedy is staged, all dedicated to the active and passive spectator. A form of communication with the masses is no longer the vision of the local inhabitant who tries to stand out in his peripheral locality, but that of imposition, through a well-defined image capable of capturing as much attention as possible. We must say that not all the buildings in the center are like this, the center offers several buildings from different eras that have characterized the capital, there are also skyscrapers that can be divided into two categories. On the one hand there are those with clear architectural volumes that are defining the image of Tirana in the future. And on the other side there are those buildings which, despite having clear architectural walls, insert elements of national folklore on the facade. In some cases, *folklorism* is only at the level of the pattern, colorful and in other cases it returns to the form, here there is a clear media objective of communication with the masses.

Let's dwell on this situation a bit, Tirana at the time of communism had slogans that appeared on the gray buildings of the time, and from there in the 2000s there were facades painted by the most important contemporary artists of that time, where the facade was a canvas that communicated with the passerby. And during these years, many parts of the city have disappeared to give way to multi-store concrete buildings, depriving the city of its identity, while some of these buildings use, for example: the map of Albania, Skanderbeg's head, carpets with national folklore motifs and many others. The question arises spontaneously: is it a way to dress the city in history while the very construction of those buildings has erased the history of the city?

Pattern and Facade.

The facade is a component very important in a building, they create a relationship between what is inside and outside the building. It separates two spaces and at the same time communicates through this separation. Facade models or the patterns that represent them can be related to the symbolic and cultural context, representing historical, religious or traditional themes. Since they have a direct impact on people and the way people perceive shapes in relation to space, harmony and visual balance is important. In the book *“The Dynamics of Architectural Form”* (Arnheim, *The Dynamics of Architectural Form*, 2009)

Rudolf Arnheim emphasizes the importance of visual elements, such as patterns, in the creation and perception of art and architecture. By including the patterns found on the facades, they play an important role in guiding the viewer's perception and creating a sense of visual harmony. Based on his work, we can say that visual perception is a dynamic process that includes the interaction of the viewer's mind and the visual elements that are presented to him.

They are not created to simply have a certain visual form, but at the same time they perform several functions that are very important for the building, such as protection from the sun's radiation, winds or other climatic aspects. The materials with which the facades are built must create a very good balance between form and function. It can affect the deformation or maintenance of the facade model. Therefore, when we do an analysis of it, this approach between the operation of these elements or not should be taken into account. On the other hand, the pattern that the building conveys affects the viewer in obtaining information about the building. Back to Arnheim, he emphasizes that facades must be created in such a way that they can be perceived as elements that communicate with each other. Buildings must communicate visually with a code that pertains to the territory where they were previously built, or where a

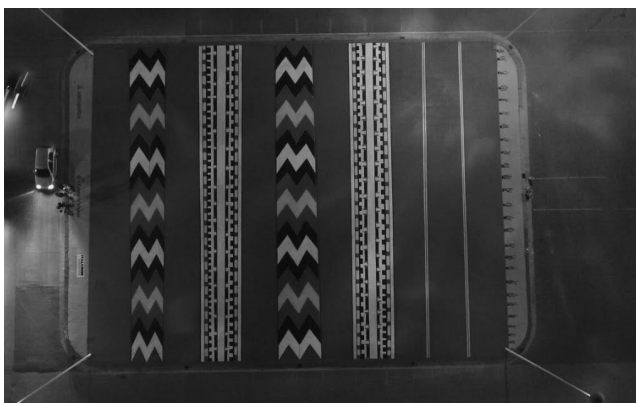


Figure 3: Qilimi, Mother Tresa Square, Tirana, Albania

new aesthetic element will be built.

Folkloric forms in architecture refer to design elements, architectural styles, or features derived from traditional or regional folk art, culture, and customs. These forms are often characterized by their simplicity, their connection to local traditions and the incorporation of cultural symbols or beliefs. They can be found in different types of buildings, such as houses, churches and other structures, which reflect the cultural heritage of the community to which they belong. These folkloric forms in architecture serve not only as an expression of cultural identity, but also as practical solutions adapted to the local environment and climate. They continue to inspire contemporary architecture and preserve the unique heritage of diverse communities around the world. If we go back for a moment to the architecture that was built during communism in Tirana, we can notice very well different structural parts on the facades of the buildings.

As for example in the shapes of the carpets that are repeated in the staircases of the buildings, like empty spaces that create the design through their cutting. Such elements can be found in several palace buildings of this period. While folkloristic forms, as a way of preservation of symbolic elements or materials that are part of Albania, we also see them in the square, which is built on the concept of preserving the identity of matter but not shown in an illustrated form. And other elements of the buildings around the center of Tirana are emphasizing once and more this visual need to express identity through form.

Albania is characterized by a diversity of folklore elements. Some of the reasons that make these changes possible are because of the climatic conditions, which change and affect the type of material that is chosen to create these carpets. These products being part of the family economy, we see that these conditions have made possible the interpretation of the forms by women. Where they have interpreted the shapes by putting the feelings and choosing the colors to create the shapes (Zozji, 2024). Contemporary architecture does not come out of nowhere. It is reconstructed by analyzing the buildings of the past and their adaptation to the culture and needs of the area. These forms, which are sketched above as representatives, without color and without matter, of some repeating elements in Egyptian carpets. There are also shapes that have symbolism. Since Albania has many regions, some deep and some that have had contact with other cultures, it has created a diversity of forms that are repeated. It seems that over time, these forms have been preserved, and we can say that they had many symbolic values. Below are some carpets where, in different areas, we see the same repetitions but with an interpretation in the color ratios. Like the shapes taken from the zigzag carpet. In some cases, we look at images that have emerged from the contrast between the subject and the background, where sometimes we see shapes stand out and sometimes, they appear in the background, turning into a repeated shape. Here we are talking about the symbol of the geometric shape with two heads. Drawings and interpretations of the symbol of the national flag have been interpreted in various forms in the symbolism of carpets or decor in Albania. This has come to us as a need for popular communication through the national image. To make this creative connection more. Usually, this corpse of the eagle symbolism comes from

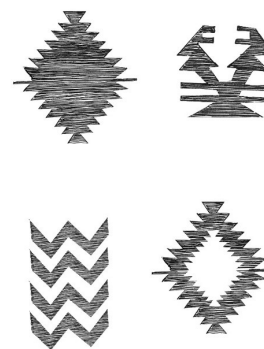


Figure 4: Qilim ornaments. Ornament drawings derived from the Albanian traditional carpet. Courtesy by Armela Lamaj.

