International Journal of Research, Science, Technology & Management
ISSN Online: 2455-2240, Volume 4 Issue I, July 2016

Scientific Foundations of Knowledge

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***Abstract*— In this paper, we propose that knowledge can be initially designed like any scientific object such a rudimentary automobile, airplane or spacecraft. The premise is based on the theme that a specific body of knowledge rests on the embedded noun objects and the structural relation between these key-groups of knowledge centric objects (KCOs). The events, interactions and forces in the society alter such KCOs and their structural relationships. The design of knowledge deploys a very pragmatic approach that knowledge based on these key objects, their interrelationships, and their interactions can be processed by knowledge machines. Knowledge thus undergoes dynamic changes in the society, the minds of human beings and in the knowledge structures stored in the memories and knowledge banks. Structures of knowledge can be altered in the KPUs of knowledge machines much like data structures are altered in the CPU's of traditional computers.**

***Keywords*—** *Noun Objects, Verb Functions, Knowledge processing, Knowledge Centric Objects, Knowledge Machines*

I. Introduction

To a large extent, society processes knowledge in a covert and continual fashion. The social processes modify prior knowledge numerous levels ranging from gossip to creative problem solving. These processes update the bodies of knowledge (BoKs). The mind stashes away these BoKs and updates the memory. At the lowest levels, gossip and rumors are plentiful and at the highest levels, profound scientific contributions heighten the pinnacles of wisdom. Human mind handles these accordingly. Knowledge machines simulate such knowledge dynamics in the society and follow certain intrinsic flow patterns to make the flow of knowledge organized, structured, scientific, useful and possibly benevolent to the society. Left unattended and ignored, knowledge can assume hideous dimensions and confusing shapes that rattle human perceptions.

Human endeavor and knowledge are securely intertwined. Total independence of either is nearly impossible since both have a continuum in the neural paths and time dimensions and both change accordingly. The rate of change of knowledge alters the mental state and the vice versa, and to this extent change in driven by the energy in the other. The evolution of computer systems has altered this balance slightly. We have learned to alter the status of either one incrementally but for short durations. Computation without comprehension is utterly useless as thought without confirmation.

Scientific representation, validation, attestation and verification enhance the utility of any thought process. Amidst the latter processes mathematics, computation, programming and numerical corroboration with other observations start to gain foothold. The entire structure from human thought to derived social value becomes a discipline. Knowledge provides a background of continuum in the entire discipline and humans manipulate knowledge as much as comprehension manipulates human action. The long feedback can become frustrating to differentiate between cause and effect. In order to avoid dead ends in knowledge science, we suggest building bridges in the well established islands of knowledge where sciences have made deep in roads and highways. For example, science and spirituality may not be directly connected but the human mind-soul relation provides a link. Before Charles Darwin, evolution of species and forces of nature were not directly linked, but the logical basis of his reasoning provided the basis for accepting his flawless logic.

Where there has been no utility in mere thought process, humans have enjoyed tittle-tattle, chitchat, hearsay, gossip, rumor, and even scandal at the lowest end of knowledge processing (KP). Conversely, when there is universal significance in thought processes of individuals, societies, nations, and human kind, the flavor of knowledge processing becomes significant enough to bring about breakthroughs (e.g. the steam engine, transistor, fiber optics, etc.) and revolutions (French, industrial, knowledge, and network, etc.). All aspects of all sciences are invoked at the higher end of KP. The convergence of thought needs the concurrence of truth drawn from all disciplines. Human constructs are crossing barriers in knowledge thus altering the structure and bounds of knowledge to navigate the mind born free that knows no structure and bounds.

II. Infrastructure of Sciences

Knowledge is basis of science and science is organization of knowledge. Knowledge and science form a bonded pair to pursue progress. Imbedded in this synergy is the underlying commitment that human values and ethics will be preserved and enhanced. In a sense, knowledge has evolved to serve humankind. More than ever before complete, precise and incisive knowledge holds the key towards being successful, optimal and efficient. Unsubstantiated knowledge can soon become embarrassing, misleading, dangerous, destructive and devastating.

When knowledge is considered as a resource and as utilitarian, its accuracy and its preservation become essential. Left unattended and unprocessed, even basic scientific and benevolent knowledge can become gossip and rumor; conversely, the myths and legends may become laws and norms in the society. Such transpositions are abundant in

IJRSTM
ISSN ONLINE: 2455-2240

history and numerous cults have left painful memories in the pages of Western society. In a more immediate sense and in the context of the Internet age, high speed networks add an additional element of complexity to the social transactions and transpositions and can become weapons of mass deception rather than backbones of constructive communication.

Physics leads into electricity and magnetism and then into electrical engineering. Being procedural, quantitative and pragmatic, it becomes feasible to navigate directly into electrical engineering, signal transmission and processing at the outset. Being human and behavior minded, it becomes feasible to navigate directly into Marshall's utility theory and then into von Neumann's game theory. At the broad intersection of the two major disciplines, the domain of knowledge sciences can be discovered with relative ease. The quantitative issues are addressed by (the laws) of physics and the behavioral issues are guided by (the laws) of economics. Figure 1 depicts the resources in different disciplines that form a broad overview of knowledge science.

A. *Platform of Pure Sciences*

1) Role of Role of Physics

Physics provides deep insights of concepts and a rich methodology for quantitative verifications and leads into the technologies that have proved valuable to the society. In pursuing the role of physics to establish knowledge science, electrical engineering and signal processing become prime contributors and depicted as columns 1 and 2 of Figure 1.

Most of these tools and techniques from pure science and applied sciences may not be directly compatible for the analysis and quantification of knowledge (KCOs and BoKs) nor the knowledge elements (*v's, *'s* and *n's*). However, when appropriately transformed into knowledge domain from own domains, the noun objects (KCO's, BoK's and *n's*) start to exhibit similar relationships. For example, the change of structure from KCO_i to KCO_{i+1} would need energy. This energy would be appropriately measured as human (or machine) work at a given level of expertise for *'t'* seconds.

As an example if a KCO represented as ($F= m\ a$) needed five years of Newton's time, then the energy of the KCO would be 5 (Newton-caliber)-years, etc. On the other hand, if a knowledge machine was used to derive this equation and it took one day of knowledge machine (of caliber 2010), then the energy of the KCO would be one (2010caliber-KM) day.

