BotPrize 2012 Champion: A Human-like Bot for Unreal Tournament

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Abstract

The famous Turing Test poses the question of whether a computer can fool people into believing it is human via a text conversation. In contrast, the BotPrize competition posed the question of whether a computer playing a First-Person Shooter video game (Unreal Tournament 2004) could convince other players it was human. The competition ran for 5 years before the question was answered in the affirmative: The bot that tricked players into thinking it was human over 50% the time is presented, and now you have the chance to see if you can distinguish between the human and the bot.

1 BotPrize

- An international competition started in 2008: `http://botprize.org/`.
- A Turing Test for game bots: goal is to see if a game bot can convince humans that it is human.
- 3D First-Person Shooter Unreal Tournament 2004 used as test domain.

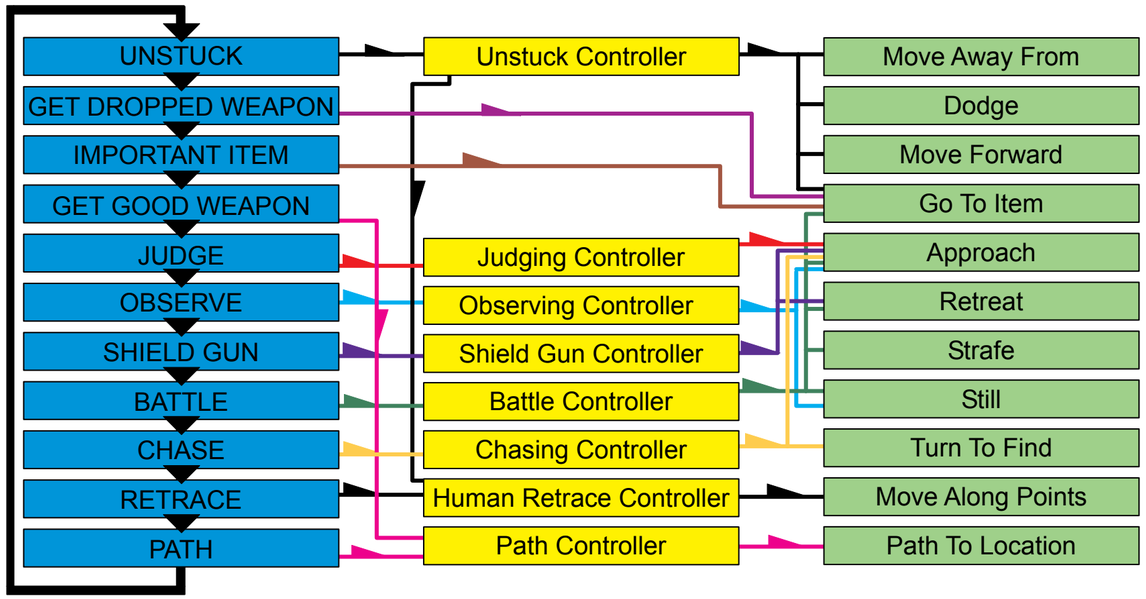
Opponents preparing for combat in Unreal Tournament

- Human players (and bots) have access to judging gun used to tag opponents as human or bot.
- Bot with the highest percentage of human tags after several matches wins the competition.
- Grand prize is only won by bot that is tagged as human over 50% of the time.
- Grand prize was won for the first time in 2012 by bot named `UT^2` [2, 3], for **U**niversity of **T**exas in **U**nreal **T**ournament.

2 Bot Design

- `UT^2` used a modular architecture similar to a behavior tree, so that high-level behaviors could be easily prioritized.
- Navigation was based on a mixture of A* search and replay of human traces.
- Combat behavior was learned using multiobjective neuroevolution.
- Because bots had access to the judging gun, `UT^2` pretends to play the judging game.
- Behaviors were constrained to prevent super-human levels of performance.

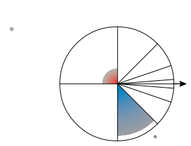
3 Bot Architecture



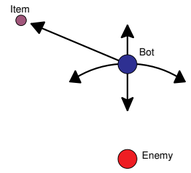
Modules on the left are listed in decreasing priority order. If the trigger for a module fires, then the appropriate controller in the middle column activates. Each controller has access to some set of simple actions listed on the right.

