GESIS Spring Seminar 2022: Simulation Techniques in the Social Sciences

Syllabus for week 1: “Agent-based Modelling in the Social Sciences"

Lecturers: Prof. Dr. Andreas Flache Carlos de Matos Fernandes (M.Sc.) Tanzhe Tang (M.Sc.)
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Date: 07-11 March 2022
Time: 09:30 - 12:30 lectures. Lunch break 12:30-14:00. Hands-on tutorial sessions 14:00-17:00. Time for individual consultation 17:00-17:45 or on individual appointment. All online sessions will have regular short breaks.
Time zone: CEST/CEDT
Venue: Online via Zoom

About the Lecturers:

Andreas Flache is professor of sociology at the University of Groningen in the Netherlands. His research addresses intergroup relations in a diverse society, opinion dynamics, cooperation problems, social networks, and social learning. Andreas uses agent based computational and game theoretical modeling, laboratory experiments, and network research. He leads externally financed research projects in these areas. Andreas published in social science journals like American Journal of Sociology, Journal of Conflict Resolution, Organization Science, as well as in multidisciplinary journals like the Proceedings of the National Academy of Sciences or Science, and specialized journals like Sociology of Education, Rationality and Society, or Journal of Mathematical Sociology. He holds a master’s degree in Computer Science and a PhD in Social Sciences.
For more information see: https://flache.gmw.rug.nl/
Google scholar: https://scholar.google.nl/citations?user=dt9jPJ0AAAAJ&hl=en

Carlos de Matos Fernandes is a PhD student at the department of Sociology and the Interuniversity Center for Social Science Theory and Methodology (ICS) at the University of Groningen in the Netherlands. His PhD project revolves around cooperation and how individual-level features, such as social value orientations, and personality traits, as well as social mechanisms, such as meritocratic matching, social learning, and selection, jointly affect cooperation levels both on the individual and collective level. Carlos studies these processes by means of agent-based modeling and social network analysis.
For more information see: https://www.rug.nl/staff/c.a.de.matos.fernandes/
Google scholar: https://scholar.google.nl/citations?hl=en&pli=1&user=AvGDOBAAAAJ

Tanzhe Tang is a Postdoctoral researcher at the Faculty of Behavioural and Social Sciences at the University of Groningen in the Netherlands. His research interest is opinion dynamics, agent-based modelling, and complex systems. In particular, he works on the relations between opinion and behaviour and how this is related to opinion polarization. Recent work has been published in, among others, the Journal of Mathematical Sociology and the Journal of Artificial Societies and Social Simulation.

Course Description:
Agent-based computational modeling (ABCM, or often just ABM) increasingly attracts social scientists as a tool for unravelling the complex dynamics which often underlie puzzling social phenomena such as segregation, cultural diversity, opinion polarization, or collective action. ABCM is an approach for theory elaboration that combines analytic precision, ability to capture complex micro-macro interactions in a computational model, and flexibility to accommodate empirically realistic assumptions. This course gives an introduction to ABCM for social scientists,
focusing on its use for theory building and on best practices for systematic experimentation and analysis of models. In tutorials accompanying the lectures, participants get a “hands-on” introduction to software tools specifically designed for ABCM of complex (social) dynamics. Participants learn to build ABCM from scratch for a range of core domains in the social sciences, including segregation, cooperation, cultural diversity, and opinion polarization and how to systematically experiment with these models for gaining a deep understanding of them. Throughout the lectures, “classical” and more recent ABCM will be introduced and explained, while participants learn to work, experiment, and extend these models in tutorial sessions. Participants will specifically work with two software tools: NetLogo, a widely used software and defSim, a new Python-based tool for modelling social influence dynamics.

Keywords:
Agent-based computational modelling, social complexity, NetLogo, segregation, polarization, cooperation

Course Prerequisites:
▪ Interest in and affinity with formal (computational, mathematical) modelling of social processes
▪ Master, research-master, PhD-student or postdoctoral level in a social science discipline or related disciplines
▪ No specific prior programming programing experience required
▪ Affinity with formalizing social-scientific theories is desirable

Target Group:
Participants will find the course useful if:
▪ Master, research-master or PhD-student level in a social science discipline or related disciplines.
▪ Affinity with formalizing social-scientific theories

Course and Learning Objectives:
By the end of the course participants will:
▪ Understand the use of ABCM for analysing complex social processes
▪ Understand the concept of social complexity and its relation to ABCM
▪ Know and understand the substantive problems, theories and classical as well as recent related computational models in a number of core areas of social scientific research (e.g., segregation, diversity, polarization, cooperation)
▪ Be able to build ABCM models tackling these phenomena from scratch, using NetLogo or defSim (a tool based on Python)
▪ Be able to apply a set of good practices for developing a deep understanding of complex social dynamics through systematic experimentation with ABCM.
▪ Be able to reflect upon the strength and pitfalls of ABCM as a tool for theory development in the social sciences.

