Mathematics for data analysis

Academic Year: (2023 / 2024) **Review date: 21-04-2023**

Department assigned to the subject: Mathematics Department

Coordinating teacher: MOLERA MOLERA, JUAN MANUEL

Type: Compulsory ECTS Credits : 3.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Proficiency in undergraduate mathematics (Linear Algebra, in particular)

OBJECTIVES

- Use of advanced methods of Linear Algebra for analysing big data
- Understanding the fundamentals of certain algorithms used in big data, in order to interpret the results, their meaning and validity

Learning results:

· Deep review of basic linear algebra: linear systems, vectors and matrices, including matrix diagonalization and linear transformations
· Review/Learning of orthogonality concepts in linear algebra, including orthogonal matrix diagonalization and applications
· Learning of the singular value decomposition (SVD) of a real matrix, including applications

DESCRIPTION OF CONTENTS: PROGRAMME

1. Matrices
(a) Matrix Operations
(b) Change of Basis Matrix
(c) Matrix of a Linear Transformation

2. Linear Systems of Equations
(a) LU factorization
(b) Cholesky factorization
(c) Applications: Iterative Methods

3. Diagonalization
(a) Diagonalization
(b) Orthogonal Diagonalization
(c) The Power Method
(d) Markov processes

4. Least Squares Problems
(a) Data fitting
(b) Orthogonal projections and Least square problems
(c) QR factorization
(d) Constrained LSP

5. Singular Value Decomposition
(a) Singular Value Decomposition
(b) The pseudoinverse
(c) Principal component analysis

LEARNING ACTIVITIES AND METHODOLOGY

This course is in FLIPPED CLASSROOM format:

- The students must visualize some videos and answer a quiz about the videos before attending the class
- In the class, there'll be a review of the theoretical concepts of the videos, and some problems will be solved
- The students must solve extra problems as homework

Tutorials are available

ASSESSMENT SYSTEM

1. Day-to-day to assesment, C.
The grade C will be obtained from Quizzes (Q), 30%, and Tasks (T), 70%:

C = 0.3*Q + 0.7*T.

2. Final exam, E, and final grade G.

-- If C >= 5 there are two options:

1. You can decide not to take the final exam. The final grade will be G=5.
2. If you want to get more than a 5 on your final grade you will have to take necessarily the final exam. In that case your final
grade will be
G = max{0.6*C + 0.4*E, 5, E}, where E is the final exam grade.

-- If C < 5 you will have to take necessarily the final exam to pass the course. The grade, in that case, will be

G = E.

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

BASIC BIBLIOGRAPHY

- Timothy Sauer Numerical Analysis 2e, Pearson, 2012
- W. Keith Nicholson Linear Algebra with Applications, Lyryx, Open Edition, 2021
- David C. Lay, Steven R. Lay, Judi J. McDonald Linear Algebra and Its Applications, Pearson; 5 edition, 2016
- Lloy N. Trefethen; David Bau, III Numerical Linear Algebra, SIAM, 1997

ADDITIONAL BIBLIOGRAPHY

- Carl D. Meyer Matrix Analysis and Applied Linear Algebra, SIAM, 2010
- Cleve Moler Numerical Methods with Matlab, SIAM, 2004
- David Watkins Fundamentals of Matrix Computations, 3rd Ed, Wiley, 2010
- James W. Demmel Applied Numerical Linear Algebra, SIAM, 1997

BASIC ELECTRONIC RESOURCES

- Marc Peter Deisenroth, A Aldo Faisal, and Cheng Soon Ong . Mathematics for Machine Learning: https://mml-book.github.io/