ROBONOMICS
The Journal of the Automated Economy
https://journal.robonomics.science

Robonomics: The rise of the automated economy

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Abstract
The technological advances in the last decades are transforming the global economy and society paving the way for the automated economic system, aka *robonomics*. This editorial provides a brief overview of automation technologies, their application in various sectors of the economy and society, and elaborates on robonomics as an economic system and a scientific field. Robonomics is introduced as an economic system that relies almost entirely upon automation as a production factor rather than human labour. As a new scientific field, robonomics goes beyond the economic aspects of the automated economy and focuses on the social, cultural, demographic, political, environmental, legal, geographic, psychological and other issues raised by automation technologies as well. Finally, the editorial introduces *ROBONOMICS: The Journal of the Automated Economy*, and the publications in the inaugural issue.

Keywords: Robonomics, Automation, Artificial intelligence, Robots, Economics, Politics

Type: Editorial

Citation: Ivanov, S. (2021). Robonomics: The rise of the automated economy. *ROBONOMICS: The Journal of the Automated Economy*, 1, 11.

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1. Introduction

The technological advances in the last decades are transforming the global economy and societies. Companies and organisations more and more actively use automation technologies to streamline their operations, speed up processes, shorten production/service delivery time, provide consistent product quality, save on costs, increase revenues, improve competitiveness and economic efficiency, design experiences for customers and employees, etc. Automation technologies is an umbrella term for a wide scope of technologies that are used to produce products and deliver services instead of human employees: e.g. *artificial intelligence* (AI) (Ertel, 2017; Neapolitan & Jiang, 2018; Russell & Norvig, 2016), *robots* (Ben-Ari & Mondada, 2018; Bhaumik, 2018; Kanda & Ishiguro, 2016; Mihelj et al., 2019; Miller & Miller, 2017; Royakkers & van Est, 2016), *smart factories* (Wang et al., 2016), *autonomous vehicles* (Maurer et al., 2016), *chatbots* (Galitsky, 2019; Singh, Ramasubramanian & Shivam, 2019), *automated trading algorithms* (Chan, 2017), *self-service kiosks* (Rastegar et al., 2021, Vakulenko, Hellström, & Oghazi, 2018), *wearable and implantable devices* (Bhunia, Majerus, & Sawan, 2015; Delabrida Silva, Rabelo Oliveira, & Loureiro, 2018; Dey, Ashour, Fong & Bhatt, 2019; Przegalinska, 2019; Velez & Miyandoab, 2019), *face recognition technologies* (Berle, 2020; Datta, Datta, & Banerjee, 2015; Li & Jain, 2011), *3D printing / additive manufacturing* (Dietrich, Kenworthy & Cudney, 2019; Niaki & Nonino, 2018; Singh & Davim, 2019), *voice-activated devices* (Buhalis & Moldavska, 2021; Hoy, 2018), *robotic process automation* (Moffitt, Rozario & Vasarhelyi, 2018) and *intelligent automation* (Bornet, Barkin & Wirtz, 2021; Ng, Chen, Lee, Jiao, Yang, 2021), *virtual, augmented, mixed realities* (Israel, Tscheulin & Zerres, 2019; tom Dieck & Jung, 2019), *Internet of Things* (Dey, Shinde, Mahalle & Olesen, 2019; Sendler, 2018), etc. Automation technologies are the driving force of the "Fourth Industrial Revolution" (Schwab, 2016; Skilton & Hovsepian, 2018).

