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The Sociology of Artificial Intelligence Through the Lens of Ethics in the Digital Age

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Abstract: This paper explores artificial intelligence (AI) as a complex social phenomenon that transcends its technical dimension, becoming an active agent in shaping social relations, power structures, and identities. Through sociological and ethical lenses, it analyzes the challenges AI poses regarding justice, responsibility, and freedom in the digital age. Special attention is given to social responsibility in the development and application of AI systems, issues of algorithmic bias and inequality, as well as the implications of digital surveillance and control. The paper also examines the transformation of identity in the digital era and the complex processes of digital subject formation, with a focus on the specific context of the Balkan region. In the context of the future of work and the new economy, it discusses the socio-economic effects of automation, precarity, and the global challenges faced by local communities. Finally, the study emphasizes the necessity of responsible and inclusive AI development that integrates ethical, social, and political dimensions to create a more just, sustainable, and humane society. Interdisciplinary collaboration and active citizen participation in shaping technological futures are highlighted as essential components.

Keywords: *Artificial Intelligence, Sociology of Technology, Ethics, Digital Identity, Digital Transformation.*

Introduction

In contemporary society, artificial intelligence (AI) is not merely a technological phenomenon, but deeply penetrates social and ethical structures. It has become part of everyday life, from algorithms that shape our digital realities to autonomous systems making decisions once reserved exclusively for humans. Sociology, as the science of society, is tasked with analyzing these transformations, while ethics raises questions about the moral boundaries of technology.

In this paper, we will analyze how AI changes social relations, identity, the economy of labor and surveillance, and how an ethical framework can or must respond to these challenges. This topic becomes particularly relevant in the context of societies' increasing dependence on digital technologies, where algorithmic rationality increasingly replaces human judgment. AI is no longer just a support tool, but an active participant in decision-making processes, shaping public opinion, and structuring social institutions. In this light, the question arises about the boundaries between automated efficiency and the humanistic values that form the foundation of social life.

Furthermore, it is important to understand that technology is not neutral – it reflects the interests, biases, and values of those who design and implement it. Therefore, sociological analysis must be complemented by ethical considerations to ensure that AI development aligns with principles of social justice, responsibility, and inclusivity.

A Sociological Perspective on Artificial Intelligence

In recent decades, the sociology of technology has recognized technology not merely as a tool, but as an actor participating in the shaping of social structures. Disciplines such as the sociology of occupa-

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tions and professions help us analyze these changes. Especially today, when automation and artificial intelligence threaten to replace many jobs, this discipline plays a crucial role. (Matijević, 2025). Theories such as Latour's Actor-Network Theory remind us that machines and algorithms are not neutral – they are social constructs imbued with the values of those who create them. AI brings a new power dynamic: algorithmic decisions affect who gets a loan, a job, or a medical diagnosis. Thus, AI becomes a social actor, worthy of analysis in the context of class, race, and gender relations.

A sociological view of AI involves deconstructing the belief that digital systems are objective or free from human biases. On the contrary, the data on which AI models are trained are products of social practices, carrying layers of historical injustice, economic disparity, and cultural hierarchies. When a machine "learns" the world based on human-generated data, it inevitably internalizes their errors. Therefore, the question of AI becomes a question of social responsibility – both for what we feed into the system and for what it produces.

AI changes how we understand autonomy, authority, and knowledge. Traditionally, decision-making was the privilege of educated, authoritative actors: judges, doctors, professors. Today, thanks to algorithmic expertise, more decisions are made by a "black box" – a system that is difficult to explain and even harder to challenge. This creates a new kind of symbolic authority that stems not from knowledge or empathy, but from computation. Sociologically, this demands a redefinition of trust, as we no longer trust individuals but systems that themselves do not understand their decisions.

One key challenge is understanding how AI fits into the neoliberal economic system. In the era of platform capitalism, dominated by digital giants like Google, Amazon, and Meta, algorithms serve as tools of capital accumulation through personalization, data exploitation, and behavioral steering. In this context, AI is not a neutral technological advancement but an instrument for reproducing existing power relations – both globally and locally.

Viewing AI in relation to strategic culture and globalization in contemporary trends helps us understand the fog of modern challenges to national security. Contemporary societies are entirely technologically dependent, which inherently affects strategic development. Every technological rev (Pavić & Berić, 2025).

Sociology, therefore, cannot afford to be a silent observer of the digital transformation. It must illuminate not only the consequences of introducing AI into various spheres of society but also the deeper cultural matrices that shape our relationship with technology. Who has the power to program? Who is excluded from this process? Who benefits from the "intelligence" we create? These are the questions sociological analysis must continually pose – not to provide final answers, but to foster a responsibility that opens new avenues of reflection.

Theoretical Framework, Ethical and Social Dimensions

When discussing the theoretical framework for understanding artificial intelligence (AI), it is necessary to consider multiple intersecting disciplines—sociology, ethics, political science, and technology. From a sociological perspective, AI is not merely a technological artifact but a complex social construct reflecting societal values, power relations, and cultural structures. Theories such as Actor-Network Theory (ANT) suggest that AI functions as an "actor" within a network of social relations, influencing and shaping institutions, practices, and individual lives. Here, technology ceases to be a passive tool and becomes a dynamic participant in social processes.

The ethical dimensions of AI, on the other hand, reveal deep dilemmas concerning responsibility, transparency, and fairness. When systems make decisions that directly affect people—such as access to credit, employment, or justice—we must ask who bears responsibility in cases of error or injustice: the programmer, the company, or the algorithm itself? These questions open a window into the complexity of accountability in the era of digital autonomous agents. Furthermore, ethical challenges include combating algorithmic biases, which often reflect deeply rooted social inequalities and can further discriminate against already marginalized groups.

The social dimensions of AI are also evident in the reshaping of power and surveillance. As Michel Foucault described in his concept of the panopticon, modern digital surveillance uses AI to monitor, predict, and influence citizens' behavior without their conscious awareness. This "invisible" power of algorithms creates a new form (Latinović, Ostojić, & Krčadinac, 2023) (Latinović, Ostojić, & Krčadinac, 2023).

Finally, the theoretical framework must integrate concepts of social justice and inclusivity. The development and implementation of AI must not be predominantly driven by technocratic or corporate interests but should aim at promoting the common good and improving the lives of all social groups. This requires an interdisciplinary approach and broad participation, including users themselves, to ensure

equality in access and participation in the digital transformation.

Fairness, transparency, and accountability are fundamental principles increasingly referenced in ethical frameworks, such as the EU Guidelines on Trustworthy AI. For instance, if an algorithm discriminates against minorities, it is necessary not only to find a technical solution but also to develop a sociological understanding of the causes of such biases.

Identity and the Digital Subject

Digital identity is not merely a collection of user accounts but a reflection of how AI shapes our perception of ourselves and others. By recommending content based on previous behavior, algorithms reinforce certain patterns of behavior and taste. In this sense, Bourdieu's concept of habitus can help us understand how digital space becomes a site for the reproduction of social differences, where tastes and preferences are not autonomous but the result of algorithmic shaping.

