ESCI upf.
School of International Studies

TEACHING PLAN FOR

ALGEBRA

1. Basic description

Name of the course: Algebra

Module: **Mathematics and Statistics**

Academic year: 2016-2017
Year: 2017
Term: Third
Degree / Course: First
Code: 51310
Number of credits: 4
Total number of hours committed: 100
Teaching language: English
Lecturer: Marta Casanellas Rius, Jesús Fernández Sánchez
Timetable: See official schedule

2. Presentation of the course

- Algebra is one of the compulsory subjects in mathematics of the BSc. in Bioinformatics. The aim of this course is to provide algebraic tools that are essential when dealing with modelling and computational issues related to bioinformatics problems.

We will introduce the basic concepts of linear algebra and geometry with the final goal that students feel confident when dealing with concepts as change of basis, linear map, or diagonalization. We will also introduce the numerical issues related to this type of mathematical topics. The biological problems that can be solved with linear algebra will be underlie all the lectures and practical sessions, as the motivation will always come from biological models and computational problems in bioinformatics. We shall make use of the open software Octave (www.gnu.org/software/octave) for practical sessions.

3. Competences to be worked in the course

General competences	Specific competences
CB1, CB2, CB4, CB5, CG1	CE2, CE5, CE8, CE9

I. General competences

CB1. That the students have demonstrated to have acquired the knowledge and understanding in a field of study that starts from the basis of general secondary education, and is typically at a level that although it is supported by advanced textbooks, includes some aspects that involve knowledge of the forefront of their field of study.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional manner and have competencies typically demonstrated through devising and defending arguments and solving problems within their field of study.

CB4. That the students can convey information, ideas, problems and solutions to both specialist and non-specialist audiences.

CB5. That the students have developed those skills needed to undertake further studies with a high degree of autonomy.

CG1. That the students will acquire an intra- and interdisciplinary training in both computational and scientific subjects with a solid basic training in biology.

II. Specific competences

CE2. To manage and exploit all kinds of biological and biomedical information to transform it into knowledge.

CE5. To apply mathematical foundations, algorithmic principles and computational theories in the modeling and design of biological systems.

CE8. To identify meaningful and reliable sources of scientific information to substantiate the state of arts of a bioinformatic problem and to address its resolution.

CE9. To apply statistical and computational methods to solve problems in the fields of molecular biology, genomics and medical research and population genetics.

Learning outcomes

RA 2.2 Improve understanding of disease onset and progression.

RA5.1. Recognize and use the basic tools of mathematical language.

RA 5.2. Apply mathematical and statistical treatment to large amounts of biological data.

RA 5.3. Model biological information in mathematical language for further analysis and processing.

RA 8.2. Quote valid sources of scientific information to support the state of the arts of a bioinformatic problem.

RA9.1. Identify and use appropriate statistical methods to each type of data.

4. Contents

- Basic description of contents outlined for the curriculum

  Vector spaces and linear maps (systems of linear equations, rank and determinant of matrices, eigenvalues and eigenvectors, orthogonality) and its interaction with numerical linear algebra, matrix decompositions, Markov matrices and systems of differential equations

- Provide more detail and expand upon the description of contents

  1. Matrices. Operations, elementary transformations, rank, determinant, inverse of a matrix
  2. Linear systems of equations. Gaussian elimination, Perron-Frobenius theorem, numerical methods
  3. Vectors and coordinates. Linear combinations, dependency, systemos of generators, basis, coordinates and change of basis, subspaces
  4. Linear maps. Matrices and linear maps, image, kernel, change of basis
  5. Eigenvalues and eigenvectors. Definition, criteria for diagonalization, numerical methods. Special case of Markov matrices.
  6. Linear dynamical systems applied to biology.
  7. Orthogonality. Inner product, norm, distance, orthogonal projection, quadratic least squares, singular value decomposition and rank approximation.

The course will include practical sessions that shall be performed with the software Octave or other software recommended by the teachers.

5. Assessment

- ***Ways of assessing the subject including:***

1) Participation in planned activities in the classroom
2) Exams
3) Individual work (essays, practical classes)

4) Group work
5) Presentations or demonstrations.

The subject will be assessed by means of two compulsory assessment elements (see (1) and (2) in the table below) which will consist of individual exams. There will also be four compulsory tests along the course to check the learning process of the students (see (3)-(6) in the table below) which will suppose 30% of the final qualification.

- ***Prerequisites for taking the subject***

Basic knowledge on matrices and vectors, and resolution of linear systems of equations.

- ***Terms and conditions for extraordinary exam sitting***

Extraordinary exam will take place according to the schedule fixed by the Degree Coordination. Failure to attend this exam imply student will keep his initial score. The extraordinary exam will only re-assess elements 1 and 2.

