Degree competences to which the subject contributes

At the end of this course students will be able to design, implement, train and evaluate a machine learning system based on deep neural networks.

Prior skills

A previous knowledge on basic machine learning is advisable. In terms of programming, it is recommended that students are familiar with Python programming language beforehand.

Teaching methodology

Lectures, in class labs and assignments.

Learning objectives of the subject

At the end of this course students will be able to design, implement, train and evaluate a machine learning system based on deep neural networks.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>26h</th>
<th>20.80%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>13h</td>
<td>10.40%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>86h</td>
<td>68.80%</td>
</tr>
</tbody>
</table>
## 1. DEEP NEURAL NETWORKS

**Description:**
1.1 The Perceptron. Regression vs classification. The Softmax classifier.
1.2 Multi-layer perceptron (MLP).
1.3 Basic layers: Fully connected. Convolutions/Deconvolutions, Non-linearities (ReLU, tanh, sigmoid).
1.4 Interpretability: t-SNE, visualizations, highest activations.

**Learning time:** 18h  
Theory classes: 3h 57m  
Self study: 14h 03m

## 2. TRAINING

**Description:**
2.1 Backpropagation  
2.2 Optimizers  
2.3 Loss functions  
2.4 Methodology  
2.5 Efficient computation

**Learning time:** 35h 59m  
Theory classes: 7h 53m  
Self study: 28h 06m

## 3. MEMORY NETWORKS

**Description:**
3.1 Recurrent Neural Networks  
3.2 Gated models: LSTM, GRU, ...  
3.3 Advanced models: QRNN, pLSTM, ...

**Learning time:** 18h  
Theory classes: 3h 57m  
Self study: 14h 03m
### 4. BEYOND SUPERVISED LEARNING

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Unsupervised and semi-supervised learning.</td>
</tr>
<tr>
<td>4.2 Adversarial training and generative models</td>
</tr>
<tr>
<td>4.3 Incremental learning</td>
</tr>
<tr>
<td>4.4 Active learning</td>
</tr>
<tr>
<td>4.5 Reinforcement learning</td>
</tr>
<tr>
<td>4.6 Meta-learning</td>
</tr>
</tbody>
</table>

**Learning time:** 18h  
Theory classes: 3h 57m  
Self study: 14h 03m

### 5. COMPUTATION

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Software stack</td>
</tr>
<tr>
<td>5.2 Computational requirements</td>
</tr>
<tr>
<td>5.3 Scalability</td>
</tr>
</tbody>
</table>

**Learning time:** 18h  
Theory classes: 3h 57m  
Self study: 14h 03m
# Planning of activities

## Lectures

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. DEEP NEURAL NETWORKS</td>
</tr>
<tr>
<td>2. TRAINING</td>
</tr>
<tr>
<td>3. MEMORY NETWORKS</td>
</tr>
<tr>
<td>4. BEYOND SUPERVISED LEARNING</td>
</tr>
<tr>
<td>5. COMPUTATION</td>
</tr>
</tbody>
</table>

**Hours:** 108h  
Theory classes: 23h 40m  
Self study: 84h 20m

## Labs in class

**Description:**  
1. Classification vs Regression  
3. Data pipelines between CPUs and GPUs.  
5. Generative adversarial networks.

**Support materials:**  
Deep learning frameworks used during the labs: Caffe, Tensorflow and Keras.

**Hours:** 10h  
Laboratory classes: 5h  
Self study: 5h

## Project

**Description:**  
Hands on project where students must design, train and test their own deep learning model.

**Support materials:**  
GPUs on a cloud service.

**Descriptions of the assignments due and their relation to the assessment:**  
Oral presentation  
Poster

**Hours:** 40h  
Theory classes: 1h  
Laboratory classes: 8h  
Self study: 31h

## Grading

**Hours:** 4h  
Theory classes: 4h
Description:
Written exams in class.

Qualification system
Labs: 15%
Midterm: 15%
Project: 40%
Final exam: 30%

Bibliography

Others resources:

Hyperlink
https://telecombcn-dl.github.io/2017-dlcv/
Deep Learning for Computer Vision Summer School at UPC ETSETB TelecomBCN 2017

https://telecombcn-dl.github.io/2017-dlai/
Web page of the course

Audiovisual material
https://telecombcn-dl.github.io/2017-dlsl/
Resource