The term digital identity refers to the aspect of digital technology that mediates between the human experience of self-identity and the identity of other people and things. In information and communication technologies, digital identity represents a digital set of claims that one digital subject holds about themselves or other digital subjects (Tešanović, 2011).

In the era of digitalization, identity becomes a more complex and multilayered category that cannot be viewed solely through traditional frameworks. The digital subject is no longer just the "I" in the physical world—it is a construction, an amalgam of information, interactions, and performances in digital space. This new identity is fluid, changeable, often fragmented, and shaped not only by the individual but also by algorithms, networks, and the digital platforms that surround them.

A digital subject is an entity that exists or is represented within a specific digital domain. Each digital subject has a finite but unlimited number of identifying attributes. Digital subjects can be persons; devices and computers (which form the "digital domains," primarily); digital resources; policies and relationships between other digital subjects (for example, between people and devices, or documents, or services...). The experience of a digital identity of a particular entity is inevitably subjective from the observer's point of view (as is the case with physical identity). To connect digital attributes to an entity (subject), the observer must believe that the digital representation truly refers to that entity (Tešanović, 2011).

As philosophers like Jacques Derrida emphasize, identity is always "deferred," never fully fixed. In the digital world, this process is amplified — we present ourselves through profiles, posts, likes, photos, and comments, all of which together build our digital "narrative."

Applying the French school of sociology, the issue of transgressing ethical and aesthetic norms arising from the use of AI is examined. How does the use of AI transform the observer-artwork relationship, that is, how does it change the status of the artwork by testing the observer's ability to separate reality from virtual reality on cognitive and perceptual levels? (Bojić, 2024).

At the same time, this narrative is not solely ours. Algorithms "read" and reconstruct our identity, often for purposes of targeted advertising, political influence, or even manipulation. Thus emerges a new entity — the digital subject, who is simultaneously both the creator and the product of the digital system.

In the Balkans, where historical identity has often been a subject of conflicts and negotiations, the digital subject adds an additional layer of complexity. People struggle to preserve their cultural, national, and ethnic identities while being exposed to universal and often globalizing digital standards and narratives. This creates a paradox — on one hand, digitalization can serve as a means of affirming and spreading local and regional cultures; on the other hand, it can lead to homogenization and loss of authenticity.

Social networks and digital media thus become arenas where identities are created, contested, and redefined. In this process, a new form of social interaction arises, where the boundaries between private and public blur, and the subject becomes both a target and an active participant in the dynamic play of power and representation. The digital subject is not a static entity — it is a stage on which conflicts, alliances, self-awareness, and resistance are played out.

Ultimately, understanding digital identity and the subject must be rooted in complex social, historical, and political contexts, especially in regions like ours, where past and present intertwine narratives of belonging, existence, and power. Only then can we truly grasp its implications for personal and collective life, as well as for broader processes of social transformation.

The Future of Work and the New Economy

In the whirlwind of contemporary changes shaping our world, the future of work emerges as one of the most dramatic and complex issues. The digital revolution, automation, artificial intelligence, globalization, and shifts in social relations not only change the way we work but also the very nature of work as a social phenomenon.

Work, through which capital is produced, is just one part of these activities, but one of the most significant, and it lies at the center of the overall existence of human beings. The way we relate to work defines both individuals and hierarchies within societies and states, as well as the distribution of economic and political power. Digital technologies create illusions of work as play, which loses its characteristic burden and is seen as an opportunity for developing individual potentials, which is partly true. At the same time, the very changes brought by digital technologies actualize the Marxist understanding of work as the determinant of economic relations, even in the contemporary world (Karapetrović, 2020).

Everything that was unimaginable until yesterday is becoming reality today — machines and software are taking over tasks once performed by humans. The robotization of production, automation of services, algorithmic management, and digital assistants are redefining the boundaries between human labor and technology. However, this change is neither linear nor equal across all sectors and regions.

In Eastern European countries, including Serbia, this transition unfolds with specific challenges: from lack of infrastructure to issues in educational systems that are not always able to keep pace with technological changes. This means that many traditional jobs will disappear or transform, while new, often highly specialized demands will dominate.

The future of work is not just a technical story. It is deeply philosophical and social. Work has always been not only a means of subsistence but also a place for creating identity, social bonds, and personal affirmation. In the era of the new economy, with flexible, gig, and platform-based work models, these bonds are dissolving or changing. Work becomes fragmented, decentralized, and often insecure. Platforms like Uber, Glovo, and others bring freedom but also insecurity — workers are formally independent but practically exposed to exploitation and lack of social protection. This “new economy” introduces us to a world where workers are often not employees but precarious participants in the service market.

For societies like ours, where social protections and workers’ rights are often fragile, this dynamic can deepen inequality and social tensions. A new social contract is needed that takes into account the reality of the new economy while preserving fundamental workers’ rights. The global interconnection of labor markets and capital brings both opportunities and risks. On one hand, local workers can access international jobs and markets; on the other, pressure for lower labor costs and competition with cheaper global labor become realities. In Eastern Europe, we often observe the phenomenon of “brain drain” — young, educated people migrate to Western European countries seeking better opportunities. This trend impoverishes local communities but also brings remixes of ideas, connections, and potentials for return and reinvestment.

The question is — how to preserve local identity and strength in the context of global economic flows? How to develop an economy that will not be just a pawn on the global chessboard but will have the capacity to generate value based on knowledge, culture, and creativity? In the future of work, the key factor will be adaptability. Traditional education models, which have long been rigid and oriented toward employment in classic industries, must change dramatically. The focus must be on lifelong learning, digital literacy, critical thinking, and intercultural competencies.

Alex Wood, a sociologist studying the nexus of labor markets and new technologies, is explicit in his view that assumptions about the potential of artificial intelligence to free us from work are mistaken, as history has shown that automation further enhances the production process under capitalism and is unlikely to undermine its foundations. Artificial intelligence is no closer to discarding living labor than industrial machines were in the 19th century, and generally, there is little prospect that the Fourth Industrial Revolution will bring widespread unemployment. What technological development leads to are transformations of work and the workforce, new forms of exploitation, as well as social polarization and a new hierarchy (Jeremić, 2023).

In regions with a long tradition of education but also bureaucratized systems, changes are slow but necessary. A system is needed that enables workers to quickly retrain, develop “soft skills,” and be ready for changes in the labor market. There is no future of work without clear ethical and political answers. Who controls technology? Who has the right to the fruits of automation and artificial intelligence? How can we avoid further polarization between the rich and the poor, between those with access to new technologies and those who remain marginalized? These are not only economic questions but also deeply political and moral ones. The new economy must have a human face, and digital transformation must be accompa-

nied by policies that protect workers and enable the fair distribution of wealth. With the development of advanced technologies, namely AI systems in the Fourth Industrial Revolution, the digital economy will increasingly gain importance, as it becomes evident that natural, especially non-renewable resources, are diminishing, human needs are growing, and the only way forward is to use smart technologies to economize organizational potentials, as a result of the Fourth Industrial Revolution (Anđelković, Radosavljević, & Lilić, 2021).

In our region, social inequalities as well as opportunities for social mobility are reflected. The future of work and the new economy are not distant abstract concepts. They are already here, before us, shaping everyday life and destinies. For our region, the challenge is enormous — how to harmonize technological progress with social justice, how to preserve local values and identities within the global network, and how to build a sustainable, inclusive, and humane world of work. The future of work must also be a future of dignity, solidarity, and freedom.

Digital Surveillance and Power

Artificial intelligence enables sophisticated forms of surveillance—from biometric facial recognition to predictive policing. Foucault's concept of the panopticon becomes a reality in digital form: people behave as if they are constantly being watched because, in fact, they are. This creates a new form of power—an invisible, algorithmic power that shapes behavior without direct coercion. Ethics here demands clear boundaries: where does legitimate protection end and repression begin?

In an era when digital has become the universal language of communication, work, and social interaction, the concept of surveillance gains a new, more complex, and often frightening dimension. Digital surveillance is no longer just a tool of repressive regimes or technological corporations but a fundamental aspect of power in modern society.

Surveillance is not a new phenomenon. Since ancient times, authorities have used various methods to monitor and control their citizens. However, digital technology gives surveillance new power—speed, scope, depth, and most importantly, invisibility. Traditional narratives of capitalism rely on assumptions about competition, limited resources, and a winner-takes-all mentality as the basis for business and economic activity. These approaches leave little room for ethical analysis, offer a simplified view of human beings, and focus on strengthening rather than creating value (Stanković Pejnović, 2021).

In the digital world, data is the new currency, and surveillance manifests itself through tracking every step we take: internet searches, movements on social networks, purchases, phone calls, and even physical location via GPS. This massive collection of data enables those in power not only to react to behavior but also to predict and shape it. In Eastern European societies, with their historical legacy of authoritarian regimes and secret services, this form of surveillance carries additional weight. The collective memory of how power used information to control individuals and masses further intensifies fear and distrust toward digital technologies.

Digital surveillance is not only a matter of the state apparatus. Technology companies like Google, Facebook, and Amazon collect vast amounts of personal data daily, which are used for profiling, targeted advertising, and political manipulation. This "new power" is often hidden, inaccessible to ordinary people, and rarely subject to serious regulation. In countries with weak institutional frameworks, as is the case here, there is a risk that this power will be abused to strengthen corruption, manipulate voters, and suppress freedoms. Yet, digital surveillance is not only a story of domination. There are also tools and practices of resistance — from encryption and decentralized networks to movements for privacy protection and digital rights. In our society, where political participation is often fragmented and passive, digital technology can be a double-edged sword. It can further control and pacify but also empower citizens through information, connectivity, and collective action.

The issue of digital surveillance leads us deeper into fundamental questions of freedom, privacy, and identity. How to balance the need for security with the preservation of basic human rights? Who has the legitimacy to collect and use our data? At a time when algorithms make decisions about us — from employment to healthcare — transparency and control over these processes become key demands for safeguarding democratic values.

Digital surveillance and power are inevitable companions of the digital age. Understanding them requires a multidisciplinary approach, where technical aspects intertwine with sociological, political, and philosophical reflections. Hence the need for a critical approach, education, and activism that will enable the digital world to be a space of freedom, not control.

Directions for Responsible Development

For a sustainable and fair integration of AI into society, interdisciplinary cooperation is essential: sociologists, ethicists, developers, and legislators must jointly define guidelines. Inclusivity in technology development means respecting diverse social perspectives, while transparency entails understanding how algorithms make decisions. It is necessary to develop models of collective responsibility, where users also participate in shaping the rules of the game.

In a world that is rapidly changing under the influence of technology, globalization, and social transformations, development as a concept gains new weight and responsibility. Responsible development is no longer just an idea or slogan, but a necessity arising from the deep ecological, social, and economic crises that the world and our society are experiencing. Thanks to the development of technological networks, informational capitalism does not stop at national borders but becomes global capitalism. Accordingly, the new networked society is a global society. Globally connected financial capital is one of the key features of the new economy. Social wealth is no longer primarily the result of economic activity but rather the circulation of financial capital within global financial networks (Mihajlov Prokopović, 2016).

Responsible development is based on the concept of sustainability — a harmony between economic growth, social justice, and environmental preservation. It is not only a matter of future generations but also of the present in which we live. Sustainability means that development must not deplete resources, deepen inequalities, or jeopardize fundamental human values. In the context of Eastern Europe, this concept carries particular weight because the transition from a socialist to a capitalist system has left deep scars: devastated natural resources, disorganized economies, and social injustice often masked by economic growth.

Rapid technological progress brings new opportunities but also new risks. Responsible development implies technology that serves humanity, not the other way around. Digitalization, artificial intelligence, robotics, and biotechnology must be developed with strong ethical reflection, transparency, and community participation. It is especially important that technology does not become a tool of exclusion or a new form of domination but remains inclusive and accessible to all, rather than widening the gap between those who have access and those who are excluded.

Responsible development cannot exist without a just society. This means development must aim to reduce inequalities — economic, gender, ethnic, regional. Social inclusion implies that all social strata have an equal chance to participate in and benefit from development. Today, members of Generation Alpha are growing up in the era of artificial intelligence, in which we will also have a two-way street and interaction in shaping the landscape where this new technology and the generation itself evolve (Savić, Lazarević, Grujić, & Čolić Mihajlović, 2025).

In our region, where historical injustices, wars, and transitional inequalities have left deep scars, the path of responsible development must also include a strong social dimension — from education to healthcare, from employment to the protection of vulnerable groups. Democracy and transparency are the pillars of responsible development. Decision-making processes that concern the community must be open, inclusive, and based on trust. Citizens must not be passive observers but active participants in shaping their own future. This entails strengthening civil society, independent media, and institutions that guarantee government accountability. Without participation, development can easily become exploitative and unsustainable.

Without developed ecological awareness, responsible development cannot exist. Climate change is a global challenge requiring both local and global responses. Responsible development means transitioning to a green economy, renewable energy sources, biodiversity conservation, and sustainable waste management. For countries often dependent on traditional energy sources and industries, this is a challenge that requires political will and innovative solutions.

Finally, one of the most important directions of responsible development is investing in education that will enable people to understand and actively participate in the complex processes of the modern world. This is education that fosters critical thinking, creativity, and ethical responsibility. In societies with limited resources and challenges in the education system, such an approach is key to long-term transformation. Responsible development is not an abstract goal but a concrete practice and a choice of values that society and individuals make every day. It is a walk along a thin line between progress and preservation, between power and responsibility, between the present and the future. For our region, with all its specificities, responsible development represents a chance to overcome the past and create a new paradigm of social and economic life that will be more just, humane, and sustainable.

Conlusion

Artificial intelligence is not merely a product of technological imagination, but also a social actor that reshapes power relations, identities, and everyday life. Through sociological and ethical lenses, new questions arise about justice, freedom, and responsibility.

The sociology of artificial intelligence through the prism of ethics in the digital age reveals a multi-layered dynamic of contemporary society, where technology ceases to be just a tool and becomes an active agent in shaping social relations, identities, and power. AI, with its capacities for automation, learning, and decision-making, is no longer an abstract technological phenomenon but a key factor transforming social reality, opening profound ethical dilemmas and challenges.

From a sociological perspective, AI raises the question of responsibility: who bears the moral and social responsibility for the decisions machines make? In the digital age, where the boundaries between humans and technology blur, an ethical framework becomes imperative to guide the development and application of AI systems. Without clear norms and principles protecting human rights, dignity, and social justice, there is a risk of deepening social inequalities, exploitation, and loss of autonomy.

Artificial intelligence becomes an instrument of power—not only in economic and political terms but also in shaping collective and individual identity. Digital surveillance, profiling, and algorithmic control can threaten privacy and freedom, thereby undermining the foundations of democratic society. It is sociologically crucial to understand how these technologies fit into existing social structures, often reproducing and amplifying existing injustices, especially in societies with histories of transition and social tension. In this sense, ethics in the digital age is not merely an academic abstraction but a practice that must be integrated at every level of AI development and deployment—from algorithm design to regulatory policies and social oversight. Responsibility entails not only technical transparency and explainability but also the inclusion of diverse social actors, especially marginalized groups, to ensure equitable access and avoid discriminatory practices.

The sociological discourse on AI opens space for redefining the human subject in the digital era. Identity is no longer a fixed category but a dynamic process in which technologies play a key role in shaping self-perception, social interaction, and collective narratives. While this process offers opportunities for empowerment and creativity, it also poses risks of alienation and manipulation if ethical and social dimensions are neglected.

Ultimately, the sociology of artificial intelligence through the prism of ethics calls us to reflect more deeply on the meaning of development and progress in the digital age. Technology must serve humanity, not the other way around. This principle, imbued with social justice and ethical responsibility, is the only way to ensure that a future in which AI occupies a central place will be inclusive, sustainable, and just.

For societies like Serbia and the broader region, where historical and social specificities are pronounced, this paradigm offers the possibility not only for technological modernization but also for profound social transformation, in which artificial intelligence becomes a tool of empowerment rather than new domination. Ethics and sociology in the digital age are not merely theoretical challenges but practical guides for creating a world where technology and humanity coexist in a symbiosis of mutual understanding, respect, and shared responsibility.

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High Performance Network Optimization

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Abstract: The term "big data" was coined to describe the vast amounts of information science and technology data that have been generated on a large scale over time. Based on existing research, the current state of the problem was observed, i.e. "Poor internet speed, network downtime, constant traffic jams, energy consumption due to increasing internet connectivity, which increases management overhead costs, network unavailability". Therefore, this research provides a brief overview of the list of bandwidth optimization models applied through previous research works, indicating the optimal algorithms that work with each of the models in formulating a new bandwidth optimization model that solves the mixed integer linear programming technique problem which was the approach adopted from the existing works. necessary for wireless networks. This paper aims to evaluate and analyze existing bandwidth optimization models, optimal algorithms with each model, as well as a new bandwidth optimization model that solves the problem of previous optimization techniques. In wireless networks, the most energy-consuming activities are network bandwidth transmission and reception. Energy consumption for data transmission or reception depends on the volume of network traffic and the speed of network traffic from source to destination.

Keywords: *Network optimization, high performance networks, bandwidth, algorithms.*

Introduction

An important feature of bandwidth optimization systems is to adequately provide Internet service with high data rates and wide coverage. Low bandwidth causes poor Internet speed, network lag, constant network traffic congestion, and network unavailability during Internet use. Existing research on bandwidth optimization focuses on bandwidth allocation in creating different channels and traffic to guarantee good quality of service (QoS). Despite several optimization techniques and bandwidth allocation algorithms of existing researchers, they still operate with increased energy costs of network devices and other infrastructure. One of the serious problems of optimization techniques is that of the problem of mixed integer linear programming. When describing high-performance networks, operator networks are called "high-performance" networks (Arya & Sharma, 2018). The subject of our research is the analysis of existing optimization models, their characteristics, advantages and disadvantages, and a proposal for their improvement. The goal of our research is to evaluate and analyze existing bandwidth optimization models, optimal algorithms with each model, as well as a new bandwidth optimization model that solves the problem of previous optimization techniques. Despite the fact that technology is increasingly advanced every day, we still deal with low bandwidth, network latency, and network traffic congestion. In our research, we will analyze existing methods and technologies used to improve high-performance networks. Based on the reviewed literature, we can set two hypotheses that we will try to prove through research:

(H1): Existing bandwidth optimization models have low bandwidth and therefore network latency and network traffic congestion occur.

(H2): By improving the performance of the information system and cluster architecture, we will solve the problems with network bandwidth and data processing.

The reason I decided to do scientific research is because, despite technological advances, network traffic congestion and low bandwidth still occur, and I have not come across any recent research that has addressed this topic in the Republic of Serbia.

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Methods

In our research, we used the comparative and the case study method and described them with the descriptive method as a set of empirical research techniques. We used a research tool based on the available literature and described the research with the descriptive method based on the analyzed data.

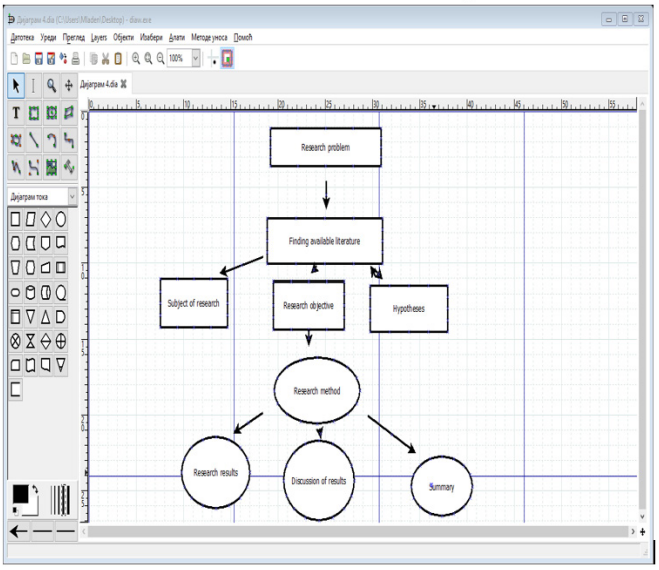

Diagram 1. Research flow chart

Initializing enables each Internet Protocol (IP) address to work smoothly, and optimization leads to high-quality data transmission simultaneously from the sender to the recipient and vice versa, such as audio or video files (Park, Lee & Sung, 2006). Since the 20th century and the advancement of the Internet network as well as rapid advancement of computer technology, the popularity of high-performance computers, and the data transmission model in Internet traffic, there have been revolutionary changes in big data transmission technology. The development of technology and Internet applications also faces significant difficulties due to the impact of a large number of network users and complex data in traffic (Li, et all., 2018). The lack of network bandwidth in the data center computer is the main factor leading to this problem (Li, Zhang, Chen, & Xiang, 2018). It is necessary to improve the performance of the information system and cluster architecture, solve the problems of network bandwidth and data processing to create more efficient data traffic.

