

GESIS Spring Seminar 2022: Simulation Techniques in the Social Sciences

Syllabus for week 2: “Policy Modelling”

Lecturers: Prof. Dr. Petra Ahrweiler Dr. Corinna Elsenbroich
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Date: 14-18 March 2022
Time: 10:00-13:00 +14:00-17:00
Venue: Online via Zoom

About the Lecturers:

Since 2013, **Prof. Dr. Petra Ahrweiler** is Full Professor of Sociology of Technology and Innovation, Social Simulation, at Johannes Gutenberg University Mainz, Germany. Her appointment at JGU started in 2013 with getting leave for obtaining the position of Director and CEO at the EA European Academy of Technology and Innovation Assessment in Bad Neuenahr-Ahrweiler, Germany, until 2017. Before 2013, she had been Full Professor of Technology and Innovation Management at Michael Smurfit School of Business, University College Dublin, Ireland, and Director of its Innovation Research Unit IRU. Furthermore, she was Research Fellow of the Engineering Systems Division at Massachusetts Institute of Technology (MIT), Cambridge/USA. Since 2020, she holds the position as president of the [European Social Simulation Association \(ESSA\)](https://www.essa-simulation.org/)

For more information see: <https://technologyandinnovation.sociology.uni-mainz.de/team/prof-dr-petra-ahrweiler/>
Google scholar: <https://scholar.google.com/citations?user=Th5reZUAAAAJ&hl=de>

Dr Corinna Elsenbroich is a Reader in Computational Modelling at Glasgow University (MRC/CSO Social & Public Health Sciences Unit). Corinna is interested in methodological and epistemological aspects of novel methods, in particular computational methods such as agent-based modelling and social simulation, and has published on aspects of ontology, explanatory power, and context validity in modelling. As a computational modeller she has developed models of dynamic social networks of juvenile delinquency, neighbourhood effects of extortion racketeering and collective reasoning in social dilemma situations. She is particularly interested in complexity sensitive social science methods, comprising computational, case based and participatory methods. As a co-investigator in the Centre for Evaluation of Complexity Across the Nexus (CECAN) she is involved with developing these methods in a policy relevant way. She is currently working on how to combine methods through novel research designs.

For more information see: Google scholar: <https://scholar.google.co.uk/citations?user=PnV0o6MAAAAJ&hl=en>

Course Description:

This course is about policy modelling with a focus on complexity issues. Policy modelling means to identify areas that need intervention, to specify the desired state of the target system, to find the regulating mechanisms, to design policy and its implementation, and to control and evaluate the robustness of interventions. The methodological difficulty hereby is to bridge the gap between policy practice, often expressed in qualitative and narrative terms, and the scientific realm of formal models. Furthermore, policymaking in complex social systems is not a clear-cut cause-

effect process but characterised by contingency and uncertainty. To take into account technological, social, economic, political, cultural, ecological and other relevant parameters, policy modelling can be enhanced and supported by new ICT-oriented research initiatives. Reviewing the current state-of-the-art of policy context analysis such as forecasting, foresight, backcasting, impact assessment, scenarios, early warning systems, and technology roadmapping, the need for policy intelligence dealing with complexity becomes more and more obvious. This course will introduce the participants to complexity sensitive computational methods for policy modelling, with a particular focus on agent-based modelling (ABM).

Modelling of policy initiatives can take into account more parameters than previously possible and perform social simulations to forecast potential impacts of proposed policy measures. Changing parameters within ABMs is analogous to applying different policy options in the real world. These models could therefore be used to examine the likely real-world effects of different policy options before they are implemented. Thus, altering elements of the models that equate with policy interventions makes it possible to use ABM as a tool for evaluating the results of the policy interactions that typically occur between policy interventions, policy contexts and agents. The objective of this course is to explore these issues. The course will promote exchange of experiences and ideas with respect to policy modelling.

