

2019 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student

Ravi Jagadeesan was awarded the 2019 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student at the 125th Annual Meeting of the AMS in Baltimore, Maryland, in January 2019.



Ravi Jagadeesan

Citation

The recipient of the 2019 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student is Ravi Jagadeesan of Harvard University. Jagadeesan was selected as the winner of the Prize for “[his] fundamental contributions across several topics in pure and applied mathematics, including algebraic geometry, statistical theory, mathematical

economics, number theory, and combinatorics” from a pool with outstanding candidates who impressed the selection committee. His papers have been published or accepted for publication in journals such as *Proceedings of the London Mathematical Society*, *Electronic Journal of Combinatorics*, *Research in Number Theory*, *American Economic Journal: Microeconomics*, and *Games and Economic Behavior*. Additionally, he has presented three papers at the Association for Computing Machinery Conference on Economics and Computation.

Jagadeesan’s research in mathematics began early, when he published combinatorics papers on pattern avoidance for permutations in the context of (i) alternating permutations and (ii) Young’s diagrams and tableaux (joint with

Nihal Gowravaram). Then he went on to derive a new invariant for the action of the absolute Galois group of \mathbb{Q} on the set of isomorphism classes of the so-called *dessins d’enfants* (children’s drawings). In another paper, he gave a new proof of Serre’s characterization of regular local rings (joint with Aaron Landesman). At Harvard, he has worked on the birational geometry of elliptic fibrations and its connections to the combinatorics of hyperplane arrangements. His resulting award-winning senior thesis and three related papers (joint with Mboyo Esole, Steven Jackson, Monica Kang, and Alfred Noël) lie at the interface of algebraic geometry, combinatorics, and string theory.

Jagadeesan’s work in mathematical economics is in the fields of matching theory, market design, and public finance. In the view of his references, he brings deep mathematical insights and connections from multiple areas to the table. His papers in matching theory (joint with Tamás Fleiner, Zsuzsanna Jankó, Scott Kominers, Ross Rheingans-Yoo, and Alex Teytelboym) leverage topological fixed-point theorems and ideas from general equilibrium to yield insights into the structure of equilibria in markets with frictions. His work in market design streamlined the analysis of proposed market-clearing mechanisms and clarified the role of key mathematical assumptions. His paper on optimal taxation with an endogenous growth rate is described as being an important contribution to theoretical public finance.

In addition to the above work, Jagadeesan has extended Ramsey theory via quasi-colorings to write a paper on causal statistical inference in the presence of an underlying graph or a network. Regarding this contribution, a reference letter writer states that they were most satisfied by Jagadeesan's "harnessing the beauty and power of mathematics to find structure in a messy real-world problem...making fundamental progress on an important problem of our times." Indeed, the committee members felt that this statement could be applied as well to much of Jagadeesan's work in economics and other areas. Case in point: he has used ideas from category theory to coauthor a Python library, *Matriarch*, for biomaterials architecture (joint with Tristan Giesa, David Spivak, and Markus Buehler).

Biographical Note: Ravi Jagadeesan

Ravi Jagadeesan grew up in Naperville, Illinois. His interest in mathematics was inspired at a young age by his grandparents—all four of them mathematicians—and his parents—who are both computer scientists. He attended Phillips Exeter Academy in Exeter, New Hampshire, for high school, where he had the opportunity to take advanced courses in mathematics and develop his problem-solving skills. He graduated from Harvard with an AB *summa cum laude* in mathematics (with a minor in economics) and with an AM in statistics.

He had the opportunity to work in several different areas of pure and applied mathematics—including algebraic geometry, combinatorics, number theory, statistical theory, and mathematical economics—under a host of advisers. His first experience with mathematical research was during high school, when he was a student in the MIT math department's Program for Research in Mathematics, Engineering, and Science (PRIMES). He then became interested in exploring applied work and spent summers working on research in applied mathematics at the Center for Excellence in Education's Research Science Institute (RSI) at MIT and as an Economic Design Fellow at the Harvard Center of Mathematical Sciences and Applications (CMSA). He is currently a student in Harvard's PhD program in Business Economics, where he is a National Science Foundation Graduate Research Fellow.

Jagadeesan earned a gold medal at the International Mathematical Olympiad in 2012 and was named a Putnam Fellow in 2014. He received Harvard's Jacob Wendell Scholarship Prize, and his senior thesis on "Crepan resolutions of \mathbb{Q} -factorial threefolds with compound Du Val singularities" was awarded the Thomas Temple Hoopes Prize.

Outside of mathematics and economics, he enjoys dancing and is a member of the Harvard Ballroom Dance Team.

Response from Ravi Jagadeesan

It is a great honor to receive the 2019 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research

in Mathematics by an Undergraduate Student. I would like to thank Mrs. Morgan, as well as the AMS, MAA, and SIAM, for establishing this prize and for recognizing me.

I would also like to thank my many mentors—Markus Buehler, Noam Elkies, Mboyo Esole, Pavel Etingof, Zuming Feng, John Geanakoplos, Tristan Giesa, Jerry Green, Joel Lewis, Akhil Mathew, Natesh Pillai, John Rickert, David Spivak, Stefanie Stantcheva, Alex Teytelboym, Alex Volfovsky, Shing-Tung Yau, and, especially, Scott Kominers—for their advice and support over the years.

I am grateful to the MIT Program for Research in Mathematics, Engineering and Science, the Research Science Institute, and the Harvard Center of Mathematical Sciences and Applications for providing excellent work environments.

