

# JUGAL GARG

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## RESEARCH INTERESTS

Computational Aspects of Economics and Game Theory, Combinatorial Optimization, Design and Analysis of Algorithms, and Mathematical Programming

## APPOINTMENTS

- **Assistant Professor**, Dept. of Industrial and Enterprise Systems Engineering, Univ. of Illinois at Urbana-Champaign, January 2018 - present.
- **Research Assistant Professor**, Dept. of Industrial and Enterprise Systems Engineering, Univ. of Illinois at Urbana-Champaign, January 2016 - December 2017.
- **Affiliate Research Assistant Professor**, Dept. of Computer Science, Univ. of Illinois at Urbana-Champaign, May 2016 - present.
- **Postdoctoral Fellow**, Max-Planck-Institut für Informatik, Saarbrücken, Germany, August 2014 - January 2016.
- **Postdoctoral Fellow**, College of Computing, Georgia Tech, USA, September 2012 - August 2014.
- **Research Intern**, Microsoft Research, India, June - August, 2011 & February 2012.
- **Ph.D.**, Computer Science and Engineering, Indian Institute of Technology, Bombay, July 2007 - August 2012.

## PUBLICATIONS

### Refereed Journal Papers

- J9. Jugal Garg, Ruta Mehta, and Vijay Vazirani. Substitution with Satiation: A New Class of Utility Functions and a Complementary Pivot Algorithm. *Mathematics of Operations Research*, *forthcoming*, 2018.
- J8. Jugal Garg, Ruta Mehta, Vijay Vazirani, and Sadra Yazdanbod. ETR-Completeness for Decision Versions of Multi-Player (Symmetric) Nash Equilibria. *ACM Transactions on Economics and Computation*, *forthcoming*, 2018.
- J7. Reshmina William, Jugal Garg, and Ashlynn Stillwell. A Game Theory Analysis of Green Infrastructure Implementation Policies. *Water Resources Research*, 53:9 8003-8019, 2017.
- J6. Jugal Garg. Market Equilibrium under Piecewise Leontief Concave Utilities. *Theoretical Computer Science*, 703: 55-65, 2017.
- J5. Nikhil Devanur, Jugal Garg, and László Végh. A Rational Convex Program for Linear Arrow-Debreu Markets. *ACM Transactions on Economics and Computation* 5(1): 6:1-6:13, 2016.
- J4. Jugal Garg, Ruta Mehta, and Vijay Vazirani. Dichotomies in Equilibrium Computation, and Membership of PLC markets in FIXP. *Theory of Computing* 12(1): 1-25, 2016.
- J3. Jugal Garg, Ruta Mehta, Milind Sohoni, and Vijay Vazirani. A Complementary Pivot Algorithm for Market Equilibrium under Separable, Piecewise-Linear Concave Utilities. *SIAM Journal on Computing* 44(6): 1820-1847, 2015.
- J2. Bharat Adsul, Ch. Sobhan Babu, Jugal Garg, Ruta Mehta and Milind Sohoni. A Simplex-like Algorithm for Fisher Markets. *Current Science*, 103(9): 1033-1042, 2012.

- J1. Narayan Rangaraj, Milind Sohoni, Prashant Puniya, and Jugal Garg. Rake Linking for Suburban Train Services. *Opsearch*, 43(2), 2006.

