XII Edición
Premios Fundación BBVA Fronteras del Conocimiento
BBVA Foundation Frontiers of Knowledge Awards
12th Edition

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Press release
19 February, 2020

The BBVA Foundation recognizes Isabelle Guyon, Bernhard Schölkopf and Vladimir Vapnik for work that has advanced the field of artificial intelligence by teaching machines the human skill of classifying data

- The three laureates have managed to teach computers to recognize patterns in large volumes of data, so they can be sorted into categories, in a process where the machine learns from numerous examples
- The methods they developed are "transforming the everyday world," says the committee's citation, "improving fields as diverse as medical diagnosis, computer vision, natural language processing and the monitoring of climate change"
- Thanks to their contributions, today's computers can be trained to classify data sets with human precision, or at times even better. This learning ability allows them to perform such functions as voice, writing or facial recognition, and has even been used in astrophysics to discover 21 new exoplanets

The BBVA Foundation Frontiers of Knowledge Award in the Information and Communications Technology category has gone in this twelfth edition to Isabelle Guyon, Bernhard Schölkopf and Vladimir Vapnik, for their "fundamental contributions to machine learning," in the words of the committee. The methods they developed in artificial intelligence are "transforming the everyday world, improving fields as diverse as medical diagnosis, computer vision, natural language processing and the monitoring of climate change."

"Vapnik, Guyon and Schölkopf," the citation continues, "have collectively performed ground-breaking research that transcends traditional boundaries in computer science, and deservedly rank among the world's leading innovators."

The awardees have developed methods that endow machines with the essential human skill of recognizing patterns in large volumes of data, enabling them to be sorted into categories. The goal is for the machine to learn through being presented with numerous examples.

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Vapnik and Guyon came up with the mathematical tools known as support vector machines (SVM), while Schölkopf extended their range and power through the use of kernel methods, which allow for the input of much more specific categories, thereby multiplying applications. These models are described by the committee as representing "a major machine learning paradigm in both research and applications."

Thanks to SVM and kernel methods, intelligent machines can now be trained to classify data sets with human precision, or at times even better, enabling them to recognize everything from voices, handwriting or faces to cancer cells or the fraudulent use of credit cards.

SVMs are now being used in genomics, cancer research, neurology, diagnostic imaging, and even in HIV drug cocktail optimization, as well as finding diverse applications in climate research, geophysics and astrophysics.

Schölkopf, Director of the Max Planck Institute for Intelligent Systems in Tübingen (Germany), has recently been employing these methods to analyze data from the NASA satellite *Kepler 2*. This has helped with the discovery of 21 extrasolar planets, including one with an atmosphere in which signs of water vapor have been detected for the first time.

In the words of one of the nominators, Martin Stratmann, President of the Max Planck Society, machine learning is a core discipline of modern artificial intelligence, consisting of "the study of how to extract patterns or regularities from empirical data." And Vapnik, Guyon and Schölkopf, he adds in his letter, are "the three scientists who have jointly shaped the field."

Machines that learn "from examples"

The three laureates coincided at America's Bell Laboratories in the early 1990s. Yet their backgrounds had little in common. Vapnik, born in 1936 in the former USSR, had worked until 1990 at the Institute of Control Sciences in Moscow, where he and his then pupil Alexey Chervonenkis – who died in 2014 – laid the mathematical foundations for automated pattern recognition methods. Vapnik is now widely recognized, the committee remarks, as "a living legend in machine learning."

Isabelle Guyon (Paris, France, 1961) was a postdoctoral researcher when she met Vapnik in 1991. Together they two would create the first proven method enabling optimal classification of data, the support vector machine. In 1994 they were joined in their efforts by one of Vapnik's doctoral students, Bernhard Schölkopf, who expanded the application range of SVMs.

For Vapnik, speaking on the phone after hearing of the award, "the main problem in artificial intelligence is how to get the machine to recognize things, how to distinguish, for instance, between men and women or between different medical diagnoses. You cannot give the machine the rule, the machine has to learn the rule. The support vector machine was developed precisely

to fulfil this condition. The aim of all these methods of machine learning is simply so the machine can learn from examples."

"Machine learning technology is the foundation of almost everything in AI-related business, and will become more and more important in future," affirms Vapnik, who confesses that he too has been greatly surprised at how much the field has expanded in the past few decades.

The awardee also recalled the initial problem that gave rise to the machine learning field "over fifty years ago," when he was asked "to solve a small, practical problem that consisted of distinguishing between oil and water, so as to achieve greater precision during prospections based on geological observations."

