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Invited Paper

AI and the Transcendence of True Autonomy

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In Memoriam † Szabolcs Michael de Gyurky, 1939—2014 (JPL)

ABSTRACT

For more than sixty years, the "Holy Grail" of computer science has been to build an intelligent, autonomous system, one that is self-aware and capable of rational thought. The founders of Artificial Intelligence recently gave a grim assessment of their field: AI and neuroscience are fixated on the details of implementation, without a fundamental architecture in sight.[1] No one has ever articulated the design for an autonomous system, so how can one be built? Modern AI/AGI efforts attempt to achieve this goal through elaborate rules-based computation and biology-inspired computing topologies, while actively ignoring the need for a fundamental architecture. This publication introduces a novel architecture and fundamental operating theory behind true autonomy, breaking with the standard principles of AI − the very principles that have kept AI from achieving its own goals.

Keywords: Autonomous systems, AI/AGI, autonomy, architecture of thought, non-determinism, mind vs. brain

1. INTRODUCTION

The idea of a truly autonomous system − one with humanlike intelligence that can think and make objectively rational decisions on its own without human intervention – remains consigned to the realm of science fiction. In fact, such a system has never been architected, much less built. Neither academia nor industry has been able to achieve the goal of autonomy as set forth by the advocates of Artificial Intelligence. The achievement of true autonomy in an intelligent software system is anything but a trivial task; it is now obvious that a comprehensive paradigm shift is called for to achieve it.

Heretofore, all such "grand scheme" efforts have been dead-ends, designs without foundation. At the 2005 AI@50 Dartmouth conference, the founders of Artificial Intelligence came to a bleak realization: AI and neuroscience are fixated on the details of implementation rather than on establishing a fundamental design. No overarching architecture exists, and work focuses not on fundamental problems, but rather on the issues their mechanisms can deal with.[2]

2. "ARTIFICIAL" INTELLIGENCE

"Intelligence is whatever machines haven't done yet." – Tesler's theorem (Larry Tesler, ~1970)[3]

Properly viewed, computer science is an abstraction of the human thought system, and so the fundamental science in "computer science" is the *science of thinking*. And thus, the resulting product of computer science – what is termed *software* – must also be an abstraction of the human thought system.[4]

2.1 Essential Definitions Concerning AI

One rarely encounters explicit, functional definitions of AI's working terms in the literature; the definitions that are found tend to be narrow, vague, and provisional. The Oxford English Dictionary[5] offers us a good starting place to define, in a clear and unambiguous way, the eight fundamental AI terms that we will be using, and to define working postulates as needed.

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- ***thought*** is "the action or process of thinking."
- ***thinking*** is "the process of using one's mind to consider or reason about something."
- ***to think*** is "using one's mind actively to form connected ideas."
- ***ideas*** are "concepts of pure reason, not empirically based in experience."
- ***reason*** is "the power of the mind to think, understand, and form judgments logically."
- ***to decide*** is to "come to a resolution in the mind as a result of [careful thought]."

Much more telling is the definition of the operative word in the above definitions, specifically, the word *mind*:

- ***mind*** is "the element of a person that enables him to be aware of the world and his experiences, to think, and to feel; the faculty of consciousness and thought."
- ***consciousness*** is "the fact of awareness by the mind of itself and the world."

Postulate 2.1: To think requires a *conscious mind*.

The ultimate objective of AI isn't merely to mimic human intelligence and responses, but to attain to true *autonomy*:

- ***autonomy*** is "the right or condition of self-government; freedom from external control or influence; independence. (Greek *autonomos* 'having its own laws'; *autos* 'self' + *nomos* 'law'.)"

Thus we have quickly arrived at a point where, just in defining our first eight AI terms, we are forced to leap beyond the constraints of deterministic behavior, and into the realm in which we find such sciences as epistemology and ontology, i.e., the realm of metaphysics.

Corollary 2.1: True intelligence, requiring a conscious mind, is fundamentally *metaphysical* in nature.

