

ARTIFICIAL INTELLIGENCE FOR SOCIAL GOOD:
FROM A GLOBAL PERSPECTIVE TO A REGIONAL ONE

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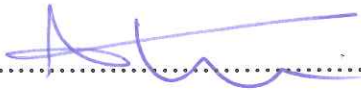
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ABSTRACT

Artificial Intelligence for Social Good: From a Global Perspective to a Regional One

This thesis looks into the question of how the use of artificial intelligence can be utilized for the social good, what problems can it alleviate and what possible solution we can discover by using these new technologies around aligned with the specific needs of the countries with an emphasis on cases from Japan and China.

In answering this question, the reports on the subjects from governments, international organizations, global and regional NGOs are used as a framework to reach conclusions about the means AI-based technologies are implemented for the purpose of social good. While considering these notions, the thesis also examines the proposed and applied AI legislations of the countries, the approaches made by various technology companies and the views from academia. Just like many other organizations and institutions working on the subject, the thesis uses the United Nations' Sustainable Goals as a general scheme while addressing the societal problems that can be solved by AI applications, and offers advices for future frameworks while enabling social good.

ÖZET

Toplumsal Fayda için Yapay Zeka:

Küresel bir Perspektiften Bölgesel Bir İncelemeye

Bu tez, yapay zekanın toplumsal fayda için nasıl kullanılabileceği sorusunu, hangi problemleri çözebileceğini ve bu yeni teknolojileri kullanarak ne tarz olası çözümler keşfedebileceğimiz sorularını Japonya ve Çin Halk Cumhuriyeti'ndeki kullanım alanları dahilinde ele almaktadır.

Bu sorulara cevap ararken devletlerden, uluslararası organizasyonlardan ve yerel sivil toplum kuruluşlarından konularla ilgili raporlar yapay zeka temelli teknolojilerin toplumsal fayda için kullanım yolları hakkında sonuçlara varmak için bir çerçeve olarak kullanılmaktadır.

Bu düşünceleri değerlendirmesinin yanı sıra bu tez yapay zekayla ilgili olarak ülkelerin tasarımı halinde olan ya da uygulanan tüzüklerini, çeşitli teknoloji şirketlerinin yaklaşımlarını ve akademik çevrelerin görüşlerini de inceler. Konuyla ilgili olarak çalışan birçok diğer kurum gibi bu tez de yapay zekayla çözülebilecek sosyal problemleri ele alırken Birleşmiş Milletler sürdürülebilir kalkınma hedeflerini genel bir çerçeve olarak kullanmaktadır ve gelecekte toplumsal faydanın sağlanması için oluşturulacak tasarımlar hakkında tavsiye niteliği taşımaktadır.

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ABBREVIATIONS

AGI: Artificial General Intelligence

AI: Artificial Intelligence

ANI: Artificial Narrow Intelligence

APPI: Act on the Protection of Personal Information

ASI: Artificial Super intelligence

ASICs: Application-specific Integrated Circuits

AWS: Autonomous Weapon Systems

CIFAR: Canadian Institute for Advanced Research

CNN: Convolutional Neural Networks

D4R: Data for Refugees

DFFT: Data Free Flow with Trust

ECOSOC: Economic and Social Council

EU: European Union

FPGAs: Field-programmable Gate Arrays

GDPR: General Data Protection Regulation

IBM: International Business Machines Corporation

ICLR: International Conference on Learning Representations

ICML: International Conference on Machine Learning

ICT: Information and Communication Technologies

IFIP: International Federation for Information Processing

IMF: International Monetary Fund

IoT: Internet of Things

IP3: The International Professional Practice Partnership

MEXT: The Ministry of Education, Culture, Sports, Science and Technology

METI: Ministry of Economy, Trade and Industry

ML: Machine Learning

NeurIPS: Neural Information Processing Systems

NLP: Natural Language Processing

NGOs: Nonprofit Organizations

NISSTC: National Information Security Standardization Technical Committee

OECD: Organisation for Economic Co-operation and Development

SDGs: Sustainable Development Goals

TUBITAK: The Scientific and Technological Research Council

UN: United Nations

UNCTAD: United Nations Conference on Trade and Development

UNICRI: United Nations Interregional Crime and Justice Research Institute

XAI: Explainable AI

INTRODUCTION

Like many other great and groundbreaking inventions that have occurred in the history of humanity, the aspiration to create a machine which can perform in a manner that represents human behavior and at a human level performance seemingly started with a single pioneering question proposed by an enthusiastic researcher “Can machines think?”¹

Though the answer to the aforementioned question is yet to be found, and is deemed irrelevant at the moment for practical purposes, it is clear that machines, whether they are intelligent or not, are taking part in our daily lives more and more each day, and in parallel the way society works also changes in different aspects; culturally, economically, socially and structurally.

In today’s world, it is not uncommon to ask questions to our phone and actually receive coherent answers as they are now home to AI-based chatbots, which can be described as “an artificial intelligence (AI) software that can simulate a conversation (or a chat) with a user in natural language through messaging applications, websites, mobile apps or through the telephone”²; none of us would get extremely surprised seeing a robot harvesting grapes instead of a viticulturist upon entering into a vineyard, and we do not get amazed as much as previous generations would when our TV platform recommends us just the perfect show to watch that night, which in turn has resulted in the said platform earning millions of dollars thanks to this feature.³

¹ Turing, “Computing machinery and intelligence,” 23-65.

² Expert System, “Chatbot: What is a Chatbot? Why are Chatbots Important?”

³ Gomez-Urbe and Hunt, “The netflix recommender system: Algorithms, business value, and innovation,” 13.

As AI technologies get more complex each passing day, their effects on our future are becoming a hot issue among researchers coming from different backgrounds; today not only computer scientists pursue this domain, but also people working on different topics including sociology, psychology, philosophy, medicine, art, linguistic and many more are doing interdisciplinary research about various aspects of artificial intelligence to thoroughly understand how the systems work in specific situations so that they can be developed in a way that maximizes their positive contributions to the society.

On the other hand, as it becomes clearer that AI-technologies are here to stay people's need to understand the way AI-enabled systems work increases accordingly as well as their worries about the results that may occur if this technology is used in an unethical, biased way; concepts such as Explainable AI (XAI), an area of study aiming to bring transparency and explainability to the decisions algorithms make,⁴ entered into our lives, concurrently new concerns such as ethics and fairness of AI applications occurred.

While the competition for integrating AI technologies in business has grown fiercer for many reasons due to the technologies' profitable nature, the amount invested by both governments, academia and industry increased drastically, some may call within in a short amount of time; the countries, one by one, started to announce their AI strategies with the aim to lead the AI debate for many years to come: the early adopters to improve their capacity, and the rest to catch up with what seems to be the next big thing that will provide a competitive advantage over those lagging behind.⁵

⁴ Forbes, "Understanding Explainable AI."

⁵ Deloitte, "Future in the balance? How countries are pursuing an AI advantage."

The changes to come to different societies all around the globe have only just begun. The advancements in the fields of AI and robotics push the concepts thought to be from science-fiction works closer to reality with each passing year. As stated in the report by the Cabinet Office of Japan, *Report on Artificial Intelligence and Human Society*; “Artificial Intelligence (AI) is expected to transform our society, not only by substituting for routinized tasks but also by supporting and enhancing human activities and decision-making.”

The ways and means these technologies will be used is a matter of discussion on its own, nevertheless the potential to harness these new technologies for the common good of humanity is out there, and if we do so, they will carry us into the future, no matter where we are coming from.

If we fail to discuss, develop, deploy and regulate the AI systems in the right and comprehensive way they should be, the fourth industrial revolution, driven by new technological advancements can either be an opportunity to change the way we relate and interact with each other by “harnessing converging technologies in order to create an inclusive, human-centred future”⁶ or it can be just like previous ones and may end up creating a privileged group of people, which will deepen the scars in all societies.⁷

It is needless to say that AI systems can be of great use considering their real life applications due to their nature: “AI technologies support and augment human intellect and actions, and they execute parts of intellectual behaviors on behalf of humans. This is supposed to greatly benefit and empower human society and contribute to ensuring its sustainability”.

⁶ World Economic Forum, “Fourth Industrial Revolution.”

⁷ Treanor, “Fourth industrial revolution set to benefit richest, UBS report says.”

However, the misuse of the same technologies could be detrimental to our lives in deeply disruptive ways.⁸ A globally utilized AI application must be developed according to certain standards acknowledged by all actors involved in the deployment process including the developers, enablers, enforcers, which will determine how it will affect the users.

Thankfully, just like any other technology ever invented, AI can also be used in a way that benefits society and assists humanitarian work and can be utilized to solve societal problems related to poverty, increasing agricultural productivity, healthcare, education, gender equality, economic growth, building an inclusive society, optimizing energy consumption, reducing waste, predicting climate disasters, combating illegal fishing, urban planning.⁹

To make sure that these developments are conducted within a framework of mutually discussed notions of ethics and to maximize the application of AI in favor of all layers of society, many countries, companies, international organizations and academic institutions started to set a group of rules that will contribute to creating a more “human-centric” AI by publishing guidelines and announcing various legislative proposals to keep AI implementations coordinated and as human-centric and ethical as possible by highlighting the importance of diversity, explainability, fairness and transparency.

In addition to the public sector and international organizations, the companies also started to open departments solely focusing on utilizing a responsible AI while they are running their projects.

⁸ Cabinet Office, *Report on Artificial Intelligence and Human Society*, 4.

⁹ Smith, *Artificial intelligence and human development: Towards a research agenda*

Moreover, some big technology companies and institutions such as Google, Intel and McKinsey issue reports that give advice to public and policy-makers about how AI applications can be used for the purposes of social good as a result of examining their own cases and some of them like Google start challenges offering funding to smaller AI-based technology companies working for social good.¹⁰

Whether these attempts are sincere or not, the companies unsurprisingly insist that these efforts are carried out with good intentions. Notwithstanding their sincerity, the intentions alone usually fail to be sufficient when it comes to real-life situations; without having a consensus on ethics and global governance, and a legislative system that is organized to enforce these notions, these are just documents, full of pretty words, that try to lure the actors involved to where they stand. In absence of legal regulations, the ideas of truth and what is right and wrong may change drastically depending on the organizations, companies and practitioners, which, in the best-case scenario, may result in assessing situations in view of cultural relativity. In the worst, the lack of a well-designed law may cause cases of exploitation and malicious use.

It is important to think about how we will use this new technology not just for practical aspects of the things but because it will deeply affect all generations to come since they will not only change the way we function and interact now, but they will also reshape our future as a global community by giving us a chance to reassess things like fairness, equality, ethics and human rights.

Considering all these and having the hope to reshape our future in a more sustainable and fair approach, I believe that it will be possible to utilize AI for Social

¹⁰ Google, “The Google.org Impact Challenge.”

Good by establishing a global governance system that will determine the law and ethics of deploying these applications notwithstanding the intentions.

Other than these, we need to take a step forward and make sure to co-create and co-develop with all actors to have an integrated system that recognizes every actors rights and benefits; just assuming that scientific progress is the progress towards the right way without considering the foundations and the reasons of a societal problem will lack in giving results as these problems usually tend to have roots deep down both socially and economically, and can only be solved through a collaboration of people from various related disciplines and under guidance of organizations with enough knowledge of the origins of the issues at hand as well as a clear set of rules about definitions, applications and solutions.

Failing to follow these steps will result in contributing to creating more inefficient systems in the best case scenario, and in the worst, it will cause solidifying the negative aspects of the current situation. For example, trying to fix gender pay gap through AI-enabled systems without considering the origins of the issue will only offer short-term solutions such as handing out competitive entry level salaries since the systems are driven on historical data, which has been biased for so long that it is embedded in our culture, which is reflected in the data we collect.¹¹ To ensure achieving building AI projects beneficial for everyone, we need to prevent these biases from being embedded into algorithms also, which makes it a necessity to avoid creating systems without taking all aspects into account. This can only be managed by having a consensus about the definitions and solutions of the problems as the systems will only be as just and fair as the data provided them are.

¹¹ Hak, “How AI can help close the gender pay gap and eliminate bias.”

While the literature about these aspects of the AI deployment is lacking, there are recent researches mentioned further in this thesis being published as of 2019 that points out these above stated facts, which is a hopeful turn of events since failing to do so may end up not only increasing the negative impacts of the problems of today but also they may end up creating new problems that are harder to solve due to system's dependency of data.

This thesis aims to decipher the concept of ethics and social good in view of this debate and highlight the need of a mutually agreed upon approach towards the way actors collect, share, and use data to build these technological systems as well as argues the necessity of a methodology for developing and implementing these AI-based solutions, then give a detailed explanation of the means they can be utilized for social good within the framework of the Sustainable Development Goals (SDGs) announced by the United Nations (UN), which constitutes a guide for practitioners that aspire to contribute to the equal development of the society.

Moreover, this thesis will present a comparative analysis of two countries, People's Republic of China, referred simply as China within this thesis, and Japan, that have been actively involved in the global AI scene by underlining their advantages and disadvantages in terms of the AI talent pools they host, the AI patents and publications they own, AI solutions they develop for social good as well as the documents issued by the countries related to these technologies with an emphasis on their approach to ethics and data privacy.

On the other hand, as I argue further in the thesis, having a few documents issued here and there, and AI for Social Good themed projects developed from time to time will do very little to help create a world where AI-based technologies are implemented for the good of all humankind. The unethical, and unwise deployment

of AI systems would only increase inequalities; these negative outcomes can only be balanced out by reaching a consensus on what ethics and law entail in context of AI applications, moreover, after an established consensus, global governance must be ensured by thoroughly structured global governance system covering all aspects of the AI development and deployment process.

The narrative build on an AI race, where countries compete with each other, especially in regard to the military applications, to implement AI-technologies faster and more efficiently compared to the rest of the world is inhibiting for an emerging “AI for Social Good” movement as it causes scientists and policy-makers to forego ethical concerns and undermines the idea of a global governance, which, if applied properly, will encourage the implementation of these systems for prosocial purposes.¹²

Chapter 1, “Understanding Artificial Intelligence,” summarizes the history of artificial intelligence, its global effects and what is the international and regional reaction to this global phenomenon by giving an insight as to the meaning of artificial intelligence concept and how this term is used for within the context of this thesis.

Chapter 2, “The Rise of Artificial Intelligence,” gives a detailed account of the utilization of AI by going through documents issued by countries related to the subject as well as offers arguments about the ethical, social and legal issues that arise with the spread of this technology by discussing the notions of ethics and law.

Chapter 3 “AI for Social Good,” aims to provide a way to define what social good really entails as a concept and tries to spark a multidimensional discussion about the ways to enable social good through these recently emerging technologies

¹² Hagendorff, “The Ethics of AI Ethics--An Evaluation of Guidelines.”

by highlighting the importance of reaching a common conclusion of what governance and ethics are in view of the debate about these AI-based technologies as well as discusses the positive contributions of open platforms and interdisciplinary work. The chapter also summarizes both the global and the regional development of AI for social good with an emphasis on the use of AI technologies to accelerate the achievement of the United Nations Sustainable Development Goals by giving case studies related to each goal by presenting projects in the field on a case by case basis, and the challenges we face when implementing AI technologies in the real world.

Chapter 4 “A Comparative Analysis of AI Development in China and Japan “ gives a detailed account of the governmental approaches of China and Japan on AI and related technological developments. The chapter compares the AI scenes, patents, publications and talent pools of the countries as well as underlines the means they apply AI technologies for the benefits of their societies and to bring solutions to their country-specific societal problems. While China and Japan are located in the same region as discussed further in the said chapter, their stand on data privacy laws, the advantages and disadvantages of their AI scenes, and their societal needs vary drastically, which makes comparing the countries productive in terms of the reached outcomes, and for the benefit of gaining a different point of view.

The last chapter, “Conclusion,” where a final assessment of the use of AI technologies in society, especially for the ‘social good’ is made with an emphasis on a comparison between China and Japan, offers insight regarding the means and reasons to enable social good through AI applications.

Finally, in the epilogue, I offer a roadmap for Turkey, which has recently been taking steps towards initiating a well-established AI strategy and considering the ways to utilize AI for Social Good.

On a final note I would like to point out that the military usage of AI applications are purposely left out as they would make a thesis subject on their own due to their complexity and controversiality.

It is a known fact when it comes to global spending on AI applications, the military expenditure of the countries are one of the biggest pieces of the cake; the military AI market is estimated to reach \$18.82 billion by 2025,¹³ which is one-seventh of the whole market value projected by the same date.¹⁴ But as I mentioned before, the military aspect of the AI application is another key factor to be further analyzed, which would by itself constitute a whole another research topic, therefore I opted to not cover military research and development, markets, companies and related documents within the scope of this thesis.

¹³ Daigle, "Analysts project military AI market will reach \$18.82 billion by 2025."

¹⁴ Liu, "Global AI software market worldwide from 2018 to 2025."

CHAPTER 1

UNDERSTANDING ARTIFICIAL INTELLIGENCE

While there is no universal concession on the definition of AI, the Organisation for Economic Co-operation and Development (OECD)¹⁵ and United Nations Conference on Trade and Development (UNCTAD)¹⁶ define AI as “...the ability of machines and systems to acquire and apply knowledge, and to carry out intelligent behavior. This includes a variety of cognitive tasks...and demonstrating an ability to move and manipulate objects accordingly. Intelligent systems use a combination of big data analytics, cloud computing, machine to machine communication and the Internet of Things (IoT) to operate and learn.”¹⁷

This chapter aims to provide a brief insight into the concept of AI systems by looking into major historic moments as well as categorize the types and applications of such systems as they will be referred within the context of this thesis, before going into details about the purposes and means they are utilized for, and the frameworks they are subjected to or should be subjected to in the future.

1.1 History of AI

AI is becoming more and more mainstream as a topic with optimistic dreamers on one side and apocalyptic doomsayers on the other side. But the story of AI is not a new one and in fact had already begun in the 1950s,¹⁸ with intriguing personalities

¹⁵ OECD, *OECD Science, Technology and Innovation Outlook 2016*.

¹⁶ UNCTAD, *Information Economy Report 2017*.

¹⁷ UN ESCAP, *Artificial Intelligence in Asia and Pacific*, 1.

¹⁸ Also several nineteenth-century thinkers including Charles Babbage and Ada Lovelace arguably predicted the advent of AI and even prepared designs for machines capable of carrying out intelligent tasks. See, for example, Christopher d. Green, “Charles Babbage, the Analytical Engine, and the Possibility of a 19th-Century Cognitive Science”, in *The Transformation of Psychology*, edited by

such as Alan Turing¹⁹ and John von Neumann.²⁰ To be even more precise; in the summer of 1956, John McCarthy, a professor of mathematics at The Dartmouth Summer Research Project (Dartmouth Conference) at Dartmouth College called this rapidly emerging technology *artificial intelligence*. The scientists and researchers who attended the conference were not always in total agreement on the problems or their possible solutions but they had a clear vision that they shared as they have stated in the proposal for the conference; “The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it.”²¹

Before the 1950s and the invention of the term “artificial intelligence,” on research on the subject during those years Jones says that the main idea was that:

...the brain consisted of an electrical network of pulses that fired and somehow orchestrated thought and consciousness. Alan Turing showed that any computation could be implemented digitally. The idea, then, that building a machine that could mimic the human brain couldn’t be far off. Much early research focused on this strong aspect of AI, but this period also introduced the foundational concepts that all machine learning and deep learning are built on today.²²

The field of AI in the 1950s was more focused on what we generally refer to as strong AI, the lack of improvement brought on weak AI, utilizing AI for a narrow set

Christopher d. Green, Thomas Teo, and Marlene Shore (Washington, DC: American Psychological Association Press, 2001), 133–152. See also Ada Lovelace, “Notes by the Translator”, Reprinted in R.A. Hyman, ed. *Science and Reform: Selected Works of Charles Babbage* (Cambridge: Cambridge University Press, 1989), 267–311.

¹⁹ Alan Mathison Turing—outstanding mathematician, logician, and computer scientist, a researcher at the University of Cambridge, University of Manchester, and the National Physical Laboratory in London. He is considered as one of the “fathers” of computer science. Turing defined the universal (Turing) machine, which is a mathematical model of computation.

²⁰ Jones, “A beginner’s guide to artificial intelligence, machine learning, and cognitive computing.”

²¹ Moor, “The Dartmouth College artificial intelligence conference: The next fifty years,” 87–91.

²² Jones, “A beginner’s guide to artificial intelligence, machine learning, and cognitive computing.”

of problems.²³ There are still many issues that need to be addressed in the field, and as Marvin Minsky²⁴ expressed, one main problem is the project selection tends to be based on the popularity of the subject. Another issue he emphasizes is only success stories being published in general and the failures not being shared thus prevent to some degree for AI to be established as a scientific field.²⁵ Figure 1 gives us a basic timeline of the development of AI. Each development on this timeline brings us one step closer to the current AI technology.

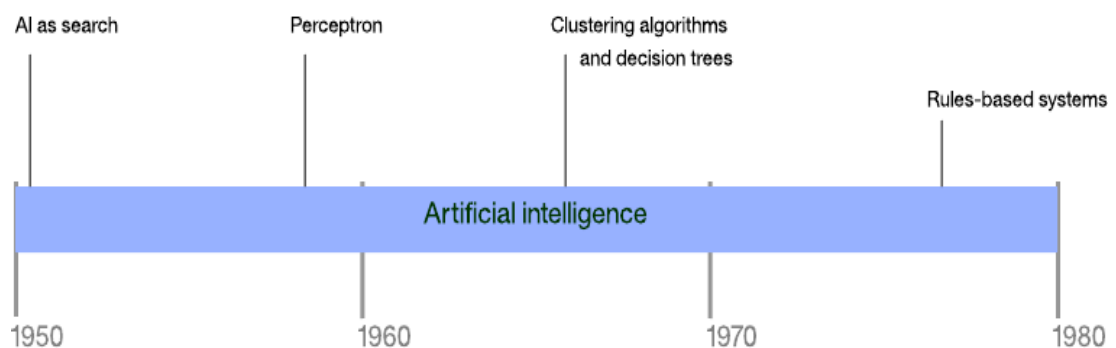


Figure 1. Timeline of artificial intelligence approaches to 1980.

Source: Jones, "A beginner's guide to artificial intelligence, machine learning, and cognitive computing."

Following the developments until the 1980s, the field was mostly split between weak AI and strong AI, but just around this time machine learning (ML) started to become a notable field of research. With developments in the field of ML accelerating, computers were now being given the ability to learn and construct new models. This opened the field for activities like the ability to perform predictions in specific areas.²⁶ Around the 2000s a new field called deep learning emerged. Research from

²³ Ibid.

²⁴ Marvin Lee Minsky (August 9, 1927 – January 24, 2016) was an American cognitive scientist concerned largely with research of AI, also co-founder of the Massachusetts Institute of Technology's AI laboratory.

²⁵ Moor, "The Dartmouth College artificial intelligence conference: The next fifty years," 87–91.

²⁶ Jones, "A beginner's guide to artificial intelligence, machine learning, and cognitive computing."

both AI and ML had a hand in creating this field. Jones describes this new area of research; “Computer scientists used neural networks in many layers with new topologies and learning methods. This evolution of neural networks has successfully solved complex problems in various domains.”²⁷ Following this in the 2010s the field of cognitive computing surfaced with the goal of building “...systems that can learn and naturally interact with humans.”²⁸ In Figure 2 we can see the timeline of these new fields of research that have been born out of a process of continuous development.

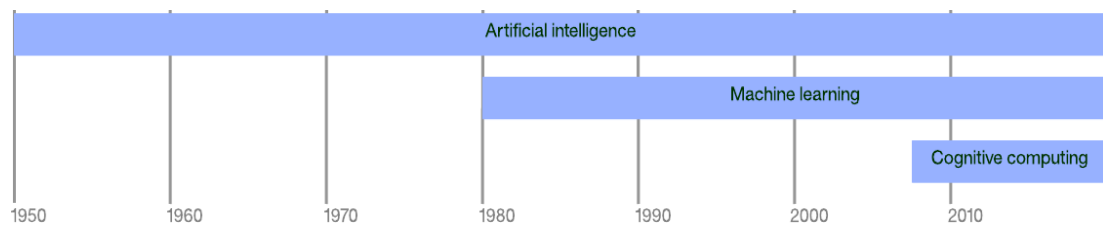


Figure 2. A timeline of modern artificial intelligence

Source: Jones, “A beginner’s guide to artificial intelligence, machine learning, and cognitive computing.”

1.2 Understanding various types of AI

When discussing AI, the “artificial” part is quite easy to grasp; it is something made by people, often a copy of something that does occur naturally.²⁹ The harder part is to understand the concept of “intelligence”, which can describe a spectrum of aspects.³⁰

AI is one of the more complex creations of humanity and we are still at the beginning of a long journey and we have yet to set concrete definitions for AI. As computer scientist Jerry Kaplan says on what AI is, “That’s an easy question to ask

²⁷ Ibid.

²⁸ Ibid.

²⁹ Cambridge Dictionary, s.v. “artificial,” accessed October 14, 2019.

³⁰ Turner, *Robot Rules: Regulating Artificial Intelligence*, 7.

and a hard one to answer...First, there's little agreement about what intelligence is. Second, there's scant reason to believe that machine intelligence bears much relationship to human intelligence, at least so far."³¹ John McCarthy says that there is not yet "a solid definition of intelligence that doesn't depend on relating it to human intelligence".³² On the subject, there has also been suggestions that an absence of a general agreement has in fact been advantageous for the development of AI. In Stanford University's *One Hundred Year Study on Artificial Intelligence* the authors state:

Curiously, the lack of a precise, universally accepted definition of AI probably has helped the field to grow, blossom, and advance at an ever-accelerating pace. Practitioners, researchers, and developers of AI are instead guided by a rough sense of direction and an imperative to "get on with it".³³

In essence research on AI aims for machines to imitate human intelligence and capabilities. In the simplest sense the various types of AI are defined by their degree of human-likeness. There are different types of categorization for AI, the most basic being *Weak AI (Narrow AI)* and *Strong AI (General AI)*, a distinction that is also made in the article "Open Ended Intelligence: The Individuation of Intelligent Agents"³⁴ On the subject Johnathan Charles Flowers says; "Work in artificial intelligence and machine consciousness is often discussed using Searle's (1980) distinction between Strong and Weak AI. Weak AI presents AI as a tool for solving problems, whereas Strong AI is the generation of an "actual" mind."³⁵

³¹ Kaplan, *Artificial Intelligence: What Everyone Needs to Know*, 1.

³² McCarthy, "What Is Artificial Intelligence?"

³³ Stone et al., "defining AI", in "*Artificial Intelligence and Life in 2030*". *One Hundred Year Study on Artificial Intelligence: Report of the 2015–2016 Study Panel* (Stanford, CA: Stanford University, September 2016), <http://ai100.stanford.edu/2016-report>

³⁴ Weinbaum, and Viktoras, "open Ended Intelligence: The Individuation of Intelligent Agents," 371–396.

³⁵ Flowers, "Strong and Weak AI: Deweyan Considerations."

In a nutshell Weak or Narrow AI is what we are generally used to; AI as a tool to solve a problem. Information as quantifiable data is fed to an algorithm so that the machine can solve the preselected problem according to the data provided. The main focus of the algorithm is ‘one narrow task’, thus appearing smarter than it is. “An example would be a poker game where a machine beats human where in which all rules and moves are fed into the machine. Whereas Strong AI is something that has yet to have been fully realized, machines that are able to think by themselves and act accordingly like a real human being. While it is something we have yet to achieve, this is thought to be the end-game of AI in some ways and the desire to build a strong AI has pushed the research and resulted in rapid progress in the field.³⁶

Another categorization of AI is one that is based on their functionalities. There are four types detailed in this categorization; ‘Reactive Machines’, ‘Limited Memory’, ‘Theory of Mind’ and ‘Self-aware AI’. Reactive machines are the most basic of these four types. The most famous example of this is ‘Deep Blue’, the chess program of IBM that was able to win against chess master Garry Kasparov. This type of AI does not store memory nor is it able to utilize past information for future actions. Machines that can store memory to some degree, where AI is able to use experiences for future decision-making are called limited memory. The most mainstream use of this can be observed in chatbots like Apple’s Siri and again in some functions of self-driving cars.³⁷

The ‘Theory of Mind’, the third type in this categorization is still in its infancy. This type of AI, in theory, would be able to understand human emotions, beliefs, thought processes and be able to socially interact with real human beings.

³⁶ Ibid.

³⁷ Togelius, *Playing Smart: On Games, Intelligence, and Artificial Intelligence*.

While there has been great improvements in the field, this type of AI is still far from its completed state. The last type based on functionality is self-aware AI. It is clear from the name that awareness of a self is the main objective of this type. An AI that is aware of itself, is conscious and sentient. Of course yet this type of AI does not exist and only exists in science-fiction movies.³⁸ Figure 3 gives a clear view of the types that are used to classify AI in scientific literature.

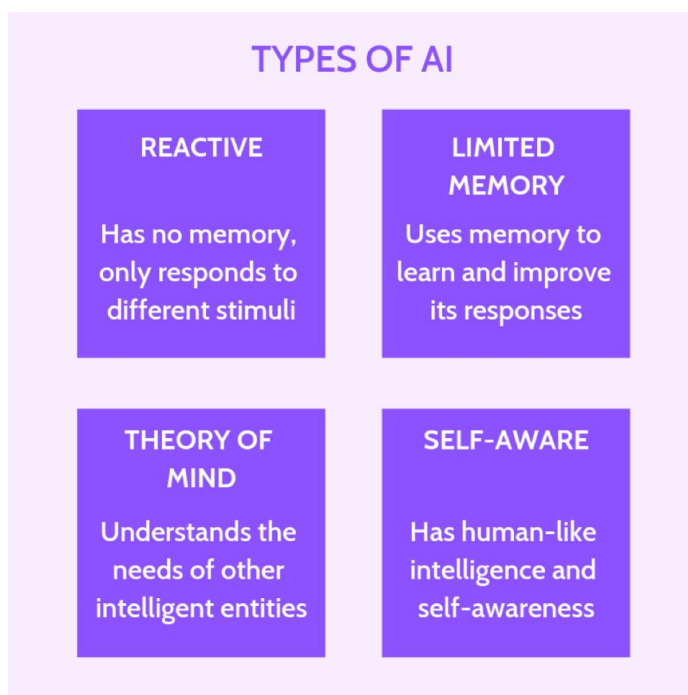


Figure 3. Types of artificial intelligence based on their functionality
Source: Joshi, “7 Types of Artificial Intelligence.”

There is yet another categorization used for differentiating various AI types.

‘Artificial Narrow Intelligence (ANI)’, ‘Artificial General Intelligence (AGI)’ and ‘Artificial Superintelligence (ASI)’. ANI is actually the AI of today, this type is only able to perform what they have been programmed to do and all reactive machines and limited memory AI would also be categorized as ANI. Thus, all programs of

³⁸ Çelikok, Interactive AI with a Theory of Mind.

present, from the simplest to the most complicated AI that is utilizing machine learning and deep learning are a part of this type. AGI would be the next step, an AI with the ability to function, at least to some extent, as a human being. It would be able to independently collect and connect information across domains, then utilize this data to create connections and generalizations. This type would cut down the training time immensely and replicate humans to some degree. ASI is the type of AI we see in dystopian science-fiction stories; AI becoming superior to human beings and this would lead to the scenario most often referred to as ‘singularity’. While this is and will continue to be for the foreseeable future a fictional existence only seen in science-fiction, it is also true that the field of AI will continue to expand. As the field is not yet stabilized these categorizations of AI are not yet concrete and with advances in the field, different categorizations may also appear in the future.³⁹

1.3 Main applications of artificial intelligence

Today AI is utilized in an array of fields; from autonomous vehicles to robots that clean your house from sorting your inbox to logistic planning for companies. Some of the most commonly encountered applications of AI include Natural Language Processing (NLP), Machine Learning (ML) and Deep Learning, Computer Vision, Robotics and Autonomous Vehicles to name a few.

A well-known field of AI is NLP; with email spam detection, translations and chatbots as the most common examples that utilizes this technology, most people do use this technology in their everyday lives. In the simplest sense NLP is the “automatic manipulation of language by software”⁴⁰ and can be defined as

³⁹ Strelkova and Pasichnyk, *Three Types of Artificial Intelligence*, 1-2.

⁴⁰ Sommer, “Artificial Intelligence, Machine Learning and Cognitive Computing.”

“Algorithms that process human language input and convert it into understandable representations.”⁴¹

ML as Sommer describes is what gives machines the “...ability to continuing learning without being pre-programmed after a manual. Machine Learning is algorithms that learn from data and create foresights based on this data.” ML can be used to differentiate between objects such as oranges and apples to building models which are able to predict customer demand by learning from the correlation of sales and local events.⁴²

Another term we need to explain is the Internet of Things (IoT). Merriam-Webster Dictionary gives the description as “the networking capability that allows information to be sent to and received from objects and devices using the Internet.” The meaning of the term has evolved some over the last 20 years from; a device that is capable of connecting to the internet to the ability of things to be connected over a network.⁴³

Computer vision is in the simplest sense the area of AI which allows machines to “see” by interpreting images. It can be defined as; “The process of pulling relevant information from an image or sets of images for advanced classification and analysis.”⁴⁴ In the earlier days of computer vision was focused on looking at “semantically meaningful elements” with machine learning that would correspond to bigger and more general items. Currently the focus has changed with the advent of neural networks. While the main aspect is still machine learning, neural networks and more specifically convolutional neural networks (CNN) are being used to create “models of objects” from extensive collections. Kaplan says;

⁴¹ UN ESCAP, Artificial Intelligence in Asia and Pacific, 1.

⁴² Sommer, “Artificial Intelligence, Machine Learning and Cognitive Computing.”

⁴³ ITU, *The Internet of Things*.

⁴⁴ UN ESCAP, Artificial Intelligence in Asia and Pacific, 1.

“Very loosely speaking, CNNs look for patterns in small, overlapping sections of an image, then can spread what they “learn” first to neighboring sections and then to progressively larger regions of the image.”⁴⁵

Robotics does need much explanation, it is the field that engineers robots; machines which are able to perform physical chores. While the field does not need too much description, where do the idea of robots come from? “The word itself comes from a Czech play from the 1920s, entitled *R.U.R. (Rossum’s Universal Robots)*, by Karel Čapek.⁴⁶ In the play, the “robots” are artificial humans used as slave labor in a factory (*roboti* in Czech translates to “serf labor,” with the associated connotations of servitude and drudgery).”⁴⁷ Before this, ‘automat’ was used to describe automated machines. Humanity’s curiosity regarding the automation of things; automats and “mechanized human-like figures” goes back a long time; to Ancient Greece and on the other side of the globe, to China.⁴⁸ While the fictional robot usually resembles a human being the reality is not so; “Much ongoing work seeks to develop lighter-weight, more flexible, stronger materials and methods of control as well as novel designs (often inspired by nature), but what really distinguishes robotic research in AI from more pedestrian mechanical automation is the attempt to build devices that are capable of more general classes of tasks.”⁴⁹ Examples of areas that utilize robots include assembly lines in factories, cleaning services, food preparation, hospitality, farming and many more.

Autonomous vehicles have been under the spotlight for some time. While the smart cars have garnered the most attention, the vehicles also include buses, trains,

⁴⁵ Kaplan, *Artificial Intelligence: What Everyone Needs to Know*, 54-55.

⁴⁶ Karel Čapek, *R.U.R. Rossum’s Universal Robots* (1920).

⁴⁷ Calo et al, *Robot law*, 5.

⁴⁸ de Solla Price, “Automata and the origins of mechanism and mechanistic philosophy.”

⁴⁹ Kaplan, *Artificial Intelligence: What Everyone Needs to Know*, 49-50.

ships and drones. There is also a need to make it clear the difference between autonomous technologies of weaponized and non-weaponized varieties, so as to not impeditment the advancements to be made in the field.⁵⁰As the more these technologies begin to be widely used, there will be instances where they are used in ways that are illegal, or hurtful to society. Thus it is important to understand the rise and spread of AI. In Figure 4 it is possible to see a clear branching of the fields of AI.

