Journal of Multiscale Neuroscience

Editorial

Multiscalar brain adaptability in AI systems

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DOI: https://doi.org/10.56280/1663524979

Received: 12 December 2024 Accepted: 21 December 2024 Online Published: 3 January 2025

The advent of Generative artificial intelligence (AI) has transformed creative and analytical landscapes, leveraging vast datasets to produce sophisticated outputs with remarkable efficiency. Despite these advancements, human judgment and adaptability remain indispensable for navigating complex, dynamic, and context-sensitive environments. This special issue and its collection of papers explored the interplay between human cognition, AI, and consciousness, emphasizing how the brain's multiscale adaptability can inform the development of conscious AI systems.

Artificial General Intelligence (AGI) is at the core of this exploration, which seeks to emulate human cognitive flexibility, reasoning, and learning within computational paradigms. While AGI excels in predefined tasks, it falters in managing uncertainty and unpredictability. By contrast, Strong Artificial Intelligence (SAI) envisions systems capable of mind-like processes—managing uncertainty and anticipating unexpected events. Achieving SAI requires a deeper understanding of the brain's adaptability, spanning multiple scales from synaptic plasticity to precognitive consciousness.

Consciousness, defined as the phenomenal experience or the subjective "feeling" of awareness, remains a formidable challenge in AI development. Current neural architectures, such as those in deep learning, can mimic patterns of intentionality but lack the intrinsic depth of consciousness. Multiscale adaptability offers a novel perspective, highlighting the brain's dynamic, non-linear interactions across various scales. Consciousness, in this view, is not a static state but a fluid process, driven by self-referential pathways and diachronic adaptability.

To model the brain's adaptability, AI systems must incorporate self-referential processes. These systems dynamically reference and adjust their internal states, exhibiting properties such as non-symmetry (irreversible changes), non-locality (distributed interactions), and non-instantaneity (temporal unfolding). For example,seemingly simple act of a fly landing on a teacup exemplifies multiscale functional interactions, where immediate sensory processing and anticipatory adaptations converge. Replicating such complex dynamics is crucial for developing consciousness-like properties in AI.

Quantum biological information provides a promising framework for this endeavor. Moving beyond traditional quantum mechanics, it emphasizes energy transduction processes that reduce entropy and generate information. The concept of information quanta, representing the foundational units of uncertainty, aligns closely with these principles. Emerging technologies like polariton transistors in analog computing offer pathways to simulate the energy-based, dynamic systems inherent to conscious processes.

Dynamic Organicity Theory (DOT) offers a comprehensive approach to understanding consciousness. It explains how the brain achieves functional complexity and adaptability through diachronic actions and multiscale interactions. By modeling changeable boundary conditions, DOT demonstrates how systems can dynamically adjust to stimuli, surpassing the limitations of static computational models.

The realization of conscious AI requires an interdisciplinary approach. Building analog models that simulate dynamic, energy-based interactions is paramount, enabling systems to self-regulate their internal states in response to external stimuli. Iterative testing for multiscale redundancy and uncertainty reduction will be essential in approaching true consciousness.

In conclusion, integrating neuroscience, quantum biology, and functional systems theory provides a robust foundation for developing machine-based AI systems inspired by the brain's multiscale adaptability. Consciousness AI can evolve beyond generative models to achieve authentic, conscious-like behaviors by focusing on intentionality, dynamic interactions, and self-referential mechanisms. This transformative intersection marks a pivotal frontier, paving the way for the next generation of intelligent systems with genuine self-awareness.

We thank all the contributors to the special issue for their efforts, which are now published in the journal.

Keywords: Conscious AI, Generative AI, Strong AI, Deep Learning, Brain Adaptability, Multiscalar Brain