Course guides
270716 - CN - Complex Networks

Unit in charge: Barcelona School of Informatics
Teaching unit: 1042 - URV - Universitat Rovira i Virgili.
Degree: MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Optional subject).
Academic year: 2021  ECTS Credits: 5.0  Languages: English

LECTURER

Coordinating lecturer:

Others:

PRIOR SKILLS

Prior skills on Algorithmics and Programming:
- Abstract data types and computational cost
- Graphs, trees and 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.

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.

Transversal:
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Basic:
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.

TEACHING METHODOLOGY

Master classes, practice with computers, resolution of practical exercises.

Due to the exceptional situation caused by the COVID-19, during the course 2020-21 this subject will be taught in a 100% non-face-to-face way. When the situation allows it in a stable way, a transition towards semi-attendance will be agreed.
LEARNING OBJECTIVES OF THE SUBJECT

1. Detection of systems which may be represented using complex networks
2. To know how to study and characterize the structure of complex networks
3. To know models of complex networks and their implementation
4. To know the main dynamics on top of complex networks
5. To know how to perform and validate Monte Carlo simulations
6. To know how to apply the knowledge in complex networks to extract information of systems which can be described using this framework

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory classes</td>
<td>8,0</td>
<td>6.40</td>
</tr>
<tr>
<td>Practical classes</td>
<td>16,0</td>
<td>12.80</td>
</tr>
<tr>
<td>Theory classes</td>
<td>16,0</td>
<td>12.80</td>
</tr>
<tr>
<td>Guided activities</td>
<td>5,0</td>
<td>4.00</td>
</tr>
<tr>
<td>Self study</td>
<td>80,0</td>
<td>64.00</td>
</tr>
</tbody>
</table>

Total learning time: 125 h

CONTENTS

Introduction
Description:
Examples of complex networks in many knowledge fields. Complex network types.

Structure of complex network
Description:
Main topological and structural characteristics of complex networks: degree distribution, small-world, transitivity, assortativity, community structure, centrality. Community detection algorithms.

Complex network models
Description:
Erdős-Rényi random networks, Barabási-Albert model, Watts-Strogatz model, configuration model.

Dynamics on complex networks
Description:
## ACTIVITIES

### Introduction

**Description:**
Introduction

**Specific objectives:**
1

**Full-or-part-time:** 2h
Theory classes: 2h

### Structure of complex network

**Description:**
Development of the topic

**Specific objectives:**
2

**Full-or-part-time:** 26h 30m
Theory classes: 12h
Laboratory classes: 2h 30m
Guided activities: 2h
Self study: 10h

### Complex network models

**Description:**
Development of the topic

**Specific objectives:**
3

**Full-or-part-time:** 30h
Theory classes: 6h
Laboratory classes: 2h
Guided activities: 2h
Self study: 20h

### Dynamics on complex networks

**Description:**
Development of the topic

**Specific objectives:**
4, 5

**Full-or-part-time:** 24h
Theory classes: 10h
Laboratory classes: 2h
Guided activities: 2h
Self study: 10h
Project

Description:
Complex networks project

Specific objectives:
1, 2, 3, 4, 5, 6

Full-or-part-time: 42h
Laboratory classes: 1h
Guided activities: 1h
Self study: 40h

Delivery of practical exercises about structure of complex networks

Description:
Delivery of practical exercises about structure of complex networks

Specific objectives:
2

Delivery of practical exercises about complex networks models

Description:
Delivery of practical exercises about complex networks models

Specific objectives:
3

Delivery of practical exercises about community detection

Description:
Delivery of practical exercises about community detection

Specific objectives:
2

Delivery of practical exercises about simulation of dynamics

Description:
Delivery of practical exercises about simulation of dynamics

Specific objectives:
4, 5
Interview of the project

Description:
Interview of the project

Specific objectives:
1, 6

Full-or-part-time: 0h 30m
Guided activities: 0h 30m

GRADING SYSTEM

Resolution of practical exercises
Development of a complex networks project

BIBLIOGRAPHY

Basic:

RESOURCES

Hyperlink:
- http://gephi.github.io/
- http://igraph.org/
- http://pajek.imfm.si/doku.php
- https://networkx.github.io/