While manufacturing was leading the introduction of automation technologies for decades (e.g. Ross, Fardo & Walach, 2018) other sectors of the economy and administration catch up quickly. For example, automation technologies have been adopted by companies in agriculture (Verdouw, Tekinerdogan, Beulens & Wolfert, 2021; Zhou & Zhang, 2019), and in warehousing (Mahroof, 2019). More recently, robots, artificial intelligence and service automation technologies are implemented for the provision of various services (Huang & Rust, 2018; Wirtz et al., 2018), including travel, tourism and hospitality services (Ivanov & Webster, 2019a). Artificial intelligence is applied in marketing for pricing, creating value for and maintaining relationships with customers (Galitsky, 2021; Gentsch, 2018; Vlačić, Corbo, Costa e Silva & Dabić, 2021; Wodecki, 2019). Public authorities acknowledge the power of AI as well (Wirtz, Weyerer & Geyer, 2019) and its importance for national security (Allen & Chan, 2017). Robots and artificial intelligence support the educational experience of students (Daniela, 2019; Luckin, Koedinger & Greer, 2007). Artificial intelligence identifies spam email messages (Bhowmick & Hazarika, 2018), filters results in online searches (Chau & Chen, 2008), and determines which posts social media users see (Lada, Wang & Yan, 2021). Wearable technologies gather data about people's physical activities (Lee, Drake & Williamson, 2015) while implantable medical devices improve people's health and wellbeing (Fitzpatrick, 2015). Millions of robotic vacuum cleaners help households keep their homes clean (Loup Ventures, 2019). Automated border control e-gates rely on face recognition technology to identify passengers (del Rio, Moctezuma, Conde, de Diego, & Cabello, 2016). Robotic technologies help doctors (Desai, Patel, Ferreira & Agrawal, 2018; Mittal & Srinivasan, 2021; Riojas & Labadie, 2020; Schweikard & Ernst, 2015) and rescue teams (Nagatani et al., 2013; Sakour & Hu, 2017) save lives, but they also help soldiers take the lives of enemy soldiers without risking their own (Crootof, 2015; Lorber, 2021; Sparrow, 2007; Springer, 2013). Sex robots are already offered on the market and humans are developing sexual relationships with them (Cheok, Devlin & Levy, 2017; Danaher & McArthur, 2017; Lee, 2017; Zhou & Fischer, 2019). Algorithms perform automated transactions on financial markets (Budish, Cramton & Shim, 2015; Dunis et al., 2017), provide legal services (Ashley, 2017; Remus & Levy, 2017), execute smart contracts (Corrales, Fenwick & Haapio, 2019), and write press articles (Clerwall, 2014; Latar, 2018). The natural language generation capabilities of artificial intelligence reached the point that allowed the first academic book written by artificial intelligence to be published in April 2019 (Writer, 2019). Appendix 1 provides an example of AI-generated text on the topic of this editorial that even includes references to the cited sources.

This short overview of the scope and directions of implementation of automation technologies reveals that these technologies have already permeated most, if not all aspects of society. They started to revolutionise how people live, work and do business (Agrawal, Gans & Goldfarb, 2018; Corea, 2019; Daugherty & Wilson, 2018; Davenport, 2018; Ford, 2009, 2015; Johannessen, 2019a, 2019b; Johannessen & Sætersdal, 2020; Makridakis, 2017; Moore, Upchurch & Whittaker, 2018; Talwar, Wells, Whittington, Koury & Romero, 2017; von Braun, Archer, Reichberg & Sorondo, 2021; Webster & Ivanov, 2019; West, 2018; Wilkinson & Barry, 2020) but their profound social, economic, and political impacts are yet to be revealed.