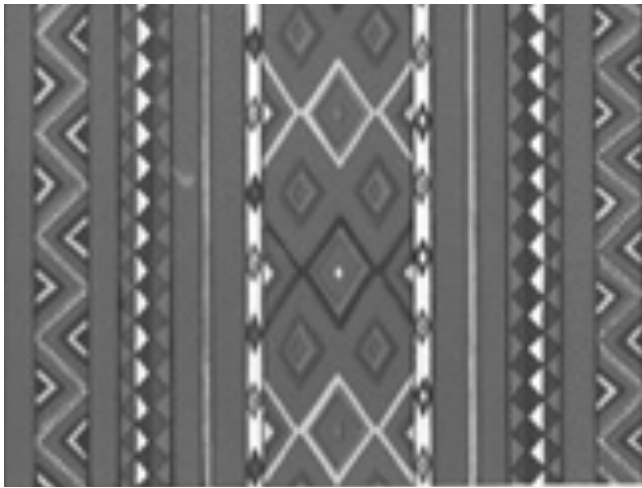


Figure 5: Carpet woven in kukes, (repetition of zig zag elements)

red as an element of an identity representative.

Folk – Form

Following the discourse, we can say that it is a little too complex to make a differentiation between the pattern of the facade and the form, although we can say that the facade is only about the external appearance with the help of the ornament. In some cases, this becomes easy to distinguish, in other cases, as in the case of the building under construction, simply called Skanderbeg's head by most, regardless of whether it is officially called Tirana Rock, the difference between the facade and the shape becomes complex. Because through interventions in the form of balconies, walls and other architectural elements, the building is changing in its general form, that is, in its volumes.

We will return to the topic shortly afterwards, but above we have tried to argue the pattern and the ornamental interventions by means of folklore to the facades; those decorative incorporations often serve a more symbolic purpose than a practical one (Doherty, 2003). For example, we have several cases where the element "carpet" (qilimi) was used, in the case of the carpet painted as a trompe l'oeil on the facade of a government building in Tirana, as well as on the floor of Mother Teresa Square in Tirana (fig. 3). In both these cases, there is no practical and functional value in the creation of these painted facades, even the aesthetic values are not present in those facades, turning into what is described as a kitsch imagery (Baudrillard, 1981).

The art historian and critic Clement Greenberg defines kitsch as a style typified by excessive sentimentality or tackiness that is frequently devoid of actual creative worth (Greenberg, 1939). Moreover, on the same issue, Mattei Călinescu warns against using folklore-inspired motifs carelessly, as they run the risk of becoming kitsch (Calinescu, 1987). Examples of such motifs include painted trompe l'oeil carpets that we mentioned above. These decorative interventions serve largely to elicit nationalist sentiments (Smith, 1991). These embellishments, based on collective recollections of popular folklore, are meant to evoke an emotional response in the audience, instilling a sense of pride and belonging (Anderson, 1983). However, their cultural significance and aesthetic worth are diminished by the commercialization of these traditional symbols for mass consumption (Appadurai, 1986). Their original significance is lost, and they are reduced to mere imitations rather than authentic representations of cultural

heritage (Baudrillard, 1981).

Clearly, there is a dispute between authenticity and commercialism in the portrayal of national identity through architectural adornment. Although the employment of folkloric elements may appear to be a celebration of cultural heritage, unthinking appropriation for decorative purposes risks perpetuating superficial stereotypes and damaging the integrity of the cultural heritage they are meant to represent. It is necessary to move beyond superficial representations towards a more nuanced understanding of cultural heritage and identity.

Formally, there is a similar case, is the new pedestrian walkway of Shiroka in Shkodra (fig. 6) designed by the Danish studio Casanova + Hernandez under the name Albanian Carpet (Casanova+Hernandez, 2023), but this time regardless of the fact that the pattern's ornaments come from the carpet and the very name of the project is based on the carpet as an essential part of the tradition and Albanian folklore, the project has not ended in kitsch imagery. The subject of the pattern in this case is also represented by the function itself. In addition to the form, in particular, which is connected with symbolic ornaments, it also has the function of a carpet, due to the way the repetition of forms is built. Inviting you to welcome, the area is closely connected with the services of the restaurant. In this area, one can enjoy local products, like at home. The finding of this element as part of the designers' thought and concept is harmoniously connected with the surroundings. The way in which color is interpreted has a special importance in bringing back motifs from the past and also in the interpretation of forms. In this case, the colors are contained and reproduced together with the material, such as stone tiles. The painting of the road was not used, something that would invalidate this project in a very short time, which in a very subtle way conveys positive emotions and warmth from the past. As it seems in this case, regardless of the fact that folklore motifs are used, it does not fall into that kitsch imagery that Baudrillard described. We can say that it is in balance, preserving the use of folklore motifs with intelligence. Even the ornamental excess described by Clement Greenberg here is contained, without excess. Another case is the one mentioned a little above, that of Tirana Rock (Skenderbeu's head) (fig. 7), an unprecedented case in our country but with a historical precedent in world architecture, as David Brussat reminds us, and it is the Harvard Lampoon Building (Brussat, *Architecture Here and There*, 2014) in 1909 by Edmund March Wheelwright (fig. 8), bearing witness to the lasting impact of creative design throughout time and space.

If we want to just recall other cases that history teaches us, in fact, regardless of the massive use of interventions not only in the facade but also in the form, they do not manage to change the plastic of the building or structure into a sculptural volume. Although during Spanish modernism, with the well-known architect Antoni Gaudí, some attempts may have been made and perhaps some analogies can be found, in any case, they remain within the framework of biomorphic forms (Khurram, 2023). Within our country, Tirana Rock is a unique creation that resembles more than just a typical building—rather, it embodies a sculpture bust, regardless of the fact that it is an 85 m



Figure 6: Shiroke, Shkoder, Albania (Albanian Carpet is a patterned plaza. Top image: it is made from blocks of granite).



Figure 7: Tirana Rock. Retrieved from online website, Ana shpk.



Figure 8: Harvard Lampoon Building. Edmund March Wheelwright, Boston, 1909.

high building according to what the construction firm, Ales Construction (Ales Construction, 2023) claims. The building is located next to Skanderbeg Square, which bears the name of our national hero, because this building also refers to this national hero, paying homage to his legacy. The designers have tried to adapt the building with its plastic moldings to give us the likeness of a bust, it refers to the bust of Odise Paskali, which is also the image of Albanian banknotes. In a statement, Winy Maas, founding partner of MVRDV, said that today cities around the world are increasingly similar to each other and encourage them to find their individual character, advocating for a comeback to personality and pleading with local governments to recover their distinct identities. Referring specifically to this building, he states that this building is an opportunity to make a difference. Although at first glance we can agree with his statement about the similarity of cities and the difficulty of having an individuality among the modern cities of our time. But this building imposes itself as a sculpture and essentially as a monument, as a means of communication with the spectator and the space using the folkloric element. Just like in the case of the carpet pattern, where it was used on the facades of buildings only because it brings with it elements capable of conveying national feeling.

The other building under construction, Tirana DownTown (MVRDV, 2019), was designed by the MVRDV studio and represents yet another noteworthy project in the field of architecture. The building is located on Bajram Curri Boulevard, at the threshold of the Lanes River. Its main facade is 140 meters high. It is planned to be a building for the following purposes: residential, office, commercial, and entertainment. Its main facade, as shown in figures 9 and 10, mostly consists of consoles. Referring to the official website of the company, it is said that each apartment or office represents a village or city, so seen from afar, these consoles form an abstract map of Albania. Maps have been used as a means of determining coordinates, places, and settlements; they have been used by travelers and different navigators throughout history. But they are also used as a means of communication with the public; in many cases, they are used by different artists. One of them was the Italian arte povera artist Luciano Fabro, who, in his 1994 work "Italia all'asta" (Rivoli, n.d.) (Italy on Auction), the outline of the geographical map of Italy is made of iron, and the reproductions were superimposed on each other in order to reverse the geographical coordinates. Crossed by a long pole, the resulting sculptural form evokes a variety of symbols. Fabro is not the only one either; even the American artist Nate Lowman, with his Maps (Lowman, 2018) of united states, addresses the fluid nature of borders. For him, maps are not fixed entities, and for this reason, his artistic practice is a bit similar to that of American pop artist Jasper Jons and his maps. However, although these artists used the shape of the map for its clear symbolism and its communicative immediacy, their choice is justified by the fact that it has exclusively artistic purposes aimed at an audience that chooses to see it or not, at an audience that the vision was not imposed on him. Therefore, the game created with

the form or its modifications remains within the scope of artistic originality and cannot be justified or compared to the decorative ornamentation of the facades of an architectural object. The project, it takes upon itself the representation of the nation through a parthen-form with a pixelated map of Albania. That plays in the same way, risking turning into kitsch for the reason that this ornamental use often also takes a chance on cultural symbolism turning into a meaningless show. This ornamental use of national symbols frequently veers dangerously close to kitsch (Radovic, 2018), where genuine historical significance is replaced by aesthetic appeal. By employing such components, we run the risk of creating a sanitized history that forces a manufactured story on the inhabitants that has no real historical roots in tradition or heritage. A manufactured past, an authentic but hollow replica of history, threatens to supplant what was once a reliable indicator of a city's identity or cultural affiliation as a result of the superposition of these layers of symbolism. The phenomenon, which is defined by the appropriation and commercialization of elements of folklore (DuBois, 1903), not only lessens the diversity of cultural heritage but also feeds back into a distorted sense of collective memory. It imposes a façade of pseudo-history, distancing the present from historical context and cultivating a disassociation from real cultural roots. To minimize this risk, architects, designers, and urban planners must exercise caution, striking a balance between the desire for innovation and a respectful recognition of cultural authenticity. Rather than succumbing to the allure of superficial embellishment, projects should strive to engage with history in a meaningful way, fostering a dialogue between past and present that



is authentically relevant to the community's lived experiences.

Conclusion and Future Research.

Regardless of the fact that this article does not aim to give a verdict on the use of folkloric ornaments on the facades or volumes of recent buildings in Tirana and Albania, it simply tries to give another perspective on the danger that these interventions create. In all cases covered in this article, it is necessary to delve deeper into the type of development of the sculptural-aesthetic form within architecture, focusing in particular on urban environments in the city of Tirana, Albania. According to the analysis provided in the text on some of the architectural trends of the last decade, it seems clear that there is a proliferation of folkloric elements included in the design of buildings, blurring the lines between architecture and art. While this phenomenon may contribute to the visual attractiveness of the urban landscape, it also raises questions about its impact on the organic integrity of urban spaces and its ability to promote a sustainable and contemporary image of the city.

In some moments of this text, the problem of not falling into kitsch aesthetics and imagery is highlighted, comparing and defining the definition of what can be defined as kitsch through the different authors who are cited in the text. In some cases, the ornamental elements through the folkloric motif have been used intelligently, as in the case of the Shiroke pedestrian walkway in Shkodra. They offer functionality and simplicity in addition to aesthetics and values that recall the cultural heritage. In a ruling, this could be the way to approach interventions that require content linked to tradition, heritage, and folklore. Skepticism is evident when talking about Tirana's skyscrapers still under construction, such as Downtown One Tirana and Tirana Rock. The word skepticism in this case encompasses the danger offered by the use of folklore motifs, the use of national symbols, and the use of shapes that are a clear reference to national geographical

shapes. According to the definition we have given to the Kitsch image group, these elements used in these two objects but also in similar cases, for example, the carpet painted on the floor of Mother Teresa Square, clearly risk being a Kitsch imageri. These interventions do not take into account the imposition of the image and the change in the visual perception of the urban landscape. Through the architectural interventions in the two skyscrapers mentioned, the volume and shape are transformed in order to impose on citizens a sort of history recreated using national folklore. When these elements overlap on different layers, where they once constituted an element of identification for the city or for the people, this is denied by occupying the place and recreating a history without a past, a false history. Ultimately, this research aims to open a discussion whether such sculptural forms contribute to the evolution of the urban landscape in terms of cultural heritage and radical thinking. By exploring the implications of these architectural choices, it aims to stimulate dialogue on the balance between tradition and innovation in shaping the urban landscape of Tirana and beyond.

