**BIOST 2054 / STAT 2261**
**Survival Analysis**
**Spring 2018**

**Course Instructor**: Ying Ding, Ph.D.
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**Teaching Assistant**: Tao Sun
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**Text Books**: Required:
Survival Analysis
Techniques for Censored and Truncated Data
2nd Edition, 2005
Klein and Moeschberger

Reference:
The survival Analysis of Failure Time Data
2nd Edition, 2002
Kalbfleisch & Prentice

**Class time and location**: Tuesdays, Fridays
10:00-11:25 am
A216 Crabtree Hall
Graduate School of Public Health

**Prerequisite**: BIOST 2044 or STAT 1152 or STAT 1632, knowledge on SAS programming

**Instructor Office Hours**: Tu Fr 11:25-12noon (in the classroom) or by appointment

**TA Office Hours**: Tuesday 1-2pm in A412 Crabtree Hall

**Grading**: 30% Midterm (in class)
35% Final Project (a report and an oral presentation)
35% Homework (~ 5 assignments)

Grading scale: 90-100% A
80-89% B

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| 70-79% | C |
| 60-69% | D |
| < 60% | F |

**Course Description:**
This is a mid-level course in the analysis of time-to-event data. The problem of analyzing time-to-event data, often referred to as survival data, arises in many fields such as medicine, public health, engineering, economics, and demography. An important feature with survival data is censoring and truncation. The materials covered in this course include introduction of basic concepts and terminologies, estimation of summary statistics for survival data, hypothesis testing of comparing time-to-event distributions under censoring and truncation, regression methods for survival data, and multivariate models for survival data. The statistical techniques will be exemplified mainly through medical or biological data. The course will focus on both theories and applications.

Students are expected to be familiar with fundamental statistical concepts and theories such as probabilities, distributions, likelihood, hypothesis testing, estimation and inference. Basic knowledge on SAS programming is also required.

The main software used for fitting survival models will be SAS. For some examples and homework problems, R code will be also provided (for self-learning purpose).

**Learning Objectives:** Mathematically rigorous contents to understand statistical inference on time-to-event data under various censoring mechanism are covered in this course. At the end of the semester, students should be able to

- Distinguish different types of censoring and/or truncation mechanisms
- Identify basic quantities and statistics from various survival models
- Conduct nonparametric, parametric and semiparametric inference such as to obtain Kaplan-Meier estimator, perform Log rank test, fit parametric and semiparametric survival models and etc.
- Analyze various survival datasets and appropriately summarize and interpret the analysis results

**Assignments:**
Homework will be assigned every other week and must be submitted on time. While students are encouraged to discuss course content with each other, students must do their own analyses and write their own homework. Copying assignments from other students will NOT be tolerated.

Midterm is in class (1.5 hours). It is a closed-book closed-notes exam (no computer). Details regarding the final project will be discussed in class around the midterm time.

**Student Opinion of Teaching Surveys:**
Students in this class will be asked to complete a *Student Opinion of Teaching Survey*. Surveys will be sent via Pitt email and appear on your CourseWeb landing page during

the last three weeks of class meeting days. Your responses are anonymous. Please take time to thoughtfully respond, your feedback is important to me. Read more about *Student Opinion of Teaching Surveys*.

**Accommodation for Students with Disabilities:**
If you have any disability for which you may require accommodation, you are encouraged to notify both your instructor and the Office of Disability Resources and Services, 140 William Pitt Union (Voice or TTD 412-648-7890) as early as possible in the term.

**Pitt Public Health Academic Integrity Statement:**
All students are expected to adhere to the school's standards of academic honesty. Any work submitted by a student for evaluation must represent his/her own intellectual contribution and efforts. The GSPH policy on academic integrity, which is based on the University policy, is available online at: www.publichealth.pitt.edu/academicintegrity . The policy includes obligations for faculty and students, procedures for adjudicating violations, and other critical information. Please take the time to read this policy

Students committing acts of academic dishonesty, including plagiarism, unauthorized collaboration on assignments, cheating on exams, misrepresentation of data, and facilitating dishonesty by others, will receive sanctions appropriate to the violation(s) committed. Sanctions include, but are not limited to, reduction of a grade for an assignment or a course, failure of a course, and dismissal from GSPH.

All student violations of academic integrity must be documented by the appropriate faculty member; this documentation will be kept in a confidential student file maintained by the GSPH Office of Student Affairs. If a sanction for a violation is agreed upon by the student and instructor, the record of this agreement will be expunged from the student file upon the student's graduation. If the case is referred to the GSPH Academic Integrity Hearing Board, a record will remain in the student's permanent file.

# Survival Analysis
# Spring 2018

## Course outline:

| Date | Lecture Topic | Key Learning Points | Chapters |
|---|---|---|---|
| 1/9 (Tu) | Syllabus, Examples of Survival Data | Different scenarios when censoring or truncation occurs | Chp1.1-1.19 |
| 1/12 (Fr) | Basic Quantities and Models | Survival and hazard functions | Chp2.1-2.3 |
| 1/16 (Tu) | Basic Quantities and Models (continue) | Mean/median residual life, parametric distributions/models for survival data | Chp2.4-2.6 |
| 1/19 (Fr) | Censoring and Truncation | Formal definition for various types of censoring and truncation | Chp3.1-3.4 |
| 1/23 (Tu) | Likelihood for Censored or Truncated Data | Likelihood construction and parameter estimation for data under different censoring or truncation mechanisms | Chp3.5-3.6 |
| 1/26 (Fr) | Nonparametric Estimation of Basic Quantities | Point estimates of survival and hazard functions for right-censored data | Chp4.1-4.2 |
| 1/30 (Tu) | Nonparametric Estimation of Basic Quantities (continue) | Interval estimates of survival and hazard functions for right-censored data | Chp4.3-4.4 |
| 2/2 (Fr) | Nonparametric Estimation of Basic Quantities (continue) | Point and interval estimates of mean and median survival time, estimates of survival function for left-truncated and right-censored data | Chp4.5-4.6 |
| 2/6 (Tu) | Estimation of Basic Quantities for Other Sampling Schemes | Estimation of survival functions for other types of censored data | Chp5.1-5.3 |
| 2/9 (Fr) | Estimation of Basic Quantities for Other Sampling Schemes (continue) | Cohort life table, Introduction of counting process | Chp5.4, 3.6 |
| 2/12 (Tu) | Models for competing risk (by Dr. Yu Cheng) | Models and summary curves for competing risk data | Chp2.7, 4.7 |
| 2/16 (Fr) | No Class | *Happy Lunar New Year* | |
| 2/20 (Tu) | Hypothesis Testing (by Tao Sun) | One-sample tests for right-censored data | Chp7.1-7.2 |
| 2/23 (Fr) | Hypothesis Testing (continue, by Dr. Jong Jeong) | Test for two or more samples | Chp7.3, 7.7 |
| 2/27 (Tu) | Hypothesis Testing (continue) | Tests for trend, stratified tests, Renyi type tests | Chp7.4-7.6 |
| 3/2 (Fr) | **MIDTERM EXAME** | | |
| 3/13 (Tu) | Parametric Regression Models | Introduction of parametric model framework, Weibull regression model | Chp12.1-12.2 |
| 3/16 (Fr) | Parametric Regression Models (continue) | Log logistic regression model | Chp12.3 |

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| 3/20 (Tu) | Semiparametric PH Models with Fixed Covariates | Introduction of semiparametric framework, partial likelihood without ties | Chp8.1-8.3 |
| 3/23 (Fr) | Semiparametric PH Models with Fixed Covariates (continue) | Partial likelihood with ties, local tests | Chp8.4-8.5 |
| 3/27 (Tu) | Semiparametric PH Models with Fixed Covariates (continue) | PH model building, estimation of survival functions | Chp8.7-8.8 |
| 3/30 (Fr) | Semiparametric PH Models under more challenged situations | Time-dependent covariates | Chp9.1-9.2 |
| 4/3 (Tu) | Semiparametric PH Models under more challenged situations (continue) | Stratified PH models, PH models for left-truncated data | Chp9.3-9.4 |
| 4/6 (Fr) | Regression Diagnostics | Different types of residuals, determination the functional form of a covariate | Chp11.1-11.3 |
| 4/10 (Tu) | Regression Diagnostics (continue) | graphical checks, detection of influential observations | Chp11.4-11.6 |
| 4/13 (Fr) | Special topic 1 | Models for bivariate survival data | |
| 4/17 (Tu) | Special topic 2 | Multistate models (tentative) | |
| 4/19 (Fr) | Final Project Presentations - 1 | | |
| 4/24 (Tu) | Final Project Presentations - 2 | **Final project report is due by 5pm 4/24 (Tuesday)** | |

**Note: no classes on March 6, 9 (Spring break).**