The 9th International Workshop in Sequential Methodologies

American University, Washington, DC, USA

June 1 - 4, 2026

Conference Program

May 19, 2026

https://www.american.edu/cas/iwsm2026/

International Workshop in Sequential Methodologies

Conference Mission

The International Workshop in Sequential Methodologies (IWSM) meets every two years and brings together researchers and practitioners to explore the latest advancements in sequential statistics. The workshop provides a platform for presenting theoretical results, exploring practical applications, and addressing challenges in areas such as sequential testing, change-point detection, sequential estimation, selection and ranking, machine learning, artificial intelligence, clinical trials, adaptive design, stochastic quality and process control, optimal stopping, stochastic approximation, applied probability, mathematical finance, and related fields of probability, statistics, and applications. By covering a broad range of methodological and applied areas, IWSM aims to advance sequential statistical analysis and its diverse modern applications.

History

The 1st IWSM took place in 2007 at Auburn University, Alabama, USA

The 2nd IWSM took place in 2009 at the University of Technology of Troyes, France

The 3rd IWSM took place in 2011 at Stanford University, California, USA

The 4th IWSM took place in 2013 at the University of Georgia, Athens, Georgia, USA

The 5th IWSM took place in 2015 at Columbia University, New York, USA

The 6th IWSM took place in 2017 at the University of Rouen, Normandy, France

The 7th IWSM took place in 2019 at the State University of New York, Binghamton NY, USA

The conference returned to its two-year cycle after the pandemic:

The 8th IWSM took place in 2024 at the Utah Valley University in Orem, UT, USA

The 9th IWSM takes place in 2026 at American University in Washington, DC, USA

Sponsors

We thank the generous sponsors of the 9th IWSM:

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Alexander G. Tartakovsky, AGT StatConsult, Los Angeles, CA, USA
Gideon Zamba, University of Iowa, Iowa City, IA, USA
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Nitis Mukhopadhyay, University of Connecticut, Storrs, CT, USA
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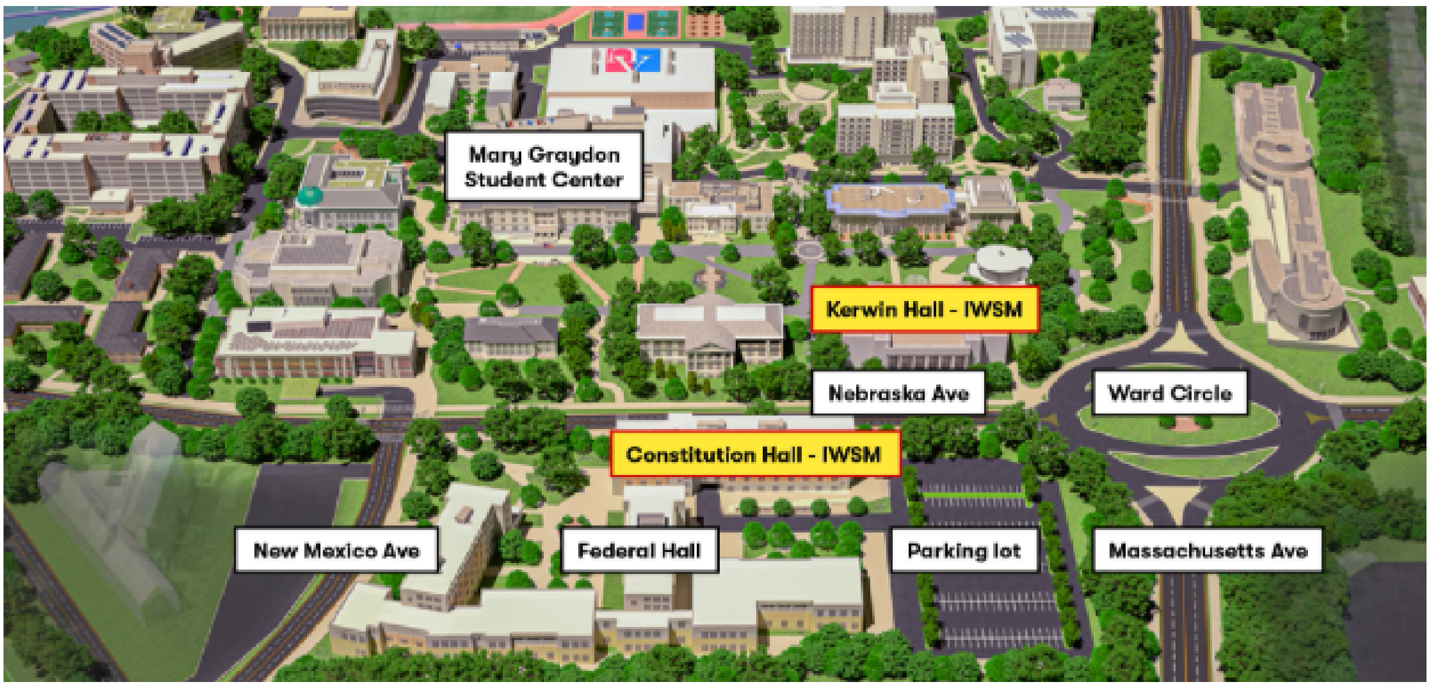
Yao Xie, Georgia Institute of Technology, Atlanta, GA, USA
Haipeng Xing, State University of New York, Stony Brook, NY, USA
Gideon Zamba, University of Iowa, Iowa City, IA, USA
Yan Zhuang, Connecticut College, New London, CT, USA

Local Information

The 9th IWSM takes place at American University in Washington, DC, USA, on June 1–4, 2026.

At the Conference:

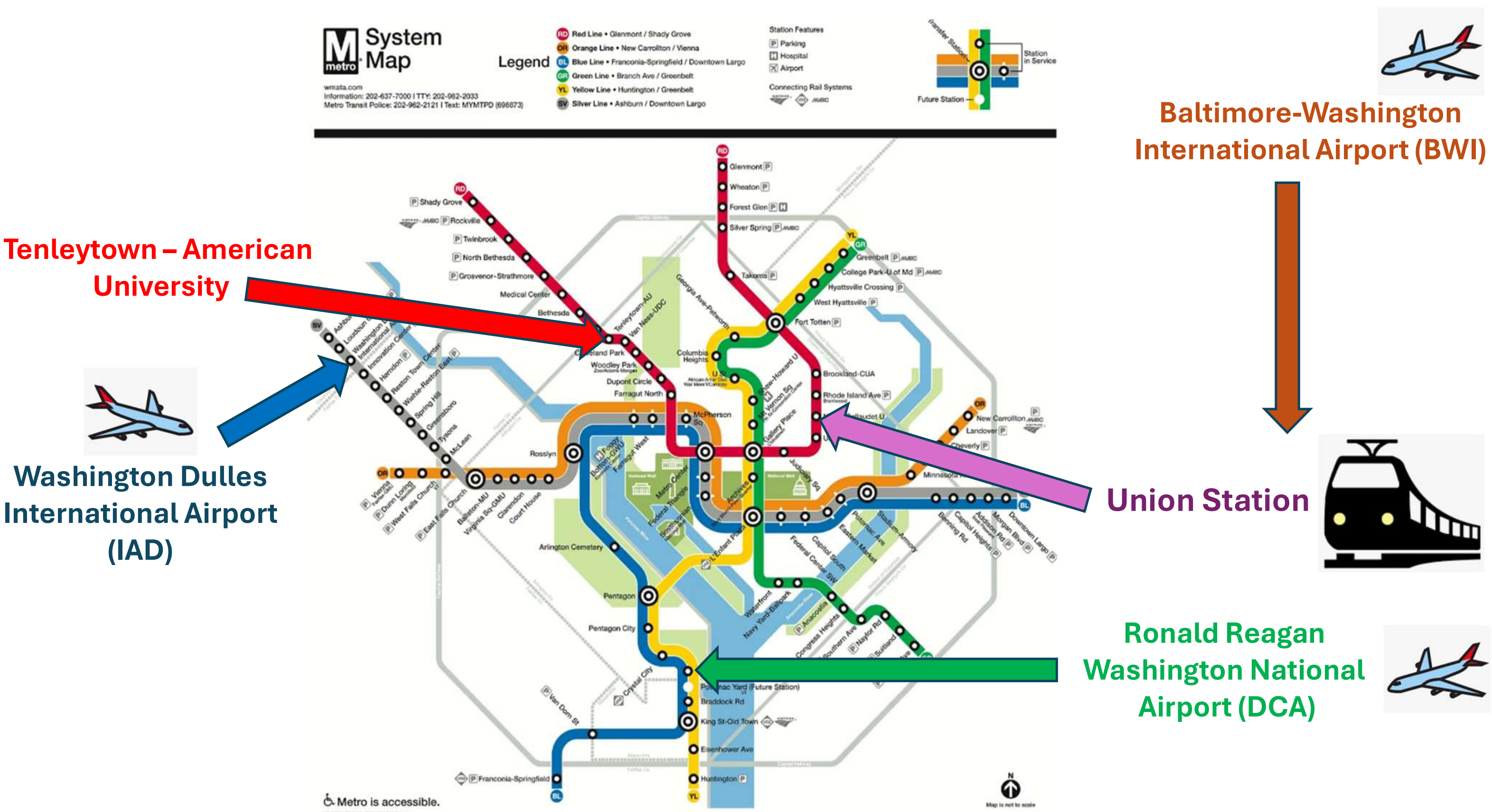
WiFi: Free WiFi via **AUGuest-byRCN** — no special configuration or password.



- Conference opening, sessions, breakfasts on June 1-2 are in **Kerwin Hall**, Terrace level (use stairs or an elevator to go one level down from the entrance).
- Conference sessions, breakfasts, and lunches on June 3-4 are in **Constitution Hall**, the right-side entrance from inside the campus.
- Conference banquet is on June 1 in **Constitution Hall**.
- Lunches on June 1-2 are in **Mary Graydon Center**, one level down from the entrance.
- Photo session on June 2 at the **Mary Graydon Center** entrance.
- Tour bus boarding on June 3 on **New Mexico Ave.**
- On-campus lodging and reception desk in **Federal Hall**.

Getting to the Conference

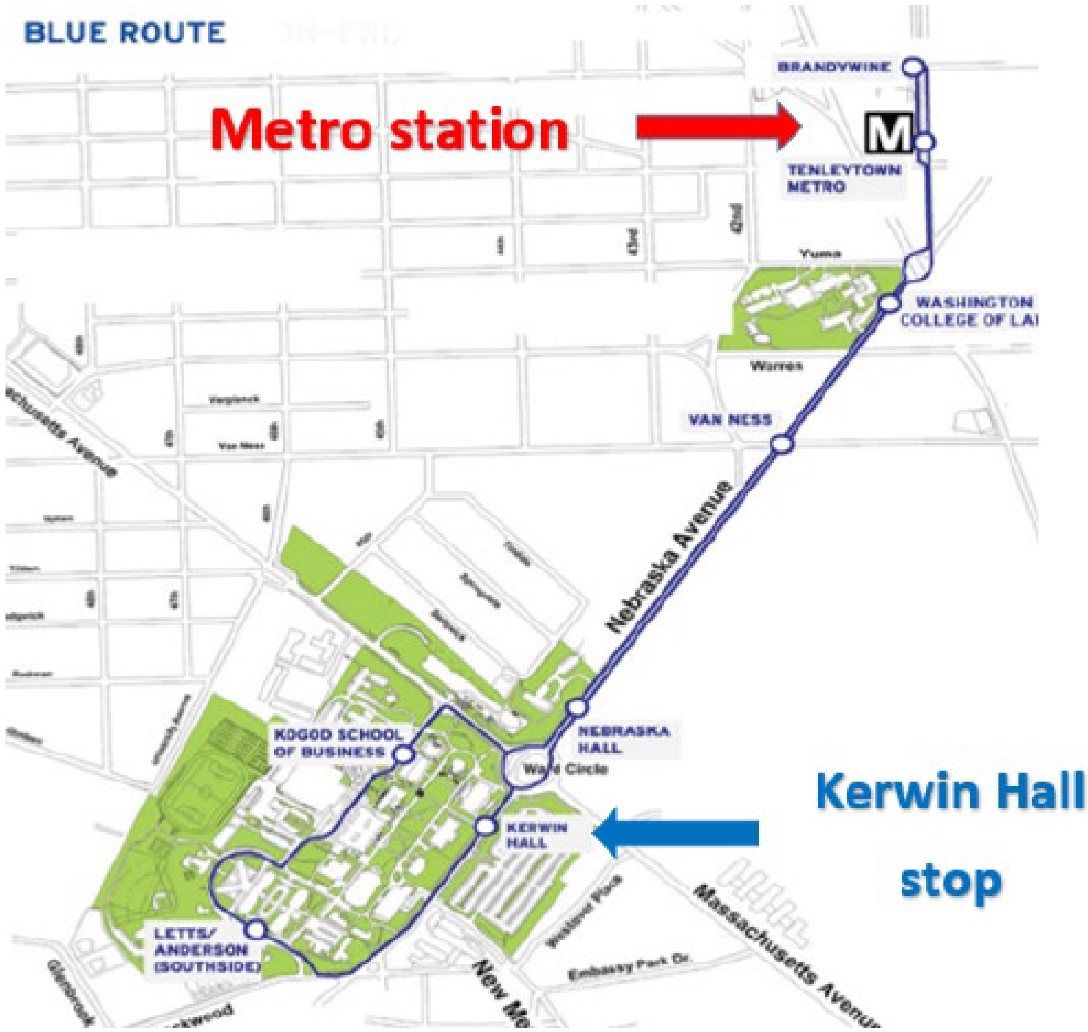
Public transportation. The closest metro station is “Tenleytown-AU” on the Red Line of Washington Metro.



The conference is 1 mile (1.6 km) from the metro station. You can take free AU Shuttle or city bus number D90, or walk 20-25 minutes south along Nebraska Avenue.

AU Shuttle Bus. Exit the station toward the east side. Board the free AU Shuttle (Blue Route) on 40th street. Get off at the Kerwin Hall stop, right after passing through Ward circle. As you leave the shuttle, Kerwin Hall will be in front of you, and the East Campus with Constitution and Federal Halls will be across Nebraska Avenue.

You can use the same Kerwin Hall stop to board the AU shuttle toward the metro station. It will go around the campus and then back to the Tenleytown-AU station.



City bus D90 also connects the AU campus with the Tenleytown-AU metro station. Toward the metro, D90 stops at Constitution Hall.

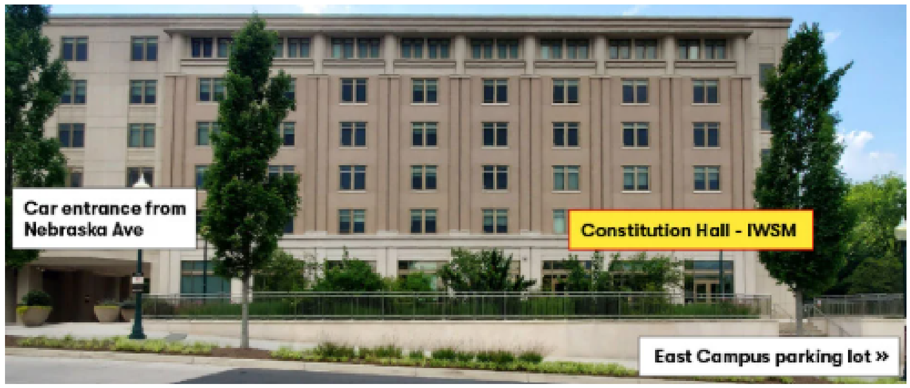
Driving, Taxi, Uber. Use destinations:

3590 Nebraska Ave NW, Washington, DC 20016	for	Kerwin Hall
3501 Nebraska Ave NW, Washington, DC 20016	for	Constitution and Federal Halls

Parking is available on campus, with the most convenient options being

- The East Campus surface parking lot.
- The underground SIS garage.

The East Campus lot is adjacent to Constitution Hall and Federal Hall. It is accessed from Nebraska Avenue with a **right turn only** entrance from Nebraska Ave. under the arc of Constitution Hall.



If you are driving on Nebraska Ave. from Ward Circle, the left turn under the arc into East Campus is not permitted. It may then be more convenient to use underground parking in the SIS (School of International Studies) garage or East Campus garage. To enter the SIS parking garage, turn right from Nebraska Ave at the intersection with New Mexico Ave.

Parking fee is $2/hour or $16/day. Conference participants can purchase virtual guest parking permits in advance on AU Parking Portal or enter their license plate numbers into the kiosks to pay for parking. There are parking kiosks on the East Campus surface parking lot and in the SIS garage near the elevators. The Parking Portal is on https://american.t2hosted.com/cmn/auth_guest.aspx

Watch for the signs, some parking spots are not allowed.

Check the conference web site https://www.american.edu/cas/iwsm2026/ for links and details.

Schedule at a Glance

Monday, June 1

8:30 – 9:00	Breakfast
9:00 – 9:15	Conference Kick-Off. Introduction and Welcome
9:15 – 10:15	**Plenary Talk P1:** Recent Advances in Statistical Process Control for Dynamic Disease Screening and Spatio-Temporal Disease Surveillance, by *Peihua Qiu*
10:15 – 10:40	Coffee Break
10:40 – 12:10	Parallel Sessions: 1. Anytime-Valid Inference Using E-processes and Confidence Sequences 2. Sequential Estimation Methods for Dependent Data I 3. Statistical Learning Methods for Optimal Public Health Policy 4. Sequential Methods for Signals and Complex Data 5. Adaptive Designs and Clinical Trials
12:10 – 13:40	Lunch
13:40 – 14:40	**Plenary Talk P2:** Nearly Optimal Sequential Multihypothesis Tests for General Stochastic Models with Dependent and Nonidentically Distributed Observations, by *Alexander G. Tartakovsky*
14:40 – 15:10	Coffee Break
15:10 – 16:40	Parallel Sessions: 6. Recent Sequential Analysis Methods in the Health Sciences 7. Sequential Estimation Methods for Dependent Data II 8. Entropy Estimation and Entropic Statistics 9. Optimality in Sequential Estimation and Testing 10. Woodroofe Awardees Session. *In Memory of Michael Woodroofe (1940 - 2022)*
16:50 - 18:20	11. **Special session:** A Conversation with Professor Nitis Mukhopadhyay
18:30 – 20:30	**Banquet**

Tuesday, June 2

8:30 – 9:00	Breakfast
9:00 – 10:00	**Plenary Talk P3:** From Theory to Decision: a Journey with Sequential Methods in Clinical Trials, by *Dong-Yun Kim*
10:00 –10:30	Coffee Break
10:30 – 12:00	Parallel Sessions:
	12. Recent Advances in Optimal Sequential Change Detection and Hypothesis Testing
	13. Modern Change-Point Problems I
	14. Recent Advances in Sequential Estimation
	15. Statistical Learning and High-Dimensional Inference
	16. Sequential Clinical Trials
12:00 – 12:10	Photo Session
12:10 – 13:40	Lunch
13:40 – 14:40	**Plenary Talk P4:** Shortest Fixed-Width Confidence Intervals for a Bounded Parameter: the Push Algorithm, by *Jay Bartroff*
14:40 – 15:10	Coffee Break
15:10 – 16:40	Parallel Sessions:
	17. Clinical Trials, Sequential Analysis and the Health Sciences
	18. Modern Change-Point Problems II
	19. Advances in Sequential Inference Methods
	20. Reinforcement/AI-Assisted Learning, Detection & Decision Support
	21. Sequential Learning and Applications to Medical Studies
16:50 – 18:20	Parallel Sessions:
	22. ICH E20 Guidance on Adaptive Designs in Clinical Trials
	23. Modern Change-Point Problems III
	24. Sequential Monitoring and Detection
	25. Learning for Interpretable Models and from Data with Shifts
	26. Quickest Change Detection Algorithms for Complex Systems

Wednesday, June 3

8:30 – 9:00	Breakfast
9:00 – 10:30	Parallel Sessions:
	27. Sequential Parametric and Nonparametric Estimation
	28. Modern Change-Point Problems IV
	29. Sequential Inference: Change-Points, Prediction, and Optimality. *Part I (Focus: Methodological and theoretical advances in detecting changes)*
10:30 – 11:00	Coffee Break
11:00 – 12:30	Parallel Sessions:
11:00 – 12:30	30. **Special session:** Abraham Wald Prize in Sequential Analysis and Celebration
	31. Modern Change-Point Problems V
	32. Sequential Inference: Change-Points, Prediction, and Optimality. *Part II (Focus: Sequential inference and decision-making under uncertainty)*
12:30 – 13:30	Lunch and Poster Session
13:30 – 15:00	Parallel Sessions:
	33. Modern Views on Sequential Selection and Ranking
	34. Modern Change-Point Problems VI
	35. Sequential Methods in Genetics
15:10 - 16:10	36. Sequential Analysis in the Undergraduate Classroom (panel discussion)
15:30 – 20:30	**Tours:**

Group 1 schedule:

15:30 - 16:00	Bus transfer to Georgetown
16:00 – 18:00	Potomac River Cruise
18:00 – 19:30	Washington Bus City Tour

Group 2 schedule:

16:30 – 18:00	Washington Bus City Tour
18:00 – 20:00	Potomac River Cruise
20:00 - 20:30	Bus transfer to American U.

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Thursday, June 4

8:30 – 9:00	Breakfast
9:00 – 10:30	Parallel Sessions:
	37. Recent Advances in Online Changepoint Detection
	38. Sequential Methods in Clinical Trials and EHR data I
	39. Modern Process Monitoring Methods
10:30 – 10:50	Coffee Break
10:50 – 12:20	Parallel Sessions:
	40. Sequential Analysis as a Tool for Changepoint Detection
	41. Sequenital Methods in Clinical Trials and EHR Data II
	42. Statistical Methods for Robust, Fair, and Personalized Decision-Making
12:20 – 13:20	Lunch
13:20 – 14:50	Parallel Sessions:
	43. Recent Advances in Sequential Change Detection
	44. Optimal Stopping and Detection in Network and Streaming Data. *In Memory of Tze Leung Lai (1945 - 2023)*
	45. Adaptive Decision-Making and Statistical Inference in Sequential Data
14:50 – 15:10	Coffee Break
15:10 – 16:40	Parallel Sessions:
	46. Recent Advances in Multi-Stream Sequential Multiple Testing
	47. Recent Advances in Multiple Testing and Change Detection
	48. Sequential Modeling and Applications
16:40	Conclusion and Fairwell

Plenary Talks

Peihua Qiu

P1. Recent Advances in Statistical Process Control for Dynamic Disease Screening and Spatio-Temporal Disease Surveillance

Monday, June 1, 9:15 – 10:15, in Kerwin Hall, room T01

Speaker: **Peihua Qiu**, Dean's Professor and Chair, University of Florida, Gainesville, FL, USA

Dr. Peihua Qiu is a Dean's Professor and the Founding Chair of the Department of Biostatistics at the University of Florida. He received his PhD in Statistics from the University of Wisconsin–Madison in 1996. Following his doctoral training, he served as a senior research consulting statistician at The Ohio State University and subsequently held faculty appointments at the University of Minnesota, where he progressed from Assistant Professor to Full Professor. In 2013, he was recruited to the University of Florida to establish and lead its new Department of Biostatistics.

Dr. Qiu is internationally recognized for his fundamental contributions to jump regression analysis, image processing, statistical process control, survival analysis, dynamic disease screening, and spatio-temporal disease surveillance. He is the author of three books and has published over 185 peer-reviewed research articles. He is a Fellow of the American Association for the Advancement of Science (AAAS), the American Statistical Association (ASA), the American Society for Quality (ASQ), and the Institute of Mathematical Statistics (IMS), and an elected member of the International Statistical Institute (ISI). He served as Editor-in-Chief of Technometrics from 2014 to 2016 and as Associate Editor for leading journals including the Journal of the American Statistical Association, Biometrics, and Technometrics. In 2024, he received the prestigious Shewhart Medal from the American Society for Quality in recognition of his outstanding contributions to statistical science.

Alexander G. Tartakovsky

P2. Nearly Optimal Sequential Multihypothesis Tests for General Stochastic Models with Dependent and Nonidentically Distributed Observations

Monday, June 1, 13:40 – 14:40, in Kerwin Hall, room T01

Speaker: **Alexander G. Tartakovsky**, President, AGT StatConsult, Los Angeles, CA, USA

Dr. Alexander Tartakovsky is the Founder and President of AGT Consulting (AGT StatConsult) and a world-renowned expert in sequential analysis, change-point detection, and statistical signal processing. He received his PhD from the University of Southern California and previously held senior research and faculty positions in academia, government, and industry, including appointments at the University of Southern California and the National Institutes of Health.

Dr. Tartakovsky has made foundational contributions to quickest change detection theory, adaptive detection algorithms, and their applications in cybersecurity, network monitoring, biosurveillance, and quality control. He is the author of several influential books, including Sequential Change-Point Detection and Hypothesis Testing, and has published extensively in leading journals such as The Annals of Statistics, IEEE Transactions on Information Theory, and Sequential Analysis. He is a Fellow of the Institute of Mathematical Statistics (IMS) and a recipient of the Abraham Wald Prize in Sequential Analysis. He has served in editorial leadership roles for major journals, including Sequential Analysis and IEEE Transactions on Signal Processing.

Dong-Yun Kim

P3. From Theory to Decision: a Journey with Sequential Methods in Clinical Trials

Tuesday, June 2, 9:00 – 10:00, in Kerwin Hall, room T01

Speaker: **Dong-Yun Kim**, Mathematical Statistician, NIH National Heart, Lung, and Blood Institute, Bethesda, MD, USA

Dr. Dong-Yun Kim is a mathematical statistician at the Office of Biostatistics Research within the National Heart, Lung, and Blood Institute (NHLBI), National Institutes of Health, in Bethesda, Maryland. She received her PhD in Statistics from the University of Michigan, Ann Arbor, in 2003. Prior to joining the NIH in 2013, she held a faculty position at Virginia Tech.

Her research focuses on fully sequential methods for clinical trials, change-point inference, and statistical genetics, with current work in large NHLBI-sponsored clinical trials and intramural projects involving MRI imaging, pulmonary disease, and cancer research. She has extensive collaborative research experience across diverse fields including mobile health, bioengineering, and environmental science. Dr. Kim served as President of the Caucus for Women in Statistics and Data Science (2023) and is a member of the Board of Directors of the Korean International Statistical Society (KISS). Since 2024, she has also served as an adjunct professor in the Department of Statistics at George Mason University. In 2022, she received the Achievement Award from the Korean Women Scientists and Engineers Association for her leadership and service to the scientific community.

Jay Bartroff

P4. Shortest Fixed-Width Confidence Intervals for a Bounded Parameter: the Push Algorithm

Tuesday, June 2, 13:40 – 14:40, in Kerwin Hall, room T01

Speaker: **Jay Bartroff**, Professor and Associate Chair, University of Texas, Austin, TX, USA

Dr. Jay Bartroff is Professor in the Statistics and Data Sciences Department at the University of Texas, where he is also Associate Department Chair. Prior to that he was Professor of Mathematics and Vice-Chair for Statistics at the University of Southern California for 15 years. Before that he was an NSF postdoc in the Stanford Statistics Department, following his PhD at Caltech and his undergraduate degree at U.C. Berkeley. His research interests include sequential analysis, multiple testing, Stein's method, and biomedical applications including clinical trial design. Jay's research has been supported by the NSF, NIH, FDA, and NSA. His publications include a textbook on sequential methods published by Springer. In 2023 he won the 17th Abraham Wald Prize in Sequential Analysis. Jay is an Associate Editor for the Journal of the American Statistical Association, Biometrics, and Statistica Sinica. In Summer 2026 Jay will begin as Editor in Chief of The American Statistician.

Conference Sessions

Monday, June 1

Session 1. Anytime-Valid Inference Using E-processes and Confidence Sequences

Monday, June 1, 10:40 – 12:10, in Kerwin Hall, room T01

Organizer: Aaditya Ramdas, Carnegie Mellon University, Pittsburgh, PA, USA

Chair: Venugopal Veeravalli, University of Illinois, Urbana-Champaign, IL, USA

1. *Distribution- and Time-Uniform Central Limit Theory for Asymptotic Confidence Sequences*

   by Ian Waudby-Smith, University of California, Berkeley, CA, USA

2. *Positive Semidefinite Matrix Supermartingales*

   by Hongjian Wang, Carnegie Mellon University, Pittsburgh, PA, USA

3. *Tight Lower and Upper Bounds for One-Sided Sequential Testing*

   by Shubhada Agrawal, Indian Institute of Science, Bangalore, India

4. *Asymptotically Optimal Sequential Change Detection for Bounded Means*

   by Ashwin Ram, Carnegie Mellon University, Pittsburgh, PA, USA

Session 2. Sequential Estimation Methods for Dependent Data I

Monday, June 1, 10:40 – 12:10, in Kerwin Hall, room T03

Organizer and chair: Serguei Pergamenchtchikov, Universite de Rouen Normandie, Rouen, France

1. *Multi-Step Estimators and Shrinkage Effect in Time Series Models*

   by Rebecca Killick, Lancaster University, Lancaster, United Kingdom

2. *Truncated Sequential Guaranteed Estimation for the Cox-Ingersoll-Ross Models*

   by Mohamed Ben Alaya, Universite de Rouen Normandie, Rouen, France

3. *Sequential Guaranteed Estimation for the Cox-Ingersoll-Ross Models Based on Discrete Observations*

   by Thi Bao Tram Ngo, University of Evry Val d'Essonne, Evry, France

Session 3. Statistical Learning Methods for Optimal Public Health Policy

Monday, June 1, 10:40 – 12:10, in Kerwin Hall, room T04

Organizer: Justin Weltz, Santa Fe Institute, Santa Fe, NM, USA

Chair:

1. *An Optimal Dynamic Treatment Regime Estimator for Indefinite-Horizon Survival Outcomes*

   by Michael Kosorok, University of North Carolina, Chapel Hill, NC, USA

2. *Adaptive Respondent-Driven Sampling via Reinforcement Learning*

   by Eric Laber, Duke University, Durham, NC, USA

3. *Reinforcement Learning for Respondent-Driven Sampling*

   by Justin Weltz, Santa Fe Institute, Santa Fe, NM, USA

Session 4. Sequential Methods for Signals and Complex Data

Monday, June 1, 10:40 – 12:10, in Kerwin Hall, room T05

Organizers: Stephen Casey, American University, Washington, DC, USA, and Michael Baron, American University, Washington, DC, USA

Chair:

1. *AIS Vessel Trajectory Identification*

   by John Scott, University of Central Florida, Orlando, FL, USA

2. *Sampling Expansions for AFB Signals via Change-Point Detection*

   by Stephen Casey, American University, Washington, DC, USA

3. *GMRA of ODE flow manifolds for efficient practical identifiability*

   by Nathaniel Strawn, Johns Hopkins University, Chevy Chase, MD, USA

4. *Conditional Independence Testing with a Single Realization of a Multivariate Non-stationary Nonlinear Time Series*

   by Michael Wieck-Sosa, Carnegie Mellon University, Pittsburgh, PA, USA

Session 5. Adaptive Designs and Clinical Trials

Monday, June 1, 10:40 – 12:10, in Kerwin Hall, room T06

Organizers: Michael Baron, American University, Washington, DC, USA, and Yaakov Malinovsky, University of Maryland, Baltimore County, Baltimore, MD, USA

Chair: Jason Qin, George Washington University, Washington, DC, USA

1. *Recent Development in Early Detection of Treatment's Side Effects*

   by Jiayue Wang, Indiana University, Indianapolis, IN, USA

2. *A Three-Stage Adaptive Design to Select the Most Effective Treatment and Estimate its Mean Effect*

   by Neeraj Misra, Indian Institute of Technology, Kanpur, India

3. *Optimal Two-Stage Biomarker-Stratified Designs with Enrichment*

   by Anastasia Ivanova, University of North Carolina, Chapel Hill, NC, USA

4. *Global Optimality in Phase I Cancer Model-Assisted Designs*

   by Shouhao Zhou, Pennsylvania State University, Hershey, PA, USA

Session 6. **Recent Sequential Analysis Methods in the Health Sciences**

Monday, June 1, 15:10 – 16:40, in Kerwin Hall, room T01

Organizer and chair: Gideon Zamba, University of Iowa, Iowa City, IA, USA

1. *Self-Starting Shiryaev (3S): A Bayesian Change Point Model for Online Monitoring of Short Runs*

   by Panagiotis Tsiamyrtzis, Politecnico di Milano, Milan, Italy

2. *Air Pollution Surveillance Using Control Charts*

   by Xiulin Xie, Florida State University, Tallahassee, FL, USA

3. *A Dynamic Screening System for Early Detection of Multiple Interconnected Events*

   by Zibo Tian, University of Florida, Gainesville, FL, USA

Session 7. **Sequential Estimation Methods for Dependent Data II.** *Sponsored by the project WIND-SURE of the Ingenium European University Alliance (https://ingenium-university.eu/)*

Monday, June 1, 15:10 – 16:40, in Kerwin Hall, room T03

Organizer: Serguei Pergamenchtchikov, Universite de Rouen Normandie, Rouen, France

Chair: Mohamed Ben Alaya, Universite de Rouen Normandie, Rouen, France

1. *Sequential Model Selection for Nonparametric Autoregressive Processes*

   by Jean-Yves Brua, Universite de Rouen Normandie, Rouen, France

2. *Robust Adaptive Efficient Estimation for Autoregressive Big Data Models*

   by Ouerdia Arkoun, Universite de Rouen Normandie, Rouen, France

3. *Guaranteed Estimation Method for Semi-Markov Processes in Continuous Time*

   by Nikolaos Limnios, Universite de Technologie de Compiegne, Compiegne, France

4. *Efficient Sequential Estimation for Big Data Models in Continuous Time*

   by Serguei Pergamenchtchikov, Universite de Rouen Normandie, Rouen, France

Session 8. Entropy Estimation and Entropic Statistics

Monday, June 1, 15:10 – 16:40, in Kerwin Hall, room T04

Organizer and chair: Michael Grabchak, University of North Carolina, Charlotte, NC, USA

1. *A Paradox Resolved in Constructing Binary Decision Trees*

   by Zhiyi Zhang, University of North Carolina, Charlotte, NC, USA

2. *Necessary And Sufficient Conditions for Characterizing Finite Discrete Distributions via Generalized Shannon's Entropy*

   by Jialin Zhang, Mississippi State University, Starkville, MS, USA

3. *On Turing's Formula and the Estimation of the Missing Mass*

   by Michael Grabchak, University of North Carolina, Charlotte, NC, USA

Session 9. Optimality in Sequential Estimation and Testing

Monday, June 1, 15:10 – 16:40, in Kerwin Hall, room T05

Organizers: Michael Baron, American University, Washington, DC, USA, and Yaakov Malinovsky, University of Maryland, Baltimore County, Baltimore, MD, USA

Chair: Jason Qin, George Washington University, Washington, DC, USA

1. *Weighted Asymptotically Optimal Sequential Testing*

   by Soumyabrata Bose, University of Texas, Austin, TX, USA

2. *Recurrent Estimation of Heterogeneous Common Mean*

   by Andrew Rukhin, University of Maryland, Baltimore County, Baltimore, MD, USA

3. *The Nonparametric Kiefer-Weiss Problem*

   by Michael Fauss, ETS Research Institute, Princeton, NJ, USA

Session 10. Woodroofe Awardees Session. *In Memory of Michael Woodroofe (1940 - 2022)*

Monday, June 1, 15:10 – 16:40, in Kerwin Hall, room T06

Organizer: Dong-Yun Kim, NIH National Heart, Lung, and Blood Institute, Bethesda, MD, USA

Chair:

1. *Gaussian Process Regression Models for Forecasting Geomagnetic Perturbations*

   by Yang Chen, University of Michigan, Ann Arbor, MI, USA

2. *Online Kernel CUSUM for Change-Point Detection*

   by Yao Xie, Georgia Institute of Technology, Atlanta, GA, USA

3. *Wasserstein-Cramér-Rao Theory of Unbiased Estimation*

   by Bodhisattva Sen, Columbia University, New York, NY, USA

Session 11 (Special). **A Conversation with Professor Nitis Mukhopadhyay**

Monday, June 1, 16:50 – 18:20, in Kerwin Hall, room T01

Organizer and chair: Yan Zhuang, Connecticut College, New London, CT, USA

Tuesday, June 2

Session 12. Recent Advances in Optimal Sequential Change Detection and Hypothesis Testing

Tuesday, June 2, 10:30 – 12:00, in Kerwin Hall, room T01

Organizer and chair: Yanglei Song, Queen's University, Kingston, ON, Canada

1. *Finite-Horizon Quickest Change Detection Balancing Latency with False Alarm Probability*

   by Venugopal Veeravalli, University of Illinois, Urbana-Champaign, IL, USA

2. *Score-Based Quickest Change Detection for Dependent Data*

   by Taposh Banerjee, University of Pittsburgh, Pittsburgh, PA, USA

3. *Detection and Acceleration of a Series of Changes*

   by Georgios Fellouris, University of Illinois, Urbana-Champaign, IL, USA

Session 13. Modern Change-Point Problems I

Tuesday, June 2, 10:30 – 12:00, in Kerwin Hall, room T03

Organizers: Yajun Mei, New York University, New York, NY, USA, and Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

Chair: Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

1. *Change-Point Detection in High-Dimensional Time Series Using Mosum*

   by Runmin Wang, Texas A&M University, College Station, TX, USA

2. *Post-Detection Inference for Sequential Changepoint Localization*

   by Aytijhya Saha, Massachusetts Institute of Technology, Cambridge, MA, USA

3. *A Note on Single-Affected-Case in Quickest Detection*

   by Xinyuan Zhang, Georgia Institute of Technology, Atlanta, GA, USA

Session 14. Recent Advances in Sequential Estimation

Tuesday, June 2, 10:30 – 12:00, in Kerwin Hall, room T04

Organizers and chairs: Yan Zhuang, Connecticut College, New London, CT, USA, and Nitis Mukhopadhyay, University of Connecticut, Storrs, CT, USA

1. *Adaptive Procedure to Estimate Confidence Interval for Population Sizes under Mark-Recapture-Mark Sampling*

   by Debanjan Bhattacharjee, Utah Valley University, Orem, UT, USA

2. *Sequential Sampling for Ellipsoidal Confidence Regions for Multivariate Means*

   by Swathi Venkatesan, Fairfield University, Fairfield, CT, USA

3. *Sequential Estimation Made Easy and More Practical: Big Data Perspectives*

   by Nitis Mukhopadhyay, University of Connecticut, Storrs, CT, USA

Session 15. Statistical Learning and High-Dimensional Inference

Tuesday, June 2, 10:30 – 12:00, in Kerwin Hall, room T05

Organizers: Michael Baron, American University, Washington, DC, USA, and Yaakov Malinovsky, University of Maryland, Baltimore County, Baltimore, MD, USA

Chair:

1. *An Improved False Discovery Estimate for Variable Selection*

   by Yet Nguyen, Old Dominion University, Norfolk, VA, USA

2. *Multi-Dimensional Ranking: on the Kemeny Ranking Problem*

   by Ashish Das, Indian Institute of Technology, Mumbai, India

3. *Robust and Transparent Fraud Detection: Integrating Adversarial Machine Learning with Explainable AI*

   by Akshata Moharir, Microsoft, Portland, OR, USA

Session 16. Sequential Clinical Trials

Tuesday, June 2, 10:30 – 12:00, in Kerwin Hall, room T06

Organizer: Dong-Yun Kim, NIH National Heart, Lung, and Blood Institute, Bethesda, MD, USA

Chair:

1. *The Effect of Channeled Dependence on Bayes Estimators in Two-Stage Experiments*

   by Nancy Flournoy, University of Missouri, Columbia, MO, USA

2. *Information Borrowing for Reducing the Mean Squared Error in Group Sequential Studies*

   by Sergey Tarima, University of Kentucky, Lexington, KY, USA

3. *An Information Metric for Assessing Interim Decisions in Group Sequential Trials*

   by Gianmarco Caruso, University of Cambridge, Cambridge, United Kingdom

★ *Discussion* by William Rosenberger, George Mason University, Fairfax, VA, USA

Session 17. Clinical Trials, Sequential Analysis and the Health Sciences

Tuesday, June 2, 15:10 – 16:40, in Kerwin Hall, room T01

Organizer and chair: Gideon Zamba, University of Iowa, Iowa City, IA, USA

1. *A Family of Modified Huber Loss Functions for Continual Reassessment Methods in Clinical Trials*

   by Ling Zhang, U.S. Food and Drug Administration, Silver Spring, MD, USA

2. *Adaptive Shrinkage Estimation for Dose-Toxicity Relationships in Small Sample Settings*

   by Fangfang Jiang, University of Iowa, Iowa City, IA, USA

3. *Multiscale Spatio-Temporal Data Monitoring Using Forward Elimination and Scale Information Criterion*

   by Kai Yang, Medical College of Wisconsin, Milwaukee, WI, USA

Session 18. Modern Change-Point Problems II

Tuesday, June 2, 15:10 – 16:40, in Kerwin Hall, room T03

Organizers and chairs: Yajun Mei, New York University, New York, NY, USA, and Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

1. *The Average Run Lengths of a Differentially Private CUSUM Algorithm*

   by Benjamin Yakir, Hebrew University of Jerusalem, Jerusalem, Israel

2. *A Speed-Based Estimator of Signal-to-Noise Ratios*

   by Olympia Hadjiliadis, Hunter College, New York, NY, USA

3. *Sequential Monitoring for Object-Valued Time Series*

   by Yi Zhang, Washington University in St. Louis, St. Louis, MO, USA

Session 19. Advances in Sequential Inference Methods

Tuesday, June 2, 15:10 – 16:40, in Kerwin Hall, room T04

Organizer: Yan Zhuang, Connecticut College, New London, CT, USA

Chair: Elena Buzaianu, University of North Florida, Jacksonville, FL, USA

1. *Subset Selection with Curtailment Among Treatments with Binary Outcome in Comparison with a Control*

by Pinyuen Chen, Syracuse University, Syracuse, NY, USA

2. *Robust Alpha Spending for Unstable Information*

   by Ivair Silva, Federal University of Ouro Preto, Ouro Preto, Brazil

3. *Novel Compression Algorithms Using Multi-Stage Methods*

   by Swarnali Banerjee, Loyola University, Chicago, IL, USA

Session 20. Reinforcement/AI-Assisted Learning, Detection & Decision Support

Tuesday, June 2, 15:10 – 16:40, in Kerwin Hall, room T05

Organizer and chair: Jiayang Sun, George Mason University, Fairfax, VA, USA

1. *Personalized Reinforcement Learning via Kernel Embedding: Applications to Emergency Department Patient Management*

   by Linda Zhao, University of Pennsylvania, Philadelphia, PA, USA

2. *OSOL: Online Expectation-Maximization for Multi-Fidelity Simulation Optimization under Fixed Budgets*

   by Wei Dai, George Mason University, Fairfax, VA, USA

3. *Optimal Detection for Language Watermarks with Pseudorandom Collision: Connections to Ehr Data Curation and Quality Control in Generative AI*

   by Xiang Li, University of Pennsylvania, Philadelphia, PA, USA

★ *Discussion* by Ray Bai, George Mason University, Fairfax, VA, USA

Session 21. Sequential Learning and Applications to Medical Studies

Tuesday, June 2, 15:10 – 16:40, in Kerwin Hall, room T06

Organizer: Dong-Yun Kim, NIH National Heart, Lung, and Blood Institute, Bethesda, MD, USA

Chair:

1. *Causal Inference in the Closed-Loop: Marginal Structural Models for Sequential Excursion Effects*

   by Gabriel Loewinger, National Institute of Mental Health (NIMH), NIH, Bethesda, MD, USA

2. *Off-Policy Evaluation for Missingness-Aware Policies in Markov Decision Processes with Rewards Missing not at Random*

   by Rui Miao, University of Texas at Dallas, Richardson, TX, USA

3. *Combining a Discrete FDR-Based Pipeline with a Tabular Foundation Model and Standard Machine Learning to Improve Discoveries in Genomic Association Studies*

   by Anat Reiner-Benaim, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Session 22. ICH E20 Guidance on Adaptive Designs in Clinical Trials

Tuesday, June 2, 16:50 – 18:20, in Kerwin Hall, room T01

Organizer and chair: Vladimir Dragalin, Johnson & Johnson, Spring House, PA, USA

1. *Overview of the ICH E20 Guidance on Adaptive Designs in Clinical Trials - Perspectives of a PhRMA Member of the Expert Working Group*

   by Vladimir Dragalin, Johnson & Johnson, Spring House, PA, USA

2. *Bayesian Adaptive Designs*

   by Telba Irony, Johnson & Johnson, Titusville, NJ, USA

3. *Control of Unconditional Type I Error in Clinical Trials with External Control*

   by Ping Gao, Innovatio Statistics, Bridgewater, NJ, USA

Session 23. Modern Change-Point Problems III

Tuesday, June 2, 16:50 – 18:20, in Kerwin Hall, room T03

Organizers: Yajun Mei, New York University, New York, NY, USA, and Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

Chair: Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

1. *High-Dimensional Change Point Detection with Missing Values*

   by Abolfazl Safikhani, George Mason University, Fairfax, VA, USA

2. *High-Dimensional Robust Change-Point Detection via Angular Energy Statistics*

   by Jyotishka Ray Choudhury, Georgia Institute of Technology, Atlanta, GA, USA

3. *Change Detection Related to Wasserstein Distances*

   by Ansgar Steland, RWTH Aachen University, Aachen, Germany

Session 24. Sequential Monitoring and Detection

Tuesday, June 2, 16:50 – 18:20, in Kerwin Hall, room T04

Organizers: Michael Baron, American University, Washington, DC, USA, and Yaakov Malinovsky, University of Maryland, Baltimore County, Baltimore, MD, USA

Chair:

1. *Directional Neighborhood Embeddings for Sequential Anomaly Detection in Sparse Event Count Panels*

   by Hsin-Hsiung Huang, University of Central Florida, Orlando, FL, USA

2. *Detecting Transitions Between Collective Motion Regimes Using Functional Hypothesis Test of the Time-Varying Persistence Homology*

   by Thevasha Sathiyakumar, Coppin State University, Baltimore, MD, USA

3. *Multistage Sequential Adaptive Group Testing for Optimal Prevalence Estimation*

   by Md Shamim Sarker, Radford University, Radford, VA, USA

Session 25. Learning for Interpretable Models and from Data with Shifts

Tuesday, June 2, 16:50 – 18:20, in Kerwin Hall, room T05

Organizer and chair: Jiayang Sun, George Mason University, Fairfax, VA, USA

1. *Flexible Interpretable Model Learning*

   by Shenghao Ye, George Mason University, Fairfax, VA, USA

2. *Intrusion Detection Using PEM and Connection with Domain Shifts*

   by May Nguyen, National Geospatial-Intelligence Agency, Arlington, VA, USA

3. *Dynamic Learning From Data With Data Shifts Using a Generalized Selection Bias Framework*

   by Zixiang Xu, George Mason University, Fairfax, VA, USA

★ *Discussion* by Jiayang Sun, George Mason University, Fairfax, VA, USA

Session 26. Quickest Change Detection Algorithms for Complex Systems

Tuesday, June 2, 16:50 – 18:20, in Kerwin Hall, room T06

Organizer and chair: Taposh Banerjee, University of Pittsburgh, Pittsburgh, PA, USA

1. *Asymptotically Optimal Change Detection for Unnormalized Pre- and Post-Change Distributions*

   by Arman Adibi, Augusta University, Augusta, GA, USA

2. *Multiple-Experiment Quickest Change Detection under Cost Constraints*

   by Patrick Lubenia, University of Pittsburgh, Pittsburgh, PA, USA

3. *Sequential Change Detection with Differential Privacy*

   by Liyan Xie, University of Minnesota, Minneapolis, MN, USA

Wednesday, June 3

Session 27. Sequential Parametric and Nonparametric Estimation

Wednesday, June 3, 9:00 – 10:30, in Constitution Hall, room 1

Organizers: Nitis Mukhopadhyay, University of Connecticut, Storrs, CT, USA, and Yan Zhuang, Connecticut College, New London, CT, USA

Chair: Jun Hu, Oakland University, Rochester, MI, USA

1. *Penalized Sequential Estimation for Recurrent Events with High-Dimensional Covariates*

   by Laura Dumitrescu, Fairfield University, Fairfield, CT, USA

2. *MRPE Problems for a Function Involving an Unknown Scale Parameter under a Gamma Distribution with Known-Shape Parameter*

   by Jing Li, University of Maryland, Baltimore County, Baltimore, MD, USA

3. *Sequential Estimation and Boundary Correction for the Overlap Coefficient*

   by Zhe Wang, Denison University, Granville, OH, USA

Session 28. Modern Change-Point Problems IV

Wednesday, June 3, 9:00 – 10:30, in Constitution Hall, room 2

Organizers and chairs: Yajun Mei, New York University, New York, NY, USA, and Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

1. *Monitoring a Sequence of Bernoulli Random Variables Subject to Gradual Changes*

   by Marlo Brown, Niagara University, Lewiston, NY, USA

2. *Sequential Change Detection in Poisson Arrivals with Exponential Sojourn Times*

   by Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

3. *Solution Path for a Shifted Maximum Subarray Problem and its Applications to Change-Point Detection*

   by Ruiyang Wu, Baruch College, The City University of New York, New York, NY, USA

Session 29. **Sequential Inference: Change-Points, Prediction, and Optimality.** *Part I (Focus: Methodological and theoretical advances in detecting changes)*

Wednesday, June 3, 9:00 – 10:30, in Constitution Hall, room 3

Organizer and chair: Yao Xie, Georgia Institute of Technology, Atlanta, GA, USA

1. *Quickest Detection in High Dimension via Random Matrix Theory*

   by Alfred Hero, University of Michigan, Ann Arbor, MI, USA

2. *Higher-Criticism for Sparse Multi-Stream Change-Point Detection: Optimality and Delay Bounds*

   by Alon Kipnis, Reichman University, Herzliya, Israel

3. *Change-Point Analysis with Irregular Signals*

   by Wei Biao Wu, University of Chicago, Chicago, IL, USA

4. *Fundamental Limits of Detecting Abrupt Changes in Point Processes*

   by Anirudh Sridhar, New Jersey Institute of Technology, Newark, NJ, USA

Session 30 (Special). **Abraham Wald Prize in Sequential Analysis and Celebration**

Wednesday, June 3, 11:00 – 12:30, in Constitution Hall, room 1

Organizer: Nitis Mukhopadhyay, University of Connecticut, Storrs, CT, USA

Chair: Tumulesh Solanky, University of New Orleans, New Orleans, LA, USA

1. *Abraham Wald Prize Announcement Ceremony*

   by Tumulesh Solanky, University of New Orleans, New Orleans, LA, USA

2. *Fixed-Width Confidence Intervals Based on Maximum Likelihood Estimation from Possibly Dependent Observations*

by Jun Hu, Oakland University, Rochester, MI, USA

3. *Sequential Estimation with Record Data*

   by Yan Zhuang, Connecticut College, New London, CT, USA

Session 31. **Modern Change-Point Problems V**

Wednesday, June 3, 11:00 – 12:30, in Constitution Hall, room 2

Organizers and chairs: Yajun Mei, New York University, New York, NY, USA, and Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

1. *Is Grouping Always Detrimental to Monitoring Multinomial Data?*

   by Jun Li, University of California, Riverside, CA, USA

2. *Quickest Causal Change Point Detection by Adaptive Intervention*

   by Haijie Xu, Tsinghua University, Beijing, China

3. *Neural Anomaly Detection with Statistical Guarantees: Synthetic Data, Minimax Theory, and Cybersecurity Applications*

   by Tian-Yi Zhou, Columbia University, New York, NY, USA

Session 32. **Sequential Inference: Change-Points, Prediction, and Optimality.** *Part II (Focus: Sequential inference and decision-making under uncertainty)*

Wednesday, June 3, 11:00 – 12:30, in Constitution Hall, room 3

Organizer and chair: Yao Xie, Georgia Institute of Technology, Atlanta, GA, USA

1. *On Sequential Decision Problems for Marked Poisson Processes*

   by Vincent Poor, Princeton University, Princeton, NJ, USA

2. *Time-Series Conformal Prediction with Optimal Weights*

   by Jonghyeok Lee, Georgia Institute of Technology, Atlanta, GA, USA

3. *Provably Efficient Risk-Sensitive Online Reinforcement Learning with Human Feedback*

   by Lifeng Lai, University of California, Davis, CA, USA

4. *Online Euclidean Mirror and First Order Change-Point*

   by Tianyi Chen, Johns Hopkins University, Baltimore, MD, USA

Session 33. Modern Views on Sequential Selection and Ranking

Wednesday, June 3, 13:30 – 15:00, in Constitution Hall, room 1

Organizers: Nitis Mukhopadhyay, University of Connecticut, Storrs, CT, USA, and Elena Buzaianu, University of North Florida, Jacksonville, FL, USA

Chair: Swarnali Banerjee, Loyola University, Chicago, IL, USA

1. *Hypothesis Testing for Two-Arm Proportion Comparisons with Two Binary Endpoints Under Curtailment*

   by Chishu Yin, Syracuse University, Syracuse, NY, USA

2. *Adaptive Two-Stage Design Methods for Multi-Arm Trials with Binary Outcomes*

   by Elena Buzaianu, University of North Florida, Jacksonville, FL, USA

3. *Nonparametric Procedures for a Partition Problem*

   by Tumulesh Solanky, University of New Orleans, New Orleans, LA, USA

Session 34. Modern Change-Point Problems VI

Wednesday, June 3, 13:30 – 15:00, in Constitution Hall, room 2

Organizers: Yajun Mei, New York University, New York, NY, USA, and Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

Chair: Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

1. *A Robust Online Control Chart Based on the Adaptive Conformal Method*

   by Miaomiao Yu, East China Normal University, Shanghai, China

2. *Sequential Changepoint Detection Based on Energy Statistics*

   by Wei Ning, Bowling Green State University, Bowling Green, OH, USA

3. *Breakdown-Robust Sequential Change-Point Detection under Contamination*

   by Qunzhi Xu, MD Anderson Cancer Center, Houston, TX, USA

Session 35. Sequential Methods in Genetics

Wednesday, June 3, 13:30 – 15:00, in Constitution Hall, room 3

Organizer and chair: Nancy Flournoy, University of Missouri, Columbia, MO, USA

1. *Searching for Breakpoints in Spatial or Temporal Data with Application to Genomics*

   by Jie Chen, Augusta University, Augusta, GA, USA

2. *A Sequential Pasting Strategy for Recapitulating Whole-Genome 3D Structure Using Hi-C Data*

   by Shili Lin, The Ohio State University, Columbus, OH, USA

★ *Discussion* by Nancy Flournoy, University of Missouri, Columbia, MO, USA, and Guoqing Diao, George Washington University, Washington, DC, USA

Session 36. Sequential Analysis in the Undergraduate Classroom (panel discussion)

Wednesday, June 3, 15:10 – 16:10, in Constitution Hall, room 1

Organizer and chair: Zhe Wang, Denison University, Granville, OH, USA

1. *Bayesian Online Changepoint Detection on COVID-19 Data and Policy Analysis*

   by Nemi Kapur, Denison University, Granville, OH, USA

2. *How Far Does War Reach? Sequential Detection of Conflict-Language Spillover into Apolitical Reddit Communities*

   by Long Kim, Denison University, Granville, OH, USA

★ *Panel discussion* by Nitis Mukhopadhyay, University of Connecticut, Storrs, CT, USA, Swarnali Banerjee, Loyola University, Chicago, IL, USA, and Yan Zhuang, Connecticut College, New London, CT, USA

Thursday, June 4

Session 37. Recent Advances in Online Changepoint Detection

Thursday, June 4, 9:00 – 10:30, in Constitution Hall, room 1

Organizer and chair: Rebecca Killick, Lancaster University, Lancaster, United Kingdom

1. *RAPID - an Online Multiple Change Point Detector*

   by Meenu Rani, Indian Institute of Technology, Rupnagar, India

2. *Early Stopping with Random Features in Fixed-Design Regression*

   by Alain Celisse, Paris 1 Panthéon-Sorbonne University, Paris, France

3. *Online Multivariate Changepoint Detection: Leveraging Links with Computational Geometry*

   by Gaetano Romano, Lancaster University, Lancaster, United Kingdom

4. *Forecasting Seasonal Changepoint Models Utilizing Changepoint Uncertainties*

   by Vasileios Pavlopoulos, University of Alabama, Huntsville, AL, USA

Session 38. Sequential Methods in Clinical Trials and EHR data I

Thursday, June 4, 9:00 – 10:30, in Constitution Hall, room 2

Organizers and chairs: Yajun Mei, New York University, New York, NY, USA, and Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

1. *To Adaptively Randomize or to Rerandomize: A Comparison of Covariate-Adaptive Randomization and Rerandomization*

   by Ziji Qin, George Washington University, Washington, DC, USA

2. *Dynamic Borrowing of External Controls in Clinical Trials*

   by Xiaoting Chen, New York University, New York, NY, USA

3. *The Kiefer-Weiss-Lorden-Lai (KWLL) Minimax Framework for Interim Evaluation of Efficacy and Futility*

   by Yajun Mei, New York University, New York, NY, USA

Session 39. Modern Process Monitoring Methods

Thursday, June 4, 9:00 – 10:30, in Constitution Hall, room 2

Organizer and chair: Eric Chicken, Florida State University, Tallahassee, FL, USA

1. *Eigenvector Perturbation Approaches to Profile Monitoring*

   by Eric Chicken, Florida State University, Tallahassee, FL, USA

2. *Online Process Monitoring on Networks*

   by Jonathan Stewart, Florida State University, Tallahassee, FL, USA

3. *Dynamic Calibration of Computer Models*

   by Chiwoo Park, University of Washington, Seattle, WA, USA

Session 40. Sequential Analysis as a Tool for Changepoint Detection

Thursday, June 4, 10:50 – 12:20, in Constitution Hall, room 1

Organizer and chair: Rebecca Killick, Lancaster University, Lancaster, United Kingdom

1. *General Purpose Score-Based Time Series Segmentation*

   by Euan McGonigle, University of Southampton, Southampton, United Kingdom

2. *Nonparametric Detection of Changes in Conditional Quantiles*

   by Colin Gallagher, Clemson University, Clemson, SC, USA

3. *Detection of Collective and Point Anomalies at the Presence of Trend and Seasonality*

   by Florian Pein, Lancaster University, Lancaster, United Kingdom

4. *A Grid-Based Methodology for Fast Online Changepoint Detection*

   by Per August Jarval Moen, University of Oslo, Oslo, Norway

Session 41. Sequenital Methods in Clinical Trials and EHR Data II

Thursday, June 4, 10:50 – 12:20, in Constitution Hall, room 2

Organizer: Yajun Mei, New York University, New York, NY, USA

Chair: Yanhong Wu, California State University Stanislaus, Turlock, CA, USA

1. *Precision Physical Activity Prescription via Reinforcement Learning for Functional Actions*

   by Xiaoke Zhang, George Washington University, Washington, DC, USA

2. *Using Sparse Longitudinal Cardiometabolic Risk Factors in Electronic Health Records to Identify Latent Diabetes Risk Groups Under Missing not at Random*

   by Rebecca Anthopolos, New York University, New York, NY, USA

3. *A Causal Framework for Evaluating Jointly Longitudinal Outcomes and Surrogate Markers: a State-Space Approach*

   by Silvaneo Vieira dos Santos Junior, University of Texas, Austin, TX, USA

Session 42. Statistical Methods for Robust, Fair, and Personalized Decision-Making. *Sponsored by KISS, the Korean International Statistical Society*

Thursday, June 4, 10:50 – 12:20, in Constitution Hall, room 3

Organizers: Hyebin Song, Pennsylvania State University, University Park, PA, USA, and Sakshi Arya, Case Western Reserve University, Cleveland, OH, USA

Chair: Sakshi Arya, Case Western Reserve University, Cleveland, OH, USA

1. *On Fairness-Assisted Sequential Variable Selection*

   by Wei Qian, University of Delaware, Newark, DE, USA

2. *Statistical Inference for Misspecified Contextual Bandits*

   by Yongyi Guo, University of Wisconsin, Madison, WI, USA

3. *Learning When and Where Clinical Interventions Work*

   by Nilanjana Laha, Texas A&M University, College Station, TX, USA

Session 43. Recent Advances in Sequential Change Detection

Thursday, June 4, 13:20 – 14:50, in Constitution Hall, room 1

Organizer and chair: Georgios Fellouris, University of Illinois, Urbana-Champaign, IL, USA

1. *Uniform Error Control in Online Change Diagnosis*

   by Austin Warner, United States Naval Academy, Annapolis, MD, USA

2. *Nearly Optimal Hypothesis Testing in Multiple Data Streams*

   by Grigory Sokolov, The College of New Jersey, Ewing, NJ, USA

3. *Sequential Change Detection with Controlled Sensing and Composite Hypotheses*

   by Arghya Chakraborty, University of Illinois, Urbana-Champaign, IL, USA

Session 44. Optimal Stopping and Detection in Network and Streaming Data. ***In Memory of Tze Leung Lai (1945 - 2023)***

Thursday, June 4, 13:20 – 14:50, in Constitution Hall, room 3

Organizer and chair: Haipeng Xing, State University of New York, Stony Brook, NY, USA

1. *Optimal Community Detection with Graphical Neural Network*

   by Hongsong Yuan, Shanghai University of Finance and Economics, Shanghai, China

2. *An Optimal Stopping Problem with a Latent Variable in Finance*

   by Farid Aitsahlia, University of Florida, Gainesville, FL, USA

3. *Deep Learning for Bayeisan Sequential Change-Point Detection in High-Dimensional Diffusion Processes*

   by Haipeng Xing, State University of New York, Stony Brook, NY, USA

4. *Advancing Sequential Importance Sampling: a Tribute to Professor Tze Leung Lai*

   by Yuguo Chen, University of Illinois, Urbana-Champaign, IL, USA

Session 45. Adaptive Decision-Making and Statistical Inference in Sequential Data. *Sponsored by KISS, the Korean International Statistical Society*

Thursday, June 4, 13:20 – 14:50, in Constitution Hall, room 3

Organizer: Hyebin Song, Pennsylvania State University, University Park, PA, USA

Chair: Wei Qian, University of Delaware, Newark, DE, USA

1. *The Fallacy of Minimizing Cumulative Regret in the Sequential Task Setting*

   by Ziping Xu, University of North Carolina, Chapel Hill, NC, USA

2. *Identification of Emotionally Stressful Periods Through Tracking Changes in Statistical Features of Health Data*

   by Younghoon Kim, Cornell University, Ithaca, NY, USA

3. *Single-Index Contextual Bandits: Learning and Inference*

   by Sakshi Arya, Case Western Reserve University, Cleveland, OH, USA

Session 46. Recent Advances in Multi-Stream Sequential Multiple Testing

Thursday, June 4, 15:10 – 16:40, in Constitution Hall, room 1

Organizer and chair: Georgios Fellouris, University of Illinois, Urbana-Champaign, IL, USA

1. *Second-Order Optimal Sequential Multi-Hypothesis Tests*

   by Yanglei Song, Queen's University, Kingston, ON, Canada

2. *Joint Sequential Detection and Isolation of Anomalous Data Streams*

   by Anamitra Chaudhuri, University of Texas, Austin, TX, USA

3. *Sequential Pure Detection and Joint Detection and Isolation with Minimum Total Sampling Cost*

   by Yiming Xing, Tongji University, Shanghai, China

Session 47. Recent Advances in Multiple Testing and Change Detection

Thursday, June 4, 15:10 – 16:40, in Constitution Hall, room 2

Organizer and chair: Shubhanshu Shekhar, University of Michigan, Ann Arbor, MI, USA

1. *Multiple Testing In Multi-Stream Sequential Change Detection*

   by Sanjit Dandapanthula, Carnegie Mellon University, Pittsburgh, PA, USA

2. *Time-Uniform Dependent Central Limit Theory*

   by Spencer Ge, University of Michigan, Ann Arbor, MI, USA

3. *Change Detection via Adaptive Aggregation of Predictive Distributions*

   by Topi Halme, Aalto University, Espoo, Finland

4. *Sequential Change Detection with Simulators*

   by Shubhanshu Shekhar, University of Michigan, Ann Arbor, MI, USA

Session 48. Sequential Modeling and Applications

Thursday, June 4, 15:10 – 16:40, in Constitution Hall, room 3

Organizers: Michael Baron, American University, Washington, DC, USA, and Yaakov Malinovsky, University of Maryland, Baltimore County, Baltimore, MD, USA

Chair:

1. *When Should You Stop the Most Exciting Game? Sequential Inference for General Posterior Win Martingales*

   by Karl Engelund, University of Copenhagen, Copenhagen, Denmark

2. *Modeling Bloom Dates as Stopping Times*

   by Jonathan Auerbach, George Mason University, Fairfax, VA, USA

3. *How Many Extreme Scores Are Distinct in Large Random Round-Robin Tournaments?*

   by Yaakov Malinovsky, University of Maryland, Baltimore County, Baltimore, MD, USA

Poster Presentations

Wednesday, June 3, 12:20 – 13:30, in Constitution Hall

1. *Markov Chain Model to the Distribution of Annual Rainfall for Agricultural Production*

   by Dila Ram Bhandari, Tribhuvan University, Kathmandu, Nepal

2. *Digital Twin for Predictive Maintenance*

   by Natalie Buchbinder, Georgia Institute of Technology, Atlanta, GA, USA

3. *Benchmarking Bayesian Shrinkage and Deep Count Regression for Geopolitical Anomaly Detection*

   by Yuh-Haur Chen, University of Central Florida, Orlando, FL, USA

4. *Time-Indexed Split Conformal Classification and Risk-Optimal Decision Making Based on Conformal Survival Prediction Sets*

   by Mesfin Haileyesus, University of Maryland, Baltimore County, Baltimore, MD, USA

5. *A Study of Boosting Techniques for Quickest Change Detection*

   by Yu-Han Huang, University of Illinois, Urbana-Champaign, IL, USA

6. *How Far Does War Reach? Sequential Detection of Conflict-Language Spillover into Apolitical Reddit Communitie*

   by Long Kim, Denison University, Granville, OH, USA

7. *Assessing Compositional Equivalence: Univariate and Multivariate Frameworks for Food Safety*

   by Bo Liu, University of Maryland, Baltimore County, Baltimore, MD, USA

Abstracts

Asymptotically Optimal Change Detection for Unnormalized Pre- and Post-Change Distributions

Adibi, Arman, Augusta University, Augusta, GA, USA

Abstract: This talk addresses the problem of detecting changes when only unnormalized pre- and post-change distributions are accessible. This situation happens in many scenarios in physics, such as in ferromagnetism, crystallography, magneto-hydrodynamics, and thermodynamics, where the probabilistic models are difficult to normalize. Our approach is based on the estimation of the Cumulative Sum (CUSUM) statistics, which is known to produce optimal performance. We first present an intuitively appealing approximation method. Unfortunately, this produces a biased estimator of the CUSUM statistics and may cause performance degradation. We then propose the Log-Partition Approximation Cumulative Sum (LPA-CUSUM) algorithm based on a numerical integration technique from statistical physics in order to estimate the log-ratio of normalizing constants of pre- and post-change distributions. It is proved that this approach gives an unbiased estimate of the log-partition function and the CUSUM statistics, and leads to an asymptotically optimal performance. Moreover, we derive a relationship between the required sample size for thermodynamic integration and the desired detection delay performance, offering guidelines for practical parameter selection. Numerical studies are provided demonstrating the efficacy of our approach.

Tight Lower and Upper Bounds for One-Sided Sequential Testing

Agrawal, Shubhada, Indian Institute of Science, Bangalore, India, with *Aaditya Ramdas*, Carnegie Mellon University, Pittsburgh, PA, USA

Abstract: We prove two lower bounds for stopping times of sequential tests between general composite nulls and alternatives. The first lower bound is for the setting where the type-1 error level α approaches zero, and equals $\log(1/\alpha)$ divided by a certain infimum KL divergence, termed KL-inf. The second lower bound applies to the setting where α is fixed, and KL-inf approaches 0 (meaning that the null and alternative sets are not separated) and equals c/(KL-inf) loglog (1/KL-inf) for a universal constant c¿0. We also provide a sufficient condition for matching the upper bounds and show that this condition is met in several special cases. Given past work, these upper and lower bounds are unsurprising in their form; our main contribution is the generality in which they hold, for example, not requiring reference measures or compactness of the classes.

An Optimal Stopping Problem with a Latent Variable in Finance

Aitsahlia, Farid, University of Florida, Gainesville, FL, USA

Abstract: I consider the valuation of an American option, where the volatility of the

underlying stock price follows a mean-reverting process. I show that the associated optimal stopping boundary can be approximated via splines requiring only a small number of hyperplanes thanks to sharp concentration bounds. This efficient and accurate option pricing method also enables the determination of so-called hedge parameters that are critical in practice.

Using Sparse Longitudinal Cardiometabolic Risk Factors in Electronic Health Records to Identify Latent Diabetes Risk Groups Under Missing not at Random

Anthopolos, Rebecca, New York University, New York, NY, USA, with *Qixuan Chen*, Columbia University, New York, USA, *Ying Wei*, Columbia University, New York, NY, USA, and *David C. Lee*, New York University, New York, NY, USA

Abstract: Since 2015, type 2 diabetes screening in Asian Americans (AAs) has been recommended for individuals with a body mass index (BMI) of 23 kg/m2 or higher. However, the utility of the 23 kg/m2 cutoff is unclear because AAs have demonstrated significant prevalence of diabetes and its risk factors like high blood pressure and poor cholesterol at lower BMIs. We hypothesize that identifying and characterizing latent cardiometabolic risk profiles may provide critical information for improving diabetes screening. We are motivated by longitudinal data on cardiometabolic risk factors (BMI, blood pressure, cholesterol, and glycosylated hemoglobin (A1C)) collected in electronic health records (EHRs) from patients of Asian race in a New York City hospital system. Although researchers from diverse biomedical fields have used growth mixture models (GMMs) to analyze latent heterogeneity in longitudinal data, in EHRs, the application of GMMs to identify latent risk groups faces two key challenges: First, the unspecified nature of the data generating process in EHRs introduces the potential for a dual missing not at random mechanism (MNAR) from the visit process and the response process for a longitudinal outcome given a clinic visit. Second, longitudinal outcomes in EHRs may be very sparsely observed, leading to estimation challenges that may prevent discovery of at-risk subgroups. We propose a Bayesian multivariate shared parameter model which extends a GMM of multiple longitudinal cardiometabolic risk factors to account for an MNAR visit process and an MNAR response process given a clinic visit. We incorporate alternative shrinkage approaches to allow flexible trajectory and variance estimation in the presence of data sparsity. In contrast to analysis based on missing at random, our analysis reveals that the diabetes at-risk class is characterized by increasing BMI and blood pressure trajectories and marked between-patient variability in individual risk factor trajectories. Rather than a static BMI cutoff, EHRs may offer the opportunity to improve diabetes screening by incorporating a patient's longitudinal cardiometabolic history.

Robust Adaptive Efficient Estimation for Autoregressive Big Data Models

Arkoun, Ouerdia, Universite de Rouen Normandie, Rouen, France

Abstract: In this talk, we propose an efficient adaptive estimation method using robust sequential model selection procedures for big data models represented through the non-parametric autoregressive processes. To this end, by applying the Van Trees inequality to this model, we obtain a lower bound for the robust risk expressed in the form of a Pinsker-type constant. Then, using the weighted least squares method together with non-asymptotic oracle inequalities, we develop an analytical framework that allows us to establish the minimax efficiency property of the proposed estimation procedure, that is, we show that the upper bound of its risk coincides with the obtained lower bound. It is worth emphasizing that this efficiency property is achieved in an adaptive setting where the regularity of the autoregressive function is unknown.

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Single-Index Contextual Bandits: Learning and Inference

Arya, Sakshi, Case Western Reserve University, Cleveland, OH, USA, with *Satarupa Bhattacharjee*, University of Florida, Gainesville, FL, USA, and *Bharath Sriperumbudur*, Pennsylvania State University, State College, PA, USA

Abstract: This talk focuses on statistical inference for contextual bandits with structured reward models. In particular, it considers single-index bandits, where the effect of covariates on each action is mediated through a low-dimensional projection, balancing interpretability and flexibility. While single-index structure is well studied in classical regression, bringing it to online decision-making introduces new challenges for uncertainty quantification because data are collected adaptively and observations are dependent. The talk presents a kernel-based framework for learning these models sequentially, combining Stein-based estimation of the index parameters with RKHS methods for nonparametric reward estimation. Emphasis is placed on the theoretical challenges posed by adaptive data collection and on the inferential guarantees that can be established, including confidence regions for the index direction and pointwise confidence intervals for the reward functions. The framework also yields finite-time regret guarantees, illustrating that principled uncertainty quantification can be achieved without sacrificing learning performance, with examples highlighting how these uncertainty summaries support interpretability in practice.

Modeling Bloom Dates as Stopping Times

Auerbach, Jonathan, George Mason University, Fairfax, VA, USA, with *Elizabeth Wolkovich*, The University of British Columbia, Vancouver, BC, Canada

Abstract: Many biological processes are triggered by accumulated exposure. for example, the law of the flowering plants states a bud blooms once cumulative temperatures reach a specific threshold. Such biological processes can be viewed as stopping-time events, whose behavior can be analyzed using tools from sequential analysis. In this presenta-

tion, we apply these tools to the problems of temperature reconstruction and bloom date prediction, and we offer new insights into the effects of climate change.

Novel Compression Algorithms Using Multi-Stage Methods

Banerjee, Swarnali, Loyola University, Chicago, IL, USA, with *Bhargab Chattopadhyay*, Indian Institute of Technology, Jodhpur, India, and *Partha Sarkar*, Florida State University, Tallahassee, FL, USA

Abstract: Our growing research demands bigger datasets which also makes compression algorithms the need of the hour. Since most of the data sizes are dynamic, sequential and multi-stage algorithms are very useful to construct such algorithms. For the past few years our research has focused on constructing multi-stage methods for data compression algorithms using Principal Component Analysis. For data arriving sequentially, however, several online PCA methodologies exist which focus only on compression risk minimization. Our work focusses on minimizing the cost-compression risk which considers the compression loss and the sampling cost using a multistage PCA procedures. While our previously published work focusses on fixed dimensions, our current work explores these algorithms under "growing dimensions". Under certain regularity conditions, these procedures are shown to be first-order and second order efficient and risk efficient. The proposed algorithms are novel, fast and efficient on various types of data as will be seen in illustrations.

Score-Based Quickest Change Detection for Dependent Data

Banerjee, Taposh, University of Pittsburgh, Pittsburgh, PA, USA, with *Wuxia Chen*, University of Pittsburgh, Pittsburgh, PA, USA, and *Vahid Tarokh*, Duke University, Durham, NC, USA

Abstract: We study the problem of quickest change detection in high-dimensional Markov processes with unknown transition kernels. We take a score-based approach where the the gradient of the logarithm of the conditional density is learned from the data. Based on this score, we develop a score-based CUSUM procedure that uses conditional Hyvarinen score differences to detect changes in the kernel. To ensure bounded increments, we propose a truncated version of the statistic. With Hoeffding's inequality for uniformly ergodic Markov processes, we prove exponential lower bounds on the mean time to false alarm. We also prove asymptotic upper bounds on detection delay. These results give both theoretical guarantees and practical feasibility for score-based detection in high-dimensional Markov models. We also apply our algorithm to real and simulated high-dimensional data to show its effectiveness.

Shortest Fixed-Width Confidence Intervals for a Bounded Parameter: the Push Algorithm

Bartroff, Jay, University of Texas, Austin, TX, USA

Abstract: A novel method for fixed-width confidence intervals – called the Push Algorithm – for the binomial success probability appeared in Asparaouhov's PhD thesis, and cited an unknown manuscript by Lorden. In this talk I'll discuss the little-known method, and our extension of it to any bounded parameter in a monotone likelihood ratio family. The method produces the shortest possible fixed-width confidence interval for a given confidence level, and if the Push interval does not exist for a given width and level then no such interval exists. We demonstrate it on the binomial, hypergeometric, and normal distributions with our available R package, where it outperforms the standard intervals, including the venerable z-interval in the normal case. If there is time, I will discuss sequential implications. This is joint work with Asmit Chakraborty.

Truncated Sequential Guaranteed Estimation for the Cox-Ingersoll-Ross Models

Ben Alaya, Mohamed, Universite de Rouen Normandie, Rouen, France

Abstract: The drift sequential parameter estimation problems for the Cox-Ingersoll-Ross (CIR) processes under the limited duration of observation are studied. Truncated sequential estimation methods for both scalar and two-dimensional parameter cases are proposed. In the non-asymptotic setting, for the proposed truncated estimators, the properties of guaranteed mean-square estimation accuracy are established. In the asymptotic formulation, when the observation time tends to infinity, it is shown that the proposed sequential procedures are asymptotically optimal among all possible sequential and non-sequential estimates with an average estimation time less than the fixed observation duration. It also turned out that asymptotically, without degrading the estimation quality, they significantly reduce the observation duration compared to classical non-sequential maximum likelihood estimations based on a fixed observation duration.

Markov Chain Model to the Distribution of Annual Rainfall for Agricultural Production

Bhandari, Dila Ram, Tribhuvan University, Kathmandu, Nepal, with *Aayan Bhandari*, Seneca College, Toronto, ON, Canada

Abstract: This paper develops and applies a first-order Markov chain model to inspect annual rainfall variability and its implications for crop production in Nepal. A Markov chain provides a probabilistic framework for modelling climatic sequences in which future states depend only on current conditions. The process satisfies the Markov property $P(X_{t+1} = j \mid X_t = i, X_{t-1}, \ldots) = P(X_{t+1} = j \mid X_t = i)$ with transition probabilities concise in a matrix $P = [p_{ij}]$. Stationary distributions are taken by solving $\pi = \pi P$, enabling long-run appraisals of rainfall behaviour. If ergodicity conditions are met, the chain converges to a unique stable distribution independent of initial rainfall conditions. Annual rainfall was classified into four states low, moderate well-spread, high, and moderate not well-spread and transition probabilities were estimated to describe how rainfall patterns evolve from year to year. The stationary distribution of the chain signifies that, in the long run, Kathmandu will experience approximately 14% low-rainfall years, 34% moderate well-spread rainfall years, 47% high-rainfall years, and 5% moderate not well-spread rainfall years. These results highlight the dominance of high rainfall conditions and the relatively low frequency of drought-like years. By linking rainfall states to crop production potential, the model provides a useful predictive framework for agricultural planning, helping farmers and policymakers assess climatic risks and strategize for enhanced crop yields under variable monsoon patterns.

Adaptive Procedure to Estimate Confidence Interval for Population Sizes under Mark-Recapture-Mark Sampling

Bhattacharjee, Debanjan, Utah Valley University, Orem, UT, USA, with *Ivair Silva*, Federal University of Ouro Preto, Ouro Preto, Brazil, and *Yan Zhuang*, Connecticut College, New London, CT, USA

Abstract: In this paper, we modify the conventional mark-recapture strategy to estimate the size (N) of a finite population. In this new procedure non-marked, resampled items are marked before they are released back into the population. A sequential adaptive stopping rule for fixed-length-interval-estimation of N is proposed. A Monte Carlo solution is derived and compared with the accelerated sequential method. Estimating sizes of finite populations can become particularly relevant in knowing the total number of patients infected with a disease at a particular time in a geographical region. Our new method is illustrated with a simulation that estimates the number of infected COVID-19 individuals in a near-closed population. In addition, we present a numeric application inspired by the problem of estimating the population size of endangered monkeys of the Atlantic Forest in Brazil.

Weighted Asymptotically Optimal Sequential Testing

Bose, Soumyabrata, University of Texas, Austin, TX, USA, with *Jay Bartroff*, University of Texas, Austin, TX, USA

Abstract: This paper develops a framework for incorporating prior information into sequential multiple testing procedures while maintaining asymptotic optimality. We define a weighted log-likelihood ratio (WLLR) as an additive modification of the standard LLR and use it to construct two new sequential tests: the Weighted Gap and Weighted Gap-Intersection procedures. We prove that both procedures provide strong control of the family-wise error rate. Our main theoretical contribution is to show that these weighted procedures are asymptotically optimal; their expected stopping times achieve the theoretical lower bound as the error probabilities vanish. This first-order optimality is shown to be robust, holding in high-dimensional regimes where the number of null hypotheses grows and in settings with random weights, provided that mild, interpretable conditions on the weight distribution are met.

Monitoring a Sequence of Bernoulli Random Variables Subject to Gradual Changes

Brown, Marlo, Niagara University, Lewiston, NY, USA

Abstract: We look at a sequence of Bernoulli random variables where the success rates change from θ_1 to θ_2. We will assume that both the success rates starts to increase at some unknown time point. We assume that this change does not happen abruptly but gradually over a period of time η where η is known. We calculate the probability that the change has started, and completed. We also look at optimal stopping rules assuming that there is a cost for a false alarm and a cost per time unit to stop late.

Sequential Model Selection for Nonparametric Autoregressive Processes

Brua, Jean-Yves, Universite de Rouen Normandie, Rouen, France

Abstract: In this talk, we study the problem of nonparametric estimation of a function in an autoregressive model under quadratic risk. To this end, we develop an adaptive sequential model selection method based on efficient sequential kernel estimators proposed by Arkoun and Pergamenshchikov (2016). Through the sequential kernel estimators, one passes from an autoregressive model to a regression model, in which the noises are conditionally independent random variables. Then, in the framework of this regression model, the unknown function is estimated on the basis of the model selection procedure based on the family of the weighted least square estimators with the weights defined through the Pinsker efficient method. Then for this procedure, one derives sharp non-asymptotic oracle inequalities for the robust quadratic risk. This inequality means that the proposed estimation procedure is quasi-optimal in the non-asymptotic sense, i.e. the quadratic risk for the constructed procedure is minimal up to some coefficient close to one among all weighted least square estimators with the coefficients of Pinsker form, which under known regularity of the unknown function provide the efficient estimation in the asymptotic setting.

Digital Twin for Predictive Maintenance

Buchbinder, Natalie, Georgia Institute of Technology, Atlanta, GA, USA, with *Ramesh Natarajan*, Yeshiva University, New York, USA, and *Anna Timonina-Farkas*, Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland

Abstract: Scheduled maintenance is essential for the proper functioning of a variety of industrial machines, since unanticipated component failures lead to unnecessary downtime, safety hazards and/or revenue loss. The fixed maintenance schedules that are currently used in practice, do not take into account usage variability and machine sensor data, and consequently, these schedules result in the failure-prone components either being replaced prematurely or only after failure occurs. By contrast, predictive maintenance schedules attempt to find exactly when a component failure threshold will be met, so that timely

remediation can happen as needed.

However, one of the challenges in predictive maintenance is that custom usage dynamics and predictive models must be developed for each machine and component type that is encountered in practice. Furthermore, usage and failure data on the machine components is often proprietary and difficult to access until the predictive maintenance solution is actually accepted and deployed in production.

Our project addresses these two challenges using modern artificial intelligence techniques (large language models, context engineering, code generation) to automate the development of digital twins encapsulating model dynamics, sensor data and component failure models. We describe a specific example of predictive maintenance for commercial coffee machines, with models for the core components including grinders, pumps, heating elements, and milk systems, and simulators their physical behavior and degradation over time depending on usage, typical wear rates and the operational environment. The whole process of model development and simulated data generation is automated, and the testing and validation can be performed before integration into the production environment for sensor/usage data assimilation and maintenance planning.

Adaptive Two-Stage Design Methods for Multi-Arm Trials with Binary Outcomes

Buzaianu, Elena, University of North Florida, Jacksonville, FL, USA

Abstract: Adaptive randomization methods have become increasingly popular in clinical research for improving trial efficiency and flexibility. for studies comparing multiple treatments, we consider a multi-arm two-stage design that selects the best treatment in the first stage and compares it with a control in the second. To better utilize interim data, we propose response-adaptive randomization two-stage designs for trials with binary outcomes. Two allocation strategies are examined, and optimal designs are derived relative to minimizing expected failures and the average sample size. Simulation studies demonstrate that the proposed adaptive designs outperform traditional non-adaptive designs in efficiency.

An Information Metric for Assessing Interim Decisions in Group Sequential Trials

Caruso, Gianmarco, University of Cambridge, Cambridge, United Kingdom, with *William Rosenberger*, George Mason University, Fairfax, VA, USA, and *Pavel Mozgunov*, University of Cambridge, Cambridge, UK

Abstract: Group sequential designs enable interim analyses and potential early stopping for efficacy or futility, which can shorten trial duration and reduce patient exposure to ineffective treatments. However, if interim decisions are ignored in the analysis, posterior estimates of the treatment effect can be substantially affected, often producing overly optimistic credible intervals aligned with the stopping decision. Drawing on information theory, we use the Kullback-Leibler divergence to quantify the cumulative impact of interim decisions in group sequential trials. This measure summarizes the impact across the full range of treatment effect values rather than at individual points. By comparing alternative decision boundaries and prior specifications, we illustrate how this measure can improve the understanding of trial results and inform the planning of future adaptive studies. We also introduce a pre-experimental version of this metric to support investigators in trial design choices, including the timing of interim analyses and stopping boundaries. This guidance complements traditional strategies based on type-I error rate control by quantifying how sequential monitoring influences posterior treatment effect estimates at each interim look. We illustrate its practical use in a group sequential trial evaluating a treatment for central nervous system disorders.

Sampling Expansions for AFB Signals via Change-Point Detection

Casey, Stephen, American University, Washington, DC, USA, with *Michael Baron*, American University, Washington, DC, USA

Abstract: This talk outlines sampling expansions designed specifically for adaptive frequency band (AFB) signals. Optimal sampling of AFB requires changing sampling rates. The proposed expansion, the *Projection Method* gives a more computationally efficient way to sample, transmit, and then reconstruct AFB signals. The entire system is developed with flexible parameters, perfect for AFB. To detect changing bandwidth, we use statistical methods of *change-point detection*. We propose a two-component system – using techniques of statistical change point detection as a front end to detect changing signal bandwidth, and then using the flexibility built into the Projection system to adjust to the changing bandwidth.

Early Stopping with Random Features in Fixed-Design Regression

Celisse, Alain, Paris 1 Panthéon-Sorbonne University, Paris, France

Abstract: The present work analyzes the behavior of early stopping rules in the context of fixed-design regression. The setting is the one of high-dimension with a limited amount of available data. In this setting reducing the dimension is a natural purpose and choosing how many features should be considered at the (non-linear) feature space level is a classical question. Projection estimators of the regression function are sequentially considered, each of them being associated with a nested collection of feature spaces. With no smoothness assumptions on the regression function, a first statement is given which proves that the (data-driven) early stopping rule based on the discrepancy principle exhibits a non-improvable rate $O(1/\sqrt{n})$. By contrast if one makes stronger smoothness assumptions, considering a smoothed version of the empirical risk for choosing the dimension of the feature space allows for improving the rate of convergence. These rates are made explicit in particular for Random Features when the regression function does belong to an RKHS.

Sequential Change Detection with Controlled Sensing and Composite Hypotheses

Chakraborty, Arghya, University of Illinois, Urbana-Champaign, IL, USA, with *Georgios Fellouris*, University of Illinois, Urbana-Champaign, IL, USA

Abstract: We study the problem of sequential change detection under a general composite post-change hypothesis with controlled sensing. At each time instant, an action is selected that influences the distribution of the current observation, with actions allowed to depend on the previously collected data. The objective is to jointly design a control policy and a stopping rule to detect the change as quickly as possible while controlling the false alarm rate. We propose a scheme that achieves first-order asymptotic optimality under Lorden's minimax criterion as the mean time to false alarm - and possibly the number of available controls - tends to infinity. We also derive upper bounds for the expected detection delay in other asymptotic regimes where the number of controls grows at a faster rate. Numerical experiments demonstrate the performance of the proposed method and compare it with existing alternatives.

Joint Sequential Detection and Isolation of Anomalous Data Streams

Chaudhuri, Anamitra, University of Texas, Austin, TX, USA, with *Yiming Xing*, Tongji University, Shanghai, China, and *Georgios Fellouris*, University of Illinois, Urbana-Champaign, IL, USA

Abstract: A setup with multiple, independent, sequentially monitored data streams is considered. for each of them, two composite hypotheses are postulated, with the interpretation that the stream is anomalous if the corresponding alternative hypothesis holds. It is of interest to detect as quickly as possible whether there is at least one anomalous stream, and also to identify upon stopping the subset of anomalous streams. To address this joint sequential detection and isolation problem, we propose a sequential multiple testing framework where the probabilities of four kinds of error are controlled below distinct, user-specified levels. Two of them refer to the detection task, and the other two to the isolation task. A testing policy is proposed and it is shown to achieve the minimum possible expected sample size, under each point of the parameter space, to a first order asymptotic approximation as the four target error probabilities go to 0. The general theory is illustrated in the case that the data streams generate iid observations that belong to a multi-parameter exponential family, and simulation results show improved performance over the existing methods.

Searching for Breakpoints in Spatial or Temporal Data with Application to Genomics

Chen, Jie, Augusta University, Augusta, GA, USA

Abstract: Searching for multiple breakpoints (aka change points) in sequentially observed

data lately became trendy across various practical fields. These changes are prevalent in data collected from quality control, finance, economics, climate studies, social media, cybersecurity, medicine, health sciences, and genomics. The central questions to-be-answered in the data analytics for such data include whether there are breakpoints in the data stream and how to estimate the unknown loci of the breakpoints when they exist. Methods such as CUSUM, Likelihood procedure, and penalized regression, coupled with searching algorithms, have been used in the detection of multiple breakpoints in practice. DNA-sequencing and RNA-sequencing data, along with linearized index (loci) of the genome, can be considered as data observed in a temporal or spatial order. Such a conceptualized formulation gave rise to new waves of sequential methodology development for the identification of genomic features such as CNVs or CpG sites using DNA-sequencing or RNA-sequencing data. In this talk, a brief review of sequential methods used for the detection of breakpoints in genomic data will be given. Our Bayesian framework that incorporates the idea of on-line detection for breakpoints with a Markov chain assumption on the loci will be presented, as well as a compound Poisson model, along with a sliding window approach. Applications of our methods to genomics will be given.

Subset Selection with Curtailment Among Treatments with Binary Outcome in Comparison with a Control

Chen, Pinyuen, Syracuse University, Syracuse, NY, USA, with *Elena Buzaianu*, University of North Florida, Jacksonville, FL, USA, and *Lifang Hsu*, Le Moyne College, Syracuse, NY, USA

Abstract: This paper proposes a closed adaptive sequential procedure for selecting a random-sized subset of size t (> 0) among k $(\geq t)$ experimental treatments so that the selected subset contains all treatments superior to the control treatment. All the experimental treatments and the control are assumed to produce two binary endpoints, and the procedure is based on those two binary endpoints. A treatment is considered superior if its both endpoints are larger than those of the control. While responses across treatments are assumed to be independent, dependence between endpoints within each treatment is allowed and modeled via an odds ratio. The proposed procedure comprises explicit sampling, stopping, and decision rules. We show that for any sample size n and any parameter configuration, the sequential procedure maintains the same probability of correct selection as the corresponding fixed-sample-size procedure. We use the bivariate binomial and multinomial distributions in the computation and derive design parameters under three scenarios: (i) independent endpoints, (ii) dependent endpoints with known association, and (iii) dependent endpoints with unknown association. We provide tables with the sample size savings achieved by the proposed procedure compared to its fixed-sample-size counterpart. Examples are given to illustrate the procedure.

Online Euclidean Mirror and First Order Change-Point

Chen, Tianyi, Johns Hopkins University, Baltimore, MD, USA, with *Yao Xie*, Georgia

Institute of Technology, Atlanta, GA, USA, *Carey Priebe*, Johns Hopkins University, Baltimore, MD, USA, *Zachary Lubberts*, University of Virginia, Charlottesville, VA, USA, and *Avanti Athreya*, Johns Hopkins University, Baltimore, MD, USA

Abstract: We describe a model for network time series governed by an underlying stochastic process known as the latent position process. In this framework, network evolution is represented in Euclidean space by a curve termed the Euclidean mirror. We define the notion of a first-order changepoint for network time series, characterized by a change in the rate of continuous evolution, and construct a family of latent position process networks that exhibit these dynamics. We prove that a spectral estimate of the associated Euclidean mirror can detect and localize these changepoints, even when the graph distribution evolves continuously. We further extend this methodology to the sequential observation setting, deriving an online kernel CUSUM algorithm for monitoring first-order changepoints in streaming graph data. We show that this CUSUM-based approach can track changes in the underlying latent process in real time.

Dynamic Borrowing of External Controls in Clinical Trials

Chen, Xiaoting, New York University, New York, NY, USA

Abstract: In randomized clinical trials, sample size constraints arising from practical and ethical considerations often motivate borrowing external historical information, such as prior randomized studies or Electronic Health Record (EHR) data, to augment the control arm. In the first part of this talk, we review the existing dynamic borrowing methods, including power priors and hierarchical modeling frameworks that adaptively incorporate external historical information. While these approaches can substantially improve estimation efficiency and power, they may induce Type I error inflation under prior-data conflict and are less well-developed for longitudinal data. In the second half, motivated by a recent Ritlecitinib trial for Alopecia Areata, where extrapolating unobserved longitudinal endpoints from a 24-week control to a 36-week treatment target was ethically necessary, we propose a novel dynamic borrowing framework for continuous longitudinal outcomes under a linear mixed-effects (LME) model with slope constraints. Hope our research can stimulate further methodological development on dynamic borrowing that achieves efficiency gains while maintaining the Type I error control in clinical trials.

Gaussian Process Regression Models for Forecasting Geomagnetic Perturbations

Chen, Yang, University of Michigan, Ann Arbor, MI, USA

Abstract: As the availability of observations from space weather monitoring instruments continues to grow, data-driven approaches are becoming increasingly competitive for real-time forecasting of geomagnetic perturbations. The primary challenges of such prediction tasks include: hybrid regular and heavy-tailed noisy observations, the presence of heterogeneous temporal trends on stormy and non-stormy days, and complex nonlinear relation-

ships among response variables recorded at different geographic locations and global and regional predictor variables. Additionally, the symmetry and non-symmetry characteristics of geomagnetic indices are captured by sparse and unevenly distributed observations. In this talk, I present approaches to tackling these issues with sparse variational contaminated noise models, deep Gaussian process models, and the incorporation of mirror symmetry in deep Gaussian process models. Furthermore, I will showcase our real-time forecasting website for global geomagnetic indices and introduce an arora forecasting model as a byproduct.

Advancing Sequential Importance Sampling: a Tribute to Professor Tze Leung Lai

Chen, Yuguo, University of Illinois, Urbana-Champaign, IL, USA

Abstract: In this talk, we highlight the contributions of Professor Tze Leung Lai to sequential importance sampling (SIS) methods and their applications. SIS is a versatile and powerful Monte Carlo method for tackling complex statistical inference problems. Professor Lai's work conducted rigorous theoretical analyses of SIS and provided deep insights into the development of more effective SIS methods. His work has significantly enriched the theory and practice of SIS, and will continue to influence the field of sequential Monte Carlo methods and provide a foundation for future research in simulation-based inference.

Benchmarking Bayesian Shrinkage and Deep Count Regression for Geopolitical Anomaly Detection

Chen, Yuh-Haur, University of Central Florida, Orlando, FL, USA, with *Hsin-Hsiung Huang*, University of Central Florida, Orlando, FL, USA, and *John Scott*, University of Central Florida, Orlando, FL, USA

Abstract: Geolocated event records from the Global Database of Events, Language, and Tone (GDELT) can be aggregated into weekly spatiotemporal panels. Because these panels are typically sparse, bursty, and overdispersed, calibrated probabilistic forecasting is essential for monitoring rare geopolitical surges. This research evaluates Bayesian count regression pipelines to detect anomalies and interpret spatial spillovers. First, we pair deterministic deep temporal encoders with negative binomial (NB2) and zero-inflated (ZINB2) likelihood heads, yielding predictive quantiles that support robust right-tail anomaly scoring. Second, to provide interpretable spillover attribution, we implement a Bayesian generalized linear model featuring a two-step screen-and-refit procedure under a three-parameter beta-normal (TPBN) shrinkage prior. A key contribution of this work is connecting these statistical spillovers to directional statistics. Active cross-region effects are mapped to geodesic bearings on the WGS84 ellipsoid and summarized using weighted circular moments, rose diagrams, and bearing-field maps. Through benchmarking and real-world conflict-panel case studies, we demonstrate an accurate and highly

visual workflow for detecting and attributing geopolitical shocks.

OSOL: Online Expectation-Maximization for Multi-Fidelity Simulation Optimization under Fixed Budgets

Dai, Wei, George Mason University, Fairfax, VA, USA, with *Jie Xu*, George Mason University, Fairfax, VA, USA, and *Jiayang Sun*, George Mason University, Fairfax, VA, USA

Abstract: Efficient integration of multi-fidelity data is central to simulation optimization, where sequential estimation and allocation decisions must be made under a limited budget of expensive high-fidelity evaluations. We consider the fixed-budget setting in which the best among k alternatives is to be identified using high-fidelity data guided by cheap low-fidelity surrogates. We model the joint distribution of high- and low-fidelity performance through a hierarchical Gaussian mixture model and estimate its parameters online via a stochastic approximation variant of the EM algorithm, which we term Offline Simulation Online Learning (OSOL). We establish almost sure convergence of the OSOL parameter estimates to stationary points of the Kullback-Leibler divergence. To enable adaptive sampling, we propose an ϵ-mixing extension that alternates uniform exploration with focused exploitation across rounds, preserving the independence structure required for convergence while progressively concentrating the budget on promising alternatives. Building on the precision-additive structure of the updated estimates, we introduce a regret quantity that tracks the probability of incorrect selection and decompose its incremental change into deterministic and stochastic components, providing a principled basis for sequential allocation with connections to information-directed sampling. Numerical experiments are conducted to evaluate the probability of correct selection of the proposed methods relative to existing procedures.

Multiple Testing In Multi-Stream Sequential Change Detection

Dandapanthula, Sanjit, Carnegie Mellon University, Pittsburgh, PA, USA, with *Aaditya Ramdas*, Carnegie Mellon University, Pittsburgh, PA, USA

Abstract: Multi-stream sequential change detection involves simultaneously monitoring many streams of data and trying to detect when their distributions change, if at all. Here, we theoretically study multiple testing issues that arise from detecting changes in many streams. We point out that any algorithm with finite average run length (ARL) must have a trivial worst-case false detection rate (FDR), family-wise error rate (FWER), per-family error rate (PFER), and global error rate (GER); thus, any attempt to control these Type I error metrics is fundamentally in conflict with the desire for a finite ARL (which is typically necessary in order to have a small detection delay). One of our contributions is to define a new class of metrics which can be controlled, called error over patience (EOP). We propose algorithms that combine the recent e-detector framework (which generalizes the Shiryaev-Roberts and CUSUM methods) with the recent e-Benjamini-Hochberg procedure and e-Bonferroni procedures. We prove that these algorithms control the EOP at any desired level under very general dependence structures on the data within and across the streams. In fact, we prove a more general error control that holds uniformly over all stopping times and provides a smooth trade-off between the conflicting metrics. Additionally, if finiteness of the ARL is forfeited, we show that our algorithms control the worst-case Type I error.

Multi-Dimensional Ranking: on the Kemeny Ranking Problem

Das, Ashish, Indian Institute of Technology, Mumbai, India

Abstract: Multi-dimensional ranking aims to derive a comprehensive ordering of alternatives based on multiple quantitative variables. It seeks to combine several independent rankings into a single consensus ranking that best represents overall performance. We focus on the Kemeny ranking problem, where the goal is to minimize the total disagreement among individual rankings, and compares its performance with the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method, a distance-based multi-criteria approach. To improve the effectiveness of the Kemeny framework, two tie-breaking criteria are introduced to enhance ranking stability. Furthermore, iterative optimization techniques, including the SubIterative Convergence Algorithm, Greedy Aggregation, FUR, and SIgFUR, were implemented to study convergence patterns and computational performance under different k-values, search radii, and initial inputs. The analysis, conducted on quantitative bank data, shows that both TOPSIS and the modified Kemeny approach offer valuable insights for multi-dimensional ranking tasks, each with distinct computational and interpretational characteristics. The study highlights how these methods can complement one another in addressing quantitative multi-criteria decision-making problems.

Overview of the ICH E20 Guidance on Adaptive Designs in Clinical Trials - Perspectives of a PhRMA Member of the Expert Working Group

Dragalin, Vladimir, Johnson & Johnson, Spring House, PA, USA

Abstract: In the rapidly evolving landscape of clinical research, adaptive designs offer promising avenues to enhance flexibility, efficiency, and ethical standards in trial execution. Recognizing the significance of this innovation, the International Council for Harmonization (ICH) has developed the Draft E20 Guideline on Adaptive Designs in Clinical Trials, aiming to provide key principles and a harmonized framework for the development, implementation, and evaluation of adaptive designs. This presentation will open with a concise yet comprehensive overview of the Draft E20 Guideline, focusing on its key principles, scope, and the primary topics it addresses. Core elements - including adaptive design types, statistical considerations, operational challenges, and regulatory expectations - will be discussed, with particular attention to how these aspects can be harmonized to support global development strategies. The session will facilitate a critical discussion to pinpoint areas in the guidance where clarification, improvement, and inno-

vation are needed, ensuring it remains practical, scientifically robust, and responsive to the demands of modern clinical trials.

Penalized Sequential Estimation for Recurrent Events with High-Dimensional Covariates

Dumitrescu, Laura, Fairfield University, Fairfield, CT, USA

Abstract: The study of recurrent events, such as hospital readmissions or stock market volatility spikes, is important in biostatistics and finance but poses statistical challenges due to complex dependencies and censoring. Under a semiparametric framework for modeling gap times between events, we employ a penalized sequential estimating equations approach to handle high-dimensional covariates. The procedure yields estimators with attractive large sample properties and we illustrate how the rate of divergence in the number of parameters affects the convergence rate of penalized estimators when the number of covariates grows to infinity as the number of clusters increases. The proposed method has the advantage of simultaneously estimating parameters while selecting important variables and accounting for the within-cluster correlation.

When Should You Stop the Most Exciting Game? Sequential Inference for General Posterior Win Martingales

Engelund, Karl, University of Copenhagen, Copenhagen, Denmark, with *Steven Campbell*, Columbia University, New York, NY, USA

Abstract: Prediction and betting markets, such as Kalshi and Polymarket, transform uncertain future events into real-time probability processes. Motivated by Aldousâ€™ formulation of the most exciting game, we study the sequential decision problem of when to stop observing such a process and commit to a decision. We formulate this question for a broad class of posterior win martingales, balancing terminal inference loss against time-dependent observation costs. The resulting problem is an optimal stopping problem whose solution is described by a free boundary: once the posterior crosses this boundary, it is optimal to stop and declare a winner. We solve the problem in considerable generality to treat homogeneous and inhomogeneous settings in both finite and infinite horizons. We establish smooth fit, regularity of the stopping boundary, and an integral-equation characterization, and illustrate the theory through examples arising from canonical win martingales and sequential-inference models.

The Nonparametric Kiefer-Weiss Problem

Fauss, Michael, ETS Research Institute, Princeton, NJ, USA, with *Vincent Poor*, Princeton University, Princeton, NJ, USA, and *Abdelhak M. Zoubir*, TU Darmstadt, Darmstadt, Germany

Abstract: We propose and solve a nonparametric variant of the Kiefer-Weiss problem. The objective is to minimize a weighted sum of the error probabilities of a binary sequential test subject to a constraint on its maximum expected sample size, where this maximum is taken over all possible distributions on the sequence space. We show that this problem reduces to an optimal stopping problem and characterize the optimal stopping policy via a nonlinear Bellman equation. This policy is based on a two-dimensional test statistic, with one component tracking the likelihood ratio and the other one tracking the expected remaining sample size.

We further show that the use of randomization is critical to control the expectedÂ remaining sample size. The optimal randomization rule is determined by a unique function that maps the likelihood ratio to an integer-valued sample size. We propose two approximations of this function that are easy to evaluate in practice. The results are illustrated with numerical examples.

Detection and Acceleration of a Series of Changes

Fellouris, Georgios, University of Illinois, Urbana-Champaign, IL, USA, with *Yangchang Liang*, University of Illinois, Urbana-Champaign, IL, USA

Abstract: We consider the problem of detecting and accelerating a series of changes. Specifically, we assume that the sequentially collected observations are responses to certain actions, which are taken in real-time. These actions determine the distributions of the responses but also influence the underlying state of the system. The goal is to minimize the expected number of observations until the final change is detected, subject to a global false alarm constraint. An optimal solution to this problem will be presented under a Bayesian change-point model. Practical suboptimal alternatives will be explored and compared in simulation studies.

The Effect of Channeled Dependence on Bayes Estimators in Two-Stage Experiments

Flournoy, Nancy, University of Missouri, Columbia, MO, USA, with *Sergey Tarima*, University of Kentucky, Lexington, KY, USA

Abstract: This work builds on Flournoy and Tarima (Statistical Papers, 2023). A typical planned experiment with an interim analysis secures pre-determined type 1 error rate and power at some relevant treatment effect (Jennison and Turnbull, 1999). However, despite substantial progress in recent years, efficient post-testing estimation remains challenging. The root of the challenge is that the distributions of estimators may be altered from those of studies without interim analyses. This talk focuses on two-stage experiments with channeled dependence in which we require predetermined rules for interim decisions that are (1) fully determined by stage 1 data with (2) stage 2 data (including the possibility of being unobserved) only depending on stage 1 data through the interim decision. Channeled dependence occurs with sample size re-estimation, early stopping for futility or efficacy or accuracy, and various dose-finding and enrichment designs. With channeled dependence in Gaussian settings, post-testing frequentist estimators (e.g., the sample mean) are not

sufficient or unbiased and confidence intervals do not have the nominal coverage determined by Gaussian distribution; Simons (1980) showed that in addition to being biased, channeled sample means do not adhere to the well-known Rao-Cramer lower bound with independent observations (even accounting for bias); nor do they adhere to the sequential version of Wolfowitz (1947). For Bayes estimators, we argue that conditioning the sampling density on interim decisions when updating the posterior is more principled from a Bayesian philosophical viewpoint in that, after a stopping decision has been made, the conditional density more closely reflects the data-generating process underlying the observed trial path. We demonstrate the effect of updating posteriors with the conditional sampling density for several Bayes estimators in the literature.

Nonparametric Detection of Changes in Conditional Quantiles

Gallagher, Colin, Clemson University, Clemson, SC, USA, with *Sha Wan*, Clemson University, Clemson, SC, USA

Abstract: Most changepoint detection methods are based on mean or regression parameter changes or parametric models, while nonparametric attempts typically use estimated values of the cumulative distribution function or ranks. We consider detecting changes in conditional quantiles of an observed time series. The cost function consists of the conditional one-step likelihood approximated via a selected set of quantiles. Given the approximated cost function, shifts in the conditional distribution can be detected sequentially using at most one change detection and binary segmentation, or via penalized cost function minimization.

Control of Unconditional Type I Error in Clinical Trials with External Control

Gao, Ping, Innovatio Statistics, Bridgewater, NJ, USA

Abstract: Patient enrollment can be a substantial burden in rare disease trials. One potential approach is to incorporate external control (EC) into concurrent randomized trials, or EC borrowing, to reduce such burden. Extensive research has been conducted to explore statistical methodologies. As in all designs, type I error control is essential. Conditional type I error rate has been used in the literature as the de facto metrics for type I error rate. However, research has shown that controlling the conditional type I error rate at the alpha level will disallow EC borrowing. Therefore, EC borrowing is practically at an impasse. Kopp-Schneider et al (2020) concluded that a “more appropriate metric” for type I error is necessary. We show that a trial with EC borrowing can be considered as a two-stage adaptive design. With this perspective, we propose to define type I error as the weighted averages of conditional type I error rate in trials with EC borrowing. Dynamic borrowing methods for controlling type I error are proposed.

Time-Uniform Dependent Central Limit Theory

Ge, Spencer, University of Michigan, Ann Arbor, MI, USA, with *Yanlong Liu*, University of Chicago, Chicago, IL, USA

Abstract: Confidence sequences (CSs) are sequences of confidence intervals that are uniformly valid over time, but constructing finite-sample-valid CSs is hard and sometimes even not feasible in complex settings. To obtain central limit theorem (CLT)-like flexibility while retaining (asymptotic) time-uniform guarantees, recent work has leveraged strong invariance principles to construct asymptotic CSs by uniformly approximating the sample-average process with an implicit Gaussian process. Existing time-uniform central limit theorems primarily focus on cross-sectional settings, with relatively few studies addressing temporal dependence. We extend this framework to (potentially nonstationary) time series settings with serial correlations. In particular, we enable statistical inference for unconditional (running) means, which are not only easier to estimate, but also often more practically relevant for managerial and economic decision-making because their trajectories admit direct geometric interpretation, in contrast to conditional (running) means built under martingale dependence. To achieve this, we first establish a new strong Gaussian approximation result for a broad class of potentially nonstationary processes. Using m-approximation within the functional dependence measure framework, we obtain a near-optimal approximation error rate under mild and easily verifiable dependence assumptions. Next, by establishing strong consistency of variance estimators for stationary and nonstationary time series, we establish a time-uniform dependent central limit theorem.

On Turing's Formula and the Estimation of the Missing Mass

Grabchak, Michael, University of North Carolina, Charlotte, NC, USA

Abstract: In this talk we address the question: *How do we estimate the probability of something that we've never seen before?* This probability is often called the missing mass. In the context of ecological applications, it corresponds to the probability of observing a new species, while, in the context of authorship attribution studies, it corresponds to the probability that an author will use a word that he or she has not used before. Perhaps, the most famous estimator of the missing mass is Turing's formula. In this talk, we give necessary and sufficient conditions for the consistency and asymptotic normality of this formula. We then show that these conditions always hold when the distribution is regularly varying with index $\alpha \in (0, 1]$.

Statistical Inference for Misspecified Contextual Bandits

Guo, Yongyi, University of Wisconsin, Madison, WI, USA, with *Ziping Xu*, University of North Carolina, Chapel Hill, NC, USA

Abstract: Contextual bandit algorithms have transformed modern experimentation by enabling real-time adaptation for personalized treatment and efficient use of data. Yet these advantages create challenges for statistical inference due to adaptivity. A fundamental property that supports valid inference is policy convergence, meaning that action-selection

probabilities converge in probability given the context. Convergence ensures replicability of adaptive experiments and stability of online algorithms. In this paper, we highlight a previously overlooked issue: widely used algorithms such as LinUCB may fail to converge when the reward model is misspecified, and such non-convergence creates fundamental obstacles for statistical inference. This issue is practically important, as misspecified models – such as linear approximations of complex dynamic system – are often employed in real-world adaptive experiments to balance bias and variance.

Motivated by this insight, we propose and analyze a broad class of algorithms that are guaranteed to converge even under model misspecification. Building on this guarantee, we develop a general inference framework based on an inverse-probability-weighted Z-estimator (IPW-Z) and establish its asymptotic normality with a consistent variance estimator. Simulation studies confirm that the proposed method provides robust and data-efficient confidence intervals, and can outperform existing approaches that exist only in the special case of offline policy evaluation. Taken together, our results underscore the importance of designing adaptive algorithms with built-in convergence guarantees to enable stable experimentation and valid statistical inference in practice.

A Speed-Based Estimator of Signal-to-Noise Ratios

Hadjiliadis, Olympia, Hunter College, New York, NY, USA, with *Yuang Song*, Columbia University, New York, NY, USA

Abstract: We present an innovative estimator of the signal-to-noise ratio (SNR) in a Brownian motion model. That is, the ratio of the mean to the standard deviation of the Brownian motion. Our method is based on the method of moments estimation of the drawdown and drawup speeds in a Brownian motion model, where the drawdown process is defined as the current drop of the process from its running maximum and the drawup process is the current rise of the process above its running minimum. The speed of a drawdown of K units (or a drawup of K units) is then the time between the last maximum (or minimum) of the process and the time the drawdown (or drawup) process hits the threshold K. We compare our estimator to traditional ones. Numerical results show that our estimator consistently outperforms some traditional estimators but not the uniformly minimum-variance unbiased estimator. However, we discuss cases in which the statistic related to our estimator can be useful. This is when the SNR changes in a real-time observation stream and the problem is jointly detecting and estimating the pre-and-post SNR's. We finally present the asymptotic distribution of our estimator.

Time-Indexed Split Conformal Classification and Risk-Optimal Decision Making Based on Conformal Survival Prediction Sets

Haileyesus, Mesfin, University of Maryland, Baltimore County, Baltimore, MD, USA, with *Soumadeep Bhowmick*, University of Maryland, Baltimore County, Baltimore, MD, USA, *Yehenew Kifle*, University of Maryland, Baltimore County, Baltimore, MD, USA, and *Anindya Roy*, University of Maryland, Baltimore County, Baltimore, MD, USA

Abstract: Uncertainty quantification for survival predictions remains challenging in the presence of right censoring. While existing conformal approaches for survival analysis typically target event times or entire survival curves, such targets are often difficult to interpret and may require strong modeling assumptions. In this paper, we propose a conformal prediction framework for constructing time-specific prediction bands for the binary at risk indicator $Y(t) = \mathbf{1}(T > t)$. The method applies split conformal prediction to residuals based on an estimated survival function and incorporates inverse probability of censoring weighting (IPCW) to account for right-censored observations. Under independent censoring and mild regularity conditions on the censoring estimator, the resulting bands achieve asymptotically valid marginal coverage at each fixed time point, regardless of whether the assumed survival model is correctly specified. The proposed approach naturally induces time-indexed prediction sets that distinguish confident survival, confident failure, and explicit regions of uncertainty. Through extensive simulation studies, we demonstrate that the method maintains near-nominal coverage across a wide range of scenarios. In addition, we demonstrate a risk-optimal decision framework that combines conformal survival prediction set with robust decision rules. We also characterize the conditions under which robust actions agreement holds despite prediction set disagreement. An application to the METABRIC breast cancer dataset illustrates how the time-indexed prediction sets provide interpretable, subject-specific, and uncertainty-aware survival predictions. Overall, this work provide a decision-relevant conformal framework that translates valid inference to optimal downstream actions.

Change Detection via Adaptive Aggregation of Predictive Distributions

Halme, Topi, Aalto University, Espoo, Finland, with *Visa Koivunen*, Aalto University, Espoo, Finland

Abstract: We consider the problem of detecting a change in distribution when the post-change distribution is unknown. Recently, so-called adaptive change detection methods that employ a plug-in estimate of the post-change parameters based on past data to approximate the post-change distribution have received attention. We make the observation that the important quantity is the Kullback-Leibler loss of the induced approximating distribution, and distributions constructed with natural plug-in estimates can be suboptimal in this regard. Then, we propose a method that combines predictive distributions constructed from different sliding window lengths with adaptive weighting. We show that the method has smaller detection delay asymptotically (in the second-order term) than what is achievable with any single window length. The number of different window lengths used by the procedure is small, meaning that computational advantages of adaptive change detection methods are retained. Depending on the type of predictive density chosen, the method is applicable to both parametric and non-parametric problems.

