

Unraveling the complexity of the brain

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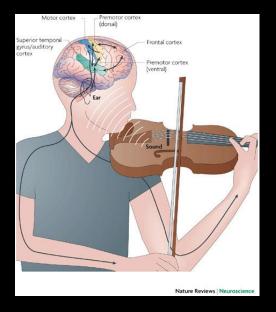
Human Brain

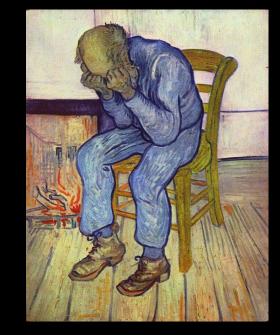
86 billion neurons

Representing our emotions, thoughts and actions



Neural activity not only represents the brain function ... but also its dysfunction







Induced Coma, Anesthesia

Movements

Depression

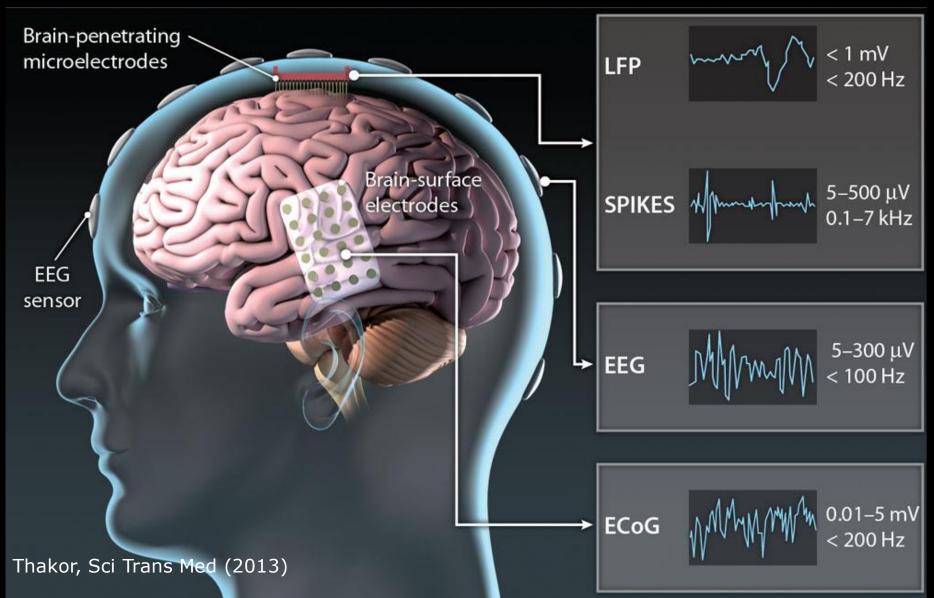
How can engineering help us

Understand

Restore & Treat

Enhance

Record Brain Networks



Manipulate Brain Networks



S C T Z 5 0 0 P T

Biological Optogenetics Psychiatry & Psychiatry →

Application of Optogenetics Annual Review of Neuroscience 2011



Method of the Year: 2010 nature

Optogenetics

2010 nature protocols optogenetics protocols ->



2012 Analysis

nature Quantitative Opsin Properties →

> nature REVIEWS Optogenetics & Neural Circuits in Brain Disease *

Neuron



Build Interfaces to the Brain



Neuroprosthetics



Deep brain stimulation



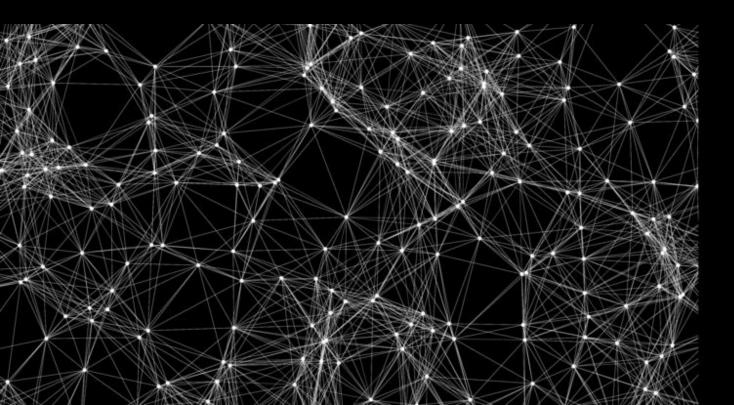
Automatic anesthetic delivery



Algorithms for Neural Systems

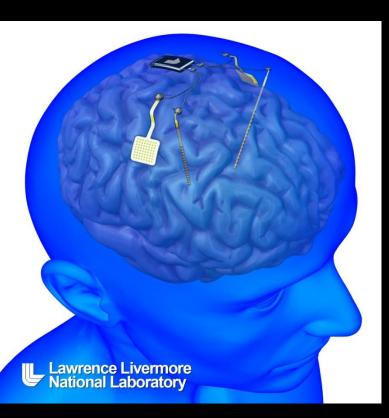
Machine Learning & Statistical Inference Decode brain states

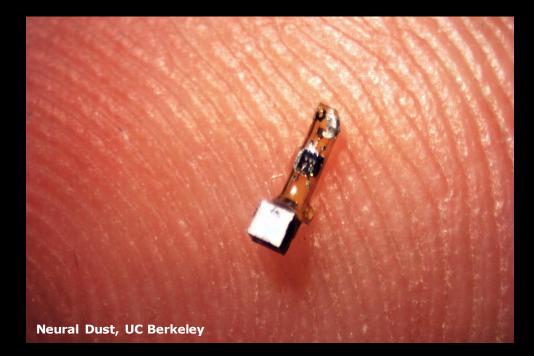
Control Theory Build closed-loop interfaces



Implement on Integrated Circuits

Low-power, miniaturized, efficient, biocompatible





Ellis Meng (USC) Technologies to interface to the brain for recording and modulation

Jose Carmena (UC Berkeley)

Brain-machine interfaces for neuroscience & clinical translation

Konrad Kording (U Penn)

Rethinking the role of machine learning in biomedical science

Azita Emami (Caltech) Efficient feature extraction and classification in neural interfaces







