ARTIFICIAL NEURAL NETWORK

in Python LANGUAGE

USEFUL INFORMATION

- **COURSE: ARTIFICIAL NEURAL NETWORK**
- **PROGRAMMING LANGUAGE: Python**
- **SOFTWARE: Visual Code**
- **TEXTBOOKS:**

- N. Ketkar, Deep Learning with Python, A Hands-on Introduction, Apress, 2017, ISBN: 978-1484227664.
- A. I. Galushkin, Neural Network Theory, Springer, 2007, ISBN 978-3540481249.
- K. Fukunaga, An Artifical Neural Network Book, Academic Press, 1990, ISBN 978- 0122698514
- I. Goodfellow et al., Deep Learning, MIT Press, 2016
- H. Kinsley and D. Kukiela, Neural Network from Scratch in Python, 2020.

ASSIGNMENT & GRADING

- **ASSIGNMENT & EXAMINATION:**
  - **Midterm : (50%)**
    - **Mid-term test on Computer (90 minutes)**
    - **Project**
  - **Final Examination: (50%)**
    - **On Computer (120 minutes)**

CHAPTER 1: INTRODUCTION

1.1. Introduction to Machine learning

- **Machine learning:**
  - **Def 1:** “Machine learning (ML) is a branch of artificial intelligence (AI) and computer science that focuses on the using data and algorithms to enable AI to imitate the way that humans learn, gradually improving its accuracy.” – *Source:* What Is Machine Learning (ML)? | IBM
  - **Def 2:** “Machine learning is the kind of programming which gives computers the capability to automatically learn from data without being explicitly programmed. This means in other words that these programs change their behavior by learning from data”. *Source:* Intro to Machine Learning with Python | Machine Learning (python-course.eu).
  - **Def 3:** Machine learning is the way of programming a computer to automatically recognize features (classify) or solve a particular problem without explicitly giving it the formulas (predict). The computer is capable of learning by experience, i.e. using data and output errors for optimization.

1.1. Introduction to Machine learning

- **How does it works ?**

A typical machine learning program can be divided in 3 parts:

- A Decision Process: Giving Prediction / classification based on data (labeled / unlabeled).
- An Error Function: Evaluate the prediction/classification and calculate the accuracy if training data is available.
- A Model Optimization Process: An iterative process allowing the update of parameters in order to improve the accuracy and make it converge to acceptable threshold.

Source: What Is Machine Learning (ML)? | IBM

1.1. Introduction to Machine learning

- **ML categories:**

Supervised learning

Each input data has the corresponding labelling. This means that the training data has to be labelled by the programmer. Ex: K-means, KNN, SVM (Support vector machine)

Unsupervised learning

No training data are provided to the learning algorithm → no label. The program determines by itself the input data clustering. Ex: PCA, SVD (Singular values decomposition)

Reinforcement learning

The computer program receiving positive and/or negative feedback from the environment (no label data) and improve its performance by optimizing the learning parameters.

- *Source:* Intro to Machine Learning with Python | Machine Learning (python-course.eu).

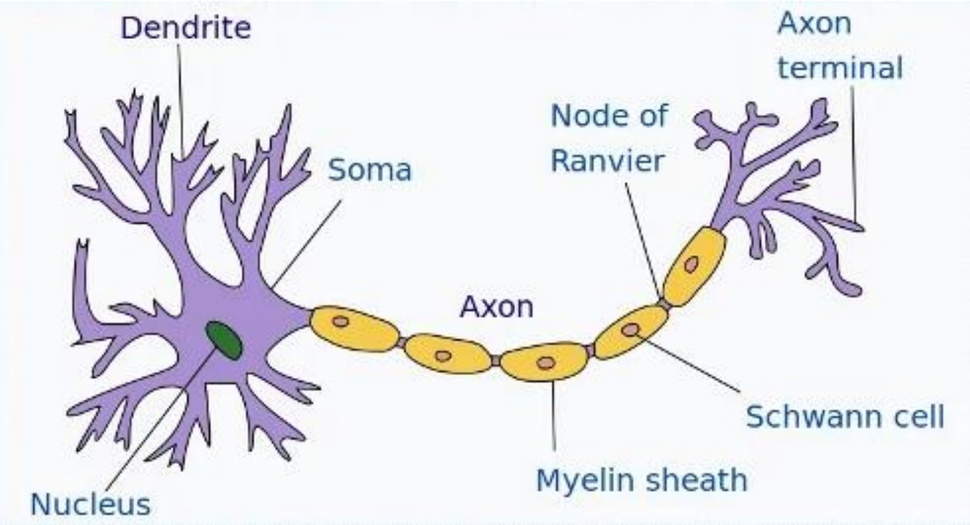
1.2. Introduction to ANN

- **Artificial Neural Network:**
  - Development of Artificial Neural Networks: early 1940s.
  - Became popular: late 1980s thanks to advances in computer science.
  - Purpose of ANN:
    - Development of ”intelligent” systems to achieve highly complexed tasks, reaching a performance comparable to that of the human brain
    - Contribute to neuroscience by understanding the functioning mechanism of the human brain.
  - ANNs need to be trained. They are capable of learning from experiences and generalizing by mean of a training data set.

1.2. Introduction to ANN

- **Artificial Neural Network:**

  - Each neuron in the brain has a relatively simple function.
  - 10 billion of neurons (60 trillion connections) → incredible processing unit, massive parallelism
  - The brain is trained by its environment → Learning by experience.



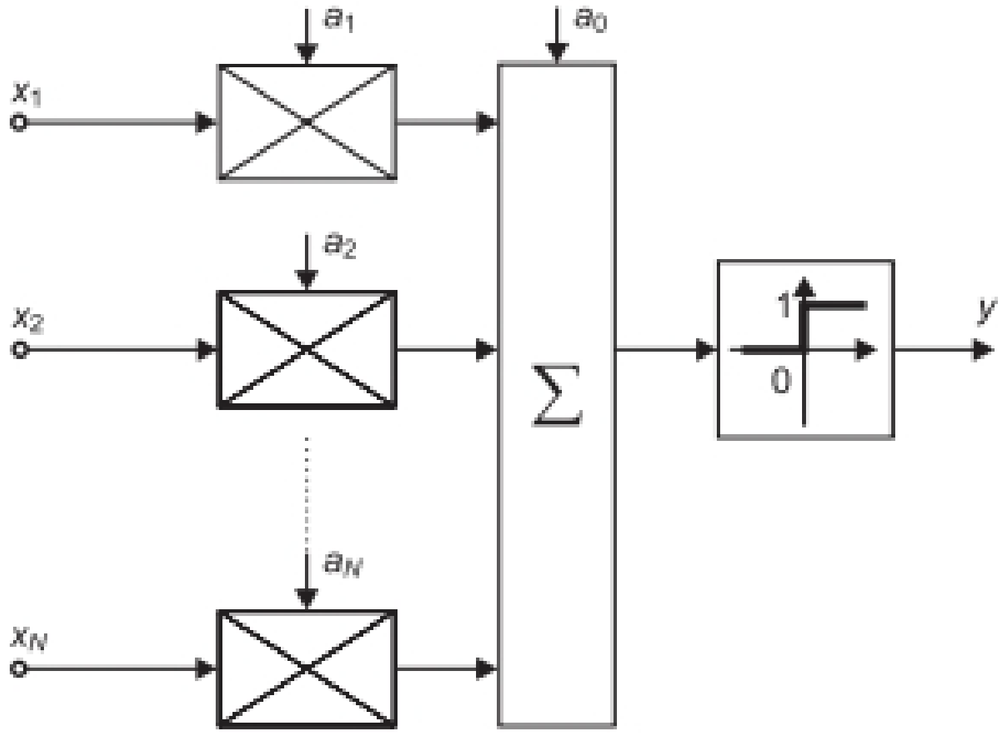
Source: Intro to Machine Learning with Python | Machine Learning (python-course.eu).

1.2. Introduction to ANN

- **Artificial Neural Network:**

  - Structure of an artificial neuron network:

"The dendrites branch of from the soma in a tree-like way and become thinner with every branch. They receive signals (impulses) from other neurons at synapses. The axon - there is always only one - also leaves the soma and usually tend to extend for longer distances than the denrites. The axon is used for sending the output of the neuron to other neurons or better to the synapsis of other neurons." (*Source:* Intro to Machine Learning with Python | Machine Learning (python-course.eu).

