ODRS 2016

ORDERED DATA AND THEIR APPLICATIONS IN RELIABILITY AND SURVIVAL ANALYSIS:

AN INTERNATIONAL CONFERENCE IN HONOUR OF
N. BALAKRISHNAN FOR HIS 60TH BIRTHDAY

August 7-10, 2016 ★ McMaster University ★ Hamilton, ON, Canada

COMMITTEES

Organizing Committee

Katherine Davies (University of Manitoba, Winnipeg MB, Canada)
William Volterman (Syracuse University, Syracuse NY, USA)

Invited Session Organizers

Edwin van den Heuval (Department of Mathematics and Computer Science: Eindhoven University of Technology, Eindhoven, Netherlands)
Maria Kateri (Institute of Statistics: RWTH Aachen, Aachen, Germany)
H. N. (Raj) Nagaraja (Department of Biostatistics: The Ohio State University, Columbus OH, USA)
Jorge Navarro (Department of Statistics and Operations Research: University of Murcia, Espinardo Murcia, Spain)
Hon Keung Tony Ng (Department of Statistical Science: Southern Methodist University, Dallas TX, USA)
Omer Ozturk (Department of Statistics: The Ohio State University, Columbus OH, USA)
Suvra Pal (Department of Mathematics: University of Texas Arlington, Arlington TX, USA)
Leandro Pardo (Department of Statistics and Operations Research, Complutense University of Madrid, Madrid, Spain)
Ram Tripathi (Department of Management Science and Statistics: University of Texas at San Antonio, TX, USA)
Po Yang (Department of Statistics: University of Manitoba, Winnipeg MB, Canada)
Peng Zhao (School of Mathematics and Statistics: Jiangsu Normal University, Xuzhou Jiangsu, China)
Xingqiu Zhao (Department of Applied Mathematics: The Hong Kong Polytechnic University, Hong Kong, China)

Volunteers (McMaster University)

Sandip Bariu, Tian Feng, Chengwei Qin, Alessandro Selvitella, Tao Tan, Angela Wang, Elaine Zhou

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PREFACE

Dear Students, Colleagues, Friends and Visitors:

It is our great pleasure to greet all of you here at McMaster University in Hamilton. We are delighted that you all have come to join in *Ordered Data and their Applications in Reliability and Survival Analysis: An International Conference in Honour of N. Balakrishnan for his 60th Birthday.*

This event, entailing a student workshop and three day conference, was planned for the simple goal to honour Professor Balakrishnan. As you are all aware, Bala is a very active individual, especially in his roles as a researcher and a supervisor. It is through these roles that he has become one of the most prolific researchers in statistics. In fact, at McMaster University, he was once identified as the professor with the the highest number of citations. His publications, numbering in the hundreds, are simply too many to count. Perhaps more importantly, his impact on students has been unbound. He continues to mentor both students and young researchers, always offering his help and guidance. His research areas have ranged from order statistics to distribution theory to survival analysis, just to name a few (literally).

As he crosses this milestone in his life, it was therefore instinctive to take this opportunity to acknowledge these contributions and show our gratitude. We have gathered co-authors, students and friends, and we hope you will share in expressing our sentiments.

We have a busy program planned for these next days. We hope you will find the talks interesting, discussions fruitful and leave the event with some new ideas and new collaborations. Furthermore, we hope you enjoy yourself as much as we enjoyed planning the event.

While we prepared for the event, we had the help of several student volunteers. At any time, you may ask us or them any questions you may have.

Thank you in advance for partaking in this special event.

Organizing Committee

Katherine Davies

William Volterman

Contents

About Professor Balakrishnan

Professor N. Balakrishnan- known simply as "Bala" to those close to him- is a Distinguished University Professor in the Department of Mathematics and Statistics at McMaster University and a world renowned statistician. For nearly 30 years, he has been providing many valuable services to his students, his department, the university, and the academic community at large.

Professor Balakrishnan received a Bachelor of Science (Statistics) and Masters of Science (Statsitics) from the University of Madras, India in 1976 and 1978, respectively. Following these, he received his Ph.D. (Statistics) from the Indian Institute of Technology, Kanpur, India in 1981. From there he held various positions, including a postdoctoral fellowship at the University of Manitoba. He soon joined McMaster University, which has since become his home. At McMaster University, he has had a successful career in teaching, research and service to the university and community. He has served as the Coordinator of the Graduate Program in Statistics and has been awarded several teaching awards. As a supervisor, he has supervised over 60 M.Sc. students and over 50 Ph.D. students.

Worldwide, he has given and continues to give lectures and workshops to students and faculty alike. He has been a visiting professor in universities around the world, including the University of Waterloo, King Saud University, Bowling Green State University, and the University of Vienna.

He is an Elected member of the International Statistical Institute, a fellow of the American Statistical Association, a fellow of the Institute of Mathematical Statistics and a Fellow of the Turkish Statistical Association. He is also an elected honorary member of the Greek Statistical Institute and a winner of the Don Owen award as presented by the American Statistical Association. He has served as Associate Editor for several journals and Editor-in-Chief for Communications in Statistics (Theory & Methods and Simulation & Computation) for many years. He was also the Editor-in-Chief for the Revised Edition of the Encyclopedia of Statistical Sciences.

Amongst his various areas of expertise, his research areas include ordered data, survival analysis and distribution theory. With nearly 300 co-authors and approximately 500 published articles, along with several authored and co-authored books, he is likely one of the most prolific researchers in the world.

Reflecting on his contributions to teaching, research and the general scientific community, Professor Balakrishnan is an academic in its truest sense.

Schedules and Locations

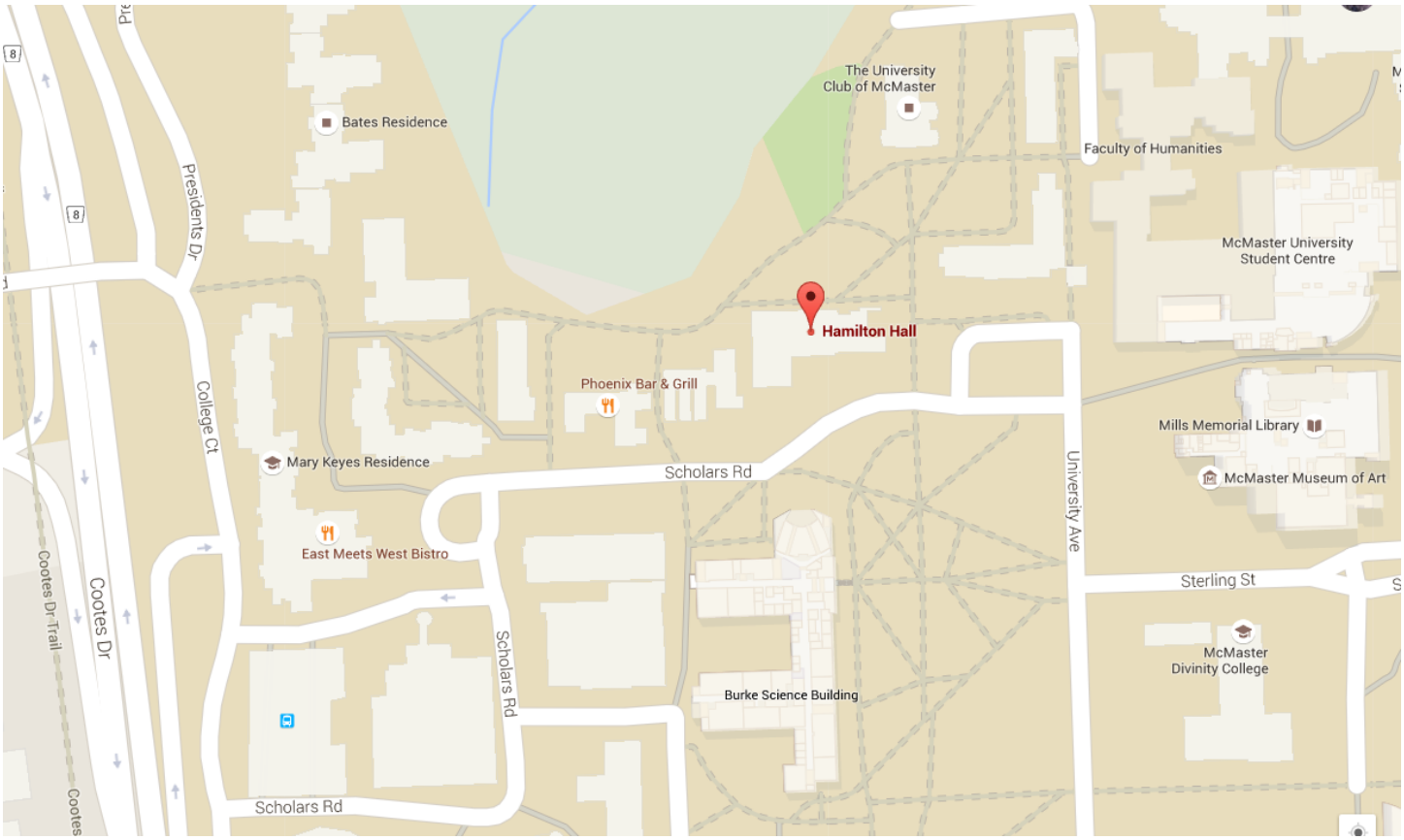
Locations and Maps

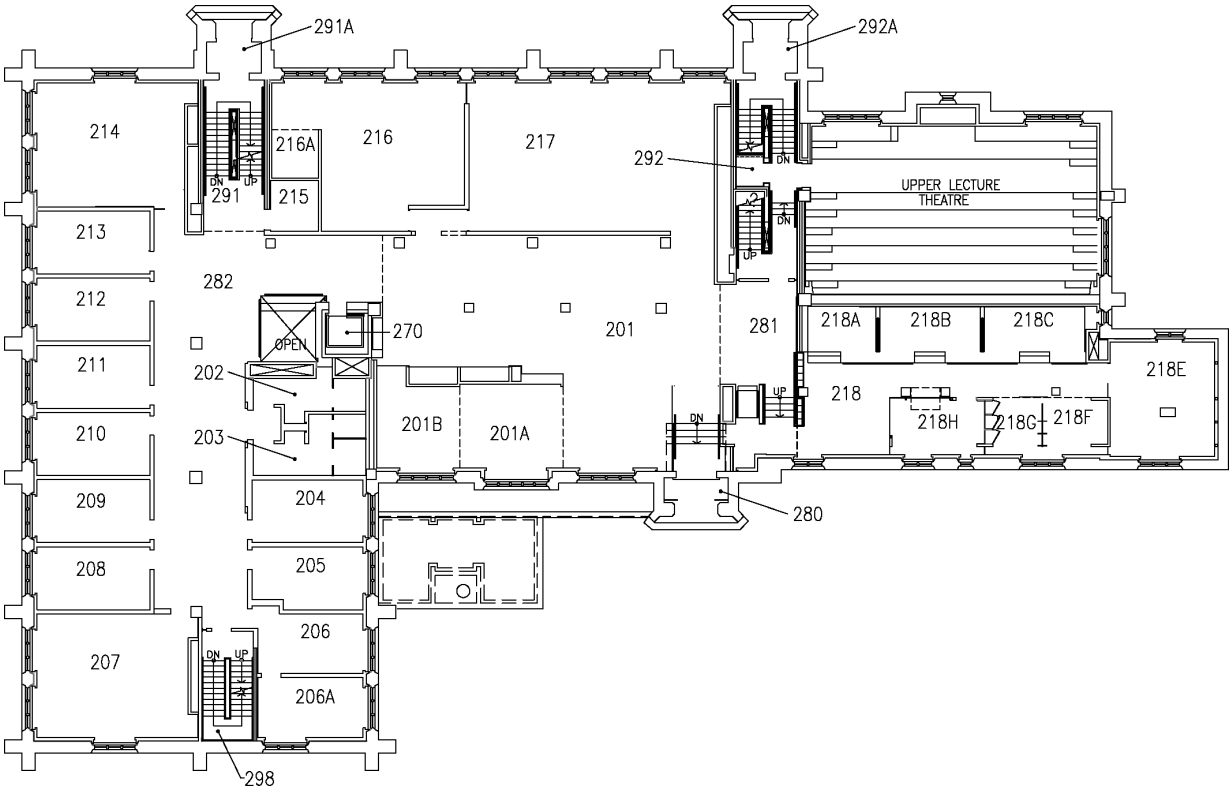
The conference will take place entirely in *Hamilton Hall* (HH) with exception to the lunches, reception, and banquet which will take place elsewhere. The building is wheelchair accessible. If you need access to the elevator when entering the building, you can access it from the first floor of HH.

Registration, as well as the coffee breaks, will take place in the Math Cafe which is in the lobby of HH on the second floor which is in fact the main floor of HH. Note that the Math Cafe is labelled as 201 on the map of HH on the following page. Registration is listed as first thing Monday August 7th, but will be open Sunday as well and will remain open for the duration of the conference.

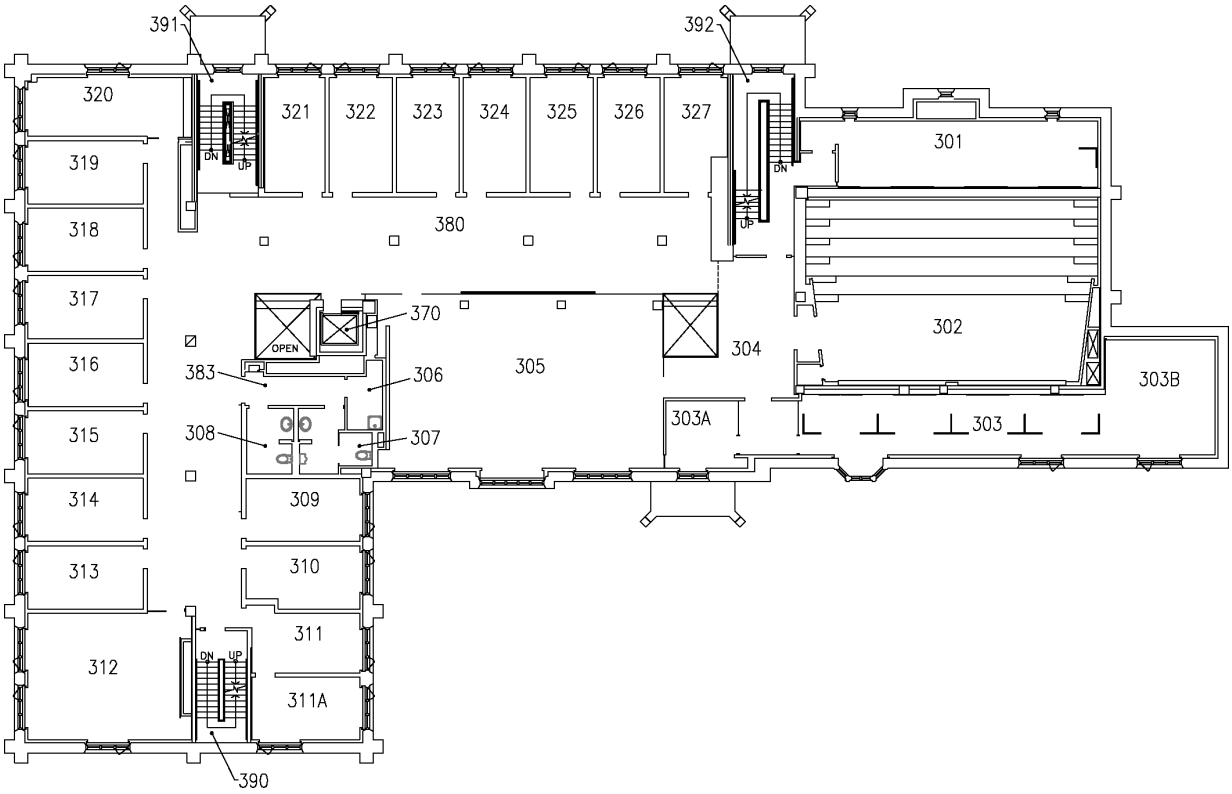
The plenary talks as well as the opening and closing remarks will take place in HH 302. Note that HH 302 is accessible from both the third and fourth floors. The parallel sessions will occur in HH 305 and HH 217. Sections labelled A will occur in HH 305, those labelled B will occur in HH 217, and those labelled C will occur in HH 302.

The workshop lunch and conference reception will be held in the Phoenix which is in the Refectory building just west of HH. The conference lunches will be held in the University Club in Alumni Memorial Hall behind HH. On Wednesday the busses to the Banquet to the Royal Botanical Gardens (RBG) will depart from Mary Keyes Residence at 5:30 and return to campus at 9:30 and 10:00.





Hamilton Hall Floor 2



Hamilton Hall Floor 3

3 Day Conference Overview

Time	August 8^{th}	August 9^{th}	August 10^{th}
8:15 - 8:45	Registration	–	–
8:45 - 9:00	Opening Remarks	–	–
9:00 - 10:00	Plenary Lecture	Plenary Lecture	Plenary Lecture
	Regina Liu	Bo Henry Lindqvist	Fabrizio Ruggeri
10:00 - 10:15		Coffee Break	
10:15 - 11:45	Discrete Distributions I	Design of Experiments I	Analysis of Reliability and Survival Data I
	Contributed Session	Contributed Session	Contributed Session
11:45 - 2:00		Lunch Break	
2:00 - 3:30	Discrete Distributions II	Design of Experiments II	Analysis of Reliability and Survival Data II
	Biostatistics I	Step Stress Models	Statistical Inferences Based on Distances
	Contributed Session	–	–
3:30 - 3:45		Coffee Break	
3:45 - 5:15	Ranked Set Sampling	High Dimensional Survial Analysis	Survival Analysis
	Biostatistics II	System Signatures	Stochastic Orders
5:15 - 5:30	–	–	–
5:30 - 5:45	Reception	–	Closing Remarks
5:45 - 6:00	Reception	–	–
6:00 - 7:00	Reception	Banquet	–
7:00 - 9:00	–	Banquet	–

Workshop Schedule

Sunday August 7, 2016		
8:15 - 8:30	Registration	HH Math Cafe
8:30 - 10:00	Conditionally Specified Distributions	HH 305
10:00 - 10:15	*Coffee Break*	HH Math Cafe
10:15 - 11:45	Conditionally Specified Distributions	HH 305
11:45 - 1:30	*Lunch Break*	The Phoenix
1:30 - 3:00	Generalized Order Statistics	HH 305
3:00 - 3:15	*Coffee Break*	HH Math Cafe
3:15 - 4:45	Generalized Order Statistics	HH 305

Conference Daily Schedule

Monday August 8, 2016		
8:45 - 9:00	Opening Remarks	HH 302
9:00 - 10:00	Plenary Lecture: **Regina Liu**	HH 302
10:00 - 10:15	*Coffee Break*	HH Math Cafe
10:15 - 11:45	Session 1A: Discrete Distributions I	HH 305
	Session 1B: Contributed Session	HH 217
11:45 - 2:00	*Lunch Break*	University Club
2:00 - 3:30	Session 2A: Discrete Distributions II	HH 305
	Session 2B: Biostatistics I	HH 217
	Session 2C: Contributed Session	HH 302
3:30 - 3:45	*Coffee Break*	HH Math Cafe
3:45 - 5:15	Session 3A: Ranked Set Sampling	HH 305
	Session 3B: Biostatistics II	HH 217
5:30 - 7:00	Reception	The Phoenix

Tuesday August 9, 2016		
9:00 - 10:00	Plenary Lecture: **Bo Henry Lindqvist**	
10:00 - 10:15	*Coffee Break*	HH Math Cafe
10:15 - 11:45	Session 4A: Design of Experiments I	HH 305
	Session 4B: Contributed Session	HH 217
11:45 - 2:00	*Lunch Break*	University Club
2:00 - 3:30	Session 5A: Design of Experiments II	HH 305
	Session 5B: Step Stress Models	HH 217
3:30 - 3:45	*Coffee Break*	HH Math Cafe
3:45 - 5:15	Session 6A: High Dimensional Survial Analysis	HH 305
	Session 6B: System Signatures	HH 217
5:15 - 5:30	Busses depart for Banquet	Mary Keyes
6:00 - 9:00	Banquet @ Royal Botanical Gardens	RBG
9:30 - 10:00	Busses depart for McMaster	Outside RBG

Wednesday August 10, 2016		
9:00 - 10:00	Plenary Lecture: **Fabrizio Ruggeri**	HH 302
10:00 - 10:15	*Coffee Break*	HH Math Cafe
10:15 - 11:45	Session 7A: Analysis of Reliability and Survival Data I	HH 305
	Session 7B: Contributed Session	HH 217
11:45 - 2:00	*Lunch Break*	University Club
2:00 - 3:30	Session 8A: Analysis of Reliability and Survival Data II	HH 305
	Session 8B: Statistical Inferences Based on Distances	HH 217
3:30 - 3:45	*Coffee Break*	HH Math Cafe
3:45 - 5:15	Session 9A: Survival Analysis	HH 305
	Session 9B: Stochastic Orders	HH 217
5:30 - 5:45	Closing Remarks	HH 302

Workshop Information

Morning Session

Conditionally Specified Distributions

In efforts to visualize bivariate densities, it is often helpful to introspect on the corresponding conditional densities, which are essentially cross sections of the joint density. This observation leads to the consideration of joint densities that are specified in terms of their conditional densities, so called conditionally specified distributions. Questions of compatibility of families of possible conditional densities are thus of interest. Conditions for uniqueness of conditional specifications must be addressed.