Quickest Detection in High Dimension via Random Matrix Theory

Hero, Alfred, University of Michigan, Ann Arbor, MI, USA, with *Robert Malinas*, MIT Lincoln Laboratory, Lexington, MA, USA, *Benjamin Robinson*, Air Force Office of Scientific Research, Arlington, VA, USA, and *Dogyoon Song*, University of California, Davis, CA, USA

Abstract: We address the problem of detecting a change in the distribution of a high-dimensional multivariate normal time series. Assuming that the post-change parameters are unknown and estimated using a sliding window of historical data, we extend the framework of quickest change detection (QCD) to the high-dimensional setting in which the number of variables increases proportionally with the number of samples used to estimate the post-change parameters. Our analysis reveals that the high-dimensional asymptotic performance of QCD procedures is governed by an information-theoretic quantity: the Kullback-Leibler (KL) divergence between the true and estimated post-change distributions. Using random matrix theory, we express this divergence asymptotically in terms of the underlying post-change model. We further identify estimators that asymptotically minimize this KL divergence over a class of shrinkage covariance estimators, yielding a robust QCD method that provably outperforms classical approaches based on maximum likelihood estimation.

Fixed-Width Confidence Intervals Based on Maximum Likelihood Estimation from Possibly Dependent Observations

Hu, Jun, Oakland University, Rochester, MI, USA

Abstract: Under suitable regularity conditions, we develop a sequential procedure for constructing a fixed-width confidence interval (FWCI) for an unknown parameter, based on its maximum likelihood estimator (MLE) derived from a sequence of possibly dependent observations. The procedure is shown to be both asymptotically efficient and asymptotically consistent. To illustrate its applicability, we present three examples: (i) estimation of the autoregressive parameter in an AR(1) model, (ii) estimation of the exponential mean using record values, and (iii) estimation in a Markov-Bernoulli model that incorporates dependence between successive trials.

Directional Neighborhood Embeddings for Sequential Anomaly Detection in Sparse Event Count Panels

Huang, Hsin-Hsiung, University of Central Florida, Orlando, FL, USA, with *Yuh-Haur Chen*, University of Central Florida, Orlando, FL, USA, and *John Scott*, University of Central Florida, Orlando, FL, USA

Abstract: News-derived event databases generate large panels of event counts that are sparse, bursty, and strongly overdispersed, creating persistent challenges for sequential monitoring and alarm triage. We present a likelihood-based anomaly detection workflow that combines a temporal encoder that learns nonlinear dynamics from multivariate histories with a Bayesian count likelihood head that produces calibrated predictive dis-

tributions for online tail scoring.

Our key methodological addition is a directional neighborhood signal defined on the sphere. for each focal region and time point, we summarize nearby-region activity using great-circle bearings and intensity weights, yielding a circular covariate time series. These directional summaries are represented using trigonometric moment features such as mean direction and concentration, and they enter the count model through sine and cosine regression terms. This construction respects circular geometry and enables posterior inference on an interpretable preferred bearing that indicates where surrounding activity is concentrated.

For sequential detection across many simultaneous series, we compute right-tail predictive probabilities for each forecast and apply the Benjamini Hochberg procedure across the panel to produce anomaly lists with false discovery rate control. To reduce overly optimistic uncertainty from reusing learned representations in-sample, we use a two-stage procedure that freezes the encoder and fits the Bayesian likelihood head using out-of-sample embeddings that include validation-based predictions, improving tail calibration.

Simulations with directional spillover and case studies based on GDELT illustrate that directional neighborhood embeddings improve interpretability and can materially improve calibrated tail behavior relative to transformer-only baselines, producing anomaly flags that are both statistically defensible and geographically actionable.

A Study of Boosting Techniques for Quickest Change Detection

Huang, Yu-Han, University of Illinois, Urbana-Champaign, IL, USA, with *Venugopal Veeravalli*, University of Illinois, Urbana-Champaign, IL, USA

Abstract: In the problem of quickest change detection, a change detector declares a change whenever its statistic surpasses some threshold. The choice of this threshold can be conservative due to the possibility of the statistic overshooting the threshold at the stopping time. To improve the looseness induced by the overshoot, a boosting technique is proposed to improve change detectors under various optimality criteria. The boosted variants of the change detectors attain smaller detection delay with more precise false alarm control without imposing additional computational complexity per step. Although the boosting technique improves performance in theory, our numerical results for a variety of pre- and post-change distributions demonstrate that the boosting technique does not improve the tradeoff between detection delay and false alarm.

Eigenvector Perturbation Approaches to Profile Monitoring

Iguchi, Takayuki, Air Force Institute of Technology, Wright-Patterson Air Force Base, OH, USA, with *Andres F Barrientos*, Florida State University, Tallahassee, FL, USA, *Eric Chicken*, Florida State University, Tallahassee, FL, USA, and *Debajyoti Sinha*, Florida State University, Tallahassee, FL, USA

Abstract: In Statistical Process Control, control charts are often used to detect undesirable behavior of sequentially observed quality characteristics. Designing a control chart with desirably low False Alarm Rate (FAR) and detection delay (ARL_1) is an important challenge especially when the sampling rate is high and the control chart has an In-Control Average Run Length, called ARL_0, of 200 or more, as commonly found in practice. Unfortunately, arbitrary reduction of the FAR typically increases the ARL_1. Motivated by eigenvector perturbation theory, we propose the Eigenvector Perturbation Control Chart for computationally fast nonparametric profile monitoring. Our simulation studies show that it outperforms the competition and achieves both $ARL_1 \approx 1$ and $ARL_0 > 10^6$.

Bayesian Adaptive Designs

Irony, Telba, Johnson & Johnson, Titusville, NJ, USA

Abstract: Bayesian Adaptive Designs provide a flexible and principled framework for incorporating accumulating evidence into clinical trial decision-making. This session will discuss key concepts underlying Bayesian adaptive approaches, including interim analyses, information borrowing, and dynamic learning throughout a study. Practical considerations, advantages, and potential applications in modern drug development will be discussed, along with updates from the new FDA draft Bayesian guidance document, highlighting how Bayesian methods can improve efficiency while maintaining scientific rigor and regulatory alignment

Optimal Two-Stage Biomarker-Stratified Designs with Enrichment

Ivanova, Anastasia, University of North Carolina, Chapel Hill, NC, USA

Abstract: We consider biomarker-stratified trials with a pre-defined targeted patient group, the biomarker-positive subgroup. The goal is to evaluate the treatment effect in the biomarker-positive subgroup and in the overall population. We discuss optimality criteria for these designs and describe optimal two-stage designs. We give as an example PrecISE, a biomarker-stratified clinical trial in patients with severe asthma, where the optimal two-stage design was used.

Adaptive Shrinkage Estimation for Dose-Toxicity Relationships in Small Sample Settings

Jiang, Fangfang, University of Iowa, Iowa City, IA, USA, with *Emine Bayman*, University of Iowa, Iowa City, IA, USA, and *Gideon Zamba*, University of Iowa, Iowa City, IA, USA

Abstract: Dose-escalation designs such as the continual reassessment method (CRM) typically rely on a prespecified working dose-toxicity model to support inference on dose-limiting toxicity probabilities and to estimate the maximum tolerated dose (MTD). In small-sample phase I trials, misspecification of the working model can distort toxicity probability estimation and compromise escalation decisions when early data are sparse. We propose a Bayesian semi-parametric extension of CRM that adaptively balances prior

information from a parametric working model with data-driven flexibility. The dose-toxicity relationship is modeled using a monotone I-spline basis, which enforces a non-decreasing toxicity curve by construction. To preserve the practical strengths of CRM, we introduce an adaptive shrinkage prior on spline coefficients that shrinks the semi-parametric curve toward the user-selected working model and stabilizes extrapolation to untried doses. A separate smoothing component penalizes excessive local variation, while the shrinkage mechanism allows departures from the working model when supported by observed outcomes. Posterior inference is obtained via efficient Markov chain Monte Carlo (MCMC) with Polya-Gamma augmentation for binary toxicity endpoints and constrained updating to maintain monotonicity. The resulting framework yields posterior toxicity estimates for all candidate doses after each cohortâ€™s outcomes are observed and can be embedded within standard dose-escalation rules to guide escalation, de-escalation, or retention without requiring strict adherence to a parametric form, providing a robust and practical approach to dose finding in small-sample clinical trials.

Multi-Step Estimators and Shrinkage Effect in Time Series Models

Killick, Rebecca, Lancaster University, Lancaster, United Kingdom

Abstract: Many modern statistical models are used for both insight and prediction when applied to data. When models are used for prediction, one should optimize parameters through a prediction error loss function. Estimation methods based on multiple-step-ahead forecast errors have been shown to lead to more robust and less biased estimates of parameters. However, a plausible explanation of why this is the case is lacking. In this talk, we provide this explanation, showing that the main benefit of these estimators is in a shrinkage effect, happening in univariate models naturally. However, this can introduce a series of limitations due to overly aggressive shrinkage. We discuss the predictive likelihoods related to the multistep estimators and demonstrate what their usage implies for time series models. To overcome the limitations of the existing multiple-step estimators, we propose the Geometric Trace Mean Squared Error, demonstrating its advantages. We conduct a simulation experiment showing how the estimators behave with different sample sizes and forecast horizons. Finally, we carry out an empirical evaluation on real data, demonstrating the performance and advantages of the estimators. Given that the underlying process to be modelled is often unknown, we conclude that the shrinkage achieved by the GTMSE is a competitive alternative to conventional ones.

From Theory to Decision: a Journey with Sequential Methods in Clinical Trials

Kim, Dong-Yun, NIH National Heart, Lung, and Blood Institute, Bethesda, MD, USA

Abstract: Fully sequential methods offer a principled framework for real-time decision-making as data accrue. My journey with sequential methodology began in nonlinear renewal theory and evolved significantly after joining the National Institutes of Health

(NIH). Working closely with clinical trial teams shifted my focus from asymptotic theory to practical questions When and why should we stop? How can we allow early decisions without impacting Type I and Type II errors? What are the ethical implications?

Although sequential designs once faced barriers due to random sample sizes and concerns about early stopping, modern adaptive design and continuous monitoring have renewed their relevance. Sequential methodology embodies a philosophy of learning as we go—an approach essential for real-time adaptation, dynamic monitoring, and ethical decision-making in the era of big data and AI.

In this talk, I will discuss some of the recent developments in fully sequential methods with focus on continuous event-rate monitoring and design of two-arm trials with multi-sites whose primary endpoint is time-to-event data. I will also briefly mention practical use of sequential confidence intervals for other endpoints.

How Far Does War Reach? Sequential Detection of Conflict-Language Spillover into Apolitical Reddit Communities

Kim, Long, Denison University, Granville, OH, USA

Abstract: When Russia invaded Ukraine on 24 February 2022, discussion of the war immediately dominated political forums. Yet, how quickly did conflict language appear in online communities organized around cooking, fitness, personal finance, and relationships? We treat this as a multi-stream sequential change-point detection problem. We monitor K = 12 non-political subreddits for changes in the daily proportion of posts containing conflict-related keywords (a curated lexicon of 45 terms including "Ukraine," "Russia," "Putin," "NATO," "Kyiv," and related vocabulary). Each subreddit is monitored with a one-sided CUSUM detector calibrated against a 90-day pre-invasion baseline. The key methodological challenge is controlling false alarms across K simultaneous streams while exploiting the known invasion date as a temporal anchor. We apply Bonferroni-adjusted Lan-DeMets alpha-spending that concentrates the error budget in a 60-day post-anchor window, with thresholds calibrated via permutation resampling of the pre-anchor period. This approach requires no parametric distributional assumptions on the text-derived signal. Unlike retrospective tests that assume a known change-point, the sequential framework estimates when each community first shows a detectable signal, producing the detection delay as a continuous measurement rather than a binary present/absent classification. We report the detection delay - the number of days between the invasion and the first statistically significant CUSUM signal for each subreddit, producing a permeability ranking of communities to international crises. Preliminary results show substantial heterogeneity: subreddits with broad topical scope (r/AskReddit) show detectable spillover within 3 days, while narrowly focused communities (r/cooking, r/fitness) show delayed or undetectable signals. The permeability ranking suggests that community topical breadth, rather than user base size, predicts vulnerability to crisis-discourse intrusion, with implications for platform moderation policies during international crises.

Identification of Emotionally Stressful Periods Through Tracking Changes in Statistical Features of Health Data

Kim, Younghoon, Cornell University, Ithaca, NY, USA, with *Sumanta Basu*, Cornell University, Ithaca, NY, USA, and *Samprit Banerjee*, Weill Cornell Medicine, New York, NY, USA

Abstract: Identifying the onset of emotional stress in older patients with mood disorders and chronic pain is important in mental health research. Studying the relationship between passively sensed physical activity measurements and self-reported stress levels collected via mobile devices offers a promising approach. In our previous study (Kim et al., 2025), we combined change point detection (CPD) with sequential hypothesis testing to explain changes in stress levels associated with physical activity measures. The resulting segments help improve stress prediction using conventional machine learning (ML) methods. However, this approach is limited when multiple types of changes occur simultaneously and when delays exist between activity and stress changes. Moreover, the model linking these variables must be assumed, which is challenging, unlike physiological sensing data that rely on predetermined decision rules defined by clinical experts. In follow-up work, we propose a new algorithm to detect time intervals during which distributional shifts in passive sensing variables are likely associated with changes in stress levels, using a moving sum (MOSUM)-type CPD framework. We also develop a data-driven decision rule based on signed iterative random forests (s-iRF) to predict stress status from tracked changes in statistical features. Simulation studies under mixed and asynchronous distributional shifts show that the extended MOSUM framework outperforms benchmark methods. The s-iRF based decision rule achieves improved predictive performance over other ML methods with interpretable results. We further apply our methods to ALACRITY Phase I data to identify time points of distributional shifts in targeted patients and to explain the dynamics between variables.

Higher-Criticism for Sparse Multi-Stream Change-Point Detection: Optimality and Delay Bounds

Kipnis, Alon, Reichman University, Herzliya, Israel, with *Tingnan Gong*, Georgia Institute of Technology, Atlanta, GA, USA, and *Yao Xie*, Georgia Institute of Technology, Atlanta, GA, USA

Abstract: We consider the problem of quickest change-point detection in a multi-stream setting, where a distributional change may occur at an unknown time and affect only a small, unknown subset of streams. To address this sparse regime, we propose a procedure based on higher criticism (HC), which aggregates evidence from individual stream-wise change-point tests. Beyond detection, the HC thresholding step naturally identifies a subset of streams likely affected by the change.

We analyze the proposed method under a sparse heteroscedastic normal change-point model. We establish an information-theoretic lower bound on the detection delay for

procedures based on likelihood ratio and generalized likelihood ratio statistics, and show that the delay of the HC-based procedure converges in distribution to this bound. In the homoscedastic case, the bound recovers known optimal results (e.g., Optimal Sequential Detection in Multi-Stream Data).

Numerical experiments demonstrate that the HC-based method outperforms existing approaches in detecting sparse changes.

An Optimal Dynamic Treatment Regime Estimator for Indefinite-Horizon Survival Outcomes

Kosorok, Michael, University of North Carolina, Chapel Hill, NC, USA, with *Jane She*, University of North Carolina, Chapel Hill, NC, USA, and *Matthew D. Egberg*, University of North Carolina, Chapel Hill, NC, USA

Abstract: We propose a method for indefinite-horizon settings for estimating optimal dynamic treatment regimes for time-to-event outcomes. This method allows patients to have different numbers of treatment visits and is constructed using generalized survival random forests to maximize mean survival time. We use summarized history and data pooling, preventing data from growing in dimension as the number of decision points increases. The algorithm operates through model re-fitting, resulting in a single model optimized for all patients and all visits. We derive theoretical properties of the estimator such as consistency of the estimator and value function and characterize the number of refitting iterations needed. We also conduct a simulation study with a flexible number of treatment stages to examine finite-sample performance of the estimator. Finally, we illustrate use of the method with administrative insurance claims data for pediatric Crohn's disease patients.

Adaptive Respondent-Driven Sampling via Reinforcement Learning

Laber, Eric, Duke University, Durham, NC, USA, with *Justin Weltz*, Santa Fe Institute, Santa Fe, NM, USA, and *Alex Volfovsky*, Duke University, Durham, NC, USA

Abstract: Respondent-driven sampling (RDS) is widely used to study hidden or hard-to-reach populations by incentivizing study participants to recruit their social connections. The success and efficiency of RDS can depend critically on the nature of the incentives, including their number, value, call to action, etc. Standard RDS uses an incentive structure that is set *a priori* and held fixed throughout the study. Thus, it does not make use of accumulating information on which incentives are effective and for whom. We propose a reinforcement learning (RL) based adaptive RDS study design in which the incentives are tailored over time to maximize cumulative utility during the study. We show that these designs are more efficient, cost-effective, and can generate new insights into the social structure of hidden populations. In addition, we develop methods for valid post-study inference which are non-trivial due to the adaptive sampling induced by RL as well as the complex dependencies among subjects due to latent (unobserved) social network

structure. We provide asymptotic regret bounds and illustrate its finite sample behavior through a suite of simulation experiments.

Learning When and Where Clinical Interventions Work

Laha, Nilanjana, Texas A&M University, College Station, TX, USA

Abstract: Modern biomedical studies increasingly rely on complex observational data, such as electronic health records (EHR), to evaluate the effectiveness of clinical and public health interventions. However, drawing causal conclusions from such data is challenging due to confounding, treatment heterogeneity, and model misspecification. In this talk, I will discuss flexible statistical methods for optimal decision-making using medical data, focusing on the case where the treatment can vary with time. I will discuss how AI and statistical learning tools can be used to identify subgroups that benefit most from an intervention using observational data.

Provably Efficient Risk-Sensitive Online Reinforcement Learning with Human Feedback

Lai, Lifeng, University of California, Davis, CA, USA, with *Xinyi Ni*, University of California, Davis, USA

Abstract: Unlike standard Reinforcement Learning (RL) that relies directly on reward signals, reinforcement learning with human feedback (RLHF) integrates human feedback into the decision-making process. This paper introduces an online risk sensitive RLHF framework that integrates static Conditional Value-at-Risk (CVaR), ensuring policy alignment with human defined risk preferences. We propose a black-box reward estimation method for tabular Markov Decision Processes (MDPs) that integrates seamlessly with existing CVaR RL algorithms. While preserving the sample complexity of the base solver, our method incurs only a human feedback query complexity that is linear with Eluder dimension of the reward function class for trajectory-based comparisons, and scales as SAH^2 for state action-based comparisons. We extend our framework to low-rank MDPs and develop a maximum likelihood estimator (MLE)- based reward inference method. Regret analysis are provided to guarantee the computational efficiency.

Time-Series Conformal Prediction with Optimal Weights

Lee, Jonghyeok, Georgia Institute of Technology, Atlanta, GA, USA, with *Chen Xu*, Toyota Research Institute, Atlanta, GA, USA, and *Yao Xie*, Georgia Institute of Technology, Atlanta, GA, USA

Abstract: In this work, we present a novel conformal prediction method for time-series, which we call Kernel-based Optimally Weighted Conformal Prediction Intervals (KOWCPI). Specifically, KOWCPI adapts the classic Reweighted Nadaraya-Watson (RNW) estimator for quantile regression on dependent data and learns optimal data-adaptive weights. Theoretically, we tackle the challenge of establishing a conditional coverage guarantee for

non-exchangeable data under strong mixing conditions on the non-conformity scores. We demonstrate the superior performance of KOWCPI on real and synthetic time-series data against state-of-the-art methods, where KOWCPI achieves narrower confidence intervals without losing coverage.

MRPE Problems for a Function Involving an Unknown Scale Parameter under a Gamma Distribution with Known-Shape Parameter

Li, Jing, University of Maryland, Baltimore County, Baltimore, MD, USA, with *Nitis Mukhopadhyay*, University of Connecticut, Storrs, CT, USA

Abstract: In this talk, I will present a general multi-stage sampling strategy to address MRPE (Minimum Risk Point Estimation) problems for a function involving an unknown scale parameter within a Gamma population, assuming the shape parameter is known. We approach the problem under the SEL (Squared Error Loss) framework, incorporating sampling costs. First, I will outline a foundational theoretical structure, derived under general conditions on the function and additional sufficient conditions for the multi-stage strategy itself. I will also discuss the asymptotic first-order efficiency of the proposed MRPE strategy, which our paper demonstrates to meet the asymptotic risk efficiency criteria. Furthermore, I will introduce purely sequential, accelerated sequential, and three-stage estimation strategies, each of which achieves both first-order and asymptotic risk efficiency under general conditions. The talk will also include extensive data analysis from simulations, along with illustrative application using a bone marrow transplant (BMT) dataset. Lastly, I will present potential extensions of the MRPE framework, including sampling strategies for analogous problems under mixture-gamma distributions, demonstrating how these strategies fit into the broader context of related statistical challenges.

Is Grouping Always Detrimental to Monitoring Multinomial Data?

Li, Jun, University of California, Riverside, CA, USA, with *Yajun Mei*, New York University, New York, NY, USA

Abstract: Monitoring processes with multi-category outcomes is critical in many domains, including manufacturing, healthcare, and public health. Two natural approaches for such monitoring are: (1) using a full multinomial CUSUM chart, or (2) grouping the categories and applying Bernoulli CUSUM charts to the resulting binary outcomes. A common belief is that grouping would lead to a loss of information and thus inferior monitoring performance. In this talk, we critically examine this belief by asking: Is grouping always detrimental to monitoring multinomial data? Our findings reveal a nuanced answer that depends on the degree of prior knowledge about the true post-change category probabilities. When strong prior knowledge is available, grouping does lead to a loss in efficiency, with the multinomial CUSUM chart outperforming the Bernoulli CUSUM charts. However, in more realistic scenarios where such knowledge is limited or unavailable, grouping can actually enhance monitoring performance. In particular, adaptive Bernoulli CUSUM

charts often outperform their multinomial counterparts under these conditions. Through both theoretical insights and extensive simulations, we demonstrate that grouping, when paired with adaptivity, can unexpectedly improve detection performance. These results challenge long-held assumptions in statistical process control and point to new strategies for effective and robust monitoring of multinomial processes in real-world applications.

Optimal Detection for Language Watermarks with Pseudorandom Collision: Connections to Ehr Data Curation and Quality Control in Generative AI

Li, Xiang, University of Pennsylvania, Philadelphia, PA, USA, with *Tony Cai*, University of Pennsylvania, Philadelphia, USA, *Qi Long*, University of Pennsylvania, Philadelphia, PA, USA, *Weijie Su*, University of Pennsylvania, Philadelphia, PA, USA, and *Garrett Wen*, Yale University, New Haven, CT, USA

Abstract: Text watermarking plays a crucial role in ensuring the traceability and accountability of large language model (LLM) outputs and mitigating misuse. Beyond traceability, watermarking provides a principled tool for data provenance and quality control in generative AI systems. It enables detection of synthetic contamination in large-scale training pipelines and certification of controlled generation in AI-assisted documentation, such as EHR curation. While promising, most existing methods assume perfect pseudorandomness. In practice, repetition in generated text induces collisions that create structured dependence, compromising Type I error control and invalidating standard analyses.

We introduce a statistical framework that captures this structure through a hierarchical two-layer partition. At its core is the concept of minimal units—the smallest groups treatable as independent across units while permitting dependence within. Using minimal units, we define a non-asymptotic efficiency measure and cast watermark detection as a minimax hypothesis testing problem. Applied to Gumbel-max and inverse-transform watermarks, our framework produces closed-form optimal rules. It explains why discarding repeated statistics often improves performance and shows that within-unit dependence must be addressed unless degenerate. Both theory and experiments confirm improved detection power with rigorous Type I error control. These results provide the first principled foundation for watermark detection under imperfect pseudorandomness, offering both theoretical insight and practical guidance for reliable tracing of model outputs.

Guaranteed Estimation Method for Semi-Markov Processes in Continuous Time

Limnios, Nikolaos, Universite de Technologie de Compiegne, Compiegne, France, with *Serguei Pergamenchtchikov*, Universite de Rouen Normandie, Rouen, France

Abstract: In this talk, for the first time, sequential procedures are proposed for the problem of estimating the kernel of semi-Markov processes observed in continuous time, which provides guaranteed fixed non-asymptotic estimation accuracy. for this purpose, we use the sequential analysis approach developed by Borisov and Konev (1977) for the parameter identification problem of stochastic dynamic systems. First, we construct sequential procedures based on the empirical estimator. It should be noted that the usual empirical estimator in a non-sequential setting is a nonlinear function of observations, and it is not possible to study this estimator in the non-asymptotic framework. Through the sequential analysis method, this non-linear estimator is transformed into a linear one. Then, using the stopping time techniques for the martingales, one shows that the proposed sequential procedures provide non-asymptotic guaranteed mean square accuracy of estimation. Furthermore, using the properties of geometric ergodicity of the semi-Markov model, some properties of the stopping time of observations are studied, and, in particular, sharp upper bounds are obtained for its mean, which asymptotically determine the optimal convergence rate.

A Sequential Pasting Strategy for Recapitulating Whole-Genome 3D Structure Using Hi-C Data

Lin, Shili, The Ohio State University, Columbus, OH, USA

Abstract: The three-dimensional (3D) spatial organization of the genome is closely linked to biological function and can be captured by Hi-C assays through interrogating genome-wide chromatin interactions. Methodologies for inferring 3D structures from Hi-C data, summarized as a two-dimensional (2D) contact matrix, include sampling-based methods. These are probabilistic model-based approaches that can account for features inherent in Hi-C data, including dependency, heterogeneity, over-dispersion, and sparsity. However, whole-genome 3D structure recapitulation is too computationally expensive for current sampling-based methods. While a chromosome-by-chromosome strategy is an option, it ignores important information from inter-chromosomal contacts. To address these issues, we propose the truncated Random effect EXpression-cut and paste (tREX-cap) method, which applies the tREX model alongside a sequential pasting strategy. This method inherits the data-feature-cognizant properties of tREX while efficiently inferring the whole-genome 3D structure. We demonstrate the performance of tREX-cap through an extensive simulation study and an analysis of a Hi-C lymphoblastoid dataset.

Assessing Compositional Equivalence: Univariate and Multivariate Frameworks for Food Safety

Liu, Bo, University of Maryland, Baltimore County, Baltimore, MD, USA, with *Thomas Mathew*, University of Maryland, Baltimore County, Baltimore, MD, USA

Abstract: Foods derived from genetically modified (GM) crops may be placed on the market only after they have been demonstrated to be safe for human health and the environment. Regulatory safety assessments typically adopt a comparative approach, in which the compositional and agronomic characteristics of a GM genotype are compared with those of appropriate reference genotypes that have a documented history of safe use. Statistical equivalence testing plays a central role in such comparative assessments. However, phenotypic and compositional data collected in field trials are inherently multivariate, involving measurements on numerous correlated endpoints that must be jointly evaluated to support a single regulatory decision regarding equivalence. Despite the growing number of applications for regulatory approval of GM crops, there remains a lack of statistically robust and powerful methods for establishing equivalence in this multivariate setting. In this study, we propose a new, interpretable equivalence criterion for the safety evaluation of GM crops based on multi-site randomized complete block field designs. The proposed approach facilitates the integration of multiple phenotypic variables into a unified equivalence assessment. Simulation studies demonstrate that the proposed procedure maintains the statistical power across a wide range of scenarios, including unbalanced designs commonly encountered in practice. The strengths and limitations of the proposed method are discussed, and its practical applicability is illustrated using real-world field trial data.

Causal Inference in the Closed-Loop: Marginal Structural Models for Sequential Excursion Effects

Loewinger, Gabriel, National Institute of Mental Health (NIMH), NIH, Bethesda, MD, USA, with *Alex W. Levis*, University of Pennsylvania, Philadelphia, PA, USA, and *Francisco Pereira*, National Institute of Mental Health (NIMH), NIH, Bethesda, MD, USA

Abstract: Optogenetics is widely used to study the effects of neural circuit manipulation on behavior. However, the paucity of causal inference methodological work on this topic has resulted in analysis conventions that discard information, and constrain the scientific questions that can be posed. To fill this gap, we introduce a nonparametric causal inference framework for analyzing "closed-loop" designs, which use dynamic policies that assign treatment based on covariates. In this setting, standard methods can introduce bias and occlude causal effects. Building on the sequentially randomized experiments literature in causal inference, our approach extends history-restricted marginal structural models for dynamic regimes. In practice, our framework can identify a wide range of causal effects of optogenetics on trial-by-trial behavior, such as, fast/slow-acting, dose-response, additive/antagonistic, and floor/ceiling. Importantly, it does so without requiring negative controls, and can estimate how causal effect magnitudes evolve across time points. From another view, our work extends "excursion effect" methods—popular in the mobile health literature—to enable estimation of causal contrasts for treatment sequences greater than length one, in the presence of positivity violations. We derive rigorous statistical guarantees, enabling hypothesis testing of these causal effects. We demonstrate our approach on data from a recent study of dopaminergic activity on learning, and show how our method reveals relevant effects obscured in standard analyses.

Multiple-Experiment Quickest Change Detection under Cost Constraints

Lubenia, Patrick, University of Pittsburgh, Pittsburgh, PA, USA, with *Taposh Banerjee*, University of Pittsburgh, Pittsburgh, PA, USA

Abstract: Classical models of quickest change detection typically involve a single experiment used to monitor a stochastic process. This study considers the scenario where, at every observation time, a decision-maker must select from a variety of experiments, each characterized by distinct information qualities and associated costs. The primary objective is to minimize the worst-case average detection delay while adhering to constraints on false alarm and cost constraints. To this end, the 2E-CUSUM algorithm is introduced for scenarios involving two experiments. The study further explores more complex designs involving multiple experiments, extending the 2E-CUSUM framework accordingly. The proposed algorithms are demonstrated to be asymptotically optimal.

