ECONOMIC, SOCIAL AND PUBLIC POLICY OPPORTUNITIES ENABLED BY AUTOMATION

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The rise of artificial intelligence & robotics is expected to create a wealth of opportunities to sustain growth and development over the next decades. It could trigger a wave of productivity gains and fuel revolutions in healthcare, transportation, education, security, justice, agriculture, retail, commerce, finance, insurance, banking and more.

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- HEALTH MONITORING

INTRODUCTION

According to a majority of experts, the potential benefits of the rise of artificial intelligence & robotics are of the same magnitude as the three preceding industrial revolutions. The expected wave of productivity gains triggered by automation has the potential to sustain growth and development over the next decades, counterbalancing the decreasing working-age population. How? By making decision-making processes and resource management of complex systems much more efficient through the systematic mining of the growing stocks and flows of data. By commoditizing expertise and prediction, the rise of AI could also radically enhance quality of life for all, through revolutions in healthcare, transportation, education, security, justice, agriculture, retail, commerce, finance, insurance and banking, as well as other domains. The benefits that can be reaped need to be better understood, supported, and governed.

A. EFFICIENCY OF PUBLIC AND PRIVATE MANAGEMENT

PLANNING, ALLOCATION AND MONITORING OF RESOURCES

The rise of AI and robotics could first and foremost translate into a revolution in the efficiency of decision-making processes for all actors, both public and private. This, in turn, could give rise to new forms of public-private partnerships. The ability of advanced machine-learning algorithms to mine the growing stocks and flows of data related to the planning and operations of complex systems at the micro or macro levels is likely to trigger a wave of optimization across domains – energy, agriculture, finance, transportation, healthcare, construction, defense, retail and many more – and production factors, including the weather, labor, capital, innovation, information and, of course, the environment.

AI can be essentially analyzed as a "prediction technology,"[1] the diffusion of which could drastically bring down the cost of processing historical data and therefore of making prediction for a wide array of crucial tasks such as risk profiling, inventory management, and demand forecasting. Such a cost decrease would in turn favor reliance on prediction for a growing number of tasks and activities, including and not limited to banking and insurance, preventative health care for patients, predictive maintenance for all types of equipment and complex infrastructure, and crop efficiency through the analysis of satellite or drone imagery.

The optimization potential in terms of resource consumption in complex dynamics is highly significant. Consider the case of energy and its associated carbon emissions. Google DeepMind has already demonstrated how its advanced machine-learning algorithms can be used to reduce energy consumption in data centers. Concluding a two-year experiment cross-analyzing over 120 parameters in a Google data center, DeepMind's artificial neural network worked out the most efficient and adaptive method of cooling and overall power usage. The outcome of the experiment went far beyond traditional formula-based engineering and human intuition. DeepMind claims that this method resulted in a net fifteen percent reduction in overall power consumption, potentially translating into hundreds of millions of dollars worth of savings per year.[2] And the company qualified this as a "phenomenal step forward" given how sophisticated its data centers already are in the field of energy consumption optimization. DeepMind claims that "possible applications of this technology include improving power plant conversion efficiency [...], reducing semiconductor manufacturing energy and water usage, or helping manufacturing facilities in general increase throughput.[3]

Similar predictive approaches are already applied to banking,[4] for product recommendations, advisory services and risk profiling, trading,[5] transportation, traffic management and logistics, healthcare, and meteorology. Firms like Ocado and Amazon are already relying on AI to optimize their storage and distribution networks, planning the most efficient routes for delivery, and making best use of their warehousing capacity. In healthcare, data from smart phones and fitness trackers can be analyzed to improve management of chronic conditions – including mental illnesses – as well as predicting and preventing acute episodes.

1 Ajay Agrawal, Joshua Gans, and Avi Goldfarb, "The Simple Economics of Machine Intelligence", Harvard Business Review, November 2016. https://hbr.org/2016/11/the-simple-economics-of-machine-intelligence

