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The Development of Artificial Intelligence Start-Ups: A comparison between the BENELUX and Japan

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Abstract

Since the 1950s, Artificial Intelligence is an on-going revolutionary technology that is about to disrupt or help many business sectors. The involvement of A.I. in a business tool, as well as a public sector tool, is more than ever being chase by a various amount of countries, such as the BENELUX union and Japan. The goal of these different countries is to have a strategic position in order to adapt to the technology, innovate and develop different A.I., whilst marketing them through the use of start-ups. The goal is to create a well-positioned society, that is ready to cease the different opportunities of such a technology, at an economical or societal level. To cease these opportunities, there is a need to be in the upper hand group of A.I. leading countries, as there is a fierce belief in the winner takes all.

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Introduction

Today's business world is changing at a fast pace, partly due to the transition towards a digital world, as well as partly due to the increase in innovations all around the World (EPP, 2015). As this tough environment is technologically orientated, it is important for all the parties to be embracing these technologies to have an upper hand over the competition. As the latest add-on to the list of tomorrow's technologies we can find Artificial Intelligence (A.I.), this innovation that everyone has on their lips. The trendy term of Artificial Intelligence has therefore attracted a lot of attention, whilst no one is aware of what benefits it could really have on our business environment.

Although the technology is praised by every stakeholder in every industry around the World, this technology has already gone through different hard times. The concept was coined for the first time in the 1950s and was sold to the entire World as the most promising invention of the century (Aggarwal, 2018). A few years later, due to a lack of concretizing the theoretical findings into actual products or services, most investors decided to withdrawal their investment from this less appealing technology. Artificial Intelligence went therefore through a tough phase, where only passionate researcher would work on improving it as they had a true believe in the opportunities it could offer the World. The technology improved and is now back to being the primary focus of many different parties, but it is still not clear what it can perform (Aggarwal, 2018).

As the world has digitalized, and the creation of 'Big Data' has occurred, it is now viable to investigate the potential that A.I. can give to society (Jacobs, 2018). The amount of data that is necessary in order to train the different machines to act as humans is finally available. The evolution in computing power also enables us to combine the different pieces of the puzzle to realize Alan Turing's dream. As it was arguable by many researchers that there was a lack of computing power and technological advances to make A.I. scale-up in the past, we now have no excuses to not see it revolutionize the entire World. Therefore, different governments have also changed their focus towards this slowly exploding technology, which is seen by many as the next tool to transition towards the next future type of society.

The United States of America and China have therefore radically changed their opinion and decided to act directly in order to establish themselves as a dominant force in this new technology (Qingqing, 2017). The different governments invested heavily in the research and development of such technologies, as it could also be prolific for the public sector. Rather sooner after the frontrunners have made the first step and stating their interest in the new technology, many other governments such as Japan, the United Kingdom, Germany, and France all followed. This was partly due to fearing being dependent either of the USA or China, but also to enable its citizens to benefit from the

potential various economical and societal opportunities that the technology offers. This the reason why different countries started to express the need to establish their strategic plan to cease the maximum of the different opportunities. But also, to express their different opinions on how A.I. should be regulated and used.

As we can see that many dominant economies are battling to be the leader in this new trendy technology, it is important for smaller countries to also try and take part in the race, even if their impact would be smaller. The BENELUX union, relatively small countries of the EU are therefore trying to not be left behind and are trying to join the race in their own manner. But how is it possible to understand what their impact is on the technology without comparing the union to a dominant country in the world. We will conduct a comparison between the different strategic approaches the countries of the BENELUX have compared to a dominant but not leading country, Japan. Japan seems to be a dominant country in innovations as it was visible during the transition in the past industrial revolution where Japan was leading in many ways, and most likely they will try and repeat it again with the rise of A.I.. Therefore, comparing the BENELUX to Japan will give us a better understanding of whether the potential of smaller countries is truly low, or if it could play a role in the development of Artificial Intelligence.

Objective and motivation the topic

The functionalities related to the use of A.I., in terms of societal or economical benefits, are attractive for every country around the World. This why even countries that are considered as smaller and less impactful in the business world are often running being the leading countries. The development of this new technologies leaves a gap of opportunities for any country to try and shine in the research and development of A.I., although huge amount of data and investment are needed. This is therefore the best opportunity for the country of the BENELUX to try and make themselves a place in this new technology, as if they lag it will not be possible to catch up later.

The thesis will therefore analyse literature reviews to understand what A.I. is and how it is evolving over time. This will in turn give the reader a better understanding of the different ways A.I.s evolved and how they work more precisely. Then we will define what A.I. truly is on order to understand what it can offer us and how it might already be present in today's World. The different visions of both region, the BENELUX and Japan, will then be analysed in order to understand the different visions and position each country have already been able to cease. Then we will discuss the different start-up ecosystem, as start-ups will be the dominant driving force in order to get countries to innovate at a fast pace. It will also give the reader knowledge about different existing start-ups and what type of A.I. can be found across these ones. We will then focus on two specific sector in order to get a better understanding on whether the BENELUX are has potential to realize with a country of the size of Japan or if it is already lagging behind in terms of technological advances. The final goal will be to have a better understanding of the possible potential the BENELUX area could have in A.I. and how the future generation of entrepreneurs could potentially benefit of the advances that are currently being made.

Covid-19 impact

The assumption of meeting different stakeholders in the different markets in order to discuss and gather some primary data has clearly been limited by the Covid-19 Pandemic. This is due to the inability to travel across the BENELUX area freely to meet the different stakeholders. This limited the ability that I had to treat the topic and I had to turn to literature and numerical data that can be found online, as well as offline in the different books that were available to me. Different interviews with specialists across the BENELUX area would have made my research more solid, as there might be some lack of personal input. As this topic is fairly young it is also important to not that through the limitation of the interactions with the different stakeholders, there was a clear limitation in data that is reflected through the metrics phase in the thesis. This is clearly a disappointment as the topic is really interesting and has a huge potential for future research.

PART 1 – Artificial Intelligence

1.1 Historical Background (1945-2010)

Today's hot topic of Artificial Intelligence (A.I.) is a complex environment. To understand this complex environment, it is important to understand where the term comes from and what it involved at its creation and the evolvement of such a technology in today's fast developing World.

1.1.1 1945-1954

Before the era of big data and portable computers, a whole team led by Alan Turing, a British mathematician and logician, had been able to break the Enigma code. This code, created by the German forces in *World War II* to encrypt their messages and mislead the allies, had been broken by one of the first ever automatic machine. The Turing Machine, inspired by Turing's icon David Hilbert, was initially created to compute mathematical problems, and solve complicated algorithms.

In the 1950s, Alan Turing went on with his work on computer and initiated the belief that a machine could potentially imitate human intelligence. In the seminal paper "Computing Machinery and Intelligence" (Turing, 1950) written by Alan Turing, he developed the imitation game. The imitation game (Turing test), considered by many researchers as the beginning of A.I., involves three different parties, a human, a computer, and a human interrogator that will interact over written responses. The three different parties are in three different rooms and the purpose of the game will be for the interrogator to understand who the computer is and who the human is. To do this, the computer will have to persuade the interrogator that he is the human. This made Alan Turing believe, as explained to a BBC interview in 1952, that in 2000 there will be less than 70% chances of identifying the human as being the human after a five-minute exchange period (Sharkey, 2012).

Many other researchers have also formulated models that are making machines reproduce intelligent life. Marvin Minsky, an American scientist passionated by neuroscience, created a machine, the Stochastic Neural Analogy Reinforcement Computer (SNARC) that would reproduce the behaviour of a rat. This was the creation of the first neural network machine that resulted in making it possible to create a model that represents the behaviour of a rat looking for food in a small maze (Minsky & Edmonds, 1951). Another American scientist, Arthur Samuel, created the Checkers-Playing Program in 1952 (McCulloch & Pitts, 1943). This was ultimately the first self-learning program, that would advise the player if the move that would be played was a good or a bad move.

1.1.2 1955-1983

After being motivated by the whole movement, John McCarthy, a professor at Dartmouth College, decided to organize a conference in 1955. At this conference, John McCarthy formulated the term "Artificial Intelligence". After this conference, a research group of 10 scientists was created in order to "find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves." (McCarthy, 1955.) This conference and research group created a shock wave in the whole environment of A.I. and machine learning, this resulted in a multitude of different inventions in the following years.

Arthur Samuel had also created the important concept of Machine Learning in 1959, a few years after coining the Artificial Intelligence term (Samuel, 1959). Machine Learning was introduced as the concept of computers being able to learn without being programmed. It is meant that programs were supposed to evolve by themselves and learn from data that was fed to them. To do so, many computers were working with 'Neural Networks' that imitate the human brain, more specifically neurons, using different algorithms to recognise basic relationships between different sets of data. Frank Rosenblatt, an American psychologist, head of the cognitive system section at the Cornell Aeronautical Laboratory at the time, used this neural network system to introduce the concept of Perceptron Network (Rosenblatt, 1957). The perceptron network is an artificial model of communicating neurons, that is an algorithm for supervised machine learning. This model uses an algorithm to help the machine learn and process different elements of a training set. But they were not comparable to human neurons as they could not produce the same outputs. Although perceptron networks were limited at the time, Rosenblatt still managed to create Mark 1, which was the first machine that was able to recognise basic images (Rosenblatt, 1957). Alexey Ivakhnenko and Valentin Grigor'evich Lapa established the first ever "deep learning algorithms", that was based on a continuous work on Rosenblatt's findings (Ivakhnenko & Lapa, 1965). In 1971, Alexey Ivakhnenko also provided an eight-layer deep neural network and a way of training the different deep neural network (Ivakhnenko, 1971). In terms of neural network, Kunihiko Fukushima, a Japanese computer scientist, was the first scientist to develop a Convolutional Neural Network (CNN) in 1979. Fukushima's CNN is called Neocognitron, it has a multi-layer and hierarchical design that enables the machine to learn and recognize different visual patterns. It was first introduced to recognize handwritten characters and other patterns recognition tasks.

Noam Chomsky, an American linguistic and cognitive scientist, reformed the whole linguistic world with his "Universal Grammar Rule" in 1957 (Chomsky, 1957). This rule is suggesting that every language has a set of laws that they follow, for example the way to ask a question, to answer something negatively or to identify a gender. If this set of grammar laws are the same in all the languages, then a child would only have to follow

a set of rules to learn another language. This whole Universal Grammar Rule gave the opportunity for scientists to develop further usage of such a theory and apply it to computer programs. Terry Winograd, an American computer science professor, invented the SHRDLU Natural Language Processing program in 1968-70 (Winograd 1971). This program was created to have a conversation with a computer and make it do several actions. The program was built on a simplified "blocks world" where the human would as the machine to recognize and move different virtual boxes that are present in the virtual world. This was the evidence that it is possible to make machines understand and produce certain actions that a human being asks.

In the 1960s, Reedy Raj, an American Scientist, worked on speech recognition and speech to text processing. He created the *Hearsay I*, a program that was the first program to be able to convert vocabulary into text by a computer (Juang & Rabiner, 2004). His program was later reworked by Baker and Baker, two of his students, and released *Dragon System* in 1975 (History of Speech Recognition, 2015). This program was improved by the Hidden Markov Model (Rabiner, 1975), this gave it the ability to merge different sources of acoustics, languages and syntaxes.

The first theoretical and first applications of A.I. throughout this phase led to the first commercial applications. Joseph Weizenbaum, a German computer scientist, created ELIZA: the first ever chatbot between 1964 and 1966 (Weizenbaum, 1976). This chatbot was able to communicate with a human through a program and humans were often fooled to believe that they were talking to a human being, although the answers stayed standard. The responses were meaningless overtime, but this chatbot was the first ever program to be able to attend the Turing test (imitation game). In 1972, *ELIZA* had been reworked by Kenneth Mark Colby, an American psychiatrist that was fully involved with the application of computer science to psychiatry (Franchi & Güzeldere, 1995). *PARRY* was programmed to mirror a person that has paranoid schizophrenia and worked exactly like *ELIZA*. In the imitation game, it was difficult for therapists to judge which patient was the real human and which one was the computer, as only 48% succeeded.

There had also been many advances in machinery, as the first programmable robot was released in 1954. George Devol, an American inventor, used A.I. to create the automated robot called *Unimate*, which was bought by General Motors in 1961 for their assembly lines (Nof, 1999). This is considered as the first real sold A.I. product. Following the improvements of the *Unimate*, the University of Waseda released the *WABOT-1*, which was the first robot able to walk because of his lower limbs that were able to move, carry objects with hands that use different sensors and to speak in Japanese (Waseda, n.d.). It could also understand the different distances and directions, although it has been assessed that his mental faculty is comparable to a child that is less than two years old. This invention led to enable the different industries to develop robots that had increased performances compared to the *Unimate* and *WABOT-1*.

Artificial Intelligence fell into a decline of interest after 1975, as it experienced different problems. The first problem was the limited computer power at the time, it was too expensive to develop supercomputers that could still not produce enough power to be more developed. A study conducted by Hans Moravec, a Canadian scientist, displayed some of the limitations of the supercomputers at the time. He assessed that to produce edge-matching and motion detection of a human's retina it would require a supercomputer that is at least ten times more performing than what was available in 1976 (Moravec, 1976). It was also assessed that the creating of a perceptron network as performing as human neurons would have been valued at a price that is comparable to the United States GDP of 1974, so around 1.6 trillion USD (GDP, 1974). The second problem was that at the time of the first development of A.I. neurological mechanism was still unknown. This meant that it was impossible to understand what machine learning was supposed to imitate as it was still unclear of how the neuronal networks were working. As a direct effect, many governments decided to withdraw their funding in the 1970s and 1980s as the results and the theoretical part of A.I. were not materializing. This lead A.I. to collapse in a short time, as the belief of its success was fading away.

1.1.3 1984 - 2010

Subsequently after the first skyrocketing success happening in the 1950s and 60s and the downfall in the 70s, A.I. had to evolve and illustrate the theory into edge matching products.
As A.I. was trying to stay alive, due to funding drying up, many researchers were focusing on how to improve machine learning and ideas of some researchers.

The idea of neural network was in the first line of sight of the researchers, the importance of this network could not be neglected, if A.I. wanted to be evolving in the future. In 1983, John Hopfield, an American scientist, promoted the idea of Recurrent Neural Networks (RNNs). Compared to the perceptron of Rosenblatt, as discussed earlier, Hopfield was allowing the connection to go in both ways, from the input to output and from the output to input, unlike the feedforward of Rosenblatt. The biggest differences between the neural network of Rosenblatt and Hopfield's was that it was able to demonstrate temporal behaviour, as well as use internal memory to process incoming data (Sathasivam, 2008). In 1997, two German scientist, Sepp Hochreiter and Jürgen Schmidhuber, improved Hopfield's neural network. The Long-Short Term Memory (LTSM) was reducing some of the problems the RNNs were facing throughout their training phases, while increasing the usage of LTSM for specific time-series predictions (Hochreiter &. Schmidhuber, 1997) Although all these neural networks were working and that their training was eased with the new discoveries, three scientists

came up with a new neural network. In 2006, Geoffrey Hinton, Simon Osindero and Yee-Whye Teh, released a paper introducing their concept of Deep Belief Networks (Hinton et al., 2006). The revolution of this paper was that it introduced for the first time that each layer of the perceptron could be pre-trained individually, which enables them to be more efficient at giving a good representation of the whole network, rather than only

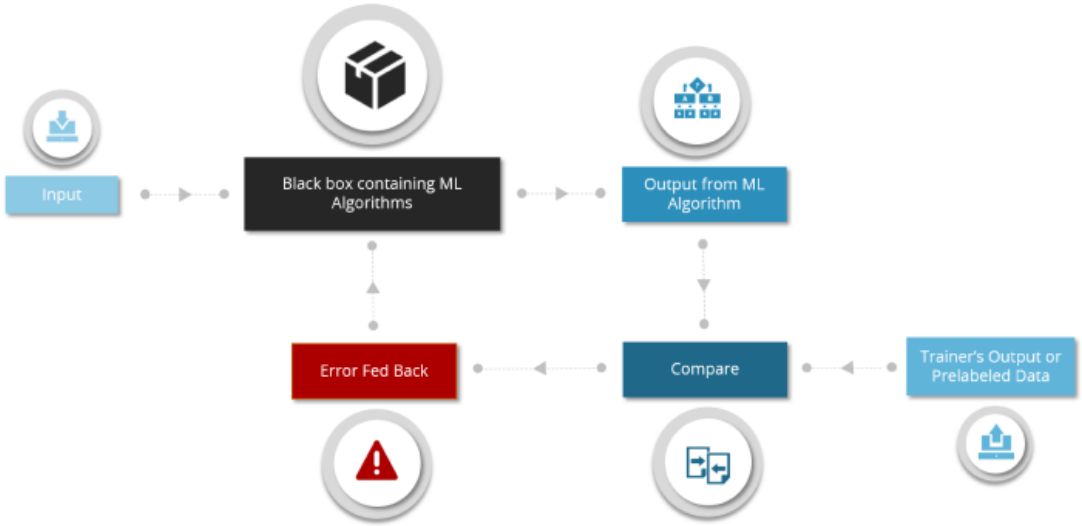


Figure 1: Process Flow for Supervised Learning Techniques

the input and output.

The improvement of machine learning was also crucial to make and understand better how machine learning was acting and what could make the machines more efficient. The first machine learning technique that was introduced was the Supervised Machine Learning (SML) (Mohri et al., 2012). SMLs need to be trained by humans using data that has been labelled. Once it is trained, the human will provide the black box, that contains the machine learning algorithms, with one data and let it process it. If the data that is processed comes out correctly, then the input and output are the same. If it is coming out different, the machine will have to realign itself by modifying its internal code to succeed for the next challenge.

The second machine learning technique is the Unsupervised Learning Algorithms (ULA) (Hastie et al., 2009). Compared to SMLs, ULAs require to be fed with unlabelled data to understand and draw a hidden pattern that is visible within the data. This technique will compute the hidden probability distribution by splitting the data into "common" groups, but it is sometimes hard to define their potential accuracy due to unlabelled data. These types of algorithms are often used for marketing purposes and in disease management.

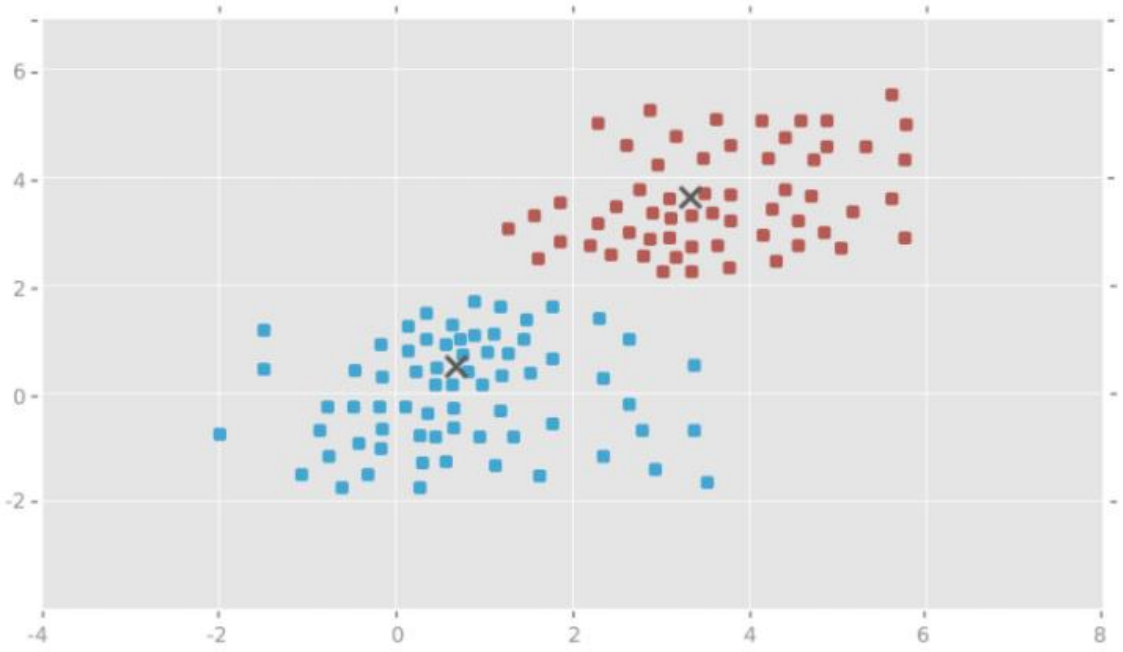


Figure 2: Typical Output of a 2-means algorithm for partitioning red and blue points in a plane

The third machine learning technique is called the Reinforcement Learning (RL) (Bertsekas & Tsitsiklis, 1996). This technique is totally different from the two previous techniques, as it does not require to be taught by a human or being fed with labelled data. The algorithms learn from the consequence of their own actions, by this it is meant that they base their actions depending on past experiences and potential new choices. They learn through trying and failing in a simulated environment, then at the end of each learning session they will grade themselves according to the results they had. Each session they will try and improve their score in order to improve their algorithm, once the improvement from one session to the other is minimal the algorithm will then be ready for use.