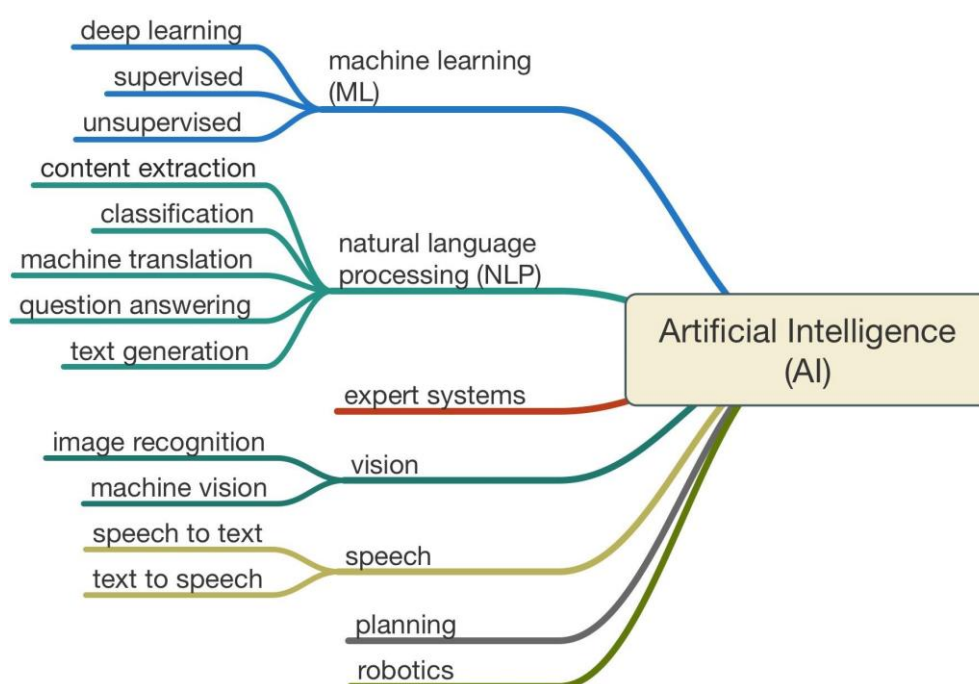


Figure 4. The subfields of AI

Source: Dollin, Defining Artificial Intelligence: Say “Hello!”

⁵⁰ Sparrow, “Killer robots.”

CHAPTER 2

THE RISE OF ARTIFICIAL INTELLIGENCE

Every technological advancement in history came with its benefits and pitfalls and AI is no different. Thus, it is important to mention the good, the bad and the ugly related to the development and deployment of AI technologies before even discussing the ways to implement it for the purpose of achieving social good.

The novel technology now dubbed artificial intelligence did not come into existence overnight. While talking about such advancements and their reflections in our daily lives, all circles of the society should take a reasonable and responsible approach. Utilizing certain technologies just for the sake of implementing them for increased profit or without considering the results proved to be unwise repeatedly since the beginning of our known history. While there are certain institutions, both private and public, that can foresee the negative effects resulting from careless applications of such emerging technologies; the lack of paperwork is still worrying.

This chapter will look into various countries' approaches by assessing the official documents issued by key players and discussing the concepts of ethics and law in light of the ethical, social and legal issues currently arising or that may arise in upcoming years.

Lastly, I will summarize the history of the movement "AI for Social Good" and, despite a mutual understanding does not exist regarding what this title stands for as an umbrella term, from which roots did the idea of utilizing these technologies for the benefit of all human-kind emerged.

2.1 AI strategies around the world

The progressions that led to the technological marvel that is artificial intelligence of today did not happen in a day. It is possible to follow the evolution of technology throughout centuries in the form of industrial revolutions. The First Industrial Revolution in the 18th century with technological breakthroughs by using steam and simple automation of production. The Second Industrial Revolution follows this in the 19th century with progress in the chemical and heavy industries. The 20th century is maybe the most important in terms of getting closer to our current technological progress with the formation of the internet and developments in computer technology; the Third Industrial Revolution. The Fourth Industrial Revolution which we are a part of was the result of advancements in the fields of AI, IoT, blockchain and their usage in industry.⁵¹

The next phase in this technological evolution story is the formation of systems that would utilize the things⁵² which were and are being handled as separate objects to be connected in the digital arena. Collaboration and coordination between multiple fields will become much simpler thus speeding progress throughout society altering the way people live and work to some extent.⁵³

The societal classification of our current era is assumed to be the information society. We are already utilizing data in tremendous volumes, amounts never seen before throughout our history as a species. The developments in information and communication technologies (ICT) have created an opening for information exchanges in incredible volumes.⁵⁴ This concept; information society is used when

⁵¹ Stearns, *The industrial revolution in world history*.

⁵² “Things” in this context refers to the IoT; Internet of Things.

⁵³ Fukuyama, “Society 5.0: Aiming for a New Human-Centered Society,” 47–50.

⁵⁴ Nath, “The Information Society,” 19-29.

defining the *post-industrial society* where information and data become prominent factors. Used in the 1960s in Japan as a novel term; *Johou Shakai* or *Johouka Shakai*⁵⁵ (information society) in the social sciences field, there still does not exist a general agreement on the definition in concrete terms. The main characterizations are technological, economic, occupational (sociological), spatial, and cultural. While there is no concrete definition agreed upon exist, the main idea is that there is a usage of information in our current society, in volumes that did not exist in previous eras.⁵⁶

The changes to come to different societies all around the globe have only just begun. The advancements in the fields of AI and robotics push what was thought to be science-fiction closer to reality with each passing year. The rise and the widespread utilization of AI around the world have pushed the governing bodies to try and regulate or to at least create boundaries to some degree. To this end, much of the developed world has been creating policies on the subject. With the advent of AI, all around the world countries with enough technological capabilities have taken the leap to become a part of this ever-growing field. While it is a relatively recent field it is expanding rapidly and the number of countries and organizations trying to be a part of the movement is ever-growing. However, as with any other technology the advancements are often way ahead of any governmental regulation to be developed. While on the subject; the utilization of the words ‘regulating’ and ‘regulation’ when discussing the governmental strategies might feel restricting for the development of the technology and impede or at least slow the advancements in AI. And while an AI policy of a government does not differ from a governmental regulation, the use of the term ‘policy’ instead of ‘regulation’ creates the illusion of a more innovation-friendly

⁵⁵ *Johou Shakai*. 情報社会 and *Johouka Shakai* 情報化社会 (Information society)

⁵⁶ Webster, *Theories of the Information Society*, 8-14.

governmental approach. The government reports and written strategies that have begun to sprout are quite recent, and there will be many more to follow in the footsteps of these countries as these technological advancements become more widespread.

The first country to create and publish a governmental report was Canada with its “Pan-Canadian AI Strategy” in March 2017, a five-year program with a plan to invest C\$125 million (US\$93,250) on AI research. Developed by Canadian Institute for Advanced Research (CIFAR), the main objectives of the policy were; to create an interconnected scientific environment, to increase the number of researchers in the field, to make it easier to develop AI technologies for the national community and to also help develop a more international thought on the advances of AI and its implications.⁵⁷

Following Canada, Japan also published its AI strategy in 2017 the same month. The Strategic Council for AI Technology was established in 2016 to create a roadmap for research and development in the field of AI. *Jinkō Chinō no Kenkyū Kaihatsu Mokuhyō to Sagyōka no Rōdō Mappu 人工知能の研究開発目標と産業化のロードマップ* (The Artificial Intelligence Technology Strategy). The strategy includes a roadmap for industrialization of AI technologies. The plan is deeply intertwined with Japan’s societal structure *Society 5.0*. The priorities of the strategy are health, mobility and productivity as a result of the rapidly aging population of Japan. The AI strategy also includes plans of investment in research and

⁵⁷ Canadian Institute for Advanced Research, “CIFAR Pan-Canadian Artificial Intelligence Strategy.”

development, talent development and start-ups.⁵⁸ I will be giving a more detailed description of the Japanese government's AI strategy in Chapter 4 of my thesis.

On May 2017, Singapore published its national AI strategy; “AI Singapore” a five-year plan with the main objective of enhancing the nations AI capabilities. The goals described in the report include; investing in AI technology, finding solutions to societal and economic issues through the utilization of AI and generalizing the use of AI within the industry.⁵⁹

Another country to release its AI strategy in 2017 was China; 新一代人工智能发展规划 (The Next Generation Artificial Intelligence Development Plan), the most comprehensive of national AI strategies, in which China details its objectives for research and development, industrialization, AI talent, education, ethical norm development, security and also standard setting. China has an ambitious goal of cultivating an AI industry of RMB 1 trillion (US\$144.160.760.000) by the year 2030.⁶⁰ I will be having an in-depth look at the AI strategy being developed by China in Chapter 4.

In the Middle East, the United Arab Emirates (UAE) was the first to create and publish an AI strategy. The report “UAE Strategy for Artificial Intelligence” was published in 2017 simultaneously with the creation of the Ministry for Artificial Intelligence. In the report the government lists the sectors it will invest in for AI related developments; health, transport, education, environment.⁶¹

⁵⁸ New Energy and Industrial Technology Development Organisation. (2017). Jinkō Chinō no Kenkyū Kaihatsu Mokuhyō to Sagyōka no Rōdō Mappu 人工知能の研究開発目標と産業化のロードマップ (The Artificial Intelligence Technology Strategy Roadmap). Retrieved from <https://www.nedo.go.jp/content/100862412.pdf>

⁵⁹ AI Singapore, “AI Singapore.”

⁶⁰ The State Council of the People’s Republic of China, *Notice of the State Council Issuing the New Generation of Artificial Intelligence Development Plan*, 5.

⁶¹ United Arab Emirates, “UAE Strategy for Artificial Intelligence.”

On the European continent the first country to develop a national strategy on AI was Finland at the end of 2017. Its report titled “Finland’s Age of Artificial Intelligence” gives an overview of the recommendations for Finland to become a leader in the field of AI on a global level while also going through the weaknesses and strengths of the country.⁶²

Another Asian country to develop and publish an AI strategy is South Korea; “Mid-to long-term master plan in preparation for the intelligent information society” by the Interdepartmental Exercise of the Korean Government in July 2017.⁶³

Also in 2017, while not an AI strategy Australia published its ‘innovation roadmap’; “Australia 2030: Prosperity through Innovation” where the government declared its intentions to prioritize AI development.⁶⁴ Following 2017, there is a sudden explosion in the number of countries to develop and publish a national AI strategy. In 2018, India has published its report “National Strategy for Artificial Intelligence,”⁶⁵ while Mexico has published a study that would serve as a foundation for future national AI policies titled; “Towards an AI Strategy in Mexico: Harnessing the AI Revolution”.⁶⁶ The United Kingdom published a policy paper titled “AI Sector Deal” in 2018 which was updated in May 2019. A quite comprehensive policy paper with goals including boosting research and development, education, improving digital infrastructure, improving data ethics.⁶⁷

⁶² Ministry of Economic Affairs and Employment of Finland. (2017). Artificial intelligence programme. Retrieved from <https://tem.fi/en/artificial-intelligence-programme>

⁶³ Government of the Republic of Korea Interdepartmental Exercise, *Mid- to long-term master plan in preparation for the intelligent information society*.

⁶⁴ Department of Industry, Innovation and Science, “Australia 2030: Prosperity through Innovation.”

⁶⁵ NITI, “National Strategy for Artificial Intelligence.”

⁶⁶ C minds, “Towards an AI Strategy in Mexico: Harnessing the AI Revolution.”

⁶⁷ Department for Business, Energy & Industrial Strategy, “AI Sector Deal.”

March 2019, the Danish government released its national strategy of AI; “National Strategy of Artificial Intelligence.”⁶⁸ For the Russian Federation, while President Putin had talked about AI in 2017 when asked a question on the subject; “whoever becomes the leader in this sphere will become the ruler of the world,”⁶⁹ it was October of 2019, when Russia finally published its AI strategy “National Strategy for the Development of Artificial Intelligence Over the Period Extending up to the Year 2030”. The objectives include short-term and long-term goals including; improvement of availability of data, hardware, the creation of standards and regulations to guarantee public safety and the stimulation of AI development.⁷⁰ The United States also did not have a comprehensive national AI strategy until 2019. Published in 2019 a report by the Select Committee on Artificial Intelligence of the National Science & Technology Council; “National Artificial Intelligence Research and Development Strategic Plan”. Their objectives include; prioritizing AI investment, improving AI-human collaboration, regulating ethical, legal and societal implications of AI.⁷¹

Other AI policies and strategy reports to have been published include; Belgium’s “AI 4 Belgium,”⁷² Czech Republic’s “National Artificial Intelligence Strategy of the Czech Republic,”⁷³ Estonia’s “Estonian Artificial Intelligence: Report of the Expert Group on Deployment.”⁷⁴ Italy has published a white paper titled

⁶⁸ Danish Ministry of Finance and Ministry of Industry, Business and Financial Affairs, “National Strategy of Artificial Intelligence.”

⁶⁹ Dutton, An Overview of National AI Strategies.

⁷⁰ Prezidenta Rossijskoj Federacii [Russian Federation Presidency], “O razvitii iskusstvennogo intellekta v Rossijskoj Federacii [On the development of artificial intelligence in the Russian Federation]”

⁷¹ National Science & Technology Council, “National Artificial Intelligence Research and Development Strategic Plan.”

⁷² AI 4 Belgium, “AI 4 Belgium.”

⁷³ Ministry of Industry and Trade of the Czech Republic, “National Artificial Intelligence Strategy of the Czech Republic.”

⁷⁴ Riigikantselei, “Estonian Artificial Intelligence.”

“Artificial Intelligence at the service of the citizen” promoted by the Agency for Digital Italy. Other countries to have developed and published AI strategies or policies include France, Germany, Austria, New Zealand, Norway, Portugal, Saudi Arabia, Spain, Sweden.⁷⁵ While the main objectives of the strategies the governments create are not so different from each other, their emphasis slightly changes based on the needs of their people.

In the academia side of things; in addition to the top conferences chasing the state-of-the-art practices regarding the subject, universities and research centers worldwide also began to assemble summits and open up institutions, departments and centers concerned with the non-profit aspect and ethical approaches of AI-technologies and their integration into our daily lives for the sake of social good.

In the United States of America, The Stanford Institute for Human-Centered Artificial Intelligence invests in projects that will help the advancement of AI by contributing to create a better future for humanity.⁷⁶

Founded in 1998, The Berkman Klein Center for Internet and Society at Harvard University is a multidisciplinary research institute that welcomes researchers from various fields held more than a thousand events and published over 250 publications related to the subject.⁷⁷

In Japan, the Next Generation Artificial Intelligence Research Center based in The University of Tokyo aims to develop projects within the framework of “human AI,”⁷⁸ RIKEN Center for Advanced Intelligence Project was established in hopes to find answers to societal questions while discussing the ethical and legal codes that

⁷⁵ Organisation for Economic Co-operation and Development, “AI initiatives worldwide.”

⁷⁶ Stanford University, “Human-Centered Artificial Intelligence.”

⁷⁷ For more information about the Berkman Klein Center for Internet and Society at Harvard University, you can see the website: <https://cyber.harvard.edu/>

⁷⁸ University of Tokyo, “About us.”

should be taken into account during the process of implementing AI practices to the layers of society.⁷⁹

In collaboration with Waseda University, Digital Asia Hub held one of the first conferences held on the subject named AI in Asia: AI for Social Good On March, 2017 with attendees coming from all over the world including Belgium, the USA, Japan, China and more.⁸⁰

As stated in the report by the Cabinet Office of Japan, *Report on Artificial Intelligence and Human Society*; “Artificial Intelligence (AI) is expected to transform our society, not only by substituting for routinized tasks but also by supporting and enhancing human activities and decision-making.” How these technologies will be used is a matter of discussion on its own. If we can harness these new technologies for the good of humanity, they will carry us into the future. “AI technologies support and augment human intellect and actions, and they execute parts of intellectual behaviors on behalf of humans. This is supposed to greatly benefit and empower human society and contribute to ensuring its sustainability.” However, the misuse of the same technologies could be detrimental to our lives in deeply disruptive ways.⁸¹

2.2 The pitfalls of AI

2.2.1 Legal issues

The laws are ever changing, they evolve with the advent of new information, new societal structures and in the case of AI and robotics; the laws are being newly

⁷⁹ RIKEN, “About AIP.”

⁸⁰ Digital Asia Hub, “AI in Asia: AI for Social Good.”

⁸¹ Cabinet Office, *Report on Artificial Intelligence and Human Society*, 4.

developed. As Nicolas Petit puts it, there can be an “...inconsistency between an innovation-adverse rule of strict liability on AI programmers on the one hand and an innovation-friendly legal framework that encourages computer scientists to work on AI through the allocation of subsidies, intellectual property (IP) rights and tax benefits on the other hand. Or consider a statute that confers dignity rights to robots. As part of such rights, a prohibition of torture would prevent to test how a robot reacts in stressful circumstances, and in turn undermine experimental research on the design of safer robots.”⁸²

Sometimes, it takes a while for the law to catch up with the new technological developments. The law needs some time to get used to fresh ideas, and work how to add them into existing legal systems. The advent of AI and related technologies created such a period. A similar era was also experienced in the 90s; as a result of the Internet becoming popular. New and unanswered questions had risen regarding jurisdiction, ownership, control, the meaning of ‘net neutrality’ and issues of privacy. To solve these issues, legal academics researched the field and developed cyberlaw. AI is now creating similar problems for the legal system that await solutions for a smooth incorporation of these new technologies into our daily lives.⁸³

The approach to AI and similarly to robotic technologies in the legal field can be classified into two main patterns; Legalistic and technological.⁸⁴ Legalistic pattern starts within the legal system and lists the problems that might arise as a result of being affected by AI technologies; privacy, cyber security, liability, etc.⁸⁵ The technological pattern aims to foresee the legal problems that could happen from

⁸² Petit, “Law and Regulation of Artificial Intelligence and Robots,” “2.

⁸³ Calo, “Robotics and the lessons of cyberlaw,” 514-515.

⁸⁴ Petit, “Law and Regulation of Artificial Intelligence and Robots,” 2.

⁸⁵ De Cock Buning et al., “Mapping the Legal Framework for the introduction into Society of Robots as Autonomous Intelligent Systems.”

the utilization of new technologies; in this instance smart cars, smart houses, robots, etc.⁸⁶

The UN has also got into the creation of a legal framework regarding AI and robotics. Because while the benefits these technologies will bring are indisputable, there are some concerns regarding security and safety. There are concerns about the advancements in robotics as they are able to cause physical harm but the concerns are not limited to the physical realm only; algorithm bias,⁸⁷ black boxes in decision making,⁸⁸ privacy issues and obviously the danger of misuse of these new technologies by criminals or terrorists. To deal with these problems, the United Nations Interregional Crime and Justice Research Institute (UNICRI) in 2015, started its program on AI and robotics to share awareness on the subject. In 2017, with help from the Municipality of the Hague and the Ministry of Foreign Affairs of the Netherlands UNICRI opened the Centre for Artificial Intelligence and Robotics. The centre is committed to educating about the dangers and benefits of AI and robotics, in the areas of crime and security. To achieve success UNICRI has created an immensely well-organized international network.⁸⁹

One of the main problems of AI that needs to be solved for a more general acceptance of AI, the clarification of responsibility in the legal field must be addressed. A much used issue regarding this is smart cars. While they do help decrease the accidents in general, the problem is when an accident happens. Where does the responsibility go? Who will be held accountable? The driver, the

⁸⁶ Palmerini et al., “RoboLaw: Towards a European framework for robotics regulation.”

⁸⁷ Algorithm bias, also known as machine learning bias or AI bias, is a phenomenon that occurs when an algorithm produces results that are systematically prejudiced due to erroneous assumptions in the machine learning process.

⁸⁸ When AI makes decisions that humans can not understand, or follow the thought process.

⁸⁹ UNICRI, “Artificial Intelligence and Robotics.”

programmer, the maker? This is an important issue to clarify before we can heavily utilize the technology.⁹⁰

A different topic that is being heavily discussed is the responsibility in the area of autonomous weapon systems (AWS), which will be used more frequently in the future and are capable of deciding matters of life and death. The issue of ‘moral judgement’ or ‘human moral judgment’ comes into light, if the AI is given free reign, how will the consequences pan out? In the article ‘Autonomous machines, moral judgment, and acting for the right reasons’ moral judgement is defined as “...(it) requires either the ability to engage in wide reflective equilibrium, the ability to perceive certain facts as moral considerations, moral imagination, or the ability to have moral experiences with a particular phenomenological character.” As AI does not have this characteristic, is it morally just to send these AWS’s into the battlefield, as this act would open discussions about the issue the responsibility gaps.⁹¹ This is also argued by Robert Sparrow, he raises questions about the responsibility of blame if and when an AWS kills a civilian, a similar problem to the one with autonomous cars.⁹²

Another issue raised in the *Report on Artificial Intelligence and Human Society* by the Cabinet Office of Japan is; “AI technologies are becoming able to support and make decisions and actions that only humans have previously been able to perform. Many people have concerns and anxieties about AI’s potential manipulation or operation of their minds and behavior, the evaluation or ranking of people by AI technologies, and AI influencing people’s emotions, affections, and faith. Ethical discussions might especially be needed if these are conducted without

⁹⁰ Cabinet Office. *Report on Artificial Intelligence and Human Society*.

⁹¹ Purves, et al., “Autonomous machines, moral judgment, and acting for the right reasons.”

⁹² Sparrow, “Killer robots.”

people's awareness.” Also from the same report on the subject of data and privacy; “The ability to exploit big data would make AI technologies more useful. It is necessary to consider appropriate institutional frameworks (laws, guidelines, and contracts) to avoid the chilling effects of privacy invasion and to balance the usefulness of AI technologies with privacy issues. A mature society has to discuss access rights to personal information data, data portability, and related security issues with international cooperation.”⁹³

2.2.2 AI ethics

The ethical machine debate is a long and ongoing discussion that will continue to evolve as the machines themselves develop further and while I will not be going into it in this thesis, as it is a whole subject to be scrutinized, I cannot stay completely out of it as the utilization of artificial intelligence warrants for a mention of the ethical repercussions it creates.

Before going into what machine ethics is, there is a need for a general definition of what ethics entails. In the simplest sense, ethics or moral philosophy is the branch of philosophy that deals with the concepts of right and wrong. Modern philosophers generally subdivide the field into three categories; metaethics, normative ethics and applied ethics. Metaethics examines where we derive our ethical principles from and what they imply. Normative ethics aims to achieve an understanding of moral standards. Applied ethics deals with issues such as abortion, infanticide, animal rights, environmental rights, capital punishment, the use of nuclear power.⁹⁴ And recently another area of study has come on to the scene; AI ethics, or machine ethics.

⁹³ Cabinet Office. *Report on Artificial Intelligence and Human Society*, 16-17.

⁹⁴ Fieser, “Ethics.”

It is no wonder that machine ethics is a rapidly growing subsection in the study of moral philosophy as the advent of AI and related technologies have started to become an incremental part of our daily lives.⁹⁵ This new field mainly deals with developing ethical principles for machines in order to help them settle the ethical impasses they might come across and create an environment where they could function without being ethically irresponsible.⁹⁶

Ethical principles are not static. They change with the times and it is important to take into consideration what the historical and cultural context was at any given time in history when that particular ethical view rose in popularity. As the social environment changes so does the ethical beliefs people hold.⁹⁷

Currently, machine ethics are being discussed and are becoming even more relevant as the technologies the discussions originate are spreading over the globe at an unseen pace. But we have to realize that AI technologies are beginning to be utilized in an unequal world; socio-economically and politically. Another point in the discussions should include the cultural differences that make the perceptions of AI differ. The differences in societal structures create a discrepancy of the public view of the new technologies. And resistance in public could impede the widespread utilization of a technology that could be beneficial for the whole of society. Thus, the significance of universal AI principles is higher than ever.⁹⁸

In EU ethics guidelines, a “trustworthy AI system” is defined as lawful, ethical, and robust.⁹⁹ According to the report, an ethical AI system ensures

⁹⁵ Hagerty and Rubinov, “Global AI Ethics: A Review of the Social Impacts and Ethical Implications of Artificial Intelligence.”

⁹⁶ Anderson, M. and Anderson, S. L., *Machine ethics*, 1-2.

⁹⁷ Rawls and Herman, *Lectures on the history of moral philosophy*, 2-4.

⁹⁸ Hagerty and Rubinov, “Global AI Ethics: A Review of the Social Impacts and Ethical Implications of Artificial Intelligence.”

⁹⁹ European Parliamentary Research Service, “EU guidelines on ethics in artificial intelligence: Context and implementation.”

faithfulness to ethical principles and values. These ethical requirements include human agency and oversight, technical robustness and safety, privacy and data protection, transparency, diversity, non-discrimination and fairness, societal and environmental well-being, and accountability.

Human agency and oversight includes that a machine should not have full control over the decision processes and there should always be human oversight to ensure that there is an ultimate functionality for a human to override the decision made by the AI system. Technical robustness and safety is especially a major concern for safety-critical systems on AI research.¹⁰⁰ In the EU guidelines, it is mainly referred to as the requirement to ensure cybersecurity. Privacy and data protection imposes that all EU citizens should have full control over their data and the AI systems should collect data to avoid discrimination or socially constructed bias about them. Transparency establishes the traceability of the collected data and the explainability of the decisions and processes of an AI system to the user. Diversity, non-discrimination and fairness includes that the design of the AI algorithms should not be biased towards any stakeholders directly or indirectly affected by the system. This means that these stakeholders should be consulted in the design of the system. An example is ensuring that the system is accessible to persons with disabilities. Societal and environmental well-being assures that an AI system should be environmentally friendly in the context of energy consumption. The societal role of this guideline is that the physical and mental state of people and the effects of AI systems on society in general should be considered. Accountability is another criterion when developing AI systems and it provides that the developers of AI systems must ensure responsibility and accountability for possible outcomes. If

¹⁰⁰ Akhtar and Mian, "Threat of adversarial attacks on deep learning in computer vision: A survey," 14410-14430.

there is a conflict of two ethical requirements when implementing an AI system, the trade-off between them should always be considered.¹⁰¹

The EU is not the only entity that publishes guidelines or legislation on AI ethics. The United States, China, Australia, Japan and many other countries, whether as government-led regulations, institutions, or companies, also have principles on the development of AI systems following ethical compliance.

Ethical principles on development of AI systems are mostly self-regulated by companies, organizations, and institutions in the United States. Two examples of this are Microsoft and Google. Microsoft established its own AI advisory board named “FATE: Fairness, Accountability, Transparency, and Ethics in AI”.¹⁰² In June 2018, Google published its AI principles as guidelines to develop products and research responsibly.¹⁰³ The Association for Computing Machinery (ACM), a US based organization consisting of special interest groups all related to computing and computer science, published “Code of Ethics and Professional Conduct” in 2018 as ethical guidelines for computing professionals.¹⁰⁴ All of these codes and guidelines mostly share the same principles as the EU guidelines. However, AI Now Institute of New York University issued a report that the internal operations of most technology companies fail to follow the accountability principles for AI systems.¹⁰⁵

In China, government, industry, and universities provide non-binding principles and self-regulations in recent years. Chinese government released “Next Generation Artificial Intelligence Development Plan” in 2017¹⁰⁶ to establish strategic

¹⁰¹ European Parliamentary Research Service, “EU guidelines on ethics in artificial intelligence: Context and implementation.”

¹⁰² Microsoft, “FATE: Fairness, Accountability, Transparency, and Ethics in AI.”

¹⁰³ Pichai, “AI at Google: our principles.”

¹⁰⁴ Association of Computing Machinery, “ACM Code of Ethics and Professional Conduct.”

¹⁰⁵ AI Now Institute, *AI Now 2018 Report*.

¹⁰⁶ Triolo et al., “Translation: Chinese government outlines AI ambitions through 2020.”

objectives for the development of AI in China by 2030. “Establishing regulatory and ethical frameworks to ensure the healthy development of AI in China” is one of the goals in the plan. In May 2019, an alliance of Chinese technology companies and universities, the Artificial Intelligence Industry Alliance, issued guidelines for self-regulation in AI.¹⁰⁷ Moreover, an expert committee under the China Ministry of Science and Technology released eight non-binding principles to develop responsible AI systems in June 2019.¹⁰⁸

It should be noted that all of these ethical principles, guidelines, and conducts that have been issued by different institutions in these countries share mostly the same framework as the EU guidelines.

Now that I stated the principles of AI ethics, I will clarify why the AI developers should follow these ethical rules since the growing worldwide embrace of adopting AI systems is prone to causing potential harm. In 2019, The Alan Turing Institute published the work “understanding artificial intelligence ethics and safety” as a framework for developing AI systems that comply with AI ethics.¹⁰⁹ This work has summarized the potential harms caused by AI systems in six categories. First of these categories is bias and discrimination. Since many AI systems reflect the biases in the data that they analyze, they are prone to bias when, for example, making predictive analysis. One other point to make here is that such AI systems may also mirror the potential biases or preconceptions of their designers. This becomes even more prevalent as algorithms are being used to solve real-world problems involving

¹⁰⁷ Webster, “Joint Pledge on Artificial Intelligence Industry Self-Discipline Translation: Chinese Expert Group Offers 'Governance Principles' for 'Responsible AI'.”

¹⁰⁸ Laskai and Webster, “Translation: Chinese Expert Group Offers 'Governance Principles' for 'Responsible AI'.”

¹⁰⁹ Leslie, “Understanding artificial intelligence ethics and safety: A guide for the responsible design and implementation of AI systems in the public sector.”

real people and affecting their lives.¹¹⁰ David Leslie states in the study that: “The data samples used to train and test algorithmic systems can often be insufficiently representative of the populations from which they are drawing inferences.” This may be harmful since such a model may infer biased and discriminatory results based on its training data. And this bias does not even have to always have devastating results to be disturbing as it can be seen in Figure 5. the cultural bias that exists in the data leads to only a western style bride to be identified as such.¹¹¹



Figure 5. Algorithms often recognize only the image on the left as a bride
Source: Left: iStock/Getty; Right: Prakash Singh/AFP/Getty

Another potential harm of an AI system may be the denial of individual autonomy, recourse, and rights. AI systems today have the ability to make automated decisions based on their functionality. In any case of negative consequence, it is not clear who will be held accountable since such systems are designed and implemented

¹¹⁰ Courtland, “Bias detectives: the researchers striving to make algorithms fair.”

¹¹¹ Zou and Schiebinger, “AI can be sexist and racist-it's time to make it fair,” 324.

collaboratively. An example of this situation is the AWS mentioned in the legal section. In case of unforeseen civilian casualties, who will be held accountable? An additional potential harm is non-transparent, unexplainable, or unjustifiable outcomes. AI models, or more specifically machine learning models, work with high-dimensional data. These algorithms produce outcomes by finding mathematical correlations in these high-dimensional data and for some of these algorithms it is not trivial to explain or justify the rationale behind the outcome. This lack of interpretability and explainability may be tolerable in some use cases. However, if the processed data by the algorithm contains bias, inequity, discrimination, or unfairness, the inexplainable outcomes may be utterly questionable. Another important possible harm of AI systems is privacy invasion. Many companies and even governments work with personal data. In some cases, these entities collect or process personal data without having the proper consent of the user. They may also handle this personal data in a way that parts of it may be exposed to public or other parties. This may violate the basic right of a human to live a private life free from unchosen influence. Isolation and disintegration of social collection is another potential harm. The benefit of AI systems that offer personalized digital services comes with some potential risks. When the level of automation becomes extreme, this may inhibit the need for human-to-human interaction. There is also the problem of walled gardens. With the help of algorithms, we build our walled garden by keeping people with different worldviews than ours outside and this may cause polarization in social relationships. AI technologies should keep preserving relations of trust, empathy, and mutual understanding between societies. The final category of potential harms caused by AI is unreliable, unsafe, or poor-quality outcomes. The design process of an AI system is crucial to the reliability of its outcome. Any

negligent behavior in any development step of a system (data collection, data handling, design and implementation, testing, deployment etc.) may result in poor outcomes. In addition to causing harm to the wellbeing of individuals and the public, these poor AI systems may also hurt the public trust against AI systems in general. If an autonomous car makes an obvious mistake and injures or even kills a person, then the public opinion may become extremely fragile against the safety of autonomous cars. Policy-makers on AI and funders of AI systems may incline towards rethinking their positive stances.

I will now move on to reviewing some use cases on the potential ethical harms of AI systems. An example is a system called COMPAS, a risk assessment software analyzing if a criminal is likely to reoffend by analyzing the profile data of the criminal. In 2017, an inquiry by a non-profit news organization called ProPublica showed that the system is somewhat racially biased.¹¹² In their analysis of more than 10,000 criminals in Florida, checking if they reoffended or not, they found some unsettling results. In predicting the criminals that actually reoffended, there was no racial bias since the number of actual reoffenders was roughly the same among white people and people of color. However, the number of people of color who were falsely identified as “likely reoffenders” was twice as much as white people. This shows a disturbing racial discrimination and to think about that this algorithm is being used widely in the U.S. courtrooms adds up to the importance of the subject. There are potential problems for other automated decision making (ADM) systems used in different areas such as credit scoring on deciding whether a customer should be given a loan or not, job applications on deciding if a candidate is suitable for a position or not, and even offering cell-phone deals to customers for a reduced cost.

¹¹² Spielkamp, “Inspecting Algorithms for Bias.”

One point to emphasize here is that this is most likely a case when the bias is in the analyzed data itself. An example I can give is that between January 2004 and June 2012, New York City police stopped 4.4 million people on the streets to question them, or search them for weapons or contraband. It is interesting that 88 percent of the people who were stopped and searched were released without any action. What is even more interesting is that 83 percent of the people who have been stopped were either black or hispanic and the population of the two groups were just over half the population²³. This actually relieves at least some of the responsibility from the AI system since the data set used in the training and testing phases of this system was already flawed with actual human bias and discrimination. On the other hand, AI ethics guidelines developed by governments, firms in the industry, and institutions all over the world holds the developers of the system responsible for implementing the system without checking for (or even worse knowing that there exists) any bias or discrimination in the data.

The AI Now Institute of New York University issues annual reports on the development of AI ethics, emerging problems, and possible solutions to these problems. In the report issued for 2018, they talk about the dangers posed by AI based surveillance (particularly face recognition) and automated decision making systems.¹¹³ It is public information that China uses AI-enabled facial recognition tools to monitor large amounts of people and profile them. Facial recognition faces the most public scrutiny among other AI based surveillance systems (such as biometric fingerprint recognition, handwriting recognition, signature recognition, and even gait recognition.) An apparent reason is that facial attributes of a person are very sensitive biometric personal data as it is not easy to change or it is not possible

¹¹³ AI Now Institute, *AI Now 2018 Report*.

to opt-out from an actively monitoring camera. Also, after recognizing a face, it is possible for an algorithm to link the identification of a person to other sorts of personal data such as their criminal records, social graphs, and credit scores. Another reason for the public scrutiny is that it is possible to make predictions about an individual's emotions, intentions, even lip readings through the analysis of face features.

It is claimed in the AI Now Report 2018 report that some growing technology companies have the infrastructure to monitor the behaviors of their users for marketing purposes and even Pentagon funded AI based surveillance systems to apply large-scale behavior analysis on social media¹¹⁴. Even in the field of education, some U.S. universities have tried to use emotion analysis on their students in classrooms.¹¹⁵ Their motivation was to detect the emotions of students with a webcam in the classroom and analyze the results for teachers to adapt the lecture in a way that encourages the engagement of students. This may be a harmful AI system in multiple degrees. First, a simplified emotion recognition system may not be able to grasp some complex emotions of students (poor AI system). If a student is predicted as “angry”, does the student or even the lecturer know how this algorithm came to this conclusion (inexplainable, unjustifiable AI system). Does the system respect the privacy of the students, meaning that where does the collected data is stored, and is the data processed or reported in any way that may cause a privacy problem (an AI system with privacy issues). It is also perplexing that there is no evidence the students were informed about or consented to the pilot use of the system. It can be

¹¹⁴ AI Now Institute, *AI Now 2018 Report*.

¹¹⁵ Lieberman, “Sentiment Analysis Allows Instructors to Shape Course Content around Students’ Emotions.”

clearly seen that such a student monitoring system raises many questions related to AI ethics.

ETH Zurich Health Ethics & Policy Lab recently published a paper in *Nature* examining the AI ethics policies of the countries and the issued parties in 2019.¹¹⁶ In their study, the researchers present a demographic of 84 documents on ethical guidelines issued by policy-makers, companies, and institutions. The research shows that more economically developed countries lead the way in the amount of published ethical guidelines on AI with the USA leading with 20 documents (23.8%), followed by UK with 14 documents (16.7%), and third place in Japan by 4 documents (4.8%). These findings support the fact that many use cases about AI ethics around the world are mostly emerging from the USA and the EU countries (total number of documents on AI ethics in all EU member states including the guidelines issued by EU is 19). See Appendix A for the table of issued AI ethics guidelines.

There is still a long way to go for establishing, and more importantly, applying a solid and unified view of AI ethics in the development of AI systems. On the other hand, there is a promising example. A recent study including Turkish AI researchers implemented an AI system for detecting if a person is lying or not by using the testimony videos from courtrooms.¹¹⁷ In their system, they eliminated any feature that may cause discrimination such as race and ethnicity from their training and testing sets to build a system that does not rely on such attributes.

¹¹⁶ Jobin et al., “Artificial Intelligence: the global landscape of ethics guidelines.”

¹¹⁷ Ngo et al., “Deception detection by 2D-to-3D face reconstruction from videos.”

2.2.3 Social issues

The social issues introduced by the AI systems heavily intersect the topics of legal and ethical issues. In this section, I will present a brief summary on selected social issues that AI algorithms bring. I will mainly cover three topics: Impact of AI on labor, the use of AI based systems and its implications in healthcare, and the issue of data privacy arising from AI.

It is estimated that by 2030, global GDP may rise up to 14% with the increasing development and take-up of AI.¹¹⁸ Another study estimates that 12 developed economies will double their annual economic growth rate by 2035 with the help of AI. Majority of studies emphasize the same result: AI will have a serious impact on the global economy. On the other hand, increasing use of AI systems in many fields raises questions about whether AI will create more jobs or cause unemployment because of automated systems. While the debate in the role of automation in the economy is still ongoing, there are some concerning studies. One particular study by OECD among 32 countries points out that half of the jobs could be affected by automation to some degree.¹¹⁹ Highly automatable jobs in OECD countries take-up almost 14% of all jobs (a highly automatable job means that the automation probability is above 70% for that job). This corresponds to 66 million workers among the 32 countries in the study.

There are different views among researchers on whether AI will create more jobs or cause more unemployment.¹²⁰ A view is based on the transformation of the agriculture industry in the U.S. In 1900, the agriculture industry was 41% of the U.S. workforce. In 2000, this number was reduced to only 2%. Even with this dramatic

¹¹⁸ European Parliamentary Research Service, *Economic impacts of artificial intelligence*.

¹¹⁹ Servoz, *The future of work? Work of the future!*

¹²⁰ The AI Now Institute, *The Social and Economic Implications of Artificial Intelligence Technologies in the Near-Term*.

change, unemployment in the long-term has not increased. However, other economists think that the wide adoption of AI systems in different industries will extremely reduce the number of available jobs. Furthermore, labor economists still debate on whether the transformations in the labor market are related to technology or they are caused by economic policies. Still, some economists including Joseph Stiglitz and Larry Mishel argue that regulations and other policy changes related to automation systems and AI should be carefully considered to protect workers.¹²¹

Another question to think about with AI systems impacting labor is that will the jobs created by AI be desirable jobs with a decent wage. Furthermore, many studies focus on the fact that AI will impact the labor on low-wage, working class jobs such as trucking, retail, and service work. However, there is significant research on assistant AI systems in sectors that include specialized education or advanced degrees, such as medicine or law. In light of this, more issues arise with professional responsibility and liability.

AI systems also impact the traditional employer-worker relationships. Uber, for example, uses an AI and big data driven algorithmic management system for automated scheduling of drivers and the assignment of drivers to clients.¹²²

According to AI Now Institute, the use of AI-driven workforce management and scheduling systems are increasing to remotely manage labor. Although this approach has its advantages, there are also numerous studies that show the tension and uncertainty experienced by the workers.³² The problem arises from the fact that algorithms assign less work to some employees, causing a stable underemployment.

¹²¹ The AI Now Institute, *The Social and Economic Implications of Artificial Intelligence Technologies in the Near-Term*.

¹²² Lee et al., "Working with machines: The impact of algorithmic and data-driven management on human workers," 1603-1612.

This causes a chain reaction starting from financial instability issues to not having enough social benefits and protections as traditional full-time workers. It is harder for workers to spare some time for family or self-care, or even search for another job since such algorithmically managed schedules require workers to be available around-the-clock.¹²³ Gleason and Lambert state in their study “uncertainty by the hour” that camera surveillance systems watching employees while they work to monitor their productivity (or software that track the sales counts of workers) are actually making it much harder for them with the illusion of awarding the hard-working ones. Mostly, the reward for these workers are more preferable schedules with more hours. Workers work even harder in their short shifts to get more hours as rewards. However, since the workers are paid hourly and the system is designed to keep them working part-time or close to part-time, extra hours only add extra fatigue for workers and the additional money that they earn from these extra hours do not add up to their financial stability.³⁴

I will now move on to the impact of AI systems used in healthcare from a social perspective. AI systems in healthcare, as it is the case for most of them, work on large collections of data sets to come up with complex statistical models and machine learning to obtain an understanding of the data and to make predictions or decisions based on it. Some examples of AI systems research on healthcare are on patient risk stratification¹²⁴ and reducing readmissions for heart failure and heart diseases.¹²⁵ These approaches continue to grow with the amount of healthcare data

¹²³ Gleason and Lambert, “Uncertainty by the Hour.”

¹²⁴ Wiens et al., “Patient risk stratification with time-varying parameters: a multitask learning approach,” 2797-2819.

¹²⁵ Bayati et al., “Data-driven decisions for reducing readmissions for heart failure: General methodology and case study,” 2-9.

being available. Stable and accurate collection of electronic health records (EHR) play an important role in this.

There are a few social issues that may arise from the usage of AI systems in healthcare and medicine. One of them comes from the nature of AI: Leveraging under-representing or biased collections of data to build the systems. Medical data used to train and test the AI system should ideally be objective and universal. As discussed in the section on ethics, data should not contain any biases or discriminations of the people who collect them or implement the system that uses them. Large collections of medical data should also be as general and representative as possible. For example, AI systems present great benefits for healthcare research in terms of their ability to help with the diagnostics. Because of its nature, AI systems are good at finding patterns in vast amounts of data and this may lead to early diagnostics of very rare and critical diseases.¹²⁶ Another problem in healthcare may arise from the accessibility and affordability of such AI systems. Evidence already shows that access to medical care is distributed unequally. More specifically, female, poor, and non-white communities are often in a disadvantage.¹²⁷ This requires a careful consideration for AI systems since the collected data to train and test the systems should also include the conditions of the often underprivileged and underrepresented communities. If this is not the case, such systems will only reflect the medical properties of some fortunate people who have stable access to healthcare and in the end they will build up a medical database that completely excludes the people who do not have access to affordable healthcare.

¹²⁶ Paparrizos et al., "Screening for pancreatic adenocarcinoma using signals from web search logs: Feasibility study and results," 737-744.

¹²⁷ Artiga, "Health coverage by race and ethnicity: The potential impact of the Affordable Care Act.," 10-11.

As another social issue that AI systems cause, I will move on to the problems with data privacy. Not getting too far from the healthcare domain, using medical records as data sets for AI systems poses a great threat for the privacy of the patients. As it is known, a person's medical data is accepted as sensitive data. Increasing use of EHRs on AI systems makes one question the security and anonymity of the sensitive data since the records are kept and shared across multiple databases and computer networks. A security breach in any one of these distributed systems may cause harmful third parties to access the patients' sensitive medical records.¹²⁸ Although there are some advanced encryption technologies that allow the use of sensitive data in AI systems without anyone actually seeing them, the development of these technologies are still far from being used in general-purpose applications. A concerning example is from the insurance industry. Some insurance companies are using genetic risk information to categorize the insurance level of their clients. Despite the fact that the genetic information is highly sensitive and personal, it is now common to use it in data analytics for differential pricing.¹²⁹ Furthermore, a good deal of software that collects data are proprietary software, meaning that they are not open-source and experts cannot examine their code to see if there are any possible problems or bugs that will endanger the safety and security of the collected data.¹³⁰

Perhaps the most concerning issue on privacy is related to AI-driven face recognition and affect recognition systems. In China, government and military backed automated surveillance technologies are being used, mostly targeting marginalized groups, to monitor large amounts of people. There is reported use of

¹²⁸ Nissenbaum, "Biosensing in context: Health privacy in a connected world," 79.

¹²⁹ Joly et al., "Life insurance: genomic stratification and risk classification," 575-579.

¹³⁰ Pasquale, *The black box society*.

facial recognition systems at the Hong Kong-Shenzhen border.¹³¹ There are also robotic surveillance drones in China across five provinces that are being used to monitor the population.¹³² Social credit monitoring system deployed in China is also one of the uses of AI based surveillance that greatly resembles the dystopian TV-series Black Mirror.¹³³

In Xinjiang Autonomous Region, a Uighur ethnic minority area, use of the automated surveillance system is very pervasive.¹³⁴ There are reports of common use of surveillance cameras, Wi-Fi sniffers, biometric data collection, and spyware to collect data and build AI systems to get lists of possible suspects for detention. These are very dangerous examples of AI-driven systems that do not care for any kind of privacy since the people being subjects to these systems neither have the option to opt-out nor have asked for consent.

I will finish this section with a quote from the AI report of International Development Research Centre of Canada:

...ML techniques that learn by finding patterns in datasets, such as deep learning, have a higher inherent risk of bias and privacy threats. If a training dataset contains biased data, the algorithm will learn this bias. If the algorithm feeds into consequential decision-making processes, it can reinforce or even exacerbate existing social inequalities. Furthermore, if an algorithm is designed to extract personal information from data, it can jeopardize the privacy of the individuals whose data are in that dataset. Depending on the context, this loss of privacy can seriously undermine fundamental human rights

After having discussed all the pitfalls, now we can move onto take a look at the foundations of the term “AI for Social Good” as widely used by various actors.

¹³¹ Shen, “Facial Recognition Tech Comes to Hong Kong-Shenzhen Border.”

¹³² Chen, “China’s Robotic Spy Birds Take Surveillance to New Heights.”

¹³³ Morris “China Will Block Travel for Those With Bad ‘Social Credit’.”

¹³⁴ The Economist, “China Has Turned Xinjiang into a Police State like No Other.”

2.3 The emergence of AI for social good

Thanks to the modern twist placed in it under the title of “social”, the term “social good” has and is becoming more popular each day, replacing more traditional ones such as “common good,”¹³⁵ which can be described based on the ideas of Aristotle as “proper to, and attainable only by, the community, yet individually shared by its members,”¹³⁶ and “philanthropy”, explained by the Oxford Dictionary as “The desire to promote the welfare of others, expressed especially by the generous donation of money to good causes.”¹³⁷ The notions like “Big Data for Social Good”, “Social Media for Social Good”, “Data Science for Social Good” and one of the most recent additions to the term pool “AI for Social Good”, or simply, “AI for Good” found their way into the literature.

Even though the idea of using technology to address and ensure social good is not a new one, the growth of AI, both in terms of research and its applications, caused public and private organizations to consider brainstorming about ways to implement the new technologies for purposes of what can be referred to as common good. In a rapidly changing world and on the brink of what is viewed as the fourth industrial revolution, where we can track the data retrieved from cellular phones in Sub-Saharan Africa region after a disaster or follow and analyze social media platforms to assess the damage during a crisis, the innovation of the humanitarian sector was also inescapable and necessary.¹³⁸

While there are many concerns using real-life applications of AI integrated advancements such as autonomous vehicles or assisting systems for medical

¹³⁵ Bentley, “The Question You Were Too Afraid to Ask: What is Social Good?”

¹³⁶ Dupré, “The Common Good and the Open Society,” 690.

¹³⁷ *Oxford Dictionaries*, s.v. “philanthropy,” accessed October 2, 2019, <https://www.oxfordlearnersdictionaries.com/definition/english/philanthropy?q=philanthropy>

¹³⁸ Betts and Bloom, *Humanitarian Innovation: The State of the Art*, 4-6.

diagnosis for humanitarian purposes, especially in regard to the transparency and explainability,¹³⁹ the deployment of AI technologies in the field seems unavoidable, moreover, welcomed by many organizations as in the SDG Action Zone held during High-level week of UN General Assembly on September 2019, the Deputy Secretary-General of the UN, Amina J Mohammed, highlighted the importance of AI technologies for achieving the 17 Sustainable Development Goals (SDGs) and 169 targets set by the UN in the 2030 Agenda For Sustainable Development adopted by the member states in 2015, the fact that this statement was expressed in words by her can be viewed as an indication that the existing and upcoming AI technologies will become and remain a key player when it comes to global humanitarian work.¹⁴⁰ To see a more detailed account of the SDGs and anticipated results of their implementations, you can see Appendix B.

Other than their contribution to the humanitarian aspects of the practices related to the social good, AI technologies already found their place in our daily lives, finding solutions to our daily issues such as traffic, education or health; the importance of AI-centric solutions is highlighted once more when XPRIZE, a non-profit organization established in 1994 that holds prized competitions to bring solutions to the global societal challenges, in partnership with IBM Watson opened a four-year competition with a total prize purse of \$5 million on June 23, 2016 with the aim to encourage people working in the field to demonstrate the ways to apply AI-technologies to solve current problems for human benefit through human-machine collaboration.¹⁴¹

¹³⁹ Kaspersen, “Deploying Artificial Intelligence technologies in humanitarian action is not without risks.”

¹⁴⁰ Mohammed, “Advancing the Global Goals with AI, SDG Action Zone during the High-Level Week.”

¹⁴¹ XPRIZE, “AI to solve the world’s grand challenges.”

In addition to this, as the use of AI applications started to get common each passing day, the need to set a global standard and open a healthy dialogue by sharing knowledge and experiences also grew; the third edition of the AI For Good Summit, a United Nation's platform for bringing leading companies, humanitarian officers, governments and international cooperations together to solve problems by utilizing AI was held in Geneva from 28 to 31 May 2019¹⁴² and highlighted a wide range of problems such as education, healthcare and wellbeing, social and economic equality, space research, and smart and safe mobility,¹⁴³ which can be solved through open dialogue and collaboration, a community-driven platform AI Commons¹⁴⁴ was formed to bring problem owners with people working in the field. who can offer AI-solutions, under the same roof to work on projects with a global impact.

Moreover, many of the big technology companies with great market values such as Google, Facebook, Sony and more not only open their own units in pursuit of a more socially responsible and ethical AI but also they get involved inclusive platforms that support formulating AI practices that benefit society while ensuring equal accessibility and explainability¹⁴⁵ so that the understanding of the public can advance in parallel with the growth of AI applications since the future should be designed in a way that takes into account all layers of society, including governments, private and humanitarian sector and public itself to maximize the social benefits of the newest technologies; as stated in the words of Dr. Ayanna Howard, the School Chair for Interactive Computing in the College of Computing, Georgia Institute of Technology "...it is our responsibility to ensure that we are an

¹⁴² AI for Good, "AI for Good Global Summit."

¹⁴³ The International Telecommunication Union, "3rd AI for Good Global Summit gives rise to 'AI Commons'"

¹⁴⁴ AI Commons, "About us".

¹⁴⁵ Ibaraki, "Why 'AI for Good' is gaining ground".

integrated part of the conversation that includes all diverse stakeholders – whether it is corporations, policy makers, or just the general public.”¹⁴⁶

To create a productive and multidisciplinary environment where ideas regarding the ways to implement such technologies in line with the existing public policies and recreate some policies in order to safely adopt these technologies in today’s world to increase the quality of life and level of sustainability, academics from related fields, students, policy-makers and people from industry and non-profit organizations gather together to bring solutions.

Though the term “AI for Social Good” received good publicity as of 2018, there were other notions which covered similar concepts and offered solutions through ever-growing pool of data.

“Data for Good”, “Data Science for Good” or “Big Data for Good”, “ML for Good”, “Beneficial AI”, or simply “Science for Good” all found their way into the literature in one way or another; though the definitions of “Data Science”, “AI” and “Machine Learning” differ from each other in many ways, surprisingly, for these sorts of events and publications, they almost seem to be referred interchangeably. It could be said that in the eyes of non-technical people when it comes to talking about such projects and events the titles “Data for Social Good” evolved into “ML for Social Good” and finally to “AI for Social Good”. While the terminology changes from data to ML to AI, the main concept does not differ, as all these refer to the same idea, which is to make use of these technologies in a way that will benefit the public.

As the call for papers are conducted in line with the SDGs of United Nations, some of the papers directly focused on the issues highlighted by the UN and targeted by the sustainable development goals, for example, in their paper presented at ICLR

¹⁴⁶ Partnership On AI, “Dr. Ayanna Howard”.

AI for Social Good Workshop 2019 “AI-based evaluation of the SDGs: The case of crop detection with earth observation data”, Natalia Efremova, Dennis West and Dmitry Zausaev show an example of using computer vision and pattern recognition technologies to efficiently segment satellite imagery for crop detection.¹⁴⁷

Using the data from satellite imagery for various problems is also a trending topic in the papers presented at the AI for Social Good Workshops; the satellite imagery can be used for solving many problems not only for agricultural purposes as explained in the aforementioned study of Efremova and et al but also for disaster monitoring and prioritizing emergency response¹⁴⁸ as well as mapping the distribution of poverty in developing countries such as the Philippines.¹⁴⁹

It is also important to note that one of the papers on the subject of improving traffic safety through video analysis by using classification, motion and segmentation models, which was submitted to NeurIPS AI for Social Good Workshop 2018, was about a project supported by Jakarta Smart City, a management division operating under Jakarta Provisional Government, and the United Nations Global Pulse Jakarta (PLJ),¹⁵⁰ proving that these types of projects have caught the attention of smaller governmental organizations and have real-life applications that can solve real-life, daily issues like traffic jams in addition to more major problems arising due to poor healthcare, unsustainable agriculture practices, unequal development or inaccessible education.

¹⁴⁷ Efremova, et al., “AI-based evaluation of the SDGs: The case of crop detection with earth observation data”.

¹⁴⁸ Doshi, et al., “From satellite imagery to disaster insights”.

¹⁴⁹ Tingzon, et al., “Mapping Poverty in the Philippines Using Machine Learning, Satellite Imagery, and Crowd-sourced Geospatial Information.”

¹⁵⁰ Caldeira et al., “Improving Traffic Safety Through Video Analysis in Jakarta, Indonesia.”

Organizers from different backgrounds hold various events related to the applications of these technologies for social good, which can be sponsored by public or private institutions as well as academic institutions such as “UK’s Data For Good Conference” bringing practitioners together with non-profits,¹⁵¹ The Alan Turing Institute’s “AI For Social Good” symposium¹⁵² many others initiated by private companies, an example being Bloomberg’s Data for Good Exchange, whose overall theme of 2019 is highlighted as “Data Science for the SDGs” and which will contemplate the idea of “how data scientists, corporations, policy-makers and researchers can collaborate on data science projects that will move us toward achieving the UN’s Sustainable Development Goals by 2030.”¹⁵³

When looked into the literature, we see that AI for Social Good stands as an umbrella term for defining the application of AI-based technologies for solving social problems and for using them to aid humanitarian action. Though, I will be briefly describing how these applications are utilized for humanitarian purposes in the following paragraph, I would like to point out that the majority of this thesis will focus on cases that fall under the former definition. If needed to be divided into two main categories; AI for Social Good can be considered to be a generic term for explaining projects that utilize “AI for Humanitarian Action” and “AI for Common Good”, which constitutes the main topic of this thesis and defines the real essence of what I refer when I state the term “AI for Social Good”.

Humanitarian action in the broadest sense, is defined as “saving lives, alleviating suffering and maintaining human dignity during and in the aftermath of crises”. The definition also implicitly includes preventing and strengthening the

¹⁵¹ Data For Good Conference, “About”.

¹⁵² Alan Turing Institute, “AI For Social Good”.

¹⁵³ Bloomberg, “About Data For Social Good Exchange”.

preparedness for the occurrence of such situations globally. Crises include natural disasters such as earthquakes, flooding, tsunami, climate change and also “human-triggered” disasters such as displacement of affected people from wars or dangers to civilians in armed conflict zones.¹⁵⁴

There are four core principles of humanitarian action that should be taken into account before taking any action. The first principle is humanity, meaning that the suffering of humans must be addressed wherever it is found since the objective of humanitarian action is to preserve health, life and guarantee respect for human beings. The second principle, neutrality, consists of not taking any sides in hostilities or engaging political, racial, ideological or religious controversies whatsoever. Impartiality is the third principle that ensures giving priority to the most urgent cases and carrying out humanitarian action on the basis of need. Actors of humanitarian action should not make any distinctions based on nationality, race, gender, religious belief, class or political opinions. The final principle is independence, meaning that humanitarian action must not be driven with political, economic, military, or other objectives that the actor may be related to where the action is being applied.¹⁵⁵

The term “AI for Humanitarian Action” comes into play where the data-driven, cloud-enabled and largely scalable AI systems come into play for solving problems related to the immediate response and the long-term preparation for natural and human-triggered disasters. The president of Microsoft, Brad Smith states that:

...while global relief organizations scramble to respond to these events, their work by definition is often reactive and difficult to scale. We believe that technology, like artificial intelligence (AI) combined with cloud technology, can be a game changer, helping save more lives, alleviate suffering and restore human dignity by changing the way frontline relief organizations anticipate, predict and better target response efforts.¹⁵⁶

¹⁵⁴ Organisation for Economic Co-operation and Development, *Towards Better Humanitarian Donorship*.

¹⁵⁵ Inter-Agency Standing Committee, *Introduction to Humanitarian Action*.

¹⁵⁶ Smith, “Using AI to help save lives.”

In conjunction with the United Nations General Assembly, Microsoft announced in 2018 that the company is launching “AI for Humanitarian Action” program by providing \$40 million as funding. It is pledged that the initiative will focus on four areas in a five year program, helping disaster recovery, helping with the needs of children, protecting refugees and displaced people, and promoting respect for human rights.

A case worth mentioning related to AI for humanitarian response is the multi-partnered challenge issued in 2018 with the anonymized mobile phone usage data collected by Türk Telekom, the Data for Refugees (D4R) Challenge,¹⁵⁷ led by Albert Ali Salah and colleagues. The scientific committee of the challenge issued a call for projects that makes use of the provided data to solve the integration, safety and security, health, education, and unemployment problems of the refugees in Turkey (which was numbered more than 3 million at the time). Within the scope of the challenge, a number of projects were awarded. An example of AI driven solutions to the healthcare focused problems of refugees of Turkey is quantifying the risk of epidemics by examining the mobility patterns of refugees in Turkey in the context of spreading of measles.¹⁵⁸ Another example, focused on improving education opportunities for the refugees, analyzes the mobile phone data to better allocate resources to provide access for refugees to schools to prevent a “lost generation” because of the displacement and lack of education.¹⁵⁹

In consideration of all these, in the following chapter, I will move onto make a definition of social good by diving in-depth into the notions it entails as well as

¹⁵⁷ Salah et al, “Data for refugees: the D4R challenge on mobility of Syrian refugees in Turkey.”

¹⁵⁸ Bosetti et al, “Reducing measles risk in Turkey through social integration of Syrian refugees.”

¹⁵⁹ Mamei et al, “Improve education opportunities for better integration of Syrian refugees in Turkey,” 381-402.

review documents issued by tech giants with regard to the subject. Moreover, I will use the UN's SDGs as a framework to show the real-life applications of AI technologies for social good and propose means to enable utilizing these systems for social good.

CHAPTER 3

ARTIFICIAL INTELLIGENCE FOR SOCIAL GOOD

If you run a simple online search to figure out what is social good, you may end up being greatly disappointed since you will see that there is not a single explanatory page in regarding the title itself.

However, as stated in the last section of Chapter 2, notions like “Big Data for Social Good”, “Social Media for Social Good”, “Data Science for Social Good” and one of the most recent additions to the term pool “AI for Social Good”, or simply, “AI for Good” found their way into the literature somehow.

Though cannot be defined in plain words yet, the term ‘social good’ is out there, not only appearing in the curriculums of some of the most prestigious universities offering computer science courses¹⁶⁰ and being a focus of students clubs in various campuses,¹⁶¹ aiming to “empower students to leverage technology for social good by inspiring action, facilitating collaboration, and forging pathways towards change.”¹⁶² but also being discussed for hours by world’s leading computer scientists, all experts in their field, in workshops held by top institutions and conferences.

To understand what “AI for Social Good” is all about, we need to first begin with defining what, in fact, social good is.

¹⁶⁰ Stanford University included many courses focusing on utilizing AI technologies for social good, to name a few: CS 106S: Coding for Social Good, CS 51: CS + Social Good Studio: Designing Social Impact Projects, CS 52: CS+ Social Good Studio: Implementing Social Good Projects, CS21SI: AI for Social Good. To have a general idea about the content of such courses, you can check the syllabus of Stanford University’s AI For Social Good course here: web.stanford.edu/class/cs21si/schedule.html

¹⁶¹ Georgia Tech <https://www.gtcsocialgood.com/>, Duke <https://hackduke.org/>, MIT <http://codeforgood.mit.edu/>, Stanford <https://www.cs4good.org/>, UC Berkeley <https://calblueprint.org/> and many more are now home to student clubs, run by students from a wide range of studies, targeting social problems and hoping to make a social impact through collaboration.

¹⁶² GT CS + Social Good, “About.”

In addition to defining the meaning of the word, we need to come up with a framework to figure out the ways to implement AI-based technologies for the purpose of solving global social problems, regardless of the country where the project is developed. Considering these, just like many other scholars working in the area, I opted to use the SDGs, which I will cover in the third section of this chapter, as a set of rules that clearly highlights the means to implement AI solutions to some of today's most crucial problems, which can only be solved through a collective and interdisciplinary effort as "The complexity of sustainable development cannot be adequately addressed by research approaches restricted to single scientific disciplines."¹⁶³

In light of all these, for this chapter I would like to divide the approaches involving "AI for Social Good" projects into three parts: the first part will define the concept of social good, and offer ideas in regard to the ways to enable it, the second section will consider the means to use AI for Social Good considered within the framework of SDGs, which, in absence of a globally agreed upon approach seem to constitute the most coherent set of rules; the third one is big technology companies' approach and definitions regarding the subject, which can be quite influential due to the scope of impact companies hold in the tech ecosystem.

3.1 Defining and enabling "social good"

It is uncommon to see such a vague concept, lacking a clear definition stating what it really is and what it is not, coming this far and finally taking place in the center of

¹⁶³ Zinsstag et al., "Interdisciplinary approaches in research for sustainable development," 207.

many heated and surprisingly multidisciplinary discussions, however, social good has become a buzzword for the tech literate portion of the population.¹⁶⁴

AI for Social Good gained a solid ground in academia and research circles as it is not uncommon to see more and more prestigious conferences such as Conference on Neural Information Processing Systems (NeurIPS), International Conference on Learning Representations (ICLR), International Conference on Machine Learning (ICML) holds workshops under the title of AI for Social Good with a wide range of focus-topics including but not limited to concerns such as improving traffic safety, increasing rural water supply, using satellite imagery for disaster monitoring as well as agriculture and health monitoring.¹⁶⁵ Currently, the call for papers is held within the framework of nine objectives listed based on seventeen SDGs announced by the UN and hopes to bring solutions to social problems that fall under the categories of and focusing on education, protecting democracy, assistive technology for people with disabilities, health, agriculture, environmental sustainability, social welfare and justice, sustainable development by using AI-technologies with an interdisciplinary approach.¹⁶⁶

One of the most acclaimed of these workshop papers, presented at the ICLR AI for social good workshop 2019, deals with the issue of creating a systematic pipeline to have a timely emergency response when faced with incidents or disasters such as traffic accidents or fires by using an algorithmic approach, which will help the first responder teams while they prioritize their actions and follow a well-established strategy.¹⁶⁷

¹⁶⁴ Bentley, “The Question You Were Too Afraid to Ask: What is Social Good?”

¹⁶⁵ You can see a list of accepted papers at NeurIPS 2018 AI for Social Good Workshop here:<https://aiforsocialgood.github.io/2018/acceptedpapers.htm>

¹⁶⁶ AI for Social Good, “Call for Papers.”

¹⁶⁷ Mukhopadhyay and Vorobeychik, Pipeline for emergency response.

Another above stated factor to be emphasized on is the importance of open platforms while tracing the progress of AI development. In terms of AI systems and software, open platforms can be described as;

...software programs that has provision for open application programming interfaces (API), or flexible scope to use the software for purposes other than as it was intended, or has an open source code that can be edited by users to tailor it to their needs, or allows free adoptability – usage without going through official channels, or adaptability – editing functionality of specific features.¹⁶⁸

These platforms are of great value since developing AI models can be extremely expensive, and along with the uneven distribution of AI talent, building and training a model can be quite time and resource consuming; the platforms make it is easy for developers to access the necessary frameworks, datasets and models, which will help them develop a system upon already tested and established foundations.¹⁶⁹ In general, “openness” of AI platforms and the systems’ development process will contribute greatly to field’s advancement by giving a chance to the underrepresented and under-resourced communities on accessing the source code, data, capabilities to put their own cents, which will pave the way for equal development and technological advancement in view of these new applications as well as will speed the development progress thanks to its inclusiveness of data, labor and funding in short-term, and in long-term it will fuel the competition to bring in more to the table.¹⁷⁰

In addition to the positive outcomes of having open platforms with regard to their contributions to the advancement of the field, these collaborative efforts can be an opportunity to ensure using AI applications for social good by providing the

¹⁶⁸ The Business Professor, “Open Platforms vs Closed Platforms – Definition.”

¹⁶⁹ Rimi, “Artificial intelligence: an open source future.”

¹⁷⁰ Bostrom, *Strategic Implications of Openness in AI Development*.

organizations with similar, current or potential, problems with common technological solutions by offering an established system that will help the practitioners customize aligned with their own needs and the cases' requirements depending on the problems they encounter; if the problematic patterns overlap in many areas, so will the foundations of guidance and support they require, which, in this case, is a generic open platform that can be specialized to adopted in different situations originated from the same roots, as it is evident in the similarity of the datasets.¹⁷¹

At the moment what is really worrying is that there is neither a sign of a global governance that is coming soon apart from a series of fact sheets and documents published by various institutions, organizations and governmental organs originated from different countries and disciplines, nor a set of global regulations that handle this delicate subject as the foundation of worries related to the concept of using AI technologies for social good lies in-depth of the meaning of the term; there is a chance that what is viewed as good by a group of people might mean other things to another group.

An example of such a dilemma can be easily discussed through the military applications of AI integrated systems such as semi autonomous and autonomous vehicles with sensor suites that can aid the soldiers by performing certain assigned and independent tasks,¹⁷² intelligence services with face recognition, which is a very controversial topic since it lacks explainability in the eyes of the public, full of concerns arising out of ethical and legal aspects of the situations.

¹⁷¹ Mojsilovic and Varshney, "Open Platforms for Artificial Intelligence for Social Good: Common Patterns as a Pathway to True Impact."

¹⁷² Hoadley and Lucas, "Congressional Research Service Report: Artificial Intelligence and National Security."

When talking about such dilemmas, one may think that the only problem is to decide whether to integrate the systems or not to somehow weaponize AI as they tend to be unexplainable in their decision-making,¹⁷³ especially in the view of people not involved in the field but the real issue it constitutes is one that has always been, is and will be controversial for many more years: Who is deciding what and who is good and what and who is bad? How to define what is good and what is bad and how to react when a decision is taken in this regard?

If one thinks that the answer lies in a statement that involves notions such as “the nations’ good” or “the common good of the country”, it is important to remember that in his works “The Discourses on Livy” and “The Prince”, Niccolo Machiavelli, a Renaissance philosopher of modern politics, whose cynical ideas about what is best for the future of the republic promotes heated debates among politicians, philosophers, scientists alike, also underlined the importance of patriotic-like ideas can be summarized in his own words as “bringing common benefit to everyone.”¹⁷⁴

On the other hand, as opposed to Aristotle and Machiavelli’s republican approach to the notion,¹⁷⁵ it is also important to highlight that phrase “social good,” which found itself a place within studies and/or statements related to the technological developments and ethical and social concerns of their applications, in the contemporary sociopolitical discourse seem to originate from a liberal approach that is more human rights-based and proclaims that the common good of the society

¹⁷³ United Nations Interregional Crime and Justice Research Institute, “Artificial Intelligence and Robotics.”

¹⁷⁴ Hanasz, “The Common Good In Machiavelli,” 57-85.

¹⁷⁵ Lee, S. (February 15, 2016). “Common Good”. *Encyclopædia Britannica*. Retrieved from <https://www.britannica.com/topic/common-good>

can be achieved through ensuring equal standards and rights for all, and they are also a way to realize the said common good.¹⁷⁶

Regardless, none of the above definitions can completely cover what is framed by “AI For Social Good” as they cannot catch up with modern times in terms of globalization; when looked at the most acclaimed papers published in the field, it is not uncommon to see a scientist from a country can work in a project in another one to bring a solution that does not directly affect his homeland, which makes the term “AI For Social Good” more inclusive than the above-mentioned ones, moreover, a part of supranational social policy. It is important to remember that the most challenging societal problems we face have political origins and cannot be solved without specifically addressing the meaning of what good is, what social good entails and how it can be applied.¹⁷⁷

For the purpose of this thesis that tries to offer a framework to work with in absence of regulations, defining the concept of “social good” as an act or service that “benefits the largest number of people in the largest possible way”¹⁷⁸ and using the SDGs released by the United Nations as a roadmap to define “social good” projects developed by utilizing AI-based technologies by abiding to the human rights regime seem to make sense, which is an idea also emphasized by the UN itself; in the SDG Action Zone held during High-level week of UN General Assembly on September, 2019, the Deputy Secretary-General of the UN, Amina J Mohammed, highlighted the importance of AI technologies for achieving the SDGs, a statement indicates that while there are many concerns using real-life applications of AI integrated advancements such as autonomous vehicles or assisting systems for medical

¹⁷⁶ Jaede, “The Concept of Common Good.”

¹⁷⁷ Moore, “No, AI is not for social good.”

¹⁷⁸ Guidi et al., “C.T. Editorial: Smart Objects and Technologies for Social Good ,” 1680–1681.

diagnosis for humanitarian purposes, especially with regard to the transparency and explainability,¹⁷⁹ the deployment of AI technologies in the field seems unavoidable, furthermore the existing and upcoming AI technologies will become and remain a key player when it comes to global social work.¹⁸⁰

While defining the essence of social good can be very tricky, so is the journey of developing social good projects by utilizing AI applications, as deploying an AI project without considering the outcomes may cause unintended results; in his paper recently published under AI for Social Good workshop in NeurIPS 2019, Ben Green rightly says that the solutions of good brought to the table by only computer scientists tend to aspire to improve the system rather than change it,¹⁸¹ which is understandable as it is not their job to dive into the reasons of the problem at hand, while it is very important to recognize the good intentions, I need to say that I completely agree with Green as the status quo as it is unsustainable in more than many aspects and requires altering in various levels, by themselves algorithms cannot bring drastic change that is needed to cure recurring societal problems such as poverty, gender gap, education and healthcare inequality, which are results of a long-term unhealthy system developed in duration of hundreds of years. The problems require strict definitions and a proper methodology consisting of educated steps designed with focused ideas targeting the roots of the problems from various aspects.¹⁸²

This does not mean that these efforts are in vain, they just need to be channeled into building a better world for everyone by ensuring sustainable

¹⁷⁹ Kaspersen, “Deploying Artificial Intelligence technologies in humanitarian action is not without risks.”

¹⁸⁰ SDB Action Zone held during High-level week of UN General Assembly, 29 september 2019, Amina J Mohammed, “advancing the global goals with artificial intelligence”

¹⁸¹ Green, ““Good” isn’t good enough.”

¹⁸² Berendt, “AI for the common good?! pitfalls, challenges, and ethics pen-testing,” 44-65.

development as currently AI systems are, especially for underdeveloped countries, in danger of increasing the level of inequality for vulnerable communities, who are already being marginalized within the system, this may lead to fueling unequal development, which is a fact creating dispute among all societies, as history showed us many times.¹⁸³

While implementing AI technologies it is true that the developers and scientists carry great responsibility, especially considering the said vulnerable layers of the society, in terms of transparency, ethics and fairness; if properly introduced these technologies can offer tremendous contributions to bettering the society as a whole.¹⁸⁴ If not to put simply “Poor ethics lead to bad designs, which produce harmful outcomes”.¹⁸⁵

On the other hand, this is a burden too heavy to be solely borne by the people who are developing the systems, rather than discussing the what may happen in the future on a negative note, all actors involved need to take a step forward to create an inclusive, interdisciplinary debate to agree on main considerations; the computer scientists need to stay in touch with the social scientists to handle the situations correctly, which will help accomplish the necessary social change to eliminate the core issues.¹⁸⁶ While considering the safe application of AI systems, computer scientists need to collaborate with social scientists to educate themselves about the human rights and values, as well as make human-based experienced, which will help them build models that will advance the positive outcomes by initiating human-only

¹⁸³ Hagerty and Rubinov, “Global AI Ethics: A Review of the Social Impacts and Ethical Implications of Artificial Intelligence.”

¹⁸⁴ Stewart, “AI can help to bridge the digital divide and create an inclusive society.”

¹⁸⁵ Greene et al., “Better, nicer, clearer, fairer: A critical assessment of the movement for ethical artificial intelligence and machine learning.”

¹⁸⁶ Green, ““Good” isn’t good enough.”

debates; the answers reached after these debates may constitute a guide while developing models that are beneficial and safe when applied to everyday situations.¹⁸⁷

The problem definitions and frameworks are components that contribute to decision-making tremendously, same with algorithms; before they are implemented there needs to be certain frameworks and definitions that will ensure their effectiveness, and a methodology needs to be set to make sure they are implemented for solving problems in a sustainable way.¹⁸⁸ The necessity of a multilateral discussion is clearly due to the fact that the pitfalls and the solutions that may be offered in future originate from legal, social, policy-oriented and economic reasons; thus all these aspects must be studied carefully so that the solutions designed are not tailor made to fit a certain situation but can be applied to other problematic cases.¹⁸⁹

In the former sections of chapter 2, I offered various insights regarding the meaning of ethics in context of AI discourse, and ethical issues arising out of these applications.

Going back to that, and the fact that the notion of ethics is subjected to change depending on a variety of considerations, the projects developed can be labelled many things; while one may conclude China's use of facial recognition to this extent as oppressive, and an indicator of a highly authoritarian regime, there may be other people who consider the use of these AI applications by the states to be ensuring, and may think that they serve to the greater peace and harmony.

