Lalit Jain

CONTACT INFORMATION	Michael G. Foster School of Business University of Washington Seattle, WA 98195 USA	*Email:* lalitj@uw.edu *Web:* http://www.lalitjain.com

RESEARCH INTERESTS

Broad: Building machine learning and adaptive data collection algorithms and systems. My research includes **Reinforcement Learning, Interactive Machine Learning, and User Preference Learning** with applications to Online Platforms.

Specific: Multi-Armed Bandits, Contextual Bandits, Active Learning, Statistical Learning Theory, Fairness, Dynamic Pricing, Optimization, Metric/Ordinal Embedding and Multidimensional Scaling, Ranking Models, Practical Systems for Adaptive Crowdsourced Data Collection.

WORK HISTORY

Prime Division, Amazon, Seattle, WA, August 2019-Present
Amazon Visiting Academic/Scholar: Developed a best-arm identification experimentation framework for marketing and multi-variate testing. This system drives the majority of experimentation for Prime user acquisition and retention and serves millions of impressions daily. Worked with a cross-functional team of scientists and engineers to develop the science, design and build the underlying systems including dashboards. Worked backwards from marketer needs, including using surveys and understanding points of failures of the existing system.

Foster School of Business University of Washington, Seattle, WA, January 2020-Present
Assistant Professor in Marketing and International Business,

Paul G. Allen School of Computer Science and Engineering, University of Washington
Seattle, WA, 2018-2019
Research Scientist (Postdoc), Mentored by Professor Kevin Jamieson.

Department of Mathematics, University of Michigan, Ann Arbor, MI, 2016-2017
Assistant Professor (Postdoc), Mentored by Professor Anna Gilbert

Intuit Inc., San Diego, CA, 6/2015-9/2015
Data Scientist Consumer Tax Group: Developed and deployed contextual bandits algorithms for market segmentation. Also worked on a library for data transformation, manipulation and imputation. Received a company spotlight for my work.

EDUCATION

University of Wisconsin-Madison, Madison, Wisconsin USA
    Ph.D., Mathematics, August 2016
        Dissertation Topic: "Big Mod ℓ Monodromy of Families of G-Covers"
        Advisor: Jordan Ellenberg
    Minor: Computer Science

University of Waterloo, Waterloo, Ontario Canada
    Masters of Mathematics in Pure Mathematics, May 2008
        Thesis: "Koblitz's Conjecture for the Drinfeld Module"
        Advisors: Yu-Ru Liu and Wentang Kuo

University of Waterloo, Waterloo, Ontario Canada
    Bachelors of Mathematics in Pure Mathematics, December 2006
    Minor in Combinatorics and Optimization, Graduated with Honors and Distinction

Preprints

L. Jain, Z. Li, E. Loghmani, B. Mason, and H. Yoganarasimhan, *Effective Adaptive Exploration of Prices and Promotions in Choice-Based Demand Models.* Available at SSRN 4438537. Submitted to Marketing Science. 2023.

R.Camilleri, A. Wagenmaker, L. Jain, J. Morgenstern, K. Jamieson. *(Less Biased) Fair Classification: Passive and Active Approaches*, 2023 Submitted.

A. Tajdani, L. Jain, K. Jamieson. *Minimax Optimal Submodular Optimization with Bandit Feedback*, 2023 Submitted

Publications

Z. Li, K. Jamieson, L. Jain. *Optimal Exploration is no harder than Thompson Sampling*, AISTATS 2024

Z. Xiong, R. Camilleri, M. Fazel, L. Jain, K. Jamieson. *A/B Testing and Best-Arm Identification for Linear Bandits with Robustness to Non-stationarity*, AISTATS 2024

S. Alizadeh, A. Bhargava, K. Gopalswamy, L. Jain, B. Kveton, G. Liu. *Pessimistic Multi-Objective Optimization*, AISTATS 2024

T. Fiez, S. Gamez, A. Chen, H. Nassif, L. Jain. *Adaptive Experimental Design and Counterfactual Inference*, RECSYS REVEAL+CONSEQUENCES Workshop 2022. Spotlight Talk. Published at WWW '24.

J. Weltz, T. Fiez, A. Volfovsky, E. Laber, B. Mason, H. Nassif, L. Jain. *Experimental Designs for Heteroskedastic Variance*, Advances in Neural Information Processing Systems 34, 2023.

