HBP SCIENCE MARKET

NEUROMORPHIC COMPUTING PLATFORM

SP9

What we do

The Neuromorphic Computing Platform takes two fundamentally different paths to support scientific research and applications.
The BrainScaleS system, based in Heidelberg, employs a mixed signal approach employing analogue electronics to model 4 million neurons and 1 billion synapses, as well as their connections and intercellular communications, using digital communications protocols. It is targeted to the emerging field of bio-inspired AI as well as a better understanding of the learning and development in the brain. The system is a direct, silicon-based image of the neuronal networks found in nature and runs 10,000 times faster than its biological archetype, allowing a day of biological development to be compressed into 10 seconds.
The SpiNNaker system, based in Manchester, is a massively parallel computing platform, targeted towards neuroscience, robotics and computer science. For robotics, SpiNNaker provides mobile, low power computation, and makes possible the simulation of networks of tens of thousands of spiking neurons, as well as processing sensory input and generate motor output, all in real time and in a low power system. The system is unconventional in that SpiNNaker nodes communicate using simple messages (spikes) that are inherently unreliable. This break with determinism not only offers new challenges, but also the potential to discover powerful new principles of massively parallel computation.
Both approaches are involved in technological next generation development (both hardware and software) and integration.
The establishment of principles for brain-like computation, computational capabilities through learning and large scale organisation of cognitive computation are also focuses of interest.
Outreach activities include user training, support, and coordination for effective application of the Platform.

How we are organised

WP9.1 PLATFORM SOFTWARE AND OPERATIONS. This WP operates the Neuromorphic Computing Platform constructed in the HBP Ramp-Up Phase, maintains and further develops the software methods and tools required for the neuromorphic hardware systems, and integrates them with the HBP Collaboratory, other HBP Platforms and, where possible, external resources.
WP9.2 NEXT-GENERATION PHYSICAL MODEL IMPLEMENTATION. We develop, prototype, manufacture, assemble, test and operate next-generation hardware systems to implement massively parallel, physical models of brain cells, circuits and networks. These prototype neuromorphic physical model (NM-PM) systems will be integrated in future versions of the Neuromorphic Computing Platform.
WP9.3 NEXT-GENERATION MANY CORE IMPLEMENTATION. This WP develops, prototypes, manufactures, assembles, tests and operates next-generation hardware systems to implement massively parallel, many-core implementations of brain cells, circuits and networks. These prototype neuromorphic many-core (NM-MC) systems will be integrated in future versions of the Neuromorphic Computing Platform.
WP9.4 COMPUTATIONAL PRINCIPLES. In this WP, we use brain activity and plasticity data to develop principles that enable brain-like computation, cognition, and learning in neuromorphic systems. This work supports emulation of specific brain functions or cognitive processes in existing neuromorphic hardware and will guide the design of next-generation neuromorphic systems.
WP9.5 PLATFORM TRAINING AND COORDINATION. This WP provides training and documentation for SP9's various neuromorphic systems and ensures that these are accessible via the Neuromorphic Computing Platform. It also coordinates the SP's R&D work and its integration with the rest of the HBP.

SP LEADER Karlheinz MEIER
DEPUTY SP LEADER Steve FURBER
WORK PACKAGE LEADERS
- WP 9.1 Platform software and operations: Andrew DAVISON
- WP 9.2 Next generation physical model implementation: Johannes SCHEMMEL
- WP 9.3 Next generation many core implementation: Steve FURBER
- WP 9.4 Computational Principles: Wolfgang MAASS
- WP 9.5 Platform training and coordination: Karlheinz MEIER

SP MANAGER Björn KINDLER

Publication highlights

SpiNNaker System

Sen-Bhattacharya B, Serrano-Gotarredona T, Balassa L, Bhattacharya A, Stokes A, Rowley A, *et al.* ***A spiking neural network model of the lateral geniculate nucleus on the SpiNNaker machine.*** Front Neurosci 2017;11:454 DOI: 10.3389/fnins.2017.00454.

Knight JC, Tully PJ, Kaplan BA, Lansner A, Furber SB. ***Large-scale simulations of plastic neural networks on neuromorphic hardware.*** Front Neuroanat 2016;10:37. DOI: 10.3389/fnana.2016.00037.

BrainScaleS System

Schemmel J, Kriener L, Müller P, Meier K. ***An accelerated analog neuromorphic hardware system emulating NMDA- and calcium-based non-linear dendrites.*** 2017, arXiv preprint arXiv:1703.07286.

Schmitt S, Klähn J, Bellec G, Grübl A, Guettler M, Hartel A, *et al.* ***Neuromorphic hardware in the loop: Training a deep spiking network on the BrainScaleS wafer-scale system.*** 2017 International Joint Conference on Neural Networks (IJCNN), pp. 2227–2234. New York, NY: IEEE, 2017.

Contact

Björn KINDLER bjoern.kindler@kip.uni-heidelberg.de
https://www.humanbrainproject.eu/en/about/project-structure/subprojects/

Human Brain Project

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