The Evolution of Artificial Intelligence Effects on Invention & Innovation

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Abstract: Significant social changes are being brought about by the challenges posed by sustainability and the digital revolution, which is placing a great deal of pressure on competitiveness. Artificial intelligence (AI) is a multidisciplinary field that tries to automate jobs that currently need human intelligence. Though little known, artificial intelligence (AI) is a technology that is revolutionizing every aspect of life. This paper addresses the following topics, the evolution of artificial intelligence, the financial consequences of new research instruments, the relationship between new invention approaches and universality of invention and how it affects innovation.

Keywords: AI, Research Tools, Robotics

1. Introduction

Artificial intelligence aims to make computers function more like humans in a fraction of the time it takes a human to do so. The objective of artificial intelligence is the development of computer science in practical applications. The rapid advancement of AI will have a significant impact on business and society as a whole. These advancements have the potential to directly affect the production and characteristics of a wide range of goods and services, with substantial implications for productivity, employment, and competition. Artificial intelligence has the ability to change the innovation process itself, with ramifications that could be equally as big as or greater than the direct effects, even though these effects are probably going to be substantial. While deep learning promises changes in the nature of innovation within these sectors as well as productivity gains across a wide range of industries, some applications of artificial intelligence will surely serve as higher-quality or more affordable inputs into many current production processes, raising concerns about the possibility of significant job displacement. It is noted that by enabling innovation across multiple applications, the "invention of an invention method" has the potential to have a significantly higher economic influence than the production of any single new product. Here, we argue that because recent advances in machine learning and neural networks have the potential to improve both the nature of the innovation process and the performance of end-use technologies, they will likely have a disproportionately large impact on innovation and growth. Therefore, one of the main concerns for policy is to understand the conditions under which different prospective innovators might obtain these tools and employ them in a way that promotes competition. These elements consist of the potential development-shaping incentives and impediments.

2. Impact of New Research Tools

The likelihood of a large underinvestment in research, particularly in basic research or fields of invention with low inventor appropriability, is known to economists. Both in terms of the overall strength of those incentives and the direction that research is taking, there has been a great deal of progress made in understanding the situations in which the incentives for innovation may be marginally or dramatically distorted. When we think about the possible impacts of AI developments on innovation, two ideas come to mind as being especially important: the possibility of contracting problems associated with the development of a new, widely applicable research instrument and the possibility of coordination problems associated with the adoption and spread of a new "general purpose technology." Compared to the relatively narrow areas of industrial robotics and classical automation, we argue that the fastest-growing fields of artificial intelligence, such as deep learning, are likely to pose major problems in both dimensions. Initially, consider the challenge of providing appropriate incentives for innovation when a particular innovation can impact numerous applications in terms of technological and organizational transformation. These "general purpose technologies" are oftentimes foundational breakthroughs with the potential to significantly increase quality or production across a wide range of fields or sectors. According to David's groundbreaking research on the electric motor, industries as varied as manufacturing, agriculture, retail, and residential building all experienced significant technological and organisational change as a result of this invention. Such "GPTs" are typically understood to satisfy three requirements that set them apart from other innovations: they have widespread application across many sectors; they encourage additional innovation in those sectors; and they are themselves improving quickly. A general-purpose technology creates both vertical and horizontal externalities in the innovation process, according to Bresnahan and Trajtenberg. These externalities can lead to underinvestment and distortions in the direction of investment depending on the disparities in performance between private and social returns in different application industries. A lack of incentives in one sector can, in example, result in an indirect externality that lowers inventive investment overall in the system if there are "innovation complementarities" between general purpose technology and each of the application sectors. The private incentives for innovative investment in each application sector are determined by the market structure and conditions for appropriability however innovation in one sector drives innovation within the GPT, which in turn drives demand (and more innovation) in downstream application sectors. The original industry is rarely able to claim these profits. Consequently, there will probably be a significant drop in innovation investment if there is a lack of coordination between application sectors, within application sectors, and between the GPT and application sectors. Despite these challenges, a reinforcing cycle of innovation between the GPT and a wide range of application industries can result in a more systemic change of the as innovation rates rise across all sectors. For thinking about AI, a second conceptual framework is the economics of study tools. Some research advances simply boost productivity "in the lab" or inspire new avenues of inquiry. Several of these innovations appear to hold great potential in a variety of domains, outside of their initial use: As Griliches emphasized in his seminal studies of hybrid maize, certain new research tools are innovations that do not merely develop or better a specific product, but rather they represent a new means of producing new products, with far wider application. Advances in machine learning and neural networks appear to hold great potential as research instruments for problems related to classification and prediction. These are important limiting issues in many research endeavors, and as the Atomwise example shows, applicability The application of "learning" methodologies to AI holds forth the possibility of significantly reduced costs and enhanced performance in R&D endeavors when these are significant obstacles. Many research tools serve primarily to reduce the cost or raise the caliber of an innovation process that has already been developed; they are neither IMIs nor GPTs. For example, novel materials in the pharmaceutical industry assert to improve the efficacy of specific research techniques. Although they can be thought of as IMIs, other research tools nevertheless have a rather limited range of applications.

