

**Title:** Deep Learning: Principles, Methodologies and Applications

**Teacher:** Gabriele Costante

**Contact:** [gabriele.costante@unipg.it](mailto:gabriele.costante@unipg.it)

**Lecture dates (tentative):**

- Monday 18 March 2024 from 3.30 pm to 6.30 pm
- Monday 25 March 2024 from 3.30 pm to 6.30 pm
- Thursday 4 April 2024 from 3.30 pm to 6.30 pm
- Monday 15 April 2024 from 3.30 pm to 6.30 pm
- Monday 22 April 2024 from 3.30 pm to 6.30 pm
- Monday 29 April 2024 from 3.30 pm to 6.30 pm
- Monday 6 May 2024 from 3.30 pm to 5.30 pm

## **ABSTRACT.**

In the last decade, we experienced an immense spread of digital information and autonomous devices, and their rate of production and distribution is exponentially increasing as we speak. For this huge flood of heterogeneous and complex data and systems to become valuable and with a significant impact on our lives, more effective and efficient data analysis techniques need to be developed. The realization of intelligent systems with high-level reasoning skills has therefore become one of the most crucial elements to take a substantial step towards technological advancement in a countless number of contexts, ranging from computer science, medicine, industry, agriculture and robotics to marketing, finance, security and human assistance, to name a few. In this process, Deep Learning (DL) and Deep Reinforcement Learning (DRL) have emerged as key technologies, capable of unlocking applications and solutions previously unthinkable. This has become possible thanks to the powerful set of algorithms, strategies and software frameworks that have been developed within the DL and DRL contexts.

The first objective of this course is to recap the basic principles of Deep Learning, focusing on Deep Neural Networks (DNNs), Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs). Afterward, the course will provide practical advice and best practices to be considered in a Deep Learning project. Solutions for contexts with partial or absent supervision information will also be discussed. Reinforcement Learning and Deep Reinforcement Learning will then be presented, introducing their foundations, principles and algorithms.

A series of case studies will be examined, with code implementations developed using the Pytorch framework.

## **PROGRAM**

- Deep Learning: recap of the basic principles of deep neural networks (DNNs), convolutional neural networks (CNNs) and recurrent neural networks (RNNs).
- Practical aspects of a Deep Learning project.

- Deep Learning without supervision information: unsupervised, self-supervised and weakly supervised deep learning.
- Reinforcement Learning: basic principles, motivations and algorithms
- Deep Reinforcement Learning
- Case studies and practical examples with code.