The logic Fuzzy in the operation of the knowledge of the interaction human-computer tasks in complex machines: Learning in significance sets.

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Abstract - *The Two machines: The Human and the Computer, one biological and other mechanical/ electronics that use and implement their natural computational logic in sharing the tasks for controlling complex machines. Both components (Human and Computer) in charge of the control and operation of complex machines need to learn their tasks each in its own way. But questions arise: The format of the training, learning objects and the training process are correct? The operationalization of the knowledge showed satisfactory? This article presents a critical analysis of learning processes and the operation for the joint work of these two components, where supposedly the symbiosis in the distribution of tasks is proposed to extract the greatest advantages of each process. The great advantage of man associated with the computer appears as a large capacity for recognition and processing qualitative information, that is often not covered in computer systems with their great ability to process a large amount of data very fast and accurate.*

Keywords: Fuzzy logic, New technologies; Automation; Human error.

1 Introduction

The computer will always proceed in according to circumstances stated in programming that determines, in the final instance, the decisions of cyber component incorporated into automated command of an aircraft, for example. The theory assumes that the two different capacities are complementary in processing information. The literature on the state of the art in aviation indicates that the expectation of the responsible for automating aircraft are translated in the combination of the capabilities of the human and the computer to integrate like "a perfect symbiosis to conduct aircraft". This article is a critical analysis of the learning processes and the implementation of the joint work of these two components, where supposedly the symbiosis in the distribution of tasks is proposed to extract the greatest mutual benefit. Specific prior knowledge of aircraft piloting are converted into machines procedures that operationalize the distributed actions supported by onboard computers. On this scenery, are included actions on critical moments in the aviation field in automated aircrafts. The perfect harmonic and unrealistic combination of human and computer in the control of aircraft is symbolized at figure 1.

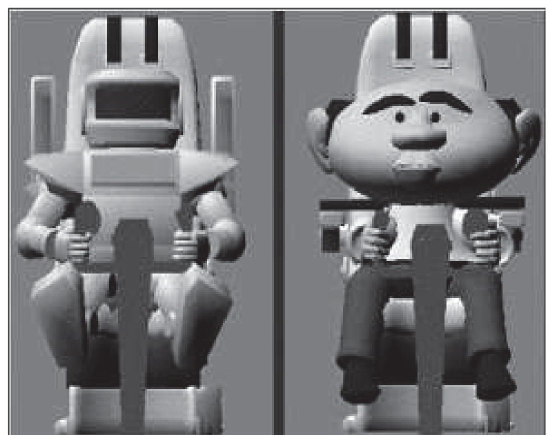

Fig. 1 The pilot and the computer piloting a highly automated aircraft (*Fly-by-Wire*)

The Human actions are anchored in subsumers where the actions are supported by computers. This "knowledgement" is converted into procedures commanded by programs and computers. A part of this program is used to assist pilots in controlling these aircraft and that also has its "subsumers", as Ausubel definition [1] , anchored in historical situations that reflect best piloting techniques. But also includes prior knowledge of risk situations and when they happen, are evaluated by computers, "defending" and blocking the aircraft unplanned procedures performed by pilots and that can lead to accidents. The logic normally used in the construction and programming these computers is the logic whose characteristic is boolean, binary, Cartesian, univalent, mutually exclusive and unirelacional. This provides accurattion and the final product is the review of the results presented by these machines, but the human being learns how to fly the aircraft and operates this knowledge in the same way that the computer looks into cartesian pattern where subsumers are transformed into action that is originate on the mental structures previously existing? The concept that establishes control of binomial Human-Computer at applied ergonomics on distributed system exhausts the possibilities of appropriate actions to prevent some rare existing accidents but it provides all critical situations becoming failsafe? The pilot's actions, while aided by computers, when make mistakes can be quickly corrected by computers and vice-versa? We know from recent history of accidents in aviation that the answer is NO. The problem always lies, for various reasons, including convenience and lack of a culprit in human error. We formulate a hypothesis across this question: The fuzzy logic applied in the "learning" of the on-board computers aircraft translated into your schedule might be a good solution to mitigate of the "mind" asynchronism between human and computers? If we consider the following three quotes, we can weave a doubtful scenario that allows failures behavior of harmony in the human work together and computers.