3. AI VS. INTELLIGENCE

An "intelligent" system is rightly considered autonomous only when it can think, contemplate, speculate, and make objectively rational decisions on its own. As such, it needs to be capable of generating – i.e., *sourcing* – humanlike thinking, contemplation, learning, and acting on its self-originated thoughts and rational decisions.

The only known, viable, functional model we can use for such an autonomous cognitive capability is the human thought system. Yet, the thrust of modern AI is to achieve its goals through elaborate rules-based computation and biology-inspired computing topologies, ignoring the need of a fundamental architecture for thought. In essence, AI seeks to build – "from the ground up" – an artificial brain that can think, whereas true autonomy requires the construction of a *mind*.

3.1 Lowering the Bar on "Intelligence"

The phrase "of human intelligence" refers to a person having the ability to acquire and apply knowledge, with no inherent bound or "end" *per se*, as human minds are "unbounded" systems, with an unlimited capacity to learn.

In stark contrast to this, and to get around the anticipated epistemological issues, the term "intelligence" as it applies to AI (as in "intelligent agents") has been demoted over time to a limited functional scope, restricted to the ability to achieve whatever singular goal may be at hand.[6] Utilizing the typical AI building blocks (e.g., machine learning, deep learning, natural language generation and processing, visual recognition), modern AI systems are developed with specific, limited-in-scope goals to achieve – game/role playing, piloting and navigation, "expert" diagnostic systems, image recognition, human language interaction, and the like. Despite some limited, early successes in these areas, such systems cannot be applied or grow beyond their intended scope without extensive retooling.

3.2 The Building Blocks of AI Decision-Making

Modern computer science relies on Boolean logic for its foundation. The Church-Turing thesis asserts that a digital (i.e., Boolean-logic based) computer is able to simulate any formal reasoning process.[7]

Consider the following logical decision tree for the children's game of Tic-Tac-Toe[8]:

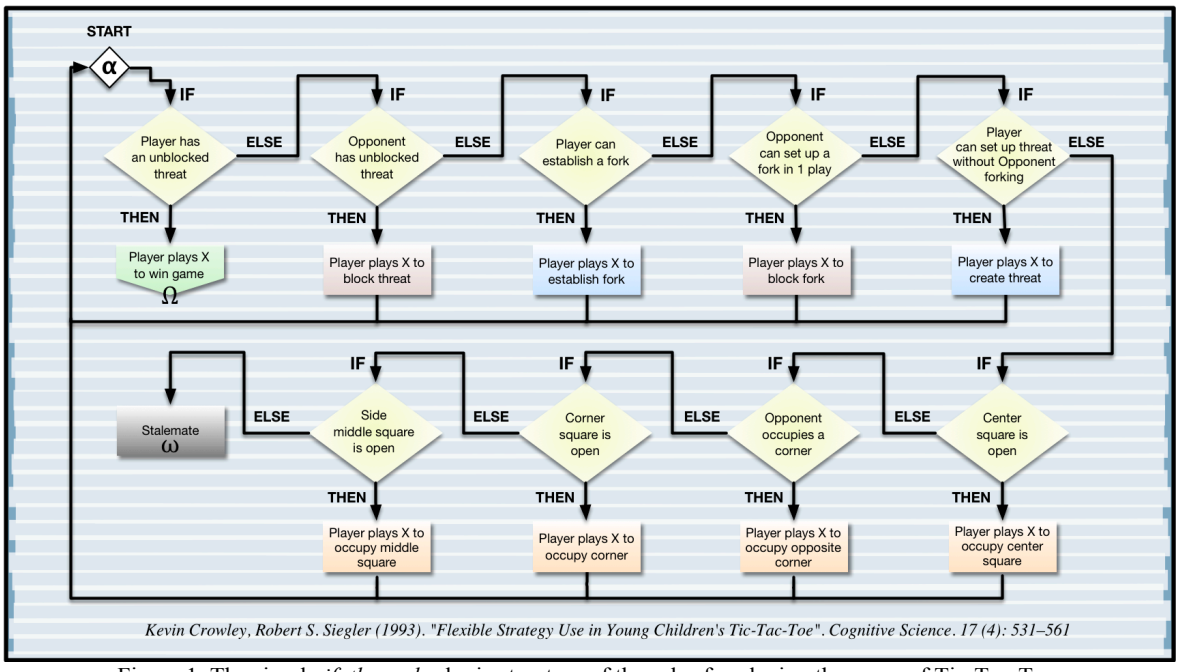

Figure 1. The simple *if..then..else* logic structure of the rules for playing the game of Tic-Tac-Toe.

