MESG

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Artificial Intelligence: An Exploratory Study about the Impact on Service

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Ao meu avô.

Abstract

Services are the backbone of modern economies and are increasingly supported by technology. In our time, society is witnessing an accelerated growth of new technologies that are able to learn by themselves, providing more and more reliable results. Authors believe that Artificial Intelligence offers a way to augment human intelligence. Others claim that it is a threat to traditional and human depended jobs. The impact of these emerging technologies in the most important sectors of our society is still mostly unknown, far from being fully uncovered. Furthermore, technology has a pivotal role in service, leading to important and powerful developments. As such, it is crucial to understand how AI will alter and transform service delivery. To achieve a state-of-the-art service design concept, the employment of innovative and cutting-edge technologies is necessary. Thus, these new technologies can provide strategic advantages to companies, especially in the service sector context, but they will have a disruptive effect that will transform the traditional way we provide services.

In this dissertation, a qualitative study based on interviews and following grounded-theory was conducted with ten Artificial Intelligence experts from industry and academia. The objective of this study is to understand the impact of AI on service, namely by understanding current trends in AI, and how they are, and will, impact society and service provision. Along with the inevitable change in employment and job ratio, the customization of customer services and the forthcoming automation in almost all repetitive tasks, this research project also reflects a behavioral shift on service, society and human temperament, alongside with the ethical issues that are equidistant with the evolution of AI. At the same time, the knowledge generated through AI research can be reflected and applied in diverse areas such as medicine, environment, industry, retail, economy, logistics, education, ethics and law.

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List of abbreviations

AGI – Artificial General Intelligence

AI – Artificial Intelligence

ANN – Artificial Neural Networks

ASI – Artificial Superintelligence

BMC – Business Model Canvas

DL – Deep Learning

IBM – International Business Machines

IoT – Internet of Things

GNR – Genetics, Nanotechnology and Robots

HSR – Human Support Robot

ML – Machine Learning

MSc – Master of Science

NLP – Natural Language Processing

NN – Neural Networks

PhD – Doctor of Philosophy

Q&A – Questions and Answers

1 Introduction

Artificial Intelligence (AI) has been defined as "a computational method that attempts to mimic, in a very simplistic way, the human cognition capability so as to solve engineering problems that have defied solution using conventional computational techniques" (Shahin, 2016). Russell & Norvig claim that systems that think like humans, act like humans, think rationally and act rationally can be related with Artificial Intelligence (Russell & Norvig, 2013). Hence, AI is, and will be, increasingly more common in our lives. Google or Amazon products are being integrated in our daily life and many more companies are providing smart services in their own products. When observing AI evolution, it is possible to posit that AI will shape the service field, as careers and opportunities, i.e., jobs, employees and/or tasks are replaced by AI and new service channels also arise (Huang & Rust, 2018). Thus, robotics and AI will create changes in economics and on businesses, bringing new ways of living and sociological effects (Dirican, 2015).

Concurrently, there has been a growing academic interest in services, with more disciplines rethinking their curricula, due to the growth of services (Spohrer & Maglio, 2008). In this way, many companies are facing new demands and intense competition. Therefore, they aim to apply services to differentiate themselves from the competition (Ostrom, Parasuraman, Bowen, Patrício, & Voss, 2015).

Lovelock & Wirtz define services as economic activities that are offered by one party to another, applying time-based performances to bring expected results in recipients themselves or in objects or other assets that purchasers have liability (Lovelock & Wirtz, 2007). This definition has since evolved towards an understanding of service as the process of reciprocal application of resources for others' benefit (Vargo & Lusch, 2008). Furthermore, service customers are expected to obtain value from accessing goods, labor, skills, facilities, networks and systems but not taking ownership of any physical elements involved, in exchange for money, time and effort (Lovelock & Wirtz, 2007).

The interest in technology from a service perspective has also led to a growing interest on smart services (Wuenderlich et al., 2015). According to Wuenderlich et al., smart services are powerful, allowing real-time data collection, continuous communication and interactive feedback (Wuenderlich et al., 2015). However, research on these topics is still in its early stages, despite the accelerating technological development.

Due to the accelerated evolution in technology, it is important to incorporate technological change to improve service strategy (Huang & Rust, 2017). Furthermore, technology in services with a smart oversight has a huge potential, but it requires further research to bring success to organizations and customers (Wuenderlich et al., 2015). Advances in technology are aiming towards a development of new and transforming services, changing how customers behave in purchases (Ostrom et al., 2015). Smart interactive services can offer several paths of research (Wünderlich, Wangenheim, & Bitner, 2013) and it is crucial and far-reaching to understand how will AI alter and transform service delivery.

This dissertation explores the possible impacts of AI in the service sector. To achieve this objective, a qualitative study based on Grounded Theory methodology was performed, involving semi-structured interviews with ten AI experts from academia and practice (Charmaz, 2006; Corbin & Strauss, 1990). This exploratory approach enables a rich and in-depth understanding of what services will be most probably impacted by AI and how.

Next, in this section, a short background of this project is given, as well the problem description. Then, the research questions are presented, as well as the outline of the report.

1.1 Project Background

Service science is "the study of service systems, which are dynamic value co-creation configurations of resources (people, technology, organizations, and shared information)" (Maglio & Spohrer, 2008), and services are moving to the center stage in the global arena, aiming towards a business performance transformation. Therefore, the integration of technology can be an issue when we think in a systematic service innovation, where firms could invest in talent and in technology (Spohrer & Maglio, 2008), especially knowledge-intensive business services aimed at business performance transformation. IBM and many other companies shifted from a manufacturing-dominant logic to a service-dominant logic and to improve and innovate their businesses, these providers rely increasingly in technologies and automation (Maglio & Spohrer, 2008). Thus, the service's market share has shown a major rising, in comparison with the one seen in the production market. This means that manufacturing industries are changing to services industries (Buera & Kaboski, 2009). On figure 1, there is the percentage of labor force in agriculture, manufacturing and services in the USA.

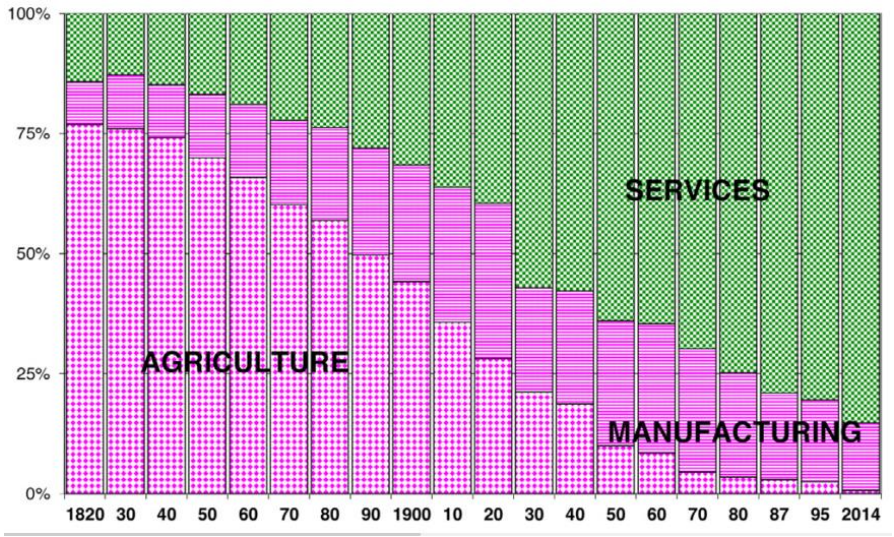

Figure 1 - USA: Percentage of labor force in agriculture, manufacturing and services (Makridakis, 2017)**.**

The traditional mind-set that considered that services jobs would be difficult to automate (even the ones that do not demand any skill) is probably out-dated, where "the abstract, creative, problem-solving, and coordination tasks" can be complemented with automation, normally done by highly-educated workers (Autor & Dorn, 2013). Comparisons to other technology features in other companies are often issues faced by some customers. These are threats that we will face even more, when the era of customized products and services is here, with a very high number of features and high quality. Furthermore, science, knowledge and technologies are evolving at an exponential rate (Goux-Baudiment, 2014) and its impacts on service and society are not sufficiently studied.

These challenges are approached in this study through a grounded-theory and exploratory based strategy with qualitative interviews (Charmaz, 2006; Strauss & Corbin, 1997) with experts from academia and industry, conducted through a detailed and prepared interview script, in order to understand what are the most recent and disruptive developments in AI and how are they going to impact on service, its design and development.

1.2 Problem description and Research Questions

Economies and businesses will transform themselves with robotics and AI. New lifestyles will come up along with sociological side effects (Dirican, 2015), raising questions and concerns towards the impact of these new emerging technologies into society. According to Makridakis, AI revolution has the purpose of replacing, augmenting and complementing almost all tasks that are currently performed by humans, directly competing with them. However, the more jobs are automated, the greater should be the skills for the remaining tasks and other technologies (Makridakis, 2017).

The future is still unknown, but it is expected subjective experiences from machines, just as we do today. Trends show that we are heading for nonbiological systems that are as complex as their biological counterparts (Kurzweil, 2005). Hence, the future in fifteen years may be far different from what it is forecasted. The nature of the machine is still to be figured out, if electromechanical or virtual, and what will be the role of humans throughout this development (Goux-Baudiment, 2014).

These changes will have a profound impact on how service is provided. Some authors claim that AI will reshape jobs, threatening human service jobs (Dirican, 2015; Kurzweil, 2005; Makridakis, 2017). Others say that it will ease the daily life, constituting a major source of innovation (Huang & Rust, 2018). According with Makridakis, “the AI revolution aims to substitute, supplement and amplify practically all tasks currently performed by humans, becoming in effect, for the first time, a serious competitor to them” (Makridakis, 2017). Thus, since services are reliant on technology, the application of AI has a disruptive effect that will transform the traditional way we provide services.

Since smart service is a new subject that is starting to be addressed in service marketing research (Wuenderlich et al., 2015) and has been trending upward along with AI technologies, it is important to address it, since many companies have already implemented it in their businesses. According to Wuenderlich et al., smart services are powerful, allowing real-time data collection, continuous communication and interactive feedback. However, research on these topics is still in its early stages, despite the accelerating technological development. As such, further exploration of the effects of smart services have on organizations should be properly addressed (Wuenderlich et al., 2015).

In every research project, it is important to define what should be the scientific questions to be answered. Research questions normally should be defined for the project in order to begin a focused literature review. However, in qualitative research with Grounded Theory, flexibility is added and the direction of the study could be changed in the middle of the project, whenever new sorts of information are discovered (Neuman, 2014). This dissertation aims to explore the possible impacts of Artificial Intelligence in different sectors, including the service sector and to understand what the future trends of AI technologies could be.

1.3 Dissertation Outline

The dissertation is organized in 6 sections:

Section I – Introduction which includes a project background, a problem description, the research questions and the dissertation's outline;

Section II – Literature review in AI and technology enabled services. Firstly, an historical contextualization of AI is given, along with its definition. Secondly, machine learning, deep learning and current existing applications are briefly presented with some examples of known algorithms that were mentioned during the qualitative study. Lastly, service science, service enabling technologies, AI in services and its impact.

Section III – Explanation of the methodology followed in this study, introducing the relevant literature and the data collection and analysis procedures.

Section IV – Presentation of results, with a deeper analysis of the most important results obtained.

Section V – Discussion, where results are analysed in light of current literature and main take-aways are explored.

Section VI – Conclusion with the main results in a nutshell, theoretical contributions of this dissertation, limitations and future research.

2 Literature Review

In this section, relevant literature is reviewed to address relevant topics for this research. On a first glance, an historical context is given to introduce Artificial Intelligence, alongside with some state-of-the-art examples and technology singularity as a final state of AI and its unfathomable changes on society. Afterwards, the concept of machine learning, its algorithms, deep learning and the most used applications is explained. Lastly, service enabling technologies and AI in services are introduced.

2.1 Foundations of AI

The first recognized AI work was done by Warren McCulloch and Walter Pitts in 1943, with a model of artificial neurons characterized by “on” and “off”. Marvin Minsky and Dean Edmonds built the first neural network computer in 1950. Alan Turing’s work was the most notable with the introduction of the Turing Test in the 50’s, machine learning, genetic algorithms and reinforcement learning (Russell & Norvig, 2013; Turing, 1950).

From 1956 until the early 80’s, AI was scrutinized, where famous new hypotheses were formulated, such as AI programming languages and limited domains known as microworlds. On the other hand, these developments suffered with the lack of significant technology and the behindhand scientific knowledge. From 1980 to the present, a large investment from the industry towards understanding and building AI systems was started to be seen. Neural Networks started to be again a trending subject, as well as Data Mining and concepts such as the Human-Level AI, Artificial General Intelligence - computers as smart as humans - and Big-Data (Gurkaynak, Yilmaz, & Haksever, 2016; Russell & Norvig, 2013).

State-of-the-art examples of AI technologies such as robotic vehicles, speech recognition, autonomous planning, machine translation and image recognition for skin cancer classification are expected to be seen in a near future. In the service sector, chatbots, robotic service providers and intelligent agents are also emerging technologies (Huang & Rust, 2017, 2018; Makridakis, 2017; Russell & Norvig, 2013). For Davis, the best way to understand the state-of-the-art of AI technologies is by illustrating simple but narrow defined AI actions through examples (Davis, 2012), such as:

- Recognizing birds in image: A program that recognizes major components of a bird's body (body, head, wings, legs) and identifies the category of bird (duck, heron, hawk, owl, songbird) in pictures of birds achieved a precision of about 50 percent on finding the components, and about 40 percent on identifying the category (Farrell et al., 2011).
- Identifying images that match simple phrases: A program was developed to identify images in a standard collection that match simple phrases. E.g. at a 50 percent recall cut off, the precision was about 85 percent for "person riding bicycle" and 100 percent for "horse and rider jumping." For other phrases, it was much less successful; e.g. at 50 percent recall, the precision was below 5 percent for "person drinking [from] bottle," "person lying on sofa," and "dog lying on sofa" (Sadeghi, M. A., & Farhadi, 2012).
- Coreference resolution: A state of the art system for coreference resolution—identifying whether two phrases in a text refer to the same thing or different things—achieved success rates ranging from 82 percent recall and 90 percent precision to 40 percent recall and 50 percent precision, depending on the source of the text and the grammatical category involved (Kong, Zhou, Qian, & Zhu, 2010).

- Event extraction: A program for identifying events of a specified type in news articles; specifically, for identifying the event trigger, the arguments, and their role. For example, in the sentence "Bob Cole was killed in France today," the trigger for the event die is "killed," the arguments are "Bob Cole" and "France" and the roles are victim and place respectively. There are 33 different event types. The system achieved an F-score (harmonic mean of recall and precision) of 56.9 percent on trigger labelling, 43.8 percent on argument labelling, and 39.0 percent on role labelling (Liao & Grishman, 2011).

Further in the future and according to Miller, technological singularity is “a threshold of time at which AI’s that are at least as smart as humans, and/or augmented human intelligence, radically remake civilization”. Technological singularity could be possible if real-world reasoning issues would be avoided (Davis, 2012).

According to Kurzweil, a superintelligence will thrive leading to a technological singularity (Čerka, Grigienė, & Sirbikytė, 2017) and after the nanotechnology settle in the society, virtual reality will became a common feature within the nervous system and the human society will have the possibility to be a different person, physically and emotionally. Hence, Kurzweil predicted that computers will reach human intelligence around 2029 while Singularity will come by 2045 (Kurzweil, 2005).

Makridakis summarized four possible upcoming scenarios described also from some researchers for the tasks and roles of humans when AI technologies could perform better (at an affordable cost) all tasks that humans do: the Optimistic, where Genetics, Nanotechnology and Robots (GNR) would revolutionize everything; the Pessimist, where GNR would threat human species; the Pragmatist, where the possible consequences of AI are seen as negatives; and the Doubter, who do not believe in AI and its harmful and threatful implications to humanity (Makridakis, 2017).

Although far from the futuristic scenarios illustrated by these authors, nowadays, technology can be found everywhere in service and it is the main origin for innovation, empowering firms to leverage its benefits based to their strategic position. Furthermore, it can aid firms to standardize, customize, transact and rationalize service (Huang & Rust, 2017). However, it needs to be adequately deployed to support service innovation, in order to provide seamless customer experiences and bring great pledge to service (Grenha Teixeira et al., 2017).

In order to understand some of the concepts that are going to be presented throughout this dissertation, machine learning, some of its algorithms and deep learning methods are narrowly introduced.

2.2 Machine learning

Back to 1954, using the game of Checkers, A. Samuel programmed a computer through a set of pre-defined parameters in which the digital computer could learn to play better just by going in all possible directions and actually learning from itself (Samuel, 1954). That was the beginning of the term “Machine Learning”, which is an intelligence algorithmic technology that enables its improvement through acquiring, encoding and storing learned information for prediction, reasoning and hypothesis generation (Greenwald & Oertel, 2017).

Depending on the nature of its learning process, its algorithms can be divided into different categories: supervised learning, unsupervised learning and semi-supervised learning, all

dependent on the level of labelled and/or unlabelled data, in order to improve its algorithm, clustering or not the information through their similarity (Silva et al., 2017).

There are several algorithm methods in machine learning (ML), all belonging to the three different categories presented in the previous paragraph.

According to Witten, Frank, Hall, & Pal, in order to understand the algorithms that are used for real-world applications, it is necessary to present some of the basic and rudimentary learning algorithms (Witten et al., 2016):

Naïve Bayes – used in the field of document classification, assumes that all attributes are independent of each other in the respective context (Mccallum & Nigam, 1998). From Witten et al., 2016, "The moral is, always try the simple things first.", being Naïve Bayes a very simplistic model of probability used in simple examples.

Decision Trees ("divide-and-conquer") – being a decision support tool and having in consideration all possible consequences, classifies all new instances with a "yes" or "no" with the representation of the expected information (Witten et al., 2016).

"Separate-and-conquer" – starting by identifying a rule that covers the more instances in the class (excluding the ones that aren't), basically this algorithm will keep learning and acquiring rules until all or most of positive instances are covered without (or without most of) negative examples (Fürnkranz, 1999).

Association rules – often used in binary situations and for very large datasets, it is a method for locating concerned relations between datasets (Witten et al., 2016).

Linear models – the most known methods are the linear regression and logistic regression. Using numeric attributes instead of the nominal attributes, they are predictions, measuring the relations and probabilities between the dependent variables and one or more independent variables (Witten et al., 2016).

Instance-based learning - using only specific instances to solve incremental learning tasks and generating classification prediction, instance-based learning include a set of stored instances (Aha, Kibler, & Albert, 1991) with a distance function that is used to determine which member is closest to an unknown test instance (Witten et al., 2016).

Clustering – since clustering involves several techniques in which its result can be expressed (Witten et al., 2016), it will only be explained what it is generally the algorithm. Bishop defines a cluster as "a group of data points whose inter-point distances are small compared with the distances to points outside of the cluster" (Bishop, 2013). Clustering algorithms are based in probability density estimation, classifying new data according to the clusters already discovered (Witten et al., 2016).

Multi-instance Learning – when complex applications of machine learning happen that the learning system has incomplete knowledge about each training example (Dietterich, Lathrop, & Lozano-Pérez, 1997), it is called multi-instance learning, where the best approach could be grapple the problem, transforming it into a single-instance problem (Witten et al., 2016).

2.2.1 Complex machine learning Algorithms

To be up to the real-world problems, ML algorithms need to be much more powerful, although the principle is basically the same as the simple ones explained before, like for example support vector machines, probabilistic methods (principal component analysis and Dirichlet allocation),

ensembles of nested dichotomies, singular value decomposition, independent component analysis, and much more (Witten et al., 2016). However, newly methods of ML are also arising, like deep leaning, which is a complex ML algorithm that we will focus more in this work. In order to understand what DL requires, we should first know what Standard Neural Networks are, in order to understand the applied Artificial Neural Networks and how it steps in into AI.

