Nisarg Shah University of Toronto

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Research Interests

Computational social choice, voting, fair division, algorithmic game theory, mechanism design, multiagent systems, algorithmic fairness, incentives in machine learning.

Appointments

Assistant Professor Aug 2017 - Present
Department of Computer Science
University of Toronto, Canada

Postdoctoral Fellow Sep 2016 - Jul 2017
Center for Research on Computation and Society (CRCS)
Harvard University, USA
Supervisors: David C. Parkes and Yiling Chen

Education

Ph.D. in Computer Science Aug 2011 - Aug 2016
Carnegie Mellon University, USA
Thesis Title: Optimal Social Decision Making
Advisor: Ariel D. Procaccia

B.Tech. in Computer Science with Honors and Minor in Management Jul 2007 - Apr 2011
Indian Institute of Technology Bombay (IIT Bombay), India
Thesis Title: A QBF Solver Using Factor Graphs
CGPA: 9.94/10.00

Selected Fellowships & Recognitions

AI's 10 to Watch, IEEE Intelligent Systems 2020
Awarded biennially to 10 young AI scientists with outstanding achievements.

Victor Lesser Distinguished Dissertation Award, IFAAMAS 2016
Awarded annually to the best dissertation in the area of Autonomous Agents or Multiagent Systems.

Facebook Graduate Fellowship, Facebook Inc. 2014-15
Awarded annually to selected graduate students conducting promising and innovative research.

Hima and Jive Graduate Fellowship, Carnegie Mellon University 2013-14
Awarded annually to one international student in the School of Computer Science.

President's Gold Medal, IIT Bombay 2011
Awarded annually to the top student across all programs in the graduating class at IIT Bombay.

Research Internships & Visits

Duke University, USA — Jun 2015 - Jul 2015
Mentor: Vincent Conitzer — Research Area: Recommendation Systems

Microsoft Research New York, USA — May 2013 - Aug 2013
Mentor: David Pennock — Research Area: Prediction Markets
Mentor: Sébastien Lahaie — Research Area: Social Choice

Microsoft Research Cambridge, UK — May 2012 - Aug 2012
Mentor: Yoram Bachrach & Ian Kash — Research Area: Cooperative Game Theory

IST Austria, Austria — May 2010 - July 2010
Mentor: Krishnendu Chatterjee — Research Area: Game Theory in Formal Methods

INRIA Sophia Antipolis, France — May 2009 - July 2009
Mentor: Frédéric Cazals — Research Area: Computational Geometry

Book Chapters

(*All chapters have alphabetical author ordering.)

BC2. H. Aziz and N. Shah. *Participatory Budgeting: Models and Approaches.* In Rudas and Gábor (Eds.), *Pathways between Social Science and Computational Social Science: Theories, Methods and Interpretations*, pp. 215-236, Springer, 2021. **(Invited Chapter)**

BC1. N. Shah. *Reverting to Simplicity in Social Choice.* In Laslier, Moulin, Sanver, and Zwicker (Eds.), *The Future of Economic Design: The Continuing Development of a Field as Envisioned by Its Researchers*, pp. 39–44, Springer, 2020. **(Invited Chapter)**

Journal Publications

(*All but one papers have alphabetical author ordering.)

J13. G. Benade, A. D. Procaccia, S. Nath, and N. Shah. *Preference Elicitation for Participatory Budgeting.* Management Science, 2020, Forthcoming. Supercedes the AAAI-17 paper below.

J12. A. Agarwal, D. Mandal, D. C. Parkes, and N. Shah. *Peer Prediction with Heterogeneous Users.* ACM Transactions on Economics and Computation (TEAC), Volume 8, Number 1, Article 2, 2020. **Invited for the special issue on selected papers from EC-17.** Supercedes the EC-17 paper below.

