Course guides
270700 - CI - Computational Intelligence

Last modified: 20/07/2020

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.

Degree: MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Compulsory subject).

Academic year: 2020 **ECTS Credits:** 5.0 **Languages:**

LECTURER

Coordinating lecturer: MARIA ANGELA NEBOT CASTELLS

Others: Primer quadrimestre:
RENATO ALQUEZAR MANCHO - 11, 12
LUIS ANTONIO BELANCHE MUÑOZ - 11, 12
MARIA ANGELA NEBOT CASTELLS - 11, 12
ENRIQUE ROMERO MERINO - 11, 12

PRIOR SKILLS

Elementary notions of probability, statistics, linear algebra and real analysis

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
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.

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.

CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.

TEACHING METHODOLOGY

The topics exposed in the lectures are very well motivated (why is this important?) and motivating (why is this relevant nowadays?) and supplemented with many real examples. These lectures will introduce all the knowledge, techniques, concepts and results necessary to achieve a solid understanding of the fundamental concepts and techniques.

These concepts are reflected in the practical work that must be delivered at the end of the course. There are three laboratory sessions serve to reinforce the theoretical concepts introduced in the lectures as well as to prepare for the practical work. This practical work requires the student to pick a real problem that collects and integrates the knowledge and skills of the course. There is also a written test of essential knowledge of the subject. In addition, there are 3 small practical exercises after each laboratory class.

LEARNING OBJECTIVES OF THE SUBJECT

1.Know the scope of C□omputational Intelligence (CI), and the types of tasks that can be tackled with CI methods
2.Know the most important modern computational intelligence techniques
3.Organize the problem solving flow for a computational intelligence problem, analyzing the possible options and choosing the most appropriate techniques or combinations of techniques
4.Decide, defend and criticize a solution to a computational intelligence problem, arguing on the strengths and weaknesses of the chosen approach
5.Learn the fundamentals of neural computation and apply them effectively to develop correct and efficient solutions to a computational intelligence task
6.Learn the fundamentals of evolutionary computation and apply them correctly to develop correct and efficient solutions to computational intelligence tasks.
7.Learn the fundamentals of fuzzy computation and apply them correctly to develop correct and efficient solutions to computational intelligence tasks

STUDY LOAD

Type	Hours	Percentage
Hours small group	9,0	7.20
Self study	80,0	64.00
Hours large group	36,0	28.80

Total learning time: 125 h

CONTENTS

Introduction to Computational Intelligence

Description:
Computational Intelligence: definition and paradigms. Brief historical sketch.

Foundations of Neural Computation

Description:
Introduction to neural computation: biological inspiration, neural network models, architectures and training algorithms. Learning and generalization.

Foundations of Evolutionary Computation

Description:
Introduction to evolutionary computation: evolutionary processes in nature, genetic operators, evolutionary optimization algorithms. Genetic algorithms. Evolution Strategies and CMA-ES.

Foundations of Fuzzy Computation

Description:
Introduction to fuzzy computation: fuzzy sets and systems, fuzzy inference systems and hybrid.

Applications and case studies

Description:
Applications and case studies on real problems in regression, classification, identification and system optimization

ACTIVITIES

Development of topic 1 of the course

Description:
The teacher presents an overview and basic concepts of computational intelligence as well as modern application examples.

Specific objectives:
1, 2

Related competencies :
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.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.

Full-or-part-time: 3h
Theory classes: 3h

Development of topic 1 of the course

Description:
The teacher presents the fundamentals of neural computing: inspiration in biological neuron models, architectures and training algorithms. The teacher explains the concepts of learning and generalization and introduces methodologies for obtaining effective models and to guarantee an honest assessment of their effectiveness.

Specific objectives:
2, 5

Related competencies :
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.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.

Full-or-part-time: 24h
Theory classes: 9h
Laboratory classes: 3h
Self study: 12h

Development of topic 3 of the course

Description:
The professor explains the fundamentals of evolutionary computation: evolutionary processes in nature, genetic operators, evolutionary optimization algorithms. Focuses on genetic algorithms and Evolution Strategies and CMA-ES. Points to other existing evolutionary algorithms.

Specific objectives:
2, 6

Related competencies :
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.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.

Full-or-part-time: 24h
Theory classes: 9h
Laboratory classes: 3h
Self study: 12h

Development of topic 4 of the course

Description:
The teacher explains the fundamentals of fuzzy computing: fuzzy sets and fuzzy systems, fuzzy inference systems and FIR.

Specific objectives:
2, 7

Related competencies :
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.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.

Full-or-part-time: 24h
Theory classes: 9h
Laboratory classes: 3h
Self study: 12h

Development of topic 5 of the course

Description:
The teacher presents one or more real case studies that might require solutions from computational intelligence. The teacher looks at the options and outlines one or more possible solutions, discussing their advantages and disadvantages.

The teacher presents the course work that must be carried out, which is similar to previous case studies.

Specific objectives:
1, 3, 4

Related competencies :
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.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.
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.

Full-or-part-time: 6h
Theory classes: 6h

Execution and delivery of practical work

Specific objectives:
1, 2, 3, 4, 5, 6, 7

Related competencies :
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.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.
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.

Full-or-part-time: 35h
Self study: 35h

Exam

Description:
It is a written test on the knowledge of the fundamental concepts of the course

Full-or-part-time: 3h
Guided activities: 3h

GRADING SYSTEM

The course is scored as follows:

NLab1 = Score of laboratory exercises 1
NLab2 = Score of laboratory exercises 2
NLab3 = Score of laboratory exercises 3
NExam = Score of the exam
NPract = Score for the practical work

NFINAL = 5% NLab1 + 5% NLab2 + 5% NLab3 + 35% NExam + 50% NPract

BIBLIOGRAPHY

Basic:
- Haykin, S. Neural networks and learning machines. 3rd ed. Prentice Hall, 2009. ISBN 9780131471399.
- Bäck, T. Evolutionary algorithms in theory and practice: evolution strategies, evolutionary programming, genetic algorithms. Oxford University Press, 1996. ISBN 0195099710.
- Klir, G.J.; Yuan, B. Fuzzy sets and fuzzy logic: theory and aplications. Prentice Hall, 1995. ISBN 0131011715.
- Engelbrecht, A.P. Computational intelligence: an introduction. 2a. ed.,reimp. John Wiley & Sons, 2008. ISBN 9780470035610.

Complementary:
- Begg, R.; Lai, D.T.H.; Palaniswami, M. Computational intelligence in biomedical engineering. CRC/Taylor & Francis, 2008. ISBN 9780849340802.
- Wang, L.-X. A course in fuzzy systems and control. Prentice-Hall PTR, 1997. ISBN 0135408822.

RESOURCES

Hyperlink:
- http://cis.ieee.org/