Superficial Analogies and Differences between the Human Brain and the Computer

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Abstract
This paper is an outcome of the studies of the following three articles namely,(i) the opinion of Mr.Micheal A.Arbib[15] who has actively advanced the notion that "the brain is not a computer in the recent technological sense, but that we can learn much about brains from studying machines, and much about machines from studying brains. His thoughts have influenced, encouraged, and enhanced many research workers in the field of neural networks",(ii) the study of the article entitled, "Integrating Language and Cognition", by Perlovsky[1] (Refer: Philosophy to applications, topic 5, of the article), and (iii) Authors' comment paper on Perlovsky's article[18]. The main objective of this paper is to present (i) some suggestions to overcome the limitations of the MFT algorithm[18],and(ii) an improved MFT diagram. Incidentally, this technical paper has brought out the differences between the human brain and the computer, with the intention of furthering more research in the area of Artificial Intelligence (AI), Artificial Neural Network (ANN), and also Computational Intelligence (CI), in order to improve the cognition procedure. At the end, some discussions on the improvement of the MFT diagram, have been presented.

Key words:
Cognition, Brain, Digital Computer, Computational Intelligence (CI), Artificial Intelligence (AI), and Modeling Field Theory(MFT).

1. INTRODUCTION

Historically, the mind is described in psychological terms and philosophical terms, whereas, the brain is described in terms of neuro-biology and medicine. Many research papers have come out recently on brain –like computing, cognitive science, and computational neuro-science, etc. Since cognitive science is the scientific study of mind and intelligence, the study of "superficial analogies and differences between the human brain and the computer", may be helpful in understanding the cognition process and on improvement of the MFT algorithm, developed by Perlovsky in his article[1]. Cognition involves a number of sub processes, and attributes, including internal representations and their manipulations, attention, memory, concept formation, knowledge, generalization, recognition, understanding meaning, prediction, imagination, intuition, emotion, decisions, reasoning, goals, behavior, conscious and unconscious (Grossberg [2]). Cognition process by computer may be better understood, if we know the working of the human brain. Finally, it is our effort to bring out the relevance of the digital computers in understanding the human brain and, in turn, knowing the working of human mind itself. Recently, Perlovsky[1] introduced a novel concept called Modeling Field Theory to explain the human brain's ability to recognize objects in the world and learn concepts, founded on the basic concept of a-priority and adaptation. This study was emerged due to the existence of some loop holes in MFT algorithm during the process of recognition. Mind versus brain is an old philosophical controversy, which has been resolved today by computational Intelligence. Since the efforts are going on in the area of Computational Intelligence by various research workers throughout the world to replicate the organic brain in a machine. Hence, this comparative study of the human brain and the computer justifies the work carried out by the authors. The research work i.e, presented in this technical note, is just a supplement to the work already done by several people. The results have been given below in the tabular form(2), that consists of similarities and differences between the brain and the computer.

2. SIMILARITIES DIFFERENCES

Construction material
Human brain is the organ (a highly complex nonlinear system) for information processing. The Basic unit of the brain is the neuron (a biological material). It consists of $10^{\wedge 11}$ neurons. The brain processes 100 trillion synapses which connect the neurons. Carbon technology is used in brain. Brain contains chemical elements such as carbon, hydrogen, oxygen, Nitrogen etc.,. It is an organic system.
Basic unit of computer is silicon chips/transistors (an inorganic material) GaA's are the main components in super computers[4]. It contains static elements, and needs $10^{\wedge 12}$ logic circuits. Now-a-days VLSI technology is adopted in the circuitry of computers. It is an in-organic system.
Memory growth
The brain's memory grows by stronger by para synaptic connections. Neuronal circuits play an important role in the increase of the memory. Memory capacity is equal to 10^8432 bits.

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Whereas, the computer memory is enhanced by adding more chips. Memory size is limited.

Memory system

The brain has a memory of events and words. Memory is affected by physical fitness. Memory is a recording machine, and it possesses free association property.

Computer memory consists of RAM and ROM chips etc., . Now- a- days bio- chips have been developed. Recent technology of computer memory consists of biological storage devices (Rhodopslin).

