- Caltech's president preps for transition
- Solid, liquid, or both?
- Superbugs, big personalities, and more

Computer, Start Your Engine

Caltech has a long history of success in out-of-the-ordinary car races. In the Great Electric Car Race of 1968, Caltech's battery-powered Volkswagen bus beat MIT's plug-in Chevy Corvair in a cross-country contest. In 1987, Caltech's Sunraycer won the World Solar Challenge, the first-ever race featuring solar-powered cars.

Now, the Institute can add another achievement to its list. In January 2025, the Caltech Autonomous Systems and Technologies (CAST) Racer made its debut by competing in the Indy Autonomous Challenge (IAC) at the Las Vegas Motor Speedway.

The Caltech racer—an IAC AV-24 IndyCar retrofitted with autonomy hardware and Caltech's control algorithms that allow for autonomous engine/brake control, steering, and navigation—reached a top speed of 155 miles per hour and an average lap speed of more than 144 miles per hour. The roughly 10-person CAST team comprised faculty members, students, postdocs, and staff who notched the impressive high-speed record even though they only formed the full team and started testing in October 2024.

"We are happy with what we achieved because it set a good baseline, so that we can incorporate our advanced autonomy and AI-based software in the next competition. It has taken other teams a few years to reach that speed," says Soon-Jo Chung, the CAST Racer's team leader, Caltech's Bren Professor of Control and Dynamical Systems and a senior research scientist at NASA's JPL, which is managed by Caltech.

Also competing in the race were teams from UC Berkeley, Purdue University, the University of Virginia, Auburn University, Indiana University, Italy's Polytechnic University of Milan and the University of Modena and Reggio Emilia, as well as the Korea Advanced Institute of Science and Technology.

continued on page 6

Computer, Start Your Engine

continued from page 5

Every team in the competition received a functional drive-by-wire IndyCar that they could program for high-speed autonomous driving. After Caltech's IndyCar was delivered in September, the CAST team installed and tested its autonomous driver system, which analyzes data from onboard technology that includes two GPS systems, three LiDAR (Light Detection and Ranging) sensors, inertial measurement units, two radar sensors, and six color cameras.

"With such a high-speed racer, every worst-case scenario for AI-based software is amplified, like road-induced perturbations and turbulence," Chung says. "Everything becomes more challenging. For example, we actually experienced strong winds in Las Vegas, which blew over our heavy monitors and desks. Our racer is best equipped to handle such challenging perturbations because we can utilize our prior machine-learning-based core algorithms to make control decisions a lot faster and safer."

Though the racer was fully autonomous during the competition, autonomous driving is built on human skills, particularly in the areas of data collection and AI software refinement. Caltech staff scientist Matt Anderson, who helped develop the AI software and manage the team, steered the racer during the team's test-drive days on the track. Anderson would ride in the passenger seat of a chase car and assume control of the million-dollar CAST vehicle when it encountered any sudden problems. He did so with a very familiar piece of equipment.

"I drive it with a small Xbox controller," Anderson says. "I've been using one since my parents let me play video games, so I have 30-plus years of experience with it."

The project is also co-led by two other Caltech faculty members, Fred Hadaegh, research professor in aerospace and a senior research scientist and technical fellow at JPL, as well as Mory Gharib, the Hans W. Liepmann Professor of Aeronautics and Medical Engineering, director and Booth-Kresa Leadership Chair of CAST, and director of the Graduate Aerospace Laboratories of the California Institute of Technology. Funding was provided by CAST, Beyond Limits (a Caltech/JPL spinout), and Aramco, among others.

Next up for the CAST Racer is a competition at the WeatherTech Raceway Laguna Seca in Salinas, California, in July 2025.

LA Fires: What Comes Next?

"We know about the problems we face immediately after the disaster. We have to clean out the waste and see what structures can be rebuilt. But we also have to rebuild community, rebuild the businesses. Small businesses are essential to a community. The restaurants and the other types of retail—they are part of who we are and why we feel like we belong in a certain place. Some of them burned. They will try to figure out how to rebuild. But there are a lot of others that weren't burned but are losing their customers—people who can't live here right now, who are busy with recovery, or who are freaked out and start shopping somewhere else. An important piece to a successful recovery is to support those businesses and keep our community alive."

– **Lucy Jones,** a visiting associate in geophysics at Caltech and founder of the Dr. Lucy Jones Center for Science and Society, on community recovery following the LA fires.

Rosenbaum to Retire as President

Thomas F. Rosenbaum, the Sonja and William Davidow Presidential Chair and ninth president of Caltech, will retire on June 30, 2026, after 12 years in the position. He will remain at the Institute as a member of the physics faculty. Under Rosenbaum's leadership, Caltech more than doubled its endowment and completed a historic capital campaign, *Break Through*, that raised $3.4 billion; instituted programs to enhance students' educational and co-curricular experiences and make a Caltech education more affordable; and strengthened NASA's Jet Propulsion Laboratory, which is managed by the Institute.

Rosenbaum ensured that Caltech researchers had the resources and freedom to create, experiment, and define new areas of inquiry, leading to innumerable accomplishments, including the 2015 observation of gravitational waves; the demonstration of the first wireless transmission of power in space, which also led to detectable power being beamed to Earth for the first time; the development of a new type of vaccine that protects against the COVID-19 virus and closely related viruses; and the launch of landmark missions by JPL to study the early history of the universe (SPHEREx) and our closest planetary neighbor (the Mars 2020 Perseverance Rover). During Rosenbaum's tenure, three Caltech faculty members were awarded the Nobel Prize (two of whom were honored in 2017 for the detection of gravitational waves). Institute researchers have also received the National Medal of Science, the Breakthrough Prize, the Kavli Prize, MacArthur Fellowships, and other significant honors.

Rosenbaum also guided the Institute through historic challenges, including the COVID-19 pandemic, a reconsideration of Caltech's admissions practices and the co-curricular student experience, reflection on the Institute's past, public doubts about the value of science, and the devastating Los Angeles fires.

"The path forward has not always been easy or straightforward," Rosenbaum said in a letter to the Caltech community on April 7, 2025, announcing his retirement. "At the same time, these challenges have underscored the value of the skills that we teach to advance societal well-being, educate an involved citizenry, and improve people's lives. … Caltech boasts a solid financial footing, remarkable new research and educational facilities, and, most importantly, the capacity to recruit and sustain the brightest and most innovative individuals from every walk of life and from every corner of the world."

Object Lesson:
Polycatenated Architected Materials

Squishy, shear resistant, and solid as a rock? Though it might seem impossible for a material to possess all three of these characteristics at once, that is the case for a new type of matter known as polycatenated architected materials (PAMs). Developed in the lab of Caltech's Chiara Daraio, the G. Bradford Jones Professor of Mechanical Engineering and Applied Physics and a Heritage Medical Research Institute Investigator, PAMs respond to some stresses as a fluid and to others like a solid. They were designed to replicate lattice structures found in crystalline substances, but fixed particles were replaced by entangled rings connected in a stable geometric pattern, similar to chain mail. Because the rings slide against one another when they are not under pressure, they slide into a beaker like a liquid. But when these structures are compressed, they may become fully rigid, behaving like solids. These lattices were 3D printed using a variety of materials, including acrylic polymers, nylon, and metals. Researchers believe PAMs could be used to make helmets and other protective gear as well as biomedical devices and robots.

After the Fires

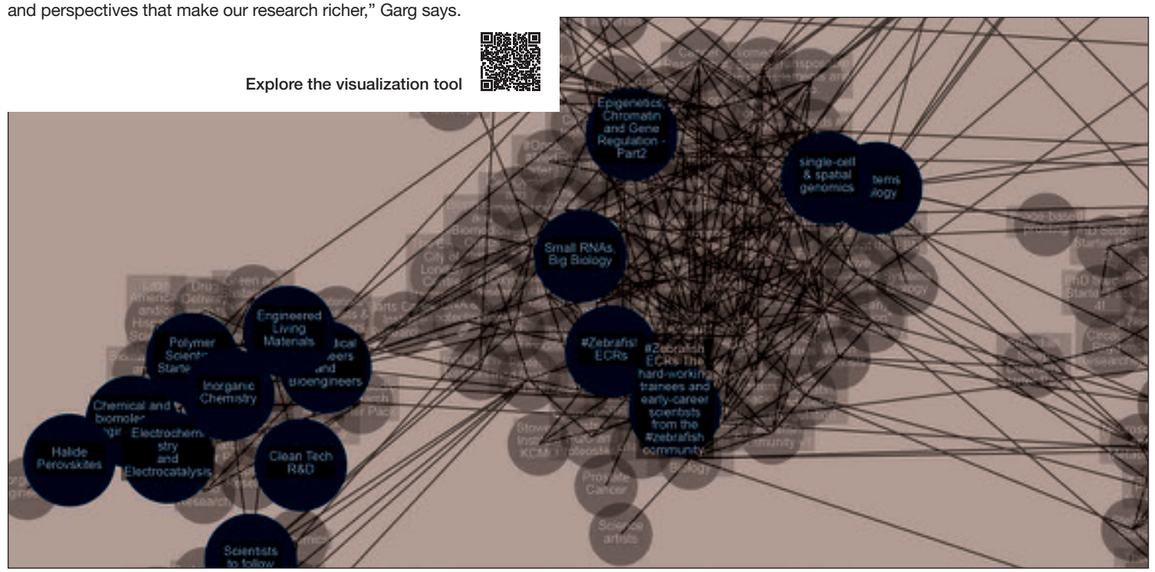
The Caltech Science Exchange launched a limited-series podcast, *After the Fires,* to highlight what Institute scientists and engineers have learned about the burn zones following the Los Angeles wildfires in January 2025. Since the disaster, researchers from Caltech have deployed sensors to collect information on air quality, tested samples of soil and ash from the burn zone and beyond, monitored debris-flow models that predict areas of concern, studied how the mountains react to rains after fires, and contributed to conversations about community resilience and rebuilding.

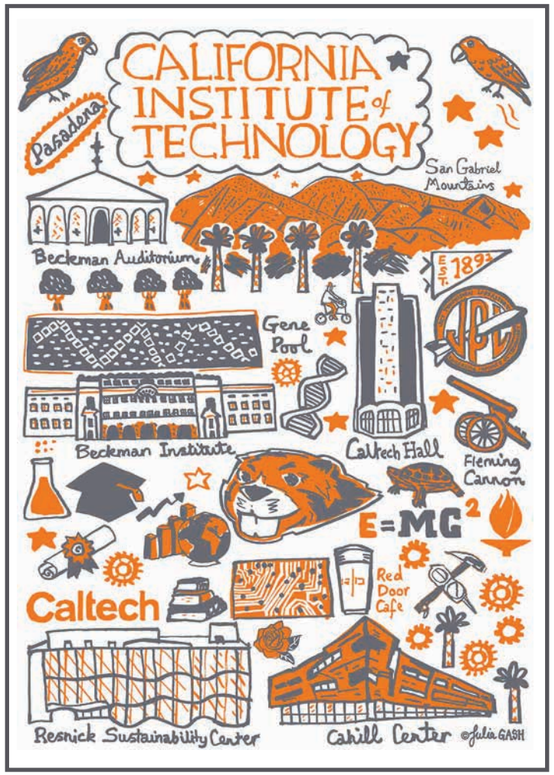
Listen to After the Fires for free via Apple Podcasts, Spotify, or your favorite podcast app. For more on Caltech's fire-related research, see page 32.

Visualizing Academic Communities

Research thrives on the exchange of ideas across disciplinary communities, including those at Caltech. Social media can help those groups grow and build new bonds. Ketika Garg, a postdoctoral scholar working on social behavior and social media, wanted to examine these interactions more closely, so she built a tool that visualizes how academic communities connect with one another on BlueSky. The orange nodes in the image below represent BlueSky "starter packs" (lists of accounts related to a topic) that include members of the Caltech community. Connection lines denote how many members the nodes share. "The science we do on a specific topic, in a specific subdiscipline, is part of a much bigger human endeavor with cross-cutting ties and perspectives that make our research richer," Garg says.

Explore the visualization tool





Buy it here

Fire Relief Merchandise

New merchandise featuring a hand-drawn illustration of iconic Caltech and Pasadena symbols by artist Julia Gash can be purchased from the Caltech Store. Fifty percent of the proceeds will go toward the Caltech and JPL Disaster Relief Fund to assist community members impacted by the LA fires.

Early Eruption Warning

The Reykjanes Peninsula at Iceland's southwestern edge is one of the country's most populated regions, and it is also one of the most volcanically active. In 2024, sensing technology developed in Zhongwen Zhan's lab at Caltech was deployed in the region to study the motion of subsurface magma and its eruption into lava on the surface. Using data from the technology, called distributed acoustic sensing (DAS), researchers developed a method to provide warnings up to 30 minutes in advance of lava eruptions. DAS works by pointing lasers into unused underground fiber-optic cables. The image on the right shows an eruption on the peninsula that started on November 25, 2024.

"We run some of the best seismic networks in the world. The Southern California Community Seismic Network (SCSN) runs throughout the region and contains over 500 seismometers. We're planning on adding to networks like these with even more precise tools to measure seismic waves. For example, my laboratory has been developing a method to repurpose telecommunications fibers as a dense array of seismic sensors. With these, we can improve the resolution of measuring earthquakes.

We've also been applying AI to extract information about earthquakes more quickly to better characterize patterns. There is also a lot of work on using both better satellite observations and better computational tools to extract more information from the data."

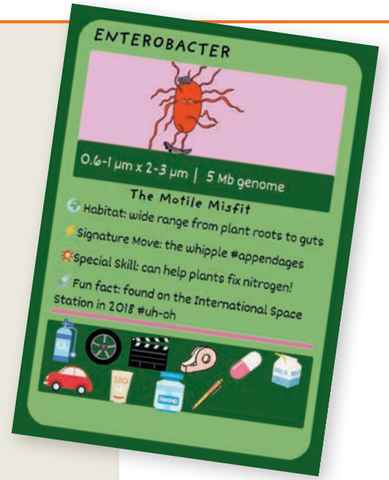
–Professor of Geophysics Zhongwen Zhan (PhD '14), who began a five-year term as the Clarence R. Allen Leadership Chair and director of the Caltech Seismological Laboratory in February, discusses some of what is in store for the lab going forward.

Read more

Which Stealthy Superbug Are You?

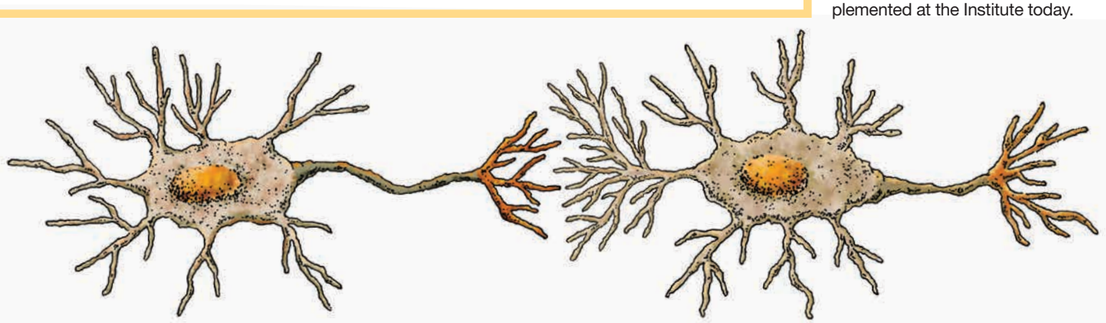
Superbugs are pathogens that have acquired resistance genes, making them difficult to treat with antibiotics. Smruthi Karthikeyan, the Gordon and Carol Treweek Assistant Professor of Environmental Science and Engineering and a William H. Hurt Scholar, together with her team, studies these tiny organisms in their natural ecosystems to develop new ways to fight infections. As part of Karthikeyan's Watson Lecture on April 23, 2025, titled "The Secret Life of Superbugs: How Antimicrobial Resistance Moves Between Humans and the Environment," graduate student Grace Solini (below left) created a quiz for guests to find out which superbug best matches their own personality, featuring artwork by her lab mate Sarah Garzione (below right), a grad student in the Caltech–Kaiser Permanente Bernard J. Tyson School of Medicine MD–PhD program.

Take the quiz



Making the Connection: Neurons and AI

The human brain contains approximately 86 billion neurons, which are the primary cells responsible for receiving and sending signals throughout the brain and nervous system. In 1982, John Hopfield, then a professor of biology and chemistry at Caltech, wrote a seminal paper describing how an artificial neural network, modeled after the structure of the brain, could be programmed to learn and to recall. Beginning on **page 15,** find out how the research of Hopfield and others led to the creation of some of today's most popular AI tools, such as ChatGPT, and discover how AI is being studied, engineered, and implemented at the Institute today.



Julian Navarro (fourth-year undergraduate student)

#SoCaltech *is an occasional series celebrating the diverse individuals who give Caltech its spirit of excellence, ambition, and ingenuity. Know someone we should profile? Send nominations to* ***magazine@caltech.edu.***

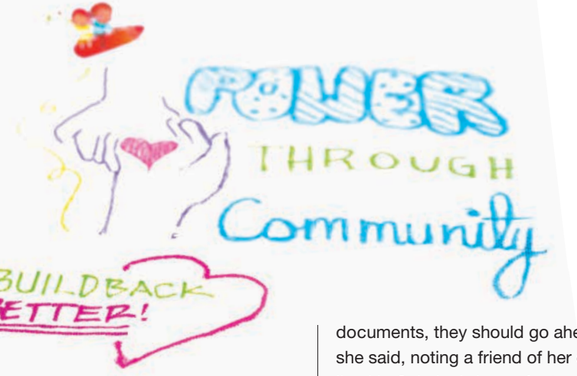
Navarro is a fourth-year computer science major from San Juan, Puerto Rico. After working as a teaching assistant in 2023 with the First-Year Success Research Institute (FSRI), Navarro co-founded CS Careers @ Caltech, a club that helps students network with recruiters from tech firms and gain professional development skills. After graduation in June 2025, he plans to start a job as a software engineer at Oracle, where he completed an internship in 2024.

"In my first year, I didn't get any summer jobs I interviewed for. I didn't know how to talk. I didn't know what they wanted to hear. Other students had way more coding experience than me coming from high school. When I started teaching at FSRI, I learned how to prepare. I also have a friend at Caltech named Favour Okodogbe who got an internship, and I learned a lot from her about how to communicate in interviews and how to express yourself—like making eye contact and sharing your thought process. That motivated me to help other students who might be in the same position I was in.

Now, with help from Caltech's CALE (Career Achievement, Leadership, and Exploration) and our alumni network, our club brings companies to campus to do workshops. Last year, we brought NVIDIA and Roblox, and we talked about the interview process and the importance of LinkedIn. Then, we set up photo shoots so people can have a good LinkedIn picture. We also made a visit to Google's Venice office with students interested in software engineering and quantum computing. These companies want to recruit here, and we give students the opportunity to connect with them directly in a more personal way."

In the Community

Responding to an Unprecedented Disaster



The devastating wildfires that tore through Los Angeles County in January left more than 300 members of the Institute community without homes, including more than 180 employees at JPL, which the Institute manages for NASA. But in the wake of the fires, people across campus and Lab came together to support their friends and colleagues in any way they could.

Caltech grad students and postdocs started a donation drive that filled up the Hameetman Center with supplies like water and clothing. Many community members welcomed displaced colleagues into their homes—including Caltech President Thomas F. Rosenbaum, who took in then JPL director Laurie Leshin's family when fire threatened their home. At the Institute level, Caltech's Faculty Housing and Student Housing offices helped those displaced by the fire and mandatory evacuation orders to find short- and long-term housing. The Institute also established the Caltech and JPL Disaster Relief Fund to support affected staff, faculty, and students who either lost their homes or needed assistance due to the disaster. As of publication, 1,500 people had applied for assistance, while over 4,000 donors had contributed nearly $5 million. Gifts have ranged from $5 to $500,000, with Caltech alumni contributing more than half a million dollars alone.

Assistance came in other forms as well. Kitty Cahalan, assistant director for educational outreach in the provost's office, left her Pasadena home during the fires to take refuge with her pets and kids at Caltech's Center for Teaching, Learning, and Outreach (CTLO) office. After Cahalan learned that her house in Bungalow Heaven had survived the blaze, she gathered a master list of affected community members and a list of organizations accepting donations.

"I was finding people mostly through social media and text to find out who was affected among our friends," she says. "So, I compiled a spreadsheet of people that we know who were displaced. We were just sending that out to our personal friends, saying, if you want to give, these are the organizations and these are GoFundMe pages of people who we know." When she could return to her own home, Cahalan offered it as a resource. "We said, if anybody ever needs to just come over here, relax, print documents, they should go ahead," she said, noting a friend of her child lived in Cahalan's home for two months until their family could find a more permanent place that could house them all together.

When Mayte Garcia evacuated her Altadena home on the evening of January 7, she did not believe the flames would reach her street. "I live near JPL, and we never thought the fire would get that low," says Garcia, operations manager at the Caltech Center for Inclusion and Diversity (CCID). "It wasn't until a neighbor from our block sent us a video of our house that we realized it did not make it."

After a hotel stay and a week spent living with a family friend, Garcia moved to a new residence in Azusa. During this traumatic period, Garcia's CCID colleagues offered support to her and others whose homes were threatened or lost. "It felt very good that at least one part of my life was stable when everything else wasn't," Garcia says. "They put together a care package and asked what essential items we needed. That felt so good because when your house is gone, you realize you need everything."

Elsewhere, Ralph Adolphs, the Bren Professor of Psychology, Neuroscience, and Biology, organized a fundraiser among his third-floor colleagues in the Chen Neuroscience Research Building to assist custodian Sergio Lopez Meza, who lost his home in the Eaton fire.

"The community has stepped forward in amazing ways," Rosenbaum said at the January campus gathering. "We've been able to open our hearts and open our homes."

–Andrew Moseman

Origins

How Caltech Launched a Leading AI Conference

When Yaser Abu-Mostafa (PhD '83) joined the Caltech faculty as an assistant professor after receiving his doctorate, AI had a bad reputation. "Nobody would say they were working in AI because it had promised much and delivered little," says Abu-Mostafa, now a professor of electrical engineering and computer science.

