Universidad Zaragoza

Academic Year/course: 2022/23

69152 - Machine Learning

Syllabus Information

Academic Year: 2022/23
Subject: 69152 - Machine Learning
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 615 - Master's in Robotics, Graphics and Computer Vision/ Robótica, Gráficos y Visión por Computador
ECTS: 6.0
Year: 1
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The goal of this subject is to study the main machine learning techniques, understand their mathematical and algorithmic foundations, and be able to apply them in realistic examples related to robotics, graphics and computer vision.

These approaches and objectives are aligned with some of the Sustainable Development Goals, SDG, of the 2030 Agenda (https://www.un.org/sustainabledevelopment/es/) and certain specific goals, in such a way that the acquisition of the Learning outcomes of the subject provides training and competence to the student to contribute to a certain extent to their achievement:

- Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
    - Target 8.3 Promote development-oriented policies that support productive activities, the creation of decent jobs, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro, small and medium-sized enterprises, including through access to financial services
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
    - Target 9.4 By 2030, modernize infrastructure and reconvert industries so that they are sustainable, using resources more efficiently and promoting the adoption of clean and environmentally sound industrial technologies and processes, and ensuring that all countries take measures in accordance with their respective capabilities
- Goal 16: Promote peaceful and inclusive societies for sustainable development, facilitate access to justice for all, and create effective, accountable and inclusive institutions at all levels
    - Target 16.7 Ensure the adoption at all levels of inclusive, participatory and representative decisions that respond to the needs

1.2. Context and importance of this course in the degree

Machine learning is a cross-cutting and essential field of study today in many areas of application, including robotics, graphics, and computer vision. Therefore, it is essential to provide the student with a good machine learning background to be able to face innovative developments in the mentioned fields.

1.3. Recommendations to take this course

Prior knowledge of programming, basic algebra, calculus and statistics is recommended.

2. Learning goals

2.1. Competences

The student will acquire the following basic and general skills:

- CB6 ? To possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context.
- CB7 - That students know how to apply the acquired knowledge and ability to solve problems in new or little-known settings within broader (or multidisciplinary) contexts related to their area of ??study.
- CB8 - That students are able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.
- CB9 - That students know how to communicate their conclusions and the latest knowledge and reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way.
- CB10 - That students possess the learning skills that allow them to continue studying in a way that will have to be largely self-directed or autonomous.
- CG02 - Ability to apply and integrate their knowledge, their understanding, their scientific foundation and their problem-solving abilities in new and imprecisely defined environments, including multidisciplinary contexts, as highly specialized researchers and professionals.
- CG03 - Ability to evaluate and select the appropriate scientific theory and the precise methodology of their fields of study to formulate judgments based on incomplete or limited information, including, when necessary and pertinent, considerations on social or ethical responsibility linked to the solution that is proposed in each case.
- CG04 - Ability to predict and control the evolution of complex situations by developing new and innovative work methodologies adapted to the specific scientific / research, technological or professional field, generally multidisciplinary, in which their activity is carried out.
- CG05 - Ability to transmit in English, orally and in writing, in a clear and unambiguous way, to a specialized audience or not, results from scientific and technological research or the most advanced field of innovation, as well as the most relevant foundations on which they are based.
- CG06 ? To have developed sufficient autonomy to participate in research projects and scientific or technological collaborations within their subject area, in interdisciplinary contexts and, where appropriate, with a high component of knowledge transfer.
- CG07 - Ability to take responsibility for your own professional development and specialization in one or more fields of study.
- CG09 - Ability to use the techniques, skills and tools of Engineering necessary for solving problems of the Robotics, Graphics and / or Computer Vision fields.
- CG11 - Ability to manage and use bibliography, documentation, databases, software and hardware specific to the fields of Robotics, Graphics and / or Computer Vision.
- CG12 - Ability to work in a multidisciplinary group and in a multilingual environment.

The student will acquire the following specific skills:

- CE01 - Ability to apply mathematical and artificial intelligence methods to model, design and develop Robotics, Graphics and / or Computer Vision systems and applications.
- CE08 - Ability to conceive, design and develop Machine Learning systems, and apply them to Robotics, Graphics and / or Computer Vision problems.

2.2. Learning goals

The student must be able to:

- Know the different types of machine learning systems.
- Understand the fundamental algorithms of supervised and unsupervised learning.
- Understand the fundamentals of decision systems and reinforcement learning.
- Be able to adequately prepare training and evaluation data.
- Know how to analyze the results of a learning system.
- Design and develop Machine Learning systems for different applications related to Robotics, Computer Graphics or Computer Vision.

2.3. Importance of learning goals

Machine learning systems have become fundamental parts of a multitude of systems that require the analysis of large amounts of data, opening up new opportunities and topics for study and application in many areas, including robotics, graphics and computer vision.

Applications such as search engines, recommendation systems, bioinformatics, social networks, personal assistants, intelligent transport, among others, make use of machine learning techniques. This makes the ability to develop this type of systems have a notable and growing interest for our society, both in research and industrial environments.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

- E01 [40%] - Written and laboratory examination. One or more tests on practical cases proposed by the teachers or on the project developed by the student. This includes evaluation of the activity performed during the practical sessions.
- E02 [50%] - Directed work. Assignments, exercises, and reports of laboratory sessions, in which the knowledge and skills acquired in the course will be put into practice.
- E03 [10%] - Presentations and debates. Oral presentations and discussions of the results from assignments and lab sessions will be evaluated.

To pass the course, it will be necessary to pass the E01 examination with at least a grade of 5 out of 10 points (N1), and the E02 examination (during the sessions or through the delivery of reports) with a grade of at least 5 on 10 points (N2).

In case of passing both tests, the final grade will be calculated according to the following formula: 0.4 * N1 + 0.5 * N2 + 0.1 * N3. If neither N1 nor N2 is exceeded, the final grade will be one of the highest. In case of not passing N1 or N2, the grade will be that of the failed test.

Global evaluation will consist of a single evaluation where the three types of activities described above (N1,N2,N3) will be evaluated, following the same weights.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology is geared towards achieving the learning outcomes and skills described above. The teaching-learning process will be carried out through multiple activities: master classes and expert talks (oral presentations of content), problem solving classes (examples and practical cases with active participation of students), laboratory sessions (in small groups, with simulation tools or real systems) and the development of practical assignments and study work supervised by the faculty.

More details regarding the development of the subject will be specified on the first day of class.

4.2. Learning tasks

The course consists of 6 ECTS credits that correspond to an estimated student dedication of 150 hours distributed as follows:

- Master class. Problem-solving and cases: 38h
- Laboratory sessions: 15h
- Assignments of practical application or research work: 31 h
- Study: 60 h
- Assessment and evaluation activities: 6 h

4.3. Syllabus

The course will cover the following modules:

- Introduction to probability and linear algebra for machine learning
- Supervised learning (regression and classification models, linear and non-linear approximations)
- Unsupervised learning
- Reinforcement learning

- Machine learning applications for robotics, graphics and computer vision

4.4. Course planning and calendar

The calendar of the subject will be defined by the center in the academic calendar of the corresponding course. The detailed calendar of activities will be available in Moodle, and will be presented on the first day of class.

4.5. Bibliography and recommended resources

- Machine Learning: a Probabilistic Perspective, by Kevin Patrick Murphy, MIT Press, 2012
- Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016
- Mathematics for Machine Learning. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong. Published by Cambridge University Press 2020
- Reinforcement Learning: An Introduction, Richard S. Sutton and Andrew G. Barto, Second Edition, MIT Press, 2018

Biblioteca Unizar:
http://biblos.unizar.es/br/br_citas.php?codigo=69152&year=2020