01 *DR. ALEKH AGARWAL (RESEARCHER MICROSOFT)*

02 *CO-CHAIR: TADEU FERREIRA, PH.D. CANDIDATE & PRESIDENT SGSU AND CO-CHAIR: REIHANEH ENTEZARI, PH.D. CANDIDATE & VICE-PRESIDENT SGSU*

03 *PANEL DISCUSSION (LEFT TO RIGHT): TADEU FERREIRA, PROFESSOR RUSLAN SALAKHUTDINOV, DR. ALEKH AGARWAL AND PROFESSOR DANIEL ROY*

Research Day: Machine Learning for Big Data

The Research Day (RD) was organized by the Statistics Graduate Student Union and the Department of Statistical Sciences at The Fields Institute on April 17th, 2015. The event was a huge success this year with a record attendance of more than 170 participants. The audience was graced with the presence of three renowned researchers working in companies with cutting-edge discoveries in Big Data:

Following the talks there was a panel of discussion involving the keynote speakers and professors from the stats department.

Ruslan Salakhutdinov and Daniel Roy had lively discussions with the keynote speakers on many of the topics submitted during registration.

The 2015 RD was well attended by attendees from University of Waterloo, York, Guelph, Queen's, McMaster, Ryerson, Western Ontario and companies like Google Canada, AMD, Microsoft, Accenture, Zynga and many others.

On behalf of SGSU and the Department of Statistical Sciences, we would like to thank everyone that helped to make the event a huge and informative success.

ORGANIZING COMMITTEE (UNIVERSITY OF TORONTO)
Tadeu Ferreira | co-chair: PH.D. candidate & president SGSU. **Reihaneh Entezari** | co-chair: PH.D. candidate & vice-president SGSU. **James Stafford** | professor. **Nancy Reid** | professor. **Annette Courtemanche. Christine Bulguryemez.**

Guest Speakers | Company

Guest Speakers	Company
Dr. Robert Bell	Researcher at Google
Dr. Alekh Agarwal	Researcher at Microsoft
Dr. Kevin Patrick Murphy	Researcher at Google

Student Speakers | Department

Student Speakers	Department
Alexander Shestopaloff	Department of Statistical Sciences
Jimmy Ba	Department of Computer Science
Patrick Halina	Department of Statistical Sciences

Actuarial Research Conference

50th Annual Actuarial Research Conference: University of Toronto

The University of Toronto is proud to have hosted the 50th annual Actuarial Research Conference (ARC). The conference took place from Wednesday, August 5 through Saturday, August 8 at historic Victoria College on the U of Toronto campus. In 2015, the Canadian Institute of Actuaries also celebrates 50 years since its founding. In addition, the University of Toronto celebrates (at least) 130 years of actuarial education.
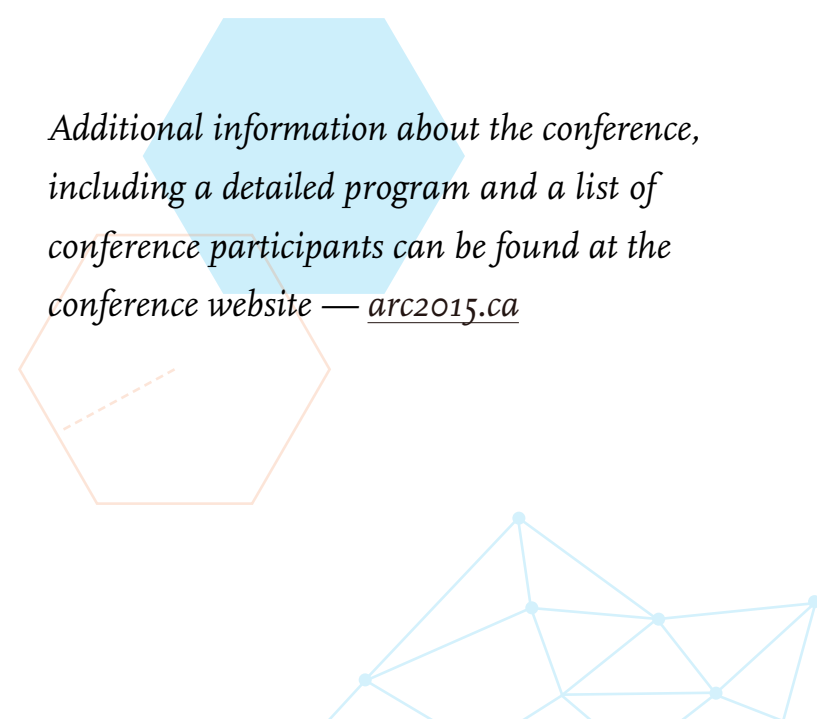
Almost 250 people registered for this year's ARC. This is the largest attendance that the ARC has had to date. There were almost 120 papers presented in the 35 parallel sessions of contributed papers and special sessions. The parallel sessions covered over a dozen topics from Actuarial Education to Statistical Methods (almost A to Z), most with multiple parallel sessions. In addition, there were several sessions on special topics including one on Software Innovation for High Performance Actuarial Modelling, an SOA Entrepreneur Section panel and a session on Emerging Trends in P&C Insurance.

