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# The Secret Auction That Set Off the Race for AI Supremacy

How the shape of deep learning—and the fate of the tech industry —went up for sale in Harrah's Room 731, on the shores of Lake Tahoe.

BY THE TIME he stepped onto a bus in downtown Toronto for the first leg of a trip to

Lake Tahoe in December 2012, <u>Geoff Hinton</u> hadn't taken a seat for seven years. "I last sat down in 2005," he often said, "and it was a mistake."

He first injured his back as a teenager, while lifting a space heater for his mother. As he reached his late fifties, he couldn't sit down without risking a slipped disk, and if it slipped the pain could put him in bed for weeks. So he stopped sitting down. He used a standing desk inside his office at the <u>University of Toronto</u>. When eating meals, he put a small foam pad on the floor and knelt at the table, poised like a monk at the altar.

He lay down when riding in cars, stretching across the back seat. When traveling longer distances, he took the train or went by ship. He couldn't fly, at least not with the commercial airlines, because they made him sit during takeoff and landing. "It got to the point where I thought I might be crippled—that I wouldn't be able to make it through the day—so I took it seriously," he says. "If you let it completely control your life," he adds dryly, "it doesn't give you any problems."



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That fall—before lying down in the back of the bus from Toronto to New York, taking the train 2,700 miles to Truckee, California, at the crest of the Sierra Nevadas, and then stretching across the back seat of a taxi for the hour-long drive to South Lake Tahoe— Hinton had created a new company. It included only two other people, both young graduate students in his lab at the university. It made no products. It had no plans to make a product. And its website offered nothing but a name, DNN-research, which was even less inviting than the sparse page. The 64-year-old Hinton—who seemed so at home in academia, with his tousled gray hair, wool sweaters, and twosteps-ahead-of-you sense of humor-wasn't even sure he wanted to start a company

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If you buy something using links in our stories, we may earn a commission. This helps support our journalism. <u>Learn more</u>. until his two students talked him into it. But as he arrived in South Lake Tahoe, some of the biggest tech companies in the world were gearing up for a contest to acquire his newborn startup.

He was headed for Harrah's and Harveys,

the two huge casinos at the foot of the mountains near the shore of the lake. Rising up over the Nevada pines, these twin slabs of glass, steel, and stone also serve as convention centers, offering hundreds of hotel rooms, dozens of meeting spaces, and a wide variety of (second-rate) restaurants. That December, they hosted an annual gathering of computer scientists then called NIPS. Short for Neural Information Processing Systems—a name that looked deep into the future of computing—NIPS was a conference dedicated to artificial intelligence. A London-born academic who had explored the frontiers of AI at universities in Britain, the United States, and Canada since the early 1970s, Hinton made the trip to NIPS nearly every year. But this time was different. To his mind, this year's conference seemed like the ideal venue for a high-stakes auction.

**TWO MONTHS EARLIER**, Hinton and his students had changed the way machines saw the world. They built what was called a <u>neural network</u>, a mathematical system modeled on the web of neurons in the brain, and it could identify common objects—like flowers, dogs, and cars—with an accuracy that had previously seemed impossible. As Hinton and his students showed, a neural network could learn this very human skill by analyzing vast amounts of data. He called this "deep learning," and its potential was enormous. It promised to transform not just computer vision but everything from talking digital assistants to driverless cars to drug discovery.

The idea of a neural network dated back to the 1950s, but the early pioneers had never gotten it working as well as they'd hoped. By the new millennium, most researchers had given up on the idea, convinced it was a technological dead end and bewildered by the 50-year-old conceit that these mathematical systems somehow mimicked the human brain. When submitting research papers to academic journals, those who still explored the technology would often disguise it as something else, replacing the words "neural network" with language less likely to offend their fellow scientists.

