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Brain Science meets Artificial Intelligence

13 - 15 December 2024, Bangkok, Thailand

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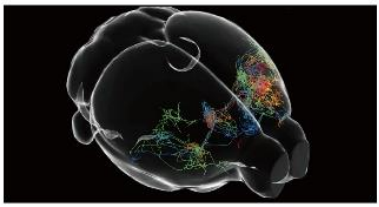
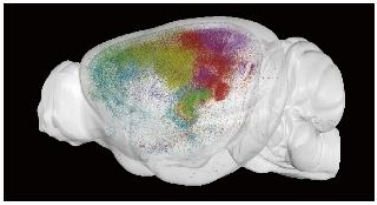
fluorescence Micro-optical Sectioning Tomography



Three-Dimensional Reconstruction of IT Neurons in the Motor Cortex
(Meng Wang et al., Nat Commun 2022)



Quantitative Analysis of Corticotropin-Releasing Hormone (CRH) Neurons in the Whole Brain
(Zhao Peilin et al., Scientific reports 2020)

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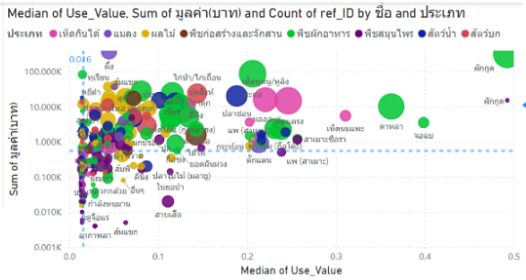
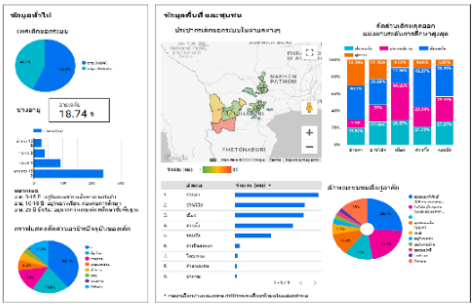


This project utilizes the data to understand and analyze whether economic status affects the opportunity to access food resources in the Lohjood Sub-District, Narathiwat Province.

This project utilizes the data collected from the area volunteers to demonstrate the situation of dropout children in Ratchaburi Province.



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Preface

The International Conference on Brain Informatics (BI) has established itself as the premier global event in the field of brain informatics, an emerging interdisciplinary domain that integrates cognitive science, neuroscience, medical science, data science, machine learning, artificial intelligence (AI), and information and communication technology (ICT). BI 2024 provided an international platform for researchers and practitioners from diverse fields to present original findings, exchange innovative ideas, and share insights into the latest developments in brain informatics. The central theme of the conference, "Brain Science Meets Artificial Intelligence," encompassed five core tracks: Cognitive and Computational Foundations of Brain Science, Human Information Processing Systems, Brain Big Data Analytics, Informatics for Brain and Mental Health, and Brain-Machine Intelligence and Brain-Inspired Computing.

The Brain Informatics conference series began in 2006 with the WICI International Workshop on “Web Intelligence Meets Brain Informatics” in Beijing, China. As one of the first conferences to explore the application of informatics to brain science, it laid the foundation for subsequent BI events. Over the years, the conference evolved, with the 2nd to 5th BI conferences held in Beijing (2009), Toronto (2010), Lanzhou (2011), and Macau (2012), respectively. In 2013, the conference shifted focus to Brain Informatics and Health (BIH), emphasizing real-world applications of brain research in human health and well-being. BIH conferences were held annually from 2013 to 2016 in Maebashi (Japan), Warsaw (Poland), London (UK), and Omaha (USA). In 2017, the conference returned to its original vision, focusing on brain informatics and its role in advancing information technologies, and the conference title reverted to Brain Informatics. BI 2024 continued this tradition, held in Bangkok, Thailand, from December 13-15, in a hybrid format.

BI 2024 featured a range of high-quality papers, world-class keynote speeches, workshops, poster sessions, and special sessions. The event attracted leading experts in brain research and informatics technologies from nearly 30 countries and regions, including Europe, Africa, Asia, Australia, North and South America. The conference program included 35 full papers, 17 workshop papers, and 58 abstract presentations, covering the latest advancements in brain informatics, spanning methodologies, frameworks, techniques, applications, and case studies. These papers reflect the cutting-edge progress in the field, bridging scales from molecular biology to cognition and behavior.

Five distinguished keynote speakers presented at BI 2024:

- Professor Kenji Doya, Okinawa Institute of Science and Technology, Japan
  Title: Brain/MINDS 2.0 and the Digital Brain Project
- Professor Hanchuan Peng, SEU-ALLEN Joint Center, Southeast University, China
  Title: Toward Building a Whole Brain Connectome at Single Neuron Resolution
- Professor Ramesh Srinivasan, University of California Irvine, USA
  Title: Graphical Modeling of Brain Networks
- Professor Lucina Q. Uddin, University of California Los Angeles, USA
  Title: Neuroinformatics and Cognitive Ontologies
- Professor Allison Sekuler, Baycrest Health Sciences, McMaster University & University of Toronto, Canada
  Title: Predictive Neuroscience for Precision Aging: Dementia Prevention, Detection, Treatment, and Care

We extend our sincere gratitude to the BI 2024 organizing committee, whose dedicated efforts were essential to the success of the conference. Our deepest appreciation goes to the Program Committee members for their meticulous review of submitted papers, as well as to our generous sponsors, including King Mongkut's University of Technology Thonburi (KMUTT), IEEE, the Web Intelligence Consortium (WIC), the International Neural Network Society, IEEE Computational Intelligence Society (CIS) Brain Informatics Task Force, IEEE-CIS Thailand Chapter, Asia-Pacific Neural Network Society (APNNS), the Chinese Association for Artificial Intelligence, the Chinese Society for Cognitive Science, Thailand Convention & Exhibition Bureau, Wuhan OE-Bio Co.,Ltd., PsychTech, BRAIN–X Holding Co.,Ltd., Biosemi AWTC, Inc., Solumate Co. Ltd. Professional Computer Co., Ltd, Forth Co., Ltd, Innoviz Solutions Co., Ltd, YIP IN TSIO Co., Ltd. We also wish to acknowledge the invaluable support from the local organizing teams at the Neuroscience Center for Research and Innovation, Learning Institute, the School of Information Technology at KMUTT, and the Research and Innovation Sustainability Center in Thailand. Our thanks extend to Springer's LNCS team for their continued partnership in publishing this special volume. We are grateful to Prof. Ning Zhong, chair of the Steering Committee and Advisory Board, for his leadership and vision in organizing and promoting BI 2024. Lastly, we would like to express our profound appreciation to all contributors, presenters, and volunteers who made BI 2024 a resounding success, even in the face of ongoing challenges.

December 2024
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Giorgio Ascoli
Anan Li
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Keynote Speakers

Brain/MINDS 2.0 and the Digital Brain Project

Professor Kenji Doya

Okinawa Institute of Science and Technology (OIST) Graduate University, Japan

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Abstract

Following the conclusion of the Brain/MINDS project (2014-2024), a new six-year program Multidisciplinary Frontier Brain and Neuroscience Discoveries (Brain/MINDS 2.0) has started. A remarkable feature of this program is that the Digital Brain plays a central role in integrating structural and dynamic brain data from multiple species for understanding brain functions and tackling neuropsychiatric disorders. This talk will present what is the Digital Brain of Brain/MINDS 2.0, how we can build that, and how we can use that. The primary aims of the Digital Brain Project are to develop open-source software tools for data-driven model building by integrating anatomical, genetic, physiological, and behavioral data from mice, marmosets, macaques and humans and to provide cloud-based platform for cross-species data search, data-driven model building, and simulation analyses. By utilizing those tools and platforms, we aim to build models that realize brain functions like reinforcement learning and Bayesian inference and reproduce neurodegenerative disorders like Parkinson's disease and psychiatric disorders like schizophrenia to help early diagnosis and exploration of

therapeutic and preventive strategies. This ambitious project requires fresh talents from math, computation, AI and brain sciences, as well as broad international collaborations. Through this conference, we hope to extend our network with researchers and research projects with overlapping interests and technologies.

Biography

Kenji Doya is a Professor of Neural Computation Unit, Okinawa Institute of Science and Technology (OIST) Graduate University. He studies reinforcement learning and probabilistic inference, and how they are realized in the brain. He took his PhD in 1991 at the University of Tokyo, worked as a postdoc at U. C. San Diego and the Salk Institute, and joined Advanced Telecommunications Research International (ATR) in 1994. In 2004, he was appointed as a Principal Investigator of the OIST Initial Research Project and as OIST established itself as a Graduate University in 2011, he became a Professor and served as the Vice Provost for Research till 2014. He served as a Co-Editor in Chief of Neural Networks from 2008 to 2021 and the Chairperson of Neuro2022 in Okinawa, and currently serves as the President of Japanese Neural Network Society (JNNS). He received INNS Donald O. Hebb Award in 2018, JNNS Academic Award and APNNS Outstanding Achievement Award in 2019, and the age-group 2nd place at Ironman Malaysia in 2022.

Toward Building a Whole Brain Connectome at Single Neuron Resolution

Professor Hanchuan Peng

SEU-ALLEN Joint Center, Southeast University, China

Abstract

In this talk I will discuss our work of a large-scale study of whole-brain morphometry, analyzing 3.7 peta-voxels of mouse brain images at the single-cell resolution, producing one of the largest multi-morphometry databases of mammalian brains to date. We annotated 3D locations of cell bodies of 182,497 neurons, modeled 15,441 dendritic microenvironments, characterized the full morphology of 1,876 neurons along with their axonal motifs, and detected 2.63 million axonal varicosities that indicate potential synaptic sites. Our analysis covers six levels of information related to neuronal populations, dendritic microenvironments, single-cell full morphology, sub-neuronal dendritic and axonal arborization, axonal varicosities , and sub-neuronal structural motifs, along with a quantification of the diversity and stereotypy of patterns at each level. Overall, our study provides an integrative description of key anatomical structures of neurons and their types, covering a wide range of scales and features, and contributes a large-scale resource to understanding neuronal diversity in the mammalian brain. With this dataset, we start to formulate a possible whole brain scale connectome at the single neuron resolution for mouse brains.

Biography

Hanchuan Peng (Fellow, IEEE, AIMBE, Founding Director – Institute for Brain and Intelligence; Founding Director – SEU-ALLEN INSTITUTE Joint Center) develops technologies to generate, manage, visualize, analyze, and understand massive-scale structure and function data related to brains and other biomedical applications. Peng was the Director – Advanced Computing, Allen Institute for Brain Science, and also an Affiliate Professor with University of Washington, University of Georgia, among others). Peng was also a PI with Janelia, HHMI. Peng's original work include the widely cited mRMR feature selection algorithm, APP1/APP2 neuron reconstruction algorithms, Virtual Fingers, Vaa3D, TeraFly, TeraVR, etc. His workwas cited about 30,000 times, in a number of fields. Peng founded Bioimage Informatics conferences in 2005, and iconized Bioimage Informatics as a new field in major bioinformatics journals including Bioinformatics, BMC Bioinformatics, Nature Methods, Nature Biotechnology, etc. He was the co-Editor-in-Chief of Brain Informatics (2016-2020) and a Section Editor of BMC Bioinformatics (2011-2018), and Bioinformatics (2021-2024).

Predictive Neuroscience for Precision Aging: Dementia Prevention, Detection, Treatment, and Care

Professor Allison Sekuler

Baycrest Health Sciences, McMaster University & University of Toronto, Canada

Abstract

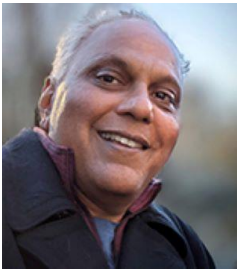
The world is aging faster now than ever before, and as we age the risk of dementia is growing. Brain changes linked to Alzheimer's Disease (AD) and related dementias begin years before the onset of clinical symptoms. However, we lack sufficient tools to accurately identify individuals during preclinical stages of dementia, which limits our ability to implement interventions that could prevent or slow disease progression. Although memory loss is one of the most common symptoms of dementia, visual perceptual and attention can also be impacted at the early stages of disease, but can be difficult to assess throughout disease progression. I will describe some of the ways in aging affects visual perception (including behavioural assessments and electrophysiological markers of face processing and contour integration), how those changes differ in healthy aging and neurodegeneration, and how tools from vision science can probe function in individuals living with dementia and beyond. The results of the work I will discuss are important for developing rapid, non-verbal assessments of visual function that could be used as early screening tools for dementia and assessment throughout disease progression. I also will share other examples of Baycrest's approach to predictive neuroscience for precision aging, including a range of collaborative opportunities spanning dementia prevention, detection, treatment, and care.

Biography

Dr. Allison Sekuler (FSEP, FPS, FAPS) is the Sandra A. Rotman Chair in Cognitive Neuroscience and Vice-President Research at Baycrest Health Sciences. A graduate of Pomona College (BA, Mathematics and Psychology) and the University of California, Berkeley (PhD, Psychology), Dr. Sekuler holds faculty positions in the Department of Psychology, Neuroscience & Behaviour at McMaster University and the Department of Psychology at the University of Toronto. Her research uses behavioural and neuroimaging approaches to understand how the brain processes visual information, with specific interests in face perception, motion processing, perceptual learning, neural plasticity, aging, and neurotechnology. Her research was the first to show conclusively that older brains "rewire" themselves to compensate for functional changes. Her clinical and translational research aims to develop methods to prevent, detect, and treat age-related sensory and cognitive decline. She has scientific and industry collaborations across North America, the EU, and Asia, and her work has been published in leading international journals, including Nature, Current Biology, and the Journal of Neuroscience.

She Chairs the Natural Science and Engineering Research Council's Public Impact Value Proposition committee; serves on the Board of Governors for Hamilton Health Sciences and Brains can and the scientific advisory board for VISTA; and is a founding steering committee member of the Canadian Brain Research Strategy. She also is a longstanding and passionate supporter of research communication and public outreach, serving, for example, as the only scientist on founding committee of the the Science Media Centre of Canada; and a sought-after speaker, podcaster, and commentator in national and international media. Co-founder of FoVea (Females of Vision et al.),

an international organization to advance women in vision science, and co-Executive Champion of the Ontario Hospital Association's Research and Innovation Anti-Racism Taskforce, Dr. Sekuler is a highly respected advocate for women and underrepresented groups in science, engineering, and technology. Dr. Sekuler has won numerous national and international awards for research, teaching, and leadership -- including serving as the country's first Canada Research Chair in Cognitive Neuroscience and recently being named one of WXN's Top 100 Most Powerful Women in Canada (2019). In her spare time, she is proving that you're never too old to learn: she picked up her first drumsticks a few years ago, joined a band, and recently earned her Drum Professional Certificate from the Berklee College of Music.



Graphical Modeling of Brain Networks

Professor Ramesh Srinivasan

University of California, Irvine, USA

Abstract

Much of our understanding of human brain function is developed from the analysis of statistical relationships between brain signals and behavior. Graphical models of brain signals are generative models that potentially provide causal insight into brain signals and their relationship to behavior and disease. I will discuss different studies in graphical modeling that we have used to (1) model structure-function relationships, (2) model the relationship between brain injury and function, (3) develop new approaches to hyperscanning based on symbolic dynamics, (4) model joint latent space to link cognitive parameters to both neural signals and behavioral measures. To study structure-function relationships we incorporate anatomical knowledge of brain networks to build a graphical model of brain signals and demonstrate in fMRI data that we can predict the effects of disconnection due to injury in stroke (Wodeyar et al., 2021). These graphical models capture the dynamic effects of injury in a manner not apparent in anatomy or in the raw signals. Measures of network properties in structurally informed graphical models of EEG reflect how efficient signal routing is essential to maintain motor functional status after stroke(Zhou et al., 2024). Graphical modeling also provides an entirely new approach to hyperscanning in coordination and other

forms of social cognitive neuroscience. We modeled the joint state of two individuals performing coordinated motor tasks with simultaneous EEG recordings, as a transition network in a symbol space defined by the graphical models, i.e., a graph of graphs. The symbolic dynamics over this graphical model capture the different coordination modes in a manner not possible by statistical analysis of correlations between brain signals. Graphical modeling can also be useful for formulating the link between brain activity and latent cognitive processes. Behavioral measures, such as accuracy and speed of motor responses, reflect latent cognitive processes underlying decision making. We have developed a novel approach that allows a theoretical account of the cognitive process of decision-making, and artificial neural networks to estimate a joint latent space to link cognitive parameters to both neural signals and behavioral measures (Vo et al., 2024). This joint latent space model is a valuable new framework for computational cognitive neuroscience, allowing for new forms of inference and hypothesis generation. The power of graphical modeling can allow for a more comprehensive understanding of the triplet relationship between behavior, brain activity, and cognitive processes.

Biography

Ramesh Srinivasan is a Professor of Cognitive Sciences and Biomedical Engineering at the University of California, Irvine. The primary focus of Srinivasan's research is on developing signal processing and computational modeling to relate brain networks to cognitive functions. This foundational signal processing research has broad impact in clinical and cognitive neuroscience research. Dr Srinivasan's PhD training in Biomedical Engineering at Tulane University was on the development of theoretical models of electroencephalography (EEG) largely contributed to the book (with Paul Nunez) Electric Fields of the Brain: The Neurophysics of EEG, 2nd ed., Oxford UP . He developed cognitive science and neuroscience expertise through postdoctoral training at the University of Oregon and at the Neurosciences Institute in San Diego. He joined the faculty in Cognitive Sciences and Biomedical Engineering at the University of California, Irvine in 2000 and was Chair of the Cognitive Sciences department from 2012 to 2022. He was appointed a Senior Fellow of the US Army Research Lab in 2022. He has published more than 100 papers in EEG/MEG signal processing, theoretical computational neuroscience, cognitive neuroscience applications in perception, attention, and decision making, and clinical research especially focused on motor functions and stroke. His recent work is focused on graphical models of EEG, MEG, and fMRI signals that incorporate structural and functional modeling to develop probabilistic generative models of brain networks linked to behavior and clinical status.

Neuroinformatics and Cognitive Ontologies

Professor Lucina Q. Uddin

University of California Los Angeles, USA

Abstract

Decades of cognitive neuroimaging work has identified distinct patterns of brain activation that occur during performance of different tasks, as well as revealed patterns of task-general activation and deactivation. These data can in principle be used to provide the basis for constructing biologically informed, data-driven taxonomies of psychological processes. This talk will highlight some of the progress and challenges associated with the construction of cognitive ontologies based on functional neuroimaging data.

Biography

After receiving a Ph.D. in cognitive neuroscience from the Psychology Department at the University of California Los Angeles, Dr. Uddin completed a postdoctoral fellowship in the Child Study Center at New York University. For several years she worked as a faculty member in Psychiatry & Behavioral Science at Stanford University. She recently returned to UCLA where she currently directs the Brain Connectivity and Cognition Laboratory and the Center for Cognitive Neuroscience Analysis Core in the Semel Institute for Neuroscience and Human Behavior. Within a cognitive neuroscience framework, Dr. Uddin's research combines functional and structural neuroimaging to examine the organization of large-scale brain networks supporting the development of social cognition and executive function. Her current projects focus on understanding dynamic brain network interactions underlying cognitive inflexibility in neurodevelopmental conditions such as autism spectrum disorder. Dr. Uddin's work has been published in the Journal of Neuroscience, Cerebral Cortex, JAMA Psychiatry, Biological Psychiatry, PNAS, and Nature Reviews Neuroscience. She was awarded the Young Investigator award by the Organization for Human Brain Mapping in 2017.

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Xueshen Li, Stevens Institute of Technology, USA

Yongjie Li, University of Electronic Science and Technology of China, China

Youjun Li, North China University of Technology, China

Hualou Liang, Drexel University, China

Hua-Yi Lin, China University of Technology, Taiwan

Pawan Lingras, Saint Mary's University, Canada

Feng Liu, Stevens Institute of Technology, USA

Jie Liu, Purdue University, USA

Ke Liu, Chongqing University of Posts and Telecommunications, China

Weifeng Liu, China University of Petroleum, China

Chau Ma, Vietnam National University, Vietnam

Rashed Majumder, Jahangirnagar University, Bangladesh

Hiroshi Makino, Nanyang Technological University, Singapore

Mariofanna Milanova, University of Arkansas, USA

Phi Le Nguyen, Hanoi University of Science and Technology, Vietnam

Gabriella Panuccio, Istituto Italiano di Tecnologia, Italy

Stefano Panzeri, Istituto Italiano di Tecnologia, Italy

Stefano Panzeri, University Medical Center Hamburg-Eppendorf, Germany

Miodrag Potkonjak, University of California Los Angeles, USA

Dimeter Prodonov, IMac, Belgium

M Mostafizur Rahman, American International University Bangladesh, Bangladesh

Jason Rajsic, Northumbria University, UK

Michele Ruta, Politecnico di Bari, Italy

Divya Sardana, University of Cincinnati, USA

Andrew Saxe, University College London, UK

Lars Schwabe, University of Rostock, Germany

Christina Schweikert, St. John's University, USA

John Serences, University of California San Diego, USA

Teo Jeon Shin, Seoul National University, South Korea

James M. Shine, The University of Sydney, Australia

Marek Sikora, Silesian University of Technology, Poland

Vorasith Siripornpanich, Mahidol University, Thailand

Andrzej Skowron, Warsaw University, Poland

Dominik Slezak, University of Warsaw, Poland

Neil Smalheiser, University of Illinois, USA

Bo Song, University of Southern Queensland, Australia

Tommy Sprague, University of California, USA

Xiaohui Tao, University of Southern Queensland, Australia

Jerzy Tiuryn, University of Warsaw, Poland

Xiaoyu Tong, Lehigh University, USA

Pedro A. Valdes-Sosa, University of Electronical Science and Technology of China, China

Iris Vilares, University of Minnesota, USA

Feng Wan, University of Macau, China

Zhijiang Wan, Maebashi Institute of Technology, Japan

Alan Wang, University of Auckland, New Zealand

Guoyin Wang, Chongqing University of Posts and Telecommunications, China

Rongpin Wang, Guizhou University, China

Shouyi Wang, University of Texas at Arlington, USA

Yangang Wang, Southeast University, China

Yimin Wang, Guangdong Institute of Intelligence Science and Technology, China

Yuan Wang, University of South Carolina, USA

Yuanjia Wang, Columbia University, US

Geoffrey Woodman, Vanderbilt University, USA

Huisi Wu, Shenzhen University, China

Jingpeng Wu, Lin Gang Laboratory, China

Yu-Wei Wu, Institute of Molecular Biology, Academia Sinica, Taiwan

Vicky Yamamoto, University of Southern California, USA

Yang Yang, Beijing Forestry University, China

Yiyu Yao, University of Regina, Canada

Boxin Zhang, Orengon State University, USA

Daoqiang Zhang, Nanjing University of Aeronautics and Astronautics, China

Jiani Zhang, Fidelity Investments, USA

Lijun Zhang, Case Western Reserve University, USA

Tielin Zhang, Chinese Academy of Sciences, China

Xiaofei Zhang, Jiangsu University of Science and Technology, China

Yanqing Zhang, Georgia State University, USA

Zhiguo Zhang, Harbin Institute of Technology, China

Ning Zhong, Maebashi Institute of Technology, Japan

Tao Zhou, North Minzu University, China

Tong Zhou, Johns Hopkins University, USA

Yan Zhou, University of Macau, China

Xiaoting Zhu, University of Cincinnati, USA

Junjie Zhuo, Hainan University, China

Jacek M. Zurada, University of Louisville, USA

Conference Program

The 17th International Conference on Brain Informatics (BI 2024)

Location: Knowledge Xchange for Innovation (KX) Building,

King Mongkut's University of Technology (KMUTT), Bangkok, Thailand
Dates: 13-15 December 2024

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13 December 2024 (Morning Sessions)
Location: KX 10th Floor

Registration

- **8:00 AM - 9:00 AM**

Opening Ceremony & Keynote Lectures

Local Chair & Moderator: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, Learning Institute, KMUTT, Thailand

Location: Conference Room X04
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/95452994239
(Zoom Meeting ID: 954 5299 4239)

- **9:00 AM - 9:30 AM: BI24 Opening Ceremony**
  Speakers:
  - **Kanyawim Kirtikara,** Senior Vice President for Research and Innovation, King Mongkut's University of Technology Thonburi (KMUTT), Thailand
  - **Ning Zhong,** Advisory Chair of BI24 and the Director & Chairman of the Web Intelligence Consortium (WIC), Maebashi Institute of Technology, Japan
  - **Sirawaj Itthipuripat,** General Chair of BI24 and the Director of Neuroscience Center for Research and Innovation, Learning Institute, KMUTT, Thailand

- **9:30 AM - 10:15 AM: Keynote Lecture on Brain/MINDS 2.0 and the Digital Brain Project**
  Speaker: **Kenji Doya,** Okinawa Institute of Science and Technology, Japan
  Moderator: **Anan Li** (BI24 General Chair), Huazhong University of Science and Technology, China

- **10:15 AM - 10:30 AM: Coffee Break**

- **10:30 AM - 11:15 AM: Keynote Lecture on Brain Dynamics and Flexible Behaviors**
  Connectome at Single Neuron Resolution
  Speaker: **Hanchuan Peng,** SEU-ALLEN Joint Center, China
  Moderator: **Giorgio Ascoli** (BI24 General Chair), George Mason University, USA

- **11:15 AM - 12:00 PM: Keynote Lecture on Graphical Modeling of Brain Networks**
  Speaker: **Ramesh Srinivasan,** University of California, Irvine, USA
  Moderator: **Sirawaj Itthipuripat** (BI24 General Chair), King Mongkut's University of Technology, Thailand

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Lunch
Location: KX 9th Floor
Time: 12:00-1:00 pm

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13 December 2024 (Afternoon Sessions)

Location: KX 10th Floor

Conference Symposia

Location: Conference Room X04

Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/95452994239
(Meeting ID: 954 5299 4239)

- **1:00 PM - 1:45 PM: The Symposium on Advanced Methods in Computational Social Neuroscience**
  Chair: **Italo Ivo Lima Dias Pinto,** University of California, Irvine, USA
  Local Chair: Thitaporn Chaisilprungraung**,** Neuroscience Center for Research and Innovation, KMUTT, Thailand

- **2:00 PM - 5:00 PM: The Symposium on Computational and Informatics Frameworks for Studying Cognitive Functions and Neurodegeneration**
  Chairs: **Narun Pat** (BI24 Leading Program Chair), University of Otago, New Zealand & **Daniel Thayer**, University of California, Santa Barbara, USA
  Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Sittiprapa Isarangura, Mahidol University, Thailand

Workshop Sessions

Location: Conference Room X01

Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/99636493536
(Meeting ID: 996 3649 3536)

- **1:00 PM - 4:00 PM: The International Workshop: Generative AI Empowers Brain Signal Processing (GAIEBSP 2024)**
  Chairs: **Shuqiang Wang,** Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China, **Sadia Shaki,** The Chinese University of Hong Kong, Hong Kong & **Baiying Lei,** Shenzhen University, China
  Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand

Location: Conference Room X02

Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/94619238270
(Meeting ID: 946 1923 8270)

- **1:30 PM-4:50 PM: The 4th International Workshop on Environmental Adaptation and Mental Health (EAMH 2024)**
  Chairs (online): **Yang Yang**, **Yidi Chen**, **Zelong Meng**, & **Huixin Hu**, Beijing Forestry University, China
  Local Chairs: Singh Intrachooto & Sarigga Pongsuwan, Research and Innovation Sustainability Center, Thailand & Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Zoom links:
(13 December 2024)

The 17th International Conference on Brain Informatics (BI 2024)	
Date and Time	**Friday, Dec 13, 2024 (8.00am-8.00pm Bangkok Time)**
Room : X04	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/95452994239 Meeting ID: 954 5299 4239
Room : X01	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/99636493536 Meeting ID: 996 3649 3536
Room : X02	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/94619238270 Meeting ID: 946 1923 8270

14 December 2024 (KX 11th Floor)

Morning Sessions

Keynote Lecture
Locations: Conference Room X11.7 (main keynote lecture room) **& X11.3** (live broadcast)
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/94600113097
(Meeting ID: 946 0011 3097)

- **9:00 AM - 9:45 AM: Keynote Lecture on Toward Building a Whole Brain Connectome at Single Neuron Resolution**
  Speaker: **Lucina Q. Uddin,** University of California, Los Angeles, USA
  Chair & Moderator: **Sirawaj Itthipuripat** (General Chair of BI24), Neuroscience Center for Research and Innovation, KMUTT, Thailand
  Local Chair: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, Learning Institute, KMUTT, Thailand & Tai Chaiamarit, Mahidol University, Thailand

- **9:45 AM - 10:00 AM: Coffee Break**

Workshop Sessions
Location: Conference Room X11.7
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/94600113097
(Meeting ID: 946 0011 3097)

- **10:00 AM - 11:55 AM: The International Workshop on Reconstruction and Modeling of the Brain at the Single-Cell Level (RMBSCL 2024)**
  Chairs: **Yufeng Liu** & **Lijuan Liu,** Southeast University, **Weiyao Lin,** Shanghai Jiao Tong University & **Guoqiang Yu,** Tsinghua University, China

Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Tai Chaiamarit, Mahidol University, Thailand

Location: Conference Room X11.1
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/95129031089
(Meeting ID: 951 2903 1089)

- **09:00 AM - 11:00 AM: The International Workshop on Elucidation of Mechanistic Information using Neuroimaging for Psychiatric Disorders (EMINPD 2024)**
  Chairs (online): **Xiaofu He, Bin Xu** & **Xi Zhu,** New York State Psychiatric Institute & Columbia University, USA & **Yunyu Xiao,** Cornell University, USA
  Local Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Location: Conference Room X11.2
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/98337575267
Meeting ID: 983 3757 5267

- **09:30 AM - 12:00 PM: The International Workshop on Computational Tools for Cognition (CTC 2024)**
  Chairs (online): **Stephanie Neilli,** Occidental College, USA, **Ioannis Pappas,** University of Southern California, **Nuttida Rungratsameetaweemana,** Columbia University, USA
  Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand; Maytus Piriyajitakonkij, The University of Manchester, UK & Agency for Science, Technology and Research (A*STAR), Singapore

Lunch
Location: KX 9th Floor
Time: 12:00-1:00 pm

14 December 2024 (Afternoon Sessions)

Location: KX 11th Floor

Conference Symposia

Location: Conference Room X11.2

Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/98337575267
Meeting ID: 983 3757 5267

- **1:00 PM - 4:30 PM: The Symposium on Cognitive and Computational Approaches to Advancing Mental Health Research**
  Chairs: **Mufti Mahmud,** King Fahd University of Petroleum and Minerals, Saudi Arabia & **Narun Pat,** University of Otago, New Zealand
  Local Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Location: Conference Room X11.3
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/96563960134
Meeting ID: 965 6396 0134

- **1:00 PM - 2:15 PM: The Symposium on Cognitive and Computational Foundations of Visual Cognition**
  Chair: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand
  Local Chair: Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Workshop Sessions
Location: Conference Room X11.7
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/94600113097
(Meeting ID: 946 0011 3097)

- **1:00 PM - 5:35 PM: The International Workshop on Mesoscopic Brain-wide Connectivity Atlas (MBCA 2024)**
  Chairs: **Anan Li** (BI24 General Chair), Huazhong University of Science and Technology, China, **Junjie Zhuo** & **Zhao Feng,** Hainan University, China
  Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Tai Chaiamarit, Mahidol University, Thailand

Location: Conference Room X11.1
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/95129031089
(Meeting ID: 951 2903 1089)

- **2:00 PM - 4:45 PM: The 2024 International Workshop on Web Intelligence meets Brain Informatics (WImeetsBI 2024)**
  Chairs: **Jianzhuo Yan**, **Jianhui Chen** & **Jiajin Huang**, Beijing University of Technology, China
  Local Chairs: Kajornvut Ounjai, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand

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Riverside Gala Dinner & Award Ceremony
Location: Away Bangkok Riverside Kene Hotel
Address: 1, Soi Charoen Nakhon 35, Charoen Nakhon Rd, Khlong San, Khlong San, Bangkok
Time: 6:30-9:30 pm

Award Presentations

- Best Conference and Student Paper Awards
Chairs: Sirawaj Itthipuripat, Giorgio Ascoli, Anan Li

- WIC Outstanding Service Award
Chair: Ning Zhong

- Springer Awards for Brain Informatics Journal
Chair: Ning Zhong

Announcement of Brain Informatics 2025 in Bari, Italy
Speaker: Angela Lombardi

Zoom links:
(14 December 2024)

The 17th International Conference on Brain Informatics (BI 2024)	
Date and Time	**Sat, Dec 14, 2024 (8.00am-8.00pm Bangkok Time)**
Room : X11.7	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/94600113097 Meeting ID: 946 0011 3097
Room : X11.1	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/95129031089 Meeting ID: 951 2903 1089
Room : X11.2	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/98337575267 Meeting ID: 983 3757 5267
Room : X11.3	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/96563960134 Meeting ID: 965 6396 0134

15 December 2024 (Morning Sessions)

Location: KX 11th Floor

Keynote Lecture

Location: Conference Room X11.7 (main keynote lecture room) & **X11.3** (live broadcast)
Join Zoom Meeting:https://kmutt-ac-th.zoom.us/j/93117861184
Meeting ID: 931 1786 1184

- **9:00 AM - 9:45 AM: Keynote Lecture on Predictive Neuroscience for Precision Aging: Dementia Prevention, Detection, Treatment, and Care**
  Speaker: **Allison Sekuler**, Baycrest Health Sciences, McMaster University & University of Toronto, Canada
  Chair & Moderator: **Chaipat Chunharas** (BI24 Program Chair), Faculty of Medicine, Chulalongkorn University, Thailand
  Local Chair: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, Learning Institute, KMUTT, Thailand
  Local Chair: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, Learning Institute, KMUTT, Thailand

- **9:45 AM - 10:00 AM: Coffee Break**

Conference Symposium

Location: Conference Room X11.7

Join Zoom Meeting:https://kmutt-ac-th.zoom.us/j/93117861184
Meeting ID: 931 1786 1184

- **10:00 AM - 12:00 PM: The Symposium on Brain Big Data Analytics, Curation, and Management (Note* afternoon session 1:00 PM - 2:00 PM)**
  Chairs: **Liya Ding**, University of Chicago, USA & **Carlos Enrique Gutierrez**, Okinawa Institute of Science and Technology, Japan
  Local Chairs: Itthi Chatnuntawech, National Center of Nanotechnology & Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Location: Conference Room X11.3

Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/92154423454
Meeting ID: 921 5442 3454

- **10:30 AM - 12:00 PM: The Symposium on Brain-Computer Intelligence and Brain-Inspired Computing**
  Chair: **Thitaporn Chaisilprungraung**, Neuroscience Center for Research and Innovation, KMUTT, Thailand
  Local Chair: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand

Workshop Sessions

Location: Conference Room X11.1

Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/98355254203
Meeting ID: 983 5525 4203

- **9:00 AM - 11:30 AM: The 6th International Workshop on Cognitive Neuroscience of Thinking and Reasoning (CNTR 2024)**
  Chairs: **Peipeng Liang**, Capital Normal University, China & **Vinod Goel**, York University, Canada
  Local Chairs: Kajornvut Ounjai, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand

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Lunch
Location: KX 9th Floor
Time: 12:00-1:00 pm

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15 December 2024 (Afternoon Sessions)

Location: KX 11th Floor

Conference Symposia

Location: Conference Room X11.7

Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/93117861184
Meeting ID: 931 1786 1184

- **1:00 PM - 2:00 PM: The Symposium on Brain Big Data Analytics, Curation, and Management (Continued)**
  Chair: **Carlos Enrique Gutierrez**, Okinawa Institute of Science and Technology, Japan
  Local Chairs: Itthi Chatnuntawech, National Center of Nanotechnology & Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Workshop Sessions

Location: Conference Room X11.1

Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/98355254203
Meeting ID: 983 5525 4203

- **1:00 PM - 3:00 PM: The International Workshop on Multimodal Computational Approaches for Brain Biomarkers Discovery (MCABBD 2024)**
  Chairs: **Hieu Pham**, VinUniversity & **Nguyen The Hoang Anh**, Vietnam – Korea Institute of Science and Technology, Vietnam
  Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand

- **4:00 PM - 5:50 PM: The 4th Special Session on Explainable Artificial Intelligence for Unveiling the Brain: From Black-Box to Glass-Box (XAIB 2024)**
  Chair (online): **Chiara Camastra**, Neuroscience Research Center, Department of Medical and Surgical Sciences, Magna Graecia University of Catanzaro, Italy
  Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Location: Conference Room X11.2
Join Zoom Meeting: https://kmutt-ac-th.zoom.us/j/95093505758
Meeting ID: 950 9350 5758

- **2:00 PM - 3:40 PM: The International Workshop on Application of Artificial Intelligence and Innovative Technologies in Brain Informatics and Health (AAIITBIH 2024)**
  Chair (online): **Zhijiang Wan**, Nanchang University, China
  Local Chairs: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand & Sittiprapa Isarangura, Mahidol University, Thailand

Zoom links:
(15 December 2024)

The 17th International Conference on Brain Informatics (BI 2024)	
Date and Time	**Sun, Dec 15, 2024 (8.00am-8.00pm Bangkok Time)**
Room : X11.7	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/93117861184 Meeting ID: 931 1786 1184
Room : X11.1	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/98355254203 Meeting ID: 983 5525 4203
Room : X11.2	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/95093505758 Meeting ID: 950 9350 5758
Room : X11.3	Join Zoom Meeting https://kmutt-ac-th.zoom.us/j/92154423454 Meeting ID: 921 5442 3454

MAIN CONFERENCE SYMPOSIA SCHEDULE

Main Conference Symposia on 13 December 2024

The Symposium on Advanced Methods in Computational Social Neuroscience

Chair: Italo Ivo Lima Dias Pinto, University of California, Irvine, USA

Location: Kx Building (10th floor) - Conference Room X04
Date: 13 December 2024
Time: 1:00 PM - 1:45 PM
Local Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand

1:00 PM - 1:15 PM - Paper Presentation
B240: Symbolic Dynamics of Brain Networks during Hyperscanning to Investigate Coordination of Behavior
Author(s): Italo Ivo Lima Dias Pinto, Zhibin Zhou, Ramesh Srinivasan
Institution(s): University of California, Irvine, USA

1:15 PM - 1:30 PM - Paper Presentation
B262: Developing a Multi-Site Hyperscanning Procedure for Investigating Interbrain Synchrony Underlying Remote Social Interaction
Author(s): Sirapakit Limtragooltongchai, Kawin Yamtuan, Javier Gracia, Chaipat Chunharas, Ramesh Srinivasan, Thitaporn Chaisilprungraung, Sirawaj Itthipuripat
Institution(s): King Mongkut's University of Technology Thonburi, Thailand; DEVCOM Army Research Laboratory, USA; King Chulalongkorn Memorial Hospital, Thailand; University of California, Irvine, USA

1:30 PM - 1:45 PM - Paper Presentation
B261: A Near-Infrared Hyperscan Study of the Effects of Mechanical Massage Combined with Mindfulness on functional brain connectivity and mental health
Author(s): Yuqi Sun, Ke Hu, Shiqi Liao, Ke Jiang
Institution(s): Wenzhou Medical University, China; Wenzhou No.7 People's Hospital, China

