

# Sushant Sachdeva

Assistant Professor, University of Toronto

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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 Awarded **Simons-Berkeley Research Fellowship**, Fall 2013 (USD 26,466)  
Awarded Postdoctoral Research Fellowship by Institute for Computational and Experimental Research in Mathematics (2013-2014, USD 50,000 – declined)  
Awarded **President of India Gold Medal** for topping the class of 2008 (of 500+ students)  
Ranked **1st all over India** in IIT Entrance Examination 2004 (among 170,000+ students)  
**Bronze Medalist** at 36<sup>th</sup> International Chemistry Olympiad (IChO) 2004, Kiel, Germany  
Awarded Honorable Mention representing IIT Bombay at **ACM ICPC World Finals, Tokyo 2007**  
Scored a perfect SPI of 10.0 in 7 semesters out of 8 at IIT Bombay  
Awarded a grade of AP for outstanding performance in ten courses at IIT Bombay  
Awarded Jayanti Deshmukh Memorial Gold Medal for being the most outstanding B.Tech.

student in the computer science class of 2008 (out of 35 students)

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

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

Awarded 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 JOURNAL *The mixing time of the Dikin walk in a polytope – A simple proof*  
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. Loriot, 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 CONFERENCE / WORKSHOP PUBLICATIONS *Convergence Results for Neural Networks via Electrodynamics*  
R. Panigrahy, A. Rahimi, S. Sachdeva, Q. Zhang  
In 9<sup>th</sup> 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 29<sup>th</sup> 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 49<sup>th</sup> ACM Symposium on Theory of Computing (STOC) 2017
- A framework for analyzing resparsification algorithms*  
R. Kyng, J. Pachocki, R. Peng, S. Sachdeva  
In 28<sup>th</sup> ACM-SIAM Symposium on Discrete Algorithms (SODA) 2017
- Approximate Gaussian Elimination for Laplacians: Fast, Sparse, and Simple*  
R. Kyng, S. Sachdeva

In 57<sup>th</sup> 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 48<sup>th</sup> ACM Symposium on Theory of Computing (STOC) 2016

*Fast, Provable Algorithms for Isotonic Regression in all  $\ell_p$ -norms*

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

In 29<sup>th</sup> 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 28<sup>th</sup> Conference on Learning Theory (COLT) 2015

*Simultaneous Approximation of Constraint Satisfaction Problems*

A. Bhangale, S. Kopparty, S. Sachdeva

In 42<sup>nd</sup> 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 28<sup>th</sup> 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 44<sup>th</sup> 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 26<sup>th</sup> 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 13<sup>th</sup> ACM Conference on Electronic Commerce (EC) 2012

*Testing Permanent Oracles — Revisited*

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

In 16<sup>th</sup> 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 14<sup>th</sup> 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*

Department Seminar, University of Waterloo, November 2017

Highlights of Algorithms, Berlin, June 2017

Simons Collaboration on Algorithms & Geometry, New York, March 2017

TOCA-SV, Stanford, Nov 2016

TCS Plus Seminar, Sept 2016

Theory of Computation Seminar, Harvard University, Sept 2016

Theory Lunch, Boston University, Sept 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

Taught one 1.5-hr lecture

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](mailto:spielman@cs.yale.edu))  
Henry Ford II Professor of Computer Science, Mathematics, and Applied Mathematics  
Yale University

Prof. Sanjeev Arora ([arora@cs.princeton.edu](mailto:arora@cs.princeton.edu))  
Charles C. Fitzmorris Professor of Computer Science  
Princeton University  
(Please contact admin. assistant Mitra Kelly at [mkelly@cs.princeton.edu](mailto:mkelly@cs.princeton.edu))

Prof. Nisheeth K. Vishnoi ([nisheeth.vishnoi@epfl.ch](mailto:nisheeth.vishnoi@epfl.ch))  
Associate Professor of Computer Science  
EPFL (École Polytechnique Fédérale de Lausanne)

Prof. John Lafferty ([lafferty@galton.uchicago.edu](mailto: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](mailto:kelner@mit.edu))  
Mark Hyman, Jr. Career Development Associate Professor of Applied Mathematics  
MIT (Massachusetts Institute of Technology)