Biostats
sample moments

BIOSTATISTICS—THE INTERSECTION OF SCIENCE, ART, AND DISCOVERY.

features:

Highlight

Melissa Begg, ScD was recruited to take on the position of Columbia University's Vice Provost for Educational Programs. In her new role, Dr. Begg is responsible for advancing inter-school and interdisciplinary educational initiatives, and developing, implementing, and monitoring education and continuing education program proposals, distance education programs, partnerships with US and foreign universities, and contractual agreements with other schools, universities, organizations, or agencies where students fulfill part of their education requirements. Dr. Begg has retained her faculty appointment in the Department of Biostatistics.

Read more about faculty, student, staff, and alumni achievements under *of SIGNIFICANCE* (pg.4)

Greetings to alumni, former and current faculty, and other friends of Columbia University's Department of Biostatistics

in the Mailman School of Public Health. I joined the Mailman School as the new Chairman of Biostatistics in January 2104 and am sincerely honored to lead our great Department. My arrival at Columbia provides an opportunity to reflect on the excellent leadership that the Department has enjoyed over its nearly 75 year history, including Dr. John Fertig (1940-1975), Dr. Joseph Fleiss (1975-1992), Dr. Paul Meier (1992-1998), Dr. Bruce Levin (1999-2011), and Dr. Roger Vaughan (Interim Chair, 2011-2013). Drs. Levin and Vaughan continue to be vital members of the Department and the School, and they have both been instrumental in facilitating my transition as the new department head. Joining me on our department leadership team, Dr. Todd Ogden began serving as the Vice-Chairman of Biostatistics in January. I am proud to announce two other important School and University leadership transitions for Biostatistics faculty. Dr. Vaughan has become the Vice Dean for Academic Advancement in the Mailman School of Public Health, and Dr. Melissa Begg has become the Vice Provost for Educational Programs at Columbia University.

We face an exciting time for our field and for our department. The rapid advances in high throughput biomedical (and other scientific) technologies, high performance computing, and information systems have led to a new era in biostatistics characterized by massive amounts of data. Big data applications encompass areas such as brain imaging, where each of a relatively limited number of experimental units contributes hundreds of thousands of spatio-temporal measurements, as well as settings containing millions of experimental units, such as electronic medical records for millions of patients. Also, the lines are often fluid between big data areas and other traditional areas of application, since many traditional studies are also experiencing increases in the amount of data collected from one or more data sources. For many research areas, our ability to collect terabytes (and in some cases, petabytes) of data has far exceeded our ability to rigorously analyze the data. Biostatisticians are poised to make central contributions by developing novel analytic techniques and adapting existing methods to handle large data sets. The development, validation, and application of such techniques stand to make profound contributions to statistics, public health, and medicine.

I am very enthusiastic about the future of our department. My vision is for the Department of Biostatistics at Columbia to be a national leader working at the cutting edge of methodological research for big data applications. We have several faculty with established strengths in application areas producing big data such as brain imaging, genomics, electronic health records, personal tracking/monitoring devices, medical decision making, and environmental exposure studies, among others. Relevant methodological strengths of the faculty include functional data methods, quantile regression, penalized regression, machine learning, statistical genetics, clinical trials methodology, Bayesian modeling, and spatial statistics. Many of these methodological specialties are not exclusively applied in big data settings, and of course the Department seeks to sustain its historical strengths in many of these traditional areas of application. The Department will continue to expand our faculty with experts who

are leaders in the analysis, collection, storage, curation, and federation of big data. We will also seek new ways to deepen our graduate students' exposure to big data applications through course work, collaborative research experiences, and methodological research opportunities.

The Department provides big data analytic expertise within the Mailman School of Public Health and Columbia University Medical Center. We are also affiliated with other initiatives at the University, including the Institute for Data Sciences and Engineering. Another immediate priority for the Department is augmenting our faculty who specialize in cancer statistics to collaborate with investigators from the Herbert Irving Comprehensive Cancer Center. I look forward to the future achievements of our outstanding faculty – both current and future.

The Department has thriving graduate programs leading to four degrees: Master of Science (MS), Master of Public Health (MPH), Doctor of Philosophy (PhD), and Doctor of Public Health (DrPH). One unique highlight of our MS in Biostatistics program is that we offer specialized tracks that tailor the training for students who enter with specific interests or who intend to seek specific employment opportunities upon graduation. The tracks include: Theory and Methods, Clinical Research Methods, Statistical Genetics, and Pharmaceutical Statistics as well as an Accelerated Pre-Doctoral Training track for students who wish to continue to the PhD program. Additionally, the MS in Patient Oriented Research program offers training to prepare investigators for independent and competitive careers as clinical scientists. The Department will continue its efforts to provide exceptional training to students to prepare the next generation of biostatistics professionals and scholars.

In closing, I would like to call for alumni and other friends of Columbia Biostatistics to remain engaged with the Department. Please join us at receptions at the Joint Statistical Meetings, reconnect with us during the annual Alumni Summit for Public Health Leadership activities, and visit us within the Department. For employers, new graduates from the Department of Biostatistics at Columbia provide a rich talent pool for summer internships and permanent employment. We also ask that you consider supporting the Department with financial gifts using the following link: **mailman.columbia.edu/academic-departments/biostatistics/make-gift**. Gifts can be made in an unrestricted fashion, to support students (for example, tuition, stipend, and travel to conferences), and to support our innovative research programs (addressing major diseases such as cancer, Parkinson's disease, Alzheimer's disease, infectious diseases, and cardiovascular disease).

Throughout the remainder of this newsletter, you will note a few of the many notable achievements of our faculty and students in research, education, and service to our profession. I am proud of the rich history of our department and hope that you share my excitement about our bright future.

DuBois Bowman, PhD
Professor and Chair of Biostatistics

AWARDS & ACHIEVEMENTS
SPRING - SUMMER 2014

February

▶ **Dr. Prakash Gorroochurn's** article *"Errors of Probability in Historical Context"* is included in the annual anthology, "The Best Writing on Mathematics 2013." The anthology presents 2013's most memorable writings on mathematics.

▶ **Dr. Todd Ogden** begins serving as the new **Vice Chair** for the Department of Biostatistics.

▶ **Dr. Yuanjia Wang** secures **funding of over $1 million** from the National Institute of Neurological Disorders and Stroke (NINDS) and the National Institutes of Health (NIH) for her project, *Identifying Huntington's Disease Markers by Modern Statistical Learning Methods.*

▶ **Tianle Chen**, PhD '14, wins the **Student Paper Award** from the ASA Statistical Learning and Data Mining section for her paper *"Multiple Kernel Learning with Random Effects for Predicting Longitudinal Outcomes and Data Integration."* This award is presented to the student whose paper demonstrates statistical novelty, innovation and significance of the contribution to the field of application. Tianle presented her work at JSM 2014 in Boston this August.

March

▶ Among MSPH departments, **Biostatistics** achieves the highest average scores in course evaluations on 3 key parameters (likelihood that students would recommend the course, instructor effectiveness, and students' perception of their ability to demonstrate the competencies of the course). **Dr. Martina Pavlicova** scores above the 90th percentile with respect to instructor effectiveness in classes with 50 or more students.

▶ The **BEST Diversity program** is re-funded by the National Heart, Lung, and Blood Institute (NHLBI) and enters its second 5-year cycle.

▶ **Dr. Roger Vaughan** is elected **Fellow of the New York Academy of Medicine**. NYAM Fellows embody the highest levels of achievement and leadership in the fields of urban health, science, social work, nursing, education, law, medicine and research.

April

▶ **Dr. Ken Cheung** and **Dr. Melanie Wall** are named **American Statistical Association (ASA) Fellows**. Nominees for Fellows are evaluated by their peers for excellence and innovation across 6 major content areas; Consulting on Statistical Problems, Statistical Applications and Data Collection Methods, Administration of Statistical Activities, Teaching and Dissemination of statistical knowledge, Statistical Research, and participation in the ASA.

▶ **Dr. Bruce Levin** publishes his new book, *"The Biostatistics of Aging."* (See pg. 23.)

▶ **Dr. Xinhua Liu** is promoted to **Professor of Biostatistics at CUMC**.

▶ **Katy Hardy** is one of the recipients of the **2014 Mailman Staff Award for Excellence**. These awards recognize the outstanding Mailman School employees who demonstrate the highest standards of excellence and extraordinary performance.

▶ **Dr. Ben Lebwohl** (MS-POR '10) is selected as a **2014 Louis V. Gerstner Jr. Scholar**. Dr. Lebwohl will assess the impact of gluten consumption on gut microbial diversity among a clinic-based cohort of patients with celiac disease and patients with non-celiac gluten sensitivity.

▶ **Dr. Nir Uriel** (MS-POR '13) is recruited to **direct the heart failure program at the University of Chicago**.

May

▶ **Dr. Melissa Begg** is recruited to be Columbia University's Vice Provost for Educational Programs, effective July 1, 2014.

▶ **Dr. Roger Vaughan** wins the 2014 Presidential Teaching Award. Dr. Vaughan was selected as one of five winners from over 500 individual nominations. The presidential awards honor the best of Columbia's teachers for the influence they have on the development of their students and their part in maintaining the University's longstanding reputation for educational excellence.

▶ **Brenda Chang**, PhD candidate, is selected as a 2013-2014 Columbia Teagle Fellow. As part of Columbia's "Preparing Doctoral Students for the 21st-Century Teaching Initiative," a select cohort of 8-10 Columbia University graduate students cultivate advanced practices in teaching and peer evaluation.

▶ **Hsin-wen Chang**, PhD '14, wins the International Chinese Statistical Association Student Paper Travel Award. This award is intended to encourage student members to participate and present their research.

▶ **Tianle Chen**, PhD '14, is the recipient of the Jiann-Ping Hsu Pharmaceutical & Regulatory Sciences Student Paper Award. This award is given to a student who engages in innovative research in the Pharmaceutical & Regulatory Sciences.

▶ **Adam Ciarleglio**, PhD '14, wins the Sanford Bolton-John Fertig Award. This award is given to the top doctoral dissertation in Biostatistics, in recognition of the strong influence John Fertig had on students through his encouragement, help, and outstanding teaching.

▶ **Chih-Chi Hu**, PhD '14, wins the Joseph L. Fleiss Memorial Prize. This award is given to a Biostatistics doctoral student whose outstanding dissertation advances statistical methods and their applications to biomedicine and public health.

▶ **Annie Lee**, PhD candidate, is awarded a TL1 scholarship. This scholarship provides doctoral students with research training to prepare for an academic research career that contributes to the field of Personalized Medicine.

▶ **Ying Liu**, PhD candidate, is the first place winner of the Student Paper Award Competition for the Mental Health Section of the American Statistical Association. The award is given to the student whose paper best demonstrates the importance of the problem in mental health and the quality of the statistical methodology, application, and writing.

▶ **Yutao Liu**, MS-TM student, wins the Student Travel Award to JPSM, funded by Westat, to the Conference on "Hierarchical Modeling in Observational Studies, Complex Surveys and Big Data" in May.

▶ **Gary Yu**, DrPH '14, receives the Challenor Spirit Prize. The Challenor Spirit Prize is awarded to a student who exemplifies the spirit of Professor Bernard Challenor MD, MPH. Dr. Challenor was a professor and interim Dean at MSPH, who believed in the school as a community. He was the only faculty member who, at one time or another, taught in every department of the school. He continually made concerted efforts to create a sense of community for students and faculty that transcended departmental boundaries.