According with Schmidhuber, a Standard Neural Network is a network of several neurons in a simple status, which produce activations with a defined frequency (Schmidhuber, 2015). As Dayhoff & DeLeo wrote in their paper about Artificial Neural Networks, ANN are "highly robust multifactorial mathematic models" inspired by biological neural networks, diverging from conventional methods from changing as the changing is taking place, being neural networks nonlinear summing devices (Dayhoff & DeLeo, 2001).

2.2.2 Pattern recognition

One of the main applications of machine learning since the beginning of the decade is pattern recognition, being a field that is concerned with the automatic discovery of regularities. It is based on proper categorization with new examples that differ from those used in training sessions – generalization – the central aspect in pattern recognition (Bishop, 2013).

Human intelligence was always strong in the ability of recognizing patterns. With the development of machine intelligence, AI will be able to master pattern recognition with the speed, accuracy and memory capacity of an intelligent machine (Kurzweil, 2005). Furthermore, it is inherently pertinent to relate it with supervised Artificial Neural Networks, since the best technologies with Neural Networks have won several competitions in Pattern Recognition (Schmidhuber, 2015).

2.3 Deep Learning

When a computational model composed of several processing layers acquires data representations with multiple levels of abstraction, then we are talking about DL. It is commonly used in voice and visual recognition, in medicine and many other scientific areas (Lecun, Bengio, & Hinton, 2015). Artificial Neural Networks, being the base of DL and inspired by models of living neurons, follow non-linear approaches of summing devices, therefore, extremely complex multi-layered systems (Dayhoff & DeLeo, 2001). In a short form, the machine freely finds the best path automatically to either detect or classify, through raw data previously introduced (Lecun et al., 2015).

> *Just as humans do, cognitive systems are driven to understand things by decomposing expressions of an idea and then combining that with context.*
>
> (High, 2012)

When we speak about the Artificial Intelligence state-of-the-art, we should also speak about representation learning, which is a set of methods used for classification using raw data and DL methods using several levels of representation, starting from the raw input and climbing to an abstract level, leveraging AI to a new era of problem solving (Lecun, Bengio, & Hinton, 2015). Although Artificial Narrow Intelligence technologies are getting even more impressive, with the perfect understandability of what a human need, want or say, they are still not in a general

level, where they could be capable of performing everything intellectual that a human can (Gurkaynak et al., 2016). That's why often ambiguities are often a problem. Many of these ambiguities can be solved using simple rules that are acquired using simple comparisons. However, a part of them can only be resolved using a very rich understanding of the subject matter (Davis, 2012). NLP systems may help to solve this problem. They can flag ambiguous texts, being today a condition where it can be used in real world applications, highly used in Requirements Engineering (Huyck & Abbas, 2000).

One known example of a type of cognitive system that employs Deep Natural Language Processing employment is the IBM Watson. It generates and evaluates hypotheses with dynamic learning, achieving accuracy by attempting to approach nearly as much context as possible getting it within the passage of the question and from the knowledge base. Furthermore, IBM Watson is also used in other areas, such as Oncology diagnosis, utilization management, credit analysis and basic research (High, 2012).

Real-World Reasoning is one of the most difficult tasks to relate with AI, due to the fact that it is something inherent in the Human mind-set, out of the scientific reasoning, affecting directly the quality which tasks of an AI system could be carried out (Davis, 2012). In Lecun, Bengio, & Hinton, major progress in artificial intelligence is claimed to arise "through systems that combine representation learning with complex reasoning" (Lecun et al., 2015).

2.4 Service science and technology in services

Being service science the study of service systems, which are "dynamic value co-creation configurations of resources" – people, technology, organizations and shared information (Maglio & Spohrer, 2008), it is important to address the future developments of technology and its implications on society. As such, further exploration of the effects of smart services have on organizations should also be properly addressed (Wuenderlich et al., 2015). When we think about adding value through a service, we must be aware that the customer shall be at the center of the process of designing a service. After all, customers do not seek products; they seek satisfaction (Michel, Brown, & Gallan, 2008). To effectively leverage technology and enable a seamless customer experience across interfaces and systems, service design and implementation must be carefully managed (Grenha Teixeira et al., 2017). However, technology in services has some challenges, especially when they are implemented in existent business models. Organizations require adaptations in their business models and their services offerings need to hold new smart business models. Thus, collaborations between researchers and managers are beneficial for the development of smart service offerings (Wuenderlich et al., 2015). Design thinking can be the answer, as it is a very known methodology, which uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity (Brown, 2008).

In a service encounter, aside from the fact that this represents a cross- disciplinary process integrating technical knowledge with psychological knowledge of interaction dynamics, it has been verified that when social robots show innovative service behaviours during a service encounter, they normally exceed customer expectations and deliver exceptional experiences to customers (Stock & Merkle, 2018). Being AI and smart technologies the disruptive state-of-the-art, they can help to provide better and better service over time (Huang & Rust, 2017). However, the study of AI in service is still in an initial stage.

2.5 Artificial Intelligence in Services

According with Huang & Rust, the theory of artificial intelligence job replacement is based on the premise that there are four types of intelligence which will be mastered by AI chronologically – mechanical, analytical, intuitive and empathetic – being the first one the easiest to master and the last one the harder to overcome. Furthermore, portraying what humans do nowadays and define what can be augmented by machines is known as Augmentation (Davenport & Kirby, 2015). That is why Huang & Rust theorized in their article a second and third theory that the job replacement will happen at the task level, from the easier and lower skilled intelligent tasks (mechanical) to the higher intelligence tasks (Huang & Rust, 2018). On figure 2, there is a conceptual representation of the four intelligences from Huang & Rust.

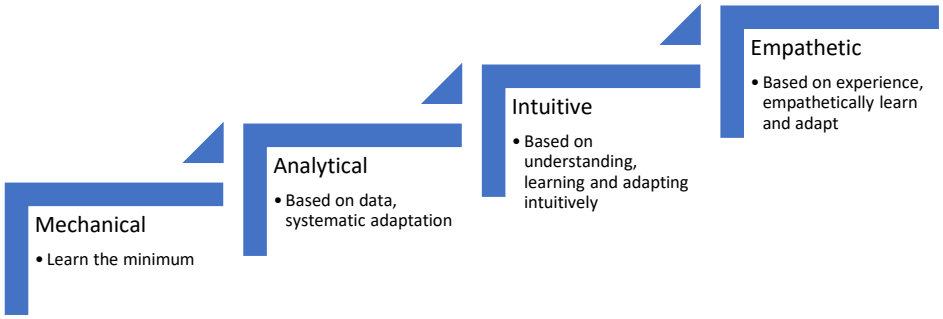

Figure 2 - The Four Intelligences (Huang & Rust, 2018)

2.5.1 Mechanical Intelligence

According with Ulrich, Mechanical Intelligence is the possibility "to imbue a mechanism with the ability to respond and react to the environment without guidance from a controller" (Ulrich, 1989). The tasks that normally embed this type of intelligence include the ones who don't require further education or skills, like call center agents or waiters/waitresses (Huang & Rust, 2018). An everyday use that we give to one of the most known tools which is Google, Bing or any other type of search engine platform is considered a type of AI, included in the category of Mechanical Intelligence, because it retrieves the most relevant information, according with previously done searches. A further profound change could happen with the self-driving cars, which can be considered a very good example of an AI (Del Prado, 2015).

Concerning mechanic types of AI, service robots are already at this stage. Some studies have been performed, where positive responses have been obtained, when innovative service behaviour is performed, leading to "customer satisfaction and delight with the Humanoid Service Robot" (Stock & Merkle, 2018). Furthermore, these social assistive robots can bring value in a social context, because they can be evaluated similarly to human actors, if equipped with both assistive and social resources (Čaić, Odekerken-Schröder, & Mahr, 2018).

But how can we deal with such a "fast-projectile" which is the human-robot interaction, facing this emergence of exponential growth of technology and mastery related to robots? (Goux-Baudiment, 2014). In the intuitive and empathetic intelligences, we will include some examples of deep and complex AI interfaces like IBM Watson and Humanoid Service Robots like "Sophia".

2.5.2 Analytical Intelligence

Whenever there is information that needs to be processed, analysed, evaluated, judged and compared, the need of Analytical Intelligence is appropriated (Sternberg, 2005).

Problem solving, logical and mathematics are primary characteristics that define Analytical Intelligence, normally acquired by training and refined by cognitive thinking, usually used by "computer and technology-related workers, data scientists, mathematicians, accountants, financial analysts, auto service technicians, and engineers" (Huang & Rust, 2018). Although it is not possible for Analytical Intelligence to simulate intuition, since it is very hard to simulate, machine learning (ML) and Internet of Things (IoT) are two concepts which can be thoroughly studied, which can lead us in the future to evolve to an intuitive artificial intelligence state. The collection of data and inter-machine communication are the two main and most important features of AI that it is known in the service field (Huang & Rust, 2018). IoT, according with Xia et. al., 2012, "is a networked interconnection of everyday objects, which are often equipped with ubiquitous intelligence", making possible the rising of "everywhereness" of the Internet, by embedding every object into systems, making possible to communicate with human beings or other devices through distributed communicating networks (Xia, Yang, Wang, & Vinel, 2012).

2.5.3 Intuitive Intelligence

Intuitive intelligence requires a higher state of creativity and problem solving abilities, like management consultants, lawyers, doctors and marketing managers have (Huang & Rust, 2018). This type of intelligence distinguishes from the analytical one because it can analyse several data, understand the subject and the content of a certain fact. As Del Prado defends, if a certain system could read all pages of millions of books that are related to a specific subject and actually understand how to combine them all in a single answer, we would have evolved then to a new level of intelligence (Del Prado, 2015). Tasks that are creative, chaotic, things that most skilled humans in sports or entertainment do, require intuitive intelligence for providing the best service they can. (Huang & Rust, 2018).

2.5.4 Empathetic Intelligence

Seddon & Biasutti present an example in music of how empathising is intrinsically connected with interpersonal social skills and requiring collaboration towards creativity (Seddon & Biasutti, 2009). From a service provision perspective, the way employees show their emotions while fulfilling service tasks to a certain customer defines how good the service was, from the customer point of view. An example is a flight attendant or a psychiatric doctor (Huang & Rust, 2018).

Empathetic intelligence is different from emotional or cognitive intelligence, being the connection between thinking and feeling, inspired by intuition and reflective practice, requiring recognition on a complex system between culture and human responsiveness (Arnold, 2005). Being directly connected with people and with others' feelings, it is a type of intelligence normally required by psychologists or customer-related personnel (Huang & Rust, 2018).

This is the most difficult stage of intelligence to simulate in a machine, due to the fact that "emotion is considered a biological reaction" (Huang & Rust, 2018). As Fabrega states, cognitive-emotional space of consciousness has always mapped the humans, from pre-historical times to what we are today (Fabrega, 2000). In Turing, the AI pioneer Alan Turing starts his

book with the following statement: “Can machines think?”. The Turing test determines if a computer can think like a human based on their behaviour (human or computer) observed by an outsider, not mattering how they achieved that level (Turing, 1950).

Reaching this type of intelligence is very hard on Artificial Intelligence machinery, and some are often designed not to look humanoids, for ethical purposes. Some examples are *Han* and his more intelligent and recent version – *Sophia* – who was recently awarded with a Saudi Arabian citizenship (Huang & Rust, 2018). Furthermore, it is expected that computers will pass successfully the Turing test, indicating intelligence indistinguishable from humans, by the end of this decade (Kurzweil, 2005).

Philip Van Loocke introduces in his book “The Physical Nature of Consciousness” the concept of what is consciousness and in what aspect can we compare the level of consciousness in a quantum version of artificial intelligence technology, being our intuition a leverage feature to define what has or not consciousness (Loocke, 2001).

3 Methodology

This research aims to explore the impact of artificial intelligence on service and understand what the future trends of AI could be. Qualitative research helps to address these exploratory questions, enabling researchers to address "why" and "how" questions, as opposed to quantitative research that is focused on measuring and validating (Neuman, 2014). As such, this study followed a qualitative approach based on Grounded Theory (Charmaz, 2006) involving semi-structured interviews with experts in AI, both from academia and industry.

Neuman explores two categories for acquiring data which are quantitative (numerical) and qualitative (words). Both quantitative and qualitative data are related with conducting social science research, both sharing core scientific principles but differing in their steps and purposes (Neuman, 2014). Quantitative methods, while useful, are unable to translate people's experience purposefulness (Creswell, Hanson, Clark Plano, & Morales, 2007).

Qualitative methods offer a more flexible approach and are specific for a given context (Neuman, 2014). This project was developed with an exploratory path, requiring a qualitative method, for its challenges and information acquiring mechanisms. The sample involved AI experts (researchers and developers), and was collected through semi-structured interviews (Corbin & Strauss, 1990) and followed a previously defined script (Appendix B).

All the gathered data was literally transcribed, coded and analysed using a Computer-Assisted Qualitative Data Analysis Software (NVIVO11®).

3.1 Qualitative study and Grounded Theory

In the 60's, when quantitative researchers saw qualitative methods as unsystematic and biased, Barney G. Glaser and Anselm L, Strauss made innovative statements with notions of systematic strategies and procedures for qualitative studies - the Grounded Theory Methods – a methodical and standardized method, although limber enough, allowing the reshape and improvement of the data collected. According to Charmaz, "Strauss brought notions of human agency, emergent processes, social and subjective meanings, problem-solving practices and the open-ended study of action to grounded theory." Nowadays, Grounded Theory is well-established between the scientific community (Charmaz, 2006).

Constant comparative analysis and the arise of theoretical thoughts are pivotal aspects of the methodology of Grounded Theory (Strauss & Corbin, 1997). Thus, to avoid overgeneralization, premature closure and false consensus, it is important to rely on this kind of research processes. This study has the benefit of gathering the subject's experience (Neuman, 2014). It is also important to mention that all Grounded Theory is based on data, fostering the possibility to bring new data perspectives in an exploratory and analytic way, in order to develop right from the beginning of the project a theoretical analysis (Charmaz, 2006).

According to Glaser and Strauss (Glaser, 1978; Glaser & Strauss, 1967; A. Strauss, 1987), Grounded Theory practices are based on:

- Symbiotic involvement between data collection and forthcoming analysis, to bring new and relevant aspects to further interviews. In Neuman, the term "adequacy" was addressed from the statement of Morse (Neuman, 2014): "In qualitative research, adequacy refers to the amount of data collected, rather to the number of subjects as in quantitative research. Adequacy is attained when sufficient data has been collected that saturation occurs" (Morse, 1994).

- A categorization from the gathered data and further coding to analyse is important, and not from preconceived logically deduced hypotheses. Glaser & Strauss assume that Grounded Theory is more successful than theories logically deduced from a priori assumptions (Glaser & Strauss, 1967);

- The use of the constant comparative method has the purpose of generating theory more systematically and help the researcher to bring the data "in a form clear enough to be readily". Thus, it makes probable "the achievement of a complex theory that corresponds closely to data" (Glaser & Strauss, 1967), which involves making comparisons during each stage of the analysis;

- Advancing theory development during each step of data collection and analysis, towards an improvement of notions and concepts, being the analyst imposed to develop propositions on a high general level than the qualitative material being analysed (Glaser & Strauss, 1967);

- "Sampling aimed toward theory construction, not for population representativeness." (Glaser & Strauss, 1967). The aim is to reach experts of a well-defined population in a relevant subject, not yielding to a random representative population (Charmaz, 2006). The objective is to achieve a theoretical category saturation.

Grounded Theory methods demystify qualitative inquiry management and facilitate research and motivation (Charmaz, 2006). The most relevant aspects for this dissertation of Grounded Theory, such as sampling, data collection and coding, are going to be explained next.

3.2 Sampling

"Sampling aimed toward theory construction, not for population representativeness"

(Glaser & Strauss, 1967)

For any qualitative study and depending on the objective of the study, the sampling definition and randomness should be appropriately evaluated (Marshall, 1996). This study was based on a qualitative approach, where data was obtained from a sample of experts with the objective of obtaining theoretical saturation as an indicator of no new properties of categories during data collection (Charmaz, 2006). Furthermore, Marshall states that "choosing someone at random to answer a qualitative question would be analogous to randomly asking a passer-by how to repair a broken down car, rather than asking a garage mechanic" (Marshall, 1996). Random sampling would not be suitable to this particular study, due to the complexity of the topic.

There are three approaches for selecting a sample in a qualitative study: convenience sample, which requires the less amount of time, effort and money but may result in poor quality results; judgement sample, in which the researcher selects the most productive sample for the case and the last one is the theoretical sample, which is the one used in this work and it is the basis for a Grounded Theory study. It requires interpretative theories from the emerging data in order to select a new sample (Marshall, 1996). According to Glaser & Strauss, theoretical sampling provides constant direction to researchers, giving purpose and confidence (Glaser & Strauss, 1967).

Taking in consideration the object of the study, a sample of ten AI experts from academia and industry was chosen. In table 1, there is the socio-demographic information of the respondents, distributed by age, education level and occupation.

Table 1 – Socio-demographic information of the sample

	Male	*Female*	*TOTAL*
Age			
20-29	3	0	**3**
30-39	3	1	**4**
40-49	0	1	**1**
>50	1	1	**2**
Education Level			
Master of Science (MSc)	2	0	**2**
Doctor (PhD)	5	3	**8**
Occupation			
Data-Scientist	3	0	**3**
Bioengineer / Researcher	1	0	**1**
Informatic Engineer / Researcher	1	0	**1**
University Professor	2	3	**5**

3.3 Data collection and analysis

Data for this study was collected between the 20th of March and the 4th of May of 2018. Firstly, a selection of AI experts was done, based on their professional activity. Either these experts work on companies performing with AI or are researchers on the topic. All the interviewees were contacted by e-mail to explain the objectives of the study and, if agreed upon, the interviews were scheduled. Nine of ten of the interviews were performed through video chat using Skype. The remaining interview was done face-to-face. Before the session, the interviewer began with an introduction about the project and the purpose of the study. A contextualization was also included to offer guidance to the interviewee (Foddy, 1994). All the interviews were audio recorded and further fully transcribed for a thorough analysis. An informed consent was given and signed by the interviewee and the respondent, that included assurances of confidentiality and anonymity of the interview (Appendix A). The questions were made in an easy and understandable way, and every time the answer was not fully understood by the interviewee, it was rephrased and clues were given in order to make the message totally clear (Foddy, 1994).

The interview script (Appendix B) was followed to obtain a common structure for all interviews, ensuring that all relevant subjects were covered. However, the respondents come from different cultural and social situations and there were different ways to answer the same question. Therefore, an open-ended approach was sometimes taken in consideration (Neuman, 2014), meaning that interesting topics that emerged during the interview were subjected to further questioning. This is aligned with Grounded Theory precepts that allow for flexibility that can bring further richness to the collected data (Charmaz, 2006).

The interviews were fully transcribed and analysed with NVIVO 11® software. The analysis process was progressive, where several elements of different interview texts were compared and aggregated in different codes (Charmaz, 2006; Corbin & Strauss, 1990) with the objective of not missing any relevant information in the interviews. It is pretended with coding a "quantification" of non-numerical information (Neuman, 2014). On figure 3, it is possible to see the coding evolution of an example of a citation from one respondent, from the open coding, until the selective coding.

