CAST Newsletter

Special Issue

2024 International Congress on Basic Science advances science for humanity

Headlines

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Plenary session of the 2024 ICBS
Photo credit: Official WeChat account of ICBS

From July 14 to 26, the 2024 International Congress on Basic Science (ICBS) was held in Beijing, organized by the China Association for Science and Technology (CAST), the Ministry of Science and Technology of China, the International Consortium of Chinese Mathematicians (ICCM), and other groups. Under the theme "Advancing Science for Humanity," the congress attracted over 1,000 scientists from more than 40 countries and regions to focus on three key branches of basic science: mathematics, theoretical physics, and theoretical computer and information sciences. The program featured over 500 high-level lectures, six satellite meetings, more than ten exchange events, and various science outreach activities.

The congress presented the 2024 Basic Science Lifetime Achievement Award (BSLA) and the Frontiers of Science Award (FSA) to scientists who made outstanding contributions to basic science. BSLA recipients included six outstanding contemporary scientists: Andrew Wiles of the University of Oxford, Richard Hamilton of Columbia University, Edward Witten of the Institute for Advanced Study at Princeton, Alexei Kitaev of the California Institute of Technology, Andrew Chi-Chih Yao of Tsinghua University, and Leslie Valiant of Harvard University.

Also, 139 top research papers from universities, research institutions, and companies in more than 20 countries and regions were selected for the FSA. These included 88 papers in mathematics, 24 in theoretical physics, and 27 in theoretical computer and information sciences.

ICBS also provided an interactive platform for young scholars, students, and science enthusiasts. A series of special events took place during the congress including three salons—Evening of Mathematics, Evening of Physics, and Evening of Computer Science—at which several international award winners discussed cutting-edge scientific topics. At the "Dialogue with Scien-

tists" event, exceptional young individuals found the chance to engage in close conversations with leading scientists. Two poster sessions showcasing the achievements of Chinese university and high school students were also held, offering international scholars a direct look at the innovative work of China's youth.

A look back at the inaugural ICBS

The first International Congress on Basic Science, held at the newly completed Tsinghua Xuetang from July 16 to 28, 2023, was organized by CAST, the Ministry of Science and Technology of China, ICCM, and others under the theme "Advancing Science for Humanity." It brought over 300 international scientists from more than 40 countries and regions together, including nearly 80 of the world's leading experts, many of whom hold prestigious awards such as the Nobel Prize, Fields Medal, A.M. Turing Award, Wolf Prize, Shaw Prize, and Breakthrough Prize. The event was also attended by academics and representatives of major international academic organizations. With a strong emphasis on openness, trust, and cooperation, the first ICBS established a new platform for academic exchange, promoting greater openness and cooperation in basic science research in China.

(Sources: gmw.cn and the official WeChat account of ICBS)

Dialogues with Scientists

A.M. Turing Award laureates gather in Beijing to explore frontiers of computer science

At the 2024 ICBS, the A.M. Turing Award winners in theoretical computer and information science including Andrew Chi-Chih Yao and Leslie Valiant delivered compelling talks. They shared cutting-edge research findings and academic insights in the field of computer science.

"Educability" as core capability behind humanity's development of complex civilizations

On July 16, the A.M. Turing Award-winning computer scientist Leslie Valiant delivered a lecture titled "The Importance of Being Educable" in which he explored the fundamental capability that empowered humans to build complex civilizations. He introduced the concept of "Educability," offering it as a key explanation for humanity's unique achievements.

Valiant argued that the term "intelligence" lacks the behavioral specificity needed to explain human

Leslie Valiant during his presentation
Photo credit: Official WeChat account of ICBS

development and that it isn't computationally feasible in its current form. To address this, he proposed "Educability"—a capability that involves learning from experience, learning from others, and integrating these forms of learning to apply knowledge effectively in various situations.

He broke down "Educability" into three components: first, acquiring beliefs and knowledge through inductive reasoning from experience similar to the "Probably Approximately Correct (PAC)" model used in machine learning; second, applying this acquired knowledge to specific scenarios; and third, gaining knowledge through descriptions and instruction from others. These combined abilities enable humans to continuously progress and develop advanced technologies and sciences.

Valiant highlighted the performance of large-scale language models in generating coherent text as an example of how computational tasks can simulate certain human capabilities. However, he pointed out that current machine learning models excel primarily at learning from examples and do not capture the full spectrum of human abilities. The concept of "Educability" thus aims to broaden the scope of computational models, offering a more comprehensive simulation and understanding of human potential.

In concluding his lecture, Valiant proposed six research directions rooted in the concept of "Educability." He emphasized that better understanding human abilities through computational models could set the stage for future technological advancements and provide a more scientific basis for educational practices.

Importance of asking good questions in computer science

On July 15, A.M. Turing Award winner in 2000 and computer scientist Andrew Chi-Chih Yao delivered a presentation titled "Building Computer Science by Asking Good Questions." In
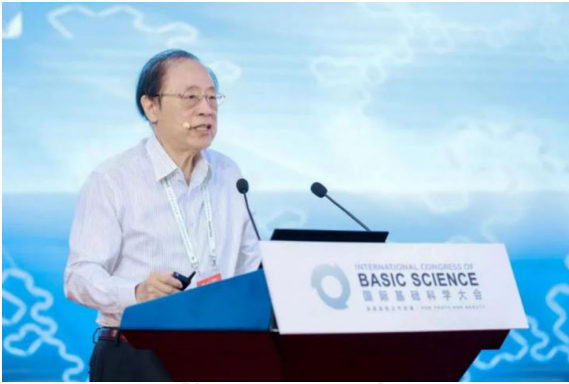
Andrew Chi-Chih Yao during his presentation
Photo credit: Official WeChat account of ICBS

his talk, Professor Yao explored the critical role that asking the right questions plays in scientific research, particularly in the field of computer science, through examples from various disciplines.

Professor Yao emphasized that the advancement of science is deeply intertwined with the formulation and resolution of questions. He noted that innovative and thought-provoking questions often lead to new theories and conjectures, revealing connections between seemingly unrelated problems. To differentiate between the discovery of natural phenomena and the exploration of new applications in scientific research, he quoted writer George Bernard Shaw: "You see things; and you say, 'Why?' But I dream things that never were; and I say, 'Why not?'"

Yao suggested that asking good questions is the driving force behind significant innovations and breakthroughs. He pointed to the inventions of flight, sound recording, and antibiotics as examples—all of which originated from profound questioning. He also discussed the work of renowned physicist James Clerk Maxwell on the stability of Saturn's rings, demonstrat-

ing how a well-posed question can propel scientific exploration. Maxwell's theory, which was eventually validated, underscores the enduring value of scientific inquiry.

In the field of cryptography, Yao introduced the Multi-Party Computation (MPC) model, which focuses on privacy-preserving joint computation. He cited the "Millionaire's Problem" to demonstrate how two individuals can compare wealth without revealing private information. Yao also delved into the concept of communication complexity, explaining how minimizing communication costs can enhance the efficiency of distributed computing. He provided specific examples to show the profound impact of communication complexity in both practical and theoretical contexts, underscoring its importance in the study of computational complexity.

In conclusion, Yao reflected on the evolution of artificial intelligence since the Turing Test was proposed. He pointed out that the questions and challenges posed by the Turing Test have continually driven progress in the AI field. Recent breakthroughs in deep learning, particularly in areas such as image recognition, Go, and protein folding, suggest that AI is approaching the capability to pass the Turing Test. Yao urged computer scientists to continue asking and exploring new questions to further advance the fields of artificial intelligence and computer science.

(Source: Official WeChat account of ICBS)

Event Highlights

Evening of Computer Science discusses the finite and infinite in AI

Roundtable session of the Evening of Computer Science
Photo credit: Official WeChat account of ICBS

On July 17, the Evening of Computer Science was held as part of the 2024 ICBS, attracting numerous experts, scientists, industry representatives, and university faculty and students from the field of computer science. The event focused on the current state and future of artificial intelligence, highlighting the latest advances and facilitating meaningful exchange between the international academic and industrial communities.