As another example if it took 50 years for the naked human eye (KCO_i) to identify the rings of Saturn and it takes 10 minute of the radio telescope (KCO_{i+1}) at Mauno kea (Hawaii) to detect the rings, then the kenergy of Saturn rings is 50 (eye-caliber-retina processor) years or 10 (Mauno kea-caliber image processor) minutes. Equating the two timings, the processor power of Mauno kea radio telescope entity is 2.628 million times faster than the naked eye retina processor to be able to detect ring type configurations elsewhere, etc.

On an incremental basis, if a student in a state *i*, (i.e., a typical high school graduate or KCO_i) needs to be transformed to a state *i+1*, (i.e., a college graduate or KCO_{i+1}), the extra energy required would be 4 (sophomore-junior caliber) years. In this case, the sophomore-junior caliber level is taken as average caliber of an entry-level fresh-man and a graduating senior from a "standard university" and it take four years to graduate.

2) Role of Electrical Engineering

Electrical engineering offers the extensive rigor of most well known scientists who have contributed to the measurement of power and energy. The unit of power has been established since the days of James Watt (1736-1819). This unit of power range from lowest (femtowatt (10^{-15} of a watt)) to the highest (petawatt (10^{15} watts)). The range for energy is also very wide from femtowatt-secs to terawatt-hrs or even petawatt-centuries. All these derived units fall back on the unit of power of one watt or W, i.e., one Joule per second. It becomes advantageous to find if this chain of reasoning of the early scientists will lead to customized units of power and energy in the knowledge domain. The units for kenergy are derived from the writings of Clausius [1, 2], Boltzman [3, 4], Gibbs [5, 6], and MaCulloch [2] in the field of thermodynamics (See boxes at rows C, D, E, F in column 3 of Figure 1).

Signal transmission and processing bears a good deal in common with knowledge flow and knowledge processing. Both signals and knowledge suffer degradations and distortions (attenuation and dispersion), both get contaminated and get cleansed, both get transmitted and get recovered, both suffer losses and leakages, both need power and energy to propagate. Accordingly, there is sufficient overlap between the two realms of signal flow and knowledge flow. In pursuing the mechanisms behind the signal and knowledge flows, entities such as voltages (nominal, maximum and effective values), currents (nominal, maximum and effective values), impedances (Ohmic values), signal to noise ratios (SNRs), losses (resistive wattages), phase shifts, power and energy (transmit and received), reflections and phase distortions, bear notable anomalies in the knowledge and information domain. The methodologies of signal transmission in electrical circuits and media are used to derive the transformation matrix for the social media as information and knowledge traverse such social media. The nature of the matrix is presented in [7]. See boxes at rows C through I in columns 1 and 2 of Figure 1.

This signal flow in electrical engineering and knowledge flow in social media is explained when two objects *n1* and *n2* interact in a humanistic machine. If objects *n1* and *n2* have similar characteristics and work in a non resistive mode, the information and knowledge content will flow from *n1* to *n2* and vice versa without distortions, reflections, attenuation and dispersion. This is a direct corollary of the equations in data and signal flow through transmission lines, circuits and electro-magnetic fields.

Additionally, the magnitude and phase of reflected and transmitted signals bear established algebraic relations [8] to the differences in the media characteristics. An estimation of the refraction and reflection effects of any given KCO or BoK, at the boundary of two inhomogeneous social media (e.g., two different cultural environments) can be is feasible by a comparison of the transformation matrices for the media surrounding the boundary.

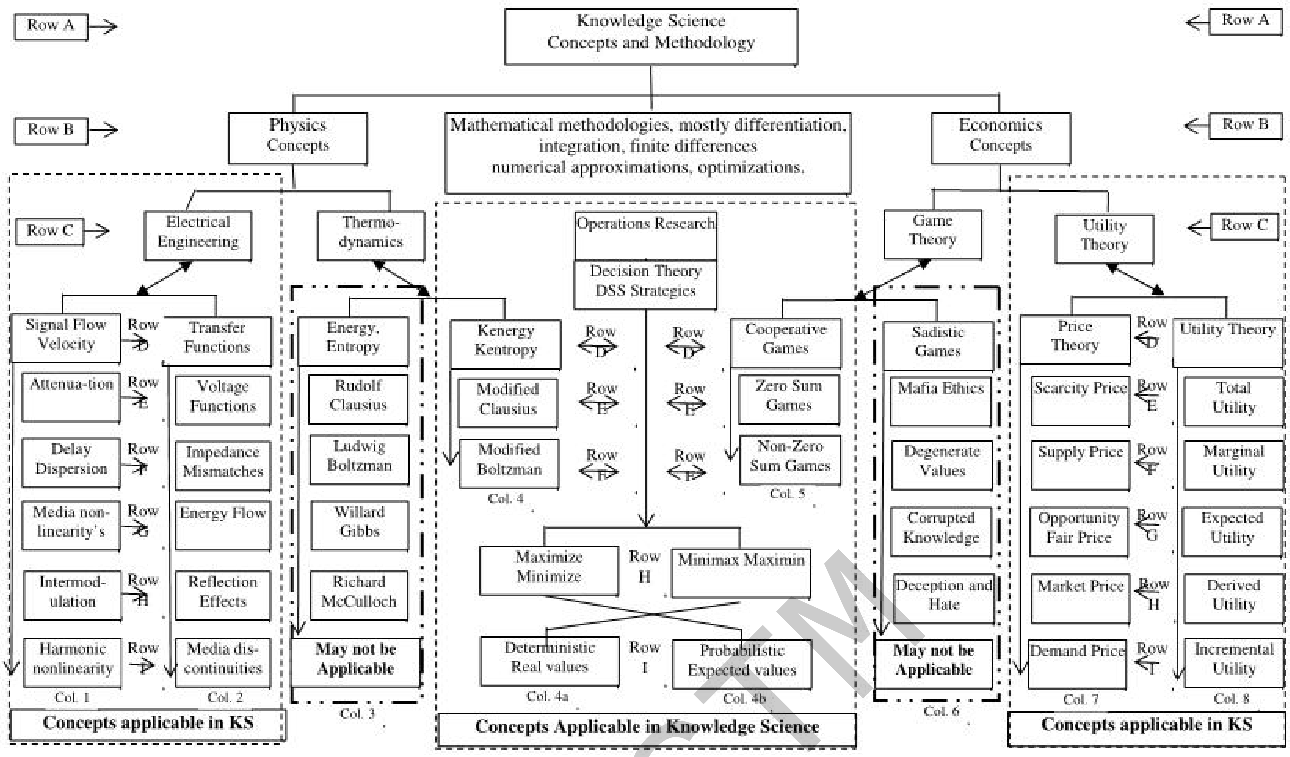

Figure 1 Conceptual-platform matrix for knowledge science (KS) derived from scientific perspective of physicists and electrical engineers (columns 1-4) as much as it is derived from behavioral perspective of economists and game theorists (columns 4-8). These intertwined concepts in the knowledge domain are discussed in Section 5.