The common denominator of automation technologies is that the tasks (e.g. data entry, issuing of a document, item delivery, product manufacturing, information provision, etc.) are implemented by a machine or an autonomous agent. The role of the human is minimised or eliminated. Therefore, automation technologies have a strong substitution effect on jobs (DeCanio, 2016; Frey & Osborne, 2017). On the other hand, such technologies allow employees, companies and organisations to be more productive with their available resources; i.e. automation technologies have an enhancement effect as well (see also, Acemoglu & Restrepo, 2019; Ivanov, 2020). The substitution and enhancement effects of automation technologies shape how they are perceived by different social groups. Some authors have more positive perceptions of automation technologies and see them as tools to improve product quality, decrease costs of goods and services, increase the production/service capacity, productivity and competitiveness of companies, create new business models, improve people's health, longevity and quality of life (e.g. Brynjolfsson & McAfee, 2014; Danaher, 2019; LaGrandeur & Hughes, 2017; Makridakis, 2017; Schwab, 2016; Talwar et al., 2017). At the extreme, the transhumanism movement predicts that humans will transcend their biological limitations through their merger with technologies (Kurzweil, 2005; Lee, 2019; MacFarlane, 2020; Manzocco, 2019). Other authors emphasise the potential technological unemployment due to the substitution effect of automation technologies on labour (Leonhard, 2016), the privacy concerns related to these technologies (Berle, 2020; Klitou, 2014; Przegalinska, 2019), and the aggravation of economic and social inequality by automation (Ernst, Merola, & Samaan, 2019). The fear of AI, more specifically the fear of artificial superintelligence (Bostrum, 2014) resulting from the technological singularity when AI performs better than any human in any activity (Callaghan, Miller, Yampolskiy & Armstrong, 2017; Kurzweil, 2005; Shanahan, 2015; Vinge, 1993), even forces some authors to claim that AI will be 'our final invention' (Barrat, 2013). Nevertheless, the implementation of automation technologies will continue to accelerate in the future until societies reach a point when all (or an overwhelming share of) goods and services are produced by automation technologies with minimal human involvement. Such **an economic system that relies almost entirely upon automation as a production factor rather than human labour is called '*robonomics*'** (Crews, 2016; Ivanov, 2017).

2. Robonomics as an economic system

The term 'robonomics' for denoting an automated economic system that relies on robots, artificial intelligence and other automation technologies for the production of goods, delivery of services and implementation of various administrative processes, was introduced by John Crews in his 2016 book "*Robonomics: Prepare today for the jobless economy of tomorrow*". The term was popularized by Ivanov (2017). Chase (2016) uses the term 'economic singularity' for the same economic system, analogous to the 'technological singularity' concept by Verge (1993). Regardless of the preferred term, the automated economic system is characterised by the following features (Ivanov, 2017):

- ✓ High level of automation: the economy relies extensively on automation technologies as a production factor rather than labour;
- ✓ Few jobs for human employees as most production tasks are automated;
- ✓ A disconnection between employment and incomes due to the low level of employment of people;
- ✓ High cost-efficiency of production due to automation;

✓ Artificial intelligence takes economic decisions (e.g. purchases, sales, use of resources in production), usually without the direct supervision of humans;

✓ Small and dispersed factories located closer to customers;

✓ Companies provide mainly cheap technology-delivered high-tech services or expensive human-delivered high-touch services but various shades of grey exist between these two extremes;

✓ Labour and capital abundance are not sources of competitive advantages but knowledge and creativity.

The decreased role of human labour in the economy is one of the determining characteristics of robonomics with huge social repercussions. On the positive side, robonomics would lead to improved quality of life, health and life expectancy of people in the long term due to elimination of work stress, repetitive, dirty, dull and dangerous tasks for humans, more time available for leisure, pleasure and creative activities (Ivanov, 2017). Liberating people from work will give them opportunities to do the things they want. On the negative side, the automated economic system raises various challenges. For example, the current economic system, regardless of whether based on market and/or socialist principles, generates household incomes from ownership (e.g. dividends, interest, rent, capital gain), employment (e.g. salaries, wages, self-employment income), retirement accounts (i.e. pension), and welfare (e.g. social payments to unemployed or to people with special needs). However, employment is the single most important income source for most households worldwide. The elimination of this income source due to technological unemployment is posed to create huge social tension and would require the reorganisation of relationships between participants in the economic system. Furthermore, robonomics might lead to fewer social contacts, psychological problems of people who have too much free time, social unrest and political instability (Ivanov, 2017). Universal basic income (basic income guarantee) is a solution proposed by many authors to these challenges (Caputo, 2012; McDonough & Bustillos Morales, 2020; Sheahen, 2012).