The roundtable session featured six distinguished guests: Fields Medalist Shing-Tung Yau, A.M. Turing Award winner Leslie Valiant, Distinguished Tencent Scientist Liu Wei, JD.com Group Vice President He Xiaodong, Distinguished Google Research Scientist Moti Yung, and Distinguished Scientist at Microsoft Research AI for Science Tie-Yan Liu. Their in-depth dialogue explored the prospects and challenges of AI technology, providing participants a platform for thoughtful reflection and exchange while fostering a deeper understanding of AI's potential and risks.

During the discussion, Tie-Yan Liu empha-

sized that AI is bringing profound changes across various industries, noting that it has evolved from a laboratory experiment to a practical tool capable of transforming lives and industries. Leslie Valiant predicted that AI technology would permeate all aspects of life, presenting significant opportunities but also amplifying potential risks. Shing-Tung Yau expressed cautious optimism about the current contributions of AI and acknowledged its enormous potential in many areas.

In addition to the roundtable, experts from renowned universities and research institutions around the world presented cutting-edge technology. Ravi Ramamoorthi, an Association for Computing Machinery (ACM) fellow and professor at the University of California, San Diego, demonstrated a new method his team has developed to create immersive scenes from a few irregularly sampled images. Qiu Jiezhong, a ZJU100 Young Professor at Zhejiang University-Zhejiang Lab, presented research on Graph Contrastive Coding (GCC). David Brady from the University of Arizona presented multi-scale gigapixel photography technology and its applications, and Li Xiaolei, a PhD student at the Graphics and Geometric Computing Group of Tsinghua University, presented research on complex scene generation, proposing a method for "object decoupling and interactive modeling."

(Source: Official WeChat account of ICBS)

Fundamental Science Panel Discussions address broad range of issues

As part of the Tsinghua University Special Event on July 20 during the 2024 ICBS, the Fundamental Science Panel Discussions (71st and 72nd "Top Talk") were held at the Tsinghua University Auditorium. The forum brought nine of the world's leading scholars in physics and mathematics together.

Panel Discussions in Physics
Photo credit: Official WeChat account of ICBS

At the Fundamental Science Panel Discussions on Physics, the participants delved into topics such as

"Future Development and Potential Research Directions in Theoretical Physics," "The Impact of Technological Advances on Physics," "The Interrelation between Physics and Mathematics," and "Overlooked Areas in Theoretical Physics."

Panel Discussions on Mathematics
Photo credit: Official WeChat account of ICBS

Similarly, the Panel Discussions on Mathematics covered a range of topics including "The Journey of Conducting Mathematical Research," "Key Directions for the Future Development of Mathematics," "Interdisciplinary Interaction in Geometric Research," and "Academic Advice for Young Students."

When asked for advice for students just beginning their academic journey, Professor Caucher Birkar from the Yau Mathematical Sciences Center (YMSC) at Tsinghua University emphasized the importance of discovering and pursuing one's passion. He also noted that mentorship becomes crucial in graduate school. Wolf Prize laureate Richard Schoen advised undergraduates to balance the depth and breadth of their studies, encouraging them not only to refine their mathematical skills but also to explore other disciplines such as physics, chemistry, and biology. Yau Shing-Tung, ICBS President and a Fields Medalist, urged students to master analytical tools while gaining a deep understanding of the intersections between mathematics and other fields. He also stressed the importance of being bold in asking questions and honing the skill on how to ask them.

(Source: Official WeChat account of ICBS)

ICBS popular science book introduction session

On July 20, the Yau Mathematical Sciences Center (YMSC) of Tsinghua University and the CAST Children & Youth Science Center (CYSC) jointly hosted a science book introduction session at Tsinghua University. The event featured presentations by three distinguished scientists: A.M. Turing Award winner Leslie Valiant, Dirac Medal winner Cumrun Vafa, and Hirosi Ooguri, a fellow of the American Academy of Arts and Sciences (AAAS) and a renowned

Q&A during the book introduction
Photo credit: cn.chinadaily.com.cn

popular science writer. Each expert delivered a captivating lecture and engaged in interactive discussions with students.

