Course guides
270401 - ALG - Algebra

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: 2021  ECTS Credits: 6.0  Languages: Catalan, Spanish

LECTURER
Coordinating lecturer: JAUME MARTÍ FARRÉ - JOSÉ LUIS RUIZ MUÑOZ
Others: Primer quadrimestre:
JAUME MARTÍ FARRÉ - 11
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.

General:
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.
CBS. 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**

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
</tbody>
</table>

**Total learning time:** 150 h

**CONTENTS**

**Complex numbers.**

**Description:**

**Matrices. Determinants. Linear systems of equations.**

**Description:**

**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. Diagonalization.**

**Description:**
## ACTIVITIES

### Development of topic 1

**Description:**
Theoretical classes and problem sessions on topic 1.

**Specific objectives:**
1

**Related competencies:**
- **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.
- **CG2.** To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
- **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.
- **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.
- **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.
- **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.

**Full-or-part-time: 7h**
- Theory classes: 2h
- Practical classes: 2h
- Self study: 3h
Development of topic 2.

Description:
Theoretical classes and problem sessions on topic 2.

Specific objectives:
2, 3, 4, 5

Related competencies:
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.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
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.
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.
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.
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.

Full-or-part-time: 18h
Theory classes: 6h
Practical classes: 6h
Self study: 6h
Development of topic 3.

Description:
Theoretical classes and problem sessions on topic 3.

Specific objectives:
2, 3, 4, 5

Related competencies:
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.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
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.
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.
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.
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.

Full-or-part-time: 30h
Theory classes: 10h
Practical classes: 10h
Self study: 10h
## Development of topic 4.

**Description:**
Theoretical classes and problem sessions on topic 4.

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

**Related competencies:**
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.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
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.
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.
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.
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.

**Full-or-part-time:** 36h
 Theory classes: 12h
 Practical classes: 12h
 Self study: 12h
Partial exam

**Description:**
Partial exam

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

**Related competencies:**
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.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
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.
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.
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.
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.

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

Final exam

**Description:**
Final exam

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

**Related competencies:**
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.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
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.
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.
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.
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.

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

**Description:**
Problem delivery

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

**Related competencies:**
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.

CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

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.

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.

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.

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.

**Full-or-part-time:** 2h
Self study: 2h

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**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:

\[ \text{Final Grade} = \max(0.50F + 0.30P + 0.20T, F) \]

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

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**BIBLIOGRAPHY**

**Basic:**
Complementary:

RESOURCES

Hyperlink: