An Analysis of Blue Brain Technology

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ABSTRACT: The human brain, which serves as the command centre for the central nervous system, regulates all of the body's activities and retains memories, while Blue Brain, the world's first virtual computer, is the first to perform as a suitable application of a synthetic human brain. Reverse engineering is often used to enable cellular level implementation and reconstruction of the human brain inside a simulation. With technological advances, humans are typically maintained as the ultimate source of data and discovery, ensuring that intellect is seldom lost. IBM's blue gene supercomputer allows for a quantum leap in the level of detail that can be modelled in the brain. This technique pinpoints the brain's basic principles, functions, and capacities. This review article includes comprehensive information on the comparison of real and simulated brains, artificial brain implementation, and the different stages involved in constructing a simulated brain using Artificial Intelligence.

KEYWORDS: Blue Brain, Humans, Intelligence, Neurons, Technology.

1. INTRODUCTION

The human brain is brimming with complexity. Blue Brain technology seeks to build and gain knowledge about our brain at the molecular level, allowing for rapid treatment of brain-related diseases. Henry Markram, a scientist at EPEL in Switzerland, started this research. This initiative was started in 2005 by IBM (International Business Machines) and EPEL (Ecole polytechnique federale) [1]. Scientists are now working on developing a brain that can think, store data, react, and make choices. The goal of this research is to utilize people's brains even after they have died. When a person dies, the brain ceases to function, and we are unable to utilize his or her brain; nevertheless, we may use his or her brain after death via the use of blue brain technology. A person's brain is uploaded into a computer using this technique. It enables a computer to reason and make choices. The goal of this initiative is to repurpose a person's knowledge and intellect. This technology may greatly aid in the completion of pending tasks. In this world, the human brain is a highly complicated mechanism [2].

There are about a trillion neurons (nerve cells) and connections in this system. A neuron's job is to send information to other neurons or cells. Synapses assist neurons in communicating with one another. The main equipment for this research is IBM's Blue Gene supercomputer, thus the moniker Blue Brain. As simulation software, Michael Hine's NEURON is utilized, along with other custom-built components. We can maintain a person's knowledge and intellect even after death with this scientific technique. Artificial Intelligence, robotics, computer games, and Blue Eyes technologies are all part of today's world. Artificial intelligence is a cutting-edge and rapidly developing technology. This project makes use of artificial intelligence. This project is expected to be finished by 2023. And this is going to be the main virtual brain. This project employs reverse engineering techniques. It makes advantage of the fastest supercomputers, which are designed to do certain tasks that require a large amount of mathematical calculation [3].

Artificial Intelligence lies at the heart of this technology, which has the potential to transform the whole planet.Blue Brain is the world's first virtual brain. It is modulated with hardware and

software to think, process, remember, store, and react, despite the fact that it is not a real brain. The most important concept for creating this virtual brain reproduced inside the computer with full simulation is reverse engineering. The Blue Brain explains how exceptional minds like Steve Jobs and Stephen Hawking's intellect may be preserved for future use. The Blue Brain technology's goal is to gather existing brain data and create a complete theoretical framework inside a computer [4].

1.1 What is blue brain?

A virtual brain is a computer that can think in the same way as a human mind. Like a real brain, it can make choices and retain information. Supercomputers with a lot of processing power and storage capacity can be used to construct a virtual brain. An interface between the artificial brain and the human brain is also needed. The information stored in the human brain is uploaded onto personal computers via this interface [5].

1.2 Need for Blue Brain:

Intelligence in nursing is linked to inborn quality, which cannot be produced and saved for later use. Intelligence is a characteristic that we can't manufacture; it's a natural trait. Some individuals are born with intellect and have the ability to think in ways that others cannot. Such intellect is constantly required by humans. All of our intellect is lost when we die, and we often have trouble remembering key dates, people's names, historical facts, and so on. In such a busy age, a virtual brain may be a clever solution to the issue of someone needing to dwell inside a PC as a program so that it is easy to remember all the information [6].