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On imitation and Style (Transfer). Discussions on the Revivalism Permeating AI Technologies

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The surge in the proliferation of AI-generated images within the past three years has significantly disrupted the established norms of architectural production. Whether manifested in text-to-image, image-to-image, or text-to-video systems, the pervasive influence of generative AI has introduced novel considerations into ongoing discussions within global architectural communities. These discussions scrutinize the rightful application or potential misuse of generative AI in academic research and professional contexts, prompting a reevaluation of its legitimacy. Despite the ongoing debate, there is a persistent and growing interest in these artificial intelligence tools that should focus not only on the legitimacy of their use but also on the appropriate ability to evaluate this production and establish some rules so that they can be analyzed and discussed. As an individual actively engaged in teaching architectural design, the enormous volume of images produced by students using artificial intelligence stimulates deep reflections. Indeed, these reflections extend beyond the simple methodologies of their use to a fundamental reexamination of the imperative to establish relevant criteria for their evaluation. This transformative influence of artificial intelligence in architectural design echoes a broader discourse in the academic community (Datta et al., 2018; Gkoumas et al., 2020; del Campo, Manninger, S., Carlson, A., 2020). The implications of such technological interventions require conscientious assessment of their ethical, pedagogical, and professional ramifications (O'Neil, 2016). In particular, the increasing use of artificial intelligence tools underscores the im-

perative for educators and practitioners to engage critically with these advances, ensuring their responsible incorporation into the discipline of architectural design.¹ In a few words: what is the aesthetic and aesthetical category than can be found behind this mass production that we are encountering today? As we know, the word 'aesthetic' – deriving from the Greek "aisthetikos", meaning "sense of perception" - was introduced in the 18th century from the German philosopher Baumgarten and became a proper branch of philosophy. Next, we can refer to Birkhoff's investigation in his functional formulation centered on two essential parameters: (a) the viewer's perception, denoted as C in his function, and (b) the object's intrinsic characteristics, represented as O. The interaction between these two parameters results in the derivation of an aesthetic measure, denoted as M. This measure serves as an evaluative metric that confers recognition on the viewer's perception and understanding of the object. Birkhoff's formulation emphasizes the importance of both subjective perception and the object's intrinsic qualities in shaping aesthetic experience, culminating in a comprehensive and nuanced assessment of aesthetic value. In sum, the classical philosopher found that "beauty" is related to the object, whether considered as "an object" or a series of several connected parts communicating a sense of harmony and proportion. Refer-

¹The motivation for this article comes from an initial reflection started with a colleague, prof. Skender Luarasi, on the necessity to develop some conceptual framework for the evaluation of AI-generated architecture.

ring to the architectural field, Vitruvius identifies six principles that are at the base of the discipline: order, arrangement, symmetry, eurythmy, propriety and economy, to then compact these 6 into 3: firmitas, venustas and, utilitas. Later on, in the golden age of the Renaissance, Leon Battista Alberti shifted the Vitruvian category to something that was more in line with the idea of the perfect city and the new insights that the new architecture of the city should have represented and incarnated. The categories identified by the Alberti were: number of parts, placement of parts, and concinnitas (Proportional relationship), extrapolating this last one from Cicero's concept of beauty. In recent years, before the advent of AI – or more precisely – before their mass diffusion in architectural production - Ghom and George's findings led them to assert that aesthetics in architecture has evolved beyond mere visual appeal. Instead, they identified a multifaceted paradigm encompassing nine distinct parameters. These parameters include spatial organization, functional efficiency, social and psychological dimensions, environmental considerations, sustainability, technology integration, economic aspects, legal frameworks and rating systems, as well as durability and maintainability. According to their conclusion, the aesthetic evaluation of architecture now involves a comprehensive assessment across these diverse dimensions, highlighting a broader and more nuanced understanding of architectural aesthetics that extends beyond the traditional visual criteria. In the current landscape where the production of architectural knowledge has transitioned to utilize more advanced and intelligent tools, the challenge lies in establishing pertinent categories for evaluating these works. Moreover, contemplating aesthetics specific to 'architectural intelligence' becomes imperative. According to Mario Carpo (2023), the idea of reaching a state of 'post-human developments' facilitated by these tools remains distant. Instead, Carpo suggests that these tools are experiencing a revival of dormant visual strategies that have been present in architectural production, emphasizing a continuation of human engagement in the creative process facilitated by technological advancements. Visual similarities are at the core of this process. Carpo makes the example of the generation of a dog from an AI tool: what do AIs do? Firstly, they search for similarities among the billions of images they have in their database until they find what the different pictures have in common and, indeed, they search for an archetype of a dog. After that, they start generating to decompose the image of the archetypal one until something new comes out, something that, anyhow, should already have a trace inside the database they are trained to follow. The AI is then 'imitating' continuously the archetypal one that is always present in every generation. Even though the aesthetics of the dog might change, the initial reference is always there expressing to the 'discriminator' part whether the generation is correct or not. Even when it comes to mixing more databases, there is always an exchange of information where the different lists of references activate a give-and-take process between them. There is always the dynamic of extracting something from one to infuse them into the others to generate something new, in a few words, we are facing something that is called style transfer: a process that utilizes deep neural networks to extract and combine the content of one image with the stylistic features of another, resulting in a new image that merges the content of one source with the aesthetic elements of another. Imitation, style, repudiation, etc. are keywords that dominated the art and architectural debate before the advent

of Modernism: The principle "form follows function" is a key tenet of modernist design, emphasizing that the design of an object or structure should be primarily dictated by its intended purpose or function. From a modernist perspective, imitating traditional forms without a corresponding adherence to their original functions can be considered a mistake or, in more critical terms, a deviation from the ethos of modernism. Since we have inherited from Modernism a so-called "forward-looking and purpose-driven approach to design," it seems somewhat hilarious that the most intelligent tools we have so far are simply feeding the architectural debate with theories and aesthetic theories that have been completely eradicated over the past two centuries. Imitation seemed to be something relegated to classical theories, to a world that no longer existed and could be considered 'the old man' with respect to the emancipation promoted by modernist architects, and for us 'imitating' another style was understood as a shameful approach to architectural design that should incorporate other 'substances' (quoting Edoardo Persico) instead of fishing in the past. Perhaps, in this magmatic succession of things we are currently facing, and considering that artificial intelligence seems to be already included in 'old' techniques, we need to revive some critical awareness of what imitation means, how it works, and how we can work with it. Certainly, in the dynamic and rapidly changing landscape in which we currently move, where artificial intelligence (AI) is becoming increasingly integrated into established practices, it becomes imperative to cultivate a heightened critical awareness of the concept of imitation. In essence, cultivating a renewed and critical understanding of imitation in the context of artificial intelligence is essential to address the complexities of contemporary technological advances and ensure that these tools contribute to progress, innovation and ethical considerations rather than perpetuating outdated paradigms.

