Earlier this year, an IBM computer named Watson competed on *Jeopardy!* against two flesh-and-blood contestants. It was a classic humans-versus-machine challenge. Intelligent systems experts like Pitt’s **Diane Litman** and her colleagues are working to make computers ever more compatible with—and useful to—people.

A live episode of *Jeopardy!* lights up a flat screen in a computer-science conference room, where students and faculty watch the action as they chat casually and chow down on pizza. “Let’s go to ‘U.S. Geographic Nicknames’ for $1,600,” one of the televised contestants says. The game-show host reads the clue: “It’s known as both ‘The Steel City’ & ‘The Iron City.’”

From the room on campus, several folks shout “Pittsburgh” before the contestants on TV have a chance to answer. The group is watching the show inside Sennott Square, home to the Department of Computer Science of, one might say, the University of Steel City. On TV, Ken Jennings—the most successful and celebrated *Jeopardy!* contestant of all time—correctly says “What is Pittsburgh?” His answer boosts his earnings to $13,400, more than double the earnings of his opponents. But the trivia game is taking a surprising turn:

One of the contestants—a computer—is losing. Tonight’s *Jeopardy!* game has been touted by CNN, ABC, and other national news outlets as a contest of man versus machine. The techies in the Pitt conference room are cheering for the machine. After all, they study and research computer science every day. They’re rooting not so much for the computer, but for the experts who built it. A team at IBM designed the computer nicknamed Watson.
Although Watson doesn’t beat Ken Jennings to the buzzer for the Steel City & Iron City clue, it has a pretty good hunch about the correct answer. During the broadcast, the bottom of the television screen displays how the computer ponders each clue. For the Steel City question, Watson is 59 percent certain that the answer is Pittsburgh, but it also figures there’s a 27 percent chance that the answer is Jamshedpur, an industrial city in India, and an 11 percent chance that it is Bethlehem, Pa., the headquarters of the former Bethlehem Steel Corporation.

Answering Jeopardy! questions is particularly challenging for Watson because English isn’t its native tongue. Computers typically communicate in languages like HTML or C++, Plain English is a conundrum. But as the game continues, it’s apparent that Watson has been doing its English homework. Watson begins answering more and more clues, soon overtaking Ken Jennings and tripling its earnings. The Pitt crew is delighted, especially the pizza-party hostess, Diane Litman, a professor of computer science and intelligent systems. “I have been excited about the Watson project for a long time,” she enthuses.

Litman is director of Pitt’s Intelligent Systems Program, which involves education and research on how to apply advanced computer technologies to fields like education, law, medicine, and business. Her research focuses on artificial intelligence, computational linguistics, knowledge representation and reasoning, natural-language learning, and more.

She has invited members of the intelligent systems program and computer science department to watch Watson on Jeopardy! because the computer incorporates many of the technologies that the Pitt group researches and develops. Plus, it’s fun. The show highlights the achievements of computer scientists around the nation, such as those at Pitt who are continually making progress in shaping our 21st-century digital landscape.

Litman and her colleagues cheer when Jeopardy! host Alex Trebek announces that Watson is the winner of the game. They can appreciate the hours of hard work that the IBM experts put into building the computer to score this victory. To the millions of other viewers watching the show, Watson’s win may not seem that surprising or impressive. Many have probably lost to a computer in a digital game like Tetris or chess. But when a computer beats a human in those sorts of games, the machine has an advantage because it’s programmed with all the rules and information it needs.

Watson is different.

On the game show, Watson had to first understand each clue—written in English—and then figure out what sort of information it needed to answer it. Then it had to search millions of texts—all written in English—to find that information. This, in particular, is what intrigues Litman. She’s an expert in natural language processing, a field that investigates how to create computers capable of understanding and using human languages like English or Chinese or Arabic.

Litman codirects Pitt’s Natural Language Processing Laboratory and teaches an introductory course on the topic. A number of Pitt faculty focus on natural language processing, and their research aims to improve human-computer interactions—how we search the Internet, translate foreign languages, receive medical diagnoses, and learn in classrooms.

Natural language processing technologies are already part of our everyday lives. “All those systems you get on the phone when you want to speak to an operator, those are examples of natural language processing,” Litman says. As a scientist with AT&T Labs/Bell Laboratories in New Jersey for 15 years, she helped to invent automated systems for call centers. During that time, she worked with an expert who is now part of the Watson project, which is how she first heard about the Jeopardy! challenge. At AT&T, she and her colleagues developed software that could understand spoken English, resulting in three patents.

Since joining Pitt in 2001, Litman has continued to advance a computer’s understanding of the quirks and subtleties of spoken English. Instead of teaching them English so that they can be operators in an automated phone system, she’s teaching computers how to become physics tutors. Through her role as a senior scientist in Pitt’s Learning Research and Development Center, Litman oversees researchers who are observing how human tutors and students converse in English while trying to solve physics problems. The researchers are applying those observations to software programs in an effort to foster similar interactions between computer tutors and human students.

“Human tutors use conversation, and they’re very effective,” says Litman. “Perhaps it’s not just an accident. There’s something about the conversational process that’s good for learning. If we can figure out what it is, we can put it into the computer tutors.” One of her goals is to create a talking computer tutor that can provide personalized instruction to individual students as a supplement to classroom learning. Students will be able to ask the tutor questions and receive custom responses.