1.3 Steps for Blue brain:

There are basically three steps in this process which are as described below:
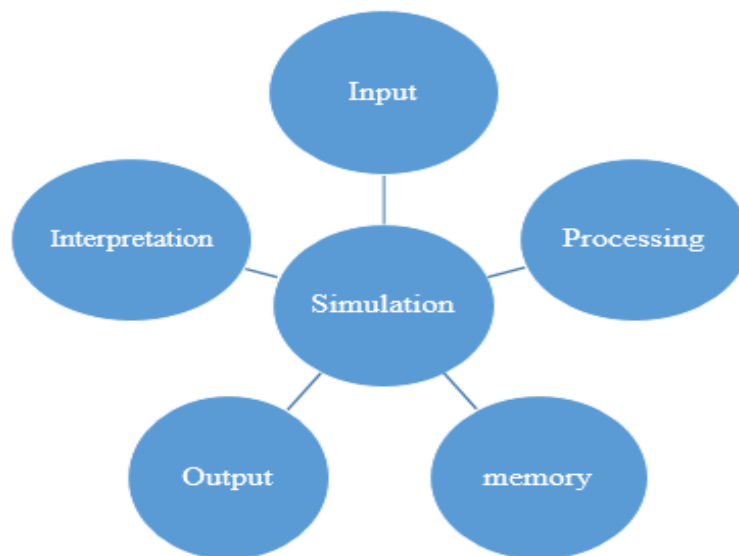
1.3.1   Data collection:

It entails removing sections of the brain, examining them under a microscope, and determining the structure and electrical activity of individual neurons. This technique of examining and categorizing neurons is well-known and used all around the globe. The form, electrical and physiological activity, location within the cerebral cortex, and population density of the neurons are all used to identify them. These findings are converted into exact algorithms that explain the neuron's process, function, and placement techniques. The algorithms are then utilized to create physiologically realistic-looking virtual neurons that are ready for simulation [7].

1.3.2   Data Simulation:

It is divided into two parts: simulation speed and simulation workflow. Speed of simulation Simulations of a single cortical column (more than 10,100 neurons) operate at approximately 200 times the speed of real time. One second of stimulated time takes approximately five minutes to complete. Uneven line scaling may be seen in the simulations. Biological soundness, rather than appearance, is now the most sought after quality. It may be possible to cultivate components that do not subsidize in order to enhance performance after learning physiologically important variables for a specific impact. The main goal of this phase is to create virtual cells using the algorithms that were developed to define and describe actual neurons. Algorithms and restrictions are tailored to the age, species, and stage of illness of the simulated animal. Each protein is modelled separately.

1.3.2.1.   BBP-SDK:

Researchers may utilize and audit prototypes and simulations using the Blue Brain Project - Software Development Kit, which is a collection of Application Programming Interfaces. The Blue Brain Project-SDK is a Java and Python wrapper for a C++ library. NEURON is the most often used program for neural simulations. This was created in the early 1990s by Yale University's Michael Hines and Duke University's John Moore. It's written in C, C++, and FORTRAN. It is open source software that is freely accessible. Everything, including the code and binary data, is freely accessible on the website. In 2005, Michael Hines worked with the BBP team to transfer the program to the huge and parallel Blue Gene.

1.3.3   Visualization of results:

The primary application used by Blue Brain Project for visualizing neuronal simulations is RT Neuron. This program was created by the BBP team in-house. It's written in C++ and OpenGL. RT Neuron is ad-hoc software designed especially for neural simulations; it cannot be used to other simulation types. In NEURON, RT Neuron takes the output from Hodgkin-Huxley simulations as an input and renders it in 3D. This enables programmers and researchers to see the propagation of activation potentials across or between neurons. The researchers may interact with the model by pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pausing, pa Multi-scale visualizations are used (they can render individual neurons or a whole cortical column).

1.4 Advantages of blue brain:

- Blue brain is a method of storing and using human intellect and information that exists in the mind even after death.
- It is a significant step forward in the computer or machine's ability to make decisions on its own.
- Business analysis, attending conferences, reporting, and other important tasks that an intelligent computer may do on a regular basis.
- It may be used to connect the brains of humans and animals. The BBP has shown to be effective in rats and other animals, which is a good indication.
- It is an effective treatment for human disabilities, such as deafness, since it allows deaf people to receive information via direct nerve stimulation.