Z. Li, L. Ratliff, H. Nassif, K. Jamieson, L. Jain. *Instance-optimal PAC Algorithms for Contextual Bandits*, Advances in Neural Information Processing Systems 34, 2022

R. Camilleri, A. Wagenmaker, J. Morgenstern, L. Jain, K. Jamieson, *Active Learning With Safety Constraints*, Advances in Neural Information Processing Systems 34, 2022

J. Brennan, L. Jain, S. Garman, A.E. Donnelly, E.S. Wright, K. Jamieson. *Sample-efficient identification of high-dimensional antibiotic synergy with a normalized diagonal sampling design*, PLoS computational biology 18 (7), e1010311

B. Mason, R. Camilleri, S. Mukherjee, K. Jamieson, R. Nowak, L. Jain, *Nearly Optimal Algorithms for Level Set Estimation*, AISTATS 2022

L. Jain, B. Mason, K.S. Jun, An Experimental *Design Approach for Regret Minimization in Logistic Bandits*, AAAI 2022

R. Camilleri, Z. Xiong, M. Fazel, L. Jain, K. Jamieson, *Selective Sampling for Online Best-Arm Identification.* Advances in Neural Information Processing Systems 33, 2021

J. Zhang, J. Katz-Samuels, L. Jain, K. Jamieson, *Improved Algorithms for Agnostic Pool-based Active Classification.* International Conference on Machine Learning, 2021

K. Jun, L. Jain, B. Mason, R. H. Nassif. *Improved Confidence Bounds for the Linear Logistic Model and Applications to Linear Bandits.* International Conference on Machine Learning, 2021

J. Katz-Samuels, L. Jain, K. Jamieson. *An Empirical Process Approach to the Union Bound: Practical Algorithms for Combinatorial and Linear Bandits.* Advances in Neural Information Processing Systems 32, 2020

B. Mason, L. Jain, A. Tripathy, R. Nowak. *Finding All Epsilon-Good Arms in Stochastic Bandits.* Advances in Neural Information Processing Systems 32, 2020

U. Varma, L. Jain, A. Gilbert. *Spectral Methods for Ranking with Scarce Data.* Uncertainty in Aritifical Intelligence, 2020.

T. Fiez, L. Jain, K. Jamieson, L. Ratliff. *Sequential Experimental Design for Transductive Linear Bandits.* Advances in Neural Information Processing Systems 32, 2019.

L. Jain, K. Jamieson, *A New Perspective on Pool-Based Active Classification and False-Discovery Control.* Advances in Neural Information Processing Systems 32, 2019.

L. Jain, K. Jamieson, *Firing Bandits: Optimizing Crowdfunding.* International Conference on Machine Learning, 2018

K. Jamieson, L. Jain, *A Bandit Approach to Multiple Testing with False Discovery Control.* Advances in Neural Information Processing Systems 31, 2018.

L. Jain, B. Mason, R. Nowak, *Learning Low-Dimensional Metrics.* Advances in Neural Information Processing Systems 30, 2017

S. Katariya, L. Jain, N. Sengupta, J. Evans, R. Nowak, *Adaptive Sampling for Coarse Ranking.* AISTATS, 2017.

Anna Gilbert, L. Jain, *If it ain't broke, don't fix it: Sparse metric repair.* Allerton 2017

L. Jain, K. Jamieson, R. Nowak, *Finite Sample Prediction and Recovery Bounds for Ordinal Embedding.* Advances in Neural Information Processing Systems 29, 2016.

K. Jamieson, L. Jain, C. Fernandez, N. Glattard, R. Nowak, *NEXT: A System for Real-World Development, Evaluation, and Application of Active Learning* in Advances in Neural Information Processing Systems 28, 2015.

Other Publications

L. Jain, *The Big Mod ℓ Monodromy of Families of G-Covers.* Available as PhD Thesis.

E. Dummit, R. Harron, L. Jain, R. Pollack, D. Ross , M. Hablicsek, *Explicit computations of Hida families via overconvergent modular symbols.* Research in Number Theory. 2015.

L. Jain, P. Tzermias, *Beukers' integrals and Apéry's recurrences.* Journal of Integer Sequences. 8: Issue 1, Article 05.1.1., 2005

J. Holmes, V. Danilov, L. Jain, *Transverse Stability Studies of the SNS Ring.* Proceedings of 2005 Particle Accelerator Conference, Knoxville, Tennessee, 2254-2256, 2005.

