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The Future of Processing

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Abstract— There is so much to learn from the mighty brain. The Brain is an intricate piece of art. Billions of neurons function incessantly, processing input and passing output, forming labyrinth of neural networks which are complex circuits, carrying valuable information. Computers have been emulating the brain. Arguments against computer's comparability to the Brain have always surfaced. How the mighty structure is able to process myriad types of data, without restricting to digital data. Today, we have sensors to feel the touch, piezoelectric to sense the adrenaline rushes and Siri to do the talking. Its computational and processing prowess is the brain's pride. Modern computing is leaving is no stones unturned to converge this distance. There is a need to re-measure the distance between the brain and the computer and the Future of Processing lays in deciphering these secrets of the brain.

Keywords—*Artificial Neural Networks; the Human Biocomputer; Artificial Consciousness; Self Programmability*

1. Introduction

Modern computer has moved on from being a mere calculator to an intricate machine which can do whatever you need. Modern computers have left no stones unturned to prove what they are capable of doing. From being present in every home to emulating human behavior, today's world cannot be imagined without computer.

Modern technology can give you directions, can run your entire business, even entire countries. This huge leap in computer science became a reality when we realized that computer is capable of doing everything we can do. Computer processes the same way our Brain does. Our Brain like any computer takes input, processes it and gives output. Many argue that the computer can never be comparable to the brain, because brain is much more complex than any computer ever made. The fact to be pointed out here is that any computer which exists today is much more complex than any which existed before. It took 6 million years for the human brain to evolve, how we can expect the human brain to build another "brain" in just 50 years.

The paper tries to predict the future of processing, a time when the computer can think, just like our brain. The future where, the computer is self programmable, where it is consciously aware. To be in a future such, we need to realize that computer can be inspired from the brain itself. Work has already been started in the direction. The microprocessor gets the basic processing unit like the brain i.e. neurons. IBM has developed a chip with 4000 cores which can process in the same manner the brain does. Each core has its own routing mechanism to send the information to the next core, just like the neuron does [6]. Another development is in the field of Artificial Intelligence (AI), where artificial neural networks help in cognition [7].

The 2nd section presents the brain as computational device. Emulating will be easier if we could clearly state the working of the Brain similar to that of a computer. In the 3rd section we try to explore the newly emerged concept of Artificial Consciousness (AC), give a computing model of our Conscience and hence predict the existence of the Self Programmable Computer. The conclusion and references follow.

2. Brain is a Computational Device

The very basic act of seeing performed by our eyes, is an example of computation completed by our brain. Though, completed by intricate network of neurons, it involves processing at every step. From the rods and cones deciphering the color to the brain retrieving the memory matching the input about the shape and the size of the object and output leading to the identification of the object.

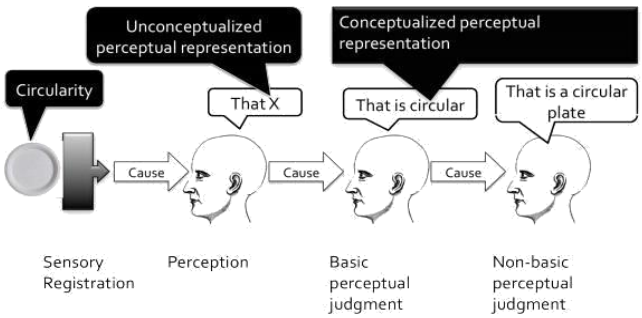

Fig.1: The act of Perception

The basic functioning of the Brain can be stated as follows: the brain has around 13 billion neurons, which are

basic processing unit of the CNS. The neuron receives input, processes it and sends output in the form of action potentials, generated due to potential difference of -70mW. Neuron sends the output to the target neuron through dendrites, which pose as the bus system.

Corroborating my above speculation is very popular approach, Computational Theory of Mind. [3, 4]. The computational theory of mind holds that the mind (the software) is a computation that arises from the (the hardware) acting as a computing machine. The theory can be elaborated in many ways, the most popular of which is that the brain is consider as a computer and the mind is the result of the program that the brain runs [5].

The brain derives output representations of the world from input depiction and internal memory in a way that is comparable with the theory of computation. These representations of the world depend upon the ability of the memory to store and update experiences and retrieve them as when needed. The previous line is monumental as a premise for the further text, and eventually our research question.

2.1 The Language of Thought

We should question whether the brain's thought fabricating process is innate or no. The brain is proud of its thought inducing abilities. The power of an idea is massive its results, either catastrophic or messianic. Language gave meaning to the very process of thought and communication. For, thought would have never existed without a language. Language is a system we have learnt, it was never natural and it has been programmed into us.

The MIT researchers have designed a novel computer program that, through listening to samples of speech, was able to recognize different categories of sounds [2], similarly to the procedure of a child learning the alphabet. Here, the comparison of the process of learning to the task of coding some basic set of procedure to a piece of hardware is inferable. The hardware is only able to think after it knows in which form to think. Next subsection discuses a very prominent theory by John C. Lilly, where he assimilates the consciousness as a Metaprogram [1].

2.2 The Human Biocomputer

This section discusses how the term computer is not only colloquially used for the brain, how it actually matches the functionality of a computer. The brain is self-computable till a very large extent. It needs the very basic (like language as mentioned above) but important help from the environment, but after that the conscience self-programs itself.

- This metaprogram controls other subprograms /subroutines. If we are restraining ourselves to appropriate behavior while in particular situation, the consciousness is at work.
- Programs are acquirable throughout life. They can be updated as well.
- The hardware part is the physical brain, which is made of complex circuitry, doing millions of computations in parallel. The brain is termed as the human Biocomputer.

All human beings, all persons who reach adulthood in the world now are programmed biocomputers. None of us can escape our own nature as programmable entities. (Lilly, John C. 1972)

The result: Brain and Computer being Analogous. This proves that more is derivable from the brain, which the modern- day computer can emulate for a brighter future. One such property of the brain is Self Programmability. The idea of a Self- Programmable Computer waits the next section.

3. The Self-Programmable Computer

Computers have never theoretically in the past programmed themselves. How do we program ourselves and what is the term for that are learning. When you learn, you program yourself, even when you were a baby just learning how to hold a spoon.

The Self programmable computer will be a consciously aware computer. It must adhere to the conjectured theory of Artificial Consciousness (AC). As the name suggests AC would mean a computer who could be aware of the surroundings and its internal states and could mould its direction of working accordingly. The aim of the scientific theory of artificial consciousness is to describe that which would have to be synthesized were consciousness to be found in an engineered artifact (Aleksander 1995).

3.1 The Structure

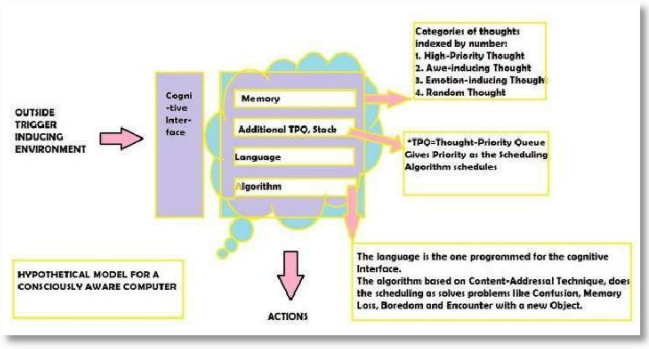

Fig.2: The structure of the Self-Programmable Computer

The self programmable computer will be much easy to envisage if we could make a working computing model of

our conscience. Our conscience is guided with the help of triggers. Triggers are events happening in the environment.

Though, external these triggers are the only factors which help our self-conscious function. The term consciousness always conveys a very autonomous meaning, but actually like every machine, our conscience too, is directed externally. It needs to be fed by input, which cannot be self generated. Hence, the concept of absolute intelligence is speculative, rather utopian. The hypothesized structure consists of (as depicted in Figure 2).

- Outside Environment: This provides events as input to be processed.
- A cognitive Interface: This Interface measures some pre-defined attributes. For e.g. shape, size, speed, color, length etc. The cognitive interface identifies objects and stores them in the memory in the language. The cognitive part detects the changes in the outside environment which are triggers to initiate thought process.
- The language: Every attribute will be some bit hexadecimal code, i.e. every attribute can have a number of variations. Every object will have a special combination of these attribute, differentiating it from other objects. Object code generation is depicted in Figure 3.
- Memory: The memory is broadly divided into two: Active and Passive.
  - Passive: It stores the object codes. It has the State Saving Stack.
  - Active: The transient part which has some broad thought categories indexed by number and the Though Priority Queue (TPQ).
- Algorithm: The algorithm is discussed in the next subsection.
- The Thought-Priority Queue (TPQ): As scheduled by the algorithm the TPQ has thought on it, with a priority for scheduling. Interrupts/Trigger can put the normal scheduling to hold to be on top a high-priority, awe-inspiring or emotion-inducing thought.

