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Fuzzy Logic

The Genius of Lotfi Zadeh "Father of Fuzzy Logic"

by

Hugh Ching "Father of Post-Science"

Summary and Significance

This article in the December Issue of the IEEE Industrial Electronics Magazine traces the advancement of human culture in terms of knowledge from 2,500 years ago to the next 4,000 years, particular, in reference to the cultural advancement of Chinese and the Western civilizations. Technically, the article "***Fuzzy Logic: the Genius of Lotfi Zadeh, the Father of Fuzzy Logic"*** by Hugh Ching, the Father of Post-Science, exposes the gross defect in the very foundation of computer science and life science, both of which should share the same foundation of complete automation achievable by separating the fuzzy and the exact operational components. It explains why reality is fuzzy, not exact, and claims that fuzzy is actually more accurate than exact. Mathematically, the most accurate description of reality should be the Fuzzy Exact Solution, not the current Exact Solution. Quoting from the article: ***"The greatness of Lotfi A. Zadeh can be realized from the ubiquitous effect of fuzzy logic on all knowledge that, henceforth, a solution should be defined as all the answers, which lie within the fuzzy range of value or tolerance of the solution."*** The article gives a detailed technical description of the theoretical discovery in 1986 of DNA as completely automated software based on quaternary number system versus the discovery of the structure of DNA in 1953. It concludes with a chronological speculation on the progress of human culture based on knowledge for over 6,000 years from the down of human civilization 2,500 years ago to the post-creational culture of fuzzy logic based on the sacrifice of precision in the expansion of the range of tolerance in order to survive and flourish for all the possibilities of an uncertain future. Each reader would be able to measure one's own cultural level with this cultural yardstick based on one's knowledge of morality, religion, reason, science, social science, life science, robotics, self-creation, and, finally, in 4,000 years, fuzzy logic, all of which are contained in a speck of DNA representing the wisdom of the universe accumulated from the infinite past.

Fuzzy Logic

The Genius of Lotfi Zadeh, the Father of Fuzzy Logic

by

Hugh Ching, the Father of Post-Science

Lotfi Askar Zadeh was the father of fuzzy logic and, according to many, he was mankind's most renowned thinker. The greatness of Lotfi A. Zadeh can be realized from the ubiquitous effect of fuzzy logic on all knowledge that, henceforth, a solution should be defined as all the answers, which lie within the fuzzy range of value or tolerance of the solution. Fuzzy logic, a post-creational technology, has helped propel human knowledge forward thousands of years, far beyond scientific and post-scientific applications.

Understanding Fuzzy Logic

The key to fully understanding fuzzy logic involves answering two important questions: 1) Why is reality fuzzy? and 2) When is fuzzy logic necessary?

Reality is fuzzy because precision is sacrificed during the process of expanding a creation's range of tolerance. Whether that creation is a human being or a washing machine, for it to survive and flourish in a permanently uncertain future, fuzzy logic becomes necessary and essential when the creator is absent.

While engineering deals with the construction of temporary entities, life science pertains to the establishment of permanent entities. From a post-science or universe-centered point of view, engineering should not be considered as life science, because any temporary creation will sooner or later become valueless. When an engineering product e.g., a driverless car, encounters an unforeseen issue, its human creator, or the driver, can still intervene to manually correct the problem. However, the human being or the entire living system must be able to survive in the absence of its creators. All of the possibilities of the future must be considered in the design of the living system. Furthermore, the future must not be left to chance or probability—since probability deals with certainty—because a probabilistically designed living system will eventually perish.

From a technical point of view, the range of tolerance of the living system must be wide enough to cover all of the possibilities of a permanently uncertain future. This range of tolerance or expansion in synthesizing emotion or distorting reality could be considered the ultimate psychological defensive mechanism against failures. For example, emotional quotient (EQ) is a measure of the range of tolerance of others' mistakes. Survival is more important than precision; therefore, precision is sacrificed during the process of expanding the range of tolerance of a creation. As a result, fuzzy technology,

while post-science, a creational technology and science, a nonliving technology. Engineers currently working on fuzzy logic have successfully tested the concept of the range of value or tolerance on temporary or nonliving products, and their findings indicate that only when the originator is no longer available, is fuzzy logic necessary.