August

▶ **Dr. Siqin Ye** (MS-POR '13) is awarded a K23 grant from the National Heart, Lung, and Blood Institute (NHLBI), National Institutes of Health (NIH) for his project, *Patient Health Information Preference and Statin Therapy*.

CONGRATULATIONS GRADUATES!

From left to right - BACK ROW: Dr. DuBois Bowman, Shulai Zhou, Ling Chen, Xin Jin, GuangWei Qui, Dan Bai; FRONT ROW: Wenxi Tang, Xinyu Hu, Xingyuan Li

MPH

Paul Chambliss

MS/CRM

Clare Boyd	Margaret Lee	Stephanie Pouch
Cynthia Gyamfi	Omar Martinez	

MS/TM

Dan Bai	Xin Jin	Wenxi Tang
Manisha Brahmachary	Joshua Kriger	Madeline Vossbrinck
Xiao Du	Xingyuan Li	Yidi Wang
Ruth Esther Eisenberg	Ian Ouellette	Mengfei Wu
Qi Gao	Zhi Pan	Shulai Zhou
Xinyu Hu	GuangWei Qui	

MS-POR

Natalie Elissa Cusano	Sewanti Limaye	Minjae Kim
Gian Marco De Marchis	James Peacock	Aviva Sopher
Daniel Freedberg	Meghan Sise	Aleksander Tichter
Ragy Girgis	Lauren Khanna	

DrPH

| Gary Yu | May 2014 | *Identifying patterns in behavioral public health data using mixture modeling with an informative number of repeated measures* | *Sponsor: Melanie Wall* |

PhD

Tianle Chen	May 2014	*Statistical modeling and statistical learning for disease clarification and prediction*	*Sponsor: Yuanjia Wang*
Chih-Chi Hu	May 2014	*Sequential quantile estimation using continuous outcomes with applications in dose finding*	*Sponsor: Ken Cheung*
Xiaoyu Jia	May 2014	*Two-stage continual reassessment method and patient heterogeneity for dose-finding studies*	*Sponsor: Ken Cheung*
Xiaochen Cai	Oct 2014 (expected)	*Methods for handling measurement error and sources of variation in functional data models*	*Sponsor: Todd Ogden*
Hsin-Wen Chang	Oct 2014	*Empirical likelihood tests for stochastic ordering based on censored and biased data*	*Sponsor: Ian McKeague*
Xuezhou Mao	Oct 2014	*Sequential designs for individualized dosing in phase I cancer clinical trials*	*Sponsor: Ken Cheung*
Hui Zhou	Oct 2014 (expected)	*Graph structure inference for high-throughput genomic data*	*Sponsors: Shuang Wang & Tian Zheng (Stats)*

From left to right: Drs. Qixuan Chen, Ying Wei, Tianle Chen, and DuBois Bowman

A warm welcome

to the 2014-2015 academic year!

BY THE NUMBERS   2014-2015

35
NUMBER OF FULL-TIME
FACULTY MEMBERS

8
NUMBER OF ACTIVE
ACADEMIC PROGRAMS

Program	New students	Total for 2014-2015
MPH	1	2
MS/CRM	4	13
MS/PS	5	11
MS/SG	7	7
MS/TM	43	77
MS-POR	7	18
DrPH	4	18
PhD	7	19
TOTAL	78	165

Student body

21-40
AGE RANGE

24
AVERAGE ENTRY AGE

14
STATES
REPRESENTED

8
NATIONS
REPRESENTED

35%
MALE

The Department is also home to:

2 PART-TIME FACULTY MEMBERS

2 ASSOCIATE RESEARCH SCIENTISTS

4 POST DOCTORAL RESEARCH SCIENTISTS

6 OFFICERS OF RESEARCH

9 RESEARCH STAFF

Did you know...

free stuff!

Those teaching a SAS class, or a course that uses SAS, may be eligible for TWO complimentary SAS books per semester through their Academic Evaluation Copy Program.

SAS also offers a 20% academic discount on products published by the SAS Institute.

1
TON OF PAPER

DESTROYS
ON AVERAGE

24
TREES

PROCESSING
1
TON OF PAPER

USES — ENOUGH ENERGY TO POWER THE AVERAGE AMERICAN HOME FOR **6** MONTHS

CONSUMES — THE EQUIVALENT OF **7,000** GALLONS OF WATER

PRODUCES — **3.3** CUBIC YARDS OF LANDFILL SPACE

CREATES — THE EQUIVALENT OF **1** METRIC TON OF CARBON IN GREENHOUSE GAS EMISSIONS

HELP US BECOME A GREENER SCHOOL

Visit the School's **Paper Reduction Initiative webpage** for more information and tips for saving paper.

Fall 2014
Levin Lecture Series

Organized by Jeff Goldsmith and Min Qian

September 4
Speed Seminars
DuBois Bowman, Qixuan Chen, Ken Cheung,
Todd Ogden, Arindam RoyChoudhury,
and Yuanjia Wang

September 11
Michael Rosenblum, PhD
Assistant Professor, Department of Biostatistics
John Hopkins Bloomberg School of Public Health
Hosted by: Ian McKeague, PhD

September 18
Jian Kang, PhD
Assistant Professor, Department of Biostatistics
Emory University Rollins School of Public Health
Hosted by: DuBois Bowman, PhD

September 25
Dennis Lin, PhD
Professor, Department of Statistics
Penn State University Eberly College of Science
Hosted by: Ying Wei, PhD

October 2
Yunwen Yang, PhD
Assistant Professor, Department of Biostatistics
Drexel University School of Public Health
Hosted by: Ying Wei, PhD

October 9
Bin Nan, PhD
Professor, Department of Biostatistics
University of Michigan School of Public Health
Hosted by: Min Qian, PhD

October 16
Lynn Kuo, PhD
Professor, Department of Statistics
University of Connecticut Health Center
Hosted by: Arindam RoyChoudhury, PhD

October 23
Li Hsu, PhD
Full Member, Department of Biostatistics
Fred Hutchinson Cancer Research Center
Hosted by: Yuanjia Wang, PhD

October 30
Abdus S. Wahed, PhD
Associate Professor, Department of Statistical Science
University of Pittsburgh School of Public Health
Hosted by: Min Qian, PhD

November 6
Jim Ramsay, PhD
Adjunct Professor, Department of Statistics
Queens University
Hosted by: Ian McKeague, PhD

November 20
Jerry Reiter, PhD
Associate Director, Department of Statistical Science
Duke University
Hosted by: Qixuan Chen, PhD

*Visit the **Biostats Events webpage** for the most up-to-date information.*

A SMALL SAMPLE OF CURRENT RESEARCH

Faculty are...

- Researching efficient statistical methods using large-scale biomarker data for disease risk prediction, informing clinical trial designs, discovery of personalized treatment regimes, and guiding new and more effective interventions. Y. WANG

- Analyzing data to link cancer risk to specific environmental, behavioral, or biological exposures over the lifecourse. BOWMAN

- Developing statistical methods for summarizing toxicity burden and toxicity trajectories to incorporate the information in the design of early phase clinical trials. LEE

- Developing and applying statistical methods to analyze complex survey data and data with missing values, providing important support to biomedical research across a number of disciplines, including epidemiology, environmental health sciences, and health policy and management. Q. CHEN

- Investigating novel statistical methods for rigorous analysis of high-throughput genetics data. Methods have led to the discovery of new genes, which influence risk to schizophrenia and autism, and are being used to uncover additional genes. IONITA-LAZA

- Developing statistical methods for growth trajectories, inference for optimal treatment rules in personalized medicine, tests of hazard rate ordering using empirical likelihood, and marginal screening of predictors in high-dimensional regression problems. MCKEAGUE

- Researching stroke's impact on motor control have uncovered valuable trends across patients in person-level control deficits related to stroke severity. GOLDSMITH

- Quantifying the effects of aging on daily physical activity intensity patterns, furthering the understanding that older age is primarily associated with decreasing activity in the late afternoon but not in the morning. GOLDSMITH

- Discovering biomarkers for Parkinson's disease from a combination of massive brain imaging datasets reflecting various properties of brain function and structure, clinical data, and biologic data. BOWMAN

- Developing two complex methods – quantile regression methods to investigate genetic association with secondary quantitative human traits in genome-wide association studies and statistical methods for sequencing studies – have been applied to chronic obstructive pulmonary disease, stroke, and breast cancer research. WEI

- Developing sequential methods for selecting subsets of promising new therapies in phase II clinical trials controlling the probability of false declarations while maintaining high probability of acceptable subset selections. LEVIN

The 2014 BEST and CSIBS Programs

BEST Program
http://bit.ly/columbia-biostats-best

The Biostatistics Enrichment Summer Training Diversity Program (BEST) seeks to expand and diversify the behavioral and biomedical sciences' workforce by introducing undergraduates from underrepresented populations to research in the areas of biostatistics and cardiovascular and pulmonary disease.

CSIBS Program
http://bit.ly/columbia-biostats-csibs

Columbia Summer Institute for Training in Biostatistics (CSIBS) provides advanced undergraduates and select recent college graduates with training and exposure to the biostatistical sciences.

The BEST and CSIBS programs graduated another 28 aspiring biostatisticians this summer! Students came from a wide array of backgrounds and undergraduate institutions — Harvard, Wheaton College, SUNY-StonyBrook and UCLA, to name a few. Emily Roberts, a CSIBS student, remarked, "I was able to meet and work with students from across the country with various backgrounds and learn about their lifestyles and interests. Not only did I learn a great deal that will benefit me, but I had so much fun and gained so many unforgettable experiences during the program." Through seminars and coursework, the students developed statistical analysis skills that prepared them to engage in research projects that were led by faculty mentors at Mailman and CUMC. Students had the opportunity to work on projects that ranged from finding an association between sleep deficiency and heart disease, to re-assessing the waitlist for lung transplants, to examining the relationship of a commonly found compound and obesity in children. For both students and mentors, the research project and culminating poster presentation served as the highlight of the program. The summer proved to be an eye opener for many of the students. "Before the BEST Program, I had no idea of what I wanted to do after my undergraduate career. I now know that graduate school is a great option and that a career in public health, more specifically Biostats, would be a great way to consolidate my interests in math and medicine," said Omar Pineda, a junior and math major at Amherst College.

We look forward to welcoming another bright and eager group in Summer 2015!

Contributed by Justine Herrera

The 2014 ICSA / KISS Joint Applied Statistics Symposium

Dr. Zhezhen Jin is pictured first from the left in the back row.
Doctoral student Hsin-Wen Chang is pictured 3rd from the left in the first row.

D r. Zhezhen Jin served as the program chair for the 2014 International Chinese Statistical Association (ICSA) / Korean International Statistical Society (KISS) joint applied statistics symposium.

The 2014 ICSA/KISS joint symposium was ICSA's 23rd annual symposium and the 1st for KISS. The meeting, held from June 15 to June 18 in Portland, Oregon, was attended by more than 400 participants from the United States, Canada, and countries of Asia and Europe. The joint symposium featured 7 short courses, 3 keynote lectures, and 77 invited and contributed scientific sessions. The Department was well-represented at the four-day event. Dr. Xinhua Liu served as a member of program committee and Dr. Qixuan Chen served as a member of student award committee. Drs. Ying Wei, Yuanjia Wang, Cheng-Shiun Leu, and Shing Lee attended the symposium along with Jimmy Duong and Wen (Jenna) Su. This year, ICAS/KISS offered eight student paper awards and travel grants. Hsin-Wen Chang, a doctoral student advised by Dr. Ian McKeague, received one of the awards for her paper titled *"Empirical likelihood based tests for stochastic ordering under right censorship"* and presented her paper at the meeting. Hsin-Wen successfully defended her PhD dissertation in July and will graduate in October.

Contributed by Zhezhen Jin

International Chinese Statistical Association (ICSA)
http://www.icsa.org

Korean International Statistical Society (KISS)
http://www.statkiss.org

Statistics and Today

By Arindam RoyChoudhury

Late Julian Besag, a noted statistician, was invited to a multi-disciplinary conference at Europe to speak about the future of statistics circa 2003. He was caught off guard by a noted chemist, who commented that statistics was soon going to be obsolete. Increased accuracy of new technologies would, according to the chemist, leave little room for statistical error.

That was then! Today we know that the exact opposite has happened. The new technologies, in fact, have ushered a new era of statistical innovation, due in no small part to the big data boom. While the measurements have gotten more accurate, we are now able to measure more things and new things, needing more statistical applications.

The need for statistics is now realized across a wide variety of disciplines, from industry to government to academia. By providing decision rules and estimation based on exact science, statistics serves a key role in any scientific endeavor. The value of such ability has long been realized in some sectors of industry and academia. Other sectors have recently caught on, creating a high demand for statisticians, along with high salaries.

According to glassdoor.com, the national median salary for data scientists is $115,000 (n=361), and they are employed by a variety of industry leaders: Facebook, Google, Microsoft, Apple, IBM, eBay, Netflix, American Express, MasterCard, Nokia, AstraZeneca, Merck etc. For comparison,

the national median salary for computer scientists is $103,000 (n=845). However, these high salaries and high demand are yet to create enough job seekers with analytical expertise. According to McKinsey Global Institute and McKinsey's Business Technology Office, the US needs 140,000 to 190,000 more people with analytical expertise and 1.5 million manager level experts who can interpret big data analyses. To meet this demand, universities are expanding their statistics and data science programs. There has also been a renewed interest in statistics among students. The number of students graduating with a Bachelor's degree in statistics has approximately doubled since 2008, according to the National Center for Education Statistics. However, we are nowhere near meeting the shortage, and it is about to create a big hiring boom with graduates with analytical skills.

The demand for well-trained statisticians is here to stay. This is partly due to the ongoing big data boom, which can only get bigger. Computational methods, being indispensable for big data analyses, are going to be even more important in future. New graduates, who have significant knowledge in statistical computing and data mining techniques, will have an edge.

Another aspect of big data is the multiple layers of data from different types of sources. For example, health related data can be analyzed along with genomic data and social networking data. Recognizing this, National Science Foundation has already started at least one program geared towards combining specific multi-layered datasets. The statisticians with ability to effectively design new analyses combing different types of data will be in high demand.

The Bureau of Labor Statistics has projected a 27% increase in statistical jobs from 2012 to 2022. This outlook is far better than the average for all professions. Overall, it is a good time to start your career with a statistics degree.

> **glassdoor.com reports that the national median salary for data scientists is $115,000.**

See the results of the Salary Survey conducted by a contractor of the ASA:

For business, industry, and government statisticians
http://magazine.amstat.org/blog/2013/11/01/salarysurveyspaig/

For academic statisticians
http://magazine.amstat.org/blog/2014/01/01/academic-salary-survey-2/

# Fiducial Probability: Fisher's Greatest Ambition and Failure

By Prakash Gorroochurn

Ronald Aylmer Fisher (1890-1962) was the statistician of the twentieth century and amongst the greatest that ever lived. Much of the modern theory of statistical inference was developed single-handedly by him. Words such as "likelihood", "consistency", "efficiency", and "sufficiency" were his invention. If Laplace was France's Newton, then undoubtedly Fisher was England's Laplace. Laplace and Fisher shared several similarities, not least of which was their frequent use of the phrase "it is easy to see", which usually meant that they omitted the details of the result to follow because it required pages and pages of intricate derivation! On a more serious note, although both men were equipped with tremendous insight, they had a tendency to favor intuition rather than rigor, which is why reading their works proves very challenging even today.

The search for a statistical method which would make probability statements about parameters of populations has been amongst the greatest quests of statisticians, and we owe it to Bayes for having made the first such attempt. However, Bayes' method required the making of an assumption about the prior distribution of the parameter concerned. Although Bayes himself was very cautious about making such prior assumptions, which is probably why he refrained from publishing his paper while still alive, Laplace was much more cavalier about them. He frequently assumed a uni-

form prior which he presumed would represent a complete lack of prior information about the parameter. However, such an assumption led to very serious mathematical contradictions. These were soon noticed by the mathematical community and Bayesianism (or inverse probability) as applied by Laplace lost considerable ground.

