250ST2033 - Advanced Models of Demand

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research
Academic year: 2017
Degree: MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN SUPPLY CHAIN, TRANSPORT AND MOBILITY MANAGEMENT (Syllabus 2014). (Teaching unit Optional)
ECTS credits: 5  Teaching languages: English

Teaching staff

Coordinator: Montero Mercadé, Lidia
Others: Codina Sancho, Esteve

Prior skills

Students must have sufficient knowledge of algebra and mathematical analysis in order to assimilate concepts regarding sets, matrix algebra, numerical series, the functions of real variables in one or more dimensions, derivation and integration. Familiarity with R will be helpful, but is not necessary.
Programming in pseudo code or any high level programming language.
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Familiarity with R will be helpful, but is not necessary.
Programming in pseudo code or any high level programming language.

Degree competences to which the subject contributes

Specific:
CETM3. Knowledge for planning, management and operation of transportation systems and mobility, ability to analyze service levels to users, operating costs and environmental and social such as mass transit, and private vehicle traffic impacts, air transport, sea transport, intermodal transport and urban mobility.
CETM1. Knowledge of the design, planning of transport infrastructure and modal terminals, such as highways, railways, ports, airports, railway stations and transport logistics centers exchange.
CESCTM3. Design and conduct studies demand analysis, demand modeling and structuring for different transport models.
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Teaching methodology

Learning the course consists of three distinct phases:

1. Acquisition of specific knowledge through the study of literature and material provided by teachers.
2. The acquisition of skills in specific techniques of data analysis, exploitation of information and modeling.
3. Integration of knowledge, skills and competencies (specific and generic) by solving case studies.

In theory classes serve to expose the foundations of methodologies and techniques of the subject. The practical classes are useful to learn how to use of specific techniques for model building, using appropriate informatics tools, in this sense, students first must follow and take notes about the analysis carried out by the teacher and then solve in the selflearning hours a similar case study that focuses on the current block/contents and with a questionnaire including the description of the practical application. Case studies have to be solved according to the questionnaire at most in 1 week after the block is completed and due date will be scheduled by the lecturer. Feedback will be provided before 14 days, a discussion about common problems encountered by the teacher will be scheduled lasting 20 min.

For case studies, students are settled into groups of maximum 3 persons, in selflearning hours. Case studies serve to put into practice the knowledge, skills and competences in solving problems provided by the teacher and related to Demand Modeling. R software is the selected statistical tools for data analysis and modeling. Common professional software (TransCAD, EMME4, VISSUM, NLOGIT) capabilities are presented and related to R tools and mlogit package in R. Commercial software use according to available licences at UPC.

Learning objectives of the subject

The purpose of the subject is to provide students with the knowledge and skills to cope with demand modeling arising in the field of Transportation and Logistics. The classical four steps framework for transportation planning is analyzed and related models formulated, estimated and validated supported with statistical tools presented in previous subjects. Demand models presented in this subject fulfill the needs of organizations and professional practice. The course is developed based on solving case studies, after providing key conceptual aspects. Discrete choice models have become an essential tool in modeling individual behavior. The techniques are used in all social sciences, marketing research, transport research, etc., since choice models are used in modeling brand choice in marketing, travel mode choice in transport, and a huge variety of applications in the social and behavioral sciences. The course is divided into 5 areas: Generation/Atraction Models, Distribution Models, Discrete Choice Modeling, Design of Stated Preferences Survey and Static/Dynamic Estimation of Demand Matrices from sensor data. This course will provide a gateway to the professional literature as well as practical application of the methods at the level of common applications in the transportation field.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
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<tbody>
<tr>
<td>Hours large group:</td>
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<tr>
<td>Hours medium group:</td>
</tr>
<tr>
<td>Hours small group:</td>
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<tr>
<td>Guided activities:</td>
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<tr>
<td>Self study:</td>
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<td>0h</td>
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<td>30h</td>
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<td>15h</td>
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## Content

### Block 1. Conceptual 4-stage model in transport studies

**Description:**
The data collection phase and first elements of modeling. Spatial representation and zoning. The role of surveys and sampling. Role models generation / attraction travel. The travel distribution, basic elements of modeling transport networks and the concept assignment

**Specific objectives:**
Knowing the different models within the conceptual framework of four phases of transportation studies.

