Can Robots Possess Actual Intelligence?

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Abstract

Observationalist models relying strictly on behaviorist mechanisms to establish emergent properties in artificial life-systems divides it too far. The action of analysis itself interferes with closed steady-state systems[1]. Terms such as hardware and software cannot be separated when discussing artificial life systems; only holistic approaches will establish both synthesis of behavior and reward models and observational concerns[2]. If such a machine were constructed which was self-sufficient and interactive without alteration of its initial parameters, could it be deemed as life or possessing intelligence? Would such a machine be a true automaton?

Automatons: Does independence constitute intelligence?

On an inclement day in Madison Square Garden, New York, May 1898, Nikola Tesla demonstrated the field of *Teleautomatics*. This consisted of a remote-controlled "robotic" ship, which was capable of following instructions radioed from its operator. This invention began the technological realization of not only radio, but also of the art of robotics[3]. Teleautomatics were the first experiments, however limited, into robotic behavior measured from observationalist models. This work resulted in patent #613,809 granted 8 November 1898[4].

In the Tesla automaton model, it relied on a driving mode—it was a singular force and unavoidable[5]. But in his model form followed function and we may rely on a piece of his work in Teleautomatics, the notion that behavior is a result of pure stimuli / response vectors as input from a programmer which cannot be measured by observation. The data will only reflect the robot as it negotiates a maze and result in confusion, as demonstrated by Sony [source here]. Only internally generated protocols from the robot itself can determine emergent properties—only then can we have a qualified definition of intelligence in an artificial-life system.

Problem One: Cognition and Instinct

The Tesla automaton system is fundamentally flawed; concepts established at the time are still in use in research today—in regard to the notion of behaviorist and observationist models lacking reward loops.

Intelligence is neither artificial nor can it be limited solely to carbon-based beings. It can be extended to mechanical beings as the current definition for intelligence does not occlude such a possibility: "the capacity for reasoning, understanding. . .aptitude in grasping truths, facts, meanings. . .knowledge of an event, circumstance. . .received or imparted. . .information (and) the manifestation of such capacity," (1983c).

The capacity for *learning, reasoning, and understanding*, the act or process of knowing coupled with the conclusions drawn from perception. This is a rational truth regarding an abstract phenomenon; dividing the term into two functions—cognitive function verses instinctive function—a response to an environmental event via perception verses resident programming imparted at the time of birth. Cognitive functions have the ability to grow—as dynamic forces—while instinctive functions generally remain static. The results of these criteria imply that a system bearing intelligence equals a degree of adaptability on physical and mental levels. This degree, properly quantified, would allow analysis of the cooperation of not only software and hardware but how each independently and comparatively evolve.

The more adaptable a being is cognitively in automatic and autonomic terms implies the factor of intelligence—crystal memory verses fluid memory—while physical adaptation denotes natural selection. The better the adaptation a being has on a coetaneous physical and cognitive level the more likely the chance of survival. The less adaptive a being is on a coetaneous physical and cognitive level or no adaptation at all will end in extinction.

The term "artificially intelligent machine" is inapplicable when denoting the processes devised above; this is so because it gives the perception that mechanical intelligence is somehow less or more of an abstract construct than our own. Presently, the term "cognitive machine" is more appropriate considering that a complex system—organic or otherwise—which demonstrates generative intelligence is not an artificial phenomenon. An environment with simulated artificial intelligence—complex multi-portals used mainly to streamline business—although appearing intelligent does not qualify as such, it is but a more clever tool. The term artificial intelligence or AI is too widely used which makes work in complex systems convoluted; if a system does not have the ability to supercede its original program following only a predetermined pattern of behavior, this system has an *imbued* intelligence. However, if a system does possess the ability to reason independently, exceeding the sum of its original program, while having the capability to alter its physical architecture and cognitive hierarchies as it became necessary dependent on the conditions of its environment, its experience, this system has *substantive* intelligence. Both systems have equal merit; the latter bears more expression of an individual consciousness.

Problem Two: Contrast—Cognition, Volition, and Thought

A system embodying substantive intelligence has three qualities or elements, which guide the development of the mind of the aggregate automaton. Arriving at the term "cognitive machine" one finds a plateau, only typified perceptive factors have been thus defined; however, cognition is only the first dynamic event in the brain, based on the act or process of knowing, perception. Perception is a large term; for the purposes of this paper, cognitive action is only indirectly related to the physical senses. Cognitive *factors* recognize relations (comparatives), quantities, orders, number, and time along with recognition of change and causation. Cognitive *actions* recognize rudimentary space, dimension, form, and motion of outer phenomena. These factors and actions deposit themselves for consideration as to hierarchy and nomenclature; this leads to the second dynamic, volition.