More than a century after Bayes' and Laplace's times, it was left to Fisher to make a serious attempt at the perennial problem of direct inference on parameters of populations. And his answer was…fiducial probability. Unfortunately, Fisher never provided a rigorous development of fiducial theory and instead developed the method
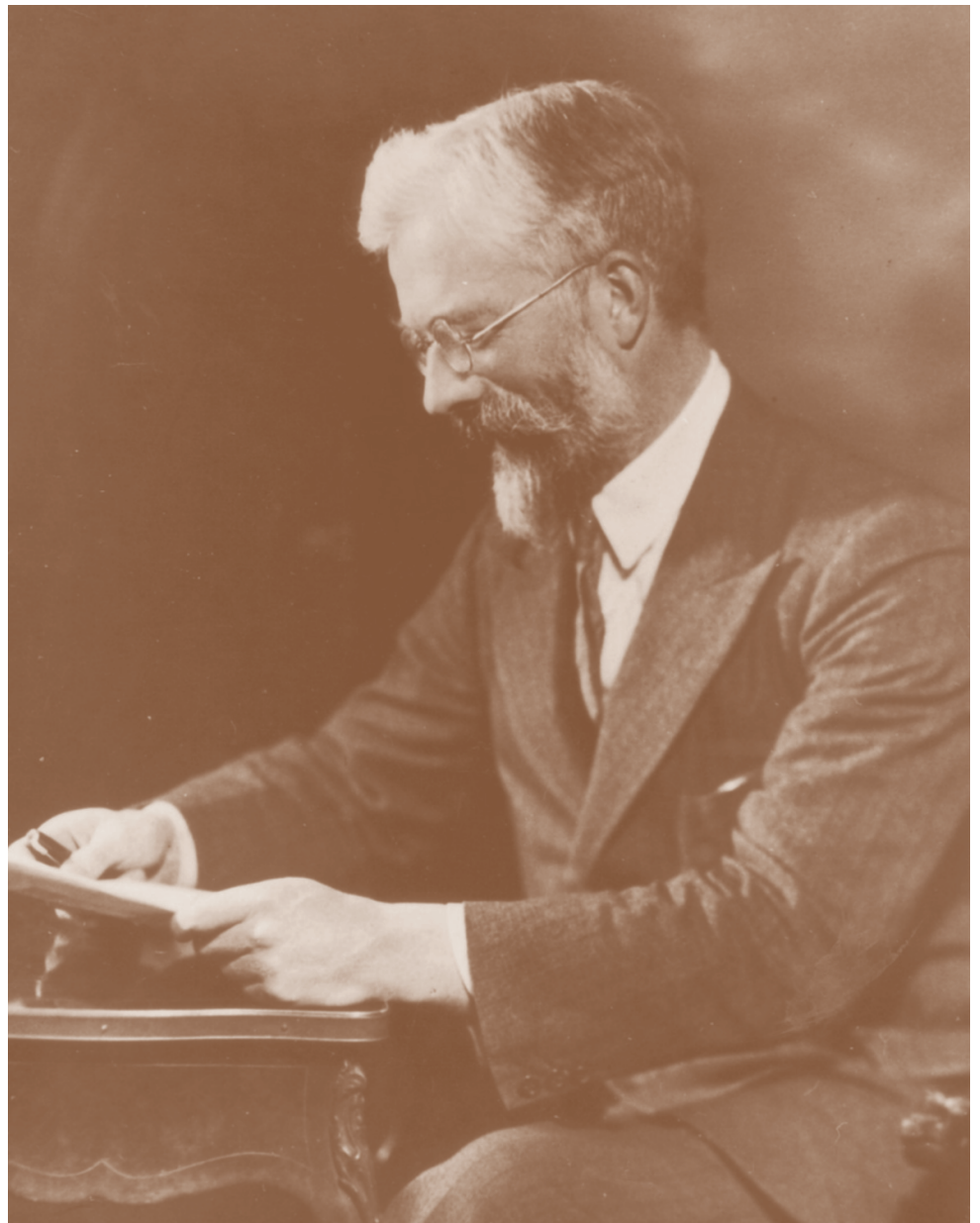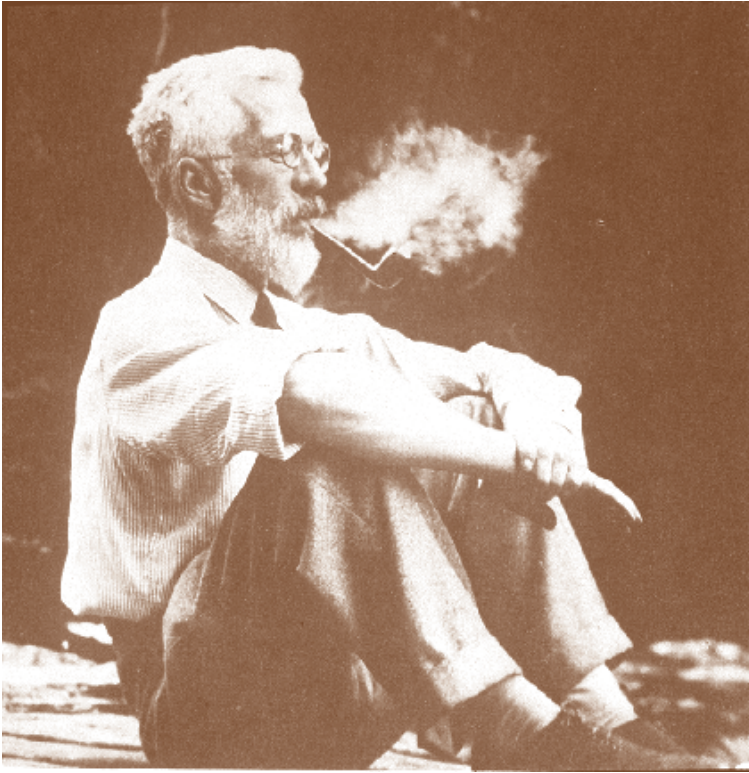
through examples. Many statisticians even today do not completely understand the fiducial argument, but in a nutshell it goes as follows: Suppose T is a sufficient statistic, θ is a parameter and p is number in [0, 1]. Let $\Pr\{T < \theta\} = p$. Then Fisher's fiducial argument consists in claiming that, even for an observed value t of the statistic T, we still have $\Pr\{t < \theta\} = p$. The reader will hopefully realize that Fisher's argument is a big leap in probability logic, not least because now θ assumes the status of a random variable, even though intrinsically it is not one! It is little wonder that most mathematicians were at first confused about the true nature and status of fiducial probability. However, Neyman soon after developed the idea of confidence intervals which were identical, at least for the simple cases considered, to Fisher's limits using fiducial probability. Thus the statistical community, including Fisher and Neyman, at first thought that Fisher's fiducial and Neyman's confidence arguments were just the two faces of the same coin. However, a then young Bartlett soon came up with an example (the notorious 'Behrens-Fisher' problem) that exposed serious cracks in the fiducial argument. Bartlett considered the case of two populations of unknown means and unknown (and unequal) variances, and showed that

Fisher's fiducial (1-α) limits for the difference in population means did not have the frequency property of capturing the true population mean difference (1-α)% of the time in the long run. This was a big blow to the fiducial argument. Several other issues soon emerged which made statisticians distance themselves from fiducial probability.

Fisher spent a major portion of his life defending the fiducial argument, which was to him the solution to the fundamental problem of statistical inference. But the argument is now almost defunct, although there have been a few attempts to revive it.

Nonetheless, the failure of the fiducial argument in no way diminishes the unparalleled contributions made by Fisher to statistical inference. The following beautiful sentence he wrote in 1947 to his French colleague Fréchet sums up his thoughts regarding his contributions to statistics:

> I should be glad if anyone reading my works should take what good they may find in them and make good use of it, and trouble themselves little about what they think to be false or defective.

An Interview with
Assistant Professor Jeff Goldsmith

Dr. Goldsmith joined the Department in 2012 after completing his PhD in Biostatistics at Johns Hopkins School of Public Health.

Why did you decide to enter the field of biostatistics? What path brought you here?

That's a great question for a couple of reasons. One is that there are many paths people can take to get into biostatistics. The second is that I think mine is somewhat indicative of how people get into biostatistics by chance. At the end of my senior year in college, I was finishing up a major in mathematics and wasn't exactly sure of what I wanted to do next. I looked into applying to math and economics graduate programs, but towards the end of the application process I heard about biostatistics. I wasn't sure what it was, so I ended up looking it up on Wikipedia and writing my statement of purpose based on that entry. As I learned more about what the field was all about, I realized that biostatistics gave me a route to use the numerical skills I had built up as a math major for real world problems, and that was very exciting for me.

What is your area of expertise and why did you decide to focus on it?

I typically focus on functional data analysis. Nowadays data are recorded more or less continuously in a lot of subject areas. For in-

stance, an accelerometer is a device that people wear as they go about their day and it continuously monitors physical activity. Researchers can use this to get an idea of what activity looks like over the course of the day, or every day over the course of the week. Another example of this sort of continuous measurement is neuroimaging, where a full brain image is a single data point - it's a highly structured, high dimensional variable. Those types of data are becoming more and more common as the ability to collect and store information grows at the pace of computing power. So there is a need for statistical methods that can handle high dimensional data that has a lot of structure, and use this structure for making some inference, for learning something about what the subjects are doing.

What are you most passionate about professionally? What most excites you about your work and the contribution you can make to your field?

What excites me the most about the work that I do is the fact that it brings something to the table that medical researchers don't already have. Biostatistics focuses on the development of quantitative skills, which means that when you walk into a room with your medical collaborators, you're bringing something extra. You're bringing something you're skilled in that they may not be skilled in. That means you can be a very integral part of a research team. It means that you are capable of posing and answering questions in a way that other researchers maybe aren't able to do. So in my research in particular, I'm very grateful for the fact that you can go into a collaborative meeting and talk with researchers that are world-class in their area of research but recognize a need for statistical methods to quantify the underlying hypothesis and intuitions that the researchers have.

What are you passionate about personally? What do you really enjoy?

I've only been in NYC for a couple of years, so I try to take advantage of the opportunities of living in the city. Everyone always talks

about what there is to see and do in NY and I think that it's absolutely true. So I'm exploring the city, going to museums, restaurants, parks, going to plays and operas and just all sorts of things. I'm really passionate about just enjoying everything NYC has to offer.

Where can we find you when you're not working? What's your favorite way to spend a weekend?

To be honest, I try to relax as much as possible. You'll find me sitting at the park, having a long brunch on the weekends, having ice cream outside Lincoln Center, taking it easy.

Jeff is pictured here sporting his favorite socks.

What are you reading right now?

I read magazines for the most part – news magazines like Time, New Yorker, and the Economist. I read the Game of Thrones series not too long ago – got hooked and read the whole thing all the way through. I started on some short stories recently, which is great because you can make your way through them in a short time. There are several other novels I've been interested in reading but I've had a harder time getting around to them.

What are your pet peeves?

My biggest pet peeve is walking behind slow people on sidewalks. Even worse than that is being behind someone on an escalator and when they get to the bottom, they don't know where they're going so they just stop and stand there, like there's not a conveyor belt of people right behind them. That's a pet peeve. It's not unique to me.

Who is your personal hero and why?

It's sort of cliché, but I would say my father is my personal hero because he has, for a very long time, emphasized the importance of learning, curiosity and chasing the desire to figure something out as far as it will go. He's meant that in a lot of contexts. He's a scientist by training, so he's meant that scientifically but also sort of in general. If there was something that puzzled me growing up, he would encourage me to go and figure out what it was and how it worked and try to master the underlying concepts. That's something I very much appreciate.

If you could be a superhero, what would you want your superhero power to be?