In search of cause-effect

Although their paths have diverged, the three laureates have continued to collaborate. Specifically, Guyon and Schölkopf are working on what is seen as one of the key problems in the area: how to identify not just statistical correlations in a forest of data but also relations of causality. Advances in this terrain could tell us, for example, whether a genetic mutation is the cause or consequence of a cancerous process.

The committee says in this respect that "Schölkopf and Guyon have independently and cooperatively advanced the science of causal discovery, uncovering cause-and-effect relationships in observed data, a problem considered by many to be unsolvable."

In conversation yesterday, Schölkopf explained how his work on causality aided in the discovery of exoplanets: "We had a causal model to distinguish between the signals coming from the star and planet, and the noise produced by the space telescope itself. With this model we managed to filter out the 'noise' and determine which signals really originated in outer space."

A fan of astronomy since childhood, Schölkopf cannot hide his satisfaction at the fact that one of the 21 exoplanets discovered with his aid lies in the habitable zone, and has been found to have water vapor in its atmosphere.

Guyon, meantime, has founded not-for-profit educational initiatives, developed crowd-sourced research and worked on the application of AI techniques to address problems in electricity transmission.

The future of AI

Both Vapnik and Schölkopf are convinced that the AI-led transformation of society is only just starting, and that many of the tasks now performed by humans will be taken over by machines. But this is not to say that machines will actually surpass us in intelligence.

"The machine can already do better than humans at recognizing things, for example, in cases of medical diagnosis or facial recognition," says Vapnik. "But for me that doesn't mean that the

machine is intelligent. Intelligence is a whole lot more, and we are only just beginning to understand what it is."

Schölkopf agrees that "we are extremely far away from a machine being more intelligent than a human being." It is true, he adds, that "in very specific applications, like playing chess or Go, or perhaps in optical recognition scenarios like the diagnosis of skin cancer, machines can do better than humans." Like Vapnik, however, Schölkopf does not believe that pattern recognition "should really be defined as intelligence," since what we are talking about is "performance in one very restricted task."

"What is interesting about our intelligence," Schölkopf continues, "is that we can play Go then get up from the table and make dinner, which a machine cannot do." By this general standard of intelligence, the German scientist insists that "machines are still much more stupid than humans." That said, advances in machine learning are compelling enough, he believes, to cause "legitimate concern that the technology may in future take some kinds of jobs away," and this is something "we should begin to think about as a society."

Laureate bio notes

Isabelle Guyon (Paris, France, 1961) graduated from the École Supérieure de Physique et Chimie Industrielles in Paris, then went on to earn a PhD in Physical Sciences at Université Pierre et Marie Curie (1988). For the next seven years she worked as a researcher at AT&T Bell Labs in New Jersey (United States). She has held teaching posts at ETH Zurich, Aix-Marseille University, New York University, the University of California, Berkeley and Université Paris-Saclay, where she is currently Professor of Big Data in the Laboratoire de Recherche en Informatique (LRI).

She created consultancy firm Coplinet in 1996 and in 2011 founded ChaLearn, to educate the public in machine learning matters by organizing challenges that attract thousands of entrants from dozens of countries, and has earned the support of the European Commission. Author of over 130 publications and co-holder of nine patents, she is an Action Editor of the Journal of Machine Learning Research and a Series Editor for Challenges in Machine Learning.

Bernhard Schölkopf (Stuttgart, Germany, 1968) studied physics, mathematics and philosophy in the universities of London and Tübingen (1988-1994), before going on to earn a PhD in Computer Science at TU Berlin in 1997. After spells as a researcher and group leader at the National Research Center for Computer Science (Berlin), Microsoft Research (Cambridge) and Biowulf Technologies (New York), in 2001 he was appointed head of the Max Planck Institute for Biological Cybernetics. He remained there until 2010, and the following year took up the post of Director at the Max Planck Institute for Intelligent Systems, where he also heads the Department of Empirical Inference.

Author of more than 460 publications, he is also an Affiliated Professor at ETH Zurich and an Amazon Distinguished Scholar. He is one of three Editors-in-Chief of the Journal of Machine Learning Research and a Series Editor of Information Science and Statistics, as well as serving on the boards of the Neural Information Processing Systems Foundation and of the International Machine Learning Society.