Identification of families of joint densities with conditionals in specified parametric families provides potentially useful extensions of well-known bivariate models. Several examples will be provided. Conditional specification is particularly natural in the Bayesian context of eliciting suitable prior densities in multiparameter models. Conditionally conjugate priors yield posterior densities that are tailor-made for Gibbs sampler simulations. Some discussion of inference for conditionally specified models will be provided. Natural multivariate extensions of conditional specification concepts will also be presented.

Speaker: Barry Arnold (University of California, Riverside CA, USA)

Bio: Professor Arnold- a Distinguished University Professor at the University of California, Riverside- is a fellow of the American Statistical Association and Institute of Mathematical Statistics as well as an elected member of the International Statistical Institute. Professor Arnold is the author of a number of books including: A First Course in Order Statistics, Records, Pareto Distributions, and Conditional Specifications of Statistical Models. His research interests include records, learning models, stochastic processes, Bayesian inference, multivariate distributions and conditionally specified distributions.

Afternoon Session

Generalized Order Statistics

Order statistics and record values appear in many statistical applications and are widely used in statistical modeling and inference. Both models describe random variables arranged in ascending order of magnitude. Generalized order statistics provide a unified approach to a variety of models of ordered random variables with different interpretations, such as common order statistics, sequential order statistics, progressively type II censored order statistics, record values, k-record values and Pfeifer-records. These models can be effectively applied, for example, in reliability theory to model influences of failed components on the remaining system. Well known structural properties of order statistics and record values turn out to be valid for generalized order statistics, too.

A survey of their distribution theory is given, and, for example, results on relations and bounds for moments, structural properties, characterizations of distributions, preservation of aging properties and stochastic orderings as well as results on extreme value theory are shown. In particular, statistical inference based on generalized and sequential order statistics is addressed. Recent and future research directions are discussed.

Speaker: Udo Kamps (RWTH Aachen University, Aachen, Germany)

Bio: Professor Kamps is the current Chair of Statistics at RWTH Aachen University in the Department of Statistics and Econometrics. He is an elected member of the International Statistical Institute and member of the Bernoulli Society for Mathematical Statistics and Probability, German Mathematical Society (Stochastics Section), and German Statistical Society. He is the editor for Metrika and associate editor for Communications in Statistics Theory and Methods and Communications in Statistics Simulation and Computation. His research interests are in stochastic modelling, actuarial and reliability theory, and ordered data models and their applications.

Plenary Talks

Monday August 8, 2016 (9:00 - 10:00 Room 302)

Speaker: Regina Liu (Rutgers University, New Brunswick NJ, USA)

Chair: Bo Henry Lindqvist (Norwegian University of Science and Technology, Trondheim, Norway)

Title: Fusion Learning: Fusing Inferences from Multiple Sources for More Powerful Findings

Abstract: Inferences from multiple databases or studies can often be fused together to yield a more powerful overall inference than individual studies alone. Fusion learning refers to the development of effective approaches for synergizing learnings from different data sources. Effective fusion learning is of vital importance, especially in light of the ubiquitous information and data collection nowadays. Decision-making processes in many domains such as medicine, life science, social studies, etc. often benefit greatly from considering data from different sources, possibly with varying forms of complexity and heterogeneity in their data structure.

This talk presents some new fusion methodologies for extracting and merging useful information. Some methodologies are motivated by challenges arising from massive complex structures from different data sources, and some others by specific goal-directed applications similar to precision (or individualized) medicine. Underlying those methodologies is the tool confidence distribution (CD), which, simply put, is a versatile distributional inferential scheme (unlike the usual point or interval inferences) without priors. Some simulation and real applications are also presented.

This is joint work with John Kolassa, Jieli Shen and Minge Xie, Rutgers University, and Dungang Liu, University of Cincinnati.

Bio: Professor Liu is a Distinguished University Professor and a well-known researcher. She is also an elected fellow of the American Statistical Association and an elected member of the International Statistical Institute and the Institute of Mathematical Statistics and has held awards from NSF, NIH, NSA, and the FAA. She was the former editor of the Journal of Multivariate Analysis and former associate editor of: the Annals of Statistics, JASA, TEST, and Advances in Statistical Analysis. Her research interests are fusion learning, confidence distribution, data depth, nonparametric multivariate analysis, Text mining, resampling techniques, extreme statistics, statistical quality control, and aviation risk management.

Tuesday August 9, 2016 (9:00 - 10:00 Room 302)

Speaker: Bo Henry Lindqvist (Norwegian University of Science and Technology, Trondheim, Norway)

Chair: Tomasz Rychlik (Institute of Mathematics, Polish Academy of Sciences)

Title: Some new perspectives on the signature of a coherent system in engineering reliability

Abstract: The signature of a coherent system with independent and identically distributed component lifetimes has been found to be a useful tool in the study and comparison of lifetimes of engineered systems. A key result is the representation of a system's survival distribution in terms of its signature vector, which leads to several results on stochastic comparison of system lifetimes. In order to compare two systems of different sizes by using signatures, the smaller system needs to be represented by an equivalent system of the same size as the larger system. Here equivalence between systems means that their lifetime distributions are identical for any component distribution. One may also consider the opposite problem, whether, for a given mixed system, there can be found equivalent, or possibly stochastically better, systems of smaller sizes. Sufficient conditions for this to be the case will be presented, in particular for the case when restricting to purely coherent systems. Various applications of signatures to repair, maintenance and cost modeling in engineering reliability will be considered.

This is joint work with Francisco J. Samaniego and Arne B. Huseby.

Bio: Professor Lindqvist is a fellow of the American Statistical Association and elected member of the Royal Norwegian Society of Sciences and Letters and the International Statistical Institute. He is an associate editor for Naval Research Logistics and Editor-in-Chief of the Series on Mathematics and Statistics (ISTE/Wiley). His research interests include theoretical statistics and applied probability as well as reliability and survival analysis.

Wednesday August 10, 2016 (9:00 - 10:00 Room 302)

Speaker: Fabrizio Ruggeri (Institute of Applied Mathematics and Information Technologies, Milano, Italy)

Chair: H. N. Nagaraja (The Ohio State University)

Title: Wear of cylinder liners in ships: one dataset, many models

Abstract: The talk will present data about wear of cylinder liners in ships and a selection of the models which have been used so far to model such process.

Bio: Professor Ruggeri is a fellow of the American Statistical Association and International Society for Bayesian Analysis and an elected member of the International Statistical Institute. He received the Zellner Medal, the ISBAs most prestigious award. He currently is the Editor-in-Chief of Applied Stochastic Models in Business in Industry and Chair of the scientific program committee for the 20017 ISI 61st World Statistics Conference to be held in Morocco. His research interests are primarily in Bayesian and industrial statistics, particularly in robustness, decision analysis, reliability and stochastic processes.

Session List

1A: Discrete Distributions I Organizer: Ram Tripathi (University of Texas at San Antonio) Chair: Ramesh Gupta (University of Maine)	
10:15 - 10:45	**k-out-of-n Systems with NINID Discrete Lifetimes of Components** *Anna Dembińska, Warsaw University of Technology*
10:45 - 11:15	**Noncentral Pólya-Aeppli Distributions** *Leda Minkova, Sofia University*
11:15 - 11:45	**An Overview of Generalizations of the Negative Binomial Distribution with Some Recent Results and Applications** *Ram Tripathi, University of Texas at San Antonio*

1B: Contributed Session Organizer: NA Chair: Man Ho Ling (Hong Kong Institute of Education)	
10:15 - 10:45	**A Two-Piece Laplace Distribution Based on the Skewing Methodology of Balakrishnan, Dai and Liu** *Paul Jacobus van Staden, University of Pretoria*
10:45 - 11:15	**Some Alternative Bivariate Kumaraswamy Models** *Indranil Ghosh, University of North Carolina Wilmington*
11:15 - 11:45	**Bivariate Birnbaum-Saunders Autoregressive Conditional Duration Model** *Tao Tan, McMaster University*

2A: Discrete Distributions II Organizer: Ram Tripathi (University of Texas at San Antonio) Chair: Ram Tripathi (University of Texas at San Antonio)	
2:00 - 2:30	**Bivariate Conway-Maxwell-Poisson Distribution: Formulation, Properties, and Inference** *Kimberly Sellers, Georgetown University*
2:30 - 3:00	**Discrete Frailty Models in Survival Analysis** *Ramesh Gupta, University of Maine*
3:00 - 3:30	**Reliability Functions of Discrete Distributions and their Properties** *Pushpa Gupta, University of Maine*

2B: Biostatistics I Organizer: Edwin van den Heuval (Eindhoven University of Technology) Chair: Fotios Milienos (University of Piraeus)	
2:00 - 2:30	**Construction of Bivariate Distributions** *Amparo Casanova, McMaster University*
2:30 - 3:00	**Stepped Wedge Designs** *Edwin van den Heuval, Eindhoven University of Technology*
3:00 - 3:30	**Statistical Harmonization** *Lauren Griffith, McMaster University*

2C: Contributed Session Organizer: NA Chair: Maria Kateri (RWTH Aachen University)	
2:00 - 2:30	**Role of LambdaMax in Determining Optimal Censoring Schemes** *Nutan Mishra, University of South Alabama*
2:30 - 3:00	**Goodness-of-Fit Test Based on Cumulative Kullback-Leibler Information for Progressively Type-II Censored Data** *Arezou Habibi Rad, Ferdowsi University of Mashhad*
3:00 - 3:30	**Selection Models for Discrete and Other Non-Gaussian Response Variables by A.Azzalini** *Adelchi Azzalini, University of Padua*

3A: Ranked Set Sampling Organizer: Omer Ozturk (The Ohio State University) Chair: Charalambos Charalambides (University of Athens)	
3:45 - 4:15	**Use of Unbalanced Ranked Set Sampling in Cluster Randomized Studies** *Xinlei Wang, Southern Methodist University*
4:15 - 4:45	**Two-Stage Cluster Samples with Ranked Set Sampling Designs** *Omer Ozturk, The Ohio State University*
4:45 - 5:15	**Model Based Inference Using Ranked Set and Judgment Post Stratified Sampling in Finite Populations** *Konul Bayramoglu Kavlak, Hacettepe University*

3B: Biostatistics II Organizer: H. N. Nagaraja (Ohio State University) Chair: Leandro Pardo (Universidad Complutense de Madrid)	
3:45 - 4:15	**Odds Ratios from Logistic, Geometric, Poisson, and Negative Binomial Regression Models** *H. N. Nagaraja, The Ohio State University*
4:15 - 4:45	**Modeling and Analysis of Paired Functional Method Comparison Data** *Pankaj Choudhary, University of Texas at Dallas*
4:45 - 5:15	**Adaptive Design of Clinical Trials** *Xikui Wang, University of Manitoba*

4A: Design of Experiments I Organizer: Po Yang (University of Manitoba) Chair: William Li (University of Minnesota)	
10:15 - 10:45	**The Order of Error Probabilities for Response Adaptive Designs** *Yanqing Yi, Memorial University of Newfoundland*
10:45 - 11:15	**Blocked Semifoldovers of Two-Level Orthogonal Designs** *Po Yang, University of Manitoba*
11:15 - 11:45	**Response Adaptive Designs for Continuous Outcomes with Misspecified Covariates** *Xuan Li, University of Minnesota Duluth*

4B: Contributed Session Organizer: NA Chair: Udo Kamps (RWTH Aachen University)	
10:15 - 10:45	**Nonparametric Confidence Intervals Based on Record Values** *Jafar Ahmadi, Ferdowsi University of Mashhad*
10:45 - 11:15	**Role of Order Statistics in Non-Gaussian Stable Distributions Inferences** *Adel Mohammadpour, Amirkabir University of Technology (Tehran Polytechnic)*
11:15 - 11:45	**Parameter Estimation for the Generalized Pareto Distribution and its Applications** *Hideki Nagatsuka, Chuo University*

5A: Design of Experiments II Organizer: Po Yang (University of Manitoba) Chair: Po Yang (University of Manitoba)	
2:00 - 2:30	**Some Properties of Optimal Foldover Designs with Column Permutations** *William Li, University of Minnesota*
2:30 - 3:00	**Optimal Designs for Measurement Error Models When the Second-Order Least Square Estimator is Adopted** *Xiaojian Xu, Brock University*
3:00 - 3:30	**Some Approaches for the First Passage Time of Degradation Processes and Applications in Reliability-based Optimal Design** *Chengwei Qin, McMaster University*

5B: Step Stress Models Organizer: Maria Kateri (RWTH Aachen University) Chair: Omer Ozturk (The Ohio State University)	
2:00 - 2:30	**On Multiple Step Stress Model Under Order Restriction** *Debasis Kundu, I.I.T. Kanpur*
2:30 - 3:00	**On Optimal Designs for Step-Stress Models** *Maria Kateri, RWTH Aachen University*
3:00 - 3:30	**Minimal Repair Processes Under a Step-Stress Test** *Udo Kamps, RWTH Aachen University*

6A: High Dimensional Survival Analysis Organizer: Xingqiu Zhao (The Hong Kong Polytechnic University) Chair: George Iliopoulous (University Of Piraeus)	
3:45 - 4:15	**A New Nonparametric Screening Method for Ultrahigh-dimensional Survival Data** *Xingqiu Zhao, The Hong Kong Polytechnic University*
4:15 - 4:45	**Censored Cumulative Residual Independent Screening for Ultrahigh-Dimensional Survival Data** *Yanyan Liu, Wuhan University*
4:45 - 5:15	**On robustness of optimal adaptive design for censored exponential response trials** *P. S. Chan, The Chinese University of Hong Kong*

6B: System Signatures Organizer: Jorge Navarro (University of Murcia) Chair: William Volterman (Syracuse University)	
3:45 - 4:15	**Evaluations of Quantiles of System Lifetime Distributions** *Tomasz Rychlik, Institute of Mathematics, Polish Academy of Sciences*
4:15 - 4:45	**Comparisons of Coherent Systems Based on Sequential Order Statistics** *Marco Burkschat, RWTH Aachen University*
4:45 - 5:15	**Birnbaum Component Importance Measure for Systems with Dependent Components** *Patryk Miziula, Institute of Mathematics, Polish Academy of Sciences*

7A: Analysis of Reliability and Survival Data I Organizer: Hon Keung Tony Ng (Southern Methodist University) Chair: Anna Dembińska (Warsaw University of Technology)	
10:15 - 10:45	**Recent Advances in Precedence-Type Tests and Applications** *Hon Keung Tony Ng, Southern Methodist University*
10:45 - 11:15	**Exact Inference for the Scale Parameter of Erlang Distribution Based on Censored Data** *George Iliopoulos, University of Piraeus*
11:15 - 11:45	**Modelling Extreme Percentiles in Bivariate Birnbaum-Saunders Distributions: EM-Estimation** *Filidor Vilca, Universidade Estadual de Campinas*

7B: Contributed Session Organizer: NA Chair: Leda Minkova (Sofia University)	
10:15 - 10:45	**The Problem of Points, with Geometrically Varying Probabilities, and Related q-Combinatorial Identities** *Charalambos Charalambides, University of Athens*
10:45 - 11:15	**Bayesian Predictive Density Estimation with Additional Information and Related Distribution** *Abdolnasser Sadeghkhani, Universite de Sherbrooke*
11:15 - 11:45	**Probable Maximum Loss for The Florida Public Hurricane Loss Model: A comparison** *Sneh Gulati, Florida International University*

8A: Analysis of Reliability and Survival Data II Organizer: Hon Keung Tony Ng (Southern Methodist University) Chair: Hon Keung Tony Ng (Southern Methodist University)	
2:00 - 2:30	**Penalized Empirical Likelihood for the Cox Regression Model** *Dongliang Wang, SUNY Upstate Medical University*
2:30 - 3:00	**Model Mis-Specification Analyses of Weibull and Gamma Models Based on One-Shot Device Test Data** *Man Ho Ling, Hong Kong Institute of Education*
3:00 - 3:30	**Proportional Hazards Under COM-Poisson Cure Rate Model and Associated Inference** *Sandip Barui, McMaster University*

8B: Statistical Inferences Based on Distances Organizer: Leandro Pardo (Complutense University of Madrid) Chair: Graciela Gonzalez (CIMAT)	
2:00 - 2:30	**The Asymptotic Behavior of the Minimum Phi-Divergence Estimator for Multinomial Logistic Regression Models Using Complex Survey Data** *Elena Castilla, Universidad Complutense de Madrid*
2:30 - 3:00	**Empirical Phi-Divergence Test-Statistics for the Equality of Means of Two Populations** *Leandro Pardo, Universidad Complutense de Madrid*
3:00 - 3:30	–

9A: Survival Analysis Organizer: Suvra Pal (University of Texas at Arlington) Chair: Suvra Pal (University of Texas at Arlington)	
3:45 - 4:15	**A New Family of Cure Rate Models** *Fotios Milienos, University of Piraeus*
4:15 - 4:45	**Bayesian Approach for Analyzing Data Arising from Two-Arm Trials** *Saman Muthukumarana, University of Manitoba*
4:45 - 5:15	**Bayesian Approaches to Analyzing Competing and Semi-Competing Risks Data: Applications in Cancer** *Ananda Sen, University of Michigan*

9B: Stochastic Orders Organizer: Peng Zhao (Jiangsu Normal University) Chair: Marco Burkschat (RWTH Aachen University)	
3:45 - 4:15	**Stochastic Comparison in Cybersecurity** *Maochao Xu, Illinois State University*
4:15 - 4:45	**Some Novel Results on Computation and Properties of System Signature** *Gaofeng Da, University of Science and Technology of China*
4:45 - 5:15	**On Aggregate Risks from Two Sets of Heterogeneous Portfolios** *Peng Zhao, Jiangsu Normal University*

Abstracts

[4B:1] Nonparametric Confidence Intervals Based on Record Values

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Record values can be used to construct nonparametric confidence interval for quantiles of parent distribution. It is shown that the coverage probability of the confidence interval can be improved by interpolating between two intervals which have the closest coverage probability from above and below to the pre-determined level. Similarly, the procedure can be done for prediction in term of record values. The results are compared via a simulation study.

[2C:3] Selection Models for Discrete and Other Non-Gaussian Response Variables

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Consider observation of a phenomenon of interest subject to selective sampling due to a censoring mechanism regulated by some other variable. In this context, an extensive literature exists linked to the so-called Heckman selection model. Most of this work has been developed under Gaussian assumption of the underlying probability distributions; among the few exceptions, an even smaller number of contributions has dealt with the case of a discrete response variable. We examine a fairly general construction which encompasses a variety of situations, in the continuous and the discrete case, with various options of the selection mechanism. Inferential methods based on the pertaining likelihood function are developed.

[8A:3] Proportional Hazards Under COM-Poisson Cure Rate Model and Associated Inference

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Cure rate models or long-term survival models play an important role in survival analysis and some other applied fields. In this paper, by assuming a Conway-Maxwell Poisson (COM-Poisson) distribution under a competing cause scenario, we study a flexible cure rate model in which the lifetimes of non-cured individuals are described by a Coxs proportional hazard model. Inference is then developed for a right censored data by the maximum likelihood method with the use of expectation-maximization (EM) algorithm and a profile likelihood approach for the estimation of the dispersion parameter of the COM-Poisson distribution. An extensive simulation study is performed, under different scenarios including various censoring proportions, sample sizes and lifetime parameters, in order to evaluate the performance of the proposed inferential method. Discrimination among some common cure rate models is then done by using likelihood-based and information-based criteria. Finally, for illustrative purpose, the proposed model and associated inferential procedure are applied to analyze a cutaneous melanoma data.

[3A:3] Model Based Inference Using Ranked Set and Judgment Post Stratified Sampling in Finite Populations

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In survey sampling studies, statistical inference can be constructed either based on design based randomization or super population model. Even though both models are used extensively in simple random, stratified and cluster samples, super

population model is not used in ranked set sample (RSS) and judgment post stratified (JPS) sample. In this paper, we develop statistical inference based on super population model in a finite population setting using RSS and JPS samples. RSS and JPS samples are constructed without replacement. We show that the sample mean of RSS and JPS samples are model unbiased and they have smaller mean square prediction error (MSPE) than the MSPE of a simple random sample mean. Using unbiased estimators of MSPE, we also construct prediction confidence intervals for the population mean. A small scale simulation study shows that estimators are as good as or better than SRS estimators when the ranking information in RSS and JPS sampling is low or high quality, respectively. Simulation study also indicates that coverage probabilities of the prediction intervals are very close to the nominal coverage probabilities. Proposed inferential procedure is applied to a real data set.

[6B:2] Comparisons of Coherent Systems Based on Sequential Order Statistics

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Sequential order statistics have been proposed to model successive failure times in a technical system. In such a system failures may have an impact on the lifetime distributions of the other components. For coherent systems with these components the system lifetime distribution has a mixture representation with the weights given by the associated signature. In the talk, conditions in order to obtain stochastic comparisons of system lifetimes are studied in this setting. Moreover, new results on the asymptotic behavior of some system characteristics are given.

[2B:1]Construction of Bivariate Distributions

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The diagonal expansion of a bivariate distribution has been used to construct bivariate distributions with normal and other marginals choosing appropriate sets of orthonormal functions (canonical variables) and correlations. An extension of this method consists in using the so-called principal components of the marginal variables as canonical functions. In this presentation, sufficient and necessary conditions for the diagonal expansion via principal components to be a representation of a bivariate distribution are given. The corresponding copula densities are obtained, as well as formulae for computing Pearson's correlation and Spearman's rho in terms of the correlations of the principal components. The method is applied to construct bivariate distributions with uniform, exponential, logistic and Pareto marginals.

[8B:1] The Asymptotic Behavior of the Minimum Phi-Divergence Estimator for Multinomial Logistic Regression Models Using Complex Survey Data

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Multinomial logistic regression is frequently the method of choice when the outcome is categorical and interest is in the relationship between the outcome and covariates. In many practical studies the source data arise from complex survey sample: Stratification, Clustering, and sampling weight. Use of multinomial logistic regression models in the analysis of data from complex surveys requires that the parameter and variance estimates take into account their design of the survey. This paper introduces, as a natural extension of the maximum likelihood estimator, the minimum phi-divergence estimators from complex survey and study the asymptotic behavior of it. A simulation study pointed out the efficiency of it in relation to the maximum likelihood estimator for small o moderate sample sizes. This family of minimum phi-divergence estimators permits us to introduce two estimators for the design effect.

[6A:3] On robustness of optimal adaptive design for censored exponential response trials

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We study the performance and robustness of response-adaptive randomization procedures for comparing two treatments with censored exponential response trials. Random censoring time and fixed censoring time models are considered. Optimal allocations between two treatments in a clinical trial with censored exponential response time are presented based on two different optimality criteria. Allocation rule analogous to the randomized play-the-winner rule and complete randomization are also included in the comparative study. Monte Carlo simulations are used to evaluate the different allocation rules in finite sample cases under exponential distributional assumption and derivation from this assumption.

[7B:1] The Problem of Points, with Geometrically Varying Probabilities, and Related q-Combinatorial Identities

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The present paper is concerned with the classical problem of division of stakes after a series of games between two players, which is interrupted before either player has achieved victory. It is assumed that the odds or the probability of winning each game for player a (or player b) varies geometrically, with rate q, either with the number of games or with the number of wins. The solutions are expressed in pairs, using q-binomial and negative q-binomial distributions of the first and second kind. The equivalence of the solutions in each pair leads to several interesting identities. Set-theoretic and combinatorial derivation of these identities are provided.

[3B:2] Modeling and Analysis of Paired Functional Method Comparison Data

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We discuss a statistical methodology for modeling and analysis of paired functional data arising in method comparison studies where measurements of a continuous variable are made using two methods of measurement on a sample of subjects. The data are viewed as two smooth curves per subject that are observed with noise at a common set of discrete time points which may vary from subject to subject. We use functional principal components analysis within the framework of mixed-effects models to represent each curve in terms of a small number of principal components. The dependence within a subject is modeled using common principal component scores for the curves. Penalized splines and bootstrapping methodology are used for inference on model parameters and measures of similarity and agreement. The methodology is illustrated using a core body temperature dataset from the literature.

[9B:2] Some Novel Results on Computation and Properties of System Signature

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Computing the system signature has been a crucial but challenge problem in the system reliability. In this talk, we present an explicit formula of system survival signature by employing a simple shock model. The formula relies only on the information of minimal cuts sets or minimal path sets. By using this formula, we derive some novel results on ageing properties of signature which are used to address related problems in literature. Some numerical examples are provided to illustrate our results as well.

[1A:1] k-out-of-n Systems with NINID Discrete Lifetimes of Components

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In this talk, we will give a general formula describing the joint probability mass function of any subset of order statistics arising from not necessarily independent and not necessarily identically distributed (NINID) variates. We will also show how this formula simplifies under assumption that the variates are independent.

Next, we will apply these results in reliability to calculate failure probabilities of k-out-of-n systems consisting of elements with discrete lifetimes. In particular, we will provide compact formulas expressing the probability mass function of the lifetime of such a system as well as some conditional probability mass functions of this lifetime given information about early failures of the components of the system.

[1B:2] Some Alternative Bivariate Kumaraswamy Models

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In this paper we discuss various strategies for constructing bivariate Kumaraswamy distributions. As alternatives to the Nadarajah, Cordeiro and Ortega (2011) bivariate model, four different models are introduced utilizing a conditional specification approach, a conditional survival function approach, an Arnold-Ng bivariate beta distribution construction approach, and a copula based construction approach. Distributional properties for such bivariate distributions are investigated. Parameter estimation strategies for the models are discussed, as are the consequences of fitting two of the models to a particular data set involving hemoglobin content in blood samples before and after treatment.

[2B:3] Statistical Harmonization

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In meta-analysis, standardization procedures are commonly used to combine phenotype data measured using different instruments, but there is little information on how the choice of standardization method impacts summary estimates of effect and heterogeneity. Using two-stage IPD analyses, we compared two common methods of standardization, T-scores and Category-centred scores (C-scores), to create combinable memory scores using cross-sectional data from three Canadian population-based studies. A simulation was then conducted the impact of varying the following across populations: 1) the effect size, 2) the distribution of confounders, and 3) the relationship of the confounders with the outcome. We found that effect sizes based on the unadjusted C-scores tended to be larger than the T-scores, although the differences were negligible when adjusted scores were used and most IPD meta-analyses identified significant heterogeneity. The simulation indicated that in terms of heterogeneity, the method of standardization played a smaller roll than different effect sizes across populations and differential confounding of the outcome measure across studies. Although there was general consistency between the two types of standardization methods, the simulation study identified a number of sources of heterogeneity, some of which are not the standard sources considered by researchers.

[7B:3] Probable Maximum Loss for The Florida Public Hurricane Loss Model: A comparison

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Hurricanes are a way of life in South Florida where owning a home without windstorm insurance is almost an impossibility. Insurance premiums for windstorm loses are computed through the use of complex mathematical models called Catastrophe (cat) Models. When they were first developed, cat models focused on the calculation of average annual loss due to wind.

However, with exposure increasing rapidly along the coast of South Florida, it is imperative for insurance companies to protect themselves from the once in a hundred year event; in other words, probable maximum loss (PML.) Gulati et al. (2014) investigated the computation and distribution of probable maximum loss in case of personal residential structures for Version 5.0 of the Florida Public Hurricane Loss Model using parametric and non-parametric methods. Here we investigate the computation of probable maximum insured losses for personal and commercial residential buildings Version 6.1 of the model using the same methods. We also compare how PML values for total insured loss has changed between the two versions.

[2A:2] Discrete Frailty Models in Survival Analysis

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Frailty models are often used to model heterogeneity in survival analysis. The distribution of the frailty, is generally, assumed to be continuous. However, there are certain situations where the heterogeneity may be analyzed by using discrete frailty models. The situation might arise, for example, in cure models, where the number of metastasis -competent cells (clonogens) are unknown and the event occurs as soon as one of the clonogens metastasizes. This unknown number can be modeled as a discrete frailty.

[2A:3] Reliability Functions of Discrete Distributions and their Properties

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In this presentation, we will discuss the reliability functions, namely, the failure rate, the mean residual life function and the variance residual life function, for discrete variables. Their monotonicity and relationships will be investigated. Similar functions for the past life will be considered. The hazard rates and the reversed hazard rates for the series and parallel systems will also be considered.

[2C:2] Goodness-of-Fit Test Based on Cumulative Kullback-Leibler Information for Progressively Type-II Censored Data

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Goodness-of-fit procedures have been developed in the literature for the cases when the available samples are censored. Recently, a more flexible and efficient form of censoring, called progressive censoring, has been studied.

In this paper, we construct a goodness-of-fit test statisttic based on cumulative Kullback-Leibler information (Baratpour and Habibi Rad, 2014) for Weibull distribution by using maximum likelihood estimates of the model parameters. Finally, we use Monte Carlo simulation to evaluate the power of the proposed test for several alternatives under different sample sizes and progressive censoring schemes. Also, the results are compared with the goodness-of-fit test introduced by Habibi Rad et al. (2011). The use of the proposed test is shown in an illustrative example.

[2B:2] Stepped Wedge Designs

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The stepped wedge design is a special randomized controlled trial to determine the efficacy of a new treatment with respect to a control treatment. All participants first start at the control treatment and then (groups of) participants switch to the new intervention at predefined switch moments and they stay on this new treatment until the end of the trial. Allocation of

participants to the switch moments is randomized. Due to this one-directional structure, the statistical analysis is considered less straightforward than more classical designs. The talk starts with a short history of the SWD followed by its definition and the advantages and disadvantages. The main part of the talk is about the statistical contributions that have been established so far: statistical analysis, sample size calculation, and optimal designs. A specific case study is presented to illustrate the complexities. The final part discusses a few issues that are still open.

[7A:2] Exact Inference for the Scale Parameter of Erlang Distribution Based on Censored Data

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In this work, I consider type-I or type-II censored data from an Erlang distribution with known shape parameter and discuss exact likelihood inference for its scale parameter, θ. I prove the existence and uniqueness of the MLE, $\hat{\theta}$, as well as its stochastic monotonicity with respect to θ. Next, an analytic expression for the distribution of $\hat{\theta}$ is provided. Based on this expression, exact confidence intervals are constructed for small and moderate sample size. When the sample size is larger, exact confidence intervals are obtained using the method of Bølviken and Skovlund (*JASA*, 1996). Alternative exact confidence intervals based on the Total Time on Test statistic are also presented and compared to the MLE-based ones. Finally, approximate inference for a gamma distribution with general known shape parameter are discussed.

[5B:3] Minimal Repair Processes Under a Step-Stress Test

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A sequence of failure times of a technical system or a component is considered within a minimal repair scheme. With respect to just one component, upon failure, it will instantaneously be repaired, and by this, put into the condition immediately prior to its failure. Another interpretation of minimal repair is to say that, successively, the failed component is replaced by a component of equal age. It is well known that the joint distribution of minimal repair times coincides with the joint distribution of record values based on some corresponding distribution function as well as with that of epoch times of some nonhomogeneous Poisson process. The idea of successive minimal repair of a single particular component within a system can be extended to practical situations of complex systems (cf. Ascher and Feingold 1984).

Methods of accelerated life-testing (see Bagdonavicius and Nikulin 2002), in particular step-stress methods (see Balakrishnan 2009), are a common approach in life-time experiments and are applied in general to reduce experimental time, when technical systems tend to have quite long life times. Under normal operating conditions, life-time tests would be time consuming and expensive. Therefore, an accelerated testing is adopted, wherein experimental units are exposed to increasing stress levels higher than the normal one.

In a simple step-stress minimal repair experiment with independent samples under Type-II censoring based on exponential distributions and an associated cumulative exposure model or based on a scale family of distributions and an associated hazard rate model (cf. Kateri and Kamps 2015), maximum likelihood estimates of the model parameters are presented along with some properties.

The talk is based on joint works with N. Balakrishnan and M. Kateri.

[5B:2] On Optimal Designs for Step-Stress Models

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For step-stress accelerated life test (SSALT) experiments, alternative models have been developed, that differentiate in terms of the assumption adopted for the time points of stress level change (usually the cumulative exposure or the tampered failure rate), the underlying lifetime distributions, the type of censoring, if present, and the way of monitoring. The issue of optimal designing a SSALT experiment is important for all type of models, for one as well as multi-sample experiments. A crucial

aspect in designing a SSALT experiment of s stress levels is the optimal allocation of the time points of stress level change. For simple SSALT models ($s = 2$), the classical A-, C-, D- and E-optimality criteria are discussed along with a criterion based on the minimization of the non-existence probability of the maximum likelihood estimators (MLEs) of the models parameters. In case of experiments with more than two stress levels ($s > 2$), an additional assumption is required with regard to the length of the testing period under each stress level. The determination of these time intervals' length is most commonly based on the assumption of equal spacing (ES) or equal probability (EP). Alternative approaches, a deterministic and two hazard rate based, are introduced. The criteria and approaches discussed, are illustrated in the context of a SSALT type-I censored experiment, under the tampered failure rate TFR) assumption, for which the testing items are interval monitored. The underlying lifetimes in each stress level follow a general scale family of distributions having, among others, the exponential and the Weibull as special cases. Simulation results indicate that the proposed approaches outperform the standard ones (ES and EP).

[5B:1] On Multiple Step Stress Model Under Order Restriction

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In this article we consider multiple step stress model based on the cumulative exposure model assumption. Here we assume that for a given stress level, lifetime of the experimental units follow exponential distribution and the expected lifetime decreases as the stress level increases. We mainly focus on the order restricted inference of the unknown parameters of the lifetime distributions. First we consider the order restricted maximum likelihood estimators of model parameters and the associated confidence intervals. The Bayes estimates and associated credible intervals under square error loss function are also provided in this paper. Due to the absence of explicit form of Bayes estimates, we propose to use importance sampling technique to compute the Bayes estimates. We provide an extensive simulation study in case of three stress levels mainly to see the performances of the proposed methods. Finally we provide the analyses of two data sets for illustrative purposes.

[4A:3] Response Adaptive Designs for Continuous Outcomes with Misspecified Covariates

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Response adaptive randomization helps balance the collective benefits and the individual benefits and improves efficiency without undermining the validity and integrity of the clinical research. It deliberately skews treatment allocation and adaptively modifies the randomization procedure in order to assign more subjects to the potentially better treatment. In this talk we formulate response adaptive randomization for continuous responses in the presence of imperfectly measured covariates. The effect of measurement error on treatment allocation and some related simulation results are presented. This is joint work with Su Hwan Kim, Department of Mathematical and Statistical Sciences, University of Alberta, Canada.

[5A:1] Some Properties of Optimal Foldover Designs with Column Permutations

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Foldover is a follow-up technique used in design of experiments. Traditional foldover designs are obtained by changing the sign of some columns of an initial design. We further consider to perform a column permutation. We investigate when a column permutation results a combined foldover design with better G- and G2-aberrations. Properties of such foldover designs are studied. Optimal G2-minimum aberration designs are searched and tabulated for practical use.

[8A:2] Model Mis-Specification Analyses of Weibull and Gamma Models Based on One-Shot Device Test Data

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Model mis-specification is of great importance in reliability assessment. Different choices of probability models for fitting data may result in substantially different inference on some lifetime characteristics of interest. Gamma and Weibull models have been used extensively for modeling lifetime data. Hence, accelerated life models have been developed recently for one-shot device test data under both these models for making inference on mean lifetime and the reliability at use level. However, model mis-specification analyses between both models have not been studied in this context. Here, we examine the effect of model mis-specification between gamma and Weibull models on the likelihood estimation and the inference on the mean lifetime and the reliability at some mission times based on one-shot device test data. Moreover, a distance-based test statistic and the Akaike information criterion as specification tests are studied for model verification. A simulation study is carried out to evaluate the bias and coverage probabilities of confidence intervals under model mis-specification. The obtained results reveal that the effect of model mis-specification is negligible only when the sample size is small and the accelerated and use levels are close, and that the use of specification test is quite important for an accurate reliability assessment.

[6A:2] Censored Cumulative Residual Independent Screening for Ultrahigh-Dimensional Survival Data

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For complete ultrahigh-dimensional data, sure independent screening methods can effectively reduce the dimensionality while ensuring that all the active variables can be retained with high probability. However, limited screening methods have been developed for censored data, which often arise in clinical trials and genetic studies. We propose a censored cumulative residual independent screening method that is specially tailored to the ultrahigh-dimensional survival data. The proposed screening method is model-free, and it tends to rank the active variables over the inactive ones in terms of their association with the survival times and also enjoys the sure independent screening property. Compared with several existing methods, our model-free screening method works well with general survival models, is invariant to the monotone transformation of the responses, and requires substantially weaker moment conditions. Numerical studies demonstrate the usefulness of the censored cumulative residual independent screening method.

[9A:1] A New Family of Cure Rate Models

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In this work, we study a new family of cure rate models by relaxing some assumptions of the bounded cumulative hazard (BCH) cure rate model (e.g. Tsodikov, Ibrahim and Yakovlev, 2003). The proposed model could be viewed as a generalization of the frailty models studied by Yin and Ibrahim (2005) and Zeng, Yin and Ibrahim (2006), or a class of models studied by Tsodikov (2002). It shares the same biological motivation with the BCH model and, it includes as special cases some well studied cure rate models, such as the promotion time, the geometric and the negative binomial. In addition, it offers a generalization of a number of destructive cure rate models.

Exact likelihood inference is developed by the aid of the EM-algorithm; a profile likelihood approach is also adopted for estimating the parameters of the model while the likelihood ratio test is used for model discrimination. A simulation study demonstrates the accuracy of the proposed inferential method; as an illustration, we fit the proposed model to a cutaneous melanoma dataset.

[1A:2] Noncentral Pólya-Aeppli Distributions

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In this paper we consider a random variable which is a sum of Poisson distributed and Pólya-Aeppli distributed variables. The resulting distribution is called a noncentral Pólya-Aeppli distribution. The probability mass function, recursion formulas and some properties are derived. Then, by trivariate reduction method we introduce a bivariate noncentral Pólya-Aeppli distribution. As application we define the corresponding univariate stochastic process and call it a noncentral Pólya-Aeppli process (NPAP). For the risk model with NPAP counting process we consider the joint distribution of the time to ruin and deficit at the time of ruin. The differential equation of the ruin probability is given. As example we consider the case of exponentially distributed claims.

[2C:1] Role of LambdaMax in Determining Optimal Censoring Schemes

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Based on samples coming from a type II progressive censoring scheme, the estimates of location and scale parameters of two parameter distributions are computed by various authors using various estimation methods. The variance covariance matrix of estimators of these two parameters (say sigma) are computed by them. Determinant and trace of this matrix are considered as objective functions to choose an optimal censoring scheme.

