Thematic Course

Academic Year	2024-25
Subject	Mortality Modelling and Forecasting
Instructor	Carlo Giovanni Camarda (Institut national d'études démographiques, France)
Course description	The creation of the first life table about 350 years ago was not only a milestone in statistics but also marked the beginning of demography and mortality analysis. Successive approaches have further illuminated our understanding of mortality trends. This course aims to provide an introduction to both classic and modern techniques for modeling mortality, with particular emphasis on the features necessary for forecasting mortality as the final research goal. On the first day, we will cover classic parametric models. While survival analysis is the primary tool for handling individual data, many mortality models can also be expressed within this framework. Even for aggregate data, model estimation relies on survival analysis techniques. We will start by revisiting key concepts in survival analysis, such as observation schemes and estimation procedures, before moving on to specific models used in demography. We will begin with the Gompertz law of mortality (1825), a foundational model used by demographers and actuaries to simplify mortality trends across ages with a set of parameters that have clear and interpretable physical meanings. From there, we will explore other models developed over the past two centuries, each designed to capture age-related mortality patterns with a few key parameters. We will study their features, learn how to estimate them, assess the uncertainty around these estimates, and forecast mortality trends by extrapolating the time series of their parameters. On the second day, we will examine the Lee-Carter model, a groundbreaking approach introduced in 1992 and later generalized and widely used. The Lee-Carter model represents a significant advancement in modeling and forecasting mortality, using linear extrapolations of the logarithms of age-specific death rates and principal component techniques. It employs a single index coefficient to capture the time trend in mortality rates, with forecasts derived from projecting this index using standard time series methods. We will learn how to interpret the model's outcomes, discuss its strengths and limitations, and cover refinements and enhanced approaches for forecasting future mortality rates. While we will touch on some theoretical concepts, the course will be hands-on. Students will receive handouts and routines to reproduce all outcomes presented, and will use the statistical software R on publicly available demographic datasets throughout the course.

Learning Objectives	The course aims to equip PhD students in statistics at the DSEAS of the University of Palermo with skills in both theoretical and practical aspects of mortality modeling and forecasting. By the end of the course, students should be proficient in understanding and applying classic and modern mortality models, including the Gompertz law and the Lee-Carter model and its variants. Additionally, basic concepts in survival analysis will be reviewed, and students will gain practical skills in estimating and forecasting mortality trends using R. The course spans 2 days and includes lectures paired with practical, hands-on sessions.
Suggested readings	- Chapters 1-3. Preston, S. H., Heuveline, P., and Guillot, M. (2001). *Demography. Measuring and Modeling Population Processes*. Blackwell (available at https://gwern.net/doc/statistics/2001-preston-demography.pdf) - Chapters 1-5. Klein, J. P. and Moeschberger, M. L. *Survival Analysis Techniques for Censored and Truncated Data*. Springer (available at https://link.springer.com/book/10.1007/b97377) - Chapter 7. *Lecture Notes* by German Rodriguez (Princeton University). Available at https://grodri.github.io/glms/notes/c7.pdf - Basellini, U., C. G. Camarda and H. Booth (2023) Thirty years on: A review of the Lee–Carter method for forecasting mortality *International Journal of Forecasting*. 39. 1033-1049. Open access
Course Activity (hrs)	8 hours
Credits	
Assessment Method	Participants will be evaluated on the basis of class participation and possibly a talk or report
Teaching Methods	Theory classes and computer labs
Calendar	Provisional days: 16 and 17 December 2024 (mornings and afternoon)
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