New math model can help computers avoid communication breakdowns

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Language is so much more than a string of words. To understand what someone means, you need context.

Consider the phrase, "Man on first." It doesn't make much sense unless you're at a baseball game. Or imagine a sign outside a children's boutique that reads, "Baby sale - One week only!" You easily infer from the situation that the store isn't selling babies but advertising bargains on gear for them.

Present these widely quoted scenarios to a computer, however, and there would likely be a communication breakdown. Computers aren't very good at pragmatics – how language is used in social situations.

But a pair of Stanford psychologists has taken the first steps toward changing that.

In a new paper published recently in the journal *Science*, Assistant Professors Michael Frank and Noah Goodman describe a quantitative theory of pragmatics that promises to help open the door to more human-like computer systems, ones that use language as flexibly as we do.

The mathematical model they created helps predict pragmatic reasoning and may eventually lead to the manufacture of machines that can better understand inference, context and social rules. The work could help researchers understand language better and treat people with language disorders.

It also could make speaking to a computerized customer service attendant a little less frustrating.

"If you've ever called an airline, you know the computer voice recognizes words but it doesn't necessarily understand what you mean," Frank said. "That's the key feature of human language. In some sense it's all about what the other person is trying to tell you, not what they're actually saying."

Frank and Goodman's work is part of a broader trend to try to understand language using mathematical tools. That trend has led to technologies like Siri, the iPhone's speech recognition personal assistant.

But turning speech and language into numbers has its obstacles, mainly the difficulty of formalizing notions such as "common knowledge" or "informativeness."

That is what Frank and Goodman sought to address.

The researchers enlisted 745 participants to take part in an online experiment. The participants saw a set of objects and were asked to bet which one was being referred to by a particular word.

For example, one group of participants saw a blue square, a blue circle and a red square. The question for that group was: Imagine you are talking to someone and you want to refer to the middle object. Which word would you use, "blue" or "circle"?

The other group was asked: Imagine someone is talking to you and uses the word "blue" to refer to one of these objects. Which object are they talking about?

"We modeled how a listener understands a speaker and how a speaker

decides what to say," Goodman explained.

The results allowed Frank and Goodman to create a mathematical equation to predict human behavior and determine the likelihood of referring to a particular object.

"Before, you couldn't take these informal theories of linguistics and put them into a computer. Now we're starting to be able to do that," Goodman said.

The researchers are already applying the model to studies on hyperbole, sarcasm and other aspects of language.

"It will take years of work but the dream is of a computer that really is thinking about what you want and what you mean rather than just what you said," Frank said.

Provided by Stanford University