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Artificial Intelligence in Financial Services

An analysis of the AI technology and the potential applications, implications, and risks it may propagate in financial services

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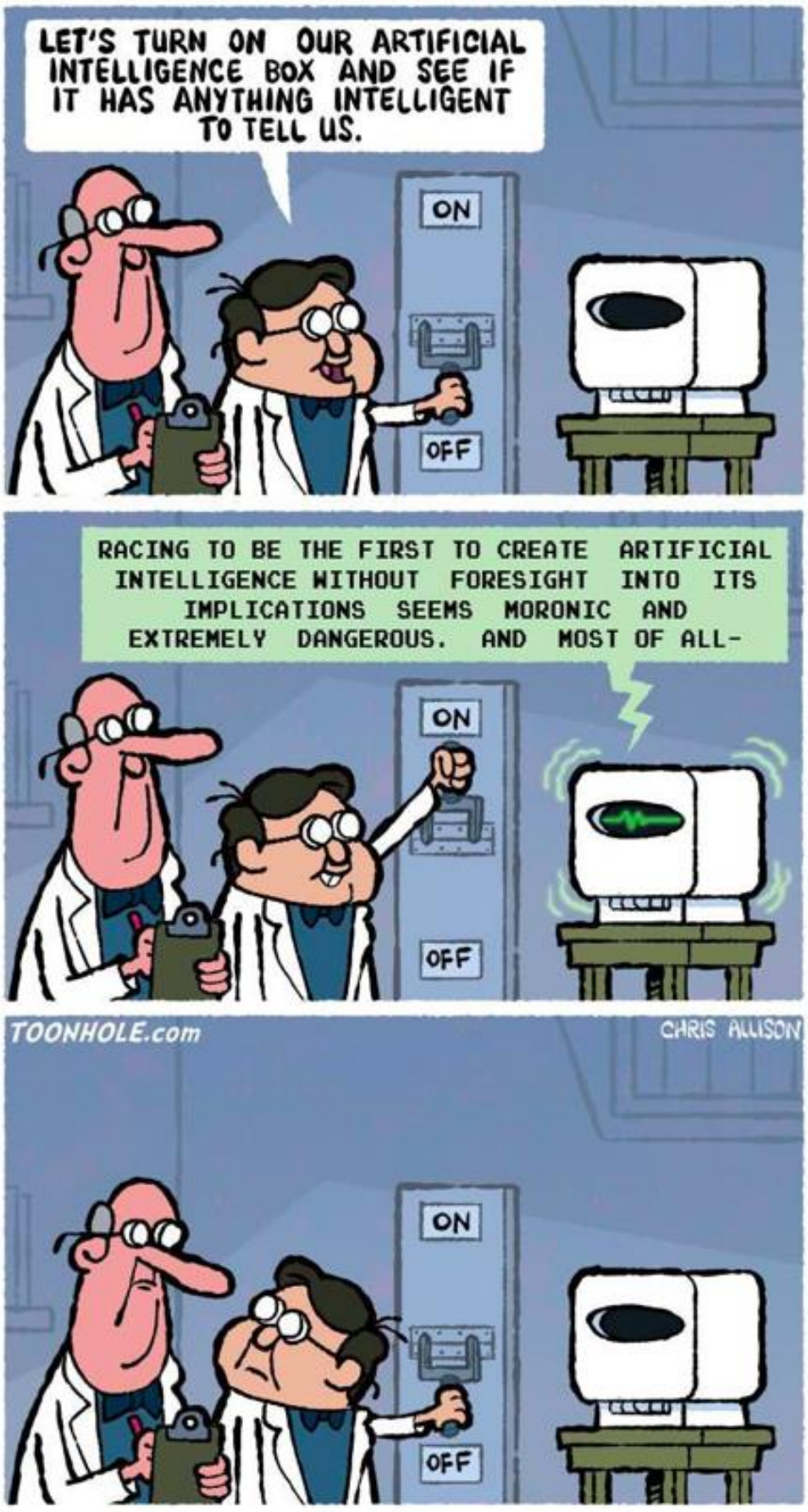
ABSTRACT

It is hard to deny the fact that artificial intelligence and robotization have been the centre of research for the last decades. Moreover, during the past few years it has really boomed and is now widely utilized in many companies through a wide range of sectors. Most of the time artificial intelligence has been referred to as some kind of automatization of processes within the industrial sector, but we have started to see a greater way of using technology for the better, particularly in financial services. The financial industry has been somewhat slower in its approach of implementing artificial intelligence and accepting its powers due to several reasons. Reasons such as uncertainty, regulations, need for better cyber security, shortfalls in technology, and disruption of standard already profitable procedures are all apprehensions the industry have faced previously.

Firms operating in financial services have started to see the benefits artificial intelligence brings to the company, and never before have something like this been talked more about. That is maybe one of the reasons why this transformation is called the fourth industrial revolution. It is highly disruptive, in both a good and bad way. Solutions become much more efficient, precise, and cost effective. However, with great power, comes great responsibility. Given that the financial sector is undergoing significant change at a rapid pace, precautions and security have never been more important to companies. We humans have yet to discover the many pros and cons this technology brings. Although artificial intelligence was originally introduced to us in the 1950s, it has achieved new eminence lately as computational power has risen, and the amount of accessible data has become immense.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You have all impacted this project in a positive way and have raised the quality of this thesis. Once again, your effort is truly appreciated.

EXECUTIVE SUMMARY

This past year has been quite busy for emerging technologies and one in particular, artificial intelligence. In fact, it's estimated that during the second quarter of 2019, AI start-ups have funded a tremendous $7.4 billion globally on various projects and companies (CB Insights, 2019). In today's day and age, AI is slowly transforming the traditional financial services we previously have seen where banks and financial institutions have mostly relied on physical interaction with customers and clients. Combining the power of AI with data analytics, firms are now able to get contextual insights and empower consumers to achieve their financial goals based on historical data and holistically accurate predictions. In recent years we have seen applications such as algorithmic trading, cyber security, robotic advisory services, and fraud detection propagate and lay the foundation for future AI utilization.

Despite all the enthusiasm, implementation of AI is not without challenges. Unsurprisingly, risks often cited by firms in financial services include transparency, algorithms and biases in data, shortfalls in technology, regulations, and complexity. Moreover, the quality of data used to run AI is crucial. You could really have the fanciest systems out there, but if the stream of data going through them is poor, then you fail significantly. However, if you learn how to utilize and combine AI with data analytics, you will possess a great intellectual system that is able to learn and predict patterns and trends like never before. Hence, facilitating for a successful implementation of AI, give firms a competitive advantage in today's information driven economy.

In this thesis we have really focused on the real usage areas of AI and have in particular chosen to collaborate with a newly launched subsidiary of Sparebanken Vest, called Bulder Bank. They are the first all-digital bank in Norway that utilizes AI to execute their daily operations. Through their innovative and efficient strategy, they are able to provide customers with a mortgage offer in 2-4 minutes and handle a growing customer base with minimal human interaction. By disrupting the process with AI, they are increasing the bar for traditional banking solutions in Norway. Even though they still are a small bank with only 24 employees, their launch has been a significant success and according to their CTO, they have a very bright and exciting future ahead of them.

ABBREVIATIONS

AI	Artificial Intelligence
AML	Anti Money Laundering
AT	Algorithmic Trading
CAP	Credit Assignment Path
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CTO	Chief Technology Officer
DL	Deep Learning
ETF	Exchange-Traded Fund
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
HFT	High Frequency Trading
HTF	Health Technologies Fund
ICT	Information Communication Technology
KPI	Key Performance Indicators
ML	Machine Learning
NLG	Natural Language Generation
NLP	Natural Language Processing
NYSE	New York Stock Exchange
PwC	PricewaterhouseCoopers
ROE	Return on Equity
ROI	Return on Investment
SPV	Sparebanken Vest
S&P	Standard & Poor
UBS	Union Bank of Switzerland

List of Figures

Figure 1: Forecast of global AI-derived business value 4
Figure 2: Industrial revolutions 9
Figure 3: Global AI hubs outside the US & cross border AI deals 12
Figure 4: The four types of AI 14
Figure 5: Overview of AI categories 16
Figure 6: History of AI 17
Figure 7: ML classification 19
Figure 8: Comparing a ML approach to a DL approach 20
Figure 9: Neural networks and DL 21
Figure 10: The 4 V's in big data 23
Figure 11: The process of text mining 24
Figure 12: The process of NLP 24
Figure 13: Python, R, LISP, Prolog, and Java 29
Figure 14: Algorithmic trading with different time horizons 35
Figure 15: Distribution of US occupational employment over computerization 43
Figure 16: Sparebanken Vest and Bulder Bank 48
Figure 17: Companies collaborated with 48
Figure 18: Organizational map over Bulder Bank 57
Figure 19: Descriptive flowchart from a customer perspective 58
Figure 20: Descriptive flowchart from all underlying processes 59
Figure 21: Flowchart of the collateral valuation process 61
Figure 22: The loan process in SPV 62
Figure 23: Potential way of implementing applications in Bulder Bank 65

Table of Contents

ABSTRACT II

ACKNOWLEDGEMENT IV

EXECUTIVE SUMMARY V

ABBREVIATIONS VI

List of Figures VII

1.0 Introduction 1

1.1 Motivation 5

1.2 Aim and Objectives of the Thesis 6

1.3 Research Questions 7

1.4 Thesis' Structure 7

2.0 Theoretical Foundation 9

2.1 History and Evolution of Artificial Intelligence 9

2.2 The Global Growth of the Artificial Industry 11

2.3 Types of Artificial Intelligence 14

2.4 Overview of Artificial Intelligence 16

2.4.1 Machine Learning 17

2.4.2 Deep Learning 20

2.4.3 Big Data 22

2.4.4 Text Mining/NLP 23

2.4.5 Natural Language Generation 25

2.5 Coding Languages Used in Artificial Intelligence 26

2.5.1 Python 27

2.5.2 R 27

2.5.3 LISP 27

2.5.4 Prolog 28

2.5.5 Java 28

2.6 Ethical Dilemmas with Artificial Intelligence 29

2.6.1 Unemployment 29

2.6.2 Wealth Inequality 30

2.6.3 Humanity 30

2.6.4 Artificial Stupidity 30
2.6.5 Bias 31
2.6.6 Security 31
2.6.7 Evil Geniuses 32
2.6.8 Singularity 32
2.6.9 Robot Rights 32
3.0 How Artificial Intelligence is Changing Financial Services 34
3.1 Algorithmic Trading 34
3.2 Fraud Detection and Compliance 37
3.3 Chatbots and Robotic Advisory Services 38
3.4 Cyber Security 39
3.5 Accounting and Auditing 42
3.6 Other Applications of Artificial Intelligence 44
4.0 Methodology 46
4.1 Research Method 46
4.2 Data Collection 49
4.3 Evaluating the Data 49
4.3.1 Reliability 49
4.3.2 Validity 50
4.3.3 Research Ethics 52
4.4 Limitations and Weaknesses 53
5.0 Bulder Bank - Case Study and Analysis of the Mortgage Process 55
5.1 What is Bulder Bank? 55
5.1.1 Goals and Visions 56
5.2 Bulder Bank's Structure 56
5.2.1 Organizational Map 56
5.3 How Artificial Intelligence is Implemented in the Mortgage Process 57
5.3.1 Descriptive Flowcharts 58
5.3.2 How is This Process in Sparebanken Vest? 61
5.3.3 Comparing Quicken Loans to Bulder Bank 62
5.4 Future Artificial Intelligence Processes in Bulder Bank 63
5.5 Challenges with the Implementation of Artificial Intelligence 64
5.5.1 Organizational Challenges 65
5.5.2 Ethical Challenges 67

5.5.3 How Deep Leaning Could be a Challenge 67
5.6 The Need for External Technological Support 68
5.7 Benefits with the Implementation of Artificial Intelligence 69
6.0 Conclusions and Discussions 70

7.0 References 74

8.0 Appendix 86
8.1 Modelling the Research Questions 86
8.2 Agreement Contract Thesis 90
8.3 Interview Questions Bulder Bank 92
8.4 Interview Questions AVO Consulting 96
8.5 Interview Questions Accenture Norway 99
8.6 Interview Questions Karabin Consulting..... 102

1.0 Introduction

Technology has become a major part of our daily lives and we depend on different types of technologies in almost every situation. Since the third industrial revolution and the introduction to computing power, our lives have been radically changed. One of the technologies that are revolutionizing the way we use data and machines is artificial intelligence (hereafter known as AI). Most of us have probably heard about AI, and it sounds fairly fancy and modern, but the history of AI goes all the way back to the 1950s when the mathematician Alan Turing was grappling with the question "Can machines think?". Today financial executives and professors believes that AI technology will revolutionize the financial industry. Since 2013 over 3600 AI start-ups have been founded and raised a total of $66 billion in funding. This could be the start of the so called 4th industrial revolution whereas businesses and individuals are forced to rethink how technology is utilized (Dunies et al., 2016).

However, the financial industry has been somewhat reluctant to implement and utilize AI due to several reasons. Apprehensions such as uncertainty, technology shortfalls, and regulations have been major concerns that have propagated barriers of entry for AI. As more industries and sectors have started using this technology and yielded great results, firms in financial services have now began to see the many merits AI brings. Cognitive robotics have and will be essential moving forward either in a customer or client interaction or a retail banking setting. With the use of DL, ML, big data, NLG, and NLP one has the ability to replicate human intelligence where learning and self-correction are key to a successful implementation (Binner et al, 2004). Previously, only the big established companies had the resources and systems available to integrate AI and hire professionals in the field. But over time, AI frameworks with high abstraction level have been developed and with just a few lines of code, smaller firms are also now able to create an intelligent system.

AI can mimic actions it has seen previously without the use of any new intervention. ML is defined as a particular approach to AI that is able to take data and algorithms and deploy it to new settings and patterns without any further need for programming. DL is viewed as a branch of ML, just more sophisticated. It provides machines with algorithms that are

necessary to understand the magnitude of an action and significant amounts of data. These data points can then be cointegrated so that the system can learn on its own and deepen the skills with which they are provided. Further, NLP and NLG are also subcategories of AI in which they are more related to text reading, analysis, and extraction. As we will touch upon later, all these branches of AI are used in financial services today to facilitate for a better client and customer result as well as competitiveness. We will in particular dig into algorithmic trading, cyber security, fraud detection and compliance, chatbots and robotic advisory services, and accounting and auditing. Obviously, the list is immensely longer, but by focusing on these points, we will cover the most important parts of AI in financial services.

Some of the world's largest tech companies such as Alibaba, Google, Facebook, Amazon, and Tencent are investing tremendous amounts of money into AI research. AI is continuously becoming more sophisticated and complex, making it important for firms to be updated on the technology in order to maintain their competitive advantages. We are in an era where customers and clients are rapidly switching to digital platforms and hence, to be able to keep up with the race, traditional firms need to become more customer and client-centric by focusing on their needs. The reality is that barriers for entry have become so low that customers are able to switch to other services or companies with just some simple clicks. By implementing AI, not only the customer experience is increased, but better and more precise financial decisions are made with augmented recommendation. For example, combining ML with behavioural economics, one can understand customer individual earnings and spending to advise on what is safe to spend before the next salary comes in. This also goes for customer's wealth management and financial market preferences whereas AI is able to track and recommend decisions that are best suited for your preferences. There is no doubt that implementation of AI is beneficial, but at what costs are the advantages justified?

What exactly are the costs of AI? Almost every research paper discussing AI brings up the ethical dilemmas which are correlated with this technology. Especially in financial services, ethical questions are very important when dealing with computational power because at the end of the day, people and businesses are relying on AI to make financial decisions based on their preferences. Hence, in order to facilitate for a sustainable future, it is imperative that humans know the potential consequences that may propagate. As with anything else,

transparency, trust, fairness, collaboration, morality, and integrity are essential for any venture or partnership. It is significantly hard to hard code a set of morals or ethics into an AI system, that automatically tells it what to do in every possible scenario. Being able to differentiate between right and wrong is not enough anymore, at least not in the financial industry where businesses constantly have investors and stakeholders following all their actions. Moreover, looking at it from a different perspective, what is the social cost of removing humans and replacing them with machines? Can you just fire someone because you have found a more cost-effective solution? In many countries that have weak human rights and labour rights, this might be an issue that can create a social problem which propagates because of AI. As for now, we are teaching computers, but in the future, scientists say that computers will outsmart humans with great margins. Hence, creating systems and machines that are able to combine the merits of AI in collaboration with human labour might be something important we are yet to discover (World Economic Forum, 2019).

Benefits of AI are many. Moreover, one very important thing is the significant positive impact AI will make on the world economy. The technology is expected to add a staggering $15.7 trillion to the global economy by 2030 (PwC, 2017). Just to put that in perspective, China's entire GDP in 2018 was $13.61 trillion and Norway's GDP in 2018 was $434.75 billion (World Bank, 2019). This tremendous growth can be explained by factors such as increased worker productivity, detection and prevention of cyber security threats, identification of cost-saving patterns, and improved personalization of products and services. Further, it's estimated that a $800 billion revenue shift will happen because of AI and its power of personalization within financial services, healthcare and retail. Looking at the chart on the next page, we can see a forecast of AI-derived business value globally (Gartner, 2018).

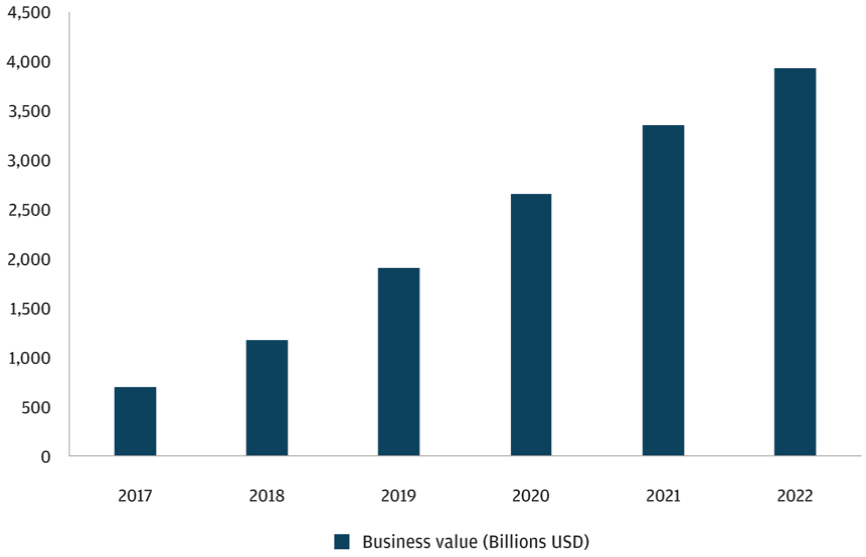


Figure 1: *Forecast of global AI-derived business value*

Not only the business value will increase because of AI, but the pool of investments is also expected to boom immensely in the coming years. In section two of the thesis we will talk more specifically about this. In today's data driven world, firms have two choices. Either they choose to be overwhelmed by the substantial amount of data or they can join the AI wave and turn all the information to a competitive advantage. However, it seems like most companies have recognized this. In fact, according to a survey done by NewVantage Partners, a whopping 88% acknowledged that they feel the urge invest into AI in 2019. Also, 77% of the same population responded that they are uncertain of the mass business adoption of AI and that is why many are on the fence of investing. Investing in AI does not mean that benefits appear right away. Utilizing AI is a hard task and only firms with the right competency at this stage are able to do it successfully. Hence, more preparations and education are needed globally in order for it to be mass adopted. That is, information asymmetry is a significant barrier in AI adoption.

Our main aim of this thesis is to investigate how AI is implemented in the financial services globally and what challenges and benefits this transition reveals. In order to do this, we have systematically done research on important theoretical aspects that lays the foundation of this thesis. Further, we see it beneficial to include some of Norway’s most leading consultancy

firms that are experts in this field to give us valuable inputs on how they see the future of AI in the field of financial services. We have reached out to AVO Consulting, Accenture Norway, and Karabin Consulting to gain this kind of knowledge and they have all been exceptionally open and helpful with all our requests. Also, we were lucky to work with Bulder Bank who is Norway's first all-digital commercial bank utilizing AI in their processes. Therefore, we wanted to conduct a case study where we looked deep into their mortgage process and how AI is helping them being more competitive and efficient. Since Bulder is a subsidiary of Sparebanken Vest, we then wanted to draw parallels and see what the differences were in an AI vs. non-AI approach by comparing the two. Lastly, we will also compare Bulder Bank to America's largest mortgage provider to examine the differences and similarities they share since they both are highly digital driven.

1.1 Motivation

"Success in creating AI would be the biggest event in human history. Unfortunately, it might also be the last, unless we learn how to avoid the risks."

- *Stephen Hawking, Theoretical Physicist*

The potential of AI is tremendous, and we are now starting to build programs, robots, and machines we have only seen in science fiction movies previously. AI will undoubtedly change the financial system we see today, but what is the recent trends of AI within financial services? And how has the technology turned out so far for businesses that have already implemented AI? These are the questions we have been very eager to answer and our interest for this subject started before our graduate degree at Norwegian School of Economics. Having a passion for coding, blockchain and technology in general, AI has been no exception to our interest. Moreover, having been exposed to exciting courses such as "Banking and Financial Technology" at NHH and having worked in a FinTech venture fund in San Francisco, we really want to explore this untouched subject from a financial perspective. Knowing that no one have written a dissertation about this subject before at NHH makes this whole challenge more exciting and really motivates us.

In this thesis we want to dig into the history of AI and look at potential applications, implications and risk it may propagate within financial services. We will have a strong focus on fully digital financial platforms that can facilitate a sustainable use of cognitive computing and AI. To fully understand the magnitude of what we are researching, it is important to know the theoretical foundation of how everything is linked together. Further, it is important to us that the thesis reflects a realistic approach whereas we see it necessary to collaborate with digital companies that already are using AI or have great knowledge about the technology. Hence, we see it quite intuitive to get in touch with several companies that deal with this kind of things on a day to day basis in order to analyse what possibilities and restrictions AI brings to financial services.

1.2 Aim and Objectives of the Thesis

The terminology "Artificial Intelligence" covers quite a wide spectrum. Our aim for the thesis is to identify the technology within the financial sector and the use of it. Moreover, we will analyse and provide the potential applications, and risks that might propagate with the implementation of artificial intelligence. The objective of this thesis is simply to study and hopefully discover which areas of finance AI is being used today and what it's capable of doing in the future. We will go through how the technology has penetrated the market in recent times and come up with real life cases where different AI techniques are being used and how it's impacting businesses today. Following objectives are given attention to:

A) Examine the theory and history behind AI to better understand the use cases and what the technology is capable of doing.
B) Examine which sub-techniques within the AI we have and if they are possible to integrate.
C) Discuss the potential applications, risks, and implications of using AI.
D) Identify the current and future use of AI in financial services.
E) Conduct a case study where theory is put into practical context.

1.3 Research Questions

A) What is AI?

B) Why is not AI currently as widely used in financial services as in technological companies such as Google, Facebook etc.?

C) What are the possible advantages/disadvantages with combining the different techniques within AI?

D) How is AI utilized in Bulder Bank and how does this compare to Sparebanken Vest?

1.4 Thesis' Structure

The thesis is divided into different chapters where we have included all the relevant topics, we feel are necessary in order to finish the research successfully. In short terms our aim has been to provide the reader with the relevant knowledge about AI and hence, further be able to understand the coming chapters and discussions in an easy way. We have tried to explain things and make AI as understandable as possible since it might be a topic that is unknown and difficult to understand for the wider audience. The study is structured in mainly 6 sections:

- **Section 1** establishes the thesis' background, our motivation for the study, aims and objectives, and lastly formulation of the research questions.