Hinton remained one of the few who believed it would one day fulfill its promise, delivering machines that could not only recognize objects but identify spoken words, understand natural language, carry on a conversation, and maybe even solve problems humans couldn't solve on their own, providing new and more incisive ways of exploring the mysteries of biology, medicine, geology, and other sciences. It was an eccentric stance even inside his own university, which spent years denying his standing request to hire another professor who could work alongside him in this long and winding struggle to build machines that learned on their own. "One crazy person working on this was enough," he imagined their thinking went. But with a nine-page paper that Hinton and his students unveiled in the fall of 2012, detailing their breakthrough, they announced to the world that neural networks were indeed as powerful as Hinton had long claimed they would be.

Days after the paper was published, Hinton received an email from a fellow AI researcher named Kai Yu, who worked for Baidu, the Chinese tech giant. On the surface, Hinton and Yu had little in common. Born in postwar Britain to an uppercrust family of scientists whose influence was matched only by their eccentricity, Hinton had studied at Cambridge, earned a PhD in artificial intelligence from the University of Edinburgh, and spent most of the next four decades as a professor of computer science. Yu was 30 years younger than Hinton and grew up in Communist China, the son of an automobile engineer, and studied in Nanjing and then Munich before moving to Silicon Valley for a job in a corporate research lab. The two were separated by class, age, culture, language, and geography, but they shared a faith in neural networks. They had originally met in Canada at an academic workshop, part of a grassroots effort to revive this nearly dormant area of research across the scientific community and rebrand the idea as "deep learning." Yu, a small, bespectacled, round-faced man, was among those who helped spread the gospel. When that nine-page paper emerged from the University of Toronto, Yu told the Baidu brain trust they should recruit Hinton as quickly as possible. With his email, Yu introduced Hinton to a Baidu vice president, who promptly offered \$12 million to hire Hinton and his students for just a few years of work.

For a moment, it seemed like Hinton and his suitors in Beijing were on the verge of sealing an agreement. But Hinton paused. In recent months, he'd cultivated relationships inside several other companies, both small and large, including two of Baidu's big American rivals, and they, too, were calling his office in Toronto, asking what it would take to hire him and his students.

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Seeing a much wider opportunity, he asked Baidu if he could solicit other offers before accepting the \$12 million, and when Baidu agreed, he flipped the situation upside down. Spurred on by his students and realizing that Baidu and its rivals were much more likely to pay enormous sums of money to acquire a company than they were to shell out the same dollars for a few new hires from the world of academia, he created his tiny startup. He called it DNNresearch in a nod to the "deep neural networks" they specialized in, and he asked a Toronto lawyer how he could maximize the price of a startup with three employees, no products, and virtually no history.

As the lawyer saw it, he had two options: He could hire a professional negotiator and risk angering the companies he hoped would acquire his tiny venture, or he could set up an auction. Hinton chose an auction. In the end, four names joined the bidding: Baidu, Google, <u>Microsoft</u>, and a two-year-old London startup called <u>DeepMind</u>, cofounded by a young neuroscientist named Demis Hassabis, that most of the world had never heard of.

THE WEEK OF the auction, Alan Eustace, <u>Google</u>'s head of engineering, flew his own

twin-engine plane into the airport near the south shore of Lake Tahoe. He and Jeff Dean, Google's most revered engineer, had dinner with Hinton and his students in the restaurant on the top floor of Harrah's, a steak house decorated with a thousand wine bottles. It was Hinton's 65th birthday. As he stood at a bar table and the others sat on high stools, they discussed Google's ambitions, the auction, and the latest research under way at his lab in Toronto. For the Googlers, the dinner was mostly a way of running the rule over Hinton's two students, whom they had never met. Baidu, Microsoft, and DeepMind also sent representatives to Lake Tahoe for the conference. Kai Yu, the Baidu researcher who'd kicked off the race, held his own meeting with the Toronto researchers before the bidding began. But none of the bidders ever gathered in the same place at the same time. The auction itself played out over email, with most bids arriving from corporate executives elsewhere in the world, from California to London to Beijing. Hinton hid the identity of each bidder from all the rest.