Another determining characteristic of robonomics is that many decisions are taken and implemented by artificial autonomous agents, not by human beings. Autonomous agents are defined as 'software programs which respond to states and events in their environment independent from direct instruction by the user or owner of the agent, but acting on behalf and in the interest of the owner' (Bösser, 2001). In practice, there are three approaches in designing the human-technology relationship in the decision-making process: the human can be kept 'in the loop', 'on the loop', or 'off the loop'. Being 'in the loop' means that the AI recommends a decision (e.g. a new price of a product) but it is up to the human to accept it or not. The human is in full control of the decision-making process while the AI has a supporting role. In the 'on the loop' approach, the AI takes and implements a decision but the human can always interfere and override it. For example, a human can take over the communication between a chatbot and a user when necessary. In the third approach, 'off the loop', the human is effectively shielded from the decision-making process - the AI takes and implements autonomous decisions without any human intervention. While the 'in the loop' and 'on the loop' approaches show the enhancement effect of automation technologies, the 'off the loop' approach substitutes the humans in decision-making processes. For many decisions (e.g. autonomous vehicles, military drones, high-frequency trade on the financial markets by automated trading algorithms) the 'off the loop' approach is inevitable because decisions should be taken and implemented within milliseconds which goes beyond the capabilities of the human brain. In the robonomic economic system, most of the economic decisions will be based on the 'off the loop' approach. Considering that the economic decisions (e.g. buying, selling, price setting, use of resources, etc.) will be taken and implemented by autonomous intelligent agents (algorithms, robots, chatbots) rather than their human owners, these agents might need to be considered as customers (Ivanov & Webster, 2017) or employees, while the legal system might need to be adjusted to grant some rights to social robots (Gellers, 2021; Gunkel, 2018).

The robonomic economic system will not happen overnight but it will be a gradual process that will allow people, companies, and organisations to adapt to the new realities. Public authorities and international organisations started to acknowledge the benefits and challenges of the automated economy. For instance, in

2016 during the Obama administration the Executive Office of the President of the USA, National Science and Technology Council, and the Committee on Technology released three documents focusing on the preparation of the US economy for the massive introduction of artificial intelligence: *The National Artificial Intelligence Research and Development Strategic Plan* (2016), *Preparing for The Future of Artificial Intelligence* (2016) and *Artificial Intelligence, Automation, and the Economy* (2016). A year later, the Organisation for Economic Cooperation and Development published a report on the implications of automation for businesses and governments (OECD, 2017). In the same vein, the World Economic Forum addresses the future of jobs in a series of annual reports (WEF, 2020). The robonomics revolution will not be only technological but largely economic, social, political, cultural, demographic. It will require actions on various levels (global, international, national, regional, local, corporate, household) by different stakeholders (international organisations, governments, local authorities, producers of automation technologies, companies that implement automation in their operations, educational institutions, NGOs, and individuals) to smoothen the process of transformation of economies and societies.

3. Robonomics as a scientific field

Robonomics is a subfield of economic theory that analyses problems of the automated economy from the perspective of three production factors – capital, labour and automation technologies. The current economic theory considers only two production factors– capital and labour. Technology (including automation) is treated as part of the capital. Furthermore, the general implicit premise of current economic thought is that the decision-maker is a human being taking decisions alone (e.g. a buyer, a seller) or in a group (e.g. a corporate board). However, as the preceding discussion has outlined, humans have already transferred much of the decision-making process to autonomous agents which can buy and sell assets, take and implement decisions instead of humans with tangible financial outcomes for humans. Therefore, besides *labour*, the economic theory needs to incorporate artificial intelligent *autonomous agents* (AAs) as decision-making units as well. From an economic perspective, the ability of AAs to take and implement decisions independent of human supervision makes them similar to labour as a production factor. From an accounting perspective, AAs and the automation technologies they are embedded in (e.g. robots, drones, chatbots, voice-activated devices, etc.) are assets used by humans for productive activities; hence they have the characteristics of capital as well. Therefore, the economic theory has to acknowledge the decision-making role of autonomous agents and include the automation technologies they are embedded in as a production factor in addition to the traditional factors of capital and labour (see, for example, DeCanio, 2016).