The real danger of deploying AI for solving societal problems without thinking through all the aspects results in being ignorant regarding the main reasons

¹⁸⁷ Askel and Irving, "AI Safety Needs Social Scientists."

¹⁸⁸ Berendt, "AI for the common good?! pitfalls, challenges, and ethics pen-testing," 44-65.

¹⁸⁹ Elsayed-Ali, "In response to "Good" isn't Good Enough."

lying behind the said problems and the whole process; when a facial recognition system presents an unfair racial bias, this can be due to on many things including data providers to engineers that built the system.¹⁹⁰

It seems like every organization, company and country are in a race to issue a list of principles of their understanding of AI ethics, while these efforts and intentions are of great value, without a consensus collaboratively reached on what AI ethics are and what they entail, these are only ideas individually followed by a group of people no matter how populated that group is; after comparing thirty-six documents issued related to AI ethics, it was seen that there is at least an understanding on 8 key points: “Privacy”, “Accountability”, “Safety and security”, “Transparency and explainability”, “Fairness and non-discrimination”, “Human control of technology”, “Professional responsibility” and “Promotion of human values”.¹⁹¹

This study also shows that there is newly occurring convergence regarding the main considerations among companies, governmental organizations as well as non-profits utilizing or concerned with these issues, nevertheless it is important to remember that these documents are usually non-binding, advisory pieces, and without being integrated to an enforceable system they will fail to persuade the actors into building the AI systems within the agreed ethical framework.¹⁹²

Another loud opinion standing out among researchers argues that while building these ethical standards we need to make sure that all communities will be

¹⁹⁰ Wong, “Why facial recognition's racial bias problem is so hard to crack.”

¹⁹¹ Fjeld et al., “Principled Artificial Intelligence: Mapping Consensus in Ethical and Rights-Based Approaches to Principles for AI.”

¹⁹² Colaner, “AI Weekly: Meta analysis shows AI ethics principles emphasize human rights. Venture Beats.”

represented, and the ethical standards will be inclusive without eliminating the basic cultural values of societies.¹⁹³

Even though, I agree that this kind of inclusiveness must be assured, the ethical considerations applied during the development process of an AI system must avoid being too consumed by discussions of cultural relativism, an idea claiming that “values may co-vary with their cultural and social background”.¹⁹⁴

Holding on to these kinds of arguments, suggesting that getting into moral discussions are inherently unfruitful due to their lack of objectiveness when it comes to decision-making process, and their dependence on notions such as culture and nation, tend to undermine the efforts of practitioners who would like to follow standards set by Universal Declaration of Human Rights¹⁹⁵ as it suggests that states need to have their own set of rules and regulations depending on their own dynamics, which will prevent building an effective global governance system based on rule of law that will regulate the development and utilization of AI technologies. It is true that the states should regulate AI applications in line with the society’s needs and in accordance with the problems that may occur in that specific country, but they must not give up seeking global governance to contribute to an applicable and sustainable policy-making.

I also agree with the argument that the regulations related to the AI systems must be designed in accordance with human rights, and the ideas categorized to fall

¹⁹³ Fan, “What Does Ethical AI Look Like? Here’s What the New Global Consensus Says.”

¹⁹⁴ Baghranian and Carter, “Relativism.”

¹⁹⁵ Kathrani, “Quality circles and human rights: tackling the universalism and cultural relativism divide,” 369–375.

under the notion of human rights must be updated in line with the new advancement in the fields of AI and robotics in favor of all societies across the world.¹⁹⁶

In absence of a global governance and an enforceable rule of law, currently the human rights regime can constitute a moral compass for government-oriented and business-oriented actors as well as developers and researchers themselves.¹⁹⁷

If the human rights regime can be used as a moral compass, the sustainable development goals described case by case in the following section can be considered as a roadmap to ensure social good through AI applications.

On a final note about law and ethics, I would like to underline the importance of ethical reasoning, even there were to be a globally applied law is to get executed at this very moment, it must be remembered that the rule of law and ethics cannot be used as each other's substitute; the ethical discussions must resume no matter what so that we can renovate our approach every single day and do not get easy by following certain regulations issued at that time by power-holders.¹⁹⁸

3.2 United Nations: Using AI to achieve sustainable development goals

While talking about what can the AI applications do to contribute to the improvement of the human condition worldwide, referring to the UN SDGs, adopted by the members of the UN as of 2015, is not uncommon as more and more academic research in the field with regard to the AI's implementation for the benefit of the social good is based on the targeted problems as proposed in the UN 2030 Agenda, which constitutes a framework of strategies to deal with world's grand problems

¹⁹⁶ Liu and Zawieska, "From responsible robotics towards a human rights regime oriented to the challenges of robotics and artificial intelligence."

¹⁹⁷ Van Veen, "Artificial Intelligence: What's Human Rights Got To Do With It?."

¹⁹⁸ Zimmerman, "AI Ethics: Seven Traps. Freedom to Tinker."

categorized as 17 main goals to ensure well-being of people and planet by increasing the levels of prosperity and peace as well as building partnerships all over the world for empowering problem-solvers everywhere.¹⁹⁹

The UN SDGs quite masterfully captures the essence of the main problems plaguing humanity in our age. The solutions to these grave issues require a multidisciplinary approach that also creates a bridge between multiple platforms and reaching experts across the board. For several years now, the movement now dubbed as ‘AI for Social Good’ has been trying to match experts in the field of AI to organizations focused on the betterment of humanity, usually tackling one of the issues brought to us as one of the SDGs. The creation of a dialogue between these groups has been able to present an untapped potential of a multidisciplinary approach to make progress towards the SDGs and have shown that a partnership is possible and quite advantageous for the movement in addressing the problems.²⁰⁰



Figure 6. Sustainable Development Goals

Source: UNESCO

¹⁹⁹ UN General Assembly, *Transforming our world : the 2030 Agenda for Sustainable Development*.

²⁰⁰ Varshney and Mojsilovic, “Open Platforms for Artificial Intelligence for Social Good: Common Patterns as a Pathway to True Impact.”

Since the declaration of these goals as shown in the Figure 6 above, scientists, researchers and policy-makers working in the fields benefiting from AI capabilities took actions to address the issues relevant to the targeted societal problems by sharing ideas on open platforms such as “Japanese – German – French Conference: AI for SDGs – How Can AI Help Solve Environmental Challenges?”²⁰¹ As accessing the data gets easier and less costly and if provided with the necessary data, the organizations that are intending to help society achieve the SDGs within the timeframe will increase in number and become more pliant to invest to create a measurable impact.²⁰²

We can also observe a similar approach taking root in academic circles regarding the utilization of AI technologies to achieve the SDGs; in AI for Social Good workshop of NeurIPS 2019, Chief Data Scientist of UN Global Pulse, an innovation initiative of the United Nations working to harness big data, artificial intelligence and other emerging technologies to support sustainable development and humanitarian action,²⁰³ Miguel Luengo-Oroz was invited to talk about his experience while “researching and developing real applications of data innovation and AI for sustainable development, humanitarian action and peace.”²⁰⁴ In his talk, Luengo-Oroz also mentioned the necessity of having a multidisciplinary team to succeed in coming up AI-based solutions for real-life issues, which requires a collaboration of work from like-minded people coming from different backgrounds and own unique skill sets to carry responsibilities of positions including -but not limited to- data

²⁰¹ DWIH Tokyo, “AI for SDGs- How can AI help solve environmental challenges?”

²⁰² PWC, “Measuring impact on the SDGs through AI.”

²⁰³ United Nations Global Pulse, “About”.

²⁰⁴ NeurIPS AI for Social Good Workshop, “Schedule.”

scientist, development experts, designers, communication specialists, humanitarian experts, machine learning experts, privacy officers, and many more.²⁰⁵

Assembled under a common goal “Accelerating progress towards the SDGs”, the second edition of AI For Good Summit included 35 proposals concerning the implementation of AI for common good whether it is by using satellite imagery for various reasons or by finding solutions in healthcare or smart cities.²⁰⁶

As a result of the AI for Good Summit held in 2019, Dataminr, an AI platform helps organizations deal with crises by detecting risks by processing public data,²⁰⁷ and United Nations Global Pulse, an innovation initiative of the United Nations working to harness big data, artificial intelligence and other emerging technologies to support sustainable development and humanitarian action,²⁰⁸ agreed to establish a collaboration that contributes to the content of the UN Secretary-General’s Strategy on New Technologies, which are a set of internal goals that supports the use of cutting-edge technologies aligned with the needs occurring during the progress towards the SDGs; through this partnership UN teams started using AI technologies for the moments that require fast response and rapid mobilization when faced with critical issues.²⁰⁹ See Appendix C to understand more about utilizing Big Data in alignment with UN’s SDGs.

It is safe to state that if applied in a way that compliments the needs of the society, utilizing AI applications to find solutions for these specific issues may end up becoming an emerging trend; explained by the report published by McKinsey

²⁰⁵ Luengo-Oroz, “Translating AI Research into operational impact to achieve the Sustainable Development Goals.”

²⁰⁶ Mead, “Global Summit Focuses on the Role of Artificial Intelligence in Advancing SDGs.”

²⁰⁷ Dataminr, “The Leading AI Platform for Real Time Event and Risk Detection.”

²⁰⁸ United Nations Global Pulse, “About”.

²⁰⁹ United Nations Global Pulse, “UN and Dataminr partner to use artificial intelligence in support of humanitarian response.”

Global Institute, a leading think tank that issues in-depth analysis and reports under a variety of themes and focuses on finding decision and policy-based solutions to a wide range of societal problems including the ones that are and may be arising due to the impact of AI,²¹⁰ each of the 17 goals can be addressed with existing and upcoming AI technologies as shown in the example cases, which makes them an efficient tool for achieving the SDGs and furthering the efforts to raise global standards.²¹¹ For more information about McKinsey’s Case Studies, you can see Appendix D.

Currently, AI-based technologies can cover all 17 goals and offer solutions related to 128 targets out of 169 targets covered by 2030 agenda, which sums up to 76% of all the targets listed under the goals,, after assessing these numbers, it is safe to state that positive outcomes exceed the negative ones as it can be seen in the Figure 7 below.²¹²

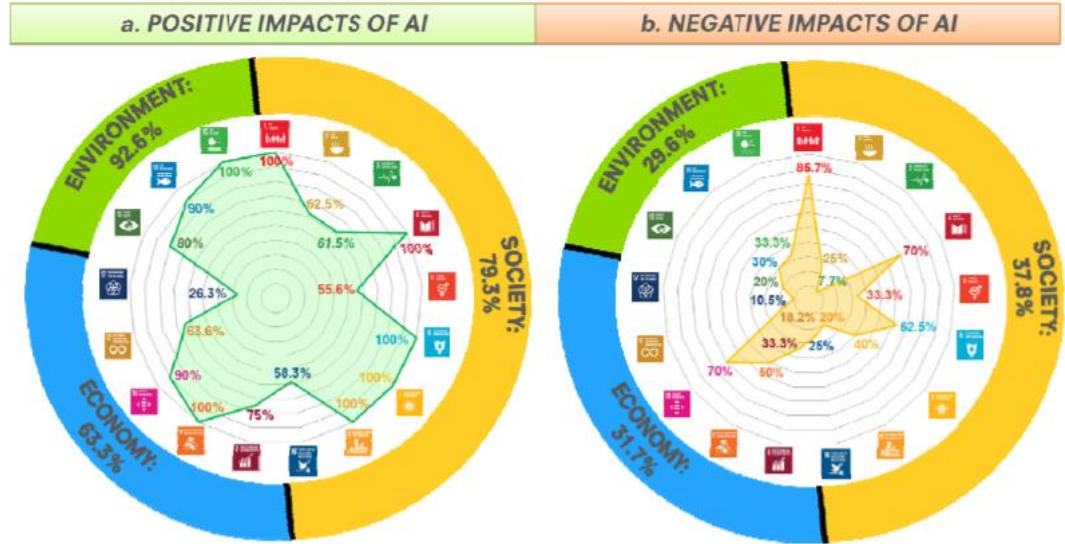


Figure 7. The positive and negative impacts of AI on society
Source: Vinuesa, et al., “The role of artificial intelligence in achieving the Sustainable Development Goals,”.

²¹⁰ McKinsey Global Institute, “About MGI.”
²¹¹ Chui, et al., “Using AI to help achieve sustainable development goals.”
²¹² Vinuesa, et al., “The role of artificial intelligence in achieving the Sustainable Development Goals,” 3.

In addition, it is important to highlight that benefits of AI for purposes of achieving SDGs can only be maximized if only all layers and organizations of society, including businesses, governments, academic and multilateral institutions, work collaboratively to address these goals to ensure a future with sustainable AI.²¹³

It is also important to note that in addition to the international organizations, governmental and academic institutions, many of the big technology companies are using AI use SDGs as a framework to examine AI projects to evaluate whether they fall under the category of a “social good project” or not.

In September 2019, Google published a report stating the outcomes of their acclaimed Google Impact Challenge, an open call for proposals that focus on the means to utilize AI for solving societal problems. The report underlined that the proposed projects addressed all 17 SDGs.²¹⁴ You can see Appendix E for a table presented in Google Impact Challenge report that includes all 17 SDGs and some ways they were touched upon in the project proposals.

Goal 1. No Poverty

UN’s goal to “end poverty, in all its forms, everywhere” by 2030 mainly focuses on providing equal access to basic needs such as food, safety, clean water and education as well as ensuring the protection of those who are vulnerable, especially in regard to natural disasters including but not limited to earthquakes, floods, wildfires, hurricanes; and creating productive policies so as to fight extreme poverty.²¹⁵

²¹³ 2030 global Goals Technology Forum, “AI & The sustainable development goals: The state of play,” 25.

²¹⁴ Google, *Accelerating social good with artificial intelligence: Insights from the Google AI Impact Challenge*.

²¹⁵ UN General Assembly, *Transforming our world : the 2030 Agenda for Sustainable Development*.

To understand the level of wealth in a certain area and to predict the distribution of poverty in specific locations so as to have policymakers come up with effective poverty reduction strategies by prioritizing the locations in greater need, a popular machine learning research conducted by researchers from Stanford University's Sustainability and Artificial Intelligence Lab,²¹⁶ targeting five African countries; Nigeria, Tanzania, Uganda, Malawi, and Rwanda, combined publicly available night and daylight satellite images to estimate household consumption, which will lead to efficiently detect the poor areas.²¹⁷

Goal 2. Zero Hunger

Under the motto of “end hunger, achieve food security and improved nutrition and promote sustainable agriculture”, the UN hopes to ensure access by all people when it comes to food through various methods such as increasing agricultural productivity and production.²¹⁸

As stated by Stephen Ibaraki during a joint meeting of the UN GA Second Committee and Economic and Social Council (ECOSOC), the board director of The International Professional Practice Partnership (IP3), a project of the International Federation for Information Processing (IFIP), a platform that helps policymakers design and implement policies that ensure the professionalism in IT worldwide in accordance with globally recognized ethical standards,²¹⁹ “agriculture productivity is increased through predictive analysis from imaging with automated drones and from

²¹⁶ For more information about the lab's works, see: <http://sustain.stanford.edu/>

²¹⁷ Jean et al., “Combining satellite imagery and machine learning to predict poverty,” 790-794.

²¹⁸ UN General Assembly, *Transforming our world : the 2030 Agenda for Sustainable Development*, 15.

²¹⁹ The International Professional Practice Partnership (IP3), “About”.

satellites. Nearly 50% of crops are lost through waste, over consumption and production inefficiencies.”

A good example of this is a project run by a team of multidisciplinary researchers from Carnegie Mellon University in the USA called FarmView,²²⁰ which uses the most recent AI technologies and robotics to collect and analyze data in hopes to determine the parameters necessary for an improved yield as well as the ones most resistant to crop diseases, which can result in a significant increase in productivity and production since there can be a great waste due to these reasons.²²¹



Figure 8. FarmView in the field

Source: Carnegie Mellon University, “FarmView: CMU Researchers Working to Increase Crop Yield With Fewer Resources.”

²²⁰ Carnegie Mellon University, “FarmView: CMU Researchers Working to Increase Crop Yield With Fewer Resources.”

²²¹ Dormehl, “To Feed a Growing Population, Scientists Want to Unleash AI on Agriculture.”

Goal 3. Good Health and Well-being

UN's goal to "ensure healthy lives and promote well-being for all at all ages", designed to cover every stage of human life; by 2030, the member states aim to decrease the global maternal mortality ratio as well as prevent epidemics of various diseases including but not limited to AIDS, tuberculosis and malaria.²²²

When it comes to healthcare AI-related practices can be of many uses including helping to manage a healthy life by promoting healthier behaviour, early detecting diseases such as cancer through a more detailed monitoring, diagnosis, aiding decision making with the help of predictive analytics, treatment and end of life care as well as empowering medical practitioners and researchers by enabling a more efficient research and training process.²²³

In parallel with the needs of the industry, the health AI sector also expanded drastically within the last few years, from robot-assisted surgery to virtual nursing assistants, the sector itself is estimated to value \$6.6 billion by 2021.²²⁴

Equal and efficient healthcare is a global priority, which makes the research conducted in the field extremely important. Thus, it is not surprising to see that there are many accepted papers in the AI for Social Good Workshops of the conferences touching these subjects.

Despite yet to be evaluated in a clinical setting, a wide range of research is run to apply deep learning algorithms to detect cancer cell or metastases in women with breast cancers, including one proposed by Ehteshami Bejnordi, et al, without a

²²² UN General Assembly, *Transforming our world : the 2030 Agenda for Sustainable Development*, 16-17.

²²³ PWC, "No longer science fiction, AI and robotics are transforming healthcare."

²²⁴ Collier et al, "Artificial Intelligence HealthCare's New Nervous System."

time restraint, deep learning algorithms could mimic the routine of an expert pathologists and interpret the slides with same efficiency.²²⁵

A similar paper presented at ICML AI for Social Good Workshop 2019, “Deep Neural Networks Improve Radiologists’ Performance in Breast Cancer Screening” is a great example of the ways we can use AI technologies for assisting humans in real-life situations such as medical diagnosis as the deep convolutional neural network model trained for improving the accuracy of breast cancer screenings also proved to make predictions as accurate as an experienced radiologist, which can improve the radiologists performance if used for diagnosis purposes.²²⁶

In addition to fast-developing theoretical research, private funded companies such as PathAI²²⁷ follow the steps of the state-of-art applications to use these recent applications of the technology to assist pathologists while they are trying to make a diagnosis.

Goal 4. Quality Education

By 2030 UN institutions are determined to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all,” in a manner that is designed to be accessible for everyone, especially those who are in vulnerable situations such as people with disabilities, children, and women.²²⁸

An example application is Quill,²²⁹ which is an open-source and free AI-based tool for underprivileged elementary, middle school, and high school students

²²⁵ Ehteshami Bejnordi, et al., “Diagnostic Assessment of Deep Learning Algorithms for Detection of Lymph Node Metastases in Women With Breast Cancer.”

²²⁶ Wu, et al.,. “Deep Neural Networks Improve Radiologists' Performance in Breast Cancer Screening.”

²²⁷ PathAI, “What we do.”

²²⁸ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 17-18.

²²⁹ Smith, “Quill.org: better writing with machine learning.”

to improve their writing skills. Quill is a non-profit project funded by many foundations and companies. It provides writing exercises that can integrate with physical courses and gives instant feedback to students on their writing using deep learning.

Another example is the well-funded Chinese startup Squirrel AI.²³⁰ The aim of the company is to provide equal education opportunities to every school in China. The main methodology is to collect data from classrooms and to optimize the learning process in a data-driven way by offering online personalized tutoring through AI algorithms. I will give more details about Squirrel AI in Chapter 4.

Goal 5. Gender Equality

“To achieve gender equality and empower all women and girls”, the UN aims to create applicable regulations and policies to prevent all negative practices against women and girls including unequal treatment and discrimination, unrecognized domestic work and exploitation, as well as to give equal rights in terms of economic and natural resources, education, and accessing recent technological developments to ensure empowerment and healthy being of women everywhere.²³¹

It is well known that many ML datasets reflect the biased and discriminatory aspects existing in the world. An example is a recent study that evaluates gender bias in facial recognition and skin type classification.²³² It has been shown that these types of datasets are overpopulated with lighter-skinned subjects and consequently

²³⁰ Hao, “China has started a grand experiment in AI education. It could reshape how the world learns.”

²³¹ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 18.

²³² Buolamwini and Gebru, “Gender shades: Intersectional accuracy disparities in commercial gender classification,” 77-91.

the most misclassified ones are the darker-skinned females. These types of studies uncover the bias that exists not only in the data but also in societies.

Goal 6. Clean Water and Sanitation

“Ensuring availability and sustainable management of water and sanitation for all” until 2030, by enabling the equal access to clean water, reducing pollution to protect existing water resources and creating and redesigning the water and sanitation-related programs that aims for ultimate efficiency is among one of the most addressed SDGs, especially considering the changing natural norms.²³³

Microsoft’s “Clean Water AI” is a prototype designed to detect the unwanted and harmful bacteria in clean water at the microscopic level.²³⁴ Researchers use a CNN based real-time model to classify and detect the dangerous bacteria and particles in water. Although it is still a prototype, the model holds great potential to analyze the clean water sources and improve the quality of the drinkable water.

Goal 7. Affordable and Clean Energy

Access to energy for everyone is vital in the current state of the world since energy is in the center of all major challenges the planet earth is facing today. Focusing on renewable energy also interlinks with almost all of the other SDGs. Coming up with solutions to critical environmental issues such as climate change includes challenges in terms of creating novel economic and job opportunities with

²³³ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 18-19.

²³⁴ Microsoft, “Clean Water AI on Microsoft AI Lab.”

increased energy efficiency, global energy access, and wider adoption of renewable energy.²³⁵

According to the UN, there are roughly 3 billion people that have no access to clean cooking solutions and are susceptible to critical levels of air pollution. Besides, almost 1 billion people are living without electricity. There are significant steps taken towards declining the use of non-renewable energy in recent years. However, there is still much to be done.²³⁶

An example of AI enabled energy efficiency is DeepMind's machine learning model, which is trained on energy consumption data obtained with thousands of sensors along the data centers belonging to Google.²³⁷ AI-based model regulates the power consumption of data centers with a data-driven approach and reduces the data center cooling bill by 40%. This is very important since it is widely known that data centers in today's computer-aided world consume large amounts of power, corresponding to 2% of electricity worldwide.²³⁸ This percentage is expected to reach 8% by 2030.

Goal 8. Decent Work and Economic Growth

The purpose of this goal is to “promote inclusive and sustainable economic growth, employment and decent work for all”. While almost half the population of the world is still living with about \$2 a day, having a job does not mean liberation from poverty in many parts of the world. People's standards of living are decreasing

²³⁵ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 23.

²³⁶ United Nations, “Energy - United Nations Sustainable Development.”

²³⁷ Evans and Gao, “DeepMind AI Reduces Google Data Centre Cooling Bill by 40%.”

²³⁸ Elegant, “The Internet Cloud's Dirty Secret: It Consumes Tons of Energy, Has Large Carbon Footprint.”

since there are still many countries that are getting slower in their growth rates, moving away from the 7% growth rate target for 2030 with labor productivity decreasing and the unemployment rates rising.²³⁹

A Netherlands based organization, SkillLab, is using AI technology to help integrate the refugees in Europe to the labor market.²⁴⁰ Users are able to log in to the mobile application, upload their resumes, and see job opportunities that best suit their profile with the help of AI. This approach overcomes the language barrier and unclarity of a person's skills because of a poorly written CV since the application is available in many languages and it also supports automatic generation of powerful CVs.

Goal 9. Industry, Innovation, and Infrastructure

“Build resilient infrastructure, promote sustainable industrialization and foster innovation” is the motto of this SDG. General improvement of education and health, increased productivity and incomes all come from investing in the infrastructure such as irrigation, transportation, energy, and information and communication technology. Industrialization will be a natural consequence of innovation and the progress of technology. Furthermore, industrialization will bring development. Energy-efficiency and increased resources also come with technological advancements. There should be significant investments in high technology products that will offer more efficient production and also the focus on mobile cellular services will increase the connections of people and societies.²⁴¹

²³⁹ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 23-24

²⁴⁰ Skilllab, “Pathways to Employment Through Technology.”

²⁴¹ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 24-25

An example use case from the perspective of innovation is using AI systems to discover new drugs.²⁴² AI systems, more specifically machine learning models, are used to find data-driven solutions to drug discovery, drastically improving the process of discovering new drugs and showing the innovative ability of AI.

Goal 10. Reduced Inequalities

Access to all available assets, especially health and education services is crucial for everyone regardless of race, ethnicity, age, sex, disability, economic or social status. Although they are making progress, the least developed countries, small island developing states, and the landlocked developing countries are the most vulnerable nations to poverty. Inequality and large discrepancies still remain on accessing basic services such as health and education in these countries.²⁴³

Income equality has been reduced to some degree with economic, social, and environmentally sustainable development principles. However, there is still work to be done. Universal duty-free policies should be applied in favor of the exports of developing countries and these policies should pay attention to the needs of these dismissed and disadvantaged populations.

NexLeaf analytics is a non-profit organization established in 2009 with the goal of using data for good. Their work includes tracking the temperatures of vaccines with sensors to detect if they are damaged. By tracking the quality of the cold equipment in low and middle income countries, they greatly improve the supply chain of vaccines and they contribute to equal distribution of vaccines to the people that need them.²⁴⁴

²⁴² Cockburn et al., *The impact of artificial intelligence on innovation*.

²⁴³ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 25-26

²⁴⁴ Nexleaf Analytics, "A History of ColdTrace."

Goal 11. Sustainable Cities and Communities

Cities should be safe, inclusive, resilient, and sustainable. Urbanization is growing rapidly and it is projected that 5 billion people will live in cities by 2030. This rapid increase will bring challenges such as urban planning, congestion, urban management, adequate housing shortage, waste removal and management, rising air pollution and so on. Cities are very important for development since they enable the sharing of culture through many opportunities, the progress of science with universities and institutions, increase productivity, social development and much more. There should be a future for cities that can live and thrive by themselves by providing equal opportunity for all through access to basic services.²⁴⁵

UN Pulse Lab in Jakarta, Indonesia developed a data-driven model to overcome traffic congestion and safety problems in the city. Their approach includes object detection and tracking methods with neural networks to detect any anomalies that occur in the city. Their work is preliminary in terms of defining a methodology and a starting point to develop sustainable cities.²⁴⁶

Goal 12. Responsible Consumption and Production

The world population expectancy of the year 2050 is 9.6 billion. If the population actually reaches this number, the equivalent of three planets of natural resources is needed to sustain the current living standards. There are multiple factors that point to this result. Humanity relies on only 0.5% of the world's water for drinkable freshwater. Annual energy consumption is rapidly growing in spite of the

²⁴⁵ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 26

²⁴⁶ Caldeira et al., "Improving Traffic Safety Through Video Analysis in Jakarta, Indonesia."

technological advances that enable more energy-efficient products. Almost a third of all food produced is going to waste every year with an estimated value of \$1 trillion. All these facts point to the necessity of responsible consumption and production.²⁴⁷

In many places, especially in Eastern Asia, the consumption of natural resources is increasing. Many countries are also trying to solve problems with air, water, and soil pollution. The motto of sustainable consumption and production is “doing more and better with less”. Therefore, everyone from producer to consumer should be informed and educated on sustainable consumption and adapt their lifestyles accordingly.

An India based non-profit research organization, Wadhwani AI, is working on helping farmers through photos taken with smartphones by detecting pest types and populations using an AI-based, data-driven application. This greatly helps prevent the overuse of pesticides and reduce crop loss, leading to a more responsible production process.²⁴⁸

Goal 13. Climate Action

The description of this goal is to “take urgent action to combat climate change and its impacts”. Climate change is a major threat that affects national welfare and economies with sudden changes in weather patterns, rising sea levels, more extreme weather events, and concerning the growth of greenhouse gas emissions. It is still not too late to stop the surface temperature of the earth from increasing and surpassing 3 degrees centigrade until the end of this century.

However, all countries in the world, especially the developed countries should turn to

²⁴⁷ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 26-27

²⁴⁸ Ganjoo, “Google wants Indian farmers to use AI to find bugs in cotton crop, improve annual yield.”

renewable energy sources and adopt other urgent measures to reduce emissions. The matter of climate change exceeds all national borders and threatens the very world that we live in.²⁴⁹

There are many studies and projects on how AI can help with the fight against climate change from evaluating energy consumption levels and optimizing them to using computer vision for tracking and monitoring the visual climate data.²⁵⁰ One such example project comes from the partnership of Borealis AI and a Canadian research institute MILA.²⁵¹ Researchers implemented a generative machine learning model that can take any street scene photograph as an input and synthesize another version of it in extreme weather conditions using the local climate model corresponding to that geography. The project provides personalized insights about extreme weather conditions to residents living in their streets.

Goal 14. Life Below Water

“Conserve and sustainably use the oceans, seas and marine resources”.

Oceans of the world are vital in terms of both means of trade and transportation, and natural resources and systems that make the world habitable. Food, oxygen in the air, weather, climate, drinking water, rainwater are partly coming from seas around the world. The pollution and the degradation of the oceans in recent years should come to an end for a sustainable world. There should be regulations and policies on

²⁴⁹ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 27-28

²⁵⁰ Technology Networks, “How Machine Learning and AI Can Help in the Fight Against Climate Change.”

²⁵¹ Borealis AI, “Borealis AI supports MILA research on visualization of climate change.”

polluting coastal waters, ocean acidification, and overfishing to conserve and sustain the life below water.²⁵²

The Global Fishing Watch platform makes use of AI to watch vessel movement through satellite data. The AI software that the platform uses identifies the size of the vessel, its engine power, the fishing type, and the gear. The aim is to track and understand the global fishing activity, preserving the biodiversity below water, and fascinatingly, tracking human slavery and rights abuse emerging from the fishing industry.²⁵³

Goal 15. Life on Land

The official description of this goal is “sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss”. Forests cover almost a third of the earth’s surface and they fight against climate change, protect biodiversity, and provide shelter and food security to many people. Preventing deforestation and desertification by protecting the forests is extremely important to fight against climate change and poverty.²⁵⁴

There are some efforts to protect forests and fight against desertification with two international agreements, ensuring that resources are used reasonably. There are also financial investments supporting biodiversity.

Rainforest Connection is an organization that focuses on protecting rainforests with machine learning. The idea is using old mobile phones and other devices to listen to the sounds of the rainforests to prevent illegal deforestation,

²⁵² UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 28-29

²⁵³ Kourantidou, “Artificial intelligence makes fishing more sustainable by tracking illegal activity.”

²⁵⁴ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 29

poaching of animals, and protect biodiversity. Detection and classification of sound signals as logging sounds, animal calls, or chirping of birds, is done with the collected data using AI.²⁵⁵

Goal 16. Peace, Justice and Strong Institutions

This SDG is to promote just, peaceful, and inclusive societies by putting a stop to bribery in the judiciary, police, or other institutions, human trafficking, sexual violence, violence against children, and international homicide. There should be more efficient and applicable regulations against such crimes with realistic government budgets. There are still many prisoners worldwide held in detention without sentence, corruption, bribery, tax evasion, theft, and many other problems regarding peace, justice, and strong institutions.²⁵⁶

A non-profit organization based in Switzerland, HURIDOCS, is using AI-based natural language processing tools to handle large amounts of case-related data to help lawyers with human-rights cases. Lawyers are able to conduct effective research through the clutter of publicly available case data and help defending their cases involving many of the human-rights crimes stated above.²⁵⁷

Goal 17. Partnerships

With the “revitalize the global partnership for sustainable development” motto, this SDG is concerned with building and sustaining partnership between government entities, industry, and public society to ensure that every entity in the

²⁵⁵ Coldewey, “Rainforest Connection enlists machine learning to listen for loggers and jaguars in the Amazon.”

²⁵⁶ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 30

²⁵⁷ Finch, “A collaborative effort to make the machine work for human rights information.”

partnership shares the same values, vision, and goals to put the future of the planet at the center. Long-term investments, regulations, and legislations are needed to make sure that all the Sustainable Development Goals are achieved by 2030.²⁵⁸

In Japan, SoftBank introduced the SoftBank Vision Fund, which aims to bring the powerful companies together to solve social challenges with AI systems. Targeting the UN SDGs, the company is eager to establish strategic partnerships and implement governance in social good projects, working together with 2030 Vision, an initiative founded for improving the technological processes in achieving the 2030 goals.²⁵⁹

In China, Alibaba Cloud, the cloud-computing branch of the Alibaba company, has announced their partnership with iamtheCode, an African-led movement to push the governments, businesses and NGOs in the direction of better education, to support young women coders. By 2030, the partnership that is named “Tech for Change” wants to enable 1 million young women coders.²⁶⁰

I will go into more detail about SoftBank and Tech for Change in the following section.

3.3 Big tech for social good

The big technology companies not only have the necessary sources, whether it is the adequate brain power or financial means, which advances the field in various ways but also they have the power to implement these new applications more than solely for profit. In short, “with great power comes great responsibilities.”²⁶¹

²⁵⁸ UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 30-32

²⁵⁹ Social Impact, “SoftBank Vision Fund.”

²⁶⁰ Alibaba Clouder, “Alibaba Cloud Launches Tech for Change Initiative for Social Good at MWC19.”

²⁶¹ Lee, *Amazing Fantasy*, 11.

As the usage of AI-based technologies get common each day and the big technology companies one by one start to announce projects, open up departments and publish releases that focus on the ways to utilize, in general, technology for good as well as build responsible and inclusive AI applications.

Notwithstanding the discussion about their sincerity, especially of those like Microsoft that provides technology for military applications and simultaneously funds non-profits and institutions aiming to advance the technology for the benefit of the society,²⁶² some of these reports and projects constitute the most well-thought pieces of work in the field regarding the subject and cover many problematic aspects of implementing AI in terms of regulations and public policies.

On top of that, big technology companies that issue such reports generally include the means these new technologies may be used for accelerating the achievement of SDGs issued by the UN. It is also important to note that these companies boast great market values that exceed billions, even trillions, of dollars up to \$3.02 trillion,²⁶³ which makes their contribution valuable, how half-hearted, or even hypocritical, they may seem to the public eye. While reviewing this part of the chapter it is important to remember that these documents issued are self-declared voices and claims of the companies; they are designed to be biased and adversarial, which may cause them to appear seemingly baseless, since these are all new documents/projects, the companies' intentions are yet to be observed.

Furthermore, as companies utilizes these technologies, the ethical issues arising out of the implementation of AI-based technologies also concerns the public about the intention of such projects, to avoid getting caught up with this drama,

²⁶² Simonite, "Can AI Built to 'Benefit Humanity' Also Serve the Military?"

²⁶³ Ponciano, "The Largest Technology Companies In 2019: Apple Reigns As Smartphones Slip And Cloud Services Thrive."

companies such as Huawei voiced their opinions on ethical approach to AI,²⁶⁴ many other companies one by one started to issue their reports about ethical AI.

When America-based technology giant Microsoft launched Microsoft AI, the website listed more than the products and services offered through the technology; the website also highlights Microsoft's approach on "responsible AI" by underlining values such as "Fairness", "Reliability & Safety", "Privacy & Security", "Inclusiveness", "Transparency" and "Accountability".²⁶⁵

In addition, their declared AI principles, that will ultimately contribute to developing a socially beneficial AI systems, Microsoft also runs a series of projects, both by directly taking part and providing financial support and the necessary technology, under the title of "AI for Good", which are gathered under four main sections: "AI for Earth", "AI for Accessibility", "AI for Humanitarian Action" and "AI for Cultural Heritage".²⁶⁶ Moreover, Microsoft holds AI for Good challenges to make funding for projects that "uses AI to advance improvements in accessibility and sustainability."²⁶⁷

Another big tech company that has been investing in projects that serve the common good is Google. Google, a multinational American Company that consists of publicly-traded organizations gathered around the well-known search engine regarded as the company's face.²⁶⁸ There is no need to say that the company is a big

²⁶⁴ Eckert, "Need For Ethical Approach With AI."

²⁶⁵ Microsoft, "Our Approach to AI."

²⁶⁶ Microsoft, "AI For Good."

²⁶⁷ Microsoft, "AI Idea Challenge."

²⁶⁸ The initial steps to create the company were taken in 1996 and since then the company keeps growing and spreading. With more than 151 different services and products Google Inc. became an indispensable part of education, business, communication, science and daily life. Today the majority of the people uses google for its original purpose and that is to match people with the target information. The name of the company even started being used as a verb and "googling" became a thing.

shareholder in the AI world. Its search engine itself works with complicated algorithms and collects data every second passes to improve itself.

While developing AI tools and sharing it with the public, Google established some ground rules for itself, such as this technology should be used to help people, should be socially beneficial, fair, accountable and should work for everyone. One of the strong sides of Google-AI is that it does not discriminate between jobs. Even from the simplest problem to the biggest concerns Google tries to help you; in 2018 through Google AI Impact Challenge, Google funded 20 organizations with a total of \$25 million and provided consulting services with Google AI experts and opened online tools for people to experience AI. Quickly and accurately forecasting floods, Predicting risk for cardiac events and mapping global fishing activity are some examples of the projects Google runs to solve societal problems.²⁶⁹

Furthermore, Google emphasizes the importance of developing AI-based projects in line with the requirements needed to fulfill the UN SDGs; one of the companies most acclaimed releases regarding the subject is called “Accelerating social good with artificial intelligence: Insights from the Google AI Impact Challenge”, the report underlines the importance of considering the targets of the goals while trying to bring solutions, and offers advice to all actors including funders, policy-makers and both developing and implementing organizations.²⁷⁰ Google also established an incubator to fund startups that develop projects for accelerating the achievement of the SDGs.²⁷¹

²⁶⁹ Google, “AI for Social Good.”