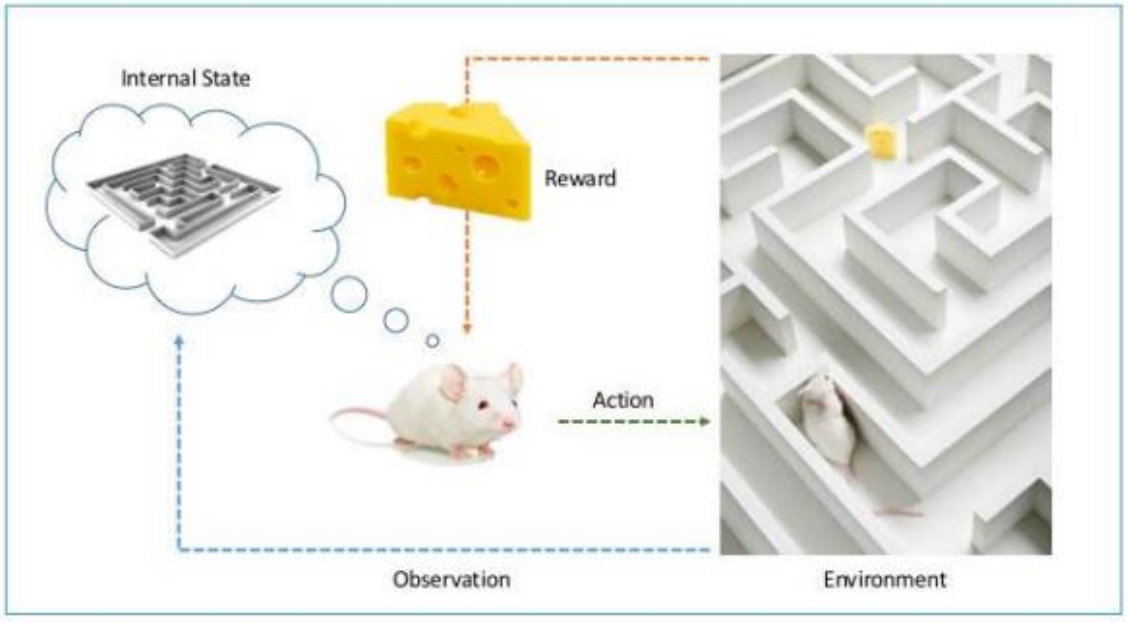


Figure 3: SNARC was the First Reinforcement Network Machine built by Minsky and Edmonds in 1951

The fourth, and last, machine learning technique is the Mixed Learning (ML). This technique bases itself on the usage of the three previous machine learning technique, by this it is meant that it uses a combination of the three precedent techniques. This enables them to create semi-supervised techniques to often save time and investments to label some enormous amounts of data. The broad usages of ML are classification, clustering, anomaly detection and pattern recognition in data.

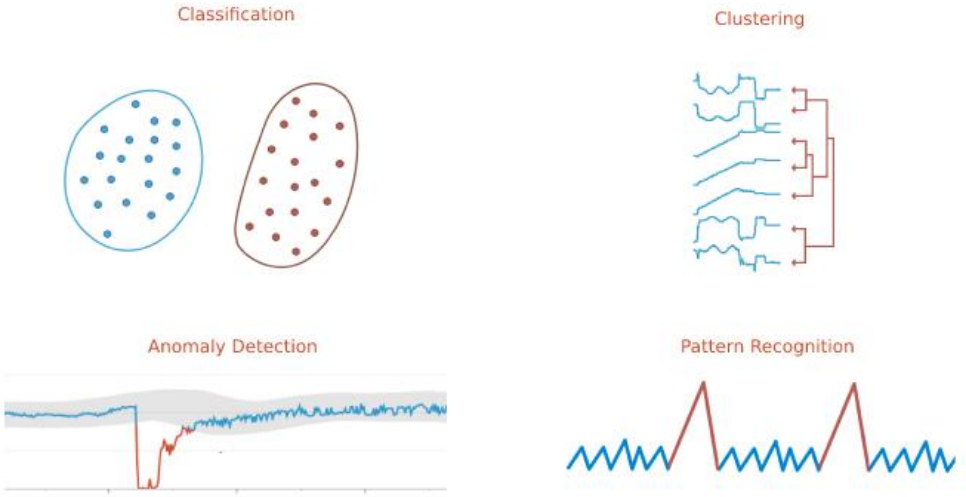


Figure 4: Potential Uses of Machine Learning Algorithms

The improvement of hardware between the 1950s and the early 2000s had been outstandingly improving in terms of performances, it is estimated that the difference of

performance is in the range of 500,000 times better and faster in 50 years. Dr. Gordon Moore argued on some sets of observations, that electronic circuits double approximately every 2 years, which means that the increase in computing power is enormous. Computer became more and more popular and the high competition in the sector made the prices drop at a fast pace, which made it accessible to most people. This meant that anyone could have one computer that could already process data and exercise machine learning at a much faster speed. Although computers were more performing, it was still not enough to use one computer to be able to treat data and complex algorithms. In 2003, Google published the *Google File System paper*, and made it follow by the MapReduce paper in 2004, which was a plan and an associate implementation to enable bigger process and generation of data with parallel and distributed algorithms (GoogleFiles,2004). This enabled the distributed computing to be possible, which had not been possible in the past and was arguably the biggest break to the progress of A.I..

The price of computers dropping, and the creation of the internet meant that many people were starting to use the technology and create data that could be used for A.I.. John Mashey, an American Computer scientist, introduced the term “Big Data”, which was representing the huge volume of data, the variety of the existing data and the pace at which the data was being created (Mashey, 1998). This data became vital for A.I., as they are used to feed them to be able to make them learn and improve. The Internet enabled A.I. to skyrocket again. Companies started to store their data and the creation of Social Medias enabled the generation of billions of Gigabytes of Big Data, labelled as well as unlabelled data (Gershgorn, 2107). This amount of data eased the path of the development of A.I. in the early 2000s and made A.I. skyrocket again in terms of investments as it is seen as the future revolution.

1.2 Artificial Intelligence

1.2.1 Definition

Artificial Intelligence is often mentioned by many researchers and different medias, politicians, or businessmen, but it is also often hard to understand the exact meaning of the term. After our history review on the creation of A.I., and the understanding we have developed through certain concepts mentioned in that section, we will have a look at how the concept is defined.

The term was first introduced in 1956 at the "Dartmouth summer research project on Artificial Intelligence" (McCarthy, 1955). The definition from 1956 of Artificial Intelligence is no longer valid, as since then many research and projects have been conducted around it and how it functions. Many academics, politicians, businessmen and scientist are having a range of different definitions on what A.I. is and it is arguably hard to determine what definition is the most accurate. The reason of this lack of accuracy is due to one factor, we are unable to define intelligence through a definition or a concept as it always varies on the context. As described by Daniel Faggella "*a traditionalist might define intelligence as level of reasoning power, and this seems one of the reasons why a popular determiner of AI has often been games*" (Faggella, 2018). Dictionaries are also trying to define the term. For example Encyclopaedia Britannica defines A.I. as "*the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings"(Encyclopaedia Britannica, 2020),* and Cambridge dictionaries defines A.I. as "*the study of how to produce machines that have some of the qualities that the human mind has, such as the ability to understand language, recognizing pictures, solve problems and learn.*"(Cambridge Dictionary, 2020). There are also some other definitions, such as "*The science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable"* (McCarthy, 2007). As we can see in all these definitions, we can observe that they all allude to compare A.I. to the intelligence of a human being.

To understand what artificial intelligence is, it is important to understand what factors are playing a role in being intelligent. As explained by Shang Legg and Marcus Hutter, intelligence is a characteristic of an individual, or an object, that they call *agent*. This agent must interact with a problem or a situation, which they call the *environment*. In order to understand the intelligence of the agent, they will study its ability to succeed

in achieving one or a multitude of objectives, that are called the *goal*. They also stipulate that learning, adapting and being flexible is a must as agents do not know every environment, and intelligence requires to be able to deal with every situation that an agent is confronted to. After making these remarks, Legg and Hutter came up with an informal definition that is as follows: "*Intelligence measures an agent's general ability to achieve goals in a wide range of environments.*" (Legg & Hutter, n.d.). Hutter and Legg consider that there is a combination between RL and Algorithmic Complexity Theory (ACT). This is an important factor as machines that use RL have agents that send actions to the environment, then they receive *observations* and *rewards*. The importance for the machine is to get the most rewards back, which means to be as efficient as possible. For that they need to learn the structure of the environment and what goals need to be fulfilled in order to be successful. From this explanation we can draw three different points, that an entity needs to be considered as intelligent:

- Intelligence is when an agent is in contact with an environment

- Intelligence is the ability of an agent to be able to achieve goals

- Intelligence is the ability to learn, adapt and be flexible in different environments

With the understanding of what intelligence is, we can understand better what Artificial Intelligence is. To understand this concept, we analysed a study conducted by Daniel Faggella, where he asked experts to a respond to a range of 5 definitions of A.I. and to note which one is the most appropriate (Faggella, 2018). If the experts fail to agree with any of the five definitions that are proposed, they are allowed to come up with their own definition. Subsequently, Faggella summarised his findings and came up with a definition for A.I., stated as follows "*Artificial Intelligence is an entity (or collective set of cooperative entities), able to receive inputs from the environment, interpret and learn from such inputs, and exhibit related and flexible behaviours and actions that help the entity achieve a particular goal or objective over a period of time.*" (Faggella, 2018). This definition will be the one we will use as a reference for this research paper, as it is complete and backed-up by many experts, such as Dr. Andreas Kornai, from the Budapest Institute of Technology, Dr. Ashok Goel, from the Georgia Institute of Technology, and Dr. Pei Wang from the Temple University. It is also important to note that this definition gives us a good idea of how A.I. has evolved since the Turing Test (1950). Modern A.I. needs to reach proportionate levels of similarity in all the different aspects of human intelligence, rather than respond and fool a human being to think that a machine is a human. We shifted from humanizing machines to use their power to ease tasks for the human.

1.2.2 What types of A.I. can we identify

Many different research divide A.I. into two different categories: capabilities and functionality. Since humans are trying to make machine imitate their intellectual capabilities and functioning, the extent to which it is successful of this imitation will be one criterion to determine the A.I.. We can argue that this is based on their functionality.

The type of A.I. based on functionality is declined into four different categories of A.I. or A.I. based categories (Javapoint, n.D.). The third and fourth categories are not yet used A.I. categories because they are still in the development phase. The first category is Reactive Machines, which are the oldest and most basic type of A.I.. These A.I. systems are purely reactive to certain types of stimuli and do not store past experiences to forecast a situation that was already met. In other words, these machines only focus on the problem they are facing and only try to achieve the best reaction possible. The second category is Limited Memory, which is similar to Reactive Machine with one exception, they are able to store some memory of past experiences or data. This means that they can react to certain problems with their own reference model (Javapoint, n.D.). This category is the most present A.I. today. The third category is the Theory of Mind, A.I. will have to understand different human emotions, beliefs and be able to interact in society like any human can. This type of A.I. is in innovation phase and will be the next booming A.I. category, as there are many researches that are being conducted. The fourth, and last category, is the Self-Aware A.I., which is only hypothetical. This type of A.I. is still far away of what we can achieve with today's technology, but it is the final goal expressed by Turing, make machines act and be as intelligent as a human being. They will develop their own emotions, consciousness, and self-awareness, which could make them as performing as the human intelligence, or even outperform it.

On the other hand, A.I. is also categorized depending on their tech-capabilities, which are often the most discussed categories of A.I. (Fourtané, 2019).

The first category of A.I. is Weak A.I., or also called Narrow Artificial Intelligence (ANI). It is the type of A.I. that can only perform a dedicated action using intelligence comparable to human intelligence. This makes it limited in the scope it can operate in, as it cannot perform outside of its scope of actions, as it is only trained for one specific action. Weak A.I. are the only category of A.I. that we have been able to produce so far in time, it is arguable that the two other categories are hypothetical, but many research are currently conducted to make these types of A.I. achievable. The second category is General A.I., which is any type of A.I. that can perform any intellectual action or tasks

like a human being (Fourtané, 2019). This A.I. is expected to learn, think, understand, and perceive like a human being, which will make them multi-functional. Once this is achieved, it will take close to no time to train these types of A.I. and they will be fully comparable to humans. The third and last category is Super A.I., this A.I. is expected to perform any tasks better than humans and develop fully functional cognitive proprieties. The key characteristics that we expect these A.I.s to develop is to think, reason, make judgements, plan, learn and communicate by itself (Fourtané, 2019). This type of A.I. is often pictured in many different Hollywood films, such as “Ex Machina” by Alex Garland, but it is by far the furthest A.I. that will be achieved in the upcoming years.

1.3 Progress made in terms of A.I. & Rivalling Human

The progress made in A.I., and how it has already rivalled the human being, is the best way to understand how effective A.I. is developing. The aim is to make A.I.s be as efficient as human intelligence, and perform tasks without being supervised, with a close to 100% success rate.

The skyrocketing development of A.I. since the 2000s has enabled A.I. to perform as good, or even better, than humans in a multitude of different domains. As humans like to play games and are competitive, many different A.I. have been developed in this domain. Although the development of A.I. that can play games goes back to the late 1980s, there are still newly created A.I.s that are performing in more complicated environments. After the win of IBMs Deep Blue in a chess game against Gary Kasparov in 1989 (Aung, 2010) and TD-Gammon in 1992 Tesauro, 1995), IBM focused on different A.I.s that would be able to play more complex games. In 2006, IBM decided to innovate with a more complex A.I. that would be able to play the famous *Jeopardy!* game, which is airing on TV. *Jeopardy!* consists of a television show where three humans compete against each other in a general knowledge quiz, with one of the competitors being the champion of the last edition. This quiz consists of generating a question that asks the answer that is given, so in other terms if the competitors are given as an answer like 'Calendar date with which the 20th century began' the contestants are supposed to respond 'What is the 1st of January 1901?' (Jeopardy!, n.d.). IBM in 2011, decided to create a machine that was able to compete in this game, IBM Watson (Mullen, n.d.). This A.I. would use machine learning, information retrieval techniques and natural language to compete with humans. It was a supercomputer that was able to process 500 gigabytes per seconds, as a point of comparison it represents about a million of books per second. IBM Watson was also fed with a special feature that made it be able to be a strong competitor in the *Jeopardy!* game, it contained all of Wikipedia, and other databases, documents, books, and encyclopaedias (Mullen, n.d.). By 2011 IBM Watson was powerful enough to compete and beat humans in Jeopardy!, which was revolutionary as IBM Watson was able to understand natural language. This had never been done before and it acted as a game-changer in diverse areas of technological and A.I. development. In 2016, some researchers that were working at Google's Deep Mind, created an A.I. that was able to compete in the game *Go*. *Go* is a Chinese board game that consists of two players battling on a board to control the most territory possible. This board game, a bit like chess, has limited number of different moves that are delimited, although for Go we are talking about millions of different combinations. *AlphaGO*, the A.I. created in 2016, had been trained through supervised learning and by RL through self-play. It enabled the A.I. to be able to beat Lee Sodol, the world champion

at the time. A better version of *AlphaGO*, *AlphaGO Zero* (Silver & Hassabis, 2017), has been created in the following year. This new version was only learning through RL, after being taught the rules, and learned by self-playing 5 million games against itself. It was later able to beat his predecessor 100-0 and was performing at levels that were unexpected. *AlphaGO Zero* proved that for games, and a multitude of different domains were A.I. can be used, A.I. does not require to be supervised to learn well and perform (Silver & Hassabis, 2017). This A.I. made it believable that it will be able to save a certain amount of investments as training will not need to be supervised by humans directly.

A.I. has also been able to perform better and rivalling human in the automotive industry, as automated assistances and self-driving cars are expected to be the future. There has already been some studies to demonstrated that A.I. can be more performing than humans in many different aspects. In an article, published in 2015, Tijmen Mekel highlights the differences between computers and humans in terms of breaking distance at various speeds (Mekel, 2015). He argues that humans are about 6 times slower than computers and are less concentrated due to many distractions. If we take this into account, we can clearly see on the graph below that the difference of reaction-time makes a huge matter in breaking distances and humans are clearly being rivalled by computer in this area. Although this feature already exists in new cars and is called 'Automated driver assistance systems' (ADAS), the development of such A.I. are crucial on long-term base as it is a key function for driverless cars in the future. These features are based on RL and supervised learning, but there has also been huge development of image processing and computer vision to create these types of features (Mekel, 2015).

After the creation of Chat-bots such as ELIZA, there has been huge progresses. The development of newer speech recognition and improvement of natural language processing, companies such as Apple were able to release an A.I. called SIRI. These A.I. are the development of initial chat-bot, but evolved in a speaking version, rather than in a text version in the 1964. Other development of A.I. were also made in the healthcare sector with the development of the Deep Patient (Miotto et al.,2016). This A.I. was fed with data from 700,000 patients, that were auscultated in a hospital in New York. It was unsupervised to understand if it could draw some outcomes by itself. This A.I. was able to discover some patterns for people that could potentially have a cancer of any type. The most interesting outcome of Deep Patient was its ability to identify some psychological disorders such as schizophrenia, which is difficult for doctors to diagnose (Miotto et al.,2016). This represents a huge leap forward in terms of A.I. in healthcare.

1.4 Position of the different actors

As explained earlier, A.I. is hugely based on data that is available, as it is needed in order to train the different intelligences and machines. As a result, data generators are huge contenders on the different A.I. markets. Different leading companies of each sector are also trying to rework their business optic and are listing A.I. as one of the most important development at the C-level (Vanian, 2020). As A.I. is in every companies' mind and that it is important to develop, many companies are trying to be leaders, either of their industry or of a multitude of industries. We will identify some of the leading companies, either over a few industries or their own industry, to have a better image of the whole environment.

1.4.1. Big size companies

Amazon, the giant American multinational technology company, is the biggest player in A.I. markets. Amazon is currently using A.I. both on the customer and the back-end side, this means that they try to be present in every possible A.I. solutions. The company uses A.I. for its recommendation section for every user, for Alexa, their smart A.I. based speaker that uses voice recognition and a natural language processing engine. This speaker revolutionized the market and made Amazon generate gigabytes of data that was re-fed to the A.I. for it to be more performant every day. With the success of their A.I. creation, Amazon decided to develop a text-to-speech component called 'Polly', and a natural language processing engine called Lex, which they also sell to many companies. Amazon created their web service that helps companies to manage their IT services and it is through this service that Amazon sells its A.I.. They work with different types of companies, such as NASA or the NFL, to provide them machine learning. This is the reason that they are leading in A.I., if they sell their A.I. to corporate users it will limit the amount of competition. Massimo Capoccia, Vice-President of Infor, said "Amazon is doing it anyway, so why would we spend time on that? We know our customers and we can make it applicable to them."(Levy, 2018), this perfectly describes the strategy that American Multinational is using to stay the biggest competitor of Artificial Intelligence. Amazon also acquired many different technology companies in the past decade, which enables them to offer a more complete A.I. Portfolio to its customers. (Levy, 2018)

Apple, another American giant in the technology industry, is the second largest A.I. power. The billion-dollar company, uses A.I. through the different products they sell, explicitly focusing on the iPhones. To offer their customers many different A.I. features such as SIRI, the Apple equivalent of Alexa on their iPhones, or different facial

recognition systems (Siri Team, 2017). They have also developed HomeKit, a software that helps you keep track of your smart house through an application. They offer many different features within their own products, but they do not create and commercialize services like Amazon. They acquired an enormous amount of different A.I. start-ups in the last decade, which enables them to focus more on how to market the A.I. through their products, rather than create it. It is although important to note that Apple offers *Core ML (Apple, 2020)* to its Mac users, in order to create different machine learning models to use for image recognition and finding patterns in numerical values.

Google, the most notorious American technology company around the world, is a key player in A.I. development across various sectors. Google formed their so called 'Google Brain' team in the 2010s, which is acting as the deep learning artificial intelligence team of the company (Google, 2020). As the most famous web company, Google has been able to gather millions of gigabytes of data over their years of activity. This data enables them to be competitive in A.I. as they are in the top 5 companies that detain the biggest amount of data in the world (Nielsen, n.d.). As they believe everyone should be able to access A.I., Google produced open-source machine learning and large-scale computing resources. Google decided to invest a lot of money around the World to develop high end A.I., through partnerships with companies, communities, and universities and from different sectors (Statell, 2019). Google are also acquiring many different A.I. or technology companies to get a better competitive edge in various sectors.

