

Artificial Intelligence & Data Science's Impact on Sustainability and Creating Cities of the Future

Environment and Sustainable Lifestyles

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Abstract

This research seeks to examine the technological innovations generated by Data Science and Artificial Intelligence(AI) in future “smart cities” as well as their impact on sustainability and policy development. The primary research method for this project was literature review which will comprehensively review AI from a historical, economic, functional, and ethical perspective. There are a number of ethical concerns regarding Artificial Intelligence Applications to Sustainability and Smart Cities but many technological innovations have also been developed in a short period that have greatly enhanced urban living. Because new developing technologies like Artificial Intelligence have the potential to bring rapid improvements to our everyday lives in a variety of ways as well as economic disruption, Policy Makers and Technologists will need to work together on policy development to help create a fair social environment and ease the transition to a more digital economy.

Introduction

Understanding the role of Data Science/Artificial Intelligence and its contribution to Environmental Sustainability and smarter efficient cities is extremely important as the world is currently undergoing a digital revolution where organizations are taking the opportunity to utilize massive volumes of data to change how we live. With all of this new-found data and technological innovation, many Data Scientists and AI Engineers are creating tools and technologies for the public's benefit.

In addition, United Nations Statistics reports that, 54 percent of the world's population lives in urban areas which is expected to increase to around 66 percent by 2050. [1] As cities continue to be the dominant area people live in the world, it is increasingly important to innovate and develop cities for sustainable living. Smart Cities are a new term coined for cities that utilize innovation and technology to optimize a city. According to Boston University Research, "a smart city is that is safer, greener, less congested, cleaner, and mostly cost- and energy- efficient." [2] This research paper will first review technological advancements that have enabled AI to thrive in the modern era, examine the economic incentives that have been driving AI globally, research AI and its applications to Sustainability and Smart Cities, and lastly investigate the ethical concerns associated with these new technologies.

Technological Advances Enabling Artificial Intelligence

From the areas of Logistics, Health-Care, and facial recognition on our phones: Data Science/Artificial Intelligence is now increasingly becoming a part of our daily lives. There have been many advances in technology that have contributed to these trends including Big Data, the Internet of Things (IoT), and increases in available computing power that provide an environment that enables Artificial Intelligence and Smart Cities to flourish. This section will define these advancements and also provide practical examples of how they apply to everyday modern life.

The world is currently undergoing a data revolution where massive volumes of data are constantly being collected and stored by companies, organizations, and even governments. According to Ex-Google CEO Eric Schmidt, “we now create as much information in two days as we did from the dawn of civilization until 2003.” [3] This volume of data is staggering when put into this perspective and the term often used to describe this phenomenon or technological advancement is Big Data. As reported by Gartner Research, “Big data can be defined as is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation.” [4] In simpler terms, big data is an increase in capability regarding storage and handling of data which allows us to drive more real time positive outcomes in analytics and automation. Companies nowadays collect data on almost everything about their consumers as well as their processes and this ability to handle large amounts of data is one of the biggest enablers and key inputs to Artificial Intelligence.

In addition, almost every device we have has sensors that collect data and are now connected and exchanging data with other devices on the Internet. This concept is called the Internet of Things (IoT). An organization called IEEE which is a global engineering organization whose mission is to foster technological innovation for humanity’s benefit has simply defined IoT as “A network of items- each embedded with sensors- which are connected to the internet.” [5] For example, many everyday objects in our home now have sensors including cars, smartphones, computers, and other electronics that produce and share data with each other. An example of this from the perspective of a smart city would be traffic sensors that examine road congestion and communicate with smart phones to optimize a driver’s route. In a way, the connection of many devices in an ecosystem like fashion and

their data collection capabilities are assisting in the artificial intelligence revolution especially with regards to technology in smart cities.

Another key contributor to the Artificial Intelligence revolution are the increases in computing power and storage brought about by Moore's Law. Moore's Law comes from a famous paper written in 1965 by Gordon Moore regarding an observation in the doubling of transistors in computer chips every two years. [6] According to Jason Waxman a vice president of Intel's Data Center Group, "Moore's Law has brought dramatic advances in computing and memory technologies, increasing capability and affordability,"[7] Computing power refers to how fast a computer can solve problems or process data while storage refers to how much a physical device can contain from a memory perspective. Many Artificial Intelligence applications require a significant amount of computing power (processing speed) and storage (capacity) to function which modern advances have largely assisted with.