4 Evolved Combat Behavior

- Battle Controller selects movement actions according to an evolved neural network.
- Many sensors were used: range finders for walls, pie-slice sensors for opponents, etc.
- Movement actions are ego-centric, but also opponent-relative (e.g. approach opponent, strafe left around opponent, etc.) in order to encourage the bot to focus on one opponent.



Activation of pie-slice sensors.

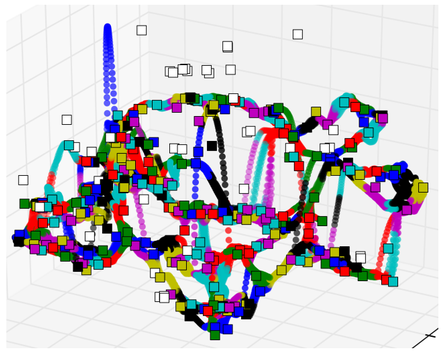


Available movement actions.

- Movement actions are further constrained based on surroundings, e.g. the bot will not back away into a wall.
- Evolutionary algorithm used is a combination of NeuroEvolution of Augmenting Topologies (NEAT [4]) and Nondominated Sorting Genetic Algorithm II (NSGA-II [1]).
- Multiple objectives: maximize damage dealt, minimize damage received, and minimize wall collisions.
- Controller constrained to pick an appropriate weapon based on distance from opponent.
- Shooting accuracy of bot depends on movement speed and distance from target, thus discouraging evolution of inhuman aiming skill.

5 Replay of Human Traces

- Human traces for specific levels can be replayed to get unstuck or explore levels.
- Database of traces collected from both standard matches, and when exploring levels without opponents present.

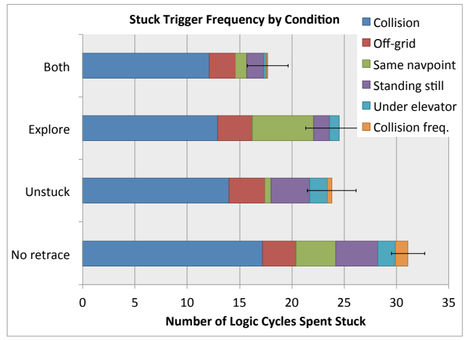


Human traces for a single level.

- Traces in the presence of opponents are filtered out of database.
- Traces indexed by nearest navpoint and stored in KD-Trees.
- If a trace runs out, or fails to replay properly, then another is selected.
- Navigation with A* search used when no trace is available.

5 Replay of Human Traces (continued)

- Use of human traces results in the bot getting stuck less often.



Using human traces for exploration, to get unstuck, or for both means the bot gets and stays stuck less often.

6 Final Results

The BotPrize competition ran for five consecutive years with the gap between humans and bots gradually closing. In the 2012 competition, two bots won the grand prize with humanness ratings above 50%: `MirrorBot` and `UT^2`.

`MirrorBot`	52.2%
`UT^2`	51.9%
`ICE-CIG2012`	36.0%
`NeuroBot`	26.1%
`GladiatorBot`	21.7%
`AMISBot`	16.0%

Note that although `MirrorBot` achieved a slightly higher humanness rating, `UT^2`'s rating was based on slightly more judgments (27 for `UT^2` vs. 23 for `MirrorBot`). In any case, both are far beyond the next highest rating of 36.0%.

7 More Information

- Download `UT^2`: `http://nn.cs.utexas.edu/?ut2`
- Videos: `http://nn.cs.utexas.edu/?botprize2012`

References

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[2] J. Schrum, I. V. Karpov, and R. Miikkulainen. UT^2: Human-like Behavior via Neuroevolution of Combat Behavior and Replay of Human Traces. In *Proceedings of the IEEE Conference on Computational Intelligence and Games (CIG 2011)*, pages 329–336, Seoul, South Korea, September 2011. IEEE.

[3] J. Schrum, I. V. Karpov, and R. Miikkulainen. Humanlike Combat Behavior via Multiobjective Neuroevolution. In P. F. Hingston, editor, *Believable Bots*, pages 119–150. Springer Berlin Heidelberg, 2012.

[4] K. O. Stanley and R. Miikkulainen. Evolving Neural Networks Through Augmenting Topologies. *Evolutionary Computation*, 10(2):99–127, 2002.