²⁷⁰ Google, *Accelerating social good with artificial intelligence: Insights from the Google AI Impact Challenge*, 13.

²⁷¹ George, “Google launches incubator for SDG-aligned startups.”

Other than these, Google issued a report about developing AI responsibly, which also contributes to AI governance, and finding a consensus about non-technological aspects of the systems such as ethics, regulations and policies.²⁷²

Another household name that should be mentioned when counting big tech that does projects for social good is International Business Machines Corporation (IBM). IBM is a multinational technology company that has been operating in areas such as Cognitive Solutions, Global Business Services, Technology Services & Cloud Platforms, Systems and Global Financing.

Having established 12 laboratories on 6 continents all around the world, IBM is not only concerned with modern trending research topics that include Computer Vision, Conversational Systems, Deep Learning, Hardware and Architectures for AI, NLP, TrustedAI, but also is willing to collaborate with like-minded institutions and individuals in order to provide the society fast and efficiently. The Company has a huge effect on shaping the industry and technology of today's and future by investing in critical fields such as AI, Blockchain and Quantum Computing. Among all these topics TrustedAI plays a role between society and AI interference in life with elaborate perspectives.²⁷³ To take its involvement with the community and the social good movement one step further IBM has launched a new project in 2016, IBM Science for Social Good which is described by them as a platform where IBM researchers are partnered with "...academic fellows, subject matter experts from a diverse range of non-governmental organizations (NGOs), public sector agencies, and social enterprises to tackle emerging societal challenges using science and technology. The Science for Social Good program is built on the premise that applied

²⁷² You can see Google's document on "Responsible Development of AI" here: <https://ai.google/static/documents/responsible-development-of-ai.pdf>

²⁷³ IBM Research, "Trusted AI."

science and technology can solve the world's toughest problems by accelerating the rate and pace of solutions through the scientific method.”²⁷⁴

IBM has successfully executed 28 projects in this program, ranging from deconstructing epidemics, to the creation of antimicrobial peptides, to modeling hate speech. The 2019 projects of the program include; ‘Prescribing Guidelines for Addressing the Opioid Epidemic’, ‘Causal Pathways Out of Poverty’, ‘Fairness in AI-based skin cancer diagnosis.’²⁷⁵

An Asian company that needs a mention is Huawei, one of the fastest growing telecommunication company that is based in China.²⁷⁶ Huawei has huge expectations from AI and like all leading companies in the tech world, Huawei also stepped in to the wide world of AI and started the development of projects with significant importance for the society. One of the projects is designed to help convey emotions between visually impaired people by sensing emotions via different channels and making sounds accordingly so that the other person can take a better grasp of the opponent's emotional state without facial expressions. Another project targeted specifically the children with hearing loss as they have hold backs when they first learn to read books. The application quickly accepted by numbers since 34 million of 460 million people with hearing loss are children and learning to read texts is as critical as it is challenging for them. The system uses image recognition and OCR (optical character recognition) systems to translate children's books to sign language.²⁷⁷

²⁷⁴ IBM Research, “Science for Social Good.”

²⁷⁵ Varshney and Mojsilovic, “IBM Science for Social Good 2019 Projects Announced.”

²⁷⁶ In 1998 the company contracted with IBM for approximately 5 years and expanded its borders to overseas in 2000.

²⁷⁷ Kongyu, “AI for Good.”

Back across the ocean, founded in 1968, Intel is the world's first microprocessor maker that has kept its presence side by side with the pioneer companies creating the future. The company comes front with the vision to use its AI technologies to enhance life by supporting institutions and organizations that have good objectives with the necessary AI and work for making all artificial intelligence movement more understandable, and moreover making it equally accessible for all out there; the three main areas that the company focuses on are earthly/environmental, social and health issues, concerning these Intel not only tries to help today's life but also aims to protect the inheritance to the next generations by investing environmental and earthly causes, while trying to find innovative solutions by using quantum computing methods the company tries to put new perspectives and solve the problems conventional machines can not handle.²⁷⁸

Tencent is China's one of the biggest companies by revenue and profits centered itself around an instant messenger called QQ. With the breakthroughs in mobile technology it is a well known fact that mobile users' numbers are growing each day and Tencent is proud to state that it is a visionary company taking advantage of the change.

Other than the instant messenger Tencent offers WAP portal, email service, online game, network service, e-commerce and search engine providers. The company's CEO Pony Ma stated their mission statement as "technology for social good." Over the WeChat an application developed for messaging, social media and mobile payment by Tencent, the company started China's first open large-scale online donation activity allowing users to donate money to designated public welfare

²⁷⁸ Intel, "AI for Social Good."

organizations through mobile devices. Up to 2019, the “9.9 Public Welfare Project” has raised nearly \$309 million, with more than 49.51 million people donating.

Accenture is a leading global professional services company, providing a broad range of services and solutions in strategy, consulting, digital, technology and operations. Combining unmatched experience and specialized skills across more than 40 industries and all business functions – underpinned by the world’s largest delivery network – Accenture works at the intersection of business and technology to help clients improve their performance and create sustainable value for their stakeholders. With more than 401,000 people serving clients in more than 120 countries, Accenture drives innovation to improve the way the world works and lives.²⁷⁹

The company’s Accenture Labs recently issued a document called “TECHNOLOGY FOR GOOD: Scaling up Social Transformation in the Fourth Industrial Revolution”, in this document Accenture gave an insight about how they approach developing AI projects with human-centric considerations; the main three components of such projects are listed as “Human at the Center”, “Ethical Design” and “Compliance.” The first of the projects is pretty straight forward; enabling technologies that are human-compatible. Ethical design, aims to implement ethical standards to its designs while maintaining a transparent work process. And the final component; compliance is their wish to influence government regulations and evolving with them while remaining on the same page with the public sentiment.²⁸⁰

Baidu, the famous Chinese search engine founded in 2002 with its headquarters in Beijing. As a multinational technology company Baidu specializes in internet related services and artificial intelligence. Baidu is mainly preferred in Asia

²⁷⁹ Accenture, “About Our Company.”

²⁸⁰ Accenture Labs, “Technology For Good: Scaling Up Social Transformation In The Fourth Industrial Revolution,” 18

since it is compatible with Chinese characteristics and the company has its roots in China. They even call themselves as Chinese language search provider. In July 2019, a conference called Baidu Create 2019 was held to gather AI world in one place, create partnerships and offer AI powered solutions to industry. Baidu provides more than 40 different services such as cloud services, personal assistant systems and self driving cars. Mainly focusing on minimizing the potential threats and promoting safe usage of technology Baidu has a unique approach to AI. The company dedicated itself to designing AI with social values in mind. They develop AI projects with safety, fairness and transparency.²⁸¹

Based in South Korea, with more than 309,630 employees in global Samsung is one of the prominent technology makers in the world and dedicated its efforts to push the technology to its limits. From visual display and mobile technologies to memory and networks systems we can see the company working on non-stop. Under the topic of “Intelligence of things” Samsung carries out projects related to Automotive Electronics, 5G & Beyond, Robotics and Artificial Intelligence. In addition to these Samsung has several opportunities for the society to get involved with the development of the company. The program called C-Lab (Creative Lab) helps employees nurture creative business ideas. Since the launching in 2012, 229 projects and 36 spin-off companies have been supported. With platform MOSAIC employees can share innovative ideas and cooperate with one another. “Samsung Solve for Tomorrow” is a contest where participants create solutions to problems faced by communities with science, technology, engineering and math (STEM). “Samsung Innovation Campus” helps young people to understand future technologies. Like its slogan “Together for Tomorrow!” The company is enthusiastic

²⁸¹ “Baidu Lays Out Vision to Empower a New Era of Intelligent Industry at Create 2019”

about new ideas and supportive with projects. Samsung is one of the greenest companies in the world and established a Green Management Value System in 2008.²⁸²

Moreover, while talking about AI ethics, Samsung is one of the more inclusive countries as they made polls among young people to give them a voice in AI debate, which makes sense since AI-integrated systems will be a part of their daily lives.²⁸³

Another big technology company from the United States, formerly an online bookstore, today Amazon is one of the world's largest online retailer companies. The company started its business in 1995 and has always been an innovative one since then. so that it announced its Amazon Prime Air Drone Delivery Service in 2013.

In addition, it is needless to say that the online shopping itself has been growing each year, e-commerce is now the most preferred shopping trend of new generations with mobile devices, fast deliveries and secure payments. Amazon is not just an online marketing website since it supports small businesses and offers professional education and training to those who need it; Amazon also opened "Alexa Skills Challenge", giving prizes to smaller organizations, nonprofit organizations(NGOs) and local communities for their attempts to bring solutions for their local problems.²⁸⁴

Sony, a well-known global company that has its roots in Japan is also now becoming a part of the AI for Social Good movement. Through AI the company is aiming to help create a peaceful and sustainable society. To frame this work Sony

²⁸² Samsung, "Strategy: Corporate Citizenship: Sustainability."

²⁸³ You can see the details about Samsung's "Fair Future: Involving Everyone in AI" here: https://images.samsung.com/is/content/samsung/p5/global/mkt/explore/uk/productivity/life/artificial-intelligence/pdf/Samsung_Fair-Future_involving-everyone-in-AI_A4_Digital.pdf

²⁸⁴ Amazon, "Tech for good"

has developed a guideline, “the Sony Group AI Ethics Guidelines” in 2018. The previous year, Sony had also become the first Japanese company to be a part of the Partnership on AI to benefit people and society, a non-profit that was created to help develop solutions to the issues humanity suffers from which includes furthering the understanding of AI.

The company states, “Sony will continue utilizing the knowledge it has gained from its AI and robotics-related research, development, and business ventures while working with the Partnership's diverse group of stakeholders to solve crucial AI-related issues, including how to construct a suitable cooperative relationship between humans and AI, and how to best apply AI to the rapidly advancing field of robotics as well as products and services with differing amounts of autonomy.” Sony also takes part in the Japanese side of the AI for Social Good movement. The initiatives they take part in include; ‘the AI Utilization Strategy’ which was published by Keidanren (Japan Business Federation) in 2019 and ‘the Social Principles of Human-centric AI’ that was published by the Cabinet Office in March 2019.²⁸⁵

Once again in China, in 2019, Alibaba, the online shopping giant has also joined the movement with its cloud-computing section of the Alibaba group, Alibaba Cloud has announced a new initiative ‘Tech for Change’. The initiative aims to “tackle global social and humanitarian challenges in areas such as education, economic development and the environment.” An example of this initiative aims at the amelioration of the education of women, especially women programmers in less developed parts of the world , with a partnership with iamtheCODE, an Africa-based movement. Alibaba Cloud has also created in 2017, a technology based philanthropy

²⁸⁵ Sony, *Sustainability Report*, 51.

platform, ‘Green Code’. a program that connects IT specialists with non-profits in China.²⁸⁶

The final tech company I will talk about is based in Japan. Softbank, the telecommunication giant of Japan has announced a partnership with ‘2030Vision’, an initiative that was founded to help the development of technology which will support the UN SDGs and create an environment where all can live peacefully and reach their full potential in a sustainable future.²⁸⁷

While issuing such documents are a hopeful beginning, the companies should refrain from standing at the sidelines and waiting for regulations to get announced. Moreover, they need to make their voices heard and contribute to the development in the field, not just in technical wise but also in legislative wise by getting involved in open platforms and partnerships aiming to create discussion platforms for collaborative efforts, which will give them an opportunity to build solid connections with non-profits and organizations working on the ethical, legal and economic aspects of the AI systems in the way they are reflected in the society. A good example of these efforts can be shown in “Partnership on AI”, a multistakeholder organization consisting of researchers, academics, civil society organizations and companies such as Samsung, Sony, Amazon and Google, which aims to target societal problems to use AI advances for social good by providing an open platform of inclusive discussion regarding best practices of such technologies while assessing the safety-critical application areas and utilizing AI in a fair, transparent, accountable way as well as initiating collaboration between AI systems and people who develop and get exposed to them.²⁸⁸

²⁸⁶ Alibaba Clouder, “Alibaba Cloud Launches Tech for Change Initiative for Social Good at MWC19. *Alibaba Cloud*.”

²⁸⁷ Softbank Vision Fund, “Social Impact.”

²⁸⁸ Partnership on AI, “Our work”

CHAPTER 4

COMPARATIVE ANALYSIS OF AI DEVELOPMENT IN CHINA AND JAPAN

China and Japan stand out as the competing forces in the region on many levels. Both countries have a great history of being competitive in the international technology market offering their own characteristic advances, especially with respect to their area of focuses; Japan, with its aim to build a human-centered, simultaneously a technologically advanced, society for its aging population²⁸⁹ and China for aspiring to become the next tech superpower by utilizing these technologies.²⁹⁰

4.1 AI development in Japan and China

The hype in the AI sector is gradually increasing with governments from all regions as well as private companies hopping into the train. The competition is fierce to become a leading force in the field, whether it is in academia, public or private sectors. Taking a closer look at the regions; out of 20 top countries that are leading the AI scene in terms of the number of talents, the necessary infrastructure, operating environment, research and development, five of them are located in Asia: China Singapore, South Korea, Japan, India, respectively.²⁹¹ In accordance with this ranking, China places first place, scoring 100 out of 100 points, for governmental strategies and second for commercial applications, scoring 34.4, whereas Japan places twelfth, scoring 74.1, and eight, scoring 10.9, for the same.²⁹²

²⁸⁹ Fukuyama, "Society 5.0: Aiming for a New Human-Centered Society," 49–50.

²⁹⁰ Diamandis, "China Spotlight: Next AI Superpower?"

²⁹¹ Papadopoulos, "Report: Countries That Are Leading The Artificial Intelligence Race"

²⁹² Tortoise Media, "The Global AI Index."

In the following chapter, I will summarize a list of certain aspects that stand out and are of great value concerning the development and implementation of AI technologies: a) to have a well-structured national strategy consisting of an ethical, legal and economic framework, which enables a uniformed, goal-oriented and regulated development and deployment process, b) to host an open and profitable AI financial and academic ecosystem for new startups and ideas to flourish that will lead to increasing the capital, c) to have enough and appropriate data for the AI systems to work on, d) to accommodate the adequate AI talent pool for developing, implementing and maintaining the technologies both in academia through incremental works, including published papers and filed patents, and in private as well as public sector with R&D projects, e) to domestically establish the necessary computing infrastructure that can catch up with the advances in the field so that the country can be self-sufficient, which ensures a sustainable development.²⁹³

Moreover, I will dive into the details of the national AI strategies and official reports to understand where the government stands in terms of AI-based technologies.

4.1.1 Governmental strategies for AI

The increased attention from Chinese officials in regard to every aspect of AI technologies is not surprising, on the contrary it is completely understandable as China is estimated to have the biggest impact, a total of 26.1% gain in GDP, thanks to AI-enabled systems.²⁹⁴

In the words of President Xi Jinping during the opening of the 19th party congress in 2017: “China has transformed to high-quality growth, from high-speed

²⁹³ Omega Venture, “China's AI Talent Retention Problem.”

²⁹⁴ PwC, “Sizing the prize.”

growth ... we need to speed up building China into a strong country with advanced manufacturing, pushing for deep integration between the real economy and advanced technologies including internet, big data and AI,”²⁹⁵

As shown in the figure below, China’s artificial intelligence market size is expected to grow approximately ten times compared to 2015’s numbers, and in a country where the ruling party, in this case Communist Party of China, has a strong hold in all sectors both on national and local levels,²⁹⁶ it is unsurprising since taking a brief look at “Next Generation Artificial Intelligence Development Plan”, a seemingly follow-up document to “The 13th Five-Year Plan” approved on March 2016, which does not mention artificial intelligence but highlights five key themes that can also be attributed to the AI development; “innovation”, “coordinated development”, “green growth”, “inclusive growth” and “openness” and the recent technologies’ contribution in achieving them to ensure a sustainable economy²⁹⁷ and “Made in China 2025”, an industrial plan initiated by the state to create an “innovation-driven” Chinese economy that is a “manufacturing power”²⁹⁸ as well as “Three-Year Action Plan for Promoting Development of a New Generation Artificial Intelligence Industry (2018–2020)” is enough to understand that Chinese government considers achieving global leadership in implementing and developing cutting-edge artificial intelligence technologies, both in industry and through research, as a way to ensure the continuity of the state.²⁹⁹

²⁹⁵ Yu et al, “China scours the globe for talent to transform into world leader in artificial intelligence and big data.”

²⁹⁶ Yan and Huang, “Navigating Unknown Waters: The Chinese Communist Party's New Presence in the Private Sector.”

²⁹⁷ Koleski, *The 13th Five-Year Plan*, 3

²⁹⁸ Kania, “Made in China 2025, Explained.”

²⁹⁹ Holst, “Size of the artificial intelligence market in China from 2015 to 2020.”

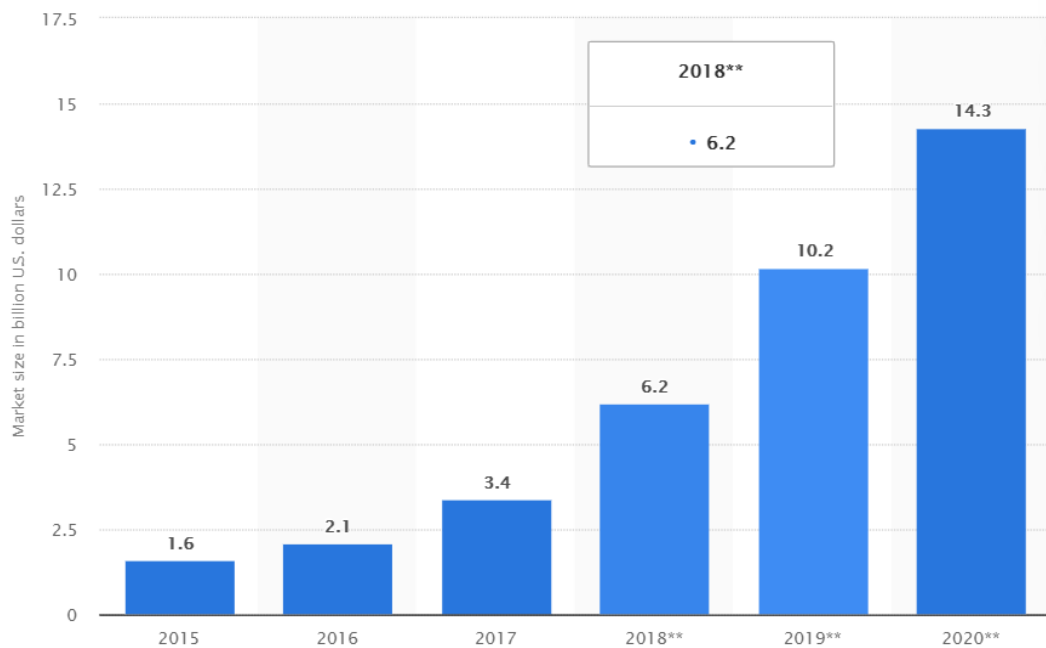


Figure 9. Size of the artificial intelligence market in China from 2015 to 2020 (in billion U.S. dollars)

Source: Holst, “Size of the artificial intelligence market in China from 2015 to 2020”, 2019

Released on July 2017, The Next Generation Artificial Intelligence

Development Plan (新一代人工智能发展规划) is divided into three main steps: “to keep up the overall technology and application of artificial intelligence with the advanced level of the world by 2020”; “to achieve a major breakthrough in artificial intelligence basic theory, including large data intelligence, cross-media perceptual computing, hybrid enhanced intelligent, group intelligence, autonomous collaborative control and optimization decision, advanced machine learning, brain intelligent computing, and quantum intelligence computing theories, and parts of the technology and application will be at a world-leading level by 2025”; “to make artificial intelligence theory, technology and application achieve the world's leading level to be the major artificial intelligence innovation center of the world, intelligent economy, intelligent society achieve remarkable results, and lay an important

foundation for China's entry into the forefront of the innovative countries and economic powers."³⁰⁰

When looked into the basic principles of the proposed plan, four key themes stand out: Leadership of technology, acquired by trying to explore the concepts in-depth and achieve breakthrough in AI theory to escalate the implementation capability of artificial intelligence to benefit from the first-mover advantages; systematic layouts, where utilizing all the advantages of a socialist system by acting within the framework of a "target systematic development strategy that based on basic research, technology development, industrial development and industry application"; market-oriented approach, implemented by strengthening the government's role in multiple aspects through the whole process including "guidance, policy support, security, market regulation, environmental construction, ethical regulations, etc."; Keeping the process open source, managed by promoting sharing and collaboration of research, production and the result itself.³⁰¹

The Next Generation Artificial Intelligence Development Plan also puts emphasizes on other fundamental necessities: constructing the adequate intelligent infrastructure, focused on big data, network and high computing applications; increasing the number of AI talents; reforming the educational institutions; promoting the development of emerging AI industries, including smart robots and terminals, virtual reality and augmented reality, intelligent hardware and software, and vehicles and the fundamentals of the IoT; in addition, the plan strives to upgrade the existing industries by implementing AI-based technologies including agriculture, logistics, finance, manufacturing, business services, and home building systems.³⁰²

³⁰⁰ The State Council of the People's Republic of China, "Notice of the State Council Issuing the New Generation of Artificial Intelligence Development Plan."

³⁰¹ Ibid, 4.

³⁰² Ibid, 13-17, 22.

Furthermore, the document covers a list of societal problems, categorized as “the urgent needs of the society”, that can be solved, or at least improved, by utilizing these technologies such as inequalities and problems related to education, healthcare, and aging and public safety as well as promotes AI-integrated social governance by developing an intelligent government, transportation systems and environmental protection.³⁰³

While allocating the resources, the government plans to offer financial guidance by taking a market-led financial support approach, and support enterprises of all kinds by all means to lead the innovation trend; keeping this in mind, Chinese government also encourages the collaborative work of domestic and international enterprises and research institutions.³⁰⁴

The Plan also lists the key factors that will help accomplish the constructive and safe implementation of these technologies in line with the above-stated aspirations in the required field: “Develop laws and regulations and ethical norms that promote the development of AI”; “improve the key policies that support AI development”; “establish standards and the intellectual property system for AI technology”; “establish safety supervision and evaluation systems for AI”; “vigorously strengthen training for the labor force working in AI”; “ carry out a wide range of AI science activities.”³⁰⁵

Following the announcement of the Next Generation Artificial Intelligence Development Plan, the government intimated a non-profit organization called China Artificial Intelligence Industry Innovation Alliance, which is led by China Center for Information Industry Development and tech giants in the field.³⁰⁶ In accordance with

³⁰³ Ibid, 17-21.

³⁰⁴ Ibid, 23-25.

³⁰⁵ Ibid, 27.

³⁰⁶ Shuiyu, “China forms 1st AI alliance.”

the idea of “openness” and to encourage the collaboration on both domestic and international level with the participation of a variety of actors including ones from academia, industry and government, together with Intel China, this alliance led the establishment of “the Artificial Intelligence Open and Innovative Platform (chinaopen.ai)” in Guiyang City to be an open platform that “foster AI innovation from a close cooperation among government, industry and academic research.”³⁰⁷ The Platform provides an open data-set resources of a wide range of categories including road surveillance, health, security, street surveillance, public bus terminal and many more.³⁰⁸

While the Next Generation Artificial Intelligence Development Plan can be viewed as a comprehensive strategy that will be implemented through the decade, Chinese government issued an action plan to apply the first steps of the said Plan and Made in China 2025; “Three-Year Action Plan for Promoting the Development of Next Generation Artificial Intelligence Industry (2018-2020)”.

The Three-Year Action Plan for Promoting the Development of Next Generation Artificial Intelligence Industry (2018-2020) (促进新一代人工智能产业发展三年行动计划 (2018-2020年))

This Action Plan is designed to offer guidance to all actors in the AI scene, and, once again, emphasizes the major themes important for the development of AI technologies including “system layouts”, “key breakthroughs”, “open and orderly”, and “collaborative innovation”.³⁰⁹

³⁰⁷ The Artificial Intelligence Open and Innovative Platform, “Our Mission.”

³⁰⁸ The Artificial Intelligence Open and Innovative Platform, “Data Resources.”

³⁰⁹ Triolo et al., “Translation: Chinese government outlines AI ambitions through 2020.”

This Action Plan prioritizes eight targets: autonomous driving smart cars; robotics; drones; medical imaging aided diagnosis systems; facial recognition systems; intelligent voice interactive systems (including speech recognition technology); intelligent translation systems.³¹⁰ The Action Plan also highlights the importance of open platforms, and developing core foundations such as chips and sensors, which is in line with the aspirations of Made in China 2025, especially in regard to the domestically building the necessary software and hardware to reduce dependency to foreign countries.³¹¹

Meanwhile, the Japanese government is dealing with issues like shrinking population, rising number of elderly citizens and the strain it puts on the economy. Japan has the highest percentage of elderly citizens in the world, a position they will likely keep in the upcoming decades. The population prediction of 2019 by the UN Department of Economic and Social Affairs makes it clear that by 2050 the elderly population of Japan is expected to rise to 38% of the population a 10% increase from this year's 28%.³¹² The population is also decreasing and the government estimates that by 2050 the population as a whole will be under 100 million.³¹³

While the popularity of the topic is relatively new, the decrease in population had started as early as the 1980s, and has created a population pyramid that is top-heavy. This kind of population structure cannot be maintained long term as the economic and psychological burden it puts on society is not sustainable.³¹⁴

³¹⁰ Zhao, "China's three year action plan for AI."

³¹¹ Triolo et al., "Translation: Chinese government outlines AI ambitions through 2020."

³¹² United Nations, "The 2019 Revision of World Population Prospects."

³¹³ Ministry of Internal Affairs and Communication, Statistics Bureau, *Statistical Handbook of Japan 2018*.

³¹⁴ Weil, The economics of population aging, 968-970.

The reasons were clear; the increase for life expectancy at birth and a decrease in fertility rates.³¹⁵ Professor Naohiro Yashiro believes one of the causes of decreased fertility to be the decline in marriage rates as the average number of children per marriage have stayed practically the same but the same cannot be said for marriage rates.³¹⁶ Women are having babies, later in life, if at all.

The aging of the population also has an effect on public spending as the elderly retire and start depending on social benefits.³¹⁷ This is also exasperated by the fact that the number of working-age adults will also be going down which can be seen in more detail in Figure 10.³¹⁸

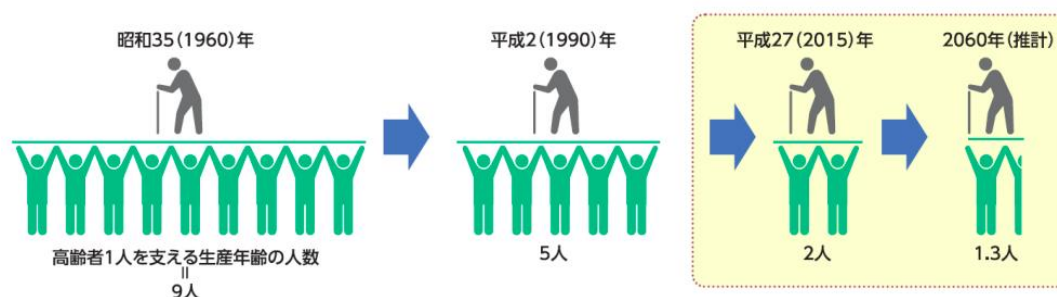


Figure 10. The number of working-age persons to support an elderly

Source: Hiroshima Keizai Dōyuukai, 人口回復に向けた広島経済同友会の取り組み Jinkō Kaifuku ni Muketa Hiroshima Keizai Dōyuukai no Torikumi (The Approach of Hiroshima Economic Association for Population Recovery)

This trend of aging of the population coupled with low-birth-rates has also been affecting the nursing and care services in the country.³¹⁹ The official estimate for

³¹⁵ Japanese Nursing Association, *Nursing in Japan*.

³¹⁶ Yashiro, "social implications of demographic change in Japan," 298.

³¹⁷ Organisation for Economic Co-operation and Development, *Better Policies Japan: Promoting Inclusive Growth for an Ageing Society*.

³¹⁸ National Institute of Population and Social Security Research, *Population Projections for Japan: 2001-2050*.

³¹⁹ Ministry of Economy, Trade and Industry, *Report by the Study Group on the Provision of Nursing Care Services in Response to Future Nursing Care Demand*.

nurse and care-giver shortage is 377,000 by 2025,³²⁰ unofficially the number rises to 500,000.³²¹ To create solutions for a number of issues that are arising, Japanese government has developed a societal plan, a smart society; Society 5.0.

Society 5.0 or Super Smart Society as a concept of a new societal structure was put forward by the Council for Science, Technology and Innovation in 2016 during the *5th Science and Technology Plan*. Society 5.0 could be defined as; "A human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space."³²² The main objective of Society 5.0 is to equalize the necessary service and product over the population.³²³

To understand what the Japanese government is aiming for with this initiative we need to understand the road-map of societal structures the Japanese have defined: the hunter-gatherer society (1.0), agrarian society (2.0), industrial society (3.0), and the information society (4.0). We are currently living in the information society, or Society 4.0 as the Japanese would label it. However, with Society 5.0, the 'information' aspect of this age will be connected to systems of information that would also become a part of the world on a physical level.³²⁴ The purpose of this initiative also lies with the government's plans to create a more sustainable society, where all age groups of the society are able to live a comfortable life.³²⁵

³²⁰ Ministry of Health, Labour and Welfare. 2025 Nen ni Muketa Kaigo Jinzai ni Kakaru Jukyū Suikei (Kakuteichi) ni Tsuite. 2025年に向けた介護人材にかかる需給推計（確定値）について.

(Supply and Demand Estimation for Care Workers in 2025).

³²¹ Emont, "Japan Prefers Robot Bears to Foreign Nurses."

³²² Cabinet Office, *Society 5.0*.

³²³ Hitachi, "Realizing Society 5.0 through 'Habitat Innovation'," 3-5.

³²⁴ Cabinet Office, *Dai Go Ki Kagaku Gijutsu Kihon Keikaku* 第5期科学技術基本計画 [The 5th Science and Technology Basic Plan].

³²⁵ Shiroishi et al., "Society 5.0: For Human Security and Well-Being," 91–95.

In Japan there are discussions happening on a governmental level on how to integrate these new technologies such as AI, IoT and Robotics into the daily lives of the people.³²⁶ The 2015 Report by the Cabinet Office “New Robot Strategy” aims to set clear goals on how to incorporate robotics and AI into Japanese society with the best possible outcomes. Their strategy also details the steps to boost the domestic robotics industry.³²⁷

The New Energy and Industrial Technology Development Organisation (NEDO) held the Strategic Advancement of Multi-Purpose Ultra-Human Robot and Artificial Intelligence Technologies (SAMURAI) Workshop in 2017; based on the strategies of the New Robot Strategy of 2015. The objective of the event was; “...promote development of promising technologies for practical use, the event provided business matching opportunities for project contractors and companies that agreed to sign non-disclosure agreements.”³²⁸

On the official site of the Japanese Cabinet Office the Society 5.0 initiatives objective is described as; “...creating a society where we can resolve various social challenges by incorporating the innovations of the fourth industrial revolution (e.g. IoT, big data, artificial intelligence (AI), robot, and the sharing economy) into every industry and social life.”³²⁹ The same year this initiative was made public as a viable countermeasure for the aging population problem, the Advisory Board on Artificial Intelligence and Human Society was also created as a part of Science and Technology Policy. The aim of this board is the advancement of research and development of AI technologies; “AI technology is one of the most significant

³²⁶ Harayama., “Society 5.0: Aiming for a New Human-centered Society”, 8-13.

³²⁷ Fujiwara, “Why Japan leads industrial robot production”.

³²⁸ New Energy and Industrial Technology Development Organisation, “NEDO Held "Strategic Advancement of Multi-Purpose Ultra-Human Robot and Artificial Intelligence Technologies (SAMURAI) " Workshop - Business Matching - Event.”

³²⁹ Cabinet Office, *Society 5.0*.

technologies that facilitates the realization of Society 5.0. The Advisory Board has worked especially to clarify benefits, issues, challenges, and future directions with special attention to AI technologies that exist or will be realized in the near future and a society in which such technologies prevail.”³³⁰ Japan is aiming to create a highly technology dominated future with a human-centric approach. Society 5.0 scheme is a clear road-map for the government on how to ameliorate the societal problems that are arising as a direct consequence of the aging of the society, decreased fertility and the labor shortages that are rapidly showing themselves as a result.

4.1.2 A comparison of Japanese and Chinese artificial intelligence scenes

In their region, China and Japan are among the leading forces on the road to implementing AI applications to all layers of the society and integrated the AI systems in people’s daily lives. China is currently the world’s second leading AI force, only seconded by the United States, that holds 12.56 percent of the global AI market share.³³¹

Even though Japan lags behind compared to the rapidly AI investment rate of China at the moment, it is important to remember that Japan was one of the earlier participants in the AI scene; the very first “intelligent humanoid” was delivered to the public eye by Japan in 1972,³³² ten years after the Japanese Ministry of International Trade and Industry started a joint project run by the government and

³³⁰ Advisory Board on Artificial Intelligence and Human Society, *Report on Artificial Intelligence and Human Society*.

³³¹ Xinhua, “China’s AI market to reach 71b yuan in 2020: report.”

³³² Ray, “History of AI.”

eight computer manufacturers from the industry to develop “Fifth Generation Computer Systems”, with a ten-year budget of around \$380 million.³³³

Though the project itself failed and never managed to be breakthrough as imagined, especially in natural language processing applications, the fact that Japanese government not only worked closely with industrial actors but also opened the project to the collaboration of foreign scientists still remains remarkable.³³⁴

The past is the past; in the present, as an advanced economy with an aging population, Japan needs to work hard to catch up with global forces to stay in the game.³³⁵ Japan has long been fighting to stop the decline in its workforce due to a rapidly aging population, though over 70% of the manufacturing industry in Japan and over 55% of all work force can be automated even now,³³⁶ the country needs to stay competitive by increasing the number of AI talents it educates, and by offering a healthy ecosystem for new ideas to emerge.

Japan’s position in the globally developing AI ecosystem also worries the leading technology companies in the country and not for in vain: SoftBank, also the initiator of the SoftBank Vision Fund, one of the world’s biggest private equity funds known for only investing in companies dealing with AI applications, that has over 70 investments worldwide, not a single one of them is in Japan.³³⁷

There are a lot to compare in terms of Japan’s and China’s AI approaches including their national strategies, announced in March and July 2017 respectively, and the ways AI applications are utilized.

³³³ Nilsson, *The Quest for Artificial Intelligence*, 22-27.

³³⁴ *ibid*, 27.

³³⁵ Jacobsen, “5 Countries Leading the Way in AI.”

³³⁶ Miremadi, “The Countries Most (and Least) Likely to be Affected by Automation.”

³³⁷ Kumar, “Japan Losing Its Tech Position As It Lags In Adopting Artificial Intelligence.”

Needless to say, the countries economic, political and social conditions are very different because of countless reasons including the population, history, economic agendas, and area of focuses as well as societal problems; while China is battling with the issues come with unequal development like educational inequality, especially because there is a huge gap between students of rural and urban origins,³³⁸ and ensuring equal healthcare nationwide, specifically for the rural areas,³³⁹ Japan is trying to take measures against the disadvantages of a rapidly aging society, which is taking its toll on the Japanese economy and labor force; as calculated by the International Monetary Fund (IMF), the average annual GDP growth of Japan is in the risk of shrinking one percentage point within thirty years.³⁴⁰

Talking about each country's political systems is also essential; China is a one-party state, known for its authoritarian characteristics, whose government gradually started to shift to transform into a market economy, which empowered the private sector and reconstructed the government's role in the market as of 1980s.³⁴¹

Japan is a constitutional monarchy with a catch: the dominating party remains the same as of 1955, which makes Japanese democracy fundamentally different compared to its Western counterparts due to the way political power is within the grasp of a single political approach, which of course have its disadvantages as well as advantages.³⁴²

It is important to underline that China and Japan are also unlike one another when it comes to the economic systems; considering the varieties of capitalism approach proposed by Hall and Soskice in 2001, which categorizes the countries

³³⁸ Gao, "China's Education Gap."

³³⁹ Song et al, "Increased Inequalities in Health Resource and Access to Health Care in Rural China."

³⁴⁰ Walia, "How Does Japan's Aging Society Affect Its Economy?"

³⁴¹ Dahlman, "Different innovation strategies, different results: Brazil, Russia, India, China and Korea (the BRICKs)."

³⁴² Darlington, "Japanese Political System."

based on the means the companies implement capitalism and their relations with other actors, Japanese economy can be defined as “a coordinated market economy, where corporate ownership, finance, inter-firm relationships and industrial relations all display higher degrees of coordination based on relationship-specific assets and long-term, cooperation ties”³⁴³ that is subjected to a “group- based coordination.”³⁴⁴

China boasts itself to implement a “socialist market economy with Chinese characteristics,” where state-owned enterprises are major components of the ecosystem and the government’s role in the market is significant in every aspect of the process³⁴⁵ shouted in the agenda with clear words: “encourage, support and guide”, of course, the target sectors.³⁴⁶ But to ensure a logical comparison, when we evaluate the country once again within a framework of the varieties of capitalism paradigm, though it may seem to be a coordinated market economy due to its political structure, China falls under “liberal market economy” category in many respects as it mainly “draws on market forces”, compared to Japan’s “coordinated market economy, which draws on non-market interaction among economic actors.”³⁴⁷

Nevertheless, it must be remembered that, as stated above, China’s shift to being a market-oriented economy is a recent transition and both its political and economic structures are unique, which makes it hard to place the country under a certain category.

³⁴³ Jackson and Miyajima, “Varieties of Capitalism, Varieties of Markets: Mergers and Acquisitions in Japan, Germany, France, the UK and USA”

³⁴⁴ Hall and Soskice, *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*, 21-27

³⁴⁵ Xun and Cortese, “A socialist market economy with Chinese characteristics: The accounting annual report of China Mobile.”

³⁴⁶ Pelkmans, “China’s “Socialist Market Economy”: A Systemic Trade Issue.”

³⁴⁷ Witt, “China: What Variety of Capitalism?”

These natural differences show themselves in the way they prioritize their AI research and application areas, while China focused on the means to industrialize AI applications to fulfill its “Manufacturing Power” agenda, Japan tries to implement AI applications to public’s daily lives and transform the whole country’s system by building “Society 5.0”.³⁴⁸

In Oxford Insights’ “AI Government Readiness Index 2019”, that evaluated “the current capacity of governments to exploit the innovative potential of AI” in metrics under four groups: governance, whose main indicators are a well-defined data or privacy law and a multi-layered national; infrastructure and data, including data availability, data/AI capability and necessary hardware; skills and education, based on technology skills, private sector innovation capability and the number of AI startups; government and public services, Japan³⁴⁹ ranked tenth.³⁵⁰

Though explained at a high-level in Chapter 2, I find going into the details of both governments published documents regarding the past, present and future of implementing these technologies extremely important as they also give us a clue about the AI ecosystem specific to that country.

China is a good place to be for artificial intelligence companies and relevant institutions from a wide range of aspects including government incentives, research funding and the amount of data that can be processed without being subjected to strict privacy regulations, due to its large population of more than one billion people

³⁴⁸ Tsinghua University, *China AI Development Report 2018*, 5

³⁴⁹ According to the AI Government Readiness Index 2019, Since China is not represented in OFKN Open Data Index, it is hard to estimate exactly which spot it would take among all countries. Though they placed China in the twentieth place due to lack of data, in other researches especially considering governmental strategies China scores exceptionally high points as underlined in the introduction of this chapter. On the other hand, Japan is well-integrated to global platforms, which convinces me the country’s rank is, excluding the China’s placement, true. The data processed for the said report can be found here: <https://docs.google.com/spreadsheets/d/1SuPCkaQsin1MsUYOn48bSQApfntJfOVh7-rL94KZWsq/edit#gid=15836467>

³⁵⁰ International Government Research Centre, *Government Artificial Intelligence Readiness Index*.

who currently make up “the world’s largest number of internet users”³⁵¹ and comparatively loose privacy regulations, which constitute the fundamentals for building a well-established AI-based technology ecosystem.

Chinese officials do not refrain from showing the utmost effort to design policies and regulations that boosts the deployment of AI technologies and the state itself is a big supporter of the industry since they see the emergence of these technologies as the “industrial revolution akin to the advent of the combustion engine, electricity or the Internet”, which is a unique approach that allows establishing a more direct and interconnected relationship between main governmental institutions, academia and industry that enables the private companies to access public data and the government to access the technology built for commercial uses.³⁵²

This positive ecosystem turned some of the most populated cities of China into technology hubs including Beijing, the city of world-famous universities such as Tsinghua and Peking universities and some of the nation’s most profitable AI companies including Baidu, JD.com, Bytedance, SenseTime and Megvii, is also building a \$2 billion worth AI research park that will be a home to approximately 400 enterprises;³⁵³ Hangzhou City, in which Alibaba runs its smart city project “City Brain 2.0”, Shenzhen, the newest technology hub where Tencent, Huawei and Peng Cheng Laboratory is located, a global attraction site for AI research centers of big tech giants both national such as Tencent and Alibaba as well as international ones like Microsoft and Amazon, Shanghai.³⁵⁴

³⁵¹ Ramanathan, “China's Booming AI Industry: What You Need to Know.”

³⁵² Cadell and Jourdan, “China aims to become world leader in AI, challenges U.S. dominance.”

³⁵³ Cadell, “Beijing to build \$2 billion AI research park.”

³⁵⁴ Peng, “Top 10 Chinese Cities for AI Development: Beijing Ranks No. 1.”

Moreover, the start-up ecosystem in China follows a unique pattern consisting of individual private equity investment worth an average of \$150 million, which is a number, compared to the investments in other countries, ten times more.³⁵⁵

In 2019, Chinese government funded many AI-related small and medium-sized enterprises as well as startups and offered them generous tax incentives in accordance with the fifth article of the Next Generation Artificial Intelligence Development Plan,³⁵⁶ which received a total of \$16.6 billion in investment through “government guided funds” distributed by local governments and state-owned enterprises.”³⁵⁷

It is also worth remembering for that though it may seem very beneficial for the private enterprises in terms of favorable allocation of resources, and for the government as it helps leading the market in a direction aligned with the system’s demands, this top-down system caused trouble for other industries, whose actors were heavily dependent on the government funding resulting in a case of unsustainable economic system; currently some Chinese AI companies leading the field are already highly dependent on government funding, the rates range between 30 and 68 percent of their profits, due to over reliance on subsidies.³⁵⁸

The number and comprehensiveness of AI policies in China gradually increased as of 2009, which led to the announcement of the first official government reports and plans involving these technologies in 2013; these documents slowly

³⁵⁵ Organisation for Economic Co-operation and Development, “Private Equity Investment in Artificial Intelligence.”

³⁵⁶ The State Council of the People’s Republic of China, “Notice of the State Council Issuing the New Generation of Artificial Intelligence Development Plan.”

³⁵⁷ Shoham et al, *The AI Index 2018 Annual Report*, 27

³⁵⁸ FTI Consulting, “Artificial Intelligence: The Race Is on the Global Policy Response to AI.”

became national-level strategic guides targeting more specific aspects of the field with a top-down approach.³⁵⁹

In state's efforts to accelerate AI development in favor of the nation's agenda, the Chinese government chose four big technology companies, arming them with funding, incentives and world-class infrastructure, the state also invited these private companies to conduct research in their assigned areas through "open innovation platforms" in the national laboratories such as National Engineering Laboratory of Big Data Systems and Software led by Tsinghua University and National Engineering Laboratory for Deep Learning Technologies led by Baidu, the company also responsible for advancing the research in autonomous vehicles; Alibaba Cloud (Aliyun) is responsible for smart cities,³⁶⁰ Tencent for medical imaging, and iFlytek for smart voice, which contributes to strengthen private sector-state cooperation for a coordinated AI development, which is claimed to improve the industry and not exclude small players due to its "openness" in terms of platforms and data.³⁶¹

As directed by the state each of these companies have their own open technology and application platforms in their specific fields: Baidu, in autonomous driving called Baidu Autonomous Driving; Alibaba in smart city applications named Alibaba City Brain; in intelligent healthcare Tencent Medical Imaging led by Tencent; for intelligent speech and vision iFLYTEK Intelligent Speech and SenseTime Intelligent Vision respectively; in smart education Squirrel AI Intelligent Adaptive Learning and finally for smart retail: JDAI.³⁶²

³⁵⁹ Gao et al, "Comparative Analysis between International Research Hotspots and National-Level Policy Keywords on Artificial Intelligence in China from 2009 to 2018. Sustainability"

³⁶⁰ The pilot city Hangzhou exceeds even Beijing, the country's unrivaled technology hub, in terms of smart services benefiting the public. You can see the details on Deloitte's report, page: 20. <https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/innovation/deloitte-cn-innovation-ai-whitepaper-en-190118.pdf>

³⁶¹ Kania, "China's AI Agenda Advances."

³⁶² Deloitte, *Global artificial intelligence industry whitepaper.*, 47.

These companies are happy to join in and benefit from generous incentives and advantages offered by the state for many reasons: they view AI as a long-term investment that will pay off greatly in the end, and are contented to wait patiently until all the investments give fruit; these investments and the support from the government will help them acquire the top talent and the most recent technologies they need to stay competitive -it is not a coincidence that these companies all established offices in the Silicon Valley; most importantly, by giving their backs to the state, these companies make sure that they have access to the giant pool of data in China, the amount of data the state holds will help these companies to step up their game in the field.³⁶³

Japan expects a total of JPY 121 trillion (US\$ 1.135.744.986) from AI technologies by 2015, it is also estimated that the AI market size will reach JPY 87 trillion (US\$816.756.000) by 2030, which is about fifteen time more compared to 2015; just like Chinese tech giant, Japan also have a group of key players dominating the field: NEC, focusing on “public safety solutions include urban surveillance systems and crowd behavior analysis, landslide prediction solution, and plant failure sign detection system are examples of infrastructure/plant management solutions”; Fujitsu, offering AI-based consulting recently developed a software that can recognize emotions on people’s faces; Toshiba, utilizing AI for advanced analytic system, also developed a dialogue-based virtual assistant offering inheritance advice; Hitachi, developed a software that can make robots instruct employees based on data and performance; Mitsubishi Electric, working on developing driver-assisted systems; NTT Group, utilizing AI to protect customers from cyberattack; SoftBank, partnered with IBM’S AI Watson system aims to improve education, healthcare,

³⁶³ The Economic and Social Commission for Asia and the Pacific, *Artificial Intelligence in Asia and the Pacific*, 4.

banking and many more social services in Japan; Toyota, takes part in public-private initiatives to use AI-based technologies in manufacturing and infrastructure processes; Canon, aiming to completely automate manufacturing of digital cameras using AI, which will decrease the labor cost significantly.³⁶⁴

In the meantime, AI startup scene in Japan is also expanding with the efforts of the government; the Japanese government not only implements new policies and creates funding to support new startups but also encourages other actors of the sector to coordinate funding new startups, and promotes open innovation platforms by establishing organizations such as Japan Open Innovation Council.³⁶⁵

The funding on top 10 startups vary between \$5 million to \$130 million, and their focus areas also cover a wide range of applications including internet of things, big data, autonomous vehicles, optical character recognition, natural language processing, fintech, and of course, robotics- what the country is known and famous for in this field.³⁶⁶

In addition, just like the other global actors Japanese government also sees value in the collaborative work of academia, industry and governmental organs as they state “Promotion of R&D Projects Based on Industry-Academia-Government Collaboration” a priority in the Artificial Intelligence Technology Strategy issued by the State Council for AI Technology.³⁶⁷

Even though these insights may seem impressive, an in-depth look shows the dire state of the Japanese AI ecosystem when it comes to AI practitioners or investors since considering the region, whereas China is home to 93 unicorns, a

³⁶⁴ Lundin, ”Artificial Intelligence in Japan (R&D, Market and Industry Analysis.)”

³⁶⁵ State Council for AI Technology, *Artificial Intelligence Technology Strategy*, 9.

³⁶⁶ Nanalyze, “Top-10 Artificial Intelligence Startups in Japan.”

³⁶⁷ State Council for AI Technology, *Artificial Intelligence Technology Strategy*, 9.

startup that values over \$1 million, Japan only as two.³⁶⁸ This slow transition to AI applications are generally attributed to the Japanese work culture that promotes life-long employment and risk-free, repetitive style of business, which hinders the innovative achievements by neglecting the new generation's opinions and thirst of cutting-edge knowledge.³⁶⁹

4.1.3 Data: Quantity, collection, storage, and sharing

Before comparing the countries advantages and disadvantages in terms of data pool, we need to clear out why data is of such importance when we talk about AI applications.

To put it simply, in order for an AI-based project to work, it requires a good quality of data, your system is only effective as the quality of the data you properly collect and store.³⁷⁰

After collecting the data, you need to make sure to have the adequate infrastructure to safely and structurally store it, only after this stage you can start exploring/cleaning phase, that will let you label data and prepare training sets for you to introduce a simple machine learning algorithm to experiment, test and optimize, which will eventually have you implement AI systems; all these steps are shown below in the data science hierarchy of needs introduced by Monica Rogati.³⁷¹

Moreover, measuring data only in numbers is not going to give the most solid results as there are other parameters in action when considering the role of data for AI systems that can be listed as depth, which can be described as the “different

³⁶⁸ Kumar, “Japan Losing Its Tech Position As It Lags In Adopting Artificial Intelligence.”

³⁶⁹ Stanford, “Why is the Progression of Japan's AI Slow?”

³⁷⁰ Sundblad, “Data Is The Foundation For Artificial Intelligence And Machine Learning.”

³⁷¹ Rogati, “The AI Hierarchy of Needs.”

aspects of user behavior”, quality meaning the accuracy of data processed and stored, diversity in various origins of data and access, the availability of data to different actors.³⁷²

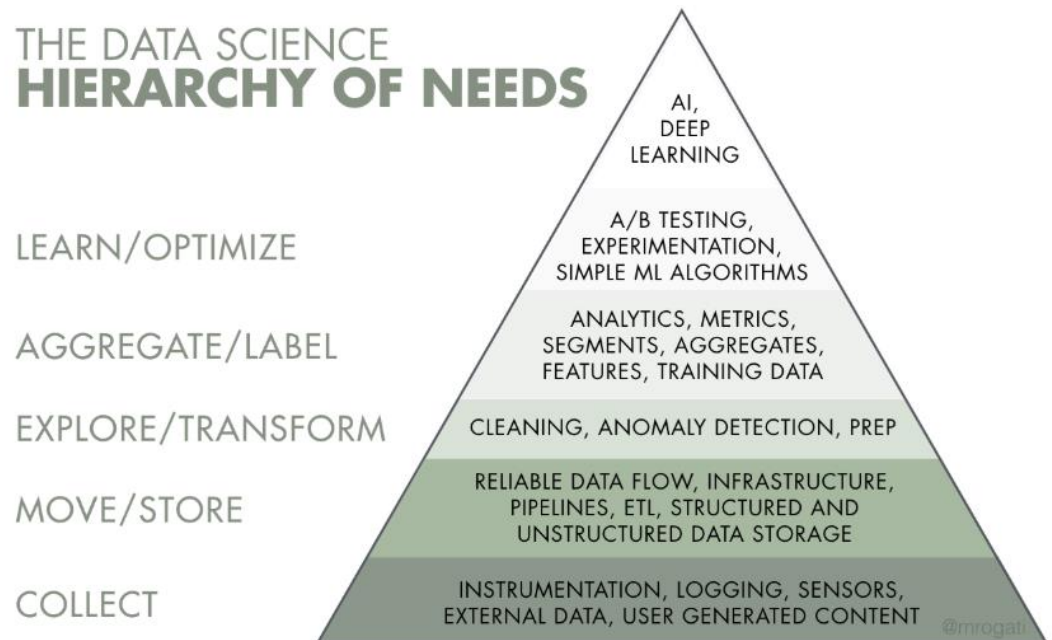


Figure 11. The data science hierarchy of needs
Source: Rogati, “The AI Hierarchy of Needs.”

As stated in the beginning of this chapter, on the road to becoming a leader in global AI scene, domestically China holds a competitive amount of data in quantity thanks to the number of internet users, who are big fans of online shopping and online wallet systems working with more advanced technologies like facial payment systems introduced by Alipay, a side branch of Alibaba, called “Smile-to-pay”, and “Frog Pro” more recently developed by Tencent.³⁷³

Though it is true that when it comes to the sheer number of domestic data, China seems to have an unrivaled advantage that cannot be overlooked, it is

³⁷² Sheehan, “Much Ado About Data: How America and China Stack Up”

³⁷³ The Guardian, “Smile-to-pay: Chinese shoppers turn to facial payment technology.”

important to note that domestic data is limited data in terms of diversity and quality, which puts Chinese companies like WeChat with 1.1 billion local users in a questionable state compared to other global competitors like Facebook, who has access to tremendous amount of diverse data thanks to its global reach, and for the quality of data Chinese government is recently introducing frameworks to collect and store data.³⁷⁴

Considering these numbers, it is not surprising that China included building a solid, sustainable big data infrastructure a priority; in the *New Generation of Artificial Intelligence Development Plan*, China states its purpose to construct government governance to create an integrated data system nationwide that is created based on the national data sharing exchange platform and data open platform, which will be implemented in every corner of the country.³⁷⁵

On the other hand, the country tries to gain access to foreign data and increase diversity through companies operating in other continents including Latin America and Africa as well as Asia such as SenseTime and CloudWalk, exporters of surveillance technology; in addition, China has the convenient regulatory and commercial environment necessary for a rapid growth.³⁷⁶ By the end of the year, China is estimated to have 20% of the global data, which is estimated to climb up 30% by 2030.³⁷⁷

While talking about the availability of data in China, another aspect worth mentioning is the data privacy as in the eyes of the public, Chinese government's success in utilizing AI applications is greatly linked to the lax data privacy

³⁷⁴ Castro et al, "Who Is Winning the AI Race: China, the EU or the United States?"

³⁷⁵ State Council for AI Technology, *Artificial Intelligence Technology Strategy*, 22.

³⁷⁶ Smart et al, "Geopolitical Drivers of Personal Data: The Four Horsemen of the Datapocalypse."

³⁷⁷ Saylor, *Artificial Intelligence and National Security*, 22.

regulations, especially after the infamous testimonial speech Mark Zuckerberg gave before the congress about how strict data protection regulations will cause the technology sector to be dominated by Chinese companies.³⁷⁸

In 2017, China took the first steps to establish a safe environment for its netizens by introducing the Cybersecurity Law that handled the fundamental issues regarding privacy considerations including consent requirements while dealing with data; covering only basics, these documents were not enough to secure the netizens from data leakages.³⁷⁹

It is true that loose, and almost non-existent, data privacy regulations eased the efforts of Chinese companies while they are developing AI systems. Though China is currently establishing a data regulatory system, and in 2018, National Information Security Standardization Technical Committee (NISSTC) has issued a national standard on personal information protection called Personal Information Security Specification (PI-Specification), similar to European Union's General Data Protection Regulation (GDPR), setting rules for data collection, storage, processing and sharing, these document were commented to be more detailed but not as strict in enforcement as the one issued by European Union since the former one is not designed to be binding and comes across as a "comprehensive framework" offered to the companies, but on a positive note the PI-Specification gives the government right to investigate in case of non-compliance, and was put in effect time to time since their date of issue.³⁸⁰

The Chinese officials started taking measures against some of the most used apps online in terms of the way they handle data; after the evaluation of more than

³⁷⁸ Sacks and Laskai, "China Is Having an Unexpected Privacy Awakening"

³⁷⁹ Sheng, "One year after GDPR, China strengthens personal data regulations, welcoming dedicated law."

³⁸⁰ Sacks, "New China Data Privacy Standard Looks More Far-Reaching than GDPR."

400 applications, the results showed that around 100 them did not comply with the recently issued guidelines - their data collection was either too excessive or done in a highly unprotected way-; these companies were asked to improve the means they dealt with the user data, which turned out to be a fruitful process.³⁸¹

Keeping things loose is important for the Chinese government because “the government does not want to undermine efforts for developing fields seen as crucial for China’s economy like artificial intelligence, which relies on access to massive datasets.”³⁸²

As the public awareness regarding data privacy increases in China, so does the governments need to accelerate the process of establishing a well-functioning legislative system that not only avoids hindering the booming AI ecosystem of China but also protects internet users’ rights by looking out for the interests of all groups involved including the government itself, people and companies, which is, unarguably, not so easy to accomplish without the cooperation of each group.³⁸³

Another thing worth underlining is the fact that the PI-Specification while they may regulate the tech companies attempts of data collection and sharing without consent, it has the opposite effect when it comes to government surveillance since it does not prevent the government from using facial recognition and big data to monitor the public, and collecting data without consent for this purpose.³⁸⁴

Chinese government also announced that in 2020, they will put great emphasis on data protection and construct a multi-layered legislative system that covers the loose ends of the currently persuasive guidelines.³⁸⁵ This is not just for

³⁸¹ Xinhua, “China Focus: China accelerates personal data protection.”

³⁸² Sacks, “China’s Emerging Data Privacy System and GDPR.”

³⁸³ Sheng, “One year after GDPR, China strengthens personal data regulations, welcoming dedicated law.”

³⁸⁴ Sacks and Laskai, “China’s Privacy Conundrum.”

³⁸⁵ Data Protection Laws of the World, “China.”

ethical reasons, as China aspires to set up Chinese companies across the Europe, which has very strict data protection regime, and ultimately all over the world, which is impossible without ensuring to follow certain standards of data privacy and to gain trust of foreign partners in terms of data protection.³⁸⁶

Japan has over 117 million internet users, which sums up to a more than 90% internet penetration rate by the population of the country,³⁸⁷ an impressive number especially considering that China's rate is only 61.2%.³⁸⁸

The number of users shows themselves in the large amount of data the country holds, nevertheless the data is not of great use for building AI-based systems as the data is usually not digitized, which makes it harder for Japan to make use of this advantage as much as it possibly could.³⁸⁹

As mentioned before, the investment rates and company profiles when it comes to Japanese AI sector is worrying and causes the company, just five years ago considered to be one of the leaders in the technology word,³⁹⁰ to fall behind, the impressive internet penetration rate may have had a positive effect on another aspect of the AI utilization besides the business; within the framework Society 5.0., Japan started to integrate, and has plans to further integrate AI systems in the public administrations: in Kawasaki City has an app called "AI Concierge" that offers services for the citizens including services of nursing, garbage arrangements, residence registration and various application process; Saitama City offers an AI-based system that arranges childcare services aligned with the needs of the parents in terms of timing and location; in Fukuoka City an AI-assistant is used for planning

³⁸⁶ Chalk, "Commentary: China's great leap forward in data protection."

³⁸⁷ Internet World Statistics, "Asia."

³⁸⁸ Xinhua, "China has 854 mln internet users: report."

³⁸⁹ Swiss Business Hub Japan, *Opportunities for Swiss Companies AI in Japan*, 8.

³⁹⁰ Jolley, "Artificial Intelligence—Can Japan Lead the Way."

assigning care managers for old or sick people; Tokyo and Metropolitan Police and Kyoto Prefecture Police plan to use AI systems to prevent crimes from occurring by analyzing the reports of citizens; Itoshima City is developing an AI recommendation system for migration services; in Chiba City AI is being used for city reporting system that can detect the road damages; Osaka City is utilizing AI-based technologies for family register processes; in addition to these, robots for traveling in rural areas, robots in information cabinets, and therapy/assistance robots for aging society are among the deployed projects.³⁹¹

Moreover, the Japanese government itself also has plans to use the AI technologies in the parliament; the technology will be used for policy-making based on past examples and responses to issues and situations and help writing of the drafts to be proposed by the officials by first processing five years worth of data, which can be expanded to apply to the other areas if successful.³⁹²

Japan was one of the earliest adopters of a data protection legislation, especially among the Asian countries; the Act on the Protection of Personal Information (APPI) was released in 2003 at first, and was amended to put into effect in accordance with the needs of today's world as of 2017, a year earlier than European Union's GDPR.³⁹³

Though very strict on paper, just like China, when enforcing the act Japan is known for taking a more easy-going approach: When a violation is detected, Japan's responsible authority of data protection, Personal Information Protection Commission, contacts the business operator to make the necessary arrangements to

³⁹¹ The Government of Japan, "Artificial Intelligence projects in the public administrations of Japan."

³⁹² Chin, "Japan trials AI for parliament use."

³⁹³ Coos, "Data Protection in Japan: All You Need to Know about APPI."

eliminate the danger of a violation or leak; in case the said operator does not comply with the request of rectification, only then an administrative order is issued.³⁹⁴

At the moment, the penalty for not complying with the requirements of the administrative order varies between a monetary penalty of JPY 300.000 (US\$ 2,805), and for some cases imprisonment up to six months.³⁹⁵

It is true that currently Japan is not among the top leaders of what many refer as AI race, especially when it comes to making incremental advancements in the field. Nevertheless, the country's voice in the international arena is loud and clear, which makes Japan a key player setting the game since the country is highly integrated to systems of global actors; avoiding an isolated progress will put the Japanese government in an advantageous position compared to China as currently China has no international presence other than some newly issued documents.

For example, Japan and European Union recognized each other's data regimes to be equivalent of one another's, which will speed up the global integration of Japan in terms of utilizing data to be applied in AI systems and give more room to cooperation among countries.³⁹⁶

In addition to getting recognized by various leading global actors such as European Union, and the United States, with which the country recently executed a digital trade agreement that stands against data localization and enables free cross-border data flow as well as open access to government data,³⁹⁷ Japan initiated a global action on data governance in G20 Osaka Summit, where Prime Minister

³⁹⁴ Kirchhoff and Schiebe, *The Reform of the Japanese Act on Protection of Personal Information From the Practitioner's Perspective*, 15-17.

³⁹⁵ Personal Information Protection Commission, *Amended Act on the Protection of Personal Information*.

³⁹⁶ Abe, "Defeatism about Japan is now defeated": Read Abe's Davos speech in full."

³⁹⁷ Agrawal, "USA, Japan sign Digital Trade Agreement, stand against data localisation."

Shinzou Abe, aspiring to lead the discourse on such a critical discussion, argued for Data Free Flow with Trust (DFFT) for planting the seeds of a worldwide data governance system.³⁹⁸

The track argues for a data governance structure designed in hopes of using global, non-personal traffic, medical or industrial data to build a bridge to eliminate the gap between genders, classes and nations aligned with the articles of Society 5.0.³⁹⁹

Though China also signed on this track, the country already has a strict data localization system that requires the companies to store the data within the country and prevents it from sending out without provision; other countries such as India, who also possess an abundance of data are not as cooperative to join in this global data governance framework as many others since the main advantage lies in the amount of data they process, and are wary of “data colonialism” enforced by tech giants.⁴⁰⁰

Despite there are little to none joint progress in respect of the countries approach to data and internet policy due to their culturally and economically relative priorities, one way or another, the means countries handle data will be subjected to certain standards to offer value reflected in productive economies that maximizes the beneficial social outcomes while adhering to legal responsibilities; Japan’s DFFT initiative grants a very direct framework to define what is good and what is bad universally when it comes to the content shared cross-borders.⁴⁰¹

³⁹⁸ Koshino, “RESOLVED: Japan Could Lead Global Efforts on Data Governance.”

³⁹⁹ Hurst, “Japan Calls for Global Consensus on Data Governance.”

⁴⁰⁰ Hicks, “‘Digital colonialism’: Why countries like India want to take control of data from Big Tech.”

⁴⁰¹ Atkinson et al, “Principles and Policies for “Data Free Flow With Trust.”

Leading the world this direction may help Japan's national strategy on many levels as it will not only pave the way for the country to access to other countries' data pool, but also will ensure that Japan remains a key player in the global arena notwithstanding the fact that it has a shrinking AI talent pool, and cannot compete with forces such as the United States or China on its own.

4.1.4 AI talents

In the recent years, the AI talent pool in Asia showed a gradual and consistent growth, while China is winning the race of attracting talents from all over the world as well as educating local ones, Japan seems to be an exceptional case in this regard as compared to its competitors, the AI talent pool of Japan is following a completely different trend; it is shrinking, even considering much smaller economies.⁴⁰²

This shrinking does not necessarily represent the number of talents leaving the country, as both China and Japan are considered anchored countries when it comes to top-tier AI talents, which means the talent inflow and outflow neutralize each other; it mostly means that the number of AI talents produced in Japan or attracted from overseas does not increase.⁴⁰³

China's AI talent pool, consisting of 18232 talents is outstanding, and makes them the second country to hold such a numerous pool, nevertheless underrepresented by top AI talents as they only represent about 5% of the said talent pool.⁴⁰⁴

Though, the shortage of top AI talents cannot put a shadow on the remarkable fact that Chinese AI talent pool has grown ten times within the last ten years based

⁴⁰² Hiramoto, "Asia's AI talent pool broadens, except in Japan."

⁴⁰³ Gagne, *Global AI Talent Report 2019*.

⁴⁰⁴ Tsinghua University, *China AI Development Report 2018*, 33-41.

on the number of AI scientists attending the NeurIPS conference, the same talents also tend to leave, making Chinese government take measures against such an outflow.⁴⁰⁵

As of 2008, the Chinese government initiated programs such as “1000 Talents Plan”, officially known as the “Recruitment Program of Global Experts”, to attract top talents working in the high tech fields from overseas, providing a wide range of benefits both for the awardee and their family, which is a strategy to increase the number of high quality researchers.⁴⁰⁶ While the government pursues these nationwide talent recruitment programs, on a more local level, cities like Shanghai also take matters into their own hands by starting projects to attract young talents, a joint effort of the industry and academia.⁴⁰⁷

Retention is a problem but so is growing the base for domestic AI talent, aligned with their increasing ambitious, the Chinese government tries to diminish the talent gap by investing in AI education, and encouraging all academic institutions to focus on educating home-grown AI talents; the Ministry of Education issued *AI Innovation Action Plan for Colleges and Universities*, setting a guideline to cultivate the AI talent, to encourage global cooperation, and to increase the institutions’ capabilities in innovation technologies.⁴⁰⁸

According to this plan, China will “create 50 world-class teaching materials for undergraduate and graduate studies related to AI applications for specific industries; create 50 national-level high-quality online open courses; and establish 50 artificial intelligence faculties, research institutions, or interdisciplinary research

⁴⁰⁵ Ma, “China’s AI Talent Base Is Growing, and then Leaving.”

⁴⁰⁶ Recruitment Program of Global Experts, “About.”

⁴⁰⁷ Wei, “Shanghai announces AI talent development plan.”

⁴⁰⁸ Zhang, “China Puts Education Focus on AI; Plans 50 AI Research Centres By 2020”

centers.”; in addition another five-year plan was established to educate five thousand students in the field as well as five hundred teachers.⁴⁰⁹

While China is in trouble with retention, on the other hand, as stated, Japan’s AI talent does not show any sign of growing, and the number of practitioners who have the capability of developing and deploying AI projects proved to be insufficient compared to the global trend that is rapidly changing and evolving; being aware of this situation the government organs also underline the importance of bringing a solution to this problem as Japan’s Ministry of Economy, Trade and Industry announced that the need for AI specialist will reach out to be “a shortage of 120,000 AI business experts by 2030”.⁴¹⁰

To combat the odds, Japan is transforming its education system to meet the requirements of Society 5.0, especially in terms of producing more AI talent; courses such as math, data science, and programming as well as philosophy and language will constitute the of education,⁴¹¹ and all students attending the universities and technical schools will be obligated to take mandatory AI courses, in a country where only 2.800 AI students complete a master’s degree, the country hopes to produce 250.000 AI experts per year through an upgraded, interdisciplinary and inclusive education system.⁴¹²

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Economy, Trade and Industry (METI) of Japan has joined forces with the Japan Business Foundation (Keidanren) to make sure post-graduates are updated with state-of-the-art methods in the field; MEXT also

⁴⁰⁹ Ibid.

⁴¹⁰ Gurin, “The AI Market in Japan: GlotureBlog.”

⁴¹¹ The Global Japan, “How students are being prepared for Society 5.0.”

⁴¹² Yamashita, “Japan aims to produce 250,000 AI experts a year.”

encourages AI companies and universities to cooperate while training AI students through newly announced funding opportunities.⁴¹³

Currently, Japan hosts a total of 3117 AI talents, though only summing up to 1.5 percent of the global numbers, more than 20 percent of these talents are considered among the top AI talents.⁴¹⁴

In addition to a reformed education system that will pay off in the long-term, Japanese companies also take matters into their own hands: Big companies like Sony follow the other global tech giants to attract AI talent by increasing the salaries and welcoming more foreign engineers, on the other hand some companies who fall behind the competition for attracting talents try to catch up by offering speed-up AI courses, and educating their workers in aligned with the sector's needs; even ones without a background in AI studies.⁴¹⁵

4.1.5 AI patents and publications

Japan and China are actively participating in academic research, and applying for new AI patents, to make sure they take the lead in the new breakthroughs.

Just like in many other areas related to the field, China is in a heated competition with the USA in regard to AI-related publications: China is currently the world's top publisher in numbers, but when it comes to impact China is still lagging behind the USA, which is estimated to change in near future as further discussed below.⁴¹⁶ On a more positive note, "Field-Weighted Citation Impact (FWCI), which

⁴¹³ Harris, *Research brief: developments in artificial intelligence (AI) in Japan and implications for Australia*.

⁴¹⁴ Tsinghua University, *China AI Development Report 2018*, 33-41.

⁴¹⁵ Kajimoto, "As Japan frets about dearth of AI talent, Daikin develops own program."

⁴¹⁶ Shoham et al, *The AI Index 2019 Annual Report*, 20-40.

is the average number of citations received by AI publications originating from that region divided by the average number of citations by all AI publications worldwide in the same publication year, subject area, and document type, has been increasing considerably and is estimated to exceed the USA by 2025 in this regard.⁴¹⁷

It is also important to note that the government-affiliated publications were four times more than corporate ones; the government produced publications grew 400% more in the last ten years compared to the corporate sector, which escalated by 73% in the same period of time.⁴¹⁸ This can be seen as an indicator of the government's smart guidance as the impact level of the papers increased accordingly.

Japan is fourth in the world considering the number of publications in AI conferences, when it comes to journal publications the country falls back to sixth place; just like China, Japan takes advantage of a healthy cooperation between the academia and private sector when it comes to AI research.⁴¹⁹ 10% of Japan's AI research comes from the corporate sector, 7% more than China, and research conducted by governmental institutions takes up 14% of the total output, which highlights the importance the government put into these emerging technologies.⁴²⁰

While discussing the representations of AI research in the global AI scene, the number of AI patent applications also need to be considered to evaluate the incremental value of the researchers.

Even though Japan made the first AI patent filing in the 1980s, 50 percent of the existing AI patents were filed in last 5 years; as the potential of these technologies were acknowledged once and for all, each year the number of

⁴¹⁷ Schoenick, "China May Overtake US in AI Research."

⁴¹⁸ Shoham et al, *The AI Index 2018 Annual Report*, 14.

⁴¹⁹ Shoham et al, *The AI Index 2019 Annual Report*, 19-30.

⁴²⁰ Hugget and Bert, "6 new insights into AI research – dig into the data for your country."

companies, hoping to utilize AI-based technologies to climb up the scoreboard of most profitable companies, and research institutions as well as universities aiming to advance the field, applying for AI patents increases drastically.⁴²¹ As shown in the figure 12 below, considering the global AI patent publications, companies make up the most of AI patent applicants.

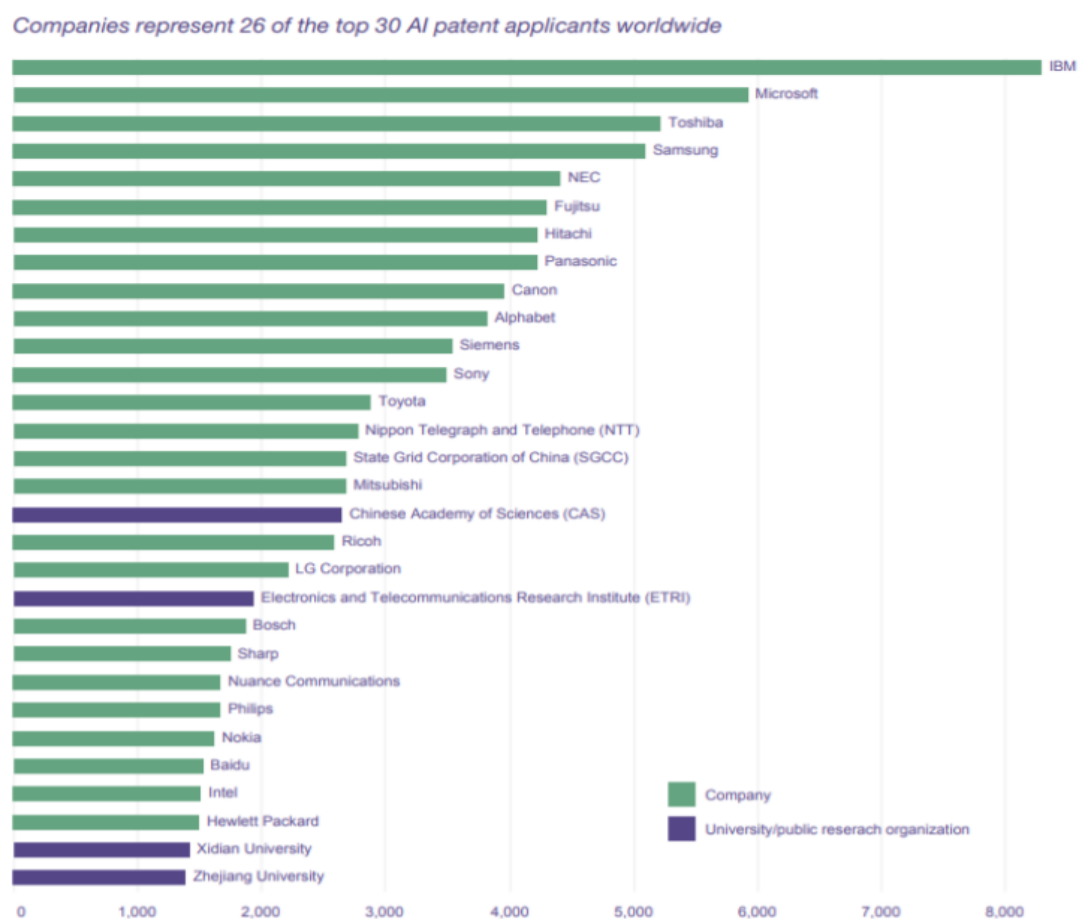


Figure 12. The top 30 AI patent applicants.