“With AT&T, the idea was to save the human operators for when they’re needed. If somebody wants to find out an account balance for next month, that’s really easy for a computer to do, and you could save the human’s time for something much more complicated. Similarly, computer tutors could free up teacher time to work on things that require a sophisticated human up there in the classroom,” she says.

Litman’s work has been attracting widespread interest in the field of natural language processing. She frequently is invited to present her latest findings at international conferences and workshops. During the past five years, she and her team have received four “Best Paper” awards for research they’ve presented at computer science conferences in Hawaii, New York, and Pennsylvania. So far this year, the team has generated 18 additional publications.

Call centers, computer tutors, and Jeopardy! are only a few of the possible forums for natural language processing. One of Litman’s fellow codirectors of Pitt’s Natural Language Processing Laboratory is Janyce Wiebe, a computer science professor who is developing methods for computers to analyze opinions across large groups of texts, such as newspaper editorial archives or collections of product reviews.
...Wiebe's research team has built a variety of software such as OpinionFinder, which scans English documents to detect subjective, opinionated sentences. Wiebe—an intelligent systems faculty member and former director of the program—also is researching ways to create software that could analyze medical reports for uncertainty, alerting doctors and nurses to potential problems.

“If you type into Google, ‘What does this person think about George Bush,’ you’re not going to get an answer that’s going to satisfy you,” Wiebe says. “The search results will be a mess of compilation of various thoughts and ideas. Her goal is to improve search engines so that they can organize billions of pages of text by their overall viewpoints, helping to manage the overwhelming amounts of information that are available on the Internet and in library databases.

Teaching the subtle connotations of English words to computers is not an easy task. Wiebe cites the example of the word “benefit.” It seems like typing that keyword into a search engine would generate plenty of articles with positive connotations. “That’s a good clue, but only when it has a prepositional phrase following it, like ‘benefit to society,’” she says. “If you don’t have that prepositional phrase, then you get a lot of false hits like ‘employee benefits.’”

By using analytical methods from linguistics, Wiebe’s research team has built a variety of software such as OpinionFinder, which scans English documents to detect subjective, opinionated sentences. Wiebe—an intelligent systems faculty member and former director of the program—also is researching ways to create software that could analyze medical reports for uncertainty, alerting doctors and nurses to potential problems. And she’s studying whether the technologies she’s developing to analyze English texts could also be used to analyze documents in other languages.

The third codirector of the Natural Language Processing Laboratory, Rebecca Hwa, has been conducting related research. Hwa, who earned her doctoral degree in computer science from Harvard, is seeking to improve technologies underlying popular Internet translation services, like Babblefish and Google Translate, which allow users to copy and paste paragraphs of text from one language and have them translated into another. These services do an adequate job, she says, but the translated texts often contain incomprehensible phrases.

Hwa, a professor of computer science and intelligent systems who is fluent in both English and Chinese, says that when computers translate documents into English, the texts often “make less sense than what a non-native English speaker would write.” Her latest research project is to teach imperfect English to computers to see whether that helps them to improve their translation abilities. She started the project last year during a sabbatical leave at the U.S. Naval Academy in Annapolis, Md.

One evening in February at her Maryland apartment, she put her work aside to watch Watson compete on Jeopardy! “It was really fun. It was great to see how well it did,” she says of Watson.

“It could get some of the really tough questions, but then it would mess up on something that we as people find trivial. It doesn’t have the same sort of common sense that we do, so it has to make inferences over the data it sees.”

That’s why when Watson pondered the Steel City & Iron City clue, it didn’t use common sense and consider the category was U.S. Geographic Nicknames. If it had, it would’ve immediately disregarded its second guess of Jamshedpur, India, based on geography.

A month after Watson appeared on Jeopardy!, the computer embarked on a national tour of colleges and universities. The tour began in Pittsburgh, with a Pitt symposium and a Watson appearance at neighboring Carnegie Mellon University. During the morning of the Watson visit, Pitt hosted the symposium “Natural Language Processing in the World of Business, Law, and Medicine.” Litman joined other Pitt professors, Carnegie Mellon faculty, and IBM scientists in a public discussion about how natural language processing technologies, like those used by Watson, can be applied to serious, real-world problems. Held in the University Club on campus, the symposium illustrated how much Pittsburgh has changed from a Steel City and Iron City. Everybody was talking about computer technologies that operate on metals like silicon, not the metals of yesteryear.

The symposium included discussion about Watson’s potential for improvement. “Right now, Watson is great at playing Jeopardy!, but we normally don’t ask a question, then stop, then ask again,” Litman said while explaining that the strides she’s made with talking computer tutors could make Watson an even better computer. She also mentioned the work of her colleagues, Wiebe and Hwa, and how their research on deciphering opinions and computer translation could advance Watson’s skills.

Afterward, Pitt and Carnegie Mellon students faced off against Watson in a Jeopardy!-style game before a standing-room-only audience at Carnegie Mellon. Like Ken Jennings, the students didn’t have much luck against the computer—Watson won the competition—but, at least, the Pitt team placed first among the human contestants.

This fall, Diane Litman expects her course on natural language processing to be filled with new students, eager to learn about the field. In a sense, they’ll be asking: What is Watson? And then they’ll learn to surpass the answer. ❔