Machine Intelligence from Cortical Networks (MICrONS)

Reverse-Engineering the Algorithms of the Brain

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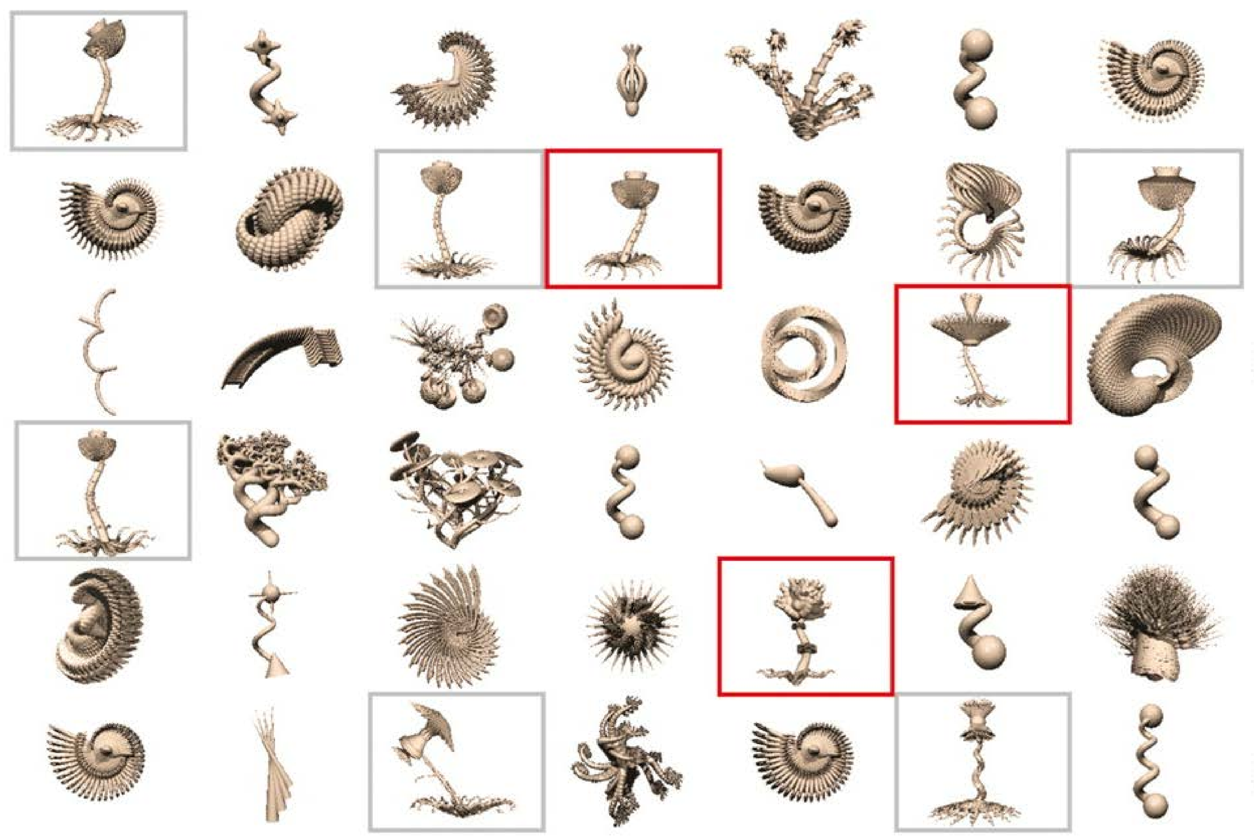
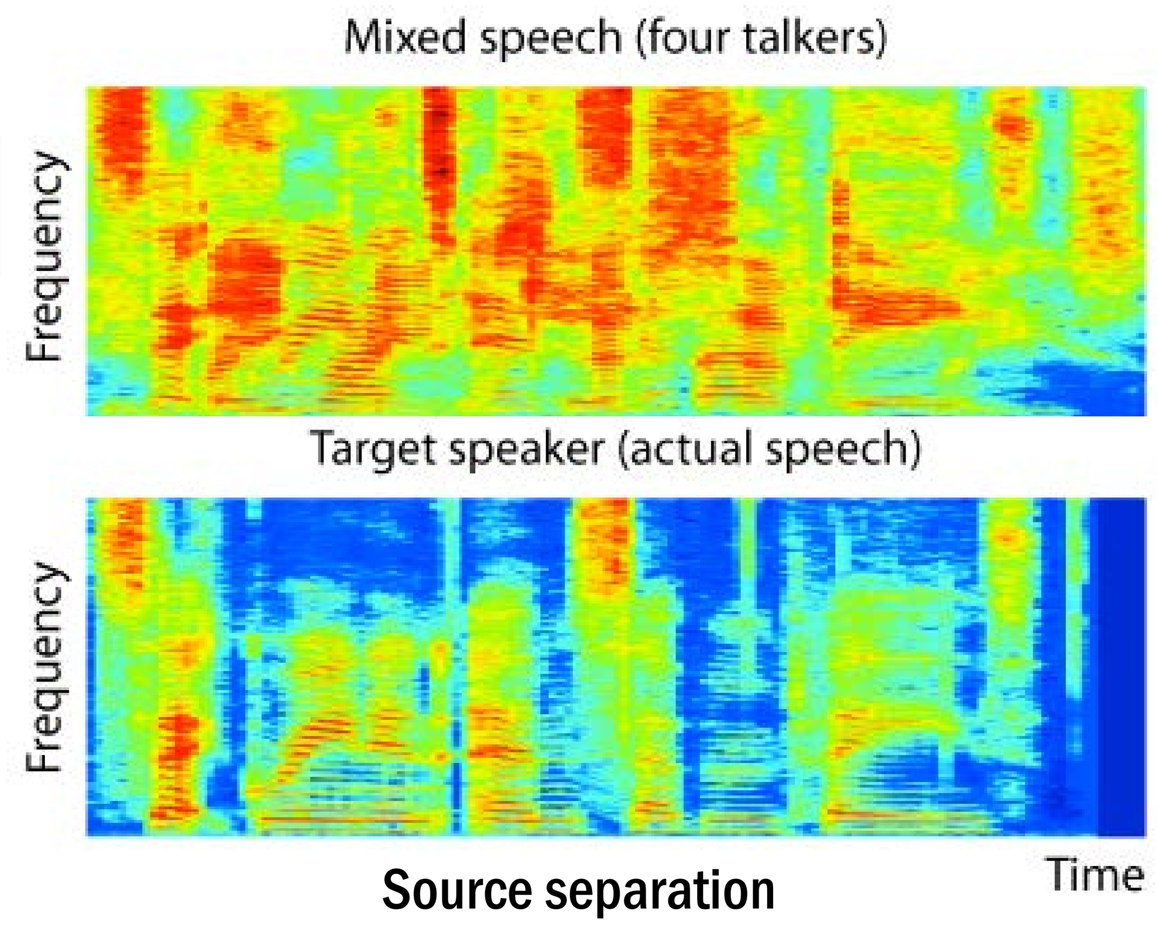
The brain exhibits a remarkable capacity for recognition and generalization that far exceeds the capabilities of today's state-of-the-art machine learning systems