Google detains many different A.I. technology companies that are subsidiaries of Alphabet Inc., Google's parent company. Deepmind, a United Kingdom based technology company, acquired by Google in 2014 (DeepMind, 2020). Deepmind created a neural network that has been used in the Gaming industry, which enabled the A.I. to perform as well as a human. They are also the company behind the creation of the AlphaGO and AlphaGO Zero A.I.s that compete in the Chinese GO board game. The company is trying to achieve great goals in A.I., as they are trying to combine machine learning and systems neuroscience to create learning algorithms.

Google has also invested in the car industry and the development of A.I. in this industry. Waymo, an autonomous car company, subsidiary company of Alphabet Inc., uses an A.I. based software for their autonomous cars (Waymo, 2020). Deepmind, was also used to help Waymo to improve the A.I. of their self-driving cars to accelerate the process of machine learning. Waymo was also the first company in the world at that time to be able to test on public roads, in Arizona in 2017 (Hawkins, 2017). This subsidiary is a promising company for A.I. in the automotive industry.

Facebook, the most impactful American Social Media company of the 2000s, can be considered as a leading company in A.I.. Facebook is one of the top 5 data generators of the World due to the billions of users over their different platforms (Zijian et al., 2014). Through this amount of data, Facebook acts as a data seller, and an A.I. creator with its Facebook A.I. Research (FAIR) team (Facebook, 2020). The FAIR team has produced some efficient A.I. in the past years, such as the creation of cutting-edge translation program that uses A.I., or bad content detectors that are able to analyse if contents need to be censored or deleted from the platforms (Wiggers, 2019). Facebook also decided to release their free open source 'Torch' deep learning module, to speed up the training of large-scale neural networks that will help to train A.I. (Facebook, 2019). Facebook also used its data to create some cutting edge A.I. such as Detectron 2, a highly efficient A.I. that can accurately detect objects and segment objects one from another (FAIR, 2020b). Facebook has also launched a partnership for their Deepfake Detection Challenge Dataset, which is their next generation of A.I. that will be able to detect fake videos, and to censor them (FAIR, 2020a). Deepfake also aims at countering the manipulation of media, to make Facebook a safer social media.

DJI, a Chinese A.I. based company, is the leading company in the manufacturing and sale of drones (DJI, 2020). Their drones are build-in with different types of A.I., such as image processing and object detection to avoid contact and accidents (Vaddi, 2019). This technology company is controlling 70% of the industry they operate in and acts as key players in the development of future technologies in the matter of drones (Kesteloo, 2017). DJI has had some partnership with Microsoft in order to give their drones the ability to use A.I. and stream their visual in real time data to be able to compute problems of what they see, such as holes in the roof of a building or a default in power lines (MNC, 2018). DJI are also working on A.I. algorithms to make their drones be autonomous and fly by themselves (DJI, 2019). This company is the biggest A.I. company in China and has an enormous potential.

1.4.2 Smaller companies

Datavisor, a leading American A.I. company that operates in the security sector (Datavisor, 2020). This company works on detecting and acting against online fraud, digital risks, and different digital attacks, with their A.I. platforms. Datavisor uses a modern A.I. architecture to manage the different threats that their customers could face, and they help them to analyse them and get rid of them (Datavisor, 2020). The main customers of Datavisor are Finance companies and the threats that they could face could be as follows: fake accounts, money laundering, and fraudulent transactions. This A.I. is a promising tool as everything is now connected and subject to frauds at all time,

as a necessity for all companies, Datavisor has an optimal solution that keeps on developing from day to day.

Casetext, an American technology company that operates in the law industry (Casetext, 2020a). This A.I., called CARA A.I., is helping the Legal consultants to look legal documents online at a faster pace. CARA A.I. operates 24.5% faster than a human being, it allows experts to go through record much more effectively, remove duplicates and rank the different information in a hierarchy based on their relevance (Casetext, 2020b). This A.I. is evolving everyday with all the cases that get fed to the system, Casetext is the future for its industry and the best research tool for the future lawyers to exercise their work in an optimal way.

Ubtech Robotics is a leading Chinese A.I. robotic company, that is a worldwide leader in its industry (Ubtech, 2020a). Ubtech sells humanoid robots that are working through an A.I. system to fulfil different tasks such as STEM skill-building robots for kids, or enterprise service robots. The robots use different types of A.I. such as facial recognition, object detection, target tracking and human pose estimation, which makes them as intelligent as possible (Ubtech, 2020b). Apple and Amazon are two of the few partners that are behind Ubtech Robotics, as this company is expanding at a fast pace.

Through the different industries and companies, we can see that most of the A.I. that is produced is often bought by a bigger technology company to increase their own features. Such companies are companies from the United States of America and China as they are the two-leading countries of the A.I. race in the World. Every industry is starting to see the purpose of A.I. and more and more are being created and sold around the different companies in the World, which makes it a hot topic in business. Although A.I. seems to be on everyone's lips, it is also important to understand how A.I. can be applied in modern business.

1.5 Application of A.I. in modern business

After being discussed for more than a decade, A.I. is finally present in modern business, even though some companies are reluctant to use it. A.I. is mostly used as a supporting tool, rather than a replacement, as it does not have the abilities yet to complete the same tasks as humans. Mainly used to process and analyse data throughout the whole business scope, it enables the decision-making to be supported in a better way to take efficient decisions.

A.I. is already used in the energy business, as it is used in the energy management systems. It collects some data from different sensors that are all around the supply lines, then processes these data base and delivers the humans with a full report on the different usages. This enables decision-making to understand better its market, as they identify the different quantities that are used. It also reports where the lines might have potential defaults and need maintenance. Markus Schmitt, from Medium, explains the different use of A.I. that are prolific to the energy industry in a three Article research (Schmitt, 2020). A company such as ABB, uses A.I. to understand what possible faults their pipelines or machinery can have. The chief officer of ABB, Guido Jouret, explains furthermore that this helps the company to save money and understand more accurately when the downtimes will happen and minimise their length (ABB, 2019).

The presence of A.I. is also crucial in the technology and cybersecurity sector, as it gets more and more complicated to look at potential failures in network defences. The number of cybersecurity experts are too limited compared to the increasing amount of problems and the complexity of these problems. According to Michael Roytman, from Kenna Security, it is already possible to train A.I. in order that they analyse if software's have different security problems. This enables Kenna Security to be able to stay ahead of potential new attacks by reworking the weakest points in the different systems (KennaSecurity, 2020). RAA Financial Advisors have also adopted A.I. in their cybersecurity defence, such as explained by John Sanborn. The A.I. analyses the different traffics on their networks and it can find an anomaly and report it in time to avoid different breaches and leak of information (Forbes, 2018).

The usage is also present in customer relationship management (CRM) systems. The use of A.I. in CRM can automate customer reports, data capture and therefore avoid high risks of human error (Commercient, 2019)(Bushnell, 2019). It is also used to understand what patterns are the most effective in terms of how to price certain products, but it also predicts future sales. Since A.I. can process data, it will achieve an accurate segmentation of customers and help companies to focus better on each category of customers. The use of A.I. also helps different companies to be more customer centric. Alan Price, from visioncritcal.com, explains that their company uses

A.I. to analyse different responses to surveys. This enables their customers to be more aware of their own customers and to be able to react in accordance to what their customers want.

The use of A.I. is also present in the finance industry as there are many different practices. For example, Underwrite.io is an American company that offers an A.I. that is calculating the different risks that are present when offering credits to customers or small businesses (Underwrite, 2020a). This company uses an algorithm that finds different patterns in enormous datasets and classifies the potential customers as 'Good' or 'Bad' in terms of status or profitability. This will enable banks or loaning companies to reduce risks of potential money loss. According to a case study published on the official website of Underwrite.ai, they analyse the efficiency of their A.I. through a real case (Underwrite, 2020b). This case is the study of a major online instalment lender and the reduction of their first payment default rate (FPD), which was initially at 32.8%. The effectiveness was calculated over 9 months, from May 2015 to January 2016, and showed that it managed to reduce the FPD from 32.8% to 6.5%. The average of FPD are at 35% for the sector, this enables underwrite.ai to stand out and act as a remarkable solution.

Healthcare is a sector were a vast innovation process is possible, as A.I. could help reduce costs, become faster and more efficient. PricewaterhouseCoopers conducted a study called 'What doctor? Why A.I. and robotics will define New Health' to understand how the whole sector is changing with the involvement of the new technologies (PWC, 2017). As assessed in this paper, A.I. is now part of our daily healthcare sector and is used in many ways, from diagnosing and early detection of illness, to treatments and decision making. A software, created by researchers in the Houston Methodist Research Institute in the United States of America, uses A.I. to predict potential breast cancer through the interpretation of mammograms. This software is arguably 30 times faster than a human, and reliable at 99% (Ackerman, 2016). This application is a great example of how the whole industry will be faster and accessible to more consumers. It will also prevent people from being diagnosed too late, as the flux of people getting hospitalised is increasingly correlated to the population growing every day.

PART 2 – The BENELUX and Japan, two different visions

This section will cover the different visions that the BENELUX and Japan have on A.I. and how the different governments are trying to promote A.I. within their country. There will be a literature review of different documents that were published by both sides, to understand the full scope of the visions.

2.1 BENELUX

The BENELUX is a politico-economic union and an international intergovernmental cooperation between Belgium, The Netherlands and Luxembourg. The BENELUX is now part of the European Union (EU) within which it represents 3.9% of the total EU population and 7.16% of Europe's PPP GDP. This ranks the BENELUX, as a union, to be the seventh biggest in population (Worldometers, 2020) and fourth in terms of EU GDP[1](Eurostat, 2019).

2.1.1 Luxembourg

Luxembourg, the smallest country of the BENELUX Union, has published a paper on A.I. called "Artificial Intelligence: a strategic vision for Luxembourg." that will be our main source of analysis to understand the vision and position towards A.I. (DigitalLuxembourg, 2019). It is important to note that due to the size of the country the development of revolutionary A.I. research is limited, as the production of large dataset is not possible. On the other hand, Luxembourg has the necessary funding, ecosystem, and infrastructures to advance in terms of A.I. and attract different key actors.

2.1.1.1Vision

According to the document published by the government of Luxembourg, in association with Digital Luxembourg, Luxembourg is aiming to have a strategic vision for A.I.. The aim of the Luxembourgish government is to be among the leading A.I. societies in the EU, and in the World. The government also wishes to "become a data-driven and sustainable economy" and they "support human-centric A.I. development" (DigitalLuxembourg, 2019). Although it misses the data creation of bigger countries, Luxembourg has a strong applied and focused A.I. research, that could be helpful for the

[1] Taking into account that the UK is not part of the European Union since the 31st of January 2020

development of different services. But as Luxembourg's A.I. research centre is working on many different projects already; it is necessary that they receive the data to exploit the full capacity of their development. To do this, the aim is to create and shape an attractive environment for data-driven and data-intensive services and activities in the field of A.I., so that they decide to come to Luxembourg.

2.1.1.2 Human-centric focus

The Luxembourgish state is aware of the existing technologies acting more as a companion technology, which means that it does not replace the human but rather it tries to assist it as much as possible. This technology should help the different workforce to work in a faster and more efficient way in complex environments and should result in humans being at the centre of all the A.I. services that are supported in Luxembourg.

As it is evident for the Luxembourgish government, the holders of the most interesting data and datasets will be able to profit from the full potential of A.I.. By creating a special strategy, the Ministry of the Economy is trying to create the best opportunities possible for Luxembourg to be a data-driven economy and attract these data-driven companies (DigitalLuxembourg, 2019).

The direct link between society and the different products and services is A.I., as it can scan through gigantic datasets in order to establish patterns. This is important for the state of Luxembourg, as the use of A.I. can be important to solve local problems, while also being accessible and actionable throughout the different industries and societies.

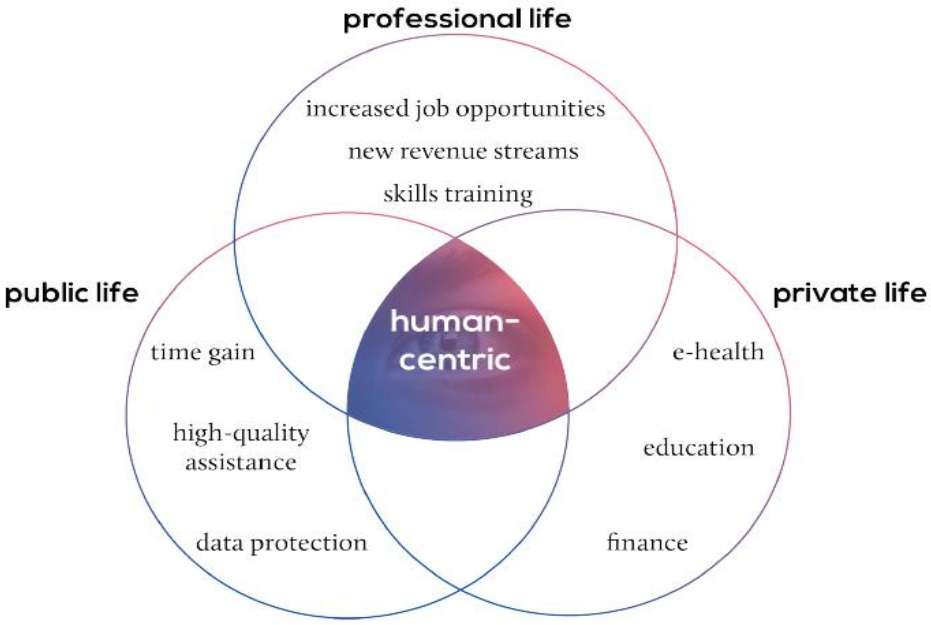
Although the Luxembourgish government wants to adopt A.I. at a fast pace, it recognises that A.I. can also welcome negative consequences. In these consequences you can find problems such as new working conditions, employment laws and different labour relations. These issues need to be addressed by the government, in a close cooperation with different social institutions and partners. It is also important that the government prioritizes Cybersecurity and Data protection, as A.I. services are directly resulting from the use of personal data. This potential negative consequence is ranked as high on the government's priority list, as it has a direct impact on the population(DigitalLuxembourg, 2019).

Like any technology, as well as having negative consequences, you also have some opportunities that should be seized. The implementation of A.I. could lead to the creation of new categories of jobs, new skill requirements and potentially to a better ramification of the labour market. It is also important that labour market policies are orientated towards the full integration of all companies, in order that no one is left behind in the transition to A.I..

A.I. is not considered as an economic-driven factor for the government of Luxembourg, but rather as a support to improve the citizens daily life. As A.I. is still young and will probably change a lot in the future years, it is important that the role of A.I. in our society is revisited on a recurrent basis by the government to stay human-centric. A.I. therefore needs to be 'understandable, transparent, and ultimately, trustworthy', whilst also being on the same level for all "the diverse stakeholders investing, working or living in Luxembourg" (DigitalLuxembourg, 2019).

To be the most human-centric approach as possible, the government wants to create policies that will affect and change the lives of citizens of each sphere. The graph below will show you the three different spheres that the Luxembourgish government focuses on.

Figure 5: The human centric approach by DigitalLuxembourg, 2019



To understand the graph, we will discuss all three spheres in separate sections below.

- A.I. in Private/Personal life (DigitalLuxembourg, 2019)

According to the vision of the Luxembourgish government, A.I. has a huge potential to improve the daily lives of its stakeholders and citizens. It can assist individuals in experiencing better mobility experiences, more efficient modes of transportation and in general a safer mode of mobility. It also offers individuals better sustainable solutions in terms of energy consumption, waste management and building efficiency, to be making economies at the same time as being more eco-friendly. A.I. will also revolutionize the healthcare sector with advancements in diagnosis and treatments of patients, but also with different tools to predict future illness, boost the efficiency of the healthcare sector and enhance its quality. This will be achievable through the new

health strategy, of the ministry of health, called E-Health. This E-Health strategy will help diagnose and treat illnesses quicker, as the diagnosis will be conducted with the help of A.I. that will go through datasets of symptoms that are like the one the patient is experiencing. It will analyse the symptoms and match them of other similar cases in the world, to diagnose the individual's illness at a record time, and give an efficient treatment to the patient. The Government is also focusing on developing improved urban life experiences through integrated and sustainable A.I. solutions, such as smart living, connectivity, or mobility.

- A.I. in Professional life (DigitalLuxembourg, 2019)

A.I. is increasingly impactful in the professional sphere, as it can be a relief for professionals. The technology is mostly used to treat large amounts of data and divide them in logical segmentations. By conducting the heavy-data task, A.I. will enable workers to focus on more human strengths, such as social relations, creativity, or cultural sensitivity. This will result in humans and A.I.s to team up to achieve better results and eliminate unnecessary situations of stress, while also being more time efficient. Unlike it is often assumed, A.I. will be present in every categories of work, in other words in highly-, low- and basic-skilled jobs. It will eliminate repetitive tasks, but it will also play a role in Human Resource (HR) by facilitating the way people are recruited. As A.I. will be used to find the best matching Curriculum Vitae. Because the companies will change, it is important that the workforce is trained for other expectations, A.I. will therefore also be used for training purposes, that can be tailored from one person to another. This will enable the workforce to be more adapted to the different expectations, while also trained in a faster way as it will be a one on one training. The Luxembourgish government is already aware of this up-skilling of the workforce and launched the 'Digital Skills Bridge initiative', which aims at doing that, while also helping companies acquire the different digital expertise to integrate these technologies.

- A.I. in Public life (DigitalLuxembourg, 2019)

The public sector will also be affected by A.I. as it will probably enable to ease the interaction between individuals and the government. There will be administrative simplification, in other words it will offer more efficient and quicker services to the citizens of Luxembourg and the people that work in Luxembourg. The government has already made the public aware that they will digitalise more and more procedures, which has started with the Guichet.lu portal that is an online administrative website. Different A.I., such as a chat-bot, could probably enhance the experience and the fastness of such a portal. The government also wants to be as transparent as possible

about their datasets, as they post them on Data.Public.lu, which gives transparency to the public but also to the different industries that want to create different A.I. services. The government is trying to bring these A.I.s closer to the citizens and ease their way through the public bureaucracy.

2.1.1.3 What is the position of Luxembourg in A.I.?

In the past decade, there has been an enormous increase in the A.I. based research community in Luxembourg. A multitude of different actors – Luxembourg Institute of Health (LIH), Luxembourg Institute of Socio-Economic Research (LISER) and Luxembourg Institute of Science and Technology (LIST) – have grown a noticeable amount in terms of A.I., showing solid and diverse deep learning competences. The Interdisciplinary Centre for Security and Trust (SnT) have 40% of their research projects that are linked directly to A.I.. The National Health Laboratory also uses the A.I. technology to diagnose brain tumours, based on molecular markers.

There are a couple of companies in the industrial sector, such as Husky or Goodyear, that are introducing deep learning in their research processes, but also in their operational processes, which will help them work in a pro-efficient way. The social listening company, Talkwalker founded in Luxembourg, is the most noticeable success story in terms of A.I. technology company created in Luxembourg. This A.I. orientated company works worldwide for B2B operations with different multinationals such as Adidas and Accor Hotels. There are also a multitude of different start-up that are emerging from Luxembourg, such as the electronic music composer AVIA, specialised in classical and symphonic music and recognized by SACEM (Société des auteurs, compositeurs et éditeurs de Musique) (DigitalLuxembourg, 2019).

Luxembourg counts on a multitude of different international partnerships to increase their involvement in A.I.. But of what is already visible, the A.I. ecosystem is alive and increasing every day. The outputs that the Luxembourgish ecosystem establishes is remarkable due to the size of the country and the different limitations that the country is facing in terms of data creation.

2.1.1.4 The areas on which Luxembourg is focusing

As we now understand why the different visions are important in order to fulfil the different aims stated by the Government earlier, we will have a look at the different areas the Luxembourgish Government decided to work on.

1. Luxembourg as a living laboratory for applied A.I. (DigitalLuxembourg, 2019)

As stated in the report published by the Government, “Luxembourg understands the importance of transferring research findings to the real World”. Their research and development centres target primarily applied research with interdisciplinary centres of excellence to accentuate their position and excel in biology, cybersecurity, networking, and trust. The focus point of Luxembourg is to unite research and application in real environments, this makes the country a living laboratory for tomorrow’s innovations.

2. Data: The cornerstone of A.I. (DigitalLuxembourg, 2019)

Luxembourg understood the importance of Data in the race to being the leading country, or union, in the A.I. race. The government has decided to transform the country into a large “European data lakes” to ease “research-enabled solutions for society”. One of the lakes has been created by the National Centre for Excellence in Research on the well-known Parkinson Disease, which has been created by a cooperation between four different research partners.

Luxembourg also pledges on an open data portal, with enormous datasets, which would be created for and used by public and private sector actors. This would enable Luxembourg to act as a high-quality data hub for researchers and different companies that would be willing to create or train their A.I. applications.

3. Ethics, privacy regulation & security (DigitalLuxembourg, 2019)

As the implementation of A.I. is facing some risks, it is crucial for Luxembourg to identify relationships between A.I. and privacy regulations, ethics, and security. A high standard of transparency will therefore be crucial for A.I. innovations. Luxembourg is therefore working in parallel with these issues to create an improve A.I.-friendly framework. New regulations will therefore be important to implement, as otherwise the ecosystem might face some high risks.

