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THE CHALLENGES OF AI

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Abstract. The term *Artificial Intelligence* (AI) was suggested to the Conference of Dartmouth, 1956, by John Mac Carthy as "the science and technology necessary to make computers think engineering and learn". Specifically, this refers to the development of *intelligent* programs that solve problems for which there are no specific algorithms. Recall that an algorithm is a limited sequence of steps designed to solve a problem computationally. But there are situations that resist algorithm development, as Learning, Pattern Recognition, or the analysis of large amounts of data, such as when studying the evolution of weather, consumer behavior, or the Stock Exchange. AI is developing new techniques to address these problems. More and more systems we interact with, and others unbeknownst to us, are using AI techniques. Artificial Intelligence will have an increasing influence on our lives. It is a technological change that radically transforms the relations of production and the whole landscape of communication. I analyze here such advances and its logical-philosophical consequences.

1. Introduction

Marvin Minsky, the famous *gurú* of AI, said in an interview, when asked whether computers would someday be able to think, that "they already think in a certain way", but to pass to think differently, "we must come to understand how the thought process occurs". To another question, on the argument that CPUs just follow the instructions, just faster than us, he said this judgement is wrong, because CPUs can also follow other processes, and can be programmed to carry out *evolutive* searches, solving problems by the method of trial and error. On whether someday machines may develop something like a *conscience*, he responded that "if an ability of the brain that allows us to reflect on one's actions is called 'conscience', there are programs that do things like that, so that can be said to possess a certain degree of consciousness".

Some advocates of AI argue, perhaps correctly, that free will is an illusion. If someone is perceived to have used *free will* to make a decision, that would really mean that we do not know enough about her mind to understand why it has taken such a decision and not another. Hubert Dreyfus believes that common sense is intangible, and that being smart is to see the analogies (the analog relations) between the new and old situations, of which we know how "to go". Edward Feigenbaum said that one day robots will exist with *common sense* stored in their database system. And this is also true intuition or imagination. It would be possible to produce large-scale minds, by providing computers with the ability of self-learning.

2. Hard AI vs. Soft AI

Ray Kurzweil is one of the most brilliant and active minds in the field of AI. Among his many inventions is the first electronic reader for the blind, speech recognition systems and also the first digital scanner. It has created business, sold them and created others. Currently, he is head of research at Google, in San Francisco. An inventor and a soothsayer, or diviner of the future of technology, he has made many predictions, most of which have been met. Lika a Jules Verne of today. Among his most notable works, *The Singularity is Near* refers to the time (the 'singularity') when machines will reach and surpass the power of human thought: he figures that threshold will be crossed in 2045. In *How to Create a Mind?* he discusses the functioning of the brain (especially the structure of the neocortex) and how it could be imitated or simulated into the computer.

In a recent interview [31], he was asked about the difference between a human brain and a computer. He replied that on the one hand a computer is not able to do two things at once; it can do just one, but very quickly and accurately. The mind is on the other hand "a bit of the contrary". It makes millions of operations at the same time, but much more slowly and with less exactitude. There are many obstacles to simulate such operation of the mind on a computer, but it would not be impossible. Kurzweil concurs with Alan M. Turing, when he established that any form of computing is in the end, is equivalent. Then, a device with sufficient memory could simulate the operation of any other device, which would also apply to the computer and the mind. The computer would be able to simulate the behavior of the human brain by performing the same operations, just very quickly. Kurzweil predicts that this will be possible "in just a decade". But, what are the most difficult features of the human brain to replicate? According to Kurzweil, "The level of abstraction that is capable of achieving", as well as irony or sarcasm (or polysemy in general); because interpreting them involves several levels of interpretation, which is confusing for computers. "What makes the human brain is creating a hierarchy with respect to its own thinking." Therein lies the secret of how to interpret, and replicate, human thinking.

Ray Kurzweil is perhaps a clear representative of the so-called 'hard AI', as Marvin Minsky. Others have defended the 'soft AI', instead. The British cosmologist Roger Penrose, in his book The Emperor's New Mind, affirms that a computer can never have intuition or imagination. Penrose argues that human consciousness is non- algorithmic, and thus is not possible to modeled it by a conventional Turing machine-type of digital computer. Penrose hypothesizes that Quantum Mechanics plays a very essential role in the understanding of human consciousness. The collapse of the quantum wave function is seen as playing an important role in brain function.