Assessment elements	Time period	Type of assessment		Assessment agent			Type of activity	Grouping		Weight (%)
		Comp	Opt	Lecturer	Self-assess	Co-assess		Indiv	Group (#)	
(1) Assessment on the first part of the course	Week 5	x		X			Conceptual and pursuit of the subject	x		30%
(2) Assessment on the theoretical and practical part of the course	Week 11	x		X			Conceptual and pursuit of the subject	x		40%
(3) assessment on the practical part of the course	Week 2	x		X			Application based	x		7.5%
(4) assessment on the practical part of the course	Week 4	x		X			Application based	x		7.5%
(5) assessment on the practical part of the course	Week 7	x		X			Application based	x		7.5%
(6) assessment on the practical part of the course	Week 9	x		X			Application based	x		7.5%

Working competences and assessment of learning outcomes:

	CB 1	CB 2	CB 4	CB 5	C G1	CE 2	CE 5	CE 8	CE 9	RA 2.2	RA 5.1	RA 5.2	RA 5.3	RA 8.2	RA 9.1
(1) Assessment on the first part of the course	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2) Assessment on the theoretical and practical part of the course	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
(3) assessment on the practical part of the course	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
(4) assessment on the practical part of the course	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
(5) assessment on the practical part of the course	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
(6) assessment on the practical part of the course	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

6. Bibliography and teaching resources

- Basic bibliography

Allman, E.S.; Rhodes, J.A. Mathematical models in biology: an introduction. Cambridge: Cambridge University Press, 2004. ISBN 978-0- 521-81980-0. See http://cataleg.upc.edu/record=b1297072~S1*cat

Friedberg, S., Insel, A., Spence, L. *Linear Algebra* (2nd edition). Prentice Hall, 1989

C. D. Meyer, Matrix analysis and applied linear algebra, SIAM, 2000.

D. Poole, Linear Algebra, a modern introduction, 3rd edition, Brooks/Cole, 2011

H. M. Sauro, Systems biology: Linear Algebra for Pathway modeling, Ambrosius Publishing and Future skill software, 2014.

- Supplementary bibliography

Hernández, E., Vázquez, M.J., Zurro, M.A. *Álgebra lineal y geometría,* Pearson Educación, 2012 (spanish)

Lipschutz, S.; Lipson, M. *Linear Algebra,* Schaum Outlines, McGraw Hill, 2009

Colomé Nin, G.; Miró-Roig, R.M. Álgebra Lineal: una puerta de entrada a las matemáticas. Textos universitarios, edited by E-LectoLibris and RSME, 2014 (spanish)

Daniel, J. W., Noble, B. *Applied linear Algebra*, Prentice-Hall, 1989 (English version Applied Linear Algebra, 3rd Edition)

- Teaching resources

Octave
(https://www.gnu.org/software/octave/, distributed under the terms of the GNU General Public License).

Kahoot
(www.kahoot.it, learning game made from series of multiple choice questions).

Other useful resources: C, C++ or Python programming, SAGE (www.sagemath.org), Wolfram Apha www.wolframalpha.com

7. Methodology

Different methodologies will be applied for theoretical and practical sessions. Theoretical sessions will consist mainly of lectures, based on slides and blackboard explanations. There will be two types practical sessions: (P)roblem-solving, where students will be entitled to solve problems on the concepts developed in the theoretical sessions, and (L)ab sessions which will be organized following the statement of some short projects and performed at the computer classroom. The students will work in groups and will be required to both apply previously acquired knowledge and use the suggested resources (see also Section 6).

8. Scheduling activities

- Indicate:
  1) Allocation of hours between theory and practical lessons (based on the number of credits in the curriculum):
     - In 6 ECTS subjects, 3 h of lecture and 1 h of seminar
     - In 4 ECTS subjects, 2 h of lecture and 1 h of seminar (beginning in the second week of class)
     - Exception: Maths, in principle, will have 5.5 lecture hours per week

  2) Scheduling activities under the curriculum, from:
     - In the classroom: 1) Lecture classes, 2) Seminars, 3) Face-to-face tutorials, 4) “Regulated” practical classes (lab…)
     - Outside the classroom: 5) Group work, 6) Individual work (reports, exercises…), 7) Internships (outside companies), 8) Independent study

Week	Activity in the classroom Grouping/type of activity	Activity outside the classroom Grouping/type of activity
Week 1	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 6h Type 6) 2h
Week 2	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 6h Type 6) 2h
Week 3	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 6h Type 6) 2h
Week 4	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 6h Type 6) 2h
Week 5	Assessment (1): 2h	Type 8) 8h
Week 6	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 4h Type 6) 2h Type 5) 2h
Week 7	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 4h Type 6) 2h Type 5) 2h
Week 8	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 4h Type 6) 2h Type 5) 2h
Week 9	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 4h Type 6) 2h Type 5) 2h
Week 10	Type 1) 2h Type 2) 1h Type 3) 1h	Type 8) 4h Type 6) 2h Type 5) 2h
Week final exams	Assessment (2): 3h Assessment (3): 1h	Type 8) 8h

La còpia i/o plagi total o parcial als treballs i/o exàmens comportarà suspendre l'assignatura amb una qualificació de zero sense dret a recuperació, sense perjudici de l'aplicació de les altres sancions previstes al Reglament de Règim disciplinari dels estudiants de la Universitat Pompeu Fabra en funció de la gravetat de la infracció.

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