3) Role of Thermodynamics

This offshoot of physics becomes instrumental in accommodating the highly variable nature of human beings and social entities. Thermodynamics offers a framework to instill the initial knowledge level of *n1* and *n2*, and the individual characteristics of both. Thermodynamics plays the desirable role in tailoring the programs for machines to individual human entities that deploy them. In an oblique framework, heat flow also imitates knowledge flow, but all the laws of thermodynamics (especially, the specifying the conservation of energy (and heat)) are not applicable in the knowledge domain.

However, it is possible to view the kenergy of *n1* in relation to the changes of kentropy in *n2* via a transfer-function. Such transfer-functions are generally used in signal flow analysis where active circuit component can and do amplify the signal levels. The admixture of concepts and (mathematical) methodologies from electrical engineering and thermodynamics will permit a knowledge scientist to follow the flow of KCO's and BoKs from different objects (*n1* and *n2*) and be precise about the changes in the kenergies and kentropies. The framework of thermodynamics offers an excellent platform to deal with (k)energy and (k)entropy. Even though the second laws of thermodynamics are not applicable in the knowledge domain, the concepts of energy and entropy find abundant commonality. When knowledge centric objects interact and find an operational stability, the energies of the driving entity play a significant part in altering the entropy of the reacting entity and vice versa. When the definition of Clausius [1, 2] and the derivations of Boltzman [4, 6] are brought to bear in the way human and social entities should be treated as unique "objects", then the interaction between "who" (an unique KCO) deals with "whom" (another unique KCO) can be interjected as particular coefficients of "who" and "whom".

B. Platform of Social Science

1) Role of Economics

The laws of economics find a quick entry in knowledge sciences. To a large extent humans treat knowledge as an economic entity. In a pragmatic sense, knowledge has value, it has a price and it yields utility. Aspects from numerous price theories in economics and the utility theory of Marshall's [9] and then the marginal utility theories [10] shed light upon the way humans deal, achieve, manage and utilize all utilitarian objects including knowledge See rows C through I of columns 7 and 8 of Figure 1. When humans control machines to explore the knowledge domain, the machines provide a mathematical framework wherein the expected utility of the effort is maximized in one or numerous dimensions.

Decision theory (from operations research or OR) lurks in the knowledge ware programs and their behavioral libraries. When the utility is not deterministic and can only be expected, the game theory brings in the individualistic character of a particular human or of a particular social entity. In a very pragmatic sense, knowledge needs management and utility of knowledge needs maximization according to Marshall. In a very humanistic sense, knowledge needs to benefit and satisfy the individual and social character of the entities that use the machines.

2) Role of Game Theory

Morgenstern and von Neumann [11] have initially formulated game theory to shed some light upon the way humans deal, achieve, utilize, manage and utilize knowledge. When humans control machines to explore the knowledge domain, the machines provide a mathematical framework wherein the expected utility of the effort is maximized in one or numerous dimensions.

The game theory concepts impact decision theory (from operations research or OR) in two areas; in the deterministic setting the most economic decisions become readily evident and in the nondeterministic setting, situational and estimation of gathered evidence also enter the decision making process, but bin a probabilistic sense. Such approaches are common in medical field when the doctors start to investigate other clues that either substantiate or refute the partial decisions about the prior conclusions.

Typically, knowledgeware programs and their behavioral libraries would provide some direction to this type of decision making based on past experience and "best" guess. The chances of making the correct decision can only be increased but not assured. In a very pragmatic sense, knowledge libraries need updating and management. This role of knowledge science becomes even more precarious when the KCO's play a (intelligent) conflictive games without any "rules of the game" except to be opportunistic and deceptive. This part of the knowledge science dealing with the negative side of humans and "negative" knowledge is depicted in column 6 of Figure 1. The laws of affirmative knowledge cannot be simply reversed to plough through this column and the negative creativity starts to fuel a very undesirable negative humanistic machine.

C. Integration of Two Platforms

Integration of the pure sciences, physics in particular, (Dewey Decimal System or DDS 530) and electrical engineering (DDS 620) with social sciences, economics in particular, (DDS 330) is possible because of universal tools and techniques of mathematics, computer sciences, and knowledge sciences that run through all these disciplines. Social behavior (DDS 304) and social interactions (DDS 302) also play a role in knowledge sciences because humanistic objects (KCO's) treat knowledge as a utilitarian commodity. Behavioral patterns of social entities and objects become important in the emulation of such (KCO's). Unfortunately, the mathematical tools and procedures are not well documented in the DDS 302 and DDS 304, but some of the behavioral modes can be emulated as programmable computer processes [7].

1) Role of Mathematics

Calculus plays the most comprehensive role, even though operations research, game theory, probability and statistics (if they are considered as branches of mathematics) also influence the specialized techniques for the knowledge domain. Differentiation, integration, and partial differential equations have established inroads in econometrics, micro and macro economics. Almost all topics in economics deploy differentiation, partial differentiation, and/or finite differentials of economic quantities. As it is knowledge sciences, economics deals with objects and entities that are dynamic and constantly changing making mathematics, its tools and techniques transparent between the disciplines. But more than that, the concepts and patterns behind behavior also experience commonality.

Integration leads to cumulative effects of and upon economic objects in economics and KCO's in knowledge science. The effect of time is handled by time series analysis and discreet algebraic methods in economics and analysis of observed data. Both these methods find applicability in knowledge science via the observation of social and individual knowledge centric objects. For example, if an active noun object *n1* initiates a verb function (*v*) or a convolution of verb functions (*v's*) directed towards a noun object *n2*, then a time series analysis of the behavior of *n2* will reflect the effectiveness of one strategy for implementing versus another, or the effects of one teaching methodology versus another, and so on.