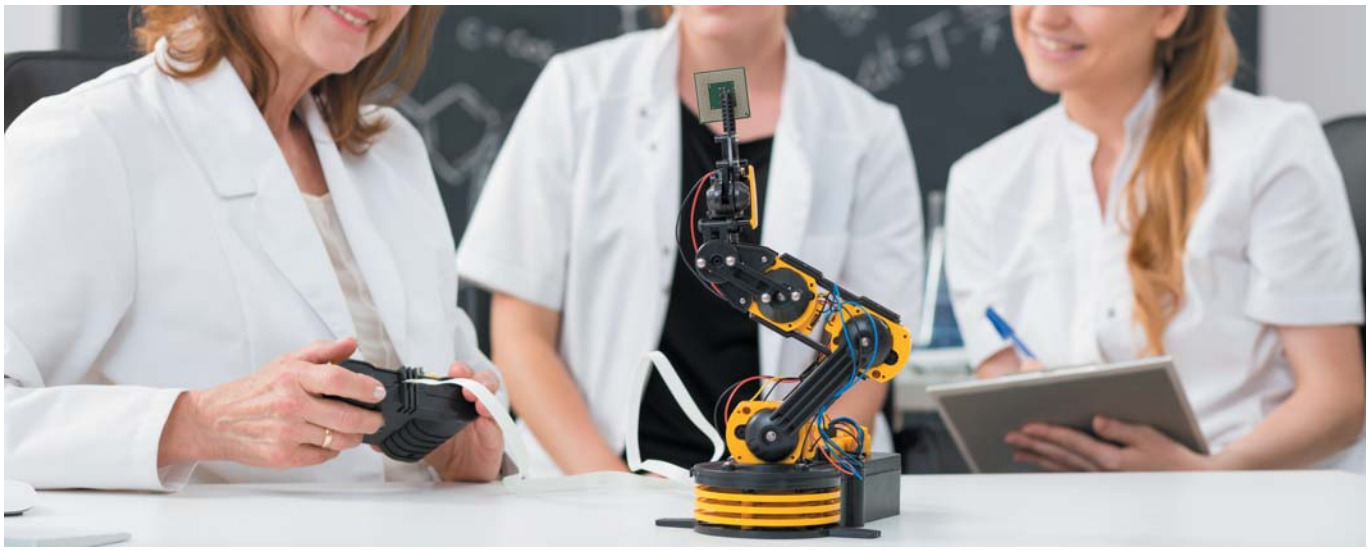
2 Considering that Google used over 4 million MWh of electricity in 2014 (equivalent to the amount of energy consumed by 366,903 US households), this 15 percent will translate into savings of hundreds of millions of dollars over the years. https://deepmind.com/blog/deepmind-ai-reduces-google-data-centre-cooling-bill-40/

3 For instance the industrial robotics company Fanuc has teamed up with Cisco to develop a platform to reduce factory downtime—estimated at one major automotive manufacturer to cost US$20,000 per minute. Based on machine learning, Fanuc Intelligent Edge Link and Drive (FIELD) captures and analyzes data from the manufacturing process to improve efficiency. Tantzen, B., "Connected Machines: Reducing Unplanned Downtime and Improving Service," October 6, 2015; and *FANUC*, "Manufacturing Automation Leaders Collaborate: Optimizing Industrial Production Through Analytics," April 18, 2016.

4 https://thefinancialbrand.com/63322/artificial-intelligence-ai-banking-big-data-analytics/

5 https://www.wired.com/2016/01/the-rise-of-the-artificially-intelligent-hedge-fund/

"AI CAN BE ESSENTIALLY ANALYZED AS A PREDICTION TECHNOLOGY, THE DIFFUSION OF WHICH COULD DRASTICALLY BRING DOWN THE COST OF PROCESSING HISTORICAL DATA AND THEREFORE OF MAKING PREDICTION FOR A WIDE ARRAY OF CRUCIAL TASKS SUCH AS RISK PROFILING, INVENTORY MANAGEMENT, AND DEMAND FORECASTING."



IBM Watson is researching the development of automated speech analysis tools running on mobile device to predict the onset of neurological (Huntington's, Alzheimer's, Parkinson's, etc.) and mental (depression or psychosis) diseases for earlier intervention and better treatment planning.[6] The field of "affective computing" aims more broadly at enabling computers to understand and simulate emotions.

DETECTING CRIMINAL AND FRAUDULENT BEHAVIORS

Machine-learning has also started to be used to detect early criminal and fraudulent behaviors, and to ensure compliance in innovative ways. One of the first uses of AI in banking was precisely for fraud detection through a continuous monitoring review of accounts activity patterns, with aberrations being flagged for review. With advances in machine-learning, we are now moving towards near real-time monitoring.