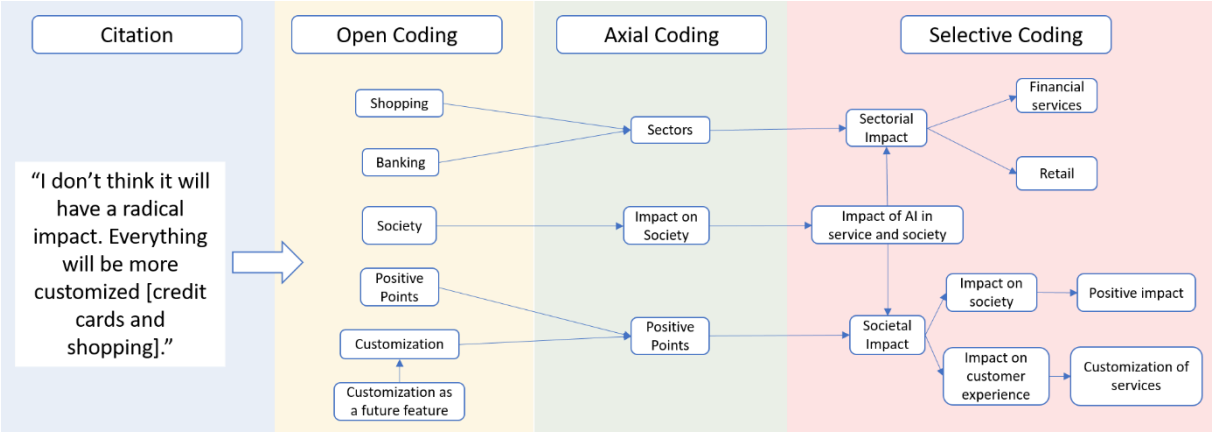

Figure 3 – The different coding evolutions using a citation example

Corbin & Strauss define coding as an analytical process to categorize the acquired data (Corbin & Strauss, 1990). Following Grounded Theory coding procedures, there are three types of coding: open coding, which consists in constant comparisons, with a set of major categories of information, where initially data was broken down through subjectivity and bias to gain new insights, by always making systematic comparisons in order to classify and categorize properly codes (Corbin & Strauss, 1990; Creswell et al., 2007), axial coding, where previous categories merge into subcategories and relationships are proved and selective coding, which usually occurs in later phases of the study (Corbin & Strauss, 1990), with the purpose of examining the previous codes to identify major concepts, in which all categories are organized around this major theme.

4 Results

In this section the results of the qualitative study are depicted. They are represented throughout different sections that were defined during the analysis and coding of the interviews. Firstly, the framework that emerged during data analysis is explained. Afterwards, the main categories are introduced and divided by sectorial and societal impacts, following the coding pattern that emerged from the analysis. Every sector will be represented through a table that includes the coding tree generated from the interview analysis. When explaining the categories, citations from the customers are also provided to add further detail. The codes with the most sources are highlighted, and the full coding tree is represented in the Appendix D.

4.1 Framework

After all interviews being fully transcribed, they were deeply analysed using the fundamentals of Grounded Theory methodology. The codes emerged from this analysis reflecting sectorial impacts and societal impacts with positive and negative impacts, challenges and barriers and also possible practical real-world applications, as it can be seen below on figure 4, where a conceptual framework was built to illustrate the organization created from the coding system.

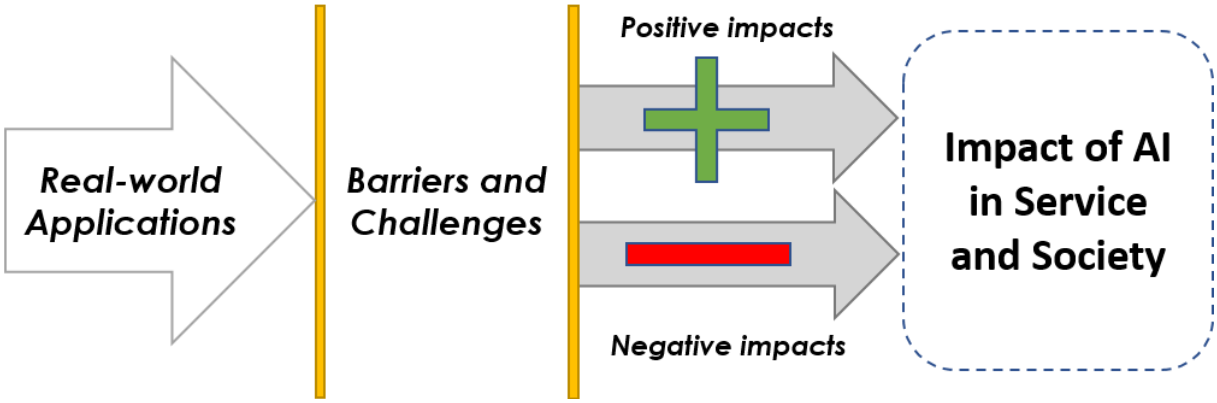

Figure 4 – Conceptual framework of the first level of categories for the impact of AI in service and society

4.2 Categories

The codes from the interview's information were aggregated by different categories: impact of AI in service and society; metadata, where the coding system aggregated information that is not relevant for the result, but for identification and sampling organization; AI trends, where the most significant trends in AI are exhibited and finally, AI state-of-the-art, which shows the actual and future directions of AI technologies. Coding trees and citations from the respondents are also provided along this section to add further detail and the full coding tree can be seen in the Appendix D. Nevertheless, the impact of AI in service and society is the category that we will give further consideration, due to the fact that a major part of the gathered data and categorization through coding was in this category (Charmaz, 2006).

4.2.1 Impact of AI in service and society

In this section, there were identified from our respondents' interviews fourteen sectors on society that could have direct impact from AI development. They were divided into two major sections: societal impacts, due to the stratification of the interviews and referral to different collaborative and structuralist groups on society, and sectorial impacts, which refer directly to practical subdivisions on sectors that affect economy. These categories are shown on table 2.

Five sectors (impact on social behaviour, science and technology, labor, healthcare and industry) were referred from all ten sources. This section will describe each of these impacts, following the conceptual framework presented previously.

Table 2 – Impact of AI in service and society

Societal Impacts	Sources (n=10)	Sectorial Impacts	Sources (n=10)
Impact on social behavior	10	Impact on science and technology	10
Impact on labor	10	Impact on industry	10
Impact on legal aspects	8	Impact on healthcare	10
Impact on ethic aspects	7	Impact on customer experience	9
Impact on education	6	Impact on transportation and autonomous driving	9
Impact on home	5	Impact on financial services	4
Impact on environment	4	Impact on retail	4

4.3 Societal impacts

In this section, the results regarding the societal impacts of AI are presented. These societal impacts, while not directly focused on service, bring important implications to the design and development of new services using AI. These implications are detailed in section 5.

Following table 2, this section details all the impacts from the ones with most sources – impact on social behavior – until the one with the least sources – impact on environment.

4.3.1 Impact on social behavior

As shown in table 3 with the coding tree for impact on social behavior, when respondents were asked about impact on society in general, all ten sources referred barriers and challenges in which most difficulties for AI development were caused by humans, or the need of explanation from the AI algorithms.

Table 3 – Coding tree for impact on social behavior

Name	Sources	Name	Sources
Barriers and challenges	**10**	**Negative impact on Society**	**8**
Difficulties originated by humans	8	*Replacement*	6
Explanation	6	*Imbalance*	5
Privacy issues	2	*Isolation*	2
Weak implementation of AI in our society	1	**Applications**	**2**
Positive impact on society	**9**	*Recommendation based on the people's image*	1
Adaptation	8	*Drone delivery of first goods in remote areas*	1
Humanity thriving	5		

"There will be one challenge: fight the first fear of people using these systems."

Male, Data Scientist

"If we do not know ourselves, how can we reproduce ourselves in a machine?"

Female, University Professor

Nevertheless, the positive impact on society was the second most referred subject regarding social behavior. Eight sources gave positive impressions concerning the ability of humans to adapt to a forthcoming AI development and five claimed that humanity will thrive even with AI development, because there are inherent social skills in humans that AI will never imitate. Also, three respondents refer that with AI, humans will have more free and quality time.

"Nothing will be imposed (...). Organizations are aware of necessities and will adapt themselves. It shows that society is already anticipating change."

Female, University Professor

"There are people who say that in the future we will have more free time."

Female, University Professor

However, replacement, imbalance and isolation are still issues that the respondents refer as possible negative impacts triggered by the development of AI. Privacy loss or fear of AI technologies overtaking human place in the society in general were issues referenced several times during the interviews.

4.3.2 Impact on labor

The impact on labor had also strong representability among interviews, with eight sources mentioning that with the evolution of technology, there will be a positive and smart redirection of the current professions that we know today. Below, there is table 4 with the coding tree for impact on labor.

Table 4 – Coding tree for impact on labor

Name	Sources	Name	Sources
Positive impact on society	**8**	*Unemployment*	5
Smart redirection of Human Resources in the society	6	*Replacement of jobs*	2
Repetitive tasks automation	5	*Everything that doesn't require creativity can be replaced by AI*	2
No necessity of the humanity to work in the future	1	**Applications**	**6**
Acquisition of new capabilities and competences due to AI impact	1	*Creation of new professions*	6
Negative impact on Society	**7**	**Barriers and challenges**	**1**
Human labor employment unawareness	5	*There is a lack of experts in AI area*	1

AI will influence the way firms operate and how they are managed, leading to an unavoidable shift in employment. Five of the respondents also made a positive reference to the automation of repetitive tasks. The recent developments in ML will reduce the labor tasks demand that can be routinised. However, there is a big paradox and dilemma by the replacement of human work forces by robots and artificial intelligence, according to five respondents. They claimed that unemployment and the unawareness of the future status of jobs could be two of the negative impacts in society.

"[There is] no follow-up on the reconversion of jobs."

Male, PhD

Hence, in six of the interviews, our experts specified new applications on labor sector as the creation of new professions with the emergent growth of AI.

4.3.3 Impact on legal aspects

Concerning legal aspects and its impact, most of the respondents mentioned negative impacts and barriers and challenges. On table 5, there is the coding tree for impact on legal aspects.

Table 5 – Coding tree for impact on legal aspects

Name	Sources	Name	Sources
Negative impact on Society	6	Privacy and personal data balance	2
No regulation of technologies can be harmful	3	Robots and citizenship	1
Political issues	3	***Applications***	4
Inability of providing explanation	2	GDPR and connection with AI	3
Development too fast with no restrictions or regulations	2	ID Authentication with visual recognition	1
Surveillance can interfere legally with people's privacy	1	ID Authentication with digital print match	1
No awareness of the consequences of AI	1	***Positive impact on society***	1
Barriers and challenges	6	Reduce the number of ID falsifications	1
The right of explanation from a machine	4		

The fact that there is no regulation, the lack of it and its harmful consequences were mentioned by three sources, along with the political issues that are inherent to these regulations.

"There is a set of regulations, a domain that needs to be improved, in order to build a safer path [in the future]."

Male, Data Scientist

"It can be used to pursue political opponents [example of China], to reduce the people's privacy. That could be a negative potential of AI"

Male, Informatic Engineer / Researcher

Furthermore, the lack of explanation was mentioned by four sources, regarding the need of obtaining a meaningful explanation of how the machine accomplished a certain algorithm and how can it be used in legal matter.

"There is pending legislation to ask machine an explanation. Often, it is impossible to demand a simple and proper explanation. (...) People will request explanations and will get too complex ones, which they are not going to understand."

Male, Data Scientist

"Which is the rationale behind the machine [algorithm] in order to take a certain decision? The Decision Support System is a black-box"

Male, Data Scientist

4.3.4 Impact on ethic aspects

In the case of ethics and its impact, the chosen framework is different from the other societal impacts. Most of the analysed codes were actual and factual examples. Below, there is the coding tree for impact on ethic aspects on table 6.

Table 6 – Coding tree for impact on ethic aspects

Name	Sources	Name	Sources
Actual examples	7	***Barriers and challenges***	6
Case of the autonomous car and ethics	7	Ethical questions as a long-term issue	4
Cambridge Analytica case of Facebook	3	Balance between privacy and safety-security	3
Case of the Sophia and her citizenship in Saudi Arabia	1	Ethic involved when there is personal data recorded	2
		Ethic related to decisions and explanations from machines	2

The most highlighted aspect was the case of the autonomous car and its ethic related aspects. Seven respondents mentioned that there are a lot of ethical issues involved when it covers accidents and on what should be the car reaction when there are several people involved.

"An example: let's say that I am in the autonomous vehicle. If I go straight forward, I run over a person, but if I make a little turn, I run over five people. These questions are very complicated and need to be studied".

Female, University Professor

"In a run over case, the vehicle could need to decide in function of the passenger or the passer-by. How these decisions are take, raises a lot of questions which I cannot answer."

Male, University Professor

Thus, as a barrier and challenge, the fact that these ethical questions could stay as a long-term issue was mentioned by four respondents, discussing it as an issue that will be hard to overcome, and humanity should need to define considerably where the limits are.

"I think that the [long-term] barrier will be the limit of ethics. We cannot run over the ethic's barrier, having drones recording without permission or machines deciding when to euthanize. It is possible to have supporting systems, but we cannot have systems that break the reasonability limit and human rights."

Male, Bioengineer / Researcher

4.3.5 Impact on education

Although no negative impact and no application information was extracted from the analysis of the interviews, three sources mentioned a positive impact on society, regarding the arise of new disciplines in the school, with highlight to a possible arise of AI programming school programs. On table 7, there is the coding tree for impact on education.

Table 7 – Coding tree for impact on education

Name	Sources	Name	Sources
Positive impact on Society	3	Uncover from universities towards future occupations	1
New disciplines in school – AI Programming	3	***Negative impact on Society***	0
Barriers and challenges	3	***Applications***	0
Media misunderstanding about AI	2		

Furthermore, it was mentioned a media misunderstanding about AI, which reflects directly in people's education. Two sources claimed that most people have wrong or distorted information about the future impacts of AI.

"I think that AI should be taught, at least the programming part, since people are very young. I'm not saying to supress other disciplines but any person in the future will have to work with AI in the future."

Male, Data-scientist

4.3.6 Impact on home

For the impacts on home, no negative impacts nor barriers and challenges were expressed. However, several applications in the domotics field were mentioned: vacuum cleaner robots, which though already exist, they can be augmented with AI, daily-life programming robots, that are AI machines which help on daily house tasks such as ironing, cooking, etc. Below there is the coding tree for impact on home on table 8.

Table 8 – Coding tree for impact on home

Name	Sources	Name	Sources
Applications	**4**	Smart garbage collection	1
Domotics		***Positive impact on society***	**2**
Vacuum cleaner robot	2	Intrusion detection	1
Daily-life programming robot	2	Surveillance as a area of big investment	1
Robotic arm chef	1	***Negative impact on Society***	**0**
Automatic or semi automatic fridge replenisher	1	***Barriers and challenges***	**0**
Google Home	1		

As a positive impact, surveillance, in a safety point-of-view, will be a high investment area, although lack of privacy issues can also be related to surveillance.

"I'd like my house with several Robots."

Male, Data-scientist

4.3.7 Impact on environment

From an environmental point-of-view, the most mentioned aspects were about possible future applications where AI can be present, such as smart fire detections, pollution measurement systems, atmospheric sensors, space modulation for retrieving 3D images of certain animals on a specific location and better waste management systems, as seen on table 9 with the coding tree for impact on environment.

Table 9 – Coding tree for impact on environment

Name	Sources	Name	Sources
Applications	3	***Negative impacts on society***	1
Smart fire detection	2	High electricity consumption from AI technologies	1
Concentration of polluents measurement	1	***Barriers and challenges***	1
Atmospheric sensors	1	No coverage from the current energetic production	1
Space modelation for animal identification	1	***Positive impacts on society***	0
Waste management systems	1		

"On an ecologic level, preventive measurements could be made – studying the forecast of forest fires."

Female, University Professor

On a service level and in the Portuguese reality, it is several times mentioned the fire detection, with smart fire detection and not on a cleaning forest basis".

Female, University Professor

4.4 Sectorial Impacts

This section presents the results regarding the impacts of AI on different sectors. From the several sectors mentioned and illustrated in table 2, it is possible to see that most of these sectors are service sectors. This already shows the strong potential impact of AI in service. This subject is further discussed on section 5. The sectors are represented through a coding table and they are sorted from the ones with most sources – impact on science and technology – until the one with the least sources – impact on retail.

4.4.1 Impact on science and technology

In this section, there are the same number of sources regarding positive impacts and barriers and challenges. The coding tree for impact on science and technology is shown on table 10.

Table 10 - Coding tree for impact on science and technology

Name	Sources	Name	Sources
Positive impact on Society	**9**	*AI needs Infrastructures and major investments in hardware acquisition*	3
Exponential evolution of AI technologies	4	*Lack of data to have better algorithms*	2
More knowledge generated through AI research and debates with experts	4	*Short term cost issue*	2
Programmers have the ability to define the limits	3	*Too much data to optimize*	2
AI as a technology facilitator	3	*Barrier itself of working with unstructured data*	1
People from different backgrounds working in AI development	2	**Negative impact on Society**	**4**
More automation creates more productivity with faster discoveries	1	*AI technologies developed for negative purposes*	3
Technology learning online without human input	1	*Cybersecurity vulnerabilities to get sensitive data*	2
Barriers and challenges	**9**	**Applications**	**2**
Hardware Efficiency to perform ML Algorithms	5	*AI applied to Forensics*	1
Inefficiency and inexistence of a general AI	5	*Learning sensors in AI technologies*	1

Four sources mentioned that AI technologies are growing at an exponential rate, which was seen as a positive impact, encouraging people from different backgrounds to work on a common AI development integration.

Furthermore, it should be necessary AI experts to debate and generate common deliberations about the current state of AI development, for knowledge advance.

"It is necessary the existence of debates and discussions"

Male, Bioengineer / Researcher

"This is evolving in an extremely exponential way."

Male, Data-scientist

Thus, the existence of a general AI is still unknown, in accordance to five of the respondents, meaning that a general computer that is smart as a human and fully capable of all intellectual tasks of a human doesn't exist yet.

"We are still on a long way towards «the» General Intelligence"

Male, Data-Scientist

Regarding the negative impacts, three respondents mentioned that the development in a scientific environment of AI technologies for atrocious purposes can be a reality, due to tensions from governments and private companies.

4.4.2 Impact on industry

Four of the ten respondents claimed that automation brings more productivity, especially on mechanical activities with repetitive movements. On table 11, there is the coding tree for impact on industry.

Table 11 – Coding tree for impact on industry

Name	Sources	Name	Sources
Positive impacts on society	**9**	**Negative impacts on society**	**4**
More productivity with automation	4	*Society has less or no awareness of the current automation impact*	4
Breakthroughs in History lead to a technology development	3	**Barriers and challenges**	**1**
AI Technologies as facilitators in repetitive operations	3	*Traditional companies and weak AI implementation*	1
Involvement of new start-ups in AI	1	*Challenge of understanding how big companies will subsist or being replaced*	1
Deep Learning in the research field developed to the industry	1	*No knowledge about all AI existing companies*	1
		Applications	**0**

"First positive aspect regarding automation is the potential of increasing productivity in companies and with that hoping a costing reduction on those products."

Male, Informatics Engineer / Researcher

One aspect that was mentioned by three respondents were the breakthroughs in History – industry revolutions or military events that guided to technology progress and expansion - and considered that AI could be one of these History breakthroughs.

No applications were coded from the interviews.

"There are moments in Humanity's History which are Breakthroughs and lead to a non-expectable jump."

Male, Data-Scientist

4.4.3 Impact on healthcare

During the interviews, most references were made to possible applications in the healthcare and medicine area, in which eight respondents talked about an AI application to medical diagnosis and seven to preventive medicine. These categories are shown on table 12.

Table 12 – Coding tree for impact on healthcare

Name	Sources	Name	Sources
Applications	**10**	*Baby condition during gestation*	1
AI applied to medical diagnostics	8	**Positive impact on Society**	**1**
AI applied to preventive medicine	7	*New discoveries to create new medicaments*	1
AI as second opinion systems	6	**Negative impact on Society**	**1**
AI applied to medicine imaging (MRI or X-rays)	3	*Human opinion cannot be replaced only by AI systems*	1
AI applied to Neuroscience	2	**Barriers and challenges**	**1**
Elderly care system with AI aid	2	*Assurance of robust algorithms that work for all possible patients*	1
Prediction of illnesses for elderly people	1		

"…related with Medical Diagnosis in which there is several human errors, all these intelligent algorithms that absorb trillions of registers could be an asset to us."

Female, University Professor

"If we have technology that gets health signals from our body and alerts for a disease development, even before our symptoms, that would be great. There are already some technology developments."

Male, Informatic Engineer / Researcher

Although just one source mentioned the potential discoveries in the healthcare industry related with medicaments, also just one mentioned the fact that AI will never replace the need of a human opinion for validation, meaning that AI can't work independently. It can be seen also as a positive impact when it is related with job replacement. However, the respondent mentioned it as a negative impact for evolution in the healthcare sector.

For barriers and challenges, the need of systems that can handle all possible cases is something that needs to be overcame, as there are no perfect systems.

"In skin lesions, it has been verified a very known algorithm in literature that worked only for people with certain skin color. Assurance of repeatability and robustness in this extreme and usual cases is needed"

Male, Bioengineer / Researcher

4.4.4 Impact on customer experience

This sector, alongside with industry, was one of the most supported by the sources. Below, there is table 13 with the coding tree for impact on customer services.

Table 13 – Coding tree for impact on customer experience

Name	Sources	Name	Sources
Applications	**9**	**Positive impact on society**	**6**
Call Centers	7	Customization of services	5
Chatbots	6	All services can be automated anyway	1
Disappearance of the call centers	1	Redirection of clients in customer services based on their behavior	1
Virtual Personal Assistance	1	Use of information to add value in services	1
Humanoid robot	3	Chatbots are increasingly better	1

Automated supermarket	2	**Negative impact on society**	**2**
Personalized discount vouchers	1	Bots answering phones and not humans	1
AI applied to services to which men has less or no affinity	1	Replacement of services	1
		Barriers and challenges	**0**

Most of our respondents suggested applications on customer services, mainly for call centers – chatbots, as supporting systems and targeted for call center automation. However, only one source mentioned the disappearance of call centers.

"Nowadays, chatbots are frequently applied on society and internet. (...) In alternative, we could have a real person 24/7 answering Q&A, although that would bring very high costs to companies."

Male, Bioengineer / Researcher

From a positive impact side, five respondents mentioned that the increase of AI technologies is directly proportional to the customization achievability of services, according to the needs of each customer, with a high level of personalization and therefore, more valuable. Thus, one respondent added that with more and more mass services, a customized service would be more valued.

"Door-to-door services"

Male, Bioengineer / Researcher

"Everything will be more customized [in the Service sector]"

Male, Data-Scientist

"A personal virtual assistance, which knows what I want to do and automatically answers my needs"

Male, Data-Scientist

Although no respondent outlined a hypothetical barrier or challenge, one respondent referred an unpleasantness when bots are answering on the other side of the phone line, and another respondent claimed that AI will bring replacement of the current services that exist today, for non-qualified service jobs or for traders in stock market.

"I immediately turn off the call when my mobile operator phones me and actually it is a machine."

Male, University Professor

"Replacement of services will happen. Non-qualified jobs will suffer impact but also qualified [service] jobs."

Male, University Professor

4.4.5 Impact on transportation and autonomous driving

This section includes not only transportation, but also an important application of AI in this sector that emerged from the interviews: autonomous driving. These categories are shown on table 14.

Table 14 – Coding tree of impact on transportation and autonomous driving

Name	Sources	Name	Sources
Applications	**8**	Autonomous car connected with the hospital	1
Space exploration	3	Autonomous cargo ships	1
Non-stop autonomous cars in logistics-distribution	3	**Positive impact on Society**	**5**
Roadways only dedicated to autonomous cars	2	Autonomous cars will reduce accidents	3
Shortest path to a specific point on map	2	Autonomous cars can learn very quick than humans	2
Flying autonomous cars	2	Less strikes in the transportation sector due to autonomous cars	1
Google Glasses as an aid for mechanics in car shops	1	Disappearance of the car-key	1
AI applied to Cargo transports	1	Autonomous cars will reduce traffic	1
Sensors in transports	1	**Negative impact on Society**	**2**
Hyper-Loop	1	Autonomous cars will reduce the driving pleasure	1
Airport efficiency for check-ins and check-outs	1	Autonomous cars in a chaotic environment could not respond	1
Autonomous bus	1	**Barriers and challenges**	**0**

Eight respondents made references to applications in the transportation sector. This was reflected on the richness of possible applications that were mentioned.

"[A service which I think it will thrive in 10 years is] the Space Exploration"

Male, Data-Scientist

"Autonomous cars in distribution could have an enormous impact. It can lower the cost of drivers. Can you imagine a truck or a train nonstop?"

Male, University Professor

On a positive side, three sources mentioned that autonomous cars will increase safety, eliminating the error factor that comes from the human side. Furthermore, having a controlled environment where autonomous cars communicate and learn from themselves will also increase safety.

"Autonomous cars will increase the comfort of not having to drive. Consequently, it will increase safety since there will be less accidents."

Male, University Professor

Only one source claimed that the pleasure of driving is lower when there is a car that drives by himself. Another source indicated an inefficiency of ML when there are too many variables – chaotic environment. No barriers were referred.

"On a controlled environment, the machine learns very well. In a system, it can be chaotic, and the response rate can be not effective."

Female, University Professor

4.4.6 Impact on financial services

In the financial services sector, the main application was the fraud detection on credit card transactions, cloning, tax evasion and bank accounts. No barriers and challenges were identified either. For positive impacts, the disappearance of password is imminent. These categories are shown on table 15.

Table 15 – Coding tree for impact on financial services

Name	Sources	Name	Sources
Applications	**4**	***Positive impact on Society***	**1**
Fraud detection	4	Disappearance of passwords for facial or digital print recognition	1
Negative impact on Society	**1**	***Barriers and challenges***	**0**
Cryptocurrency being not enough credible for society	1		

"AI will help to reduce the number of frauds [in economic sectors]."

Male, Bioengineer / Researcher

4.4.7 Impact on retail

On retail, no negative impact nor barriers and challenges were extracted from the interview's analysis. However, it is important to transmit that there is a positive impact for the society with AI in the retail area which is the persistence of physical stores for customer care. Regarding applications, mainly AI sensors and smarter recommendation systems in advertisement were stated. These categories are shown on table 16.

Table 16 – Coding tree for impact on retail

Name	Sources	Name	Sources
Applications	4	***Positive impact on Society***	**1**
Sensors in clothes	2	Physical stores need to persist in the future for customer care	1
Shopping recommendation systems	2	***Negative impact on Society***	**0**
Door-to-door shopping system	1	***Barriers and challenges***	**0**

"The capacity of having sensors in every clothing article."

Male, University Professor

In a nutshell, the collected data reveals a deep significance of societal impacts on services. Furthermore, it is possible to complete this section with the evidence that the major part of the identified sectors belongs to service.

4.5 AI trends

Alongside with different societal and sectorial impacts, the expected AI trends that will thrive in few years were also extracted, divided by technologies and existing products. An isolated and subjective category expressed by the emerging of new technologies depending on current problems on society was also created. Below, there is the coding tree for AI trends on table 17.

Table 17 – Coding tree for AI trends

Name	Sources	Name	Sources
Technology	10	Video processing	1
Autonomous cars	10	***Examples of existing products***	6
Recognition technologies	8	Google products	5
Image and Pattern Recognition	7	Google Glass product didn't avenge	2
Voice Recognition	4	Facebook products	3
Hypothesis generation from image recognition	3	Amazon products	3
Text Recognition	2	Mechanical Turk	1
Robots	5	Oenology related with AI technologies	1
Quantic computers	2	Apple products	1
Blockchain	2	***AI trends depend on current or new problems***	2

Considering the information obtained for the AI technology trends, it is possible to observe that all ten respondents were unanimous that autonomous cars, all its technologies inherent and respective infrastructures will thrive in the following years. On a general way, eight respondents mentioned that recognition technologies (image, speech and text) will also became more common on daily-life, with highlight to the image and pattern recognition. Nevertheless, robots were also portrayed by five respondents as a prosper automation mechanism feasible and achievable to humans.

4.6 AI in the Future

Due to the technique the interviews were conducted, it was possible to define a fourth and final category. This section is mainly to attain what will be the future of AI. Upon thorough analysis, it was possible to define two principal groups: certainty – our respondents were confident about the future and uncertainty – the answers weren't revealed with steadiness. These categories are shown on table 18.

Table 18 – Coding tree for AI in the future

Name	Sources	Name	Sources
Certainty	6	***Uncertainty***	6
Aggregation of AI systems	2	There is no limit - humanity defines its own limit	4
AI should never overcome ethic and privacy limits	2	Uncertainty of the future with AI	3
Humanoid	1	AI future is somehow related with reasoning and data knowledge	2
Systems supporting machines and not replacing machines	1	Technological singularity is improbable	1
Systems as intelligent as humans	1	AI is still in a very early stage	1

Although six respondents induced certainty on what relates with AI and its role on future, also six respondents considered that there is a lot of uncertainty in the flourish of AI. Notwithstanding, the most quoted sub-category was the nonexistence of boundaries for the blossom of AI, which is directly associated with the liberty allied with Humanity wilfulness to progress in perpetuity.

> *"It is a very open question. (...) I am not sure where are we going to be in a few years. [However] we should live in a world where the machine helps and doesn't replace, with a privacy balance."*
>
> Male, University Professor

5 Discussion

This study generated a rich set of results that sparked interesting questions for discussing how AI impacts service. This section details the most interesting discussion topics, namely AI and job replacement in the service sector, privacy, security, ethics and liability, healthcare and AI, customer services and service design, AI in the industry, human skills and education and lastly, humanity and daily contact with AI.

5.1 AI and job replacement in the service sector

This is probably the most evident consequence of the evolvement of AI technologies, where the impact in service will be profound. Most of the respondents agreed on a future smart redirection of the human resources. However, Dirican claims that there will be a big paradox with the replacement of human work forces and AI (Dirican, 2015).

Huang & Rust explore several hypotheses for job replacement in services and what human skills will be the most important for the coexistence between AI and human jobs, especially when most jobs are migrating from manufacturing to service (Huang & Rust, 2018).

Nowadays, repetitive tasks automation are already common for precise and well-defined procedures (Autor & Dorn, 2013). According to Goux-Baudiment, 47 percent of today's jobs will be automated by 2033. Furthermore, with state-of-the-art sensors, robots are capable of producing goods with higher quality than humans (Frey & Osborne, 2017). Results support this position for industrial related sectors. In the unlikely event of AI ability to perform all possible tasks that humans can perform – mechanical, analytical, intuitive and empathetic – all human jobs could be under threat (Huang & Rust, 2018). Some authors call it AGI, which are computers that are smart as humans and are capable of all the intellectual tasks of humans. Thus, the majority of the world's leading AI experts claim that, although we are not in the presence of AGI's, this event can probably happen near the year 2030 (Gurkaynak et al., 2016).

AI can surely destroy middle range jobs, increasing inequality between low and high paid jobs (Makridakis, 2017), complementing with one of the negative impacts that AI will bring to society – imbalance – especially on low skilled work forces. Hence, initially, robotics and AI will be used by financial institutions (Dirican, 2015).

> *"The more tasks of a job that AI takes on, the fewer employees are needed for doing that job."*
>
> (Huang & Rust, 2018)

The remaining tasks that can't yet be automated will require greater skills from people. Creativity and innovation are crucial characteristics of the type of jobs that require social and interpersonal skills. Huang & Rust also agree with the theory of "soft" people skills that will increasingly become the most important components for employability (Huang & Rust, 2018). People with these features will have more employment opportunities with the arise of AI (Makridakis, 2017). Occupations that require a high degree of creative intelligence are unlike to be automated (Frey & Osborne, 2017).

Since jobs are already migrating from manufacturing to services, and the service sector is increasing along with AI, it is important to assess how AI can replace low-skilled service jobs,

like healthcare workers. Empathetic and intuitive skills aren't yet mimicked by AI, which means that people who work daily in high-skilled service jobs will not be much impacted like those who perform tasks that are possible to automatize (Huang & Rust, 2018), which goes in agreement with the acquired results.

Thus, companies will be able to manage profitability and risks more efficiently. The future organizational charts will be affected, as also BMC's. CEO's and managers will have background and knowledge in IT, science and engineering, with AI training (Dirican, 2015).

> *"The successful firms during the AI revolution will have in addition to the Chief Innovation Officer (CIO) to also appoint a Chief Artificial Intelligence Officer (CAIO) (…)."*
>
> (Makridakis, 2017)

Nevertheless, a computer and technological bottleneck is predicted to be an issue in the share of occupation's employment that are more likely to be automated, especially in the ML area (Frey & Osborne, 2017). One of the challenges that were referred by our respondents in science and technology was the lack of hardware to perform ML algorithms and the need of investments in infrastructures and hardware to make AI affordable and capable of dealing with huge amounts of data. The progress in software is longer than in computational hardware (Kurzweil, 2005), meaning that the investment in Hardware and infrastructures needs to be done to catch up software developments.

5.2 Privacy, Security, Ethics and Liability

Discussions of data security and privacy are an important subject for humanity (Dirican, 2015). Some respondents mentioned a binary operation when it relates privacy and security. In order to have more security, privacy should be granted. Hence, AI has the potential to mass-produce surveillance, but this colossal computerization leads to a loss of privacy (Russell & Norvig, 2013). In fact, the balance between privacy and protection has been considered one of the massive challenges humanity will have to overcome (Kurzweil, 2005). Interfaces and software should be primarily designed with privacy guidelines through encryption and data access control (Gurkaynak et al., 2016).

With regard to autonomous cars, they do quite well, especially in the challenging problem of off-road driving (Davis, 2012). They could revolutionize the automotive industry, contributing to a stronger economic growth (Makridakis, 2017), and in military situations they could support very precise missions, adjusting to changing environments (Kurzweil, 2005). Nonetheless, throughout the world, legislation is currently being developed for the use of this type of vehicles (Gurkaynak et al., 2016).

During the interviews, the case of the autonomous vehicle and running over probability was referred, in respect to ethics and law. What would happen if a car must decide between a person or a group of people? Autonomous vehicles should reduce accidents, but this dilemma rises other questions (Bonnefon, Shariff, & Rahwan, 2016). Automated vehicles are not considered "drivers" when it relates to speed limit regulation and enforcement. But in case of an accident, the person responsible of that automated vehicle could be liable. There is a big lack when we speak about liability in this type of technology (Russell & Norvig, 2013). As such, the creation

and development of autonomous transportation services might be limited while law makers establish the required boundaries and liabilities for the use of autonomous transportation.

With the possible extension and development in technology, the number of incidents will also increase. Thus, AI systems will be able to learn from their own experiences and create their own decision support systems. Therefore, the question of if these agents should be classified as having their own legal personality needs to be debated (Čerka et al., 2017).

Hence, in a medical environment, these AI systems might result in a loss of accountability, since the fault of a wrong diagnosis could be given to the system that predicted the diagnosis or to the physician that relied on the diagnosis. However, these expert systems could become so reliable that physicians might became legally liable if they don't use these recommendations systems (Russell & Norvig, 2013). It is trustworthy to mention that the same ethic that it is verifiable on medicine should be enforced on technology, with focus in AI.

Furthermore, service design is supported by design thinking with methods to match people's necessities and what is technological feasible (Brown, 2008). Therefore, it is also important to have in mind that services that comprise AI can have high implications in ethics and laws. Concerning privacy and the high rate of personalization that AI enables, it is important to measure what is the trade-off between personalization and privacy (Huang & Rust, 2017).

5.3 Healthcare and AI

The interviews enabled possible applications that medicine could have with the arise of AI. Most of them were related with diagnosis and preventive medicine, side by side with medical imaging but also with services like distance doctor and accessibility to all sorts of exam results in a short period of time. Ray Kurzweil mentioned a hypothetical case, where doctors could receive automated diagnosis using pattern recognition applied to medical exams (Kurzweil, 2005). Thus, ANN are being widely used for medicine applications, often for classification tasks, diagnosis, prediction and drug dosing (Dayhoff & DeLeo, 2001). Eight respondents mentioned applications for medical diagnosis with AI supporting systems, going in accordance with Fürnkranz, who says that it is not a new trend, when it relates Medicine and ML (Fürnkranz, 1999). Nonetheless, it was also mentioned these AI systems should be seen only as supporting systems.

Gurkaynak et al. report the fact that health sector should have new guidelines for the new trending robotic technologies. Furthermore, it was also mentioned in interviews the use of special glasses (e.g. Google Glasses) to aid surgeries (Gurkaynak et al., 2016). In a same line, new guidelines could be conceived for service design, to include new AI technologies in new services.

In nursing, our respondents made also reference to elderly care systems with AI technologies as functioning systems. Literature has also some reference: nurse-robots taking care of elderly people (Makridakis, 2017) or reminding patients to take medicines (Čerka et al., 2017). However, the human expectations or responses to automated machines are not well known (Stock & Merkle, 2018).

5.4 Customer Services and service design

During interviews, the main transmitted idea was the future technology evolution and its consequently change in service, especially in customer service. Technology innovation rapidly transforms service experiences (Grenha Teixeira et al., 2017).

"What critics fear is the speed of job obsolescence through AI technologies in the service sector."

(Makridakis, 2017)

The main coding reference within call-centers was chatbot, as a tool that will disruptively - for some respondents or progressively and supporting for others - change customer support. Thus, call center agents are a type of job that don't require high skilled labor people (Huang & Rust, 2018), being chatbot a tool that is somehow adjustable to current call centers' conditions.

Stock & Merkle performed a study with HSR's and if they express behavioral and innovative notions during the service encounter, they could exceed customer expectations and deliver noteworthy experience to customers (Stock & Merkle, 2018). Overall, it could be possible to have automatic service encounters and still have the best reactions from customers. Furthermore, Huang & Rust affirm that most service tasks that require lower levels of intelligence will be first replaced, but depending on the nature of services, more specifically relational services who require more human interaction, it will be more difficult to go through replacement (Huang & Rust, 2018). They will more likely be supported by AI than being totally replaced.

Regarding positive impacts, customization of services was mentioned by five respondents. Customer satisfaction can be enhanced with customization through a better experience with smart technology, integrating IoT with emotional technologies, engaging customers in the center of the service process (Huang & Rust, 2017). AI enables mass-personalization, based on Big Data from customers, empowering service robots to evolve to network machines with collaborative intelligence (Huang & Rust, 2018).

Since service design is an emerging field and new approaches should be always considered (Patrício & Fisk, 2017), fostering innovation towards new and better service offerings is important. Therefore, the use of new technologies with AI capabilities is crucial for differentiation, and it should be considered during the iteration process of service design (Brown, 2008; Stickdorn & Schneider, 2010).

5.5 AI in the Industry

"Technology can facilitate automation, cognition, and emotion, can standardize and personalize back-end service processes, front-end service interactions, and service offering, and can replace or augment unskilled and skilled service labor."

(Huang & Rust, 2017)

Although the impacts in industry were mentioned by all sources due to the forthcoming automation along with AI technologies, impacts on services were more evident through the other sectorial impacts that are more related with service.