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Furnishing Gorica Neighborhood with Public Spaces and the Problem of Upgrading the Historic Centers

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The City of Berat, of which Gorica and Mangalem are two of its most notable neighborhoods, forever looking at each other from opposite sides of the Osum River, became a UNESCO World Heritage Site in 2008. Such prestigious affiliation promotes the city's monumental and historical values and makes it the subject of an extensive nomenclature of preservation and restoration, laws, values, and practices. In other words, being UNESCO World Heritage Site puts the city on a map. Such affiliation has triggered an increase in domestic and international tourism, which demands an imaginative upgrade of Berat's urban infrastructures, both on an architectural and urban scale. Most of the vernacular buildings are currently being transformed into hospitality structures, while the streets and public spaces are furnished with additional public functions. These upgrades must respond to the larger flux of people and different kinds of activities and mobilities on the one hand, and enhance the city's historical, vernacular, and monumental values on the other. The project presented here responds strategically to this condition by proposing a network of small urban spaces or mini plazas at key junctures of the existing road network of Gorica quarter as well as a vehicular artery above the urban assembly of the neighborhood. The Gorica quarter is considerably younger than the other two important quarters, Kala and Mangalem. It is between 300-400 hundred years old and has about 200 historic houses of the first and second category, several distinctive buildings constructed between the two World Wars, as well as two reconstructed



Figure 1: The City of Berat.



Figure 2: View towards Gorica neighborhood.

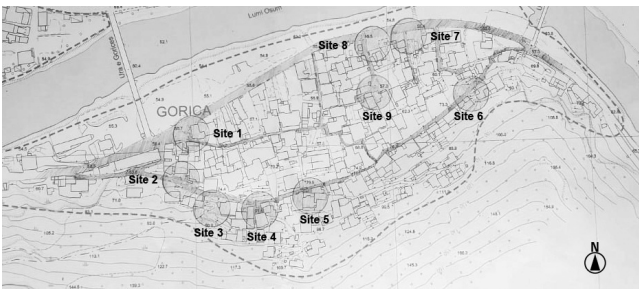


Figure 3: Mini public places in the urban fabric of Gorica quarter.

churches. Unlike the other quarters, Gorica faces north, which makes it rather an unfavorable location, especially in winter season. But what lacks in orientation and direct sun light is compensated by a dramatic urban and topographic configuration. The Gorica quarter is located at the bottom of a hill and is an integral part of the amphitheater-like silhouette of the city of Berat. The best views of the Mangalem quarter, which is the most well-known and photogenic part of the city are offered from Gorica neighborhood. Gorica's urban ensemble has a distinct silhouette, streetscape, and topography. Its main street is of a crescent shape that crosses the Gorica quarter longitudinally, and it is characterized by an architectural diversity and variety of large traditional houses with *çardak* surrounded by gardens. Our proposal aims to improve or emphasize several existing mini public places in the urban fabric of Gorica quarter and create new ones. After we surveyed the Gorica quarter we stra-

telegically selected a few potential places as possible public mini squares with panoramic balconies. We envision these places not only as passages, in the way they have been functioning until now, but also as spaces for living and as an infrastructure for urban events. These places are designed to work *scenographically*, like urban stages that frame urban encounters among people and tourists. These stages have “accidental” or irregular shapes; they are enclosed spaces on three sides and open on the fourth, with a direct view toward the Mangalem quarter. As William H. Wide says, “smaller places, with a reassuring ‘sense of enclosure’ and attractive and busy edges are normally the best.”¹ Local traditional materials and trees and shrubs will be used in their design. Being easy to reach and part of the existing infrastructure, these small squares have the potential to be popular meeting and mingling places.

The other objective of the proposal is to introduce different kinds of *urban furniture*, like in-built seating, fountains, signs, niches, and lighting along the pathways of the quartier. The urban furniture helps the daily activities of the citizens, orient and inform the tourists both spatially and chronologically about the form, history, and culture of the town, and they enhance the Gorica quarter as a *whole* unified unit, by marking its itineraries, its urban texture and spaces.

The Gorica quarter is traversed by two main longitudinal streets, one is the main street and the other a riverside street. We envision a third longitudinal street as another artery above the urban ensemble, a two-way street between the urban ensemble and the green area above which took shape after WWII. This artery was first proposed in the Italian General Plan of 1942 and can be reintroduced as a viable solution in redirecting traffic and in providing the citizens and tourists with vehicular access to the quarter. In this proposal we also propose the *repair* and modification of several, more recent buildings that do not dialogue well with Gorica's urban ensemble as well as the reconstruction of a group buildings burned down by the German army in September of 1944. What was summarized above is the practical ambition of this proposal. The latter relates, however, to a larger theoretical problem,

²John Ruskin, *Seven Lamps of Architecture*, (London: Smith, Elder and Co., 1849), pp. 162-82, in Jorge Otero-Pailos, *Historic Preservation Theory*, (Sharon, Connecticut: Design Books, 2023), 54

³*Ibid.*

⁴Eugène-Emmanuel Viollet-le-Duc, “Restoration,” from *Dictionnaire raisonné de l'architecture française du XIe au XVIe siècle (1854-68)*. English Edition, *On Restoration*, (London, 1875), in *Historic Preservation Theory, Ibid.*, 61

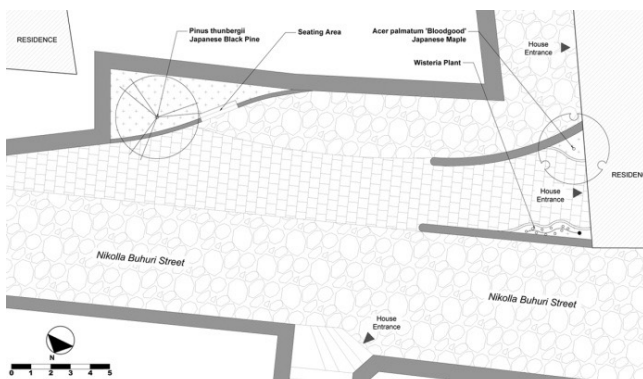


Figure 4: Site 2, Conceptual Proposal



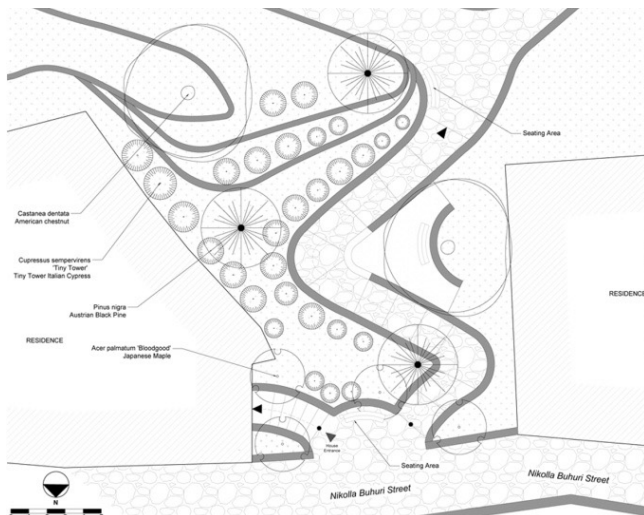


Figure 5: Site 3, Conceptual Proposal

which has to do with the restoration and preservation of the historic centers in modernity. The necessary modern or contemporary upgrade of heritage object or site threatens the preservation and restoration of the very values that makes the city a Heritage Site in the first place. Indeed, the very practice of repair, preservation, and restoration can be seen, in a long run, as a slow “destruction” or violation of the monumental and artistic values of heritage. John Ruskin went so far as to condemn restoration altogether, as a betrayal of the original character of the building. For Ruskin there should not be restoration, but only preservation. Yet, how can the original character be preserved without, however slightly, intervening in the time of author or the post-author, second time, to use some of Cesare Brandi’s terms? Ruskin is intransigent in his position, by stating that it is better to leave the monuments to ruin than restore them: “We have no right whatsoever to touch them. They are not ours.”²² Yet he also claims that if we “take care

