



UNIVERSIDAD DE CÓRDOBA

ESCUELA POLITÉCNICA SUPERIOR DE CÓRDOBA

GRADO DE INGENIERÍA**INFORMÁTICA**

2024/25 YEAR

METAHEURÍSTICAS

Course details

Course name: METAHEURÍSTICAS**Code:** 101425**Degree/Master:** GRADO DE INGENIERÍA INFORMÁTICA**Year:****Field:** METAHEURÍSTICAS**Character:** OBLIGATORIA**Duration:** SECOND TERM**ECTS Credits:** 6.0**Classroom hours:** 60**Face-to-face classroom percentage:** 40.0%**Study hours:** 90**Online platform:** <https://moodle.uco.es/>

Coordinating teacher

Name: GARCIA MARTÍNEZ, CARLOS**Department:** INFORMÁTICA Y ANÁLISIS NUMÉRICO**Office location:** Dpto. Informática y Análisis Numérico. Anexo C3 en Edificio Marie Curie, planta baja (X3BN090)**E-Mail:** cgarcia@uco.es**Phone:** 957212660

Brief description of the contents

In this course, metaheuristics are introduced, which are approximate methods for solving problems, such as finding a circuit that passes through all the nodes of a graph, without repeating any of them and returning to the initial node.

The course content is organized into the following blocks:

Introduction to problem optimization using search techniques

Local solution optimization

Path-based metaheuristics

Population-based metaheuristics

Characterization and comparison of metaheuristics

Other problems

Prerequisites

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 in statistics, maths, and algorithms

Study programme

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, constrained, and machine learning problems.

In the various topics, examples will be presented in which some will be related to agro-forestry issues, for example, problems of optimizing land use.

2. Practical contents

1. Local optimisation.

2. Population-based metaheuristics.

3. Dealing with a concrete real problem.

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
 - Sebastián Ventura, José María Luna: Pattern Mining with Evolutionary Algorithms. Springer 2016, ISBN 978-3-319-33857-6, pp. 1-190
- CC2020: Computing Curricula 2020: Paradigms for Global Computing Education.

BIBLIOGRAFÍA COMPLEMENTARIA

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. Stützle, "Stochastic Local Search", Morgan Kaufmann, 2004

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

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

Review Articles

Methodology

General clarifications on the methodology (optional)

(With regards to the Sustainable Development Objectives, we shall indicate that metaheuristics are nowadays applied for many tasks of the majority of the considered objectives. The selected ones are those with a direct connection with metaheuristics)

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...)

Individual assistance: Students will be allowed to appoint individual meetings with the teachers to dispel their doubts. However, student should know that individual assistance is not aimed at substituting the regular sessions, so no aspect or doubt apart from those in the student personal notes will be addressed.

Methodological adaptations for part-time students and students with disabilities and special educational needs

Partial time students, as full time students, do not have to attend classes to pass the course. They will be able to get the material from the webpage of the course and appoint meetings with the teachers to dispel their doubts. Nevertheless, students must know that individual assistance is not aimed at substituting the regular sessions, so no aspect or doubt apart from those in the student personal notes will be addressed.

Face-to-face activities

Activity	Large group	Medium group	Total
<i>Assessment activities</i>	2	2	4

Activity	Large group	Medium group	Total
<i>Oral communication activities</i>	17	-	17
<i>Practical experimentation activities</i>	-	22	22
<i>Projects based on the course contents</i>	17	-	17
Total hours:	36	24	60

Off-site activities

Activity	Total
<i>Exercise and problem solving activities</i>	30
<i>Information processing activities</i>	45
<i>Information search activities</i>	15
Total hours	90

Results of the training and learning process

Knowledge, competencies and skills

- CTEC2 Ability to know the theoretical foundations of programming languages and associated lexical, syntactic and semantic processing techniques, and know how to apply them for the creation, design and processing of languages.
- CTEC3 Ability to evaluate the computational complexity of a problem, know algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance according to the established requirements.
- CTEC4 Ability to know the fundamentals, paradigms and techniques of intelligent systems and analyze, design and build systems, services and computer applications that use these techniques in any field of application.
- CTEC5 Ability to acquire, obtain, formalize and represent human knowledge in a computable way to solve problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments.

Assessment methods and instruments

Intended learning outcomes	Examination	Means of practical execution	Students assignments
<i>CTEC2</i>	X	X	X
<i>CTEC3</i>	X	X	X

Intended learning outcomes	Examination	Means of practical execution	Students assignments
<i>CTEC4</i>	X	X	X
<i>CTEC5</i>	X	X	X
Total (100%)	50%	20%	30%
Minimum grade (*)	5	5	5

(*)Minimum mark (out of 10) needed for the assessment tool to be weighted in the course final mark. In any case, final mark must be 5,0 or higher to pass the course.

General clarifications on instruments for evaluation:

The evaluation mainly consists in the assessment of the theoretical knowledge acquire by the student by means of an exam and the work carried out in laboratory assessments, placement reports and project. Besides obtaining scores greater than or equal to those minima indicated in the table, it is required that the students pass each laboratory assessment individually. The global score will be computed as the weighted sum according to the weights in the Table, in case the minimal scores are satisfied. Otherwise, the global score will be computed as the minimum between 4 and the weighted sum.

Special Situations: Extraordinary calls will be evaluated accordint to the same indications

Clarifications on the methodology for part-time students and students with disabilities and special educational needs:

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

Clarifications on the evaluation of the extraordinary call and extra-ordinary call for completion studies:

Standard indications apply.

Qualifying criteria for obtaining honors:

The UCO regulations for honors enrollment will be taken into account, and it will be assigned to students with the highest final grade, provided that it is equal to or greater than 9.

Sustainable development goals

Good health and well-being
 Industry, innovation and infrastructure
 Sustainable cities and communities

Other Faculty

Name: LUNA ARIZA, JOSÉ MARÍA

Department: INFORMÁTICA Y ANÁLISIS NUMÉRICO

Office location: Dpto. Informática y Análisis Numérico. Edificio Albert Einstein, planta tercera

E-Mail: jmluna@uco.es

Phone: 957212218

The methodological strategies and the evaluation system contemplated in this Teaching Guide will respond to the principles of equality and non-discrimination and must be adapted according to the needs presented by students with disabilities and special educational needs in the cases that are required. Students must be informed of the risks and measures that affect them, especially those that may have serious or very serious consequences (article 6 of the Safety, Health and Welfare Policy; BOUCO 23-02-23).
