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Research Article

Ontological Engineering in System Design: Bridging Human Cognition and Technological Systems

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ABSTRACT

The application of Ontological Engineering (OE) to QMH (Quantifying Mental Health) is intended to provide the system engineer with the ability to either design, analyze, and/or validate the system/subsystem of concern. The notions of designing, analyzing, and validating are addressed by the employment of Ontological Engineering based of Model Reference Subsystems. In addition, the methodology presented will provided a procedural mechanism for design and deployment of new systems and the analysis of existing legacy systems. Systems for which the methodology has been applied are as follows: Aerospace, auto industry, bio-engineering, data processing, weather prediction, and the stock market. Dorf provides an additional WKDB (World Knowledge Database) for exploitation and application to scientific/social systems.

Keywords: Ontological engineering; Intelligent systems; Modeling; Control; Brain; Sensor, Measurement; Knowledge; Thought

INTRODUCTION

The subject matter of this paper is intended to provide the practioner the tools to overcome the obstacles required to develop high fidelity knowledge data bases that are necessary to break today's bottleneck in intelligent systems, i.e., their brittleness when confronted by the unforeseen problems encountered when attempting to capture the full spectrum of human knowledge and reasoning. As such the system engineer will satisfy customer demands regarding legacy systems and migration of these systems to modern hosting platforms and languages.

Since the design of such a data base is constrained to maintain the properties of how the human brain works, the design requires a representation of the true world with sufficient fidelity that will enable the intelligent system to "compile away" the general knowledge and assumptions in order to produce efficient, special-case rules and procedures necessary to solve the complex problems of associated with various systems.

Since the objective of this treatise is to capture the full spectrum of human knowledge and reasoning, it is necessary to introduce the philosophical notions that will be drawn upon. These notions will serve as the baseline assumptions from which the mathematical theory for the model reference system will be designed.

Philosophical concepts of ontological engineering

Ontological Engineering can best be defined as the "engineering of systems based on knowledge of how the human mind operates". Therefore its success of implementation is based on the designer's/analyst's ability to harness the psychological and physiological knowledge of the mind and the placement of this knowledge into an archival adaptive database.

Definition: Though the term was first coined in the 17th century, ontology is synonymous with metaphysics or "first philosophy" as defined by Aristotle in the 4th century BC. Because metaphysics came to include other studies (e.g., philosophical cosmology and psychology), ontology has become the preferred. The encyclopaedia Britannica defines the metaphysical ontology as the theory or study of being as such; i.e., of the basic characteristics of all reality [1].

MATERIALS AND METHODS

The philosophy of ontological engineering

As applied to an engineering system, reality is brought about

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by the discovery (estimation) of the state of the internal system extracted from the observations of the system multiple outputs as obtained from a set of measurement sensors [2-3]. For example, in the human system, two of these sensor systems are the persons ears and eyes. The state of the human would consisted partially of the persons hearing state and seeing state (Figure 1).

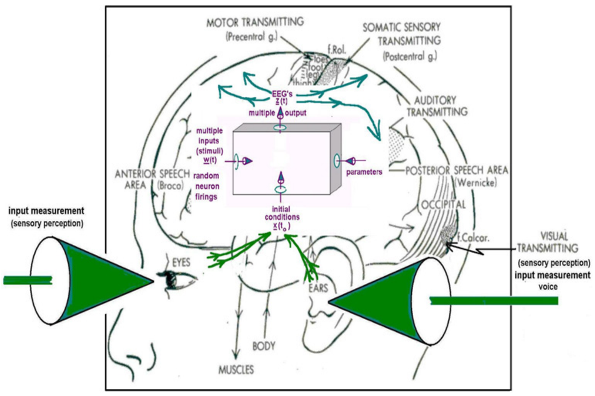

Figure 1: Human external stimuli~courtesy [4].

The extractions of the state from the measurements/observations is made possible by use of a model reference system which invokes the language of mathematics to delineate its features [5]. The translation of these observations into reality thru the language of mathematics (and its philosophy) is a branch of philosophy concerned with the epistemology and ontology of mathematics. "Early in the 20th century, three main schools of thought-called logicism, formalism, and intuitionism-arose to account for and resolve the crisis in the foundations of mathematics".

"Logicism argues that all mathematical notions are reducible to laws of pure thought, ontological principles; a variant known as mathematical Platonism holds that mathematical notions are transcendent ideals, or forms, independent of human consciousness. Formalism holds that mathematics consists simply of the manipulation of finite configurations of symbols according to prescribed rules; a "game" independent of any physical interpretation of the symbols. Intuitionism is characterized by its rejection of any knowledge or evidence-transcendent notion of truth [1]". Exercising intuitionism permits only the creation of objects that can be constructed in a finite number of steps and completely rejects the laws of thought. These three schools of thought were principally led, respectively, by Bertrand Russell, David Hilbert, and the Dutch mathematician Luitzen Egbertus Jan Brouwer.

RESULTS AND DISCUSSION

The philosophy of phenomenology

Improvements in understanding/knowledge evolved from the joint intellectual inquiries into science and philosophy, i.e., they were never separated. Edmund Husserl used the term Phenomenology to name a whole philosophy. In order to rid his transcendental investigation of empirical prejudgments and to discover connections of meaning that are necessary truths underlying both psychological and physical sciences.

Philosophy of science

The study, from a philosophical perspective, of the elements of scientific inquiry and of the validity of conclusions.

Philosophy of model reference system

In order to support of the decision automation problem, an innovative architectural solution must be developed. Such an architecture will provide the framework for deploying internally developed research, tools, and software technologies for robust plan generation. In addition, such an architecture shall mimic the human's cognitive processing abilities. These reasoning abilities shall incorporate a knowledge database and the use of metrics from which to provide a value judgment on the results of the design, analysis, performance, and etc. of the system being investigated (Figure 2) [7].

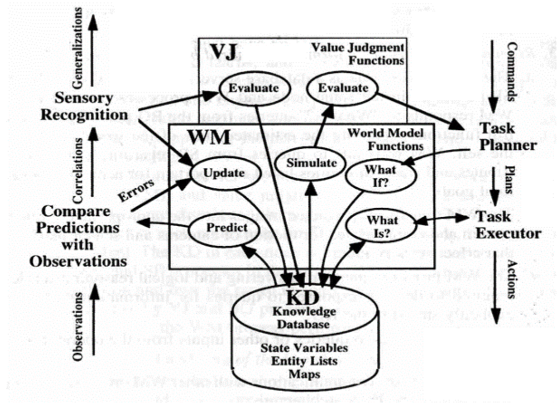

Figure 2: World knowledge database courtesy [6].

Attempts of utilizing Artificial Intelligence (AI) to design legacy architectures have failed. This failure can be traced (in part) to the inability to design and access a high fidelity knowledge database. Old AI techniques fell into the "representation trap which prevented multiple expert systems from cooperating or even sharing rules [4]". However, the basic assumption of classical AI was flawed. In part the failure of classical AI to live up to its potential is based in the fallacy associated with its basic assumption. In philosophy, reasoning that fails to establish its conclusion because of deficiencies in form or wording are defined as a fallacies. Formal fallacies are types of deductive argument that instantiate an invalid inference pattern (deduction; validity); an example is "affirming the consequent: If A then B; B; therefore, A." Informal fallacies are types of inductive argument the premises of which fail to establish the conclusion because of their content. There are many kinds of informal fallacy; examples include argumentum ad hominem ("argument against the man"), which consists of attacking the arguer instead of his argument; the fallacy of false cause, which consists of arguing from the premise that one event precedes another to the conclusion that the first event is the cause of the second; the fallacy of composition, which consists of arguing from the premise that a part of a thing has a certain property to the conclusion that the thing itself has that property; and the fallacy of equivocation, which consists of arguing from a premise in which a term is used in one sense to a conclusion in which the term is used in another sense [8-11].

CONCLUSION

The close links between thought and the brain having been amply demonstrated by the neurosciences, it is now time to draw conclusions. After having shown that the specific characteristic of Thought is the self, the author's underline the impossibility of explaining the self by objective study and the consequent need to preserve for the Thought its specificity in relation to matter-energy. After having excluded, by this statement, attitudes tending to deny explicitly or implicitly the specificity of thought and having rejected spiritualist hypotheses as not conforming to scientific data, only two possible interpretations remain: That of the identity of thought and matter-energy treats thought as the other face of energy, that of creation makes it necessary to admit a transformation from energy to thought (E=KP). The problems of thermodynamics and of the quantification of thought thus raised are considered. Whatever the solution, it is necessary to admit that a "Universal Thought" exists. The universe is conscious of itself. The effort of cerebralisation in the evolution of species seems a mean of giving autonomy to individual Thought which is necessarily included in Universal Thought. "Mantras were not viewed as the only means of expressing truth, however. Thought, which was defined as internalized speech, offered yet another aspect of truth. And if words and Thoughts designated different aspects of truth, or reality, then there had to be an underlying unity behind all phenomena".

AI assumptions include

- In every society, organization or group something works.
- What we focus on becomes our reality.
- Reality is created in the moment, and there are multiple realities.
- The act of asking questions of an organization or group influences the group in some way.
- People have more confidence and comfort to journey to the future (the unknown) when they carry forward parts of the past (the known).
- If we carry parts of the past forward, they should be what is best about the past.
- It is important to value differences.
- The language we use creates our reality.

The successfulness of the application of Ontological Engineering depends on the practiioner's ability to satisfy the assumptions upon which it is based. These assumptions are the same as those required to design and deploy ethical, sustainable, stable scientific/social systems.

REFERENCES

1. Marx K. Encyclopedia britannica. Encyclopaedia Britannica Ultimate Reference Suite M/CD. Chicago: Encyclopsedia Britannica. 2012.
2. Albus JS. The engineering of mind. Informat Sci. 1999;117(1-2):1-18.
3. Fermelia A. Closed loop methodology applied to simulation. Instit Electric Electron Engin (IEEE); 1983.
4. Ternyik S, Fermelia A. QMH *via* ontological engineering with a bias towards it's mood science. 2019.
5. Lenat DB. Ontological *versus* knowledge engineering. IEEE Transact Knowled Data Eng. 1989;1(01):84-88.
6. Albus JS. Mechanisms of planning and problem solving in the brain. Mathemati Biosci. 1979;45(3-4):247-293.
7. Dorf RC, Bishop RH. Modern control systems twelfth edition. Pearson. 2011;859-868.
8. Fermelia AL. Closed Loop Methodology (CLM) overview. 2015.
9. Mental health by the numbers.
10. Fermelia A, Ternyik SI. Third order mathematical model of the brain validated *via* cerebral evoked potentials. SSRN. 2019.
11. Ternyik SI, Fermelia A. Comparison of human and bullfrog neuronal characteristics. SSRN. 2021.