3. Artificial Intelligence in the field of Robotics

In his comprehensive historical history of AI research, Nilsson defines AI as "that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment". He explains how advances in AI have come from a variety of fields, including but not limited to mathematics, philosophy, logic, engineering, computer science, biology, languages, psychology, and cognitive sciences. Regardless of their specific techniques, Turing and his discussion of the possibilities of mechanizing intelligence has unquestionably been a major point of engagement for artificial intelligence study since its inception. Despite being frequently combined, robotics, neural networks, and symbolic systems are three linked but distinct fields that are helpfully distinguished from one another in the conceptual history of artificial intelligence as a scientific and technological field. Under the general title of symbolic systems, perhaps the most fruitful research path in the early years of artificial intelligence (AI) dates back to the 1960s. Generally speaking, a second significant trend in AI has focused on robotics. The field of robotics didn't really take off until the 1980s, despite the notion of "robots" as machines that can perform human functions existing at least since the 1940s. This was caused by improvements in machine tools that are mathematically controlled as well as the development of robotics that is more adaptive but still dependent on rules and requires active sensing of a known environment. This field of AI may have seen its most economically significant application to date with the increasing usage of "industrial robots" in manufacturing. These gadgets have been meticulously designed to carry out a certain task in a strictly controlled environment. It could be more accurate to refer to these specially designed instruments as very sophisticated numerically controlled machines rather than as robots with significant artificial intelligence (AI) content. They are often housed in "cages" within extremely specialized industrial processes, most notably the manufacturing of automobiles. Over the past 20 years, robotics innovation has greatly benefitted manufacturing and automation, especially with the creation of more responsive robots that rely on pre programmed response algorithms that can react to a range of inputs. Rod Brooks (1990) was a notable pioneer of this method, which changed AI's commercial and innovative emphasis from modeling intelligence similar to human intelligence to providing feedback mechanisms that would enable effective robotics for specific applications. Applications of this understanding included the Roomba and other flexible industrial robots that could speak with humans, such as Baxter from Rethink Robotics. Continued advancements in robotics technologies, particularly in the ability of robotic devices to perceive and interact with their surroundings, may lead to a wider applicability and adoption outside industrial automation. These advancements are noteworthy, and the most advanced robots continue to draw attention anytime the term artificial intelligence is spoken. But generally speaking, advances in robotics are not IMIs. Automation of lab apparatus boosts research productivity, but these robotics advancements are not (yet) inextricably connected to the manner in which researchers can devise strategies for pursuing innovation across a range of fields. Of course, there are counterexamples to this assertion. For instance, automated remote sensing devices have the potential to revolutionize some fields of study and have been an essential research tool in planetary science due to their ability to acquire data in challenging situations or at extremely large sizes. However, specialized end-use "production" applications continue to be the main purpose for robots. Lastly, a third field of research that has been essential to AI from the beginning is commonly known as a "learning" technique. Rather than focusing on exact sense-and-react systems or symbolic logic, the learning approach aims to develop reliable and accurate methods for the prediction of certain occurrences (physical or logical) in the presence of specified inputs. The concept of a neural network has been particularly important in this context. A neural network is a computer software that uses a combination of weights and thresholds to convert a set of inputs into a set of outputs. It then assesses how "close" these outputs are to reality and adjusts the weights used to narrow the difference. Neural networks were formerly seen as having enormous promise, but they have since fallen out of favor particularly in the US. Their problem seems to be that the technology from the 1980s to the mid-2000s had severe constraints that were not simply fixed by adding more layers of "neurons" or utilizing larger training datasets. Nonetheless, in the mid-2000s, a handful of innovative algorithmic methods demonstrated potential for enhancing prediction via back propagation across several layers. These neural networks could expand to any size and gained predictive power as they were used on ever-larger datasets.

