ABACUS MEDAL 2026
SHAYAN OVEIS GHARAN

INTERNATIONAL MATHEMATICAL UNION

SHORT CITATION

Shayan Oveis Gharan is awarded the IMU Abacus Medal 2026 for his landmark contributions to the theory of algorithms, taking the analysis of algorithms beyond combinatorics and probabilistic analysis into the theory of the geometry of polynomials and related topics. This theory has led to deeper understanding of distributions on spanning trees and matroid bases in general. Oveis Gharan's work improved the approximation of the metric travelling salesperson problem, breaking the limit on the approximation factor in Christofides' 3/2-algorithm from 50 years ago, and led to a revolution in the understanding of Markov Chain Monte Carlo sampling algorithms (proving the Mihail-Vazirani conjecture and giving a self-contained proof that resolved the strongest version of Mason's conjecture) through spectral independence.

LONG CITATION

Shayan Oveis Gharan has made groundbreaking contributions in developing algorithms for the travelling salesperson problem, and in designing and analyzing Markov chains to solve longstanding conjectures. He has significantly enlarged the mathematical and algorithmic arsenal in the field, bridging the theory of geometry of polynomials with spectral analysis and other algorithmic techniques.

Travelling Salesperson Problem (TSP). The early work of Oveis Gharan includes developments of approximation algorithms for the Travelling Salesperson Problem, which is one of the most fundamental and well-known NP-hard problems. In 1976, Christofides provided an approximation algorithm that delivers a solution with at most 3/2 of the optimal value in polynomial time. For a directed version, called the asymmetric TSP (ATSP), Frieze, Galbiati, and Maffioli (1982) devised an O(log n)-approximation algorithm, where n is the number of sites to visit. Since then, decades went by without improvements in the design of approximation algorithms for these problems.

Oveis Gharan, in joint work with Asadpour, Goemans, Madry, and Saberi, broke this barrier by presenting the first polynomial-time algorithm that achieved an asymptotically better approximation factor: O(log n/ log log n). This was accomplished by introducing the technique of rounding random samples from the maximum entropy distribution. Subsequently, in a joint paper with Anari, Oveis Gharan showed that the Held-Karp linear programming relaxation for ATSP has an integrality gap that is a polynomial in log log n. This suggested that further improvement of the approximation factor may be possible, and in fact Svensson, Tarnawski, and Végh later devised a constant factor approximation algorithm for ATSP. On the symmetric TSP with a graphic metric, Oveis Gharan, together with Saberi and Singh, made a major advance of improving the approximation ratio a little below 3/2, exploiting the maximum entropy distribution. While the quantitative improvement was limited, it was a crack in the dam. A deluge of papers improving this bound followed. A major question left was whether or not the approximation factor of 3/2 for the general case of metric TSP can be improved. Oveis Gharan finally provided a positive answer to this question in a joint paper with Karlin and Klein.

Markov Chain Monte Carlo (MCMC) convergence. Another major contribution of Oveis Gharan concerns matroids, introduced by Whitney in 1935. In a series of joint papers with Anari, Liu, Vinzant, and Vuong, entitled “Log-Concave Polynomials,” Oveis Gharan clarified properties of matroids by introducing log-concave polynomials, which generalize real stable polynomials. The obtained results include the proof of the Mihail-Vazirani conjecture on rapid mixing of the natural Markov chain of bases and the proof of the strongest version of Mason’s conjecture on the number of independent sets. The papers initially leveraged a breakthrough in Combinatorial Hodge Theory by Adiprasito, Huh, and Katz, although the authors have since discovered an elementary approach.

In a subsequent paper with Anari and Liu, Oveis Gharan developed a fundamental technique for bounding convergence rates known as "spectral independence," which led to the answer to a nearly 30 year old open question concerning rapid mixing of the Glauber dynamics for sampling from the hardcore distribution from statistical physics and chemistry up to the algorithmic phase transition threshold and progress on using MCMC to sample proper colourings on locally dense graphs that led to a near-optimal analysis of the Glauber dynamics for sampling proper edge colourings of the graph in a follow-up work, answering a long-standing open problem.

Further achievements by Oveis Gharan include the proof of a higher order Cheeger inequality, providing a theoretical justification for clustering algorithms that use the top k eigenvectors of a graph to construct a partitioning into k sets. This discovery was used by Miclo (2013) as the main technical tool in proving a famous conjecture of Simon and Høegh-Krohn from mathematical physics concerning the spectral gap of hyperbounded Markov operators.