There is a growing interest in the economic aspects of robots, artificial intelligence and other automation technologies (e.g. Acemoglu & Restrepo, 2019, 2020; Agrawal, Gans & Goldfarb, 2018, 2019; Autor, 2015; Autor & Salomons, 2018; DeCanio, 2016; Ivanov & Webster, 2019b), and the importance of research in this direction is only going to increase with the widespread implementation of automation technologies. As a scientific field, robonomics goes beyond the economic aspects of the automated economy and focuses on the social, cultural, demographic, political, environmental, legal, geographic, psychological and other issues raised by automation technologies as well. The list below provides a non-comprehensive overview of topics that fall within the scope of robonomics as a scientific field and some relevant publications that deal with them:

A. Core robonomics topics at *micro*-level:

- ✓ Microenvironmental, corporate, and psychological drivers of robonomics
- ✓ The economics of automation technologies (Agrawal, Gans & Goldfarb, 2018, 2019).
- ✓ Automation in a specific industry
- ✓ Attitudes towards automation, automation fears, and technological neo-Luddism (Hudson, Orviska & Hunady, 2017; Ivanov, Kuyumdzhiev & Webster, 2020; Jones, 2006).

✓ The future of work / impact of automation on labour (Autor, 2015; Autor & Salomons, 2018; Deschacht, 2021; Frank et al., 2019; Frey & Osborne, 2017; Jesuthasan & Boudreau, 2018; Kaplan, 2015; Webster & Ivanov, 2020; West, 2018).

✓ Zero-employee companies

✓ Automated factories / smart manufacturing (Soroush, Baldea & Edgar, 2020; Wang et al., 2016).

✓ Autonomous farming (Verdouw, Tekinerdogan, Beulens & Wolfert, 2021; Zhou & Zhang, 2019)

✓ Autonomous transportation (Acheampong, Cugurullo, Gueriau & Dusparic, 2021; Cunningham, Regan, Ledger & Bennett, 2019; Maurer et al., 2016)

✓ Smart cities (Coletta, Evans, Heaphy & Kitchin, 2019)

✓ Corporate competitiveness in an automated economic system

✓ Robonomics, health, well-being, and quality of life

✓ Automated decision-making in organisations, companies and government administration

✓ Automated management and decision-making

✓ Automated marketing management

✓ Automated operations management

✓ Automated financial management

✓ Automated human resource management

✓ Human-robot/AI interaction/collaboration (Kanda & Ishiguro, 2016)

✓ Robots as service providers/employees

✓ Robots as customers (Ivanov & Webster, 2017)

✓ Sex robots / companion robots / social robots (Lee, 2017; Nørskov, 2016; Royakkers, & van Est, 2016)

✓ Developing robot-friendly (robot-inclusive) architecture and infrastructure

✓ Willingness-to-pay for automated services

B. Core robonomics topics at *macro*-level:

✓ Characteristics of robonomics as an economic system (Ivanov, 2017)

✓ Macroenvironmental drivers of robonomics (Webster, 2021)

✓ Social, political, environmental, legal aspects of automation technologies

✓ Ethical issues of robonomics – AI/robot ethics (Bartneck, Lütge, Wagner, & Welsh, 2021; Coeckelbergh, 2020; Leben, 2019; Lin, Abney & Bekey, 2014).

✓ Social aspects and impacts of robonomics (Hudson, 2019).