J11. I. Caragiannis, D. Kurokawa, H. Moulin, A. D. Procaccia, N. Shah, and J. Wang. *The Unreasonable Fairness of Maximum Nash Welfare.* ACM Transactions on Economics and Computation (TEAC), Volume 7, Issue 3, Article 12, 2019. **Invited for the special issue on selected papers from EC-16.** Supercedes the EC-16 paper below.

J10. D. Kurokawa, A. D. Procaccia, and N. Shah. *Leximin Allocations in the Real World.* ACM Transactions on Economics and Computation (TEAC), Volume 6, Issue 3-4, Article 11, 2018. **Invited for the special issue on selected papers from EC-15.** Supercedes the EC-15 paper below.

J9. I. Caragiannis, S. Nath, A. D. Procaccia, and N. Shah. *Subset Selection Via Implicit Utilitarian Voting.* Journal of Artificial Intelligence Research (JAIR), Volume 58, pp. 123-152, 2017. Supercedes the IJCAI-16 paper below.

J8. I. Caragiannis, A. D. Procaccia, and N. Shah. *When Do Noisy Votes Reveal the Truth?* ACM Transactions on Economics and Computation (TEAC), Volume 4, Number 3, Article 15, 2016. **Invited for the special issue on selected papers from EC-13.** Supercedes the EC-13 paper below.

J7. A. D. Procaccia, N. Shah, and Y. Zick. *Voting Rules as Error-Correcting Codes.* Artificial Intelligence (AIJ), Volume 231, pp. 1-16, 2016. Supercedes the AAAI-15 paper below.

J6. D. C. Parkes, A. D. Procaccia, and N. Shah. *Beyond Dominant Resource Fairness: Extensions, Limitations, and Indivisibilities.* ACM Transactions on Economics and Computation (TEAC), Volume 3, Number 1, Article 3, 2015. **Invited for the special issue on selected papers from EC-12.** Supercedes the EC-12 paper below.

J5. K. Chatterjee, M. Henzinger, M. Joglekar, and N. Shah. *Average Case Analysis of the Classical Algorithm for Markov Decision Processes with Büchi Objectives*. Theoretical Computer Science (TCS), Volume 573, pp. 71-89, 2015. Supercedes the FSTTCS-12 paper below.

J4. I. Kash, A. D. Procaccia, and N. Shah. *No Agent Left Behind: Dynamic Fair Division of Multiple Resources.* Journal of Artificial Intelligence Research (JAIR), Volume 51, pp. 579-603, 2014. Supercedes the AAMAS-13 paper below.

J3. F. Cazals, T. Dreyfus, S. Sachdeva, and N. Shah. *Greedy Geometric Optimization Algorithms for Collection of Balls*. Computer Graphics Forum (CGF), Volume 33, Issue 6, pp. 1-17, 2014.

J2. K. Chatterjee, M. Henzinger, M. Joglekar, and N. Shah. *Symbolic Algorithms for Qualitative Analysis of Markov Decision Processes with Büchi Objectives*. Formal Methods in System Design (FMSD), Volume 42, Issue 3, pp. 301-327, 2013. Supercedes the CAV-11 paper below.

J1. M. Joglekar, N. Shah, and A. Diwan. *Balanced Group-Labeled Graphs*. Discrete Mathematics. Volume 312, Issue 9, pp. 1542-1549, 2012.

Archival Conference Publications

(*All papers have alphabetical author ordering.)

C49. D. Peters, G. Pierczyński, N. Shah, and P. Skowron. *Market-Based Explanations of Collective Decisions.* Proc. of 35th AAAI Conference on Artificial Intelligence, 2021. Forthcoming.

C48. D. Halpern, G. Kehne, D. Peters, A. D. Procaccia, N. Shah, and P. Skowron. *Aggregating Binary Judgments Ranked By Accuracy.* Proc. of 35th AAAI Conference on Artificial Intelligence, 2021. Forthcoming.

C47. H. Hosseini, V. Menon, N. Shah, and S. Sikdar. *Necessarily Optimal Matchings.* Proc. of 35th AAAI Conference on Artificial Intelligence, 2021. Forthcoming.

C46. S. Barman, U. Bhaskar, and N. Shah. *Settling the Price of Fairness for Indivisible Goods.* Proc. of 16th Conference on Web and Internet Economics (WINE), pp. 356-369, 2020.

C45. D. Halpern, A. D. Procaccia, A. Psomas, and N. Shah. *Fair Division with Binary Valuations: One Rule to Rule Them All.* Proc. of 16th Conference on Web and Internet Economics (WINE), pp. 370-383, 2020.

C44. D. Halpern, N. Shah, and V. Gkatzelis. *Resolving the Optimal Metric Distortion Conjecture.* Proc. of 61st Annual IEEE Symposium on Foundations of Computer Science (FOCS), pp. 1427-1438, 2020.

C43. R. Freeman, N. Shah, and R. Vaish. *Best of Both Worlds: Ex-Ante and Ex-Post Fairness in Resource Allocation.* Proc. of 21st ACM Conference on Economics and Computation (EC), pp. 21–22, 2020.

C42. D. Mandal, N. Shah, and D. P. Woodruff. *Optimal Communication-Distortion Tradeoff in Voting.* Proc. of 21st ACM Conference on Economics and Computation (EC), pp. 795–813, 2020.

C41. E. Micha and N. Shah. *Proportionally Fair Clustering Revisited.* Proc. of 47th International Colloquium on Automata, Languages and Programming (ICALP), pp. 85:1–85:16, 2020.

C40. S. Hossain, A. Mladenovic, and N. Shah. *Designing Fairly Fair Classifiers Via Economic Fairness Notions.* Proc. of 29th International World Wide Web Conference (WWW), pp. 1559–1569, 2020.

C39. S. Hossain and N. Shah. *Pure Nash Equilibria in Linear Regression.* Proc. of 19th International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS), pp. 511–519, 2020.

C38. E. Micha and N. Shah. *Can We Predict the Election Outcome from Sampled Votes?* Proc. of 34th AAAI Conference on Artificial Intelligence (AAAI), pp. 2176–2183, 2020.

C37. S. Hossain, E. Micha, and N. Shah. *The Surprising Power of Hiding Information in Facility Location.* Proc. of 34th AAAI Conference on Artificial Intelligence (AAAI), pp. 2168–2175, 2020.

C36. D. Mandal, A. D. Procaccia, N. Shah, and D. P. Woodruff. *Efficient and Thrifty Voting by Any Means Necessary.* Proc. of 33rd Annual Conference on Neural Information Processing Systems (NeurIPS), pp. 7178–7189, 2019.

C35. D. Halpern and N. Shah. *Fair Division with Subsidy.* Proc. of 12th International Symposium on Algorithmic Game Theory (SAGT), pp. 374-389, 2019.

C34. V. Conitzer, R. Freeman, N. Shah, and J. W. Vaughan. *Group Fairness for the Allocation of Indivisible Goods.* Proc. of 33rd AAAI Conference on Artificial Intelligence (AAAI), pp. 1853-1860, 2019.

C33. A. Borodin, O. Lev, N. Shah, and T. Strangway. *Primarily about Primaries.* Proc. of 33rd AAAI Conference on Artificial Intelligence (AAAI), pp. 1804-1811, 2019.

C32. C. Alkalay-Houlihan and N. Shah. *The Pure Price of Anarchy of Pool Block Withholding Attacks in Bitcoin Mining.* Proc. of 33rd AAAI Conference on Artificial Intelligence (AAAI), pp. 1724-1731, 2019.

C31. B. Fain, K. Munagala, and N. Shah. *Fair Allocation of Indivisible Public Goods.* Proc. of 19th ACM Conference on Economics and Computation (EC), pp. 575-592, 2018.

C30. Y. Chen, C. Podimata, A. D. Procaccia, and N. Shah. *Strategyproof Linear Regression in High Dimensions.* Proc. of 19th ACM Conference on Economics and Computation (EC), pp. 9-26, 2018.