Back-up systems

The brain has built-in back-up system i.e. if one of the pathways in the brain is damaged, then there is often an another pathway that can take the function of the damaged path. The brain is a self-organized system.

Memory power

Human brain's memory power is around 100 terra flops. (i,e,100 trillion calculations/sec). 100 trillion synapses hold the equivalent memory power around 100 million mega bytes.

Memory density The packing density of the brain is 10^7 circuits/cm3 i.e,10^4 times more densely packed with the information. Memory density is independent of location (addresses). It is in space, and is subject addressable.

Memory density in computer is 10^14 bits/cm3. Generally the memory is specified in terms of positions and locations, and hence it is label addressable.

Memory power in computer is around 10^12 bytes, which is equivalent to 100 million mega bytes[4].

Back-up system in computer is provided by secondary storage devices such as floppy disks, CD-ROMS, Hard disks, pen drives, etc.,.

Information storage

Information stored in the brain is in the form of Electro chemical and Electro magnetic form. The brain uses neuronal circuits to store the information. It stores the information throughout the network and also at the molecular level. Stores information in a classified way.

In computer, the method of storage of information is numeric and symbolic[9]. It stores the information in terms of binary bits in the pattern of 1's and 0' (on and off switches).Stores information in a non-classified way.

Memorization Procedure and method of access and retrieve

The brain's memorization is interconnected (synapse connect) and it scans a group of information at a time. The brain retrieves information by associating facts with others. Classification systems give rapid access to the information and also to store it. The brain can access information by its contents. Process of association is a major feature of biological memory, whereas, a partial feature of the object triggers the retrieval of the complete information of the object. The brain seems to store and re-call pattern based information, with associated memory.

In Computer, memorization procedure is in the form of bits[11]. It is like a ward-robe. Computer retrieves information instantaneously.

Size and Weight

The volume of the brain is 1500 cm3 and its weight is around 3.3 pounds. The size of the neuron is very small compared to a chip.

The weight of the computer varies from a few grams to many tons and is miniature in size.

Energy

Brain needs nutrients like oxygen, glucose and sugar for power and uses 12watts of power.

The computer needs electricity to keep working and uses Giga-watts of power.

Use of electrical signals

Brain uses chemicals to transmit information.

Computer uses electricity to transmit information.

Information processing system

Brain's processing power is infinite and provides on line processing. Processing power is around 100 terra flops i.e. roughly 100 trillion calculations/sec. The brain processes information slowly, since neurons are slow in action(order of milli-seconds). It is 10^5 times slower than the electronic components. It is 1000 instructions/sec/neuron. It uses Electro-chemical reactions to process. The cerebral system cannot be relieved at will.

Computer processing power is large and it is due to fast transistors. It is million times faster than the brain. Processing power depends upon the type of processors. Super computers composed of tens of thousands of the fastest micro-processors and can process a few million instructions/sec(MIPS).

Constituent parts

Brain – $10^{\wedge 15}$ cts/neuron

Computer – $10^{\wedge 10}$ cts/neuron

Input/Output Equipments

In brain, it is through sensory organs (Receives information through eyes, ears etc.,) , and does action through hands, feet etc.,.

No sensory parts; Input devices like keyboards, mouse and sensors like web cameras etc.,; output devices like printers, monitors etc., [3, 9].

Structural Organization

Local organization of the brain is largely self-organized and it is adaptable to a large number of situations. The structure is hierarchical.

It possesses a pre-programmed structure and not self-organized.

Reliability and Damageability properties

The brain has an overall reliability due to its self-organizing and self checking features. The brain is also self-maintaining. However, functionally speaking, human memory is prone to mistakes. It has a substantial redundancy property[4]. It is a fault tolerant system which

has fidelity characteristics. There are no new used parts for the brain. However, some work is being done with transplantation of nerve cells for certain neurological disorders such as Parkinson's disease. It gets tired and fatigued.

Computer is reliable but it can't correct itself. Any failure in one path means the failure of information. It is easier to fix a computer by just getting new parts. It performs a monotonous job.

Working Principles

The brain works on Electro-chemical and on Neuro-transmission principle[11]. It works on the following three principles i) Molecular ii) Sub cellular, iii) Organism. The brain is an analog system. It works on both serial and parallel processing principles. It has a function system operation, i.e., memory, emotions, etc.. It works on semantic property.

