Ubiquity Symposium

Digital Economy

AI Powers the Digital Economy
by Jeff Riley

Editor's Introduction

Artificial Intelligence (AI) has had a profound impact on the digital economy. We explore that impact, and outline how AI technologies, including machine learning and big data analytics, have revolutionized sectors such as eCommerce, finance, supply chain, logistics, and manufacturing. The integration of AI has led to increased efficiency, personalized customer experiences, and significant transformations in traditional business models. We anticipate continued growth in AI's influence on the digital economy, with the Internet of Things contributing to even more data-driven advancements. AI is a driving force powering and shaping the future of the digital economy.

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What is the "digital economy"? Bukht and Heeks describe the digital economy as "an economy that is based on digital computing technologies but is often perceived as conducting business through markets based on the internet and the World Wide Web" [1]. Wikipedia adds that the digital economy "is also known as the Internet Economy, New Economy, or Web Economy. The digital economy is intertwined with the traditional economy, making a clear delineation harder" [2]. This is an important point to note—the new digital economy and the old traditional economy have become intertwined, and businesses that have hitherto operated only in the traditional economy must adapt to the digital economy, or risk being left behind.

Torrents of Data

The recent availability of vast amounts of data collected primarily by companies such as Facebook (now Meta), Amazon, and Google, as well as financial and health/medical-related institutions, along with the increase in computing power and speed over the past few decades, have enabled artificial intelligence (AI) to make a powerful impact on the digital economy. The rapid adoption of AI over the past decade or so has realized significant benefits in many areas of the digital economy, including, but not limited to, eCommerce, the financial sector, manufacturing, transport (particularly the supply chain and logistics), health, education, security, etc.

AI has quickly become an important tool, if not industry, for many countries. Processes and tasks that hitherto took people days or longer to complete are now done in minutes by machines. Governments have taken notice and are taking steps to harness these new technologies. Figure 1 shows the timeline of development of national strategies on AI by country. We can see from Figure 1 that while countries were beginning to develop strategies on AI as long ago as 30–40 years, rapid development has taken place more recently. Boukherouaa and Shabsigh posit that this rapid increase is being driven by technological advances that are facilitating fast deployments of AI systems across a wide range of sectors directly affecting the economy [3].
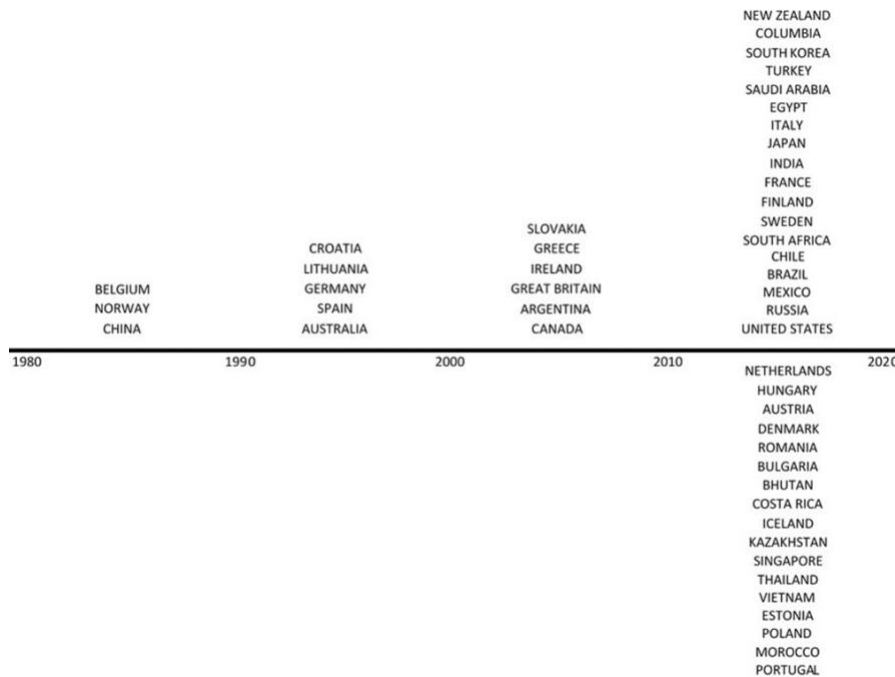
Figure 1. National Artificial Intelligence Strategy Timeline, adapted from Boukherouaa and Shabsigh (2021).

