2019 Conference on Lifetime Data Science: Foundations and Frontiers

The 2^{nd} Conference on Lifetime Data Science

University of Pittsburgh

Pittsburgh, Pennsylvania, USA

May 29 – 31, 2019

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Welcome

On behalf of the Program Committee we are very pleased to extend a warm welcome to the *2019 Conference on Lifetime Data Science: Foundations and Frontiers*. This three day event is modeled after the highly successful inaugural lifetime data science conference whose scientific program was co-Chaired by Mei-Cheng Wang and Jack Kalbfleisch and graciously hosted by the University of Connecticut in 2017.

We have another wonderful program this year, beginning with short courses by leading researchers in life history methods which are followed by a welcome reception and poster session taking place from 6:30 to 8:30 p.m. on Wednesday, May 29 at the Wyndham Hotel. We are delighted to have Keynote Presentations by Professors Odd Aalen, Danyu Lin and Ross Prentice, each of whom have made important pioneering contributions in statistical methods for the design and analysis of life history studies. The program is also packed with a series of exciting invited sessions which will make it hard to choose which sessions to attend so we encourage you to plan ahead. This can be achieved using the Whova cell phone app which we encourage you to download if you haven't already!

The many exciting areas of research within lifetime data science are clearly in evidence from our scientific program. The theme this year of "Foundations and Frontiers" was chosen to acknowledge the importance of the foundations of our discipline when tackling new problems arising in the frontiers of modern science and technology. The challenges include high dimensional genomic data, dependent selection and observation schemes, issues surrounding estimands and causal inference, use of administrative data for scientific inquiry, among many others. Statistical science is a young and exciting discipline and we are fortunate that many of the founding researchers continue to be active making important contributions to our discipline and maintain their scientific leadership. You may well find yourself sitting next to such a person at this meeting!

To put a conference together of this magnitude is no small task and there are many people to thank. First we wish to thank Professor Ying Ding and Professor Yu Cheng along with all of the members of the Local Arrangements Committee for their leadership, hard work, and dedication. Their tireless efforts at managing the registration, Whova app, website and facilities have ensured things run smoothly and that we are able to enjoy this wonderful venue. We extend this thanks to the staff devoted to this conference at the University of Pittsburgh and University of Waterloo, and the Department of Biostatistics and Department of Statistics at University of Pittsburgh in particular. We also gratefully acknowledge the Executive Committees of the Lifetime Data Analysis Interest Group, and more recently the ASA Section on Lifetime Data Science, for their wisdom and guidance during the planning stages of the event.

The Student Paper Competition drew a remarkable number of submissions which attests to the health of our discipline. We thank Professor Guoqing Diao and the members of the Student Paper Award Committee for promoting the event, reviewing the many papers, and taking on the difficult task of selecting the winners. There was a very strong pool of candidates and we thank all participants, congratulate the winners and look forward to hearing their presentations during the conference. Their awards will be presented at the conference banquet at the Wyndham Hotel on the evening of May 30 at 6:00 p.m..

This conference also serves as a chance to celebrate the creation of our Section on Lifetime Data Science within the American Statistical Association, which took effect in January of this year. The support expressed for the creation of our section was very strong and the enthusiasm is reflected by the engagement of our members in every aspect of the program.

Finally we would like to thank all session organizers whose efforts have ensured our exceptional scientific program, and the speakers whose work form the foundation of this conference.

In conclusion, we hope you enjoy your visit to Pittsburgh and take the time to renew friendships and extend your networks. We hope there are also lots of opportunities to jointly explore current and future research directions and that you have a productive and fun-filled time at this very special conference.

We are privileged to be co-chairs of this important conference and hope you find it a rewarding event.

Richard Cook
Co-Chair, Program Committee
University of Waterloo

Jianwen Cai
Co-Chair, Program Committee
University of North Carolina at Chapel Hill

Acknowledgements

The ASA Lifetime Data Science (LiDS) section would like to acknowledge the generous support from the following committees and teams. We also gratefully acknowledge our student volunteers.

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Program Overview

Wednesday May 29

8:30 – 16:30	Short Courses
	Short Course I: **Ørnulf Borgan & Sven Ove Samuelsen** Two Phase Studies for Lifetime Data
	Short Course II: **Hein Putter** Dynamic Prediction in Survival Analysis
	Short Course III: **Jing Qin** Biased Sampling, Left Truncation and Survival Analysis
18:30 – 20:30	Poster Session and Welcome Reception at *Wyndham Hotel*

Thursday May 30

8:45 – 9:00 Welcome

9:00 – 10:00 Keynote Presentation: **Odd O. Aalen**
Causal Inference for Survival Data, with Emphasis on Mediation Analysis

10:00 – 10:30 Refreshment Break

10:30 – 12:00 Invited Sessions

1. **Ming-Hui Chen**: Recent Development of Bayesian Joint Modeling of Time-to-Event and Longitudinal or Spatial Data
2. **Yu Cheng**: Novel Semi-parametric Models for Complex Survival Data
3. **Guoqing Diao**: Advances in the Analysis of Composite Endpoints subject to Component-wise Censoring
4. **Noorie Hyun**: Survival Analysis Methods for Complex Sample Data
5. **Torben Martinussen**: Causal Conclusions Based on Cox Regression Analysis
6. **Edsel A. Peña**: Threshold Modeling, Cancer Risk, and Agreement Assessments
7. **Jonathan Siegel**: Estimands: The First Update to Regulatory Statistical Guidance in 20 Years - The Pharmaceutical Industry Working Group on Estimands in Oncology
8. **Ronghui (Lily) Xu**: Prediction and Estimation for Complex Survival Data

13:30 – 15:00 Invited Sessions

9. **Chunyan Cai and Yongseok Park**: Clinical Trial Design and Data Analysis with Late-Onset Effects
10. **Wei Chen**: Advanced Analysis Methods for Survival Outcome with High-Dimensional Data
11. **Richard Cook**: Founders Session on Current Topics in Lifetime Data Analysis
12. **Jon Michael Gran**: Causal Inference in Life History Analysis
13. **Hélène Jacqmin-Gadda**: Joint Models for Time-to-Event and Multiple Longitudinal Data or High Dimensional Data
14. **Daniel Nevo**: Survival Analysis with Error-Prone or Missing Covariate Measurements
15. **Douglas Schaubel**: Novel Methods for the Analysis of Recurrent Event Data
16. **Mei-Ling Ting Lee**: New Methods for Complex Censored Data

15:00 – 15:30 Refreshment Break

15:30 – 17:00 Invited Sessions

17. **Jianwen Cai**: Advanced Statistical Methods for Time to Event Data in Complex Observational Studies
18. **Ying Ding**: Recent Advances in Complex Bivariate Time-to-Event Data Modeling and Analysis
19. **Ruzong Fan**: Complex Data Analysis in the Biomedical and Health Research
20. **Chiung-Yu Huang**: Recent Advances in Survival and Recurrent Event Data Analysis
21. **Lei Liu**: Survival Analysis Methods for Alzheimer's Disease
22. **Ruth Pfeiffer**: Mediation Analysis for High-Dimensional Data
23. **Rajeshwari Sundaram**: Innovative Applications of Joint Modeling
24. **Mei-Ling Ting Lee**: Applied Stochastic Models for Time-to-Event Data

18:00 – 20:30 Banquet at *Wyndham Hotel*

Friday May 31

8:00 – 9:00 Keynote Presentation: **Ross Prentice**
Regression Models and Multivariate Life Tables

9:00 – 10:00 Keynote Presentation: **Danyu Lin**
Semiparametric Regression Analysis of Interval-Censored Data

10:00 – 10:30 Refreshment Break

10:30 – 12:00 Invited Sessions

25. **Paul Albert**: Innovative Approaches for Studying the Effects of Chemical Mixtures on Disease Throughout the Life-span
26. **Rebecca A. Betensky**: Methods for Dependent Truncation
27. **Richard Cook**: Methods for Lifetime Data Processes Under Intermittent Observation
28. **X. Joan Hu**: Cross-Sectional Analysis of Life History Data
29. **Aiyi Liu**: Novel Approaches for Time-to-Event Data
30. **Edsel A. Peña**: Multiple Testing, Simultaneous and Joint Modeling, and Calibration
31. **Mei-Ling Ting Lee**: Genomic Applications with Survival Outcomes
32. **Mei-Cheng Wang**: New Methods for Risk Prediction and Precision Medicine
33. **Ronghui (Lily) Xu**: Causal Inference for Survival Data

13:30 – 15:00 Invited Sessions

34. **Guoqing Diao**: Session for Student Paper Award Winners (1)
35. **Lu Mao**: Causal Inference with Time-to-Event Data
36. **Hein Putter**: Multistate Models as A Framework for Life History Analysis
37. **Thomas Scheike**: Models and Applications with Recurrent Events
38. **Yu Shen**: Challenges and Advances of Research in Health Service Studies
39. **Rajeshwari Sundaram**: Innovative Methods for Assessing Diagnostic Accuracy and Prediction Accuracy
40. **Andrew Titman**: Extensions to Joint Longitudinal-Survival Modelling
41. **Grace Y. Yi**: Emerging Issues and Methods on Censored Data
42. **Leilei Zeng**: Intermittent Observation of Life History Processes

15:00 – 15:30 Refreshment Break

15:30 – 17:00 Invited Sessions

43. **Mouna Akacha**: Multi-State Models in Practice
44. **Guoqing Diao**: Session for Student Paper Award Winners (2)
45. **Jong Hyeon Jeong**: Recent Developments in Statistical Methods on Semi-Competing Risks Data
46. **Bin Nan**: Survival Analysis with Missing or Mismeasured Data
47. **Hua Shen**: Recent Advances in the Analysis of Complex Lifetime Data Involving Recurrent Events
48. **Xiao Song**: Personalized Treatment Selection with Censored Survival Outcome
49. **Jianguo (Tony) Sun**: Recent Development in the Analysis of Recurrent Event Data
50. **Donglin Zeng**: Novel Application of Survival Models in Complex Biomedical Studies

Keynote Presentations: Details

Causal Inference for Survival Data, with Emphasis on Mediation Analysis

Odd O. Aalen (University of Oslo, Norway)

Overview

Causal inference is becoming an important theme in survival analysis. We discuss causal mediation analyses for survival data and propose an approach based on the additive hazards model. The emphasis is on a dynamic point of view, that is, understanding how the direct and indirect effects develop over time. To define direct and indirect effects in a longitudinal survival setting we take an interventional approach (Didelez, 2018) where treatment is separated into one aspect affecting the mediator and a different aspect affecting survival. In general, this leads to a version of the non-parametric g-formula (Robins, 1986). In the present talk, we demonstrate that combining the g-formula with the additive hazards model and a linear structural equation model for the mediator process results in simple and interpretable expressions for direct and indirect effects in terms of relative survival as well as cumulative hazards. Our results generalise and formalise the method of dynamic path analysis (Fosen et al, 2006; Strohmaier et al, 2015) and also work by Lange and Hansen (2011). An application will be given.

About the Keynote Speaker

Odd O. Aalen is Professor Emeritus of Biostatistics at the University of Oslo and member of the Oslo Centre for Biostatistics and Epidemiology. His doctoral work, completed at the University of California, Berkeley in 1976, led to a revolution in the field of survival analysis by reformulating it in terms of counting processes thereby enabling the use of martingales for the development of large sample theory. Odd has made many important contributions to the fields of survival and event history analysis including the development of nonparametric methods of estimation, additive hazards models, advancing understanding of the implications of frailty in sampling and analyses, and causal analysis with life history data through dynamic path analysis. Much of this work is reflected in the highly acclaimed 2008 Springer book with Ørnulf Borgan and Håkon Gjessing entitled *Survival and Event History Analysis: A Process Point of View*. His collaborative work has included infectious disease epidemiology, screening for and treatment of cancer, the effects of gestational alcohol exposure, and studies of employment and disability. He is Fellow of the American Statistical Association, was the 2008 Armitage Lecturer at the University of Cambridge and is an elected member of the Norwegian Academy of Science and Letters.

Regression Models and Multivariate Life Tables

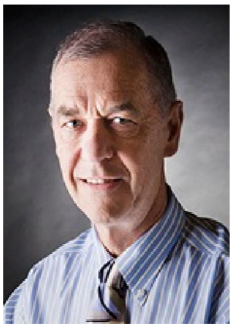
Ross Prentice (Fred Hutchinson Cancer Research Center/University of Washington)

Overview

Regression methods that adapt Cox regression to multivariate failure times, on the same or different failure time axes, will be presented. These methods specify Cox-type semiparametric regression models for marginal single and double failure rates, and use estimating functions and empirical process methods, like those developed by Danyu Lin, L.J. Wei and colleagues for marginal single failure hazard rates, for hazard ratio parameter and for baseline hazard rate estimation. Sandwich type variance process estimators are developed for all model parameters, along with a perturbation resampling procedure for complex constructs of modeled parameters. As a byproduct semiparametric estimators of pairwise survivor functions, given covariates that may be evolving in time, are readily obtained from Peano series representations of these survivor functions in terms of marginal single and double failure rates, and corresponding semiparametric estimators of cross ratio and concordance functions are also readily obtained to characterize pairwise dependencies between failure times given covariates. An application to clinical outcome data from a large low-fat dietary intervention trial among post menopausal women will be presented, and some contrast between these approaches and those based on counting process intensity modeling, as well as on frailty and copula modeling, will be provided. This is joint work with Dr. Shanshan Zhao of NIEHS.

About the Keynote Speaker

Ross Prentice is an ongoing member and former Director of the Public Health Sciences Division of the Fred Hutchinson Cancer Research Center, and is Professor of Biostatistics at the University of Washington.



Ross has made substantial and pioneering contributions in biostatistics and epidemiology with an emphasis on issues arising in the analysis of failure time data. These include the development of innovative research designs, methods for the use of surrogate endpoints, and methods for dealing with covariate measurement error. Ross' work has been motivated through problems arising in his long-standing collaborations in genetic epidemiology, nutritional epidemiology, biomarker studies, and cancer research. He served as Principal Investigator of the Clinical Coordinating Center for the Womens Health Initiative from 1992-2011 and continues to serve as Co-PI. He is a Member (1990) of the Institute of Medicine/National Academy of Sciences, and served on its Food and Nutrition Board. Honors include the Marvin Zelen Leadership Award from Harvard University, the Prentice Professorship for Biostatistical Collaboration at the University of Washington, the Research Excellence in Epidemiology and Prevention Award from the American Association for Cancer Research (AACR), the Team Science Award from the AACR, and the COPSS Presidents and R.A. Fisher Lectureship awards.

Semiparametric Regression Analysis of Interval-Censored Data

Danyu Lin (University of North Carolina at Chapel Hill)

Overview

Interval censoring arises frequently in clinical, epidemiological, financial, and sociological studies, where the event or failure of interest is not observed at an exact time point but is rather known to occur within a time interval induced by periodic monitoring. We formulate the effects of potentially time-dependent covariates on the interval-censored failure time through semiparametric regression models, such as the Cox proportional hazards model. We study nonparametric maximum likelihood estimation with an arbitrary number of monitoring times for each study subject. We develop an EM algorithm that involves very simple calculations and converges stably for any dataset, even in the presence of time-dependent covariates. We show that the estimators for the regression parameters are consistent, asymptotically normal, and asymptotically efficient with an easily estimated covariance matrix. In addition, we extend the EM algorithm and asymptotic theory to competing risks and multivariate failure time data. Finally, we demonstrate the desirable performance of the proposed numerical and inferential procedures through simulation studies and applications to real medical studies.

About the Keynote Speaker

Danyu Lin is the Dennis Gillings Distinguished Professor of Biostatistics, a Member of the Lineberger Comprehensive Cancer Center, and a member of the Center for AIDS Research. Danyu is a prolific researcher with most of his articles appearing in leading statistical and genetic journals. He has made many fundamental contributions to statistical methods for the designs and analysis of biomedical studies, especially in the areas of survival analysis and statistical genetics. Danyu also has extensive applied research experience in cancer, cardiovascular diseases, AIDS, and psychiatry. He has received numerous honors and awards, including Fellow of both the American Statistical Association and the Institute of Mathematical Statistics, Mortimer Spiegelman gold medal from the American Public Health Association for outstanding contributions to biostatistics, and George W. Snedecor Award from the Committee of Presidents of Statistical Societies for the development of statistical theory in biometry. He has served on many editorial and advisory boards, including Associate Editor of Biometrika, Journal of the American Statistical Association and Biometrics, Consultant to the FDA, the Site Visit Team to the NCI Biostatistics Branch, and the External Advisory Committee of Fred Hutchinson Cancer Research Center.

Scientific Program

Wednesday May 29

Wednesday May 29, 8:30 – 16:30

Wednesday May 29, 8:30 – 16:30 **Short Course I** **BENEDUM G29**

8:30 – 16:30 **Ørnulf Borgan** (University of Oslo, Norway) and
Sven Ove Samuelsen (University of Oslo, Norway)
Two Phase Studies for Lifetime Data

Wednesday May 29, 8:30 – 16:30 **Short Course II** **BENEDUM G30**

8:30 – 16:30 **Hein Putter** (Leiden University Medical Centre, The Netherlands)
Dynamic Prediction in Survival Analysis

Wednesday May 29, 8:30 – 16:30 **Short Course III** **BENEDUM G31**

8:30 – 16:30 **Jing Qin** (NIH/NIAID)
Biased Sampling, Left Truncation and Survival Analysis

Wednesday May 29, 10:00-10:30 Refreshment break **BENEDUM Lobby**
14:30-15:00 Refreshment break **BENEDUM Lobby**

Wednesday May 29, 18:30 – 20:30

Wednesday May 29, 18:30 – 20:30 **Wyndham Hotel**

18:30 – 20:30 **Poster Session and Welcome Reception**

Xiaotian Gao (University of Pittsburgh)
Inference on Mean Quality-adjusted Lifetime Using Joint Models for Continuous Quality of Life Process and Time to Event

Isabelle Weir (Boston University School of Public Health)
Multivariate meta-analysis model for the difference in restricted mean survival times

Pål Christie Ryalen (University of Oslo)
The additive hazard estimator is consistent for continuous-time marginal structural models

Tao Sun (University of Pittsburgh)
Machine learning with GWAS to predict AMD progression

Cynthia Crowson (Mayo Clinic)
Creating and error-checking datasets for survival and multi-state models

Elizabeth Atkinson (Mayo Clinic)
Calculating Adjusted Survival Curves

Xinjun Wang (University of Pittsburgh)
A comparison and assessment of tree-based methods for subgroup identification with time-to-event data

Jimmy Efird (Cooperative Studies Program Epidemiology Center)
Asymptotic Distribution of Constrained Left-Tailed Survival Densities

18:30 – 20:30 **Poster Session and Welcome Reception**

Myeonggyun Lee (New York University)
Empirical comparison of Sub-cohort sampling designs for Breast cancer risk prediction model on the NYU Woman's Health Study (NYUWHS)

Huining Kang (University of New Mexico)
A cost-effective approach to high-throughput gene expression analysis under case-cohort design

Sarah Conner (Boston University)
Association between body mass index and risk of atrial fibrillation in the Framingham Heart Study: g-formula method and difference in restricted mean survival times

Andrew Ying (University of California San Diego)
Causal Effects on Birth Defects with Missing by Terathanasia

Niklas Maltzahn (Oslo Center for Biostatistics and Epidemiology)
Hybrid Landmark estimation of transition probabilities

Yun-Hee Choi (Department of Epidemiology and Biostatistics, University of Western Ontario)
Joint nested frailty models for clustered recurrent and terminal events: An application to colonoscopy screening visits and colorectal cancer risks in Lynch Syndrome families

Busola Sanusi (University of North Carolina at Chapel Hill)
Nonparametric Estimation of the Joint Distribution of a Survival Time and Mark Variable in the Presence of Dependent Censoring

Adane F. Wogu (University of North Carolina at Chapel Hill)
Proportional Subdistribution Hazards Model for Competing Risks in Case-Cohort Studies

Thursday May 30

Thursday May 30, 8:45 – 9:00

Thursday May 30, 8:45–9:00 **BENEDUM 157**

8:45 – 9:00 Welcome

Thursday May 30, 9:00 – 10:00

Thursday May 30, 9:00 – 10:00 **Keynote Presentation** **BENEDUM 157**

Keynote Presentation: Odd O. Aalen

Chair: Richard Cook (University of Waterloo, Canada)

9:00 – 10:00 **Odd O. Aalen** (University of Oslo, Norway)
Causal Inference for Survival Data, with Emphasis on Mediation Analysis

Thursday May 30, 10:00 – 10:30

Thursday May 30, 10:00–10:30 **BENEDUM Hall Lobby**

10:00 – 10:30 Refreshment Break

Thursday May 30, 10:30 – 12:00

Thursday May 30, 10:30 – 12:00 **Invited Session 1** **BENEDUM G30**

Recent Development of Bayesian Joint Modeling of Time-to-Event and Longitudinal or Spatial Data

Chair: Dandan Liu (University of Vanderbilt)

Organizer: Ming-Hui Chen (University of Connecticut)

10:30 – 10:55 **Paul Albert** (NIH/NCI)
A Joint Model Approach for Longitudinal Data with no Time-Zero and Time-To-Event with Competing Risks

10:55 – 11:20 **Guanyu Hu** (University of Connecticut)
Bayesian Variable Selection for Cox Regression Model with Spatially Varying Coefficients with Applications

11:20 – 11:45 **Ming-Hui Chen** (University of Connecticut)
Assessing Importance of Biomarkers: a Bayesian Joint Modeling Approach of Longitudinal and Survival Data with Semicompeting Risks

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Thursday May 30, 10:30 – 12:00 **Invited Session 2** **BENEDUM G31**

