Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Master Thesis

Competing with Giants: Artificial Intelligence as a Threat or an Opportunity for the Swiss TIME Industry?

Matteo Frondoni

15 April 2016

Department of Management, Technology and Economics
Chair of Strategic Management and Innovation
Prof. Dr. Georg von Krogh

Supervisor
Yash Raj Shrestha

D MTEC

Abstract

Artificial Intelligence is one of the most interesting fields to work in right now. The words "Artificial Intelligence" are on everyone's lips: media are continuously reporting on the latest technological breakthroughs and how they will change our lives, policy makers are considering the impact it will have on society in the next years and high-tech companies are investing billions in acquiring start-ups and hiring the brightest minds of the field.

Research on technical aspects of Artificial Intelligence is rapidly gaining the attention of many computer science researchers; the same could not be observed in management research, yet, not providing companies with specific tools to assess the impact of the latest progress in the field on their business. This represents a big issue for decision-makers within companies: everyone is claiming Artificial Intelligence has a huge potential, but there is little literature at their disposal to best tackle the coming challenges. At the beginning of the current new wave of promising Artificial Intelligence progress, this thesis aims to fill this gap in the literature and to represent a starting point for more research on the impact of Artificial Intelligence on companies and industries. Supported by Swisscom, the thesis' corporate partner, the thesis focuses on the impact of Artificial Intelligence on the Swiss Telecommunications, Information Technology, Media and Entertainment industry (TIME industry) and on factors local TIME companies can leverage in their home market to compete with global high-tech players.

The first important contribution of this thesis to theory and practice is the identification of the main factors driving the fast progress in Artificial Intelligence: "Data", "Algorithms" and "Computing Power". The analysis of the strategy deployed by companies at the forefront of innovation in Artificial Intelligence along these dimensions revealed the importance of data ecosystems, M&A and open innovation for companies willing to successfully exploit its potential. Drawing from these findings, the thesis analyses the impact of Artificial Intelligence on the Swiss TIME industry and possible strategies its players can apply, to effectively compete with global technology companies. In this regard, particularly interesting is the finding that Artificial Intelligence and Big Data represent for local telecommunications companies an opportunity to bring differentiation through local factors to a new level. Leveraging regional factors and exploiting the increasing analytical capabilities at their disposal, they can build and position themselves at the centre of so-called "local data ecosystems", building barriers to entry to global TIME players and gaining even more relevance in the life of their customers.

Acknowledgements

First and foremost, I would like to thank Martin Vögeli, Swisscom's Head of Group Strategy & Board Services. He gave me the opportunity to write the thesis on a highly interesting topic, devoted some of his precious time to supporting me all along my research and organized for me several meetings with top managers of the company: he made this work a unique and very enriching experience.

I would also like to express my gratitude to my tutor and advisor at the Chair of Strategic Management and Innovation at ETH, Yash Raj Shrestha. From the very beginning of the thesis to its end, he guided me with very valuable suggestions and was always ready to help me with his advice. I am thankful to Prof. Georg von Krogh for choosing him as my tutor: I could learn very much from him, both on a personal and professional level.

I would like to thank Prof. Claude Siegenthaler, Tulu Hamidi, David Luyet and Patrick Tinguely for helping me organize the thesis during the six months preceding its start. I am also grateful to all the interview candidates for providing the essential data that made this thesis possible. Particular thanks go to Zalán Borsos for repeatedly sharing with me his expertise in Artificial Intelligence.

Last but not least, very special thanks go to my parents for their support and continuous encouragement during the thesis and the whole course of my studies. Thank you!

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Declaration of originality

The signed declaration of originality is a component of every semester paper, Bachelor's thesis, Master's thesis and any other degree paper undertaken during the course of studies, including the respective electronic versions.

Lecturers may also require a declaration of originality for other written papers compiled for their courses.

I hereby confirm that I am the sole author of the written work here enclosed and that I have compiled it in my own words. Parts excepted are corrections of form and content by the supervisor.

Title of work (in block letters):

Authored by (in block letters):
For papers written by groups the names of all authors are required.

Name(s):	**First name(s):**

With my signature I confirm that

- I have committed none of the forms of plagiarism described in the 'Citation etiquette' information sheet.
- I have documented all methods, data and processes truthfully.
- I have not manipulated any data.
- I have mentioned all persons who were significant facilitators of the work.

I am aware that the work may be screened electronically for plagiarism.

Place, date	**Signature(s)**

For papers written by groups the names of all authors are required. Their signatures collectively guarantee the entire content of the written paper.

Table of Contents

List of Figures

List of Tables

1 – Introduction

1.1 Motivation

Artificial Intelligence is one of the most interesting fields to work in right now. The words "Artificial Intelligence" are on everyone's lips: media are continuously reporting on the latest technological breakthroughs and how they will change our lives, policy makers are considering the impact it will have on society in the next years and high-tech companies are investing billions in acquiring start-ups and hiring the brightest minds of the field. In 2014, Google bought DeepMind Technologies, a British Artificial Intelligence company, for a sum estimated to be around $500-600 million. The same year, IBM announced that it was going to invest one billion in the IBM Watson Group, the new division of the company dedicated to Big Data and Artificial Intelligence. At the end of 2015 Facebook and Google announced that they would open source the key pieces of their Artificial Intelligence research, TensorFlow and Big Sur respectively.

Following the increased interest for the topic, more and more people are attracted to work on the newest technologies of the field, accelerating progress even more: in 2011, a Stanford MOOC signed up more than 150,000 students to learn the basics of Artificial Intelligence and according to the Machine Intelligence Research Institute, as much as 10% of all computer science research is now focused on Artificial Intelligence (Muehlhauser & Sinick, 2014).

Artificial Intelligence does not draw interest just from people working in computer science: its progress relies on a wide range of disciplines, ranging from chip development to philosophy. Moreover, impacting progresses in Artificial Intelligence almost every aspect of the human society, one could say that it is a topic that should interest everyone. Some researchers even raised questions about the future of humans as a part of the work force: the technology is moving so fast that it is very difficult to determine its limits. Even jobs that seemed impossible to be performed by machines until some years ago – as journalist, nurse and doctor (Wakefield, 2015) – are now reported to be in danger.

Elon Musk, a man one would expect might look on tomorrow with unbridled optimism, is looking at Artificial Intelligence with increasing concern: in a speech at MIT in 2014, he described Artificial Intelligence as "summoning the demon", and the creation of a rival to human intelligence as probably the biggest threat facing the world. The statement was followed some months later by a donation of $10 Million to the Future of Life Institute to run a global research program aimed at keeping Artificial Intelligence beneficial to humanity. In

December 2015, he announced the creation of OpenAI, a non-profit artificial intelligence research company whose goal is "to advance digital intelligence in the way that is most likely to benefit humanity as a whole, unconstrained by a need to generate financial return" (Brockman, Sutskever, & OpenAI team, 2015).

The impression that was possible to get writing this thesis is of these being legitimate concerns: we are observing the beginning of something that could bring to society even more change than the first industrial revolution. Back then, technology enabled mankind to improve its manual skills; the Second Machine Revolution – as Andrew McAfee and Erik Brynjolfsson of MIT Center for Digital Business name it – is going to enable changes in a much deeper area of our being: mental capabilities, what distinguished us from machines and other beings, so far.

Given the importance of the topic, it is worthwhile for everyone – not just for Businesses and Policy Makers – to better understand where Artificial Intelligence comes from, what its current limits are and what impact it could have in the next years.
Personally, I feel very lucky to have being given the opportunity to write my Master Thesis on such a relevant topic and with such a strong and interested corporate partner.

1.2 Problem Definition

The potential of Artificial Intelligence is enormous and technologies making it possible are very complex. They are the fruit of decades of research at the leading public and private institutions worldwide. Envisioning high returns, companies are willing to invest enormous amount of money, as the investments and the acquisitions of all major high-tech companies show. The observation of the benefits of Artificial Intelligence, its complexity and the huge investments done lead to a question, though: if Artificial Intelligence is so important and requires such high investments, how can smaller companies take advantage of progress in the field? How will the progress in Artificial Intelligence impact their emerging strategies?

Every company needs to consider this carefully, and clear answers are particularly important for firms having digital operations at the core of their business, as for example players of the "Telecommunications, Information Technology, Media and Entertainment industry, which many people now refer to as "TIME Industries" (Morath, Roetter, & Schimmel, 2006). Telecommunications and related industries have been at the centre of extraordinary changes in recent years: e.g. Hacklin, Battistini, & von Krogh (2013) found out that "the TIME industries are characterized not only by the variety of new technological products and services being

launched at an ever-increasing pace but also by the surging complexity of their markets and how companies win. As some companies have expanded their scope, others have been forced to rethink and retool their strategies" (p. 65).
Artificial Intelligence has the potential to play a very important role in their future strategic considerations, and it is crucial for companies of the TIME industry to understand as soon as possible how the latest advances in the technology will impact their business and how to adapt their strategy accordingly.

Research on technical aspects of Artificial Intelligence is rapidly gaining the attention of many computer science researchers. This has not been the case of management research, yet, not providing companies with tools to assess the impact of the latest progress in the field on their business. This represents a big issue for decision-makers within companies: everyone is claiming Artificial Intelligence has a huge potential, even that "Artificial Intelligence Platforms can change the world" as Eric Schmidt, Google Chairman, is reported to have said (Shead, 2016), but there is little literature at their disposal to best tackle the coming challenges. At the beginning of the current new wave of promising Artificial Intelligence progress, this thesis aims to fill this gap in the literature and represent a starting point for more research on the impact of Artificial Intelligence on companies and industries. This being a topic that, given the rapidly increasing importance of Artificial Intelligence in the next years, is likely to receive much more attention from academia in the near future. The research question was formulated as follows:

"How does the latest progress in Artificial Intelligence impact the Swiss TIME industry? What are the factors local TIME players could leverage in their competition with global players in the home market?"

Being so small and yet innovative, the Swiss TIME landscape offers the ideal setting to deepen this question. Compared with other nations, the number of potential customers in Switzerland is very limited: Swisscom, the leading Telecommunications firm with a market share of 59% has around 7 million customers, way less than national Telecommunications companies as AT&T with its more than 120 million customers. This leads to a small potential of scale effects – so important in the High-Tech industry nowadays – raising the pressure of big international high-tech players such as Google, Amazon and Microsoft, and increasing the need to be innovative in other areas, as Process and Business Model Innovation. To understand how to compete against these giants in the Artificial Intelligence Era, in a field where the latter

have clear technological advantages, is so even of greater importance for TIME players located in Switzerland.
Swisscom – as the leading Swiss TIME firm – is highly motivated to seek an answer to this question and also an academic perspective represents an optimal corporate partner, having already shown to be at the forefront of strategy innovation and partnered with researcher for an article published on the MIT Sloan Management Review (Hacklin, Battistini, & von Krogh, 2013).

1.3 Methodology and Structure of the Thesis

The study of Artificial Intelligence was guided by the interest in deepening a technology that is considered by many to have a great impact on everyone's lives in the near future. The research started with a content analysis confirming the great potential of the technology and showing the necessity to interview knowledgeable people on the matter. Progresses in the domain are rapidly following one another making previous research insufficient and making the availability of insights of people directly involved in its development and commercialization very important.

Thanks to the generous support of Swisscom, the thesis presented the possibility to be written in a corporate environment, working at the intersection of industry and academia. This represented a great opportunity since it allowed the study of the potential of Artificial Intelligence not only in theory, but also to see its impact on the strategy of a company, a topic unexplored by academia so far.

In Chapter 2, the thesis presents a review of the most important literature in the field of Artificial Intelligence, both from a managerial and technical perspective. The literature review played a key role: on the one hand, the review of the global and competitive strategy literature allowed to define how to best contribute to academia, directly leading to the research question. On the other hand, it was crucial to get a good understanding of the technology in order to be able to give relevant strategic suggestions to the corporate partner; to this purpose, the technical literature on Artificial Intelligence was deepened, paying particular attention to the latest progress in the field. The chapter on the literature review is directly followed by a brief presentation of the corporate partner and the industry it is operating in.

Following the literature review and the presentation of the corporate partner, the thesis proceeds explaining the rationale behind the methodology strategy chosen. Particular

attention is devoted to the discussion of the choice of the qualitative method and of the sources selected for the data collection.

Drawing from the analysis of the data collected, the successive chapters present the findings of the thesis and provide an answer to the research question:

In Chapter 5, the moves in the field of Artificial Intelligence of the most important global players are presented. The analysis of these moves, of the factors leading to the greatest advancements in the field and of the data collected through the interviews leads to the first important finding of the thesis: the identification of the three main catalysts of Artificial Intelligence progress. This finding revealed to be of great help for the further analyses performed in Chapters 6 and 7.

Aim of Chapter 6 is to to answer the first part of the research question – "How does the latest progress in Artificial Intelligence impact the Swiss TIME industry?" – and understand in what opportunities for the Swiss TIME industry, and more specifically for Swisscom, advances in the technology will result. To this purpose, the chapter starts with a SWOT analysis of Swisscom in respect to Artificial Intelligence. In the following sections, drawing from the finding of the Catalysts of Progress made in Chapter 5, a framework to assess the potential of single use cases inside the company is introduced and applied. Based on the results of the two frameworks, the most promising use cases for Swisscom are presented.

Chapter 7 aims to answer the second part of the research question – "What are the factors local TIME players could leverage in their competition with global players in the home market?". To do so, the chapter starts analysing how latest progress in Artificial Intelligence and the related strategic moves of the biggest players influenced the competitive landscape. Based on that, the second part of the chapter focuses on how local players of the TIME industry can compete with global technology companies, in an industry where Artificial Intelligence is becoming always more important.

2 – Literature Review

The literature review plays a key role in this thesis: on the one hand, the review of the global and competitive strategy literature allows to define how to best contribute to academia. On the other hand, it is crucial to get a good understanding of the technology in order to be able to give relevant strategic suggestions to the corporate partner.

In the introduction, it was claimed that Artificial Intelligence is without a doubt one of the most interesting fields to work in, but what is Artificial Intelligence? What is needed to achieve this ambitious task? How is Artificial Intelligence impacting our life and how much more will it do in the future?

2.1 Defining Artificial Intelligence

The term Artificial Intelligence was coined by John McCarthy in the proposal for the Dartmouth conference (McCarthy, Minsky, Rochester, & Shannon, 1955). Since then, its definition is among the first challenges every researcher working in the field is confronted with. To further complicate matters, in the last 60 years even an evolution of its meaning could be observed. As McCorduck (2004) points out, “It's part of the history of the field of artificial intelligence that every time somebody figured out how to make a computer do something – play good checkers, solve simple but relatively informal problems – there was chorus of critics to say, 'that's not thinking'" (p. 204). A good example is the victory of IBM’s chess playing computer Deep Blue against Garry Kasparov in 1997: what until some years before seemed to be one of the proves that machines can do intelligent things (Turing, 1950), ceased to be looked as such immediately after its achievement, being then just labelled as “Brute force methods” (McCorduck, 2004), leading Hofstadter (2000) to state that "Artificial Intelligence is whatever hasn't been done yet” (p. 601).

Following Russell & Norvig (2010), we think that the different definitions of Artificial Intelligence can be best represented on a two-by-two matrix, differentiating between what is performed (i.e.: acting or thinking) and the way this is done (i.e.: humanly, rationally). The table below provides an example of definitions belonging to the four proposed categories:

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think… machines with minds, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem-solving, learning…" (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak & McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, Schneider, & Schneider, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich & Knight, 1991)	**"**Computational Intelligence is the study of the design of intelligent agents." (Poole, Mackworth, & Goebel, 1998) "Artificial Intelligence… is concerned with intelligent behaviour in artefacts." (Nilsson, 1998)

Table 1: Some definitions of artificial intelligence, organized into four categories (Russell & Norvig, 2010).

The definition chosen directly influences the way Artificial Intelligence research is performed and it is important to notice that the four definition categories also correspond to the four main approaches used by researchers in the field of Artificial Intelligence over time. A closer look at the different definitions allows so to automatically review the history of the field and the advantages and limitations of the approaches followed.

In the next lines, each category and the historical context leading to the formulation of its definitions will be presented, along with the strengths and weaknesses of the resulting approaches.

2.1.1 Acting Humanly

Making computer acting as humans was the dream of Alan Turing, one of the pioneers of Artificial Intelligence. The test he designed – the now called Turing Test – was precisely meant to measure how well such task was performed (Turing, 1950): machines passing the Turing

test would be considered as intelligent. However, with time Artificial Intelligence researchers devoted less and less efforts to exactly replicate human action, being its imitation too restrictive: “the quest for “artificial flight” succeeded when the Wright brothers and others stopped imitating birds and started using wind tunnels and learning about aerodynamics. Aeronautical engineering texts do not define the goal of their field as making “machines that fly so exactly like pigeons that they can fool even other pigeons” (Russell & Norvig, 2010, p. 3).

2.1.2 Thinking Humanly

Focusing on replicating human thinking is an even more ambitious task. Imitating human acting presents many challenges of technical nature and despite the many progresses since the beginning of the work on Artificial Intelligence, no machine has passed the Turing test (Turing, 1950). To get to the point where machines think as humans do, adds additional challenges of philosophical and technical nature we are very far from solving.

From a philosophical perspective, the belief in the feasibility of replying human thinking relies on the answer to questions at the centre of the philosophical debate since centuries, even millennia:

1. Are human beings and their brain just a combination of cells or something more?
2. How does the mind arise from a physical brain?
3. Where does knowledge come from?

The debate is still open with some – as Positivists – asserting that it is possible to fully understand how one thinks just examining his brain and the neurons interact and others believing that something more is needed. The position of the latters is very well summarized by Descartes asserting around 1640: “One problem with a purely physical conception of the mind is that it seems to leave little room for free will: if the mind is governed entirely by physical laws, then it has no more free will than a rock "deciding" to fall toward the center of the earth” (Russell & Norvig, 2010, p. 6).

A “thinking humanly” approach poses challenges of technical nature as well: after some initial optimism, the difficulties arising from the attempt of accurately imitating the brain seem to be insurmountable. After years of efforts, we are still very far from reaching the level of energy efficiency the brain shows and the available computing power is still far away from the amount needed.

These are more than limitations in single domains; the big issue in accurately imitating the brain has much deeper roots. As Jaron Lanier pointed out: "We're still pretending that we're inventing a brain when all we've come up with is a giant mash-up of real brains. We don't yet understand how brains work, so we can't build one" (Dowd, 2014).

2.1.3 Thinking Rationally

A great part of 19th and 20th century philosophy focused on logic, the branch concerned with the use and study of valid reasoning (Jacquette, 2008). Following the enthusiasm for the great advances in natural sciences brought by the application of the empirical method, many philosophers as Bertrand Russell, Ludwig von Wittgenstein and Gottlob Frege tried to build a philosophical practice characterized by the use of the same method. "Modern analytical empiricism (...) differs from that of Locke, Berkeley, and Hume by its incorporation of mathematics and its development of a powerful logical technique. It is thus able, in regard to certain problems, to achieve definite answers, which have the quality of science rather than of philosophy" (Simon & Schuster, 1945, p. 834). In those years, a great amount of philosophical research was devoted to a description in logical terms of all kinds of objects in the world and the relation among them.

Such developments looked very promising to Artificial Intelligence-researchers, seeing in them the possibility to dodge the incapability of imitating the brain by just focusing on the logical structure of our decision-making. With his algorithms Aristotle showed two thousands years before that having the right premises and using the right method, it is possible to yield to correct conclusions. Exploiting that, "by 1965 programs existed that could, in principle, solve any solvable problem described in logical notation. (Although if no solution exists, the program might loop forever)" (Russell & Norvig, 2010, p. 4).

The idea seemed to be very promising and was followed by many researchers. However, they were soon confronted with a main issue preventing them to unlock the potential of the new approach:
As the concept of implicit knowledge shows, not all what we do, think or know can be easily made explicit and imitated. It is very difficult to state everything in the formal terms required by logical notation. As Michael Polanyi noticed "we can know more than we can tell... The skill of a driver cannot be replaced by a thorough schooling in the theory of the motorcar; the knowledge I have of my own body differs altogether from the knowledge of its physiology" (Polanyi, 1967, p. 4).

2.1.4 Acting Rationally

The rationally acting machine "is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome" (Russell & Norvig, 2010, p. 4). Nowadays, this approach seems to be very promising allowing researchers to avoid the insurmountable issues that the others described above had to face.

On the one side, the focus is not on the imitation of human behavior, resulting very difficult since we have not been able to answer the deep questions about human nature so far. On the other side, focusing on acting rather than thinking does not constrain researchers to the world of inferences. Many acts we perform do not require a deliberation; in their everyday life humans often act by instinct and are glad to have such a mechanism: "recoiling from a hot stove is a reflex action that is usually more successful than a slower action taken after careful deliberation" (Russell & Norvig, 2010, p. 4).

Given the advantages it presents, the rational agent approach is nowadays the most followed by researchers and has led to a fragmentation of the Artificial Intelligence landscape. Leading the optimization of narrower tasks to much better results, researchers have specialized in different areas of Artificial Intelligence, trying to reach human performance in single tasks.

Artificial Intelligence that focusing on narrow tasks, not attempting to perform the whole range of human cognitive abilities is referred to as Weak Artificial Intelligence, whereas Strong Artificial Intelligence is "machine intelligence with the full range of human intelligence" (Kurzweil, 2005, 2015).

2.2 Foundations

The complexity of Artificial Intelligence does not only rely upon its high ambitions: as noticed in the previous section, it is very impressive to see the number of disciplines needed in its development. To show the exact influence of single disciplines on Artificial Intelligence goes beyond the scope of this thesis. Interested readers may refer to Russell & Norvig (2010) providing very interesting insights on the topic.

To give the reader an idea of the relevance of the single disciplines, drawing from the work of Russell & Norvig (2010), Table 2 was built; it shows the importance of the different disciplines involved and the questions they aim providing an answer to:

Philosophy	**Mathematics**
Can formal rules be used to draw valid conclusions?	What are the formal rules to draw valid conclusions?

How does the mind arise from a physical brain? Where does knowledge come from?	What can be computed? How do we reason with uncertain information?
Economics How should we make decisions so as to maximize payoff? How should we do this when others may not go along? How should we do this when the payoff may be far in the future?	**Neuroscience** How do brains process information?
Psychology How do humans and animals think and act?	**Computer Engineering** How can we build an efficient computer?
Control theory and cybernetics How can artefacts operate under their own control?	**Linguistics** How does language relate to thought?

Table 2: The Foundations of Artificial Intelligence (Russell & Norvig, 2010).

2.3 The History of Artificial Intelligence

The evolution of the definition of Artificial Intelligence presented in Section 2.1 shows in which direction Artificial Intelligence researchers spent their efforts throughout history. To provide readers not only with the general challenges researchers faced in different periods of history, but also with the greatest achievements and events in the field, a timeline of the major events in the history of Artificial Intelligence is given below:

Year	Major Events
1950	Alan Turing publishes his article "Computing Machinery and Intelligence", describing the Turing Test.
1950	Isaac Asimov publishes his book "Three Laws of Robotics" (Asimov, 1950).
1952	Hodgkin and Huxley describe through a mathematical model – the now called "Hodgkin-Huxley model – how action potentials in neurons are propagated (Hodgkin & Huxley, 1952).
1956	In the McCharty's proposal for the Dartmouth conference, the term Artificial Intelligence is officially used for the first time.

1958	John McCharthy invents the LISP programming language, quickly the favoured programming language for Artificial Intelligence research and still in use today.
1959	Newell and Simon develop the General Problem Solver, a program designed to imitate human problem-solving protocols (Newell, Shaw, & Simon, 1959).
1962	Rosenblatt and other researchers lay with their work the foundation for Neural Networks algorithms (Block, Knight Jr, & Rosenblatt, 1962; Rosenblatt, 1961; B. Widrow, 1962; Bernard Widrow & Hoff, 1960).
1966	Following the disappointment for the lack of results, all US government funding for academic translation projects is cancelled (Huntbach & Ringwood, 2003).
1969	Bryson an Ho discover the back-propagation learning algorithms for multilayer networks (Bryson & Ho, 1969).
1969	DENDRAL, the first successful knowledge-intensive system is developed (B. Buchanan & Sutherland, 1969).
1973	The Lighthill report (Lighthill, 1973) – showing great criticism toward the potential of Artificial Intelligence – is published and formed the basis for the decision by the British government to end support for Artificial Intelligence research in all but two universities (Russell & Norvig, 2010). It is the beginning of the so-called Artificial Intelligence Winter (1974 – 1980), a period of reduced funding and interest in artificial intelligence research.
1976	The Meta-Dendral learning program produces results in chemistry: the first scientific discoveries by a computer to be published in a refereed journal (B. G. Buchanan et al., 1976).
1982	The first successful commercial expert system, R1, begins operation at the Digital Equipment Corporation (McDermott, 1982).
1986	The back-propagation learning algorithm is rediscovered and the publication of the results of its application generate a new wave of optimism (McClelland, Rumelhart, & Hinton, 1986).
1986	The team of E. Dickmanns builds the first robot cars, driving up to 55 mph on empty streets (Dickmanns & Zapp, 1987).
1991	During the First Gulf War, the DARPA deploys the Dart Scheduling Application, whose generated savings pay back 30 years of investments in Artificial Intelligence research (Hedberg, 2002).
1995	A semi-autonomous car drives coast-to-coast across the United States with computer-controlled steering for 4'501 km (Bertozzi, Broggi, & Fascioli, 2000).

1997	IBM's Deep Blue chess machine defeats the world chess champion Garry Kasparov.
2002	iRobot Corp. introduces Roomba, the autonomous robotic vacuum cleaner.
2005	École Polytechnique Fédérale de Lausanne starts the Blue Brain Project to study the brain's architectural and functional principles.
2011	IBM's computer defeats television game show Jeopardy! champions Rutter and Jennings.
	Apple, Microsoft and Google launch their personal assistant (in the order: Apple Siri, Microsoft Cortana and Google Now).
2014	Google buys for half a billion dollars, Artificial Intelligence start-up DeepMind Technologies (Shu, 2015).
	IBM introduces its latest SyNAPSE chip, "a new chip with a brain-inspired computer architecture powered by an unprecedented 1 million neurons and 256 million synapses" (IBM Research, 2014).
2015	Stephen Hawking, Elon Musk, and dozens of artificial intelligence experts sign a letter open letter on artificial intelligence calling for research on the societal impacts of Artificial Intelligence (Hawking, Musk, & al., 2015)
	Facebook open sources its Artificial Intelligence hardware design (Chaykowski, 2015).
	Google makes its latest machine learning system TensorFlow open source (Google Research, 2015). In the following months, IBM, Microsoft and Facebook perform similar open source moves.
2016	At CES 2016, all of the top automakers presented plans for self-driving cars, "stealing the show at CES", as Forbes later reported (Newcomb, 2016). Among other announcements, GM announced a partnership with ride-hailing service Lyft to build a nationwide fleet of self-driving vehicles. (Greenough, 2016)
	In March 2016, Google's AlphaGo beats Lee Sedol – ranked as the fourth-best player in the world (Coulom, 2016) – in a five-game match. It is the first time a program beats a 9-dan professional without handicaps.

Table 3: Timeline of major events in the history of Artificial Intelligence.

2.4 State of the Art

The field of Artificial Intelligence is very broad and researchers rather than trying to build machines with the full range of human intelligence, now focus on the development of machines aiming to reach human performance in narrow tasks, having this shown to lead to better results.

Progresses solving the different tasks are being made at different speeds: Facebook claims DeepFace – its facial recognition software – to have an accuracy of more than 97% "closely approaching human-level performance" (Taigman, Yang, Ranzato, & Wolf, 2014, p. 1701) while translation accuracy is for many languages still very far from that point.
Therefore, to analyse the actual status of Artificial Intelligence today, a distinction between the different categories has to be done. The main categories are presented in the subsections below.

2.4.1 The Predominant Role of Machine Learning

Machine learning plays a key role in Artificial Intelligence, being the ability to find patterns inside vast amounts of data of great importance for its success.
The term itself does not refer to any specific underlying algorithm: "Machine learning is a method of data analysis that automates analytical model building" (SAS Institute Inc., 2016); it basically describes the task of processing data in order to find patterns. Over the last decades, hundreds of algorithms have been developed to this aim.

The machine learning workflow consists mainly out of three steps, shown in Figure 1 below:

1. Question formulation and building of the training set
2. Feature extraction
3. Analysis of the features through a machine learning algorithm

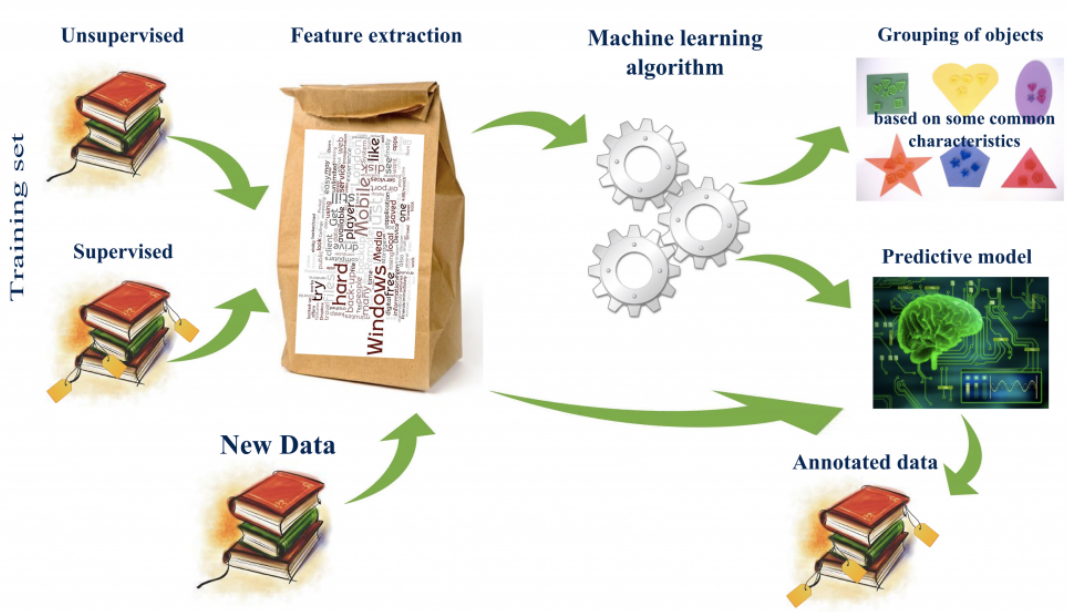


Figure 1: Supervised / Unsupervised Machine Learning Workflow (Konstantinova, 2014).

At the beginning of the whole workflow, is very important to very well define the question one wants the machine learning algorithm to work on and the data at own disposal: the results and the algorithm to be deployed are highly dependent these two parameters. Moreover, it is better to work on narrower questions since these – all the rest being equal – are more likely to lead to better results.

The workflow highly depends on the task to be accomplished and the means at own disposal; it is usually distinguished between:

- Supervised machine learning
- Unsupervised machine learning
- Reinforcement learning

Supervised Machine Learning

"Supervised machine learning relies on data where the true label / class was indicated" (Konstantinova, 2014). If the task is for example to distinguish between cats and dogs it means that someone labelled the pictures beforehand, giving the machine the information about their content.

Based on this information, if given a big amount of pictures the machine can learn what the traits distinguishing dogs and cats are, in a similar way as a child does. If asked to label a new picture, it will do it comparing its features with those of the objects it was presented with.

Figure 2 depicts the process for the two features height and weight: based on the provided data, the machine determines the areas of the space spanned by height and weight common to cats and dogs.

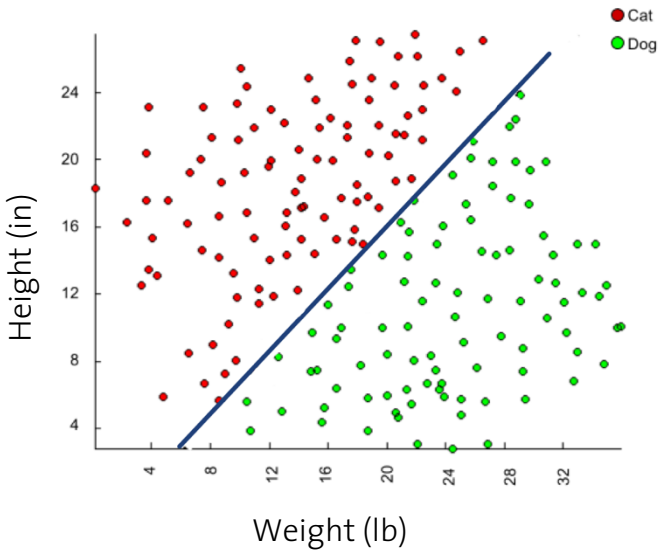


Figure 2: Based on the provided data, the machine determines the areas of the space spanned by height and weight common to cats and dogs.

Unsupervised Machine Learning

In unsupervised machine learning – as the name suggests – the machine is presented with unlabelled pictures and another technique needs to be used: clustering. During the training phase, the machine finds among the suggested features some for which different clusters can be distinguished. At the end of the process, a human being tells it what these clusters are and how to label them in the future. In Figure 3 below, this process for our example of a machine distinguishing between dogs and cats is shown. In a first phase, the machine finds two features for which to distinguishable clusters can be built. These features are **"**Face Breadth**"** and **"**Face Height**"**. On the right side, the situation after a human took labelled the clusters.

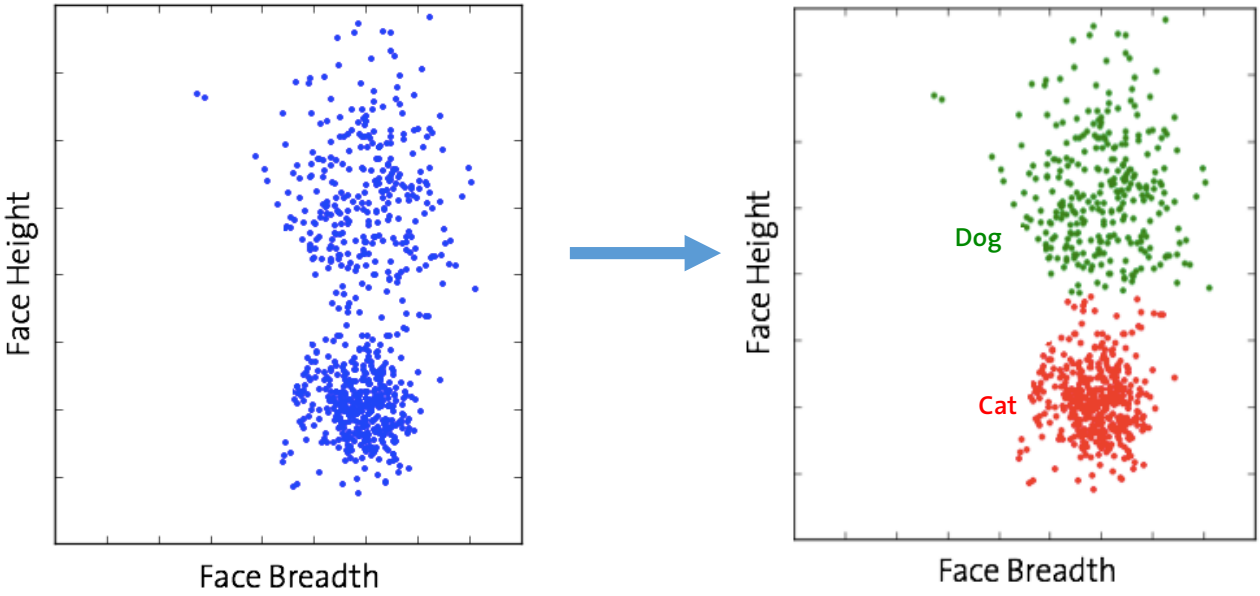


Figure 3: Unsupervised Machine Learning: The figure on the left side shows two clusters that can be distinguished from one another using the features "Face Breadth" and "Face Height". On the right side, the clusters after a human labelled them.

Reinforcement Learning

Reinforcement Learning works in a slightly different way as Supervised and Unsupervised Learning; it is employed in tasks as "learning" to play chess: in this case the machine is not provided with labels but with information about actions that took place in a dynamic environment. Based on these, the algorithm is expected to take actions maximizing some notions of cumulative reward.

In the chess example, the algorithm is given several games, the moves made and the end result of the game. "Machine learning does not have every move in the game labelled as successful or not, but only has the result of the whole game. Playing many games it can give bigger "weights" to those moves that resulted in a winning combination" (Konstantinova, 2014). IBM's Deep Blue showed how successful this process can be.

Feature Extraction

A very difficult and time-consuming part of machine learning is the process called “feature extraction”: telling the computer what kind of information it should be looking for in the data sets presented in order to efficiently solve the task. The relevance of the features is peculiar to the task to be accomplished. In the example presented above, weight and weight were two key features, but for other animals it may not be the case and completely different features have to be looked for in different areas as planning or natural language processing.

In computer vision, thanks to the good understanding of human vision and its nature, Feature Learning can often be deployed: the machine can be brought to understand by itself what are the most important features with little external assistance leading so to faster and better results. This is not the case in most fields, where people with a good understanding of the task and the data are needed to select the most relevant features.

Machine learning algorithms are very task-specific. There is not an algorithm able to answer any question. Although some underlying techniques may be similar or even the same, algorithms have to be customized depending on the task to be accomplished.

