Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	**Network Thinking and Agent-based modeling**
Course code	27508
Scientific sector	Secs-P/08
Degree	Master in Data Analytics for Economics and Management – Curriculum Business Analytics
Semester and academic year	2nd semester, a.y. 2024/25
Year	1st study year
Credits	6
Modular	No
Total lecturing hours	36
Total lab hours	Not foreseen
Total exercise hours	Not foreseen
Attendance	Not required
Prerequisites	Not foreseen
Course page	Master in Data Analytics for Economics and Management / Free University of Bozen-Bolzano (unibz.it)
Specific educational objectives	Network thinking and agent-based modeling (ABM) are ways to conceptualize complexity in the phenomena we observe. The main objective is to approach different phenomena with a complexity lens and understand how current behaviors and patterns emerge using network models and agent-based models. In this regard, network and agent-based models provide the logic to tackle the complexity of adaptive systems, in the context of business (e.g. innovation and entrepreneurship). The lecturer will introduce the students to the specific approaches and to a computing environment for network and agent-interaction simulation to describe and analyze data related to open innovation phenomena. The application of complexity and simulation on applied projects will be introduced. This course develops advanced representations of different types of data commonly used in the economic and/or business fields, knowledge of statistical and mathematical tools for the analysis of data under conditions of uncertainty, including large network data sets.

	It also develops advanced data analysis approaches to improve the quality of forecasts to support decision-making processes in companies as well as skills related to the presentation and visualization of results. Finally, it develops skills for the inclusion in interdisciplinary groups in economic-financial institutions and private companies.

Lecturer	Roberto Gabriele Roberto Gabriele / Free University of Bozen-Bolzano (unibz.it)
Scientific sector of the lecturer	Business Economics SECS-P/06
Teaching language	English
Office hours	Please refer to the lecturer's web page
Lecturing assistant	Not foreseen
Teaching assistant	Not foreseen
Office hours	18 Hours My SNS - MY Timetable
List of topics covered	• Introduction to systems and complexity • Introduction to networks • Introduction to agent-based modeling • Modeling Diffusion dynamics • Application of complexity on timely topics such as sustainability
Teaching format	Frontal lectures, combined with laboratory sessions in which students develop and implement models.

Learning outcomes	1) **Knowledge and understanding** This course will provide knowledge and understanding of models useful for the quantitative analysis and visualization of complex adaptive systems, social and business networks studying their properties, and how patterns are emerging in systems in the context of innovation and entrepreneurship. 2) **Ability to apply knowledge and understanding** During this course, students will be given a framework with which they will be able to apply and implement agent-based modeling and network analysis techniques focusing on different types of datasets including network companies, social networks of innovators or networks of consumers.

	With this approach, students will be able to critically assess and judge different phenomena given the complexity and aid business decision-making. Students will strengthen further their computing abilities by applying agent-based and network modeling via the NetLogo program and the R computing environments, which are widely used and useful to further simulate and exp network and agent-based models. 3) **Making judgements** Students will have the ability to apply the acquired knowledge to interpret business network data in order to make managerial and operational decisions in an economic-business context as well as to support processes related to production, management and business promotion activities, through the organization, analysis and interpretation of complex databases. The achievement of these objectives takes place through the analysis of case studies, projects and reports. 4) **Communication skills** Students will be able to effectively communicate the specialized contents of the individual disciplines in oral and written form through the discussion of case studies during interactive lessons which include group discussions. 5) **Learning skills** Students will acquire the ability to identify connections and to establish relationships between methods of analysis and business application context, to frame the problem object of the study and to implement suitable analysis solutions.
Assessment	There are no differences between attending and non-attending students. Project work and final written exam. The final written exam will contain conceptual questions concerning theoretical topics and/or short applications of the studied methods. The project work will be organized in groups. A data analysis project will be assigned to each group and the results of the project will be discussed during a final presentation. The final exam is aimed at verifying skill 1 (Knowledge and understanding). The project work allows to verify skills 2, 3 and 4 (Applying knowledge and understanding, Making judgements, Communication skills). The skill concerned with autonomous study (5, Learning skills) is indirectly

	verified, because passing the final exam is possible by the autonomous execution of exercises suggested by the lecturer as homework.
Assessment language	English
Evaluation criteria and criteria for awarding marks	Project work including final presentation: 30% Final exam 70% **Assessment criteria**: clarity of the project work and presentation, correct application of the modeling framework and simulation approach, show critical views on the topic of the project work, sound argumentations.

