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A Review on the Blue Brain Project

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Abstract

The blue brain project is an attempt to reverse-engineer the brain of any vertebrate of the class mammalian.Through this, brain function and dysfunction can be studied using the detailed simulations.

Keywords: Brain, Neuron, Microcircuit, Somatosensory cortex.

Introduction

The cerebral cortex, the convoluted "grey matter" that makes up 80% of the human brain, is responsible for our ability to remember, think, reflect, empathize, communicate, adapt to new situations and plan for the future. The cortex first appeared in mammals, and it has a fundamentally simple repetitive structure that is the same across all mammalian species.

The brain is populated with billions of neurons, each connected to thousands of its neighbours by dendrites and axons, a kind of biological "wiring". The brain processes information by sending electrical signals from neuron to neuron along these wires. In the cortex, neurons are organized into basic functional units, cylindrical volumes 0.5mm wide by 2mm high, each containing about 10,000 neurons that are connected in an intricate but consistent way. These units

Fig. 1. Human brain as microcircuit.

Operate much like microcircuit in a computer. The microcircuit, known as the neocortical column is repeated millions of times across the cortex. The difference between the brain of mouse and the brain of a human is basically just volume. Humans have many more neocortical columns and thus neurons than mice.

This structure lends itself to a systematic modelling approach. And indeed, the first step of the Blue Brain project is to re-create this fundamental microcircuit down to the level of biologically accurate individual neurons. The microcircuit can then be used in simulations.

What the blue brain project is not

The Blue Brain Project is an attempt to reverse engineer the brain, to explore how it functions and do serve as a tool for neuroscientist and medical researchers. It is not an attempt to create a brain. It is not an artificial intelligence project. Although we may one day achieve insights into the basic nature of intelligence and consciousness using this tool, the Blue Brain Project is focused on creating a physiological simulation for biomedical applications.

Model and simulation

The first phase of the Blue Brain Project started after 15 years of systematically dissecting the micro anatomical, genetic and electrical properties of the elementary unit of the neo cortex - a single neocortical column, which is a slightly bigger than the head of a pin. After collecting information's from 15,000 experiments conducted in the rat somatosensory cortex, the concept of modelling the parts of the brain is believed to be possible.The project has focused, however, not only on building a model of the neo cortical column, but also on developing a generic facility that could allow a swift modelling, simulation and experimentation of any brain region ,if the data can be measured and provided according to specifications. The facility has be used to build the first model of the neocortical column, which consists of 10,000 3D digitization's of real neurons that are populated with model ion channels constrained by the genetic makeup of over 200 different kinds of neurons.To frame the model and to perform the experiments a parallel supercomputer is employed, so that the behaviour of the tissue can be predicted through simulations.Phase 1 mark the completion of a proof – of – principle simulation - based research process that has resulted in a cellular level model of the neocortical column. The achievement of biological fidelity of the model makes itself now serves as a primary tool for evaluating the consistency and relevance of neuron organic knowledge and also provides direction for advanced exploratory exertions. These advanced information's will serve to rarefy the neocortical column model. The assembled process allows neuroscientists to investigate scientific questions by integrating the available experimental data and evaluating hypotheses of network dynamics and neural function. The completion of phase 1 provides the basis now for increasing the resolution of the models down to the molecular level and expanding the size of the models towards the whole brains of mammals.

What can we learn from the blue brain project?

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 hypothetical approaches. It includes:

A. Completing a puzzle.

At a time experiments can obtain and view only small parts of the structure and function of the puzzle. Convoking the pieces of the neocortical column according to the blue print could reveal the overall picture.

B. Defining functions of the basic elements.

The comprehensive definition of the functions of the basic elements cannot be provided through cenury of experimental and philosophical approaches . A intricate model will provide fine control of the basic elements and allow a systematic investigation of their contribution to the emergent behaviour.

C. Understanding complexity.

The brain facsimiles 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 arborisations, rather than the simplified, uniform types found in many models.

D. Exploring the role of dendrites.

This is an ritzy approach to explore the dendritic object theory, which proposes that three-dimensional voltage objects are generated continuously across dendritic segments regardless of the origin of the neurons, and that spikes are used to maintain such dendritic objects.

