2019 Norbert Wiener Prizes in Applied Mathematics

The 2019 Norbert Wiener Prizes in Applied Mathematics were presented at the 125th Annual Meeting of the AMS in Baltimore, Maryland, in January 2019. The prizes were awarded to Marsha Berger and to Arkadi Nemirovski.

Marsha Berger

Citation: Marsha Berger

The 2019 Norbert Wiener Prize in Applied Mathematics is awarded to Marsha Berger for her fundamental contributions to Adaptive Mesh Refinement and to Cartesian mesh techniques for automating the simulation of compressible flows in complex geometry.

In solving partial differential equations, Adaptive Mesh Refinement (AMR) algorithms can improve the accuracy of a solution by locally and dynamically resolving complex features of a simulation. Marsha Berger is one of the inventors of AMR. The block-structured approach to AMR was introduced by Berger in her 1982 thesis, and, from this, the Berger–Oliger algorithm and the Berger–Colella algorithm were developed by Berger, Joseph Oliger, and Phillip Colella. Berger provided the mathematical foundations, algorithms, and software that made it possible to solve many otherwise intractable simulation problems, including those related to blood flow, climate modeling, and galaxy simulation. Her mathematical contributions include local error estimators to identify where refinement is needed, stable and conservative grid interface conditions, and embedded boundary and cut-cell methods. She is part of the team that created Cart3D, a NASA code based on her AMR algorithms that is used extensively for aerodynamic simulations and which was instrumental in understanding the Columbia Space Shuttle disaster. She also helped build GeoClaw, an open source software project for ocean-scale wave modeling. It is used to simulate tsunamis, debris flows, and dam breaks, among other applications.

Biographical Note: Marsha Berger

Marsha Berger received her PhD in computer science from Stanford in 1982. She started as a postdoc at the Courant Institute of Mathematical Sciences at NYU, and is currently a Silver Professor in the computer science department, where she has been since 1985.

She is a frequent visitor to NASA Ames, where she has spent every summer since 1990 and several sabbaticals. Her honors include membership in the National Academy of Sciences, the National Academy of Engineering, and the American Academy of Arts and Science. She is a fellow of the Society for Industrial and Applied Mathematics. Berger was a recipient of the Institute of Electrical and Electronics Engineers Fernbach Award and was part of the team that won the 2002 Software of the Year Award from NASA for their Cart3D software.

Response from Marsha Berger

What a thrill to learn that I will be one of the recipients of the 2019 Norbert Wiener Prizes! One of the main enjoyments I get from my research is developing tools to solve real problems in aerodynamics, tsunami modeling, etc., that others can use. This has been possible because of collaborators I have been fortunate to meet, starting with Phil Colella and Antony Jameson, and later Randy LeVeque and Michael Aftosmis, along with a number of postdocs.

I am particularly pleased that this kind of research is being recognized. The Adaptive Mesh Refinement (AMR) and Cartesian grid projects have both required the creation of new techniques in mathematics and computer science. They were decade-long efforts where I and my collaborators developed theory and algorithms, while paying attention

to important practical aspects of their use in realistic geometries. Complicated algorithms have complicated implementations, and accuracy, robustness, and performance are all essential parts of the research.

About the Prize

The AMS-SIAM Norbert Wiener Prize in Applied Mathematics is awarded every three years to recognize outstanding contributions to applied mathematics in the highest and broadest sense. Established in 1967 in honor of Norbert Wiener (1894–1964), the prize was endowed by the Department of Mathematics of the Massachusetts Institute of Technology. The prize is given jointly by the AMS and the Society for Industrial and Applied Mathematics (SIAM). The recipient must be a member of one of these societies. The prize carries a cash award of US$5,000.

For the 2019 prize, the members of the AMS-SIAM selection committee were:

- Emmanuel Candes (Chair),
- James Weldon Demmel,
- Charles R. Doering.

A list of the previous recipients of the Norbert Wiener Prize in Applied Mathematics may be found on the AMS website at `https://www.ams.org/profession/prizes-awards/pabrowse?purl=wiener-prize`.

