

Sushant Sachdeva

Assistant Professor, University of Toronto

<https://www.cs.toronto.edu/~sachdeva/>
sachdeva@cs.toronto.edu

RESEARCH INTERESTS

Algorithms, and its connections to learning, optimization, and statistics

My research is focused on the design of fast algorithms for problems ranging from theoretical computer science to machine learning and statistics. My work brings together tools from convex optimization, numerical linear algebra, and approximation theory.

APPOINTMENTS

University of Toronto

Toronto, ON, Canada

Assistant Professor, Department of Computer Science

Aug 2017 – Present

Institute for Advanced Study

Princeton, NJ, USA

Visitor

Fall 2019

Special year on Optimization, Statistics, and Theoretical Machine Learning

Google

Mountain View, CA, USA

Research Scientist

Aug 2016 – Aug 2017

Yale University

New Haven, CT, USA

Postdoctoral Associate, Department of Computer Science

Jan 2014 – Jul 2016

Supervisor: Prof. Daniel Spielman

Lecturer, Department of Computer Science

Jan 2015 – May 2015

UC Berkeley, Simons Institute for the Theory of Computing

Berkeley, CA, USA

Simons Research Fellow

Aug 2013 – Dec 2013

Program: Real Analysis in Computer Science

EDUCATION

Princeton University

Princeton, NJ, USA

Ph.D., Department of Computer Science

Sep 2008 – Sep 2013

Thesis: New Results in the Theory of Approximation — Fast Graph Algorithms and Inapproximability

Adviser: Prof. Sanjeev Arora

Area of study: Theoretical Computer Science

M.A., Department of Computer Science

Sep 2008 – Jun 2010

GPA: 4.0/4.0

Indian Institute of Technology Bombay

Mumbai, India

B.Tech., Department of Computer Science and Engineering

Jul 2004 – Aug 2008

Adviser: Sundar Vishwanathan

CPI: 9.97/10.00

HONORS AND AWARDS

NSERC Discovery Grant 2018-2023 (CAD 172,500)

Connaught New Researcher Award 2018 (CAD 10,000)

Google Faculty Research Award, 2017 (USD 43,335)

Simons-Berkeley Research Fellowship, Fall 2013 (USD 26,466)

Postdoctoral Research Fellowship by Institute for Computational and Experimental Research in Mathematics (2013-2014, USD 50,000 – declined)

President of India Gold Medal for topping the class of 2008 (of 500+ students)

Jayanti Deshmukh Memorial Gold Medal for being the most outstanding B.Tech. student in the computer science class of 2008 (out of 35 students)

Honorable Mention at **ACM ICPC World Finals, Tokyo 2007** representing IIT Bombay

1st all over India in IIT Entrance Examination 2004 (among 170,000+ students)

Bronze Medalist at 36th International Chemistry Olympiad (IChO) 2004, Kiel, Germany

Perfect SPI of 10.0 in 7 semesters out of 8 at IIT Bombay

AP grade for outstanding performance in ten courses at IIT Bombay

Aditya Birla Scholarship 2004–08, covering my undergraduate studies. It is awarded to only 10 engineering students each year.

Dhirubai Ambani Scholarship 2004–08 for being among the top 10 students of Maharashtra state in AISSCE 2004.

Kishore Vaigyanik Protsahan Yojana (KVPY) fellowship 2002–04. Awarded to around 50 students each year; aimed at promoting research careers in the sciences.

MONOGRAPHS

Faster Algorithms via Approximation Theory

S. Sachdeva, N. K. Vishnoi

In Foundations and Trends in Theoretical Computer Science 9.2 (FTTCS) 2014, pp. 125-210

REFEREED

The mixing time of the Dikin walk in a polytope – A simple proof

JOURNAL

S. Sachdeva, N. Vishnoi

PUBLICATIONS

In Operations Research Letters, 44.5 (September 2016), pp. 630–634

An Arithmetic Analogue of Fox’s Triangle Removal Argument

P. Hatami, S. Sachdeva, M. Tulsiani

In Online Journal of Analytic Combinatorics 11 (OJAC) 2016

Provable ICA with Unknown Gaussian Noise, and Implications for Gaussian Mixtures and Autoencoders

S. Arora, R. Ge, A. Moitra, S. Sachdeva

In Algorithmica 72.1 (May 2015), pp. 215–236

Inapproximability of Minimum Vertex Cover on k -Uniform k -Partite Hypergraphs

V. Guruswami, S. Sachdeva, R. Saket

In SIAM Journal on Discrete Mathematics 29.1 (SIDMA) 2015, pp. 36–58

Greedy Geometric Algorithms for Collection of Balls, with Applications to Geometric Approximation and Molecular Coarse-Graining

F. Cazals, T. Dreyfus, S. Sachdeva, N. Shah

In Computer Graphics Forum 33–6, 2014

On the Characterization and Selection of Diverse Conformational Ensembles with Applications to Flexible Docking

S. Lorient, S. Sachdeva, K. Bastard, C. Prevost, F. Cazals

In Computational Biology and Bioinformatics, IEEE/ACM Transactions on 8.2 (TCBB) 2011, pp. 487–498

REFEREED

Faster p -norm minimizing flows, via smoothed q -norm problems

CONFERENCE /

D. Adil, S. Sachdeva

WORKSHOP

To appear at 31th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2020

PUBLICATIONS

Fast, Provably convergent IRLS Algorithm for p -norm Linear Regression

D. Adil, R. Peng, S. Sachdeva

To appear at 33rd Conference on Neural Information Processing Systems (NeurIPS) 2019

Which Algorithmic Choices Matter at Which Batch Sizes? Insights From a Noisy Quadratic Model

G. Zhang, L. Li, Z. Nado, J. Martens, S. Sachdeva, G. Dahl, C. Shallue, R. Grosse

To appear at 33rd Conference on Neural Information Processing Systems (NeurIPS) 2019

Flows in Almost Linear Time via Adaptive Preconditioning

R. Kyng, R. Peng, S. Sachdeva, D. Wang

In 51st ACM Symposium on Theory of Computing (STOC) 2019

Improved Semi-Supervised Learning with Multiple Graphs

K. Viswanathan*, S. Sachdeva*, A. Tomkins, S. Ravi (*=equal contribution)

In 22nd International Conference on Artificial Intelligence and Statistics (AISTATS) 2019

Iterative Refinement for ℓ_p -norm Regression

D. Adil, R. Kyng, R. Peng, S. Sachdeva

In 30th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2019

Short Cycles via Low-Diameter Decompositions

Y. P. Liu, S. Sachdeva, Z. Yu

In 30th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2019

Graph Sparsification, Spectral Sketches, and Faster Resistance Computation, via Short Cycle Decompositions

T. Chu, Y. Gao, R. Peng, S. Sachdeva, S. Sawlani, J. Wang

To appear at 59th IEEE Symposium on Foundations of Computer Science (FOCS) 2018

Invited to SIAM Journal on Computing **Special Issue**

Invited to **Highlights of Algorithms 2019**

Convergence Results for Neural Networks via Electrodynamics

R. Panigrahy, A. Rahimi, S. Sachdeva, Q. Zhang

In 9th Innovations in Theoretical Computer Science (ITCS) 2018

Near-optimal approximation algorithm for simultaneous Max-Cut

A. Bhangale, S. Khot, S. Kopparty, S. Sachdeva, D. Thiruvengatachari

In 29th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2018

Sampling Random Spanning Trees Faster than Matrix Multiplication

D. Durfee, R. Kyng, J. Peebles, A. B. Rao, S. Sachdeva

In 49th ACM Symposium on Theory of Computing (STOC) 2017

A framework for analyzing resparsification algorithms

R. Kyng, J. Pachocki, R. Peng, S. Sachdeva

In 28th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2017

Approximate Gaussian Elimination for Laplacians: Fast, Sparse, and Simple

R. Kyng, S. Sachdeva

In 57th IEEE Symposium on Foundations of Computer Science (FOCS) 2016

Invited to **Highlights of Algorithms 2017**

Sparsified Cholesky and Multigrid Solvers for Connection Laplacians

R. Kyng, Y. T. Lee, R. Peng, S. Sachdeva, and D. A. Spielman

In 48th ACM Symposium on Theory of Computing (STOC) 2016

Fast, Provable Algorithms for Isotonic Regression in all ℓ_p -norms

R. Kyng, A. B. Rao, S. Sachdeva

In 29th Advances in Neural Information Processing Systems (NIPS) 2015

Algorithms for Lipschitz Learning on Graphs

R. Kyng, A. B. Rao, S. Sachdeva, D. A. Spielman

In 28th Conference on Learning Theory (COLT) 2015

Simultaneous Approximation of Constraint Satisfaction Problems

A. Bhangale, S. Kopparty, S. Sachdeva

In 42nd International Colloquium on Automata, Languages, and Programming (ICALP) 2015

Optimal Inapproximability for Scheduling Problems via Structural Hardness for Hypergraph Vertex Cover

S. Sachdeva, R. Saket

In 28th IEEE Conference on Computational Complexity (CCC) 2013

Approximating the Exponential, the Lanczos Method and an $\tilde{O}(m)$ -Time Spectral Algorithm for Balanced Separator

L. Orecchia, S. Sachdeva, N. K. Vishnoi

In 44th ACM Symposium on Theory of Computing (STOC) 2012

Provable ICA with Unknown Gaussian Noise, and Implications for Gaussian Mixtures and Autoencoders

S. Arora, R. Ge, A. Moitra, S. Sachdeva

In 26th Advances in Neural Information Processing Systems (NIPS) 2012

Invited to **Algorithmica Special Issue for Machine Learning**

Finding Overlapping Communities in Social Networks: Towards a Rigorous Approach

S. Arora, R. Ge, S. Sachdeva, G. Schoenebeck

In 13th ACM Conference on Electronic Commerce (EC) 2012

Testing Permanent Oracles — Revisited

S. Arora, A. Bhattacharyya, R. Manokaran, S. Sachdeva

In 16th International Workshop on Randomization and Computation (RANDOM) 2012

Nearly Optimal NP-Hardness of Vertex Cover on k -Uniform k -Partite Hypergraphs

S. Sachdeva, R. Saket

In 14th International Workshop on Approximation Algorithms for Combinatorial Optimization Problems (APPROX) 2011

THESES

New Results in the Theory of Approximation: Fast Graph Algorithms and Inapproximability

Ph.D. Thesis, Princeton University, 2013. Advised by Sanjeev Arora

On the Hardness of Approximating Vertex Cover

B.Tech. Thesis, IIT Bombay, 2008. Advised by Sundar Vishwanathan

SELECT

Cuts in Cartesian Products of Graphs

MANUSCRIPTS

S. Sachdeva, M. Tulsiani

SUPERVISION

Graduate students:

Deeksha Adil (M.Sc. student, UToronto, 2017-2019, Ph.D. student, 2019–)

Undergraduate students:

Zejun Yu (UToronto, Summer 2018)

Mentees:

Yang P. Liu (Summer 2018). Graduate student, Stanford.

Joshua Wang (Summer 2017). Research Scientist, Google.

Qiuyi (Richard) Zhang (Fall 2016). Software Engineer, Google.

Xiao Shi (Fall 2015). Software Engineer, Facebook.

TALKS

Fast IRLS Algorithms for p -norm regression

Seminar on Theoretical Machine Learning, Institute for Advanced Study, Nov 2019

Theory Seminar, Yale University, Nov 2019

Graph Sparsifiers via Short-Cycle Decompositions

Highlights of Algorithms, Copenhagen, Jun 2019

Improved ℓ_p -norm Optimization via Iterative Refinement

Seminar, Indian Institute of Technology, Mumbai, Sep 2019

Seminar, Indian Institute of Technology, Delhi, Sep 2019

Theory Seminar, Northwestern, Evanston, Feb 2019

Theory Seminar, UChicago / TTIC, Chicago, Feb 2019

STOCA Workshop, Google Mountain View, Feb 2019

Approximate Gaussian Elimination and Applications

Laplacian 2.0 Workshop, FOCS 2018, Paris, Oct 2018

Fast Approximate Gaussian Elimination for Laplacians

High Performance Graph Algorithms, Dagstuhl Seminar, Germany, Jun 2018
 Canada Applied and Industrial Mathematics Society (CAIMS), Toronto, Jun 2018
 Department Seminar, University of Waterloo, Nov 2017
 Highlights of Algorithms, Berlin, Jun 2017
 Simons Collaboration on Algorithms & Geometry, New York, Mar 2017
 TOCA-SV, Stanford, Nov 2016
 TCS Plus Seminar, Sep 2016
 Theory of Computation Seminar, Harvard University, Sep 2016
 Theory Lunch, Boston University, Sep 2016

Fast Algorithms for Optimization and Learning on Graphs

Google, New York, May 2016
 Computer Science Colloquium, Purdue University, Apr 2016
 Department of Computer Science Lecture, University of Toronto, Canada, Mar 2016
 Computer Science Seminar, University of Colorado Boulder, Mar 2016

Regression on Graphs – Lipschitz and Isotonic

Simons Seminar, University of Texas Austin, May 2016
 University of Chicago, Scientific and statistical computing seminar, Nov 2015

Lipschitz Learning on Graphs

Theory seminar, CS Department, Carnegie Mellon University, Nov 2016
 IIT Bombay, CS department seminar, Jul 2015
 EPFL (École Polytechnique Fédérale de Lausanne) INF department seminar, Jul 2015
 Conference on Learning Theory (COLT), Paris, Jul 2015
 UC San Diego, CS department theory seminar, May 2015
 Yale University, Statistics department seminar, Apr 2015

Triangle Removal in Groups

Simons Institute, UC Berkeley, Real analysis seminar, Nov 2013
 Institute for Advanced Study (IAS) Computer science/discrete mathematics seminar, Apr 2013

Generalizations of KKL Theorem and Friedgut’s Junta Theorem

Simons Institute, UC Berkeley, Real analysis workshop, Aug 2013

Hardness for Scheduling Problems

Conference on Computational Complexity (CCC), Palo Alto, Jun 2013

Near-linear Time Algorithms for Balanced Separator

Rutgers University, DIMACS/CS theoretical computer science seminar, Mar 2013
 University of Washington, ETP theory connections, Aug 2012
 Symposium on Theory of Computing (STOC), New York, May 2012
 Institute for Advanced Study (IAS) Computer science/discrete mathematics seminar, Apr 2012

Testing Permanent Oracles

International Workshop on Randomization and Computation (RANDOM), Boston, Aug 2012

PROFESSIONAL
SERVICE

Editor:

Siam Journal on Computing (SICOMP) STOC 2019 special issue

Program Committee:

Symposium on Theory of Computing (STOC) 2019, Phoenix, AZ, USA

Organizer:

Workshop ‘Laplacians 2.0’, FOCS 2018, Paris, France

Reviewer: COLT 2019, ICML 2019, ICALP 2019, STOC 2019, SODA 2019, FOCS 2018, NIPS 2018, SICOMP, STOC 2018, ICLR 2018, ICALP 2018, SODA 2018, ICML 2018, FOCS 2017, WADS 2017, SPAA 2017, APPROX 2017, NIPS 2017, STOC 2017, SODA 2017, FOCS 2016, NIPS 2016, STOC 2016, SODA 2016, STOC 2015, SODA 2015, SIDMA, QIC, Random 2014, FOCS 2014, STOC 2014, FSTTCS 2013, SODA 2014, Approx 2013, TOC, Algorithmica, ITCS 2013, SODA 2013, ICALP 2012, LATIN 2012, SODA 2012, FSTTCS 2011

TEACHING EXPERIENCE	Assistant Professor , University of Toronto	
	<i>Instructor for CSC 263H5 : Data Structures and Analysis</i>	Winter 2018
	Teaching evaluation score : 4.4/5.0	
	<i>Instructor for CSC 2421H : Fast Algorithms via Continuous Methods</i>	Fall 2017
	Teaching evaluation score : 4.5/5.0	
	Lecturer , Yale University	
PROFESSIONAL EXPERIENCE	<i>Lecturer for CPSC 665 : An Algorithmist's toolkit</i>	Spring 2015
	Designed and taught a full course on advanced algorithms (2 lectures a week)	
	55% of students rated the course excellent (highest rating)	
	Teaching Assistant , Princeton University	
	<i>Assistant in Instruction for COS 433: Cryptography</i>	Spring 2010
	<i>Assistant in Instruction for COS 340: Reasoning About Computation</i>	Fall 2009
	Toyota Technological Institute	Chicago, IL
	Research Intern, Summer 2012	
	Supervisor: Yury Makarychev	
	Lower bounds for Vertex Sparsifiers.	
	Microsoft Research India	Bangalore, India
	Research Intern, Summer 2011	
	Supervisor: Nisheeth K. Vishnoi	
	Fast algorithms for Balanced Separator.	
	INRIA	Sophia-Antipolis, France
	Research Intern, Summer 2007	
	Supervisor: Frederic Cazals (Research Director, Geometrica group).	
	Selecting a representative set of protein conformers.	
	ETH	Zurich, Switzerland
	Research Intern, Summer 2006	
	Supervisor: Riko Jacob (Algorithms, Data Structures, and Applications group).	
	Cache efficiency of shortest path algorithms with preprocessing.	
REFERENCES	Prof. Daniel Spielman (spielman@cs.yale.edu)	
	Henry Ford II Professor of Computer Science, Mathematics, and Applied Mathematics	
	Yale University	
	Prof. Sanjeev Arora (arora@cs.princeton.edu)	
	Charles C. Fitzmorris Professor of Computer Science	
	Princeton University	
	(Please contact admin. assistant Mitra Kelly at mkelly@cs.princeton.edu)	
	Prof. Nisheeth K. Vishnoi (nisheeth.vishnoi@epfl.ch)	
	Associate Professor of Computer Science	
	EPFL (École Polytechnique Fédérale de Lausanne)	
	Prof. Jonathan Kelner (kelner@mit.edu)	
	Mark Hyman, Jr. Career Development Associate Professor of Applied Mathematics	
	MIT (Massachusetts Institute of Technology)	