

# 2023 Lifetime Data Science Conference: *Making an Impact in the Era of Data Science*



## The 3<sup>rd</sup> Lifetime Data Science Conference

Marriott City Center; Raleigh, NC, USA

May 31 to June 2, 2023

# TABLE OF CONTENTS

ii	Welcome
iii	Sponsors
v	Acknowledgements
1	Program Overview
4	Keynote Presentations
6	Detailed Program
24	Short Courses
28	Marriott: Floor Map
29	Marriott: Parking Instructions
30	Map of Downtown Raleigh

## Welcome

On behalf of the Program Committee and all those who worked so hard to make this conference happen, welcome to the 2023 Lifetime Data Science Conference! As many of you will recall, this conference was initially scheduled for 2021 but was postponed due to the COVID pandemic. Briefly revisiting the history, the Lifetime Data Science Interest Group (LiDS IG) was formed in 2014, an effort led by Mei-Ling Lee who also founded survival analysis' flagship journal, *Lifetime Data Analysis*. The LiDS IG was approved for full-fledged Section status officially in 2018. Instrumental in the development of the LiDS Section was the highly successful 2017 Conference on Lifetime Data Science held at the University of Connecticut. The meeting was so well received that an equally successful meeting was held in 2019 at the University of Pittsburgh. With no desire to depart from a tried-and-true formula, the organizers of the 2023 event retained the basic structure of its predecessors.

All events for the 2023 Conference will take place at the Marriott City Center Raleigh. The Conference kicks off on Wednesday, May 31, with an exciting line-up of short courses on recurrent events, multi-state and competing risk models, causal inference and prediction modeling, each led by leading researchers in their respective fields. The evening of May 31 will feature a Welcome Reception (and poster session) which will take place from 6:30 to 8:30 p.m. The next two days, Thursday-Friday June 1-2, each begin with an exciting keynote presentation. We are honored to have as our keynote speakers Mei-Cheng Wang (June 1) and Per Andersen (June 2), long-standing leaders in our field who have made foundational methodologic contributions to survival analysis. The keynote presentations are each followed by three blocks (morning, early afternoon, late afternoon) of 7-9 parallel invited sessions. At this conference, we recommend that you select in advance the sessions you plan to attend. We encourage you to download and make full use of the Whova cell phone app for this purpose. Finally, note that a banquet (tickets required) will be held on Thursday from 6:30 to 8:30 pm.

The theme of this year's conference, "Making an Impact In the Era of Data Science", was chosen to underscore the importance of event history analysis in satisfying the demands and challenges posed by emerging and more complex data structures. This is reflected by the impressive breadth of the Conference's invited session program, with topics that include high-dimensional predictors, causal inference, composite end-points and other trial design elements, alternative regression modeling strategies, mediation analysis, and many other areas. It's an exciting time to be studying event history analysis. In addition to the field's natural evolution in response to its ever-changing environment, long-standing paradigms are also being challenged, leading to what appear to be several unresolved controversies.

Consistent with previous LiDS conferences, papers submitted for the 2023 LiDS Student Paper Competition were impressive in terms of number and quality. The future of our field is clearly in good hands! We thank Professor Jing Ning, who chaired the LiDS Conference Student Award Committee, as well as committee members Min Zhang, Hong Zhu, Sharon Xie and Wen Li for their dedicated and timely effort to select the winning submissions. A note that the Student Paper Awards will be presented at the start of the banquet, with their impressive works to be presented during a dedicated parallel session held on Friday starting at 10:30 a.m.. We thank all students who submitted manuscripts to the Student Paper Award competition, and offer our congratulations to the winners!

A conference of this magnitude requires a considerable amount of work, with our heartfelt thanks owed to many. A huge thank you to the Local Organizing Committee, tirelessly Co-Chaired by Shanshan Zhao and Wenbin Lu, for their incredibly hard work and dedication to carry out an endless list of tasks in preparation for this event. Great thanks are also owed to Wenbo Wu for developing the Whova app which allows you to easily peruse parallel sessions, and for developing and maintaining the Whova and LiDS Section Conference websites. The parallel sessions are brought to you by a committed LiDS membership, and we thank the invited session organizers for their hard work in recruiting such an impressive array of speakers. We thank our student volunteers from North Carolina State University, UNC Chapel Hill, Duke University and UNC Charlotte, who graciously donated their time and energy to make the conference run smoothly. Finally, holding a conference on this scale and at a top-tier venue is not possible without external support. We offer huge thanks to our sponsors (displayed at the front of this booklet and throughout the venue) for their generous support of the 2023 LiDS Conference, namely the National Institute of Environmental Health Sciences (NIEHS/NIH); New York University Grossman School of Medicine Division of Biostatistics; United Therapeutics Corporation; and ViiV Healthcare. In closing, we thank you for taking part in the 2023 Lifetime Data Science Conference! We hope that you find the conference to be a fun and academically stimulating meeting, and that this conference inspires the continuation of what has become the LiDS Section's flagship event.

Douglas Schaubel  
Co-Chair, Program Committee  
University of Pennsylvania

Mimi Kim  
Co-Chair, Program Committee  
Albert Einstein College of Medicine

*The Lifetime Data Science (LiDS) Section is grateful to the National Institute of Environmental Health Sciences (NIEHS/NIH) for their generous support of the 2023 LiDS Conference*



# National Institute of Environmental Health Sciences



**United  
Therapeutics**

C O R P O R A T I O N

*The Lifetime Data Science (LiDS) Section is grateful to the NYU Grossman School of Medicine Division of Biostatistics, United Therapeutics, and ViiV Healthcare for their generous support of the 2023 LiDS Conference*

## Acknowledgements

The ASA Lifetime Data Science (LiDS) Section would like to acknowledge the generous support from the following committees and teams.

### Local Organizing Committee

Co-Chair: Shanshan Zhao  
 Co-Chair: Wenbin Lu  
 Amy Shi  
 Xiaofei Wang  
 Feng-Chang Lin  
 Qingning Zhou

### Scientific Program Committee

Co-Chair: Douglas Schaubel  
 Co-Chair: Mimi Kim  
 Grace Y. Yi

### Online Platform Committee

Chair: Wenbo Wu  
 Douglas Schaubel

### Student Award Committee

Chair: Jing Ning  
 Wen Li  
 Sharon Xie  
 Min Zhang  
 Hong Zhu

### Student Volunteers

Xu Cao (University of North Carolina Charlotte)  
 Elizabeth (Liz) Davis (North Carolina State University)  
 Taekwon Hong (North Carolina State University)  
 Huijun (Jean) Jiang (University of North Carolina Chapel Hill)  
 Yexuan Jiang (University of North Carolina Chapel Hill)  
 Myeonggyun Lee (National Institute of Environmental Health Sciences)  
 Kaida Lou (North Carolina State University)  
 Xi Ning (University of North Carolina Charlotte)  
 Jilin Tian (Duke University)  
 Steve Wainaina (University of North Carolina Charlotte)  
 Han Wang (North Carolina State University)  
 Mufan Wang (Duke University)  
 Yifei (Krystal) Wang (Duke University)  
 Jing Xu (University of North Carolina Charlotte)  
 Sen Zhang (North Carolina State University)

### LiDS Executive Committee

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 Chair-Elect: Tony (Jianguo) Sun  
 Past Chair: Douglas Schaubel  
 Administrative Officer: Sharon Xie  
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 Program Chair: Ying Ding  
 Program Chair-Elect: Pamela Shaw  
 Past Program Chair: Jing Ning  
 Representative to ASA Council of Sections: Ronghui (Lily) Xu  
 Webinar Committee: Esra Kurum (Chair), Wenbo Wu  
 Communications Officer: Wenjie Wang  
 Technical Officer: Wenbo Wu

### Student Paper Award Winners

Xi Fang (Medical College of Wisconsin)  
 Nir Keret (Tel Aviv University)  
 Jinghao Sun (Yale University)  
 Yuyao Wang (University of California San Diego)

## Invited Session Organizers:

Yu Cheng (University of Pittsburgh)  
 Walter Dempsey (University of Michigan)  
 Teng Fei (Memorial Sloan Kettering Cancer Center)  
 Fei Gao (Fred Hutchinson Cancer Center)  
 Malka Gorfine (Tel Aviv University, Israel)  
 Charles Hall (Albert Einstein College of Medicine)  
 Kevin He (University of Michigan)  
 Hyokyung G. Hong (National Institutes of Health)  
 Li Hsu (Fred Hutchinson Cancer Center)  
 Li-Shan Huang (National Tsing Hua University, Taiwan)  
 Michael Hudgens (University of North Carolina Chapel Hill)  
 X. Joan Hu (Simon Fraser University, Canada)  
 Zhezhen Jin (Columbia University)  
 Ruth Keogh (London School of Hygiene & Tropical Medicine, U.K.)  
 Esra Kurum (University of California Riverside)  
 Julia Lee (Northwestern University)  
 Feng-Chang Lin (University of North Carolina Chapel Hill)  
 Yi Li (University of Michigan)  
 Zhiguo Li (Duke University)  
 Judith Lok (Boston University)  
 Wenbin Lu (North Carolina State University)  
 Bin Nan (University of California Irvine)  
 Andy Ni (The Ohio State University)  
 Jing Ning (MD Anderson Cancer Center)  
 Herbert Pang (Genentech/Roche)  
 Michael Pennell (The Ohio State University)  
 Jing Qin (National Institutes of Health )  
 Stephen Salerno (University of Michigan)  
 Thomas Scheike (University of Copenhagen, Denmark)  
 Jonathan Siegel (Bayer)  
 Amy Shi (AstraZeneca)  
 Alisa Stephens (University of Pennsylvania)  
 Robert Strawderman (University of Rochester)  
 Tony Sun (University of Missouri)  
 Yifei Sun (Columbia University)  
 Sally Thurston (University of Rochester)  
 Ludovic Trinquart (Tufts Medical Center)  
 Rui Wang (Harvard Medical School)  
 Xiaofei Wang (Duke University)  
 Wenbo Wu (New York University Grossman School of Medicine)  
 Sharon Xie (University of Pennsylvania)  
 Gongjun Xu (University of Michigan)  
 Ronghui (Lily) Xu (University of California San Diego)  
 Grace Y. Yi (University of Western Ontario, Canada)  
 Jessica Young (Harvard Medical School)  
 Leilei Zeng (University of Waterloo, Canada)  
 Min Zhang (University of Michigan)  
 Shanshan Zhao (National Institute of Environmental Health Sciences)  
 Qingning Zhou (University of North Carolina at Charlotte)