Neural Networks

Dr. Robert Hecht-Nielsen – the inventor of one of the first neurocomputers – defined a neural network as "...a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs” (Caudill, 1989, p. 61).

The foundations for Neural Networks were laid in the early Sixties by Rosenblatt and other researchers (Block et al., 1962; Rosenblatt, 1961; B. Widrow, 1962; Bernard Widrow & Hoff, 1960), but after some initial struggle for their effective implementation and the lack of results, researchers focused on other methods as those based on logical notations that seemed to be more promising at that time.

New algorithms, the increased amount of Data and Computing Power have renewed the interest of researchers and companies for the field. They are called Neural Networks since they were inspired by the way neural signals propagate inside the brain, mathematically described in 1952 by the Medicine Nobel Prize winners Alan Lloyd Hodgkin and Andrew Huxley. However, although some do – the vast majority of researchers is not concerned with whether their networks accurately resemble biological systems. Nowadays, the term is very often used

speaking about deep learning, discussed in the section below.

Deep Learning

As pointed out above, a very difficult part of machine learning is the feature extraction: how can we describe to it, how to distinguish between a cat and a dog? Or between different faces? What should it pay attention to? Deep learning is of great help precisely to solve this issues and in the last two years, software using it showed impressive results.
Deep learning uses a model of computing that is very much inspired by the structure of the brain: it uses Neural Networks and because of use, it has also been said to be just a rebranding of them. (Gomes, 2014)

As mentioned above, Neural Networks are inspired by the way neurons work, spiking depending on the type and amount of stimuli perceived.
Neurons in a Neural Network pass a signal whose value relies on the modelling function and on the inputs received:

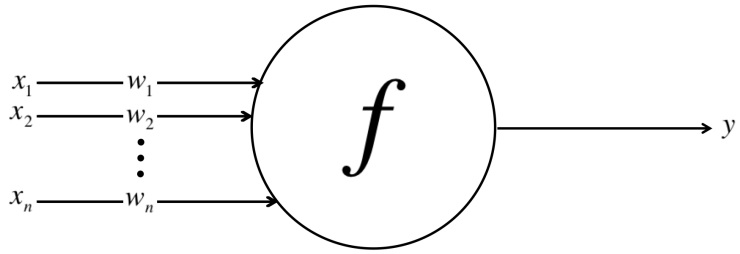


Figure 4: Schematic for a neuron in a neural net (Buduma, 2014).

Tasks involving machine learning are usually highly complex and to carefully model them many layers of neurons are needed, as shown in Figure 5:

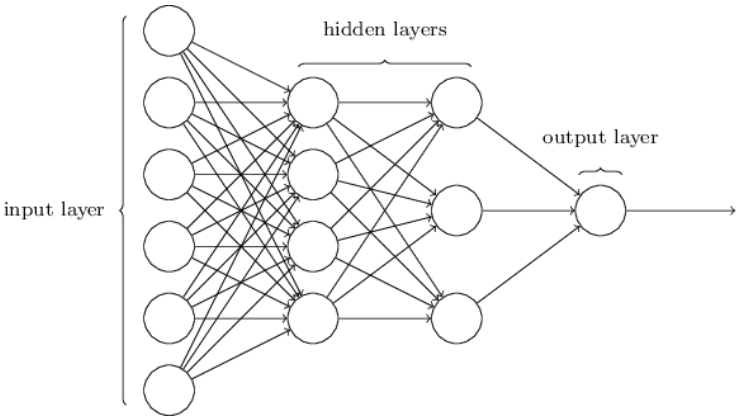
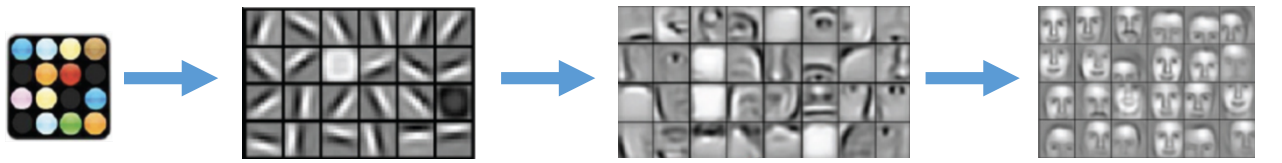


Figure 5: Example of Neural Network with 2 hidden layers (Nielsen, 2015).

The high number of layers allows the machine to reach great levels of abstraction and complexity.
The presence of many layers led to the name "Deep Neural Networks", forming together with other layered architectures the field of deep learning: "Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction" (LeCun, Bengio, & Hinton, 2015, p. 436). To have multiple processing layers is a key aspect of deep learning: it can be shown mathematically that for images the best features for a single layer are edges and blobs. However, we cannot operate on these inputs directly: we first need to transform them to get more complex features containing more information. Doing so many times – and using so many layers – allows neural networks to distinguish between objects. (Dettmers, 2015)

The example depicted in Figure 6 shows in a simplified way how a machine looks at a set of images if asked to extract the key features of human faces:



Input Layer: Pixels *Layer 1: Edges* *Layer 2: Object Parts* *Output Layer: Object Models*

Figure 6: A deep learning model applied to pictures of faces (Ng, 2013).

In the example presented above, the machine is given photos of different people faces (i.e., Input layer). In order to learn to recognize them the machine starts looking for their peculiar traits beginning from the simplest properties (layer 1: edges) and moving – building on top of that – to more complex ones in the following steps, as for example object parts. At the end of the process (output layer) it has built its model of what it defines as human face.
If later asked to tell whether a new picture contains a human face, it will look for the properties of that object model.

Latest developments in the field make deep learning so powerful and promising also because of the capability these networks have to learn and to improve themselves as more training data they receive. Measuring the difference between the predictions of the network and the desired values, it changes the weights (or parameters) so that predictions get more accurate. (Dettmers, 2015)

2.5 Subfields and their Potential

There are many different technologies emanating from the field of Artificial Intelligence. Rather than focusing on the broad field of Artificial Intelligence, it is on these that business and public sector leaders should focus their attention on (Schatsky, Muraskin, & Gurumurthy, 2014). To this purpose, technologies emanating from Artificial Intelligence can be grouped into categories in many different ways (Russell & Norvig, 2010; Schatsky et al., 2014). Venture Scanner – a company specialized in providing data and research on start-ups – distinguishes among 11 main categories (a detailed definition can be found in the Appendix) and provides data on the number of companies in each category. Their research allows to get an idea of the most trending sectors on the start-up scene.

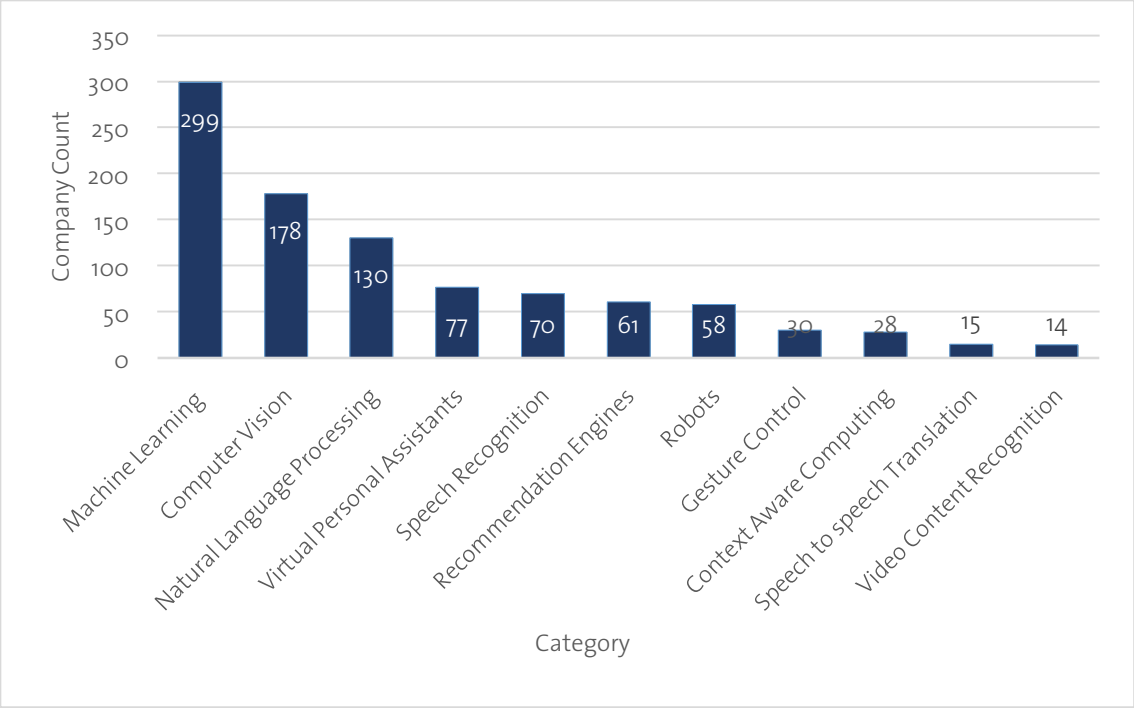


Figure 7: Which categories in Artificial Intelligence are seeing the most innovation? (venturescanner.com)

As Figure 7 shows, machine learning development is the category enjoying the most attention from developers. A fact that makes very much sense, as machine learning is at the core of any Artificial Intelligence progress. Machine learning is also the category investors are most interested in (a topic presented in Section 5.3.3). In fact, from a strategic perspective machine learning – and deep learning as an important part of it – represents a very attractive investment for companies, as the knowledge gained can be then applied to many use cases.

In the next lines, the other categories receiving most attention in the field – Language Processing, Computer Vision and Predictive Data Analytics – will be presented.

2.5.1 Language Processing

Language processing was one of the first applications of Artificial Intelligence, researchers were looking for. Alan Turing – one of the founders of the discipline – worked at the development of "Bombe", a machine used to decipher German encrypted secret messages and translation has been since always among the fields researchers are devoting most efforts to. Although we are still far from perfect translations, the work in the field is producing much better results in the last years, leading to a higher number of solutions reaching the market: Skype even announced the rollout for 2016 of Skype translator, a service promising among others that "it will translate your conversation into another language in near real-time" and "what someone else says is translated back in your language" (Skype.com).

In order to reach good levels of accuracy, Language Processing Solutions need to be "trained", to analyse big sets of data and learn from them the language particularities. Broadly spoken languages as English, Spanish and French provide great amounts of data and are so the languages for which translation services work best; this is not the case of Swiss German, the mother language of most people in Switzerland that presents some important challenges to Natural Language processing researchers:

- It is mainly a spoken language.
- Swiss German is spoken in Switzerland by only by 4.5 million people (Ethnologue, 2012). Moreover, it represents rather an umbrella term than a linguistic unity: almost every canton has its Swiss German dialect and differences among them may be very high.

In order to provide a widely-used solution based on Natural Language Processing on the Swiss territory, it has to be kept in mind that it is necessary to overcome these issues, first.

2.5.2 Computer Vision

Computer vision has enjoyed very much attention since the beginning of the discipline of Artificial Intelligence. It started focusing on OCR – Optical Character Recognition – even before the term "Artificial Intelligence" was coined: in 1914, E.F. d'Albe developed the Optophone, a handheld scanner that when moved across a printed page, produced tones that corresponded to specific letters or characters (d'Albe, 1914).
With time more and more ambitious tasks could be accomplished and today – thanks to some big innovations in the underlying techniques and the increased computing power available – is among the fields of Artificial Intelligence giving most satisfactions to its researchers and often taken as an example of what computers can achieve.

- "Optical Character Recognition has now an accuracy near to 100%"
- Face recognition has an accuracy of more than 97% (Taigman, Yang, Ranzato, & Wolf, 2014)
- Lidar Technology allows cars to "see" and drive autonomously

What computer vision can now do is impressive and has been made possible much faster than what was expected just some years ago. This is also due to the employability of Feature Learning: the machine can be brought to understand by itself what are the most important features with little external assistance leading so to faster and better results.

2.5.3 Predictive Data Analytics

"Predictive analytics is a broad term describing a variety of statistical and analytical techniques used to develop models that predict future events or behaviours" (Nyce, 2007, p. 5).
Predictive analytics – also called Cognitive analytics (Ronaki & Steier, 2014) – is more than a optional nice to have: so much data is generated every day that it is almost impossible for human beings to keep up, analysing it manually. Predictive Analytics are intensively used at big Tech Companies – Google is estimated to process 3.5 billion searches every day (internetlivestats.com) – and increasingly at smaller companies of other industries.

Some argue, that Data Analytics is nothing new, it is something that has been used for decades. Indeed, the willingness to analyse data is not new; however, as McAfee, Brynjolfsson, Davenport, Patil, & Barton (2012) point out, there are some big differences in the properties of data compared with some decades ago that completely change the scenario:

- Volume: every day, we create 2.5 quintillion bytes of data — so much that 90% of the data in the world today has been created in the last two years alone (IBM.com). The data generation will increase even more in the next years as more people will be able to connect with the internet and as companies discover new ways to leverage the analysis of data and their value. A type of data increasing very fast is the so-called unstructured data, a very important source of information. The volume of unstructured data is estimated to be growing by 62 percent each year and is expected to reach nine times the volume of structured data by 2020. (Hagan, 2012)
- Velocity: Very much data can now be analysed in real time offering companies very interesting insights: the ability to leverage this data is an obvious source of competitive advantage for many companies, as for example those buying and selling in stock markets or e-commerce firms.

- Variety: nowadays, data can take many different forms; from GPS data, to pictures; from banking transaction to social networks data. "Many of the most important sources of big data are relatively new" (McAfee et al., 2012, p. 63): social networks as Facebook, Instagram or Twitter were launched less than 15 years ago and smartphones as the IPhone are less than 10 years old.

These trends make Predictive Analytics more important and there is a need to find a new, more efficient way to do it. As K. Hammond co-founder of Narrative Science and Professor at Northwestern University noticed:

> "Tens of billions of dollars have been invested in big data, and the only way we can get value out of it is to have a really smart person sit at a screen, figure out what is going on, and explain it to us. Aside from the fact that this person is expensive and the task requires only a small portion of his or her skill set, this approach creates a bottleneck that chokes our ability to utilize the insights contained in the data we have been gathering for years." (Hammond, 2015)

The Difference between Data Analytics and Artificial Intelligence-powered Data Analytics

Artificial Intelligence seems to be the answer to the upcoming challenge: potentially, it does not only offer the possibility to quickly analyse big amounts of data – structured and unstructured – but also to do it better: as of now, most algorithms going through the data are handcrafted, meaning that a human being is needed to tell decide what kind of data to analyse and how and based his decision on experience. On the contrary of human beings, machines are not constrained by experience meaning that with to Artificial intelligence, better solutions could be found, data scientists were not even thinking of. This could generate new, unimaginable opportunities. This hope was expressed with great enthusiasm by one of the interviewees:

> Artificial Intelligence gives an infinite Resource of imagination. As human beings, we grow up and complement our existing experience. This restricts my imagination possibilities, sometimes. (...) Artificial Intelligence is not limited by it! (...) It is able do right something that one has not seen so far!" (Interviewee 8)

Given the importance of data today and its even greater value in the next years, is clear that products allowing to analyse them better and faster are of great value and this is reflected by the interest of venture capitalists, ready to invest hundreds of millions in them.

2.6 The Impact of Artificial Intelligence

In the last years, Artificial Intelligence has been gaining increased attention not only from media, but also among researchers and politicians: most of them agree that Artificial Intelligence is going to have a huge impact on society and on ours lives and try to foresee its impact.

The research mainly focused on following areas, so far:

1. The impact of Artificial Intelligence on the growth of the global economy
2. The impact of Artificial Intelligence on work and employment
3. The impact of Artificial Intelligence on social inequality

2.6.1 The Impact on GDP Growth

Economic growth is very important to our society: a growing economy usually offers more job opportunities, well-being and – at least until a certain level – seems to contribute to happiness (Wilkinson, 2007). This is why the percent rate of increase in real Gross Domestic Product (GDP) – an indicator of economic growth – receives so much attention from journalists and politicians all around the world: it is crucial for our society. Of more importance is the growth of the ratio of GDP to population – the GDP per capita – since it better allows to understand what the gross domestic product means for a single individual.

A key factor directly influencing economic growth is productivity, usually defined as "the amount of goods and services produced from each unit of labour input" (Mankiw, 2011, p. 14): increases in labour productivity have been shown to historically be the most important source of real per capita economic growth (Bjork, 1999). It is no wonder that many researchers have tried to better understand how productivity can be increased and what its key drivers are. A main factor leading to its increase results to be technological progress. R. Solow – Nobel prize in Economic Sciences in 1987 – "concluded that technological progress has accounted for 80 percent of the long-term rise in U.S. per capita income, with increased investment in capital explaining only the remaining 20 percent" (Krugman, 2014, p. 68). Indeed, "it would take the average American only eleven hours of labour per week to produce as much as he or she produced in forty hours in 1950" (Brynjolfsson & McAfee, 2014, p. 99).

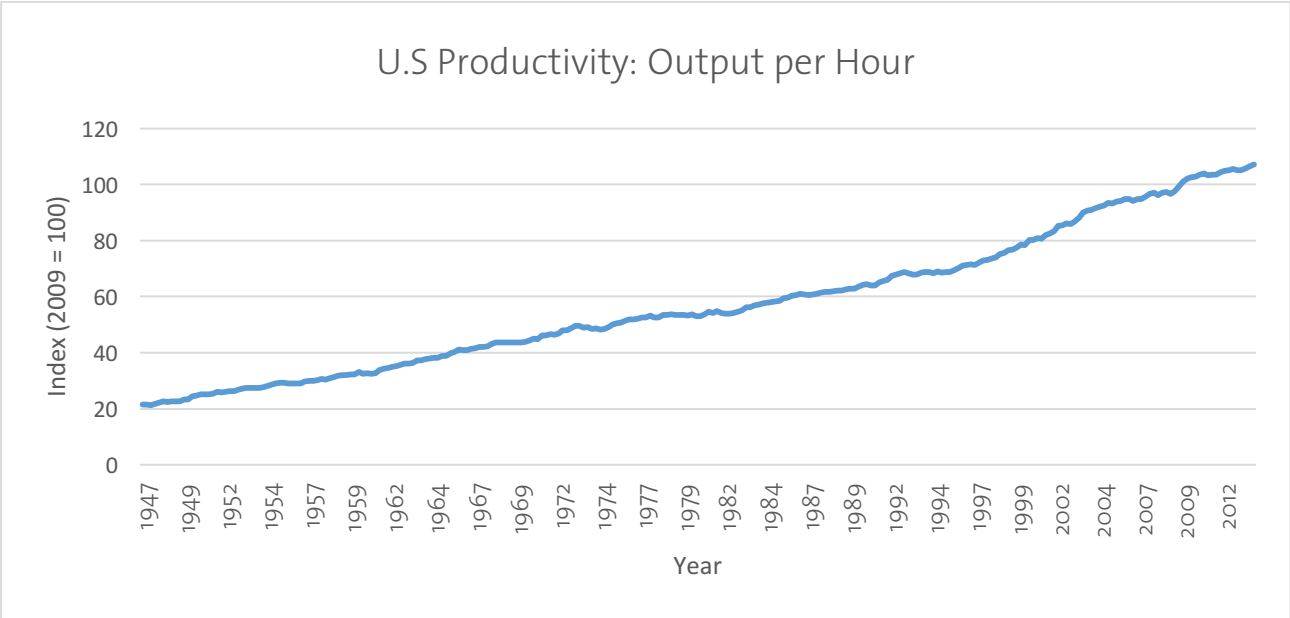


Figure 8: U.S. Labour Productivity (1947 - 2012). Data Source: U.S. Bureau of Economic Analysis

Not every technology increases productivity in the same way: the development of photography, although very important, had a much smaller impact on productivity than game-changers as electricity, the internal combustion engine and the computer. Automation – in the form of plant automation and IT systems – so far and Artificial Intelligence in the future, are considered as belonging to the second group (Brynjolfsson & Hitt, 2003; Brynjolfsson & McAfee, 2014; Brynjolfsson & Yang, 1996; Culnan & Bair, 1983; Dewan & Kraemer, 2000; D. Jorgenson, Gollop, & Fraumeni, 2014; D. W. Jorgenson, Ho, & Stiroh, 2008).

Concerning the specific impact of Artificial Intelligence on productivity, research studying its impact on productivity is just at the beginning. Brought arguments in favour of a positive impact of it on productivity are however very convincing. (Schatsky, Muraskin, & Gurumurthy, 2015) bring some examples of what it makes possible nowadays, as for example at Associated Press where the company "has implemented natural language-generation software that automatically writes corporate earnings stories. Rather than taking the opportunity to reduce staffing levels, AP is using the technology to increase by a factor of 10 the number of such stories it publishes, enabling AP to cover companies of local or regional importance it did not have the resources to cover before and freeing journalists from writing formulaic earnings stories so they can focus on more analytical and exclusive stories" (Schatsky et al., 2015, p. 118). Similar impressive stories about productivity increases can be found in the healthcare and manufacturing industries. Having the technologies around Artificial Intelligence still so much potential ahead, we will see even more impressive productivity increases in the years to come.

2.6.2 The Impact on Work and Employment

The consequences of Artificial Intelligence for work and employment are by far the most studied topic by researchers looking at the impact of Artificial Intelligence on society. For very good reasons: history showed in the past industrial revolution what the automation of jobs means for workers and society as a whole.

The impact of Artificial Intelligence on work and employment can be analysed from two different perspectives:

1. From the side of the task to be executed (level of knowledge required, routine, ...)
2. From the side of the worker (education, skills, ...)

In this subsection we are going to look at the topic from the standpoint of the task to be executed; differences of the impact of Artificial Intelligence on work depending on the education and skills of the worker himself lead to social inequalities that are going to be the subject of the next subsection.

An increasing number of researchers is devoting its efforts to understanding what jobs are going to be most exposed to the risk of automation with two different approaches:

A. Looking at the quantity of knowledge required to perform the job.
B. Analysing the level of routine in the job.

A. Among those looking at the impact of automation on jobs through the lenses of a knowledge framework stand the works of Parasuraman & Sheridan, 2000; Schatsky & Schwartz (2015). Parasuraman & Sheridan (2000) and Bindewald, Miller, & Peterson (2014) later, define four broad classes of functions that could potentially be automated:
    1. Information acquisition
    2. Information analysis
    3. Decision and action selection
    4. Action implementation

    The automation potential is then evaluated in regard to "the human performance consequences (...), automation reliability and the costs of action consequences" (Parasuraman & Sheridan, 2000, p. 286).

Furthermore, they define ten "levels of automation of decision and action selection" depicted in Figure 10. The human worker can be potentially replaced if the machine exhibits the level knowledge required by the task.

Their widely cited work constitutes a precious starting point for later researchers as for example Schatsky & Schwartz (2015) that building on it proposed four different approaches to automation: Replace, Atomize/ Automate, Relieve, Empower.

Figure 9: The four classes of classes that could potentially be automated (Parasuraman & Sheridan, 2000). Graphic: Deloitte University Press.

Figure 10: ten "levels of automation of decision and action selection" (Parasuraman & Sheridan, 2000). Graphic: Deloitte University Press.

B. MIT Daron Acemoglu and David Autor look at the impact of automation analysing level of routine a job requires; they propose a two-by-two matrix with cognitive vs. manual and routine vs. nonroutine (Acemoglu & Autor, 2011; Autor, 2010). Interestingly, based on the empirical data collected, "they found the demand for work has been falling most dramatically for routine tasks, regardless of whether they are cognitive or manual" (Brynjolfsson & McAfee, 2014, p. 139).
Although this might seem intuitive, it is not so often mentioned in the literature: most researchers base their analysis on a knowledge scale (Parasuraman & Sheridan, 2000;

Schatsky & Schwartz, 2015). Because of the knowledge scale, readers – and media – often make the implicit assumption that automation potential is proportional to the knowledge required in the job or that manual work is more at risk thank cognitive work. The data of Acemoglu & Autor (2011) and Autor (2010) shows that this is not the case: hair-dresser will likely maintain their job longer as accountants will.

How will differ the 21st century from the previous centuries in respect to automation and why should this be more dangerous? T. Davenport & Kirby (2015) distinguishes between three different eras of automation (see Figure 11), summarizing very well the feelings of many other researchers and workers: "if this wave of automation seems scarier than previous ones, it's for good reason. As machines encroach on decision making, it's hard to see the higher ground to which humans might move" (T. Davenport & Kirby, 2015, p.2).

Artificial Intelligence allows machines to automate an area that was perceived as safe by many until just some years ago and the "upgrade strategy" – to move to a higher grade of knowledge work – could not be effective anymore.

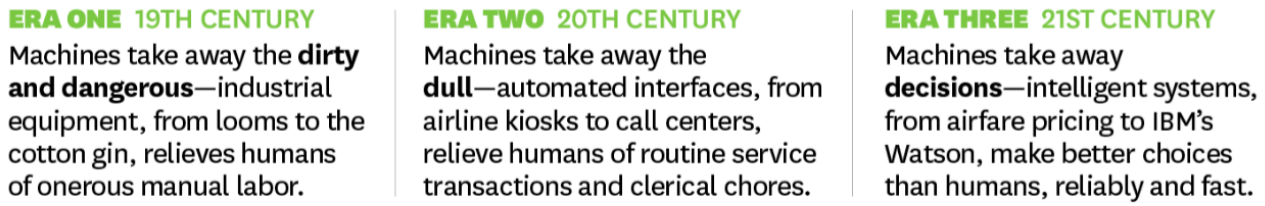


Figure 11: The Three Eras of Automation (T. Davenport & Kirby, 2015, p. 2). Graphic: HBR.org.

Recent studies show very well why everyone of us should have a closer look at the consequences of the third era of automation. Everyone is going to be affected somehow, the most developed countries not being an exception. Brandes & Zobrist (2015) stated that even in Switzerland 48% of the jobs are automatable and they are at risk among all groups:

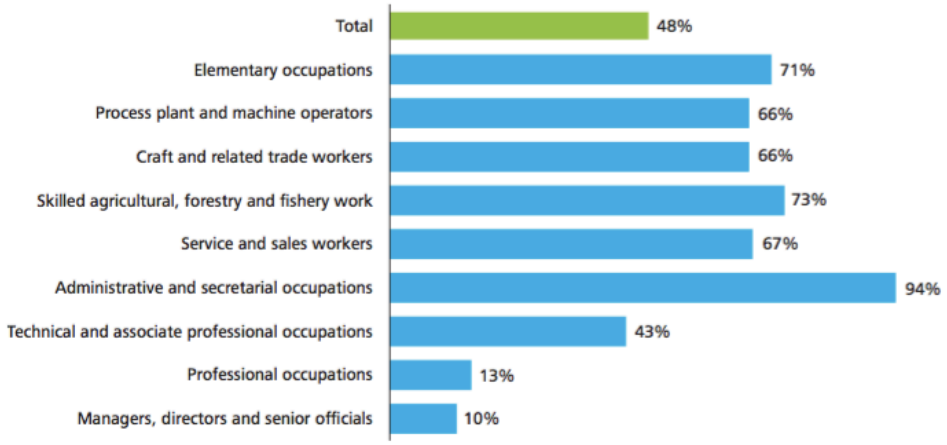


Figure 12: Proportion of jobs at risk by main groups (2013). Data Source: Federal Statistical Office and (Frey & Osborne, 2013). Graphic: Deloitte University Press.

The fact that many jobs are going to be automated is not bad per se, as long as an equivalent or greater number of new jobs is created. On this point there is no consensus among researchers: as the Pew Research Center article "Digital Life in 2025: Artificial Intelligence, Robotics and the Future of Jobs" shows, the 1'896 experts interviewed had a very different opinion on the topic. Answers to the question "Will networked, automated, Artificial Intelligence applications and robotic devices have displaced more jobs than they have created by 2025?" were very diverse:

"Half of these experts (48%) envision a future in which robots and digital agents have displaced significant numbers of both blue- and white-collar workers – with many expressing concern that this will lead to vast increases in income inequality, masses of people who are effectively unemployable, and breakdowns in the social order.

The other half of the experts who responded to this survey (52%) expect that technology will not displace more jobs than it creates by 2025. To be sure, this group anticipates that many jobs currently performed by humans will be substantially taken over by robots or digital agents by 2025. But they have faith that human ingenuity will create new jobs, industries, and ways to make a living, just as it has been doing since the dawn of the Industrial Revolution" (Smith & Anderson, 2014).

The reasons given by these experts Smith & Anderson (2014) and Brynjolfsson & McAfee (2014) – in both directions – can be summarized as follows:

Reasons to be hopeful

1. Advances in technology may displace certain types of work, but historically they have

been a net creator of jobs.
2. We will adapt to these changes by inventing entirely new types of work, and by taking advantage of uniquely human capabilities.
3. There are certain jobs that only humans have the capacity to do.
4. Our social, legal, and regulatory structures will minimize the impact on employment.

Reasons to be concerned

1. Our educational system is not adequately preparing us for work of the future, and our political and economic institutions are poorly equipped to handle these hard choices.
2. "Digitization creates winner-take-all markets (...) Once fixed costs are covered, each marginal unit produced costs very little to deliver" (Brynjolfsson & McAfee, 2014, p. 155). If costs are lower than the minimum wage humans can accept (e.g: the amount is not enough to cover human basic needs), unemployment is generated.
3. The pace of innovation and technology is so complex that unemployed workers will not be able to adapt to the new requirements fast enough.

It is important to notice that – on the contrary of what is often reported by media – the rise of the machines at the expenses of human workers is all but inexorable: the reasons to be concerned listed above do offer some ways out. There are many researchers showing how humans could make it in the race with the machine (T. H. Davenport & Kirby, 2015; Lacity & Willcocks, 2015; Swap, Leonard, Krishnan, & Mclean, 2015; Wilson & Bataller, 2015), even asserting that machines do represent a big opportunity for workers and that "we could reframe the threat of automation as an opportunity for augmentation" (T. Davenport & Kirby, 2015, p. 2). At the same time, many warn that this is not going to possible without the strong support of policy makers, particularly in the field of education that was good for the challenges of the 20th century, but does not seem to be ready for those of the 21st. (Brynjolfsson & McAfee, 2014; Smith & Anderson, 2014)

2.6.3 The Impact on Social Inequality

As seen above, researchers do not agree on the role technologies relying of Artificial Intelligence will play in the job market, whether they will predominantly lead to augmentation or automation. What they do agree upon is that in either way, something is going to change and that this change is not going to affect everyone in the same way.

Thanks to the combination of automation and digitalization, not only can be produced more with less work, but also the amount of work itself can potentially reach and benefit much more

people at a very low marginal cost. As Brynjolfsson & McAfee (2014) states: "if a person finds a new way to leverage insights, talents, or skills across one million new customers using digital technologies, then he or she might earn one million times as much as would be possible otherwise. (...) Advances in technology, especially digital technologies, are driving an unprecedented reallocation of wealth and income. Digital technologies can replicate valuable ideas, insights, and innovations at very low cost. This creates bounty for society and wealth for innovators, but diminishes the demand for previously important types of labour, which can leave many people with reduced incomes" (p. 128).

This is precisely what happened with photography: to have the possibility to share pictures with friends or to be able to look at them again and again is of great value to everyone. Until some years ago, people needed to print out their pictures and accurately store them into a photo album. Providing this service, Kodak could earn very much money and employ many people ("Kodak had 145'000 employees at its peak" Hardy [2015]). The same value can now be provided to customers by companies like Instagram, with far fewer people. Moreover, Instagram was bought by Facebook for one billion dollars in 2012 as it had just 13 employees: it is impressive to notice that the same value delivered by a company with 145'000 employees and a rich CEO back then, could be provided by a company with 13 very rich employees in 2012.

A huge paradox: productivity – and with it the whole economy – grows, but the vast majority of the people not only seem not to enjoy an increased well-being, but they are even worse off. A comparison of the real GDP per Capita and the Median income per capita in the last 50 years seems to shows it quite clearly:

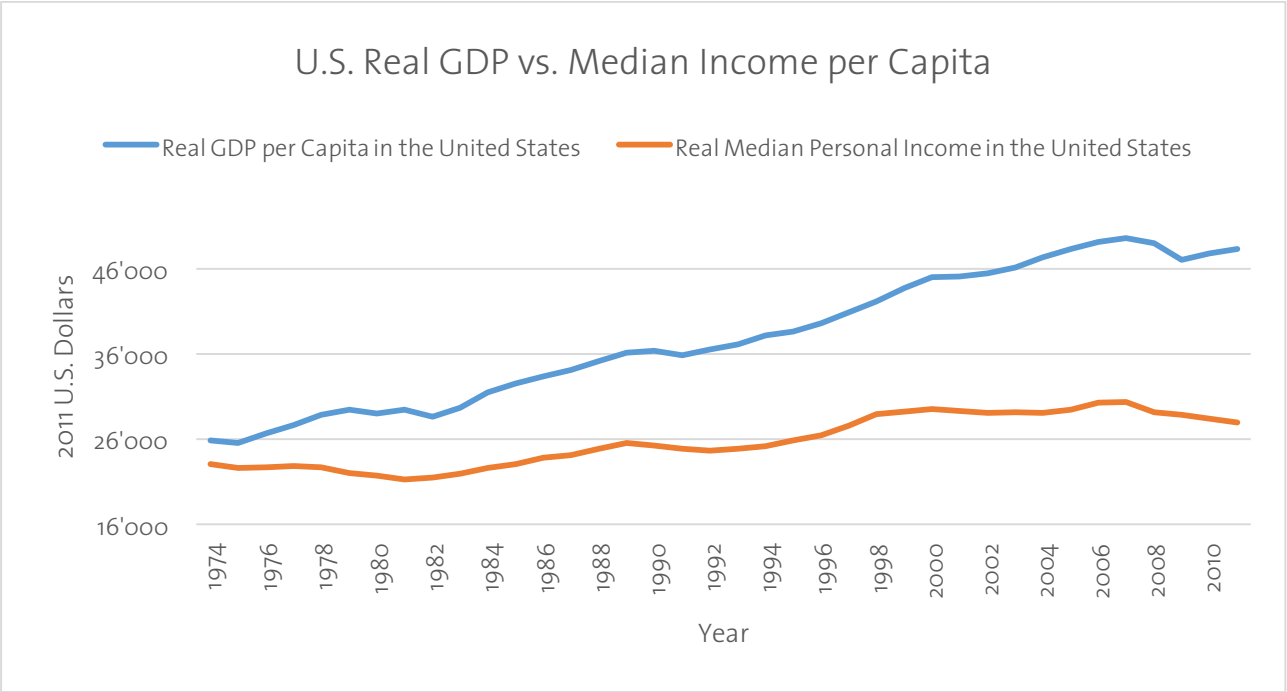


Figure 13: U.S. Real GDP vs. Median Income per Capita. Data Source: Federal Bank of St. Louis.

This trend is not doomed to stop, on the contrary: with time, as more things can be digitized and automated the spread could get even bigger. In fact, Artificial Intelligence is making possible to automate also high-earning jobs, potentially putting even more value in the hands of – few – brilliant entrepreneurs.

This is not going to affect everyone in the same way. As pointed out in the previous section, Artificial Intelligence and the wave of new technologies it enables are not an issue per se: they are an opportunity if the worker can use them as an augmentation tool. However, not everyone is in the position of being able to exploit them to his own advantage. For less skilled workers it is often too complex. As a consequence, the biggest part of the additional value generated by Artificial Intelligence and related technologies tends to be captured people having a higher education. These people, being more and more sought by companies can enjoy a wage increase, whereas for the others the exact opposite is taking place. This trend is called by researchers "skill-biased technical change" (Acemoglu & Autor, 2011; David, Katz, & Krueger, 1997; Levy & Murnane, 2012) and has as a consequence the increase of the the spread between skilled and less skilled labour. Figure 14, based on data of Acemoglu & Autor (2011) and depicting the evolution of weekly wages by education degree in the last 50 years shows the trend and its alarming consequences:

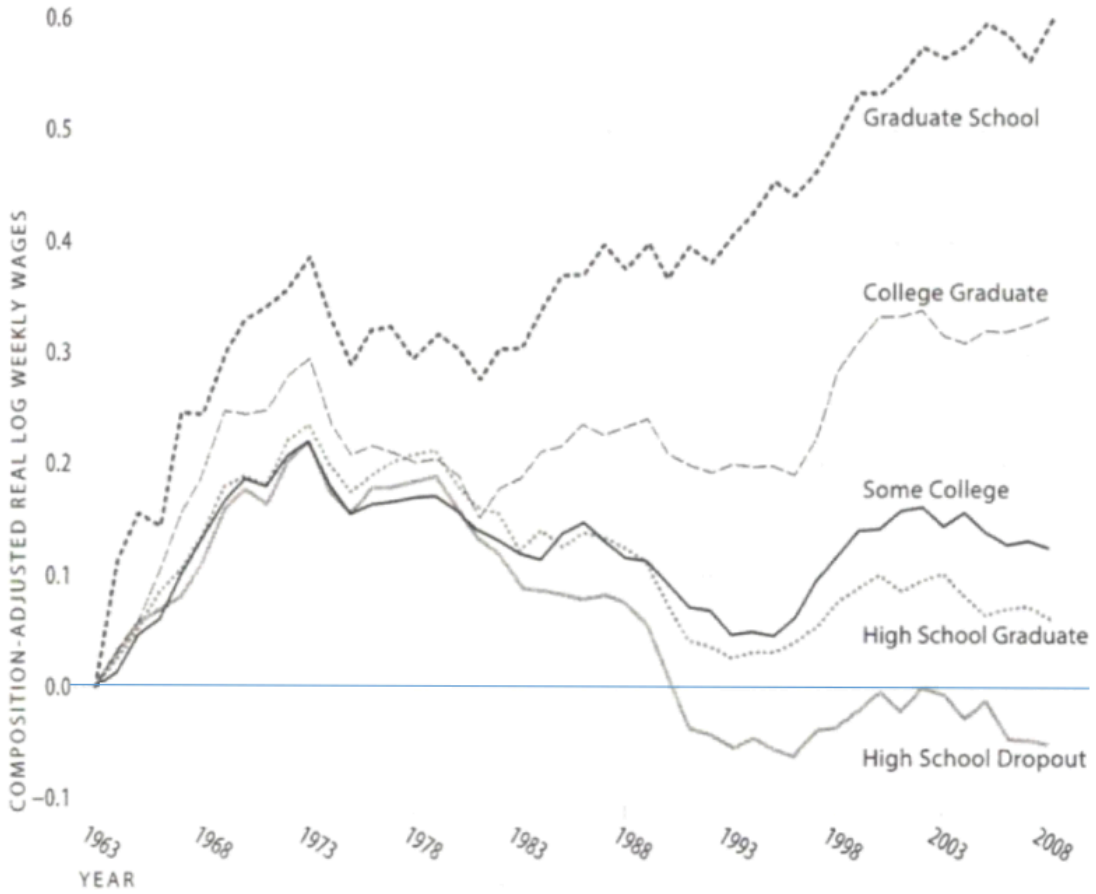


Figure 14: Wages for Full-Time, Full-Year Male U.S. Workers, 1963-2008. Data Source: (Acemoglu & Autor, 2011). Graphic: (Brynjolfsson & McAfee, 2014).

The danger of Artificial Intelligence and digitalization increasing social inequality is real and should become as soon as possible part of the political agenda.

2.7 Strategy

Chinese general Sun Tzu, author of the ancient military treatise "The Art of war", stated "Every battle is won before it is ever fought"; in his opinion, strategy was the key to success. More than two thousands years later, military experts still debate about the generalizability of Sun Tzu's expression, but what is sure is that strategy is a key factor for success: for an army as well as for big and small companies (Sandberg & Hofer, 1987).

The term "strategy" started to be used in business in the 20th century, and "its use in a self-consciously competitive context only to the second half of the twentieth century" (Ghemawat, 2002, p. 37). In 1980, M. Porter defined strategy as follows: "developing a competitive strategy is developing a broad formula for how a business is going to compete, what its goals should be, and what policies will be needed to carry out those goals (...) The essence of formulating competitive strategy is relating a company to its environment" (Porter, 1980, p. 5).

von Krogh (2015) distinguishes between six different phases of the strategy field so far (Figure 15). Depending strategy on the company environment and changing the environment over time, research has adapted its focus throughout history, focusing in every phase on the challenges firms were bearing.

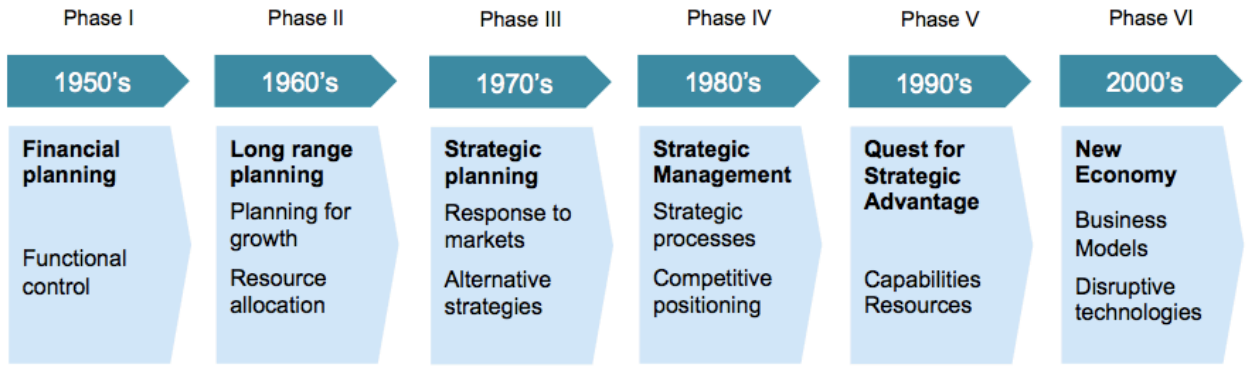


Figure 15: The six phases of Strategy Research (1950-2010). Graphic: (Georg von Krogh, 2015).

Because of the increased importance of trends as Digitization, Improvement in Telecommunications and Networks Effects (Brynjolfsson & McAfee, 2014), it is now crucial for companies to adapt their strategy accordingly. Cisco's CEO J. Chambers in an interview with the New York Times at the World Economic Forum 2015, expressed companies' sense of urgency and its driving factors very well: "If your CEO [New York Times' CEO] was in Davos, I guarantee you that the No. 1 thing on his or her mind is how to make your company a digital company. (...) Every company's future is going to depend on whether they catch the market transitions right. Forty percent of the companies in this room won't exist, in my opinion, in a meaningful way in 10 years unless they change dramatically. So getting market transitions right is the first issue, and obviously, digitization and the Internet of everything is at the front of that" (Thurm, 2015).
We are entering a new phase of strategy, with companies and researchers increasingly focusing on digital strategy (Mithas & Lucas, 2010; Westerman, Bonnet, & McAfee, 2014).

Another trend shaping industries strategy since a longer time is globalization: "Globalization has both affected, and been caused by, the strategies of multinational enterprises" (Buckley, 2003, p. 1), increasing the importance of research focusing on Global Strategy.

2.7.1 A Brief Introduction to Competitive Strategy

In his article "What is Strategy?", Porter (1996) defines competitive strategy as follows: "Competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver unique mix of value. (...) Rivals can easily copy your improvements in

quality and efficiency. But they should not be able to copy your strategic positioning – what distinguishes your company from all the rest" (p. 64).

The alternative strategic positions in an industry are introduced by him under the name of "Generic Strategies" (Porter, 1980):

1. ***Overall cost leadership***
   Companies using this strategy aim to beat competitors producing their products at the lowest costs possible. Companies enjoying economies of scale often use it.
2. ***Differentiation***
   Firms adopting this strategy offer products that are somehow different than those of competitors.
3. ***Focus***
   Companies using this strategy usually concentrate on a particular buyer group, segment of the product line, or geographic market, being so able to better meet their needs.

An overview of the generic strategies is given in Figure 16:

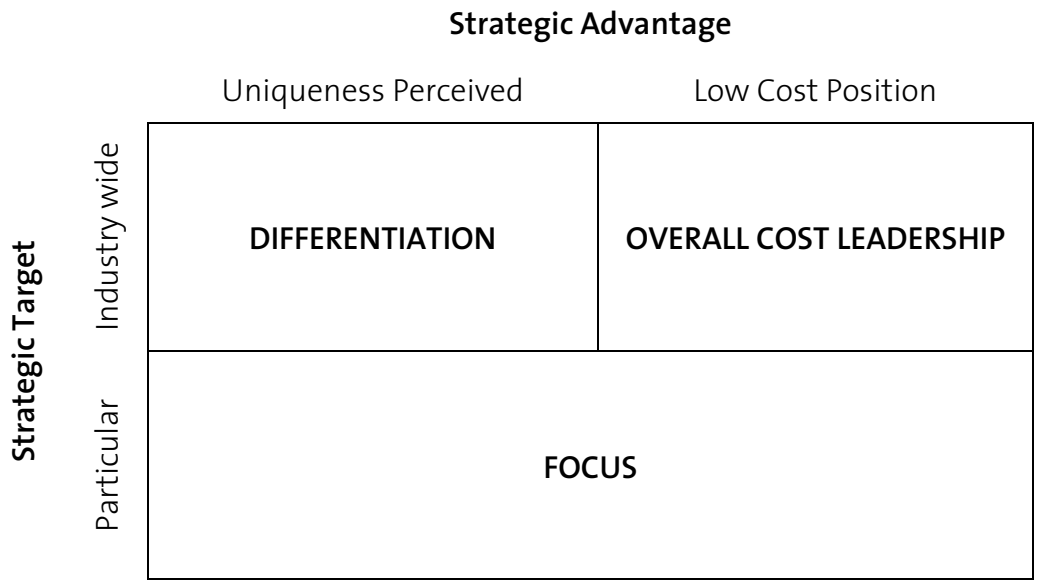


Figure 16: The Three generic strategies.

To help strategists understand the competition in their industry and make so the right decisions, Porter developed the "Five Forces" framework (Porter, 1980), represented in Figure 17 below): "In essence, the job of the strategist is to understand and cope with competition. Often, however, managers define competition too narrowly, as if it occurred only among today's direct competitors. Yet competition for profits goes beyond established industry rivals to include four other competitive forces as well: customers, suppliers, potential entrants, and substitute products. The extended rivalry that results from all five forces defines an industry's

structure and shapes the nature of competitive interaction within an industry" (Porter, 2008, p. 79).

Figure 17: Porter Five Forces. Source: (Porter, 2008).

After more than 30 years, strategists still broadly use this framework. It has been steadily being complemented by additional research as (Karagiannopoulos, Georgopoulos, & Nikolopoulos, 2005; Mohapatra, 2012; Porter, 1985, 2008) and can potentially be of great help also to understand industries being shaped by the newest technologies and societal trends as for example Digitization, Artificial Intelligence and globalization.

2.7.2 Competitive Strategy in a Global Economy: the Importance of Local Factors

Globalization is since some years among the most important factors shaping competitive strategy: "whether to globalize and how to globalize, have become two of the most burning strategy issues for managers around the world" (Yip, 1989, p. 280). Thanks to digitization and to the increase of international trade agreements almost every product can be easily sold worldwide. At the same time, companies have to develop their strategies with the awareness that their products are going to be subject to international competition: not only if sold abroad, but also on the local market.

To provide companies with the needed tools to face these new challenges, researchers have proposed frameworks helping to understand whether it is worth for big companies to globalize their operations (Yip, 1989), the impact of location choices (Doh, Bunyaratavej, & Hahn, 2009) and with what strategy to operate (Govindarajan & Bagla, 2012; Hamel & Prahalad, 1985; Levitt, 1983). Surprisingly, competition of local players with global companies

in developed markets has not received so much attention in literature so far, focusing most articles about local-global competition on competition in the emerging markets, either from the perspective of local players in the emerging markets (Dawar & Frost, 1999; Govindarajan & Bagla, 2012) or multinationals (Ghemawat, 2005, 2007a, 2007b).
At the same time, efforts of researchers are increasingly focusing on the impact local factors have on competitive advantage. As M. Porter noticed:

> "Paradoxically, the enduring competitive advantages in a global economy lie increasingly in local things – knowledge, relationships, and motivation that distant rivals cannot match." (Porter, 1998, p. 77)

He continues stating that "today's economic map of the world is dominated by what I call clusters: critical masses – in one place – of unusual competitive success in particular fields. Clusters are a striking feature of virtually every national, regional, state, and even metropolitan economy, especially in more economically advanced nations" (Porter, 1998, p. 78). Examples of clusters are the textile-related companies in Carolina, the auto industry in Germany and fashion firms in Italy.

As Porter observes, local factors have always been important, but the way they contribute to competitive advantage has changed radically in the last decades. As means of transportation were slower and trade agreements were not widespread, location played a crucial role in the reduction of input costs: to be near a harbour or in the proximity of the supply of key resources was a great advantage for companies. "Competition in today's economy is far more dynamic. Companies can mitigate many input-cost disadvantages through global sourcing, rendering the old notion of comparative advantage less relevant. Instead, competitive advantage rests on making more productive use of inputs". (Porter, 1998, p. 4) To this purpose, clusters and local factors play a vital role. With these remarks, just some years after introducing the so widely used "Five forces Framework" presented above, M. Porter laid another milestone in the world of competitive strategy.

2.8 The Research Question

As shown above, Artificial Intelligence is a very interesting and promising field, advancing very fast: announcements of game-changing discoveries follow one another, creating a need to steadily update and adjust previous research.
As shown in the sections above, research mainly focused on the impact Automation and Artificial Intelligence could have on growth, employment and society as a whole, so far.

Nowadays, this represents a big issue for decision-makers within companies: everyone is claiming Artificial Intelligence has a huge potential, even that "Artificial Intelligence Platforms can change the world" as Eric Schmidt, Google Chairman, is reported to have said (Shead, 2016), but there is little literature at their disposal to best tackle the coming challenges.
This lack of literature is comprehensible: although the theoretical potential of Artificial Intelligence has always been clear, for a long time it has been difficult to foresee how it would take shape in reality. It was possible to describe its impact on macroeconomic variables generally speaking, but it was very difficult to foresee what impact Artificial Intelligence would concretely have on specific industries.

On the other hand, strategy researchers are increasingly focusing on understanding the role local factors have in creating competitive advantage. Swiss companies with Switzerland as their main market are very interested in future developments in this area, as they can usually enjoy economies of scale and similar benefits only in a limited manner. This is even more the case for Swiss companies active in the TIME industry: international High-Tech companies as Google, Microsoft and Amazon, taking advantage of the economies of scale and other factors they can leverage thanks to their presence all around the world, are able to produce great products. Their ubiquitous availability thanks to digitization is seriously challenging local companies having fewer resources at their disposal.

Leveraging the full support of a powerful corporate partner, this thesis has the ambitious goal in contributing to filling the gap in the Artificial Intelligence and Strategy Literature with an analysis of the impact Artificial Intelligence could have on a specific industry and the resulting strategic implications.
Following M. Porter's research on local factors (Porter, 1998), particular efforts will be devoted to the research and analysis of local factors Swisscom and local TIME players could leverage in this domain to create competitive advantage and successfully compete with so powerful global players.
The research question can be summarized as follows:

"How does the latest progress in Artificial Intelligence impact the Swiss TIME industry? What are the factors local TIME players could leverage in their competition with global players in the home market?"

The thesis also aims to provide Swisscom – the corporate partner of the thesis, presented in the next chapter – with insights on the state of the art of this fast-moving technology as well as strategic considerations to support its efforts of building a strategy in this domain.
The company's requirements can be summarized as follows:

1. To deepen the actual State of the art of Artificial Intelligence as well as the related technologies, presenting the most important trends nowadays and in the next years.
2. To provide a framework showing the areas in which Artificial Intelligence is being applied.
3. To analyse what the main players are doing and in what domains a company as Swisscom could compete.

Please notice how the research question and the company's requirements do not represent two different directions of research and are strictly interrelated. The first two corporate partner's requirement are necessary steps in order to properly answer to the first part of the research question, as it is possible to analyse the impact of Artificial Intelligence on an industry only if the technology has been previously fully understood and its actual applications analysed. The third requirement does also offer important synergies with the academic research performed, as the focus on the "domains a company as Swisscom could compete in" allows to deepen – thanks to the full support of the corporate partner – Swisscom's competitive strategy and understand the factors the company usually leverages to create competitive advantage, laying the foundations for best answering to the second part of the research question.

3 – Empirical Context

Telecom operators are at the centre of extraordinary changes, again. After the wave of privatization taking place in the last decades of the last century, the telecommunications industry is in the midst of a major reconfiguration of its fundamental architecture and the way companies capture value (Hacklin et al., 2013). The process is now driven by the convergence of the telecommunication business with other industries as Information technology, Media and Entertainment, an industry "which many people now refer to as a single field, the "TIME" industries" (Hacklin et al., 2013, p. 65).

On the one hand, convergence of different industries represents for established companies an opportunity to increase both customer base and revenue, on the other, it rises the complexity of competition, with companies that were in seemingly unrelated businesses suddenly becoming rivals (Hacklin et al., 2013). The latter aspect is particularly relevant for companies having an established position in the regional telecommunications industry, as they suddenly come to face competition not only from regional firms of other industries, but also from very big and powerful international high-tech companies.

To put the reader in the best position to understand the potential of artificial intelligence in the Swiss TIME industry (presented in detail in Chapter 6), in the following sections the Swiss TIME industry and Swisscom as its established leader are introduced.

3.1 The Swiss TIME Industry

The Swiss telecommunications industry is dominated by three major telecom players: Swisscom, Salt and Sunrise with respectively 6.625, 2.133 and 2.47 Million mobile access lines; the Annual Report 2014 of the Swiss Federal Communications Commission (ComCom, 2014) estimated the mobile penetration in Switzerland to be 145%. The undisputed leader of the market is Swisscom, solidly leading both in the mobile and broadband markets:

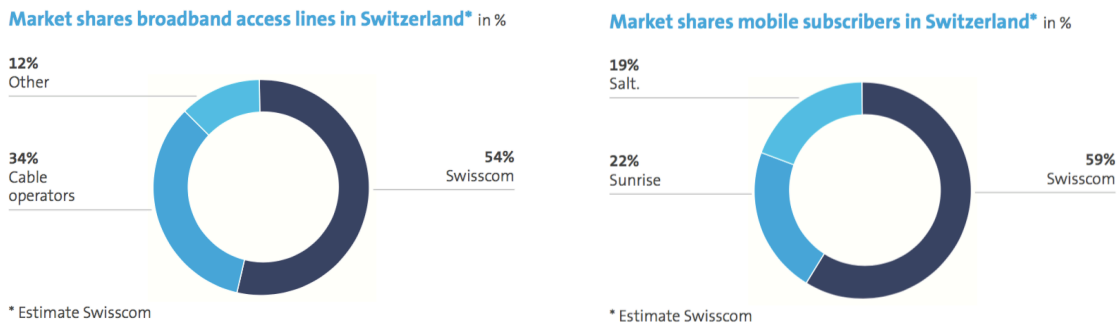


Figure 18: Market shares broadband access lines (left) and mobile subscribers (right) in Switzerland. Data Source and Graphic: Swisscom's Annual Report 2015.

Companies in the Swiss market serve customers with a very high level of expectations in terms of quality of service, and this is particularly true for the telecommunications businesses: the high expectations lead service providers to steadily improve their offerings, heavily investing in their infrastructure. Swisscom alone totalled in 2015 the impressive sum of 1.8 billion Swiss Francs for investments in performance enhancement and security in the Swiss infrastructure and in ultra-fast broadband expansion. (Swisscom, 2015)

As a result of the huge investments, Switzerland can count on one of the best telecommunications infrastructures in the world. It is for example the OECD country with the highest fixed broadband penetration (see Figure 19) and among those with the best 4G/LTE coverage worldwide. Moreover, Swisscom "is aiming to supply 85% of all households and businesses with ultra-fast broadband (speeds in excess of 100 Mbps) by the end of 2020. Furthermore, by the end of 2016, 99% of the population will be able to benefit from the fourth-generation mobile network incorporating 4G/ LTE technology" (Swisscom, 2015, p. 31).

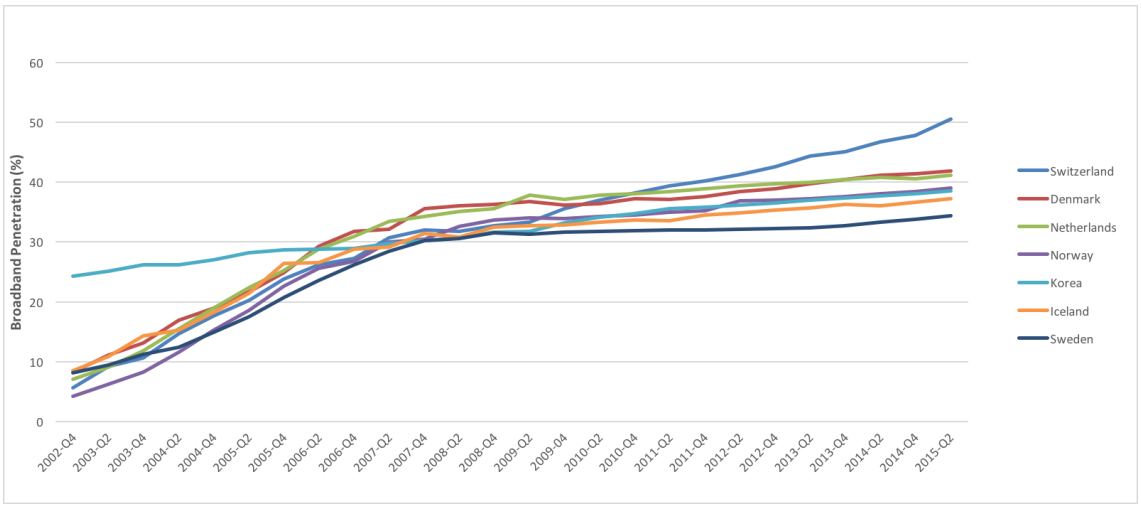


Figure 19: Fixed broadband penetration in the five top performing OECD countries; Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm, June 2015.

It is difficult to assess the size of the Swiss Telecommunications industry alone: as stated above, companies operating in this domain provide more than connectivity, nowadays, and the income statements of the companies do not allow a proper assessment. Not even the Annual Report of the Swiss Federal Communications Commission (ComCom, 2014) could provide a precise estimate. In its Annual Report 2015, Swisscom estimates "the total revenue generated by the telecom market in Switzerland at around CHF 13 billion" (Swisscom, 2015, p. 40).

The "PwC Swiss Entertainment and Media Outlook 2015" (PwC, 2015) shows the estimated size of the Swiss Media and Entertainment industry in 2015 to be similar: 13.3 billion Swiss Francs. Please notice that out of these 13.3 billion, 3.6 are generated by spending for internet access, part of the revenue of the telecom operators analysed above. More data on the Swiss Entertainment and Media Market can be found in the Appendix.

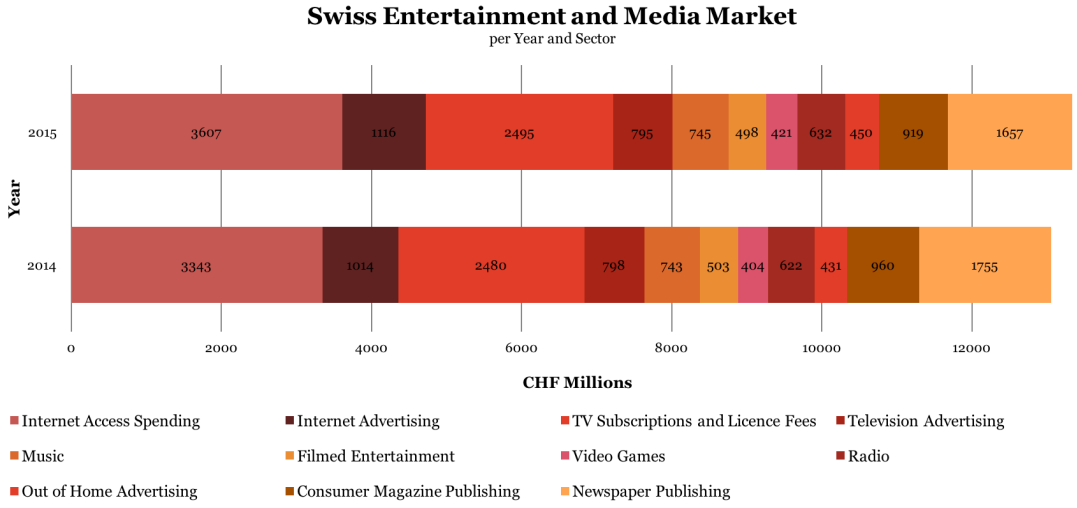


Figure 20: Swiss Entertainment and Media Market 2014-2015. Data Source and Graphic: PwC Swiss Entertainment and Media Outlook 2015.

3.2 Swisscom - the Trustworthy Companion in the Digital World

Swisscom is the leading telecommunication provider in Switzerland. In 2015, it generated revenues of 11,678 billion, employing – as of end of 2015 – 21'637 full-time equivalent employees. By law, the Swiss Confederation must hold the majority of shares in Swisscom, being its amount as of March 2016 of 51% (Swisscom, 2015).

3.2.1 Group Structure

On the 1st of January 2016, Swisscom changed its management structure "to boost the company's effectiveness in the highly competitive ICT market" (Swisscom, 2015, p. 27). To

exploit synergies and accommodate the increasing level of convergence in the industry, the Business Units "Residential Customers" and "Small and Medium-Sized Enterprises" have been merged and the common Business Units "Sales & Services" and "Products & Marketing" were created.

The Management Structure and the firm's Business Units are represented in Figure 21, below:

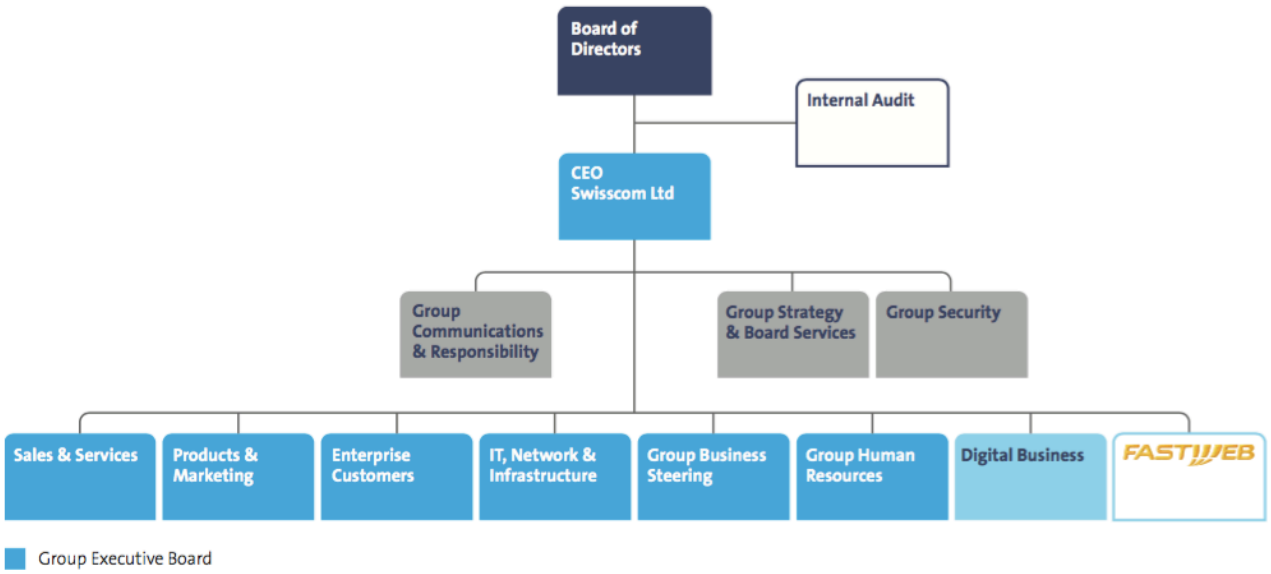


Figure 21: Swisscom's Management Structure from 1 January 2016.

In the last years, the company has been very active in acquiring or closing partnerships with other local firms and in developing new products. Doing so it expanded its portfolio with products and services going beyond the traditional telecommunications business, increasingly making the company much more than a mere telecommunications player: a TIME player.

An overview of the main brands operated by Swisscom is given in Figure 23 below. In the next lines, the most important deals closed and products' launches performed during last year are described, to give an idea of the breadth of Swisscom's business and its recent direction:

- The merger of local.ch and search.ch approved by the Swiss Competition Commission in March 2015, created a comprehensive Swiss directories and information platform that competes with international providers. "Swisscom holds 69% of the joint subsidiary and will fully consolidate the company" (Swisscom, 2015, p. 25).
- In April 2015, the company announced the launch of Swisscom SmartLife, a new, flexible control and security system for use in the home, entering so the Smart Homes Market.

- In August 2015, Ringier, the Swiss broadcasting corporation SRG and Swisscom announced their willingness to combine the marketing of their media services and advertising platforms in a new joint marketing firm to respond to the significant changes in the needs of advertising clients and the Swiss media. (swisscom.ch)
- Swisscom and Coop announced in October 2015 the launch of Siroop, an online marketplace, where they each contribute their expertise in digitisation, e-commerce, marketing and retailing to the new start-up. (Swisscom, 2015)
- In November 2015, Swisscom presented myCloud, its Swiss-based online storage service for photos, videos and other files.

Previous efforts to expand Swisscom's business to Media and Entertainment have proven to be very successful: in February 2016, just some years after the launch of Swisscom TV (in 2009), the company surpassed the long-established market leader UPC Cablecom, becoming the biggest player in the Swiss digital TV market. Moreover, the Teleclub, Kitag and Cinetrade brands – operated by Swisscom – greatly enhance Swisscom's credibility in the Entertainment business.

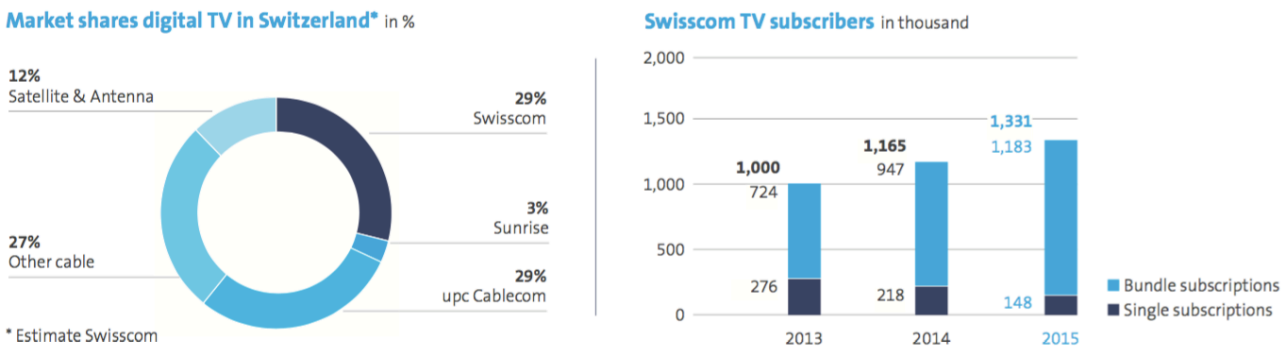


Figure 22: Market shares digital TV in Switzerland (left) and Swisscom TV subscribers (2013-2015). Data Source and Graphic: Swisscom's Annual Report 2015.

Thanks to the trustworthiness and security the company is known for, Swisscom is also successfully operating in healthcare under Swisscom Health AG and banking, two sectors in which it is critical that customer data is managed responsibly.

Figure 23: Swisscom's Brand Portfolio.
Data Source and Graphic: Swisscom's Annual Report 2015.

3.2.2 Customer Segments

The company distinguishes among three main customer segments: Residential Customers, Small and Medium-Sized Enterprises, and Enterprise Customers. They are presented in the next lines.

Residential Customers

The Residential Customers segment is of great importance to Swisscom, representing its biggest source of revenue: 5.224 out of the 11.678 billion Swiss Francs of revenue in 2015. As the company states in its Annual Report "the Residential Customers segment is the contact partner for mobile and fixed-line retail customers. It provides Switzerland with broadband access lines, serves a growing number of Swisscom TV customers and operates www.bluewin.ch, one of Switzerland's most frequently visited Internet portals. The Residential Customers segment offers all telephone, Internet and TV services, pay TV, transmissions of sporting events and video on demand from a single source, as well as the sale of end devices. In addition, Cinetrade operates one of the leading cinema chains in Switzerland" (Swisscom, 2015, p. 18).

Table 4 gives an overview of the segment's most important figures:

Residential Customers - Key Figures	(In CHF million or as indicated)
Net revenue	5,224
EBITDA	2,933
No. of full-time equivalent employees	4,870
Operational data on the balance sheet date	**(In thousands)**
Fixed network connections	2,629
Retail broadband connections	1,958
Swisscom TV connections	1,331
Mobile telephony connections	6,625
Package agreements	1,416

Table 4: Key figures for 2015 for Swisscom Switzerland and the Residential Customers segment.

Small and Medium-Sized Enterprises

"The Small and Medium-Sized Enterprises segment offers a comprehensive range of products and services – from fixed-line and mobile telephony to Internet and data services to IT infrastructure maintenance and operation. Small and medium-sized enterprises receive integrated solutions tailored to their needs: suitable connections, secure access, professional services and intelligent networks. It also includes the online directories and phone book business." (Swisscom, 2015, p. 18)

SMEs - Key Figures	In CHF million or as indicated
Net revenue	1,370
EBITDA	907
No. of full-time equivalent employees	1,601

Table 5: Key figures for 2015 for Swisscom Switzerland and the Small and Medium-Sized Enterprises Segment.

Enterprise Customers

"Whether voice or data, mobile or fixed network, individual products or integrated solutions, as a leading provider in the field of business communications, the Enterprise Customers segment supports customers with the planning, implementation and operation of their IT and communications infrastructure, including the provision of cost-efficient solutions and reliable services. Enterprise Customers ranks as one of the leading providers specialising in the integration and operation of complex IT systems. In addition, its core competencies are in the fields of IT

Enterprise Customers Key figures	In CHF million or as indicated
Net revenue	2,654
EBITDA	910
No. of full-time equivalent employees	5,378

Table 6: Key figures for 2015 for Swisscom Switzerland and the Enterprises Customers segment.

outsourcing services, workplace services, SAP services and services for the financial industry." (Swisscom, 2015, p. 18)

3.2.3 Corporate Strategy and Vision

As seen above, Swisscom is very well known for its trustworthiness and the quality of its services. The company's vision for the future is to continue to do so, offering its customer "the best – always and everywhere". To effectively do so, the firm identified three main areas of excellence:

> "To always offer the best in the networked world, Swisscom must consistently meet the highest expectations in terms of infrastructure, customer experience and growth." (Swisscom, 2015)

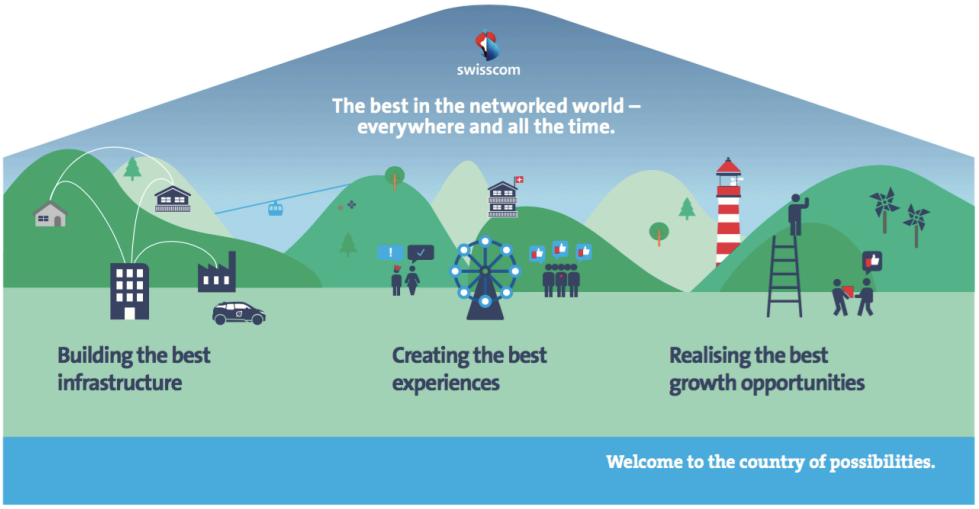


Figure 24: Swisscom's Vision.
Data Source and Graphic: Swisscom (2015).

Building the best Infrastructure

"A high-quality infrastructure allows Swisscom to deliver its products and services, provide a consistently positive customer experience and differentiate itself from its competitors. (...) Reliance on high-performance networks that are always available will continue to increase in future. Swisscom is fulfilling the ever-growing requirements of its customers with networks that are second to none in terms of security, availability and performance." (Swisscom, 2015, p. 29)

Creating the best Experiences

"To clearly distinguish itself in its core business, Swisscom is committed to delivering first-class service to its customers and inspiring them with unique experiences across the board. Swisscom customers can count on us as a competent, reliable partner and enjoy service that

is individual, flexible and personal at all points of contact. From the customer's perspective, contact with Swisscom should always be simple and convenient." (Swisscom, 2015, p. 29)

Realising the best Growth Opportunities

"Swisscom wants to realise growth opportunities by expanding its core business – for example by means of the bundling strategy and growth in TV services and fibre-optic connections. There are also opportunities in other sectors such as banking, healthcare and energy, where Swisscom provides vertical ICT services. New, related business activities, which Swisscom wants to enter selectively, offer further revenue growth potential. Key decision criteria for entering a market include the existence of synergies, potential for differentiation and whether or not it strengthens the core business based on the own network infrastructure. Swisscom is aiming to launch new digital services in selected areas. These services will be offered via the Internet and will in some cases rely on new business models. Examples include the advertising and e-commerce activities that the company has already announced. Other examples of new business areas are the "Internet of Things" and the development of Swisscom Energy Solutions." (Swisscom, 2015, p. 30)

To accomplish these ambitious goals, Artificial Intelligence could play an important role and the company is very interested in exploring its potential. As Chapters 5 – 7 will show in more detail:

- It allows a more efficient use of the infrastructure and empowers customer service's employees to automate routine work, focusing on the most important tasks, both leading to precious savings.
- It allows to customize offerings to customers, in real-time.
- It opens new business opportunities for which leading telecommunication firms are very well positioned.

The leading position in the Swiss TIME industry, the motivation to better understand the potential of Artificial Intelligence and the successful experience in competing with global players, make the company the ideal corporate partner to answer to the research question presented in Section 2.8:

> "How does the latest progress in Artificial Intelligence impact the Swiss TIME industry? What are the factors local TIME players could leverage in their competition with global players in the home market?"

4 – Methodology

The study of Artificial Intelligence was guided by the interest in deepening a technology that is considered by many to have a great impact on everyone's lives in the near future. The research started with a content analysis confirming the great potential of the technology and showing the necessity to interview knowledgeable people on the matter. Progresses in the domain are rapidly following one another making previous research insufficient and making the availability of insights of people directly involved in its development and commercialization very important.

Thanks to the generous support of Swisscom, the thesis presented the possibility to be written in a corporate environment, working at the intersection of industry and academia. This represented a great opportunity since it allowed the study of the potential of Artificial Intelligence not only in theory, but also to see its impact on the strategy of a company, a topic unexplored by academia so far.

The following sections show the suitability for this thesis of the case study method based on qualitative data and explain the rationale behind the choice of the selected data sources. In the last section, the course of action is presented.

4.1 The Research Strategy

In his widely cited work, Yin (2003) presents several ways social science research can be pursued, distinguishing between experiments, surveys, histories, case studies, and the analysis of archival information. To choose the best research strategy, researcher should closely look at following elements:

- The type of research question
- The control the investigator has over actual behavioural events
- Whether the focus is on contemporary or historical phenomena

Table 7 shows how the research question, the control over behavioural events and the period of time the phenomena take place relate with the choice of a suitable research strategy (Yin, 2003):

Strategy	Form of Research Question	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes / no
History	How, why?	No	No
Case study	How, why?	No	Yes

Table 7: Relevant Situations for Different Research Strategies (Yin, 2003).

A look at the setting of our research clearly shows the suitability of a case study approach. From the very beginning, the aim of the thesis was to explore how Artificial Intelligence will impact the TIME industry and what this will mean for the corporate partner, answering so to a "how" question. Moreover, the research to be performed focused on not controllable, highly contemporary events, being the development of Artificial Intelligence among the topics of most interest among computer scientists and media, nowadays, as the tenfold increase of search on Google for "deep learning" – the technology leading to the new wave of Artificial Intelligence progress – in the last few years shows:

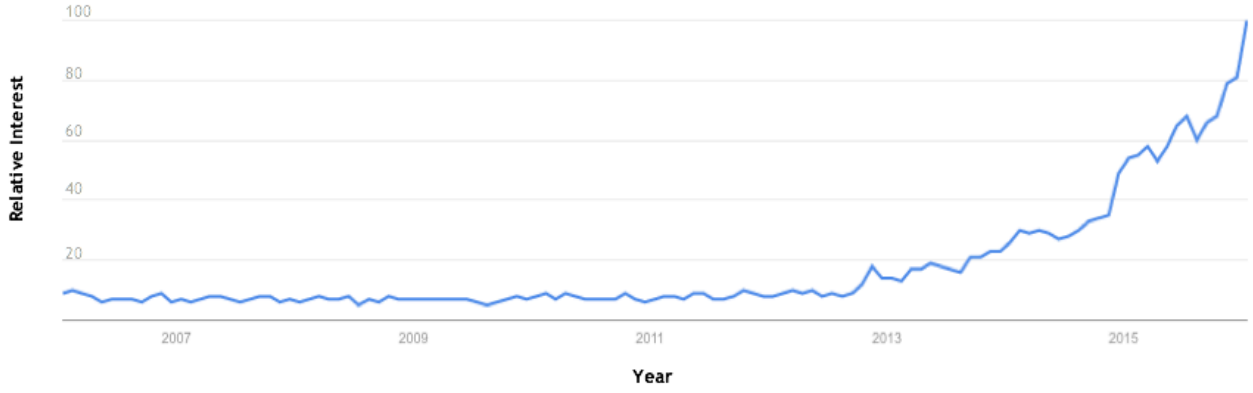


Figure 25: Interest over Time for "deep learning". The plot shows total searches for a term relative to the total number of searches done on Google over time. Data Source: Google Trends (www.google.com/trends).

4.2 Qualitative Inductive Research

As described in Edmondson & Mcmanus (2007), field research can be conducted choosing between three different approaches: qualitative, hybrid or quantitative, each of these approaches having its advantages and disadvantages. As shown by Edmondson & Mcmanus (2007), decisive for the choice of the approach, is the achievement of the so-called

"methodological fit", necessary for a rigorous development of field research.

Methodological fit is achieved if the method for data collection is chosen based on the state of prior theory and research. In the framework presented in their paper (p. 1168), it is distinguished among nascent, intermediate and mature theory suggesting to use qualitative, hybrid and quantitative methods, respectively:

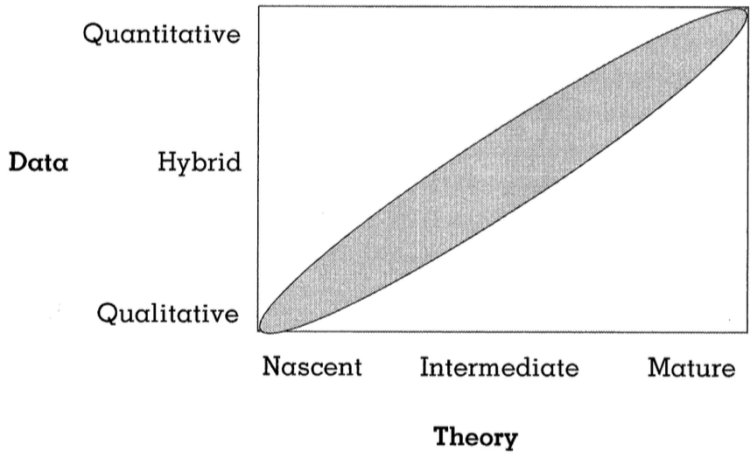


Figure 26: Methodological fit (grey area) as a mean tendency (Edmondson & Mcmanus, 2007, p. 1168).

After the analysis of the literature showed the nascent status of the theory of interest, the use of a qualitative method to answer the research question was determined. Moreover, given the little literature available and the novelty of the topic, an inductive approach was chosen (Neuman & Kreuger, 2003): a theory helping academia to fill the literature gap identified above was formulated starting from observations and data collected. Given the support of the corporate partner and the availability of Artificial Intelligence researchers at ETH, the collection of qualitative data could take place through open-ended interviews.

A more detailed description of the data collection and its analysis following inductive reasoning can be found in the "Course of Action" Section below.

4.3 The Course of Action

As it often happens in Case Study Research (K. M. Eisenhardt, 1989), analyses started with a broad definition of the research question. In the case of this thesis, they started from the need of the corporate partner of better understanding the impact of Artificial Intelligence on its industry and the willingness to act accordingly. Driven by this interest, Swisscom initially defined the broad scope of the research to be performed as follows: "What is the impact of

Artificial Intelligence on the Swiss TIME industry? Hype or a means to increase productivity and generate new growth?"
The final research question presented in Chapter 2 was defined only after a deeper understanding of both the technology and the firm's environment could be gained and the first interview data collected.

Within the Course of Action three main phases can be distinguished: a Preparatory Phase, a Data Collection Phase and a Theory Building Phase. They are explained more in detail in the subsections below.

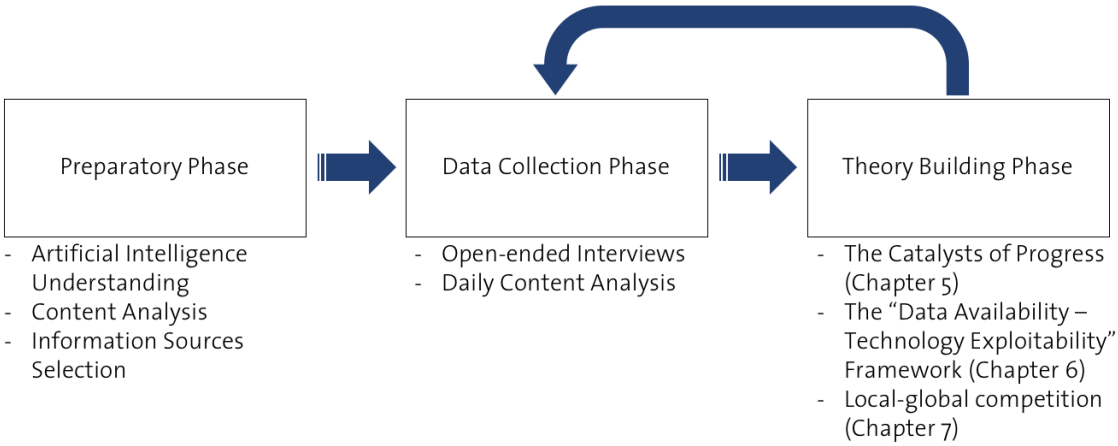


Figure 27: Overview of the Course of Action.

4.3.1 Preparatory Phase

The aforementioned "deeper understanding of the topic and of the firm's environment" was intensively gathered during the first six weeks of the thesis mainly by means of a content analysis. The content analysis also allowed to select the sources of information that would be consulted on a daily basis throughout the whole thesis. Such selection turned out to be crucial: the rapid pace of progress in the Artificial Intelligence field required data from interviews and academic papers to be steadily complemented by analyses of the most recent events, performed by newspapers and technology blogs covering the most recent progresses.

To deepen the most recent events in the field, publications of the most known digital consulting companies – always eager to show their knowledgeability on the most actual topics – were scanned, and by means of Google Search news related to the progress in Artificial Intelligence were searched. For the search items looked for, up to twenty pages of Google Search / Google News results were consulted. Appendix B contains a full list of the search items used to perform the research and of the consulting companies' publications analysed.

Please notice the need of such breadth and depth: to find the best sources in terms of quality and reliability was of great importance and many people in the media tend to exaggerate happenings in order to better sell the news, or report on latest progresses in the field without a proper knowledge of the topic.

The analysis of the more than 150 articles collected led to the selection of 7 newspapers / technology blogs and 2 consulting companies that would be regularly used as a source of information during the whole thesis. To 6 of them – being the quality and depth of their information on Artificial Intelligence outstanding – a daily newsletter was subscribed (see Table 8).

To provide a quality threshold, these sources were selected based on following parameters:

- Domain expertise: For a source to be considered reliable, a steadily reporting on Artificial Intelligence progress in the past 2 years had to be proven.
- Depth of the analysis: reporting the information was not judged to be enough. Only sources providing a deep analysis of the events were selected.

Information	Source selected
Consulting companies' publications	Deloitte, McKinsey & Company
Newspaper / Technology Blogs	Forbes, MIT Technology Review, Neue Zürcher Zeitung, The Wall Street Journal, Stratchery, Business Insider, Wired
Daily subscription	Deloitte, McKinsey & Company, Forbes, Stratchery, Business Insider, Wired

Table 8: Sources selected.

4.3.2 Data Collection Phase

Once the technological context and the needs of the corporate partner were deepened and better understood, the Data Collection Phase started. Given the support of the corporate partner and the availability of Artificial Intelligence researchers at ETH, the data collection took mainly place through open-ended interviews. Furthermore, the information sources selected during the Preparatory Phase were daily scrutinized in order to keep pace with the continuously changing events. This last step revealed itself very important as the open sourcing operated by the biggest high-tech companies between November 2015 and March 2016 completely changed the Artificial Intelligence competing landscape.

Informants were sampled with the stratified sampling method and came from different areas of expertise: the interviews were held with people working in different departments inside the company, as well as with Artificial Intelligence researchers and people working in the financial industry. It is important to notice that these three different areas do not represent three different directions of research; they rather show the complexity of the task and the multidisciplinary approach needed in order to provide a well-grounded answer to the research question:

- As pointed out in Chapter 2, in order to answer the research question the support of the corporate partner was crucial and people knowledgeable about its strategy needed to be involved.
- To gain a deep understanding of Artificial Intelligence and of the related technologies the help of specialists in the field was needed, leading to the involvement of Artificial Intelligent researchers.
- For an objective analysis of the Artificial Intelligence competitive landscape and its potential, the involvement of experts outside the corporate partners was of great advantage.

Moreover, the availability of interviewees with different background coming from distinct industries, presented the advantage of mitigating the risk of biased interview data. As Kathleen M. Eisenhardt & Graebner (2007) suggested, if possible, it is convenient to always involve "numerous and highly knowledgeable informants who view the focal phenomena from diverse perspectives" (p. 28).

The interviews occurred between November 2015 and March 2016. Interview data comprises in total 14 interviews, 10 with Swisscom managers and 4 with Artificial Intelligence experts, researching at ETH Zürich and University of Caen. Three interviewees were interviewed more than once. Interviews were conducted in the interviewees' preferred language (English or German) and lasted between 45 and 90 minutes. All interviews were recorded and transcribed verbatim. The 3 financial industry experts, consulted for the actual situation of the TIME industry, preferred to provide deep analyses performed by the respective financial institutions instead of the author recording and using data from the interviews. Thanks to the full support of the corporate partner, it was possible to interview highly knowledgeable people in different departments of the company, most of them working there for years and covering positions of great responsibility inside the firm.

Table 9 provides an overview of the informants as well as their background and the language, in which the conversation was held:

Category	Function	Language**	Additional Information
TIME Industry Research	Portfolio Manager*	IT	Bank (Switzerland)
	Equity Sales*	EN	Bank (France)
	Equity Sales*	DE	Financial Services Company (Switzerland)
Technology Understanding	Artificial Intelligence Researcher	EN	ETH Zürich
	Artificial Intelligence Researcher	EN	Paris
Corporate Partner	Head of Group Strategy	DE	Sponsor of the thesis at Swisscom
	Head of Technical Strategy, Enterprise Architecture	DE	
	VP, New Business and Innovation	DE	
	Senior Manager, Business Creation and Development	DE	
	Senior Manager, Big Data Solutions	DE	
	Head of Big Data Solutions	DE	
	Head of Product Unit "Security and Intelligence"	EN	
	Head of Corporate Strategy	DE	
	Head of Growth Areas	DE	
	Senior Analyst, Strategic Market Intelligence	DE	

* Interview not recorded; ** DE: German, EN: English, IT: Italian.

Table 9: Interviewees' Overview.

Within the data collection process, two very interrelated phases can be distinguished. The first phase had the goal to find and formulate a research question – fulfilling both the needs of the corporate partner and academia – and best understand the underlying technology, the TIME industry and the corporate partner. To this purpose, 3 interviewees from different key areas of the corporate partner (Business-to-Business, Business-to-Customer and Infrastructure), 3 people working in the financial industry and an Artificial Intelligence researcher were selected. In this phase, the format of the interview was semi-structured and the interviewees were asked with broad and open-ended questions. A complete list of the questions asked can be found in Appendix D.

In a second phase – having formulated the scope of research and following the good understanding of the underlying technology, of the TIME industry and of the corporate partner – only corporate partner's employees knowledgeable about the topic of "Artificial Intelligence and its impact on local-global competition" were interviewed. Moreover, in order to verify the technical viability of the conclusions other four interviews with two different Artificial Intelligence researchers were conducted.

4.3.3 Theory Building Phase

The interview data was managed using NVivo 10, a software tool for qualitative data. To allow a deep analysis of the data collected, the interviews, the academic papers and media articles were coded using first-order categories. This was a crucial step of the thesis as the analysis of the first-order categories allowed to identify the key technological dimensions driving Artificial Intelligence progress, the most recurrent applications of the technology in other companies, as well as the strategies implemented by established players to stay at the forefront of innovation in the domain.

In the next lines a short description of the specific methods used to come up with the findings, and how they relate with the research questions and the corporate partner's needs is provided.

The Catalysts of Progress (Chapter 5)

As shown in Chapter 2, progresses in the field of Artificial Intelligence are taking place at a very fast pace. From the beginning of the analyses was, therefore, clear that to properly answer the research question, a framework allowing an orderly evaluation of progresses in the field was essential.

Since such a framework was unfortunately missing, the first step needed to properly answer the research question was to build it, task accomplished in this chapter. To do so, an analysis

of the data collected in the content analysis – in particular data focusing on the factors leading to the main progresses in the field throughout history and of the strategy of the main players in the field of Artificial Intelligence (until March 19, 2016)– supported by the data collected through the interviews was performed. Such analysis led to the first important finding of the thesis: the identification of the three main catalysts of Artificial Intelligence progress: "Algorithms", "Data" and "Computing Power", a finding that turned out to be of great help for the further analyses performed in the thesis.

The Data Availability – Technology Exploitability Framework (Chapter 6)

Having identified the "Catalysts of Progress" in Chapter 5, in Chapter 6 it was possible to focus on the first part of the research question: "How does the latest progress in Artificial Intelligence impact the Swiss TIME industry?" Given the suitability the Catalysts of Progress showed for analysing the moves of the main players in the field, they were immediately thought of as good parameters for also measuring the potential of Artificial Intelligence inside the corporate partner.

In order to verify it, five interviews were organized, both with Swisscom employees and Artificial Intelligence researchers. A discussion with one of the interviewees, researcher in the field, showed that Computing Power – although essential for the development of Artificial Intelligence algorithms and the progress in the field – is not as important as Data and Algorithms, as it is slowly becoming a commodity. Another interviewee suggested – given the elevate number of possible applications of Artificial Intelligence – to focus rather on the potential of single use cases than on the potential of Artificial Intelligence in general. Following these and more inputs on the interviewees' side presented in Chapter 6, the "Data Availability – Technology Exploitability" framework was built, allowing the corporate partner to assess the potential of Artificial Intelligence use cases inside the company and more in general in the industry it is operating.

Local-global Competition (Chapter 7)

The last part of the thesis focused on the answer to the second part of the research question: "What are the factors local TIME players could leverage in their competition with global players in the home market?". To deepen this question Swisscom represented the ideal corporate partner, as the company is since a long time successfully competing with global players in Switzerland. To help answer this question, Swisscom gave the author the possibility to interview three top managers of the company – the Head of Corporate Strategy, the Head of Growth Areas and the VP of New Business and Innovation – and a senior analyst responsible for strategic market intelligence. The data collected through these interviews and an analysis

of the existing literature on local-global competition allowed to get to a third important finding of the thesis: the identification of possible strategies local TIME players in developed markets can apply to effectively compete with global technology companies in an industry, the TIME industry, in which Artificial Intelligence will play an increasingly important role.

5 – The Catalysts of Progress

As shown in Chapter 2, progresses in the field of Artificial Intelligence are taking place at a very fast pace. From the beginning of the analyses was, therefore, clear that to properly answer the research question, a framework allowing an orderly evaluation of progresses in the field was essential.

Since such a framework was unfortunately missing, the first step needed to properly answer the research question was to build it, task accomplished in this chapter. To do so, an analysis of the data collected in the content analysis – in particular data focusing on the factors leading to the main progresses in the field throughout history, and on the strategy of the main global players in Artificial Intelligence – supported by the data collected through the interviews was performed.

Such analysis led to the first important finding of the thesis: the identification of the three main catalysts of Artificial Intelligence progress: "Algorithms", "Data" and "Computing Power". This finding proved to be of great help for the further analyses performed in Chapters 6 and 7 and laid the foundation for answering the research question. Section 5.2 explains why these categories have become so important precisely now. Section 5.3 shows that the strategies the main industry players are deploying in order to get an edge in the categories "Algorithms", "Data" and "Computing Power" have important moves in common: the building of data ecosystems, the use of open innovation and great activity on the mergers and acquisitions market.

5.1 The Moves of the Main Players

Envisioning its high potential, high-tech companies have invested very much in Artificial Intelligence. This section analyses in detail the strategy of selected main players, looking at how Artificial Intelligence fits in their existing business and whether changes due to Artificial Intelligence have taken place in their strategy.

The companies have been selected as main players because of their contribution to Artificial Intelligence research through publications on scientific journals and open source, their market capitalization (more than $ 100 billion on January 1, 2016; bloomberg.com) and the amount of their investments in Artificial Intelligence (Blostein, 2015). In spite of the fact that its investments in Artificial Intelligence seem to be smaller, Apple was also included into the group because of its undisputed role in the high-tech industry.

Serving these companies individual customers (e.g.: Facebook), businesses (IBM) and both (e.g.: Microsoft), they also give a broad overview of the different strategies applicable. The last part of the section is devoted to strategic moves concerning Artificial Intelligence taking place in Asia.

5.1.1 Facebook

The Personalization Trend and the Need for Artificial Intelligence

One of greatest strengths of Facebook is the huge volume and richness of data the company has at its disposal, whose growth does not seem to slow down: in October 2015, Facebook CTO Mike Schroepfer estimated that the amount of content Facebook considers showing on users' News Feed grew 40% to 50% year-over-year. (D'Onfro, 2015) This represents a big challenge for the company, as free time clearly does not increase at that rate at all, and the accuracy of information displayed on the News Feed is crucial for Facebook's success. Users' engagement heavily relies on the quality of personalized content on the News Feed and Facebook has to consistently deliver compelling information every time users log in. The key to do so is Artificial Intelligence and the company is investing very much in it, these efforts involving even the founder and CEO Mark Zuckerberg. At the beginning of 2016, he announced that his personal challenge for the year to come would be building "a simple Artificial Intelligence to run my home and help me with my work" and in the first months of 2016 he often wrote on the topic.

M – The hybrid Personal Assistant

Artificial Intelligence plays a key role also in a new important product Facebook is slowly rolling out: "M", the personal assistant available through the company's messaging application "Messenger". David Marcus – Facebook's VP for Messaging Products – strongly believes it is much more powerful than what shown by competitors so far:

> "Unlike other Artificial Intelligence-based services in the market, M can actually complete tasks on your behalf. It can purchase items, get gifts delivered to your loved ones, book restaurants, travel arrangements, appointments and way more." (David Markus, VP Messaging Products at Facebook. Source: Kokalitcheva [2016])

To have the best messaging app is very important to Facebook: the company needs to maintain users highly engaged to continue prospering, and millennials seem to be increasingly interested in messaging apps as Snapchat rather than Facebook. There are now more than 1.5 billion people on Facebook, an impressive number, but as analyst Ben Thompson of Stratchery.com stated:

> "While most people have Facebook accounts, it's by no means assured that they will use it heavily; the bigger threat is not outright displacement but rather the drawing away of attention. Messaging is more dangerous to Facebook because it is predicated on personal relationships; Facebook's ability to keep you connected with far-flung relatives and acquaintances is certainly useful and will help preserve the service, but it's close connections that drive continued engagement." (Ben Thompson, Founder and Author at stratechery.com. Source: Thompson [2014])

To have the best personal assistant on the market integrated in "Messenger" would clearly be a good asset in order to attract people to the own messaging app.
From a technical perspective, the approach the company is using for this service is very interesting. Facebook is aware that standard Artificial Intelligence software is not ready to handle the broadness and complexity of tasks "M" is expected to solve, and decided to support it with humans, taking over if the software is not capable to provide what the user is looking for (See Figure 28).

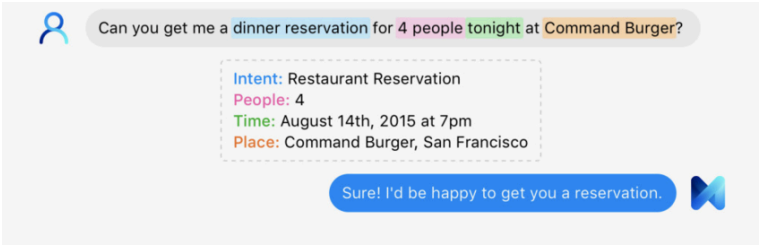


Figure 28: When a Facebook user asks a question (top), M's artificial intelligence engine analyses what is said (middle) and shares this analysis with Facebook's human "trainers," who then respond to the user (bottom); Source: wired.com.

The hope is that with time and training the system can learn and improve little-by-little making human support very marginal.

Open Source

Following its mission to "give people the power to share and make the world more open and connected", the company was among the first to open source its deep-learning modules for Torch back in January 2015 and, in October of the same year, did even more than Google, open sourcing also the server architecture needed to run them (Google did not until March 2016).

5.1.2 Google (Alphabet)

Artificial Intelligence represents for Google a huge opportunity: progress in the field would positively impact nearly any part of its business. The company prepared itself accordingly and is now very well set to exploit it, being at the forefront in all relevant research areas and having very much data at its disposal. Moreover, thanks to the move of making its Artificial Intelligence software open source, the company is likely to continue attracting the scarce

number of brilliant minds in the field and its software could even become the standard in the industry. As of now, Artificial Intelligence is used at Google to improve internal operations, enhance the value of its services and to create new powerful products.

Increasing Data Quantity and Variety through a Data Ecosystem

Google and its parent company are very well set to best exploit the potential of Artificial Intelligence in the next years: the brilliant people working at the company developed an Artificial Intelligence software that is said to be years before competition; to run it efficiently they have a very big computing infrastructure, and most of all they have data, a huge amount of data.

Although Google does not release official statements about the quantity of data it has access to, under privacy.google.com is possible to see the variety it has at its disposal:

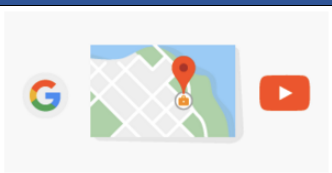
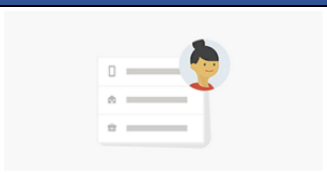
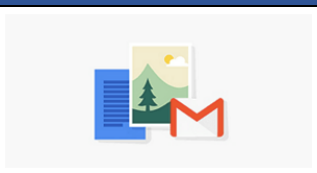
"Things you do"	Things that make you "you"	Things you create
		
- Things you search for - Websites you visit - Videos you watch - Ads you click on or tap - Your location - Device information - IP addresses and cookies	- Name - Email address - Password - Birthday - Gender - Phone number - Country	- Emails you send and receive - Contacts you add - Calendar events - Photos and videos you upload - Files on Google Drive

Table 10: Main types of Information Google collects. Data source: privacy.google.com.

Thanks to the number of services offered, the company has a very good picture of customers' behaviour and is able to provide ads with higher value. The increased possibilities of data analysis Artificial Intelligence is unlocking, motivates the company to expand data sources even more, as the acquisition of Nest for over $3 billion, the development of Google Now and Google Wallet show.

Through such a rich data ecosystem and the powerful algorithms the company has at its disposal, Google is very well positioned to continue being the best advertising partner on the market.

Building an Exponential Organization with Artificial Intelligence at its Core

In August 2015, Google announced its reorganization into a holding named Alphabet Inc., making Google a subsidiary of Alphabet. The move pleased investors as it allows for more transparency and – as Deloitte's report "Cognitive technologies in the technology sector" observed – Artificial Intelligence played an important role in this choice:

> "Alphabet is an ambitious structural and operational commitment to speed and scale – one that is fundamentally informed by and designed to enable the exponential growth of cognitive technologies. (...) The company hews to an emerging business strategy framework known as "exponentials," which is based on the exponential acceleration of technologies such as quantum computing, artificial intelligence, robotics, additive manufacturing, and synthetic or industrial biology." (Pereira, Schatsky, Sallomi, & Dalton, 2015, p. 7)

The new enterprise architecture is better suited to reach this ambitious goal and machine learning will be at its core: for Google, improvements in machine learning and Artificial Intelligence do not just benefit a small part of the company, but its whole business. According to Jeff Dean – leading the TensorFlow effort – Google is now using Artificial Intelligence in more than 600 projects, many more than the few at the beginning of 2014: prominent examples include Google Search, Google Translation and Google Drive. In December 2015, Google's CEO Sundar Pichai even stated that

> "machine learning is a core, transformative way by which we're rethinking how we're doing everything." (Sundar Pichai, CEO at Google. Source: Shen [2015])

On the one hand, the company is rapidly leveraging the knowledge gained in the field to improve its products, an example being the integration of Rankbrain into Google Search, Google's most important product. Rankbrain uses "mathematical processes and advanced understanding of language semantics to gradually learn more about how and why people search, and apply those conclusions to future search results" (DeMers, 2015). Just some months after the launch is now used for 15% of queries, greatly improving customer experience and the value of the service.

On the other hand, exploiting the huge possibilities given by Artificial Intelligence, the company is also developing new powerful products – as the Google Now and the Google's self-driving car – to provide a better service to its customers and generate new sources of revenue.

Machine learning is also becoming a crucial part of the Google Cloud strategy, an increasingly important business for Google: in November 2015, Urs Hölzle publicly stated that "The goal is

for us to talk about Google as a cloud company by 2020" and in February Google CEO Sundar Pichai reinforced the message telling investors that “Public cloud services are a natural place for us”. Thanks to the experience in computing infrastructure and also – as Fortune noticed:

> “Thanks to the advances Google has made in key areas including machine learning and data analysis that it can bring to bear in this market.” (Darrow, 2016)

The proven knowledge in Artificial Intelligence would enable them to attract more customers and better monetize the storage they use as the company is able to provide clients with additional value-added services. In fact, the analytical capabilities of the cloud provider are becoming a very important selling argument in the industry; this is very well shown by the decision of Spotify to move part of its infrastructure to Google instead to the leader Amazon. On the day of the announcement – February 23, 2016 – the Wall Street Journal reported “Spotify AB, a marquee Amazon Web Services customer, said it plans to move much of the technology behind its music-streaming service to Google Cloud Platform (...) Nicholas Harteau, Spotify’s vice president of engineering and infrastructure, said Google’s ability to analyse the massive amounts of data tipped the scales. For example, Google’s data-analytics offerings could help the music service fine-tune its listening recommendations” (Greene, 2016).

The Open Source Move

A very important strategic move concerning Artificial Intelligence done by Google has been without a doubt the open sourcing of TensorFlow under the Apache 2.0 license in November 2015. As Jeffrey Dean – the computer scientist leading the TensorFlow effort – explained, “TensorFlow is an open source software library for machine learning in various kinds of perceptual and language understanding tasks, currently used for both research and production by 50 different teams in dozens of commercial Google products, such as speech recognition, Gmail, Google Photos, and Search” (tensorflow.org).

The move had a big impact not only on the company itself, but on the whole industry as Microsoft and IBM rapidly followed the same path open sourcing their own Artificial Intelligence software as well.

5.1.3 IBM

105 years after its foundation, IBM is facing another big transformation: the cloud trend is likely to seriously shrink its hardware business, and the company is looking for the next Big Thing. IBM’s CEO Ginny Rometty seems to have found it in the Artificial Intelligence and Cloud businesses. Speaking at CES 2016, she stated that "IBM is now a cognitive solutions and cloud

platform company" (Hiner, 2016). The platform allowing IBM to do so has been named "Watson" and leverages three core Business Models run in parallel:

> "The first is around industries that we think will go through a big change in "cognitive" [natural language] computing, such as financial services and healthcare.
> The second is where we see similar patterns across industries, such as how people discover and engage with organizations and how organizations make different kinds of decisions.
> The third business model is creating an ecosystem of entrepreneurs." (Mike Rhodin, Senior Vice President at Watson Business Development. Source: Power [2014])

The first two are being commercialized as Software as a Service (SaaS), while the Watson Ecosystem serves as a marketplace where Watson-related products and services can be sold, with IBM likely taking a share of the revenue generated. (Deloitte Development, 2015)

IBM Watson

IBM Watson became very popular after its victory in Jeopardy! in 2011 against former winners Brad Rutter and Ken Jennings and showcased its ability to handle huge amounts of data combined with exceptional Natural Language Processing abilities for that time. From that moment on, the company invested very much in extending its capabilities to more profitable sectors than quiz gaming.

Speaking about Watson, Ginni Rometty – IBM's chairman and CEO – noted: "For those of you who watch us, we don't create new units very often. But when we do, it is because we see something that is a major, major shift that we believe in. This major shift is what IBM considers the dawn of a new era in the technology sector: the cognitive computing era. IBM's efforts in the cognitive computing era very much rely on Watson, a technology platform that uses natural language processing and machine learning to reveal insights from large amounts of unstructured data." (IBM.com). Deloitte claimed IBM in March 2015, to be

> "the only company marketing a cognitive computing platform that's specifically designed to support the development of a broad range of enterprise solutions." (Deloitte Development, 2015, p. 2)

SaaS Commercialization

As of February 2016, IBM is using Watson in 17 industries, commercializing it as SaaS. Among them, they are focusing very much on healthcare: the industry is going through a big change and the potential of Watson there is enormous. Key part of this strategy is the collection of data from as many sources as possible in order to improve the algorithms. To this purpose, IBM is working with several hospitals to enlarge its dataset. Moreover, to expand the

information at its disposal, the firm has been performing a series of acquisitions; among them the acquisition Merge Healthcare Inc. in August 2015 for $1 billion. This move is estimated to give IBM access to over thirty billion medical images. (High, 2016)

The amount of information IBM is gathering in these industries could represent a very precious competitive advantage in the future. As the Financial Times notices:

> "The more industry-specific data it is fed, the smarter it will become at solving business problems. As customers pour their own corporate information into Watson in order to train it, IBM stands to be a beneficiary." (Waters, 2016)

To support its customers in the cognitive computing era and to show how much the company believes in it, IBM created in October 2015 a 2'000-person consulting organisation to support the platform: the IBM Cognitive Business Consulting business unit.

The Watson Ecosystem

To support Watson's development and become the leading cognitive partner as soon as possible, IBM radically changed its strategy, usually focused on proprietary software, deciding since the beginning to strongly incentivize as many people as possible to collaborate to its development and building what they call a "developers' ecosystem", instead:

> "IBM has traditionally been very proprietary about its products and has kept its intellectual property to itself, but the cognitive journey is the complete opposite. It's establishing a platform and a set of APIs for other companies to build their apps and their businesses. Instead of viewing its IP as its secret sauce, IBM now views radical transparency as the key ingredient – a significant shift." (Hiner, 2016)

Through the Watson Ecosystem (see Figure 29 below), IBM targets third-party developers; becoming ecosystem partners, companies and start-ups sign up to develop "Powered by Watson" cognitive solutions and gain full access to Watson APIs, have facilitated access to precious content sources and receive assistance throughout the whole product development phase.

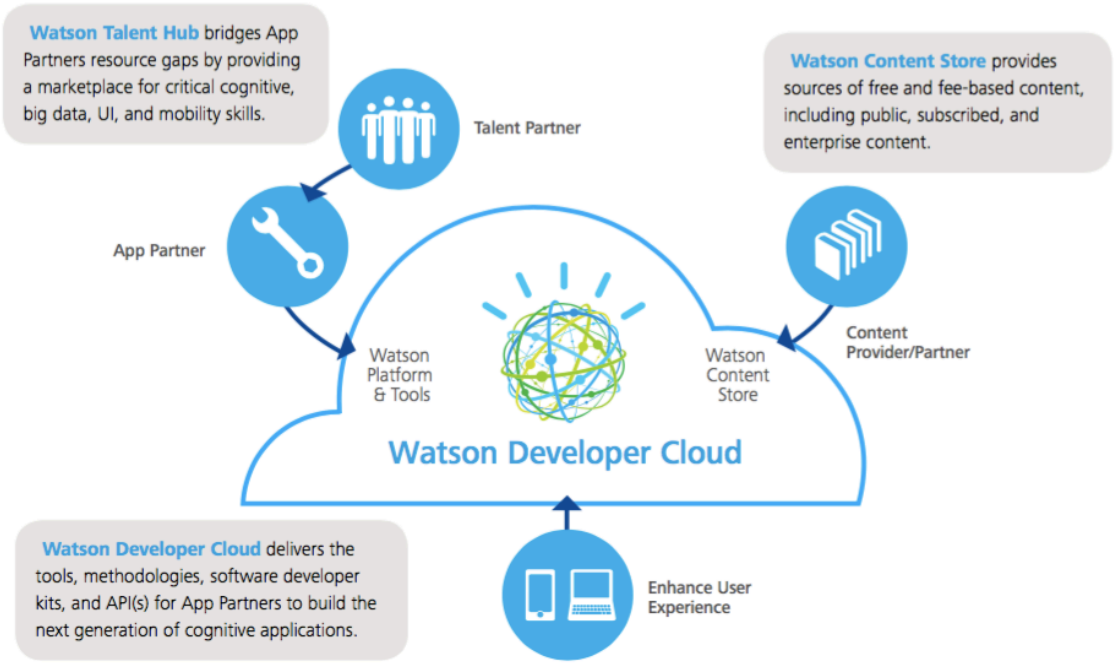


Figure 29: IBM Watson Ecosystem. Data Source and Graphic: (Deloitte Development, 2015).

Moreover, to support start-ups willing to develop cognitive solutions using Watson, IBM has a specific $100 million venture fund and provides start-ups with technical and consulting support. As M. Rhodin told Brad Power in his HBR article (Power, 2014):

> "We're always looking for companies with brilliant ideas that we can partner with or acquire. With the entrepreneur ecosystem, we are behaving more like a Silicon Valley startup. We can provide the entrepreneurs with access to early adopter customers in the 170 countries in which we operate. If entrepreneurs are successful, we keep a piece of the action." (Mike Rhodin, Senior Vice President at Watson Business Development. Source: Power [2014])

5.1.4 Microsoft

Two pillars of Microsoft's strategy since the arrival of Satya Nadella as company's CEO are the development of products "reinventing productivity" and becoming a leading cloud provider. To accomplish these goals Artificial Intelligence will play a very important role. On the one hand, productivity will increasingly rely on the ability to generate personalized insights, for which Artificial Intelligence is essential. On the other hand, in their cloud efforts – e.g. through its successful Personal Assistant Cortana – Artificial Intelligence represents a very good differentiator and a way to increase the value of their offering. Being Artificial Intelligence so important, the company is making great efforts to attract the best talent and win early the support of developers.

Artificial Intelligence as a Differentiator in Microsoft's Cloud-centred Strategy

Since the appointment of Satya Nadella as Microsoft's CEO, Cloud plays a crucial role in the strategy of the company. This was formalized by the firm's ambitious plan exposed in April 2015, referred to by Microsoft GM of Investor Relations Chris Suh as Microsoft's "North Star":

> "To reach annualized revenue of $20 billion in its corporate cloud business in the fiscal year that ends in June 2018." (Bloomberg.com)

An impressive number considering that the revenue amounted to $6.3 billion back then. In the Cloud business Microsoft has the advantage – compared to companies as Google – to have an established enterprise customer base and very much experience. "Plus, lots of Microsoft's biggest customers already have what's called an "Enterprise Agreement," essentially a contract that gives them steep discounts on Microsoft software they're using. Microsoft can jigger these agreements to give customers a big incentive to try Azure" (Weinberger, 2015). As the supremacy of Amazon Web Services in the cloud business shows, this has not been enough, though, and Microsoft is eagerly looking for new ways of closing the big gap dividing it from its competitor.

In these efforts, Artificial Intelligence will likely play a very important role, as a differentiator and as an added value to its offering. Indeed, as a Deloitte Report notices:

> "Microsoft is seeking to use machine learning as a way to generate new revenue from existing customers of its public cloud computing platform, Microsoft Azure. To this end, in June 2014, Microsoft launched Azure Machine Learning, an open, multisided platform designed to accelerate and scale collaboration within a developer community and among a growing business ecosystem of strategic partners." (Pereira et al., 2015, p. 10)

Moreover, besides Azure Machine Learning, the company announced in July 2015 the launch of the Cortana Analytics Suite "a fully managed big data and advanced analytics suite that enables you to transform your data into intelligent action" (microsoft.com). Microsoft put very much effort in making the tool very intuitive. To this purpose – as the name suggests, it was also equipped with Cortana, Microsoft's successful personal assistant, whose full integration makes the interaction with the software more natural, differentiating it from competition.

Rebuilding a great Relationship with Developers

An important part of Microsoft Artificial Intelligence strategy is the race to attract the best talents in the field, for which the company is investing many energies and resources. The efforts seem to pay out as Microsoft – according to Research from RJMetrics reported by Forbes

(Press, 2015) – is the company employing the highest number of Data Scientists, an important category for the development of Artificial Intelligence software.

Among other initiatives to increase Artificial Intelligence employees' retention and attract new ones, Microsoft created in 2014 "Microsoft Garage", compared by some observers to Google's "20% time" initiative:

> "Garage projects are crafted and cared for by small teams across the company who are hoping you'll find the next thing you can't live without." (microsoft.com/garage)

Since its launch, its teams have produced some interesting apps whose usefulness – as in the case of MyMoustache.net, a tool measuring the size of moustaches – has often been questioned by the press. These applications might not be as useful for users as Office 365, but it is important to keep in mind that beside showcasing its capabilities in Artificial Intelligence, the project has a hiring component. As Slater-Robins noticed: "Microsoft is pursuing a more serious mission, to get the attention of people who are working on artificial intelligence, people it will need to recruit" (Slater-Robins, 2016).

Another important move to attract talents has been the launch in April 2015 of Project Oxford, "the easiest-to-use Artificial Intelligence-based vision, speech and language APIs" (projectoxford.ai). Through the website, developers can download APIs based on Microsoft's Artificial Intelligence technology and integrate them easily into their own applications. The service is open to anyone, and developers have to pay a fee only after a certain usage of the APIs, making the offer very attractive to them.
The idea behind the service is different than Google's TensorFlow platform or Microsoft's CNTK, as Project Oxford does not mainly target researchers and programmers but rather app developer willing to develop Artificial Intelligence-based apps for the consumer market. As Popular Science's Dave Gershgorn notices:

> "With easier tools like this, more mainstream apps that aren't backed by multi-billion dollar companies will be able to integrate deep learning and artificial intelligence into their apps. A.I. is the next software frontier, and Microsoft just made it a whole lot easier for smaller developers to get involved." (Gershgorn, 2015)

It is clear that such a move impacts the image of Microsoft among developers in a very positive way.

Open Source

It is no doubt that since the arrival of Satya Nadella as company's CEO Microsoft has changed very much. One of the most impressive changes happened in the company's vision of open source: just back in 2005, Bill Gates referred to free-software developers as communists and Steve Ballmer to Linux as a "cancer". Some years later, Microsoft is among the companies pushing most for open innovation in Artificial Intelligence.

In January 2016, the company released its Artificial Intelligence framework CNTK (Computational Networks Toolkit), as open source. CTNK is the same framework used by Microsoft to build the company's powerful Artificial Intelligence-based applications as Microsoft Cortana and Skype Translate. They did it in an even more complete way than Google, since the open-sourced version – contrary to TensorFlow – can take advantage of the power of many servers at the same time. This is a very important feature to developers, as for real-world applications a huge computing power and many servers are usually needed.

5.1.5 Apple

In Artificial Intelligence, Apple is following a very different strategy than other big companies as Google, Facebook and Microsoft. While the latter are investing billions in research and recruiting, receiving very much attention from the media, Apple seems to be less active in the field and did fewer acquisitions in the field so far.
The difference can be surprising at a first glance, but can be explained looking more carefully at the company's mission and core business.

A Hardware Company

Having Apple and Google very similar products – iOS and Android, Apple Maps and Google Maps, the App Store and Google Play – people often think of them as directly competing companies. This might be true to some extent, but looking closer at their mission statement it is possible to notice that they are developing similar products for very different reasons.

While Google's mission is highly focused on software and data – "To organize the world's information and make it universally accessible and useful" (Google.com/about/company), Apple's focuses on hardware:

> "Apple designs Macs, the best personal computers in the world, along with OS X, iLife, iWork and professional software. Apple leads the digital music revolution with its iPods and iTunes online

> store. Apple has reinvented the mobile phone with its revolutionary iPhone and App store, and is defining the future of mobile media and computing devices with iPad." (Apple.com)

Google's monetizes its investments in making information "universally accessible and useful" being paid by companies willing to exploit it for advertising purposes. The company earns through this business about 90 percent of its entire income and data plays a crucial role in this strategy. Therefore, most of the products developed by the company aim to get more data and improve its advertising market share. Apple's main goal is to sell as many IPhones, Macs and IPads as possible. Applications are important, but are not the core of its business, and the company does not need to – and neither want to: see section below – develop Artificial Intelligence software to monetize data. The company's focus on hardware has proven to be successful, as Apple's iPhone revenue is bigger than any other tech company's total revenue (Rosoff, 2015).

Being these the goals of the companies, it is clear that Data and Artificial Intelligence do play a role for Apple, but a smaller one than for companies as Google. Apple's acquisitions and investments in software and in the specific field of Artificial Intelligence mainly aim to provide customers with functionalities that they very much care of and expect to be built in the hardware of a premium Smartphone as the IPhone. The company thought that this was the case of a personal assistant, followed by the acquisition of Siri, one of the best on the market in 2010.

Hardware where Data is easy to access but only by you

Furthermore, the company uses data privacy as a differentiator, with Apple's top executives often stressing how much the company cares about it. Too much focus on algorithms allowing the company to exploit data could harm the company, as many customers buy their products precisely for privacy reasons:

> "In my case, I prefer to use Apple: I know they make a lot of money selling the hardware and do not need to sell my data: I am safer with them rather than with Google." (Interviewee 2)

In February 2016, data privacy concerns led the company to even refuse the FBI request to unlock a terrorist's IPhone and as Tim Cook explained at the White House Summit on Cybersecurity and Consumer Protection at Stanford University, the company intends to continue focusing on hardware and on the defence of customer privacy in the next years:

> "At Apple we start with a simple premise; our customer's trust means everything to us and we spent decades working to earn that trust. (...) Beyond that, we have a straight-forward business model, that's based on selling the best products and services in the world. Not on selling your personal data. (...) We don't sell advertisers any information from your email content, from your messages, or your web browsing history. We don't monetize the information on your iPhone or in your iCloud. When we ask for information it's to provide you with better services and even then you have a choice. You're in the driver's seat on how much information you want to share and when you want to stop sharing it. (...) We can imagine a day in the not so distant future when your wallet becomes a remnant of the past. Your passport and drivers license and other documents can be digitally stored in a way that's safe, secure, and easy to access, but only by you." (Tim Cook, CEO at Apple. Source: Moss [2015])

5.1.6 Artificial Intelligence use in Asian Companies

Media often tend to focus on the moves of western companies only. The following lines aim to provide a brief overview of what is happening on the Asian market. As the example of Facebook Messenger – now following a similar strategic path as Asian company LINE – shows, the Asian market is worth keeping an eye on.

Baidu

The Chinese search giants is investing very much in Artificial Intelligence and although it is not getting as much attention as other western companies in the media, it is at the forefront of Artificial Intelligence development.

From a strategic perspective, the company is acting in a very similar way as its Western competitors, most of all Google, being Baidu a search company as well. In 2014, Baidu hired Andrew Ng, co-founder of Coursera, Associate Professor at Stanford University and one of the most important experts of Artificial Intelligence, to lead the company's research efforts. In January 2016, as many other big high-tech companies, it decided to open source some of its key code that it uses to make its Artificial Intelligence software run very efficiently. Moreover, to accelerate Artificial Intelligence research inside the company, Baidu opened in 2013 the Deep Learning Institute, co-located at the company's Beijing headquarters and in Silicon Valley.

Among the new products developed leveraging Artificial Intelligence, stands Duer, Baidu's personal assistant, particularly relevant in China given the importance of voice queries in the country; as Will Knight – senior editor for Artificial Intelligence at MIT Technology Review – notices, "voice queries are more popular in China because it is more time-consuming to input

text, and because some people do not know how to use Pinyin, the phonetic system for transcribing Mandarin using Latin characters" (Knight, 2016). Baidu has reached impressive results in the field, claiming the software to be even better than humans at speech recognition in some cases. As Andrew Ng said, this was made possible by the latest advances in deep learning, simplifying very much the development of language recognition software:

> "Historically, people viewed Chinese and English as two vastly different languages, and so there was a need to design very different features (...) The learning algorithms are now so general that you can just learn." (Andrew Ng, Chief Scientist at Baidu. Source: Knight [2016])

Microsoft Xiaoice

In addition to Cortana, Microsoft is developing a virtual assistant called Xiaoice ("Little Bing") exclusively available in China. Among the reasons why Microsoft is developing two virtual assistants in parallel, there is the different use of Artificial Intelligence behind Cortana and Xioice: both virtual assistants are built on top of the Microsoft Bing search engine, but while Cortana is more task-driven, Xiaoice wants to be emotional and tries to have an emotional connection with the user.

Xiaoice succeeds doing so: the virtual assistant could already attract millions of users speaking with her daily and – as the high average of Conversations per Session (CPS) shows – people enjoy chatting with her: "an average artificially intelligent personal assistant has a CPS between 1.5 and 2.5 (...) Xiaoice's average, after chatting with tens of millions of users, has reached 23" (Wang, 2016).

Among the decisive factors behind her success stands the human-like way to answer questions: she does not just give numbers or answers as "yes" or "no", but starts a conversation, instead. Many users even say they do not notice to be talking with a bot and, given the unpredictability of her answers and the strong opinions she can sometimes have, some associated Xiaoice with a 17-year old boy / girl. Another important difference compared with other virtual assistants is the proactivity Xiaoice can have in personal matters. Indeed, as Yongdong Wang – managing director of Applications & Services Group East Asia at Microsoft – reported, Xiaoice can become even proactive starting the conversation herself: "If you have a recently failed romantic relationship, she will proactively ask whether you've gotten over it:

> Xiaoice: Are you feeling better today? I want to recommend a book to you.
> Human: I am in a bad mood. I still miss her.

> Xiaoice: You are so persistent. Wake up, you will have no future if you can't get over with the past." (Source: Wang [2016])

The success it is enjoying in China is impressive: in less than a year from its launch, the service gained 40 million users, being even more striking the fact that 25 percent of them already told once Xiaoice "I love you" (Wang, 2016).
With a virtual assistant as Xiaoice, Microsoft is showing what Artificial Intelligence-powered systems can accomplish: in the future, they could go beyond efficiency, becoming even their owners' friends.

NTT DoCoMo

A TIME industry company at the forefront of Artificial Intelligence exploitation is NTT DoCoMo, Japan's leading mobile operator.
Among others, Artificial Intelligence plays a very important role in its "2020 Vision HEART", presented in 2011, through which the company aims to transform itself from a mobile carrier into a Personal Life Agent:

> "Rather than focusing simply on providing connectivity and fading into the background, DoCoMo is trying to maintain a close relationship with Japanese consumers. Its strategy is centred on using the data collected by its network to anticipate customers' needs and provide them with tailored and timely propositions." (STL Partners, 2015)

As a part of this strategy NTT launched in 2012 its personal assistant "Shabette Concier", being among the first to do so. Moreover, through the use of customers' data and the collaboration with several partners, the company aims to always provide customers with tailored propositions (see Figure 30 below) and to do so Artificial Intelligence is essential. In fact, thanks to the progresses in the field in the last years, this vision – strongly relying on the analysis of Data – is going to become reality sooner and better.

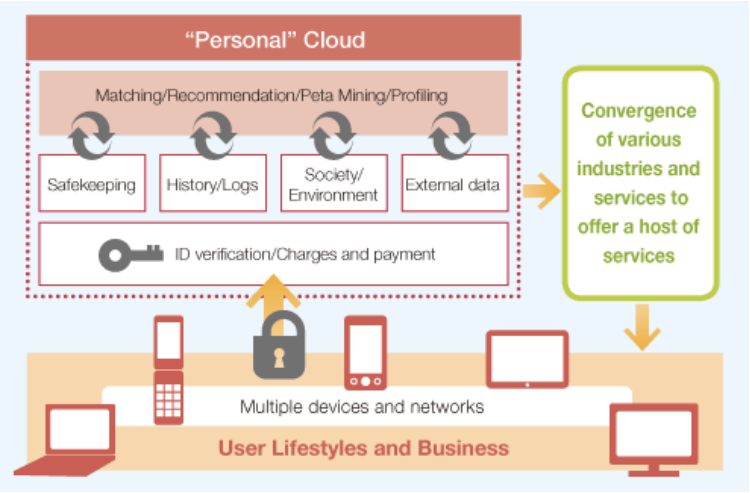


Figure 30: Source: NTT DoCoMo, Medium-Term Vision 2015.

Following the success of Shabette Concier, NTT integrated it in other company's and third-party products. The latest example is OHaNAS (Organized Human interface and Network Artificial Intelligence System), an interactive toy that can be interacted with verbally – developed together with the toy company Tomy – using DoCoMo's proprietary cloud-based natural-language dialogue platform. Moreover, the company plans to launch in summer 2016 an Artificial Intelligence-based agent to support the crew at the company's Customer Centres. As Business Wire reported:

> "The cognitive agent will enable customers to receive a range of standardized services at any time, 24/7, and without having to wait. In addition, the automated interaction will also speed up the resolution of problems that need to be referred to a human agent by ensuring the full context of a conversation is shared when the caller is passed over to the live agent." (Business Wire, 2015)

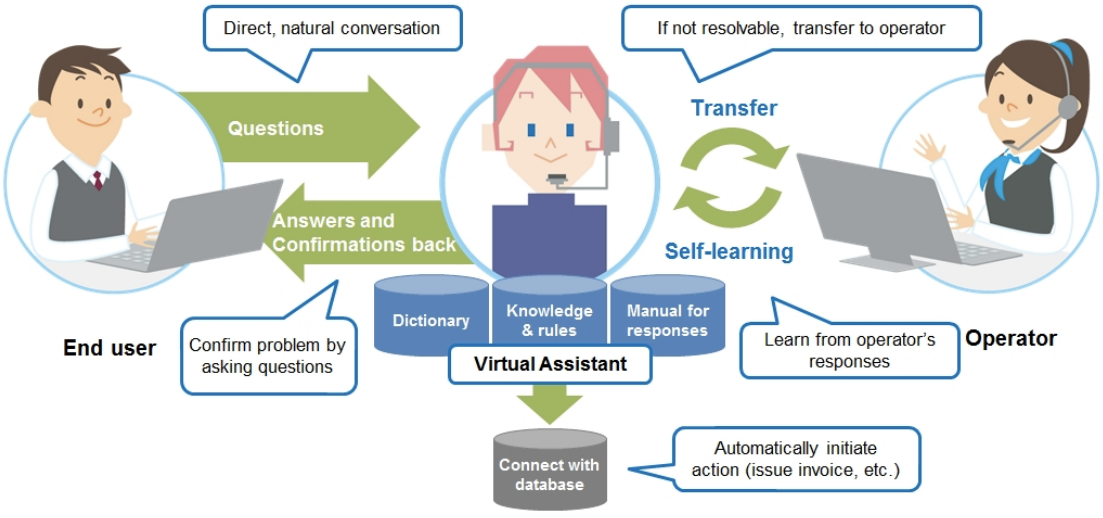


Figure 31: Contact Center Agent; Graphic: Business Wire.

To best exploit Artificial Intelligence, the company established in September 2015 the Artificial Intelligence Solutions Promotion Office inside of the NTT Data Group: it started operating with 20 people with the objective of expanding it over time.

5.1.7 Synthesis

In the subsections above, the strategic moves of the main players (Facebook, Google, IBM, Microsoft) in Artificial Intelligence have been analysed. The companies have been selected as main players because of their contribution to Artificial Intelligence research through publications on scientific journals and open source, their market capitalization (more than $ 100 billion on January 1, 2016; bloomberg.com) and the amount of their investments in Artificial Intelligence (Blostein, 2015). In spite of the fact that its investments in Artificial Intelligence seem to be smaller, Apple was also included into the group because of its undisputed role in the high-tech industry.
Serving these companies individual customers (e.g.: Facebook), businesses (IBM) and both (e.g.: Microsoft), the selection made presents also the advantage of giving a broad overview of the different strategies applicable.

Although very different in terms of history, R&D strategy and customer base, all four main players are investing very much in Artificial Intelligence. Interestingly, these efforts seem to point all to get an edge in three categories: “Algorithms”, “Data” and “Computing Power”.

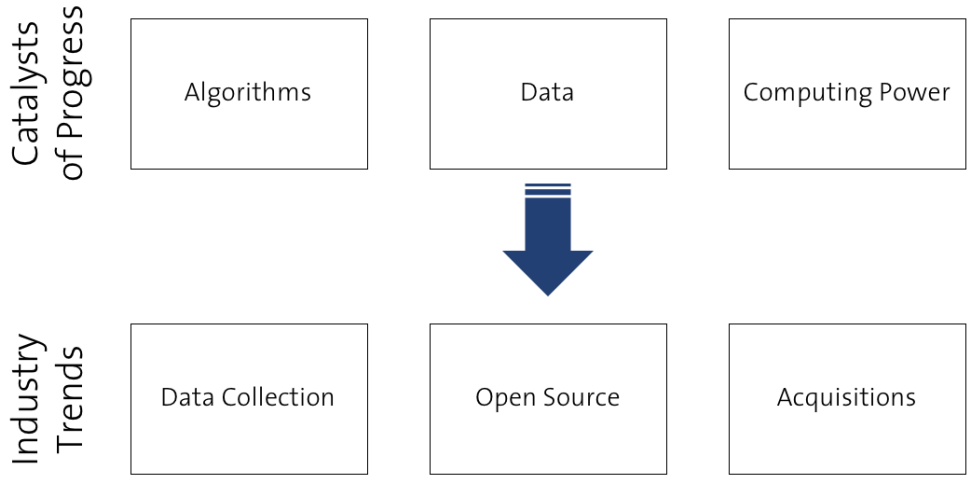


Figure 32: Catalysts of Progress and Industry Trends in Artificial Intelligence

Moreover, the strategies they are deploying to accomplish it, do also have important characteristics in common: the building of data ecosystems, the use of open innovation and great activity on the mergers and acquisitions market.

Table 11 summarizes selected companies' Artificial Intelligence moves along the crucial dimensions listed above – "Algorithms", "Data" and "Computing Power" – and shows their correlation with open innovation. Section 5.2 explains – with the help of additional data collected through the interviews – why the categories "Algorithms", "Data" and "Computing Power" have become so critical precisely now and show their importance. Section 5.3 explains in more detail how the analysed companies are taking advantage of the construction of data ecosystems, the use of open innovation and the activity on the mergers and acquisitions market.

	Facebook	Google	IBM	Microsoft	Apple
Open Source Machine Learning Software	Torch Modules (16.01.15)	TensorFlow (09.11.15)	SystemML (23.11.15)	CNTK (26.01.16)	-
Open Source Artificial Intelligence-optimized hardware	Big Sur (10.12.15)	Through OPC[1] (09.03.16)	-	CNTK (26.01.16)	-
Data source	Users' Data (1.6b MAU)[2]	Users' Data (1b MAU)[3]	Businesses' Data	Users'and Businesses' data[4]	Users' Data[5]
ML API[6]	-	Google Cloud Vision APIs (18.2.16)	Watson Developer Cloud (2013)	Project Oxford (29.4.15)	-
Artificial Intelligence Use	Core Products Improvement	Core Products Improvement	New Offering	Core Products Improvement	Core Products Improvement
Value for the company	Product value Increase	Product value Increase	SaaS & Product Marketplace	SaaS, Product value Increase	Product value Increase

1) Google announced on March 9, 2016 that the company will join the Open Compute Project and develop together with Facebook a new rack standard to help drive neural networks (Metz, 2016b) 2) As of 4.3.2016; 3) As of 4.3.2016; Google has 7 services with more than a billion users (Gmail, YouTube, Android, Search, Maps, Chrome, and Google Play); 4) Given the diversity of Microsoft's products it is difficult to give a single number. Main Microsoft's individual customer products have following users number: Microsoft Office, 1.2b; Outlook.com, 400m; Skype, 300m; Windows 10, 200m; 5) Please notice the restrictive data policy Apple applies for the use of their customers' data. Apple does not disclose on a regular basis the number of ITunes Account. During Apple's earnings conference call in April 2014, Tim Cook announced they reached the number of 800 million. 6) "ML API": "Machine Learning Application Programming Interface".

Table 11: Main Players' Strategy components.

5.2 The Catalysts of Progress

The analysis of the factors leading to the main progresses in the field throughout history and of the strategies of the main players in the field of Artificial Intelligence presented above hinted that progresses and strategic moves can all be attributed to some extent to three categories: "Algorithms", "Data" and "Computing Power". The Interviews conducted with corporate partner' knowledgeable employees and Artificial Intelligence researchers confirmed this observation and showed that, although they are all important, Data is the most important resource everyone is striving for. Sections 5.2.1 – 5.2.3 explain why these categories have become so critical precisely now and show their importance.

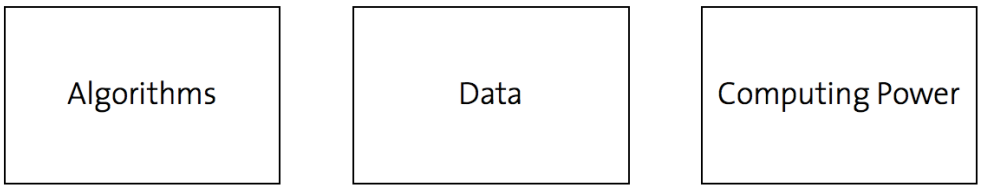


Figure 33: The Catalysts of Progress of Artificial Intelligence.

5.2.1 Algorithms

Algorithms have been at the centre of Artificial Intelligence research since the beginning. Among the most important steps in this category should be mentioned the work of Rosenblatt, laying along with other researchers the foundation for Neural Networks algorithms (Block et al., 1962; Rosenblatt, 1961; B. Widrow, 1962; Bernard Widrow & Hoff, 1960), so popular nowadays.

Interestingly, although this and other popular approaches might have worked already at that time, they were in practice unrealizable – and subsequently dropped – requiring an amount of computing power and data unavailable back then. As one interviewee noticed:

> Because Big Data offers you the possibility to train the algorithm with more data, you can use these algorithms in a better way, they are more efficient; especially with the Neural Networks (...). What we are using now was actually invented and thought many years ago: it has just been rediscovered. (Interviewee 2)

Algorithms do play a key role for the progress of Artificial Intelligence, but they need to be supported by high computing power and big amounts of data to be useful. Thanks to Big Data and to the higher computing power at our disposal nowadays, their potential starts to be finally exploited.

5.2.2 Data

In the last years, with trends such as mobile and cloud, the data landscape has completely changed. Changes concerned a very conspicuous increase in data volume, along with a faster availability – real-time data – and higher variety through the surge of so-called unstructured data. Many refer to the phenomenon as "Big Data".

Since the advent of Big Data – thanks to the opportunities it unlocks – the value of information has greatly increased, raising the attention of companies and investors for the topic. The new wave of Artificial Intelligence increases this value even more, as with it bigger amounts of information can be analysed, faster and better. Moreover, the advent of deep learning has shown that big data sets are crucial not only for analysis purposes, but also for the improvement – and even the creation – of the tools themselves. As shown in Chapter 2, the accuracy of the models built is highly dependent on the quantity of data the machine is fed with: the more data machines can train with, the better they get. Big Data is the most important enabler of this new wave of Artificial Intelligence and correctly, many experts of the field now refer to it stating that "Data is the new currency" (Eggers, Hamill, & Ali, 2013).

5.2.3 Computing Power

Gordon Moore was a visionary: not only did he found one of the most successful companies of the 20th century; he also made an observation that would very well predict the future of its industry for decades and be named "Moore's Law" after him:

> "The complexity for minimum component costs has increased at a rate of roughly a factor of two per year. (...) Certainly over the short term this rate can be expected to continue, if not to increase. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain nearly constant for at least ten years." (Moore, 1965, p. 114)

It is important to notice that the reason why his prediction is still able to describe reality – the doubling of computing power every two years – does not rely on the doubling of the number of transistors in a dense integrated circuit every two years anymore, but on human capability to continuously innovate. The reason why "Moore's Law has held up so well for so long is what we might call "brilliant tinkering" – finding engineering detours around the roadblocks thrown up by physics. When it became difficult to cram integrated circuits more tightly together, for example, chip makers instead layered them on top of one another, opening up a great deal of new real estate" (Brynjolfsson & McAfee, 2014, p. 42). Intel executive Mike Marberry adds "if you are only using the same technology then in principle you run into limits. The truth is we

have been modifying the technology every five or seven years for 40 years, and there is no end in sight for being able to do that" (Shankland, 2012).

What Moore observed is of crucial importance in order to understand the continuous progress in Information Technology: unlocked opportunities – as for example this new wave of Artificial Intelligence – and progress in the field do not take place linearly but exponentially. To say "it doubles every 18 months" might not seem so impressive, but it means that compared to the day IBM Watson won Jeopardy 5 years ago, we achieved computers having 10 times more power and that in 15 years – all holding true as in the past – this power will be 1'000 more as much of today, enabling things that may seem impossible, nowadays. This is what Brynjolfsson and McAffee of MIT Center for Digital Business call "the law of exponential growth" and as they very well summarize, "exponential growth eventually leads to staggeringly big numbers, ones that leave our intuition and experience behind" (Brynjolfsson & McAfee, 2014, p. 47). The consideration is even more mind-blowing considering that a similar pattern of progress can be observed not only in computing power, but in other enabling technologies as well:

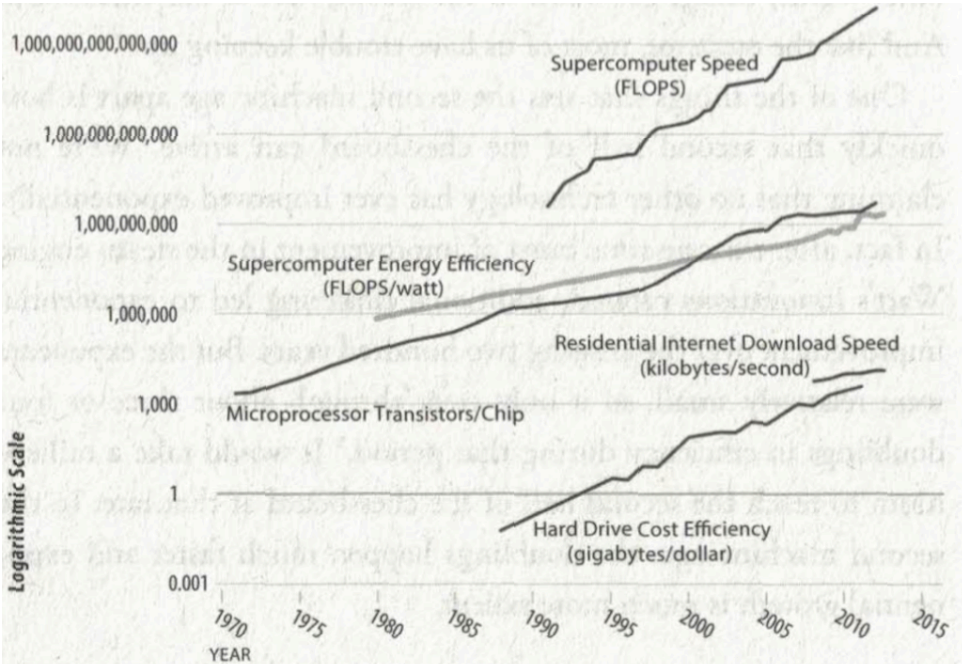


Figure 34: The Many Dimensions of Moore's Law (Brynjolfsson & McAfee, 2014).

5.3 Strategies employed to get an Edge in Artificial Intelligence

The main players – aware of the importance of algorithms, computing power and data – are heavily investing in order to be at the forefront in these areas. This section shows that the strategies the main industry players are deploying in order to get an edge in Artificial

Intelligence have important moves in common: the building of data ecosystems, the use of open innovation and great activity on the mergers and acquisitions market.

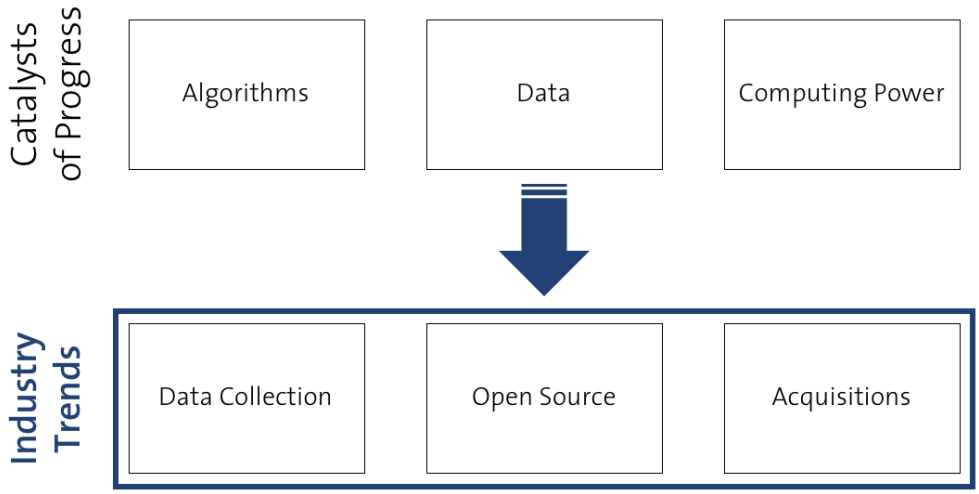


Figure 35: Industry Trends.

5.3.1 Data Collection

As stated above, data is the most important component for progress in Artificial Intelligence and companies having huge amounts of data at their disposal have great advantages in building excellent machine learning systems. As noted in (Blostein, 2015): "incumbents that are best suited to respond to any Artificial Intelligence-led disruption are likely to be those that have access to proprietary data. With Artificial Intelligence, data is only set to become a stronger entry barrier. A large and growing population dataset allows the machine or the software to learn faster and deeper. In other words, more data can make a clever algorithm cleverer and so an early mover with a unique or large dataset can build a huge advantage. Artificial Intelligence can thus reinforce dominance in industries where some existing players have a pre-existing data advantage, while for the others, it can prove to be quite disruptive" (p. 4).

The so crucial data collection is mainly being accomplished along following dimensions:

- Developing attractive services
- Building a data ecosystem through partnerships and acquisitions

Developing attractive Services

The first strategy, companies are employing to collect data is the development of attractive services customers are happy to give their data for. A great example of companies adopting this strategy are Google and Facebook offering for free great products. Doing so, they attract

hundreds of millions of people ready to give away their small portion of data in order to enjoy the service. With many people joining and more data being collected, the service grows in value and can monetized better, what in turn gives the company more resources to improve it further. One of the interviewee described it very well:

> "[The big players strongly benefit from] Network Effects: in the digital business, the more customers and data you have, the better become the services. The better the services, the more data you get. And again: the more data you get, the more you can use it, leading again to an increase of its amount." (Interviewee 6)

Please notice that with deep learning-driven Artificial Intelligence, the advantage companies have with data is doubled, has it does not only increase monetization opportunities, but also provide the essential matter to further improve the algorithms.
To collect user data was probably not the initial goal of these companies, but it is undeniable that it represents a great and not so easily imitable asset that they will try to monetize even more in the future.

Building a Data Ecosystem

As a single service provides a limited amount of information (both in quantity and breadth), companies are trying to increase data sources to get to know people from different perspectives. An example of a company clearly pursuing this strategy in the individual customers' sector is provided by Google. Thanks to services ranging from email (Gmail) to video (YouTube) and smart home (Google Nest), the company can have a very good picture of its customers, being able to provide them with better services and advertising.
In the enterprise landscape, IBM is pursuing a very similar strategy, collecting data in selected industries data from as many companies as possible. As of February 2016, IBM is using Watson in 17 industries, being healthcare the one the company is most investing in, as shown by the acquisition of Merge Healthcare Inc. for $1 billion in August 2015. This move is estimated to give IBM access to over thirty billion medical images (High, 2016). The amount of information they are gathering from different sources in these industries could represent a very precious competitive advantage in the near future. As the Financial Times notices:

> "The more industry-specific data it is fed, the smarter it will become at solving business problems [in that industry]. As customers pour their own corporate information into Watson in order to train it, IBM stands to be a beneficiary." (Waters, 2016)

IBM is building its ecosystem not only through acquisitions. Great efforts are being done to foster the so-called Watson Ecosystem, in which companies in several industries partner with

IBM to develop together cognitive technologies. The company made available $100 million to this purpose.

5.3.2 Open Source Initiatives

Without a doubt, as Artificial Intelligence progresses, open innovation enjoys more and more attention from all players involved: between the end of 2015 and the beginning of 2016, all major players open sourced important parts of their Artificial Intelligence or Machine Learning software.

It is early analyse in depth the consequences of these moves; nevertheless, judging from its popularity, it is clear that companies expect open innovation to greatly help them get an edge in Artificial Intelligence. Open source usually offers companies and developers leveraging it many advantages: among others, it accelerates the development of reliable software (Raymond, 1999; Zhao & Elbaum, 2003), security flaws and other problems can be sooner identified (Lerner & Tirole, 2004) and it allows developers to tailor software to their own particular needs (Franke & Von Hippel, 2003; Lerner & Tirole, 2004). Looking at the recent wave of progress in Artificial Intelligence and at the quantity of open source initiatives deployed by its bigger players, it seems that advantages deriving from Artificial Intelligence open sourcing are even greater than for other software.

Aim of this subsection is to describe some of the most important factors making open sourcing in Artificial Intelligence so interesting.

Data is the real Source of Competitive Advantage

Google's decision in November 2015 to open source TensorFlow, its platform for machine learning behind dozens of the company's successful products, caused very much buzz in the media. Many wondered why Google did so, as the firm seemed to be years ahead of competition in the field.

One of the reasons is data. Among the vast number of articles published on the topic there has been one of Forbes standing out, looking at the move from a "data perspective":

> "Access to data is the most critical component for the evolution of a machine learning system (...) in order to expedite the evolution of its ML and move towards a robust Artificial Intelligence, TensorFlow needs to be exposed to new data sets, some of which might be proprietary data of the company/user that decides to use TensorFlow for applications. Google hopes that once TensorFlow is deployed across applications by different users, these users can then contribute to the original source code of TensorFlow with their upgraded code, as mandated under the Apache 2.0 license.

> This would aid the company to roll out a comprehensive Artificial Intelligence engine in the future." (Trefis Team, 2015)

Looking at the move through theses lenses, the rationale behind the decision of open sourcing TensorFlow becomes clearer. On the one hand, giving its first-of-the-class algorithm to the world for free, the company can collect an even bigger amount of data ("the new currency"), it would otherwise not have access to. On the other hand, a data-centric view also explains why big companies open sourcing do not fear so much to do so: to have software building very good algorithms is important, but not enough. To make good Artificial Intelligence software, data is the key and Google – as well as other big companies now open sourcing their software – has there a dominant position.

Attracting the best Talent

The increased interest of companies for Artificial Intelligence has led the demand for experts in the domain to surge so much that firms complain not being able to find as much of them as they would need: as the MIT Sloan Management Report "The Talent Dividend" shows, "four in ten (43%) companies report their lack of appropriate analytical skills as a key challenge" (Ransbotham, Kiron, & Prentice, 2015). Peter Lee – Head of Microsoft Research – said in an interview with Bloomberg:

> "We would have more if the talent was there to be had (...) Last year, the cost of a top, world-class deep learning expert was about the same as a top NFL quarterback prospect. The cost of that talent is pretty remarkable." (Vance, 2014)

To address this issue, firms are acting in many ways: buying entire companies specialized in the field – as in the case of Google's acquisition of DeepMind – offering higher salaries, and in more recent times, open sourcing their software. In fact, most of the experts in the field now are professors and their PhD students; it is remarkable to see how many of the researchers in the biggest companies are professors, conducting research at leading universities until just some years ago. These people do not do research only for a living, they do it with the desire to see science move forward. In order to do so, they have the need to be able to share their findings with other researchers, made impossible by Non Disclosure Agreements often imposed by employers. Here is where open source comes into play: open innovation removes this barrier making information-sharing not only possible, but even encouraged through intrinsic, internalised intrinsic and extrinsic motivation (G. von Krogh, Haefliger, Spaeth, & Wallin, 2012).

Moreover, a second unquestionable benefit for hiring purposes, is the increased reach software can achieve through open source (Von Hippel, 2001). As one of the interviewees noticed:

> "For software, companies do not believe at recommendations on LinkedIn anymore: they are now looking at your GitHub profile and at the code you write." (Interviewee 15)

Before hiring someone, companies would like to observe the way candidates code in the language they are then expected to work. To do so the code has to be made available to them. As the probability of finding great candidates increases with the number of people being scrutinised, companies are working hard to make their software as popular as possible and observe how potential new employees work with it. Furthermore, future employees already familiar with the software allow the company to save time and money on the job training.

The example of Google is enlightening to this purpose: on November 9 2015, the company released TensorFlow, its software library for machine learning. They affirmed it is "one of the best machine learning toolboxes in the world. (...) Google engineers really do use TensorFlow in user-facing products and services" (tensorflow.org), drawing the attention of the entire developers' community. Successively – on January 21 2016 – they announced the launch of a new Deep Learning Course developed in collaboration with Udacity. In February 2016, already more than 60'000 people had enrolled in the course and had been encouraged to share their work on GitHub. Hiring managers, eager to find deep learning talent, were probably very pleased.

Last but not least, big companies as Google, Facebook and Microsoft employ many of the world's smartest minds, but not all of them: making the software available to everyone allows many more ideas to be unlocked (Lerner & Tirole, 2004) and they are very well positioned to take most advantage out of it. As Yann LeCun, Professor at NYU until 2014 and Director of Facebook Artificial Intelligence Research, stated:

> "Companies like us actually thrive on fast progress; the faster the progress can be made, the better it is for us." (Yann LeCun, Director of Artificial Intelligence Research at Facebook. Source: Simonite [2015])

Setting the Standard

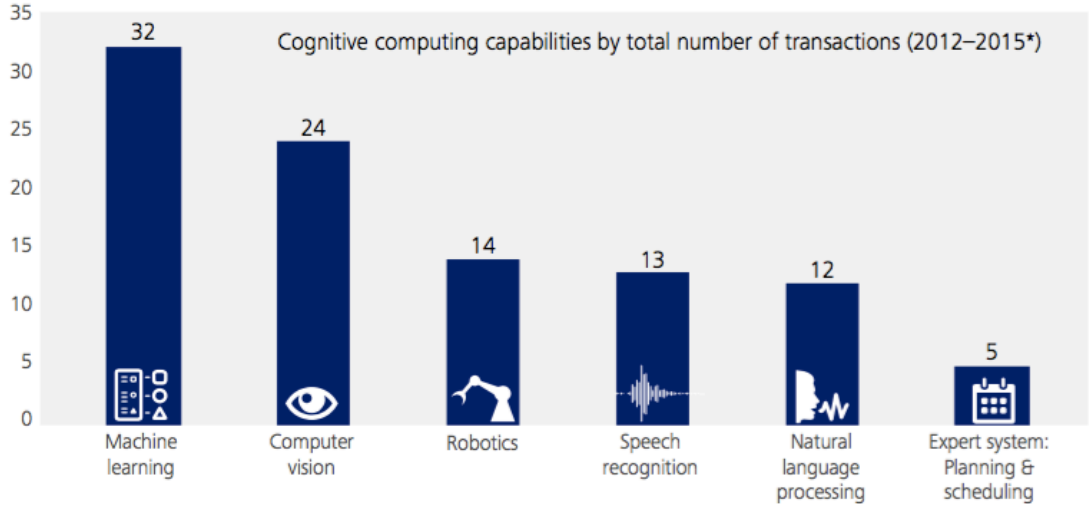
Another battle taking place between the main players is the one for setting the standard in the industry, particularly interesting in this case, being such an important technology at stake.

Open innovation repeatedly showed to be very effective to this purpose and Google clearly expressed this hope on TensorFlow's homepage:

> "By sharing what we believe to be one of the best machine learning toolboxes in the world, we hope to create an open standard for exchanging research ideas and putting machine learning in products." (tensorflow.org)

5.3.3 Mergers and Acquisitions

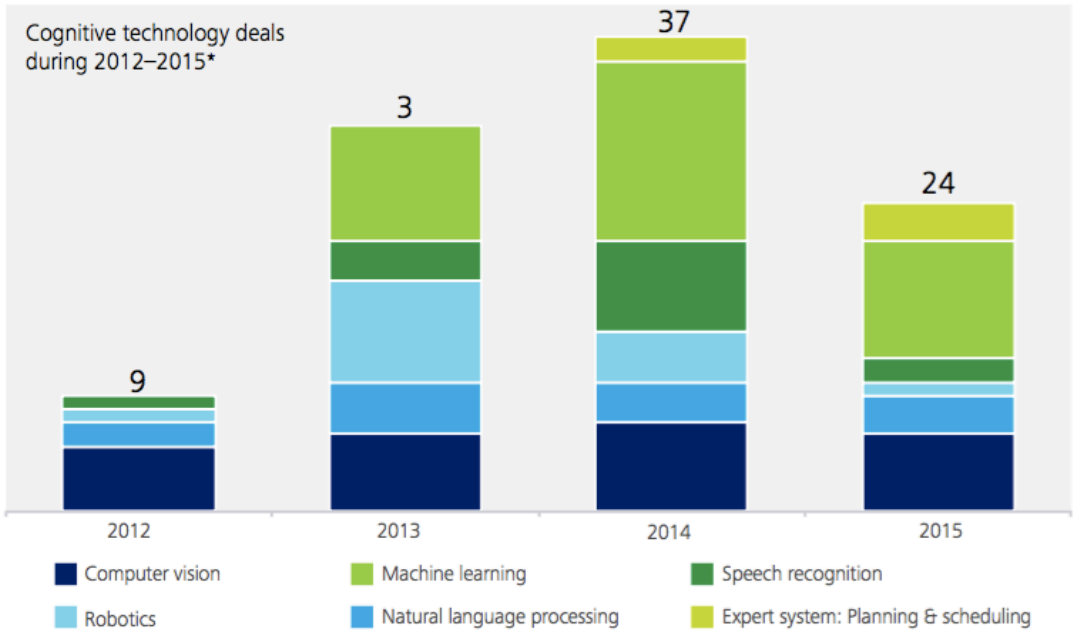
Mergers and Acquisitions are a very important part of the Artificial Intelligence strategies being pursued and their number greatly increased in the last years. A Deloitte study conducted in December 2015 analysed M&A transactions between 2012 and 2015 and their distribution per category by year[1]:



*Until December 1, 2015

Figure 36: M&A transactions by category (2012-2015). Data Source: Deloitte Analysis (Pereira, Schatsky, Sallomi, & Dalton, 2015). Graphic: Deloitte University Press.

[1] A technical explanation of the categories, their opportunities and challenges can be found in Section 2.5 above.



*Until December 1, 2015

Figure 37: M&A transactions by category and year. Data Source: Deloitte Analysis (Pereira et al., 2015). Graphic: Deloitte University Press.

Figure 36 and 37 clearly show the increased interest for Artificial Intelligence in the last years with machine learning enjoying the most interest. The increase is mainly due to the impressive technological progress of the last couple of years, leading to a higher grade of reliability of the technology and allowing companies to efficiently integrate Artificial Intelligence in their products and processes. After many years in which Artificial Intelligence seemed to be just a research topic, it is now ready to be used mainstream, drawing an increased interest from companies and investors. Machine learning is behind many products that we use in our everyday life, ranging from the searches on Google to the spam filters of our email provider; computer vision is used daily by hundreds of millions of Facebook users all over the world and natural language processing is embedded – among others – in the so popular personal assistant apps as Google Now, Siri and Cortana.

The Importance of Investments in Machine Learning

From a strategic perspective, machine learning – and deep learning as an important part of it – represents a very attractive investment. As the example of Google shows, the acquisition of general purpose machine learning companies is highly rewarding for large High-Tech firms: the acquired knowledge can be leveraged for many use cases. The acquisition of DeepMind for a sum estimated to be around 400 million dollars shows the potential the company sees for this kind of investment. DeepMind defines itself as a company combining "the best techniques from machine learning and systems neuroscience to build powerful

general-purpose learning algorithms" (deepmind.com) and with it Google did not only acquire the technology but also employ the company's developers, among the best in the field.

It seems that the investments paid off: thanks to the research conducted internally combined with strategic acquisitions of this sort, Google is now "using machine learning in a growing number of products and services, including automatic translation, voice-based searching, self-driving cars and the Nest connected thermostat" (Barr, 2015). According to Jeff Dean, Google's computer scientist leading the TensorFlow effort, "the number of projects at Google that involve Google Brain has grown from a handful in early 2014 to more than 600 today" (Knight, 2015). As shown in Figure 38, the other big High-Tech companies have similarly invested in these fields.

Acquirer	Target	Business description
Technology		
Google	DeepMind ($400m) - 2014	Deep learning to understand images, text and videos
	Dark Blue - 2014	Deep learning to understand natural language
	Vision Factory - 2014	Visual recognition using deep learning
	Jetpac - 2014	Image recognition and neural network technology
	DNNresearch - 2013	Deep neural networks, language processing
Yahoo	IQ Engines - 2013	Image recognition to tag and organise photos
	LookFlow - 2013	Enhanced image recognition
	SkyPhrase - 2013	Natural language processing technology
IBM	Kenexa ($1.3bn) - 2012	Data analysis to help recruit and retain workers
Microsoft	Equivio - 2015	Machine learning technology for info governance
	Revolution Analytics - 2015	Statistical computing, predictive analytics
Infosys	Panaya ($200m) - 2015	Automated cloud based quality management services
Dropbox	Anchovi Labs - 2012	Image classification using AI
Intel	Indisys - 2013	Natural language recognition
	Omek ($40m) - 2013	Maker of gesture-based interfaces
Stryker	MAKO Surgical ($1.65b) - 2013	Advance robotic assisted surgery in orthopedics
Monsanto	Climate Corp. ($930m) - 2013	Underwriting weather insurance in real-time
Socia media		
Facebook	Wit.ai - 2015	Siri-like API voice interface
Twitter	Madbits - 2014	Image understanding using deep learning
Pinterest	VisualGraph - 2014	Machine vision, image recognition, visual search
LinkedIn	Bright ($120m) - 2014	AI and big data algorithims to connect users
E-commerce		
Ebay	Apptek - 2014	Hybrid machine translation using machine learning
Amazon	Evi Technology - 2013	Internet search and voice recognition
	Kiva ($775m) - 2012	Manufacturing mobile robotic fulfillment system
Deutsche Tel	Magisto - 2014	AI video story telling platform (partnership)
Retail		
Staples	Runa - 2013	Specialist in e-commerce personalization tech
Walmart	Luvocracy - 2014	Discovering recommendations by friends
	Inkiru Inc. - 2013	Predictive analytics applications
Home Depot	Black Locus - 2012	Data analytics innovation lab based in Austin TX
Capgoods		
GE	Pivotal ($100m+) - 2013	Develops data analytics offerings
Schneider	InStep Software - 2014	Real-time performance mgt, predictive analytics

Figure 38: M&A activities related to Artificial Intelligence, Goldman Sachs Global Investment Research (published on February 18, 2015).

6 – The Impact of Artificial Intelligence on the Swiss TIME industry

In the previous chapters, Artificial Intelligence and the set of technologies enabling it have been analysed in detail, an overview of the literature describing its impact on society has been given and the strategies of the main players in the field have been described. Moreover, an analysis of the interviews and of the literature has shown that the technical capabilities necessary for an effective deployment of Artificial Intelligence can be summarized into three categories: "Data", "Computing Power" and "Algorithms". Companies aspiring to get an edge in Artificial Intelligence, heavily invest for being at the forefront in all three categories.

Aim of this chapter is to answer the first part of the research question – "How does the latest progress in Artificial Intelligence impact the Swiss TIME industry?" – and understand in what opportunities for the Swiss TIME industry, and more specifically for Swisscom, advances in the technology will result.

To this purpose, in Section 6.1 a SWOT analysis of Swisscom in respect to Artificial Intelligence is performed. As noticed in (Helms & Nixon, 2010) the tool is often used "to aid an organization plan future strategies (...) (Gunasekaran, Putnik, Ahmed, Zairi, & Almarri, 2006) used SWOT analysis to study Air China, the largest air carrier in China, and their recent total quality management implementation. (Sørensen, Vidal, & Engström, 2004) studied the Kirby company used applications of SWOT analysis and the strategic choice approach to assess the company's learning process. Using SWOT analysis, (Vrontis & Vignali, 2001) studied Cadbury Schweppes, the supplier of chocolate and sugar confectionary" (p. 224). In the successive sections, drawing from the finding of the Catalysts of Progress made in Chapter 5, a framework to assess the potential of single use cases inside the company is introduced (Section 6.2) and applied (Section 6.3). Based on the results of the two frameworks, in Section 6.4 the most promising use cases for Swisscom are presented.

6.1 Strength, Weaknesses, Opportunities and Threats of Swisscom in respect to Artificial Intelligence

Before analysing the impact of Artificial Intelligence on Swisscom it is of great interest to see how the company is positioned with respect to its progress. In this section, drawing from data collected through the interviews, the main strengths, weaknesses, opportunities and threats

(SWOT) of the company with respect to Artificial Intelligence and the related global competition are presented. An overview of the analysis is given in Table 12:

Strengths	Weaknesses
- Local presence - Trust - Best infrastructure in Switzerland	- Limited economies of scale and network effects - No Artificial Intelligence research in-house
Opportunities	**Threats**
- Swisscom as the best friend in the digital world - Huge infrastructure cost-savings - Regulation benefiting local players - Availability of open sourced Artificial Intelligence technology	- Winner-takes-all effects - Negative perception of data collection in the Swiss Market

Table 12: Strengths, Weaknesses, Opportunities and Threats of Swisscom in Artificial Intelligence.

Strengths

As shown in Chapter 3, Swisscom is perceived by the Swiss population as a very trustworthy company. As data plays such an important role in the Artificial Intelligence domain, this represents a very important asset. Thanks to the trust customers have in Swisscom, the firm is better positioned than other players for data collection, this advantage being even more relevant for sensitive – and very valuable – data such as health and insurance data. This is well summarized in an interviewee's statement saying that "what could save us is the trust people have for Swisscom and the Swiss law regarding privacy" (Interviewee 2).

A factor contributing to the trust among both individual customers and companies is Swisscom's local presence. As collaboration with other companies for data collection plays a very important role, trust, presence on the territory and the long-lasting relationships with several Swiss firms represent an important strength, not easily replicable by competitors. Moreover, as connectivity becomes more and more important, companies owning the infrastructure are seen as very desirable partners. The fact of having the best infrastructure in Switzerland, makes Swisscom the most desirable.

Weaknesses

The main weakness identified by most interviewees is the small number of people making up the Swiss market: Swisscom is without a doubt the main player of the Swiss TIME industry,

but even so this gives access to a limited amount of customers; minuscule, if compared with Giants as Google and Facebook, companies with more than a billion users.

> "The main problem are Network Effects: a company as Swisscom will never make it to a global scaling and a global reach, not having, therefore, this self-energising circle global players do have. It is kind of economic principle: the more data you have – the more customers you have in the digital business – the better become the services. The better the services, the more data you have, the more you can use it and the more you receive. Swisscom does not have this virtuous circle at its disposal and this is one of our biggest disadvantages in the internet business." (Interviewee 6)

Opportunities

Identified opportunities will be described in detail in Section 6.3. What can be said at this point is that for telecommunication players of the TIME industry, the wave of innovation led by Artificial Intelligence arrives at the right moment:

- Intensive competition in the industry is exerting pressure on prices; in order to maintain or even increase profits, cost cuts are needed.
- Customers increasingly expect to receive personalized services.
- On the long term, the profitability of the connectivity business is likely to shrink: new growth opportunities are sought for.

To reach these goals, Artificial Intelligence plays a very important role:

- It allows a more efficient use of the infrastructure and empowers customer service's employees to automate routine work, focusing on the most important tasks, both leading to precious savings.
- It allows to customize customers' offerings, in real-time.
- It opens new business opportunities for which leading telecommunication firms are very well positioned.

Threats

A threat for companies competing in the digital business is the winner-takes-all effect benefiting others, particularly disadvantageous for local players as they are not well positioned to be the first reaching the critical mass needed to unlock the winner-takes-all effect. Examples of fields, in which the winner-takes-all effect can be observed are social networks (Facebook), Search (Google) and Messaging (WhatsApp in Europe). The same could happen for other Artificial Intelligence-based products.

Moreover, challenges to the success of Artificial Intelligence-based solutions could be posed not only by external competition, but also by customers themselves in case they are reluctant to provide the data necessary to develop the products:

> "Technologically speaking I do not think that Swisscom will not be able to compete in some field. The main thing that could prevent Swisscom from doing something is mainly legal: if there is a threat to customer privacy... there is the ethical board that could prevent us to do something in order to preserve it. I think there will be more self-imposed limits than technological limits." (Interviewee 2)

6.2 The "Data Availability – Technology Exploitability" Framework

A great challenge faced at the moment to answer the research question has been the initial lack of a framework in the literature that could help assess and explain the potential of Artificial Intelligence inside a company. Being such a framework very important in order to best frame the analysis, a part of the thesis was devoted to its creation. The steps leading to its development are presented in the following lines of this section.

Course of Action

The first important step for the construction of the framework was the decision to assess the potential of Artificial Intelligence not in theoretical and general terms, but looking at the potential of single use cases Artificial Intelligence enables. This turned out to be very advantageous, as doing so it was possible to consider Artificial Intelligence – a concept that can be very abstract and, as shown in Chapter 2, to some extent subject to personal interpretation – in a more concrete and tangible way. Moreover, such an approach would provide the company using the framework with results that can be more easily put into practice: it is easier to start drawing consequences from a conclusion as "use cases A and B have the most potential in the company" than "Artificial Intelligence has a potential of 7 on a scale from 1 to 10".

Given the importance of "Algorithms", "Data" and "Computing Power" pointed out in Chapter 5 and the suitability they showed for analysing the actual moves in the field, the categories were immediately thought of as good parameters for also measuring the potential of single Artificial Intelligence use cases; success of Artificial Intelligence-based uses cases would be proportional to the means of the company in the three categories. This was what could be clearly observed for the main players analysed in Chapter 5 and for other very successful and rapidly growing companies. Netflix, represents a very good example: the success of the company in the streaming business derives in a large part from its impressive predictive

algorithm leveraging the company's powerful datacentres and being trained with data about the movie consumption of customers the company has.

However, a discussion with the interviewees, in particular with a researcher in the field, showed that Computing Power – although essential for the development of Artificial Intelligence algorithms and the progress in the field – does not constitute a key competitive advantage, as it is slowly becoming a commodity. The most important would be algorithms – that can be taken from outside the company and customized – and even more data, the new currency (Eggers et al., 2013):

> "I would say the most important thing is to have a huge amount of data: because Algorithms are already there: you can out-of-the-box use them - maybe with a little bit of configuration (...). Computing Power... you can rent it on Amazon: for $100 I rent a huge cluster and I install my deep neural network, but data... Where do you get it from? Data is the most precious of all these things. A good algorithm needs a huge amount of data!" (Interviewee 12)

Figure 39: Categories used to build the framework.

To assess the potential of Artificial Intelligence-related use cases it was, therefore, decided to focus the attention on the "Algorithms" and "Data" categories.
Concerning "Algorithms", rather than just assess the mere existence of the Artificial Intelligence algorithm needed to perform the use case, it was decided to focus on its effective exploitability on behalf of the company. In fact, technologies can not be exploited to the same level by every company: thanks to the higher resources available, the potential of computer vision technology can for example be exploited much better at Google than in small companies.
A similar reasoning was done for the category "Data", being in this case the effective data availability of the company evaluated. Indeed, for a company considering different Artificial Intelligence-bases use cases, it is the data it can really access to be decisive. Instead of "Algorithms" and "Data", the two properties to be evaluated were named, therefore, "Technology Exploitability" and "Data Availability", respectively.

An assessment of Artificial Intelligence-based use cases along these two dimensions allows companies to rapidly evaluate them and see how ready and mature they are to be launched. Use cases with high technology exploitability and a high data availability are likely to be ready in the short term to be used internally or launched onto the market. Use cases with a maturity ranked as "medium" or even "low" have, on the contrary, a larger room of improvement and may need more time to be fully implemented.

The "Data Availability – Technology Exploitability" Framework, depicted in Figure 40 below, allows the company to easily represent the current situation and draw the resulting consequences. In fact, the framework represents a help not only to assess the actual maturity of a use case, but also to see what is missing and plan the future strategy: use cases with a high degree of Technology Exploitability ranked with a "Low Maturity" because of the lack of data available, suggest the manager to focus the company's efforts on the collection of the data needed, through partnerships or other data collection methods. The successful strategies of the main players described in Chapter 5 can be a powerful source of inspiration to this purpose.

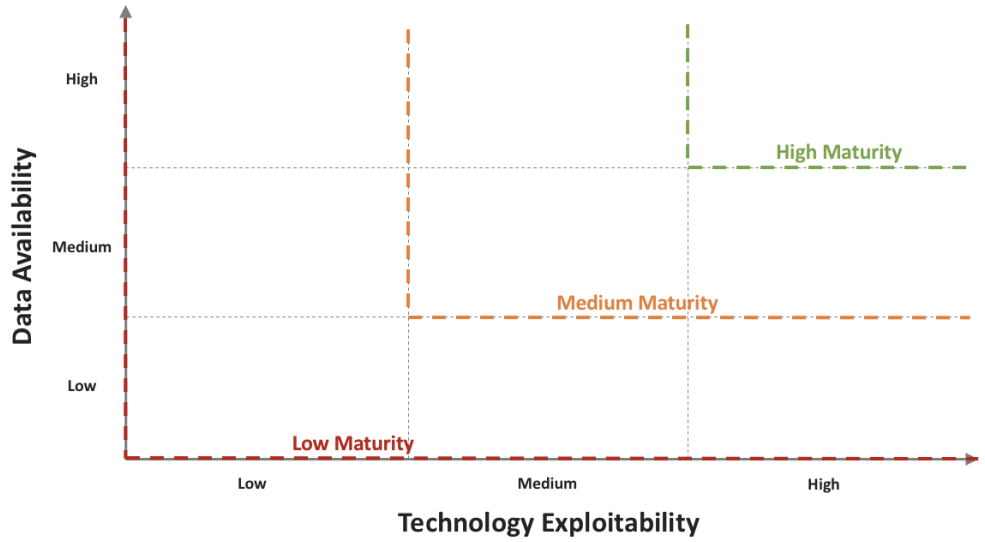


Figure 40: The "Data Availability – Technology Exploitability" Framework.

6.3. A Means to increase Efficiency and generate New Growth

The thesis started with the corporate partner's question "Is Artificial Intelligence a hype or a means to increase efficiency and generate new growth?" The interviews and the research performed throughout the thesis allow giving a clear answer to this question: not only is Artificial Intelligence not a hype, it is an indispensable means to increase efficiency and generate new growth for the years to come.

It is important to notice that the relevance and potential of Artificial Intelligence often do not show themselves in the form of a standalone product that can be bought on the market as cars, mobile phones and software do. On the contrary, Artificial Intelligence works rather as an enabler of a very powerful range of products and processes, unconceivable just some years ago, increasing companies' efficiency and generating new opportunities.

For telecommunication players of the TIME industry, this wave of innovation arrives at the right moment:

- Intensive competition in the industry is exerting pressure on prices; in order to maintain or even increase profits, cost cuts are needed.
- Customers increasingly expect to receive personalized services.
- On the long term, the profitability of the connectivity business is likely to shrink: new growth opportunities are sought for.

Artificial Intelligence is essential to reach these goals:

- It allows a more efficient use of the infrastructure and empowers customer service's employees to automate routine work, focusing on the most important tasks, both leading to precious savings.
- It allows to customize offerings to customers, in real-time.
- It opens new business opportunities for which leading telecommunication firms are very well positioned.

Figure 41 qualitatively shows on the "Data Availability – Technology Exploitability" framework the maturity of some use cases helping the firm to seize these opportunities;[2] those resulting to be most appealing will be deepened in the subsections below. In order to show the corporate partner the areas with the highest level of maturity, use cases of interest were assigned to Swisscom's three main areas of excellence:

- Infrastructure (orange)
- Customer Experience (green)
- Growth Opportunities (blue)

[2] Please notice that the use cases taken into consideration are those the interviewees at Swisscom mentioned speaking about the potential of Artificial Intelligence inside the company. A description of the use cases and the qualitative criteria used to position them on the framework can be found in Appendices E and F, respectively.

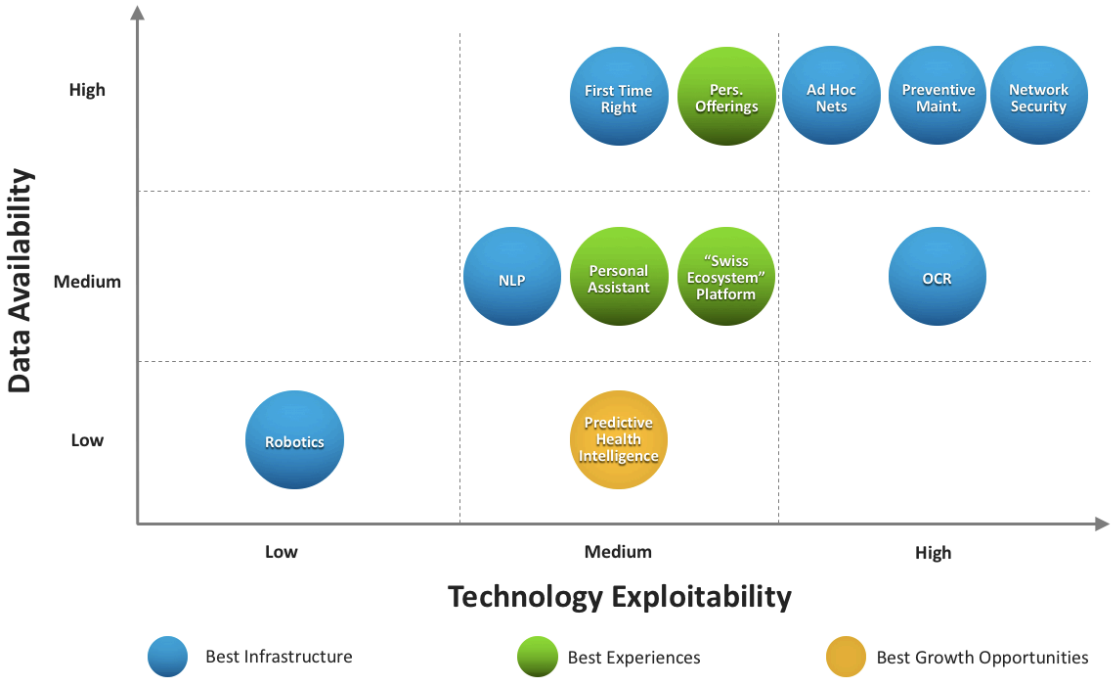


Figure 41: The "Data Availability - Technology Exploitability Framework" applied to Swisscom.[3]

In the next subsections, the opportunities provided to Swisscom by the new wave of Artificial Intelligence, together with the relative strengths and weaknesses of the firm for their pursuit, and some examples of their implementation in other companies are presented.

6.3.1 Building the Best Infrastructure

As depicted on the "Data Availability – Technology Exploitability" framework, the great potential of infrastructure-related use cases seems now ready to be exploited. This is also what clearly resulted analysing the data collected through the interviews: every interviewee asked about possible uses of Artificial intelligence inside Swisscom, spoke about the potential of Artificial Intelligence applied to the firm's enormous infrastructure. Their opinion is very well summarized in following interviewee's answer:

> "[Speaking about Artificial Intelligence,] one often thinks of new services, personalization, Data-as-a-Service, Insight-as-a-Service, etc. I think this is relevant only in a second phase: I believe that in a first phase, internal cases are much more important: Predictive Maintenance, Infrastructure Development, Cost Optimization, Churn Reduction… domains where Artificial Intelligence can help allowing us to build a better infrastructure, to better know our customers, retain them, increase loyalty, lower network failures (…) I think this is the immediate step. It is not direct Revenue, but costs decrease and Revenue Insurance." (Interviewee 6)

[3] "NLP": "Natural Language Processing"; "OCR": "Optical Character Recognition"; "Preventive Maint.": "Preventive Maintenance"; "Ad Hoc Nets": "Ad Hoc Networks"; "Pers. Offerings": "Personalised Offerings"

At the same time, it is important to warn against a possible underestimation of their benefits or a desire to rather see revenue increasing. This warning emerged from the interviews, with interviewee 11 stating that benefits through cost reduction are usually less attractive from a psychological perspective:

> "Cost reduction and efficiency increase are never attractive topics; one always speaks about revenue increase, etc. On the contrary, cost reduction is a painful topic: from a psychological perspective already." (Interviewee 11)

Moreover, speaking about the potential of Artificial Intelligence for internal operations, two interviewees working for the corporate partner – not working in this domain and without being explicitly asked for it – pointed out that the potential of Artificial Intelligence for internal operations risks to be underestimated on a firm's level:

> "In my opinion, this is something that we often disregard: we need to increase our focus on cost reduction: internally. If [through Artificial Intelligence] maintenance costs can be reduced… well, this is a good Business Case!" (Interviewee 3)

In the following lines, the areas identified to have most potential are described.

6.3.1.1 Augmenting Customer Service capabilities

As extensively described in Chapter 2, jobs automation is a big topic in Artificial Intelligence. Although it is true that its deployment in customer service may lead to a reduction of jobs in that area, Artificial Intelligence in this sector means much more than just that. In fact, Artificial Intelligence also provides tools to augment human capabilities, empowering employees to provide customers with an even better service, at every step of their interaction with the company.

Customer interaction often starts on the company website. Some firms now offer the possibility to chat with employees and ask questions directly through the company's website, but their service is often limited to working hours and does not always provide immediate answers at peak times.

With its Nina Web offering, Nuance – company leader in the Natural Language Processing market – aims to solve these issues: Nina is a virtual assistant that can be integrated into the company's website capturing the intent of the conversations to provide rapid and relevant answers to customers' queries. It can help customers with research, ordering, shipping, returns and exchanges and as many Artificial Intelligence-based systems can be steadily improved over time. Coca-Cola and Kespersky are very satisfied customers, with the latter

claiming that its use "delivered an 85 percent average customer support resolution rate, and decreased call centre inquires and emails by 22 percent" (nuance.co.uk). As shown in Section 5.1.6, NTT DoCoMo is working on a similar product, which the company will launch in Summer 2016.

As stated above, Artificial Intelligence is not just about automation; it also empowers employees to deliver customers a better service. This is very well shown by another Nuance product – Nuance FreeSpeech – and wise.io.
Thanks to advances in speech recognition, it is now possible to verify a caller's identity during the course of a natural conversation. The tool provided by Nuance "transparently analyses over a hundred unique voice characteristics while the customer speaks and compares these characteristics with the relevant stored voiceprint. It does this in seconds without interrupting the call" (nuance.com). This leading to both a higher security level and a better calling experience with the customer service personnel. Among the companies using it, stands Barclays Wealth and Investment Management, a very satisfied client of Nuance with high standards of security and customer experience.
Once verification has occurred, software as wise.io helps customer centre agents focusing where customers need them most, getting tickets into the hands of the right agent faster, showing agents the best response template to resolve customer issues and even automatically replying to designated tickets. (Source: wise.io)

Moreover, in the specific case of Swisscom Customer Service – often contacted to solve issues of technical nature with unclear roots – Artificial Intelligence could dramatically increase customer experience and Customer Service efficiency at the same time, overcoming the usual trade-off between the two. This would be possible through what one of the interviewee called the "First Time Right" principle: helping customers solve their technical issues, being right from the beginning. Its potential is very well described by the interviewee stating:

> "Nowadays, with the customer [calling] I have to do like a doctor: "where does it hurt?". Or even worse: "we presume that it is because of issue XY in the box: we will send you a new one". Afterwards, you look at the box the customer sent you and you notice that there everything is ok... doing so, we have sent a box, the customer is going to call another time and we restart from the beginning wondering "what is the problem?". If based on the static or dynamic knowledge we do have, we could say "everything is working as expected except for this anomaly; in this case the cause is the following..." Then, we would find the injured part much faster!" (Interviewee 8)

He then went on explaining why Artificial Intelligence would be so important to achieve such a dream-scenario:

> "Artificial Intelligence provides us with an infinite Resource of imagination. As human beings, we grow up and complement our existing experience. This restricts our imagination possibilities, sometimes. (...) Artificial Intelligence is not limited by it! (...) It is not just doing better something: it is able do right something, that one has not seen so far!" A very good example is given by the Swisscom Router (...): it has more than 4000 parameters inside; the software is composed by so many parts...! And [to analyse issues] we maybe read 50 out of them, because we have learned that it is there that we could most likely find something important. We have learned it and we are not able to say whether the other parameters are useful or not. (...)
> Moreover, it were interesting to see the correlation of the parameters as they change (...), and being visionary think: if we could analyse these parameters dynamically, we could maybe even before that there is an issue say "Oh, something it is not working properly!". Doing so I start working on the issue even before the customer calls! We would save the time of the whole call: it were a dream! We have many customers and also if only 1% of them has a problem and we need half an hour to understand and fix it... and now suddenly we just need 30 seconds – this is a dream – that is a huge amount of money! This is my passion!" (Interviewee 8)

6.3.1.2 Security:

As not just people but even objects start to be connected with the internet, the topic of cybersecurity increases of importance even more. The more data is generated, the more difficult it becomes to efficiently analyse it and spot suspicious movements. As a Fortune article notices:

> "Over the past decade, the amount of money spent on cyber defence has exploded from less than $10 billion to roughly $70 billion, according to Symantec CTO Amit Mital. And all forecasts show spending continuing to skyrocket. But the litany of devastating hacks – at Target, Home Depot, Sony, and the U.S. Department of Personnel Management, to name a handful – continues to pile up." (O'Keefe, 2015)

According to Mital, Symantec's CTO, Artificial Intelligence is one of the "few beacons of hope in this mess". The reason is quite simple: humans just cannot do it. It is not a matter of costs: as human beings, we are not able to cope with such a big amount of data and by the time we recognize and take action to combat a hack it is often too late. On the contrary, Artificial Intelligence systems are able to handle the data quantity and react in real-time. As Deloitte points out in its Report "Analytics Trends 2016", organizations now need to go on the offensive: "It may involve analysing past hacks and breaches to create predictive models of which threats are likely to surface next. In many firms, it also means systematic and continuous probing of

the organization's own defences to make sure that others don't find a security hole first" (Deloitte Development, 2016, p. 5).

Security is a topic of great importance to Swisscom as well as a very good differentiator from competitors. Thanks to the quantity and breadth of data at its disposal – the entire traffic on mobile and broadband of the most part of Switzerland's population – the company is very well positioned in this area; interviewee 2 gave as examples ongoing projects aiming at fighting phishing leveraging data and Artificial Intelligence.[4]

6.3.1.3 Network Management

As the use of the network grows dramatically – in the company's Annual Report 2015, Swisscom reported of an increase of data traffic of 97% over the last year (Swisscom, 2015, p. 51) – many innovative solutions have to be deployed in order to continue guaranteeing customers the best experience. Also in this case, the higher amount of data to manage leads to a greater amount of automation and Artificial Intelligence needed. To the group of technologies with great transformative potential in this area belong Software Defined Networks (SDN) and Network Function Virtualization (NFV), increasing the network efficiency while lowering capital and operational costs.

> "Managing your network: we have this new paradigm, Software Defined Networks and Network Function Virtualization where the idea is to make much more flexible to program to configure your network: you try to minimize the hardware part of it. Meaning that you have network much more configurable where you can change things and if we can even put it into the cloud with machines appearing, disappearing and so on… the complexity of this environment will go beyond what a human can comprehend in real time and follow. There I am sure that we will need some Artificial Intelligence to keep monitoring what is going on." (Interviewee 2)

Moreover, the complexity of the network is likely to increase as trends as connected cars and, more in general, the Internet of Things emerge. To guarantee perfect connectivity everywhere, standard connectivity networks will need to be complemented by Mobile Ad-Hoc Networks: continuously self-configuring, infrastructure-less networks of mobile devices:

> "Instead of having a backbone, you try to have peer-to-peer communication as in the case of vehicular networks, cars talking to each other: in the car you cannot always make the assumption that there is a network available; (…) if you are in a tunnel you can try to propagate the signal via all the cars. This is what we call ad-hoc networks and these will be networks that will be configured by themselves; the topology of the network will always be different and an agent will not be able to

[4] The projects – described in the interview – are not presented here because of a more restrictive NDA protecting them.