Novel Semi-parametric Models for Complex Survival Data

Chair and Organizer: Yu Cheng (University of Pittsburgh)

10:30 – 10:50 **Jing Ning** (University of Texas MD Anderson Cancer Center)
Semiparametric Model and Inference for Bivariate Survival Data Subject to Biased Sampling

10:50 – 11:10 **Sunyoung Shin** (University of Texas at Dallas)
Ensemble Estimation and Variable Selection with Semiparametric Regression Models

11:10 – 11:30 **Xianghua Luo** (University of Minnesota)
Time-dependent Covariates in Recurrent Event Models

11:30 – 11:50 **Thomas Scheike** (University of Copenhagen, Denmark)
Excess Risk in the Matched Cohort Study

Thursday May 30, 10:30 – 12:00 **Invited Session 3** **BENEDUM G36**

Advances in the Analysis of Composite Endpoints subject to Component-wise Censoring

Chair: Qingxia Chen (Vanderbilt University)

Organizer: Guoqing Diao (George Mason University)

10:30 – 10:50 **Junshan Qiu** (FDA)
The Win Ratio : On Interpretation and Handling of Ties

10:50 – 11:10 **Audrey Boruvka** (Roche, Canada)
Computation and Applications in Joint Models for Progression and Survival under Componentwise Censoring

11:10 – 11:30 **Ingrid Van Keilegom** (KU Leuven, Belgium)
A Multivariate Normal Regression Model for Survival Data Subject to Different Types of Dependent Censoring

11:30 – 11:50 **Guoqing Diao** (George Mason University)
Semiparametric Regression Analysis for Composite Endpoints Subject to Component-Wise Censoring

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Thursday May 30, 10:30 – 12:00 **Invited Session 4** **BENEDUM G27**

Survival Analysis Methods for Complex Sample Data

Chair: Jaeun Choi (Albert Einstein College of Medicine)

Organizer: Noorie Hyun (Medical College of Wisconsin)

10:30 – 10:55 **Takumi Saegusa** (University of Maryland, College Park)
Survival Analysis for Integrated Data from Multiple Sources

10:55 – 11:20 **Noorie Hyun** (Medical College of Wisconsin)
Sample-Weighted Semiparametric Models for Competing Risks Data Subject to Left-/Interval Censoring from Electronic Health Records

11:20 – 11:45 **Ai (Andy) Ni** (Ohio State University)
Concordance Measures in Survival Analysis on Survey Data

Thursday May 30, 10:30 – 12:00 **Invited Session 5** **BENEDUM G29**

Causal Conclusions Based on Cox Regression Analysis

Chair: Ying Ding (University of Pittsburgh)

Organizer: Torben Martinussen (University of Copenhagen, Denmark)

10:30 – 10:55 **Jonathan Bartlett** (University of Bath, UK)
Hazard Ratios - What's Different and What's Not

10:55 – 11:20 **Morten Valberg** (Oslo University Hospital, Norway)
Potential Causal Consequences of Observed Proportional Hazards

11:20 – 11:45 **Torben Martinussen** (University of Copenhagen, Denmark)
Subtleties in the Interpretation of Hazard Ratios

Thursday May 30, 10:30 – 12:00 **Invited Session 6** **BENEDUM 158**

Threshold Modeling, Cancer Risk, and Agreement Assessments

Chair: Jonathan Race (Ohio State University)

Organizer: Edsel A. Peña (University of South Carolina)

10:30 – 10:55 **Michael Pennell** (Ohio State University)
A Bayesian Semiparametric First Hitting Time Model for Latent Fetal Development

10:55 – 11:20 **Jung In Kim** (NIH/NIEHS)
Accounting for Preinvasive Conditions in the Analysis of Invasive Cancer Risk: With Application to Breast Cancer and the Sister Study

11:20 – 11:45 **AKM Fazlur Rahman** (University of Alabama at Birmingham)
Nonparametric Regression Method for Broad Sense Agreement

Thursday May 30, 10:30 – 12:00 **Invited Session 7** **BENEDUM 227**

Estimands: The First Update to Regulatory Statistical Guidance in 20 Years - The Pharmaceutical Industry Working Group on Estimands in Oncology

Chair: Ulrich Beyer (Roche)

Organizer: Jonathan Siegel (Bayer)

10:30 – 10:55 **Jonathan Siegel** (Bayer)
Survival Trial Design Strategies in an Estimands Framework

10:55 – 11:20 **Feng Liu** (AstraZeneca)
Developing Estimands in Oncology Trials : Understand Scientific Questions of Interest

11:20 – 11:45 **Shoubhik Mondal** (Boehringer Ingelheim)
Sensitivity Analyses in Estimands in Oncology

Discussant: **Anja Schiel** (EMA/CHMP)

Thursday May 30, 10:30 – 12:00 **Invited Session 8** **BENEDUM G28**

Prediction and Estimation for Complex Survival Data

Chair: Andrew Ying (University of California, San Diego)

Organizer: Ronghui (Lily) Xu (University of California, San Diego)

10:30 – 10:55 **Yingwei (Paul) Peng** (Queen's University, Canada)
Measures of Explained Variation under the Cure Model for Survival Data

10:55 – 11:20 **Wenqing He** (Western University, Canada)
Parametric and Semiparametric Estimation Methods for Survival Data under a Flexible Class of Models

11:20 – 11:45 **Yuan Wu** (Duke University)
Predictive Accuracy of Markers or Risk Scores for Interval Censored Survival Data

Thursday May 30, 12:00 – 13:30

Thursday May 30, 12:00 – 13:30

12:00 – 13:30 Lunch Break

Thursday May 30, 13:30 – 15:00

Thursday May 30, 13:30 – 15:00 **Invited Session 9** **BENEDUM G37**

Clinical Trial Design and Data Analysis with Late-Onset Effects

Chair: Chi Hyun Lee (University of Massachusetts Amherst)

Organizer: Chunyan Cai (University of Texas Health Science Center at Houston) and Yongseok Park (University of Pittsburgh)

13:30 – 13:50 **Chunyan Cai** (University of Texas Health Science Center at Houston)
A Bayesian Design for Phase II Clinical Trials with Late-onset Responses Based on Multiple Imputation

13:50 – 14:10 **Ruitao Lin** (University of Texas MD Anderson Cancer Center)
Time-to-Event Bayesian Optimal Phase II Trial Design for Cancer Immunotherapy

14:10 – 14:30 **Mengling Liu** (New York University)
Design and Analysis of Clinical Trials in the Presence of Delayed Treatment Effect

14:30 – 14:50 **Yongseok Park** (University of Pittsburgh)
Designing Cancer Immunotherapy Trials with Random Treatment Time-Lag Effect

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Thursday May 30, 13:30 – 15:00 **Invited Session 10** **BENEDUM G31**

Advanced Analysis Methods for Survival Outcome with High-Dimensional Data

Chair: Ruzong Fan (Georgetown University Medical Center)

Organizer: Wei Chen (University of Pittsburgh School of Medicine)

13:30 – 13:55 **Heng Huang** (University of Pittsburgh)
Deep Learning for Biomedical Data Analysis

13:55 – 14:20 **Yanming Li** (University of Michigan)
XG Boosting Variable Selection for a Discrete Time Cure Rate Survival Model with High-Dimensional Time Varying Imaging Predictors

14:20 – 14:45 **Ying Ding** (University of Pittsburgh)
A Copula-Based Semiparametric Model for Progression Prediction of Age-Related Macular Degeneration (AMD) using GWAS Data

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Thursday May 30, 13:30 – 15:00 **Invited Session 11** **BENEDUM G29**

Founders Session on Current Topics in Lifetime Data Analysis

Chair and Organizer: Richard Cook (University of Waterloo, Canada)

13:30 – 13:55 **Mei-Ling Ting Lee** (University of Maryland, College Park)
Distribution-free Threshold Regression for Longitudinal Time-to-event Analysis

13:55 – 14:20 **Jack Kalbfleisch** (University of Michigan)
Direct and Indirect Standardized Mortality Ratios Based on the Cox Model

14:20 – 14:45 **Mei-Cheng Wang** (Johns Hopkins University)
Complexity in Simple Cross-Sectional Data with Binary Disease Outcome

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Thursday May 30, 13:30 – 15:00 **Invited Session 12** **BENEDUM G30**

Causal Inference in Life History Analysis

Chair and Organizer: Jon Michael Gran (University of Oslo, Norway)

13:30 – 13:55 **Kjetil Røysland** (University of Oslo, Norway)
Causal Interpretation in Survival Analysis

13:55 – 14:20 **Mats Julius Stensrud** (University of Oslo, Norway)
New Estimands for Causal Inference in the Presence of Competing Risks

14:20 – 14:45 **Ruth Keogh** (London School of Hygiene and Tropical Medicine)
The sequential trials approach for estimating effects of treatment on survival using longitudinal observational data

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Thursday May 30, 13:30 – 15:00 **Invited Session 13** **BENEDUM 158**

Joint Models for Time-to-Event and Multiple Longitudinal Data or High Dimensional Data

Chair: Virginie Rondeau (Université de Bordeaux, France)

Organizer: Hélène Jacqmin-Gadda (Université de Bordeaux, France)

13:30 – 13:55 **Sheng Luo** (Duke University)
Dynamic Prediction of Alzheimer's Disease Progression Using Features of Multiple Longitudinal Outcomes and Time-to-Event Data

13:55 – 14:20 **Cecile Proust-Lima** (Université de Bordeaux, France)
Joint Modelling of Multiple Latent Processes and Clinical Endpoints: Application in Alzheimers Disease

14:20 – 14:45 **Dimitris Rizopoulos** (Erasmus University Medical Center, The Netherlands)
Using Joint Models for Personalized Optimal Scheduling of Invasive Procedures

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Thursday May 30, 13:30 – 15:00 **Invited Session 14** **BENEDUM G36**

Survival Analysis with Error-Prone or Missing Covariate Measurements

Chair: Malka Gorfine (Tel Aviv University, Israel)

Organizer: Daniel Nevo (Tel Aviv University, Israel)

13:30 – 13:55 **Daniel Nevo** (Tel Aviv University, Israel)
A Novel Calibration Framework for Survival Analysis When a Binary Covariate is Measured at Sparse Time Points

13:55 – 14:20 **Xiao Song** (University of Georgia)
Partially Time-Varying Coefficient Proportional Hazards Models with Error-Prone Time-Dependent Covariates -an Application to the AIDS Clinical Trial Group 175 Data

14:20 – 14:45 **Molin Wang** (Harvard University)
Semi parametric Methods for Exposure Misclassification in Propensity Score-Based Time-to-Event Data Analysis

Discussant: **Malka Gorfine** (Tel Aviv University, Israel)

Thursday May 30, 13:30 – 15:00 **Invited Session 15** **BENEDUM G27**

Novel Methods for the Analysis of Recurrent Event Data

Chair and Organizer: Douglas Schaubel (University of Michigan)

