MODELLO D (inglese)			
General Information	AA 2019-2020		
Academic subject	Numerical Methods for Computer Science		
Degree course	Master Degree in Computer Science		
Curriculum			
ECTS credits	12		
Compulsory attendance	No		
Language	English		
Subject teacher	Name Surname	Mail address	SSD
	Nicoletta Del Buono, Mazzia Francesca	nicoletta.delbuono@uniba.it francesca.mazzia@uniba.it	MAT/08– Numerical Analysis
ECTS credits details	8	4	
Basic teaching activities	Lectures	Laboratory experiments	
Class schedule			
Period	Second term		
Year	First year		
Type of class	Lectures- Laboratory experiments		
Time management			
Hours	124		
Hours of lectures	64		
Tutorials and lab	60		
Academic calendar			
Class begins	March 2, 2020		
Class ends	May 31, 2020		
Syllabus			
Prerequisites/requirements	Basic knowledge of methods in Numerical Analysis		
Expected learning outcomes (according to Dublin Descriptors) (it is recommended that they are congruent with the learning outcomes contained in A4a, A4b, A4c tables of the SUA-CdS)	*Knowledge and understanding* Knowledge and understanding of numerical linear algebra techniques useful for treating structured data. Application of optimization methods for solving problems in data mining, image processing and information retrieval. Knowledge and understanding of classical methods in statistical learning. *Applying knowledge and understanding* Acquiring the main numerical linear algebra techniques and statistical learning methods for treating real world problems. Ability to design efficient numerical codes implementing numerical techniques for solving problems in data mining, image processing and information retrieval. *Making informed judgements and choices* Judgment autonomy is acquired through critical study and interpretation of texts. The achievement of an adequate autonomy is verified through the exercises, which are held during the teaching programme and with the final written and oral examinations.		

	Communicating knowledge and understanding Students are able to express the topics included in the teaching programme by emploing the specific lexicon of the discipline. *Lifelong learning skills* Learning an appropriate studying methodology, supported by text consultation and implementation of the techniques proposed during the course.
Contents	• Numerical Linear Algebra Basic and Advanced Notions • Systems of nonlinear equations and optimization. • Least squared approximation methods. • Low Rank matrix approximation techniques and dimensionality reduction methods • Mathematical methods for information retrieval. • Explorative Data Analysis
Course program	Numerical Linear Algebra. Space of matrices. Operation of matrices. Properties of square and rectangular matrices. Vector spaces and subspaces. Spanning sets. Range and Null spaces. Basis of subspaces. Rank, connectivity and graphs. Properties of AA^T and A^TA. Linear Transformations. Similarity. Structured matrices and their properties. Norms, scalar product and orthogonality. Gram-Schmidt ortho-normalization algorithm. QR factorization. Eigenvalues, eigen-vectors and their properties. QR method. Power method. Unconstrained optimization. Line search method. Gradient descent methods. Exact and inexact line search. Backtracking algorithm. Backtracking gradient method. Newton methods. Least squares problems. System of normal equations and their properties. Least squares line and the optimization problem related. Levenberg Marquardt method for nonlinear least squares. Support vector machines and their formulation as an optimization problem. Constrained optimization Constraint optimization and KKT conditions. Penalization and barriers optimization methods. Optimization and machine learning. Stochastic gradient descent method. Singular Value Decomposition. Eckart-Young Theorem. Truncated SVD. Principal Component Analysis. Eigenface model. Latent Semantic Indexing. Mathematical Models and Text Retrieval. Eigenbased methods for web information retrieval. Hits and Pagerank algorithms. Exploratory data analysis: some mathematical approaches.
Bibliography	1. V. Comincioli, Metodi numerici e statistici per le scienze applicate, Milano, Ambrosiana, 1992. 2. C. Meyer, Matrix Analysis and Applied Linear Algebra, SIAM, 2003. 3. A. N. Langville, C. D. Meyer: Google's PageRank and beyond. Princeton Univ. Press, 2006.

	4. M. W. Berry, M. Browne. Understanding Search Engines: Mathematical Models and Text Retrieval. SIAM, 1999. 5. A. Cichocki, R. Zdunek, A.H. Phan, S.I Amari, Nonnegative Matrix and Tensor Factorizations, Wiley, 2009 6. M. Turk and A. Pentland. Eigenfaces for recognition. Journal of Cognitive Neuroscience 3(1): 71–86. doi:10.1162/jocn.1991.3.1.71 (1991)
Notes	All the references will be integrated by suggested readings, slides and notes provided during the lectures
Teaching methods	Lectures with slides. Laboratory experiments with open source software and available datasets
Assessment methods (indicate at least the type written, oral, other)	Written and oral examinations
Evaluation criteria (Explain for each expected learning outcome what a student has to know, or is able to do, and how many levels of achievement there are).	Students are to be evaluated on the basis of the degree of their knowledge concerning the various topic included in the syllabus.
Further information	