✓ Political aspects of robonomics

✓ The political economy of automation (Frey, 2019; Kiggins, 2018)

✓ Environmental and sustainability aspects of robonomics

✓ Legal issues in robonomics – AI/robot-related legislation (Calo, Froomkin & Kerr, 2016; Turner, 2019; Wischmeyer & Rademacher, 2020), robot rights and liabilities (Čerka, Grigienė & Sirbikytė, 2015; Gellers, 2021; Gunkel, 2018), birthright patents, taxation of automation technologies.

✓ Macroeconomic policies in an automated economy

✓ International trade in robonomics

✓ Governance in robonomics (Bloom, 2020)

✓ Technological unemployment (Feldmann, 2013; Kim, Kim & Lee, 2017; Kim & Scheller-Wolf, 2019).

✓ Societal benefits and challenges of robonomics (Ivanov, 2017)

✓ Solutions to the societal challenges of robonomics (Hudson, 2019; LaGrandeur & Hughes, 2017; Susskind, 2020).

✓ The technological singularity (Callaghan, Miller, Yampolskiy & Armstrong, 2017; Kurzweil, 2005; Shanahan, 2015; Vinge,1993)

✓ Universal basic income (Caputo, 2012; McDonough & Bustillos Morales, 2020; Sheahen, 2012)

✓ Transhumanism (Kurzweil, 2005; Lee, 2019; MacFarlane, 2020; Manzocco, 2019)

✓ Robonomics, education and life-long learning

- ✓ Media and communications in robonomics
- ✓ Education in a robonomic society
- ✓ Tourism, hospitality, leisure and recreation in a robonomic society

4. ROBONOMICS: The Journal of the Automated Economy

While the problems of robonomics have been addressed in many journals, there is a need for a journal that focuses specifically on them. *ROBONOMICS: The Journal of the Automated Economy* answers to that need. The journal addresses the economic, social, political, legal, ethical, technological, and environmental aspects of the automated economic system and aims to develop the theoretical foundations of robonomics. The journal adopts a social science perspective to the issues of robonomics. The engineering aspects of automation technologies fall within the scope of the journal as long as they are discussed from a social science perspective. *ROBONOMICS: The Journal of the Automated Economy* is a true open-access journal – there are no publication fees for authors, and there are no subscription fees for readers. The journal is open to all researchers. There are no preferences towards the methodology (qualitative/quantitative) as long as it is relevant to the particular study and helps the authors achieve their research aim and objectives.

This inaugural issue consists of five publications – this editorial, two articles, one research note and one viewpoint that discuss various issues of the automated economy: the digital revolution and its impact on the labour economics of automation (Deschacht, 2021), demography as a driver of robonomics (Webster, 2021), the use of robots to reduce risks to essential workers (Esterwood & Robert, 2021), AI and the dark side of management (Wagner, 2021). It is the first small step that starts the long journey.

ROBONOMICS has awakened!

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Received: 01/03/2021
Revised: 11/03/2021
Accepted: 12/03/2021

Appendix 1. *Exemplar AI generated text*

Keywords: Robonomics, Robots, Artificial Intelligence, Economics, Jobs
Software: http://ai-writer.com/

Advances in artificial intelligence and robotics will produce "robo-nomics" (in economic jargon, machines are better substitutes for humans) and increasing labor-market elasticity. The three laws of robotics provide a guide to how we think about how robotization will affect workers and the economy, and how this should affect policy. As technology lowers production costs, putting pressure on wages, the cost of robots and machines to replace humans will also fall. [Sources: 1]

Advances in artificial intelligence and robotics will produce "robo-nomics" (in economic jargon, machines are better substitutes for humans) and an increasingly flexible labor market. As technology lowers production costs, squeezing wages, so will the cost of robots and machines that replace humans. Income will increasingly come from the labor market, not only from wages and benefits, but also from capital gains and dividends. [Sources: 1]

