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Study on Blue Brain with its Application

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Abstract

The Blue Brain Project is the first made comprehensive attempt to reverse-engineer the brain of mammalian, so that through detailed simulations the function of brain can be understood. BLUE BRAIN is the name of the world's first virtual brain which means, a machine that can function as human brain. Today, scientists are in research to create an artificial brain that can think, respond, take decision, and store anything in memory. The main aim of this research is to upload human brain into machine. So that man can think and take decision without any effort. After the death of the body, the virtual brain will act as the man. So, even after the death of a 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. 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: Blue Brain.

Introduction

The Blue Brain System is an attempt to reverse engineer the human brain and recreate it at the cellular level inside a computer simulation. The project was founded in May 2005 by Henry Markram 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. The research involves studying slices of living brain tissue using microscopes and patch clamp electrodes. 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". The simulation software is based on Michael Hines's NEURON, together with other custom-built components. As of August 2012 the largest simulations are of micro circuits containing around 100 cortical columns such simulations involve approximately 1 million neurons and 1 billion synapses. This is about the same scale as that of a honey bee brain. It is hoped that a rat brain neocortical simulation (~21 million neurons) will be achieved by the end of 2014. A full human brain simulation (86 billion neurons) should be possible by 2023 provided sufficient funding is received.

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.

History of the blue brain

The aim of the project, founded in May 2005 by the Brain and Mind Institute of the École Polytechnique Fédérale de Lausanne (Switzerland) is to study the

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brain's architectural and functional principles. The project is headed by the Institute's director, Henry Markram. Using a Blue Gene supercomputer running Michael Hines'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 it will eventually shed light on the nature of consciousness. There are a number of sub-projects, including the Cajal Blue Brain, coordinated by the supercomputing and Visualization Center of Madrid (CeSViMa), and others run by universities and independent laboratories.

Goals

Neocortical column modeling

The initial goal of the project, completed in December 2006, was the simulation of a rat neocortical column, which can be considered the smallest functional unit of the neocortex (the part of the brain thought to be responsible for higher functions such as conscious thought). Such a column is about 2 mm tall, has a diameter of 0.5 mm and contains about 60,000 neurons in humans; rat neocortical columns are very similar in structure but contain only 10,000 neurons (and 108 synapses). Between 1995 and 2005, Markram mapped the types of neurons and their connections in such a column.

Whole brain simulation

A longer term goal is to build a detailed, functional simulation of the physiological processes in the human brain: "It is not impossible to build a human brain and we can do it in 10 years, "Henry Markram, director of the Blue Brain Project said in 2009 at the TED conference in Oxford. In a BBC World Service interview he said: "If we build it correctly it should speak and have intelligence and behave very much as a human does."

Progress

In November 2007, the project reported the end of the first phase, delivering a data-driven process for creating, validating, and researching the neocortical column. By 2005 the first single cellular model was completed. The first artificial cellular neocortical column of 10,000 cells was built by 2008. By July 2011 a cellular microcircuit of 100 neocortical columns with a million cells in total was built. A cellular rat brain is planned for 2014 with 100 microcircuits totaling a hundred million cells. Finally a cellular human brain is predicted possible by 2023 equivalent to 1000 rat brains with a total of a hundred billion cells. Now that the column is finished, the project is currently busying itself with the publishing of initial results in scientific literature, and pursuing two separate goals: construction of a simulation on the molecular level, which is desirable since it allows studying the effects of gene expression; simplification of the column simulation to allow for parallel simulation of large numbers of connected columns, with the ultimate goal of simulating a whole neocortex (which in humans consists of about 1 million cortical columns).

Uploading human brain

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 non invasive 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. Travelling 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 as us. All that is required is a computer with large enough storage space and processing power. Is the pattern and state of neuron connections in our brain truly all that makes up our conscious selves? Many people believe firmly those we possess a soul, while some very technical people believe that quantum forces contribute to our awareness.But we have to now think technically. Note, however, that we need not know how the brain actually functions, to transfer it to a computer. We need only know the media and contents. The actual mystery of how we achieved consciousness in the first place, or how we maintain it, is a separate discussion.

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

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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 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 ourbrain 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.

What can we learn from blue brain?

Detailed, biologically accurate brain simulations offer the opportunity to answer some fundamental questions about the brain that cannot be addressed with any current experimental or theoretical approaches. Understanding complexity At present, detailed, accurate brain simulations are the only approach that could allow us to explain why the brain needs to use many different ion channels, neurons and synapses, a spectrum of receptors, and complex dendritic and axonal arborizations.

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

Advantages

1. We can remember things without any effort.
2. Making decision without the presence of a person is possible.
3. We can Use the intelligence of a person after his/her death.
4. Understanding the activities of animals is possible.
5. Allowing the deaf to hear via direct nerve stimulation is achievable.

Limitations

1. We become dependent on the Computer.
2. Others may use technical knowledge against us.
3. Another fear is found today with respect to human Cloning.
4. In addition there seem to be power constraints. The brain consumes about 20W of power whereas supercomputers may use as much as 1MW or an order of 100,000 more (Note: Landauer limit is 3.5x1020 op/sec/watt, at room temperature).

Requirements-hardware and software

1. A Super computer
2. Memory with a very large storing capacity
3. Processor with a very high processing power.
4. A very wide network.
5. A program to convert the electric impulses from the brain to input signal, which is to be received by the computer and vice versa.
6. Very powerful Nanobots.

Conclusion

The whole idea is that mental illness, memory and perception triggered by neurons and electric signals could be soon treated with a supercomputer that models all the 1,000,000 million synapses of brain. The key finding is that irrespective of gender and race, human brains are basically identical. We will be able to map the differentiations by nuancing the patterns later. The exciting part is not how different we are but how similar we all are. There are good reasons to believe that, regardless of implementation strategy, the predictions of realizing artificial brains in the near future are optimistic.

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