

**Algorithmics and Combinatorics in Graphs.
Heuristic Methods**

Code: 104388
ECTS Credits: 6

| Degree | Type | Year | Semester |
|--|------|------|----------|
| 2503740 Computational Mathematics and Data Analytics | FB | 1 | 2 |

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Teaching groups languages

You can check it through this [link](#). To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Albert Ruiz Cirera

Prerequisites

It is recommended that the student has taken Mathematics in the two baccalaureate courses and has examined this matter in the PAU.

[Translated from the Catalan version by Google translator]

Objectives and Contextualisation

- Know the combinatorial graphs and their terminology.
- Know the different search algorithms and movement in graphs.
- Know the types of dynamic data for representation of graphs and their implementation in C.
- Know the basic algorithms of optimal searches in graphs and their complexity.

[Translated from the Catalan version by Google translator]

Competences

- Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.

- Demonstrate a high capacity for abstraction and translation of phenomena and behaviors to mathematical formulations.
- Formulate hypotheses and think up strategies to confirm or refute them.
- Make effective use of bibliographical resources and electronic resources to obtain information.
- Relate new mathematical objects with other known objects and deduce their properties.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Using criteria of quality, critically evaluate the work carried out.
- Work cooperatively in a multidisciplinary context assuming and respecting the role of the different members of the team.

Learning Outcomes

1. "Explain ideas and mathematical concepts pertinent to the course; additionally, communicate personal reasonings to third parties."
2. Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.
3. Contrast, if possible, the use of calculation with the use of abstraction in solving a problem.
4. Describe the concepts and mathematical objects pertaining to the subject.
5. Develop autonomous strategies for solving problems such as identifying the ambit of problems within the course, discriminate routine from non-routine problems, design an a priori strategy to solve a problem, evaluate this strategy.
6. Evaluate the advantages and disadvantages of using calculation and abstraction.
7. Identify the essential ideas in the demonstration of certain basic theorems and know how to adapt these to obtain other results.
8. In an orderly and accurately manner, draft brief mathematical texts (exercises, resolution of theoretical questions, etc.).
9. Make effective use of bibliographical resources and electronic resources to obtain information.
10. Read and understand a mathematical text at the current level of the course.
11. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
12. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
13. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
14. Using criteria of quality, critically evaluate the work carried out.
15. Work cooperatively in a multidisciplinary context, taking on and respecting the role of the distinct members in the team.

Content

- Combinatorial algorithms for graphics.
- Combined graphs and graph searches.
 - Theory of graphs: introduction.
 - Search in graphs: Depth-first and Breadth-first.
 - Greedy Algorithms.
 - Recursion.
- Abstract data types and object-oriented programming: Dynamic lists and trees.
- Graphic representation algorithms. Avantatgews disadvantages of each of the options.

- Abstract and dynamic data types for graphs and their implementation in C.
- Basic algorithms for optimal search graphs and their complexity.
 - Calculation of distances from latitude and longitude.
 - Algorithm of Dijkstra for optimal routes in graphs.
 - Algorithm A *: heuristic search for optimal paths in graphs.

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Methodology

The weekly sessions of the subject will be divided, usually, in two parts:

1. A theoretical part in which the teacher will introduce the concepts, methods and examples related to the syllabus of the subject.
2. A practical part in which students will be proposed a series of problems or exercises in which they will be shown and a concrete work will be worked on that which has been seen in the theoretical part. Each practice will have a different statement, which will be published on the Virtual Campus and will involve the delivery of the answers to some questions raised.

Complementary exercises will also be proposed as an autonomous activity to help them understand the applied part of the subject.

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Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

| Title | Hours | ECTS | Learning Outcomes |
|--|-------|------|--------------------------------------|
| Type: Directed | | | |
| Attend the theoretical and practical classes | 49 | 1.96 | 2, 3, 4, 1, 7, 10, 8, 9 |
| Type: Supervised | | | |
| Completion of the practices | 62 | 2.48 | 2, 14, 6, 3, 1, 10, 12, 11, 8, 15, 9 |
| Type: Autonomous | | | |
| Resolution of complementary exercises | 30 | 1.2 | 2, 14, 6, 3, 1, 10, 12, 11, 8, 15, 9 |

Assessment

The evaluation will consist of the following activities:

- A final exam, which accounts for 40% of the note.
- An individual practical work with a delivery period where it will be necessary to develop and implement algorithms, which account for 35% of the note.
- Delivery, during practical sessions, of practical exercises that will be carried out in groups of two. They count 25% of the note. This is a continuous evaluation activity and is not recoverable.

The minimum grade in each of the three evaluation activities to be able to pass the subject is 3.5 points out of 10.

Final exam and individual practical work are recoverable for those students who have participated in the three items of the evaluation but have not passed the subject.

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Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---------------------------------|-----------|-------|------|--|
| Delivery of practical exercises | 25% | 0 | 0 | 2, 14, 4, 5, 1, 10, 13, 12, 11, 8, 15, 9 |
| End of term exam | 40% | 4 | 0.16 | 4, 1, 7, 10, 11, 8 |
| Individual practical work | 35% | 5 | 0.2 | 2, 14, 6, 3, 4, 5, 1, 10, 12, 11, 8 |

Bibliography

- Fundamentos de programación (algoritmos, estructuras de datos y objetos), Luis Joyanes, McGraw-Hill, Madrid etc. (2003).
- Algoritmos y estructuras de datos - una perspectiva en C, Luis Joyanes y Ignacio Zahonero, McGraw-Hill, Madrid etc. (2004).
- Grafs combinatòris i cerques en gràfs:Wikipedia
- Tipus abstractes de dades i programació orientada a objectes: Llistes dinàmiques i arbres; Tipus abstractes i dinàmics de dades per a grafs i la seva implementació en C.
 - Notes del curs
 - Algoritmos + Estructura de datos = Programas, Niklaus Wirth, Ediciones del Castillo, Madrid (1986).
 - C algoritmos, programación y estructuras de datos, Luis Joyanes Aguilar et al., McGraw-Hill, Madrid etc. (2005).
- Algorismes de representació de grafs. Avantatgews inconvenients de cada una de les opcions: Wikipedia i notes del curs
- ACàlcul de distàncies a partir de la latitud i la longitud: Wikipoedia i notes del curs
- Algorisme de Dijkstra per a rutes òptimes en grafs: Presentació d'Eric Demaine
- Algorisme A*: cerca heurística per a rutes òptimes en grafs
 - Heuristics: Intelligent Search Strategies for Computer Problem Solving*, Judea Pearl Addison-Wesley Pub (Sd) | ISBN: 0201055945 | 1984-04 | djvu (ocr) | 399 pages | 3.66 Mb Pàgines: 33 to 46, 48, 49, 64, 65, 73--85.L'exemple a les pàgines 52--54 pot ser relevant.

Software

C