Last update: 20-07-2018

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: 2018

Degree: MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: Spanish

Teaching staff

Coordinator: LIDIA MONTERO MERCADÉ

Others: Primer quadrimestre:
SERGI CIVIT VIVES - A
LIDIA MONTERO MERCADÉ - 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.

Last update: 20-07-2018

200608 - SIM - Simulation

Teaching methodology

-Theory and exercices
-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 especifically 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

Total learning time: 125h	Hours large group:	30h	24.00%
	Hours medium group:	0h	0.00%
	Hours small group:	15h	12.00%
	Guided activities:	0h	0.00%
	Self study:	80h	64.00%

Last update: 20-07-2018

200608 - SIM - Simulation

Content

Topic 1. Introduction to simulation.

Learning time: 14h 30m

Theory classes: 3h
Laboratory classes: 1h 30m
Self study : 10h

Description:
Introduction to Simulation. Its use in Statistics. Its use in Operations Research for System Modeling. Basic use-cases.

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:
Pseudorandom sequences generation. General methods of discrete and continuous random variable generation. Generation of the main univariate distributions. Random vector generation. Stochastic processes generation.

Topic 4. Introduction to discrete systems simulation.

Learning time: 24h

Theory classes: 6h
Laboratory classes: 3h
Self study : 15h

Description:
Simulation models. Discrete and continuous simulation. Theoretic models for discrete system modeling: waiting systems. Stationarity. Little?s formula. Exponential models. GI/G/s models, approximations. System analysis: entities, attributes and relations identification. Simulation models formalization. Discrete systems simulation methodologies, "event-scheduling". Examples and applications.

Last update: 20-07-2018

200608 - SIM - Simulation

Topic 5. Design of simulation experiments.	Learning time: 3h Theory classes: 3h

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

Topic 6. An introduction to the bootstrap and to permutation tests	Learning time: 32h Theory classes: 8h Laboratory classes: 4h Self study : 20h

Description:
Bootstrap, plug-in principle and simulation. Parametric and nonparametric bootstrap. Bootstrap confidence intervals. Permutation tests: exact and Montecarlo. Some permutation tests.

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 globar 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.

Last update: 20-07-2018

200608 - SIM - Simulation

Bibliography

Basic:

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Banks, J. et al. Discrete-event system simulation. Prentice Hall, 2005.

Law, Av.M.; Kelton, W.D. Simulation modeling and analysis. 5th ed. McGraw-Hill, 2014.

Fishman, G.S. Discrete-event simulation modeling, programming and analysis. Springer, 2001.

Robert, C.P.; Casella, G. Monte Carlo statistical methods. 2nd ed. Springer, 2004.

Ross, S.M. Simulation. 4a ed. Academic Press, 2006.

Kroese, Dirk P.; Taimre, Thomas; Botev, Zdravko I. Handbook of Monte Carlo Methods. New Jersey: John Wiley & Sons, 2011. ISBN 978-0-470-17793-8.

Efron, B. and Tibshirani, R. An introduction to the bootstrap. Chapman & Hall, 1993.

Good, Phillip I. Permutation, parametric and bootstrap tests of hypotheses [Recurs electrònic] [on line]. 3rd ed. New York, NY: Springer Science+Business Media, Inc, 2005Available on: <http://dx.doi.org/10.1007/b138696>. ISBN 9780387271583.

Others resources:

Campus virtual