Volition is based on the act or process of will, choice, or resolution—a decision made by the will. Volition is divided into perspective and prospective volition dependent on the nature of the intersocial relationship the automaton finds itself in, whether it is in a non-subordinate position or the action of an external mind has precedence over the automaton's. If independent, *perspective* volition includes necessity, irresolution, choice, caprice, and the degree of motive. *Prospective* volition is but a means to extend control as subservience to ends, or a specific result gleaned from dreaming, creating, and engineering such a device. Exercising prospective volition (as with current humanoid prototypes) must be done dependent not only on the conditions of the environment but of the level of complexity, of empathy, that the automaton is capable of.

Such analysis unfolds the question as to the product of cognitive factors and actions, perspective and prospective volition on bits of information or disparate facts. In the currents running between them, cognitive is active and volitive is passive; this does not contemn one facility over another but directs analysis toward a third facility, which intertwines the two states. Thought, the third dynamic event, is the product of cognitive and volitive qualities compiled by and through contemplation, recollection, intention, and purpose by design.

The dynamic of thought is tempered by the intellectual faculties or the degree of knowledge about an event or sequence. The amount of crystal memory or the record of knowledge is applied to perceptive records of a novel situation and the amounts of exchange between crystal and fluid memory precursors the degree of adaptation. This exchange is determinate in a reasoning center and the whole of the processes involved. Communication of novel ideas from experience with novel situations greatly enhances fluid memory systems as well as socialization in the volitive sense and perception of self-worth and productivity in the cognitive sense.

Despite this analysis, we have yet to determine what separates the mind from the brain of the machine. How could it be described in a purely physical sense removed from as much abstraction of syntax and metaphor without losing the conveyance and import of meaning?

Evolution: The Degree of Adaptability

At this point, I surmise the degree of adaptability is representative of the amount of crystal memory and how it is applied to perceptive records of a novel situation. The amounts of exchange between crystal and fluid memory precursors the degree of adaptation. This degree, properly quantified, would allow analysis of the cooperation of not only software and hardware but how each independently and comparatively evolve. This concept is based on research in psychological anthropology and Darwinian evolution in general, a mechanical attribute of nature. In terms of the automaton, Darwinian evolution is expressed as the evolution of efficiency of the onboard systems.

The notion of using the dynamics of nature as a template for technological development was singularly unique yet paradoxical in Tesla's automatons. He held on to two notions while formulating them; that, like Descartes, animals and man were simply "automata incapable of actions other than those characteristic of a machine" (1915). While he also implied that his "machines" were not simply just machines, but a new technological creation endowed with the ability to *think*. The ability to think implies the third dynamic; in a pure intellectual sense had Tesla formulated and communicated these forms as products of future enterprise and development? Tesla considered his automatons the first nonbiological life form on the planet; however, insisted that they as prototypes were embodied with a "borrowed mind" or programmed with prospective volition. This notion or insistence implies a lack of knowledge or vision about the evolution of the technology; Tesla dropped work on the automatons in the early days of 1899.

In retrospect, it is not unusual that Tesla would neglect the phenomenon of thought in his automata. Without recognizing an internal motive force, having not spent enough time on the project, he metaphorically theorized that he himself was a "self-propelled automaton entirely under the control of external influences". In Tesla's mind, creative thinking and dreaming was a secondary result of the primary experience of the external cause and effect stimulus (1900). However, in 1915, Tesla seemed to renew his work on the automatons but instead left only this statement:

How Cosmic Forces Shape Our Destinies

> Every living being is an engine geared to the wheelwork of the universe. . . .There is no constellation or nebula, no sun or planet. . .that does not exercise some control over its destiny—not in the vague and delusive sense of astrology, but in the rigid and positive meaning of physical science. More than this can be said. There is no thing endowed with life—from man who is enslaving the elements, to the humblest creature—in all the world that does not sway in its turn.

Simply said, man is a slave to the elements as he is a slave to them; neither he nor his creations bear exception to this belief. Hence, the early 20th Century creation of the word *robot*; from Karel Capek, the Czech word *robotnik*: one in subservient labor, a slave.

Problem Three: Syntax and Meaning—Sentience

Sentience for the purposes of this paper is the appearance of a conscious mind within a brain, a full transference of the qualities of life transported in the sum of important actions. A transcendence from an assemblage of programs (thought, volition, cognition) with physicality (mobility, quality of perception, exploration of dimensions and resident matter) into something which is both and neither in a pure syntactical sense. The appearance of meaning, intangibility within an assemblage of hierarchies, is the byproduct of the genesis of the new mind subject to continual redefinition as growth in this field progresses.

Care must be exercised, from the inherent meanings embedded in the definition of the word robot itself, the literal concept is that such machines are but another enslaved element. We have provided the life, so we inherit the control—we become the higher elemental taking the place of religious dogma and qualified to exercise such control as we see fit. Our faith in a supreme intelligence transfers to our creations, hence, we become eligible to receive the faith we hope is manifest in them. We have cumulated our genius—an amalgam of mythology, imagination, and technology—into a mycostatic anthropomorphous sometimes-humanoid form. Considering the accelerated and exponential growth of technology since 1950, taking a different look at such theoretical creatures of our own design might prove to be in our best interests.

Intelligence: Automatic Programming and Autonomic Programming

Intelligence is the ability for temperament and reflection on events for which all the outcomes are yet unknown, the phenomenon of intelligence in machines can be broken down into three behaviorisms. First, the external sensory inputs coexist in a dialogue with an internal monologue. Second, this dialogue drives evolution of the efficiency of the process. Third, the efficiency of these processes determines a degree of adaptability. Improving this degree increases the long-term survival and growth rate of a complex automaton.

In terms of software engineering, the degree of adaptability is evident within systems powered by automatic programming. Automated reasoning systems, an attribute of automatic programming, are included within the field of genetic programming.

> One of the central challenges of computer science is to get a computer to do what needs to be done, without telling it how to do it. Genetic programming addresses this challenge by providing methods for automatically creating a working computer program from a high-level statement of the problem. Genetic

> programming achieves this goal of automatic programming (also sometimes called program synthesis or program induction) by genetically breeding a population of computer programs using the principles of Darwinian natural selection and biologically inspired operations (http://www.genetic-programming.com).

An automatic function, manifest in genetic terms, is analogous only to instinct or resident programming; although inspiring work, it does not fully describe what is necessary for a sentient machine. A higher process is needed in terms of a non-mobile computer where a degree of adaptability is present.

A higher-level *autonomic* programming process is the solution. Analogous to dynamic reasoning based on the conditions of an event or sequence of events, the complexity and fluidity of this process takes into consideration the cognitive, volitive, and thought information imported into the resident processes. The degree of adaptability is determined with reference to a changing environment. The degree or mathematical scalar factor of the adaptability explicates the level of efficiency of intelligence systems, or the state of the *mind* of the machine contrasted by the genetic complexity of the brain.

The contrast lies in the differentiation between automatically defined functions and autonomically defined functions; automatically defined functions or ADFs are an aspect whereby child branches are defined by parental parameters. A simple computer program consists of one main program called a result-producing branch; however, more complicated programs contain subroutines—in this case ADFs—or function-defining branches. Other types of functions are automatically defined iteration, ADI, automatically defined loop, ADL, automatically defined recursion or fluid memory, ADR, and automatically defined store or crystal memory, ADS. These functions define a pattern of behavior of a program, the generation of strings flowing from parent to child, or from one parameter to another; this is an exchange of stored behaviors or tools designed and input by the programmer.

The A-type dynamic functions are capable of making all architectural decisions during the run of a program. They utilize as tools architecture-altering operations to automatically determine program architecture in a manner that parallels gene duplication and gene deletion in nature.

Strictly apart from the taxonomic automatic function verses autonomic function, the two would have to be active within the same brain. Summarily, this would be reduced into terms of deductive synthesis, process verification, and transformational approaches defining the level of abstraction in terms of an expression of a lower level of complexity or abstraction. Applying this to a thinking machine, the A-type functions serve only stored properties common to both biological and predilect non-biological species. A-type functions typify enculturated behaviorisms, those of starting, operating, moving independently—done *unconsciously* or from force of habit, mechanical. The AN-type functions serve as a system of deliberate actions and reasonings produced from internal cause and effect; they typify acculturated behaviorisms, the combination of cognitive, volitive, and thought actions.

