



PRESS RELEASE

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NUS Medicine researchers unveil NeuroAI-powered analytical tool for early detection and diagnosis of brain disorders

Singapore, 18 December 2024 – To improve our understanding of how different brain regions work together and develop better methods for analysing the complex, changing patterns of brain activity over time and space, researchers at the Yong Loo Lin School of Medicine (NUS Medicine) have unveiled a cutting-edge analytical tool designed for analysing brain dynamics, known as Brain-JEPA (Joint-Embedding Predictive Architecture).

Like ChatGPT trained on large amounts of text data, the Brain-JEPA foundation model optimises artificial intelligence (AI) and works on large amounts of brain recordings, using a "functional map" to understand how brain regions work together—not just where they are located and how they function individually—and breaks down complex brain patterns into smaller, manageable pieces to analyse them more effectively.

Led by Associate Professor Helen Zhou, Director of the Centre for Translational Magnetic Resonance Research (TMR) at NUS Medicine, Brain-JEPA achieves high performance in predicting demographic traits, diagnosing, and forecasting diseases, and understanding human cognition through fine-tuning of the foundation model. Unlike previous approaches that try to reconstruct raw brain signals, Brain-JEPA learns abstract patterns in brain activity and can effectively predict demographics (such as age and gender), understand personality traits, and diagnose brain disorders across different ethnic groups.

A/Prof Zhou said, "The benefits of this approach span across healthcare, science, and medicine. In healthcare, it enables earlier and more accurate diagnoses of brain disorders, better disease progression predictions, and personalised treatment plans, while being globally applicable across diverse ethnic groups. In science, Brain-JEPA offers a new way to understand brain function, improve brain scan data analysis, and also sets a higher standard for AI in neuroscience. In medicine, it facilitates earlier intervention, reduces healthcare disparities, and is cost-effective, as a single model can serve multiple purposes." A/Prof Zhou is also from the Centre for Sleep and Cognition, and Healthy Longevity and Human Potential Translational Research Programmes at NUS Medicine.

"Brain-JEPA sets a new standard for understanding the brain. It is faster, smarter, and works well across diverse populations, which is a big step forward for brain research," explained Dong Zijian, co-first author of the paper. "Unlike previous models, it works well on people from different ethnic backgrounds, which makes it a powerful tool for global research."

Dr Li Ruilin, co-first author of the paper, added, "Brain-JEPA could also help doctors diagnose conditions like Alzheimer's disease earlier and more accurately, and also offer insights into

how the brain works, which could lead to treatments for mental health and neurological disorders.” Both co-first authors are also from the Centre for TMR at NUS Medicine.

Instead of reconstructing raw data, Brain-JEPA predicts patterns in brain activity, making it faster, more accurate, and better at handling complex brain signals. The model introduces two key breakthroughs: ‘Brain Gradient Positioning’, which provides a coordinate system for mapping how different brain regions work together functionally; and ‘Spatiotemporal Masking’, which enhances the analysis of complex brain data by focusing on critical patterns in functional MRI signals.

The [research](#) was presented at the 38th annual Conference on Neural Information Processing Systems in December 2024. Moving forward, the team hopes to understand patterns and behaviours of these models to establish fundamental rules about how they behave regarding dataset size, model size, and other aspects, and provide guidelines for developing the next generation of NeuroAI models. The Brain-JEPA model is open to researchers worldwide, encouraging collaboration and innovation in neuroscience. This technology bridges the gap between AI and brain research, paving the way for exciting breakthroughs in understanding human health and behaviour.

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Our multidisciplinary and real-world approach to education, research and entrepreneurship enables us to work closely with industry, governments, and academia to address crucial and complex issues relevant to Asia and the world. Researchers in our faculties, research centres of excellence, corporate labs and more than 30 university-level research institutes focus on themes that include energy; environmental and urban sustainability; treatment and prevention of diseases; active ageing; advanced materials; risk management and resilience of financial systems; Asian studies; and Smart Nation capabilities such as artificial intelligence, data science, operations research, and cybersecurity.

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About the NUS Yong Loo Lin School of Medicine (NUS Medicine)

The NUS Yong Loo Lin School of Medicine is Singapore's first and largest medical school. Our enduring mission centres on nurturing highly competent, values-driven, and inspired healthcare professionals to transform the practice of medicine and improve health around the world.

Through a dynamic and future-oriented five-year curriculum that is inter-disciplinary and inter-professional in nature, our students undergo a holistic learning experience that exposes them to multiple facets of healthcare and prepares them to become visionary leaders and compassionate doctors and nurses of tomorrow. Since the School's founding in 1905, more than 12,000 graduates have passed through our doors.

In our pursuit of health for all, our strategic research programmes focus on innovative, cutting-edge biomedical research with collaborators around the world to deliver high impact solutions to benefit human lives.

The School is the oldest institution of higher learning in the National University of Singapore and a founding institutional member of the National University Health System. It is one of the leading medical schools in Asia and ranks among the best in the world (Times Higher Education World University Rankings 2024 by subject and the Quacquarelli Symonds (QS) World University Rankings by subject 2023).

For more information about NUS Medicine, please visit <https://medicine.nus.edu.sg/>