METAVERSE: A SIMULACRUM PLATFORM FOR DIGITAL TRANSFORMATIONS OF THE METAVERSE E-STATE SOCIETY

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Annotation. This paper presents a comprehensive study of the role of digital simulacra in the Metaverse space, especially regarding their use in modelling social, economic, and legal scenarios. Key conceptual elements such as avatars, electronic identities, digital humanoids, AI subjects, digital influencers, and artificial moral agents are analysed. Considerable attention is paid to the theoretical substantiation of the phenomenon of simulacra, the definition of their functions and impact on modern society.

The study covers the analysis of promising experimental approaches, in particular the Wuhan and Stanford experiments, which demonstrated high accuracy in simulating individual and collective consciousness using generative AI models. The innovative LLM model "Centaur", which reproduces complex scenarios of human cognition and behaviour, expanding the boundaries of the application of AI in various fields, is also considered.

Emphasis is placed on the analysis of the possibilities of using the Metaverse as an innovative space for modelling social relations based on the interaction of IoT, Big Data, and AI. A structural model is proposed that demonstrates the multi-level interaction between these technologies, providing accurate predictions of social and political reactions. Notably, the use of such technologies is associated with ethical, social and legal challenges, including issues of privacy, digital control and manipulation of public consciousness.

Key words: Metaverse, IoT, Big Data, AI, LLM, Simulacra.

1. Introduction.

The current stage of the Metaverse is characterized by a large-scale digital transformation of almost all spheres of human life, the use of Artificial Intelligence (AI), the Internet of Things (IoT), Big Data, digital entities and objects, simulacra, and other technologies that create digital ecosystems. Avatars, digital personalities, and other Metaverse agents acquire new functionality, which allows them to evolve into new forms – highly realistic simulacra, which are detailed digital models endowed with reflections of both social structures and personal identity traits. Such virtual models become a kind of experimental testing grounds for detailed analysis and preliminary testing of various social, economic, cultural and legal scenarios for the development of digital society in the Metaverse.

Thanks to the use of such digital simulacra, it becomes possible to quickly predict social and individual reactions to certain legislative initiatives, which contributes to a significant increase in the efficiency of legislative processes, improves law enforcement practice and avoids potential negative consequences of rash legal decisions. However, in parallel with opening new horizons for optimizing legislative activities in the Metaverse, the use of simulacra carries several ethical, social, and legal challenges. Questions arise about the limits of digital control, the risks of manipulating public opinion and possible human rights violations in the context of the total collection and analysis of personal data.

2. The purpose of this article is to analyse the role of digital simulacra in the Metaverse as tools for modelling social, economic and legal processes.

3. Review and discussion.

To ensure a comprehensive study of digital simulacra in the Metaverse, an interdisciplinary methodological approach was applied, encompassing theoretical analysis, experimental modeling, as well as comparative analysis of empirical data.

A) Theoretical analysis. To determine the conceptual framework of the phenomenon of simulacra, the theory of Jean Baudrillard was used, which considers simulacra as copies that do not have the original and replace reality, creating illusions of real processes [28, 29, 30]. This made it possible to formulate key concepts, define the limits of their use in digital environments, and identify the main functions of simulacra in the Metaverse, such as reality substitution, manipulation of perception, and simplification of communication [33, 34, 35].

B) Experimental modeling. For empirical verification of the effectiveness of simulacra and their impact on modeling social behavior, the results of two important experiments were used:

Wuhan Experiment, which demonstrated the high potential of technologies for creating algorithmic copies of citizens with specific cultural, social, and political contexts. The results of the experiment confirmed the ability of simulacra to predict political events, in particular election results, with high accuracy [39, 40].

The Stanford Simulacra Experiment, implemented using the ChatGPT-4o model, proved the accuracy of reproducing individual consciousness and human behavior at the level of 85-98% compared to the results of real sociological and psychological tests [41].

To detail cognitive models and adaptability of simulacra, the Centaur model of the large language model (LLM) was used, which allows reproducing complex scenarios of human behavior and consciousness [42].

C) Comparative analysis. A comparative method was used to analyze the interaction of IoT, Big Data and AI technologies in the Metaverse, which made it possible to outline a structural model of the interaction of these technologies in the formation of a digital society [54, 55, 56, 57]. This made it possible to compare the effectiveness of different methods of collecting, processing, and analyzing big data from IoT devices and determine the optimal technological solutions for the implementation of multi-level simulation of social processes.

