A Decision Making system Analysis in Artificial Intelligence

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***Abstract*--Research in AI has built upon the tools and techniques of many different disciplines, including formal logic, probability theory, decision theory, management science, linguistics and philosophy. However, the application of these disciplines in AI has necessitated the development of many enhancements and extensions. Among the most powerful of these are the methods of computational logic. This paper highlights how a deep understanding of Artificial Intelligence and its integration in the process of organizational decision making of knowledge-intensive firms enable humans to be augmented and to make smarter decisions. It appears that Artificial Intelligence is used as a decision making support rather than an autonomous decision maker, and that organizations adopt smoother and more collaborative designs in order to make the best of it within their decision making process.**

***Index Terms*—Artificial Intelligence, Decision theory, Decision making support, Computational logic.**

I. INTRODUCTION

Computer scientists continue to gain influence in our society. Greater influence means that large corporations and government bodies are funding and supporting computer engineers for development of the world's newest technologies. Computers manage increasingly many aspects of our lives, and we still have not tapped their full potential. Still, there is no specific body, and few rules in place to assure that computer program technologies will be safe and beneficial to the general public. Artificial intelligence (AI) is now becoming a reality, and no one knows for sure what direction it will take. In light of new developments in intelligent programming technologies like neural networking, this paper will argue that truly intelligent machines may be in our future. More importantly, it will establish that computer scientists have considerable ethical and political responsibilities to the public.

1.1 What is Artificial Intelligence?

Artificial intelligence is the design and study of computer programs that behave intelligently [Dean 1]. It is in many ways the ultimate goal of computer programming. There is an ongoing effort to make more intelligent computer programs that are easier to use, even at the expense of simplicity and efficiency. Programs, after all, are designed to solve problems. That they should do so intelligently is a logical objective. This chapter will explain what it means for a computer program to behave intelligently and outline some uses for intelligent programs. It is perhaps better to think of artificial intelligence as the study and design of computer programs that respond flexibly in unanticipated situations [Dean 1]. A computer program can give the illusion of intelligence if it is designed to react sensibly to a large number of likely and unlikely situations. This is similar to the way we might judge human intelligence, by a person's ability to solve problems and cope effectively with a wide variety of situations [Dean]. In this case, it is not necessary for an intelligent program (or person) to develop an original solution to a problem. Strong artificial intelligence is the design of a computer program that may be considered a self-contained intelligence (or intelligent entity). The intelligence of these programs is defined more in terms of human thought. They are designed to think in the same way that people think. Passage of the Turing test, for example, might be one criterion for development of a strong AI system. The ethical issues in this paper deal largely with the strong AI methodology. However, the bulk of useful artificial intelligence applications lie in the realm of weak AI.

1.2 Knowledge-intensive firms

There are many who argue that we are shifting from the 'Industrial Society' to the era of the 'Knowledge Society' that is commonly called 'knowledge-based economy'. In that new economy, knowledge is supposed to play a more fundamental role than in the past. Nevertheless, although numerous uses and attempts to define it across the literature, it is hard to find a clear definition of the concept of the knowledge-based economy (Smith, 2002, p. 6). It is often used as a metaphor rather than a meaningful concept (Smith, 2002, p. 6). The origins of that concept are not clear either. While the use of the term knowledge-based economy has become popularized in the 1990's, this concept already existed in the 1960's (Gaudin, 2006, p. 17). However, it is during the 1990's that scholars attempted to define it. This change in the worldwide economy is traditionally attributed to globalization and new technologies (Nurmi, 1998) such as internet, and, more recently, big data, which have had a strong impact on the spread of knowledge. The first definition of 'knowledge-based economy' from the OECD is about ''economies which are directly based on the production, distribution and use of knowledge and information'' (1996, p. 3, cited in Godin, 2006, p. 20-21). Smith (2002, p. 8) considers that four characteristics are often retained by scholars to qualify the knowledge-based economy: 1) knowledge is becoming more important as an input, 2) knowledge is increasingly more important as a product (consulting, education, etc.), 3) a rise in the importance of codified knowledge compared to tacit knowledge, 4) innovations in information and communication technologies led to the knowledge economy.