- **Section 2** will give the reader insights into what AI is and the theoretical foundation of the history and future of AI. Further, we will examine existing subjects and report important findings along the way. In this way the reader will better understand the theoretical concepts and hence, the applications of the technology in today's industry.

- **Section 3** describes different use cases of AI in financial services today.

- **Section 4** will take on the methodology used in our research and describes how we have collected, used and analysed the research data.

- **Section 5** consist of discussions and analysis around the use of AI in Bulder Bank, based on the framework in the methodology part. The focus here is on the research questions and how we can expect the AI technology to evolve in the future.

- **Section 6** consists of our discussions and conclusion. Here we summarize the key findings and provide personal insights.

2.0 Theoretical Foundation

While the technological phenomenon AI can be traced over fifty years back in time, the possibilities have significantly risen in today's world. In simplicity the aim of AI is to do things normally done by humans, and more specifically acting intelligently. The adoption of AI has created a large ecosystem of categories within the segment which is important to recognize in order to better understand what the technology is capable of. The purpose of this chapter is to evaluate exactly this and to give the reader a comprehensive understanding of the different forms of AI and their distinctive features. Further, we will look a bit into the history of AI, global growth and how it's changing the financial industry. Here we will give real specific examples on the implementations of AI, what has been already done, before determining what can be done further.

2.1 History and Evolution of Artificial Intelligence

Through history we have seen three significant industrial revolutions so far. The first revolution started in 1784 when we saw the first steam engine. The second revolution was in 1870 when we saw the start of electricity. Third revolution was the IT revolution in 1969, and we are now witnessing the fourth revolution, AI (Skilton & Hovsepian, 2017). The fourth revolution is about big data, intense automation, and a world where everything is connected based on AI technology.

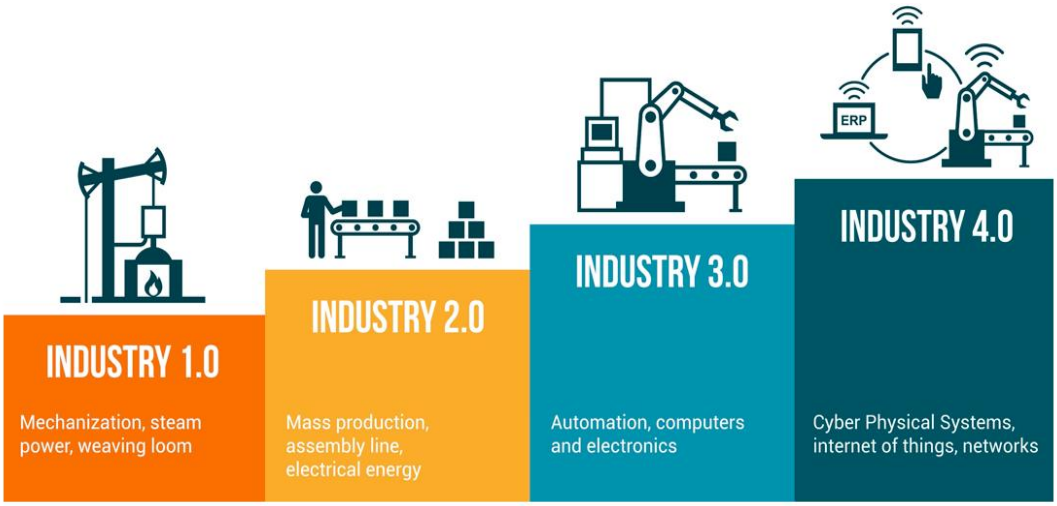


Figure 2: *Industrial revolutions*

This one is leveraging on the third revolution and is a combination of advancements that connects the borderlines between computerized, physical, and biological circles (Schwab, 2017). It all started when Alan Turing, a mathematician and WWII code breaker was grappling with the question "Can machines think?" Still the term "Artificial Intelligence" was coined by John McCarthy in 1956. We find the definition of AI in the Oxford English Dictionary as (Lexology, 2017):

"Artificial intelligence is the theory and development of computer systems that are able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages".

Kaplan and Haenlein (2018) has also included a definition in their report:

"AI is a system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation".

Alan Turing was wondering why people were able to utilize data, resolve complex issues, and make rational decisions while computers could not. Based on this, Turing (1950) invented an operational test described in his paper, "Computing Machinery and Intelligence". Today the test is used as a guideline to measure the machine`s capability to think as a human. The Turing Test paved the way for machine learning, reinforcement learning as well as genetic algorithms as we will read more about later.

In this thesis we will focus on financial applications. Still most of the development of AI in the 1950s and 1960s was not focused towards financial services. Most of the work was towards Bayesian statistics with laid the ground for the machine learning we use today. Their biggest problems back then were lack of data power and storage. Millions of dollars were invested into AI, but the results were not that impressive. This resulted in reduced funding and interest around AI in 1970 leading to what has been called the "AI Winter". The winter did not last very long and in the 1980s, AI witnessed a revival due to better computer technology and new funding. As a result of heavy investments from Japan, the UK, and the US, the first AI solutions entered the financial industry in 1982 when James Simons founded

the quantitative investment firm “Renaissance Technologies”. Later they became famous for their financial processing techniques around pattern recognition.

In the 1990s, AI gained interest within fraud detection. The Financial Crimes Enforcement Network (FinCEN) implemented a system to detect money laundering in 1993, called the FinCEN Artificial Intelligence System (FIAS). The results were great, and the system was able to review over 200 000 transactions every week, and within two years the system had detected 400 money laundering attempts worth $1billion (Senator et al., 1995).

The growth of computer processing power and storage have been growing exponentially since 2011. This has given us new possibilities within deep learning which has become the breakthrough of AI. Since 2013, over 3600 AI start-ups have been founded within almost every industry and raised a total of $66 billion in funding. Still not every implementation of AI has been successful. An example is Knight Capital who lost $440 million in less than an hour due to an unverified trading software. Also, in 2013, Goldman Sachs was affected by a 17 minutes computer glitch, resulting in orders to purchase 800 000 contracts of equities and ETFs.

2.2 The Global Growth of the Artificial Intelligence Industry

From 2000 to 2016 the US has been the main player within AI technology. Having 3033 start-ups or 37.41% of all AI start-ups worldwide (Buchanan & Cao, 2018). This accounts for a significant 71.78% of the world's total funding. They were also the first country investing heavily into AI. In the time period from 2012 to 2016, the US invested $18.2 billion towards this technology compared to $2.6 billion in China and $850 million in the UK. However, from 2017, the US has lost their leading position to China who has started investing heavily in this technology and surpassed the US in total funding (CB Insights, 2018). In the Asian market China leads along with a proportion 68.67% of Asian AI start-ups the last five years.

As of patents, China has also overtaken the US for AI patents the last five years. “Machine vision” is where China dominated with more than 55% of all the patents globally. Machine vision refers to facial recognition as well as objects recognitions and is used within autonomous driving, e-commerce, public security, and healthcare.

There are two main reasons for the explosive growth in AI the last few years. First and foremost, the amount of data available has increased tremendously. Today we create 2.5 quintillion bytes of data every day, and 90% of all data generated has been generated over the last two years alone. Secondly, the increase in computing power and data storage combined, have given us more possibilities in developing new AI solutions. Worldwide we have established 5154 AI start-ups over the last five years, 175% growth relative to the previous twelve years (Marr, 2018).

What's interesting is the rise in cross border investments. Previously China often invested inside the Chinese market but as we see in the figure below, China invests way more into AI start-ups in the US than vice-versa. The figure below shows how the gap between the two has grown since 2015. We see from both of these graphs that the US has still the most AI start-ups and the highest number of total equity deals. But they are gradually losing their global deal share to new AI hubs growing outside of the US.

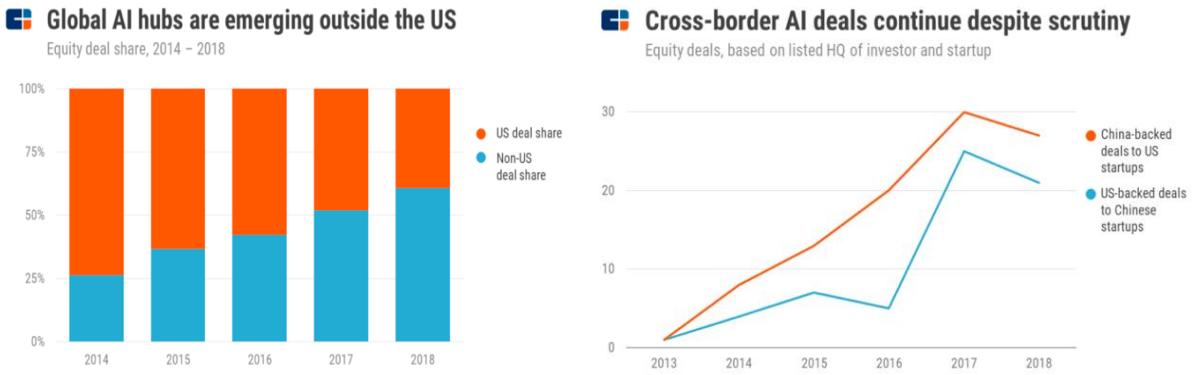


Figure 3: *Global AI hubs outside the US & cross border AI deals*

One of the explanatory reasons why China has increased their market share in AI, is their availability to tremendous amounts of data, which is the most important part of ML. For example, WeChat has about one billion users generating data every day. Secondly, they are a very large provider of AI chips and leading within facial recognition which is fuelling their drive forward.

In all different technological devices, we need chips. Right now, there is a big competition between China and the US in AI chip technology. Alibaba has been working on their first AI chip and has during this fall unveiled their first self-developed AI chip for cloud computing services (Horwitz, 2019). Called Hanguang 800, this chip is the first AI inference chip in the world. Alibaba is currently using this chip within the company to enhance product search, personalized recommendations on their website and automatic translation. Alibaba's CTO, Jeff Zhang, states that this chip is an important step to next-generation technologies, boosting computing capabilities for both businesses and improving energy-efficiency. Interestingly they are also stating that they are not going to sell this chip as a commercial product. The chip was developed by the DAMO Academy, a research institute that Alibaba launched a few years ago.

The AI technology is developing at an extremely fast pace, but as of today both Facebook and Google are still developing their own custom AI chips to improve the performance of AI tasks within their own data centres. Still American and Chinese businesses have differed a lot in terms of their AI focus. Companies like Tencent, Alibaba, and Baidu has put their main focus towards AI research and image recognition while Google, IBM, and Microsoft have focused on ML, and speech synthesis. In 2017 the "China State Council" announced a plan aiming to become a world leader in AI by 2030. Their timeline estimated that Chinese companies and research would be at level with the US in 2020. As a step towards their goal, the Chinese government has set up an "intelligence industry zone" in Tianjin together with $16 billion in funds to support the AI industry (Chen, 2018).

Europe on the other hand has fallen a bit behind in the AI race, and based on data from McKinsey`s digital survey in 2017, the same gap between Europe and China/USA remains (Bughin et al., 2019). Europe's GDP is comparable with the US and is slightly larger than China's. When it comes to the digital portion of Europe's ICT sector, we see that it only stands for 1.7% of the GDP compared to 2.1% in China, and only half the 3.3% of the US GDP. On the other hand, Europe is highly knowledgeable when it comes to AI. For instance, there are more professional developers in Europe than in the US with close to six million developers. European Commission has also taken the AI situation seriously and are putting up

a fund of public and private investments to invest €20 billion each year from over the next decade (European Commission, 2019).

2.3 Types of Artificial Intelligence

There is no doubt that AI is a multifaceted technology which provides several subsections one can apply. However, there are more general specific domains of AI under which all these extended categories fall into. Explaining the four types of AI will give some knowledge about the categorization before going further into some key areas later in the paper. According to Forbes, we have four types of AI or AI-based systems: reactive machines, limited memory machines, theory of mind, and self-aware AI (Joshi, 2019).

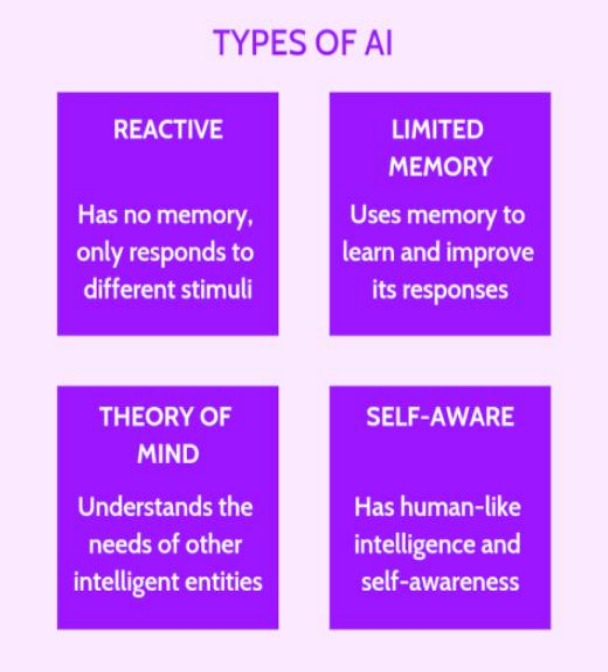


Figure 4: The four types of AI

Reactive machines are the oldest forms of AI systems that also happens to have extremely limited capability. They are fundamental since they don't have memory-based functionality or use past experiences to anticipate their future activities. Hence, these machines do not have the ability to learn and can only be used to automatically respond to a limited set or combination of inputs. They cannot be used to rely on memory to improve their operations. A

popular example of these machines is IBM's Deep Blue, which won against chess Grandmaster Garry Kasporov in 1997 by simply seeing the pawns on a chess board and respond to them. As mentioned, it cannot allude to any previous experiences and cannot improve with training. The Google AlphaGo is also another example of an AI reactive machine (Ray, 2018).

Limited memory machines can only retain data for a short amount of time. In addition to having the capabilities of reactive machines, they are also capable of learning from historical data to make future decisions. Nearly all existing applications we know of today are under this category of AI. Machine learning and deep learning algorithms are often in this space since they rely on historical data in order to give an output. So, in other words, almost all present AI applications from chatbots and virtual assistants are driven by limited memory AI (Reynoso, 2019).

Theory of mind is a powerful type of AI which has the ability to understand thoughts and emotions which affect human behaviour. This type can comprehend feelings, motives, intentions, expectations and can interact socially. In other words, theory of mind is a decision-making ability equal to the extent of a human mind, but by machines. While we have come a long way in the development and implementation of AI in today's world, we still haven't managed to make machines that are fully capable of holding conversations relative to human standards. An example of the theory of mind machine is "Sophia", who is a humanoid robot invented by Hanson Robotics in 2016.

Lastly, we have ***Self-aware*** machines that have human-level consciousness. However, this type of AI is not currently existing but would be the most powerful form of AI known to mankind. The traits of this machine are not only the ability to recognize and replicate human-like behaviour, but to think for itself, have desires and understand what it's feeling. In essence, self-aware machines are an advanced extension of theory of mind where they can and will have self-driven thoughts and reactions. They are the future generation robots and machines, making them super intelligent, sentiment and conscious. However, some researchers say that these machines may propagate threats and risks to us humans (Yaninen, 2017).

2.4 Overview of Artificial Intelligence

As mentioned in the introduction AI enhances the true power of computers and machines which enables them to act like humans. Even though we still haven't successfully conquered Turin's Test (Turing, 1950), machines that are identical to people, AI has risen quite substantially in recent years making us able to build smarter machines. The main aim has been to develop an intelligent and autonomous system which can interpret data and learn in many more dimensions. Machines are good tools for looking at high dimensional data and determine patterns. Once this is done, they can create powerful and accurate forecasts that are far better than humans are able to make. Though there are multiple subfields of AI, it would not be feasible for us to take them all into account. Given that we are doing the research within the financial sector, we also aim to make it clear which facets of the technology that can be used in our field. Hence, we have explained five capabilities of AI which already are in use and can be developed even further.

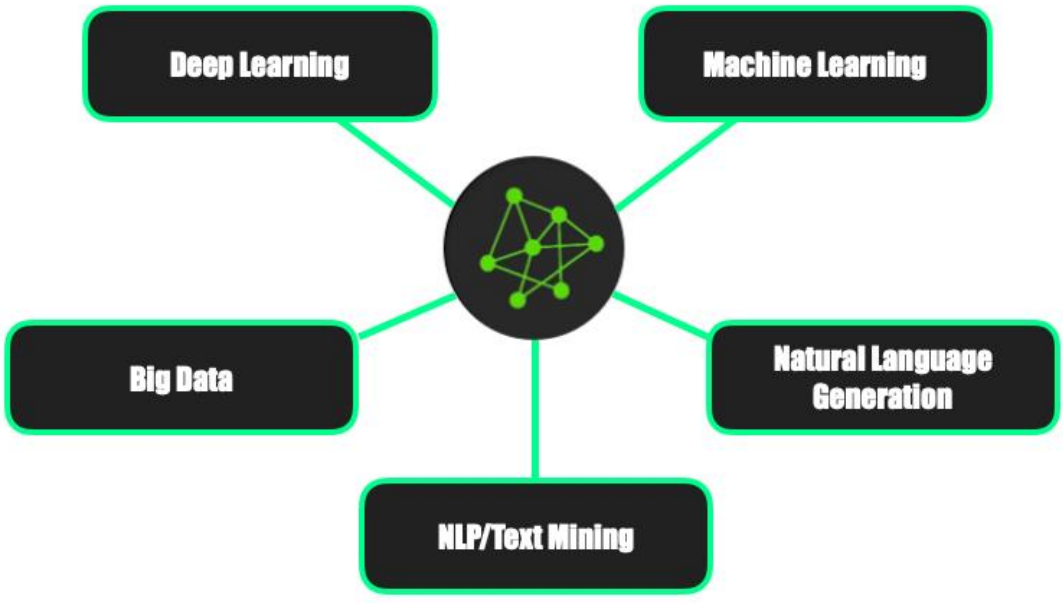


Figure 5: *Overview of AI categories*

2.4.1 Machine Learning

Most people who have some interest in technology have heard of the term machine learning which is perhaps the most core foundation of AI. ML is an application of AI that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. It focuses on the development of computer programs that can access data and use it to learn for themselves (Expert Systems, 2017). The learning process is closely related to computational statistics and begins with observations of data, instructions or direct experience. This is done to examine patterns in the data and make better decisions based on the examples provided, aiming to make the machines automatically learn and recreate the action without human intervention or assistance. Even though the AI technology started to blush in the 1950s, it wasn't until around 1980 that ML started to flourish which also later led to the rise of deep learning.

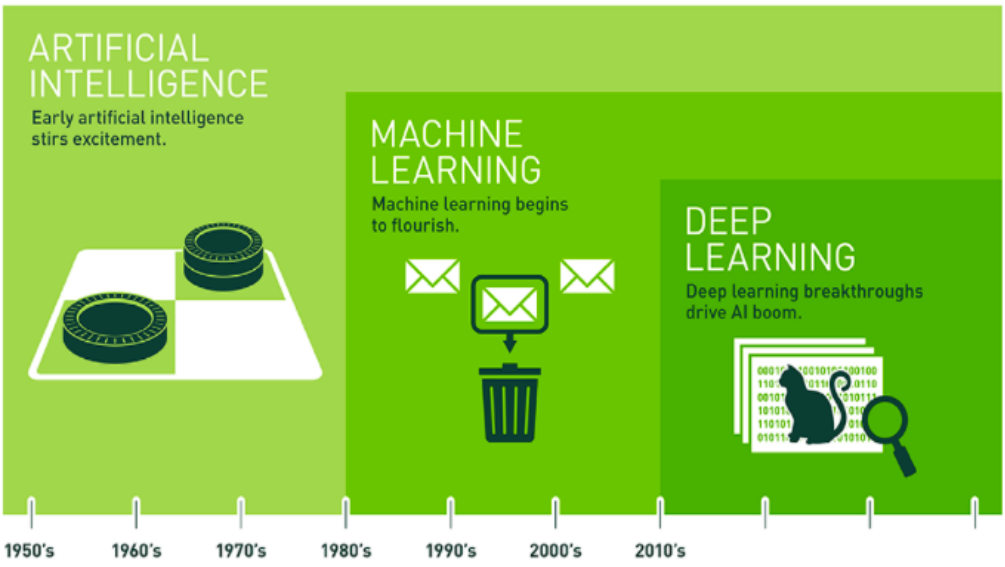


Figure 6: *History of AI*

Speaking of ML, it's also important to mention that the algorithms are often categorized into supervised ML, semi-supervised ML, unsupervised ML, and active ML (Dietrich, Heller & Yang, 2015). All four categories are explained further in detail below.

Supervised ML is the supervised version of the learning where the algorithm creates a

mathematical model from a specific package of data which also contains the inputs and desired outputs. Practically speaking, this could be a task where the machine is to determine whether certain pictures in the dataset have a distinct object in them or not. The result or output would then be a picture with some kind of label indicating that this picture does have this object appearing.

Now, in disparity from the supervised ML, ***unsupervised ML*** algorithms are used when the information or data is unlabelled and unclassified. This makes patterns hard to observe for humans and hence, the AI technology comes in good use. This can for example be a marketing campaign where the algorithms are used to examine unspecified data about segments of prospects with similar shopping habits.

Semi-supervised ML is somewhat in between supervised- and unsupervised ML where both classified and unclassified data is provided. Typically, the systems that use this kind of learning are able to increase their accuracy considerably making the algorithms less prone to mistakes with increased experience.

Lastly, ***Reinforcement ML*** provides the system with a method to measure its performance with positive reinforcement, instead of giving wanted input-output pairs. Trial and error search and delayed reward are the most relevant characteristics of this type of learning. In other words, the machine tries to solve a problem in many several ways and is rewarded with a signal if it's done successfully. This artificial behaviour is then stored in the memory and reused next time the same problem occurs.

In other terms, ML enables us to handle massive quantities of data. While it's a much faster way of detecting and delivering accurate results, it also may require a great amount of time and resources to train it properly. It's therefore important to do a cost-benefit analysis on whether this is something you should put the company's effort into. However, combining ML with AI and cognitive technologies can make it even more efficient to process large volumes of data.

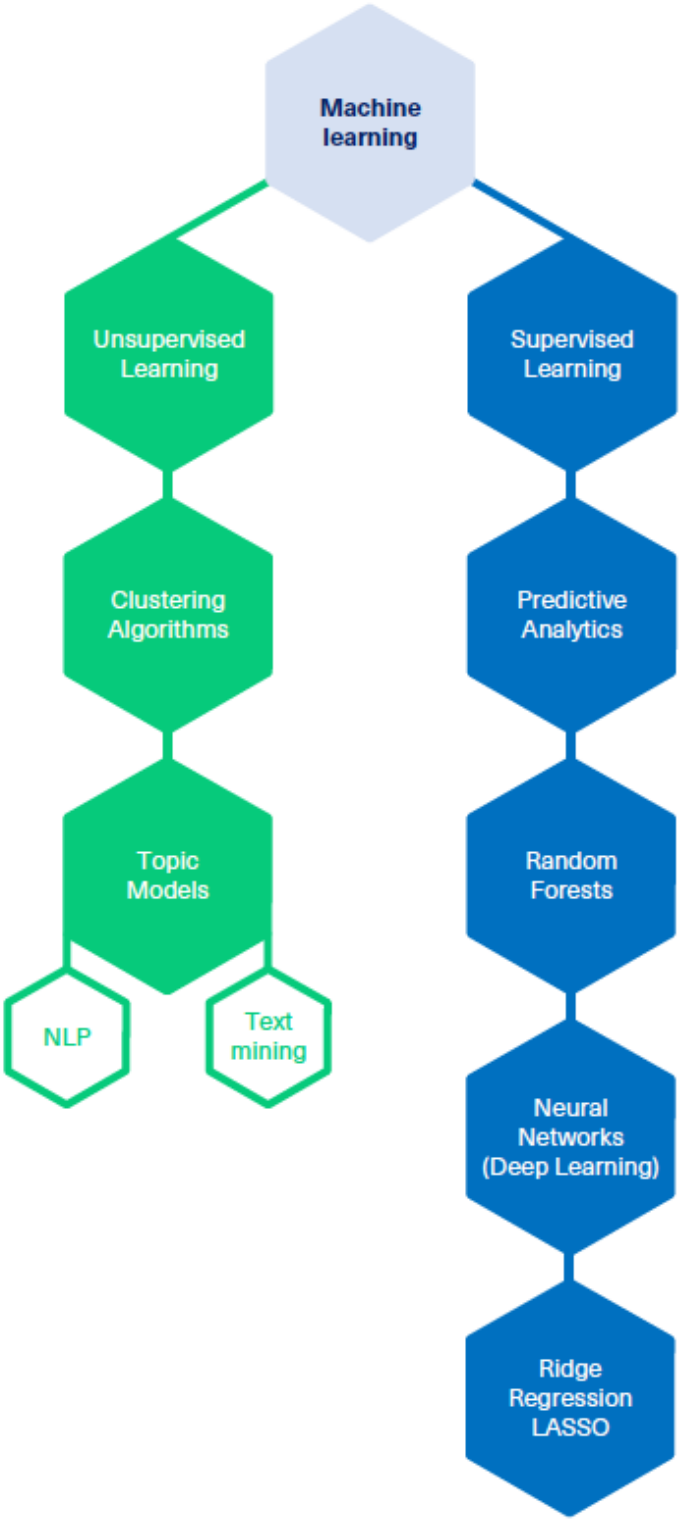


Figure 7: *ML classification*

2.4.2 Deep Learning

If we now dig deeper into ML methods, we see that DL is a part of the broader family and based on artificial neural networks, specifically convolutional neural networks (CNN)s. The term “deep learning” was first introduced to the machine learning community by Rina Dechter in 1986, and to artificial neural networks by Igor Aizenberg and colleagues in 2000, in the context of Boolean threshold neurons (Schmidhuber, 2015). Easily explained it’s a machine learning technique that teaches computers to do what comes naturally to humans. An algorithm is considered to be deep if the data is passed through a series of nonlinearities or nonlinear transformations before it gives an output. In contrast, most modern traditional ML algorithms are considered as “shallow” because the input can solitarily go through a few layers of subroutine calling. For example, in image processing, lower layers may identify edges, while higher levels only reveal the relevant concepts to humans such as digits, letters or faces (Techopedia, n.d). DL also has identically to ML ways of learning such as *supervised learning, unsupervised learning* and *Reinforcement learning.*

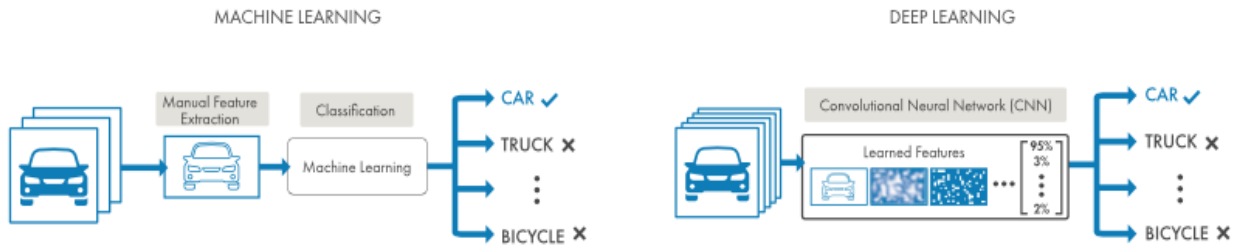


Figure 8*: Comparing a ML approach to a DL approach*

In DL, each level learns to transform its output data into a slightly more abstract representation. As mentioned above, in an image recognition application, the raw output may be a matrix of pixels where the first representational layer may abstract the pixels and encode edges. The second layer may compose and encode arrangements of edges. Moreover, the third layer may encode nose and eyes and lastly, the fourth layer may recognize that the image is an illustration of a human face.

The words “deep learning” refers to the number of layers which the data is transformed. In a more theoretical framework, the term *credit assignment path* (CAP) is used for explaining the potential causal connections between input and output (Schmidhuber, 2014). While it’s really unlimited how many depth layers CAP can have, CAP of depth 2 has been shown to be a universal approximator in the sense that it can emulate any function. However, even deeper models (CAP > 2) have shown to better extract features than shallow models and hence, extra layers help in learning the details more efficiently.

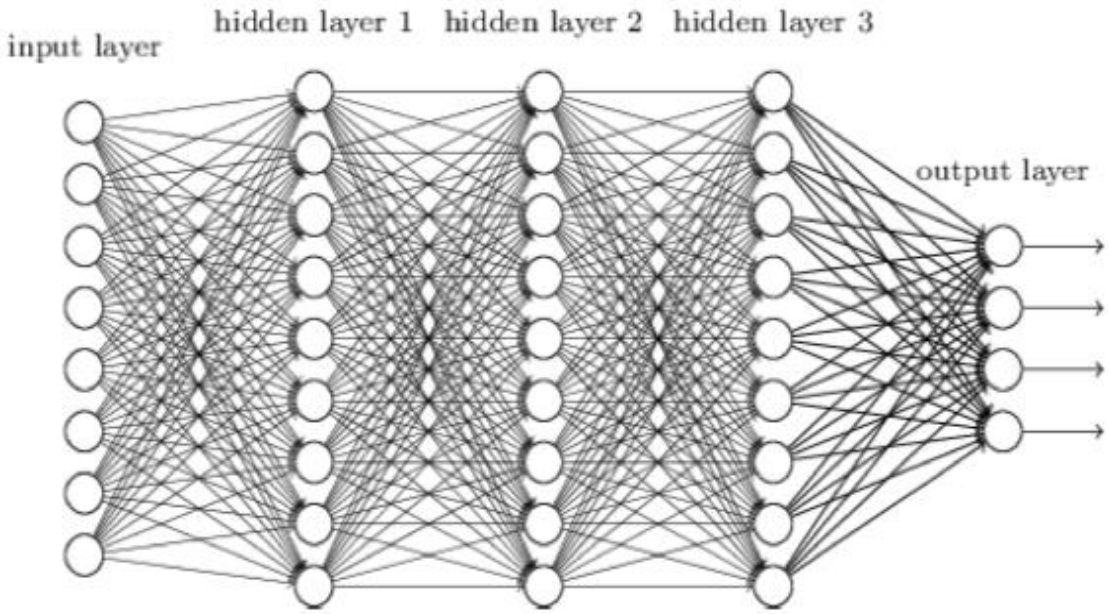


Figure 9: *Neural Networks and DL*

In terms of usage and applications, DL is widely used today in industries such as in business and automated driving (MathWorks, n.d). For example, automotive researchers are using the technology to automatically detect stop signs and traffic lights. Also, being able to recognize pedestrians is something researchers and car manufacturers work hard on conquering since it helps to mitigate accidents. Moreover, the business applications have in recent times boomed whereas tech companies such as Google for instance, is using DL in automated hearing and speech translation. For example, home assistance devices that respond to your voice and know

your preferences are powered by DL applications.

2.4.3 Big Data

Big data is creating significant new opportunities for organizations to derive new value and create advantages from their most valuable asset, information. For businesses, big data help drive efficiency, quality, and personalized products and services, producing improved levels of customer satisfaction and profit. For scientific efforts, big data analytics enable new avenues of investigation with potentially richer results and deeper insights than previously available (Dietrich, Heller & Yang, 2015). In many cases, big data analytics integrate unstructured and structured data with real time feeds and queries, opening new paths to innovation and insight. But what exactly is big data?

Explained in understandable terms, big data refers to large and diverse sets of information, that grow at ever-increasing rates. these datasets usually have sizes beyond the ability of commonly used software tools to capture, curate, analyse, and manage in a tolerable amount of time. Current usage of the term “big data” often refers to the use of predictive analytics, user behaviour analytics, or certain other advanced data analytics methods that extract value from data, and seldom to a particular size of data set. When speaking of big data, we have four attributes that stands out (Korpela, 2017).

Volume which is the quantity of generated and stored data. The size of the data determines the value and potential insight, and whether it can be interpreted as big data or not. ***Variety*** refers to the type and nature of the data. This helps people who analyse it to efficiently use the resulting insight. Big data is drawn out from text, audio, pictures and video. ***Velocity*** is an indication of the speed, which the data is generated and processed to meet the demands and challenges that lie in the path of growth and development. Lastly, we have ***Veracity,*** which is the extended definition of big data. Referring to the data quality and certainty of the information. Since the value of the data can vary greatly, it can also affect the accuracy of the analysis quite significantly.

Figure 10: *The 4 V's in big data*

AI works very well with big data due to all the facets we have talked about above. That is why they now are seemingly inseparable. ML and DL are learning from all data inputs and using them to develop new rules for future business analytics (Maryville University, n.d). However, there might arise problems when the data gathered is not trustworthy or inconvenient. with that being said, the era of big data is most assuredly here to stay at this point, and hence AI will also be in high demand for the upcoming future. AI and big data are dancing into a synergistic marriage where they both need each other to expose their full potential. AI is simply useless without data and data is hopeless without AI.

2.4.4 Text Mining/NLP

Text mining is often referred to as text analytics where the idea is to analyse large amounts of text data provided by software that can identify topics, patterns, concepts, keywords, and other attributes. During the last few years, text mining has become really practical for data scientists and business analysts to develop big data platforms and DL algorithms that can examine unstructured data. The mining helps companies to find potentially valuable business insights in corporate documents, customer emails, social network posts, and other sources of text-based data. It also does a great job when it comes to cyber threats and attacks whereas it can possibly prevent these things better than the human eye. Increasingly, text mining capabilities are also more frequently implemented into AI chatbots and virtual agents that companies develop in order to provide automated responses to customer and clients (Rouse & Stedman, 2018).

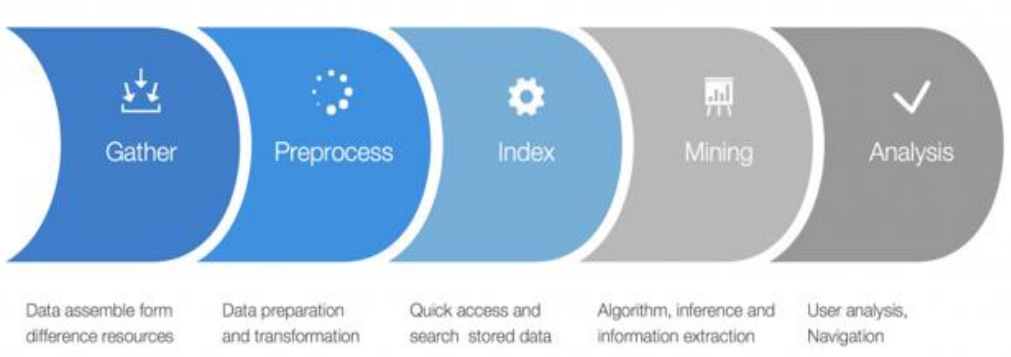


Figure 11: *The process of text mining*

The abbreviation NLP stands for "Natural Language Processing" and is a component within text mining. It's a special kind of linguistic analysis that essentially helps a machine with text reading. The analysis is quite complex and uses a variety of different methodologies to decipher the ambiguities in the human language. Some essential methods used are entity extraction, automatic summarization, part-of-speed tagging, disambiguation, relation extraction, and natural language understanding and recognition (Expert Systems, 2016). In order for the NLP to work, the software needs a large and consistent database of knowledge, such as thesauruses, datasets for linguistic, lexicon and grammatical rules. While this process may seem time consuming, it's actually not. Thanks to today's technology the vast majority of NLP software runs in the "background" while you may conduct other important tasks.

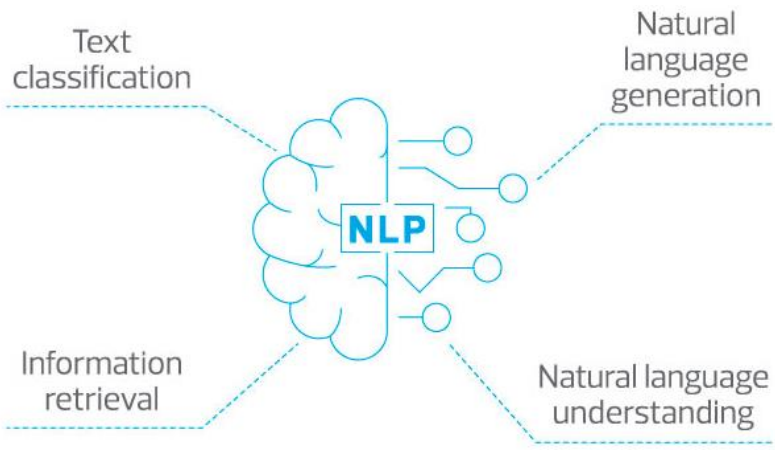


Figure 12: *The process of NLP*

For an untrained eye, it may not be easy to distinguish between text mining and NLP. However, it is very important to learn this in order to enhance the powerful value of them combined. The power of identifying and returning important information to us right away is remarkably valuable. Instead of us needing to read millions of pages of information, text mining applications does this for us. While only text mining would stop the process there, combining the two makes the process go even more in detail about the text itself (meaning, ... etc) and reveals patterns across the millions of documents in your dataset. Companies are using text mining and NLP more frequently as there are constantly new features and applications popping up in today's highly technologically driven world. For instance, text mining is being used in screening job candidates based on the wording in their resumes, classifying website content, blocking spam emails, flagging insurance claims that may be fraudulent, and examining corporate documents as part of the electronic discovery process (Rouse, 2010). On the other hand, since NLG technology mines the documents and data it's appointed, it can create text on its own. For example, some NLG algorithms are used to write descriptions of neighbourhoods for real estate listings and explanations for key performance indicators (KPIs) tracked by business intelligence systems.

2.4.5 Natural Language Generation

Natural Language Generation (NLG) is a subsection of AI and is often misinterpreted with NLP even though they both are two different categories. The important key here is to understand the last wording in the names which are "processing" and "generation". Unlike NLP, the NLG software generates structured data into written narrative, writing like us humans but in the speed of lightning (Rouse & Stedman, 2018). The velocity can vary from thousands of pages to millions per second depending on which machine that's being used. The magnificent speed of NLG makes it useful for producing news and other time sensitive content on the internet and is in fact so accurate that the output often can be published precisely as web content.

There are several stages in this "generation" process according to Dale and Reiter (2000). The first stage is called ***Content Determination*** where the software decides what information to mention in the text. The second stage is called ***Document Constructing*** and is about the

organization of the information transfer. The next stage is called ***Aggregation*** where we have merging of similar sentences to improve readability and naturalness, whereas alongside aggregation we have ***Lexical Choice.*** This stage is putting words to the concepts in the text giving them a more whole and descriptive meaning. ***Referring Expression Generation*** is about creating objects and regions in the data, giving some geographical descriptiveness. This task also includes making decisions about pronouns and other types of anaphora. Last but not least we have ***Realization*** which is about creating the actual text. This should be appropriate according to the rules of syntax, orthography, and morphology. However, an alternative way of NLG is to use end-to-end ML to build a system without having all the sections just mentioned. This method has perhaps been the most successful approach in image captioning, that is automatically generating textual captions for an image (Heriot-Watt University, 2017).

Nowadays there are significant commercial interest in using NLG to summarise financial and business data. In fact, Gartner Inc. which is a S&P 500 company traded at the New York Stock Exchange (NYSE), has said that NLG will become a standard future of 90% of modern business intelligence and analytics platforms (Panetta, 2017). Since 2009, there have been several companies induced which builds software or systems that transform data into narrative using AI and NLG techniques. Just to mention some of them, Narrative Science, Arria NLG, Automated Insights, Phrasetech, Yseop and United Robots.

2.5 Coding Languages Used in Artificial Intelligence

Now that we have introduced AI in depth and explained in detail what it is, you are probably wondering about how all this works in real life. How is AI actually applied in practice? And how are machines programmed to conduct all these intelligent behaviours? Well, it all starts will algorithms which is a process where a set of rules are to be followed in calculations or other problem-solving operations, especially by a computer. In other words, the algorithms are shortcuts that help us give instructions to computers. It tells the computer what to do next with an “and”, “or”, “if” or “not” statement. Like most problems in mathematics the computational codes start of fairly easy and goes into an infinitely complex script only very experienced data scientists or mathematicians can understand and edit. There are several

different ways of writing AI codes and we will introduce the five most widely used programming languages below (Nautiyal, 2019).

2.5.1 Python

Python is perhaps the most favourable programme to use among AI developers since its syntax is simple and widely versatile. Therefore, many AI algorithms can be implemented in it and are easily edited if necessary. Compared to other programming languages such as Ruby, C++, and Java development takes significantly less time and Python supports object-oriented, functional as well as procedure-oriented styles of programming. Also, there are plenty of libraries in the language, which makes some tasks much more convenient to run in Python. For example, we have “Numpy”, which is a library that helps us to solve many scientific computations. In addition to that, we have “Pybrain”, which is used for machine learning. Some drawbacks of Python may be that it’s not well suited for mobile computing since it’s mostly developed for computer tasks. Moreover, programmers accustomed to using Python often face difficulties in adjusting different syntax when they try using other languages to programme AI.

2.5.2 R

R is one of the most effective programming languages in the world when it comes to analysing and manipulating data for statistical processes. The plots one can create using R, are well-designed and including mathematical symbols and formulas where needed isn’t a problem either. The fact that it’s a general programming language, does not limit its capabilities. R has numerous packages such as “RODBC”, “Gmodels”, “Class”, and “TM” which are used in the field of machine learning. These packages make the implementation of AI algorithms easy, for cracking the business associated problems.

2.5.3 LISP

Another programming language for AI development is LISP. It’s the second oldest programming language out there and has over time shown to become a strong and dynamic coding language. Lisp was created in 1958 by John McCarthy, the father of AI. It is excellent

for prototyping capabilities and dynamic creation of new objects, with automated garbage collection. Further, its development cycle allows interactive evaluation of expressions and recompilation of functions of file while the programme is still running. LISP, unlike other coding languages, is more efficient in solving specific problems as it adapts to the needs of the solutions a developer is writing. It's highly usable in inductive logic projects and ML. A drawback of LISP in AI is that there are few developers left who are well acquainted with it since it's seen upon as outdated.

2.5.4 Prolog

Prolog is also one of the oldest programming languages out there and was specifically designed for AI development and computational linguistics. In terms of interaction it's quite similar to LISP by offering a number of features helpful for solving logic problems and facilitating expert systems for ML. For example, some of the features include efficient pattern matching, tree-based data structuring and automatic backtracking. All these traits provide a surprisingly powerful and flexible programming framework. Efficiency and easy to use are both pros of Prolog while it shares a con with LISP, whereas there are quite a few developers who are not well acquainted with it due to outdatedness.

2.5.5 Java

Unlike the programmes mentioned above, Java is more of a versatile purposed programming language which also happens to be a good tool for AI development. Since AI has a lot to do with searching algorithms, neural networks, and genetic programming, Java provides a lot of benefits. Like C and C++, it is used a lot for writing applications and hence, it has integrated a lot of the same syntaxes. Once code has been written in Java, it can be read or run anywhere. Making it really fast adopting and quite dynamic. Some of Java's traits are that it's easy to use, have a good library of packages, debugging ease, graphical representation of data, and better user interaction than the vast majority of other coding languages. Last but not least it has Swing and SWT (Standard Widget Toolkit) which are tools for making graphics and interfaces even more appealing and more sophisticated. A major drawback of Java is its performance. It's time-consuming and significantly slower than some of the natively compiled languages.

Figure 13: *Python, R, LISP, Prolog, and Java*

2.6 Ethical Dilemmas with Artificial Intelligence

While there are countless of possibilities within AI, we must not forget that in many ways this is just a new frontier for ethics and risk assessment as it is for the emerging technology. From optimizing supply chains to chatting with Amazon's "Alexa" and Apple's "Siri", artificial intelligence has a heavily impact on our economy and society. Over the years as technology grows immensely, the need for ethics and regulations propagates as well. What ethical dilemmas may AI expose us to? The World Economic Forum mentions 9 possible ethical dilemmas we humans must face during the implementation and further development of AI (Bossmann, 2016). We will now address these briefly below.

2.6.1 Unemployment

Is Artificial intelligence getting rid of jobs? This concern rapidly keeps popping up then talking about robotization and AI. As we already have automated labour extensively, we have still created room for people to do more complex tasks, moving from the physical labour that dominated the pre-industrial market to more cognitive and strategic ways of working. A highly exposed labour market towards automatization is trucking. What will happen if Elon Musk's promised self-driving trucks are widely available in the next decade? This is the crossroad for humans where we need to answer the question about how we are going to spend our time. While most people today rely on their income to pay for bills and sustain their families, we can only hope that AI will make people find non-labour activities. Anything from caring for their families to be more active within the communities, learning how to be more proactive, and contribute to the human society. Who knows, maybe one day we'll look back in time and think that we were crazy to use your valuable and brief years on earth doing labour

just to be able to live.

2.6.2 Wealth Inequality

Another dilemma Bossmann (2016) talks about in the World Economic Forum is how we will distribute the wealth created by machines. The world's economy is based on a compensation system where we are paid for contributing to the economy. Most companies today are still using hourly wage for employees but for the wealthy companies that are able to implement AI, their wage costs will mitigate significantly. This means that they will make at least the same profits and distribute it between fewer people. Hence, individuals who have ownership in AI driven companies will make all the money, making the gap between wealthy and poor even greater than it already is in some countries. The governments and big corporations should therefore start thinking of how we can redistribute that wealth so that everyone can participate in our future economy.

2.6.3 Humanity

How will machines affect our human behaviour and interaction? The level of machine sophistication has increased tremendously the past years and they are more capable of holding a conversation with humans than ever. For example, we have Apple's "Siri" and Amazon's "Alexa" who are able to interact and speak to humans to a certain extent where they reply and execute commands based on the input they get. Through the coming years we will interact with machines even more whether it's in customer service or sales. While we humans have a limitation in terms of attention and kindness expected from each other, robots can convey literally unlimited amount of resources into building relationships. The most important thing is that humans and machines should be able to interact and build relationships with each other in an ideal world. Because if we don't have the ability to interact, we will lose an important piece of our human nature which is significant to us.

2.6.4 Artificial Stupidity

As mentioned earlier, machines accumulate intelligence through learning. They learn how to detect the right patterns and act according to their input. But obviously, the machine cannot

ever be trained to handle all possible examples that might come up in the real world. In this way, machines have a higher chance of getting fooled compared to humans. For example, random dot patterns can help machines to see things that aren't there. If we trust AI to bring us into a new world of labour, economics and efficiency, it's important that we trust the technology and ensures that others can't overpower it to use it for their own benefits.

2.6.5 Bias

Another huge ethical dilemma in focus is about the biases of AI. Is AI fair? How can we eliminate AI bias? Although the technology is fast, efficient and much more precise than humans, it fair to say that machines have their flaws of their own and may not always be neutral. AI takes on the biases from datasets it learns from. That is, if researchers train a machine on data that are skewed for race, gender, education, wealth etc., the machine will implement that bias. For instance, an AI application in the US used to predict future criminals, showed higher risk scores and recommended stricter penalties for black people compared to white people. This was based on racial bias in America's criminal incarceration data.