He ran the auction from his hotel room, number 731 in the Harrah's tower, which looked out over the Nevada pines and onto the snowy mountain peaks. Each day he set a time for the next round of bidding, and at the designated hour, he and his two students would gather in his room to watch the bids arrive on his laptop. The laptop sat on a trash can turned upside down on a table at the end of the room's two queensize beds, so that Hinton could type while standing up.

The bids arrived via Gmail, just because that was where he kept an email account. But according to Hinton, Microsoft didn't like the arrangement. In the days before the auction, the company complained that Google, its biggest rival and likeliest competitor in the auction, could eavesdrop on private messages and somehow game the bids. Hinton had raised the same possibility with his students, though he was less expressing a serious concern than making an arch comment on the vast and growing power of Google. In the end, both Hinton and Microsoft set their concerns aside—"We were fairly confident Google wouldn't read our Gmail," he says.

The auction rules were simple: After each bid, the four companies had an hour to raise the buying price by at least a million dollars. This hour-long countdown started at the time stamped on the email holding the latest bid, and at the end of the hour, if no one lodged a new bid, the auction was over. DeepMind bid with company shares, not cash, but it couldn't compete with the giants and soon dropped out. That left

Baidu, Google, and Microsoft. As the bids continued to climb, first to \$15 million and then to \$20 million, Microsoft dropped out too, but then returned. Each increment felt heavy with meaning as Hinton and his students debated which company they'd rather join. Late one afternoon, as they looked out the window, two airplanes flew past from opposite directions, leaving contrails that crossed in the sky like a giant X right above a set of mountain peaks. Punchy with excitement, they mused about what this might mean, before remembering that Google was headquartered in a place called Mountain View. "Does that mean we should join Google?" Hinton asked. "Or does it mean we shouldn't?"

At about \$22 million, Hinton temporarily suspended the auction to hold a discussion with one of the bidders, and half an hour later Microsoft dropped out again. That left Baidu and Google, and as the hours passed, the two companies took the price still higher. Kai Yu handled the initial Baidu bids, but when the price reached \$24 million, a Baidu executive took over from Beijing.

From time to time, Yu would stop by, hoping to glean at least a small sense of where the auction was headed. Unbeknownst to Yu, these visits prompted a bit of a farce inside room 731. Hinton often got sick when he traveled to places like Lake Tahoe, where the air was cold, thin, and dry. He was worried he might get sick again, and he didn't want any tech industry people to see him that way. "I didn't want them thinking I was old and decrepit," he says. To keep illness at bay, he had removed the mattress from the pullout couch against the wall, laid it on the floor between the two beds, stretched an ironing board and a few other long, sturdy objects across the gulf between the beds, then dampened several towels with water and draped them across the gaps. He slept each night in the wet air under this makeshift canopy. But Hinton didn't want Yu to see his personal humidifying chamber, so every time Yu dropped in for a chat, Hinton turned to his two students, the only other people in his three-person company, and asked them to disassemble and hide the mattress and the ironing board and the wet towels. "This is what vice presidents do," he told them.

After one visit, Yu left the room without his backpack, and when Hinton and his students noticed it sitting on a chair, they wondered if they should open it to see if anything inside would tell them how high Baidu was willing to bid. But knowing it wasn't the right thing to do, they didn't. In any case, they soon discovered Baidu was willing to go much higher: \$25 million, \$30 million, \$35 million. Inevitably, the next bid wouldn't arrive until a minute or two before the top of the hour, extending the auction just as it was on the verge of ending. The price climbed so high, Hinton shortened the bidding window from an hour to 30 minutes. The bids quickly climbed to \$40 million, \$41 million, \$42 million, \$43 million. "It feels like we're in a movie," he said. One evening, close to midnight, as the price hit \$44 million, he suspended the bidding again. He needed some sleep.

The next day, about 30 minutes before the bidding was set to resume, Hinton sent an email saying the start would be delayed. About an hour later, he sent another. The auction was over. At some point during the night, Hinton had decided to sell his company to Google—without pushing the price any higher. His email to Baidu said that any other messages the company sent would be forwarded to his new employer, though he didn't say who that was.