Working principles of the computer is based on ALU, Control unit, and memory. Computers are working at two levels viz,. 1)Software 2)Hardware. Massive parallel processing is possible. It works on syntactic property.

Transmission and Communication

Neurons in the brain are either on (or) off by either firing an action potential or not firing an action potential, because the excitability of information from other cells through synaptic contacts. Information traveling across a synapse does not always result in action potential; rather this information alters the chance that an action potential will be produced by raising or lowering the threshold of the neurons. In brain, it is through synapses. (It acts as a toll-gate.) A communication is done with the help of neuro transmission receptors and modulators. The rate of information transmission is slow, being 10-30bits/sec. Signal transmission will be at the rate of 0.04 million instructions/sec. The pulse duration is of 1/10 sec.

In computer, communication is through Electrical (data technology) coded signals and Electro-magnetic pulses. The signals speed is very high and is of the order of $14x10^{\wedge 4}$ mega instructions/sec. Computer uses switches that are either ON or OFF.

Performance criteria

Brain's performance is increased by its use.

Computer's performance depreciates by its use. However, techniques have been developed to improve the performance of the computer. eg. Intelligent neural networks.

Computational and Notational Languages

Language is the key linkage which, makes both brain and computer to work efficiently. The brain does not work on binary system. It is innately pre-disposed to the decimal system, since we have ten fingers and alphanumeric strings. It can create new symbols out of its resources and can adapt to natural languages.

Presently, computer works on binary mathematics[12]. They are faster in computations and logic. Can't create new symbols until it is defined and can't adapt to other languages except machine dependent languages/computer languages.

Safety measures

In brain, skull provides the cover. Spiritual mind is an anti-virus package for the human mind.

Computers are protected by hand cover. Firewalls act as anti-virus package to virus infected computer, to protect from virus attack.

Adaptability and learning abilities

There exists local memory in the brain. The brain learns more than it consciously remembers. It can handle fuzzy better. The brain works on heuristic principles, and on the theory of rejection. Human brain seems to be consisting of largely regular structures, and trimmed neurons that are developed and learned. It can learn from experience. It also does multi-tasking using autonomous nervous system viz,. controlling breathing, heart beat rate, blood pressure etc., along with the handling of simultaneous tasks. Any unknown repeated information is adapted by the brain.

In computer the distributive learning is present. It learns those things which are in its memory. Learning is ,yet, in its infant stage. Efforts are going on to learn on uncertain imprecise and fuzzy things. Computers have a fixed set of programs, and it can do multi-tasking programs. If an undefined command is repeatedly given to the computer, it won't accept.

Evolved over time

The brain has weighted 3.3 pounds in the last 1, 00,000 years. Scientists say that the brain has been evolved over millions of years.

Computers have evolved much faster than the brain. Computers have been around a few decades, yet a rapid technological advancement has been made by computer in the last few decades.

Both can be Modified

The brain is always changing and being modified and there is no "Off" for the brain. Brain works even while in sleep i.e. Signal transmission will take place.

Computer changes, when it's Hardware and its Software gets changed. There is an "OFF" for the computer. When the power is off, no signal transmission takes place.

Mathematics and logistics

Brain is better in interpreting the outside world and it can come up with new ideas and it can also imagine.

Computer is faster in doing arithmetic and logical things.

Studied by Engineers and Scientists

There are thousands of neuro-scientists studying the human brain. Nevertheless, there is still much more to learn about brain. There is more 'we do NOT know about the brain', than what we do know about the brain.

Computers have been studied by engineers and there is a constant change in technology to suit the needs.

Information furnishing method

DNA furnishes a cell how to assemble proteins.

Whereas, computer programs instruct a computer how to process information.

Parallelism

Brain possesses a massive parallelism.

Computer possesses parallelism but to a limited extent. CPU is capable of performing several jobs at a time, one at the front end and others at the back end. Hence it provides parallelism.

Creative Power

Brain intrinsically possesses a creative power. It is the human brain which has created the computer. Creativity is the hall-mark of the brain. Brain's activities are not pre-defined.