3. Challenges of logic in AI

Challenges of logic in Artificial Intelligence are many. They can be classified in groups of important problems. In Communication and Perception:

- Natural language. Among the open problems for natural language processing are the analysis of sentences, syntactic and semantic; the sometimes very difficult treatment of polysemy, and/or ambiguity of words. the meaning of words depends on the context. In terms of communication, multilingual machine translation.
- Artificial Vision.
- Manipulation (for example, robots).
- Symbolic reasoning. Intelligent Systems Rules are based on heuristics, that is, for those who have prior knowledge of the domain, to prevent Blind Search', for which we should explore all states or situations, that is, all nodes in the tree in question.
- Knowledge Engineering. Looking at its sub-areas:
  - Knowledge Representation. The acquisition of this can be accomplished by supervised learning, with Rules of Logic and 'training' sessions.
  - The inference method, which according to the amount of data, could be carried out by Fuzzy Logic.
  - The processing of natural language (NL), which facilitates the man-machine relationship. Enabling a specialist in any field, with the help of a technician, to develop an expert system that can function independently. For example, a physician, or a control engineer.

For each problem, has been to analyzed what will be the most appropriate tool to solve it.

Knowledge engineering operates in a sequence of steps:

- Selecting tools and the right strategy to solve the problem.
- Analysis of knowledge that will be necessary. Build a Knowledge Base (KB), and test it on a large number of cases.
- Expand and modify the program, to make it work as we want.
- Maintain and update the system.
- Etc.

Assume that the biochemical properties of the brain may be responsible for the beliefs and thoughts. We can make an analogy between such properties and those that allow birds a self-sustained flight. Today we know the aerodynamic properties which allow them to support themselves. Thus, science has built a body of knowledge on the laws governing both the flight of birds such as aircraft. And 'artificial' flight has progressed, but not by a direct imitation of natural flight. Similarly, AI has mad progress in reproducing intelligent behavior, with a brief history but continuous developments; and yet with amazing challenges.

To address these challenges and solve the problems, IA is providing increasingly more sophisticated tools, such as those related to logic:

- Propositional logic (or sequential).
- First Order Logic (FOL).
- Fuzzy Logic (or Heuristic Logic).
- Fuzzy Systems.
- Logic Default (or Default Reasoning). NML for Non-Monotonic Logic.

But there are other problems in AI requiring the handling of incomplete information or uncertainty. We have for them different design tools in Logics:

- Bayesian Networks. Among them, the so-called Hidden Markov Models; HMM), or Kalman filters.

- Artificial Neural Networks (NNs), used as classifiers of satellite images, or to detect objects in real time. They have great capacity for learning. The first models of NNs proceed from Mc Culloch and Pitts (1943), and then Donald Hebb (1949).
- Genetic algorithms (GA Genetic Algorithms) are a class of stochastic adaptive algorithms. Processes are useful for search and optimization. They were first used in the Netherlands in 1975.
- Intelligent agents, which are entities capable of perceiving their environment and to process such perceptions, and from this information act within their environment in a 'rational' way, i.e., correctly and optimizing results. Among their many uses are web services adapting educational content in e-learning platforms.
- Super-Intelligent Machines: a hope, especially in the hardware of the future, providing for the creation of ever more powerful machines.

4. About Jan Lukasiewicz

Among the members of the Lvov-Warsaw School, one of the most interesting thinkers was Jan Lukasiewicz, the father of many-valued logic.

Jan Lukasiewicz began teaching at the University of Lvóv, and then at Warsaw, then Dublin after World War II. Some aspects of his *CV* cause awe. For instance, that a Polish Minister of Education in Paderewski's cabinet, in the new Polish Republic, and also Rector for two times at Warsaw University, was awarded with a Doctorate 'Honoris Causa' in spring 1936, at University of Mnster, among the maximum of effervescency of Nazism in Germany. The explanation must be his good relation with a very good friend, the former theologian, and then logician, Heinrich Scholz, which was the first Chairman of Mathematical Logic in German universities.

Lukasiewicz first studied Law, and then Mathematics and Philosophy in Lvov (then Lemberg). His doctoral supervisor was Kazimierz Twardowski, and in 1902 he obtained his Ph. D. with a very special mention: 'sub auspiciis Imperatoris' (i.e., under the auspices of the Kaiser). Also, he received a doctorate ring with diamonds from the Kaiser of the Austro-Hungarian Empire, Franz Joseph I.

He defends his 'Habilitationschrift' in 1906, entitled "Analysis and construction of the concept of cause". This permits him to give university courses. His first lectures were on the Algebra of Logic, according to the recent translation to Polish of this book of the French logician Louis Couturat.

Between 1902 and 1906, Lukasiewicz continued his studies in the universities of Berlin and Leuwen (Lovaina). In 1906, by his 'Habilitationschrift', he obtain the qualification of university professor at Lvov. And them, in 1911, he was appointed as associate professor in his 'alma mater' (Lemberg).

As Arianna Betti said, "Jan Lukasiewicz is first and foremost associated with the rejection of the Principle of Bivalence and the discovery of Many-Valued Logic." The discovery of MVL by Lukasiewicz was in 1918, a little earlier than Emil Leon Post. According to Jan Wolenski, "although Post's remarks were parenthetical and extremely condensed, Lukasiewicz explained his intuitions and motivations carefully and at length. He was guided by considerations about future contingents and the concept of possibility". So, he introduces, first, three-valued logic, then four-valued logic, generalized to logics with an arbitrary finite number of veritative values, and finally, to logics with a countably infinite-valued number of such values.