There were two invited plenary speakers. Prof. Rob Tibshirani of Stanford University, a world renowned expert in statistical learning, spoke on Thursday, August 6. On Friday, August 7, the plenary lecture was given by Prof. Mogens Steffensen of the University of Copenhagen, a world leading expert in the mathematics of life insurance.

The conference organizers extend their deep gratitude to the various sponsors who so generously contribut-ed support for the conference. The three professional societies, CIA, SOA and CAS were sponsors along with Munich Re, Manulife Financial, RSA, Sun Life, Canada/Great West Life, Coaching Actuaries, and Towers Watson. In addition, at the CIA sponsored reception on Thursday, the CIA presented to the University of Toronto Actuarial Science Program a plaque commemorating 130 year so actuarial education at the University of Toronto.

Additional information about the conference, including a detailed program and a list of conference participants can be found at the conference website www.arc2015.ca. We are looking forward to a great ARC next year in Minneapolis-St. Paul, jointly hosted by the University of Minnesota and the University of St. Thomas.

Additional information about the conference, including a detailed program and a list of conference participants can be found at the conference website — arc2015.ca

Statistical Inference, Learning and Models for Big Data Thematic Program

JANUARY TO JUNE 2015

The thematic program on Statistical Inference, Models and Learning for Big Data focussed on the study and advancement of inferential techniques for statistical learning in big data. The emphasis on inference was prompted by the urgent need for new statistical, computational, and mathematical research to address the ever-increasing demands of big data.

The program committee was appointed by the Canadian Institute of Statistical Sciences, and allied events on the same topic took place across the country, at PIMS, CRM, and AARMS. The scientific program had two complementary strands. One strand emphasized inference and data in particular substantive areas: social policy, health policy, networks, and environmental science. The other focused on cross-cutting areas of mathematical, computational and statistical sciences, including statistical learning, visualization, optimization, and new inferential paradigms.
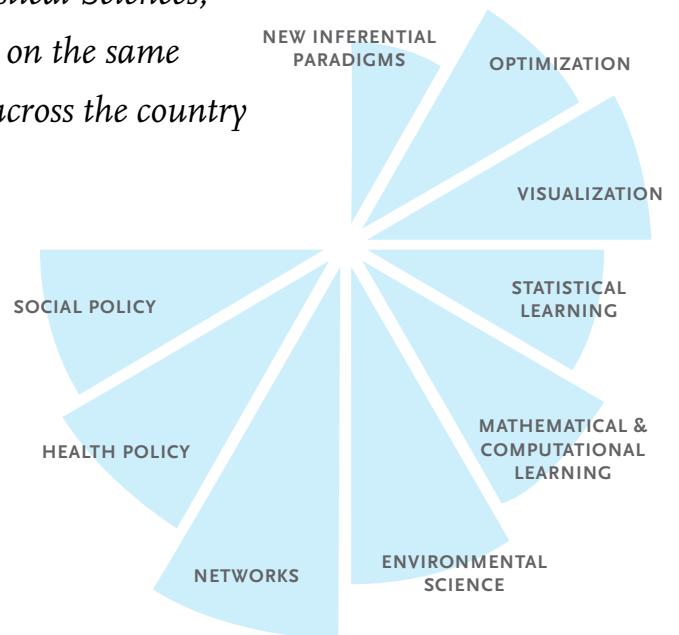
Several other activities at the Fields Institute were also focused on inference for big data, including both the 2014 and 2015 Distinguished Lecture Series in Statistics: given by Bin Yu and by Terry Speed, the Coxeter Lectures given by Michael Jordan, a workshop on Complex Spatio-Temporal Data Structures, a workshop on Big Data in Commercial and Retail Banking, a Distinguished Public Lecture by Andrew Lo, an Industrial Problem Solving Workshop, and a wildly successful and over-subscribed graduate student research day, which featured Robert Bell from ATT, Alekh Aggarwal from Google, and Kevin Murphy from Microsoft.

The training program was anchored by two graduate courses, as well as the opening workshop and bootcamp (January 9 to 23); these gave graduate students and postdoctoral fellows unique exposure to cutting edge research in a wide range of areas. There were six postdoctoral fellows in residence throughout the program; Roger Grosse was a Marsden PDF and Armin Hatefi was a Fields-Ontario PDF. PDF Einat Gil, a specialist in learning environments and technology, developed a very interesting program on big data for Grade

12 mathematics students which was piloted at a local high school for five weeks. All activities at the Fields Institute were streamed using FieldsLive, which was widely used both during the workshops and later: the archive is an invaluable research resource.

The opening workshop and bootcamp devoted one day to each of the themes of the various workshops, following two days of overview lectures. It quickly became apparent during this workshop that the breadth of application of inference for big data is immense, and that several common themes emerge that do indeed cut across all areas. Many speakers began their presentations with a definition or description of Big Data: key features widely identified are called the "Four V's"

The program committee was appointed by the Canadian Institute of Statistical Sciences, and allied events on the same topic took place across the country

NEW INFERENTIAL PARADIGMS

OPTIMIZATION

VISUALIZATION

STATISTICAL LEARNING

SOCIAL POLICY

MATHEMATICAL & COMPUTATIONAL LEARNING

HEALTH POLICY

ENVIRONMENTAL SCIENCE

NETWORKS

THE SCIENTIFIC PROGRAM

— volume, velocity, variety, and veracity. In essence we have big data because technology makes it possible to measure many new things in nearly continuous time. A great deal of this concerns human activity and is thus intrinsically interesting, and there is a pervasive sense that although this data is unstructured and difficult to handle, it contains valuable information. As just one of many interesting examples, David Buckeridge of McGill University discussed the problem of measuring the effect of nutrition. Three relevant databases for this problem that he is working with include a 10% sample of all products sold at convenience stores, along with their UPC codes, which can be linked to nutritional content; details from loyalty programs on household purchases; and medical records of disabilities or chronic disease such as diabetes. Shane Reese from Brigham Young University described the use of four years of twitter messages in South America, combined with an increase in the use of the TOR anonymizer, to predict insurgencies.

A detailed report of the bootcamp prepared by the postdoctoral fellows and long term visitors identified a number of common challenges, and a number of common approaches. One set of challenges arises from the volume: most statistical and computational methods do not scale well, and simply fail on very large datasets. Special infrastructure, such as clusters of computers combined with parallel processing, selective sampling, and so-called divide and recombine techniques all have a role to play. Big data may be "long", involving a very large number of individual observations, or "wide", involving a very large number of measurements on a relatively small number of individuals. Both raise difficulties: the former of the need to model potentially complex dependencies, and the latter a failure of traditional statistical theory and methods. Challenges arising from the variety of big data include the need to develop new methods for the analysis of text, images, video and networks. Spatial and time-series data may be highly heterogeneous. For example spatial data on human populations are in some databases available at the level of postal code, and in others at the level of census tract. Data on historical records of climate are constructed by combining information from ice cores, tree rings, pollen, and surface temperature records. Challenges associated with veracity include both data quality and data privacy. There are some high-profile failures of large datasets, such as Google Flu Trends to provide correct inferences, due to hidden or unacknowledged biases. This is partly related to the prob-

lem that a great deal of big data is observational, or even administrative, so was not collected with the purpose of addressing particular scientific concerns. It is also partly related to the emphasis in some fields on a 'black-box' approach to prediction, without developing a modeling strategy that describes important features of the data. These black-box approaches are very useful for dealing with the velocity of big data; for example for recommender systems with online viewing or purchasing, but must be used with care if the veracity of the data is in doubt. There have also been some high profile failures of privacy, by linking various databases. Privacy has long been a concern of government statistical agencies and health records agencies, and is now engaging the computer science and cryptography communities.

Common solutions to many of these problems include building more complex models, assuming underlying sparsity, developing non-convex optimization techniques, developing new visualization tools and developing new asymptotic theories. All of these approaches were developed and extended in the various workshops.
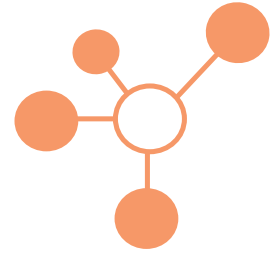
Special infrastructure, such as clusters of computers combined with parallel processing, selective sampling, and so-called divide and recombine techniques all have a role to play.

Highlights From M/L Workshop

Highlights from Optimization workshop:

The workshop on Optimization and Matrix Methods for Big Data (Feb 9 – 11) highlighted several recent advances in new algorithms for data mining that come with strong statistical guarantees. One theme of the workshop was the recent emergence of non-convex optimization methods for big data. Conventionally, non-convex optimization comes with relatively weak guarantees, but P. Loh and A. Anandkumar showed two important application areas in which non-convex optimization is guaranteed to be efficient and also to recover the hidden structure in the data. Another emerging theme addressed by Q. Berthet, B. Recht and other speakers is the limit of our ability to carry out inference: although a signal may be present in the data and detectable in the information-theoretic sense, its detection may be beyond the range of tractable computation. Finally, many speakers discussed the crucial challenge of adapting existing algorithms for the case of really massive data sets. The workshop boasted participants from universities in Canada, the U.S., and Europe as well as government labs (Sandia) and industry (Microsoft and IBM).

Highlights from Visualization workshop:

The workshop on Visualization (Feb 23 – 27) brought together experts from the research communities in information visualization, in scientific visualization, and in statistical graphics. Visualization is an interesting problem for big data because our current visual devices can display only a small portion of the data, so the question becomes what to present, how to summarize the data, and how to develop interactive displays that permit multi-scale views of a given database. Sheelagh Carpendale, founder and director of the Innovations in Visualization Laboratory of the University of Calgary described new types of interactive graphical display, some modelled on fractal scales in mathematics and in nature. The Papilio display develops a visual display appropriate for a data structure that includes a partial ordering. Katy Borner, Director of the Cyberinfrastructure for Network Science Center at Indiana University emphasized the role of visualization in engaging the viewer and creating new conversations about science, technology and innovation that permits interested non-specialists to engage in conversations around big data.

Hadley Wickham, of RStudio, and Di Cook from Iowa State University have, with their students and collaborators, revolutionized the graphical presentation of statistical data, and the organization of data bases for both plots and for statistical inference, with an original and important suite of R packages, including dplyr, ggplot2, ggvis, and tidyr. A series of presentations of ongoing work by graduate students in Di Cook's laboratory was a highlight of the workshop. One interesting aspect of visualization, especially interactive visualization, is the difficulty of capturing the dynamic nature of the process in a static publication. Thus developing tools to record the steps of an investigation paly an important role, and this resonates well with the increasing emphasis on reproducible research in scientific work. RStudio, in particular, makes the careful recording of work flow much easier than it has been in the past, and this has important uses far outside the application to visualization.

Highlights from Social Policy workshop:

The workshop on Big Data in Social Policy (Apr 13 – 16) explored the interface between social and decision information theory and policy. Workshop days were devoted to official statistics, network models and agent-based modeling, living analytics and privacy, and urban analytics. The spiralling cost of carefully collected survey and census data is pushing governments to increase their emphasis on administrative data collected for other purposes, including taxation, for example. Robert Groves, former director of the US Census, emphasized the many policy challenges facing government statistical agencies; this is sometimes

called the 'all data revolution'. While all data revolution provides new sources of data to inform policy, it also requires changes in policy, and these changes require strategies based on statistical reasoning. Eric Miller of the University of Toronto described the use of agent-based microsimulation models for modelling, for example, travel demand and to experiment with the effect of alternative transportation policy decisions on travel demand and travel patterns. Archan Misra from Singapore Management University described the "Living Analytics" project there, which is using mobile technology on campus to understand human behaviour, including social networks, queuing episodes, and indoor movement.

Highlights from Health Policy workshop:

The workshop on Big Data in Health Policy (Mar 23 – 27) focused on causal inference techniques for healthcare data. Causality is hard to establish in large databases, where a massive number of variable associations can often be explored. Moreover, traditional approaches for causal inference, such as regression adjustment and stratification, have limitations in big data environments. Speaker presentations focused on graphical methods, research designs, and inferential techniques that can be used to explore causal relationships in population health and healthcare use. Two mini-workshops, on the topics of propensity score and marginal structural models, were led by Drs. Peter Austin (University of Toronto) and Erica Moodie (McGill University), respectively. A diverse range of big data applications were explored in such areas as medical device surveillance, drug safety and effectiveness, and micro-simulation modeling of population health. Speakers were from several provinces in Canada, the US, and Europe.

SUMMARY STATISTICS FROM REGISTRATIONS	
OPENING CONFERENCE	59 REGISTRANTS; 20 HQP
MACHINE LEARNING	67 REGISTRANTS; 34 HQP
OPTIMIZATION	29 REGISTRANTS; 9 HQP
VISUALIZATION	51 REGISTRANTS; 22 HQP
HEALTH POLICY	73 REGISTRANTS; 21 HQP
SOCIAL POLICY	38 REGISTRANTS; 5 HQP

THERE ARE SEPARATE STATISTICS AVAILABLE FROM FIELDSLIVE, WHICH ANECDOTALLY HAS BEEN VERY WIDELY USED. AT THE OPENING CONFERENCE AND M/L WORKSHOPS IN PARTICULAR, THERE WERE LARGE NUMBERS OF REGULAR ATTENDEES WHO DID NOT REGISTER.

New Course Development

Using Actuarial Software to Explore the Real World of Insurance

BY VICKI ZHANG

With the generous funding of University of Toronto's Advancing Teaching and Learning award, we recently developed a new capstone course at the actuarial science program – Insurance Market, Products, and Regulation with AXIS. The course is currently in its first pilot year and offered to the fourth-year, graduating class of UofT's actuarial science program.

We strive to achieve three key objectives in this course: (1) to bridge crucial technical gaps in the undergraduate curriculum that addresses current internal risk management and modeling techniques; (2) to introduce reflective topics and improve actuarial students' independent and critical thinking skills as well as oral and written communication skills; and (3) to learn to model realistic modern insurance products in the widely-used actuarial software AXIS.

To fulfill the first objective, we introduced course readings for many technical topics that are immensely useful for a future practitioner but rarely covered in undergraduate programs: how to read and reconcile a realistic income statement and balance sheet of an insurance company, how to calculate reserves under various methodologies from around the world, basic and advanced reinsurance arrangements, dynamic hedging of variable annuities with guarantees, pricing VA using a stochastic-on-stochastic model, basics of insurance securitization, etc. As some of the technical topics covered in the course appear to be challenging for undergraduates, we designed case studies that utilize AXIS and/or Excel to demonstrate the techniques in the context of real-life products or actuarial practices.

