INCOMPLETENESS, CREATION-SCIENCE AND MAN MADE MACHINES

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Abstract

In this article, in order to correct a few misconceptions, a simple yet in-depth discussion of the procedures, methods and results associated with Gödel type incompleteness theorems is given. In particular, the important concepts of formal and informal reasoning processes are discussed and illustrated. Further, information is compiled from the discipline of Mathematical Logic and elsewhere that gives exceedingly strong evidence that there are human mental processes that cannot be duplicated by a man-made machine.

Introduction

Recently there have appeared within creation-science literature some very imprecise and confused statements relative to various incompleteness results as first developed by Kurt Gödel (1931). This is unfortunate since these incompleteness results have very important consequences for creation-science. In Hoffman (1993, p. 14), we read, among other statements, a Gödel incompleteness theorem interpretation. "In any system diverse enough to be of interest, there will always occur inconsistencies or contradictions." This statement has no meaning unless phrases such as "system diverse enough," "of interest," and "inconsistencies or contradictions" are specifically and nonambiguously defined, for a reader of this statement might conclude, incorrectly, that a formal logical system is, in all respects, the type of system used within the informal mathematical sciences. Certainly, the logical system referred to by Hoffman could not be the dialectic he uses to argue for the acceptance of his conclusions.

In the letter by Groah (1994, p. 190), we have a more formalized interpretation of Gödel's theorem. "Every consistent, recursively axiomatized extension of the Peano system has at least one undecidable i.e., neither provable nor refutable—sentence." A reader not trained in the technical jargon used within the discipline of mathematical logic would find this statement also meaningless even if each term was defined specifically. More importantly, however, is the fact that a significant concept relative to a specific logical system is missing from the Groah's quoted statement. Without this concept, Groah's statement is misleading for the specific Gödel "sentence" referred to by this quotation is a (provable) theorem within the informal theory of natural numbers. This article is an attempt to more accurately describe the significance of such incompleteness results for such results are important in that they indicate that the informal mental processes, the intuition and ingenuity displayed by the mathematician, and, indeed, by all individuals, in producing acceptable informal statements seem not to be formalizable by means of a fixed set of rules and procedures. Assuming that computer programs must include for their proper operation a fixed set of rules or procedures (i.e. algorithms) in order to function properly, then if one accepts as correct the methods used to obtain incompleteness and related results, then the functions of the human brain that produce comprehensible informal statements cannot be regarded as totally reproducible by such a machine. This last conclusion will be discussed more fully.

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Informal Versus Formal

It seems that much of the confusion produced by the above quoted statements is simply the result of mixing "apples and oranges." Within mathematics, certain terms take on completely different meanings depending upon the context. With respect to incompleteness and similar concepts, there is always exhibited two distinctly different mathematical approaches, the informal and the formal. Although different names are given to the various languages and methods used within different branches of mathematics, they all fall within two distinct categories. The languages used in an *informal* mathematical approach can be termed "metalanguages." This is a natural native language such as English, French, Russian, Spanish, etc. The term informal will always refer to information conveyed by means of a native language. A *formal* language is composed of a collection of finitely long strings of symbols. They are called *formulas, formal symbol strings* or *well formed formula.* For example, for some formulations of the formal predicate language $(x)(P(x,y) \rightarrow Q(x,y))$ is a formula. The logical procedures used in the informal approach are not specified. In some cases, these informal procedures are simply called by the general expression "the metalogical procedures." I mention that 99% of all mathematical discourse is informal.

Gödel used as a formal language a slightly modified Whitehead and Russell (1910-13) language of "types." You will not find this language described in any of your elementary texts in Mathematical Logic. Significant to the ideas within any informally described procedure is the concept called "content." The *content* of any form of informal communication directed towards an individual is the collection of all impressions the communication evokes within the individual's mind, or brain if you wish. The content of a communication depends upon an individual's education, training, life experiences and the like. In order to analyze patterns of human thought without these patterns being confused by content, formal symbol strings are used. However, how does one construct and analyze these patterns? Often using a portion of the informal theory of natural numbers, informal rules are given that detail how to combine the symbols in a left to right pattern in order to form the formula. These informal rules are written in such a simplistic manner and the content is so specific that they can be repeated over and over again by millions of individuals and the end result of these repetitions will be similar collections of formulas. You can think of a formula as a geometric configuration of lines and curves. Because these informal rules, when repeated, yield geometrically similar collections of formulas, these rules form what is technically called an *algorithm*. Indeed, the rules are so simplistic that I have on my desk a computer program written in True Basic that will also produce the same collection of symbol strings.

