Degree competences to which the subject contributes

Learning objectives of the subject:
The objectives are to introduce students to the main algorithms for learning from data / machine learning, and for
understanding how to make the algorithms work with real data.

Learning results of the subject:

- Ability to understand the general principles of the machine learning algorithms.
- Ability to distinguish the relevant properties of algorithms for a given problem.
- Knowledge of the main machine learning techniques.

### Study load

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong> 125h</td>
<td>39h</td>
<td>0h</td>
<td>0h</td>
<td>0h</td>
<td>86h</td>
</tr>
<tr>
<td></td>
<td>31.20%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>68.80%</td>
</tr>
</tbody>
</table>
### Content

| Introduction to the techniques of machine learning | **Learning time:** 33h  
Theory classes: 8h  
Self study: 25h |
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Description of the types of machine learning models based on data, emphasizing structure, geometry and the relationship with deep learning.</td>
</tr>
<tr>
<td><strong>Related activities:</strong></td>
<td>Individual Deliverable+ individual practices</td>
</tr>
</tbody>
</table>

| Bayesian Framework | **Learning time:** 18h  
Theory classes: 6h  
Self study: 12h |
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>A classification model based on Bayes' formula is presented, its plausibility. From the general formula the typology of classification models obtained is explained. In parallel geometric interpretations are presented. The Bayesian framework is generalized to the approximation of functions and parametric regression.</td>
</tr>
<tr>
<td><strong>Related activities:</strong></td>
<td>Individual Deliverable+Individual practices</td>
</tr>
</tbody>
</table>

| Linear Discriminant Functions and lineal regression | **Learning time:** 7h  
Theory classes: 2h  
Self study: 5h |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Based on the simplest model geometry, it is a hyperplane, the duality between classification and function approximation is presented. Geometric model is related to the Bayesian framework and underlying assumptions are clarified. The various ways of calculating the model parameters are also presented.</td>
</tr>
<tr>
<td><strong>Related activities:</strong></td>
<td>Individual Deliverable+Individual practices</td>
</tr>
</tbody>
</table>
### Multilayer perceptron and radial basis functions

**Learning time:** 21h  
Theory classes: 7h  
Self study : 14h

**Description:**  
The underlying geometry of the models of multilayer perceptron and radial basis functions is described. From the geometrical properties of the models and the types of problems that can be solved with these models are derived. Then are presented the algorithms to estimate the parameters. Also the conditions under which they can function properly. A Bayesian interpretation of the geometry associated with the two models is given. The techniques that make deep learning work are described.

**Related activities:**  
Individual Deliverable+Individual practices

### Exploratory Data analysis

**Learning time:** 3h  
Theory classes: 1h  
Self study : 2h

**Description:**  
Different techniques are presented to study how the data are distributed in order to choose the technique of ‘machine learning’ more suitable for the data type.

**Related activities:**  
Individual Deliverable

### Advanced methods for machine learning

**Learning time:** 39h  
Theory classes: 13h  
Self study : 26h

**Description:**  
Advanced SVM methodologies, unsupervised techniques, k-nearest neighbours, decision trees, random forests and boosting are described.

**Related activities:**  
Weekly essay and ML practical application
Planning of activities

EXTENDED ANSWER TEST (FINAL EXAMINATION)

<table>
<thead>
<tr>
<th>Weekly deliverables</th>
<th>Hours: 2h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>weekly essay + lab practice at home</td>
<td></td>
</tr>
</tbody>
</table>

Qualification system

Autumn term: Lab work: 25%. Delivery of homework: 20%. Participation in the proposed ML challenge: 15%. Final exam: 40%.
Spring term: Max of {40% deliverables, 60% final exam}, {100% final exam}.

Bibliography

Basic:

Complementary: