

# 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 **NSERC Discovery Grant** 2018-2023 (CAD 130,000)  
AWARDS 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 36<sup>th</sup> 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 *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 PUBLICATIONS *The mixing time of the Dikin walk in a polytope – A simple proof*  
S. Sachdeva, N. Vishnoi  
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 *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 59<sup>th</sup> IEEE Symposium on Foundations of Computer Science (FOCS) 2018
- 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 MANUSCRIPTS	<i>Cuts in Cartesian Products of Graphs</i> S. Sachdeva, M. Tulsiani
TALKS	<p><i>Fast Approximate Gaussian Elimination for Laplacians</i> 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 &amp; 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</p> <p><i>Fast Algorithms for Optimization and Learning on Graphs</i> 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</p> <p><i>Regression on Graphs – Lipschitz and Isotonic</i> Simons Seminar, University of Texas Austin, May 2016 University of Chicago, Scientific and statistical computing seminar, Nov 2015</p> <p><i>Lipschitz Learning on Graphs</i> 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</p> <p><i>Triangle Removal in Groups</i> Simons Institute, UC Berkeley, Real analysis seminar, Nov 2013 Institute for Advanced Study (IAS) Computer science/discrete mathematics seminar, Apr 2013</p> <p><i>Generalizations of KKL Theorem and Friedgut’s Junta Theorem</i> Simons Institute, UC Berkeley, Real analysis workshop, Aug 2013</p> <p><i>Hardness for Scheduling Problems</i> Conference on Computational Complexity (CCC), Palo Alto, Jun 2013</p> <p><i>Near-linear Time Algorithms for Balanced Separator</i> 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</p> <p><i>Testing Permanent Oracles</i> International Workshop on Randomization and Computation (RANDOM), Boston, Aug 2012</p>
PROFESSIONAL SERVICE	<i>Reviewer:</i> 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	<p><b>Lecturer, Yale University</b></p> <p><i>Lecturer for CPSC 665 : An Algorithmist’s toolkit</i> <span style="float: right;">Spring 2015</span> Designed and taught a full course on advanced algorithms (2 lectures a week) <b>55% of students rated the course excellent (highest rating)</b></p> <p><b>Teaching Assistant, Princeton University</b></p>

*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](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)