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# Survival Analysis

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TU Dortmund University

Based on earlier work by: F. Scheipl, M. Herrmann, A. Bender, L. Fahrmeir, T. Hothorn, G. Kauermann, H. Küchenhoff, B. Sischka, S. Thiemichen (all LMU Munich).

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## General Information

Suitable modules: BS 14 / 15; BD W2; MS 6 / 7; MD E1 (Methods); ME 7

### Homepage:

- URL: <https://moodle.tu-dortmund.de/course/view.php?id=29346>
- Registration key: survana2223
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## General Information

### **Lecture** (Andreas Groll):

Presumably pre-recorded online videos

### **Q & A session** (Andreas Groll):

Date: presumably Thursday 16-17 pm and in physical presence

### **Exercises** (Guillermo Briseño Sanchez):

Date: Presumably in presence on Tuesdays, begin on the second week of the semester.

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## General Information

### Final Exam:

- Date: to be announced
- ECTS: 9
- Room: to be announced
- Language: English
- **Mandatory:** Registration via BOSS opens  $\approx$  1 month before the exam
- There will be a requirement for the exam. More information will be announced in the first lecture.

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## What is Life-time Data Analysis (LDA)?

- LDA is a collection of statistical procedures to investigate data where “the outcome variable of interest is *time until an event occurs*” (Kleinbaum, 2005)
- A more general name would be *Time-to-Event Analysis*

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## What is Life-time Data Analysis (LDA)?

- Historically, the first applications of time-to-event analysis considered the outcome *time until death*, thus called *Survival Analysis*
- Other synonyms:
  - event history analysis
  - duration models
  - failure time models

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## What is Life-time Data Analysis (LDA)?

- **time** until an event can be measured on different scales
  - years
  - milliseconds
  - days
  - ...
- possible **events** include
  - Death after operation (yes/no)
  - Recidivism (Rearrest after release from prison)
  - Leaving a web page (after following a link on social media)
  - ...

→ In LDA we observe an outcome tuple  $\langle time, event \rangle$

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## Outline

### 1. Introduction and basics

- Examples
- Duration time distributions
- Censoring

### 2. Estimation of survival function and hazard rate

- Non-parametric estimation
- Parametric estimation
- Log-rank test



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## Outline

### 3. Part a) **Regression models**

- Transformation models (AFT models)
- Cox Proportional Hazard Models
- Time-Dependent Covariates
- Time-Varying Effects

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## Outline

### 3. Part b) **Extending (semi-)parametric regression models**

- Time-discrete Survival Model
- Piece-wise Exponential (Additive Mixed) Model
- Frailty and Heterogeneity

### 4. (& 5.) **Further Models**

- Aalen Additive Hazard Model
- Competing Risk Model

### 6. **Extensions**

- ... (depending on how much time there will be left)

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## References

- Klein, John P., and Melvin L. Moeschberger (1997). *Survival Analysis: Techniques for Censored and Truncated Data*. Springer.
- Therneau, Terry M., and Patricia M. Grambsch (2001). *Modeling Survival Data: Extending the Cox Model*. Springer.
- Kleinbaum, David G. and Mitchel Klein (2011). *Survival Analysis*. Springer.
- Moore, Dirk F. (2016). *Applied Survival Analysis Using R*. Springer.
- Tutz, Gerhard, and Matthias Schmid (2016). *Modeling Discrete Time-to-Event Data*. Springer.
- Beyersmann, Jan, Arthur Allignol, and Martin Schumacher (2012). *Competing Risks and Multistate Models with R*. Springer.