# Precision Convergence Webinar Series

## Moving towards Interpretable Models of Functioning Brains For Adaptive Real-World Behavior and Sustainable Health

*By Raghu Machiraju*
*Ohio State University, Ohio*
*With High-Level Panel of Leaders in Science, Technology, On-the-Ground Action, and Policy*
Wednesday, Sep 27, 2023| 11 AM to 1 PM EST (2 hours in duration)

***For Remote Participation, please register HERE***

**ABSTRACT:** As exemplified by the Virtual Brain Platform that ispart of the EU-lead e-Brain initiative, the brain can be best modeled as a complex, dynamic and adaptive system that is adept at engaging in non-trivial decision making or learning tasks. In previous work we have shown that appropriate state- space models can depict how the various regions of a functioning brain are recruited in a cascacadic manner to complete mental arithmetic. These models were used to explain the different functioning of normal, dyscalculic and dyslexic brains. I will describe this work in sufficient detail and especially highlight the crucial role of state-space models. In more recent interactions, I explored how these state-space models can be used for more general decision making tasks. The goal was to create "models similar to a functioning brain" rather than replicate the brain as is often done in the annals of neuromorphic computing. When successful, it will be then possible to simulate the behavior of humans when they interact with both natural and managed-natural systems. Thus, the models of experts can be shared to teach novices particular tasks. Further, I will also propose that is possible to model living systems of human brain and body as integrated into a larger environment as they adapt to change. Thus, cancers like glioblastomas, living plant(s), and other organisms can be modeled as adaptive precision care. Interestingly, one could create specialized virtual E-brains and realize them either as von-Neuman systems at the least, or as material systems (e,g.,photonic systems emulating photo-synthesis) that sense, compute and store information and interact with each other. I therefore offer a blueprint for an e- brain-in-a-box which, in turn, will rest on many tools from difference projects assembled in high-performing computing integrative architecture like C-Brain.

**PRESENTER: Raghu Machiraju** is a Professor of Biomedical Informatics, Computer Science and Engineering (CSE), and Pathology at the Ohio State University (OSU). He founded the $170M, 55-faculty strong, Translational Data Analytics Institute dedicated to the adoption of data science and analytics on the campus of Ohio State. Currently, he is the Associate Chair for Growth in the Department of Computer Science and Engineering and an essential member of a leadership team overseeing tremendous growth in size and reputation. Over the last two years, CSE@OSU has risen 11 spots and is now a top-25 department and is seeking to transform itself into a school of computing. Raghu's own research interests span areas where computing intersects with various domains. As a Co-PI of a $20M NSF-funded AI Institute, he helps with the adoption of AI by various domain specialists while contributing to AI foundations. As an independent researcher, he has contributed to developing machine learning methods to characterize unsteady flow, model state transitions of a functioning brain, integrate multiple omics data to predict patient outcomes with both semin- supervised and unsupervised tools, create weakly supervised models that rely on weak labels and enable robust grading of large whole slide histopathology images, and develop tools of GenAI to convert text describing branching processes to flow graphs.

**About the series:** The precision convergence series is launched to catalyze unique synergy between, on the one hand, novel partnerships across sciences, sectors and jurisdictions around targeted domains of real-world solutions,and on the other hand, a next generation convergence of AI with advanced research computing and other data and digital architectures such as PSC's Bridges-2, and supporting data sharing frameworks such as HuBMAP, informing in a real time as possible the design, deployment and monitoring of solutions for adaptive real-world behavior and context.

**The McGill Centre for the Convergence of Health and Economics (MCCHE)** is a virtual world network of scientist, action and policy leaders promoting the weaving of digital-powered interdisciplinary science into person-centered domain-specific solutions at scale to global challenges faced by traditional and modern economy and society worldwide. The MCCHE stimulates lasting collaborations that bridge the many divides in the market, economy, and society that are at the root of these most pressing modern challenges through collaborative of modular convergence innovation platforms.

