

SELECTED APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN THE FACTORS OF PRODUCTION

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Purpose: The article presents the emergence and development of Artificial Intelligence as one of the key technologies of Economy 4.0. Selected applications of AI in the context of classical production factors are also presented.

Design/methodology/approach: The article contains theoretical considerations and practical applications of general artificial intelligence. Literature analysis made it possible to distinguish key technologies in the fourth industrial revolution. From among many of them, the author chose the one that, in his opinion, has the greatest potential for development. The main goal of this paper was to determine the influence of Artificial Intelligence on production factors.

Findings/Conclusions: The summary of this article is an indication of the key applications of Artificial Intelligence along with its practical examples based on the analysis of literature and internet sources. The author also pointed to the process of transforming classical production factors into a new paradigm, taking into account the achievements of the fourth industrial revolution, i.e. machine labor and data. Artificial Intelligence in the case of labor is the most controversial because people fear being replaced by machines. As the analysis of literature and historical data has shown, the fear is unjustified, because with the arrival of new technologies, new jobs are being created.

Research limitations/implications: Artificial Intelligence is a tool that is neither good nor bad. Its purpose depends entirely on the person using it. So far, no legal or scientific restrictions have been defined that would allow for the safe use of such advanced technology. The article is an introduction to the discussion on limiting access to such technology and its potential and undesirable threats.

Practical implications: One of the applications of Artificial Intelligence is to support company management in the form of creating a tool for analyzing financial data of private limited companies and employing AI as a virtual director, which would serve as a real-time data center and make fairer staff assessment.

Social implications: Artificial Intelligence is one of those technologies that surrounds society at every turn. It is used to improve everyday life, e.g. road navigation or presenting suggested shopping offers. In order to fully use the potential of AI, it is necessary to change the education system, taking into account not only hard and soft, but also digital competences. That in the future will be a significant asset for people entering the labor market.

Originality/value: The transformation of the classical understanding of production factors into a new paradigm, taking into account the achievements of the fourth industrial revolution, is a new field of scientific research, which is important in the context of the transformation of

enterprises to the requirements of the modern market. The paper is an introduction to the discussion about the direction and impact of these changes on societies and the economy.

Keywords: Artificial General Intelligence, Industry 4.0, Machine Learning, Production Resources, Manufacturing.

Category of the paper: Conceptual paper, Viewpoint paper.

1. Introduction

The global COVID-19 epidemic of 2020 created new, previously unforeseen situations, the consequences of which we will face for the next many years. Each state reacted differently to the spreading disease. Some have introduced severe restrictions and lockdowns that have significantly affected people's lives and the running of businesses, while others only recommended adherence to hygiene rules.

Enterprises not only had to face the prevailing pandemic, but also a strong competitive environment. They had to adapt production processes to changing consumer needs and develop new innovations. COVID-19 significantly influenced the supply chain of materials (Enache, 2022), the availability of means of production as well as begot staff shortages caused by sickness absenteeism (Kniffin et. al., 2021). The above-mentioned aspects affect the increasingly complex and sensitive production systems.

It turns out that a company is not able to cope with such a huge number of challenges due to the lack of tools and platforms, which are crucial for the mutual cooperation of all areas of the company's operation. To remedy this, a search was started – a search for a concept that would combine knowledge, forecasting, learning and optimization in order to improve functioning in post-covid conditions.

Despite the outbreak of a global pandemic, modern enterprises must operate in the conditions of the fourth industrial revolution. The fourth revolution, otherwise known as Industry 4.0 (German: Industrie 4.0), consists of several pillars (Erboz, 2017):

- Big Data and Analytics.
- Autonomous Robots.
- Cyber Security.
- Industrial Internet of Things (IIoT).
- Cloud Computing.
- Artificial Intelligence, Machine Learning.
- Horizontal and Vertical System Integration.
- Additive Manufacturing (3d printing).
- Simulation.
- Augmented Reality.

The fourth industrial revolution can also be described as Economy 4.0, as it holistically covers all areas of social life, technological development and value chain organization (Hermann et al., 2015).