13:30 – 13:55 **Jianwen Cai** (University of North Carolina at Chapel Hill)
Analysis of Recurrent Events Data from Case-Cohort Studies

13:55 – 14:20 **Chiung-Yu Huang** (University of California, San Francisco)
Recurrent Events Analysis with Data Collected at Informative Clinical Visits

14:20 – 14:45 **Sehee Kim** (University of Michigan)
Risk Discrimination Indexes for Recurrent Event Models : An Application to Identify Modifiable Risk Factors of Hospitalizations Among Dialysis Patients

Thursday May 30, 13:30 – 15:00 **Invited Session 16** **BENEDUM G28**

New Methods for Complex Censored Data

Chair: Chien-Yu Peng (Academia Sinica, Taiwan)

Organizer: Mei-Ling Ting Lee (University of Maryland, College Park)

13:30 – 13:50 **Chung-Chou H. (Joyce) Chang** (University of Pittsburgh)
Modeling Exposure-Time-Response Association in the Presence of Competing Risks

13:50 – 14:10 **Catherine Huber** (University of Paris, France)
Efficient Semiparametric Maximum Likelihood Estimation (SPMLE) Under Interval Censoring and Truncation

14:10 – 14:30 **Ying Qing Chen** (University of Washington)
Data Enriched Regression for Censored Time-to-Event

14:30 – 14:50 **Jonathan Race** (Ohio State University)
Semiparametric Bayes Testing of Ordinal Effects on Survival

Thursday May 30, 15:00 – 15:30

Thursday May 30, 15:00 – 15:30 **BENEDUM Hall Lobby**

15:00 – 15:30 Refreshment Break

Thursday May 30, 15:30 – 17:00

Thursday May 30, 15:30 – 17:00 **Invited Session 17** **BENEDUM G29**

Advanced Statistical Methods for Time to Event Data in Complex Observational Studies

Chair and Organizer: Jianwen Cai (University of North Carolina at Chapel Hill)

15:30 – 15:50 **Haibo Zhou** (University of North Carolina at Chapel Hill)
Secondary Analysis in Outcome Dependent Sampling Studies

15:50 – 16:10 **Yu Shen** (University of Texas MD Anderson Cancer Center)
Density Ratio Model for Analyzing Length-Biased Data

16:10 – 16:30 **Qingning Zhou** (University of North Carolina at Charlotte)
Two-stage Outcome-dependent Sampling with Interval-censored Failure Time Data

16:30 – 16:50 **Donglin Zeng** (University of North Carolina at Chapel Hill)
Semiparametric Regression Analysis of Multiple Right- and Interval-Censored Events

Thursday May 30, 15:30 – 17:00 **Invited Session 18** **BENEDUM G30**

Recent Advances in Complex Bivariate Time-to-Event Data Modeling and Analysis

Chair and Organizer: Ying Ding (University of Pittsburgh)

15:30 – 15:55 **Yu Cheng** (University of Pittsburgh)
Quantile Association Model for Bivariate Survival Data

15:55 – 16:20 **Joanna Shih** (NIH/NCI)
Survival Analysis of Error-prone Self-report Time-to-event Outcome with an Internal Validation Sample Identified from a Mover-Stayer Model

16:20 – 16:45 **Jong Hyeon Jeong** (University of Pittsburgh)
A Clustered Win Ratio for Semi-Competing Risks Data

Discussant: **Richard Cook** (University of Waterloo, Canada)

Thursday May 30, 15:30 – 17:00 **Invited Session 19** **BENEDUM 158**

Complex Data Analysis in the Biomedical and Health Research

Chair: Wei Chen (University of Pittsburgh School of Medicine)

Organizer: Ruzong Fan (Georgetown University Medical Center)

15:30 – 15:50 **Christopher I. Amos** (Baylor College of Medicine)
Understanding Complex Etiology of Autoimmune Diseases by Application of Machine Learning Tools

15:50 – 16:10 **Jason H. Moore** (University of Pennsylvania)
Accessible Artificial Intelligence for Data Science

16:10 – 16:30 **Saonli Basu** (University Of Minnesota)
A Robust and Unified Framework for Estimating Heritability in Twin Studies using Generalized Estimating Equations

16:30 – 16:50 **Ruzong Fan** (Georgetown University Medical Center)
Mixed Models for Gene-based Association Analysis of Complex Traits

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Thursday May 30, 15:30 – 17:00 **Invited Session 20** **BENEDUM G36**

Recent Advances in Survival and Recurrent Event Data Analysis

Chair and Organizer: Chiung-Yu Huang (University of California, San Francisco)

15:30 – 15:50 **Lili Wang** (University of Michigan)
Penalized Survival Models for the Analysis of Alternating Recurrent Event Data

15:50 – 16:10 **Yifei Sun** (Columbia University Mailman School of Public Health)
Survival Forest for Dynamic Risk Prediction

16:10 – 16:30 **Zhezhen Jin** (Columbia University Mailman School of Public Health)
On Time to Event Analysis for Transplant Data

16:30 – 16:50 **Mi-Ok Kim** (University of California, San Francisco)
Extended Likelihood Methods for Censored Data

Thursday May 30, 15:30 – 17:00 **Invited Session 21** **BENEDUM G27**

Survival Analysis Methods for Alzheimer's Disease

Chair and Organizer: Lei Liu (Washington University in St. Louis)

15:30 – 15:50 **Sharon X. Xie** (University of Pennsylvania)
Adjusting for Covariate Measurement Error in Failure Time Analysis Under Competing Risks with Applications to Alzheimer's Disease Biomarker Research

15:50 – 16:10 **Guoqiao Wang** (Washington University in St. Louis)
Survival Analysis for Alzheimer Disease Without "Known Survival" Time

16:10 – 16:30 **Dandan Liu** (Vanderbilt University)
Partly Conditional Modeling for Alzheimer's Disease

16:30 – 16:50 **Lei Liu** (Washington University in St. Louis)
Variable Selection in Joint Frailty Model of Recurrent and Terminal Events

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Thursday May 30, 15:30 – 17:00 **Invited Session 22** **BENEDUM G31**

Mediation Analysis for High-Dimensional Data

Chair and Organizer: Ruth Pfeiffer (NIH/NCI)

15:30 – 15:50 **Joshua Millstein** (University of Southern California)
A Modification to the Causal Inference Test (CIT) Addresses Challenges of Mediation Analysis in Genomic Settings

15:50 – 16:10 **Michael B. Sohn** (University of Rochester)
A Compositional Mediation Model for Microbiome Data

16:10 – 16:30 **Andriy Derkach** (NIH/NCI)
High Dimensional Mediation Analysis

16:30 – 16:50 **Xi Luo** (Brown University)
Mediation Analysis for Large and Multilevel Data

Thursday May 30, 15:30 – 17:00 **Invited Session 23** **BENEDUM G28**

Innovative Applications of Joint Modeling

Chair and Organizer: Rajeshwari Sundaram (NIH/NICHD)

15:30 – 15:50 **Qing Pan** (George Washington University)
Constrained Maximum Entropy Models to Select Genotype Interactions Associated with Survival Outcomes

15:50 – 16:10 **Sedigheh Mirzaei** (St. Jude Children's Research Hospital)
Statistical Modeling of Discrete Survival Time in Presence of Recall Bias: A Joint Modeling Approach

16:10 – 16:30 **Angelo Elmi** (George Washington University)
Approximate Imputation Based Methods for Joint Modeling of Longitudinal and Time-to-Event Data

16:30 – 16:50 **Li Cheung** (NIH/DCEG)
Mixture Models for Undiagnosed Prevalent Disease and Interval Censored Incident Disease: Applications to a Cohort Assembled from Electronic Health Records

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Thursday May 30, 15:30 – 17:00 **Invited Session 24** **BENEDUM G37**

Applied Stochastic Models for Time-to-Event Data

Chair: Henry W. Block (University of Pittsburgh)

Organizer: Mei-Ling Ting Lee (University of Maryland, College Park)

15:30 – 15:55 **Satish Iyengar** (University of Pittsburgh)
Diffusion Models for Time-to-Event Data

15:55 – 16:20 **Chien-Yu Peng** (Academia Sinica, Taiwan)
Robust Processes in Degradation Analysis

16:20 – 16:45 **Tianzhou Ma** (University of Maryland, College Park)
Variable Selection in Threshold Regression Model with Application to HIV Drug Adherence Data

Thursday May 30, 18:00 – 20:30

Thursday May 30, 18:00 – 20:30 **Wyndham Hotel**

18:00 – 20:30 Banquet

Friday May 31

Friday May 31, 8:00 – 10:00

Friday May 31, 8:00 – 9:00 **Keynote Presentation** **BENEDUM 157**

Keynote Presentation: Ross Prentice

Chair: Jianwen Cai (University of North Carolina at Chapel Hill)

8:00 – 9:00 **Ross Prentice** (Fred Hutchinson Cancer Research Center/University of Washington)
Regression Models and Multivariate Life Tables

Friday May 31, 9:00 – 10:00 **Keynote Presentation** **BENEDUM 157**

Keynote Presentation: Danyu Lin

Chair: Jianwen Cai (University of North Carolina at Chapel Hill)

9:00 – 10:00 **Danyu Lin** (University of North Carolina at Chapel Hill)
Semiparametric Regression Analysis of Interval-Censored Data

Friday May 31, 10:00 – 10:30

Friday May 31, 10:00–10:30 **BENEDUM Hall Lobby**

10:00 – 10:30 Refreshment Break

Friday May 31, 10:30 – 12:00

Friday May 31, 10:30 – 12:00 **Invited Session 25** **BENEDUM G30**

Innovative Approaches for Studying the Effects of Chemical Mixtures on Disease Throughout the Life-span

Chair and Organizer: Paul Albert (NIH/NCI)

10:30 – 10:55 **Shelley Liu** (Icahn School of Medicine at Mount Sinai)
Bayesian Methods for Analyzing Chemical Mixtures

10:55 – 11:20 **David Wheeler** (Virginia Commonwealth University)
Models for Environmental Chemical Mixtures and Childhood Leukemia Risk

11:20 – 11:45 **Zhen Chen** (NIH/NICHD)
A Bayesian Multi-dimensional Couple-based Latent Risk Model with an Application to Infertility

Discussant: **Paul Albert** (NIH/NCI)

Friday May 31, 10:30 – 12:00 **Invited Session 26** **BENEDUM 158**

Methods for Dependent Truncation

Chair and Organizer: Rebecca A. Betensky (New York University)

10:30 – 10:55 **Lior Rennert** (Clemson University)
Cox Regression Model under Dependent Truncation

10:55 – 11:20 **Jing Qian** (University of Massachusetts, Amherst)
Estimation under Covariate-Induced Dependent Truncation with Inverse Probability of Weighting

11:20 – 11:45 **Bella Vakulenko-Lagun** (Harvard University)
Nonidentifiability in the Presence of Factorization for Truncated Data

Discussant: **Rebecca A. Betensky** (New York University)