1.3 Organization Design

The organization configuration is defined as the set of organizational design elements that fit together in order to

support the intended strategy (Johnson et al., 2017, p. 459). To design an organization, key elements have to be taken into account (Johnson et al., 2017). Snow et al. (2017), have explored the design of digital organizations and they have concluded that new organizational designs base their principles on those used in designing digital technologies such as object-oriented design or the architecture of Internet (Snow et al., 2017, p. 3). Such architecture is called actor-oriented organizational architecture and it is a suitable and optimal organization for KIFs (Snow et al., 2017, p. 5,6). This organizational architecture should include three elements from the actor-oriented architecture: the actors, the commons and protocols, processes and infrastructures.

II. KNOWLEDGE-BASED ECONOMY AND KNOWLEDGE-INTENSIVE FIRMS

The aim of the following part is to define the scope of our research subject, namely knowledge-intensive firms. There are many definitions of what a KIF is across the literature. Consequently, our review does not aim to be exhaustive. We will simply explain what the main characteristics of KIFs are, how they differ from traditional firms, and later focus on the specific aspects of decision making within that type of firms.

2.1 The knowledge-based theory of the firm

The knowledge-based theory of the firm was born in the 1990's, with authors such as Prahalad & Hamel (1990), Nnaka & Takeuchi (1995), and Grant (1996). It originates from the assumption that companies should build a comprehensive strategy regarding their core competencies in order to succeed: they should organize themselves so that they become able to build core competencies and make them grow (Prahalad & Hamel,1990). According to Nonaka & Takeuchi (1995), knowledge is that core competency that can provide firms with competitive advantage in an uncertain world. It is an "outgrowth of the resource-based view" (Grant, 1996, p. 110), knowledge being the most important component among the firm's unique bundle of resources and capabilities. Thus, knowledge and the capability to create and utilize such knowledge are the most important sources of competitive advantage" (Ditillo, 2004, p. 401). It is important to notice that the knowledge-based theory of the firm does not specifically apply to one type of business. This theory claims to be relevant for any industry. That so, KIFs are enterprises that make profit thanks to its employees' knowledge.

2.1.1 Knowledge-based economy and knowledge-intensive firms

As the Industrial Society was characterized by industrial manufacturing companies, the Information Era will be led by KIFs (Nurmi, 1998). What is that type of firms? A problem of definition arises there: "the difference between KIFs and other companies is not self evident because all organizations involve knowledge" (Ditillo, 2004, p. 405). The term 'knowledge intensive firms' is built on the same model than 'capital-intensive' and 'labor intensive' firms. Following the same logic, it refers to businesses in which "knowledge has more importance than other inputs" (Starbuck, 1992, p. 715). However, some scholars distinguish KIFs from traditional firms through the nature of their offering. Thus, KIFs are companies that "process what they know into knowledge products and services for their customers" according to Nurmi (1998, p. 26). Other scholars add a focus on the location of the resources of the firms. It is the case of Ditillo (2004, p. 401), who argues that "knowledge-intensive firms refer to those firms that provide intangible solutions to customer problems by using mainly the knowledge of their individuals". Davis and Botkin11 (1994, p. 168) argue that as awareness of the value of knowledge is increasing, many companies try to implement a better use of it within their organization. Thus knowledge based business are companies that manage to do it through putting information to productive use in their offering; it means that they try to make the best possible use of the information they access, at every level of their organization.

