270090 - SIM - Simulation

Coordinating unit: 270 - FIB - Barcelona School of Informatics
Teaching unit: 715 - EIO - Department of Statistics and Operations Research
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits: 6  
Teaching languages: Catalan

Teaching staff

Coordinator: - Josep Casanovas Garcia (josepk@fib.upc.edu)
- Pau Fonseca Casas (pau@fib.upc.edu)

Others: - Joan Garcia Subirana (joan.garcia-subirana@upc.edu)
- Jordi Montero Garcia (monty@fib.upc.edu)

Prior skills

Statistics.

Requirements

- Prerequisite PE

Degree competences to which the subject contributes

Specific:
CES1.1. To develop, maintain and evaluate complex and/or critical software systems and services.

CES2.2. To design adequate solutions in one or more application domains, using software engineering methods which integrate ethical, social, legal and economical aspects.

CT2.1. To demonstrate knowledge and capacity to apply the principles, methodologies and life cycles of software engineering.

CT2.4. To demonstrate knowledge and capacity to apply the needed tools for storage, processing and access to the information system, even if they are web-based systems.

Generical:

G2. SUSTAINABILITY AND SOCIAL COMPROMISE: to know and understand the complexity of the economic and social phenomena typical of the welfare society. To be capable of analyse and evaluate the social and environmental impact.

G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity; capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Teaching methodology

The course is designed taking into account cooperative learning and problem/project-based learning methodologies, complemented with some theoretical sessions intended to develop the set of deliverables with the best guarantees and achievement.
270090 - SIM - Simulation

Learning objectives of the subject

1. Being able to write a technical article and correctly express concepts in English language.
2. Ability to produce a consulting project.
3. Ability to develop a discrete event simulation system study.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>30h</th>
<th>20.00%</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>30h</td>
<td>20.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>3h</td>
<td>2.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>87h</td>
<td>58.00%</td>
</tr>
</tbody>
</table>
### Introduction

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>What is a simulation study? A practical approach by presenting a real project that will allow students to identify the phases that must be followed for the development of a valid and useful simulation study.</td>
</tr>
</tbody>
</table>

### Simulation and Statistical methods

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>Randomness as the cornerstone of modeling and experimentation. Statistical distributions, generation of numbers and random variables. Some known distributions and their application in simulation models. Monte Carlo Methods and simulation sampling process.</td>
</tr>
</tbody>
</table>

### Simulation paradigms.

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>Introduction to the main paradigms in simulation and applicability of them. Introducing Netlogo, a specific IDE based on agents-based models. ABM system development.</td>
</tr>
</tbody>
</table>

### System modeling and related data.

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>How to build a simulation model using specification languages like UML, SDL ... Input data analysis. How to fit empirical data to random distributions.</td>
</tr>
</tbody>
</table>

### Discrete Event Simulation (DES)

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>How a discrete event simulator works, what components are necessary for its development. Integration with third-party applications.</td>
</tr>
</tbody>
</table>

### Verification and validation of simulation models.

| Degree competences to which the content contributes: |
**Description:**
Methodologies to build verified, validated and credible simulation models.

**Experimental design and output analysis.**

**Degree competences to which the content contributes:**

**Description:**
Basic concepts and methods, the design of experiments in simulation: Scenarios and experiments. Results quality.

**Presentation and defense of a simulation study**

**Degree competences to which the content contributes:**

**Description:**
Multidisciplinary and team work. Presentation and defense of a simulation study for a client. Goals definition and results presentation quality, discussion and future work.
## Planning of activities

