tion. The current technology can capture neither the play of emphasis, rhythm, and intonation in spoken language (which linguists call *prosody*) nor the emotional experience of speaking and understanding language. Descartes favored a division between reason and emotion, and considered language to be a vehicle of the former. But speech without emotion, it turns out, isn't really speech. Cognitively, the words should mean the same thing, regardless of their emotional content. But they don't.

Speech recognition is a multidisciplinary field, involving linguists, psychologists, phoneticians, acousticians, computer scientists, and engineers. At speech conferences these days, emotional recognition is a hot topic. Julia Hirschberg, a professor of computer science at Columbia University, told me that at the last prosody conference she attended it seemed like three-quarters of the presentations were on emotional recognition. "Research is focused on how to recognize speakers' emotional state and on how to make synthetic voices more emotionally expressive."

Elizabeth Shriberg, a senior researcher in the speech group at SRI International (formerly Stanford Research Institute), said, "Especially when you talk about emotional speech, there is a big difference between what the speaker intended and what the listener reads. Real anger, she went on, often builds over a number of utterances, and is much more variable than acted anger. For more accurate emotional recognition, Shriberg said, "we need the kind of data that you get from 911 and directory-assistance calls. But you can't use those, for privacy reasons, and because they're proprietary."

At SAIL—the Speech Analysis and Interpretation Laboratory, on the campus of the University of Southern California, in Los Angeles—researchers work mostly with scripted speech, which students collect from actors in the U.S. film and drama programs. Shrikant Narayan, who runs the lab, is an electrical engineer, and the students in his emotion-research group are mainly engineers and computer scientists. One student was studying what happens when a speaker's face and voice convey conflicting emotions. Another was researching how emotional states affect the way people move their heads when they talk. The research is a grind. Students painfully listen to voices expressing many different kinds of emotion and tag each sample with information, such as how energetic the voice is and its "valence" (whether it's a negative or a positive emotion). Anger and elation are examples of emotions that have different valences but similar energy levels. Humans use context, as well as facial and vocal cues, to distinguish them. Since the researchers have only the voice to work with, at least three of them are required to listen and decide what the emotion is. Students note voice quality, pacing, language, "cadences" (false starts, "um's", and pitch). They need at least two different data sets, so that they can use separate ones for training the computer and for testing it.

Facial expressions are generally thought to be universal, but so far Narayan's lab hasn't found that similarly universal vocal cues for emotions are as easily established. "Emotions aren't discrete," Narayan said. They are a continuum, and it isn't clear to any one receiver where one emotion ends and another begins, so you end up studying not just the speaker but the perceiver." The idea is that if you could train the computer to sense a speaker's emotional state by the sound of his voice, you could also train it to respond in kind—the computer might slow down if it sensed that the speaker was confused, or assume a more soothing tone of voice if it sensed anger. One possible application of such technology would be video games, which could automatically adapt to a player's level based on the stress in his voice. Narayan also mentioned simulations—such as the computer-game-like training exercises that many companies now use to prepare workers for a job. "The program would sense from your voice if you are overconfident, or when you are feeling frustrated, and adjust accordingly," he said. That reminded me of the moment in the novel "2001" when HAL, after discovering that the astronauts have doubts about him, decides to loll them. While struggling with one of the astronauts, Dave, for control of the ship, HAL says, "I can tell from your voice harmonics, Dave, that you're badly upset. Why don't you take a shower and get some rest?"

But, apart from call-center voice analytics, it's hard to find many credible applications of emotional recognition, and it is possible that true emotional recognition is beyond the limits of the probabilistic approach. There are futuristic projects aimed at making emotionally responsive robots, and there are plans to use such robots in the care of children and the elderly. "But this is very long-range, obviously," Narayan said. In the meantime, we are going to be dealing with emotionless machines.

There is a small market for voice-based lie detectors, which are becoming a popular tool in police stations around the country. Many are made by Nemesysco, an Israeli company, using a technique called "layered voice analysis" to analyze some hundred and thirty parameters in the voice to establish the speaker's psychological state. The academic world is skeptical of voice-based lie detection, because Nemesysco will not release the algorithms on which its program is based; after all, they are proprietary. Layered voice analysis has failed in two independent tests. Nemesysco's American distributor says that's because the tests were poorly designed. (The company played Roger Clemens's recent congressional testimony for me through its software, so that I could see for myself if the Rocket's stress levels leaping.) Nevertheless, according to the distributor more than a thousand copies of the software have been sold—at fourteen thousand five hundred dollars each—to law enforcement agencies and, more recently, to insurance companies, which are using them in fraud detection.

One of the most fully realized applications of emotional recognition that I am aware of is the aggression-detection system developed by Sound Intelligence, which has been deployed in Rotterdam and Amsterdam, and other cities in the Netherlands. It has also been installed in the English city of Coventry, and is being tested in London and Manchester. One of the designers, Peter van Hen-