



Association for  
Computing Machinery

*Advancing Computing as a Science & Profession*



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## **ACM-INFOSYS FOUNDATION AWARD GOES TO ARCHITECT OF NEW APPROACHES FOR HARD-TO-SOLVE COMPUTATIONAL PROBLEMS**

### **Princeton Computer Scientist Sanjeev Arora Honored for Breakthroughs that Have Advanced the Power of Computing**

**NEW YORK and BANGALORE, INDIA, March 29, 2012** – ACM (the Association for Computing Machinery) and the Infosys Foundation announced today that Sanjeev Arora, 44, of Princeton University, is the recipient of the 2011 ACM-Infosys Foundation Award in the Computing Sciences for his innovative approaches to problem solving. Arora's research revolutionized the approach to essentially unsolvable problems that have long bedeviled the computing field, the so-called NP-complete problems. These results have had implications for problems common to cryptography, computational biology, and computer vision, among other fields.

The ACM-Infosys Foundation Award <http://awards.acm.org/infosys>, established in August 2007, recognizes personal contributions by young scientists and system developers to a contemporary innovation that exemplifies the greatest recent achievements in the computing field. Financial support for the award, which was increased this year to \$175,000, is provided by an endowment from the Infosys Foundation.

"With his new tools and techniques, Arora has developed a fundamentally new way of thinking about how to solve problems," said ACM President Alain Chesnais. "He also demonstrated that when we can't solve these problems, we understand why this is the case. In particular, his work on the PCP theorem is considered the most important development in computational complexity theory in the last 30 years. He also perceived the practical applications of his work, which has moved computational theory into the realm of real world uses."

Arora's work provides key theoretical concepts for distinguishing between problems that can be approximated efficiently and those that cannot. He played a key role in the development of probabilistically checkable proofs (PCP) that resulted in the PCP theorem, which leads to designs for more secure use of agents common in cloud computing, and implies limits on our ability to understand proteins and other biological

systems. He also contributed new ways to find approximate solutions to problems. His efforts have inspired other computer theory researchers and helped raise the level of funding for theoretical computer science.

"Infosys is proud to partner with ACM to recognize Dr. Arora's contributions in computing. His research on approximation algorithms, and the tools he has developed, can help speed the pace of innovation, which is critical in today's increasingly fast-paced global economy," said S. D. Shibulal, CEO and Managing Director of Infosys. "The ACM-Infosys Foundation Award underscores our ongoing commitment to support advances in computing sciences, and encourage groundbreaking uses of technology to help build tomorrow's enterprises."

### **Challenging the Conventional Wisdom of Problem-Solving**

Arora and his colleagues developed tools that advanced the use of approximate solutions rather than exact solutions to many optimization problems classified as NP-complete. A deep, unsolved question of computational complexity is whether the class P of decision problems that can be efficiently solved is the same as the class NP of problems whose solution can be efficiently verified. The most difficult problems in NP are called NP-complete. The PCP theorem enables computer scientists to classify the computational difficulty of computing approximate solutions to NP-complete problems by giving a surprising new definition of NP. It employs a certificate of proof which can be "spot-checked" by reading only a constant number of bits from the certificate, which are selected by a randomized process. As a result, a complex mathematical proof can also be spot-checked by revealing only a constant amount of the proof, challenging the conventional wisdom that a proof is only as strong as its weakest element.

Arora developed techniques for the design of approximation algorithms as well. Algorithms are the basic set of rules for solving a problem in a finite number of steps. He helped create new algorithms that compute approximate solutions for fundamental problems. These include the Euclidean traveling salesman problem with applications for planning, logistics, and microchip manufacturing, and the sparsest cut problem, used in clustering image pixels into components that is common to computer vision and artificial intelligence. The results yield not only the best known approximation algorithms for some of the most studied optimization problems, but they establish influential methods that have been used to obtain important results in other areas.

His more recent research focuses on the use of semidefinite optimization in approximation algorithms, a relatively new field of optimization. He led the design of very fast semi-definite-programming-based algorithms, which take a widely-used theoretical approach, previously considered impractical, into the realm of practical applications. His recent work casts new light on the status of the *unique games conjecture*, a potential "PCP theorem on steroids" formulated by Subash Khot, a Ph.D. student of Arora.

Arora was the founding director of the Center for Computational Intractability, which addresses the phenomenon that many problems seem inherently impossible to solve on current computational models. The organization, a joint venture of Princeton University, the Institute for Advanced Study, Rutgers University, and New York University, is funded by a grant from the National Science Foundation. It is devoted to designing new approaches to fundamental problems in computing as well as other sciences.

## **Background**

The Charles Fitzmorris Professor of Computer Science at Princeton, Arora was a co-winner of both the 2001 and 2010 Gödel Prize, an award sponsored jointly by the European Association for Theoretical Computer Science (EATCS, <http://www.eatcs.org>) and the Special Interest Group on Algorithms and Computation Theory of ACM (ACM SIGACT, <http://sigact.acm.org>). He was named an ACM Fellow in 2008, and a co-winner of the ACM Doctoral Dissertation Award in 1995. He coauthored *Computational Complexity: A Modern Approach* with Boaz Barak, which has become a popular text in higher education. A graduate of the Massachusetts Institute of Technology with an S.B. degree in Mathematics and Computer Science, Arora earned a Ph.D. degree in Computer Science from the University of California, Berkeley. He also attended the Indian Institute of Technology at Kanpur for two years before moving to the U.S.

ACM will present the ACM-Infosys Foundation Award at its annual Awards Banquet on June 16 in San Francisco, CA.

### **About ACM**

*ACM, the Association for Computing Machinery [www.acm.org](http://www.acm.org), is the world's largest educational and scientific computing society, uniting computing educators, researchers and professionals to inspire dialogue, share resources and address the field's challenges. ACM strengthens the computing profession's collective voice through strong leadership, promotion of the highest standards, and recognition of technical excellence. ACM supports the professional growth of its members by providing opportunities for life-long learning, career development, and professional networking.*

### **About the Infosys Foundation**

*Established in 1996, the Infosys Foundation is the philanthropic arm of Infosys and has the sole objective of fulfilling the social responsibility of the company by creating opportunities and working toward a more equitable society. The Infosys Foundation has made effective strides in the areas of healthcare, education, social rehabilitation, and the arts. The company contributes up to one percent of its profit to the foundation each year.*

### **About Infosys**

*Many of the world's most successful organizations rely on the 145,000 people of Infosys to deliver measurable business value. Infosys provides business consulting, technology, engineering and outsourcing services to help clients in over 30 countries build tomorrow's enterprise.*

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