2.2 Organizational design within KIFs: Actor-oriented architecture

Actor oriented organizations are characterized by collaboration and self-organization with a minimal usage of hierarchy to reduce uncertainty and risk, speed the development of a new product and reduce the cost of process development, and access to new knowledge and digital technologies (Fjeldstad et al., 2012, p. 739). Decision making within this organizational design is decentralized, which means that the decision belongs to the team in charge of the project and not the top management (Fjeldstad et al., 2012, p. 739). The design of actor-oriented organization boils down to three components summarized in the Figure

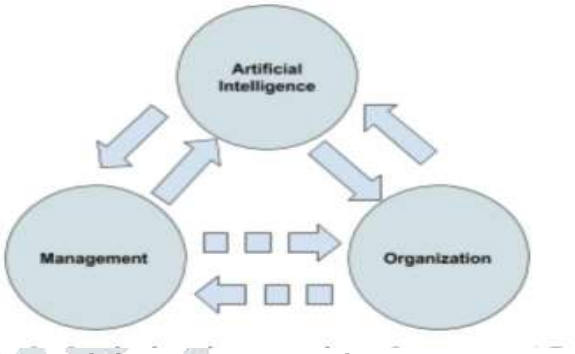

Fig 1: Framework depicting interactions between AI, organizations and management

2.2.1 Actors in the organizational design of KIFs

Actors refer to individuals, teams and also firms that have the ability to self-organize and collaborate (Snow et al., 2017, p. Actors in an actor-oriented architecture possess suitable knowledge, skills and values for digital organizations where they can work with digital co workers (Snow et al., 2017, p. They have accumulated hard and soft skills as well as a specific knowledge from their internet activities (Snow et al., 2017, p.Hard skills are considered to be "about a person's skills set and ability to perform a certain type of task or activity" (Hendarmana & Tjakraatmadjab, 2012). Hard skills in KIFs involve computational thinking or information and communication technologies (ICT) literacy and knowledge management (Snow et al., 2017, p. 8; Hendarmana & Tjakraatmadjab, 2012). Knowledge management can be defined as "how best to share knowledge to create value-added benefits to the organization." (Liebowitz, 2001). To collaborate with the digital co-worker, humans should understand basic knowledge about coding and data to better understand the basic function of AI and systems in order to educate and to learn from AI; Dejoux & Léon, 2018, p. 209, 219). Soft skills are defined as "personal attributes that enhance

an individual's interactions and his/her job performance (...) soft skills are interpersonal and broadly applicable" (Hendarmana & Tjakraatmadjab, 2012). Soft skills in the digital environment include social intelligence - like complex communication when to teach or manage - and collaboration capabilities, trans-disciplinarity, sense-making, critical thinking, systemic thinking i.e. contextualization and design mindset

III. AI DECISION MAKING PROCESSES

Along with the development of AI techniques and applications, organizations are questioning the influence of AI on human jobs (Jarrahi, 2018, p. 2). Elon Musk considered AI as a disruptive technology that will replace human in a broad range of jobs. Thus, AI may be seen as the principal cause of an unprecedented wave of automation (Jarrahi, 2018, p. 2). Some scholars praise the rise of machines as a substitution of human decision making since humans are too biased and irrational (Parry et al. 2016, p. 571, 572). The power of computers to analyze huge amounts of data - Big Data -, their objectivity and their processes based on rules enable them to make decisions based on grounded facts and models (Parry et al. 2016, p. 577, 580). AI-based decision making systems are free of human preconceptions and present a better representation of the reality (Parry et al. 2016, p. 577). AI can decide in an autonomous, unbiased and rational way thanks to ML and algorithms (Dejoux & Léon, 2018, p. 198, 199). Decisions are already made by machines when to consider high frequency trading (Dejoux & Léon, 2018, p.198). In an investment fund called Bridgewater, a CEO decided to put an AI at his position to run the enterprise. Within KIFs, commons (especially knowledge commons) and PPI - platforms with processes and computer servers can potentially assist and replace the human decision maker especially when they adopt a rational process. A crystallization of commons and PPI for the decision making is represented by Decision Support Systems

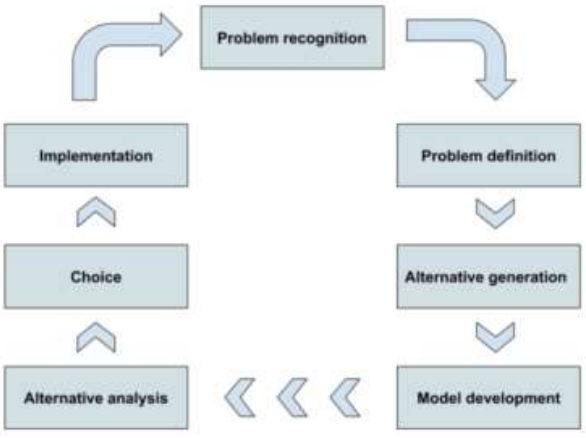

Fig 2: Example of decision making process.

The most common application in organizations for system supporting decision making is Group Support System (GSS) or Group Decision Support System (GDSS) which is the convergence of DSS and knowledge management (Alyoubi, 2015, p. 278; Courtney, 2001, p. 20). Indeed, over the past two decades, with the development of AI and ES, GDSS have emerged to "provide brain-storming, idea evaluation and communications facilities to support team problem solving", i.e. GDSS deliver to the decision maker a smart support (Courtney, 2001, p. 20). Indeed, Parry et al., (2016, p. 573) qualify GDSS as decision making processes that attempt to imitate human intelligence. GDSS are described as systems that "[combine] communication, computing, and decision support technologies to facilitate formulation and solution of unstructured problems by a group" like IBM's Watson (Parry et al. 2016, p. 573). GDSS adopt a rather rational decision making process based on knowledge and unstructured information.

3.1 Partnership between humans and AI in the decision making process

According to Kahneman (2003, p. 712), when it comes to making a decision, the dual-task method can be useful; this method consists in validating assumptions of an underlying intuitive decision - system 1 of the Figure 6 - thanks to the support and correction of arational thinking - system 2 of the Figure 6 - (Kahneman, 2003, p. 712). If we draw a parallel of this process of decision making with the symbiosis in decision making between AI and humans described by Jarrahi (2018, p. 1), we can assign the system 1 to humans and the system 2 to AI. It appears that a partnership between humans and AI can foster the decision making process. Even if some scholars have considered a partnership between AI and humans, Epstein (2015, p. 44) addresses some limits when considering this partnership on a theoretical level since "Although tales of human–computer collaboration are rampant in science fiction, few artifacts seek to combine the best talents of a person and a computer" (Epstein, 2015, p. 44).

Consequently, according to Epstein (2015, p.44), the gap existing in the literature can be explained with the following two main issues: (1) it is complex to include humans in empirical studies "Because people are non-uniform, costly, slow, error-prone, and sometimes irrational, properly designed empirical investigations with them are considerably more complex."; (2) "the original vision for AI foresaw an autonomous machine. We have argued here, however, that a machine that shares a task with a person requires all the behaviors the Dartmouth proposal targeted, plus one more the ability to collaborate on a common goal.

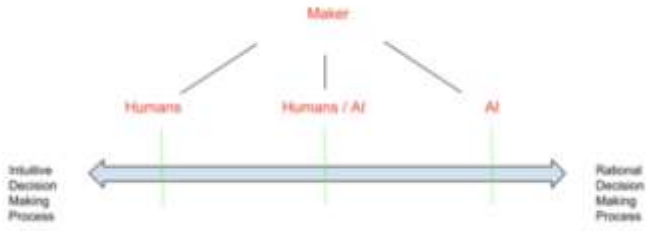

Fig 3: Decision maker within the continuum of decision making processes

To sum up our part about the role of AI and humans in decision making processes, we have established a continuum describing the decision making process and the related decision maker in the figure 3. Intuition and rationality are the extreme parts of the continuum. We have coupled those two indicators with the three types of combinations of decision makers that we have described, humans only, the relationship between humans and AI, and autonomous AI.

