Course guide
270212 - BD - Databases

Unit in charge: Barcelona School of Informatics
Teaching unit: 747 - ESSI - Department of Service and Information System Engineering.
Degree: BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Compulsory subject).
Academic year: 2022  ECTS Credits: 6.0  Languages: Catalan

LECTURER
Coordinating lecturer: ANTONI URPI TUBELLA
Others:
Primer quadrimestre: JOAQUIM MOTGER DE LA ENCARNACION - 11
                     MARIA CARME QUER BOSOR - 12
                     ANTONI URPI TUBELLA - 11, 12, 13

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:
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.

General:
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.

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.

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.

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 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.
7. To have an overview of data warehouses and multidimensional databases, and to know how to express OLAP statements via SQL.
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 Standard.
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>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
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</table>

Total learning time: 150 h
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<th>Description</th>
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<tr>
<td>Introduction</td>
<td>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.</td>
</tr>
<tr>
<td>The relational model</td>
<td>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.</td>
</tr>
<tr>
<td>Languages: Relational algebra and SQL</td>
<td>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.</td>
</tr>
<tr>
<td>Logical database components</td>
<td>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.</td>
</tr>
<tr>
<td>Data Warehouses and OLAP</td>
<td>Introduction to data warehouses and multidimensional databases. SQL Extensions for OLAP</td>
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<tr>
<td>SQL Programming</td>
<td>Programming in Java and JDBC. Considerations and quality criteria in the design and implementation of programs that access databases.</td>
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<tr>
<td>Introduction to the design of relational databases</td>
<td>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</td>
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</table>
### Transactions and concurrency

**Description:**

### 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:**
- CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
- 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 databases introduction

**Specific objectives:**
3

**Related competencies:**
- CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
- 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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- 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:** 4h
- Theory classes: 1h
- Practical classes: 1h
- Self study: 2h
### Study of the data logical components

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

**Related competencies:**
- CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
- 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
- Theory classes: 2h
- Practical classes: 4h
- Self study: 6h

### Study of the introduction to design of relational databases

**Specific objectives:**
9, 10

**Related competencies:**
- CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
- 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:**
- CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
- 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 design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
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CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
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, 6

Related competencies:
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
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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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: 25h
Laboratory classes: 12h
Self study: 13h
Study of data warehouses and in OLAP

Specific objectives:
6, 7, 8

Related competencies:
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
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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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: 6h
Laboratory classes: 2h
Self study: 4h

Study of stored procedures and triggers

Specific objectives:
3, 4, 6

Related competencies:
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
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.
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: 10h
Laboratory classes: 8h
Self study: 2h
**Programming with SQL - JDBC**

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

**Related competencies:**
- CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
- 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.
- 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:** 12h
Laboratory classes: 6h
Self study: 6h

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**Partial exam**

**Specific objectives:**
1, 2, 3, 4, 6, 7, 9, 10

**Related competencies:**
- CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
- CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
- CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
- 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.
- 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:** 17h
Guided activities: 2h
Self study: 15h
Final Exam

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

Related competencies:
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.
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.
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: 18h
Guided activities: 3h
Self study: 15h

Reviews and resolution of doubts about the exams

Full-or-part-time: 1h
Guided activities: 1h

GRADING SYSTEM

The qualification of the technical competences is based on:

- NL - Active participation in laboratory sessions. The classes in which students have participated will be taken into account in case of successfully submission of the exercises proposed in the class through LearnSQL. The grade will be calculated in proportion to the classes in which the students have actively participated.

- NEP - Partial exam grade. The partial exam includes the topics: 1, 2, 3, 4 (no stored procedures nor triggers), 5 and 7

- NEF - Final exam grade. The final exam includes the following topics: 4 (only stored procedures and triggers), 6, 8 and 9.

\[ NF = 0.45 \times NEP + 0.45 \times NEF + 0.1 \times NL \]

- For students who can take the re-assessment, the re-assessment exam mark will replace NEF and NEP

BIBLIOGRAPHY

Basic:
Complementary: