Neuroromorphic Computing: Simulating the Brain's Visual Cortex for a Faster, More Effecient Computer

Strauss, Robert (School: Los Alamos High School)

The biological brain can do complex visual processing, object recognition, fine motor tasks, and more, all using very little energy. A traditional computer programmed to do these things would require immense amounts of energy and would overheat. Neuromorphic computing is an alternative model to standard von neumann computers, and it aims to be faster and use far less energy by modeling the brain. However, unlike traditional computers, neuromorphic computers can’t be programmed with an algorithm or language. Instead, they have to be trained. In this project, I aimed to replicate the brain’s visual processing with neuromorphic computing. As the eye in this system, I used a silicon retina, which is a special type of camera which emits spike signals rather than frames. As a neuromorphic computer, I programmed a simulation of a Spiking Neural Network, which is very different from an Artificial Neural Network. In a Spiking Neural Network, Leaky Integrate and Fire Neurons process time-series data using spike signals. I designed, implemented, tested and redesigned various Spiking Neural Network architectures. I trained one to classify handwritten digits, and one to reconstruct a standard image from moving, spiking, silicon retina data. I then found my model generalized partially to an entirely different domain of data. Despite only being taught to reconstruct handwritten digits, it was able to somewhat successfully reconstruct many other classes, such as natural images. I demonstrated the potential for creating neuromorphic systems that do complex tasks using thousands of times less energy than traditional computers.

Awards Won:

Fourth Award of $500

Association for the Advancement of Artificial Intelligence: Honorable Mention