The main impact rises with automation, mentioned by the respondents as a positive impact. It provides cost efficiency and quality, over standardized and repetitive tasks (Huang & Rust, 2018) widely used in industry, as well in service.

Other positive impact was the existence of breakthroughs in our History that can conduct humanity to forthcoming evolutions and technology developments, based also on the ancient

events. Ray Kurzweil considers that there is somehow the possibility of future breakthroughs that can create breath-taking advances, although it is a hypothetic and unsubstantiated theory based only on the present information (Kurzweil, 2005).

5.6 Human skills and education

A great number of interviewees mentioned positive impacts on society with the intervention of AI. Mostly, they claimed that we will adapt gradually, being able to live with these machines among us. Goux-Baudiment illustrated that a synergetic process with robots will increase transition, i.e., including them in our daily life is crucial for a smooth adaptation and a faster changeover (Goux-Baudiment, 2014).

Free and more quality time for humans in the future is also a theory defended in some interviews, which according with Makridakis, AI will shrink the level of work left for people and increase their free time, making people possible to pursue their own interests (Makridakis, 2017).

Moreover, music as a creative operation, consciousness and empathy as inherent human features and entrepreneurship as a human ability are also supported by literature with more consensus. Tasks that require creativity, strategic thinking, entrepreneurship are not expected to be algorithmically done, providing pre-eminence in humans.

Real world reasoning is somehow a built-in capability for humans but extremely hard to automate in AI technology (Davis, 2012). Huang & Rust emphasize that fostering creative thinking and intuition in students can be the key to remain humans important in an Universe with machines that can replace our analytical and mechanical abilities (Huang & Rust, 2018). That goes also in agreement with a statement from the respondents that new disciplines in school should be promoted, with focus on AI technologies. However, Dirican alleges that universities would suffer by these improvements, where most academic people would be replaced (Dirican, 2015).

5.7 Humanity and daily contact with AI

> *"Robotics and Artificial Intelligence will be also opening new pages in the economics and business which are also bringing new life style and sociological side effects."*
>
> (Dirican, 2015)

It is possible to verify that most respondents enumerated difficulties that were caused by humans, with emphasis in the first fear of using AI technologies. Humanity fear the unknown, the fear of losing control, of being injured. However, that fear will disappear when that technology becomes common (Goux-Baudiment, 2014). The perspective of Kurzweil that technology singularity will cause Humanity extinction due to AI is somehow indorsed in the scientific community. Bill Gates and Stephen Hawking mentioned that Humanity should have a very safeguarding and conservative view of AI, due to the harm that it can cause (Gurkaynak et al., 2016). The creation of services that can humanize AI open an opportunity to converge technologies with customers. Services could be designed having already in consideration the possible harmful consequences and the impact on society.

One important aspect mentioned in the interviews concerning this topic was that most barriers are caused by humans (see table 3). Therefore, how can we achieve an Artificial General

Intelligence or even an Artificial Superintelligence, without knowing ourselves so well? The knowledge of our brain is still not enough. Thus, we still don't know how to build a human-level intelligence machine (Yudkowsky et al., 2010) but R&D in AI and ML are growing at a very fast pace (Russell & Norvig, 2013). Hence, there could be a partnership with neuroscientists for the possibility of emulating human brains (Yudkowsky et al., 2010). The need to better understand the brain mechanism at an algorithmic level is the key to advance AI (Brooks, Hassabis, Bray, & Shashua, 2012).

> *"Human intelligence is the most powerful known biological technology. But our place in history probably rests not on our being the smartest intelligences that could exist, but rather on being the first intelligences that did exist."*
>
> (Yudkowsky et al., 2010)

Another important aspect was the fact that machines that evolve with very complex algorithms are unable to give a clear and simple explanation of the algorithm process for humans, especially those who provide results from ANN's. They provide little explanatory insights, often labelled "black boxes" (Olden & Jackson, 2002).

Nevertheless, some of the respondents defended that human society would adapt to AI developments in a natural and non-forced way. Adaptation will be as quickly as it was for softbots (software bot), although a global discussion will be needed to avoid primitive reactions of fear and anger (Goux-Baudiment, 2014). Furthermore, technology is becoming more sophisticated as it is taking traditional human features, requiring even less adaptation efforts from humans (Kurzweil, 2005). Tasks that involve originality, negotiation, persuasion and human intrinsic values have a very low risk of computerization (Frey & Osborne, 2017). People's attitude will change towards technology development and with the arise of autonomous systems (Čerka et al., 2017). There is a necessity of further research and debates between the scientific community. The impacts of a superintelligence and the risks it exposes to humanity require investigation and it should be done before it is too late (Müller, Vincent, Bostrom, & Nick, 2016).

In service, the impact will be profound. AI is vastly adaptive and enables high personalization. Thus, it can learn from customer's past behavior, which empowers improvement (Huang & Rust, 2017). Consequently, the inclusion of AI in service encounters could be more frequent, which can alter the way services are provided and the way people prospect services. However, in services that require a stronger human interaction with empathetic characteristics, AI will be harder to replace. Having both humans and machines supporting themselves can be one possible strategy (Huang & Rust, 2018).

6 Conclusion and future research

"The resulting advances in computing and autonomous systems would be expected to yield profound scientific and societal impacts."

(Greenwald & Oertel, 2017)

The data and results obtained in this study allows us to better understand the impacts of AI on service. Although it is not possible to make extensive assumptions, this research can be complemented with a quantitative study, to understand and quantify whereupon these impacts are relevant and significant using a wider sample. Even though there is plenty to explore in this topic, this dissertation begins to tread the necessary thoroughfare for a better perceptiveness.

Employment will suffer with AI, where most mechanical and repetitive actions will mostly be replaced by AI engines. On the other hand, it is possible to understand that new tasks will arise with these emerging technologies, making either possible a smart redirection of employees within companies or in some cases a job disintegration and adaptation. The most known example in customer service is the chatbot, where companies are increasingly implementing them to cover most repetitive and usual inquiries. But it is unknown if chatbots will totally replace human workforce or will only replace the most repetitive and easy inquiries, giving humans the most complex customer support tasks. This will directly depend on the evolution of complex abilities from AI. Thus, more free and quality time due to the automation from AI is also portrayed as a conceivable scenario. Then, we could cherish our social skills for leveraging human workforce, having AI in supporting mechanical and analytical tasks that involve huge amounts of data and highly repetitive but standardized tasks.

Concerning service encounters, smart technologies add value to smart services (Wuenderlich et al., 2015), so it is important to embrace AI technologies but never neglecting customer satisfaction. Customization is additionally more conceivable with AI, enabling mass-personalization based on Big Data from customers. Furthermore, service design is one very good example where AI can be consequently applied, during the different stages of service design process: exploration, ideation, reflection and implementation (Patrício & Fisk, 2017). Human skills are the most unique characteristics that can differentiate us from machines, since we are still far away from having a general AI engine that can gather human social skills, along with all mechanical and analytical features. Creativity and entrepreneurship will be the most advantaging features when it relates our mastery towards AI and our key differentiator for jobs - because these human social skills can't yet be mimic by AI - but also in service to foster customer satisfaction. Moreover, education should be also redesigned to include AI science, in a way that humans could work with AI aid but also improving characteristics that could differentiate them from machines.

Naturally, Humanity fear that agents like AGI's evolve to ASI's and somehow affect the expansion and evolution of humans, making humans become in the future obsolete. Hence, in academia research there are different presuppositions whereas these developed agents would influence the flourish of mankind. Thus, the development of AI technologies relies upon scientific momentum, as well as how far can we go. On the other hand, regulations are vital for a strong and healthy advancement with regards to ethics and liability. The most prevailing examples are autonomous vehicles and its liability and accountability. Should it be given responsibility to the car manufacturer, the car operator or to the company that developed the autonomous car technology? We can learn from past breakthroughs in History, which are vital

for understanding how new further technological turnovers can be carried out in a responsible way. However, regulating in a very early phase can perturb innovation developments. Scientific communities should actively debate implications and further directions of AI, making possible the creation of guidelines for AI endeavours.

Although consciousness remains a mystery (Russell & Norvig, 2013), a forecast date for the appearance of an AI system that can aggregate several other types of intelligence is still debatable, although some authors claim that it is near the year 2030 (Gurkaynak et al., 2016). Nevertheless, Humanity is the main responsible for either the advance or the barrier to the development of any AI advance, being it the main responsible for defining where is the limit. AI entities will not have the capacity to develop new goals by themselves unless required by their code, induced by their programmers (Gurkaynak et al., 2016).

Humans are still, at this point, the standard for comparison in computerized intelligence, due to the fact that we are the most powerful known biological technology (Yudkowsky et al., 2010). The best way to address these possible and hypothetical consequences is through deep research which should be fostered as soon as possible in scientific environments. Prevention is fundamental to avoid undesirable consequences.

> *"Humans never think that something will disruptively change unless it actually happens.*"
>
> (Gurkaynak et al., 2016)

In this research project, a set of experts were assessed through interviews that were conducted to known individuals (experts, developers, researchers and professors) related with Artificial Intelligence, adopting a qualitative study approach, based on Grounded Theory. The number of ten respondents was ample enough to obtain interesting results. However, the ideal would be to have as more respondents as possible, which was not possible due to time constraints, availability, openness, and lack of experienced people in this field of study.

Literature review was conducted throughout the development of this research project, which had a pivotal and dire role in the interview stage. However, there is a lack of substantial literature concerning AI and services since this is a new and emerging subject in the scientific community. Therefore, further research is needed to understand the minutiae of all the impacts covered in this study. Moreover, this dissertation enables future work to be carried out for deeper and thorough individual study of the different areas of impact of AI. In this regard, to support further developments about the impacts of AI on service and disseminate this research, a conference paper was already submitted to HICSS - Hawaii International Conference on System Sciences (Appendix C).

However, this study has some limitations that can also prompt future opportunities for research. It is necessary a deeper study with multidisciplinary efforts for each impact and it should not be addressed only as a technological endeavour. Additional studies can explore the different impacts individually, to try to answer such questions. These impacts will directly depend on the evolution of complex abilities from AI.

References

Aha, D. W., Kibler, D., & Albert, M. K. (1991). Instance-Based Learning Algorithms. *Machine Learning*, *6*, 37–66.

Arnold, R. (2005). *Empathic intelligence : teaching, learning, relating*. Sydney, Australia: UNSW Press.

Autor, D. H., & Dorn, D. (2013). The Growth of Low Skill Service Jobs and the Polarization of the U . S . Labor Market. *American Economic Review*, *103*(5), 1553–1597.

Bishop, C. M. (2013). *Pattern Recognition and Machine Learning*. *Journal of Chemical Information and Modeling* (Vol. 53).

Bonnefon, J.-F., Shariff, A., & Rahwan, I. (2016). The social dilemma of autonomous vehicles. *Science*.

Brooks, R., Hassabis, D., Bray, D., & Shashua, A. (2012). Turing centenary: Is the brain a good model for machine intelligence? *Nature*, *482*(7386), 462–463.

Brown, T. (2008). Change by Design. *Harvard Business Review*, 86(6).

Buera, F. J., & Kaboski, J. P. (2009). The Rise of the Service Economy. *NBER Working Paper*, *I*(21 May 2009), 1–13.

Čaić, M., Odekerken-Schröder, G., & Mahr, D. (2018). Service robots: value co-creation and co-destruction in elderly care networks. *Journal of Service Management*, *29*(2), 178–205.

Čerka, P., Grigienė, J., & Sirbikytė, G. (2017). Is it possible to grant legal personality to artificial intelligence software systems? *Computer Law and Security Review*, *33*(5), 685–699.

Charmaz, K. (2006). *Constructing grounded theory: a practical guide through qualitative analysis*. *Book* (Illustrate, Vol. 10). London, UK: Sage Publications.

Corbin, J., & Strauss, A. (1990). Grounded Theory Research: Procedures, Canons and Evaluative Criteria. *Zeitschrift Fur Sociologie*.

Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative Research Designs: Selection and Implementation. *The Counseling Psychologist*, *35*(2), 236–264.

Davenport, T. H., & Kirby, J. (2015). Beyond automation: strategies for remaining gainfully employed in an era of very smart machines. *Harvard Business Review*, (93(6)), 58–65.

Davis, E. The technological singularity: The singularity and the state of the art in artificial intelligence, Department of Computer Science, New York University 1–12 (2012).

Dayhoff, J. E., & DeLeo, J. M. (2001). Artificial neural networks. *Cancer*, *91*(S8), 1615–1635.

Del Prado, G. M. (2015). AI robots don't need to be conscious to become human enemies - Business Insider. Retrieved February 1, 2018, from http://www.businessinsider.com/artificial-intelligence-machine-consciousness-expert-stuart-russell-future-ai-2015-7?IR=T

Dietterich, T. G., Lathrop, R. H., & Lozano-Pérez, T. (1997). Solving the multiple instance problem with axis-parallel rectangles. *Artificial Intelligence*, *89*(1–2), 31–71.

Dirican, C. (2015). The Impacts of Robotics, Artificial Intelligence On Business and Economics. *Procedia - Social and Behavioral Sciences*, *195*, 564–573.

Fabrega, H. (2000). The Feeling of What Happens: Body and Emotion in the Making of Consciousness. *Psychiatric Services*, *51*(12), 1579–1579.

Farrell, R., Oza, O., Zhang, N., Morariu, V. I., Darrell, T., & Davis, L. S. (2011). Birdlets: Subordinate categorization using volumetric primitives and pose-normalized appearance. *Proceedings of the IEEE International Conference on Computer Vision*, 161–168.

Foddy, W. (1994). *Constructing questions for interviews and questionnaires: Theory and practice in social research* (Illustrate). Cambridge, UK: Cambridge University Press.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to

computerisation? *Technological Forecasting and Social Change*, *114*, 254–280.

Fürnkranz, J. (1999). Separate-and-Conquer Rule Learning. *Artificial Intelligence Review*, *13*, 3–54.

Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. *Observations* (Vol. 1).

Goux-Baudiment, F. (2014). Sharing Our Humanity with Robots. *World Futures Review*, *6*(4), 412–425.

Greenwald, H. S., & Oertel, C. K. (2017). Future Directions in Machine Learning. *Frontiers in Robotics and AI*, *3*, 79.

Grenha Teixeira, J., Patrício, L., Huang, K. H., Fisk, R. P., Nóbrega, L., & Constantine, L. (2017). The MINDS Method: Integrating Management and Interaction Design Perspectives for Service Design. *Journal of Service Research*, *20*(3), 240–258.

Gurkaynak, G., Yilmaz, I., & Haksever, G. (2016). Stifling artificial intelligence: Human perils. *Computer Law and Security Review*, *32*(5), 749–758.

High, R. (2012). The Era of Cognitive Systems: An Inside Look at IBM Watson and How it Works. *International Business Machines Corporation*, *1*(1), 1–14.

Huang, M. H., & Rust, R. T. (2017). Technology-driven service strategy. *Journal of the Academy of Marketing Science*, *45*(6), 906–924.

Huang, M. H., & Rust, R. T. (2018). Artificial Intelligence in Service. *Journal of Service Research*, *21.2*, 155–172.

Huyck, C., & Abbas, F. (2000). Natural Language Processing and Requirements Engineering: a Linguistics Perspective. *Proceedings of 1st Asia-Pacific Conference on Software Quality*, (January 2000), 1–12.

Kong, F., Zhou, G., Qian, L., & Zhu, Q. (2010). Dependency-driven Anaphoricity Determination for Coreference Resolution. *Computational Linguistics*, (August), 599–607.

Kurzweil, R. (2005). *The Singularity is Near : when humans transcend biology*. *VIKING*. NY: Viking Press.

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

Liao, S., & Grishman, R. (2011). Can Document Selection Help Semi-supervised Learning? A Case Study On Event Extraction, 260–265.

Loocke, P. Van. (2001). *The physical nature of consciousness*. Amsterdam, The Netherlands: John Benjamins Publishing.

Lovelock, C. H., & Wirtz, J. (2007). *Services marketing : people, technology, strategy* (6, illustr ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.

Maglio, P. P., & Spohrer, J. (2008). Fundamentals of service science. *Journal of the Academy of Marketing Science*, *36(1)*, 18–20.

Makridakis, S. (2017). The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. *Futures*, *90*, 46–60.

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice*, *13*(6), 522–525.

Mccallum, A., & Nigam, K. (1998). A Comparison of Event Models for Naive Bayes Text Classification. In *AAAI-98 workshop on learning for text categorization* (p. Vol. 752, No. 1, pp. 41–48).

Michel, S., Brown, S. W., & Gallan, A. S. (2008). Service-Logic Innovations: How to Innovate Customers, Not Products. *California Management Review*, *50*(3), 49–65.

Miller, J. D. (2012). *Singularity rising : surviving and thriving in a smarter, richer, and more dangerous world*. Dallas, TX: Benbella Books, Inc.

Morse, J. (1994). Designing funded qualitative research. In *Handbook of qualitative research* (N. K. Denz, pp. 220–235). Thousand Oaks, CA, US: Sage Publications, Inc.

Müller, Vincent, C., Bostrom, & Nick. (2016). Future progress in artificial intelligence: A survey of expert opinion. In *Fundamental Issues of Artificial Intelligence* (pp. 553–571). Cham, Switzerland: Springer.

Neuman, W. L. (2014). *Social Research Methods: Qualitative and Quantitative Approaches*. *Relevance of social research* (Seventh Ed). Edinburgh: Pearson Education, Limited.

Olden, J. D., & Jackson, D. A. (2002). Illuminating the "'black box'": a randomization approach for understanding variable contributions in artificial neural networks. *Ecological Modelling*, *154*(154), 135–150.

Ostrom, A. L., Parasuraman, A., Bowen, D. E., Patrício, L., & Voss, C. A. (2015). Service Research Priorities in a Rapidly Changing Context. *Journal of Service Research*, *18*(2), 127–159.

Patrício, L., & Fisk, R. P. (2017). Creating new services. In *Serving Customers: Global Services Marketing Perspectives Introduction* (Vol. Chapter 10, pp. 185–207).

Russell, S., & Norvig, P. (2013). *Artificial Intelligence A Modern Approach*. *Artificial Intelligence* (3, illustr ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.

Sadeghi, M. A., & Farhadi, A. (2012). *Recognition Using Visual Phrases*. University of Illinois.

Samuel, A. L. (1954). Machine Learning Using the Game of Checkers. *IBM Journal of Research and Development*, *44*(1.2), 206–226.

Schmidhuber, J. (2015). Deep learning in neural networks: An overview. *Neural Networks*, *61*, 85–117.

Seddon, F. A., & Biasutti, M. (2009). Modes of Communication Between Members of a String Quartet. *Small Group Research*, (40(2)), 115–137.

Shahin, M. A. (2016). State-of-the-art review of some artificial intelligence applications in pile foundations. *Geoscience Frontiers*, 33–44.

Silva, J., Figueira, C., Barandas, M., Gonçalves, J., Costa, J., Rosado, L., … Gamboa, H. (2017). Machine Learning @ Fraunhofer Portugal AICOS.

Spohrer, J., & Maglio, P. P. (2008). PRODUCTION AND OPERATIONS MANAGEMENT The Emergence of Service Science: Toward Systematic Service Innovations to Accelerate Co-Creation of Value, *17*(3), 238–246.

Sternberg, R. J. (2005). The theory of successful intelligence. *Interamerican Journal of Psychology*, *39*(2), 189–202.

Stickdorn, M., & Schneider, J. (2010). *This Is Service Design Thinking* (eds.). Amsterdam: BIS Publishers.