With advances in Big Data, the recent trend of Internet of Things (IoT), and advances in computing power, Artificial Intelligence has become easier to apply to society on a large scale. These essential inputs have helped drive all of these technological innovations in AI and Data Science as it fuels many of the tools, algorithms, and applications being created from a structural perspective.

Economic Incentives brought about by Artificial Intelligence

Fueled by Big Data, the Internet of Things (IoT), and advances in computing power many applications have been created by data scientists and artificial intelligence researchers in the private and public sectors. Examples of AI created by the private sector that we interact with on a daily basis include online services like Facebook and Netflix or Home assistant devices like Google Home and Siri. The development of these devices through initial investments in AI has no doubt brought these companies a great deal of economic returns. A large amount of innovation required to develop these devices was motivated by the economic

and market incentive gained for creating the next cutting-edge device for all consumers to use which spurred their competitive advantage. A Survey by Boston Consulting Group and MIT Sloan Management of 3,000 business executives revealed that 84 % believe AI will help them obtain or sustain competitive advantage while 83 % also believed AI to be a strategic priority for their businesses. [8] Recently, Artificial Intelligence and Data Science are definitely topics of great interest for Private Sector Technology and Strategy Executives.

Despite the fact that Artificial Intelligence Engineers and Data Scientists now have the ability to quantify things and optimize processes that were previously unknown frontiers for organizations, this is largely not being leveraged in the public sectors. A report released by McKinsey Global Institute titled the Age of Analytics in 2016 revealed that only 10-20 % of potential data uses have been employed in the public and health care sectors. [9] The potential for Artificial Intelligence and Data Science applied to the urban development setting is great but still not at its full or expected potential.

Artificial Intelligence for Sustainability/Smart Cities

Artificial Intelligence has many broad applications and can be applied to nearly any problem in any industry or domain as long as the data input exists. Although AI is not leveraged as greatly in the public sector as it is in the private sector there are many applications to AI and Data Science for Sustainability and Smart Cities. Some examples of AI being applied to Sustainability and Smart Cities include technological innovations in areas like Pollution Reduction, Crime and Safety, Health Care, Food Production, Water Management, Energy Efficiency, and Transportation optimization which this section will cover in detail.

In regard to Pollution reduction, IBM researchers are currently testing a computer system capable of predicting pollution levels in different parts of a city based on many data points. According to Technology Review, IBM uses data supplied by the Beijing Environmental

Protection Bureau to refine its models and are 30 percent more precise than those derived through conventional approaches. [10] This can have great positive impact on pollution reduction in the future especially if these predictive models are applied to other developing nations where pollution is currently an issue.

Intelligent Policing is a term often used to describe Artificial Intelligence and its applications to crime and safety within cities. According to Stanford University Research, “Machine learning and Artificial Intelligence significantly enhances the ability to predict where and when crimes are more likely to happen and who may commit them”. [11] Many of these measures are already being implemented in cities around the world like New York to reduce and predict crime. On one hand, Artificial Intelligence in Policing can make cities safer but there are also some concerns about this technology as it has a risk of creating an over invasive police force.

In regards to Health Care, Artificial Intelligence has many use cases but there are some challenges regarding their implementation as this would require widespread adoption from both a patient and medical professional perspective. Some applications cited by Stanford Research in this area include clinical decision support, patient monitoring, automated devices to assist in surgery, and management of health care systems. [12] Another study by Accenture on the AI Health Market mentions that AI applications to health care have the opportunity to create 150 \$ billion in annual savings for the US health care economy by 2026. [13] In addition, there are many new startup companies trying to enter the artificial intelligence health care space. The potential for life saving innovation and cost savings for governments around the globe will likely influence their increasing adoption in the health care space.

Artificial Intelligence also has many applications in the optimization of food production, Water conservation, and Energy Efficiency. According to an article by Intel, Farmers are now using an approach called precision farming where data inputs are utilized to allow more to be

grown using less resources. [7] Another startup cited by FastCompany, utilizes Artificial Intelligence and robots to help municipalities detect aging pipes for replacement before it's too late. [14] In addition, the U.S Department of Energy has made it a national policy goal to support smart grid infrastructures, which utilize AI to manage the flow of energy via smart data processing. [15] With the world's population estimated to increase by around 66 % by 2050, Artificial Intelligence can greatly reduce the burden induced by potential resource scarcity in an urban setting by optimizing various processes related to our natural resources.

Lastly, perhaps the most notable cases of AI being used in recent media are in the transportation industry with driverless and autonomous vehicles. One recent breakthrough was the ability for a driverless truck made by Otto, an uber-owned company to deliver 50,000 cans of beer on a 120-mile drive in Colorado, USA. [16] Other autonomous vehicles seen in media in recent development include driverless taxis, driverless cars, and even autonomous trains. The potential impact that automation and smart data systems can bring will likely lead to less congestion in transit systems but there are also concerns regarding the future of workers in these fields as well as safety concerns regarding autonomous technology.