<table>
<thead>
<tr>
<th>Learning time</th>
<th>5h</th>
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<tbody>
<tr>
<td>Practical classes</td>
<td>2h</td>
</tr>
<tr>
<td>Laboratory classes</td>
<td>1h</td>
</tr>
<tr>
<td>Self study</td>
<td>2h</td>
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</tbody>
</table>

### Block 2. Prediction and estimation of the planning variables

**Description:**
Sources. Predictions related to population and employment. Method cohorts. Lowry model. Predictions regarding the engine and car-park ownership: extrapolations from time series and econometric methods. The issue of value of time: analysis methods. Concept of revealed preference and stated preference

**Specific objectives:**
Being able to identify the main variables that influence the demand for transport and the sources that can supply samples or surveys appropriate for the purposes of a particular study.

<table>
<thead>
<tr>
<th>Learning time</th>
<th>14h</th>
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</thead>
<tbody>
<tr>
<td>Practical classes</td>
<td>4h</td>
</tr>
<tr>
<td>Laboratory classes</td>
<td>2h</td>
</tr>
<tr>
<td>Self study</td>
<td>8h</td>
</tr>
</tbody>
</table>

### Block 3. Models for Trip Generation and Attraction

**Description:**
Type of travel: modes, purposes, and slot type of traveler. Main factors and socioeconomic characteristics affecting production / attraction for travelers and freight movements. Formulation of trip generation / attraction models as general multiple regression models. Regression in terms of area (ZAT) and household level: stratification techniques

**Specific objectives:**
Using statistical techniques suitable for the calibration and validation of models of generation / attraction presented in the course.

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<thead>
<tr>
<th>Learning time</th>
<th>8h</th>
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<tbody>
<tr>
<td>Practical classes</td>
<td>2h</td>
</tr>
<tr>
<td>Laboratory classes</td>
<td>1h</td>
</tr>
<tr>
<td>Self study</td>
<td>5h</td>
</tr>
</tbody>
</table>
Block 4. Trip Distribution Models

Learning time: 30h
- Practical classes: 6h
- Laboratory classes: 3h
- Self study: 21h

Description:

Specific objectives:
- Knowing the distribution models presented in the course and what resources provide the main commercial packages.
- Knowing the advantages and disadvantages of aggregated and disaggregated models.
- Formulate, estimate and validate in the appropriate context for models travel distribution.

Block 5. Modal Choice: Discrete Choice Models

Learning time: 37h
- Practical classes: 7h
- Laboratory classes: 6h
- Self study: 24h

Description:

Specific objectives:
- Formulate, estimate and validate mode choice models
- Meet the commercial packages available for estimating demand models: scope and limitations.
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### Block 6. Demand Estimation using sensor data

<table>
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<tr>
<th>Description:</th>
<th>Learning time: 14h</th>
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</table>
Laboratory classes: 2h  
Self study : 8h |

<table>
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<tr>
<th>Specific objectives:</th>
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<tbody>
<tr>
<td>Learn the basics to make refinements and adjustments of origin-destination matrices using static assignment models for unimodal transport networks and counts provided by sensors. Learn the basics of Kalman filtering for dynamic OD matrix estimation.</td>
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### Quiz and Final Exam

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<tr>
<th>Description:</th>
<th>Learning time: 17h</th>
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| Assessment | Practical classes: 5h  
Self study : 12h |

### Qualification system

Assessment of the course integrates the three phases of learning process: knowledge, skills and competencies.

The knowledge is assessed by one quiz and the final exam (F1 and F2 scores), in the middle and last week of the course.

The skills and competencies are assessed from the delivery of m practices (m=3) based on the provided case studies and related to the contents of the course. Each of the blocks from 3 to 5, might involve a practice that students will perform in group (max 3 per). From the average of the m scores comes out the L score. Students have to quantify the hours addressed to solve each practice. Feedback for formative evaluation will be given by the lecturer at most in 14 days. Common problems and mistakes will be discussed in class.

The final mark will obtained weighing the three scores: Final Mark = 0.55F + 0.45L. Where F is Max(F2, 0.3F1+0.7F2).

### Regulations for carrying out activities

Slides for theory sessions, statistical tables, calculator and manuals for the software packages included in the course are allowed. Resolutions of exams from previous courses are not allowed.
Bibliography

Basic:


Others resources:

Web Page of the Course containing:
- Planning of the subject
- Notes related to block contents and slides presented in theory classes.
- Description of the practical sessions, questionnaires for each block and candidate case studies.
- Case studies: data (R and MS-Excel format) and description of the context and target variable/s.
- Guidelines for case studies are provided in the form of a list of questions guiding the analysis and R scripts to fulfill the analysis.
- Final Exams and Quizzes from previous courses.

Hyperlink

http://www-eio.upc.es/teaching/madt/

MADT Web Page

Computer material

CAMPUS VIRTUAL ATENEA

Tasks - ATENEA Only for Tasks related to Assignments