Modern industrial robots are capable of performing work in a human-like manner, but at the same time they are equipped with tools for monitoring, collecting and sending data to servers or to the cloud during the performed tasks (Thames, Schaefer, 2017). The current revolution is not only technological advancement, but also a human factor that must cooperate with the novelties. Collecting new knowledge and acquiring new skills by employees are necessary to perform their duties more effectively. The aim of integration in Economy 4.0 is a transformation of existing production companies or establishing new ones in a way they would become fully automated, self-controlling and self-adapting Cyber Physical Systems (CPS) (Lasi et al., 2014).

The author's aim is to describe a selected issue from a wide set of constituents that make up the fourth industrial revolution, i.e. the deployment of Artificial Intelligence in the factors of production.

2. Characteristics of Artificial Intelligence and related concepts

Artificial Intelligence (AI) is a broad scientific discipline that combines computer science, statistics, operations research, mathematics, social sciences, philosophy, and the Humanities. The goal of AI is to develop non-biological systems such as machines and computers in such a manner that they would be capable of performing work that previously required human intelligence. Artificial Intelligence has been divided into several main applications, e.g. machine learning, robotics, speech recognition, expert systems or natural language processing (e.g. writing advertising leads), and these in turn have more comprehensive functions.

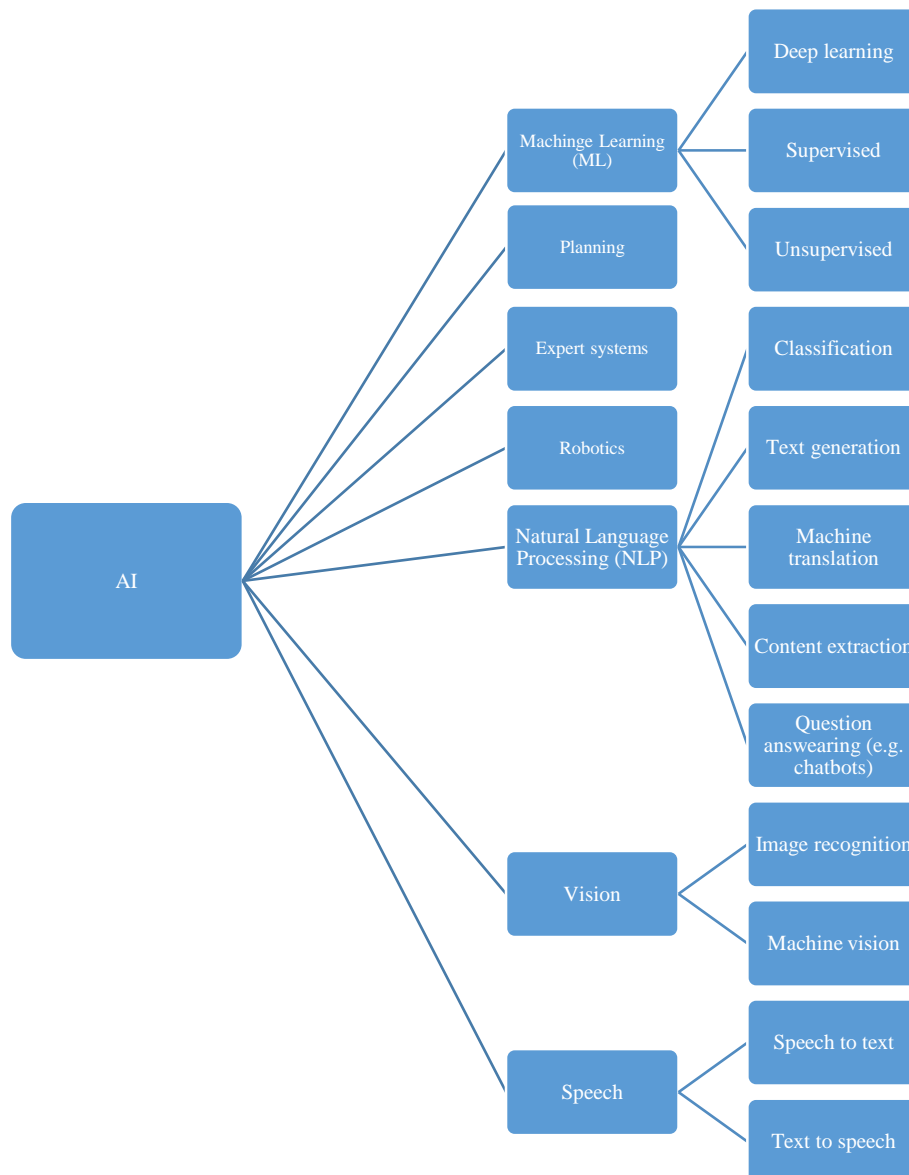


Figure 1. Examples of AI.

