GENERAL INFORMATION

Course information	
Name	Artificial Intelligence
Code	
Degree	Official Master's Degree in Research in Engineering Systems Modeling (MRE)
Year	2016-2017
Semester	1
ECTS credits	6
Type	Elective (Even year)
Department	
Area	Artificial Intelligence
Coordinator	

Instructor	
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DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

This course will contribute to the professional profile of the student by his/her training in research practices based on the use of artificial intelligence techniques. The student will learn and practice during the course the use of artificial intelligence methods for managing problems where knowledge has to be used in programs or devices in order to reproduce some human skills. Also the student will learn to extract specialized knowledge from raw data. Finally, the student will get experience for the management of knowledge with imprecise terms and metaheuristics methods for solving complex optimization problems. All these tools will improve the research potential of the student for facing problems in the area of management and use of expert human knowledge.

Prerequisites

CONTENTS

Contents
Chapter 1: BASIC DEFINITIONS USED IN ARTIFICIAL INTELLIGENCE.
1.1 Concepts. **1.2** Perception. **1.3** Artificial Intelligence
Chapter 2: KNOWLEDGE-BASED SYSTEMS.
2.1 Knowledge acquisition, knowledge representation **2.2**. Inference. **2.3** Uncertainty management.
Chapter 3: KNOWLEDGE REPRESENTATION USING THE FUZZY SETS THEORY.
3.1 Distributions of possibility. **3.2** Logic and inference. **3.3** Clustering. **3.4** Fuzzy control. **3.5** Fuzzy linear programming.
Chapter 4: PARADIGMS OF AUTOMATIC LEARNING BY INDUCTION.
4.1 Decision trees. **4.2** Rough sets. **4.3** Neural networks.
Chapter 5: META-HEURISTICS ALGORITHMS.
5.1 Tabu search. **5.2** Simulated Annealing. **5.3** Genetic algorithms and other bio-inspired algorithms.

Competences and Learning Outcomes

Competences

General Competences

CB1. To learn advanced scientific knowledge and to demonstrate, in a context of scientific and technological research highly specialized, a detailed understanding of theoretical and application aspects and the methodology of work in one or more study fields. Acquire learning skills that will allow further study in a self-directed or autonomous manner.

Basic Competences

CE9. Know the techniques, methods and/or tools required to approach a specific research topic in a specific technological context or sector.

Specific Competences

CO5. To know and understand different methods of acquisition and use of human expert knowledge used in knowledge engineering, and their implementation in intelligent systems. Also different methods of uncertainty management, inherent in the human knowledge, will be learned.

CO6. To know and understand different techniques of artificial intelligence for the automatic acquisition of knowledge from examples and their later implantation in intelligent systems. Also the basic principles of the meta-heuristic algorithms will be learned.

Learning outcomes

By the end of the course students should be able to:

RA1. To know and understand the components of a knowledge based system and the design of its architecture.

RA2. To understand and use techniques of uncertainty management that is inherent to the human knowledge and raw data from the field.

RA3. To know and apply paradigms of automatic learning based on decision tress for the extraction of information from a training set.

RA4. To understand the principles of rough sets and their use for the extraction of information from a set of examples.

RA5. To understand the principles of fuzzy sets theory and its application to the engineering field.

RA6. To build and recognize information patterns based on the use of artificial neural networks.

RA7. To know and apply the principles of the meta-heuristic algorithms and their application in the solution of real problems.

RA8. To know and apply hybrid techniques of artificial intelligence for the extraction of information from a training set.

RA9. To understand the components of an intelligent multi-agent architecture and to know how to integrate the different techniques reviewed during the course in this architecture.

TEACHING METHODOLOGY

General methodological aspects	
The teaching method is focused on easing the learning of knowledge and increasing the student critical thinking on artificial intelligent methods. Teaching objectives require the active participation of the student. In addition, the in-class activity should be complemented by the individual student work performed out of class. Both aspects are taken into account in the evaluation method.	
In-class activities	**Competences**
▪ **Lectures and problem-solving sessions (50 hours)**: The lecturer will introduce the fundamental concepts of each chapter, along with some practical recommendations, and will go through worked examples to support the explanation. Active participation will be encouraged by raising open questions to foster discussion and by proposing short application exercises to be solved in class either on paper or using a software package.	CB1, CE9
▪ **Practical exercises with computer (10 hours):** This is a 50% activity developed in the classroom. This is useful for the students in order to know the use of software tools.	CB1, CE9, CO5, CO6
▪ **Tutoring** for groups or individual students will be organized upon request.	CB1, C30
Out-of-class activities	**Competences**
▪ Personal study of the course material and resolution of the proposed exercises (30 hours).	CB1, CE9
▪ Homework for solving practical cases. These can be solved individually or in groups. The cases are proposed by the Professor. This permits the practice of theoretical concepts and this is an incentive to the autonomous thinking of the student session preparation to make the most of in-class time (50 hours).	CB1, CE9, CO5, CO6
▪ Practical exercises on the computer. This is a 50% out-of-class activity. This is useful for the students in order to know the use of software tools (10 hours).	CB1, CE9, CO5, CO6
▪ Final project. Each student proposes a project to develop based on a real case and techniques used during the course. The results will be included in a final report with format of journal paper (30 hours).	CB1, CE9, CO5, CO6

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
Final exam It permit to evaluate the knowledge acquisition and skills acquired by the student during the course.	▪ Understanding of concepts. ▪ Application of these concepts to problem-solving. ▪ Writing presentation.	30%
Performance evaluation • Individual practical exercises proposed during the course. • Participation in class and solution of cases. • Final project of the course which topic will be proposed by the student including the solution of practical examples.	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem-solving. ▪ Analysis and interpretation of the results obtained in the solution of practical exercises. ▪ Comparison of results using different techniques of information analysis ▪ Writing presentation.	70%

GRADING AND COURSE RULES

Grading
Regular assessment
In order to pass the course, the mark obtained must be greater or equal to 5 out of 10 points. The student can use till two periods of final evaluation during one academic year. The regular assessment will be carried out at the end of the course (end of the semester). In case that the course was not passed, the student has another opportunity of final assessment at the end of the academic year. The dates for these evaluation periods will be announced in the web page. The final grade of the course will be obtained by addition of the following criteria for any evaluation period: • 30% final exam. • 20% individual practical exercises proposed during the course. • 10% participation in class and solution of cases. • 40% course final project.
Retakes

See previous section

Course rules

- Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Academicas) of the ICAI School of Engineering. Not complying with this requirement may have the following consequences:
  - Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.

Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

WORK PLAN AND SCHEDULE[1]

Session (2 h)	Contents
1	Introduction / Perception
2	IA concepts / Knowledge-Based Systems
3	Knowledge-Based Systems
4	Metaheuristic algorithms
5	Knowledge-Based Systems
6	Metaheuristic algorithms
7	Knowledge-Based Systems
8	Metaheuristic algorithms
9	Machine Learning - Decision Trees
10	Metaheuristic algorithms
11	Machine Learning - Decision Trees
12	Fuzzy Sets Theory
13	Machine Learning - Decision Trees
14	Machine Learning - NNs / Fuzzy Sets Theory
15	Machine Learning - Rough Sets
16	Fuzzy Sets Theory
17	Fuzzy Sets Theory
18	Machine Learning - Rough Sets
19	Fuzzy Sets Theory
20	Machine Learning - Neural Networks
21	Fuzzy Sets Theory
22	Machine Learning - Neural Networks
23	Machine Learning - Neural Networks
24	Fuzzy Sets Theory
25	Machine Learning - Neural Networks
26	Fuzzy Sets Theory
27	Fuzzy Sets Theory
28	Fuzzy Programming
29	Fuzzy Programming
30	Final Exam

[1] A detailed work plan of the subject can be found in the course summary sheet (see following page). Nevertheless, this schedule is tentative and may vary to accommodate the rhythm of the class.

STUDENT WORK-TIME SUMMARY			
IN-CLASS HOURS			
Lectures	**Practical exercises with computers**	**Final exam**	
50	10	2	
OUT-OF-CLASS HOURS			
Self-study	**Homework for solving practical cases**	**Practical exercises with computers**	**Final project**
28	50	10	30
		ECTS credits:	**6 (180 hours)**

BIBLIOGRAPHY

- M. Negnevitsky, Artificial Intelligence. A guide to Intelligent Systems. Ed. Addison Wesley, second edition 2005
- S. Russel, P. Norvig, Artificial Intelligence: A Modern Approach. Prentice Hall, third edition, 2010
- J. Han, M. Kamber. Data Mining: Concepts and Techniques. Elsevier, second edition 2006
- M.J. Zaki, W. Meira, Data Mining. Fundamental Concepts and Algorithms, first edition, 2014
- Fundamentals of the new artificial intelligence. Munakata, T. Springer, 1998.
- Multiagent Systems. A Modern Approach to Distributed Artificial Intelligence. Ed. G. Weiss. MIT Press, 1999.
- Fuzzy Sets and Fuzzy Logic, Theory and Applications, Prentice Hall, George J. Klir, Bo Yuan, 1995.
- Fuzzy Set Theory and its Applications, Kluwer Academic Publishers, H. J. Zimmermann, 1996
- Fuzzy Mathematical Programming and Fuzzy Matrix Games (Studies in Fuzziness and Soft Computing), Bector, C. R., Chandra, Suresh, Springer-Verlag New York, Inc. Secaucus, NJ, USA, 2005
- M. Inuiguchi, H. Ichihashi, and H. Tanaka, "Fuzzy Programming: a survey of recent developments," in Stochastic versus Fuzzy approaches to Multiobjective Mathematical Programming under Uncertainty, R. Slowinski and J. Teghem, Eds. Dordrecht, The Netherlands: Kluwer Academic Publishers, 1990
- Nature-inspired Metaheuristic Algorithms, Xin-She Yang, Luniver Press, 2010.
- Handbook of Genetic Algorithms, Davis, Van Nostrand Reinhold, New York, 1991
- Handbook of Memetic Algorithms, Neri, Ferrante, Cotta, Carlos, Moscato, Pablo (Eds.), Series: Studies in Computational Intelligence, Vol. 379, 2012, XXVI, 370 p.