Keywords:

Policy modelling, social complexity, ABM

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 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 modelling and simulation for policy
- Understand the concept of social complexity and its relation to policy
- Understand the concept of participation and its relation to policy modelling
- Know and understand the substantive problems, theories and classical as well as recent related computational models in a number of core areas of policy modelling (e.g., research policy, public policy)
- Be able to conceptualise a policy model (a tool based on Python)
- Be able to apply a set of good practices for developing a policy model
- Be able to reflect upon the strength and pitfalls of policy modelling

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 policy modelling, substantive problem areas in the related literature and the specific policy models and their contribution to scientific insight per policy domain. In the tutorials, participants are expected to work individually or in small groups on building concepts and toy models for specific research questions discussed in the lectures. They will work based on template models and instructional material provided by the lecturers. Lecturers will provide hands-on guidance and supervision.

Software requirements:

Participants will need to use their own computers for purposes of conducting exercises. We will use the most recent version of **NetLogo**, freely available at <https://ccl.northwestern.edu/netlogo/download.shtml>. Participants should install **NetLogo** on their machines prior to the workshop.

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: The Perils of Policy Making

We have to make decisions, small decisions on a daily basis, for example whether to take an umbrella as well as big decisions whether to accept a new job or move house. We base our decisions on evidence, evaluating our options against what we think is likely to happen. We try to glean the future through the prism of the present. Policy makers are faced with the exact same problem of having to make decisions based on evidence, trying to glean the future. And they have to make decisions, sometimes very fast, on limited evidence and in a complex and dynamic world.

To support policy decision making several activities are developed and executed, such as policy appraisal, monitoring and policy evaluation. This session will look at the perils of policy making in a complex world and the tools there are to support this.

- Making important decisions on limited information.
- Appraisal
- Monitoring
- Evaluation

Group work:

- Define a social problem you want to tackle.
- List 3-5 policies you might want to implement.
- Define what you will need to monitor implementation and development.
- Sketch out how you will evaluate whether the policies were successful.

Literature:

Cartwright, N. and Hardie, J., 2012. *Evidence-based policy: A practical guide to doing it better*. Oxford University Press.

Hallsworth, M. with S. Parker and J. Rutter (2011). *Policy Making in the Real World: Evidence and Analysis*. London: Institute for Government. Retrieved 10 December 2017 from: <https://www.institute-for-government.org.uk/sites/default/files/publications/Policy%20making%20in%20the%20real%20world.pdf>

Pawson, R. (2006). *Evidence-based policy: a realist perspective*. Sage.

Day 2: Scaffolding the Ivory Tower

Today's session goes into more depth on the challenge of complexity and dynamics of the social world. One way of exploring complex interdependencies and dynamics is simulation modelling. The session will provide an overview of what kinds of simulation models are available, what they are useful for and how they can support policy making. The session will also look at the policy reality on who actually uses the models, who develops the models and questions of accountability and transparency.

- What kinds of models are available?
- Traditional and computational models (incl System Dynamics, Microsimulation and ABM)
- Who develops models?
- Who uses models?
- Who has accountability?

Group work:

- What kinds of traditional models are used in the field of your policy problem?
- Who are the stakeholders?
- What is the current level of development of the policy area? (long standing problem like education inequalities or newer pressing problem like climate change?)

Literature:

Cartwright, N. and Hardie, J., 2012. *Evidence-based policy: A practical guide to doing it better*. Oxford University Press.

Kolkman, D. A., Campo, P., Balke-Visser, T., & Gilbert, N. (2016). How to build models for government: criteria driving model acceptance in policymaking. *Policy Sciences*, 49(4), 489-504.

Pawson, R. (2008). Causality for beginners. In: NCRM Research Methods Festival (Unpublished). Retrieved 10 December 2017 from: <http://eprints.ncrm.ac.uk/245/>

Stern, E., Stame, N., Mayne, J., Forss, K., Davies, R., & Befani, B. (2012). Broadening the range of designs and methods for impact evaluations. Report of a study commissioned by the Department for International Development. DFID: Department for International Development.

Day 3: Computational Models I

One particularly useful kind of simulation modelling is agent-based modelling (ABM). ABM are models of individuals that interact with each other and their environment. ABM are particularly good to understand heterogeneity of a population and emergent phenomena. There is a large variety of ABM, from very abstract models implementing simple behaviour assumptions to models based on complex decision models. This session covers the simpler variety of ABM, including modelling transport systems and epidemiology.

This session will cover ABM

- Agent-based Models of simple behaviours
- TransSim
- EpiSim

Group work:

- What kinds of computational models are used in the field of your policy problem?
- Which computational models could be used and how?
- Outline a model for the appraisal, monitoring and/or evaluation of the policy.

Literature:

Ahrweiler, P. (2017): Agent-based Simulation for Science, Technology, and Innovation Policy. *Scientometrics* Vol. 110 (1): 391-415. DOI: 10.1007/s11192-016-2105-0.

Ahrweiler, P., & Gilbert, N. (2015). The quality of social simulation: An example from research policy modelling. In *Policy practice and digital science* (pp. 35-55). Springer, Cham.

Edmonds, B. (2017). Different modelling purposes. In *Simulating social complexity* (pp. 39-58). Springer, Cham.

Gilbert, N., & Troitzsch, K. (2005). *Simulation for the social scientist*. McGraw-Hill Education (UK).

Day 4: Computational Models II

This session covers ABM based on more complex agent behaviours. Models of a housing market, of energy behaviours and innovation will be discussed. The session will put particular focus on the SKIN model that has been used within policy domains.

- Agent-based Models of complex behaviours
- Housing Model (Gilbert PWC)
- Wholesem

Group work:

- Further develop the model
- What data do you need for construction, calibration, validation?
- What kinds of things can you measure with your model?
- Who do you need buy-in from?

Literature:

Ahrweiler, P., Pyka, A. and Gilbert, N. (2016) "Policy Modelling of Large-Scale Social Systems: Lessons from the SKIN Model of Innovation," in *Joining Complexity Science and Social Simulation for Innovation policy*. Cambridge Scholars, pp. 156-0180.

Ahrweiler, P., Schilperoord, M., Pyka, A. and Gilbert, N. (2015) "Modelling Research Policy: Ex-Ante Evaluation of Complex Policy Instruments," *Journal of Artificial Societies and Social Simulation*, 18(4), p. 5. doi: 10.18564/jasss.2927.

Elsenbroich, C. (2012). Explanation in agent-based modelling: functions, causality or mechanisms?. *Journal of Artificial Societies and Social Simulation*, 15(3), 1.

Narasimhan, K., Gilbert, N., Hope, A., & Roberts, T. (2018). *Demystifying energy demand using a practice-centric agent-based model*. Working paper retrieved from <http://cress.soc.surrey.ac.uk/web/publications/working-papers>.

Day 5: Possibilities and Limitations of Computational Modelling for Policy

Having covered a range of models to support the difficult task of policy makers to negotiate a complex and dynamic world, this session will look at how models can be used as well as how they must not be used. The focus will be on developing and co-developing, using and reporting computational models.

- Models as end products
- Models as mediators (Barbrook Johnson Models as interested amateurs)
- Prediction? Or rather Paul the Octopus?

Group work:

- Group presentations

Literature:

- Barbrook-Johnson, P., Schimpf, C., & Castellani, B. (2019). Reflections on the use of complexity-appropriate computational modeling for public policy evaluation in the UK. *Journal on Policy and Complex Systems*, 5(1), 55-70.
- Gilbert, N., Ahrweiler, P., Barbrook-Johnson, P., Narasimhan, K. P., & Wilkinson, H. (2018). Computational modelling of public policy: Reflections on practice. *Journal of Artificial Societies and Social Simulation*, 21(1).
- Johnson, P. G. (2015). Agent-based models as “interested amateurs”. *Land*, 4(2), 281-299.