Theoretical component consists of face-to-face classes where the teacher will review concepts of Deep Learning, present applications, and other recent trends in the field. At the end of the course, students will have to read and analyse articles from Deep Learning to demonstrate the knowledge learned.

The practical component is composed by individual practices, where students will have to experiment with the various techniques of Deep Learning. Based on simple experiments, and using popular Deep Learning libraries (e.g., Keras, TensorFlow, Theano, Caffe), the students will test the effects of the various available techniques.

Learning objectives of the subject

1. Understand the various techniques that can be integrated into a deep learning system, and know how to experiment with them coherently in a realistic production environment through the use of third-party libraries.
2. Be able to understand scientific articles from the area of deep learning, to extract the most relevant conclusions, and to derive possible applications or limitations.
Study load

<table>
<thead>
<tr>
<th>Total learning time: 40h 30m</th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>40h 30m</td>
<td>40h 30m</td>
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</table>

Content

Convolutional Neural Networks

Degree competences to which the content contributes:
Description:
We will review the main aspects of CNNs. How they work, why, and how can they be improved.

We will review the main aspects of RNNs. How they work, why, and how can they be improved.

Degree competences to which the content contributes:
Description:
We will review the main aspects of RNNs. How they work, why, and how can they be improved.

Embeddings

Degree competences to which the content contributes:
Description:
We will review several ways in which neural network embeddings can be used, the pros and cons.

HPC&DL

Degree competences to which the content contributes:
Description:
We will review basic concepts of High Performance Computing in the context of Deep Learning.
### Practical experimentation

**Hours:** 17h 36m  
Guided activities: 2h 36m  
Self study: 15h

**Description:**  
Experimentation using deep learning libraries, and reporting of the relevant conclusions.

**Specific objectives:**  
1

### Theoretical comprehension

**Hours:** 11h  
Guided activities: 2h  
Self study: 9h

**Description:**  
Read a relevant article in the field of deep learning, describe and present the main contributions, as well as possible future work lines or limitations of the same.

**Specific objectives:**  
2

### Review of Multilayer Perceptron and Convolutional Neural Networks

**Hours:** 9h  
Theory classes: 3h  
Practical classes: 0h  
Laboratory classes: 3h  
Guided activities: 0h  
Self study: 3h

### Lab on Multilayer Perceptron and Convolutional Neural Networks

**Hours:** 12h  
Theory classes: 0h  
Practical classes: 0h  
Laboratory classes: 3h  
Guided activities: 0h  
Self study: 9h

### Review of Recurrent Neural Networks

**Hours:** 9h  
Theory classes: 3h  
Practical classes: 0h  
Laboratory classes: 3h  
Guided activities: 0h  
Self study: 3h
<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
<th>Theory classes:</th>
<th>Practical classes:</th>
<th>Laboratory classes:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab on Recurrent Neural Networks</td>
<td>12h</td>
<td>0h</td>
<td>0h</td>
<td>3h</td>
<td>0h</td>
<td>9h</td>
</tr>
<tr>
<td>Review of Neural Embedding Spaces</td>
<td>9h</td>
<td>3h</td>
<td>0h</td>
<td>3h</td>
<td>0h</td>
<td>3h</td>
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<tr>
<td>Lab on Neural Embedding Spaces</td>
<td>12h</td>
<td>0h</td>
<td>0h</td>
<td>3h</td>
<td>0h</td>
<td>9h</td>
</tr>
<tr>
<td>Review of HPC for Deep Learning</td>
<td>9h</td>
<td>3h</td>
<td>0h</td>
<td>3h</td>
<td>0h</td>
<td>3h</td>
</tr>
<tr>
<td>Lab on HPC for Deep Learning</td>
<td>12h</td>
<td>0h</td>
<td>0h</td>
<td>3h</td>
<td>0h</td>
<td>9h</td>
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</table>
This subject will be evaluated taking into account the theoretical (25%) and practical (75%) aspects. For the theoretical part, students must read an article from Deep Learning (proposed or validated by the teacher) and do a presentation detailing the main contributions to the class. They will also have to do a critical analysis of the article, detailing aspects that could be done differently, future work that could be derived from the paper, or limitations of the same methodology.

For the practical part, the students will have to do a summary of the experiments realized in the practices, detailing the results obtained in each experiment, and interpreting these results. This includes 4 independent practices.

**Bibliography**

**Basic:**