

Sushant Sachdeva

Assistant Professor, University of Toronto

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

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

INTERESTS 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
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 130,000)
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)
1st all over India in IIT Entrance Examination 2004 (among 170,000+ students)
Bronze Medalist at 36th International Chemistry Olympiad (ICHO) 2004, Kiel, Germany
Honorable Mention at **ACM ICPC World Finals, Tokyo 2007** representing IIT Bombay
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

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

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 | <p><i>Faster Algorithms via Approximation Theory</i>
S. Sachdeva, N. K. Vishnoi
In Foundations and Trends in Theoretical Computer Science 9.2 (FTTCS) 2014, pp. 125-210</p> |
| REFEREED
JOURNAL
PUBLICATIONS | <p><i>The mixing time of the Dikin walk in a polytope – A simple proof</i>
S. Sachdeva, N. Vishnoi
In Operations Research Letters, 44.5 (September 2016), pp. 630–634</p> <p><i>An Arithmetic Analogue of Fox’s Triangle Removal Argument</i>
P. Hatami, S. Sachdeva, M. Tulsiani
In Online Journal of Analytic Combinatorics 11 (OJAC) 2016</p> <p><i>Provable ICA with Unknown Gaussian Noise, and Implications for Gaussian Mixtures and Autoencoders</i>
S. Arora, R. Ge, A. Moitra, S. Sachdeva
In Algorithmica 72.1 (May 2015), pp. 215–236</p> <p><i>Inapproximability of Minimum Vertex Cover on k-Uniform k-Partite Hypergraphs</i>
V. Guruswami, S. Sachdeva, R. Saket
In SIAM Journal on Discrete Mathematics 29.1 (SIDMA) 2015, pp. 36–58</p> <p><i>Greedy Geometric Algorithms for Collection of Balls, with Applications to Geometric Approximation and Molecular Coarse-Graining</i>
F. Cazals, T. Dreyfus, S. Sachdeva, N. Shah
In Computer Graphics Forum 33–6, 2014</p> <p><i>On the Characterization and Selection of Diverse Conformational Ensembles with Applications to Flexible Docking</i>
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</p> |
| REFEREED
CONFERENCE /
WORKSHOP
PUBLICATIONS | <p><i>Convergence Results for Neural Networks via Electrodynamics</i>
R. Panigrahy, A. Rahimi, S. Sachdeva, Q. Zhang
In 9th Innovations in Theoretical Computer Science (ITCS) 2018</p> <p>Near-optimal approximation algorithm for simultaneous Max-Cut
A. Bhangale, S. Khot, S. Kopparty, S. Sachdeva, D. Thiruvengatadhar
In 29th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2018</p> <p><i>Sampling Random Spanning Trees Faster than Matrix Multiplication</i>
D. Durfee, R. Kyng, J. Peebles, A. B. Rao, S. Sachdeva
In 49th ACM Symposium on Theory of Computing (STOC) 2017</p> <p><i>A framework for analyzing resparsification algorithms</i>
R. Kyng, J. Pachocki, R. Peng, S. Sachdeva
In 28th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2017</p> |

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

TALKS

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

Reviewer: 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

Lecturer, Yale University

Lecturer for CPSC 665 : An Algorithmist's toolkit 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

Assistant in Instruction for COS 433: Cryptography Spring 2010
 Taught weekly precepts, organized weekly question hours, graded assignments and exams

Assistant in Instruction for COS 340: Reasoning About Computation

Fall 2009

Taught weekly precepts, organized weekly question hours, graded assignments and exams

PROFESSIONAL
EXPERIENCE

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. John Lafferty (lafferty@galton.uchicago.edu)

Louis Block Professor at Departments of Statistics, Computer Science, and the College
University of Chicago

Prof. Jonathan Kelner (kelner@mit.edu)

Mark Hyman, Jr. Career Development Associate Professor of Applied Mathematics

MIT (Massachusetts Institute of Technology)