The previously described questions and answers, and their implications, are what separates Zadeh and his devotees from the rest of the world, as well as from the fuzzy logic community. For scientists who have developed the practice of, and are accustomed to being exact, fuzzy logic can be difficult to understand. To fully appreciate fuzzy logic, post-science, which deals with the solutions of value, complete automation, and robot touch, all of which involve fuzzy logic, must first be understood.

The Concept of Fuzzy Logic

Fuzzy logic is best summarized in one short sentence: Fuzzy is more accurate than exact. Fuzzy logic has raised the ceiling on mathematics by replacing the mathematical concept of exact solution with "fuzzy exact solution," as the most accurate description of reality. In logic, fuzzy logic offers an operational definition of computer science that states, "computer science is the communication between the fuzzy human and the exact computer." In life science, the exact deoxyribonucleic acid (DNA) generates a living system that has sacrificed precision as the range of tolerance of that living system is expanded in order for it to survive and flourish given all of the possibilities in a permanently uncertain future. Even though recognition should be given to all of the visionary thinkers contributing to the pioneering evidence that fuzzy logic is useful in engineering, the full significance of fuzzy logic will only be revealed when applied directly to the living system, which is far beyond the current domain of engineering and science.

With the passing of Zadeh on 6 September 2017 fuzzy logic will enter into a new era. Applications from engineering based on science will advance into applications in life science based on cognitive science, artificial intelligence (AI), synthetic biology, and post-science, whose solutions of value, complete automation, and robot touch is naturally fuzzy (not exact), while solutions in the current age of science are exact. Zadeh, therefore, has established a solid technical foundation for describing the fuzzy reality with his founding of fuzzy logic, specifically in the areas of range of value or tolerance, possibility theory, and the general theory of uncertainty, all of which form a completely logical system that explains why reality is fuzzy. Unfortunately, fuzzy logic will become necessary only after we are all dead. Additionally, Zadeh spearheaded the invention, the explanation, or the foundation of the following ideas and theories:

***Z*-transformation**
common sense
decision theory
free will

computing with words
***Z*-number**
membership functions
the restriction-centered theory of truth and meaning
fuzzy sets
fuzzy numbers
fuzzy mathematics
soft science.

Fuzzy information science, the last project he worked on before his passing, will likely be at the forefront of technology in the years to come.

The most convincing argument for creationism as opposed to random evolution, are the discoveries of post-science and fuzzy logic. In particular, post-science has identified DNA as a completely automated software; therefore, the living system can be manufactured when DNA is programmed using just the computer source code 0, 1, 2, and 3. Post-science demonstrates the feasibility of mankind's self-formation, which, in turn, demonstrates that mankind is self-created. The fact that reality is fuzzy rather than exact provides one of the most convincing arguments in support of creationism. Universal permanent software (UPS) can be considered a theoretical discovery of DNA by identifying DNA as self-generating software, which should be considered even more significant than the 1869 discovery of DNA's existence, as well as the 1953 experimental discovery of DNA's structure, because the theoretical UPS connects mankind to its creators and to the universal community [1]. The theoretical discovery of DNA leads to a change in the representation of DNA nucleotides, from *A*, *C*, *G*, and *T* (which have no operational significance), to 0, 1, 2, and 3, to allow a parity check of 3s and other logic operations. DNA is quaternary versus binary for the computer, as illustrated in Table 1.

Computer science manages the interaction between the fuzzy human and the exact computer, and computer software automates knowledge. Concurrently, the UPS completely automates software. It starts with a universal user interface (UUI) that is arranged in a simple tree-structured, numerical multiple-choice question format. In the case of DNA, the UUI can be written for all three levels as: 1. adenine (*A*), 2. cytosine (*C*), 3. guanine (*G*), and 4. thymine (*T*)?

TABLE 1 – THE THREE DIGITS OF QUATERNARY DNA AND BINARY COMPUTATIONAL REPRESENTATIONS.