How Many Extreme Scores Are Distinct in Large Random Round-Robin Tournaments?

Malinovsky, Yaakov, University of Maryland, Baltimore County, Baltimore, MD, USA

Abstract: Round-robin tournament models arise naturally in ranking systems, paired comparisons, sports competitions, and related stochastic models. In this talk, we study the extreme scores in large random tournaments with equally strong players.

We focus on the following question: how many of the extreme scores are distinct with high probability as the number of players grows? We show that, under a broad class of tournament models, including classical win-loss competitions, models with ties, and more general scoring rules, a surprisingly large number of the top scores are distinct with probability tending to one.

The analysis combines probabilistic methods from large deviations, concentration inequalities, and negative dependence theory. The results also reveal interesting connections and contrasts with classical questions on extreme degree sequences in random graphs.

General Purpose Score-Based Time Series Segmentation

McGonigle, Euan, University of Southampton, Southampton, United Kingdom, with *Haeran Cho*, University of Bristol, Bristol, United Kingdom, *Claudia Kirch*, Otto von Guericke Universität, Magdeburg, Germany, and *Niclas Stoffregen*, Otto von Guericke Universität, Magdeburg, Germany

Abstract: In time series analysis, many data sets of practical interest contain abrupt changes in structure, such as the canonical setting of change points in the mean. We propose new methodology based on estimating functions in a general framework for detection of change points in the model parameters of a multivariate time series, including scenarios such as change in mean, regression, and potentially nonlinear autoregression. We propose a two-stage method; in the first stage, a multiscale scanning step produces initial change point estimators, which are used to define optimally sized intervals in the sense that they are as large as possible and each contain only one true change point. In

the second step, a cumulative sum (CUSUM)-based approach refines the initial change point estimators using the intervals generated in step one. The proposed approach is computationally efficient, suitable for heavy-tailed and dependent time series, and is robust to model misspecification. The theoretical properties of the procedure are examined, and the flexibility of the method is illustrated by applying it to a data example from the environmental sciences.

The Kiefer-Weiss-Lorden-Lai (KWLL) Minimax Framework for Interim Evaluation of Efficacy and Futility

Mei, Yajun, New York University, New York, NY, USA

Abstract: Futility analysis provides an important mechanism for improving efficiency and reducing costs in group-sequential designs. The existing main statistical tool is the conditional power method, which is intuitively appealing but might sacrifice statistical optimality. Here we provide a new Kiefer-Weiss-Lorden-Lai (KWLL) minimax framework for jointly evaluating efficacy (rejecting the null hypothesis) or futility (accepting the null hypothesis). The core idea is to embed Lorden's 2-SPRT test within the Kiefer-Weiss optimization problem under Lai's formulation, which controls Type I error probability and the maximum sample size while treating the alternative hypothesis space as a design parameter. Hopefully the proposed KWLL paradigm will offer new methodological tools and insights for efficient group-sequential designs in clinical trials.

Off-Policy Evaluation for Missingness-Aware Policies in Markov Decision Processes with Rewards Missing not at Random

Miao, Rui, University of Texas at Dallas, Richardson, TX, USA

Abstract: In offline Reinforcement Learning, immediate rewards in logged batch data are often unobserved due to sparse or irregular record-keeping, or censored beyond certain reward values. This issue arises in practical settings, including health care and marketing. We investigate off-policy evaluation (OPE) in finite-horizon Markov decision processes when rewards are missing not at random (MNAR), which breaks ignorability and induces selection bias even after conditioning on states and actions. To address this, we formalize a reward-dependent propensity model and use future states as shadow variables to identify the full-data conditional mean reward. We further introduce a bridge function that recovers the conditional mean reward without explicitly modeling the MNAR mechanism, and estimate it via a min-max procedure to avoid double sampling. Building upon these identification results, we propose a Fitted-Q-Evaluation-style estimator that propagates the recovered rewards while allowing target policies to depend on past missingness indicators. Finally, we establish consistency and finite-sample error bounds for our OPE estimator, and show through simulations the strong performance of our method compared to existing benchmarks.

A Three-Stage Adaptive Design to Select the Most Effective Treatment and

Estimate its Mean Effect

Misra, Neeraj, Indian Institute of Technology, Kanpur, India, with *Yogesh Katariya*, Indian Institute of Technology, Kanpur, India

Abstract: Most two-stage adaptive designs provide a framework for selecting the most promising experimental treatment in an interim analysis, followed by a confirmatory evaluation in the second stage. However, eliminating all but the single best-performing treatment at the interim stage carries a risk that the apparently superior treatment may not, in fact, be the most effective. Retaining multiple promising treatments mitigates the possibility of prematurely discarding the true best treatment due to random fluctuations or limited interim information. In this paper, we consider a three-stage adaptive design for $k(\geq 2)$ treatments that permits pre-planned modifications during the trial based on the data accumulated up to each stage. The proposed design involves eliminating low-efficacy treatments at the interim stage, selecting one treatment from the remaining options as the best candidate, and subsequently estimating the mean effect of the treatment identified as the best. We assume that the treatment effects are described by independent Gaussian responses with unknown means and a common variance. To understand the structure of an optimal estimator, we initially assume that the common variance is known and that the total sample size is fixed in advance. In view of the importance of controlling bias in clinical trials, we derive the uniformly minimum variance conditionally unbiased estimator (UMVCUE) of the mean effect of the final selected treatment conditioned on the set of indices selected at the first and second stages. Since the UMVCUE cannot be expressed in a closed form in some cases (involving intractable double integrals under multiple sums), we propose a Monte Carlo simulation-based method for obtaining the UMVCUE. We compare the mean squared error (MSE) and bias performances of the UMVCUE with competing estimators through simulation studies. A real-life data example is also presented to illustrate the practical application of our results.

A Grid-Based Methodology for Fast Online Changepoint Detection

Moen, Per August Jarval, University of Oslo, Oslo, Norway

Abstract: We propose a grid-based methodology for online changepoint detection that allows offline changepoint tests to be applied to sequentially observed data. The methodology achieves low update and storage costs by testing for changepoints over a dynamically updating grid of candidate changepoint locations. for a broad class of test statistics, including those based on empirical averages and likelihood ratios, the resulting online procedure has update and storage costs that grow at most logarithmically with the sample size. Moreover, finite-sample power guarantees for the offline test translate directly into non-asymptotic upper bounds on the online detection delay, under a mild robustness assumption. Building upon the methodology, we construct methods for detecting changes in the mean and in the covariance matrix of multivariate data, and prove near-optimal non-asymptotic upper bounds on their detection delays. The effectiveness of the method-

ology is supported by a simulation study, where we compare its performance for detecting mean changes with that of state-of-the-art online methods.

Robust and Transparent Fraud Detection: Integrating Adversarial Machine Learning with Explainable AI

Moharir, Akshata, Microsoft, Portland, OR, USA, with *Divya Nayak*, George Washington University, Washington, DC, USA

Abstract: Fraud detection systems powered by machine learning have become indispensable across industries including e-commerce, insurance, healthcare, telecommunications, and digital platforms. However, these systems face two fundamental challenges: vulnerability to adversarial attacks where bad actors deliberately manipulate inputs to evade detection, and the opacity of complex models that hinders trust, accountability, and continuous improvement. This presentation explores the integration of Adversarial Machine Learning (AML) techniques with Explainable AI (XAI) methods to build fraud detection systems that are both robust against sophisticated evasion attempts and transparent in their decision-making. We examine how adversarial training can harden models against manipulation while XAI techniques such as SHAP and LIME provide interpretable explanations that enable human oversight and system refinement. The synergy between these approaches offers a pathway toward fraud detection systems that organizations can trust, stakeholders can audit, and analysts can continuously improve.

Sequential Estimation Made Easy and More Practical: Big Data Perspectives

Mukhopadhyay, Nitis, University of Connecticut, Storrs, CT, USA

Abstract: We focus on rather complicated (i.e., technically very inconvenient) expression of a parametric function by beginning with its fixed-sample-size UMVUE. One may want to construct a fixed width confidence interval (FWCI) or the minimum risk point estimation (MRPE) for such a parametric function of interest. Often these require individualized sequentially designed sampling strategies for gathering appropriate data. The existing literature is vast and the ensuing technicalities are too many to enumerate. A general class of unified theory of simple-to-implement sequential methodologies has been developed (Mukhopadhyay and Zhang 2025, Journal of Statistical Theory and Practice, 19, 18, pp. 1-56, https://doi.org/10.1007/s42519-024-00424-0) along with associated first-order and second-order asymptotic properties. In this presentation, we will illustrate some especially complicated sequential estimation problems under big data perspectives. We will briefly explore the extent of help that may be rendered by normal approximations in our understanding of some of the ensuing data analysis. This presentation is based on some follow-up joint research with a former Ph.D. student, Dr. Boyi Zhang.

Sequential Guaranteed Estimation for the Cox-Ingersoll-Ross Models Based on Discrete Observations

Ngo, Thi Bao Tram, University of Evry Val d'Essonne, Evry, France

Abstract: We consider the estimation of the parameters in the drift of the Cox-Ingersoll-Ross (CIR) process. Based on a sequential analysis approach, we develop a new truncated estimation method based on observations over a fixed time interval of the CIR process, whose diffusion coefficient is unbounded and non-Lipschitz. We propose explicit-form estimators for these parameters, which are proven to have a guaranteed non-asymptotic mean square estimation accuracy. Moreover, using asymptotic analysis methods, we show that the proposed truncated guaranteed procedures are optimal in the minimax sense for local and general quadratic risks. Numerical simulations supporting our theoretical results are also provided.

Intrusion Detection Using PEM and Connection with Domain Shifts

Nguyen, May, National Geospatial-Intelligence Agency, Arlington, VA, USA, with *Jiayang Sun*, George Mason University, Fairfax, VA, USA

Abstract: With the rapid growth of technology and global communication, network traffic and security threats have increased substantially. As a result, Intrusion Detection Systems (IDS) based on artificial intelligence, machine learning, and statistical methods must be continuously improved to detect malicious attacks. We present a novel approach, PEMID (pronounced as PEM-ID) for intrusion detection when new data streams are introduced into an existing source. PEMID builds on the Partial Expectation-Maximization (PEM) algorithm (Sun, Liu & Chen, 2025) to efficiently update parameter estimates in finite mixture models, when the number of components is unknown or changes as new data arrive. This approach reduces computational cost for large datasets and enables the detection of both known and emerging anomalies. PEMID has two versions. PEMID1 identifies existing and new anomalies in incoming data, delivered in batches. PEMID2 provides detection when new anomaly samples are sparse. We validate PEMID through simulation studies and comparisons with AI-based methods, and apply it to fault detection and to a newly collected IoT dataset. Future work will explore integration with language models. In the context of data shifts, our PEMID addresses domain shifts where label spaces may expand.

An Improved False Discovery Estimate for Variable Selection

Nguyen, Yet, Old Dominion University, Norfolk, VA, USA, with *Farzana Noorzahan*, Old Dominion University, Norfolk, VA, USA, and *Hyeongseon Jeon*, University of Houston, Houston, TX, USA

Abstract: Recent work by Luo, Fithian, and Lei (2024) provides a false discovery rate (FDR) estimation procedure for variable selection methods such as LASSO, forward stepwise regression, etc. Their estimator serves as a companion to cross-validation prediction error in assessing the performance of variable selection methods. In this work, we propose an improved version of this estimator that is less biased than the original approach.

Sequential Changepoint Detection Based on Energy Statistics

Ning, Wei, Bowling Green State University, Bowling Green, OH, USA, with *Joseph Njuki*, Coastal Carolina University, Conway, SC, USA

Abstract: In this talk, we propose a sequential nonparametric test based on windowed energy statisticsÂ (Szekely and Rizzo, 2013) to detect changes in the distribution of independent random variables. The proposed method is simple and does not rely on the choice of kernel such as U-statistic-based tests to detect any distributional changes regardless of type. In addition, the method does not require the parametric assumptions for both the null and alternative distributions. We illustrate that the proposed method outperforms other existing methods in the sequential testing procedure in terms of the false-alarm rate and power through simulations. We then apply the method to the problem of detecting radiological anomalies using datasets provided by Padila et al. (2019) for the background gamma-radiation spectrum on a large university campus. We observe a success in improving the time-to-detection for any type of radiological anomalies.

Dynamic Calibration of Computer Models

Park, Chiwoo, University of Washington, Seattle, WA, USA, with *Yang Xu*, University of Washington, Seattle, WA, USA

Abstract: We present a new method for calibrating computer models using field observations when the underlying physical system experiences a combination of abrupt and gradual (ramp) changes. This work is motivated by the need to calibrate computer-model-based digital twins in the presence of evolving physical system counterparts. We empirically validate the proposed method using smart factory case studies.

Forecasting Seasonal Changepoint Models Utilizing Changepoint Uncertainties

Pavlopoulos, Vasileios, University of Alabama, Huntsville, AL, USA, with *Rebecca Killick*, Lancaster University, Lancaster, United Kingdom

Abstract: Forecasting in the presence of changepoints is a challenging task. However, if changepoints occur regularly across seasons, we want to utilize that information in our predictions for the next season. In this paper, we develop a framework for forecasting seasonal data that contain within-season changepoints. In our forecasts, we account for uncertainty in the changepoint locations both within and across seasons via a weighting approach across changepoint uncertainties. The framework is very flexible across different changepoint model assumptions and approaches to identifying changepoint confidence sets. We demonstrate the improvement in forecasting performance of our framework for 1) atmospheric pressure with a multivariate changepoint approach and 2) air pollution with a univariate changepoint approach.

Detection of Collective and Point Anomalies at the Presence of Trend and

Seasonality

Pein, Florian, Lancaster University, Lancaster, United Kingdom

Abstract: Detecting anomalies in time series data is a challenging task with broad relevance in many applications. Existing methods work effectively only under idealized conditions, typically focusing on point anomalies or assuming a constant baseline. Our approach overcomes these limitations by detecting both collective and point anomalies, while allowing for polynomial trends and seasonal patterns. We establish statistical theory demonstrating that our method accurately decomposes the time series into anomaly, trend, seasonality, and a remainder component. We further show that it estimates the number of anomalies consistently and their locations with minimal error. Simulation studies confirm its strong detection performance with finite samples, and an application to energy price data illustrates its practical utility.

Efficient Sequential Estimation for Big Data Models in Continuous Time

Pergamenchtchikov, Serguei, Universite de Rouen Normandie, Rouen, France, with *Leonid Galtchouk*, University of Strasbourg, Strasbourg, France

Abstract: We consider drift estimation problems for high dimension ergodic diffusion processes in nonparametric setting based on observations at discrete fixed time moments in the case when diffusion coefficients are unknown. To this end on the basis of sequential analysis methods we develop model selection procedures, for which we show non asymptotic sharp oracle inequalities. Through the obtained inequalities we show that the constructed model selection procedures are asymptotically efficient in adaptive setting, i.e. in the case when the model regularity is unknown. for the first time for such problem, we found in the explicit form the celebrated Pinsker constant which provides the sharp lower bound for the minimax squared accuracy normalized with the optimal convergence rate. Then we show that the asymptotic quadratic risk for the model selection procedure asymptotically coincides with the obtained lower bound, i.e this means that the constructed procedure is efficient. Finally, on the basis of the constructed model selection procedures in the framework of the big data models we provide the efficient estimation without using the parameter dimension or any sparse conditions.

On Sequential Decision Problems for Marked Poisson Processes

Poor, Vincent, Princeton University, Princeton, NJ, USA, with *James DeLucia*, IDA Center for Communications Research, Princeton, NJ, USA

Abstract: This paper develops and explores the sequential detection and quickest detection problems for marked Poisson processes. In particular, mixed-differential-difference equations that describe the error probabilities and average sample numbers of the sequential probability ratio test, and the average time between false alarms and the average delay until detection of the cumulative sum test are derived. A numerical technique for

solving these equations is described, and this method is used to analyze several examples.

On Fairness-Assisted Sequential Variable Selection

Qian, Wei, University of Delaware, Newark, DE, USA

Abstract: In high-dimensional modeling, sequential variable selection is an important technique for interpretable and efficient model construction. We propose a novel stepwise sparsity learning method for generalized linear models that integrates fairness considerations into the sequential variable selection process. This method facilitates the identification of potentially fair model candidates, while preserving consistency properties if the true model lies within the sparse feasible set. We further introduce a model averaging framework under fairness constraints, which aggregates a collection of sparse model candidates generated via the sequential variable selection method to produce asymptotically fair estimators and achieves near-optimal estimation risk in flexible scenarios. The proposed approach is demonstrated through an application to a community crime dataset to showcase its practical utility in high-dimensional predictive modeling.

To Adaptively Randomize or to Rerandomize: A Comparison of Covariate-Adaptive Randomization and Rerandomization

Qin, Ziji, George Washington University, Washington, DC, USA, with *Feifang Hu*, George Washington University, Washington, DC, USA, and *Yang Liu*, Renmin University of China, Beijing, China

Abstract: In comparative studies, achieving balance in influential baseline covariates is fundamental to the credible assessment of treatment effects. Two prominent strategies for improving covariate balance are covariate-adaptive randomization (CAR) and rerandomization (RR). CAR is originally designed for settings in which subjects are enrolled sequentially, whereas RR requires that all subjects enter the trial simultaneously. Although both approaches aim to mitigate covariate imbalance, their underlying mechanisms differ substantially, which has hindered systematic comparisons and left important theoretical questions unresolved. This article develops a unified framework that enables a rigorous comparison of CAR and RR when both procedures target an identical imbalance criterion. Within this framework, we establish conditions under which RR achieves balance properties comparable to those of CAR and characterize how each design affects the asymptotic behavior of treatment-effect estimators. We further investigate the computational burden of RR, showing that it grows linearly with the sample size but exponentially with the covariate dimension. As a result, while RR can be effective in small to moderate samples, its computational cost escalates rapidly, limiting its scalability in large trials or experiments with a large number of covariates. In contrast, CAR retains computational efficiency while delivering strong balance guarantees in both sequential and simultaneous enrollment settings.

Recent Advances in Statistical Process Control for Dynamic Disease Screen-

ing and Spatio-Temporal Disease Surveillance

Qiu, Peihua, University of Florida, Gainesville, FL, USA

Abstract: Statistical process control (SPC) charts are powerful tools for sequential monitoring of data streams. In this talk, we present recent SPC concepts and methods developed for two important healthcare applications. The first application involves disease screening for individuals based on sequential monitoring of disease-related risk factors. In this setting, the distribution of risk factors can evolve over time even for disease-free individuals, leading to dynamic, serially correlated observations that are often irregularly spaced. Such features violate the assumptions underlying conventional SPC charts, motivating the development of new methods. The second application focuses on spatio-temporal disease surveillance, where disease incidence rates are collected sequentially across multiple locations. Detecting disease outbreaks in this setting is challenging due to evolving distributions over space and time, spatio-temporal dependence, and other complex data structures. Over the past decade, our research group has developed a series of SPC concepts and methods tailored to address challenges in these healthcare applications. This talk will provide an overview of these recent developments and highlight their practical implications for modern disease screening and surveillance.

Asymptotically Optimal Sequential Change Detection for Bounded Means

Ram, Ashwin, Carnegie Mellon University, Pittsburgh, PA, USA, with *Aaditya Ramdas*, Carnegie Mellon University, Pittsburgh, PA, USA

Abstract: We consider the problem of quickest changepoint detection under the Average Run Length (ARL) constraint where the pre-change and post-change laws lie in composite families $\mathcal{P}$ and $\mathcal{Q}$ respectively. In such a problem, a massive challenge is characterizing the best possible detection delay when the "hardest" pre-change law in $\mathcal{P}$ depends on the unknown post-change law $Q \in \mathcal{Q}$. And typical simple-hypothesis likelihood-ratio arguments for Page-CUSUM and Shiryaev-Roberts do not at all apply here. To that end, we derive a universal sharp lower bound in full generality for any ARL-calibrated changepoint detector in the low type-I error ($\gamma \to \infty$ regime) of the order $\log(\gamma)/\mathrm{KL}_{\mathrm{inf}}(Q, \mathcal{P})$. We show achievability of this universal lower bound by proving a tight matching upper bound (with the same sharp $\log \gamma$ constant) in the important bounded mean detection setting. In addition, for separated mean shifts, we also derive a uniform minimax guarantee of this achievability over the alternatives.

RAPID - an Online Multiple Change Point Detector

Rani, Meenu, Indian Institute of Technology, Rupnagar, India

Abstract: We present the Rebase-Adjusted Patchwise Indexed Detector (RAPID), an online method for detecting multiple change points in a univariate time series. RAPID compares short, fixed-length recent patches of streaming data to a rolling baseline history

of disjoint patches and triggers an alert only after repeated evidence in a short window. At each step, it computes a patchwise generalized likelihood ratio (GLR) and requires the GLR score to exceed a calibrated threshold. An alert is issued only when a k-of-m persistence rule follows. After each alert, RAPID rebases by rebuilding its baseline from the most recent data and applying a brief lockout so that follow-up detections reflect new regime changes rather than boundary effects. RAPID runs in constant time per sample with bounded memory and is robust to spikes and short pulses. We compare the RAPID results against several online methods (`ocp`, GLR from `cpm`, `OnlineBCP`, and `FLOC`) using simulations that cover changes in mean, variance, and both. Under a common configuration with strict one-to-one matching, RAPID achieves fast detection with strong recall and precision at modest computational cost. We also demonstrate its performance on multiple real-world time series and its efficacy in picking up regime shifts swiftly without over-alerting.

High-Dimensional Robust Change-Point Detection via Angular Energy Statistics

Ray Choudhury, Jyotishka, Georgia Institute of Technology, Atlanta, GA, USA, with *Yao Xie*, Georgia Institute of Technology, Atlanta, GA, USA

Abstract: We study change-point detection in a high-dimensional, low sample size (HDLSS) regime, where the sequence length is fixed while the ambient dimension is large. This regime arises naturally in quick change-point detection, where only a small number of post-change observations are available in order to achieve low detection delay, even when each observation is high-dimensional. In this setting, many likelihood-based and distance-based methods become unreliable due to sample scarcity, concentration effects, tuning sensitivity, and reliance on restrictive distributional assumptions. We propose a simple and robust scan-based change-point detection method built on angular energy statistics that is fully nonparametric, tuning-free, and requires no moment assumptions on the underlying distributions. We develop a precise theoretical analysis of the resulting scan process in the HDLSS regime, establishing high-dimensional consistency of the estimated change-point location under mild conditions. Under a strong mixing condition across coordinates, we further prove a high-dimensional multivariate central limit theorem, which enables principled calibration and yields asymptotically valid type-I error control and optimal detection rates under local alternatives. Simulation studies and real data analyses demonstrate reliable performance in HDLSS settings where existing approaches, including kernel MMD-based methods, often degrade, and we also extend the method to an online change-point detection setting while preserving its nonparametric and tuning-free nature.

Combining a Discrete FDR-Based Pipeline with a Tabular Foundation Model and Standard Machine Learning to Improve Discoveries in Genomic Association Studies

Reiner-Benaim, Anat, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Abstract: The project investigated whether combining a discrete FDR-based GWAS pipeline with a tabular foundation model (TabPFN) and standard machine learning can improve both discovery and prediction of SNP modifiers of disease severity. Our objective was to use discrete FDR controlling procedures as the primary statistical filter to define a credible subset of SNPs and then evaluate how TabPFN and classical AI-based models behave when restricted to this subset, in terms of feature importance and predictive performance. We use a case-control genomic association dataset of patients of a rare disease, BBS. We first use an appropriate discrete association test and apply discrete FDR procedures to obtain a set of candidate SNPs and compare it to TabPFN-based importance ranking. Next, we apply predictive modeling with the initial set as input, using logistic regression, Random Forest, XGBoost and TabPFN under a consistent cross-validation scheme, and compare metrics such as AUC and accuracy to see which model performs best. Key risks include overfitting due to the tiny sample size, instability of SNP rankings, and the possibility that predictive performance remains modest even after careful modeling. We further use simulated configurations of the original set and compare FDR and power across the proposed procedures.

Online Multivariate Changepoint Detection: Leveraging Links with Computational Geometry

Romano, Gaetano, Lancaster University, Lancaster, United Kingdom, with *Liudmila Pishchagina*, Universite d'Evry Paris-Saclay, Evry-Courcouronnes, France, *Paul Fearnhead*, Lancaster University, Lancaster, United Kingdom, *Vincent Runge*, Universite Paris-Saclay, Evry-Courcouronnes, France, and *Guillem Rigaill*, Universite Paris-Saclay, Evry-Courcouronnes, France

Abstract: The growing volume of high-frequency data streams creates significant computational challenges for real-time changepoint detection. Likelihood-ratio–based tests have excellent statistical properties, but a straightforward online implementation is computationally infeasible because, at time n, it requires considering $\mathcal{O}(n)$ candidate change locations. We introduce Md-FOCuS, an algorithm that reduces the set of candidate changepoint locations at time n to approximately $\frac{2}{d!}\log(n)^d$ for a d-dimentional sequence without introducing approximations. This is achieved by exploiting a mathematical connection between candidate changepoint locations and convex hulls of random walks generated from the data. In one dimension this enables fast optimization via sequential convex-hull search algorithms; in higher dimensions it leverages established computational-geometry methods. Empirical results show the resulting online algorithm can detect changes under a wide range of models and achieves constant average per-iteration cost up to five-dimensional sequences (and beyond, with an approximation). We demonstrate empirical performance across a range of simulation studies and on real datasets.

Recurrent Estimation of Heterogeneous Common Mean

Rukhin, Andrew, University of Maryland, Baltimore County, Baltimore, MD, USA

Abstract: In the statistical estimation problem of the heterogeneous mean one has to determine the weights corresponding to each observation. We suggest the Bayes procedure against noninformative prior both for the mean and the unknown independent variances. The recurrent formula for evaluation of this estimator is discussed as well as its relation to barycentric Lagrange formula. Further Bayes rules are discussed. They are illustrated by practical examples.

High-Dimensional Change Point Detection with Missing Values

Safikhani, Abolfazl, George Mason University, Fairfax, VA, USA

Abstract: Assuming fixed model parameters over a relatively large time interval is unrealistic due to possible external shocks to the dynamics of the data generating process. A more realistic assumption is to let parameters behave in a piecewise constant manner, where time points with jumps in model parameters are called change (break) points. Estimating the number and location of such change points is the main goal of change point detection algorithms. We consider a change point detection problem in a high-dimensional mean shift model with missing values. The presence of missing values among observations further complicates the detection problem due to possible loss of information before and after a change point. A four-step algorithm is designed to tackle this problem. First, observations are split into blocks of a certain size and a regularized estimator is defined to perform parameter estimation while missing values are imputed properly. This step is followed by thresholding and re-imputation to fine-tune the estimation results due to the occurrence of misspecification in the first step. Finally, an exhaustive search is performed to locate the change points. Theoretical properties of the proposed algorithm are established, including the consistency of estimating both the (unknown) number and the location of change points under mild conditions. Additionally, the effect of missingness is explicitly quantified in the consistency rates. Furthermore, effectiveness of the developed detection algorithm is confirmed empirically through comparison with some competing methods as well as through various synthetic data and two real data examples.

Post-Detection Inference for Sequential Changepoint Localization

Saha, Aytijhya, Massachusetts Institute of Technology, Cambridge, MA, USA, with *Aaditya Ramdas*, Carnegie Mellon University, Pittsburgh, PA, USA

Abstract: While sequential changepoint detection is well-studied, the problem of post-detection inference remains largely unexplored. This talk introduces a unified framework for constructing confidence sets for a changepoint using only the data observed up to the moment an alarm is triggered. Our framework is nonparametric, making no assumption on the composite post-change class, the observation space, or the sequential detection procedure used, and is nonasymptotically valid. We also extend it to handle composite pre-change classes under a suitable assumption, and also derive confidence sets for the change magnitude in parametric settings. We provide theoretical guarantees on the width

of the confidence intervals. In summary, we present the first general method for sequential changepoint localization, which is theoretically sound and broadly applicable in practice.

Multistage Sequential Adaptive Group Testing for Optimal Prevalence Estimation

Sarker, Md Shamim, Radford University, Radford, VA, USA

Abstract: Surveillance of infectious diseases can be efficiently performed by using group (pooled) testing. The benefits gained from group testing can critically depend on the appropriateness of the pool size(s) used. Statistical methods have been developed in the literature to find optimal pool sizes; however, these methods often use a single-stage method or require the use of perfect diagnostic assays. The goal of our work is to overcome these limitations and to formulate a more flexible and general optimization framework. We study several optimization criteria (e.g., estimation and cost efficiency) of a disease prevalence estimator based on group testing data. Then the pool size is determined by optimizing these criteria. To reduce the dependence of the optimization procedure on an a priori estimate of the true disease prevalence, we propose a multistage sequential adaptive pooling strategy, where pool sizes are updated based on information obtained in earlier stages. We show that this estimator can yield substantial gains in efficiency and is robust to the misspecification of the a priori estimate. Our method is illustrated using chlamydia data, and a software application tool is provided to facilitate its application.

