
Title of the course

- **230502 Artificial intelligence techniques in Engineering**

Organizing center/area leading the course

Deusto International Research School (DIRS) – PhD program in Engineering for the Information Society and Sustainable Development

Training category

AF7. Methodology and research techniques

Professor/Coordinator of the training course

Coordinator: Pablo Garaizar Sagarminaga

Lecturers: Enrique Onieva, Aitor Almeida, Iñaki Vázquez

Priority group

2nd year PhD students, but it can be taken by 1st and 3rd year students too

Competences

SPECIFIC COMPETENCE SC1. Identify and apply Bayesian networks to distinct problems in Engineering.

SPECIFIC COMPETENCE SC2. Describe and apply the basic concepts of fuzzy genetic systems, together with their application.

SPECIFIC COMPETENCE SC3. Identify and apply social network analysis basic concepts and apply them to real examples.

SPECIFIC COMPETENCE SC4. Identify and convolutional and recurrent neural network basic concepts and apply them to real examples.

SPECIFIC COMPETENCE SC5: Identify and apply reinforcement learning methods to design intelligent agents that solve real-world problems.

Pre-requisites / prior knowledge

Basic statistical and mathematical knowledge

Contents

Unit 1. Generic Fuzzy Systems (12 hours – Enrique Onieva Caracuel). Design and implementation of systems based in fuzzy rules. Evolving computation principles. Generic Fuzzy systems. Application to traffic congestion and autonomous car driving. Data mining based on fuzzy systems with KEEL.

Unit 2. Social network analysis. Convolutional and Recurrent Neural Networks. (12 hours – Aitor Almeida). Graph models and its components. Graph generation (Erdos-Renyi, Barabasi-Albert, Watts-Strogatz...). Centroid analysis (degree, eigenvector, closeness, betweenness...). Community

detection. Social network analysis tools (Gephi, networkx) and its application to real cases. Introduction to CNNs. Introduction to RNNs. Data augmentation. Attention mechanisms.

Unit 3. Reinforcement Learning (6 hours – Iñaki Vazquez). Basic concepts. Markov Decision Processes. Exploration and exploitation. Tabular methods. Function approximation methods. Policy gradient methods. On-policy and off-policy control. Deep Reinforcement Learning. Multi-Agent Reinforcement Learning. Experimentation and simulation environments. Applications.

Level of the course

Intermediate

Methodology

Next, the methods and techniques used during the course are summarized and the research strategy is defined:

- *Lecture*. The lecturer presents the contents of the course in a detailed and organized manner, within the lecture room. The contents, available during the lectures, will be made available in advance to the students (as slides) and classified by units.
- *Individual work*. The students will carry out a set of guided practical activities associated to the course topics.

Language of instruction

English

Mode of instruction

In-class

Number of places

PhD students: 30

Personnel: 10

Assessment

Be able to apply the techniques demonstrated in the module to a given exercise proposed by each lecturer at the end of their module

Number of hours

30

Bilbao Campus

- Month when the course begins: January 2024
- Dates:
 - Monday, 15 January 2024 (15:00-18:00)
 - Tuesday, 16 January 2024 (15:00-18:00)
 - Wednesday, 17 January 2024 (15:00-18:00)
 - Thursday, 18 January 2024 (15:00-18:00)
 - Monday, 22 January 2024 (15:00-18:00)
 - Tuesday, 23 January 2024 (15:00-18:00)
 - Wednesday, 24 January 2024 (15:00-18:00)
 - Thursday, 25 January 2024 (15:00-18:00)
 - Tuesday, 30 January 2024 (15:00-18:00)
 - Thursday, 1 February 2024 (15:00-18:00)