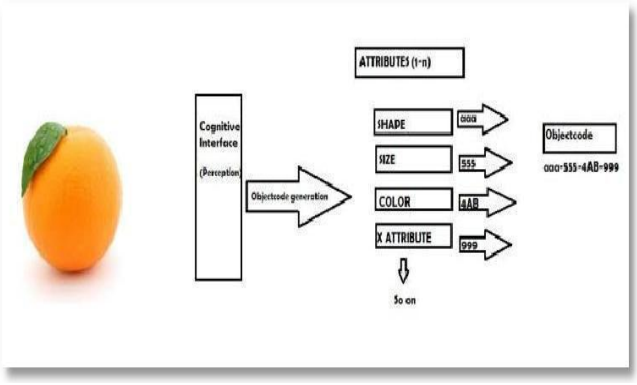

Fig.3: Object Code Generation

3.2 The Algorithm

- The basic algorithm works on a content addressable technique. The content addressable technique remembers how many time keywords have been used together and generates results predicting often used keywords with other. The various object codes are grouped in groups according to the number of times they have been perceived together. This string of object codes will be a Thought.
- One object code has an index number attached with other object. The more experience one object code has with other the more is their index number.
- When the cognitive Interface (CI) captures something, its object code is checked for availability in the passive memory. This is Recognition.
- Once the object is recognized, other object codes with highest index number with the recognized object code are loaded in the memory. This is Prediction.
- If an object code has not been retrieved from the passive memory for a long interval of time, all index number attached with it is reduced to 0. This process is Memory Loss.
- How are the thoughts categorized into various types?
  - The High-Priority Thoughts are short lived in the TPQ, i.e. object codes in this type are retrieved in the memory in a short span, a large no. of times.
  - The Awe-inspiring Thoughts are too short lived in the TPQ but are accessed for once or twice, but for a long interval of time.
  - The Emotion-inducing Thoughts are the once which have repercussions on the machine outside the computing device. (For e.g. crying, adrenaline rushes etc.)
  - The Random Thoughts are the ones where the computing device perceives something from the outside world starts processing, but the thought is not one of the broad categories of thought.

Now, explaining why certain phenomenon occurs, with the help of our model of consciousness.

A. Confusion

- Confusion occurs when a recognized object code, has same index number with 2 or more other object codes. Leading too much toil in the formation of a Thought.
- Confusion is solved when; an object code (say k@@@@@@@) is found which has different index in the two simultaneously generated confusing thoughts, the though tin which k@@@@@@@ has a greater index number is the thought to be loaded on the TPQ.

B. Awe

- Awe will be produced when a recognizable object code has no other object code indexed with it.
- That is, it has never been formulated into a thought.

C. Learning

- Learning is a very time consuming process, which is perennial. Our brain/consciousness has infinite processing abilities, infinite memory, and can process the most complex of the algorithm.
- The first time this model works, it sees a certain number of events/things in the environment which it object codifies and places as one thought indexed together.

3.3 Situation Simulation on our Model

To make it even clearer, let's assume a situation, and simulate it on the model.

- I look at the watch, it shows 5pm.
  Inference: The time is 5pm. Time is an externally programmed notion. Time helps to schedule my next piece of work, rather my next thought.
- Deadline for the essay is 10pm.
  Inference: It will take two hours to complete the essay, and another 1hr to reach home. The task essay is externally generated, which produces a High priority thought.
- Suddenly, a squirrel runs down a tree and catches my attention.
  Inference: squirrel is a trigger, an interrupt that shifts the current thought control to the trigger. Now our TPQ has the squirrel on the top, then the essay, then the time.
- Whilst watching the squirrel, I completely forgot when I entered the bicycle lane, and a cyclist collided with me, I fell on the ground with shock and immense pain.
  Inference: The squirrel puts us in an Awe-inducing thought state, which puts up a state in the machine, which is not really related to the type of states currently being processed, hence using most of the control. These thought can have effects like adrenaline rushes, delusion, impulsion etc. The next state is Emotion-inducing thought, which I am currently in. I am experiencing shock and pain from the hit. These states are realizable for some interval time and stay in the memory for a longer interval of time. Now the on the TPQ only the state of pain resides other have been stored in the State saving block. Now the pain recedes, I say sorry to the cyclist, look at the watch again, its 5:15 and start standing up to go back home. Now my queue reverts to the normal state, thought-priority order being;
  a) Essay deadline/reaching home.
  b) The pain.
  c) The time(The squirrel has exited the queue).

3.4 The Self-Programmable Computer

On the basis of the theory developed above, presenting a computing model of the Consciousness, a self programmable computer might come to reality. It is to be noted that self programmable computer would not miraculously conjure up programs and algorithms. For, the brain cannot also do that. Certainly, a few things might never actually be emulated, brain's infinite memory, its infinite computing ability which can process the most complex algorithm.

The self programmable computer would suggested learn with time. It is important that how now we are using humanly words interchangeably with technical terminology. It will take time to be fully autonomous, would need to undergo various simulated external environments. That would require external input because as pronounced above absolute intelligence can never be achieved. A newborn's brain would not just automatically start playing chess.

4. Conclusion

The first section of the paper depicts brain as a programmable device, which can be trained to think. Brain just like any other Computing device, has programmable functions, based on a set of Instructions. Also, this paper discusses several examples of current projects that represent modern research directions in computer science, ranging from artificial neural network's contribution in Artificial Intelligence (AI), neuromorphic chips mimicking the Neuron and Synapse to computer performing cognition. The meaning of the term processing does not limit to performing certain algorithms, it has developed, and it is now analogous to thinking.

The last section focuses on the near future, wherein the computer will be a conscious machine, deciding what do, when to do, when to do. To accomplish that we have to learn how we are conscious beings, how our conscience works. The modern day computer faces challenges similar to what a human does; it has evolved from a Calculator, to become an intricate structure.

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Harshita Trikha is a 3rd year B.Tech.CSE student at Ramanujan College, Delhi University, India. This is her first attempt at writing a research paper. Her findings and observations reflect her curiosity towards the extent modern processing can decipher or rather learn from the mighty brain. Her interests lie in the fields of artificial intelligence, neural networks, and artificial consciousness.