Friday May 31, 10:30 – 12:00 **Invited Session 27** **BENEDUM G29**

Methods for Lifetime Data Processes Under Intermittent Observation

Chair and Organizer: Richard Cook (University of Waterloo, Canada)

10:30 – 10:55 **Jerald Lawless** (University of Waterloo, Canada)
Independence Conditions and Life History Analysis with Intermittent Observation of Individuals

10:55 – 11:20 **Pamela Shaw** (University of Pennsylvania)
Assessing efficacy for an interval-censored bivariate failure time outcome when one event is a surrogate

11:20 – 11:45 **Andrew Titman** (Lancaster University, UK)
A Joint Models for Multi-state Models with Informative Observation Processes

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Friday May 31, 10:30 – 12:00 **Invited Session 28** **BENEDUM 226**

Cross-Sectional Analysis of Life History Data

Chair and Organizer: X. Joan Hu (Simon Fraser University, Canada)

10:30 – 10:55 **Leilei Zeng** (University of Waterloo, Canada)
Multistate Analysis from Cross-Sectional and Auxiliary Samples

10:55 – 11:20 **Niels Keiding** (University of Copenhagen, Denmark)
Possible Application of Current Duration Analysis to Estimate Time-to-Pregnancy Distributions from Demographic Survey Data

11:20 – 11:45 **Cuiling Wang** (Albert Einstein College of Medicine)
Evaluate Cross-Sectional Association and Diagnostic Accuracy for Disease using Longitudinal Markers with Missing Data

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Friday May 31, 10:30 – 12:00 **Invited Session 29** **BENEDUM 227**

Novel Approaches for Time-to-Event Data

Chair: Guoqing Diao (George Mason University)

Organizer: Aiyi Liu (NIH/NICHD)

10:30 – 10:55 **Wei Qian** (University of Delaware)
Double-slicing Assisted Sufficient Dimension Reduction for High Dimensional Censored Data

10:55 – 11:20 **Rajeshwari Sundaram** (NIH/NICHD)
Analyzing Recurrent Events in Presence of Recall Error : An Application to Time-to-repeat Hospitalization

11:20 – 11:45 **Antai Wang** (New Jersey Institute of Technology)
Analysis of Semi-competing Risks Data using Archimedean Copula Models

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Friday May 31, 10:30 – 12:00 **Invited Session 30** **BENEDUM G27**

Multiple Testing, Simultaneous and Joint Modeling, and Calibration

Chair: Shiwen Shen (New York Life Insurance)

Organizer: Edsel A. Peña (University of South Carolina)

10:30 – 10:55 **Yen-Yi Ho** (University of South Carolina)
P value Adjustment Procedure Using Empirical Weights

10:55 – 11:20 **Piaomu Liu** (Bentley University)
Joint Dynamic Modeling of a Longitudinal Marker, Recurrent Competing Risks and a Terminal Event

11:20 – 11:45 **Beidi Qiang** (Southern Illinois University - Edwardsville)
Estimating Concentration Response Function and Change-Point using Time-Course and Calibration Data

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Friday May 31, 10:30 – 12:00 **Invited Session 31** **BENEDUM G28**

Genomic Applications with Survival Outcomes

Chair: Tianzhou Ma (University of Maryland, College Park)

Organizer: Mei-Ling Ting Lee (University of Maryland, College Park)

10:30 – 10:55 **George Tseng** (University of Pittsburgh)
Heterogeneity and Robust Machine Learning in Transcriptomic Analysis of Multiple Studies

10:55 – 11:20 **Philippe Broët** (INSERM, France)
Predicting the Occurrence of an Adverse Event using Bagged Survival Trees Built on Random Structured Subsets: Application in Clinical Immunology

11:20 – 11:45 **Chien-Wei Lin** (Medical College of Wisconsin)
RNASeqDesign: A Framework for RNA-Seq Genome-wide Power Calculation and Study Design Issues

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Friday May 31, 10:30 – 12:00 **Invited Session 32** **BENEDUM G31**

New Methods for Risk Prediction and Precision Medicine

Chair and Organizer: Mei-Cheng Wang (Johns Hopkins University)

10:30 – 10:55 **Yanxun Xu** (Johns Hopkins University)
Bayesian estimation of Individualized Treatment-Response Curves in Electronic Medical Record Data

10:55 – 11:20 **Jon Arni Steingrimsson** (Brown University)
Deep Learning with Time-to-event Outcomes

11:20 – 11:45 **Xingqiu Zhao** (Hong Kong Polytechnic University, Hong Kong)
Subgroup Analysis in the Cox Model

Friday May 31, 10:30 – 12:00 **Invited Session 33** **BENEDUM G36**

Causal Inference for Survival Data

Chair and Organizer: Ronghui (Lily) Xu (University of California, San Diego)

10:30 – 10:55 **Eric J. Tchetgen Tchetgen** (University of Pennsylvania)
Mendelian Randomization for Failure Time Outcome with Invalid Instrumental Variables

10:55 – 11:20 **Jessica Young** (Harvard Pilgrim Health Care Institute)
A Causal Framework for Classical Statistical Estimands in Failure Time Setting with Competing Events

11:20 – 11:45 **Jelena Bradic** (University of California, San Diego)
Inference on Treatment Effects in High-dimensional Survival Models

Friday May 31, 12:00 – 13:30

Friday May 31, 12:00 – 13:30

12:00 – 13:30 Lunch Break

Friday May 31, 13:30 – 15:00

Friday May 31, 13:30 – 15:00 **Invited Session 34** **BENEDUM 226**

Session for Student Paper Award Winners (1)

Chair: Guoqing Diao (George Mason University)

Organizer: Guoqing Diao (George Mason University)

13:30 – 13:50 **Ting Ye** (University of Wisconsin-Madison)
Robust Tests for Treatment Effect in Survival Analysis under Covariate-Adaptive Randomization

13:50 – 14:10 **Gabrielle Simoneau** (McGill University, Canada)
Estimating Optimal Dynamic Treatment Regimes with Survival Outcomes

14:10 – 14:30 **Rui Chen** (University of Wisconsin-Madison)
Tailored Optimal Post-Treatment Surveillance for Cancer Recurrence

14:30 – 14:50 **Nicole Butera** (University of North Carolina at Chapel Hill)
Estimating Biomarker Change by Adjusting for Informative Time to Treatment Initiation

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Friday May 31, 13:30 – 15:00 **Invited Session 35** **BENEDUM G30**

Causal Inference with Time-to-Event Data

Chair and Organizer: Lu Mao (University of Wisconsin-Madison)

13:30 – 13:55 **Mark van der Laan** (University of California, Berkeley)
Target MLE of Causal Effects of Interventions on Survival Outcomes

13:55 – 14:20 **Yifan Cui** (University of Pennsylvania)
Instrumental Variable Estimation of Marginal Structural Cox Model for Time-Varying Exposure

14:20 – 14:45 **Constantine Frangakis** (Johns Hopkins University)
Deductive Semiparametric Estimation in Double-Sampling Designs with Application to Estimating Mortality in PEPFAR

Discussant: **Lu Mao** (University of Wisconsin-Madison)

Friday May 31, 13:30 – 15:00 **Invited Session 36** **BENEDUM G31**

Multistate Models as A Framework for Life History Analysis

Chair and Organizer: Hein Putter (Leiden University Medical Centre, The Netherlands)

13:30 – 13:50 **Hans C. van Houwelingen** (Leiden University Medical Center, The Netherlands)
An Alternative for the Fine-Gray Approach to Competing Risk Modelling: a Bridge Between Multi-State and Subdistribution Hazard

13:50 – 14:10 **Ronald Geskus** (University of Oxford at Ho Chi Minh City, Vietnam)
A Bayesian Analysis of the Natural History of HIV-2 Infection using a Hidden Markov Cure Model

14:10 – 14:30 **Jeremy Taylor** (University of Michigan)
Handling Missing Covariate Data in Multistate Models

14:30 – 14:50 **Jon Michael Gran** (University of Oslo, Norway)
Estimating Causal Effects of Time-varying Treatments in Multi-State Models - An Application to Registry Data on Sick Leave and Disability

Friday May 31, 13:30 – 15:00 **Invited Session 37** **BENEDUM G29**

Models and Applications with Recurrent Events

Chair and Organizer: Thomas Scheike (University of Copenhagen, Denmark)

13:30 – 13:55 **Virginie Rondeau** (Universitè de Bordeaux, France)
Multivariate Joint Frailty Model for the Analysis of Nonlinear Tumor Kinetics with Recurrent Progressions of Nontarget Progression and Dynamic Predictions of Death

13:55 – 14:20 **Per Kragh Andersen** (University of Copenhagen, Denmark)
Marginal Regression Models for Recurrent Events with Competing Risks using Pseudo-Obervations

14:20 – 14:45 **Frank Eriksson** (University of Copenhagen, Denmark)
The Mean, Variance, and Correlation for Bivariate Recurrent Events Data with a Terminal Event

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Friday May 31, 13:30 – 15:00 **Invited Session 38** **BENEDUM 158**

Challenges and Advances of Research in Health Service Studies

Chair: Liang Zhu (University of Texas Health Science Center at Houston)

Organizer: Yu Shen (University of Texas MD Anderson Cancer Center)

13:30 – 13:55 **Jane Lange** (Fred Hutchinson Cancer Research Center)
Estimating and Comparing Cancer Progression Risks Under Varying Surveillance Protocols : Moving Beyond the "Tower of Babel"

13:55 – 14:20 **Nabihah Tayob** (University of Texas MD Anderson Cancer Center)
Longitudinal Biomarker Screening Algorithms: Guidelines for When They are Most Useful

14:20 – 14:45 **Liang Li** (University of Texas MD Anderson Cancer Center)
Modeling the Longitudinal Trajectory of Medical Cost for Cancer Care

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Friday May 31, 13:30 – 15:00 **Invited Session 39** **BENEDUM G27**

Innovative Methods for Assessing Diagnostic Accuracy and Prediction Accuracy

Chair: Sedigheh Mirzaei (St Jude Children's Research Hospital)

Organizer: Rajeshwari Sundaram (NIH/NICHD)

13:30 – 13:55 **Paramita Saha-Chaudhuri** (McGill University, Canada)
Monitoring with Repeatedly Measured Marker: Assessing Incremental Value of Additional Measurements

13:55 – 14:20 **Aasthaa Bansal** (University of Washington)
Evaluating the Time-varying Prediction Accuracy of Survival Models Used in Dynamic Decision-making

14:20 – 14:45 **Paramita Saha-Chaudhuri** (McGill University, Canada)
Mean Risk Stratification and Number Needed to Test: A New Approach to Quantifying Risk Stratification for Comparing the Usefulness of Diagnostic Tests

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Friday May 31, 13:30 – 15:00 **Invited Session 40** **BENEDUM G28**

Extensions to Joint Longitudinal-Survival Modelling

Chair and Organizer: Andrew Titman (Lancaster University, UK)

