Welcome to Week 3

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Learning Objectives

- The main objective of Week 3 is to introduce basics of neural networks, in particular, deep neural network (DNN).
- In Week 3, you will learn
  - basic concepts of neural networks, e.g. neurons, layers and activation functions.
  - deep neural network (DNNs), including network architecture and backpropagation for parameter optimization;
  - the application of DNNs to derivative pricing and its Python implementation.

Supplementary material

- The teaching material for Week 3 is based on Chapter 5 of the book [1] (Chinese version) and [2] (English version).
- The code examples can be found at the Chapter5_NeuralNetwork/Section5.2_ANN.ipynb at the link `https://github.com/deepintomlf/mlfbook`.

Neural Networks

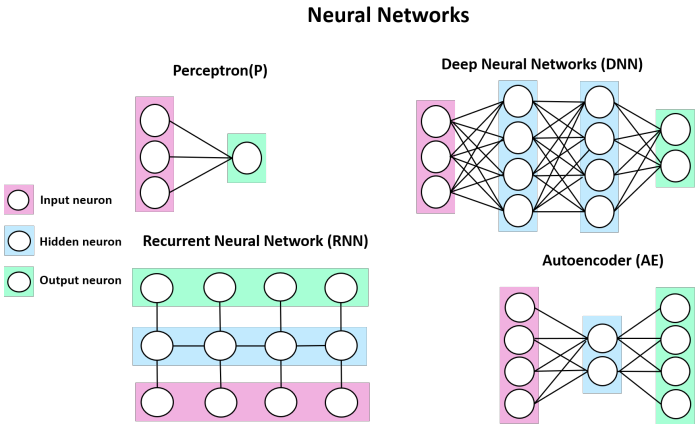
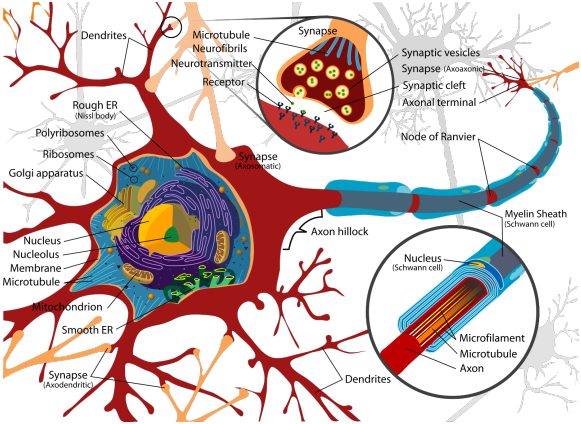


Figure: Neural Network Zoo.

Basic Terminology



A *neuron* is the basic unit of a neural network. Neural network models are vaguely inspired by biological neural networks that constitute human brains.

The *neural network* has the similar structure and working mechanism as biological neural network. Each neuron may be connected with the other and signals are transformed between each other.

Figure: The typical structure of a biological neuron.

Layers

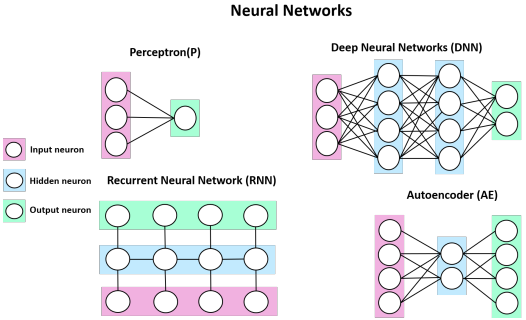


Figure: Neural Network Zoo.

- Several neurons constitute a layer, and several layers form a multi-layer neural network.
- Neurons in two consecutive layers may have different kinds of connectivity, such as full connectivity or local connectivity.
- There are three common types of layers in each neural network, i.e. input layers, hidden layers and output layers.

Building block of neural networks

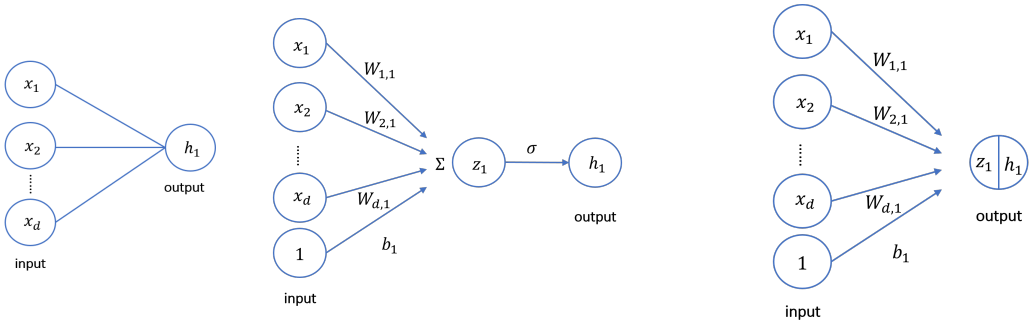


Figure: An illustration of the building block of neural networks. Here $\sigma : \mathbb{R} \to \mathbb{R}$ is called the *activation function*, e.g., $\sigma(x) = \frac{1}{1+\exp^{-x}}, \forall x \in \mathbb{R}$.

Neural Network Applications in Finance

Financial Applications

Examples include but are not limited to

- Limit order book prediction [3].
- High frequency trading [4, 5]; Deep hedging [6].
- Financial synthetic data generation [7].

Thanks for your attention!

References I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