IV. PROPOSED WORK FOR DECISION MAKING SYSTEM

4.1 A definition of AI and its classification

According to Atos employee 1, AI "includes a set of techniques that enable a machine to cope with a problem that is not clearly stated by humans, so the machine can adopt its behavior according to the stated problem.". AI is not a simple algorithm. AI classification 38 boils down to two main domains. The first one is expert system (ES) (rules, decision trees) and the second one is ML with NLP, image recognition. An ES is "a set of rules established by humans. ES follow the principle that if there is this type of input there, there will be this type of output." In other words, ES is similar to a decision tree. Also, ES is often called a "white box" since we can comprehend the links made by the algorithm and the rules of ES are set beforehand by humans.

ML is an algorithm that is learning continuously through training. The model of algorithm used in ML is based on the human neurons and human brain, that is why we call this model of algorithm Artificial Neural Network (ANN). This model functions as the human brain, the neurons in the algorithm are gathered in layers: input layer, hidden layers and output layer. The input layer receives the raw data from humans. Humans get the results of the algorithm from the output layer. Between the first and the last layers, there are hidden layers that connect the neurons with one another. We call them 'hidden' because humans do not understand the connections the algorithm made between neurons. We illustrate the ANN algorithm in Figure 4. ANN is a technique increasingly used in the branch of ML.

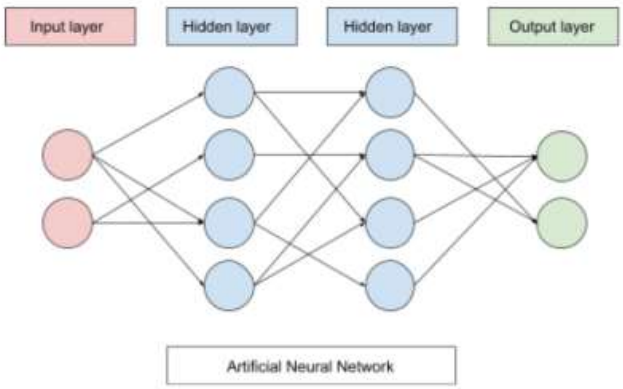

Fig 4: Representation of an Artificial Neural Network, a model of algorithm used in ML

The algorithm's training can be supervised or unsupervised. In supervised training, human's role is determinant as humans will orientate the algorithm and if humans are wrong the algorithm will be wrong too. In supervised training, as input to the ANN, humans will show images and will calculate the expected image outcome for each neuron. Then, humans will make a comparison between the expected outcome and the outcome given by the ANN. Next, if the model did not give the expected outcome humans will, with a retroaction function, change the weight of the inputs to orientate the results

In supervised training, ML is using labels in order to classify data during the input stage of the algorithm - the input phase is when humans give data to an algorithm and the output phase is the result given by the algorithm - and control the expected outcome. For example, in a binary classification like recognizing a face or not on a picture, we are going to give to the algorithm images that contain a face or not. Then, the algorithm will give us as output two classifications of images, one with faces and the other one without faces. In ML, we can also use features instead of labels in order to get complex data from the output.

However, in unsupervised training, the human role is not determinant as the algorithm learns on its own. The algorithm will be autonomous in the tasks. If we take the example of image classification, we can ask the algorithm to classify the image in clusters, i.e. in a determined number of categories. Also, humans can let the algorithm choose the criteria for each category, or humans can ask the algorithm to classify without précising the number of 39 categories. When the algorithm will classify the images, the choice of classification will not make sense for humans. In that case we talk about "black box" among the ANN. Atos employee 2 explains that, at the stage of right now, "[AI] is just to mimic the cognitive aspects of what a human can do, or several humans." Yet, he clarified that this definition narrows down to neural AI, so that AI comprises in fact many other capabilities.

