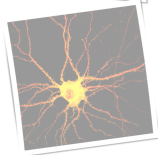
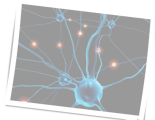
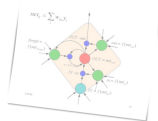
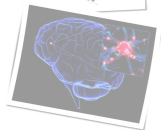


Games and Competitions

Spyros Samothrakis
Research Fellow, IADS
Univerisity of Essex

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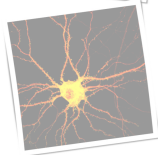
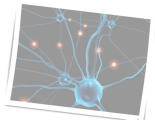
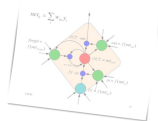
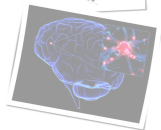


Games as a research tool

Narrow competitions

General competitions

The future of competitions



GAMES AS A RESEARCH TOOL

- ▶ Almost every Game AI paper begins with something along these lines:
- ▶ “Games have/can be used for Artificial Intelligence Research”
 - ▶ Because games are:
 - ▶ Fun (!)
 - ▶ Provide nice abstractions of real world problems
 - ▶ Are universally accepted
 - ▶ Easy to compare with other researchers’ AIs/agents
- ▶ Let’s have an overview of the modern history of game research

ZERMELO

- ▶ First important result by *Ernst Zermelo*, 1913
- ▶ Uses the game of chess as an abstraction
- ▶ Kickstarts game theory - of course no real computers
- ▶ “Given that a player (say White) is in ‘a winning position’, how long does it take for White to force a win?”
- ▶ Wikipedia cites the correct papers, has the definitions are mixed-up with ...



VON NEUMANN

- ▶ Modern tools actually invented in *John von Neumann, 1944* or possibly *1928*
- ▶ Backwards Induction
- ▶ You must have heard it as “min-max” - again, no real computers at the time
- ▶ Poker and bluffing are discussed as well



TURING

- ▶ Most modern additions to min-max pioneered by *Alan Turing, 1953*
- ▶ Learning, look-aheads, evaluation functions
- ▶ No fast computers at the time
- ▶ But the potential was well understood



FROM THEORY TO PRACTICE

- ▶ From this point onwards, there was a race
- ▶ Fundamentally asking the question
 - ▶ “Can we use computers to actually do what was conceptualised in theory”
 - ▶ i.e., can we create super-human machines?
 - ▶ Chess - *IBM Deep Blue*, 1996
 - ▶ Head's Up Holdem (Poker) *University of Alberta*, 2015
 - ▶ Go *Deep Mind*, soon - apparently Japanese competitor?
- ▶ 50-60 years between theoretical breakthroughs and actual implementations

WHERE DID ALL THIS RESEARCH GET US?

- ▶ Most classic games will be/are solved
- ▶ But what does it mean for Artificial Intelligence?
 - ▶ Narrow approaches for building narrow systems
 - ▶ Chess
 - ▶ General approaches for building narrow systems
 - ▶ Backgammon, Poker, *Maybe* GO
 - ▶ *narrow approaches for building general systems*
 - ▶ Nothing

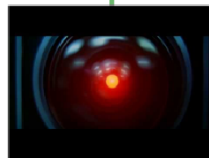
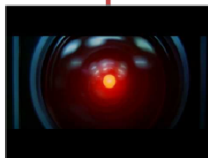
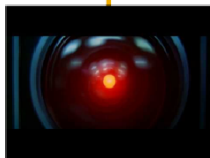
ENTER COMPETITIONS

- ▶ Implicitly one can think of these “races to the top” as competitions
- ▶ Competitions are the most anti-intellectual thing you can do
 - ▶ Adolescent/childish idea of “I can run faster than you”
 - ▶ When it comes to algorithms, it’s mostly “My dad is stronger than your dad”
- ▶ But there is value
- ▶ You need some way to measure progress
 - ▶ The debate about which algorithm has better qualities can go on forever
 - ▶ At least we have some measurement of quality

SOME MODERN VIDEO GAME AI COMPETITIONS

- ▶ Pacman
 - ▶ <https://www.youtube.com/watch?v=Zo0YujjX1PI>
- ▶ Tron (two-player!)
 - ▶ <https://www.youtube.com/watch?v=Jyys22xoWDI>
- ▶ Simulated Car Racing
 - ▶ <https://www.youtube.com/watch?v=aZqswgdsNic>
- ▶ Mario AI
 - ▶ <https://www.youtube.com/watch?v=DlkMs4ZHHr8>
- ▶ Starcraft
 - ▶ <https://www.youtube.com/watch?v=S7Lgwn5tIng>
- ▶ There are others....

