



OPEN ACCESS

EDITED AND REVIEWED BY
Si Wu,
Peking University, China

*CORRESPONDENCE
Nabamita Deb
✉ deb.nabamita@gmail.com

RECEIVED 01 July 2025
ACCEPTED 07 July 2025
PUBLISHED 06 August 2025

CITATION

Deb N, Khan Z, Sulaiman M and Abu Bakar M (2025) Editorial: Interdisciplinary synergies in neuroinformatics, cognitive computing, and computational neuroscience. *Front. Comput. Neurosci.* 19:1657167. doi: 10.3389/fncom.2025.1657167

COPYRIGHT

© 2025 Deb, Khan, Sulaiman and Abu Bakar. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](#). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Editorial: Interdisciplinary synergies in neuroinformatics, cognitive computing, and computational neuroscience

Nabamita Deb^{1*}, Zardad Khan², Muhammad Sulaiman³ and Maharani Abu Bakar⁴

¹Department of Information Technology, Gauhati University, Guwahati, India, ²Department of Statistics and Business Analytics, United Arab Emirates University, Al-Ain, United Arab Emirates, ³Department of Mathematics, Abdul Wali Khan University Mardan, Mardan, Pakistan, ⁴Department of Applied Mathematics, Universiti Malaysia Terengganu, Kuala Terengganu, Malaysia

KEYWORDS

synergies in neuroinformatics, cognitive computing, computational neuroscience, affective computing, brain computer interface

Editorial on the Research Topic

Interdisciplinary synergies in neuroinformatics, cognitive computing, and computational neuroscience

“Converging Minds: Synergies in Neuroinformatics, Cognitive Computing, and Computational Neuroscience”

The past years have seen a interesting blend of neuroscience, artificial intelligence (AI), cognitive science, and computational modeling. The topics at the focus of this synergy are neuroinformatics, cognitive computing, and computational neuroscience, each providing unique insights and instruments, taken collectively driving our understanding of the human brain and intelligent systems. Neuroinformatics is a framework for brain data management, standardization, and analysis. It provides the computational infrastructure and ontologies necessary to support large-scale, heterogeneous data from neuroimaging, electrophysiology, and genetics (Kennedy, 2016). Global endeavors such as the Human Brain Project (Amunts et al., 2016) and the Neuroscience Information Framework (Gardner et al., 2008) demonstrate how interoperable platforms and open-access data repositories have facilitated reproducible and collaborative research in brain science. At the same time, computational neuroscience employs mathematical and theoretical models as a formulation of neuron and network dynamics, ranging from models of single ion channels to simulations of whole-brain systems (Izhikevich and Edelman, 2008). Computational neuroscience focuses on deriving equations or algorithms when modeling biological mechanisms. This is an important interface between cognition potentially grounded in physiological mechanisms and artificial systems that seek to simulate such processes.

Cognitive computing, which takes inspiration from neurobiological systems, is transforming AI by unifying human-like properties including contextual comprehension, learning, and adaptive reasoning. Cognitive architectures such as IBM's Watson (Ferrucci et al., 2010) and neuromorphic chips like Intel's Loihi (Davies et al., 2018) seek to emulate aspects of human cognitive abilities, combining insights drawn from psychology, neuroscience, and machine learning to create systems that not only calculate but comprehend.

The convergence of these three fields has provided fertile soil for innovations like brain-computer interfaces (BCIs), neurotherapies on an individual basis, and cognitive-robotic hybrid systems. EEG models of stress detection and affective computing (Alarcao and Fonseca, 2017), real-time decoding of decision-making (Cavanagh and Frank, 2014), and neuro-symbolic systems (Besold et al., 2021) highlight the increased explanatory capacity and utility from multi-domain integration.

This collection encompasses of four very varied articles, and a brief about each has been given below:

In the first article (Oyama et al.), the authors developed a predictive-coding inspired variational recurrent neural network (VRNN) that autonomously shifts between focused attention and mind-wandering. The meta-prior parameter w rises when reconstruction error increases, which prompts the network to rely more on internal predictions (mind-wandering). In other case of reduced error, it lowers w , shifting focus back to external sensory input (focused state). The second article (Zeki and Dag) introduce a mathematically reduced discrete-map model for inhibitory neural networks whose bursting behavior is modulated by slow calcium currents. Their model predicts the number of spikes per burst based on initial calcium levels, maps fixed points, and tests stability. It closely matches the behavior of the original continuous system, offering analytical insights into calcium's vital role in shaping neural bursts.

The third article (Li et al.) proposes a novel digital handwriting assessment paradigm for early detection of mild cognitive impairment (MCI) due to Alzheimer's disease (AD). The study was done on 72 subjects (34 healthy controls, 38 MCI due to AD), which collected dynamic handwriting and imagery data via touchscreen and analyzed digital biomarkers from the writing process. Their method achieved $AUC = 0.918$ —substantially outperforming classical MMSE ($AUC = 0.783$) and MoCA ($AUC = 0.859$) scales. The technique is intelligent, convenient, and demonstrates strong early-warning potential, though its generalizability across scripts and cultures remains to be verified.

The final article (Luo et al.) highlights the use of a constraint-based metabolic model to investigate bioenergetic disparities between synaptic terminals and neuronal somata in dopaminergic neurons, which are critically implicated in Parkinson's disease (PD). Their model quantifies differential metabolic demands and suggests that synaptic energy metabolism uniquely contributes to neuronal vulnerability in PD. This work connects metabolic modeling with

neurodegenerative disease mechanisms and opens avenues for targeted metabolic interventions.

Moving forward, the synergistic collaboration between neuroscientists, computer scientists, data engineers, psychologists, and ethicists will be indispensable. The complexity of cognition demands such pluralism in approach. As we aim to decode the brain and encode intelligence, the integrative spirit of these disciplines must guide our scientific and technological journey. This Research Topic is a call to celebrate and advance this interdisciplinary synergy.

We hope that the reader will find in this Research Topic a useful reference for the state of the art in the emerging field of tools rooted in information theory and applied to neuroscience.

Author contributions

ND: Writing – review & editing, Writing – original draft. ZK: Conceptualization, Writing – review & editing, Validation. MS: Conceptualization, Resources, Writing – review & editing. MA: Writing – review & editing, Conceptualization.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

- Alarcao, S. M., and Fonseca, M. J. (2017). Emotions recognition using EEG signals: a survey. *IEEE Trans. Affect. Comput.* 10, 374–393. doi: 10.1109/TAFFC.2017.2714671
- Amunts, K., Ebell, C., Müller, J., Telefont, M., Knoll, A., and Lippert, T. (2016). The human brain project: creating a European research infrastructure to decode the human brain. *Neuron* 92, 574–581. doi: 10.1016/j.neuron.2016.10.046
- Besold, T. R., Bader, S., Bowman, H., Domingos, P., Hitzler, P., Kühnberger, K. U., et al. (2021). “Neural-symbolic learning and reasoning: a survey and interpretation 1,” in *Neuro-symbolic Artificial Intelligence: The State of the Art* (IOS press), 1–51.
- Cavanagh, J. F., and Frank, M. J. (2014). Frontal theta as a mechanism for cognitive control. *Trends Cogn. Sci.* 18, 414–421. doi: 10.1016/j.tics.2014.04.012
- Davies, M., Srinivasa, N., Lin, T. H., Chinya, G., Cao, Y., Choday, S. H., et al. (2018). Loihi: a neuromorphic manycore processor with on-chip learning. *IEEE Micro* 38, 82–99. doi: 10.1109/MM.2018.112130359
- Ferrucci, D., Brown, E., Chu-Carroll, J., Fan, J., Gondek, D., Kalyanpur, A. A., et al. (2010). Building Watson: an overview of the DeepQA project. *AI Magazine* 31, 59–79. doi: 10.1609/aimag.v31i3.2303
- Gardner, D., Akil, H., Ascoli, G. A., Bowden, D. M., Bug, W., Donohue, D. E., et al. (2008). The neuroscience information framework: a data and knowledge environment for neuroscience. *Neuroinformatics* 6, 149–160. doi: 10.1007/s12021-008-9024-z
- Izhikevich, E. M., and Edelman, G. M. (2008). Large-scale model of mammalian thalamocortical systems. *Proc. Natl. Acad. Sci. USA* 105, 3593–3598. doi: 10.1073/pnas.0712231105
- Kennedy, D. N. (2016). Neuroinformatics for the new millennium. *Neuroinformatics* 14, 1–3.