

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
Thursday, June 22, 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 is part of the EU-led 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 cascading 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 it 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 semi-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:



Rigoberto Hernandez, PhD, is the Gompf Family Professor in the Dept. of Chemistry at the Johns Hopkins Univ., and the Director of the Open Chemistry Collaborative in Diversity Equity (OXIDE). He is also a Professor in the Depts of Chemical and Biomolecular Engineering, and Materials Science and Engineering at Johns Hopkins Univ. Before joining Hopkins in 2016, he was a Professor in the School of Chemistry & Biochemistry at Georgia Tech for 20 years. He was born in Havana, Cuba and is a U.S. Citizen by birthright. He holds a B.S.E. in Chemical Engineering and Mathematics from Princeton Univ. (1989), and a Ph.D. in Chemistry from UC Berkeley (1993). His research area can be broadly classified as the theoretical and computational chemistry of systems far from equilibrium. Applications include dynamics in colloidal suspensions, liquid crystals, sustainable nanotechnologies, protein folding and rearrangement, autonomous computing machines, and energetic formulations. The work is presently supported by the NSF, DOE and Sloan Foundation.



Dan Isaacs is the Chief Technology Officer and General Manager of Digital Twin Consortium. He is responsible for setting and facilitating the technical direction of the Member Consortium, liaison partnerships, and business development support for new memberships. Dan also serves as the Chief Strategy Officer for the Object Management Group (OMG). His responsibilities include developing and implementing a comprehensive strategy to unify OMG community of consortia (AREA, BPM+ Health, CISQ, DTC, IIC, OMG SDO, and Responsible Computing). Dan is responsible for driving advanced technology awareness and adoption towards accelerating sustainable global digital transformation across industries, academia, government, and geographies. Previously, as Director of Strategic Marketing and Business Development at Xilinx, Dan was responsible for emerging technologies, including AI/ML and executing the IIOT ecosystem strategy. Dan has over thirty years of experience working in Automotive, Industrial, Aerospace, and Consumer-based companies, including Ford, NEC, LSI Logic, and Hughes Aircraft. An accomplished speaker, Dan has delivered keynotes, seminars and served as a panelist and moderator at World Forums, Industrial IOT Global conferences and Embedded Systems. He holds degrees in Computer Engineering: EE from Cal State University B.S. in Geophysics from ASU.



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.