AI Key Technologies

In the simplest terms, AI is the application of a collection of technologies that allow machines to perform tasks that resemble human cognitive functions. Since the term "artificial intelligence" was first coined in the 1950s, and even before as the embryonic theories underpinning AI were being developed, the technologies that comprise AI have been evolving as the computing framework upon which it is built has evolved. More data, and richer data, has become available, and our understanding of what is possible and how it can be implemented has improved [4]. The past two decades have seen rapid change, growth, and focus, of AI technologies. The list of technologies that can be considered to come under the umbrella of AI is long, and the scope of technologies broad (see Figure 2).
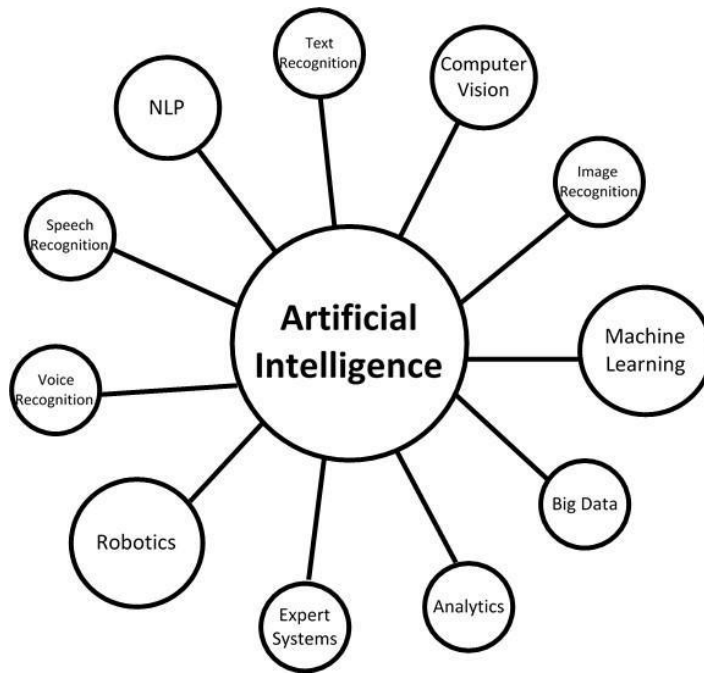
Figure 2. AI technologies

Following is a brief description of some of the more important technologies, especially in the context of the digital economy.

Machine Learning (ML) is an umbrella term that refers to a group of AI technologies based on the notion that we can learn from data. ML technologies seek to automatically construct analytical models that can make decisions with minimal, or no, human intervention. Artificial neural networks (ANNs) and deep learning are two technologies that fall under the ML umbrella.

Big Data/Analytics often falls under the umbrella of ML, but important in its own right. The ability to analyze huge amounts of data available across many areas of the digital economy, and develop smart, predictive, analytics is a game-change for businesses in the digital economy.

Text/Voice/Speech Recognition and Natural Language Processing are grouped together because they are often used together, or at least used in similar contexts, although these are all different technologies. Text and voice recognition systems often feed into speech recognition systems, which in turn feed into natural language processing (NLP) systems. Text and voice recognition systems are the underlying systems that attempt to recognize written and spoken words (in various languages), and the NLP systems attempt to understand the meaning of the

words (written or vocal). To do this the NLP system must understand and recognize syntax, as well as subtleties such as mood and context. These technologies are becoming increasingly important in the digital economy as businesses deploy computer/AI-drive customer-facing interfaces such as self-help telephone systems and kiosks, self-check-in kiosks at airports, meal ordering kiosks at fast-food restaurants, etc.

Computer Vision, or Image Recognition, is the ability for computers to "see" objects, or images of objects, and recognize those objects. This is an important AI technology, especially for AI systems embedded into robots, including industrial robots, and autonomous and semi-autonomous vehicles, as well as prosthetic vision systems for vision-impaired humans.

Expert Systems are systems that use (generally) subject-specific databases (knowledge bases) and inferencing techniques to simulate the judgment of subject-matter experts.

Robotics is the intersection of several technologies, predominantly engineering and AI. In 2005 90% of all robots assembled cars. In 2019 that had fallen to less than 50%, and robots could be found assisting, or replacing, humans in almost all industries [5].