Source: World Intellectual Property Organization, “WIPO Technology Trends 2019: Artificial Intelligence.”

Though the first two patent applicants with the biggest portfolios, Microsoft and IBM, are of the United States origin, Chinese and Japanese entities follow up closely for dominating the field; overall list of top 30 patent applicants includes 12 Japanese companies/institutions and 5 Chinese ones, which makes up more than half

⁴²¹ Rodriguez, “Patenting AI: Let's start with a history lesson.”

of the list; another important thing to point out is that while China is home to 17 of the top 20 research institutions when it comes to AI patent filing, 12 Japanese companies found themselves a place in the top 20 companies for AI patent filing that mostly apply for patents under the categories of machine learning and computer vision.⁴²² In AI patent filings, in terms of AI research areas, Japan competes with China in certain categories such as fuzzy logic, computer vision and speech processing, and with regard to the AI applications specific for field, Japan is right next to China for categories including “arts and humanities”, “document management” and “publishing” and “military applications”.⁴²³

While considering these numbers we need to take into account the fact that only 19 percent of the Chinese AI patents were published filed in more than one country whereas for Japan it is 58 percent of all published patents, which means the numbers of the Chinese patent may be underrepresented solely because the Chinese researchers pursue a more isolated approach in this regard.⁴²⁴

4.1.6 Semiconductors: AI chips rising

While talking about China, it is important to point out that there are certain obstacles as well, as the investment in R&D grew rapidly in many angles to exceed \$300 billion, China remains dependent to other countries when it comes to core technologies including semiconductors and intellectual property that are usually

⁴²² World Intellectual Property Organization, *WIPO Technology Trends 2019: Artificial Intelligence*, 58-65.

⁴²³ Ibid, 82,100.

⁴²⁴ Intellectual Property Office, *Artificial Intelligence: A worldwide overview of AI patents and patenting by the UK AI sector*, 39.

imported from three countries: 31 % from the USA, 21% Japan and 10% from Germany, which sums up to more than half of the total purchased amount.⁴²⁵

China's dependency on the foreign semiconductors worried the officials too; President Xi Jinping declared, in fact numerous times, that China cannot afford to be dependent on other countries for the core of the developing technologies.⁴²⁶ As a result, China hopes to raise the percentage of the semiconductors produced domestically from 16% to 70% by 2025 within the scope of 'Made in China 2025.'⁴²⁷

This may come off surprising as we are used to the "Made in China" label everywhere when it comes to technological devices but the truth is usually, only the operational process are held in China, the primary components of the electronics are coming from above stated countries; even in the drone market, where Chinese companies enjoy an unchallenged dominance, semiconductors are of U.S. origin; to change this China not only made developing the semiconductor sector a priority, but it also initiated a governmental aspiration on focusing on the AI accelerator chips, which are chips designed for boosting AI applications.⁴²⁸

The Chinese government's' efforts for building a self-sufficient domestic semiconductor market is not new, despite all the investment and funding, the country could not have caught up with the global competitors, a fact Chinese officials hope to change with upcoming AI chips; the semiconductor companies invest in developing AI chips according to the needs of a certain applications, which will let China advantage of its AI advancements.⁴²⁹ This is undoubtedly a chance not to be missed

⁴²⁵ Bughin et al, *China in the World*, 27-37.

⁴²⁶ Lewis, "China's Pursuit of Semiconductor Independence"

⁴²⁷ Naderi, "China's semiconductor industry shifts into a higher gear, here's why."

⁴²⁸ Allen, "Understanding China's AI Strategy."

⁴²⁹ Dai et al, "Lagging in semiconductors, China sees a chance to overtake the US with AI chips as 5G ushers in new era."

for China because the market revenue of AI chips will escalate tremendously within the next 10 years, as it can be seen from the figure 13 below.⁴³⁰

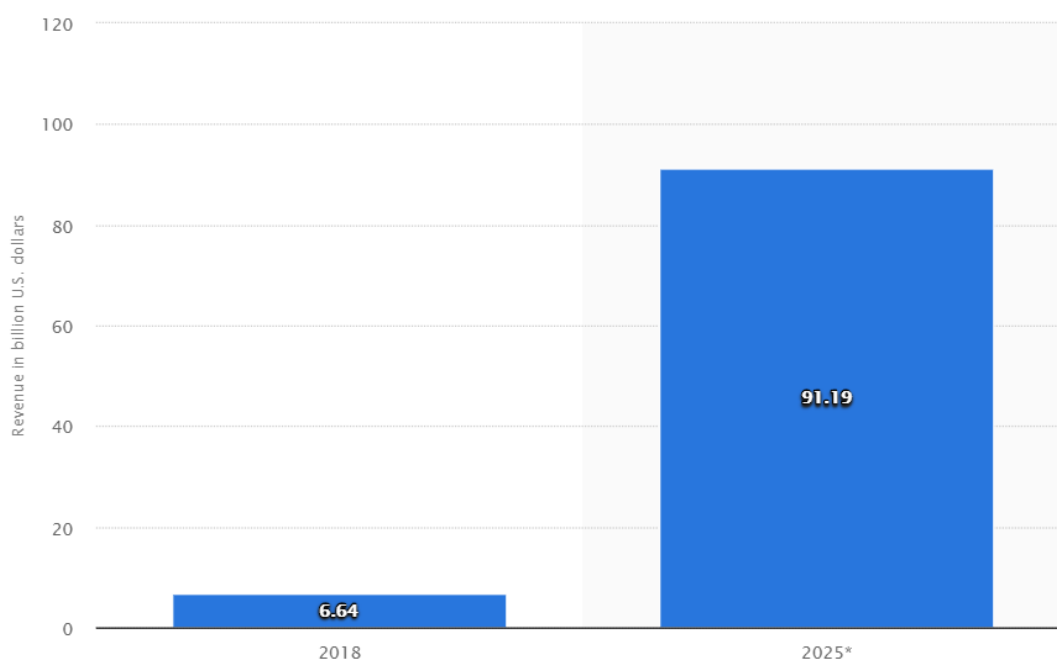


Figure 13. Artificial intelligence (AI) chip market revenue worldwide in 2018 and 2025 (in billion U.S. dollars)

Source: Holst, “Global revenue of AI chip market 2018 and 2025”.

Though at the moment ML-optimized Graphics Processing Units (GPUs) and Central Processing Units (CPUs) are in high demand due to their effectiveness and usefulness, they are general-purposed in their nature, which prevents AI systems from flourishing in maximum capacity, since they require the computing as much as they require data.⁴³¹

Domain-specific AI accelerator chips, that stand out for their capability to handle big data, and their precision for data representation, will be the main component of AI technologies’ infrastructure, providing the necessary specialized

⁴³⁰ Holst, “Global revenue of AI chip market 2018 and 2025.”

⁴³¹ Deloitte, *Hitting the accelerator: the next generation of machine-learning chips*, 2-7.

computational density while building AI-based projects, which makes China's efforts completely understandable.⁴³²

These new chips developed specialized for AI applications are field-programmable gate arrays (FPGAs) and application-specific integrated circuits (ASICs), which require less energy but offers greater speed against low cost thanks to the way they were customized for such systems.⁴³³

In light of all these, it is not a surprise that big tech giants such as Alibaba, Baidu and Huawei are designed chips specifically for the needs of Chinese AI market;⁴³⁴ it also comes as no surprise that Chinese government officials announced their will to invest more than \$161 billion for the chip industry by 2025 remains strong.⁴³⁵

Two unicorns stand out: Horizon Robotics that develops AI chips for image recognition, autonomous vehicles and various IoTs recently raised an additional amount of \$600 million funding, and reached the total value of approximately \$3 billion;⁴³⁶ valued in \$2.5 billion, Cambricon Technologies that builds chips utilizing neural processing units (NPUs) that can handle much heavier AI workload,⁴³⁷ which supports both edge and cloud computing, and design chips that outperform general purpose processors thanks to its high compliance with deep learning and machine learning algorithms.⁴³⁸

⁴³² You, *White Paper on AI Chip Technologies*, 8-15

⁴³³ Hwang, *Computational Power and the Social Impact of Artificial Intelligence*. 9-12.

⁴³⁴ Choudhury, "5 Game-changing Semiconductor Chips By Chinese Tech Giants."

⁴³⁵ King, "China Has Big Plans for Homegrown Chips."

⁴³⁶ Dai, "AI chip unicorn Horizon Robotics raises US\$600m in funding as China seeks to reduce dependence on imported semiconductors."

⁴³⁷ Wei, "New chip an intelligent move for Cambricon."

⁴³⁸ Wang, "Chinese startup Cambricon Technologies challenges Nvidia's dominance in AI chip market."

Notwithstanding the country, the need for fundamental software and hardware is apparent; as declared explicitly by Jack Ma, the founder of Alibaba, “the market for chips is controlled by Americans. . . And suddenly if they stop selling—what that means, you understand. And that’s why China, Japan, and any country, you need core technologies.”⁴³⁹

Japan has been a leading force in the semiconductor sector for long time; an important actor in producing, companies such as Sony, Toshiba and Renesas Electronics are well known for their R&D works in the field.⁴⁴⁰ Currently, almost 35% of the world’s semiconductor equipment is produced in Japan, and half of the manufacturing materials are supplied from the country to the rest of the world.⁴⁴¹

In light of all these, it is extremely important for Japan to innovate their manufacturing methods, and change their direction towards developing AI chips, which, as stated above, is market rapidly growing, and one of the fundamental components of building an AI system; especially considering that Japan has fallen out of AI game recently.

Aware of these facts, the Japanese government tries to make up for what they lack in terms of talent pool, incremental research, software and investment rates by promoting the research in semiconductors, namely AI chips: Japanese Ministry of Economy, Trade and Industry views staying in the game in the semiconductor sector is an aspect to be ensured, therefore the ministry declared that a state help will be granted to the developers working in the field as it is an expensive business right from the start.⁴⁴²

⁴³⁹ Smart et al, “Geopolitical Drivers of Personal Data: The Four Horsemen of the Datapocalypse.”

⁴⁴⁰ Deloitte, *Global artificial intelligence industry whitepaper*, 62.

⁴⁴¹ Semicon Japan, “About.”

⁴⁴² Nikkei, “Japan to pump funding into AI chip development.”

The licensing fees and prototype costs sums vary between \$5 million to more than \$10 million, which prohibit the new researchers and startups hoping to create original design chips; the state-funded infrastructure to help these companies by paying for the software and equipment costs will be initiated by the National Institute of Advanced Industrial Science and Technology as well as various government-affiliated institutions or universities, which shows the Japanese governments' efforts to stay in the game by focusing on other aspects of AI development.⁴⁴³

4.2 AI for social good applications in China and Japan

Though AI can be utilized for many purposes while solving societal problems, both Japan and China highlighted their own problems in the documents issued for AI-based technologies. While China put emphasis on bringing AI-powered solutions to the issues arising due to unequal distribution of healthcare and education among the regions, concerned with its aging society and labor shortage resulting from that fact, Japan included the said notions in its grand framework, Society 5.0.

While countries attempt to utilize AI applications, and creating governmental documents for these purposes, it should come as a surprise that they, understandably, tend to prioritize areas of focus depending on their specific societal problems as well as take measurements considering the conjecture of the country both on a domestic and global level.

Both China and Japan issued various documents about their AI and data strategies, and helped certain sectors flourish to strengthen their place in the global AI industry.

⁴⁴³ Ibid.

On top of the official documents concerning the development of AI, the countries also issued papers regarding the ethical and social responsibilities need to be considered while utilizing AI technologies.

As mentioned in the previous section, after having been criticized for having a loose approach with AI technologies for a long time, especially considering data privacy and AI ethics, as of 2018 China issued one document after another to show the world that the country seeks to establish a safe environment to its netizens, and build AI systems by avoid overlooking the ethical problems that may arise due to unregulated applications.

After including the importance of establishing an ethical and moral framework for AI development and research in their *Notice of the State Council Issuing the New Generation of Artificial Intelligence Development Plan*,⁴⁴⁴ China took another step forward to announce an ethical framework that also involves thoughts on ensuring the healthy governance of AI.

Jointly supported by Chinese Ministry of Science and Technology (MOST) and the Beijing municipal government, The Beijing Academy of Artificial Intelligence (BAAI), in collaboration with Peking University, Tsinghua University, and companies such as Baidu, Alibaba, and Tencent issued a document called Beijing AI Principles, where they underlined the means to build beneficial and responsible AI.⁴⁴⁵

Beijing AI Principles are giving advice on three steps along the way to develop a full-fledged AI ecosystem and sets rules for each: the most detailed section is the research and development phase, the principles' advice the developers to “do

⁴⁴⁴ The State Council of the People's Republic of China, *Notice of the State Council Issuing the New Generation of Artificial Intelligence Development Plan*, 25.

⁴⁴⁵ Vincy, “Following EU, China releases AI Principles.”

good by promoting the progress of the society”, “be ethical by designing the system trustworthy,” “control risks by ensuring the security for the data, the safety and security for the AI system itself,” “use AI for humanity by making sure it serves humanity and conforms to human values as well as the overall interests of humankind”, “be responsible by having sufficient considerations for the potential ethical, legal, and social impacts and risks”, “be diverse and inclusive by designing applications to reflect diversity and inclusiveness, and be designed to benefit as many people as possible”, “be open and share by establishing AI open platforms to avoid data/platform monopolies, to share the benefits of AI development to the greatest extent, and to promote equal development opportunities for different regions and industries.”⁴⁴⁶

On top of that, National New Generation Artificial Intelligence Governance Expert Committee operating under MOST recently announced a series of governance principles for building “responsible AI”; while the principles' advice developers to adhere to notions like “harmony and friendliness”, “fairness and justice”, “inclusivity and sharing”, and “agile governance”, it also promotes respecting privacy and shared responsibility as well as emphasizes the importance of open collaboration and developing safe and controllable AI systems.⁴⁴⁷

It is important to note that Beijing AI Principles were not directly issued by a governmental organ so it does not constitute an official statement, nevertheless while talking about AI ethics in China the first document referred to is this document, which makes including it to this research necessary.

⁴⁴⁶ Beijing Academy of Artificial Intelligence, “Beijing AI Principles.”

⁴⁴⁷ Laskai and Webster, “Governance Principles for a New Generation of Artificial Intelligence: Develop Responsible Artificial Intelligence.”

On an international level, China is at a stage where it could potentially take a leading role in establishing a governing body to advance the development of AI in a peaceful and inclusive environment in a sustainable way but the driving force behind this global agency needs to be establishing and regulating the standards of AI and creating an ethical guideline; from an economical perspective, if China plays its cards right regarding the development of a global governing body while advancing the AI technologies on its home ground, they could continue their growth technologically and economically while at the same time making sure that these advancements would also contribute to the common good of humanity as a whole.⁴⁴⁸

This brings us back to the significance of a global cooperation while establishing the ethical and governance standards regarding the development of AI, a big actor such as China needs to take part in the debate so that the principles can be applicable on an international scale.⁴⁴⁹

In addition to their own set of goals, as one of the permanent members China is a signatory of United Nations's 2030 Agenda,⁴⁵⁰ and committed to realize the SDGs. In 2016, the Ministry of Foreign Affairs of the People's Republic of China issued the report called *the China's National Plan on Implementation of the 2030 Agenda for Sustainable Development*; the document also mentioned artificial intelligence, the goals it can accelerate such as "Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all".⁴⁵¹

Japan was one of the early birds when it comes to issuing a series of principles regarding ethical AI; on 2017 Japanese Ministry of Internal Affairs and

⁴⁴⁸ Barton et al, "Artificial intelligence: Implications for China."

⁴⁴⁹ Kharpal, "China cares as deeply about A.I. ethics as the US, Microsoft CEO says, as he calls for global rules."

⁴⁵⁰ United Nations Security Council, "Current Members."

⁴⁵¹ Ministry of Foreign Affairs of the People's Republic of China, *China's National Plan on Implementation of the 2030 Agenda for Sustainable Development*, 33.

Communications (MIC) formed an expert committee, AI Network Society, whose members published *Draft AI Utilization Principles*, which was followed by a more detailed document offering advice on global level called AI R&D Principles for International Discussion.

Both these non-binding documents mention 9 essential principles: “Principle of collaboration”, “Principle of transparency”, “Principle of controllability”, “Principle of safety”, “Principle of security”, “Principle of privacy”, “Principle of ethics”, “Principle of user assistance”, “Principle of accountability”, which provide a brief but clear framework for safe AI systems.⁴⁵²

Another governmental document was issued on 2018 was named *Social Principles of Human-centric AI (Draft)* by the Government of Japan Cabinet Office, which sets the rules for creating a human-centric AI society that can be integrated within Society 5.0.; in this document Japan not only highlights the necessity of education, human-centric responsibility, privacy, security fairness, accountability, and transparency, the officials also draw attention to the fair competition and innovation to ensure sustainable advancements.⁴⁵³

The Japanese government also expressed its wish to comply with the sustainable development goals⁴⁵⁴ set by the United Nations Development Programme (UNDP) in 2015 in its *5th Science and Technology Basic Plan*, by incorporating them into its Society 5.0 scheme.⁴⁵⁵ This means that while the Society 5.0 project is a development system for Japan, it is by no means restricted to Japanese society. The difficulties Japan currently faces as a result of its demographic changes will appear in

⁴⁵² AI Network Society, *Draft AI R&D GUIDELINES for International Discussions*, 7-20.

⁴⁵³ Council for Social Principles of Human-centric AI, “Social Principles of Human-centric AI.”

⁴⁵⁴ United Nations, “Sustainable Development Goals.”

⁴⁵⁵ Cabinet Office, *Dai Go Ki Kagaku Gijutsu Kihon Keikaku* 第5期科学技術基本計画 [The 5th Science and Technology Basic Plan].

different nations in the near future around the world as well. By finding solutions to these problems, Japan will be able to help settle these comparative issues worldwide and help accomplish the SDGs.⁴⁵⁶

The SDGs were referred to in both of the above mentioned documents, and each of these documents ended with a call to other international partners; considering that Japan is deemed to lag behind in AI scene, the country's contribution to global debate, and its aspiration to take part in the global AI governance while it is still being established is outstanding, moreover, in my opinion, a very smart move since it will give the country an advantage while setting the game.

The necessity of being a global actor setting these governance rules emphasized by one of the leading Tencent researchers, who declared that “China should also actively construct the guidelines of AI ethics, play a leading role in promoting inclusive and beneficial development of AI. In addition, we should actively explore ways to go from being a follower to being a leader in areas such as AI legislation and regulation, education and personnel training, and responding to issues with AI.”⁴⁵⁷

4.2. Overcoming Inequality in Chinese Healthcare and Education Systems, Finding Solutions for Japan's Aging Society and Labor Shortage

While accelerating the development and implementing applications of AI technologies, China also puts great importance to utilizing these advancements for the benefit of all society, especially related to inequality in education and healthcare systems arising due to regional and class problems, including the gap between rural

⁴⁵⁶ Harayama., “Society 5.0: Aiming for a New Human-centered Society”, 8-13.

⁴⁵⁷ Ding, *Deciphering China's AI Dream*, 31.

and urban areas as well as low-income and high-income families, which was a result of rapid but somewhat unequal development.⁴⁵⁸

In 2009, China issued an agenda hoping to reform the healthcare system, and reduce the inequality by 2020.⁴⁵⁹ As a part of this agenda, Chinese government, did the next best thing besides opening up a hospital in each rural area; the government started an initiative by bringing together educated doctors in a team called “Sunshine on the Road” under its “Rural Health Project”, whose purpose was to travel to rural areas to offer services to rural residents.⁴⁶⁰

Even though the intentions were good, these projects that required physical labor proved to be not as effective as once hoped due to the problems occurring in logistics and shortage of medical specialists, which makes seeing, “intelligent healthcare” as one of the top important societal problems to be targeted by utilizing AI applications listed in the Next Generation Artificial Intelligence Development Plan, unsurprising.⁴⁶¹

As stated in the *Three-Year Action Plan on Promoting the Development of Next Generation Artificial Intelligence Industry (2018-2020)*, one of China’s main focus is to improve medical imaging aided diagnosis systems;⁴⁶² it is also important to note that Chinese government decided to commercialize the medical diagnosis support systems, which is, as stated in many times within this thesis, very unlike of their usual stand but also proves how urgent and important the situation is in view of the government officials, who acknowledge the fact that private sector can greatly

⁴⁵⁸ Organisation for Economic Co-operation and Development Observer, “China’s urban-rural divide.”

⁴⁵⁹ Liu, “Is China Facing a Health Care Crisis?”

⁴⁶⁰ The World Bank, “China: Doctors on Wheels Bring Quality Care to Rural Residents.”

⁴⁶¹ The State Council of the People’s Republic of China, *Notice of the State Council Issuing the New Generation of Artificial Intelligence Development Plan*, 19.

⁴⁶² Ministry of Industry and Information Technology, “Three-Year Action Plan for Promoting Development of a New Generation Artificial Intelligence Industry.”

contribute to advancing the integration of AI-based technologies to healthcare services.⁴⁶³

AI is utilized in a wide range of aspects when it comes to healthcare applications most popular subjects include: AI-assisted image analysis for radiology; predictive analytics for hospital resource optimization; assisting pathologists for diagnosing tissue samples; contributing to population-level disease prevention; AI-individualized medicine; drug discovery; AI-powered clinical decision support systems.⁴⁶⁴

AI can provide a way to deliver equal services to both rural and urban areas, as stated by one of the leading AI-based clinical imaging startups Deepwise's CEO Qiao Xin "AI is widely believed to be able to greatly improve healthcare efficiency in China, and that is important because we have imbalanced medical resources among different regions and an acute shortage of doctors and nurses."⁴⁶⁵

China's education system is known for days of long hours of work and a highly selective university entrance exam held nationwide; the compulsory education last nine years, and is provided by the government, nevertheless as of elementary school, students in the urban areas are luckier than their rural counterparts since they have access to better sources both in regard to facilities and educators.⁴⁶⁶ In the document issued by the government, *Outline of China's National Plan for Medium and Long-term Education Reform and Development*, China stated its will to make equal education all over the country a priority; one of the methods suggested was "speeding up infrastructure construction", which was proposed to ensure that "quality resources and advanced technology shall be put into full use, operational

⁴⁶³ Batavia, "Everything you should know about China's 3-year AI action plan."

⁴⁶⁴ Zeller, "Top 10 AI Applications in Healthcare & the Medical Field."

⁴⁶⁵ Feifei and Zhihua, "AI reshaping healthcare industry."

⁴⁶⁶ Project Partner, "China's Education Gap – A Surprising Factor in Rural Poverty."

mechanisms and management modes shall be renovated, and available resources shall be integrated, so that a sophisticated, efficient and practical online education infrastructure can be built.”⁴⁶⁷

Utilizing AI in education will not only make it more accessible but also it will design the educational process to be more customized: “Personalized learning is described using computational tools that enhance student and group experience, reflection, and analysis, and supply data for development of novel theory development.”⁴⁶⁸

China included “intelligent education” to the country’s New Generation of Artificial Intelligence Development Plan, too:⁴⁶⁹

Intelligent education. Use intelligent technology to accelerate the promotion of personnel training models, teaching methods reform. The new education system includes interactive learning and intelligent learning. Carry intelligent campus construction, promote AI in teaching, management, resource construction and other full-scale applications. Develop three-dimensional integrated teaching fields, based on big data intelligence online learning platforms. Develop intelligent education assistants; establish intelligent, fast and comprehensive education analysis systems. Establish a learnercentered educational environment. Provide precision push education services to achieve daily education and life-long education.

To realize these intentions China’s Ministry of Education encourages schools to adopt AI technologies for monitoring both student and teachers to analyze their

⁴⁶⁷ China Central Government, *Outline of China’s National Plan for Medium and Long-term Education Reform and Development*, 14.

⁴⁶⁸ Woolf et al, “AI Grand Challenges for Education.”

⁴⁶⁹ The State Council of the People’s Republic of China, *Notice of the State Council Issuing the New Generation of Artificial Intelligence Development Plan*, 19.

performance and progress, which is currently being regulated in terms of data collection and storage.⁴⁷⁰

To develop the AI education sector, Chinese government provided great tax breaks and incentives, and invested over \$1 billion in the sector; as I mentioned in the Chapter 3, companies such as Squirrel AI increase their impact and value as a result of outstanding success cases, which makes it seem like the efforts of the government in this regard was not in vain, and will prove to be fruitful many years to come.⁴⁷¹

A student registered to Squirrel AI's platform receives customized tutoring advice from the AI assistant and a human educator combined, optimized according to the student's profile regularly analyzed by the system; eventually, this system may contribute to narrowing the education gap between urban and rural areas as "AI is duplicatable at a lower cost, and is unaffected by time and location."

4.3 Concluding remarks

Japanese and Chinese governments both put utmost effort into deploying AI projects for various reasons; Japan is on the way to realizing its grand plan "Society 5.0", China, on the other hand, aspires to return to the good, old days, where the country was the center of innovation and technology.

There is a huge gap in the AI ecosystem of the countries as China is one of the leading forces of the AI sector considering the capacity of investment and influence, in this regard Japan seems to lag behind due to an outdated work/research environment.

⁴⁷⁰ Xie, "Artificial intelligence is watching China's students but how well can it really see?"

⁴⁷¹ Hao, "China has started a grand experiment in AI education. It could reshape how the world learns."

Speaking in numbers, while China ranked second, Japan fourth in the world for publications in the top tier AI conferences between the years of 2015-2018.⁴⁷² For the number of patents published in the same period of time Japan placed in second and China eighth.⁴⁷³ Furthermore, as stated before China strives to attract more and more AI talents to the country by offering scholarships and incentives both on business and academic level to support the growth of its competitive and productive AI ecosystem, on the other hand, Japan is on the brink of a brain drain due to the unproductive work culture, as well as an outdated scheme, a trend mirrored in the business ecosystem: there are only two AI startups worth more than \$1 million in Japan.

Both Japan and China are in need of attracting more AI talents and produce their own for developing and implementing AI systems for the benefit of the country; suffering from an aging population and labor shortage due to that fact, Japan tries to think of ways to integrate AI-based technologies to daily lives; China works catalyze AI ecosystem with the aim to become a manufacturing giant that has global influence.

When looked into governmental documents issued in the initial stage of the flourishing of global AI scene Japan was clearly ahead of time; Society 5.0 is designed not only to be an “action plan” but also a vision of the future with human-centric AI applications integrated into daily life, solving societal problems. Looking at the documents issued by the officials and summits held regarding the subject, we can conclude that Japan is looking to lead the discussion about the global governance of data and AI systems, and wants to remain a key player during all steps of

⁴⁷² Shoham et al, *The AI Index 2018 Annual Report*, 27

⁴⁷³ Shoham et al, *The AI Index 2018 Annual Report*, 31

standardization and implementation process by collaborating with other leading forces in AI, which may help to keep the country in the game even though currently it lacks the talent to further the studies in the field. Both “Data Free Flow with Trust” initiative and documents issued such as Social Principles of Human-centric AI are concerned with an international consensus on different aspects of such technologies.

China also issued one document after another with carefully designed prospects for integrating AI systems in all layers of the society, especially with a focus on doing business and research. One of the areas of great importance for the Chinese authorities, the government continues to seek balancing the dynamics between main actors, industry, academia, and users to avoid hindering the AI progress, which the officials consider to crucial for the future of the country.

Concerning the number of internet users, China clearly has the upper hand, but the diversity and quality of the data collected is questionable as it does not issue documents that are in line with the ones issued by the leading forces in the rest of the world; to fix this China tries to make AI-based investments in other countries to increase the level of diversity but without building a solid system that makes Chinese countries being subjected to a proper governance, the Chinese actors will have no access to global data due to concerns arising out of privacy considerations.⁴⁷⁴

Moreover, China is not keen on sharing the data it possesses, or not keen to share as freely as the country agreed to by signing the Osaka Track proposed by Japan; the country’s new cybersecurity regimes gets even more strict in the requirements to store the data within the country, or at least go through a security audit before flowed out, on top of that while Japan and European Union have signed an adequacy agreement for data governance regimes, China and those countries

⁴⁷⁴ O’Meara, “Will China lead the world in AI by 2030?”

following the framework established by European Union may never find a solid common ground as it seems impossible for Chinese countries to comply with the homeland's requirements and the GDPR's requirements at the same time.⁴⁷⁵

Without being recognized as “safe”, it will be hard for China to access the diverse data the country is in need of to develop more functional AI systems, on the other hand DTTF, will grant Japan a way to not only stay in the game but also the proposal is claimed to be made to advance the field through collaboration and to create a common platform to tackle societal problems aligned with the standards set by Society 5.0 by deploying new technologies, will give Japan access to an open environment to share data, which would be beneficial to all countries involved as it would help to increase the amount of data available for processing, and surely would diversify the data collected, which is of great importance as stated before.

Overall, China and Japan stand at opposite sides when it comes to how they deal with data; whereas China is proud to have a well-defined data localization law that is also an indicator of its general technological nationalism,⁴⁷⁶ Japan is a strong advocate of free data flow between the countries, and adopted an adequacy decision with European Union, which established “the world's largest area of safe data flows.”⁴⁷⁷

In addition, Japan was one of the first countries to issue data protection legislation, which is typical of the Japanese way of doing business; first planning, then applying. Japan's documents and reports about the ethical considerations of these technologies were and still are very far-reaching and inclusive, even if they were not the country is not in a bad place compared to China, which has a bad

⁴⁷⁵ Sacks and Sherman, “Global Data Governance Concepts, Obstacles, and Prospects.”

⁴⁷⁶ Liu, “China's data localization.”

⁴⁷⁷ European Commission, “European Commission adopts adequacy decision on Japan, creating the world's largest area of safe data flows.”

reputation it needs to overcome in this regard. When it comes to enforcing data protection, Japan has been slowly but surely establishing a well-defined system that can also be globally recognized in terms of the business operators' ways to deal with netizens' data.

Japan efforts to hold summits and issue papers that could be acknowledged by the rest of the world may be the key to staying in the AI game due to the above stated reasons, and a smart move on the country's part.

Another thing to be considered for developing AI systems is the necessary hardware. While good at assembling, China always had issues with taking part in the global semiconductor sector; on top of that, China seems to have a strong dependency to other countries, one of them being Japan, in regard to the providing these pieces.

China wants to alter this course by investing tremendously in the AI chips sector, which has been recently expanding; thanks to the advantages the country has in terms of AI development. With this, China found a long sought-after chance to gain independence by meeting the needs of the domestic sector.

One of the unchallenged leaders of the global semiconductor market, Japan also wants to formalize its dominant position in the sector with generous state support offered to the research institutions and companies.

While comparing the countries, it is clear that China has some natural advantages that cannot be ignored, these natural advantages are only as effective as the extent they can be utilized; China needs to cooperate with other countries to an extent by a setting globally accepted market and regulation system so that the country can increase the diversity and quality of the data it processes.

Good at being an important actor in the global AI debate, Japan is lacking in terms of AI talent, publication, and investments; an updated work environment would keep the young researchers in the country, and smartly developed policies would attract foreign AI practitioners, which can help Japan regain its position in the AI sector.

Notwithstanding these, both Japan and China are key players in the global AI sector, and their voices should be loud and clear on the way to standardizing and governing AI since their opinions and contributions will be of great value while we are paving the way for utilizing AI for Social Good.

As far as the issues that can be solved by applications, both Japan and China have their own priorities, which is understandable as the needs of the countries vary, depending on their culture, economy and system overall.

Suffering from an imbalanced distribution of education and healthcare services among regions due to a rapid but unequal development, China tries to bring AI-based solutions that would require less capital and workforce.

Meanwhile, Japan is trying to deal with a rapidly aging population and labor shortage by focusing on robotics, and administrative AI applications in the public sector.

Comparing these two regional actors may set an example of the means to compare other countries starting from the development phase of the AI technologies and set a light to how the countries approach come to life while they are growing their ecosystem and bringing their opinions to the table in the international area. Japan advocates DFFT, and builds digital trade strategy around that claim, on the other hand being a forced to reckon with on its own, China is yet to make its move to have global presence in terms of regulations and governance.

CONCLUSION

None of the groundbreaking developments took place in human history was without its own obstacles, and when it comes to the domain of AI, it is not surprising that it has run a similar course, especially considering its extent of innovativeness, and the fact that every step of the developing and implementing process regarding these technologies carries a high level of controversiality.

Though AI technologies have a lot to offer for the future of humanity in terms of changing the way we process information and apply solutions to various societal problems, they also bring in their unique risks concerning safety, ethics, fairness and transparency. While the accuracy of AI-enabled decision are still under a question, it is also clear that, if subjected to carefully designed regulations, and operated under a well-structured legislative system, they can be of great use for the common good of people everywhere.

AI investments are growing in numbers, accordingly, the invested amounts are increasing tremendously as stated within the thesis in various occasions, this is especially important as these investments coming from different actors are the main components in reshaping the current status, and building our future.

What is referred to as the fourth industrial revolution by some is now becoming a part of our daily lives and notions that seem to belong in a science fiction movie are now our reality; the time to develop strategies to make sure that all humans can equally benefit from these advancements is not tomorrow, it is in this exact moment, since everything about this domain happens in a heartbeat and is adopted even faster than that, the countries and companies that fall behind may end up finding themselves in a disadvantageous condition for years to come.

During this journey on implementing the most recent applications, the international organizations and countries are responsible for ensuring that the positive outcomes arising due to these new technologies will not contribute to a system of privilege but it will expand to all layers of society by announcing more legislative proposals and funding more projects concerning the use of AI for Social Good.

While considerably a high number of big technology companies are opening departments, to name a few called “Responsible AI”, “Explainable AI”, “AI for Good” departments, or at least start projects to contribute finding ways to use AI technologies for the social good, there are many that only focus on the profit without considering the consequences of an uneven distribution of such power, which makes establishing a collaborative approach by policy-makers and industry a priority.

On the other hand, as the industry continues to expand, so does the range of research and development, indicating that the number of start-ups and academic projects focusing on a variety of aspects related to these emerging technologies will continue to increase as well; especially in countries such as China and Japan, the development of the industry and research of AI technologies is closely observed, and the states hope to direct the trends in accordance with their own interest.

As stated before, AI technologies are not without their downsides, but will become inseparable part of our collective future; the challenges such as the ones opened by Google and Xprize can help encourage people working in the field to shift their focus to brainstorm about ways to consider taking a non-profit approach to the practices and even though funds received will be used to develop projects for a certain cause, the nature of AI technologies make them easily adaptable for other problems, which means the pool of knowledge will develop quicker than expected.

The great news is that there are already many academic papers involving the implementation of a type of AI application published in align with the sustainable development goals that aspire to contribute finding solutions that will benefit not just a group of people but various groups from all over the world, it is every governmental organizations' responsibility to increase the number of these projects, and to support the talented scientists of all disciplines working on these projects by any means; especially they are proven to be beneficial to all humankind.

While the European Union continues to set rules so that each layer of the society can be integrated to the changing system as smoothly as possible, Asian countries such as Japan already started to establish a well-grounded structure to embrace the future and transform their cities as well as societies to benefit from these existing and upcoming technologies at all levels; nevertheless a global governance is almost non-existing, only recently countries start to recognize each other's AI and data legislation documents, which is nearly enough as in absence of global governance and understanding of what it and what is not ethical while developing these AI systems, the advancement may or may not resume in the most sustainable direction.

It is not certain what the future holds, surely it will not be as worrying or as promising as many of us think but one thing to make sure that this becomes a peaceful global advancement instead of an unbalanced and local one is; we need to have a global governance, and we need to consider demanding our policy-makers to design policies that will encourage the use of AI purposes more than military and entertainment-related occasions, no matter how profitable they are, the utilization of these technologies must be conducted in the most inclusive and productive way possible to benefit everyone.

While utilizing AI-based technologies for the benefit of the society would be a dream come true, this is only possible if the applications are implemented and governed in the proper way that takes into account all layers of the process including policy-making, ethical, social and legal obstacles as well as the importance of conducting a well-thought and comprehensive research that will help develop responsible and ethical AI systems and policies, which should be opened to the contribution of researchers and practitioners of all research areas to build the legal and philosophical framework.