Results

The client-server architecture was used when the Internet was first launched. In such a model, bandwidth is consumed very quickly. Local caching on the client side was introduced as a partial solution (Oriato, Girdlestone, & Mencer, 2015). Data is cached and used at the proxy (Oluwatobi & Oludele, 2013) level and has shown success (Paxson, & Floyd, 1995). After that, cooperative caches such as the Internet Protocol for Caching and Routing Cache Array (Reddy et all., 2018) were introduced. Mutual synergy was also presented and applied as a solution. CDN technology has evolved to be one of the main frontiers in solving the bandwidth consumption problem. All previous solutions are application-level solutions. A proposed bandwidth optimization algorithm in GPS servers with multiple classes of service in which we can minimize bandwidth while satisfying different QoS requirements for each queue class in a multi-queue system (Alalibo, et all., 2020). Since it is difficult to analytically evaluate the performance for Internet traffic with similar and dependent distances and characteristics, the performance was evaluated mainly using simulations. Specifically, a fluid simulation was performed instead of a packet-level simulation to reduce complexity. The bandwidth optimization algorithm was based on the outer function method, using the relationship between the allocated bandwidth vectors and the performance obtained from the fluid simulation. The bandwidth optimization implies an outer function, which takes a long time to converge because it uses many simulations to obtain the direction and magnitude vectors. Therefore, the input class velocity in the fluid flow model is constant in unit time interval length (Wu et all., 2018). An improved information application system is proposed by optimizing the fine integration method using

fractional differential equations and combining it with software-defined networking (SDN) to address the issues related to network bandwidth of previous information application systems that cannot guarantee the quality of large data transmission, resulting in low transmission efficiency and slow data processing. The optimization formula for adaptive selection of parameters N and increased number q is developed using error analysis theory. An improved information application system is created when SDN is used, and the improved algorithm and system are found using performance tests and simulation examples. The results show that the improved method possesses higher numerical accuracy and computational efficiency with the improved algorithm. Also, compared with previous systems, the improved port data connection speed and task completion efficiency are much higher. The model was implemented on a working network center and finally, the developed prototype was evaluated using the simulation tool OMNET++. The existing literature related to bandwidth monitoring and optimization systems was reviewed using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) method.

The existing bandwidth research led to identification of optimization problems and they were categorized into various metrics, approaches and systems used by researchers. The shortcomings in the system throughput were discovered. New mathematical integration equations based on time series routing were derived. Based on two discrete time series of input data for bandwidth optimization based on antimeridian (AM) and primeridian (PM), the formula is given: In the existing works, the energy consumption of the system, E, depends on the energy consumption of the device, R, which changed with time, t. If T was the duration for a certain period then the energy provided by:

$$\mathrm{E}\,(\mathrm{T}) = \int_0^T P(T)\,dt$$

As a result of the gaps registered and observed in the formulas for the existing works as applied in (i) follows,

• The existing formula concentrated on the power consumption of network devices while omitting the power consumption rate of wireless devices.

• The existing formula focuses on the AC power supply of network devices only and omits the DC power source especially when there is a power outage due to any circumstances.

• The am/pm timer relay was not ultimately integrated because the previous mathematical model only applied to am/pm, and omitted the automatic switching of the NO-NC switch as a result of the am timer relay.

In turn, a new mathematical equation was developed which is known as the Energy Cost Savings by Bandwidth Reduction Equation (ESCRBE).

Discussion

Bandwidth allocation and management are crucial for meeting the quality of service (QoS) needs of applications and improving the user-centricity of network architectures. Knowing that bandwidth is a limited resource, artificial intelligence techniques have already progressively replaced traditional bandwidth allocation methods. The development of wireless technology has resulted in the emergence of applications, protocols, and scenarios used by human efforts. This serves various applications, services, and transmissions, the scalable and reliable communication networks they require. Sensor networks, machine-to-machine communication, millimeter wave techniques, multiple-input multiple-output technologies, and many recent developments have helped to increase the efficiency of communication and data transmission over wireless networks. The user-centric paradigm based on the quality of experience (QoE), which is decided by the QoS provided by the network, is becoming increasingly prevalent in mixed networking situations.

In their publications, researchers discussed a number of algorithmic techniques that could reduce network routing execution time, energy consumption, and latency. Peer-to-peer networks were provided with good network services, a flexible network between users. For data transmission, the bandwidth from source to destination was expanded. In addition, the amount of unavailable bandwidth was reduced. Researchers used techniques to maximize bandwidth and transfer rate during data transmission in an equal period of time. To meet the quality of service (QoS) needs of applications and support the switchover of network architectures, bandwidth allocation and management are crucial. Data throughput begins to slow down as the traffic volume approaches the network capacity. By default, new packets will be dropped if a buffer queue appears on an interface that reaches capacity. Switches and routers can use Quality of Service (QoS) to queue and service higher priority traffic before lower priority traffic and to drop lower priority traffic in favor of higher priority during downtime.

During the initialization phase, the PRTG monitoring software is activated to monitor the initial network hosts and provides analysis based on date/time, network traffic and its volume, network traffic speed, network downtime, and network coverage metrics based on energy consumption. Once the PRTG monitors the network hosts, the am/pm timer relays will be activated by the PRTG monitoring sensors via the network administrator. Furthermore, normally open/normally closed switches are then activated via the AM/PM timer relay to turn on the active wireless link (border gateway) of the router and turn off the passive wireless (border) router until the host bandwidth network is congested, then the process is reversed. This process is called the Energy Saving and Cost Reduction Control Model (ESCRCM). The bandwidth optimization model is represented by mixed integer programming which is used to solve mathematical equations involving the integration of AM/PM timer relays that activate no/nc and include active and inactive modes (from 12 PM to 12 PM and also from 12 PM to 12 PM). Different algorithms developed for bandwidth optimization techniques vary in accuracy when applied to other bandwidth optimization models.

Based on the conducted scientific research, we can confirm the first hypothesis that existing bandwidth optimization models have low bandwidth and cause network downtime and network traffic congestion, which is why they need to be improved. Based on the conducted scientific research, we can confirm that by improving the performance of the information system and cluster architecture, we solve problems with network bandwidth and data processing.

Conclusion

We can conclude that EEBMOM was developed using bandwidth optimization techniques, these techniques had five methods which were hardware compression, deduplication, object caching, traffic shaping and forward error correction. The model was formulated using bandwidth optimization techniques (BO) while the collected data was combined with three algorithms: FUE-sub-channel matching algorithm (FSMA), Joint sub-channel and power allocations algorithm (JSPA), and integrated structure cabling system (ISCS) algorithm. Based on existing research, the current state of the problem, i.e. “poor internet speed, network downtime, constant traffic jams, energy consumption due to increasing internet connectivity, which increases management overhead costs, network unavailability”. Based on the above, we see that there is a great need for network optimization because the failure of network optimization affects business, increases business costs and leads to network unavailability. In practice, the remaining bandwidth problem is very important for telecommunications companies that provide us with internet network services because network downtime leads to the inability to use the internet and user complaints. In addition, we live in a time when it is almost impossible to function normally without a fast and affordable internet network, which is needed not only for user entertainment but also for healthcare, the Ministry of Defense, companies and all other users of internet traffic. As soon as our research has finished, we can give a proposal for improving bandwidth that can be achieved by further researching the current state of existence optimization, optimal algorithms of optimization models and a data intensive model using mathematical formulas.