As ethical discussions are important around A.I., the Commission’s High-Level Expert group on A.I. published some Ethics Guidelines for Trustworthy A.I., that Luxembourg will encourage and follow. The link between legal, societal implications and the development of different A.I.-human collaboration needs to be invested in, to limit the different problematics that could emerge. Public research has also the power to counterbalance private research that is not prioritizing and exercising social good, to have a little control over negative creation and research.

4. Boosting investments & developing strategic partnerships (DigitalLuxembourg, 2019)

The constant investment growth over the past 15 years in international connectivity, ICT infrastructures and innovation projects, has enabled Luxemburg to engage in different strategic partnerships. The creation of Luxembourg Commercial Internet eXchange (LU-CIX), or the High-Performance Computer (HPC) are the best examples to show how Luxembourg tries to open-up to a broader range of experts and actors across the A.I.-based services and products.

The long-term investment, made by Luxembourg, has given them a competitive edge and a clear advantage to integrate new cutting-edge technologies. This investment has also enabled Luxembourg to have some of the infrastructure possible, which has helped them to attract some of the key competitors in the technology industry. There have also been partnerships between the public and private sector in order to support research and development in advanced robotics, digital manufacturing, and improve perceptual capabilities of A.I. systems.

5. A.I. for the public sector (DigitalLuxembourg, 2019)

Luxembourg is fiercely investing in A.I. for the public sector to ease the interaction between the public authorities and companies or individuals. There has already been key investments to create eGovernment and multilingual answers that could be useful for the future potential A.I. applications. This will result in improving the different ways to access public services, while also making them accessible at any hour and at any location. Public services will then be cheaper, better, and faster, while also inspiring for positive social impacts. The enhancement of the public services will also make SMEs win time, as the paperwork and delays will all be digitalised.

6. Skills & lifelong learning (DigitalLuxembourg, 2019)

As Luxembourg was investing in excellent Infrastructures for the past 15 years, they have attracted some of the best researcher and talents, which enables them to establish strong foundations in A.I. expertise. As the use of A.I. across all sectors has increased, it is important that companies re-skill or up-skill their workers as an anticipation to the need of future skills. There will need to be an incentive to offer lifelong training to the firms, workers, and unemployed, so they can assimilate the notions of A.I. and the changing labour markets. As explained earlier, the Luxembourgish government has therefore created the “Digital Skills Bridge”, to address the different potential issues that labour markets could face. Luxembourg also insists on sharing their best practices on how to retain A.I. talents in Europe, involve more women into A.I. and how to reinforce A.I. excellence.

7. International cooperation (DigitalLuxembourg, 2019)

As the focus on the latest A.I. technology is going on all around the Globe it is crucial for Luxembourg to develop and sustain regional and international cooperation.

The country acts actively in the EU initiatives and is willing to participate in all A.I.-related corporations that can be created in the EU. Luxembourg is also actively participating in the initiatives that take place in the Greater Region, which is with its neighbouring countries, collaborating to get rid of issues such as employment, mobility, and health through the development of collective A.I..

2.1.2 Belgium

Belgium, the second biggest country of the BENELUX Union and the host of the capital of the EU, Brussels, is also trying to establish itself as a leader in the A.I. ecosystem in the EU. As Belgium is a federal state, divided into three major regions, there has been a shift of power from the federal government to various actors in the different regions. Each region has their own vision and development of A.I., which complicates the development of A.I. in Belgium. The study of each region will be important to understand where Belgium lies in terms of A.I., this study will be conducted through data collected from the three different regions actors, as well as the European Commission website (EC,2019). We will then analyse the recommendations that were published by AI4Belgium - a multidisciplinary team supported directly by the Belgian Government – called"AI4Belgium" (AI4Belgium, 2019). This research paper will be our main source of analysis to understand the different developments of Belgium towards the A.I. ecosystem to be a strong actor in European A.I..

2.1.2.1 Vision

Belgium, a country with a high potential in the development of A.I. in Europe, is one of the few countries of the EU that does not have a strategy to capture the potential benefits of the new technology (EC,2019). Although there is no strategy to capture the different opportunities, Belgium is aware of the potential that A.I. has, and is ready to adopt and invest into it for the future. As explained by the Ministers of Digital Agenda, "a key force behind social progress can be technological progress, of which Artificial Intelligence (A.I.) is now one of the principal drivers." (AI4Belgium, 2019). The awareness of the government pushed them to have a positive vision of A.I. for the future, with positive social impacts. There is a growing importance to orientate the country towards a rapid development in the field of A.I., in order to not fall behind, but it is important to note that the new innovations should be used as a help for humans, and not the other way around.

2.1.2.2 Human, the primary focus

According to the report published by AI4Belgium, Belgium should primarily focus on humans, which means that they should aim at providing awareness and training on A.I.. It is also important to note that Roland Berger estimates at 840,000 the amount of new A.I. jobs that will be created by 2030, to replace 350,000 human-jobs. For about 300,000 jobs, people will have to be completely retrained in order to do their work. It is also mentioned that 4,5 million people will have to be upskilled, as the biggest impact will be at the office job level (AI4Belgium, 2019).

To cease the opportunity that shows itself to Belgium, the workforce will have to be retrained and every stakeholder should imperatively focus on developing lifelong training opportunities. This is the biggest goal for Belgium, as training is under financed and seen as unwanted by the workforce. Technological advances should also be available for the future generations, by initiating them since their youth. The learning of technology should happen at the youngest age through classes of integrated coding, use of different types of technology for a various number of courses and try to attract girls to STEM studies (AI4Belgium, 2019). Teachers should also be retrained to introduce the students in the right manner to A.I.. These different focuses on the future generation could give Belgium a competitive edge in the A.I. sector, while also keeping the focus on humans, as the technology is only a companion yet, and not a replacement (AI4Belgium, 2019).

2.1.2.3 Development of a potential data strategy

The fourth industrial revolution seems to be arriving at a faster pace than expected and Data is the raw material that everyone is trying to acquire. To deal correctly with this raw material, data regulations and strategies should be adopted by the public sectors to gain trust by their stakeholders (AI4Belgium, 2019).

As there are still discussions on whether A.I. is using data correctly and ethically, or if it is reinforcing unwanted human beliefs. The Belgian Government should be proactive to avoid these problems. To do so, the policymakers and regulators on A.I. and Digital Development should be trained to have higher awareness on the different matters to create correct laws and regulations on data for A.I.. The public sector should help to enforce the law and avoid letting A.I. be used in a malicious way (AI4Belgium, 2019). There is an increase need for companies and A.I. creators, as well as the state, to be fully transparent on the data they use and show their respect of the A.I. ethics policies. There should also be regulations and best practices on how companies and public institutions should focus on ethical matters. According to AI4Belgium, the Belgian Government should focus on creating an ethical committee that could provide the different sectors and industries, public authorities, and individuals with advice on how to deal with ethics and regulations towards A.I..

The free movement of Data is crucial to dispatch it correctly to the different users that need it for the creation and training of A.I.. At this moment in time, Belgium has a low, or close to no, movement of data as they are stacked in silos. The creation of Belgian data-sharing platforms is important to tackle this issue, and as they would be regulated by the state it would restrain the different potential misuse of the data. There should also be cooperation between the private and public sectors, this would foster the development of common standards (AI4Belgium, 2019).

These points represent the most important factors that the Belgian Government should focus on implementing an effective data strategy to foster the creation and research on A.I. and machine learning. This would help the country to gain a competitive edge and keep it in the race to be a leader in the A.I. sector with the EU (AI4Belgium, 2019).

2.1.2.4 How to implement the strategy and make it effective

The key to implement a successful strategy for the introduction of A.I., within the Belgian ecosystem, will follow some crucial steps. According to the report published by AI4Belgium, to adopt A.I. effectively the government needs to "support private sectors, innovate and radiate, and improve public service and boost the ecosystem". By following these focal points, it should enable Belgium to implement A.I. effectively. We will now discuss each section of this strategy to understand what they all mean and need in order to be implemented in the best possible way (AI4Belgium, 2019).

The first step for an effective implementation of A.I. strategies, is to help the private sectors and the population to adopt A.I.. Artificial Intelligence is considered as a potential way to improve products and services, whilst helping them to become cheaper. It is important to provide to the different sectors and individuals the minimum of awareness and potential that emerges from using these technological advances, as it is one of the biggest limitations in Belgium. To ensure this awareness, the Belgian government should create a Massive Open Online Course (MOOC) in the first place, like other EU states like Finland or Estonia have already done. This would potentially enable a certain percentage of the population to access training. This training would potentially attract people towards the use of A.I., rather than creating a reject, as people that are aware of the possibilities and opportunities are often more likely to use the different technologies, such as A.I.. These should be followed by events that would promote the success stories of different Belgian A.I. companies or start-ups. While also setting up different financing programs for projects that have positive social impacts using A.I.. Secondly, the Belgian state should aim at bringing the whole community together, by creating a country-wide hub, which would help all the different stakeholders to be able to create collaborations. This hub should be certified as a European Digital Innovation

Hub, as it would be supported by investment made by the EU and could help to be the link between the Belgian A.I. and other EU A.I. communities. By linking the different communities with the Belgian Hub, it would also enable the different actors to share common building blocks. These building blocks would be technological, such as Law firm working together on the development of Natural Processed Language (NPL), which would lower the costs for innovators as they would be shared. It is also important to create common A.I. trainings in order to involve all the different actors, from the provider to the companies, without forgetting about the academics and government institutions, in order to make sure that every stakeholder has the same knowledge while sharing training costs (AI4Belgium, 2019). Thirdly, it is important to support Small and Medium size Enterprise (SME) with different financing to trial the use of A.I. and understand what the company could benefit from using such a technology. The Belgian government should also support every candidature of Belgian Small and Medium size Enterprise for European financing program, as the first barrier to A.I. is often investment. By promoting the use of these European programs, the Belgian state enables its SMEs to transition towards A.I. with less barriers.

The different institutions in Belgium, such as universities, start-ups and research labs have proven a multitude of times that the capacity of innovation is present in Belgium (AI4Belgium, 2019). In comparison, to all the other European countries, Belgium also faces difficulties to retain their A.I. talents at home, while also having difficulties to grow the different A.I. orientated businesses. There are a multitude of solutions to face these problems and there needs to be an increase in support of the private sectors. Belgium should first try and position itself as a European A.I. Lab, where other governments and stakeholders could come and test their solutions. The Belgian Government would offer the different tools to test the solutions, in other words, the Government would create A.I. sandboxes. These sandboxes would promote the adoption of A.I. in the private sector, as less investment would be required to access A.I. creations and solutions. Another complementary solution would be to implement an alliance between the Belgian laboratories, or to create an A.I.-lab that would be functional over the whole country to enable better collaborations between privates (AI4Belgium, 2019). Secondly, the Belgian state should try and promote the creation of different higher education A.I. programs, such as A.I. bachelor and master orientated programs. This would enable Belgium to create a horde of Belgian A.I. experts, which is crucial to become a stronger player in the EU. PhD students should also be offered the possibility to work with private and public sector companies on A.I. applications. There could also be an initiative to create shorter study programs to gain A.I. skills, such as programmers. This would also enable to have skilled A.I. workers increasing in Belgium, which would lead towards an upskilled workforce. There should also be an incentive to ease the different regulations in terms of student VISA, as it should be promoted to attract A.I. talents towards Belgium. Thirdly, to make Belgium more attractive for start-

ups to scale-up, it is necessary that the public and private sectors invest jointly to enable this growth. This should also be matched by the EU, as the problem of upscaling start-ups is a recurring problem within the whole EU. Belgium and the EU could also focus on bringing a specific type of expertise to the World, with expertise in ethical-by-design applications. This means that their expertise would be sufficiently important to enable them to have an advantage over other countries on this type of A.I. (AI4Belgium, 2019). It would also create an important inflow of stakeholders that are focusing on this expertise, as it would become a go to.

As every country, in Belgium it is expected that A.I. will improve the development of public services. Public services should become easier to access, faster, cheaper, and better with the use of new technology. They will also give the opportunity to the public force to focus on other services that can give a competitive advantage to Belgium (AI4Belgium, 2019). To offer the best services to every stakeholder it is important that the public force is trained and pushed towards the transition to A.I.. To do so, there should be an increase in public investment for experimentation of A.I. in public sectors and mass training opportunities. It is crucial that this transition happens fast, as otherwise Belgium might fall behind in the race to be a global A.I. competitor. The public sector should also transition towards management of different platforms to manage the ecosystem, rather than provide services. These services could be fulfilled by other actors that work in cooperation with the public sector. They should also appoint a Chief Digital Officer (CDO) to manage all these challenges and changes to supervise them, the CDO should also be the linchpin in the collaboration of all the actors within Belgium and foster further development of the research side of A.I., by connecting academics to A.I. Labs and Hubs.

2.1.2.5 Reaction of the different regions

As explained earlier, Belgium is a federal state and there is an increase need for a multi-level coordination to be able to achieve good results in the sector of A.I.. Each region has reacted in their manner to A.I., we will therefore have a look at all the different initiatives that have been taken.

2.1.2.5.1 Flanders

The Flemish government has taken the matter of A.I. seriously, they have launched the Flemish Action Plan to promote A.I. in Flanders. This action plan is more an investment plan that will help companies and A.I. actors to access higher amounts of financing. In addition, with the €56 million provided by both the Fonds voor Wetenschapplijk Onderzoek (FWO) and VLAIO, the Flemish Action Plan grants another

€32 million of their annual budget for A.I. implementation (EC, 2019). These €32 million are expected to promote the implementation of three different pillars that the Flemish government identified: €12 million will be used to promoted Basic Applied Research and development of A.I. applications; €15 million for 'Technology Transfer and Industrial Application' while helping the private sector to transition towards A.I.; the €5 million that are left will be used to support all the A.I. activities through awareness, training and increase of the expertise in A.I. ethics (EC, 2019).

2.1.2.5.2 Brussels Capital

Brussels Capital is the region that is undoubtedly the most developed, as it has been focusing on A.I. for a longer period of time than the other two regions. The first A.I. call, Team Up, to foster the collaboration between academia and the industries has been backed up by Innoviris, an innovation fund that amounts to €20 million (EC, 2019). This shows that Brussels Capital is trying to join research and innovations since 2017, by helping different actors to collaborate. The collaborations have been shown to be successful as 19 projects have been funded with €12 million of subsidies. Recently most projects that were funded are in specific sectors, like promoting A.I. for predictive medicine or for the industry 4.0. In 2018, Brussels Capital also introduced a program called 'Anticipate', which is supposed to fund projects that analyse the impact of A.I. on society, in a social and economic way. This program helped the region to understand what ethical, social, and economical problems A.I. could bring, which is needed in order to create an ethical strategy to limit negative impacts. Different tools are also offered by the Brussels Capital region to help the different companies to promote the development of A.I.. There is also a focus on training and bringing more awareness of A.I. to STEM students, but also to promote the involvement of women in A.I. (EC, 2019).

2.1.2.5.3 Wallonia

The Walloon region of Belgium came up with their own program, DigitalWallonia4.ai, which discusses the four different objectives that Wallonia should aim to achieve to consolidate their position in A.I.. The first objective of DigitalWallonia4.ai aims to bring A.I.-awareness to its citizens, businesses, and public authorities, through a set of resources, in order to foster the usage of A.I.. The second objective is to promote the usage and awareness of A.I. in companies. To achieve this, DigitalWallonia4.ai offers Start A.I. and Tremplin A.I.. Start A.I. offers a three-day program to coach, by an expert from DigitalWallonia4.ai, companies in terms of A.I. (DigitalforWallonia, 2019). Tremplin A.I. aims at enabling companies to understand whether, or not, it is achievable for them to implement A.I.. The third objective is to provide two different training programs, that should be accessible by anyone, to build

awareness and expertise on A.I.. The fourth objective of DigitalWallonia4.ai is to promote partnerships to be an A.I. leader in Belgium. Wallonia is focusing on accelerating the adoption of A.I. through these four objectives.

2.1.3 The Netherlands

The Netherlands is the biggest country of the BENELUX Union, with a population of 17.28 million (Worldometers, 2020), and is aiming at being the best EU A.I.-orientated country. As a country that is recognized as a leading in information and communication technologies, the Netherlands represents the pillar of A.I. in the BENELUX area. According to Forbes: from the 2000 companies in the ICT sector, 60% have operations going in the Netherlands, due to good infrastructure, as well as competitive taxes (InvestinHolland, 2020a). Their awareness on digital technologies gives the Netherlands a strong position on the development of A.I.. The Government from the Netherlands published, in 2019, a "Strategic Action Plan for Artificial Intelligence" (Gov.nl, 2019). We will use this source as primary source to understand where A.I. lies in the Netherlands and what vision it expresses towards this technology.

2.1.3.1 Vision

As the Netherlands is advanced in ICT, and its excellent infrastructures, the country is willing to be a leader in the A.I. technology, therefore they need to have a long-term vision. The government of the Netherlands understood the strategic benefits that such a technology could have on the growth, prosperity, and wellbeing of the country. There is a belief in the Netherlands that the winner-takes-all or the lagers need to be dependent of the advanced countries, which could have different impacts on the country (Gov.nl, 2019). The long-term vision on A.I. by the government is therefore to adopt A.I. as soon as possible and get rid of societal issues, such as aging population, healthcare, and climate change. Although the government is aware of potential threats that A.I. has on society, that they need to closely monitor, the country could create an outstanding performance in the new technology. The reason of this potential is that many pilots of development and promotion of key technologies, in the EU, regularly come from the Netherlands (Gov.nl, 2019).

2.1.3.2 Societal and economic focus

The Netherlands have a focus on A.I. for its societal and economic benefits that it could offer the country. The reason why it has such a huge potential is because the technology can be applied to any sector. According to an Ernest Young report on A.I. in the Netherlands, 86% of companies believe that A.I. will have a huge impact on their sector (EY, 2019). The application of A.I. would offer better performance in terms of healthcare diagnosis, and other healthcare matters, which is a must for society, but it could also enable to improve public services. There is a direct impact on the logistic sector, that is enormous in the Netherlands, as well as being a key force in the development of self-driving cars. The manufacturing industry could also benefit from A.I. through a combination of A.I. and robots, which would have a long-term economic benefit. These different factors are the reason the Netherlands want to be leading in the A.I. sector (Gov.nl, 2019).

2.1.3.3 The strategic plan to implement A.I.

In order to act accordingly, to grow and be a dominant force, the Netherlands draw the different tracks that they should follow to be able to implement A.I. in an efficient and effective manner. The strategic plan to implement A.I. published by the Dutch government, is divided into three different tracks that should help the Netherlands to be dominant in the field of A.I.. This would be achieved through the capitalisation of societal and economic opportunities that show themselves to the Netherlands, to create the right conditions to cease these opportunities and to strengthen the different existing foundations to foster the public to promote the usage of A.I (Gov.nl, 2019).

The first track of the Strategic Action Plan for A.I. (SAPAI) published by the government of the Netherlands is the capitalisation of the country on societal and economic opportunities that A.I. offers. The strong and well-developed Public-Private Partnership (PPP) that is present in the Netherlands is crucial as it enables the country to focus better on societal challenges. The way it works is that the government creates the right conditions for innovation in A.I. and its implementation in every sector, public as well as private. Then the companies need to innovate in order to help the Netherlands to be competitive and innovative, this will allow the Netherlands to be the difference in terms of A.I. (Gov.nl, 2019). The government also created the Dutch A.I. Coalition to make the private and public sector join their efforts to cease the different opportunities. These corporations would enable the Netherlands to use A.I. in different sectors, such as the Security sector for justice, security, and defence. The cooperation would also promote A.I. in other sectors, such as the healthcare sector, the agri-food sector, the energy sector as well as the mobility and logistic sector. As A.I. could challenge all these sectors, it is also important for the Government to use A.I. optimally in the different

performances of public tasks to challenge the private sector to innovate. To do so, the government will have to make sure that the different public servants have sufficient expertise and knowledge of the technology, as A.I. must meet high standards (Gov.nl, 2019). The government needs to implement ethical, effective, and transparent A.I. that meet these high standards, as it must be value-based designed and respect the public values. Once the government has understood how to implement correctly A.I. and limit its negative impacts, it will share its knowledge with the private sector to help them integrate properly A.I. in their organisations. There is also a crucial need that the different government bodies are working jointly to facilitate the transition to A.I., by reducing existing barriers, together with the sharing of datasets including different information. There is also an increasing need that the government works with different organisations such as universities, as it can bring knowledge to different governmental agencies and help the transition towards the use of A.I.. The government is also experimenting different types of A.I., such as in chatbots, decision and translation algorithms, but it fosters the private sector to innovate more in terms of A.I., so that the government can have better A.I. technologies. The government also invests considerably, €73.3 billion, to encourage the private sector to develop different A.I. systems that can be used in the public sector. The public sector is composed of companies of all sizes and most of them are already working with deepening their knowledge on A.I. and how to implement it well (Gov.nl, 2019). There is although a government initiative to promote the creation of more A.I. start-ups and scale-ups, that are mostly focusing on the development of A.I. business software, marketing, care and fintech. The government has therefore unlocked a budget of €65 million, so that the entrepreneurial sector can be stimulated correctly. The Netherlands understood correctly that A.I. start-ups need to be heavily invested in, as otherwise they will not be able to scale-up fast enough to have an impact internationally on A.I. markets or networks.

As the Netherlands seem to understand how they need to cease the different opportunities that are available with the use of A.I., it is important that they create the right conditions to promote and support A.I. (Gov.nl, 2019). The second track is therefore directed towards the creation of these different conditions in the Netherlands. Research is therefore the most important aspect of A.I., as research is the condition to create a successful A.I.. The Netherlands are therefore creating a system that is trying to stimulate fundamental and applied research, through the development of A.I. labs. There is also an initiative of the Ministry of Education, Culture and Science to invest into a supercomputer, which will help to conduct further research in some specific areas. By increasing their activity in the research of fundamental and applied sciences, the Netherlands are trying to be leading in the EU in terms of A.I. knowledge centres. The Netherlands are also willing to increase their cooperation in terms of A.I. with the EU, as they are trying to increase the visibility of their A.I. Labs and knowledge centres (Gov.nl,

2019). The Netherlands are part of the Confederation of Laboratories for Artificial Intelligence Research in Europe (CLAIRE), which gives the cooperation between the Netherlands and the EU an important position (CLAIRE, 2020)(Gov.nl, 2019). The Dutch A.I.-related projects are also hugely- financed by the EU through the European Horizon 2020 program. It is also expected that there will be more investment in the upcoming years, as the importance of A.I. is growing in the agenda of the European Commission (EC) and the EU. As well as the different cooperation, the Netherlands should also focus on giving better training, knowledge and promote opportunities to acquire more A.I. talents. As it is expected that A.I. will change the way workers work, it will be important to upskill them in order for them to achieve their work the best way possible and in accordance with the new technology (Gov.nl, 2019). There will need to be increased training in terms of A.I. specific skills, through public and private investment. There is also an increasing need to involve the workers with the development of A.I. to create an inclusive labour market. Furthermore, there is a need of increasing the educational system to train the future workforce in accordance with the future technologies (Gov.nl, 2019). The Netherlands are currently facing a capacity issue in Universities, since there are not enough lectures and funds for students to be able to study A.I. and computer science. As there is an increasing need for both male and female A.I. experts, universities should focus on creating more spaces to develop a higher number of experts. Even if the capacity issue would be fixed, there would still be a high number of experts and data professionals that would still not match the demand. Therefore, there is also an increasing need to attract foreign A.I. experts and promote ICT as another important direction for students that cannot access A.I. expert courses. It is although also important to prepare the future generation of pupils for the Dutch government (Gov.nl, 2019). There will be an increased focus of ICT skills, information skills and computational thinking in primary and secondary schools. This will help the future generation to have the skills to understand, develop and cooperate with A.I.. As pupils will be faced with A.I. earlier in their life, there is an expectation to create a generation that is promising for the future need in A.I. experts, where the Netherlands are trying to act as a role model. As data is as important as A.I. experts, it is important for the Netherlands to focus on an amount of quality data, rather than low quality data that increases the risks of inaccuracy of A.I.s. There needs to be an increase in the promotion of Findable, Accessible, Interoperable and Reusable (FAIR) data, as it offers a good framework for the standards, the trainings, and tools for every specific sector. The Dutch government also promotes the reuse of the provision of the public sector information, using overheid.nl (Gov.nl, 2019). There is also an important increase in the need to share data in a better way. Data sharing between companies, the government, or other institutions, should become more common through responsible data sharing principles or regulations established by the government. The Netherlands are also pro-European Data Space, which should increase the possibility of exchange of data across boarders in the EU, to promote A.I. projects and to develop them at their full potential. Thanks to

one of the best connectivity in EU, the Netherlands are one of the few countries that are ready to test A.I. products and services at a big scale. The government released a Connectivity Action Plan, in 2018, to describe the future steps to ensure that the Netherlands keep a leading position in connectivity across the EU (*Connectivity Action Plan*, 2018). The introduction of the new 5G network being one of the key focal point. The 5G network will enable the Netherlands to be the perfect place to test innovative A.I. applications, that need constant connectivity, such as self-driving cars, or remote surgery. The connectivity network will also undergo certain changes, as it will be transformed towards an Intelligent Connectivity that will be regulated by A.I.s (Gov.nl, 2019). This will enable the telecommunication lines to directly adapt in case of changes in demand, while also improving the networks quality and the customers experience. This would make the Netherlands a paradise for testing A.I.s, as their network lines would be as optimised as possible for such testing's. As well as being in advance in connectivity, the Netherlands are constantly monitoring the increase in demand for computing power. There will most likely be a need to increase the computing power that is available, as there is a daily increase in the complexity of the tasks that computers are demanded to execute. The Netherlands are also fully committed to cooperate with other members of the EU to join their forces to research and innovate in terms of HPCs (High Performance Computing), which is expected to start in 2021 with the Digital Europe Programme.

The third track of the Strategic Plan for the Netherlands is an increase in its foundations to capture the opportunities and limit the potential risks. The increase of data flows and A.I. application in society rises many questions on whether this new technology is respecting the public values and human rights (Gov.nl, 2019). In the Netherlands this is an important matter and the government showed that there is an important increase in importance that effective implementations are conducted by legislators to frame the new technology. There are also different regulations, at a European or national level, that act to protect human rights, such as the Global Data Protection Regulation in the EU, or the Equal Treatment Act present in the Netherlands. To achieve such a goal, it is important that every institution, public or private, are fully transparent on the way they use A.I.. A legal framework needs to be drawn in an ethical way, while also promoting trust of the different stakeholders, as it is important to the successful development and application of A.I. (Gov.nl, 2019). To do so, the Netherlands are trying to stimulate public and private forces to join the High-Level Experts, from the EC, to draw ethical guidelines for A.I.. The Netherlands should also promote to develop only responsible A.I., which means that these A.I.s are benefiting people and ensuring that the human rights are protect. By promoting trust, the Netherlands will have an advantage as the population will be praising new technologies and the transition towards using more and more A.I. will be achieved in a faster and easier way. The government is calling for an increase in research on different topics and the Netherlands

Organisation for Scientific Research is investing €2.3 million on research towards exploitability, socially aware and responsible A.I. (Gov.nl, 2019). This research will be used to develop and apply better responsible A.I. standards, but also to promote further trust. On top of research, the government should focus on auditing the different A.I. that potentially have high impacts on society, legal consequences or if human intervention is limited as the A.I. is working on its own. This effective supervision is crucial to limit the risks within the Dutch society. To conduct this activity, the establishment of supervisory authorities will be crucial, but they will be supervised themselves by higher public authorities. This will enable the government to make sure that the supervisory authorities have the right expertise and tools to supervise the different algorithms, or whether there are many obstructions to the supervisors. It is also crucial that the legal framework has a clear view on identifying who is liable in case of damage using A.I. (Gov.nl, 2019). The Netherlands will implement this factor in their legal framework and are expecting the European Commission to introduce a liability issue framework in the upcoming years. As well as implementing trust, the Netherlands needs to be able to compete in the different markets to promote the use of its A.I. and achieve to be a leader in this industry. It is therefore important to ensure that A.I. markets are competitive, there needs to be an increased implementation of competition laws. The reason for this is that enormous online platform markets, and other companies, tend to have too much power which limits the entry of new SMEs. This unfair competition as the entry barriers are too high to promote innovation and development of more performing applications. The Netherlands established, through the help of the Authority for Consumer and Markets (ACM), a dedicated digital competition team that is made of lawyers, economists, experts, and data scientists. This team will be able to develop expertise on how new technologies and business models have an impact on competition. This way, unfair competition can be detected and limited (Gov.nl, 2019). Consumer laws and the enforcement of them should also be the primary focus for the Netherlands, and the EU, which is why the Netherlands "accepted the Directive on better enforcement and modernisation of EU consumer Law". These directives will ensure that A.I. will not bias certain choices that are taken by the buyer, as A.I. can examine patterns in the way consumer buys and influence them to buy different products by taking advantage of this pattern. It is therefore important to protect the consumer, as without the use of A.I. in certain situations, consumers would not behave the same way towards buying certain goods. The usage of A.I. in this manner is seen as an unfair commercial practice, but it is crucial to create a legal framework to punish these types of practices in the Netherlands, moreover in the EU (Gov.nl, 2019). On the other hand, the Netherlands are also working towards the protection of Intellectual Property of different companies that develop A.I.s. The Dutch government is always closely monitoring what developments are being made in terms of Intellectual Property and A.I. in the EU, and in the World. The Netherlands complies with the European Copyright Directive, to limit what text and data mining activities can be carried out by research organisations. The Dutch government

has also adopted the most recent guidelines on patentability of A.I. that have been established by the European Patent Office, to protect the intellectual properties that are created in the Netherlands. As well as the consumers and the A.I. creators, the state needs to protect itself, its citizens, businesses, and different government entities. To do so, the Dutch government is conducting some research on how A.I. could potentially have negative impacts on national security, economic security, and cybersecurity. On the other hand, there are also increased incentives to use A.I. to develop better cyber defences, as research are being conducted by the Cyber Security Council, but also for other entities such as the army.

2.2 Japan

Japan, the advanced Asian technological country that contributed to most of the Digital Revolution of the 20th century, has for goal to stay in the leading front of technological innovations. The role played by Japan in innovation is enormous and still present as of today, this is visible as the number of international patents applications of Japan is of 66,968 in 2019 (METI, 2020). This makes Japan the third country in terms patents application, and the first country in terms of patents per capita. In 2016, the Japanese government established their A.I. Technology Strategy Council to understand how Japan should tackle the next innovations (FoL, 2020). In order to do so, the government came up with the idea of the Society 5.0, where Japan transitions towards a smart society, where everything is connected through the Internet of Things (IoT) and most technologies are implemented across all sectors (SCTS, 2017).

2.2.1 Vision

The Japanese government understands the importance of transitioning towards a strong A.I. nation, as it could bring benefits to society, to the economy and to the human beings. The human-centric vision that Japan promotes is expecting A.I. and humans to live in harmony, but also to respect the human rights and autonomy (SCTS, 2017). There is also a strong vision and incentive, promoted by the government for the Japanese stakeholders, to focus on research and development activities to propose unique solutions to the whole World. In the document on R&D guidelines proposed by the Japanese Government, there is an increase need for A.I.s to be balancing the potential benefits with the potential risks, as both facets will always be present. The vision of Japan is therefore to be actively present in the new technology, as they are

expecting to be ahead of the competition and that it would benefit its population (SCTS, 2017).

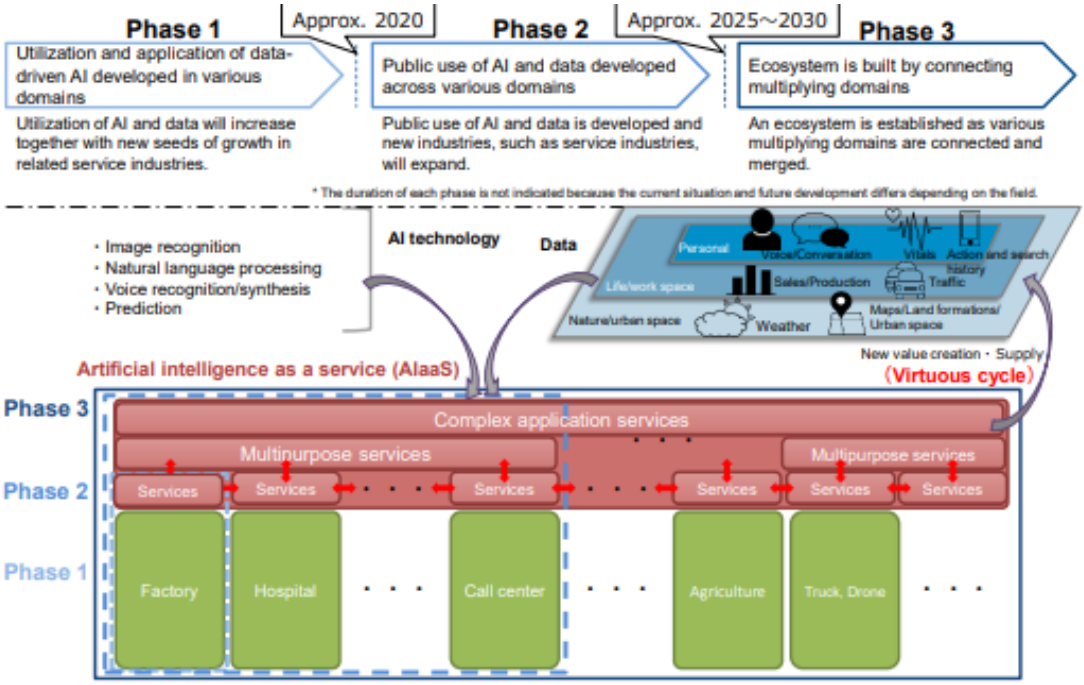
2.2.2 Japan's A.I. Technology Strategy to be successful

As Japan is aware, the combination of A.I. and other technologies could result into new products and services that could be used to eradicate social issues (SCTS, 2017). To lead the World in terms of A.I. and the use of A.I. in various industries, Japan needs to capitulate on the different advancements it already has due to its technological development. There is also an increasing need to for the different stakeholders, such as academia, industry leaders and the government, to cooperate, to make research and development be implemented into society. The Japanese Strategic Council for A.I. Technology published a paper, "Artificial Intelligence Technology Strategy" that introduces all the different ways A.I. will be implemented to set Japan as a leader in A.I. (SCTS, 2017). The A.I. Technology Strategy is divided into five different sections, that all treat the different ways the strategy will be implemented, from the implementation in industries to how to foster start-ups.

The Strategic Council of A.I. (SCoAI) has establish an Industrial Roadmap for various industries. This roadmap is giving the Japanese companies an idea of how A.I. needs to be merged with other technologies that are available in Japan (SCTS, 2017). The fusion between the different technologies is expected to focus on resolving different social issues that are happening in Japan. It is also important that Japan tries to keep a competitive edge in terms of A.I. use in industrialization, as the country is dominant in on-site strengths. The different stakeholders also need to coordinate to transition from research to the application of the different findings that Japan creates (SCTS, 2017).

The SCoAI have analysed A.I. as a technology that is purely a service, in other words "A.I. as a service" (AIaaS). The use and necessity of AIaaS is cross-domain and only depends on the various data that is available to be used and combined. The implementation of the use of A.I. in Japan is therefore divided into 3 different phases, as shown in the graph below.

Figure 6: The Strategic Process for A.I. in Japan by SCTS, 2017



The different years that the phases are supposed to transition from one to another are purely theoretical, as there are different limitations that could delay the transitions. It is also important to note that different industries might develop faster than others due to higher access to different data and expertise. The Strategic Council is also aware that A.I. could expand to nonindustrial activities, but to rather more business or resource saving purposes. Different data and technology environment are purely base on the different phases and depend on them (SCTS, 2017).

To tackle the implementation of the industrialisation road map the best way possible, the Japanese Government and the Strategic Council for A.I. Technology decided to focus on three different areas. These three areas are: “productivity”, “mobility” and “health, medical care, and welfare”. There has also been active talks to discuss whether they should “information security” as fourth area (SCTS, 2017).

The first section focuses on how Japan should focus on R&D and what directions the different policies should be taking. As the Government has three different research centers, Center for Information and Neural Networks (CiNet), RIKEN Center for A.I. Project (AIP), and A.I. Research Center (AIRC), it should focus on in a priority way. These centers have the advantage to be working jointly and to develop advancement for the private and public sectors at a fast pace. Research with various objectives are currently being conducted on practical applications and on fundamental technologies (SCTS, 2017). Although the three different Research Centers are coordinating and helping the research to develop at a national level, it is important to note that they will work on themes that cannot be monetized on short-term by the private sector, themes that are in cooperative domains, or even themes that need constant approach such as the implementation of basic research to social level. It is still important to note that the

three different centers will not be able to do all the R&D that will be covered by Japan, but they will act more as hubs, or help to jointly established projects between the public, private and academical sectors. There is therefore an increasing need to have deep collaboration between Academia, the Private Sector, and the Government (SCTS, 2017). It will enable to access increased investments in R&D, but also in academia. The government is also fostering companies to invest into academia and R&D centers as it will help Japan to stay in the competition to be a leading country in A.I. as their R&D will be well developed and able to innovate. Research and Development will be actively needed in Phase 2 and 3 of the A.I. development process published by the Strategic Council of A.I. Technologies (SCTS, 2017).

Secondly, there is also an importance in fostering Human Resources (HR), as there is shortages of A.I. experts and active personnel in different fields, such as computer science or problem-solving areas. The SCoAI understood correctly that there will be an increasing need of A.I. experts through the different phases of its A.I. Development Phases program, which is why there is a need to enable Japan to acquire an increasing number of A.I. experts (SCTS, 2017). In order to attract and retain such personnel, the Japanese agency identified different ways in which the three R&D centers should change to resolve this problem. The R&D centers should offer more attractive salaries and work environments, but also make the experts work on attractive content and foster joint research partnerships. There is also an increasing need to promote exchange of A.I. experts through the collaboration of academia around the world or external research centers (SCTS, 2017). Japan also understood that there is a need to change it educational system to make it match the societal requirements of personnel, which is a problem that is currently being talked about by the government.

Thirdly, as Data is relevant for every A.I. Nation, Japan is focusing on data maintenance in different areas that are key sectors. The three different R&D centers should therefore be able to collaborate well with each other to utilize the data to best match the social and sectorial needs. There should also be an increase focus one stablishing a system that would be able to maintain and manage the data, as it would be able to identify the necessary data for each actor and provide it to them in the best possible (SCTS, 2017). This would limit the overload of different institutions that are currently acting as manager and maintainers of A.I.. Japan is also focusing on including the Private Sector into promoting and utilizing data, the *Basic Act for Promotion of Public and Private Data Utilization* was therefore enacted. This act is establishing regulations in order to foster this Data collaboration and distribution. The SCoAI is although aware that there a specific danger to the utilization of private-owned and personal data, this will need the development of specific rules in order to avoid any problems arising from the use of this type of data (SCTS, 2017).

Fourthly, as there are many negative impacts of A.I. that are being pointed out, it is important for Japan to promote understanding of the new technologies and how its development will help society (SCTS, 2017). A.I. has an enormous potential to the economy as well as to the industries, will also be hugely beneficial to society as it will have important impacts on mobility, healthcare, and other sectors that humans need. Development should also be fostered at the maximum level as the way to understand A.I. and analyse it in order to understand all the subtilities of it acts. There is also a really important factor, the different stakeholders need to understand that the performance and safety of the different A.I. technologies is often related to the Data used to create them and the environment they operate in. There should therefore be an increase in the understanding of the different stakeholders of the A.I. technology in order to limit the different negative impacts it could have on the different users.

Lastly, the SCoAI focuses on the support of Start-ups to promote innovation in the new A.I. technology (SCTS, 2017). Large companies are hinted to invest in start-ups through which A.I. innovations are being create, as larger companies are often big actors in the funding of smaller ones. Start ups also need to be active in helping larger corporations to resolve certain problems, as the creation of different technologies could solve them. There is also an enormous need to match A.I. experts that are in the innovation sector with management actors, as often there is a lack of management in order to commercialize the new innovations, as larger companies are not always willing to invest in order to develop new innovations (SCTS, 2017). The Strategic Council of A.I. is therefore pressing on the importance to match both skills, which seems to be one of the key aspects for start-ups to be more successful and go on with innovation.

As we understand the different vision that each country has towards the strategic implementation of A.I.. It is now important to understand how to foster the start-up ecosystem to innovate on a big scale in order to give the different countries a competitive edge in the new A.I. technology.

PART 3 – The start-up ecosystems

3.1 Start-ups

In the fast changing World we live in, there is an increasing number of entrepreneurs raising daily (Entrepreneur, 2017). This rise promotes the different business environments to change dynamically on a regular basis and has shorten the different lifecycles of services and products. This is done through the setup of a company that is trying to innovate through a service or product that does not yet exist. As we can see through an article published by Check Warner, 'The Explosive Rise of The Entrepreneur', we can understand that there is an increasing number of entrepreneurs around the UK (Warner, 2019). The European Commission is although warning that only 37% of Europeans would like to be self-employed, 'compared to 51% in the US and China', which means that entrepreneurship should be promoted (EC, 2020).

