270703 - IML - Introduction to Machine Learning

Coordinating unit: 270 - FIB - Barcelona School of Informatics
Teaching unit: 1004 - UB - (ENG)Universitat de Barcelona
Academic year: 2019
Degree: MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2012). (Teaching unit Compulsory)
MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Teaching unit Compulsory)
MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2009). (Teaching unit Optional)
MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 5

Prior skills
It is necessary to have knowledge in programming: Python and Java languages

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>Total learning time: 125h</th>
<th>Hours large group: 16h</th>
<th>12.80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group: 16h</td>
<td>12.80%</td>
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</tr>
<tr>
<td>Hours small group: 8h</td>
<td>6.40%</td>
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</tr>
<tr>
<td>Guided activities: 5h</td>
<td>4.00%</td>
<td></td>
</tr>
<tr>
<td>Self study: 80h</td>
<td>64.00%</td>
<td></td>
</tr>
</tbody>
</table>
1. Introduction to machine learning

Degree competences to which the content contributes:

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

Degree competences to which the content contributes:

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

Degree competences to which the content contributes:

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
## Planning of activities

| Work 1 - (W1) Unsupervised exercise | Hours: 15h  
<table>
<thead>
<tr>
<th></th>
<th>Self study: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>Unsupervised exercise related to the techniques studied in this course</td>
<td></td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td></td>
</tr>
<tr>
<td>(ENG)</td>
<td></td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td></td>
</tr>
<tr>
<td>(ENG)</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
</tr>
<tr>
<td>(ENG) 2</td>
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</tbody>
</table>

| Work 2 - (W2) Lazy learning exercise | Hours: 15h  
|                                      | Guided activities: 0h  
<table>
<thead>
<tr>
<th></th>
<th>Self study: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>implement a lazy learning exercise for a particular problem</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

| Work 3 - (W3) Kernel Learning exercise | Hours: 15h  
|                                       | Guided activities: 0h  
<table>
<thead>
<tr>
<th></th>
<th>Self study: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>This exercise is devoted to implement or analyse a Kernel Learning</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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</tbody>
</table>

| Work 4 - (W4) Non Linear Decision exercise | Hours: 15h  
|                                           | Guided activities: 0h  
<table>
<thead>
<tr>
<th></th>
<th>Self study: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>This exercise is devoted to implement or analyse Ensemble Learning algorithms</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
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<tr>
<td>2</td>
<td></td>
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</tbody>
</table>
## Work 5 - (W5)  Readings of different research papers

**Hours:** 10h  
Guided activities: 0h  
Self study: 10h

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

**Specific objectives:**

1.

## Introduction to ML

**Hours:** 4h  
Theory classes: 4h  
Practical classes: 0h  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 0h

**Description:**  
Introduction to ML

## Cluster Analysis

**Hours:** 7h  
Theory classes: 3h  
Practical classes: 0h  
Laboratory classes: 3h  
Guided activities: 0h  
Self study: 1h

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

## Factor analysis

**Hours:** 5h  
Theory classes: 4h  
Practical classes: 0h  
Laboratory classes: 1h  
Guided activities: 0h  
Self study: 0h

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

<table>
<thead>
<tr>
<th>Hours: 4h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
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<tr>
<td>Self study: 0h</td>
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**Description:**
Study of self-organized maps and multi-dimensional scaling techniques

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### Introduction to supervised learning

<table>
<thead>
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<th>Hours: 4h</th>
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<tbody>
<tr>
<td>Theory classes: 3h</td>
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<tr>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
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<tr>
<td>Self study: 0h</td>
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</tbody>
</table>

**Description:**
Introduction to supervised learning

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### Lazy Learning

<table>
<thead>
<tr>
<th>Hours: 3h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
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<tr>
<td>Self study: 0h</td>
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</table>

**Description:**
Study of different Lazy Learning techniques

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### Feature Selection

<table>
<thead>
<tr>
<th>Hours: 5h</th>
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<tbody>
<tr>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
</tr>
<tr>
<td>Self study: 1h</td>
</tr>
</tbody>
</table>

**Description:**
Study of Feature Selection techniques applied in machine learning
### Model selection and taxonomy

**Hours:** 3h  
Theory classes: 2h  
Practical classes: 0h  
Laboratory classes: 1h  
Guided activities: 0h  
Self study: 0h

**Description:**  
Model selection and taxonomy

### Linear Decision

**Hours:** 5h  
Theory classes: 4h  
Practical classes: 0h  
Laboratory classes: 1h  
Guided activities: 0h  
Self study: 0h

**Description:**  
Linear Decision: Algorithms

### Kernel Learning

**Hours:** 5h  
Theory classes: 3h  
Practical classes: 0h  
Laboratory classes: 2h  
Guided activities: 0h  
Self study: 0h

**Description:**  
Kernel Learning

### Ensemble Learning

**Hours:** 5h  
Theory classes: 3h  
Practical classes: 0h  
Laboratory classes: 2h  
Guided activities: 0h  
Self study: 0h

**Description:**  
Ensemble Learning
Recommender Systems

<table>
<thead>
<tr>
<th>Hours: 5h</th>
<th>Theory classes: 3h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 0h</td>
</tr>
<tr>
<td></td>
<td>Self study: 0h</td>
</tr>
</tbody>
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Description:

Qualification 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:

