METER

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METER (Multi-state Estimates for Time-to-Event Research) is a Python package for multi-state modelling of time-to-event data. It contains functions for building multi-state life tables from discrete-time data that can be used to generate point estimates and confidence intervals for life expectancies. METER also provides functions to produce plots of transition probabilites and Kaplan-Meier plots of survival data.

CHAPTER

ONE

GUIDE

1.1 Should I use METER?

METER is specifically designed for discrete-time, time-inhomogenous, and acyclic multi-state markov models. To go through each of these elements individually:

- The main assumption of a **markov model** is that the past states of a process do not affect transition probabilites going forward. If you have an application where the previous states of a process are likely to have an effect (if you are studying radiation exposure, for example) this assumption will not hold and you should consider using a semi-markov model.

- **Discrete-time** means that observations are taken at regular time intervals that can be indexed by natural numbers. Typically this means that the data is indexed by days or years. This assumption will not hold for data with inconsistent intervals between observations, which would be typical for clinical data on cancer relapse and many types of survey data.

- **Acyclic** means that states have a defined order and it is not possible to move backwards to a preceding state. For the time being, METER does not support cyclic models, although this is high on the list of planned improvements.

- **Time-inhomogenous** means that time from study entry affects the probability of transitions between states. This is typical for data that stretches over long periods of time, where subject age may be a relevant factor. For example, an individual diagnosed with type 2 diabetes at age 20 is going to have a much better short-term survival prognosis than an 80-year-old with the same diagnosis.

You can still use METER if believe that your process is time-homogenous, but you might have simpler options available. If you want to model a continuous time process, I suggest using the R package MSM.

1.2 Installation

Run the following in your command line or python console:

```
pip install METER
```

For a look at past versions or to download files directly, visit PyPI.

1.3 Constructing Multi-State Life Tables

The first step to using METER is to have your data in the correct format. The data should have one subject per row, and have columns containing each of the transition times. Transition times can be specified as calendar dates or time from study entry, as the wide_format function will convert everything into the latter format.

To obtain the transition matrices of the multi-state model you should do the following:

1. Use `METER.wrangler.wide_format()` to obtain the data in wide format.
2. Use `METER.table.atrisk_and_transitions()` to obtain the risk sets and number of transitions made at each time point.
3. Use `METER.table.transitionprobs_and_samplesizes()` to obtain the transition matrices for each time point, and the associated sample sizes.

If you don't need the transition probabilities directly, and just want associated life expectancies or other survival estimates, you can just do step one and then skip forward to the section on generating estimates.

Note: You should still be running wide_format even if your data already has transition times specified as time from study entry. This is because the wide_format function creates status columns that indicate whether each transition ever occured for a given subject, and ensures that there is only one transition per year.

CHAPTER

TWO

GENERAL

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CHAPTER

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INDICES AND TABLES

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