INVITED TALKS	**Cartoons, Captions, and Confidence Intervals** Center for Statistics and Social Sciences, University of Washington, November 2023 **Optimal Exploration using Posterior Sampling** Amazon Prime Science Seminar, October 2023

Pessimistic Multi-Objective Optimization Amazon Prime Science Seminar, September 2023
Experimenting when you Can't Experiment Choice Symposium, Fontainebleau France, Aug 2023
Adaptive Exploration with Application to Pricing and Promotions SICS, Haas School of Business, Berkeley CA, June 2023
Adaptive Exploration with Application to Pricing and Promotions Marketing Seminar, Kellogg School of Business, Northwestern University, April 2023
Recent Progress in Adaptive Experimental Design INFORMS, Indianapolis Indiana, October 2022
Adaptive Experimental Design and Counterfactual Inference Consequences+Reveal, Recsys 2022, October 2022
Experimentation for Causal Inference. Junior Quant Seminar, Yale University, September 2022
Level Set Estimation. ISOM Seminar, University of Washington, February 2022
Ubiquity of Best-Arm Identification. Lions Seminar, Arizona State University, November 2021
Adaptive Data Collection. Amazon CX Data Science, April 2021
Finding Good arms in Stochastic Bandits. Bass Forms Conference. February 2021
Adaptive Experimental Design INFORMS, November 2020
Finding Good arms in Stochastic Bandits. Northwest Data Science Seminar. July 2020
Large Scale Experimentation. Marketing Science Conference. July 2020
Adaptive Data Collection. Starbucks Data Science, May 2019
Sequential Experimentation for False Discovery Control. SILO, University of Wisconsin, March 2019
Large Scale Human Driven Data Collection for Preference and Similarity Learning. eScience Community Seminar, University of Washington, February 2019
Large Scale Human Driven Data Collection for Preference and Similarity Learning. Marketing Seminar, Stanford Graduate School of Business, October 2018
Large Scale Human Driven Data Collection for Preference and Similarity Learning. Math Colloquium, Portland State University, October 2018
Never Fearing Features. Research Seminar, Amazon, October 2018
Adaptive Data Collection for Crowdfunding. Computational and Applied Math Colloquium, University of Chicago, October 2018
Monodromy and Cohen Lenstra Heuristics. Number Theory Seminar, University of Washington, April 2017
NEXT: Active Learning in the Wild. Interactive Learning, Simons Institute, February 2017
Active Learning in Theory and Practice. Recent Advances and Applications in Machine Learning, Chicago chapter of American Statistical Association, March 2016
Ordinal Embedding. Student Signal Processing Seminar, University of Michigan, November 2016
PSD matrices and Ordinal Embedding. Applied Algebra Days, University of Wisconsin-Madison, April 2016
Monodromy of Hurwitz Spaces. Topology Seminar, University of Wisconsin-Milwauke, Fall 2016
The ℓ-adic monodromy of G-covers. Frontier Seminar, Colorado State University, Fall 2014,
Applications of Monodromy to Number Theory. PANTS XXII Fall 2014

TEACHING
EXPERIENCE

University Level

University of Washington, Seattle, Washington
2020-2023. BUS AN 517 Machine Learning. Designed and taught a course on machine learning for the Masters of Science in Business Analytics Program. **Received a Teaching Excellence award each year taught.**
2021-2023. BUS AN 515 Digital Marketing Analytics.

Spring 2023. MKTG 596 Special Topics in Machine Learning. Topics covered included adaptive experimentation, multi-armed bandits, and game theory.
Winter 2020/2021. MKTG 466 Digital Marketing Analytics.

University of Michigan, Ann Arbor, Michigan
Instructor - Fall 2017. Instructor for Math 425, Introduction to Probability. Main instructor for a three credit course on Probability Theory. Topics included discrete probability, working with continuous distributions, and limit theorems.
Instructor - Fall 2016. Instructor for two sections of Math 115, Calculus 1. Responsible for writing quizzes and leading three eighty minute flipped classroom sessions.

University of Wisconsin-Madison, Madison, Wisconsin
Teaching Assistant. Led discussion sections, wrote and graded quizzes/homework and held office hours. Received excellent TA evaluations each semester.

Fall 2014, Math 221: Calculus I
Fall 2013, Math 114: Algebra and Trigonometry
Fall 2012, Math 320: Differential Equations and Linear Algebra
Spring 2011-2013, Math 490: NSF sponsored CURL (Collaborative Undergraduate Research Lab)
Fall 2010, Math 221: Calculus I

Grade School and Enrichment

Ida B. Wells High School, 2008-2010, San Francisco, California USA
Teacher. Taught a variety of classes as a Teach for America high school teacher.

