Games and Competitions

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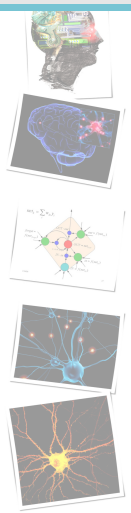
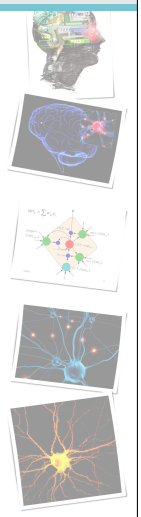


Games as a research tool

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

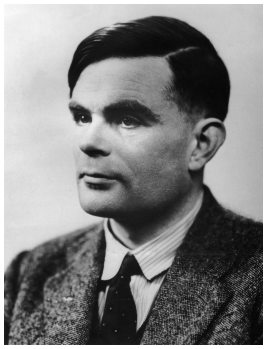
- First important result by *Ernst Zermelo, 1913*
- Uses the game of chess as an abstraction
- Kickstarts game theory - of course no real computers
- "Given that a player (say White) is in 'a winning position', how long does it take for White to force a win?"
- Wikipedia cites the correct papers, has 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

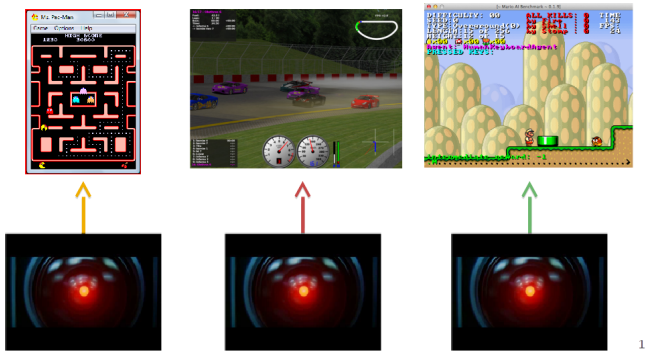
Enter competitions

- 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=ZoOYujjX1PI`
- 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)



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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)

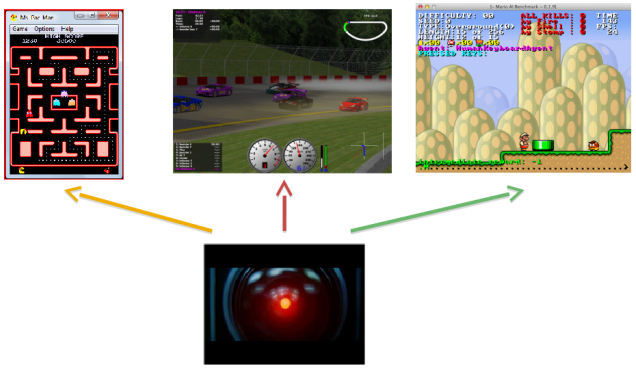
General Game Playing

- 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)



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General Video Game Playing Competition (III)

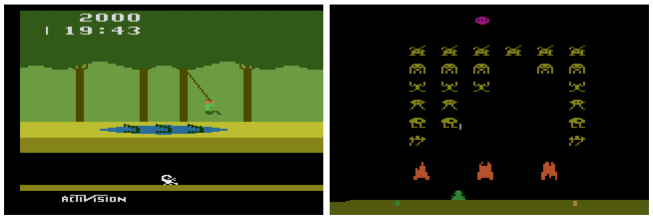
- Agents are given a model!
- 3 Game Sets, 10 games each, 5 levels per game
- Training Set: 10 games distributed with the framework
- Validation Set: 10 games, unknown to the participants
- Test Set: 10 games, unknown, and only executed in once

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?