200608 - SIM - Simulation

Coordinating unit: 200 - FME - School of Mathematics and Statistics
Teaching unit: 715 - EIO - Department of Statistics and Operations Research
1004 - UB - (ENG)Universitat de Barcelona

Academic year: 2017
Degree: MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: Spanish

Teaching staff

Coordinator: JORDI OCAÑA REBULL
Others: Primer quadrimestre:
  LIDIA MONTERO MERCADÉ - A
  JORDI OCAÑA REBULL - A

Prior skills

* Probability, statistical inference and Linear Models
* Some skills in a general purpose programming language, especially an scripting language. Familiarity with the R statistical software environment.

Degree competences to which the subject contributes

Specific:
4. CE-1. Ability to design and manage the collection of information and coding, handling, storing and processing it.
5. CE-2. Ability to master the proper terminology in a field that is necessary to apply statistical or operations research models and methods to solve real problems.
6. CE-3. Ability to formulate, analyze and validate models applicable to practical problems. Ability to select the method and / or statistical or operations research technique more appropriate to apply this model to the situation or problem.
7. CE-6. Ability to use appropriate software to perform the necessary calculations in solving a problem.
8. CE-8. Ability to discuss the validity, scope and relevance of these solutions and be able to present and defend their conclusions.

Transversal:
1. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
2. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
3. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
200608 - SIM - Simulation

Teaching methodology

- Theory and exercises
- Practical sessions
- Guided work

Learning objectives of the subject

Students must acquire the main concepts and skills in Monte Carlo simulation as a tool to investigate statistical methods. Introduction to simulation as an Operation Research approach to work with systems models when a mathematical analytical approach is not available or unpractical. In depth knowledge of the model building process as a tool in decision-making. To obtain a panoramic view of the different approaches to systems simulation, and especially a more in depth vision of discrete systems modeling. To acquire the main concepts and skills in the event-scheduling approach in simulation. Familiarise with the characterisation of stochasticity in modeling input data, random variate generation methods, simulation experimental design and simulation output data analysis.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>30h</th>
<th>24.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>12.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>80h</td>
<td>64.00%</td>
</tr>
</tbody>
</table>
## Content

### Topic 1. Introduction to simulation.

**Learning time:** 14h 30m  
- Theory classes: 3h  
- Laboratory classes: 1h 30m  
- Self study: 10h  

**Description:**  

### Topic 2. Input Data Analysis.

**Learning time:** 21h  
- Theory classes: 4h  
- Laboratory classes: 2h  
- Self study: 15h  

**Description:**  
System analysis: data collection and knowledge acquisition processes. Randomness analysis. Descriptive analysis techniques. Probabilistic hypotheses formulation, simulation models adjustment and validation.

### Topic 3. Samples generation.

**Learning time:** 28h 50m  
- Theory classes: 7h  
- Laboratory classes: 3h 30m  
- Self study: 18h 20m  

**Description:**  

### Topic 4. Introduction to discrete systems simulation.

**Learning time:** 24h  
- Theory classes: 6h  
- Laboratory classes: 3h  
- Self study: 15h  

**Description:**  
**200608 - SIM - Simulation**

**Qualification system**

- 1 midterm exam of topics 1 to 3. It is a qualifying exam.
- 2 practical works, one of them centered on Simulation in Statistics, Bootstrap and Permutation tests, and the other on Systems Simulation.
- 1 final exam, topics 4 and 6 in the case of midterm exam approval, topics 1 to 6 otherwise.

Let "E" be the exams grade (mean of midterm and final grades on the case of approved midterm; only final otherwise) and "T" the works grade. Then, the global grade will be $0.5E + 0.5T$.

**Regulations for carrying out activities**

Midterm exam is a qualifying exam: on approbation, no further examination of these topics is required. Satisfactory delivering of ALL Practical Works is requested to pass.

---

**Topic 5. Design of simulation experiments.**

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>3h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>3h</td>
</tr>
</tbody>
</table>

**Description:**

**Topic 6. An introduction to the bootstrap and to permutation tests**

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>32h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>8h</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>4h</td>
</tr>
<tr>
<td>Self study:</td>
<td>20h</td>
</tr>
</tbody>
</table>

**Description:**

---

**Learning time:**
- **Topic 5:** 3h
  - Theory classes: 3h
  - Laboratory classes: 4h
  - Self study: 20h
- **Topic 6:** 32h
  - Theory classes: 8h
  - Laboratory classes: 4h
  - Self study: 20h

**Description:**
- **Topic 5:** Design of simulation experiments. Finite horizon simulations. Infinite horizon simulations: batch-means techniques, regenerative methods, etc. Variance reduction techniques.
Bibliography

Basic:


Others resources:

Campus virtual