



Comparative Study on Correlation of Brain and Digital Logic.

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ABSTRACT:

Digital Logic is the advent of advanced engineering mathematical computational concepts that include Boolean logic, network analysis, etc., for developing a digital signal processing model, appreciated for its precision, accuracy, and noise-free communication in contrast to the analog communication model. However, the human brain is considered a unique nature engineering endeavour, which performs high standards of the decision-making process through a complex neural network evolving multiple logic functions.

The study analyses that digital-based devices and the human brain have several commonalities and the expression of technical outcomes reflects the underlying neural mechanism of human thought processes. The objective of the study is to explore how the neural mechanism of the brain and man-made digital communication run parallel to achieve desired results. This study hypothesizes that modern digital concepts are a result of the projection of the computation model of the human brain. The study concludes that communication modes within and across different regions of the brain are based on neuroscience principles and are far superior to the performance of a supercomputer. This aspect has inspired man to develop various models of neural work applicable to AI and ML models. Its application in medicine, space, education, etc., is well accepted.

Key Words: Digital Logic, Brain, Neural Network, and Computation.

Introduction

Man is a highly evolved creature of Natural evolution and the human brain is endowed with both general and unique capabilities to perform Concrete and Abstract functions (Goldstein, 1946). Concrete functions perform day-to-day activities to accomplish instincts such as drinking water to overcome thirst, food intake to fight hunger, etc, the above said behavioral response is to prevent the body from clinical issues such as dehydration, undernutrition, etc. Darwin's theory that addresses the successful existence of an organism is based on three pillars of existence a) Survival of the Fittest, b) Struggle for existence, and Species preservation [1] as opposed to abstract thinking [2] including cognition of mathematical, ideas, etc.

However, the survival of the fittest in highly evolved animals requires effective sensory and motor functions in order to exhibit suitable interaction with the environment cues which could be threatening or any other situations, etc., and to evoke appropriate responses there is a need to keep a constant awareness about the ever-changing surrounding environment and to make the decision for a smooth and efficient action to enable comfortable human existence.

Review of Literature:

The cortex of the human brain is the central apparatus for abstract perception, cognition, and developing meaningful ideas as well as decision-making functions. The neurons are the basic unit or building blocks of the human brain structure and elicit electrical impulses upon stimulation [3]. These are electrical responses arising from neurons. The neurons elicit both electrical and chemical responses [4] to various stimuli such as light, mechanical, heat, and chemical interactions. The response to these stimulations is recorded as sensory responses like a vision through the eyes, chemical stimulation as Odor sensed through the nose, taste by the tongue, and allergic response by the skin. The neurons express two types of electrical response; a) [5] and b) "All but None" response [6]. The first type elicits a gradient response with varying electrical potential of less than 5 millivolts (Mv) while the second type elicits maximum electrical response or no response. The combination of both response types operates to regulate involuntary and voluntary body function. The involuntary function includes regulation of heartbeat, blood pressure, pulse beat, etc. The voluntary function includes body movements such as hands while writing, tongue movements, chewing while eating, leg movements while walking, running, etc. Therefore, the salient features behind the two types of electrical responses of the neurons and their logical relevance in the processing information of stimulus from the surrounding

environment. This aspect of the biological signal processing concept guides toward the technical concept of signal processing are discussed in the main section of the article.

The neurons are the basic unit of the Human nervous system and the brain has innumerable clusters of neurons comprising more than trillions of neurons and each cluster of neurons is represent neural canter or neural generators [7]. There are several neural generators that are further grouped in different regions of the brain performing specific functions. The anatomy of humans is compartmentalized into the lower brain and the higher brain. The lower brain monitors and regulate body functions such as blood circulation, heartbeat, respiration, digestion, excretion, etc., that serve as system hardware. This is analogous to the system software of the computer. While the higher brain takes care of handling of sensory data such as vision, sound, smell, etc., the higher brain has a vital role in perception, cognition, motor functions, etc that work as application software

Objective:

To find a correlation between the concept of Digital logic of Machine Language and the Human brain's "All but None" logic of the electrical impulse of neurons.