4. Effects of Artificial Intelligence on Innovation

Given that these three streams of AI differ greatly in their potential to be either GPTs or IMIs or both differentiating between them is an essential first step in gaining a clearer understanding of how AI is likely to impact the innovation process in the future. First, while superhuman performance across a broad range of human cognitive abilities is a major topic of public discourse when discussing artificial intelligence (AI), it's important to remember that, at least thus far, the major advancements in AI have not come from the "general problem solver" approaches that formed the foundation of early work in symbolic systems. Actually, the majority of recent advances in deep learning and robotics are related to rather narrow problem domains that necessitate a significant degree of human planning. (For instance, playing Go, recognizing faces, picking up specific objects, etc.) While it is certainly possible that in the future, technology will be able to replicate human subjective intelligence and emotion, the most recent advancements that have attracted the interest of scientists and industry are completely unrelated to these domains. Secondly, it is imperative to highlight that there is a notable distinction between the prospective uses of deep learning that have gained prominence recently and the developments in robotics that were the main focus of AI research applications in the 2000s. While most analyses of AI's economic and policy implications focus on the effects of the past 20 years of automation, they also take into account the potential economic effects of AI in the future (such as the displacement of jobs for an ever-increasing number of tasks). The bulk of recent developments in robotics are related to extremely specialized applications that are more focused on end-user requirements than the innovation process itself, and it does not yet appear that these developments have produced an IMI that is more widely applicable. Therefore, in the context of robotics, we might focus on the effects of innovation (better performance) and diffusion (wider application) in terms of job displacement versus work enhancement. There is currently no indication of widespread robotics applications outside of industrial automation, likely due to the need for considerable breakthroughs in the ability to sense, respond to, and manage the physical world. Certain research instruments and algorithm-based IMIs have altered the way certain fields of study are carried out, notwithstanding their limitations. These static collection of programming instructions-based algorithmic research tools are helpful IMIs, but they don't seem to be broadly applicable outside of a specific field, which means they don't fit the requirements for GPTs. For example, advanced algorithms to scan brain images (called functional magnetic resonance imaging) have transformed our understanding of the human brain, despite their inherent flaws. This is because of the knowledge they have generated in addition to creating an entirely new paradigm and technique for brain research.

