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A Research Study On Blue Brain

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Abstract— Human Brain is one of the most precious and complex creation of God. Every single action we take in our life is because of our brain. Different people have different intelligence levels but this intelligence comes to an end with death. Blue Brain project was started in order to preserve this intelligence by uploading it into a digital machine. Blue Brain will allow to preserve the personality, intelligence, feelings etc for a long time. This paper consist the information regarding to what is blue brain, how it is created, requirements, merits and demerits and much more.

Keywords— Blue Brain, Virtual Brain, Intelligence, Neocortex, IBM, BBP-SDK

I. INTRODUCTION

Blue Brain Project is an initiative to reverse engineer a human brain of a person with all the intelligence of that person and recreate it inside a super computer. Blue Brain project was started in May 2005 by the Brain and Mind institute by founding director Henry Markram in Switzerland. The main goal of the Blue Brain project is to create a biologically detailed digital reconstruction of a human brain inside a computer. If this is achieved human knowledge can be preserved for a long time even after death. The simulations are carried out on a supercomputer built by IBM named Blue Gene, hence the name Blue Brain.

IBM, The International Computer Giant has done research in intelligent neurons and developed a virtual brain known as Human Brain. This made huge improvement in the field of Super Computing. The supercomputing or high performance computing with Blue Brain is based on the current close connections between IBM and the Blue Brain technology. Because of its uniqueness this project is getting fame all over the world.

Fig 1. Blue Brain

II. NEED OF BLUE BRAIN

Intelligence is an inborn gift. Different people have different intelligence level. Some people have such a high level of intelligence that others really can't reach up to their level. But all of this comes to an end when life ends. This is where the need of Blue Brain is emerged. Blue Brain allows uploading the knowledge of a person on a computer and preserving it for a long time. This will also help in remembering things without any effort.

III. GOALS OF BLUE BRAIN PROJECT

A. Neocortical column modeling

In December 2006, first phase of the project which was the simulation of the rat neocortical column was completed. It is the smallest functional unit of neocortex which is responsible for functions such as conscious thoughts. A single column is about 2.0mm tall with a diameter of 0.5mm. Rat neocortical column has similar structure to humans but contains only 10000 neurons as compared to human neocortical column which contains roughly 60,000 neurons.

B. Progress

A. In November 2007, the first phase was reported to be completed.

B. In 2005, first single cellular model was completed.

C. By 2008, first artificial cellular neocortical column of 10,000 cells was built.

D. By July 2011, a circuit of 100 columns with around million cells was built.

E. In 2015, a quantitative model of relationship between glial cells astrocytes and neurons was built which describes the energy management of the brain.

F. Finally a cellular human brain is predicted to be possible by 2023.

C. Brain Simulation

At a TED conference, Henry Markram said that, "It is not impossible to create human brain and we will do it in 10 years."

IV. STEPS FOR BUILDING A BLUE BRAIN

A. Data Acquisition

B. Data Simulation

C. Visualization of result

A. Data Acquisition

Data Acquisition involves taking individual slices of brain, and placing under microscope for observation purposes, to measure the electrical activity and shape of the individual neurons. The neurons are captured accordingly by their morphology (their shape), location within the cortex, their population density and electrophysiological behavior. The method of cataloguing and studying is very familiar worldwide. The observations are then translated into mathematical algorithms which describe the function, positioning and form of the neurons. The algorithms are then used to generate biologically realistic virtual neurons ready for the simulation phase.

B. Data Simulation

The Data Simulation itself consists of 3 major parts namely:

i. BBP-SDK

ii. Simulation Speed

iii. Simulation Workflow

i. BBP-SDK (NEURON)

The primary software used by the BBP (Blue Brain Project) for neural simulation is a package named NEURON. It is a software development kit, developed in the 1990s by Michael Hines at Yale University and by John Moore at Duke University. It is written in C, C++ and FORTAN programming language. BBP-SDK is open source software and is freely available online to work upon (where the website includes the required codes and also the binary data for free). The BBP team collaborated with Michael Hines to port the package to the massively parallel Blue Gene supercomputer in 2005.

Fig 2. BBP-SDK

ii. Simulation Speed

The simulations of one cortical column (more than 10,200 neurons) run at approximately 300 times slower than real time. Which means one second of simulated time takes about five minutes to complete. The simulation display uneven line scaling (which indicates that doubling the size of the neural network doubles the time it takes to simulate). Currently the primary goal is biological validity rather than the performance.

iii. Simulation Workflow

It involves synthesizing virtual cells using the algorithms that were found to describe the real neurons. The algorithms and parameters are adjusted for species, disease stage of the animal being simulated and the age. Every single protein is simulated (and there are about a billion of these in a single cell).

Steps: Firstly, a network skeleton is built from all the synthesized neurons. After that the cells are connected together (based according to the rules that are found out experimentally). At last the neurons get functionalized and the simulation is brought to life. The blueprint of the emerging behavior is visualized using visualizing software.

