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AN OVERVIEW ON DISCOVERY OF REALITY-BLUE BRAIN

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Abstract— Understanding the human brain is one of the greatest challenges facing 21st century science. In recent years, half a dozen major research groups have simulated or constructed sizeable networks of artificial neurons, with the ultimate goal to emulate the entire human brain. Some approaches are more scalable, some are more practical with current technologies, and some are more accurate in their emulation of biological neurons. This paper presented the overview of Blue Brain.

Keywords- neuroscience, blue brain, virtual brain

I. INTRODUCTION

The human brain participates in every human emotion, every human feeling, every human thought and every human decision. No other natural or engineered system can match its ability to adapt to novel challenges, to acquire new information and skills, to take complex decisions and to work reliably for decades on end. And despite its many diseases, no other system can match its robustness in the face of severe damage or match its amazing energy efficiency. Our brain consumes about 30W, the same as an electric light bulb, thousands of times less than a small supercomputer. The human brain is a massively complex information processing system with a hierarchy of different yet tightly integrated levels of organisation: from genes, proteins, synapses and cells to microcircuits, brain regions, and the whole brain as shown in Figure 1.

Human brain, the most valuable creation of God. The man is called intelligent because of the brain .Today human beings are developed because they can think, that other animals cannot do. But they loss the knowledge of a brain when the body is destroyed after the death of man.

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In ***neuroscience***, neuroinformatics and brain simulation can collect and integrate the experimental data, identifying and filling gaps in presented knowledge, prioritizing and enormously increasing the value that can be extract from future experiments.

In ***medicine***, medical informatics can identify biological signatures of brain disease, allowing diagnosis at an early stage, before the disease has done irreversible damage and enabling personalised treatment, adapted to the needs of individual patients. Better diagnosis, combined with disease and drug simulation, can accelerate the discovery of new treatments, speeding up and drastically lowering the cost of drug discovery.

In ***computing***, new techniques of interactive supercomputing, driven by the needs of brain simulation, can impact a vast range of industries, while devices and systems, modeled after the brain, can overcome fundamental limits on the energy-efficiency, reliability and programmability of current technologies, clearing the road for systems with brain-like intelligence.

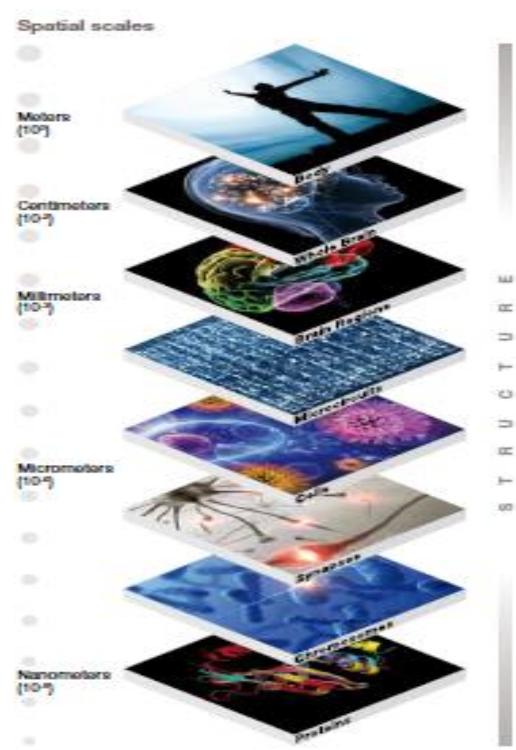

Figure 1: From molecules to the body: spatial scales for the brain's different levels of organisation span nine orders of magnitude

II. HUMAN BRAIN PROJECT

The ***Human Brain Project (HBP)*** as shown in figure 2 should pursue four goals, each building on existing work, and acting as a catalyst for new research.

1. *Data*: generate strategically selected data essential to seed brain atlases, build brain models and catalyse contributions from other groups.

2. *Theory:* identify mathematical principles underlying the relationships between different levels of brain organisation and their role in the brain's ability to acquire, represent and store information.