Required readings	• *Arthur, W.B., 2021. Foundations of complexity economics. Nature Reviews Physics, 3(2), pp.136-145.* • *Holland, J.H., 2014. Complexity: A very short introduction. Oxford.* • *Kolaczyk, Eric D., and Gábor Csárdi. Statistical analysis of network data with R. Vol. 65. New York: Springer, 2014.* • *Newman, M., 2018. Networks. Oxford university press.* • *Wilensky, U., & Rand, W. (2015). An introduction to agent-based modeling: modeling natural, social, and engineered complex systems with NetLogo. Mit Press.*
Supplementary readings	• Arthur, W.B., 1999. Complexity and the economy. science, 284(5411), pp.107-109. • Bocken, Nancy MP, Ingrid De Pauw, Conny Bakker, and Bram van der Grinten. "Product design and business model strategies for a circular economy." Journal of Industrial and Production Engineering 33, no. 5 (2016): 308-320. • Carayannis, E.G., Grigoroudis, E., Campbell, D.F., Meissner, D. and Stamati, D., 2018. The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models. R&D Management, 48(1), pp.148-162. • Clift, Roland, and Angela Druckman, eds. Taking stock of industrial ecology. Springer, 2015. • De Jesus, Ana, and Sandro Mendonca. "Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy." Ecological economics 145 (2018): 75-89. • Garcia, R., 2005. Uses of agent-based modeling in innovation/new product development research. Journal of Product Innovation Management, 22(5), pp.380-398. • Gilbert, N., Ahrweiler, P. and Pyka, A. eds., 2014. Simulating knowledge dynamics in innovation networks. Heidelberg: Springer. • Inigo, Edurne A., and Laura Albareda. "Understanding

sustainable innovation as a complex adaptive system: a systemic approach to the firm." Journal of Cleaner Production 126 (2016): 1-20.
- Kirchherr, Julian, Denise Reike, and Marko Hekkert. "Conceptualizing the circular economy: An analysis of 114 denitions." Resources, conservation and recycling 127 (2017): 221-232.
- Mitchell, M., 2009. Complexity: A guided tour. Oxford university press.
- Nowak, A., Szamrej, J. and Latané, B., 1990. From private attitude to public opinion: A dynamic theory of social impact. Psychological review, 97(3), p.362.
- Phelps, C., Heidl, R. and Wadhwa, A., 2012. Knowledge, networks, and knowledge networks: A review and research agenda. Journal of management, 38(4), pp.1115-1166.
- Railsback, Steven F., and Volker Grimm. Agent-based and individual-based modeling: a practical introduction. Princeton university press, 2019.
- Rogers, E.M., 2010. Diffusion of innovations. Simon and Schuster.
- Schelling, T. C. "Dynamic models of segregation." Journal of mathematical sociology 1, no. 2 (1971): 143-186.
- Schelling, T.C., 1969. Models of segregation. The American Economic Review, 59(2), pp.488-493.
- Snowden, D., 2003. Innovation as an objective of knowledge management. Part I: The landscape of management. Knowledge Management Research & Practice, 1(2), pp.113-119.
- Stahel, Walter R. "The circular economy." Nature 531, no. 7595 (2016): 435-438.
- Zink, Trevor, and Roland Geyer. "Circular economy rebound." Journal of Industrial Ecology 21, no. 3 (2017): 593-602.

Additional materials and slides will be distributed during the course.