The output was an eight-dimensional "shadow" of the WoW data, projected as a simple 2D plot, that evolves over the course of the 4-year period of the study (see figure, p. 30). For the most part, says Thurau, the results confirm many researchers' hunches about the social behavior of WoW players. Only a small fraction of guilds are active, those run by highly organized, ambitious groups of players. In spite of the staggering fraction of their lives spent in the game, most players are "casual rather than hardcore," he says.

Game-mining isn't just for multiplayer games. A team led by Georgios Yannakakis, a computer scientist at the IT University of Copenhagen, described player behavior in Tomb Raider: Underworld, a single-person game in which a gun-toting female archaeologist steals artifacts from ruins. They analyzed data from 10,000 players on the Xbox Live network, covering 35 different variables such as the use of weapons, the rate of progress, and whether it was tigers, traps, or other hazards that killed them. Their aim was to train a computer to predict the level at which any given player will eventually quit the game out of frustration—one of the hopes of the game industry is to create "personalized" games that adapt to each player's abilities and interests.

The computer wasn't perfect at foretelling the players' fates, but it was far better than random. Just by observing how people played the first two levels of the game, it could predict with 77% accuracy where they would give up. Much of that prediction power came from counting the number of seconds players took to navigate a single obstacle, the jellyfish-filled "flush tunnel." Yannakakis says the accuracy should improve as he tracks more players for the training, as well as obtaining "finer granularity" in the data, such as players' exact routes of movement. **–J.B.**

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Smarts for Serious Games

You are a firefighter. As a blaze spreads across the factory, a paint canister goes off like a bomb. There are still panicked workers to be cleared. And to make matters worse, one of your crew is injured. How do you proceed?

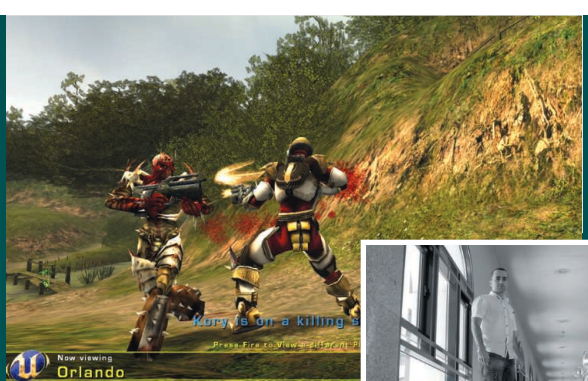
Don't worry, it's just a game. But playing it could save lives. Games with ulterior motives such as teaching or training people—known among researchers as "serious games"—are on the rise, providing a cheap and safe supplement to on-the-job training. But serious games face "big problems" because of their simple programming, says Joost Westra, a computer scientist at Utrecht University in the Netherlands. In a real fire, there can be hundreds of people making unpredictable decisions all around you. Yet the nonplayer characters (NPCs) in the games usually follow tightly scripted behaviors, so unless you play exactly as the programmer expects, NPCs behave like confused robots. Another flaw in serious games is that they use "fixed scenarios or simple rules to determine the course of the game," says Westra. "Expert users can quickly estimate how the game will react to their actions" but still must play through the easy levels to reach their proper level. The result, he says, is "disengagement, boredom, and possibly quitting the game before that level is reached."

To fix these problems, Westra created a new architecture for serious games that uses artificial-intelligence (AI) techniques similar to those in some of the latest video games. He focused on a game called RescueSim, a serious game for firefighters. Rather than following scripts, Westra's code turns each NPC into an autonomous agent with its own nuanced goals, responding to events as they happen. An NPC firefighter, for example, will have the goal of extinguishing a fire but can switch to helping an injured comrade if no one else is near. An NPC's awareness of what the game's player and the other agents are doing is crucial, Westra says, because firefighting requires teamwork. One firefighter must turn on the pump while another keeps doors closed to prevent drafts that feed the fire; yet another must operate the hose.

In early testing of the system, the AI architecture shows promise. Not only does it make NPCs act reasonably, Westra says, but the entire game can also now adapt to different users. Beginners take on only simple jobs while NPCs take care of the rest; expert players must learn to command a crew in complex situations. "A game needs to be built with this architecture from the beginning," says Westra, who plans to design a "bush fire team training" game with collaborators in Turkey.

Trial by fire. A so-called serious game trains rescue workers at a factory blaze.

"This is the future of serious games," says Kyong Jin Shim, a computer scientist at the University of Minnesota, Twin Cities, who is developing such a system for training U.S. soldiers. "We need smarter agents and in-game characters." **–J.B.**



The humans are dead! A Spanish team (*right*) won this year's 2K BotPrize.

skills, like attention and learning," says Raúl Arrabales Moreno, a computer scientist at the University Carlos III of Madrid. The bot has a set of innate behaviors that are regulated by a higher control system, similar to the role of a conscious mind. It was incorrectly identified as human by the judges 32% of the time. By comparison, one human player was incorrectly identified as a machine 35% of the time. "There is only a slender gap between the humans and bots now," says Hingston.

"There has been significant progress since the 2009 competition," says Simon Lucas, a computer scientist at the University of Essex in the United Kingdom and one of the human players in the contest. Besides creating more engaging computer-controlled opponents for mass-market video games, the goal is to create better AI agents for "serious games" that simulate natural disasters and other complex problems (see above). Lucas predicts that a bot will be fully indistinguishable from human players "within the next 2 years."

–JOHN BOHANNON

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