Hence, it's important to not forget that even AI is made and based on human preferences. Also, there is no such thing as a perfect dataset. There will always be challenges and not all challenges can be addressed so quickly. Mitigating bias and providing training making the machines understand the importance of equality is a major aspect to address in order for AI to be sustainable and in line with ethical behaviour.

2.6.6 Security

It's safe to say that with more intelligence and power, comes a greater responsibility. With the development of AI, security becomes more important as they can be used for nefarious reasons as well as good. This applies not only to robots produced for war, autonomous weapons, but also to AI systems that can cause great damage if used the wrong way or by the wrong people. Throughout the history of war, the setting has been mostly barbaric and bloody resulting in massive casualties. However, in this century and in the future, the fights will not only be at the battleground as digitization has led to an emerging digital war platform. The

importance of cyber security has never been more important as we need to protect confidential information and personal data from getting into the wrong hands.

2.6.7 Evil Geniuses

Now, it's not just adversaries we need to protect us against. How do we protect ourselves against AI if it suddenly decided to go against us? With "evil" we don't think about the machines directly turning evil but rather machines that suddenly made actions that had terrible unforeseen consequences. However, when speaking of machines, they are very unlikely to be malice at any point of time. They will rather be untrained to understand the full context in some situations, making them unpredictable and potentially dangerous. For example, if machines were assigned to cure cancer and at some point, they eventually do by killing everyone on the planet. The machines have been successful at their task, but obviously not in the way humans wanted it.

2.6.8 Singularity

How can we stay in control of a complex intelligent system? The reason we humans are on top of the food chain isn't because we are muscularly dominant, have sharp claws and teeth. The reason is that we are the most intelligent specie on earth with our mind and ingenuity. We are more superior, bigger, stronger, and furious animals than because we know how to create tools to capture and control them. This leads to the question about AI and if machines will someday do the same thing to us. Will it one day have the same advantage towards us? When machines and AI is developed to an extent where they are fully functional and self-fulfilling, we cannot rely on pulling the plug on them since they most likely would anticipate that and defend themselves. This is what the World Economic Forum defines as the "Singularity Problem", simply the point in time where humans no longer are the most intelligence species in the world.

2.6.9 Robot Rights

How do we define the human treatment of AI? A more conceptual ethical concern is whether the machines should have rights. Given that they are in most cases just computer codes, it

would be easy to think that they wouldn't have any feelings. Could we consider a system to be suffering if the output given is negative? As of now, these systems are fairly superficial but further down the road when we have developed them into individual entities that can perceive, feel and act, it's not an unfair question to ponder their legal status. For example, you could scream at Siri or Alexa without making them sad or hurting their feelings.

Some ethical challenges are about reducing the suffering and risking negative outcomes. With the AI technology becoming smarter is obvious that we want them to be on our side and create a harmonically relationship based on mutual respect. Therefore, codifying humane treatment of machines could play a significant role in that. Because at the end of the day, we want them to be our friends, not enemies.

3.0 How Artificial Intelligence is Changing Financial Services

The financial industry is one of the largest spenders towards AI services and the use is growing fast. Hedge funds and high-frequency (HFT) trading businesses were the first users of AI, but different applications have now infiltrated other areas within the financial industry such as banks, insurance companies, regulators, and different FinTech platforms (Citibank, 2018). Within these industries we see a lot of different AI applications and the numbers are increasing fast. Some of the most relevant features include algorithmic trading, portfolio composition and optimisation, robotic advisory services, virtual customer assistants, market analysis, and other types of analysis with huge amount of data. We are going to focus towards a few of these specific use cases where AI is transforming the current traditional financial services.

3.1 Algorithmic Trading

Algorithmic trading (AT) also called "Automated Trading System", has become one of the main players in the global financial markets. AT goes all the way back to the 1970s when computerized trading systems were introduced in American financial markets (Chen, 2019). Cartea et al (2015) defines AT as the implementation of trading rules into a sophisticated program and then use it to trade. Today, AT has implemented complex AI systems that are able to act extremely fast and hence, able to trade immensely faster than humans. HFT and computers generates 50-70% of all trades in equity markets and 60% of futures trades (Seth, 2019). Some estimate this number to be even higher in the US and a bit lower in emerging markets such as India with about 40%.

So why is AT so commonly used? Well, there are several reasons. First of all, these programs have the ability to execute trades at the best possible price. Secondly, a computer has a much lower risk for making mistakes compared to a human. Next is the ability to deal with tons of data all at once and check multiple markets at the same time. Lastly, is the fact that when using a computer, human emotions does not affect the trading or is likely to reduce irrational decisions. Ideally, to be able to use AT and HFT we need to have the lowest possible time delays and a high grade of automatization and integration capabilities within the stock exchange. HTF trading is most dominated by proprietary trading firms spread across different

securities such as equities, index funds, ETFs, and derivatives. Hedge funds, bank proprietary trading desks, and corporates are also known for utilizing HTF (Seth, 2019).

Today AT and HFT systems are able to make trades in milliseconds. The research paper "The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Response", reveals the potential of HTF algorithms to detect minor changes and capitalize on these micro changes (Budish, Cramton & Shim, 2015). The graphs below show tick-by-tick price movements of E-mini S&P 500 futures (ES) and SPDR S&P 500 ETFs at different time frequencies. When zooming into the graphs we see that the price difference between two securities are significant. At first glance they look perfectly correlated. The deeper one zooms into the graphs, the greater price differences can be found between two securities. In this case what seems perfectly correlated ends up being very profitable in perspective of super-fast AT bots.

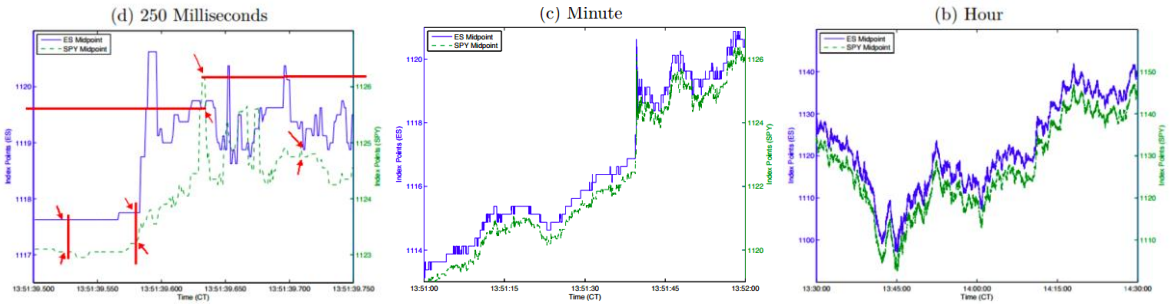


Figure 14: *Algorithmic trading with different time horizons*

These margins might seem small, but the algorithmic trading systems are able to make millions of these small trades every day, with potential of making huge profits. There have been several discussions whether it is a good thing or not. Some argue that AT helps with price discovery and also improved efficiency in the trading market by making it more liquid. Hendershott and Riordan (2013) stated that AT could provide a more stable market, and Menkveld (2014) says that AT could reduce trading costs. They are also stating that the

traditional field of market microstructure will continue to be changed because of development in new AI and DL technology.

There are several other use cases of AT in the financial industry today. One of these technologies is the AT strategy known as “news reader”. This technology scans for news headlines and articles and is trained to react in a certain way based on this news. Next, is the “pattern recognition” technology that enables machines to see, learn, and react based on different patterns. Third, is the “signal processing” which is a mathematical extension of complex technical analysis. The signal processing technology is filtering information to eliminate false information and get more correct discern trading patterns. Finally, we have the “market sentiment” where the computer is not aware of the market activity until we feed it with data. The objective of this form of AT is to provide the algorithm sufficient data to analyse as well as learn market psychology (supply and demand).

Still many people are sceptic to AT, especially the traditional trader seems to be sceptical because of the lack in transparency and black box problems. Black box problem is the potential problem that might occur with an IT system, such a hacking (Breton, 2018). Other problems are the model risk and that the nature of AT may not be perfectly accurate with the world as we see it. Traders are also often copying other strategies without backing the underlying value of the asset being traded. Some might also have valuable inside information that is not available to the public. This is something AT cannot predict. AT have not been flawless and has been blamed several times for the “Flash Crash” at the S&P 500 in May 2010 when the index plummeted more than 7% before it quickly rebounded back. This crash has been known for being the first market crash due to new automated trading (Mitchell, 2019).

Interestingly, we found “algorithm aversion”. Many empirical studies show that evidence-based algorithms are able to predict the future far better than humans. But when a human is choosing between a man-made forecast or an artificial one, he or she will most likely choose the first one (Dietvorst, Simmons & Massey, 2014). Even after humans have seen an algorithm perform, they are more likely to choose the forecast from a human. This is because a human is more willing to accept failure from a human than a computer.

Dietvorst et al (2014) also saw that participants were most willing to use AT as long as humans were able to modify the algorithms. Psychologically explained, this is because humans want to have some control over the forecasting results. Still, UBS and JP Morgan have already started using AT and AI technology as their trading tools. Today, UBS uses AI technology to trade on volatility and JP Morgan uses AI algorithms on equity trades.

3.2 Fraud Detection and Compliance

We have seen a boom in the e-commerce market the last decade and as a result to this market trend online fraud has also increased. In US banks spend more than $70 billion each year on compliance because banks can get huge fines imposed upon them if they fail to stop fraud og illegal financing (Chinner, 2018). As a part of their compliance, banks are now implementing AI technologies to make these processes more efficient and accurate. Moreover, McAfee has estimated that cybercrimes current cost the global economy about $600 billion yearly whereas credit card fraud is the most common one.

Benford's Law has existed all the way back to late 18th century and is the simplest way to detect fraud. Benford's Law is accomplished with an analysis of the first digits in a given dataset. ML, a part of AI is used to analyse millions of data points to detect attempts on fraud that would take an enormous amount of time for a human to go through. ML are also able to actively learn and calibrate to improve the precision and reduce false rejections. One of the most successful fraud detection applications with ML is within credit cards. Based on monitoring systems that are based on previous data, algorithm training and back testing, banks today are way more efficient in rejecting and accepting credit card payments. The AI applications are also able to flag transactions and put them into different risk groups so that the bank can keep control and dig deeper into some of the transactions (Van Liebergen, 2017).

Today different financial companies are implementing AI to detect fraud. One of them is Mastercard. Their AI application called “Decision Intelligence” is using existing data to see patterns from historical use of their cards to establish a “standard transaction”, then Mastercard compares and scores every transaction from new customers up against their standard transaction. Another challenge in fraud detection and compliance is to decline

transactions too aggressively. The Javelin Strategy Report (2015) says that wrongly declined transactions is a big threat to financial services. They stated in the report that these “false positive” declined transactions account for $118 billion in retail losses as a result of credit cards being incorrect declined.

3.3 Chatbots and Robotic Advisory Services

Financial services has in recent years started to implement AI-based systems to make their businesses more efficient. Traditionally, large financial companies have a large client base and are therefore implementing automated services such as chatbots to make their interaction with customers more efficient. A chatbot is able to answer customers immediately and are able to deliver 24-hour service 7 days a week, and 64% of individuals are positive to interacting with a chatbot as they often are more secure and effective than talking to a human. These chatbots interfaces are able to handle millions of customers with a high grade of user experience at a very low cost. Juniper Research study states that banks are on average saving 4 minutes handling each customer with chatbots saving them a lot of labour cost (Medium, 2019).

The term Chatbot and robotic advisory is actually misleading since it does not include a robot. Instead at chatbot is based on NLP and ML algorithms written to provide a personalized conversational system. Robotic advisory are algorithms written to find the best portfolio for a customer based on the user's risk tolerance and goals. Today the savings of using Chatbots have made it almost an industry standard for financial companies with a large user base such as banks as insurance companies. Based on how popular millennials are with interacting with AI systems this is only the beginning. Some studies found that millennials prefer to interact with the company using AI rather than talking to a person. On average only 12% preferred talking to a person (Mubarak, 2019).

Today there are different AI applications improving financial services. One of the robotic advisory applications that help users manage their money and savings are an application called Clerkie. Clerkie is a combination of a chatbot and a robotic advisory application that can control all your financials with the use of your smartphone (Clerkie, 2019). You can apply for loans from different banks and the AI engine are able to analyse customers income and

spending to estimate how much they are able to spend and how much they should save. They are also offer different investment solutions based on your risk profile and time horizon. Within the app you also get a credit score which is needed to apply for loans and open credit accounts in the US.

Another AI application is JP Morgan`s "COiN". This is an AI application able to review documents and extract data faster than a human. Their system "COiN" is able to read about 12.000 documents within a few seconds, while this would take a huma more than 360 000 hours of work to get through the same documents (Son, 2017).

Rohner and Uhl (2017) have found three general advantages with robotic advisory and put them into three groups. The first is access to and rebalancing of rule-based investment strategies. The second advantage is the cost efficiency where one should be able to have a well-diversified asset allocation at a low cost. Lastly, are the behavioural biases. They found that robotic advisory applications could save costs up to 4.4% per year compared to traditional investment advice.

3.4 Cyber Security

Cyber security is a big deal. Security comes in many forms such as security for documents, information, property etc., and is constantly being improved through today's era of technology. Moreover, our world as we know it today is reinforced with network technology, from internet banking to governmental infrastructure. Thus, cyber security and data protection are crucial since they mitigate the risk of losing valuable and sensitive data. In fact, according to a 2014 CNBC report, the global economy is allegedly losing US $400 million each year because of cybercrimes (Thompson, 2014). The weakest link in this context is the human factor and it's also the main reason why cyber security often fails. To address this weakness, automated systems such as artificial intelligence applications are widely used in the cyber security space.

As we have seen, AI has limitless potential across several industries and markets. Likewise, implementing a stronger cyber security network with the help of AI can make organizations protected against cyber threats and identify newer malwares too. Moreover, these security

models can ensure efficient security standards and prevent mistakes, making it a no-brainer to implement in many cases. Nonetheless, it is also important to be aware of the fact that future AI chips could have malware and spyware installed in them due to various reasons such political interest. According to Forbes, AI have several usage areas in cyber security whereas the first one we will be covering is biometric logins (Joshi, 2019).

Just days before Black Friday in 2018, Amazons security network was breached by hackers and both email addresses, personal and credit card information from thousands of customers were compromised (Brignall, 2018). As a post action, the Amazon officials told their customers to change passwords in order to make sure that the hackers were denied access to accounts. However, many security experts made it clear that Amazon and other companies must be better suited for these kinds of attacks and the usage of AI was brought up several times. Only changing the password may not be sufficient in today's world of technology as hackers are mastering the skill of breaching passwords and encrypted data. Therefore, deploying AI in this space has introduced us to different kinds of *biometric logins* for a more secure access. Some of these AI applications are fingerprint scanners, retina and palm prints, and facial recognition. Just by implementing these functions in addition to the traditional password, we are increasing the barrier for hackers immensely. It’s worth mentioning that most smartphones on the market today have these functions already and there is a pretty good change that you who are reading this thesis have to either unlock your phone by scanning your finger or face.

The next application we are talking about is *detecting threats and malicious activities*. Conventional cyber security systems utilize advanced threat prevention to detect and protect against cyber-attacks. However, year to date there have been created over 968 million malwares, up from 845 million in 2018 (AV Test, 2019). This emphasizes the significant importance of precautions for you and me as well as companies and government infrastructures. The rapid growth of vicious malware is due to traditional cyber security systems, that are not well adapted for handling these new threats. Therefore, implementing AI systems would mitigate the growth of malware and the proportion of successful damage made. Cyber security firms are training AI systems to identify viruses and dangerous malware by using many data sets that include advanced algorithms and code. This way, AI can run

pattern recognition that helps discovering malicious behaviour in software and data. Further, ML can actually predict paths in software and on websites that will navigate you to infected domains. Likewise, AI applications can indicate malicious files, like web shell, and instantly isolate you from the system. Also, AI can be trained to analyse micro-behaviour of ransomware attacks to recognize ransomware before it encrypts a system. Lastly, the use of AI predictive analytics to AI based alternatives will always make it far quicker and more efficient compared to a manual approach.

The third and one of the most significant reasons to use AI in the cyber security space is the potential of *Natural Language Processing* which also was mentioned in the last section. AI technology can quickly and automatically collect data for reference by scanning articles, studies, and news on cyber threats. Making it a great advantage in staying cope with the rapidly growing number of viruses and malware. As explained before, NLP is a way for AI technology to scan and collect valuable information from different texts, data, and websites. such information can help us to mitigate the risk of anomalies, cyber-attacks and strengthening our prevention strategies. By further analysing this information we can then calculate risk, identify timescales and harvest insightful data to make precise predictions. Therefore, the use of AI in this area can help us immensely with our prediction and preparational power to save organizations, infrastructures and sensitive information.

Lastly, we have *securing conditional access.* Companies and organizations usually use an authentication-based system to keep vital data from unwanted parties and intruders. Many companies allow you to work from home. It’s then important to be able to access sensitive data remotely from the organization’s own network and this makes the security system more prone to cyber-attacks and hackers. By implementing AI, one can allow for more flexibility in the company and make the cyber security system more agile and dynamic such that threats are effectively compromised even when you are remote. In order to have a global authentication system that alters access privileges based on location and network, one can deploy Multi-Factor Authentication systems. In this way, the AI system collects user information to analyse the behaviour of the user, applications, devices, networks, data and locations in order to change any user’s access privileges to establish efficient cyber security even on remote networks.

Even though we want secure networks that prevents hackers and malicious malware, we need to keep in mind that AI is not something that is fully developed yet and as much as it has its benefits, it also does have limitations. Deploying AI too soon may disrupt the mainstream adoption to technology. One of the negative traits is that maintaining AI systems require an immense amount of resources, capacity, computing power, and data. Companies need to constantly cope with the threats out there and feed the AI system with relevant data about malware to keep the computers up to date. Besides, the data used in training needs to be accurate, whereas providing inaccurate data can make the whole process fail during a real attack. Also, similar to ethical hackers and cyber security experts, criminal hackers too have the ability to train their systems. Thereby, making more advanced code and malware that are AI-proof. Using their own principles, hackers can outperform other AI systems out there today and make the whole cyberspace a very infected and dangerous place to store data and records. All this emphasizes the need for persistency and accuracy in AI development before deploying the technology in vital online networks.

3.5 Accounting and Auditing

The field of accounting and auditing is undergoing a fundamental change due to advancement in data analytics and AI. Looking back at the Deep Shift 2015 report from The World Economic Forum, 816 senior executives from the information technology and communication sector were in on a survey about *Technology Tipping Points and Societal Impact*. They reported that 75% of respondents agreed that a tipping point of 30% of corporate audits performed by AI will be achieved by 2025 (World Economic Forum, 2015). One of AI's best traits is that it's excellent at matching patterns, which makes the technology amenable in several sectors and large companies. The Deep Shift report clearly emphasizes that in the coming years, more and more jobs will be replaced by automated processes and robots. As we can see from the figure below, accounting and auditing goes under "Management, Business, and Financial" and will with a very high probability be automatized with a large fraction within the next 10-20 years. This only takes into account the US economy. Looking at it from a global scale, the changes will be significantly greater.

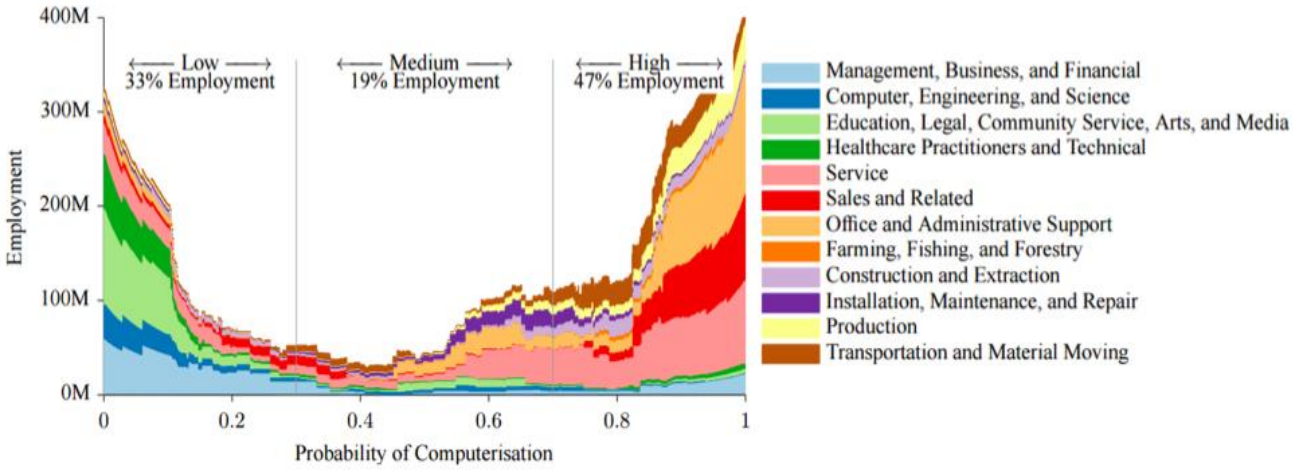


Figure 15: *Distribution of US occupational employment over computerization*

Auditing is especially well suited for applications for AI and business analytics because it has become quite challenging to implement huge volumes of both structured and unstructured data in order to gain insights into financial and nonfinancial performance of companies. Moreover, since many of the tasks in auditing are structured and repetitive, a collaboration with AI can automatize these processes. We know that each of the four large consultancy companies are heavily invested into AI and particularly in auditing. Just to mention some recent news, we have KPMG who has partnered with IBM's Watson AI to develop AI auditing tools (Melendez, 2016). Then we have PriceWaterhouseCoopers (PwC) who has developed Halo, an analytics platform that functions as a pipeline to AI and augmented reality products (Beedham, 2019). Deloitte has also heavily invested into AI with the development of Argus for AI and Otix for data analytics (Deloitte, 2018). Lastly, EY has developed their own AI platform with the help of Microsoft Azure, in addition to hiring many new tech heads that can help them improve and develop the system further (EY, 2019).

To look at more specific cases, AI can be used to automatically code account entries and to develop and improve fraud detection models by creating sophisticated ML code. As for the audit sector, there are more advanced AI technology such as DL that can analyse both structured and unstructured data in order to assemble reports or predict precise forecasts. The range of data DL can scan is very immense and can include anything from social media posts,

audio files, conference calls, and emails. By implementing AI in accounting and audit one can review contracts more thoroughly by allowing a larger amount of data to be scanned.

EY and other companies are actually using this technology today for reading and extracting information from different lease contracts, making it much more efficient and faster than a manual assessment (Boillet, 2018). By making it possible for auditors and accountants to use these analytical tools, one can optimize time and hence, having more time to make human judgements to analyse the data. Furthermore, it also enables them to interact better with CFOs, audit committees, company boards, and ask better questions in order to deliver a product for the client that is overall better. Last but not least, this whole shift of technology in the audit and accounting sector may also contribute to making the future in these sectors more exciting and appealing.

3.6 Other Applications of Artificial Intelligence

We have seen that AI has been integrated within the banking and insurance industry when it comes to approving loans, talk to customers, assessing risk, and manage assets. Further, we have elaborated on the usage of AI in cyber security, accounting and auditing, algorithmic trading, and chatbots and robotic advisory services. With that being said, there are also other applications of AI in financial services that we want to briefly mention.

One of them is within recruitment processes. AI systems which use ML algorithms are now able to recruit new people as well as the new company director based on sophisticated algorithms (Forbes, 2018). These algorithms quickly assess your qualifications, merits, and traits based on provided resume or data. This process is both time saving for the recruiting company as well as being an ethical approach that leaves out potential biases towards gender, ethnicity, and race. Whereas candidates are strictly chosen based on their qualifications. When it comes to selecting company directors, Weisbach et al. (2019) found that ML could predict the success of a new director. Directors that were predicted to perform poorly by the algorithms ended up performing worse than the directors that were predicted to perform well.

Also, business proposals are something very important in finance (Forbes, 2018). Automatization of business proposals allow for a more thoroughly process where one is

reviewing terms and conditions as well as valuations. Further, one can paint a quick picture about contractors' historical performance, asset pricing, risk exposure and expected profitability relative to the proposed business agreement one has derived. This allows for a more transparent situation where companies and clients get much more efficiency in a process that is very often time consuming and complex. Cutting expensive costs in this area, may make the whole business proposal more profitable than initially expected.

4.0 Methodology

In this part we will present the methodology used to answer the research questions. A qualitative research approach was taken due to the novelty and uncertainty linked with AI. McNamara and Bono (2011), suggests that the methodology is thoughtfully chosen to ensure that the results do not depend on the method used, but instead reflect the nature of the reality as precisely as possible. First, we will present research design and justify our methodology. Next step, the data collection process is explained in detail, followed by which techniques we have used in order to conduct analysis in the paper. Further, we will also explain key areas within empirical research that concerns validity, reliability, and research ethics. Lastly, we discuss weaknesses with the research and possible limitations that are important to account for.

4.1 Research Method

Research Design

Briefly explained, a research design is an overall plan on how to design and assess the research question (Yin, 2017). The choice of methodology should be based on which questions one is assessing and to what extent one has control over the phenomenon of study. As mentioned in part 1.3, we have five objectives given attention to and wanting to analyse further in detail:

1. Examine the theory and history behind AI to better understand the use cases and what the technology is capable of doing.

2. Examine which sub techniques within the AI technology we have and if they are possible to integrate

3. Discuss the potential applications, risks and implications of using AI.

4. Identify the current and future use of AI in financial services.

5. Identify areas for further study. Our study suggests a combination of explanatory and descriptive research design, also known as qualitative research method (Saunders, Lewis & Thornhill, 2015).

Research Approach

According to Saunders et al. (2015), there are three different research approaches, namely, *deductive, inductive and abductive*. Deductive approach is used when one is drawing conclusions from logical reasoning, when existing theory is tested, and when hypotheses are formed and tested. Inductive approach involves the search for patterns from observations and the evolution of explanations for those patterns through a series of hypotheses. Lastly, abductive approach is set to address weaknesses associated with the inductive and deductive approaches, giving it a critical character. At the same time, it has to be clarified that abductive reasoning is similar to deductive and inductive approaches in a way that it is applied to make logical inferences and construct theories. In our study, existing theory as well as observations and interviews are used to enlighten and develop knowledge about AI and how the technology can be implemented into financial services. Making our research mainly inductive under an interpretative paradigm.

Research Method

Because of its strength, *case study* is a particularly appealing design for applied fields of study and has been proven very useful for studying educational innovations, evaluating programmes, and information policy (Merriam, 2009). It was in our interest to conduct a case study where we were able to compare a big leading Norwegian commercial bank called Sparebanken Vest to their own newly released subsidiary all-digital bank, called Bulder Bank. A case study approach allows for an in-depth, holistic analysis of a complex situation applied to a real-life situation. Thus, given the scenario where we wanted to compare these two banks, it was appropriate to go with a case study. The fact that Bulder Bank is using AI capabilities, gave us insightful information about how the technology actually makes a difference in practice and made it possible to analyse the benefits and pitfalls between the two.

AI is a novel and still quite an uncertain technology for most people. This made it hard to write a quantitative paper collecting numerical data from AI companies. Having tried to gather data, we experienced that companies in this sector are very cautious in sharing valuable and confidential primary data, making it infeasible to make a dissertation based on that. However, some data about Bulder Bank's demographics have been provided. The aim has mainly been to study about AI in financial services in a broader and detailed way, with also a case study to explore artificial intelligence in practicality.

Figure 16: *Sparebanken Vest and Bulder Bank*

In the creation of this thesis we have taken both a primary and secondary approach to data. Since our aim has been to run a case study, it has been significantly essential to get hold of the digital bank's management in order to have an in-depth interview. Further, interviews with leading tech consultancy firms such as AVO Consulting, Accenture and Karabin have been conducted to gain valuable inputs about how AI is applied in finance. Also, their contribution has ensured that the content quality of our thesis is up to date and immensely relevant.

Figure 17: *Companies collaborated with*

4.2 Data Collection

The method used to collect primary data was mainly through interviews with representatives from the respective companies mentioned. At Bulder Bank particularly, we were fortunate enough to have a meeting with the CTO of the company who gave us some really complex and insightful information about how the organization is structured and how they operate. However, we were only able to collect a minimal amount of numerical primary data due to their precautions. Numerical data collected is about the bank's demographics. Since most of the primary data also allegedly is too complex for us to understand, we have focused more on the operational part. By gathering information about how things are done in practice, we are aiming to answer our research questions as well as giving the reader a better understanding of AI's challenges and benefits.

Like all the analytical methods in a qualitative research, information analysis needs to be checked and analysed in order to perceive meaning, gain understanding, and develop knowledge (Bowen, 2009). As for the secondary data, we have collected an immense amount of data from reliable sources in the form of online articles, journals, reports, empirical studies, and other literature on AI. There has been a great amount of up-to-date data available around our topics, which has provided us with an adequate information to successfully answer our research questions. Furthermore, by having taken this qualitative approach to our study we have been able to easily adapt to changes in information at a low cost. With AI being a novelty and constantly evolving, we have experienced this first-hand ourselves during our four months of research. Within this timeframe, we have constantly found new sources of reliable information such as articles and journals that were not available in the beginning of our study. This only emphasizes the need for staying cope with AI if you are already using these sophisticated machines, unless you want to be outperformed by competitors.

4.3 Evaluating the Data

4.3.1 Reliability

Explaining reliability, one can say to what extent the questionnaire will provide consistent and replicable findings, whether similar observations and conclusions can be made by other

researchers. These findings need to be at different times, under various circumstances, and make sure it is transparent the way results are drawn from the raw data. (Saunders et al., 2015). way

Since most of the data collected for this thesis was qualitative it was really necessary for us to ensure that the data sources were valid and reliable. Articles and theory about AI were accessible abundantly, forcing us to screen lots of information. We had to ensure that the knowledge gained from our sources was relative to the mentioned technologies and financial services as well as our objectives for the thesis. There were mainly two approaches taken in order to increase reliability. First, we had each other reviewing the materials each of us were using and secondly, we had help from external companies as mentioned above to review some of the points we were uncertain about.

4.3.2 Validity

For a questionnaire to be valid, it must be reliable. However, being only reliable is not sufficient. Validity have concerns such as the accuracy of the analysis and results, if the measures used are appropriate, and the generalizability of the findings (Saunders et al., 2012). Further, we have that validity can be measured through two dimensions; *internal validity* and *external validity*.

Internal Validity

Campbell & Cook (1979) remarks that internal validity refers to the degree to which a researcher is justified in concluding that an observed relationship is causal. Looking at internal validity relative to our thesis, it seems like this type of validity is irrelevant. It is not our intent to assess or derive a causal relationship since our objective is to have a better understanding of AI's current and future situation.

External Validity

This kind of validity refers to the extent to which the results from the study are generalizable, indicating that they can be applied to other research settings (Campbell & Cook, 1979). When conducting a study in one organization, or in an organization that differs from the industry

standard, one should be cautious about generalizing the findings. Campbell & Cook (1979) mentions several ways to ensure external validity.

1. *How many and what kinds of people were interviewed.*
2. *Selection process for choosing interview candidates.*
3. *The nature of relationship between the interviewer and people.*
4. *The contextual information.*
5. *Information about informants.*
6. *Methods and data collection.*

However, as our thesis only have one case study around Bulder Bank, and since this is the first bank in Norway that is pure a digital AI implemented bank, results and conclusions drawn may not be generalized.

Improvement Strategies

Since AI is a novel area, we have not been able to elaborate so much on internal and external validity. However, methods and procedures to improve validity are taken. They are essential to the process of ruling out validity threats and increasing our conclusions' credibility. According to J. A. Maxwell (2012) there are seven strategies one can use to mitigate or diminish threats to validity in a qualitative paper.

1. *Intensive Long-Term Involvement* - This is essential to create and complete an in-depth understanding of research field, including the opportunity to repeat observations and interviews.

2. *Rich Data* - To fully cover the research field and having interviews with varied and detailed data.

3. *Respondent Validation* - To gather feedback from people studied, in order to mitigate the chances of misinterpretation of their reported behaviours and views.

4. *Search for Discrepant Evidence and Negative Cases* - To test for competing or rival explanations.

5. *Triangulation* - To collect merged evidence from different sources.

6. *Quasi Statistics* - To use numerical data instead of adjectives. Such as explaining things and elaborating with numbers rather than “typical”, “rare”, or “prevalent”.

7. *Comparison* - To compare findings across a variety of groups, different settings or events.

Taking Maxwell’s seven steps into consideration, we can argue that 3, 5, 6, and 7 are used in our thesis. Arguably, 1 can also be used but due to the length of research of 4 months, we have decided to not include this. 3 is used because feedback from all interviewees was collected and their views on our research questions were provided. Number 5 is quite significant since more than one type of person has been interviewed and an immense literature research was conducted. The literature used in this thesis is mostly published by field experts from reputable institutions (either commercial or educational) such as Forbes and The World Economic Forum (WEC).

Further, all dates have been double checked to verify that the information is up to date with today's applications and research. Moreover, the original sources have also been checked to ensure the reliability of data used. Gathering some numerical data from Bulder Bank as well as prominent numerical information about the global AI sector, makes number 6 satisfied. Lastly, 7 because several companies operating in different sectors have been collaborated with even though they all have a strong focus on AI. Given these insights, which contains a great amount of research, advice from experts and people with high positions in companies operating in financial services, one can say that our approach seems to be prominently valid.

4.3.3 Research Ethics

This section refers to the appropriateness of our behaviour in relation to the rights of those who become subject to the thesis, or those who will be affected by the study. The initial

principal behind it is that we as researchers are not supposed to cause any harm under the making of this dissertation. Ethical issues need to be taken into account under all chapters of this study and especially under the data collection and literature review whereas valid citations from the original source have been made to avoid plagiarism. The guidelines followed are from the Norwegian School of Economics' research ethics which can be found at NHH's homepage (Norwegian School of Economics, 2015).

When conducting such a study that we have done, it is important to think about the ethical concerns that might propagate when collecting data from questionnaires. Concerns such as data privacy, company privacy, respect, and volunteerism have all been taken into account to ensure an ethical approach in our research. All participants in this work have collaborated voluntarily, and respondents have had the right to withdraw their statements at any time seeing fit without the need for any further explanations. Confidentiality and anonymity have also been considered for our participants whereas data used are not in any way personal to the questionnaires. They have also had the ability to remain anonymous if wanted. Lastly, to ensure objectivity and avoid biases in our work, we have tried to report all data provided. That is, we have not been selective relative to the gathered data and have honestly and truthfully reported all our findings. Thus, at every stage in this research all ethical guidelines from the Norwegian School of Economics have been followed.

4.4 Limitations and Weaknesses

AI is a broad, diverse, and complex area encompassing a wide range of applications and technologies. Thus, a comprehensive survey to our informants would not have been feasible. Instead, we have focused on pulling together a practical approach to realistic applications in today's economy. Rather than focusing narrowly on just one industry and technology such as "deep learning in auditing", we have aimed to cater to a broader audience in order to understand the fundamentals of AI. The reason why we have chosen to do this is because most people know very little about AI and hence, digging deep into DL and the complexity it has, would not make people apprehend our work.

One of our main limitations in this thesis have obviously been ***availability to numerical primary data***. Since Norway is not one of the most AI developed countries, gathering this

kind of data from many reliable sources have been difficult. As also mentioned, most tech companies operating in this sector are very cautious with handing their data to other parties since it could compromise their competitive position. Therefore, we made ourselves a clear strategy to focus on the important parts around numerical data and hence, chosen a qualitative study. Other weaknesses have been ***skills shortage*** as there are very few people who have an in-depth understanding of AI and its subcategories. Data scientists who are experts in this area are hard to find but we were fortunate enough to get in touch with Bulder Bank's CTO, who have many years experience in this area. However, it would have been great if we were able to connect with more AI scientists. Lastly, ***reliability of sources*** has been something to consider greatly under making of this study because of the immense amount of information available. This has been a challenge, but we have solved this by having cross-sectional sources to verify the reliability. Not only has it been necessary to screen information but getting the right one has also been a difficulty in some cases due to AI's novelty. However, as mentioned, we have taken several steps to ensure the reliability and validity of our sources and made it a top priority to confidently cite our references.

5.0 Bulder Bank - Case Study and Analysis of the Mortgage Process

In this part of the thesis we will do a case study of Bulder Bank, a new leading digital bank based out of Sparebanken Vest (SPV). We want to dig in to how Bulder Bank utilizes AI and other types of technology to establish a fully digital bank. As part of this case study we will also look into what challenges the use of AI propagates. In order to successfully accomplish this, we have spoken with several highly skilled people from different consulting companies with responsibility of leading AI & digitisation projects.

5.1 What is Bulder Bank?

Bulder Bank is a fully digital bank based out of SPV that went live 30th of October this year. The CEO of SPV said nine months ago that they wanted to build a modern fully digital bank with no strict plan of what the bank is going to offer, but rather listen to the customers and ask what types of digital services they might be interested in. Nine months later in October, Bulder Bank went live. This new bank is built from scratch, and they wanted to build it completely without old systems and the traditional structure of a commercial bank, which we will talk more about later. By using new modern solutions and modern systems they are now able to move extremely fast and implement new services much faster than a traditional bank. Their main goal is that you can use your phone for everything with the use of their Bulder Bank app. By using the convenient app on your phone, they want their customers to have a better overview of your economy.

The new bank initially went live during the summer of 2019 but only with a limited amount of trial customers. A few months later now and after the official launch, they have already passed 13.000 users. According to their CTO, their goal within 2021 is to have at least 20 000 customers in their portfolio. What's interesting is that most of the new customers were not former SPV customers. They have managed to target a new group of customers, and the age spread is huge. We assumed that the majority of the customers were young people, but the result so far shows that people in all age categories are using their services. At this stage, they have not rolled out all their services, but this will eventually happen soon. However, their mortgage service is up and running already with great success. Their aim here is to have provided customers with a total of NOK 20 billion within 2021.

5.1.1 Goals and Vision

SPV's vision has always been; "everything we do is to contribute making the life at Vestlandet even better", still this does not reflect their ambitions about Bulder Bank. They want to have customers spread all around Norway. This is purely a strategic move in order to build a new brand that reaches consumers all around the country. At the same time, they are used as a test-project for a future fully digitized SPV and hence, they aim for the same ROE of 12% moving forward. This is somewhat a non-traditional approach of releasing a new company and product since new firms often sacrifices results to increase the growth of the organization. Further, by making the bank fully digital they remove the need for local presence and local customer support.

5.2 Bulder Bank's Structure

Bulder Bank is a subsidiary from SPV, the third largest bank in Norway and are operating under their licenses. By being a part of this large bank on the west coast, they are able to utilize workforce if needed. However, Bulder Bank is structured as a separate company. The structure is not like a normal bank and this is because they do not need massive customer support like a large commercial bank would. As of now they have manual customer service utilising resources from Sparebanken Vest, but this will be mostly digitalized with chatbots in the future. Chatbots are as you read in the theory part one of the most popular use cases today of AI. When we spoke with the CTO, he also mentioned that they have a very flat structure.

5.2.1 Organizational Map

As we see in the model below, the organization is rather small and consists of only 24 people in total. The majority of the people are highly skilled IT developers with long experience within financial technologies and firms. What is interesting is the fact that they have only 3 financial advisors for 13.000 customers today. We do not know the traditional ratio of advisors per mortgage customer, but we think it is safe to assume this number is way higher in a bigger commercial bank. At the same time there is not a limit of how many customers they can facilitate as almost everything goes automatically as we will show in the flowchart of their processes. When we interviewed Markus Nordstrønen, CTO of Bulder Bank with 10+ years of experience from DNB, he told us that when they started this project, they were

fortunate enough to pick the best developer from all around Norway. This way, they are able to provide the smoothest and most efficient mobile bank ever in Norway's history.

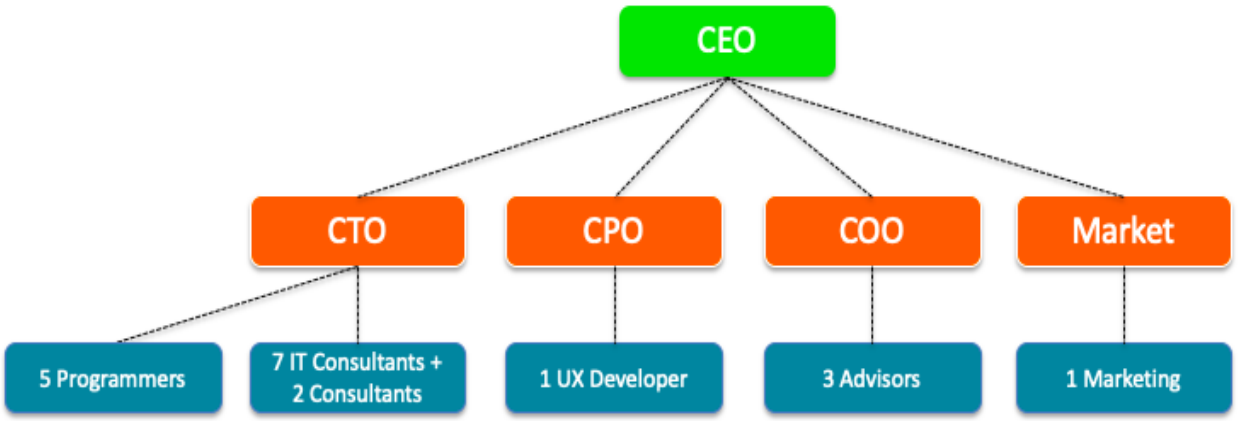


Figure 18: *Organizational map over Bulder Bank*

5.3 How AI is Implemented in the Mortgage Process

Artificial Intelligence is a fundamental part of Bulder Bank. In this part we will describe the whole process from when a customer applies for a loan and until the loan is approved/declined and what happens when the estimated price of the collateral increases or decreases. Also, we will describe the part where your interest rate on the mortgage decreases automatically as your loan amount is decreased. Traditionally, you would call or show up to your local bank to apply for a loan, they would then go through all your financials and look at the value of your collateral before they could give you an offer. From a customer perspective this is a process that needs planning and preparation. From the bank's perspective this is a process they estimate takes 30 minutes, and since it is a person taking the decision you could get more irrational decision making. In Bulder Bank this process is now automated and hence, they reduce the risk of irrational decisions and also remove the need for customer advisory services. We will now dig into how this is done and what types of AI they use.

5.3.1 Descriptive Flowcharts

To better understand the loan process, we have made this flowchart that show us what the customer sees and have to do before moving their loans to Bulder Bank. As we can see, this is a fairly easy process that takes only two to four minutes in total.

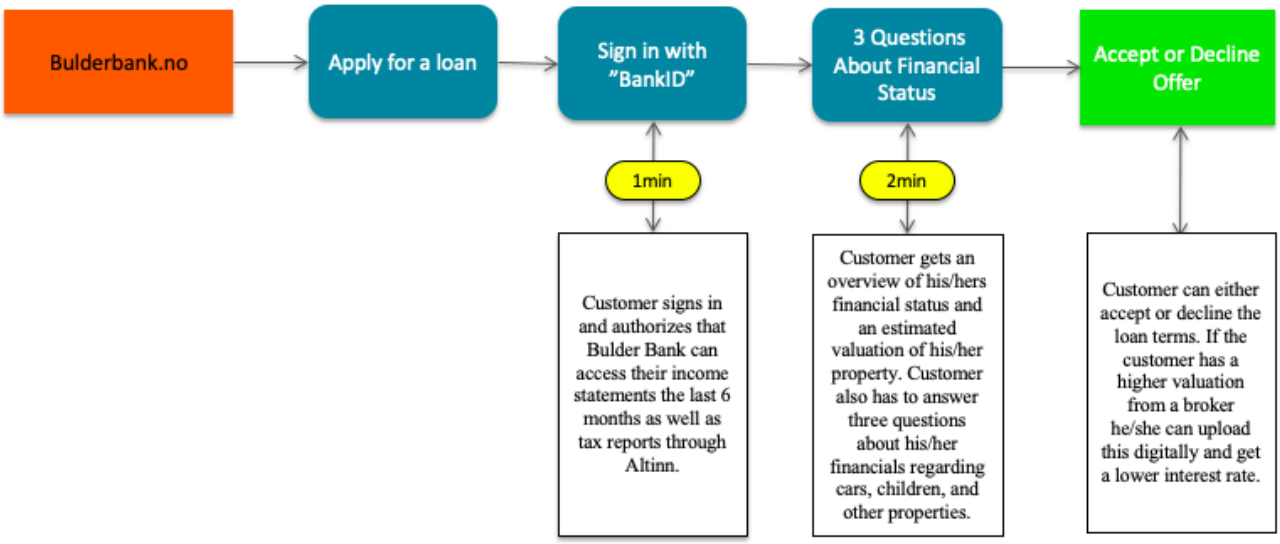


Figure 19: *Descriptive flowchart from a customer perspective*

The customer enters their website or their app, and push "apply for loan". Then they log in with the use of Bank ID and authorizes that Bulder Bank can use his or her financials from Altinn. The customer then has to answer three questions before he or she is able to see the estimated interest rate and get the option to apply for the loan. The bank then collects mortgage down payment status from his former bank and moves the loan over to them automatically. From a customer perspective this is a very easy process and most importantly, very convenient.

What is interesting and relevant for this thesis is everything that happens in the background and how they are able to do this whole process with the use of AI. We will now show a flowchart of all the underlying processes that happens in the background, and many of these are based on AI and other algorithms. The most important form of AI used, is ML and DL to utilize huge data sets from "Eiendomsverdi.no", "Altinn", and "Gjeldsregisteret".

Eiendomsverdi is a platform where valuation of all apartments and houses are stored and Altinn is likewise a platform where one can collect information about income and employment. Lastly, Gjeldsregisteret is a valuable tool where all information about customers' debt is stored. Moreover, their own data from SPV is also utilized to calculate the risk of the customer based on former relationships with a similar financial status (if this is an option).

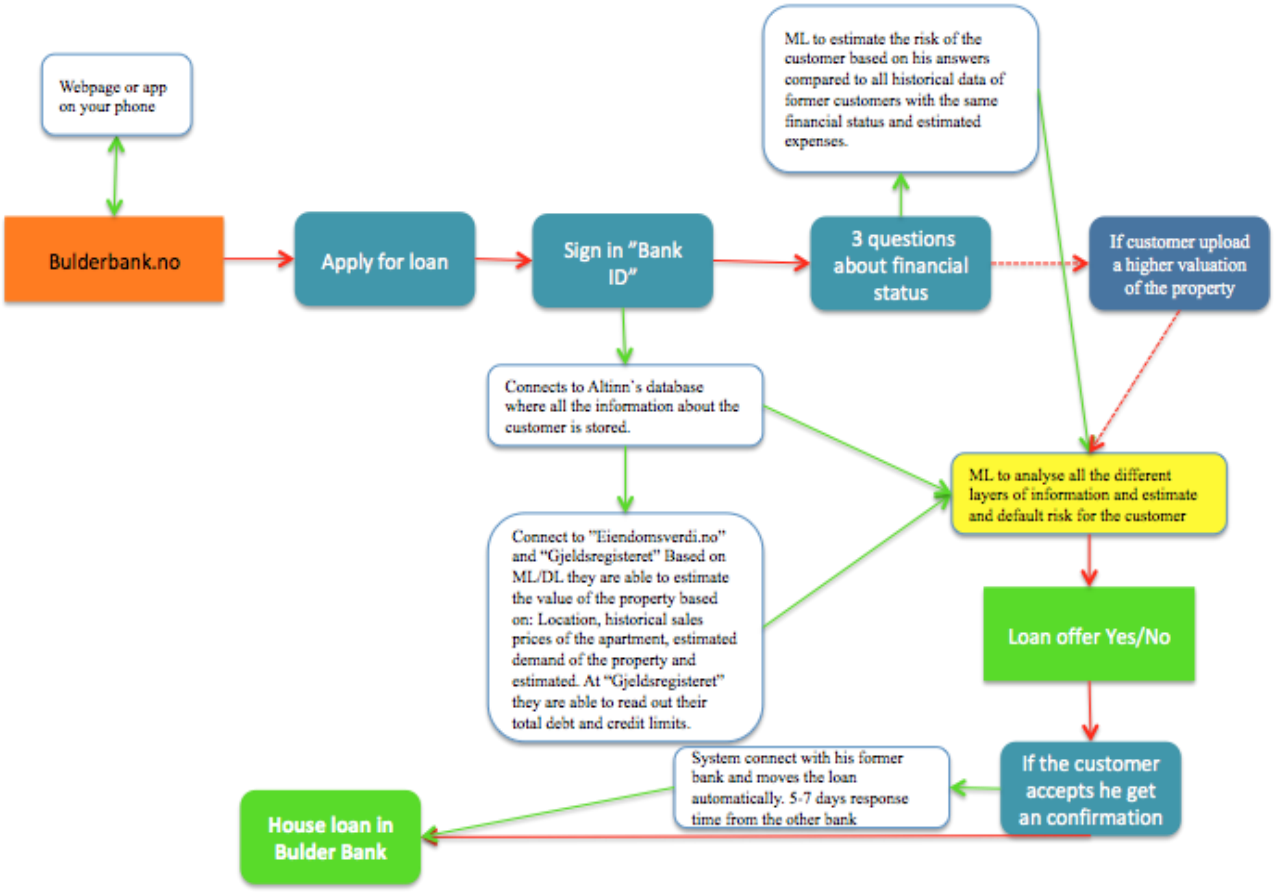


Figure 20: *Descriptive flowchart of all underlying processes*

As we can see clearly from the model, this process has to connect with multiple different sources of information. It starts with collecting data from Gjeldsregisteret and Altinn's database where they are able to find all the different properties the person owns, the total amount of debt, and his/her personal status regarding children, and if there have been any financial problems in his past. The algorithm then continues to look into Eiendomsverdi's database where they store information about all properties sold in Norway the last recent

years. This database is able to see potential trends of the apartment, how many times it has been sold and the development in price. Further, by utilizing ML to analyse this information they are able to estimate the property's value. One of the biggest weak points of this database is that the data cannot see if the properties are of high or low standard or if it has been renovated. However, location is taken into consideration. This is why they have made a function in the process where the customer can upload a tariff for the property if the valuation should differentiate from the estimated value.

Then, the customer continues with answering the following three questions. 1: Status regarding cars he/she has to pay for, 2: How many children he/she has, and 3. Properties that he/she is paying for. This could for example be rented apartments or a cabin that he/she owns with other family members. If the customer has a higher valuation on the property than the estimated value, this can then be uploaded digitally with just typing in the reference number from the tariff.

When all this information is collected into Bulder Bank's database, they are able to check this data with their large SPV database. With the use of ML, they are able to estimate the default risk for this customer. If the scores are within their boundaries, they give the customer an offer to move the loan to Bulder Bank. At this stage the customer is also able to compare his previous loan with the new loan offered by the Bank to see if there are any long-term savings from this transaction. When the new loan terms are accepted, the system automatically sends a request to the former bank and asks them to move the loan. At this stage information is also double checked with the former bank. Normally it takes 5-6 days before the bank responds and they are able to transfer the mortgage.

One of the main advantages of Bulder Bank is that their interest rate automatically adjusts as you make down payments on the mortgage. As illustrated below, you see that the system continuously checks the estimated valuation of the collateral and when your loan reaches certain levels of debt to value ratio, the interest changes automatically.

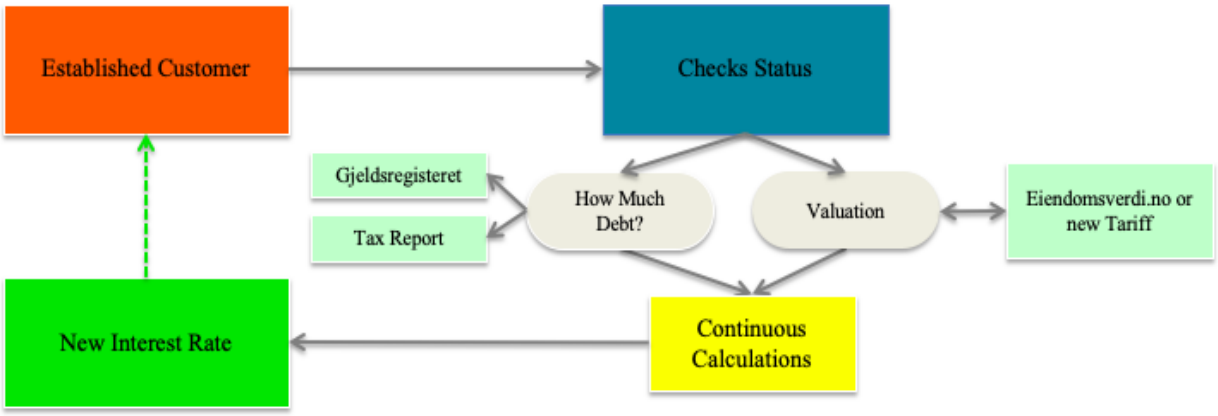


Figure 21: *Flowchart of the collateral valuation process*

This process is utilizing AI and an algorithm that continuously runs in the background to check for updated information regarding the status of the mortgage as shown above. As with the original loan process the system continuously rely on ML and DL results from Eiendomsverdi.no.

5.3.2 How is This Process in Sparebanken Vest?

In SPV they are doing this the traditional way by the customer contacting the bank and then goes through the process, either on the phone or by a personal meeting. This requires a physical contact person in the bank, and when we spoke to the CTO of Bulder Bank he told us that this process usually takes about 30-40 minutes. The financial advisor then has to log into the database and go manually through all the financial information about the customer and collateral. Based on this information and guidelines, the bank then decides whether the customer is approved for the mortgage and under which terms. There is also room for negotiation in the contract.

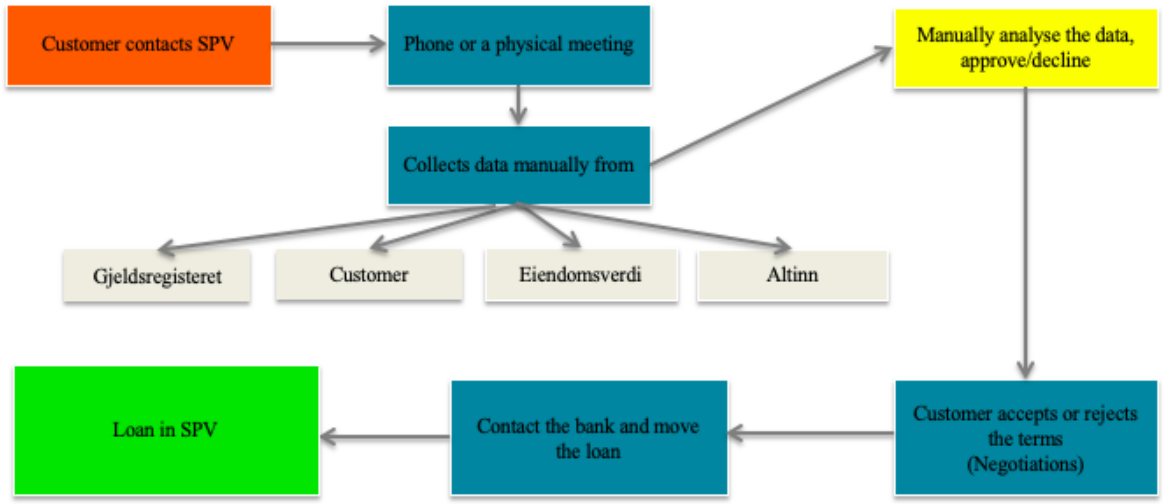


Figure 22: *The loan process in SPV*

5.3.3 Comparing Quicken Loans to Bulder Bank

As mentioned earlier, Quicken Loan is America's largest mortgage provider with just recently passing a $40 billion volume in this third quarter (Lane, 2019). Bulder Bank and Quicken Loans are in many ways comparable tech wise as they share the same holistic vision and goals. Since 1985, this mortgage company located in Detroit, has been focusing on providing new mortgages as well as refinancing old ones in a fast and efficient way. In recent years their technology also has evolved immensely making them ahead of competitors such as Nationstar Mortgage and LendingTree. This has allowed them to lend out high volumes at still competitive low interest rates of around 3-4%.

Looking at their website, one can instantly notice the AI driven chatbot called “Rockelle”, who works as Quicken Loans’ virtual assistant. Further, their loan process is divided into several steps. The core and fundamental part of the process which also is comparable with Bulder Bank is the process where you apply. Like Bulder, one can use their app to apply for a refinancing or a new mortgage where they guarantee that they will match your current financials or give you the best terms on the market. However, unlike Bulder Bank, the process of gathering information about your income statements, tax reports, and house valuation

happens manually. Here the customer or client needs to provide necessary documents and upload them into their online application. This is immensely less efficient and may be due to several reasons. There might be regulatory or technological barriers that prevents them from doing the whole process automatically. Taking this into account, Bulder Bank is more innovative and efficient, making the customer barely wait before an offer comes through.

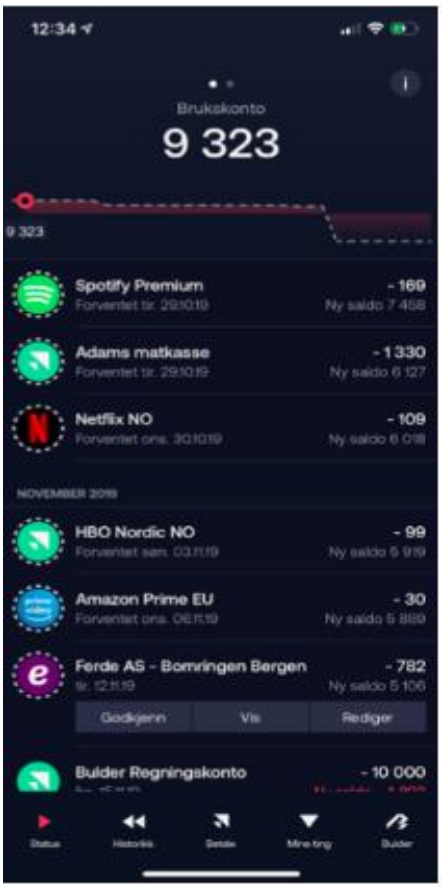
However, the process is still fast enough to acquire a large fraction of the market. According to themselves, this is because of their strong customer satisfaction focus. Looking at their website they seem like a very user-friendly company having the customer in focus as they apparently offer customers perks such as the "RateShield Approval" (Quicken Loans, n.d). This perk is a 90 days lockup on the interest rate whereas if the rates decrease, your rate also decreases and if rates rise, your remains the same. Features like this and many other service-related ones, make their company stand out and acquire most of the American mortgage customers.

Bulder Bank is also in the process of making an AI chatbot that will soon be implemented both on their website and app. Their holistic vision is very much in line with Quicken Loans'. They want to be the best all-digital bank in Norway, delivering quality products at an efficient and convenient way with strong focus on customer satisfaction. As we have seen and experienced through conversations with the bank, they are more efficient and innovative than Quicken Loans. Furthermore, they also offer a floating interest rate where the rate decreases as the mortgage amount is reduced (happens automatically). Quicken Loans offer customers only one fixed rate, making Bulder approach more attractive to customers. Comparing the two, gives us a feeling that Bulder Bank has a great starting point with an exciting future head.

5.4 Future AI Processes in Bulder Bank

Bulder Bank is about to release a new function in their application mainly driven my ML and DL. This is a function based on all your payment information and all your monthly subscriptions. Based on this, data Bulder Bank is able to estimate how much you are going to pay in the future and also at which date the invoice is due. The algorithm then estimates your income based on the last month and is able to calculate how much money you have in your

account after your estimated expenses are paid. Having these algorithms in place makes the user of the app able to have full control of his or her financials at all time. To the right, you can see how this feature will look in the app. Another project in the pipeline is to predict what and where the customer is going to shop in the future. So far, the ML algorithms have only been able to predict with a 60% hit rate of future trade patterns, but the hit rate is continuously rising as they get more data on historical consumption. This data could also be valuable to other firms and hence, an extra way of receiving revenue might be selling data to other vendors in the future. These processes are driven almost fully by ML and DL and is a good example of how combining the power of AI is important for Bulder Bank, now and in the future.



5.5 Challenges with the Implementation of Artificial Intelligence

When we spoke with the CTO of Bulder Bank, he told us that one of the biggest challenges when dealing with implementation of AI is to have sufficient data. This was confirmed when we spoke with "Head of Analytics & AI" at AVO Consulting. Julija told us that when they are working with clients, the amount of data available is normally not a problem. The biggest problem is to have relevant and valid data to get accurate results. In order to making sure that they are using correct data, they have to spend a lot of time cleaning it and go through the data points to set up a correct data warehouse. She also told us that many clients go too wide when wanting to implement AI applications which is something both Karabin and Accenture emphasized.

Another problem is to make sure that new applications are integrated with the system's other programs and that they are able to communicate with each other. Older programs are not built with intention of adding ML, DL, and chatbots, which are the most popular applications to

integrate in financial services today. When we asked about what the most time-consuming part of AI integration was, she told us that building a strategy and organizational challenges are the most demanding ones. With organizational challenges many leaders find it hard to substitute employees with a digital software and this results in restructuring the whole organization. In his restructuring usually employees get new areas of responsibility and new daily tasks at work.

5.5.1 Organizational Challenges

To address the organizational challenges, we spoke with Atle Sandal, one of the partners at Karabin Consulting. He previously has led several public and private digitalisation processes. Atle told us that there were mainly three different levels that needed a separate focus to be able to have a successful digitisation project. The CTO of Bulder Bank told us that they had no structure for how they implemented new projects, and because the organization is rather small, he meant it was unnecessary. Still, we think there should be an overall strategy for their new upcoming future projects. With input from Karabin we have made this chart that describes how Bulder Bank could implement new applications in their organization.

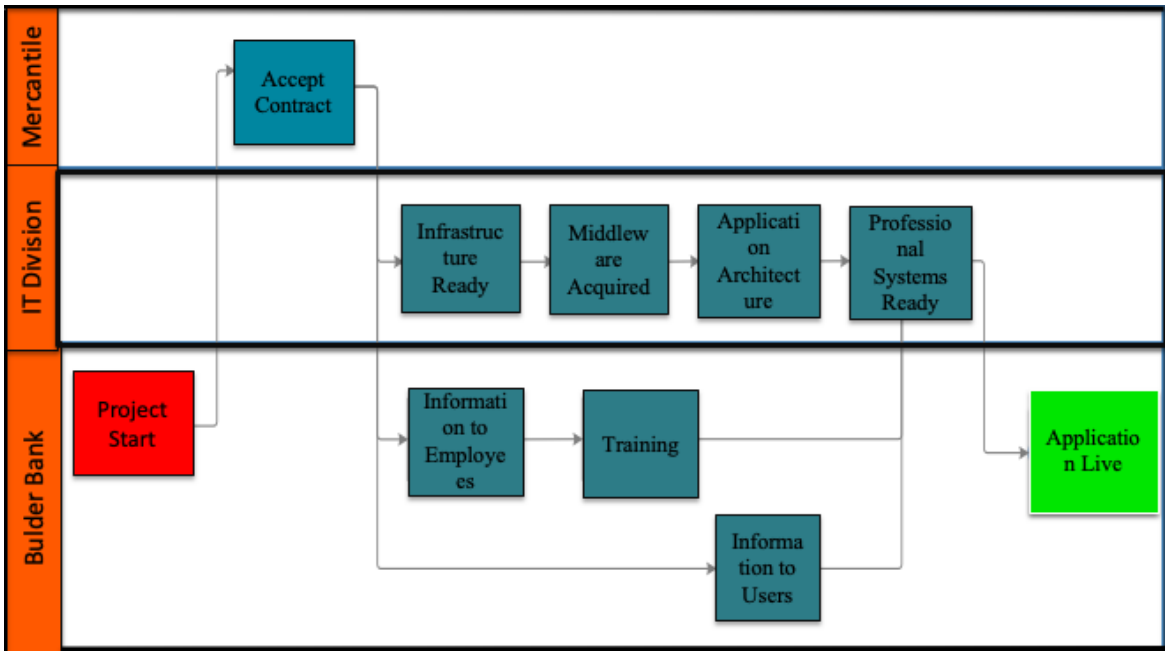


Figure 23: *Potential way of implementing applications in Bulder Bank*

First level is Boulder Bank in general. This is to make sure that all employees are aware of and onboard the projects. With projects we are talking about new solutions, new products, or a new form of AI integration as for example a DL project for better risk assessment. Further out in the process, training for employees starts. Atle at Karabin told us that it is important for the employees to have sufficient training in the new project to make sure they have the skills necessary to help customers and make sure that new application runs smoothly. In Bulder Bank the number of employees integrating directly with the customers is low, but there should still be a general understanding of the project in the organization.

Second level is the IT division. In Bulder Bank this would be the CTO and his team. They have the responsibility of integration and development of the project. This process starts of by making sure that the current infrastructure is able to cope with the new system. Further, they have to acquire the middleware. This is an extremely important part as most of Boulder Bank is built on external middleware as we will talk more about later. When the right middleware has been chosen and tested the process of building the application architecture starts. At the end of this process, information to customers and clients should be shared. This is to make sure that the they are aware of this new application when the product is ready to go live. Moreover, customers can then also share their views and inputs on the project. Third level is the mercantile level. Hence, the contractual work and making sure that the business case is a good one.

Atle Sandal also emphasized the importance of developing AI solutions 100% before implementing them. From his experience firms usually have “one shot” to successfully make customers adapt to the changes due to the complexity of the solution. Hence, this makes things challenging for customer support when dealing with customers who do not get the application or solution to work. In other words, if one fail or make an unreliable product in the first release, you could scare the customers away. Normally, if you have a problem you can just call your bank or send an email to get the problem fixed manually. This is not possible if AI is utilized and there is a shortage on customer advisors.

5.5.2 Ethical Challenges

AVO told us that there were primarily a few ethical challenges when digitizing former manual tasks. The first challenge is employment. What to do with the employees that ends up losing their job? The second ethical challenge is how the computer should adapt to human behaviour since people on an individual level do not always think rationally. Hence, you get a potential mismatch between an AI machine that is trained to be 100% rational. Still, when it comes to Bulder Bank, they are actually not taking away any jobs as for now. Instead, they create work for programmers and other consultants who are helping them out with their systems. Recalling from before, these AI systems constantly need maintenance and updates in order for everything to run smoothly. On the other hand, Bulder Bank is stealing customers from traditional commercial banks, and the ratio of customers per employee is increasing significantly. Hence, the need for employees in the large banks is declining and this is very much an ethical challenge. Not only is this a huge problem for financial services, but a negative trend that impacts all sectors in the economy.

Another problem is the data whereas there is no perfect dataset for the algorithms. This could affect customers and clients that should have been offered a loan. Instead, they do not get an offer because the data used, was not reflecting this specific situation. Bulder Bank has been aware of this challenge but at the same time this problem could also occur when someone is having a physical meeting with a financial advisor in a physical bank. Unfortunately, we do not have a conclusion on how Bulder Bank should solve this challenge as there are no definite answers on how this should be solved. However, Bulder Bank assured us that they are constantly checking their routines for improvements such that they can mitigate occurrence of ethical challenges.

5.5.3 How Deep Learning Could be a Challenge

At first glance, DL seems like a very positive contribution to financial services and in Bulder Bank. Julija at AVO Consulting explained that they addressed a huge challenge with the implementation of DL. DL uses different layers of information and connect these different layers to generate outputs. Based on the complexity of DL, the results are very hard to explain to customers and clients. Hence, many firms are often negative to the validity of the results as they are too complex to describe to customers. Secondly, DL need huge amount of data to

operate and today personal data are harder to store due to the General Data Protection Regulation (GDPR). In Bulder Bank the use of complex DL is minimal and the customer has to accept that Bulder Bank is allowed to use their personal data though Altinn, Gjeldsregisteret, and Eiendomsverdi before applying for a loan. Hence, they are able to avoid many of the challenges that DL and GDPR brings along.

5.6 The Need for External Technological Support

We have mentioned previously that a significant challenge for traditional banks, is their IT infrastructure. Most of these systems are now old and outdated, making it harder to implement new modern solutions. In Bulder Bank they have solved this problem by building the infrastructure from scratch using Google's different solutions. All applications are based out of this and their servers are also storing in the cloud. Utilizing external providers gives them the possibility to exploit the best programs at all times as they have no long binding contracts. They are also able to “shop” the programs they want which save them a lot of time and money. With the vision of being the best digital bank in Norway, they are continuously testing other solutions from other providers to make sure that they have the best product for the customers. Some parts of the coding have also been outsourced, creating more time to focus on other important things. However, every code still has to be accepted by another programmer before it goes live. Lastly, the core banking solutions they provide are base out of EVRY, which is a major systems provider for banks in Norway.

A weakness when building a bank out external solutions is the vulnerability. If Google and some of their other smaller providers gets a problem, it would be out of Bulder Banks control and create a lot of chaos. However, Markus made it quite clear that the bank would never have existed today if they had to develop every single solution themselves. Thus, looking at it from a wider perspective, this is a risk factor they just have to accept. Nonetheless, making sure that they have backup solutions and alternative providers is something they take seriously and have this already in place as we speak.

5.7 Benefits with the Implementation of Artificial Intelligence

If we compare Bulder Bank with traditional commercial banks, we see that there are several benefits with utilizing AI and digitalisation. By making the bank digital and convenient for the customer, Bulder Bank has seen big improvements in the advisor to customer ratio. By increasing the ratio of each financial advisor per customer, the need for advisors decreases and hence, reducing the cost immensely long term. Another advantage is more accurate decision making. By exploiting ML and DL, Bulder Bank is able to estimate customers' probability and probability of default in a more efficient and precise way. They are also making sure that all customers get the same treatment and that this is transparent to the public.

As mentioned earlier, we talked about how AI is changing financial services. Here we emphasized the benefit of fraud detection and anti-money laundering (AML). By using big data, ML, and DL, the bank is able to observe and prevent fraudulent activities among their customers and clients. As they have plans to soon offer credit cards, ensuring safe and compliant transactions is essential. Since the banking industry is a heavily regulated space, it is important for Bulder Bank to monitor their customers and make sure that they are not committing any crimes with their services. This is all done according to GDPR and the Norwegian Financial Supervisory Authority's regulations.

Lastly, the CTO told us that by specifically utilizing DL in the future, they are able to predict customers consumption patterns and hence, create appropriate invoices which is then displayed in the app. This way, they are saving customers time from checking for invoices themselves or importing with the use of "E-faktura". Nowadays, it is normal for people to have several subscriptions based online products such as Spotify, Audible, Netflix etc., and by gathering all invoices in the app, customers can see what their money is being spent on. That is, providing better and innovative solutions are very much in line with their overall goal of an excellent reputation and satisfaction among customers.

6.0 Conclusion and Discussions

The aim of this thesis has been to study about AI in financial services and examine the influence it has on our modern world. Further, through our dissertation we have analysed the various challenges, opportunities, risks, and applications AI brings to our domestic and international economy. A qualitative research approach was taken and in collaboration with several profiled companies that utilizes technology and AI on a day to day basis, we have gained great insights on how all this theory works in a practical context. With great help from Accenture, AVO Consulting, Karabin, and Bulder Bank, we have been able to dig deep into the world of AI and answer our research questions.

AI in the financial services industry is still in the early days. One can with great confidence say that only a small fraction of this futuristic technology has yet been discovered and only the human imagination can limit its boundaries. AI can improve communications with staff and customers and analyse large amounts of complex data to find patterns or connections that humans can't find. Further, it can make precise and better investment decisions as well at mitigating fraud and credit risk. All these applications are just a small fraction of AI's possibilities. Moving forward, the technology will be more seen in finance, and with that comes several challenges including legal, ethical, economic, and social barriers. However, in order to achieve mass adoption, humans have to evolve as well with the evolution of technology. A focus on realistic deployment, timeframes, and accuracy measuring the effectiveness and ROI of AI is abundantly critical to keep the current momentum and grow AI moving forward. Just looking at the internet, it took decades for it to grow to this stage and the same will probably be the case with AI. Previously, robots and artificial intelligence have only been a part of science fiction but have slowly developed into the technology Amazon uses to recommend products, and Facebook uses to tag pictures. That is, one can with great confidence say that tech companies have played a significant role in the evolution of AI.

As a result of our research, we have found out that AI is rapidly being implemented in a wide variety of organizations and sectors. Both AVO Consulting and Accenture emphasized that AI offers financial institutions an immense amount of new possibilities such as recruitment, cost cutting, fraud prevention, investments and communication. Changes are expected to be made

within traditional procedures to radical, industry-evolutionary practices. Accenture mentioned that they are experiencing a clear shift in this area whereas they are expanding their competence and increasing the volume of projects. Further, AVO clearly stated that they already have a large portfolio of clients who are helped with development and further perfectionating their AI systems. Lastly, Karabin is also experiencing this shift of technology in their day to day projects all the way from banking to tech companies.

Collaborating with Bulder Bank, gave us the opportunity to conduct a case study to see how a brand new all-digital bank that utilizes AI, makes them different to the conventional commercial banks. We have specifically looked into the process of applying for a mortgage and seen how they have managed to develop AI systems that makes their process highly competitive. Bulder Bank has a team of highly capable professionals who are determined to become Norway's largest smart-based bank, providing their customers fast and efficient products at low prices. Looking closer at their process, we can see how they utilize big data, ML, and DL to enhance the true power of computers. Compared to large commercial banks, Bulder doing everything through their app and website, making it very convenient for customers. The era where one had to show up physically with documents or even upload documents online is over, whereas they now have automized all processes and are able to collect all necessary information through “Altinn”, “Eiendomsverdi”, and “Gjeldsregisteret”. That is, you simply apply for a mortgage or mortgage refinancing through their platform and you have an offer within 2 to 4 minutes. Never have someone in Norway done this before.

Further, we compared Builder Bank to America's largest mortgage provider, Quicken Loans, to see how they are relative to each other. Even though the demographic and housing market in America is different to Norway, we can still examine how Quicken Loans has grown since 1985, outperforming its peers significantly. Like Bulder Bank, Quicken Loans have a strong focus on customer service and technology, whereas they offer fast and efficient services. They are similar in the loan process as they both have an app and online platform customers can communicate and interact with. In addition, Quicken Loans has an AI based virtual chatbot who are able to assist you 24/7. This feature is also very soon available at Bulder Bank. However, looking at the part where information about the customer is gathered, Bulder Bank has a huge advantage as they are able to collect all this automatically through the use of ML,

and DL. At Quicken Loans, customers still need to upload all documents manually into their online application. Looking at these two comparable companies, we can see that even though Quicken Loans have a larger customer base and better brand recognition, Bulder seems to have a very good starting point. Their CTO clearly states that the customers they already have are very satisfied with them and they can already see a significantly growing demand for their services. According to them, their future is abundantly bright.

To address the structural and organizational challenges we spoke with different leading digitalisation consulting companies. They emphasised that the organizational structure was one of the most important aspects to be able to integrate digital solutions such as AI. We were not impressed with their current implementation strategy as there were none. Hence, we strongly recommend Bulder Bank to create an overall strategy for implementing new applications and AI projects in the bank shown in *figure 23* on page 65. On the positive side, the rest of their organization is very effective and able to move fast with new solutions and new integrations of AI. They have a flat structure where everyone is able to share their ideas. Also, they only consist of 24 employees resulting in fewer information barriers.

Bulder Bank has also created a completely new IT infrastructure mainly based on Google and is built to be able to integrate with several IT-providers. This makes them quick on their feet if they want to change infrastructure or implementing new systems. Still we are unsure if they are able to be so dynamic in the future as the number of applications increases as well as the customer base. Basing the organizational structure out of secondary providers of IT systems, also makes them vulnerable for external problems. On the other side, the CTO of Bulder Bank told us they were aware of this and has a backup plan with other external providers if they get major problems and hence, we only look at this as a minor problem. In total we are very positive about the structure of the bank as they are well suited to cope with future applications and AI systems, and is reflecting the experience these people have from working several decades in the banking and the IT industry.

Our main objective besides answering our research questions, has been to write a thesis that gives the reader a fundamental understanding of AI and its traits. As for the research questions A-D, we have made some models back in the appendix (section 8.1) that visually

explains the most important answers briefly. These models are based on the Minto pyramids developed by Barbara Minto, a former McKinsey employee. She was one of the first woman granted an MBA from Harvard Business School and her “Minto Pyramid Principles” are widely used in a range of businesses today. Even though we answer the research questions throughout the thesis, we thought it might be interesting to present our findings in some visual models as well. We have focused on assembling the thesis with parts that are relevant and tried to explain things in an easy way since most of the theory behind AI is quite complex and difficult to comprehend. Along with big data, AI is viewed in the financial services sector as a technology that has the potential to deliver significant analytical powers with precise accuracy. However, we have yet many risks and challenges to overcome before it is mass adopted. One of the most important ones being how AI will behave under a financial crisis. How will the algorithms and precaution systems react when there is a massive recession or a massive surge in the economy? There have for instance been several cases where systems of financial firms have not responded as anticipated, leading to errors and flash crashes. Hence, it is important to build a robust technology capable of adapting to human weaknesses so that organizations and companies can implement these AI systems safely.

With that being said, it's too early to predict right here and now how humanity will overcome all these implications and facilitate for an effortless AI evolvement. For all we know there might propagate similar yet different kinds of technologies that have even better traits. Maybe they will replace AI in the future due to better and more efficient solutions. However, through our study one can safely say that AI is significantly relevant and have the capability to solve many days to day challenges more precise and efficiently than options already out there. There is clearly a need for more education on AI literacy and awareness. As the late Stephen Hawking said to BBC under an interview in 2014 (Cellan-Jones, 2014): “ The development of full artificial intelligence could spell the end of the human race ...It would take off on its own, and re-design itself at an ever-increasing rate. Humans, who are limited by slow biological evolution, couldn’t compete and would be superseded”.

7.0 References

Books

Binner, M. J., Kendall, G., & Chen, H. S. (2004). *Advances in Econometrics Vol 19*: Applications of Artificial Intelligence in Finance and Economics. Bingley, The UK: Emerald Group Publishing Limited.

Campbell, T. D., & Cook, D. T. (1979). *Quasi-Experimentation*: Design & Analysis Issues for Field Settings. Boston, The US: Houghton Mifflin.

Cartea, A., Jaimungal, S., Penalva, J. (2015). *Algorithmic and High-Frequency trading.* Cambridge: The UK. Cambridge University Press.

Dale, R., & Reiter, E. (2000). *Building Natural Language Generation Systems*. Series: Studies in Natural Language Processing. Cambridge, The UK: Cambridge University Press.

Dietrich, D., Heller, B., & Yang, B. (2015). *Data Science & Big Data Analytics*: Discovering, Analyzing, Visualizing and Presenting Data. Indianapolis, The US: John Wiley & Sons, Inc.

Dunis, L. C., Middleton, W. P., Karathanasopolous, A., Theofilatos, K. (2016). *Artificial Intelligence in Financial Markets*: Cutting Edge Applications for Risk Management, Portfolio Optimization and Economics. London, The UK: Macmillan Publishers Limited.

Maxwell, A. J. (2012). *Qualitative Research Design*: An Interactive Approach. California, The US: SAGE Publications, Inc.

Merriam, S. (2009). *Qualitative Research*: A Guide to Design and Implementation. San Francisco, The US: John Wiley & Sons, Inc.

Saunders, M., Lewis, P., & Thornhill, A. (2012). *Research Methods for Business Students 7th Edition*. Essex, The UK: Pearson Education Limited.

Saunders, M., Lewis, P., & Thornhill, A. (2015). *Research Methods for Business Students 7th Edition*. Essex, The UK: Pearson Education Limited.

Schwab, K. (2017). *The Fourth Industrial Revolution*. New York, The US: Crown Publishing Group, Division of Random House Inc.

Skilton, M., Hovsepian, F. (2017). *The 4th Industrial Revolution*: Responding to the Impact of Artificial Intelligence on Business. London: The UK. Palgrave Macmillan.

Yin, K. R. (2014). *Case Study Research and Applications*: Design and Methods 5th Edition. California, The US: SAGE Publications, Inc.

Online Resources

AV Test. (2019). Malware. Available at: https://www.av-test.org/en/statistics/malware/

Bachinskiy, A. (2019). *The Growing Impact of AI in Financial Services*: Six Examples. Medium. Available at: https://towardsdatascience.com/the-growing-impact-of-ai-in-financial-services-six-examples-da386c0301b2

Beedham, M. (2019). PwC Has a New Cryptocurrency Auditing Tool… and Actually, it Sounds Alright. Available at: https://thenextweb.com/hardfork/2019/06/20/pwc-halo-tool-audit-cryptocurrency/

Boillet, J. (2018). *How Artificial Intelligence Will Transform the Audit*. EY. Available at: https://www.ey.com/en_us/assurance/how-artificial-intelligence-will-transform-the-audit

Bono, J. E., & McNamara, G. (2011). From the editors: Publishing in AMJ—Part 2: Research design. *Academy of Management Journal Vol 54.* Available at: https://psycnet.apa.org/record/2011-21380-003

Bossmann, J. (2016). *Top 9 ethical issues in artificial intelligence*. World Economic Forum. Available at: https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/

Bowen, A. G. (2009). *Document Analysis as a Qualitative Research Method*. Western Carolina University. Available at: https://pdfs.semanticscholar.org/0e25/32c31c992ac0930998561932f198b467572d.pdf?_ga=2.68549720.811106208.1572909725-1357797736.1572909725

Breton, A. (2018). *Quant Investing:* The dangers of the Black Box. Available at: https://www.refinitiv.com/perspectives/future-of-investing-trading/quant-investing-dangers-black-box/

Brignall, M. (2018). *Amazon Hit with Major Data Breach Days Before Black Friday*. The Guardian. Available at: https://www.theguardian.com/technology/2018/nov/21/amazon-hit-with-major-data-breach-days-before-black-friday

Buchanan, G. B., & Cao, X. C. (2018). *Quo Vadis?* A Comparison of the Fintech Revolution in China and the West. Available at: https://swiftinstitute.org/wp-content/uploads/2018/10/SIWP-2017-002-_Fntech_China_West_BuchCao_FINAL.pdf

Budish, E., Cramton, P., & Shim, J. (2015). *The High-Frequency Trading Arms Race*: Frequent Batch Auctions as a Market Design Response. Available at: https://faculty.chicagobooth.edu/eric.budish/research/HFT-FrequentBatchAuctions.pdf

Bughin, J., Seong, J., Manyika, J., Hamalainen, L., Windhagen, E., & Hazan, E. (2019). *Tackling Europe's gap in digital and AI*. McKinsey Global Institute. Available at: https://www.mckinsey.com/featured-insights/artificial-intelligence/tackling-europes-gap-in-digital-and-ai

CB Insights. (2018). *Top AI Trends to Watch in 2018*. Report available at: https://www.cbinsights.com/research/report/artificial-intelligence-trends-2018/

CB Insights. (2019). *AI In Numbers*: Global Funding, Exits, And R&D Trends In Artificial Intelligence. Available at: https://www.cbinsights.com/research/report/ai-in-numbers-q2-2019/

Cellan, J. R. (2014). Stephen Hawking Warns Artificial Intelligence Could End Mankind. BBC News. Available at: https://www.bbc.com/news/technology-30290540

Chen, Y., (2018). China's city of Tianjin to set up $16-billion artificial intelligence fund. Reuters. Available at: https://www.reuters.com/article/us-china-ai-tianjin/chinas-city-of-tianjin-to-set-up-16-billion-artificial-intelligence-fund-idUSKCN1II0DD

Chen, J. (2019). *Algorithmic Trading*. Investopedia. Available at: https://www.investopedia.com/terms/a/algorithmictrading.asp

Chinner, V. (2018). *Artificial Intelligence and the Future of Financial Fraud Detection*. Forbes. Available at: https://www.forbes.com/sites/theyec/2018/06/04/artificial-intelligence-and-the-future-of-financial-fraud-detection/#2e8ed8fb127a

Citibank. (2018). *Bank of the Future:* The ABCs of Digital Disruption in Finance. Available at: https://www.citigroup.com/commercialbank/insights/assets/docs/2018/The-Bank-of-the-Futue/

Clerkie. (n.d). Homepage. Available at: https://clerkie.io

Copeland, M. (2016). *What's the Difference Between Artificial Intelligence, Machine Learning and Deep Learning?* NVIDIA. Available at: https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/

Deloitte. (2018). *16 Artificial Intelligence Projects from Deloitte Practical Cases of Applied AI*: Unleash the power of AI for your organization. Available at: https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/innovatie/deloitte-nl-innovatie-artificial-intelligence-16-practical-cases.pdf

Dietvorst, B., Simmons, P. J., & Massey, C. (2014). *Algorithm Aversion*: People Erroneously Avoid Algorithms After Seeing Them. Available at: https://www.researchgate.net/publication/268449803_Algorithm_Aversion_People_Erroneously_Avoid_Algorithms_After_Seeing_Them_Err

European Commission. (2019). *Digital Single Market:* Artificial Intelligence. Available at: https://ec.europa.eu/digital-single-market/en/artificial-intelligence

Evelson, B., Sridharan, S., Brown, G. E., & Perdoni, R. (2018). *The Nine Providers That Matter Most and How They Stack Up.* The Forrester New Wave Report: NLG for Analytics. Available at: https://www.forrester.com/report/The+Forrester+New+Wave+Natural+Language+Generation+For+Analytics+Q4+2018/-/E-RES142736#

Expert Systems. (2016). *Natural Language Processing and Text Mining*. Available at: https://www.expertsystem.com/natural-language-processing-and-text-mining/

Expert Systems. (2017). *What is Machine Learning?* A definition. Available at: https://www.expertsystem.com/machine-learning-definition/

EY. (2019). EY Announces the First Solution Designed to Help Gauge Impact and Trustworthiness of Artificial Intelligence Systems. Available at: https://www.ey.com/en_gl/news/2019/04/ey-announces-the-first-solution-designed-to-help-gauge-impact-and-trustworthiness-of-artificial-intelligence-systems

Forbes. (2018). 15 Business Applications for Artificial Intelligence and Machine Learning. Available at: https://www.forbes.com/sites/forbestechcouncil/2018/09/27/15-business-applications-for-artificial-intelligence-and-machine-learning/#2190620579f2

Hendershott, T., & Riordan, R. (2013). *Algorithmic Trading and the Market for Liquidity. Journal of Financial and Quantitative Analysis Vol. 48*. Available at: https://faculty.haas.berkeley.edu/hender/ATMonitor.pdf

Heriot-Watt University. (2017). E2E NLG Challenge. Available at: http://www.macs.hw.ac.uk/InteractionLab/E2E/

Horwitz, J. (2019). *Alibaba unveils self-developed AI chip for cloud computing services*. Reuters. Available at: https://www.reuters.com/article/us-alibaba-chip/alibaba-unveils-self-developed-ai-chip-for-cloud-computing-division-idUSKBN1WA09R

Javelin Strategy Report. (2015). *False-Positive Card Declines Push Consumers to Abandon Issuers and Merchants*. Available at: https://www.javelinstrategy.com/press-release/false-positive-card-declines-push-consumers-abandon-issuers-and-merchants

Joshi, N. (2019). *Can AI Become Our New Cybersecurity Sheriff?* Forbes. Available at: https://www.forbes.com/sites/cognitiveworld/2019/02/04/can-ai-become-our-new-cybersecurity-sheriff/#11090a8836a8

Joshi, N. (2019). *7 Types of Artificial Intelligence*. Forbes. Available at: https://www.forbes.com/sites/cognitiveworld/2019/06/19/7-types-of-artificial-intelligence/#487c98e2233e

Kaplan, A., & Haenlein, M. (2018). *Siri, Siri, in my hand*: *Who's the fairest in the land?* On the interpretations, illustrations, and implications of artificial intelligence. Available at: https://reader.elsevier.com/reader/sd/pii/S0007681318301393?token=A3915364EC5F78441839EAE336B3A051291E6195266EE7C3DFCB5672BA601F9E39126CFBC30CD1B0F24732D9321C1708

Korpela, K. (2017). *Big Data*: A cheat sheet for the rest of us. Medium. Available at: https://medium.com/the-chic-geek/big-data-a-cheat-sheet-for-the-rest-of-us-8d64a3e5672

Lane, B. (2019). Quicken Loans has already had its best mortgage lending year yet: Surpassed previous full-year record in just nine months. HousingWire. Available at: https://www.housingwire.com/articles/quicken-loans-has-already-had-its-best-mortgage-lending-year-yet/

Lexology. (2017). *Artificial Intelligence (AI):* What is it and how does it work? Available at: https://www.lexology.com/library/detail.aspx?g=5424a424-c590-45f0-9e2a-ab05daff032d

Marr, B. (2018). *How Much Data Do We Create Every Day?* The Mind-Blowing Stats Everyone Should Read. Forbes. Available at: https://www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-the-mind-blowing-stats-everyone-should-read/#61c686d260ba

Martin, N. (2019). *13 Best Quotes About the Future of Artificial Intelligence*. Forbes. Available at: https://www.forbes.com/sites/nicolemartin1/2019/06/27/13-greatest-quotes-about-the-future-of-artificial-intelligence/#7aea40c93bdf

Maryville University. (n.d). *How is Big Data Working with AI?* Available at: https://online.maryville.edu/blog/big-data-is-too-big-without-ai/

MathWorks. (n.d). *What is Deep Learning?* 3 Things You Need to Know. Available at: https://se.mathworks.com/discovery/deep-learning.html

Medium. (2019). *7 Ways AI Can Improve Customer Experience*. ChatbotNews. Available at: https://chatbotnewsdaily.com/7-ways-ai-can-improve-customer-experience-be015f2834ba

Melendez, C. (2016). *Artificial Intelligence Gets into Auditing, What's Next?* As AI spreads to new businesses, good software development will be crucial for achieving success. Available at: https://www.infoworld.com/article/3044468/artificial-intelligence-gets-into-auditing-whats-next.html

Menkveld, J. A. (2014). *High-Frequency Traders and Market Structure*. Available at: https://onlinelibrary.wiley.com/doi/pdf/10.1111/fire.12038

Mitchell, C. (2019). *The Two Biggest Flash Crashes of 2015*. Investopedia. Available at: https://www.investopedia.com/articles/investing/011116/two-biggest-flash-crashes-2015.asp

Mubarak. (2019). *Alarming Influence of AI and Chatbot in the Banking and Finance Industry*. Available at: https://www.mubarak.om/ai-and-chatbot-in-banking-and-finance/

Nautiyal, D. (2019). *Top 5 best Programming Languages for Artificial Intelligence field*. Available at: https://www.geeksforgeeks.org/top-5-best-programming-languages-for-artificial-intelligence-field/

Nielsen, A. M. (2015). *Neural Networks and Deep Learning*. Available at: http://static.latexstudio.net/article/2018/0912/neuralnetworksanddeeplearning.pdf

Norwegian School of Economics. (2015). *NHHs retningslinjer for forskningsetikk UTVALGETS RAPPORT*. Available at: https://www.nhh.no/globalassets/om-nhh/etikk-og-ansvarlig-atferd/nhhs-forskningsetiske-retningslinjer.pdf

OpenMinted Communications. (2018). *Text Mining 101*. Available at: http://openminted.eu/text-mining-101/

Panetta, K. (2017). *Neural Networks and Modern BI Platforms Will Evolve Data and Analytics*. Gartner. Available at: https://www.gartner.com/smarterwithgartner/nueral-networks-and-modern-bi-platforms-will-evolve-data-and-analytics/

Pascal, K. (2017). *Humans vs. Machines:* Who Will Manage the Factory of the Future. Digital Initiative, Harvard Business School. Available at: https://digital.hbs.edu/platform-rctom/submission/humans-vs-machines-who-will-manage-the-factory-of-the-future/

Purdy, M., & Daugherty, P. (2016). *Why Artificial Intelligence is the Future of Growth.* Accenture. Available at: https://www.accenture.com/t20170524t055435__w__/ca-en/_acnmedia/pdf-52/accenture-why-ai-is-the-future-of-growth.pdf

PwC. (n.d). *Artificial Intelligence and Digital Labor in Financial Services*. Available at: https://www.pwc.com/us/en/industries/financial-services/research-institute/top-issues/artificial-intelligence.html

PwC. (2017). *Sizing the Price:* What is the real value of AI for your business and how can you capitalize? Available at: https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf

Quicken Loans. (n.d). *Quicken Loans:* Our Mortgage Process. Website. Available at: https://www.quickenloans.com/about/our-mortgage-process?qlsource=nav

Ray, S. (2018). *Four Types of AI*. Medium. Available at: https://codeburst.io/four-types-of-ai-6aab2ce57c19

Reynoso, R. (2019). *4 Main Types of Artificial Intelligence*. Learning Hub. Available at: https://learn.g2.com/types-of-artificial-intelligence

Rohner, P., & Uhl, W. M. (2017). *Robo-Advisors versus Traditional Investment Advisors: An Unequal Game.* The Journal of Wealth Management. Available at: https://doi.org/10.3905/jwm.2018.21.1.044

Rouse, M. (2010). *Electronic discovery (e-discovery or ediscovery).* Available at: https://searchfinancialsecurity.techtarget.com/definition/electronic-discovery

Rouse, M., & Stedman, C. (2018). *Text Mining (Text Analytics)*. Available at: https://searchbusinessanalytics.techtarget.com/definition/text-mining

Schmidhuber, J. (2014). *Deep Learning in Neural Networks:* An Overview. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0893608014002135?via%3Dihub

Schmidhuber, J. (2015). *Deep Learning*. Scholarpedia. Available at: http://www.scholarpedia.org/article/Deep_Learning

