Fundación **BBVA**

2010 **BBVA** Foundation Frontiers of Knowledge Awards

CSIC
Consejo Superior de Investigaciones Científicas

PRESS RELEASE

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This is the third edition of the Frontiers awards, with 3.2 million prize money distributed across eight categories

Mathematician Donald E. Knuth takes the BBVA Foundation Frontiers of Knowledge Award for "making computing into a science"

- His work was instrumental in creating the computer science field; his contributions mark him out as "a giant among giants".

- Knuth's book *The Art of Computer Programming* systematizes the way that human beings talk to machines. A landmark publication, its first volume dates back to 1968. And he is still working on it today.

- The BBVA Foundation Frontiers of Knowledge Awards, established in 2008, recognize world-class research and artistic creation. Their eight categories reflect the main scientific, technological, social and economic challenges of the present day.

January 18, 2011.- The BBVA Foundation Frontiers of Knowledge Award in the Information and Communication Technologies category goes in this third edition to U.S. mathematician Donald E. Knuth, for "making computing a science by introducing formal mathematical techniques for the rigorous analysis of algorithms", in the words of the prize jury.

"He brought elegance into programming", the citation continues, "by advocating for code that is simple, compact and intuitively understandable."

Knuth's book *The Art of Computer Programming* "is considered the seminal work on computer science in the broadest sense, encompassing the algorithms and methods which lie at the heart of most computer systems, and doing so with

uncommon depth and clarity" the jury affirms. "His impact on the theory and practice of computer science is beyond parallel."

Knuth laid the foundation for modern compilers, the programs which translate the high-level language of programmers into the binary language of computers. Programmers are thus able to write their code in a way that is closer to how a human being thinks, and their work is then converted into the language of machines.

The new laureate is also the "father" of the analysis of algorithms, that is, the set of instructions conveyed to a computer so it carries out a given task. "Algorithms", as the jury clarifies, "are at the heart of today's digital world, underlying everything we do with a computer". Knuth systematized software design and "erected the scaffolding on which we build modern computer programs".

Knuth is also the author of today's most widely used open-source typesetting languages for scientific texts, TeX and METAFONT. These two languages, in the jury's view, "import the aesthetics of typesetting into a program which has empowered authors to design beautiful documents".

Volume 4A arrives today

Donald Knuth (1938, Wisconsin) has since 1993 served as Professor Emeritus at Stanford University (United States), which he joined as a professor at the age of thirty. Officially retired, he still devotes much of his time to the monumental *The Art of Computer Programming*, a series he began work on in 1962 with three volumes published to date – in 1968, 1969 and 1973. Coincidentally, volume 4A of the series has just come off the press and Knuth hopes to receive his copy today, as he remarked during the phone conversation when he was informed of the Frontiers award.

The jury chair, Andrea Goldsmith, unveiled the name of the new laureate at an announcement event in the Marqués de Salamanca Palace, the Madrid headquarters of the BBVA Foundation, where she was accompanied by the Foundation's Director, Rafael Pardo, and Juan José Damborenea, Assistant Vice-President of Scientific and Technical Areas at the Spanish National Research Council (CSIC).

Knuth's nomination was put forward by John L. Hennessy, President of Stanford University, and endorsed by professors Richard Karp (University of California at Berkeley, United States); Philippe Flajolet of the Institut National de Recherche en Informatique et en Automatique (INRIA, France); Kurt Mehlhorn (Max Planck Institute, Germany); Christos Papadimitriou (University of California at Berkeley, United States); Robert Tarjan (Princeton University, United States); Leslie Valiant (Harvard University, United States), and Andrew Yao (Tsinghua University, China).

"The Art of computer programming": a life's work

Knuth's devotion to his work is so all-absorbing that he avoids any kind of distraction, including e-mail. He states this plainly on his website: "I have been a happy man ever since January 1, 1990, when I no longer had an e-mail address. (…) What I do takes long hours of studying and uninterruptible concentration. I try to learn certain areas of computer science exhaustively; then I try to digest that

knowledge into a form that is accessible to people who don't have time for such study."

Talking on the phone yesterday, he offered some insights into his work: "it is basically about finding a way to sort out the things that are going to last a long time (in computer science) instead of changing rapidly". For example, "the Internet changes dramatically every month, but still there are things that are happening now that are going to be important 50 years on, and my job is to find out what they are".