Move stuff with my brain. Telekinesis, I guess. Yeah, I would do that because then you can do anything. Flying? You just pick yourself up with your brain. Need a sandwich? Brain. I mean, it is all built in to telekinesis. That's an easy one.
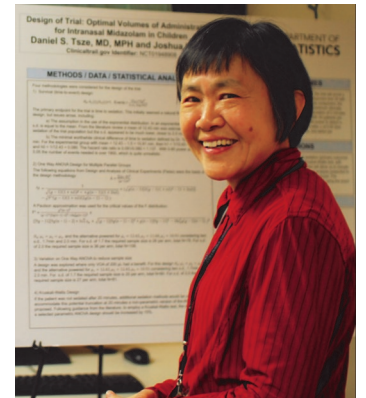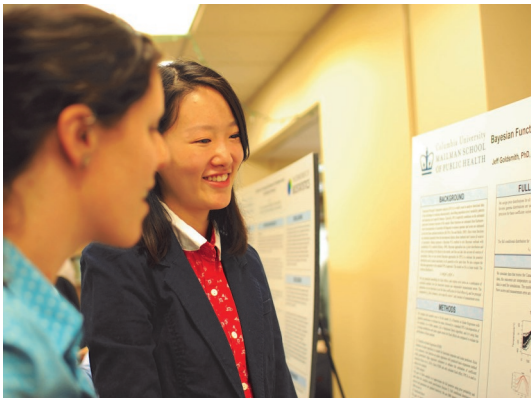
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IN THE WORDS OF AN ALUM

As a former student, I could start off by describing the excitement and intensity of the curriculum organized by the Department of Biostatistics. The students are inevitably expected to take legible notes, program in R/SAS/STATA, follow sometimes-negotiable deadlines, brainstorm for appropriate models, and collaborate with professionals. However, I would not hold credits in succeeding all due to perseverance in experiencing the dynamic and social aspects of the department, and modestly to a greater extend, New York City.

As a statistician, I am working at a global consumer goods company in Switzerland. I have colleagues who are specialized in science, engineering, law, and finance. But only a few had basic training in statistics. So it was not just the ability to list out the most complicated models and graphs that I have learned from attending the biostatistics courses. Regardless to which field I am conducting the analyses, the curriculum required internship experiences that had taught me the decision-making and soft skills needed to meet individual request.

Learning biostatistics is about understanding what is question, who needs the analysis, why using the method, where to apply the model, when to deliver the result, and how to implement the concept. Biostatistics is an extremely active and practical tool that helps me in solving problems proposed by various professions. I feel grateful for the opportunities and the cautiousness that biostatistics had prepared for me. At the end of the day, we are the ones to interpret and convey a message to the management level or, potentially, the general public.

Contributed by Elizabeth J Wang (MS/TM '12)

NEW BOOK

The Biostatistics of Aging:
From Gompertzian Mortality to an Index of Aging-Relatedness

By Gilberto Levy and Bruce Levin
Published April 2014
by John Wiley & Sons, Inc.

In *The Biostatistics of Aging: From Gompertzian Mortality to an Index of Aging-Relatedness*, authors Gilberto Levy and Bruce Levin explore the notion of what it means for a condition to be related to aging. The term "aging-related disease" (or its variants) is widely used in the medical literature not only with respect to neuro-degenerative diseases, especially Alzheimer's disease, but also cardiovascular diseases and neoplasia. However, until now there has been neither a precise definition nor a way to quantify just how related to aging a particular disease is. To fill this lacuna, the authors devised an index of aging-relatedness rooted in statistical and evolutionary biology theories, and applicable to mortality and aging-related diseases of complex etiology. In this book, they describe an extensive theoretical framework including: (i) original results on the asymptotic behavior of the minimum of time-to-event random variables, which extends those of the classical statistical theory of extreme values; (ii) a comprehensive and satisfactory explanation based on biological principles of the Gompertz pattern of mortality in human populations; (iii) the development of an evolution-based model of causation relevant to mortality and aging-related diseases of complex etiology; and (iv) an explanation of how and why the description of human mortality by the Gompertz distribution can be improved upon from first principles. A quantitative index of aging-relatedness emerges from this framework, and the book also features an illustrative application of the proposed method.

The new index has remarkable biomedical and public-health relevance which arises from its interpretation, in a special sense, in terms of the relative contributions of genetic and environmental factors to mortality and disease incidence in a population. At the same time, the new index of aging-relatedness avoids several pitfalls inherent in existing measures such as the heritability index. The book concludes with a discussion of the implications of the method for the understanding of aging and aging-related diseases. In particular, the work is directly relevant to the current emphasis in public health of promoting "healthy" or successful aging.

Gilberto Levy, MD, DrPH, was a researcher in the G.H. Sergievsky Center and in the Department of Biostatistics at the Mailman School of Public Health at Columbia University.

Bruce Levin, PhD, is Professor of Biostatistics and past chair of the Department of Biostatistics at the Mailman School of Public Health at Columbia University.
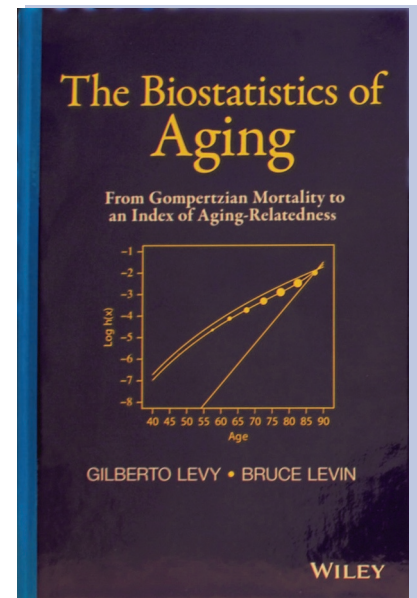
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