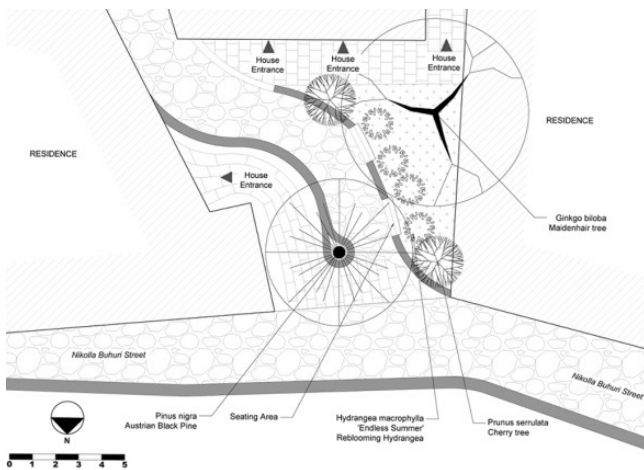


Figure 6: Site 4, Conceptual Proposal



of [our] monuments, we will not need to restore them.”²³ Viollet-le-Duc was the opposite of Ruskin, and claimed that “to restore a building is not to preserve it, to repair it, or rebuild it; it is to reinstate it in a condition of completeness which could never have existed at any given time.”²⁴ For Viollet-le-Duc there should be a rational approach and an epistemology of restoration that enables the stylistic restoration or completion of the monument.

These were the two great oppositions of the nineteenth century, and as it often happens with radical oppositions, they also meet at some discursive juncture. This juncture is the concept of the whole, namely, that *what must be eventually and absolutely preserved is the whole, as a whole unit, the image of the whole*. Whether this whole should be the memory and character of the monument, or whether it should be the form and style of the monument is where these two positions differ. However, there are other architects, theorists, and restorers that came later, like



²³Gustavo Giovannoni, “Le Miglioramento dei Nuclei Interni: La Teoria del Diradamento,” in *Vecchie Città ed edilizia nuova*, (Torino: Unione tipografico- editrice torinese, 1931), pp. 248-80, in *Historic Preservation Theory*, trans. Cesare Brignani, 171
²⁴*Ibid.*

Camillo Sitte, Camillo Boito and Gustavo Giovannoni, and the following generation of Giulio Carlo Argan, Roberto Pane, Brandi, and Giovanni Carbonara who, despite their differences, occupy a moderate position between Ruskin and Viollet-le-Duc, because they recognize the theoretical and practical complexity of the problem of restoration and preservation in modernity.

At the very heart of their work is how to preserve and restore an historical monument – whether this is a building or an urban landscape – under the modern conditions of continuous change and transformation. Sitte, for example, believed that it is possible to combine the image and experiential character of the town or city with vehicular and infrastructural requirements. Giovannoni also emphasized the combination of the preservation of the formal structure of the existing streets and buildings with the repair and surgery of the existing fabric. Such interventions may consist of the removal or demolition of certain fabric and its replacement of with “little plazas,” which function both aesthetically and urbanistically on the one hand, and as “small lungs” that help the dense existing fabric to “breathe...” What pulls together the approach of these different theorists, is, again, the recognition of the challenge and necessity to maintain a coherent image of the whole, of the unit, both as form and as character.

What we propose here is similar to what Sitte and Giovannoni propose, namely the introduction of small plazas within the structure of the city, yet *without* extensively demolishing parts of the city, but through contouring these plazas within and across the circulatory structure of the city, as well as by providing a peripheral vehicular access to the town. Yet what is the image or the form of this city that we should preserve and restore?

Berat has what we would characterize as a *form without parts*. One could argue that Mangalem, Gorica, and the Castle, among others, are its parts. But they are far from being parts that form a whole, which, in Albertian terms, nothing can be added on or taken away from. There is no formal relationship between, say, Mangalem and Gorica other than the fact that there is a river between them. Together they do not form one whole but rather a com-position of two things: Mangalem + Gorica, being always more or less than a whole. Mangalem could very well exist without Gorica and Gorica without Mangalem. They are not parts but more like *zones* or *patches of figural inten-*

sity whose form is not determined by their extensive border or contour. It is only upon entering and walking in these zones that one could start to read its form. Upon entering Gorica, for instance, one is immediately trapped in narrow streets bounded by crooked and tall blank stoned walls, occasionally punched with a door, and ending with flying cantilevered volumes with rows of windows above – a dramatic experience of involution and oscillation between contraction and expansion, between pressure and release. But these are not streets in the sense of a skeleton or a spine organizing the town – they often end abruptly into dead ends or front doors. Or in the sense of a public space vs. private one, there is a minimal interaction between the interior spaces and the streets, other than the one provided by the doors. These streets are more like bowels or intestines that have only one function: to “upload” or “download” people to and from the houses. These bowels often end with multiple steep steps and abrupt platforms that enable access to the front doors of the houses. Sometimes these steps and platforms are accommodated inside the houses and continue in the exterior spaces either as part of the *çardak* or as stairs within interior spaces. These cracks, tunnels, and chutes bring people in the upper floor, toward the light. Berat has only one formal idea: *the trans-formation of topography into light*. Both Mangalem and Gorica (which never receives any actual sunlight) are kaleidoscopic forms, but not for viewing Osum’s valley or Tomor – though that is a desirable byproduct, for the tourist..., but about receiving light. *The form of Berat, is the form of light*.

