**Digital Data Processing**

*Academic Year*: 2022/2023

*Professor*: Matteo Frosi

*Language*: English

**COURSE OBJECTIVES AND EXPECTED LEARNING RESULTS**

The main purpose of the course is to introduce students to an appropriate theoretical and practical knowledge of the topics of data mining, machine learning and deep learning. Thanks to modern technologies and the enormous amount of data that companies have available, prediction models and ad-hoc neural networks are increasingly in demand, especially in the agri-food sector. With a view to a future working environment for the students, the various topics will be dealt with comprehensively, but not in depth, given the vastness of material and studies that have emerged in recent decades. Furthermore, the various themes will be accompanied by case studies, allowing students to understand and evaluate possible applications in the real world. Finally, it will be possible to carry out, optionally, a small project, linked to the topics of machine learning and deep learning, which will allow students to put into practice what they have learned during the theory lessons. In summary, at the end of the course students will be able to:

1. Know the meaning and the theoretical bases of the topics of data mining, machine learning and deep learning, knowing how to describe the various topics covered, both in writing and orally (e.g., neural networks or regression).
2. Analyze case studies and be able to independently identify appropriate algorithms and methodologies to address the various problems and requests.
3. Evaluate potential applications in the agri-food sector that can be managed/solved through the methods studied.
4. Put into practice what has been learned through an optional project.

**COURSE PROGRAM**

The course will be addressed, broadly, as follows:

1. Introduction to machine learning and data mining.
2. Supervised learning and regression.
3. Supervised learning and classification.
4. Case studies: machine learning applications in the real world.
5. Deep learning and neural networks.
6. Case studies: deep learning applications in the real world.

**STUDY MATERIAL AND BIBLIOGRAPHY**

* Bishop, Christopher M., and Nasser M. Nasrabadi. *Pattern recognition and machine learning*. Vol. 4. No. 4. New York: Springer, 2006.
* Faul, Anita C. *A concise introduction to machine learning*. CRC Press, 2019.
* Witten, Ian H., et al. "Practical machine learning tools and techniques." *DATA MINING*. Vol. 2. 2005.
* Chatterjee, Jyotir Moy, et al., eds. *Internet of Things and Machine Learning in Agriculture: Technological Impacts and Challenges*. Vol. 8. Walter de Gruyter GmbH & Co KG, 2021.
* Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep learning*. MIT press, 2016.

**TEACHING METHOD**

The various theoretical concepts, together with the case studies, will be addressed in class, usually through presentations (an integral part of the study material), in the order described in the paragraph of the course program. At the end of each topic, a mini-exercise will be carried out in which toy examples will be studied, to put into practice what was seen during the lessons. Students are invited to explore the literature, looking for publications and documents related to the applications of the various methodologies in the agri-food sector.

**ASSESSMENT METHOD AND CRITERIA**

The knowledge learned by students will be dynamically tested, through an assessment divided into two parts: a presentation and various questions on the course content. The required presentation must be based on the analysis of two scientific publications, in literature, about the applications of the methodologies, seen in class, within the agri-food chain. The presentation, which will have to deal in detail the problem studied in the articles and the approach used, will have a value of 16 points (8 per publication). The remaining 14 points will then be assigned on the basis of an oral discussion, in which various theoretical and practical questions will be asked, to evaluate the student's ability to reason.

During the duration of the course, mini-challenges will be periodically presented, from simple questions to numerical problems to be solved, which will guarantee 1 additional point to the student who will be the first to solve them correctly (for a maximum of 2 points per student). Furthermore, there will be the possibility of avoiding the presentation by carrying out, in its place, a project, to be defined with the teacher, to put into practice what has been learned during the course, on real data.

**WARNINGS AND PREREQUISITES**

As this is an introductory course to the topics of data mining, machine learning and deep learning, no prerequisites are needed to follow the content. However, a review of the fundamentals of algebra and statistics is recommended.

**SCHEDULE AND PLACE OF RECEPTION OF STUDENTS**

Professor Matteo Frosi is available after each lesson held in Cremona and to receive students, by appointment, also through remote meetings (Zoom or Microsoft Teams).