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Artificial Intelligence-A Literature Survey of Blue Brain

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Abstract:
A man becomes intelligent because of brain. It is complex than any other circuits in the world. Understanding the human brain is one of the greatest challenges facing 21st century scientist. Today scientists are in a research to create an artificial brain that can think, take decision and keep anything in memory at any time .The main aim of this paper is to describe and upload human brain into machine [11]. IBM's Blue Gene supercomputer allows a quantum leap in the level of detail at which the brain can be modeled. Blue Brain is the world's first virtual brain, which means machine can function as human brain. After the death of the body, the virtual brain will act as the man [6].So, even after the death of person we will not lose the knowledge, intelligence, personalities, feelings and memories of that man that can be used for the development of the human society [9]. In this paper, we present the complete research work which explains the concept and functioning model of blue brain and the recent research and developments in the process.

KEYWORDS: Neurons, visualization, neural network,

1. INTRODUCTION:

Blue brain would be the world's first virtual brain. Within 30 years, we will be scanning ourselves into the computers [2]. We can say it as virtual brain (that is) 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 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 the computer. This interface can be achieved through the data stored in the natural brain can be uploaded into the computer [12]. So the brain and the knowledge, intelligence of anyone can be kept and used for ever, even after the death of the person. It is like uploading a mind in a computer. Mind uploading can probably can be achieved by either of two methods: 1. Copy and Transfer. 2. Slow and steady replacement of neurons.

FIGURE1: BLUE BRAIN

Reverse engineering the brain is one of the Grand challenges posed by the United States National Academy of engineering[14].. In this paper, we assess a current status in approaching this difficult goal of brain Emulation. We contrast computing approaches and examine the major obstacles. Over the past 50 years advances in technology have successively and phenomenally increased our ability to emulate neural networks with speed and accuracy. At the same time and particular over the past 20

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years, our understanding of neurons in the brain has increased substantially, with imaging and microprobes contributing significantly to our understanding of neural physiology. These advances in both technology and neuroscience make possible the projects we describe in this paper, aimed at modeling large number of interconnected neurons. In spite of the progress in many brain emulation efforts, there are major challenges that must be still addressed. Neural complexity; scale; Interconnectivity, plasticity, power consumption.(3) Sandberg and BOSTROM prove an excellent survey of the overall tissues in brain emulation although they do little discussion of actual brain emulation project. They cover different level of emulation, different neural model, computational requirements of emulation and brain mapping technologies. Using a blue brain supercomputer running Michael Hine's NEURON software, the simulation does not consist simply of an artificial neural network, but involves a biologically realistic model of neurons. It is hoped that is will eventually shed light on the nature of consciousness. There are a number of sub projects including the CAJAL blue brain, coordinated by the supercomputer and others run by universities and independent laboratories.

2.ORIGIN OF THE BLUE BRAIN:

The Blue Brain System is an attempt to reverse engineer the human brain and recreate it at the cellular level inside a computer simulation [13]. The project was founded in May 2005 by Henry Markham at the EPFL in Lausanne, Switzerland. Goals of the project are to gain a complete understanding of the brain and to enable better and faster development of brain disease treatments.

2.1. What is Blue Brain?

Blue Brain is the world's first virtual brain. The research involves studying slices of living brain tissue using microscopes and patch clamp electrodes [11]. Data is collected about all the many different neuron types. This data is used to build biologically realistic models of neurons and networks of neurons in the cerebral cortex. The simulations are carried out on a Blue Gene supercomputer built by IBM, hence the name "Blue Brain".

2.2 NEED FOR THE BLUE BRAIN:

The scientists have moved towards the invention of blue brain due to two important facts are:

1. Some people have a brain to great extends. After their death we would lost their knowledge and intelligence. Using this concept, we can still use their knowledge and intelligence .It can be achieved by virtual brain.

2. In a fast moving lifestyle of man, it is difficult to remember the birthday dates and important facts … etc. Using the virtual brain we can upload them into a computer and we get relaxed.

3. WORKING OF A NORMAL BRAIN:

The working of a normal human brain had consists of three simple functions are

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 environment is called sensory input..

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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 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.

4. STEP TO BUILD A BLUE BRAIN: There are three main steps to build the virtual Brain:

A. Data Acquisition.

B. Simulation

C. Visualization of Results.

4a. Data Acquisition:

Under data acquisition, the brain slices are placed under microscope and the shape as well electrical activity of individual neurons are measured [5]. The neurons are examined by their shape called as morphology.These observations are translated into mathematical algorithms which describe the form, functions and position of neurons. The algorithms are then used to generate biologically-realistic virtual neurons ready for simulation [7].To study the electrophysiological behavior of the neurons, the main tool required is 12 patch clamp. It allows twelve living neurons to be concurrently patched.