Stock, R. M., & Merkle, M. (2018). Can Humanoid Service Robots Perform Better Than Service Employees ? A Comparison of Innovative Behavior Cues 2 . Theoretical Background & Hypotheses. *In Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS)*, 1056–1065.

Strauss, A., & Corbin, J. (1997). *Grounded theory in practice* (Illustrate). Thousand Oaks, CA: Sage Publications.

Turing, A. M. (1950). *Computing machinery and intelligence*. *Parsing the Turing Test. Springer* (Vol. 59).

Ulrich, N. T. T. (1989). Grasping with mechanical intelligence. *Technical Reports (CIS)*, (December), 846.

Vargo, S. L., & Lusch, R. F. (2008). Service-dominant logic: Continuing the evolution. *Journal of the Academy of Marketing Science*, *36*(1), 1–10.

Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). *Data Mining: Practical Machine Learning Tools and Techniques*. Amsterdam, The Netherlands: Morgan Kaufmann.

Wuenderlich, N. V., Heinonen, K., Ostrom, A. L., Patricio, L., Sousa, R., Voss, C., & Lemmink, J. G. A. M. (2015). "Futurizing" smart service: implications for service researchers and managers. *Journal of Services Marketing*, *29*(6/7), 442–447.

Wünderlich, N. V., Wangenheim, F. V., & Bitner, M. J. (2013). High Tech and High Touch: A Framework for Understanding User Attitudes and Behaviors Related to Smart Interactive Services. *Journal of Service Research*, *16*(1), 3–20.

Xia, F., Yang, L. T., Wang, L., & Vinel, A. (2012). Internet of Things. *INTERNATIONAL JOURNAL OF COMMUNICATION SYSTEMS Int. J. Commun. Syst. Int. J. Commun. Syst*, *25*(25).

Yudkowsky, E., Salamon, A., Shulman, C., Kaas, S., Mccabe, T., & Nelson, R. (2010). Reducing Long-Term Catastrophic Risks from Artificial Intelligence. *The Machine Intelligence Research Institute*.

APPENDIX A: Informed Consent

INFORMED CONSENT

We are requesting your participation on a research project conducted by Pedro Manuel Marques Ferreira (Student of the Faculty of Engineering of the University of Porto) in the scope of a Master Thesis, for a Master Degree in Services Engineering and Management, oriented by Professor Jorge Daniel Grenha Luís Teixeira (Professor of the Faculty of Engineering of the University of Porto) and co-oriented by Professor Luís Filipe Pinto de Almeida Teixeira (Professor of the Faculty of Engineering of the University of Porto).

This master dissertation topic concerns the current and future evolution of Artificial Intelligence and how it can impact current services that are available to the public and future, yet to be developed, services.

These interviews will be recorded to allow its in-depth analysis. The recording will be started only with your permission, expressed through a signature in this informed consent.

The information gathered is strictly confidential and used in the scope of this research project **only**. The results will be reported in an aggregated structured, without identifying individually the interviewed, or its affiliation.

Your participation in this research project is voluntary. You can interrupt the interview. If so all information collected will not be used for this study.

For any further information, you can contact me, up200801481@fe.up.pt, +351 918961330 or my dissertation supervisor, Prof. Dr. Jorge Teixeira (jteixeira@fe.up.pt), Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, s/n 4200-465 Porto, tlf. 225083437.

Date...../...../.....

Student's signature

_____

Date...../...../.....

Interviewee's signature

_____

APPENDIX B: Interview Script

Interview Script

My name is Pedro Ferreira and I am currently enrolled in University of Porto, Portugal, in the Master of Service Engineering and Management. University of Porto is one of the leading Universities in Engineering and Service Research in Europe and we are currently developing research on the application of new technologies to the service sector context. In this context, my master dissertation topic concerns the current and future evolution of Artificial Intelligence and how it can impact current and future, yet to be developed, services.

As you know, Artificial Intelligence is each day more common in our lives. Google or Amazon products are integrated in our daily life and many more companies are providing smart services in their own products. While services are increasingly reliant on technology, the application of Artificial Intelligence has a disruptive effect that will transform the traditional way we provide services.

With this in mind and resorting to your expertise in AI, I would like to pose you some questions.

As stated in the informed consent, these interviews will be recorded to allow its in-depth analysis. The recording will be started only with your permission, expressed through the signature of the informed consent.

The information gathered is strictly confidential and used in the scope of this research project only. The results will be reported in an aggregated structured, without identifying individually the interviewed, or its affiliation.

Your participation in this research project is voluntary. You can interrupt the interview. If so all information collected will not be used for this study.

Regarding interviewee information:

- Can you tell me your age, professional activity and academic background?
- Can you explain me how do you work/research with AI?
    - Field of work (research, commercial, etc.). (ask to explain with some detail)
    - Practical applications of the work performed…

Thinking about the Present or Near Future:

- What are the main trending topics in AI? (E.g. Humanoids, Pattern Recognition, Machine Learning, etc.) Why do you consider them important?
    - What AI technologies are currently emerging?
    - What do you know about the current practical applications of these topics and technologies?
    - What are the challenges/barriers to be surpassed for these technologies to reach a wider audience?

- What impacts do you see AI having in society? (i.e. jobs)
    - What are the positive and negative aspects of Artificial Intelligence
    - And impacts on currently available services?
- What new services do you know that are emerging (now), based on Artificial Intelligence?
    - Do you use any of these services? What is your opinion about them?

Think about the future: (in 10 years)

- What would be the main trending topics in 10 years from now in AI? Why?
    - What AI technologies could thrive?
    - What would be the challenges/barriers to be surpassed?
- What new services could emerge, based on Artificial Intelligence?
    - Will you use any of those services? Why?
- What could be the utterly state-of-the-art of AI technology?

Would you like to leave further comments or address something new?

Thank you for your time. I am still searching for new interviewees, as such, I want to ask you if *you know someone that could be available in taking part this interview?*

Thank you.

APPENDIX C: Article submitted to the HICSS Conference (http://hicss.hawaii.edu/)

Artificial Intelligence: An Exploratory Study about the Impact on Services

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Abstract

Services are the backbone of modern economies and are increasingly supported by technology. Meanwhile, there is an accelerated growth of new technologies that are able to learn from themselves, providing more and more reliable results, i.e. Artificial Intelligence (AI). While there have been significant advances on the capabilities of AI, the impacts of this technology on service are still unknown. Authors believe that AI offers a way to augment human capabilities. Others claim that it is a threat to human depended jobs. The objective of this study is to explore the impact of Artificial Intelligence on service, namely by understanding current trends in AI, and how they are, and will, impact service provision. To achieve this, a qualitative study, following Grounded Theory methodology was performed, with ten Artificial Intelligence experts from industry and academia.

1. Introduction

Artificial intelligence (AI) has been defined as "a computational method that attempts to mimic, in a very simplistic way, the human cognition capability to solve engineering problems that have defied solution using conventional computational techniques" (Shahin, 2016). Russell & Norvig (Russell & Norvig, 2013) claim that systems that think like humans, act like humans, think rationally and act rationally can be related with AI. Hence, AI is, and will be, increasingly more common in our lives. Google or Amazon products are being integrated in our daily life and many more companies are providing smart services in their own products. When observing AI evolution, it is possible to posit that AI will shape the service field, as new service channels arise and are reinvented and jobs and tasks are replaced by AI (Huang & Rust, 2018). Thus, robotics and Artificial Intelligence will create changes in economics and business, bringing new ways of living and sociological effects (Dirican, 2015).

Concurrently, there has been a growing academic interest in services, with more disciplines rethinking their curricula, due to the growth of services (Spohrer & Maglio, 2008). In this way, many companies are facing new demands and intense competition. Therefore, they aim to apply services to differentiate themselves from the competition (Ostrom et al., 2015).

Lovelock & Wirtz (Lovelock & Wirtz, 2007) define services as economic activities that are offered by one party to another, applying time-based performances to bring expected results in recipients themselves or in objects or other assets that purchasers have liability. This definition has since evolved towards an understanding of service as the process of reciprocal application of resources for others' benefit (Vargo & Lusch, 2008). Furthermore, service customers are expected to obtain value from accessing goods, labor, skills, facilities, networks and systems but not taking ownership of any physical elements involved, in exchange for money, time and effort (Lovelock & Wirtz, 2007). Following a more technology-oriented perspective, service science has emerged as "the study of service systems, which are dynamic value co-creation configurations of resources (people, technology, organizations and shared information)" (Maglio & Spohrer, 2008).

The interest in technology from a service perspective has also led to a growing interest on smart services (Wuenderlich et al., 2015). According to Wuenderlich et al. (Wuenderlich et al., 2015), Smart services are powerful, allowing real-time data collection, continuous communication and interactive feedback. However, research on these topics is still in its early stages, despite the accelerating technological development.

Due to the accelerated evolution in technology, it is important to incorporate technological change to improve service strategy (Huang & Rust, 2017). Thus, technology in services with a smart oversight have a huge potential, but it requires further research to bring success to organizations and customers (Wuenderlich et al., 2015). Advances in technology are aiming to develop new and transforming services, changing how customers behave (Ostrom et al., 2015). Smart interactive services can offer several research lines (Wünderlich et al., 2013) and it is crucial and far-reaching to understand how will AI alter and transform service delivery.

Some authors claim that AI will reshape jobs, threatening human service jobs (Dirican, 2015; Kurzweil, 2005; Makridakis, 2017). Others say that it will ease the daily life, constituting a major source of innovation (Huang & Rust, 2018). According to Makridakis (Makridakis, 2017), "the AI revolution aims to substitute, supplement and amplify practically all tasks currently performed by humans, becoming in effect, for the first time, a serious competitor to them". Thus, since services are increasingly reliant on technology, the application of AI has a disruptive effect that will transform the traditional way we provide services.

This research paper has the purpose to explore the possible impacts of AI in the service sector. To achieve this objective, a qualitative study based on Grounded Theory methodology was performed, involving semi-structured interviews with ten AI experts from academia and practice (Charmaz, 2006; Corbin & Strauss, 1990). This exploratory approach enables a rich and in-depth understanding of what services will be most probably impacted by AI and how. Before introducing the research methodology and the results of the study technologies, the next section includes relevant literature for the purpose of this study.

2. Literature Review

In this section, the topics of this research are reviewed in the literature. On a first glance, an historical context is given to introduce AI and some state-of-the-art examples. Afterwards, technology-enabled services and initial studies on AI in services are introduced.

The first recognized AI work was done by Warren McCulloch and Walter Pitts in 1943, with a model of artificial neurons characterized by "on" and "off". Marvin Minsky and Dean Edmonds, built the first neural network computer in 1950. Alan Turing's work was the most notable with the introduction of the Turing Test in the 50's, machine learning (ML), genetic algorithms and reinforcement learning (Russell & Norvig, 2013; Turing, 1950).

From 1956 until the early 80's, AI was scrutinized, where famous new hypotheses were formulated, such as AI programming languages and limited domains known as microworlds. On the other hand, these developments suffered with the lack of significant technology and the behindhand scientific knowledge. From 1980 to the present, investment from the industry towards understanding and building AI systems started to become more relevant. Neural Networks started to be again a trending subject, as well as Data Mining and concepts such as the Human-Level AI, Artificial General Intelligence - computers as smart as humans - and Big-Data (Gurkaynak et al., 2016; Russell & Norvig, 2013).

State-of-the-art examples of AI technologies such as robotic vehicles, speech recognition, autonomous planning, machine translation and skin cancer classification through image recognition are expected to be seen in a near future. In the service sector, chatbots, robotic service providers and intelligent agents are also emerging technologies (Huang & Rust, 2017; Makridakis, 2017; Russell & Norvig, 2013). Furthermore, it expects that computers pass successfully the Turing test, indicating intelligence indistinguishable from humans, by the end of this decade (Kurzweil, 2005).

Further in the future, and according to Miller (Miller, 2012),
technological singularity is "a threshold of time at which AI's that are at least as smart as humans, and/or augmented human intelligence, radically remake civilization".

According to Kurzweil (Kurzweil, 2005), a superintelligence will thrive leading to a technological singularity (Čerka et al., 2017), and after the nanotechnology settle in the society, virtual reality will become a common feature within the nervous system and the human society will have the possibility to be a different person, physically and emotionally. Hence, Kurzweil predicted that computers will reach human intelligence around 2029 while Singularity will come by 2045 (Kurzweil, 2005).

While far from the futuristic scenarios drawn by these authors, nowadays, technology can be found everywhere in service and it is the main origin for innovation, empowering firms to leverage its benefits based to their strategic position. Thus, it can aid firms to standardize, customize, transactionalize and relationalize service (Huang & Rust, 2017). However, it needs to be adequately deployed to support service innovation, in order to provide seamless customer experiences and bring great pledge to service (Grenha Teixeira et al., 2017).

As such, further exploration of the effects of smart services have on organizations should be properly addressed (Wuenderlich et al., 2015). When we think about adding value through a service, whom should be aware that the customers are at the center of the process of designing a service. After all, customers do not seek products; they seek satisfaction (Michel et al., 2008). To effectively leverage technology and enable a seamless customer experience across interfaces and systems, the design of the service and its implementation must be carefully managed (Grenha Teixeira et al., 2017). However, technology in services bring challenges, especially when they are implemented in existent business models. Organizations require adaptations in their business models and their services offerings need to hold new smart business models. Thus, collaborations between researchers and managers are beneficial for the development of smart service offerings (Wuenderlich et al., 2015).

In a service encounter, aside from the fact that this represents a cross-disciplinary process integrating technical knowledge with psychological knowledge of interaction dynamics, it has been verified that when social robots show innovative service behaviors during a service encounter, they normally exceed customer expectations and deliver exceptional experiences to customers (Stock & Merkle, 2018). Being AI at the cutting edge of smart technologies used in services, they can help to provide better and better service over time (Huang & Rust, 2017). However, the study of AI in service is still in an initial stage.

Huang & Rust (Huang & Rust, 2018) have proposed a theory of AI job replacement in service, based on the premise that there are four types of intelligence which will be mastered by AI chronologically – mechanical, analytical, intuitive and empathetic – being the first one the easiest to master and the last one the harder to overcome. Furthermore, portraying what humans do nowadays and define what can be augmented by machines is known as Augmentation (Davenport & Kirby, 2015). That is why Huang & Rust (Huang & Rust, 2018) theorized in their article a second and third theory that the job replacement will happen at the task level, from the easier and lower skilled intelligent tasks (mechanical) to the higher intelligence tasks.

According to Ulrich (Ulrich, 1989), Mechanical Intelligence is the possibility "to imbue a mechanism with the ability to respond and react to the environment without guidance from a controller". The tasks that normally embed this type of intelligence include the ones who don't require further education or skills, like call center agents or waiters/waitresses (Huang & Rust, 2018). An everyday use that we give to one of the most known tools, which is Google, Bing or any other type of search engine platform, is considered a type of AI, included in the category of Mechanical Intelligence, because it retrieves the most relevant information, according with previously done searches. A further profound change could happen with the self-driving cars, which can be considered a very good example of an AI (Del Prado, 2015).

Whenever there is information that needs to be processed, analysed, evaluated, judged and compared, the need of Analytical Intelligence is appropriated (Sternberg, 2005). Thus, problem solving, logical and mathematics are primary characteristics that define Analytical Intelligence, normally acquired by training and refined by cognitive thinking, used usually by "computer and technology-related workers, data scientists, mathematicians, accountants, financial analysts, auto service technicians, and engineers" (Huang & Rust, 2018). Although it is not possible for Analytical Intelligence to simulate intuition, since it is very hard to replicate, machine learning (ML) and Internet of Things (IoT) are two concepts which can be thoroughly studied, leading us in the future to evolve into an intuitive artificial intelligence state. The collection of data and inter-machine communication are the two main and most important features of AI that it is known in the service field (Huang & Rust, 2018).

Intuitive Intelligence requires a higher state of creativity and problem solving abilities, like management consultants, lawyers, doctors and marketing managers have (Huang & Rust, 2018). This type of Intelligence distinguishes from the analytical since it is able to analyse several data, understand the subject and the content of a certain fact. As Del Prado (Del Prado, 2015) defends, if a certain system could read all pages of millions of books that are related to a specific subject and actually understanding how to combine them all in a single answer, then we would have evolved to a new level of intelligence. Tasks that are creative, chaotic, things that most skilled humans in sports or entertainment do, require intuitive intelligence for providing the best service they can. Those features require Intuitive Intelligence (Huang & Rust, 2018).

Seddon & Biasutti (Seddon & Biasutti, 2009) presents an example in music of how Empathising is intrinsically connected with interpersonal social skills and requiring collaboration towards creativity. From a service provision perspective, the way an employee shows their emotions while fulfilling service tasks to a certain customer, actually defines how good the service was, from the customer point of view. An example is a flight attendant or a psychiatric doctor (Huang & Rust, 2018). Empathetic Intelligence is different from emotional or cognitive intelligence, being the connection between thinking and feeling, being inspired by intuition and reflective practice, requiring recognition on a complex system between culture and

human responsiveness (Arnold, 2005). Being directly connected with people and with others' feelings, it is a type of Intelligence normally required by psychologists or customer-related personnel (Huang & Rust, 2018).

This is the most difficult stage of intelligence to simulate in a machine, due to the fact that "emotion is considered a biological reaction" (Huang & Rust, 2018). As Fabrega (Fabrega, 2000) states, cognitive-emotional space of consciousness has always mapped the humans, from pre-historical times to what we are today. In Turing (Turing, 1950), the AI pioneer Alan Turing starts his book with the following statement: "Can machines think?". The Turing test determines if a computer can think like a human based on their behavior (human or computer) observed by an outsider, no mattering how they achieved that level. Reaching this type of intelligence is very hard on AI machinery, and some are often designed not to look humanoids, for ethical purposes. Some examples are *Han* and his evolution and a more intelligent version – *Sophia* – who was recently awarded with a Saudi Arabia citizenship (Huang & Rust, 2018).

This current research shows that AI will have a very significant impact on service provision over time, although it does not further characterize this impact. Based on a qualitative study, this paper aims to contribute towards closing this research gap.

3. Methodology

This research aims to understand the impact of AI on service. Qualitative research helps to address these exploratory questions, enabling researchers to address "why" and "how" questions, as opposed to quantitative research that is focused on measuring and validation (Neuman, 2014). Therefore, qualitative research is suitable to address the aims of this research. As such, this study follows a qualitative approach based on Grounded Theory (Charmaz, 2006) involving semi-structured interviews from the AI field, in academia and industry.

Barney G. Glaser and Anselm L, Strauss made innovative statements with notions of systematic strategies and procedures for qualitative studies - The Grounded Theory Methods – a methodical and standardized method, although adjustable enough, allowing the reshaping and improvement of the data collected (Strauss & Corbin, 1997). Grounded Theory provides guidance on the sampling, data collecting and data analysis procedures. Corbin & Strauss (Corbin & Strauss, 1990) define coding as an analytical process in order to categorize the acquired data. In grounded theory research, there are three types of coding: open coding, which consists in constant comparisons, with a set of major categories of information (Creswell et al., 2007), axial coding, where previous categories merge into subcategories and relationships are proved and selective coding, which usually occurs in later phases of the study (Corbin & Strauss, 1990), with the purpose of examining the previous codes to identify major concepts, in which all categories are organized around this major theme.

For any qualitative study and depending on the objective of the study, the sampling definition and randomness should be appropriately evaluated (Marshall, 1996). This study was based on a qualitative approach, where data was obtained from a sample of experts with the objective of obtaining theoretical saturation as an indicator of no new properties of categories during data collection (Charmaz, 2006), which means that no additional information is found, in every further new iteration (Glaser & Strauss, 1967).