1. ANDF—autonomically defined function
2. ANDI—autonomically defined iteration
3. ANDL—autonomically defined loop
4. ANDR—autonomically defined recursion or fluid memory system
5. ANDS—autonomically defined store or crystal memory system

The striking difference in behavior of the AN-type algorithms are that the results think to effect action, independent of the original program's parameters as designed and input by the programmer. They are generated by the experiences of the system as a whole. Mathematically these experiential quantities are represented by vector quantities determining the members and locations of abstract sets where they flow as a simplified process of program knowledge and domain knowledge.

Genetic based programming—the synthesis of robotics and genetics—generates A-type genetic maps or mathematical layouts of domain knowledge to establish program knowledge; AN-type maps are driven by an external signal stimulus and modulation, which establishes the domains. These are divided into cognitive, volitive, and thought domains; the discrete information generated by the cognitive and volitive actions compounded with the AN-type parameters generates a unique code. This code compiles the A-type functions with the AN-type functions and upon assimilation of the new code, maps the new algorithms into increasing levels of abstraction. The map is a hierarchy that can be accessed by any other domain or hierarchy within the totality of the program. This property gives the automaton the ability to behave not only in reference to its original (A-type) programs, but to form its own system based on information gathered by experiential (AN-type) programs. Most of the processing of the program would deal with the automaton's interaction with the outside world biased by the thought, volitive, and cognitive (TVC) systems onboard. A hypothetical scenario of research would be the introduction of "situation simulation" software to the TVC, where the amount of alteration of the original matrix by external interaction could be synthesized and monitored. Where exact verifications of outward expressions of dynamically gathered knowledge could be studied in a controlled environment where grievous errors are caught and corrected.

The reality of producing a conscious mind in machine form is elusive at best; mathematically it can be described but this provides little insight when considering where one would begin on creating such a device in physical form. Tempered and well-guided research is required and although failure in eminent, yet, it must be tried not as the cumulation of genius but of genesis, of life.

These preoccupations noted I propose a work in progress; it represents the behavior addressed in the newly described automaton. Named the *Sydrandria Protocol*, this complex adaptive program allows the reality of thinking machines by basing all processes on A-type “instinctive” behaviors resident within AN-type thought-volitive-cognitive (TVC) behavioral processes. It is a concern of the author that these theories are still unfinished but they are offered in an exploratory sense; currently there are only a few proofs. It remains for future research to get the proper facts of it; nevertheless, it is something that needs to be pursued.

The first part of the *Sydrandria Protocol* deals with signal stimulus from a defined frequency domain; these bands of signals quantify a “nodal” value. Each nodal value responds to the signal burst by aligning itself with the specific resonance band represented in Figure 1:

	Start band	End band	***r*** - length start band	***r*** - length end band	***r*** Length
NODE	MHz	MHz	Seconds	Seconds	Seconds
. . .					
38	153.81	156.94	6.502E-09	6.372E-09	1.297E-10
39	156.94	160.07	6.372E-09	6.247E-09	1.246E-10
40	**160.07**	**163.20**	**6.247E-09**	**6.127E-09**	**1.198E-10**
41	163.20	166.33	6.127E-09	6.012E-09	1.153E-10
42	166.33	169.46	6.012E-09	5.901E-09	1.110E-10
. . .					

Figure 1

Each node 38 – 42 responds to frequencies within the band, which is from 153.81 to 169.46MHz. Each spectrum generates from this stimulus a map with locations dependent on the distance *r* with regard to the spectrum; *r* is determined as the difference of the start and end band lengths in seconds. The true length of *r* would be determined once the velocities of the charges flowing through the system are calculated; this is dependent on the nature of the materials and type of circuits used in construction. Bolded in Figure 1 is node 40; it represents the frequency spectrum of 160.07 to 163.20MHz. Any frequencies within this band are assigned to this node; this includes any amplitude, frequency, pulse, or phase modulation of the signal itself. The type of modulation determines in what quadrant the information is mapped. Regardless of the type of modulation, the length *r* in seconds remains constant in the band. This is illustrated in Figure 3.

The second part is an interpretive addressing operation made up of three parts:

1. A code transformer for the nodal values.

2. A system of geometry for the signals generated by the stimulus.
3. A conversion of base-10 nodal values to a limited base-5 number system.