<table>
<thead>
<tr>
<th>Node</th>
<th>Hours</th>
<th>Theory classes</th>
<th>Practical classes</th>
<th>Laboratory classes</th>
<th>Guided activities</th>
<th>Self study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fonaments bàsics de la simulació</td>
<td>6h</td>
<td>2h</td>
<td>0h</td>
<td>2h</td>
<td>0h</td>
<td>2h</td>
</tr>
<tr>
<td>Description:</td>
<td></td>
<td>Introducció a l'assignatura, exemples de sistemes i de models. Revisió històrica. En aquesta activitat l'estudiant aprendrà les diferents fases associades a un estudi de simulació i l'existència de simuladors específics i genèrics. Motivar a l'alumne i explicar la importància de la disciplina a través d'exemples reals.</td>
<td>Specific objectives:</td>
<td>2, 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aleatorietat i Simulació</td>
<td>14h</td>
<td>4h</td>
<td>0h</td>
<td>4h</td>
<td>0h</td>
<td>6h</td>
</tr>
<tr>
<td>Description:</td>
<td></td>
<td>En aquesta activitat l'estudiant identificarà l'estreta relació entre l'estadística i els seus mètodes i realitzar un estudi de simulació de qualitat.</td>
<td>Specific objectives:</td>
<td>2, 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulació basada en agents</td>
<td>20h</td>
<td>6h</td>
<td>0h</td>
<td>6h</td>
<td>0h</td>
<td>8h</td>
</tr>
<tr>
<td>Description:</td>
<td></td>
<td>Paradigmes de Simulació. L'estudiant aprendrà a utilitzar un IDE específic orientat a modelització basada en agents (ABM), un enfoc a la simulació social, i comprendrà la diferència entre simuladors event-schedulling i time-step</td>
<td>Specific objectives:</td>
<td>2, 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Estudi de Simulació

**Hours:** 16h  
Theory classes: 4h  
Practical classes: 0h  
Laboratory classes: 4h  
Guided activities: 0h  
Self study: 8h

**Description:**  
L'estudiant aprendrà la importància d'establir clarament els objectius i els elements significatius a ser observats, modelats i validats, en l'estudi proposat.  
**Specific objectives:** 1, 2, 3

### Discrete Event Simulation (DES)

**Hours:** 36h  
Theory classes: 6h  
Practical classes: 0h  
Laboratory classes: 6h  
Guided activities: 0h  
Self study: 24h

**Description:**  
Activitat principal del curs que permetrà a l'estudiant assolir els coneixements teòrics que l'ajudin a desenvolupar un simulador específic orientat a esdeveniments discrets.  
**Specific objectives:** 1, 2, 3

### Verificació i Validació de models de simulació

**Hours:** 14h  
Theory classes: 4h  
Practical classes: 0h  
Laboratory classes: 4h  
Guided activities: 0h  
Self study: 6h

**Description:**  
Descriure les tècniques més usuals per poder Verificar i Validar (VV&A) els models de simulació. Es posa èmfasi en la necessitat d'utilitzar aquestes tècniques per tal de poder emprar el simulador amb garanties de qualitat.  
**Specific objectives:** 1, 2, 3

### Disseny d'experiments i Anàlisi de Resultats

**Hours:** 14h  
Theory classes: 4h  
Practical classes: 0h  
Laboratory classes: 4h  
Guided activities: 0h  
Self study: 6h
Writing the final report

**Description:**
Compiling all the information generated during the course and creating the final report.

**Specific objectives:**
2, 3

<table>
<thead>
<tr>
<th>Hours</th>
<th>Theory classes: 0h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 15h</td>
</tr>
</tbody>
</table>

**Qualification system**

The subject follows a continuous evaluation method, with reviews of the work carried out in class and the deliverables of the programmed activities. It requires a continuous involvement of the student in all activities in order to be able to reach the course.

Final grade: $0.1 \times T1 + 0.1 \times T3 + 0.2 \times T2 + 0.3 \times T4 + 0.15 \times T5 + 0.15 \times T6$ requires to pass all the work in order to achieve the subject.

T1: Practical work assessing the ability of the student to perform empirical data analysis.
T2: Practical work assessing the ability of the student to develop an agent-based model and G3.1 competence
T3: Practical work assessing the capacity of reasoning and analysis of the student in front of a project of simulation and the competences G9, CES2
T4: Practical work assessing if the student has assimilated the concept of DES and the competences CT2, CES1 in the development of the case study simulator.
T5: Practical work to assess the technical competence CT2.1
T6: Practical work that evaluating the G2 cross-competence

The qualification NP "did not attend" will be given when the student participates in a number of assessment items with an aggregated weight less than 20% of the final grade.
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

http://www.acm-sigsim-mskr.org/

https://plus.google.com/communities/101706154509075557846

http://www.flexsim.com/

http://www.wintersim.org/