SOME MODERN AI COMPETITIONS (NARROW AI)



TOO NARROW

- ▶ You need to develop one agent for each game
- ▶ Each agent would have its own model, heuristics etc
- ▶ The methods involved in agent creation can be a “dump” of the programmer’s expertise
- ▶ Hence the “narrow methods for narrow systems”
- ▶ Some competitors go in with general methods, but it’s up to them

STATE OF THE ART IN GAME AI

- ▶ Some form of short-horizon local dataset (MCTS, A^*)
- ▶ Coupled with premature stopping (a value function)
- ▶ Some ability to do fast, guided lookaheads (a pre-learned policy)
- ▶ System seeded from real human plays
- ▶ Heavy use of reinforcement learning, machine learning (e.g., neural networks)

GENERAL GAME PLAYING

- ▶ As a response to this perceived “narrowness”, the general game competition was born
 - ▶ <http://games.stanford.edu/>, 2005
- ▶ There is a coursera course about this:
 - ▶ <https://www.coursera.org/course/ggp>
- ▶ Two-player board-like games where agents get to compete against each other
- ▶ Agents don't know the games a-priori
- ▶ But they are given the *model* at the beginning of each game

GENERAL VIDEO GAME PLAYING COMPETITION (I)

- ▶ But how about video games?
- ▶ The general video game competition (GVG-AI)
- ▶ Lunched some years ago
 - ▶ <http://gvgai.net/>
- ▶ Let's see some videos:
 - ▶ <https://www.youtube.com/watch?v=AMsk28dXA3A&list=PLe89c3ir1UJcgr04LxvD09UVR93GIXMws>

GENERAL VIDEO GAME PLAYING COMPETITION (II)



GENERAL VIDEO GAME PLAYING COMPETITION (III)

- ▶ Agents are given a model!
- ▶ 3 Game Sets, 10 games each, 5 levels per game
- ▶ Training Set: 10 games distributed with the framework
- ▶ Validation Set: 10 games, unknown to the participants
- ▶ Test Set: 10 games, unknown, and only executed in once

GENERAL VIDEO GAME PLAYING COMPETITION (IV)

- ▶ GVGAI 2014 Competition:
 - ▶ 23 entries
 - ▶ Winner: Adrien Couetoux (51.2%; OLETS) [Perez et al., 2015]
- ▶ GVGAI 2015 Competition:
 - ▶ ACM GECCO 2015 (July 2015)
 - ▶ 60 entries
 - ▶ Winner: YOLOBOT (63.8%; MCTS, BFS, Sprite Targeting Heuristic)
 - ▶ IEEE CIG 2015 (August 2015)
 - ▶ 77 entries
 - ▶ Winner: Return42 (35.8%; GA with heuristic, random walks, A*)
 - ▶ IEEE CEEC 2015 (September 2015)
 - ▶ 77 entries
 - ▶ Winner YBCriber (39.2%; Iterative Widening, Danger Avoidance)
 - ▶ 2015 GVGAI Winner: YOLOBOT (45.8% victories)

THE PROBLEM WITH THE MODEL

- ▶ I don't think having a model is “general”
- ▶ Better than one-game competitions of course
 - ▶ But both GG competitions use a model
- ▶ Atari 2600 games (no formal competition) can be used without a model
 - ▶ Used by Google as a benchmark



UPCOMING ADDITIONS

- ▶ Procedural content generation
 - ▶ “Can I create games that humans would like, given that a human behaves a bit like agent X”
 - ▶ ...or just generate something that looks good to humans?
 - ▶ New track for GVG-AI soonish!
- ▶ Two-player games
 - ▶ Two player games are super-addictive to competitors
 - ▶ A bit harder to setup, Elo scores etc.
 - ▶ Most games are two player games anyway
- ▶ A new “learning” track for GVG-AI
 - ▶ Later this year
 - ▶ Agents will be given training time and three levels to learn on
 - ▶ Testing will be on two different levels per game

WHAT ABOUT BELIEVABLE CHARACTERS

- ▶ Important for the gaming industry
- ▶ “Turing test” like competitions
 - ▶ Unreal Tournament
 - ▶ Real human playing in the game
 - ▶ Human judges must find if opposing players are bots or humans
- ▶ Might also need them in order to procedurally generate

CHARACTERISTICS OF A GOOD COMPETITION

- ▶ Competitions can be thought of as a formalisation of “Games as Benchmarks”
- ▶ Require good looking website
- ▶ Instant gratification
 - ▶ No human in the evaluation loop
 - ▶ Machines should be able
- ▶ A “competition slave”
 - ▶ Also called “organiser”!

TEXT

- ▶ Role Playing Games
- ▶ ...or text adventure games
- ▶ Allow agents to act on words as they are received
- ▶ Some new benchmarks (from Facebook) but no competitions
 - ▶ Neural Turing Machine, Memory Networks etc
- ▶ Maybe we should do more on this?

WHERE TO FROM HERE?

- ▶ Need better benchmarks
- ▶ Current competitions only scratch the surface of creating generally intelligent agents
- ▶ We need competition tailored towards general systems
 - ▶ *Without getting into the trap of "General approaches for narrow systems"*
 - ▶ Not sure how we can do this at the moment
 - ▶ Problems with learning systems (e.g. catastrophic forgetting, transfer learning)
 - ▶ Move to more than two agents

THANK YOU!

- ▶ Some of the images from Diego Perez/Julian Togelius et.al. talk
 - ▶ http://www.diego-perez.net/papers/aaai2016_gvgai.pdf
- ▶ Some ideas from Mile Brundage excellent blog post
 - ▶ <http://www.milesbrundage.com/blog-posts/alphago-and-ai-progress>
- ▶ Wikipedia articles on the subject could do with a bit of help, volunteers?