Aside from technical topics that are not typically offered in an undergraduate program, the course also provides an overview and a forum to learn and discuss the history of insurance product evolution and changes in regulatory framework. Many topics in this component of the course are open-ended or even controversial – the pros and cons of different regulatory systems, the traditional function of insurance and the financial innovation, the changing risk profile of the insurance sector, the social responsibility of actuaries,

etc. Students are required to submit reflective comments in the online discussion forum and continue the discussions during the seminars. Towards the end of the semester, students are asked to consolidate their thoughts and compose a longer paper on a controversial topic of their choice.

In the final component of the course, students learn to model realistic insurance products (term and whole life, universal life, variable life, fixed and variable annuity, etc.) using the popular actuarial software AXIS. This involves both model coding and result reconciliation, which simulates work tasks of an industry practitioner. Preliminary results from the course exit review showed students' appreciation for learning beyond standard actuarial exams and calculators, for exploring the real world of insurance using sophisticated modern technology, and for challenging themselves to think reflectively and deeply.

WE STRIVE TO ACHIEVE THREE KEY OBJECTIVES IN THIS COURSE:

01 —— to bridge crucial technical gaps in the undergraduate curriculum that addresses current internal risk management and modeling techniques

02 —— to introduce reflective topics and improve actuarial students' independent and critical thinking skills as well as oral and written communication skills

03 —— to learn to model realistic modern insurance products in the widely-used actuarial software AXIS.

Jeffrey Rosenthal invention of "Pi Instant"
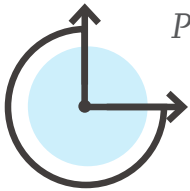
Pi Instant: March 14, 2015, at 9:26:53.58979... a.m.

The mathematical constant pi (or ϖ) represents the ratio of a circle's circumference to its diameter. It is an extremely important value for geometry, trigonometry, calculus, Fourier analysis, quantum mechanics, and so much more. It has no exact rational or finite decimal form, but its numerical value is approximately 3.1415926535897932385...

In honour of pi, Pi Day is celebrated each March 14, since "March 14" can be written as "3/14" which comprises the first three digits of pi. Pi Day in the year 2015 was special, since "March 14, 2015" can be written as "3/14/15", thus comprising the first *five* digits of pi, not just three. Extending this, some have observed that on March 14, 2015, at the time 9:26:53 a.m. (or p.m.), the date and time can be written as "3/14/15; 9:26:53", thus comprising the first ten digits of pi — a "Pi Second".

I propose to take this idea a step further. The time 9:26:53 refers to 26 minutes and 53 seconds after 9 o'clock. By extension, the time 9:26:53.58979... refers to 26 minutes and 53.58979... seconds after 9 o'clock. If the remaining (infinite) decimal expansion of 53.58979... is chosen to follow pi's digits exactly, then we obtain a single precise instant, "3/14/15; 9:26:53.58979...", during which all of the infinite digits of pi are all represented by a single precise date and time.

I thus propose that March 14, 2015, at 9:26:53.58979... (i.e., at 26 minutes and 53.58979... seconds after 9 o'clock a.m., where the remaining digits of 53.58979... all follow the digits of pi) be designated and celebrated as Pi Instant, the single instant when all of pi's infinite digits were all laid out before us.