These statements below begin to establish similarities and differences of the human mind related to computers and reinforce the need for a possible change in the learning scenario of the two. A progress already achieved in the scientific community is the use of fuzzy logic.

The advantage of this tool, is adopt the use of the continuous intermediate values between 0 and 1 (or true and false). In a way, with fuzzy logic it is possible to devise a more flexible computing closer to reality of the human mind, and this is certainly a great advance. Still, one can not compute contradictions, although this logic allows transactions involving ambiguities, vaguidez, inaccuracies, noise and incomplete inputs. Fig. 2 metaphorizes the help of ergonomics distributed human-computer, as designed in beginning of the process of automation.

Fig. 2-The automatized help, implemented to prevent failure of human

Automated systems sometimes have left the pilots at risk for not knowing that the automatic attitudes controls are taking at any time as drawn in Figure 3.

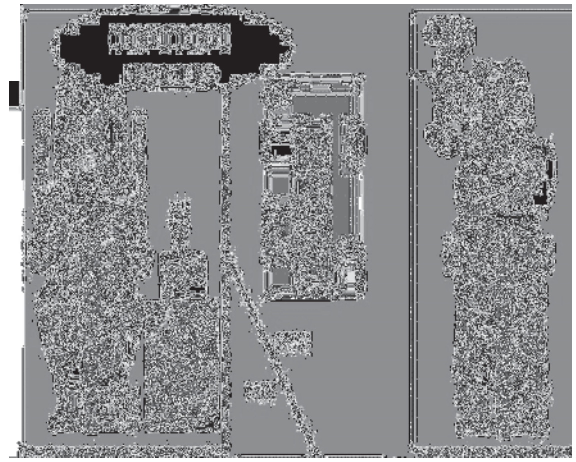

Fig.3- Often the pilot does not "know" what the computer is doing.

2 Fundamentals

The operation is built to be operated by humans and the computer in the control of automated aircraft but as acts each component? In automated aircraft, when a new component is installed, the corresponding computer to solidarity sensors and semantic establishes a new network of interrelationships between crew and aircraft environment. Command decisions are then redistributed between man and machine (computer / aircraft). Thus we have a symbiosis between different and complementary skills in information processing and command of the aircraft. But analyzing this operation working together and we will mention some serious errors, referencing accident cases where this type of task distribution failed. Initially we need to understand the operation of each "component": The human and the computer.

2.1 Classical logic, sequential processing and parallel and artificial intelligence

There are some theories about how the mind works but we can not prove that automation and electronic computing are similar from the standpoint of the nature of mental phenomena. Even the Cognitive Science, settled in bias of classical computing, does not establish the similarities necessary to consolidate this theory. The digital computer developed by Von Neumann was derived mainly from machine called Colossus, designed by Allan Turing during World War II. And this, in turn, is settled in the logic function. The mono-processor computing using procedural languages are based on classical logic and show the typical features of a logical / sequential system.

The technique called parallel processing on a single computer, which is still incipient and currently crawls in the area of business applications (if we do not consider the processing of applications deployed in distributed computer networks), we could have a slight correspondence with the human mind. The possible similarity with human beings was implemented by John Von Neumann in 1946-1952 on the machine called *IAS*. Neumann's project is invaluable in computational projects and was a major scientific breakthrough in the post-war. Promoted all this electronic scientific supported by electronic actuators represented today by micro-computer and personal micro-computers. But it is a sequential machine whose logic is binary, Cartesian, Boolean.

These computers are perfect and remarkable for accuracy but useless to establish absolute similarities with the workings of the mind before nebulous situations, inaccurate, unclear, not perfect, not visible or where it is required to process unplanned or insufficient information to establish decision-making in critical situations or that represent real and present danger. The big computer's ability to assist humans in almost all procedural areas of science obliterated his vision of the true difference of the human mind in the operation of knowledge structures in comparison with the formal, fast and precise applications that computers promote.