	Quaternary	(Decimal)	DNA		Binary	(Decimal)
Third Digit	Second Digit	First Digit		Third Digit	Second Digit	First Digit
3 (=48)	3 (=12)	3 (=3)	T			
2 (=32)	2 (=8)	2 (=2)	G			
1(=16=4^2)	1 (=4=4^1)	1 (=1=4^0)	C	1 (= 4=2^2)	1 (=2=2^1)	1 (=1=2^0)
0 (=0)	0 (=0)	0 (=0)	A	0 (=0)	0 (=0)	0 (=0)

The integers 1, 2, 3, and 4 are to be the answers to the questions and will form the integer source code to be handled by the computer. For example, choosing 1, 1, and 1 for the three levels will lead to the codon 111 or AAA = lysine. The human language expressions adenine (*A*), cytosine (*C*), guanine (*G*), and thymine (*T*) are to be read by humans, and they can be changed into, say, Chinese to form a UUI for the Chinese, such as: 1. 腺嘌呤 (*A*), 2. 胞嘧啶 (*C*), 3. 鸟嘌呤 (*G*), and 4. 胸腺嘧啶 (*T*)? Or, the order of the integer choices can be altered to form a new UUI, such as: 1. thymine (*T*) 2. cytosine (*C*), 3. guanine (*G*), and 4. adenine (*A*)? The UPS patent [1] has shown that the UPS can automatically update the old source code 111 to the new source code 444, as has been demonstrated in the virtual machine. In this case, the UPS can be considered a novel use of an old idea, i.e., the virtual machine. The novelty is complete, rather than partial, automation.

DNA is a chemical generator that generates protein by feeding RNA into ribosome; in fact, DNA is so powerful that it makes its host modify the function of DNA according to the behavior of the host (i.e., according to its lifestyle). Post-science believes that DNA, with its inherent wisdom, dominates the universe, while 0, 1, 2, and 3 correspond to computer source codes in computer science. The source codes are used to generate the program, which corresponds to protein.

The user interface of any programming language can be converted manually to UUI, and UUI can be completely automatically updated to any other UUI. Furthermore, using the self-generating feature of UPS [1], UUI can be converted to any human native language or any multimedia expression. Thus, the greatest practical contribution of UPS to the progress of human knowledge is to allow all humans over the age of 6 or even some intelligent animals or robots, and aliens from outerspace to write software, which will not become obsolete as the programming language changes.

UUI corresponds mathematically to the set theory, which allows similar items to be grouped into subsets in the second and lower levels of UUI, and corresponds physically and cognitively to the fuzzy Human Associative Memory (HAM), which allows humans to access an unlimited amount of information, but is fuzzy. The human native language in UUI is permanently fuzzy, but is isolated from the execution of the computer. The executable source code or the choices in UUI is completely flexible or interchangeable in UPS. An obvious choice of an UUI corresponding directly to Table 1 can be written for all three levels of UUI as 0. adenine (*A*), 1. cytosine (*C*), 2. guanine (*G*), and 3. thymine (*T*)? And lysine (AAA) can be represented by the integer 0. DNA source code in the form of 0, 1, 2, and 3 can be directly fed into the UPS to generate the representations of the 64 codons or any protein.

Demonstration is available to show that UPS can self-generate to form a self-generated neural network of software cells of unlimited size, or until the disk is full. The self-generated network can eventually be developed into an electronic brain, with features, such as Human Associative Memory or HAM. Thus, in the design of a self-generating

completely automated intelligent system with unlimited complexity, such as the living system and a completely automated computer system, HAM is needed to create HAM. Even today, the usefulness of HAM, possibly without being fully recognized by the current computer designers, has been amply demonstrated by the computerized hypertext system, the computerized menu system, the computerized library system, all of which enable their users to theoretically access unlimited amount of information, but have not yet incorporated the completely automated capability of UPS [1].

Conclusions

The method of solving problems defines the cultural level of the people. Fuzzy logic is the most advanced method discovered by mankind up to now. The advanced nature of fuzzy logic can be described by a speculation of the future chronological order of the progress of human culture described below and summarized in Figure 1 and Figure 2.

