270715 - ATCI - Advanced Topics in Computational Intelligence

Coordinating unit: 270 - FIB - Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science
Academic year: 2019
Degree: MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2012). (Teaching unit Optional)
MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Teaching unit Optional)
ECTS credits: 4

Prior skills

Basic concepts of Computational Intelligence, mainly neural networks, fuzzy logic and evolutionary algorithms

Degree competences to which the subject contributes

Specific:
CEA11. Capability to understand the advanced techniques of Computational Intelligence, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.

Generical:
CG3. Capacity for modeling, calculation, simulation, development and implementation in technology and company engineering centers, particularly in research, development and innovation in all areas related to Artificial Intelligence.
CG4. Capacity for general management, technical management and research projects management, development and innovation in companies and technology centers in the area of Artificial Intelligence.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Teaching methodology

Theory classes will introduce the knowledge, techniques and concepts required to apply them in practice during the laboratory classes. Theory classes will be mainly of the type magisterial lecture, but some of them may be of the type exposition-participation, with the participation of the students in solving problems or exercises.

Laboratory classes have as objective that the students work with software tools which allow the application to real problems of the techniques presented in theory classes. Students will use these tools to develop their practical work of the course, which will consist of a part of autonomous individual work and a part of cooperative work in a team of 2/3 people. Some time of the laboratory classes will be devoted to the orientation and supervision by the professor of these autonomous and cooperative works.

A final exam will evaluate the specific objectives of understanding the concepts and methods presented during the course. On the other hand, the individual and cooperative practical works by the students will allow the evaluation of the specific objectives of applying the presented techniques, as well as the general, basic and transverse skills associated with the course.

Learning objectives of the subject
1. To understand the fuzzy inductive reasoning methodology for modelling systems and predicting their behavior.
2. To apply the fuzzy inductive reasoning methodology to the simulation of environmental, biomedical, industrial or economical processes.
3. To understand the different ways of designing computational intelligence hybrid techniques by integrating fuzzy logic, neural networks and evolutionary algorithms.
4. To apply computational intelligence hybrid techniques to solve complex data mining problems in real scenarios.
5. To understand some of the most advanced and recent techniques in the field of neural networks (e.g. recurrent neural nets, extreme learning machines, deep neural nets).
6. To apply neural network advanced techniques to solve complex data mining problems in real scenarios.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 100h</th>
<th>Theory classes: 12h</th>
<th>12.00%</th>
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<tbody>
<tr>
<td></td>
<td>Practical classes: 12h</td>
<td>12.00%</td>
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<tr>
<td></td>
<td>Laboratory classes: 8h</td>
<td>8.00%</td>
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<tr>
<td></td>
<td>Guided activities: 4h</td>
<td>4.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 64h</td>
<td>64.00%</td>
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</table>
### Content

#### Fuzzy inductive reasoning

**Degree competences to which the content contributes:**

**Description:**
The fuzzy inductive reasoning (FIR) methodology allows the qualitative modelling of systems and the quantitative prediction of their behavior.

#### Hybrid fuzzy systems: neuro-fuzzy systems and genetic-fuzzy systems

**Degree competences to which the content contributes:**

**Description:**
The hybrid fuzzy systems improve the abilities of fuzzy systems by introducing neural networks and genetic algorithms to learn and adapt their parameters for a better performance.

#### Fuzzy and heterogeneous neural networks

**Degree competences to which the content contributes:**

**Description:**
Similarity-based neural networks, possibly trained using evolutionary algorithms, allow the processing of fuzzy and heterogeneous data in classification or regression problems without the need of data coding.

#### Incremental methods for neural network construction and extreme learning machines

**Degree competences to which the content contributes:**

**Description:**
Incremental methods for neural network construction allow an efficient computation of simple models with good generalization performance. Extreme learning machines do so by assigning random weights to some part of the neural architecture and optimizing the rest of weights.

#### Deep neural networks

**Degree competences to which the content contributes:**

**Description:**
Deep neural networks ,,,, (to complete)

#### Recurrent neural networks

**Degree competences to which the content contributes:**
Description:
Discrete-time recurrent neural networks allow the learning and processing of dynamic input/output tasks such as time-series prediction, sequence classification and translation.
# Planning of activities

<table>
<thead>
<tr>
<th>Topic</th>
<th>Hours</th>
<th>Description</th>
<th>Specific objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fuzzy Inductive Reasoning</strong></td>
<td>7h 36m</td>
<td>Development of the corresponding topic and laboratory exercises</td>
<td>1, 2</td>
</tr>
<tr>
<td><strong>Hybrid fuzzy systems</strong></td>
<td>11h 24m</td>
<td>Development of the corresponding topic and laboratory exercises</td>
<td>3, 4</td>
</tr>
<tr>
<td><strong>Fuzzy and heterogeneous neural networks</strong></td>
<td>8h 30m</td>
<td>Development of the corresponding topic</td>
<td>3</td>
</tr>
<tr>
<td><strong>Incremental neural networks and extreme learning machines</strong></td>
<td>9h 30m</td>
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## 270715 - ATCI - Advanced Topics in Computational Intelligence

<table>
<thead>
<tr>
<th>Description:</th>
<th>Development of the corresponding topic and laboratory exercises</th>
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</thead>
<tbody>
<tr>
<td>Specific objectives:</td>
<td>5, 6</td>
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</tbody>
</table>

| **Deep neural networks** | **Hours:** 15h 12m  
Theory classes: 5h 24m  
Practical classes: 0h  
Laboratory classes: 1h 48m  
Guided activities: 0h  
Self study: 8h |
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<tbody>
<tr>
<td>Description:</td>
<td>Development of the corresponding topic and laboratory exercises</td>
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<tr>
<td>Specific objectives:</td>
<td>5, 6</td>
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| **Recurrent neural networks** | **Hours:** 16h 12m  
Theory classes: 4h 30m  
Practical classes: 0h  
Laboratory classes: 2h 42m  
Guided activities: 0h  
Self study: 9h |
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<tbody>
<tr>
<td>Description:</td>
<td>Presentation of the corresponding course topic and lab exercises</td>
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<tr>
<td>Specific objectives:</td>
<td>5, 6</td>
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</tbody>
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| **Tutorized practical works** | **Hours:** 22h  
Theory classes: 0h  
Practical classes: 0h  
Laboratory classes: 0h  
Guided activities: 2h  
Self study: 20h |
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<tbody>
<tr>
<td>Specific objectives:</td>
<td>2, 4, 6</td>
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</table>

| **Final exam** | **Hours:** 7h  
Guided activities: 3h  
Self study: 4h |
|----------------|---------------------------------------------------------------|
Specific objectives:
1, 3, 5

Qualification system

The technical skills mark (M) is calculated as follows:

\[ M = 0.40 \times \text{FINAL EXAM} + 0.60 \times \text{PRACT WORK} \]

where

* FINAL EXAM refers to the mark of the final exam;
* PRACT WORK refers to the global mark of the practical works (at least 3 works) defined by the teachers during the course and carried out in small groups; it is calculated as the average of the marks of these practical works.

Nevertheless, M will be NP if the student do no present anything in the assessment activities.

The generic skill (Teamwork) mark will be directly given by PRACT WORK.
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink