Department of Epidemiology and Public Health
University of Miami, Miller School of Medicine

BST 690 – Theory of survival analysis

Fall 2015

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Course Description:

Survival analysis has become an important tool of statistics, with applications ranging from medicine to actuarial sciences to particle physics, to mention just a few. Because of its usefulness, most courses are mainly taught in terms of its applicability. In this course, without losing sight of such applications, we will give special emphasis to the probabilistic theoretical foundations, in terms of counting processes and Martingales.

Course Learning Objectives:

Upon completion of the course, it is expected that students be able to develop research on censoring and failure time models from the foundation of point processes and Martingales, based on the theoretical framework provided. From this viewpoint, students should learn estimation and hypothesis testing as well as asymptotics from Cox regression models. It is also expected that students be able to use the probabilistic and statistical tools considered in applied research through the analysis of real (public) data.

Course requirements:

Active participation in class, quizzes and completion of assignments.

Course material:

Fleming T.R and Harrington D.P. (2005). *Counting Processes and Survival Analysis*. Wiley.

Grading:

Weekly homework (1/3). Active participation in class (1/3). Weekly 5-minutes quizzes (1/3).

The *weekly* homework and quizzes will involve problem solving, proofs and counterexamples. The solution of these problems will be an important aspect of class discussions, which will center on the results and any difficulties found by students.

Class format:

A. Seminar style. All mathematical developments will be presented with reference to the survival setting.
B. Active discussion between students and the teacher of theory and problem sets.

Course schedule:

Week 1: ***Review of Foundations*** (Appendix 1)

- Stieljes-Lebesgue integral
- Review of Probability Theory

Week 2: ***Introduction*** (Chapter 0)

- Data Set
- Definition of Survival Concepts

Week 3-4: ***The Counting Process and Martingale Framework*** (Chapter 1)

- Stochastic Processes and Stochastic Integrals
- The (Survival) Martingale
- The Doob-Meyer Decomposition
- A transformation of a Martingale

Week 5-6: ***Local Square Integrable Martingales*** (Chapter 2)

- Localization of Stochastic Processes and the Doob-Meyer Decomposition
- The Survival Martingale Revisited
- Stochastic Integrals with Respect to Local Martingales
- Continuous compensators
- Compensators with discontinuities

Week 7: ***Finite Sample Moments and Large Sample Consistency*** (Chapter 3)

- Nonparametric Estimation of the Survival Distribution
- Finite Sample Properties of Linear Rank Statistics

- Consistency of the Kaplan-Meier estimator

Week 8-9: ***Censored Data Regression Models*** (Chapter 4)

- Proportional Hazard and Multiplicative Intensity Models
- Partial Likelihood Methods
- Martingale Residuals

Week 10-11: ***Martingale central Limit Theorem*** (Chapter 5)

- Motivation
- Convergence of Martingale difference arrays
- Weak Convergence

Week 12: ***Large Sample Results of the Kaplan-Meier Estimator*** (Chapter 6)

- A Large Sample Result for Kaplan-Meier and Weighted Logrank Statistics.
- Confidence Bands for the Survival Distributions

Week 13: ***Competing risks and multistate models*** (Chapter 7)

- Large Sample Null Distribution
- Consistency and Efficiency of Some Tests
- Some Versatile Test Procedures

Week 14: ***Modeling and analysis of recurrent event data*** (Chapter 8)

- Intensity processes for recurrent events
- Overall intensity process modeling and estimation
- Mean process modeling and estimation
- Conditioning on aspects of the counting process history