The man, impressed with the high ample opportunities for processing of computers is taken to perform a reverse engineering with the mind of the human, comparing it and establishing a parallel operation, with propriety and competence, as Pinker cites (2000) in their theories. Pinker does the reverse work of John Von Newman (when he developed the design of your computer by copying characteristics of the human being). Pinker presents the computational characteristics of the mind pointing, appropriately, for schedules and similar biological structures to electronic systems. But the branch of artificial intelligence is facing severe criticism and lines of work just because the mind is a hardened bunker with his secrets of its operation.

The various lines of interpretation and mind functioning of theories have been made since the last Decartes Pinker by Piaget, Vygotsky and Vernaut among many notable and obstinate scientists who have devoted themselves to the study of mind, intelligence, knowledge and training of the senses and language. What we will focus in this paper is mainly the implementation of this knowledge in the form of treasury stock and objective as a human and computer controlling complex machines in critical and unexpected situations.

2.2 As each component (human and computer) "learns" your own tasks.

Classical logic has a very close relationship with the natural language. However, some characteristics of natural language is not suitable for a formal procedure. For example, natural language is permeated with contradictions. Therefore Frege, founder of modern logic, sought the development of a more economical and accurate artificial language (unambiguous), A formal system must submit: (1) any set of symbols, or alphabet; (2) a set of terms "well-formed"; (3) a set of axioms; a finite set of rules.

Furthermore, the classical logic of computers principle works with two values: true and false. Thus, a predicate can be true or false, but never both true and false. In this classic logic there is concern that an expression is a really true or not for science or philosophy. Their procedures work independent of veracity. In other words, what is in the grip of this logic are formal procedures for from premises and achieve a result. The correspondence between this result and something external to the logic itself is not a matter that the LC is proposed. The AI is usually based on the LC to generate a model of the functioning of the mind, and in that sense the Allan Turing machine and Tommy Flowers (Colossus) is an abstract logical model of the mind. But you can ask to what extent this model is really appropriate. Or, what aspects of the human mind are evident through this model. The answer to these questions involve not only philosophical, but also computer and, if so, logic. The Colossus, precursor of computers, aimed to "learn" the war deciphers codes.

The difference between humans and machines is observed when each "learns" to solve problems The computer is an electronic machine that, to "learn", requires the installation of a program, which is a logical series of operations, today developed and installed by the Human. The man, in turn, requires that, theoretically, occur a series of connections and subsumers conjunction [2].

Learning object translates into information symbols and formatted signals are re-set in bits (binary digit- bit or binary digit is the smallest unit of information stored and / or handled on computers) of material (neurons), which is transmitted in the form of connection patterns and activities of the neurons [3]. In this way no information is lost when migrates to another physical station, such as oral information that is formatted in sound patterns transmitted through the air to the auditory system which switches back of material. At the end, processing returns to the brain through the neuronal activity.

The symbols formed by this same brain-mind are not just the result of an entry / internal representation, from the senses. Are symbols which may contain, in addition to the representational information causal properties, which means that both contain information and are part of a chain of physical events, or can generate information and / or actions.

Then, the information bits processed by the human brain can trigger other mind-bit symbol components to produce sense: validate or not information (true or false, which will form the individual set of beliefs); or can trigger bits connected with muscles, resulting in movement. Thus, mental computation is complex and enables the combination of processes involving, for example, a symbol processed under given set of rules, event triggers a mechanical (or electronic, as with an actual computer, or a programmable automaton to perform functions, or, as I thought Alan Turing in 1937, happen to a processor symbols able to read symbols and operate from a fixed set of rules). If an artificial system is based on the classical computer that operates from the classical logic, you can order such a system performing a given task. For example, determine the time needed to complete a flight in an aircraft, considering wind, aircraft speed and other conditions. Such a proposal involves subtleties which, perhaps, a machine can not compute. At first, the machine would calculate the distance traveled faster and more accurately than a human being to drive from Sao Paulo to Tokyo. On the other hand, a human could answer that it is not possible to drive from Sao Paulo to Tokyo. This example, although trivial, shows some interesting differences in the way of handling problems for humans and machines. Humans tend to consider the truth of the premises they work. Not that prevent the implementation of a purely formal, but whether or not to the truth of the premises can significantly change the relationship between individual and problem [4].

According to a perspective of Vygotsky, proven empirically by Luria, there are different steps for troubleshooting by humans [5]. First, there is the location of the problem to the historical and social world of the individual. The human being creates a conceptual framework (frame) that can treat the data in question, usually using the language as a control tool. It is a "question of how the non-monotonic reasoning, such as adding information affecting the state supporting the conclusions, is able to inhibit or discard options inferences" [6]. Secondly, the individual performs the actual computing activities. He makes the calculation in question through a formal procedure.

The importance of Vygotsky's description is to put the context (external) socio-historical perspective in the resolution of the problem, and this means that before any formal logic and computing the individual will probably check the relevance and veracity of the premises. In the case of processors supported by procedural systems, such as occurs in Artificial Intelligence, there is only the logical computation. An artificial system is not, in principle, able to establish socio-historical relations. That is, it is unable to locate the problem in an individual socio-historical context. Even so, a system could even conclude that it is not possible to travel by car from New York to Tokyo, but such a solution would result in a more complete computer programming, and not of verifying the relevance of assumptions.

It is possible to simulate an artificial system, and efficiently procedures performed by humans. But this does not seem sufficient to explain the workings of the mind, as the computer continues to work just syntactic operations without verifying the relevance of its premises and conclusions. This model is a good tool for better understanding of the nature of mental processes, an artifact that allows empirically test hypotheses and theories about the mind and reproduces certain parts of its operation, particularly its logical-formal reasoning, its operation deductive . But on the other hand, it is difficult to argue that this model is possessor of a mind just like the human mind due to the limits of classical logic and non-consideration of other possible types of reasoning to be realized.

Anyway, on the one hand the difference consists in the fact human verify the relevance of the assumptions that logic works, their relationship with respect to what is external to itself. On the other hand, the problem is internal to the logic limited to a formal logic which does not allow ambiguities or inconsistencies. In this sense, the use of a logic allowing greater proximity to the human mind and its natural language has great interest. In particular a logic that allows intermediate states between the true and the false, and even allowing the emergence of contradictions. There is a structured paradigm called on Computational Theory of Mind, assuming for the functioning of the human mind the nature of the computational process information in the form of symbols [7].

The computational process is associated with the human brain ability to mentally represent knowledge (visual representation, phonological, grammatical and an internal mental language of the human being) in complex layers and interrelated associative networks of meanings. This peculiar biological-human species informational system is also equipped with processing systems of rules that would be infinitely more flexible than those rules comprise any conventional computer program, which enable not only the categorization precise knowledge and / or probabilistic (fuzzy) logic abstract but also, for example, allowing the human being to recognize a face or even the sense of individuality.

This powerful genetically improved software also functions to keep the mental representation, preserving the relations of exact or probabilistic true that formed the alleged true relationship observed in reality, the first time that the brain operated on that symbol. "These events are a computer, because the mechanism was devised so that if the interpretation of symbols that trigger the machine is a true statement, the interpretation of symbols created by the machine will also be a true statement." [8].

Characteristics of Fuzzy Logic and Fuzzy:

- Bivalence is, Since Aristotle, a classical logic and is based on bivalence V, F - (Non-Contradiction:

- Multivalency was developed by Lukasiewicz to deal with the uncertainty principle in mechanics. Quantum V, F, IN - 1920-3 values / 1930 - n values

- • Fuzzy Logic and developed by Lotfi Zadeh [9] (Fuzzy Sets) where elements belong to a certain set with different degrees (degree of ASSOCIATION, relevance)[10]

- Aristotle (384-322 BC) was the first scholar to make a representation of the thought process, through the systematization of logical reasoning.

Commercial Applications:

• Control: Aircraft Control (Rockwell Corp.), Sendai Subway Operation (Hitachi), Automatic Transmission (Nissan, Subaru), Space Shuttle Docking (NASA)

• Optimization and Planning: Elevators (Hitachi, Fujitech, Mitsubishi), Stock Market Analysis (Yamaichi)

• Signal Analysis: TV Image Adjustment (Sony), Autofocus for Video Camera (Canon), Video Image Stabilizer (Panasonic)[11].

