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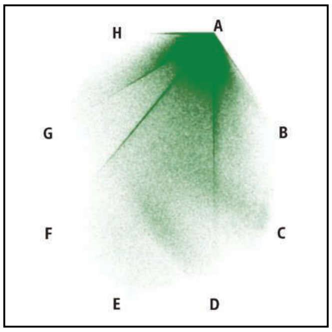
Game-Miners Grapple With Massive Data



Science, attack! Plotting data (*above*) from guilds in World of Warcraft—this one (*left*) is named Science—revealed the social evolution in that virtual world.

After describing his methods with dozens of mathematical formulae, Christian Thurau's next slide shows the result. It looks like a pile of fine metal dust in a magnetic field, revealing the invisible lines of force. This plot comes from the kind of data set that social scientists dream about: a flawless digital record of the social behavior of more than 10 million people interacting in a highly controlled setting over a 4-year period. But Thurau, a computer scientist at the Fraunhofer Institute for Intelligent Analysis and Information Systems in Bonn, Germany, never observed any of his research subjects, at least not in person. He harvested the data from World of Warcraft (WoW), the wildly popular online fantasy game.

It's called game-mining: digging for insights on human behavior in the terabyte-sized data logs generated by computer games. "You have over 10 million people playing World of Warcraft about 4 hours per day, 7 days a week," says Jaideep Srivastava, a computer scientist at the University of Minnesota, Twin Cities. "And that's on average; some play 80 hours per week!"

Because players' interactions are automatically recorded in WoW and many similar virtual worlds, researchers can use these massively multiplayer online games as natural laboratories. But the data are a challenge to interpret. Thurau's WoW study is a case in point. His goal was to reveal the evolution of WoW's guilds, the groups that players voluntarily form with each other to socialize, share resources, and slay monsters. Just the basic demographic information associated with the guilds amounted to 192 million 70-dimensional data points that represent information on the levels, skills, and activities of the players. "How do we make sense of that?" asks Thurau.

After failing with the classical techniques for finding patterns in high-dimensional data sets, he turned to a mathematical tool called archetype analysis, developed in the 1990s for physics and economics research. The original method failed at first because its computing time grows exponentially with the size of the data set, but Thurau devised a mathematical shortcut. The method works by identifying the most extreme data points—in this case, the guilds that are most different from each other—and describes the rest of the guilds as combinations of these archetypes. "It turns high-dimensional data into something that makes sense to humans," says Thurau.

CREDITS (LEFT TO RIGHT): WORLD OF WARCRAFT; CHRISTIAN THURAU

Killer Bots Are Getting Human

It was standing room only in the computer lab as intense violence played out on a giant screen. The game was Ultimate Tournament 2004, the classic multiplayer first-person shooter. But not all of the avatars blasting at each other were controlled by humans. Half of them were bots programmed by scientists in the room, nervously monitoring their programs for crashes. This was the third annual 2K BotPrize, a competition to create artificially intelligent game-playing agents that can fool a judge into believing they are human.

The contest is a variation on a classic test, first proposed in 1950 by computing pioneer Alan Turing, in which a judge has a conversation with a human and a computer and must decide which is which. The Turing test still defeats artificial intelligence (AI) 60 years later; machines largely remain terrible conversation partners.

Action-based video games can offer an alternative Turing test. "They don't require speech, they provide a highly constrained environment but are still a challenge for AI," says Philip Hingston, the computer scientist at Edith Cowan University in Perth, Australia, who organized the contest. The rules are simple: Avatars controlled by humans and bots are dropped in a complex environment littered with weapons. It's kill or be killed. Each round, some of the human players—the judges—must decide which of their opponents are machine-controlled, based solely on their behavior. The team that designed the bot best at fooling the judges wins the $5000 prize and a trip to Australia, funded by the game company 2K.

This year's prize was scooped by Conscious Robots, a team of Spanish computer scientists. Its bot represents a leap forward for game AI, says Hingston, because the team used machine consciousness, a technique rarely applied because of its complexity. Rather than just mimicking human behaviors—such as using imperfect aim or introducing randomness into running routes—the team's bot was designed to think like a human. "In our approach, we try to effectively integrate several cognitive

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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.**

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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