5. Future Impact of AI

- **Improved Business Automation:** About 55 percent of organizations have adopted AI to varying degrees, suggesting increased automation for many businesses in the near future. With the rise of chat bots and digital assistants, companies can rely on AI to handle simple conversations with customers and answer basic queries from employees. AI's ability to analyze massive amounts of data and convert its findings into convenient visual formats can also accelerate the decision-making process. Company leaders don't have to spend time parsing through the data themselves, instead using instant insights to make informed decisions.
- **Job Disruption:** Business automation has naturally led to fears over job losses. In fact, employees believe almost one-third of their tasks could be performed by AI. Although AI has made gains in the workplace, it's had an unequal impact on different industries and professions. For example, manual jobs like secretaries are at risk of being automated, but the demand for other jobs like machine learning specialists and information security analysts has risen. Workers in more skilled or creative positions are more likely to have their jobs augmented by AI, rather than be replaced. Whether forcing employees to learn new tools or taking over their roles, AI is set to spur up-skilling efforts at both the individual and company level.
- **Data Privacy Issues:** Companies require large volumes of data to train the models that power generative AI tools, and this process has come under intense scrutiny. Concerns over companies collecting consumers' personal data have led the FTC to open an investigation into whether Open AI has negatively impacted consumers through its data collection methods after the company potentially violated European data protection laws. In response, the Biden-Harris administration developed an AI Bill of Rights that lists data privacy as one of its core principles. Although this legislation doesn't carry much legal weight, it reflects the growing push to prioritize data privacy and compel AI companies to be more transparent and cautious about how they compile training data.
- Increased Regulation: AI could shift the perspective on certain legal questions, depending on how generative AI lawsuits unfold in 2024. For example, the issue of intellectual property has come to the forefront in light of copyright law suits filed against Open AI by writers, musicians and companies like The New York Times. These lawsuits affect how the U.S. legal system interprets what is private and public property and a loss could spell major setbacks for Open AI and its competitors. Ethical issues that have surfaced in connection to generative AI have placed more pressure on the U.S. government to take a stronger stance. The Biden-Harris administration has maintained its moderate position with its latest executive order, creating rough guidelines around data privacy, civil

liberties, responsible AI and other aspects of AI. However, the government could lean toward stricter regulations, depending on changes in the political climate.

- **Climate Change Concerns:** On a far grander scale, AI is poised to have a major effect on sustainability, climate change and environmental issues. Optimists can view AI as a way to make supply chains more efficient, carrying out predictive maintenance and other procedures to reduce carbon emissions. At the same time, AI could be seen as a key culprit in climate change. The energy and resources required to create and maintain AI models could raise carbon emissions by as much as 80 percent, dealing a devastating blow to any sustainability efforts within tech. Even if AI is applied to climate-conscious technology, the costs of building and training models could leave society in a worse environmental situation than before.
- **Accelerated Speed of Innovation:** AI technology could speed up research in the biological sciences as much as tenfold, bringing about a phenomenon he coins "the compressed 21st century," in which 50 to 100 years of innovation might happen in the span of five to 10 years. This theory builds on the idea that truly revolutionary discoveries are made at a rate of maybe once per year, with the core limitation being a shortage of talented researchers. By increasing the cognitive power devoted to developing hypotheses and testing them out, Amodei suggests, we might close the time gap between important discoveries like the 25-year delay between CRISPR's discovery in the '80s and its application to gene editing.

6. Impact of AI in Industries

- **AI in Manufacturing:** Manufacturing has been benefiting from AI for years. With AI-enabled robotic arms and other manufacturing bots dating back to the 1960s and 1970s, the industry has adapted well to the powers of AI. These industrial robots typically work alongside humans to perform a limited range of tasks like assembly and stacking, and predictive analysis sensors keep equipment running smoothly.
- **AI in Healthcare:** It may seem unlikely, but AI healthcare is already changing the way humans interact with medical providers. Thanks to its big data analysis capabilities, AI helps identify diseases more quickly and accurately, speed up and streamline drug discovery and even monitor patients through virtual nursing assistants.
- **AI in Finance:** Banks, insurers and financial institutions leverage AI for a range of applications like detecting fraud, conducting audits and evaluating customers for loans. Traders have also used machine learning's ability to assess millions of data points at once, so they can quickly gauge risk and make smart investing decisions.
- **AI in Education:** AI in education will change the way humans of all ages learn. AI's use of machine learning, natural language processing and facial recognition help digitize textbooks, detect plagiarism and gauge the emotions of students to help determine who's struggling or bored. Both presently and in the future, AI tailors the experience of learning to student's individual needs.
- **AI in Media:** Journalism is harnessing AI too, and will continue to benefit from it. One example can be seen in The Associated Press' use of Automated Insights, which produces thousands of earning reports stories per year. But as generative AI writing tools, such as Chat GPT, enter the

market, questions about their use in journalism abound.