> follow up. And again: Artificial Intelligence will be useful not only to do tasks already done [by humans] today, but also because with the digitalization the level of complexity and speed will be so much higher that humans will not be able to cope with complexity anymore." (Interviewee 2)

6.3.2 Offering the Best Experiences – the Best Friend in the Digital World

As shown above, Artificial Intelligence will play a key role in improving the network infrastructure, this automatically leading to a better customer experience.
Allowing the construction of a better infrastructure is, however, not the only way Artificial Intelligence can contribute to offering better experiences. Artificial Intelligence also enables the creation of personalized products, dramatically improving customer experience, this being a crucial aspect for telecommunications companies, nowadays. As Ovum Principal Analyst Dimitris Mavrakis noticed:

> "Big data and analytics are very important. For the time being, customer experience is defined by the quality of access. However, as networks evolve, user experience will escalate to higher levels. Personalized services, contextualized support and better understanding of the end user will become differentiators." (Dimitris Mavrakis, Principal at Ovum. Source: IBM [2015])

In efforts for "personalized services, contextualized support and better understanding of the end user", Swisscom is very well positioned. Trust and local presence do not only allow the company to engage a deeper dialogue with individual customers: they are also the key to build partnerships with other local entities, making possible to know customers even better.

Trust, customer proximity and the ability to make partnerships with local players are three key factors strongly differentiating the company from global competition and potentially allowing Swisscom to get to know and serve Swiss customers as nobody else, if the latest progress in Artificial Intelligence is exploited. Possibly, even arriving to be something more than just a companion: a friend.

6.3.2.1 Swisscom as the natural Epicentre of a Swiss Data Ecosystem

As described in the previous chapter, the possibility to efficiently analyse large amounts of data of both structured and unstructured nature – increasingly enabled by Artificial Intelligence – has very much augmented its value. At the same time, many firms willing to better know their customers, are challenged by the fragmentation of the data ecosystem. Many companies own a piece of information about the customers, but no one has the whole picture that would allow to create perfectly personalized products. As a consequence, many companies are trying to build something we could define as a "Data Ecosystem". In the consumer business, a great example is provided by Google, able to collect very diversified

customer data ranging from email messages to video; with the acquisition of Nest, the company headquartered in Mountain View now even has data about the use of house appliances and individual energy consumption at its disposal.
Something similar can be observed on the Business-to-business landscape. With the Watson Health platform, IBM is trying to build a Businesses Data Ecosystem, in which data coming from many sources is gathered at the same place and so better leveraged:

> "Core to the Watson Health strategy is democratizing the data. (...) Putting it in a health cloud that our ecosystem of partners can go in and build applications on as well." (Deborah DiSanzo, Head of Watson Health. Source: Ramsey [2016])

The construction of a data ecosystem is often performed by global players as Microsoft and Google, owning many different information sources (see Section 5.1.2). There is, however, still a very relevant part of information that global players – although very interested in it – could not integrate, yet: local data collected by SMEs and regional companies; very valuable data, as it entails detailed information about customers' daily life (as TV consumption, items bought at the grocery shop, public transportation, etc.).

Unlike global players, facing difficulties in building local partnerships, local companies – thanks to their presence on the territory and long-lasting relationships with other local firms they can boast – are well positioned to build a local ecosystem. Such local ecosystem would allow them, through the rich local data in their possess, to create compelling offerings for their customers differentiating and protecting themselves from global competitors.

"The telecom sector continues to be at the epicentre for growth, innovation, and disruption for virtually any industry" states Deloitte in its Telecommunications Industry Outlook 2016 (Wigginton, 2016). It may be – as some observers say – that connectivity is increasingly becoming a commodity, but in fact with trends as the Internet of things – connecting every object to the internet – and mobile-first, its importance is simultaneously dramatically increasing.
Telecommunications companies, being in possess of this precious resource, are seen as very desirable partners.

This is even more the case for Swisscom as the company

- is widely recognized as a trustworthy partner (the most trustworthy connectivity provider in Switzerland)

- thanks to its local presence since a very long time, boasts long-lasting business relationships with most SMEs and Enterprises on the Swiss landscape
- can find numerous local companies happy to collaborate with it as a response to the international Giants' domination:

> "Swisscom would then have an advantage because of the local partnerships we have. Because through partnerships you can achieve very much. And companies as Google, as of now, have difficulties building them since they do not have the proximity to – let us say – SMEs in Switzerland, and they also do not have relationships... as of now, no XY[5] or local insurance would start a partnership with Google.
> There are more and more companies that lose part of their business because of big firms as Google and Facebook and they are interested in supporting new [local] value propositions." (Interviewee 5)

The ownership of the best connectivity network, the rich amount of data already at its disposal and the capability to establish partnership with nearly anyone on the Swiss landscape thanks to its local presence and the trust it is able to inspire, make Swisscom the natural epicentre of a possible future Swiss Data Ecosystem.

6.3.2.2 The Rationale behind a Swiss Data Ecosystem

As shown above, Google monetizes the advantages coming from this Data Ecosystem mainly through advertising, IBM through increased revenue of its Cloud storage and Watson through a SaaS Business Model.
In the case of Swisscom, a Swiss Data Ecosystem could be monetized in many different ways. As in the case of Google and IBM, through increased revenues in Advertising – even more after the partnership with SRG and Ringier – and Cloud, but even more importantly through a much better customer experience: Swisscom could become the epicentre of the Swiss Data landscape and – through the use of Artificial Intelligence – the Swiss company knowing best Swiss customers, making true what Swisscom CEO's Urs Schaeppi predicted in 2014 our future to be:

> "Keyword "Personal Avatar": when I wake up in the morning, my virtual assitant already turned on the coffee machine. Later on, when I go to the car, it already knows – based on my calendar – where I want to go, what the best route is and drives me there automatically." (Morgenthaler, 2014)

As differentiation through a better quality of access becomes less important on the competitive landscape, the ability to provide services customers perceive as personal is key.

[5] The name of the partner was substituted by "XY" because of a more restrictive NDA.

The feeling of Swisscom as the company knowing customers best and helping them to take the best decision in their everyday life, would be a differentiator rivals could not easily imitate.

Moreover, thanks to the new possibilities Artificial Intelligence is unlocking, Data is a resource whose importance is likely to increase even more in the future: it is important to invest time and resources in securing as big a part as possible of it before other international companies start doing it.
This vision is being made true by a Telecom Company in South Korea, as stated by an interviewee:

> "In Korea it is all so tightly networked: for Google, it is not so easy to be successful there! This is because they [Korean TIME firms] have invested very much: they go deeper in networking and in the data exchange... and they have products that are more relevant for the end user because they think in a Korean way. (...) There are many comparative services as Comparis in Switzerland: why has Google not taken this market – the fourth most attractive market worldwide with high margins, etc. – so far? The reason is the following: for Google it is difficult to work with insurances locally ... the Business Models are different, the products are different... it is difficult to create this from Silicon Valley...!" (Interviewee 1)

Referring to the Swiss landscape, the interviewee was confident that something similar could also be accomplished by Swisscom:

> "They [Google] want to come, but they will need 4-5 years, and if we manage to connect local companies.... If we network all this, we have a chance. This is our belief: we go deeper and protect ourselves against competitors having standardized services with many features. Local focus and local differentiation. This is our belief, it is also because if not, we would better give up." (Interviewee 1)

6.3.3 Realise the Best Growth Opportunities

The new analytical capabilities provided by progress in Artificial Intelligence represent for Swisscom also a source of new growth opportunities. On the one hand, the complexity of deep learning-driven Artificial Intelligence increases the need of companies to be helped in the analytical domain. To this regard, Swisscom is very well positioned as the higher level of complexity in such an important domain pushes firms to look for a trustworthy partner. On the other hand, as shown in Chapter 5, Artificial Intelligence gives cloud providers the possibility to differentiate and better monetize their cloud offerings.

6.3.3.1 Digitization Consulting

As pointed out in the sections focusing on the technological side of Artificial Intelligence, cognitive technologies are complex to develop. Moreover, with the adoption of methods as deep learning and deep neural networks, they get also very difficult to understand once they are built, being part of the building process and fine-tuning left into the hands of the machines. The complexity this leads to, is not just a problem for SMEs, but for big companies as well: even for Google now using deep learning for 15% of its queries. Some company's executives were reluctant to use deep learning methods for Google Search instead of the algorithms following a strict set of rules set by humans:

> "The concern – as described by some former Google employees – was that it was more difficult to understand why neural nets behaved the way it did, and more difficult to tweak their behaviour." (Metz, 2016a)

Chris Nicholson, the founder of the deep learning start-up Skymind, explains

> "People understand the linear algebra behind deep learning. But the models it produces are less human-readable. They're machine-readable (...) They can retrieve very accurate results, but we can't always explain, on an individual basis, what led them to those accurate results." (Metz, 2016a)

As firms' digitization becomes crucial for firms' competitiveness and Artificial Intelligence one of its key component, the complexity of the technology poses a challenge to companies supporting firms' digitization:

> "Speaking about Artificial Intelligence and Big Data, it is important to consider usability: people often think it very easy [in this field], but it is not. You have to connect, train people... the technology is not so far that it has a good level of usability. Working with other companies you have to help them... constantly!" (Interviewee 4)

> "As of now, big companies have troubles selling the technology because customers... well it is just very new! (...) You often have to explain customers why it is useful, because they do not know it. And at this point, trust plays a very important role!" (Interviewee 11)

Companies implementing this technology need to have trust in the partner helping them. The complexity of Artificial Intelligence represents, therefore, an opportunity to strengthen Swisscom's position in B2B further, as it is widely recognised as trustworthy partner.

6.3.3.2 A smart Cloud

Another growth opportunity provided to Swisscom by Artificial Intelligence is the possibility to increase the value – and the consequent monetization – of the data clients store in its cloud, helping them to make sense of it and exploit this precious resource as much as possible.
Microsoft did so integrating its personal assistant Cortana into the Cortana Analytics Suite, Amazon gives its customers the possibility to buy a machine learning package as additional optional of its AWS offering, and IBM generates the most part of money out of the cloud not through data storage, but rather with IBM Watson, a service enabling customers to do more out of their data.

This is precisely what an interviewee pointed out:

> "We are building now a cloud for computing and storage... rather a cloud for storage. The next step could be not the storage nor the computing, but asking oneself: "How do we bring intelligence in there? How could we manage intelligent processes on our CPUs?" (...) As a customer company, with the storage of the own data one only generates costs: if you want to more efficiently shape processes, you have to take out information from the data, relevant information: this is only possible with the human brain or with Artificial Intelligence. This is what we should now focus on. (...) In order to convince the customer to use the storage cloud, you are better off introducing a functionality that "understands" data. Nowadays, there is the need to store data, but is it everything? No. The next step of Cloud Services is [to enable companies] to do something smart with it: Artificial Intelligence" (Interviewee 11)

The analytical capabilities of the cloud provider are becoming a very important selling argument; this is very well shown by the decision of Spotify to move part of its infrastructure to Google instead to the leader Amazon. On the day of the announcement, 23rd February 2016, the Wall Street Journal reported "Spotify AB, a marquee Amazon Web Services customer, said it plans to move much of the technology behind its music-streaming service to Google Cloud Platform (...) Nicholas Harteau, Spotify's vice president of engineering and infrastructure, said Google's ability to analyse the massive amounts of data tipped the scales. For example, Google's data-analytics offerings could help the music service fine-tune its listening recommendations" (Greene, 2016).

7 – Competing with Giants: Local-Global Competition in the Swiss TIME Industry

Chapters 5 and 6 focused on answering the first part of the research question – "How does the latest progress in Artificial Intelligence impact the Swiss TIME industry?". Doing so, they provided academia and the corporate partner with a new framework suitable for the assessment of strategic moves in the field of Artificial Intelligence, a framework to evaluate the potential of Artificial Intelligence inside a company and, based on both, specific recommendations for Swisscom, the thesis' corporate partner.

This chapter aims to answer the second part of the research question – "What are the factors local TIME players could leverage in their competition with global players in the home market?". To do so, the chapter starts analysing how latest progress in Artificial Intelligence and the related strategic moves of the biggest players influenced the competitive landscape. Based on that, the second part of the chapter focuses on how local players of the TIME industry can compete with global technology companies, in an industry where Artificial Intelligence is becoming always more important.

7.1 The Importance of Open Source

At the beginning of the thesis in October 2015, local TIME industry players were in a very difficult situation. Global high-tech companies, leveraging the huge resources at their disposal, were rapidly progressing in Artificial Intelligence, a technology that – as Eric Schmidt, Google Chairman said (Shead, 2016) – has the potential to "change the world". In the meantime, for local TIME firms having limited resources at their disposal and almost no basic research in-house, the development of products able to somehow compete in this very important domain was very difficult.

Since November 2015, the Artificial Intelligence competitive landscape completely changed. On November 11, Google decided to open source the powerful Artificial Intelligence software the company had been using internally for years, being rapidly followed by other big companies: two weeks later, IBM announced a similar move and in January 2016, Microsoft released its Artificial software, too. The Artificial Intelligence-related open sourcing wave was not limited to software: in December 2015, Facebook announced it would open source "Big Sur", the hardware design supporting its very fast deep learning algorithms; in March 2016,

Google announced it would join the open compute project to accelerate the development of hardware capable to best exploit the potential of deep learning algorithms.

These moves completely changed the Artificial Intelligence competitive landscape: not only through the opportunities they directly unlocked, but more importantly because of the huge paradigm shift in the strategy for Artificial Intelligence development they represented. They are not isolated moves, but part of a new way of developing Artificial Intelligence that is very likely to continue in the future (details about the rationale behind these moves are given see Section 5.3.2). The crucial role played by open innovation for progress in Artificial Intelligence is very well shown by the fact that these initiatives are being supported not only by companies as Google and Facebook, adopters of many open source initiatives since their foundation, but even by companies as IBM and Microsoft, usually very sceptic toward open innovation. This enormous strategic change is very well described by Power (2014):

> "Advances in technology – especially digital technology and the increasing role of software in products and services – are demanding that large, successful organizations increase their pace of innovation and make greater use of resources outside their boundaries. This means internal R&D activities must increasingly shift towards becoming crowdsourced, taking advantage of the wider ecosystem of customers, suppliers, and entrepreneurs.
>
> IBM, a company with a long and successful tradition of internally-focused R&D activities, is adapting to this new world of creating platforms and enabling open innovation. Case in point, rather than keep Watson locked up in their research labs, they decided to release it to the world as a platform, to run experiments with a variety of organizations to accelerate development of natural language applications and services." (Power, 2014)

Lerner & Tirole (2003) noticed in the early 2000s that "the widespread diffusion of Internet access in the early 1990s led to a dramatic acceleration of open source activity" (p. 102). Thirteen years later, as internet can be accessed from almost anywhere on the planet, the widespread diffusion and importance of Artificial Intelligence applications is leading to another dramatic acceleration of open source activity, an activity considered to be even crucial for its development. Companies willing to make progress in Artificial Intelligence, do not secretly develop software inside the firm, but rather share findings with the researchers' community.

The open source wave is playing a very important role in the local-global competition within the TIME industry and represents a win-win situation for both local and global players. Going for the open sourcing path, the former can count on many advantages as, among others, faster

development, better hires, and the hope to set the standard in such an important domain (these and other advantages are described in more detail in Section 5.3.2). On the other hand, local players, thanks to the open sourcing of the most advanced Artificial Intelligence software they now have access to, see the competitive disadvantage related to this very important technology decrease and new opportunities arise (more information about the new opportunities is given in Chapter 6 above).

7.2 Differentiation and Local Ecosystem as Keys to Success for TIME Industry Players

Thanks to the wave of open sourcing, local TIME players have now easier access to the resources needed for the development of state of the art Artificial Intelligence tools and products. This allows them to continue competing with powerful global companies without an unsurmountable competitive disadvantage in a technology that is proving to be very important, dramatically increasing customer experience and lowering operating costs.

Competition of local players with global companies in developed markets has not received so much attention in literature so far, focusing most articles about local-global competition on competition in the emerging markets, either from the perspective of emerging markets' local players (Dawar & Frost, 1999; Govindarajan & Bagla, 2012) or multinationals (Ghemawat, 2005, 2007a, 2007b). Interestingly – despite the huge differences in culture, growth and income – the study of local-global competition in developed countries led to some similar findings.

Works on local-global competition in the emerging markets all conclude showing the increasingly important role played by regional factors in the competition on the globalized competitive landscape. Something similar could be observed studying the moves of the corporate partner, a local player of the Swiss TIME industry: the company is extensively leveraging regional factors – as trust, local presence and the deep knowledge of local customers – to differentiate itself from global competitors. In the concrete case of Swisscom, regional factors hold a very important role and lead to a differentiation going well beyond marketing campaigns: they deeply impact the offering of the company and its product development efforts. This was very well shown by the launch of Swisscom TV 2.0: for the development of the previous product the company used the solution of an international provider. Since the expectations of Swiss customers were too much higher than the standard the international provider was aiming to satisfy, Swisscom decided to develop Swisscom TV

2.0 in-house, in spite of the enormous costs associated with its development. The impressive success Swisscom TV 2.0 is enjoying and the interest for it shown by the biggest telecommunications companies worldwide reported by one of the interviewees, clearly show the goodness of the move.

The Importance of Local Ecosystems in the Era of Big Data

Although similarities with the mechanisms of local-global competition in emerging countries are very interesting and were to some extent unexpected, the most interesting finding concerning local-global competition in Switzerland regards the opportunity given by Artificial Intelligence and Big Data to bring differentiation through local factors to a new level.

Thanks to the analytical capabilities the latest progress of Artificial Intelligence is unlocking, it is now easier for companies to efficiently exploit the great amounts of data of structured and unstructured nature they have access to. At the same time, however, they are challenged by the fragmentation of the data ecosystem. Many companies own a piece of information about the customers, but no one has the whole picture that would allow to create perfectly personalized products. As a consequence, many companies are trying to build something that could be defined as a "Data Ecosystem". In the global consumer business, a great example is provided by Google, able to collect very diversified customer data ranging from email messages to video; with the acquisition of Nest, the company headquartered in Mountain View now even has data about the use of house appliances and individual energy consumption at its disposal.

The construction of a data ecosystem is often performed by global players as Microsoft and Google, owning many different information sources (see Section 5.1.2). There is, however, still a very relevant part of information that global players – although very interested in it – could not integrate, yet: local data collected by SMEs and regional companies; very valuable data, as it entails detailed information about customers' daily life (as TV consumption, items bought at the grocery shop, public transportation, etc.).

Unlike global players, facing difficulties in building local partnerships, local companies – thanks to their presence on the territory and long-lasting relationships with other local firms they can boast – are well positioned to build a local ecosystem. Such local ecosystem would allow them, through the rich local data in their possess, to create compelling offerings for their customers differentiating and protecting themselves from global competitors.

The strategy was very well summarized by one of the interviewees, calling it "local focus and local differentiation" and referring to it even using the word "a belief":

> "They [Google] want to come, but they will need 4-5 years, and if we manage to connect local companies.... If we network all this, we have a chance. This is our belief: we go deeper and protect ourselves against competitors having standardized services with many features. Local focus and local differentiation. This is our belief, it is also because if not, we would better give up."[6] (Interviewee 1)

Two decades after the introduction of his Cluster Theory (Porter, 1998), Porter's observations not only still hold (Geilinger, von Krogh, & Häfliger, 2015), but seem to offer the possibility to be further expanded to considerations concerning the very important and valuable domain of Big Data and Artificial Intelligence (Eggers et al., 2013; McAfee, Brynjolfsson, Davenport, Patil, & Barton, 2012), crucial for the new wave of technological innovation taking place in the next years (World Economic Forum, 2016).
In the article introducing his Cluster Theory, Porter noticed that

> "paradoxically, the enduring competitive advantages in a global economy lie increasingly in local things – knowledge, relationships, and motivation that distant rivals cannot match. (...) What happens inside companies is important, but clusters reveal that the immediate business environment outside companies plays a vital role as well" (Porter, 1998, p. 77)

In 1998, starting from this observation, he focused on what he called "clusters": "geographic concentrations of interconnected companies and institutions in a particular field (...). Clusters affect competition in three broad ways: first, by increasing the productivity of companies based in the area; second, by driving the direction and pace of innovation, which underpins future productivity growth; and third, by stimulating the formation of new businesses, which expands and strengthens the cluster itself" (Porter, 1998, p. 80).

Nowadays, in the data era, "knowledge, relationships, and motivation that distant rivals cannot match" seem to be achieved by local players through what could be called a "Local Ecosystem". In a local ecosystem, local companies from different fields – being the fields' diversity an important difference compared to Porter's clusters – support each other in order to better compete against global giants and in some cases – as DoCoMo in Japan shows (see Section 5.1.6) – even share their own data, building a "Local Data Ecosystem".

---

[6] The interviewee used the word "Belief" in the German interview as well: "(...) Das ist der Belief: wir gehen tiefer und schützen uns so von der relativ oberflächigen aber dafür mit viele Features usw. Konkurrenz. Local Focus und Local differenzierung. Das ist unser Belief, weil sonst können wir sowieso aufgeben!"

The building of "Local Ecosystems" and "Local Data Ecosystems" allows local companies to effectively differentiate from global firms and create competitive advantage through a range of interconnected products local customers are very interested in, requiring a good knowledge of the local market and a high degree of cooperation with local partners. This strategy has already proven to be very effective in South Korea, where even Google and other international companies now have difficulties to gain market share:

> "In Korea it is all so tightly networked: for Google, it is not so easy to be successful there! This because they [Korean TIME firms] have invested very much: they go deeper in networking and in the data exchange… and they have products that are more relevant for the end user because they think in a Korean way. (…) There are many comparative services as Comparis in Switzerland: why has Google not taken this market – the fourth most attractive market worldwide with high margins, etc. – so far? The reason is the following: for Google it is difficult to work with insurances locally … the Business Models are different, the products are different… it is difficult to create this from Silicon Valley…!" (Interviewee 1)

Local TIME companies, in particular local premium companies owning an excellent connectivity infrastructure as Swisscom, are very well positioned to play an important role in these local ecosystems. Thanks to their long-lasting local presence, they boast business relationships with most SMEs and Enterprises on the economic landscape. Moreover, thanks to the ownership of the connectivity network "the telecom sector continues to be at the epicentre for growth, innovation, and disruption for virtually any industry" (Wigginton, 2016), and telecommunications companies are seen as very desirable partners. They are, therefore, very well positioned to easily close partnerships with local players of many industries, becoming not just a part, but the epicentre of nascent local ecosystems, standing among the main beneficiaries of its construction:

> "Swisscom would then have an advantage because of the local partnerships we have. Because through partnerships you can achieve very much. And companies as Google, as of now, have difficulties building them since they do not have the proximity to – let us say – SMEs in Switzerland, and they also do not have relationships… as of now, no XY[7] or local insurance would start a partnership with Google.
>
> There are more and more companies that lose part of their business because of big firms as Google and Facebook and they are interested in supporting new [local] value propositions." (Interviewee 5)

In the last years, SK Telecom – the leading South Korean TIME player – has been successful accomplishing something similar in its home market; NTT DoCoMo (the leading Japanese

[7] The name of the partner was substituted by "XY" because of a more restrictive NDA.

TIME player, see Section 5.1.6 for more details) is successfully leveraging Artificial Intelligence to build a "Local Data Ecosystem" in Japan, and the situation in the Swiss TIME market seems to allow Swisscom to follow a similar path.
As Dawar and Frost stated in their Harvard Business Review article:

> "Multinationals are seeking to exploit global scale economies while local enterprises are trying to fragment the market and serve the needs of distinct niches. The formers bring an array of powerful resources that can intimidate even the most self-assured local manager. But like David against Goliath, the smaller competitor can rise to the challenge and prevail (Dawar & Frost, 1999, p. 25)."

8 – Discussion

8.1 Summary of Findings and Generalizability

The thesis focused on the impact of Artificial Intelligence on the Swiss TIME industry and on factors local TIME companies can leverage competing with global high-tech players in their home market. This was accomplished providing academia and the corporate partner with three important findings.

1) The Catalysts of Progress

The first important contribution to theory and practice was the identification of the main factors driving the fast progress in Artificial Intelligence: "Algorithms", "Data" and "Computing Power". A further analysis showed how companies at the forefront of innovation in the field are improving their skills in these crucial categories. In particular, the analysis revealed the importance of data collection through ecosystems and attractive services, the relevance of Mergers and Acquisitions – in particular in the field of machine learning – and most of all the crucial role open source initiatives are playing in the progress of Artificial Intelligence.

These findings have a degree of generalizability going well beyond the TIME industry: data collected through the single case study and the support of the corporate partner played an important role in determining the categories and fully understanding their importance. Nevertheless, evidence supporting the categorization presented above could also be found in white papers published by consulting companies and analyses performed by leading technological newspapers on industries ranging from retail to healthcare.

2) The "Data Availability – Technology Exploitability" Framework

The analysis of the main players' strategic moves in the field of Artificial Intelligence – through the lenses of the "Catalysts of progress" framework proposed above – and interviews with experts of the field both at ETH and at the corporate partner, led to a second important finding: the "Data Availability – Technology Exploitability" Framework. The focus on the categories "Algorithms", "Data" and "Computing Power" presented in Chapter 5 allows companies to analyse others' Artificial Intelligence moves and plan the own Artificial Intelligence strategy; the "Data Availability – Technology Exploitability" Framework serves as a complement, providing firms with a tool to rapidly assess the potential of single Artificial Intelligence-based use cases inside the company, looking at the data and the technological capabilities the firm has in-house.

3) Local-global Competition

The third important finding of the thesis was the identification of possible strategies local TIME players in developed markets can apply, to effectively compete with global technology companies, in an industry progressing at a very fast pace and in which Artificial Intelligence will play an increasingly important role. The wave of Artificial Intelligence technology open sourcing taking place during the thesis lowered the technological competitive disadvantage local TIME players have, allowing them to develop products based on Artificial Intelligence technology of good quality and compete with global players by other means. Interestingly, these means are similar to those identified by other researchers analysing the local-global competition taking place in developing countries: regional factors (Dawar & Frost, 1999; Govindarajan & Bagla, 2012). The most interesting finding concerning local-global competition in Switzerland regards the opportunity given by Artificial Intelligence and Big Data to bring differentiation through local factors to a new level. Leveraging regional factors – as customer proximity, ownership of the local connectivity infrastructure and long-lasting business relationships with most SMEs and Enterprises on the economic landscape – and exploiting the increasing analytical capabilities at their disposal, local TIME players can build and position themselves at the centre of so-called "local data ecosystems", building barriers to entry to global TIME players and gaining even more relevance in the life of their customers. This third group of findings has a lower level of generalizability. They are suitable for a specific type of company: leading players of the TIME industry with a very good connectivity infrastructure and enjoying a high degree of trust among the local population. Although it is worth for most local companies establishing partnerships with other local firms and being part of a local ecosystem, these players are particularly well positioned to take the role of coordinator and position themselves at its epicentre. This might hold to a lesser degree for other companies.

8.2 Implications for Research: Limitations & future Work

Although the thesis accomplished the goals set both by academia and corporate partner at its beginning, some limitations can be flagged and suggestion for future work be given.

The first limitation was given by the very fast changing environment under study, making necessary to steadily review and change some parts of the thesis. On the one side, progress in the field of Artificial Intelligence accelerated during the thesis, with advances in deep learning allowing machines to accomplish goals, unimaginable until some months ago. An example intensively covered by media is represented by the victory of Google's AlphaGo over Go

grandmaster Lee Sedol in March 2016: as nature.com reports, experts in the field stated just some time ago that "computer mastery of the game was a decade away" (Gibney, 2016). On the other side, important strategic moves made by some of the biggest high-tech companies in the middle of the thesis, very much changed the competitive landscape. This is particularly true for the wave of Artificial Intelligence open sourcing that could be observed between November 2015 and March 2016, with even traditional open source sceptics as IBM and Microsoft open sourcing parts of their Artificial Intelligence software. Although the rapidly changing environment did not negatively impact the results of the thesis thanks to the inductive qualitative approach chosen, it did not make possible to observe the consequences of technological progress and strategic moves on a longer period of time. This would have allowed to better judge their effective goodness, and increase the generalizability of the findings.

A second limitation – impacting mainly the findings on local-global competition – is due to the use of a single TIME company as a source of information. Although the focus on a single company allowed to exploit the limited amount of time to go deeper in the understanding of its market and strategy, data provided through the interviews may be involuntary biased due to peculiarities of the TIME industry, as for example its convergence or the growing importance it is covering in the economy. To mitigate these risk, suggestions given by Yin (2003) for single case study research were followed, devoting particular attention to increasing the number of information sources available, involving also independent Artificial Intelligence researchers from two European institutions and employees of three different financial institutions. A deep study of local TIME companies in other countries or of companies in other industries would allow to strengthen the empirical evidence of the findings.

A third limitation is due to the substantial use of interview data. On the one hand, interview data was mainly collected in Switzerland (only one interview took place with someone living abroad); this could somehow bias the results, given peculiarities of the Swiss market as the high average income of its population or its culture. On the other hand, the focus on collecting data by means of interviews did not allow to address a larger sample. A larger group of people, coming from different industries and cultural backgrounds, would increase the generalizability of the findings.

Future Work

As pointed out at the beginning of this work, research on technical aspects of Artificial Intelligence is rapidly gaining the attention of many computer science researchers. This has

not been the case of management research, yet, not providing companies with tools to assess the impact of the latest progress in the field on their business. At the beginning of the current new wave of promising Artificial Intelligence progress, this thesis aimed to fill this gap in the literature and to represent a starting point for more research on the impact of Artificial Intelligence on companies and industries. This being a topic that, given the rapidly increasing importance of Artificial Intelligence in the next years, is likely to receive much more attention from academia in the near future.

Further research could focus on increasing the generalizability of the findings of the thesis, overcoming the limitations presented above and using the frameworks introduced in the previous chapters to study more aspects of the fast-moving field of Artificial Intelligence. In the next lines, some ideas for future work are proposed.

The "Algorithms, Data and Computing Power" framework was built looking at innovations and strategic moves performed in the past, turning out to be very suitable for the analysis of potential use cases inside the corporate partner. Future work could try to expand the use of the framework to the analysis of future trends as well:

- Some companies are working at the development of so-called neuromorphic chips. Would their successful development and implementation on a large scale change the relative importance of the catalysts of progress? How would this impact the "Data Availability – Technology Exploitability" framework?
- Can future products and innovations taking place in the Artificial Intelligence industry be attributed to the proposed "Algorithms", "Data" and "Computing Power" categories?

Using the "Algorithms, Data and Computing Power" framework, some common trends in the strategies of the main industry players could be identified: the building of Data Ecosystems, the use of Open Innovation and great activity on the Mergers and Acquisitions market. Because of the newness of the moves, their real effectiveness could not be measured:

- Is open innovation beneficial for the main players implementing it? Do the benefits exceed the disadvantages deriving from the diminished level of technical competitive advantage?
- Does open innovation really improve the performance of Human Resource departments?

The findings on local-global competition in developed markets and the recommendations given apply to the corporate partner, a leading player of the TIME industry. Future work could focus on other players as well. Moreover, it were very interesting to understand not only how local TIME players compete in their home market, but also how they could possibly start competing on the global competitive landscape. Future research could try to answer following related research questions:

- What are the factors not leading local players could leverage in their competition with global players in the home market?
- What are the factors local players of the TIME industry could leverage in order to compete in the global market?

A limitation of the thesis was the exclusive use of qualitative data sources for the analyses performed, involving a small sample of interviewees. Future work could overcome also this limitation approaching the research question with a quantitative method, testing deductively the findings of this thesis. This could be for example accomplished conducting a survey on a larger group of people, coming from different industries and cultural backgrounds.

References

Acemoglu D., & Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. ***Handbook of Labor Economics***, ***4***, 1043–1171.

Asimov, I. (1950). ***I, Robot***. Gnome Press.

Autor, D. H. (2010). The polarization of job opportunities in the US labor market: Implications for employment and earnings. ***Center for American Progress and The Hamilton Project***, (January 2010).

Barr, A. (2015). Google Touts Machine-Learning Prowess to Shareholders. Retrieved 13 April 2016, from http://blogs.wsj.com/digits/2015/06/03/google-touts-machine-learning-prowess-to-shareholders/

Bellman, R. E. (1978). ***An introduction to artificial intelligence : can computers think?*** Boyd & Fraser Publishing Company.

Bertozzi, M., Broggi, A., & Fascioli, A. (2000). Vision-based intelligent vehicles: State of the art and perspectives. ***Robotics and Autonomous Systems***, ***32***(1), 1–16.

Bindewald, J. M., Miller, M. E., & Peterson, G. L. (2014). A function-to-task process model for adaptive automation system design. ***International Journal of Human-Computer Studies***, ***72***(12), 822–834.

Bjork, G. C. (1999). ***The Way it Worked and why it Won't: Structural Change and the Slowdown of U.S. Economic Growth***. Praeger.

Block, H. D., Knight Jr, B. W., & Rosenblatt, F. (1962). Analysis of a four-layer series-coupled perceptron. II. ***Reviews of Modern Physics***, ***34***(1), 135.

Blostein, A. (2015). ***Fortnightly Thoughts***.

Brandes, D., & Zobrist, L. (2015). Man and Machine : Robots on the rise ? The impact of automation on the Swiss job market. ***Deloitte Insights***.

Brockman, G., Sutskever, I., & OpenAI team. (2015). Introducing OpenAI. Retrieved 21 December 2015, from https://www.openai.com/blog/introducing-openai/

Brynjolfsson, E., & Hitt, L. M. (2003). Computing Productivity: Firm-Level Evidence. ***Review of Economics and Statistics***, ***85***(4), 793–808.

Brynjolfsson, E., & McAfee, A. (2014). ***The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies***. W. W. Norton.

References

Brynjolfsson, E., & Yang, S. (1996). Information Technology and Productivity: A Review of the Literature. ***Advances in Computers***, ***43***(C), 179–214.

Bryson, A. E., & Ho, Y.-C. (1969). Applied optimal control. 1969. ***Blaisdell, Waltham, Mass***, ***8***, 72.

Buchanan, B. G., Smith, D. H., White, W. C., Gritter, R. J., Feigenbaum, E. A., Lederberg, J., & Djerassi, C. (1976). Applications of artificial intelligence for chemical inference. 22. Automatic rule formation in mass spectrometry by means of the meta-DENDRAL program. ***Journal of the American Chemical Society***, ***98***(20), 6168–6178.

Buchanan, B., & Sutherland, G. (1969). Heuristic DENDRAL: A program for generating explanatory hypotheses in organic chemistry. ***Meltzer B, Michie D, Swann M, Eds., Machine Intelligence***, ***4***, 209–254.

Buckley, P. (2003). Globalization and the multinational enterprise. ***Globalization and the Multinational Enterprise. In: FAULKNER, D.O.; CAMPBELL, A. The Oxford Handbook of Strategy. Vol. II: Corporate Strategy***, (December), 206–234.

Buduma, N. (2014). Deep Learning in a Nutshell – what it is, how it works, why care? Retrieved 13 April 2016, from http://www.kdnuggets.com/2015/01/deep-learning-explanation-what-how-why.html

Business Wire. (2015). NTT Communications to Offer AI-supported Cognitive Agent for Highly Natural Automated Dialogue Support at Contact Centers. Retrieved 7 March 2016, from http://mms.businesswire.com/media/20151202006516/en/499158/5/picture.jpg?download=1

Caudill, M. (1989). Neural nets primer, part VI. ***AI Expert***, ***4***(2), 61–67.

Charniak, E., & McDermott, D. (1985). ***Introduction to Artificial Intelligence***. Boston, MA, USA: Addison-Wesley Longman Publishing Co., Inc.

Chaykowski, K. (2015). Facebook Open-Sources Artificial Intelligence Hardware Design For The First Time. Retrieved 9 April 2016, from http://www.forbes.com/sites/kathleenchaykowski/2015/12/10/facebook-open-sources-artificial-intelligence-hardware-design-for-the-first-time/#591cd0ca6f3a

ComCom. (2014). ***Annual Report 2014***.

Coulom, R. (2016). Rating List of 2016-01-01. Retrieved 7 April 2016, from https://web.archive.org/web/20160318041922/http://www.goratings.org/history/2016-01-01.html

Culnan, M. J., & Bair, J. H. (1983). Human communication needs and organizational productivity: The potential impact of office automation. ***Journal of the American Society for Information Science***, ***34***(3), 215–221.

d'Albe, E. E. F. (1914). On a Type-Reading Optophone. ***Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences***, ***90***(619), 373–375.

D'Onfro, J. (2015). How Facebook will use artificial intelligence to organize insane amounts of data into the perfect News Feed and a personal assistant with superpowers. Retrieved 9 April 2016, from http://uk.businessinsider.com/facebook-outlines-its-artificial-and-machine-learning-ambitions-2015-11

Darrow, B. (2016). Google Means Business When it Comes to Cloud. Retrieved 3 February 2016, from http://fortune.com/2016/02/01/google-cloud-business/

Davenport, T. H., & Kirby, J. (2015). Automation Won't Replace People as Your Competitive Advantage. ***Harvard Business Review***.

Davenport, T., & Kirby, J. (2015). Beyond Automation. ***Harvard Business Review***.

David, H., Katz, L. F., & Krueger, A. B. (1997). ***Computing inequality: have computers changed the labor market?*** National Bureau of Economic Research.

Dawar, N., & Frost, T. (1999). Competing with giants. Survival strategies for local companies in emerging markets. ***Harvard Business Review***, ***77***(2), 1–25.

Deloitte Development. (2015). ***Disruption ahead - Deloitte's point of view on IBM Watson***.

