Universitat Autònoma de Barcelona

2020/2021

Vector Spaces

Code: 104343
ECTS Credits: 6

Degree	Type	Year	Semester
2503758 Data Engineering	FB	1	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Francesc Xavier Xarles Ribas

Prerequisites

No required.

Objectives and Contextualisation

In order to acquire a good mathematical training in the treatment of data, it is essential to fully understand the theory of Vector Spaces. It is necessary to learn to manipulate the objects that are introduced and interpret its meaning. The tools that are provided in this course are essential not only in all branches of Mathematics but also in most of the engineering.

Among the training objectives we emphasize the following: understand and correctly use mathematical language, see the need for demonstrations and develop a critical sense in the face of mathematical affirmations.

As more specific objectives: the student will learn to manipulate arrays as a basic tool to analyze systems of linear equations, formalize the language necessary to understand the concepts of vector space and linear application, as well as manipulate bilinear forms. Diagonalization in linear applications, and some application in the world of data engineering. All this will be reinforced by the introduction of certain software.

Competences

- Demonstrate sensitivity towards ethical, social and environmental topics.
- Make a critical evaluation of work carried out.
- Search, select and manage information and knowledge responsibly.
- 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.

- Use the concepts and methods of algebra, differential and integral calculus, numerical methods, statistics and optimisation necessary for solving engineering problems.

Learning Outcomes

1. Be able to manipulate matrices.
2. Calculate and interpret the meaning of the representations given by projection in a vector subspace.
3. Demonstrate sensitivity towards ethical, social and environmental topics.
4. Make a critical evaluation of work carried out.
5. Search, select and manage information and knowledge responsibly.
6. 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.
7. Understand the concept of vector space, basis and linear representation both in finite dimension spaces and in infinite dimension spaces.

Content

The subject is structured in four blocks: a first more computational block where the algebraic manipulation of matrices is prioritized, introducing their basic operations. In the second block the concepts of abstract vector space and linear application will be formalized, relating them to the contents of the first block. The third block presents a factorization in linear applications that has different uses in the world of engineering. The fourth block is dedicated to more advanced concepts that take advantage of the structure of vector space with metrics.

Topic 1: Matrices and linear equations

(A) Operations with matrices. Invertible matrix.

(B) Elemental transformations in matrices.

(C) Rank of a matrix. Invertibility criterion. PAQ-reduction. Generalized Invers matrix.

(D) Resolution of systems of linear equations.

(E) Determinant of a square matrix.

Topic 2: Vector spaces and linear applications

(A) Definition of space and vector subspace. Scalar products in vector spaces. Linear independence, generators and bases. Dimension.

(B) Nucleus and image of a linear application. Composition.

(C) Vector coordinates and matrix associated with a linear application.

Topic 3: Diagonalization

(A) Characteristic polynomial. Eigenvalues.

(B) Eigenvectors associated with an eigenvector. Diagonalization of matrices.

(C) Minimum polynomial.

Topic 4: Orthogonality, normed spaces and quadratic forms.

(A) Bilinear forms and diagonalization in symmetric matrices.

(B) Singular values and SVD factoring (Singular Value Decomposition). Fitting Date.

(C) Hilbert spaces.

Methodology

The subject has during the semester of 4 weekly hours grouped in blocks of 2 hours. Each of these blocks will be divided into a theoretical introduction of content and problem solving, which may be on paper or with the use of software.

To introduce the software, more time will be devoted to this part of the sessions at the beginning of the course.

There will be during theory classes or problems, and in the last half hour of the block, and without previous sighting, there will be (during 4 dates) a small test that students must do individually, which will count in the evaluation part.

The subject will have the corresponding Moodle classroom within the UAB servers to be able to complement the explanations made in class, offer the necessary material.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Solving exercises and Computer class with a mathematic programme.	24	0.96	4, 5, 2, 1, 7
theory class	26	1.04	2, 1, 3, 7
Type: Autonomous			
Learn theoretical concepts and solving exercises.	61	2.44	5, 2, 1, 7
Preparing the exercises for a avaluation	10	0.4	5, 2, 1, 7
Work with Sage Math	22	0.88	5, 1, 7

Assessment

Continuous assessment:

During the course there will be 1 individual delivery of a list of exercises that will be posted in the Moodle classroom a week before. Students must submit the resolution of the list individually. The note of this delivery can not be recovered, we call this a grade of 10 for A.

During the course, and without previous sighting, half an hour of the theory class or the class of problems will be devoted to doing a small test, type Quiz, on the content of the subject of each subject of the course in finalizing it. It will be done individually, in the classroom. There will be 4 Quiz, one per subject. The notes of these tests are not recoverable either. Each Quiz will have an equal score, and the average between 0 and 10 will be scored by B.

Exam type evaluation:

During the month of December, at a time and date that will be set there will be an evaluation of practices with a computer. It will evaluate the level reached with the subject with the help of a software with the laptop. The test will be individual. This test may be recovered during the recovery date, however it has a minimum score of 1 point out of 10 to be able to evaluate the subject, otherwise the subject will be suspended, see section rating. We denote this note between 0 to 10 for P, and remember it is mandatory to take this test since P must be greater than or equal to 1 in order to pass the subject.

At the end of the course, there will be a final exam of the whole subject. Denote by E the final exam grade on 10 points.

Qualification of the subject (without recovery exams):

If the notes E> 3.5 and P> 1, then at this time the student has the qualification N = 0.1 * A + 0.25 * B + 0.15 * P + 0.5 * E. If the note is higher or equals 5, the student passes the subject with the note N.

If P <1 or E <3,5 (or has not been submitted to the practical exam or end of the subject) the student obtains the minimum grade between N and 4.5 points.

The student obtains a No Presented (NP) if he does not have delivery of exercises, he does not present himself to the last two Quiz and he does not appear in any of the exams.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evaluation delivery of a concrete list of exercises	10%	0	0	4, 5, 2, 1, 7, 6
Final exam	50%	3	0.12	2, 1, 7, 6
Quiz	25%	2	0.08	4, 5, 2, 1, 3, 7, 6
SageMath exam	15%	2	0.08	4, 1, 7, 6

Bibliography

Bretscher,O. "Linear Algebra with Applications", 1997, Prentice-Hall International, Inc.

Nart,E.;Xarles,X."Apunts d'àlgebra lineal", 2016, col.lecció Materials UAB, num.237.

Seasone,G"Elementary notions of Hilbert Spaces" 1991, NewYork, Dover.