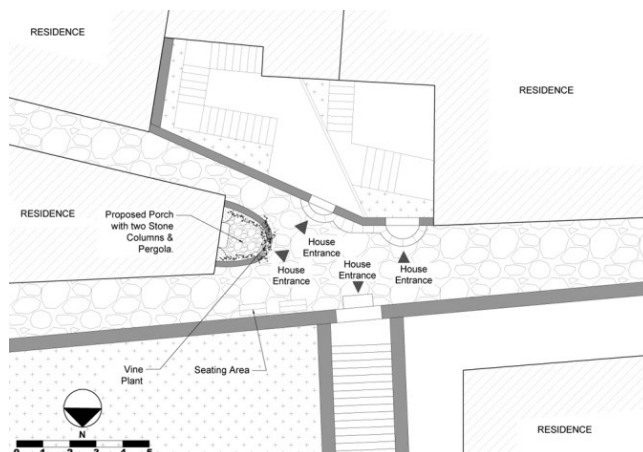


Figure 7: Site 5, Conceptual Proposal

Machines Hallucinations. Architecture and Artificial Intelligence

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Editors: Matias Del Campo, Neil Leach

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Matias Del Campo and Neil Leach are two of the most avant-garde researchers and academics in a multidisciplinary field exploring the implications of the use and spread of Artificial Intelligence in current architectural practice. What they have been advocating is that we are submerged into a paradigmatic shift in the way we conceive and produce architecture and that, presently, a substantial portion of our architectural intellect collaborates with machines or non-human entities. This collaboration differs from the architectural assistant specialization in space representations prevalent in the eighties and nineties.

Then, if the architectural design was documented as an homage to human intellectual prowess and, within this realm, human ingenuity found expression in the creation of either sublime aesthetics, appreciated by the discerning observer, or optimal spatial arrangements, indicative of the achievements of the rational scientist, what should happen now that 'different' intelligences have joined the discussions? What will happen if do not use technology just as a tool to represent and visualize the space we think of but we start communicating with them as active players in a sort of co-shared design process?

If we think about it, Artificial Intelligence (AI) has seamlessly integrated into our daily lives, often without explicit awareness. It permeates our smartphones, discernibly filtering spam, recognizing acquaintances on Facebook, and categorizing images on Instagram. Additionally, AI assumes residence within our households through virtual assistants such as Siri and Alexa. Its presence extends to our vehicles, including cars and planes. What we just haven't imagined is the possibility for it to play an active role and be more than a decision-making tool but a yet-to-be-discovered potential for architects and design.

The book *Machine Hallucinations: Architecture and Artificial Intelligence*, tries to set the bar for a discussion in this direction, engaging some of the most well-known researchers in this cross-polluted field of research for a total of 21 contributions. Not just academics, but also architects currently implementing it in their daily workflow as active users really training them-

selves neural networks to imprint into them their thoughts and, to some extent, personality traits. The editorial for the editor's duo takes a strong position affirming that "it is the right moment for a discussion about the impact of AI on the world of Architecture". Such a statement is motivated by the consciousness that we are facing a so-called 'huge explosion' of creativity in architecture. Even though this could be caused by different and heterogeneous reasons: commercial, productive, curiosity-driven ones, it is undeniable that the way machines 'hallucinate' (or do not) is food for thought for architects all over the world, facing the need to extrapolate proper methodologies from the use/abuse of neural networks and GANs and to learn to organize, comprehend and – why not – create their own datasets from which move their researches on. Writing a review for such a wide-ranging book would be challenging for every author. Each one of the essays contained in the publication is worthy of a dedicated comment that could unveil and deepen the importance of the concepts and the findings contained in it. Readers can identify various threads within the book that offer avenues for elevating their professional endeavours or embarking on individual research initiatives. These threads serve as pathways to experiment with, analyze, and engage in discussions surrounding the keywords encapsulated in the text. For this reason, the strategy followed was to identify some macro-areas where these contributions focus and then to choose one of them as the exemplary work to discuss and analyze more in-depth. Some of the fields we can identify starting from the index could be something like creativity, intelligence, synthesis, space, and hallucinations. Of course, not one excludes the others but these could be considered some of the main ingredients where the authors decided to focus and to express their position in such disruptive field of research.

In his *Creative AI. Augmenting Design Potency*, Daniel Bolojan - Assistant Professor at Florida Atlantic University School of Architecture, founder of Nonstandardstudio and a PhD student in Vienna – explores the idea that AI and intelligent tools could have the power to free architects and designers during their creative process. Nevertheless, he affirms at the same time that human and non-human intelligence could not be equated or even compared but they could properly pair to offer new direction and creative opportunities. The article marks an important distinction between expert systems and learning systems, considering them as the two main approaches when it comes to developing intelligent entities. The first ones were popular during the '80s and are classified as knowledge systems that are typically composed of two interrelated subsystems: a knowledge base and an inference engine. The knowledge base is responsible for specifying rules, while the inference engine utilizes

these rules to process known facts, thereby deriving new facts through logical reasoning. Most importantly, they need a human expert to insert information in the knowledge system to let them be 'intelligent'. Differently, learning systems – such as neural networks - do not rely on the presence of a human factor, and they do not learn from hardcore solutions but rather through experience and examples. Indeed, they do not have a set of a priori conditions to stick to but they semantically learn generating their own condition to operate. At the end of his disquisition – and to sustain his thesis – Bolojan presents a work of his studio titled *Machine Perceptions: Gaudi + Neural Networks* (2021). The main objective of this research is not to preserve or duplicate the Sagrada Família, nor is it focused on generating mere interpolations of the acquired representation. Instead, the aim is to garner insights and formulate geometrical strategies that facilitate the liberation of the composition while preserving the fundamental tectonic details, ultimately yielding innovative and novel compositions. The result is a series of generations that could be enlisted with the Sagrada Família domains of form, semantics, and aesthetics but completely generated through the constant communication between two intellects and – most importantly – the shared agency that can be achieved through their relationship.

The ideas expressed by Bolojan are part of a longer and more articulated discussion contained in the book. Whether we refer to creativity/style/synthesis the main thread is always the idea that architects are starting to implement and to 'playfully' interact with some other intelligencies that can learn outside a series of pre-coded situations to which extract from. Each of the essays could be of interest because it is linked to the other from the idea that each of the people involved is showing the way they are learning to communicate with such intelligencies and the way their work is reshaping itself thanks to this new interaction. One of the authors, Matias Del Campo is a friend. We met during the pandemic and we started working together on a project that, despite the difficulties of the last years, will soon be ready. He is the one who explained to me for the first time the implications of these new tools in the architectural practice and, somehow, I feel like one of the people he initiated to this field of research. If it is true that intelligent machines can 'hallucinate', meaning that they can create outputs that are nonsensical or altogether inaccurate to the human viewer due to some glitches in the interpolated dataset they have, I like to think that also in our conversations Matias and I hallucinated a little bit discussing on what we are currently living and where this road could take us and, at the same time, this book is the results of a series of 'collective hallucinations' from the researchers trying to open up new perspectives for the readers.

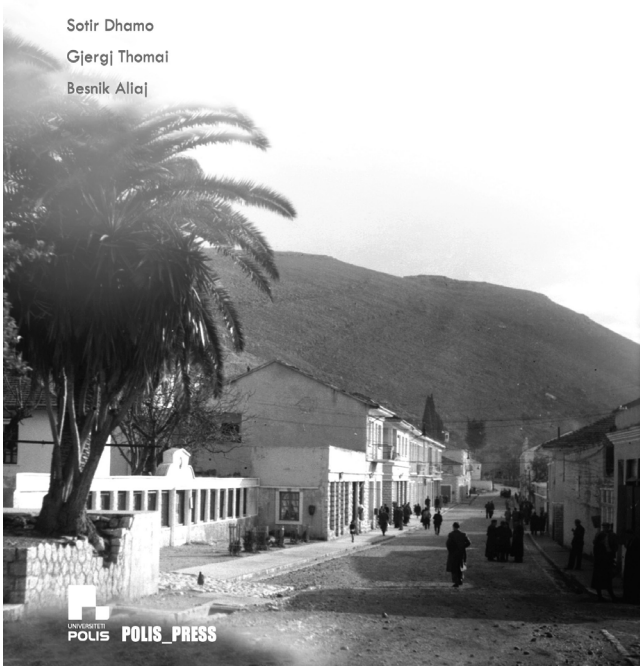
Saranda, Qyteti i Munguar -Saranda, The Absent City

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SARANDA QYTETI I MUNGUAR

Sotir Dharmo
Gjergj Thomai
Besnik Allaj



Editors: Besnik Allaj, Sotir Dharmo, Dritan Shutina

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The book "Saranda, the Absent City", by the authors Sotir Dharmo, Gjergj Thomai, Besnik Allaj (2022), delves into the layers of a city's history, exploring the moments and factors that shaped its perception, continuation, and transformation. The authors provide a narrative which unfolds as a testament to the city's hidden soul, a source of both nostalgia and the imaginary of the transformative process. In a time when cities struggle to define their identity, "The Absent City" defines the importance of research focused on the city, emphasizing its relevance for future values and actions. This book is focused on the narrative is the concept of the absent city, a dichotomy between the real and imaginary, or the existing and desired city. The quest for understanding becomes a journey to investigate and revive a series of absent cities. As a continuation of the series, "Saranda" further explores the impact of change on the city. The authors focus into projects, visions, and the intellectual energy invested in designing the city, examining their profound effects on its future trajectory and to contemplate the intricate relationship between thought, action, and the evolving urban landscape.

The authors employ a mix of descriptive and analytical language to describe the complexity of the city's evolution which it feels very fluently. The rhythm is likely deliberate, as the narrative seems to unravel the layers of the city's history, emphasizing the significance of each element in shaping its identity. This prudent rhythm suggests a thorough and reflective approach to the narrative which indicates a description of a blend of nostalgia and forward-looking optimism. The author seems to balance the exploration of the city's past with a focus on its potential for positive transformation of the various metaphysical systems of knowledge. The contemplative nature of the writing may require readers to invest time in reflecting on the concepts presented, making it a more immersive but potentially demanding reading experience. Overall, the authors' aims to provide a well-suited approach for those who enjoy thought-provoking and intellectually stimulating narratives about the

dynamics of urban development. The book appears to follow a well-organized structure, progressing chronologically through key periods in Saranda's development. The inclusion of "Aspects of the absent city" in each chapter suggests a consistent thematic thread, providing coherence to the overall narrative. Several major themes emerge from the structure outlined. The highlighted theme appears to revolve around the concept of the "absent city," emphasizing the disparity between envisioned plans and the actual development of Saranda. The effectiveness of conveying themes will depend on the author's ability to balance detail with accessibility. The detailed exploration of plans and projects must be accompanied by clear explanations and contextualization, especially for readers less acquainted with urban planning terminology. The recurring theme of the "absent city" should resonate with readers interested in urban studies, but it's crucial to ensure that the narrative remains engaging and does not become overly academic.

The inclusion of the theme, "Aspects of the absent city," adds a layer of continuity and reflection, emphasizing the disparity between envisioned plans and actual urban development. The authors' commitment to exploring the historical, professional, and contextual aspects of each period is commendable and contributes to a nuanced understanding of Saranda's identity. The book's strengths lie in its detailed examination of regulatory plans and designed projects, offering valuable insights into the factors shaping the city. The thematic exploration of professional situations, tourism, and the impact of plans adds richness to the narrative. Constructively, there is a potential challenge regarding pacing and accessibility, particularly for readers less familiar with urban planning terminology. Ensuring clarity in conveying complex ideas and finding a balance between depth and accessibility will be crucial to maintaining reader engagement. In summary, "Saranda, the Absent City" is a commendable exploration of urban development, offering a thorough examination of Saranda's history. With a focus on balancing detail and accessibility, the book has the potential to engage a

diverse readership interested in urban studies and the dynamics of city planning. The inclusion of the recurring theme, "Aspects of the absent city," adds a layer of continuity and reflection, emphasizing the disparity of the absent city, a dichotomy between the real and imaginary, or the existing and desired city, emphasizing its relevance for future values and actions. The author's commitment to exploring the historical, professional, and contextual aspects of each period is commendable and contributes to a nuanced understanding of Saranda's identity.

TesserACT

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TesserACT represent the desire to investigate the fourth dimension in the context of topology through a reflection on time, the component constituting the unified four-dimensional space-time wherein all events of our universe occur and exist. Through the use of AI and neural networks, the central hall of POLIS University has been scrutinized, enlarged, altered, and morphed until the original spaces persist, albeit concurrently compressed into a fourth-dimensional realm wherein the initial coordinates are reassessed through the temporal perspective. In the Tetraspace, the object is seen simultaneously from multiple points of view symbolizing the representation of higher dimensions, consciousness expansion, and the interconnectedness of all things. The image wants to witness how the syntax-based relationships at the core of AI tools could offer new perspectives on comprehending and exploring the space that surrounds us expanding its realm and time of existence. TesserACT comprises in itself a great set of values, compositional rules, and aesthetic sensibilities filtered through the lens of time in an artificial intelligence-driven process where reality blends with the unknown and the possibilities of extracting meaningful patterns in the magmatic chaos of a large dataset. The slow composition of the final image through a series of recursive iterations in the software recalls the cubist fracturing of the picture frame and finds its *raison d'être* in a space-time relation.

Drawing. Original artwork by Valerio Perna and Ledian Bregasi, generated with Midjourney AI

