

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

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

Advisor: Prof. Sanjeev Arora

M.A., Department of Computer Science

Sep 2008 – Jun 2010

Indian Institute of Technology Bombay

Mumbai, India

B.Tech., Department of Computer Science and Engineering

Jul 2004 – Aug 2008

Advisor: Sundar Vishwanathan

CPI: 9.97/10.00

HONORS AND AWARDS

Ontario Early Researcher Award 2022-27 (CAD 150,000)

NSERC Discovery Grant 2018-2023 (CAD 177,500)

MITACS Accelerate Grant 2021 (CAD 65,000)

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)

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
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.

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| 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>Graph Sparsification, Spectral Sketches, and Faster Resistance Computation via Short Cycle Decompositions</i>
T. Chu, Y. Gao, R. Peng, S. Sachdeva, S. Sawlani, J. Wang
SIAM Journal on Computing, FOCS 2018 Special Issue (2020), pp. 85–157</p> <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. 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</p> |
| REFEREED
CONFERENCE /
WORKSHOP
PUBLICATIONS | <p><i>Maximum Flow and Minimum-Cost Flow in Almost-Linear Time</i>
L. Chen, R. Kyng, Y. P. Liu, R. Peng, M. P. Gutenberg, S. Sachdeva
In 63rd IEEE Symposium on Foundations of Computer Science (FOCS) 2022</p> <p><i>A Convergent and Dimension-Independent Min-Max Optimization Algorithm.</i>
V. Keswani, O. Mangoubi, S. Sachdeva, N. K. Vishnoi
In 39th International Conference on Machine Learning (ICML) 2022.</p> <p><i>Nested Dissection Meets IPMs: Planar Min-Cost Flow in Nearly Linear Time</i>
S. Dong, Y. Gao, G. Goranci, Y.T. Lee, R. Peng, S. Sachdeva, G. Ye
In 33th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2022</p> <p><i>Unifying Width-Reduced Methods for Quasi-Self-Concordant Optimization</i>
D. Adil, B. Bullins, S. Sachdeva
In 34th Conference on Neural Information Processing Systems (NeurIPS) 2021</p> |

Almost-linear-time Weighted ℓ_p -norm Solvers in Slightly Dense Graphs via Sparsification.

D. Adil, B. Bullins, R. Kyng, S. Sachdeva

In 48th International Colloquium on Automata, Languages, and Programming (ICALP) 2021

Regularized linear autoencoders recover the principal components, eventually

X. Bao, J. Lucas, S. Sachdeva, R. Grosse

In 33rd Conference on Neural Information Processing Systems (NeurIPS) 2020

Faster Graph Embeddings via Coarsening

M. Fahrback, G. Goranci, S. Sachdeva, R. Peng, C. Wang

In 37th International Conference on Machine Learning (ICML) 2020

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

D. Adil, S. Sachdeva

In 31th ACM-SIAM Symposium on Discrete Algorithms (SODA) 2020

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

D. Adil, R. Peng, S. Sachdeva

In 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

In 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

In 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. Bhargale, 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

SUPERVISION

Graduate students:

Deepkamal Kaur Gill (MScAC student, UToronto, 2022–)
 Hao Zhang (MScAC student, UToronto, 2021–22)
 Lawrence Li (Ph.D. student, UToronto, 2020–)
 Yibin Zhao (Ph.D. student, UToronto, 2020–)
 Deeksha Adil (M.Sc. student, UToronto, 2017–2019, Ph.D. student, 2019–)

Postdocs:

Gramoz Goranci (2020–2021). Assistant Professor at U. Glasgow.

Undergraduate students:

Anvith Thudi (UToronto, 2022–)
 Devansh Ranade (UToronto, 2020–2021)
 Jack McKinney (UToronto, Summer 2020)
 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

Almost-linear time Algorithms for Max-Flow and More

10th Anniversary Symposium, Simons Institute for Theory of Computing, May 2022
 Theory Seminar, University of Texas Austin, Apr 2022
 Theory Seminar, University of Waterloo, Mar 2022
 Algorithms and Complexity Seminar, IRIF Paris, Mar 2022

Improved ℓ_p -norm Optimization via Iterative Refinement

Theory Seminar, University of Washington, Seattle, Apr 2021
 Theory Seminar, Carnegie Mellon University, Pittsburgh, Feb 2021
 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

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

Symposium on Discrete Algorithms (SODA), Salt Lake City, Jan 2020

Fast IRLS Algorithms for p -norm regression

Fuji Co-creation Lab, University of Toronto, May 2020
 Institute for Advanced Study, Princeton, Nov 2019
 Theory Seminar, Yale University, Nov 2019

Graph Sparsifiers via Short-Cycle Decompositions

Institute for Advanced Study, Princeton, Dec 2019
 Highlights of Algorithms, Copenhagen, Jun 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:

ACM Transactions of Algorithms (TALG) SODA 2021 special issue

SIAM Journal on Computing (SICOMP) STOC 2019 special issue

Program Committee:

European Symposium on Algorithms (ESA) 2022

Symposium on Theory of Computing (STOC) 2022

ACM-SIAM Symposium on Discrete Algorithms (SODA) 2021

Symposium on Theory of Computing (STOC) 2019

Organizer:

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

Conference Reviewing: STOC (2014–2020), FOCS (2014–2021), SODA (2012–2020), CCC 2020, COLT 2018–2019, ESA 2019, NeurIPS / NIPS (2016–2021), ICML (2018–2020), ITCS (2013, 2020), ICLR 2018,ICALP (2012, 2018–2019), APPROX (2013, 2017), RANDOM (2019, 2014), WADS 2017, SPAA 2017, FSTTCS (2011, 2013), LATIN 2012, QIC 2015

Journal Reviewing: Siam Journal on Discrete Mathematics (SIDMA), Algorithmica, Theory of Computing, Siam Journal on Computing (SICOMP)

TEACHING
EXPERIENCE

Assistant Professor, University of Toronto

Instructor for CSC 263H5 : Data Structures and Analysis

Winter 2018–2021

Instructor for CSC 373H5 : Algorithm Design and Analysis

Fall 2020

Instructor for CSC 2421H : Graphs, Matrices, and Optimization

Fall 2018, Winter 2021

	<i>Instructor for CSC 2421H : Fast Algorithms via Continuous Methods</i>	Fall 2017
	Lecturer, Yale University	
	<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
PROFESSIONAL EXPERIENCE	Toyota Technological Institute	Chicago, IL
	Research Intern. Supervisor: Yury Makarychev	Summer 2012
	Microsoft Research India	Bangalore, India
	Research Intern. Supervisor: Nisheeth K. Vishnoi	Summer 2011
	INRIA	Sophia-Antipolis, France
	Research Intern. Supervisor: Frederic Cazals	Summer 2007
	ETH	Zurich, Switzerland
	Research Intern. Supervisor: Riko Jacob	Summer 2006