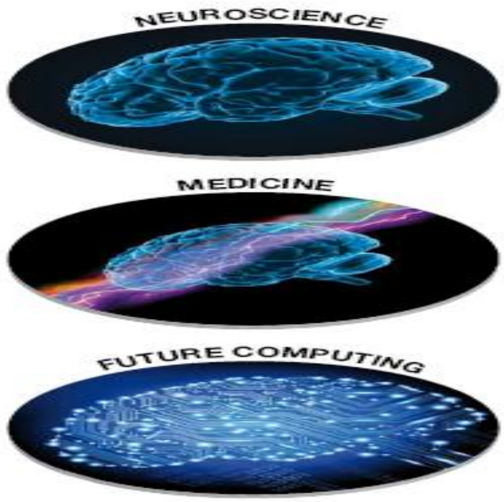

Figure 2-HBP research areas

3. *ICT platforms:* provide an integrated system of ICT platforms offering services to neuroscientists, clinical researchers and technology developers that accelerate the pace of their research.

4. *Applications:* develop first draft models and prototype technologies, demonstrating how the platforms can be used to produce results with immediate value for basic neuroscience, medicine and computing technology.

These goals are discussed in detail below:

Data

Modern neuroscience research has already generated huge volumes of experimental data; large-scale initiatives already in progress will produce a deluge of new findings. Even then, however, much of the knowledge needed to build multi-level atlases and unifying models of the brain will still be missing. The first goal for the HBP should thus be to generate and interpret strategically selected data, unlikely to come from other sources. The HBP-PS has identified three main focuses for this research. They are as follows:

- ***Multi-level brain structure in mouse.*** Many results from studies of the mouse brain are applicable to all mammals. A systematic study of the relations among its different levels of organisation would provide vital input for atlases and models of the human brain.
- ***Multi-level structure of the human brain.*** Mouse data provides many insights into the human brain. Obviously, however, the human brain is different. To identify and characterize these differences, HBP research should generate strategically selected data for the human brain, as far as possible matching the data available for mouse.
- ***Brain function and neuronal architectures.*** One of the HBP's most important goals must be to understand the relationship between brain structure and function. A third focus for HBP research should thus be the neuronal architectures responsible for specific cognitive and behavioural skills – from simple capabilities, also present in non-human species, to those such as language, that are exclusive to humans.

Theory

Without sound theoretical foundations, it will not be possible to overcome the fragmentation of neuroscience data and research. The HBP should thus include a concerted programme of theoretical research, focusing on the mathematical principles underlying the relationships between different levels of brain organisation and the way the brain acquires, represents and stores information. As part of this programme, the HBP should establish a *European Institute for Theoretical Neuroscience*, encouraging participation by scientists from outside the project and acting as an incubator for novel approaches.

ICT platforms

The HBP's third goal should be to create an integrated system of ICT platforms with the potential to set in motion a new kind of ICT-based brain research. It is proposed that there should be six of these platforms, dedicated to Neuroinformatics, Brain Simulation, Medical Informatics, High Performance Computing, and Neurorobotics.

- ***Neuroinformatics.*** The HBP *Neuroinformatics Platform* should provide technical capabilities making it easier for neuroscientists to analyse structural and functional brain data and to build and navigate multi-level brain atlases. The platform should also include tools for *predictive neuroinformatics*, making it possible to detect statistical regularities in the relationships between data representing different levels of brain organisation and to estimate the values of parameters that are difficult or impossible to measure experimentally. These tools will provide a new way of filling the gaps in data and knowledge that current ly prevent us from achieving an integrated understanding of the brain.
- ***Brain Simulation.*** The HBP should create a large-scale *Brain Simulation Platform*, making it possible to build and simulate multi-scale brain models at the different levels of detail appropriate to different scientific questions. The platform – which would play a central role in the whole project – should provide researchers with modelling tools, workflows and simulators allowing them to integrate large volumes of heterogeneous data in multi-scale models of the mouse and human brains, and to simulate their dynamics. This possibility would allow them to perform *in silico* experiments, impossible in the lab. Tools provided by the platform would generate input essential for HBP research in medicine (models of diseases and the effects of drugs), neuromorphic computing (brain models for implementation in neuromorphic hardware), and neurorobotics (models of neural circuitry for specific cognitive and behavioural tasks).
- ***High Performance Computing.*** The HBP *High Performance Computing Platform* should provide the project and the community with the computing power they need to build and simulate models of the brain. This should include both the