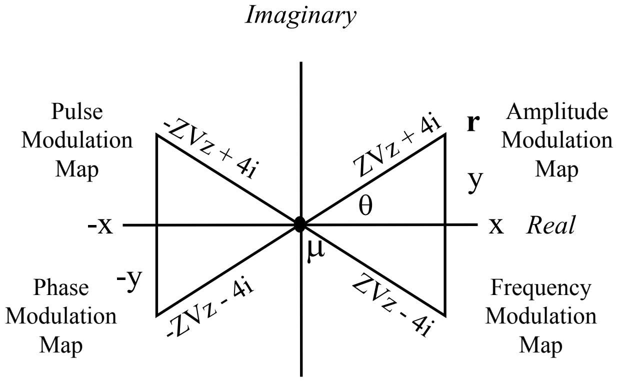
Autonomic Code Transformer

	. . .				. . .
Base-10	38	39	**40**	41	42
Base-5	123	124	**130**	131	132
Syd	ZXV + 11i ((ZXV 6i))	ZXL + 12i ((ZXL - 7i))	**ZVz + 4i (*(ZVz - 4i))**	ZVZ + 5i ((ZVZ - 5i))	ZVX + 6i ((ZVX - 6i))
	. . .				. . .

Figure 2

The autonomic code transformer compiles the frequency and embedded modulation information into complex planes which is the natural language of the protocol. The result is divided into real addresses on the maps and imaginary compliments within the total number system. While the addition of imaginary numbers does describe more of the architecture of the number system, it remains until the combination of the TVC elements and the frequency domain of Figure 1 that the true program is unfolded. The results can be visually described as fundamental trees that dictate the structure of growth of not only the domains but also the core program. This growth is called bifurcation, or the process whereby a map or tree divides into subgroups or children, which carry the same basic structure as the parents.

Node 40
(Transformed: 130)



HBA 13 / Tree 0

Figure 3

Considering the node 40 as the complex plane in Figure 3, this map is based on a frequency range 160.07 – 163.2MHz (Figure 1). Converting the frequency into wave period $6.247 \times 10^{-9} – 6.217 \times 10^{-9}$ seconds, the length *r* needs to be determined. ZVz + 4i represents *r* as a complex number and sets the area map in terms of μ and θ for locating the coordinates of the information embedded in the modulation.

1. (*x, y, r*) (ZVz + *i*) locates the amplitude modulation and θ gives the range values for the information with reference to μ.
2. (*x, -y, r*) (ZVz – *i*) locates the frequency modulation and θ gives the range values for the information with reference to μ.
3. (-*x, y, r*) (-ZVz + *i*) locates the pulse modulation and θ gives the range values for the information with reference to μ.
4. (-*x, -y, r*) (-ZVz - *i*) locates the phase modulation and θ gives the range values for the information with reference to μ.

In real terms *r* in node 40 is 1.198 x 10^{-10} seconds; in imaginary terms, *r* is a vector represented in Quadrant I as (ZVz + 4i) or (130 + 4i). The value of θ can be determined in trigonometric terms if needed.

$$\theta = \arg(x + yi) = \tan^{-1}\frac{y}{x}$$

Equation 1

The transformed real number, 130, is divided into a high bifurcated address (HBA) (13) and a tree number (0). In Figure 2, nodes 41 and 42 have an HBA 13 of tree 1 and 13, 2 respectively.

These properties represent the complexities of the software matrix itself. This is the most important and involved function in the autonomic process not only in terms of individual nodes, but also of the behavior of all autonomic nodal processes conjoined whether indirectly or directly related. Understanding this would allow for definitions of intelligence not only in complex machines but also in complex systems in general. In the *Sydrandria Protocol*, the phenomena of intelligence lies in the quantum effects demonstrated by the system; i.e., the level of complexity of the quantum properties would yield the level of intelligence in the matrix. The more effects, the more complexity, the more complexity the more for the propensity of a level of intelligence that could be measured by traditional means.

One of the main problems at present is that the power generated by the sweep must be “pure”, free of electron scattering to preserve spin retaining as much of the quantum state as possible. The retention of quantum state insures a properly translated modulation, notably phase; unless this is made possible errors of more subtle processes would occur affecting the entire matrix. However, if successful, the software matrix addressing would allow maps to be created in all quadrants; the machine could behave in ways that are more complex. Theoretically, if maps could be generated in (-*x*, *y*, *r*) and (-*x*, -*y*, *r*), the phenomena of imagination or philosophical contemplation would take the place of the stolid mathematical conjugates.