4.2 Decision maker: humans and AI in the process of decision making.

4.2.1 Human processes in decision making

According to IBM employee 1 and 2, decision making remains a human task. However, IBM employee 2 added a nuance saying that "Nowadays, I will say yes, but in 10 years I will say no." Indeed, it should remain a human task due to the limit of the AI technology but also because humans are gifted with creativity, common sense, critical thinking (IBM employee). That is why, they can solve a dilemma, putting this dilemma in perspective in a context, innovating in the solutions proposed. Humans can push the boundaries of our world. All of those characteristics are specific to humans and "it is not possible to put those specificities into code." According to IBM employee, humans are gifted with intuition and for this reason "humans can make an intuitive decision thanks to their own implicit knowledge and experience. Humans cannot explain explicitly why they made this decision
but they embrace the decision made and they can visualize it.

IBM employee 1 thinks that humans have limits regarding "their brain plasticity in the sense that a person is accustomed to make a decision in a certain way due to his cognitive system and what he learnt during his life." In other words, the decision making approach and process is deeply rooted in the people's mind and brain. Considering this limit, IBM employee 1 reckons that humans tend to make a decision by applying the same approach 46 and process; and it is hard to adapt to a new way of decision making. However, IBM employee 1 explained that humans brain can evolve and adapt from one generation to the next using the reference of Michel Serres. Indeed, even if people tend to oppose human intelligence to AI, Michel Serres demonstrates that from one technologic revolution to the next - writing, internet…-, human's brain has evolved from one

generation to the next. That is why, humans can change the way they make decisions from one generation to another one. According to IBM employee 1, "the digital native generation have a different brain plasticity when comparing with Einstein brain plasticity", so digital native generation makes decisions in a different way. IBM employee 1 extend the topic by saying "If we consider a generation that will be accustomed to the usage of AI, internet and the like right at the beginning of the primary school, they will consider the approach and process of decision making in a different way and they might make better decisions than the generation of today."

4.2.2 AI decision making processes: autonomous AI in decision making

AI has advantages over humans when it comes to speed of analysis and data storage. However, AI has the following three limits technical, legal and societal. First, for the technical limit, according to IBM employee 1 "AI is not capable of create something new, solve a new problem, to have common sense or being innovative. Those characteristics are peculiar to humans. That is why, people doubt to what extent an algorithm can drive a car." Besides, IBM employee added that AI is based on rules, but when making a decision we have to go beyond the rule because of creativity and innovation, so AI is not able to go beyond the rules as humans do. Second, regarding the legal limit, IBM employee explained that if AI make a bad decision, it is hard to determine who is responsible for the decision and how the legal system can assert the responsibility of AI. To illustrate, IBM employee 1 took the example of the problem of responsibility raised by self-driving car. "The machine is not able to forecast human behaviours, so accident can occur. In this case, with a self-driving car who is responsible for the accident? The car maker? The owner? Or the person who develops the algorithm?" Third, in regard to societal limits, IBM employee said that AI is not accepted fully by the society and the society does not trust AI.

V. CONCLUSION

Several insights stemmed from the findings of our qualitative study. We found that currently, AI cannot replace humans in the decision making process. Indeed, although AI offers a faster and deeper analysis on very specific topics compared to humans, it cannot integrate parameters that are emotional and ethical, and AI cannot solve a dilemma or solve a new problem out of its scope of expertise without having human's inputs and training. Consequently, AI's role in the decision making process is the one of an assistant and a support to humans in the analysis and the formulation of alternative decisions, so that humans still have an important role to play in the decision making process. The first role of humans in the decision making process is to pose the problem to AI and to formulate a question thanks to their critical sense, common sense and contextualization capabilities. Then, humans assess the alternatives proposed by AI and choose the best solution to implement or choose to think about another alternative not proposed by AI thanks to their grid of values, ethics, creativity and intuition.

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