Whereas, computers are crudely developed by human mind. Computers can never create the human brain. The programs are pre-defined.

Intelligence

The brain has a natural intelligence.

Whereas in the last 10- 20 years efforts are going on to bring an intelligence into the computer (Artificial Intelligence) [8].

Concept of Finite theory

Brain adopts the concept of finite theory.

There exists a concept of finite theory in computer also.

Intelligence Quotient

For brain, if we consider 100 units.

The Modern Computer possesses an order of 0.2 units.

Architecture and circuitry

Cortex, brain, Stem circuits make an assemble of integrated modules, that function together as a whole.

In the same way the CPU, input and output units in the computer function as a whole.

Evolution

Brain has been evolved through natural selection[18] and adaptivity is the main property of the brain. Brain makes 'approximations' to make solutions.

Computer doesn't possesses the above properties. It is yet to achieve.

Working method

Brain works in non-algorithmic way

Computer works in algorithmic way

Computations

Brains does computations consciously

Computer does it unconsciously

Reasoning method

Brain provides common sense reasoning

Computer lacks common sense reasoning

Understanding capabilities

The Brain possesses understanding capabilities

Computer lacks understanding capabilities

Software

Mind is the software of the brain

Programs are the software of the computer

Data

Brain can work without data;

Computer requires minimum amount of data to work.

3. THE FOLLOWING ARE THE IMPORTANT FINDINGS OF OUR OBSERVATIONS BASED ON THE ARTICLE[1] AND THE PRESENT WORK BY THE AUTHORS

1) In the last decade computational methods have been developed taking the advantages of unknown mechanism of the mind and the brain. But still, knowledge is far from complete. Among the big unknowns are relationships between cognition and language.

2) There should be integration between cognitive model and language model, But, Perlovsky has mentioned in his article, the language model as an independent model.

3) "Are the computational procedure by which the brain processes the information, the same as the procedure by which the computer processes the same information"? (This problem is posed by John Searle[16]).

4) It is said that the mind operates with concepts but it is not yet known whether computer can have concepts like the mind.

5) The brain access memories by contents. How about the computer?

6) When we show a car to the child, we say that 'This is a car' to the child, then it sees the car and it records the scene of the car along with its name. Parameters for recognition are ("Scene (Vision) ,Language").The machine should take into account these two parameters for recognition procedure.

7) Perlovsky speaks of computational intelligence with respect to the MFT model. But in human being a biological computation takes place (Refer paper Subhas Kak[17]).

8) Intelligence is something that can be constructed with the pattern matching and feed back loops of various kinds.

9) Learning by imitation and experience is important.

10**) In reality the memory is fundamental to mental operations. Without this, there could be no intelligence**.

11) Brain rarely uses a single representation. Instead, it runs several sceneries in parallel so that multiple view points are possible.

12) Memory is the mechanism that records, stores and classifies information, making its subsequent retrieval possible.

4. SUGGESTIONS TO IMPROVE MFT

After studying the differences between the human brain and computer, the following concepts may be useful in improving the MFT algorithm.

I. Supervisory learning
II. Association property
III. Memory and storage devices
IV. Label addressable
V. Subject addressable
VI. Working on non-algorithmic way/Fuzzy way
VII. Redundancy (These are equivalent to concept of many models Mk(Sk) of Perlovsky's algorithm).

