Neuromorphic Cortical Architectures for Bio-inspired Learning Machines

- University of California San Diego (UCSD) Institute for Neural Computation (INC)
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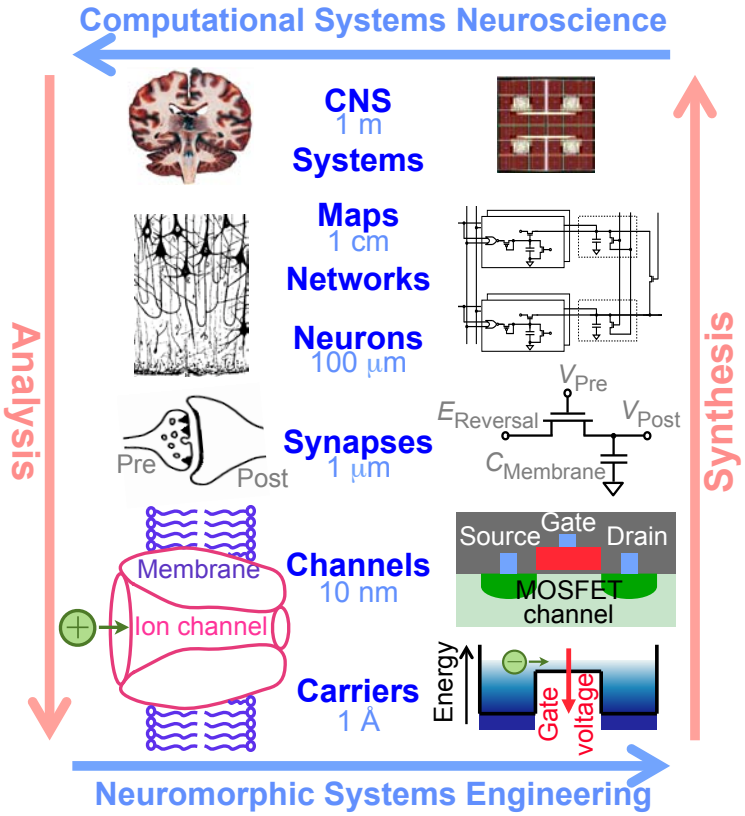
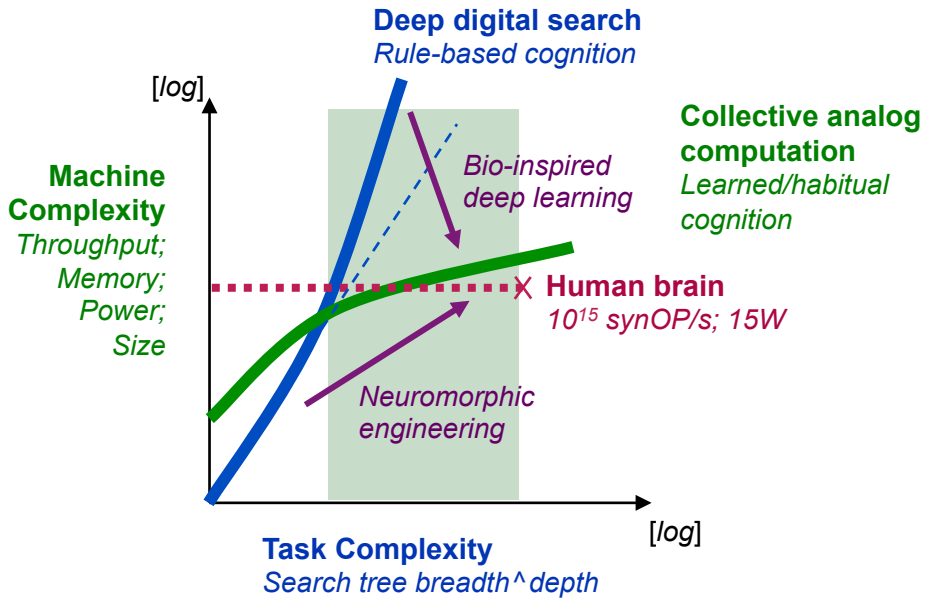


Multi-scale levels of investigation in analysis of the central nervous system and corresponding neuromorphic synthesis



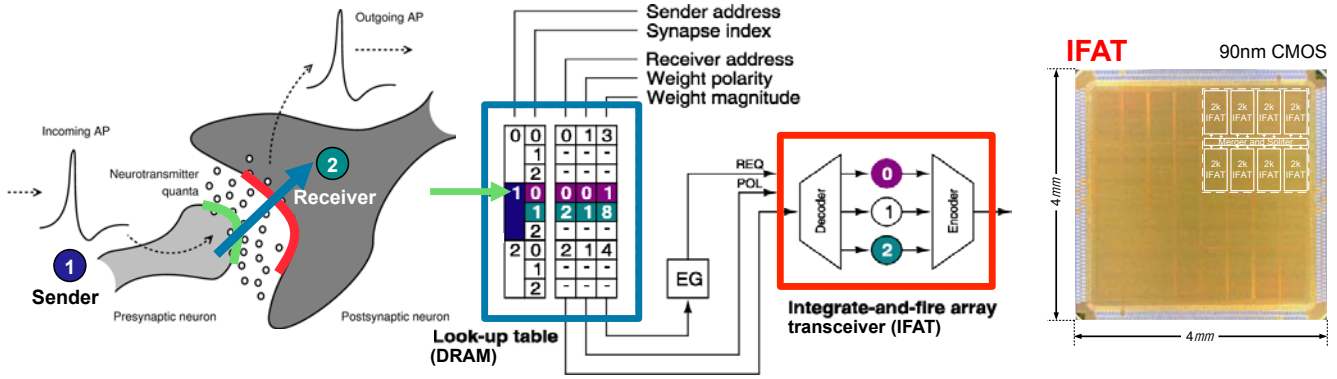
Our research pursues human-level machine intelligence by converging:

- Neuromorphic computing resources approaching connectivity and energy efficiency levels of the human brain;
- Bio-inspired deep learning methods, and supporting neuroscience data, to adaptively reduce algorithmic complexity.

G. Cauwenberghs, "Reverse Engineering the Cognitive Brain," *PNAS*, 2013

Unique qualifications and capabilities

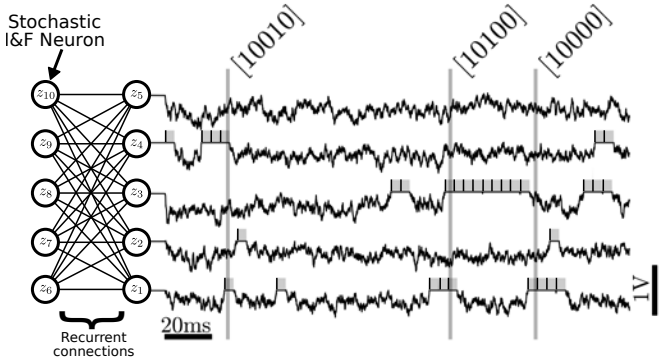
- Dynamically reconfigurable adaptive neuromorphic supercomputers:

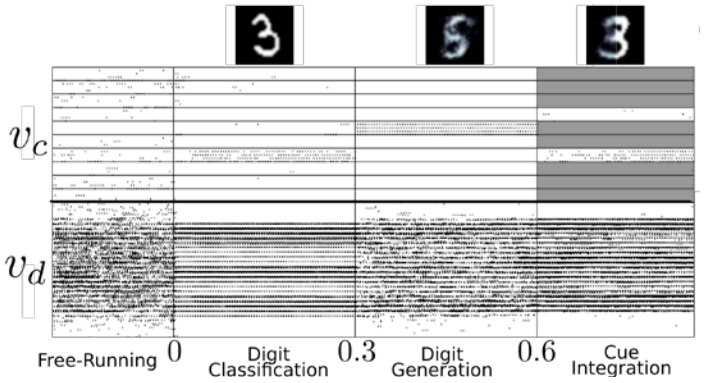


- 65k two-compartment integrate-and-fire neurons
- Individually programmable synaptic connectivity, conductance, and axonal delay in external memory
- 22 pJ per synapse event

Park *et al.*, "A 65k-Neuron 73-Mevents/s 22-pJ/event Asynchronous Micro-Pipelined Integrate-and-Fire Array Transceiver", 2014

- Spike-based machine learning mapped onto neural substrates:





- Probabilistic inference using neural sampling with integrate-and-fire neurons
- Spike-based online training of Boltzmann machines with STDP

Neftci *et al.*, "Event-driven contrastive divergence for spiking neuromorphic systems", *Frontiers in Neuroscience*, 2014

Collaborative opportunities

- Identifying cortical primitives of neural computation and learning, accounting for multi-scale biophysical detail in:
  - Dendritic computation and spatially distributed network dynamics
  - Axonal conduction delays and neural synchrony
  - STDP and temporally distributed forms of synaptic plasticity

- High-throughput connectomics and systems neuroscience providing anatomical and physiological constraints in network and learning architectures

- Thermodynamical foundations of machine learning with biophysically realistic neural sampling

Contact Information

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