A roadmap for digital neuroscience: Researchers summarize current status and further developments

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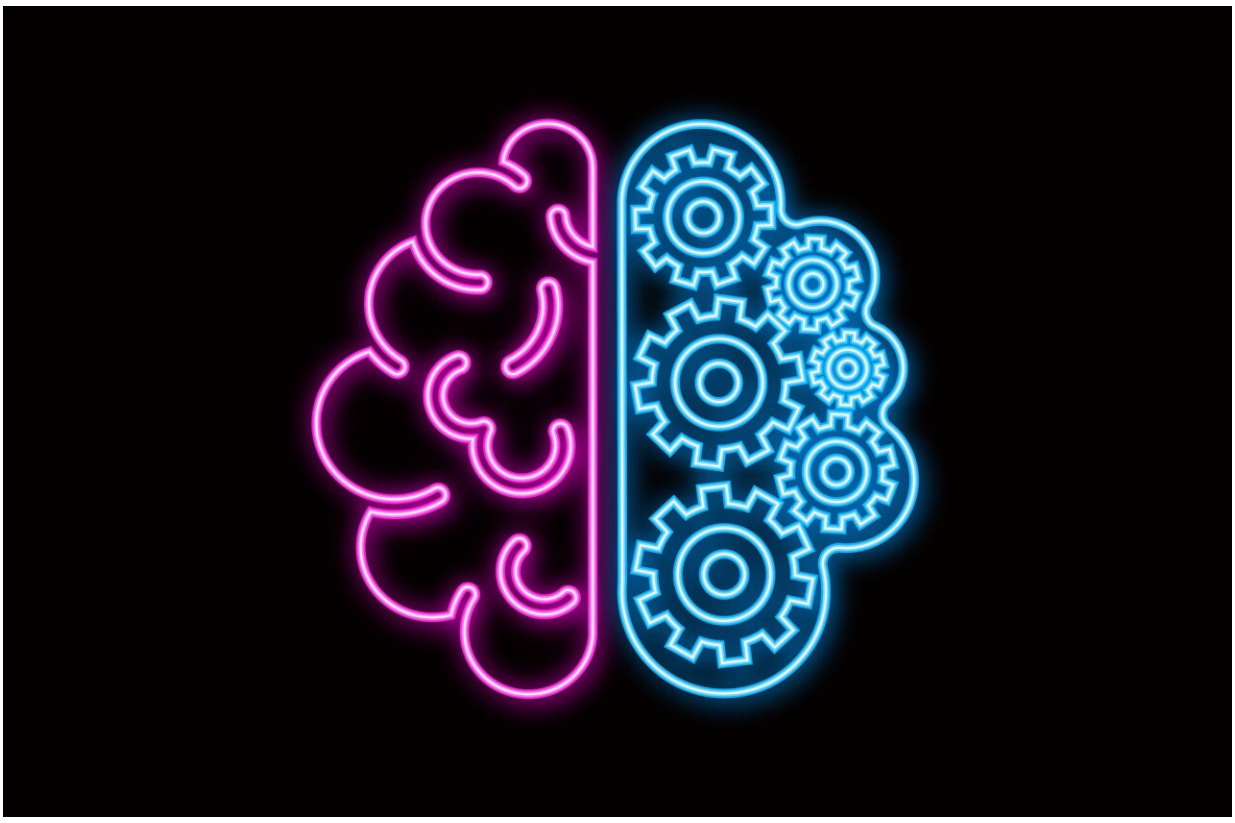

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Neuroscience has entered a new, digital phase. The combination of brain research with supercomputing in large-scale, multi-disciplinary research

collaborations has enabled an innovative approach to deciphering the brain, using powerful scientific technologies and data resources.

These developments open up new possibilities for brain research, medicine and technology. A position paper by over 100 authors, now published in the journal *Imaging Neuroscience*, summarizes the current status and identifies the key points for further developments in digital neuroscience.

Digital technologies have fundamentally changed neuroscience in recent years. The challenges posed by increasingly large and complex data have been met with innovative shared platforms and novel tools for scientific investigation.

Large-scale research initiatives within Europe and worldwide have shaped these developments and enabled synergies in scientific efforts. Examples include the EU Flagship Human Brain Project (HBP), and its digital research infrastructure EBRAINS, which enable scientists to integrate data from different scales according to FAIR principles, use models and software at EBRAINS for gaining new insights and working collaboratively on a larger scale. This change has led to significant progress and offers the opportunity to advance neuroscience, medicine and brain-inspired technologies.

Against this background, the position paper titled "The coming decade of digital brain research—A vision for neuroscience at the intersection of technology and computing" is primarily intended as a roadmap for digital neuroscience over the next ten years.

"It is crucial that we assess, anticipate and shape the changes occurring in neuroscience and its related fields. The position paper identifies points of convergence and common goals, and provides a scientific framework for current and future developments in digital brain research based on a

structured process of discussion with the research community at large," says lead author Prof. Katrin Amunts, Director at the Jülich Institute of Neuroscience and Medicine and Joint CEO of EBRAINS.

The position paper lists a total of eight key areas for digital neuroscience research. Near-term, middle-term and long-term goals are discussed, as well as novel developments like "digital twin"-approaches, with their applicability, potential and limitations in brain science.

A "digital twin" is a type of personalized computational brain model that can be continuously updated with measured data obtained from its real-life counterpart, i.e., the patient. While not aimed at being an exact replica, the increasing sophistication and predictive power of these models is bringing new clinical and research applications into reach.

Further key areas described in the paper include ultra-high-resolution digital atlases and models of the brain that integrate multiple scales and modalities, neuro-derived artificial intelligence (AI) and computing innovations.

EBRAINS has a key role in in the interaction between brain research and computing, offering scientists access to the most powerful European supercomputers via the computing network Fenix and to the brain-inspired computing systems BrainScaleS and SpiNNaker. An Executive Summary of the paper has been published on the website of the EBRAINS research infrastructure.

More information: Katrin Amunts et al, The coming decade of digital brain research: A vision for neuroscience at the intersection of technology and computing, *Imaging Neuroscience* (2024). DOI: 10.1162/imag_a_00137