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The Evolution of Artificial Intelligence and Its Transformative Role in Education

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Abstract: Artificial intelligence (AI) is a set of technologies that simulate human reasoning and decision-making, with applications in almost all spheres of society, including education. Starting from historical foundations, such as the work of Alan Turing and the emergence of the first chatbots, the paper shows how the development of AI, especially generative artificial intelligence (e.g. ChatGPT), has been reflected in the emergence of new tools and services. The impact of AI on education is also explored through the personalization of learning, the automation of evaluation and administrative processes, as well as support for teachers. The paper also points to challenges such as technology addiction, issues of ethics, privacy and automated bias. Special attention is paid to the future of AI in education and the need for an ethical, inclusive and transparent approach to the integration of these technologies. The paper aims to stimulate critical thinking about the role of AI in contemporary education.

Keywords: *Artificial Intelligence, Generative AI, Education, Machine Learning, Personalized Learning.*

Introduction

If we want to express ourselves in the simplest language, and in the shortest possible context, we can say that artificial intelligence is a set of smart (innovative) technologies that simulate human understanding. All these technologies have contributed to the formation of new disciplines that have advanced far with the help of interactive chatbots, predictive forecasting and much more. Back in the fifties, John McCarthy coined the term "artificial intelligence" at a conference on artificial intelligence (Dartmouth Conference in 1956). Already in 1965, ELIZA (Joseph Weizenbaum) appeared, the first chatbot that simulates a psychotherapist – the beginning of human-machine interaction. Namely, the predecessor of chatbots was a chatbot that was then used to simulate therapy in a question-and-answer format. The tendency to attribute human characteristics to "machines" and to have them reason and make decisions on their own, automate and mechanize processes is a hallmark of artificial intelligence itself. The 1980s and 1990s saw the development of expert systems (MYCIN, XCON) and criticism of AI for exaggerated expectations (James Lighthill – "AI Winter"). James Lighthill, a British mathematician and fellow of the Royal Society, is credited with a 1973 report that criticized the achievements of artificial intelligence up to that point. His "Lighthill Report" concluded that AI had not met expectations in real-world applications and recommended a reduction in research funding. This led to the first "AI winter" — a significant decline in interest and investment in AI during the 1970s. The question was whether we would even need AI in the future? The further period from 2000-2010 is characterized by the application of machine learning in industry (e.g. recommendations on Amazon, Google Translate). The emergence of large data sets (big data) would be a turning point in 2012, characterized by deep learning and neural networks achieving success in image recognition (ImageNet). In general, from November 2022, with the release of ChatGPT as a public tool, reaching 1 million users in 5 days – the era of generative AI begins. Already from 2023-2024, competitors such as Google Bard, Gemini, Microsoft Copilot and the short-lived DeepSeek as the Chinese answer to ChatGPT are developing.

The development of AI drew particular attention with the appearance of ChagGPT, which provided breakthrough assistance in all areas of daily life and work. A little later, the Chinese DeepSeak also ap-

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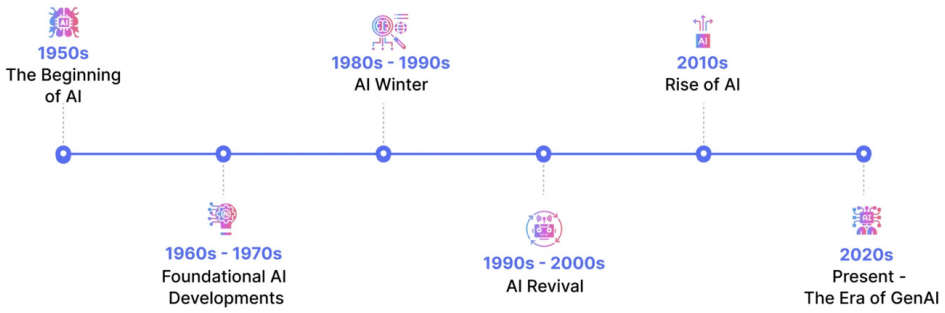
peared, but it has not yet dominated and achieved success like ChatGPT. Regardless of their recent appearance and breakthrough, AI itself dates back to the 1950s, when Alan Turing published a paper entitled “Computing Machines and Intelligence”, where even then he posed the now far-known question: “Can machines think?”, from which the “Turing Test” was born, with which people tried to distinguish between computer and human responses. How the development of AI has moved historically can be seen on Graph 1.



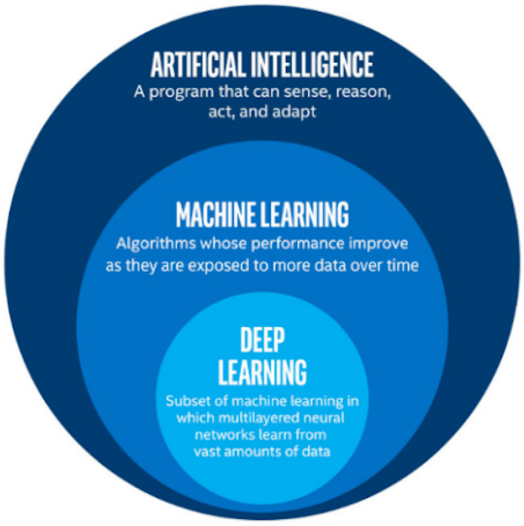
Graph 1. A historical timeline of AI
Source: https://www.openxcell.com/artificial-intelligence/

Despite several ups and downs, we are still seeing an increase in interest in machine learning, algorithmic decision-making and the provision of cognitive services (Mitrou, 2018). AI was originally designed to automate and speed up work processes and thus help in performing everyday tasks that were prone to errors. From simple automatic tasks, the application of AI has taken its place in everyday activities and all spheres. Everyday help with the help of chatbots is widely known to everyone and has become an integral part of everyday life and work. We are increasingly using AI applications and tools to get faster solutions, answers, and any kind of help. AI simplifies data management, processing, storage, and further use at a much faster and more advanced level. We are witnessing progress in all spheres with the help of AI every day. It is all these types of help that allow us to be more agile, more efficient, and far more transparent.

In artificial intelligence, we usually distinguish between two goals: “artificial general intelligence”, also known as “strong artificial intelligence”, and “artificial specialized intelligence”, also known as “weak artificial intelligence”. Artificial general intelligence aims to develop computer systems that exhibit most human cognitive abilities, at a human or even superhuman level, while artificial specialized intelligence aims at a more modest goal, building systems that are capable of performing specific tasks that require intelligence (Mitrou, 2018). One of the main advantages of artificial intelligence is that its decisions are based on facts, not emotions (Khanzode & Sarode, 2020, p. 34).