It will increasingly come from the labor market, not only from wages and benefits, but also from capital gains and dividends. This is the first part of a three-part series examining the impact of robots, automation, and employment, based on a survey of more than 1,000 US workers and their families. Robots replace workers in many industries, from manufacturing to retail and healthcare to manufacturing and manufacturing. [Sources: 1, 4]

Some technologists predict that automation will lead to a future without work, while others are more skeptical of such scenarios. [Sources: 4]

But a study co-authored by an MIT professor shows that companies "numbers are trending, lagging far behind a robotic takeover. To date, economists and technologists have dominated the debate about the impact of automation on jobs in the US economy and the world as a whole. [Sources: 0, 4]

The arguments of both groups imply the belief that technology shapes social and economic outcomes, and therefore defines progress, and that these outcomes are inevitable and universal. The former disagree about whether technological progress will disrupt the economy; the latter largely agree that such a disruption is imminent; they differ only in the extent to which it is likely to cause significant economic disruption. [Sources: 0]

It should be noted that RPA technology will take on repetitive tasks and will even be involved in risky processes in people's lives. The work of scientists on technology has examined the fact that technology ultimately has an inalienable right to work that people do not share. [Sources: 0, 5]

Intelligent automation is the next milestone that is worthwhile due to its increased versatility and ability to transform business processes and people's lives. [Sources: 5]

Robots will work with artificial intelligence to develop various solutions to further simplify the workflow of organizations. After the introduction of software robots in the company, an interdisciplinary research area called "Robonomics" has developed, which deals with the use of advanced technologies that use AI, whether they are used for human-machine interaction or for the development of new types of robots. This will enable the automation of increasingly complex processes and, together with artificial intelligence (AI) and machine learning, will bring about significant changes in business processes. [Sources: 5]

The adoption of advanced digital technologies has enabled RPA to redistribute the repetitive and error-prone routines it has used to create value in business processes, and its conception has recently been extended to the use of artificial intelligence and machine learning in the development of new types of robots. [Sources: 5]

Artificial intelligence is what we imagine when we read science fiction books of the last century. The authors claim that robotics is the key to the future of human civilization and the creation of a new world order. [Sources: 2, 5]

We have already published on Bitnewstoday material on the impact of artificial intelligence (AI) and robotics on the future of jobs in the United States. The real application of AI in human-machine interaction is still a long way off, but robotics and AI will inevitably overlap. [Sources: 2]

Let us see how this combination of the latest technologies can affect the economy as a whole and how it will affect jobs in the United States. [Sources: 2]

The rise of robots will have a positive impact on productivity and economic growth, and will lead to the creation of new jobs. But tens of millions of jobs could be lost, and the poor local economy would depend on a less skilled workforce. This increase poses challenges for governments and policymakers, as it will affect the economy, jobs, and society. [Sources: 3]

On the technology side, the range of skills robots can perform in competition with humans is expanding from physical tasks to routines. Computer scientists develop algorithms that enable machines to learn independently. The robotics revolution is accelerating, and technological advances are changing what robots can do and what human tasks they can perform in a wide range of industries, from agriculture to manufacturing to healthcare. [Sources: 1, 3]

The coming driverless revolution will reflect parallel changes in other sectors that affect our lives. I predict that tomorrow's scientists will have a much greater impact on the economy than legions of virtual doctoral students did in the 1970 "s and 1980" s. [Sources: 1]

Sources:

[0]: https://delange.rice.edu/conference_X/speakerabstracts.html
[1]: https://harvardmagazine.com/2016/05/who-owns-the-robots-rules-the-world
[2]: https://bitnewstoday.com/news/robototechnics-ai-and-blockchain-together-they-can-more/
[3]: https://rsci.app.link/nhGDh8t00bb?_p=c1103fdc9a0765eee31e8be3ebb2
[4]: https://news.mit.edu/2020/how-many-jobs-robots-replace-0504
[5]: https://content.sciendo.com/view/journals/emj/12/2/article-p21.xml?language=en