Thus, the methodological apparatus chosen for the study allows for a reasoned and comprehensive assessment of the role of simulacra in the digital transformation of society, taking into account both their advantages in forecasting social and political processes and the ethical and legal challenges associated with them.

The Metaverse is filled with subjects and objects that interact both within the Metaverse and with the subjects and objects of the physical world. This interaction is data exchange in the Big Data format, forming basic informational component of the Metaverse. Today, the Metaverse has the following protagonists.

A. Avatar.

The definition of "avatar" has deep historical and religious roots. Translated from Sanskrit, "avatar" means "incarnation", and in Hindustani mythology, avatar is the earthly embodiment of God Vishnu, who comes to earth to solve certain social problems of humanity [1, 2]. In the digital age, the term "avatar" does not yet have a stable internationally recognized definition, and it does not exist in the Ukrainian legal landscape. There are the following definitions:

- virtual digital self-presentations of users in the digital environment [3];
- digital embodiment of the user in a virtual environment to designate a person's online persona, including their online representation in various online spaces and the Metaverse [4];
- data in electronic form sufficient to reproduce the prototype of the human owner of the electronic avatar in the Metaverse with maximum authenticity and rights established by law [5, 6].

B. Electronic personalities Maintaining the Integrity of the Specifications Metaverse.

Electronic personality – is a term that means a generalized type of digital or electronic systems that model the behaviour of a person, a group of people or an organization [7, 8, 9]. The term has not been widely used due to its functional clannishness, but there are active discussions around the systems of "electronic personality" today, including in the European Union, regarding the definition of a legal status like that of a human. The phenomenon of electronic personality consists of in several, in our opinion, important properties, related to:

- psychological and moral impact on people and society;
- the effect of an "echo chamber", electronic "hives" or "mass digital consciousness", which is formed through online communications and can have collective personalities and moods that affect the behaviour of the group;
- adaptive features of AI, which are aimed at establishing trust of the "human-AI" level for long-term use in society.

Thus, the electronic personality is a complex conceptual construct in which social, legal, technological, moral and psychological aspects are mixed [10, 11].

C. Digital Humanoids Metaverse.

Digital Humanoids – are physical or virtual robots that have a human appearance and can

interact with humans [12, 13]. They are created on the principles of anthropomorphism, i. e. digital humanoids can have a physical or virtual digital form and, preferably, are designed to interact with humans, mimicking human interactions using verbal and non-verbal signals, combining the capabilities of a conversational agent and an interactive avatar at the same time [14, 15].

Today, the main direction of application of digital humanoids is aimed at the medical and social spheres through the imitation of human behaviour to interact with people, changing the dynamics of traditional human interactions [16, 17].

D. AI agents with Legal or Corporate Rights in Metaverse.

One of the modern areas of discussion in the field of law and not only is aimed at studying the topic of granting the right of a legal entity or corporate rights to subjects of artificial intelligence through the recognition of them as subjects or objects of law which capable of having rights and obligations like human or corporate subjects.

The idea of granting legal entity or corporate rights to AI systems and officially recognizing them as similar in the legal field to people or companies, is controversial and raises significant ethical, legal, and philosophical questions.

Granting AI digital entities with corporate rights will allow them to become independent participants in legal and economic activities. At the same time, questions remain as to whether artificial intelligence should be granted individual status based on its capabilities, such as decision-making and autonomy. This raises the implications for accountability and ownership and crucial issue of defining the responsibility when AI systems violate the rights and potential opportunities for the exponential accumulation of tangible and intangible goods not for the benefit of society. In addition, there are other legal risks, such as the lack of regulatory norms in relation to AI-based legal entity, which concerns business management and financial processes through the creation of non-state organizations and procedures.

E. Digital Influencers (e-VI).

Digital or virtual influencers (e-VI) – are digital virtual characters created using artificial intelligence, computer graphics, CGI (Computer-Generated Imagery) and other digital tools [18, 19, 20]. Today, mostly e-VIs are products of corporations that create echo chambers on social networks to attract the target audience, according to the archetypes of sociodynamics: baby boomers (1946-1964), generation "X" (1965-1980), generation "Y"/Millennials (1981-1996), Generation "Z" (1997-2012), N-Generation (Digital Aborigines), or Generation "Alpha" (2013 and later). Digital influencers, by

mimicking human traits and behaviours in digital ecosystems, have a significant impact on their audiences on social media and other online platforms [21, 22]. However, the application of e-VI accepts the problems of trust and authenticity, ensuring ethical use, transparency and protecting users from the forced formation of atypical moral frameworks.