Detecting Transitions Between Collective Motion Regimes Using Functional Hypothesis Test of the Time-Varying Persistence Homology

Sathiyakumar, Thevasha, Coppin State University, Baltimore, MD, USA

Abstract: In a biological system of many similar self-propelled entities ranging from flocks of birds and school of fish to cells and molecules, the interactions with neighbors can lead to a coherent state, meaning the formation of visually compelling aggregation patterns due to the local adjustment of speed and direction. Although the importance of such collective behaviors are well recognized, there is limited knowledge on how such patterns emerge over time, particularly in response to environmental stimuli. In this study, we focus on understanding early transitions of cultured cells from a disordered to an ordered motion. We introduce a statistical-topological framework that extracts this earliest detectable transition window directly from sparse trajectory data. Persistent homology encodes the evolving shape of the point cloud data as persistence landscape contours, and a sequential functional hypothesis test with false discovery correction compares these summaries across time windows. Validation with an agent-based model reveals sharp dynamical regime shifts driven by two key parameters: strength of interaction and strength of propulsion. Applying the pipeline to in-vitro trajectories of non-malignant cervical epithelial cells exposed to elevated extracellular calcium uncovers an analogous topological signature that detects the emergence of coordinated migration. By combining topological sensitivity

with rigorous statistical inference, this method can be applicable for probing collective transitions in swarms, tissues, and active matter systems where early detection is essential.

AIS Vessel Trajectory Identification

Scott, John, University of Central Florida, Orlando, FL, USA, with *Hsin-Hsiung Huang*, University of Central Florida, Orlando, FL, USA

Abstract: We address a real time method for Automatic Identification System (AIS) vessel identity relabeling across nationwide U.S. waters. We propose a hybrid method that first applies physics-based forward projection to screen active track endpoints and retain a small candidate set, then uses a neural classifier to assign each new AIS posit (a single time-stamped position report) either to one of the screened candidates or to a new vessel. Evaluation uses posit accuracy (credit for correctly identifying each posit's predecessor and successor). On held-out days, this approach attains 0.53 posit accuracy, improving over a constant acceleration baseline (0.44) and a fully unsupervised CBTR method (trajectory reconstruction using forward and backward projection of each posit by Chen and Huang, 2023; 0.38). An oracle analysis with perfect post-screening classification indicates an empirical ceiling near 0.85 for this screen size. Accuracy is highest in open water where data is sparse, and degrades in dense port and river systems, with errors concentrated at docks and marinas.

Wasserstein-Cramér-Rao Theory of Unbiased Estimation

Sen, Bodhisattva, Columbia University, New York, NY, USA, with *Nicolas Garcia Trillos*, University of Wisconsin, Madison, WI, USA, and *Adam Jaffe*, Columbia University, New York, NY, USA

Abstract: The quantity of interest in the classical Cramér-Rao theory of unbiased estimation (i.e., the Cramér-Rao lower bound, exact efficiency in exponential families, and asymptotic efficiency of maximum likelihood estimation) is the variance, which represents the instability of an estimator when its value is compared to the value for an independently sampled data set from the same distribution. In this paper, we study a different quantity that captures the instability of an estimator when its value is compared to that obtained under an infinitesimal additive perturbation of the original data set; we refer to this as the sensitivity of an estimator.

The resulting theory of sensitivity is based on Wasserstein geometry in much the same way that the classical theory of variance is based on Fisher-Rao (equivalently, Hellinger) geometry. This perspective yields several results paralleling the classical case: a Wasserstein-Cramér-Rao lower bound for the sensitivity of any unbiased estimator, a characterization of models admitting unbiased estimators that attain this bound exactly, and a guarantee that Wasserstein projection estimators achieve the bound asymptotically. We illustrate the theory through a range of statistical examples, in some cases revealing new optimality properties of existing estimators and in others introducing new ones.

Sequential Change Detection with Simulators

Shekhar, Shubhanshu, University of Michigan, Ann Arbor, MI, USA

Abstract: In this talk, I will discuss the problem of sequential change detection with simulators for the pre- and post-change distributions. Specifically, we consider a stream of observations $(U_t, V_t, X_t)_{t\geq 1}$, where $(U_t)_{t\geq 1}$ and $(V_t)_{t\geq 1}$ are generated by the simulators, and $(X_t)_{t\geq 1}$ represents the actual data sequence. Our goal is to develop an efficient strategy for detecting when the distribution of X_t shifts from an unknown distribution P_0 to another unknown distribution $P_1 \neq P_0$ at an unknown time T. Additionally, we know that $U_t \sim Q_0$ and $V_t \sim Q_1$, where $Q_0 \approx P_0$ and $Q_1 \approx P_1$. I will discuss how this problem can be reduced to that of detecting changes in the sign of the mean of the observation stream. This reduction allows us to leverage recent advancements in sequential anytime-valid methods for estimation and uncertainty quantification, leading to powerful change detection techniques.

Robust Alpha Spending for Unstable Information

Silva, Ivair, Federal University of Ouro Preto, Ouro Preto, Brazil, with *Judith Maro*, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, MA, USA

Abstract: In sequential hypothesis tests, data arriving over time is stable. for example, in post-market vaccine safety surveillance of adverse events, the number of events observed in the past should stay the same for the subsequent analysis. But, in certain applications, the data of previous tests may present changes. for instance, due to a revision during a cohort exposed-unexposed study, events of past tests can move from exposed to unexposed subjects, and vice-versa, events can disappear over time, and sample sizes can reduce. When such modifications in the data are detected, should one take it in account for constructing the signaling threshold of future tests? How do these changes in the information affect the overall type I error probability, power and surveillance time? To respond to these questions, we introduce the "robust alpha spending" concept. This way, predictable data changes are embedded in the signaling threshold construction without compromising the expected time to signal, enabling appropriate control of the overall significance level and statistical power. The algorithm for an exact robust alpha spending is described for binary/Binomial, Poisson and Conditional Poisson data and implemented in the R Sequential package.

Nearly Optimal Hypothesis Testing in Multiple Data Streams

Sokolov, Grigory, The College of New Jersey, Ewing, NJ, USA, with *Alexander G. Tartakovsky*, AGT StatConsult, Los Angeles, CA, USA, and *Serguei Pergamenchtchikov*, Universite de Rouen Normandie, Rouen, France

Abstract: We consider sequential testing of parametric composite hypotheses in multiple streams with dependent and non-identically distributed observations, assuming that the

number of affected streams is unknown. While the results hold in general, for this presentation we focus on a particular case where only a single stream can be affected, but it is not known which one. A test has to detect and identify which stream is affected.

We propose two procedures: an adaptive version of the multistream sequential likelihood ratio test, and a multistream generalized sequential likelihood ratio test. We show that they are nearly optimal, minimizing the average sample size or—more generally—moments of the sample size distribution for all parameter values and all hypotheses when the probabilities of errors are small. Several examples of interest for applications are presented. A detailed study and a comparison of these tests are performed for the problem of detection of signals with unknown intensity in white Gaussian noise with unknown variance. The results of this study show that the two tests are compatible.

Nonparametric Procedures for a Partition Problem

Solanky, Tumulesh, University of New Orleans, New Orleans, LA, USA

Abstract: Partitioning treatments by comparing them to a control treatment is a fundamental problem in the area of selection and ranking. For over eighty years, this problem has been explored by numerous researchers using various statistical designs to establish partitioning criteria and optimize data collection strategies. In this presentation, we examine several key formulations from the literature through the lens of practical application. Particular focus is given to the design proposed by Tong (1969), which extended Bechhofer's (1954) indifference-zone concept to partition treatments relative to a control population. Building on Tong's versatile formulation, we propose a generalization that partitions treatments within the indifference zone as a distinct and identifiable group, while preserving the foundational concept of the indifference zone. It is demonstrated that Tong's formulation represents a limiting case of the proposed generalization. Additionally, an illustrative example is provided to demonstrate the proposed generalization and compare it with other procedures in the literature.

Second-Order Optimal Sequential Multi-Hypothesis Tests

Song, Yanglei, Queen's University, Kingston, ON, Canada

Abstract: We study sequential testing with multiple data streams, where the goal is to identify an unknown subset of signals while controlling error metrics such as the generalized misclassification rate, generalized familywise error rates, and false discovery/non-discovery rates. for each of these metrics, sequential procedures have been developed that are first-order optimal, meaning that the ratio of their expected sample size (ESS) to the minimal possible ESS converges to one as the error levels vanish. In this work, we develop a unified second-order asymptotic optimality theory showing that, for every fixed signal configuration, the ESS of these procedures differs from the minimal ESS by at most a bounded amount, uniformly over all error levels. Our analysis leverages optimality results in associated Bayesian formulations and translates them into their frequentist counterparts. In addition, we derive a second-order accurate approximation of this minimal ESS using nonlinear renewal theory.

Fundamental Limits of Detecting Abrupt Changes in Point Processes

Sridhar, Anirudh, New Jersey Institute of Technology, Newark, NJ, USA, with *Anna Brandenberger*, Massachusetts Institute of Technology, Cambridge, MA, USA, and *Elchanan Mossel*, Massachusetts Institute of Technology, Cambridge, MA, USA

Abstract: We consider the problem of detecting abrupt changes (i.e., large jump discontinuities) in the rate function of a point process. The rate function is assumed to be fully unknown, non-stationary, and may itself be a random process that depends on the history of event times. We show that abrupt changes can be accurately identified from observations of the point process, provided the changes are sharper than the "smoothness" of the rate function before the abrupt change. This condition is also shown to be necessary from an information-theoretic point of view. We then apply our theory to several special cases of interest, including the detection of significant changes in piecewise smooth rate functions and detecting super-spreading events in epidemic models on graphs. Finally, we confirm the effectiveness of our methods through a detailed empirical analysis of both synthetic and real datasets.

Change Detection Related to Wasserstein Distances

Steland, Ansgar, RWTH Aachen University, Aachen, Germany

Abstract: Methods related to Wasserstein distances and optimal transport has recently gained interest. However, in multivariate settings Wasserstein distances are difficult to estimate, have poor convergence rates and are generally difficult to handle, including high computational costs. This has led to related distances based on projections. In machine learning they are typically approximated by neural networks which are then estimated from training data.

This talk discusses some new approaches and results, which try to circumvent such issues and offer interesting features, especially robustness, the possibility to focus on changes in certain parts of the distributions, and a new look on some classical statistical problems

Online Process Monitoring on Networks

Stewart, Jonathan, Florida State University, Tallahassee, FL, USA

Abstract: We discuss methods for performing process monitoring on networks observed at discrete time points. We consider a Phase II monitoring problem, where we have an historical trajectory of the network observed. We propose an online monitoring methodology is proposed for network statistics (both local and aggregate) based on recent advancements in non-parametric distribution estimation for network statistics. We establish theoretical properties and guarantees of our method and demonstrate its performance in empirical

studies and an application.

GMRA of ODE flow manifolds for efficient practical identifiability

Strawn, Nathaniel, Johns Hopkins University, Chevy Chase, MD, USA

Abstract: Identifying which of several candidate ODEs generated a noisy trajectory can be recast as projecting the measurements onto a low-dimensional model manifold parameterized by initial conditions. We adapt Geometric Multi-Resolution Analysis to this setting by building the multiscale tree directly in parameter space, using the variational equations of the ODE to compute tangent planes and curvatures analytically. This yields coarse-to-fine projection at logarithmic cost per query and a principled, curvature-based refinement criterion tied to the noise level. Across a library of candidate ODEs, the construction enables aggressive early pruning of implausible models before their fine-scale trees are descended. We present connections to classical nonlinear-regression curvature theory and numerical results showing speedups over standard Gauss–Newton fitting.

Information Borrowing for Reducing the Mean Squared Error in Group Sequential Studies

Tarima, Sergey, University of Kentucky, Lexington, KY, USA, with *Yuri Dmitriev*, Tomsk State University, Tomsk, Russia

Abstract: If early futility and/or efficacy stopping is possible, the sample mean is a biased estimator. When early stopping rule is determined by an ALPHA-spending function, the asymptotic squared bias is inversely proportional to the sample size. The large sample distribution of the sample mean is different from gaussian even if the central limit theorem applies to the sample mean without early stopping rule. Available methods for borrowing external information are not designed for reducing the mean squared error of the biased estimators. This article proposes estimators borrowing external information with the objective of reducing the mean squared error. Large sample properties are derived, not gaussian, but are functions of standard gaussian random variables, which allows us to evaluate probabilistic characteristics of the proposed estimator if the sample size is large enough. The theoretical probabilistic properties of the proposed estimators are also confirmed using Monte-Carlo simulation studies.

Nearly Optimal Sequential Multihypothesis Tests for General Stochastic Models with Dependent and Nonidentically Distributed Observations

Tartakovsky, Alexander G., AGT StatConsult, Los Angeles, CA, USA

Abstract: We propose a class of multihypothesis sequential probability ratio tests constructed from mixture-based and adaptive one-sided sequential probability ratio tests, achieving asymptotic optimality for both simple and parametric composite hypotheses. The proposed procedures minimize not only the expected sample size but also its higher moments as the error probabilities vanish, maintaining near-optimal performance in general non-i.i.d. models with dependent and nonidentically distributed observations, where log-likelihood ratios between hypotheses converge completely to positive constants. These results extend Lai's (1981) two-hypothesis framework and Lorden's (1976) multihypothesis results to broad classes of dependent stochastic models. Applications include rapid detection of space objects in imagery and early localization of epidemics across multiple data streams.

A Dynamic Screening System for Early Detection of Multiple Interconnected Events

Tian, Zibo, University of Florida, Gainesville, FL, USA, with *Peihua Qiu*, University of Florida, Gainesville, FL, USA

Abstract: Sequential monitoring of temporal processes is central to early disease detection, where risk factors are observed longitudinally and timely decisions must be made across a population of individuals. Existing statistical process control and dynamic screening system (DySS) methods are primarily designed for detecting a single event and are therefore inadequate for modern screening problems involving multiple, interrelated diseases. In clinical practice, patients often experience multimorbidities which share common risk factors but may occur at different times and exhibit complex dependence structures. To address this challenge, we propose a new DySS framework for the early detection of multiple events based on conditional risks modeled through single-index multinomial logistic regression. The proposed method quantifies an individual's evolving risk profile for multiple diseases and sequentially monitors cumulative deviations from baseline risk patterns observed in non-diseased populations, triggering a signal when one or more conditional risks of interest become abnormally elevated. Numerical studies and an application to the Framingham Heart Study demonstrate effectiveness of the proposed approach for early detection of some diseases given the status of others.

Self-Starting Shiryaev (3S): A Bayesian Change Point Model for Online Monitoring of Short Runs

Tsiamyrtzis, Panagiotis, Politecnico di Milano, Milan, Italy, with *Konstantinos Bourazas*, Athens University of Economics and Business, Athens, Greece

Abstract: The Shiryaev's change point methodology is a powerful Bayesian tool in detecting persistent parameter shifts. It has certain optimality properties when we have pre/post-change known parameter setups. In this work we will introduce a self-starting version of the Shiryaev's framework that could be employed in performing online change point detection in short production runs. Our proposal will utilize available prior information regarding the unknown parameters, breaking free from the phase I requirement and will introduce a more flexible prior for the change-point parameter, compared to what standard Shiryaev employs. Apart from the on-line monitoring, our proposal will provide posterior inference for all the unknown parameters, including the change point.

The modeling will be illustrated for Normal data guarding for persistent shifts in both the mean and variance. A real data set will illustrate its use, while a simulation study will evaluate its performance against standard competitors.

Finite-Horizon Quickest Change Detection Balancing Latency with False Alarm Probability

Veeravalli, Venugopal, University of Illinois, Urbana-Champaign, IL, USA, with *Yu-Han Huang*, University of Illinois, Urbana-Champaign, IL, USA

Abstract: A finite-horizon variant of the quickest change detection (QCD) problem that is of relevance to learning in non-stationary environments is studied. The metric characterizing false alarms is the probability of a false alarm occurring before the horizon ends. The metric that characterizes the delay is latency, which is the smallest value such that the probability that detection delay exceeds this value is upper bounded to a predetermined latency level. The objective is to minimize the latency (at a given latency level), while maintaining a low false alarm probability. Under the pre-specified latency and false alarm levels, a universal lower bound on the latency, which any change detection procedure needs to satisfy, is derived. Change detectors are then developed, which are order-optimal in terms of the horizon. The case where the pre- and post-change distributions are known is considered first, and then the results are generalized to the non-parametric case when they are unknown except that they are sub-Gaussian with different means. Simulations are provided to validate the theoretical results.

Sequential Sampling for Ellipsoidal Confidence Regions for Multivariate Means

Venkatesan, Swathi, Fairfield University, Fairfield, CT, USA, with *Nitis Mukhopadhyay*, University of Connecticut, Storrs, CT, USA

Abstract: Traditional fixed-size confidence region (FSCR) methods for estimating the mean of a multivariate normal distribution often fix the region's maximum diameter in advance, without regard to the quality of available data. We propose a new approach that incorporates data quality into determining the region's size. Starting with a modified FSCR method where the structure of the variance-covariance matrix is known, we introduce a minimum risk FSCR (MRFSCR) framework inspired by point estimation methods that balance estimation accuracy and sampling cost. We develop a unified multistage sampling strategy to construct these regions, ensuring desirable asymptotic properties. The methodology is illustrated through practical sampling strategies, simulation studies, and real-data examples.

A Causal Framework for Evaluating Jointly Longitudinal Outcomes and Surrogate Markers: a State-Space Approach

Vieira dos Santos Junior, Silvaneo, University of Texas, Austin, TX, USA, with *Layla Parast*, University of Texas, Austin, TX, USA

Abstract: Surrogate markers offer the potential to reduce the burden of data collection by replacing costly or invasive primary outcomes with more accessible measurements, provided that they can faithfully indicate the effectiveness of a treatment. However, appropriate evaluation of a surrogate is particularly complex in longitudinal studies, where both outcomes and surrogates can evolve dynamically over time and interest lies not only in the treatment effect at one time, but rather treatment effects that may vary along the entire trajectory. In this paper, we develop a statistical framework for surrogate evaluation when both the surrogate and primary outcome are measured over time. Specifically, within the potential outcomes framework, we propose a formal causal definition of the proportion of the treatment effect on the longitudinal primary outcome that is explained by the treatment effect on the longitudinal surrogate. for estimation, we leverage state-space models, together with the Kalman filter and smoother, enabling efficient estimation of treatment effects under realistic conditions of temporal evolution, measurement error, and patient-level variability. We introduce a nonparametric bootstrap strategy for state-space models, a temporal homogeneity test, and demonstrate the finite-sample performance of our proposed methods via a simulation study and application to a diabetes clinical trial.

Smooth and Abrupt Changes in Autoregressive Tensor Models

Wang, Fan, University of Melbourne, Melbourne, Australia, with *Yi Yu*, University of Warwick, Coventry, United Kingdom, and *Haotian Xu*, Auburn University, Auburn, AL, USA

Abstract: In this talk, we propose an autoregressive tensor model, with time-dependent regression coefficients. With respect to the regression coefficients, three different regimes are considered: stationary, smooth-varying and abruptly-changing. We propose a computationally-efficient estimation procedure to handle these three regimes simultaneously, supported with theoretical guarantees and numerical experiments. Two extensions are considered: dynamic community detection in these three regimes and an estimation procedure for a more general class of time series models.

Positive Semidefinite Matrix Supermartingales

Wang, Hongjian, Carnegie Mellon University, Pittsburgh, PA, USA, with *Aaditya Ramdas*, Carnegie Mellon University, Pittsburgh, PA, USA

Abstract: We explore the asymptotic convergence and nonasymptotic maximal inequalities of supermartingales and backward submartingales in the space of positive semidefinite matrices. These are natural matrix analogs of scalar nonnegative supermartingales and backward nonnegative submartingales, whose convergence and maximal inequalities are the theoretical foundations for a wide and ever-growing body of results in statistics, econometrics, and theoretical computer science. Our results lead to new concentration inequalities for either martingale-dependent or exchangeable random symmetric matrices

under a variety of tail conditions, encompassing now-standard Chernoff bounds to self-normalized heavy-tailed settings. Further, these inequalities are usually expressed in the Loewner order, are sometimes valid simultaneously for all sample sizes or at an arbitrary data-dependent stopping time, and can often be tightened via an external randomization factor.

Recent Development in Early Detection of Treatment's Side Effects

Wang, Jiayue, Indiana University, Indianapolis, IN, USA, with *Ben Boukai*, Indiana University, Indianapolis, IN, USA

Abstract: With the rapid emergence and global spread of infectious diseases with pandemic potential (such as COVID-19), new vaccines were authorized for large-scale deployment under Emergency Use Authorization (EUA). This created a need for statistical methods capable of monitoring potential acute vaccine side effects during the early stages of vaccination campaigns. We propose an (α, β)-optimal sequential testing framework that enables early detection of one or more potential side effects and incorporates a stopping rule that halts vaccination once the observed number of adverse events exceeds a pre-determined safety threshold. We study the properties of the sequential test in the case of single side effect and the case of two (or more) side effects and derive the exact expressions of the Power Function, the Average Sample Number (ASN) of the stopping time (and its variance) via the regularized incomplete beta function. Moreover, we construct the post-test parameter estimates and study their sampling properties, including their asymptotic behavior under local-type alternatives. These limiting behavior results provide the consistency and asymptotic normality of the post-test parameter estimators. In the two side-effect case, we also analytically account for the potential inter-correlation among side effects and analyze their associated relative risk as well. The results of a small simulation study are provided along with detailed examples based on some available COVID-19 side effects data.

Change-Point Detection in High-Dimensional Time Series Using Mosum

Wang, Runmin, Texas A&M University, College Station, TX, USA

Abstract: In this talk we study the problem of detecting abrupt dense changes in the mean of a high-dimensional time series. We shall focus on the dense change in the sense that a large proportion of the elements in the mean vectors can change, although our method can also handle sparse change if the jump size is large. Specifically we developed a nonparametric methodology to identify the change-point location for a time series with both temporal and cross-sectional dependence. We construct a MOSUM statistic which can also be considered as a trimmed U-statistic for the L2 norm of the mean change at each location, and the local maximizer of the MOSUM statistics serves as a natural estimator for the true change point location. The limiting distribution of the proposed estimator can be derived, which is a two-sided Brownian motion with a drift. We further

compare the constructed MOSUM statistics with some threshold to determine the number of changes points in the data so that the same method can work under both single change point model or multiple change point model. Simulation results show that the method can accurately estimate both the number and the location of change points, and the method is not sensitive to the tuning parameters.

Sequential Estimation and Boundary Correction for the Overlap Coefficient

Wang, Zhe, Denison University, Granville, OH, USA

Abstract: Overlap quantifies the shared area between two probability distributions and serves as an intuitive measure of similarity between populations. The Overlap Coefficient (OVL) provides a numerical value for this shared region, ranging from 0 to 1. In this presentation, we develop both fixed-sample and sequential estimation methodologies for constructing fixed-size confidence intervals of the OVL. Special attention is given to challenges that arise when the true OVL lies near the boundaries (0 or 1), where traditional normal approximations often fail. We discuss variance-stabilizing transformations and boundary corrections for improving the performance of sequential stopping rules. Simulation studies demonstrate the efficiency and accuracy of the proposed methods across small, moderate, and large OVL settings, followed by applications to real-world data examples.

Uniform Error Control in Online Change Diagnosis

Warner, Austin, United States Naval Academy, Annapolis, MD, USA, with *Georgios Fellouris*, University of Illinois, Urbana-Champaign, IL, USA

Abstract: In this talk I will describe the problem of online change diagnosis, where observations are obtained on-line, an abrupt change occurs in their distribution, and the goal is to quickly detect the change and accurately identify the post-change distribution, while controlling the false alarm rate. It is critical that algorithms deployed for this problem perform well even when the change occurs after monitoring for some time. However, many algorithms that have been proposed for this problem implicitly use pre-change data for determining the post-change distribution. This can lead to performance degradation unless the change occurs as soon as monitoring begins. I will outline recent developments towards achieving error control that is uniform with respect to the time of the change.

Distribution- and Time-Uniform Central Limit Theory for Asymptotic Confidence Sequences

Waudby-Smith, Ian, University of California, Berkeley, CA, USA, with *Edward Kennedy*, Carnegie Mellon University, Pittsburgh, PA, USA, and *Aaditya Ramdas*, Carnegie Mellon University, Pittsburgh, PA, USA

Abstract: This work develops a theory of distribution- and time-uniform asymptotics, culminating in the first large-sample anytime-valid inference procedures that are shown

to be uniformly valid in a rich class of distributions. Historically, anytime-valid methods—including confidence sequences, anytime p-values, and sequential hypothesis tests—have been justified nonasymptotically. By contrast, large-sample inference procedures such as those based on the central limit theorem occupy an important part of statistical toolbox due to their simplicity, universality, and the weak assumptions they make. While recent work has derived asymptotic analogues of anytime-valid methods, they were not distribution-uniform (also called "honest"), meaning that their type-I errors may not be uniformly upper-bounded by the desired level in the limit. The theory and methods we outline resolve this tension, and they do so without imposing assumptions that are any stronger than the distribution-uniform fixed-n (non-anytime-valid) counterparts or distribution-pointwise anytime-valid special cases. It is shown that certain "Robbins-Siegmund" probability distributions play roles in anytime-valid asymptotics analogous to those played by Gaussian distributions in standard asymptotics. As a central application, we derive a sequential analogue of the Generalized Covariance Measure test due to Shah and Peters [2020]. This seems to be the first nontrivial anytime-valid test of conditional independence without the Model-X assumption.

Reinforcement Learning for Respondent-Driven Sampling

Weltz, Justin, Santa Fe Institute, Santa Fe, NM, USA, with *Angela Yoon*, Duke University, Durham, NC, USA, *Yichi Zhang*, University of Rhode Island, South Kingstown, RI, USA, *Alex Volfovsky*, Duke University, Durham, NC, USA, and *Eric Laber*, Duke University, Durham, NC, USA

Abstract: Respondent-driven sampling (RDS) is widely used to study hidden or hard-to-reach populations by incentivizing study participants to recruit their social connections. The success and efficiency of RDS can depend critically on the nature of the incentives, including their number, value, call to action, etc. Standard RDS uses an incentive structure that is set *a priori* and held fixed throughout the study. Thus, it does not make use of accumulating information on which incentives are effective and for whom. We propose a reinforcement learning (RL) based adaptive RDS study design in which the incentives are tailored over time to maximize cumulative utility during the study. We show that these designs are more efficient, cost-effective, and can generate new insights into the social structure of hidden populations. In addition, we develop methods for valid post-study inference which are non-trivial due to the adaptive sampling induced by RL as well as the complex dependencies among subjects due to latent (unobserved) social network structure. We provide asymptotic regret bounds and illustrate its finite sample behavior through a suite of simulation experiments.

Conditional Independence Testing with a Single Realization of a Multivariate Nonstationary Nonlinear Time Series

Wieck-Sosa, Michael, Carnegie Mellon University, Pittsburgh, PA, USA, with *Michel F. C. Haddad*, Queen Mary University, London, UK, and *Aaditya Ramdas*, Carnegie Mellon

University, Pittsburgh, PA, USA

Abstract: Identifying relationships among stochastic processes is a core objective in many fields, such as economics. While the standard toolkit for multivariate time series analysis has many advantages, it can be difficult to capture nonlinear dynamics using linear vector autoregressive models. This difficulty has motivated the development of methods for causal discovery and variable selection for nonlinear time series, which routinely employ tests for conditional independence. In this paper, we introduce the first framework for conditional independence testing that works with a single realization of a nonstationary nonlinear process. We also show how our framework can be used to test for independence. The key technical ingredients of our framework are time-varying nonlinear regression, estimation of local long-run covariance matrices of products of error processes, and a distribution-uniform strong Gaussian approximation.

Solution Path for a Shifted Maximum Subarray Problem and its Applications to Change-Point Detection

Wu, Ruiyang, Baruch College, The City University of New York, New York, NY, USA, with *Xiyang Mo*, University of Arizona, Tucson, USA, *Han Xiao*, Rutgers University, New Brunswick, NJ, USA, *Yue Niu*, University of Arizona, Tucson, AZ, USA, and *Ning Hao*, University of Arizona, Tucson, AZ, USA

Abstract: The maximum subarray problem is the task of locating a contiguous subarray with the greatest sum, within a given one-dimensional array. In this talk, I will discuss a variant of the maximum subarray problem, called the shifted maximum subarray (SMS) problem, which studies the maximum subarray when all the values in the original array are shifted by a quantity, say λ. In particular, I will present an efficient algorithm to calculate the full solution path of the SMS problem when λ varies, as well as its important applications to the problems of geometric object detection and epidemic change-point detection. Computing the exact value of the classical test statistic for detecting an epidemic change typically requires $O(n^2)$ operations for a sequence of length n. Numerical evidence shows that our implementation is significantly faster with an $O(n \log n)$ time complexity in practice, making computationally intensive procedures such as bootstrap or permutation tests feasible for large-scale data.

