Real-time decoding of human thoughts using brain scanner [0]

Goal: Software to read human thoughts in real-time leveraging parallel computing and machine learning to reveal how neural activity in different brain regions “give rise to learning, memory, and cognitive functions”.

Potential Applications & Impact on AI field: Transfer learnings from “human intelligence and cognition to machine learning and artificial intelligence” to advance objectives such as “safer autonomous driving, quicker drug discovery, and earlier cancer detection”. Clinical diagnosis and treatment of brain disorders, therapy by training brains to weaken intrusive memories, detect extent of student attention in class, mind research, design algorithms and processing to identify brain activity patterns that correlate thoughts, rapidly sort large data sets.

Challenges: Limited to a few hundred brain image scans per person, divided into voxels for analysis.

Experiments: Test and provide feedback on extent of focus of a volunteer’s attention on a visual image or if mind wandered to other thoughts or memories depending on image clarity.

Tools: Python, Scikit-learn. Functional magnetic resonance imaging (fMRI), whose scans capture signals from brain blood flow changes during human thoughts and generate large data sets.

Collaborators: Intel, Princeton University Neuroscience Institute.

Outputs: Brain Imaging Analysis Kit (BrainIAK) analysis software that processes fMRI data.

Achievements: Reduced time to extract thoughts from brain scans from days to less than a second.

Future Goals: Decode in real-time specific identity of face being mentally visualised by human.

Relationship with Section 2 and 3: [0] could be used decode [1]

Organic brain neuron communication bus of Artificial Synapses (AS) [1]

Goal: Build neural network of Artificial Synapses (AS) (artificial neurons that mimic the communication bus between neurons in the human brain) using significantly less power than traditional computing. AS built based on battery design as electronic device with “inexpensive organic materials” that are “compatible with the brain’s chemistry”. It saves state to learn through training using the same voltage used by human neurons, it can grow cells, and each can support 500 states for “neuron-type computation models” using 10% of the energy used in modern computers, but still 10,000 times less energy efficient than neurons.

Outputs: Built one AS. Simulated array of it in neural network. Recognised 97% of handwriting.

Potential Applications & Impact on AI field: Brain-machine interfaces where AS communicates with live neurons. Voice-controlled interfaces of driverless cars.

Relationship with Section 1 and 3: [1] could be decoded by [0]

Molecular Robot built with biomolecules (DNA and proteins) [2]

Goal: Build molecular robot by integrating “molecular machines” into an “artificial cell membrane” so it functions similar to living organisms.

Output: Molecular robot the size of a human cell that starts and stops changing shape using an actuator composed of protein, with a transmission force controlled by a clutch composed of DNA that responds to specific DNA signals in a molecular-level environment that was designed by researchers.

Potential Applications & Impact on AI field: Autonomous soft robots. Robot that treats live culturing cells. Robot that monitors environmental pollution.

Relationship with Section 1 and 2: [3] could be used to treat humans using [1] and [2].

References

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[3]Tohoku University. "Shape-shifting molecular robots respond to DNA signals." ScienceDaily. ScienceDaily, 2 March 2017. www.sciencedaily.com/releases/2017/03/170302090817.htm.