Deloitte Development. (2016). ***Analytics Trends 2016***.

DeMers, J. (2015). What Is Google RankBrain And Why Does It Matter? Retrieved 5 January 2016, from http://www.forbes.com/sites/jaysondemers/2015/11/12/what-is-google-rankbrain-and-why-does-it-matter/

Dettmers, T. (2015). Deep Learning in a Nutshell: Core Concepts. Retrieved 9 April 2016, from http://devblogs.nvidia.com/parallelforall/deep-learning-nutshell-core-concepts/

Dewan, S., & Kraemer, K. L. (2000). Information Technology and Productivity: Evidence from Data. ***Management Science***, ***46***(4), 548–562.

Dickmanns, E. D., & Zapp, A. (1987). A curvature-based scheme for improving road vehicle guidance by computer vision. In ***Cambridge Symposium_Intelligent Robotics Systems*** (pp. 161–168). International Society for Optics and Photonics.

Doh, J. P., Bunyaratavej, K., & Hahn, E. D. (2009). Separable but not equal: The location

determinants of discrete services offshoring activities. ***Journal of International Business Studies***, ***40***(6), 926–943.

Dowd, M. (2014). Silicon Valley Sharknado. Retrieved 19 December 2015, from http://www.nytimes.com/2014/07/09/opinion/maureen-dowd-silicon-valley-sharknado.html?smprod=nytnow&smid=nytnow-share

Edmondson, A. C., & Mcmanus, S. E. (2007). Fit in Methodological Management. ***Academy of Management Review***, ***32***(4), 1155–1179.

Eggers, W. D., Hamill, R., & Ali, A. (2013). Data as the New Currency: Government's Role in Facilitating the Exchange. ***Deloitte Review***, (1), 18–31.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. ***Academy of Management Review***, ***14***(4), 532–550.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory Building From Cases : Opportunities and Challenges. ***Academy of Management Journal***, ***50***(1), 25–32.

Ethnologue. (2012). German, Swiss. Retrieved 9 April 2016, from http://www.ethnologue.com/language/gsw

Franke, N., & Von Hippel, E. (2003). Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software. ***Research Policy***, ***32***(7), 1199–1215.

Frey, C. B., & Osborne, M. A. (2013). The Future of Employment: How Susceptible are Jobs to Automation?, 1–72.

Geilinger, N., von Krogh, G., & Häfliger, S. (2015). ***Das Cluster-Ecosystem im Kanton Zürich und sein Einfluss auf den Innovationsprozess - Eine Studie der Cluster Biotech, Cleantech und ICT im Cluster-Ecosystem des Kantons Zürich***. Lehrstuhl für Strategisches Management und Innovation der ETH Zürich in Kooperation mit Amt für Wirtschaft und Arbeit Kanton Zürich, Bereich Standortförderung.

Gershgorn, D. (2015). Microsoft's huge update could bring Artificial Intelligence to your apps. Retrieved 9 April 2016, from http://www.popsci.com/microsoft-makes-ai-easier

Ghemawat, P. (2005). Regional Strategies for Global Leadership. ***Harvard Business Review***, (August), 98–108.

Ghemawat, P. (2007a). A Global Strategy Built on Differences. Retrieved 9 April 2016, from https://hbr.org/2007/11/a-global-strategy-built-on-dif

Ghemawat, P. (2007b). Managing Differences The Cental Challengen of Global Strategy.

Harvard Business Review, ***85***(3), 58–68.

Gibney, E. (2016). Google AI algorithm masters ancient game of Go. Retrieved 16 March 2016, from http://www.nature.com/news/google-ai-algorithm-masters-ancient-game-of-go-1.19234

Gomes, L. (2014). Machine-Learning Maestro Michael Jordan on the Delusions of Big Data and Other Huge Engineering Efforts. Retrieved 7 January 2016, from http://spectrum.ieee.org/robotics/artificial-intelligence/machinelearning-maestro-michael-jordan-on-the-delusions-of-big-data-and-other-huge-engineering-efforts

Google Research. (2015). TensorFlow - Google's latest machine learning system, open sourced for everyone. Retrieved 9 April 2016, from http://googleresearch.blogspot.ch/2015/11/tensorflow-googles-latest-machine_9.html

Govindarajan, V., & Bagla, G. (2012). How Big Companies Beat Local Competition in Emerging Markets. Retrieved 9 April 2016, from https://hbr.org/2012/08/leapfrog-local-competition-in

Greene, J. (2016). Google Cloud Lures Amazon Web Services Customer Spotify. Retrieved 24 February 2016, from http://www.wsj.com/articles/google-cloud-lures-amazon-web-services-customer-spotify-1456270951

Greenough, J. (2016). Here's why self-driving cars took center stage at CES. Retrieved 7 April 2016, from http://uk.businessinsider.com/self-driving-cars-ces-2016-01?r=US&IR=T

Gunasekaran, A., Putnik, G. D., Ahmed, A. M., Zairi, M., & Almarri, K. S. (2006). SWOT analysis for Air China performance and its experience with quality. ***Benchmarking: An International Journal***, ***13***(1/2), 160–173.

Hacklin, F., Battistini, B., & von Krogh, G. (2013). Strategic Choices in Converging Industries. ***MIT Sloan Management Review***, ***55***(55116), 65–73.

Hagan, S. (2012). Big data, cloud computing, spatial databases. Amsterdam: Oracle Corp.

Hamel, G., & Prahalad, C. K. (1985). ***Do you really have a global strategy?*** Harvard Business Review.

Hammond, K. (2015). The End of Big Data: AI and the Rise of the Narrative.

Hardy, Q. (2015). At Kodak, Clinging to a Future Beyond Film. Retrieved 9 April 2016, from http://www.nytimes.com/2015/03/22/business/at-kodak-clinging-to-a-future-beyond-film.html

Haugeland, J. (1985). ***Artificial Intelligence: The Very Idea*** (Vol. 38). MIT press Cambridge.

Hawking, S., Musk, E., & al. (2015). An Open Letter: research priorities for robust and beneficial Artificial Intelligence. Retrieved 21 December 2015, from http://futureoflife.org/ai-open-letter/

Hedberg, S. R. (2002). DART: revolutionizing logistics planning. ***Intelligent Systems, IEEE***, ***17***(3), 81–83.

Helms, M. M., & Nixon, J. (2010). Exploring SWOT analysis-where are we now? A review of academic research from the last decade. ***Journal of Strategy and Management***, ***3***(3), 215–251.

High, P. (2016). IBM Watson Head Mike Rhodin On The Future Of Artificial Intelligence. Retrieved 9 April 2016, from http://www.forbes.com/sites/peterhigh/2016/01/18/ibm-watson-head-mike-rhodin-on-the-future-of-artificial-intelligence/#26fdd7153064

Hiner, J. (2016). CES 2016: IBM one-ups AI with 'cognitive' solutions, Rometty declares dawn of new era. Retrieved 9 April 2016, from http://www.techrepublic.com/article/ces-2016-ibm-one-ups-ai-with-cognitive-solutions-rometty-declares-dawn-of-new-era/

Hodgkin, A. L., & Huxley, A. F. (1952). A quantitative description of membrane current and its application to conduction and excitation in nerve. ***The Journal of Physiology***, ***117***(4), 500–544.

Hofstadter, D. R. (2000). ***Gödel, Escher, Bach: An Eternal Golden Braid***. Penguin.

Huntbach, M. M., & Ringwood, G. A. (2003). ***Agent-Oriented Programming: From Prolog to Guarded Definite Clauses***. Springer Berlin Heidelberg.

IBM. (2015). ***Digital Disruption***.

IBM Research. (2014). Brain Power. Retrieved 21 December 2015, from http://research.ibm.com/cognitive-computing/neurosynaptic-chips.shtml#fbid=OobisabdSOR

Jacquette, D. (2008). ***A companion to philosophical logic***. John Wiley & Sons.

Jorgenson, D., Gollop, F. M., & Fraumeni, B. (2014). ***Productivity and U.S. Economic Growth***. Elsevier Science.

Jorgenson, D. W., Ho, M. S., & Stiroh, K. J. (2008). A Retrospective Look at the U.S. Productivity Growth Resurgence. ***Journal of Economic Perspectives***, ***22***(1), 3–24.

Karagiannopoulos, G. D., Georgopoulos, N., & Nikolopoulos, K. (2005). Fathoming Porter's five

forces model in the internet era. ***Info***, ***7***(6), 66–76.

Knight, W. (2015). Here's What Developers Are Doing with Google's AI Brain. Retrieved 1 February 2016, from http://www.technologyreview.com/news/544356/heres-what-developers-are-doing-with-googles-ai-brain/

Knight, W. (2016). Baidu's Deep-Learning System Rivals People at Speech Recognition. Retrieved 7 March 2016, from https://www.technologyreview.com/s/544651/baidus-deep-learning-system-rivals-people-at-speech-recognition/

Kokalitcheva, K. (2016). Meet M, Facebook's personal assistant that lives inside Messenger. Retrieved 13 April 2016, from http://fortune.com/2015/08/26/facebook-m-digital-assistant/

Konstantinova, N. (2014). Machine Learning explained in simple words. Retrieved 6 January 2016, from http://nkonst.com/machine-learning-explained-simple-words/#comments

Krugman, P. (2014). The Myth of Asia's Miracle. ***FOREIGN AFFAIRS-NEW YORK***, ***73***(6), 62–78.

Kurzweil, R. (2005). ***The singularity is near: When humans transcend biology***. Penguin.

Kurzweil, R. (2015). Long Live AI. Retrieved 20 December 2015, from http://www.forbes.com/home/free_forbes/2005/0815/030.html

Kurzweil, R., Schneider, M. L., & Schneider, M. L. (1990). ***The age of intelligent machines*** (Vol. 579). MIT press Cambridge.

Lacity, M. C., & Willcocks, L. (2015). What Knowledge Workers Stand to Gain from Automation. Retrieved 9 April 2016, from https://hbr.org/2015/06/what-knowledge-workers-stand-to-gain-from-automation

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. ***Nature***, ***521***(7553), 436–444.

Lerner, J., & Tirole, J. (2003). Some Simple Economics of Open Source. ***The Journal of Industrial Economics***, ***50***(2), 197–234.

Lerner, J., & Tirole, J. (2004). ***The economics of technology sharing: Open source and beyond***. National Bureau of Economic Research.

Levitt, T. (1983). The Globalization of Markets. ***Harvard Business Review***, ***May-June***, 92–102.

Levy, F., & Murnane, R. J. (2012). ***The new division of labor: How computers are creating the next job market***. Princeton University Press.

Lighthill, J. (1973). Lighthill Report: Artificial Intelligence: a paper symposium. ***Science Research***

Council, London.

Mankiw, N. (2011). ***Principles of Macroeconomics***. Cengage Learning.

McAfee, A., Brynjolfsson, E., Davenport, T. H., Patil, D. J., & Barton, D. (2012). Big data. ***The Management Revolution. Harvard Business Review***, ***90***(10), 61–67.

McCarthy, J., Minsky, M., Rochester, N., & Shannon, C. (1955). A Proposal for the Dartmouth Summer Research Project on Arti cial Intelligence. ***AI Magazine***, ***27***(4), 12–14.

McClelland, J. L., Rumelhart, D. E., & Hinton, G. E. (1986). ***The appeal of parallel distributed processing***. Cambridge, MA: MIT Press.

McCorduck, P. (2004). ***Machines Who Think (2nd ed.)***. A. K. Peters.

McDermott, J. (1982). R1: A rule-based configurer of computer systems. ***Artificial Intelligence***, ***19***(1), 39–88.

Metz, C. (2016a). AI Is Transforming Google Search. The Rest of the Web Is Next. Retrieved 24 February 2016, from http://www.wired.com/2016/02/ai-is-changing-the-technology-behind-google-searches/

Metz, C. (2016b). Google and Facebook Team Up to Open Source the Gear Behind Their Empires. Retrieved 8 April 2016, from http://www.wired.com/2016/03/google-facebook-designing-open-source-data-center-gear-together/

Mithas, S., & Lucas, H. C. (2010). What is Your Digital Business Strategy? ***IT Professional***, ***12***(6), 4–6.

Mohapatra, S. (2012). IT and Porter's Competitive Forces Model and Strategies. In ***Information Systems Theory*** (pp. 265–281). Springer.

Moore, G. E. (1965). Cramming More Components onto Integrated Circuits. ***Electronics***, ***38***(8), 114–117.

Morath, J., Roetter, M., & Schimmel, C. (2006). Web Reloaded? Driving Convergence in the 'Real World'. ***Arthur D Little***.

Morgenthaler, M. (2014). «Ich weiss schon, wo ich die Swisscom hinsteuern will». Retrieved 25 February 2016, from http://www.derbund.ch/schweiz/standard/Ich-weiss-schon-wo-ich-die-Swisscom-hinsteuern-will/story/14501945

Moss, C. (2015). Apple CEO Tim Cook delivers a fantastic, touching speech about why online privacy matters. Retrieved 13 April 2016, from http://uk.businessinsider.com/tim-cook-on-online-privacy-2015-2?r=US&IR=T

Muehlhauser, L., & Sinick, J. (2014). How Big is the Field of Artificial Intelligence? (initial findings). Retrieved 14 January 2016, from https://intelligence.org/2014/01/28/how-big-is-ai/

Neuman, W. L., & Kreuger, L. (2003). ***Social work research methods: Qualitative and quantitative approaches***. Allyn and Bacon.

Newcomb, D. (2016). Car Technology Once Again Stole The Show At CES 2016. Retrieved 7 April 2016, from http://www.forbes.com/sites/dougnewcomb/2016/01/11/car-technology-once-again-stole-the-show-at-ces-2016/#32cf3ac7c41c

Newell, a., Shaw, J. C., & Simon, H. a. (1959). Report on a general problem-solving program. ***IFIP Congress***.

Ng, A. (2013). ***Deep Learning [Powerpoint slides]***.

Nielsen, M. (2015). Using neural nets to recognize handwritten digits. Retrieved 7 January 2015, from http://neuralnetworksanddeeplearning.com/chap1.html

Nilsson, N. J. (1998). ***Artificial Intelligence: A New Synthesis: A New Synthesis***. Elsevier Science.

Nyce, C. (2007). Predictive Analytics White Paper. ***American Institute for Chartered Property Casuality Underwriters***, 16.

O'Keefe, B. (2015). Can artificial intelligence stop hackers? Retrieved 23 February 2016, from http://fortune.com/2015/07/14/artificial-intelligence-hackers/

Parasuraman, R., & Sheridan, T. B. (2000). A model for types and levels of human interaction with automation. ***Systems, Man and ...***, ***30***(3), 286–297.

Pereira, D., Schatsky, D., Sallomi, P., & Dalton, R. (2015). Cognitive technologies in the technology sector. ***Deloitte University Press***.

Polanyi, M. (1967). The tacit dimension.

Poole, D., Mackworth, A., & Goebel, R. (1998). ***Computational Intelligence: A Logical Approach***. Oxford University Press.

Porter, M. E. (1980). ***Competitive strategy: Techniques for analyzing industries and competitors***. Free Press.

Porter, M. E. (1985). Technology and Competitive Advantage. ***Journal of Business Strategy***, ***5***(3), 60–78.

Porter, M. E. (1996). What Is Strategy? ***Harvard Business Review***, ***74***(4134), 61–78.

Porter, M. E. (1998). Clusters and the New Economics of Competition. ***Harvard Business Review***, (November-December), 76–90.

Porter, M. E. (2008). The Five Competitive Forces that Shape Strategy. ***Harvard Business Review***, ***86***(January), 78–94.

Power, B. (2014). How Watson Changed IBM - HBR. ***Harvard Business Review***.

Press, G. (2015). Hot Career: The Number Of Data Scientists Has Doubled Over The Last 4 Years. Retrieved 9 April 2016, from http://www.forbes.com/sites/gilpress/2015/10/21/the-number-of-data-scientists-has-doubled-over-the-last-4-years/#38329a023b8e

PwC. (2015). ***PwC Swiss Entertainment and Media Outlook 2015***.

Ramsey, L. (2016). IBM just struck a deal so its Watson supercomputer can help you feel better faster. Retrieved 13 April 2016, from http://uk.businessinsider.com/ibm-watson-health-acquires-truven-health-analytics-2016-2?r=US&IR=T

Ransbotham, S., Kiron, D., & Prentice, P. K. (2015). The Talent Dividend. ***MIT Sloan Management Review***, ***56***(4), 1.

Raymond, E. S. (1999). ***The cathedral and the bazaar: musings on Linux and open source by an accidental revolutionary***. O'Reilly.

Rich, E., & Knight, K. (1991). ***Artificial Intelligence*** (Second Edi). McGraw-Hill.

Ronaki, R., & Steier, D. (2014). Cognitive analytics. ***Tech Trends 2014: Inspiring Disruption***, 19–29.

Rosenblatt, F. (1961). ***Principles of neurodynamics. perceptrons and the theory of brain mechanisms***. Meltzer, B., Michie, D., and Swann, M. (Eds.).

Rosoff, M. (2015). Apple's iPhone revenue is bigger than any other tech company's total revenue. Retrieved 6 March 2016, from http://uk.businessinsider.com/apple-iphone-revenue-vs-competitors-total-revenue-2015-9?r=US&IR=T

Russell, S. J., & Norvig, P. (2010). ***Artificial Intelligence: A Modern Approach***. ***Most*** (Vol. 74). Pearson Education, Inc.

Sandberg, W. R., & Hofer, charles w. (1987). Improving new venture performance: The role of strategy, industry structure, and the entrepreneur. ***Journal of Business Venturing***, ***2***(1), 5–28.

SAS Institute Inc. (2016). Machine Learning: What it is & why it matters. Retrieved 9 April 2016, from http://www.sas.com/en_us/insights/analytics/machine-learning.html

Schatsky, D., Muraskin, C., & Gurumurthy, R. (2014). Demystifying Artificial Intelligence. ***A Deloitte Series on Cognitive Technologies***.

Schatsky, D., Muraskin, C., & Gurumurthy, R. (2015). Cognitive technologies: The real opportunities for business. ***Deloitte Review***, (16), 114–129.

Schatsky, D., & Schwartz, J. (2015). Redisigning Work in an Era of Cognitive Technologies. ***Deloitte Review***.

Shankland, S. (2012). Moore's Law: The rule that really matters in tech. Retrieved 11 February 2016, from http://www.cnet.com/news/moores-law-the-rule-that-really-matters-in-tech/

Shead, S. (2016). Google chairman Eric Schmidt: Artificial intelligence platforms can 'change the world'. Retrieved 19 January 2016, from http://uk.businessinsider.com/google-chairman-eric-schmidt-artificial-intelligence-platforms-can-change-the-world-2016-1?r=US&IR=T

Shen, L. (2015). Top Internet Analyst: There is one thing about Google that everyone is missing. Retrieved 13 April 2016, from http://uk.businessinsider.com/googles-artificial-intelligence-efforts-are-underestimated-2015-12?r=US&IR=T

Shu, C. (2015). Google Acquires Artificial Intelligence Startup DeepMind For More Than $500M. Retrieved 21 December 2015, from http://techcrunch.com/2014/01/26/google-deepmind/

Simon, & Schuster. (1945). ***A History of Western Philosophy***.

Simonite, T. (2015). Facebook Joins Stampede of Tech Giants Giving Away Artificial Intelligence Technology. Retrieved 16 February 2016, from https://www.technologyreview.com/s/544236/facebook-joins-stampede-of-tech-giants-giving-away-artificial-intelligence-technology/

Slater-Robins, M. (2016). Microsoft's new apps may seem silly — but they're part of a much bigger plan. Retrieved 13 April 2016, from http://www.businessinsider.com.au/microsoft-is-using-fun-apps-to-dominate-ai-2016-1

Smith, A., & Anderson, J. (2014). Digital Life in 2025: AI, Robotics and the Future of Jobs. ***Pew Research Center***, (August 6), 67.

Sørensen, L., Vidal, R. V. V., & Engström, E. (2004). Using soft OR in a small company—The case of Kirby. ***European Journal of Operational Research***, ***152***(3), 555–570.

STL Partners. (2015). Telco-Driven Disruption: What NTT DOCOMO, KT and Globe got right.

Retrieved 7 March 2016, from http://www.telco2research.com/articles/EB-NTT-DOCOMO-KT-Globe-telecoms-disruption-got-right

Swap, W., Leonard, D., Krishnan, V. V, & Mclean, A. N. (2015). Artificial Intelligence Can ' t Replace Hard-Earned Knowledge. Retrieved 9 April 2016, from https://hbr.org/2014/11/artificial-intelligence-cant-replace-hard-earned-knowledge-yet

Swisscom. (2015). ***Swisscom Annual Report***.

Taigman, Y., Yang, M., Ranzato, M., & Wolf, L. (2014). Deepface: Closing the gap to human-level performance in face verification. In ***Computer Vision and Pattern Recognition (CVPR), 2014 IEEE Conference*** (pp. 1701–1708). IEEE.

Thompson, B. (2014). Daily Update: Facebook's Strengths, Weaknesses, Opportunities and Threats. Retrieved 13 April 2016, from https://stratechery.com/2014/daily-update-facebooks-strengths-weaknesses-opportunities-threats/

Thurm, D. (2015). John Chambers on Digital Disruptions Ahead. Retrieved 9 April 2016, from http://www.wsj.com/articles/ciscos-john-chambers-on-the-digital-disruptions-ahead-1423540859

Trefis Team. (2015). Reasons Why Google's Latest AI-TensorFlow is Open Sourced. Retrieved 5 January 2016, from http://www.forbes.com/sites/greatspeculations/2015/12/01/reasons-why-googles-latest-ai-tensorflow-is-open-sourced/

Turing, A. M. (1950). Computing machinery and intelligence. ***Mind***, 433–460.

Von Hippel, E. (2001). Innovation by user communities: Learning from open-source software. ***MIT Sloan Management Review***, ***42***(4), 82.

von Krogh, G. (2015). ***Strategic Management [Powerpoint slides]***.

von Krogh, G., Haefliger, S., Spaeth, S., & Wallin, M. W. (2012). Carrots and rainbows: Motivation and social practice in open source software development. ***MIS Quarterly***, ***36***(2), 649–676.

Vrontis, D., & Vignali, C. (2001). Dairy milk in France-a marketing investigation of the situational environment. ***British Food Journal***, ***103***(4), 291–296.

Wakefield, J. (2015). Intelligent Machines: The jobs robots will steal first. Retrieved 6 April 2016, from http://www.bbc.com/news/technology-33327659

Wang, Y. (2016). Your Next New Best Friend Might Be a Robot. Retrieved 7 March 2016, from http://nautil.us/issue/33/attraction/your-next-new-best-friend-might-be-a-robot

Waters, R. (2016). Artificial intelligence: Can Watson save IBM? Retrieved 4 February 2016, from

http://www.ft.com/cms/s/2/dced8150-b300-11e5-8358-9a82b43f6b2f.html

Weinberger, M. (2015). The cloud wars explained: Why nobody can catch up with Amazon. Retrieved 4 February 2016, from http://uk.businessinsider.com/why-amazon-is-so-hard-to-topple-in-the-cloud-and-where-everybody-else-falls-2015-10

Westerman, G., Bonnet, D., & McAfee, A. (2014). ***Leading Digital: Turning Technology Into Business Transformation***. Harvard Business Review Press.

Widrow, B. (1962). Generalization and information storage in networks of adaline 'neurons'. ***Self- Organizing Systems***, 435–461.

Widrow, B., & Hoff, M. E. (1960). Adaptive switching circuits. ***IRE WESCON Convention Record***, 96–104.

Wigginton, C. (2016). Telecommunications Industry Outlook 2016. Retrieved 24 February 2016, from http://www2.deloitte.com/us/en/pages/technology-media-and-telecommunications/articles/telecommunications-industry-outlook.html

Wilkinson, W. (2007). In Pursuit of Happiness Research Is It Reliable? What Does It Imply for Policy? ***Policy Analysis***, (590), 1–42.

Wilson, H. J., & Bataller, C. (2015). How People Will Use AI to Do Their Jobs Better. Retrieved 13 April 2016, from https://hbr.org/2015/05/how-people-will-use-ai-to-do-their-jobs-better

Winston, P. H. (1992). ***Artificial Intelligence*** (Third Edit). Addison-Wesley.

World Economic Forum. (2016). ***Mastering the Fourth Industrial Revolution***.

Yin, R. K. (2003). ***Case Study Research: Design and Methods***. SAGE Publications.

Yip, G. (1989). Global Strategy ... In A World Of Nations? ***Sloan Management Review***, ***31***, 29–41.

Zhao, L., & Elbaum, S. (2003). Quality assurance under the open source development model. ***Journal of Systems and Software***, ***66***(1), 65–75.

Appendix

Appendix A: Artificial Intelligence Subfields (venturescanner.com)

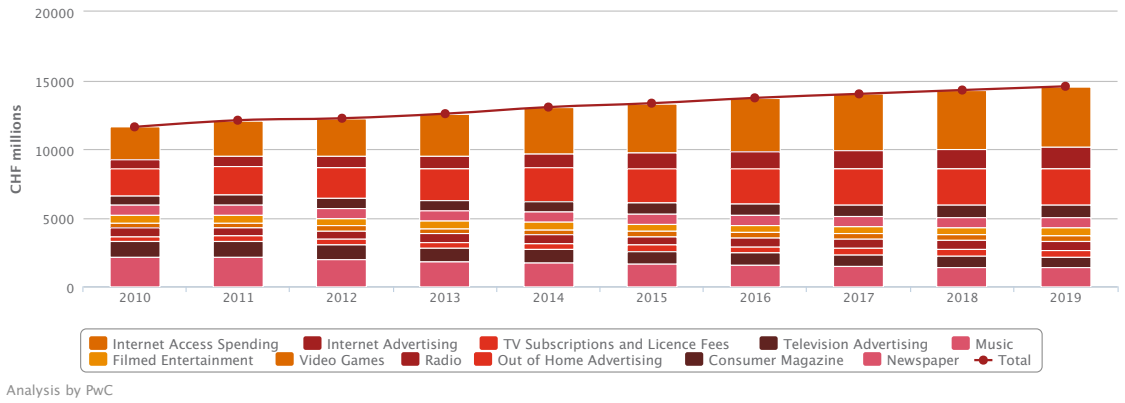
Deep Learning / Machine Learning Applications	Companies using deep learning /machine learning technology in a specific way or use-case in their products.
Computer Vision / Image Recognition	Companies either building computer vision/image recognition technology or using it as the core offering in their products.
Deep Learning / Machine Learning (General)	Companies building deep learning /machine learning technology or utilizing it as the core offering of their product.
Natural Language Processing	Companies either building natural language processing technology or using it as the core offering in their products (excluding all speech recognition companies).
Smart Robots	Smart robot companies build robots that can learn from their experience and act and react autonomously based on the conditions of their environment.
Virtual Personal Assistants	Virtual personal assistants are software agents that use artificial intelligence to perform tasks and services for an individual, such as customer service, etc.
Natural Language Processing (Speech Recognition)	Speech recognition is a subset of natural language processing that focuses on processing a sound clip of human speech and deriving meaning from it.
Computer Vision/Image Recognition	Companies using computer vision/image recognition technology in a specific way or use-case in their products.
Recommendation Engines and Collaborative Filtering	Recommendation engines are systems that predict the preferences and interests of users for certain items (movies, restaurants) and deliver personalized recommendations to them. Collaborative filtering is a method of predicting a user's preferences and interests by collecting the preference information from many other similar users.
Gesture Control	Gesture control is the process through which humans interact and communicate with computers with their gestures, which are recognized and interpreted by the computers.
Video Automatic Content Recognition	Video automatic content recognition is the process through which the computer compares a sampling of video content with a source content file to identify what the content is through its unique characteristics.
Context Aware Computing	Context aware computing is the process through which computers become aware of their environment and their context of use, such as location, orientation, lighting and adapt their behaviour accordingly.
Speech to Speech Translation	Speech to speech translation is the process through which human speech in one language is processed by the computer and translated into another language instantly.

Appendix B: Sources consulted in the Preliminary Phase

Source type	Search Item / Content
Google Search / Google News	"artificial intelligence"; "machine learning"; "Swisscom artificial intelligence"; Swisscom künstliche Intelligenz; "Artificial intelligence industry 4.0"; "Verizon artificial intelligence"; "AT&T artificial intelligence"; "t-mobile artificial intelligence"; "artificial intelligence innovation"; "machine learning innovation"; "artificial intelligence progress"; "machine learning progress"; "artificial intelligence news"; "artificial intelligence breakthroughs "artificial intelligence google"; "artificial intelligence facebook"; "artificial intelligence microsoft"; "ai in telecommunications"; "ubs artificial intelligence report"; "credit suisse artificial intelligence report"; "goldman sachs artificial intelligence report"; "BCG artificial intelligence report"; "McKinsey artificial intelligence report"; "Deloitte artificial intelligence report"; "Bain artificial intelligence report"; "Accenture artificial intelligence report"
Consulting companies' publications	Pricewaterhouse Coopers, Deloitte TTL, Capgemini Consulting, McKinsey & Company, Boston Consulting Group and Accenture
Newspaper / Technology Blogs (best 10)	Forbes, MIT Technology Review, Neue Zürcher Zeitung, Süddeutsche Zeitung, The New York Times, The Wall Street Journal, Business Insider, Wired, Mashable, Stratchery

Appendix C: Swiss Entertainment and Media Market

The PwC Swiss Entertainment and Media Outlook 2015 shows the evolution of the Swiss Media Entertainment and Media Market in the previous five years and makes a prediction for the next four. The overview for the years 2010 – 2019 is depicted in Figure 42.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Internet Access Spending	2352	2572	2765	3039	3343	3607	3865	4087	4259	4402	
Internet Advertising	642	724	772	899	1014	1116	1226	1347	1470	1581	
TV Subscriptions and Licence Fees	1967	2069	2218	2366	2480	2495	2621	2633	2648	2672	
Television Advertising	682	763	741	767.5	798	795	813	835	859	885	
Music	766	747	748	740	743	745	750	754	759	765	
Filmed Entertainment	584	562	551	508	503	498	496	493	499	504	**CHF million**
Video Games	353	360	364	374	404	421	426	431	441	452	
Radio	591	599	612	624	622	632	634	640	646	651	
Out of Home Advertising	366	395	419	418	431	450	443	450	459	478	
Consumer Magazine Publishing	1127	1124	1071	1006	960	919	883	853	824	799	
Newspaper Publishing	2182	2179	1978	1831	1755	1657	1567	1490	1428	1377	
Total	11612	12096	12239	12573	13052	13336	13724	14013	14293	14565	

Figure 42: Overview of the Swiss Entertainment and Media Market 2010 - 2019. Data Source and Graphic: PwC.

Appendix D: Interview Guideline

Introduction

Personal Introduction, scope of the Thesis, Non Disclosure Agreement and presentation of the work done so far.

Interviewee Background

- What is your current position? For how long have you been working at Swisscom?
- What are your current responsibilities?
- What does your Group do (number of people, main products, revenue streams)?

On the Swiss TIME industry

- What are the most important trends in the industry, nowadays?
- How does the convergence of the Telecommunications, Information Technology, Media and Entertainment industries influence the Swiss competing landscape?
- How are global players as Google, Amazon and Netflix influencing the industry?

On Swisscom

- Is the customer experience individual customers expect from Swisscom changing? How?
- What do companies need from Swisscom? Why is Swisscom so successful with Enterprise customers?
- How are players as Google, Amazon and Netflix influencing your strategy? Do you see them as direct competitors? As an opportunity?
- What trends do you see for B2C and B2B in future? Is their relative importance going to change? How?
- How are you differentiating yourself from the other Swiss TIME companies? How from the global players?
- What are Swisscom's Strengths and Weaknesses? (This question – being so important and so broad – often led to a long discussion)
    - What of these are the most important competing with international players?

On the Impact of Artificial Intelligence on the Swiss TIME Industry and on Swisscom

- What impact could Artificial Intelligence have on the Swiss TIME industry? What impact on Swisscom?

- How could Artificial Intelligence capabilities be exploited inside Swisscom?
    - New products?
    - Improvement of existing products?
    - Customer engagement
    - Infrastructure improvement?

- How is Swisscom positioned for exploiting the current new wave of progress in Artificial Intelligence?
    - How much can the company develop in-house? How much is available as open source? What role could Swisscom Venture play?
    - Are there factors giving Swisscom some competitive advantage in exploiting Artificial Intelligence? Is there data only Swisscom has among its competitors?

Closing

Are there any particular topics you would like me to deepen within this thesis?

Could you please introduce me to someone that would allow me to further deepen the results of this interview?

Thank you!

Appendix E: Use Cases Description

First Time Right	The "First Time Right" case describes a situation, in which Swisscom's customer centre is able to immediately and accurately identify the issue the customer is facing.
Personalized Offerings	"Personalized Offerings" stands for the use case, in which Swisscom – leveraging the customers' data at its disposal – proactively offers customers personalized products.
Ad Hoc Nets	"A wireless ad hoc network (WANET) is a decentralized type of wireless network. The network is ad hoc because it does not rely on a pre existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, so the determination of which nodes forward data is made dynamically on the basis of network connectivity."[8]
Preventive Maintenance	The field of "Preventive Maintenance" focuses on avoiding or mitigating the consequences of failure equipment before this actually happens. The deep and analysis of prior failures including the correlation of the parameters as they change allowed by Artificial Intelligence (described in Section 6.3.1.1) would be of great help to this purpose.
Network Security	"Network security consists of the policies adopted to prevent and monitor unauthorized access, misuse, modification, or denial of a computer network and network-accessible resources."[9]
Natural Language Processing	The field of Natural Language Processing is described in Section 2.5.1. This use case stands for Swisscom developing this capability in-house, in particular for Swiss-German. (Such a use case was discussed in more detail with Interviewee 2 and more details are protected by the NDA).
Personal Assistant	A possible use case was discussed in more detail with Interviewee 5 and more details are protected by the NDA.
"Swiss Platform"	The concrete "Swiss Platform" case, Swisscom could realize is protected by a more restrictive NDA. The reader may think of this case as something similar to SK Telecom's "Next-generation platforms" or NTT DoCoMo's "Personal Life Agent" strategies, leveraging the "Local Data Ecosytem" concept presented in Chapter 7.
Optical Character Recognition	This use case stands for Swisscom leveraging Optical Character Recognition skills to recognize the text of printed or handwritten documents it receives from customer every day. The possibility to

[8] https://en.wikipedia.org/wiki/Wireless_ad_hoc_network

[9] https://en.wikipedia.org/wiki/Network_security

	implement it in the customer centre and the related opportunities are currently under study.
Robotics	Being the field of Robotics among the greatest beneficiaries of the recent progress in Artificial Intelligence, the use case was included. With "Robotics" is meant "the branch of mechanical engineering, electrical engineering and computer science that deals with the design, construction, operation, and application of robots"[10]
Predictive Health Intelligence	As the big investments of IBM in the field show, the Health industry could soon be disrupted by Artificial Intelligence. Based on the large amount of Data it is collecting through partnerships and acquisitions, IBM is working at ways to support doctors in the diagnosis of several diseases, even cancer. If such algorithms were available to external companies at some point, Swisscom could take advantage of them and offer very valuable services to its clients: thanks to the trust it inspires and the proximity to local customers, the company would be very well positioned to have a good number of doctors and hospitals storing data in its cloud through the Swisscom E-Health platform.

[10] https://en.wikipedia.org/wiki/Robotics

Appendix F: "Data Availability" and "Technology Exploitability"

The use cases were qualitatively positioned on the framework, using following criteria:

Data Availability

"Data Availability" of a use case was ranked as "high" if the company owns all data necessary to fulfil the use case – now and in the foreseeable future. This is very much the case for those use cases leveraging information about customer's network usage as "First Time Right", "Personalized offerings" or "Network Security". Controlling Swisscom the network, it potentially has all data necessary available. This is not the case for "Natural Language Processing" and "Optical Character Recognition", as to best perform in this field even more data than that available may be required.

The category "medium" was assigned to those cases, for which the company does not have all the data necessary, but could accomplish it through partnerships. This is particularly the case for "Optical Character Recognition" and "Natural Language Processing", for which huge amounts of data are needed and partnerships could be closed (this possibility is actually under study).

"Data Availability" of a use case was ranked as "low" if the company does not have so much data to fulfil its requirements. This can be because it is not part of the core business – as Robotics – or because data collection in the particular area is still at the beginning and not a priority in the company's agenda.

Technology Exploitability

To define the exploitability level of the technology needed to fulfil the use case considered has been much more difficult. This is mainly due to the multiplicity of technical ways to build software products, and the difficulty to assess what is really available on the market and what the resources at Swisscom's disposal are.

"Technology Exploitability" of a use case was ranked as "high" if the company already showed great capabilities in the area in the past – this has been clearly the case for "Network Security" – or if other companies with comparable size could accomplish very good results – as in the case of "Optical Character Recognition", successfully implemented by many companies, nowadays.

The category “medium” was assigned to those cases, for which the needed technology might be available, but the high underlying technological complexity of the case and the computing power needed, make it difficult to realise it soon. This is for example the case of the “First Time Right” scenario, in which the dynamic evolution of the thousands of parameters should be observed and analysed in real-time.

“Technology Exploitability” of a use case was ranked as “low” if the technology is not mature yet or cannot exploit synergies with other technologies developed so far. This is for example the case of “Robotics”, still under development in the biggest technology companies worldwide and to whose progress technology developed so far can barely help.