Course guide
270401 - ALG - Algebra

Last modified: 10/07/2024

Unit in charge: Barcelona School of Informatics
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2021). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: JOSÉ LUIS RUIZ MUÑOZ - JAUME MARTÍ FARRÉ

Others: Primer quadrimestre:
JAUME MARTÍ FARRÉ - 11, 12
JOSÉ LUIS RUIZ MUÑOZ - 11, 12

PRIOR SKILLS

Students must master high school mathematics and have skills in solving high school level math problems.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE01. To be able to solve the mathematical problems that may arise in the field of artificial intelligence. Apply knowledge from: algebra, differential and integral calculus and numerical methods; statistics and optimization.
CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems . To be able to apply all these for solving problems.

Generical:
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

Transversal:
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Basic:
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

TEACHING METHODOLOGY

Different methodologies will be considered for theory classes and problems. Theory classes will consist mainly of master classes, based on presentations and explanations on the board; problem classes will consist of solving exercises and practicing concepts learned in theory sessions.

LEARNING OBJECTIVES OF THE SUBJECT

1.Acquisition of the basic knowledge of complex numbers.
2.Acquisition of basic knowledge of linear algebra.
3.Recognize concepts of complex numbers and linear algebra within interdisciplinary problems.
4.Learn how to use complex numbers and linear algebra in solving problems in data analysis and artificial intelligence.
5.Using tools from linear algebra and complex numbers in solving mathematical problems.
6.Understanding the notions of matrix decomposition, its geometric interpretation and its applications in problem solving.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours small group	30,0	20.00

Total learning time: 150 h

CONTENTS

Complex numbers.

Description:
The imaginary unit. Ordered pair and binomial form. The conjugate. Module and argument. Trigonometric and polar expressions. Powers and roots. Exponential and matrix expressions.

Matrices. Determinants. Linear systems of equations.

Description:
Matrices. Operacions with matrices. Elementary transformations by rows and by columns. Row echelon form. Gauss method. Rank. Determinants. Linear systems of equations. Inverse matrix.

The real and complex n-dimensional vector spaces.

Description:
Vector structure of n-dimensional real and complex spaces. Vector subspaces. Euclidean structure of real n-dimensional space.

Linear transformations. Diagonalitation.

Description:
Linear transformations of the n-dimensional space. Associated matrix of linear trnasformation. Equivalent and similar matrices. Matrix diagonalization. Singular value decomposition.

ACTIVITIES

Development of topic 1

Description:
Theoretical classes and problem sessions on topic 1.

Specific objectives:
1

Related competencies :
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CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems . To be able to apply all these for solving problems.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Full-or-part-time: 10h
Self study: 6h
Theory classes: 2h
Practical classes: 2h

Development of topic 2.

Description:
Theoretical classes and problem sessions on topic 2.

Specific objectives:
2, 3, 4, 5

Related competencies :
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.
CE01. To be able to solve the mathematical problems that may arise in the field of artificial intelligence. Apply knowledge from: algebra, differential and integral calculus and numerical methods; statistics and optimization.
CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems . To be able to apply all these for solving problems.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Full-or-part-time: 30h
Self study: 18h
Theory classes: 6h
Practical classes: 6h

Development of topic 3.

Description:
Theoretical classes and problem sessions on topic 3.

Specific objectives:
2, 3, 4, 5

Related competencies :
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.
CE01. To be able to solve the mathematical problems that may arise in the field of artificial intelligence. Apply knowledge from: algebra, differential and integral calculus and numerical methods; statistics and optimization.
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CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Full-or-part-time: 40h
Self study: 20h
Theory classes: 10h
Practical classes: 10h

Development of topic 4.

Description:
Theoretical classes and problem sessions on topic 4.

Specific objectives:
2, 3, 4, 5, 6

Related competencies :
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.
CE01. To be able to solve the mathematical problems that may arise in the field of artificial intelligence. Apply knowledge from: algebra, differential and integral calculus and numerical methods; statistics and optimization.
CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems . To be able to apply all these for solving problems.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Full-or-part-time: 47h
Self study: 25h
Theory classes: 12h
Practical classes: 10h

Partial exam

Description:
Partial exam

Specific objectives:
1, 2, 3, 4, 5

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CE01. To be able to solve the mathematical problems that may arise in the field of artificial intelligence. Apply knowledge from: algebra, differential and integral calculus and numerical methods; statistics and optimization.
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CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Full-or-part-time: 6h
Self study: 4h
Guided activities: 2h

Final exam

Description:
Final exam

Specific objectives:
1, 2, 3, 4, 5, 6

Related competencies :
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.
CE01. To be able to solve the mathematical problems that may arise in the field of artificial intelligence. Apply knowledge from: algebra, differential and integral calculus and numerical methods; statistics and optimization.
CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems . To be able to apply all these for solving problems.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Full-or-part-time: 8h
Self study: 5h
Guided activities: 3h

Problem delivery

Description:
Problem delivery

Specific objectives:
1, 2, 3, 4, 5

Related competencies :
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.
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CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems . To be able to apply all these for solving problems.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
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Full-or-part-time: 12h
Self study: 12h

GRADING SYSTEM

Subject assessment consists of three parts: P, F, T.

Grade P comes from a midterm partial exam.
Grade F comes from a final exam.
Grade T comes from the resolution and delivery of problems throughout the course.

Final grade is computed as:

FinalGrade = max(0.50F + 0.30P, 0.80F) + 0.20T

Transversal Competence (Self Learning) assessment will be done according to the final grade as following:

A: 8.5 - 10
B: 7 - 8.4
C: 5 - 6.9
D: 0 - 4.9
NA: NP

BIBLIOGRAPHY

Basic:
- Strang, G. Introduction to linear algebra. 6th ed. Wellesley, Mass.: Wellesley-Cambridge Press, 2023. ISBN 9781733146678.
- Llerena, Irene; Miró-Roig, Rosa M. Matrius i vectors. Barcelona: Publicacions i Edicions de la Universitat de Barcelona, 2010. ISBN 9788447534685.

Complementary:
- Ayres, Frank. Teoría y problemas de matrices. México: McGraw-Hill, 1969. ISBN 9684511906.
- Rafel Amer; Vicenç Sales. Àlgebra lineal : problemes resolts. 2009. Barcelona: Edicions UPC, 1993. ISBN 8476532768.
- Rojo García, Jesús; Martín, Ana Isabel. Ejercicios y problemas de álgebra lineal. 2a ed. Madrid [etc.]: McGraw-Hill, 2004. ISBN 8448198581.

RESOURCES

Hyperlink:
- https://ocw.mit.edu/courses/mathematics/18-06sc-linear-algebra-fall-2011/index.htm