Once you have constructed a formal language, then a second set of informal algorithm-like rules gives specific directions as to the exact formulas you are allowed to write down in a finite list and, usually, an informal rule or rules that describe how to use a finite collection of the listed formula to obtain a formula not already present in the list. When a formula is written down, you state which of the informal rules you used to obtain the formula. An individual's ability to obtain a list of formulas depends, of course, upon the content of the informally stated rules. Much like a demonstration in elementary geometry, a *formal proof* is obtained by writing down, in a list, a numbered column of formulas on the left of a piece of paper and a corresponding numbered column on the right that states the informal rule that was used to obtain the formula immediately to the left. This allows the formal proof to be checked by other individuals who can exactly repeat the rules (i.e. individuals who have the requisite training). The final formula listed in the left hand column is called a *formal theorem*. Finally, the entire list of formula with the last one being the formal theorem is called a *formal proof*. Often in the literature, the adjective "formal" is missing from the expressions "language" "theorem," "theory" and "proof." Although, it may seem repetitious or tedious, these adjectives are retained in all that follows.

The Hilbert Program

In order to analyze the processes associated with obtaining a formal proof, David Hilbert chose a certain subset of the informal theory of natural numbers. This subset is of such a simplistic nature that it is assumed to be, at least, empirically consistent. Hilbert allowed a certain subset of the classical rules of informal logic to be used during such an analysis, as well as a very weak portion of the language of informal set-theory. Gödel used all of the allowed informal methods to develop his conclusions. However, as would be expected when new concepts first appear in print, he obtained his results in a slightly compact manner. All modern approaches to the concept of incompleteness are expanded improvements over Gödel's original. Today, there are many different approaches that lead to the same incompleteness conclusions. I will discuss two approaches and mention some of the others.

In Mendelson (1979), we find an approach that improves upon and parallels the Gödel original. Mendelson selects a certain formal axiom system (i.e. a specific set of formula) called S and the informal rules for what is termed a *first-order logical system*. But as they are stated, these formal axioms have no content, they have no meaning. By an informal mathematical process called an *interpretation* these formal symbol strings can be given a "meaning." Under an interpretation, these formal axioms are informally shown to be informal theorems in the informal theory of natural numbers where the informal theory's semiaxiom system is called the Peano Axioms. The informal rules for formal theorem construction are then used to obtain formal proofs of various formulas (i.e. formal theorems of S).

Next, the allowed informal portion of the theory of natural numbers is used to give definitions and construct informal theorems about recursive functions and relations. The definitions, the theorems and all else relative to recursive functions are produced by application of informal mathematical reasoning and are all informal in character. Now comes the most important *informal* process of all. An informal description is given that produces a correspondence between the informal natural numbers and the formal symbol strings. Whether or not this description is comprehensible by an individual or, indeed, is accepted as a "correspondence" depends upon the descriptions content. Using this correspondence, it is claimed that certain informally expressed recursive functions or relations will model the informal rules and procedures for formal theorem construction. Rules for this modeling process are not specifically described, they are intuitive in nature. The acceptance of these recursive objects as models depends upon an individual's experience with translating informally described physical processes into an informal mathematical language or what is called mathematical modeling. The same can be said about mathematical models for any physical process. But, in this case, the physical processes are certain (human) linguistic processes. This modeling is done in such a way that each of these recursive objects can be further translated into a formal theorem. This last translation process also depends upon an individual's experience in recognizing when a formal symbol string corresponds to an informal mathematical statement. Thus, it is claimed, that we have formal theorems that represent informal processes and objects.

The actual two part incompleteness result is an informal theorem. If one accepts the informal methods allowed by Hilbert (a very important acceptance at this point), then part one of this theorem says, when informally interpreted, that, assuming that S has a property called simple consistency, there is a formula, call it G, that is not a formal theorem of S. At this point, this result is not surprising at all since simple consistency implies that there are numerously many formula that are not formal theorems of S.

The general concept of completeness means that a formal or informal process produces *at least* a certain collection of formal or informal theorems. To show how different the specific completeness definitions can be, consider the fact that Gödel previously published his famous completeness result (Gödel, 1930). One year later, he published his incompleteness result. In this article, it is not necessary to discuss, in any depth, the second part of Gödel's Incompleteness Theorem nor the Rosser (1936) improvement—a result that can be interpreted as stating the formal incompleteness of a formal axiom system. [Formal incompleteness for a formal axiom system is described as the existence of two formula, one the formal negation of the other, and neither is a formal theorem.]

Does the formula G itself have meaning? The answer is no, unless you supply an informal interpretation. Using an informal argument and an interpretation, the formula G can be given meaning within the informal theory of natural numbers and, more importantly, it is an *informal theorem* established by informal mathematical means (Mendelson, 1979, p. 159). This means that the interpreted G does not establish the informal incompleteness of number theory. Moreover, a formula with the same character as G can actually be formally proved if the formal logical system is strengthened to one that is called a second-order logical system (Robbin 1969, p. 121). Thus, due to the missing concepts that deal with different logical systems, the informal and the formal, the above quoted statements are, indeed, very imprecise.

Although interpreted G is an informal theorem about natural numbers, does it give any information that can be construed as interesting to a number theorist? The answer is again no, for interpreted G states that there exists a collection of ordered pairs of natural numbers (i.e. a binary relation), call it Pf, and there does not exist a particular natural number as a second coordinate. This is not a very startling disclosure for informally there exists numerously many such relations. But what if we step back out of the informal theory of natural numbers and into the language of the Hilbert mathematical approach to analyze formal logic, then G can be interpreted informally in terms of the formal processes used to produce formal theorems. The number that does not appear as any second coordinate in the relation Pf is a numerical name for G itself. The numbers that appear as first coordinates in Pf are numbers that give to each and every formal proof an identifying name and, informally, the relation Pf exists. Rephrasing this metamathematical interpretation, we have that if one uses a portion of informal number theory, as well as a specific correspondence between the natural numbers and symbol strings, specific algorithm-type informal rules for formal theorem proving, a portion of informal mathematical reasoning, and the informal concept of consistency, then there is a specific formula G that, when interpreted, is an informal theorem of number theory and that shows the existence of a specific mathematical relation Pf. Further, if this relation Pf is interpreted informally with respect to the Hilbert analytical methods, then it states that we cannot use the formal system S to formally prove G. If you reject any of the hypotheses stated in the above two sentences, then there is no Gödel incompleteness theorem. I note that the formal system S can be replaced by other similar formal systems that are listed in a similar manner.

Thus far, this shows that you either do not analyze, with the above stated methods, formal logic, or that, assuming a Hilbert type approach is allowed for all such analysis, a formal axiom system such as S cannot capture all of the "informal theorems" produced by means of informal mathematical reasoning from a broadly interpreted informal theory of natural numbers. Here "broadly" implies the actual use of the theory of numbers to count and analyze real physical entities such as the actual marks on a piece of paper that we call formula.

The major effect of Gödel's result was to stop the Hilbert program search for a formal axiom system that could capture all of the informal theorems of informal number theory. More importantly, using this result, Gödel's Second Theorem put a stop to the Hilbert program search for a formal first-order proof based upon a formal axiom system such as S that would have as its last formula a statement that when interpreted would say that the system is simply consistent. Gödel's Second Theorem (Mendelson, 1979, pp. 163-164) shows that under the Hilbert procedures no formal first-order proof of consistency exists. I again mention, however, that a formula that can be interpreted to mean "consistency" can be proved formally if we strengthen the formal logical processes used. Further, in Herrmann (1987, p. 13), it is shown that there is an informally produced ultralogic that behaves like first-order logic and that can "prove" all of the informal theorems of number theory. This is one of the ultralogics that can be used to obtain all of the properties of the MA-model (Herrmann, 1991). Historically, the fact is that, even prior to Gödel's work, many mathematicians conjectured that their informal methods could not be formalized.

Mathematical Logic

Who is it that determines the correctness of such incompleteness results and can we remove some of the vague informal procedures? As in all disciplines, the correctness of a result is determined by expert witnesses. In this case, these are experts in the discipline called Mathematical Logic. All such experts agree that these results follow the proper procedures of their discipline. There are some individuals that claim, especially today, that there are errors of one sort or another with the incompleteness results. Need I mention that many come from the disciplines called Artificial Intelligence and Computer Science. All that I will say is that the expert witnesses from the area of Mathematical Logic have taken on the challenges of these "objectors" and have given very convincing arguments that under the rules of modern Mathematical Logic the claimed errors do not exist. Indeed, the formal incompleteness results for many formal axiom systems can be argued for in a more convincing manner than the arguments given in Mendelson (1979).

