November 8, 2018

Hello,

This is my application to the NBER PhD Student Workshop on the Economics of Digitization 2019. I am a PhD student at the Stanford economics department and I am in my fourth year. I specialize in econometrics and machine learning.

I work on several projects, including:

- Estimating heterogeneous causal effects with random forests from data with multiple treatments and multiple outcomes (with Susan Athey, Stefan Wager, and Julie Tibshirani)
- Quantifying and correcting for finite sample bias arising in causal estimation with weak instrumental variables (with Guido Imbens)
- Accelerating digital experiments at Facebook through proxy Gaussian process models and navigating competing objectives through efficient exploration of the Pareto frontier (with Eytan Bakshy)

I presented that last work at the MIT Conference on Digital Experimentation this year.

My research agenda is to navigate this new world of big data made possible through, among other things, internet companies. I use modern econometric and statistical tools to answer novel questions of economic relevance made possible with these data and methods. I am excited to learn frontier economics research in this area at the PhD Student Workshop.

I am attaching my CV to detail my educational background, including coursework and experience. Thank you for considering me.

Best,

Karthik Rajkumar
PhD student, Economics
Stanford University

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Research Interests

Causal inference, econometric theory, machine learning for applied microeconomics

Education

Stanford University, Stanford, California
Ph.D. in economics (2015–)
M.A. in economics (2018)
M.S. in statistics (2015)

Indian Institute of Technology Madras, Chennai, India
B.Tech. in electrical engineering, with minor in theoretical computer science (2013)

Research

Multivariate generalized random forests (September 2017–)
joint with Susan Athey and Stefan Wager
We use random forests for multivariate analysis and causal inference. Our method allows for multivariate treatments and multivariate outcomes, and provides valid uniform confidence intervals for estimands defined under a broad local GMM framework. It is attractive in several empirical settings, including factorial experiments and heterogeneous treatment effect estimation with regression discontinuity designs. We provide a fast implementation of these generalized random forests in C++ and R at `https://github.com/rajkumarkarthik/mgrf-develop`.

Inference with instrumental variables under finite-sample bias (November 2017–)
joint with Guido Imbens
We demonstrate strong evidence of bias with instrumental variable inference in small samples, common in empirical economics research. We diagnose the problem as stemming from weak instruments as well as sensitivity to outliers. We provide refinements for inference using resampling methods, including the bootstrap and the jackknife, and show trade-offs between removing bias and increasing variance when choosing 2SLS estimators. We provide rules-of-thumb to flag situations in practical settings with strong interference from finite-sample bias.

Optimal donut-holes in regression discontinuity designs (February 2018–)
joint with Evan Rosenman
We study causal effects in a regression discontinuity design when the forcing variable is subject to manipulation. Donut holes are used in the literature to delete data where manipulation is suspected in order to reduce bias and concerns of reverse causality. We provide a nonparametric framework of optimality in the trade-off between bias reduction and accurate treatment effect estimation. We compare our method with parametric approaches used in the literature and offer recommendations.

Professional experience

Facebook Research, Menlo Park, California (June – September 2018)
Team: Core data science
In work with Eytan Bakshy, I design multi-task Gaussian processes (GPs) for modeling multiple outcomes in noisy experiments for more efficient Bayesian Optimization. I create a novel residual covariance estimator to fit multiple tasks better. I also provide a novel perspective of regularization with GPs using a prior that shrinks task correlations toward zero. I contribute to GPyTorch at `https://github.com/cornellius-gp/gpytorch`, an open-source deep-learning library for Gaussian processes.

Talks & Posters

"Multi-task Bayesian Optimization in noisy experiments," with Eytan Bakshy, MIT Conference on Digital Experimentation, 2018.

Other Experience

- Research assistant to Prof. Guido Imbens, Stanford University, studying various topics in econometrics and causal inference. (2016–)
- Research assistant to Profs. David Lobell and Marshall Burke, Stanford University, studying crop yields through satellite imagery. (2014–2015)

Teaching

TA for MGTECON 640, a class for advanced PhD students doing quantitative social science research. Prepared section lectures and help students navigate topics in optimization algorithms, discrete choice models, MCMC, nonparametric treatment effects estimation, and machine learning methods for panel data. (2018)

Relevant Coursework

- *Economics:* Core graduate microeconomics, core graduate macroeconomics, advanced econometrics, computational econometrics, public economics, industrial organization, social networks, machine learning for causal inference, economic history.
- *Statistics & Mathematics:* Core graduate probability theory, core graduate mathematical statistics, advanced topics in statistics, modern applied statistics, real analysis, measure theory, time series analysis, graphical models, stochastic processes, ANOVA, applied linear algebra, mathematical logic, complex analysis.
- *Computer Science & Electrical Engineering:* Programming abstractions, analysis of algorithms, graph theory, machine learning, computational methods, theory of computation, information & coding theory, non-linear control & analysis, analog & digital signal processing, networks & systems.

Skills

R, MATLAB, C++, Python, ArcGIS, Stata, Git, Latex

Honors

- Stanford Enhancing Diversity in Graduate Education (EDGE) Doctoral fellowship, 2018.
- Stanford Diversifying Academia, Recruiting Excellence (DARE) Fellowship Alternate, 2018.
- Amos Warner research fellowship, Stanford economics department, 2016–17.
- Graduate student fellowship, Stanford economics department, 2015–16.
- DAAD WISE scholarship, from the German Academic Exchange Service in 2012 to do a fully-funded summer research project at TU Berlin, Germany.
- IIT Madras Merit Award for ranking 143 nation-wide in IIT Joint Entrance Examination 2009 among 400,000 students.
- CBSE merit scholarship for ranking 179 nation-wide in All India Engineering Entrance Examination 2009 among over a million students.
- One of 125 KVPY (young scientists fellowship) scholars in 2008 selected by the Department of Science and Technology, Government of India.

Personal

Citizenship: Indian
Date of Birth: June 12, 1992