Knuth's distinctive personality is well known in the scientific community. As a child he played with this father's calculators – Knuth senior was a high school book-keeping teacher – struggling to find the square root of 10 by trial and error. But later, studying at the Lutheran College in Milwaukee, the teenage Knuth did not feel particularly drawn to mathematics, and in fact was concerned that his far-from-brilliant subject grades would keep him out of university. This evidently ungrounded fear was rooted in what he now admits was an inferiority complex, which obliged him to work double: he got into Case University with the best grades then on record. And it was there that one of his teachers won him over to mathematics at the expense of physics – Knuth, it seemed, was not cut out to be an experimental scientist.

Against the advice of his professors

His first encounter with a computer, an IBM650, was while doing a summer job. The machine so impressed him that Knuth later offered it a dedication in one of his works "in memory of many pleasant afternoons". Ignoring the pleas of his professors, who could not see any kind of future in computers, Knuth spent sleepless nights in front of the IBM650, mesmerized, as he puts it, by its lights. Not long after, he constructed a formula for the value of each player that could help his school basketball team win the league. This was so novel a proposition at the time that it got picked up and published by the national press.

In 1963, he obtained a PhD in Mathematics from the California Institute of Technology and began to work there as associate professor. By that time, he had accepted a commission to write a book on compilers, which would later become the multi-volume *The Art of Computer Programming*.

Computer science was then taking its first, hesitant steps. "It was a totally new field", Knuth recalls, "with no real identity. And the standard of available publications was not that high (…). A lot of the papers coming out were quite simply wrong. (…) So one of my motivations was to put straight a story that had been very badly told".

The difference between science and art

Why did I choose the word 'art' for the title? "Art means something artificial, devised by human beings rather than by Nature, but it also means a work of beauty. What I want is to create something of beauty: that a computer program

has style and elegance and communicates well. Good programs should also be well written", he remarked yesterday.

"I have this sort of statement: the difference between science and art is that science is something that we understand well enough to explain it to a computer, and art is everything else".

The reason it took so long to complete *The Art of Computer Programming* is that "there are so many new things being discovered. There is an enormous amount of material that I think is always going to be important".

Despite being a founder member of one of the boom fields of the past decades, Knuth has not lost his sense of wonder: "Everything about computers today surprises me, there wasn't a single thing that I could have predicted 30 years ago."

International jury

The jury in this category was chaired by **Andrea Goldsmith**, Professor of Electrical Engineering at Stanford University (United States), with **Ramón López de Mántaras**, Director of the Artificial Intelligence Research Institute of the Spanish National Research Council (CSIC), acting as secretary. Remaining members were **Ronald Ho**, Distinguished Engineer and Director of the VLSI Research Project at Oracle Laboratories (United States); **Oussama Khatib**, Professor of Computer Science in the Artificial Intelligence Laboratory of Stanford University (United States), and **Nico de Rooij**, Director of the Institute of Microengineering at the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland.

The awardees in the two previous editions in the ICT category were Israeli Jacob Ziv, whose work enabled the compression of the data, text, image and video files used in today's personal computers; and U.S. engineer and mathematician Thomas Kailath, for a development permitting the production of increasingly small size chips.

The BBVA Foundation Frontiers of Knowledge Awards honor world-class research and artistic creation across eight prize categories. Their uniqueness lies in their close alignment with the scientific, technological, social and economic challenges of the present century.

UPCOMING AWARD ANNOUNCEMENTS

CATEGORY	DATE
Basic Sciences	Thursday, January 27, 2011
Biomedicine	Friday, February 4, 2011
Ecology and Conservation Biology	Wednesday, February 8, 2011
Contemporary Music	Tuesday, February 15, 2011
Economics, Finance and Management	Wednesday, February 16, 2011

The BBVA Foundation supports knowledge generation, scientific research and the promotion of culture, relaying the results of its work to society at large. This effort materializes in research projects, human capital investment, specialization courses, grants and awards. Among the BBVA Foundation's preferred areas of activity are basic sciences, biomedicine, ecology and conservation biology, the social sciences and literary and musical creation.

A video recording of the new laureate's first impressions on receiving news of the award is available from the Atlas FTP with the following coordinates:

Server: **213.0.38.61**
Username: **agenciaatlas1**
Password: **amapola**

The name of the video is: Premio Fronteras TIC

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