Digital Economy Key Sectors

Here I address some of the more critical areas of the digital economy powered by AI: eCommerce, the financial sector, supply chain and logistics, and manufacturing.

eCommerce is the process of selling goods and services over the internet, which means anyone can participate in the global marketplace. Not only has the reach of big business expanded enormously—the customer base is now worldwide, not just local to a brick-and-mortar store— but almost anybody can operate an online store that, due to the power of AI, is indistinguishable from any large, established, business operating in the online space. Chatbots that give smart, personalized, product recommendations; voice recognition and visual searching; augmented reality for immersive online shopping; fraud protection and detection; and fulfilment and predictive inventory management are examples of how AI is changing the landscape of eCommerce. Indeed, Servion Global Solutions predicts that 95% of all customer interactions will be powered by AI by 2025 [6].

It is not just online that AI is helping transform business. AI-driven automation helps all businesses track and analyze their performance in the global market, including traditional retail brick-and-mortar stores. Smart software that can predict outcomes based on key metrics, past

performance, and current sales data, helps businesses optimize and strategize future performance.

The financial sector is undergoing transformational change as a result of the use of AI/ML technologies to streamline and optimize internal processes and provide personalized services to customers.

Banks now routinely provide customers with AI-driven tools to help monitor budgets, allowing customers to make real-time spending decisions and adjustments. Digital assistants and chatbots use AI to provide personalized, computer-generated, financial and banking advice. Using AI in this way, banks can provide customers with instant self-help, 24/7.

Credit providers use AI technologies to find and sift through large amounts of data to more accurately assess the risk of lending to individual borrowers. More broadly, AI solutions allow financial institutions to monitor past and current data to recognize trends and identify risks.

The electronic trading of stocks is not new, but quantitative trading, where statistical analysis is applied to large datasets to identify patterns in trading and financial data, has been transformed by the advent of AI and ML. AI-powered algorithms can analyze vast amounts of complex data much faster than humans, and automate the trading process, resulting in faster, strategic, and more timely trades.

Vast amounts of money are moved (virtually) around the world daily, by huge numbers of digital transactions initiated from all manner of devices (terminals at bank branches, personal computers, smart phones, ATMs, etc.). The opportunity for fraud presented by such vast numbers of transactions makes it imperative for the financial sector to pay constant attention to cybersecurity and fraud detection efforts to stay ahead of cyber-criminals. AI plays a key role in these efforts.

The digital economy and eCommerce are revolutionizing the supply chain and logistics. The complexity of the supply chain and logistics is increasing exponentially as sales volumes increase and customer expectations drive delivery speeds down to previously unthinkable levels. Where businesses in the traditional economy may have delivered within a few suburbs of their bricks-and-mortar store, or perhaps city or state-wide, delivery options for most online businesses are now worldwide. Businesses participating in the digital economy are leveraging AI and ML in the supply chain and logistics to create efficiencies between suppliers and business partners globally in order to develop order fulfilment processes that meet customer expectations.

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Planning and scheduling, inventory management, and warehouse efficiency are all areas that are critical to the success of businesses and are becoming increasingly complex in the digital economy. Maintaining optimum stock levels, in the optimum location, is one of the biggest challenges for businesses of all types. Being able to locate and move product quickly is imperative.

The forecasting of demand for products, and variations of those products (color, packaging size, etc.) is becoming increasingly difficult as the customer-base increases and the demand for different variations increases accordingly. AI/ML strategies in this area provide significant efficiencies and value to the business. It's not only the volume of the product required that needs to be anticipated—businesses need to accurately forecast the geographic location to which the product needs to be shipped, and the time it is required. Accurately predicting demand patterns—volume, location, and time—effectively in real-time is increasingly important in the digital economy, and here AI/ML is being deployed to help make the task more manageable. Furthermore, forecasting the decline and end-of-life of products, as well as the sales growth of new products, and the demographics of the volume changes, is an area in which AI/ML can contribute, both in terms of the accuracy and timeliness of predictions.

While eCommerce businesses, such as Amazon, were purpose-built for the digital economy, and have developed order fulfilment strategies and supply chain processes that dovetail into their online sales processes, traditional consumer packaged goods (CPG) businesses are trying to shoe-horn their legacy processes and tools into the new world of the digital economy. Supply chain issues can prevent these traditional economy businesses from competing effectively with the new breed of eCommerce businesses, but the AI solutions used by eCommerce businesses are being retrofitted to the traditional CPG companies to resolve these issues.

