

## Networks in Socio-Economic Systems (F000920)

**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

lecture

seminar

**Lecturers in academic year 2024-2025**

Correa da Rocha, Luis Enrique

EB21

lecturer-in-charge

**Offered in the following programmes in 2024-2025**

	<b>crdts</b>	<b>offering</b>
Master of Science in Business Economics (main subject Accountancy)	6	A
Master of Science in Business Economics (Double Degree)(main subject Accountancy)	6	A
Master of Science in Business Economics (Double Degree)(main subject Corporate Finance)	6	A
Master of Science in Business Economics (main subject Corporate Finance )	6	A
Master of Science in Business Engineering(main subject Data Analytics)	6	A
Master of Science in Business Engineering (Double Degree)(main subject Data Analytics)	6	A
Master of Science in Business Engineering (Double Degree)(main subject Finance)	6	A
Master of Science in Business Engineering(main subject Finance)	6	A
Master of Science in Business Economics (Double Degree)(main subject Marketing)	6	A
Master of Science in Business Economics (main subject Marketing)	6	A
Master of Science in Business Engineering (Double Degree)(main subject Operations Management)	6	A
Master of Science in Business Engineering(main subject Operations Management)	6	A
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; complex networks; social networks; human behaviour; socio-economic systems; data science; data analytics; modelling; agent-based.

**Position of the course**

This methodological and interdisciplinary course introduces fundamental and state-of-the-art network science tools, and aims to guide students in the application of network modelling and network analytics to real-world data to study socio-economic problems from a system's perspective, e.g. social and communication networks, interbank lending, trade and transportation networks, innovation, collaboration, opinions, migration, mobility, among others.

**Contents**

The course covers a spectrum of network data modelling and analytic quantitative techniques relevant to study socio-economic systems. The course is divided in three parts.

**Part 1. Fundamentals of Network Science.**

This part introduces elementary mathematical and computational network methods and concepts such as network modelling, data representation, and network visualisation. It also introduces elementary algorithms to extract information from network data, e.g. node degree, clustering, motifs, paths, centrality, core-periphery, assortativeness.

### **Part 2. Processes on Networks.**

This part introduces techniques to model dynamic processes on networks, as for example diffusion of information (e.g. opinions, rumours), epidemics, network attacks, failures and cascades.

### **Part 3. Advanced Network Analytics.**

This part introduces advanced analytic methods, e.g. community detection, temporal networks, and network sampling.

#### **Initial competences**

A strong quantitative mindset, mathematical knowledge of probability and statistics, including probability distributions/histograms, matrices, vectors, differential equations, computer literacy (i.e. use of Windows, MacOS, or Linux), and familiarity (basic to medium level) with one computer programming language (e.g. Python, R, C/C++, Matlab, Java, or Scilab). Willingness to learn Python (basic to medium level) is fundamental since the labs use Python. Consult the course-leader for clarifications about the expected technical background.

#### **Final competences**

- 1 Identify and critically analyse socio-economic problems from a system's perspective.
- 2 Select network methods for a particular network data analytics task.
- 3 Implement a network data analysis project using network tools in Python.
- 4 Manage collaborative data analysis projects
- 5 Presenting professional and convincing data analytics reports.
- 6 Reflecting on own learning process and that of peers.

#### **Conditions for credit contract**

Access to this course unit via a credit contract is unrestricted: the student takes into consideration the conditions mentioned in 'Starting Competences'

#### **Conditions for exam contract**

Access to this course unit via an exam contract is unrestricted

#### **Teaching methods**

Seminar, Lecture

#### **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. Journal club, discussions, peer-assessment

#### **Study material**

Type: Handbook

Name: Networks: An Introduction. Oxford University Press

Indicative price: € 65

Optional: yes

Language : English

Author : Mark Newman

ISBN : 978-0-19880-509-0

Number of Pages : 780

Online Available : Yes

Available in the Library : Yes

Available through Student Association : No

Usability and Lifetime within the Course Unit : regularly

Usability and Lifetime within the Study Programme : one-time

Usability and Lifetime after the Study Programme : occasionally

Additional information: This is one of the recommended textbook for ambitious students

Type: Handbook

Name: Introduction to Scientific Programming in 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: Freely available online

Type: Handbook

Name: A First Course on Network Science. Cambridge University Press  
Indicative price: € 45  
Optional: yes  
Language : English  
Author : F Menczer, S Fortunato, C A Davis  
ISBN : 978-1-10847-113-8  
Number of Pages : 300  
Online Available : No  
Available in the Library : Yes  
Available through Student Association : No  
Usability and Lifetime within the Course Unit : regularly  
Usability and Lifetime within the Study Programme : one-time  
Usability and Lifetime after the Study Programme : occasionally  
Additional information: The textbook is not mandatory but highly recommended.

Type: Slides

Name: Lecture slides  
Indicative price: Free or paid by faculty  
Optional: no  
Language : English  
Number of Slides : 12  
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 available before the Lab. They cannot be shared without prior approval by the course leader.

## References

- **F Menczer, S Fortunato, C A Davis (2020). A First Course on Network Science. Cambridge University Press**
- A-L Barabasi (2016). Network Science. Cambridge University Press, UK. ISBN 1107076269
- MO Jackson (2010). Social and Economic Networks. Princeton University Press, USA. ISBN 0691148201
- D Easley and J Kleinberg (2010). Networks, Crowds, and Markets: Reasoning about a Highly Connected World. Cambridge University Press, UK. ISBN 0521195330
- 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. 1<sup>st</sup> summative assessment after the 1<sup>st</sup> part of the course (around week 7)
- b. 2<sup>nd</sup> summative assessment after the 3<sup>rd</sup> part of the course (around week 12)
- c. 3<sup>rd</sup> summative assessment after the 3<sup>rd</sup> part of the course (around week 13)

Final mark =  $a*0.5 + b*0.3 + c*0.2$

Further information can be found on Ufora.

**Calculation of the examination mark**

Final mark =  $a*0.5 + b*0.3 + c*0.2$

- The pass mark is 10 for all assessments.
- 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.