Consider what is found in Robbin (1969). We have the formal axiom system called RA. This is larger than the S system and incorporates enough formal symbolism so that the necessary informal theorems relative to recursive function theory can be formally reproduced. This does not remove all informal requirements. You still have the informal rules for formal theorem construction, an informal correspondence that associates some of the recursive functions with language symbols and the use of the informal mathematical reasoning. Indeed, Robbin gives away one of the basic methods that mathematicians use to obtain formal proofs. The actual formal theorems are produced by first establishing the informal theorems and then translating them into formal proofs. This is necessary because there are numerously many formal proofs that can be produced by such an axiom system. We cannot know which to select unless the selection is based upon a procedure that includes content. Formal symbol strings have no content. Further, it is the necessary elements in the informal portion of the Gödel methods that leads to the construction of the language RA.

What one obtains by this process is a "more" formalized proof of a new formal theorem H. Of course, H has no meaning unless we interpret the formal symbols. Interpreting H in terms of the informal rules yields the statement "If RA is simply consistent, then there exists a formula J in the formal language of RA that is not a formal theorem of RA" which is the informal statement of the first part of Gödel's theorem. The formal statement J that cannot be formally proved, when interpreted, has the same meaning as G. Once again, it can be informally argued that the formula J, when interpreted, is an informal natural number theorem (Robbin, 1969, p. 115), but is of no interest to natural number theorists.

There are other approaches to incompleteness and formal consistency that are considerably different from the above approaches. One is the semantical (algorithmic) approach of Uspenskii (1974), another is the model-theoretic and tree approach that appears in Smorynski (1977). But the most startling result was obtained in 1977. First, I mention that Feferman (1960) showed that whether or not one can formally prove by means of a formal axiom system the concept of consistency depends upon how one formalizes the definition of consistency. In discussing the Paris and Harrington (1977) result, we assume that the concept of consistency has been formalized in the usual way so that Gödel's Second Theorem can be used. Paris and Harrington first prove informally a theorem about modern number theory that adds a great deal of content to this informal theory and that seems to be relevant to computer construction. This informal theorem is not related to the methods of mathematical logic. However, they also show that this informal theorem cannot be a formal theorem for any formal axiom system such as S or RA. It is the first nontrivial Gödel-type theorem ever discovered. The technical evidence continues to suggest that there are informal human thought processes that cannot be duplicated by a man made machine.

Thought Processes

It is rather obvious that a formal language can be considered as a proper subset of a metalanguage. Further, there is a *metaworld* that includes as objects informal entities, informal mental processes as well as formal entities and the formal logical processes. Let M_1 denote the first-order metaworld. Let L_1 denote the formal entities of a first-order logic as well as the formal first-order processes. The symbol " $\subset$ " denotes "subset but not equal to." Then we have that $L_1 \subset M_1$. I have mentioned the idea of second-order logic. Before we have second-order logic, we have a metalanguage. Before we have a second-order language and the second-order formal logical processes, we have a second-order metaworld M_2. The symbols used, formula constructed and the formal first-order logical procedures can be so defined as to form a proper subset of second-order logic (i.e. $L_1 \subset L_2$). In this case, all of the informal algorithms used to describe second-order logical processes, when restricted to the first-order language, describe all of the first-order processes. This yields that $L_1 \subset L_2 \subset M_2$ and $M_1 \subset M_2$. One continues up the scale of the logical hierarchies and defines, by induction, the nth-order logics and nth-order formal logical processes L_n by using the nth-order metaworld M_n. This yields finite sequences $L_1 \subset L_2 \subset ... L_n \subset M_n$, and $M_1 \subset ... \subset M_n$. Significantly, the nth-order metaworld is always the upper bound for the L_n. There is one common feature for each M_n. The same informal mathematical reasoning takes place internal to each M_n, but external to L_n. Why? Because a Gödel-type formula relative to L_n and determined by an appropriate axiom system S_n can be interpreted in M_n in the same manner as in the first-order case. This is accomplished by an informal argument using the common mathematical reasoning processes.

This logic-language hierarchy is analogous to what takes place within computer science. The basic algorithm-like rules for computer language construction and how to use such a computer language to construct computer programs first requires a metalanguage that contains the computer language as a proper subset. And it also requires informal reasoning on the part of a student to construct a computer program. As mentioned in the introduction, incompleteness and related results are relative to the clash between formalized concepts and algorithms and those informal processes of human thought that are often based upon intuition, ingenuity, reflection and probably vague notions that cannot be verbalized. How did I arrive at this very significant conclusion?

