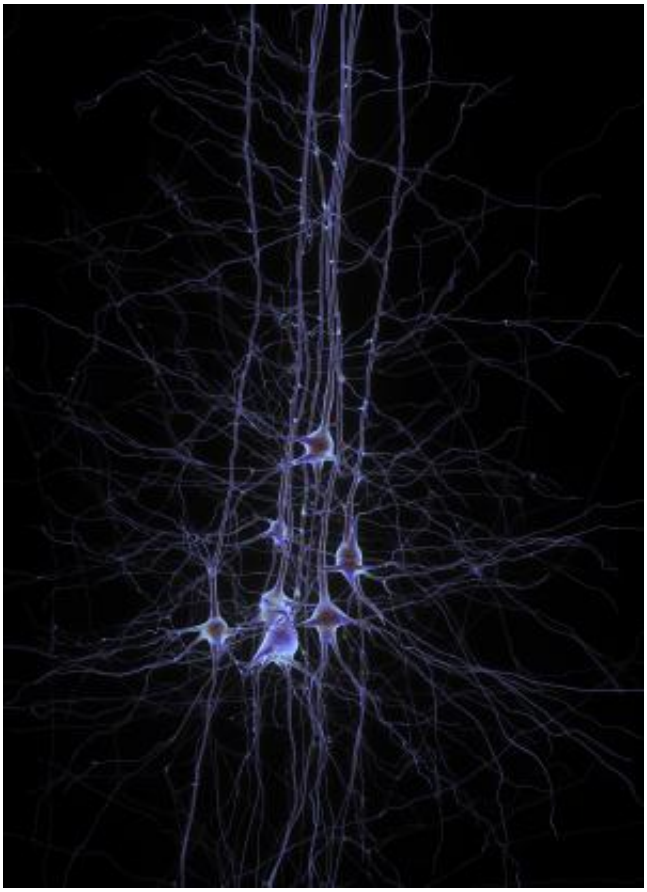
Thinking it through: Scientists seek to unlock mysteries of the brain

February 16 2014



This is a group of neurons. Credit: EPFL/Human Brain Project

Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to this challenge, we will gain profound insights into what makes us human, develop new treatments

for brain diseases, and build revolutionary new computing technologies that will have far reaching effects, not only in neuroscience.

Scientists at the European Human Brain Project—set to announce more than a dozen new research partnerships worth Eur 8.3 million in funding later this month—the Allen Institute for Brain Science, and the US BRAIN Initiative are developing new paradigms for understanding how the human brain works in health and disease. Today, their international and collaborative projects are defined, explored, and compared during "Inventing New Ways to Understand the Human Brain," at the 2014 AAAS Annual Meeting in Chicago.

Brain Simulation, Big Data, and a New Computing Paradigm

Henry Markram from the Ecole Polytechnique Fédérale de Lausanne (EPFL), in Switzerland, where the Human Brain Project is based, describes how the project will leverage available experimental data and basic principles of brain organization to reconstruct the detailed structure of the brain in computer models. The models will allow the HBP to run super-computer based simulations of the inner working of the brain.

"Brain simulation allows measurements and manipulations impossible in the lab, opening the road to a new kind of in silico experimentation," Markram says.

The data deluge in neuroscience is resulting in a revolutionary amount of brain data with new initiatives planning to acquire even more. But searching, accessing, and analyzing this data remains a key challenge.

Sean Hill, also of EPFL and a speaker at AAAS, leads The

Neuroinformatics Platform of the Human Brain Project (HBP). In this scientific panel, he explains how the platform will provide tools to manage, navigate, and annotate spatially referenced brain atlases, which will form the basis for the HBP's modeling effort—turning Big Data into deep knowledge.

The Neuroinformatics Platform will bring together many different kinds of data. University of Edinburgh's Seth Grant, a key member of the HBP, describes how he is deriving new methods to decode the molecular principles underlying the brain's organization, such as how individual proteins assemble into larger complexes. As Grant explains in Chicago, this has important practical applications as many mutations in schizophrenia and autism converge on these so-called supercomplexes in the brain.

As we understand more and more about the way the brain computes we can apply this knowledge to technology. Karlheinz Meier, of Heidelberg University in Germany and a speaker at AAAS, outlines how he is working to create entirely new computing systems as part of the HBP. These Neuromorphic Computing Systems will merge realistic brain models with new hardware for a completely new paradigm of computing—one that more closely resembles how the brain itself processes information.

"The brain has the ability to efficiently perform computations that are impossible even for the most powerful computers while consuming only 30 Watts of power," Meier says.

Brain: Get Ready For Your Close-up

At AAAS, Christof Koch lays out another ambitious, 10-year plan from the Allen Institute for Brain Science: to understand the structure and function of the brain by mapping cell types from mice and humans with

computer simulations and figuring out how the cells connect, and how they encode, relay, and process information. The project, Koch says, promises massive, multimodal, and open-access datasets and methodology that will be reproducible and scalable.

At Harvard University, George Church is participating in the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative, which aims to map every neuron in the brain with rapidly advancing technologies. At AAAS, he describes progress on new tools for measurements of brain cell development, connectivity, and functional state dynamics in rodent and human clinical samples.

What do all of these projects have in common? They seek to help find some of the most elusive answers known to man: what makes us human, how does the brain function, what causes neurological and mental illness, and, most importantly, how can we treat or cure these afflictions?

More information: www.humanbrainproject.eu/

Provided by Ecole Polytechnique Federale de Lausanne