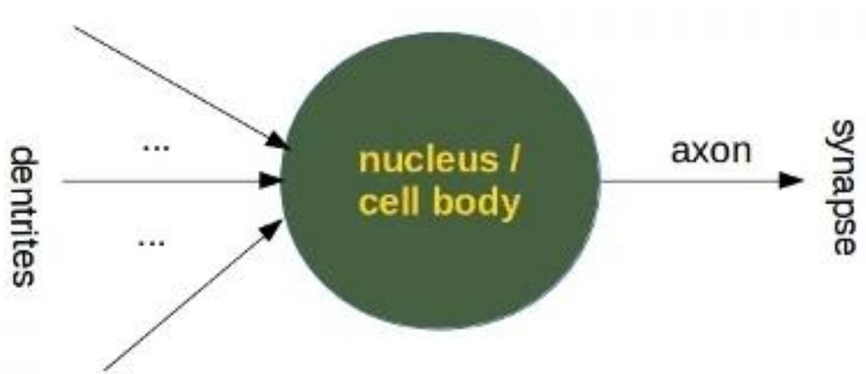


Source: *Neural Network Theory - Galushkin*

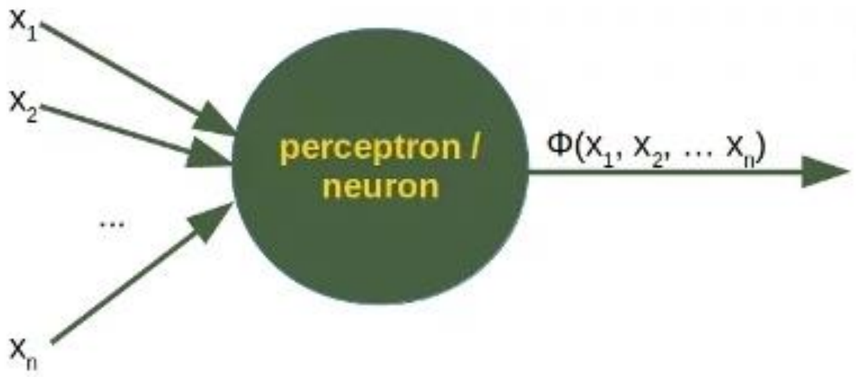
1.2. Introduction to ANN

- **Artificial Neural Network:**

- Simplified structure of a biological neuron:



- Structure of an artificial neuron:

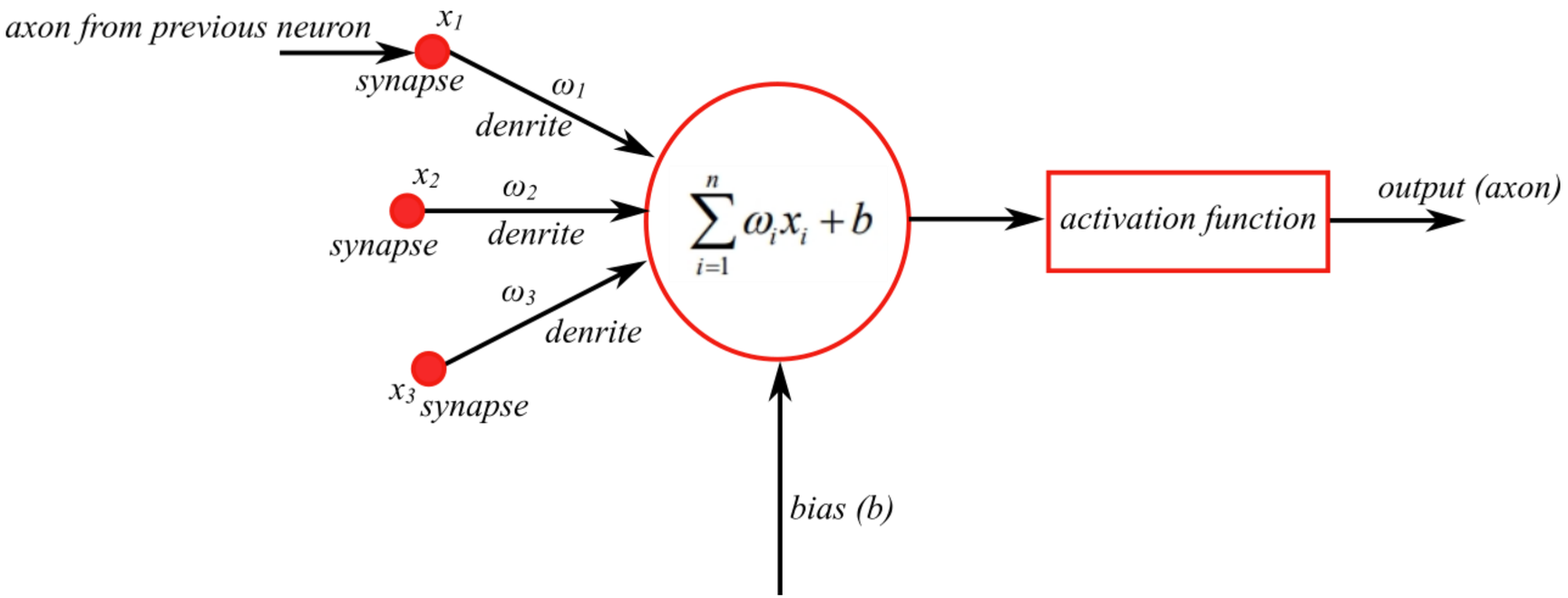


Source: Intro to Machine Learning with Python | Machine Learning (python-course.eu).

1.2. Introduction to ANN

- **Artificial Neural Network:**

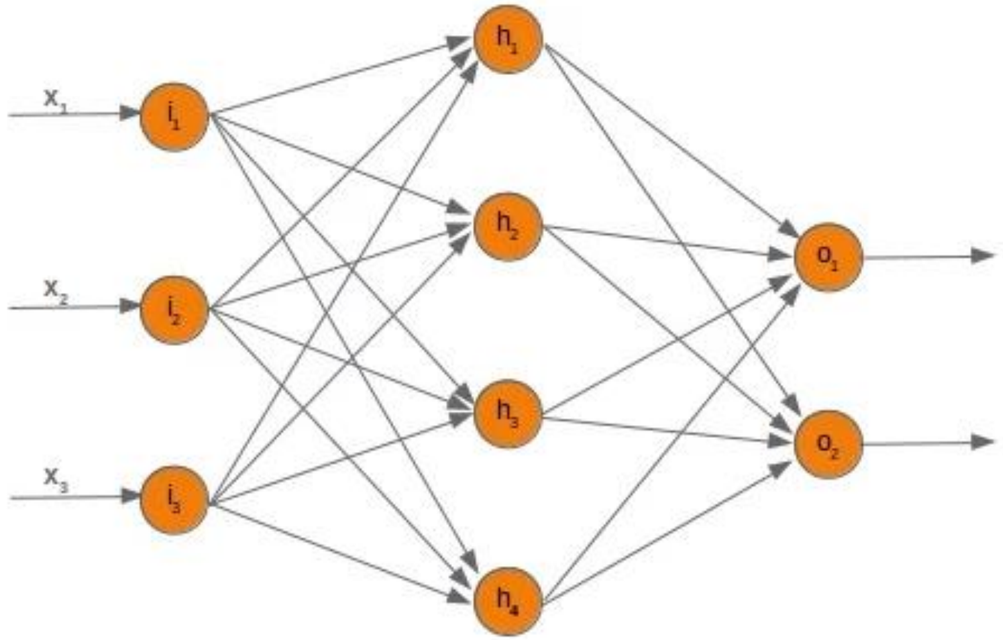
  - Structure of an artificial neuron:



Source: Intro to Machine Learning with Python | Machine Learning (python-course.eu).

1.2. Introduction to ANN

- **Artificial Neural Network:**
  - Example of structure of an artificial neural network: 3 inputs, 1 layer, 2 outputs



Source: Intro to Machine Learning with Python | Machine Learning (python-course.eu).

1.2. Introduction to ANN

- **How to program an Artificial Neural Network:**

Elements of an artificial neural network:

- Input Layer
- Dense Layer
- Output Layer
- Activation function
- Loss & Accuracy function
- Back Propagation
- Optimization

Source: Intro to Machine Learning with Python | Machine Learning (python-course.eu).

Artificial Neural Network

END OF CHAPTER 1