500 BC – 1500 AD: The method is faith. Faith is applied to morality, which deals with beliefs favorable to the believers, and to religion, which is the sum total of morality. Morality provides temporary comfort and stability and culminates in religion, which becomes addictive and considered by Marxism as the "opium of the masses." Morality stabilized the Chinese culture for 2,000 years, and religion creates the stable Dark Age lasting over 1,000 years in the West.

1500 – 1800: The method is reason (***End of Common Sense***)**.** Reason does not change anything; reason is just viewing the same phenomenon or conclusions from different perspectives. Mathematics and logic provide examples of reason in its most advanced form. Mankind, without the stability of morality and religion, enters into the most painful period in history exemplified by the French Revolution, WWI, ad WWII, as reason cannot settle disagreements.

1800 – 2100: The method is empirical verification. The scientific method is based on empirical verification, and science currently dominates human culture and the knowledge of the establishment. Science provides a cultural shocked to China waking it from 2000-year morality.

2100 – 2500: The method is complete mathematical rigor. Solutions in social science deal with reality in its entirety. Reality extends to infinity in space and into the future. Since infinity, by definition, never arrives, deterministic set of data for empirical verification can never be obtained when infinity is involved. The solutions in social science are accepted based on complete mathematical rigor. In particular, the solution of value is a completely mathematically rigorous system, which corresponds to the price system and is the solution to financial crises. The solution of value will replace completely morality and religion by offering quantitative solutions to their problems. While doctrines in morality and religion are violable, the solution of value is non-violable and is a law of nature in social science governing human behaviors.

2500 – 3000: The method is complete rigor in logic. Solutions in life science, due to their unlimited complexity, cannot rely on the imprecision of mathematics, due to decimals and fractions, and must be confined to the rigor of logic, represented, for example, by integers. Involving infinity, the solutions in life science are accepted based on complete rigor of logic. For example, the solution of complete automated software should be the foundation of life and