Hypothesis:

The logic of the electrical response of neurons initiates the thought process evolving digital logic of the Machine Language concept.

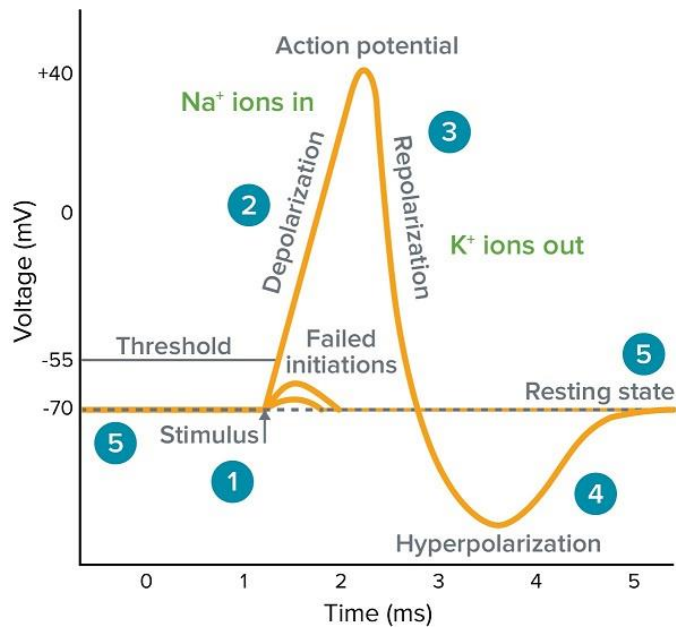
Neurons as Digital Logic Units:

The neurons are proposed as digital logic units they have different types of response to the same stimulus, they are graded responses i.e., they can be fractions referred to as gradient electrical response or All but None electrical response which resembles an integer response. But somewhat similar to "0" or "1" digital response. The anatomy of neurons has an interesting feature that is similar to the logic gate aspect of hardware that comprises on one end a lengthy single axon that serves as an input port to given stimuli, while the other end is a branched structure that serves as multiple output ports. The branched works as a multiplexer in generating alternate or parallel electrical output responses to enable a well-established neural network with different clusters of neurons or generators. The dendrites branched output [16] would also function as a choice response or selective filter to channel different response types processed by the preceding neural generator to pass on to the next neuron cluster or neural generator. This is analogous to multiplexer i.e. one to many and many to one demultiplexer hereby, this aspect of neural function works as a filter to enable a suitable output in the decision-making process.

There are various types of neural connectivity in which few neural networks conduct and differentiate response specific to stimuli. For example; stimulus modalities such as light rays trigger electrical impulses or responses in optic nerves[8],[9]the olfactory cortex triggers odor responses [10], gustatory receptors trigger an electrical response in gustatory nerves through taste buds [11] and the epidermal response below the skin triggers heat or cold sensation [12]. All these responses except visual are conducted through the brain stem which acts like a preliminary router and next advanced router-like function is the thalamus with its 10 nuclei serving as corresponding router inputs and another aspect, a priority of data process or akin to interruption command of a typical CPU, which is also a powerful router to drive selective intense sensory or motor response. It is the Limbic system of the lower brain that directs the action-specific neural network group to perform the required execution on an emergent basis such fight or flight response. Thus, the brain works as "All but None" Neural Electrical Impulse Response Co-relates reflects as natural Digital Logic biological signal" is the basis of the brain's digital function.

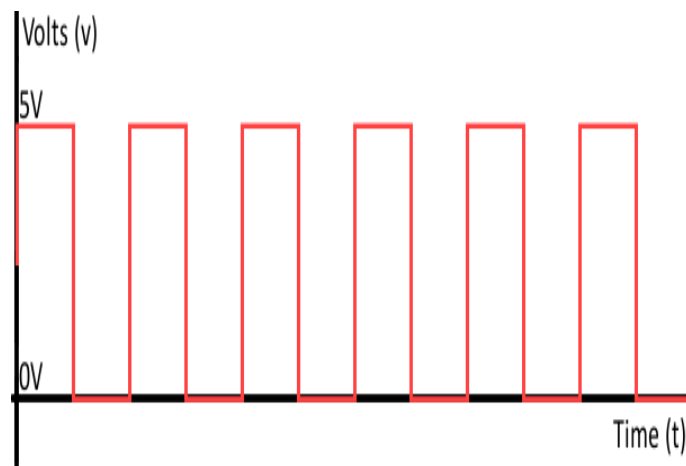
Therefore, the natural outcome of information processed by the brain is analog output but the neuron cell is the unit of the brain that generates "All but None action potential" equivalent to the Digital Signal function. However, when information is processed globally across the brain through neural networks the outcome is Analog in nature. Since stimulus input from the surrounding environment through sense organs is an Analog signal there by the outcome is also an Analog signal Therefore, It is Analog to Digital and back to Analog (ADA) but the outcome of the Digital concept by human intelligence will complete as ADAD. However, for the user, it is Digital to Analog and then back to Digital (DAD).

The neural network of the brain operates upon the interconnectivity of neurons through synapses, wherein, the connection between two neurons is referred to as the synaptic junction. The synaptic junction of the brain's neural work can communicate in Digital or Analog mode. The electrical synapse between two neurons [17] would operate in digital mode whereas the chemical synapse operates through the secretion of a chemical entity called "Neurotransmitters" (NT) [13]. It involves the secretion of NT from the pre-synaptic neuron membrane into the cleft of the synaptic junction and the same is absorbed by the post-synaptic neuron membrane that elicits successive post-synaptic action potential response [18] a digital-like action potential signal or it could be local potential, a graded response [5] similar to the Analog signal. This has the ability to convey the "All but none" Electrical nature of neural impulse response resembles the digital signal nature. The similarity between action potential and the electrical digital signal is shown in Fig. [14] [15]



Ref [14]

The networking of a group of neurons converts it to an Analog signal and regenerates a digital-type signal. This aspect of neural function is somewhat similar to repeaters that keep signals intact while performing signal propagation or signal transmission of messages. This component of transmission is performed by a combination of excitatory and inhibitory neurotransmitters. Another type of transmission is the electrical type which seems to operate similarly to the previous one and mostly works in analog mode.



Ref[15]

Working Brain Psychology:

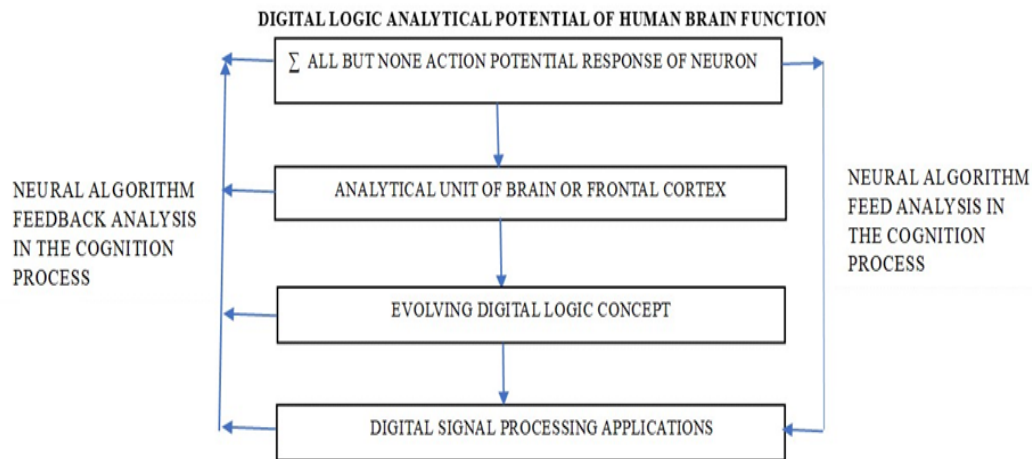
The higher brain is a unique device that has the capacity not only to deal with concrete aspects of the decision process but abstract level cognition involving the decision process, the basics of human information processing steps are akin to the CPU of a computer. However, various neural network models explain different aspects of the psychological domain of the working brain. Therefore, the field of neuroscience and computer science combinedly describe the brain function through developing neurocomputational models based on several mathematical versions of the decision-making process by sensory variables weighing input threshold further processed to evoke output that takes part in decision function.