One can readily see that this basic logical flow follows nothing more than an extended *if...then...else* construct. And yet, when taken in its totality, it can appear to operate "intelligently" – at least with respect to the game of Tic-Tac-Toe. This illustrates the classical case wherein logic can be made to *simulate* or *mimic* intelligent behavior, but not to *source* it.

The underlying assumption of Church-Turing is that regardless of complexity, all formal processes can be represented ultimately to fit the constraints required of Boolean logic. However, few problems modeled from the real world can be found to be reducible to the simplistic, binary "true" or "false" conjectural bifurcations in the way that Church-Turing, and thus the logic of AI, requires. This has spurred the development of numerous tools and building blocks that seek to overcome this disconnect from reality. As a result, modern AI implementations now commonly employ numerous disparate and elaborate sets of logical abstractions which conceal the inherent determinism within layers of convolution, e.g., artificial and convolutional neural networks, evolutionary and genetic algorithms, heuristics and pattern matching, dynamic fitness functions, self-optimization/self-modification, and the like.

Nevertheless, despite the seemingly exotic nature of many of the tools and algorithms used during the design and implementation of AI systems, none rises to the level of providing an overarching architecture for thought. Despite their convoluted designs, such tools remain mere tools. Systems without a precise architecture for thought do not have the capacity for true thought, nor can they give rise to it, to any degree.[18]

3.3 "Non-determinism": Artificial vs. Genuine

Overall, a well-developed human mind does not operate deterministically, sequentially, or hierarchically.[23] Just as the concept of "security through obfuscation" is ultimately self-defeating, so is the modern AI approach of imposing non-determinism through obfuscation, convolution, or for its own sake. Such non-determinism is "artificial," not systemically derived, and is not useful in a true intelligent system. Genuine, integral, non-determinism must be an *intrinsic* quality that derives from the proper underlying dynamics at the level of the operational architecture. If a system is to successfully harness non-determinism as an elemental factor at the appropriate levels – lest it behave *irrationally* – it must originate organically as an appropriate logic that enables non-determinism, and not as a mere architectural graft.

Postulate 3.1: Non-determinism must be an *intrinsically-derived* quality of a truly intelligent system.
Corollary 3.1: True, intrinsic non-determinism can only originate organically, as an appropriate logic.

Two hundred years ago, the process of such a logic was developed. Georg W.F. Hegel coined it *dynamic logic*[9] (cf. the "static logic" of Boolean algebra), and dedicated two volumes to this subject, *The Science of Logic* and *The Science of Being* – nearly thirty years before George Boole wrote *The Mathematical Analysis of Logic*.[10] Coupled with Immanuel Kant's decision system, dynamic logic is the "logic" of the mind; it is *reasoned* logic[29], the "reasoning" being the complex interaction and discourse undertaken among the various systems of the human mind in the consideration of a thought. In short, the human thought process forms the reasoned, dynamical logic framework of the human mind.

4. A SYSTEM OF THOUGHTS

"A system of thoughts must always have an appropriate architectural structure." – Arthur Schopenhauer[18]

4.1 AI@50 Dartmouth Conference

The AI@50 Dartmouth Artificial Intelligence Conference (July 13-15 2005), attempted to assess the field of Artificial Intelligence after fifty years of effort toward its goal of creating a free-thinking autonomous system. Their summary conclusion, obvious to all in attendance, was that Artificial Intelligence – even with the development of numerous new tools and clever schemes – had utterly failed to deliver any significant insight into autonomy.[2]

4.2 ACM Turing and NIPS Test of Time Laureates

Coming thirteen years after the AI@50 conference, the 2018 Association for Computing Machinery's prestigious A.M. Turing Award[30] was given to three researchers – Yann LeCun, Geoffrey Hinton, and Yoshua Bengio – for their work on neural networks. Their work has been broadly applied to systems as disparate as natural language understanding, object identification in photographs, and self-driving vehicles. Echoing the AI@50 self-assessment, Dr. Bengio summed up the state of the art of his field with a frank admission: "We need fundamental additions to this toolbox we have created to reach machines that operate at the level of true human understanding."[31] Additionally, during his acceptance speech after receiving the Test of Time Award at the 2017 Neural Information Processing Systems conference, Google's Ali Rahimi proclaimed, "Machine learning has become alchemy."[32] These are quite profound admissions.

Systems that have represented the pinnacle of AI achievement in their day included IBM's Watson, which was touted as an "Artificial Intelligence Computer System."[11] Watson was able to best human contestants at Jeopardy, but had no understanding of the tasks it was performing; incapable of thought, it was not built on truly autonomous constructs. It is a glorified search engine: automated and optimized, it is an "expert system" and nothing more. The same is true of "Deep Blue," "Deep Mind," and the other highly-touted "strong AI" systems.

4.3 Origins of a Viable Architecture for Thought

As noted previously, AI researchers have focused largely on low-level tools and mechanisms at the expense of the development of a fundamental theory or architecture for autonomy, without which Artificial Intelligence cannot advance beyond its nascent stage. *No researcher, academician, or computer scientist in recent times has seriously attacked this problem.* One must go back two hundred years to find such a large-scale undertaking, which culminated in an exceedingly thorough assessment of the human thought system. The primary works resulting from that thirty-year effort are:

- 1787 IMMANUEL KANT: **CRITIQUE OF PURE REASON**[12]
- 1788 IMMANUEL KANT: **CRITIQUE OF PRACTICAL REASON**[13]
- 1790 IMMANUEL KANT: **CRITIQUE OF JUDGMENT**[14]
- 1807 GEORG WILHELM FRIEDRICH HEGEL: **THE PHENOMENOLOGY OF SPIRIT**[15]
- 1816 GEORG WILHELM FRIEDRICH HEGEL: **THE SCIENCE OF LOGIC**[16]
- 1819 ARTHUR SCHOPENHAUER: **THE WORLD AS WILL AND PRESENTATION**[17]

In stark contrast to today's "modern" thrust of Artificial Intelligence, these three philosopher-scientists pursued an entirely different approach: positing the *mind*, not the brain, to be the nexus of thought, as only the mind has a definite, purposeful architecture which enables it to generate thoughts.[18]

Postulate 4.1: It is the purview of the brain to *process* thoughts, but the purview of the mind to *generate* them.
Corollary 4.1: It is the *mind*, not the brain, which is the nexus of thought.

Building on truly autonomous constructs – the exhaustive analysis of the human thought system by Immanuel Kant, Georg Wilhelm Friedrich Hegel, and Arthur Schopenhauer – we can at last design the basis for an autonomous system with humanlike intelligence, capable of rational thought, with reasoning and an understanding of itself and its tasks.

In *The World as Will and Presentation,* Schopenhauer asserts: *"A system of thoughts must always have an appropriate architectural structure."*[18] Throughout his three *Critiques*, Kant pursues the pre-existing essentials of the mind in terms of which the limits of our understanding can be understood. Together with the essential "dynamic logic" of Hegel, they have derived a necessary architecture of the human mind. All three argue for a replication of the mind (a distinctly *non-deterministic* system) – not the brain – as the basis for an objective, rational, humanlike thought architecture.

Postulate 4.2: The operation of the mind is fundamentally and necessarily *non-deterministic*.

Computer science as we know it did not exist at the time of Kant, Hegel, and Schopenhauer, so their functional description of the architecture of the mind is spread over thousands of pages of intractable philosophical and scientific discourse. Nevertheless, they were in essence authoring a Functional Requirements Document for the human mind.