Culture Level Quotient (CLQ) and Representative Thinkers

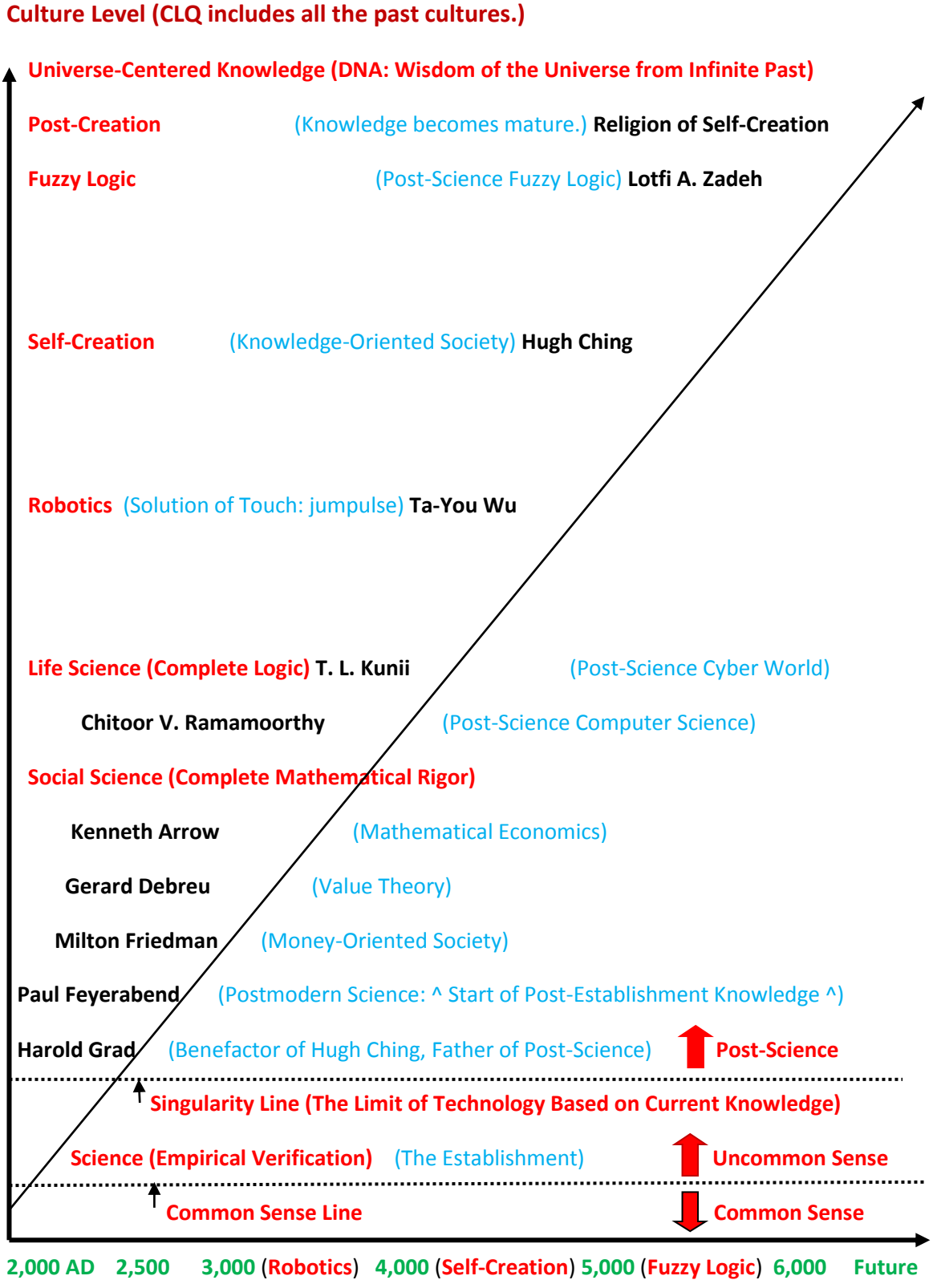

Figure 1 Culture Level Quotient (CLQ) of the Present and the Future Cultures

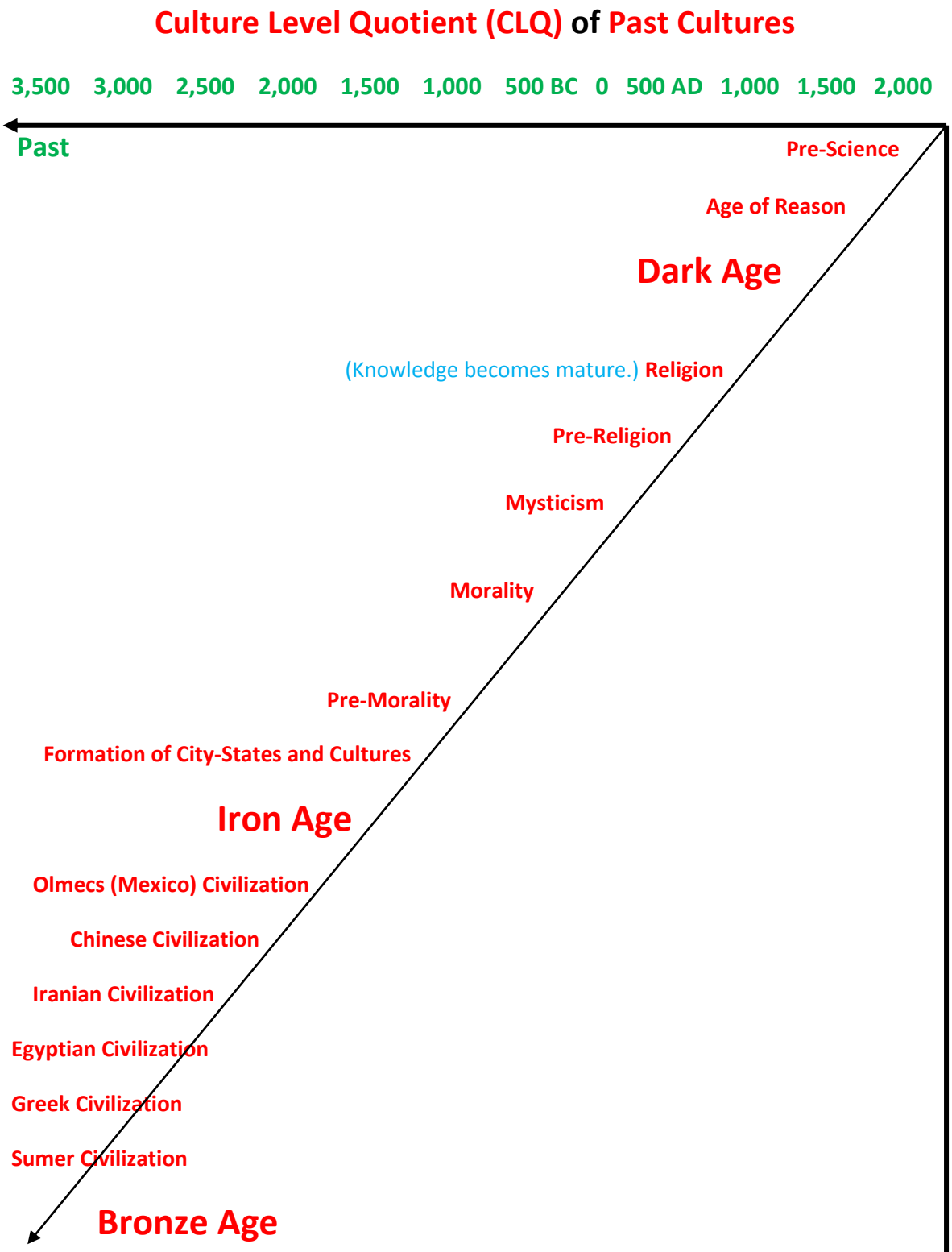

Figure 2 Culture Level Quotient (CLQ) of the Past Cultures

computer sciences, is a completely logic system, involving self-generation, auto-updating, and auto-documentation. Complete automation is the ultimate solution to unlimited complexity.

3000 – 4000: The method is complete automation. Complete automation is achieved with Self-manufactured General-Purpose Robot capable of safely interact with the external physical environment with the ability of touch and is developed and controlled by the completely automated software. The solution of touch is based on the Fuzzy Jumpulse Mechanism.

4000 – 5000: The method is self-creation. What is self-created can do anything the creator can do, thus, eliminating the creator. The design specification of self-creation reveals the meaning of life and the purpose of existence. The Robot will become the human, and software, DNA.

5000 – 6000: The method is fuzzy logic. Precision is sacrificed in the expansion of the range of tolerance of a creation to survive and flourish for all the possibilities of an uncertain future. For example, common sense, which is the most important human ability for survival, is fuzzy. Other fuzzy logic examples are multi-cellular design for ultimate fault tolerance and bio-diversification.

