Agent-based modeling in continuous time – the example of international migration

In this lecture it will be shown how agent-based modelling in continuous time can be used to overcome shortcomings of both "traditional" ABM in discrete time as well as discrete-event microsimulation. To this end, I will first discuss some features and areas of application of both traditional ABM and traditional microsimulation in continuous time.

One of the main features of ABM is that it allows to model rule-based decision-making. Moreover the explicit consideration of interaction between individuals is possible. Discrete-event microsimulation on the other hand allows to study not only the occurrence of events but also the duration until their occurrence. In demography especially, but also in many other fields, it is not only relevant *what* happens but also *when*. This can be modelled and studied in a competing-risks framework. I will show how it is possible to incorporate complex decision-making and interaction into a competing risks simulation framework.

In the computer lab we will focus on the R packages MicSim and Biograph. MicSim is available on CRAN (https://cran.r-project.org/web/packages/MicSim/index.html). For the installation of the Biograph package , you have to download the "Biograph_2.0.4.tar.gz" file from CRAN (https://cran.r-project.org/src/contrib/Archive/Biograph/) and install it from your local source repository : install.packages(<pathtopackage>, repos = NULL, type="source").

We will demonstrate how to estimate transition rates using Biograph. These serve as inputs for a discrete event simulation using MicSim. Finally we will give advice on how to incorporate MicSim life courses into an ABM.

Outline Lecture:

1. Main features and benefits of ABM
2. Main features and benefits of discrete-event microsimulation
3. Theoretical background: Decisionmaking for life events
4. Decisionmaking as a process
5. Theoretical background: Discrete-event microsimulation
6. Example application: The Theory of Planned Behavior in a continuous-time simulation model of migration
7. Discussion: Rules versus rates

Outline Lab:

1. Estimation of transition rates with Biograph
2. The MicSim package
3. How to make MicSim part of an ABM – Tipps and Tricks

Suggested readings:

Klabunde, A. and F. Willekens (2015): Decision-making in agent-based models of migration: State of the art and challenges. *European Journal of Population* (forthcoming).

Willekens, F. (2015): The decision to emigrate. A simulation model based on the theory of planned behaviour. Mimeo.

Zinn, S. (2014). The MicSim Package of R: An Entry-Level Toolkit for Continuous-Time Microsimulation. International Journal of Microsimulation (2014) 7(3) 3-32

Klabunde, A., Zinn, S., Leuchter, M. and Willekens, F. (2015): An agent-based decision model of migration, embedded in the life course - Model description in ODD+D format. MPIDR Working Paper 2015-002