## Fostering research on human-like AI

Attaining human-like AI requires systems to explain themselves in ways that people can understand. This will result in a new generation of intelligent systems, such as intelligent tutoring systems and intelligent assistants that are effective in assisting people when performing their tasks. There is a significant gap, however, between the way current AI algorithms work and how people learn and perform tasks. People are capable of learning from just a few examples, or by receiving formal instruction and/or "hints" to performing tasks, or by observing other people performing those tasks. Medical schools take this approach, for example, when medical students learn by observing an established doctor performing a complex medical procedure. Even in high-performance tasks such as world-championship Go games, a master-level player would have played only a few thousand games to train him/herself. In contrast, it would take hundreds of years for a human to play the number of games needed to train AlphaGo. More foundational research on new approaches for achieving human-like AI would bring these systems closer to this goal.

**NSF-funded Framework on Game Theory for Security**

*Security is a critical concern around the world, whether it is the challenge of protecting ports, airports and other critical infrastructure; protecting endangered wildlife, forests and fisheries; suppressing urban crime; or security in cyberspace. Unfortunately, limited security resources prevent full security coverage at all times; instead, we must optimize the use of limited security resources. To that end, the "security games" framework—based on basic research in computational game theory, while also incorporating elements of human behavior modeling, AI planning under uncertainty and machine learning—has led to building and deployment of decision aids for security agencies in the United States and around the world.[74] For example, the ARMOR system has been deployed at LAX airport since 2008, the IRIS system for the Federal Air Marshals Service has been in use since 2009, and the PROTECT system for the U.S. Coast Guard since 2011. Typically, given limited security resources (e.g., boats, air marshals, police), and a large number of targets of different values (e.g., different flights, different terminals at an airport), security-games-based decision aids provide a randomized allocation or patrolling schedule that takes into account the weights of different targets and intelligent reaction of the adversary to the different security postures. These applications have been shown to provide a significant improvement in performance of the different security agencies using a variety of metrics, e.g., capture rates, red teams, patrol schedule randomness, and others.*[74]


Many types of applications may benefit from game-theoretic approaches to security.

## Developing more capable and reliable robots

Significant advances in robotic technologies over the last decade are leading to potential impacts in a multiplicity of applications, including manufacturing, logistics, medicine, healthcare, defense and national security, agriculture, and consumer products. While robots were historically envisioned for

[74] M. Tambe, *Security and Game Theory: Algorithms, Deployed Systems, Lessons Learned*, (Cambridge: Cambridge University Press, 2011).