The above cases were just a small sample of how AI is being utilized for sustainability and smarter urban living. A combination of many of these technological influences and use cases applied to an urban development setting in synchronization through Internet of Things (IoT) is what has spawned many of the technologies that make up a smart city. In summary all of these advances, provide cost savings, create more efficient systems, and reduce waste which will likely have a positive influence on urban development as continual advancements seem to be on the horizon.

Societal Challenges / Ethical Issues related to Artificial Intelligence

According to Dan Walker, who leads the emerging technology team in British Petroleum's (BP) Technology Group, "AI is enabling the fourth industrial revolution, and it has the potential to help deliver the next level of performance." [15] Some equate these new

advances in Artificial Intelligence as positive for society and a bringer of a new industrial revolution but there are also many concerns regarding what impact this new technology will have from a societal and ethical perspective. Some issues that are often discussed in the media regarding Artificial Intelligence include data privacy, job security and labor, security, as well as autonomous weapons which will be covered in this section. The white house published a report on December 20, 2016 titled Artificial Intelligence, Automation, and the Economy and it is likely that these issues are very high on most governments radar's. [17]

Data Privacy is now an issue of increasing importance as governments, corporations, and other entities are collecting more data than ever. Many companies can now predict many of our behaviors through the sheer amount of personal data they have which can be worrisome for some. In addition, According to TechRepublic, some potential concerns regarding data privacy include data breaches, risk of discrimination from data, and identity reverse engineering. [18] Recently there have been some bills to address these data privacy concerns including the General Data Protection Regulation (GDPR) in Europe but this is likely just the start of these sorts of legislations around the world.

Another key concern is regarding job security and labor when it comes to Artificial Intelligence. As mentioned earlier in this research paper, Artificial Intelligence has the opportunity to leverage huge amounts of data to optimize processes and automate tasks. As a former IT Process Manager, I have seen the effects that process optimization could have on peoples' jobs as many of these automations eliminate many of the menial tasks that were once done by people which contributes to cost savings. A report by the White House titled Artificial Intelligence, Automation, and the Economy mentions that the increasing AI capabilities will enable automation of jobs that were previously done manually and probably disrupt the livelihoods of many Americans. [17]

Citizens and government will need to be ready as the digital age approaches as Artificial Intelligence will likely increase the pace of automation bringing about more efficiency and possible losses in jobs.

Another issue associated with Artificial Intelligence that has the potential to impact people around the world is related to cybersecurity and autonomous weapons. As mentioned previously, many of our everyday devices are now connected via the internet and this leaves them potentially at the risk of hacking. In addition, Autonomous weapons created through Artificial Intelligence are also a scary thought as they can probably create more devastating outcomes than many conventional weapons. A website called autonomousweapons.org created a video illustrating the horror of autonomous weapons if they were to get into the wrong hands as well as a campaign called Ban Lethal Autonomous Weapons. [19]

There are many ethical issues potentially associated with Artificial Intelligence and it is largely unknown what long-term implications may occur. It is very important for policy holders to create policy that can help address and defend against the upcoming changes in the next century. It is likely that the AI revolution will not be stopped as the rapid pace of technology continues to grow and it will be governments who are responsible for keeping up with the pace of change.

Conclusion

There is no doubt that there are ethical and societal concerns on the impacts of these new technologies. However, With Artificial Intelligence and Data Science we have the opportunity to build cities of the future where data is used to optimize and build cities with reduced pollution, reduced crime, better health care outcomes, more efficient food and energy production, as well as housing and transportation. In conclusion, Policy makers and Technologists will need to be at the forefront of discussion regarding these new urban smart cities to help create a world where everything is optimal and to reduce the amount of people who are negatively impacted by disruptive technologies.