### Refereed Conference Papers

- C19. Jugal Garg, Martin Hoefer, and Kurt Mehlhorn. Approximating the Nash Social Welfare with Budget-Additive Valuations. *To appear in the proceedings of the 29th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA)*, 2018.
- C18. Nikhil Devanur, Jugal Garg, Ruta Mehta, Vijay Vazirani and Sadra Yazdanbod. A New Class of Combinatorial Markets with Covering Constraints: Algorithms and Applications. *To appear in the proceedings of the 29th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA)*, 2018.
- C17. Jugal Garg, Ruta Mehta, Vijay Vazirani, and Sadra Yazdanbod. Settling the Complexity of Leontief and PLC Exchange Markets under Exact and Approximate Equilibria. *Proceedings of the 49th Symposium on Theory of Computing (STOC)*, 2017.
- C16. Xiaohui Bei, Jugal Garg, Martin Hoefer, and Kurt Mehlhorn. Earning Limits in Fisher Markets with Spending-Constraint Utilities. *Proceedings of the 10th International Symposium on Algorithmic Game Theory (SAGT)*, 2017.
- C15. Xiaohui Bei, Jugal Garg, Martin Hoefer, and Kurt Mehlhorn. Computing Equilibria in Markets with Budget-Additive Utilities. *Proceedings of the 24th European Symposium on Algorithms (ESA)*, 2016.
- C14. Xiaohui Bei, Jugal Garg, and Martin Hoefer. Ascending-Price Algorithms for Unknown Markets. *Proceedings of the 17th ACM Conference on Economics and Computation (EC)*, 2016.
- C13. Ran Duan, Jugal Garg, and Kurt Mehlhorn. An Improved Combinatorial Polynomial Algorithm for the Linear Arrow-Debreu Market. *Proceedings of the 27th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA)*, 2016.
- C12. Xiaohui Bei, Wei Chen, Jugal Garg, Martin Hoefer, and Xiaoming Sun. Learning Market Parameters using Aggregate Demand Queries. *Proceedings of the 30th AAAI Conference on Artificial Intelligence (AAAI)*, 2016.
- C11. Jugal Garg, Ruta Mehta, Vijay Vazirani, and Sadra Yazdanbod. ETR-Completeness for Decision Versions of Multi-Player (Symmetric) Nash Equilibria. *Proceedings of the 42nd International Colloquium on Automata, Languages and Programming (ICALP)*, 2015.
- C10. Jugal Garg and Ravi Kannan. Markets with Production: A Polynomial Time Algorithm and a Reduction to Exchange. *Proceedings of the 16th ACM Conference on Economics and Computation (EC)*, 2015.
- C9. Jugal Garg, Ruta Mehta, and Vijay Vazirani. Dichotomies in Equilibrium Computation, and Complementary Pivot Algorithms for a New Class of Non-Separable Utility Functions. *Proceedings of the 46th Symposium on Theory of Computing (STOC)*, 2014.
- C8. Jugal Garg and Vijay Vazirani. On Computability of Equilibria in Markets with Production. *Proceedings of the 25th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA)*, 2014.
- C7. Jugal Garg. Market Equilibrium under Piecewise Leontief Concave Utilities. *Proceedings of the 10th Conference on Web and Internet Economics (WINE)*, 2014.
- C6. Jugal Garg, Ruta Mehta, Milind Sohoni, and Nisheeth Vishnoi. Towards Polynomial Simplex-Like Algorithms for Market Equilibria. *Proceedings of the 24th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA)*, 2013.
- C5. Jugal Garg, Ruta Mehta, Milind Sohoni, and Vijay V. Vazirani. A Complementary Pivot Algorithm for Market Equilibrium under Separable, Piecewise-Linear Concave Utilities. *Proceedings of the 44th Symposium on Theory of Computing (STOC)*, 2012.
- C4. Bharat Adsul, Jugal Garg, Ruta Mehta, and Milind Sohoni. Rank-1 Bi-matrix Games: A Homeomorphism and a Polynomial Time Algorithm. *Proceedings of the 43rd Symposium on Theory of Computing (STOC)*, 2011.

- C3. Jugal Garg, Albert Jiang and Ruta Mehta. Bilinear Games: Polynomial Time Algorithms for Rank Based Subclasses. *Proceedings of the 7th Workshop on Internet and Network Economics (WINE), 2011.*
- C2. Bharat Adsul, Ch. Sobhan Babu, Jugal Garg, Ruta Mehta, and Milind Sohoni. A Simplex-like Algorithm for Fisher Markets. *Proceedings of the 3rd International Symposium on Algorithmic Game Theory (SAGT), 2010.*
- C1. Bharat Adsul, Ch. Sobhan Babu, Jugal Garg, Ruta Mehta, and Milind Sohoni. Nash Equilibria in Fisher Market. *Proceedings of the 3rd International Symposium on Algorithmic Game Theory (SAGT), 2010.*

## TEACHING

- IE 498: Computing for ISE, Spring 2016, Spring 2017, Spring 2018. Quality of course: 4.8/5.0, quality of instructor: 4.8/5.0.
- IE 598: Games, Markets, and Mathematical Programming, Fall 2016, Fall 2017.
- CS 8803: Advanced Topics in Algorithmic Game Theory, Spring 2013 (co-taught at Georgia Tech). Quality of course: 4.88/5.0, quality of instructor: 5.0/5.0.

