INTERNATIONAL
MATHEMATICAL UNION

GAUSS PRIZE 2026

YURII NESTEROV

SHORT CITATION

The Gauss Prize is awarded to Yurii Nesterov for his groundbreaking work on mathematical optimization that provided the theoretical foundation and algorithmic backbone for many numerical and data-driven fields, enabling practical computations that were previously too time-consuming to be feasible.

LONG CITATION

Yurii Nesterov is a mathematician who has made outstanding contributions to optimization that also have significant impact on several areas outside of mathematics, by drastically improving the efficiency of algorithms in engineering, computer and data sciences, machine learning, economics, and operations research.

Yurii Nesterov settled his reputation in optimization by the publication in 1994 of the influential book, Interior-Point Algorithms in Convex Programming, together with Arkadi Nemirovski. It is noteworthy that Nesterov was listed as the first author of the book, although Nemirovski was more senior and would appear first alphabetically in both English and Russian languages.

Although the study of convex geometry and convex functions was an active topic since the beginning of the 20th century, the complexity status of convex optimization was not well understood. Nesterov and Nemirovski developed in their book the novel theory of self-concordant barrier functions, which they used to design interior-point methods with guaranteed polynomial-time complexity (in the Turing model) for minimizing linear functions on convex sets endowed with well-behaved self-concordant barriers. Their results apply to important classes of convex problems, including linear programming (LP), semidefinite programming (SDP), and general conic linear programming problems. While polynomial-time interior-point algorithms for LP had been known since the work of Karmarkar in 1984, such algorithms for semidefinite and conic linear programs were completely new. The study of algorithms and applications for SDP subsequently exploded, and SDPs are now considered a fundamental tool in mathematical optimization.

Yurii Nesterov achieved many additional high-impact results in optimization, in particular, on first-order (gradient-descent-type) methods for general convex functions, not necessarily self-concordant. Most notably, he introduced in 1983 his "accelerated gradient-descent" method. He showed that it has guaranteed asymptotically faster worst-case convergence than the usual gradient-descent methods and, remarkably, that this convergence rate is optimal: no other first-order-type method can be faster.

Through his fast algorithms, which are sufficiently simple to implement, Nesterov laid down the foundation of modern optimization techniques, now ubiquitously used in machine learning and artificial intelligence (AI). The impact of his accelerated method (often called "Nesterov momentum") on non-mathematical areas is realized through the performance and efficiency gains it provides to AI technologies we use daily. This is crucial for the training of complex models on immense datasets, like in image and speech recognition, natural language processing, and recommendation systems.

Nesterov synthesized his results on first-order methods in his 2004 book, Introductory Lectures on Convex Optimization: A Basic Course. This book has become a major reference in the field and has helped to shape the optimization background and taste of generations of researchers.

It is interesting to put in perspective Nesterov's body of work with a passage in the preface of his 2004 book, where he discusses the impact of Karmarkar's algorithm for LP:

> *"… the most surprising feature of this algorithm was that the theoretical prediction of its high efficiency was supported by excellent computational results. This unusual fact dramatically changed the style and direction of the research in nonlinear optimization*."

Nesterov has in fact been the prime actor in making this type of research a major focus in optimization over the past 15-20 years.

His 1983 paper on accelerated gradient is universally known, but Nesterov also made critical contributions to various related topics such as smooth nonconvex optimization, coordinate descent in convex optimization, structured nonconvex optimization, quasi-Newton methods, cubic regularization of the Newton's method, smooth minimization of non-smooth functions, randomized derivative-free methods, and, more recently, high-order tensor techniques. While Nesterov's primary focus has been convex optimization, many of his ideas have strongly influenced nonconvex optimization as well, including practical approaches for training machine learning models using variants of stochastic gradient descent with Nesterov-type momentum.

The trajectory of Yurii Nesterov is consistent with what attracted him to mathematics. Quoting from an interview by Robynn Weldon with Nesterov in 2023[1]:

> "*That is what attracted him to mathematics: the real-world applicability of numerical modelling; the ability even to predict the future, check results against real events and adapt the model in response. And it is why he can't imagine having been anything other than a mathematician."*

The outstanding quality of his scientific work is highly recognized by his peers. Yurii Nesterov has received numerous awards, including the Dantzig Prize, the John von Neumann Theory Prize, and the EURO Gold Medal. His work has been cited more than 50,000 times on Google Scholar. Yurii Nesterov is among the most influential contemporary figures in the field of mathematical optimization.

[1] https://nccr-automation.ch/news/2023/unprecedented-overflow-why-progress-his-field-alarms-yuriinesterov