THE GRADUATE INSTITUTE GENEVA

INSTITUT DE HAUTES ÉTUDES INTERNATIONALES ET DU DÉVELOPPEMENT
GRADUATE INSTITUTE OF INTERNATIONAL AND DEVELOPMENT STUDIES

International Relation and Political Sciences (IRPS)
Academic Year 2017 - 2018

Advanced Quantitative Methods: Agent-based Computational Modeling

RI-SP076 – Spring 2018 - 3 ECTS

PROFESSOR

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Office Hours: April 25 / May 9, 14:00-16:00

ASSISTANT

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Course Description

The course "Advanced Quantitative Methods: Agent-based Computational Modeling" aims to familiarize participants with the methods of computational agent-based modeling (ABM). Computational modeling techniques are commonly not part of the standard repertoire of quantitative analyses in the social sciences. They have increasingly gained prominence though as powerful techniques that can effectively compliment more standard approaches such as regression analyses, in particular, in settings characterized by complex systemic interactions. The course will first introduce the theoretical foundations of the technique in the field of complexity theory. Students will then learn the methodology of agent-based modeling. The course covers classical examples such as Schelling's model of segregation and then familiarizes students with more complex recent models. Students will then learn about the state-of-the-art approach of evidence-driven modeling, i.e., embedding and validating agent-based models using empirical data. The course places a particular emphasis on highlighting strengths and weaknesses of computational modeling approaches for quantitative analyses and will carefully place the methods in the context of other quantitative techniques more commonly used in the social sciences. Students will also gain first-hand experience in implementing and applying the methods learned through practical programming assignments and a coding project in Python or *R*. The course therefore assumes that students have some programming background.

Note that the course will be taught in four intensive sessions throughout two weeks at the end of April and in early May 2018. Specifically, it takes place on Tuesday April 24th 16:00 – 20:00, Wednesday April 25th 08:00 – 10:00 and 12:00 – 14:00, Tuesday May 8th 16:00 – 20:00 and Wednesday May 9th 12:00 – 14:00.

Syllabus

Course Requirements

Attendance in all sessions of the course is required and students are expected to engage with the recommended readings and/or online resources in preparation for the course. Students will be required to complete a computational modeling project implemented in either Python or R and document their work in a written project report. **The coding project and report are due 4 weeks after the last course session, i.e., on June 6, 2018.**

Course Evaluation

Performance in the course depends both on active participation and the coding project with written project report. Evaluation will be based on:

1. Active participation and contribution to the course 10%
2. Coding project and written project report 90%

Course Material

Recommended scientific readings and/or online resources for individual sessions are provided with stable links in the course schedule below. The following book recommended for anyone interested in a more in-depth introduction to the topic of complexity and agent-based computational modeling.

- John H. Miller and Scott E. Page. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Princeton University Press.

Course Schedule

Session 1: Introduction – Modeling Complex Systems

Tuesday, April 24th 16:00 – 20:00

- Introduction to Complexity and Modeling

- Agent-Based Modeling

Session 2: Agent-Based Models in Social Science

Wednesday, April 25th 08:00 – 10:00 & 12:00 – 14:00

- Classical Models: Schelling and Beyond

- Evidence-Driven Modeling

Session 3: Agent-Based Models in Practice

Tuesday, May 8th 16:00 – 20:00

- Implementation of Agent-Based Models

- Best Practices and Pitfalls

Session 4: Coding Project

Wednesday, May 9th 12:00 – 14:00

- Presentations of Project Ideas

Software

The practical exercises of the course and the coding project require implementing and running agent-based models. Students may use one of two programming languages:

- Python
- *R*

The course assumes some programming background in either of the languages. Please make sure to install and familiarize yourself with the appropriate software packages prior to the class.

Required Readings

Bhavnani, Ravi, Karsten Donnay, Dan Miodownik, Maayan Mor, and Dirk Helbing. (2014). Group Segregation and Urban Violence. *American Journal of Political Science* 58(1): 226–245.

de Marchi, Scott and Scott E. Page. (2014). Agent-Based Models. *Annual Review of Political Science* 17(1): 1–20.

Epstein, Joshua M. (1999). Agent-Based Computational Models and Generative Social Science. *Complexity* 4(5): 41–60.

Epstein, Joshua M. (2008). Why Model? *Journal of Artificial Societies and Social Simulation* 11(4): 12.

Miller, John H. and Scott E. Page. (2004). The Standing Ovation Problem. *Complexity* 9(5): 8–16.

Schelling, Thomas C. (1971). Dynamic Models of Segregation. *Journal of Mathematical Sociology* 1: 143–186.

Weidmann, Nils and Idean Salehyan. (2013). Violence and Ethnic Segregation: A Computational Model Applied to Baghdad. *International Studies Quarterly* 57(1): 52–64.

Recommended Readings

Axelrod, Robert. (1986). An Evolutionary Approach to Norms. *American Political Science Review* 80(4): 1095–1111.

Axelrod, Robert. (1997). The Dissemination of Culture: A Model with Local Convergence and Global Polarization. *Journal of Conflict Resolution* 41(2): 203–226.

Axtell, Robert L., Joshua M. Epstein, Jeffrey S. Dean, et al. (2002). Population Growth and Collapse in a Multiagent Model of the Kayenta Anasazi in Long House Valley. *Proceedings of the National Academy of Sciences* 99: 7275–7279.

Bhavnani, Ravi and Dan Miodownik. (2008). Ethnic Polarization, Ethnic Salience, and Civil War. *Journal of Conflict Resolution* 53(1): 30–49.

Bhavnani, Ravi, Michael G. Findley and James H. Kuklinski. (2009). Rumor Dynamics in Ethnic Violence. *The Journal of Politics* 71(3): 1–20.

Cederman, Lars-Erik. (2003). Modeling the Size of Wars: From Billiard Balls to Sandpiles. *American Journal of Political Science* 97(1): 135–150.

Centola, Damon, Robb Willer and Michael Macy. (2005). The Emperor's Dilemma: A Computational Model of Self-Enforcing Norms. *American Journal of Sociology* 110(4): 1009–1040.

Epstein, Joshua M. (2002). Modeling Civil Violence: An Agent-Based Computational Approach. *Proceedings of the National Academy of Sciences* 99: 7243–7250.

Helbing, Dirk. (2010). Pluralistic Modeling of Complex Systems. *Science and Culture* 76(9-10): 315–329.

Macy, Michael and Robert Willer. (2002). From Factors to Actors: Computational Sociology and Agent-Based Modelling. *Annual Review of Sociology* 28: 143–166.

Schutte, Sebastian. (2010). Optimization and Falsification in Empirical Agent-Based Models. *Journal of Artificial Societies and Social Simulation* 13(1): 2.