Contribution ID: **27** Type: **Talk**

AI-Driven Neurodiagnostics: A Scalable Framework for EEG Anomaly Detection Using a Distributed-Delay Neural Mass Model

Wednesday 29 October 2025 10:45 (15 minutes)

Abstract—The integration of biophysically grounded neural simulations with Artificial Intelligence (AI) has the potential to transform clinical neurodiagnostics by overcoming the inherent challenges of limited pathological EEG datasets. We present a novel AI-driven framework that leverages a Distributed-Delay Neural Mass Model (DD-NMM) to generate synthetic EEG signals replicating both healthy and pathological brain states. Through systematic parameter tuning and domain-specific data augmentation, we enrich the diversity of simulated signals, enabling robust anomaly detection using machine learning techniques. Our approach integrates supervised classification and unsupervised one-class anomaly detection, achieving over 95% accuracy in synthetic tests and over 89% when applied to real EEG data from epilepsy patients and healthy volunteers. By providing an engineered solution that bridges computational neuroscience with AI, this framework enhances early seizure detection, adaptive neurofeedback, and brain-computer interface applications. Our results demonstrate that theory-driven simulation, combined with state-of-the-art machine learning, can address critical gaps in medical AI, significantly advancing clinical neuroengineering.
Clinical relevance—This study provides a scalable and interpretable AI-driven method for EEG anomaly detection, which can support clinicians in identifying seizure patterns and other neurological disorders with high accuracy. The integration of computational neuroscience with AI-based diagnostics offers a potential pathway for early intervention and personalized neurotherapeutic strategies.

Primary author: Dr GONZALEZ-MITJANS, Anisleidy (McGill Centre for Integrative Neuroscience, Montreal Neurological Institute, McGill University, Montreal, QC, Canada)

Co-authors: SALINAS MEDINA, Alejandro (School of Computer Science - McGill University); Dr TOUSSAINT, Paule-J (McGill University); Dr VALDES-SOSA, Pedro (University of Electronic Science and Technology of China, Chengdu, Sichuan, China); EVANS, Alan C. (McGill University)

Presenter: Dr GONZALEZ-MITJANS, Anisleidy (McGill Centre for Integrative Neuroscience, Montreal Neurological Institute, McGill University, Montreal, QC, Canada)

Session Classification: Session 3: Applications & Clinical Translation