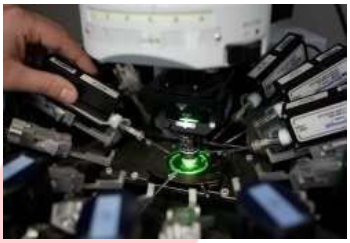

Figure 2: The 12 patch-clamp

4b. Simulation

Simulation refers to the use of a mathematical model to recreate a situation, so that the likelihood of various outcomes can be more accurately estimated. The main focus for the creation of virtual brain is on the neurons and the primary software used for neural simulation is a package called NEURON which was developed in 1990 by Michael Hines and John Morey [12]. It is written in C, C++ and FORTRAN and is free, open source software. Neural simulation is basically used for building and using computational models of neurons and network of neurons. For blue brain, the current version of neuron which is being used is 7.2. The main factors on which the simulation depends are:

i. Simulation Speed: The simulations show approximately linear scaling.The simulation time step for the numerical integrations is 0.025ms and the time step for writing the output to disk is 0.1ms.

2. Workflow: The simulation step involves synthesizing virtual cells using the algorithms

4C. Visualizations of results:

RT Neuron is the primary application and the software was developed internally by the BBP team. It is written in C++ and OpenGL.

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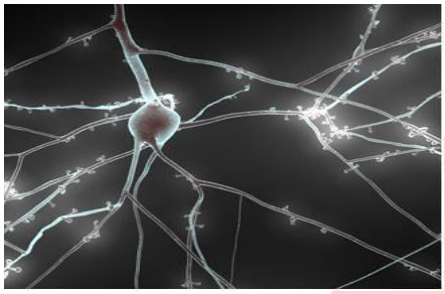

FIGURE 4:RT NEURON

RT Neuron takes the output from Hodgkin-Huxley simulations in NEURON and render them in 3D [14]. 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 RT Neuron.

5. EVOLUTION OF BLUEBRAIN:

5a GENETIC ALGORITHM:

The standard GA (Genetic Algorithm) used to help calculate the speed up factor consisted of the following steps.

1. Randomly generate 100 bit string chromosomes of length N2*(p+1).

2. Over the years we have used values, N = 16, p = 8, so our chromosomes (bit strings) were 2304 bits long.

3. Decode the chromosome into the N2 signed binary fraction weights, and build the neural network for each chromosome.

4. Perform the fitness measurements for the task concerned. For details, see the next section.

5. Rank the fitness from best to worst.

5b.BLUEGENESUPERCOMPUTER:

The primary machine used by the Blue Brain Project is a Blue Gene supercomputer built by IBM.

1. BLUE GENE/L: IBM agreed in June 2005 to supply EPFL with a Blue Gene/L as a "technology demonstrator". The IBM press release did not disclose the terms of the deal.

2. BLUEGENE/P: In June 2010 this machine was upgraded to a Blue Gene/P. The machine is installed on the EPFL campus in Lausanne and is managed by CADMOS (Center for Advanced Modeling Science). The computer is used by a number of different research groups, not exclusively by the Blue Brain Project[5].The brain simulations generally run all day, and one day per week (usually Thursdays). The rest of the week is used to prepare simulations and to analyze the resulting data. The supercomputer usage statistics and job history are publicly available online - look for the jobs labeled as "C-BPP".

Blue Gene/P technical specifications

1. 4,096 quad-core nodes
2. Each core is a PowerPC 450, 850 MHz
3. Total: 56 teraflops, 16 terabytes of memory
4. 4 racks, one row, wired as a 16x16x16 3D torus
5.1 PB of disk space, GPFS parallel file system
6. **Operating system**: Linux SUSE SLES10
7. **Silicon Graphics**: A 32-processor Silicon Graphics Inc. (SGI) system with 300 GB of shared memory is used for visualization of results.
8. **Commodity PC clusters**: Clusters of commodity PCs have been used for visualization tasks with the RTNeuron software.

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FIGURE5: Blue brain storage rack

3. BLUE GENE/Q: JUQUEEN is an IBM Blue Gene/Q supercomputer that was installed at the JULICH Research Center in Germany in May 2012. It currently performs at 1.6 pet flops and was ranked the world's 8th fastest supercomputer in June 2012. It's likely that this machine will be used for BBP simulations starting in 2013, [13] 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 [10]. This aims to develop a three-dimensional, realistic model of the human brain.

FIGURE7: JUQUEEN supercomputer in Germany

5C.Brain Chip

Matthew Nagle's brain chip was designed to provide a balance between safety, durability, and functionality. The chip had to be small enough to not hinder normal brain function and no disruptive to neural communication to avoid brain damage [13]. Nagle's chip recorded brain signals using integrated CMOS circuitry, which is an array of recording electrodes. Just like repeating an experiment ensures statistically significant results, using multiple electrodes improved the reliability of the recorded data.

5d.COLLING SYSTEM:

Due to the usage of large memory system in blue gene supercomputer[3]. The computer become overheated in order to cool the system during the data storage the IBM invented a new methodology in 2015.A Special room was built for blue gene at the EPFL and the machine site on the top of a large room that holds the cooling equipment and computer cables[4].Ice cold water from lake. Geneva is pumped into support the cooling system.

6. Merits of Blue Brain

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

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

3 .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.

7. Demerits of Blue Brain

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.

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3. Since it an approach to make machines intelligent and thoughtful it increases the risk of machines conducting war against human.

8. Conclusion:

In conclusion, we will be able to transfer ourselves into computers at some time. In the paper we would have describe the simulated rat network. In the year 2023, they would have built an artificial human brain into the computer storage.

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