I am also grateful for research and travel grants from Harvard Business School, the Harvard College Research Program, and the Harvard math department. Most of all, I would like to thank my family—including my wonderful grandparents, parents, and sister—for their love and support.

Citation for Honorable Mention: Evan Chen

Evan Chen is recognized with an Honorable Mention for the 2019 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student. He has authored many papers in combinatorics and number theory, some as a single author and some in collaboration. He has had papers accepted to the *Proceedings of the AMS*, the *Electronic Journal of Combinatorics*, *Research in Number Theory*, and the *International Journal of Number Theory*. In joint work, he proved an elliptic curve version of Linnik's theorem. He answered an open question on balance constants of posets and, in joint work, made progress on the long-studied problem of classification of Wilf-equivalence classes of patterns. He is currently a PhD student at the Massachusetts Institute of Technology, where he is supported by an NSF Graduate Fellowship.

Biographical Sketch: Evan Chen

Evan Chen was born and raised in California and completed his undergraduate degree in Cambridge, Massachusetts. He is currently pursuing a PhD in mathematics at the Massachusetts Institute of Technology, supported by an NSF fellowship.

Besides research, Evan is deeply involved in the training of the USA team for the International Math Olympiad (IMO), after having won a gold medal himself in high school. Among other roles, he is the assistant academic director for the USA's training camp and the coordinator for the USA team selection tests. He is also the current chief of staff for the Harvard-MIT math tournament and the author of a popular MAA-published book in competitive geometry. Outside of math and teaching, Evan enjoys board games and Korean pop dance.

Response from Evan Chen

It is a wonderful privilege to receive an Honorable Mention for the 2019 Frank and Brennie Morgan Prize. I would like to thank Mrs. Morgan and the AMS, MAA, and SIAM for their generosity and support of undergraduate research.

I would like to acknowledge and thank Joe Gallian and Ken Ono for their mentorship and support during my undergraduate years. The three summers I spent at these REU programs were immensely productive learning and research experiences and contributed greatly to my development. I am also deeply grateful for their encouragement and advice.

I would also like to extend thanks to my professors and teachers from the past several years, with particular thanks to Zuming Feng, Po-Shen Loh, Zvezda Stankova, and Yan Zhang. Finally I would like to thank my family and friends for their constant care and support.

Citation for Honorable Mention: Huy Tuan Pham

Huy Tuan Pham is recognized with an Honorable Mention for the 2019 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student. He has jointly authored several papers in additive combinatorics. These papers compose his undergraduate thesis, for which he won the Kennedy Thesis Prize at Stanford University. Two of his papers have been accepted to *International Mathematical Research Notices* and to *Discrete Analysis*. His work uses tools from combinatorics, number theory, and analysis to show that tower-type bounds are needed in some natural applications of Szemerédi's regularity method, including Green's generalization of Roth's theorem for popular difference. He is currently at the University of Cambridge supported by a Trinity Studentship and will start his PhD studies at Stanford this fall.

Biographical Note: Huy Tuan Pham

Huy Tuan Pham was born and raised in Ho Chi Minh City, Vietnam. After finishing high school at High School for the Gifted at Vietnam National University, Ho Chi Minh City, he attended Stanford University, where he received a BS in Mathematics with Honors and a minor in Computer Science, and an MS in Statistics. He is now at Cambridge University pursuing Part III of the Mathematical Tripos and will return to Stanford University for his PhD.

Huy's initial interest in combinatorics was developed during International Math Olympiad trainings in Vietnam. Since his sophomore year, he has been working with Jacob Fox on probabilistic and additive combinatorics. He plans to continue his study of combinatorics and probability in his PhD.

Response from Huy Tuan Pham

I am honored to receive an Honorable Mention for the 2019 Frank and Brennie Morgan Prize. I would like to thank Mrs. Frank Morgan and the AMS, MAA, and SIAM for spon-

soring this meaningful award. I am extremely thankful to my advisor Jacob Fox for his help and support throughout my undergraduate years, which has shaped my passion and understanding of combinatorics. I am also grateful to Yufei Zhao, who has given me useful advice throughout our collaboration. I am fortunate to have learned great mathematics from Stanford math professors, particularly Amir Dembo, Persi Diaconis, Andrea Montanari, Lenya Ryzhik, Ravi Vakil, and Jan Vondrak. Last but not least, I would like to thank my family and friends for their support, especially to my friend Phan-Minh Nguyen, who has provided me with tremendous encouragement and insights through our endless conversations in mathematics and statistics.

About the Prize

The Frank and Bernie Morgan Prize is awarded annually for outstanding research in mathematics by an undergraduate student (or students having submitted joint work). Students in Canada, Mexico, or the United States or its possessions are eligible for consideration for the prize. Established in 1995, the prize was endowed by Mrs. Frank (Brennie) Morgan of Allentown, Pennsylvania, and carries the name of her late husband. The prize is given jointly by the AMS, the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM) and carries a cash award of US\$1,200.

Recipients of the Frank and Bernie Morgan Prize are chosen by a joint AMS-MAA-SIAM selection committee. For the 2019 prize, the members of the selection committee were:

- Nathan Louis Gibson,
- Anant P. Godbole (Chair),
- V. Kumar Murty,
- Ken Ono,
- Catherine Sulem,
- Melanie Matchett Wood.

A list of previous recipients of the Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student may be found on the AMS website at <https://www.ams.org/profession/prizes-awards/pabrowse?url=morgan-prize>.

Credits

Photo of Ravi Jagadeesan is by Ross Campbell Photography.