Source: own work.

Machine Learning – is a sub-discipline of Artificial Intelligence that focuses on the application of statistical learning. Machine learning develops algorithms capable of automatically looking for associations among huge amounts of data in real time. With experience, the search for these dependencies among data improves. The effect of the development of Machine Learning is the isolation of Deep Learning. Initially, Bitcoin's Blockchain did not have a large size, but in later years, with the increase in the number of transactions, the size of the ledger increased significantly and in 2014 it exceeded 20 gigabytes. The amount of energy needed to maintain the network exceeded Ireland's energy demand (O'Dwyer, Mallone, 2014).

Deep Learning (DL) is a powerful statistical technique for classifying patterns which employs large training datasets and multi-layer Artificial Intelligence neural networks. It is basically a data-driven machine learning method that is loosely modeled on the way the

biological brain learns to solve problems. Each artificial neural unit is linked to many other such units, and these links can be statistically enhanced or decreased based on the data used to train the system.

Although machine learning is better at performing well-defined tasks based on the available data, it still requires human intervention. If the algorithm returns inaccurate predictions, then the supervisor must correct the modeling. However, in Deep Learning, the algorithm will decide by itself whether its results are correct or not, according to its own neural network and this will be done without human supervision (LeCun et al., 2015).

Research on Artificial Intelligence dates back to the 1940s, when scientists began to discuss the possibility of creating a thinking machine. Alan Turing was considered the first scientist who laid the foundations for recognizing whether we are dealing with artificial intelligence, the so-called Turing Test (Turing, 1950). Originally known as the "imitation game", the Turing Test examines the intelligence of a computer. The judging person is talking to two candidates - a human and a computer. If he cannot say with certainty which of them is the former and which is the latter, we can assume that we are dealing with an "intelligent" machine. Despite numerous criticisms, the Turing test is still important while speculating on Artificial Intelligence, and programmers compete in attempts to develop similar tests (including participating in the annual competition for the Loebner Prize) (Loebner, 2007).

The first applications of Artificial Intelligence focused on the development of computer programs capable of competing with people in games known since antiquity, i.e. chess, checkers and Chinese Go. Arthur Samuel's program was intelligent enough to compete with people at the amateur level (Samuel, 1959). However, the term Artificial Intelligence itself is attributed to the authorship of John McCarthy, who coined the name during the Dartmouth Conference of 1956. This date is strictly regarded as the birth of AI as a scientific discipline (McCarthy et al., 2006). Since then, Artificial Intelligence research has received a lot of attention, especially after hitting three milestones:

1. The first stone was IBM building a Deep Blue computer that was capable of defeating human chess grandmaster Garry Kasparov in 1997 (Campbell et al., 2002).
2. The second milestone is Deepmind's AlphaGo, an AI designed to defeat professional Chinese Go players in 2015 (Silver et al., 2018).
3. The third milestone was AlphaZero, also by manufactured by Deepmind, an Artificial Intelligence that reached grandmaster level for top human players in 24 hours by playing with itself. Then it beat various advanced chess programs for players in 2017 (Silver et al., 2017).

These milestones have been catalysts for significant advances in Artificial Intelligence and Machine Learning over the past two decades. Investments in research and development in the field of AI increased from 26 billion dollars in 2013 to 39 billion dollars in 2016 (Bughin et al., 2017). Global supply chains and the management of production resources have benefited significantly from developing and investing in Artificial Intelligence. Advanced IT systems

such as cloud solutions, the industrial internet of things (IIoT), wireless technologies or sensors, have contributed to the evolution of the field of operations research and business.

Today, business administration, industrial production control and supply chain management between different sites in different countries is smooth and free of any major obstacles. Smart devices such as smartphones, smartwatches, tablets, points of sale connected to the Internet, mobile applications, IIoT modules collect data on demographics, consumer behavior or the location of purchase in real time. Then, without human intervention, the potential development of a product or service is carried out, and the inventory is replenished in the future.

AI applications have allowed many companies to increase their productivity through robotization and production automation, and facilitated marketing departments to better understand customer expectations and predict their needs in the future. The flexibility of such a production system allows for the provision of personalized goods or services at the consumer's request in a significantly shorter time, which allows to eliminate production downtime. While adaptation is the fastest in the automotive industry and all types of High-Tech Industries, in the medical industry and retail sales they can bring the most benefits to society (Bughin et al., 2017).