1.5 Disadvantages:

- Humans will grow more reliant on computers.
- Because this Blue Brain initiative is dependent on computer technology, hackers and virus assaults are a concern.
- It is very costly to restore memory to a computer.
- The machine requires a large quantity of electric power to start up.
- Once a person's neural schema has been hacked, it may be utilized against that individual.
- Human cloning may be a source of anxiety.
- It may have a variety of repercussions, such as robots fighting humans.

1.6 Working of natural human brain:

Figure 1: Simulation of human brain.

The human brain is a complex system with over a trillion neurons and a hundred trillion synapses. Figure 1 illustrates simulation of human brain. To comprehend this, we must first comprehend three basic functions:

1.6.1   *Sensory input:*   Neurons transmit a message to our brain when we observe something or when our hands contact a surface. Because human mind responds after receiving information from neurons, this is referred to as sensory input.

1.6.2   *Integration:* Humans sensory cells are in charge of interpreting sensations such as touch and taste. Neurons are another name for sensory cells. Neurons are in charge of detecting changes in the environment.

1.6.3   *Motor Output:* When human brain detects changes in the environment, such as via touch, taste, or other means, it sends a message to cells through neurons. Then our neurons get to work fulfilling requests and influencing the environment. It is clear that we are putting something into the environment and receiving a response.

1.7 Working of Blue brain:

The stages of the simulated brain's operation are as follows:

- *Input:* Scientists used silicon chips to construct artificial neurons that functioned similarly to real neurons. These artificial neurons will receive input from secondary cells, as well as electrical impulses from secondary cells, which will be transmitted to supercomputers for interpretation through artificial neurons.

- *Interpretation:* A collection of registers is used to interpret the electric impulses received by synthetic neurons. The varied values in the register reflect distinct mental states.

- *Output:* The output signals are transmitted to sensory cells inside the artificial neuron once they have been processed.

- *Memory:* With the aid of secondary memory [hardware], it is possible to keep records indefinitely. The sets of registers will be kept permanently in this manner, and the information in them will be accessed and utilized as required.

- *Processing:* The computer processes certain stored information as well as the inputs received. Using the idea of artificial intelligence, an artificial brain will do certain mathematical and logical computations similar to those performed by our human brain [8].

1.8 Uploading human brain:

Nanobots are tiny robots that are used in artificial brains. These robots make their way through our circulatory system. These robots keep track of the nervous system's activity and structure. These robots used to offer an interface that was designed to be as near to human minds as possible. Nanobots are utilized to scan the structure of our brain so that all of the connections can be read out. As a result, the whole information contained in the brain is transferred to the computer.

1.9 Barriers in building blue brain:

There is now a hurdle in the neuron-artificial neuron connection. It will take more than four years to get through this barrier. Once that is confirmed, the Blue Brain project will take at least five years to complete. Nanobot development time will be reduced and performance will improve by adapting nanobot technique. As a result, we can conclude that Blue Brain can be implemented in the future with some technological development.

1.10   Hardware used:

The Blue Gene supercomputer, designed by IBM, is the main hardware used for the Blue Brain project. It was maintained by CADMOS and placed on the EPEL campus in Lausanne, Switzerland.

A) *Requirements:*
- Because there are billions upon billions of neurons, a significant quantity of memory (i.e. 16 terabytes) is needed. The amount of storage required for such a large simulation is enormous.
- A high-performance processor (256 MB to 512 MB RAM per CPU) capable of simulating billions of neurons.
- A software that transforms electric impulses from the brain into an input signal that the Supercomputer can use, and vice versa.
- A nanorobot to serve as a link between the supercomputer and the human brain.

B) *List of Supercomputers used since 2005:*
- Until 2009, Blue Gene/L was in use.
- Until 2011, Blue Gene/P, an improved version of Blue Gene/L, was utilized.
- In terms of speed, JuQUEEN [Blue Gene/Q] 10, an improved version of Blue Gene/P released in 2012, was rated 8th in the world.
- Blue Brain 5, which will be installed in 2018, will succeed the predecessor.

1.11   Application of blue brain:
- There is a significant advance in the understanding of the conscious and sub-conscious mind.
- Blue Brain may be used as a physiological and fundamental model for whole-brain simulation.
- Hundreds of years of data can be gathered and tested.
- Neural code cracking is possible.

- Blue brain is the most widely used method for drug development in the field of brain diseases.

2. LITERATURE REVIEW

Mannu Kumari et al. discussed blue brain technology in which they explained how the brain is one of the human body's most distinctive and remarkable organs. Our brain allows us to be aware of everything around us, including ourselves and our surroundings. It regulates muscle action, gland secretions, and even internal temperature and respiration. Our brain creates every thought, emotion, and idea. The neurons in our brains keep track of every action we do throughout our lives. The guy is considered "intelligent" because of his brain, but it is gone when the body is destroyed after death. Scientists are now working on developing a virtual brain. We explain how intellect may be maintained for thousands of years in this article [9].

Sharma S et al. discussed Blue Brain Technology in which they explained how the world's first virtual brain is known as Blue Brain. A virtual machine is a computer that can perform the functions of a human brain using Artificial Intelligence. Reverse engineering is a key idea in which the human brain is implemented and recreated at the cellular level inside a full simulation. Treatment of brain dysfunction, scientific curiosity in consciousness and the human mind, a bottom-up method to building thinking machines, and databases of all neuroscientific research results and associated previous tales are the four primary reasons behind Blue Brain Technology. Data collection, simulation, and display of findings are the three major stages in creating a virtual brain. The Blue Brain technology's goal is to collect all current brain information, improve global reverse engineering research efficiency, and provide a comprehensive theoretical framework [2].

Kavya Priya G.V et al. discussed Blue Brain Technology in which they explained how God's most precious creation is the human brain. Because of his brain, the guy is intelligent. The world's first virtual brain is known as "Blue Brain." This implies that a machine can do the same functions as a human brain. Humans, being the ultimate source of knowledge and discovery, should be maintained while technology advances. In other words, although humans do not live for thousands of years, the knowledge stored in their minds may be preserved and utilized for thousands of years. Scientists are now working on developing an artificial brain that can think, respond, make decisions, and remember anything. The primary goal is to transfer a human brain to a machine. So that a person may think and make decisions without exerting too much effort. Following the death of the physical body, the virtual brain will assume the role of the man. As a result, even after a person's death, we will not lose the information, intellect, personality, emotions, and memories of that individual, which may be utilized to advance human civilization [10].

3. DISCUSSION

The blue brain is the world's first virtual brain. It's a machine that can function similarly to the human brain. Scientists are now working on developing a virtual brain that can make choices and store information in memory. The concept is to put a human brain into a machine. As a result, man can think without exerting any effort. The primary benefit of this research is that we may utilize the person's knowledge and intellect even after they have died. Reverse engineering is used to create the blue brain. Through comprehensive supercomputer-based reconstructions and simulations, reverse engineering is performed to learn how brain processes operate. The Blue Brain Project is being utilized to build a digital brain reconstruction. This project may assist us in remembering things that we often forget. This paper discusses several

aspects of blue brain. The success of the Blue Brain project has the potential to alter the planet and the technologies we use today. There is a lot of study that takes decades, and in these instances, the scientist's intellect and efforts may be utilized long after they die. The process of integrating a duplicate brain into a system is difficult, and it may take decades to accomplish, yet this research has the potential to alter the world.

4. CONCLUSION

At some time, humans will be able to transfer their consciousness into computers. The majority of the counter-arguments seem to be simple to overcome. They are either simplistic in their thinking or just need more time for technology to advance. As we can see from the mix of biological and digital technology, the only significant concerns that have been highlighted have also been addressed. While there is still a long way to go, researchers have already learned a lot from their model. Up to 100 cortical columns, 1 million neurons, and 1 billion synapses may be simulated simultaneously using the Blue Gene supercomputers. This is approximately equal to a honey bee's cognitive capacity. Human cortices, on the other hand, contain approximately 2 million columns. Despite the enormity of the task, it is expected that the project will be able to do this by the year 2023. With certain advancements in today's technology, the Blue Brain may be adopted in the future, allowing human to transfer themselves to computers. Even after death, the intellect of the human brain will be preserved for the benefit of society. Without the presence of a person, humans may make choices. However, it is equally true that people will be reliant on computers. It will have both good and bad consequences for humanity. This technology will soon be extensively adopted all across the globe.

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