latest, most powerful supercomputing technology, up to the exascale, and completely new capabilities for interactive computing and visualisation.

- ***Medical Informatics.*** The HBP *Medical Informatics Platform* should federate clinical data from hospital archives and proprietary databases, while providing strong protection for patient data. Such capabilities would allow researchers to identify "biological signatures" for specific disease processes – a fundamental breakthrough. Once researchers have an objective, biologically-grounded way of detecting and classifying diseases, they will be able to understand their causes and develop effective treatments.
- ***Neurorobotics.*** The HBP *Neurorobotics Platform* should provide researchers with tools and workflows allowing them to interface detailed brain models to a simulated body in a simulated environment, comparing the behaviour they can learn against results from human and animal experiments. These capabilities would offer neuroscientists new strategies for studying the multi-level mechanisms underlying behaviour. From a technological perspective it would give developers the tools they need to develop robots with the potential to achieve human-like capabilities, impossible to realise in systems that do not have a brain-like controller.

<u>Applications</u>

The project's fourth major goal should be to demonstrate the value of its platforms for fundamental neuroscience research, for clinical studies and for technology development. We expect that successful demonstrations would trigger a wave of research by groups outside the project. To encourage this effect, a large proportion of this work should be entrusted to groups not included in the initial HBP Consortium. Later in this report, we will outline specific proposals to achieve this goal.

- ***Integrative principles of cognition.*** Researchers should use the *Brain Simulation* and *Neurorobotics Platforms* in projects that systematically dissect the neuronal circuits responsible for specific behaviours, simulating the effects of genetic defects, lesions, and loss of cells at different levels of brain organization and modelling the effects of drugs. The ultimate goal should be to model the unique capabilities that distinguish humans from other animals, in particular language. Such models would represent a fundamental advance in our understanding and would have immediate applications in medicine and technology.
- ***Understanding, diagnosing and treating brain disease.*** Research should exploit the capabilities of the *Medical Informatics, Neuroinformatics* and *Brain Simulation Platforms* to discover biological signatures associated with specific disease processes, to understand and simulate these processes, and to identify new targets for prevention and treatment. This work should demonstrate the ability of the HBP platforms to produce immediately valuable results. New diagnostic tools would make it possible to diagnose disease earlier, before it causes irreversible damage, develop new drugs and test new treatment strategies adapted to the needs of specific patients – so-called personalised medicine. The end result would be better outcomes for patients and lower healthcare costs. Better understanding and diagnosis would also help to optimize the drug discovery process, allowing better screening of drug candidates and better selection of patients for clinical trials. The benefits would include a reduction in expensive failures during late trials and reductions in the cost of developing new drugs, currently estimated at around Eur 1 billion per drug.
- ***Future Computing Technologies.*** Researchers should use the HBP's *High Performance Computing, Neuromorphic Computing* and *Neurorobotics Platforms* to develop new computing technologies and new applications. The *High Performance Computing Platform* would allow them to design hybrid technology integrating neuromorphic devices with conventional supercomputing. With the *Neuromorphic Computing* and *Neurorobotics Platforms*, they would be able to build prototypes of applications with large potential markets. These would include robots for use in the home, manufacturing and services, as well as "invisible", yet equally significant technologies, such as data mining and controllers for vehicles, household appliances, manufacturing, image and video processing, and telecommunications.

