Course guides
250MUM007 - 250MUM007 - Data Management for Transportation

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 747 - ESSI - Department of Service and Information System Engineering.
Degree: MASTER'S DEGREE IN URBAN MOBILITY (Syllabus 2020). (Optional subject).
Academic year: 2021  ECTS Credits: 4.0  Languages: English

LECTURER

Coordinating lecturer: Jovanovic, Petar

PRIOR SKILLS

Basic knowledge on relational databases and SQL.
- Basic SQL queries
- Familiarity with indexing techniques in DBMS

Basic knowledge on Geographic Information System (GIS)

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE1. Analyze and design mobility and logistics services, or their parts, by applying the methods, techniques and tools that are appropriate for each specific function and objective.
CE4. Apply modeling, optimization and simulation techniques to solve the problems posed by the design, operation and management of mobility.
CE6. Calculate fundamental variables of transport and mobility systems that determine the safety, quality and sustainability of transport infrastructure and optimization of the operation of these systems.

Generical:
CG1. Properly apply mathematical, analytical, scientific, instrumental, technological, information and management knowledge in the field of urban mobility.
CG2. Conduct research, development and innovation in the field of mobility, as well as direct the development of mobility solutions in new or little-known environments, relating creativity, innovation and technology transfer.

TEACHING METHODOLOGY

The teaching methodology includes classical theoretical session on the selected set of course topics, accompanied by the laboratory sessions that allows for putting in practice previously studied theoretical content and the continuous assessment of students throughout the course. In particular, the laboratory sessions will be focused on three main topics blocks (i.e., transportation data modelling, transportation data processing, and transportation data visualization). In each lab topic the students will work in teams, with the possibility of team rotation in every project block, to ensure active participation of all the students. At the end of each laboratory, there will be an evaluation of the team’s joint deliverable and as well of each team member individually (by means of a rapid quiz).
Regarding the study materials, theoretical sessions will be accompanied by the slides and additional written or multimedia content, where needed, and the project sessions will include project statements as well as the technical user guides of the software used in each project block.
LEARNING OBJECTIVES OF THE SUBJECT

The objective of this course is to introduce students to the concepts of database technology and data management in the context of transportation and mobility. More precisely, this includes the introduction to the traditional database theory and relational model for the given context. Furthermore, it tackles in more detail the advanced topics on spatio-temporal and trajectory data management, essential for managing transportation data. A particular focus will be given to the comparative study of traditional (relational) support and recent non-relational (NOSQL) solutions for managing trajectory data. Necessary techniques will be presented to process and prepare transportation data for further use. Finally, the course will also present techniques and solutions for the effective visualisation of transportation data.

As a result, the student should acquire knowledge in order to:
1. Be able to select data management technologies to efficiently serve the specific transportation use case and data characteristics at hand.
2. Be able to model spatio-temporal and trajectory data stores for transportation data.
3. Be able to preprocess and prepare the transportation data for further analysis and/or visualisation.
4. Be able to effectively visualise transportation data.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>15,6</td>
<td>15.60</td>
</tr>
<tr>
<td>Hours small group</td>
<td>7,8</td>
<td>7.80</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>7,8</td>
<td>7.80</td>
</tr>
<tr>
<td>Guided activities</td>
<td>4,8</td>
<td>4.80</td>
</tr>
<tr>
<td>Self study</td>
<td>64,0</td>
<td>64.00</td>
</tr>
</tbody>
</table>

Total learning time: 100 h

CONTENTS

Introduction to Data Management for Transportation

Description:
- Brief introduction to data management (relational databases, SQL)
- Definition of Geograpic Information System (GIS) and its main components
- The importance of (good) data management for transportation
- Transportation data types (spatio-temporal and trajectory data)

Related competencies:
CG2. Conduct research, development and innovation in the field of mobility, as well as direct the development of mobility solutions in new or little-known environments, relating creativity, innovation and technology transfer.
CE1. Analyze and design mobility and logistics services, or their parts, by applying the methods, techniques and tools that are appropriate for each specific function and objective.