E. Revealing functional diversity.

Utmost all models engineer a specific function, whereas a spectrum of functions might be possible with a biologically based design.

F. Understanding memory storage and retrieval.

This approach offers the possibility of determining the manner in which representations of information are imprinted in the circuit for storage and retrieval, and could concede the part that different types of neuron play in these crucial functions.

G. Tracking the emergence of intelligence.

This access bids the possibility to retrace the steps taken by a network of neurons in the emergence of electrical states used to embody representations of the organism and its world.

H. Identifying points of vulnerability.

Although the neocortex confers immense computational potential to mammals, defects are common, with calamitous subjective effects. At present, a detailed model is the only approach that could produce a list of the most vulnerable circuit criterions, revealing likely candidates for dysfunction and targets for treatment.

I. Simulating disease and developing treatments.

The whole brain facsimile could be used to test hypotheses for the pathogenesis of neurological psychiatric diseases and develop and to test new strategies.

J. Providing a circuit design platform.

Specific models could affirm powerful circuit designs that could be implemented into silicon chips for use as intelligence devices in industry.

A few benefits of the blue brain project:

- Collection and Testing 100 years of Data.
- A foundation for whole brain simulation.
- A Novel tool for molecular modeling of brain functions.
- Information processing in cortex can be well understood.
- Provides a Global platform .

- Remedy for Brain Disorders.
- Helps in cracking the neural codes.

What's next for the blue brain project?

In the future, information from the molecular and genetic level will be added to the algorithms that generate the individual neurons and also with their connections, and these details will be used in the circuit's construction. The whole brain simulations can be used to explain about what happens when this molecular or genetic information is altered situations. Say for instance what happens when the molecular environment is changed via drugs. The Blue brain project will continue to aggrandize and will necessarily involve additional scientists and research groups from around the world. The Fig. 2. Depicts the project plan. The project has been expected to be completed by 2023.The X axis represents the computing speed of the brain and the Y axis represents the computer memory.

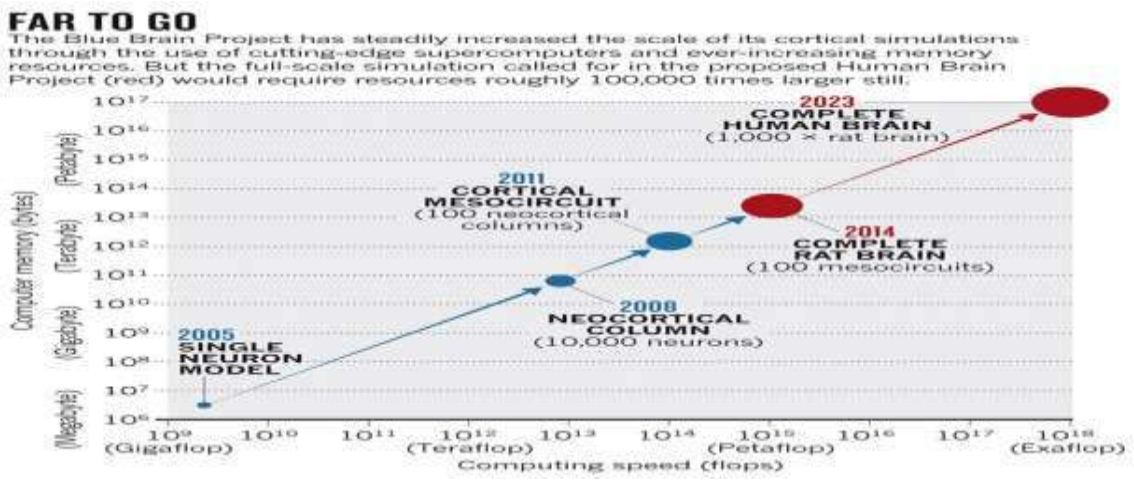

Fig. 2. Project plan.

Conclusion

The blue brain project is the advancement in biological and digital technologies. Through this technology at some point a human can be transferred into computer. The limitations and arguments in this technology are easy to overcome.

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