5. Lukasiewicz's 'resurrection'

But the writings of Jan Lukasiewicz suffered a lengthy slumber. But his ideas were revitalized by an Azeri engineer and mathematician , Lotfi Asker Zadeh, who had studied in Tehran, who followed studies at MIT and eventually arrived as a professor at the University of California, Berkeley. He was the one who would see their potential utility in 1965, first obtaining a generalized version of the classical theory of sets, "Fuzzy Set Theory" (FST), and later, its application to logic, creating "Fuzzy Logic", particularly with "fuzzy" proposition's modifiers and fuzzy rule-based systems. These are very useful for instance, on expert systems, such as the Mamdani, either the Takagi-Sugeno-Kang, or Yatsumoto's method. And over time, it was in Eastern countries where these ideas came to fruition, creating a powerful technological "boom", with new techniques based on "fuzzy" concepts. This trend was particularly strong in Japan, and then it spread to other countries, such as South Korea, China or India.

Much later those ideas, and even more their applications, came to Western countries, both European and American, producing brilliant studies, both from a mathematical point of view and its philosophical implications. Some emerging countries, such as Brazil or Turkey, are currently at the forefront in the investigation of all these theories and associated methods. Today, many of the best papers on Many-Valued Logic come from good European Universities and very active research groups; for instance, in Warsaw, Prague, Ostrava, Vienna, Opole, Barcelona, Madrid, Toulouse, Pamplona, Granada, etc.

6. A case study: Reception of many-valued logics in Spain

There are certain groups, mostly centered around a "hub", core or accumulation point, from which new ideas and impulses radiate; in the center of each of these "core engines" is usually a -more or less-veteran researcher, well connected and with prestige.

One of the first Hispanic scholars giving notice of the new currents was Juan David Garcia Bacca, who in 1936 published his *I*ntroduction to modern logic, a work praised by I. M. Bochenski and Heinrich Scholz. Later on came eminent teachers; amongst them Alfredo Deaño (editor by Spanish translation of Lukasiewicz's selected papers), Miguel Sánchez-Mazas (studying and interpreting the logic-mathematical works of Leibniz), either Jesus Mosterín or Manuel Sacristán, very often clashing against a very conservative context, unwelcoming to innovative ideas.

But one good initiative has been the creation in the old mining town of Mieres, and by the Government of Asturias, of the 'Research Center for Artificial Intelligence and Soft Computing', initially around the well-known Enric Trillas, who can be considered the father of the introduction of Fuzzy Logic in the Spanish University curricula. This center has attracted many of the most famous international researchers, such as well-known Japanese Professor Michio Sugeno. Their topics of research are very broad, but revolve around fuzzy methods, as well as the philosophical implications these carry.

Although I have left it last, a landmar name should not be omitted, it is one of those that appear only from time to time in Spain. We are referring to the Father Pablo Domínguez Prieto (1966-2009), Spanish philosopher and theologian, who wrote the first major book in Spain on the Lvov-Warsaw School, as his doctoral thesis in Philosophy, at the Complutense University at Madrid (1993). Such work is entitle *Indeterminación y Verdad. La polivalencia lógica en la Escuela de Lvov-Varsovia* (Indeterminacy and Truth), and was published in 1995, with a foreword by Arch. J. M. Zyzinski, and showing a very strong influence by Jan Wolenski.

Father Pablo can be considered as one of the Spanish forerunners in the study of MVLs, from the philosophical point of view and in particular of the great Polish contribution (LWS) to logic and mathematical fields. A romantic 'halo' surrounds hus brief existence, because his passion for mountain climbing made him want trek in the snowy Moncayo mountain, after giving lectures to the nuns of the monastery of Tulebras. But that was his last, as he died, leaving orphans these Spanish studies again.

Another interesting Spanish author who has been reporting these new streams of logic is Prof. Julián Velarde, with his paper "Polyvalent Logic", or his book *Formal Logic*, second volume of his *History of Logic.* Also of great interest is his work Gnoseology of Fuzzy Systems, which analyzes the deep philosophical connections of these issues.

New research groups have been formed in recent times, as the Spanish CSIC (Consejo Superior de Investigaciones Científicas), in Barcelona, led by Lluis Godo and Francesc Esteva. Or the group that belongs to the UPNA (Public University of Navarra), headed by Humberto Bustince; either in the University of Granada (lead by Miguel Delgado Calvo-Flores), or in the University of Zaragoza, with Tomasa Calvo; even, we find some valuable researchers in our own city, Madrid, but also in Malaga, Santiago de Compostela, Oviedo, etc.

7. Conclusions

The "singularity" of Ray Kurzweil may be possibly very near.

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