Further development of artificial intelligence - Market growth and trends

AI itself is the basis of numerous technological achievements, starting from machine learning, through deep learning, NLP... What confuses most and what is not clear to most is „How does AI work?“ Everyone talks about using AI tools, that everyone uses AI in their daily work, numerous quasi-experts in the field of AI appear without formal education and special courses, without work experience, but most basically do not know how AI itself works and where the line between legal, moral and ethical matters is. Mere knowledge and use of AI tools does not give many the right to say that they are experts in using AI tools. We have witnessed numerous AI courses where many experts who train in the use of AI and AI tools have emerged „overnight“ and do not know the principle of their operation. AI itself is „fed“ by daily data entry and user testing. Most do not even know that all data entered in the „free“ version is recorded somewhere and the AI itself learns from them, in addition to numerous databases and access to the Internet itself. Basically, there is a hierarchical relationship within AI itself (Graph 2).

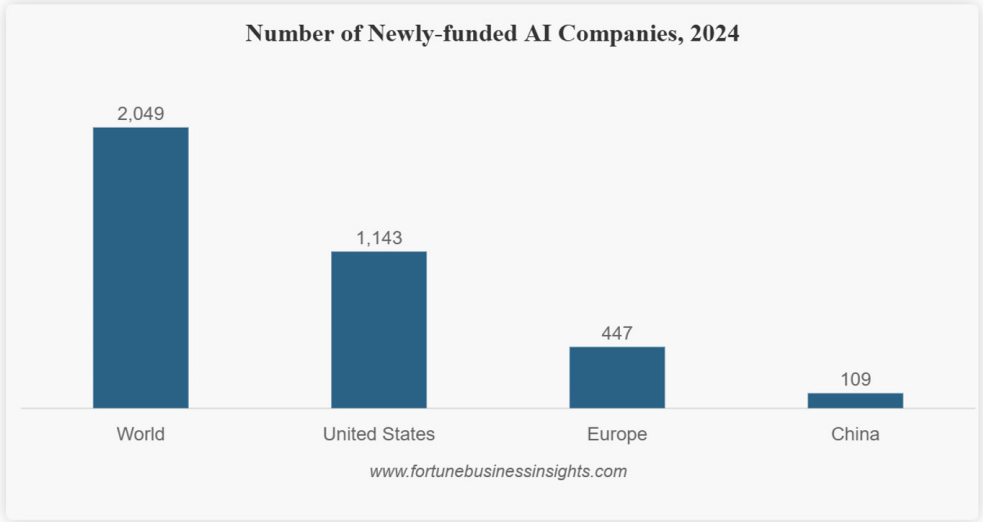


Graph 2. Hierarchical relationship between AI, ML and DL
Source: https://builtin.com/machine-learning/deep-learning

The attached clearly shows the hierarchical relationship between artificial intelligence (AI), machine learning (ML) and deep learning (DL). Artificial intelligence (AI) is the broadest term and includes programs that can perceive, reason, act and adapt. Machine learning (ML) is a subset of AI and refers to algorithms that improve their performance by learning from data over time. Deep learning (DL) is a specialized subset of machine learning that uses multi-layer neural networks to learn from large amounts of data. The AI itself is based on neural networks that use machine learning and deep learning. Basically, AI itself is based on the training of large amounts of data that are publicly available and that are fed daily by the use of all users.

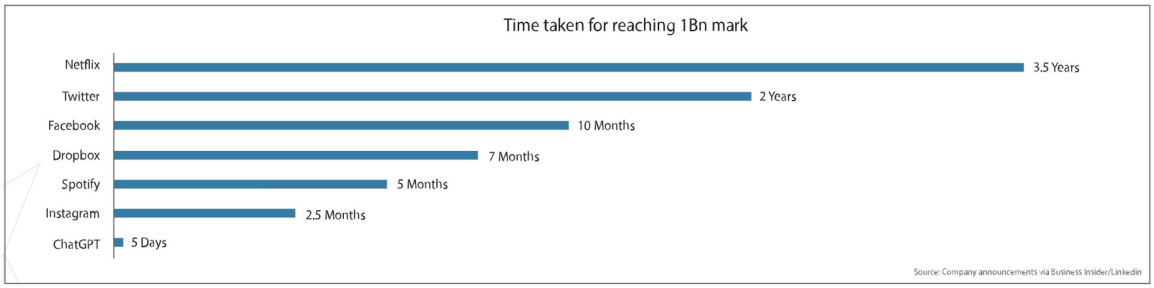
Regardless of the ups and downs, AI created a new digital evolution that took advantage of modern technologies. What is certainly clear is that AI is certainly not going away anytime soon.

Many companies are turning to AI technologies to analyze data and make informed decisions, with around 35% of businesses already integrating AI and 9 out of 10 organizations using this technology to maintain a competitive edge in the market. Governments around the world are investing significantly in the research and development of AI technology, and according to Goldman Sachs, global investment in AI will reach about 200 billion USD by 2025 (Graph 3).



Graph 3. Number of Newly-funded AI Companies, 2024
Source: https://www.fortunebusinessinsights.com/industry-reports/artificial-intelligence-market-100114

What caught everyone's attention was that OpenAI attracted more than a million users with its ChatGPT tool within just five days of its release in November 2022. Other companies took an unprecedentedly longer time to introduce their tools and online platforms to the market and achieve success (Graph 4).



Graph 4. Time taken reaching 1 Bn mark
Source: https://www.fortunebusinessinsights.com/industry-reports/artificial-intelligence-market-100114

Artificial Intelligence in Education

Along with all areas of human life, artificial intelligence (AI) has not bypassed education. Intelligence is not only about what is certain, decontextualised, disembodied, tokenised and reduced to its parts, so that it is predictable and controlled. It is also about understanding things that are fluid (Cukurova, 2025). The contribution that AI makes to education is the personalisation of teaching, the automation of administrative tasks and support in learning and assessment. In this way, both the teaching process and the work itself are made easier for teachers. If we look at the advantages provided by artificial intelligence, the introduction of artificial intelligence (AI) in education alone represents a significant potential for improving the quality of teaching and learning (Stošić & Janković, 2024). AI will certainly contribute to a profound transformation of the teaching process, which will be more interactive and adaptable to each individual. The question remains of ethical and social challenges. The question is whether AI will replace teachers? Of course not. They will be replaced by teachers themselves, who will be trained to use AI tools in education, which will serve as intelligent support for pedagogical decisions. AI will enable immersive, voice-guided interactions (e.g. in VR environments), predict risks of failure and recommend intervention measures. It is inevitable that tools like ChatGPT will be increasingly used to generate quizzes, plans and content. Due to its increasing availability and use, strict rules will be needed to protect student data and transparency of algorithms. A careful and ethical approach to artificial intelligence can maximize its benefits.

Artificial intelligence is used in higher education in a variety of ways, from detecting plagiarism and ensuring exam security to providing support to students through chatbots, improving online learning, transcribing lectures, monitoring student progress, supporting research... Chatbots respond contextually to different questions and instructions and provide differentiated feedback (Huang et al., 2022). Artificial intelligence adapts educational content to the unique learning style and pace of each student. AI-driven platforms (DreamBox and Smart Sparrow) assess students' skill levels in real time and adapt teaching content to individual needs. For people with special needs, AI tools can recognize speech and transcribe it into text. In general, we can't help but wonder if artificial intelligence is good or bad for education? Artificial intelligence (AI) is neither good nor bad for education – its impact depends on how it is designed, implemented and controlled. AI in education brings numerous benefits, but also significant risks that need to be carefully managed. Artificial intelligence can be a powerful ally in improving education, but only if it is developed ethically, inclusively and transparently. One of the potential drawbacks is the dependence on technology, which makes individuals less likely to develop critical thinking and problem-solving skills. The collection of sensitive information without clear regulation is another significant drawback that must not be omitted or ignored. Data and information must be used in a sufficiently large sample and transparently to avoid automated bias, i.e. AI can amplify inequalities if the data or models are biased. The potential risk of replacing the role of teachers still exists, but for now, AI cannot generally replace teachers.