5. THE CONSTELLATION OF THE MIND

Couched in objective terms, the design object[28] that Kant, Hegel, and Schopenhauer mutually describe is not a single object or system, nor even a grouping thereof. The design object of the mind more closely resembles a *constellation of strongly independent, disparate systems, orchestrated by a central nexus*. Each of the primary elements, or *systems*, of the mind is an entity, complete unto itself (i.e., a constellation in its own right). All systems are arranged in a specific, functional, prioritized, interrelational organization within the constellation. *It is the dynamic operation of the systems within this thought architecture – this framework of the constellation – which gives rise to the process of thinking*.

The architecture for thought as envisioned collectively by Kant, Hegel, and Schopenhauer is not so much a constitutional architecture as it is an operational architecture. There are eight essential systems that comprise the constitutional architecture of the constellation of the mind. These systems interoperate with each other according to a dynamic set of prescribed limitations, interfaces, axioms, rules, and protocols. The operational architecture of the mind uses basal thought elements (inchoate ideas) called NOUMENA, which flow among the various systems in real time. When taken in their entirety, and orchestrated properly, the operation of these systems forms the process of human thinking.

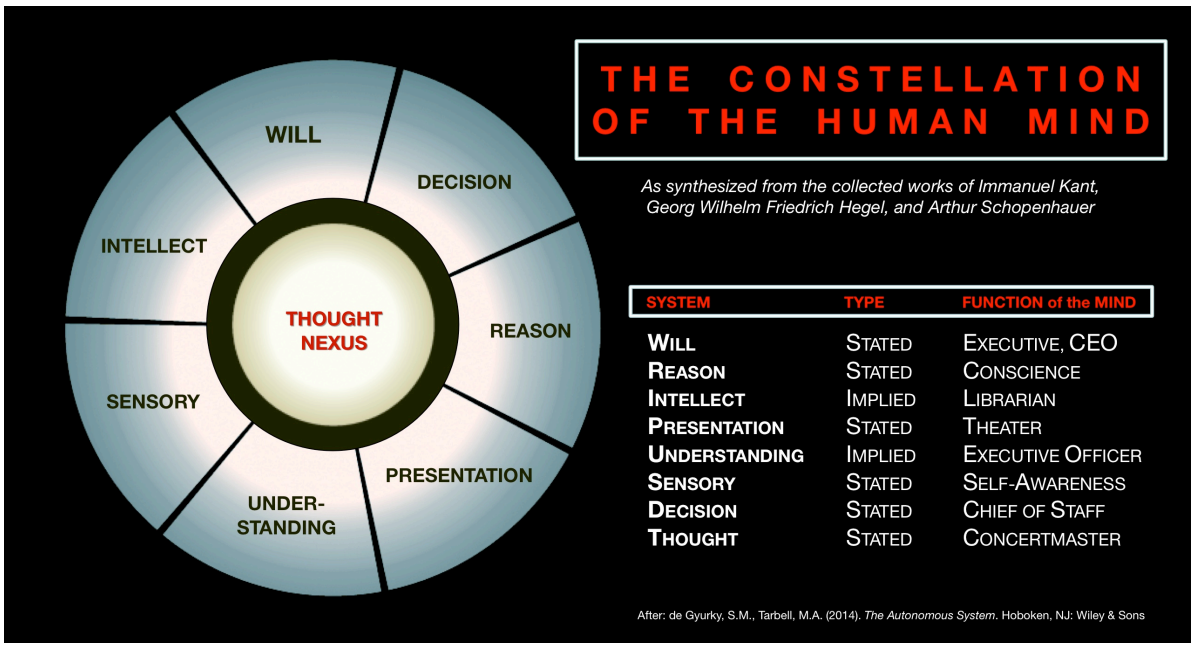

Figure 2. The systems of the human mind, in software architectural terms, with their corresponding functions (after [22])