## Program Overview

Wednesday May 31

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### Short Courses

- 8:00 – 12:00 Short Course I: **Jianwen Cai**  
Models and Methods for Recurrent Event Data
- 13:00 – 17:00 Short Course II: **Michael Pencina and Chuan Hong**  
Prediction Modeling with Censored Data
- 8:00 – 17:00 Short Course III: **Xiaofei Wang and Shu Yang**  
Statistical Methods for Time-to-Event Data from Multiple Sources: A Causal Inference Perspective
- 18:30 – 20:30 Welcome Reception and Poster Session (including Student Poster Competition)
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## Thursday June 1

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8:00 – 8:45 Breakfast

8:45 – 9:00 Welcome

9:00 – 10:00 Keynote Presentation I: **Mei-Cheng Wang**  
Cross-Sectional Data, Epidemic Dynamics and Beyond

10:00 – 10:30 Refreshment Break

10:30 – 12:00 Invited Sessions

1. **Li-Shan Huang and Sally Thurston**: Novel Statistical Approaches for Environmental Applications
2. **Charles B. Hall**: Cancer after World Trade Center Exposure: Methodological Challenges and Substantive Outcomes
3. **Kevin He**: Recent Advances in Survival Analysis for Large-Scale Complex Biomedical Data
4. **Sharon X. Xie**: Recent Advances in the Analysis of Truncated Data
5. **Jonathan Siegel**: Issues in Survival Analysis in Pharmaceutical Clinical Trials
6. **Hyokyung G. Hong**: High Dimensional Survival Analysis and Inference on Complex Data
7. **Xiaofei Wang and Herbert Pang**: Statistical Challenges in COVID-19 Research
8. **Jing Qin**: Survival Analysis under Biased Sampling
9. **Wenbin Lu**: Recent Development in Causal Inference and Dynamic Prediction for Survival Data

13:30 – 15:00 Invited Sessions

10. **Jessica Young**: Recent Advances in Causal Inference for Lifetime Data
11. **X. Joan Hu**: Statistics in Biosciences (SIBS): Real World Challenges and Recent Methodological Developments
12. **Esra Kurum**: Recent Advances in the Analysis of Censored Data
13. **Zhiguo Li**: Methods for Dealing with Non-Proportional Hazards
15. **Malka Gorfine**: High Dimensional Data and Risk Prediction
16. **Amy Shi**: Restricted Mean Survival Time (RMST)
17. **Feng-Chang Lin**: Interval Censoring, High-Dimensionality, and Risk Prediction using Survival Outcomes
18. **Bin Nan**: Machine Learning Methods for Censored Survival Data

15:00 – 15:30 Refreshment Break

15:30 – 17:00 Invited Sessions

19. **Rob Strawderman**: Causal Inference with Recurrent Events
20. **Wenbo Wu**: Novel Statistical Methods for Complexly Structured Time-to-Event Data
21. **Michael Pennell**: Novel Methods for Dose-response Assessment of Time-to-Event Outcomes
22. **Yu Cheng**: Practical Considerations of Win Ratio and Win Odds
23. **Gongjun Xu**: Recent Advances in the Analysis of Complex Survival Data
24. **Amy Shi and Gary Koch**: Innovations in Survival Analysis with RWD, Design, and Missingness in Clinical Trials
25. **Rui Wang**: Novel Methods for Survival Analysis of Complex Exposures and/or Outcomes
26. **Zhezhen Jin**: New Developments and Insights for the Challenges in the Analysis of Time-to-Event Data
27. **Jing Ning**: Recent Advancements in Statistical Methods for Complex Lifetime Data

18:30 – 20:30 Banquet  
(tickets must be purchased in advance)

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## Friday June 2

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- 8:00 – 9:00 Breakfast
- 9:00 – 10:00 Keynote Presentation II: **Per Kragh Andersen**  
The Joy of Pseudovalues
- 10:00 – 10:30 Refreshment Break
- 10:30 – 12:00 Invited Sessions
28. **Fei Gao**: Recent Development on Causal Inference with Event Time Data
  29. **Shanshan Zhao**: Recent Advances in Multivariate Survival Data Analysis
  30. **Jonathan Siegel**: Time-to-Event Estimands in Oncology
  31. **Yifei Sun**: Recent Advances in Modeling Complex Longitudinal and Survival Data
  32. **Qingning Zhou**: Advanced Survival Analysis for Complex Biomedical Studies
  33. **Leilei Zeng and Ronghui (Lily) Xu**: Advanced Survival Analysis Methods for Contemporary Biomedical Data Analysis
  34. **Michael Hudgens**: Causal Inference with Censored Data
  35. **Jing Ning**: 2023 LiDS Student Paper Awards
- 13:30 – 15:00 Invited Sessions
36. **Ruth Keogh**: New Developments in Causal Inference using Longitudinal and Event History Data
  37. **Stephen Salerno**: Cutting-Edge Methods for Modern Epidemiology Studies
  38. **Thomas Scheike**: Competing Risks Modelling
  39. **Min Zhang**: Recent Developments in Clinical Trial Design
  40. **Alisa Stephens-Shields**: Survival Analysis in Finite and Small Samples
  41. **Grace Y. Yi**: Statistical Learning of Survival Data with Complex Features
  42. **Li Hsu**: Multi-state and Dynamic Risk Estimation and Prediction
  43. **Julia Lee**: Deep Learning for Survival Analysis Problems with Applications in Biomedical Research
- 15:00 – 15:30 Refreshment Break
- 15:30 – 17:00 Invited Sessions
44. **Ronghui (Lily) Xu**: Latest Development in Proxies, Surrogates, and Computation of Survival Outcomes
  45. **Walter Dempsey**: Causal Inference and Survival Analysis
  46. **Judith J. Lok**: Estimands and Survival Analysis: What If More than One Outcome is of Interest?
  47. **Ludovic Trinquart**: Advances in Survival Analysis with the Restricted Mean Survival Time
  48. **Teng Fei**: Latent Class Methods for Survival Data
  49. **Stephen Salerno**: High Dimensional Methods for Survival Data: Beyond Regularization
  50. **Andy Ni**: Survival Analysis with Two-Stage Sampling Design
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## Keynote Presentations: Specifics

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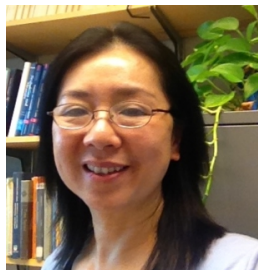
### Cross-Sectional Data, Epidemic Dynamics and Beyond

Mei-Cheng Wang (Johns Hopkins University)

#### Overview

A cross-sectional population is defined as a population of living individuals at the sampling or observational time. Cross-sectionally sampled data with binary disease outcome are commonly analyzed in observational studies, frequently as an initial attempt, for the purpose to identify how covariates or risk factors correlate with disease occurrences. At Johns Hopkins University, cross-sectional data analyses using standard methods (testing statistics, logistic regression, etc.) are commonly conducted in doctoral dissertations by students with public health or medicine majors. Publications involving such data analysis can also be easily found online by searching the key words such as 'logistic regression' or 'logistic model' and 'cross-sectional data' or 'cross-sectional study.' It is generally understood that cross-sectional binary disease outcome is not as informative as longitudinally collected time-to-event data, but there is insufficient understanding as to whether bias can possibly exist in cross-sectional data and, if it exists, how the bias is related to the population risk of interest. In this talk we study bias of absolute risk, relative risk and odds ratio arising from cross-sectional data, and connect the so-called 'survival bias' to case-control data sampled from cross-sectional population. While the presence of bias may not be surprising, a bad news is that the bias is likely to change the interpretation toward the wrong direction. With auxiliary information of lifetime distribution, we present a bias-correction method which reassigns a portion of the observed binary outcome, 0 or 1, to the other disease category. Recommendation is discussed/invited at the end of this talk to find ways to provide advise to our project collaborators, students and colleagues.

#### About the Keynote Speaker



**Mei-Cheng Wang** is a Professor in the Department of Biostatistics at the Johns Hopkins Bloomberg School of Public Health. Professor Wang has done foundational work on methods for truncation, length-bias and prevalent sampling, with an emphasis on data collected through cohort studies or healthcare systems. She has served as Principal Investigator on multiple NIH-sponsored grants to develop statistical methods for longitudinal and survival data, and has led the Survival, Longitudinal and Multivariate (SLAM) Data Working Group at JHU-SPH since 1997. In addition, Mei-Cheng served as Chair of the Lifetime Data Science (LiDS) Executive Committee in 2017.

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## Keynote Presentations: Specifics

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### The Joy of Pseudovalues

Per Kragh Andersen (University of Copenhagen, Denmark)

#### Overview

Survival analysis is characterized by the need to deal with incomplete observation of the outcome variable, most frequently caused by right-censoring, and several – now standard – inference procedures have been developed to deal with this, such as the Kaplan-Meier estimator and the partial likelihood for estimating regression coefficients in the proportional hazards model. During the last decades, methods based on pseudo-values have been studied. Here, the idea is to apply a transformation of the incompletely observed survival data and to create a more simple data set for which ‘standard’ techniques (i.e., for complete data) may be applied, e.g., methods using generalized estimating equations. An advantage of this approach is that it applies quite generally to (marginal) parameters for which no or few other regression methods are directly available (including average time spent in a state of a multi-state model). This is under the proviso that a certain property of the influence function for the estimand in question holds true. Another advantage is that it allows the use of a number of graphical techniques, otherwise unavailable in survival analysis. Disadvantages include that the method is not fully efficient and that it, in its simplest form, assumes covariate-independent censoring (though generalizations to deal with this have been developed). This presentation will review the development in the field since the idea was put forward in a 2003 *Biometrika* paper. We will, among topics, discuss graphical methods, theoretical properties, applications in causal inference, and efficient implementations.

#### About the Keynote Speaker



**Per Kragh Andersen** is a Professor in the Section of Biostatistics at the University of Copenhagen Department of Public Health in Denmark. Professor Andersen has published extensively in many domains of survival and event history analysis, including groundbreaking work establishing large-sample properties of the Cox model via martingale theory. He is also the lead author of the well-known textbook, “Statistical Models Based on Counting Processes.” In addition, Professor Andersen’s work on pseudovalues greatly expanded the range of regression-based targets of inference for survival analysis.