Credits

Photo of Marsha Berger is courtesy of Marsha Berger.

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Arkadi Nemirovski

Citation: Arkadi Nemirovski

The 2019 Norbert Wiener Prize in Applied Mathematics is awarded to Arkadi Nemirovski for his fundamental contributions to high-dimensional optimization and for his discovery of key phenomena in the theory of signal estimation and recovery.

A powerful and original developer of the mathematics of high-dimensional optimization, Nemirovski, with D. Yudin, invented the ellipsoid method used by Leonid Khachiyan to show for the first time that linear programs can be solved in polynomial time. With Yurii Nesterov, he extended interior point methods in the style of Narendra Karmarkar to general nonlinear convex optimization. This foundational work established that a rich class of convex problems, called semidefinite programs, are solvable in polynomial time; semidefinite programs are nowadays routinely used to model concrete applied problems or to study deep problems in theoretical computational complexity. A third breakthrough, with Aharon Ben-Tal, was the invention of methods of robust optimization to address problems in which the solution may be very sensitive to problem data. Nemirovski also, and rather amazingly, made seminal contributions in mathematical statistics, establishing the optimal rates at which certain classes of nonparametric signals can be recovered from noisy data and investigating limits of performance for estimation of nonlinear functionals from noisy measurements. All in all, Nemirovski's contributions have become bedrock standards with tremendous theoretical and practical impact on the field of continuous optimization and beyond.

Biographical Note: Arkadi Nemirovski

Arkadi Nemirovski was born in 1947 in Moscow, Russia. He earned his PhD (1974) from Moscow State University, under the supervision of Georgi Evgen'evich Shilov. His research areas are convex optimization (information-based complexity of convex optimization, design of efficient first order and interior point algorithms, robust optimization) and nonparametric statistics. He held research associate positions at the Moscow Research Institute for Automatic Equipment (1973–1987) and the Central Economic Mathematical Institute of USSR/Russian Academy of Sciences (1987–1993) and was professor at the Faculty of Industrial Engineering and Management, Technion, Israel (1993–2005). Since 2005, he has held a professorship at the H. Milton Stewart School of Industrial and Systems Engineering at Georgia Institute of Technology.

Arkadi Nemirovski was elected to the US National Academy of Engineering (2017) and the American Academy of Arts and Sciences (2018). He is a recipient of the Fulkerson Prize of the Mathematical Programming Society (MPS) and the AMS (1982, joint with L. Khachiyan and D. Yudin), the Dantzig Prize of MPS and SIAM (1991, joint with M. Grötschel), and the John von Neumann Theory Prize of the Institute for Operations Research and the Management Sciences (INFORMS) (2003, joint with M. Todd).

Response from Arkadi Nemirovski

I am deeply honored and grateful to receive the 2019 Norbert Wiener Prize in Applied Mathematics—a distinction I never dreamt of. As a student, I have been fortunate to be taught by brilliant mathematicians at the Mechanical

and Mathematical Faculty of Moscow University, where I was mentored by Georgi Shilov. During my professional life, I had the honor and privilege to collaborate with outstanding colleagues, first and foremost, with Yuri Nesterov, Aharon Ben-Tal, and Anatoli Iouditski, to whom I am extremely grateful for their indispensable roles in our joint research and for decades of friendship. I owe a lot to the excellent working conditions I enjoyed at the Central Economic Mathematical Institute in Moscow, at Technion—the Israel Institute of Technology, and at Georgia Institute of Technology.

I always thought that the key word in "applied mathematics" is "mathematics"—even when all we need at the end of the day is a number, I believe that what matters most are rigorous results on how fast this number could be found and how accurate it is, which poses challenging and difficult mathematical problems. I am happy to observe how my research area—convex optimization—thrives due to the effort of new generations of researchers, and how rapidly extends the scope of its applications.

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Photo of Arkadi Nemirovski is courtesy of Arkadi Nemirovski.