GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2022-2023

Complexity Economics and Agent-Based Modelling (FOOO982)

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

Credits 6.0	**Study time 180 h**	**Contact hrs**	45.0h

Course offerings and teaching methods in academic year 2022-2023

A (semester 2)	English	Gent	guided self-study	5.0h
			seminar: practical PC room classes	30.0h
			group work	10.0h
			lecture	15.0h

Lecturers in academic year 2022-2023

Correa da Rocha, Luis Enrique	EB21	lecturer-in-charge

Offered in the following programmes in 2022-2023	**crdts**	**offering**
Master of Science in Economics	6	A
Exchange programme in Economics and Business Administration	6	A

Teaching languages

English

Keywords

complex systems; complexity economics; computational modelling; agent-based modelling; data visualisation; machine learning; human behaviour; socio-economic systems; Python.

Position of the course

This course introduces fundamental computational tools and algorithms for complexity economics, and aims to guide students in the design and application of computational modelling and data techniques to mechanistically study social and economic problems. The course focuses on topics of agent-base modelling, machine learning and the connection between them for model validation. It provides a gentle introduction to computational modelling techniques, complementing the training in econometrics, statistics, and network science.

Contents

The course covers a spectrum of computational modelling and complex data techniques relevant to study socio-economic systems and validate agent-based models. The course is divided in three parts.
Part 1. Fundamentals of Complexity Economics.
This part introduces elementary concepts related to computational complexity economics. It starts with a gentle introduction to complexity, computational modelling and numerical simulations, followed by the basics of collaborative programming and Python programming language. Methods and computational tools for data processing are also covered.
Part 2. Agent-based Modelling.
This part introduces the framework of agent-based modelling, including the classic models and computational techniques. The concepts of agents, grids, interaction rules, spatial and temporal heterogeneity will be discussed in the context of social and economic problems.
Part 3. Data.
This part introduces fundamental machine learning techniques and algorithms for data analysis and model validation. It builds on previous parts by combining agent-based modelling and data to study complex social and economic systems.

Initial competences

Basic mathematical knowledge (introductory statistics), computer literacy and programming skills.

Final competences

1 Identify and critically analyse socio-economic problems using computational methods
2 Identify mechanisms and design agent-based models of socio-economic systems
3 Design a computational pipeline to study digital and online socio-economic data
4 Design and implement computational complexity economics projects using Python programming language and relevant packages
5 Organise and manage collaborative computational projects
6 Make professional and persuasive computational economics reports, oral presentations, and peer-assessments

Conditions for credit contract

This course unit cannot be taken via a credit contract

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Group work, Guided self-study, Lecture, Seminar: practical pc room classes

Extra information on the teaching methods

Enquiry-based learning. Teaching and learning are student-centred and based on social constructivism. Lectures and workshops include group work, and workshops include guided self-study.

Learning materials and price

- L Hamill & N Gilbert (2016) Agent-Based Modelling in Economics. Wiley.
Available for purchase 55 EUR.
- W McKinney (2017) Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. 2nd Edition. O'Reilly.
Available for purchase 41 EUR.
- DataCamp (2021). Python tutorial.
Freely available at: http://www.learnpython.org (Accessed 10.06.2021)
- Mesa: Agent-based modelling in Python 3+ Documentation & Tutorial (2021)
Freely available at https://mesa.readthedocs.io/en/stable/ (Accessed 10.06.2021)
- Scikit-learn Documentation & Tutorial (2021)
Freely available at https://scikit-learn.org/stable/tutorial/basic/tutorial.html (Accessed 03.11.2021)
- Pandas Documentation & Tutorial (2021)
Freely available at https://pandas.pydata.org/docs/ (Accessed 10.06.2021)
- Slides will be available online (UFora)
- Python notebooks will be available online (UFora)

References

- L Hamill & N Gilbert (2016) Agent-Based Modelling in Economics. Wiley.
- E Bonabeau (2002) Agent-based modeling: Methods and techniques for simulating human systems. Proceedings of the National Academy of Sciences 99:7280-7287
- W McKinney (2017) Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. 2nd Edition. O'Reilly.
- A C Müller & S Guido (2017) Introduction to Machine Learning with Python: A guide for data scientists. O'Reilly.
- C N Knaflic (2015) Storytelling with Data: A Data Visualization Guide for Business Professionals. Wiley.
- Google Education (2019). Introduction to Python.
Freely available at: http://developers.google.com/edu/python/ (Accessed 10.06.2021)

Course content-related study coaching

Interactive online counselling (email), individual and group support via appointment.

Assessment moments

continuous assessment

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

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

Examination methods in case of permanent assessment

Oral examination, Peer assessment, 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

a. 1st summative assessment around week 6
b. 2nd summative assessment around week 12
c. 3rd summative assessment around week 12

1st assignment

Individual report, Word length: 2500 words (without counting bibliography, 10% tolerance, plus figures)
Brief description: Each student will develop an agent-based model to study a real-world socio-economic problem. S/he will design and implement the model computationally and make a critical analysis to get socio-economic insights. S/he will write a professional report containing, at least: i. description and justification of the model; ii. Quantitative analysis of simulations; iii. Socio-economic insights. S/he must provide a Jupyter notebook with codes as appendix.

2nd assignment

Group presentation, approx. 15 min presentation + approx. 10 min Q&A per group
Brief description: Students will build up on the previous assessment and in a small group will develop advanced data analyses using a real-world socio-economic data set. They will apply analytic methods and make a critical analysis to get socio-economic insights from data. They will deliver a professional presentation containing, at least: i. a description of the data; ii. justification of chosen methods; iii. data analysis; iv. evidence-based insights. The group must provide a Jupyter notebook with codes.

3rd assignment

Individual peer assessment, Word length: 700 words (without counting bibliography, 10% tolerance)
Brief description: Each student will make a critical professional assessment of the presentation and technical aspects of one other group.

Calculation of the examination mark

a. 1st summative assessment around week 6
b. 2nd summative assessment around week 12
c. 3rd summative assessment around week 12
Final mark = a*0.4 + b*0.4 + c*0.2
- The pass mark is 50 for all parts of the assessment.
- Active participation in the group project and presentation is mandatory. If not, individual marks can be reduced.
- Deadlines must be respected. If not, marks can be reduced.

Facilities for Working Students

Lab attendance is not mandatory. Online feedback.