Course guide
270703 - IML - Introduction to Machine Learning

Unit in charge: Barcelona School of Informatics
Teaching unit: 1004 - UB - (ENG)Universitat de Barcelona.
Degree: MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Compulsory subject).

Academic year: 2022 ECTS Credits: 5.0 Languages: English

LECTURER
Coordinating lecturer: MARIA SALAMÓ LLORENTE

Others:

PRIOR SKILLS
It is necessary to have knowledge in programming: Python and Java languages

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CEP7. Capability to respect the legal rules and deontology in professional practice.

General:
CG2. Capability to lead, plan and supervise multidisciplinary teams.
CG4. Capacity for general management, technical management and research projects management, development and innovation in companies and technology centers in the area of Artificial Intelligence.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Basic:
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.

TEACHING METHODOLOGY
The class is divided in two parts:

- Theory (2 hours): introduce the contents of the course
- Laboratory (1 hour) which includes:

*Practical exercises related to work deliveries
*Participatory class where students talk about the readings suggested to go deeper into a subject

Note: These readings will be included as theory in the final exam
LEARNING OBJECTIVES OF THE SUBJECT

1. Learn and understand the most common machine learning techniques for unsupervised and supervised tasks.
2. Learn how to solve a problem using machine learning techniques.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Guided activities</td>
<td>5,0</td>
<td>4.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>8,0</td>
<td>6.40</td>
</tr>
<tr>
<td>Self study</td>
<td>80,0</td>
<td>64.00</td>
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<tr>
<td>Hours large group</td>
<td>16,0</td>
<td>12.80</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>16,0</td>
<td>12.80</td>
</tr>
</tbody>
</table>

Total learning time: 125 h

CONTENTS

1. Introduction to machine learning

   Description:
   - What is learning?
   - Definition of learning
   - Elements of machine learning
   - Paradigms of machine learning
   - Applications of machine learning
   - Nuts and bolts of machine learning theory

Unsupervised learning

   Description:
   - Introduction to unsupervised learning
   - Clustering
   - Classification of clustering algorithms: K-Means and EM
   - Factor Analysis: PCA (Principal Components Analysis) and ICA (Independent Component Analysis)
   - Self-Organized Maps (SOM) and Multi-dimensional Scaling
   - Recommender Systems

Supervised learning

   Description:
   - Introduction and perspectives
   - Lazy Learning
   - Introduction to feature selection
   - Model selection
   - Supervised learning taxonomy
   - Linear decision
   - Non-linear decision learning: Kernel methods
   - Non-linear decision learning: Ensemble Learning
   - Bayesian Learning
ACTIVITIES

Work 1 - (W1) Unsupervised exercise

Description:
Unsupervised exercise related to the techniques studied in this course

Specific objectives:
2

Related competencies:
CG2. Capability to lead, plan and supervise multidisciplinary teams.
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Full-or-part-time: 15h
Self study: 15h

Work 2 - (W2) Lazy learning exercise

Description:
Implement a lazy learning exercise for a particular problem

Specific objectives:
2

Related competencies:
CG2. Capability to lead, plan and supervise multidisciplinary teams.
CG4. Capacity for general management, technical management and research projects management, development and innovation in companies and technology centers in the area of Artificial Intelligence.
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Full-or-part-time: 15h
Self study: 15h
Work 3 - (W3) Kernel Learning exercise

Description:
This exercise is devoted to implement or analyse a Kernel Learning

Specific objectives:
2

Related competencies:
CG2. Capability to lead, plan and supervise multidisciplinary teams.
CG4. Capacity for general management, technical management and research projects management, development and innovation in companies and technology centers in the area of Artificial Intelligence.
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Full-or-part-time: 15h
Self study: 15h

Work 4 - (W4) Non Linear Decision exercise

Description:
This exercise is devoted to implement or analyse Ensemble Learning algorithms

Specific objectives:
2

Related competencies:
CG2. Capability to lead, plan and supervise multidisciplinary teams.
CG4. Capacity for general management, technical management and research projects management, development and innovation in companies and technology centers in the area of Artificial Intelligence.
CEP7. Capability to respect the legal rules and deontology in professional practice.
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Full-or-part-time: 15h
Self study: 15h
### Work 5 - (W5) Readings of different research papers

**Description:**
Read and analyse different research papers during the course

**Specific objectives:**
1

**Related competencies:**
- CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
- CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..
- CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.

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

### Introduction to ML

**Description:**
Introduction to ML

**Full-or-part-time:** 4h
Theory classes: 4h

### Cluster Analysis

**Description:**
Cluster Analysis, study of the most common techniques used in machine learning

**Full-or-part-time:** 7h
Theory classes: 3h
Laboratory classes: 3h
Self study: 1h

### Factor analysis

**Description:**
Factor analysis: study of the most common techniques

**Full-or-part-time:** 5h
Theory classes: 4h
Laboratory classes: 1h

### Visualization

**Description:**
Study of self-organized maps and multi-dimensional scaling techniques

**Full-or-part-time:** 4h
Theory classes: 3h
Laboratory classes: 1h
<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Full-or-part-time</th>
<th>Theory classes</th>
<th>Laboratory classes</th>
<th>Self study</th>
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</thead>
<tbody>
<tr>
<td>Introduction to supervised learning</td>
<td>Introduction to supervised learning</td>
<td>4h</td>
<td>3h</td>
<td>1h</td>
<td></td>
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<tr>
<td>Lazy Learning</td>
<td>Study of different Lazy Learning techniques</td>
<td>3h</td>
<td>2h</td>
<td>1h</td>
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<tr>
<td>Feature Selection</td>
<td>Study of Feature Selection techniques applied in machine learning</td>
<td>5h</td>
<td>2h</td>
<td>2h</td>
<td>1h</td>
</tr>
<tr>
<td>Model selection and taxonomy</td>
<td>Model selection and taxonomy</td>
<td>3h</td>
<td>2h</td>
<td>1h</td>
<td></td>
</tr>
<tr>
<td>Linear Decision</td>
<td>Linear Decision: Algorithms</td>
<td>5h</td>
<td>4h</td>
<td>1h</td>
<td></td>
</tr>
</tbody>
</table>
Kernel Learning

Description:
Keremel Learning

Full-or-part-time: 5h
Theory classes: 3h
Laboratory classes: 2h

Ensemble Learning

Description:
Ensemble Learning

Full-or-part-time: 5h
Theory classes: 3h
Laboratory classes: 2h

Recommender Systems

Description:

Full-or-part-time: 5h
Theory classes: 3h
Laboratory classes: 2h

GRADING SYSTEM

The course is divided into two parts:

Exam: an exam at the end of the term
Work: Work deliveries during the semester (from W1 to W5)

Mark = a x Exam + b x Work

Each course a and b will be established in the following ranges: 0,35 <= a <= 0,5 and 0,3 <= b <= 0,6

Work = c x W1 + d x W2 + e x W3 + f x W4

Each course c, d, e, and f will be established in the following ranges: 0,2 <= {c,e} <= 0,4 and 0,1 <= {d, f} <= 0,2

BIBLIOGRAPHY

Basic: