Artificially Intelligent Game Bots Pass the Turing Test on Turing's Centenary

An artificially intelligent virtual gamer created by computer scientists at The University of Texas at Austin has won the BotPrize by convincing a panel of judges that it was more human-like than half the humans it competed against.

The competition was sponsored by 2K Games and was set inside the virtual world of "Unreal Tournament 2004," a first-person shooter video game. The winners were announced this month at the IEEE Conference on Computational Intelligence and Games.

"The idea is to evaluate how we can make game bots, which are nonplayer characters (NPCs) controlled by AI algorithms, appear as human as possible," said Risto Miikkulainen, professor of computer science in the College of Natural Sciences. Miikkulainen created the bot, called the UT^2 game bot, with doctoral students Jacob Schrum and Igor Karpov.

The bots face off in a tournament against one another and about an equal number of humans, with each player trying to score points by eliminating its opponents. Each player also has a "judging gun" in addition to its usual complement of weapons. That gun is used to tag opponents as human or bot.

The bot that is scored as most human-like by the human judges is named the winner. UT^2, which won a warm-up competition last month, shared the honors with MirrorBot, which was programmed by Romanian computer scientist Mihai Polceanu.

The winning bots both achieved a humanness rating of 52 percent. Human players received an average humanness rating of only 40 percent. The two winning teams will split the $7,000 first prize.

The victory comes 100 years after the birth of mathematician and computer scientist Alan Turing, whose "Turing test" stands as one of the foundational definitions of what constitutes true machine intelligence. Turing argued that we will never be able to see inside a machine's hypothetical consciousness, so the best measure of machine sentience is whether it can fool us into believing it is human.

"When this 'Turing test for game bots' competition was started, the goal was 50 percent humanness," said Miikkulainen. "It took us five years to get there, but that level was finally reached last week, and it's not a fluke."

The complex gameplay and 3-D environments of "Unreal Tournament 2004" require that bots mimic humans in a number of ways, including moving around in 3-D space, engaging in chaotic combat against multiple opponents and reasoning about the best strategy at any given point in the game. Even displays of distinctively human irrational behavior can, in some cases, be emulated.

"People tend to tenaciously pursue specific opponents without regard for optimality," said Schrum. "When humans have a grudge, they'll chase after an enemy even when it's not in their interests. We can mimic that behavior."

In order to most convincingly mimic as much of the range of human behavior as possible, the team takes a two-pronged approach. Some behavior is modeled directly on previously observed human behavior, while the central battle behaviors are developed through a process called neuroevolution, which runs artificially intelligent neural networks through a survival-of-the-fittest gauntlet that is modeled on the biological process of evolution.

Networks that thrive in a given environment are kept, and the less fit are thrown away. The holes in the population are filled by copies of the fit ones and by their "offspring," which are created by randomly modifying (mutating) the survivors. The simulation is run for as many generations as are necessary for networks to emerge that have evolved the desired behavior.

"In the case of the BotPrize," said Schrum, "a great deal of the challenge is in defining what 'human-like' is, and then setting constraints upon the neural networks so that they evolve toward that behavior.

"If we just set the goal as eliminating one's enemies, a bot will evolve toward having perfect aim, which is not very human-like. So we impose constraints on the bot's aim, such that rapid movements and long distances decrease accuracy. By evolving for good performance under such behavioral constraints, the bot's skill is optimized within human limitations, resulting in behavior that is good but still human-like."

Miikkulainen said that methods developed for the BotPrize competition should eventually be useful not just in developing games that are more entertaining, but also in creating virtual training environments that are more realistic, and even in building robots that interact with humans in more pleasant and effective ways.

University of Texas at Austin [1]

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