

# A Survey Paper on Blue Brain

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## ABSTRACT

*Human brain is the most valuable creation of God. The man is intelligent because of the brain. The Blue Brain Project is an attempt to build biologically detailed digital reconstructions and simulations of the rat and ultimately the human brain. Today researchers are in research to make an artificial brain that can think, react, contemplate, and decide. The main aim is to upload the human brain into the machine. This paper incorporates the complete research work explaining the functioning module of the blue brain and the recent developments which are going through it.*

**Keyword:** - nanobot, neuron, neo-cortical, reverse engineering, supercomputer, simulation

## 1. INTRODUCTION

The Blue Brain Project is assumed to be the first one to explore about a true “Artificial Intelligence” via the process of reverse engineering and also the effort to reverse engineering a human brain. The project was founded in May 2005 by Henry Markram at the EPFL in Lausanne, Switzerland. The vision behind Virtual Brain will help shed some light on some aspects of human recognition. The Blue Brain Project aims to build a full computer model of a functioning brain to simulate drug treatments or any other brain related problems. Blue gene supercomputer constructed by IBM was a machine first used by Blue Brain Project and then a term Blue Brain was introduced. It can be implemented by using supercomputer, the fastest type but quite expensive and are assist for special tasks which require abundant amount of mathematical computations, like weather forecasting employs a supercomputer. The simulation software is based on Michael Hines's NEURON, together with other custom-built components. The back pane of Blue Brain is Artificial Intelligence, a technology which builds intelligent machines and imparts intelligent agents. Knowledge, learning, reasoning, planning, communication and perception are the main goals of its research.

### 1.1 WHAT IS BLUE BRAIN?

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 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.

## 1.2 WHY WE NEED BLUE 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?

## 1.3 MOTIVATION

- Treatments of Brain disfunctioning.
- Scientific curiosity about consciousness and the human mind.
- Building thinking machine.
- Database of all neuroscientific research results and related past stories.

## 2. BRAIN SIMULATION

The brain essentially serves as the body's information processing center. It receives signals from sensory neurons (nerve cell bodies and their axons and dendrites) in the central and peripheral nervous systems, and in response it generates and sends new signals that instruct the corresponding parts of the body to move or react in some way. It also integrates signals received from the body with signals from adjacent areas of the brain, giving rise to perception and consciousness. The brain weighs about 1,500 grams (3 pounds) and constitutes about 2 percent of total body weight.

**Table -1:** Comparison between Natural and Simulated Brain

Natural Brain	Simulated Brain
<p><b>INPUT</b> In the nervous system in our body the neurons are responsible for the message passing. The body receives the input by sensory cells. This sensory cell produces electric impulses which are received by neurons. The neurons transfer these electric impulses to the brain.</p>	<p><b>INPUT</b> In a similar way the artificial nervous system can be created. The scientist has created artificial neurons by replacing them with the silicon chip. It has also been tested that these neurons can receive the input from the sensory cells. So, the electric impulses from the sensory cells can be received through these artificial neurons.</p>
<p><b>INTERPRETATION</b> The electric impulses received by the brain from neurons are interpreted in the brain. The interpretation in the brain is accomplished by means of certain states of many neurons.</p>	<p><b>INTERPRETATION</b> The interpretation of the electric impulses received by the artificial neuron can be done by means of registers. The different values in these register will represent different states of brain.</p>
<p><b>OUTPUT</b> Based on the states of the neurons the brain sends the electric impulses representing the responses which are further received by sensory cell of our body to respond neurons in the brain at that time.</p>	<p><b>OUTPUT</b> Similarly based on the states of the register the output signal can be given to the artificial neurons in the body which will be received by the sensory cell.</p>
<p><b>MEMORY</b> There are certain neurons in our brain which represent certain states permanently. When required, this state is represented by our brain and we can remember the past things. To remember things we force the neurons to represent certain states of the brain permanently or for any</p>	<p><b>MEMORY</b> It is not impossible to store the data permanently by using the secondary memory. In the similar way the required states of the registers can be stored permanently and when required these information can be received and used.</p>