Note: each paper presentation includes 12-min talk + 3-min Q&A

The Symposium on Computational and Informatics Frameworks for Studying Cognitive Functions and Neurodegeneration

Chairs: Narun Pat, University of Otago, New Zealand & Daniel Thayer, University of California, Santa Barbara, USA

Location: Kx Building (10th floor) - Conference Room X04
Date: 13 December 2024
Time: 2:00 PM - 5:00 PM
Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Sittiprapa Isarangura, Mahidol University, Thailand

Schedule:

2:00 PM - 2:15 PM - Paper Presentation
B255: Neural feature dimension maps within human visual cortex support attention and working memory
Author(s): Daniel Thayer, Alison Li, Emily Machniak, Thomas Sprague
Institution(s): University of California, Santa Barbara, USA

2:15 PM - 2:30 PM - Paper Presentation
B281: EEG-based reconstruction models for measuring attention deficits in mild cognitive impairment
Author(s): Kanyarat Benjasupawan, Panchalee Sookprao, Kitnipat Boonyadhammakul, Arp-Arpa Kasemsantitham, Itthi Chatnuntawech, Kanda Lertladaluck, Chaipat Chunharas, Sirawaj Itthipuripat
Institution(s): King Mongkut's University of Technology Thonburi, Bangkok, Thailand; King Chulalongkorn Memorial Hospital, Thailand; National Nanotechnology Center, Thailand

2:30 PM - 2:45 PM - Paper Presentation
B251: Auditory construction of Music Cognition: An understanding of therapeutic implications in Parkinson's disease through Diffusion Tensor Imaging
Author(s): Poulami Kar
Institution(s): University of Allahabad, India

2:45 PM - 3:00 PM - Paper Presentation
B237: BRAINEX: A Systematic Framework for CNN Models Evaluation and XAI Methods Comparison in Brain Age Prediction
Author(s): Giuseppe Fasano, Maria Luigia Natalia De Bonis, Angela Lombardi, Carmelo Antonio Ardito, Eugenio Di Sciascio, Tommaso Di Noia
Institution(s): Polythecnic University of Bari, Italy; LUM University of Casamassima, Italy

3:00 PM - 3:15 PM - Paper Presentation (online)
B271: Neurodegenerative disorders detection and classification using Resnet-SVM
Author(s): Shikhar Raghuvanshi, Amutha S, Niha Kamal Basha, Mufti Mahmud
Institution(s): Vellore Institute of Technology, India; King Fahd University of Petroleum and Minerals, Saudi Arabia

3:15 PM - 3:30 PM: Coffee Break

3:30 PM - 3:45 PM - Paper Presentation
B266: From Alzheimer's Disease to Frontotemporal Dementia: Transfer Learning in EEG-based Diagnosis of Dementia
Author(s): Jaymar Soriano, Paulino Salmon
Institution(s): University of the Philippines, Philippines

3:45 PM - 4:00 PM - Paper Presentation
B228: Brain age has limited utility as a biomarker for capturing fluid cognition in older individuals
Author(s): Narun Pat, Alina Tetereva
Institution(s): University of Otago, New Zealand

4:00 PM - 4:15 PM - Paper Presentation
B238: Biophysical Modeling of Alzheimer's Disease Progression
Author(s): Robin Sandell, Justin Torok, Daren Ma, Ashish Raj
Institution(s): University of California, San Francisco, USA

4:15 PM - 4:30 PM - Paper Presentation (online)
B227: Higher-order Adaptive Dynamical System Modeling for the Role of Environmental Neurotoxic Pesticide Paraquat on the Epigenetics of Neurodegeneration in N27 Dopaminergic Cells
Author(s): Bana al Khayrat, Jan Treur
Institution(s): Vrije Universiteit Amsterdam, Netherlands

4:30 PM - 4:45 PM - Paper Presentation (online)
B229: Explainable GRU with Hybrid Attention and Memory-Augmented Network (xGRAM) for Cell Types Classification in Alzheimer's Disease Using Single-Nucleus Transcriptomics
Author(s): Mejbah Ahammad, Ashraful Babu, Mortuza Ahmmed, Mostafizur Rahman, Mufti Mahmud
Institution(s): Independent University, Bangladesh., Bangladesh; American International University - Bangladesh (AIUB), Bangladesh; King Fahd University of Petroleum and Minerals, Saudi Arabia

4:45 PM - 5:00 PM - Paper Presentation
B241: Identification and Evaluation of Multimodal Connectomics in Early Alzheimer's Dementia
Author(s): Yu Chen, Yingwei Fan, Xiaoying Tang, Jian Zhang, Tianyi Yan, Jinglong Wu,
Institution(s): Beijing Institute of Technology, Beijing, China

Note: each paper presentation includes 12-min talk + 3-min Q&A

Main Conference Symposia on 14 December 2024

The Symposium on Cognitive and Computational Approaches to Advancing Mental Health Research

Chairs: Mufti Mahmud, King Fahd University of Petroleum and Minerals, Saudi Arabia & Narun Pat, University of Otago, New Zealand

Location: Kx Building (11th floor) - Conference Room X11.2
Date: 14 December 2024
Time: 1:00 PM - 4:30 PM
Local Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand

1:00 PM - 1:15 PM - Paper Presentation (online)
B265: A dopaminergic basis of behavioral control
Author(s): Ian Ballard, Daniella Furman, Anne Berry, Robert White III, William Jagust, Andrew Kayser, Mark D'Esposito
Institution(s): University of California, Riverside, USA; University of California, San Francisco, USA; Brandeis University, USA; Washington University in St Louis,USA; University of California, Berkeley, USA

1:15 PM - 1:30 PM - Paper Presentation (online)
B272: The Role of Executive Functions in Emotional Coregulation: Insights from an Adaptive Network Model
Author(s): Ethel Pruss, Nancy Fortin, Jan Treur, Sander Koole
Institution(s): Vrije Universiteit Amsterdam, Netherlands; University of North Carolina, USA

1:30 PM - 1:45 PM - Paper Presentation (online)
B206: Multiscale Temporal-convolution and Attention improved Neural Network for biased mental state recognition
Author(s): Guoyu Zuo, Erjun Xiao, Tielin Zhang
Institution(s): Beijing University of Technology, China; Chinese Academy of Sciences, China

1:45 PM - 2:00 PM - Paper Presentation (online)
B235: Predicting trait alexithymia using graph neural networks
Author(s): Kin Hei Lee, Weiwei Peng, Wutao Lou
Institution(s): The Chinese University of Hong Kong, China; School of Psychology, Shenzhen University, China; Department of Biomedical Engineering, The Chinese University of Hong Kong, China

2:00 PM - 2:15 PM - Paper Presentation (online)
B233: Advancing Mental Health Problems with Machine Learning and Genetic Algorithms for Anxiety Classification in Bangladeshi University Students
Author(s): Shahriar Siddique Ayon, Muhammad Ebrahim Hossain, Md Saef Ullah Miah, M. Mostafizur Rahman, Mufti Mahmud
Institution(s): American International University-Bangladesh, Bangladesh; King Fahd University of Petroleum and Minerals, Saudi Arabia

2:15 PM - 2:30 PM - Paper Presentation (online)
B252: Empirical insights into the value of a novel compositional data approach for analyzing bipolar Likert scale data
Author(s): René Lehmann Bodo Vogt
Institution(s): Otto von Guericke University Magdeburg, Germany

2:30 PM - 2:45 PM: Coffee Break

2:45 PM - 3:00 PM - Paper Presentation
B211: Neurocomputational Modelling of EEG Connectivity: Links Between Depression, Inflammation and Gut Microbiome
Author(s): Zohreh Doborjeh, Daniel Lavin, Kirsty Hunter, Nadja Heym, Bryony Heasman, Maryam Doborjeh, Nikola Kasabov, Glen Gibson, Alexander Sumich
Institution(s): Auckland University of Technology, New Zealand; The University of Auckland, New Zealand; Nottingham Trent University, UK; The University of Reading, UK

3:00 PM - 3:15 PM - Paper Presentation
B202: Design of an Iterative Method for Integrating Multi-Omic Data and Clinical Insights in Brain Disease Research
Author(s): Aditi Durge, Deepti Shrimankar, Sony Ahuja
Institution(s): Visvesvaraya National Institute of Technology, India

3:15 PM - 3:30 PM - Paper Presentation
B257: Hippocampal Transcriptomic Signature in Schizophrenia: An Index for Dysregulated Inflammatory Immune response
Author(s): Dipayan Roy
Institution(s): All India Institute of Medical Sciences (AIIMS), India

3:30 PM - 3:45 PM - Paper Presentation (online)
B245: Comparison of haloperidol- versus phenazepam-induced anxiolytic effect on rodent behavior
Author(s): Mark Makarov, Alexandr Andreev, Danila Apushkin, Yuri Sysoev, Veronika Prikhodko, Sergey Okovityi, Eduard Korkotian
Institution(s): University of Cam-pania "Luigi Vanvitelli", Italy; Faculty of Chemistry, Perm State University, Russian Federation; Saint Petersburg State Chemical and Pharmaceutical University, Russian Federation; The Weizmann Institute of Science, Israel

3:45 PM - 4:00 PM - Paper Presentation
B210: Sleep Apnea detection from single-lead ECG signal using hybrid deep CNN
Author(s): Duc Thien Pham and Roman Mouček
Institution(s): University of West Bohemia, Czech Republic

4:00 PM - 4:15 PM - Paper Presentation (online)
B223: The Dynamics of Epigenetic Influence in Insomnia: A Higher-Order Adaptive Modeling Perspective
Author(s): Sarah Hassouna, Sophie C.F. Hendrikse, and Jan Treur
Institution(s): Vrije Universiteit Amsterdam, Netherlands; Tilburg University, Netherlands

4:15 PM - 4:30 PM - Paper Presentation
B208: Topological and Graph Theoretical Analysis of Dynamic Functional Connectivity for Autism Spectrum Disorder
Author(s): Yuzhe Chen, Dayu Qin, and Ercan Engin Kuruoglu
Institution(s): Tsinghua University, China

Note: each paper presentation includes 12-min talk + 3-min Q&A

The Symposium on Cognitive and Computational Foundations of Visual Cognition

Chair: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand

Location: Kx Building (11th floor) - Conference Room X11.3
Date: 14 December 2024
Time: 1:00 PM - 2:15 PM
Local Chair: Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

1:00 PM - 1:15 PM - Paper Presentation (Online)
B267: Unveiling the Role of Memory in Shaping Visual Perception: Empirical Insights
Author(s): Amrita Mukherjee, Avijit Paul, Ratan Kumar Saha, Kuntal Ghosh
Institution(s): IIIT Allahabad, India; Tufts University, USA; ISI Kolkata, India

1:15 PM - 1:30 PM - Paper Presentation (online)
B263: Effect of temporal correlation on motion direction flips in bistable stimuli
Author(s): Tsvetalin Totev, Nadejda Bocheva, Kalina Racheva
Institution(s): Bulgarian Academy of Sciences, Bulgaria

1:30 PM - 1:45 PM - Paper Presentation
B258: The Impact of Disfluent Fonts on Natural Paragraph Reading: An Eye-Tracking Study
Author(s): Syeda Tahiyah, Namon Nugoolsuksiri, Thitaporn Chaisilprungraung, Kejkaew Thanasuan
Institution(s): University of Toronto, Canada; King Mongkut's University of Technology Thonburi, Thailand

1:45 PM - 2:00 PM - Paper Presentation (online)
B268: Replication of the Hermann Grid Illusion By U-Net Deep Learning Architecture Performing Deblurring: A Low-level Visual Task
Author(s): Avijit Paul, Amrita Mukherjee, Kuntal Ghosh
Institution(s): Tufts University, USA; IIIT Allahabad, India; ISI Kolkata, India

2:00 PM - 2:15 PM - Paper Presentation
B242: When Sexy Avatars Get Weird: How Brain Asymmetry and Oculomotor Dynamics Navigate the Uncanny
Author(s): Mathieu Brideau-Duquette, Sara Saint-Pierre Côté, Philippe Charbonneau, Patrice Renaud
Institution(s): Université du Québec en Outaouais, Canada; École de technologie supérieure, Canada; Institut national de psychiatrie légale Philippe-Pinel, Canada

Note: each paper presentation includes 12-min talk + 3-min Q&A

Main Conference Symposia on 15 December 2024

The Symposium on Brain Big Data Analytics, Curation and Management

Chairs: Liya Ding, University of Chicago, USA & Carlos Enrique Gutierrez, Okinawa Institute of Science and Technology, Japan

Location: Kx Building (11th floor) - Conference Room X11.7
Date: 15 December 2024
Time: 10:00 AM - 2:00 PM
Local Chairs: Itthi Chatnuntawech, National Center of Nanotechnology & Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

10:00 AM - 10:15 AM - Paper Presentation (online)
B274: SmartStitcher: A Terabyte-level 3D Microscopic Image Stitching Tool Based on Mixed-Max-Resolution
Author(s): Yabo Li, Xiaoli Qi, Liya Ding
Institution(s): Southeast University, China; Cold spring harbor laboratory, USA

10:15 AM - 10:30 AM - Paper Presentation
B215: Deep Learning Methods to Evaluate the Quality of Skull-Stripped Brain MRI Images
Author(s): Li Luo, Rishikesh Phatangare, James Wang, Kenneth Vaden, Mark Eckert
Institution(s): Clemson University, USA; Medical University of South Carolina, USA; Columbia University, USA

10:30 AM - 10:45 AM - Paper Presentation (online)
B256: Feature Reduction and Machine Learning Analysis of Resting-State fMRI for Biomarker Identification in Post-Traumatic Epilepsy
Author(s): Alan Ho, Henry Noren, Pratik Jain, Spencer Chen, Hai Sun, Bharat Biswal
Institution(s): University of Miami Miller School of Medicine, USA; Robert Wood Johnson Medical School, USA; New Jersey Institute of Technology, USA

10:45 AM - 11:00 AM - Paper Presentation
B214: Gossamer: Scaling Image Processing and Reconstruction to Whole Brains
Author(s): Karl Marrett, Keivan Moradi, Chang Sin Park, Ming Yan, Chris Choi, Muye Zhu, Masood Akram, Sumit Nanda, Qing Xue, Hyun-Seung Mun, Adriana E. Gutierrez, Mitchell Rudd, Brian Zingg, Gabrielle Magat, Kathleen Wijaya, Hongwei Dong, X. William Yang, Jason Cong
Institution(s): University of California, Los Angeles, USA

11:00 AM - 11:15 AM - Paper Presentation
B221: A Computational Model for Estimating NMDA Properties from Local Field Potential Spectra
Author(s): Gabriele Mancini, Pablo Martínez-Cañada, and Stefano Panzeri
Institution(s): University Medical Center Hamburg-Eppendorf, Germany; University of Granada, Spain

11:15 AM - 11:30 AM - Paper Presentation
B207: Multimodal Physiological Signal Analysis using Attention-Based Feature and Model Fusion
Author(s): Wei Liu, Kebin Jia, Jinchao Feng, Xiaohu Zhao, and Zhonghua Sun
Institution(s): Beijing University of Technology, China

11:30 AM - 11:45 AM - Paper Presentation
B277: Towards an AI-Powered Platform for the Digital Brain in Brain/MINDS 2.0
Author(s): Carlos Enrique Gutierrez, Gaganpreet Singh Jhajj, Henrik Skibbe, Kenji Doya
Institution(s): Okinawa Institute of Science and Technology Graduate University, Japan; Athabasca University, Canada; RIKEN Institute, Japan

12:00 PM - 1:00 PM: Lunch Break

1:00 PM - 1:15 PM - Paper Presentation
B232: EEG Biomarkers based on Microstates and RQA
Author(s): Włodzisław Duch, Krzysztof Tołpa, Łukasz Furman, Ewa Ratajczak
Institution(s): Nicolaus Copernicus University, Poland

1:15 PM - 1:30 PM - Paper Presentation
B219: Topological Inference for Seizure Lateralization
Author(s): Jian Yin, Duc Anh Doan, Sofia Kollia, Andrew Yang, Pavan Turaga, Yuan Wang
Institution(s): City University of Hong Kong, China; National and Kapodistrian University of Athens, Greece; Barrow Neurological Institute, USA; Arizona State University, USA; University of South Carolina, USA

1:30 PM - 1:45 PM - Paper Presentation
B226: A Visualization and Computation Platform for the 3D Stereotaxic Mouse Brain Atlas with Single-cell Resolution
Author(s): Zhao Feng, Xueyan Jia
Institution(s): Hainan University, China; HUST-Suzhou Institute for Brainsmatics, China

1:45 PM - 2:00 PM - Paper Presentation (online)
B230: Evaluating Feature Importance in the Context of Simulation-Based Inference for Cortical Circuit Parameter Estimation
Author(s): Alessandro Sandron, Alejandro Orozco Valero, Juan Miguel García, Gabriele Macini, Francisco Pelayo, Christian Morillas, Stefano Panzeri, Pablo Martínez-Cañada
Institution(s): University of Padua, Italy; University of Granada, Spain; Istituto Italiano di Tecnologia, Italy; University of Granada, Spain; University Medical Center Hamburg-Eppendorf, Germany

Note: each paper presentation includes 12-min talk + 3-min Q&A

The Symposium on Brain-Computer Intelligence and Brain-Inspired Computing

Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Location: Kx Building (11th floor) - Conference Room X11.3
Date: 15 December 2024
Time: 10:30 AM - 12:00 PM
Local Chair: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand

10:30 PM - 10:45 PM - Paper Presentation
B234: Evaluating the Potential of Low-Cost BCI Devices for Online Classification of Four-Class Motor Imagery States
Author(s): Suparach Intarasopa, Bawornsak Sakulkueakulsuk, Thitaporn Chaisilprungraung
Institution(s): King Mongkut's University of Technology, Thailand

10:45 AM - 11:00 AM - Paper Presentation (online)
B209: Artificial Intelligence and Cognitive Neuroscience: An Integrative Review of Literature
Author(s): Minal Rehan, Irfan Butt, Iman Shamraiz, Mahnoor Butt
Institution(s): Beaconhouse School System Margalla Campus, Pakistan; Toronto Metropolitan University, Canada; University of Ottawa, Canada

11:00 AM - 11:15 AM - Paper Presentation
B218: Modelleyen: Continual Learning and Planning via Structured Modelling of Environment Dynamics
Author(s): Zeki Doruk Erden, Boi Faltings
Institution(s): Ecole Polytechnique Federale de Lausanne, Switzerland

11:15 AM - 11:30 AM - Paper Presentation (online)
B239: Gradient Ascent Activity-based Credit Assignment with History-dependent Reward
Author(s): Oussama Sabri, Luc Lehéricy, Alexandre Muzy
Institution(s): University Medical Center Hamburg-Eppendorf, Germany; Université Côte d'Azur, France; Université Côte d'Azur, France

11:30 AM - 11:45 AM - Paper Presentation
B264: A Novel Class Incremental Learning Method via Multi-granularity Balance Inspired by Human Granular Cognition Mechanism
Author(s): Yan Xian, Hong Yu, Ye Wang, Guoyin Wang
Institution(s): Chongqing University of Posts and Telecommunications, China; Chongqing Normal University, China

11:45 AM - 12:00 PM - Paper Presentation
B246: Evaluating Inductive Reasoning of Large Language Models: A Cognitive Psychology Approach Using Number Series Completion
Author(s): Yulong Gao, Ning Zhong, Peipeng Liang
Institution(s): Capital Normal University, China; Maebashi Institute of Technology Maebashi, Japan

Note: each paper presentation includes 12-min talk + 3-min Q&A

WORKSHOP SESSION SCHEDULE

Workshop Sessions on 13 December 2024

The International Workshop: Generative AI Empowers Brain Signal Processing (GAIEBSP 2024)

Chairs: Shuqiang Wang, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China, Sadia Shakil, The Chinese University of Hong Kong, Hong Kong & Baiying Lei, Shenzhen University, China

Location: KX Building (11th Floor) - Conference Room X01
Date: 13 December 2024
Time: 1:00 PM – 4:00 PM
Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand

Schedule:

1:00 PM - 1:15 PM - Invited Talk
Title: AI for Brain Functionality under Naturalistic Stimulation
Speaker: Sadia Shakil
Institution: The Chinese University of Hong Kong, Hong Kong

1:15 PM - 1:30 PM - Paper Presentation
S02205: Brain Functional Topologies under Short Reel Stimuli
Author(s): Abdul Rehman Khan, Sadia Shakil, Raymond Kai Yu Tong
Institution(s): The Chinese University of Hong Kong, Hong Kong

1:30 PM - 1:45 PM - Paper Presentation
S02207: Exploring Default Mode Network Association with Naturalistic Stimuli Using Topological Data Analysis
Author(s): Iqra Ejaz and Sadia Shakil
Institution(s): BiCoNeS lab, Department of Electrical Engineering, Institute of Space Technology (IST), Islamabad, Pakistan; The Chinese University of Hong Kong, Hong Kong

1:45 PM - 2:00 PM - Paper Presentation
S02212: Comparative Analysis of Channel Selection Methods for EEG-Based Emotion Recognition Balancing Accuracy and Efficiency
Author(s): Xintong Li, Xiaofeng Liu, Xiang Zhang, Xu Zhou, Xiaoqin Zhou
Institution(s): Hohai University, China; University of North Carolina, USA

2:00 PM - 2:15 PM - Paper Presentation
S02210: NeuroNetGen: AI-Driven Construction of Structural Brain Networks from Diffusion Tensor Imaging
Author(s): Xuhang Chen, Yihang Dong, Shuqiang Wang
Institution(s): Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

2:15 PM - 2:30 PM: Coffee Break

2:30 PM - 2:45 PM - Paper Presentation
S02208: Federated Multi-source Domain Adaptation via Vision Transformer for Multi-site Alzheimer's Diagnosis
Author(s): Tuo Cai, Baiying Lei, Xueqin Yan, Cuimei Wei, Chunhua Liang, Xiaohua Xiao, Tianfu Wang, Yunzhu Yang, Peng Yang
Institution(s): Shenzhen University, China; Shenzhen Second People's Hospital, China; Affiliated Hospital of Shenzhen University, China

2:45 PM - 3:00 PM - Paper Presentation
S02204: Intelligent Diagnosis Platform for Alzheimer's Disease Based on Multimodal Knowledge Graph
Author(s): Jiaqiang Li, Peng Yang, Jiuwen Cao, Zhenghua Guan, Junlong Qu, Lei Dong, Xueqin Yan, Cuimei Wei, Chunhua Liang, Xiaohua Xiao, Tianfu Wang, Baiying Lei
Institution(s): Shenzhen University, China; Hangzhou Dianzi University, China; Shenzhen Second People's Hospital, China; Affiliated Hospital of Shenzhen University, China

3:00 PM - 3:15 PM - Paper Presentation
S02203: Spatiotemporal Feature Extraction and Fusion for Longitudinal Alzheimer's Disease Diagnosis
Author(s): Zhenghua Guan, Peng Yang, Haijun Lei, Bao Yang, Xuegang Song, Lei Dong, Xueqin Yan, Cuimei Wei, Chunhua Liang, Xiaohua Xiao, Tianfu Wang, Baiying Lei
Institution(s): Shenzhen University, China; Shenzhen Second People's Hospital, China; Affiliated Hospital of Shenzhen University, China

3:15 PM - 3:30 PM - Paper Presentation
S02201: Brain Causality Modeling Using Structure-guided Spatiotemporal Diffusion Model for MCI Analysis
Author(s): Yanfei Zhu, Jiangtao Wang, Xuan Cheng, Junyi Chen, Hui Wei, Libin Lu, Zhi Yang, Qiankun Zuo
Institution(s): Sun Yat-Sen University, China; Hubei University of Economics, China; Wuhan Polytechnic University, China; Sichuan University, China

3:00 PM - 3:45 PM - Paper Presentation
S02206: Feature Fused Attention CNN for Classification in Alzheimer's Disease
Author(s): Ziyin Ren, Shuqiang Wang, Sadia Shakil, Raymond Tong
Institution(s): The Chinese University of Hong Kong, Hong Kong; Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

3:45 PM - 4:00 PM - Paper Presentation
B279: DoA Assessment based on EEG DFA and Entropy Features
Author(s): Xing Chen, Bo Song, Peng Wen
Institution(s): University of Southern Queensland, Australia

Note: each paper presentation includes 12-min talk + 3-min Q&A

The 4th International Workshop on Environmental Adaptation and Mental Health (EAMH 2024)

Chairs (online): Yang Yang, Yidi Chen, Zelong Meng, & Huixin Hu, Beijing Forestry University, China

Location: KX Building (11th Floor) - Conference Room X02
Date: 13 December 2024
Time: 1:30 PM - 4:50 PM
Local Chairs: Singh Intrachooto & Sarigga Pongsuwan, Research and Innovation Sustainability Center, Thailand & Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Schedule:

1:30 PM - 1:40 PM - Opening (online)
Speaker: Yang Yang
Institution(s): Beijing Forestry University, China

1:40 PM - 2:20 PM: Invited Talk (online)
Title: The impact of online games and short videos on the emotion and cognitive function of adolescents
Invited Speaker: Shuping Tan, Director of the Mental Health Research Center, Beijing Huilongguan Hospital, China

2:20 PM - 3:00 PM: Invited Talk (online)
Title: Human escaping decisions: Mechanistic insights from intracranial recordings
Invited Speaker: Haiyan Wu, Centre for Cognitive and Brain Sciences, University of Macau, China

3:00 PM - 3:10 PM: Coffee Break

3:10 PM - 3:40 PM - Workshop Discussion (hybrid)

3:40 PM - 4:00 PM - Paper Presentation
S06203: The effect of color temperature on subjective rating and neural indexes of stress and behavioral performance in a virtual environment
Author(s): Nattapat Tanjariyporn, Supunnapong Raksawong, Napol Kieatkongmanee, Sittha Preedapirat, Singh Intrachooto, Sirawaj Itthipuripat, Sarigga Pongsuwan
Institution(s): Research & Innovation for Sustainability Center, Thailand; King Mongkut's University of Technology Thonburi, Thailand

4:00 PM - 4:20 PM - Paper Presentation (online)
S06201: The Role of Episode Simulation in Influencing Junior Middle School Students' Future Time Insight and Subjective Well-being
Author(s): Zixi Zong, Xiuya Lei, Yang Yang
Institution(s): National Center for Mental Health, China; Beijing Forestry University, China

4:20 PM - 4:40 PM - Paper Presentation (online)
S06202: Self-determined or non-self-determined? Research on the influence of internal and external motivations on fund investment decisions
Author(s): Junwen Mo, Yufei Chang, Chenxi Li, Meichen Wang, Yilin Meng, Yang Yang
Institution(s): Beijing Forestry University, China

4:40 PM - 4:50 PM: Closing

Note: each paper presentation includes 15-min talk + 5-min Q&A

Workshop Sessions on 14 December 2024

The International Workshop on Reconstruction and Modeling of the Brain at the Single-Cell Level (RMBSCL 2024)

Chairs: Yufeng Liu & Lijuan Liu, Southeast University,

Weiyao Lin, Shanghai Jiao Tong University & Guoqiang Yu, Tsinghua University, China

Location: KX Building (11th Floor) -Conference Room X11.7
Date: 14 December 2024
Time: 10:00 AM - 11:55 AM

Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Tai Chaiamarit, Mahidol University, Thailand

Schedule:

10:00 AM - 10:20 AM - Invited Talk
Title: Cortical Dynamics and Underlying Mechanisms in Sleep Stage Transitions
Invited Speaker: **Yina Wei**
Institution: Zhejiang Lab, China

10:20 AM - 10:40 AM - Invited Talk
Hippocampal Sharp-Wave Ripple Transmission in Cortical Neural Networks
Invited Speaker: **Hao Si**
Institution: Zhejiang Lab, China

10:40 AM - 10:55 AM - Paper Presentation
S10205: High Throughput Training Label Generation from Whole Brain Images
Author(s): **Karl Marrett**, Keivan Moradi, Ming Yan, Chris Choi, Muye Zhu, Masood Akram, Sumit Nanda, Qing Xue, Hyun-Seung Mun, Adriana E. Gutierrez, Mitchell Rudd, Brian Zingg, Gabrielle Magat, Kathleen Wijaya, Hongwei Dong, X. William Yang, Jason Cong, Chris Sin Park
Institution(s): University of California, Los Angeles, USA

10:55 AM - 11:10 AM - Paper Presentation
S10201: BCF: An Integrated Framework to Reconstruct Whole-Brain Single-Neuron Connectivity in Mouse Brains
Author(s): **Feng Xiong**
Institution(s): Southeast University, China

11:10 AM - 11:25 AM - Paper Presentation
S10204: Smart Scope Platform (SSP): Enhancing Real-Time Microscopy Analysis Through Rapid Deep Learning Integration
Author(s): **Di Liu**
Institution(s): Southeast University, China

11:25 AM - 11:40 AM - Paper Presentation
S10203: Cell Typing and Sub-typing Based on Detecting Characteristic Subspaces of Morphological Features Derived from Neuron Images
Author(s): **Sujun Zhao**
Institution(s): Southeast University, China

11:40 AM - 11:55 AM: - Paper Presentation
S10202: Build Brain Atlases with Mobile Phones: A Crowd-Reconstructing and Cloud-Mapping Platform for Brain-Wide Neuron Morphologies
Author(s): **Lingli Zhang**
Institution(s): Southeast University, China

Note: each paper presentation includes 12-min talk + 3-min Q&A

The International Workshop on Elucidation of Mechanistic Information using Neuroimaging for Psychiatric Disorders (EMINPD 2024)

Chairs (online): Xiaofu He, Bin Xu & Xi Zhu, New York State Psychiatric Institute & Columbia University, USA & Yunyu Xiao, Cornell University, USA

Location: KX Building (11th Floor) -Conference Room X11.1
Date: 14 December 2024
Time: 09:00 AM - 11:00 AM (09:00 PM- 11:00 PM EST)
Local Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Schedule:

9:00 AM - 9:05 AM - Opening (Online)
Speaker(s): Xiaofu He & Bin Xu
Institution(s): New York State Psychiatric Institute & Columbia University, USA

9:05 AM - 9:45 AM - Invited Talk (Online)
Title: Using multi-omic approaches to dissect brain cell types in serious mental illness
Invited speaker: Anton Schulmann
Institution: Columbia University Irving Medical Center, USA

9:45 AM - 10:00 AM - Paper Presentation (Online)
S14204: Imaging Analysis of Calcium Activities in Brain Organoid Model of Neuropsychiatric Disorder
Author(s): Xiaofu He, Yutong Gao, Yian Wang, Xuchen Wang, Qifan Jiang, Bin Xu
Institution(s): New York State Psychiatric Institute, USA; Columbia University, USA

10.00 AM - 10:15 AM - Paper Presentation (Online)
S14202: Predicting fMRI Signals from Single-Channel EEG Using Deep Learning
Author(s): Luyu Huang, Jingru Gong, Zhu Xi, Xiaofu He
Institution(s): New York State Psychiatric Institute, USA; Columbia University, USA

10:15 AM - 10:30 AM - Paper Presentation(Online)
S14201: Two neuroanatomical biotypes of schizophrenia identified by using machine learning on brain MR images from 11,260 individuals
Author(s): Yuchao Jiang, Cheng Luo, Dezhong Yao, Cheng Wei, Jianfeng Feng
Institution(s): Fudan University, China

10:30 AM - 10:45 AM - Paper Presentation (Online)
S14205: Multimodal Whole-Brain Trait-like and State-like Predictors for Prolonged Exposure Treatment
Author(s): Fatima Rizwan, Xi Zhu, Sigal Zilcha-Mano, Or Duek, Luyu Huang, Yuval Neria, Ilan Harpaz-Rotem
Institution(s): New York State Psychiatric Institute, USA; Ben-Gurion University of the Negev, Israel; Yale University, USA

10:45 AM - 11:00 AM - Paper Presentation (Online)
S14203: White Matter Integrity in Youth with Suicide Ideation/Suicide Attempt, Major Depressive Disorder, and Comorbidities: A Diffusion Tensor Imaging Study
Author(s): Yixuan Wang, Yue Wang, Yuan Meng, Yunyu Xiao, Xiaofu He
Institution(s): Columbia University, USA; Weill Cornell Medicine/NewYork-Presbyterian, USA; New York State Psychiatric Institute, USA

Note: each paper presentation includes 12-min talk + 3-min Q&A

The International Workshop on Computational Tools for Cognition (CTC 2024)

Chairs (online): Stephanie Neilli, Occidental College, USA,
Ioannis Pappas, University of Southern California, USA &
Nuttida Rungratsameetaweemana, Columbia University, USA

Location: KX Building (11th Floor) -Conference Room X11.2
Date: 14 December 2024
Time: 9:30 AM - 12:00 PM
Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand; Maytus Piriyajitakonkij, The University of Manchester, UK & Agency for Science, Technology and Research (A*STAR), Singapore

Schedule:

9.30-9.35AM - Opening Remark (online)
Speaker: Ioanis Pappas
Institution: University of Southern California, USA

9.35AM-9.55AM - Special Lecture (online)
Title: Cortical computations for adaptive cognition in humans and artificial networks
Speaker: Nuttida Rungratsameetaweemana
Institution: Columbia University, USA

9.55AM-10.15AM - Special Lecture (online)
Title: Elucidating the role of sensory cortical circuits in short-term memory
Invited Speaker: Robert Kim
Institution(s): Cedars-Sinai Medical Center & Columbia University, USA

10.15AM-10.35AM - Invited Talk (online)
Title: If deep learning is the answer, what is the question?
Speaker: Stephanie Neilli
Institution: Occidental College, USA

10.35AM-10.50AM - Paper Presentation (online)
S13201: Abstract learning in RNNs and Humans
Author(s): Qiyao Wang, Bansiya Pooja, Neda Rabii, Wilder Hartwell, Compton French, Stephanie Nelli
Institution(s): Occidental College, USA

10.50AM-11.05AM - Paper Presentation
S13203: What Makes a Face Look Like a Hat: Decoupling Low-level and High-level Visual Properties with Image Triplets
Author(s): Maytus Piriyajitakonkij, Sirawaj Itthipuripat, Ian Ballard, Ioannis Pappas
Institution(s): The University of Manchester, UK; Agency for Science, Technology and Research (A*STAR), Singapore; King Mongkut's University of Technology Thonburi, Thailand; University of California, Riverside; University of Southern California, USA

11.05AM-11.20AM - Paper Presentation (online)
B280: Probing cellular mechanisms for working memory computation
Author(s): Daria Kussovska, Poomirat Nawarat, James Yu, Nuttida Rungratsameetaweemana
Institution(s): Columbia University, USA; Rajamangala University of Technology Phra Nakhon, Thailand

11.20AM-11.35AM - Paper Presentation
B282: EEG-Based Detection of Epileptic Seizures Using Convolutional Neural Network
Author(s): Thitsanapat Siwarattanan, Surat Teerapittayanon, Airin Intaratat, Itthi Chatnuntawech
Institution(s): King Mongkut's University of Technology Ladkrabang, Thailand; National Nanotechnology Center, Thailand; Chonradsadornumrung School, Thailand

11.35AM-11.50AM - Paper Presentation
B283: Parkinson's Disease Classification Using Multi-Channel Recordings from VGRF Sensors and Optimal Sensor Pair Selection
Author(s): Santipab Tongchan, Surat Teerapittayanon, Airin Intaratat, Itthi Chatnuntawech
Institution(s): King Mongkut's University of Technology Thonburi, Thailand; National Nanotechnology Center, Thailand; Chonradsadornumrung School, Thailand

11.50AM-12.00 PM: Closing Remark
Speaker: Ioanis Pappas
Institution: University of Southern California, USA

Note: each paper presentation includes 12-min talk + 3-min Q&A

The International Workshop on Mesoscopic Brain-wide Connectivity Atlas (MBCA 2024)

Chairs: Anan Li (BI24 General Chair), Huazhong University of Science and Technology, China, Junjie Zhuo & Zhao Feng, Hainan University, China

Location: KX Building (11th Floor) -Conference Room X11.7
Date: 14 December 2024
Time: 1:00 PM - 5:35 PM
Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Tai Chaiamarit, Mahidol University, Thailand

Schedule:

Section I:
Chair: Anan Li (BI24 General Chair), Huazhong University of Science and Technology, China

1:00 PM - 1:30 PM - Special Lecture
Title: Computational neuroanatomy adventures in neuroinformatics
Invited Speaker: Ascoli Giorgio (BI24 General Chair)
Institution: George Mason University, USA

1:30 PM - 2:00 PM - Invited Talk (online)
Title: Efficient Storage and Sharing of Massive Biomedical Data Using Implicit Neural Representation
Invited Speaker: Jinli Suo
Institution: Tsinghua University, China

2:00 PM - 2:15 PM - Paper Presentation
S11202: Brain Region Recognition in Micro-Optical Images Based on Feature Database Retrieval
Author(s): Xin Liu, Zhao Feng, Anan Li
Institution(s): Huazhong University of Science and Technology, China; HUST-Suzhou Institute for Brainsmatics, China

2:15 PM - 2:30 PM - Paper Presentation
S11201: Mapping Sagittal-Plane Reference Brain Atlas of the Cynomolgus Macaque Based on Consecutive Cytoarchitectonic Images
Author(s) Yue Luo, Zhao Feng, Anan Li
Institution(s): Huazhong University of Science and Technology, China; HUST-Suzhou Institute for Brainsmatics, China

2:30 PM - 2:40 PM - Coffee Break

Section II
Chair: Junjie Zhuo, Hainan University, China

2:40 PM - 2:55 PM - Paper Presentation
S11211: Sex Differences in Brain Information Processing: Insights from Specific Brain Regions and Hemispheric Connectivity
Author(s): Ying Luo, Satoshi Nishida, Ichiro Kobayashi
Institution(s): Ochanomizu University, Japan; Center for Information and Neural Networks, Advanced ICT Research Institute,National Institute of Information and Communications Technology, Japan

2:55 PM - 3:10 PM - Paper Presentation
S11205: A High-Throughput Preprocessing Pipeline for Mesoscopic Optical Brain Imaging Leveraging Differential-Guided Filtering Convolutional Neural Networks
Author(s): Hong Zhang, Shilong Zhang, Peicong Gong, Zhikang Lu, Ganghua Huang, Zhao Feng, Anan Li, Chi Xiao
Institution(s): Hainan University, China; Huazhong University of Science and Technology, China

3:10 PM - 3:25 PM - Paper Presentation
S11210: Efficient Neuronal Soma Segmentation Based on Segment Anything Model
Author(s): Tianyu Hu
Institution(s): Hubei Engineering University, China

3:25 PM - 3:40 PM - Paper Presentation
S11204: Estimate the 3D Fiber Orientation Distributions of White Matter in the Mouse Brain by Integrating Mesoscopic Nissl-Staining with dMRI Data
Author(s): Zhikang Lu, Fengming Qin, Hong Zhang, Ganghua Huang, Zhanbo Zhang, Junjie Zhuo, Anan Li, Chi Xiao
Institution(s): Hainan University, China; Huazhong University of Science and Technology, China

3:40 PM - 3:55 PM - Paper Presentation
S11206: Weakly Supervised Automatic Recognition Technology for Neuron Image Big Data
Author(s): Ganghua Huang, Xinyi Cheng, Jiang Huang, Zhikang Lu, Hong Zhang, Anan Li, Chi Xiao
Institution(s): Hainan University, China; Huazhong University of Science and Technology, China

3:55 PM - 4:10 PM - Paper Presentation
S11209: BrainScope-SAM3D: An Automatic Segmentation Model for High-Throughput and High-Resolution Microscopic Brain Images
Author(s): Shilong Zhang, Hong Zhang, Peicong Gong, Chi Xiao, Zhao Feng
Institution(s): Hainan University, China

4:10 PM - 4:20 PM - Short Break

Section III:
Chair: Zhao Feng, Hainan University, China

4:20 PM - 4:50 PM - Invited Talk (online)
Title: Specialized Inputs and Outputs Patterns of Different Cerebellar Modules
Invited Speaker: Zhenyu Gao
Institution: Erasmus MC, Netherlands

4:50 PM - 5:05PM - Paper Presentation (online)
S11207: A Computational Pipeline for Spatial Distribution of the Whole-Mouse-Brain Vasculature
Author(s): Yuxin Li, Weijie He, Tao Jiang, Xiangning Li, Anan Li
Institution(s): Xi'an University of Technology, China; HUST-Suzhou Institute for Brainsmatics, China; Huazhong University of Science and Technology, China

5:05 PM - 5:20 PM - Paper Presentation
S11203: Characterization of AD Mice Brain Images Reveals Spatiotemporal Developmental Change Properties of Plaques Under Different Morphologic Classifications
Author(s): Guixuan Gong, Anan Li, Xiangning Li
Institution(s): Huazhong University of Science and Technology, China; Hainan University, China

5:20 PM - 5:35 PM - Paper Presentation
S11208: In Vivo MRI-Based Pipeline for Cross-Modality Macaque Brain Registration
Author(s): Junjie Zhuo, Zhanbo Zhang, Chi Xiao, Anan Li, Xiaoquan Yang, and Pengcheng Li
Institution(s): Hainan University, China; Huazhong University of Science and Technology, China

Note: each paper presentation includes 12-min talk + 3-min Q&A

The 2024 International Workshop: Web Intelligence meets Brain Informatics (WImeetsBI 2024 –Brain Informatics Edition)

Chairs: Jianzhuo Yan, Jianhui Chen & Jiajin Huang, Beijing University of Technology, China

Location: KX Building (11th Floor) -Conference Room X11.1
Date: 14 December 2024
Time: 2:00 PM – 4:45 PM
Local Chairs: Kajornvut Ounjai, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Lalitta Suriya-Arunroj, Faculty of Medicine, Chulalongkorn University, Thailand

Schedule:

2:00 PM - 2:30 PM - Invited Talk
Title: Development of Foundational AI Models for Brain Source Imaging with Applications to Epileptogenic Zone Detection
Invited speaker: Feng Liu
Institution: Stevens Institute of Technology, USA

2:30 PM - 3:00 PM - Invited Talk
Title: Bridging Web Intelligence and Brain Informatics: Trustworthy AI for Cognitive Health Monitoring
Invited speaker**:** Angela Lombardi
Institution: Polytechnic University of Bari, Italy

3:00 PM - 3:30 PM - Invited Talk
Title: Never-Ending Learning for Systematic Understanding of High-Order Cognition
Invited speaker**:** Hongzhi Kuai
Institution: Maebashi Institute of Technology, Japan

3:30 PM - 3:45 PM - Paper Presentation
B270: Dual-Structural Representation Learning with Attention-Based Graph Fusion for Hierarchical MCI-AD Diagnosis
Author(s): Yu Cao, Hongzhi Kuai, Bixin Wang, Fengmei Fan, Guanqiao Peng, Ning Zhong
Institution(s): Beijing University of Technology, China; Maebashi Institute of Technology, Japan; Beijing Huilongguan Hospital, China; University of Illinois Urbana-Champaign, USA

3:45 PM - 4:00 PM - Paper Presentation (online)
B269: An Auxiliary Diagnosis Method for Mild Cognitive Impairment Based on Structural Magnetic Resonance Image
Author(s): Haiming Li, Linjin Wang, Jiangtao He, Xinwei Li
Institution(s): Chongqing University of Posts and Telecommunication, China

4:00 PM - 4:15 PM - Paper Presentation (online)
S03204: Differences in the Local Morphology of Bilateral Functional Brain Networks During the Visual Word Recognition Task
Author(s): Xiaofei Zhang, Lianfang Ma, Jianhui Chen
Institution(s): Jiangsu University of Science and Technology, China; Beijing University of Technology, China

4:15 PM - 4:30 PM - Paper Presentation (online)
S03203: A Multi-Loop Approach Reveals Differences Neural Mechanisms of Inductive Reasoning in DLPFC and SPL
Author(s): Lianfang Ma, Shiyun Chen, Jiajin Huang, Zhijiang Wang, Jianhui Chen
Institution(s): Beijing University of Technology, China; Peking University Institute of Mental Health (Sixth Hospital), China

4:30 PM - 4:45 PM - Paper Presentation (online)
S03202: Adaptive Connectivity-Driven Parallel Graph Convolution Transformer Network for EEG Emotion Recognition
Author(s): Qiang Li, Haiyan Zhou
Institution(s): Beijing University of Technology, China

Important Notice: This is Part 2 of WImeetsBI 2024, the Brain Informatics edition. We also invite you to explore Part 1, the WI-IAT edition, available at: www.wi-iat.com/wi-iat2024/.

Note: each paper presentation includes 12-min talk + 3-min Q&A

Workshop Sessions on 15 December 2024

The 6th International Workshop on Cognitive Neuroscience of Thinking and Reasoning (CNTR 2024)

Chairs: Peipeng Liang, Capital Normal University, China & Vinod Goel, York University, Canada

Location: KX Building (11th Floor) -Conference Room X11.1
Date: 15 December 2024
Time: 9:00 AM - 11.30 AM
Local Chairs: Kajornvut Ounjai, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand

Schedule:

9:00 AM - 9:10 AM: Opening Remark
Speaker: Peipeng Liang
Institution(s): Capital Normal University, China

9:10 AM - 9:40 AM: Invited Talk (online)
Title: Prevalence of False Beliefs and Implications for Rationality
Invited Speaker: Vinod Goel
Institution: York University, Canada

9:40 AM - 10:10 AM: Invited Talk (online)
Title: Gödel Consciousness and Independent Statement
Invited Speaker: Yingrui Yang
Institution: Rensselaer Polytechnic Institute, USA

10:10 AM - 10:30 AM: Coffee Break

10:30 AM - 10:50 AM - Paper Presentation
B246: Evaluating Inductive Reasoning of Large Language Models: A Cognitive Psychology Approach Using Number Series Completion
Author(s): Yulong Gao, Ning Zhong, Peipeng Liang
Institution(s): Capital Normal University, China; Maebashi Institute of Technology, Maebashi, Japan

10:50 AM - 11:10 AM - Paper Presentation
S04201: The Influence of Stimulus Similarity and Reasoning Content on Inductive Reasoning Generalization: Behavioral and Neural Perspectives
Authors: Ke Jiang and Huiqing Shen
Institution: Teacher Education College of Lishui University, China

11:10 AM - 11:30 AM - Paper Presentation
S04203: The Contributions of Hippocampal Subregions in Transitive Inference
Author(s): Congcong Zhang, Jing Zhao, Xiangbing Bian, Lingyun Cai, Xin Lou, Peipeng Liang
Institution(s): Capital Normal University, China; Chinese PLA General Hospital, China

Note: each paper presentation includes 15-min talk + 5-min Q&A

The International Workshop on Multimodal Computational Approaches for Brain Biomarkers Discovery (MCABBD 2024)

Chairs: Hieu Pham, VinUniversity, Vietnam & Nguyen The Hoang Anh, Vietnam – Korea Institute of Science and Technology, Vietnam

Location: KX Building (11th Floor) -Conference Room X11.1
Date: 15 November 2024
Time: 1:00 PM - 3.00 PM
Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Schedule:

1:00 PM - 1:10 PM: Opening Remark
Speaker: Hieu Pham
Institution(s): VinUniversity, Vietnam

1:10 PM - 1:40 PM: Special Lecture (online)
Title: Brain-Computer Interface and Current State-of-the-Art
Speaker: Nguyen The Hoang Anh
Institution(s): Vietnam – Korea Institute of Science and Technology, Vietnam

1:40 PM - 2:10 PM: Special Lecture
Title: Multimodal AI in Medicine: Recent Advances, Future Perspectives and Applications to Neuroscience Research
Speaker: Hieu Pham
Institution(s): VinUniversity, Vietnam

2:10 PM - 2:20 PM: Break

2:20 PM - 2:35 AM - Paper Presentation
S09201: Development and Evaluation of Multimodal AI Framework for Mental Health Assessment: A Preliminary Study
Author(s): Cuong Pham, My Nguyen, Huy Hoang, Hung Nguyen, Luan Nguyen, Linh Tran, Bao Nguyen, Lua Ngo, Duy Le, Tan Le, Nghia Nguyen, Huong Ha, and Hieu Pham
Institution(s): VinUniversity, Vietnam

2:35 PM - 3.50 PM - Paper Presentation
S09202: Development of AI-Enhanced Prediction Tool for Individualized Psychopathological Profile in Low-and-Middle-Income Countries
Author(s): Hung Nguyen, Minh Khau, Huyen Nguyen, Hieu Pham
Institution(s): RMIT University Vietnam, Vietnam; University of Science, Vietnam National University HCMC, Vietnam; VinUniversity, Vietnam

Note: each paper presentation includes 12-min talk + 3-min Q&A

The 4th Special Session on Explainable Artificial Intelligence for Unveiling the Brain: From Black-Box to Glass-Box (XAIB 2024)

Chair (online): Chiara Camastra, Neuroscience Research Center, Department of Medical and Surgical Sciences, Magna Graecia University of Catanzaro, Italy

Location: KX Building (11th Floor) -Conference Room X11.1
Date: 15 December 2024
Time: 4:00 PM – 5:50 PM
Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand

Schedule:
4:00 PM - 4:15 PM (UTC+7) - Opening Remark (online)
Invited Speaker**:** Prof. Alessia Sarica
Neuroscience Research Center, Department of Medical and Surgical Sciences, Magna Graecia University of Catanzaro, Italy

4:15 PM - 4:45 PM (UTC+7) - Invited Talk (online)
Title: Supervised ML in Science - From interpretability to robustness
Invited Speaker**:** Christoph Molnar
Department of Statistics, LMU Munich, Munich, Germany
Leibniz Institute for Prevention Research and Epidemiology, Bremen, Germany

4:45 PM - 5:00 PM (UTC+7) - Invited Talk (online)
Title: Deep Learning and Explainability: How Far Are We?
Invited Speaker**:** Dr. Sanjay Ghosh
Department of Electrical Engineering, Indian Institute of Technology Kharagpur, West Bengal, India

5:00 PM - 5:15 PM (UTC+7) - Paper Presentation (online)
B278: A Convolutional Neural Network with Feature Selection for Generating Explainable 1D Image Information for Brain Disease Diagnosis
Author: Luna M. Zhang
Institution: Department of Computer Science, Stony Brook University, Stony Brook, NY

5:15 PM - 5:30 PM (UTC+7) - Paper Presentation (online)
B244: Probing Temporal Filters of Vision via a Falsifiable Model of Flicker Fusion
Authors: Keerthi S Chandran and Kuntal Ghosh
Institution: Indian Statistical Institute, India

5:30 PM - 5:45 PM (UTC+7) - Paper Presentation (online)
B212: A Comparison of ANN-Optimization and Logistic Regression – An Example of the Acceptance of EEG Devices
Authors: Tina Zeilner, Andreas Uphaus, Bodo Vogt
Institution: Otto-von-Guericke-Universität Magdeburg, Germany; Hochschule Bielefeld, Germany

5:45 PM - 5:50 PM (UTC+7): Closing Remark (online)
Invited Speaker: Prof. Alessia Sarica
Neuroscience Research Center, Department of Medical and Surgical Sciences, Magna Graecia University of Catanzaro, Italy

Note: each paper presentation includes 12-min talk + 3-min Q&A

The International Workshop on Application of Artificial Intelligence and Innovative Technologies in Brain Informatics and Health (AAIITBIH 2024)

Chair (online): Zhijiang Wan, Nanchang University, China

Location: KX Building (11th Floor) -Conference Room X11.2
Date: 15 December 2024
Time: 2:00 PM - 3.40 PM
Local Chairs: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand & Sittiprapa Isarangura, Mahidol University, Thailand

2:00 PM - 2:10 PM - Opening Remark (online)
Speaker: Zhijiang Wan
Institution(s): School of Information Engineering, Nanchang University, China

2:10 PM - 2:40 PM - Invited Talk
Title: The application of EEG-fMRI technology in brain function research
Invited Speaker: **Yang Bai, Wentao Zeng**
Institution(s): Affiliated Rehabilitation Hospital, Jiangxi Medical College, Nanchang University, Nanchang, China

2:40 PM - 3:10 PM - Special Lecture (online)
Title: The Application of Individual-Specific Functional Connectivity in the Classification of Disorders of Consciousness and Its Potential Biomarkers
Speaker: Zhijiang Wan
Institution(s): School of Information Engineering, Nanchang University, China

3:10 PM - 3.25 PM - Paper Presentation
B213: Integrating Multimodal Spatiotemporal Brain Data with Spiking Neural Networks
Author(s): Maryam Doborjeh, Zien Huang, Zohreh Doborjeh
Institution(s): Auckland University of Technology, New Zealand

3:25 PM - 3.40 PM - Paper Presentation
S07202: A VR–BCI System to Support Rehabilitation for Stroke Patients
Author(s): Nguyen Minh Kien, Vu Thanh Long, Ma Thi Chau, and Nguyen The Hoang Anh
Institution(s): University of Engineering and Technology, Vietnam National University

Note: each paper presentation includes 12-min talk + 3-min Q&A

BOOK OF ABSTRACTS

Book of Abstracts (Main Conference Symposia)

The Symposium on Advanced Methods in Computational Social Neuroscience

Chair: Italo Ivo Lima D ias Pinto, University of California, Irvine, USA
Local Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand

B240: Symbolic Dynamics of Brain Networks during Hyperscanning to Investigate Coordination of Behavior

Italo Ivo Lima Dias Pinto[1], Zhibin Zhou[1], Dr. Ramesh Srinivasan[1]

[1]Department of Cognitive Sciences, University of California, Irvine, USA

Abstract

Introduction:
Experimental studies of the neural mechanisms of coordination between individuals is an emerging field of neuroscience, particularly in the context of movement coordination and other aspects of social cognition. One approach in these studies is called hyperscanning, where electroencephalography (EEG) activity of multiple subjects is simultaneously recorded during a task requiring coordinated behavior. Although these experiments have been innovative, previous analyses have generally extended the conceptual framework of interactions within a single brain to multiple brains, typically using measures of correlations or synchrony. Measures like Partial Directed Coherence and Phase Locking Value assess synchrony between different brain areas of different subjects. While this approach is effective for single-brain studies—where axonal connections (white matter) provide a physiological basis for synchronization between regions—across brains, there is no direct physiological basis for millisecond-scale neural interactions. Synchrony across brains likely results from common sensory inputs, and studies often find low levels of synchrony, leading to interpretation challenges.

In contrast to these traditional approaches, brain activity measured on a macroscopic scale using EEG can also be understood as transient, quasi-stable patterns that evolve over time. Extensive literature characterizes these patterns as functional networks, using correlation, coherence, or mutual information to identify connectivity structures between brain regions. Building on this foundation, one method of EEG analysis identifies stable patterns within short time windows, known as microstates, and characterizes the EEG signals as sequences of these microstates. By labeling each microstate with a discrete symbol, the evolution of brain states can be described as a sequence of symbols. In this study, we leverage the symbolic dynamics of brain microstates to investigate the dynamics of multiple interacting brains.

Using a data-driven approach, we define brain states based on the correlations between different brain areas for each subject, allowing us to create symbolic representations for each subject and a sequence of joint brain states as a combination of each subject's symbolic sequence. This paradigm enables the exploration of multi-brain dynamics without relying on millisecond time scale connectivity between brains. In our analysis we studied multi-brain symbolic dynamics using Recurrence Quantification Analysis (RQA), which provide powerful tools to analyze and understand the intricate dynamical processes governing metastable states in the brain. Additionally, we investigate the symbolic dynamics by constructing transition networks, providing deeper insights into the topology and dynamics of interconnected brain activity.

Methods:
We developed a symbolic dynamics framework tailored for neuroimaging data. The following steps describe a general pipeline on how we can discretize continuous brain states in a set of symbols and the follow up analytical methods that can be used to extract information of state stability, dynamical patterns and topology of the underlying brain states:

1. Signal Preprocessing: Neuroimaging data, such as EEG, MEG, or fMRI signals, are preprocessed to remove noise and artifacts.

2. Functional Connectivity Estimation: Continuous signals are transformed into a sequence of functional connectivity graphs or matrices. This transformation retains the patterns of interaction between the various brain regions.

3. Symbolic Transformation: Once the functional connectivity patterns are determined, the symbols are extracted by coarse graining the patterns in a discrete set using a clustering technique. Observed symbols are then paired across individuals and represented in a joint symbol space. The joint dynamics of brain activity during a task is then represented by a sequence of joint symbols.

4. Recurrence Quantification Analysis: The exploration of recurrences in the symbolic sequence can reveal important aspects of neural dynamics. It measures how often patterns recur (recurrence rate), the predictability of these patterns (determinism), and the complexity and stability of neural activity (dwell time). These metrics help identify stability of network states and repeated sequences of network states providing a deeper understanding of the brain's complex dynamics.

5. State Transition Network: A transition network of a symbolic sequence develops a graph that represents the transitions between different network states. It captures the frequency and patterns of these transitions, revealing the topological structure of neural activity. From this kind of analysis metrics including node degree (indicating state connectivity), transition probabilities (showing likelihood of moving between states), and clustering coefficients (highlighting state interconnections) can be obtained. This analysis helps identify dominant network states, frequent transitions, and the overall topology of the brain dynamics.

Results:
As an example of the method we applied the Symbolic Dynamics to a dyad motor coordination task. In this experiment the dyads tried to establish a coordination pattern, each dyad participated in two sessions, one to establish a synchronization pattern and the other to establish a syncopation pattern. For each coordination pattern, each dyad performed trials with an uncoupled, leader-follower and mutual feedback interaction regime.

Recurrence quantification analysis: The type of feedback regime influences the average dwell time of the observed joint brain network states (length of sequences of fixed symbols) and the average motif length (a repeating sequence of symbols). This indicates that the feedback regime affects the stability and reachability of the joint brain network states. Interestingly, different coordination patterns lead to opposite effects: For instance, the mutual feedback results in longer average dwelling times and motif lengths than what is observed in an uncoupled regime when the subjects are trying to establish a synchronization pattern, whereas the opposite relation is observed for the syncopation patterns.

Network Analysis: In our state transition network topology analysis, we found that shortest path length and betweenness centrality play crucial roles in differentiating the three interaction conditions. The shortest path between two nodes represents the sequence of joint network state transitions with the highest overall probability, with each edge's cost defined as -ln(P), where P is the transition probability. This highlights the most probable transition routes between states. Betweenness centrality measures the importance of a joint brain state as an intermediary in these high-probability sequences, with high values indicating that the joint state frequently appears in key transition paths, serving as a central hub in coordination dynamics.

In the synchronization condition, stronger coupling regimes (Leader-Follower and Mutual) led to an increase in average dwell time and motif length, while betweenness centrality remained constant and average shortest path length increased. These findings suggest that stronger coupling stabilizes a few states, making the probability flow more restricted and preserving the core-periphery structure of the network. Conversely, in the syncopation condition, the average dwell time and motif length decreased, betweenness centrality declined, and average shortest path length increased. This indicates that stronger coupling in syncopation enhances the stability of a larger set of states and distributes the probability flow, reducing the dominance of core nodes and creating a more distributed but less efficient flow. These conclusions provide insight into how coupling feedback modulates state stability and transition dynamics in the different coordination patterns.

Conclusion:
We investigated brain activity as a series of transitions between metastable states to analyze multi-brain symbolic sequences. Utilizing a data-driven approach, we defined brain states based on the similarity of correlation matrices between different brain areas for each subject, allowing us to create symbolic representations of joint states. We then analyzed these symbolic sequences using recurrence quantification analysis and a transition network approach. Recurrence quantification analysis showed that feedback regimes significantly influenced average state dwell time and motif length. A network-based analysis of symbolic dynamics revealed different topological changes with feedback regimes. These findings provide insights into how feedback between individuals affects state stability and dynamics in motor coordination tasks.

Our work offers a fresh perspective on inter-brain connectivity by analyzing a hyperscanning neuroimaging dataset through multi-brain symbolic dynamics. Metastable state dynamics are crucial for brain flexibility, enabling seamless transitions between stable functional states and supporting cognitive processes and resilience to noise through robust mechanisms. Our study expands the concept of brain metastable states to multi-person interactions, providing a novel perspective without relying on millisecond time-scale synchronization. Our results and analytical approach not only broaden the understanding of brain metastable states in the context of human interaction and coordination, but also open new avenues for studying the brain mechanisms underlying these processes. This new tool bridges brain dynamics and behavior, offering a powerful method to explore the intricate neural choreography of multi-person interactions.

Keywords: symbolic dynamics, neural synchronization, neuroimaging, functional brain networks, entropy, mutual information, network analysis.
Correspondence: Italo Ivo Lima Dias Pinto (ilimadia@uci.edu)

B262: Developing a Multi-Site Hyperscanning Procedure for Investigating Interbrain Synchrony Underlying Remote Social Interaction

Sirapakit Limtragooltongchai[1], Kawin Yamtuan[1,2], Javier O Gracia[3], Chaipat Chunharas[4,5], Ramesh Sriravanasan[3,6,7], Thitaporn Chaisilprungraung[1], Sirawaj Itthipuripat[1,8]

[1]Neuroscience Center for Research and Innovation, King Mongkut's University of Technology Thonburi, Bangkok, Thailand

[2]Institute of Field Robotics, King Mongkut's University of Technology Thonburi, Thailand [3]DEVCOM Army Research Laboratory, Humans in Complex Systems Division, MD, USA [4]Chula Neuroscience Center, King Chulalongkorn Memorial Hospital, Thai Red Cross Society, Bangkok, Thailand

[5]Cognitive Clinical and Computational Neuroscience, Department of Internal Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand

[6]Department of Cognitive Sciences, University of California, Irvine, CA, USA

[7]Department of Biomedical Engineering, University of California, Irvine, CA, USA

[8]Big Data Experience Center (BX), Department of Computer Engineering, King Mongkut's University of Technology Thonburi, Bangkok, Thailand

Abstract

EEG hyperscanning provides novel insights into inter-brain connectivity during social interactions by enabling the simultaneous recording of neural activity from multiple individuals. This research aims to develop and validate a new protocol in which dyads engage in a synchronized button-pressing task across both same-location and multi-location setups. Our findings reveal significantly higher interpersonal neural synchronization during the interaction period compared to the baseline. Notably, the increased neural synchronization is comparable across the same- and multi-location setups, spanning frontal, central, and posterior electrodes. Interestingly, the level of synchronization in the multi-location setup is greater than in the same-location setup over electrodes positioned above the right superior temporal gyrus (STG), a region associated with social cognition and the mirror neuron system (MNS). These findings validate our methodology for studies across different locations and open new avenues for research into inter-brain synchronization in remote environments. Our experimental protocol could enhance the design of experiments and applications involving social interaction, particularly in remote settings, which have gained popularity due to COVID-19. It also advances our understanding of the neural mechanisms that support social communication in the new normal era.

Keywords: Electroencephalogram (EEG), Multi-location Hyperscanning, Interpersonal Neural Synchronization, Remote Social Interaction
Correspondence: Thitaporn Chaisilprungraung (thitaporn.chaisilp@gmail.com) or Sirawaj Itthipuripat (itthipuripat.sirawaj@gmail.com)

B261: A Near-Infrared Hyperscan Study of the Effects of Mechanical Massage Combined with Mindfulness on functional brain connectivity and mental health

Yuqi Sun[1], Ke Hu[1], Shiqi Liao[1], Ke Jiang[2]

[1]Wenzhou Medical University, China,
[2]Wenzhou No.7 People's Hospital, China

Abstract

In modern society, physical and mental health has a significant interactive impact. Studies have shown that mind-body therapy is more effective than physical or psychological therapy alone. While both mechanical massage and mindfulness training separately have been shown to have positive effects on people, there have been no studies combining the two approaches to explore the effects of this mind-body therapy on functional brain connectivity and mental health. We recruited 240 college students and randomly assigned them to mindfully combined mechanical massage, mindfully only, massage-only, and resting groups, with 60 people in each

group, and randomly divided them into 30 groups. A mixed experimental design of 4 (subgroup: Mindfully combined mechanical massage group VS mindfully only group VS massage-only group VS resting group) ×2 (time: before intervention VS after intervention) was adopted. The mindfulness group combined with mechanical massage performed mindfulness meditation with audio while massaging, the mindfulness group performed mindfulness meditation with audio only, the massage group performed mechanical massage only, and the resting group sat on the massage chair with closed eyes and rest. The intervention duration was 20min. Functional Near Infrared Brain Imaging Superscanning (fNIRS) was used to measure the concentration changes of oxyhemoglobin (HbO) and oxyhemoglobin (HbR) in brain tissue to explore the positive effects of psychosomatic therapy combined with mechanical massage and mindfulness training on brain functional connectivity. Various psychological scales (such as positive and negative emotion scale, mindfulness scale, etc.) were used to measure the psychological changes before and after the intervention. The results showed that the functional connections between the prefrontal cortex and other relevant brain regions (such as parietal and temporal lobes) were significantly enhanced in the mindfulmination-combined mechanical massage group, mindfulmination-only group

and massage-only group after intervention, and the functional connections between the prefrontal cortex and other relevant brain regions (such as parietal and temporal lobes) in the mindfulmination-combined mechanical massage group after intervention were significantly stronger than those in the other 3 groups. It shows that mindfulness combined with mechanical massage is an effective mind-body therapy that can stimulate the functional connectivity of the individual brain. At the same time, the level of positive emotion and mindfulness in the group of mindfulness combined with mechanical massage after intervention was significantly higher than that in the other 3 groups. This finding provides strong evidence to explore the impact of mind-body therapy on cognitive function and brain plasticity, and highlights its potential to improve mental health.

Keywords: Mechanical Massage, Mindfulness Training, Body and Mind Therapy, Group Creativity, Functional Near Infrared Brain Imaging Superscanning (fNIRS)

Correspondence: Ke Jiang (jiangke200@126.com)

The Symposium on Computational and Informatics Frameworks for Studying Cognitive Functions and Neurodegeneration

Chairs: Narun Pat, University of Otago, New Zealand & Daniel Thayer, University of California, Santa Barbara, USA
Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Sittiprapa Isarangura, Mahidol University, Thailand

B255: Neural feature dimension maps within human visual cortex support attention and working memory

Daniel Thayer[1], Alison Li[1], Emily Machniak[1], Thomas Sprague[1]

[1]University of California, Santa Barbara, United States

Abstract

Due to the vast amounts of sensory input received at any moment, cognitive mechanisms are necessary to select only the most important inputs to successfully interact with the environment. Attention is one such mechanism that is critical for selecting important information. Many factors influence what inputs are considered important. One factor is salience, which is defined as local feature contrast of the retinal image. For example, a rapidly approaching car would be salient in a parking lot full of parked cars based on its motion, while a stationary red car among several gray cars would be salient based on its color. Another factor that determines importance is goal relevance—when looking for a strawberry, red objects have an increased chance of being attended. One prominent model of attention is the priority map framework (Wolfe, 1996; Serences & Yantis, 2007). According to this model, salience and goals determine what is important, but importance is initially computed within individual maps that index information across particular feature dimensions (e.g., motion or color). As such, if an object is salient because of motion, that would be reflected within the motion dimension map. Similarly, if looking for a colored item that would drive increased responses in the color dimension map. Once feature-specific information is computed, maps are integrated to generate a feature-agnostic 'priority map' of the visual field which indexes importance across all aspects of a scene.

Even though there is extensive neural support for a joint 'priority map' in parietal and/or frontal cortex (Bisley & Goldberg, 2006; Moore & Armstrong, 2003; Schall & Hanes, 1993), these studies primarily identified the existence of the priority map, which is only one aspect of this model. Recently, we have extended this work by identifying neural correlates of feature dimension maps (Thayer & Sprague, 2023). Across several studies, we evaluated fMRI responses from color-selective regions hV4/VO1/VO2 and motion-selective regions TO1/TO2 to investigate whether these areas could represent neural feature dimension maps. Across all studies, we presented colorful moving dot stimuli, where we could manipulate which feature dimension was salient or relevant.

In one series of experiments, we manipulated whether the color or motion of a stimulus was salient. Each region had a stronger response to the stimulus when the preferred feature dimension was salient and this response was modulated by how much their stimulus feature contrasted with the background. Thus, demonstrating that feature-selective regions of visual cortex are sensitive to manipulations of salience. For a region to be considered a neural feature dimension map, they must also have an enhanced stimulus representation when the preferred feature dimension is relevant to ongoing goals. A complementary study evaluated neural responses in feature-selective cortex when either the color or motion of an identical visual stimulus was goal-relevant. The response to the stimulus increased in color and motion regions when the color and motion of the stimulus was relevant, respectively. This further supports these regions as neural feature dimension maps.

Critically, both feature-specific salience and relevance need to interact to sculpt importance in a feature dimension map. We tested this in a study where participants performed a visual search task to find a target stimulus defined by a specific feature value, where one stimulus (target) was goal relevant and a different stimulus was image salient (singleton distractor). Both the relevant and salient stimulus were represented in neural feature dimensions maps. Furthermore, the response to the singleton distractor was modulated by which feature dimension was task relevant. This finding converges with specific models of visual search that rely on the cognitive construct of feature dimension maps (e.g., Müller et al., 1995; Liesefeld & Müller, 2019).

Lastly, priority and feature dimension maps may be recruited for other cognitive functions, such as working memory (Jerde et al., 2012; Zelinsky & Bisley, 2015). We conducted an experiment, where participants were tasked with remembering either the color or motion of a stimulus. During a brief delay period where no stimulus is presented, both color- and motion-selective regions represent feature information in a spatially global manner. This result extends the role of feature dimension maps, as it provides initial evidence that these regions may be recruited for working memory functions. Overall, this body of work directly tests a key assumption of cognitive models of priority map theory and establishes feature-selective visual cortex as neural feature dimension maps.

Keywords: Attention, Working Memory, Visual Cognition, fMRI, Computational Modeling
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B281: EEG-based reconstruction models for measuring attention deficits in Mild Cognitive Impairment

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Abstract

The cognitive domains that are mostly affected in patients with mild cognitive impairment (MCI) are visuospatial and executive functions. However, it remains unclear whether these deficits share common mechanisms such as impairment in selective attention, which processes relevant visual information and discards other distractors, or a general decline in sensory processing. Here, we compared neural processes that represent both sensory and selective information processing between elderly patients with MCI and age and sex-matched healthy controls (60-72 years old). Behavioral responses and EEG alpha (~8-12 Hz) oscillation were measured while the participants performed a modified attention-cueing Eriksen Flanker task and were asked to discriminate shapes of a cued target surrounded by distractors (i.e. flankers), and whether the target was congruent or incongruent with the distractors. Furthermore, to quantify the spatial precision and timing of attentional focus, inverted encoding models (IEMs) were employed to reconstruct the spatially selective representations of the attentional focus centered at the cue onset and the target locations based on their alpha-band activity in the EEG data.

When matched on task difficulty, MCI participants had slower average response times than the healthy controls; this was observed in both congruent and incongruent conditions. The amplitudes of the target-evoked event-related potentials (ERPs), particularly the P1 and P3 components, were reduced in these MCI compared to the healthy control group. Results showed that healthy controls exhibited more precise alpha-based spatial representations with a longer temporal window. On the other hand, the MCI patients had significantly broader spatial representations with a shorter-lived temporal window, indicating impaired sustained attention, compared to the healthy

aging group. Together, our findings provide neural evidence suggesting that declines in visuospatial and executive functions in MCI are associated with the selective attention deficiting, diminishing fidelity of selective sensory information processing. Our work highlights the potentials of exploring differentiated neural mechanisms underpinning attention deficits across MCI subtypes.

Keywords: Attention, EEG, Inverted Encoding Model, Alpha Oscillations, Computational Modeling, Aging, Mild Cognitive Impairment
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B251: Auditory construction of Music Cognition: An understanding of therapeutic implications in Parkinson's disease through Diffusion Tensor Imaging

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Abstract

Introduction:
Music Perception skill includes the ability to detect modulations in tonal (melody, pitch), qualitative (tuning, timbre, embedded rhythm), and temporal features (tempo, accent, rhythm). Less is understood about how these features contribute to music perception when people with or without musical training listen to audio clips. The neurological mechanisms involved in music perception have application in clinical interventions in motor disorders such as Parkinson's disease (PD). However, how the music perception quantitatively is structured through its features needs more investigation. Only then can we understand how the neuroplasticity developed through music helps in improving the planning and execution of motor movements in PD patients. We studied the construction of music perception through its acoustic features using PROMS-S (Profile of Music Perception Skills) introduced by Law & Zentner (2012) as a function of duration of training. We also examined the differences in the integrity of white matter tracts comparing musicians and non-musicians using diffusion tensor imaging (DTI) in fMRI (3 Tesla). Our objective is to identify training-specific and training-independent features and their associated neural correlates to provide insights on music therapy used in PD.

Methods:
Total 80 participants (36 musicians, 44 non-musicians, mean age: 28±5 years, 29 females) performed PROMS-S offline, including eight subtests of perceptual features of music, namely, melody, rhythm, embedded rhythm, tuning, tempo, accent, timbre, and pitch. In each subtest, a reference stimulus was presented, followed by repetition of its own and a comparison stimulus. The participants were required to compare the stimuli and report whether they were similar or different. We examined whether the features were normally distributed across the population using Shapiro-Wilk test. We

then compared the performance of musicians and non-musicians on all eight subtests using an independent sample t-test. We clustered musicians and non-musicians for each feature to understand variations in clustering. Since we observed multicollinearity across features, we performed Principal Component Analysis (PCA) to reduce dimensionality. As PC1 was significantly different across different durations of training, we performed a group-wise PCA to observe how duration of training modulates the construction of PC1. Factor Analysis was performed to investigate what features of music are unique to each group and identify the clinically relevant features of music. We also did Pearson's correlation analysis to investigate the association of Music Perception (PC1) with perceptual auditory features. For the neuroimaging data, we used Tract Based Spatial Statistics (TBSS) in FMRIB Software Library (FSL) to generate the contrast for white matter tracts comparing musicians and non-musicians. Then we performed another Pearson's correlation analysis to understand the association between fractional anisotropy of the white matter tracts and performance on auditory features obtained through PROMS.

Results:
The Shapiro-Wilk test showed scores on Rhythm, Tempo, Timbre, and Pitch subtests were not normally distributed across all participants. Through an independent sample t-test, we found that musicians performed better on all subtests compared to non-musicians. Effect sizes for melody, rhythm, embedded rhythm, tuning, tempo, accent, timbre, and pitch were 1, 0.40, 0.55, 1, 0.58, 0.44, 0.72, and 0.80, respectively, suggesting a strong training effect on melody, tuning, timbre, and pitch. The clusters of musicians and non-musicians were significantly different for pitch and melody, and showed the least variation for tempo. Because of multicollinearity among features, we performed a PCA and chose to work with PC1 as it accounts for maximum variation in data. PC1 was found to be significantly different across different durations of training ($p < 0.001$). For participants with no training, maximum loading for tempo was seen in PC1. With less than 5 years of training, melodic loading was 0.30 and rhythmic loading was 0.14. The highest loading was seen on timbre (0.68), and comparable loading was seen on tempo and accent (0.43). For musicians with more than 5 years of training, the highest loading was observed on pitch (0.49), 0.38 on timbre, and comparable loading on tempo and accent. Rhythmic dependence increases and melodic dependence reduces with musical training. Factor analysis showed that for non-musicians, tempo (0.476), tuning (0.544), and rhythm (0.496) emerge as the most unique features, whereas for musicians, unique features are melody (0.725), rhythm (0.722), pitch (0.500), and tuning (0.400), explaining the variance in data. The findings from factor analysis

support the information obtained through PCA. The Pearson's correlation analysis revealed that for musicians, the association between PC1 and melody is stronger, whereas for non-musicians, it was between PC1 and embedded rhythm. The association between tempo and embedded rhythm was higher for non-musicians (0.43) compared to musicians (0.27). For the neuroimaging data (through TBSS), we found that the genu, body, and splenium of the corpus callosum and internal capsule show higher white matter integrity for musicians compared to non-musicians. For musicians, the white matter integrity in genu and splenium of corpus callosum has a higher association with melody, rhythm, and pitch. The white matter integrity in these two parts is equivalent for musicians and non-musicians for temporal features. However, for non-musicians, the associations of white matter integrity with embedded rhythm and tempo are significantly higher in splenium compared to musicians.

Discussion:

We find a moderate to strong training effect on one's ability to distinguish feature-based qualities of music. Differences were observed in terms of uniqueness of certain features across musicians (melody, rhythm, pitch, and tuning) and non-musicians (tempo, tuning, and rhythm) through factor analysis. There is evidence to suggest that meter perception or rhythmic understanding develops differently for musicians compared to non-musicians. In the case of musicians, it is a top-down process, whereas for non-musicians, it follows bottom-up processing (Kondoh et al, 2021). For musicians, rhythmic understanding develops from the concept of melody, and hence both of the features may be equally unique; whereas for non-musicians, it develops from the concept of tempo, which justifies the features of tempo and rhythm to be unique in the case of non-musicians. If rhythm developed similarly in both musicians and non-musicians, then we wouldn't see this pattern as melody loses its uniqueness (0.005) for non-musicians and tempo (0.005) loses it for musicians; however, rhythm stays unique for both. We found pitch as a unique feature explaining 50% of the variance in data for musicians only. Musicians have an outstanding ability to discriminate differences in pitch (Nikjah et al., 2008; Spiegel & Watson, 1984). Previous studies suggest frequency selectivity is different very early in the auditory pathways between musicians and non-musicians (Powner et al., 2014). Tuning emerged as a unique feature for both musicians and non-musicians, suggesting that tuning accounts for information not represented by other features. Results based on PCA and correlation analysis showed a stronger association between PC1 and melody for musicians and PC1 and embedded rhythm for non-musicians. Melody refers to tonal sequence in music. Embedded rhythm (also known as melodic rhythm) refers to the musical concept whereby memorable rhythm

is composed first and then pitches are assigned to notes. The difference between "melodic rhythm" and melody is that "melodic rhythm" is recognizable even when its melody is removed (Harmony, 2016). Thus, while musicians due to training may rely on melody alone, non-musicians rely on temporal features such as rhythm, even when they have some grasp on melody. This is further reflected in the higher association between tempo and embedded rhythm for non-musicians. The neuroimaging study justifies through the white matter integrity that training has a significant effect on processing auditory features such as melody, rhythm, and pitch for musicians. The white matter integrity being equivalent to tempo for both groups backs up the universality of tempo as a feature and its clinical significance. The musicians are solely dependent on their genu of corpus callosum for processing certain auditory features, while non-musicians require additional support from splenium. This indicates a possibility of double dissociation for musicians and non-musicians between genu and splenium of corpus callosum.

Conclusion:
In this study, melody emerged as the most unique feature for musicians and tempo for non-musicians. Non-musicians primarily rely on temporal features even when they have some understanding of melodic deviations. Perception of tonal features and how they contribute to music perception is also affected by the duration of training, however, temporal features seem to have neurologically stronger representation and have a consistent contribution to music perception skills across all durations of training. Temporal features may be more resilient and have wider applications as therapeutic tools in PD. The difference in white matter integrity in genu and splenium of the corpus callosum for musicians and non-musicians, respectively, points to a double dissociation for music perception between these two groups.

Keywords: diffusion tensor imaging, factor analysis, music cognition, neuroimaging, principal component analysis
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B237: BRAINEX: A Systematic Framework for CNN Models Evaluation and XAI Methods Comparison in Brain Age Prediction

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Abstract

This study presents a systematic framework for evaluating convolutional neural networks (CNNs) in the context of brain age prediction, with a focus on interpretability through explainable AI (XAI) methods. Brain age prediction has advanced significantly using 2D and 3D CNNs, which provide high predictive accuracy. However, the complexity of these models creates challenges for clinical interpretation. Our framework not only assesses model performance but also provides deeper insights into various aspects of CNN models, including how the selected backgrounds can influence XAI values. By facilitating multisite data analysis, the framework helps identify the impact of site-specific characteristics on model behavior. The results underscore the importance of local explanations and highlight the need for careful interpretation when using population-level saliency maps.

Keywords: Brain age, Convolutional Neural Networks, eXplainable Artificial Intelligence, Interpretability
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B271: Neurodegenerative disorders detection and classification using Resnet-SVM

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Abstract

When modelling different types of brain data that vary in both space and time, relying on a single modality of data only offers a partial insight into the complex patterns of brain activity. Therefore, this study proposes the integration of multimodal spatiotemporal brain data (STBD) to enable a more comprehensive exploration of neuronal dynamics, drawing from various data collection methods. This approach leads to an enhanced accuracy for brain data modelling including classification and pattern recognition. The foundation of this method-ology is built upon a brain-inspired spiking neural network (SNN) architecture known as NeuCube. In this research, two distinct sets of brain data, Electroencephalogram (EEG) and functional Magnetic Resonance Imaging (fMRI), are employed to train and test the SNN models through a data integration strategy. Notably, this research achieved a significant 10% improvement in classification accuracy by employing an integrated EEG-fMRI SNN model when compared to single modalities such as EEG-SNN or fMRI-SNN. The utilization of spiking neural networks, such as NeuCube, provides a robust and biologically inspired framework for modelling integrated EEG-fMRI data. This approach allows us to unlock a deeper understanding of the brain's dynamics, leading to improved accuracy in our analyses and enhancing our capacity to uncover meaningful insights from these multimodal datasets.

Keywords: Multimodal, Spiking Neural Network (SNN), Spatio-temporal brain data (STBD), Electroencephalogram (EEG), functional Magnetic Resonance Imaging(fMRI)
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B266: From Alzheimer's Disease to Frontotemporal Dementia: Transfer Learning in EEG-based Diagnosis of Dementia

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Abstract

Transfer learning in the context of dementia research leverages transformer technology to generalize knowledge from Alzheimer's disease (AD) to frontotemporal dementia (FTD) using EEG data. This study explores the feasibility and effectiveness of transferring insights gained from AD versus healthy EEG patterns to classify FTD versus healthy EEG patterns. The transformer model's ability to capture complex temporal relationships in EEG signals is harnessed to adapt learned representations to a different type of dementia. Our experiments demo'strate promising results in cross-domain transfer, where the model trained on AD-related features achieves competitive performance in distinguishing FTD cases from healthy controls. Using only 10% of FTD sample, transfer learning from AD data yields a 17.16% error rate (F1 score: 86.32) and increasing this further to only 30% significantly reduces the error rate to 12.29% (F1 score: 90.07). This approach may not only enhance diagnostic accuracy but also provide insights into shared and distinct neurophysiological markers across dementia subtypes. The findings underscore the potential of transformer-based transfer learning to facilitate early detection and differential diagnosis of related neurodegenerative diseases using EEG data.

Keywords: Dementia, Transfer Learning, EEG-based Diagnosis, Neurodegenerative Diseases
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B228: Brain age has limited utility as a biomarker for capturing fluid cognition in older individuals

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Abstract

Fluid cognition usually declines as people grow older. For decades, neuroscientists have been on a quest to search for a biomarker that can help capture fluid cognition. One well-known candidate is Brain Age, or a predicted value based on machine-learning models built to predict chronological age from brain MRI data. Here we aim to formally evaluate the utility of Brain Age as a biomarker for capturing fluid cognition among older individuals. Using 504 aging participants (36-100 years old) from the Human Connectome Project in Aging, we created 26 age-prediction models for Brain Age based on different combinations of MRI modalities. We first tested how much Brain Age from these age-prediction models added to what we had already known from a person's chronological age in capturing fluid cognition. Based on the commonality analyses, we found a large degree of overlap between Brain Age and chronological age, so much so that, at best, Brain Age could uniquely add only around 1.6% in explaining variation in fluid cognition. Next, the age-prediction models that performed better at predicting chronological age did NOT necessarily create better Brain Age for capturing fluid cognition over and above chronological age. Instead, better-performing age-prediction models created Brain Age that overlapped larger with chronological age, up to around 29% out of 32%, in explaining fluid cognition, thus not improving the models' utility to capture cognitive abilities. Lastly, we tested how much Brain Age missed the variation in the brain MRI that could explain fluid cognition. To capture this variation in the brain MRI that explained fluid cognition, we computed Brain Cognition, or a predicted value based on prediction models built to directly predict fluid cognition (as opposed to chronological age) from brain MRI data. We found that Brain Cognition captured up to an additional 11% of the total variation in fluid cognition that was missing from the model with only Brain Age and chronological age, leading to around a 1/3-time improvement of the total variation explained. Accordingly, we demonstrated the limited utility of Brain Age as a biomarker for fluid cognition and made some suggestions to ensure the utility of Brain Age in explaining fluid cognition and other

phenotypes of interest. Note that this abstract has been published as a full paper elsewhere: https://doi.org/10.7554/eLife.87297.4 .

Keywords: brain age, fluid cognition, multimodal MRI, machine learning, biomarker
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B238: Biophysical Modeling of Alzheimer's Disease Progression

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Abstract

Introduction
Alzheimer's disease (AD) affects 55 million individuals worldwide, projected to double in the next two decades. The pathological hallmark of AD is the accumulation of tau protein neurofibrillary tangles, which co-locate with cortical atrophy and predict domain-specific cognitive impairments. Modeling and predicting this spatiotemporal progression in individual patients is crucial for developing therapeutic treatments that target tau accumulation, but current approaches provide limited insight into individuals' disease course and their variations. The Braak staging system which describes a stereotyped pattern of tau spread in AD effectively characterizes population-level spread. However, the advent of in vivo positron emission tomography with tau radiotracers (tau-PET) has revealed individual variability that can deviate from Braak stages (Braak, 2006). Event based modeling is a statistical approach to staging subjects on a common disease axis based on cross-sectional biomarker data, thereby enabling insight into longitudinal biomarker progression. However, EBM lacks a window into the underlying biophysical mechanisms behind biomarker progression. The biophysical Network Diffusion Model (NDM), previously used by us and others, captures the spatiotemporal dynamics of tau spread as a diffusive process mediated by the brain's anatomic network (Ge, 2020; Raj, 2012; Sepulveda, 2015). NDM, however, is unable to interpolate longitudinal spread from cross-sectional data nor assess the time since disease onset, effectively the progression stage, for each subject.
Our novel approach combines event-based and network diffusion modeling to address these limitations and leverage the strengths of each technique to create predictive individualized models of tau spread. By integrating statistical pattern recognition with mechanistic modeling, we aim to better understand both the common pathways and individual variations in tau progression, hopefully enabling more personalized therapeutic approaches in AD treatment.
Methods

The study utilized data from 650 subjects in the Alzheimer's Disease Neuroimaging Initiative (ADNI3) database, comprised of 64 Alzheimer's patients (AD), 196 mild cognitive impairment (MCI), and 390 healthy controls (CN) (adni.loni.usc.edu). The brain was parcellated into 86 regions using the Desikan-Killiany atlas (Desikan, 2006). Tau-PET (AV1451) images underwent normalization by cerebellar uptake, and averaged within each region to create regional tau vectors. Structural connectivity networks using the same parcellation were constructed using dMRI data from 418 healthy brains in the MGH-USC Human Connectome Project (Gorgolewski, 201; Jenkinson, 2002).

An event based model (EBM) based on the Z-score Subtype and Stage Inference algorithm (SuStaIn) was employed to stage all 650 subjects based on five biomarkers inputs: hippocampal volume, ADAS11 cognitive score, and entorhinal, hippocampal, and amygdala tau density. Z-score SuStaIn probabilistically stages subjects by identifying the chronological order of 'events,' defined as the progression of a biomarker over predetermined z-score thresholds (Aksman, 2021; Young, 2018). Stages are defined as the midpoint between events. Z-score thresholds for each biomarker were optimized through 10^6 MCMC sampling iterations with combinations selected based on maximum likelihood. Each biomarker had three z-score thresholds, yielding 16 distinct stages. All inputs were z-scored and age-regressed. Regional tau trajectories across stages were achieved via interpolation weighted by subjects' stage assignment probability distributions.

The extended Network Diffusion Model (eNDM) describes pathological protein spread through the brain's structural connectivity network via a system of differential equations with two key parameters: beta (global diffusion rate) and alpha (global rate of tau production). Model fitting proceeded in two stages. First, the parameters and seed vector were iteratively optimized to fit the longitudinal tau trajectories derived from EBM. The cost function included mean squared error (MSE) and correlation coefficients (R). Second, individual-level optimization was performed using two approaches: common seed with individual parameters and individual seeds with common parameters. Multiple optimization methods were employed to ensure global minimum detection, including basin hopping, differential evolution, Powell, and L-BFGS-B algorithms.

Results

EBM successfully staged all 650 subjects across 16 distinct stages, demonstrating clear separation between diagnostic categories. The cohort-level eNDM optimization achieved remarkable accuracy in fitting EBM's longitudinal tau trajectories after multiple iterations between seed vector and parameter optimization (R = 0.92). Individually optimized seeds with common parameters provided a significantly better fit to individual subjects' tau-PET data (mean MSE = 0.018, mean R = 0.849, AIC = 9,032) than using individually optimized parameters and a common seed (mean MSE =0.699, mean R= 0.149, AIC= 123,535). Entorhinal and temporal cortices were among the regions with the highest average tau seed. When compared against binary seed regions identified in previous studies as tau 'epicenters,' the individually optimized seeds outperformed with paired t-tests between R correlations of at least 116 (p=1 10^(-159) (Vogel, 2021). We validated the eNDM's predictive capability using longitudinal data from 297 subjects with follow-up tau-PET scans spanning up to 4 years. eNDM was strongly correlated to longitudinal data at corresponding EBM stages across subjects (mean R = 0.81).

The coefficient of variation (CoV) of tau density across regions generally decreases with time for both individually optimized eNDM and subjects' empirical tau-PET. In other words, tau in both biophysical models and statistically staged empirical data seems to converge across regions as AD progresses. Additionally, the distribution of pairwise R correlations of tau distributions across all subjects is much lower for optimized seeds than for empirical data, indicating that more heterogeneity exists among subjects at the origin of pathology than later in its progression.

Finally, we applied two techniques to explore the patterns underlying the inter-subject variance of optimized seeds: singular value decomposition (SVD) of the covariance matrix of seeds to uncover the primary patterns of regional variance and a k-means clustering analysis (k=3). SVD of the seed covariance matrix and k-means clustering independently identified two distinct archetypes of tau seeding: an entorhinal-dominant pattern (typical AD) and a diffuse pattern.

Discussion

We present a new method for predicting longitudinal tau from cross-sectional data for any AD subject: staging each subject with EBM and optimizing the seed pattern of a network diffusion model to fit empirical tau-PET at their assigned stage. The integration of event-based and biophysical modeling represents a significant advancement over prior uses of each in isolation. Each technique presents limitations – EBMs lack

mechanistic insight, while biophysical models struggle with temporal scaling and individual variation – both of which our combined approach successfully addresses.
The superior performance of individual seed optimization over parameter optimization and the phenomenon of convergence of regional tau over time, in both model predictions and empirical data, suggests that tau spread heterogeneity primarily originates from initial seeding patterns rather than variations in spread dynamics. This finding has significant implications for therapeutic approaches, suggesting that early intervention strategies need to be tailored to different seeding patterns rather than focusing on modifying spread mechanisms uniformly across patients. The identification of two distinct seeding archetypes - entorhinal-dominant and diffuse - also provides new insight into AD heterogeneity. While the entorhinal-dominant pattern aligns with a traditional understanding of AD progression, the presence of a significant subgroup with diffuse seeding suggests alternative pathological pathways that merit further investigation.

Our contribution to prior event-based modeling of neurodegenerative diseases is the ability of eNDM to impart biophysical relevance and the individualized nature of our analysis. Vogel et. al (2021) similarly combines event based and network diffusion models, but performs a cohort-level analysis by subtyping subjects with SuStaIn and identifying tau seed ‘epicenters’ for each subtype (Vogel, 2021). eNDM's improved fit to empirical tau-PET with individual seeds over that of Vogel et al.’s binary tau 'epicenters' indicates that heterogeneity of tau spread patterns exist within and not just between AD subtypes and enables a more fine-grained analyses.
eNDM’s ability to forecast individual tau spread patterns could enhance patient stratification for clinical trials and guide the development of personalized treatment strategies for any neurodegenerative disease characterized by protein spread. Our method enables a number of further analyses, including exploration of inter-region and subject variance and seed archetypes, opening a new world of insights into spatiotemporal tau spread.

References

Aksman, L. M.et al. pysustain: A python implementation of the subtype and stage inference algorithm. SoftwareX 16, 100811, DOI: 10.1016/j.softx.2021.100811 (2021).
Desikan, R. S. et al. An automated labeling system for subdividing the human cerebral cortex on mri scans into gyral based regions of interest. Neuroimage 31, 968–80, DOI: 10.1016/j.neuroimage.2006.01.021 (2006).
Ge, S. X. et al. ShinyGO: Gene-set enrichment tool.
Bioinformatics 36, 2628–2629 (2019).
Raj, A., Kuceyeski, A. & Weiner, M. A network diffusion model of disease progression in dementia.Neuron 73, 1204–15 (2012)
Sepulveda-Diaz, J. E. et al. HS3ST2 expression in Alzheimer's disease tau pathology. Brain 138, 16 (2015).
Vogel, J. W. et al. Four distinct trajectories of tau deposition identified in Alzheimer's disease. Nat. Medicine 27, 871–881, DOI: 10.1038/s41591-021-01309-6 (2021).
Young, A. L. et al. Uncovering the heterogeneity and temporal complexity of neurodegenerative diseases with subtype and stage inference. Nat. Commune .9 , 4273, DOI: 10.1038/s41467-018-05892-0 (2018).

Keywords: Alzheimer's, Biophysical modeling, Machine learning, Neurodegeneration
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B227: Higher-order Adaptive Dynamical System Modeling for the Role of Environmental Neurotoxic Pesticide Paraquat on the Epigenetics of Neurodegeneration in N27 Dopaminergic Cells

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Abstract

In this study, we developed a fifth-order adaptive self-modelling network model to describe the association of paraquat in epigenetic pathways potentially leading to dopaminergic neuronal loss, one of the most important hallmarks of Parkinson's disease (PD). This model is based on the structure and relevant biological processes in the animal and human brains.

Keywords: neurodegeneration, Parkinson's diseae, epigenetics, higher-order adaptive network model
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B229: Explainable GRU with Hybrid Attention and Memory-Augmented Network (xGRAM) for Cell Types Classification in Alzheimer's Disease Using Single-Nucleus Transcriptomics

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Abstract

Alzheimer's Disease (AD) is characterized by complex cellu- lar changes in the brain, also known as the most common form of demen- tia in late ages. Understanding these changes at the cellular level, particularly in the middle temporal gyrus (MTG), is crucial for developing tar- geted therapeutic strategies. In this study, we developed an Explainable GRU model enhanced with hybrid attention and memory-augmented network (xGRAM) model to classify the cell types in MTG associated with AD. We employed single-nucleus RNA sequencing (snRNA-seq) data from the Seattle Alzheimer's Disease Brain Cell Atlas (SEA-AD) to profile the gene expression of 49,043 single-nucleus transcriptomes from human MTG samples. The experiment revealed distinct gene expression patterns across the 24 (subclasses) cell types in MTG, highlighting their unique roles in AD pathology. The proposed xGRAM model achieved a high prediction accuracy of 98.76%, effectively identifying major cell types like L2/3 IT, L5 IT, L4 IT, Sst, Vip, Pvalb, and others. This study provides a comprehensive understanding of different cell types in MTG which are linked to neuroinflammation and synaptic dysfunction in AD. The findings suggest potential targets for therapeutic intervention, emphasizing the importance of cellular heterogeneity in AD research.

Keywords: Alzheimer's Disease · Explainable GRU · Hybrid Attention · Memory-Augmented Networks · Single-Nucleus Transcriptomics · Cell- Type Classification.
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B241: Identification and Evaluation of Multimodal Connectomics in Early Alzheimer's Dementia

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Abstract

Alzheimer's disease is a common neurodegenerative disease with a long disease course and is one of the main causes of dementia. To investigate the longitudinal disorder of multimodal brain networks in the process of cognitive decline and construct a connectome-based identification model for questionable dementia, we construct functional and structural connectivity of brain networks by using magnetic resonance imaging (MRI) data from the OASIS database. The discovery group of longitudinal database includes 113 healthy aging individuals, 65 healthy subjects at the time of scanning but diagnosed as questionable dementia during follow-up, and 39 subjects with questionable dementia at the time of scanning. The results showed that the default mode network of the potential dementia group had structural and functional abnormalities as early as the cognitive normal stage. Furthermore, a logistic regression model was further constructed using the connectomics features of 455 subjects in identification group to construct an objective mapping between the imaging biomarkers and the clinical dementia scale. The average classification accuracy was about 85%. The above findings may indicate the potential changes of the central nervous system in the early stage of dementia, and serve as an auxiliary and reference for clinicians in the early diagnosis of dementia.

Keywords: Alzheimer's dementia, multimodal magnetic resonance imaging, connectomics, clinical dementia rating scale, early assessment of dementia.
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The Symposium on Cognitive and Computational Approaches to Advancing Mental Health Research

Chairs: Mufti Mahmud, King Fahd University of Petroleum and Minerals, Saudi Arabia & Narun Pat, University of Otago, New Zealand
Local Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand

B265: A dopaminergic basis of behavioral control

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Abstract

Behavior is controlled by deliberate and automatic processes, often conceptualized as "model-free" and "model- (or rule-) based decision making, respectively. These two systems can conflict, such as when the desire to purchase a pint of ice cream in the supermarket conflicts with one's goal to consume less sugar. The process of determining which system governs behavior, or deciding how to decide, is termed behavioral control. Inappropriate behavioral control has a significant societal impact, from responding to phone notifications while driving to making poor retirement savings decisions. However, the neural mechanisms underlying behavioral control remain unclear. Critically, it is unknown if there are mechanisms for behavioral control that are distinct from those supporting the formation of goal-relevant knowledge. We performed deep phenotyping of individual dopamine system function by combining multiple PET scans, fMRI, and dopaminergic drug administration in a within-subject, double-blind, placebo-controlled design. Subjects performed a rule-based response time task, with goal-directed and automatic decision-making operationalized as model-based and model-free influences on behavior. We found a double dissociation between two aspects

of ventral striatal dopamine physiology: D2/3 receptor availability and dopamine synthesis capacity. Convergent and causal evidence indicated that D2/3 receptors regulate behavioral control by enhancing model-based and blunting model-free influences on behavior but do not affect model-based knowledge formation. In contrast, dopamine synthesis capacity was linked to the formation of model-based knowledge but not behavioral control. D2/3 receptors also modulated frontostriatal functional connectivity, suggesting they regulate behavioral control by gating prefrontal inputs to the striatum. These results identify central mechanisms underlying individual and state differences in behavioral control and point to striatal D2/3 receptors as targets for interventions to improve goal-directed behavior.

Keywords: dopamine, behavioral control, reinforcement learning, decision-making
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B272: The Role of Executive Functions in Emotional Coregulation: Insights from an Adaptive Network Model

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Abstract

Although the role of executive functions in individual emo- tion regulation is well documented, their influence on emotional coregula- tion—where emotions are dynamically regulated across people—remains unexplored. This study investigates the role of attention and executive functioning in emotional coregulation during dyadic interactions, using simulations of pairings with varying executive function (EF) levels: high- high, low-high, and low-low. The effects of executive functions on coregu- lation were assessed through emotional arousal and synchrony. High-high EF pairs showed strong coregulation early on, but resource depletion led to a breakdown under sustained emotional demands. In the low-high pairing, the high EF agent had a stabilizing effect on the interaction de- spite the low EF agent's emotional instability. In the low-low pairings, both agents failed to downregulate emotions but remained synchronized at high emotional arousal, illustrating that synchrony might not guarantee effective regulation. These findings emphasize the importance of attention in emotional regulation and suggest further empirical research is needed, particularly in populations with executive functioning differences.

Keywords: Emotional coregulation, executive functioning, adaptive network model.
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B206: Multiscale Temporal-convolution and Attention improved Neural Network for biased mental state recognition

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Abstract

Accurate detection of mental state is vital for sleep assess- ment and anesthesia monitoring. However, challenges exist, including 1) limited data sources caused by few modalities, few channels, biased sam- ple distribution, or large individual differences; 2) multiscale dynamic feature of mental state signals, containing complex and dynamic fluctuations. In this paper, we proposed a multiscale temporal convolution and attention improved neural network (MTA-NN) to handle these two challenges, including: a preprocessing method using a clustering-first and label-generation approach for data augmentation involves filtering the production samples to mitigate the impact of noise on model performance; multiscale temporal-convolution module for detecting different scales of temporal and frequency features; an attention module for de- coding key features in different spatial and temporal channels, and for setting the importance of historical dependencies; a full-connection layer is designed to recognize different sleep stage. The proposed MTA-NN is then verified in three typical sleep-state recognition tasks, including SleepEDF-20, SleepEDF-78, and ISRUC3. Compared to some state-of- the-art algorithms, the proposed MTA-NN achieves higher performance. Further ablation experiments show the necessary and importance of these designed sub modules in MTA-NN. We consider the same algorithm can also be extended to further similar mental state recognition tasks such as anesthesia monitoring.

Keywords: Data augmentation, Multiscale convolution, Multiscale attention, Neural network, mental state recognition.
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B235: Predicting trait alexithymia using graph neural networks

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Abstract

Background: People with alexithymia may misinterpret their emotional arousal as a symptom of physical illness and seek treatment for their physical symptoms [1]. Previous studies have reported that chronic alexithymia is consistently associated with depression and multiple symptoms of psychological disorders. Identification of alexithymia via a brain structural network would be helpful for the prevention and diagnosis of patients with mental disorders.

Methods: In the current study, 77 right-handed adults without any history of psychiatric or neurological disorders were recruited and underwent high-resolution T1-weight structural MRI using a 3T Siemens MR scanner [2]. The Chinese version of Toronto Alexithymia Scale (TAS), a four-factor structure theoretically congruent with the alexithymia construct, was assessed to evaluate trait alexithymia. Freesurfer (v6.0.0) was used to automatically segment and reconstruct the cortical surface of structural MRI and parcellated the cortical surface of each hemisphere into 74 regions of interest using the Destrieux Atlax. The cortical thickness (CT), surface area (SA), gray matter volume (Vol), mean curvature (MC), and sulcal depth (SD) were used to estimate the cortical similarity networks of individual subjects using Morphometric INverse Divergence (MIND) [3], yielding a 148x148 matrix for each participant. The BrainGNN, a recently proposed graph neural network (GNN) model [4] was implemented to predict the TAS scores. For model evaluation, 30% of subjects were used for testing purposes, and the remaining 70% were used for training, a 5-fold cross-validation was conducted to evaluate the training performance using mean absolute error (MAE). The Pearson correlation between the predicted score and the TAS score was also estimated for model testing.

Results: BrainGNN with seven communities, which is consistent with the functional brain networks, achieved an MAE 8.33 ± 0.7 with a correlation value of 0.366 ± 0.07. Furthermore, transfer learning was further performed to boost the model performance. Specifically, a model that predicts the spectrum quotient (AQ) score, one of the tools for quantifying the level of trait autism, was pre-trained to acquire the related knowledge. Using the knowledge acquired AQ pertain model, and then continuing training on TAS could enhance the correlation to the best of 0.489 In terms of interpretability, the model selected the anterior cingulate cortex and left amygdala, which were regions of interest for alexithymia, as signification nodes for the results.

Conclusion: This study validated that the GNN models, utilizing the spatial information of the brain structural network, achieved the best performance compared to classical machine learning models. With its robustness in understanding the brain and discovering the related biomarkers for the diseases, the GNN models would be a helpful tool for identifying the alexithymia and ultimately facilitating the prevention of mental disorders.

References

[1] R. M. Bagby, G. J. Taylor, and J. D. Parker, “The nomological domain of the alexithymia construct,” The (Non) Expression of Emotions in Health and Disease, Tilburg University, Tilburg, Netherlands, 1997.
[2] W. Li et al., “Gyrus rectus asymmetry predicts trait alexithymia, cognitive empathy, and social function in neurotypical adults,” Cerebral Cortex, vol. 33, no. 5, pp. 1941–1954, 2022.
[3] I. Sebenius et al., “Robust estimation of cortical similarity networks from Brain Mri,” Nature Neuroscience, vol. 26, no. 8, pp. 1461–1471, 2023.
[4] X. Li et al., “BrainGNN: Interpretable brain graph neural network for fMRI analysis,” Medical Image Analysis, vol. 74, p. 102233, 2021.

Keywords: Graph Neural Network, Alexithymia, Morphometric INverse Divergence
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B233: Advancing Mental Health Problems with Machine Learning and Genetic Algorithms for Anxiety Classification in Bangladeshi University Students

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Abstract

Mental health challenges, particularly anxiety, are a growing concern among university students in Bangladesh, impacting both their well-being and academic performance. This study aims to address this growing issue by developing a robust machine learning model tai- lored to classify anxiety levels among students. We employed eight well-known machine learning algorithms, with particular emphasis on a cus- tomized Genetic Algorithm (GA) optimized Logistic Regression (LR) model. The models were rigorously trained and evaluated using 5-fold cross-validation on a newly obtained mental health dataset that had never been investigated with such advanced approaches. This dataset contains information on 1,977 students from 15 of Bangladesh's leading universities and was thoroughly examined by five academics with 10 to 20 years of experience in academia and research. Our findings indicate that classic models, such as the Random Forest Classifier and Support Vector Classifier, attained accuracies of 92.68% and 96.72%, respectively. However, our proposed GA-based LR model succeeded them all, not only in accuracy but also in precision, recall, and F1-score, with an impressive 99.49% accuracy. The study also identified key anxiety-inducing factors, such as academic pressure and worry about academic affairs, providing valuable insights for targeted mental health interventions. These find- ings indicate the effectiveness of our customized GA-based ML model in enhancing mental health evaluations by identifying the fundamental causes of anxiety, providing vital insights to help Bangladeshi university students maintain their mental health.

Keywords: Mental Health Problems, Genetic Algorithm (GA), Machine Learning (ML), Bangladeshi University Students, Anxiety Classification.
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B252: Empirical insights into the value of a novel compositional data approach for analyzing bipolar Likert scale data

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Abstract

Traditional analyses of psychometric data typically focus on the means or sums of individual item responses. In contrast, our new compositional data approach allows us to analyze psychometric data in a novel way, providing more concise results and fresh perspectives. The data we examined were originally published by Murphy et al. (2021) and pertain to personality traits, conspiracy beliefs, and the willingness to receive a COVID-19 vaccination in the United Kingdom and Ireland. Compared to traditional statistical methods, the compositional data approach reveals additional significant findings that enhance our under- standing of human behavior and attitudes in the context of the COVID- 19 pandemic. We emphasize that interpreting bipolar psychometric scale data through a compositional lens improves subsequent statistical anal- yses and yields more insightful results than conventional methods. The results affect data science approaches in health psychology, behavioral psychology and social psychology, e.g., regression and correlation based machine learning.

Keywords: bipolar Likert scale, isometric log-ratio transformation, t-test, compositional data.
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B211: Neurocomputational Modelling of EEG Connectivity: Links Between Depression, Inflammation, and Gut Microbiome

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Abstract

The immune and enteric systems have been implicated in psychopathology, including depressive disorders. However, the precise neurocognitive mechanisms remain unclear. The present study uses Brain-Inspired Spiking Neural Network (SNN) technique to model electroencephalographic (EEG) data as a function of gut-microbiota, inflammation, and depressive symptoms. Forty-two participants (nonclinical cohort) were assessed for Bacteroides-Prevotella (BAC) colonization in faecal samples, Interleukin 6 (IL-6) in peripheral blood, depressive symptoms (self-report of cognitive and non-cognitive symptoms) and brain function (resting state EEG). SNN models were applied to EEG data to generate connection weight values across scalp regions. Connection weights were visualized as a function of 1) depression; 2) inflammation; 3) gut microbiome. Lower depression and higher BAC were associated with higher frontal

connection weights (cognitive depression = bilateral, non-cognitive and BAC=left hemisphere only). Lower cognitive depression and lower IL-6 were associated with higher posterior connection weights. The SNN models achieved higher accuracy for theta and alpha EEG sub-bands, highlighting their relevance in differentiating between groups. These findings emphasize the potential of SNNs in predicting parameters from brain functional connectivity data and developing targeted diagnostic and intervention strategies.

Keywords: Depression, Inflammation, Gut-microbiome, EEG, gut-brain axis, Spiking Neural Network
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B202: Design of an Iterative Method for Integrating Multi-Omic Data and Clinical Insights in Brain Disease Research

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Abstract

The burgeoning domain of brain disease research is increasingly recognizing the limitations of traditional genomic analysis methods, particularly in addressing the complex interplay of diverse data types inherent in the multi-omics landscape. Traditional approaches often fall short in integrating these varied data streams, resulting in a fragmented understanding of brain diseases. This fragmentation significantly impedes the development of effective diagnostic and therapeutic strategies, highlighting the urgent need for a more holistic and integrative methodology. This research introduces Design of Iterative Methods in Brain Disease Research (DIMBDR) to transcend these limitations by synergistically combining Canonical Correlation Analysis (CCA) with advanced computational techniques, including Recurrent Neural Networks (RNNs) with attention mechanisms, SHapley Additive exPlanations (SHAP) for interpretable machine learning, and transfer learning from pre-trained Convolutional Neural Networks (CNNs). CCA is employed for its prowess in integrating multi-omic data, facilitating a comprehensive view of the molecular landscape of brain diseases. RNNs, enhanced by attention mechanisms, excel in identifying subtle genomic patterns, while SHAP values offer transparency in feature importance and transfer learning leverages pre-existing models for refined disease prediction. The integration of these computational methods with clinical data offers a novel, multi-dimensional perspective on brain diseases. The proposed model was capable of achieving a superior accuracy rate of 94.2%, a higher precision of 93.6%, recall of 92.8% and F1 score of 93.2%. Its innovative approach not only enhances our understanding of complex brain diseases but also holds substantial promise for improving patient outcomes through more effective and personalized treatment strategies.

Keywords: Multiomic integration, Brain disease analysis, Canonical correlation analysis, Deep learning methods
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B257: Hippocampal Transcriptomic Signature in Schizophrenia: An Index for Dysregulated Inflammatory Immune response

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Abstract

Background:
Characteristic hippocampal changes significantly contribute to the pathology of schizophrenia, according to recent findings.

Objective of the study:
We constructed a tissue-specific transcriptomic signature based on human RNA-sequencing datasets to explore the molecular networks, disease mechanisms, and pathway dynamics.

Materials and Methods:
We analyzed two Gene Expression Omnibus (GEO) datasets, GSE138082 and GSE42546 (total 56 schizophrenia patients and 68 controls). The GEO RNA-seq Experiments Interactive Navigator (GREIN) was used for uniform data processing and identifying the differentially expressed as well as detectable genes (Power>0.80, False Discovery Rate<0.01) for each dataset. Both the gene signatures (cutoff |log (Fold Change)|≥0.585, $p<0.05$) were used to reveal the common top significant genes, which were further analyzed for protein-protein interaction, gene ontology, and pathway and network analysis.

Results:
24 common significant genes were observed. Functional enrichment (STRING and ToppGene Suite) detected significant Molecular Function—peptide antigen binding, adrenomedullin (ADM) receptor binding; Biological Process—adaptive immune response, regulation of immune response, amylin receptor signaling pathway; Cellular Component—endocytic vesicle membrane, Major Histocompatibility Complex (MHC) class Ib protein complex, Gamma-delta T cell receptor complex; and KEGG pathways—systemic lupus erythematosus (SLE), spliceosome, Th1 and Th2 cell

differentiation, Th17 cell differentiation, antigen processing and presentation, and natural killer cell mediated cytotoxicity. The ADM gene has previously been implicated as a biomarker in schizophrenia. High-Mobility Group-Box 1 (HMGB1) is known to cause neurocognitive impairment, partly contributing to the nonresponse to antipsychotics. SLE and autoimmune features exist in chronic hospitalized schizophrenia patients. Among the top targeting miRNAs were previously reported potential circulating biomarkers in psychiatric ailments.

Conclusion:
The current study identified candidate genes involved in hippocampal regulatory pathways, which may contribute to schizophrenia pathogenesis.

Keywords: Hippocampal signature, Immune response, Inflammatory response, Schizophrenia, Transcriptomics
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B245: Comparison of haloperidol- versus phenazepam- induced anxiolytic effect on rodent behavior

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Abstract

Abstract. This study investigated the effects of phenazepam and haloperidol, recognized as a tranquilizer and an antipsychotic, respectively, on anxiety using the open field test. We employed conventional behavioral assessments alongside color-tracing and color-coding methodologies to examine the comparative influences of two chosen drugs. Both compounds induced a reduction in locomotor activity, though with nuanced differences. Phenazepam’s suppressive effect manifested later, countered by increased traverses along the periphery, while haloperidol’s impact was evident earlier, accompanied by localized movements. Analysis of movement initiation revealed distinct patterns between the groups, suggesting phenazepam’s influence on cortical processes and haloperidol’s Impact on anxiety-related behavior. Despite reduced central exploration, interpretation of anxiety levels necessitates consideration of drug effects and environmental context. Our findings underscore the complexity of assessing anxiety solely based on motor activity, emphasizing the importance of incorporating

emotional dimensions in clinical evaluations. This nuanced understanding is vital for optimizing therapeutic interventions in psychiatric care.

Keywords: Open Field Test, Phenazepam, Haloperidol, Behavior, Color-Coding, Color-Tracing
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B210: Sleep Apnea detection from single-lead ECG signal using hybrid deep CNN

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Abstract

Sleep apnea (SA)is a prevalent disorder that disrupts breathing during sleep, posing risks to multiple organs and potentially causing sudden death. The electrocardiogram (ECG) is vital for diagnosing SA due to its ability to identify irregular heart activity. This study intro- duces hybrid CNN models designed to automatically detect SA using a single-lead ECG signal. We validated our method through experiments with the Physionet Apnea-ECG dataset, which contains 70 single-lead ECG recordings annotated by medical professionals. Our results surpass the current state-of-the-art methods in accurately detecting SA from single-lead ECG signals, achieving an accuracy of 91.4% for per-segment classification and 100% for per-recording classification.

Keywords: Sleep Apnea, Deep CNN, Detection, Electrocardiogram
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B223: The Dynamics of Epigenetic Influence in Insomnia: A Higher-Order Adaptive Modeling Perspective

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Abstract

Insomnia disorder (ID) is a prevalent stress-related sleep disorder involving burdening symptoms related to emotional disturbances. This paper introduces a higher-order adaptive dynamical system model to explore the potential role of epigenetic mechanisms in the development and persistence of ID. The model examines how epigenetic modifications, particularly in genes related to mechanisms of the sleep-wake regulation and stress response systems, may potentially contribute to the pathology of ID. Results of simulations of the model are reported in this study to underscore the complexity of ID as a dynamic and (mal-)adaptive system of emotion regulation and sleep-wake-regulation processes.

Keywords: Insomnia, epigenetics, higher-order, adaptive network
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B208: Topological and Graph Theoretical Analysis of Dynamic Functional Connectivity for Autism Spectrum Disorder

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Abstract

Autism Spectrum Disorder (ASD) is a prevalent neurological disorder. However, the multifaceted symptoms and large individual differences among ASD patients are hindering the diagnosis process, which largely relies on subject descriptions and lacks quantitative biomarkers. To remediate such problems, this paper explores the use of graph theory and topological data analysis (TDA) to study brain activity in ASD patients and normal controls. We employ the Mapper algorithm in TDA and the distance correlation graphical model (DCGM) in graph theory to create brain state networks, then innovatively adopt complex network metrics in Graph signal processing (GSP) and physical quantities to analyze brain activities over time. Our findings reveal statistical differences in network characteristics between ASD and control groups. Compared to normal subjects, brain state networks of ASD patients tend to have decreased modularity, higher von Neumann entropy, increased Betti-0 numbers, and decreased Betti-1 numbers. These findings attest to the biological traits of ASD, suggesting less organized and more variable brain dynamics. These findings offer potential biomarkers for ASD diagnosis and deepen our understanding of its neural correlations.

Keywords: Autism, Dynamic functional connectivity, Graph signal processing, Topological data analysis, fMRI
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The Symposium on Cognitive and Computational Foundations of Visual Cognition

Chair: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand
Local Chair: Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

B267: Unveiling the Role of Memory in Shaping Visual Perception: Empirical Insights

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Abstract

Memory plays a pivotal role in human cognition, allowing individuals to encode, store, and retrieve information about past experiences. In the context of human vision, memory holds particular significance, influencing how visual stimuli are perceived and interpreted. This integration of memory with visual processing enables individuals to recognize objects, navigate their environment, and make sense of complex scenes. Despite its importance, there is a gap in the literature regarding the specific role of memory in connecting various visual phenomena. Our study addresses this gap by empirically investigating the role of memory in multiple visual experiences commonly observed in daily life. We focus on three visual phenomena: blind spot filling-in, brightness-related visual illusions, and amodal completion. Through our investigation, we aim to uncover the mechanisms by which memory influences visual perception. We observed that updating prior beliefs with new information, achieved through memorization of predefined stimuli, can lead to changes in experienced outcomes previously imperceptible. By elucidating the relationship between memory and visual perception, our study contributes to a deeper understanding of human cognition.

Keywords: Visual perception, Blind spot filling-in, Brightness-related visual illusions, Amodal completion, Memory, Prior belief.
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B263: Effect of temporal correlation on motion direction flips in bistable stimuli

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Abstract

Bistable stimuli provoke spontaneous alternation of two stimulus interpretations whereas the stimulus information remains constant. These stimuli provide either insufficient information or ambiguous information. The last case is typical for dynamic bistable images. However, the sequential frames in these stimuli are temporally correlated. In the present study, we aim to characterize the perception of a bistable stimulus that lacks temporal correlation between successive frames. We used a sequence of spiral Glass patterns that induce a rotary motion in an ambiguous direction. The study results show that this stimulus has the typical characteristics observed for bistable stimuli. However, its perceptual characteristics differ from those of a rotating spiral Glass pattern with simulated direction flips. The specific feature of the bistable stimuli used in the study may provide new opportunities for studying the interaction of the brain areas involved in shape and motion perception and their participation in perceptual awareness.

Keywords: Bistable stimuli, Motion flips, Glass patterns.
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B258: The Impact of Disfluent Fonts on Natural Paragraph Reading: An Eye-Tracking Study

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Abstract

Fonts play a crucial role in shaping the reading experience by influencing both readability and cognitive load. Fluent fonts are generally easier to read due to their clear and familiar design, while disfluent fonts disrupt the reading flow with irregular strokes, decorative features, and inconsistent spacing. Prior research has suggested that disfluent fonts may introduce "desirable difficulties," slowing reading but potentially enhancing comprehension and retention through increased cognitive effort. However, the extent to which disfluent fonts actually promote learning and recall, particularly in more natural reading contexts, remains contested. Most existing studies have focused on isolated words, short sentences, and page or multi-page length texts, leaving the effects of font disfluency during paragraph-level reading largely unexplored. This study investigates the impact of font disfluency on reading comprehension and immediate recall in an ecologically valid, paragraph-level reading task. Ten English-speaking participants (aged 18-25) silently read college-level English passages presented in three fonts with varying styles and fluency levels: Brush Script MT (disfluent, handwritten), TH SarabunPSK (fluent, sans-serif), and Angsana New (fluent, serif). Eye movements were recorded using a high-resolution eye-tracking system, and participants answered comprehension questions immediately after each passage. Results indicated that Brush Script MT, the most disfluent font, significantly increased reading time and was rated as the most difficult to read. However, no statistically significant effects of font style were found on comprehension accuracy or the time spent answering comprehension questions. Eye-tracking analysis at the word level revealed that Brush Script MT elicited the longest fixation durations and displayed a more leftward preferred viewing location (PVL) compared to Angsana New and TH SarabunPSK, suggesting that

disfluent fonts disrupt visual processing at the word level. Despite this visual disruption, paragraph-level reading comprehension remained unaffected by font disfluency. Together, the findings suggest that while disfluent fonts can increase cognitive load and perceived difficulty, they may not enhance or impair comprehension in natural reading contexts. These results advance the understanding of how font disfluency affects reading processes in more realistic settings, as well as offer novel insights into the impact of widely-used but under-researched Thai fonts on reading behaviour.

Keywords: Font disfluency, Reading comprehension, Eye-tracking, Paragraph-level reading, Preferred viewing location (PVL)
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B268: Replication of the Hermann Grid Illusion By U-Net Deep Learning Architecture Performing Deblurring: A Low-level Visual Task

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Abstract

Memory plays a pivotal role in human cognition, allowing individuals to encode, store, and retrieve information about past experiences. In the context of human vision, memory holds particular significance, influencing how visual stimuli are perceived and interpreted. This integration of memory with visual processing enables individuals to recognize objects, navigate their environment, and make sense of complex scenes. Despite its importance, there is a gap in the literature regarding the specific role of memory in connecting various visual phenomena. Our study addresses this gap by empirically investigating the role of memory in multiple visual experiences commonly observed in daily life. We focus on three visual phenomena: blind spot filling-in, brightness-related visual illusions, and amodal completion. Through our investigation, we aim to uncover the mechanisms by which memory influences visual perception. We observed that updating prior beliefs with new information, achieved through memorization of predefined stimuli, can lead to changes in experienced outcomes previously imperceptible. By elucidating the relationship between memory and visual perception, our study contributes to a deeper understanding of human cognition.

Keywords: Visual perception, Blind spot filling-in, Brightness-related visual illusions, Amodal completion, Memory, Prior belief.

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B242: When Sexy Avatars Get Weird: How Brain Asymmetry and Oculomotor Dynamics Navigate the Uncanny

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Abstract

This study explores the psychological effects of human-machine interaction, particularly focusing on the phenomenon of the uncanny valley within the context of virtual reality (VR). This study specifically investigates the relationship between oculomotor dynamics, EEG asymmetry, and perceived uncanniness in an immersive setting with a realistic human avatar that can generate uncanny feelings. Participants engaged in a VR scenario designed to optimize their sexual interest. Eye-tracking and EEG data were collected during these interactions to assess the predictors of uncanniness. The final regression model identified significant predictors, including EEG asymmetry in frontal and parietal regions and nonlinear indices of gaze behavior. The findings suggest that the more a participants' attention was attracted towards specific cues, the higher the uncanniness. The interplay between EEG asymmetries and gaze behavior furthermore indicates that these physiological and behavioral responses are closely linked to the perception of uncanniness, offering insights into how humans interact with increasingly lifelike technologies. These insights contribute to a better understanding of HMIs potential, and may inform the development of more engaging and psychologically attuned virtual content.

Keywords: Uncanny, Virtual Reality, Immersive, Regression Analysis, Embodied Computing.
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The Symposium on Brain Big Data Analytics, Curation, and Management

Chairs: Liya Ding, University of Chicago, USA & Carlos Enrique Gutierrez, Okinawa Institute of Science and Technology, Japan
Local Chairs: Itthi Chatnuntawech, National Center of Nanotechnology & Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

B274: SmartStitcher: A Terabyte-level 3D Microscopic Image Stitching Tool Based on Mixed-Max-Resolution

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Abstract

Advancements in light microscopy have enabled neuroscience labs to employ fast, high-resolution imaging for whole-brain studies, generating vast amounts of raw data that require efficient stitching and reconstruction. Existing software struggles with handling terabyte-scale data, leading to memory and computational bottlenecks. To address these challenges, we present SmartStitcher-an intelligent tool designed to stitch ultra-large-scale (terabyte-level) microscopic data using the Mixed-Max-Resolution (MMR) approach. SmartStitcher optimizes the workflow by selectively retaining image tiles with neuronal information, reducing memory usage and computational load. It supports output in the TeraFly format and allows seamless transitions between different resolutions, enabling users to view whole-brain imaging at low resolution and zoom in on neuronal structures at high resolution. Encapsulated in a user-friendly graphical interface and available via command-line, SmartStitcher efficiently stitches large datasets within limited time and memory resources. The software is open-source and available on GitHub (https://github.com/polya1998/SmartStitcher.git).

Keywords: ultra-large-scale data, brain microscopy, 3D image stitching, intelligent selection
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B215: Deep Learning Methods to Evaluate the Quality of Skull-Stripped Brain MRI Images

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Abstract

Scientific integrity initiatives and funding requirements have motivated open access sharing of neuroimaging datasets that often includes T1-weighted images. These images have voxels that represent the face, which in some cases can be used to identify participants. Skull-stripping tools are often used to remove image voxels representing skull and facial features to comply with human subject privacy regulations. To ensure that no facial features are present in the skull-stripped images and that no voxels representing brain tissue are unintentionally removed during skull-stripping, time consuming and cumbersome visual inspection of the skull-stripped images is necessary to evaluate risk for re-identification and data quality. Here, we describe an automated program that accurately identifies recognizable facial features in the skull-stripped images and detects loss of image voxels representing brain tissue to support inspection of data quality when sharing neuroimaging data. Specifically, a multi-kernel 3D Convolutional Neural Network (CNN) model with an inception module demonstrated a 95.49% accuracy in identifying recognizable facial features and a 97.63% accuracy in detecting the loss of brain tissue voxels. The training dataset and trained models are available online at https://dyslexia.computing.clemson.edu.

Keywords: MRI images, data sharing, skull-stripping, 3D CNNs
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B256: Feature Reduction and Machine Learning Analysis of Resting-State fMRI for Biomarker Identification in Post-Traumatic Epilepsy

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Abstract

Introduction
Traumatic brain injury (TBI) affects 64 to 74 million people worldwide each year. The long-term consequences of TBI include cognitive dysfunction and depression, with 2-50% of patients developing post-traumatic epilepsy (PTE). PTE accounts for about 20% of all symptomatic epilepsies, posing substantial challenges in both medical and surgical treatment. Approximately one-third of PTE patients become medically intractable and continue to experience seizures despite being on multiple antiseizure medications.

There is currently a lack of reliable biomarkers for PTE. Although the severity of TBI, measured by tools such as the Glasgow Coma Scale (GCS), is a known risk factor, it is not a reliable biomarker for the development of PTE. Imaging techniques using MRI have highlighted potential biomarkers, including intraparenchymal, subdural, or epidural hemorrhage, dural penetration, blood-brain barrier permeability, hippocampal deformation, and reduced fractional anisotropy. Despite these significant efforts to identify biomarkers of epileptogenesis, the study of functional connectivity (FC) alterations has not been thoroughly explored, highlighting a critical gap in understanding how changes in neural networks contribute to seizure susceptibility following TBI. As epilepsy is increasingly understood as a disease affecting the brain network, we focus our studies on such alterations by changes in FC estimated from resting-state fMRI (rs-fMRI).

The main challenge is to find a ubiquitous set of FCs that truly identifies PTE amid large subject-to-subject variations, and amongst the thousands of FCs that characterize the entire brain network. In this work, we surveyed various FC ranking strategies for selecting the critical FC subset, drawing on the Random Forest (RF), a robust machine-

learning classifier, to evaluate how well the selected FC subsets differentiate between PTE subjects and seizure-free TBI subjects and healthy controls.

Methods

A total of 66 subjects were enrolled across three groups: Healthy Control (n=26), seizure-free TBI (n=22), and PTE (n=18). During the visitation session for each subject, BOLD rs-fMRI scans were obtained. Rs-fMRI were preprocessed as described by Di et al. (2023) with minor adaptations. For each subject, BOLD signals were averaged within regions of interests (ROIs) defined based on the Schaefer 100 ROI atlas. Following bandpass-filtering (0.01 to 0.1 Hz), Pearson's correlation coefficient between the 100 ROIs was computed and the elements in the upper triangular part of the correlation matrix were vectorized, representing 4950 ((100×99)/2) FC values for each subject. Correlation coefficients were transformed using the Fisher Z transform to ensure normality. For analysis, Healthy Control and TBI subjects were grouped into a non-epilepsy cohort (n=48) and compared against the PTE (Epilepsy) cohort (n=18).

We employed various FC ranking strategies to perform feature reduction, i.e. to identify the subset of FCs with the highest RF classification power. These are Gini importance, recursive feature elimination with cross-validation (RFECV), and seed-based analysis t-testing (SBA-t). Each system ranks FCs from 1 to 4950, from the most contributory to the least. We systematically computed the RF classifier performance by using only the top j-rank FCs (j = 2475, 1238, 619, 310, 155, 100, 90, 80, 70, 60, 50, 40, 30, 20, and 10 FCs) from each ranking system as the RF feature set. RFs for non-epilepsy vs epilepsy subject classification were tested 100 times with 4-fold cross-validation. The mean AUC and accuracy across each round of 400 (4x100) cross-validation runs were used to assess the classification performance of each FC subset.

Gini importance ranking was obtained from an RF classifier round trained on the complete set of 4950 FCs. RFECV is a feature selection method that recursively removes the least important features. RFECV was obtained by applying RFECV with linear support vector machines (SVM) on the complete set of 4950 FCs. SBA-t ranking was obtained from the incidence of statistical significance ($p < 0.05$) over 500 rounds of bootstrapped Student t-tests between non-epilepsy vs epilepsy subjects were applied on each FC. Lastly, our final FC ranking strategy sought to integrate insights from all three of the above strategies by taking the average numerical rank for each FC. Using the combined ranks, we re-applied RF computations to find the top n-rank FCs with the highest classification performance.

Results

Our results demonstrate that feature reduction of FCs for RF classification between non-epilepsy and epilepsy subjects is essential. When trained on all 4950 FCs, RF achieved only an AUC of 0.55 ± 0.15 and an accuracy of 0.71 ± 0.04. Substantially higher performance was achieved when a reduced set of FCs was employed instead. The highest performing RF round from Gini importance ranking was AUC 0.91 ± 0.09 and accuracy 0.84 ± 0.08 using the top 70 FCs.

Higher classification performance was achieved using alternate ranking strategies. The highest performing RF round from RFECV ranking was AUC 0.92 ± 0.09 and accuracy 0.84 ± 0.09 using the top 70 FCs. For SBA-t ranking, the highest performing RF round achieved an of AUC 0.89 ± 0.10 and accuracy of 0.85 ± 0.08 using the top 40 FCs. With combined ranks, the highest-performing model was similar to RFECV, achieving an AUC of 0.91 ± 0.09 and an accuracy of 0.84 ± 0.07 using the top 80 FCs. With all ranking strategies, performance dropped when the number of FCs was further reduced. Overall, the highest RF classification performance was achieved using 40 to 70 FCs, representing 0.8 to 1.4% of the total brain network.

We examined the location of FCs with respect to the seven commonly known resting state networks (RSNs). Irrespective of the FC ranking strategy, the FCs of the highest-performing RFs identify a widespread network alteration in PTE subjects, spanning all RSNs. From the top 100 features from the combined rank, the ROIs from the 100 FCs were distributed across the default mode (48), visual (44), somato-motor (40), frontoparietal (26), dorsal-attention (19), ventral-attention (14) and limbic (6) networks. When standardized by the size of each network, the frontoparietal and visual networks exhibited the greatest magnitude of disruption. Furthermore, we observed that of these 100 connections, 44 were cross-hemispheric connections, 38 were within right hemisphere (RH) regions, and 18 were confined to the left hemisphere (LH). A chi-squared test revealed that this was a significant ($p < .001$) difference in hemispheric connections than expected by chance. Lastly, in observing the actual FC values of each cohort, 60% of connections decreased in correlation while 40% increased. In the LH-LH connections, 12 correlations increased in strength and 6 decreased (33% of connections decreased). This contrasted with the results of the RH-RH connections, where 10 increased and 28 decreased (74%), and the cross-hemispheric connections, where 18 increased and 26 decreased (59%).

Conclusion

This work highlights the potential of rs-fMRI FC as biomarkers for PTE. Using a machine-learning approach, our study identified that a 1% fraction of rs-fMRI FCs characterizes the disrupted brain network in PTE subjects with up to 85% accuracy. The disruption was quite widespread, but preferentially affects the visual and fronto-parietal networks and their cross-network connections. While our different feature reduction strategies displayed similar performance at the same reduced feature sets, we proposed that combined ranks can offer more robustness against subject-to-subject variations, as it displayed the smallest drop-off from peak and highest F1 performance across subsets. Lastly, a majority of implicated correlations were cross-hemispheric and contained to the RH, but the connections in the LH were more abnormal in that most of them increased in strength while a majority of them decreased after PTE in the prior two categories.

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Keywords: Post-Traumatic Epilepsy (PTE), Functional Connectivity (FC), Biomarkers, Machine Learning, Feature Reduction
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B214: Gossamer: Scaling Image Processing and Reconstruction to Whole Brains

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Abstract

Neuronal reconstruction–a process that transforms image volumes into 3D geometries and skeletons of cells–bottlenecks the study of brain function, connectomics and pathology. Domain scientists need exact and complete segmentations to study subtle topological differences. Existing methods are disk-bound, dense-access, coupled, single-threaded, algorithmically unscalable and require manual cropping of small windows and proofreading of skeletons due to low topological accuracy. Designing a data-intensive parallel solution suited to a neurons' shape, topology and far-ranging connectivity is particularly challenging due to I/O and load-balance, yet by abstracting these vision tasks into strategically ordered specializations of search, we progressively lower memory by 4 orders of magnitude. This enables 1 mouse brain to be fully processed in-memory on a single server, at 67× the scale with 870× less memory while having 78% higher automated yield than APP2, the previous state of the art in performant reconstruction.

Keywords: reconstruction, computer vision, data-oriented, lightsheet microscopy, neuroscience
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B221: A Computational Model for Estimating NMDA Properties from Local Field Potential Spectra

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Abstract

The balance between excitatory (E) and inhibitory (I) neu- ral activity is crucial for brain function and is often disrupted in brain disorders. Recent model studies suggest that the slope of the frequency spectra of aggregate measures of neural activity, such as local field po- tentials (LFPs) or electroencephalograms (EEGs), can be used to predict the E/I ratio. However, these existing models overlook NMDA re- ceptors, which are critical for cognitive functions like working memory and are implicated in disorders such as schizophrenia and Alzheimer's. Here we use neural network simulations to show that the presence and strength of NMDA receptors have a major influence on the spectral slope of aggregate neural activity, particularly for lower frequencies, suggesting that spectral slopes of aggregate neural activity can be used to estimate NMDA receptor strength. We also find that estimates are better when using slopes computed from persistent activity after stimulus offset, a time when NMDA receptors affect most network dynamics. The results suggest that the spectral slope of aggregate measures of neural activity such as LFPs or EEGs may be used as a biomarker of NMDA function or dysfunction.

Keywords: NMDA Receptors, Neural Network Models, Biomarker
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B207: Multimodal Physiological Signal Analysis using Attention-Based Feature and Model Fusion

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Abstract

Disease analysis using multimodal physiological signals is currently a hot research area. Aiming at the problem that current multimodal feature fusion approaches neglect the correlation between different modalities, this paper proposes a hybrid multimodal fusion model based on the attention mechanism, which selects two modalities, EEG and speech signals, for feature fusion. In the feature extraction stage of EEG signals, the correlation between features is ana-lyzed using Spearman's rank correlation coefficient to achieve dimensionality reduction of EEG features. In the feature-level modal fusion stage, this paper applies the attention mechanism to automatically learn the contribution of different features and the complementarity between different modalities. In the model fusion layer, this paper adopts a multi-layer long and short-term memory network (multi-layer LSTM, ML-LSTM), which makes full use of the complementarity between the features of EEG signals and audio signals. Finally, the outputs of feature-level fusion and model-level fusion are weighted and combined to obtain the final prediction results. The accuracy of the proposed multimodal fusion model reached 88.54% on the MODMA dataset.

Keywords: Electroencephalographic features, Neural networks, Multimodal fusion, Attention mechanism.
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B277: Towards an AI-Powered Platform for the Digital Brain in Brain/MINDS 2.0

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Abstract

Japan has entered the second phase of its national brain initiative, Brain/MINDS 2.0, building on a decade of research. A key objective of this phase is to create a "Digital Brain" and establish an integrated research infrastructure. This initiative aims to investigate neuropsychiatric disorders at cellular and molecular levels, explore higher cognitive functions, and identify potential therapeutic targets. The Digital Brain project seeks to combine anatomical, physiological, and behavioral data into a mathematical model that replicates brain dynamics and functions.

Previously, a framework was proposed for data integration and the automated generation of simulation code to construct digital brain models (Gutierrez et al., Front. Neuroinform., 2022). However, since model parameters are often derived from scientific publications, their extraction requires frequent updates as new research becomes available, which is time- and resource-intensive. Large language models (LLMs) offer a foundational technology for processing vast information through pre-trained weights. Yet, their potential remains largely untapped in research. By refining LLMs with scientific literature and interacting with them in natural language, we can better identify model specifications and infer unknown parameters.

We present preliminary results on incorporating LLMs into a data-to-model framework to aid in parameter identification, support data-model alignment through ontologies, and extract knowledge from research papers into knowledge graphs.

Our exploration includes combining knowledge graphs with retrieval-augmented generation (RAG) to address issues such as hallucination. Unlike traditional RAG approaches that rely on isolated text fragments, our approach uses data associations to provide richer contextual information to LLMs, enhancing the reliability of parameter

extraction. We will demonstrate an initial version of our knowledge graph, centered on brain modeling entities, concepts and relations, as well as data retrieval using graph traversal, text-to-graph querying, and vector similarity.

Finally, we explore how "reasoning" capabilities can assist in identifying parameters from retrieved data and how our approach may integrate with existing frameworks.

Keywords: brain modeling large scale simulation LLM parameterization
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B232: EEG Biomarkers based on Microstates and RQA

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Abstract

Although many sophisticated methods for the analysis of electroencephalography (EEG) recordings have been developed, they are rarely used in clinical practice. To create robust EEG biomarkers that provide insight into the character of brain processes and distinguish mental disorders, we analyze neurodynamics using Recurrence Quantification Analysis (RQA) and simplify complex, non-stationary spatiotemporal oscillatory patterns using microstates. Transition patterns between microstates reflect brain dynamics. Average transition probability matrices be-tween microstates may be used as reference prototypes for the classification of mental disorders. RQA enhances the feature space that microstate analysis pro-vides, allowing for better interpretation of the results. We have tested this approach on adolescent schizophrenia data, comparing results based on microstate transitions with results based on features derived from RQA.

Keywords: EEG, microstates, recurrence analysis, schizophrenia diagnostics
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B219: Topological Inference for Seizure Lateralization

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Abstract

Topological inference based on heat kernel estimation, persistent homology, and permutation testing has shown promise in tackling various modeling challenges associated with electroencephalography (EEG) from individuals with brain network disorders. In this paper, we propose a new heat kernel estimation/smoothing method of EEG signals through Chebyshev polynomials and a fast topological permutation test to compare persistent features of two groups of smoothed signals extracted through persistent homology. We also investigate the potential of the topological inference framework in a seizure lateralization problem.

Keywords: Heat Kernel, Persistent Homology, Permutation Test
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B226: A Visualization and Computation Platform for the 3D Stereotaxic Mouse Brain Atlas with Single-cell Resolution

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Abstract

Being the basic infrastructure for locating and integrating neuroinformation, the brain atlas has long been serving as an important tool in neuroscientific research. In recent years, the progress in multi-omics and single-neuron circuit mapping enhanced our knowledge on the comprehensive understanding of the whole brain, which raised an urgent need for a stereotaxic brain template of the model animals, such as the mouse, with 3D spatial localization capability at the single-cell level. With the MOST imaging technique, we developed a 3D mouse brain template, based on a Nissl-stained cytoarchitecture image dataset with isotropic one-micron resolution. To facilitate the usage of this brain template, we built a web platform that integrated a variety of functions that met the miscellaneous needs of neuroscientific researches. This platform not only enabled the visualization of the 3D whole brain image dataset, the atlas levels on canonical planes, and the reconstructed 3D 176orphology of over 900 brain structures, but also provided computational tools, including registering the neuronal morphology data onto our atlas and visualizing them, the inter-atlas mapping between our atlas and existing mouse brain atlas for data integration, and the brain slice registration tools that mapped the user generated slice images to our atlas and visualized it instantly in the 3D space. An in-situ knowledge base that provided the anatomical knowledge was also available. We believed that this web platform could help to co-localize and integrate the neural data from different sources at the whole brain scale, and is promising to become a widely used infrastructure in the neuroscience field.

Keywords: mouse brain atlas, single-cell resolution, data integration, atlas mapping
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B230: Evaluating Feature Importance in the Context of Simulation-Based Inference for Cortical Circuit Parameter Estimation

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Abstract

Extracellular electrophysiology recordings capturing the activity of neuronal populations, e.g., Local Field Potentials (LFPs), have offered important insights into cortical dynamics. Yet there is still a lack of clarity about how features and characteristics of these extracellular potentials relate to the properties and function of the underlying neural populations. Mechanistic models combined with simulation-based inference (SBI) algorithms have emerged as an effective strategy for developing predictive tools that fit well with available empirical data and can be used to predict key parameters that describe neural activity. Numerous SBI techniques rely on summary statistics or interpretable features to approximate the likelihood or posterior. However, at present, a significant challenge is assessing how each feature impacts the SBI model's predictions. Here, we developed an approach to determine feature importance in the context of cortical circuit parameter inference. We first created a dataset that includes a million distinct simulations from a spiking cortical microcircuit model of recurrently connected excitatory and inhibitory populations. Biophysics-based causal filters were coupled with spikes to generate realistic LFP data. We then extracted a set of meaningful features from simulated LFP data that were used to train an SBI algorithm. To evaluate feature importance, we employed SHAP values, a prominent tool in machine learning for interpreting the contribution of each feature to

the prediction outcomes. Our findings demonstrate the effectiveness of our approach in pinpointing the most critical features for inferring parameters of a recurrent cortical circuit model based on electrophysiological data.

Keywords: Spiking Neural Network Model, Simulation Based Inference (SBI), Feature Importance, SHAP, Local Field Potential (LFP)
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The Symposium on Brain-Computer Intelligence and Brain-Inspired Computing

Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand
Local Chair: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand

B234: Evaluating the Potential of Low-Cost BCI Devices for Online Classification of Four-Class Motor Imagery States

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Abstract

Brain-Computer Interface (BCI) systems enable direct communication between the human brain and external devices by utilizing neural signals to control machines or computers. Among the various BCI paradigms, motor imagery (MI) BCI has garnered significant attention due to its potential in real-world applications, such as assistive technologies and smart home control. However, most existing studies on consumer-grade real-time MI-BCI systems have been limited to two-class discrimination tasks (e.g., left vs. right hand movement), which constrains their applicability to more complex, real-world scenarios. In this pilot study, we explore the feasibility of a real-time MI-BCI system capable of distinguishing among four MI classes (left hand, right hand, feet, and idle) using a dry-electrode, 8-channel EEG device (g.tec Unicorn Hybrid Black). A hybrid CNN-LSTM deep learning model was employed for classification analysis. Our results revealed a modest above-chance classification performance of 40.9% for the offline session and 35.9% for the online session, with significant variability across subjects. Further analysis indicated that the strength and clarity of Event-Related Desynchronization (ERD) patterns associated with motor imagery were critical factors influencing performance. These findings suggest that while the proposed

system shows significant promise, addressing the challenges of consistent and reliable performance, especially among new users, is essential for its real-world application.

Keywords: Brain Computer Interface, Motor Imagery, Deep Learning, Low-Cost BCI
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B209: Artificial Intelligence and Cognitive Neuroscience: An Integrative Review of Literature

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Abstract

Research Objective:
The objective of this research is to systematically explore and map the research on the intersection of cognitive neuroscience and artificial intelligence through keyword co-occurrence analysis, and identify key research trends from highly cited articles to understand their contributions to the advancement of knowledge and future research directions in the field.

Methodology:
A systematic literature review was conducted employing a comprehensive search strategy in the PubMed database. The search targeted titles and abstracts using keywords like "artificial intelligence," "machine learning," "deep learning," and "neural network" combined with "cognitive neuroscience," yielding a final sample of 205 studies. Highly influential studies were identified based on citation metrics, resulting in 39 articles shortlisted for detailed analysis. Data extraction involved capturing research questions and findings into an Excel spreadsheet, followed by a synthesis to identify themes and trends. Keyword co-occurrence using VOSviewer software revealed five major thematic clusters within the literature.

Results:
The analysis from 1992 to 2024 shows significant growth in publications, especially in the last decade. Early years (1992-2004) had sparse publications (1-3 annually). From 2008 to 2016, there was a gradual increase, peaking at 6 in 2016. A sharp rise began in 2017, peaking at 35 in 2022. Despite a dip in 2023, numbers remained high. With 19 publications in early 2024, the final count may exceed previous years. This indicates rapid expansion and heightened interest in AI and cognitive neuroscience. Using

VosViewer, the following five thematic clusters were identified: Cluster 1: "Cognitive AI Integration" This cluster focuses on integrating AI with cognitive neuroscience to model human cognition, learning, and behavior using algorithms, neural networks, and simulations. Key areas include understanding mental processes, emotions, the prefrontal cortex, and neural pathways, with developmental aspects involving infants and children. The approach combines psychology, computational biology, and behavioral neuroscience to advance AI and cognitive science.

Cluster 2: "Demographic Dynamics in Cognitive Neuroscience" This cluster examines the cognitive and demographic factors in AI and cognitive neuroscience, emphasizing age-related cognitive differences, attention, and executive function. It studies the cerebral cortex, connectome, and brain connectivity, incorporating both genders and using neuropsychological tests to measure cognitive abilities. Temporal aspects of cognitive processing like reaction time and thinking are also explored.

Cluster 3: "Visual Perception and Memory Mapping" This cluster integrates AI and cognitive neuroscience to study visual perception and memory using brain mapping and deep learning. Techniques like fMRI and MRI, along with computer-assisted image processing, are used to analyze the visual cortex. The focus is on pattern recognition, semantics, photic stimulation, and their roles in visual perception and short-term memory.

Cluster 4: "Neural Networks and Brain Function" This cluster explores the use of artificial neural networks in cognitive neuroscience to study brain function and neural activity. Techniques like EEG and electroencephalography help examine brain-computer interfaces and cognitive processes such as language comprehension. Emphasis is placed on reproducibility and reliable advancements in AI and neuroscience.

Cluster 5: "Machine Learning in Neuroimaging and Stroke Research" This cluster applies machine learning to cognitive neuroscience via neuroimaging, focusing on predicting neurological outcomes using support vector machines and voxel-based lesion-symptom mapping. Emphasizing stroke research, it aims to enhance understanding of brain structure and function, improving predictive models for better clinical outcomes.

To assess the impact of AI and cognitive neuroscience research, an analysis of highly cited studies was conducted using Google Scholar citation data. A brief summary of highly cited studies published since 2000 is give below:
Nastase et al. (2020) advocated for naturalistic paradigms in cognitive neuroscience, emphasizing ecological validity. Mutlu (2020) examined differences in user interactions between virtual and physical embodiments, highlighting distinct mindsets shaped by mechanisms like situativity and agency. McClelland et al. (2020) investigated language's role in intelligence, finding parallels between AI language processing and human neural principles. Köbis et al. (2021) revealed challenges in detecting deepfakes, noting trust issues even with awareness and incentives. Palazzo et al. (2021) showed how brain activity informs computer vision tasks. Cross and Ramsey (2021) emphasized interdisciplinary collaboration in human-machine interaction research. Prince et al. (2022) enhanced fMRI data reliability with the GLMsingle toolbox. Blum and Blum (2022) proposed the Conscious Turing Machine model for consciousness. Momennejad (2022) linked brain networks with collective cognition. Allen et al. (2022) described the Natural Scenes Dataset for vision and memory research. Santamaría-Vázquez et al. (2023) proposed MEDUSA© for neurotechnology research. De Martino and Cortese (2023) discussed neural abstractions in adaptable decision-making. These studies reflect significant advancements in cognitive neuroscience and AI, spanning naturalistic paradigms, human-machine interaction, data reliability, consciousness modeling, and decision-making.

Future Research Questions based on clusters

- How do neural networks model cognitive processes relate to emotions and learning?
- What roles do the prefrontal cortex and neural pathways play in infant and child cognitive development?
- How do developmental differences affect cognitive function and executive processes?
- What impacts do gender differences have on cognitive abilities and connectivity?
- How does deep learning enhance understanding of visual perception and memory?
- How does photic stimulation influence short-term memory and recognition?
- How do EEG-based brain-computer interfaces aid language comprehension?
- Why is reproducibility crucial in neural network studies?
- How do machine learning techniques improve stroke outcome predictions?
- What are the implications of voxel-based lesion-symptom mapping?

Future Research Questions based on findings of highly cited articles:

1. How can machine learning improve fMRI data accuracy and ethical application in reading mental states?
2. What mechanisms enable nonverbal behavior and social cognition in virtual agents and robots?
3. How can the Cognitive Atlas enhance neuroimaging data annotation and brain-function understanding?
4. How can predictive models better decode and reconstruct natural stimuli from brain activity?
5. How do attention and value in decision-making vary with different goal-framing, and what are the neural mechanisms?
6. What role does the Default Mode Network (DMN) play in processing complex concepts, and how does it relate to other brain regions?
7. How can neuroimaging and neurostimulation advances improve understanding of causal relationships in cognition and social interaction?
8. What are the implications of using large normative datasets for understanding brain function and recovery post-stroke?
9. How can ecological validity in cognitive neuroscience be increased to improve real-world generalizability?
10. What are the benefits and limitations of integrating AI with neuroscience to model human perceptual and cognitive processes?

Conclusion

This study reviews research at the intersection of artificial intelligence (AI) and cognitive neuroscience. VOSviewer analysis revealed five thematic clusters: Cognitive AI Integration, Demographic Dynamics in Cognitive Neuroscience, Visual Perception and Memory Mapping, Neural Networks and Brain Function, and Machine Learning in Neuroimaging and Stroke Research. Citation analysis highlighted influential journals like "Nature Neuroscience" and "Trends in Cognitive Sciences." Despite limitations, such as reliance on PubMed and English-only articles, the study reveals trends and areas for future exploration. Future research should include more databases, non-English articles, and varied impact assessment methods.

References

Allen, E. J., St-Yves, G., Wu, Y., Breedlove, J. L., Prince, J. S., Dowdle, L. T., ... & Kay, K. (2022). A massive 7T fMRI dataset to bridge cognitive neuroscience and artificial intelligence. Nature neuroscience, 25(1), 116-126.

Blum, L., & Blum, M. (2022). A theory of consciousness from a theoretical computer science perspective: Insights from the Conscious Turing Machine. Proceedings of the National Academy of Sciences, 119(21), e2115934119.

Cross, E. S., & Ramsey, R. (2021). Mind meets machine: Towards a cognitive science of human–machine interactions. Trends in cognitive sciences, 25(3), 200-212.

De Martino, B., & Cortese, A. (2023). Goals, usefulness and abstraction in value-based choice. Trends in Cognitive Sciences, 27(1), 65-80.

Köbis, N. C., Doležalová, B., & Soraperra, I. (2021). Fooled twice: People cannot detect deepfakes but think they can. Iscience, 24(11).

McClelland, J. L., Hill, F., Rudolph, M., Baldridge, J., & Schütze, H. (2020). Placing language in an integrated understanding system: Next steps toward human-level performance in neural language models. Proceedings of the National Academy of Sciences, 117(42), 25966-25974.

Momennejad, I. (2022). Collective minds: social network topology shapes collective cognition. Philosophical Transactions of the Royal Society B, 377(1843), 20200315.

Mutlu, B. (2021). The virtual and the physical: two frames of mind. Iscience, 24(2).

Nastase, S. A., Goldstein, A., & Hasson, U. (2020). Keep it real: rethinking the primacy of experimental control in cognitive neuroscience. NeuroImage, 222, 117254.

Palazzo, S., Spampinato, C., Kavasidis, I., Giordano, D., Schmidt, J., & Shah, M. (2020). Decoding brain representations by multimodal learning of neural activity and visual features. IEEE Transactions on Pattern Analysis and Machine Intelligence, 43(11), 3833-3849.

Prince, J. S., Charest, I., Kurzawski, J. W., Pyles, J. A., Tarr, M. J., & Kay, K. N. (2022).
Improving the accuracy of single-trial fMRI response estimates using GLMsingle. Elife, 11, e77599.

Santamaría-Vázquez, E., Martínez-Cagigal, V., Marcos-Martínez, D., Rodríguez-González, V., Pérez-Velasco, S., Moreno-Calderón, S., & Hornero, R. (2023). MEDUSA©: A novel Python-based software ecosystem to accelerate brain-computer interface and cognitive neuroscience research. Computer methods and programs in biomedicine, 230, 107357.

Keywords: Brain Mapping, Machine Learning, Neuroimaging, Artificial Intelligence, Cognitive Neuroscience
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B218: Modelleyen: Continual Learning and Planning via Structured Modelling of Environment Dynamics

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Abstract

The current machine learning paradigm relies on continuous representations and fixed neural network architectures to approximate environmental structures, leading to challenges with continual learning, internal structure design, and goal-directed behavior due to overparameterization and reliance on continuous parameter tuning. This paper introduces "Modelleyen," an alternative learning mechanism that learns environmental structures topologically in an inherently continual man- ner, and a planning algorithm that utilizes Modelleyen's output for goal- directed behavior. We demonstrate the effectiveness of Modelleyen and the planner in a simple environment, and also discuss their potential for creating human-comprehensible hierarchical models in machine learning.

Keywords: Continual learning · Planning · Structure learning
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B239: Gradient Ascent Activity-based Credit Assignment with History-dependent Reward

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Abstract

In reinforcement learning, credit assignment with history- dependent reward is a key problem to solve for being able to model agents: (i) associating the returns from their environment with their past (series of) actions, and (ii) figuring out which past decisions are responsible for the current achievement of their goal. Usual approaches simplify this problem by assuming an immediate reward for each action. Our first result is to propose a general and formal framework in which the credits assigned to actions are updated based on a gradient of expected rewards from past actions. This framework is able to model complex tasks that require fulfilling sub-tasks in order, each sub-task consisting of a specific sequence of actions. Our second result is to propose an algorithm using the activity of actions to increase (resp. decrease) the credits of necessary (resp. unnecessary) past actions. We illustrate our algorithm on a task inspired by a behavioral learning task of rodents in a maze.

Keywords: Credit assignment, Policy gradient algorithm, Non-Markovian rewards.
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B264: A Novel Class Incremental Learning Method via Multi-granularity Balance Inspired by Human Granular Cognition Mechanism

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Abstract

Class incremental learning (CIL) is a crucial approach for AI models, yet it faces the challenge of catastrophic forgetting. The CIL method that replays episodic memory is a promising solution inspired by the hippocampus in humans. However, the limited buffer budget in CIL method constrains the number of stored exemplars from old classes, resulting in an imbalance between new and old samples in each incremental learning stage, thus it affects the resolution of catastrophic forgetting. Therefore, a novel CIL method based on the multi-granularity balance (MGBCIL) is proposed, which is inspired by the granular cognition mechanisms for human problem-solving. In order to mitigates the adverse impact of sample imbalance between new and old classes at fine-, medium-, and coarse-grained levels on addressing catastrophic forgetting, MGBCIL implements specific strategies during the batch, task, and decision stages. Specifically, a weighted cross-entropy loss with a smoothing factor is proposed for batch processing. During task updating and classification decision, contrastive learning with different anchor settings is introduced to promote both local and global separation between new and old classes. Meanwhile, knowledge distillation is used to retain the knowledge of old classes. Experimental results on CIFAR-10 and CIFAR-100 datasets demonstrate the superior performance of MGBCIL compared to other methods. The average accuracy is improved by up to 20.47%, while the forgetting rate is reduced by up to 14.49%.

Keywords: Class incremental learning, Episodic memory, Imbalance, Multi-granularity cognition, Contrastive learning
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B246: Evaluating Inductive Reasoning of Large Language Models: A Cognitive Psychology Approach Using Number Series Completion

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Abstract

In recent years, the rapid advancements in artificial intelligence (AI), particularly in the development of Large Language Models (LLMs), have sparked significant interest in understanding their cognitive capabilities. One key area of focus is their capacity for inductive reasoning, a fundamental cognitive process involving the generalization from specific instances. Inductive reasoning is not only crucial for human learning and decision-making but also plays a pivotal role in various scientific and analytical tasks. As AI systems are increasingly relied upon in areas requiring sophisticated reasoning, it is essential to rigorously evaluate the extent to which these models can replicate human-like inductive reasoning.

The central question driving this study is: Are Large Language Models truly capable of inductive reasoning? This question remains a topic of debate within the academic community. On one hand, there is evidence suggesting that LLMs do exhibit notable inductive reasoning capabilities. These findings suggest that LLMs possess a certain level of cognitive sophistication that enables them to engage in tasks requiring inductive reasoning. However, the picture is far from clear-cut. Some reports have highlighted significant limitations in the inductive reasoning capabilities of even the most advanced LLMs. An illustrative example of these limitations is the poor performance of LLMs on the "Artificial Intelligence Wisdom" (AIW) test, particularly in understanding nuanced gender roles. These studies indicate that while LLMs may perform well on certain types of inductive tasks, they fall short when faced with more complex or unfamiliar challenges. The inconsistency in performance across different studies underscores the need for a more nuanced and comprehensive evaluation of LLMs' reasoning abilities.

To address this gap, our study proposes a novel approach to assessing the inductive reasoning capabilities of LLMs by utilizing methodologies from cognitive psychology. By treating LLMs as participants in psychological experiments, we can apply well-established cognitive tasks to these models and directly compare their performance with that of human subjects. One of the primary tasks in our study is the number series completion task, a widely recognized measure of inductive reasoning. This task requires participants to identify patterns within a sequence of numbers and predict the next element in the series, such as in the example "1, 5, 9, 13, 17, ?". Successfully completing such tasks relies on several cognitive processes, including relation detection, discovery of periodicity, pattern completion, and extrapolation.

We generated 120 items for the number series completion task, each based on four critical stimulus characteristics: period length, relationship complexity, working memory demand, and arithmetic operation. These characteristics were carefully selected to ensure that the tasks varied in difficulty and could challenge both human participants and LLMs. To maintain the integrity of the assessment, we adhered to several principles in task creation. First, we controlled for task difficulty by generating fewer items at higher difficulty levels. Second, we controlled for computational load by limiting the initial numbers in all items to within 5, restricting multipliers in multiplication operations to 2 or 3, and setting addends in addition operations between 1 and 4. This careful design allowed us to create a dataset covering 11 types of problems, which performed well across various measurement indices. Specifically, the internal consistency reliability of the dataset was found to be 0.97, while the split-half reliability was 0.848. Additionally, the correlation coefficient with the Raven's Progressive Matrices test, a standard measure of cognitive ability, was 0.60 ($p < 0.01$), indicating strong calibration validity.

In the comprehensive evaluation of LLMs' inductive reasoning capabilities, we conducted a detailed examination of their performance across a series of tasks. To ensure a rigorous and methodologically sound assessment, we meticulously designed a variety of prompts specifically tailored to challenge and probe these reasoning abilities. Moreover, by deliberately isolating the arithmetic operation components from the reasoning tasks, we were able to accurately determine whether the outcomes of our inductive reasoning tests were influenced by the models' numerical calculation abilities, and to what extent this influence manifested. This separation is crucial for understanding the underlying mechanisms at play and ensures that our assessment of inductive reasoning remains focused and untainted by extraneous factors.

Our evaluation of GPT-3.5, GPT-4, and MathGPT, a model specialized in mathematics, revealed that while LLMs demonstrate some ability to engage in inductive reasoning, they fall significantly short compared to human participants, particularly on tasks involving complex numeric patterns. Additionally, the LLMs' performance on arithmetic operation tasks was not inferior to that of human participants, suggesting that their poor performance on inductive reasoning tasks was not due to computational load. This finding underscores the inherent limitations of current LLMs in performing tasks that require deep cognitive processing and generalization.

Our study leverages cognitive psychology tools to evaluate the inductive reasoning capabilities of LLMs, providing a nuanced understanding of their cognitive processes. By dissecting the reasoning mechanisms within these models, we contribute to the ongoing discourse on the strengths and limitations of current AI technologies. The insights garnered from this analysis not only deepen our comprehension of LLMs but also serve as a foundational guide for the development of more sophisticated models in the future. As AI continues its rapid advancement, addressing the inherent limitations of these models becomes increasingly imperative. By enhancing their ability to emulate human reasoning, we can unlock new potential in the application of large models across various domains.

Keywords: Large Language Models (LLMs), Inductive Reasoning, Number Series Completion Task, Cognitive Psychology, Evaluation
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The International Workshop: Generative AI Empowers Brain Signal Processing (GAIEBSP 2024)

Chairs: Shuqiang Wang, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China, Sadia Shaki, The Chinese University of Hong Kong, Hong Kong & Baiying Lei, Shenzhen University, China
Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand

S02205: Brain Functional Topologies under Short Reel Stimuli

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Abstract

Introduction
Recently, understanding the brain function, under the influence of naturalistic stimuli (NS) such as movies, music, and narration has gained popularity [1]. Functional MRI (fMRI) volumes of the whole brain, collected over the entire length of an experiment, are used extensively in such studies [2, 3]. The fMRI volumes comprise of thousands of voxels and set of voxels are simultaneously co-activated under the influence of a stimulus to form functional networks [4]. The configuration of these networks alters, with the changes in stimuli contents, resulting in their spatiotemporal dynamics. Comprehension of these dynamics is important since it may provide some insights into the similarities/differences between normal and disordered brain functions. Study of functional networks' structure may be one way of understanding these dynamics.

Recently, topological data analysis (TDA) has shown promising results for the study of topological (or structural) properties of brain [5, 6]. Persistent Homology (PH) [7], an algorithm from TDA, is used to recover the global and most persistent structure of a point cloud. It captures the structure in the form of 2D persistent diagram and Betti curve capturing the topological structural information from the point cloud. By

comparing these diagrams for different point clouds, the structural similarity is quantified.

Our research explores the following questions: (1) Do the brain network topologies repeat across time, and (2) Do the brain network topologies repeat across subjects? We are answering these questions by using Persistent Homology to analyze the spatiotemporal dynamics of the brain networks, under short reels stimuli (without sound). We are extracting the topological structures from fMRI data and understanding the evolution of brain activity across subjects and sessions. We studied and provided the results in default mode network (DMN) and visual network because they are found to be the most studied brain networks [8, 9] under movie watching.

Methods

Considering the research objectives, our study is based on the fMRI-Videos dataset introduced in the paper [10]. Three subjects watched 18 video segments twice and fMRI dataset was collected per segment. Each video, of 8 min duration, comprises of varying number of short reels of different durations (2-20 seconds). The reel content spans daily life objects spanning humans, animals, fruits/vegetables, nature etc [10]. We used pre-processed T2-weighted fMRI dataset provided in [10], removed resting state volumes, and worked with 240 fMRI volumes for each segment.

We studied the spatiotemporal dynamics of brain activity in DMN and visual networks. For spatial and temporal dynamics, persistent homology was applied along voxel and time axis, respectively, and separately on each reel's fMRI signals. To obtain fMRI signals for each reel, start and end timepoints for each reel were identified and mapped to fMRI volume indices with overlapping strategy to avoid information loss. The fMRI signal had a temporal resolution of 2 seconds, while the reels were not necessarily a multiple of 2 seconds in duration, which means extraction of reel-duration fMRI volumes was not possible in such cases. To avoid information loss in such cases, we overlapped the boundary volumes while assigning fMRI volumes to reels, e.g. the last volume of a reel becomes the first volume of next reel for such reels. After extracting the reel level fMRI data, the mean and variance for each voxel's activity was computed, representing the statistical features of the voxel's activity during watching of the reel. Afterwards, PH was applied to form persistent diagram and Betti curve was plotted along both the spatial and temporal axis. This process was applied to all segments and their reels across all three subjects and their views.

To quantify the inter-subject and inter-view spatiotemporal dynamics, we measured the persistent homology distances, i.e. Bottleneck and Wasserstein [11, 12] using Persistent diagram, and Betti distance using Betti curve [11], separately for each network. These distances were measured for the reels at the same level or time, for example, the ith reel of subject1-view1 was compared with ith reel of subject2-view1 or ith reel of subject1-view2. Furthermore, the distances were measured for six different pairs of subjects and views (discussed in Results). These topological distances, for a particular reel, estimate structural similarity between fMRI signals during watching of that reel. For each reel, and for each PH-distance, the average distance was calculated across all 6 combinations, separately for both brain networks. The distances distributions were observed, and statistics were calculated for both DMN and visual networks to quantify the persistence of these networks in the human brain across various experimental combinations.

Results

To summarize the distribution of PH-distances for both DMN and visual networks, we calculated the mean, std, and skewness of their distribution. Provided that the measured metrics are distances, therefore, low mean, low std, and high skewness would indicate better persistence of the structure. For Bottleneck distance, the DMN showed mean, std, skewness values of 845, 512, and 0.7058, respectively; whereas the visual network showed lower values of mean and std (832, 463) and higher for skewness (0.8854) indicating relatively better persistence of spatiotemporal dynamics in visual network. For Wasserstein distance, the DMN showed mean, std, skewness values of 1402, 513, and 0.1914, respectively; whereas the visual network showed 1486, 479, 1.1227 values for these statistics. Even though visual network has higher mean, but std is smaller and skewness is positive showing relatively better persistence than DMN. For Betti distance, the DMN showed mean, std, skewness values of 3988, 2251, and 0.7497, respectively; whereas the visual network showed 3615, 1845, 0.5879 values for these statistics, again giving relatively better persistence of spatiotemporal dynamics.

Conclusion

With the help of topological data analysis tool named persistent homology (PH), we tried to understand the spatiotemporal dynamics in DMN and visual networks under short reels watching across multiple subjects and views. The data was processed in a reel-wise manner and spatiotemporal features were extracted using persistent homology. The topological distances and the statistics of their distribution were calculated. For Bottleneck and Betti distances, the visual network has shown higher

persistence in its spatiotemporal dynamics across multi-subject and multi-view experiments. However, the Wasserstein distance showed a relatively similar persistence across both networks. These results suggest the existence of topological similarities in spatiotemporal dynamics of brain networks across different subjects and views under the influence of short reels stimuli. In the future, segment level analysis can be conducted to jointly understand the short-term as well as long-term spatiotemporal patterns hidden in the brain networks.

References

[1] S. B. Eickhoff, M. Milham and T. Vanderwal, "Towards clinical applications of movie fMRI," NeuroImage, 2020.
[2] F. Chiossi, L. Haliburton, C. Ou, A. M. Butz and A. Schmidt, "Short-Form Videos Degrade Our Capacity to Retain Intentions: Effect of Context Switching On Prospective Memory," in Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems, 2023.
[3] C. Su, H. Zhou, L. Gong, B. Teng, F. Geng and Y. Hu, "Viewing personalized video clips recommended by TikTok activates default mode network and ventral tegmental area," NeuroImage, 2021.
[4] J. C. Gore, "Principles and practice of functional MRI of the human brain," The Journal of clinical investigation, p. 9, 2003.
[5] Z.-m. Wang, S. Li, J. Zhang and C. Liang, "Emotion recognition based on phase-locking value brain functional network and topological data analysis," Neural Computing and Applications, 2024.
[6] M. J. Catanzaro, S. Rizzo, J. Kopchick, A. Chowdury, D. R. Rosenberg, P. Bubenik and V. A. Diwadkar, "Topological Data Analysis Captures Task-Driven fMRI Profiles in Individual Participants: A Classification Pipeline Based on Persistence," Neuroinformatics, 2024.
[7] E. Munch, "A User's Guide to Topological Data Analysis. Journal of Learning Analytics," Journal of Learning Analytics, 2017.
[8] E. A. Vessel, A. I. Isik, A. M. Belfi, J. L. Stahl and G. G. Starr, "The default-mode network represents aesthetic appeal that generalizes across visual domains," Proceedings of the National Academy of Sciences, 2019.
[9] T. S. Hale, A. M. Kane, O. Kaminsky, K. L. Tung, J. F. Wiley, J. J. McGough, S. K. Loo and J. T. Kaplan, "Visual network asymmetry and default mode network function in ADHD: an fMRI study," Frontiers in psychiatry, 2014.

[10] H. Wen, J. Shi, Y. Zhang, K.-H. Lu, J. Cao and Z. Liu, "Neural encoding and decoding with deep learning for dynamic natural vision," Cerebral Cortex, vol. 28, 2018.
[11] "PairwiseDistance 2014; giotto-tda 0.5.1 documentation - giotto-ai.github.io," [Online]. Available: https://giotto-ai.github.io/gtda-docs/latest/modules/generated/diagrams/distances/gtda.diagrams.PairwiseDistance.html.
[12] M. a. M. D. a. N. A. Kerber, "Geometry helps to compare persistence diagrams," ACM New York, NY, USA, 2017.

Keywords: fMRI, Short Stimuli, Topological Data Analysis, Persistent Homology, Spatiotemporal Dynamics
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S02207: Exploring Default Mode Network Association with Naturalistic Stimuli Using Topological Data Analysis

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Abstract

Introduction:
DMN is considered a sense making network that integrates the incoming information with the prior information, making an interesting perspective about the external stimulus. Hence, in this perspective DMN is somewhat related to one's personality reflecting internal thoughts and feelings, and our personalities and viewpoints are greatly affected by the surrounding environment. Naturalistic stimuli such as movies, stories, and music are rich and dynamic, encompassing sights, sounds, textures, smells, and even social interactions that we encounter in our everyday lives. The brain's intricate neural networks are finely tuned to various processes and make sense of this information, allowing us to navigate our surroundings, make decisions, and ultimately construct a comprehensive understanding of the world around us. The insights that can be derived from investigating the DMN's role in processing naturalistic stimuli enrich our comprehension of the brain's mechanisms for interpreting meaning from sensory inputs. This, in turn, facilitates the connection of these inputs to personal experiences, making a foundation of our adaptive responses to the challenges of daily life. Understanding the relation between DMN and naturalistic stimuli can assist in comprehension of such stimuli and our thought process. This study utilizes persistent homology from topological data analysis to extract significant data-driven (from DMN) covariates that can distinguish between the modalities (watching or listening) of the incoming stimuli for the two movies. Using these covariates in binary logistic regression, we show that even activity in the DMN is both stimuli and its modality dependent.

Methods:
We used the dataset collected by (Zadbood et al., 2017) in our study. This dataset consists of fMRI data of listening (to narration) and watching of two movies (Merlin and Sherlock). Total of 36 participants out of which 18 listened to the narration of Merlin and watched Sherlock; and the other 18 listened to the narration of Sherlock and watched Merlin. Merlin Listeners and viewers consisted of 22 scenes each and Sherlock consisted of 20 scenes for each modality. Pre-processing of the data comprised of reorientation, realignment (motion correction), slice time correction, co-registration, segmentation, normalization, and smoothing. After pre-processing, DMN regions-of interest (ROIs) were extracted, which consisted of four cortices (Posterior Cingulate Cortex, Anterior cingulate and medial prefrontal cortex, Inferior parietal, Lateral temporal) based on literature (Raichle, 2015; Buckner et al., 2008)).

Pairwise correlation between the DMN cortices was estimated using Pearson correlation coefficient for every scene for both the modalities of each movie to extract the functional connectivity (FC) matrices providing the co-activation strength between these cortices. Mean correlation (mCorr) value of each matrix was computed. Persistent Homology (PH) measuring the topological features that persists across multiple scales (correlation values) was implemented on the correlation matrices. PH extracts the shape and structure of data by identifying patterns and features such as loops and holes. We used PH results to extract the Betti-curves for each matrix (Gracia-Tabuenca et al., 2020) representing the transition of these topological features from being isolated nodes to a single connected component. Consequently, Betti curves provided the topological structures of the FC matrices showing how the pairwise correlation between cortices was distributed in DMN. From these Betti curves covariates such as (area under curve (AUC), slope and kurtosis) were extracted.

We extracted four data driven co-variates (mCorr, AUC, slope, kurtosis) from DMN FC matrices of each participant. Among these co-variates, mCorr was computed from the FC matrices, while AUC, slope, and kurtosis were extracted from the Betti curve data. Binary Logistic regression (BinLR) was implemented by taking scene-wise covariates as the independent variables and modality type (listening vs. watching) as dependent variable. Similar to the analysis in (Annas et al., 2022), the best covariates model selection was based upon lowest AIC (Akaike information criterion) values and covariates were considered to have significant association having p-values <=0.05. Odds ratio was computed as exponential (covariate coefficient).

Results:
In case of the Merlin the combination of mCorr, AUC and slope was found to best differentiate the listeners from the viewers. In this case the p-value was 1.3e-15 and coefficient = 1.14 for mCorr providing the odds ratio of 3.14 suggesting that higher mCorr values were 3 times more likely to belong to the movie viewers compared to listeners. The odds ratio of AUC (p-value = 4.3e-15, coefficient = 1.29) was 3.6, suggesting that the movie viewers were more likely to have higher AUC values having more distinct correlations (connectivity) with some very large and some very small correlations. The odds ratio for the slope (p-value = 0.012, coefficient = -0.283) was 0.753 suggesting that higher negative slope values were more likely to be associated with the listeners than that of movie viewers, which means that listeners have the sharp transition from the individual nodes to connected ones as compared to the viewers. The BinLR results for Sherlock showed only mCorr to be the significant covariate in discriminating the listeners from movie viewers with odds ratio of 0.49 ratio (p-value = 8.4e-11, coefficient = -0.697) of mCorr showing that for Sherlock the listeners tend to have higher mean correlations as compared to viewers. For the case of Sherlock, even though mean correlations were significant but having no significant topological features shows that there was not significant FC structure to differentiate listeners and viewers.

Conclusion:
We used combination of persistent homology from topological data analysis and binary logistic regression in a novel manner to explore the association of different data-driven covariates (from DMN) with the modalities of the naturalistic stimuli. From the results, we concluded that mCorr values played a significant role in differentiating between viewers and listeners in both the movies. However, the structural connectivity differences were significant in Merlin but not in Sherlock. These results show that the way brain activity is associated with the stimulus modality is content dependent in addition to being connectivity dependent. Our approach provides a significant and deep insight about the relationship of DMN activity with the modalities of the incoming stimuli.

Limitations:
The limitation of our study was the size of the dataset, which was very small consisting of only 36 participants, However, the reason for including this into our study is the presence of listeners as well as viewers data for both the movies. In future, similar analysis can be performed with bigger dataset and a greater number of covariates.

References:

Annas, S., Aswi, A., Abdy, M., & Poerwanto, B. (2022). Binary Logistic Regression Model of Stroke Patients: A Case Study of Stroke Centre Hospital in Makassar. Indonesian Journal of Statistics and Its Applications, 6(1), 161-169.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network: anatomy, function, and relevance to disease. Annals of the new York Academy of Sciences, 1124(1), 1-38..

Raichle, M. E. (2015). The brain's default mode network. Annual review of neuroscience, 38(1), 433-447.

Gracia-Tabuenca, Z., Díaz-Patiño, J. C., Arelio, I., & Alcauter, S. (2020). Topological data analysis reveals robust alterations in the whole-brain and frontal lobe functional connectomes in attention-deficit/hyperactivity disorder. eneuro, 7(3).

Zadbood, A., Chen, J., Leong, Y. C., Norman, K. A., & Hasson, U. (2017). How we transmit memories to other brains: constructing shared neural representations via communication. Cerebral cortex, 27(10), 4988-5000

Keywords: Default Mode Network (DMN), Naturalistic Stimuli, Persistent Homology (PH), Binary Logistic Regression (BinLR), Narration and Movie viewing

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S02212: Comparative Analysis of Channel Selection Methods for EEG-Based Emotion Recognition Balancing Accuracy and Efficiency

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Abstract

Reducing the number of EEG channels can significantly enhance classification accuracy and computational efficiency in emotion recognition tasks. However, optimizing channel selection remains chal- lenging. This paper compares four approaches for channel selection in emotion classification: exhaustive, CSP (Common Spatial Pattern), PCA (Principal Component Analysis), and PSO (Particle Swarm Optimiza- tion). Using the DEAP, SEED, and MAHNOB-HCI datasets, which are widely recognized benchmarks for emotion recognition research, we evaluate each method across channel configurations from 1 to 32 channels. The exhaustive method serves as a baseline by evaluating all 32 channels for each participant. Our results show that PCA achieves optimal performance with 16 channels across all datasets, while PSO excels with just 2 channels, balancing accuracy and computational efficiency. CSP attains its highest accuracy with 8 channels but struggles with fewer channels, particularly in the MAHNOB-HCI dataset. This study under- scores the trade-off between channel quantity and classification performance, highlighting that reducing channels can retain accuracy while improving processing speed. These findings provide valuable guidelines for designing efficient EEG-based emotion recognition systems across different datasets.

Keywords: Channel selection, Emotion classification, Common Spatial Patter · Principal Component Analysis · Particle Swarm Optimization.
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S02210: NeuroNetGen: AI-Driven Construction of Structural Brain Networks from Diffusion Tensor Imaging

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Abstract

Brain network analysis is crucial for diagnosing and treating neurodegenerative disorders like Alzheimer's disease (AD). However, existing methods for constructing structural brain networks from diffusion tensor imaging (DTI) often rely on specialized toolkits that can be subjective and limited in capturing complex features. We propose NeuroNetGen, a novel AI-driven model for generalized construction of brain networks from DTI. NeuroNetGen integrates a Feature Extraction Module, a Generative Network, and a Graph Neural Network (GNN) classifier to capture a wide range of structural connectivity and pathology-related information. Our approach demonstrates superior performance compared to conventional toolkits on datasets from two neurodegenerative diseases, offering a powerful framework for improved diagnosis and understanding of neurodegenerative diseases.

Keywords: Generative AI, Brain network construction, diffusion tensor imaging, Alzheimer's disease
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S02208: Federated Multi-source Domain Adaptation via Vision Transformer for Multi-site Alzheimer's Diagnosis

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Abstract

Alzheimer's disease (AD) is an incurable, progressive neurodegenerative disease, and its early diagnosis is essential. Previous studies have demonstrated the superiority of utilizing multi-site data to train models for diagnosing AD. However, existing research models mostly use dimensionally reduced im- age data for model training, which loses the complete spatial information of the image. At the same time, the data from different sites are heterogeneous, and the joint training models often perform poorly when facing data from new sites. Traditional domain adaptation methods require centralized data for training, which results in the leakage of medical privacy. Our study proposes a multi-site federated learning model (FedSADA), which uses a 3D Vision Transformer as the basic framework to learn the spatial information of the complete image ful- ly. We also added a self-attention domain adaptive loss function and a local maximum mean difference loss function to perform domain adaptation on mul- ti-site data. At the same time, a federated learning framework is adopted to pro- tect medical data fully. We conducted experiments on public datasets, demon- strating that our method can effectively improve model generalization and accu- racy on new data sites.

Keywords: Vision Transformer, Federated Learning, multi-source domain adaptation
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S02204: Intelligent Diagnosis Platform for Alzheimer's Disease Based on Multimodal Knowledge Graph

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Abstract

Alzheimer's disease (AD) is an incurable chronic neurodegenerative disease. If it can be diagnosed early and intervened in time clinically, it can effectively delay the development. However, early diagnosis of AD is difficult and there is still a lack of intelligent diagnosis platforms for AD. In order to solve this problem, we propose an AD intelligent diagnosis platform based on a multimodal knowledge graph. We apply the AD intelligent diagnosis model on the intelligent diagnosis platform, which realizes the early diagnosis of AD based on patient
data and gives AD diagnosis advice. We verify the diagnostic model based on Alzheimer's Disease Neuroimaging Initiative (ADNI) dataset. We build a medical knowledge graph based on the current open source medical knowledge database. The experimental results show that the proposed method can be applied to the early diagnosis of AD. Furthermore, it can give appropriate diagnosis advice, which is expected to reduce the burden on doctors and realize the intelligent diagnosis and treatment of AD.

Keywords: Alzheimer's disease, Early diagnosis, Knowledge graph, Multi-modal feature analysis, Intelligent diagnosis platform;
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S02203: Spatiotemporal Feature Extraction and Fusion for Longitudinal Alzheimer's Disease Diagnosis

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Abstract

Alzheimer's disease (AD) is a progressive neurodegenerative disorder characterized by a gradual decline in cognitive function. The brain structure of AD patients progressively atrophies over time. Longitudinal data can capture the changes in imaging over time, providing important information for early detection and diagnosis of the disease, which is not achievable with images from a single time point. We propose a novel longitudinal AD diagnosis model that leverages deformation field data obtained by registering images from adjacent time points. Each pixel in the deformation field represents the displacement vector of the corresponding pixel between two scans, reflecting information about brain tissue atrophy. By effectively extracting both temporal and spatial features from the longitudinal data, our model enhances early AD diagnosis. The input data for the model consists of processed sMRI images and deformation fields calculated

between each pair of time points in the longitudinal sMRI data. The model is composed of three modules: Convolutional Long Short-Term Memory (CLSTM), Gate Fusion Long Short-Term Memory (GFLSTM), and an attention module. CLSTM extracts temporal features while preserving spatial features by maintaining the 3D shape of the features, GFLSTM achieves spatiotemporal feature fusion within a cascaded network, and the attention module further enhances feature representation. Our proposed method was evaluated on the Alzheimer's Disease Neuroimaging Initiative (ADNI) database, and experiments demonstrate that it outperforms several state-of-the-art methods.

Keywords: Alzheimer's disease, Longitudinal data analysis, Convolutional neural network, Convolution LSTM
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S02201: Brain Causality Modeling Using Structure-guided Spatiotemporal Diffusion Model for MCI Analysis

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Abstract

Early diagnosis of mild cognitive impairment (MCI) is crucial for the effective treatment and intervention of neurodegenerative diseases. Effective connectivity is one kind of brain network, which is helpful for analyzing the pathogenic mechanism of MCI. It is challenging to model causal relationships between brain regions from multimodal imaging data. This study proposes a new method for brain network causality modeling based on the structure-guided spatiotemporal diffusion model (SSDM), aiming to improve the accuracy of MCI diagnosis. By utilizing the advanced diffusion models, we introduced structural connectivity to guide the transformer-based network to learn topological and spatiotemporal features, which can better remove uncorrelated noise and improve effective connectivity estimation. The proposed model can not only generate temporal features of brain regions with individual differences but also construct discriminable effective connectivities. Experiments on the ADNI dataset demonstrate the effectiveness of our model, showing a certain improvement in diagnostic accuracy compared with competing methods. In addition, by analyzing the effective connectivities, our model predicts abnormal brain connections that are highly correlated with MCI. Overall, the framework proposed in this paper provides insights

into the potential neurobiological mechanisms of MCI, which may promote early intervention strategies.

Keywords: Effective connectivity, structural convolutional transformer, spatiotemporal denoising, brain causality, MCI
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S02206: Feature Fused Attention CNN for Classification in Alzheimer's Disease

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Abstract

1 Introduction

Alzheimer's disease (AD) is a neurodegenerative disorder and has become one of the primary causes of dementia among elder people [1]. With the aging of the population in recent decades, the increasing number of AD patients is posing greater challenges to the medical and social welfare departments. Thanks to the development of medical imaging technology, many brain imaging methods have been applied in the early screening of AD, such as magnetic resonance imaging (MRI) and positron emission tomography (PET). However, although MRI has high spatial resolution, it is primarily sensitive to structural changes, which are hard to detect in the earliest stages of AD. While PET can detect metabolic and functional changes in early AD phases, its resolution and SNR are fairly restricted. Combining the features of both modalities, the high resolution of MRI and the sensitivity of PET should be able to better predict AD than using either modality alone. To achieve this, we propose a deep learning framework: Feature Fusion Attention Convolution Neural Network (FFA-CNN), to integrate information from MRI and PET images for AD classification and MCI conversion prognosis. The FFA-CNN will take each subject's MRI and PET scans as input and corresponding pathological status as output. We hypothesize that when using MRI and PET as multi-modal input, the proposed model will achieve higher accuracy than using a single-modal input. The hypothesis and effectiveness of the suggested model are tested through experiments conducted on the public ADNI dataset [2].

2 Method

In this study, we use T1-weighted MRI and 18F-FDG PET images from ADNI-1 and ADNI-2 datasets. Data is obtained from the baseline visits of 882 subjects, including 236 AD, 141 pMCI, 220 sMCI, and 285 cognitive normal (CN). Only subjects with both MRI and PET scans are included in this research. The detailed demographic and clinic data of the studied subjects are listed below:
AD: 98F/138M, Age(years): 75.1±7.9, CDR: 4.6±1.7, MMSE: 23.2±2.1;
CN: 136F/149M, Age(years): 74.3±5.9, CDR: 0.0±0.1, MMSE: 29.0±1.2;
pMCI: 60F/81M, Age(years): 73.9±7.0, CDR: 1.9±1.0, MMSE: 26.8±1.7;
sMCI: 81F/139M, Age(years): 74.0±7.7, CDR: 1.4±0.9, MMSE: 27.7±1.8.
Abbreviations: F: female; M: male; AD: Alzheimer's disease; pMCI: progressive mild cognitive impairment; sMCI: stable mild cognitive impairment; CN: cognitive normal; F: female; M: male; CDR: Clinical Dementia Rating; MMSE: Mini-Mental State Examination.

First, all downloaded PET images are converted from DCM to NIFTI format using the dcm2niix command in MRIcroGL [3]. Then, both MRI and PET images are pre-processed in the FMRIB Software Library (FSL) 6.0.7.10 (https://fsl.fmrib.ox.ac.uk/) [4–6]. The BET algorithm is used for brain extraction [7] and thus the skull is stripped from the source image space. The FLIRT linear registration algorithm [8] is then used to align all MRI images to the Montreal Neurological Institute T1 standard template space. After the linear registration procedure, all MRI and PET images are cropped to a size of 152×188×152 mm by eliminating the zero-valued voxels located at the edges of the image. At last, all MRI and PET images are down-sampled to the size of 76×94×76 mm to reduce the computational complexity. An FFA-CNN framework is proposed for multi-modal AD classification. At first, MRI and PET images are fed into two feature extraction blocks separately. The feature extraction block consists of one 3×3×3 convolution layer followed by a rectified linear unit (ReLU) and a 3×3×3 max-pooling operation with stride as 2 for feature down-sampling. Then, a feature fusion block is introduced to learn and combine the multi-modal features of MRI and PET for later classification. The feature extraction block first concatenates the input MRI and PET features and then sends combined features to one 1×1×1 convolution layer followed by a 3×3×3 convolution layer. After information from two modalities is combined and learned, the combined features will pass through three 3×3×3 convolution layers and then one 3×3×3 max pooling layer with stride 2. Moreover, the model incorporates a self-attention mechanism to facilitate the modeling of multi-level and long-range correlations across picture regions [9]. The attention module consists of

two 1×1×1 convolution layers followed by a sigmoid operation. At last, a full connection layer with softmax activation is applied to generate the predicted result.

3 Experiments and Results

The proposed model is implemented by Pytorch. All experiments are conducted on Ubuntu 18.04.06 and NVIDIA GeForce RTX3090. Two binary classification tasks are considered during the model training: AD vs. CN and pMCI vs. sMCI. The train-test split ratio is set as 4:1. An Adam optimizer is applied in the training process with a batch size of 4. The learning rate is set to 0.0001, and a weight decay parameter of 0.02 is adopted. The loss function is defined as the cross-entropy (CE) between the predicted result and the real label.

Effectiveness of the suggested deep learning framework in AD classification is tested through the AD vs. CN binary classification task. Five performance measures: accuracy (ACC), sensitivity (SEN), specificity (SPE), F1-score (F1S),
and area under the curve (AUC), are calculated to evaluate the proposed model. We first evaluate the classification performance with single-modal brain images, in which the AD vs. CN classification is implemented with a single feature extraction block with MRI or PET. In the feature fusion block, the concatenate operation is removed since there is only one input feature, leaving only two convolution layers. Then, the full FFA-CNN with two input modalities is tested on the same dataset. In addition, we also tested the impact of removing the attention module on the classification performance of single- and multi-modal models. The above experimental results are listed below (all in %):

MRI+SN ACC: 74.00, SEN: 83.33, SPE: 67.24, F1S: 72.91, AUC: 86.93;
MRI+SA ACC: 72.00, SEN: 73.81, SPE: 70.69, F1S: 68.88, AUC: 78.92;
PET+SN ACC: 87.00, SEN: 73.81, SPE: 96.55, F1S: 82.66, AUC: 92.84;
PET+SA ACC: 88.00, SEN: 78.57, SPE: 94.83, F1S: 84.61, AUC: 91.75;
MRI+PET+FFN ACC: 90.00, SEN: 83.33, SPE: 94.83, F1S: 87.49, AUC: 90.83;
MRI+PET+FFA ACC: 92.00, SEN: 85.71, SPE: 96.55, F1S: 90.00, AUC: 95.44.

Abbreviations: SA: single-modality with attention module; SN: single-modality without attention module; FFN: feature fusion without attention module; FFA: feature fusion with attention module.

The experimental results show that while PET-based models can better detect AD patients than MRI-based ones, the feature fusion technique can integrate the features of both PET and MRI and achieve a better prediction performance. At the same time, the attention module improves the feature fused and the PET-based model (the prediction accuracy increased by 1~2%). However, the attention module seems to worsen the prediction performance for the MRI model. This may be because structural features are relatively easy to extract, and the introduction of an attention module increases the model complexity. Same comparison of the single- and multi-modal classification is then performed on the MCI conversion prediction (pMCI vs. sMCI). The role of the attention module is also evaluated on the same dataset.

The experimental results for pMCI vs. sMCI are listed below:

MRI+SN ACC: 65.71, SEN: 57.14, SPE: 71.43, F1S: 57.14, AUC: 65.90;
MRI+SA ACC: 64.29, SEN: 53.57, SPE: 71.43, F1S: 54.54, AUC: 63.95;
PET+SN ACC: 65.71, SEN: 64.29, SPE: 66.67, F1S: 59.99, AUC: 65.99;
PET+SA ACC: 67.14, SEN: 60.71, SPE: 71.43, F1S: 59.64, AUC: 73.77;
MRI+PET+FFN ACC: 68.57, SEN: 60.71, SPE: 73.81, F1S: 60.71, AUC: 68.11;
MRI+PET+FFA ACC: 70.00, SEN: 71.43, SPE: 69.05, F1S: 65.57, AUC: 70.03.

The experiment shows similar trends to the previous AD vs. CN task. The FFA-CNN outperforms single-modal methods based on either MRI or PET, and the attention module boosts the prediction accuracy in the FFA and PET methods but not in MRI methods. However, compared with AD vs. CN task, the classification performance accuracy is much lower in distinguishing pMCI from sMCI. This may be because the prediction of MCI status is harder than detecting AD from CN since the transition of MCI state is usually a continuous process. The subjects included in this study may likely span a continuum of sMCI to pMCI development and cannot be simply represented by 0-1 labels. In the future, it is possible to use semi-supervised or unsupervised clustering methods for better grouping MCI patients [10]. In addition, analyzing from the perspective of brain networks rather than images can also be helpful since brain connections can show distinct characteristics at different stages of AD progression [11, 12].

4 Conclusion

In this paper, a deep learning framework: FFA-CNN, is proposed for AD classifications. The FFA-CNN can take MRI and PET brain images as input and combine multi-modal features for disease classification. The experimental results on the ADNI dataset show that the FFA-CNN outperforms single-modal methods and achieves a prediction accuracy of 92.00% in the AD vs. CN and 70.00% in the pMCI vs. sMCI task, which demonstrated the effectiveness of the proposed method.

References

1. Zhan, L., Zhou, J., Wang, Y., Jin, Y., Jahanshad, N., Prasad, G., Nir, T.M., Leonardo, C.D., Ye, J., Thompson, P.M., et al.: Comparison of nine tractography algorithms for detecting abnormal structural brain networks in alzheimer's disease. Frontiers in aging neuroscience 7, 48 (2015)
2. Jack, C.: Study a. the alzheimer's disease neuroimaging initiative (adni): Mri methods. J Magn Reson Imaging 27, 685–691 (2008)
3. Rorden, C., Brett, M.: Stereotaxic display of brain lesions. Behavioural neurology 12(4), 191–200 (2000)
4. Smith, S.M., Jenkinson, M., Woolrich, M.W., Beckmann, C.F., Behrens, T.E., Johansen-Berg, H., Bannister, P.R., De Luca, M., Drobnjak, I., Flitney, D.E., et al.: Advances in functional and structural mr image analysis and implementation as fsl. Neuroimage 23, S208–S219 (2004)
5. Woolrich, M.W., Jbabdi, S., Patenaude, B., Chappell, M., Makni, S., Behrens, T., Beckmann, C., Jenkinson, M., Smith, S.M.: Bayesian analysis of neuroimaging data in fsl. Neuroimage 45(1), S173–S186 (2009)
6. Jenkinson, M., Beckmann, C.F., Behrens, T.E., Woolrich, M.W., Smith, S.M.: Fsl. Neuroimage 62(2), 782–790 (2012)
7. Smith, S.M.: Fast robust automated brain extraction. Human brain mapping 17(3), 143–155 (2002)
8. Jenkinson, M., Bannister, P., Brady, M., Smith, S.: Improved optimization for the robust and accurate linear registration and motion correction of brain images. Neuroimage 17(2), 825–841 (2002)
9. Zhang, H., Goodfellow, I., Metaxas, D., Odena, A.: Self-attention generative adversarial networks. In: International conference on machine learning. pp. 7354–7363. PMLR (2019)
10. Xu, Z., Wang, Y., Lu, D., Yu, L., Yan, J., Luo, J., Ma, K., Zheng, Y., Tong, R.K.y.: All-around real label supervision: Cyclic prototype consistency learning for semi-

supervised medical image segmentation. IEEE Journal of Biomedical and Health Informatics 26(7), 3174–3184 (2022)
11. Zuo, Q., Wu, H., Chen, C.P., Lei, B., Wang, S.: Prior-guided adversarial learning with hypergraph for predicting abnormal connections in alzheimer's disease. IEEE Transactions on Cybernetics (2024)
12. Pan, J., Zuo, Q., Wang, B., Chen, C.P., Lei, B., Wang, S.: Decgan: Decoupling generative adversarial network for detecting abnormal neural circuits in alzheimer's disease. IEEE Transactions on Artificial Intelligence (2024)

Keywords: Multi-modal fusion, Multi-modal brain images, Alzheimer's disease
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B279: DoA assessment based on EEG DFA and Entropy features

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Abstract

In this study, a novel method is proposed to combine modified detrended fluctuation analysis (DFA) and entropy to extract features of electroencephalogram (EEG), which are then processed using a random forest algorithm to generate a new DoA index. The bispectral index (BIS) was used as the reference standard. The proposed DoA index achieved Pearson and Spearman correlation coefficients of 0.97 ($p<0.01$) and 0.95 ($p<0.01$) with the BIS index, respectively. Additionally, the mean squared error (MSE), root mean squared error (RMSE), and mean absolute error (MAE) were 20.45, 4.52, and 2.85, respectively. These results indicate that the proposed DoA index is more accurate in patients' consciousness level assessment. Keywords: Anesthesia, Depth of Anesthesia, Electroencephalogram.

