Case studies of the MicMac microsimulation tool for data from the Netherlands

Sabine Zinn, Jutta Gampe
zinn@demogr.mpg.de, gampe@demogr.mpg.de
Max Planck Institute for Demographic Research
Rostock, Germany

September 15, 2008

1 Introduction

Population forecasting can be done on an aggregate cohort level, a so called macro-approach, or by projecting populations by simulating individual life-courses of members in the population, the so called micro-approach. Both strategies have their merits, and within the EU-funded MicMac-project (see www.micmac-projections.org) an attempt was made to bridge the gap between the two complementary approaches.

Microsimulation provides more detailed insights in how individual trajectories will shape future population structure, however, it is more demanding both technically and also with respect to the data needed, if the full flavour of the individual approach is to be exploited. In this talk we intend to demonstrate the capacity of the MicMac microsimulation environment by showing results from two cases studies from the Netherlands.

2 The Software Design of the Microsimulation

As part of the MicMac-project a microsimulation software tool has been designed in order to forecast large numbers of individual life courses. The software tool consists of three components.

1. The pre-processor provides tools to prepare the input data for the micro simulation. Likewise, alternative scenarios and assumptions on prospective changes are included in the input data.

2. The processor runs the simulation efficiently.

3. The post-processor offers procedures to summarize the output data of a microsimulation run in tables and graphs.

Each of these components is designed as an independent and separate feature of the microsimulation. The pre-processor and the post-processor will be devised by using `R`, which is a free and open source software for statistical computing.

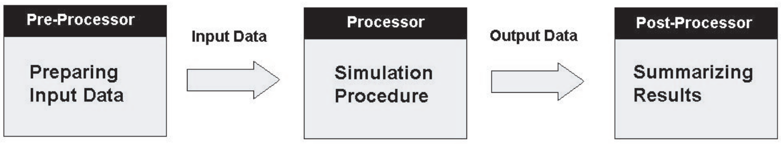

Figure 1: Software Architecture of the MicMac Microsimulation

The processor has been implemented as a plug-in within the generic multi-agent system and simulation platform JAMES II (JAva based Multipurpose Environment for Simulation). JAMES II has been developed by the Research Group for Modelling and Simulation at the Computer Science Department at the University Rostock Himmelspach (2007); Himmelspach and Uhrmacher (2007). Figure 1 depicts the structure of the software architecture of the MicMac microsimulation environment.

3 The Microsimulation Model and its Implementation

The microsimulation itself is set up as a continuous time multi-state model (CTM). The focus of the CTM is on individual life-courses that evolve along two continuous time-scales: the age of the individual and the calendar time. Life courses of individuals are characterized in terms of individual transitions between relevant demographic states during life. Possible states a person can occupy are summarized in the state space of the model. The CTM defines when and how state transitions occur. By using of Monte Carlo simulation techniques the CTM is executed within the processor (see Gampe and Zinn, 2007).

In order to perform a specific microsimulation run several input ingredients have to be provided:

- A starting and ending time of the simulation run.
- A state space and a set of corresponding transition rates.

- A base population that gives the distribution of the population under study according to the states within the state space at the starting time of the simulation run.

Herein the pre-processor could assist in preparing the base population and the set of transition rates.

The processor of the MicMac microsimulation has been set up as a plug-in within the JAMES II framework. JAMES II provides a collection of computational structures that ease the implementation of the simulation of a particular domain (see Himmelspach, 2007, Chapter III), in our case the simulation of life-courses of individuals.

The method we use to simulate the processing of individual transitions is an event-based approach. Within the MicMac microsimulation an individual transition is defined as an event. All individuals are simulated simultaneously according to a continuous calendar time line. Time evolves discretely from one event to the next. We have implemented a data structure termed event queue as an appropriate instrument to perform the event-based simulation approach (e.g. Brown, 1988).

Within a simulation run each individual is represented by a unique identification number and a set of attributes containing sex, age and the current demographic state. Subsequently, after a completed simulation run all individual attributes and life-courses are stored in ASCII files for further analysis. For this purpose the post-processor intends to combine a range of suitable tools.

4 The Case Studies

To demonstrate the capacities of the MicMac microsimulation tool we present two case studies using data from the Netherlands. The first example will deal with the transition into adulthood, leaving parental home and family formation, taking educational achievement into account. This case study includes the following state variables and categories (see Willekens et al., 2007):

1. Sex (male and female)
2. Level of educational attainment (five categories based on the International Standard Classification of Education: ISCED01, ISCED2, ISCED34, ISCED5B, ISCED5A6)
3. Marital status (never-married, married, divorced, widowed)
4. Living arrangement (child in parental home, living without partner, living with partner, living with other person(s), living in institution)
5. Number of children ever born (from childless up to 4 or more children)

The second case study will deal with transitions into disability, and finally mortality, taking marital status, living arrangement but also health behaviour, such as smoking status and BMI, into account. The respective variables considered additionally are

1. Disability status (disabled, non-disabled)
2. Smoking (never, ever, current)
3. Body mass index (underweight, normal weight, overweight, obesity).

The combinations of all categories of the state variables form the state space of the CTM. Corresponding sets of transition rates by age and calendar time and a proper base population will be provided (optionally within the pre-processor).

We will realize several microsimulation runs to obtain population projections for alternative scenarios about future transition rates, in particular ongoing plans for school reforms in the Netherlands and changing smoking behaviour.

We will use the post-processor to analyze the simulation output by appropriate graphs and tables to highlight the insights from the microsimulation analysis.

References

Brown, R. (1988). Calendar queues: a fast 0(1) priority queue implementation for the simulation event set problem. *Commun. ACM 31*(10), 1220–1227.

Gampe, J. and S. Zinn (2007). Population forecasting via microsimulation: the sofware design of the micmac-project. In *Work session on demographic projections, Bucharest, 10-12 October 2007*, pp. 237–241. Eurostat: European Communities.

Himmelspach, J. (2007). *Realisierung und Verwendung eines allgemeinen Modellierungs-, Simulations- und Experimentiersystems: Entwicklung und Evaluation effizienter Simulationsalgorithmen*. Reihe Informatik. Sierke Verlag.

Himmelspach, J. and A. Uhrmacher (2007). Plug'n simulate. In *In Proceedings of the 40th Annual Simulation Symposium*, pp. 137–143. IEEE Computer Society.

Willekens, F., J. de Beer, and N. van der Gaag (2007). Report on input data requirements of MIC. Technical report, NIDI. Technical Report within the MicMac Project.