13:30 – 13:55 **Li Su** (University of Cambridge, UK)
Accommodating Informative Dropout and Death: A Joint Modelling Approach for Longitudinal and Semicompeting Risks Data

13:55 – 14:20 **Zhigang Li** (University of Florida)
Joint Modeling Quality of Life and Survival in Palliative Care Research

14:20 – 14:45 **Bin Nan** (University of California, Irvine)
Conditional Modeling of Longitudinal Data with Terminal Event

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Friday May 31, 13:30 – 15:00 **Invited Session 41** **BENEDUM G36**

Emerging Issues and Methods on Censored Data

Chair and Organizer: Grace Y. Yi (University of Waterloo, Canada)

13:30 – 13:55 **Masoud Asgharian** (McGill University, Canada)
Prevalent Cohort Studies: Length-Biased Sampling with Right Censoring

13:55 – 14:20 **Douglas Schaubel** (University of Michigan)
Semiparametric Regression Methods for Temporal Processes Subject to Multiple Sources of Censoring

14:20 – 14:45 **Gang Li** (University of California, Los Angeles)
Ultrahigh Dimensional Screening for Survival Data

Discussant: **Ronghui (Lily) Xu** (University of California, San Diego)

Friday May 31, 13:30 – 15:00 **Invited Session 42** **BENEDUM 227**

Intermittent Observation of Life History Processes

Chair and Organizer: Leilei Zeng (University of Waterloo, Canada)

13:30 – 13:55 **X. Joan Hu** (Simon Fraser University, Canada)
Statistical Issues in Administrative Data Analysis

13:55 – 14:20 **Yueh-Ying Han** (University of Pittsburgh)
Utilizing National Health Survey Data for Surviving Analysis

14:20 – 14:45 **Eleanor Pullenayegum** (Hospital of Sick Children, Canada)
The Role of Recurrent Event Models in the Analysis of Longitudinal Data Subject to Irregular Observation: Current Practice and Future Directions

Friday May 31, 15:00 – 15:30

Friday May 31, 15:00 – 15:30 **BENEDUM Hall Lobby**

15:00 – 15:30 Refreshment Break

Friday May 31, 15:30 – 17:00

Friday May 31, 15:30 – 17:00 **Invited Session 43** **BENEDUM 158**

Multi-State Models in Practice

Chair: Richard Cook (University of Waterloo, Canada)

Organizer: Mouna Akacha (Novartis, Switzerland)

15:30 – 15:50 **David James** (Novartis, US)
Multistate Modeling and Simulation of Patient Trajectories After Allogeneic Hematopoietic Stem Cell Transplantation to Inform Drug Development

15:50 – 16:10 **Ulrich Beyer** (Roche, Switzerland)
A Multistate Model for Early Decision Making in Oncology

16:10 – 16:30 **Jan Feifel** (Ulm University, Germany)
Utilization of Multistate Models and Subcohorting to Analyze Rare Exposures

16:30 – 16:50 **Terry Therneau** (Mayo Clinic)
Practical Multi-State Models

Friday May 31, 15:30 – 17:00 **Invited Session 44** **BENEDUM 227**

Session for Student Paper Award Winners (2)

Chair: Guoqing Diao (George Mason University)

Organizer: Guoqing Diao (George Mason University)

15:30 – 15:50 **Bo Wei** (Emory University)
Generalized Accelerated Recurrence Time Model in the Presence of a Dependent Terminal Event

15:50 – 16:10 **Yi Xiong** (Simon Fraser University, Canada)
Estimating Duration Distribution from Data with Missing Time Origin

16:10 – 16:30 **Yue Wei** (University of Pittsburgh)
Gene-based Association Analysis for Bivariate Time-to-event Data through Functional Regression with Copula Models

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Friday May 31, 15:30 – 17:00 **Invited Session 45** **BENEDUM G31**

Recent Developments in Statistical Methods on Semi-Competing Risks Data

Chair and Organizer: Jong Hyeon Jeong (University of Pittsburgh)

15:30 – 15:55 **David Oakes** (University of Rochester)
Nonparametric Estimation of the Curtailed Win-Ratio

15:55 – 16:20 **Lu Mao** (University of Wisconsin-Madison)
On the Win-Loss Processes of Composite Endpoints

16:20 – 16:45 **Il-Do Ha** (Pukyong National University, South Korea)
H-likelihood Approaches for Frailty Models with Semi-competing Risks Data

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Friday May 31, 15:30 – 17:00 **Invited Session 46** **BENEDUM G30**

Survival Analysis with Missing or Mismeasured Data

Chair and Organizer: Bin Nan (University of Michigan)

15:30 – 15:55 **Ronghui (Lily) Xu** (University of California, San Diego)
Two-Stage Residual Inclusion for Survival Data and Competing Risks - An Instrumental Variable Approach for Binary Treatment with Application to SEER-Medicare Linked Data

15:55 – 16:20 **Grace Y. Yi** (University of Waterloo, Canada)
Analysis of Error-Prone Survival Data Under Additive Hazards Models

16:20 – 16:45 **Yichuan Zhao** (Georgia State University)
Rank-based Estimating Equation with Non-ignorable Missing Responses

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Friday May 31, 15:30 – 17:00 **Invited Session 47** **BENEDUM G27**

Recent Advances in the Analysis of Complex Lifetime Data Involving Recurrent Events

Chair and Organizer: Hua Shen (University of Calgary, Canada)

15:30 – 15:55 **Ming Wang** (Pennsylvania State University)
A Time-varying Joint Frailty-copula Model for Analyzing Recurrent Events and a Terminal Event: An Application to the Cardiovascular Health Study

15:55 – 16:20 **Kaida Cai** (University of Calgary, Canada)
Bi-level Variable Selection for Multivariate Failure Time Data with Observed Heterogeneity

16:20 – 16:45 **Shu Jiang** (Harvard University)
Finite Mixture Models for Multistate Processes under Panel Observation

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Friday May 31, 15:30 – 17:00 **Invited Session 48** **BENEDUM G28**

Personalized Treatment Selection with Censored Survival Outcome

Chair and Organizer: Xiao Song (University of Georgia)

15:30 – 15:55 **Abdus S. Wahed** (University of Pittsburg)
Optimizing Dynamic Treatment Regimes Based on Quality-Adjusted Survival

15:55 – 16:20 **Yingqi Zhao** (Fred Hutchinson Cancer Research Center)
Constructing Stabilized Dynamic Treatment Regimes for Censored Data

16:20 – 16:45 **Lihui Zhao** (Northwestern University)
Identifying Potential Responses to a New Treatment with Time-to-event Endpoints

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Friday May 31, 15:30 – 17:00 **Invited Session 49** **BENEDUM G36**

Recent Development in the Analysis of Recurrent Event Data

Chair: Qingning Zhou (University of North Carolina at Charlotte)

Organizer: Jianguo (Tony) Sun (University of Missouri)

15:30 – 15:55 **Yang Li** (University of North Carolina at Charlotte)
A General Additive-Multiplicative Mean Model for Panel Count Data Analysis

15:55 – 16:20 **Liang Zhu** (University of Texas Health Science Center at Houston)
Statistical Analysis on Mixed Recurrent Event Data with Clusters

16:20 – 16:45 **Shijun Zhu** (University of Maryland, Baltimore Country)
A Joint Model of Longitudinal Biomarkers and Recurrent Events and it's Application

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Friday May 31, 15:30 – 17:00 **Invited Session 50** **BENEDUM G29**

Novel Application of Survival Models in Complex Biomedical Studies

Chair and Organizer: Donglin Zeng (University of North Carolina at Chapel Hill)

15:30 – 15:55 **Yuanjia Wang** (Columbia University Mailman School of Public Health)
Early Diagnosis of Neurological Disease Using Peak Degeneration Ages of Multiple Biomarkers

15:55 – 16:20 **Fei Gao** (University of Washington)
Semiparametric Regression Analysis of Length-Biased Interval-Censored Data

16:20 – 16:45 **Qingxia Chen** (Vanderbilt University)
Treatment Effect Estimate and Model Diagnostics with Two-way Time-Varying Treatment Switching: An Application to a Head and Neck Study

Short Courses: Details

Two-Phase Studies for Lifetime Data

Ørnulf Borgan (University of Oslo Norway)
Sven Ove Samuelsen (University of Oslo, Norway)

Overview

In cohort studies, regression methods are commonly applied to assess the influence of risk factors and other covariates on mortality or morbidity; in particular Cox-regression is much used. Estimation in Coxs model is based on a partial likelihood that at each observed death or disease occurrence ("failure") compares the covariate values of the failing individual to those of all individuals at risk. Thus Cox regression requires collection of covariate information for all individuals in the cohort, even when only a small fraction of them actually get diseased or die. This may be very expensive, or even logistically impossible. Further, when covariate measurements are based on biological material stored in biobanks, it will imply a waste of valuable material that one may want to save for future studies. Cohort sampling designs, where covariate information is collected for all failing individuals ("cases"), but only for a sample of the individuals who do not fail ("controls"), then offer useful alternatives that may save biological material and drastically reduce the workload of data collection and error checking. Such cohort sampling designs may be considered as two-phase designs, where the cohort is the phase I sample (selected from a superpopulation) and the case-control sample is the phase II sample selected from the cohort.

There are two main types of two-phase designs for life time data: nested case-control and case-cohort designs, and the two types of designs differ in the way controls are selected. The course presents the two types of designs both in their original form and later extensions and describes how the statistical analysis of such two-phase studies may be performed. The focus is on estimation of relative risks using partial likelihoods and pseudo-likelihoods (or weighted likelihoods) that resemble the full cohort partial likelihood. Other topics like estimation of absolute risk and model checking will also be discussed, and methods that use all available data in the full cohort will be mentioned. There will be practical exercises in analyzing two-phase life time data, and the participants should bring their own laptop with R installed. Information on R packages that are needed will be given closer to the course.

Aims

1. Introduce the most common two-phase designs for life time data: nested case-control and case-cohort.
2. Discuss classical statistical methods for estimating relative risks for two-phase life time data, and give an outline of their theoretical properties.
3. Discuss methods for absolute risk estimation and model assessment.
4. Describe two-phase methods that use all available data from the full cohort.
5. Illustrate how to carry out statistical analyses of two-phase life time data using R.

Learning Outcomes

At the end of the day participants should:

1. Know the characteristics of the two common types of two-phase designs for life time data and understand the pros and cons of the designs.
2. Know how to estimate relative and absolute risks from nested case-control and case-cohort data.
3. Have some knowledge of methods that make use of data that are available for the full cohort.
4. Have some experience in analyzing nested case-control and case-cohort data using R.

Topics Covered

The material will be presented in a lecture format, where the theory and methods will be motivated and illustrated by examples from health research. In addition, the participants will get hands-on experience with the methods from practical exercises using R. Topics covered include:

1. Summary of methods for analyzing cohort life time data.

2. Nested case-control designs, including counter-matched sampling of the controls.
3. Case-cohort designs, including stratified sampling of the subcohort.
4. Classical methods for estimating relative and absolute risk from nested case-control and case-cohort data.
5. Analysis of general models for nested case-control and case-cohort data using inverse probability weighting.
6. Calibration of inverse probability weights for case-cohort data.
7. Methods for two-phase data that use all available cohort information (multiple imputation and maximum likelihood).
8. Practical examples and exercises using R.

Learning Strategy

The material will be presented using slides, class discussion, and practical exercises using R. Attendees will be given a booklet containing the slides, which will contain clear descriptions of the methodology, of applications, and of how to implement analyses in R.

Pre-requisites

The short course will be directed at statisticians in academia, government or industry interested in learning about two phase designs for life time data. It will be assumed that the participants are familiar with the basic concepts and methods in survival analysis and that they have some experience in using the R software.

Recommended reading

- Chapters 7 and 8 of Keogh & Cox: *Case-Control Studies*, Cambridge University Press, 2014.
- Part IV of *Handbook of Statistical Methods for Case-Control Studies*, eds Borgan, Breslow, Chatterjee, Gail, Scott & Wild, CRC Press, 2018.

About the Instructors

Ørnulf Borgan is professor of Statistics at the University of Oslo. His main research interest has been statistical methods for survival and event history data, including nested case-control and case-cohort designs. He is co-author of two books on the use of counting processes and martingales in survival and event history analysis, and he is one of the editors of the recent *Handbook of Statistical Methods for Case-Control Studies* (CRC Press, 2018). Borgan has been editor of the Scandinavian Journal of Statistics, and he is a Fellow of the American Statistical Association and member of the Norwegian Academy of Science and Letters.

Sven Ove Samuelsen is professor of Statistics at the University of Oslo. His main research interest has been statistical methods for survival and event history data, in particular case-cohort and nested case-control designs. He has been involved in planning and analyzing many case-control and other epidemiological studies. Samuelsen is on the editorial board of Lifetime Data Analysis.

Dynamic Prediction in Survival Analysis

Hein Putter (Leiden University Medical Center, The Netherlands)

Summary

The medical literature abounds with prediction models. They are statistical models based on patient- and disease characteristics, used to inform treatment decisions, to provide personalized risk estimates for the patient, and also to stratify patients in clinical trials. Important prognostic models include Adjuvant! Online in cancer and the Framingham risk score in cardiovascular disease. The vast majority of these models are focused on prognosis at one well-defined baseline moment, typically at diagnosis, shortly before treatment is initiated. It is at this time that the most important decisions on primary treatment are made. There is little doubt that the available prognostic models are important tools for the treating physician to guide treatment decisions at diagnosis. However, once primary treatment has been initiated, the prognosis of the patient will change over the course of time, as a result of the effect of treatment, possible treatment toxicity, and clinical events such as disease recurrence that may have occurred, and, very simply, because of the fact that the patient is still alive. As a result, these prediction models need to be "updated" to use the knowledge that has become available since baseline. Prediction models that incorporate this dynamic aspect are called dynamic prediction models, and they are the topic of this course.

This course will focus on methodology for dynamic prediction. The dynamic aspect of dynamic prediction involves using information on events and/or measurements up to the present, in order to "update" the prediction. It will be shown in this course how dynamic predictions may be obtained using the concept of landmarking and using multi-state models. Analyses will be illustrated using R, in particular the `mstate` and `dynpred` packages. Implementation of the methods in other statistical software packages like SAS, Stata and SPSS will be discussed.

Aims

1. Discuss situations where dynamic prediction is relevant;
2. Illustrate how the Cox model can be used to obtain dynamic predictions with time-fixed covariates;
3. Introduce multi-state models as an extension of survival analysis and competing risks;
4. Show how multi-state models can be used to obtain dynamic predictions;
5. Introduce landmarking as a way of dealing with time-dependent covariates;
6. Show how landmarking can be used to include time-dependent information in the dynamic predictions;
7. Discuss robustness properties;
8. Illustrate how to carry out the analyses discussed during the course using R.

Learning Outcomes

At the end of the course participants should:

1. Understand the connection between hazards and dynamic prediction probabilities;
2. Know how to obtain dynamic prediction probabilities from time-fixed Cox models;
3. Understand the difficulties of predicting with time-dependent covariates;
4. Be acquainted with concepts in multi-state models like transition intensities, transition probabilities, state occupation probabilities, the Markov assumption;
5. Understand the relation between transition intensities and transition probabilities, and be acquainted with the Aalen-Johansen estimator;
6. Understand how landmarking can be used for dynamic prediction.

Topics Covered

The course material will be presented in a lecture format, changing between theory and illustrations. Ample attention will be devoted to the practical implementation of the methods covered in the course, using R.

Topics covered include:

- *Dynamic use of familiar survival analysis techniques*
  A short overview of survival analysis will be given, including the Cox model. The emphasis in this overview will be on how these familiar techniques can be used to obtain dynamic predictions. We will introduce conditional survival (the effect of being alive) and the fixed width failure function, and their relation to the familiar hazard function. Extensions to competing risks will briefly be mentioned.

- *Time-dependent covariates and landmarking*
  We will then introduce time-dependent covariates and discuss techniques to handle them such as time-dependent Cox regression and landmarking. The differences between these approaches and the relative merits will be discussed.

- *Multi-state models*
  A brief overview of multi-state models will be given, including how they can be used to obtain dynamic predictions. The overview includes discussion of concepts like transition intensities and transition probabilities, and ways of estimating transition intensities. The Aalen-Johansen estimator of the transition probabilities will be presented, and the assumptions needed for validity of the Aalen-Johansen estimator, in particular the Markov assumption will be discussed.

- *Landmarking and dynamic prediction*
  Then we will show how landmarking can be used to include time-dependent information in the dynamic predictions. We will briefly discuss more traditional methods that can also be used for dynamic prediction, such as multi-state models. Advantages and disadvantages of different approaches will be discussed.

- *Practical implementation*
  Methods discussed during the lectures will be illustrated using R, and in particular the `mstate` and `dynpred` packages. Data used is available from the presenter upon request.

Learning Strategy

The material will be presented using slides and through class discussion. Attendees will be given a booklet containing the slides , which will contain clear descriptions of the methodology, of applications, and of how to implement analyses in R.

Pre-requisites

This course is directed at statisticians or epidemiologists in academia, government or industry interested in dynamic prediction in survival analysis. Participants are expected to have a fair knowledge of the techniques from classical survival analysis.

About the Instructor

Hein Putter is Professor at the Leiden University Medical Center (Department of Biomedical Data Sciences). His research interests include competing risks and multi-state models, frailty models and dynamic prediction. He is co-author of the book "Dynamic Prediction in Clinical Survival Analysis", with Hans van Houwelingen.

Biased Sampling, Left Truncation and Survival Analysis

Jing Qin (NIH/NIAID)

Overview

Biased sampling occurs when a proper randomization cannot be achieved, the observed sample will not be representative of the population of interest. Biased sampling problems appear in many areas of research, including, Medicine, Epidemiology and Public Health, Social Sciences and Economics. Left truncation and length-biased data are clearly encountered in applications of renewal processes, etiologic studies, genome-wide linkage studies, epidemiologic cohort studies, cancer prevention trials, and studies of labor economy. In observational studies, a prevalent cohort design that draws samples from individuals with a condition or disease at the time of enrollment is generally more efficient and practical. The recruited patients who have already experienced an initiating event are followed prospectively for the failure event (e.g. disease progression or death) or are right censored. Under this sampling design, individuals with longer survival times measured from the onset of the disease are more likely to be included in the cohort, whereas those with shorter survival times are unconsciously excluded. Finding appropriate adjustments for the potential selection bias in analyzing length-biased data or more general biased sampling problems has been a long standing statistical problem.

This workshop discusses various methods to deal with biased sampling problems, exponential tilting models and left truncation and right censored data problems, including prole maximum likelihood method, conditioning likelihood method, composite partial likelihood method as well as general imputation methods.

Aims and Topics Covered

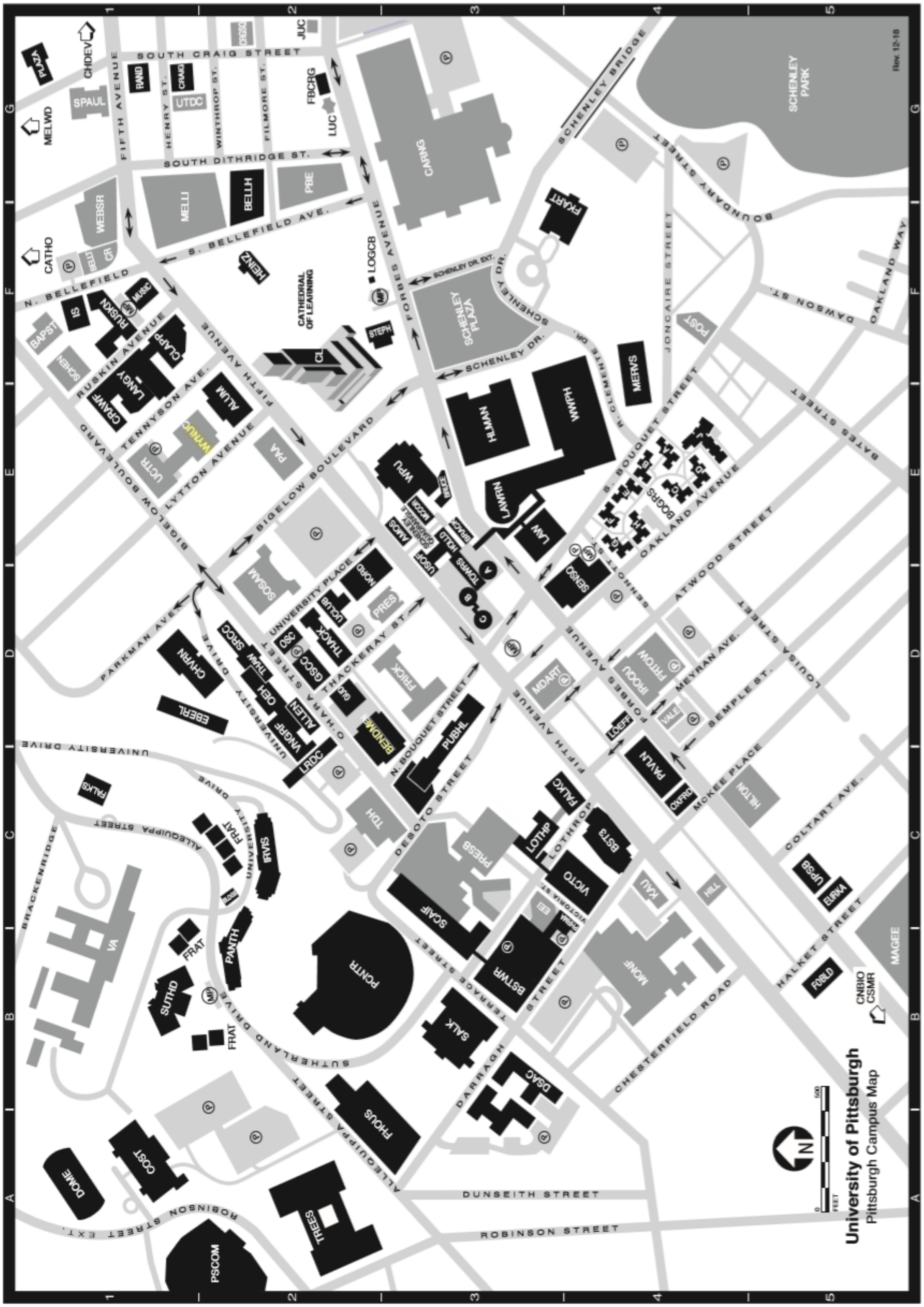
1. Discuss the general methods for handling biased sampling problems, including case and control problems, missing data and casual inference.
2. Derive the Cox partial likelihood from different angles, including rank likelihood method, prole maximum likelihood method, case and control conditional likelihood argument, and optimal estimating equation method.
3. Present the latest results on analyzing length biased survival time data, including Vardi's multiplicative censoring problem, and general imputation principle for missing survival data.
4. Discuss the well known pool adjacent violators algorithm and its combination with the EM algorithm together for estimating shape constrained inference, including estimation of monotonic decreasing density, cumulation hazard or distribution function based on current status data etc.