Full-or-part-time: 10h
Theory classes: 2h
Self study: 8h
### Modeling Transportation Data

**Description:**
- Spatial data models (object-based, field-based, networks)
- GIS data formats (vector and raster)
- Spatial data types (OGC standard)
- Trajectory representation and storage
- Trajectory data models
- Modeling spatial data warehouse (multidimensional model)

**Related competencies:**
CG1. Properly apply mathematical, analytical, scientific, instrumental, technological, information and management knowledge in the field of urban mobility.
CE6. Calculate fundamental variables of transport and mobility systems that determine the safety, quality and sustainability of transport infrastructure and optimization of the operation of these systems.
CE1. Analyze and design mobility and logistics services, or their parts, by applying the methods, techniques and tools that are appropriate for each specific function and objective.
CE4. Apply modeling, optimization and simulation techniques to solve the problems posed by the design, operation and management of mobility.

**Full-or-part-time:** 24h
- Theory classes: 6h
- Laboratory classes: 4h
- Self study: 14h

---

### Data Processing for Transportation

**Description:**
- Spatial and topological operations
- Spatial querying
  - point and ranges queries, spatial joins, distance-based join queries
- Temporal query processing
- Spatial indexes
  - Space-driven structures (Grid-file, Quadtree, etc.) and data-driven structures (R-tree, etc.)
  - Point access methods and spatial access methods
- The role of the spatial index in the spatial query processing

**Trajectory Data Processing**
- Trajectory pre-processing (cleaning, compression, map-matching, etc.)
- Trajectory querying
- Trajectory indexing

**Related competencies:**
CG1. Properly apply mathematical, analytical, scientific, instrumental, technological, information and management knowledge in the field of urban mobility.
CE6. Calculate fundamental variables of transport and mobility systems that determine the safety, quality and sustainability of transport infrastructure and optimization of the operation of these systems.
CE1. Analyze and design mobility and logistics services, or their parts, by applying the methods, techniques and tools that are appropriate for each specific function and objective.
CE4. Apply modeling, optimization and simulation techniques to solve the problems posed by the design, operation and management of mobility.

**Full-or-part-time:** 28h
- Theory classes: 8h
- Laboratory classes: 4h
- Self study: 16h
GIS in practice

Description:
Management of Big Spatial and Trajectory Data
- Introduction to the V’s of Big Data in the context of Transportation
- Non-relational support for spatial data management
- Distributed spatial and trajectory data management systems
Exploitation and visualisation of transportation data
- GIS Software
Spatial and trajectory dashboards

Related competencies:
CG2. Conduct research, development and innovation in the field of mobility, as well as direct the development of mobility solutions in new or little-known environments, relating creativity, innovation and technology transfer.
CG1. Properly apply mathematical, analytical, scientific, instrumental, technological, information and management knowledge in the field of urban mobility.
CE6. Calculate fundamental variables of transport and mobility systems that determine the safety, quality and sustainability of transport infrastructure and optimization of the operation of these systems.
CE1. Analyze and design mobility and logistics services, or their parts, by applying the methods, techniques and tools that are appropriate for each specific function and objective.
CE4. Apply modeling, optimization and simulation techniques to solve the problems posed by the design, operation and management of mobility.

Full-or-part-time: 24h
Theory classes: 6h
Laboratory classes: 4h
Self study : 14h

Exam

Description:
Written exam of the theoretical concepts introduced along the course.

Full-or-part-time: 14h
Theory classes: 2h
Self study : 12h

GRADING SYSTEM

The course includes continuous assessment through the practical laboratory (L) sessions, in which the students will work in teams. The course as well includes the final exam (E).

The final mark will be calculated as follows:
Final Mark = 40% E + 60% L
BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Hyperlink:
- LearnSQL. https://learnsq12.fib.upc.edu/moodle/