Taking in consideration the object of the study, a sample of ten AI experts from academia and industry was chosen. Concerning occupation, five sources are professors, working directly in universities, four sources work directly in the industry and one in a research facility. They are mainly data scientists and university professors. One is a bioengineer and one is an informatic engineer.

Data for this study was collected between the 20th of March and the 4th of May of 2018. Firstly, a selection of AI experts was done, based on their professional activity. All the interviewees were contacted by e-mail to briefly explain the research objectives and, if agreed upon, to schedule the interviews. The interview script was created with the intention of a common structure for all interviews, also ensuring that all subjects were covered. However, the respondents come from different cultural and social situations and there were different ways to answer the same question. Before the session, the interviewer began with an introduction about the project and the purpose of the study. A contextualization was also included to offer guidance to the interviewee (Foddy, 1994). All the interviews were audio recorded and an informed written consent was given and signed by the interviewee and the researcher. This informed consent included guarantees of confidentiality and anonymity of the interviewee. All gathered data was literally transcribed and then coded and analysed using a Computer-Assisted Qualitative Data Analysis Software (NVIVO11®) to support the analysis.

4. Results

In this section the results of the qualitative study are presented.

The codes from the interview's information were aggregated by different categories: Impact of AI in Service and Society, where the coding system reflect sectorial impacts and societal impacts with positive and negative impacts, challenges and barriers and also possible practical applications; some quotes from the respondents are also provided along this section to add further detail. These categories are shown on Table 2.

Firstly, the results regarding the societal impacts of AI are presented. These societal impacts, while not directly focused on service, bring important implication to the design and development of new services using AI.

Impact on social behavior: In this category, ten sources referred barriers and challenges in which most difficulties for AI development were caused by humans, or the need of explanation from the AI algorithms. However, replacement, imbalance and isolation are still issues that the respondents refer as possible negative impacts provoked by the development of AI.

Impact on labor: This impact had also strong representability among the interviewees, with 8 sources mentioning that with the evolution of technology, there will be a positive and smart redirection of the current professions that we know today. AI will influence the way companies operate and how they are managed, leading to an unavoidable shift in employment but also to unemployment and replacement in some areas.

Impact on legal aspects: Most of the respondents mentioned negative impacts and barriers and challenges. The fact that there is no regulation and the lack of it and its harmful consequences, were mentioned by three sources, along with the political issues that are inherent to these regulations.

Impact on ethic aspects: The most highlighted aspect was the case of the autonomous car and privacy related aspects. Seven respondents mentioned that there are a lot of ethics involving, for example, autonomous vehicles.

Impact on education: Although no negative impact or no application information was extracted from the analysis of the interviews, three sources mentioned a positive impact on society, regarding the arise of new disciplines in school and higher education, highlighting the need for AI programming school programs. Furthermore, interviewees mentioned a media misunderstanding about AI, which reflects directly in people's education. Two sources claimed that most people have wrong or distorted information about the future impacts of AI.

Impact on home: For the impacts on home, no negative impacts nor barriers and challenges were expressed. However, several applications in the field of domotics were mentioned: vacuum cleaner robots, which although already exists, can be augmented with AI, and daily-life programming robots, which are AI machines and can help on daily house tasks such as ironing, cooking, and many more.

Impact on environment: From an environmental point-of-view, the most mentioned aspects were regarding possible future applications where AI can be present, such as smart fire detections, pollution measurement systems, atmospheric sensors, space modulation for retrieving 3D images of certain animals on a specific location and better waste management systems.

Secondly, interviewees mentioned several sectors that will be impacted by AI. From the several sectors mentioned and illustrated in Table 2, it is possible to see that most of these sectors are service sectors. This highlights the strong potential impact of AI in service.

Impact on science and technology: Four sources mentioned that AI technologies are growing at an exponential rate. Furthermore, it should be necessary that AI experts openly debate about the current state of AI development, for general knowledge growth.

Impact on industry: Four of the ten respondents claimed that automation brings more productivity, especially mechanical activities with repetitive movements. One aspect that was mentioned by three respondents were the breakthroughs in History – industry revolutions or military events – that lead to technology progress and expansion and consider that AI is one of these breakthroughs.

Impact on healthcare: During the interviews, most references were made to possible applications in the healthcare and Medicine area, in which eight of the respondents talk about an AI application to medical diagnosis and seven of preventive medicine. Although just one source mentioned the potential discoveries in the healthcare industry regarding drugs, also just one mentioned the fact that AI will never replace the need of a human opinion to validate, meaning that AI cannot work independently in these highly skilled services.

Impact on customer services: This sector, alongside with industry, was one of the most supported by the sources. Most of our respondents suggested applications on customer services, mainly for call centers – chatbots, as a supporting system and for call center automation. However only one source mentioned the disappearance of call centers. From a positive impact side, five respondents mentioned that the increase of AI technologies is directly proportional to the customization achievability of services, according to the needs of each customer, with a high level of personalization and therefore, more valuable. Thus, one respondent added that with more and more mass services, a customized service will be more valued.

Impact on transportation and autonomous driving: This section includes not only transportation, but also an important application of AI in this sector that emerged

Table 19 – Impact of AI on Service and Society

	Name	Sources (n=10)	Positive Impacts on Society	Negative Impacts on Society	Barriers and Challenges	Applications / Examples (Ethic aspects))	Quotes
Societal Impacts	Impact on social behavior	10	Adaptation	Replacement Imbalance Isolation	Explanation Privacy issues	Drone delivery of first goods in remote areas	"There will be one challenge, which is fight the first fear of people using these systems."
	Impact on labor	10	Smart redirection of Human Resources on society Repetitive tasks automation	Employment unawareness Unemployment Replacement of jobs	There is a lack of experts in AI area	Creation of new professions	"[There is] no follow-up on the reconversion of jobs."
	Impact on legal aspects	8	Reduce the number of ID falsifications	No regulation of technologies Political issues Failure of explanation	The right of explanation from a machine	GDPR and connection with AI	"There is a set of regulations, a domain that needs to be improved, in order to build a safer path [in the future]."
	Impact on ethics	7	-	-	Ethics as a long-term issue Privacy safety-security balance	Autonomous car and ethics Cambridge Analytica case of Facebook	"In a run over case, the vehicle could need to decide in function of the passenger or the passer-by."
	Impact on education	6	New disciplines in school – AI Programming	-	Media misunderstanding about AI	-	"I think that AI should be teach, at least the programming part, right from elementary school."
	Impact on home	5	Intrusion detection	-	-	Domotics/	"I'd like my house with several Robots."
	Impact on environment	4	-	High electricity consumption from AI technologies	No coverage from the current energetic production	Smart fire detection Pollutants measurement	"On an ecologic level, preventive measurements could be made – studying the forecast of forest fires."
Sectorial Impacts	Impact on science and technology	10	Exponential evolution of AI technologies More knowledge from AI research and debates	AI technologies used for bad purposes Cybersecurity vulnerabilities	Hardware Efficiency to perform ML Algorithms Inefficiency and inexistence of a general AI	AI applied to Forensics Learning sensors in AI technologies	"It is necessary the existence of debates and discussions"
	Impact on industry	10	More productivity with automation development	Society has less or no awareness of the current automation impact	Traditional companies and weak AI implementation	-	"Regarding automation, the potential of increasing productivity in companies for a cost reduction."
	Impact on healthcare	10	New discoveries to create new medicaments	Human opinion cannot be replaced only by AI systems	Assurance of robust algorithms that work for all possible patients	AI in diagnostics AI in preventive medicine AI as second opinion systems	"Technology that gets health signals from our body and alerts for a disease development, even before our symptoms."
	Impact on customer services	9	Customization of services	Replacement of services	-	Call Centers and Chatbots Automated supermarket	"Everything will be more customized."
	Impact on transportation and autonomous driving	9	Autonomous cars will reduce accidents Autonomous cars can learn very quick than humans	Autonomous cars will reduce the driving pleasure	-	Space exploration Non-stop autonomous cars in logistics-distribution Roadways only dedicated to autonomous cars	"Autonomous cars will increase the comfort of not having to drive. Consequently, it will increase safety, since there will be less accidents."
	Impact on financial services	4	Disappearance of passwords for facial or digital print recognition	Cryptocurrency being not enough credible for society	-	Fraud detection	"AI will help to reduce the number of frauds."
	Impact on retail	4	Physical stores need to persist in the future for customer care			Sensors in clothes Shopping recommendation systems	"The capacity of having sensors in every clothing article."

from the interviews: autonomous driving. Eight respondents made references to applications in the transportation sector. This was reflected on the richness of possible applications mentioned. On a positive side, three sources mentioned that autonomous cars will increase safety, eliminating the error factor that comes from the human side. Furthermore, having a controlled environment where autonomous cars communicate and learn from themselves will also increase safety.

Impact on financial services: in the financial services sector, the main application was the fraud detection on credit card transactions, cloning, tax evasion and bank accounts. No barriers and challenges were identified either. For positive impacts, the disappearance of password is imminent.

Impact on retail: On retail, no negative impact and no barrier and challenge was extracted from the interview's analysis. However, it is important to highlight that there is a positive impact for the society with AI in the retail area which is the persistence of physical stores for customer care. Regarding applications, mainly AI sensors and smarter recommendation systems in advisement.

In a nutshell, the collected data reveals a great amount of impacts on services, both related with service sectors, and with societal changes.

5. Discussion

The study generated a detailed set of results that sparked interesting questions for discussing how AI impacts service. This section details the most interesting discussion topics, namely, job replacement in the service sector, implications on privacy, security, ethics and liability on services that are supported by AI, AI in customer services, human skills and education and Humanity and daily contact with AI.

In service, the impact will be profound. AI is vastly adaptive and enables high personalization. Thus, it can learn from customer's past behavior, leading to increasing improvements (Huang & Rust, 2017). However, in services that require a stronger human interaction with empathetic characteristics, AI will be harder to replace. Having both humans and machines supporting themselves can be one possible strategy (Huang & Rust, 2018). Since jobs are already migrating from manufacturing to services, and the service sector is increasing along with AI, it is important to assess how AI can replace low-skilled service jobs. Empathetic and intuitive skills are not yet mimicked by AI, which means that people who work daily in high-skilled service jobs, like healthcare workers, will not be as much impacted like those who perform tasks that are possible to automatize (Huang & Rust, 2018), which goes in agreement with the acquired results.

Job replacement is probably one of the feared consequences, as it was also verified in the results. Repetitive tasks automation are already common for precise and well-defined procedures (Autor & Dorn, 2013). According to Goux-Baudiment (Goux-Baudiment, 2014), 47 percent of today's jobs will be automated by 2033. Furthermore, with state-of-the-art sensors, robots are capable of producing goods with higher quality that humans (Frey & Osborne, 2017). Results support this position for industrial related sectors. However, services require social and interpersonal skills, which Huang & Rust (Huang & Rust, 2018) also called "soft" people skills, and these will increasingly become the most important components for employability. People with these features will have more employment opportunities with the arise of AI (Makridakis, 2017). Occupations that require a high degree of creative intelligence are unlike to be automated (Frey & Osborne, 2017).

The discussion of the data security and the privacy is also an important subject (Dirican, 2015). Some of our respondents mentioned a binary operation when it concerns privacy and security. To have more security, privacy should be granted. Hence, AI has the potential to mass-produce surveillance, but this colossal computerization leads to a loss of privacy (Russell & Norvig, 2013). Kurzweil (Kurzweil, 2005) has no doubt: the balance between privacy and protection will be one of the massive challenges to overcome with AI. As such, when designing and developing service that are supported by AI, additional measures should be taken to ensure the privacy of their users. For example, interfaces and software should be primarily designed with privacy guidelines through encryption and data access control (Gurkaynak et al., 2016).

During the interviews, the case of the autonomous vehicle running over a pedestrian was referred to when it concerns ethics and laws. What would happen if a car must decide between a person or a group of people? Automated vehicles are not considered "drivers" when it concerns speed limit regulation and enforcement. But in case of an accident, the person responsible of that automated vehicle could be liable. There is a big lack of knowledge and guidelines when we talk about liability in this type of technology (Russell & Norvig, 2013). As such, the creation and development of autonomous transportation services might be limited while law makers establish the required boundaries and liabilities for the use of autonomous transportation.

There was a special emphasis on the impact on customer services. The main coding reference within call-centers concerned chatbots, a tool that will disruptively - for some respondents or progressively and

supporting for others - change customer support. This is supported by literature as call center agents are considered a type of job that does not requires high skilled labour people, being easily replaceable by AI (Huang & Rust, 2018). Stock & Merkle (Stock & Merkle, 2018) performed a study with humanoid service robots and they concluded that if they are able to express behavioral and innovative notions during the service encounter, they could exceed customer expectations and deliver noteworthy experience to customers. Overall, tt could be possible to have automatic service encounters and still have good reactions from customers.

Free and more quality time for humans in the future was also mentioned in some interviews, which according with Makridakis (Makridakis, 2017), AI will shrink the level of work left for people and increase their free time, making people able to pursue their own interests. This might open the possibility to develop services related to leisure and entertainment. Tasks requiring creativity, strategic thinking, entrepreneurship are not expected to see algorithmically done, providing pre-eminence in humans.

It is possible to verify that most respondents enumerated difficulties faced by people regarding AI, with an emphasis on the fear of using AI technologies in the first place. People fear the unknown, losing control, and fear being injured. However, that concerns will disappear when that technology becomes common (Goux-Baudiment, 2014). This perspective from the interviewees is mirrored, and perhaps influenced, by some authors, namely Kurzweil (Kurzweil, 2005). Other very public personalities like Bill Gates and Stephen Hawking also mentioned that Humanity should have a very safeguarding and conservative view of AI, due to the harm that it can cause (Gurkaynak et al., 2016). The creation of services that can humanize AI open an opportunity to converge technologies with customers.

6. Conclusion and Future Research

Technology innovation is rapidly transforming service experiences (Grenha Teixeira et al., 2017). AI is a breakthrough technological innovation with yet unforeseen consequences for service. Through this qualitative study with AI experts, this article aims to start understanding the impacts that AI can bring to service, and to society as an all.

Employment will suffer with AI, where most mechanical and repetitive actions will mostly be replaced by AI engines. On the other hand, it was possible to understand that new tasks will arise with these emerging technologies, making either possible a smart redirection of employees within companies or in some cases a job disintegration. The most known example in customer service is the chatbot, where companies are increasingly implementing them to cover most of the repetitive and usual inquiries.

This study has some limitations that can also offer opportunities for future research. It is necessary a deeper study with multidisciplinary efforts for each impact and it should not be addressed only as a technological endeavour. Further studies can explore the different impacts individually, to answer such questions. These impacts will directly depend on the evolution of complex abilities from AI. Finally, this study can be complemented with a quantitative study, in order to quantify and validate these impacts in a wider sample.

Despite the fact that there is plenty to explore in this topic, it is possible to claim that this study allows us to better understand the impacts of AI on services and can help to prepare service providers to the sweeping changes that will arrive with the rise of AI.

7. References

Aha, D. W., Kibler, D., & Albert, M. K. (1991). Instance-Based Learning Algorithms. *Machine Learning*, *6*, 37–66.

Arnold, R. (2005). *Empathic intelligence : teaching, learning, relating*. Sydney, Australia: UNSW Press.

Autor, D. H., & Dorn, D. (2013). The Growth of Low Skill Service Jobs and the Polarization of the U . S . Labor Market. *American Economic Review*, *103*(5), 1553–1597.

Bishop, C. M. (2013). *Pattern Recognition and Machine Learning*. *Journal of Chemical Information and Modeling* (Vol. 53).

Bonnefon, J.-F., Shariff, A., & Rahwan, I. (2016). The social dilemma of autonomous vehicles. *Science*.

Brooks, R., Hassabis, D., Bray, D., & Shashua, A. (2012). Turing centenary: Is the brain a good model for machine intelligence? *Nature*, *482*(7386), 462–463.

Brown, T. (2008). Change by Design. *Harvard Business Review*, 86(6).

Buera, F. J., & Kaboski, J. P. (2009). The Rise of the Service Economy. *NBER Working Paper*, *I*(21 May 2009), 1–13.

Čaić, M., Odekerken-Schröder, G., & Mahr, D. (2018). Service robots: value co-creation and co-destruction in elderly care networks. *Journal of Service Management*, *29*(2), 178–205.

Čerka, P., Grigienė, J., & Sirbikytė, G. (2017). Is it possible to grant legal personality to artificial intelligence software systems? *Computer Law and Security Review*, *33*(5), 685–699.

Charmaz, K. (2006). *Constructing grounded theory: a practical guide through qualitative analysis*. *Book* (Illustrate, Vol. 10). London, UK: Sage Publications.

Corbin, J., & Strauss, A. (1990). Grounded Theory Research: Procedures, Canons and Evaluative Criteria. *Zeitschrift Fur Sociologie*.

Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative Research Designs: Selection and Implementation. *The Counseling Psychologist*, *35*(2), 236–264.

Davenport, T. H., & Kirby, J. (2015). Beyond automation: strategies for remaining gainfully employed in an era of very smart machines. *Harvard Business Review*, (93(6)), 58–65.

Davis, E. The technological singularity: The singularity and the state of the art in artificial intelligence, Department of Computer Science, New York University 1–12 (2012).

Dayhoff, J. E., & DeLeo, J. M. (2001). Artificial neural networks. *Cancer*, *91*(S8), 1615–1635.

Del Prado, G. M. (2015). AI robots don't need to be conscious to become human enemies - Business Insider. Retrieved February 1, 2018, from http://www.businessinsider.com/artificial-intelligence-machine-consciousness-expert-stuart-russell-future-ai-2015-7?IR=T

Dietterich, T. G., Lathrop, R. H., & Lozano-Pérez, T. (1997). Solving the multiple instance problem with axis-parallel rectangles. *Artificial Intelligence*, *89*(1–2), 31–71.

Dirican, C. (2015). The Impacts of Robotics, Artificial Intelligence On Business and Economics. *Procedia - Social and Behavioral Sciences*, *195*, 564–573.

Fabrega, H. (2000). The Feeling of What Happens: Body and Emotion in the Making of Consciousness. *Psychiatric Services*, *51*(12), 1579–1579.

Farrell, R., Oza, O., Zhang, N., Morariu, V. I., Darrell, T., & Davis, L. S. (2011). Birdlets: Subordinate categorization using volumetric primitives and pose-normalized appearance. *Proceedings of the IEEE International Conference on Computer Vision*, 161–168.

Foddy, W. (1994). *Constructing questions for interviews and questionnaires: Theory and practice in social research* (Illustrate). Cambridge, UK: Cambridge University Press.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, *114*, 254–280.

Fürnkranz, J. (1999). Separate-and-Conquer Rule Learning. *Artificial Intelligence Review*, *13*, 3–54.

Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. *Observations* (Vol. 1).

Goux-Baudiment, F. (2014). Sharing Our Humanity with Robots. *World Futures Review*, *6*(4), 412–425.

Greenwald, H. S., & Oertel, C. K. (2017). Future Directions in Machine Learning. *Frontiers in Robotics and AI*, *3*, 79.

Grenha Teixeira, J., Patrício, L., Huang, K. H., Fisk, R. P., Nóbrega, L., & Constantine, L. (2017). The MINDS Method: Integrating Management and Interaction Design Perspectives for Service Design. *Journal of Service Research*, *20*(3), 240–258.

Gurkaynak, G., Yilmaz, I., & Haksever, G. (2016). Stifling artificial intelligence: Human perils. *Computer Law and Security Review*, *32*(5), 749–758.

High, R. (2012). The Era of Cognitive Systems: An Inside Look at IBM Watson and How it Works. *International Business Machines Corporation*, *1*(1), 1–14.

Huang, M. H., & Rust, R. T. (2017). Technology-driven service strategy. *Journal of the Academy of Marketing Science*, *45*(6), 906–924.