Neural network model: AI and Machine learning

The neuroscience research has amply indicated that in animals' new neural network is formed during the learning process [20] This aspect has triggered computer scientists to understand and mimic brain function using modern IC-based design that can imitate the brain functions to some extent and learning methods adopted natural functions were investigated and trying to incorporate the similar logical functions of the brain in artificial machine-

based devices. For this purpose, an example is developing Fussy logic the logical component of the decision in the analog domain is the most difficult task as we mentioned earlier that at the neuron level brain, the unit of a fragmented information bit is digital in nature but the same on neural network level operates on the analog scale. Hence, the fussy logic aspect was more significant, especially by the device interacting with the natural environment.

The relation of Neurons generating All but None Neural Response as natural Digital Logic biological signal is indicated in the schematic diagram as shown below.



Discussion:

The interdisciplinary research to develop Brain like digital device and its application has been well attempted for various needs such as in aviation, medicine, and automation. The advanced development in this field is Brain-Computer Interface (BCI) [19] The BCI is a vital field for various purposes such as speed of human performance such as the defense that has complex operations in handling multiple devices set up like the petroleum industry, aviation, etc. And another implication is in the medical field for the comfort of the patients suffering from motor sensory impairments such as physical and mental disabilities, diabetic neuropathy, paralysis, and recent trail in managing patients with cognitive disorders such as dementia, Alzheimer, Parkinson's syndrome, etc. The need to understand the evolution of thought processes forming closed-loop feedback between the natural way of working the brain and the technical projection of the digital domain is very interesting and its relevance in solving complex problems by diagnosing through backscattering or deductive logical steps widely used in the medical, geological, evolutionary topics of life science, etc. And developing prognostic or predictive models about the future course of development in a few fields such as climate, nanoscience, pharmaceutical, medical field, etc. The need to revisit the understanding of brain function from the neuroscience perspective and interdisciplinary approach with the technical model have evolved the neuro-computational approach and the role of the mechatronics model as a substitute to restore impaired neuromuscular dysfunctions such as paralysis, neurological disorders, etc.

Therefore, the role of artificial intelligence (AI) in medical diagnostics would be a reflection of Brains' in-built logic component that matches the output of digital logic brought by the manifestation of the thought process of a biomedical engineer. This aspect has wider importance in understanding the capabilities of the Human brain to understand not only the immediate surrounding environment but also looking at the working logic of the universe. The most vital conflict of digital logic between AI and human thought process is consciousness, an intimate interaction between man and nature. Therefore, consciousness is a challenging factor between knowledge and interaction with nature, The natural intelligence of the human brain somehow works in conscious mode through unknown mechanisms. Since AI innovation attempts to compete with natural intelligence. This is an unparallel topic that is almost impossible to resolve. Hence, bridging the wide gap between natural intelligence and AI is the most challenging and hot topic of technological relevance. This aspect of technological achimenes is finding substitutes for human performance.

Conclusion:

The review study highlights that the notion of digital logic concept by human thought process has triggered from basic brain neuron response in terms of All but None response and on same line perceiving analog signal is also a contribution group of neurons that process stimulus in terms of graded potential. Therefore, conceptualizing Digital logic as the reflection of "All but None" response of neurons, whereas neural clusters of humans have the ability to convert digital messages to analog output and complex has led to understanding the basic features of the learning process and decision-making capabilities and its implication developing technical model of Machine Learning and Artificial Intelligence.

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