TEACHING GUIDE

DETAILS OF THE SUBJECT

Title: **METAHEURÍSTICAS**
Code: 101425
Degree/Master: **GRADO DE INGENIERÍA INFORMÁTICA** Year:
ECTS Credits: 6 Classroom hours: 60
Face-to-face classroom percentage: 40% Non-contact hours: 90
Online platform: http://moodle.uco.es/

TEACHER INFORMATION

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REQUIREMENTS AND RECOMMENDATIONS

Prerequisites established in the study plan

None

Recommendations

Students should possess basic programming skills, usually provided in first year courses, and certain practice with data structures and object oriented programming, usually taught in second year courses.

Additionally, it is interesting to have some background on Statistics, maths, and algorithms

OBJECTIVES

- To get an idea of the concept of the complexity class of a problem and the P vs NP problem, the difference between heuristic and metaheuristic algorithms, and the No Free Lunch Theorem for optimisation problems.

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- To be able to provide proper computer **solution encoding** for different optimisation problems in terms of the basic structures: binary, integer, ordered, floating-point and object oriented ones.

- To know and be able to implement basic **local optimisation procedures**, and to be aware of their limitations.

- To know and be able to implement the main **single solution metaheuristics**: simulated annealing, tabu search, iterated local search, greedy randomised adaptive search procedures and iterated greedy algorithms.

- To know and be able to implement the main **population based metaheuristics**: evolutionary algorithms, particle swarm optimisation, ant colony optimisation and artificial bee colony algorithms.

- To notice the importance of the balance between the diversification and intensification concepts that govern every metaheuristic and to detect their associated components.

- To be able to classify metaheuristics in terms of their characteristics: number of solutions, problem knowledge exploitation, explicit use of memory structures...

- To be able to analyse and compare the performance of several metaheuristics on a set of problems.

- To get in touch with other specific optimisation problems: multimodal, multiobjective and constrained; and to know the main approaches to solve them.

SKILLS

CTEC2
CTEC3
CTEC4
CTEC5

CONTENT

1. Theory contents

Lesson 1. **Introduction** to metaheuristics. General concepts. Solution encoding and evaluation.

Lesson 2. **Local optimisation** of initial solutions.

Lesson 3. **Single solution metaheuristics**. Simulated annealing, tabu search, iterated local search, greedy randomised adaptive search procedures, and iterated greedy algorithms.

Lesson 4. **Population based metaheuristics I**: Evolutionary algorithms. Diversity and premature convergence.

Lesson 5. **Population based metaheuristics II**: Ant colony optimisation, particle swarm optimisation and artificial bee colony algorithms.

Lesson 6. **Categorisation and metaheuristics evaluation**: Features, statistical analysis, graphs, and knowledge exploitation identification.

Lesson 7: **Other problems**: Multimodal, multiobjective and constrained problems.

2. Practical contents

1. Problems, instances, solution encoding and evaluation.

2. Local optimisation.

3. Single-solution metaheuristics.

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4. Population-based metaheuristics.

5. The quest for a good metaheuristic for a given problem.

METHODOLOGY

Clarifications

Lectures:

Students are advised to read the relevant bibliography before the theoretical classes, to lighten the lecture and promote the exposition and discussion of problem examples. Teachers will explain the connections between the concepts of the current lesson and previous ones. Main concepts will be presented, promoting the intelligent debate of the most complex aspects. Concepts will be connected to real world problems and applications. Teachers will formulate questions and scenarios to make students think critically. At the end, teachers will summarise the main concepts provided.

Teachers will use slide projectors for the concepts and white or blackboards for examples and exercises. Multimedia such as videos, webpages and online program executions can be used. All the materials will be on the webpage of the course. The theoretical content will be necessary for the correct development of the laboratory sessions, so this latter will help student to acquire the corresponding competences.

For theoretical classes longer than one hour, teachers will consider to have a break in the middle when students questions would be answered, but no new concepts would be introduced. If there had not been any break, a certain amount of time before the end of the class will be devoted to that purpose. Not interested students may leave the classroom in these time slots.

Laboratory sessions:

The goal of laboratory sessions is to expose students to the concepts provided in theoretical ones. Teachers will provide students with practice scripts. Students are advised to work at home on these scripts and dispel their doubts with the teachers in these sessions. In general, students will work on these practice scripts in groups, whose size would have been determined at the beginning of the course. Teachers would use any available academic material to answer the questions of the students (slide presenters, blackboard...)

Face-to-face activities

Activity	Total
Assessment activities	2
Debates	17
Laboratory	-
Lectures	17
Total hours:	**36**

Not on-site activities

Activity	Total
Analysis	10
Bibliographic consultations	10
Self-study	10
Trabajo asociado a las prácticas	35
Group work	25
Total hours:	**90**

WORK MATERIALS FOR STUDENTS

Practical cases and examples - http://moodle.uco.es/
Internship notebook - http://moodle.uco.es/
Dossier - http://moodle.uco.es/
Manual of the subject - http://moodle.uco.es/

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EVALUATION

Tools	Percentage
Final exam	20%
Internship reports	40%
Evaluación por pares	40%

Period of validity for partial qualifications:

Clarifications:

Partial time students, who could not attend to classes, must consult periodically the webpage to be informed about the contents and indications provided.

Partial time students will be evaluated by the same methodology described for full time ones, except by the fact that they will be allowed to develop the reports individually and will be qualified accordingly.

BIBLIOGRAPHY

1. Basic Bibliography:

Michel Gendreau, Jean-Yves Potvin. Handbook of Metaheuristics 2o Edition. Springer 2010

El-Ghazali Talbi. Metaheuristics. From Design to Implementation. John Wiley & Sons. 2009

F. Glover, G.A. Kochenberger (eds.) "Handbook of Metaheuristics", Kluwer Academic Press, 2003

Sean Luke. Essentials of Metaheuristics, 2o Edition. Lulu.com 2013

P.M. Pardalos, M.G.C. Resende, "Handbook of Applied Optimization", Oxford University Press, 2002. Review Articles

2. Further reading:

Karl F. Doener, Michel Gendreau, Peter Greistorfer. Metaheuristics: Progress in Complex Systems Optimization. Springer 2007

D. Corne, M. Dorigo, F. Glover (eds.) "New Ideas in Optmization", McGraw-Hill, 1999

A.E. Eiben, J.E. Smith, "Introduction to Evolutionary Computing", Springer, 2003

H.H. Hoos, T. Stüzle, "Stochastic Local Search", Morgan Kaufmann, 2004

M. Laguna, R. Martí, "Scatter Search", Springer, 2003

The methodological strategies and the evaluation system contemplated in this Teaching Guide will be adapted according to the needs presented by students with disabilities and special educational needs in the cases that are required.