interesting or serious matter this is happened implicitly	
<p><b>PROCESSING</b> When we take decision, think about something, or make any computation, logical and arithmetic computations are done in our neural circuitry. The past experience stored and the current inputs received are used and the states of certain neurons are changed to give the output.</p>	<p><b>PROCESSING</b> In the similar way the decision making can be done by the computer by using some stored states and the received input and the performing some arithmetic and logical calculations.</p>

**3. STEPS OF BUILDING A BLUE BRAIN**

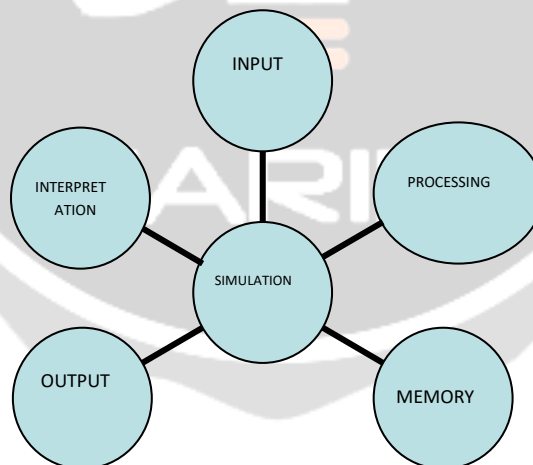
There are basically three steps of building a blue brain –

- Data Acquisition
- Simulation of Data
- Visualization of Result

**A. Data Acquisition**

In Data Acquisition, we need to study different types of neurons and catalogue them. It involves taking brain slices and placing them under a microscope, measuring the shape and electrical activity of individual neurons. Morphology (A branch of biology dealing with the study of form and structure of organisms and their specific structural features, Comparative morphology, Functional morphology and Experimental morphology are different branches of morphology), Electrophysiology behavior (A minimally invasive procedure which tests the electrical conduction system of the heart to assess the electrical activity and conduction pathways of the heart, it enables twelve living neurons to be concurrently patched and their electrical activity recorded), location within the cortex and their population density are the different factors by which neurons are typed. Form, function and positioning of neurons are obtained by translating these observations into mathematical algorithms. By the help of these algorithms, biologically-realistic virtual neurons ready for simulation are generated.

**B. Simulation of Data**



**Fig -1:** Simulation

➤ **INPUT**

In the nervous system of our body, neurons are responsible for message passing. Sensory cells convey the input to our body. Electric impulses are produced by sensory cells which are received by the neurons. Further, electric impulses (through the silicon chips of artificial neurons) are transferred to the brain by neurons.

➤ **INTERPRETATION**

Brain receives the electric impulses from the neurons which are interpreted by means of registers. Different states of brain can be accomplished by the different values in these registers.

#### ➤ OUTPUT

On the basis of the states of the registers, the electric impulses are sending by the brain representing the responses which are then received by the sensory cells to respond .The sensory cells of which part of our body is going to receive that, it depends on the state of the neurons in the brain at that time.

#### ➤ MEMORY

We can store certain information (states) permanently in our brain by certain neurons .On the basis of our requirement, the brain interprets those states and thus past things can be gathered. To do so we demand the neurons, to permanently show the clear vision of the Brain's States.

#### ➤ PROCESSING

By the use of some stored states, computation will be performed by the computer. Logical and arithmetic calculations are done in our neural circuitry. To produce the output stored past experiences and current input received are used.

#### C. Visualization of Result

Huge amount of data are generated by running the Blue Brain simulation .Thousands of times analyses of individual neurons must be repeated. Data can be analyzed by using massively parallel computers where it is created (server-side analysis for experimental data, online analysis during simulation). A visual exploration of the circuit is an important part of the analysis (given the geometric complexity of the column). It is invaluable for an immediate verification of single cell activity by mapping the simulation data onto the morphology. The Blue Gene has been translated into a 3D visual representation of the column to design a visualization interface.

