

Preface

Suppose you are asked to describe an individual. You probably list age, sex, marital status, presence of children and number of children, main occupation, education level, ethnicity, place of residence, place of work, main source of income, religious denomination and some lifestyle features. You probably add years of major transitions: when the person graduated from school, got married, entered the current job and moved to the current address. If the person has children, you may add the name, age and sex of each child. When you are asked to describe a population, you may mention size, age structure, distribution by level of education, employment status, marital status and health status. It describes the population at a point in time. If asked to describe population change, you may mention changes in size and distribution. Population change is an outcome of changes in people's lifestyle and life course. An ageing population is a result of people having fewer children and living longer. A declining married proportion is an outcome of fewer people marrying, postponement of marriage and marriages being less stable. Fewer marriages may be linked to changes in the meaning of the institution of marriage. An increase in the proportion of unemployment is an outcome of more people losing their job and/or decreased likelihood of finding a job when unemployed, resulting in longer unemployment spells. The description of population change in terms of changing lives is referred to as the biographical method. The method emphasizes personal attributes, life events and life histories.

An individual may be characterized by a set of attributes such as marital status, employment status, health status, place of residence and income level. If attributes are represented by discrete variables with finite numbers of categories, a combination of categories defines a state of existence and an individual with given values of attributes is said to occupy a state. Individuals with the same values of attributes occupy the same state. The state space is the set of possible states. In practice, one or a few attributes are selected to define the state space. Which attributes are selected depends on the research question. Other attributes that are relevant but not of primary importance are treated as covariates.

As life unfolds, an individual moves between states. The sequences of states and transitions between states describe life histories or careers. Employment histories,

marital histories and residential histories are examples of careers. In studies of life histories, two approaches are distinguished (Abbott 2001). The first views a life path as a whole and tries to find typical patterns. The approach is generally known as sequence analysis. The second views a life history as a realization of a stochastic process and aims at the description, explanation and prediction of life histories. Probability models are used to represent stochastic processes and to model the life histories that they generate. This book is about the second approach. Life histories are viewed as realizations of continuous-time Markov processes that depend on rates of transition between states. The rates are estimated from longitudinal data.

The multistate methods that are presented in this book are included in the software package *Biograph*, a package in R that implements the biographical method. The packages can be downloaded from the Comprehensive R Archive Network (CRAN) (<http://cran.r-project.org/>). *Biograph* retrieves useful information from life history data. It estimates transition rates and computes useful life history indicators. A particularly useful feature of *Biograph* is the set of utilities that connect the package to R packages for multistate modeling including *mstate*, *msm*, *mvna*, *etm*, *Epi*, and the package *TraMineR* for sequence analysis. *Biograph* produces input data in the right format and basic R objects for the packages.

The motivation to write the book was to stimulate the use of multistate modeling among social science students and researchers with basic knowledge of survival analysis and event history analysis. The methods presented in the book are illustrated using two data sets. The first is a subsample of the German Life History Survey. Blossfeld and Rohwer (2002) and Blossfeld et al. (2007) used the data to illustrate the statistical modeling of time-to-event data. By using the same data set, the multistate analysis of life histories is presented as a logical extension of the analysis of time-to-event data. At the end of the book, another data set is considered: the Netherlands Fertility and Family Survey of 1998. The data sets are included in the *Biograph* package.

The book should appeal to anyone interested in how populations change and how the change is related to the lifestyle and life course of individuals. The changes include today's major societal challenges: ageing, population decline, migration and integration, population diversity, population health, labour market dynamics and the role of education and skills in the modern knowledge society. The book should be of particular interest to demographers, epidemiologists and students of population health, sociologists, criminologists, economists and historians. The book is suitable as a textbook for graduate courses on event history analysis. It may also be used as a self-study book provided the reader has a basic knowledge of survival analysis and multistate modeling. The R code used on the book is available online.

The preparation of the book has been a long but exciting journey. Most of the work was done while I was with the Netherlands Interdisciplinary Demographic Institute (NIDI) in The Hague. The book was completed at the Max Planck Institute for Demographic Research in Rostock, Germany. I would like to thank Hans-Peter Blossfeld for allowing me to use the subsample of the German Life History Survey

that he used in his book with Götz Rohwer, *Techniques of Event History Modeling* (Blossfeld and Rohwer 2002). James Raymer, Jutta Gampe, Sabine Zinn and Arthur Allignol provided useful comments on the manuscript. I am grateful for their help.

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