Kevin A. Lai

Curriculum Vitae

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Research Interests

I am interested in developing better understanding of optimization algorithms for machine learning. One main thread of my research has been the convergence of game dynamics, which spans the fields of game theory, optimization, and online learning. My work has also touched upon areas such as regression, differential privacy, and robust estimation.

Education

Georgia Institute of Technology, Atlanta, GA — Expected May 2020
Ph.D., Algorithms, Combinatorics, and Optimization, GPA 3.83
Home department: Computer Science
Advisor: Prof. Jacob Abernethy

Princeton University, Princeton, NJ — 2013 - 2015
M.S.E., Computer Science, GPA: 3.83
Thesis: Label optimal regret bounds for online local learning
Advisor: Moses Charikar

Yale University, New Haven, CT — 2009 - 2013
B.S., Double major in Physics and Computer Science, GPA: 3.97
Summa cum laude. Phi Beta Kappa.

Publications

(author order is alphabetical and credit is shared equally, as is customary for theory papers)

Peer-Reviewed Conference Publications

Jacob Abernethy, Kevin A. Lai, Kfir Levy, Jun-Kun Wang. Faster Rates for Convex-Concave Games. *Conference on Learning Theory (COLT)*, 2018.

David Durfee, Kevin A. Lai, Saurabh Sawlani. ℓ_1 Regression Using Lewis Weights Preconditioning and Stochastic Gradient Descent. *Conference on Learning Theory (COLT)*, 2018.

Rachel Cummings, Sara Krehbiel, Kevin A. Lai, Uthaipon (Tao) Tantipongpipat. Differential Privacy for Growing Databases. *Neural Information Processing Systems (NeurIPS)*, 2018.

Kevin A. Lai, Anup B. Rao, and Santosh Vempala. Agnostic Estimation of Mean and Covariance. *Foundations of Computer Science (FOCS)*, 2016.

Pranjal Awasthi, Moses Charikar, Kevin A. Lai, and Andrej Risteski. Label Optimal Regret Bounds for Online Local Learning. *Conference on Learning Theory (COLT)*, 2015.

JOURNAL PUBLICATIONS

Mahdi Amani, Kevin A. Lai, Robert E. Tarjan. Amortized rotation cost in AVL trees. *Information Processing Letters*, Volume 116, Issue 5, May 2016, Pages 327-330, ISSN 0020-0190, `http://dx.doi.org/10.1016/j.ipl.2015.12.009`.

WORKSHOP PAPERS

Jacob Abernethy, Kevin A. Lai, and Andre Wibisono. Last-iterate convergence in convex-concave games. *NeurIPS Smooth Games Optimization and Machine Learning Workshop*, 2019.

MANUSCRIPTS

Brian Bullins and Kevin A. Lai. Higher-order methods for min-max optimization. 2019. (in preparation)

Jacob Abernethy, Kevin A. Lai, and Andre Wibisono. Fictitious Play: Convergence, Smoothness, and Optimism. 2019. `https://arxiv.org/abs/1911.08418`. (in submission)

Jacob Abernethy, Kevin A. Lai, and Andre Wibisono. Last-iterate convergence in convex-concave games. 2019. `https://arxiv.org/abs/1906.02027`. (in submission)

RESEARCH TALKS

Last-iterate Convergence in Convex-Concave Games

- Poster at NeurIPS Smooth Games Optimization and Machine Learning Workshop 2019
- Talk at Google Research weekly machine learning seminar 2019

Fast Convergence of Fictitious Play

- Talk at ACO student seminar 2019

Differential Privacy for Growing Databases

- Poster at NeurIPS 2018

ℓ_1 Regression Using Lewis Weights Preconditioning and Stochastic Gradient Descent

- Talk at Google Research weekly meeting 2018
- Talk at COLT 2018

Faster Rates for Convex-Concave Games

- Poster at COLT 2018

Agnostic Estimation of Mean and Covariance

- Poster at Georgia Tech ACO25 Conference 2017
- Talk at Park City Math Institute Summer School seminar 2016
- Talk at ACO student seminar 2016

Label optimal regret bounds for online local learning

- Talk at ACO student seminar 2015

RESEARCH EXPERIENCE

Higher-order algorithms for min-max optimization 2019 - present
In collaboration with Brian Bullins

We give higher-order algorithms for min-max optimization, showing improved iteration complexity over first-order algorithms for sufficiently smooth convex-concave problems. Our work is the first to show that higher-order methods can improve over first-order ones in iteration complexity for general smooth convex-concave problems.

Fictitious Play: Convergence, Smoothness, and Optimism 2019 - present
In collaboration with Jacob Abernethy and Andre Wibisono

We show fast convergence of Fictitious Play (FP) (at a $O(k^{-1/2})$ rate after k iterations) under lexicographic tie-breaking for the case of diagonal payoff matrices. This greatly expands the class of payoff matrices for which FP is known to converge quickly and gives a partly answer to the conjecture of Karlin [1959]. We also give fast rates for smooth and optimistic variants of FP.

Last-iterate convergence in convex-concave games 2019
In collaboration with Jacob Abernethy and Andre Wibisono

We show last-iterate convergence rates for Hamiltonian Gradient Descent (HGD) in a new class of unconstrained convex-concave settings known as "sufficiently bilinear" settings. Previously, last-iterate rates for any algorithm were only known for cases when the objective is pure bilinear or strongly convex/concave in one of the players. We also provide convergence guarantees for the Consensus Optimization algorithm for some parameter regimes.

Faster Rates for Convex-Concave Games 2018
In collaboration with Jacob Abernethy, Kfir Levy, Jun-Kun Wang

We give faster online-to-batch conversions using weighted regret and optimistic algorithms. This leads to faster convergence rates in certain convex-concave games and recovers a result of Garber and Hazan [2015] for fast Frank-Wolfe algorithms.

ℓ_1 Regression Using Lewis Weights Preconditioning and Stochastic Gradient Descent 2018
In collaboration with David Durfee and Saurabh Sawlani

We give fast SGD-based algorithms for the unconstrained overdetermined ℓ_1 regression problem. Our algorithms improve upon the previous best SGD-based algorithms and are competitive with interior point method algorithms in some regimes.

Differential Privacy for Growing Databases 2018
In collaboration with Rachel Cummings, Sara Krehbiel, and Uthaipon (Tao) Tantipongpipat

We study the design of differentially private algorithms for adaptive analysis of dynamically growing databases, where a database accumulates new data entries while the analysis is ongoing. We provide a collection of tools for machine learning and other types of data analysis that guarantee differential privacy and accuracy as the underlying databases grow arbitrarily large. We give both a general technique and a specific algorithm for adaptive analysis of dynamically growing databases.

Agnostic Estimation of Mean and Covariance 2016
In collaboration with Anup B. Rao and Santosh Vempala

We present polynomial-time algorithms to estimate the mean and covariance of a Gaussian in the presence of adversarial noise, with error guarantees in terms of information-theoretic lower bounds. As a corollary, we also obtain an agnostic algorithm for Singular Value Decomposition.

Amortized rotation cost in AVL trees 2016
In collaboration with Mahdi Amani and Robert E. Tarjan

We give a class of *expensive* n-node AVL trees E such that, given any tree in E, deleting a certain leaf and then reinserting it produces a tree in E, with the deletion having done $\Theta(\log n)$ rotations. This shows that AVL trees can cost $\Theta(\log n)$ rotations per deletion in an amortized sense, not just in a worst case sense as was previously shown.

Label Optimal Regret Bounds for Online Local Learning 2015
In collaboration with Pranjal Awasthi, Moses Charikar, and Andrej Risteski

We resolve an open question from Christiano [2014] regarding the optimal dependency of the regret achievable for online local learning on the size of the label set. We improve the upper bound on the regret in this setting and show a matching computational lower bound, assuming hardness of the planted clique problem.

Comparing Spectral Clustering Algorithms 2013
Supervised by Daniel Spielman

For my undergraduate senior research project, I ran experiments comparing different spectral clustering algorithms for graphs with the goal of characterizing the clusters produced by these algorithms for some representative graphs as well as on real-world data.

Industry Experience

Google Research NYC, Software Engineering Intern Summer 2018
Worked with Satyen Kale on extreme multiclass classification
Proved theoretical results about an optimization algorithm and ran experiments in Tensorflow

Microsoft, Software Development Engineer in Test Intern Summer 2012
Designed and implemented a proof of concept for a testing framework in C# as part of the Windows Azure End-to-End Testing Team

Professional Development

Park City Math Institute Graduate Summer School, Park City, Utah 2016
Attended three-week selective program covering topics on The Mathematics of Data

Gene Golub SIAM Summer School, Delphi, Greece 2015
Attended two-week selective program covering topics in Randomized Numerical Linear Algebra

Honours and Awards

ARC Fellowship, Georgia Tech 2016

Georgia Tech Institute Fellowship, Georgia Tech 2015 - 2019

Summa cum laude, Yale University 2013

Phi Beta Kappa, Yale University 2012

Service and Leadership

Conference Reviewing

Neural Information Processing Systems (NeurIPS)	2018, 2019
International Conference on Machine Learning (ICML)	2018, 2019
Conference on Learning Theory (COLT)	2018, 2019
Symposium on Theory of Computing (STOC)	2020
Symposium on Discrete Algorithms (SODA)	2018
Algorithmic Learning Theory (ALT)	2018, 2020
Randomization and Computation (RANDOM)	2018

Organizer for Georgia Tech ACO student seminar 2017-2018
In the 2017-2018 academic year, I was one of the organizers for the weekly ACO student seminar at Georgia Tech.

TEACHING

Guest Lecture on Online Learning for Solving Games and LPs for CS 4510, Advanced Algorithms 2019

In the Fall semester of 2019, I gave a guest lecture on Online Learning for Solving Games and LPs for the CS 4510 at Georgia Tech, Advanced Algorithms.

Teaching Assistant, Georgia Tech 2017

I worked as a teaching assistant for CS 6505 (Graduate algorithms) and CS 7545 (Graduate machine learning theory). I graded proofs and held office hours for CS 6505 and CS 7545

Teaching Assistant, Princeton University 2013 - 2015

I worked as a teaching assistant for COS 126 (Introduction to Computer Science), COS 423 (Undergrad algorithms), COS 521 (Graduate algorithms), and COS 511 (Graduate theoretical machine learning). I taught 50-minute precepts twice a week for COS 126, which involved lecturing and giving exercises on new material. I graded proofs and held Q&A sessions and office hours for COS 423, COS 521, and COS 511.