

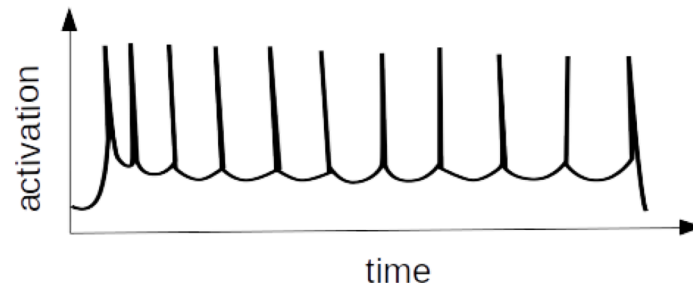
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# Artificial Neural Networks

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# Biological Neural Networks

- | Human brain ~86,000,000,000 neurons
- | Each neuron connected to ~1000 others
- | Electrochemical **inputs**
- | **Only fires if** signal exceeds voltage threshold
- | Signals are **spikes**
- | All-or-nothing response



# Artificial Neural Network (ANN)

**Machine Learning method**

- Today, often called **Deep Learning**

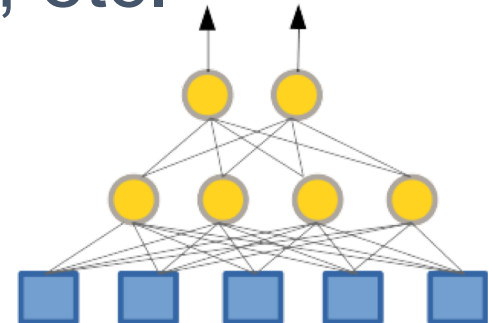
**Inspired by Biological Neural Networks**

**Mimics some of the basic functionalities**

**Can learn from large amounts of data**

**Can handle complex data types**

- Images, sound, video, EEG, etc.



# Brief History of Artificial Neural Networks

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- | **1943 McCulloch and Pitts:** One of the first mathematical models of neurons is able to calculate nearly any logical or arithmetic function.
- | **1969 Minsky and Papert:** A book published by Minsky and Papert, “Perceptrons”, showed that the XOR function can not be learned by a perceptron. Interest in neural network wanes.

# Brief History of Artificial Neural Networks

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- | **1986 Rumelhart, Hinton and Williams:**

Discovered new training algorithm that resolves issues raised by Minsky and Papert. Renewed interest in field.

- | **~2000 Vapnik and Schoelkopf:**

Probabilistic (kernel) approaches outperform ANNs and follow stricter formal procedure. Interest in ANNs declines again.

- | **~2005 LeCun, Hinton, Bengio, Schmidhuber, Ng, et al.:** Field is revived again through introduction of deeper networks, more data, new tricks (e.g. autoencoders).

# Applications



- | **Face and pose recognition**
- | **Speech recognition**
- | **Traffic sign classification**
- | **Medical image analysis**
- | **Predicting trends: stock market, twitter, etc.**
- | **Finance and portfolio selection**
- | **Automated game play: Atari games**

# Some Challenging Aspects

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- | Often large data sets are needed
- | Training with large data sets can take days or even weeks
- | Creating ANNs requires expert knowledge and experience
- | ANNs are difficult to analyze and debug

# Summary



- | **Neural networks inspired by biology**
- | **Growing field with roots in early 60s**
- | **Modern incarnation as deep learning**
- | **Network structure that learns complex computation from data**
- | **Many successful applications**
- | **Some challenges in training**