III. UPLOADING HUMAN BRAIN

The name of the world's first virtual brain. That means a machine that can function as human brain. Today human beings are developed because of their intelligence. Intelligence is the inborn quality that can not be created .Some people have this quality ,so that they can think up to such an extent where other can not reach .Human society is always need of such intelligence and such an intelligent brain to have with. But the intelligence is lost along with the body after the death. By this unbelievable attempt, the brain and intelligence will alive even after the death. Humans often face difficulties in remembering things such as people's names, their birthdays, and the spellings of words, proper grammar, important dates, history facts, and etcetera. Virtual brain may be the solution to it.

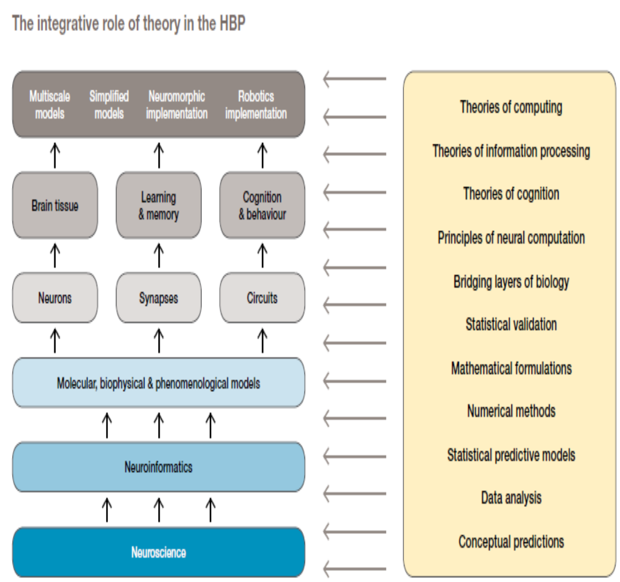

Figure 3: From biology to abstract mathematical representations

Human brain consists of 10^{11} neuron with 10^{15} connections. Today scientists are in research to create an artificial brain that can think, response, take decision, and keep anything in memory. The main aim is to upload human brain into machine. So that man can think, take decision without any effort.

The uploading is possible by the use of small robots known as the nanobots. These robots are small enough to travel through out our circulatory system. Traveling 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 computer while we still reside in our biological form. Nanobots could also carefully scan the structure of our brain, providing a complete readout of the connection. This information, when entered into a computer, could then continue to function as us. Thus the data stored in the entire brain will be uploaded into the computer. Once the microcircuit is built, the exciting work of making the circuit function can begin.

Figure 4. Human Brain

All the 8192 processors of the Blue Gene are pressed into service, in a massively parallel computation solving the complex mathematical equations that govern the electrical activity in each neuron when a stimulus is applied.

Figure 5-Nanoboats

Technology is growing faster than everything. IBM is now in research to create a virtual brain. It is called "*Blue brain* ".A network of artificial nerves is evolving right now in a Swiss supercomputer. The project is scheduled to last beyond 2015, at which point the team hopes to be ready for their primary goal: a computer model of an entire human brain. The Blue Brain project is the first comprehensive attempt to reverse-engineer the mammalian brain. In July 2005, EPFL and IBM announced an exciting new research initiative - a project to create a biologically accurate, functional model of the brain using IBM's Blue Gene supercomputer.

At the end of 2006, the Blue Brain project had created a model of the basic functional unit of the brain, the neocortical column. In November, 2007, The Blue Brain Project officially announced the conclusion of Phase I of the project, with three specific achievements:
1. A new **modeling framework** for automatic, on-demand construction of neural circuits built from biological data.
2. A new **simulation and calibration process** that automatically and systematically analyzes the biological accuracy and consistency of each revision of the model.
3. The first **cellular-level neocortical column** model built entirely from biological data that can now serve as a key tool for simulation-based research.

IV . CHALLENGE TO BRAIN EMULATION

One of the major unresolved issues for WBE(whole brain emulation) is whether it is possible to identify the functional characteristics of synapses, in particular synaptic strength and neurotransmitter content, from their morphology.In spite of the progress in many brain emulation efforts, there are major challenges :

Neural complexity: In cortical neurons, synapses themselves vary widely, with ligand-gated and voltage-gated channels, receptive to a variety of transmitters. The extent of the detailed modeling of dendritic computations and spiking necessary for brain emulation is an open question.