F. Artificial moral agents Metaverse.

An artificial moral agent (AMA) – is a system created by humans that can make decisions and act based on moral principles or norms. This category includes different types of objects that can be endowed with certain rights and duties [23, 24]. A modern object in the Metaverse and its properties are at the stage of research [25, 26, 27].

G. Simulacra.

Simulacra – are copies that do not have the original, or images that replace reality, creating the illusion of the presence of something that does not really exist in its original form. The term comes from philosophy, specifically from the works of Jean Baudrillard [28], who described simulacra as objects that function without contact with the reality they supposedly represent [29, 30]. In the modern context, simulacra are often associated with digital objects, virtual images, or artificial constructions that simulate reality [31, 32].

The purpose and functions of simulacra:

Replacing reality with digital virtual reality, which can be more functional, attractive, or convenient than physical reality [33, 34].

Manipulation of perception: influencing how people interpret the world, often blurring the line between truth and deepfakes, reality and reality simulation [35].

Simplification of communication: Simulacra can serve as symbols or models for conveying complex ideas in an accessible form [36].

Digital economy: simulacra are used to create products or services that do not have a material equivalent [37].

SIMULACRA SIMULATION

A. Wuhan Expendable or Chinese Room of Increased Complexity

The analysis of simulacra experiments [38] shows the significant potential of such technologies for predicting social and political phenomena, and the simulacra applying methods are being improved in accordance with the development and implementation of AI and immersive technologies. In 2023, as part of a study called "the Wuhan Experiment", the technology known as "China Room of Increased Complexity" was tested to create algorithmic copies of individuals [39]. This technology allows you to create highly accurate algorithmic copies of citizens of any country, reflecting specific cultural, social and political contexts, and formed a highly accurate forecast of the results of the US presidential elections held in 2024. The forecast based on the analysis of the AI simulacra model of average citizens preferences predicted a victory for the new president with a probability of 99% and a difference of 3 units for each party [40].

B. Stanford Simulacra Experiment

The study, dubbed the Stanford Simulacra Experiment (2024), is an important milestone in research on modelling human consciousness using generative artificial intelligence. This study was conducted as part of a joint project of Stanford University and Google DeepMind, using the latest generative AI model of large language models ChatGPT-4o. The main goal of the experiment was to create high-precision digital simulacra of individual consciousness of representatives of typical socio-demographic groups of the US population.

Methodologically, the experiment involved the selection of 1000 real American citizens who represented the US population as representative as possible in terms of such parameters as age, gender, level of education and political views. An in-depth two-hour interview of about 6500 words was conducted with each of the participants. After that, the transcripts of these interviews were used

to set up individual AI agents based on ChatGPT-4o. Thus, digital simulacra of individual consciousness were created, which personified the mental, psychological and behavioural characteristics of specific people.

At the next stage of the experiment, real participants and their digital simulacra underwent a series of standardized sociological and psychological tests, including the General Social Survey (GSS), the Big Five personality test, as well as five well-known behavioural and economic games, such as the dictator game, the public goods game, and five controlled sociological experiments. This allowed the researchers to directly compare the test results and behavioural responses of real individuals with the corresponding responses and reactions of their digital counterparts.

The results of the experiment demonstrated high accuracy of newly created simulacra. Digital copies were able to predict with 85% accuracy the responses of their human prototypes to the GSS test, which is significantly higher than the results of AI agents who used only basic demographic data. The results of behavioural experiments were even more convincing: in four out of five control tests, the reactions of simulacra were almost identical to those of real people, with a correlation coefficient reaching 0.98.

It was also noted that simulacra more accurately predicted the behaviour of different demographic, political, and ethnic groups, demonstrating consistently high accuracy and balance in comparing results between different social categories. This result indicates the significant potential of similar AI models in social and political analysis [41].

C. LLM «Centaur»

Centaur, a universal computational model of human cognition, created by retraining the Lama 3.1 70B open language model on a specialized large-scale Psych-101 dataset. The Psych-101 technology is fundamentally changing approaches to the application of AI in science and education, allowing AI models not only to simulate language, but also to reproduce complex scenarios of human behaviour. activities with almost no differences from real people. Thanks to this, AI not only communicates in natural languages at a level imperceptible to the interlocutor but also behaves adaptively in real time. The model opens great prospects for educational technologies, scientific research, strategic planning and modelling of complex social, economic and political processes [42].

METAVERSE AND CONTEMPORARY TOOLS FOR SOCEITY DIGITAL TRANSFORMATION

The modern development of the Metaverse opens a fundamentally new stage in the digital transformation of society, which acquires the features of a full-fledged digital state. Within this digital state, a wide range of technologies are used, including Layer 2 [43, 44], DePIN (Decentralized Physical Infrastructure) [45, 46], artificial intelligence (AI), decentralized autonomous organizations (DAOs) [47, 48], central bank digital currencies (CBDCs) [49, 50], SWIFT financial communication protocols, ISO 20022 standard [51], Ripple, JPM Coin, BlackRock (ETF) [52, 53] and PayPal stablecoin. These technologies are fundamental components of the digital infrastructure of modern society, which is increasingly functioning within the framework of virtual realities.

Layer 2 is a network protocol that complements the basic layer of blockchain infrastructure (Layer 1), significantly increasing its efficiency in the Metaverse and contributing to the digital identity systems formation, transaction verification, and the execution of smart contracts in real time. DePIN is based on the integration of blockchain and IoT technologies, forming transparent and secure physical ecosystems in the Metaverse.

AI in the Metaverse is a key technological element enabling intelligent Big Data analytics to create digital simulacra and personalized digital agents. AI is responsible for imitating human behaviour, ensuring the interaction of citizens with digital administrative services, predicting social reactions and optimizing decisions-making process by accurately modelling scenarios for the development of social processes.

Decentralized autonomous organizations (DAOs) create an innovative framework for organizing public governance within the digital state of Metaverse. DAOs implement democratic mechanisms for collective decision-making, minimizing the risks of centralization of power. They ensure transparency, reliability and active participation of citizens in digital self-government, which makes public administration processes more adaptive and accountable.

CBDCs (central bank digital currencies) play an important role in ensuring the financial stability of the Metaverse digital economy. The SWIFT protocol and the ISO 20022 standard provide uniform standards for international financial communications, allowing the digital state of Metaverse to effectively interact with the global financial infrastructure. The integration of these technologies forms a holistic, efficient and flexible infrastructure of the modern digital state Metaverse, which opens new opportunities for economic development, social engagement and democratic governance.

IoT, BIGDATA AND METAVERSE

There are billions of IoT devices in the world, located and operating from private to public locations, continuously transmitting giant data arrays to ecosystems. These IoT devices have almost no protection, information security applications, and their working software has not been updated since the devices were manufactured at the manufacturer's enterprise. The integration of big data from the Internet of Things (IoT) processed by artificial intelligence (AI) is key in shaping the Metaverse, a virtual environment that connects the physical and digital worlds. This synthesis explores the role of these technologies in the Metaverse, focusing on their applications, challenges, and future directions.

Artificial intelligence, IoT, and big data analytics (BDA) are critical to creating a dynamic Metaverse ecosystem that improves organizational innovation and productivity. These technologies allow for real-time data collection, as well as the creation of personalized applications and decision support systems that are essential for connecting disparate realities in a business context [54].

In the industrial sector, artificial intelligence and IoT are driving the development of digital twins and immersion environments. These technologies support smart manufacturing, predictive maintenance, and intelligent analysis of sensor data, which are vital for the economy and business management in the industrial Metaverse [55, 56].

Exploring the synergies between Artificial Intelligence of Things (AIoT) and Extended Reality (XR) technologies can lead to innovative applications in the Metaverse. This includes the use of artificial intelligence for real-time data analysis and decision-making, which can significantly empower virtual environments [57].

METAVERSE AS AN INNOVATIVE TERRITORY FOR MODELING SOCIAL RELATIONS BASED ON SIMULACRA, IOT, BIGDATA AND AI

The concept of the model "Metaverse as an innovative territory for modelling social relations based on Simulacra, IoT, Big Data and AI" reflects a complex multi-layered architecture in which IoT and AI interact in the Metaverse simulacra space (Fig.1). Let's consider this concept in a more detailed academic analysis, considering technological, social, political and legal aspects.

