UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Scienze Economiche, Aziendali e Statistiche
ACADEMIC YEAR	2018/2019
MASTER'S DEGREE (MSC)	STATISTICS
INTEGRATED COURSE	NUMERICAL ANALYSIS AND OPTIMIZATION - INTEGRATED COURSE
CODE	19643
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	SECS-S/06
HEAD PROFESSOR(S)	CONSIGLIO ANDREA Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	TUMMINELLO MICHELE Professore Ordinario Univ. di PALERMO CONSIGLIO ANDREA Professore Ordinario Univ. di PALERMO
CREDITS	6
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**CONSIGLIO ANDREA** Tuesday 12:00 13:00 Edificio 13, I piano, stanza 108; Building 13, I floor, room 108 Thursday 12:00 13:00 Edificio 13, I piano, stanza 108; Building 13, I floor, room 108 **TUMMINELLO MICHELE** Monday 14:00 16:00 Studio/Laboratorio: primo piano, ex DSSM Tuesday 14:00 16:00 Studio/Laboratorio: primo piano, ex DSSM

DOCENTE: Prof. ANDREA CONSIGLIO

PREREQUISITES	Vectors in R^n and their properties. Function of several variables. Matrix algebra. Differential and integral calculus. Gradient and Hessian of a function of several variables. Convexity of a function of several variables. First and second order condition of optimality.
LEARNING OUTCOMES	1. Knowledge and understanding Definition and description of unconstrained and constrained optimization. Ability to Identify and discuss for convex, linear and quadratic optimization models. Definition and vector representation of discrete optimization problems. Ability to Identify and discuss discrete optimization problems. 2. Applying knowledge and understanding Ability to Implement a GAMS model to solve a an optimization model. Ability to implement a simulated annealing and a genetic algorithm in R to search for solutions to a discrete optimization problem. 3. Making judgements Ability to analyse a real optimization problem and choice of the appropriate mathematical model. Ability to analyse a real optimization problem and choice of the appropriate method to search for solutions. 4. Communication skills Present the results in professional way through pictures and spreadsheets. 5. Learning skills Conduct research and analysis in the field of decision science using optimization models
ASSESSMENT METHODS	The exam is made up by two parts related to the two modules of the course. As far as the optimization model is concerned, the exam consists in implementing an optimization model using the software GAMS. The exam will be performed on a computer. A score sufficient to pass the exam will be assigned to students who prove to be able to input data, display the input data and properly recognizes the endogenous and exogenous variables of the problem. Concerning the calculus unit, the exam consists in the implementation of an optimization model, through either a simulated annealing or a genetic algorithm, on a low dimensional (<1000) system in R. A score sufficient to pass the exam will be assigned to students who prove to be able to upload the data, formalize the solution space as a vector space, and suitably determine a distance between two possible solutions. The final mark is the arithmetic mean of the marks obtained in the two parts.
TEACHING METHODS	Lectures and practices

MODULE OPTIMIZATION *Prof. ANDREA CONSIGLIO*	
SUGGESTED BIBLIOGRAPHY	
A. Consiglio, S. Nielsen and S.A. Zenios. Practical Financial Optimization. Wiley Finance, 2003. All chapters.	
AMBIT	50608-Matematico applicato
INDIVIDUAL STUDY (Hrs)	54
COURSE ACTIVITY (Hrs)	21
EDUCATIONAL OBJECTIVES OF THE MODULE	
At the end of the course the student will be able: 1) To define a constrained and unconstrained optimization problem 2) To determine the maxima and minima of constrained and unconstrained optimization problem 3) To distinguish between linear and nonlinear programming 4) To implement a GAMS model to solve an optimization problem 5) To represent decision problems through optimization models.	

SYLLABUS

Hrs	Frontal teaching
2	Presentation of the objectives of the course. Unconstrained optimization. First and second order condition.
2	Introduction to GAMS. Description of the GAMS IDE. Creation of project. SET statement. Enumeration of a SET. SET as indices. ALIAS statement. SCALAR statement declaration and assignment. The DISPLAY statement.
2	Data representation. Vectors, matrices and multidimensional arrays. The PARAMETER and TABLE statement.The GDX file. Input data from a GDX file. Aggregation operators: SUM, PROD, ORD, CARD, SMAX, SMIN. The $-statement.
2	The VARIABLE statement. The EQUATION statement. Scalar and vector equations. The MODEL statement. The SOLVE statement. Linear (LP) and non-linear (NLP) models.
2	Equality constrained optimization. First and second order condition.
2	Inequality constrained optimization. First and second order condition.

Hrs	Practice
2	GAMS implementation of a non-linear regression model.
4	Implementation of a quadratic optimization models. The Mean-Variance portfolio model. Supervised classification through Support Vector Machine.
3	Transforming an optimization model with absolute values in a linear optimization model. Implementation of the Conditional VaR model.

MODULE NUMERICAL ANALYSIS *Prof. MICHELE TUMMINELLO*	
SUGGESTED BIBLIOGRAPHY	
M. Newman, Networks: An Introduction, Oxford University Press. D. Pham, D. Karaboga, Intelligent Optimisation Techniques, Springer.	
AMBIT	50608-Matematico applicato
INDIVIDUAL STUDY (Hrs)	54
COURSE ACTIVITY (Hrs)	21
EDUCATIONAL OBJECTIVES OF THE MODULE	
OBJECTIVES OF THE UNIT are to: 1) construct a system of recursive equations and recognize its structure; 2) provide a vector representation of the space of solutions to a discrete optimization problem in rugged landscape; 3) analyze the convergence of an iterative and stochastic algorithm that provides suboptimal solutions to discrete optimization problem; 4) understand the difference between accuracy and precision of a solution; 5) represent the search for solutions to a discrete optimization problem through iterative and stochastic methods.	

SYLLABUS

Hrs	Frontal teaching
2	Optimization in discrete rugged landscapes. Np-complete problems and suboptimal solutions. Heuristic methods.
2	Simulated annealing
2	Genetic algorithms
2	A quick introduction to networks and the concept of community detection through modularity optimization.
2	Simulated annealing, genetic algorithms, taboo search, and extreme optimization to optimize modularity.
2	The infomap method

Hrs	Practice
4	Application of simulated annealing and genetic algorithms to real examples of optimization problems (e.g. the traveller salesman problem)
5	R and C tools for modularity optimization.