3. Selected applications of the Artificial Intelligence

In this study the author discussed the use of Artificial Intelligence in production factors. According to the assumptions of the father of classical economics, Adam Smith (Smith, 1776), there are three basic factors of production:

1. Land or natural resources.
2. Labour.
3. Capital.

These three components continue to form the basis of the production resources in the world of the fourth industrial revolution. The Economy 4.0 consists of many elements that are interconnected and interact with each other, interpenetrate through and form a coherent whole. Each concept has a greater or lesser impact on human life. Artificial Intelligence is an example of innovation in Economy 4.0, which, in the author's opinion, pervades the social, financial and technical spheres, and in the near future it may help humanity to explore the space and colonize the moon or other planets.

3.1. Land or natural resources

Natural resource management is a scientific discipline that covers a whole range of organic and inorganic natural resources, which include, for example: soil, plants, animals, metals. Particular emphasis is placed on the aspect of the quality of life of present and future generations as well as sustainable development and ecology (Sethi, 2021).

The population of people on Earth, growing every year, has increasing consumption needs and is more and more serious burden for the planet. The ruling states are exposed to constantly new, more complex challenges to ensure the security of their countries, as well as the best possible conditions for the development of their own society. The ongoing war between Ukraine and Russia has created further problems. Europe, but also the whole world, must struggle not only with the post-covid reality, but also with serious limitations in the supply of cheap energy resources necessary for the proper functioning and development of economies. As a result of the suspension of supplies of cheap raw materials from Russia, countries such as Poland faced the challenge of acquiring raw materials from other parts of the world. The restrictions affected not only heating (shortages of coal in warehouses) and transport (a radical increase in fuel prices and temporary limits for refueling cars), but also agriculture and the food industry. Natural gas is used to produce fertilizers. It is also further processed to obtain the carbon dioxide necessary in MAP packaging - creating a protective atmosphere in packing meat into trays, space filling for crisps packets, or producing fizzy drinks and beer (Ciszek, 2022).

The heatwave and drought that hit Europe in 2022 caused gigantic fires of thousands of hectares in many countries on the continent. At present, there are many different firefighting solutions. Most of them are based on the early warning system. The system uses drones that constantly patrol areas at risk of fire. Unmanned aerial vehicles (UAVs) are coupled to neural networks to detect smoke or fire much faster, by recognizing images and searching for patterns in the base using photos or video recording (Kinaneva et al., 2019).

In order to keep the natural environment as least degraded as possible by human activity, it is necessary not only to decarbonize the energy sector, but also to process waste for recycling, to use low or zero-emission energy sources, create production processes in a closed cycle (circular economy), increase the efficiency of production of goods, support biodiversity. Such balanced operation with the use of the latest technological achievements ensures development with respect for the natural environment and saves non-renewable resources for future generations. For example, an African country Morocco, in the past years based all energetics on importing minerals, while now more than 40% of energy comes from solar farms. On the other hand, restoring green spaces allows for greater carbon sequestration in ecosystems and prevents global warming of the planet to avoid the sixth mass extinction (Attenborough, 2020).

The circular economy is a challenge not only for resource management, but also for businesses and societies. The European Commission promotes the transformation from a linear (open-loop economy) to a circular economy. The development of the circular economy is at the highest level in the activities of the European Union. This new approach poses a serious challenge for entrepreneurs, but also has many benefits for the environment and societies. A circular economy, as opposed to a linear one, means a system approach, where the product is part of the life cycle and is manifoldly reusable. It is advisable to develop products that keep their functionality as long as possible and eliminate waste as much as possible. These are challenges for businesses, politicians and societies.

3.2. Labour

Labor is one of the most important areas of human life. With the successive industrial revolutions, the strength of human muscles was replaced with a steam engine; then machines and tools for production were electrified and intellectual efforts were significantly aided by the computer revolution.

Given the history of industrialization, earlier communities had a very limited number of worker specializations, and with the advancement of the past few centuries, this number has grown markedly. For example, in the United States in 1850, the number of professions was around 300, and by 2018 it would increase to almost 900 (Bureau of Labor Statistics, 2018).