**The Pittsburgh Supercomputing Center** is a joint computational research center between Carnegie Mellon University and the University of Pittsburgh. Established in 1986, PSC is supported by several federal agencies, the Commonwealth of Pennsylvania and private industry. PSC provides university, government, and industrial researchers with access to several of the most powerful systems for high-performance computing, communications, and data-handling available to scientists and engineers nationwide for unclassified research. PSC advances the state-of-the-art in high-performance computing, communications and informatics and offers a flexible environment for solving the largest and most challenging problems in computational science.

## *Co-Chairs:*

**Laurette Dubé, PhD** is the founding Chair and Scientific Director of the McGill Centre for the Convergence of Health Economics. She holds the James McGill Chair of Consumer and Lifestyle Psychology and Marketing. Her work has been published in top disciplinary journals in Psychology, Management and Medicine as well as in multidisciplinary journals. She holds an MBA in finance, and a PhD in behavioural decision making and consumer psychology. During her 2020-2021 sabbatical, she is a visiting scholar at the National Research Council of Canada and at the Pittsburgh Supercomputing Center, Carnegie Mellon, USA. https://thefutureeconomy.ca/interviews/ laurette-dube

**Sergiu Sanielevici,** Ph.D. is Director of Support for Scientific Applications at the Pittsburgh Supercomputing Center, a joint project of Carnegie Mellon University and the University of Pittsburgh. He has served as the Deputy Director of the Extended Collaborative Support Service of the US NSF XSEDE project and as the manager of its Novel and Innovative Projects program, fostering non- traditional and interdisciplinary applications of advanced computing and data resources since 2011. He is currently the Principal Investigator of the Bridges-2 project and co-Principal Investigator of the Neocortex project at PSC. Dr. Sanielevici is a proud alumnus of McGill University (Ph.D., Physics, 1986).

## *Panelists:*

**Mark Bathe** is a Professor in the Department of Biological Engineering at MIT, Director of the MIT New Engineering Education Transformation, Member of the Harvard Medical School Initiative for RNA Medicine, and Associate Member of the Broad Institute of MIT & Harvard. He obtained his Doctoral Degree at MIT working in the Departments of Mechanical, Chemical, and Biological Engineering before moving to the University of Munich as an Alexander von Humboldt Fellow to carry out his postdoctoral research in Biological Physics. He returned to MIT in 2009 to join the faculty in the Department of Biological Engineering, where he runs an interdisciplinary research group focused on engineering nucleic acids for application to vaccines, therapeutics, structural biology, and computing.

**Dana Small** is a Professor of Psychiatry and Psychology at McGill University. The primary interest of her lab is to use functional neuroimaging techniques in combination with neuropsychological, behavioral, psychophysical, genetic and physiological assessments to understand brain representation of taste, smell, flavor, and feeding in humans. She is particularly interested in understanding the dynamic relationship between brain and obesity. How do the neural circuits governing feeding and flavor preference formation predispose certain individuals to gain weight? How do weight gain and the associated physiological adaptations influence brain function? She is also interested in uncovering the fundamental neural organization of the human gustatory and flavor systems. Her lab is equipped with an fMRI simulator, a fully automated and fMRI compatible olfactometer and gustometer, and a BODPOD for measuring percent body fat.

**Petra Ritter** heads the Brain Simulation Section at the Charité University Medicine Berlin and Berlin Institute of Health. Her research focus is on integrating multimodal health data in computational avatars of patients to discover complex mechanisms of healthy function and dysfunction. She serves in the leadership of large EU infrastructure projects such as the Testing and Experimentation Facility Health AI and Robotics (TEF-Health), European Open Science Cloud's Virtual Brain Cloud und eBRAIN-Health and she is directing the Health Data Cloud of EBRAINS - a research infrastructure on the roadmap of the European Strategy Forum for Research Infrastructures. Petra Ritter studied medicine in Germany and in the US. She serves as the Director for International Affairs at the Charité and as spokesperson of the BIH Extended Directorate.

**Dr. Richard Gold** is a James McGill Professor at McGill University's Faculty of Law and Faculty of Medicine and Health Sciences. Teaching in the area of intellectual property and innovation, he currently serves as the Director of the Centre for Intellectual Property Policy. His research centers on models of innovation and novel intellectual property strategies, particularly those relying on open science. Prof. Gold has been an expert to governments, international intergovernmental agencies, and expert panels in Canada, the US and Europe