C29. A. Borodin, O. Lev, N. Shah, and T. Strangway. *Big City vs. the Great Outdoors: Voter Distribution and How it Affects Gerrymandering.* Proc. of 27th Intl. Joint Conference on Artificial Intelligence (IJCAI), pp. 98-104, 2018.

C28. V. Conitzer, R. Freeman, and N. Shah. *Fair Public Decision Making.* Proc. of 18th ACM Conference on Economics and Computation (EC), pp. 629-646, 2017.

C27. A. Agarwal, D. Mandal, D. C. Parkes, and N. Shah. *Peer Prediction with Heterogeneous Users.* Proc. of 18th ACM Conference on Economics and Computation (EC), pp. 81-98, 2017.

C26. G. Benade, A. D. Procaccia, S. Nath, and N. Shah. *Preference Elicitation for Participatory Budgeting.* Proc. of 31st AAAI Conference on Artificial Intelligence (AAAI), pp. 376-382, 2017.

C25. I. Caragiannis, D. Kurokawa, H. Moulin, A. D. Procaccia, N. Shah, and J. Wang. *The Unreasonable Fairness of Maximum Nash Welfare.* Proc. of 17th ACM Conference on Economics and Computation (EC), pp. 305-322, 2016.

C24. I. Caragiannis, A. D. Procaccia, and N. Shah. *Truthful Univariate Estimators.* Proc. of 33rd Intl. Conference on Machine Learning (ICML), pp. 127-135, 2016.

C23. I. Caragiannis, S. Nath, A. D. Procaccia, and N. Shah. *Subset Selection Via Implicit Utilitarian Voting.* Proc. of 25th Intl. Joint Conference on Artificial Intelligence (IJCAI), pp. 151-157, 2016.

C22. M. Brill, V. Conitzer, R. Freeman, and N. Shah. *False-Name-Proof Recommendations in Social Networks.* Proc. of 15th Intl. Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS), pp. 332-340, 2016.

C21. A. D. Procaccia, and N. Shah. *Optimal Aggregation of Uncertain Preferences.* Proc. of 30th AAAI Conference on Artificial Intelligence (AAAI), pp. pp. 608-614, 2016.

C20. A. D. Procaccia, and N. Shah. *Is Approval Voting Optimal Given Approval Votes?* Proc. of 29th Annual Conference on Neural Information Processing Systems (NIPS), pp. 1792-1800, 2015.

C19. D. Kurokawa, A. D. Procaccia, and N. Shah. *Leximin Allocations in the Real World.* Proc. of 16th ACM Conference on Economics and Computation (EC), pp. 345-362, 2015.

C18. A. D. Procaccia, N. Shah, and E. Sodomka. *Ranked Voting on Social Networks.* Proc. of 24th International Joint Conference on Artificial Intelligence (IJCAI), pp. 2040-2046, 2015.

C17. A. D. Procaccia, N. Shah, and Y. Zick. *Voting Rules as Error-Correcting Codes.* Proc. of 29th AAAI Conference on Artificial Intelligence (AAAI), pp. 1000-1006, 2015.

C16. A. X. Jiang, L. S. Marcolino, A. D. Procaccia, T. Sandholm, N. Shah, and M. Tambe. *Diverse Randomized Agents Vote to Win.* Proc. of 28th Annual Conference on Neural Information Processing Systems (NIPS), pp. 2573-2581, 2014.

C15. E. Elkind, and N. Shah. *Electing the Most Probable Without Eliminating the Irrational: Voting Over Intransitive Domains.* Proc. of 30th Conference on Uncertainty in Artificial Intelligence (UAI), pp. 182-191, 2014.

C14. S. Lahaie, and N. Shah. *Neutrality and Geometry of Mean Voting.* Proc. of 15th ACM Conference on Electronic Commerce (EC), pp. 333-350, 2014.

C13. I. Caragiannis, A. D. Procaccia, and N. Shah. *Modal Ranking: A Uniquely Robust Voting Rule.* Proc. of 28th AAAI Conference on Artificial Intelligence (AAAI), pp. 616-622, 2014.

C12. W. Kets, D. M. Pennock, R. Sethi, and N. Shah. *Betting Strategies, Market Selection, and the Wisdom of Crowds.* Proc. of 28th AAAI Conference on Artificial Intelligence (AAAI), pp. 735-741, 2014.

C11. A. D. Procaccia, N. Shah, and M. L. Tucker. *On the Structure of Synergies in Cooperative Games.* Proc. of 28th AAAI Conference on Artificial Intelligence (AAAI), pp. 763-769, 2014.

C10. Y. Bachrach, R. Savani, and N. Shah. *Cooperative Max Games and Agent Failures.* Proc. of 13th Intl. Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS), pp. 29-36, 2014.

C9. I. Caragiannis, A. D. Procaccia, and N. Shah. *When Do Noisy Votes Reveal the Truth?*. Proc. of 14th ACM Conference on Electronic Commerce (EC), pp. 143-160, 2013.

C8. A. X. Jiang, A. D. Procaccia, Y. Qian, N. Shah, and M. Tambe. *Defender (Mis)coordination in Security Games*. Proc. of 23rd International Joint Conference on Artificial Intelligence (IJCAI), pp. 220-226, 2013.

C7. A. D. Procaccia, I. Kash, and N. Shah. *No Agent Left Behind: Dynamic Fair Division of Multiple Resources*. Proc. of 12th International Conference on Autonomous Agents and Multiagent Systems (AAMAS), pp. 351-358, 2013.

C6. Y. Bachrach, and N. Shah. *Reliability Weighted Voting Games*. Proc. of 6th International Symposium on Algorithmic Game Theory (SAGT), pp. 38-49, 2013.

C5. D. C. Parkes, A. D. Procaccia, and N. Shah. *Beyond dominant resource fairness: extensions, limitations, and indivisibilities*. Proc. of 13th ACM Conference on Electronic Commerce (EC), pp. 808-825, 2012.

C4. A. D. Procaccia, S. J. Reddi, and N. Shah. *A Maximum Likelihood Approach For Selecting Sets of Alternatives*. Proc. of 28th Conference on Uncertainty in Artificial Intelligence (UAI), pp. 695-704, 2012.

C3. Y. Bachrach, I. Kash, and N. Shah. *Agent Failures in Totally Balanced Games and Convex Games*. Proc. of 8th Workshop on Internet & Network Economics (WINE), pp. 15-29, 2012.

C2. K. Chatterjee, M. Henzinger, M. Joglekar, and N. Shah. *Average Case Analysis of the Classical Algorithm for Markov Decision Processes with Büchi Objectives*. Proc. of 32nd Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS), pp. 461-473, 2012.

C1. K. Chatterjee, M. Henzinger, M. Joglekar, and N. Shah. *Symbolic Algorithms for Qualitative Analysis of Markov Decision Processes with Büchi Objectives*. Proc. of 23rd International Conference on Computer Aided Verification (CAV), pp. 260-276, 2011.

Magazine and Newsletter Articles

(*All articles have alphabetical author ordering.)

A2. Y. Chen, C. Podimata, A. D. Procaccia, and N. Shah. *Strategyproof Linear Regression in High Dimensions: An Overview.* SIGecom Exchanges 17(1):54-60, Nov 2018. **Invited letter.** About the EC-18 paper below.

A1. N. Shah. *Making the World Fairer.* XRDS: Crossroads, The ACM Magazine for Students, Volume 24, Issue 1, pp. 24-28, Fall 2017. **Invited article.**

Courses Taught

Undergraduate Courses

Algorithmic Game Theory and Mechanism Design (CSC304)
Fall 2017, Fall 2018, Fall 2019.

Algorithm Design, Analysis, and Complexity (CSC373)
Fall 2019, Fall 2020.

Graduate Courses

Algorithms for Collective Decision-Making (CSC2556)
Spring 2018, Spring 2019, Spring 2020.

