The Human Upgrade: Watson's next feat? Taking on cancer

IBM's computer brain is training alongside doctors to do what they can't
Story by Ariana Eunjung Cha Published on June 27, 2015

Candida Vitale and the other fellows at MD Anderson's leukemia treatment center had known one another for only a few months, but they already were very tight. The nine of them shared a small office and were always hanging out on weekends. But she wasn't quite sure what to make of the new guy.

Watson, the computer brain of "Jeopardy!" fame, is training to be the world's first artificial-intelligence expert in cancer. This is the program's physical embodiment in an IBM server room in New York City. (Andrew Spear for The Washington Post)

The Human Upgrade:
Using their ideas and their billions, the visionaries who created Silicon Valley's biggest technology firms are trying to transform the most complicated system in existence: the human body.

Rumor had it that he had finished med school in two years and had a photographic memory of thousands of journal articles and relevant clinical trials. When the fellows were asked to summarize patients' records for the senior faculty in the mornings, he always seemed to have the best answers. "I was surprised," said Vitale, a 31-year-old who received her MD in Italy. "Even if you work all night, it would be impossible to be able to put this much information together like that." The new guy's name was a mouthful, so many of his colleagues simply called him by his nickname: Watson. Four years after destroying human competitors on "Jeopardy!" to win a suspense-filled tournament watched by millions, the IBM computer brain is everywhere. It's done stints as a call center operator and hotel concierge, and been spotted helping people pick songs. It's even published its own cookbook, with 231 pages of what the company calls "recipes for innovation." (The reviews haven't been flattering — one foodie declared one of Chef Watson's creations "the worst burrito I've ever had.") But these feats were essentially gimmicks.

IBM is now training Watson to be a cancer specialist. The idea is to use Watson's increasingly sophisticated artificial intelligence to find personalized treatments for every cancer patient by comparing disease and treatment histories, genetic data, scans and symptoms against the vast universe of medical knowledge. Such precision targeting is possible to a limited extent, but it can take weeks of dedicated sleuthing by a team of researchers. Watson would be able to make this type of treatment recommendation in mere minutes. Get email updates to follow this series The IBM program is one of several new aggressive health-care projects that aim to sift through the huge pools of data created by people's records and daily routines and then identify patterns and connections to predict needs. It is a revolutionary approach to medicine and health care that is likely to have significant social, economic and political consequences.

Lynda Chin, a physician-scientist and associate vice chancellor for the University of Texas system who is overseeing the Watson project at MD Anderson Cancer Center, said these types of programs are key to "democratizing" medical treatment and eliminating the disparity that exists between those with access to the best doctors and those without. "I see technology like this as a way to really break free from our current health-care system, which is very much limited by the community providers. If you want expert care you have to go to an expert center," she said, "but there are never enough of those to go around." Instead of having to find specialists in a different city, photocopy and send all the patient's files to them, and spend countless hours researching the medical literature, a doctor could simply consult Watson, she said. Jho Low, the 33-year-old billionaire who is bankrolling the $50 million MD Anderson project with Watson, said the effort grew out of his grandfather's treatment for leukemia in Malaysia. Low said that he felt fortunate to be able to connect his grandfather's doctors remotely with MD Anderson specialists to devise the best treatment plan. He believes everyone, rich or poor, should have the same access to that kind of expertise.
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“This is very personal to my family. It is really something we have gone through and seen what kind of difference it can make,” said Low, who is a graduate of the Wharton School at the University of Pennsylvania and runs one of Asia’s most successful investment firms. Low is part of an influential new movement in scientific research driven by young philanthropists and tech titans who have faith that the chips, software programs, algorithms and big data that powered the information revolution can also be used to understand, upgrade and heal the human body. But the Watson project and similar initiatives also have raised speculation — and alarm — that companies are seeking to replace the nation’s approximately 900,000 physicians with software that will have access to everyone’s sensitive personal health information.

While there’s much debate about the extent to which technology is destroying jobs, recent research has driven concern. A 2013 paper by economists at the University of Oxford calculated the probability of 702 occupations being automated or “roboticized” out of existence and found that a startling 47 percent of American jobs — from paralegals to taxi drivers — could disappear in coming years. Similar research by MIT business professors Erik Brynjolfsson and Andrew McAfee has shown that this trend may be accelerating and that we are at the dawn of a “second machine age.” Scientists are already testing baker bots that can whip up pastries, machines that can teach math in the classroom and robot anesthesiologists. Many physicians and academics in medicine have come to view Watson’s work with reservation, despite reassurances from IBM officials that they are trying not to replace humans but to help them do their jobs better.

“I think a lot of folks in medicine, quite frankly, tend to be afraid of technology like this,” said Iltifat Husain, an assistant professor at the Wake Forest School of Medicine. Husain, who directs the mobile app curriculum at Wake Forest, agrees that computer systems like Watson will probably vastly improve patients’ quality of care. But he is emphatic that computers will never truly replace human doctors for the simple reason that the machines lack instinct and empathy. “There are a lot of things you can deduce by what a patient is not telling you, how they interact with their families, their mood, their mannerisms. They don’t look at the patient as a whole,” Husain said. “This is where algorithms fail you.”

Watson’s evolution

Named after Thomas J. Watson Sr., IBM’s first chief executive, Watson was designed to be a substantial leap forward from Deep Blue, the supercomputer that beat chess grandmaster Garry Kasparov in a marathon three-day man vs. computer match in 1997. Deep Blue’s edge was brute force. It had the ability to calculate and analyze up to 200 million scenarios per second — a skill that could be applied to complex calculations as diverse as modeling the stock market and ranking the potential of small molecules for new drugs. But the program was handicapped by its inability to perform basic skills that humans master in their first few years of life. It couldn’t make sense of regular human speech or any other type of so-called unstructured data or information that isn’t organized according to a predefined formula like a chart or table.

Named after Thomas J. Watson, IBM’s first chief executive, Watson competed on the game show Jeopardy! in 2011, soundly defeating human competitors – including Ken Jennings, who holds the show's record for longest winning streak. (Associated Press file photo) Given that the world is a messy place when it comes to data — from the text of Shakespearean plays to traffic patterns in Los Angeles — Deep Blue’s abilities were limited.

Watson was imagined from the start to be more human. One of the top priorities for programmers was to give Watson the power to read and understand natural language. They also gave it the ability to generate hypotheses and locate and parse evidence to support or refute them. Much like the human brain, Watson has become smarter over time by learning from its successes and failures and from user feedback.

Watson is literally evolving.

In the beginning, Watson’s knowledge base was limited to trivia for “Jeopardy!” But since its debut on national television in February 2011, Watson has devoured many thousands of literary works, newspaper articles and scientific journal reports as well as information input by hundreds of researchers and doctors nationwide. These experts have helped the machine brain make more reasonable inferences and conclusions by reviewing Watson’s ideas and telling it whether it is right or wrong and by highlighting which sources of information are considered more reliable than others. Unlike a human brain that can be distracted, confused or inspired by huge volumes of information, Watson is not a creative thinker but a rational one. It looks at known associations among various bits of data and calculates the probability that one provides a better answer to a question than another and presents the top ideas to the user. Rob Merkel, who leads IBM Watson’s health group, said the

company estimates that a single person will generate 1 million gigabytes of health-related data across his or her lifetime. That's as much data as in 300 million books. "You are deep into a realm where no human being could ever make sense of this information," Merkel said. That's where Watson comes in to create a "collective intelligence model between machine and man." "We're not advocating that Watson replace physicians," he explained. "We are advocating that Watson does a lot of reading on behalf of physicians and provides them with timely insights." Originally made up of a cluster of supercomputers that took up as much space at IBM as a master bedroom, Watson is now trimmer — the size of three stacked pizza boxes — and versions of it live in the server rooms of IBM's various partners.

IBM has so much faith in Watson's innovativeness that in January 2014 the company announced that it would invest an additional $1 billion in the technology, and it created a new division to grow the business. Since then, IBM has highlighted health care as Watson's priority and said it will dedicate at least 2,000 medical Practitioners, clinicians, developers and researchers to the effort and will partner with Apple, Johnson & Johnson and Medtronic to collect patient information that consumers had consented to share.
French bank Credit Agricole predicted that as much as 12 percent of IBM's total revenue in 2018 could be from Watson-related products — with a large chunk coming from "consulting" fees that would be billed per use or through a subscription for access to its expertise. It is Watson's work in cancer that is the most advanced.
Among the most ambitious projects is a partnership with 14 cancer centers to use Watson to help choose therapies based on a tumor's genetic fingerprints. Doctors have known for years that some treatments work miraculously on some patients but not at all on others due to genetics. But the expense and complexity in identifying genetic mutations and matching them up with potential therapies has made it difficult for more than a handful of patients to benefit from this new approach. The service is scheduled to launch later this year.
Meanwhile, Watson is continuing its on-the-ground training with cancer specialists.

