Course guide
270414 - IBD - Introduction to Databases

Unit in charge: Barcelona School of Informatics
Teaching unit: 747 - ESSI - Department of Service and Information System Engineering.
Degree: BACHELOR’S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2021). (Compulsory subject).
Academic year: 2022  ECTS Credits: 6.0  Languages: Catalan

LECTURER
Coordinating lecturer: PETAR JOVANOVIC - SERGI NADAL FRANCESCH
Others: Primer quadrimestre: PETAR JOVANOVIC - 11, 12
        SERGI NADAL FRANCESCH - 11, 12

PRIOR SKILLS
To know the data structures in internal memory.
To be able to implement programs of medium complexity.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.

General:
CG1. To ideate, draft, organize, plan and develop projects in the field of artificial intelligence.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

Transversal:
CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.
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.
CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.
TEACHING METHODOLOGY

Theory classes / problems
Autonomous learning: To prepare classes the student may have to read and understand materials and / or notes indicated by the teacher. Afterwards in class, the student needs to review and solve exercises on the topic of study.

Theory classes In lectures the teachers present a part of the contents of the subject. Normally, teachers use transparencies that students would be advised to obtain before classes, in order to do a better follow-up.

Problems classes In problem classes, students solve exercises about content presented during theory classes. These exercises are done in teams of two students according to a cooperative learning technique.

Evaluation. In four of the problem classes, students will solve an exercise that will be collected and evaluated by the teacher.

Laboratory classes
Autonomous learning: The contents that are worked on in the laboratory classes will be studied autonomously by the students. Each week before in the laboratory class students will have a homework assignment that will end with the resolution of a moodle / LearnSQL quiz.

Laboratory classes: Class work will be in teams of 2 students. Students have the opportunity to share doubts with their teammate about the work they have done at home, and if necessary, to ask questions that are not resolved to the teacher. Next the students do the activities that the teacher has indicated and finally solve the class questionnaire.

Assessment: There are three weeks in which laboratory tests are carried out, which count as an evaluation act of the subject.

LEARNING OBJECTIVES OF THE SUBJECT

1. To have a general vision of what a database is, what is a database model, the types of users of databases and which are the categories of databases languages.
2. To know the objectives of a database management system and their architecture.
3. To understand the database relational model, their languages (SQL and relational algebra) and the usual components of a relational database.
4. To be able to define, create and manipulate usual relational database components.
5. To be able to build programs to manage relational databases.
6. To know the different available formats for semistructured data, and know how to write SQL queries over them.
7. To be able to apply some defined quality criteria to choose between several SQL statements, database components, or programs, that manage a database and implement the same functionality.
8. To be able to apply some defined quality criteria to choose between several SQL statements, database components, or programs, that manage a database and implement the same functionality.
9. To have a general vision of how the design of a database should be included in a software development process.
10. To be able to obtain a database relational model starting from a conceptual models in UML.
11. To know the concept of database transaction and its implications.
12. To know how to identify the different types of interference that can occur between database transactions and their relationship with the isolation levels that defines the SQL
13. To know the locking concurrency control technique.
14. To know the possible physical structures for storing data and its implications for in terms of efficiency.
15. To know the access methods to data and its implications in terms of efficiency.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<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>
</tbody>
</table>

Total learning time: 150 h
## CONTENTS

### Introduction

**Description:**
Database concept. Database design and models. Types of users. Categories of languages. Concept of database management system (DBMS). Desirable goals for databases that DBMSs must provide. Architecture of the DBMS.

### The relational model

**Description:**
Objectives and origin. Structure of data with which the relational databases are built. Operations provided by the relational model to manipulate and query the data. Integrity rules to be met by the data in a relational database.

### Languages: Relational algebra and SQL

**Description:**
Introduction. Relational algebra: operations of relational algebra; queries. SQL: table creation; insertion, deletion and modification of rows in a table; queries on a database. Considerations about the implementation of queries.

### Logical database components

**Description:**
Concept of a logical database component: data and control components. Introduction to the data components: schemes, tables and domains, assertions and views. Introduction to the control components: stored procedures, triggers and privileges.

### Semistructured data formats and SQL extensions to query them

**Description:**
Introduction to the different semi-structured data formats. SQL extensions to query semi-structured data.

### SQL Programming

**Description:**
Programming in Python and DataFrames. Considerations and quality criteria in the design and implementation of programs that access databases.

### Transactions and concurrency

**Description:**
**Introduction to the design of relational databases**

**Description:**
Stages in the design of a database. Introduction to the understanding of simple UML conceptual models. Translation of simple UML conceptual models to relational model databases

**Physical storage structures, access methods and optimization**

**Description:**
Introduction. Access methods to perform queries and updates in a database. Costs of the different access methods. Introduction to Query Optimization

**ACTIVITIES**

**Study of the database introduction**

**Specific objectives:**
1, 2

**Related competencies :**
CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
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
Theory classes: 2h
Laboratory classes: 2h
Self study: 4h

**Study of the database introduction**

**Specific objectives:**
3

**Related competencies :**
CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
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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.
CB3. That students have the ability to gather and interpret relevant data (usually within their area of ??study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

**Full-or-part-time:** 2h
Self study: 2h
Study of the data logical components

**Specific objectives:**
3, 4, 7

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CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
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**Full-or-part-time:** 12h
Theory classes: 2h
Practical classes: 4h
Self study: 6h

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Study of the introduction to design of relational databases

**Specific objectives:**
9, 10

**Related competencies:**
CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
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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
Theory classes: 2h
Practical classes: 2h
Self study: 4h
Study of transactions and concurrency

Specific objectives:
11, 12, 13

Related competencies:
CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
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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: 12h
Theory classes: 2h
Practical classes: 4h
Self study: 6h

Study of storage, access methods and optimization

Specific objectives:
14, 15

Related competencies:
CG1. To ideate, draft, organize, plan and develop projects in the field of artificial intelligence.
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CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
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: 17h
Theory classes: 6h
Practical classes: 4h
Self study: 7h
Study of the Relational Algebra and SQL

Specific objectives:
3, 4, 7

Related competencies:
CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
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.
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CB3. That students have the ability to gather and interpret relevant data (usually within their area of ??study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

Full-or-part-time: 22h
Laboratory classes: 10h
Self study: 12h

Study of semistructured data models and SQL extensions to query them

Specific objectives:
6, 7, 8

Related competencies:
CG1. To ideate, draft, organize, plan and develop projects in the field of artificial intelligence.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
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.
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Full-or-part-time: 8h
Theory classes: 1h
Practical classes: 1h
Laboratory classes: 2h
Self study: 4h
### Study of stored procedures and triggers

**Specific objectives:**
3, 4, 7

**Related competencies:**
- CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
- CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
- 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.
- CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.
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**Full-or-part-time:** 12h
Laboratory classes: 6h
Self study: 6h

### Programming with SQL - Python and DataFrames

**Specific objectives:**
4, 5, 7

**Related competencies:**
- CE08. To detect the characteristics, functionalities and components of data managers, which allow the adequate use of them in information flows, and the design, analysis and implementation of applications based on them.
- CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
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**Full-or-part-time:** 8h
Laboratory classes: 4h
Self study: 4h
Laboratory control: Relational Algebra Languages, SQL, Semistructured data models

Specific objectives:
4, 6, 7

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

Laboratory control: stored procedures and triggers

Specific objectives:
4, 7, 8

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Full-or-part-time: 4h
Guided activities: 2h
Self study: 2h
Laboratory control: Programming with SQL - Python and DataFrames

Specific objectives:
5, 7, 8

Related competencies:
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CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
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Full-or-part-time: 4h
Guided activities: 2h
Self study: 2h

Final Exam

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Related competencies:
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Full-or-part-time: 26h
Self study: 26h

Reviews and resolution of doubts about the exams

Full-or-part-time: 3h
Self study: 3h
GRADING SYSTEM

The grade of the course is based on technical competencies:

- NEF: Final exam grade.
- NPR: Problems grade. It is the average of the grades of the four problems exam.
- NLB: Laboratory grade. It is calculated as the 40% of the grade of the part algebra / SQL, 30% of the grade of the part of procedures / triggers and 30% of the grade of the part of programming with SQL - Python.

Final grade = Maximum (NLB * 0.25 + NEF * 0.60 + NPR * 0.15,
NLB * 0.25 + NEF * 0.75)

- For students who can concur to the reevaluation, the reevaluation examen grade will replace NEF

BIBLIOGRAPHY

Basic:
- LearnSQL.

Complementary:

RESOURCES

Hyperlink:
- https://learnsql2.fib.upc.edu/moodle/course/view.php?id=81