Course guide
270410 - IAA - Introduction to Machine Learning

Last modified: 10/07/2024

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.

Degree: BACHELOR'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2021). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: SERGIO ÁLVAREZ NAPAGAO

Others: Primer quadrimestre:
SERGIO ÁLVAREZ NAPAGAO - 11, 12
JORGE LUQUE SERRANO - 11, 12

PRIOR SKILLS

Understand the computing flow within a software system.
Understand the basic concepts behind inference, deduction and evidence based reasoning.
Being familiarized with data distribution, basic data preprocessing, i how numerical variables can represent information.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE03. To identify and apply the basic algorithmic procedures of computer technologies to design solutions to problems by analyzing the suitability and complexity of the proposed algorithms.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
CE09. To ideate, design and integrate intelligent data analysis systems with their application in production and service environments.
CE15. To acquire, formalize and represent human knowledge in a computable form for solving problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments or environments.
CE20. To select and put to use techniques of statistical modeling and data analysis, assessing the quality of the models, validating and interpreting.

Generical:
CG1. To ideate, draft, organize, plan and develop projects in the field of artificial intelligence.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG3. To define, evaluate and select hardware and software platforms for the development and execution of computer systems, services and applications in the field of artificial intelligence.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CG6. To identify opportunities for innovative applications of artificial intelligence and robotics in constantly evolving technological environments.
CG7. To interpret and apply current legislation, as well as specifications, regulations and standards in the field of artificial intelligence.
CG8. Perform an ethical exercise of the profession in all its facets, applying ethical criteria in the design of systems, algorithms, experiments, use of data, in accordance with the ethical systems recommended by national and international organizations, with special emphasis on security, robustness , privacy, transparency, traceability, prevention of bias (race, gender, religion, territory, etc.) and respect for human rights.
CG9. To face new challenges with a broad vision of the possibilities of a professional career in the field of Artificial Intelligence. Develop the activity applying quality criteria and continuous improvement, and act rigorously in professional development. Adapt to organizational or technological changes. Work in situations of lack of information and / or with time and / or resource restrictions.

Transversal:
CT2. Sustainability and Social Commitment. To know and understand the complexity of economic and social phenomena typical of the welfare society; Be able to relate well-being to globalization and sustainability; Achieve skills to use in a balanced and compatible way the technique, the technology, the economy and the sustainability.
CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CT8. (ENG) Perspectiva de gènere. Conèixer i comprendre, des del propi àmbit de la titulació, les desigualtats per raó de sexe i gènere a la societat; Integrar les diferents necessitats i preferències per raó de sexe i de gènere en el disseny de solucions i resolució de problemes.

Basic:
CB3. That students have the ability to gather and interpret relevant data (usually within their area of ??study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

TEACHING METHODOLOGY

Interactive classes of theoretical content. Relatively autonomous laboratory sessions of practical contingency.

LEARNING OBJECTIVES OF THE SUBJECT

1.Learn the main methods of machine learning, and how to use them appropriately.
2.Interact in a critical and prudent manner with data and machine learning models
3.Recognize in an easy manner the characteristics of a problem from the perspective of machine learning

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Self study	90,0	60.00
Hours small group	30,0	20.00

Total learning time: 150 h

CONTENTS

Intro to machine learning.

Description:
Basic tipes of learning. What can they be used for, purposes and main limitations. Includes a set of warnings and sanity checks to keep in mind while working with machine learning.

Experimental design in machine learning

Description:
Using data for learning. How to design, execute and evaluate experiments conducted with machine learning techniques.

Data preprocessing

Description:
Distributions, normalization and standardization of data. How and why to prepare data to be processed by machine learning algorithms.

Applied Regression

Description:
Practical cases of regression

Dimensionality reduction

Description:
Review of the main methods to reduce the dimensionality of data: PCA, UMAP, T-SNE, ...

Classification: Basic concepts and review of basic methods

Description:
Distance measurements are studied and related to the concept of similitude, which then allows us to build and compare a large number of methods. Revision of the K-Nearest Neighbor as a simple framework and extension to other methods.

Classification methods based on other criteria

Description:
Support Vector Machines, Neural Networks (classic architectures) and Decision Trees.

Muilticlassification

Description:
The main methods of combining "weak" learning methods are studied in order to obtain more robust models: Boosting, Bagging, GAMs, EBMs, Sets

Explainability

Description:
Relevance, use and methods of explicability. Several methods are studied in order to interpret and explain the operation and result of machine learning algorithms, a basic need for the implementation and acceptance of these methods. The foundations for Explainable AI (Explainable Artificial Intelligence) are being laid.

Clustering

Description:
The bases of the classical methods of obtaining significant data sets in the absence of class information and / or prior structures are reviewed. K-means, Hierarchical Clustering, Spectral Clustering, DBSCAN.

Genetic algorisms

Description:
Introduction to genetic algorithms, as a first vision of bio-inspired learning methods. The conceptual and mathematical bases of the main mutation and crossover operators and their representational variants are reviewed.

Machine learning in graphs

Description:
The structure of the graph is widespread in various environments and has donated to a whole discipline, the Science of the Xarxes, on it is work on the structural properties of the graphs to derive properties and conclusions about the phenomenon or field that is studied. This type of learning is especially important in internet applications, near or recovery applications or knowledge detection. Detection of communities, prediction of accidents, etc.

ACTIVITIES

Introduction to Machine Learning

Description:
Types, purposes and limitations

Specific objectives:
1, 2

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Full-or-part-time: 12h
Self study: 6h
Theory classes: 6h

Data preprocessing and manipulation

Specific objectives:
1, 3

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Full-or-part-time: 22h
Self study: 12h
Theory classes: 4h
Laboratory classes: 6h

Machine learning methods

Specific objectives:
1, 3

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Full-or-part-time: 50h
Self study: 18h
Theory classes: 12h
Laboratory classes: 20h

Other aspects of machine learning

Specific objectives:
1, 2, 3

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Full-or-part-time: 18h
Self study: 10h
Theory classes: 4h
Laboratory classes: 4h

First Mid-term Exam

Specific objectives:
1

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Full-or-part-time: 14h
Self study: 12h
Guided activities: 2h

Final

Specific objectives:
1

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Self study: 12h
Guided activities: 2h

Lab evaluation

Specific objectives:
1

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Full-or-part-time: 10h
Self study: 10h

GRADING SYSTEM

The course consists of one partial exam (P) and a final exam (F). The laboratory will be evaluated continuously (LC) and through a final delivery (LF).

Final score = (0.2*P) + (0.4*F) + (0.1*LC) + (0.3*LF)

BIBLIOGRAPHY

Basic:
- Bishop, Christopher M. Pattern recognition and machine learning. New York: Springer, cop. 2006. ISBN 0387310738.