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## Wednesday May 31

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### Wednesday May 31, 8:00 – 17:00

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Wednesday May 31, 8:00 – 12:00

Short Course I

University B

8:00 – 12:00 **Jianwen Cai** (University of North Carolina at Chapel Hill)  
Models and Methods for Recurrent Event Data

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Wednesday May 31, 13:00 – 17:00

Short Course II

University B

13:00 – 17:00 **Michael Pencina** (Duke University) and  
**Chuan Hong** (Duke University)  
Prediction Modeling with Censored Data

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Wednesday May 31, 8:00 – 17:00

Short Course III

University A

8:00 – 17:00 **Xiaofei Wang** (Duke University) and  
**Shu Yang** (North Carolina State University)  
Statistical Methods for Time-to-Event Data from Multiple Sources: A Causal Inference Perspective

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### Wednesday May 31, 18:30 – 20:30

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Wednesday May 31, 18:30 – 20:30

State Ballroom C-D

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

**Qinghua Lian** (Medical College of Wisconsin)  
Multiple imputation of missing covariates for time-to-event data

**Patrick Schloemer** (Bayer AG)  
A Bayesian framework for event prediction in clinical trials with recurrent event endpoints and terminal events

**Myeonggyun (Matt) Lee** (NIEHS/NIH)  
Novel statistical approaches to handle multiple censored exposures due to detection limits in environmental mixture analysis

**Xi Ning** (University of North Carolina Charlotte)  
A Semiparametric Cox-Aalen transformation model with censored data

**Xu Cao** (University of North Carolina Charlotte)  
Two-phase outcome-auxiliary-dependent sampling with survival data

**Yiyuan Huang** (University of Michigan)  
Statistical methods for composite analysis of recurrent and terminal events in clinical trials

**Yangfan Ren** (Rice University)  
A Bayesian framework for event prediction in clinical trials with recurrent event endpoints and terminal events

**Samuel Anyaso-Samuel** (University of Florida)  
Pseudo-value regression of clustered current status data with informative cluster or subcluster sizes in a multistate model

## Thursday June 1

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### Thursday June 1, 8:00 – 8:45

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Thursday June 1, 8:00–8:45

Pre-Function Space

8:00 – 8:45 Breakfast

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### Thursday June 1, 8:45 – 9:00

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Thursday June 1, 8:45–9:00

State Ballroom C-D

8:45 – 9:00 Welcome

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### Thursday June 1, 9:00 – 10:00

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Thursday June 1, 9:00 – 10:00

Keynote Presentation

State Ballroom C-D

#### Keynote Presentation I: Mei-Cheng Wang

Chair: Douglas Schaubel (University of Pennsylvania)

9:00 – 10:00 **Mei-Cheng Wang** (John Hopkins University)  
Cross-Sectional Data, Epidemic Dynamics and Beyond

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### Thursday June 1, 10:00 – 10:30

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Thursday June 1, 10:00–10:30

Pre-Function Space

10:00 – 10:30 Refreshment Break

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### Thursday June 1, 10:30 – 12:00

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Thursday June 1, 10:30 – 12:00

Invited Session 1

University A

#### Novel Statistical Approaches for Environmental Applications

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

Organizer: Li-Shan Huang (National Tsing Hua University, Taiwan) and Sally Thurston (University of Rochester)

10:30 – 10:50 **Howard H. Chang** (Emory University)  
Identifying Critical Windows of Environmental Exposure in Time-to-Event Analysis of Adverse Reproductive Health Outcomes

10:50 – 11:10 **Sally W. Thurston** (University of Rochester Medical Center)  
Modeling mercury effects on multiple diverse longitudinal outcomes in the Seychelles Child Development Study

11:10 – 11:30 **Pei-Sheng Lin** (National Health Research Institutes, Taiwan)  
Identification of Geographic Clusters for Temporal Heterogeneity with Application to Dengue Surveillance

11:30 – 11:50 **Linda Valeri** (Columbia University)  
Bayesian kernel machine regression-causal mediation analysis for environmental mixtures

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**Thursday June 1, 10:30 – 12:00****Invited Session 2****University B****Cancer after World Trade Center Exposure: Methodological Challenges and Substantive Outcomes**

Chair and Organizer: Charles B. Hall (Albert Einstein College of Medicine)

- 10:30 – 10:50 **Rachel Zeig-Owens** (Albert Einstein College of Medicine)  
Temporal Association of Cancer Incidence with World Trade Center Rescue/Recovery Work
- 10:50 – 11:10 **Yongzhao Shao** (New York University)  
Cancer Characteristics among WTC Survivors at WTC Environmental Health Center
- 11:10 – 11:30 **Paolo Boffetta** (Stony Brook University)  
Cancer Survival among WTC Rescue and Recovery Workers: A Collaborative Cohort Study
- 11:30 – 11:50 **Rebecca Betensky** (New York University)  
Discussant

**Thursday June 1, 10:30 – 12:00****Invited Session 3****University C****Recent Advances in Survival Analysis for Large-Scale Complex Biomedical Data**

Chair and Organizer: Kevin He (University of Michigan)

- 10:30 – 10:50 **Douglas Schaubel** (University of Pennsylvania)  
Prognostic score-based methods for estimating center effects based on survival probability
- 10:50 – 11:10 **Weijing Tang** (Carnegie Mellon University)  
Recurrent Event analysis with Ordinary Differential Equations
- 11:10 – 11:30 **Shuangge Ma** (Yale University)  
Cancer prognosis analysis via integrating molecular and histopathological imaging features
- 11:30 – 11:50 **Gongjun Xu** (University of Michigan)  
Efficient estimation for censored quantile regression

**Thursday June 1, 10:30 – 12:00****Invited Session 4****State E****Recent Advances in the Analysis of Truncated Data**

Chair and Organizer: Sharon X. Xie (University of Pennsylvania)

- 10:30 – 10:55 **Leilei Zeng** (University of Waterloo, Canada)  
Using auxiliary information for estimation with left truncated data
- 10:55 – 11:20 **Sharon X. Xie** (University of Pennsylvania)  
Improved doubly robust estimation of Cox regression parameters under left truncation
- 11:20 – 11:45 **Richard J. Cook** (University of Waterloo, Canada)  
Two-phase design of biomarker sub-studies involving disease registries with state-dependent selection schemes

**Thursday June 1, 10:30 – 12:00****Invited Session 5****State A****Issues in Survival Analysis in Pharmaceutical Clinical Trials**

Chair and Organizer: Jonathan Siegel (Bayer US LLC)

- 10:30 – 10:50 **Patrick Schlömer** (Bayer AG, Germany)  
Efficiency of recurrent and time-to-first event methods in the presence of terminal events – Application to chronic heart failure trials
- 10:50 – 11:10 **Liwei Wang** (Genmab)  
Logic respecting efficacy measures in the presence of prognostic or predictive biomarker subgroups
- 11:10 – 11:30 **Godwin Yung** (Genentech/Roche)  
Balancing events, not patients, maximizes power in randomized survival studies
- 11:30 – 11:50 **Satrajit Roychoudhury** (Pfizer Inc.)  
Discussant

**Thursday June 1, 10:30 – 12:00**

**Invited Session 6**

**State B**

**High Dimensional Survival Analysis and Inference on Complex Data**

Chair and Organizer: Hyokyung G. Hong (National Institutes of Health)

- 10:30 – 10:50 **Hyokyung G. Hong** (National Institutes of Health)  
Quantile forward regression for high-dimensional survival data
- 10:50 – 11:10 **Rui Yang** (University of California Los Angeles)  
High-dimensional Inference for the Proportional Hazards Model with Interval-Censored Data
- 11:10 – 11:30 **Yichuan Zhao** (Georgia State University)  
Novel Empirical Likelihood Inference for the Mean Difference with Right-Censored Data
- 11:30 – 11:50 **Jian Kang** (University of Michigan)  
A Soft-Thresholding Operator for Sparse Time-Varying Effects in Survival Models

**Thursday June 1, 10:30 – 12:00**

**Invited Session 7**

**State Ballroom C**

**Statistical Challenges in COVID-19 Research**

Chair and Organizer: Xiaofei Wang (Duke University) and Herbert Pang (Genentech/Roche)

- 10:30 – 10:55 **Danyu Lin** (University of North Carolina at Chapel Hill)  
Evaluating the Effects of Vaccination and Prior Infection on SARS-CoV-2 Infection and Severe Outcomes Over Time
- 10:55 – 11:20 **Jin Jin** (University of Pennsylvania)  
Developing and Validating Prediction Models for Individual- and Community-level Risk for COVID-19 Mortality
- 11:20 – 11:45 **Kendrick Li** (University of Michigan)  
Double Negative Control Inference in Test-Negative Design Studies of Vaccine Effectiveness

**Thursday June 1, 10:30 – 12:00**

**Invited Session 8**

**State Ballroom D**

**Survival Analysis under Biased Sampling**

Chair and Organizer: Jing Qin (National Institutes of Health)

- 10:30 – 10:55 **Ruth Pfeiffer** (National Cancer Institute)  
Incorporating prevalent cases into case-control studies
- 10:55 – 11:20 **Yu Shen** (MD Anderson Cancer Center)  
Modeling the COVID incubation period
- 11:20 – 11:45 **Jing Qin** (National Allergy and Infectious Diseases, NIH)  
Survival analysis based on COVID-19 outbreak among passengers and crew on Diamond Princess cruise ship



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**Thursday June 1, 10:30 – 12:00**
**Invited Session 9****State F****Recent Development in Causal Inference and Dynamic Prediction for Survival Data**

Chair and Organizer: Wenbin Lu (North Carolina State University)

- 10:30 – 10:55 **Ingrid Van Keilegom** (KU Leuven, Belgium)  
Instrumental variable estimation of dynamic treatment effects on a survival outcome
- 10:55 – 11:20 **Limin Peng** (Emory University)  
Instrumental variable estimation of complier causal treatment effect with interval-censored data
- 11:20 – 11:45 **Yuanjia Wang** (Columbia University)  
Support Vector Machine for Dynamic Survival Prediction with Time-Dependent Covariates

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**Thursday June 1, 12:00 – 13:30**
**Thursday June 1, 12:00 – 13:30**

12:00 – 13:30 Lunch Break

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**Thursday June 1, 13:30 – 15:00**
**Thursday June 1, 13:30 – 15:00****Invited Session 10****State Ballroom C****Recent Advances in Causal Inference for Lifetime Data**

Chair and Organizer: Jessica Young (Harvard Medical School)

- 13:30 – 13:55 **Ruth Keogh** (London School of Hygiene and Tropical Medicine, U.K.)  
Estimation and validation of predictions under interventions, with an application in organ transplantation
- 13:55 – 14:20 **Torben Martinussen** (University of Copenhagen, Denmark)  
Predictive accuracy of covariates for survival times.
- 14:20 – 14:45 **Aaron Sarvet** (École Polytechnique Fédérale de Lausanne, Switzerland)  
Causal inference in limited resource settings: new estimands and statistical methods, with application to the COVID-19 pandemic

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**Thursday June 1, 13:30 – 15:00**
**Invited Session 11****State Ballroom D****Statistics in Biosciences (SIBS): Real World Challenges and Recent Methodological Developments**

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

- 13:30 – 13:50 **Yildiz Yilma** (Memorial University, Canada)  
Inference for multi-state cancer progression models with a cured fraction and masked causes of death
- 13:50 – 14:10 **Xuewen Lu** (University of Calgary, Canada)  
Variable selection in semiparametric transformation regression with interval-censored competing risks data
- 14:10 – 14:30 **Zeny Feng** (University of Guelph, Canada)  
ATQ: Alarm time quality, an evaluation metric for assessing timely epidemic detection models within a school absenteeism-based surveillance system
- 14:30 – 14:50 **Jerry Lawless** (University of Waterloo, Canada)  
Selection and Entry Conditions in Observational Cohorts
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**Thursday June 1, 13:30 – 15:00****Invited Session 12****State E****Recent Advances in the Analysis of Censored Data**

