GHENT UNIVERSITY

# Course Specifications

Valid as from the academic year 2024-2025

## Complexity Economics and Agent-Based Modelling (FOOO982)

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

**Credits 6.0** **Study time 180 h**

**Course offerings and teaching methods in academic year 2024-2025**

| | | | |
|---|---|---|---|
| A (semester 2) | English | Gent | group work<br>lecture<br>independent work<br>seminar |

**Lecturers in academic year 2024-2025**

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

| **Offered in the following programmes in 2024-2025** | **crdts** | **offering** |
|---|---|---|
| Master of Science in Economics | 6 | A |
| Master of Science in Economics (Double Degree) | 6 | A |
| Master of Science in Physics and Astronomy | 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-based modelling, regression 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 complex systems, computational modelling and numerical simulations, followed by the basics of Python programming language. Some 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 regression techniques for data analysis, combining agent-based modelling and data to study complex social and economic systems.

**Initial competences**

Strong quantitative mindset, mathematical knowledge of probability and statistics, including probability distributions/histograms, matrices, vectors, computer literacy, and familiarity (basic

to medium level) with one advanced computer programming language (e.g. Python, R, C/C++, Matlab, Java, or Scilab). Willingness to learn Python at basic level is expected. Consult the course instructor to clarify expectations regarding the expected technical knowledge.

**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 and implement computational complexity economics projects using Python programming language and relevant packages
4 Organise and manage collaborative computational projects
5 Make professional and persuasive computational economics reports, oral presentations, and peer-assessments

**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, Independent work

**Extra information on the teaching methods**

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

**Study material**

Type: Handbook

Name: Agent-based Modelling in Economics. John Wiley & Sons
Indicative price: € 55
Optional: no
Language : English
Author : Lynne Hamill, Nigel Gilbert
ISBN : 978-1-11894-552-0
Number of Pages : 246
Online Available : Yes
Available in the Library : Yes
Available through Student Association : No
Usability and Lifetime within the Course Unit : one-time
Usability and Lifetime within the Study Programme : one-time
Usability and Lifetime after the Study Programme : occasionally
Additional information: This book is mandatory for the 1st assignment. Available online for free.

Type: Handbook

Name: Introduction to Scientific Programming with Python. SpringerOpen
Indicative price: Free or paid by faculty
Optional: no
Language : English
Author : Joakim Sundnes
ISBN : 978-3-03050-356-7
Number of Pages : 157
Online Available : Yes
Available in the Library : No
Available through Student Association : No
Usability and Lifetime within the Course Unit : regularly
Usability and Lifetime within the Study Programme : regularly
Usability and Lifetime after the Study Programme : regularly
Additional information: This book is freely available online

Type: Slides

Name: Lecture Slides
Indicative price: Free or paid by faculty
Optional: no
Language : English
Number of Slides : 10
Available on Ufora : Yes

Online Available : Yes
Available in the Library : No
Available through Student Association : No
Additional information: Slides available before the Lecture. Slides cannot be shared without prior approval by the course leader.

Type: Other

Name: Python notebooks
Indicative price: Free or paid by faculty
Optional: no
Additional information: Python notebooks with lab exercises. They must not be distributed without prior approval by the course leader.

**References**

- L Hamill & N Gilbert (2016) Agent-Based Modelling in Economics. Wiley.
- C N Knaflic (2015) Storytelling with Data: A Data Visualization Guide for Business Professionals. Wiley.
- J Sundness (2020). Introduction to Scientific Programming in Python. SpringerOpen

**Course content-related study coaching**

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 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**

a. 1st summative assessment around week 6
b. 2nd summative assessment around week 12
c. 3rd summative assessment around week 13

**1st assignment**
Individual presentation
Brief description: Mini-lecture

**2nd assignment**
Group presentation
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.

**3rd assignment**
Short report
Brief description: Each student will write a short-report (extended abstract) of the project of the 2nd assignment.

**Calculation of the examination mark**

Final mark = a*0.4 + b*0.4 + c*0.2
- The pass mark is 10 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.