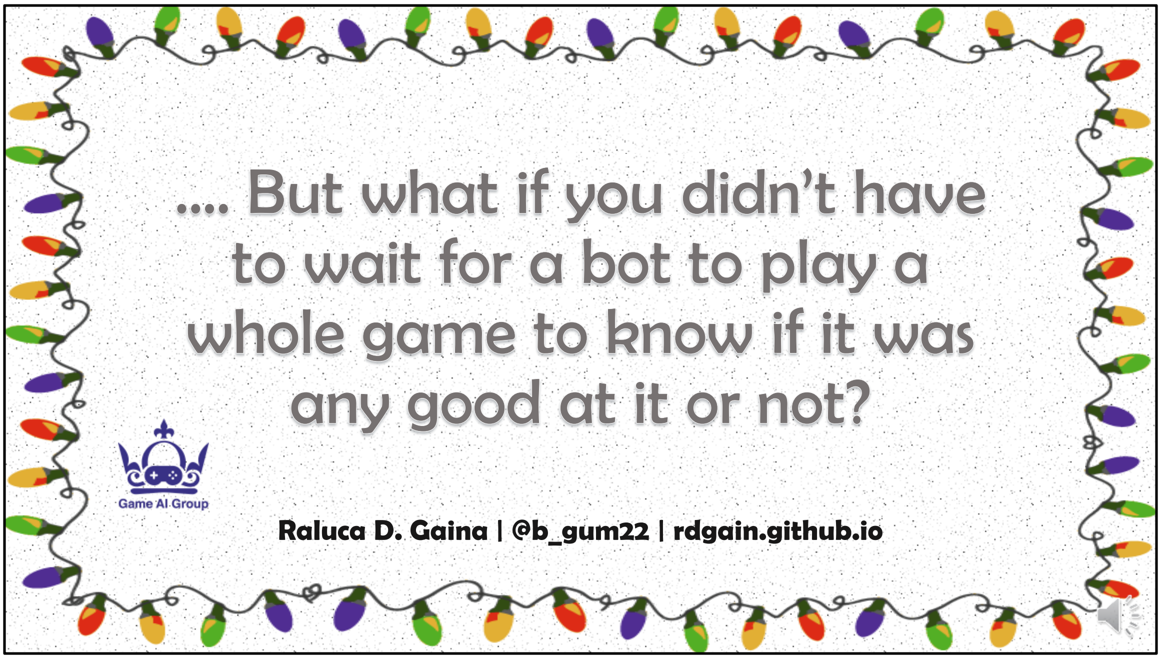
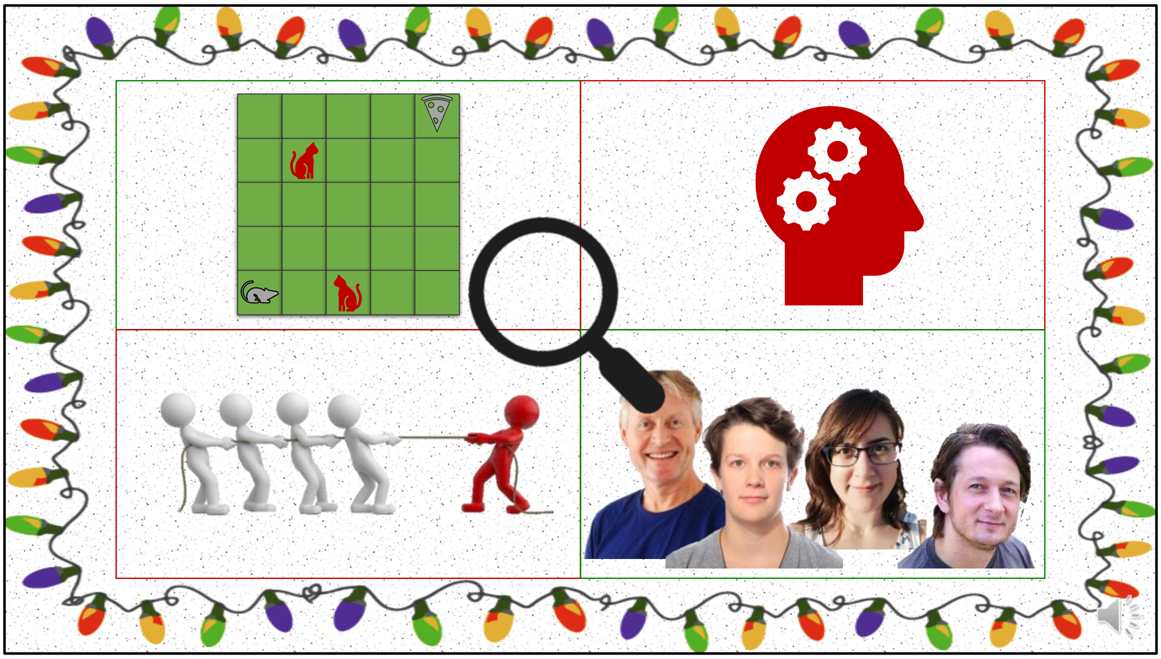


Usually people talk about AI as AI bots playing games, and getting very good at it and at dealing with difficult situations us evil researchers put in their ways. But that often involves waiting a while for the bot to actually finish playing the game, whether you're interested to see how good the bot is, or how good a game you've built is, when you use the bot to test games instead. With modern games becoming huge spaces to be explored, that is harder and harder to do.

But what if you didn't have to wait for a bot to play the whole game to know the result?

Event: https://www.qmul.ac.uk/events/items/2018/game-ai-unleashed.html

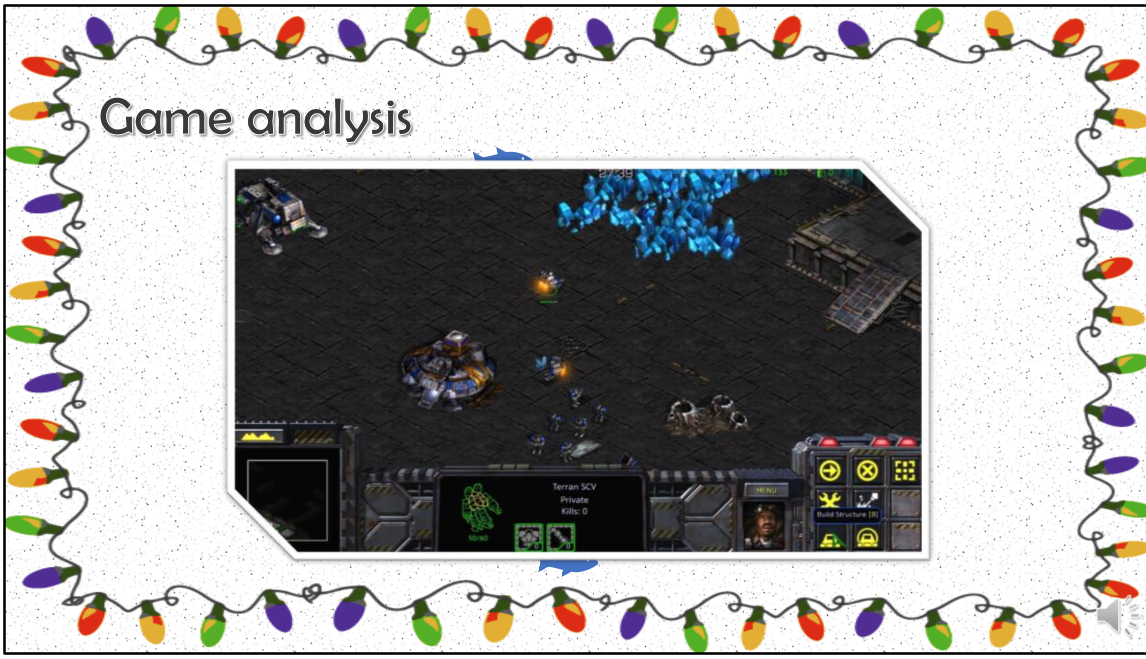
I'm going to talk a little bit about the magic behind win prediction – that is, guessing if the bot playing a game is going to win or not by the end, without waiting for the game to actually finish.



I've split this area into 4 rough sections, in which we could analyse…

- The game itself – looking at how different objects or characters are placed around us
- The brain of the bot – looking at its decision making process and getting it to explain the decisions it makes
- The behaviour of the opponent (in multiplayer games) – looking at how well the opponent is playing, or what strategy it's using
- Human gameplay – looking at many many games played by humans to predict the outcome of a game, maybe even before the game starts, based on the initial setup, like character selection (it may be that some characters are better than others)

I won't go into details on all of them, but let's dive into some examples!