Chair and Organizer: Esra Kurum (University of California, Riverside)

- 13:30 – 13:50 **Jaeun Choi** (Albert Einstein College of Medicine)  
A two-phase approach to account for unmeasured confounding and censoring of a survival endpoint
- 13:50 – 14:10 **Jarcy Zee** (University of Pennsylvania)  
Causal effects of time-varying treatments on censored recurrent event outcomes
- 14:10 – 14:30 **Chiung-Yu Huang** (University of California, San Francisco)  
Improved semiparametric estimation of the proportional rate model with recurrent event data
- 14:30 – 14:50 **Esra Kurum** (University of California, Riverside)  
A Bayesian multilevel time-varying framework for joint modeling of hospitalization and survival in patients on dialysis

**Thursday June 1, 13:30 – 15:00****Invited Session 13****State F****Methods for Dealing with Non-Proportional Hazards**

Chair and Organizer: Zhiguo Li (Duke University)

- 13:30 – 13:50 **Kaiyuan Hua** (Duke University)  
Network meta-analysis of time-to-event endpoints with individual-level data using restricted mean survival time
- 13:50 – 14:10 **Satrajit Roychoudhury** (Pfizer)  
Analysis Considerations in Immuno-Oncology Trials under Delayed Treatment Effect
- 14:10 – 14:30 **Zhiguo Li** (Duke University)  
A Powerful and Self-Adaptive Weighted Logrank Test
- 14:30 – 14:50 **Larry Leon** (Merck)  
Weighted log-rank and Cox model analyses in the presence of non-proportional hazards

**Thursday June 1, 13:30 – 15:00****Invited Session 15****State B****High Dimensional Data and Risk Prediction**

Chair and Organizer: Malka Gorfine (Tel Aviv University, Israel)

- 13:30 – 13:55 **Nir Keret** (Tel Aviv University, Israel)  
Unlocking prevalent information in EHRs – a pairwise pseudo-likelihood approach
- 13:55 – 14:20 **Li Hsu** (Fred Hutchinson Cancer Research Center)  
Risk projection for time-to-event outcome leveraging summary statistics with source individual-level data
- 14:20 – 14:45 **Jessica Barrett** (University of Cambridge, U.K.)  
Statistical Methods for Dynamic Cardiovascular Risk Prediction using Electronic Health Record

**Thursday June 1, 13:30 – 15:00****Invited Session 16****University B****Restricted Mean Survival Time (RMST)**

Chair: Dana Cella (United Therapeutics)

Organizer: Amy Shi (AstraZeneca)

- 13:30 – 13:55 **Joseph Gardiner** (Michigan State University)  
Restricted Mean Survival Time: A Brief Survey of Estimation Methods
- 13:55 – 14:20 **Guoqing Diao** (George Washington University)  
Nonparametric Methods for Longitudinal Desirability of Outcome Ranking
- 14:20 – 14:45 **Yuan Zhang** (Affiliation University of Pennsylvania)  
Semiparametric Modeling of Restricted Mean Survival Time

**Thursday June 1, 13:30 – 15:00**

**Invited Session 17**

**University C**

**Interval Censoring, High-Dimensionality, and Risk Prediction using Survival Outcomes**

Chair and Organizer: Feng-Chang Lin (University of North Carolina at Chapel Hill)

- 13:30 – 13:50 **Daewoo Pak** (Yonsei University, South Korea)  
Evaluation of the natural history of disease by combining incident and prevalent cohorts: Application to the Nun Study
- 13:50 – 14:10 **Chenxi Li** (Michigan State University)  
Multi-marker tests based on the additive hazards model with application to Alzheimer's disease genetics
- 14:10 – 14:30 **Andy Ai Ni** (The Ohio State University)  
Optimal treatment rule estimation with composite survival data
- 14:30 – 14:50 **Steven Sy Han Chiou** (The University of Texas at Dallas)  
Analysis of survival data with cure fraction and variable selection: A pseudo-observations approach

**Thursday June 1, 13:30 – 15:00**

**Invited Session 18**

**State A**

**Machine Learning Methods for Censored Survival Data**

Chair: Ying Ding (University of Pittsburgh)

Organizer: Bin Nan (University of California, Irvine)

- 13:30 – 13:55 **Ming-Yueh Huang** (Academica Sinica, Taiwan)  
Model Selection Among Dimension-Reduced Generalized Cox Models
- 13:55 – 14:20 **Sijian Wang** (University of Wisconsin)  
Lasso based AFT model with general loss function for high dimensional survival data
- 14:20 – 14:45 **Peng Huang** (Johns Hopkins University)  
Using DeepLR to improve lung cancer screening interval

**Thursday June 1, 15:00 – 15:30**

**Thursday June 1, 15:00 – 15:30**

**Pre-Function Space**

15:00 – 15:30 Refreshment Break

**Thursday June 1, 15:30 – 17:00**

**Thursday June 1, 15:30 – 17:00**

**Invited Session 19**

**State Ballroom C**

**Causal Inference with Recurrent Events**

Chair and Organizer: Rob Strawderman (University of Rochester)

- 15:30 – 15:55 **Ben Baer** (University of Rochester)  
On the estimation of treatment effects on the marginal recurrent event mean in the presence of a terminating event
- 15:55 – 16:20 **Matias Janvin** (École Polytechnique Fédérale de Lausanne, Switzerland)  
Dynamic interventions determined by recurrent events
- 16:20 – 16:45 **Robert Platt** (McGill University, Canada)  
Causal Inference for Recurrent Event Data using Pseudo-Observations

**Thursday June 1, 15:30 – 17:00**

**Invited Session 20**

**State Ballroom D**

**Novel Statistical Methods for Complexly Structured Time-to-Event Data**

Chair and Organizer: Wenbo Wu (NYU Grossman School of Medicine)

- 15:30 – 15:55 **Rebecca Betensky** (New York University)  
Analysis of Data That Feature Partial Sequential Truncation with Application to Alzheimer's Cohort Studies
- 15:55 – 16:20 **Sebastien Haneuse** (Harvard University)  
Statistical Analysis of Clustered Semi-Continuous Data Truncated by Death with Application to Nursing Home Profiling
- 16:20 – 16:45 **Dandan Liu** (Vanderbilt University Medical Center)  
Predictive Partly Conditional Model for Longitudinal Outcomes in the Presence of Informative Dropout and Death

**Thursday June 1, 15:30 – 17:00**

**Invited Session 21**

**State F**

**Novel Methods for Dose-response Assessment of Time-to-Event Outcomes**

Chair and Organizer: Michael Pennell (The Ohio State University)

- 15:30 – 15:55 **Abhisek Saha** (National Institute of Child Health and Human Development)  
Variable selection in discrete frailty model in the context of assessing multi-pollutant mixtures on time-to-pregnancy
- 15:55 – 16:20 **Matthew Wheeler** (National Institute of Environmental Health Sciences)  
Penalty subspace regression for splines in the Cox proportional hazards model
- 16:20 – 16:45 **Jonathan Race** (University of Utah)  
Semi-parametric testing for ordinal treatment effects in time-to-event data via dynamic Dirichlet process mixtures of the inverse Gaussian distribution

**Thursday June 1, 15:30 – 17:00**

**Invited Session 22**

**State A**

**Practical Considerations of Win Ratio and Win Odds**

Chair and Organizer: Yu Cheng (University of Pittsburgh)

- 15:30 – 15:50 **Huiman Barnhart** (Duke University)  
To Use Win-Ratio or not in Study Design with Composite Events
- 15:50 – 16:10 **Dali Zhou** (Food and Drug Administration )  
Statistical power considerations in the use of win ratio in cardiovascular outcome trials
- 16:10 – 16:30 **Ying Cui** (Emory University)  
Do win ratio, win odds and net benefit complement one another to show the strength of the treatment effect on time-to-event outcomes?
- 16:30 – 16:50 **Bang Wang** (Vertex Pharmaceuticals)  
A Weighted Generalized Win-Odds Regression Model for Composite Endpoints

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**Thursday June 1, 15:30 – 17:00**
**Invited Session 23****University B****Recent Advances in the Analysis of Complex Survival Data**

Chair and Organizer: Gongjun Xu (University of Michigan)

- 15:30 – 15:55 **Tony Sit** (The Chinese University of Hong Kong, P.R. China)  
Censored Quantile Regression with Time-dependent Covariates
- 15:55 – 16:20 **Shanshan Ding** (University of Delaware)  
Dimension reduction and robust nonparametric methods for high dimensional survival analysis with applications to cancer genomic data
- 16:20 – 16:45 **Hok Kan (Brian) Ling** (Queen's University, Canada)  
On Nonparametric Estimation for Cross-sectional Sampled Data under Stationarity
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**Thursday June 1, 15:30 – 17:00****Invited Session 24****State E****Innovations in Survival Analysis with RWD, Design, and Missingness in Clinical Trials**

Chair: Gary Koch (University of North Carolina at Chapel Hill)

Organizer: Amy Shi (AstraZeneca) and Gary Koch (University of North Carolina at Chapel Hill)

- 3:30 – 3:50 **Sujit Ghosh** (North Carolina State University)  
Transporting Survival of an HIV Clinical Trial to the External Target Populations
- 3:50 – 4:10 **Haitao Chu** (Pfizer Inc.)  
Non-concurrent Controls in Platform Trials: can we borrow their concurrent observation time
- 4:10 – 4:30 **Amy Shi** (AstraZeneca Pharmaceuticals)  
Reference-based Sensitivity Analyses for Time-to-event Data with Missing
- 4:30 – 4:50 **Elaine Kowalewski** (University of North Carolina at Chapel Hill)  
Ranking Methods for Comparing Two Treatments for Overall Survival with Adjustment for Control Group Treatment Switching after Disease Progression
- 4:50 – 5:00 **Gary Koch** (University of North Carolina at Chapel Hill)  
Discussant
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**Thursday June 1, 15:30 – 17:00****Invited Session 25****State B****Novel Methods for Survival Analysis of Complex Exposures and/or Outcomes**

Chair and Organizer: Rui Wang (Harvard Medical School)

- 15:30 – 15:50 **Wen Lan** (University of Waterloo, Canada)  
Stochastic treatment interventions in causal survival analysis
- 15:50 – 16:10 **Jing Qian** (Department of Biostatistics and Epidemiology, University of Massachusetts-Amherst )  
Estimation with sequentially truncated survival data
- 16:10 – 16:30 **Tom Chen** (Harvard Medical School )  
Robust estimation for recurrent event analysis in the presence of informative event censoring
- 16:30 – 16:50 **X. Joan Hu** (Simon Fraser University, Canada)  
Challenges and strategies in analysis of large administrative health data with censoring and truncation
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**Thursday June 1, 15:30 – 17:00****Invited Session 26****University C****New Developments and Insights for the Challenges in the Analysis of Time-to-Event Data**