Almost all aspects of the mathematics appear applicable in knowledge sciences. In most other discipline the role of nonlinear effect may not be as predominant as those in knowledge sciences. Human and social KCO's display the most variable characteristic responses to verb function (*v's*) or a convolution of verb functions (**v's*). The incremental changes in kenergy and kentropy can also display large swings and nonlinear effects.

2) Role of Computer Science

During the seminal stages knowledge science, the methodologies for designing and constructing comprehensive software systems are readily applicable. The whole array of software associated the almost all branches of computer science (e.g., knowledge base system design, knowledge management, library systems, AI and intelligent systems, etc.) will find way into knowledge science and its management. The use of existing computer sciences (CS) and its deployment will become essential for knowledge sciences (KS). After all KS is a superstructure atop CS.

3) Role of Knowledgeware

International Journal of Research, Science, Technology & Management
ISSN Online: 2455-2240, Volume 4 Issue I, July 2016

The tools for signal flow analysis are not established for the flow of knowledge in humanistic sciences. However, the exchanges of energies and entropies between interacting objects may be analyzed in reasonable detail and with fair accuracy by falling back to laws of thermodynamics. Great deal of caution is necessary because there is no law of knowledge that preserves kenergy. Knowledge (energy) that is shared is not depleted at the source. For this reason, the laws of thermodynamics cannot be indiscriminately pushed into knowledge science. To some extent knowledge science is unique even though there are threads of reasoning akin to those in physics, (especially electrical engineering and thermodynamics), signal processing, transmission theory, and finally economics.

To the extent that there is considerable framework of electrical engineering that can lead to the core of knowledge science, we deploy the treatment of these parameters such as voltages, currents, power, energy, attenuation, dispersion, etc. To the extent that there is some methodologies of thermodynamics that can lead to the computation of kenergy and kentropy, we deploy the treatment of the thermodynamic parameters such as energy and entropy. To the extent that there are concepts from signal processing and transmission engineering such as echo cancellation, equalization, feedback stabilization and noise reduction, we deploy to the signal processing text in References [8] and transmission engineering texts such as [12]. To the extent that KCO's and noun objects find their equilibrium with other KCO's and noun objects, based on the laws of marginal utility and utility theory, we refer to any elementary text [13] in economics.

III. FRAMEWORK OF KNOWLEDGE

In the information age, the frontiers of knowledge reach far and wide and across many disciplines and integrate their boundaries. Internet space has no geographical or subject precincts. The IP address permits global navigation. On the human side, knowledge being primordial encompasses the human mind completely. However, knowledge overloads can almost drown the senses. In a balanced proportion with human perception, knowledge nourishes the mind. When the overall human comprehension is intact, it is comprehension that encompasses knowledge. Knowledge and comprehension play out a beautiful embrace at each others' door steps. This symbiotic interdependence can last a life time, each stretching the bounds of the other.

Rather than be carried in a philosophic encounter, we propose a pragmatic and diagrammatic approach that establishes a reasonable pause in the deep embrace between knowledge and perception to explore the synergy between the two. Knowledge becomes the foundation of perception for an interval of time and then perception becomes the foundation of expansion of knowledge for the next interval which in turn calls for greater perception. Incremental gain in knowledge brings in new paradoxes for the mind to perceive. The cycle rotates in both directions for the individuals and civilizations to grow and expand. This dual cycle repeats till human being(s) refuses to learn and know anymore and the cycle can become unidirectional till the accumulated knowledge from the past is depleted and society becomes stagnant and no new knowledge is generated. During the downfall of nations and cultures, the rise of cults and self interest groups becomes evident. These destructive organizations become cancerous to the very society that once nurtured them.

History reminds us of many alarming regimes; Hitler's Germany (1933-1945) [14], Stalin's Russia (1922-1953) [15], Mao's China (1949-1959) [16], etc. Disintegration, dismay, decay, death and devastation have followed. Given an opportunity, knowledge incubates and grows in creative minds in spite of harsh environments. Pharaoh's Egypt produced marvelous structures and Ottoman's Morocco produced many fine artistic forms. The cycle pauses for a short enough interval and produces masterpieces of many cultures or the ruins, death and destruction of wars, both evident in Europe.

In the knowledge domain, the role of computers and networks has become dominant through late last century. More recently the impact of knowledge networks, Internet I and II has become dominant. The ceaseless struggle between human minds and machines penetrates the perceptual, mostly human space at the high end and the purely computational space at the low end. A snapshot of this constant ebb and flow of knowledge between the humans and machines is depicted in Figure 2.

Seven spaces are shown in the pyramid. The human mind may occupy any one space for a lifetime or move freely to explore all the seven spaces. If the upward movement in this pyramid constitutes on direction of the cycle, then the downward movement depicts the other. When these movements are made harmonious and smooth then the accumulated knowledge spills into the reality for solving the problems that face an individual or a society. Conversely, when problems are fed into the knowledge and conceptual spaces to gain global wisdom, they become an integral part of human life to move forward

Wars, social upheavals and shear indulgence on the part of individuals and nations disrupt the ebb and flow of knowledge into an uneven and almost haphazard reality. Conversely, the ill-conditioned knowledge bases during disruptions cause turmoil and a restless society. Willful moderation for this delicate balance between the surplus of knowledge and the needs of self and society can be sensed, moderated and controlled by individuals for themselves and by knowledge machines for communities and nations.

A normal flow of information/knowledge from the numerous knowledge centers (e.g., universities, libraries, research centers, etc.) of a nation becomes indicative of "health of knowledge" of the nation. By the same token, the analysis of the flow of information/knowledge from mafia strongholds, porno institutions, nightclubs, casinos, bars, etc., becomes indicative of sickness in society. Such indicators are in use for fiscal policy settings. The economic indicators are constantly monitored and balanced to provide a healthy flow of monies within the nation. In the corporate environment, the balance sheets provide a strong clue about the health and stability of a corporation. In the same vein, an activity sheet of the major knowledge functions (e.g., inventions, innovations, novelty and range of products, etc.) within a corporation provide a snap shot of creativity. If it deviates from a bench mark setting, a knowledge machine (KM) [7] will identify the opportunities for innovation and progress. More than that, the KM can formulate creative convolutions of the past verb function and current noun objects that show promise of desirable changes.