An application of fuzzy logic is the construction of fuzzy systems, which are input compounds expert systems and output figures, fuzzification method, fuzzy rules, fuzzy inference and defuzzification method [12]. These rules can be combined by logical connectives such as AND and OR. The inference engine defines the way of how the rules are combined, providing a basis for decision-making [13] Mendel 1995]. There are many inferential procedures on fuzzy logic, but the most used are Mamdani and Takagi-Sugeno-the Kangl.

Fuzzification is a domain mapping of real numbers - discrete, in general - to the fuzzy domain. This process assigns linguistic values defined by membership functions, the input variables [14].

3 Method

Defuzzification is a method used to decode the linguistic variables output inferred by fuzzy rules for real values - generally discreet. This method is the Central of the Maximum the Middle-of-Max and the Middle-Weighted [15]. Fuzzy logic allows to obtain greater generality, higher expressive power, ability to model complex problems, modeling expert knowledge systems, manipulate uncertainties and complexities reduce problems [16]. Because of its properties, fuzzy logic has been used in areas such as: Expert Systems, Computing with Words, Approximate Reasoning, Natural Language, Process Control, Robotics, Systems Modeling Partially Open, Pattern Recognition, Decision Making Process (Decision Making), among others.

Expert systems are knowledge-intensive computer programs obtained by the expertise of specialists in limited areas of knowledge. They can help in decision-making raising relevant questions and explaining the reasons for taking certain actions. Traditional programs require accuracy and precision (also called crisp): on or off, yes or no, right or wrong. But this does not happen in the real world. We know that 50 ° C is hot and -40^{o} C is cold; but 23^{O}C is hot, warm, mild or cold? The answer depends on factors such as wind, humidity, personal experience and the clothes that each is using. The basic Idea: Fuzzy sets are functions that map a scalar value in a number between 0 and 1, which indicates its pertinence to this set.

4 Conclusion

The results of this model shows that it is feasible to create tools based on fuzzy logic to aid decision making in Air Traffic Control, provided that these tools can be widely tested and validated. This model has a considerably high risk index (6.7%) for safety standards in Air Traffic Control. Thus, the group of experts approved with reservations using the tool, requiring a model of development for it to become fully operational. However, a point also being analyzed is the difficulty of human beings to use and rely on these types of tools for highly dynamic environments, complex and risky. The acquired perception was that this tool can not replace the human air traffic controller, due to various factors related to the experience of human beings and that are not currently sufficiently reflected in computational tools.

5 Applications

In this work were carried out only sixty analyzes the applicability of the model, quantity judged as insufficient to have an effective diagnosis of the model. This requirement is supported by Mcneill and Thro [16] that is indicating the need for greater dedication to the test phases, simulation and validation of fuzzy systems. The main limitation of this study is that only certain types of aircraft are included. For operation of other types of aircraft (such as Airbus 340, Boeing 747, Tucano, Navajo, Rio, Brasilia, Buffalo, etc.) a new model is needed, because the controlling decision-making are different for different aircraft (the performances are different). As a suggestion for further work, designs may be implemented to include a greater number of aircraft types as well as a simulator to test the model for testing the operational environment involving a great risk for air traffic control operations [17].

The use of type two, Fuzzy Logic is also a relevant proposal to be studied in the proposed scenario. This new concept allows you to handle greater depth the uncertainties of expert knowledge for modeling systems such as imprecise limits of fuzzy sets, uncertainty regarding the degree of membership, and uncertainty format or some parameters of the membership functions [18].

Another possibility is to build a model that uses more input variables and analyze the performance in the system results, and analysis of the computational cost for the proposed model. Some candidate's variables have been identified, such as moisture content of the track, adverse wind conditions, cloud height, other types of aircraft, among others, as these factors also affect the decision scenario.

Finally, another possibility would be to implement a mature and thoroughly tested model, since the model of this project can be considered somewhat incipient, because it does not address all possible variables used for decision making. For a more complete and autonomous model, it is probable that its implementation can be used as the input variables, identified herein, may be collected electronically using radar systems, sensors and existing information systems in air traffic operations.

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