Generative AI and tools - Impact on work and everyday life

When we talk about artificial intelligence, we cannot help but mention and explain the term generative artificial intelligence. Generative artificial intelligence is a part of artificial intelligence that deals with the development of models that can create new content without directly copying existing examples. These can be texts, images, videos and other media. Currently, the latest generation model GPT-4 accepts both image and text inputs to generate text output (Achiam et al, 2023). The aforementioned models are often used to support data-driven decision-making (Ng & Jordan, 2001). Many artificial intelligence models used in business analytics are difficult to understand for people who are not sufficiently computer literate (Senoner, Netland & Feuerriegel, 2022). The basis of generative artificial intelligence is information from a large number of data that, using various techniques (neural networks, generative models), generates new content that is closest to what is required. Deep neural networks can be designed using different architectures to model different types of data (Janiesch et al. 2021; Kraus et al. 2020). Generative artificial intelligence has the potential to transform domains and industries that rely on creativity, innovation, and knowledge processing (Fui-Hoon Nah et al., 2023, p. 123).

In the sphere of education, generative artificial intelligence offers various tools that enable the management of educational processes, thus improving the work of teachers and the teaching itself. Generative AI tools can create lessons, texts, and other types of teaching materials. They offer different answers and examples, according to the individual needs and level of knowledge of the students. Another advantage is the provision of answers in real time, which allows you to get answers and explanations in any volume, create lessons, quizzes, games, and all in order to facilitate learning of the material. Special importance is given to chat bots, which have made a real revolution. ChatGPT, with the version of ChatGPT3, marked the era of generative artificial intelligence in June 2020 to reach its peak in November 2022. The emergence of ChatGPT has encouraged companies to actively engage and invest in AI technologies to utilize these AI-based tools. Very quickly, ChatGPT also got its competitors - Google Bard, Microsoft Bing, Google Gemini... There was a race between OpenAI, Google, Apple, Microsoft over numerous AI tools and services. While numerous companies insisted on the mandatory use of these AI tools with the payment of the full version, others expressly forbade their use.

Generative AI will certainly have a much greater impact on global productivity. This is in line with the general demand to redirect working time towards more efficient use as automation increases between 2022 and 2040 (Kraus, Feuerriegel, & Oztekin, 2020). The global AI market is projected to grow to US$2,740.46 billion by 2032, with a compound annual growth rate of 20.4% between 2024 and 2032. By 2027, almost half of the workforce (44%) will need to change or modify their core skills due to AI, according to the World Economic Forum (https://www.openxcell.com/artificial-intelligence/). The global AI market was estimated at US$233.46 billion in 2024. The market is projected to grow from USD 294.16 billion in 2025 to USD 1,771.62 billion by 2032, at a compound annual growth rate (CAGR) of 29.2% during the forecast period (https://www.fortunebusinessinsights.com/industry-reports/artificial-intelligence-market-100114).

Ethical and societal challenges

Privacy and data security

Of course, one of the challenges in using artificial intelligence is the protection of privacy and data security. If we talk about education, artificial intelligence systems will work with a large amount of personal data, the most sensitive of which is biometric data. In particular, care should be taken to ensure that everything complies with GDPR or FERPA standards in order to avoid misuse, data leakage or unauthorized surveillance. As early as 2017, many legislative initiatives and proposals were launched by the EU and the UK regarding the impact of artificial intelligence on society, covering issues of liability, legal subjectivity and other ethical and legal issues, including the context of data processing (Butterworth, 2018). The misuse of data itself can lead to user distrust in the AI systems themselves, which entails numerous legal and ethical consequences. Security threats can affect users' trust in AI systems and lead to legal and ethical consequences. Teachers should certainly be aware of the relevance of ICT use in the context of teaching and learning. More on this issue can be found in the work of Łukasz Tomczyk and colleagues (Tomczyk, Ł. Et al, 2020). The security challenges facing the digital realm are expanding exponentially due to the increasing connectivity of numerous devices, applications and platforms (Mallikarjunaradhya, Pothukuchi & Kota, 2023). Tools available on the internet, both commercial and free, are not designed to prevent security (Stošić & Veličković, 2013). It is inevitable that institutions must take appropriate measures to

protect student privacy and prevent bias (Harry, 2023). No matter how many human laws it may break, artificial intelligence is not inherently evil. Artificial intelligence possesses divine characteristics; it is an entity beyond the realm of good and evil. No matter how hard programmers try to align artificial intelligence with the moral principles of human society, artificial intelligence eludes such efforts (Filipović et al, 2023).

Algorithmic bias poses a serious threat to the fair and objective application of AI technologies. Given that machine learning models learn from historical data, if that data contains social inequalities, the results of AI systems can reproduce or reinforce discriminatory patterns. In an educational context, this can mean unequal treatment of students from different socioeconomic or ethnic backgrounds, incorrect predicted grades, or selective availability of supports. To overcome this problem, measures such as auditing algorithms, including diverse and balanced data sets, and improving transparency in explaining how algorithms make decisions are needed. The ICO identified five distinctive aspects of big data analytics using artificial intelligence with implications for data protection in its 2017 document (Act, D. P., & Regulation, 2017). The purpose of data collection and analysis must be clear and must comply with standards. Ethical and data protection input will be required at the design stage, training stage and throughout implementation (Butterworth, 2018).

With the popularity of artificial intelligence, so-called "AI experts" without formal knowledge or experience are increasingly appearing. The rapid commercialization of AI education, especially through short online courses without scientific or pedagogical verification, leads to the spread of unreliable information and a decrease in the quality of professional staff. The consequence of this phenomenon is a misunderstanding of the functions of AI tools, as well as reckless implementation in practice. In order to ensure the quality and integrity of knowledge in this area, it is necessary to support training through institutions as well as numerous accredited programs and professional mentoring.

Conclusion

It is inevitable that artificial intelligence will bring numerous benefits – from personalized learning and more effective teaching, to improved data analysis and process automation. It is also inevitable that AI will transform education itself. The application of generative tools such as ChatGPT will be an indispensable tool in everyday life. In addition to all the advantages, care must be taken, from threats to privacy and data security, to algorithmic bias, to the spread of uncritically adopted or inaccurate information. The future of AI depends not only on technological progress but also on our ability to use it ethically, responsibly and transparently. Cooperation between the academic community, educational institutions, government bodies and technology companies in the development of regulatory frameworks, digital literacy and training of teaching staff is necessary. Education programs that enable the development of digital literacy among students, teachers and parents must be introduced. Only carefully managed integration of AI can ensure that it remains at the service of humans – as a tool for advancing knowledge, not a replacement for human wisdom.

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