

First IEEE Brain Initiative Workshop

December 14, 2015

Columbia University

The first IEEE Brain Initiative Workshop was held at the Faculty House at Columbia University on December 14th, 2015. The Workshop helped kick-off discussion on the definition, scope, and potential structure of the IEEE Brain effort and members from the academia, industry, and government communities were present. Steve Diamond, Vice Chair of the IEEE Future Directions Committee gave opening remarks and welcomed the attendees on the importance of IEEE's role in nurturing the development of technologies and brain research.

Paul Sajda, Professor of Biomedical Engineering and Radiology at Columbia University, Chair of IEEE Brain Initiative, and Jose Carmena, Professor of Electrical Engineering and Neuroscience at the University of California-Berkeley and Vice Chair of IEEE Brain Initiative, facilitated the workshop discussion. A key goal that was echoed throughout the day was to focus on delivering concrete results through the IEEE Brain effort. IEEE, with an unrivaled network of professionals and experts that span across multiple engineering disciplines and technologies, is in a unique position to make an impact on brain technologies and research.

The December Workshop was a blend of keynote presentations from Rafael Yuste, Professor of Biological Sciences and Neuroscience and Director of the NeuroTechnology Center at Columbia University, and Jan Rabaey, Professor of Electrical Engineering and Computer Science and a Founding Member of the Center for Neural Engineering and Prostheses at University of California, Berkeley, which stimulated technical exchanges, and informative presentations from eleven (11) IEEE Societies/Councils discussing their efforts in the area of brain.



In Rafael Yuste's keynote talk, he stressed that we are in a critical period of transition, where technology and new tools will have a major impact in accelerating discovery and giving insights into how the brain works. Yuste was one of the authors of the original proposal for the Brain Activity Map (BAM) project, which later inspired the White House's BRAIN Initiative. The average human has a hundred billion of neurons in the brain, and Yuste noted the significant challenge in studying the emergent properties of neural circuits by recording every neuron within a circuit. Current imaging techniques such as calcium imaging of neuron circuits and two-photon imaging are enabling researchers to record the activity of small groups of neurons. The short-term goal is to record the activity of smaller circuits, in the scale of 50,000 neurons in 5 years, and then 1 million neurons in 10 years. For a long-term goal (in 15 years), the expectation is to be able to record and study the entire brain of a small animal.

Yuste also noted the need for a national network of neurotechnology centers to enhance and accelerate brain research. No single facility "has it all". Neurotechnology centers will harness technologies from

existing facilities while letting them mature and be shared with others in the community to drive innovation. Yuste also called for the creation of ethics panels comprised of bioethicists, legal experts, philosophers, informed citizens, and FDA to address human rights, personhood, and dignity. He ended his talk by quoting the Nobel Laureate, Sydney Brenner, *“Progress in science depends on new techniques, new discoveries and new ideas, probably in that order.”*

The second keynote speaker, Jan Rabaey, explored the opportunities and challenges in realizing the Human Intranet. Rabaey represents a new wave of engineers from core disciplines that are helping to accelerate neuroscience research. Advances in the fields of integrated circuits, signal processing, communications, networking, material science, machine learning, controls, and other core disciplines all contribute to solving the many challenges in understanding the brain. Rabaey described how we are living in a smart dynamic world, with sensory and data processing capabilities everywhere around us. The Human Intranet is an open scalable platform of sensors, processor, actuators, storage, and network links around, on, or inside the human body acting in concert with the functions provided by the body itself. The evolution of Brain Machine Interfaces (BMI) and wearable technologies (e.g., flexible electronics, miniaturization) are enabling the realization of the Human Intranet. However, many challenges remain in areas such as energy, connectivity, safety, security, and adaptivity. The Human Intranet will certainly challenge society and humanity in many ways, and the conversation must start now.



The December workshop also gave opportunities for members of IEEE Societies and Councils to give presentations about their group’s activities and involvement in brain research. To date, 15 IEEE Societies and Councils have agreed to join and contribute to the IEEE Brain Initiative, in addition to support from IEEE Standards Association and the Digital Senses Initiative.

The following presentations from IEEE organizations were given at the workshop.

- IEEE Circuits and Systems Society and Solid-State Circuits Society (Europe), Timothy Constandinou, Imperial College London
- IEEE Circuits and Systems Society and Solid State Circuits Society (North America), Roman Genov, University of Toronto
- IEEE Computational Intelligence Society, Yoonsuck Choe, Texas A&M University
- IEEE Consumer Electronics Society, Narisa Chu, CWLab International
- IEEE Engineering in Medicine and Biology Society, Metin Akay, University of Houston
- IEEE Magnetic Society, Jian-Ping Wang, University of Minnesota
- IEEE Robotics and Automation Society, Matei Ciocarlie, Columbia University
- IEEE Sensors Council, Michael McShane, Texas A&M University
- IEEE Systems, Man, Cybernetics Society, Michael H. Smith, UC Berkeley
- IEEE Standards Association, Cherry Tom
- Digital Senses Initiative, Yu Yuan, CATE Global

These presentations confirmed that a lot is happening within IEEE and the interdisciplinary nature of brain technologies and research. IEEE already has brain assets in existing journals or special issues of journals, conferences, technical committees, and standards. A diverse range of technical disciplines is being covered within IEEE, including connectomics, neuro-sensing, imaging techniques, signal analysis, brain-machine interfaces (BCIs), deep machine learning, and neuromorphic computing just to name a few. Thus, a main goal of the IEEE Brain Initiative will be to leverage the collective expertise of IEEE and synergize activities across industry, government, and academia to advance brain research and neurotechnology development.

The workshop ended with a lively brain storming session where the attendees identified topic areas that should be addressed, communities and constituencies that should be engaged, and ways to collaborate within and outside of IEEE. There is a strong desire to engage the cognitive neuroscience community, as well as the clinical community. Ethics and privacy are areas that should not be overlooked, and the involvement of the Society of Social Implications of Technology (SSIT) is timely. Big data challenges for neuroscience and BCIs, not only in the magnitude, but in the measurement, curation, and storage of the data need to be addressed. There was also great interest in planning a BCI hackathon, to get younger researchers involved in understanding the complexity of obtaining a reliable recording of the brain's activity, perhaps through an electroencephalogram (EEG), and building an interface to perform a particular task.

The IEEE Brain Initiative is looking forward to engage with stakeholders in the brain community and begin forming a team to further its mission to advance efforts in brain research and neurotechnology development. Periodical teleconferences are being planned, and if you are interested in joining the IEEE Brain Initiative, please contact brain@ieee.org.

Presentation slides from the December workshop can be found [here](#).



Full house at the Faculty House in Columbia University



IEEE Brain Initiative Chair Paul Sajda and Vice Chair Jose Carmena with Yu Yuan, Chair of IEEE Digital Senses and Narisa Chu, CES representative



Iyad Obeid, Temple University with Michael H. Smith, SMC