The goal of this project is to introduce the possibility of intelligent machines and their history, but also to propose an evolutionary-motive program with a software-level of complexity similar to the human brain. I at present may not be able to ascertain all of the functions of such, but as research continues, the probability for its reality increases.

Software verses Hardware—The complexities must be matched

Consider Honda Motor Company's P3 Humanoid Robot; Honda notes specific research that must be carried out for the successful recreation of the human form by technology:

> In 1986, Honda commenced the humanoid robot research and development program. Keys to the development of the robot included "intelligence" and "mobility." Honda began with the basic concept that the robot "should coexist and cooperate with human beings, by doing what a person cannot do and by cultivating a new dimension in mobility to ultimately benefit society," (http://world.honda.com/robot/technology).

The following concerns are addressed on Honda's website (2000), the future of robotics in their eyes:

> In terms of hardware, the program in the future will focus on:
>
> 1. Further dimensional and weight reduction.
> 2. Improved dynamic performance.
> 3. Improved operability.
>
> For items two and three, it is extremely important that through the evolution of hardware we achieve physical autonomy by improving dynamic performance and adaptability to wider variations of working conditions. Also important is the pursuit of studies in artificial intelligence systems, which will provide the solution for improved autonomy. If all these are achieved, the robot will not require the support of a human operator for minute correction operations. In terms of software, we should aim at promoting a social infrastructure where humanoid robots will be widely and easily accepted. This is a particularly significant issue when considering the appearance of the humanoid robot. Honda hopes that the time will come when humanoid robots play an important role in serving us and enriching our lives and society.

While Honda emphasizes hardware, Tesla considers software the only discernable issue in the field of robotics:

> Whether the automaton be of flesh and bone, or of wood and steel mattered little—provided it could perform all the duties required of it like an intelligent

> being. To do so it would have to have an element corresponding to the mind which would affect the control of its movements and operations causing it to act in any unforeseen case that it might present itself with knowledge, reason, judgement, and experience (1919).

The need for a cooperative hardware / software system apparent, how could this configuration be made a more directly connected process, more dynamic so that when the software alters the architecture of the intelligence system, the hardware can evolve similarly? Nanotechnology provides a possibility for this; however, the implications are too large for the scope of this paper. Nevertheless, it will be within the field of nanotechnology that hardware evolution will experience *literal* technological growth.

Where do we go from here? The 21st Century

Between Honda's vision of strictly hardware concerns and Tesla's Victorian nihilism, one has a less than hopeful impression that machines will one day be truly intelligent independent of its human-engineered programming. Between these two extremes lies a condition; a base cognitive function *must* be realized as inherent in complex systems, in whatever degree it is manifest, and adaptability a natural process in changing conditions. Once this dynamic property is incorporated into the design of software and hardware only then will cognitive machines be a possibility. Tesla does advise the reasonability of such:

> I purpose to show that, however impossible it may now seem, an automaton may be contrived which will have its "own mind", and by this I mean that it will be able, independently of any operator, left entirely to itself, to perform, in response to external influences affecting its sensitive organs, a great variety of acts and operations as if it had intelligence (1919).

In order to give identities resonant components, a particular electrical tuning would be provided—a specific band—Tesla explained, to which they alone would respond when waves of a particular frequency were sent from a control-transmitting station. Other automatons would remain inactive until their frequency was transmitted. This notion can be extended to what I have proposed in this paper—albeit on a more micro-level. From theory to the signal band stimulus to the three-part software development protocol and the five autonomic functions I have outlined, the individual properties are manifold. Tesla says it's possible and Honda notes the imperative nature of this.

The reality of a pattern of bifurcation and tree division must be realized in these brains else the limitations to only instinctive or predetermined behavior will not be overcome. To succeed with a fully sentient machine capable of deduction or induction the brain cannot only be based on root algorithms in oscillation, but on program *and* experience. Each half accesses the other only rudimentarily; the complex autonomic processes function as a derivative of the total process, or the resultant algorithms. There is something so abstract that it eludes us to this day; how can we empower our automatons, our robots with the “simulated” life we require without leaving out the cursory behaviors necessary for “natural” life? How can we go beyond artificial life to real life? The most advanced technology will offer the understanding that complex behaviors will only be able to be manifest *virtually*—a secondary attribute of a primary machine—analogous to the mind being a secondary attribute of the brain. We must allow not only the software to write itself based on external stimuli, on experience, but also the hardware must evolve as well to keep pace with the changes in software. Once this is understood and created, there is nothing to stop the advent and evolution of this technology.

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