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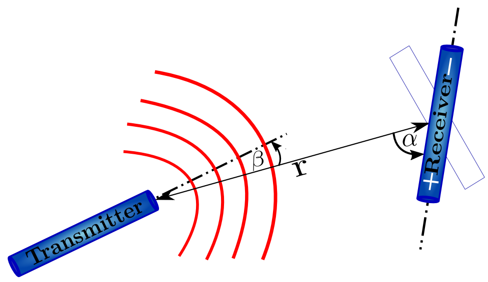
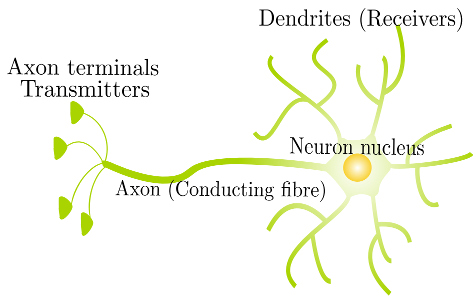
Springtime of a physical Artificial Neuron

Can we take advantage of the latest semiconductor technologies to create the next generation of brain-inspired computers and replace ordinary computers? Brain-inspired computers can be integrated into standard computers and used as independent units to tackle specific tasks in Artificial Intelligence. Moreover, thanks to their reduced power consumption and limited footprint, applications such as self-fly drones and supercomputers may benefit from it.

During the last century, many brilliant minds have contributed to the arrival of television, computers, and the internet. Artificial Neurons are exciting objects that have risen to the media's attention due to impact on Artificial Intelligence and the Internet of Things. In general, an abstract Neural Network involves mathematical algorithms and codes that are the brain of this "thinking machine". On the other hand, a set of physical neurons can be made of semiconductor nanostructure materials that most computers and chips are made of nowadays. Therefore, a physical Artificial Neuron is the key to designing novel brain-inspired computers.

In our current project, we have investigated how to simulate an Artificial Neuron able to communicate optically in a Neural Network under certain circumstances. We need two main components to construct Artificial Neurons: Receiver and Transmitter nanowires as illustrated in the figure. These components are built using semiconductor materials with unique characteristics to absorb and emit light, making them very appreciated in many fields of science and research. The ones we employ are known as nanowires. We used a Receiver nanowire during our simulations, which can be thought as a solar cell panel that can absorb light from various illumination angles. The second is a Transmitter nanowire that emits wave signals like a light bulb or light-emitting diode (LED) that functions as a light source.





In this work, we show that we can tune the strength of the neuron-to-neuron communication in a Neural Network by rotating either a Transmitter or a Receiver nanowire, as exemplified in the figure. In addition, our main achievement, the Weight function, describes the strength of the neuron-to-neuron communication which is the key-role component to construct a model that best mimic a neural network.

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