Change-Point Analysis with Irregular Signals

Wu, Wei Biao, University of Chicago, Chicago, IL, USA

Abstract: I will discuss the problem of testing and estimation of change points where signals after the change point can be highly irregular. Our setting substantially differs from the existing literature that assumes signals to be piecewise constant or vary smoothly. A two-step approach is proposed to effectively estimate the location of the change point. The first step consists of a preliminary estimation of the change point that allows us to obtain unknown parameters in the second step. In a second step we use a new procedure to determine the position of the change point. We show that the optimal OP(1) rate of convergence of the estimated change point to the true change point can be obtained. We apply our method to analyze a health time series data and estimate 8 December 2019 as the starting date of the COVID-19 pandemic.

Sequential Change Detection in Poisson Arrivals with Exponential Sojourn Times

Wu, Yanhong, California State University Stanislaus, Turlock, CA, USA, with *Wei Biao Wu*, University of Chicago, Chicago, IL, USA, and *Dong-Yun Kim*, NIH National Heart, Lung, and Blood Institute, Bethesda, MD, USA

Abstract: We study a model in which arrivals follow a Poisson process with rate λ, and each arrival has a sojourn time that is exponentially distributed with rate μ. To sequentially detect changes in both λ and μ, we propose and analyze generalized CUSUM and Shiryaev-Roberts (S-R) procedures. We show that the corresponding CUSUM and S-R statistics evolve as continuous-time Markov chains. Using the Markov renewal theorem, we develop new techniques to obtain first-order approximations for the average in-control run length (ARL0) and the conditional average detection delay (CADDT). When observations are collected at fixed time intervals, we employ a discrete-time integer autoregressive (INAR) Poisson-binomial model for change detection and derive analogous ARL0 and CADDT approximations for both procedures in this setting. A real-data example involving 2,130 patients with Poisson arrivals and exponentially distributed hospitalization times observed over 204 weeks is presented for illustration.

Sequential Change Detection with Differential Privacy

Xie, Liyan, University of Minnesota, Minneapolis, MN, USA, with *Ruizhi Zhang*, University of Georgia, Athens, GA, USA

Abstract: Sequential change detection is a fundamental problem in statistics and signal processing, with the CUSUM procedure widely used to achieve minimax detection delay under a prescribed false-alarm rate when pre- and post-change distributions are fully known. However, releasing CUSUM statistics and the corresponding stopping time directly can compromise individual data privacy. We therefore introduce a differentially private (DP) variant, called DP-CUSUM, that injects calibrated Laplace noise into both the vanilla CUSUM statistics and the detection threshold, preserving the recursive simplicity of the classical CUSUM statistics while ensuring per-sample differential privacy. We derive closed-form bounds on the average run length to false alarm and on the worst-case average detection delay, explicitly characterizing the trade-off among privacy level, false-alarm rate, and detection efficiency. Our theoretical results imply that under a weak privacy constraint, our proposed DP-CUSUM procedure achieves the same first-order asymptotic optimality as the classical, non-private CUSUM procedure. Numerical simulations are conducted to demonstrate the detection efficiency of our proposed DP-CUSUM under

different privacy constraints, and the results are consistent with our theoretical findings.

Air Pollution Surveillance Using Control Charts

Xie, Xiulin, Florida State University, Tallahassee, FL, USA

Abstract: Air pollution surveillance is critically important for public health. To monitor a sequential process online, a major statistical tool is statistical process control (SPC) chart. However, traditional SPC charts are developed mainly for monitoring production lines in the manufacturing industry under the assumptions that process observations at different observation times are independent and identically distributed with a parametric (e.g., normal) distribution when the process is stable. Nevertheless, the air pollution and meteorological data would not satisfy these conditions due to serial correlation, seasonality, and other complex data structure. In this talk, we present our latest research on sequential monitoring of air quality over time. In particular, we propose a flexible method for sequential monitoring of dynamic processes with serially correlated data. Numerical studies and real data applications show that the proposed method works well.

Online Kernel CUSUM for Change-Point Detection

Xie, Yao, Georgia Institute of Technology, Atlanta, GA, USA, with *Song Wei*, Databricks, San Francisco, CA, USA

Abstract: Sequential change-point detection studies how to detect distributional changes in streaming data with small delay while controlling false alarms. The classical CUSUM procedure is fast and recursive, but it relies on specifying a likelihood ratio, which requires a parametric model for the post-change distribution. In many modern settings, the type of change is unknown, high-dimensional, or not well captured by a simple parametric family. In this talk, I will present an online kernel CUSUM method that extends CUSUM to a nonparametric setting by replacing the parametric likelihood ratio with a kernel-based discrepancy that can capture general distributional changes. The resulting statistic can be updated sequentially and implemented online with finite memory and controlled computation. I will summarize theoretical results that characterize the false-alarm behavior and the detection delay, and I will illustrate the method on streaming examples where the change is complex and difficult to parametrize. I will also briefly discuss how this line of work grew from collaborations motivated by real monitoring problems, in the spirit of Professor Woodroofe's emphasis on starting from genuine applications.

Deep Learning for Bayeisan Sequential Change-Point Detection in High-Dimensional Diffusion Processes

Xing, Haipeng, State University of New York, Stony Brook, NY, USA, with *Hang Ye*, State University of New York, Stony Brook, USA, and *Yi Liu*, State University of New York, Stony Brook, NY, USA

Abstract: This paper presents a deep learning framework for Bayesian sequential change-point detection in high-dimensional diffusion processes. After formulating the sequential change-point detection problem first as optimal stopping problems and then as free-boundary problems, we recast the free-boundary problem as an infinite-dimensional stochastic optimization problem and employ physics-informed neural networks (PINNs) to approximate its solution. To demonstrate the effectiveness of our methodology, we apply it to various challenging high-dimensional change-point detection problems, including Wiener processes with drift, geometric Brownian motion, Ornstein-Uhlenbeck processes, and Cox-Ingersoll-Ross models. Our results illustrate the potential of deep learning in solving complex sequential detection problems with high-dimensional dynamics.

Sequential Pure Detection and Joint Detection and Isolation with Minimum Total Sampling Cost

Xing, Yiming, Tongji University, Shanghai, China

Abstract: Two sequential decision problems are considered: a pure detection problem that detects whether the number of signals in multiple, sequentially sampled data streams exceeds a preset threshold, and a joint detection and isolation problem that additionally identifies a subset of signals when the detection result is positive. We focus on the active sampling setup where, at every time instant, a subset of streams can be selected for sampling. It is assumed that sampling different subsets incurs different costs, and the goal is to minimize the moments of the total sampling cost while controlling the type-I, type-II and misclassification (if applicable) error probabilities below desired levels. for each problem, universal lower bounds on the minimum moments of the total sampling cost are established, characterizing the essential difficulty of the problem, and a novel testing procedure is proposed and is shown to be both reliable, i.e., controls the error probabilities below arbitrary user-specified levels, and efficient, i.e., achieves the minimum moments of the total sampling costs asymptotically as the levels go to zero. Simulation studies are provided to illustrate the asymptotic theory and to visualize the finite-sample performance of the proposed procedures.

Quickest Causal Change Point Detection by Adaptive Intervention

Xu, Haijie, Tsinghua University, Beijing, China, with *Chen Zhang*, Tsinghua University, Beijing, China

Abstract: We consider the sequential change point detection problem in linear causal graphs that explicitly incorporate interventions. In such graphs, changes can propagate through the graph structure to multiple nodes. To address this, we introduce a centralization technique that effectively concentrates the changes across nodes into a single dimension. Building on this, we demonstrate that appropriately selecting intervention nodes can amplify the magnitude of changes, thereby improving detection performance. Accordingly, we develop an algorithm for setting intervention values, which facilitates the identification of optimal intervention nodes based on Kullback-Leibler divergence.

Using these intervention values, we further propose two change detection methods, each equipped with an adaptive intervention policy that balances exploration and exploitation. We establish the first-order asymptotic optimality of the proposed methods and validate their effectiveness through simulation studies and two real-world case studies.

Breakdown-Robust Sequential Change-Point Detection under Contamination

Xu, Qunzhi, MD Anderson Cancer Center, Houston, TX, USA, with *Ruizhi Zhang*, University of Georgia, Athens, GA, USA

Abstract: Sequential change-point detection is studied under Huber's gross-error contamination model, where both the pre-change and post-change distributions may include an unknown fraction of arbitrary outliers and the post-change parameter is unknown. A general class of detection procedures is introduced, combining a window-based estimator of the post-change parameter with a bounded score function. Under mild conditions, exponential lower bounds are obtained for the in-control average run length (ARL), while linear upper bounds are derived for the worst-case detection delay, thereby preserving the classical ARL-delay tradeoff in contaminated settings. Robustness is quantified through explicit expressions for the false-alarm and detection-delay breakdown points, which determine the maximal outlier proportion tolerated before performance becomes unstable. Several examples of the framework are examined, including CUSUM-type likelihood ratios and M-estimation-based score functions. Numerical studies confirm substantial robustness gains compared with classical sequential detectors, with only modest loss of efficiency in uncontaminated data.

The Fallacy of Minimizing Cumulative Regret in the Sequential Task Setting

Xu, Ziping, University of North Carolina, Chapel Hill, NC, USA, with *Kelly Zhang*, Imperial College, London, United Kingdom, and *Susan Murphy*, Harvard University, Cambridge, MA, USA

Abstract: Online Reinforcement Learning (RL) is typically framed as the process of minimizing cumulative regret (CR) through interactions with an unknown environment. However, real-world RL applications usually involve a sequence of tasks, and the data collected in the first task is used to warm-start the second task. The performance of the warm-start policy is measured by simple regret (SR). While minimizing both CR and SR is generally a conflicting objective, previous research has shown that in stationary environments, both can be optimized in terms of the duration of the task, T. In practice, however, in real-world applications, human-in-the-loop decisions between tasks often results in non-stationarity. For instance, in clinical trials, scientists may adjust target health outcomes between implementations. Our results show that task non-stationarity leads to a more restrictive trade-off between CR and SR. To balance these competing goals, the algorithm must explore excessively, leading to a CR bound worse than the typical optimal rate of $T^{1/2}$. These findings are practically significant, indicating that increased exploration is

necessary in non-stationary environments to accommodate task changes, impacting the design of RL algorithms in fields such as healthcare and beyond.

Dynamic Learning From Data With Data Shifts Using a Generalized Selection Bias Framework

Xu, Zixiang, George Mason University, Fairfax, VA, USA, with *Jiayang Sun*, George Mason University, Fairfax, VA, USA

Abstract: Data from different sources or stages can experience various types of shift, such as changes in covariates, labels, or domains. These data can be naturally linked to data in subsequent stages that may involve selection bias. We introduce a generalized selection-bias model and discuss its connection with various data shifts. We then develop our estimates for predictive models under covariate or label shifts. The performance of our new estimators is evaluated through theoretical analysis and simulation against benchmark methods. Applications to astronomical and health data will be illustrated, and the practical use with RWD will be discussed, if time permits.

The Average Run Lengths of a Differentially Private CUSUM Algorithm

Yakir, Benjamin, Hebrew University of Jerusalem, Jerusalem, Israel, with *Yajun Mei*, New York University, New York, NY, USA

Abstract: In sequential change-point detection problems with differential privacy, numerous algorithms have been proposed and their privacy guarantees have been investigated. However, a precise analytical characterization of the average run length (ARL) to false alarm and the average detection delay remains an open problem. In this paper, we address this gap by deriving explicit asymptotic analytical expressions of both average run lengths for a differentially private CUSUM algorithm. Our result explicitly characterizes the effect of privacy-preserving noises and of the threshold on these average run lengths.

Multiscale Spatio-Temporal Data Monitoring Using Forward Elimination and Scale Information Criterion

Yang, Kai, Medical College of Wisconsin, Milwaukee, WI, USA, with *Qiu Peihua*, University of Florida, Gainesville, FL, USA

Abstract: Spatio-temporal process monitoring has broad applications in disease surveillance, environmental monitoring, and many other areas. Most existing spatio-temporal process monitoring methods are developed for analyzing observed data at a single geospatial scale (e.g., state, county, or census tract), and usually impose some parametric assumptions on spatio-temporal data structure. For instance, observed data are often assumed to follow a parametric distribution (e.g., normal or Poisson) and the mean and covariance of a related spatio-temporal model are assumed to have parametric forms, which are rarely valid and/or difficult to justify in many applications. In practice, spatio-temporal data (e.g., incidence rates of infectious diseases) are usually managed at multiple

geospatial scales and have complicated structure. In this talk, we introduce a new multi-scale spatio-temporal data monitoring method for change detection . At each observation time, the new method first detects anomalous regions at each spatial scale. To reduce computing time, a forward elimination procedure is suggested for this purpose. Then, an optimal spatial scale at the current observation time is determined using the detected anomalous regions and a proposed scale information criterion. Finally, a charting statistic is constructed based on the detected anomalous regions at the optimal scale. This method is fully nonparametric in the sense that no parametric assumptions are imposed on the structure of observed spatio-temporal data. It is also scalable and computationally efficient, making it a reliable and effective tool for online multiscale spatio-temporal data monitoring problems.

Flexible Interpretable Model Learning

Ye, Shenghao, George Mason University, Fairfax, VA, USA, with *Jiayang Sun*, George Mason University, Fairfax, VA, USA, and *Cynthia Beall*, Case Western Reserve University, Cleveland, OH, USA

Abstract: Interpretable statistical modeling is essential for evidence-based decision-making. Linear models are easy to interpret but lack the flexibility to capture nonlinear or complex patterns in data. In contrast, nonparametric models or deep neural networks are flexible but not directly interpretable, although they may be "explainable" based on post hoc methods, such as (projected) graphics, SHAP values, or LIME to provide feature attribution scores or local approximations of the behavior of otherwise complex and opaque "black-box" models.

We propose the S-Interpretable learning strategy, a unified pipeline for building flexible yet (more) interpretable models that combine linear, nonlinear, and nonparametric components without requiring prior assumptions about each covariate's relation with the outcome. The pipeline data-adaptively partitions covariates into three types of relations, recommends transformations for nonlinear effects, jointly estimates parametric and nonparametric parts, and assesses the adequacy of the selected transformations. Model performance is evaluated using repeated cross-validation and cross-conformal prediction.

Our contributions include both the integrated learning framework and new theoretical and algorithmic components, including an MM estimation procedure for joint estimation of unknowns in an additive model with linear, changepoint, and nonparametric submodels. Simulation studies and an application to Tibetan women's reproductive success illustrate the S-Interpretable learning method.

Hypothesis Testing for Two-Arm Proportion Comparisons with Two Binary Endpoints Under Curtailment

Yin, Chishu, Syracuse University, Syracuse, NY, USA, with *Elena Buzaianu*, University of North Florida, Jacksonville, FL, USA, and *Pinyuen Chen*, Syracuse University, Syracuse, NY, USA

Abstract: Many studies require evidence that a new treatment improves efficacy and maintains or improves safety. Composite endpoints can obscure trade-offs and complicate interpretation. We propose a single-stage hypothesis test that directly evaluates two binary endpoints against a concurrent control, offering a transparent alternative to composite endpoints. The test rejects only if observed improvements on both endpoints exceed pre-specified paired thresholds. The joint distribution of efficacy and safety is modeled with a four-category multinomial, yielding probabilities for all outcome combinations. This enables exact computation of rejection probabilities and identification of least-favorable parameter configurations to control type I error at the nominal level while retaining adequate power. Design tables map the target significance level and power, together with predefined effect sizes for each endpoint, to the required sample size and decision thresholds. To reduce expected sample size, a curtailment rule stops enrollment once the final decision (reject or not) becomes inevitable under the fixed thresholds; operating characteristics (type I error, power, expected sample size) follow from the same joint model. Simulations and two case studies illustrate design selection, real-time curtailment checks, and interpretation. The method is exact, transparent, and easy to implement, providing a principled framework for trials that require simultaneous improvement in efficacy and safety.

A Robust Online Control Chart Based on the Adaptive Conformal Method

Yu, Miaomiao, East China Normal University, Shanghai, China, with *Yu Cao*, East China Normal Unviersity, Shanghai, China

Abstract: In long-distance refined-product pipelines, precise tracking and monitoring of the oil mixing play a central role in guaranteeing oil quality and minimizing economic losses. The monitoring of continuous changes in dynamic data streams are critical for achieving real-time and accurate supervision in industrial processes and for ensuring product quality. Statistical Process Control (SPC), as a well-established online monitoring tool, automatically identifies state changes in the oil-mixing process by constructing control charts. However, existing statistical quality control methods typically determine control limits using Markov or Monte Carlo method, which suffer from low computational efficiency and poor adaptability to high-frequency continuous data streams. Moreover, these methods are inadequate for handling non-normal and non-stationary data. To address these limitations, this paper introduces conformal inference from machine learning into the SPC framework, thereby overcoming the slow convergence and limited applicability of traditional bisection methods. This paper makes two main contributions First, a quantile-based conformal inference approach is employed to efficiently and rapidly determine control limits. Second, a dual-threshold mechanism is constructed to accommodate real-time minor fluctuations in in-control data caused by external conditions, thereby improving monitoring accuracy. As a result, the proposed framework significantly improves

monitoring robustness and accuracy in complex industrial environments. Experimental results based on both simulated data and real-world datasets demonstrate the superiority of the proposed method.

Optimal Community Detection with Graphical Neural Network

Yuan, Hongsong, Shanghai University of Finance and Economics, Shanghai, China, with *Fengnan Gao*, University College, Dublin, Ireland, *Jingrong Huang*, Shanghai University of Finance and Economics, Shanghai, China, *Shenghang Luo*, Shanghai University of Finance and Economics, Shanghai, China, and *Yicheng Xu*, Shanghai University of Finance and Economics, Shanghai, China

Abstract: We investigate the theoretical optimality of community detection in networks using graph neural networks (GNNs). We show that appropriately designed GNNs for supervised community detection can match the performance of classical spectral and likelihood-based methods, achieving information-theoretic optimality under the stochastic block model (SBM). These results provide the first rigorous connection between deep learning algorithms and their statistical guarantees for community detection. We extend existing GNN-based methods into a two-stage framework, where the second stage is critical for ensuring theoretical optimality. Our algorithm is trained on synthetic and/or real-world graphs with known community labels and can be subsequently applied as generic algorithms to any network in an off-the-shelf manner, offering strong practicality.

Necessary And Sufficient Conditions for Characterizing Finite Discrete Distributions via Generalized Shannon's Entropy

Zhang, Jialin, Mississippi State University, Starkville, MS, USA

Abstract: This talk discusses necessary and sufficient conditions under which a finite set of Generalized Shannon's Entropy (GSE) characterizes a finite discrete distribution up to permutation. For an alphabet of cardinality K, it is shown that K-1 distinct positive real orders of GSE are sufficient (and necessary if no multiplicity) to identify the distribution up to permutation. When the distribution has a known multiplicity structure with s distinct values, s-1 orders are sufficient and necessary. These results provide a label-invariant foundation for inference on unordered sample spaces and enable practical goodness-of-fit procedures across disparate alphabets. The findings also suggest new approaches for testing, estimation, and model comparison in settings where moment-based and link-based methods are inadequate.

A Family of Modified Huber Loss Functions for Continual Reassessment Methods in Clinical Trials

Zhang, Ling, U.S. Food and Drug Administration, Silver Spring, MD, USA, with *Emine Bayman*, University of Iowa, Iowa City, IA, USA, and *Gideon Zamba*, University of Iowa, Iowa City, IA, USA

Abstract: In most Phase I dose-finding trials, the primary goal is to establish the safety of a proposed therapeutic regimen and determine its maximum tolerated dose (MTD) for the following phases. Methods for discovering an optimal criterion that controls toxicity while demonstrating a potential for efficacy have been the subject of statistical research. Although continual reassessment methods (CRM) have been utilized for dose-finding purposes, the consensus among practitioners and clinical trial specialists is that there is always room for improvement with CRM. Within the paradigm of a full-Bayesian method for CRM, we examine the performance of dose-selection algorithms based on a family of loss functions defined in Huber (1964), namely, the Huber loss function, with a special focus on the modified Huber loss functions (MHLF). Our exploration suggests that MHLF performs as well as, if not better than the competitors, such as the traditional escalation rule, the point estimate, the toxicity interval loss function, and Bayesian optimal interval (BOIN), in locating the MTD while doing so with fewer patients than BOIN.

Precision Physical Activity Prescription via Reinforcement Learning for Functional Actions

Zhang, Xiaoke, George Washington University, Washington, DC, USA, with *Zhuoxin Long*, George Washington University, Washington, DC, USA

Abstract: Physical activity (PA) plays an important role in maintaining and improving health. Daily steps have been a key measure for PA which are easily accessible with common wearable devices. However, methods are lacking that can recommend a personalized optimal distribution of daily steps for an individual to follow over a period of time for the best of certain health biomarkers. In this paper, we fill this void based on the data from the All of Us Research Program which includes months of step counts as well as repeated measurements of key health biomarkers. We develop a new offline reinforcement learning (RL) algorithm to learn personalized and optimal PA distributions associated with cardiometabolic risk, where the action is a function representing the daily step distribution over a period of time. Simulation studies demonstrate the advantage of the proposed approach over existing continuous-action RL methods. The learned optimal policy from the All of Us data generally suggests people take more daily steps and also follow a more consistent pattern of PA over time while offering tailed recommendations for subgroups in blood glucose level, body mass index, blood pressure, age, and sex.

A Note on Single-Affected-Case in Quickest Detection

Zhang, Xinyuan, Georgia Institute of Technology, Atlanta, GA, USA, with *Yajun Mei*, New York University, New York, NY, USA, and *Benjamin Yakir*, Hebrew University of Jerusalem, Jerusalem, Israel

Abstract: This work considers a sparse change scenario in which only one of a large number of data streams undergoes a distributional change. Assuming that the dimension grows no faster than a polynomial power of the average run length to false alarm (ARLFA) constraint, we provide an asymptotic lower bound on the detection delay of stopping times that satisfy the ARLFA constraint. In the sparse-change asymptotic regime considered, we then show that the optimal detection delay is achieved, up to a constant, by a procedure based on the sum of window-restricted Shiryaev-Roberts statistics.

Sequential Monitoring for Object-Valued Time Series

Zhang, Yi, Washington University in St. Louis, St. Louis, MO, USA, with *Xiaofeng Shao*, Washington University in St. Louis, St. Louis, MO, USA

Abstract: In this work, we propose a new procedure for monitoring change points in the marginal distribution of object-valued time series. Our approach extends a recently developed offline change-point detection method to the online setting. The proposed monitoring procedure is free of tuning parameters, can be computed recursively, and demonstrates favorable finite-sample size and power properties. We also provide theoretical justification and present numerical results based on both simulated and real data to illustrate the effectiveness of the method.

A Paradox Resolved in Constructing Binary Decision Trees

Zhang, Zhiyi, University of North Carolina, Charlotte, NC, USA

Abstract: Developing a binary decision tree is an emblematic task in modern data science. The objective of its process is to find a partition of a binary population into a mixture of several binary sub-populations, according to some observable covariates, in order to enhance the classifier. A crucial element of this process is a performance measure that would guide and evaluate the classifier during and at the end of the construction. Popular measures in practice include Gini's information impurity and Shannon's entropy. In this talk, it is demonstrated that both of these measures have paradoxical properties. In particular, they perpetually encourage finer partitioning of the population without necessarily enhancing the classifier's performance. To resolve this issue, a new entropy measure is proposed and it is demonstrated that 1) the new measure has a probabilistic interpretation directly relevant to the performance of a classifier, and 2) it avoids the said paradoxical properties of other popular measures, and 3) the functional form is unique under some conditions.

Personalized Reinforcement Learning via Kernel Embedding

Zhao, Linda, University of Pennsylvania, Philadelphia, PA, USA, with *Jeff Cai*, University of Notre Dame, Notre Dame, IN, USA, *Ran Chen*, Washington University, St. Louis, MO, USA, and *Martin Wainwright*, Massachusetts Institute of Technology, Cambridge, MA, USA

Abstract: Healthcare decision-making often involves sequential treatment choices under uncertainty, where patient responses vary significantly across individuals. Sepsis management in intensive care units provides a motivating example: clinicians must adapt treat-

ments over time based on evolving patient conditions, yet optimal personalized strategies remain unclear.

We formulate this problem within a reinforcement learning framework, where patient states evolve over time, treatments are administered sequentially, and outcomes are observed at the end of the trajectory. To account for heterogeneity, we incorporate patient-specific characteristics into the model, enabling personalized decision-making.

We propose a personalized reinforcement learning approach based on kernel embeddings of state-transition dynamics in a Reproducing Kernel Hilbert Space. This representation captures shared structure across patients while allowing heterogeneous responses to treatments, leading to adaptive and interpretable policies. We further establish theoretical guarantees for the proposed method.

Our framework provides a principled approach to learning personalized treatment strategies and has the potential to improve clinical outcomes in complex healthcare settings.

Global Optimality in Phase I Cancer Model-Assisted Designs

Zhou, Shouhao, Pennsylvania State University, Hershey, PA, USA, with *Chenqi Fu*, Penn State University, Hershey, PA, USA, and *J Jack Lee*, UT - MD Anderson Cancer Center, Houston, TX, USA

Abstract: Model-assisted designs represent cutting-edge adaptive methodologies for phase I clinical trials to identify the maximum tolerated dose (MTD). These designs exhibit robust performance comparable to more intricate, model-based designs, and their pretabulated decision rule enables them to be implemented as simply as the conventional algorithm-based designs. In this paper, we introduce the posterior predictive (PoP) design, a novel interval-based design that leverages advanced Bayesian predictive hypothesis testing techniques for dose escalation and de-escalation. Our work moves beyond the existing model-assisted interval-based designs by achieving global optimality in dose transition. Theoretically, the global optimality ensures that the proposed design can consistently select the true MTD at root-n convergence rate. Simulation studies demonstrate that the PoP design yields substantial improvement in operating characteristics to identify MTD, thereby presenting a valuable upgrade to the popular interval-based designs in practice.

Neural Anomaly Detection with Statistical Guarantees: Synthetic Data, Minimax Theory, and Cybersecurity Applications

Zhou, Tian-Yi, Columbia University, New York, NY, USA, with *Xiaoming Huo*, Georgia Institute of Technology, Atlanta, GA, USA, and *Wenke Lee*, Georgia Institute of Technology, Atlanta, GA, USA

Abstract: Modern cybersecurity systems face a fundamental challenge: new forms of cyberattack continually emerge and are crafted to evade detectors trained on previously observed behaviors. This makes classical anomaly detection methods, especially those relying on labeled attack data, fragile in practice.

In this talk, I present a unified neural network-based framework for unsupervised and semi-supervised anomaly detection that is designed to detect previously unseen attacks with statistical guarantees. The central idea is to train classifiers using only normal data, augmented with carefully constructed synthetic anomalies. From a theoretical perspective, we show that neural classifiers trained under this principle achieve minimax-optimal excess risk and, more importantly, provably learn the decision boundary of the normal region. Once this boundary is consistently estimated, the resulting detector can identify a wide range of anomalies without explicit modeling of their distributions.

Extensive experiments across network intrusion detection demonstrate that our proposed methods are robust and consistently competitive with state-of-the-art baselines. In cybersecurity benchmarks, the approach significantly improves detection of difficult and previously unseen attacks, highlighting its relevance to sequential and real-time monitoring scenarios.

A Conversation with Professor Nitis Mukhopadhyay

Zhuang, Yan, Connecticut College, New London, CT, USA

Abstract: Professor Nitis Mukhopadhyay was born and raised in the slums and suburbs of Calcutta. He published his first solo papers in sequential analysis and probability theory in 1974, earning his Ph.D. from the renowned Indian Statistical Institute, Calcutta, the following year, just as he turned 24. Since then, he has gradually become a key figure in all of statistical science as a premier mover and shaker, wearing multiple hats. This session offers a rare glimpse into the life and work of Professor Mukhopadhyay. We hope to explore what inspired him more than 50 years ago, and what continues to drive him as he stands tall this day amongst us at the age of 75.

Sequential Estimation with Record Data

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Abstract: The Weibull distribution is a widely used model for lifetime data due to its flexibility in capturing various failure behaviors. The shape parameter, in particular, plays a crucial role in governing the tail behavior and reliability characteristics of the Weibull distribution. In many life testing scenarios, such as fatigue and strength testing, only the highest observed values (upper records) drive failure. Analyzing such record data can be sufficient to yield more efficient inference for tail-behavior parameters. In this paper, we focus on statistical inferences for the shape parameters of Weibull distributions using record values. We first construct fixed-accuracy confidence intervals (FACIs) for the shape parameter of a single Weibull distribution. We then investigate the ratio of shape parameters from two independent Weibull distributions. We also discuss the FACIs for the reliability parameter, $P(X < Y)$, which quantifies the probability that one system (Y) outlasts the other (X). Extensive Monte Carlo simulation studies demonstrate the

appealing properties of our proposed methods in terms of accuracy and efficiency. The methods are further illustrated through real-world data on carbon fiber strength with different gauge lengths.

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