CIRCUMFERENCE

DIAMETER

$$\frac{\text{CIRCUMFERENCE}}{\text{DIAMETER}} = \pi$$
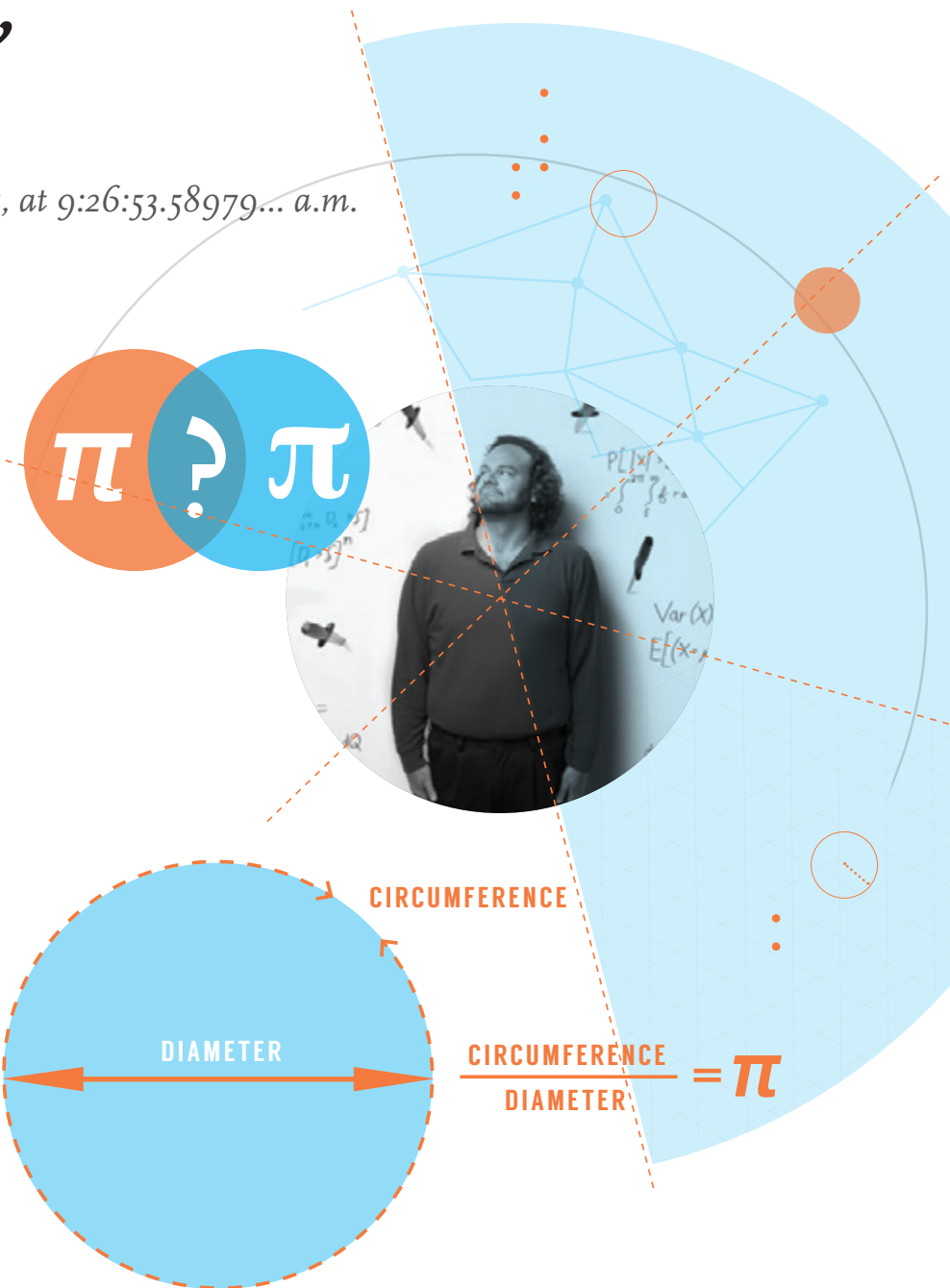
Jeffrey S. Rosenthal, October 2014 (A slightly condensed version of this note was published in the February 2015 issue of Math Horizons; see also a related radio interview.)

Baby Announcements

Dr Dan Roy's wife, Gintare Karolina, gave birth in May to their first son, Kaius Emilijus. Incidentally, Kaius's parents finished revisions to their first scientific paper together the day after while Kaius slept.

Dr Vicki Zhang welcomed Julia Jasmine Kapler in May 2015.

Professor Andrei Badescu's daughter Mila is now 2 years old but she missed our last newsletter!

Research And Study Leave Reports

Lei Sun and Radu Craiu had a great time during their sabbatical leave.

While the first half was spent in Toronto working with students and colleagues, they traveled in the second half to Toulouse, Rome, Kent and Venice where they benefitted from the gracious hospitality of old and new collaborators. It was highly motivating to talk with energetic and prolific researchers and to be part of academic interactions in

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outstanding settings. Particularly impressive was the University La Sapienza in Rome which is one of the oldest Universities in Europe, founded in 1303 and counting among its graduates Vito Volterra, Enrico Fermi, Maria Montessori and Bernardo Bertolucci. Other brief visits included Paris and Bucharest where the International Conference on Risk allowed for a brief U of T reunion with Prof. Andrei Badescu and alum Valentin Asimit.

Professor Jeffrey Rosenthal has just returned from a year-long research leave, taken from January–June 2014 and January–June 2015

During this time, he continued to conduct original research into Markov Chain Monte Carlo (MCMC) and other statistical computation algorithms, publishing a number of papers (see Faculty Publications), helping to organise a conference in Chamonix, France and visiting the University of Warwick where he stayed in the famous "Maths House" residence.

He also continued the public outreach efforts arising from his bestselling book "Struck by Lightning: The Curious World of Probabilities", including inventing and discussing Pi Instant. And he managed to squeeze in a few leisure activities, such as performing music in the play The Mumberley Inheritance.

SEE PROFESSOR JEFFREY ROSENTHAL'S SHORT ARTICLE DISCUSSING PI INSTANT AT — PROBABILITY.CA/ JEFF/WRITING/PIINSTANT.HTML

TO LISTEN TO PROFESSOR JEFFREY ROSENTHAL'S CBC RADIO INTERVIEW PLEASE VISIT — PROBABILITY.CA/ SBL/FRESHAIR2015.MP3.
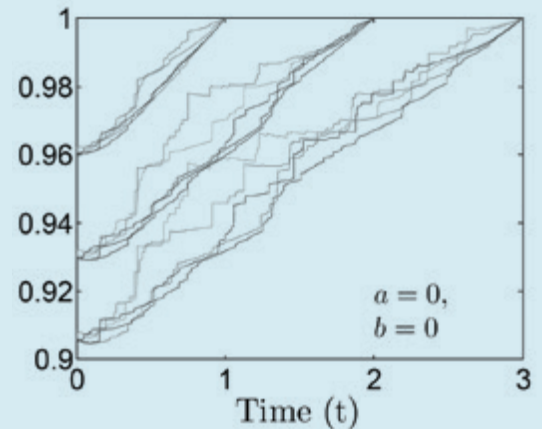

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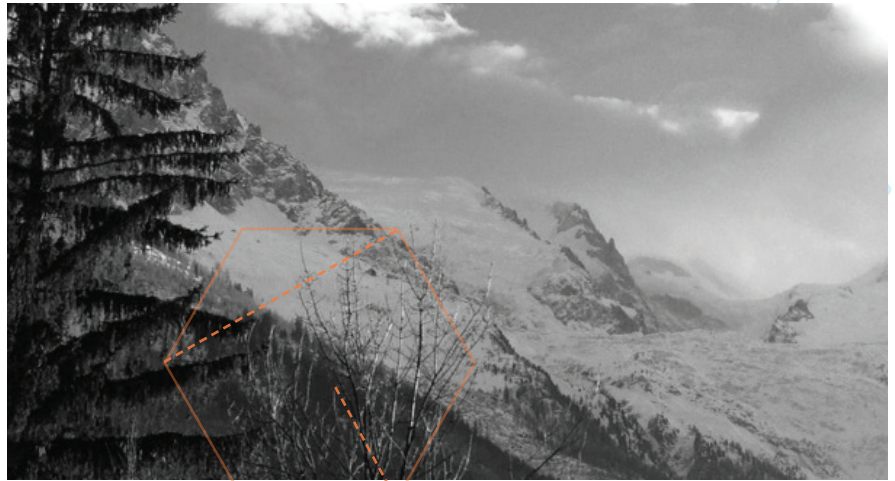
04

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01 PROFESSOR RADU CRAIU WITH FABRIZIO LEISEN AND JIM GRIFFIN AT THE UNIVERSITY OF KENT

02 PROFESSOR RADU CRAIU AND LEI SUN, THEIR CHILDREN LUCAS AND CLARA AND WITH ROBERTO CASARIN IN VENICE

03 PROFESSORS RADU CRAIU IN ACTION AT THE UNIVERSITY OF VENICE

04 THE VIEW FROM PROFESSOR JEFFREY ROSENTHAL'S HOTEL ROOM AT AN MCMC CONFERENCE IN LOVELY CHAMONIX, FRANCE.

05 PROFESSOR JEFFREY ROSENTHAL'S LODGINGS DURING HIS RESEARCH VISIT TO THE UNIVERSITY OF WARWICK INCLUDED BLACKBOARDS ON CURVED WALLS FOR PERFORMING MATHEMATICAL CALCULATIONS.

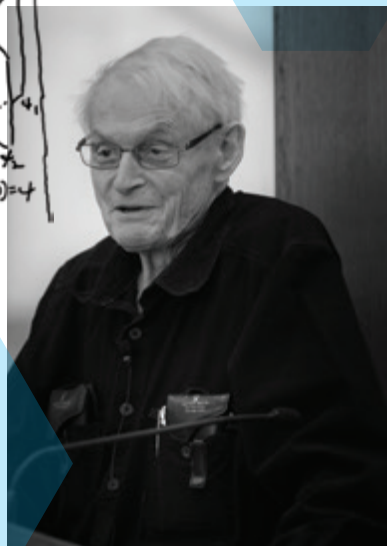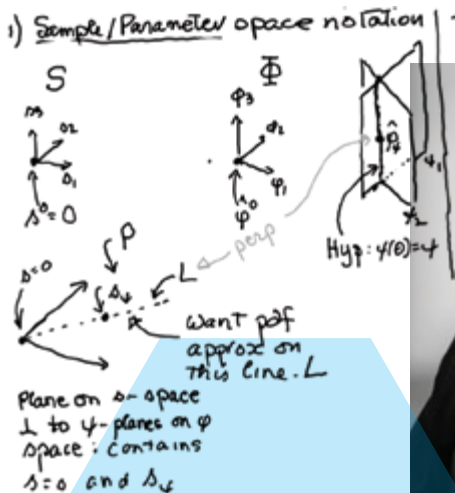# Prof Don Fraser's 90th Birthday!

On April 29, 2015 the department was delighted to celebrate the 90th birthday of Don Fraser. To this end we hosted a day long symposium at the Munk School of Global Affairs with keynote addresses given by former students of Don's, Xin Tong, who traveled a great distance to attend, and Georges Monette, as well as Don himself. The event was capped by a delightful reception — an appropriate way to honour such an important figure to our Department.