Last year, the banking multinational Credit Suisse Group AG launched an AI joint venture with Silicon Valley firm Palantir Technologies, whose solutions are widely used for surveillance and security, to detect unauthorized trading.[7] Credit Suisse started working with Palantir in 2011 after it suffered a $2.3 billion loss on unauthorized trading by Kweku Adoboli. The Zurich-based bank declared its objective is to adapt Palantir AI systems to monitor all employee behavior, so that it can catch breaches of conduct rules. Eventually, it aims to offer this service to other banks.

Besides trading, AI technologies are increasingly being used in the fight against terrorism, and for policing. The U.S. Intelligence Advanced Research Projects Activity is working on a host of programs relying on AI to enhance face recognition for identification[8] based on contextual information –spatial and temporal; or even to automatically detect and geo-localize untagged suspicious videos published online.[9]

Finally, the impact of fake news campaigns on recent elections has prompted Facebook to start working on using AI to help analyze the veracity of the trillions of posts made on the social network.[10] Facebook has started to rely on AI to detect words or patterns of words that might indicate fake news stories.[11]

B. A NEW WAVE OF PRODUCTIVITY GAINS AND GROWTH

Like other great technological revolutions in the past,[12] the largest set of opportunities created by the march of AI technologies results in their ability to trigger a new wave of productivity gains across domains. In this technological revolution, the lynchpins will be machine autonomy and automation[13]. The impacts will be

6 https://www.ibm.com/blogs/research/2017/01/ibm-5-in-5-our-words-will-be-the-windows-to-our-mental-health/

7 https://www.bloomberg.com/news/articles/2016-03-22/credit-suisse-cia-funded-palantir-build-joint-compliance-firm

8 https://www.iarpa.gov/index.php/research-programs/janus

9 https://www.iarpa.gov/index.php/research-programs/aladdin-video

10 http://www.forbes.com/sites/jasonbloomberg/2017/01/08/fake-news-big-data-and-artificial-intelligence-to-the-rescue/#db541e07a214

11 Peter Kafka, "Facebook has started to flag fake news stories", *Recode*, March 2017. https://www.recode.net/2017/3/4/14816254/facebook-fake-news-disputed-trump-snopes-politifact-seattle-tribune

12 Elizabeth Eisenstein, *The printing press as an agent of change*, Cambridge University Press, 1980; Robert Hoe, *A short history of the printing press and of the improvements in printing machinery from the time of Gutenberg up to the present day*, 1902. *And Growth and renewal in the United States: Retooling America's economic engine*, McKinsey Global Institute, February 2011.

13 "*Autonomy refers to the ability of a system to operate and adapt to changing circumstances with reduced or without human control. For example, an autonomous car could drive itself to its destination. Despite the focus in much of the literature on cars and aircraft, autonomy is a much broader concept that includes scenarios such as automated financial trading and automated content curation systems. Autonomy also includes systems that can diagnose and repair faults in their own operation, such as identifying and fixing security vulnerabilities.*
Automation occurs when a machine does work that might previously have been done by a person. The term relates to both physical work and mental or cognitive work that might be replaced by AI. Automation, and its impact on employment, have been significant social and economic phenomena since at least the Industrial Revolution". See Report on "Preparing for the Future of AI", Executive Office of the President, NSTC, October 2016 (page 10).

seen on factory shop-floors, service centers, and offices, through the automation of an increasing number of complex cognitive and physical tasks. The rise of AI also means new and more economically efficient forms of collaboration and complementarity between humans and machines. AI can be seen as potentially a new factor of production, enhancing the efficiency of the traditional factors of labor and capital, and creating a hybrid that is capable of creating entirely new workforces. In many cases, AI will be capable of outperforming humans in terms of scale and speed, and it will be capable of self-improvement.

Artificial intelligence can automatize and prioritize routine administrative and operational tasks by training conversational robot software ('bots'), which can then plan and manage interactions. Google's Smart Reply software can already draft messages to respondents based on previous responses to similar messages.[14] Newsrooms are increasingly using machine learning to produce reports and to draft articles.[15] Similar technology can produce financial reports and executive briefings. Robots using lasers, 3D depth-sensors, advanced computer vision, and deep neural networks, can navigate safely and work alongside warehouse and factory workers.