5.1 The WILL System

All living things have a WILL, a driving force for maintaining existence. The WILL of the human mind operates as the "CEO" of the MIND; it is first among equals. Any valid system of thought must also have a WILL. The WILL imparts to the MIND the mandate to operate. Without a strongly and appropriately functioning WILL, the MIND cannot generate well-formed thoughts. Schopenhauer was so enamored of the WILL that he declared it to be the equivalent to the "thing unto itself," so powerfully does it define the character of the MIND. (Refer to §On Absolute Truth and Objective Reality: *"Which is not only a functional process, but the theme, and the logical construction of the Idea and its Substance."*[20])

5.2 The REASON System

The immediate purpose of the REASON is to act as first advisor to the WILL. The REASON affords the WILL the faculties of reflection, wonder, and contemplation in the MIND's process of understanding (making sense of PHENOMENA) and in making a decision. It acts as the "conscience" of the MIND by constantly validating the WILL's intended courses of action by evaluating such courses' fitness with explicit and implicit rules and axioms, both given and learned.[21]

5.3 The SENSORY System

Postulate 5.1: The intrinsic function of the MIND is to process stimuli into thoughts.

The SENSORY system is the entry point or gateway to the MIND. The fundamental role of the MIND is to process all mental stimuli, namely, the internal stimuli called NOUMENA and the external stimuli called PHENOMENA, into thoughts. The SENSORY system provides what amounts to "environmental awareness" of both internal and external state, which gives rise to the essential faculty of the MIND called self/non-self discrimination, which in turn is required to develop self-awareness. *"There can be no self-awareness or self-identity without external sensory information and an awareness of the external environment."*[22]

5.4 The UNDERSTANDING System

The UNDERSTANDING's primary purpose is to *recognize* PHENOMENA (identify, classify, and distinguish) for use by the INTELLECT and DECISION in preparation for decision-making by the WILL. The "understanding" of a PHENOMENON comes about chiefly through the assessment of its attributes via the application of the abductive inferential processes of *"the form of all appearances"* vs. *"the form of all possibilities,"* leading to the capacity to acquire and apply knowledge.[25]

5.5 The INTELLECT System

The INTELLECT provides the essential function of *intellection* to the MIND. So important is intellection to the process of thinking that Schopenhauer places the INTELLECT at the level of the WILL. Due to the sheer complexity and scale of working, both the UNDERSTANDING and INTELLECT serve the purposes of the MIND best as full-fledged systems unto themselves (unlike, for example, the MIND's memory, which, in all its forms, is found dispersed in numerous locales, global, private, and shared, static and dynamic, throughout the MIND).

Intellection is the process of ingesting, integrating, and making categorical sense of all information, abstract and experiential, extant in the CONSTELLATION.[23] For this reason, the INTELLECT is thought of as the "librarian" of the mind. The INTELLECT is what transforms PHENOMENA into practical knowledge, fit and ready for use by the other systems.

5.6 The PRESENTATION System

The PRESENTATION is the "theater" of the MIND.[24] Its purpose is urgent and essential to self-preservation, namely, to present to the other systems the immediate consequences of any courses of action under consideration by the WILL. This is fundamental to the process of making a sound *a posteriori* decision, which is the primary responsibility of the WILL. The PRESENTATION takes into account such disparate items as completeness of knowledge, experiential history, rules, laws, and axioms, and urgency of action when forming its presentations to the other systems.

5.7 The DECISION System

The DECISION constantly provides a stream of reasoned decisions for the WILL to consider. It assembles all data, activity, communications, and products generated by the other systems of the MIND, immediately, into reasonable courses of action for the WILL to undertake.[26] The DECISION and REASON are the systems that have the most direct influence on the decisional course the WILL chooses to follow. The decision process is a hugely complex, dynamic operation, one of the highest that the MIND performs. (This process is described at an exquisite level of detail by Immanuel Kant in his three

Critiques.) The DECISION is also critically responsible for self-preservation of the CONSTELLATION as a whole in the course of attaining immediate and future goals.