Organisational Structure of the Course:
Course structure: there will be about three hours of classroom instruction and about three hours of hands-on tutorials and exercises per day. The lectures will introduce and explain the theory and methods in ABCM research, substantive problem areas in the social science literature and the specific ABCM and their contribution to scientific insight per domain. In the tutorials, participants are expected to work individually or in small groups on building from scratch, applying and extending ABCM for specific research questions discussed in the lectures. They will work based on template models and instructional material provided by the lecturers. Tutors experienced with the software tools (NetLogo, defSim) and sample models will provide hands-on guidance and supervision.

Depending on interest of the students, some time can be made available for consultation on students’ own ABCM projects.
Software requirements:

Participants will need to use their own computers for purposes of conducting exercises. The following programs will be used, one of which has to be installed before the workshop:

**NetLogo**, most recent version, freely available at [https://ccl.northwestern.edu/netlogo/download.shtml](https://ccl.northwestern.edu/netlogo/download.shtml). Participants should install NetLogo on their machines prior to the workshop.

**defSim** (open source, based on Python, can be used with google colab, [colab.research.google.com/](https://colab.research.google.com/)). See further [https://defsim.github.io/defSim/](https://defsim.github.io/defSim/). No pre-installation needed.

Recommended Literature to look at in advance:

No specific recommendations. Participants are encouraged to read the required readings of day 1 in advance.

Day-to-day schedule and literature:

**Day 1: General introduction: Agent-based modelling and social complexity**

- Agent-based computational modelling in the social sciences
- Theoretical foundations: micro-macro perspective, analytical sociology and social complexity
- Examples of complex social phenomena: e.g. segregation, cultural dynamics, polarization
- Tutorial session (afternoon): Participants will be introduced to NetLogo, practice with coding in the NetLogo environment, and already build, analyze, and extend an ABCM of segregation from scratch.

*Literature:*


*Suggested reading:*


**Day 2: Developing theoretical explanations of empirical phenomena with ABM: good practices**

- Adding realism: systematic model analysis and experimentation
- Good practices in analysing ABM
- Using discrete choice models to bridge ABM and choice data
- Problems and pitfalls
- Tutorial sessions (afternoon): “injecting realism” stepwise, implementing and analysing ABCM with discrete choice models [NetLogo]. Time permitting, students can be introduced to working with several NetLogo models from the literature (see e.g. Sage & Flache 2021 or Manzo et al, 2018).

*Literature:*


Sage, L., & Flache, A. 2021. Can ethnic tolerance curb self-reinforcing school segregation? A theoretical Agent Based Model. Journal of Artificial Societies and Social Simulation 24 (2) 2. [http://jasss.soc.surrey.ac.uk/24/2/2.html](http://jasss.soc.surrey.ac.uk/24/2/2.html)
Suggested readings:

Day 3: Cooperation, learning, and social control
- The problem of cooperation
- Modelling the emergence of cooperation: evolutionary models and learning models
- Social control and cooperation
- The weakness of strong ties
- Potentials and pitfalls of “meritocratic matching” as solution for the problem of cooperation
- Tutorial session: Students will learn to work with and understand NetLogo implementations of representative models from the literature, including models of learning in PD games, cooperation in spatial contexts and models of the emergence, effects and pitfalls of solutions to the problem of cooperation, like social control or meritocratic matching.

Literature:

Suggested readings:

Day 4: Modelling social influence: consensus, diversity, and polarization
- The problem of explaining opinion diversity and polarization
- ABCM of the emergence of opinion diversity
- ABCM identifying conditions and mechanisms of polarization
- Spatial segregation and opinion polarization: two sides of the same coin?
Tutorial session: building from scratch and modifying social influence models of cultural diversity and polarization from the literature with defSim / Python. Learning to conduct simulation experiments with defSim / Python.

**Literature:**


Suggested readings:


Mäs, M., M. Keijzer. 2021. The complex link between filter bubbles and opinion polarization. Accepted for publication in *Data Science* (671-1651).

**Day 5: Social influence dynamics in online settings**

- Do social media promote polarization … or not? And if so, under which conditions?
- Modelling effects of “globalizing interaction” on polarization and consensus
- Effects of the mode of communication: 1:1 vs many:1 interaction (offline vs. online communication)
- Modelling the effects of social bots on polarization: the strength of weak bots
- Linking models to data: online experiments, digital trace data
- Concluding discussion: benefits and challenges of ABM as tool for advancing social science theory building.
- Tutorial session: using defSim to model online social influence dynamics.

**Literature:**


Mäs, M., M. Keijzer. 2021. The complex link between filter bubbles and opinion polarization. Accepted for publication in *Data Science* (671-1651).

**Suggested readings:**


Additional Recommended Literature:

*Modelling social network dynamics with (empirically calibrated) stochastic actor oriented models*


See further material on the website of Tom Snijders: [https://www.stats.ox.ac.uk/~snijders/siena/](https://www.stats.ox.ac.uk/~snijders/siena/).

*On the history of segregation models:*


*ODD protocols for ABMs (standard for reporting ABM):*


*Selected textbooks:*