San Francisco and Oakland Math Circles , 2008-2010, San Francisco, California USA
Teacher. Led a variety of enrichment math classes for high school and middle school students.

University of Wisconsin-Madison *Organizer and Instructor* Organized the Madison Math Circles from 2011-2014. Also gave several talks on topics ranging from enumerating the ways to make change for a dollar, to facts about platonic solids.

University of Washington *Volunteer Instructor.* Helped design, implement, and run an interactive machine learning activity for students at the UW STEMsub program that introduced the basic ideas of classification and generalization.

HONORS AND AWARDS	Best Paper Award, Adaptive Experimental Design and Active Learning in the Real World. ICML (July 22, 2022). MSBA Teaching Excellence Award, University of Washington, Spring 2020-2023. NSF VIGRE Fellowship recipient, UW-Madison, 2011-2014
OTHER EMPLOYMENT	**Seventh Harmonic LLC,** Madison, WI, 8/2013-Present, Co-Founder: Co-founder and software engineer (seventhharmonic.com). Responsible for developing new products, such as Bee-Line, an Android game. **Oak Ridge National Lab/Spallation Neutron Source**, Oak Ridge, TN, 1/2008-4/2008, Intern: Researched instability thresholds at the Spallation Neutron Source particle accelerator. Studied experimental beam data using Matlab and C++ for signal processing and visualization.
OTHER TALKS	**Conference Talks and Posters:** **ISMS Marketing Science Conference.** Talk : *Adaptive Experimentation.* Zoom, 2020.

International Conference on Machine Learning, Talk: *Firing Bandits: Optimizing Crowdfunding.* Stockholm Sweden, June 2018

Neural Information Processing Systems, Poster: *A Bandit Approach to Multiple Testing with False Discovery Control.* Long Beach CA, December 2017

Neural Information Processing Systems, Poster: *Finite Sample Prediction and Recovery Bounds for Ordinal Embedding.* Barcelona Spain, December 2016

Park City Math Institute, Talk: *Distance Matrices.* Also a TA for Steve Wright's course on optimization. June 2016

Neural Information Processing Systems, Spotlight Presentation: *NEXT: A System for Real-World Development, Evaluation, and Application of Active Learning*, Montreal CA, Dec 2015

PROFESSIONAL ACTIVITIES	**Reviewer, Editorial Review Board, and Senior Program Committee Member:** Neurips, ICML, AAAI, ICLR, AISTATS, UAI, SODA, Marketing Science, Management Science, Operations Research.

Co-Organizer Neurips workshop on Adaptive Experimental Design and Active Learning in the Real World. , 2023,

SOFTWARE PROJECTS	**New Yorker Cartoon Caption Contest:** Have been running the online crowdsourced voting system for the New Yorker Caption Contest for nearly a decade (https://www.newyorker.com/cartoons/contest#thisweek). Designed and built a high-throughput online system for processing thousands of votes a minute. Each week the contest receives around one million votes on over 5000 captions. The resulting dataset (https://nextml.github.io/caption-contest-data/) is one of the largest on humor.

NEXT System for Active Learning: NEXT (nextml.org) is a real time computational framework and open-source machine learning system that simplifies the deployment and evaluation of active learning algorithms relying on human feedback. Example applications include online classification, bandit problems, and multidimensional scaling.Project was done in close collaboration with Kevin Jamieson.

Bee-Line: Working alongside Nathan Clement and Leland Jefferis (two fellow grad students at the University of Wisconsin) I created Bee-Line, an Android educational puzzle game. The goal in Bee-Line is to help Beatrice the bee find a path through a garden of flowers. As the paths get longer the challenge and fun increases! Bee-Line recieved over 20000 downloads on the Google Play store. The art, music, puzzle concept and storyline are completely original.

FORTE-Faster Ordinal Triplet Embedding: FORTE (www.github.com/lalitkumarj/FORTE) provides highly optimized algorithms for ordinal embedding in Cython. It implements several of the standard objectives including, stochastic triplet embedding, crowd kernel, and hinge loss. FORTE is designed to be used by practitioners using ordinal embedding in their research and theorists interested in developing new algorithms.

SAGE: Overconvergent Modular Symbols: Participated in the development of an overconvergent modular symbols library for Sage that explicitly implements work of Pollack and Stevens.

Music Hack Day, Boston Fall 2012: Participated with Jordan Ellenberg, Ben Recht, and Andrew Bridy. We used statistical information from the Million Song Database to create our own composition. Extended this project to use machine learning algorithms for identifying metrics of when two songs were similar. Won 20th place in a related Kaggle competition.