Fig 3. Blue Gene

C. Visualization Of Results

RTNeuron

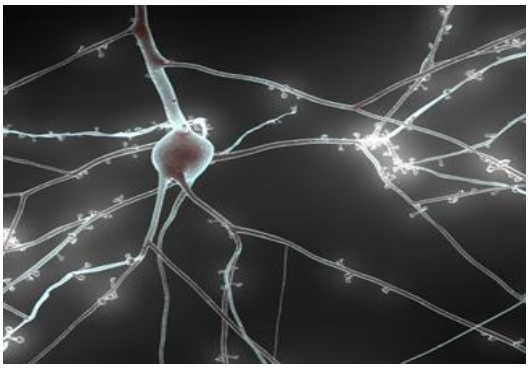

Fig 4. RTneuron

The primary application used by the BBP for visualization of neural simulation is called as RTNeuron. The software is written in C++ and OpenGL programming language, and was developed internally by the BBP team. RTNeuron is an ad-hoc software which is specifically written for only neural simulations (which means it cannot be used or generalized for other simulations). RTNeuron renders the output from Hodgkin-Huxley simulations in Neuron into 3D. Which allows the researchers to watch as activation potentials propagate through a neuron and between the neurons each other? The animations can be started and zoomed, stopped, letting the researchers to interact with the model.

V. FUNCTIONING OF NATURAL BRAIN

Humans have different abilities like ability to see, to interact, to feel etc. All of this is the work of our central nervous system. It's quite like magic, we can't see our central nervous system but it's there working through electrical impulse inside our body.One of the world's most "intricately organized" electron mechanisms is the nervous system. Even the engineers are not even close to create something precise as the nervous system.

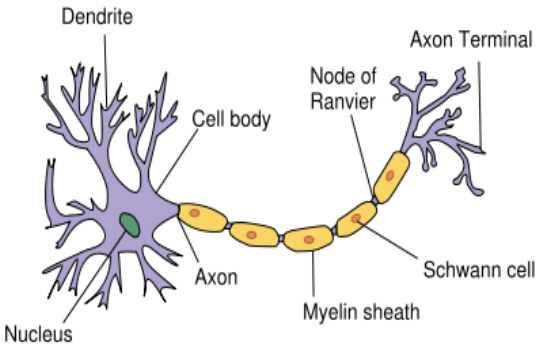

Fig 5. Neuron

To understand this system there are three simple functions.

A. Sensory Input
B. Integration
C. Motor Output

A. Sensory Input

When we touch something hot or our eyes see something the sensory cells, also known as Neurons sends a message directly to our brain. This action of getting information from our surrounding environment is called Sensory Input.

B. Integration

Integration can be defined as the interpretation of the things we have felt, tasted, touched etc with our sensory cell into responses that the body recognizes. This process is all accomplished in the brain where many neurons work together to understand the environment.

C. Motor Input

Once our brain interpret all that we have either by touching, seeing or any other sense then our brain sends a message through neurons to effecter cells, muscle or gland cells, which actually work to perform our requests and act upon the environment. How we see, hear, feel, smell, and take decision.

VI. UPLOADING HUMAN BRAIN

A. Uploading is done using small robots called Nanobots.
B. These robots being small travel through our circulatory system.
C. The structure and activity of the central nervous system is monitored by these nanobots.
D. They will be able to provide interface with the computer.
E. Nanobots can scan our brain and can provide complete readout of the connection.
F. This information allows the computer to function as us.
G. Entire data inside the brain will be uploaded to the computer.

VII. MERITS

A. Knowledge can be preserved long after the person's demise and can be used for further development.

B. Deaf people can be helped with direct nerve simulation process.
C. Faster decisions can be taken.
D. Things from the past can be remembered without any effort.
E. By interpreting the electric impulse from the brain of animals, their behavior can be understood.

VIII. DEMERITS

A. Since Blue Brain is a computer technology, it will always be prone to hacking.
B. Human will become dependent on Computer Systems.
C. Large amount of power is required for powering the machine.

IX. WHAT CAN WE LEARN FROM BLUE BRAIN

Using Brain simulations some of the fundamental questions can be answered which were not possible through experimental or theoretical approaches before.

Brain Simulation are the only approach that can allow us to explain why brain uses different neurons and synapse, a spectrum of receptors, and complex dendrite and axonal arborizations

X. REQUIREMENT- HARDWARE AND SOFTWARE

A. A super computer
B. Memory with a very large storing capacity
C. Processor with a very high processing power
D. A very wide network.
E. 100 kilowatts power consumption.
F. A program to convert the electric impulses from the brain to input signal, which is to be received by the computer, and vice versa.
G. Very powerful Nanobots.

XI. APPLICATION

A. Cracking the Neural Code
B. Understanding Neocortical Information Processing
C. A Novel Tool for Drug Discovery for Brain Disorders
D. A Global Facility
E. A Foundation for Whole Brain Simulations

XII. CONCLUSION

In conclusion, we will be able to transfer ourselves into computers at some point. Most arguments against this outcome are seemingly easy to circumvent. They are either simple minded, or simply require further time for technology to increase. Blue Brain Technology still requires 5-6 years to complete. There are good reasons to believe that, regardless of implementation strategy, the predictions

of realizing artificial brains in the near future are optimistic.

XIII. ABOUT AUTHORS

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