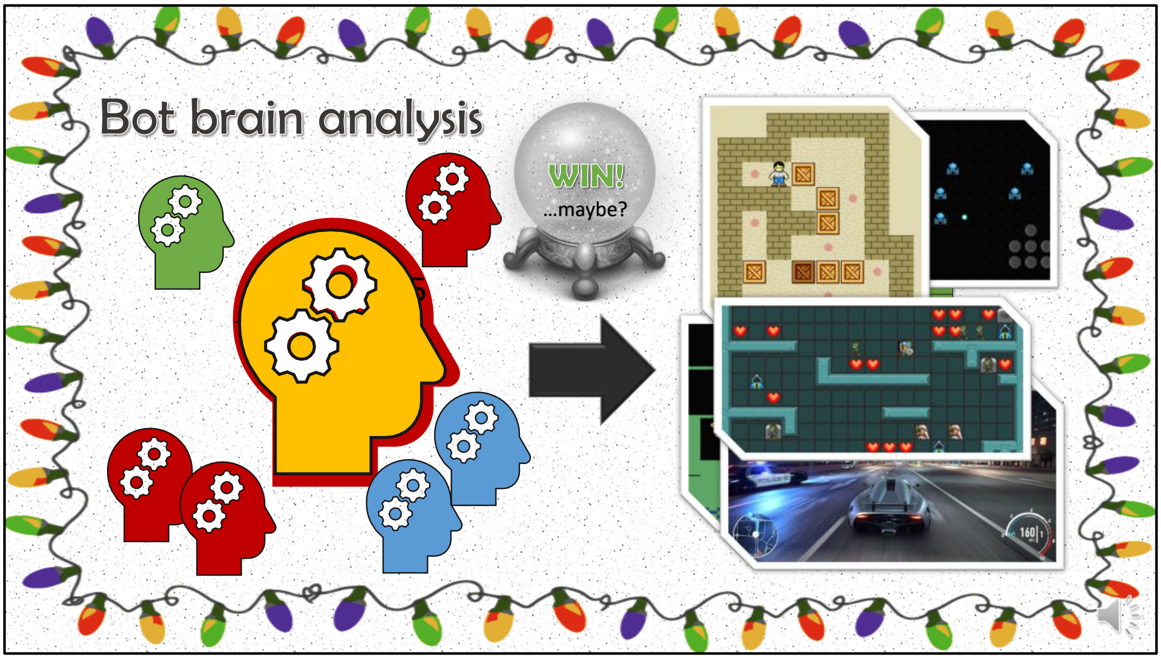


Analysing the game state – so what the player currently sees around it, such as how the trees are placed, how far away the enemies are or if the enemies are inbetween the player and the treasure they have to collect. This is the most common method used by bots, what they do when they play to guide themselves towards winning the game. Often times it's not straight forward to know at any point in the game if you're going to win or not – but human knowledge about the game can be used to define equations that tell the bots how good any particular game state actually is.

For example, if we had this game on the slide, where you're the little mouse in the bottom-left corner, and your goal is to avoid the cats, which would catch you and make you lose the game, you have to go around the trees, through which you can't pass, and finally make it to the delicious cheese waiting in the top-right corner. In this game, it's fairly easy to see that if there are no more enemies in the level, and you have a clear safe path to the treasure, then that's a pretty good situation to be in!

But you might think – hold on a moment, that's not a real game! Well this same theory *is* applied to "real games" too, like Starcraft! Vanessa here has done some interesting work on using information that the bots receive about the game (such as the current score in the game, the total damage dealt, the number of minerals collected, and many more) – all this information, which we call “features”, can be used to correctly predict if the bot is going to win a game or not, with about 70% confidence after 20 minutes of playing the game.