Senator, E. T., Goldberg, G. H., Wooton, J., Cottini, A. M., Khan, U., Klinger, D. C., Llamas, M. W., Marrone, P. M., & Wong, R. (1995). *The FinCEN Artificial Intelligence System:* Identifying Potential Money from Reports of Large Cash Transactions. Available at: https://www.aaai.org/Papers/IAAI/1995/IAAI95-015.pdf

Seth, S. (2019). *The World of High-Frequency Algorithmic Trading*. Investopedia. Available at: https://www.investopedia.com/articles/investing/091615/world-high-frequency-algorithmic-trading.asp

Son, H. (2017). *JPMorgan Software Does in Seconds What Took Lawyers 360,000 Hours*. Bloomberg. Available at: https://www.bloomberg.com/news/articles/2017-02-28/jpmorgan-marshals-an-army-of-developers-to-automate-high-finance

Stamford, C. (2018). *Gartner Newsroom:* Gartner Says Global Artificial Intelligence Business Value to Reach $1.2 Trillion in 2018. Available at: https://www.gartner.com/en/newsroom/press-releases/2018-04-25-gartner-says-global-artificial-intelligence-business-value-to-reach-1-point-2-trillion-in-2018

Techopedia. (n.d). *Deep Learning*. Available at: https://www.techopedia.com/definition/30325/deep-learning

Thompson, C. (2014). *Cybercrime Costs Global Economy $400 Billion:* Report. CNBC. Available at: https://www.cnbc.com/2014/06/09/cybercrime-costs-global-economy-400-billion-report.html

Turing, M., A. (1950). *Computing Machinery and Intelligence. Mind 49:* 433-460. Available at: https://www.csee.umbc.edu/courses/471/papers/turing.pdf

Van Liebergen, B. (2017). *Machine Learning:* A revolution in Risk management and Compliance? Available at: https://ideas.repec.org/a/ris/jofitr/1592.html

Weisbach, S. M., Tan, C., Stern, H. L., & Erel, I. (2019). *Selecting Directors Using Machine Learning*. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3144080

World Economic Forum. (2015). *Deep Shift Technology Tipping Points and Societal Impact.* Available at: http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf

World Bank. (2019). China Data. Available at: https://data.worldbank.org/country/china

World Bank. (2019). Norway Data. Available at: https://data.worldbank.org/country/norway?view=chart

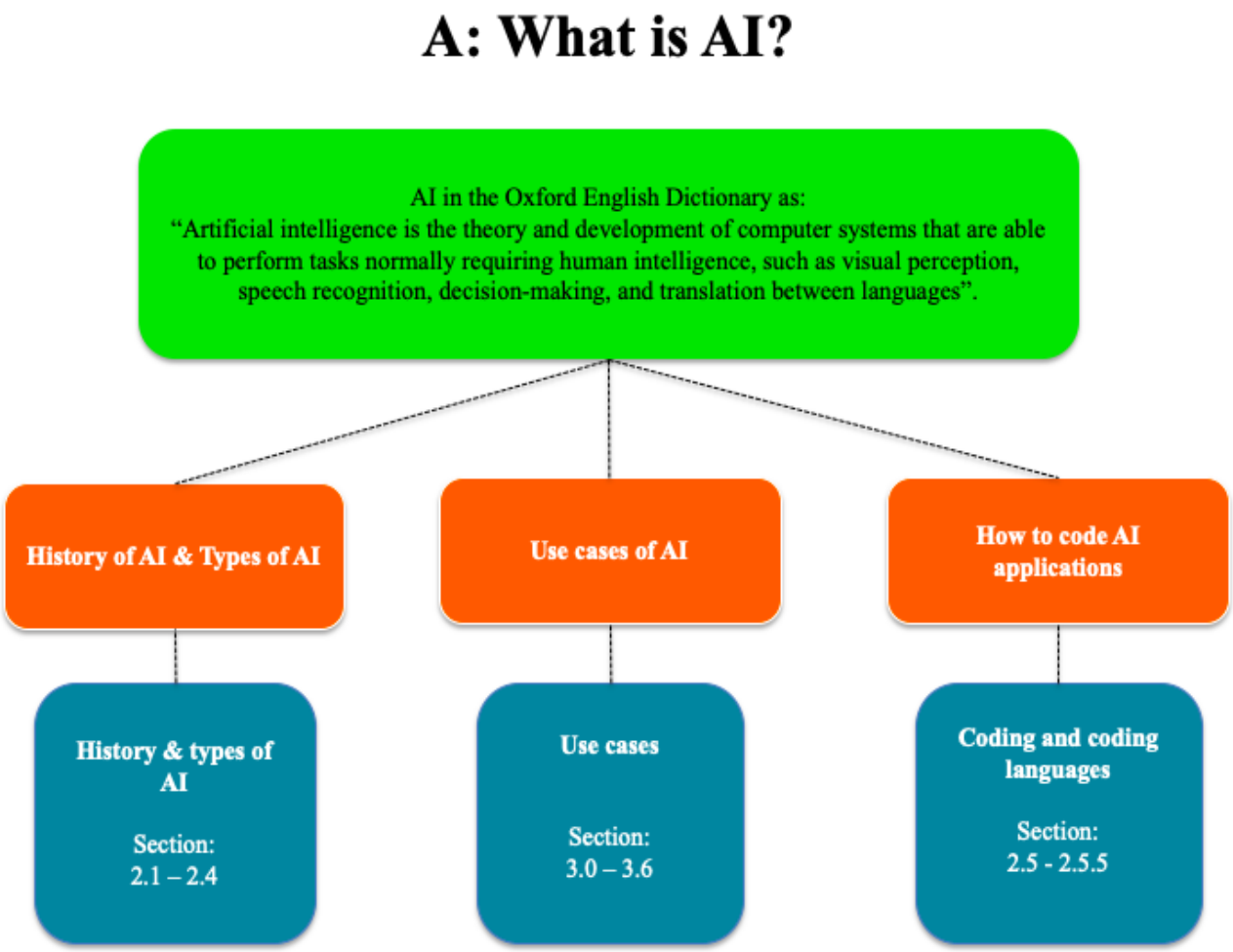
World Economic Forum. (2019). *AI Governance:* A Holistic Approach to Implement Ethics into AI. Available at: https://weforum.my.salesforce.com/sfc/p/?fbclid=IwAR3UIxGJBum3O39kC5L_6kC_RKOvOGHeEzI6LJGDCuhogFEkNdFzpI2HzFo#b0000000GycE/a/0X000000cPl1/i.8ZWL2HIR_kAnvckyqVA.nVVgrWIS4LCM1ueGy.gBc

Yaninen, D. (2017). *Artificial Intelligence and the Accounting Profession in 2030.* Available at: https://cpapng.org.pg/data/documents/CPA-Presentation-Artificial-Intelligence-and-the-Accounting-Profession-in-2030_1.pdf

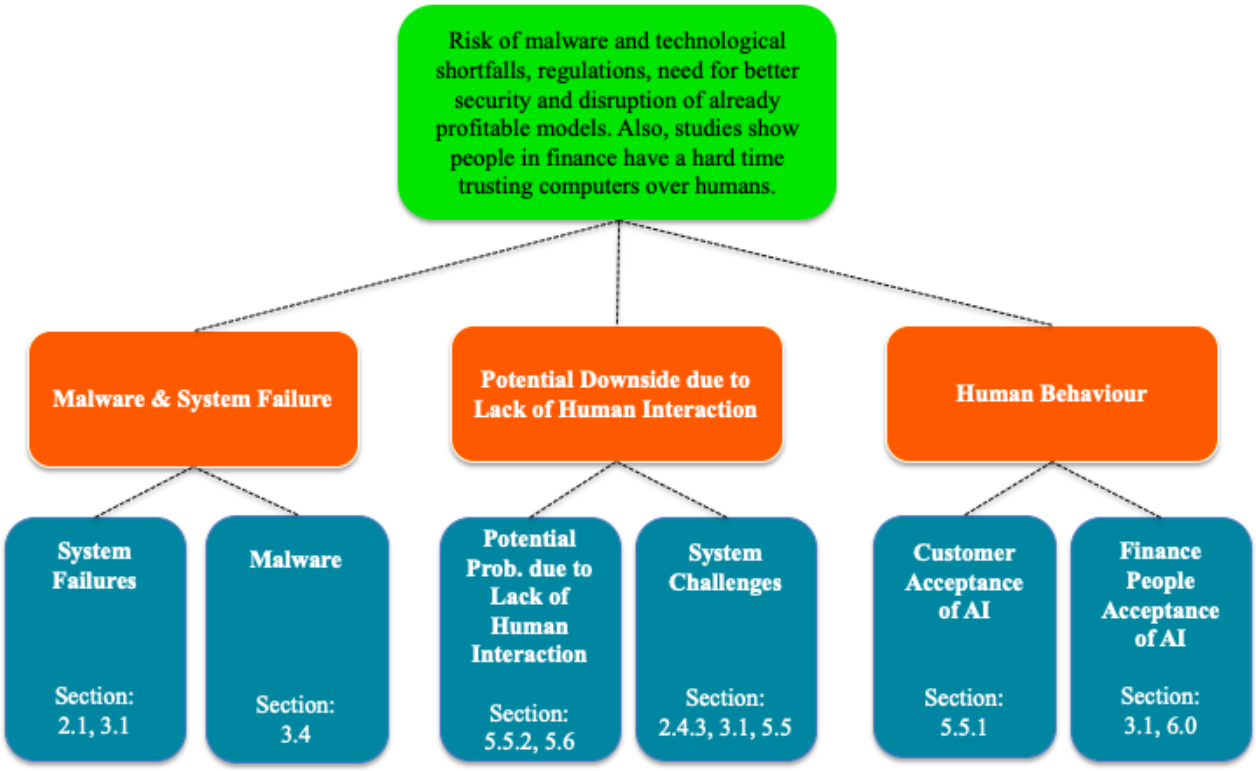
Yuchen, Z. (2019). *Four key applications of natural language processing for audit transformation.* RSM. Available at: https://www.rsm.global/singapore/insights/our-expert-insights/four-key-applications-natural-language-processing-audit-transformation

8.0 Appendix

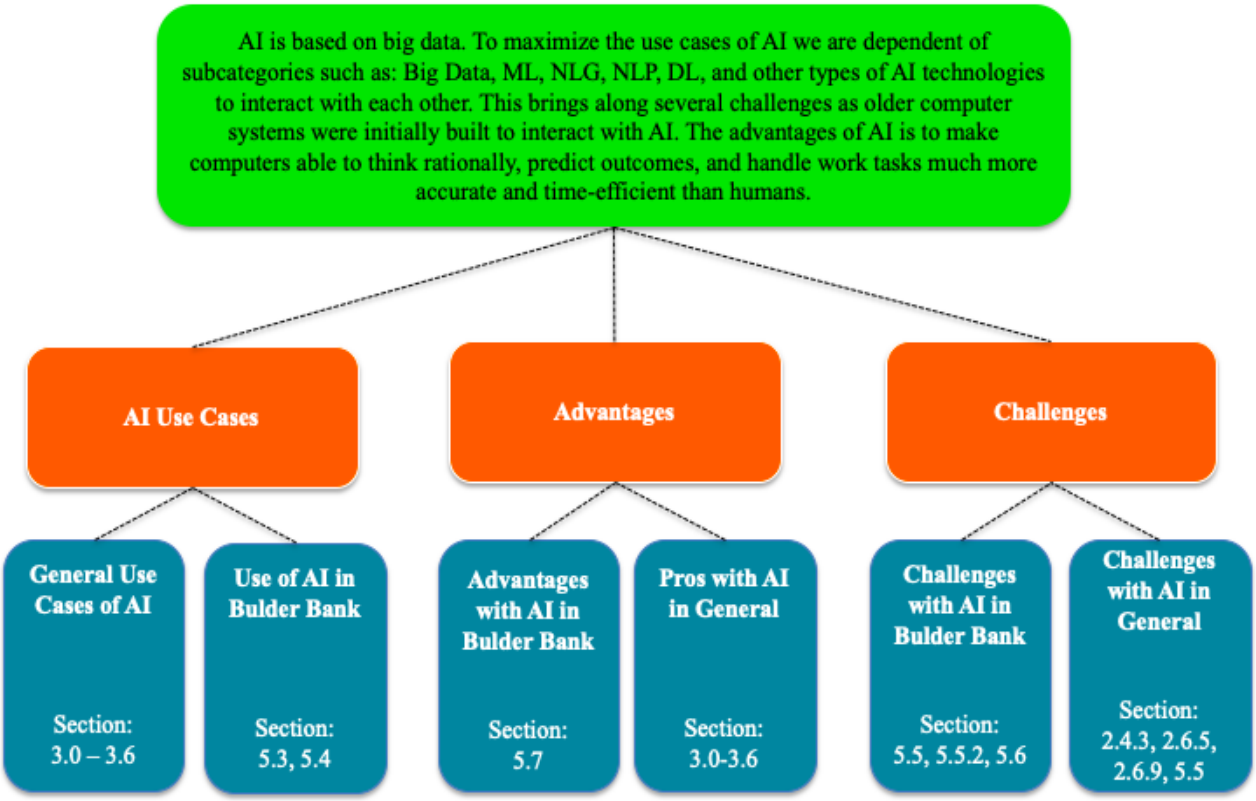
8.1 Modelling the Research Questions



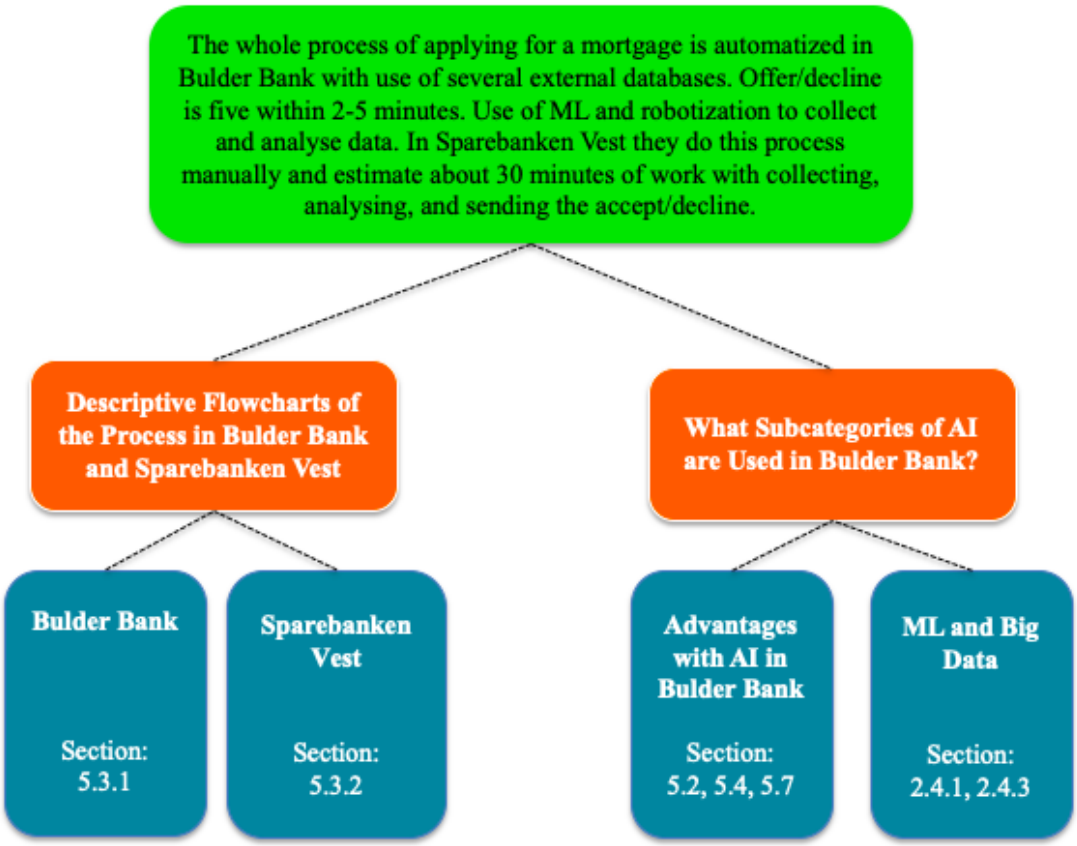
B: Why is not AI currently as widely used in financial services as in technological companies such as Google, Facebook etc. ?



C: What are the possible advantages/disadvantages with combining the different techniques within AI?



D: How is AI utilized in Bulder Bank and how does this compare to Sparebanken Vest?



8.2 Agreement Contract Thesis

Agreement contract between the two parties who wrote this thesis. The agreement was signed by both parties before the project started.

What is required to successfully complete this project?	To find a topic that both parties have a passion for in order to deliver the best possible result. Agree upon the topics we will touch into. Hence, no self-claimed text is written without notifying the other part first. Last but not least, distribute the tasks evenly between the two.
How often should we meet?	Should at least meet up 2-3 times each week to make sure that that we are on track and don't write the same things over again.
What criteria are in place for the meetings?	Have a clear outline and structure so we don't drift away into other things. Be focused. Keep it plain and simple. Last but not least, have fun.
How should we hold our deadlines?	First of all, the contract should be held. Further, each party must make sure that they do their expected work before the next meet-up. Deadlines must be held and if one party is struggling with that, then the other party should be notified.

What is expected in terms of effort?	Both parties must put in the effort needed for the result we are striving after. Obviously, we want the greatest result given our knowledge and passion for this field and hence, effort is put in accordingly. Both parties must hold their deadlines, that is important.
Who has the responsibility for what?	Both parties have the responsibility for making sure that things are done, and tasks are solved. If one party is finished with his/her tasks, he/she can contribute in other ways like helping out his/her partner. Remember, we are both on the same team and want to achieve the best result.
How often should be meet up with our supervisor?	We will reach out to our supervisor whenever we feel the need for it or when we are stuck with something. Ideally, 1-2 times a month should be sufficient.

12th of August 2019

Sign *Sign*

8.3 Interview Questions Bulder Bank

The questions are made to be a starting point for the conversation and follow up questions were asked during the interview.

Interview Object:

- Markus Nordstrønen

- CTO, Bulder Bank

Intro:

- Short introduction about ourselves and why we want this interview.
- Short introduction about our master thesis.
- Explain what the results will be used for
- Give him the possibility to be anonymous and pull his statements.

Questions:

- What is Bulder Bank?
- What is the background for establishing Bulder Bank?
- How is the firm structured?
- Which are Bulder Bank's general field of services?
- What will Bulder Bank look like in the future?

- Which processes are automated in Bulder Bank compared to Sparebanken Vest?

- What decides the interest rates for your customers?

- Is the interest rated based on a standard premium above NIBOR?

- Where do you collect information during the loan process?

- What forms of AI are used in this process?

- Would it be possible to make Bulder Bank without AI?

- How do you handle differences between a tariff and estimated value of a collateral?

- What happens if the value of a collateral changes?

- How do you collect financial income statements?

- Could you tell us the differences between Bulder Bank and Sparebanken Vest?

- How is the cost structure in Bulder Bank, and how does this differentiate to Sparebanken Vest?

- What are the results so far with the use of AI?

- What has been the main challenges of developing Bulder Bank, and what are the main challenges going forward?

- How is ML utilized to improve the process?

- What is ML used for?

- What is the ratio between customers and employees in Bulder Bank vs. Sparebanken Vest?

- How much time is saved on average per customers with automation in the mortgage process?

- What is the difference between Bulder Bank and other banks like Sbanken?

- When will Bulder Bank generate income and what is the ROE goals?

- Is there anything else relevant for our thesis that you want to mention?

Question for Markus Nordstrønen:

- What is your experience with AI?

- What are the general trends of AI?

- What kind of education do you have?

- How is Bulder Bank working out compared to other Banks?

- What is the general trend of AI in the banking sector?

8.4 Interview Questions AVO Consulting

The questions are made to be a starting point for the conversation and follow up questions were asked during the interview.

Interview Object:

- Julija Pauriene

- Senior Manager/ Head of Analytics & AI

Intro:

- Short introduction about ourselves and why we want this interview.
- Short introduction about our master thesis.
- Explain what the results will be used for
- Give her the possibility to be anonymous and pull her statements.

Questions:

- Who is AVO Consulting?
- What is your experience with digitalization and AI?
- How are financial services adapting to AI?
- What are the most common implementations of AI in financial services?
- What do you think of the future of AI?

- Do you see any challenges with use of AI?

- Which type of projects does AVO normally work on?

- What are the challenges of implementing AI?

- What is your impression of Bulder Bank?

- How is AVO working with implementing digitization processes?

- How are leaders looking at AI compared to employees in the businesses?

- Do you find that bank leaders are positive towards AI?

- What do you think is the future of AI?

- How is it with regulations and GDPR?

- Does AVO have any framework for digitization projects?

    - If yes, can you tell us about this framework

- How should Bulder Bank handle the potential risk of system failure from their providers?

- Have you seen any other businesses mainly built up by external software providers in the banking sector?

- Is there something else you think is relevant for us or Bulder Bank?

8.5 Interview Questions Accenture Norway

The questions are made to be a starting point for the conversation and follow up questions were asked during the interview.

Interview Object:

- Michael Løiten Magnussen
- AI Associate Manager, leading the commercial side of AI at Accenture Norway

Intro:

- Short introduction about ourselves and why we want this interview.
- Short introduction about our master thesis.
- Explain what the results will be used for
- Give him the possibility to be anonymous and pull his statements.

Questions:

- Who is Accenture Norway?
- What is your experience with digitalization and AI?
- How are financial services adapting to AI?

- What are the most common implementations of AI in financial services?

- What do you think AI's future?

- Do you see any challenges with use of AI?

- What types of projects does Accenture normally work on?

- What are the challenges of implementing AI?

- What type of manual work is being digitized with AI?

- What is your impression of Bulder Bank?

- How is Accenture working with implementing digitization processes?

- What is the leaders' view on AI compared to the employees in businesses?

- Do you find that leaders within the banking sector are positive towards AI?

- What do you think is the future of AI?

- How is it with regulations and GDPR?

- Does Accenture have any framework for digitization projects?
    - If yes, can you tell us about this framework?
- How should Bulder Bank handle the potential risk of system failure from their providers?
- Have you seen any other businesses built up mainly external software providers in the banking sector?
- Is there something else you think is relevant for us or Bulder Bank?

8.6 Interview Questions Karabin Consulting

The questions are made to be a starting point for the conversation and follow up questions were asked during the interview.

Interview Object:

- Atle Sandal
- Partner, Karabin Consulting

Intro:

- Short introduction about ourselves and why we want this interview.
- Short introduction about our master thesis.
- Explain what the results will be used for
- Give him the possibility to be anonymous and pull his statements.

Questions:

- Who is Karabin Consulting?
- What is your experience with digitalization and AI?
- How are financial services adapting to AI?
- What are the most common implementations of AI in financial services?
- What do you think AI's future?

- Do you see any challenges with use of AI?

- What types of projects does Karabin Consulting normally work on?

- What are the challenges of implementing AI?

- What type of manual work is being digitized with AI?

- What is your impression of Bulder Bank?

- How is Karabin working with implementing digitization processes?

- What is the leaders' view on AI compared to the employees in businesses?

- Do you find that leaders within the banking sector are positive towards AI?

- What do you think is the future of AI?

- How is it with regulations and GDPR?

- Does Karabin have any framework for digitization projects?

- If yes, can you tell us about this framework?

- How should Bulder Bank handle the potential risk of system failure from their providers?

- Have you seen any other businesses built up mainly external software providers in the banking sector?

- Is there something else you think is relevant for us or Bulder Bank?