GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2024-2025

Simulation Modelling and Analysis (F000941)

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

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 2)	English	Gent	group work lecture seminar

Lecturers in academic year 2024-2025

Maenhout, Broos	EB24	lecturer-in-charge

Offered in the following programmes in 2024-2025	crdts	offering
Master of Science in Business Engineering(main subject Data Analytics)	4	A
Master of Science in Business Engineering (Double Degree)(main subject Data Analytics)	4	A
Master of Science in Business Engineering (Double Degree)(main subject Operations Management)	4	A
Master of Science in Business Engineering(main subject Operations Management)	4	A
Exchange programme in Economics and Business Administration	4	A

Teaching languages

English

Keywords

Decision-making under uncertainty, simulation, discrete-event simulation, variance reduction, simulation-based optimisation, Monte-Carlo estimation, Random number generation, Design of Experiments

Position of the course

Managerial decision-making has become an increasingly complex task in today's business environment. The available amount of data based on which decisions can be taken increased exponentially, but entails far more ways in which that information can be incomplete, imprecise, or simply in error w12hich results in data uncertainty and variability. The decision-making process must now increasingly account for imperfect information and/or data uncertainty, which are typically modeled by statistics and probability distributions. As a result, deterministic approaches have significant shortcomings. Rational decision making is only possible if the uncertainty in the source data is both known and incorporated into the decision making process.
This course will introduce students to the means of hedging risks in large managerial decision problems to cope with data uncertainty. More specifically, the students will become acquainted with the main tools that are used in the application of simulation. In addition, the course will cover a set of practical applications where the use of such tools is called for. Applications will be inspired from a diversified range of fields of practice.
Focus: Theoretical foundations concerning the evaluation of processes and systems by means of Monte Carlo estimation and simulation under uncertainty.
Competences are acquired to model complex problems as discrete-event systems by making use of software, perform experiments and interpreting results.
Application of these theories to a complex operational, financial or marketing problem with attention to the setup of the research test design.

Contents

- Characteristics in optimisation models under uncertainty

- Typology of simulation
- Selecting input probability distributions
- Random number generation
- Monte Carlo estimation
- Discrete event systems: incidents, agenda, handlers
- Variance reduction methods and confidence intervals
- Ergodicity, stationarity, transition period, regeneration
- Simulation-based optimisation: Response surface methodology
- Design of experiments: Data gathering, setting up and correct interpretation of results of optimisation and simulation experiments (Comparison design/Screening design/Response surface design)

Initial competences

This course builds on the final competences of the course Operations research, Statistics I (A), Statistics I (B).

Final competences

1 Understand and model a complex operational, financial, marketing problem, process or system under uncertainty in an abstract simulation model.
2 Profound knowledge of the basic principles and methods regarding to Monte Carlo estimations and simulation models.
3 Identify a business management or engineering situation operating under uncertainty.
4 Represent this problem under a suitable simulation model and exploit available historical observations to adequately characterize the uncertainty.
5 Construct a test design to analyse a problem, process or system under uncertainty.
6 Implement and analyse a problem, process or system under uncertainty by means of simulation models.
7 Interpret the simulation results correctly and present them correctly in a written report.

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, Seminar, Lecture

Extra information on the teaching methods

- The theoretical concepts of the courses will be taught through a series of lectures. The theory will then be put into practice in the classroom via the coached exercises through a set of short case studies concerning realistic managerial and business engineering decision problems. The practical PC room classes will teach how the theoretical concepts can be translated into a simulation program via coding.
- The group project will be executed in teams of maximum six students. It will consist of a simulation analysis of the performance of a system under uncertainty. The specific nature of the problem may be based on a real-life environment or based upon the literature. There are in total three different task assignments:
- A task related to Monte Carlo Estimation
- A task related to Markov Chain Trajectories
- A task related to Discrete Event Simulation

The first two tasks are introductory assignments (smaller exercises). The third assignment is a larger project based on real-life. Each group is expected to submit a report at the end of the course.

Study material

Type: Handbook

Name: Simulation modeling & analysis
Indicative price: € 52
Optional: yes
Language : English
Author : Law, A.M. and Kelton, W.D.
Online Available : No

Available in the Library : Yes

Type: Slides

Name: Slides Simulation Modelling and Analysis
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes

Type: Software

Name: Programming software Python/Java/C++
Indicative price: Free or paid by faculty
Optional: no
Available on Athena : Yes
Online Available : Yes

References

A.M. Law, W.D. Kelton. Simulation modeling & analysis. Mc-Graw-Hill, 1991.

Course content-related study coaching

The student can contact the teacher before, during and after each class. They can contact the teacher or assistant using email and the ICT-platform Minerva. There is a weekly consultation hour for additional contact. Further support is available via the ICT- platform Ufora:
- The course slides
- The course schedule
- There is a forum to discuss about the course topics
- Additional exercises and example exam questions
- Intermediate feedback related to the project
- Additional course notes and papers

Assessment moments

end-of-term and continuous assessment

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

Written assessment

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

Written assessment

Examination methods in case of permanent assessment

Peer and/or self assessment, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is not possible

Extra information on the examination methods

End-of-term evaluation (50%)
Written exam (open book) with the following focus:
- Theory: The exam evaluates insight in (the assumptions of) simulation concepts and the relationship between different concepts.
- Exercises: Students should be able to model a complex problem, process or system under uncertainty. Several exam questions are solved during class.

The usage of computers and smartphones is not allowed during examination.
Permanent evaluation (50%)
Written reports as part of a group work where the students will solve a complex problem using techniques:
Task 1: Monte Carlo Estimation (5%)
Task 2: Markov Chain Trajectories (5%)
Task 3: Discrete Event Simulation (40%)
Students will be asked to solve simulation problems via the techniques covered in class. The assessment will be based on a report (one per task) and a peer assessment.

Calculation of the examination mark

Final Mark = End-of-term evaluation (50%) + Permanent evaluation (50%). Students should participate in both forms of examination to pass

the course.

The responsible lecturer retains responsibility for the final evaluation.
Peer assessment is possible at request of the students.

Facilities for Working Students

Recordings of lectures are available for students.