Chair and Organizer: Zhezhen Jin (Columbia University)

- 15:30 – 15:50 **Jiancheng Jiang** (University of North Carolina at Charlotte)  
Dimension-reduced tests for Cox's models based on regularization
- 15:50 – 16:10 **Mengling Liu** (New York University)  
Partially linear single-index generalized mean residual life models
- 16:10 – 16:30 **(Tony) Jianguo Sun** (University of Missouri)  
Variable Selection and Estimation for Interval-Censored Failure Time Data
- 16:30 – 16:50 **Cuiling Wang** (Albert Einstein College of Medicine)  
Optimal Cut-Point for Disease Incidence with Censored Data

**Thursday June 1, 15:30 – 17:00**

**Invited Session 27**

**University A**

**Recent Advancements in Statistical Methods for Complex Lifetime Data**

Chair and Organizer: Jing Ning (MD Anderson Cancer Center)

- 15:30 – 15:50 **Ziyi Li** (MD Anderson Cancer Center)  
Accommodating time-varying heterogeneity in risk estimation under the Cox model: a transfer learning approach
- 15:50 – 16:10 **Wen Li** (The University of Texas Health Science Center at Houston)  
Dynamic and Concordance-assisted Learning for Risk Stratification with Application to Alzheimer's Disease
- 16:10 – 16:30 **Dongdong Li** (Harvard Medical School)  
Proportional Hazards Regression Models for Interval-Censored Outcome Data with an Interval-Censored Covariate
- 16:30 – 16:50 **Chi Hyun Lee** (University of Massachusetts Amherst)  
Estimating time-varying treatment effects on restricted mean survival time in large patient databases

**Thursday June 1, 18:30 – 20:30**

**Thursday June 1, 18:30 – 20:30**

**State Ballroom C-D**

18:30 – 20:30 Banquet

## Friday June 2

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### Friday June 2, 8:00 – 9:00

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Friday June 2, 8:00–9:00

Pre-Function Space

8:00 – 9:00 Breakfast

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### Friday June 2, 9:00 – 10:00

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Friday June 2, 9:00 – 10:00

Keynote Presentation

State Ballroom C-D

#### Keynote Presentation II: Per Kragh Andersen

Chair: Grace Y. Yi (University of Western Ontario, Canada)

9:00 – 10:00 **Per Kragh Andersen** (University of Copenhagen, Denmark)  
The Joy of Pseudovalues

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### Friday June 2, 10:00 – 10:30

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Friday June 2, 10:00–10:30

Pre-Function Space

10:00 – 10:30 Refreshment Break

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### Friday June 2, 10:30 – 12:00

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Friday June 2, 10:30 – 12:00

Invited Session 28

State A

#### Recent Development on Causal Inference with Event Time Data

Chair and Organizer: Fei Gao (Fred Hutchinson Cancer Research Center)

10:30 – 10:55 **Yifan Cui** ( Zhejiang University)

Proximal Causal Inference for Marginal Counterfactual Survival Curves

10:55 – 11:20 **Yen-Tsung Huang** (Academia Sinica, Taiwan)

Surrogate marker assessment using mediation and instrumental variable analyses in a case-cohort design

11:20 – 11:45 **Yi Xiong** (Fred Hutchinson Cancer Center)

Causal inference for assessing cost-effectiveness with semi-competing risk data

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Friday June 2, 10:30 – 12:00

Invited Session 29

University B

#### Recent Advances in Multivariate Survival Data Analysis

Chair and Organizer: Shanshan Zhao (NIEHS/NIH)

10:30 – 10:55 **Ruoshan Li** (The University of Texas Health Science Center at Houston)

Assessing predictive discrimination performance of biomarkers in the presence of treatment-induced dependent censoring

10:55 – 11:20 **Jing Ning** (MD Anderson Cancer Center)

Conditional independence test of failure and truncation times: Essential tool for method selection

11:20 – 11:45 **Ying Ding** (University of Pittsburgh)

An Information Ratio based Goodness-of-fit Test for Copula Models on Multivariate Censored Data

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**Friday June 2, 10:30 – 12:00**
**Invited Session 30****State B****Time-to-Event Estimands in Oncology**

Chair: Godwin Yung (Genentech/Roche)

Organizer: Jonathan Siegel (Bayer)

10:30 – 10:50 **Natalia Kan-Dobrosky** (Abbvie, Inc.)  
Estimands and treatment switching10:50 – 11:10 **Vitaly Druker** (Astrazeneca Ltd)  
Treatment switching adjustment in the context of non-proportional hazards11:10 – 11:30 **Jonathan M Siegel** (Bayer)  
Applying the estimands framework to time-to-event oncology studies: What happens when you cannot follow past an intercurrent event?11:30 – 11:50 **Richard J Cook** (University of Waterloo, Canada)  
Discussant

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**Friday June 2, 10:30 – 12:00**
**Invited Session 31****State E****Recent Advances in Modeling Complex Longitudinal and Survival Data**

Chair and Organizer: Yifei Sun (Columbia University)

10:30 – 10:50 **Rajeshwari Sundaram** (National Institutes of Health)  
Joint Modeling of Geometric Features of Longitudinal Process and Discrete Survival Time Measured on Nested Timescales: An Application to Fecundity Studies10:50 – 11:10 **Dayu Sun** (Emory University, USA)  
Kernel meets sieve: transformed hazards models with sparse longitudinal covariates11:10 – 11:30 **Yifei Sun** (Columbia University)  
Semiparametric Joint Modeling of Marker Trajectory and a Failure Event in the Presence of Left Truncation11:30 – 11:50 **Ruoshan Li** (MD Anderson Cancer Center)  
A Flexible-Hazards Cure Model with Application to Patients with Soft Tissue Sarcoma

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**Friday June 2, 10:30 – 12:00**
**Invited Session 32****State Ballroom C****Advanced Survival Analysis for Complex Biomedical Studies**

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

10:30 – 10:55 **Jianwen Cai** (University of North Carolina at Chapel Hill)  
Additive subdistribution hazards regression for competing risks data in case-cohort studies10:55 – 11:20 **Yi Li** (University of Michigan)  
De-biasing the Cox regression with a large number of covariates11:20 – 11:45 **Jonathan Schildcrout** (Vanderbilt University Medical Center)  
Analyses of longitudinal, ordinal outcomes with absorbing states with connections to survival analyses

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**Friday June 2, 10:30 – 12:00**
**Invited Session 33****University A****Advanced Survival Analysis Methods for Contemporary Biomedical Data Analysis**

Chair: Leilei Zeng (University of Waterloo, Canada)

Organizer: Leilei Zeng (University of Waterloo, Canada) and Ronghui (Lily) Xu (University of California San Diego)



- 10:30 – 10:50 **Wenbo Wu** (NYU Grossman School of Medicine)  
Understanding the Dynamic Impact of COVID-19 through Competing Risk Modeling with Bivariate Varying Coefficients
- 10:50 – 11:10 **Daniel Nevo** (Tel Aviv University, Israel)  
A sensitivity analysis approach for the causal hazard ratio in randomized and observational studies
- 11:10 – 11:30 **Daniel Gillen** (University of California - Irvine)  
Censoring-robust time-dependent ROC estimation
- 11:30 – 11:50 **Ronghui (Lily) Xu** (University of California at San Diego)  
Discussant

**Friday June 2, 10:30 – 12:00**

**Invited Session 34**

**State Ballroom D**

**Causal Inference with Censored Data**

Chair and Organizer: Michael Hudgens (University of North Carolina at Chapel Hill)

- 10:30 – 10:50 **Michael Kosorok** (University of North Carolina at Chapel Hill)  
Nonparametric finite-horizon reinforcement learning for right-censored outcomes
- 10:50 – 11:10 **David Benkeser** (Emory University)  
Targeted machine learning in settings with competing risks with applications in studies of preventive vaccines
- 11:10 – 11:30 **Wenbin Lu** (North Carolina State University)  
Subgroup Detection via One-Step Value Difference Estimation with Time-to-Event Endpoint
- 11:30 – 11:50 **Eric Tchetgen Tchetgen** (University of Pennsylvania)  
Discussant

**Friday June 2, 10:30 – 12:00**

**Invited Session 35**

**University C**

**2023 LiDS Student Paper Awards**

Chair: Hong Zhu (University of Virginia)

Organizer: Jing Ning (MD Anderson Cancer Center)

- 10:30 – 10:50 **Yuyao Wang** (University of California San Diego)  
Doubly Robust Estimation under Covariate-Induced Dependent Left Truncation
- 10:50 – 11:10 **Nir Keret** (Tel Aviv University, Israel)  
Analyzing Big EHR Data - Optimal Cox Regression Subsampling Procedure with Rare Events
- 11:10 – 11:30 **Xi Fang** (Medical College of Wisconsin)  
The Cox model with adaptive fused group bridge penalty to incorporate historical data into the analysis of clinical trials
- 11:30 – 11:50 **Jinghao Sun** (Yale University)  
Causal identification for continuous-time stochastic processes

**Friday June 2, 12:00 – 13:30**

**Friday June 2, 12:00 – 13:30**

12:00 – 13:30 Lunch Break

**Friday June 2, 13:30 – 15:00****Friday June 2, 13:30 – 15:00****Invited Session 36****State Ballroom C****New Developments in Causal Inference using Longitudinal and Event History Data**

Chair and Organizer: Ruth Keogh (London School of Hygiene and Tropical Medicine, U.K.)