After carefully reviewing the governmental strategies and their implications on the global AI scene, especially when it comes to controversial issues such as ethics and safety, it is clear that all actors involved, whether from academia, industry or governmental origins need to reach a consensus about the definition of AI ethics and AI safety, what they stand for and how to avoid the malicious use of AI and prevent risking the breach of fundamental values, notwithstanding the social and cultural differences.

Following a consensus, developing a global governing method that can be applied worldwide is of great value since many things related to the development and deployment of AI applications are globally connected and needs to be regulated by a group of overarching set of rules. This is especially important for concepts such as data privacy and unethical development of algorithms as they are what lie in the foundation of such systems.

While creating these rules, an interdisciplinary approach will be essential because it requires an in-depth analysis of the situation from all aspects that can only be achieved through the collaboration of the experts in their fields, including but not limited to opinions from legal, medical, technical experts, as well as computer

scientists, mathematicians, physicians and engineers from various backgrounds including governmental organizations such as ministries, local governments and scientific committees as well as medical specialists, local and international think-tanks and NGOs, chief officers and related departments of the big technology companies active in the domain.

Encouraging government-funded or non-profit open platform initiatives for sharing the most recent research and data-sets will also help advance the field, as building and training a model from scratch can be very costly in terms of both resources and time. This also requires highly educated developers, which most countries and enterprises lack due to the mobility of AI talents. In addition to the field itself, these open platforms can greatly contribute to developing projects under the umbrella of AI for Social Good, as they will help the social organizations while they are facing similar problems not only by offering them an already established system which they can customize in line with their needs but also by providing them the technological support necessary, especially in the absence of AI talents and skilled researchers, so that they can implement these advancements to their cases.

After reaching a consensus of above-stated notions and beginning to develop a global governance policy that both protects and benefits the society in a greater extent, the researchers can develop AI for Social Good projects without being in fear of contributing to the current status quo, if these prerequisites are not met, the scientists will be left between a rock and a hard place as many of them would like to do good for society, but cannot move forward with developing AI applications that would be beneficial each time they are implemented as when the problems and outcomes are not well-defined, the solutions, whether they are AI-based or not, doomed to be lacking.

This does not mean that no action should be taken, until the time when a consistent and applicable structure worldwide is organized, I believe the Sustainable Development Goals issued by the United Nations' agenda of 2030 sets a directive framework for researchers who would like to accelerate the application of AI technologies for the benefit of the society, in the absence of comprehensive regulations, and a well-organized strategy, these goals can offer to people who would like to develop AI for Social Good projects a general direction to follow. In addition to this, AI developers, states and enterprises must keep in mind that the fact that there are no currently applied regulations should not be taken to mean that these systems are to be developed without at least considering the basics of human rights, and though the ethical discussions and aspirations to complete a well-established global governance system must continue, all actors must bear the responsibility of their actions even if the consequences are not framed by law.

Moreover, comparing the two of the biggest regional actors related to AI technologies, Japan and China, proved that the countries that are competitive in global AI scenes also have detailed national agendas and development plans, as they do not only want to take part in the game, they also want to set the game.

Though the contents may vary, especially in regard to the coverage of key issues including ethics, societal problems, and data collection, an AI strategy issued by the government offers great guidance to the academia, public, and industrial actors. Nevertheless, the fact that these documents are usually non-binding makes them unenforceable, which hinders the process of reaching a consensus to build a well-functioning system.

In addition, I agree with the argument that developing social good projects, with or without AI-based technologies involved, should be a cooperative and

inclusive process, which requires the efforts of all actors present including the scientists, local organizations and global enforcers.

In the last chapter I also reviewed the advantages and disadvantages of each country, and concluded that though some natural advantages, such as China having an abundance of data, cannot be overcome easily, well-thought guidance and policies can contribute greatly to a country's agenda; for example, Japan is pursuing a chance to become a leading actor in the international AI debate. On the other hand, despite being one of the leading forces, China fails to step up to pursue a more ambitious voice while shaping the global AI standards in terms of both ethics and regulations.

Finally, I have arrived to the conclusion that the target societal problems under AI for Good projects is highly aligned with the needs of a specific country. While Japan is trying to bring solutions for its rapidly aging society, China needs to focus on more current issues like inequality in education and healthcare, which has started to deeply affect the daily lives of Chinese people as a highly disturbed system on this level may cause cracks that cannot be cured within a short period of time.

Notwithstanding these, to enable social good it is clear that every actor should be on the same page to ensure sustainable progress, or else the fourth industrial revolution will be just like the previous ones, yet another chance of equality wasted: an opportunity for some, and a cause of misfortune for the rest, which is the main consideration we must keep in mind while developing and deploying AI systems as the history shows that the world is not in need of more conflicts of interest but a consensus on our values and the direction we will follow.

EPILOGUE

International Monetary Forum (IMF) considers Turkey to be an emerging market along with economies; in a rapidly changing global technology ecosystem, being among these countries can be a good place to be or not depending on the capacity and capability of keeping up with the recent advancements in the technology frontier, just like India and China have been accomplishing in the last decade.⁴⁷⁸ These two countries have an exceptionally high number of local internet users, who provide the AI practitioners in the countries an abundant amount of data, contributing to their success, which placed them among the leading countries in the AI market. Turkey differs from these countries in this regard, and needs to find a way to take part in the global AI debate by finding other ways to stay in the game, whether it is gaining access to global data pool by being a home to innovative companies producing advanced AI-based technologies or institutions pursuing to do cutting-edge research to set the game by attracting or producing global AI talent, just like Israel is doing at the moment. Moreover, the middle-sized emerging economies including Turkey need to align their approach to data and law with the country's partner economies' requirements to access more data and conduct business without encountering any regulatory obstacles as well as raise their voice to take part in the global AI debate to avoid being consumed by efforts of established tech giants.⁴⁷⁹

Aiming to become a regional key player in technological advancement, Turkey was an active participant of international partnerships; established in 2018,

⁴⁷⁸ International Monetary Forum, *World Economic Outlook: Global Manufacturing Downturn, Rising Trade Barriers*, 151

⁴⁷⁹ Sahbaz, "Elements of a National AI Strategy for Turkey."

the United Nations' Technology Bank for Least Developed Countries, an organization that supports the technological advancements of low-income and vulnerable countries, is headquartered in Gebze, Turkey.⁴⁸⁰ Turkey is fully aware of the necessity to increase the level of innovation, science and technology for the sustainable development, as it can be proved by the country being one of the main funders of the said organization whose launch was considered to have marked the first Sustainable Development Goal target 17.8 - Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology-⁴⁸¹ officially reached.⁴⁸²

Though having been actively contributing to the technological efforts of other countries in collaboration with the United Nations, Turkey's lack of an official stand on these emerging technologies, and a well-established roadmap for implementation, research and deployment processes has been worrying as in this rapidly changing AI ecosystem, staying behind in any phase along the way can be quite costly in the future. In 2015-2018 Information Society Strategy and Action Plan, the term artificial intelligence is not included, and as for big data, the action plan recognizes the fact that "number of implementations in this field is limited"⁴⁸³

If looked into Tortoise's Global AI Index report, out of 100 for each, Turkey scores 6.9 for talent, 32.7 for infrastructure, 43.5 for operating environment, 16.8 for research, 0.3 for development, 12.7 for government strategy and 0.6 for commercial

⁴⁸⁰ The United Nations Technology Bank for Least Developed Countries, "Who We Are."

⁴⁸¹ The United Nations Sustainable Development Goals Knowledge Platform, "Sustainable Development Goal 17."

⁴⁸² "UN 'Tech Bank' opens in Turkey, to help poor nations 'leapfrog development challenges'."

⁴⁸³ The Ministry of Development of the Republic of Turkey, *Information Society Strategy Action Plan 2015-2018*, 53.

activity, with a total score of 11.2., which places Turkey in forty-second place out of 54 countries analyzed.⁴⁸⁴

In Oxford Insights' "AI Global Readiness Index 2019" that assess the level of readiness of each country in four categories including governance, with main indicators such as a well-defined data or privacy law and a multi-layered national; infrastructure and data, including data availability, data/AI capability and necessary hardware; skills and education, based on technology skills, private sector innovation capability and the number of AI startups; government and public services, Turkey was placed in the forty-sixth spot out of 194 countries.

To change this course, Turkey has recently been speeding up the process for introducing the term "artificial intelligence" to the official documents; in "2023 Industry and Technology Strategy", the Ministry of Industry and Technology made the announcement of an artificial intelligence institute that will operate under the Scientific and Technological Research Council (TUBITAK).⁴⁸⁵

According to the same document, artificial intelligence is linked to the accelerating the accomplishment of certain goals; Turkey not only aspires to develop 23 types of smart services or products that will lead the market in this field, but also wants to build an integrated system that will pave the way for collaborating with international companies, especially the ones headquartered in Europe, as part of the *Turkey-European Union Financial Cooperation* framework.⁴⁸⁶

After reviewing the list of papers published in the leading computer science related conferences last year, it can be seen that the researchers applying from

⁴⁸⁴ Tortoise Media, "The Global AI Index."

⁴⁸⁵ Gonultas and Zengin, "Turkey plans AI institute to tap new technology."

⁴⁸⁶ Türkiye Cumhuriyeti Sanayi ve Teknoloji Bakanlığı [The Ministry of Industry and Technology of the Republic of Turkey.] *2023 Sanayi ve Teknoloji Stratejisi* [2023 Industry and Technology Strategy], 67.

Turkey had a notable presence only in “Computer Vision and Pattern Recognition Conference (CVPR)” with thirteen papers, which is a number that can be increased by supporting the right researchers at the right time during their academic journey.⁴⁸⁷

2023 Industry and Technology Strategy also underlines the necessity of educated local talent, and importance of attracting global talent through initiatives such as “International Fellowship for Outstanding Researchers Programme” and, where both fellows and their families are offered a competitive amount of scholarships and a variety of opportunities upon returning to the country.⁴⁸⁸ These fellowships and initiatives are of great importance because the numbers in the OECD database show that Turkey is among the major exporters of AI talent,⁴⁸⁹ which will ultimately hinder the goals set in all documents issued related to the future of industry and technology in Turkey.

While the government tries to prevent and reverse this type of AI brain drain through these fellowships and incentives, there are some technology nonprofits that do not only strive to increase the level of students skills so that they can become the future AI talents, but also build communities that brainstorm about the ways to utilize these emerging technologies for social good.⁴⁹⁰

Another document issued that mentioned the implementation of AI-based technologies is “The Eleventh Development Plan” ratified by Turkish Parliament on July 2019, which underlines the need of a well-thought roadmap about AI

⁴⁸⁷ The Institute of Electrical and Electronics Engineers, *Computer Vision and Pattern Recognition Conference Statistics*.

⁴⁸⁸ The Scientific and Technological Research Council of Turkey [Türkiye Bilimsel ve Teknolojik Araştırma Kurumu], *International Fellowship for Outstanding Researchers*.

⁴⁸⁹ Hudson, “AI talent is moving fast around the world, OECD database shows.”

⁴⁹⁰ You can see more detailed information about the one of leading technology nonprofit organizations in Turkey from www.inzva.com. inzva holds community-driven study groups, camps and meetups to improve the technical depth of talented students by promoting collaborative learning, and develops open source AI projects that support AI research ecosystem in Turkey.

technologies, and places them among the list of critical technologies to be focused on, especially for agriculture, education and public services.⁴⁹¹

Turkey also has started to recognize the value of sharing knowledge as the country recently took actions to initiate projects and platforms that promote open data and open source projects.

Together with TUBITAK, The Ministry of Industry and Technology have started to “Open Source Platform”, where projects using Git can be stored and planned free-of-charge.⁴⁹²

In addition, “Open Data” project initiative that aims to “provide a platform to share anonymized data for collaboratively building AI systems” has been put into action by Digital Transformation Office.⁴⁹³ Istanbul Metropolitan Municipality also initiated an open data platform with over 100 datasets including data collected for transportation, railway systems, jurisdiction, fire departments, and traffic.⁴⁹⁴ These are positive steps towards catching up with the global trends but it is important to note that these platforms require a lot of work in terms of the diversity and usability of datasets to actually enable social good projects solving local problems.

As for data law; Turkey had issued the first draft of its data protection law “The Law No. 6698 on the Protection of Personal Data”, or simply “Turkish Data Protection Law” in 2016; though the document clears out the basics about the data protection and privacy, it does not have too much to say about data privacy ethics, which would spark a guided discussion among the practitioners and end-users.⁴⁹⁵

⁴⁹¹ Türkiye Cumhuriyeti Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı [The Strategy and Budget of the Presidency of Republic of Turkey], *On Birinci Kalkınma Planı* [The Eleventh Development Plan].

⁴⁹² Açık Kaynak Kod Platformu [Open Source Platform], “Ana Sayfa [Homepage].”

⁴⁹³ Türkiye Cumhuriyeti Cumhurbaşkanlığı Dijital Dönüşüm Ofisi [The Digital Transformation Office of the Presidency of Republic of Turkey], “AçıkVeri Portalı. [OpenData Portal]”

⁴⁹⁴ Istanbul Metropolitan Municipality, “Open Data Portal.”

⁴⁹⁵ Law On The Protection Of Personal Data, *The Law No. 6698 on the Protection of Personal Data*.

Another notion worth mentioning is a recent announcement, the context of which established the fact that Turkish Data Protection Law will be revised in accordance with the European Union's General Data Protection Regulation,⁴⁹⁶ which can be viewed as Turkey's attempt to gain access to more diverse data and collaborate with European counterparts to step up its game in the field. This cooperative attitude is highly beneficial for Turkey, because without ensuring the integration into its economic partners' systems, the country can not compete with the market's leading tech giants, and countries that are home to them, which have access to a high amount of local or global data, or, for some, both at the same time.⁴⁹⁷

It is true that considering the official document issued Turkey has been falling behind, 2020 is a late date to announce a national AI strategy, and Turkey does not have any unicorns as of this date, a fact the ministry hopes to change by supporting 10 startups to become the first-ever unicorns founded in Turkey, or as referred by the minister himself, turcorns.⁴⁹⁸

These documents issued constitute a beginning in Turkey's AI strategy journey but both officials and the companies, that are yet to publish any statements with regard to the ethical aspects of AI applications, need to accelerate efforts towards creating an AI ecosystem that are on a par with the AI global scene, and try to figure out ways to utilize these systems for social good.

I would like to also point out that there are many highly accomplished academicians in Turkey, who both aspire to further the field by contributing to scientific research and encourage the next generation of AI practitioners to attend

⁴⁹⁶ Arslan and Ikiler, "Turkey Is Catching Up On The General Data Protection Regulation."

⁴⁹⁷ Sahbaz, "Artificial Intelligence and the Risk of New Colonialism."

⁴⁹⁸ Istanbul Ticaret Odası [Istanbul Chamber of Commerce], "10 TURCORN çıkarmak mümkün [It is possible to commence 10 turcorns]."

international conferences to open consider topics such as ethics, law and social good while they are developing AI projects.

Aykut Erdem⁴⁹⁹ and Erkut Erdem,⁵⁰⁰ who are Associate Professors in the Department of Computer Engineering at Hacettepe University, announced that they have chosen the theme “ML for Social Good” as the undergraduate course “Introduction to Machine Learning”, which maybe the first time the words machine learning and AI are used as part of the curriculum of a higher institution based in Turkey.⁵⁰¹

Professor Cem Say⁵⁰² from Boğaziçi University, who has been building a common ground for both practitioners and public by explaining what AI systems are and how they operate within the framework of science, ethics and law, published a book called “Artificial Intelligence in 50 Question” in 2018, and recently gave a talk titled “Unbiased Robots” at TEDx Talks.⁵⁰³

As referred in scope of this thesis, Professor Albert Ali Salah⁵⁰⁴ led the non-profit “Data For Refugees” Challenge, that was initiated with the aims of bringing solutions to Syrian refugees’ crucial and immediate issues related to healthcare, education, social integration and unemployment by providing the researchers a database indicating the activity and mobility patterns of refugees as well as citizens in Turkey.⁵⁰⁵

⁴⁹⁹ You can visit Aykut Erdem’s Google Scholar profile here:
https://scholar.google.com/citations?user=-xA1_OAAAAAJ&hl=tr.

⁵⁰⁰ You can visit Erkut Erdem’s Google Scholar page here:
<https://scholar.google.com/citations?user=eALwI74AAAAAJ&hl=tr>

⁵⁰¹ You can see a list of project topics discussed here: <https://medium.com/bbm406f19>

⁵⁰² You can see Cem Say’s Google Scholar page here:
<https://scholar.google.com/citations?user=rOum2XsAAAAAJ&hl=tr>

⁵⁰³ Say, “The Intelligence of the Future: Unbiased Robots.”

⁵⁰⁴ You can see Albet Ali Salah’s Google Scholar page here:
<https://scholar.google.com/citations?user=0ee8P-cAAAAAJ&hl=en>

⁵⁰⁵ Salah et al, “Data for refugees: the D4R challenge on mobility of Syrian refugees in Turkey.”

Based on the research I conducted within the scope of this thesis I would like to conclude this epilogue by offering my two cents about the questions I have, that will hopefully be answered in the national AI strategy, which will be issued later this year.

The official documents issued on the subject are still not as comprehensive as they should be, especially with regard to the targeted areas; as it can be seen from the “2023 Industry and Technology Strategy”, Turkey aims to utilize artificial intelligence for agriculture and health, but the question remains as for how that will be accomplished.

Just like China, Turkey needs to find a way to increase the number of AI talents it is home to; this should be conducted by bringing back the ones that are currently abroad, educating talented students by offering scholarships, supporting research in terms of both hardware and software as well as attracting foreign talents. The students who want to take part in the top conferences should be encouraged and financially supported so that the country can stay competitive in academic research.

Actively participating in the global debate; Turkey needs to make partnerships with other emerging countries and find ways to get integrated to the global AI scene by setting legislative standards in accordance with universally accepted ones so that products developed can be in line with international requirements.

Last but not the least, all actors involved in the AI scene within Turkey, notwithstanding the organizations they are affiliated with, need to start thinking and talking about AI ethics, and ultimately figure out the ways to use these emerging technologies for social good by carefully assessing the societal problems to see what should be the areas of focus. A consensus about AI governance and ethics may not

be reached in our near future, but contributing to the debate is extremely important as the outcomes of these decisions will be what we are facing while dealing with these systems. Turkish government should issue a list of principles about ethics, and encourage the companies and institutions to do the same.

Turkey is on the cross-roads with the AI development; after carefully reviewing the other countries' progress and collaborating with experts in the field, the country has the potential to design a national AI strategy with smart policy-making that will not only benefit the researchers and companies but also will contribute to raising the standards of public by developing projects that are for the good of everyone involved.

APPENDIX A

AI ETHICS GUIDELINES ISSUED TO DATE

Name of Document/Website	Issuer	Country of issuer
Artificial Intelligence. Australia's Ethics Framework. A discussion Paper	Department of Industry Innovation and Science	Australia
Montréal Declaration: Responsible AI	Université de Montréal	Canada
Work in the age of artificial intelligence. Four perspectives on the economy, employment, skills and ethics	Ministry of Economic Affairs and Employment	Finland
Tieto's AI ethics guidelines	Tieto	Finland
Commitments and principles	OP Group	Finland
How can humans keep the upper hand? Report on the ethical matters raised by AI algorithms	French Data Protection Authority (CNIL)	France
For a meaningful Artificial Intelligence. Towards a French and European strategy	Mission Villani	France
Ethique de la recherche en robotique	CERNA (Alistene)	France
AI Guidelines	Deutsche Telekom	Germany
SAP's guiding principles for artificial intelligence	SAP	Germany
Automated and Connected Driving: Report	Federal Ministry of Transport and Digital Infrastructure, Ethics Commission	Germany
Ethics Policy	Icelandic Institute for Intelligent Machines (IIIM)	Iceland
Discussion Paper: National Strategy for Artificial Intelligence	National Institution for Transforming India (Niti Aayog)	India
L'intelligenza artificiale al servizio del cittadino	Agenzia per l'Italia Digitale (AGID)	Italy
The Japanese Society for Artificial Intelligence Ethical Guidelines	Japanese Society for Artificial Intelligence	Japan
Report on Artificial Intelligence and Human Society (Unofficial translation)	Advisory Board on Artificial Intelligence and Human Society (initiative of the Minister of State for Science and Technology Policy)	Japan
Draft AI R&D Guidelines for International Discussions	Institute for Information and Communications Policy (IICP), The Conference toward AI Network Society	Japan
Sony Group AI Ethics Guidelines	SONY	Japan
Human Rights in the Robot Age Report	The Rathenau Institute	Netherlands
Dutch Artificial Intelligence Manifesto	Special Interest Group on Artificial Intelligence (SIGAD), ICT Platform Netherlands (IPN)	Netherlands
Artificial intelligence and privacy	The Norwegian Data Protection Authority	Norway
Discussion Paper on Artificial Intelligence (AI) and Personal Data - Fostering Responsible Development and Adoption of AI	Personal Data Protection Commission Singapore	Singapore

Mid- to Long-Term Master Plan in Preparation for the Intelligent Information Society	Government of the Republic of Korea	South Korea
AI Principles of Telefonica	Telefonica	Spain
AI Principles & Ethics	Smart Dubai	UAE
Principles of robotics	Engineering and Physical Sciences Research Council UK (EPSRC)	UK
The Ethics of Code: Developing AI for Business with Five Core Principles	Sage	UK
Big data, artificial intelligence, machine learning and data protection	Information Commissioner's Office	UK
DeepMind Ethics & Society Principles	DeepMind Ethics & Society	UK
Business Ethics and Artificial Intelligence	Institute of Business Ethics	UK
AI in the UK: ready, willing and able?	UK House of Lords, Select Committee on Artificial Intelligence	UK
Artificial Intelligence (AI) in Health	Royal College of Physicians	UK
Initial code of conduct for data-driven health and care technology	UK Department of Health & Social Care	UK
Ethics Framework - Responsible AI	Machine Intelligence Garage Ethics Committee	UK
The responsible AI framework	PriceWaterhouseCoopers UK	UK
Responsible AI and robotics. An ethical framework.	Accenture UK	UK
Machine learning: the power and promise of computers that learn by example	The Royal Society	UK
Ethical, social, and political challenges of Artificial Intelligence in Health	Future Advocacy	UK
Unified Ethical Frame for Big Data Analysis. IAF Big Data Ethics Initiative, Part A	The Information Accountability Foundation	UK
The AI Now Report. The Social and Economic Implications of Artificial Intelligence Technologies in the Near-Term	AI Now Institute	USA
Statement on Algorithmic Transparency and Accountability	Association for Computing Machinery (ACM)	USA
AI Principles	Future of Life Institute	USA
AI - Our approach	Microsoft	USA
Artificial Intelligence. The Public Policy Opportunity	Intel Corporation	USA
IBM's Principles for Trust and Transparency	IBM	USA
OpenAI Charter	OpenAI	USA
Our principles	Google	USA
Policy Recommendations on Augmented Intelligence in Health Care H-480.940	American Medical Association (AMA)	USA

AI Now 2017 Report	AI Now Institute	USA
Position on Robotics and Artificial Intelligence	The Greens (Green Working Group Robots)	EU
Report with recommendations to the Commission on Civil Law Rules on Robotics	European Parliament	EU
Ethics Guidelines for Trustworthy AI	High-Level Expert Group on Artificial Intelligence	EU
AI4People—An Ethical Framework for a Good AI Society: Opportunities, Risks, Principles, and Recommendations	AI4People	EU
European ethical Charter on the use of Artificial Intelligence in judicial systems and their environment	Concil of Europe: European Commission for the efficiency of Justice (CEPEJ)	EU
Statement on Artificial Intelligence, Robotics and 'Autonomous' Systems	European Commission, European Group on Ethics in Science and New Technologies	EU
Artificial Intelligence and Machine Learning: Policy Paper	Internet Society	international
Report of COMEST on Robotics Ethics	COMEST/UNESCO	international
Ethical Principles for Artificial Intelligence and Data Analytics	Software & Information Industry Association (SIIA), Public Policy Division	international
ITI AI Policy Principles	Information Technology Industry Council (ITI)	international
Ethically Aligned Design. A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems, version 2	Institute of Electrical and Electronics Engineers (IEEE), The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems	international
Top 10 Principles for Ethical Artificial Intelligence	UNI Global Union	international
The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation	Future of Humanity Institute; University of Oxford; Centre for the Study of Existential Risk; University of Cambridge; Center for a New American Security; Electronic Frontier Foundation; OpenAI	international
White Paper: How to Prevent Discriminatory Outcomes in Machine Learning	WEF, Global Future Council on Human Rights 2016-2018	international
Privacy and Freedom of Expression In the Age of Artificial Intelligence	Privacy International & Article 19	international
The Toronto Declaration: Protecting the right to equality and non-discrimination in machine learning systems	Access Now ; Amnesty International	international
Charlevoix Common Vision for the Future of Artificial Intelligence	Leaders of the G7	international
Artificial Intelligence: open questions about gender inclusion	W20	international
Declaration on ethics and data protection in Artificial Intelligence	ICDPPC	international
Universal Guidelines for Artificial Intelligence	The Public Voice	international

Ethics of AI in Radiology: European and North American Multisociety Statement	American College of Radiology; European Society of Radiology; Radiology Society of North America; Society for Imaging Informatics in Medicine; European Society of Medical Imaging Informatics; Canadian Association of Radiologists; American Association of Physicists in Medicine	international
Ethically Aligned Design: A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems, First Edition (EAD1e)	Institute of Electrical and Electronics Engineers (IEEE), The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems	international
Tenets	Partnership on AI	n.a.
Principles for Accountable Algorithms and a Social Impact Statement for Algorithms	Fairness, Accountability, and Transparency in Machine Learning (FATML)	n.a.
10 Principles of responsible AI	Women leading in AI	n.a.

Source: Jobin, Ienca, and Vayena. Artificial Intelligence: the global landscape of ethics guidelines.

APPENDIX B

UNITED NATIONS GLOBAL PULSE:

BIG DATA AND THE SUSTAINABLE DEVELOPMENT GOALS

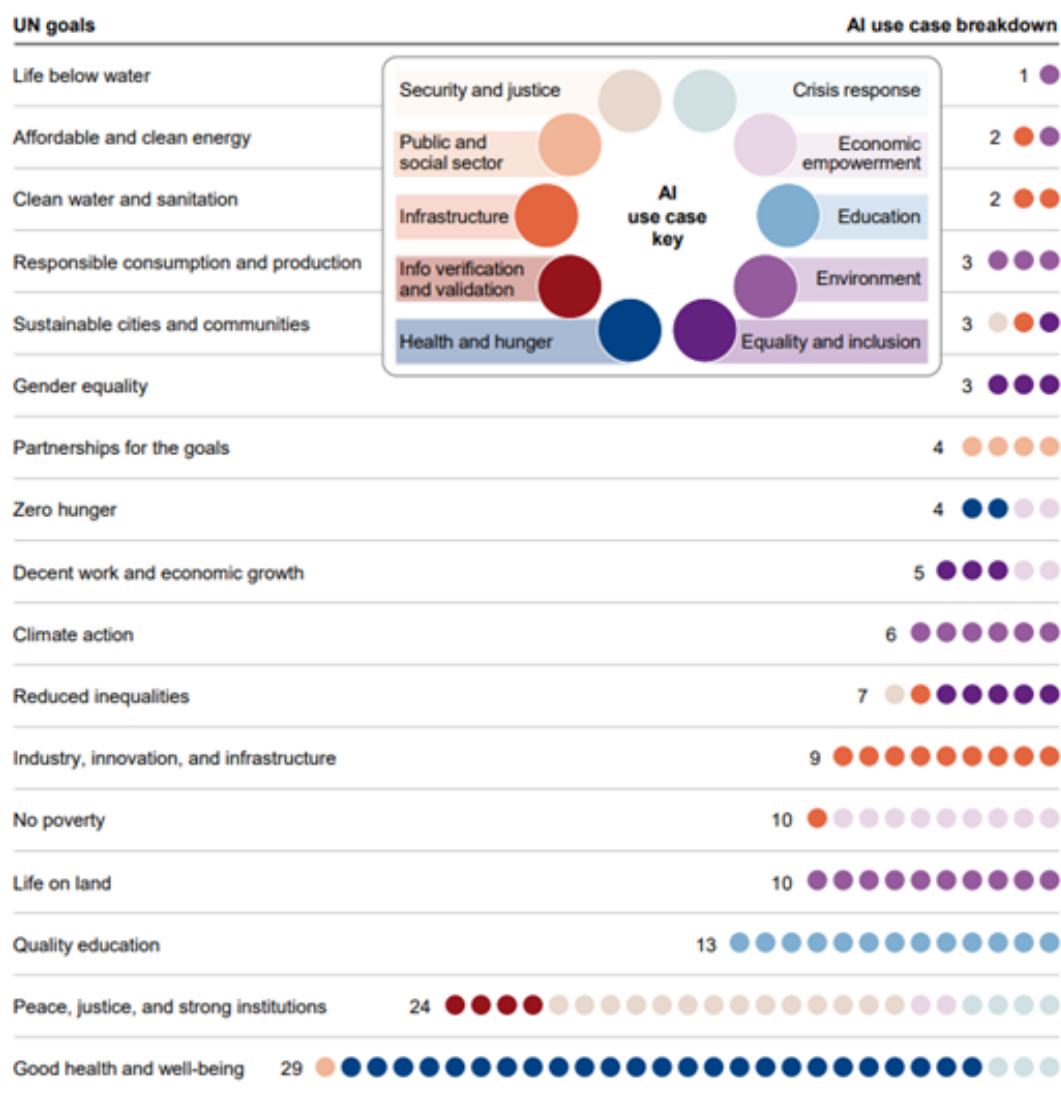


Source: United Nations Global Pulse, “Big Data and the SDGs”

APPENDIX C

USE CASES IN MCKINSEY'S LIBRARY THAT SUPPORTS UN SUSTAINABLE DEVELOPMENT GOALS

UN Sustainable Development Goals¹
Number of use cases



¹ Chart is a partial list of use cases, as 21 of the 156 identified use cases do not target any of the UN's Sustainable Development Goals.
NOTE: This chart reflects the number and distribution of use cases and should not be read as a comprehensive evaluation of AI potential for each SDG; if an SDG has a low number of cases, that is a reflection of our library rather than of AI applicability to that SDG. The chart also does not reflect all use cases in the library, more than 20 of which do not map to any SDGs. These mainly focus on effective management in the public and social sectors, or belong to the issue types of disaster response and search and rescue in the crisis response domain.

SOURCE: United Nations; McKinsey Global Institute analysis

Source: United Nations, "McKinsey Global Institute analysis."

APPENDIX D

AI FOR SOCIAL GOOD PROJECTS TACKLING UNITED NATIONS' SUSTAINABLE DEVELOPMENT GOALS

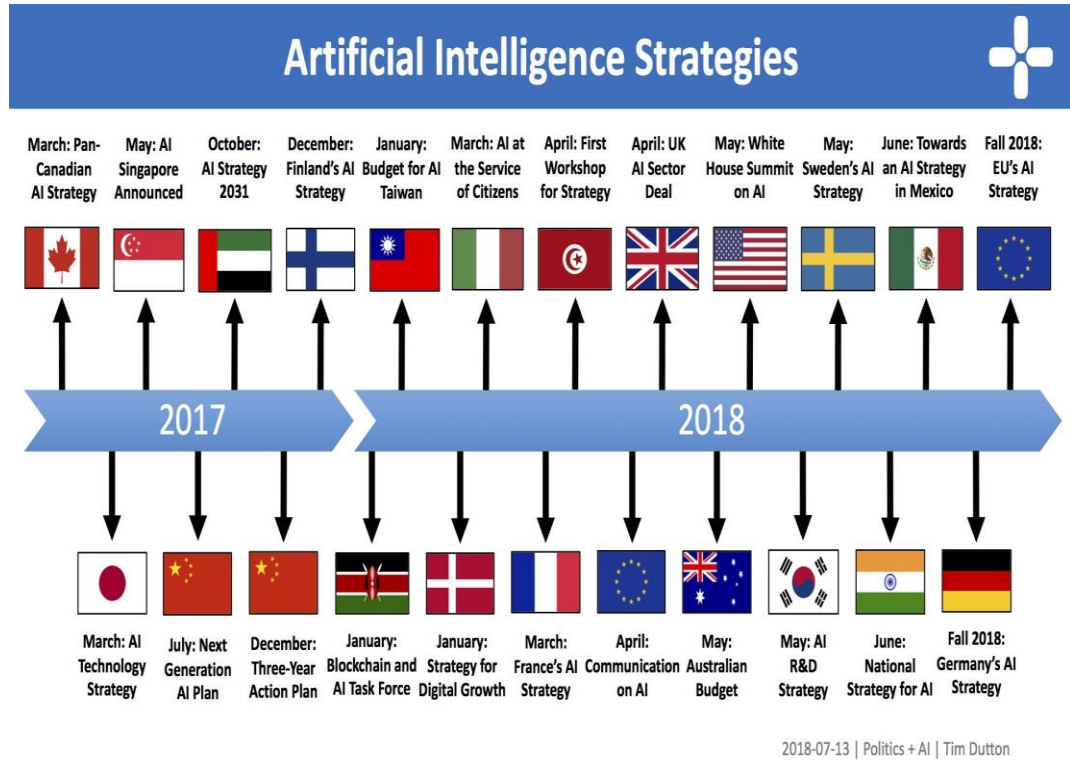
UN SDGs	Examples of AI for social good projects
1 NO POVERTY 	Applying machine learning on satellite imagery and survey data to extract socioeconomic indicators and generate visualizations and predictions of poverty in areas without survey data
2 ZERO HUNGER 	Applying machine learning to satellite images, localized food prices, and conflict data to predict and address severe acute childhood malnutrition
3 GOOD HEALTH AND WELL-BEING 	Using machine learning analytics on vaccine transit data, vaccine potency data, temperature data in vaccine refrigerators, equipment metadata, and other datasets to predict viability for common vaccines at every point in the supply chain
4 QUALITY EDUCATION 	Applying natural language processing on conversations between educators and non-English-speaking parents as well as machine learning analytics on parent and student profiles to construct a multilingual family engagement platform and deliver personalized resources that help parents digitally connect with teachers regardless of language
5 GENDER EQUALITY 	Leveraging natural language processing methods, including topic modeling, psycholinguistic feature modeling, and audio signal processing on voice recordings and chat transcripts from crisis call hotlines for women to escalate calls with high risk of intimate partner violence
6 CLEAN WATER AND SANITATION 	Leveraging machine learning analytics on thermal satellite images, weather data, and farmer-supplied agriculture data to estimate evapotranspiration and help farmers optimize the exact amount of water needed to irrigate crops
7 AFFORDABLE AND CLEAN ENERGY 	Utilizing machine learning analytics and image recognition on satellite images, power grid outlines, and relevant socioeconomic information to determine optimal resource allocation for electricity infrastructure in developing countries
8 DECENT WORK AND ECONOMIC GROWTH 	Using machine learning analytics on publicly available skills and occupational data to map an individual's skill set captured through a guided assessment directly to relevant occupations
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 	Using computer vision on Google Street View and LIDAR images to help residents to assess defensible space and identify flammable vegetation around their homes

10 REDUCED INEQUALITIES 	Applying machine learning to image and text data to develop a dictionary of norm-revealing phrases that can be used as an alternative credit-scoring mechanism to make consumer lending more accessible to low-income individuals
11 SUSTAINABLE CITIES AND COMMUNITIES 	Applying machine learning analytics on incident dispatch data and other correlative data (weather, anomalous events, city demographics, etc.) to build a predictive model around emergency response times for first responders in urban areas
12 RESPONSIBLE CONSUMPTION AND PRODUCTION 	Leveraging deep neural net and image-recognition technology on garbage and waste management images to help automate classification and sorting of recyclable items at waste management facilities
13 CLIMATE ACTION 	Applying machine learning analytics and computer vision on emissions data, satellite imagery of power plants, weather conditions, and grid conditions to monitor power plant emissions
14 LIFE BELOW WATER 	Using image-recognition technology on waste facility images and data to help increase recycling rates and reduce ocean plastic pollution
15 LIFE ON LAND 	Applying machine learning analytics and audio recognition on live audio streams from rainforests and other ecosystems to help locals derive insights and help root out any ecological threats
16 PEACE, JUSTICE AND STRONG INSTITUTIONS 	Using natural language processing and machine learning methods on legal and judicial documents (e.g., laws, jurisprudence, victim testimonies, and resolutions) to extract relevant information and empower human rights advocates
17 PARTNERSHIPS FOR THE GOALS 	Leveraging machine learning analytics on developing country economic indicators and population survey data to create a repository to help inform public and private sector entities as well as the government to better target assistance and measure return on investment

Source: Google Impact Challenge, “Accelerating social good with artificial intelligence: Insights from the Google AI Impact Challenge”

APPENDIX E

NATIONAL ARTIFICIAL INTELLIGENCE STRATEGIES



Source: Dutton, “An Overview of National AI Strategies.”

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