In 2011, IBM announced that Watson had learned as much as a second-year medical student. Since then it's graduated and has been doing residencies at some of the nation's top cancer centers, including Memorial Sloan Kettering in New York and the Cleveland Clinic. In late September, Watson achieved another training milestone: It began its first fellowship in a specialty — leukemia — at MD Anderson. Tina Cascone demonstrates Watson, officially the Oncology Expert Advisor, at MD Anderson's leukemia treatment center in Houston. The IBM program can synthesize a patient's history, offer a set of possible treatments and rate whether it has low, medium or high confidence in its recommendations. (Michael Stravato for the Washington Post)

The revolution
The process of creating the world's first artificial-intelligence expert in cancer starts with something decidedly low-tech: paper. Lots of it. A team from MD Anderson and IBM spent months feeding the computer program the names, ages and genders, and medications, lab tests, imaging results and notes from each visit for thousands of leukemia patients treated there over the past few years. Leukemia is a cancer that can be attacked in dozens of ways — including high-dose chemotherapy and immune-based therapies such as targeted antibodies — and it's often tricky for physicians to decide between one or another. Watson — or the Oncology Expert Advisor, its official name at MD Anderson — was tripped up by little things at first. It sometimes had trouble telling whether the word "cold" in a doctor's notes referred to the virus or the temperature. Or whether T2 was referring to a type of MRI scan or a stage of cancer. So each patient record had to be validated by a human. Moreover, Watson's recommendations were often a little wacky. "When we first started, he was like a little baby," said Tapan M. Kadia, an assistant professor in the leukemia department. "You would put in a diagnosis, and he would return a random treatment." It turned out that getting machines to do simple tasks humans take for granted is hard. In fact, it took Google a year to teach a computer to be able to recognize cats on YouTube. To teach Watson, the doctors would have to manually type in what they believed the "right" course of treatments should be and why. They also handpicked a number of key journal articles from the past for Watson to reference and started giving it access to newly published material. In October, the team decided Watson was ready to start its fellowship.

Koichi Takahashi, who was at the top of last year's class of fellows and recently appointed an assistant professor in leukemia, said he's been impressed so far. Watson's ability to synthesize a patient's history is "amazing," Takahashi said. "He beats me." The program still surprises Kadia. "Every once in a while you'll see something and think, 'This shouldn't be.' The other way you're surprised is, 'Oh my God, why didn't I think of that?' We don't like to admit it," Kadia said, "but it does happen." Vitale, who did her residency in hematology

in Italy, said she thought it was “a little bit strange” to learn a computer program would be in her class of fellows. But now, she said, there’s a good back and forth between her and Watson. She regularly tells Watson about journal articles she’s read that might be helpful, by inputting a citation and highlighting key passages, and Watson helps her delve into patient records much faster than she could on her own. “We are still learning trust,” she said. One afternoon at MD Anderson, Vitale was sitting next to Kadia studying a patient’s file on the Watson program on the professor’s desktop.

When the numbers from the patient’s bloodwork came up, Kadia frowned. Shamira Davis, 23, was a patient of Kadia’s. They had met two years ago when she was brought into the intensive care unit, bleeding and near Death. The stay-at-home mother was diagnosed with leukemia, and Kadia treated her with chemotherapy and a bone marrow transplant. She had been well since then. Now it looked as if her cancer had returned. Vitale, who is shadowing Kadia, studied Davis’s background and asked Watson what it thought. A long list of options appeared on the screen. Like medical doctors, Watson doesn’t operate in black and white. Instead, it offers a set of possibilities and rates whether it has low, medium or high confidence. In Davis’s case, Watson suggested a handful of standard treatments as well as experimental clinical trials as being of high and medium confidence. Kadia scanned the list, but his instincts told him that there was something more promising. He had recently been talking to a colleague about a new clinical trial for an aggressive chemotherapy treatment, and he thought it was Davis’s best chance. A few minutes later, when Davis was told that her doctors were consulting with the “Jeopardy!” champ about her case, she was intrigued. But would she trust a treatment recommendation made by a computer or by a human? Davis didn’t hesitate. “I trust Dr. Kadia,” she said.

Guillermo Garcia-Manero, a senior MD Anderson leukemia specialist who sometimes disagrees with Watson’s recommendations, said it isn’t so much that Watson is wrong but that it’s still learning. “I’m not saying we’re Kasparovs, but the doctors here are the experts, and it’s going to take him a little time to catch up,” Garcia-Manero said. In the future, Watson “will be a fantastic adjunct even for a master chess player.” But even Kasparov, of course, was beaten by a computer in the end. Computers have an edge, said Garcia-Manero, because they have a predictable view that isn’t impacted by any biases about certain types of treatments or how tired they are: “Computers can’t cut corners. Humans cut corners all the time.” Garcia-Manero’s bosses at MD Anderson and the University of Texas have been so pleased with Watson’s abilities in leukemia that they are preparing to train it in two other specialties: lung cancer and diabetes. “They keep telling me it will not replace me,” Garcia-Manero said. “But I am pretty sure it will replace me.”