In this presentation we discuss the role of maximum eigenvalue of sigma matrix (say LambdaMax), as an objective function to choose such an optimal scheme. We study role of LambdaMax for two distributions namely location and scale Weibull distribution as studied in Thomas and Wilson (1972), Balakrishnan and Aggrawala (2000) and Ng, Chan and Balakrishnan (2004) and a general location and scale family in Burkschat, Cramer and Kamps (2006). All these authors considered determinant and trace as objective functions. Using their data, we computed LambdaMax, LambdaMin and Covariances as well. We also study the impact of covariances on these objective functions.

[6B:3] Birnbaum Component Importance Measure for Systems with Dependent Components

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Importance measures of components of a coherent system were presented first by Birnbaum in the 1960s. Since then, many more different types of measures have been invented. Importance measures of all the components form a signature which delivers an information about a 'hierarchy' of system components. This allows us to identify and pay attention to the most *important* components.

Almost all of the known component importance measures require the independence of component lifetimes. So far, the only exception has been the Barlow-Proschan measure which was extended for the systems with dependent components by Iyer and further investigated by Marichal and Mathonet. In the talk a natural generalization of the classic Birnbaum measure will be presented. It is valid for arbitrarily dependent components. It is also related with the Barlow-Proschan-Iyer measure in the same way as the original Birnbaum and Barlow-Proschan measures are. The illustrative examples will be provided.

[4B:2] Role of Order Statistics in Non-Gaussian Stable Distributions Inferences

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The variance of non-Gaussian stable distributions does not exist and many moment base inferences cannot be applied to them. On the other hand, the variance of many order statistics of a stable distribution exists. One can use this advantage

to adapt well-known order statistics-base inference for stable distributions. In this paper, we recall a necessary and sufficient condition for the existence of moments of stable distributions. Based on this result, we propose estimation methods of stable parameters. Using ranked set sampling, we introduce a lack of fit type regression with non-Gaussian stable errors. Best linear unbiased estimator for stable parameters and regression coefficients are introduced in a ranked set sampling framework. We show that the proposed estimators are comparable with well-known estimators.

[9A:2] Bayesian Approach for Analyzing Data Arising from Two-Arm Trials

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Recently, there has been a growing interest in clinical trials to demonstrate whether a new treatment is not worse than an active control by more than a specified margin. In this talk, we present a Bayesian approach for assessing hypotheses of interests in two-arm trials. We also examine the suitability of a normal approximation to the posterior distribution obtained via a Taylor series expansion in testing the hypotheses of equivalence. Suitability of the Bayes factor and the relative belief ratio for testing the hypotheses of equivalence is also discussed. When there are multiple studies, a meta-analysis approach for combining results will also be discussed.

[3B:1] Odds Ratios from Logistic, Geometric, Poisson, and Negative Binomial Regression Models

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The odds ratio is used as an important metric of comparison of two or more groups in many biomedical applications when the data measure the presence or absence of an event or represent the frequency of its occurrence. In the latter case, researchers often convert the count data into binary form and apply the well-known logistic regression techniques leading to information loss. We examine the magnitude of this loss through the Fisher information matrix and precision of the maximum likelihood estimates of odds ratios for the occurrence of the event of interest. We consider commonly used negative binomial regression models and through analytic work and simulation quantify the magnitude of information loss and discuss its consequences. (This is a joint work with Dr. Christopher Sroka).

[4B:3] Parameter Estimation for the Generalized Pareto Distribution and its Applications

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The generalized Pareto distribution (GPD), named by Pickands in 1975, is a limiting distribution for exceedances over thresholds, and it offers a unifying approach for modeling the tails of various distributions. It is used in various applied areas such as hydrology, reliability, life science, material science and quality control. The estimation of the parameters of the GPD poses a challenging problem, and the existing methods have some theoretical and/or computational difficulties. In this talk, we will introduce an estimation method for the GPD which, under mild regularity conditions, provide estimates which always exist uniquely and possess consistency over the entire parameter space. Finally, we will illustrate the proposed method with some real data sets.

[7A:1] Recent Advances in Precedence-type Tests and Applications

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In this talk, we will provide a comprehensive overview of theoretical and applied approaches to a variety of problems in which precedence-type test procedures can be used. Then, some recent advances on precedence-type tests, including the extension

to progressively censored data, a two-stage test for stochastic ordering in two samples, and a sequential procedure for the two-sample problem will be discussed.

[3A:2] Two-Stage Cluster Samples with Ranked Set Sampling Designs

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This paper develops design based statistical inference for population mean and total in a finite cluster population, where secondary population units are nested within primary population units. Sample units are selected using ranked set sampling (RSS) designs in a two-stage sampling. In the first stage, RSS sample is constructed from stage I population. In the second stage, another RSS sample is constructed from each one of the secondary populations in stage I sample units. RSS samples in both stages are constructed either with or without replacement policies. The paper constructs design unbiased estimators for population mean and total based on these two-stage samples. For these estimators, the paper quantifies the amount of improvement achieved due to using with and without replacement RSS designs over simple random sample (SRS) designs, studies the relationship between the intra-cluster correlation coefficient (ICC) and efficiency, and constructs approximate confidence intervals for population mean and total. The paper also shows that information content of stage I and stage II samples depends on the the magnitude of ICC, set sizes and ranking qualities in RSS designs. For a fixed cost, the optimal sample sizes for stage I and stage II samples are constructed by maximizing the information content of the sample. The paper also shows that optimal sample sizes depend on ICC and ranking quality in RSS designs. The proposed sampling designs and estimators are applied to California School district study and Ohio corn production data.

[8B:2] Empirical Phi-Divergence Test-Statistics for the Equality of Means of Two Populations

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Empirical phi-divergence test-statistics have demonstrated to be a useful technique for the simple and composite null hypotheses to improve finite sample behavior of the classical likelihood ratio test-statistic, as well as for model misspecification problems, in both cases for the one population problem. This paper introduces this methodology for two sample problems. The family of empirical phi-divergence test statistics, considered in this paper, contains the classical empirical log-likelihood ratio statistic as a particular case. A simulation study illustrates situations in which the new test-statistics become a competitive tool with respect to the classical z-test and the likelihood ratio test-statistic. Finally, the results devoted to univariate populations are extended to k-dimensional populations.

[4A:2] Blocked Semifoldovers of Two-Level Orthogonal Designs

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Follow-up experimentation is often necessary to the successful use of fractional factorial designs. When some effects are believed to be significant but cannot be estimated using an initial design, adding another fraction is often recommended. As the initial design and its foldover (or semifoldover) are usually conducted at different stages, it may be desirable to include a block factor. We study the blocking effect of such a factor on semifoldover designs. We consider two general cases for the initial designs, which can be either unblocked or blocked designs. In both cases, we explore the relationships between semifoldover of a design and its corresponding foldover design. More specifically, we obtain some theoretical results on when a semifoldover design can estimate the same two-factor interactions or main effects as the corresponding foldover. These results can be important for those who want to take advantage of the run size savings of a semifoldover without sacrificing the ability to estimate important effects.

[5A:3] Some Approaches for the First Passage Time of Degradation Processes and Applications in Reliability-based Optimal Design

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This article investigates two approaches for the first passage time (FPT) of continuous degradation processes: if using the discrete degradation path to approximate the continuous path when the number of increments is sufficiently large, Birnbaum-Saunder distribution is a good approach, moreover its parameters can be expressed in terms of the value of threshold and the moments of increment; if taking the degradation process as a pure jump process, we can directly apply the techniques of Lévy processes so that the some properties of jump processes can be obtained by numerically inverting the Laplace transforms. To evaluate the connections between Birnbaum-Saunders distribution and Lévy inverse subordinator, their first-passage behaviours across the different values of threshold and parameters such as mean-time-to-failure and survival probability are systematically investigated. By the approaches we propose, the issue of optimal design for degradation tests driven by any one-side processes can be studied by minimizing the asymptotic variance of the estimate of the 100p-th percentile of the lifetime distribution under the constraint that the total cost cannot exceed a pre-assumed price.

[6B:1] Evaluations of Quantiles of System Lifetime Distributions

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For each coherent and mixed system with exchangeable components, we provide sharp bounds on the deviations of system lifetime distribution quantiles from the respective quantiles of single component lifetime distributions. The bounds are expressed in the scale units generated by the absolute moments of various orders of the component lifetime centered about the median of its distribution.

[7B:2] Bayesian Predictive Density Estimation with Additional Information and Related Distribution

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We consider the problem of estimating a multivariate normal density under α–divergence loss with the additional information. Specifically let $X = \binom{X_1}{X_2} \sim \mathrm{N}_{2p}\left(\theta = \binom{\theta_1}{\theta_2}, \mathbf{\Sigma} = \begin{pmatrix} \sigma_1^2\mathbf{I}_p & 0 \\ 0 & \sigma_2^2\mathbf{I}_p \end{pmatrix}\right)$ and $Y_1 \sim \mathrm{N}(\theta_1, \sigma_Y^2)$ be independent. We consider the order $\theta_{1,i} - \theta_{2,i} \geq 0$, rectangular $|\theta_{1,i} - \theta_{2,i}| \leq m_i$, and spherical constraints $\|\theta_1 - \theta_2\| \leq m$ for $i = 1, \ldots, p$, $m > 0$, $m_i > 0$, as additional information. We show how Bayes predictive density estimators of Y_1 for truncated normal priors arise and involve generalized Balakrishnan skewed normal distributions. We show that the generalized Bayes predictive density estimator for the uniform prior on the order restricted parameter space dominates the minimum risk equivariant predictive density estimator $\hat{q}_{mre} \sim \mathrm{N}(x_1, \sigma_X^2 \frac{1-\alpha}{2} + \sigma_Y^2)$.

[2A:1] Bivariate Conway-Maxwell-Poisson Distribution: Formulation, Properties, and Inference

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The bivariate Poisson distribution is a popular distribution for modeling bivariate count data. Its basic assumptions and marginal equi-dispersion, however, may prove limiting in some contexts. To allow for data dispersion, we develop here a bivariate Conway-Maxwell-Poisson (COM-Poisson) distribution that includes the bivariate Poisson, bivariate Bernoulli, and bivariate geometric distributions all as special cases. As a result, the bivariate COM-Poisson distribution serves as a flexible alternative and unifying framework for modeling bivariate count data, especially in the presence of data dispersion. This work was completed in collaboration with Darcy Morris (U.S. Census Bureau) and N. Balakrishnan (McMaster University)

[9A:3] Bayesian Approaches to Analyzing Competing and Semi-Competing Risks Data: Applications in Cancer

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The topic of analyzing time-to-event data where individuals are subjected to multiple risks for the event occurrence has been well-studied for decades. In this framework a particular case that has received lions share of attention is when the event is caused by the earliest onset of a cause, known as the case of competing risks. Earlier work in competing risks analysis utilized a series system (observing the minimum of several lifetimes) formulation in terms of latent event times. It is well known that such a formulation is fraught with the issue of identifiability, unless one can assume the different causes to act independently. In recent times, substantial efforts have been made to formulate a model that has direct links to the observables and avoids imposing a dependence structure on the causes. We present two scenarios arising in the context of analyzing competing risks data, each highlighting an application in cancer. The first focuses on the premise where the exact cause of the event may only be known partially, necessitating methodologies appropriate for handling missing data. The second deals with dependent censoring that acts as a competing risk to the main event of interest that is recurrent in nature. We shall conclude with some highlight of the difficulties of dependent competing risks formulation in general.

[1B:3] Bivariate Birnbaum-Saunders Autoregressive Conditional Duration Model

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The univariate Birnbaum-Saunders (BS) distribution has gained increasing attention and is capable of modeling a wide variety of positively skewed data. Due to its good properties, the BS autoregressive conditional duration (BS-ACD) model has been suggested to analyze high-frequency trade duration data. Recently, Kundu et al. (2010) proposed the bivariate Birnbaum-Saunders (BVBS) distribution. It inherits important properties from the BS distribution and has more desirable characteristics. In this talk, we introduce the bivariate Birnbaum-Saunders autoregressive conditional duration (BVBS-ACD) model and associated methodology. We investigate the estimation and inference of the model parameters. A simulation study is conducted to explore the asymptotic properties of the estimates. We present methods to evaluate the goodness-of-fit and predictive performance of the model. Finally, a real data example is provided to illustrate the proposed methodology.

[1A:3] An Overview of Generalizations of the Negative Binomial Distribution with some Recent Results and Applications

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Negative binomial distribution has been found suitable for describing a wide variety of data in areas such as biology, entomology, ecology and accident statistics. With a view to make it more flexible, various generalizations of this model are available. In this paper, we first give a brief review of generalizations of the negative binomial distribution available in the literature. We revisit a generalization obtained by mixing the Poisson distribution with the three-parameter generalization of Gamma distribution due to Stacy [Stacey(1962)] proposed by Hegyi ((See Hegyi 1996, 1997, 1998). We obtain its probability function in an alternative form. The expressions for its mean and variance are derived. The moment type estimators as well as the maximum likelihood estimators for its parameters are developed. Score test is developed for testing if the negative binomial distribution (GNBD) is an appropriate model rather than the GNBD considered here. This model is fitted to some data sets along with the fits afforded by other similar models proposed in the literature. Graphical comparisons are made between the shapes of the proposed GNBD with the shapes of the negative binomial distribution for various parameter combinations. A graphical comparison of relative error committed when using the negative binomial model in place of the true GNBD model is presented. It is shown that the error is serious in the right tail. A zero-adjusted version of the GNBD considered here is also developed along with some methods of estimation. Fit of this model to some real data is also provided.

[1B:1] A Two-Piece Laplace Distribution Based on the Skewing Methodology of Balakrishnan, Dai and Liu

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Recently Balakrishnan et al. (2015) proposed a new skew logistic model, constructed using the half-logistic distribution as building block. In this paper we utilize their skewing methodology to develop a two-piece Laplace (double exponential) model. We compute the moments of order statistics of this model and use them to obtain expressions for the L-moments. As with the skew logistic model of Balakrishnan et al. (2015), the L-kurtosis ratio and quantile-based kurtosis measures of our two-piece Laplace model are all skewness invariant. We furthermore show that our model is more flexible in terms of skewness compared to existing two-piece and asymmetric Laplace distributions.

[7A:3] Modelling Extreme Percentiles in Bivariate Birnbaum-Saunders Distributions: EM-Estimation

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We derive here a generalization of the bivariate Birnbaum-Saunders (BS) distribution of Kundu et al. (2010) by basing it on the bivariate skew-normal (SN) distribution. This resulting bivariate Birnbaum-Saunders distribution is an absolutely continuous distribution whose marginals are in the form of univariate Birnbaum-Saunders distributions discussed by Vilca et al. (2011). We then study its characteristics and properties, such as the joint distribution function, marginal and conditional distributions. We introduce a Non-central Bivariate BS distribution and we then present analytically a simple EM-algorithm for iteratively computing the maximum likelihood estimates of the model parameters, and we compare the performance with the estimates obtained via the estimation approach of Jamalizadeh and Kundu (2015). Moreover, the observed Fisher information matrix is is analytically derived and the simulation studies and applications to real data sets are finally presented.

[3A:1] Use of Unbalanced Ranked Set Sampling in Cluster Randomized Studies

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We consider the use of unbalanced ranked set sampling (URSS) with cluster randomized designs (CRDs), and extend non-parametric estimators and testing methods, previously developed by Wang, Lim and Stokes (JASA, in press) for the use of balanced RSS (BRSS) with CRDs, to account for unbalanced stratified structures under different ranking schemes. We study the optimality, finite-sample and asymptotic properties of the URSS estimators, and numerically quantify and compare the relative efficiency of the URSS vs. BRSS estimators. We also study and compare the power of the URSS tests vs. their BRSS counterparts via simulation. Further, we investigate the application of the proposed methods to unbalanced data from BRSS-structured CRDs due to missing observations and illustrate it with a data example using educational data. Finally, based on our results, we offer recommendations about when to use URSS over BRSS with CRDs.

[8A:1] Penalized Empirical Likelihood for the Cox Regression Model

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Current penalized regression methods for selecting and estimating regression coefficients in the Cox model are mainly developed on partial likelihood. In this paper, an empirical likelihood method is proposed in conjunction with appropriate penalty function. Asymptotic properties of the resulting estimators, including the consistency, asymptotic normality and the oracle property with respect to variable selection, are theoretically proved. Simulation studies suggest that empirical likelihood is

superior to partial likelihood in terms of selecting correct risk factors and reducing estimation error. The well-known primary biliary cirrhosis data set is used to illustrate and compare the empirical likelihood method with existing methods.

[3B:3] Adaptive Design of Clinical Trials

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Statistical design and analysis of clinical trials have always been an important part of mainstream clinical research. Adaptive designs of Phases I, II and III clinical trials involve significant statistical issues and challenges. In this talk, I will discuss various adaptive designs of clinical trials in different phases. Both frequentist and Bayesian approaches are covered.

[9B:1] Stochastic Comparison in Cybersecurity

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Cybersecurity has become a problem that is threatening the economy, human privacy, and even national security. However, the contributions to study the cybersecurity risk in the literature are largely descriptive, which is mainly because the cybersecurity risk is very different from the traditional risks. The significant property that distinguishes Cybersecurity risk from the conventional risk is that information and communication technology resources are interconnected in a network, and therefore the analysis of risk and its related potential losses needs to take into the network topology.

In this talk, we will discuss the application of stochastic orders in cybersecurity modeling. Particularly, we study the effects of dependence among cyber-attacks and network topology on the cybersecurity via stochastic comparison. Simulation evidence will be presented to support the theoretical results as well.

[5A:2] Optimal Designs for Measurement Error Models when the Second-Order Least Square Estimator is Adopted

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Possible measurement errors involved in a regression mode is often overlooked in the planning and analysis of experimental designs. In this paper, we discuss D-optimal designs for measurement error models. The second-order least squares (SLS) method is used to improve the estimation accuracy for the regression models with measurement errors. We have investigated the asymptotic properties of the SLS estimator adopted for measurement error models. D-optimal designs are obtained for various cases of variance structure associated with measurement error involved.

[4A:1] The Order of Error Probabilities for Response Adaptive Designs

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Response adaptive designs have the ethical advantages over the traditional methods, but the numbers of patients allocated to treatments are random due to the adaptation process of treatment allocation. This paper discusses the asymptotic optimality of statistical inference for response adaptive designs. The upper bound of statistical power of asymptotically level α tests is derived and the Wald statistic is shown to be asymptotically optimal in terms of achieving the upper bound. The rates of coverage error probability of the confidence interval are proven to depend on the convergence rate of the allocation proportions for non-normally distributed responses. When the convergence rate of allocation proportions is unknown, the coverage error probability of confidence interval and the type I error rate have the order of $o(n^{-1/2})$. Specially, if the response density functions are normal density functions, it is proven that the coverage error probability and the type I error has the order of $O(n^{-1})$.

[9B:3] On Aggregate Risks from Two Sets of Heterogeneous Portfolios

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In this talk, we treat the problem of stochastically comparing the aggregate risks from two heterogenous portfolios. It is shown that the more heterogeneities among aggregate risks would result in larger aggregate risks in the sense of the stochastic order. The stochastic properties of aggregate risks when the claims follow proportional hazard rates models or scale models are studied. We also present some sufficient conditions for comparing the aggregate risks arising from two sets of heterogeneous portfolios with claims having gamma distributions. In particular, the aggregate risks of portfolios from dependent samples with comonotonic dependence structures or arrangement increasing density functions are discussed.

[6A:1] A New Nonparametric Screening Method for Ultrahigh-dimensional Survival Data

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This article focuses on the development of variable screening methods for ultrahigh-dimensional survival data which frequently occur in many scientific fields. Most existing screening procedures are developed for ultrahigh-dimensional complete data and cannot be applicable to censored survival data. To address the new challenges from censoring, we propose a novel model-free screening method through the Kolmogorov-Smirnov test statistic that is specially tailored to the ultrahigh-dimensional survival data. This new method enjoys the sure screening property under some mild regularity conditions, and its superior performance over existing screening methods is demonstrated by our extensive simulation studies. A real data example of gene expression is used to illustrate the application of the proposed fully nonparametric screening procedure.