Cumrun Vafa shared insights from his popular science book *Puzzles to Unravel the Universe*. Using vivid examples, he explained the deep connections between the mysteries of the universe and mathematical physics and encouraged students to read more and explore the relationships between different disciplines. Leslie Valiant discussed the key concepts of his book *The Importance of Being Educable*, advocating for the development of a broader and clearer cognitive framework to advance education and technology. Hirosi Ooguri surveyed his popular science books including *What is Gravity?*, *Superstring Theory*, and *Spirit of Inquiry*. Through engaging and entertaining examples, he shined light on the wonders of science, sparking students' curiosity and desire to explore the world of science.

(Source: cn.chinadaily.com.cn)

ICBS Basic Sciences and Artificial Intelligence Forum

On July 21, the 2024 ICBS Basic Sciences and Artificial Intelli-

Panel discussion of the forum
Photo credit: Official WeChat account of Qiuzhen College

gence Forum, organized by Tsinghua University's Qiuzhen College and the China Communication Center for Science and Technology (CCCST), was held at the National Science Communication Center for Science and Technology.

The forum featured a lineup of prominent scientists including Hirosi Ooguri, a fellow of the American Academy of Arts and Sciences (AAAS) and the American Mathematical Society (AMS), and a professor at the California Institute of Technology; Guo Yike, a fellow of the Royal Academy of Engineering (FREng), a member of Academia Europaea (MAE), and a fellow of the Hong Kong Academy of Engineering Sciences (FHKEng); He Xiaodong, an IEEE fellow, Vice President of JD.com Group, Director of JD Explore Academy, and affiliate professor of ECE at the University of Washington; Ma Yi, a fellow of IEEE, ACM, and SIAM, and Chair Professor at the Department of Computer Science at the University of Hong Kong; and Rui Yong, a member of Academia Europaea and a fellow of several prestigious organizations including ACM, IEEE, IAPR, and the China Computer Federation. During the forum,

the distinguished experts shared insights on how to address the hallucination problem in large language models and whether the boundaries of these models can be understood from a mathematical perspective. They highlighted the current challenges in clearly defining many concepts and problems in artificial intelligence, emphasizing the importance of theoretical research. They also encouraged young students to seize this unique historical moment and contribute to solving these critical issues to position themselves as the heroes of our time.

(Source: Official WeChat account of Qiuzhen College)

Yanqi Lake Mathematics Museum opens

Photos of the Fields Medalists
Photo credit: Official WeChat account of ICBS

On July 15, the Yanqi Lake Mathematics Museum, located in Huairou Science City, Beijing, officially opened its doors. A highlight of the 2024 ICBS, the new museum is dedicated to the development and legacy of mathematics, showcasing the academic achievements and life stories of outstanding mathematicians from both China and around the world.

"Mathematicians do not aspire for wealth or a thousand-year legacy, as these are all destined to turn to ashes," said Shing-Tung Yau, the museum's principal planner and chair professor at Tsinghua University. "What we seek is the eternal truth. Our passion lies in theory and equations. They are more valuable and genuine than gold, because they represent the unique way in which nature expresses itself. They are more splendid and captivating than poetry. They are the wellspring of all applied sciences and can shape the foundation of modern society."

The museum features a dynamic panorama of the history of mathematics that empowers visitors to become immersed in the enchantment of mathematics.

The Yanqi Lake Mathematics Museum has five main exhibition areas on two floors: "Four Major International Mathematical Awards," "32

Mathematicians Who Influenced the World," "International Congress of Basic Science," "Map of Mathematicians," and "Contemporary Development of Mathematics in China." These exhibits provide a comprehensive overview of the development of mathematics in China and internationally, highlighting the academic achievements of world-renowned mathematicians and their pursuits of truth and beauty.

(Source: Official WeChat account of ICBS)

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