Course guides
230706 - DLAI - Deep Learning for Artificial Intelligence

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.
Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
Academic year: 2020  ECTS Credits: 5.0  Languages: English

LECTURER
Coordinating lecturer: Giró Nieto, Xavier
Others: Ruiz Hidalgo, Javier
Ruiz Costa-Jussa, Marta
Sayrol Clols, Elisa
Vilaplana Besler, Veronica
Morros Rubio, Josep Ramon
Casamitjana Díaz, Adrià

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.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES
Specific:
CE1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital
signal processing to communication and audiovisual systems.

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>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours small group</td>
<td>13,0</td>
<td>10.40</td>
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<tr>
<td>Hours large group</td>
<td>26,0</td>
<td>20.80</td>
</tr>
<tr>
<td>Self study</td>
<td>86,0</td>
<td>68.80</td>
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</tbody>
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Total learning time: 125 h
# CONTENTS

## 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.

**Full-or-part-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

**Full-or-part-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, ...

**Full-or-part-time:** 18h  
Theory classes: 3h 57m  
Self study : 14h 03m

## 4. BEYOND SUPERVISED LEARNING

**Description:**
- 4.1 Unsupervised and semi-supervised learning.  
- 4.2 Adversarial training and generative models  
- 4.3 Incremental learning  
- 4.4 Active learning  
- 4.5 Reinforcement learning  
- 4.6 Meta-learning

**Full-or-part-time:** 18h  
Theory classes: 3h 57m  
Self study : 14h 03m
5. COMPUTATION

Description:
5.1 Software stack
5.2 Computational requirements
5.3 Scalability

Full-or-part-time: 18h
Theory classes: 3h 57m
Self study : 14h 03m

ACTIVITIES

Lectures

Description:
1. DEEP NEURAL NETWORKS
2. TRAINING
3. MEMORY NETWORKS
4. BEYOND SUPERVISED LEARNING
5. COMPUTATION

Full-or-part-time: 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.

Material:
Deep learning frameworks used during the labs: Caffe, Tensorflow and Keras.

Full-or-part-time: 10h
Laboratory classes: 5h
Self study: 5h
**Project**

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

**Material:**
GPUs on a cloud service.

**Delivery:**
Oral presentation
Poster

**Full-or-part-time:** 40h
Theory classes: 1h
Laboratory classes: 8h
Self study: 31h

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**Grading**

**Description:**
Written exams in class.

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

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**GRADING SYSTEM**

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

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**BIBLIOGRAPHY**

**Basic:**

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**RESOURCES**

**Audiovisual material:**

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