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THE IMPACT OF GODEL ON AI

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Abstract

In this paper we have discussed some of the main contributions of Kurt Godel on artificial intelligence(AI).We give a simple description of Godel's Incompleteness Theorem which was,certainly,the major theorem he proved during his bright career.He is considered as one of the inventers of the theory of recursive functions which formed part of the foundations of computers,too. Godel was,of course,one of the greatest logicians ever.

Keywords: impact, mind,logic,artificial intelligence,incompleteness theorem.

Introduction

The ideas of many people for building a machine that will be capable to think and to perform all the works made by them and in a very similar manner with them,have been very attractive for many and many times ago.So,in 1842 in a memoir Lady Ada Lovelace wrote:"The Analytical Engine has no pretentions whatever to originate anything.It can do whatever we know how to order it to perform…".The ideas,according to which the machines cannot "think" by themselves, were widespread till the 20th century and the more convincing argument against the artificial intelligence for many times was based on Kurt Gödel's Incompleteness Theorem.This theorem states that a "sufficiently powerful" formal system cannot consistently produce certain theorems which are isomorphic to true statements of number theory.

Main Text

It was in 1931,when the Austrian mathematician Kurt Godel(April 28,1906-January 14,1978) did one of the gratest invention of the 20th century.With his "Incompleteness Theorem" he,in other words,showed that it is impossible to define a complete system of axioms,which is also consistent,that is,has no contradictions.As a result,any formal system that can generate meaningful statements is powerful enough to generate true statements that cannot be proved within the system.Consequently,mathematics cannot be placed on an entirely rigorous basis.Gödel original proof of the completeness theorem is based on the paradox of the liar.Suppose that in a community we have two kinds of people:liars and people who tell the truth.Liars always tell lies and people who tell the truth tell always the truth.Let's take a person who always tells the truth.This person will say :"I am telling the truth".This part is easy.Now,the other part :a liar should say "I am a liar",but since that person is a liar he will have to lie,and will therefore say "I am telling the truth".Hence,we cannot tell,only by asking him,if that person is a liar or not.But,remember that our aim in creating perfect axiomatic systems was that for any given correct sentence,we can demonstrate based on the axioms that it is either true or false.Let's take ,for example,the sentence:"I am a liar" based on the things a person telling the truth and a liar says,no one can actually pronounce that sentence!…"And here is the problem announced by Gödel:we have a sentence about which we cannot say anything,so we cannot prove that it is true,but we cannot prove that it is false either,even though the sentence is valid".As it is pointed out "…Godel's theorem is not an obstacle to a practical AI(artificial intelligence) system based on formal logic.Such an AI would take the form of an intelligent proof checker.Gottfried Wilhelm Liebnitz and David Hilbert's dream that disputes could be settled with the words "Gentlemen,let us compute!" and that mathematics could be formalized,should still be a topic for active research.Even though mathematicians and logicians have erroneously dropped this train of thought dissuaded by Gödel's theorem,great advances have in fact been made "covertly",under the banner of computer science,LISP and AI…"(Cole et al.,1981;Dewar et al.,1981; Levin,1974; Wilf,1982). And next,as F.Gelgi states: "The theorem published in 1931 by the 25 years old Austrian Scientist, Kurt Godel made a great impact on the scientific circles.Not only did it destroy the hopes of many scientists,but it also initiated a new point of view concerning AI and the mind.This theorem is one of the most important ones to be proven this century,ranking alongside Einstein's Theory of relativity and the Heisenberg'Uncertainty Principle…". For many and many decades it has been accepted that the Gödel's two incompleteness theorems exclude the possibility for developing a true artificial intelligence which can rival the human mind.Comparing the mind and the machines (or the natural intelligence with the artificial one) Gödel has shown that "there exist some tasks the mind can solve but machines cannot".Gregory J.Chaitin wrote: "At the time of its discovery,Kurt Gödel's incompleteness theorem was a great shock and caused much uncertainty and depression among mathematicians sensitive to foundational issues,since it seemed to pull the rug out from under the mathematical certainty,objectivity and rigor. Also, its proof was considered to be extremely difficult and recondite. With the passage of time the situation has been reversed.A great many different proofs of Godel's theorem are now known,and the result is now considered easy to prove and almost obvious:It is equivalent to the unsolvability of the halting problem,or alternatively to the assertion that there is an recursively enumerable set that is not recursive…". In 1963, John von Neumann will write:"…there have been within the experience of people now living at least three crisis…There have been two such crisis in physics,namely, the conceptual soul-searching connected with the discovery of relativity and the conceptual difficulties connected with the discoveries in quantum theory...The third crisis was in mathematics.It was a very serious conceptual crisis, dealing with rigor and the proper way to carry out a correct mathematical proof.In view of the earlier notions of the absolute rigor of mathematics, it is surprising that it could have happened,and even more surprising that it could have happened in the latter days when miracles are not supposed to take place.Yet it did happen…".

The mechanization of the mind has been a centennial dream and has a rich tradition.It begins with the axiomatization of Geometry from Euclid and the efforts of Aristotle to axiomatize the logic,continues with the Leibniz's Calculus Ratiocinator and next with the program of David Hilbert to encode all the mathematical proofs. We note here that the Gödel's original proof applies to a particular formalization of number theory and was followed by a paper showing that the same methods applied to a much broader class of formal axiomatic systems. The modern approach applies to all formal axiomatic systems,a concept which could not even be defined when Godel wrote his original paper because of the absence of a mathematical definition of an effective procedure or computer algorithm at that time. After Alan Turing succeeded in defining an effective procedure by inventing a simple idealized computer,now called the Turing machine,it became possible to proceed in a more general fashion. Alan Turing wanted,first,to give an answer to the question:which is the set of tasks that a machine can solve in general? And,as F.Gelgi pointed out again:"…By examining Gödel's Theorem one can determine very important consequences for artificial intelligence. An English mathematician, Turing, described an abstract machine called the "Turing machine".This is an abstract machine which has an unlimited amount of storage space and which can go on forever without making any mistakes. This machine can compute any type of algorithmic problem. According to the Turing Theorem all computers are Turing equivalents. After proposing this,Turing went on to observe that some type of problems have no algorithmic solutions.In the meantime,”the Halting Problem” emerged-the problem of deciding those situations in which a Turing Machine action fails never come to a halt because of the consequences of the Godel’s Incompleteness Theorem.It has been proven that a halting problem is computationally unsolvable. This leads us to an important conclusion:a computer cannot be the same as the human mind because the non-computational physics of the mind is not available for Turing equivalent machines and the nature of algorithms is not compatible with the thinking process due to the halting problem”. One interesting question is what did Godel think his first incompleteness theorem implied about the mechanism and the mind in general?In 1951,in his famous “Gibbs lecture” stated:”…So the following disjunctive conclusion is inevitable.Either mathematics is incompletable in this sense,that its evident axioms can never be comprised in a finite rule,that is to say the human mind(even with the realm of pure mathematics) infinitely surpasses the power of every finite machine,or else there exist absolutely unsolvable diophantine problems of the types specified”.That is,his result shows that either the human mind is not a Turing machine or there are certain unsolvable mathematical problems.But his impact on AI does not finish with these results. Godel formal explication of the Recursion Functions is a great achievement which yielded the basis for the recursive programming. As W.Schimanovich stated: ”Together with the Lambda-Calculus of Alonzo Church they give use to the development of LISP by McCarthy and other AI gurus”. Several of his students worked out his ideas and they continue the research on recursive functions as a new trend in mathematics and this before the time when computers would be strong tools in the scientists’s work.Since the young computer scientists mainly came from mathematics,they were influenced by the general treatment of recursive functions.And again we cite W. Schimanovich who states: ”Recursive programming did not fall from heaven(as some AI people believe today); its development is embedded in a cultural situation produced by a long period of research in mathematics and logic which had been motivated by Godel’s work”. In private conversations Godel argued the need for using the predicate logic as a programming language and the application of logic methods in computer science. The people who were engaged with the computer science at that time could not even imagine that the logic may consist a strong mean for the programming languages. But, as it was proved later,only the computer scientists with good knowledge in logic,could realize this. As a result of their work came into the sight the PROLOG language and the logic programming. The contribution of Gödel in logic attracted many new scientists to deep their knowledge in this field. But,because the results achieved in the field of logic were not those wanted,some of these scholars interrupted the studies in pure logic and continued their career in computer science…And they tried to use their knowledge in logic there.W.Schimanovich writes next:”… Therefore, sometimes publications on AI (as computer science together with some parts of logic and other fields like linguistics or psychology) forces the researchers to develop their own “logic” which seems to be more practical and promising than the traditional logic developed by pure logicians.This is also an influence of Godel-in spite of the fact that it probably was not originally intended by him…He influenced two generations of logicians and through them the development of computer science and especially that of AI ”.

Conclusion

We conclude,saying that Godel’s incompleteness theorem had a big impact on the construction of modern mathematics and currently have a big impact on the way we see programming and artificial intelligence projects. In this simple paper we tried to pay homage to the genius of Godel,who “…is not father of AI, but he can be considered as a grandfather (together with Alan Turing and possibly John Von Neumann)” as W.Schimanovich has written. And we finish here again with Godel's bright words: "Either mathematics is too big for the human mind or the human is more than a machine…".

References:

Chaitin J.Gregory, Godel's theorem and Information: International Journal of Theoretical Physics 21,1982.

Feferman,S.Godel's life and work,1986.

Gelgi Fatih.Implications of Gödel's Incompleteness Theorem on A.I.vs.Mind: Neuro Quantology,2004.

Godel K.Collected works: S.Feferman et al.,eds.,Oxford,1986.

Savas Ali Tokmen.Godel's incompleteness theorems.

Schimanovich Werner.KURT Godel and his impact on AI.