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Blue Brain

[1]J.Gowtham Kumar, [2]S.Jagadesh, [3]K.Arun kumar
Third Year, Department of Information Technology
[1]gowthamkumarj@gmail.com, [2]Jagadesh4321@gmail.com, [3]visitarun12@gmail.com
[1,2,3] R.M.D College Of Engineering

Abstract:
With the advancement in technology, human, the ultimate source of information and discovery should also be preserved. In other words, human is does not live for thousands of years but the information in his mind could be saved and used for several thousands of years. The technology helpful in this activity is Blue Brain. This paper consists of the information on Blue Brain project, concepts of Blue Brain, its requirements, strategies undertaken to build a Blue Brain, advantages and disadvantages and many more.
Keywords: Blue brain, virtual mind, BBP, Blue Gene, brain in super computer

1. GENERAL OVERVIEW

Based on: Blue Brain Project

Project aim: to study the brain's architectural and functional principles and construction of synthetic brain in a supercomputer

Project started on: May, 2005

Project undertaken by: Brain and Mind Institute of the *ÉcolePolytechniqueFédérale de Lausanne* (EPFL) in Switzerland

Project personnel: Henry Markram (Founding Director), Felix Schürmann (Co-Director), Sean Hill (Co-Director) Construction methodology: reverse-engineering of mammal brain to the molecular level.

2.WHAT IS BLUE BRAIN?

It's very clear by reading the general overview of what Blue brain is. Blue brain is a concept which allows to copy or to transfer all the contents of a human brain into a virtual brain that resides inside a Super computer. The Super computer used in this is Blue Gene as of the current information revealed. It is like uploading a mind in a computer. Mind uploading can probably be achieved by either of two methods: **1.Copy and Transfer or 2.Slow and steady replacement of neurons**. In the previous method, mind uploading would be achieved by scanning, comparing and contrasting the salient features of a normal biological brain, and then by copying, moving, and saving that information into a computer system or other computing machine. The stimulated mind then can reside into a computer that is inside a humanoid robot or a biological body. The IBM is now developing a virtual brain known as the Blue brain. It would be the world's first virtual brain. Within 30 years, we will be able to scan ourselves into the computers. We can say it as Virtual Brain i.e. an artificial brain, which is not actually a natural brain, but can act as a brain. It can think like brain, take decisions based on the past experience, and respond as a natural brain. It is possible by using a super computer, with a huge amount of storage capacity, processing power and an interface between the human brain and artificial one. Through this

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interface the data stored in the natural brain can be up loaded into the computer. So the brain and the knowledge, intelligence of anyone can be kept and used for ever, even after the death of the person.

3. NEED OF VIRTUAL BRAIN

Today we are developed because of our intelligence. Intelligence is the inborn quality that cannot be created .Some people have this quality, so that they can think up to such an extent where other cannot reach. Human society is always in need of such intelligence and such an intelligent brain to have with. But the intelligence is lost along with the body after the death. The virtual brain is a solution to it. The brain and intelligence will be alive even after the death. We often face difficulties in remembering things such as people names, their birthdays, and the spellings of words, proper grammar, important dates, history facts, and etcetera. In the busy life everyone wants to be relaxed. Can't we use any machine to assist for all these? Virtual brain may be a better solution for it. What will happen if we upload ourselves into computer, we were simply aware of a computer, or maybe, what will happen if we lived in a computer as a program?

4. HOW IT IS POSSIBLE?

First, it is helpful to describe the basic manners in which a person may be uploaded into a computer. Raymond Kurzweil recently provided an interesting paper on this topic. In it, he describes both invasive and noninvasive techniques. The most promising is the use of very small robots, or nanobots. These robots will be small enough to travel throughout our circulatory systems. Traveling into the spine and brain, they will be able to monitor the activity and structure of our central nervous system. They will be able to provide an interface with computers that is as close as our mind can be while we still reside in our biological form. Nanobots could also carefully scan the structure of our brain, providing a complete readout of the connections between each neuron. They would also record the current state of the brain. This information, when entered into a computer, could then continue to function like us. All that is required is a computer with large enough storage space and processing power.

5. FUNCTIONING OF HUMAN BRAIN

The human ability to feel, interpret and even see is controlled, in computer like calculations, by the magical nervous system. Yes, the nervous system is quite like magic because we can't see it, but its working through electric impulses through your body. One of the world's most "intricately organized" electron mechanisms is the nervous system. Not even engineers have come close for making circuit boards and computers as delicate and precise as the nervous system.

To understand this system, one has to know the three simple functions that it puts into action: sensory input, integration, motor output.

1. ***Sensory input:***

When our eyes see something or our hands touch a warm surface, the sensory cells, also known as Neurons, send a message straight to your brain. This action of getting information from your surrounding

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environment is called sensory input because we are putting things in your brain by way of your senses.

2. ***Integration:***

Integration is best known as the interpretation of things we have felt, tasted, and touched with our sensory cells, also known as neurons, into responses that the body recognizes. This process is all accomplished in the brain where many neurons work together to understand the environment.

3. **Motor Output:**

Once our brain has interpreted all that we have learned, either by touching, tasting, or using 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.

6. Achievements made in the technology

Typical scientists, impending research funders and scientific journalists are still doubtful on success of mind uploading. Significant mainstream research in related areas is being conducted in animal brains, comparing, contrasting and simulation, developing of faster super computers, virtual reality, brain-computer interfaces, connectors and information extraction from dynamically working brains.

Brain simulation is unbelievably inter-disciplinary research. It involves the domains like brain imaging, neuroscience, computer science, nanotechnology, AI, biotechnology, psychology, philosophy, and many more.

A progressively vast community of thoughtful researchers has arisen, taking this seemingly science-fictional knowledge seriously and running to it through experimental and theoretical research programs. These supporters mention many of the tools and ideas needed to achieve mind uploading activity; however, they also admit that it is very hypothetical, but still in the dominion of engineering potential.

Fig. Neuron anatomical model Fig. simple artificial neural network A typical human brain consists of approximately 85.5 billion of nerve cells called the neurons. Each neuron is individually linked to other neurons by axons and dendrites. Signals at the biological level of these connections are transmitted by releasing and detecting chemicals known as neurotransmitters. Neuroscientists have stated that important functions that a mind performs such as learning, memory, and consciousness, have been possible due to completely physical and electrochemical processes in the brain. Consciousness is a part of natural world. We believe that consciousness depends on mathematics and logic, laws of physics and chemistry and biology; it's not magical. The concept of mind uploading is based on this mechanical view of the mind. It denies the ritualistic view of human life and consciousness. Eminent computer geniuses and euroscientists have foretold that specially programmed machines will be capable of thought and even reach some level of consciousness. Such machine intelligence ability might offer a computational substrate necessary for uploading.

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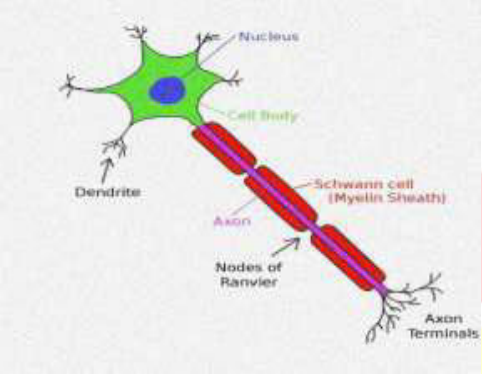

Fig. Neuron anatomical model

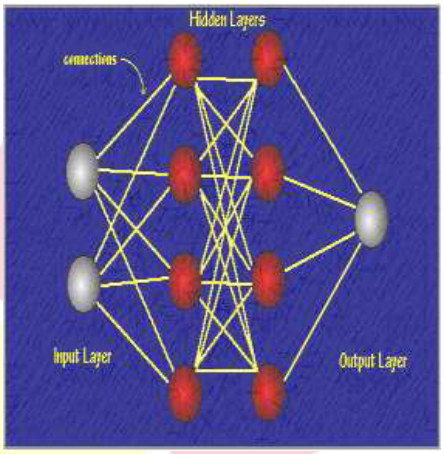

Fig. simple artificial neural network

7. STEPS TO BUILDING A BLUE BRAIN

1. Data collection
2. Data simulation
3. Visualization

1. Data collection:

It involves collecting brain portions, taking them under a microscope, and gauging the shape and electrical behavior of neurons individually. This method of studying and cataloguing neurons is very familiar and worldwide. The neurons are captured by their shape, electrical and physiological activity, site within the cerebral cortex, and their population density. These observations are translated into precise algorithms which describe the process, function, and positioning methods of neurons. Then, the algorithms are used to generate biologically-real looking virtual neurons ready for simulation.

2. Data simulation:

It concerns with two major aspects:

a. Simulation speed

b. Simulation workflow

Simulation speed

Simulations of one cortical column (more than 10,100 neurons) run about two hundred times slower than real time. It takes about five minutes to complete one second of stimulated time. The simulations display unevenly line scaling.

Presently the major seek is biological soundness rather than presentation. After understanding biologically significant factors for a given effect it might be feasible to crop constituents that don't subsidize in order to advance performance.

Simulation overflow

Making virtual cells using the algorithms, written to define and describe real neurons, is the major seek of this step. Algorithms and constraints are adapted according to the age, species, and disease stage of the animal being simulated.

Each one of the protein is simulated.

Note: there are hundreds of millions of proteins in one cell.

a. First a network skeleton is built from all the different kinds of synthesized neurons.

b. After this, the cells are joined according to the experimentally found rules.

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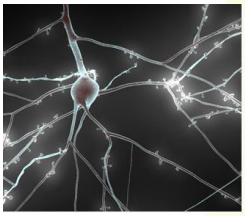
c. Finally the neurons are functionalized and the simulation brought to life.

8. BBP-SDK

The BBP-SDK (Blue Brain Project - Software Development Kit) is a set of software classes (APIs) that allows researchers to utilize and inspect models and simulations. The SDK is a C++ library wrapped in Java and Python.

9. Visualization of results



RTNeuron visualization of a neuron

RTNeuron

RTNeuron is the primary application used by the BBP for visualization of neural simulations. The software was developed internally by the BBP team. It is written in C++ and OpenGL. RTNeuron is ad-hoc software written specifically for neural simulations, i.e. it is not generalisable to other types of simulation. RTNeuron takes the output from Hodgkin-Huxley simulations in NEURON and render them in 3D. This allows researchers to watch as activation potentials propagate through a neuron and between neurons. The animations can be stopped, started and zoomed, thus letting researchers interact with the model. The visualizations are multi-scale that is they can render individual neurons or a whole cortical column. The image right was rendered in RTNeuron.

10. HARDWARE/ COMPUTER USED

1. Blue Gene/L Super computer (initially till 2009)

The first computer in the blue gene series. Trading the speed of processors for lower power consumption. Theoretical peak performance of 360 TFLOPS

2. Blue Gene/P Super computer (till 2011)

Blue Gene/P specifications:

- More than 4,000 quad-core nodes
- Each core is a PowerPC of 4.5, 8.5 GHz
- It consists of more than 6*1013flops, more than 15 terabytes memory
- 1 PetaByte of disk space and parallel file system
- Operating system: Linux SuSE SLES 10

3.**JuQUEEN (Blue Gene/Q) Super computer**

JuQUEEN supercomputer in Germany

JuQUEEN is an IBM Blue Gene/Q supercomputer that was installed at the Jülich Research Center in Germany in May 2012. It currently performs at 1.6 peta flops and was ranked the world's 8th fastest supercomputer in June 2012. It's likely that this

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machine will be used for BBP simulations starting in 2013, provided funding is granted via the Human Brain Project. In October 2012 the supercomputer is due to be expanded with additional racks. It is not known exactly how many racks or what the final processing speed will be. The JuQUEEN machine is also to be used by the research initiative. This aims to develop a three-dimensional, realistic model of the human brain.

11.Funding

The project was funded chiefly by EPFL, to which **Swiss government** donates in turn. ***EPFL and ETH*** are the only two federally-funded universities in Switzerland. This project has also been funded by other organizations like EU research grants and other entities, and individuals. In the March of 2012 the ETH Board requested an amount of CHF **85 million (€70 m)** from the Swiss government to fund the Blue Brain Project during 2013 to 2016.

IBM actually isn't funding the project, but they gave their supercomputer named Blue Gene to Ecole Polytechnique Federele De Lausanne at a minimal cost.IBM was actually interested in evaluating and examining the super computer on
different fields and BBP was one of them.

12. Merits and Demerits & Applications

Merits of BBP

1. Blue brain is an approach to store and utilize human intelligence and information present in the mind even after human demise.

2. It is an important move towards **self-decision** making by the computer or machine that holds a Blue brain.

3. Business analysis, attending conferences, reporting, etc. are very significant functions that an intelligent machine can do consistently.

4. It can be used as an interface between human and animal minds. The BBP has become successful in rat and some other animals which is a sign of success.

5. It a good remedy towards human disability like a deaf can get the information via **direct nerve stimulation.**

6.We can **cure brain diseases** like
Parkinson's Disease-Gradual loss muscle control

Demerits of BBP

1. It increases the risk of human dependency on Blue Brain every time.

2. Once a Blue Brain related to a particular person's neural schema is hacked, the brain could be used against the very person.

3. Since it an approach to make machines intelligent and thoughtful it increases the risk of machines conducting war against human (like we have been watching in the movies like **Terminator, Universal soldier**, etc.)

Applications

1. Gathering and Testing 100 Years of Data.
2. Cracking the Neural Code
3. Understanding Neocortical Information Processing
4. A Novel Tool for Drug Discovery for Brain Disorders
5. A Global Facility
6. A Foundation for Whole Brain Simulations
7.A Foundation for Molecular Modeling of Brain Function

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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. The only serious threats raised are also overcome as we note the combination of biological and digital technologies. While the road ahead is long, already researches have been gaining great insights from their model. Using the Blue Gene supercomputers, up to 100 cortical columns, 1 million neurons, and 1 billion synapses can be simulated at once. This is roughly equivalent to the brain power of a honey bee. Humans, by contrast, have about 2 million columns in their cortices. Despite the sheer complexity of such an endeavor, it is predicted that the project will be capable of this by the year 2023.

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