DONELLE FRASER, NANCY REID, DON FRASER AND AILIE FRASER

University of Toronto Actuarial Science Club

During the 2014–2015 academic year, the University of Toronto Actuarial Science Club continued to host a variety of social and industry events for actuarial science students. We had a number of social events for students to meet each other and become well acquainted outside of the academic environment. Like last year, we had office visits to both Manulife Financial and Sun Life Financial and our mentorship program has seen a growth in participation by both students and employers over the past year. As usual, we had numerous companies come on campus to host informational sessions for our students. However, we've seen an increasing interest in our student body by Property and Casualty insurers. We concluded our academic year with our annual Semi-Formal, held at the One King West Hotel. By no surprise, the event was a hit among students, indicating a fitting way to end the academic year. The Actuarial Science Club has grown over the years and will continue to do so and we will remain a cornerstone of the actuarial science student community for years to come.

**For more information please visit uoftactsciclub.com
Facebook group: facebook.com/groups/utstatsclub/**

FACULTY PUBLICATIONS

Andrei Badescu

Antonio K., Badescu A.L., Gong L., Lin X.S., Verbelen R. Fitting mixtures of Erlangs to censored and truncated data using the EM algorithm, to appear Astin Bulletin, 2015.

Badescu A.L., Gong L., Lin X.S., Tang D. Modeling correlated frequencies with application in operational risk management, Journal of Operational Risk, 2015, Vol 10(1), 1-45.

Breuer L., Badescu A.L., A generalised Gerber-Shiu measure for Markov-additive risk processes with phase-type claims and capital injections, Scandinavian Actuarial Journal, 2014, Issue 2, 93-115.

Michael Evans

Discussion of "On the Birnbaum Argument for the Strong Likelihood Principle". Evans, M. Statistical Science, Vol. 29, No. 2, 242-246, 2014.

Objectivity, Subjectivity and Statistical Evidence. Evans, M. Interdiciplinary Journal of Health Sciences, Volume 4, issue 1: Special Issue on Statistics and Health 2014.

Cao, Y., Evans, M. and Guttman, I. Bayesian factor analysis via concentration. Current Trends in Bayesian Methodology with Applications eds. S. Upadhyay, U. Singh, D. Dey and A. Loganathan, CRC Press, Taylor & Francis Group, p. 181-201, 2015.

Evans, M. Measuring Statistical Evidence Using Relative Belief, Chapman & Hall/CRC Monographs on Statistics & Applied Probability 144, 2015

Sebastian Jaimungal

Álvaro Cartea, Sebastian Jaimungal and José Penalva. Algorithmic and High-Frequency Trading, Cambridge University Press

Y. Lawryshyn and S. Jaimungal (2015) Incorporating Managerial Information into Real Option Valuation, Fields Institute Volume on Commodities, Energy, and Environmental Finance, Springer Series on Mathematics and Applications

L. Kobari, S. Jaimungal & Y. Lawryshyn (2014) A real options model to evaluate the effect of environmental policies on the oil sands rate of expansion, Energy Economics, Volume 45, Pages 155-165

Optimal Execution with a Price Limiter, RISK, July 2014, 103-112

A. Cartea, J. Cheeseman & S. Jaimungal (2015) Natural Gas Storage Modelling, in Handbook of Multi-Commodity Markets and Products: Structuring, Trading and Risk Management, Wiley Finance, pg 877-901

Sheldon Lin

Verbelen, R., Gong, L., Antonio, K., Badescu, A. and Lin, X.S. (2015). "Fitting mixtures of Erlangs to censored and truncated data using the EM algorithm," ASTIN Bulletin, accepted.

Gan, G. and Lin, X.S. (2015). "Valuation of large variable annuity portfolios under nested simulation: a functional data approach," Insurance: Mathematics and Economics, 62,138-150.

Badescu, A., Gong, L., Lin, X.S. and Tang, D. (2015). "Modeling correlated frequencies with applications in operational risk management," Journal of Operational Risk, 10(1), 1-43.

Jeffrey S. Rosenthal

J.S. Rosenthal, "Statistics and the Ontario Lottery Retailer Scandal''. CHANCE Magazine 27(1), February 2014. Reprinted in "The Best Writing on Mathematics'', Princeton University Press, 2015.

C. Sherlock, A.H. Thiery, G.O. Roberts, and J.S. Rosenthal, "On the efficiency of pseudo-marginal random walk Metropolis algorithms''. Annals of Statistics 43(1) (2015), 238-275.

Y. Yunusova, J.S. Rosenthal, J.R. Green, S. Shellikeri, J. Wang, and L. Zinman, "Detection of Bulbar ALS using a comprehensive speech assessment battery''.

MAVEBA — 8th International Workshop on Models and Analysis of Vocal Emissions for Biomedical Applications, 2014.

J.S. Rosenthal, "Interdisciplinary Sojourns''. Canadian Journal of Statistics 42(4) (2014), 509-524.

J.S. Rosenthal, "Lessons From a Twisted Career Path''. Chapter 11 of the COPSS award winners volume "Past, Present, and Future of Statistical Science'' (X. Lin, C. Genest, D.L. Banks, G. Molenberghs, D.W. Scott, and J.-L. Wang, eds.), 117-128, 2014. CRC Press.

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