## TALKS

- The 29<sup>th</sup> Annual ACM-SIAM Symposium on Discrete Algorithms (SODA), New Orleans, January 2018, *Approximating the Nash Social Welfare with Budget-Additive Valuations.*
- Invited talk, Workshop on Algorithms and Optimization, ICTS, Bangalore, India, Jan 2-3, 2018.
- The 21<sup>st</sup> Conference of the International Federation of Operational Research Societies (IFORS), Quebec City, Canada, July 2017, *A New Class of Combinatorial Markets with Covering Constraints: Algorithms and Applications.*
- The 49<sup>th</sup> ACM Symposium on Theory of Computing (STOC), Montreal, Canada, June 2017, *Settling the Complexity of Leontief and PLC Exchange Markets under Exact and Approximate Equilibria* (poster).
- INFORMS 2016 Annual Conference, Nashville, November 2016, *A Market Model for Scheduling with Applications to Cloud Computing.*
- CS Theory Seminar, UIUC, February 2016, *A Market for Scheduling, with Applications to Cloud Computing.*
- Game Theory Workshop, Bonn, Germany, December 2015, *ETR-Completeness for Decision Versions of Multi-Player (Symmetric) Nash Equilibria.*
- Operations Research Seminar, UCL, Louvain-la-Neuve, Belgium, October 2015, *Complementary Pivot Algorithms for Market Equilibria.*
- The 8<sup>th</sup> International Symposium on Algorithmic Game Theory (SAGT), Saarbrücken, Germany, September 2015, *Settling Some Open Problems on 2-Player Symmetric Nash Equilibria.*
- Operations Research Seminar, LSE, London, UK, September 2015, *Polynomial-Time Complementary Pivot Algorithms for Market Equilibria.*
- The 22<sup>nd</sup> International Symposium on Mathematical Programming (ISMP), Pittsburgh, July 2015, *Polynomial-Time Complementary Pivot Algorithms for Market Equilibria.*
- The International Colloquium on Automata, Languages and Programming (ICALP), Kyoto, Japan, July 2015, *ETR-Completeness for Decision Versions of Multi-Player (Symmetric) Nash Equilibria.*
- The 16<sup>th</sup> ACM Conference on Economics and Computation (EC), Portland, USA, June 2015, *Markets with Production: A Polynomial Time Algorithm and a Reduction to Exchange.*
- ISE Seminar, UIUC, May 2015, *Complementary Pivot Algorithms for Market Equilibria.*