Huang, M. H., & Rust, R. T. (2018). Artificial Intelligence in Service. *Journal of Service Research*, *21.2*, 155–172.

Huyck, C., & Abbas, F. (2000). Natural Language Processing and Requirements Engineering: a Linguistics Perspective. *Proceedings of 1st Asia-Pacific Conference on Software Quality*, (January 2000), 1–12.

Kong, F., Zhou, G., Qian, L., & Zhu, Q. (2010). Dependency-driven Anaphoricity Determination for Coreference Resolution. *Computational Linguistics*, (August), 599–607.

Kurzweil, R. (2005). *The Singularity is Near : when humans transcend biology*. *VIKING*. NY: Viking Press.

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

Liao, S., & Grishman, R. (2011). Can Document Selection Help Semi-supervised Learning? A Case Study On Event Extraction, 260–265.

Loocke, P. Van. (2001). *The physical nature of consciousness*. Amsterdam, The Netherlands: John Benjamins Publishing.

Lovelock, C. H., & Wirtz, J. (2007). *Services marketing : people, technology, strategy* (6, illustr ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.

Maglio, P. P., & Spohrer, J. (2008). Fundamentals of service science. *Journal of the Academy of Marketing Science*, *36(1)*, 18–20.

Makridakis, S. (2017). The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. *Futures*, *90*, 46–60.

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice*, *13*(6), 522–525.

Mccallum, A., & Nigam, K. (1998). A Comparison of Event Models for Naive Bayes Text Classification. In *AAAI-98 workshop on learning for text categorization* (p. Vol. 752, No. 1, pp. 41–48).

Michel, S., Brown, S. W., & Gallan, A. S. (2008). Service-Logic Innovations: How to Innovate Customers, Not Products. *California Management Review*, *50*(3), 49–65.

Miller, J. D. (2012). *Singularity rising : surviving and thriving in a smarter, richer, and more dangerous world*. Dallas, TX: Benbella Books, Inc.

Morse, J. (1994). Designing funded qualitative research. In *Handbook of qualitative research* (N. K. Denz, pp. 220–235). Thousand Oaks, CA, US: Sage Publications, Inc.

Müller, Vincent, C., Bostrom, & Nick. (2016). Future progress in artificial intelligence: A survey of expert opinion. In *Fundamental Issues of Artificial Intelligence* (pp. 553–571). Cham, Switzerland: Springer.

Neuman, W. L. (2014). *Social Research Methods: Qualitative and Quantitative Approaches*. *Relevance of social research* (Seventh Ed). Edinburgh: Pearson Education, Limited.

Olden, J. D., & Jackson, D. A. (2002). Illuminating the "'black

box'": a randomization approach for understanding variable contributions in artificial neural networks. *Ecological Modelling*, *154*(154), 135–150.

Ostrom, A. L., Parasuraman, A., Bowen, D. E., Patrício, L., & Voss, C. A. (2015). Service Research Priorities in a Rapidly Changing Context. *Journal of Service Research*, *18*(2), 127–159.

Patrício, L., & Fisk, R. P. (2017). Creating new services. In *Serving Customers: Global Services Marketing Perspectives Introduction* (Vol. Chapter 10, pp. 185–207).

Russell, S., & Norvig, P. (2013). *Artificial Intelligence A Modern Approach*. *Artificial Intelligence* (3, illustr ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.

Sadeghi, M. A., & Farhadi, A. (2012). *Recognition Using Visual Phrases*. University of Illinois.

Samuel, A. L. (1954). Machine Learning Using the Game of Checkers. *IBM Journal of Research and Development*, *44*(1.2), 206–226.

Schmidhuber, J. (2015). Deep learning in neural networks: An overview. *Neural Networks*, *61*, 85–117.

Seddon, F. A., & Biasutti, M. (2009). Modes of Communication Between Members of a String Quartet. *Small Group Research*, (40(2)), 115–137.

Shahin, M. A. (2016). State-of-the-art review of some artificial intelligence applications in pile foundations. *Geoscience Frontiers*, 33–44.

Silva, J., Figueira, C., Barandas, M., Gonçalves, J., Costa, J., Rosado, L., … Gamboa, H. (2017). Machine Learning @ Fraunhofer Portugal AICOS.

Spohrer, J., & Maglio, P. P. (2008). PRODUCTION AND OPERATIONS MANAGEMENT The Emergence of Service Science: Toward Systematic Service Innovations to Accelerate Co-Creation of Value, *17*(3), 238–246.

Sternberg, R. J. (2005). The theory of successful intelligence. *Interamerican Journal of Psychology*, *39*(2), 189–202.

Stickdorn, M., & Schneider, J. (2010). *This Is Service Design Thinking* (eds.). Amsterdam: BIS Publishers.

Stock, R. M., & Merkle, M. (2018). Can Humanoid Service Robots Perform Better Than Service Employees ? A Comparison of Innovative Behavior Cues 2 . Theoretical Background & Hypotheses. *In Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS)*, 1056–1065.

Strauss, A., & Corbin, J. (1997). *Grounded theory in practice* (Illustrate). Thousand Oaks, CA: Sage Publications.

Turing, A. M. (1950). *Computing machinery and intelligence*. *Parsing the Turing Test. Springer* (Vol. 59).

Ulrich, N. T. T. (1989). Grasping with mechanical intelligence. *Technical Reports (CIS)*, (December), 846.

Vargo, S. L., & Lusch, R. F. (2008). Service-dominant logic: Continuing the evolution. *Journal of the Academy of Marketing Science*, *36*(1), 1–10.

Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). *Data Mining: Practical Machine Learning Tools and Techniques*. Amsterdam, The Netherlands: Morgan Kaufmann.

Wuenderlich, N. V., Heinonen, K., Ostrom, A. L., Patricio, L., Sousa, R., Voss, C., & Lemmink, J. G. A. M. (2015). "Futurizing" smart service: implications for service researchers and managers. *Journal of Services Marketing*, *29*(6/7), 442–447.

Wünderlich, N. V., Wangenheim, F. V., & Bitner, M. J. (2013). High Tech and High Touch: A Framework for Understanding User Attitudes and Behaviors Related to Smart Interactive Services. *Journal of Service Research*, *16*(1), 3–20.

Xia, F., Yang, L. T., Wang, L., & Vinel, A. (2012). Internet of Things. *INTERNATIONAL JOURNAL OF COMMUNICATION SYSTEMS Int. J. Commun. Syst. Int. J. Commun. Syst*, *25*(25).

Yudkowsky, E., Salamon, A., Shulman, C., Kaas, S., Mccabe, T., & Nelson, R. (2010). Reducing Long-Term Catastrophic Risks from Artificial Intelligence. *The Machine Intelligence Research Institute*.

APPENDIX D: Extended Coded Tree

Name	*Sources*	*References*
AI in the future	10	21
Certainty	6	9
Aggregation of AI systems	2	4
AI should never overcome ethic and privacy limits	2	2
Humanoid	1	1
Systems as intelligent as humans	1	1
Systems supporting machines and not replacing machines	1	1
Uncertainty	6	12
AI future is somehow related with reasoning and data knowledge	2	3
AI is still in a very early stage	1	1
Technological singularity is improbable	1	1
There is no limit - humanity defines its own limit	4	4
Uncertainty of the future with AI	3	3
AI Trending	10	107
AI trending depend on current or new problems	2	5
Examples of existing products	6	20
Amazon products	3	4
Mechanical Turk	1	1
Apple products	1	1
Oenology related with AI technologies	1	1
Facebook products	3	3
Google products	5	10
Google Glass product didn't avenge	2	2
Technology	10	76
Autonomous cars	10	27
Blockchain	2	3
Quantic computers	2	2
Recognition technologies	8	32
Hypothesis generation from image recognition	3	3
Image and Pattern Recognition	7	20
Text Recognition	2	2
Voice Recognition	4	7
Robots	5	10
Video processing	1	2
Impact of AI in service and society	10	505
Impact on customer experience	9	35
Applications	9	23
AI applied to services to which men has less or no affinity	1	1
Automated supermarket	2	2
Call Centers	7	13
Chatbots	6	10
Disappearance of the call centers	1	2
Virtual Personal Assistance	1	1
Humanoid robot	3	6
Personalized discount vouchers	1	1
Barriers and challenges	0	0
Negative impact on society	2	2

Chatbots answering phones and not humans	1	1
Replacement of services	1	1
Positive impact on society	6	10
All services can be automated anyway	1	1
Chatbots are increasingly better	1	1
Customization of services	5	5
Redirection of clients in customer services based on their behavior	1	2
Use of information to add value in services	1	1
Impact on education	6	10
Applications	0	0
Barriers and challenges	3	5
Media misunderstanding about AI	2	4
Uncover from universities towards future occupations	1	1
Negative impact on society	0	0
Positive impact on society	3	3
New disciplines in the school – AI Programming	3	3
Impact on environment	4	9
Applications	3	7
Atmospheric sensors	1	1
Concentration of pollution measurement	1	1
Smart fire detection	2	3
Space modulation for animal identification	1	1
Waste management systems	1	1
Barriers and challenges	1	1
No coverage from the current energetic production	1	1
Negative impacts on society	1	1
High electricity consumption from AI technologies	1	1
Positive impacts on society	0	0
Impact on ethic aspects	7	38
Actual examples	7	14
Cambridge Analytica case of Facebook	3	3
Case of the autonomous car and ethics	7	10
Case of the Sophia and her citizenship in Saudi Arabia	1	1
Barriers and challenges	6	20
Balance between privacy and safety-security	3	7
Ethic involved when there is personal data recorded	2	4
Ethical questions as a long-term issue	4	5
Ethic related to decisions and explanations from machines	2	4
Impact on financial services	4	18
Applications	4	16
Fraud detection	4	16
Barriers and challenges	0	0
Negative impact on society	1	1
Cryptocurrency being not enough credible for society	1	1
Positive impact on society	1	1
Disappearance of passwords for facial or digital print recognition	1	1
Impact on healthcare	10	46
Applications	10	36
AI applied to medical diagnostics	8	9
Google Glasses	1	1
AI applied to medicine imaging (MRI or X-rays)	3	6

AI applied to Neuroscience	2	2
AI applied to preventive medicine	7	9
Sensors in our body to detect diseases	3	3
AI as second opinion systems	6	6
Distance doctor medicine	2	2
Baby condition during gestation	1	1
Elderly care system with AI aid	2	2
Prediction of illnesses for elderly people	1	1
Barriers and challenges	1	1
Assurance of robust algorithms that work for all possible patients	1	1
Negative impact on society	1	1
Human opinion cannot be replaced only by AI systems	1	1
Positive impact on society	1	1
New discoveries to create new medicaments	1	1
Impact on home	5	10
Applications	4	8
Domotics	4	8
Automatic or semi-automatic fridge replenisher	1	1
Daily-life programming robot	2	2
Google Home	1	1
Robotic arm chef	1	1
Smart garbage collection	1	1
Vacuum cleaner robot	2	2
Barriers and challenges	0	0
Negative impact on society	0	0
Positive impact on society	2	2
Intrusion detection	1	1
Surveillance as a area of big investment	1	1
Impact on industry	10	23
Applications	0	0
Barriers and challenges	1	3
Challenge of understanding how big companies will subsist or being replaced	1	1
No knowledge about all AI existing companies	1	1
Traditional companies and weak AI implementation	1	1
Negative impacts on society	4	4
Society has less or no awareness of the current automation impact	4	4
Positive impacts on society	9	16
AI Technologies as facilitators in repetitive operations	3	5
Breakthroughs in History will lead to a technology development	3	3
Deep Learning in the research field developed to the industry	1	1
Involvement of new start-ups in AI	1	2
More productivity with automation	4	5
Impact on labor	10	54
Applications	6	12
Creation of new professions	6	12
Brokers working entirely with an AI computer	1	1
Human body organ generator	1	1
Barriers and challenges	1	2
There is a lack of experts in AI area	1	2
Negative impact on society	7	15
Everything that doesn't require creativity can be replaced by AI	2	2

Human labor employment unawareness	5	5
Replacement of jobs	2	2
Unemployment	5	6
Positive impact on society	8	25
Acquisition of new capabilities and competences due to AI impact	1	1
No necessity of the humanity to work in the future	1	1
Repetitive tasks automation	5	12
Smart redirection of Human Resources on society	6	11
Impact on legal aspects	8	45
Applications	4	10
GDPR and connection with AI	3	4
ID Authentication with digital print match	1	3
ID Authentication with visual recognition	1	3
Barriers and challenges	6	14
Privacy and personal data balance	2	4
Robots and citizenship	1	1
The right of explanation from a machine	4	9
Negative impact on society	6	15
Development too fast with no restrictions or regulations	2	2
Inability of providing explanation	2	2
Non-awareness of the consequences of AI	1	1
Non-regulation of technologies can be harmful	3	5
Political issues	3	4
Surveillance can interfere legally with people's privacy	1	1
Positive impact on society	1	1
Reduce the number of ID falsifications	1	1
Impact on retail	4	6
Applications	4	5
Door-to-door shopping system	1	1
Sensors in clothes	2	2
Shopping recommendation systems	2	2
Barriers and challenges	0	0
Negative impact on society	0	0
Positive impact on society	1	1
Physical stores need to persist in the future for customer care	1	1
Impact on science and technology	10	65
Applications	2	2
AI applied to Forensics	1	1
Learning sensors in AI technologies	1	1
Barriers and challenges	9	28
AI needs Infrastructures and big investments in hardware acquisition	3	6
Barrier itself of working with unstructured data	1	1
Hardware Efficiency to perform ML Algorithms	5	7
Inefficiency and inexistence of a general AI	5	6
Lack of data to have better algorithms	2	4
Short term cost issue	2	2
Too much data to optimize	2	2
Negative impact on society	4	7
AI technologies developed for negative purposes	3	3
Cybersecurity vulnerabilities to get sensitive data	2	4
Positive impact on society	9	28

AI as a technology facilitator	3	7
Exponential evolution of AI technologies	4	6
More automation creates more productivity with faster discoveries	1	1
More knowledge generated through AI research and debates with experts	4	8
People from different backgrounds working in AI development	2	2
Programmers have the ability to define the limits	3	3
Technology learning online without human input	1	1
Impact on social behavior	10	110
Applications	2	3
Drone delivery of first goods in remote areas	1	1
Recommendation based on the people's image	1	2
Barriers and challenges	10	35
Difficulties originated by humans	8	14
Barrier itself of the non-awareness of the AI evolution	1	1
Fear of the first use of services or products	5	6
Hard to be all-day connected with equipment	1	1
Humanity must have a critic and non-fundamentalist vision of AI	1	1
Problem difficulty increases causing people to induce more complexity	1	1
We need to know ourselves in order to understand AI	3	4
Explanation	6	18
Chatbot interpretation and human comprehension	1	2
Machine providing a full explanation of the algorithm process	6	13
Resistance from people regarding explanation	2	3
Privacy issues	2	2
Internet information brings good and bad things to the final user	1	1
Privacy awareness in different generations	1	1
Weak implementation of AI in our society	1	1
Negative impact on society	8	32
Imbalance	5	14
Disruptive change of our way of living	1	2
Inequality	1	1
Poverty	1	2
Privacy loss	4	8
Vulnerable people affected with AI use	1	1
Isolation	2	5
Dehumanization of experience	1	1
Isolated experience with AI	1	2
Social skills being less important in the future	2	2
Replacement	6	13
AI overcoming Human Intelligence	1	1
Humanity feeling threated of replacement with AI	4	5
Humanoid Robots overtaking our place in society in a long term	3	5
Inability of decisions due to automatic DSS	2	2
Positive impact on society	9	40
Adaptation	8	19
Adaptation from the human society to the AI integration	5	6
Gradual impact on society	2	7
Human Machine interaction awareness (it is a reality)	3	5
More results in our general society due to AI	1	1
Humanity thriving	5	21
AI will not overcome human intelligence	1	1

Consciousness and empathy as an inherent human feature	2	4
Creativity and entrepreneurship as human inherent features	3	8
Inability of music or art creation from AI technology - only for humans	3	4
More free and quality time in the future for humans	3	3
Power of decision from humans	1	1
Impact on transportation and autonomous driving	9	36
Applications	8	22
AI applied to Cargo transports	1	1
Airport efficiency for check-ins and check-outs	1	1
Autonomous bus	1	2
Autonomous car connected with the hospital	1	1
Autonomous cargo ships	1	1
Flying autonomous cars	2	2
Google Glasses as an aid for mechanics in car shops	1	1
Hyper-Loop	1	2
Non-stop autonomous cars in logistics-distribution	3	3
Roadways only dedicated to autonomous cars	2	2
Sensors in transports	1	1
Shortest path to a specific point on map	2	2
Space exploration	3	3
Barriers and challenges	0	0
Negative impact on society	2	2
Autonomous cars in a chaotic environment could not respond	1	1
Autonomous cars will reduce the driving pleasure	1	1
Positive impact on society	5	8
Autonomous cars can learn very quick than humans	2	2
Autonomous cars will reduce accidents	3	3
Autonomous cars will reduce traffic	1	1
Disappearance of the car-key	1	1
Less strikes in the transportation sector due to autonomous cars	1	1
Metadata	10	225
Data	10	51
Big Data	6	15
Big Data is too valuable	2	2
Cost of data storage	1	1
Data (Value) Architecture	1	1
Data acquisition	4	9
Data Mining	4	9
Data owning	1	1
Data personalization	2	2
Data protection	1	1
Data Science	3	4
Inaccessibility to non-expert people to use these tools	1	1
Data sharing	1	1
Databases	2	3
Non-structured data	1	1
Elon Musk reference	1	2
Final User	5	15
Client's point-of-view	3	3
User Point-of-view	3	5
Machine Learning	10	102

Algorithms	10	45
Algorithm Development	3	3
Algorithm efficiency	2	2
Blackbox from the algorithms	4	5
Classification efficiency	2	3
Concrete algorithms	2	2
Data Mining algorithms	2	4
Decision Support System Algorithms	4	5
Dependency of smart algorithms	1	1
Holistic Understanding of Problems	1	1
Learning Algorithm	2	2
Random Forests	1	1
Recommendation algorithms	1	1
Search Algorithms	2	2
There is no randomness in algorithms made by humans	1	2
Traditional Algorithm	1	1
XG Boost	1	1
Automatic Machine Learning	1	2
Concept Learning	1	2
Deep Learning	7	30
Artificial Neural Networks	3	7
Deep Learning doesn't solve all the problems	1	1
Deep Learning with excellent results in the research and industry field	5	6
First layers of Deep Learning	2	3
Definition of Machine Learning	1	1
Examples	3	5
Alpha Go	1	1
Deep Blue (Chess machine)	2	2
IBM Watson	1	2
Inductive Logic Programming	1	1
Metamodels	1	1
Natural Language Processing	1	1
Non-supervised learning	3	3
Online Learning	1	1
Rule-based	1	1
Statistic relation with Machine Learning	1	2
Task training for the software	2	2
Methodologies and tests	4	7
Agile	1	1
Development of new learning automatic methodologies	2	2
Different AI flows	2	2
Pipeline	1	1
Turing test	1	1
Professional tasks description	10	26
Data Mining	3	9
CRM	1	1
Data Scientist	3	4
Fraud detection with credit card transactions	1	6
Machine Learning related with anomalies	1	1
Machine Learning related with medical data	1	1
Medical image related with software	2	2

Research field related	8	17
Data analysis for Douro's Wine production quality	1	4
Hazard chemical's concentration in waters	1	1
Inductive Logic Programming	1	1
Machine Learning for medicine purposes	2	3
Nigeria's microcredit evolution	1	1
Recommendations based on your localization-current path	1	1
Science fiction film reference	4	5