Scale: A massive system is required to emulate the brain: none of the projects discussed yet, have come close to this scale at present. The largest supercomputers and computer clusters today have thousands of processors, while the human cortex has tens of billions of neurons and a quadrillion synapses. They are a long way from cortex scale, even if one computer processor could emulate thousands of neurons, and, as it will see, it is unclear whether that emulation would be sufficiently accurate.

Interconnectivity: Emulation of the cortex in hardware represents a massive "wiring" problem. Each synapse represents a distinct input to a neuron, and each postsynaptic neuron shares synapses with an average of 10,000 (and as many as 100,000) other presynaptic neurons. Similarly, the axon emerging from each neuronal cell body fans out to an average of 10,000 destinations. Thus each neuron has, on average, 10,000 inputs and 10,000 outputs.

Power consumption: A final, indirect problem is the power consumed by brain emulation with 50 billion neurons and 500 trillion connections, and the dissipation of the associated heat generated. The human brain evolved to use very little power, an estimated 25 watts. We do not have computing technology anywhere near this power efficiency, although nanotechnology and ultra-low power design offer promise.

V. APPLICATIONS

The major goal should be to demonstrate the value of its platforms for fundamental neuroscience research, for clinical studies and for technology development. Following are the applications:

- **Understanding, diagnosing and treating brain disease:** Research should exploit the capabilities of the *Medical Informatics, Neuroinformatics* and *Brain Simulation Platforms* to discover biological signatures associated with specific disease processes, to understand and simulate these processes, and to identify new targets for prevention and treatment. New diagnostic tools would make it possible to diagnose disease earlier, before it causes irreversible damage, develop new drugs and test new treatment strategies adapted to the needs . The end result would be better outcomes for patients and lower healthcare costs. Better understanding and diagnosis would also help to optimize the drug discovery process. The benefits would include a reduction in expensive, failures during late trials and reductions in the cost of developing new drugs.

- **Future Computing Technologies:** Researchers should use the *High Performance Computing*, *Neuromorphic Computing* and *Neurorobotics Platforms* to develop new computing technologies and new applications. The *High Performance Computing Platform* would allow them to design hybrid technology integrating neuromorphic devices with conventional supercomputing. With the *Neuromorphic Computing* and *Neurorobotics Platforms,* they would be able to build prototypes of applications with large potential markets.

The pros of virtual brain are remembering things without any effort, making decision without the presence of a person, using intelligence of a person after the death , understanding the activities of animals, allowing the deaf to hear via direct nerve. Whereas the cons of virtual brain are human beings will become dependent upon the computer, others may use technical knowledge against us.

VI. CONCLUSION

Development of basic processing for handling the scan data does not appear to pose many problems beyond the need for extremely high‐throughput signal and image processing and perhaps the data management issues of the raw scans. Identifying cellular objects, in particular connectivity and synapses, is a non‐trivial image interpretation problem that is currently being studied. Basic contouring algorithms appear to work reasonably well, and it is likely, given other results in current image recognition, that synapse detectors could be constructed. Image interpretation is traditionally a computationally costly operation, and may conceivably be a bottleneck in developing early WBE models. The hardest and currently least understood issue is estimating emulation parameters from imagery.

Some of the key scientific questions for the BBP in the future may includes the approach be scaled up to deal with several cortical columns, whole brain areas, and even groups of connected brain areas, the approach based on findings in a slice of the cortex be enriched and made more relevant to understanding how the brain computes by investigating the functional connectivity in vivo, and using this as a basis for developing the model of the cortex to apply to the normal operation of the cortex when natural inputs are applied, the full details of the cortical connectivity are being discovered, can reduced computational models be produced that allow the main functional properties of the operation of the cortical circuitry to be incorporated.

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