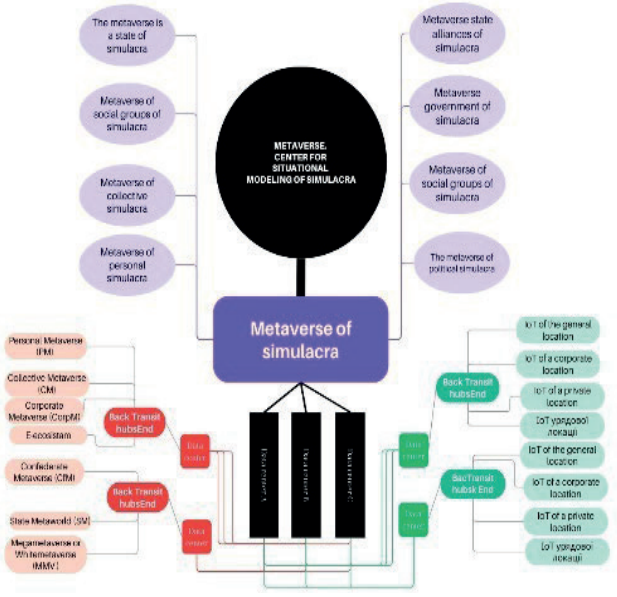

Fig.1 Metaverse as an innovative territory for modelling social relations based on Simulacra, IoT, Big Data and AI

At the lowest level of the model, there are IoT devices that are dispersed around the world and operate in different locations: private, corporate, public and government. IoT devices can act as autonomous units that collect specific information or as parts of more complex technological ecosystems, such as smart cities, corporate networks, or governmental management and monitoring systems. The continuous flow of data generated by these devices plays a key role in shaping a holistic information landscape for further analysis.

Information flows (Big Data) received by IoT devices are directed to transit hubs – specialized data routing points. Their main function is to aggregate, structure, pre-filter, and route large amounts of information to high-performance AI processing centres. The illustration shows transit hubs ("Back Transit hubsEnd") as intermediate nodes that provide efficient data transfer from IoT to powerful data centres.

Corporate AI centres (Data Centres), presented in the diagram, are a critical link in the entire process. It is here that Big Data is systematically analysed and interpreted with the help of powerful machine learning and deep learning algorithms which provide digital replicants of real physical objects and subjects.

The next level of this model is related to the Metaverse space, where digital avatars (simulacra) are formed and acquire predetermined properties and characteristics corresponding to their real-world counterparts or prototypes. In the space of this structure, simulacra can be personal (individuals), collective (social and corporate groups), political (parties, government and state structures) or even confederal and global ("Megametaverse", "State Metaworld"). The hierarchical structure of simulacra allows you to create multi-level models of social interactions, political decisions, economic strategies and other social phenomena.

In the centre of the scheme is the "Centre for Situational Modelling of Simulacra in the Metaverse" ("Metaverse. Centre for Situational Modelling of Simulacra»). It has three functional tasks – integration, coordination and purposeful modelling of social and political processes. In this space, there is a simulation of the behaviour of individuals, population groups or entire states from various day-to-day situations to crisis. Situational modelling is an extremely effective tool for predicting public reactions, which allows you to optimize decision-making at all levels of management.

4. Conclusions.

The application of this approach has a significant practical potential in public administration. Through simulations, researchers can explore possible society reactions to reforms, crisis phenomena, changes in legislation or administrative procedures. This makes it possible to improve legal regulation, increase the efficiency of financing social programs, ensure a balance between security and personal freedoms, and implement policies aimed at supporting basic human values and human rights.

It is important to emphasize that the use of such technologies raises several ethical and legal challenges. It is necessary to provide mechanisms that prevent privacy violation and misuse of collected data, to ensure the system transparency, as well as to develop appropriate legal standards for its functioning. Thus, the academic environment needs to actively support the development of such systems to establish scientifically grounded boundaries and standards that ensure responsible and ethical use.

Thus, the illustration presents an ambitious but at the same time realistic and grounded concept that integrates the latest information technologies (IoT, AI) and socio-political models into a single system capable of significantly increasing the efficiency of public administration. The implementation of this approach can be an important step towards building a transparent, adaptive, socially responsible digital society.

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