Keywords: Anesthesia, Depth of Anesthesia, Electroencephalogram
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The 4th International Workshop on Environmental Adaptation and Mental Health (EAMH 2024)

Chairs: Yang Yang, Yidi Chen, & Zelong Meng, Beijing Forestry University, China
Local Chairs: Singh Intrachooto & Sarigga Pongsuwan, Research and Innovation Sustainability Center, Thailand & Kanda Lertladaluck, Neuroscience Center for Research and Innovation, KMUTT, Thailand

S06203: The effect of color temperature on subjective rating and neural indexes of stress and behavioral performance in a virtual environment

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Abstract

In the wake of the COVID-19 pandemic, stress has become a prevalent issue for many individuals. Chronic stress significantly affects work performance and overall well-being, leading to long-term adverse effects on mental and cognitive health. With remote work and schooling becoming increasingly common, there is a growing interest in environmental psychology and architecture to explore how factors like interior and lighting design can influence stress levels and brain function. So far, there has been a lack of experimental approaches to systematically investigate how lighting design influences stress, brain activity, and work performance. To address this gap, we developed an experimental paradigm combining scalp EEG and virtual reality (VR) systems. In this study, 19 participants performed mathematical calculations during the Montreal Imaging Stress Task (MIST) within a 3D virtual room illuminated by different color temperatures (i.e., 1700K, 2700K, 3000K, 4000K, 5500K, 6500K, and 7500K; all under light illuminance of 500 Lux). Following the MIST task, participants provided subjective ratings of stress, arousal, concentration, visual comfort, preference, and familiarity under each lighting condition.

Our results revealed that color temperature influenced both subjective stress ratings and neural stress indexes—specifically, frontal beta and gamma oscillations—in a non-linear fashion. Specifically, participants reported the highest stress levels under the very warm light of 1,700K and the very bright light of 7500K, with stress scores significantly decreasing as color temperature approached the mid-range value of 4000K (i.e., white light), resulting in a U-shaped pattern. Conversely, subjective ratings of concentration, visual comfort, preference, and familiarity followed an inverted U-shaped function, with the highest scores at 4000K and the lowest at 1700K and 7500K, indicating a negative relationship between stress and these subjective measures. On the other hand, subjective arousal scores increased linearly with color temperature and did not correlate with stress or other subjective measures. Both frontal beta and gamma oscillations exhibited a U-shaped pattern similar to stress scores, with higher beta and gamma activity during the MIST period under 1700K and 7500K, and lower activity as the light color temperature approached 4000K. After the MIST period (the relaxation period), the pattern of beta and gamma oscillations reversed, showing an inverted U-shaped function. Importantly, subjective stress scores positively correlated with beta and gamma band power during the MIST period and negatively correlated with these high-frequency EEG oscillations during the relaxation period, indicating a strong relationship between subjective and neural measures of stress.

Interestingly, behavioral performance on the MIST task was not influenced by stress or arousal alone, but by the interaction between stress and arousal levels. Specifically, superior mathematical performance was observed under the very warm light of 1700K and the white light of 4000 K compared to other color temperatures. This superior performance under white light may be attributed to low stress and medium arousal levels, while the performance under very warm light may result from low arousal levels mitigating the adverse effects of stress. In contrast, inferior performance under very bright light (7500K) may be due to excessively high arousal and stress levels, leading to suboptimal sensory and cognitive processing during the MIST period.

Taken together, our results suggest that color temperature has a non-linear relationship with stress levels in the brain. However, lighting-induced changes in stress did not directly affect behavioral performance in a one-to-one mapping. Instead, other factors, including lighting-dependent arousal may interact with stress to modulate behavioral performance. Based on our findings, we recommend using a color temperature of 4000 K for workspaces due to its association with optimal behavioral performance as well low levels of stress ratings and neural stress indexes. For relaxation areas, a color

temperature of 1700 K is advisable, as it correlates with reduced beta and gamma activity and low arousal ratings during the relaxation period. Overall, this study not only highlights the impact of environmental factors such as color temperature on stress, work performance, and related brain function but also demonstrates a feasible experimental approach that integrates VR and neurotechnology to provide neuroscientific evidence for guiding lighting and interior design to promote cognitive health and mental well-being of individuals.

Keywords: Electroencephalogram, Virtual Environment, Environmental Psychology, Stress, Work Performance
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S06201: The Role of Episode Simulation in Influencing Junior Middle School Students' Future Time Insight and Subjective Well-being

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Abstract

The purpose of this study is to understand the role of episode simulation in influencing junior high school students' future time perspective and subjective well-being, and to explore ways to improve their subjective well-being. The study was a 2(group: episode simulation group, outcome writing group) × 2(subject type: high future time perspective group, Low Future Time Perspective Group) mixed design, the subjective well-being, future time insight, achievement motivation and self-efficacy of 149 junior high school students before and after the experiment were investigated and statistically analyzed. The results showed that the post-test scores of emotional well-being and achievement motivation in the episode simulation group were significantly higher than those in the pre-test, and the scores of future negative dimensions in the control group were significantly higher than those in the experiment group ($p < 0.05$) , the experimental group scored significantly higher than the control group on the feeling of emotional distress. To some extent, episode simulation can promote junior high school students' future time perspective and subjective well-being, while writing the results is not conducive to the improvement of junior high school students' future time perspective and subjective well-being.

Keywords: Mental health, Episode simulation, Future time insight, Subjective well-being
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S06202: Self-determined or non-self-determined? Research on the influence of internal and external motivations on fund investment decisions

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Abstract

Some studies suggest that fund investment is a sound strategy, but ordinary investors often prefer to make their own buying and selling decisions rather than investing in funds. Previous studies have shown that in the face of complex fund investment choices, investors will use different in-formation processing methods and will also be affected by external environment. Therefore, based on the self-determination theory, this study divides the influencing factors of fund investment into internal motivation factors (motivation types, intertemporal decision making, future time insight) and external motivation factors (social comparison). The study comprises two sub-studies:

Re-search 1 investigates how internal motivation impacts fund investment choice; Research 2 exam-ines how both internal and external motivation factors influence fund investment choice when they coexist, as well as whether fund investment choice behavior is self-determined or non-self-determined. The results reveal that: (1) The main effects of motivation type and future time insight are significant. Intertemporal decision making interacts significantly with present fatalistic views of time. (2) Social comparison interacts significantly with future time insight and intertemporal decision making respectively. (3) The interaction between motivation type, intertemporal decision making, and future time insight was found to be significant. In conclusion, external motivation alone could not independently affect fund investment behavior. In conclusion, fund investment is a self-determined behavior primarily influenced by internal motivation.

Keywords: Fund investment, Approach-avoidance motivation, Social comparison.
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The International Workshop on Reconstruction and Modeling of the Brain at the Single-Cell Level (RMBSCL 2024)

Chairs: Yufeng Liu & Lijuan Liu, Southeast University,
Weiyao Lin, Shanghai Jiao Tong University & Guoqiang Yu, Tsinghua University, China
Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Tai Chaiamarit, Mahidol University, Thailand

S10205: High Throughput Training Label Generation from Whole Brain Images

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Abstract

Neuronal labeling--a process that transforms image volumes into 3D geometries and skeletons of cells--bottlenecks the study of brain function, connectomics and pathology. Domain scientists are limited by reconstruction methods which have insufficient accuracy to be used without proofreading. Further gains in fidelity of automatic techniques may largely come from supervised methods (e.g., deep learning), however these require unique training data which is rare especially for novel imaging or experimental settings. Current protocols for label creation are fraught with issues in automation, which are exacerbated by modern data size (30 TB in this study). Furthermore for training data, quantity but not necessarily quality is paramount, which is why augmentation and weak supervision is so effective. We introduce an application that can produce adequate training labels automatically from raw lightsheet microscopy images of whole brains. This pipeline is effective at producing both weak and strong labels of two critical categories of neurons: cell bodies (somas) and whole cells.

Keywords: computer vision, data-oriented, neuroscience, lightsheet microscopy
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S10201: BCF: An Integrated Framework to Reconstruct Whole-Brain Single-Neuron Connectivity in Mouse Brains

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Abstract

Brain network of individual neurons plays a crucial role for understanding the structural and functional organizations of a brain. With the growing endeavors of producing complete neuron morphologies at whole-brain scale, the urgency of constructing single-neuron connections among involved neurons is increasingly recognized. However, due to the imaging resolution and time cost involved, it remains challenging to identify complete representation of the brain networks. To estimate, visualize, and investigate the single-neuron connections, we develop the Brain Connectivity Framework (BCF), an open-source framework for building neuron connection networks. BCF integrates recently published methods mapping whole-brain single-neuron connectivity by partitioning and probabilistically pairing neuronal morphologies and putative boutons. The framework proves to be a reliable and extensible framework for cross-validating the brain networks using multi-scale, multi-modality data. It provides both web-based interface and python-based development environment, facilitating researchers in reconstructing brain networks at sub-neuronal levels. The BCF contributes to efforts to improve reproducibility in brain connectivity research, and offers researchers the flexibility to infer neuronal connectivity from neuronal morphologies in a standardized manner.

Keywords: brain connectivity, single-neuron morphology, connectome, mouse
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S10204: Smart Scope Platform (SSP): Enhancing Real-Time Microscopy Analysis Through Rapid Deep Learning Integration

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Abstract

Deep learning has demonstrated significant promise in analyzing a broad range of biomedical data. However, its application in smart microscopy has been constrained by considerable deployment challenges. These include the complexity of integrating deep learning with existing imaging technologies and the difficulty non-developer users face in effectively utilizing advanced analytical methods. Here, we introduce the Smart Scope Platform (SSP), a flexible, open-source computational platform consisting of an analysis server and a microscope client. This platform is designed to integrate deep learning into the real-time analysis of microscopy data streams. The microscope client encapsulates the data stream and transmits it to the server, where deep learning methods are employed to process the data. SSP provides a visual interface for real-time monitoring of data streams and for remote control of the imaging process. Through SSP, users can select customized deep learning methods for the real-time analysis of microscopy data, enabling advanced functions such as image segmentation and object tracking. This platform eliminates the need for extensive technical knowledge of deep learning frameworks and microscope hardware compatibility, thereby democratizing access to advanced data analysis for researchers and clinicians alike. SSP significantly enhances the capabilities of smart microscopy by facilitating the rapid application of deep learning technologies, thus accelerating research progress and improving diagnostic accuracy in biomedical imaging.

Keywords: Deep Learning, Smart Microscopy, Real-Time Analysis, Data Streams, Image Segmentation
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S10203: Cell Typing and Sub-typing Based on Detecting Characteristic Subspaces of Morphological Features Derived from Neuron Images

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Abstract

Recent advances in reconstructing 3D neuron morphologies at the whole brain level offer exciting opportunities to study single cell genotyping and phenotyping. However, it remains challenging to define cell types and sub-types properly due to the complexity of morphological feature spaces. To address this, we introduce a novel method to detect the optimal subspace of features, enhancing neuron classification. Applying this method to one of the largest curated databases of morphological reconstructions that contains more than 9,400 mouse neurons of 19 cell types, we have identified distinctive feature subspaces for each cell type. Our method outperforms prevailing cell typing approaches in terms of its ability to identify key morphological indicators for each neuron type and separate super-classes of these neuron types. The findings lay the groundwork for enhanced precision in neuron classification and will provide profound insights into neuronal diversity and function.

Keywords: Neuronal morphology, Optimal feature subspace, Key metrics identification, Cell typing and sub-typing, Single cell
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S10202: Build Brain Atlases with Mobile Phones: A Crowd-Reconstructing and Cloud-Mapping Platform for Brain-Wide Neuron Morphologies

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Abstract

Digital atlasing of individual neurons and associated metadata has imposed unprecedented data computing challenges on the neuroscience community. While it is widely acknowledged that the effective handling of multi-dimensional whole-brain-scale data is key to success, unfortunately, much of the effort has involved simply piling up powerful data centers and supercomputing facilities. Validating the computed results produced by such facilities is often difficult, as there has been no easy way for neurobiologists to quickly and effectively reach an agreement when the data volume becomes gigantic.

To tackle this challenge, we have developed the first mobile platform software in the field, called Hi5, to make it easy for all interested individuals to access whole-brain-scale, multi-dimensional imaging data. This is followed by effective interaction, processing, and integration of the data toward validated databasing of neuronal information in an atlas. Here, we showcase the Hi5 platform by building digital atlases of neuron morphologies using mobile phones in two key steps.

Firstly, in Hi5, we use several "Virtual Fingers" algorithms to promote critical prior information for the effective reconstruction of somas, neurite segments, branching points, axonal termini, etc., in a crowd-sourcing manner. This step ends up with an integrated morphology model of neurons from distributed mobile-phone clients.

Secondly, brain-region-specific neuron morphologies are assembled and registered to a standard brain atlas by invoking brain-image registration programs running on cloud servers to produce the final neuron database. Since each mobile client is handling only a small portion of data related to the final atlas, Hi5 makes it feasible to cross-validate multiple users' results and find agreement effectively among a large number of users working simultaneously on a data-intensive neuronal atlas.

To demonstrate the strength of Hi5, we have used it to build both a mouse brain atlas that contains 156,190 neurons based on 58 fMOST-imaged whole mouse brains, and a human brain atlas that includes 3-D reconstructed morphologies of more than 1000 human cortical neurons labeled and extracted from human ex vivo tissues.

Keywords: Mobile platform software, Hi5, Multi-dimensional data, neuron, Digital atlasing
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The International Workshop on Elucidation of Mechanistic Information using Neuroimaging for Psychiatric Disorders (EMINPD 2024)

Chair: Xiaofu He, New York State Psychiatric Institute & Columbia University, USA
Local Chair: Thitaporn Chaisilprungraung, Neuroscience Center for Research and Innovation, KMUTT, Thailand

S14204: Imaging Analysis of Calcium Activities in Brain Organoid Model of Neuropsychiatric Disorder

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Abstract

Calcium activity is crucial for numerous neuronal processes, influencing synaptic functions, neuronal communication, and overall brain activity. These dynamics offer valuable insights into both normal brain physiology and various neuropsychiatric disorders, including schizophrenia, autism, epilepsy, and Alzheimer's disease. Recently developed brain organoid models derived from patient induced pluripotent stem cells (iPSCs) present unique opportunities to monitor neurodevelopmental dynamics in real time. However, existing calcium imaging techniques have not been optimized to accurately detect calcium transients and extract meaningful data from brain organoid models. This paper introduces a sophisticated computational pipeline designed for these applications. Key steps in our analysis include data cropping to reduce computational load and noise, stabilization to correct motion artifacts, and enhanced peak detection algorithms adapted from MATLAB-based tools. We demonstrate the effectiveness of our pipeline through rigorous statistical analyses of a brain organoid model of schizophrenia, revealing significant differences in individual cell calcium activity dynamics and network features between patient and control groups. This robust tool will not only aid in identifying disease mechanisms but also provide valuable insights

into the effects of pharmacological interventions on neuronal activities across various neuropsychiatric disorders.

Keywords: Calcium Imaging, Neuronal Signal Processing, Peak Detection, Psychiatric Disorder, Drug Effect
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S14202: Predicting fMRI Signals from Single-Channel EEG Using Deep Learning

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Abstract

We present a novel end-to-end deep learning framework designed to predict fMRI signals from EEG data, aiming to combine the high temporal resolution of EEG with the high spatial resolution of fMRI for cost-effective brain signal acquisition. By directly utilizing raw EEG data and minimizing preprocessing, our method reduces potential information loss and leverages the full richness of the EEG signal to improve the accuracy of fMRI prediction. Our Encoder-Decoder architecture integrates convolutional layers to extract local temporal patterns, Long short-term memory (LSTM) units to model long-range temporal dependencies, and an attention mechanism to focus on relevant time segments, effectively capturing intricate temporal dynamics in the EEG data. The model was trained and evaluated using a publicly available dataset consisting of simultaneous EEG and fMRI recordings from 10 subjects during a theta/alpha neurofeedback experiment (Meir-Hasson, 2015). Participants were instructed to maintain a relaxed state with their eyes closed for 15 minutes, during which EEG data were recorded from the Pz electrode, and fMRI signals were obtained from the right amygdala region of interest (ROI). To evaluate performance and generalizability, we conducted rigorous cross-validation experiments using 10-fold cross-validation and leave-one-subject-out (LOSO) validation. Performance was evaluated using normalized mean square error (NMSE) and Pearson correlation as the primary metrics for comparing true and predicted fMRI signals. Our results suggest that this deep learning framework outperforms traditional baseline methods, such as ridge regression models, in predicting fMRI signals from EEG data. This framework holds promise for real-time EEG/fMRI neurofeedback applications by enhancing non-invasive brain signal acquisition techniques. Future research will focus on integrating multiple EEG channels and expanding to additional fMRI ROIs to further enhance predictive accuracy and spatial coverage.

Keywords: EEG-fMRI Integration, Deep Learning, fMRI Signal Prediction, EEG, Neurofeedback
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S14201: Two neuroanatomical biotypes of schizophrenia identified by using machine learning on brain MR images from 11,260 individuals

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Abstract

Background:
Artificial intelligence methods such as machine learning can be applied to brain imaging to categorize individuals based on their profiles of brain metrics, and holds the potential for revealing the underlying neurobiological mechanisms associated with disorder subtypes. achine learning algorithms are increasingly used to subtype brain disorders. Prior studies have primarily focused on grouping individuals into distinct categories without considering disease progression. A major obstacle to identifying distinct patterns of neuro-pathophysiological progression (referred to as progression subtypes) stems from the lack of sufficient longitudinal data covering the lifespan of the disorder. Recently, a data-driven machine learning approach known as Subtype and Stage Inference (SuStaIn) was introduced. SuStaIn uses a large number of cross-sectional observations, derived from single time-point MRI scans, to identify clusters (subtypes) of individuals with common trajectory of disease progression (i.e., the sequence of MRI abnormalities across different brain regions) in brain disorders.

Methods:
With the goal of identifying subtypes of disease progression in schizophrenia, here we analyzed cross-sectional brain structural magnetic resonance imaging (MRI) data from 4,222 individuals diagnosed with schizophrenia and 7,038 healthy subjects came from 41 international cohorts from various countries around the world, including 21 cohorts of Enhancing Neuro Imaging Genetics through Meta-Analysis (ENIGMA) schizophrenia working groups from various countries around the world, 11 cohorts collected from Chinese hospitals over the last ~10 years, and 9 cohorts from publicly available datasets. To uncover diverse patterns of pathophysiological progression from cross-sectional only MRI data and cluster individuals into groups (subtypes), we

employed SuStaIn on these cross-sectional MRI data from 4,222 individuals diagnosed with schizophrenia (1,683 females, mean age=32.4±11.9 years) and 7,038 healthy subjects (3,440 females, mean age=33.0±12.6 years).

Results:
The brain imaging-driven classification algorithm (SuStaIn) identifies two distinct neurostructural subgroups by mapping the trajectory of gray matter loss in schizophrenia. 2-fold cross-validation procedure resulted in an optimal number of K=2 biotypes (Fig.1a). Fig.1b shows that only 1.2% of people were moved from biotype 1 to biotype 2, and 7.5% were moved from biotype 2 to biotype 1, indicating that 91.3% of individuals' subtype labels were consistent. Fig.1c shows the sequence of regional volume loss across the 17 brain regions for each biotype 'trajectory'. To visualize the spatiotemporal pattern of each 'trajectory', the gray matter volume z-scores (i.e., the deviation degree in patients relative to healthy controls) were mapped to a brain template (Fig.1d). The 'trajectory' 1 displayed an 'early cortical-predominant loss' biotype, which was characterized by an initial reduction in Broca's area, followed by fronto-insular regions, then extending to the rest of neocortex, and finally to the subcortex (Fig.1d). Conversely, 'trajectory' 2 exhibited an 'early subcortical-predominant loss' biotype where volume loss began in the hippocampus, spread to amygdala and parahippocampus, and then extended to accumbens and caudate before affecting the cerebral cortex (Fig.1d). Furthermore, the SuStaIn calculated the probability of each patient belonging to a specific 'trajectory' and further assigned them to a sub-stage within that 'trajectory'. Individuals who were assigned to the later stages of the 'trajectory' showed significant correlation with less GMV of Broca's area (Fig.1e, $r=0.651$, $p<0.0001$) and hippocampus (Fig.1f, $r=0.615$, $p<0.0001$). In addition, the later stages were correlated with longer disease duration (Fig.1g, $r=0.105$, $p<0.0001$), worse negative symptoms (Fig.1h, $r=0.101$, $p<0.0001$) and worse cognitive symptoms (Fig.1i, $r=0.080$, $p=0.004$). These results suggest that the SuStaIn 'trajectory' reflects the underlying neural progression in schizophrenia.

Conclusions:
Our study reveals two distinct neurostructural schizophrenia subtypes based on patterns of pathological progression of gray matter loss. The new imaging-based taxonomy holds the potential to identify a more homogeneous sub-population of individuals with shared neurobiological attributes, thereby suggesting the viability of redefining existing disorder constructs based on biological factors.

Keywords: schizophrenia, MRI, artificial intelligence, brain, Machine learning
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S14205: Multimodal Whole-Brain Trait-like and State-like Predictors for Prolonged Exposure Treatment

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Abstract

Post-Traumatic Stress Disorder (PTSD) exhibits significant clinical and neural variability, which has complicated biomarker identification and treatment responses. To address these challenges, we aim to leverage insights from structural and resting-state brain data to identify trait-like and state-like biomarkers to determine mechanisms of change and predict treatment outcomes. Trait-like biomarkers will highlight baseline characteristics that make some individuals more receptive and responsive to treatment, whereas state-like biomarkers will help track specific, treatment-induced changes in the brain. This lock-and-key approach is aimed to enhance treatment precision, prediction, and efficacy. We will use machine learning models to predict prolonged exposure (PE) treatment outcomes, with cross-validation to ensure generalizability, bridging the strengths of neuroscience research and clinical practice for improved PTSD treatment outcomes.

Keywords: PTSD, Biomarkers, Trait-like biomarkers, State-like biomarkers, Treatment prediction
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S14203: White Matter Integrity in Youth with Suicide Ideation/Suicide Attempt, Major Depressive Disorder, and Comorbidities: A Diffusion Tensor Imaging Study

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Abstract

Suicide, driven by Major Depressive Disorder (MDD), is one of the leading causes of death among adolescents. Comorbid conditions in adolescents with Suicide Ideation/Suicide Attempt (SI/SA) are common but often challenging to assess, particularly when overlapping with disorders such as bipolar disorder and sleep disturbances. Diffusion Tensor Imaging (DTI) offers a more advanced method for analyzing white matter integrity and brain connectivity. This study uses DTI to identify specific brain connectivity patterns that differentiate comorbidities in SI/SA adolescents with MDD while also exploring how demographic factors may contribute to variations in these patterns. Participants from the baseline data of the Adolescent Brain Cognitive Development Study (n=11,868; age range: 9-10 years; 44% female) were assessed for white matter integrity using DTI, which allows for the precise measurement of white matter microstructure and the integrity of neural pathways (tracts). Statistical analyses included t-tests and Analysis of Variance to identify significant tracts. Two regression models were used: the first controlled for demographic variables (age, sex, race, parent marital status, household income, and education), and the second included an interaction term between sex and group classification while also controlling for the same demographic variables. In this way, we investigate the overall effects of the demographic variables and possible sex differences in DTI signatures. Decreased fractional anisotropy (FA) in the left fornix and increased mean diffusivity (MD) in the corpus callosum and right hemisphere were statistically significant in SI/SA MDD individuals with both sleep disturbances and no bipolar disorder compared to those with sleep disturbances & bipolar disorder. In individuals with both sleep disturbances and bipolar disorder, significant increases in MD were observed in the parahippocampal

cingulum and inferior longitudinal fasciculus compared to those with neither sleep disturbances nor bipolar disorder. The sex interactions model revealed MD differences in the left cingulate cingulum and parietal superior longitudinal fasciculus. This study highlights significant alterations in tracts like the left fornix, uncinate fasciculus, and parahippocampal cingulum in individuals with SI/SA and MDD with sleep problems and/or bipolar disorder.

Keywords: Neuroimaging Signatures, Comorbidities in SI/SA MDD, White Matter Integrity.
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The International Workshop on Computational Tools for Cognition (CTC 2024)

Chairs: Stephanie Neilli, Occidental College, USA, Ioannis Pappas, University of Southern California, USA & Nuttida Rungratsameetaweemana, Columbia University, USA
Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand; Maytus Piriyajitakonkij, The University of Manchester, UK & Agency for Science, Technology and Research (A*STAR), Singapore

S13201: Abstract learning in RNNs and Humans

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Abstract

Humans are able to rapidly assemble previously learned knowledge with minimal exposure to new information, a hallmark capability of flexibly intelligent agents. Previous work localized rapidly assembled knowledge structures to dorsal stream circuits, particularly the posterior parietal (PPC) and dorsomedial prefrontal (dmPFC) cortices. On the other hand, neural network models trained with standard stochastic gradient descent do not exhibit this type of rapid learning, instead exhibiting hallmark shortcomings concerning both continual learning and one-shot learning. Research investigating solutions to continual learning posits that neural connections essentially freeze to protect existing knowledge (Zenke et al, Kirkpatrick et al). For example, neural network models predict that connections are earmarked during learning in a way that helps future knowledge restructuring by coding certainty about relations between items (Nelli et al 2023). Understanding how training curricula influence novel learning is crucial for optimizing educational strategies and enhancing cognitive abilities. The human brain's capacity for adaptation provides a lens on the impact of training on novel learning. How are relevant relations maintained while irrelevant ones are rendered

plastic in the human brain? Do these strategies have algorithmic implications for artificial systems? Here, we designed tasks for humans and neural networks that explicitly manipulate certainty to elucidate it's role of training curricula in during learning and decision making.

Keywords: Learning, Decision Making, Electroencephalography, Neural Network Models
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S13203: What Makes a Face Look Like a Hat: Decoupling Low-level and High-level Visual Properties with Image Triplets

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Abstract

In visual decision making, high-level features, such as object categories, have a strong influence on choice. However, the impact of low level features on behavior is less understood partly due to the high correlation between high- and low-level features in the stimuli presented (e.g., objects of the same category are more likely to share low-level features). To disentangle these effects, we propose a method that de-correlates low and high-level visual properties in a novel set of stimuli. Our method uses two Convolutional Neural Networks (CNNs) as candidate models of the ventral visual stream: the CORnet-S that has high neural predictivity in high-level, "IT-like" responses and the VGG-16 that has high neural predictivity in low-level responses. Triplets (root, image1, image2) of stimuli are parametrized by the level of low- and high-level similarity of images extracted from the different layers. These stimuli are then used in a decision-making task where participants are tasked to choose the most similar-to-the-root image. We found that different networks show differing abilities to predict the effects of low-versus-high-level similarity: while CORnet-S outperforms VGG-16 in explaining human choices based on high-level similarity, VGG-16 outperforms CORnet-S in explaining human choices based on low-level similarity. Using Brain-Score, we observed that the behavioral prediction abilities of different layers of these networks qualitatively corresponded to their ability to explain neural activity at different levels of the visual hierarchy. In summary, our algorithm for stimulus set generation enables the study of how different representations in the visual stream affect high-level cognitive behaviors.

Keywords: Ventral Visual Stream, Visual Decision Making, Deep Learning for Neuroscience
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B280: Probing cellular mechanisms for working memory computation

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Abstract

Working memory (WM) is a cognitive process for providing temporary storage and retrieval of information, crucial for everyday tasks, such as learning, language comprehension, and reasoning. Persistent activity of single neurons in a distributed network of brain areas, during the retention intervals in WM tasks, is the prevailing theory of memory maintenance. However, the exact mechanisms, as well as the specific contributions of different brain regions to this process remain poorly understood. To systematically investigate how memoranda is maintained in the human brain, we used an open dataset of 902 single neurons recorded from intracranially implanted epilepsy patients from the medial temporal and medial frontal lobe during a Sternberg WM task. In this task, one to three images were presented to the patient in each trial, followed by a brief interval (delay) of 2.5 to 2.8 seconds in which a blank screen was displayed. After this period, a probe image appeared on the screen and patients were asked to determine whether the probe had previously been presented in the trial. We first identified concept cells, or cells that fire significantly more for certain images than for others, to examine their spiking patterns and firing rates across different phases of the task. In particular, we set to determine whether these cells exhibit persistent activity after the stimulus is no longer present on screen. Interestingly, concept cells did not seem to demonstrate persistent activity in the maintenance period, suggesting that the memoranda might be maintained elsewhere, or be the result of a more complex interaction between single neurons in a network of brain regions. Subsequently, we trained an SVM classifier to try and decode the image identities in each trial from the spikings of the concept cells in the delay period. Our results suggest that while concept cells do carry some information about past stimuli, contrary to previous research, they may actually decrease their activity to allow other cells or processes to take over the task of memory retention. Additionally, analysis and correlation of feature vectors, which represent the image identity presented to individual subjects, indicate that the activity, as measured by firing rate, is relatively heterogeneous across brain areas and shows no consistent relationship between different regions. Overall, our results

challenge the theory of persistent activation of concept cells during memory retention, proposing that these cells might be involved in more complex processes within a broader neural network.

Keywords: working memory, single neuron analysis, memoranda maintenance, decoding
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B282: EEG-Based Detection of Epileptic Seizures Using Convolutional Neural Network

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Abstract

Epileptic seizures are unpredictable and challenging to detect due to their intricate nature, emphasizing the need for reliable and automated diagnostic tools. This study explores the hypothesis that a 2D Convolutional Neural Network (2D-CNN) can effectively classify seizure and non-seizure EEG signals, offering a scalable solution for seizure detection. Using the CHB-MIT Scalp EEG dataset, which includes 664 recordings from 22 pediatric patients and 198 seizure episodes, EEG signals were resampled from 256 Hz to 128 Hz to reduce computational complexity without compromising essential features. The data were segmented into seizure and non-seizure windows, with 27.2% labeled as seizure events.

A custom 2D-CNN architecture was designed, featuring multiple convolutional and MaxPooling layers for efficient feature extraction and dimensionality reduction, followed by fully connected layers for binary classification. The model was trained with the Adam optimizer and binary cross-entropy loss, and early stopping was applied to prevent overfitting. A 70:30 train-test split was employed for performance evaluation.

The model achieved an overall accuracy of 84.68% and a validation accuracy of 86.04%. Evaluation across various thresholds revealed the trade-off between precision and recall. At a threshold of 0.5, the recall was 83%, demonstrating high sensitivity but with an increased false-positive rate. At a threshold of 0.9, precision improved to 30%, but recall decreased to 43%, highlighting the impact of threshold adjustments on model performance.

These findings demonstrate the feasibility of 2D-CNNs for seizure detection, with adaptability to different clinical or real-time settings by tuning thresholds to balance precision and recall. Future work will focus on improving the model's generalizability across diverse datasets and refining the architecture to enhance its accuracy and usability in real-world applications.

Keywords: Convolutional Neural Network
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B283: Parkinson's Disease Classification Using Multi-Channel Recordings from VGRF Sensors and Optimal Sensor Pair Selection

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Abstract

- Parkinson's disease (PD) is one of the most common neurodegenerative diseases, affecting millions of people worldwide, especially those over the age of 50. Conventional methods, such as clinical assessment and imaging, are often expensive and inaccessible, especially in resource-limited settings. This study proposes an approach using vertical ground reaction force (VGRF) sensors to develop an AI-driven diagnostic tool for Parkinson's disease. The research focuses on identifying gait abnormalities and selecting the most appropriate pair of VGRF sensors to increase classification accuracy and reduce potential errors.

- This study hypothesized that VGRF measured by appropriately placed sensors can provide high accuracy and low loss, which can improve the accuracy of this method for diagnosing Parkinson's disease. It is hypothesized that different sensor configurations on the foot will result in different predictive performances, based on the assumption that gait characteristics, such as step length and ankle/hip coordination, are impaired in Parkinson's disease and can be monitored with VGRF data. This study aims to develop a cost-effective, easily accessible, and standardized diagnostic tool for Thai people, which will save observation time.

- This study used the PhysioNet dataset, which consists of VGRF data from 93 Parkinson's disease patients and 73 healthy controls. The data was preprocessed, including dataset balancing to reduce model bias. The time domain signals were converted to the frequency domain using FFT. An AI model was developed and tested to classify the VGRF data and evaluate different sensor pairings using identical matching to identify which sensor positions have the greatest impact on accuracy.

Preliminary results indicate that the VGRF sensor can discriminate Parkinson's gait from normal gait with the highest accuracy of 0.82. Analysis reveals that using only 4 pairs of sensor values significantly improves the model's discrimination performance and helps to understand the optimal sensor placement for efficient data collection.

- This study highlights the potential of VGRF sensors to identify Parkinson's disease and select sensor placement locations for accurate AI models. Future research will focus on matching dissimilar sensors between both feet and integrating diagnostic tools into the Thai healthcare system more harmoniously.

Keywords: Machine Learning, Parkinson Identification, vGRF Sensor, Feature Selection, Best Pair
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The International Workshop on Mesoscopic Brain-wide Connectivity Atlas (MBCA 2024)

Chairs: Anan Li (BI24 General Chair), Huazhong University of Science and Technology, China, Junjie Zhuo & Zhao Feng, Hainan University, China
Local Chairs: Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Tai Chaiamarit, Mahidol University, Thailand

S11202: Brain Region Recognition in Micro-Optical Images Based on Feature Database Retrieval

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Abstract

With the development of micro-optical imaging technology, a fundamental challenge in neuroscience research lies in the precise delineation of brain regions of interest, traditionally accomplished by seasoned neuroanatomy experts through meticulous examination of image textures and manual boundary demarcation. This approach, while thorough, is exceedingly labor-intensive and demands a depth of neuroanatomical expertise that is increasingly unfeasible in the face of exponential data expansion. Here, we introduce an automatic retrieval and registration method based on a feature database to recognize all the brain regions in brain images. The retrieval part consists of a brain image database and a feature extraction method based on anatomical structures, which is applied to develop a feature database, and then retrieves a similar image as a reference image. Then the registration part employs a sophisticated convolutional neural network to segment feature regions within both the target and reference images which are used to register to obtain the final brain region delineation. The registration phase of our method employs a state-of-the-art convolutional neural network to segment feature regions in both the target and reference images. These segmented regions are then aligned to produce the final delineation of brain regions. Our method not only excels in efficiency, capable of autonomously identifying all brain regions in two-dimensional

mouse brain images within 5 minutes, but also in precision, delivering high accuracy even for the small brain regions.

Keywords: brain region, image retrieval, image registration, image database, micro-optical image
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S11201: Mapping Sagittal-Plane Reference Brain Atlas of the Cynomolgus Macaque Based on Consecutive Cytoarchitectonic Images

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Abstract

The brain atlas is essential for exploring the anatomical structure and function of the brain. Non-human primates, such as cynomolgus macaque, have received increasing attention due to their genetic similarity to humans. However, current macaque brain atlases only offer coarse sections with intervals along the coronal direction, failing to meet the needs of single-cell resolution studies in functional and multi-omics research of the macaque brain. To address this issue, we utilized fluorescence micro-optical sectioning tomography to obtain sub-micron resolution cytoarchitectonic images of the macaque brain at the sagittal plane. Based on the obtained 8000 image sequences, a reference brain atlas comprising 45 sagittal sections was created, delineating 270 brain regions other than the cortex. Additionally, a website was established to share the reference atlas corresponding image data. This study is expected to provide an essential dataset and tool for scientists studying the macaque brain.

Keywords: Brain atlas, Continuous 3D imaging, Subcortex, Neuroanatomy, Cynomolgus Macaque
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S11211: Sex Differences in Brain Information Processing: Insights from Specific Brain Regions and Hemispheric Connectivity

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Abstract

Investigating sex differences in various functional areas of the human brain is a prevalent and unresolved issue in understanding the brain's operating mechanisms. This research examines sex differences using Univariate and Two-way Analysis on novel fMRI data obtained with music stimuli. This study proposes a method to distinguish sex differences from individual differences and uses nonparametric statistical tests to confirm the presence of sex differences, thereby validating the method. With our proposed methodology, we found more significant functional connectivity links between the hemispheres of the female brain than in the male brain. Moreover, the male brain responds to music stimuli more than the female. Finally, we uncovered that functional regions unrelated to hearing are highly active, highlighting the role of gender differences. It is predominantly found that the posterior cingulate cortex(PCC) shows high correlations in response to music stimulation in both genders. An in-depth exploration of the PCC's dominant role in sex differences is expected to significantly contribute to research related to targeting areas of the human brain that dominate sex differences.

Keywords: sex differences · brain activity · music stimuli
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S11205: A High-Throughput Preprocessing Pipeline for Mesoscopic Optical Brain Imaging Leveraging Differential-Guided Filtering Convolutional Neural Networks

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Abstract

High-throughput mesoscopic optical imaging technology has tremendously boosted the efficiency of procuring comprehensive mesoscopic datasets from mouse brains. Constrained by the imaging field of view, the image strips obtained by such technologies typically require further processing, such as cross-sectional stitching, artifact removal, and signal area cropping, to meet the requirements of subsequent analyses. However, obtaining a batch of raw array mouse brain data at a resolution of $0.65 \times 0.65 \times 3\ \mu m^3$ can reach 220TB, and the cropping of the outer contour areas in the disjointed processing still relies on manual visual observation, which consumes substantial computational resources and labor costs. In this paper, we design a efficient deep differential guided filtering module (DDGF) by fusing multi-scale iterative differential guided filtering with deep learning, which effectively refines image details while mitigating background noise. Subsequently, by amalgamating DDGF with deep learning network, we propose a lightweight automatic segmentation method , which demonstrates robust performance on our dataset, achieving Dice of 0.92, Precision of 0.98, Recall of 0.91, and Jaccard index of 0.86. Building on the segmentation, we utilize connectivity analysis for ascertaining three-dimensional spatial orientation of each brain within the array. Furthermore, we streamline the entire processing workflow by developing an automated pipeline optimized for cluster-based MPI parallel computation, which reduces the processing time for a mouse brain dataset to a mere 1.1 hours, enhancing manual efficiency by 25 times and overall data processing efficiency by 2.4 times, paving the way for enhancing the efficiency of big data processing and parsing for high-throughput mesoscopic optical imaging techniques.

Keywords: Machine learning and deep learning, Differential guided fltering, High-throughput mesoscopic optical imaging, Mouse brain data parsing
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S11210: Efficient Neuronal Soma Segmentation Based on Segment Anything Model

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Abstract

Neuronal soma segmentation is a crucial step in whole-brain neuron quantitative analysis and neuron reconstruction. Recently, deep learning techniques have demonstrated significant performance in this task. However, these methods rely on manual annotation, which could be very time-consuming and error-prone. Additionally, applying trained models to new datasets always requires fine-tuning to avoid performance degradation. In this study, the Segment Anything Model (SAM) was applied to neuronal soma segmentation in large-scale neuron images using dots as prompts. The proposed method was validated on different datasets captured by a fluorescence micro-optical sectioning tomography system and demonstrates comparable performance with state-of-the-art methods. The proposed method has the potential to segment neuronal soma for whole brain large scale images using few manually annotated samples.