Artificial Intelligence can also generate significant productivity gains by drastically reducing the cost of searching large sets of data manually. This is particularly useful for the legal sector, for instance, where companies like *ROSS*, *Lex Machina, H5* and *CaseText* already rely on machine learning for natural language processing, combing through legal documents for case-relevant information. Thousands of legal documents can now be reviewed in a matter of days, as opposed to the traditional method which might take months[16]. In another vein, natural language processing can offer a way of interacting effectively with specialized domain-specific datasets, answering factual questions like IBM Watson Virtual Agent claims it can do[17].

Productivity gains will not reside solely in the replacement of humans with machines, but also through the advent of new forms of collaboration between humans and machines harnessing the complementarity of biological intelligence with digital intelligence. It is sometimes referred to as "intelligence augmentation." Such novel forms of human-machine teaming are likely to open up a wealth of opportunities for creativity and innovation, translating into higher productivity. One notable example concerns the use of radiology to detect breast cancer, where deep-learning algorithms combined with human pathologists' inputs lowered the error rate to 0.5 per-cent, representing a 85 per-cent reduction in error rates achieved by human pathologists alone (3.5 per-cent) or machines alone (7.5 per-cent)[18].

In terms of economic impact, Accenture published a report in 2016 analyzing twelve developed economies, and claimed that AI has the potential to double their annual growth rates, and increase the productivity of labor by up to 40 per-cent by 2035.[19] In January 2017, the McKinsey Global Institute published its own report on the future of automation. Their definitional boundaries differ from that of Accenture's report, and include robotics. Whilst McKinsey's estimate of automation's pace and consequences[20] is more modest, it still offers a very positive vision: automation could raise global productivity by as much as 0.8-1.4 per-cent annually.

Economists had been preoccupied with falling productivity growth rate[21] in recent decades. Attributed to a deficit in innovation, declining working-age population, flagging education attainment and wealth inequality, this productivity growth slowdown has had serious consequences, contributing to slower growth in real wages, and increasing long-run fiscal challenges.[22] According to the McKinsey Global Institute, the expected impact of automation technologies has the potential to match the imperative of high productivity growth needed globally to balance declining birthrates and aging, thereby enabling continued GDP growth.[23] That said, countries will react and absorb the automation wave unequally depending on demography, wage levels, productivity and socio-political appetite for growth and inequality. In principle, advanced economies that have been aging would absorb the impacts of automation more easily and rapidly than emerging economies with an aging workforce.[24]

14 https://www.blog.google/products/gmail/smart-reply-comes-to-inbox-by-gmail-on-the-web/

15 https://www.theguardian.com/media/2016/apr/03/artificla-intelligence-robot-reporter-pulitzer-prize

16 ABA Journal, "How artificial intelligence is transforming the legal profession", April 1, 2016.

17 https://www.ibm.com/watson/whitepaper/solutions-guide/

18 Dayong Wang, Aditya Khosla, Rishab Gargeya, Humayun Irshad, Andrew H. Beck, "Deep Learning for Identifying Metastatic Breast Cancer," June 18, 2016, https://arxiv.org/pdf/1606.05718v1.pdf

19 Mark Purdy and Paul Daugherty, *Why Artificial Intelligence if the future of growth*, Accenture, October 2016. www.accenture.com/futureofAI

20 James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst, *Harnessing Automation for a Future that Works*, McKinsey Global Institute, January 2017. http://www.mckinsey.com/global-themes/digital-disruption/harnessing-automation-for-a-future-that-works

21 Measured productivity growth has slowed in 30 of the 31 advanced economies, slowing from a 2 percent average annual growth rate from 1994 to 2004 to a 1 percent average annual growth rate from 2004 to 2014.
Jason Furman, "Is this time different? The opportunities and challenges of artificial intelligence," remarks at AI Now: The Social and Economic Implications of Artificial Intelligence Technologies in the Near conference in New York, July 7, 2016

22 James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst, *Harnessing Automation for a Future that Works*, McKinsey Global Institute, January 2017 (p. 95-103).

23 *Research from the McKinsey Global Institute has shown that even if global productivity growth maintains its 1.8 percent annual rate of the past half century, the rate of GDP growth will fall by as much as 40 percent over the next 50 years. On a per capita basis, the GDP growth decline is about 19 percent. In order to compensate for slower employment growth, productivity would need to grow at a rate of 3.3 percent annually, or 80 percent faster than it has grown over the past half century.*
Global growth: Can productivity save the day in an aging world? McKinsey Global Institute, January 2015.

24 James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst, *Harnessing Automation for a Future that Works*, McKinsey Global Institute, January 2017 (p. 95-103).