Traffic management, while not the province or responsibility of individual businesses, directly impacts supply chain performance. AI is routinely deployed to manage traffic, especially in large cities. Fixed cameras installed at intersections, and at intervals along busy roads, help inform intelligent systems that can change the behavior of traffic signals, or deploy traffic management personnel real-time, to help control the flow of traffic. Cameras that can detect drivers who disobey the law can be used by systems that can automatically issue infringement notices or raise alarms for real-time law enforcement involvement. In-car intelligent systems can monitor local traffic and help inform drivers of road conditions, accidents, etc. to help them navigate and avoid congestion. Intelligent traffic management systems, as well as smart in-car systems, can help drivers manage fuel consumption and wear-and-tear on vehicles.

Automating and optimizing the manufacturing process are areas in which AI is employed extensively and has been for some time. Automation powered the industrial age, and now intelligent automation—AI and robots—is powering a new industrial revolution. Robots can perform recurring activities without tiring, and without significant variation, allowing 24/7 manufacturing at a much lower cost than if humans were involved. Embedded-AI can detect and correct for unexpected situations, minimizing manufacturing errors and delivering superior levels of quality. Intelligent robots monitor the quality of manufactured items, and automatically reject defective items and adjust processes to prevent further defects. AI and robots are used in all facets of manufacturing: the design process, factory and build optimization, quality assurance, preventive maintenance, raw material planning, and inventory management. Factory output is adjusted automatically by intelligent systems that are informed by supply chain systems that monitor sales and demand, raw material inventory is managed according to current and anticipated demand, and availability, and the supply chain and logistics functions are in turn informed by factory output, actual and anticipated—all made possible by AI systems.

What the Future Holds

Whatever the future holds, we know that it will be significantly influenced by AI and the application of its technologies to almost every facet of our lives.

The *Financial Tribune* states: "Artificial Intelligence plays an influential role in most of the technologies used in a digital economy that is expected to increasingly dominate modern life*"* [7].

A 2018 study by PricewaterhouseCoopers (PwC) estimates the accelerating development and implementation of AI technologies may result in a 14% increase of global GDP by 2030 [8]. The PwC study anticipates a new wave of the digital revolution driven by data generated from the Internet of Things (IoT), which is likely to be many times greater than the torrents of data already generated by the current Internet of People (IoP).

In the near term we will see more, if not most, businesses incorporate AI technologies into their regular operations, including more extensive use of robots and autonomous vehicles, leading to productivity gains due to the automation of routine tasks. This will most affect capital-intensive industries, such as manufacturing and transport (in-turn affecting the supply chain), but productivity gains will be made in other industries as businesses implement AI technologies that assist and augment their existing human workforce. The investment made to develop AI

technologies, as well as the productivity gains achieved by implementing those AI technologies, that in-turn free up time for the human workforce to focus on higher value-add activities, will continue to power the digital economy.

AI technologies will continue to be enhanced as the IoT grows—more devices mean more data from which to learn, and more endpoints and interfaces with which to affect and interact with humans. Personalized and higher-quality AI-enhanced products and services will mean digital life will be tailored to each user—the digital economy will not be immune and will adapt to provide personalized services.

Further into the future internet use will be, by necessity, ubiquitous. Connection to the internet will be necessary to conduct daily life, not just business, so much so that it may be impossible to disconnect. (By then the line between human and machine may have begun to blur—our connection to the internet may be via an implant). In a fully connected world commerce is virtually unhindered.

The digital economy will grow to such an extent that AI will be required to navigate its complexity. AI is, and will continue to be, an integral part of all facets of the digital economy. AI truly powers the digital economy.

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Biography

Jeff Riley is a 40-year veteran of the computing industry and has worked in many roles in the field including Master Technologist and Scientist with Hewlett-Packard. Jeff holds a master's degree in IT, a Ph.D. in AI, a Ph.D. in theoretical astrophysics, and is a former Adjunct Principal Research Fellow of RMIT University in Melbourne, Australia. He is the founder of Praescientem, a company specializing in AI and IT consulting and education services. Jeff also works with the Faculty of IT, and the Faculty of Science, at Monash University, Australia, and in his spare time builds robots and collects antiquarian books. Jeff's major areas of interest in the AI space are machine learning and evolutionary computation. His publications are available at https://www.praescientem.com.au/pages/research.html.