Keywords: vision transformer, neuronal soma segmentation, neuron image analysis, deep learning
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S11204: Estimate the 3D Fiber Orientation Distributions of White Matter in the Mouse Brain by Integrating Mesoscopic Nissl-Staining with dMRI Data

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Abstract

Diffusion Magnetic Resonance Imaging (dMRI) is a non-invasive imaging technique widely used in brain science research. It indirectly infers the structure of white matter fibers by measuring the diffusion properties of water molecules. However, most existing fiber tracks reconstruction methods based on dMRI focus on the macroscopic level and fail to capture detailed information about white matter fibers at the cellular or microscopic resolution. This limitation is particularly significant when trying to understand the brain's complex structure. With recent advances in mesoscopic imaging techniques, reconstructing white matter fibers at the mesoscopic level can provide more refined structural references for dMRI, thereby improving its accuracy in fiber tracks imaging. Glial cells, especially oligodendrocytes, are responsible for the myelination of white matter fibers, and their distribution and morphology directly affect the structure of fiber tracks. By combining this cellular distribution information with dMRI data, a more comprehensive understanding of white matter structure can be obtained. In this study, isotropic Nissl-stained image data of the mouse brain were collected using fluorescence micro-optical sectioning tomography (fMOST). By analyzing the distribution patterns of glial cells captured at the mesoscopic scale, particularly in white matter regions, and utilizing three-dimensional structure tensor analysis, spherical histogram statistics and least squares fitting, we estimated the directional distribution of white matter fibers across the whole brain in three dimensions. A comparative study was then conducted with dMRI data from the same spatial regions. This cross-scale comparative analysis is of great importance for understanding the mesoscopic mechanisms underlying the macroscopic structure of white matter fibers. Additionally, this study demonstrated a deep learning model using a convolutional network, with a

hierarchical calculation of loss and corresponding weighting. The model guided the estimation of the fiber orientation distributions (FODs) from dMRI data by learning white matter fiber structural features from the Nissl-stained images. Compared to traditional FODs estimation methods, such as constrained spherical deconvolution, the reconstruction results obtained using this method showed an improvement in the angular correlation coefficient by approximately 0.15, demonstrating its potential in capturing complex fiber structures. More importantly, it illustrates the feasibility of a cross-scale imaging combination method from mesoscopic to macroscopic scales. Extracting detailed information from high-resolution mesoscopic images enables a deeper understanding of the brain's fiber structure.

Keywords: diffusion MRI, deep learning, fiber orientation distributions, Nissl-staining
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S11206: Weakly Supervised Automatic Recognition Technology for Neuron Image Big Data

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Abstract

At the mesoscopic scale, the data volume of mouse brain images can reach 10 TB, while the data volume of human brain images can reach tens of petabytes. Extracting and analyzing neuronal morphology from these large brain image datasets is complex and challenging. Over the years, researchers have developed neuronal recognition algorithms based on traditional machine learning and deep learning techniques. However, traditional machine learning methods do not perform well in terms of portability and generalization. Although deep learning algorithms can enhance the generalization ability of models by utilizing large amounts of accurately labeled training data, they still face the problem of overfitting and insufficient generalization ability due to the lack of sufficiently rich labeled datasets. To address these challenges, this paper proposes a weakly supervised iterative neuron recognition framework (WSINet) based on deep learning . WSINet requires only a small amount of annotation data and generates accurate recognition results of large-scale neuron images through iterative strategies. This method shows strong generalization ability while minimizing human intervention. The framework was trained on 300 labeled neuronal datasets, each with a size of 100×100×100. WSINet generates pseudo labels for unlabeled data and approximates them to the real labels through iterative optimization while correcting topological errors that occur during iteration. By labeling weak signals, deleting error signals, and connecting broken areas, the iterative process is significantly shortened and the accuracy of labels is improved. In addition, WSINet enables the generalization of new data through transfer learning, eliminating the need for additional annotated data. We evaluated WSINet on several important datasets. In the experiment, WSINet achieves F1 scores of 0.9247 and 0.8318 respectively in the automatic recognition accuracy of fMOST and BigNeuron datasets, which is superior to other comparison algorithms. In addition, WSINet successfully met the challenge of large scale brain

data, such as whole-brain mouse and cynomolgus monkey brains, demonstrating its robustness and effectiveness in processing complex large-scale datasets.

Keywords: Weakly supervised learning, Deep learning, Neuron recognition, Iterative learning
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S11209: BrainScope-SAM3D: An Automatic Segmentation Model for High-Throughput and High-Resolution Microscopic Brain Images

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Abstract

The rapid advancement of microscopic optical imaging technology has posed higher demands on the segmentation and analysis of high-resolution microscopic images. While the Segment Anything Model (SAM) has demonstrated exceptional generalization capabilities in natural image segmentation, its performance in biomedical image segmentation, particularly in microscopic optical images, has been suboptimal. In brain science research, especially for microscopic optical images with complex tubular structures such as blood vessels and neurons, existing models still lack the ability to effectively utilize depth continuity in three-dimensional information, necessitating an expansion of model capabilities to meet the demands of high-throughput segmentation and analysis. To address this, we proposed BrainScope-SAM3D (BS-SAM3D) model, which extends the 2D segmentation capabilities of SAM to three dimensions, offering a novel approach for a deeper understanding of the spatial relationships and morphological details of cells and tissue structures in the brain.

BS-SAM3D enables more comprehensive and precise segmentation of volumetric data. The core components of the model include Automatic Prompt Segmenter and Segmentation Optimizer, where we have innovatively redesigned the Image Encoder from SAM, Automatic Prompt Encoder, and a Coarse-to-Fine Decoder to adapt to the volumetric characteristics of 3D data and the continuity in the depth direction. These improvements not only enhance the model's efficiency and robustness but also its ability to capture complex details and structures in 3D images. We validated the performance of BS-SAM3D on eight benchmark datasets using IoU and Dice as evaluation metrics, achieving state-of-the-art results in all cases. BS-SAM3D realized more precise anatomical structure delineation and pathological change recognition in 3D segmentation, laying a crucial foundation for a deeper understanding of functional connections within the brain and meeting the demand for automated, precise, and robust extraction of 3D structures and morphological information in brain images.

BS-SAM3D is expected to play a significant role in various applications in both basic research and clinical diagnostics.

Keywords: high-throughput, high-resolution, microscopic optical image, Automatic Segmentation Model, BrainScope-SAM3D
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Title: Specialized Inputs and Outputs Patterns of Different Cerebellar Modules
Invited Speaker: Zhenyu Gao
Institution: Erasmus MC, Netherlands

S11207: A Computational Pipeline for Spatial Distribution of the Whole-Mouse-Brain Vasculature

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Abstract

The study of cerebral vascular structure and morphology is crucial for understanding brain function and for the prevention and treatment of cerebrovascular diseases. Calculating indicators such as total brain vascular length density and bifurcation point density provides a reference for understanding the functional activity of different brain regions. Traditional research methods based on statistical analysis of isolated brain region vascular indicators cannot capture the spatial distribution characteristics of vessels across the entire brain. To address this, this paper proposes a method for calculating the spatial distribution of brain vascular density. First, we use a 3D convolutional neural network model to segment whole-brain vascular images from fMOST imaging of mouse brains. Next, we perform skeletonization of the 3D vascular segmentation images and obtain vessel diameter information through distance transformation. Finally, we filter capillaries based on vessel diameter and fuse multiple whole-brain datasets. The entire process is accelerated using MPI parallel processing and multithreading technology. Results indicate that this method effectively captures the common distribution characteristics of vasculature and reveals the spatial distribution of vascular density across the entire brain. This method provides a powerful tool for whole-brain vascular research.

Keywords: Whole-brain vasculature, Vasculature, Vascular distribution, fMOST
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S11203: Characterization of AD Mice Brain Images Reveals Spatiotemporal Developmental Change Properties of Plaques Under Different Morphologic Classifications

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Abstract

β-amyloid (Aβ) plaques are one of the pathological features of Alzheimer's disease (AD), and their different morphologies and distributions throughout the brain during development may provide important information for studies related to AD pathology and treatment. Limitations in imaging resolution and a lack of relevant analytical methods have resulted in the absence of studies that comprehensively elucidate the development of plaques on a brain-wide scale, using the individual plaque as the unit of analysis. By combining fluorescence micro-optical sectioning tomography (fMOST) imaging, this study constructed an image feature-based method that can characterize the morphologic classification of plaques and provide a more detailed interpretation of the pattern of change in the development of plaques in AD mice brain. We mapped the spatiotemporal distribution of Aβ plaques in the mouse brain based on existing morphologic classifications of plaque development patterns (Core, Diffuse, Cerebral Amyloid Angiopathy), and determined that plaques developed in a trend from peripheral to medial, from olfactory to caudal. Among them, there was a high concordance between the Core plaque high load regions and key brain regions involved in AD functional regulation (e.g., Subiculum, Mammillary body). Further, we combined the image features and spatiotemporal distribution features to perform information-based clustering on 5×FAD mice brain plaques, and found significant differences in plaque categories between the olfactory and caudal ends of the brain; meanwhile, there was a significant category difference between different nuclei within brain regions, which is not consistent in degree across mouse ages but follows a trend of first increasing and then decreasing in most brain regions. In addition, we found that the distribution of plaque feature values showed high similarity within brain regions and significant differences between brain regions. We summarized the features that changed most significantly with age as windvane features, which are more useful in

describing the relationship between Aβ plaques and the course of AD. The methods and conclusions proposed in this study may provide assistance in investigating the mechanisms associated between Aβ plaques and the progression of AD course.

Keywords: Aβ plaques, Feature analysis, Morphologic classifications, Spatiotemporal distribution, Information-based clustering.
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S11208: In Vivo MRI-Based Pipeline for Cross-Modality Macaque Brain Registration

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Abstract

Cell architecture imaging and fluorescence imaging are optical staining techniques widely used to study biological tissues and cellular structures. In recent years, these imaging techniques have been frequently employed in research on brain connectivity and neural fiber tracing. As a result, there is an increasing demand for more accurate multimodal registration and brain region segmentation. Currently, the most commonly used multimodal registration methods include mutual information registration, point cloud registration, and morphology-based registration. While these methods have shown promising results in mouse brains, the more complex brain structures and greater individual variability in non-human primates, particularly in monkeys, present significant challenges. Additionally, ex vivo deformation during brain slicing exacerbates these challenges, leading to difficulties in accurately registering many cortical and some internal brain structures, which in turn affects the precision of subsequent analyses. To address these issues, we propose a novel multimodal registration method. By using in vivo MRI as a mediator, our approach employs deep learning to perform modality transfer of fMOST imaging, enabling precise registration between fMOST images and a standard monkey brain template.

Keywords: Cross-Modality, Self-MRI in vivo, Modality transfer
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The 2024 International Workshop: Web Intelligence meets Brain Informatics (WImeetsBI 2024)

Chairs: Jianzhuo Yan, Jianhui Chen & Jiajin Huang, Beijing University of Technology, China
Local Chairs: Kajornvut Ounjai, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand

B270: Dual-Structural Representation Learning with Attention-Based Graph Fusion for Hierarchical MCI-AD Diagnosis

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Abstract

The integration of AI, big data, and magnetic resonance imaging (MRI) has significantly advanced healthcare, particularly in the early diagnosis and treatment of neurodegenerative diseases. Alzheimer's Disease (AD), which predominantly affects the elderly, and its precursor, Mild Cognitive Impairment (MCI), present considerable challenges in early detection due to the complex structural changes in the brain. Traditional diagnostic methods often struggle to capture these intricate changes. To address this, the systematic Brain Informatics methodology is reconsidered to realize evidence combination based on dual-structural representation and fusion computing via attention-based graph. In particular, the DS-AGF (Dual-Structural Representation

Learning with Attention-Based Graph Fusion) model was proposed for hierarchical MCIAD diagnosis. This model employs a dense convolution unit and a node optimized convolution unit to learn multi-level, fine-grained brain representations. Additionally, an attention-based graph representation fusion unit is introduced, enabling the integration of these representations and allowing the model to capture both local and global relationships between brain regions. This approach enhances the network feature learning ability on critical features, enabling multi-view visualization of key brain regions and their connectivity.

Keywords: Brain Informatics, Evidence Combination and Fusion Computing, DS-AGF Model, Mild Cognitive Impairment, Alzheimer's Disease, Hierarchical Diagnosis, Representation Learning, Attention-based Graph Fusion
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B269: An Auxiliary Diagnosis Method for Mild Cognitive Impairment Based on Structural Magnetic Resonance Image

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Abstract

Mild cognitive impairment (MCI) is regarded as an early stage of Alzheimer's disease (AD), and early diagnosis is essential for timely intervention in disease progression. However, the features extracted by existing methods often exhibit poor performance, and many diagnostic approaches fail to adequately integrate clinical information. Structural Magnetic Resonance Imaging (sMRI) is widely used in clinical settings due to its high signal-to-noise ratio, robustness against artifacts, and ability to provide stable morphological features. In this study, we proposed a framework based on sMRI image data and clinical information for the diagnosis of MCI, particularly utilizing gradient extraction to enhance the representation of brain structures. Firstly, we constructed a morphological brain network by extracting intensity and texture features from sMRI images and computed the global gradients of the brain network. These global gradients were used as node features representing brain regions, enabling the learning of individual embeddings. Next, by concatenating cognitive scores with the learned embeddings, we constructed node features for each individual in the population graph. We then calculated the correlations between risk factors (e.g., age, gender, and APOE gene) to define edge features in the population graph. Finally, we applied population graph learning to classify MCI. The results demonstrated that leveraging global gradients significantly improves diagnostic accuracy for MCI, offering promising insights for future clinical applications. The code is available at https://github.com/AstonshisL/PopGradientGNN.

Keywords: Graph Neural Networks, Global Gradients, Structural Magnetic Resonance Imaging, Mild Cognitive Impairment, Auxiliary Diagnosis.
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S03204: Differences in the Local Morphology of Bilateral Functional Brain Networks During the Visual Word Recognition Task

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Abstract

In order to investigate the topological disparities between the bilateral functional brain networks during visual word recognition in a task-oriented setting, we utilized the tfMRI data from 45 subjects sourced from the OpenfMRI project database, specifically focusing on Word and Object Processing. Based on the anatomical brain atlas Automated Anatomical Labelling (AAL), we constructed the bilateral functional brain networks under both word and consonant string conditions. Subsequently, we conducted statistical comparisons of the degree centrality, global efficiency, clustering coefficient, and local efficiency between the two hemispheres. Furthermore, we explored the relationship between the regions of interest (ROIs) defined by AAL and the language network outlined in the Willard-499 functional brain atlas. Our analysis revealed significant statistical differences in the brain network indices between the bilateral hemispheres within the sparsity domain under both experimental conditions. Specifically, under the consonant string experiment, we observed zero significant differences across all four indices. However, under the word experiment condition, we identified significant differences in 0%, 5%, 0%, and 44% of the indices, respectively. Notably, a stark contrast emerged in the percentage of significant differences between the clustering coefficient and local efficiency under the word experiment condition. These findings suggest that during visual word recognition, the bilateral functional brain networks can be differentiated in terms of their local morphological characteristics.

Keywords: visual word recognition, task-evoked functional magnetic resonance imaging, functional brain network, visual word form area, brain atlas comparison
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S03203: A Multi-loop Approach Reveals Pattern Differences of Inductive Reasoning in DLPFC and SPL

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Abstract

Recent findings in the field of neuroimaging have greatly enriched our understanding of the process of human inductive reasoning. However, as an extremely complex cognitive activity, inductive reasoning involves multiple cognitive functions such as attention, memory, executive function, symbol processing, and fluid intelligence, and requires the collaborative participation of multiple brain regions. Therefore, achieving a unified and transparent understanding of human inductive reasoning from different datasets presents formidable challenges. This paper proposes a multi-loop based integration analysis framework of multiple source brain data. By employing representational similarity analysis and multi-task functional neuroimaging analyses, this framework combines internal evidence, i.e., multi-source functional neuroimaging data, and external evidence, i.e., knowledge from published neuroimaging articles, to reveal different neural mechanisms of inductive reasoning in DLPFC and SPL. Experimental results reveal the intricate uncertainty surrounding brain localization in human reasoning.

Keywords: inductive reasoning multiple sources integration and fusionmulti-loop-learning.
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S03202: Adaptive Connectivity-Driven Parallel Graph Convolution Transformer Network for EEG Emotion Recognition

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Abstract

The field of affective computing is increasingly attracting attention from various disciplines, and electroencephalogram (EEG) signals, with their ability to accurately reflect brain activity characteristics, have been widely used in the research and practice of emotion classification. The intricate spatial dynamics within EEG signals are crucial for decoding emotional states. However, how to effectively extract both global and local spatial features remains a significant challenge. To address this issue, we propose an Adaptive Connectivity-Driven Parallel Graph Convolution-Transformer Network (AGTnetwork) for EEG-based emotion recognition. Firstly, an adaptive adjacency matrix is introduced by dynamically learning correlations between electrodes rather than relying on artificial methods. Secondly, graph convolutional neural network (GCN) is employed to extract local spatial features based on the learned adjacency matrix. In parallel, Transformer is utilized to extract the global spatial features by integrating functional connectivity information derived from the learned adjacency matrix into the computation of the attention mechanism. Finally, the global feature and the local feature are concatenated to derive a more comprehensive and discriminative feature representation, which is then used to classify different emotion states. Our proposed model is evaluated on the SEED dataset using subject-independent experimental paradigm. Specifically, we employ leave-one-subject-out (LOSO) cross-validation, where one subject's data serve as the test set and the data from all other subjects are used for training. The mean accuracy across all subjects reaches to 84.10%, demonstrating the competitive performance achieved by the proposed model.

Keywords: Adaptive Connectivity, Graph Convolution Network, Transformer
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The 6th International Workshop on Cognitive Neuroscience of Thinking and Reasoning (CNTR 2024)

Chair: Peipeng Liang, CNU School of Psychology, China
Local Chairs: Kajornvut Ounjai, Neuroscience Center for Research and Innovation, KMUTT, Thailand & Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand

B246: Evaluating Inductive Reasoning of Large Language Models: A Cognitive Psychology Approach Using Number Series Completion

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Abstract

In recent years, the rapid advancements in artificial intelligence (AI), particularly in the development of Large Language Models (LLMs), have sparked significant interest in understanding their cognitive capabilities. One key area of focus is their capacity for inductive reasoning, a fundamental cognitive process involving the generalization from specific instances. Inductive reasoning is not only crucial for human learning and decision-making but also plays a pivotal role in various scientific and analytical tasks. As AI systems are increasingly relied upon in areas requiring sophisticated reasoning, it is essential to rigorously evaluate the extent to which these models can replicate human-like inductive reasoning.

The central question driving this study is: Are Large Language Models truly capable of inductive reasoning? This question remains a topic of debate within the academic community. On one hand, there is evidence suggesting that LLMs do exhibit notable inductive reasoning capabilities. These findings suggest that LLMs possess a certain level of cognitive sophistication that enables them to engage in tasks requiring inductive reasoning. However, the picture is far from clear-cut. Some reports have highlighted

significant limitations in the inductive reasoning capabilities of even the most advanced LLMs. An illustrative example of these limitations is the poor performance of LLMs on the "Artificial Intelligence Wisdom" (AIW) test, particularly in understanding nuanced gender roles. These studies indicate that while LLMs may perform well on certain types of inductive tasks, they fall short when faced with more complex or unfamiliar challenges. The inconsistency in performance across different studies underscores the need for a more nuanced and comprehensive evaluation of LLMs' reasoning abilities.

To address this gap, our study proposes a novel approach to assessing the inductive reasoning capabilities of LLMs by utilizing methodologies from cognitive psychology. By treating LLMs as participants in psychological experiments, we can apply well-established cognitive tasks to these models and directly compare their performance with that of human subjects. One of the primary tasks in our study is the number series completion task, a widely recognized measure of inductive reasoning. This task requires participants to identify patterns within a sequence of numbers and predict the next element in the series, such as in the example “1, 5, 9, 13, 17, ?”. Successfully completing such tasks relies on several cognitive processes, including relation detection, discovery of periodicity, pattern completion, and extrapolation.

We generated 120 items for the number series completion task, each based on four critical stimulus characteristics: period length, relationship complexity, working memory demand, and arithmetic operation. These characteristics were carefully selected to ensure that the tasks varied in difficulty and could challenge both human participants and LLMs. To maintain the integrity of the assessment, we adhered to several principles in task creation. First, we controlled for task difficulty by generating fewer items at higher difficulty levels. Second, we controlled for computational load by limiting the initial numbers in all items to within 5, restricting multipliers in multiplication operations to 2 or 3, and setting addends in addition operations between 1 and 4. This careful design allowed us to create a dataset covering 11 types of problems, which performed well across various measurement indices. Specifically, the internal consistency reliability of the dataset was found to be 0.97, while the split-half reliability was 0.848. Additionally, the correlation coefficient with the Raven’s Progressive Matrices test, a standard measure of cognitive ability, was 0.60 ($p < 0.01$), indicating strong calibration validity.

In the comprehensive evaluation of LLMs' inductive reasoning capabilities, we conducted a detailed examination of their performance across a series of tasks. To ensure a rigorous and methodologically sound assessment, we meticulously designed a variety of prompts specifically tailored to challenge and probe these reasoning abilities. Moreover, by deliberately isolating the arithmetic operation components from the reasoning tasks, we were able to accurately determine whether the outcomes of our inductive reasoning tests were influenced by the models' numerical calculation abilities, and to what extent this influence manifested. This separation is crucial for understanding the underlying mechanisms at play and ensures that our assessment of inductive reasoning remains focused and untainted by extraneous factors.

Our evaluation of GPT-3.5, GPT-4, and MathGPT, a model specialized in mathematics, revealed that while LLMs demonstrate some ability to engage in inductive reasoning, they fall significantly short compared to human participants, particularly on tasks involving complex numeric patterns. Additionally, the LLMs' performance on arithmetic operation tasks was not inferior to that of human participants, suggesting that their poor performance on inductive reasoning tasks was not due to computational load. This finding underscores the inherent limitations of current LLMs in performing tasks that require deep cognitive processing and generalization.

Our study leverages cognitive psychology tools to evaluate the inductive reasoning capabilities of LLMs, providing a nuanced understanding of their cognitive processes. By dissecting the reasoning mechanisms within these models, we contribute to the ongoing discourse on the strengths and limitations of current AI technologies. The insights garnered from this analysis not only deepen our comprehension of LLMs but also serve as a foundational guide for the development of more sophisticated models in the future. As AI continues its rapid advancement, addressing the inherent limitations of these models becomes increasingly imperative. By enhancing their ability to emulate human reasoning, we can unlock new potential in the application of large models across various domains.

Keywords: Large Language Models (LLMs), Inductive Reasoning, Number Series Completion Task, Cognitive Psychology, Evaluation
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S04201: The Influence of Stimulus Similarity and Reasoning Content on Inductive Reasoning Generalization: Behavioral and Neural Perspectives

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Abstract

Objective: Inductive reasoning is a key cognitive process that helps individuals make decisions and inferences under uncertainty. The study examines how stimulus similarity and reasoning content affect generalization in inductive reasoning, while also exploring the underlying neural mechanisms using functional near-infrared spectroscopy (fNIRS).

Methods: Using a 2(content: harm, benefit) × 2 (stimulus similarity : high and low similarity) within-subjects design, participants were presented with a scenario involving a newly discovered animal with incomplete information. Participants rated the generalization of target attributes (beneficial or harmful) on a 1-10 scale.

Results: Behavioral data results showed that, particularly under low similarity conditions, participants exhibited significantly higher levels of generalization in the "harm" condition compared to the "benefit" condition. And fNIRS data indicated a significant negative correlation between generalization levels and brain activation in the supramarginal gyrus and the frontopolar cortex under the low similarity "harm" condition.

Conclusions: The findings of this study demonstrate that reasoning content and stimulus similarity significantly influence the generalization process in inductive reasoning, particularly when dealing with potentially harmful attributes. Even under low similarity conditions, individuals are more inclined to generalize harmful attributes. This phenomenon may reflect a cognitive bias in humans when facing uncertainty and potential threats, with the prefrontal cortex playing a key role in this process. The study not only enhances our understanding of the inductive reasoning process and the neural mechanisms.

Keywords: Inductive Reasoning, Functional Near-Infrared Spectroscopy (fNIRS), Generalization, Similarity
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S04203: The Contributions of Hippocampal Subregions in Transitive Inference

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Abstract

The capacity for reasoning is a core feature of human cognition. Previous research has consistently highlighted the hippocampus as a key brain region involved in transitive reasoning. However, the functional role of the hippocampus in this process remains controversial, particularly regarding whether it supports transitive inference abilities through relational cognition and representation. Recognizing that distinct hippocampal subregions contribute uniquely to cognitive functions, this study utilizes 7T ultra-high-field MRI to conduct focused functional imaging of the hippocampal region. This approach aims to achieve a more precise examination of the fine structure and functional characteristics of hippocampal subregions during graph-based and language-based transitive reasoning tasks. We found that the anterior right hippocampus is predominantly activated during spatial representation in language-based tasks, facilitating coarse-grained spatial encoding, with activation intensity surpassing that observed in graph-based tasks. These results indicate the distinct roles played by different hippocampal subregions in transitive inference.

Keywords: 7T, hippocampus, transitive inference
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The International Workshop on Multimodal Computational Approaches for Brain Biomarkers Discovery (MCABBD 2024)

Chairs: Hieu Pham, VinUniversity, Vietnam & Nguyen The Hoang Anh, Vietnam – Korea Institute of Science and Technology, Vietnam

Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand

S09201: Development and Evaluation of Multimodal AI Framework for Mental Health Assessment: A Preliminary Study

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Abstract

Background:
The global incidence of mental health illness is rising, with a notable increase in anxiety and depression in low and middle-income countries. The widening gap between demand and resources in mental health services has led to a significant shortfall in addressing the issue. Previous works highlight the potential of passive sensing data from wearable devices and smartphones as physiological and behavioral indicators, with artificial intelligence (AI) integration enhancing the screening's efficacy at scale. However, most studies inadequately evaluated how digital phenotyping (DP) is connected to clinical outcomes while limiting AI's assessment capability. Hence, it is essential to establish an innovative approach to facilitate insights across different aspects.

Objectives:
In this study, we first aim to investigate the usability and clinical validity of the derived features from DP data. Next, we build and validate a novel multimodal AI framework for early mental health screening and assessment. Then, we evaluate the framework of our designed preliminary cohort.

Methodologies: Our approach includes two main stages:
In stage 1, we used a recent cohort (K-EmoPhone) to extract in-situ affective and cognitive states, multimodal sensor data, and mental health surveys on 77 college students within a week. A data serialization and domain-specific feature extraction pipeline is designed, followed by calculating its utility relevance compared to the psychometric questionnaires. Next, a novel knowledge-based multimodal machine-learning model will be developed and evaluated for clinical score prediction tasks.
In stage 2, a cloud-based app will be built for data aggregation from Fitbit wristband, smartphone sensors, and self-reports (DASS, PHQ, GAD). We plan to collect a preliminary cohort (n=30) of Vietnamese people for 1 week, with a primary diagnosis of anxiety, depression, and control. The proposed modeling framework will be then evaluated for two different modeling tasks: (1) to predict mental health outcome scores and (2) to assess the subject's status via model classification. We evaluate its robustness when compared to conventional regressors and classifiers, across two different cohorts.

Expected Results:
First, we anticipate uncovering new findings on the public dataset about biosignals related to mental health outcomes. Secondly, we expect to explore key designs to make a robust multimodal AI system that can be generalizable for two different cohorts. In the next phase, we plan to develop a large-scale, high-quality multimodal mental health database for the Vietnamese population, emphasizing depression and anxiety research. Additionally, we expect to contribute a secure, reliable, and accessible platform for ubiquitous data acquisition that can be efficiently shared among users, researchers, and clinical experts. Finally, we aim to enable collaborative mental health research efforts to evaluate and deploy the AI-based system in low-resource settings.

Keywords: mental health, real-time screening, depression and anxiety, multimodal AI, digital phenotyping
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S09202: Development of AI-Enhanced Prediction Tool for Individualized Psychopathological Profile in Low-and-Middle-Income Countries

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Abstract

Background:
Artificial intelligence (AI) applications in mental health care are promising and are increasingly focused as AI helps tremendously with early detection, daily monitoring and personalized intervention. However, most current AI tools developed use the DSM-5 or ICD-11 as the theoretical basis for categorization of psychopathology (Olawade et al., 2024; Lee et al., 2021) to target diagnosis and treatment of specific mental disorders such as depression and anxiety. Therefore, these tools share the same limitations with these guidelines since they are similarly categorical and disorder-focus. Notably, poor mental health assessment quality (comorbidity and misdiagnosis problems), lack of personalized care and excessive "unspecified illness" diagnoses are common problems stemming from the guidelines (Kotov et al., 2017). Moreover, most of the mentioned AI tools focus on one or few specific mental disorders, hence, the comprehensive profile of clients' psychological state might be overlooked.

Addressing the shortcomings, current innovations in psychopathology research have increasingly shifted the focus of the field to alternative views of mental disorders, namely transdiagnostic dimensions and network approaches (Eaton et al., 2023). The transdiagnostic dimensions approach, representative by the Hierarchical Taxonomy of Psychopathology (HiTOP) model, views psychopathology as continuous dimensions with different levels of factors, while the network approach highlights the interconnection of mental health symptoms in forming a system governing an individual's mental status. Both approaches enhance mental health assessment by allowing for symptom co-occurrence of unrelated disorders, limiting ambiguity in diagnoses, and fostering individualized interventions. Additionally, the two approaches offer effective means of visually representing an individual's current mental state. Thus, an AI model combining data-driven theoretical foundations of both transdiagnostic

dimensions and network approaches to psychopathology shows potential to advance mental healthcare.

Objectives:
In this study, we aim to develop an AI tool for generating an individualized risk profile of a client's current symptom components and psychopathological traits. Specifically, our study focuses on predicting components and traits of internalizing mental disorders, which includes highly prevalent disorders such as depression, bipolar disorders and anxiety.

The tool is, then, validated in Vietnam mental healthcare systems and psychiatric institutions.

Proposed Methodology:
This study is conducted in three phases: (1) model building, data collection, and scale validation, (2) model training, and (3) application in practice and clinical settings.
In phase 1, we propose a deep learning model, including a main module to learn the comorbidity of symptoms, enhanced by another graph neural network learning the taxonomy of HiTOP. We, then, propose a Risk-aware Taxonomy-enhanced Symptom Encoder (RiTaSE) to aggregate all and encode raw symptom embeddings with their severity level into rich-information representations, before feeding it to a Transformer-based encoder to learn the correlation between each component and the others.

In the meantime, we aim to gather large, reliable and high-quality datasets for model training in the following phase. This involves validation of different questionnaires, including the developing HiTOP-SR, in Vietnamese population, collection of a sizable and employable sample enabling statistical significance, and standardization and mapping of symptoms from different questionnaires to the HiTOP framework. Additionally, a language model for generating input questions is also developed in this phase to minimize the number of screening items needed for an accurate and comprehensive psychopathological profile.

In phase 2, the focus is to train the proposed model using the collected dataset and the validated HiTOP-SR questionnaires. Model architecture is also adjusted if needed while training. Theoretical evaluation will be conducted by splitting the dataset into parts for training and testing. During this phase, we also plan to implement an ablation study to

gain explainability over the computation, which is essential in clinical and practice settings.

Phase 3 is highlighted by piloting and evaluating the tool in psychological and psychiatric practice settings. The design of this phase involves psychiatrists, psychologists and counselors implementing the tool in their practice, using symptoms collected via observation, screening questionnaires or data already obtained of their ongoing clients, to test model accuracy and feasibility. Adjustments for enhanced applicability in practice are also expected in this phase. In this phase, practical utility of the tool in periodic evaluations for remission monitoring and assessment of intervention effectiveness is emphasized.

Expected Outcomes:
Our proposed solution, to the best of our knowledge, will be the first attempt utilizing AI-powered tools to predict individualized psychopathological risk profiles of the most prevalent mental disorders (disorders related to internalizing) in low-and-middle-income countries (LMICs). Thus, we expect to contribute a new AI model and new knowledge in assessing this issue. Secondly, we anticipate contributing new insights relating to symptom networks and symptom comorbidity in LMICs, hence, expanding cross-cultural understanding of the paradigm-shifting framework in HiTOP. Lastly and most importantly, in clinical settings, our AI-powered psychopathological risk profiling tool is envisioned to enhance the processes of initial screening and diagnosis. Furthermore, the tool, via tracking the client's mental health in periodic evaluations, enables assessment of intervention's effectiveness and hybrid remission monitoring for both post-intervention and ongoing clients. These applications can be used to advise check-up frequency and client transferring process between counseling, psychological and psychiatric services, hence, timely intervention for relapses can be delivered.

Future work:
In the future, with the findings of the current study being achieved, we plan to extend the work in terms of both dimension and time. Specifically, we intend to expand the tool to include all dimensions of the HiTOP framework, meaning that the tool will allow prediction of more comprehensive profiles of psychopathological traits, not limiting to internalizing disorder as the current study. Additionally, building on the findings of the current study, a different AI model predicting future transition from healthy to clinical state is planned to be developed using time-series data as well as biological and social factors for model building.

Keywords: psychopathological profile, graph neural network, AI-enhanced model, mental health disorders
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The 4th Special Session on Explainable Artificial Intelligence for Unveiling the Brain: From Black-Box to Glass-Box (XAIB 2024)

Chair: Chiara Camastra, Neuroscience Research Center, Department of Medical and Surgical Sciences, Magna Graecia University of Catanzaro, Italy
Local Chairs: Titipat Achakulvisit, Department of Biomedical Engineering, Mahidol University, Thailand & Duanghathai Wiwatratana, Neuroscience Center for Research and Innovation, KMUTT, Thailand

B278: A Convolutional Neural Network with Feature Selection for Generating Explainable 1D Image Information for Brain Disease Diagnosis (online)

Luna M. Zhang[1]

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Abstract

An explainable and efficient convolutional neural network (CNN) consists of convolutional layers, a new feature selection (FS) layer, a classifier, and a novel patch row-column ranking map" (PRCRM). The PRCRM contains ranked image patch rows and ranked image patch

columns that have useful 1D information associated with decisions of the CNN. Top-ranked common features selected by different FS methods are used to generate the feature accumulation matrix". The feature accumulation matrix is used to rank image patch rows and image patch columns in the PRCRM to explain the relationship among an input image, top-ranked features, top-ranked feature maps, and the final classification decision. Simulation results using the Alzheimer's disease (AD) MRI pre-processed dataset for 4-class image classification with 6,400 128 × 128 images indicate that patch rows 6 and 11 (12.5% of 16 patch rows) and patch columns 7 and 8 (12.5% of 16 patch columns) are related to 27 distinct brain areas (48.2% of the 56 brain areas associated with AD), and 13 brain areas (28.9% of the 45 brain areas likely associated with AD). In addition, they are not associated with any brain areas not likely associated

with AD. The fine-tuned ResNet50-FS model using a small number of selected features is more accurate and more memory-efficient than the traditional ResNet50 model using all features. Thus, the new patch row-column ranking method can generate useful 1D image-row-column information to interpret decisions of a CNN model. The hybrid 1D-2D-3D information in important brain areas associated with the top patches, top patch rows, and top patch columns could be used to make robust and explainable brain disease diagnosis.

Keywords: Deep learning, feature selection, Alzheimer's disease, explainable brain imaging, image row-column ranking
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B244: Probing Temporal Filters of Vision via a Falsifiable Model of Flicker Fusion (online)

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Abstract

This work trains a Deep Neural Network (DNN) based model of flicker fusion with human psychophysics data. The convolution filters of DNNs trained on natural images acquire the features of gabor filters. Similarly the convolution filters of the DNN trained with temporal psychophysics data acquired symmetrical features. Derivatives of gaussians and gabor funcations found in human visual systems are often symmetric. The predictions made by the DNN on a complex flicker stimulus was tested with psychophysics experiment. The model is shown to be falsifiable and can be improved with further training.

Keywords: Flicker Fusion, Cognitive Computational Neuroscience, Spatio-temporal Vision, Deep Learning
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B212: A Comparison of ANN-Optimization and Logistic Regression – An Example of the Acceptance of EEG Devices (online)

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Abstract

We analyze a dataset which measures the acceptance of EEG home- monitoring dependent on different variables, such as personnel characteristics, for example. A standard approach to model these relations is the logistic regression. Another one is an ANN (Artificial Neural Network). We used 70% of the dataset to determine parameters and the remaining 30% to compare predictions with out-comes and measure the performance of both approaches. Both methods result in good predictive success. Surprisingly, the logistic regression is slightly better than the ANN. The ordering of the variables according to their importance is different in both approaches (rank correlation coefficient of -0.28). Therefore, the interpretation of the data crucially depends on the method. The use of these methods depends on which information is available: a full model as in the logistic regression or only the variables or the use of different optimization criteria in the approaches. We discuss this result.

Keywords: Artificial Neural Network, Logistic Regression, EEG home-monitoring.
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The International Workshop on Application of Artificial Intelligence and Innovative Technologies in Brain Informatics and Health (AAIITBIH 2024)

Chair: Zhijiang Wan, Nanchang University, China
Local Chairs: Kejkaew Thanasuan, Media Technology Program and Neuroscience Center for Research and Innovation, KMUTT, Thailand & Sittiprapa Isarangura, Mahidol University, Thailand

B213: Integrating Multimodal Spatiotemporal Brain Data with Spiking Neural Networks

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Abstract

When modelling different types of brain data that vary in both space and time, relying on a single modality of data only offers a partial insight into the complex patterns of brain activity. Therefore, this study proposes the integration of multimodal spatiotemporal brain data (STBD) to enable a more comprehensive exploration of neuronal dynamics, drawing from various data collection methods. This approach leads to an enhanced accuracy for brain data modelling including classification and pattern recognition. The foundation of this method-ology is built upon a brain-inspired spiking neural network (SNN) architecture known as NeuCube. In this research, two distinct sets of brain data, Electroencephalogram (EEG) and functional Magnetic Resonance Imaging (fMRI), are employed to train and test the SNN models through a data integration strategy. Notably, this research achieved a significant 10% improvement in classification accuracy by employing an integrated EEG-fMRI SNN model when compared to single modalities such as EEG-SNN or fMRI-SNN. The utilization of spiking neural networks, such as NeuCube, provides a robust and biologically inspired framework for modelling integrated EEG-fMRI data. This approach allows us to unlock a deeper understanding of the brain's dynamics, leading to improved accuracy in our analyses and enhancing our capacity to uncover meaningful insights from these multimodal datasets.

Keywords: Multimodal, Spiking Neural Network (SNN), Spatio-temporal brain data (STBD), Electroencephalogram (EEG), functional Magnetic Resonance Imaging(fMRI)
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S07202: A VR–BCI System to Support Rehabilitation for Stroke Patients

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Abstract

Brain–computer interface (BCI) is a cutting-edge interactive technology promising for restoring motor function in motor neuron diseases (MND) patients. Combining virtual reality (VR) with BCI has shown better results in rehabilitation training, yet research and practical applications remain limited, especially in Vietnam. This research aims to propose and develop a comprehensive VR–BCI system to aid stroke patients in recovering motor neuron function. The proposed system integrates a deep learning model to analyze electroencephalogram (EEG) signals, translating them into inputs for a VR environment tailored for rehabilitation, featuring avatars of the patient and a physical therapist. This approach seeks to improve neuroplasticity and motor function recovery through immersive interactions, also advancing the development of effective rehabilitation tools, particularly in developing country with limited access to advanced medical technologies such as Vietnam.

Keywords: Brain-computer interface (BCI), Virtual reality (VR), Motor imagery (MI)
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