- 13:30 – 13:55 **Jessica Young** (Harvard Medical School)  
An Alternative “Interventionist Causal Inference”: Leading with Stories
- 13:55 – 14:20 **Jon Michael Gran** (University of Oslo, Norway)  
Target trial emulation with time-varying treatment and multi-state outcomes: an application to opioid use after traumatic injury
- 14:20 – 14:45 **Oliver Dukes** (Ghent University, Belgium)  
On estimation of the causal relative chance of survival in the presence of time-varying confounders

**Friday June 2, 13:30 – 15:00****Invited Session 37****State A****Cutting-Edge Methods for Modern Epidemiology Studies**

Chair and Organizer: Stephen Salerno (University of Michigan)

- 13:30 – 13:55 **Ram Tiwari** (Bristol Myers Squibb)  
Leveraging External Data to Augment the Control Arm in Randomized Clinical Trials
- 13:55 – 14:20 **Somnath Datta** (University of Florida)  
Regression Analysis of a Future State Entry Time Distribution Conditional on a Past State Occupation in a Progressive Multistate Model
- 14:20 – 14:45 **Zhezhen Jin** (Columbia University)  
Subsampling for the analysis of large scale data

**Friday June 2, 13:30 – 15:00****Invited Session 38****State B****Competing Risks Modelling**

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

- 13:30 – 13:50 **Giuliana Cortese** (University of Padova, Italy)  
Regression models for the marginal mean of recurrent events in presence of competing risks
- 13:50 – 14:10 **Frank Eriksson** (University of Copenhagen, Denmark)  
Empirical likelihood ratio inference for comparisons of absolute risks
- 14:10 – 14:30 **Dennis Dobler** (Vrije Universiteit Amsterdam, Netherlands)  
A nonparametric relative treatment effect for direct comparisons of two dependent samples under right-censoring
- 14:30 – 14:50 **Thomas Scheike** (University of Copenhagen, Denmark)  
Efficient estimation for the Fine-Gray regression model

**Friday June 2, 13:30 – 15:00****Invited Session 39****University B****Recent Developments in Clinical Trial Design**

Chair and Organizer: Min Zhang (University of Michigan)

- 13:30 – 13:50 **Ying Yuan** (MD Anderson Cancer Center)  
Design and Sample Size Determination for Multiple-dose Randomized Phase II Trials for Dose Optimization
- 13:50 – 14:10 **Eiji Ishida** (Insmed)  
An illustrative application of an extended enhanced gatekeeping method in a two-stage design with a hierarchical testing structure “modified” after an interim analysis
- 14:10 – 14:30 **Ruitao Lin** (MD Anderson Cancer Center)  
Bayesian Predictive Platform Design for Proof of Concept and Dose Finding
- 14:30 – 14:50 **Fan Li** (Yale University)  
Design and analysis of cross-sectional stepped wedge cluster randomized trials with a time-to-event endpoint

**Friday June 2, 13:30 – 15:00**

**Invited Session 40**

**University A**

**Survival Analysis in Finite and Small Samples**

Chair and Organizer: Alisa Stephens-Shields (University of Pennsylvania)

- 13:30 – 13:50 **Pamela Shaw** (Kaiser Washington Health Research Unit )  
Hazard Ratio Estimation and Inference in Small Samples
- 13:50 – 14:10 **Rui Wang** (Harvard University)  
Robust confidence intervals for estimating the marginal treatment effect in cluster-randomized trials
- 14:10 – 14:30 **Yidan Shi** (University of Pennsylvania)  
Cox Model with Left-truncation and Auxiliary Outcomes
- 14:30 – 14:50 **Michael P. Fay** (National Institutes of Allergy and Infectious Diseases)  
Discussant

**Friday June 2, 13:30 – 15:00**

**Invited Session 41**

**State Ballroom D**

**Statistical Learning of Survival Data with Complex Features**

Chair: Ying Ding (University of Pittsburgh)

Organizer: Grace Y. Yi (University of Western Ontario, Canada)

- 13:30 – 13:50 **Robert L Strawderman** (University of Rochester)  
Ensemble methods for right censored data with missing covariates
- 13:50 – 14:10 **Grace Y. Yi** (University of Western Ontario, Canada)  
Unbiased boosting estimation for censored survival data
- 14:10 – 14:30 **Hunyong Cho** (Amazon.com & Duke University)  
A nonparametric survival dynamic treatment regime
- 14:30 – 14:50 **Ronghui Xu** (University of California San Diego)  
Doubly Robust Estimation under the Marginal Structural Cox Model

**Friday June 2, 13:30 – 15:00**

**Invited Session 42**

**University C**

**Multi-state and Dynamic Risk Estimation and Prediction**

Chair and Organizer: Li Hsu (Fred Hutchinson Cancer Research Center)

- 13:30 – 13:55 **Fei Gao** (Fred Hutchinson Cancer Research Center)  
Defining and estimating principal-stratum specific natural mediation effects with semi-competing risks data
- 13:55 – 14:20 **Malka Gorfine** (Tel Aviv University, Israel)  
Marginalized frailty-based illness-death model: Application to the UK-Biobank survival data
- 14:20 – 14:45 **Yingye Zheng** (Fred Hutchinson Cancer Research Center)  
Semi-supervised validation of biomarkers with imperfect outcomes

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**Friday June 2, 13:30 – 15:00**
**Invited Session 43****State E****Deep Learning for Survival Analysis Problems with Applications in Biomedical Research**

Chair and Organizer: Julia Lee (Northwestern University)

- 13:30 – 13:55 **Jon Steingrimsson** (Brown University)  
Deep Learning Based Risk Prediction Models for Time-to-event Outcomes
- 13:55 – 14:20 **Lili Zhao** (University of Michigan)  
Deep Neural Networks for Survival Analysis Using Pseudo Values
- 14:20 – 14:45 **Adi Andrei** (Northwestern University)  
Deep Learning With a View Towards Applications in Heart Disease
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**Friday June 2, 15:00 – 15:30****Friday June 2, 15:00 – 15:30****Pre-Function Space**

15:00 – 15:30 Refreshment Break

**Friday June 2, 15:30 – 17:00****Friday June 2, 15:30 – 17:00****Invited Session 44****State E****Latest Development in Proxies, Surrogates, and Computation of Survival Outcomes**

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

- 15:30 – 15:50 **Jue Hou** (University of Minnesota)  
Risk Prediction with Imperfect Survival Outcome Information from Electronic Health Records
- 15:50 – 16:10 **Andrew Ying** (Google Inc.)  
Proximal Identification and Estimation to Handle Dependent Right Censoring for Survival Analysis
- 16:10 – 16:30 **Layla Parast** (University of Texas at Austin)  
Using a surrogate marker for early testing of a treatment effect
- 16:30 – 16:50 **Eric Kawaguchi** (University of Southern California)  
Computational considerations for proportional hazards regression
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**Friday June 2, 15:30 – 17:00****Invited Session 45****State Ballroom C****Causal Inference and Survival Analysis**

Chair: Kevin He (University of Michigan)

Organizer: Walter Dempsey (University of Michigan)

- 15:30 – 15:55 **Aaron Sarvet** (École Polytechnique Fédérale de Lausanne, Switzerland, Switzerland)  
Causal effects of intervening variables
- 15:55 – 16:20 **Stijn Vansteelandt** (Ghent University, Belgium)  
Assumption-lean Cox regression
- 16:20 – 16:45 **Ivan Diaz** (NYU Grossman School of Medicine)  
Causal survival analysis under competing risks using longitudinal modified treatment policies
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**Friday June 2, 15:30 – 17:00****Invited Session 46****State B**

**Estimands and Survival Analysis: What If More than One Outcome is of Interest?**

Chair and Organizer: Judith J. Lok (Boston University)

- 15:30 – 15:50 **Mireille Schnitzer** (Universite de Montreal, Canada)  
Defining and estimating time-dependent exposure effects on continuous or binary outcomes when the outcome is only measured at the failure time
- 15:50 – 16:10 **Shu Yang** (North Carolina State University)  
Doubly robust estimators for generalizing treatment effects on survival outcomes from randomized controlled trials to a target population
- 16:10 – 16:30 **Dean Follmann** (NIH/NIAID)  
Semi-parametric approaches to ordered composite endpoints subject to censoring
- 16:30 – 16:50 **Judith J. Lok** (Boston University)  
The survival-adjusted median versus the median in the survivors or in the always-survivors: What are we measuring? And why?

**Friday June 2, 15:30 – 17:00**

**Invited Session 47**

**University A**

**Advances in Survival Analysis with the Restricted Mean Survival Time**

Chair and Organizer: Ludovic Trinquart (Tufts Medical Center)

- 15:30 – 15:50 **Mihai Giurcanu** (University of Chicago)  
Non-parametric inference in the accelerated failure time model using restricted means
- 15:50 – 16:10 **Wen-Chi Wu** (Merck)  
Dynamic RMST curves for survival analysis in clinical trials
- 16:10 – 16:30 **Sarah Conner** (Vertex Pharmaceuticals)  
Restricted mean time lost with competing risks
- 16:30 – 16:50 **Andrea Arfé** (Memorial Sloan Kettering Cancer Center)  
A novel Bayesian nonparametric bootstrap for censored data based on the beta-Stacy process

**Friday June 2, 15:30 – 17:00**

**Invited Session 48**

**State Ballroom D**

**Latent Class Methods for Survival Data**

Chair and Organizer: Teng Fei (Memorial Sloan Kettering Cancer Center)

- 15:30 – 15:55 **Teng Fei** (Memorial Sloan Kettering Cancer Center)  
Latent Class Proportional Hazards Regression with Heterogeneous Survival Data
- 15:55 – 16:20 **Lei Liu** (Washington University in St. Louis)  
Joint latent class model of survival and longitudinal data: An application to the OHTS study
- 16:20 – 16:45 **Donglin Zeng** (University of North Carolina at Chapel Hill)  
Mixture Survival Trees for Subgroup Discovery

**Friday June 2, 15:30 – 17:00**

**Invited Session 49**

**State A**

**High Dimensional Methods for Survival Data: Beyond Regularization**

Chair and Organizer: Stephen Salerno (University of Michigan)

- 15:30 – 15:55 **Zhipeng Lou** (Princeton University)  
Communication-Efficient Distributed Estimation and Inference for Cox's Model
- 15:55 – 16:20 **Subharup Guha** (University of Florida)  
Unbiased multigroup comparisons by integrating multiple observational studies: A new concordant population approach.
- 16:20 – 16:45 **Syed Ejaz Ahmed** (Brock University, Canada)  
Big Data Analytics: Wisdom or Folly!

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**Friday June 2, 15:30 – 17:00****Invited Session 50****University B****Survival Analysis with Two-Stage Sampling Design**

Chair and Organizer: Andy Ni (Ohio State University)

- 15:30 – 15:50 **Qingning Zhou** (University of North Carolina at Charlotte)  
Case-cohort study with interval-censored failure time data
- 15:50 – 16:10 **Yinghao Pan** (University of North Carolina at Charlotte)  
Efficient secondary analysis of data from two-phase studies
- 16:10 – 16:30 **Le Wang** (Villanova University)  
Goodness-of-fit based Two-phase Sampling Designs
- 16:30 – 16:50 **Soyoung Kim** (Medical College of Wisconsin)  
Improving estimation efficiency for left-truncated competing risks regression under the case-cohort study design
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## Models and Methods for Recurrent Event Data

Jianwen Cai (University North Carolina at Chapel Hill)

### Overview

This course will provide a comprehensive examination of methods and models for the analysis of recurrent event data. The methods will be illustrated using a variety of examples from the biomedical literature. Topics will include data structure; recurrent events as a special case of multivariate survival data; rate function versus intensity function (versus hazard function); marginal models; conditional models; recurrent events of multiple types; models with both marginal and conditional elements; recurrent/terminal event data; available software; examples.

### Topics Covered

1. Survival analysis fundamentals
2. Recurrent event data structure
3. Recurrent events as a special case of multivariate survival data
4. Rate function versus intensity function (versus hazard function)
5. Marginal models
6. Conditional models
7. Recurrent events of multiple types
8. Models with both marginal and conditional elements
9. Recurrent/terminal event data
10. Available software
11. Real-data examples

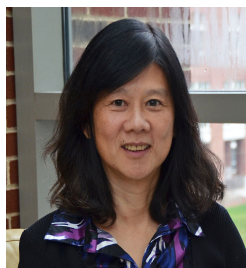
### Learning Strategy

The material will be presented will be a combination of concepts, methods, and real-data applications from a variety of biomedical settings.

### Pre-requisites

Attendees are expected to have some familiarity with survival analysis and regression modeling. Familiarity with R is also helpful in understanding the implementation of the techniques. Familiarity with recurrent event data is not required.

### About the Instructor



**Jianwen Cai** is the Cary C. Boshamer Distinguished Professor in the Department of Biostatistics at the University of North Carolina at Chapel Hill. Dr. Cai has served as Interim Chair of the Department of Biostatistics on multiple occasions. She has developed dozens of highly-cited methods for the analysis of recurrent event data, largely through four methodological grants funded by the NIH for which she has served as PI.

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## Prediction Modeling with Censored Data

Michael Pencina (Duke University) and Chuan Hong (Duke University)

### Summary

This course will provide a comprehensive examination of best practices for constructing and evaluating risk prediction algorithms and resulting clinical decision support tools. The methods will be illustrated using a variety of examples from the current practice and literature. Topics will include principles of algorithm development (data, outcomes, mathematical models, clinical applications); algorithm versus clinical decision support (CDS) tool; evaluation metrics; sources of bias in algorithms and CDS tools; recent regulatory frameworks; examples.

### Topics Covered

Topics to be covered include:

- Principles of algorithm development:
  - data structure
  - outcomes
  - mathematical models
  - clinical applications
- Algorithm versus clinical decision support (CDS) tool
- Evaluation metrics
- Sources of bias in algorithms and CDS tools
- Recent regulatory frameworks
- Examples

### Learning Strategy

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.

### Pre-requisites

Attendees are expected to have some familiarity with regression OR machine learning methods for risk prediction.

### About the Instructors



**Michael Pencina** is a Professor of Biostatistics and Bioinformatics at Duke University and Director of Duke AI Health. He previously served as Director of Biostatistics at the Duke Clinical Research Institute. Dr. Pencina is an internationally recognized authority in risk prediction model development and evaluation. Expert panels and guideline groups frequently recommend methods proposed in his research and have adopted them as the most promising new statistical tools in assessing and quantifying model performance.



**Chuan Hong** is an Assistant Professor of Biostatistics at Duke University, where her research focuses on developing advanced statistical and machine learning methods with a particular emphasis on predictive modeling, high throughput phenotyping and precision medicine using large scale biomedical data. She also has extensive expertise in data harmonization and privacy-preserving federated learning, enabling co-training models across multiple cohorts without sharing individual patient information.

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## Statistical Methods for Time-to-Event Data from Multiple Sources: A Causal Inference Perspective

Xiaofei Wang (Duke University) and Shu Yang (North Carolina State University)

### Summary

The short course will review important statistical methods for survival data arising from multiple data sources, including randomized clinical trials and observational studies. The entire short course consists of four parts and all parts will be discussed in a unified causal inference framework. In each part, we will review theoretical background. Supplemented with data examples, application of these methods in practice and implementation of these methods in freely available statistical software will be emphasized. Each part takes approximately 2 hours to cover.

### Morning Session: (Instructor: Xiaofei Wang)

In Part 1, we will review key issues and methods in designing randomized clinical trials (RCTs), including randomization, determination of number of events, determination of numbers of patients and follow-up schedule, and group sequential design. Statistical tests, such as logrank test and its weighted variants, and inference for hazard ratio with Cox proportional hazards (PH) model, and other estimand based survival functions (e.g. restricted mean survival difference), will be discussed. Examples and data from cancer clinical trials will be used to illustrate these methods.

In Part 2, standard survival analysis methods, such as Kaplan-Meier estimator, logrank test, Cox PH models, have been commonly used to analyze survival data arising from observational studies, in which treatment groups are not randomly assigned as in RCTs). We will start with an introduction of the statistical framework causal inference, then shift the focus to the causal inference methods for survival data. We will first review various methods that allow valid visualization and testing for confounder-adjusted survival curves, including G-Formula, Inverse Probability of Treatment Weighting, Propensity Score Matching, calibration weighting, Augmented Inverse Probability of Treatment Weighting. Examples and data from cancer observational studies will be used to illustrate these methods.

### Afternoon Session: (Instructor: Shu Yang)

The afternoon sections will cover the objectives and methods that allow integrative analyses of data from RCTs and observational studies. These methods exploit the complementing features of RCTs and observational studies to estimate the average treatment effect (ATE), heterogeneity of treatment effect (HTE), and individualized treatment rules (ITRs) over a target population.

In Part 3, we will review existing statistical methods for generalizing RCT findings to a target population leveraging the representativeness of the observational studies. Due to population heterogeneity, the ATE and ITRs estimated from the RCTs lack the external validity/generalizability to a target population. We will review the statistical methods for conducting generalizable RCT analysis for the targeted ATE and ITRs, including inverse probability sampling weighting, calibration weighting, outcome regression, and doubly robust estimators. R software and applications will also be covered.

In Part 4, we will review existing statistical methods for integrating RCTs and observational studies for robust and efficient estimation of the HTE. RCTs have been regarded as the gold standard for treatment effect evaluation due to randomization of treatment, which may be Underpowered to detect HTEs due to practical limitations. On the other hand, large observational studies contain rich information on how patients respond to treatment, which, however, may be confounded. We will review statistical methods for robust and efficient estimation of the HTE leveraging the treatment randomization in RCTs and rich information in observational studies, including calibration, test-based integrative analysis, and confounding function modeling. R software and applications will also be covered.

### Learning Strategy

The course material will be a blend of concepts, methods and real-data applications. Implementation of the methods, using R, will be described.

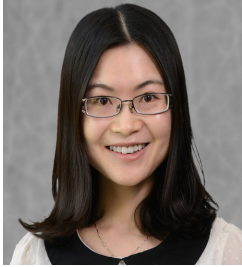
### Pre-requisites

Attendees are expected to have some familiarity with survival analysis and some concepts of causal inference, but a deep understanding of the general principles of causal inference is not required.

## About the Instructors

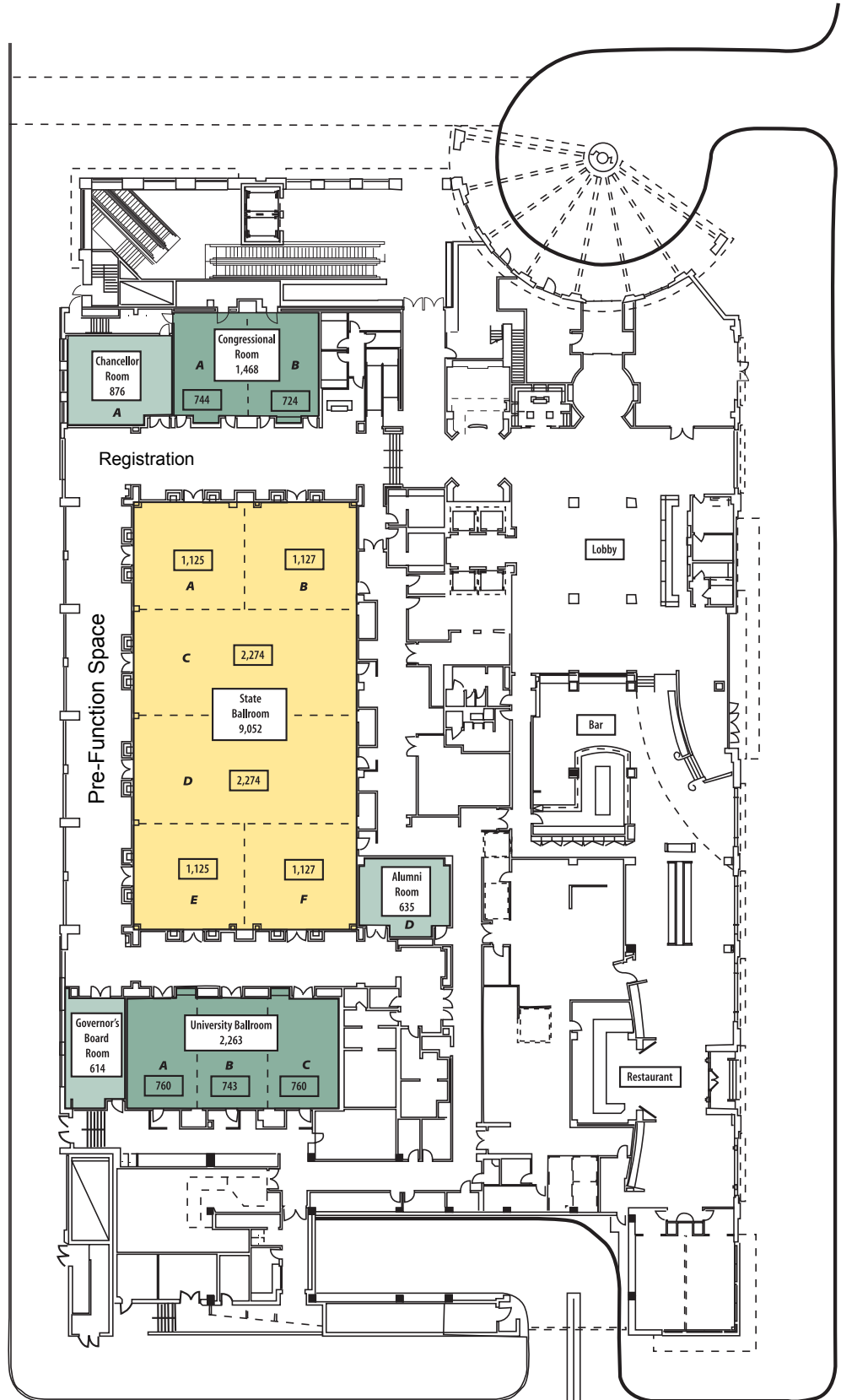


**Xiaofei Wang** is a Professor of Biostatistics and Bioinformatics at Duke University School of Medicine, and the Director of Statistics for Alliance Statistics and Data Management Center. Dr. Wang has been involved in clinical trials, observational studies, and translational studies for Alliance/CALGB and Duke Cancer Institute. His methodology research has been funded by NIH with a focus on biased sampling, causal inference, survival analysis, methods for predictive and diagnostic medicine, and clinical trial design. He is an Associate Editor for Statistics in Biopharmaceutical Statistics, and an elected fellow for American Statistical Association (ASA).