3.1.1 Definition

Many definitions have arisen over the past decade, as the term start-ups is used by many politician, media, and business individuals. There is although a concept that is being shared by many definitions, start-ups are 'founded by one or more entrepreneurs to develop a unique product or service and bring it to market.' (Fontinelle,2020). It is a company that is 'working to solve a problem where the solution is not obvious and success in not guaranteed' (Robehmed,2013) which is why high financial and success risks are often likely to happen as the business is still in the initial or starting phase. Start-ups are therefore often seen as huge players for innovation but limited in success as their scale-up is based on the amount of investment they are granted, as well as the demand from the markets.

3.1.2 The different types of Start-ups

As Start-ups are being created around the World, by millions of different entrepreneurs, there has been a trend that can be identified in order to categorise the different Start-ups types. According to Steve Blank, an American Entrepreneur from Silicon Valley, there are six different types of Start-ups that can be drawn as follows: Lifestyle Start-ups, Small Business Start-ups, Scalable Start-ups, Buyable Start-ups, Large Company Start-ups, and Social Start-ups (Blank, 2013). Only four of these different Start-up types will be relevant for us, as Lifestyle start-ups and Small Business Start-ups are

not directed towards technological developments and A.I. in any way. These two types of Start-ups are more orientated towards living of a passion or feeding the family as goal.

Scalable Start-ups, according to Steve Blank, are created by entrepreneurs that believe that their innovation will change the World and the way we act (Blank, 2013). This type of Start-ups 'tend to group together in innovation clusters' around the world and 'look for more venture capital to boost their businesses'. They have scalable business models that will enable them to scale at a fast pace and often try to hire the best and most talented workers. Many of the different American Multinational Tech companies were born through Scalable Start-ups, such as Facebook, Google, or Uber.

Buyable Start-ups are created to be sold to bigger companies in a small amount of time as they are often innovative in Web and Mobile solutions (Blank, 2013). This type of Start-up is really appealing to many entrepreneurs as the goal is to create a multimillion-dollar company that will be sold to bigger companies for an enormous amount. They create an innovation that challenges the bigger companies by creating direct competition with them, which will end up acquiring the competition in order to stay competitive themselves. We could use Instagram, a 13-employee company, as an example for Buyable Start-ups. This social media was created to create a competitor to the giant Facebook, after a couple of years and it was bought by Facebook for $1 billion.

Large Company Start-ups is the type of start-ups that makes bigger companies must be innovative to retain their customers (Blank, 2013). To do this the company has to adapt to the different change of customer tastes, innovative technologies, legislations, and the different potential new competitors. This forces big companies to innovate with new products and services, as otherwise their life expectancy will be reduced drastically, as there will be a lack of adaptation. Example of such companies are in abundance, such as Netflix adapting its business to the new Internet Technologies in order to change from DVD rental company to offer a streaming platform, which adapted with the new technology. Google also had to adapt its business with the Android system helping it to step in a different sector and adapt with the technological advances. This type of start-ups represent well the innovate or die way of today's business world.

Social Start-ups have a vision that goes against Scalable and massively money generating Start-ups, as it focuses on creating a product or service that will help the world to be a better place (Blank, 2013). As they are not financially orientated, this type of start-ups often offer their product or services to the entire world in order to make it evolve at fastest pace possible. This will enable innovations to have a positive social impact, such as *Babban Gona* an agricultural start-up that helps to support the expansion of the Nigerian agricultural sector. As well as helping the sector to grow in order to feed the most people possible, it also focuses on training the future generation in terms of Agricultural knowledge which will help future generations over a long-term view.

As we can see though the different types of Start-up categories, there are various start-up categories that could be interesting in order to establish A.I. Start-ups. It is therefore important to understand what different sectors are the biggest in the BENELUX and Japan.

3.1.3 The different start-up ecosystems

Start-ups are active in all the different sectors that are imaginable, although depending on the business trend that is going on, they are more active in certain sectors. We will therefore analyse the three most active sectors in terms of start-ups for the BENELUX are and Japan. This will help us understand what sector the different countries are focusing on in terms of innovation and what edge it could give them.

Luxembourg has a well-established Start-up ecosystem that helps start-ups to scale-up and get the best information and help possible to do so. Through the institutional supports, such as the House of Startups, the House of Entrepreneurship, and Luxinnovation (Gov.lu, 2020). There is also a high number of incubators, accelerators and innovation hubs that are present on the Luxembourgish territory, compared to the size of the country, which facilitates the development of Start-ups. Big companies such as Deloitte, PWC, and EY are also providing corporate programmes and service target to support the different Start-ups that are being created in Luxembourg. There are also different funding programs, such as Fit4Start, that are available to Luxembourgish start-ups to scale-up faster and access the financial needs that are required to start (Gov.lu, 2020). The five biggest Start-up sectors for Luxembourg, according to the data provided by Luxinnovation, Fintech, ICT, Healthcare, Mobility and Cybersecurity are the five dominant sectors in terms of Start-up. Throughout the whole start-up ecosystem, Luxembourg has more than 350 different start-ups that are active on its territory.

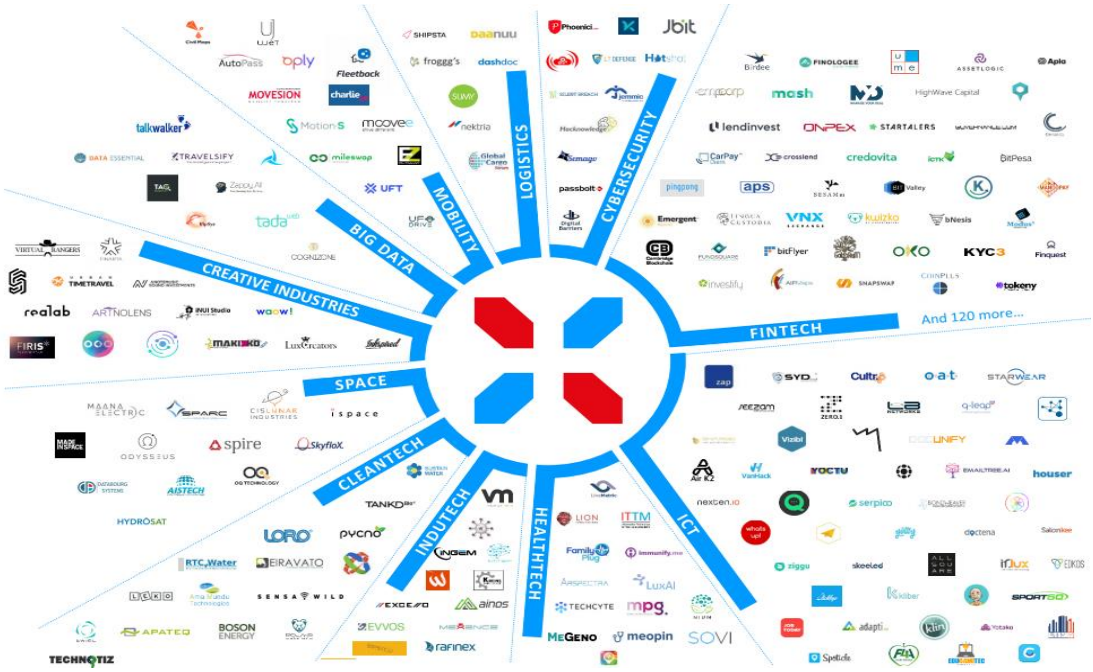


Figure 7: The Luxembourgish start-up ecosystem, by Gov.lu 2020

Belgium also has a well-established start-up ecosystem, although it is divided between the different federal states within Belgium. The whole of Belgium counts around 3300 start-ups that operate in different sectors, with Tech being the most important sector in terms of start-ups, it is followed by financial services, advertising, healthcare, and manufacturing (Startups.be, 2020). Belgium also has a good supporting system for start-ups, as according to statups.be it has around 270 start-ups hubs around the whole country. It also counts more than 500 investors, with actors such as BNP Paribas Fortis that funds many different start-up projects (BNP, 2018). Brussels is the most dominant of Belgium in terms of start-ups, it is also arguably one of the best places to be for business. According to a Survey conducted by PWC '*European Start-up Survey*', 90% of the respondents were considering Brussels as a good city to be in with their start-ups to do business, and 87% of the respondents said they would not consider leaving the capital city of Belgium (PWCPress, 2019). It places Brussels as the third best city for start-ups in Europe, behind Stockholm and Amsterdam. It put Belgium in a good position in terms of innovators, which strengthen its position across the other European Nations.

The Netherlands is a leading country in terms of innovation and start-ups within the European Union. According to *Invest in Holland*, the Dutch ecosystem is vibrant and collaborative in order to innovate the best way possible (InvestinHolland, 2020b). The Netherlands counts more than 70 incubators and accelerators across the whole country, and about 6,000 start-ups. This positions the Netherlands as 3rd best country in the EU, according to the 2019 *Global Innovation Index*, and seems to lead innovation in Europe with more than 10 leading innovation Hubs (InvestinHolland, 2020b). The Dutch Ecosystem is also valued as 4th in terms of combined value of all its Start-ups, just in front of France, for the period between 2013 and 2019, as you can see on the graphic on the left.

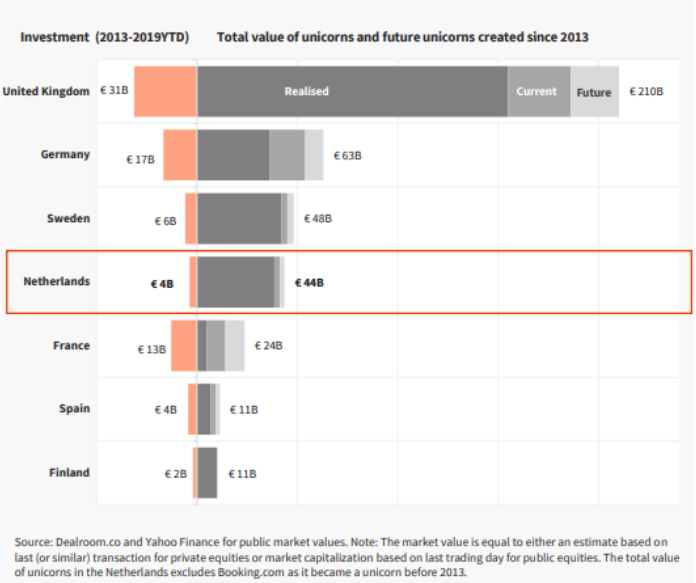
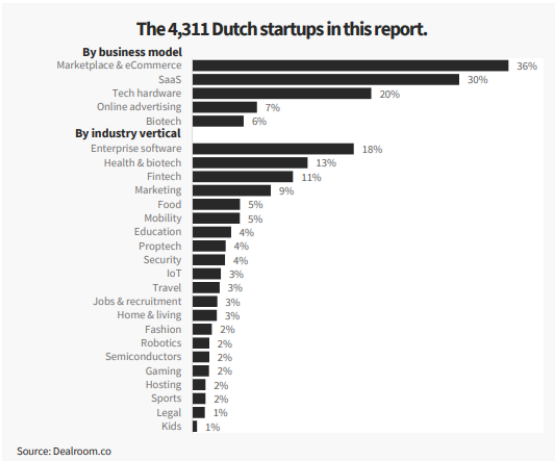


Figure 8: Total value of unicorns and future unicorns since 2013 by Dealroom.co

Figure 9: Classification of Dutch Startups by Dealroom.co



According to dealroom.com and TechLeap.NL, the most important Start-up sectors by industry for the Netherlands are Enterprise software sector, Health & Biotech, Fintech, Marketing, and Food. As seen on the graph produced by Dealroom.com, we can also see that 30% of start-ups operate in SaaS and 20% in tech hardware developers (Dealroom, 2019).

Japan is also a solid start-up ecosystem, counting over 10,000 start-ups (J-Startup, 2020) that are constantly challenging the different business barriers in order to innovate the best way possible. Japan is currently trying to position itself as a dominant force in terms of start-up players, with three cities standing out as undiscussable hubs: Tokyo, Osaka, and Fukuoka (Brochu, 2020). These three cities offer Japan the best possible start-up ecosystem, with start-ups operating in various sectors such as robotics, fintech, software service and consumer service. There is also an enormous government

program that is financing the different start-ups across Japan to enable them to scale-up to World players. This is being done through the program called J-Startup, that is directly supported by the Ministry of Economy, Trade, and Industry (J-Startup, 2020). There are also about to 50 accelerators and incubators around the country to enable the start-ups to scale-up faster and cooperate with different actors. Some cities in Japan have also lowered taxes in order to foster the creation Start-ups across the country, while also increasing the number of A.I. related start-up supported by the Government through the Strategic Plan to transition to a society 5.0.

The different ecosystems for start-ups, either for the BENELUX or Japan, are all in a healthy and growing stage. All the countries have the healthcare sector in their top sectors in terms of start-ups, this is due to an aging population that is growing in both regions. This problem is seemingly being improved through the development of start-ups that come up with innovative products and services to fight the rising issue. We can also assess that all the different countries are also focusing on FinTech, which are Financial Technologies that are supposed to improve and automate some of the financial services, mainly used by companies to manage better their financial operations, lives and processes through the use of software and algorithms. We can also understand that each region is focusing on scaling-up their start-ups in order to have a competitive edge in the production of a certain type of product and services. The two different regions have also some public funding and help in order to foster the creation of different start-ups. Japan and the BENELUX also both have some attractive cities that are considered as hubs for start-ups which give them a good international recognition.

3.1.4 A.I. Start-ups

As explained in a report written by Roland Berger, '*Artificial Intelligence – A strategy for European startups*', multinational and international companies play a small role in the innovation and development of Artificial Intelligence (Roland Berger, 2019). The development of A.I. is done by academia, laboratories, digital platforms and by start-ups. Start-ups are the main actors in many A.I. development, such as NLPs, automate driving and image recognition, which are the three main categories of A.I. that have been developed until now. By establishing a good environment for these types of A.I. start-ups it will give the different countries economic and social competitive edges as they will be leading the new technology, instead of being a lager that must live of other countries' findings. As this is the new start-up type that everyone is talking about, it is important to define the term in order to understand what can be defined as A.I. start-up.

As we have defined the term Artificial Intelligence in Part 1.2.1 and the term Start-up in Part 3.1.1, we can have a good vision of what the definition of A.I. Start-up could be. The definition that we will use in order to define the companies that are considered as A.I. Start-ups will be as follows: 'A.I. Start-ups are companies created by one or multiple research orientated entrepreneurs that sell a solution to a problem using an entity that is able to receive inputs from an environment, process and learn from the inputs, and give an output of behaviours and actions that will help to achieve a goal over time. A.I. Start-ups should also be companies that create hardware to support other companies to develop A.I., but also companies that offer A.I. consultancies in order to help different clients.' In other terms, A.I. Start-ups will be entrepreneurs that create an innovative product or a service using an algorithm that will be able to give a solution to a problem, but also companies that create hardware and consultancies for companies that use and develop Artificial Intelligence.

3.2 Common Sectors for A.I. Start-ups

3.2.1 Healthcare sector

The healthcare sector is known for its operations in the medical services, the manufacturing of medical equipment and medicines, medical insurance, and the facilitation of healthcare to the different potential patients around the World. Like the other industries, the medical industry is on the verge of changing at a fast pace due to the new technological innovations that are being created using Artificial Intelligence. As the new technology is getting as sophisticated at achieving the same performances than humans, more effective as machines do not think and feel, quicker and operate a lower cost than doctors and surgeons. There are multiple ways that healthcare can actively change the healthcare industry and improve the lives of all the different citizens around the World. As data is booming in the World, McKinsey&Company argues that there is more and more data available for the healthcare industry, which results in a more precise and sophisticated use of A.I. in this sector.

According to PWC published a document called 'No longer science fiction, A.I. and robotics are transforming healthcare' in which they draw out eight potentials benefits of A.I. in the healthcare industry (PWC, 2017).

The primary focus of A.I. in healthcare would be to provide every citizen an A.I. that helps them to stay healthy and avoid going as often to the doctor (PWC, 2017). There needs to be improvement of the Internet of Medical Things and the different health applications on different platforms that can be accessed by the different people. The tracking and coaching of such applications could help people to live in a healthier way by promoting better behaviours. This would also give the user the opportunity to understand how to have control over its health and its well-being. Such applications would also offer doctors a better daily feed of what has happened and what needs are changing for every patient. By having this data, it will be easier for the doctor to give a feedback that is more adequate to every patient to guide them towards a healthier lifestyle and support them in their journey.

The second focus of A.I. in the healthcare industry would be to help doctors to detect certain illness, such as cancer, and it would provide a more early and accurate diagnosis (PWC, 2017). As breast cancers are often wrongly diagnosed, one in two according to the American Cancer Society, would be lowered as A.I. would give results 30 times faster and with a rate 99% of success (Griffiths, 2016). There could also be different types of products, such a wearable, that could be combined with A.I. in order to help doctors monitor potential heart diseases or other illness in a better way. This

would help the entire population to be safer and treated in a better way of potential future problems.

Thirdly, Artificial Intelligence could also be able to help diagnosis and understand better what symptoms correspond to what sickness (PWC, 2017). IBM Watson has therefore been used to help the medical sector, as it is able to process, review and store millions of papers and bytes of data. This enables IBM Watson to be effectively faster than any humans to link different symptoms to a specific illness that has been talk about in any related medical document. Google DeepMind Health is also working with the healthcare sector by working together with all the different stakeholders to solve healthcare problems (GoogleH, 2020). A combination of machine learning and powerful learning algorithms in neural networks which can imitate the human brain.

Artificial Intelligence is also taking part in the decision making, this is done using big health data and the use of predictive analytics. This could be used to draw potential problems through recognitions of different patterns, such detecting early schizophrenia or mental issues (PWC, 2017).

Treatments are often hard and complicated to fully understand, this is where A.I. could play a role to help clinicians take better comprehensive approaches to manage disease and treatments better (PWC, 2017). It would also coordinate care plans in a better way, while helping patients to manage better and adhere to their treatments. It is important to understand that robots have already been present in the healthcare for at least two to three decades, helping execute, or execute by themselves, some surgeries and help different patient through rehabilitation. There could be a further innovation to combine these robots with A.I. and enable to conduct further services.

As human live longer than the previous generations and that the end of life care is getting more and more important. We are facing different and slower ways of death, like heart failure and osteoporosis, which can lead to increased medical care. It is also a phase that elderly people often go through by themselves and endure heavy moments of loneliness. A.I (PWC, 2017). could be used to revolutionize the end of life care as it could help people to remain independent for a longer period, which in turn would lift some pressure on the healthcare sector as less people would need to be in elderly houses or hospitals. With the different advances in terms of NPL and other humanoid features, it could also be possible to create robots that would entertain conversations with elderly people in order to keep their mind sharp and avoid the feeling of loneliness.

Artificial Intelligence should also be used for research as it could enable the development of drug research and discovery, which could end up in cutting costs and reducing the time that it takes to develop a drug (PWC, 2017). According to the California Biomedical Research Association, it takes up to 12 years on average to travel from a laboratory to the patient, 5 of 5,000 drugs are getting to the human testing, and only

one makes it to the approval of human usage. This whole process costs around $359 million for the development of each drug from the laboratory to the patient (CBRA, n.d.).

Lastly A.I. could be used in training, this means that A.I.s can be trained to draw different scenarios from a large database to challenge a learner to solve. The A.I. will then be able to remember the different answers and base its future training according to the different answers which would continuously challenge the trainee to improve and train in areas where the A.I. discovers lacks understanding. This training could also be accessed anywhere and at any time, as it could be programmed to be accessible on smartphones or on a computer (PWC, 2017).

As we can see Artificial Intelligence has a huge potential in the healthcare sector as a general concept, it is now important to understand what these key challenges and improvements could mean to the BENELUX and Japanese regions.

3.2.1.2 BENELUX

The BENELUX are an aging population with 18.9% of the population being above 65 years old, which represents 5,540,199 individuals (Demographics1, 2018)(Demographics2, 2018) (Demographics3, 2018). The result of an aging population is that there is a higher need for a better development of the future healthcare sector as the population lives longer and are touched by more complex illness. According to OECD data we can therefore see that the healthcare spending per capita also varies from $4766 in Belgium to $5288 in the Netherlands, with Luxembourg being in the middle with $5070 (OECD, 2018). This places the BENELUX union as top countries in the OECD ranking, whilst also being above the OECD36 average, which could be a result of their population aging and that there is an increase need of investing in order to keep this population healthy. The healthcare will therefore need to focus on technologies that will be able to help treating age-related diseases and introduce attractive solutions that will not be rejected by the population.