Algorithm Design, Analysis and Theory (CSC2420)
Fall 2017.

Selected Professional Service

Workshops

Workshop on the Distortion and Information-Efficiency Tradeoffs (DIET) at EC 2020.

Tutorials

Recent Advances in Fair Resource Allocation at EC 2019, AAAI 2020, and AAMAS 2020.

Chairmanships

2021 AAAI Focus Area on AI for Conference Organization and Delivery

Program Committees

EC	Senior PC (2020), PC (2019, 2018, 2017)
AAAI AI4SI* Track	Senior PC (2020, 2019)
AAAI Main Track	PC (2020, 2019, 2018, 2017)
IJCAI	Senior PC (2021), PC (2019, 2018, 2017, 2016, 2015)
AAMAS	Senior PC (2021)
TheWebConf/WWW	Senior PC (2021), PC (2018)
WINE	PC (2019)
NeurIPS	PC (2020)

* AI4SI = AI for Social Impact

Invited Talks

T22. *Fairness in Algorithmic Decision-Making: Theory & Applications*, Vector Institute Seminar Series, Online, December 2020.

T21. *From Fair Division To Machine Learning: Preference-Based Notions Of Algorithmic Fairness*, INFORMS Session on Fairness in Optimization and Machine Learning, Online, November 2020.

T20. *Fairness in Algorithmic Decision-Making: Theory & Applications*, Schwartz Reisman Institute for Technology and Society (SRI) Seminar Series, University of Toronto, Online, October 2020.

T19. *Making the World Fairer: Fair Division Theory & Applications*, Centre for Advancing Responsible and Ethical Artificial Intelligence (CARE-AI), Guelph University, Online, October 2020.

T18. *Resolving the Optimal Metric Distortion Conjecture*, Computer Science Theory Group Seminar, University of Toronto, Online, August 2020.

T17. *Pushing the Limits of Fairness in Resource Allocation*, 3rd Week of Mathematical Engineering and Applied Mathematics, Federal University of Rio de Janeiro (UFRJ), Online, July 2020.

T16. *On the Communication-Distortion Tradeoff in Voting*, 1st Workshop on the Distortion and Information-Efficiency Tradeoffs, Online, July 2020.

T15. *Resolving the Optimal Metric Distortion Conjecture*, International Seminar Series on Social Choice (COMSOC Video Seminar), Online, June 2020.

T14. *Pushing the Limits of Fairness in Collective Decision-Making*, Indian Institute of Science (IISc), Bangalore, December 2019.

T13. *Communication Complexity in Voting*, Workshop on Complexity in Algorithmic Game Theory at FSTTCS, Mumbai, December 2019.

T12. *Fair and Efficient Collective Decisions*, Algorithmic Aspects of Social Choice and Auctions, St. Petersburg, August 2018.

T11. *Fair and Efficient Collective Decisions*, Rensselaer Polytechnic Institute, June 2018.

T10. *Fair and Efficient Collective Decisions*, University of Waterloo, June 2018.

T9. *Optimal Social Decision Making*, AAMAS, May 2017 (invited talk as part of the Victor Lesser Distinguished Dissertation Award).

T8. *How to Ask Residents to Vote Over Public Projects?*, Harvard University EconCS Seminar, March 2017.

T7. *Computational Social Choice: For the People*, Harvard University CRCS Seminar, March 2017.

T6. *Optimal Social Decision Making*, Carnegie Mellon University AI Seminar, February 2016.

T5. *Leximin Allocations in the Real World*, Carnegie Mellon University Theory Seminar, November 2015.

T4. *Leximin Allocations in the Real World*, Duke University CS-Econ Seminar Series, July 2015.

T3. *Euclidean Voting & Prediction Markets*, Microsoft Research New York City, July 2013.

T2. *Dynamic Fair Division of Multiple Resources*, Microsoft Research Cambridge, December 2012.

T1. *On Agent Failures in Totally Balanced Cooperative Games*, Microsoft Research Cambridge, August 2012.