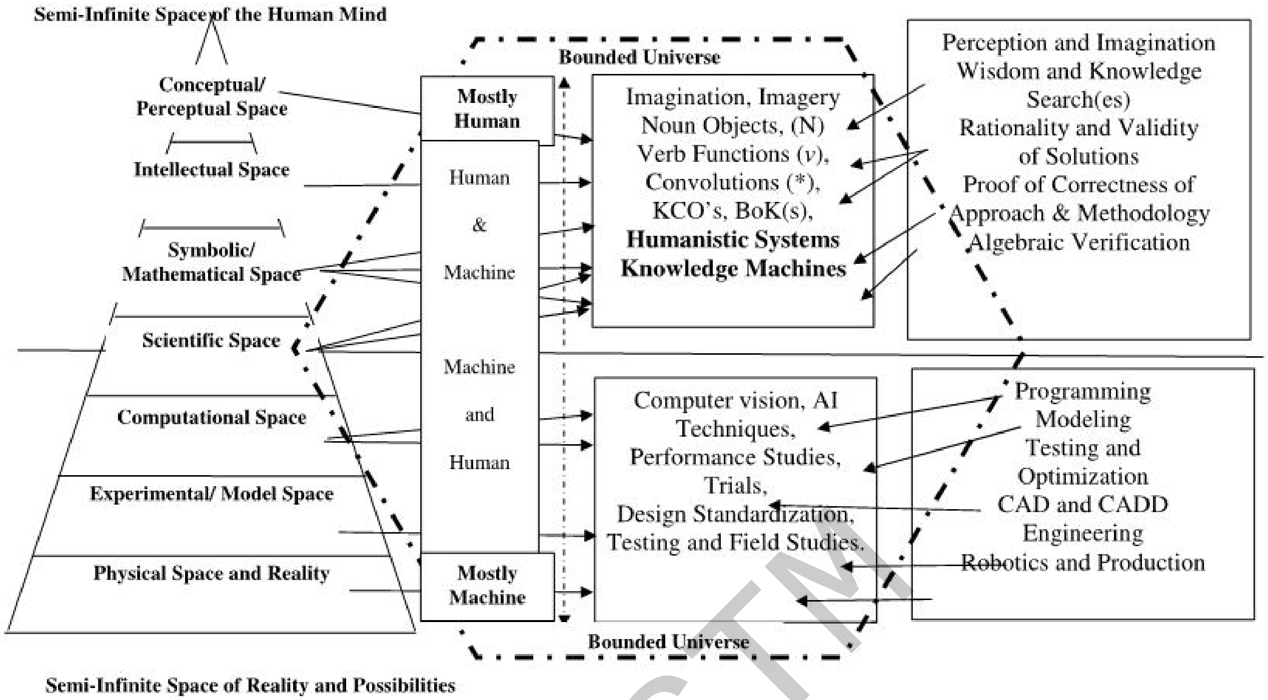

Figure 2 Diagram to illustrate the role of nouns, verbs, convolutions, knowledge centric objects and bodies of knowledge in the derivation of new knowledge from old knowledge and the reality. The human mind and then the knowledge machines and humanistic machines play the pivotal role of the creation of new knowledge

IV. HIERARCHIES OF OBJECTS AND ACTIONS

Objects in knowledge space can become as numerous as symbols in computational space. Both need further characterization. Symbols in the computer space, have been classified as numbers (integers, floating point, double precision, etc.), dimensioned arrays, matrices, etc. In addition, these symbols are tailored to a problem at hand. In the knowledge space objects may contain and encompass other objects, subordinate objects may enclose leaf objects. To this extent, recursion of objects would be desirable feature in the knowledge space as recursion of symbols in computational space of higher level scientific application programs.

In following the structure of graphs, if the node object is placed at the top of an object hierarchy and named as "knowledge centric object" or KCO, then the second level objects can be called the "bodies of knowledge" or BoKs, and the third level object can be called a "noun object", NO, or simply an object *n*. Thus in a give knowledge space the KCO, BoKs and *n's* constitute a simple graph that is indicative of the structure of knowledge in KOC. A possible depiction of the generalized object hierarchy is shown in Figure 3.

In following the classifications one step further in the organization of functions in the CPU of a computer [17], the traditional operation codes are also classified and encoded. Operation codes (OPCs) [18] exist for numerical operands, logical operands, matrices, I/O entities, etc. In the same vein, if actions in the knowledge space are classified, then the hierarchical order of actions can be written as convolution (*), action, interaction, and a verb function or verb (*v*). A possible depiction of the generalized action hierarchy (convolutions, actions, interactions, Verb functions, verbs, etc.) is shown in Figure 4.

V. KNOWLEDGE: A SCIENTIFIC ENTITY

The interpretation of any given BoK in the human mind can be highly variable. In the psychological interpretations of events, the mind sorts and relates the different events in a systematic fashion. It also disintegrates complex bodies of knowledge into their constituents to a predetermined (depending on the knowledge quotient or KQ) levels up and down and relates the current event with the other objects existing in the knowledge bank(s). A trained human mind also deals with the BoKs in an efficient and orderly way order to relate and retrieve them. A photographic image of a complex KCO consisting of numerous constituting KCOs their relations, and their attributes and connectivity's can become as cumbersome as tracing the neural pathways in the brain.

In order to instill an external order, a conceptual graph may be constructed in the computational space of machines with the data structures in their memories representing these KCOs. In the development of other disciplines, symbols and representations are used in the conceptual space of humans and the topological space of mathematics.

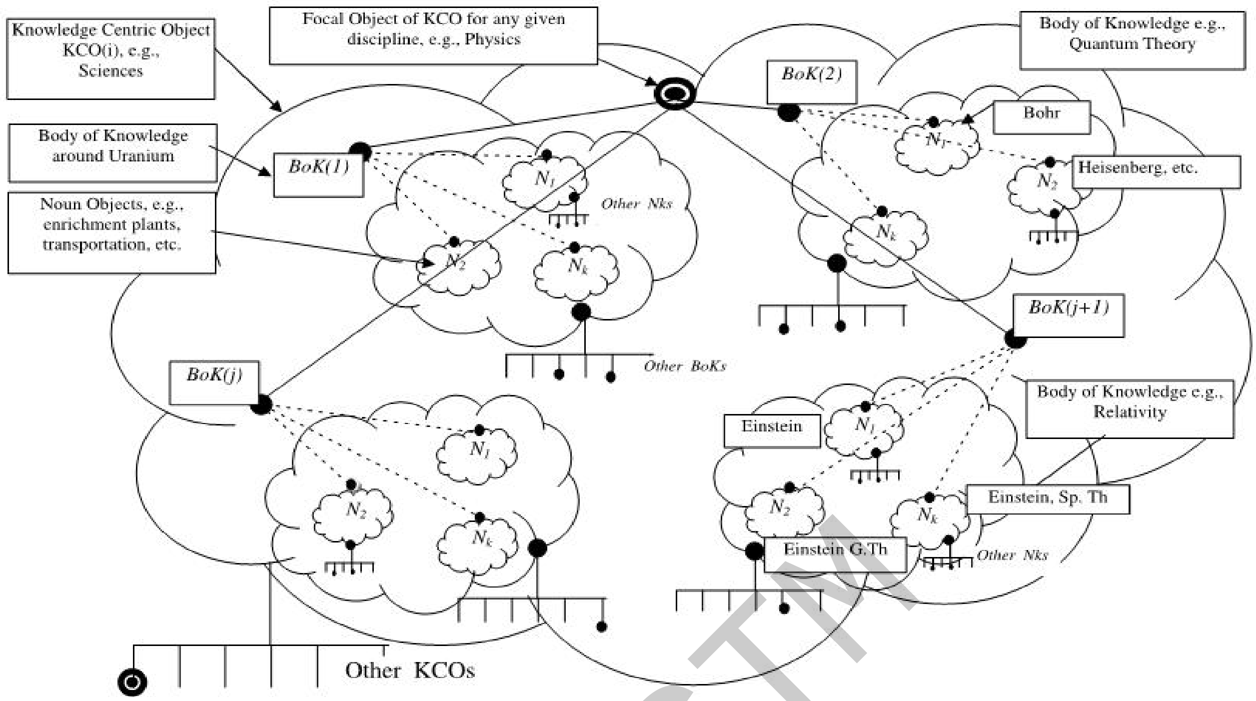

Figure 3 Depiction of any super object and the other constituting objects that contribute to the super object. The number of levels can vary significantly from one super object to another and is indicative of the depth of known objects in any discipline. Generally the routine problems in most disciplines can be investigated by three levels of representation of objects. (See Figure 5)

Knowledge manipulations may not approach the complete rigor of mathematical operations and transformations but may be traced and tracked like the tasks and transformations in managerial sciences and production engineering. For example, building an airplane is neither entirely mathematical nor entirely random actions. Yet the intermediary space between the two extremes is occupied by the discipline of computer aided design or CAD techniques in engineering.

In this vein, a complex knowledge object may be traced, tracked, modified and built as a scientific entity that has order, structure, flow and methodology. In order to facilitate this methodology, we propose two sets of axioms. The first set deals with the structure of knowledge and the second set deals with the flow of knowledge. Both sets are derived from reality and based on laws of mathematics to construct low level KCOs (like optimized macros and library routines for computer systems), intermediate level KCO's (like I/O routine, mathematical functions, and specialized processes for selected operations), higher level KCO's (like elementary application programs, connectivity's and communications) and finally the complex KCO's that may be represent new and innovative tasks. For example, building a spacecraft from the existing laws of aerodynamics in the atmosphere of earth, and then the basic laws of space flight, etc., would need a series of (*v's*, *s, and *n's*) specialized for the space craft as a complex KCO. Similar examples exist in social, managerial and political environments.

The implications of these two sets of axioms based on reality can be far reaching. They also carve out a methodology to administer changes in KCOs that humans or a society may impose. Thus the axioms form a basis to evolve major modules of knowledgeware (KW atop HW, SW, and FW) for a humanistic machine. At the outset knowledge may appear as an abstract and virtual entity but being channeled into appropriate levels of the knowledge space as being composed of interrelated KCOs, major BoKs, these noun objects soon start to appear as plants and shrubs in a garden rather than trees in a forest.

VI. STATE OF KNOWLEDGE

Knowledge like life spans micro-organisms to macrocosms. From a single gene to a vast galaxy, the implicit knowledge is the basis for existence. The activities of organisms form the theme for their ongoing existence. In the humanistic domain, knowledge within the human mind is the microcosm with order and structure for the purpose of gratifying the needs necessary for the survival of self, species and society. These constitute the primary needs. Pursuit of gratifying higher level of needs (psychological, emotional and spiritual) constitutes a secondary tier of activities. In a sense, knowledge gets clustered around objects (noun objects, *n's*) that play a role (verb functions, *v's*) in satisfying the primary needs and then the secondary needs.

