Course guide
2703113 - DMO - Discrete Mathematics and Optimization

Last modified: 11/07/2025

Unit in charge: Barcelona School of Informatics
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN BIOINFORMATICS (Syllabus 2024). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: CLÉMENT REQUILÉ

Others: Primer quadrimestre:
RICHARD COLL JOSIFOV - 11
TABRIZ ARUN AVERY POPATIA - 12
CLÉMENT REQUILÉ - 11, 12

LEARNING RESULTS

Knowledges:
K2. Identify statistical and computational methods and mathematical models that can be used to solve problems in molecular biology, genomics, medical research and population genetics.
K3. Identify the mathematical foundations, computational theories, algorithmic schemes and principles of information organisation relevant to modelling biological systems and efficiently solving bioinformatics problems through the design of computational tools.

Skills:
S3. Solve problems in molecular biology, genomics, medical research and population genetics by applying statistical and computational methods and mathematical models.

Competences:
C3. Communicate orally and in writing with others in English about learning outcomes, thought processes and decision making.
C6. Identify and overcome gaps in one’s knowledge by thinking critically and choosing the best approach to extending one’s knowledge.

TEACHING METHODOLOGY

The course will be divided between the lectures, that will be of the expository type, and problem sessions in smaller groups solved together, with one typical problem to solve individually and at home for every part of the course.

LEARNING OBJECTIVES OF THE SUBJECT

1.Acquisition of the basic knowledge of combinatorics, of linear programing and of multivariate calculus
2.Using combinatorics, linear programing and mutlivariate calculus for solving mathematical problems and apply it to discrete, linear and non-linear optimisation problems, especially in the field of bioinformatics.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours small group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Enumerative combinatorics

Description:
Basic counting. Permutations, sets and words. Combinatorial numbers.
Applications to discrete probabilities.
Recurrences. Solving linear recurrences with constant coefficients.

Graph theory

Description:
Graphs, digraphs and their representations.
Trees and DAGs.
Graph exploration.

Discrete optimisation

Description:
The shortest path problem
The minimum spanning tree problem.
Introduction to the Travelling Salesman problem.

Linear optimisation

Description:
Linear programming: modelling a problem using a linear program.
The geometric viewpoint and the simplex algorithm.

Non-linear optimisation

Description:
Recall of multivariate calculus and convex optimisation.
Iterative methods: Newton and Raphson method, gradient descent.

ACTIVITIES

Theoretical expository lectures and problem sessions

Specific objectives:
1, 2

Full-or-part-time: 150h
Theory classes: 30h
Practical classes: 30h
Self study: 90h

GRADING SYSTEM

The subject will be assessed by means of compulsory assessment elements which will consist of individual exams, the partial exam (P) and the final exam (F), and four compulsory tests in the form of small in-class exams (H) to check and orient the learning process of the students. The final grade (G) is computed as follows. Each of the two exams weights 45% of the final grade, and the average of the homeworks weights 10% of the final grade. That is:

G = 0.45*P + 0.45*F + 0.1*H.

A student is considered to have taken the subject if he/she takes the final exam. In that case, and if G< 5, the student can take the recuperaction exam (R), and the final grade becomes the maximum between G and 0.9*R + 0.1*H:

G' = max (G , 0.9*R + 0.1*H).

BIBLIOGRAPHY

Basic:
- Matoušek, Jiri; Nesetril, Jaroslav. Invitation to discrete mathematics. 2nd ed. Oxfoerd: Clarendon Press, 2009. ISBN 9780198570424.
- Guenin, B; Könemann, J; Tuncel, L. A Gentle introduction to optimization. Cambridge: Cambridge University Pres, 2014. ISBN 9781107658790.
- Kleinberg, Jon; Tardos, Éva. Algorithm design. Boston: Pearson/Addison-Wesley, cop. 2006. ISBN 978-0321295354.