GHENT UNIVERSITY

Course Specifications

From the academic year 2021-2022 up to and including the academic year

Simulation of Stochastic Systems (E005741)

Due to Covid 19, the education and assessment methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h** **Contact hrs** 60.0h

Course offerings and teaching methods in academic year 2021-2022

A (semester 1)	English	Gent	lecture	30.0h
			seminar: coached exercises	10.0h
			group work	20.0h
B (semester 1)	Dutch	Gent	guided self-study	60.0h

Lecturers in academic year 2021-2022

De Vuyst, Stijn	TW18	lecturer-in-charge
Fiems, Dieter	TW07	co-lecturer

Offered in the following programmes in 2021-2022	crdts	offering
Bridging Programme Master of Science in Civil Engineering	6	B
Bridging Programme Master of Science in Industrial Engineering and Operations Research	6	B
Bridging Programme Master of Science in Industrial Engineering and Operations Research	6	A
Master of Science in Civil Engineering	6	B
Master of Science in Industrial Engineering and Operations Research	6	B
Master of Science in Industrial Engineering and Operations Research	6	A

Teaching languages

English, Dutch

Keywords

Discrete-event simulation, modelling, FlexSim, Monte Carlo estimation,variance reduction, ergodicity, regeneration, simulation-based optimisation, output analysis, Markov chain trajectories, perfect simulation

Position of the course

Theoretical aspects concerning the performance evaluation of a system by means of Monte Carlo estimation / stochastic simulation. To teach the students the necessary skills to model company and logistics situations as discrete event systems (DES), implement those models in DES software, how to run experiments and interpret the results.

Contents

Methodology:
- Types of simulation
- Generating random sequences
- Monte Carlo estimation
- Discrete event systems: events, agenda, event handlers
- Variance reduction methods and confidence intervals
- Ergodicity, stationarity, transition period, regeneration
- Perfect simulation
- Simulation-based optimisation methods
- Demonstration of the above principles in Python

Applications:
- Use of DES simulation tool
- Collecting simulation data, processing and correct interpretation
- Conducting case studies: identifying problems and optimising performance

Initial competences

Basic knowledge probability (random variables, joint distributions, moments), stochastic processes (Poisson process) and statistics (sampling)

Final competences

1 Being able to capture a realistic manufacturing, production, logistic,services process or system into an abstract simulation model
2 Having fundamental knowledge of the basic principles and methods concerning Monte Carlo estimation, in particular of how correlation, variance, simulation length and replications influence the reliability (bias, MSE) of the estimation
3 Being able to classify simulation models with regard to ergodicity, stationarity, regenerative properties and adjust the estimation procedure accordingly
4 Know how general discrete-event simulation software works
5 Being able to model and study a realistic system with a general DES simulation tool
6 Being able to interpret simulation results correctly
7 Being aware of the limitations of Monte Carlo simulation: rare events, extremely large state space, etc.
8 Being able to reflect on the value of simulation results for taking optimal design or operational decisions
9 Having knowledge of the most frequently used techniques and algorithms for simulation-based optimisation

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Group work, Guided self-study, Lecture, Seminar: coached exercises

Learning materials and price

Course notes and presentation slide are available electronically

References

- S. Asmussen, P. Glynn. Stochastic simulation: algorithms and analysis. Springer, 2007.
- S.M. Ross. Simulation (4th ed.). Elsevier, 2006.
- K. Borovkov. Elements of stochastic modelling. World Scientific, 2003.
- A.M. Law, W.D. Kelton. Simulation modeling & analysis. Mc-Graw-Hill, 1991.
- G.Ch. Pflug. Optimization of stochastic models: the interface between simulation and optimization. Kluwer, 1996.
- M. Beaverstock et al. Applied simulation: modelling and analysis using FlexSim. FlexSim Software Products, Inc., 2011.

Course content-related study coaching

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written examination

Examination methods in case of periodic assessment during the second examination period

Written examination

Examination methods in case of permanent assessment

Participation, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

Part Methodology: written closed-book exam at the end of the semester (individually). Graded exercises during the semester.
Part Applications: Students are assigned to groups of 3-4 students for exercises and lab work. Graded lab sessions, reports and presentations.

Calculation of the examination mark

50% on the written closed-book exam of the Methodology part
50% on the Applications part together with the exercises of the Methodology part

The final score is the rounded average of the two partial scores, provided both partial scores are 8/20 or more.
When the student obtains less than 8/20 for at least one of the components, they can no longer pass the course unit as a whole. If the total score does turn out to be a mark of 10 or more out of twenty, this is reduced to the highest fail mark (9/20).

Facilities for Working Students

For working students, it may be possible to do the assignments individually and in a modified form.