**Shu Yang** is an Associate Professor of Statistics, Goodnight Early Career Innovator, and University Faculty Scholar at North Carolina State University. Her primary research interest is causal inference and data integration, particularly with applications to comparative effectiveness research in health studies. She also works extensively on methods for missing data and spatial statistics. Dr. Yang has been a Principal Investigator for the U.S. National Science Foundation and National Institute of Health research projects and a Co-Investigator for a recent grant from the Patient-Centered Outcomes Research Institute.

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**RALEIGH MARRIOTT CITY CENTER  
MEETING ROOMS**

## Parking at the Raleigh Marriott City Center

### Self- Parking Instructions:

When seeking directions to our hotel via online or GPS systems, you may also input the following address leading directly to the **self-parking** facility attached to the hotel:

100 West Lenoir Street  
Raleigh, NC 27601

The **self-parking garage** is located directly off Lenoir Street.

### Valet Parking Instructions

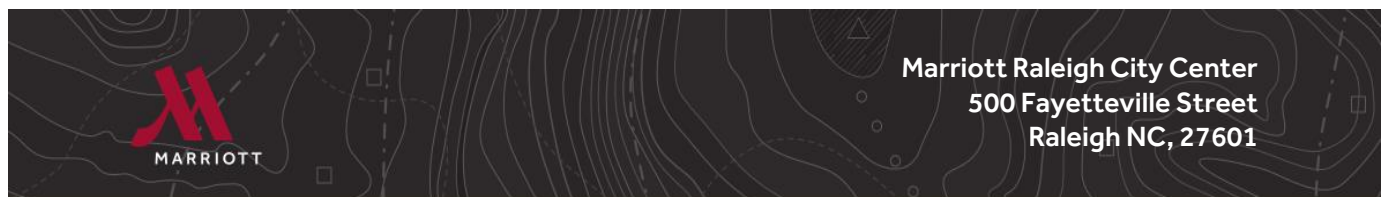
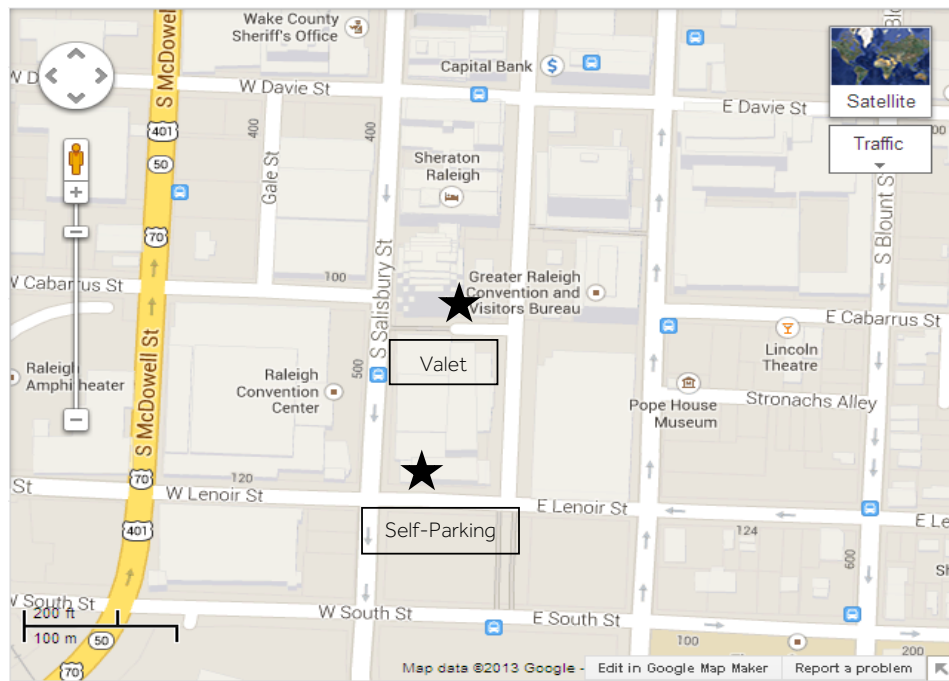
If a guest is seeking the main entrance to the hotel it may be accessed as well as our Valet Parking Services by turning left at the light at Fayetteville Street off Lenoir Street (just after the parking garage entrance) which leads to the Porte Cache at the hotel.

Hotel Address: 500 Fayetteville St Raleigh NC 2760.

### Parking Rates:

The Raleigh Marriott City Center is adjacent to a 900 space parking garage which serves the convention center and hotel guests alike. Listed below is the current pricing for parking, pricing is subject to change:

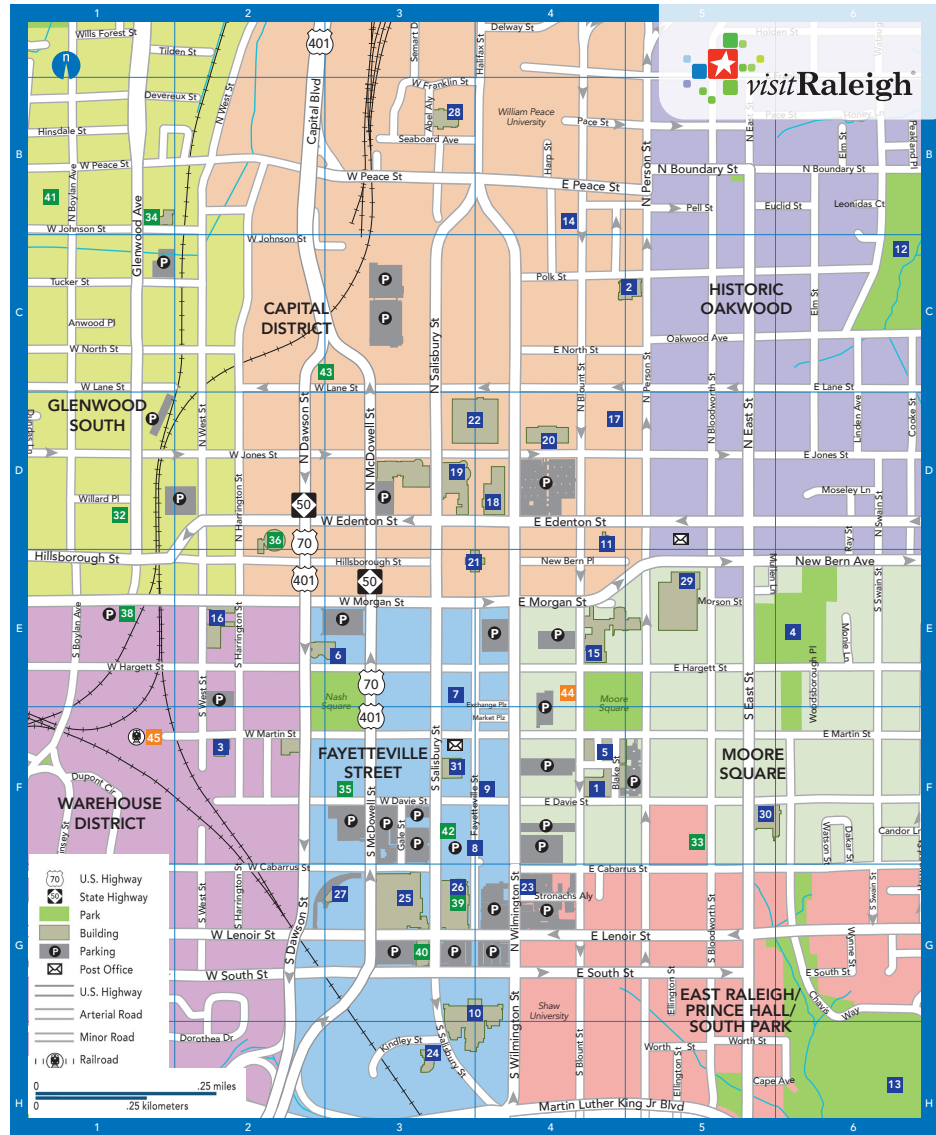
- Valet, Overnight, \$30 per night
- Self-Parking, Overnight, \$15 per night
- Valet, Day Event, \$18 per day
- Self-Parking, Day Rate, \$3 per hour with a maximum of \$15 per day



# DOWNTOWN RALEIGH, N.C.



For a detailed downtown map on your device, go to [visitRaleigh.com/mapexplorer](http://visitRaleigh.com/mapexplorer)



## POINTS OF INTEREST

- 1 Artspace (F4)
- 2 Burning Coal Theatre (C5)
- 3 CAM Raleigh (F2)
- 4 City Cemetery (E6)
- 5 City Market (F4)
- 6 City of Raleigh Municipal Building (E3)
- 7 City of Raleigh Museum (COR Museum) (E3)
- 8 City Plaza (F4)
- 9 Downtown Raleigh Alliance (F4)
- 10 Duke Energy Center for the Performing Arts (G3)
- 11 Haywood Hall House and Gardens (D4)
- 12 Historic Oakwood Cemetery (C6)
- 13 John Chavis Memorial Park (H6)
- 14 L.L. Polk House (B4)
- 15 Marbles Kids Museum/Marbles IMAX (E4)
- 16 Morgan Street Food Hall (E2)
- 17 North Carolina Executive Mansion (D4)

- 18 North Carolina Museum of History (D4)
- 19 North Carolina Museum of Natural Sciences (D3)
- 20 North Carolina State Archives (D4)
- 21 North Carolina State Capitol (E3)
- 22 North Carolina State Legislative Building (D3)
- 23 Pope House Museum (G4)
- 24 Raleigh Chamber (H3)
- 25 Raleigh Convention Center (G3)
- 26 Raleigh, N.C., Visitor Information Center (G3)
- 27 Red Hat Amphitheater (G3)
- 28 Seaboard Station (B3)
- 29 Terry Sanford Federal Building & U.S. Courthouse (E5)
- 30 Transfer Co. Food Hall (F5)
- 31 Wake County Courthouse (F3)

**R LINE** For the most current route of downtown Raleigh's free, circulator service, go to [visitRaleigh.com/R-LINE](http://visitRaleigh.com/R-LINE).

## PLACES TO STAY

- 32 AC Hotel Raleigh Downtown (D1)
- 33 Guest House Raleigh (F5)
- 34 Hampton Inn & Suites Raleigh Downtown/Glenwood South (B1)
- 35 Hilton Garden Inn and Homewood Suites Raleigh/Downtown (F3)
- 36 Holiday Inn Raleigh Downtown (D2)
- 38 Origin Raleigh (E1)
- 39 Raleigh Marriott City Center (G3)
- 40 Residence Inn Raleigh Downtown (G3)
- 41 Revis (B1)
- 42 Sheraton Raleigh Hotel (F3)
- 43 The Longleaf Hotel (C3)

## TRANSPORTATION

- 44 GoRaleigh Transit Station (E4)
- 45 Raleigh Union Station (F1)