#### A new competition was on—and the auction had been like a starting gun.

This, he later admitted, was what he had wanted all along. Even Kai Yu had guessed that Hinton would end up at Google, or at least another American company. His bad back, after all, would keep him from traveling to China. As it was, Yu was content that Baidu had taken its place among the bidders. The experience, he believed, had helped his superiors see the world the way he saw it. By pushing Baidu's American rivals to the limit, the company's brain trust had come to realize for themselves how important deep learning would be in the years ahead.

HINTON STOPPED THE auction because finding the right home for his research was ultimately more important to him than commanding the maximum price. When he told the bidders at Google he was stopping the auction at \$44 million, they thought he was joking—that he couldn't possibly give up the dollars that were still coming. He wasn't joking, and his students saw the situation much as he did. They were academics, not entrepreneurs, more loyal to their idea than to anything else.

Hinton didn't realize just how valuable their idea would prove to be. No one did. The

rise of deep learning marked a fundamental shift in the way digital technology was built. Rather than carefully defining how a machine was supposed to behave, one rule at a time, one line of code at a time, engineers were beginning to build machines that could learn and apply lessons from such enormous amounts of data that no human could ever wrap their head around it all. The result was a new breed of computing that was not only more powerful than anything that came before but also more mysterious and unpredictable. Its super-human capacities, it turned out, were also shot through with human failings. As Google and other tech giants adopted the technology, no one quite realized it was learning the biases of the researchers who built it.

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After Hinton's auction played out at Lake Tahoe and the NIPS conference came to an end, Kai Yu boarded a plane for Beijing. There, he ran into another Chinese-born researcher named Li Deng, who had played his own role in the auction as an employee of Microsoft. Yu and Deng knew each other from years of AI conferences and workshops, and they arranged for adjacent seats on the long flight to Asia. Because the bidders had remained anonymous, neither was quite sure which companies were involved in the auction. They spent hours standing in the back of the cabin, discussing the rise of deep learning. But they also felt

bound by their employers not to reveal their own involvement in the auction. So they danced around the issue, trying to understand what the other knew without giving their own secrets away. Though they didn't say it, both knew that a new competition was on—that the auction had been like a starting gun. Their companies would have to answer Google's big move. It was the beginning of a global arms race, and this race would quickly escalate in ways that would have seemed absurd a few years before.

At first, the contest would engage just a small group of scientists—spread mainly

across the four companies that made bids in Hinton's auction—and would thrust their work into the tech industry's center spotlight. DeepMind, the obscure London startup, would grow to become the most celebrated and influential AI lab of the decade, fueled by the boundless ambition of cofounder Demis Hassabis to build machines capable of attaining what's called artificial general intelligence: omnivorous, adaptable, humanlike thought. Hinton and Hassabis would come to disagree with each other about the validity of that goal, but starting in 2014 they did so under the umbrella of the same parent company—as Google acquired DeepMind that January.

Eventually Facebook and a startup called OpenAI would also join the race, with the latter becoming tied to Microsoft via major investments. The competition between all these players would dramatically accelerate the progress of artificial intelligence, sparking enormous advances in talking digital assistants, driverless cars, smart robotics, automated health care, and—stretching well past the intentions of Hinton and his students—automated warfare and surveillance.

After he checked out of room 731, Hinton boarded a train for the long trip back to Toronto—and he still hasn't sat down. Years later, in 2017, when he was asked to reveal the companies that bid for his startup, he answered in his own way. "I signed contracts saying I would never reveal who we talked to. I signed one with Microsoft and one with Baidu and one with Google," he said. He declined to mention DeepMind, which meant that some participants in the auction never had a full picture of who they had bid against for the future of computing—until now.

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In this rare interview since (jointly) winning the 2018 Turing Award for his work on neural networks, hear about the conceptual and engineering breakthroughs that have made deep neural networks a critical element of computing. Their research has allowed artificial intelligence technologies to progress at a rate that was not possible in the past and has reinvented the way technology is built.

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