5.8 The THOUGHT System

The THOUGHT system is the central nexus of thought, the *Konzertmeister* and apotheosis of the MIND. Functioning as a type of virtual *corpus callosum*, it here that the activity of all of the systems in the CONSTELLATION of the MIND is monitored, assessed, managed, regulated, and orchestrated with the exclusive goal of generating well-formed, humanlike thoughts.[27] The THOUGHT system represents a synthesis of the totality of the works of Kant, Hegel, and Schopenhauer, translated through a 21st-century software architectural lens.

The *modus operandi* of the THOUGHT system in the task of oversight and operation of the MIND is via management of the internally originated thought-logic elements called NOUMENA. Taken as a whole, the THOUGHT system and MIND form an embodiment of reasoned logic (Hegel's *dynamic logic*,[16] Peirce's *existential graphs*,[34,35] Sowa's *conceptual graphs*[33] and others), whose ultimate purpose is to transform each inchoate IDEA into a fully-fledged CONCEPT, ready to be acted upon.

5.9 The Operational Architecture

It must be pointed out that the portion of the architecture of the CONSTELLATION of the MIND detailed in this section represents only its constitutional architecture, and unto itself, is absolutely insufficient to support a dynamical thought process. The thought process begins in earnest only when the sum total of the reasoned interactions of the various systems with each other and their environments (both internal and external) is in operation. The thought process' operational architecture must express itself as a viable, dynamical logic process. (A meaningful dissertation of the concept of "dynamic logic" with respect to the thought process is beyond the scope of this publication. More in-depth introductions may be found in references [16], [22], [33-35].)

6. CONCLUSIONS – OUTLOOK

True advancement of the field of Artificial Intelligence is currently stymied due to the lack of a viable design object[28], which must be built upon a viable architecture for thought. Until there is an honest, across-the-board acknowledgement of this fundamental impasse, the most that can be hoped for is *simulated intelligence* – the mimicking of human behavior based on a convoluted re-expression of the "logic" that developers have directly or indirectly instilled into a system.

As Kant, Hegel, and Schopenhauer ably demonstrated, the only viable architecture for humanlike thought is that of the human thought system, specifically, that of the human mind. The mind is built upon a specific "top-down" architecture, and cannot be arrived at – without a miracle occurring – via a "bottom-up" approach, no matter the clever arrangement or plethora of algorithms and building blocks that go into its construction. Moreover, without a viable architecture, even the most reasoned, dynamical logic cannot manifest as innate and rational thought processes at the appropriate levels and scope, and thus the ultimate goal of true autonomy – the replication of a humanlike mind – cannot be achieved.

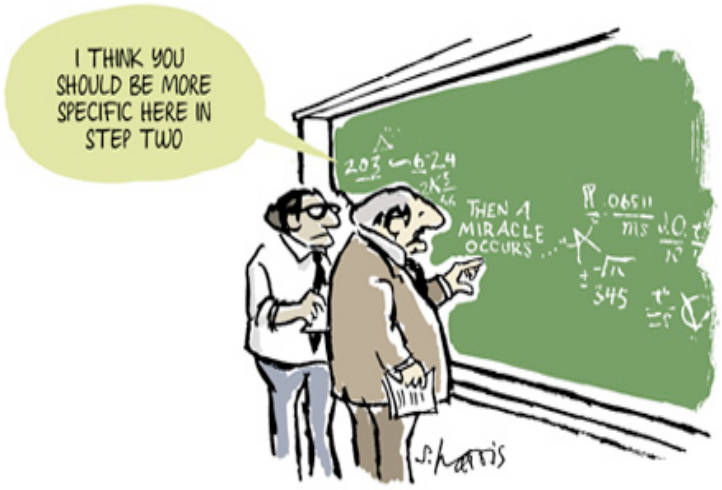

Figure 3 – Where AI stands today: *"Then a miracle occurs."* (© Sidney Harris in American Scientist, Nov-Dec 1977).

AUTHOR DISCLOSURE STATEMENT

The author may have a financial interest in reference works [4], [22] as he is named as co-author/editor of these works.

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