5. DISCUSSIONS ON IMPROVED MFT DIAGRAM

Perlovsky in his article ([1],p.8) has discussed in detail the importance of memory for recognition process, but in his MFT algorithm he is not taking into account of this factor. This comparative studies between the human brain and the computer has motivated the authors to think of adding a memory block in the MFT diagram, since one must remember that finally, the MFT concept advanced by Perlovsky is supposed to simulate the human organic brain with the machine for recognition. The memory is the foundation of Intelligence. This memory block must contain initial concept models as fuzzy entities corresponding to the objects of the world. These are also a-priori adaptive and changeable models i.e the concepts of "forms" of Aristotle. These forms meet matter via fuzzy concepts in the recognition procedure. A memory is essential for learning. Therefore, learning is combined with a-priori knowledge contained in the models. as it is well known that the meeting of the known (Organized Knowledge net-work) with the new one is one of the fundamental concepts of cognitive learning theory. The authors also substantiate the necessity of adding the memory block in MFT diagram by studying the example presented in [19] and the same is borrowed by Perlovsky in his article([1],Fig.1).This fig 1 is with respect to the recognition process of 'smiles' and 'frowns' in the background of strong noise. In this image processing problem (refer part (c)of Fig.1) , an initial model is considered to start the MFT algorithm so, the memory block which authors have suggested is required to store these initial fuzzy-models to initialize the MFT algorithm for recognition. Secondly, a general theory of MFT developed requires an explicit specification of partial Similarity measure l(n/k)[18] in terms of models Mh(n) and data(X). At the initial stage, Mh(n) should be known to compute l(n/k)., In view of all these arguments presented above, this proposed MFT diagram shown in the following fig.1 must contain a memory block in the MFT diagram. Or the model that is shown in the original MFT diagram may be merged in the memory block itself. The proposed modified MFT diagram is shown below (fig.1a.) by adding an additional block of "Memory" to the original diagram.

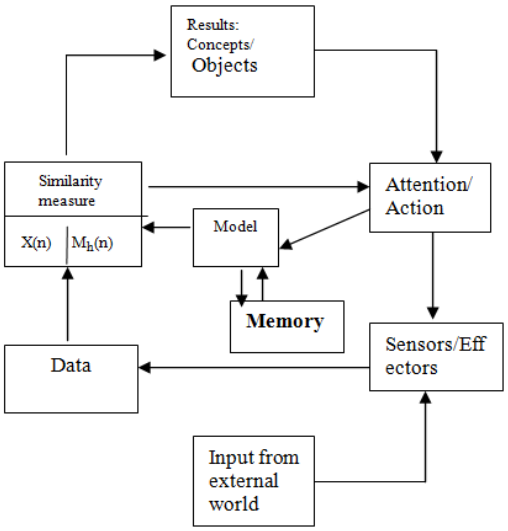

Figure 1a. Modified MFT diagram

6. CONTRIBUTION OF THE PAPER

1) A few relevant suggestions to improve MFT.
2) An improved MFT diagram (containing a memory block) to remove the loophole mentioned in the article (Refer[18],p-48,II part-shortcomings of the MFT , an item A).

7. Conclusions

After the exhaustive studies between the human brain and the computer, it can positively be said that the brain is far superior to the computer. It is a known fact, that the brain is a conscious entity vis-à-vis the computer. In spite of the high advanced research work in the area of Artificial Intelligence, still, scientists are struggling hard to comprehend the riddle of the human mind. And finally, the work that is discussed in this paper may be useful in the research work into neural networks which is one of the most exciting and rapidly expanding field of science today, bringing together, computer science, psychology, mathematics and biology to discover, how the brain accomplishes the remarkable things it does. The concept of connectionism plays a vital role in the working of the brain. We can also know from this research, that deep structure of language is an instinctive to the human brain[16]. "Is it that

to know the working of the brain, should we look to the computers or the other way?". Next generation quantum computers may help to know the working of the brain. "Does a brain, a physical model of the mind?, Or is a computer a model of human mind?". In the technical paper[14], Human recognition system (HSR) and Automatic speech recognition (ASR) system, have been discussed at length. Therefore, the authors work substantiates the need to bring out the differences between the human brain and the computer". Also, the differences in the hardware involved (Brain versus computer) is the answer to the work mentioned above. So, it is justified to carry out the research in the area of brain and computer which will be greatly useful in the field of computer science, particularly, in the area of Artificial Intelligence. We know that after studying the technical paper [16] ,there exists a communication gap between the two areas namely, ASR and HSR systems. We hope that this work of ours might throw some light in bridging the communication gap between the two. Such a comparison is necessary to know the differences between human cognition/machine cognition. Since brain is a conscious quantity, cognition process is also a conscious thing. Perlovsky says in his article[1], mind operates with concepts and he further says concepts are internal models of the objects and situations. We think that mind itself is a conscious thing. So, internal models are of conscious things of an object and situations. Finally, this field of Computational Intelligence still makes us to think a lot on the improved version of the MFT.

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