The results of the increasing specialization of professions and the growing trade exchange can be traced in changes in GDP along with the market diversification into newer products and services. The original clan societies had only a few hundred products at their disposal, which is currently less than 1% of the 70,000 products for a typical supermarket. For comparison, the e-commerce platform Amazon sold over 75 million products in March 2021 (Beinhocker, 2007, Scrapehero, 2021).

In the context presented above, where we are dealing with an increasing professional specialization and a huge variety of products or services, new knowledge is needed. Knowledge supported by Artificial Intelligence assistants to better serve individual consumer orders. As a consequence of new, differentiated tasks for employees and exchange of experiences between enterprises, other, previously unknown professions and specializations are created (Koppl et al., 2015).

For Amazon - a giant of the e-commerce industry - the goal of market dominance is to increase the automation of order processing through robotization in the operation of warehouses and delivery (e.g. drones delivering parcels) They also aim at an AI support in other areas of the company's operations. It was similar in the case of hiring employees. The AI engine they created (based on thousands of training data in the form of various applications and CVs) was to select the best candidates in terms of suitability for the company. After analyzing the recruitment process, it turned out that the algorithm only selected males, even when adjustments were made to improve the results. The project was eventually abandoned due to its bias in 2017

(Grossman, 2018). Such failed projects show how dangerous it is to create algorithms from partial data, which in turn might contribute to the creation of new excluded groups in society.

The fear of replacing a man at work with a machine is not new. Nowadays, there are also voices that human work will be automated and thousands of people will be laid off. As history has shown, such fears were unfounded.

Companies that have invested in automating their processes to replace employees see only short-term gains. A study was conducted on 1500 companies that implemented AI, but did not reduce employment. It turned out that these companies made sky-high profits as humans and intelligent machines worked together. Such cooperation, actively supplemented with the skills of people (social competences, creativity, leadership, teamwork) and machines (instant analysis of many terabytes of data), would not have been possible before. Business requires both kinds of capabilities (Wilson, Daugherty, 2018).

In the first days of September 2022, the company designing mobile games NetDragon Websoft appointed a humanoid Artificial Intelligence machine as the company's CEO. The founder of the company - Dejian Liu - called the virtual boss Tang Yu. He further explained that AI is to make fairer decisions about personnel and is to use analytical data, also serving as a real-time data center. He emphasized that they want to build an open, interactive and transparent model of company management (Anand, 2022).

3.3. Capital

Entrepreneurs make their investment decisions based on two rational premises: profit maximization and/or maximizing market value. To be clear, the term maximization suggests that further assets of the enterprise should only be acquired if this increases the net profit of shareholders. This happens when the expected rate of return exceeds the rate of investment. In principle, rational maximization of the market value takes place when the purchased assets have a positive impact on the equity of the enterprise. That means that the purchase cost of the component should be lower than the value added to the market value of the enterprise, and unfortunately it is often overestimated (Trombley, Haddad, 2018).

Therefore, in order to make the best possible investment decisions, it is necessary to carry out an acquisition valuation in accordance with due-diligence, using all possible tools. With the advent of the Economy 4.0 era, new tools were created in the form of Artificial Intelligence, as expert systems or planning and predicting engines.

In addition, managers should strive to maintain an optimal cost of capital rate that balances benefits and costs and maximizes profits and enterprise value. However, current market fluctuations, such as a pandemic crisis, supply chain disruptions and rising interest rates, have made estimating the cost of equity capital much more difficult and has also resulted in a higher total cost of capital. For example, technology companies in the United States in the 1980s began to lose the competition from Japanese companies. The cost of capital for American companies was much higher than for their Japanese opponents. Based on this factor,

US executives made decisions that were radically different from those in Japan, over the long term. This helped the Japanese managers not only gain an advantage, but also reduce the costs of, for example, debt in relation to the costs of debt service for American rivals. Although the market situation has changed nowadays, the cost of capital still plays a key role in being a competitive enterprise.

Artificial Intelligence is prevailing in a variety of fields, thanks to its ability to instantly find intricate patterns and make future predictions from huge gigabytes of data, much more accurately than humans.

A study of ten technology companies was conducted to check the estimated cost of capital and return on investment over several years (Eliasy, Przychodzień, 2020). For this purpose, historical and current data were used to forecast future share prices. A comparison was made between the two methods: using AI and traditional capital asset pricing models. It turned out that in nearly 60% of cases, AI was better able to estimate future costs. The implementation of the neural network will allow capital companies to a large extent to better evaluate the cost of capital and return on investment at any time. The advantage of more accurate forecasts is more precise planning of future steps to optimize the capital structure.