- **AI in Customer Service:** Most people dread getting a robo call, but AI in customer service can provide the industry with data-driven tools that bring meaningful insights to both the customer and the provider. AI tools powering the customer service industry come in the form of chat bots and virtual assistants.
- **AI in Transportation:** Transportation is one industry that is certainly teed up to be drastically changed by AI. Self-driving cars and AI travel planners are just a couple of facets of how we get from point A to point B that will be influenced by AI. Even though autonomous vehicles are far from perfect, they will one day ferry us from place to place.

7. Risk and Dangers of AI

- **Job Losses:** Between 2023 and 2028, 44 percent of workers' skills will be disrupted. Not all workers will be affected equally women are more likely than men to be exposed to AI in their jobs. Combine this with the fact that there is a gaping AI skills gap between men and women, and women seem much more susceptible to losing their jobs. If companies don't have steps in place to up skill their workforces, the proliferation of AI could result in higher unemployment and decreased opportunities for those of marginalized backgrounds to break into tech.
- **Human Biases:** The reputation of AI has been tainted with a habit of reflecting the biases of the people who train the algorithmic models. For example, facial recognition technology has been known to favor lighter-skinned individuals, discriminating against people of color with darker complexions. If researchers aren't careful in rooting out these biases early on, AI tools could reinforce these biases in the minds of users and perpetuate social in equalities.
- **Deep fakes and Misinformation:** The spread of deep fakes threatens to blur the lines between fiction and reality, leading the general public to question what's real and what isn't. And if people are unable to identify deep fakes, the impact of misinformation could be dangerous to individuals and entire countries alike. Deep fakes have been used to promote political propaganda, commit financial fraud and place students in compromising positions, among other use cases.
- **Data Privacy:** Training AI models on public data increases the chances of data security breaches that could expose consumers' personal information. Companies contribute to these risks by adding their own data as well. A 2024 Cisco survey found that 48 percent of businesses have entered non-public company information into generative AI tools and 69 percent are worried these tools could damage their intellectual property and legal rights. A single breach could expose the information of millions of consumers and leave organizations vulnerable as a result.
- **Automated Weapons:** The use of AI in automated weapons poses a major threat to countries and their general populations. While automated weapons systems are already deadly, they also fail to discriminate between soldiers and civilians. Letting artificial intelligence fall into the wrong hands could lead to irresponsible use and the deployment of weapons that put larger groups of people at risk.
- **Superior Intelligence:** Nightmare scenarios depict what's known as the technological singularity, where super intelligent machines take over and permanently alter human

existence through enslavement or eradication. Even if AI systems never reach this level, they can become more complex to the point where it's difficult to determine how AI makes decisions at times. This can lead to a lack of transparency around how to fix algorithms when mistakes or unintended behaviors occur.

8. Conclusion

This book chapter does not seek to provide a comprehensive analysis or prediction of the likely impacts of AI on innovation, nor does it seek to provide specific management or policy advice. Rather, our goal was to discover some first organizational, institutional, and policy implications of the premise that deep learning is a brand-new, broadly applicable invention of an invention process. Our initial investigation uncovers a few key ideas that have not yet been central to the discussion of economics and politics. First, it's critical to distinguish, at least from an innovation standpoint, between the potential for a general-purpose invention method based on the application of multilayered neural networks to large amounts of digital data to be considered a "invention in the method of invention," and significant and noteworthy advancements in fields such as robotics. This notion is supported by our early empirical study and the existing qualitative data, which point to a significant shift towards deep learning-based application-oriented research since 2009. Related to the first point, the prospect of a shift in the innovation process raises significant issues for many policy and management domains, such as how to evaluate this novel field of science and whether prediction algorithms could lead to new entrance barriers in a wide range of industries. Prospective future studies in the area of proactive analysis of suitable private and public responses to these developments seem highly encouraging.

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