A challenging task is the visualization of the neurons given the fact that a series of ten thousand neurons clustered in high quality mesh accounts for essentially 1 billion triangles for which about hundred GB of management data is required. To study in detail using further simulations, visual interface makes it easy to quickly identify those areas and to show electrical activity in the brain, a visual representation could be also used.

### 4. UPLOADING HUMAN BRAIN

Nanobots, a very small robot, are the most promising factor for uploading. Emerging technology fields creating machines or robots whose components are nearly close to the scale of a nanometer. These nanoids are so small that it can travel throughout our circulatory element. To accomplish these uploading, small robots known as nanobots are used.

The activity and structure of our central nervous system will be monitored by them by travelling into the spine and the brain. An interface will be provided with computers that is very close as our mind can be while we still reside in our biological form. Carefully scanning the structure of the brain is the additional function of the nanobots which provides a complete readout of the connections. Further, this information helps the machine to function as the human functions. Finally, by using nanobots, the data stored in the entire brain will be uploaded into the computer.

### 5. REQUIREMENTS

- Blue Gene technical specifications
  - 4,096 quad-core nodes.
  - Each core is a PowerPC of 4.5, 8.5 GHz
  - It consists of more than  $6 \times 10^{13}$  flops
  - 15 terabytes memory
  - 1 PetaByte of disk space.
  - Operating system used is Linux SuSE SLES 10



**Fig -2:** Blue Gene/P Super Computer

- JuQUEEN Blue Gene Supercomputer
  - IBM also installed a Blue Gene/Q supercomputer at the Jülich Research Center in Germany named JuQUEEN.
  - This computer was specially developed solely for the Blue Brain Project.
  - It has been ranked as the world's 8th fastest supercomputer with a computing speed of 1.6 petaflops.
  - JuQueen also aims at developing a 3D realistic model of the brain.



**Fig -3:** JuQueen Blue Gene Supercomputer

## 6. APPLICATIONS

- Treatment of neurological disorders like the autism, Asperger syndrome, Alzheimer's disease, Parkinson's disease, Bipolar disorder, chronic diseases, dementia, epilepsy, etc. by simulating the disease and its treatment.
- Continual functioning of the brain even after the death of a person.
- It can greatly help patients with physical disabilities too.
- Solutions to age old questions relevant to human brain that cannot be even answered with current engineering or scientific experimental or theoretical approaches can be sought easily.
- Learning, language, perception and memory problems can be eliminated.

## 7. ADVANTAGES

- We can remember everything without the fear of forgetting it ever.
- Decision can be made without the actual presence of a person.

- The simulated brain itself acts as a supercomputer with high performance and lots of processing speed and memory.
- Death would not affect the intelligence of a person.

## 8. LIMITATIONS

- Brain is the most powerful organ of the human body. Misuse of the even more powerful simulated brain would only bring in irreparable and incurable destruction. Our brains would become dependent on computer systems.
- Malware and viruses will become an ever-alarming threat
- Man can become the addicted slave of this new technology and would also start exploiting it for its illegal use.
- People will start fearing new technologies as it is evident with respect to human cloning.

## 9. CONCLUSION

In a nutshell, the Blue Brain Project is an attempt to reverse engineer the human brain and reform it at molecular level inside a computer simulation. The combination of biological and digital technologies would provide an impetus for the overall growth and development. However, it would be more feasible if this technology is exclusively developed for the treatment of chronic and cognitive neurological disorders as it would truly prove to be magical in the field of medicine. As said by Henry Markham (director of the Blue Brain Project), "As with Deep Blue, Blue Brain will allow us to challenge the foundations of our understanding of intelligence and generate new theories of consciousness."

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