Mankind owes a debt of gratitude to Lotfi Askar Zadeh and his dedicated team of researchers for their pioneering research in the field of fuzzy logic. Their relentless pursuit has opened the eyes of the world to this revolutionary technology. My friend and colleague lived a rational but very lonely intellectual life, having few colleagues who understood and could discuss the depths of his thinking. I am grateful that after ten years of interaction with him, I finally understand his visionary concept of fuzzy logic.

Biography

***Hugh Ching*.** (post.science@yahoo.com) received his B.S., M.S., and Sc.D. degrees from the Massachusetts Institute of Technology, Cambridge. He is the founder of the Knowledge-Oriented Society and the father of post-science. His mentors include some of the greatest thinkers of our time. Harold Grad, an intellectual descendant of David Hilbert, mentored him in mathematics, and Paul Feyerabend mentored him in philosophy relating to postmodern science. Additionally, Milton Friedman mentored him in economics relating to deregulating man-made laws. Chitoor V. Ramamoorthy mentored him in software engineering. Upon the advice of his close collaborator Tosiyasu L. Kunii, the founder of the Department of Information Science at the University of Tokyo, Ta-You Wu, the father of Chinese physics, collaborated with him on physics, particularly on the solution of robot touch based on their newly discovered physics concept of jumpulse, a sudden change of force, as Newton's impulse is a sudden change of momentum. He solved the problem of value posed by his friends Kenneth Arrow and Gerard Debreu. Lotfi A. Zadeh, the father of fuzzy logic, guided him to realize that "fuzzy is more accurate than exact."

Reference: [1] H. Ching, "Completely Automated and Self-generating Software System," U.S. Patent 5,485,601, Jan. 16, 1996.