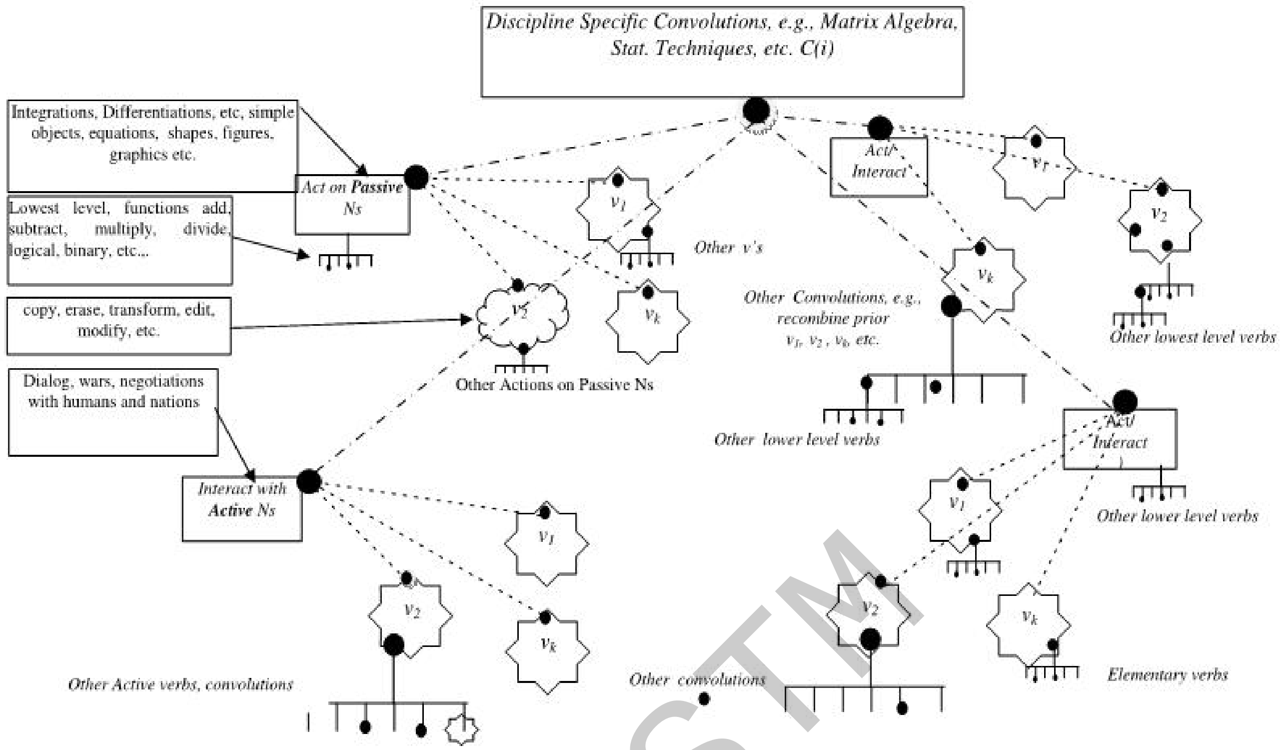

Figure 4 Depiction of a high level convolution (verb function) and the other supporting verbs such as acts, actions, verb functions, verbs that contribute to the high level convolution. The number of levels can vary significantly from one super convolution to another and is indicative of the depth of technology or processes in that discipline. Generally the routine processes in most disciplines can be investigated by three levels of processes.

The procedures for the need satisfaction is an ordeal in its own right; subsequently all aspects of knowledge to implement the mechanisms to satisfy such needs, except the most rudimentary needs, can becomes tedious and complex. In being thoughtful and algorithmic in implementation process, humans follow certain tracks and follow (verbs, *v's*), their most direct (convolutions,**'s*) highways[1] and byways in the gratification process involving one or more objects (nouns, *n's*). In general, the satisfaction of any need demands an expenditure of energy and the process of iterative convergence of the final solution is depicted in Figure 5. The noun objects and the acceptable verb functions (associated with these groups of KCOs, BOKs, and NO's) are each examined, reexamined and cross-examined till an acceptable solution is found or a new noun object is invented on the right hand side of Figure 5.

The state of knowledge in human mind is generally pragmatic and feasible, though less than perfect and optimal. Humans find a workable solution and then try to refine it. In a sense humans learn (acquire knowledge) to live and live to learn.

A. *Highways and Byways*

The binary encoding of information has altered our lives. Preservation of information and the derived knowledge both become feasible in any form of modern storage media cheaply, efficiently and free of errors. Transportation becomes equally amenable along any signal carrying media cheaply, efficiently and free of errors. The highways and byways for information and knowledge are only a click away in a networked society as much as a thought process is a twinkle away in an open mind.

Science and society have made unprecedented progress in the last few decades. Together they bring the accuracy of mathematics and the power of the knowledge in thought that creates new knowledge. The gain of knowledge in the small world we live is thus a double exponential. The processing of this new knowledge to blend with the prior knowledge becomes as essential as the blending of reason with wisdom in order to preserve a sane society. Failures to develop deploy and universalize the structure and use of gainful wisdom from new knowledge is to open the doors to knowledge wars. It

[1] In the words of an Indian poet who pleads: Know the passages within your heart, You may traverse many times to sort, The shadows of those who dart, In and out till it is time to part.

appears almost like stepping into the footsteps of Hitler [14], Stalin [15] and Mao [16] who stepped into death sentences and military wars.

Based on the immediate societies and adjoining communities the highways and bye ways of communication provide enough means for a healthy competition. Spam and unwanted emails offer sufficiently low level annoyance. Universities compete for students, businesses compete for clients, etc; wars rarely emerge. However, pushed into next two layers (nations and worlds) of organizational entities, the use of knowledge to fight dirty wars is eminently feasible.

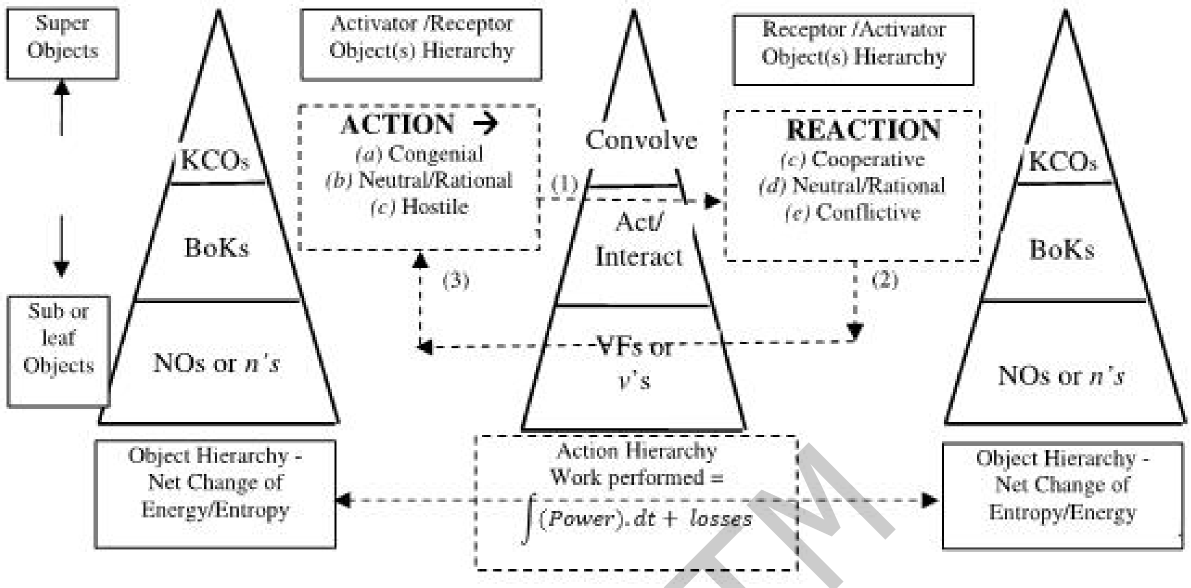

Figure 5 Representation of most active and passive actions, interactions, verb functions, verbs and processes that are feasible between super objects, knowledge centric objects, bodies of knowledge, nouns, and noun objects. There are corresponding changes in energies and entropies of objects as a result of actions in the associated the numerous space shown in Figure 2.