The Netherlands is the leading country in terms of Healthcare sector in the BENELUX area, which gives them a competitive edge compared to its neighbours in terms of innovation in A.I. based products and services. According to the Euro Health Consumer Index (EHCI) we can see that the Netherlands has a robust healthcare sector throughout Europe, as it ranks as 2nd of the 2018 EHCI edition (EHCI, 2018). This means that the most Nordic country of the BENELUX area offers its customer the 2nd best healthcare clinical services of the EU. The Netherlands is also home to approximately 3,100 health and life sciences companies, that employ a robust 34,000 people. The country is also helped by a great healthcare infrastructure and research centres such as:

‘12 research universities, 85 hospitals, 112 outpatient clinics and 50 public-private partnership between science, industry and government’ (Healthcare NL, 2020). There should therefore be a heavy focus on the healthcare sector to develop A.I. Start-ups, as it could be one of the best players in Europe. The Dutch population is also technologically orientated and welcoming for innovation, especially in e-health and different medical software. Another important factor for the success of the Netherlands in the healthcare sector is the relocation of the European Medicines Agency in 2019, from London to Amsterdam (Healthcare NL, 2020). This will strengthen indirectly the Dutch ecosystem and will boost the attractiveness of other companies to join the Dutch Ecosystem.

The Netherlands being attractive for the healthcare sector has around 40 A.I. active start-ups in the Healthcare sector (Traxcn NL, 2020). Many different start-ups are most active in Medical Imagery, such as Kheiron medical that uses machine learning in order to develop and offer intelligent tools that will be able to help the radiology department by improving the consistency, efficiency and accuracy of the image reporting. This company has been funded up to $22 million by different investors such as Atomico, Hoxton Ventures or even Greycroft Partners, which are all Venture Captial firms that aim at developing entrepreneurial innovations (Traxcn NL, 2020).

Another Innovative A.I. Start-ups, such as SkinVision that offers its customers a mobile software that is able to detect skin-cancers by regularly taking pictures of moles, red or white spots (Traxcn NL, 2020). Feeding the pictures to the application will analyse the pictures and detect non-conventional growth of certain moles or spot and alert of a risk of cancer. The different report will be directly sent to the different healthcare providers who will have a clearer view of what is happening, whilst not having to consult every patient in person but by keeping record overtime over a software. This eases the number of patients that a dermatologist would have to see every day and it will enable to focus more on the important cases that need a lot of attention. This A.I. start-up located in Amsterdam has beed funded with $13 million by different companies and venture capital firms such as LEO Pharma and PHS Capital.

Lastly we will talk about ScreenPoint, another medical imagery A.I. Start-up that focuses on using big data, machine learning and deep learning in order to detect early breast cancers (Traxcn NL, 2020). This company focuses on a specific issue, as breast cancer is one of the most frequent cancer for Women, it analyses mammograms and breast tomosynthesis that will help the A.I. to effectively detect potential breast cancers. This company has been funded by Siemens and Oost NL at an amount of $5 million as it is seen as one of the most advanced and important A.I. start-up on the Dutch territory.

On the other side Belgium is ranked as the 5th best country in terms of healthcare services by the EHCI ranking (EHCI, 2018). This means that it is the second force in terms

of healthcare sector in the BENELUX region and has a workforce of around 130,000 people in the general hospital sector (Healthcare BE, 2017). These 130,000 are from all around the scope of activities in the hospitals, from care to administration, without forgetting paramedical workers. These workers are split among 103 general hospitals around the entire country. The report with key data in the Belgian Healthcare indicates that 20% of the stays in the Belgian hospitals are from patients between 55 and 70 years old, which shows that there is a deep problem with the aging population (Healthcare BE, 2017). There is also a Belgian federation of the medical technology that counts around 200 companies affiliated to beMedTech (BEMedTech, 2018), which employ around 16,820 people thought the sector. This movement is trying to help Belgium to innovate in medical technologies and enable Belgium to take a good position to give the best healthcare, in terms of quality and accessibility, possible to its citizens. According to the report published by the beMedTech, we can assess that the dominant products in terms of medical technology in Belgium are the medical devices – consumables, closely followed by medical equipment and systems, and implants (BEMedTech, 2018).

Belgium is although an innovative country as it has a strong start-up ecosystem, it should therefore also capitalise, like its neighbour's country, on A.I. start-ups in the Healthcare sector. It currently counts around 40 A.I. healthcare start-ups (Traxcn BE, 2020). There has already been some great innovative A.I. start-ups in the healthcare industry in Belgium, such as the Biocartis Start-up that was founded in 2007 and funded with $320 million dollars, now employs around 400 people around the world and is used in various locations such as Liverpool in order to get the right drugs for the right cancer patients.

We will focus on younger companies that are still in a start-up phase, such as IcoMetrix a A.I. software that is capable of analysing brain MRI images (Traxcn BE, 2020). It detects atrophies and lesions, which are then provided as supportive material to physicians to diagnose and monitor different sclerosis. It also provides other services such as neurological image analysis that is for different clinical trials. This Belgian A.I. start-up has been funded with $20 million by different venture capital firms, such as Capricorn Venture Partners and Optum Ventures.

Another A.I. start-ups in the healthcare sector that is on the right path for innovations is ArtiQ, which is a spin-off company from the University of Leuven, Belgium (Traxcn BE, 2020). This start-up provides different pulmonary diagnosis solutions for the various medical professions. The A.I. based software offers help in order to interpret the different pulmonary function tests and mixes it with the patient medical record, which will give a better clinical report and a better diagnosis of the disorder. This start-up has only been funded by $1 million dollar, but as it was founded in 2019, the potential is still high for its future development and maybe more funding in the future.

Luxembourg, placed 7th in the EHCI ranking (EHCI, 2018), is the smallest market in the BENELUX area as it correlates with the total population of the country. The country is in the best in terms of life expectancy which shows that the population is being taken care of well and that the population has a healthy lifestyle. The country counts 18 different hospitals and is expected to increase, as the government plans to increase the Robert Schuman Hospital group (Healthcare LU, 2017). In 2017 the country was counting 3 doctors per 1000 capita which is below the average of 3.6 per 1000 capita at the time (Healthcare LU, 2017). This is a result of a lack of training in medicine in Luxembourg and creates a dependence to foreign doctors. On the other hand, there is a high amount of nurses with around 12 nurses per 1000 capita, which 4 nurses above the average. The Luxembourgish healthcare system cannot offer all the various services to its customers as it not economically effective to do it inland, which results in making its citizens go to neighbouring countries for certain illness treatments. Although the development in the healthcare sector is important, Luxembourg has some possibilities in order to act as a living hub for A.I. start-ups to test their products and services in the Luxembourgish healthcare sector. For example, the Luxembourgish group of hospitals, Robert Schuman Hospital, is partnering up with Hanalytics Sarl in order to pilot the testing of an A.I. based system called BioMind (LuxTrade&Invest, 2019). This system is active in the analysis of radiological images to analyse neurological disorders to diagnose brain tumours or stroke conditions. It generates a full report for the doctors to review, and all this in a few seconds as it uses enormous datasets from which it compares the images to understand what is present on the scan that it is given tot analyse. This could be upgrade in the future to analyse other body parts and used in a various amount of ways. Luxembourg is currently suffering from imagery specialists and radiologists; this new program could compensate for that shortage. It would help the healthcare sector and lighten the schedules of doctors that must work in order to compensate the lack of these professionals.

As there is no considerable efforts in terms of A.I. Start-ups in Luxembourg now, LuxInnovation is trying to set up a Luxembourg HealthTech Cluster in order to bring all the different actors together. This is an initiative to foster cooperation in research and development in terms of A.I. in the healthcare industry for the Luxembourgish sector, but also for the whole of Europe. For the time being, Luxembourg is acting more a testing environment on a small scale, rather than an innovator in terms of A.I. in healthcare.

3.2.2.2 JAPAN

Japan, much like many developed countries, is facing a problem of a constantly aging population with 28.38% of its population being older than 65 years old (Demographics 4,2018), which is why the health expenditure per capita is increasing yearly with $4766 in 2018 (OECD, 2018). In 2016, Japan was counting 8,442 hospitals and 101,529 clinics, with a workforce of 2.35 doctors per 1000 capita and 9.06 nurses

per 1000 capita (Healthcare JP, 2018). This means that Japan is under the average of 3.02 average of doctors per 100 captia at the time but is above the average of 8.3 nurses per 100 capita at the time (Healthcare JP, 2018). The healthcare markets and sector are therefore expecting to expand at as a fast pace, as countries with aging population need to invest heavily into healthcare infrastructure and workforce. There is also an increasing need in training more doctors as Japan is facing the same problem as Luxembourg, as it needs doctors to come from abroad to compensate for the lack of doctors. The trend of the population aging has been going on for over two decades and has made the Japanese population aware of this issue, which enables them to transition towards a more preventive medicine and nursing care, especially with an emphasis on age-related illness (Healthcare JP, 2018). Although this is a burden for Japan, it leaves great opportunities for different business opportunities to be developed. The government is also acting in order to foster the development of these opportunities as there is a clear economical and societal gain from ceasing these opportunities.

Japan counts therefore more than 200 A.I. healthcare start-ups across the whole country and is trying to cease all the opportunities that are showing up (Tracxn JP, 2020).

The most well-known start-up so far is called A.I. Medical Service, it proposes an A.I. based system that will analyse the endoscopes images provided from the clinical setting (Tracxn JP, 2020). These images will be processed by the A.I. and will be able to provide a full diagnostic report on the different cancer-related lesions of the digestive organs. This A.I. Start-up has been able to raise $57 million from venture capital firm such as World Innovation Lab, Sony Innovation Fund and Globis Capital Partners.

Another Japanese A.I. healthcare Start-up called CureApp is focusing on providing an A.I. based platform to its consumers in order to help them treat their addictions and health vitals (Tracxn JP, 2020). It offers a mobile application that will help their consumer to have a healthier life, by helping them to quit smoking. The consumer can enter a various amount of data to explain how much he smokes and at what basis and the application will calculate through an algorithm the best way to support and help its patient to stop smoking. There is also a possibility to send the data to a doctor in order to have a medical follow up of the situation. The company also focuses on other area, such as HERB-App for the management of blood pressure; NASH-App for the treatment of liver illness; and ascureSPARX that offers different mental health programs that enable the consumer to train their cognitive system. This start-up has raised $39 million through venture capital funding firms such as Iwahagin Business Creation Capital, Beyond Next Ventures and SBI Investment.

Japanese start-ups are also betting on online platforms to telemedicine as it could be easier to interact with elderlies without having them to come to the hospitals (Tracxn JP, 2020). Port Medical and Information Technology Medical are therefore both working on online platforms that will enable telemedicine to grow into a new process to

do online auscultations. It will also enable to lighten the hospitals and the doctors, in order to let them focus on more important cases that need care in physical presence. The recent pandemic has also enabled Japan to focus on future start-ups to produce different robots for the healthcare sector. The robotic company called Mira Robotics has received a multitude of enquires since the beginning of the pandemic in order to create robots that could be used in future Japanese healthcare sector for a various of human like activities.

3.2.2.3 Comparison of the healthcare sector

As the BENELUX healthcare sector is a promising healthcare sector and established as one of the best and most dominant in Europe. As it is facing the same problem of aging population as Japan, but a smaller scale, it is important for the BENELUX area to cooperate closely with Japan on this issue. An effective cooperation could be a win-win situation as both countries would benefit from each other's expertise, whilst also enabling to cut the costs of research. Both regions have different A.I. start-ups in the healthcare industry that are focused on improving Imagery analysis and both promote a preventive medicine that is trying to help the population to be diagnosed better. Both regions also have great healthcare infrastructure and different experts to direct great R&D over the next decades.

On the other hand, there are many differenced between the two different regions. The most noticeable difference is the amount of funding that Japanese companies are getting compared to companies from the BENELUX. This is mostly due to the enormous activity of American companies in Japan and their close business links with the US. We can also assess that the BENELUX are is much smaller than Japan, as its population represents one fourth of the total Japanese population. This makes the BENELUX better for small scale test trials on a small amount of population before implementing the new technologies all over bigger countries like Japan. We can also see that the BENELUX are is providing more health expenditure per capita, but on the contrary Japan is investing more as a total as the country counts a far bigger population.

As conclusion we can argue that the BENELUX healthcare sector is positioning itself as a strong contestant in terms of A.I. Start-ups, but more collaboration is needed. Luxembourg should act as a bigger funding country that could give more opportunities to A.I. start-ups from Belgium and the Netherlands to scale-up and become worldwide contestants. This is due to the missing of opportunities to create proper A.I. healthcare start-ups in Luxembourg, due to its small population. The amount of research and creation of A.I. start-ups for the BENELUX are good compared to its size, it is also notable that there is 2.07 A.I. healthcare start-ups per 1,000,000 habitants, while Japan has 1.58 A.I. healthcare start-ups per 1,000,000 habitants. This shows that the development of

A.I. healthcare start-ups in the BENELUX is a strong opportunity that it should cease, and it could also become a leader. As many developed economies are facing the same issue of aging population the BENELUX could become leader in providing this type of A.I. Worldwide.

3.2.2 FinTech Sector

Technology has been present in many different financial institutions for a long time, as it played a key role in digitalisation of many different operations. The path of the different technologies progress goes from the first ever ATM for Barclay's bank customers, to the digital NASDAQ digital stock exchange, without forgetting more recent online banking and e-commerce business models (ZIGURAT, 2020). The development of FinTech has been continuous since the 1980s and is still evolving daily in today's financial sector. After the global financial crisis of 2008, many people started having distrust in the existing banking sector, which enable the FinTech sector to evolve at a fast pace and create new players in the sector. Crypto currencies being one of the players, with the release of Bitcoin in 2009, followed by many others in the following years. The development of other technologies such as smartphones and the Internet has also enabled the FinTech industry to diverse itself through different ways of executing financial transactions, anywhere and at any time (ZIGURAT, 2020). Smart wallets have therefore been created in 2014 with the introduction of the Google Wallet and Apple Pay which both offer their consumers to pay through their phones, rather than in cash or by card. The evolvement of the FinTech industry is often portrait as the killer of banks and the existing financial sector, as they seem to be competing for the same market share, but on the contrary they need to work jointly as much as they need to compete with each other. Ultimately FinTech start-ups are in crucial need of banks, as they are their primary funds, as well as banks FinTech start-ups also need insurances and back end partners in order to deliver their products and services (Zhao, 2018). Banks are now also ultimately creating, or acquiring, their own FinTech start-ups as it helps them to leverage on new technologies and to upgrade their already existing services.

In order to understand the position of the BENELUX union and Japan on this new technology, it is important that we understand what is considered as a FinTech company. FinTech companies, as explained by Iryna Bulygina, 'provides software or technology solution for the automation of financial services for the business and customers' (Bulygina, 2018). So in other words, FinTech companies offer their customers and businesses a new digital way to operate financial services, such as: lending, payment and money transfer, budgeting and personal finacance management, equity financing, robo-advising, blockchain and cryptocurrencies, and digital banks.

Fintech has therefore changed the whole banking industry as online banking came as a response to increasing numbers of FinTech companies (Builtin, 2020). This requirement became a key feature for every customer that has a bank account, as they want to have access at any time and any where at their bank account. It is also necessary that it is accessible through mobile devices, as banks are shifting from desk-banks to an

online service where you do not need to get into contact with any human being. There is also the increase in NeoBanks, these types of banks do not have any physical branch that a customer can attend if they have questions or want to conduct an operation (Builtin, 2020). These banks are fully online, they offer their customers the same advantages as normal banks, without having the struggle of opening a desk in any location.

Cryptocurrencies & blockchains are expanding in parallel with FinTech and are not considered to work in the same sector (Builtin, 2020). Although there is that belief, their cooperation is crucial in order to offer new financial and disruptive financial services. Cryptocurrency and FinTech can offer customers a brand-new experience compared to traditional banks. They can offer the customer the possibility to use a currency that is digital through an online platform with which it can do everything like a normal bank.

FinTech has completely disrupted the concept of investments and savings, as an enormous number of investing and savings apps have appeared (Builtin, 2020). These apps have broken the barriers that were created by banks. This enables anyone to be able to invest on any market at any time, but also of any amount as dollar investments are becoming common. Customers are also able to use these types of apps as saving services, as they act as financial institutions.

The combination of ML and trading is the final goal of Fintechs companies, as they can create an algorithm that is able to spot different trends on stock markets (Builtin, 2020). It is also able to spot, using enormous datasets, potential risks that are rising in investing in a specific stock. This is changing the way trading is being done and gives the opportunity to anyone to be a trader, as the amount of analysis necessary to invest is shrinking.

The way to do payments has also completely change through the creation of these FinTech platforms, as it is easier than ever to send money digitally. Companies such as Paypal or Stripe, enable customers to pay for any product, service or digital good online without having to enter bank details, but just through log-in details (Builtin, 2020).

The entire lending system has been reworked through FinTech as applying for a loan is now also available on smartphones, and in an easier way. This offers many different populations to access loans, which they were maybe not able to before. There are many different features that calculate the different risks through different data points, which enables the company to understand whether they should lend the money (Builtin, 2020). It also enable a whole new level of transparency for everyone through the creation of this lending service

As we have now a clearer view on what a FinTech start-up can operate in, we will now analyse how the BENELUX union and Japan have adapted to this technology. We will also analyse if these two regions are acting as FinTech developers in any way, or whether they are not adapting to the new technologies.

3.2.1.1 Benelux

Luxembourg, according to the Global Financial Centres Index 24, is amongst the top 3 country in terms of financial centres in the EU (LFF, 2020a). It has been reported to be the best worldwide in finance connectivity according to McKinsey MGI Connectedness Index 2016 (LFF, 2020a). This gives a good view of the place finance takes in Luxembourg, as the whole country is evolving around the financial sector. The sector offers a various amount of diverse financial services that enable to link investors and markets all around the Globe. It Is therefore important that Luxembourg embraces the future and adapt its financial sector to the new innovative FinTech, as it is playing an enormous role in the modern financial industry. In order to do that, Luxembourg decided to create a dedicated national platform called the Luxembourg House of Financial Technology (LHoFT) who is charged to build and foster the FinTech in Luxembourg (LFF, 2020b). The role of the LHoFT is to bring together financial institutions, the new Fintech innovators, academia, research, and the public authorities. By doing this, LHoFT will enable the development of different FinTech products and services that will match the industry needs. The various sources of private and public funding that are available in Luxembourg will enable to boost the development of FinTechs companies, from their creation and throughout their whole business life. The LHoFT is also trying to link national FinTech with international ones, to foster collaboration. International FinTechs are also welcomed to join the Luxembourgish environment as an entry point in the European Single Market. This gives Luxembourg a good advantage to other EU countries as many international FinTech will land in Luxembourg, due to a facilitation of their entry, but also due to tax lowering on technological developments. It is also important to note that the Financial industry is also engaging with the different FinTech communities, this is done through dedicated working groups between FinTech, the Association of the Luxembourg fund industry (ALFI) and the Luxembourg Bankers' Association (ABBL) (LFF, 2020b). As you can see below, the Luxembourgish FinTech industry is already blooming at a fast pace with many different companies that are present in the new sector.

Figure 10: Luxembourg's FinTech Map by the LHoFT

There are an enormous amount of FinTech Start-ups that are being created in Luxembourg, a total of 70, due to its expertise in the financial sector as well as its tax easings on intellectual property (Tracxn FinTech LU, 2020).

Koosmik is the most exciting FinTech Start-up that was created in Luxembourg, it consists of a semi-closed mobile and desktop application that acts as a mobile wallet (Tracxn FinTech LU, 2020). This service enable the users to credit their wallet with a bankcard, send or request money between users for free and to pay at retailers with a fee that will be commissioned to the retailer and not the customer. This FinTech start-up also uses an algorithm in order to detect behaviours that are unusual in order to avoid fraudulent transactions or anomalies. The company raised $3 million from the LHoFT and Batipart.

Another FinTech start-up that was created in Luxembourg is Scorechain (Tracxn FinTech LU, 2020). This start-up provides a full range of different regulatory compliance, regulation, and management issues for Bitcoins and the Blockchain. This offers the customer different possibilities that facilitate their way through their journey with Bitcoins and makes it safer. An algorithm used at Scorechain provides the customer with an A.I. that combats cryptocurrency criminal activity.

Belgium, according the Financial Stability Report 2018, has a robust and efficient financial sector (FSR, 2018). A Belgian Authority, Financial Services and Markets Authority (FSMA), has established a portal for Fintechs in order to facilitate the contact

between different FinTechs and the FSMA. As the trend is growing in Belgium, the FSMA has been closely consulting the different actors throughout the country to understand the different impacts that FinTech can have on the financial sector. Since 2015, the FSMA is also the chair of the Financial Innovation Standing Committee (FISC) of the European Securities and Markets Authorities (ESMA) (FSMA, 2015). This makes the FSMA one of the leaders in terms of regulation on financial innovation, as the FISC advises the ESMA on how to draw the different guidelines and recommendations in order to avoid the use of inappropriate financial innovations that might threaten the financial stability. This positions Belgium as a leader in terms of regulations and different guidelines of the FinTech sector in the EU. As they are helping to create these guidelines, the Belgium FinTech sector is actively trying to innovate whilst respecting the new regulations that are renewed on a regular basis. Belgium has also a FinTech community, called FinTech Belgium which enables the cooperation between all the different stakeholders to discuss the different innovations for the financial sector.