I have often been asked what is abstract mathematical research? Except for teaching, what do research mathematicians do to earn their keep? How does one learn to do what often appears to be an art rather than a science? I can only discuss my personal thirty years of experience with creating new mathematical results—results that number well over 2,000—and how this experience correlates not only to incompleteness results within the above logic-language hierarchy but also to the closely related *decision problems.*

Shortly after Gödel's Incompleteness Theorem appeared, mathematicians realized that the basic reason that Gödel's result could be established using the Hilbert approach was in the method used to describe informally the algorithm-like rules for formal language construction and formal deduction. Turing (1936-1937) proposed what might be considered a new way to describe informally the necessary algorithms—the famous Turing Machines. Post (1936) presented a technique for algorithm description. Markov (1954) described his algorithms. Using computer terminology, Lambek (1961) and Melzak (1961), among others, described what are called register machines. Register machines are more powerful than any actual computer since these register machines have unbounded memory. Then Cook (1971) described the random access machines. Every such attempt to describe informally an algorithm has been shown to be modeled by the partial recursive functions or relations of informal number theory. Again using the discipline of mathematical logic, it can be shown that if descriptions for a repeatable algorithm are modeled by Gödel-type recursive objects (Robbin, 1969, p. 126) or modeled by partial recursive objects (Manaster, 1975, p. 138), then there can be no algorithm producing description for a set of rules that can be used to determine whether or not an informal statement about number theory is an informal theorem. But counter to this negative result, as mathematicians have known for hundreds of years, what differentiates the expert mathematician from others is the ability to select a theorem, *prior to* constructing its proof, from numerously many informal statements. This is yet stronger evidence that certain human mental processes cannot be duplicated by a man made machine.

Expert Witnesses and Creation-Science

Informal mathematics is done in a portion of a metaworld such as M_n. When a theorem is proved, it can then be translated into an L_n. Computers can be programmed to follow the rules of L_n and check the correctness of the informal proof as it has been formalized. As implied at the end of the previous two sections of this article, there appears to be one area of mathematical experience that cannot be replicated by such machines. Although the above negative results are suggestive, they do not present the strongest evidence. The simple reason is that no one has ever been able to describe, in naturalistic terms, the mental processes involved in such a prior selection. When I see an informal statement with terms taken from an informal mathematical theory, I cannot describe the processes, in natural terms, that my brain undergoes that allows me to select one of the two statements "This statement is a theorem that I can prove." Or, "This statement is not a theorem, so don't try to prove it." If I could describe the processes, I could train individuals to become very successful mathematicians. If I select the first statement, then the consuming problem becomes, "How do I construct an acceptable proof?" Dreyfus (1993/94, p. 8) has Concluded that "[A]n expert . . . intuitively sees what to do without applying rules." Dreyfus agrees that the rules cannot be described in the required manner and, hence, no computer can successfully become an expert theorem selector, proof creator or an expert in anything. However, I disagreed with Dreyfus' definition for "intuition" which he claims is a process of searching, for example, among all the previously constructed proofs of which I have knowledge and finding one that will fit this particular situation. This is simply not true. It is a fact that I have constructed informal proofs the structure of which I had never encounter previously.

This kind of indescribable selection from a potentially infinite list is actually practiced by most individuals, but for a Christian and, especially, members of the creation-science community, there exists a reasonable explanation. But this explanation does not yield a materialistic description for such a selection process and would not be accepted by secular science. This is especially so when Genesis 1:1-2 is selected as a literal description for the creation of our universe over numerously many other naturalistic statements. "He is the source from which all your reasoning power comes: . . ." and "He lends us a little of His reasoning powers and that is how we think: . . ." (C. S. Lewis, 1960, pp. 52, 60) For a Spirit indwelled Christian, the scriptures add an additional aspect to these materialistically indescribable processes. "But the anointing which ye have received of him abideth in you, and ye need not that any man teach you: but as the same anointing teacheth you all things, and is truth, and is no lie, and even as it hath taught you, ye shall abide in him." 1 John 2:27

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Quote: Where Have All The Dinosaurs Gone?

Finally, although it is not crucial to the central thesis, comes the nagging problem of the lack of any dinosaurs surviving into post-Cretaceous times. If cold was responsible for their annihilation, even if it accompanied the initial burst of radiation from a nearby supernova, why did dinosaurs not persist in the warmer equatorial regions? Is it conceivable that the entire globe was subjected to intense cold? It seems unlikely. Even though both land masses in the northern hemisphere, America and Eurasia, were situated in middle and high latitudes in late Cretaceous times, and were bordered to the south by the Tethys Ocean, South America and Africa were more favourably situated climatically. The abruptness, ubiquity and severity of the Cretaceous extinctions makes it increasingly difficult to dismiss a cataclysmic theory.

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