B. Nation of Knowledge

Nations at war is an ongoing scenario. Greed and malice are never too far from humans who deploy mathematics and science to suit. Special interest groups (SIGs) and self propagators who are close enough to both groups (the DAH group; deception, arrogance and hate and the SET group; science, economics and technology) will deploy SET into DAH, and *vice-versa*. Nations of knowledge in conflict emerge and knowledge wars (based on nuclear, petroleum, refinery, techniques) develop. The wisdom component is missing in both groups. Unabated, history of intellectual slave-trade and religion-for-sale will become business enterprises assuming new names in the future knowledge society. The handwriting is already on the walls of corporate headquarters of many a mobsters.

Global fiber optic networks and trans-oceanic dense wave-length division multiplexed highway systems serve the intents of SIGs as well as needs of the societies. The access to power of deployment of these potent computer and communication technologies without the temper or discipline to evaluate the global impact is an open door way to the death of a society. Only a few notables of the past (Lincoln, Kennedy, Carter, Einstein, Tesla, Marshall, and alike) have brought immense social rewards without personal gain, even without global information highways.

C. World of Knowledge

Astronomy and space exploration have shrunk our world and proven that science and knowledge are indeed universal. They bring the far reaches of universe on to HDTV screens. The sensors to scan the universe and networks to communicate obey the laws of physics and mathematics embedded in a framework of knowledge with order and discipline. The expansion of information is phenomenal in comparison with our capacity to process the newly acquired information.

The need for processing knowledge is urgent while traditional computers are idling away tracking junk information and hype knowledge. The proof of this scenario is the lack of human-ware to reach over the under-deployed supercomputers in scientific laboratories and unlit fibers buried in the oceans. The world of knowledge surrounds us willing to be subservient partner for the scientists and knowledge machinists who can deploy the hardware, software, firmware, knowledgeware, and finally the human ware that intellectually surrounds the unused silicon chips in the laboratories and optical fiber lying deep in the ocean beds.

D. Universe of Knowledge

Knowledge is alive but not well everywhere. It almost has a life form adapting to survive everywhere. It can assume all

IJRSTM
ISSN ONLINE: 2455-2240

the attributes ranging from being healthy to sick, half-dead to gloriously alive. The classification of the type of knowledge ailments, though feasible, is beyond the scope of this book. However, the dynamics of knowledge that deals with healthy changes in knowledge centric objects (KCOs) as they flow through the vines of society can be studied by scientific methodologies. During the ebb and flow, such knowledge centric objects can get damaged, become distorted, and become disconnected with the neighboring objects, thus losing their identity, cohesion and structure. This analogy with medical sciences starts to get too fuzzy too quickly.

However, the analogy can be meaningfully extended in physics and electrical engineering. Some of the major contribution in EE, signal processing and basic physics start to shed light on the possible degradation and degeneration of knowledge as it flows through society. After all, wave shapes and electrical signals carry information. They do get distorted and lose their shape. They are restored and original information is reconstructed. In coding theory, electrical signal wave shapes and their relative positioning with respect to each other carry the original information. In a similar setting, when information and knowledge pass through society, the KCOs, their structure and their interrelations start to get altered. Reconstruction and restoration of the signals for the ultimate recovery of data (and thus the embedded information) is a major discipline in and the design of communications systems and networks components.

When the concepts from transmission theory from electrical engineering (EE) are projected into the knowledge domain, the extent of degradation and distortion can be measured in terms of signal to noise ratio (SNR). It is indicative of the quality of received information as it passes through any transmission media. When KCOs flow through a social media (such as human groups, corporations, cultures, etc.), the extent of degradation of the KCOs, their interrelationships and their attributes is indicative of the nature and character of that social media. Originally embedded knowledge in the source and its representation after many media distortion become indicative of the nature or bias in the media. Knowledge machines can perform such checks and reveal the SNRs in a free society, a biased society, or a subversive society. In reality, such incidents occur too frequently to be ignored. During Mao's regime in China, dissemination of scriptures was banned, during Watergate scandal of Nixon era, white house tapes were conveniently destroyed, the during the Iraq war of the Bush and Cheney Administration, the KCOs (names of torturers and the tortured) of the Guantanamo Bay prison were blocked from news media. History bears painful scars of the past when the flow of truth-bearing KCOs is deceptively distorted, blocked or/and adulterated. Such distortions have occurred too frequently to be ignored.

The analogy cannot be taken too far because the classical laws of physics and EE can be too rigid and too well defined whereas the social laws and interpersonal interpretation are ill-defined and fuzzy. Fuzzy and ill-defined such laws might be, they are not irrational, false, or significantly inaccurate. To this extent, we follow the concepts for the flow of signals in transmission media and derive the general framework but discard them when the rules become inapplicable to the flow of KCOs. Signal flow analysis in digital subscriber lines, fiber optic and satellite systems use the laws of physics and EE but combine the results from various groups of environments by the laws of statistics to interpret the system performance of a given environment. In essence, the scientific foundation is established firmly and the applications are built atop the equations in physics and EE.

VI. CONCLUSIONS

In this paper, we present a framework of knowledge based on reality that noun objects drive verb functions. When verb-functions are convolved with noun objects, action, order and life starts to take shape. In humanistic systems, the energy to drive such verb function arises for the human needs and in machine/robotic systems the energy is channeled by application programs and software from energy/monetary reserves available as resources. Complex verb-functions can be decomposed elementary human actions in the human environment and to operation code level in knowledge processors. Humans and machines can thus coexist in close proximity monitoring the local and global accuracy, computation and viability of solutions.

The flow of knowledge from humans and machines is tied to the awareness and use of knowledge centric objects (KCOs) between minds and as flow of data-structures between machines. Such KCOs initiate, enhance, modify and terminate verb-functions to restore orderly transactions between human beings and machines. Such transactions exist everywhere from classrooms, hospitals and banks.

Further in this paper, we present a basis for customizing mathematical techniques and measures for gauging, extrapolating and exploiting past and current knowledge to meaningfully deploy it into the future. Physics and electrical engineering from the hard sciences are integrated with economics and operations research from social sciences and decision theory. The role of knowledge-oriented mathematics, computer sciences and knowledgeware atop of software, firmware and human-ware is delineated to make knowledge machines regiment, compute and evaluate and offer solutions to human and global problems.

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