Belgium counts a robust FinTech Start-up environment in its financial market, that enables 232 Start-ups to actively operate in (Belgium Tracxn FinTech BE, 2020). This represents an enormous number of Start-ups comparing to the healthcare sector, as there is nearly six times more FinTech start-ups.

The most notorious FinTech start-up is UnifiedPost, a cloud-based platform that offers payment automation (Belgium Tracxn FinTech BE, 2020). This start-up uses a specific type of A.I., called Robotic Process Automation technology, that enables the platform to provide 'automated business functions, from e-invoicing and payment processing, to working capital financing, e-identity solutions and more' (Unifiedpost, 2020). This company has funded by different investors, such as SmartFin or SFPI, for an amount of $48 million. This represents the biggest investment in a Belgian Fintech Start-up.

Aividens is another A.I. FinTech start-up that comes from Belgium, most exactly from the FinTech Belgium community, this start-up is a predictive risk management company that provides companies a with predictive data in order to reduce their bad debts (Belgium Tracxn FinTech BE, 2020). It also enables them to mange their cash management in a better way. This start-up uses A.I. to assess and segment the different data sets that they access and draws out the different risk indicators that might exist.

The Netherlands have a very favourable position in terms of financial sector, many large financial institutions understood it well and have their headquarters located in the Netherlands (HollandFinTech, 2019). This has given the Dutch financial sector an acceleration in terms of growth as a dominant financial sector in Western Europe. The Dutch financial sector is also highly innovating and has a high adaptivity, which mixed with modern legislations enables the Netherlands to be a big competitor in the European FinTech sector. Since the Brexit has happen, many FinTech companies that

were in London have moved aboard and located their Headquarters in Amsterdam (HollandFinTech, 2019). This strengthens the position of the Netherlands in terms of FinTech as it establishes Amsterdam as the second FinTech after London. Amsterdam has also been named a European Capital of Innovation in 2016, due to its strong combination of its financial sector, well developed tech ecosystem, a dynamic start-up scene, an entrepreneurial drive and a strong adopter of innovative tech makes it the best country to develop FinTech (FinTechAms, 2020). Amsterdam is also the place were most FinTech events are taking place in the Netherlands, this also shows that most of the community is probably located around the big region of Amsterdam (FinTechAms, 2020).

As the Netherlands is on of the dominant forces in terms of FinTech, it is also present in the development of FinTech start-ups with 696 FinTech start-ups on its territory (Tracxn FinTech NL, 2020).

Adyen, the most successful FinTech start-up created in the Netherlands and the unicorn of the European Fintech industry, is an Amsterdam-based digital payment company. This company is offering a digital platform for business to be able to set-up and make payments across different channels (FinTech NL, 2020). They are also using an in-house created A.I. algorithm that is detecting potential fraud, in order to grant better safety for the different payments that are made over the platform. This start-up has different customers such as big tech players like Facebook, Netflix, and Spotify. It is also supported by Silicon Valley, due to its innovation since its creation in 2006. The company went public in 2019 and has been able to gather around €293 million of funding (FinTech NL, 2020).

Another innovative FinTech start-up created in the Netherlands is Convious, an A.I. tech start-up that offers its customers data-driven e-commerce solutions (FinTech NL, 2020). The company is providing different customers with different A.I. powered marketing tools that will them to deal more effectively with various aspects of their companies, such as data-driven ads and pricing strategies. This company has gathered around €3.6 million in funding and is highly innovating FinTech company from the Dutch FinTech environment.

3.2.1.2 JAPAN

Japan, the third biggest economy in the World, has a well-developed financial sector but with robust barriers (*7 facts about Japan's economy, the third biggest in the world*, 2017). These barriers are avoiding new technologies to enter the sector as successfully as in other countries developed countries. According to a report made by

Deloitte, Japan are focusing more on correcting the existing technologies and improving their quality (Deloitte, 2017). They only invest 21% of their IT investment into new technologies that could give the financial sector a competitive edge in FinTech, while the other 79% are used for maintenance and operations on existing technologies (Deloitte, 2017). There is also an important culture of paper payments in Japan, which is the second country in terms of cash payments in the World, right behind Germany (Paypers, 2020). The Japanese government has introduced various subsidies in order to get its population to use more cashless ways of payments, such as lowering by 2% to 5% discounts for customers that purchase from SMEs in a cashless way (Paypers, 2020). This shows how reluctant the Japanese financial sector is towards innovations and the adaptation that is required for it to work. The Japanese has tried to rework its Banking Act in 2017 in order to foster financial services that use Application Programming Interface (APIs), but the society is not educated in order to move towards such new technologies (Paypers, 2020). It is therefore important that the Japanese government educates its population to enable financial APIs to penetrate the different market and to let the financial sector innovate towards a FinTech sector. The FinTech is although still not developed enough in order to penetrate the market well, but once Japan will embrace this new technology there will be a drastic need in the new technology, which will leave frontrunners as winners.

Nevertheless, the FinTech start-up environment is still present in Japan, although its size is limited. Japan counts around 258 FinTech start-ups around the whole country, but most often are in Tokyo (Tracxn FinTech JP, 2019).

WealthNavi is one of Japan's most developed FinTech start-up, it operates as platform that has an automatic asset management (Tracxn FinTech JP, 2019). The company uses a financial algorithm that has been created by the Nobel Prize winners, that enables to automatically combines the different assets in order to calculate efficiently the risk of the assets (WealthNavi, 2020). Once that the risk is calculated, the customer can choose to take risks to define a safer but lower return, or a higher risk with a bigger return. This A.I. FinTech start-up has gathered $130 million in funding through venture capital firms such as DBJ capital or UTokyo Innovation Platform (Tracxn FinTech JP, 2019).

Money Design is another A.I. based FinTech start-up from the Japanese innovation centres (Tracxn FinTech JP, 2019). This company provides its customer an automated investment platform, this means that uses Theo, an A.I. based technology to manage the different portfolios of the customers (*THEO [テオ] by お金のデザイン*, 2020). Using this A.I. Money Design is trying to help its customers to generate the highest returns whilst limiting the risks at the maximum level. The company also offers different types of investment advisory, which could be crucial to help some of its

customers. This company was funded by Tokai Tokyo Financial Holdings, Pegasus Tech Ventures and Dentsu Innovation Partners for an amount of $74 million.

3.2.1.3 Comparison of the FinTech Sectors

As we can see, through the analysis of the BENELUX union and Japan, the two different regions are not at all at the same stage in the development of FinTech. Japan, as well as being the third economy in the World, is lagging as its financial sector is not ready yet for the implementation and the introduction of different technologies that could contest the existing financial sector. The change in the Banking Act could help a faster transition soon, but there still needs to be significant improvements in the market penetration of FinTech initiatives. Japan is developing a poor performance with only 258 FinTech start-up over the whole Japanese territory. On the other hand, in the BENELUX area we can see that the Netherlands is a huge contender for a strong position in the EU FinTech market and it has already proven it through its Ayden unicorn. The BENELUX union counts 998 FinTech start-ups, which shows their involvement in increasing their position of the leaders. The only problem is that the funding of the different start-ups in the BENELUX area is too small and does not enable them to scale-up fast, on the contrary Japan has bigger amounts of funding that enable its start-up to scale up at a faster pace.

The Covid-19 pandemic will have an enormous impact on Japan as most of their transactions are done in paper, which was not possible during the pandemic. This might represent the right movement for Japan to transition drastically towards a digital financial sector, which would promote cashless payments and buying through different FinTech platforms.

Part 4 – The comparison in terms of A.I.

4.1 The metrices

4.1.1 Government Artificial Intelligence Readiness

Oxford Insights conducted an analysis of four different factors to understand how ready governments were in terms of ceasing A.I. opportunities to use and deliver the new A.I. technologies in their public sector (OxfordInsights, 2019). In order to calculate the different results, Oxford Insights decided to take 11 different metrics into consideration, and group them into four big categories as follows: governance; infrastructure and data; skills and education; and government and public services. The different data base that were used vary from UN eGovernment Development Index to the number of AI Startups on Crunchbase (OxfordInsights, 2019).

Figure 11: A.I. Readiness Index , by Oxford Insights

OVERALL RANKINGS FOR GOVERNMENT AI READINESS
2019

Rank	Country	Score
1	Singapore	9.186
2	United Kingdom	9.069
3	Germany	8.810
4	United States of America	8.804
5	Finland	8.772
6	Sweden	8.674
6	Canada	8.674
8	France	8.608
9	Denmark	8.601
10	Japan	8.582
11	Australia	8.126
12	Norway	8.079
13	New Zealand	7.876
14	Netherlands	7.659
15	Italy	7.533
16	Austria	7.527
17	India	7.515
18	Switzerland	7.461
19	United Arab Emirates	7.445
20	China	7.370
21	Israel	7.348
22	Malaysia	7.108
23	Estonia	6.968
24	Belgium	6.859
25	Luxembourg	6.857
26	South Korea	6.839
27	Poland	6.835
28	Iceland	6.809
29	Russia	6.748
30	Portugal	6.693

As we can see in the table above, the BENELUX countries are unsurprisingly ranked in accordance to our research. This means that the Netherlands is ranked 14th, which represents the best ranking of the three BENELUX countries, Belgium ranks second with a 24th place and Luxembourg third with a 25th position. On the other hand, Japan ranks as the 10th country, this shows that the country is seemingly more ready in terms of A.I. compared to the BENELUX countries. It is important to note that this ranking is based on 11 metrics and shows some limitations in term of an accurate ranking, as it can be showed through the 20th position of China in the ranking. This inaccuracy is not due some missing data points in certain data sets that were available in order to do the ranking. This is the primary reason why China is under evaluated, as there were too many missing points for it to ranked correctly. There is also a problem of finding data that has been updated from one year to another. Therefore, Oxford Insights allowed itself to use the latest data that was available, even if they had to reuse data from the precedent report.

Although there are a couple of limitations, we can still use this ranking as a good point of comparison between the BENELUX union and Japan (OxfordInsights, 2019). The ranking reflects Japan's development in terms of A.I., it is the country that has the best strategic plan implemented at the government level. In the BENELUX area, strategic plans in order to implement A.I. have been drafted in the recent years, which leaves them lagging in the transition towards Artificial Intelligence. We can also acknowledge that the public sector has not yet fully integrated A.I. technologies and is still struggling to effectively use them to stay competitive. This is a common problem in the European Union, although bigger and stronger economies were able to transition faster towards stronger positions in terms of A.I., such as the United Kingdom and Germany. Middle and smaller countries were more impacted of such a late transition, which explains the reason why the BENELUX area has fallen behind.

4.1.2 University programs ranking

Artificial Intelligence has become the trend that every business, government, and researcher wants to develop. This technology, as complicated as it is, is a blend between different topics of studies, such as computer science, maths, psychology, and engineering. Therefore, it requires highly skilled workers to research and develop future effective A.I.s (Gupta, 2017).

As Bhasker Gupta explains in his article, "there is no doubt about the face that soon the demand for professionals trained in Artificial Intelligence would outrun supply" (Gupta, 2017). There is therefore an enormous need to develop different programs that offers students the possibility to specialise in these types of professions. Artificial Intelligence is still in its early stages of academia, where not many courses are yet only

focusing on this field of studies. Most universities include A.I. in different computer science programs, but do not have A.I. as a full curriculum by itself.

Bhasker Gupta decided therefore to conduct a research and see what universities were already offering a dedicated master program in Artificial Intelligence. The ranking was as follows (Gupta, 2017):

- KU Leuven – Master of Artificial Intelligence (the Netherlands)
- Polytechnic University of Catalonia – Master in Artificial Intelligence (Spain)
- Radboud University – Master's programme in Artificial Intelligence (the Netherlands)
- University of Amsterdam – Master's Programme in Artificial Intelligence (the Netherlands)
- University of Edinburgh – MSc in Artificial Intelligence (Scotland, UK)
- University of Georgia – MS in Artificial Intelligence (USA)
- University of Groningen – MSc in Artificial Intelligence (the Netherlands)
- University of Sheffield – MSc Computational Intelligence and Robotics (England, UK)
- University of Southampton – MSc Artificial Intelligence (England, UK)
- Utrecht University – MSc in Artificial Intelligence (the Netherlands)

As we can see from this list, five of the ten universities that were listed in this article as the leading centres in terms of Master's Programs in A.I. are from the Netherlands. This shows that the education towards the development of A.I. is starting to develop as a frontrunner mostly in the Netherlands, as well as the UK and USA, which will soon be followed by many different universities. This should enable the Netherlands to take a head start in understanding how to effectively teach A.I. and what will be crucial to teach the students to enable them to be top expert in the A.I. field. This should enable Dutch universities to try and be the best universities in terms of teaching Artificial Intelligence, which would offer them opportunity to form and attract foreign experts.

4.1.3 Number of A.I. experts

The Global A.I. Talent report, published by jfgagne, has conducted an analysis, and tried to understand better how it is possible to quantify how many A.I. talents are present around the World (Kiser & Mantha, 2019). To do this, they have reviewed the publications from the 21 leading scientific conferences on A.I. around the World. Secondly they have conducted several targeted searches on LinkedIn in order to

understand how many people were self-reporting to have a PHD, as well as the different skills needed to be considered an A.I. specialist. Their findings showed that there were 22,400 people that published at least once at one conference in the field of ML (Kiser & Mantha, 2019). According to the search criteria for the A.I. specialists on LinkedIn, the findings were that there were 36,524 people that were qualifying themselves as A.I. specialists (Kiser & Mantha, 2019).

According to the survey conducted over the LinkedIn profiles, we can see that Belgium detains 302 A.I. specialists, the Netherlands detains 687 specialists and Japan detains 455 specialists (Kiser & Mantha, 2019). This can show us that according to the survey, the BENELUX area counts two times more A.I. specialists than Japan. There is an enormous limitation to these numbers which are not fully reliable due to data that is self-entered by the different individuals. The second limitation to this survey is that there is not an exact distribution across all the countries, which means that in the US people are more likely to use LinkedIn than in China. Therefore this survey should be taken as a sample and not as exact data.

4.1.4 Number of A.I. start-ups

In order to understand how different the BENELUX union is to Japan in terms of A.I. start-ups, we need to assess how many A.I. Start-ups per 1,000,000 capita that are present in each country. By putting it in scale per 1,000,000 capita it will give us a better point of comparison as the scale will be the same. To do this we will take data from Tracxn, an online database which will provide us with data about the four different countries that we are analysing.

Luxembourg is the most undeveloped countries in terms of A.I. start-ups, the country counts 16 active A.I. Start-ups, which shows that they have a poor impact in terms of A.I. creation (Tracxn AI LU, 2020). Belgium, the second largest country of the BENELUX has 150 actives A.I. start-ups across the country, which can show that they have a decent impact in A.I. creation (Tracxn AI BE, 2020). The Leading country of the union, the Netherlands, has 333 A.I. start-ups on their territory, which shows us that it leads the BENELUX union by far in terms of Artificial Intelligence (Tracxn AI NL, 2020). On the other hand, Japan counts 262 A.I. start-ups (Tracxn AI JP, 2020).

This means that the BENELUX union has 499 start-ups for a population of roughly 29.55 million, this show that the BENELUX area has 16.88 start-ups per 1,000,000 capita. On the other hand, Japan has 262 start-ups for a population of 126.5 million, which represents 2.07 start-ups per 1,000,000 capita.

This shows clearly that the BENELUX area, more specifically the Netherlands is a country that is trying to innovate and take the lead in the EU race to A.I. dominance. On

the other hand, Japan can be shown as country that is finding it hard to transition towards new technologies and innovate. The start-up ecosystem of Japan is still in expansion, but there is clearly a lack of innovative start-ups in terms of Artificial Intelligence.

4.2 Limitations of the research

There may be possible limitations in this study. Artificial Intelligence is a hot topic that still needs to be studied as it is still too recent to assess its full impact on business.

The first limitation is that the entry of A.I. in the business environment is still recent, as the focus of the different governments to involve A.I. in the public sector. This limitation has an impact on this study, as there has not been enough time to assess whether A.I. will have a positive or negative impact on the business environment and consequently on the public sector. It is a big lake of "ifs" that will be able to be understood well in 10 years when the entry of A.I. has been completed within the different sectors. For the moment being it results more into analysis of what A.I. is, the different advantages it potentially has and how different countries are trying to capture these advantages.

The second limitation that this study faces is the lack of available data to produce impactful metrices to compare the different countries with numerical data. There is nowhere to find accurate data on how many A.I. experts there is around the World for example, or how many A.I. start-ups every country counts. This gives the whole metrices a certain type of inaccuracy, which most likely will be easier to analyse in the future, due to more available data through properly made reports. It is also important to find data for a country as small as Luxembourg, as it is edge on A.I. is not interesting as there is a lack of A.I. production.

The third limitation of this study is that there has been a real barrier in order to access different A.I. experts around the World due to the Covid-19 Pandemic. This has limited the personal contribution that was able to be given, as most individuals that where contacted were not available to contribute. It has also limited the different in-depth analysis of certain Start-ups as there was an unavailability to access different person to create primary data through interviews.

Nonetheless, this study needs to be interpreted with prudence, as the limitations should be considered. Further research in future years might be able to help this study to evolve into further research, as the availability of data will be more abundant.

Conclusion

Artificial Intelligence has deep roots that are present since the end of World War Two, with the breakthrough innovations in computing sciences lead by Alan Turing. The evolution of this technology has enabled different business to leverage on the opportunities that it can offer in terms of efficiency improvements and its cost-cutting edge. An increasing interest has also been noticed by the different governments around the world, as the potential of A.I. is seen as high.

The different countries around the World are trying to battle to create the best environments to foster the creation of breakthrough A.I. in their country. As seen in Part - 2, the three BENELUX countries and Japan are all actively trying to establish strategic plans in order to cease some of the opportunities created by Artificial Intelligence. We can also see that the different countries have common visions on A.I., as it should be helping economically and socially each country. The strategic implementation of the new technology is although very different from one country to another.

As seen in Part - 3, there are various types of start-ups, that depend on the goal of the entrepreneur. Some entrepreneurs rather have a social impact and create a product or service that will help the world to change. Whilst other want to create buyable start-ups that scale-up and sell them in order to make big profits, or to create a start-up that will turnout into a dominant company in a specific sector. These different styles of start-ups will help different entrepreneurs around the world to create specific types of A.I. Start-ups that follow the same principals. As bigger companies often buy A.I. start-ups to integrate their research, most entrepreneurs create buyable start-ups as there is not much place to competition with the existing multinational companies.

Although we are comparing the BENELUX union to Japan, we can see that there are some similarities in terms of the potential sectors that need to be invested in. The healthcare sector is one of the most crucial sectors for developed countries, as the problem of the aging population need to be tackled down in the best way possible. This aging population brings a multitude of problems, such as appearances of new illnesses and a saturation of the healthcare sector. This saturation can be linked due to the need of elderly people to go to hospitals on a more frequent basis than the younger populations, as they are more likely to be facing illnesses that makes them need to spend a certain duration in the hospitals. There is therefore an enormous investment in the future A.I. healthcare sector, in order to foster innovation that will be able to enable the healthcare sector to be more adequate to its population. The second sector that has been analysed was the FinTech sector, this sector is the most flourishing sector in terms of new technologies. FinTech companies are enormous start-ups that use A.I. technologies and manage to scale-up at a fast pace through different rounds of funding. This sector is generating profits enormous profits if the start-up is able to scale-up and

operate worldwide, like the unicorn Ayden. The FinTech sector also represents a sector that needs development worldwide, as the financial sectors need to be able to also innovate and propose more adequate products and services depending on the available technology that our smartphones and the internet is offering us.

The comparison of the BENELUX union with Japan was also done through four different metrices that enabled us to verify our findings that were conducted through the thesis. Japan is a country that has had some difficulties to innovate in terms of Artificial Intelligence, but they have the potential to become a leading force in this new technology. Japan has been on the front of the technological development during the industrial revolution, and has the potential to be leading once again, as show through its high ranking in Government A.I. Readiness. On the other hand, the BENELUX area is less likely to be successful in A.I. technologies due to it is limited data generation and smaller financing possibilities. A country like Luxembourg is therefore trying to act as a hub for data lakes, in order to be an actor in the A.I. development but in another aspect of it. A closer link should also be established between the Netherlands and Luxembourg to cooperate better in terms of financing of start-ups created in the Netherlands. This would enable the Netherlands to help its A.I. start-up to scale faster and play bigger roles in the EU. It is although interesting to see that Medium and Small size countries of the European Union can compete with enormous countries like Japan, as the BENELUX seems to conduct better innovations in healthcare and FinTech than the Asian force.

Further research should be considered in the domain, as it is interesting to have a good view of the countries that might not be leaders in A.I. within the EU, but still have good understanding and development of new technologies. Countries of the size of the BENELUX countries are often side-lined by the bigger European countries, which limits the potential that they can have in the new technologies. Lastly it is interesting to turn to smaller countries in the EU to understand that cooperation is key for them to be successful, which is why smaller unions are present in the EU.