One of the few serious drawbacks of introducing such a solution to the enterprise are various difficulties and costs of training in Artificial Intelligence. This will not only require a huge amount of data, but also will force hiring new specialists. Therefore, the researched technology companies did not implement such tools.

On the other hand, one also needs to pay attention to what happens if every potential investor starts using Machine Learning to predict company valuation and people trust such forecasts completely. One may come across a situation where certain companies on the stock exchange are overvalued to the limit and the speculative bubble bursts, causing an economic crisis on an unpredictable scale, much more fateful than the Great Depression of the last century.

4. Summary

The fourth industrial revolution incorporates many breakthrough technologies that surround and permeate social and economic life. It is no different with the development of engines of Artificial Intelligence. The progress of this revolution is much faster and more forcible than the previous ones, despite the fact that there are still areas in the world where even the second revolution did not arrive – i.e. electrification. Thus, not all inhabitants of the Earth will benefit from new industrial revolution.

The architecture of the Artificial Intelligence network has great potential to be used. So it will find many applications, not only those mentioned by the author, but also for example:

- in forensics - as a tool to recognize the faces of criminals among the crowds,
- in medicine - early warning against pathogenic changes (e.g. emerging cancer cells),
- assistants of the disabled,
- anti-money laundering,
- risk analysis in human insurance,
- individual learning for students.

There is no doubt that the future will belong to solutions using Artificial Intelligence. More and more services are offered to consumers with the use of AI solutions, e.g. film offers on VOD platform or e-commerce websites suggesting further purchases.

In turn, marketers can use Artificial Intelligence to better manage customer relationship (CRM) and understatedly advertise their products and services.

Image recognition helps protect the environment against, for example, fires, Deep Learning facilitates the valuation of companies, and NLP allows instant translation of texts into many languages. Artificial General Intelligence (AGI) will help in the transformation from linear to a circular economy and in better recycling of waste. But like any technology –still the creation of the human mind - despite the enormous advantages and benefits for mankind, it will not be without its drawbacks.

Yuval Harari believes that strict regulations regarding the use of AI should be introduced. Otherwise, huge corporations with inexhaustible financial resources and access to data that people themselves give them using their services, will be able to "hack" people. According to Harari, it means that thanks to AI, corporations will be able to get to know people better than they do themselves. Ultimately, within 10 or 20 years, such algorithms could also tell what a given person is to study, where to work, who to marry, and even who to vote for, which in the future will deal with digital tyranny and dictatorship and elite rule (Harari, 2018). For the 2023 elections to the Danish parliament, a political party called Synthetic Party was registered. The group announced that its program will be created by Artificial Intelligence. The party that wants to vote in June 2023 hopes to win 15 percent of the Danish votes. Asker Bryld Staunaes, one of the party members, explained that AI analyzed the programs of other political parties, creating a program that would represent the "vision of the common people" (Diwakar, 2022).

On the other hand, Theodore Kaczynski alias Unabomber, showed an extreme anti-technological attitude. In his manifesto, he argued that technological development serves to enslave and subordinate the masses to elites, rather than to restore freedom to individuals (Kaczynski, 1995).

This research paper has come with some limitations. The author described only selected applications of Artificial Intelligence in relation to production factors. According to Adam Smith, these factors are land (natural resources), labor and capital. Given the impressive technological development of the economy 4.0, the old paradigm:

Land (Natural Resources) – Human Labor – Capital

should be abandoned and a different one, enriched with new production factors, should be used:

Land (Natural Resources) – Human Labor – Capital – Machine Labor – Data

In the face of such a transformation of economic systems into Economy 4.0, it is reasonable for the education system to change as well. These changes should be aimed at preparing society for the challenges of the modern labor market. It is necessary not only to develop hard and soft, but also digital skills to be able to synergistically use the modern innovations of the fourth industrial revolution.

It is obvious that the General Artificial Intelligence, like any tool, is neither good nor bad, and it is only up to the human being how it will be used. Despite the above statement, it is worth quoting the thought of the Nobel Peace Prize winner, Christian Lous Lange: "Technology is a useful servant, but a dangerous master".

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