Works Cited

- [1] "World's Population Increasingly Urban with More than Half Living in Urban Areas." United Nations, 10 June 2014, www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html.
- [2] Rimer, Sara. "Thinking about Smart Cities." Boston University Research, 16 Nov. 2016, www.bu.edu/research/articles/smart-cities/.
- [3] Siegler, MG. "Eric Schmidt: Every 2 Days We Create As Much Information As We Did Up To 2003." *TechCrunch*, TechCrunch, 4 Aug. 2010, techcrunch.com/2010/08/04/schmidt-data/.
- [4] "What Is Big Data? - Gartner IT Glossary - Big Data." *Gartner IT Glossary*, 19 Dec. 2016, www.gartner.com/it-glossary/big-data.
- [5] "Towards a Definition of the Internet of Things (IoT) ." IEEE Internet of Things, 27 May 2015, iot.ieee.org/images/files/pdf/IEEE_IoT_Towards_Definition_Internet_of_Things_Revision1_27MAY15.pdf.
- [6] Moore, G. E. "Cramming more components onto integrated circuits." *Electronics* 38(8) 1965, http://www.monolithic3d.com/uploads/6/0/5/5/6055488/gordon_moore_1965_article.pdf
- [7] "How Data Science Technology Seeds Precision Farming." IQ UK, 28 June 2016, iq.intel.co.uk/how-data-science-technology-seeds-precision-farming/.
- [8] Columbus, Louis. "How Artificial Intelligence Is Revolutionizing Business In 2017." *Forbes*, Forbes Magazine, 12 Sept. 2017, www.forbes.com/sites/louiscolumbus/2017/09/10/how-artificial-intelligence-is-revolutionizing-business-in-2017/#86e39b45463a.
- [9] Nicolaus Henke, Jacques Bughin, Michael Chui, James Manyika, Tamim Saleh, Bill Wiseman, and Guru Sethupathy. "The age of analytics: Competing in a data-Driven world." *McKinsey & Company*, Dec. 2016, www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-age-of-analytics-competing-in-a-data-driven-world.
- [10] Knight, Will. "IBM Tests Machine Learning to Help Chinese Cities Decrease Air Pollution." *MIT Technology Review*, MIT Technology Review, 1 Sept. 2015, www.technologyreview.com/s/540806/how-artificial-intelligence-can-fight-air-pollution-in-china/.
- [11] Peter Stone, Rodney Brooks, Erik Brynjolfsson, Ryan Calo, Oren Etzioni, Greg Hager, Julia Hirschberg, Shivaram Kalyanakrishnan, Ece Kamar, Sarit Kraus, Kevin Leyton-Brown, David Parkes, William Press, AnnaLee Saxenian, Julie Shah, Milind Tambe, and Astro Teller. "Artificial Intelligence and Life in 2030." One Hundred Year Study on Artificial Intelligence: Report of the 2015-2016 Study Panel, Stanford University, Stanford, CA, September 2016. Doc: <http://ai100.stanford.edu/2016-report>

[12] Peter Stone, Rodney Brooks, Erik Brynjolfsson, Ryan Calo, Oren Etzioni, Greg Hager, Julia Hirschberg, Shivaram Kalyanakrishnan, Ece Kamar, Sarit Kraus, Kevin Leyton-Brown, David Parkes, William Press, AnnaLee Saxenian, Julie Shah, Milind Tambe, and Astro Teller. "Artificial Intelligence and Life in 2030." One Hundred Year Study on Artificial Intelligence: Report of the 2015-2016 Study Panel, Stanford University, Stanford, CA, September 2016. Doc: <http://ai100.stanford.edu/2016-report>.

[13] "Artificial intelligence: Healthcare's new nervous system." *Artificial Intelligence in Healthcare* | Accenture, 2016, www.accenture.com/us-en/insight-artificial-intelligence-healthcare.

[14] Terdiman, Daniel. "How Robots And AI Could Save American Water Utilities Half A Trillion Dollars." Fast Company, Fast Company, 24 Feb. 2017, www.fastcompany.com/3068423/how-robots-and-ai-could-save-american-water-utilities-half-a-trillion-dolla.

[15] "How Artificial Intelligence Will Revolutionize the Energy Industry." *Science in the News*, 27 Aug. 2017, sitn.hms.harvard.edu/flash/2017/artificial-intelligence-will-revolutionize-energy-industry/.

[16] "The Future of Trucking." *Uber*, 2016, www.uber.com/info/atg/truck/.

[17] Lee, Kristin. "Artificial Intelligence, Automation, and the Economy." *National Archives and Records Administration*, National Archives and Records Administration, 20 Dec. 2016, obamawhitehouse.archives.gov/blog/2016/12/20/artificial-intelligence-automation-and-economy.

[18] Weathington, John. "Big data privacy is a bigger issue than you think." *TechRepublic*, 17 Feb. 2017, www.techrepublic.com/article/big-data-privacy-is-a-bigger-issue-than-you-think/.

[19] "BAN LETHAL AUTONOMOUS WEAPONS." *Ban Lethal Autonomous Weapons*, 12 Nov. 2017, autonomousweapons.org/.