230706 - DLAI - Deep Learning for Artificial Intelligence

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications
Academic year: 2020
Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5  Teaching languages: English

Teaching staff
Coordinator: Giró Nieto, Xavier
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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>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>26h</th>
<th>20.80%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>13h</td>
<td>10.40%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>86h</td>
<td>68.80%</td>
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## Content

| 1. DEEP NEURAL NETWORKS | **Learning time:** 18h  
Theory classes: 3h 57m  
Self study: 14h 03m |
|-------------------------|----------------------|
| **Description:**  
1.1 The Perceptron. Regression vs classification. The Softmax classifier.  
1.2 Multi-layer perceptron (MLP).  
1.4 Interpretability: t-SNE, visualizations, highest activations. |

| 2. TRAINING | **Learning time:** 35h 59m  
Theory classes: 7h 53m  
Self study: 28h 06m |
|--------------|----------------------|
| **Description:**  
2.1 Backpropagation  
2.2 Optimizers  
2.3 Loss functions  
2.4 Methodology  
2.5 Efficient computation |

| 3. MEMORY NETWORKS | **Learning time:** 18h  
Theory classes: 3h 57m  
Self study: 14h 03m |
|-------------------|----------------------|
| **Description:**  
3.1 Recurrent Neural Networks  
3.2 Gated models: LSTM, GRU, ...  
3.3 Advanced models: QRNN, pLSTM, ... |
### 4. BEYOND SUPERVISED LEARNING

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

**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

### 5. COMPUTATION

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

**Description:**  
5.1 Software stack  
5.2 Computational requirements  
5.3 Scalability
### Planning of activities

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Hours: 108h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
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<tr>
<td>1. <strong>DEEP NEURAL NETWORKS</strong></td>
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<tr>
<td>2. <strong>TRAINING</strong></td>
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<tr>
<td>3. <strong>MEMORY NETWORKS</strong></td>
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<tr>
<td>4. <strong>BEYOND SUPERVISED LEARNING</strong></td>
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<td>5. <strong>COMPUTATION</strong></td>
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<table>
<thead>
<tr>
<th>Labs in class</th>
<th>Hours: 10h</th>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>1. Classification vs Regression</td>
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<td>3. Data pipelines between CPUs and GPUs.</td>
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<td>5. Generative adversarial networks.</td>
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**Support materials:**
- Deep learning frameworks used during the labs: Caffe, Tensorflow and Keras.

<table>
<thead>
<tr>
<th>Project</th>
<th>Hours: 40h</th>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Hands on project where students must design, train and test their own deep learning model.</td>
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**Support materials:**
- GPUs on a cloud service.

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

<table>
<thead>
<tr>
<th>Grading</th>
<th>Hours: 4h</th>
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<tbody>
<tr>
<td><strong>Theory classes:</strong> 4h</td>
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**Description:**
Written exams in class.

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

**Bibliography**

**Basic:**

**Others resources:**

**Hyperlink**

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

**Audiovisual material**
- [https://telecombcn-dl.github.io/2017-dls/](https://telecombcn-dl.github.io/2017-dls/) Resource