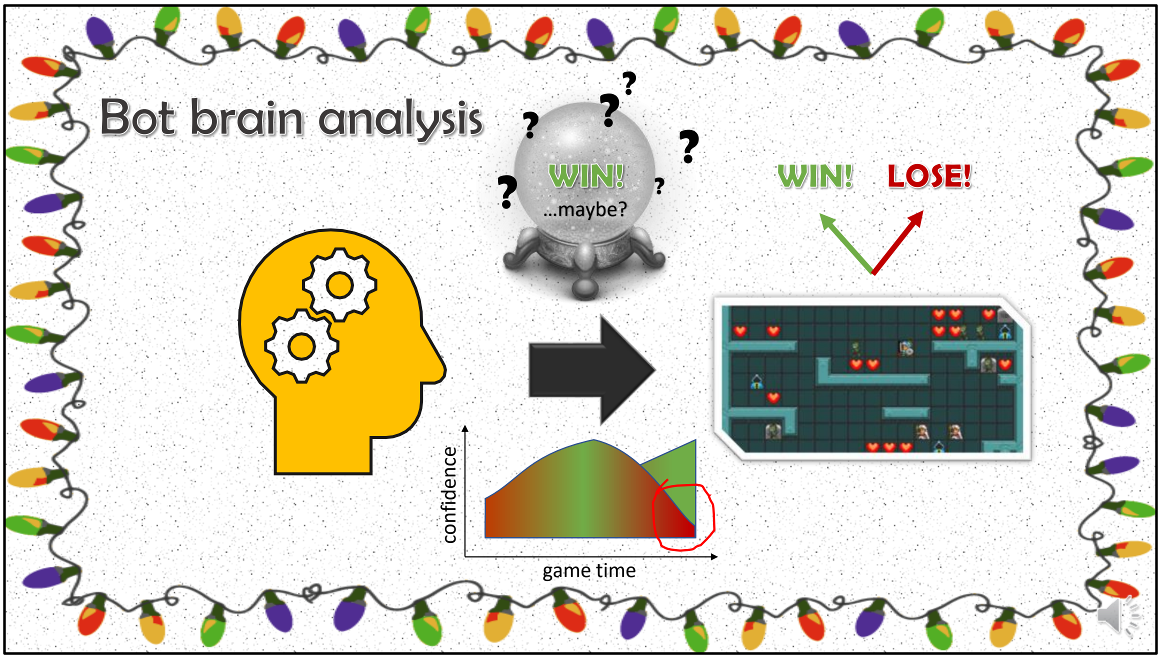
Find out more:
- https://pdfs.semanticscholar.org/87a6/71703c7ed169ab96528854edbeb9627df81c.pdf
- Any paper covering value functions, e.g. https://storage.googleapis.com/deepmind-media/alphago/AlphaGoNaturePaper.pdf



Next, let's look at analysing the bot's brain. My own research recently touched on this.

- So the idea is that we have a bot playing a game, doing things, thinking what to do next
- Let's get more information out of it, all the good stuff: numbers, equations, graphs. Things that describe the bot's thinking process in more than 1 state: win or lose.
- And what if we had more brains, of different types, playing more games.
- Then we could have a magic ball – or, what we call a classifier – absorbing all the information and analysing it to see which type of information matches which type of game result; and so it is capable of predicting what happens in any given situation, with some degree of confidence.
- We could even predict if a new bot is going to win a new game while the play is happening.

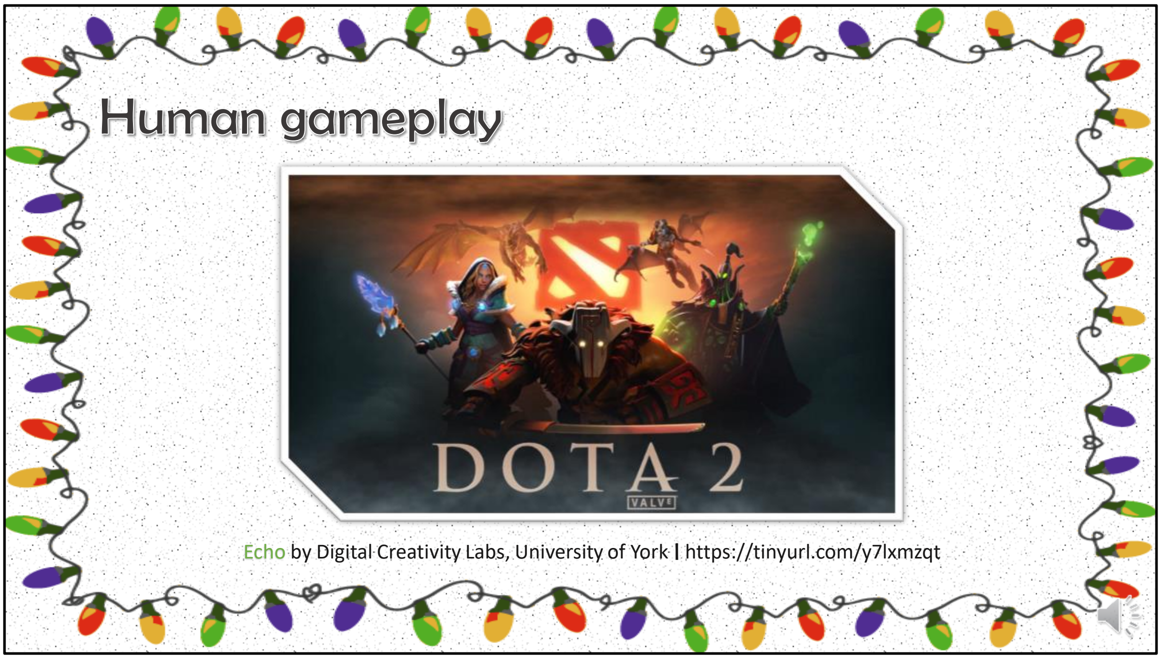
Find out more:
- https://rdgain.github.io/assets/pdf/general-win-prediction.pdf
- https://www.youtube.com/watch?v=zq9zaEjspUY



The prediction confidence changes over time, as may be expected. But the curve is not linear as you may think, which means the confidence starts at the lowest and slowly increases as the bot plays the game and gains more information about how the game actually works. A recent study I did showed this curve to be more mid-high-low in shape, on average.

The biggest difference is here, at the end, where it's a lot lower than we'd expect. And that, we think, is because our bots are greedy, and towards the end they know one of 2 things: they're going to win (and they do everything they can to win), or they're going to lose (and they do everything they can not to lose). So their behaviour changes dramatically from the middle of the game when they were happily exploring the game, trying to find out what happens in different situations – and this messes up with our magic ball predictor.

But generally this prediction system works as a first step, with many more improvements possible.



The last thing I'm going to talk about is prediction from human gameplay data. And we're going to look at what researchers have done in the game Dota 2. A first interesting system is Echo, developed by researchers at the University of York, in the Digital Creativity Labs. Echo is a tool used for visualisation of statistics about the current game being played, which help those who are not so familiar with the game understand better what is going on and if a move made by one player was actually good or not, as this may not be completely clear. This tool was used for the first time in a competitive tournament, ESL Hamburg, last year, with great feedback from the viewers. Additionally, researchers from York work on win prediction from human matches: looking at win rates of various characters in the context of the whole team chosen for a game.

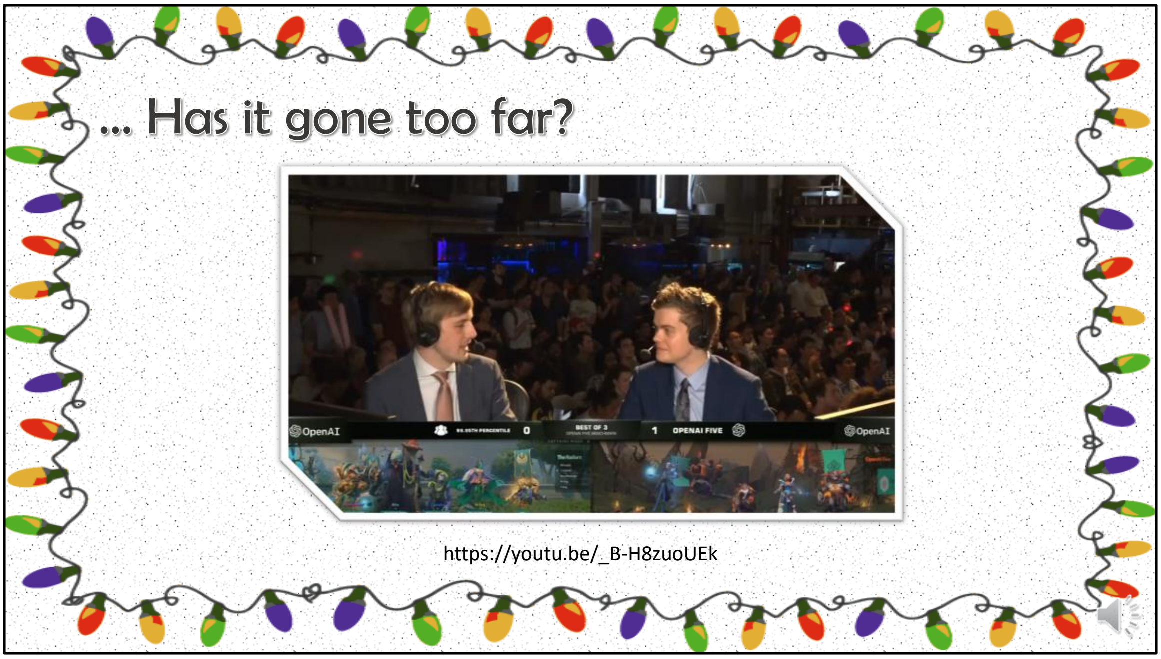
Find out more:

- http://eprints.whiterose.ac.uk/124333/1/ArXiv_1711.06498.pdf
- https://www.digitalcreativity.ac.uk/projects/win-prediction-esports
- https://esportsinsider.com/2018/05/dr-florian-block-university-of-york-researching-esports/
- https://www.digitalcreativity.ac.uk/projects/%E2%80%98glance%E2%80%99-visualizing-dota-2

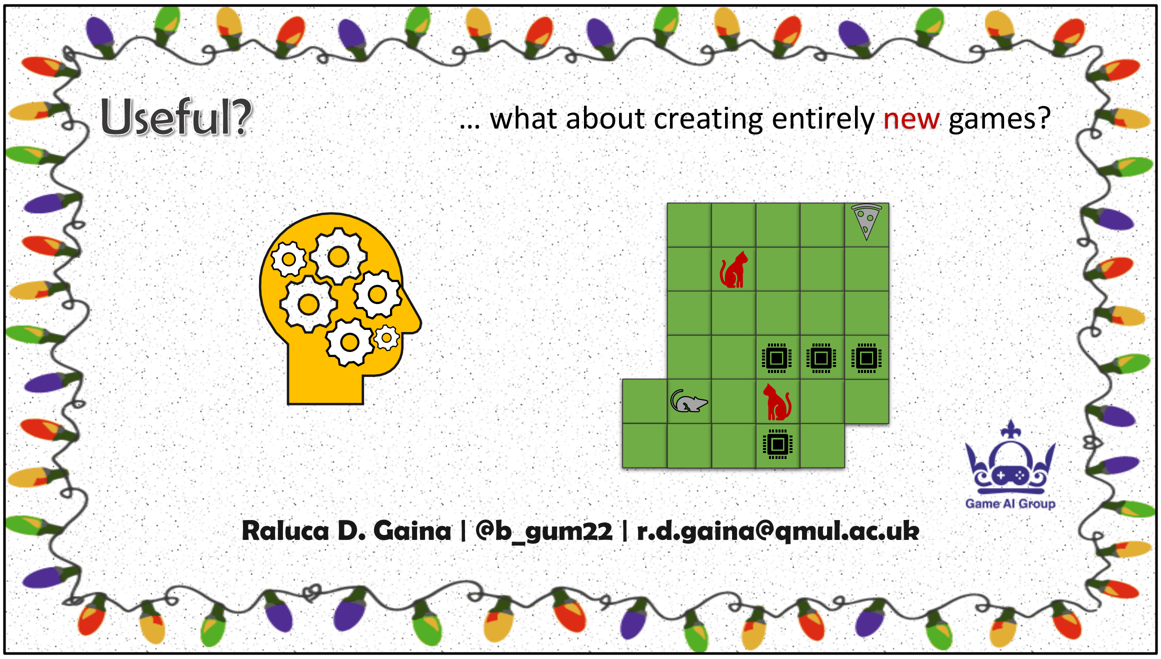
Another win prediction system in Dota2 was shown off by OpenAI and their full team of 5 bots playing the game of Dota2 against humans. We can see this in action while the selection of characters before the match is going on – the different numbers you're about to see showcase the confidence of the bots winning if that particular character was chosen. This is again based on a history of human matches, as well as the bots own period of training - or practicing - for the match. So the bots learn from all games they play and improve this prediction of what might work, and what might not, based on their experience.

Find out more:

- https://blog.openai.com/openai-five/
- https://openai.com/five/
- https://blog.openai.com/openai-five-benchmark-results/



… But has the bots learning gone too far? Here we can see the bots learning to pause the match, for no apparent reason – except that the humans had paused the match in a previous game, and they thought “hey! That’s an interesting strategy, let’s use it!”



Is this whole area of research actually useful though? I would argue that it is. And we can use it in 2 ways: Making bots smarter and more adaptive to games, for better bots.
But we could also use it in game design, and procedural content generation, for better games.

- And this is only *one* thing that could help improve games
- But what about creating entirely new ones…? → transition to Vanessa Volz and Simon Colton talking about PCG and computational creativity.

Find out more:

- https://arxiv.org/pdf/1803.01403.pdf
- https://arxiv.org/pdf/1805.00728.pdf
- https://youtu.be/NObqDuPuk7Q

Find out more about the group's work at: gameai.eecs.qmul.ac.uk