Vladimir Vapnik (born in the former USSR in 1936) graduated in mathematics from the Uzbek State University (1958), then went on to complete a PhD in Statistics at the Institute of Control Sciences in Moscow (1964), where he subsequently worked, rising to the Head of the Computer Science Research Department. In 1991, he moved to the United States and joined the Adaptive Systems Research Department at AT&T Bell Labs, where he would spend the next ten years. In 2002, he was recruited by NEC Laboratories to work in their Machine Learning group, and remained there until 2014.

From 1996 to 2014, Vapnik was Professor of Computer Science and Statistics at Royal Holloway, University of London. Since 2003, he has served as Professor of Computer Science at Columbia University in New York, combining this post with consulting work for Facebook AI Research. He is author of over a hundred publications summing close to 198,000 citations, with one book alone, The Nature of Statistical Learning Theory, cited more than 85,000 times.

Information and Communication Technologies committee and panel

The committee in this category was chaired by Joos Vandewalle, Honorary President of the Royal Flemish Academy of Belgium for Science and the Arts, with Ron Ho, Director of Silicon Engineering at Facebook (United States) acting as secretary. Remaining members were Liz Burd, Pro Vice-Chancellor in Learning and Teaching at the University of Newcastle (Australia), Georg Gottlob, Professor of Informatics at the University of Oxford (United Kingdom) and Vienna University of Technology (Austria), Oussama Khatib, Professor of Computer Science and Director of the Robotics Laboratory at Stanford University (United States), Rudolf Kruse, Emeritus Professor in the Faculty of Computer Science at the University of Magdeburg (Germany), and Mario Piattini, Professor of Computer Languages and Systems at the University of Castilla-La Mancha (Spain).

The evaluation support panel of the Spanish National Research Council (CSIC) was coordinated by M. Victoria Moreno, Deputy Vice President for Scientific and Technical Areas, and formed by: Carmen García García, Deputy Coordinator of the Global Area MATERIA and

research professor at the Institute of Corpuscular Physics (IFC); Luis Hernández Encinas, scientific researcher and Director of the Institute for Physical and Information Technologies "Leonardo Torres Quevedo" (ITEFI); Josep María Porta Pleite, tenured scientist at the Institute of Robotics and Industrial Informatics (IRII); Carlos Prieto de Castro, Coordinator of the Global Area MATERIA and research professor at the Institute of Materials Science of Madrid (ICMM); and Carles Sierra García, research professor at the Artificial Intelligence Research Institute (IIIA).

About the BBVA Foundation Frontiers of Knowledge Awards

The BBVA Foundation centers its activity on the promotion of world-class scientific research and cultural creation, and the encouragement of talent.

The BBVA Foundation Frontiers of Knowledge Awards, established in 2008, recognize and reward contributions of singular impact in diverse fields of science, technology, social sciences and the humanities that have demonstrably expanded the frontiers of the known world, opening up new paradigms and knowledge fields. Their eight categories are reflective of the knowledge map of the 21st century, encompassing basic research in Physics, Chemistry and Mathematics, Biology and Biomedicine, Information and Communication Technologies, Humanities and Social Sciences, Economics, Finance and Management, Ecology and Conservation Biology, Climate Change, and, within the arts, the supremely creative realm of music.

The BBVA Foundation is aided in the evaluation process by the Spanish National Research Council (CSIC), the country's premier public research organization. The Foundation and CSIC jointly appoint the evaluation support panels charged with undertaking an initial assessment of the candidates proposed by numerous institutions across the world and drawing up a reasoned shortlist for the consideration of the award committees. CSIC is also responsible for designating the chair of each committee, formed by eminent authorities in the subject area.

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LAUREATES' FIRST DECLARATIONS AND IMAGES

A recording of the laureates' first interview on receiving news of the award is available from the following FTP:

Server: 5.40.40.61 ||| Username: AgenciaAtlas4 ||| Password: mediaset17

The video is in the folder:

"**PREMIO** TECNOLOGÍAS DE LA INFORMACIÓN Y LA COMUNICACIÓN"

In the event of connection difficulties, contact Miguel Gil at production company Atlas:

Mobile: +34 619 30 87 74 ||| Email: mgil@mediaset.es

Calendar of announcement events

Basic Sciences	Tuesday, 3 March, 2020
Economics, Finance and Management	Tuesday, 17 March, 2020
Music and Opera	Tuesday, 31 March, 2020
Humanities and Social Sciences	Wednesday, 15 April, 2020

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For more information on the BBVA Foundation, visit: www.fbbva.es