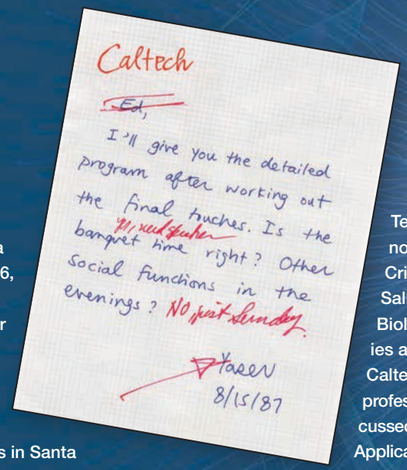
That attitude was about to change, thanks largely to what was happening at Caltech. In 1982, shortly after John Hopfield, now an emeritus professor at Princeton and Caltech's Roscoe G. Dickinson Professor of Chemistry and Biology, Emeritus, published his computer model demonstrating the basic feasibility of artificial neural networks (see page 15), Abu-Mostafa organized a workshop at the Institute to discuss the model and its implications.

"If you were a scientist in this area, and you looked at the whole picture, you said, 'This will lead to something. I don't know what, but it'll lead to something, and we'd better pursue it.'"

–Yaser Abu-Mostafa on the AI research presented at the first NeurIPS conference in 1987

Today, that event with just 75 attendees has grown into what is called the Conference of Neural Information Processing Systems (NeurIPS), the leading gathering of artificial intelligence researchers and professionals in the world, which attracts thousands of attendees every year.

"The Hopfield model was very inspirational for us," says Abu-Mostafa about the recent Nobel laureate's work. "We wanted to analyze the capabilities, see what could be done with it, and so on." After two more years of small gatherings, the workshop had a growth spurt. In 1986, Abu-Mostafa's former Caltech advisor Demetri Psaltis, together with Bell Labs, co-hosted a larger meeting of about 150 scientists in Santa Barbara. "That's when we realized this is serious business," Abu-Mostafa recalls.


Caltech

Ed,

I'll give you the detailed program after working out the final touches. Is the banquet time right? Other social functions in the evenings? No golf Sunday.

Yaser
8/15/87

In November 1987, Abu-Mostafa and Ed Posner, the late Caltech professor and JPL chief technologist, organized the first NeurIPS conference in Denver, Colorado, with sponsorship from the Institute of Electrical and Electronics Engineers Information Theory Society. Posner served as the founding general chair. As program chair, Abu-Mostafa says he "sweated bullets" knowing the conference's success hinged on the quality of the research presented. He was so selective that he nearly rejected a paper submitted by a member of the conference organizing team and only permitted himself to present a poster about the relationship between entropy and connectivity in neural networks. "I invested a ridiculous amount of time in the program, and it paid off," he says.

Around 600 scientists attended the first official conference, including computer scientists, biologists, mathematicians, and engineers. The first two plenary speakers were Carver Mead, Caltech's Gordon and Betty Moore Professor of Engineering and Applied Science, Emeritus, who spoke about the engineering side of "Networks for Real-Time Sensory Processing," and Terry Sejnowski, now the Francis Crick Chair at the Salk Institute for Biological Studies and a former Caltech visiting professor, who discussed "Biological Applications of Neural Network Models."

"There was enough substance that if you were a scientist in this area, and you looked at the whole picture, you said, 'This will lead to something. I don't know what, but it'll lead to something, and we'd better pursue it,'" Abu-Mostafa says.

The conference remains a primary forum for scientists and engineers to present and discuss developments in AI. Now organized by the NeurIPS Foundation, established by Posner, the 38th conference last December in Vancouver, British Columbia, saw more than 16,000 registrants attend along with nearly 3,000 others online.

"Every breakthrough over the last 37 years was presented at NeurIPS," Abu-Mostafa says. These include AlexNet (2012), a model developed by a University of Toronto grad student that roundly outperformed all computer vision programs of the time; AlphaGo (2019), the Google DeepMind program that defeated human champions of the Chinese game *Go*; and the model for ChatGPT (2022).

"AI is no longer a bad word," Abu-Mostafa says. "It is either an exciting word or a scary word. It is incumbent upon us, the AI researchers, to make sure that the exciting part flourishes and the scary part is eliminated or at least mitigated."

–Kimm Fesenmaier