- CSE Seminar, IIT-Bombay, India, March 2015, *Equilibrium in Markets: Algorithms and Complexity*.
- CSE Seminar, IIT-Kanpur, India, March 2015, *Equilibrium in Markets: Algorithms and Complexity*.
- School of Technology and Computer Science Seminar, Tata Institute of Fundamental Research, Mumbai, India, March 2015, *Equilibrium in Markets: Algorithms and Complexity*.
- The 10<sup>th</sup> Conference on Web and Internet Economics (WINE), Beijing, China, December 2014, *Market Equilibrium under Piecewise Leontief Concave Utilities* (Poster).
- CSE Seminar, IIT-Bombay, India, December 2014, *Leontief Exchange Markets Can Solve Multivariate Polynomial Equations, Yielding FIXP and ETR Hardness*.
- School on Algorithmic Game Theory, Sangli, India, December 2014, *Lectures on Equilibrium Computation*.
- MPI Seminar, Germany, November 2014, *Leontief Exchange Markets Can Solve Multivariate Polynomial Equations, Yielding FIXP and ETR Hardness*.
- Dagstuhl Seminar on Equilibrium Computation, Germany, August 2014, *Leontief Exchange Markets Can Solve Multivariate Polynomial Equations, Yielding FIXP and ETR Hardness*.
- The 46<sup>th</sup> ACM Symposium on Theory of Computing (STOC), New York, June 2014, *Dichotomies in Equilibrium Computation, and Complementary Pivot Algorithms for a New Class of Non-Separable Utility Functions*.
- The 25<sup>th</sup> ACM-SIAM Symposium on Discrete Algorithms (SODA), Portland, January 2014, *On Computability of Equilibria in Markets with Production*.
- ACO Seminar, Georgia Tech, Atlanta, October 2013, *On Computability of Equilibria in Markets with Production*.
- The 24<sup>th</sup> ACM-SIAM Symposium on Discrete Algorithms (SODA), New Orleans, January 2013, *Towards Polynomial Simplex-Like Algorithms for Market Equilibria*.
- The 21<sup>st</sup> International Symposium on Mathematical Programming (ISMP), Berlin, Germany, August 2012, *A Complementary Pivot Algorithm for Market Equilibrium under Separable, Piecewise-Linear Concave Utilities*.
- China Theory Week 2012, Aarhus University, Denmark, August 2012, *Linear Complementarity Problem and Market Equilibria*.
- Mysore Park Theory Workshop 2012, Mysore, India, August 2012, *Linear Complementarity Problem and Market Equilibria*.
- IBM T. J. Watson Research Center, New York, May 2012, *A Complementary Pivot Algorithm for Market Equilibrium under Separable, Piecewise-Linear Concave Utilities*.
- The 44<sup>th</sup> ACM Symposium on Theory of Computing (STOC), New York, May 2012, *A Complementary Pivot Algorithm for Market Equilibrium under Separable, Piecewise-Linear Concave Utilities*.
- Microsoft Research, India, March 2012, *A Complementary Pivot Algorithm for Market Equilibrium under Separable, Piecewise-Linear Concave Utilities*.
- Microsoft Research, India, June 2011, *Rank-1 Bi-matrix Games: A Homeomorphism and a Polynomial Time Algorithm*.
- Workshop on Innovations in Algorithmic Game Theory, Israel, May 2011, *Rank-1 Bi-matrix Games: A Homeomorphism and a Polynomial Time Algorithm* (Poster).
- The 3<sup>rd</sup> International Symposium on Algorithmic Game Theory (SAGT), Athens, Greece, October 2010, *Nash Equilibria in Fisher Market*.
- International Summer School on Algorithmic Game Theory, Shanghai, China, July 2010, *Nash Equilibria in Fisher Market*.

## AWARDS AND HONORS

- Featured in the “List of Teachers Ranked as Excellent” Spring 2016, IE498: Computing for ISE.
- Algorithms and Randomness Center (ARC) Postdoctoral Fellowship, Georgia Tech, September 2012 - August 2014.
- MSR India Rising Star Award 2011.
- Shantanu Deshpande Memorial Scholarship for 2009-2012 (one scholarship in IIT-Bombay – Rs. 400,000/year; Total Rs. 1,600,000)
- Invited to China Theory Week 2012, Aarhus University, Denmark.
- Microsoft India Travel Award to attend STOC 2011, WINE 2011, and ISMP 2012.

## PROFESSIONAL ACTIVITIES

- **Program Committee:** WINE 2017, WINE 2016
- **Journal Refereeing:** Mathematical Programming, Annals of Operations Research, International Journal on Game Theory, Information and Computation, SIAM Journal on Discrete Mathematics, Mathematical Methods of Operations Research, IEEE Transactions on Cloud Computing
- **Conference Refereeing:** APPROX, FOCS, ICALP, SAGT, SODA, STACS, STOC, WINE
- **Committee Memberships:** Engineering – Computer Science Liaison (UIUC)
- **Member of Ph.D. Examining Committee:** Ioannis Panageas, College of Computing (ACO program), Georgia Tech (Advisor: Prasad Tetali), Defended in July 2016 (Reader).
- Part of organizing committee of FSTTCS 2011.