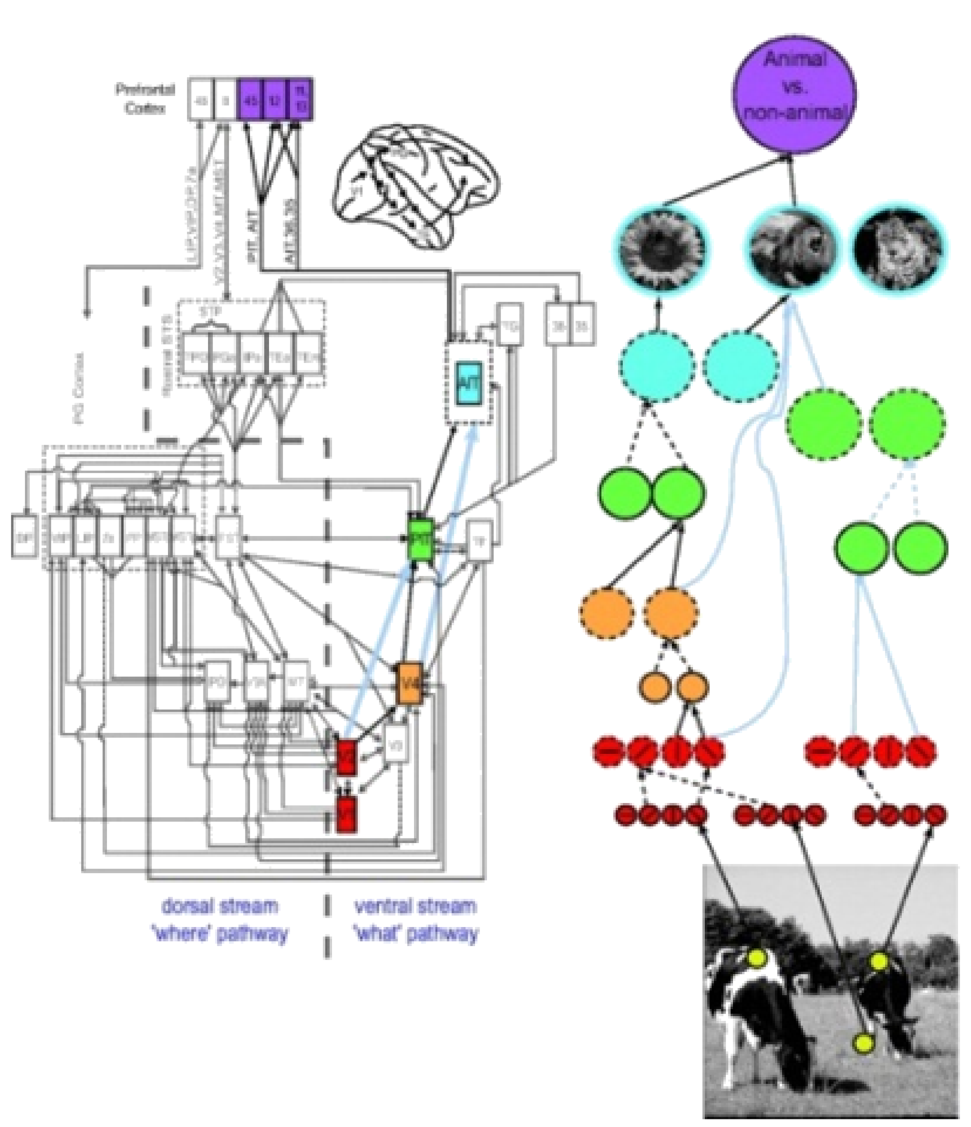


One-shot learning & Unsupervised clustering



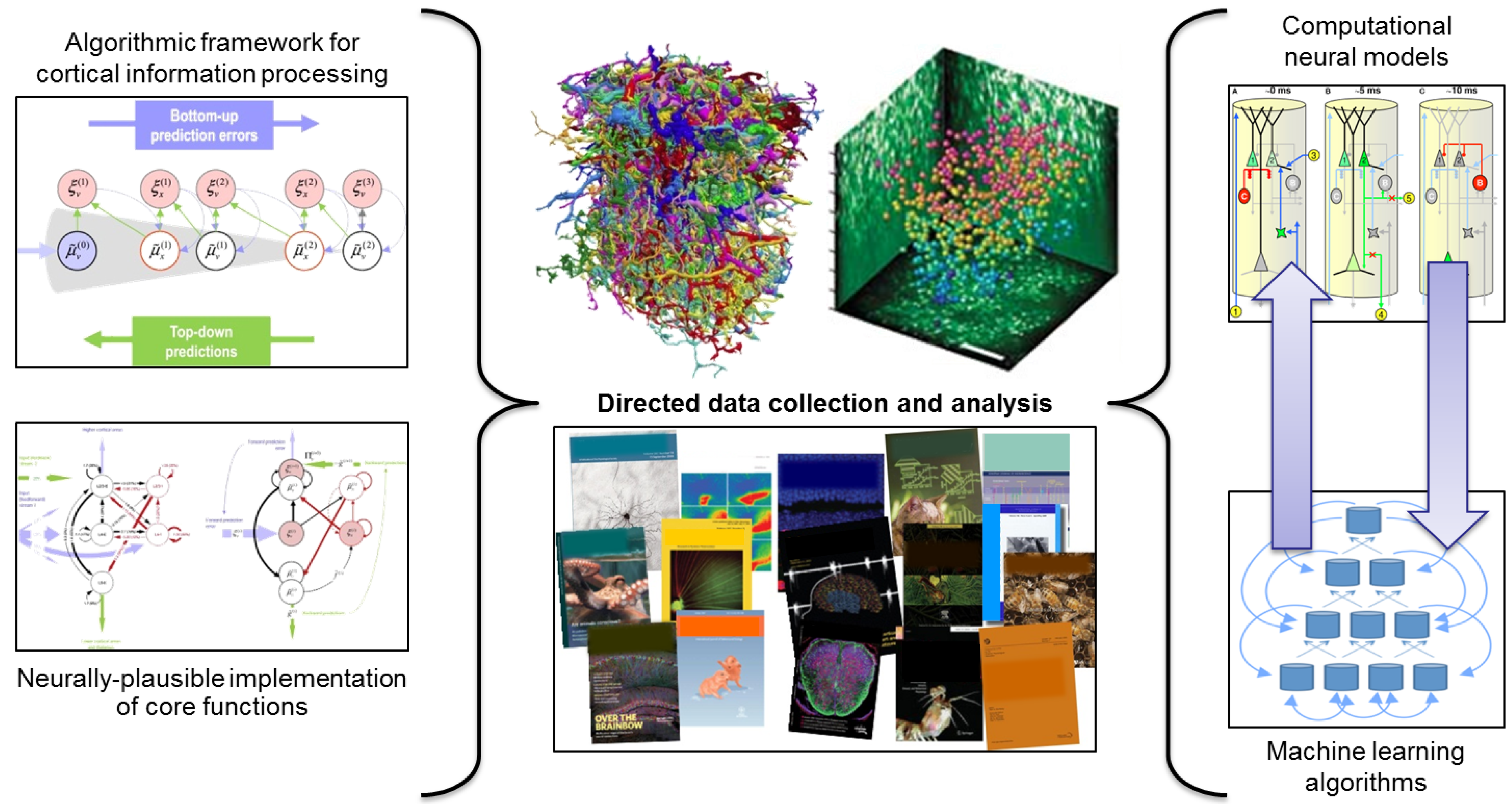
Source separation

Neural and mathematical algorithms today correspond at the architectural level but differ substantially in the details of operation, suggesting improvements can be found in those details



- Most of what is known about the brain concerns its *micro* scale (one or a few neurons) and *macro* scale (millions of neurons) operation
- Little is known about the structure and function of *meso* scale (thousands of neurons) cortical circuits that implement the specific computations underlying cortical information processing
- Current approximations of neural algorithms are insufficient; achieving brain-like performance requires knowledge and use of brain-like computations at multiple scales
- MICrONS seeks to fill the mesoscale gap in our understanding of cortical computation and exploit the findings to advance machine learning

MICrONS will combine neuroscience and data science to advance machine learning by uncovering how the cortex performs computations at the mesoscale



Detailed measurements and reconstruction of cortical computing circuits will inform novel algorithms for understanding and manipulating physical and abstract data

Phase	Computational Objectives	Experimental Objectives	Modeling Objectives
1	• Representational similarity	• 500 x 500 x 100 um^3 functional data volume at single-neuron and sub-second resolution • 100 x 100 x 100 um^3 structural data volume at single-synapse resolution	• Identify plausible neural mechanisms for the proposed representations, transformations, and learning rules consistent with the published neuroscience literature
2	• One-shot learning • Unsupervised clustering	• 1 x 1 x 0.5 mm^3 functional data volume at single-neuron and sub-second resolution • 1 x 1 x 1 mm^3 structural data volume at single-synapse resolution	• Use the data acquired in Phase 1 to inform and constrain plausible neural mechanisms
3	• Detection in complex scenes		• Use the data acquired in Phase 2 to further inform and constrain plausible neural mechanisms

Figure credits: Tenenbaum et al., 2011; Hershey et al., 2011; Serre et al., 2007