Learning Outcomes

At the end of the day participants should have some new ideas on handling biased sampling problems and survival data. This course is particularly helpful for those who are interested in learning some "theoretical results" and some "applied problems". The accompanied R programs will be discussed.

Background for the Instructor

Jing Qin is a Mathematical Statistician at the Biostatistics Research Branch in the National Institute of Allergy and Infectious Diseases. Dr. Qin's research interests include empirical likelihood method, case-control study, length bias sampling, econometrics, survival analysis, missing data, causal inference, genetic mixture models, generalized linear models, survey sampling and microarray data analysis. He is the author of "Biased sampling, over-identied parametric problems and beyond" (Springer, 2017). He was elected as a Fellow of the American Statistical Association in 2006.


University of Pittsburgh
Pittsburgh Campus Map
Rev. 12-18
SOUTH CRAIG STREET
FIFTH AVENUE
HENRY ST.
WINTHROP ST.
FILMORE ST.
SOUTH DITHRIDGE ST.
S. BELLEFIELD AVE.
N. BELLEFIELD
FORBES AVENUE
SCHENLEY BRIDGE
BOUNDARY STREET
SCHENLEY PARK
SCHENLEY DR. EXT.
SCHENLEY DR.
SCHENLEY PLAZA
CATHEDRAL OF LEARNING
JONCAIRE STREET
DAWSON ST.
OAKLAND WAY
BATES STREET
S. BOUQUET STREET
OAKLAND AVENUE
ATWOOD STREET
LOUISA STREET
MEYRAN AVE.
SEMPLE ST.
McKEE PLACE
COLTART AVE.
HALKET STREET
CHESTERFIELD ROAD
RUSKIN AVENUE
TENNYSON AVE.
LYTTON AVENUE
BIGELOW BOULEVARD
PARKMAN AVE.
UNIVERSITY PLACE
THACKERAY ST.
O'HARA STREET
UNIVERSITY DRIVE
N. BOUQUET STREET
DESOTO STREET
LOTHROP
VICTORIA ST.
TERRACE STREET
DARRAGH STREET
SUTHERLAND DRIVE
ALLEQUIPPA STREET
BRACKENRIDGE
DUNSEITH STREET
ROBINSON STREET
ROBINSON STREET EXT.
MELWD
CHDEV
CATHO
CNBIO
CSMR
PLAZA
SPAUL
RAND
CRAIG
UTDC
JUC
FBCRG
LUC
CARNG
MELLI
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PBE
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LOGCB
HEINZ
MUSIC
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BAPST
CLAPP
LANGY
CRAWF
ALUM
WYNUC
UCTR
PAA
CL
STEPH
HLMAN
WWPH
MERVS
FKART
POST
WPU
LAWRN
LAW
SENSC
BOGRS
SOSAM
PRES
UCLUB
THACK
GSCC
CHVRN
EBERL
FRICK
MDART
FRTOW
IROCU
LOEFF
PAVLN
OXFRD
HILTON
BENDM
PUBHL
VNGRF
OEH
ALLEN
LRDC
FALKS
FRAT
IRVIS
TDH
PRESB
LOTHP
FALKC
BST3
VICTO
KAU
HILL
UPSBB
EURKA
MAGEE
SCAIF
BSTWR
MONF
FOBLD
PANTH
SUTHD
PCNTR
SALK
DSAC
FHOUS
VA
COST
DOME
TREES
PSCOM
N
FEET

Allen Hall ALLEN D2
Alumni Hall ALUM E2
(Office of Admissions and Financial Aid, Office of Alumni Relations)
Amos Hall (residence hall) AMOS E3
BAPST *(map abbreviation for First Baptist Church)*
• **Barco Law Building** LAW E3
Bellefield Hall BELLH G2
Bellefield Presbyterian Church PRES D3
Bellefield Towers BELLT F1
• **Benedum Hall** BENDM D3
Thomas E. Starzl Biomedical Science Tower (Tower 1) and Biomedical Science Tower 2 BSTWR B3
Biomedical Science Tower 3 BST3 C4
Bouquet Gardens BQGRS E4
(residence halls A–J)
Brackenridge Hall (residence hall, Parking Services Office, The Pitt Shop) BRACK E3
Bruce Hall (residence hall) BRUCE E3
Building 5 BLDG5 C2
• **Carnegie Library of Pittsburgh, Carnegie Museums of Pittsburgh** CARNG G3
Cathedral of Learning CL F2
CATHO *(map abbreviation for Ryan Catholic Newman Center)*
Center for Bioengineering *off map* CNBIO B4
Center for Sports Medicine and Rehabilitation *off map* CSMR B4
Charles L. Cost Sports Center COST A1
CHDEV *(map abbreviation for University Child Development Center)*
• **Chevron Science Center** CHVRN D1
Clapp Hall CLAPP F1
Community of Reconciliation Building CR F1
Craig Hall CRAIG G1
Craig Square CRGSQ G2
Crawford Hall CRAWF E1
Darragh Street Apartment Complex DSAC A3
Eberly Hall EBERL D1
Engineering Auditorium ENGUD D2
Eureka Building EURKA C5
Eye and Ear Institute EEI C3
Falk Medical Building FALKC C3
Falk School FALKS C1
First Baptist Church (United Campus Ministry) BAPST F1
Fitzgerald Field House FHOUS A2
Forbes Craig Apartments FBCRG G2
Forbes Oakland Building FOBLD B5
Forbes Pavilion (Forbes Hall [residence hall]; Department of Parking, Transportation, and Services) PAVLN C4
Forbes Tower FRTOW D4
Fraternity Housing Complex FRAT B1, C2
• **Frick Fine Arts Building** FKART F3
Gardner Steel Conference Center GSCC D2
Heinz Memorial Chapel HEINZ F2
Hill Building HILL C4
• **Hillman Library** HLMAN E3
Hilton Garden Inn HILTON C4
Holland Hall (residence hall) HOLLD E3
• **Information Sciences Building** IS F1
Iroquois Building IROQU D4
Jewish University Center JUC G2
K. Leroy Irvis Hall (residence hall) IRVIS C2
Kaufmann Medical Building KAU C4
• **Langley Hall** LANGY E1
LAW *(map abbreviation for Barco Law Building)*
Lawrence Hall LAWRN E3
Learning Research and Development Center LRDC C2
Litchfield Towers (residence halls A, B, C) TOWRS D3
Loeffler Building LOEFF D4
Log Cabin LOGCB F2
Lothrop Hall (residence hall) LOTHP C3
Lutheran University Center LUC G2
Magee-Womens Hospital MAGEE B5
Mark A. Nordenberg Hall (residence hall, Student Health Service) NORD D3
McCormick Hall (residence hall) MCCOR E3
Medical Arts Building MDART D3
Mellon Institute (Pittsburgh Supercomputing Center) MELLI F1
Melwood Maintenance Building *off map* MELWD G1
• **Mervis Hall** MERVS F4
UPMC Montefiore MONF B4
• **Music Building** MUSIC F1
O'Hara Student Center OSC D2
Old Engineering Hall OEH D2
Oxford Building (3501 Forbes Avenue) OXFRD C4
Panther Hall (residence hall) PANTH B2
Park Plaza PLAZA G1
Parkvale Building VALE D4
PAVLN *(map abbreviation for Forbes Pavilion)*
The John M. and Gertrude E. Petersen Events Center PCNTR B2
Petersen Sports Complex PSCOM A2
Pharmacy Administration PHRMA C3
Pitt Sports Dome DOME A1
Pittsburgh Athletic Association PAA E2
Pittsburgh Board of Education PBE G2
Pittsburgh Science and Technology Academy FRICK D3
Post Office (Oakland Branch) POST F4
PRES *(map abbreviation for Bellefield Presbyterian Church)*
UPMC Presbyterian PRESB C3
UPMC Presbyterian South Tower PRESB-S C3
Public Health (Crabtree Hall and Graduate School of Public Health) PUBHL D3
Rand Building RAND G1
Ruskin Hall RUSKN F1
Ryan Catholic Newman Center (The Oratory) *off map* CATHO F1
St. Paul Cathedral SPAUL G1
Salk Hall SALK B3
• **Scaife Hall** SCAIF C3
Schenley Park G4
Schenley Place SCHEN F1
Schenley Plaza F3
Schenley Quadrangle E3
Sennott Square SENSQ D4
Soldiers & Sailors Memorial Hall & Museum SOSAM D2
Space Research Coordination Center SRCC D2
• **Stephen Foster Memorial** STEPH F2
Sutherland Hall (residence hall) SUTHD B1
Thackeray Hall (registration) THACK D2
Thaw Hall THAW D2
• **Thomas Detre Hall of the Western Psychiatric Institute and Clinic** TDH C2
TOWRS *(map abbreviation for Litchfield Towers)*
Trees Hall (athletic facilities) TREES A2
University Center (UPMC) UCTR E1
University Child Development Center *off map* CHDEV G1
University Club UCLUB D2
University Public Safety Building UPSB C5
University Store on Fifth (Book Center, Copy Cat) USOF E3
University Technology Development Center UTDC G1
VA Pittsburgh Healthcare System—University Drive Division VA B1
VALE *(map abbreviation for Parkvale Building)*
Van de Graaff Building VNGRF D2
Victoria Building VICTO C4
Webster Hall WEBSR F1
Wesley W. Posvar Hall WWPH E4
Western Psychiatric Institute and Clinic (see Thomas Detre Hall)
William Pitt Union WPU E3
Wyndham Pittsburgh University Center WYNUC E1

Ⓟ Parking
Ⓜ Metered Parking
• Library in Building
Handicap Parking available in University parking lots.