Automated Game Playing

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Announcements

- Thursday Virtual Help Session for Assignment 5 (or other stuff) from 5pm to 8pm
- **Make-up oral exams for assignments on or before December 7th.**
- Quiz 5 returned by next week
- USRIs soon*
- Today: Automated Game Playing
- Wednesday: Generating Dialogue + Story
- Friday: AI-*based* Game Design (final lecture)
- (next) Monday: Quiz 6 (no class) and Assignment 5 due

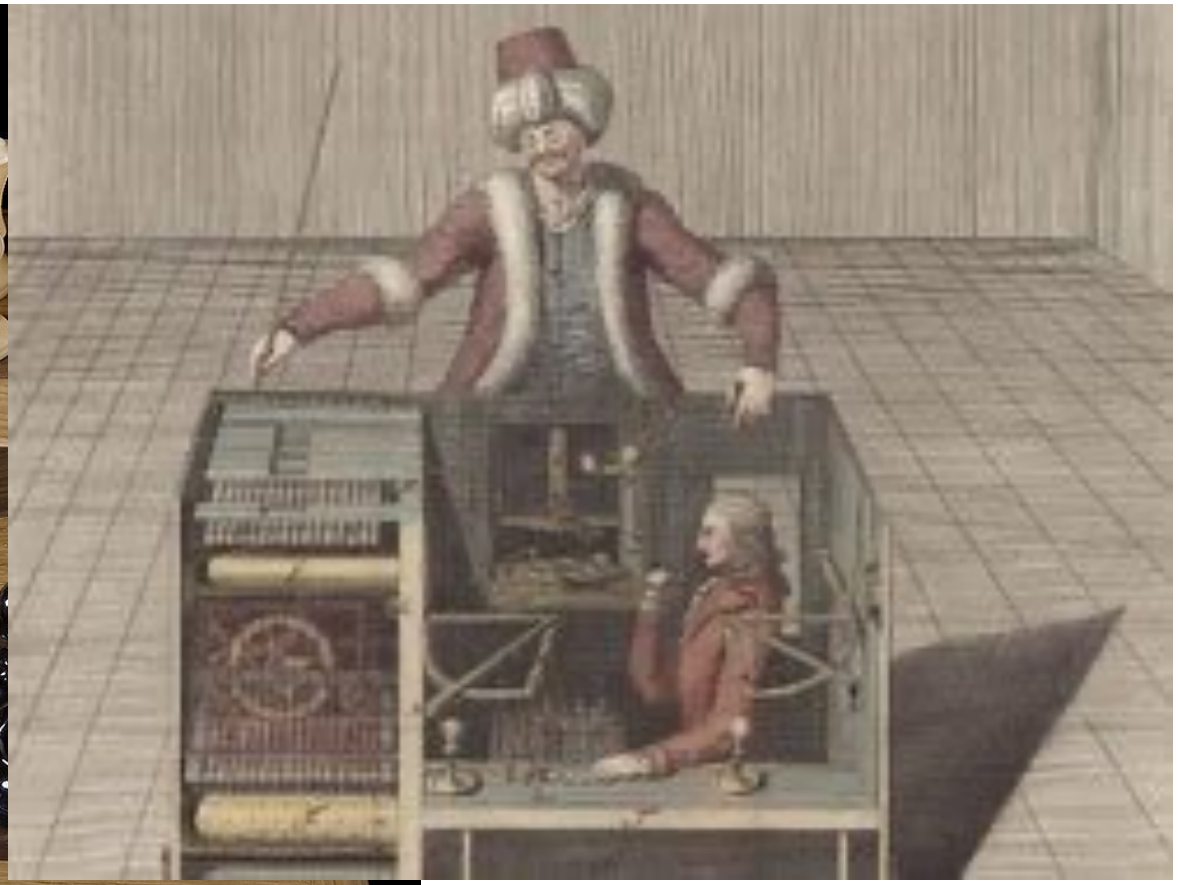
Quiz 5 Review

Today: Automated Game Playing

How to get an AI agent to take the role of a human player in a game?

Chess

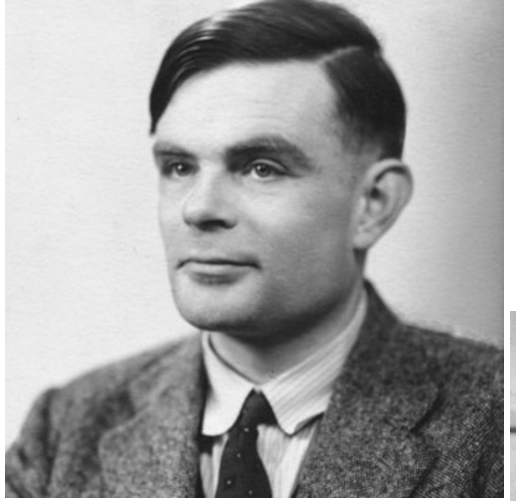
Chess



“Mechanical Turk” 1770

First “real” efforts

- 1940’s experiments: Alan Turing, John von Neumann, Claude Shannon
- 1951: Dietrich Prinz writes a program that solves the “mate in 2” problem (a heuristic)
- 1956: Dartmouth Conference ”begins” the field of AI research
- 1958: IBM Researcher Alex Bernstein writes the first chess bot (rule-based)



Alan Turing

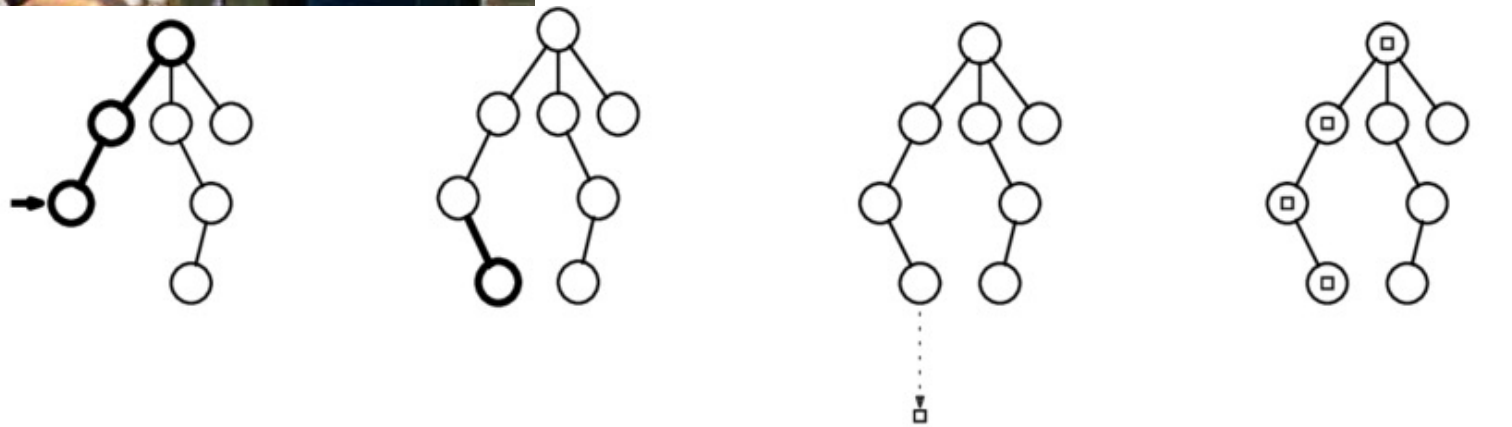
Dietrich Prinz

Alex Bernstein

Why this focus on chess?

These were all rich white guys who thought that the ability to play chess was the same as intelligence.

Deep Blue vs. Kasparov (1997)



Selection

Tree traversed using *tree policy*

Expansion

New node added to the tree (selected using the *tree policy*)

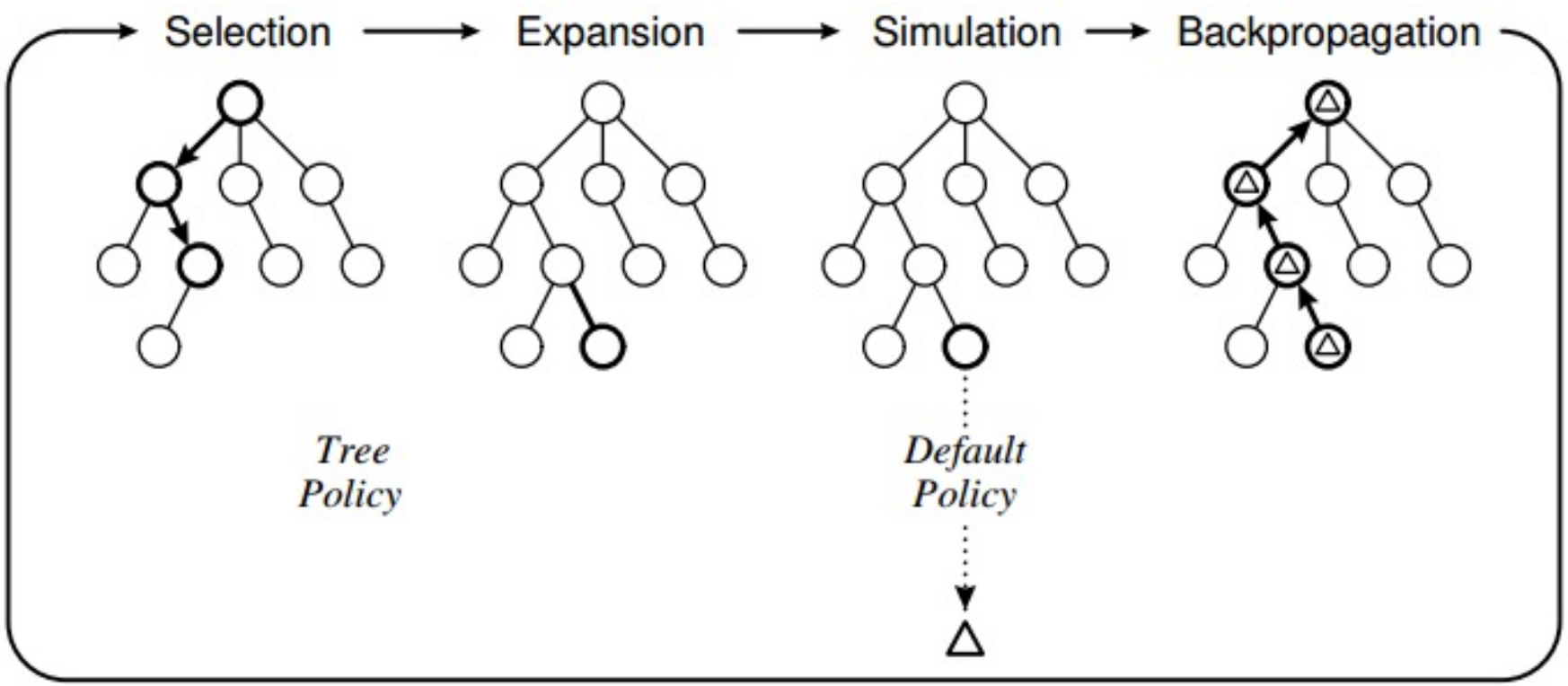
Simulation

Rollouts are played from new node using *default policy*

Back-propagation

Final state value is backpropagated to parent nodes

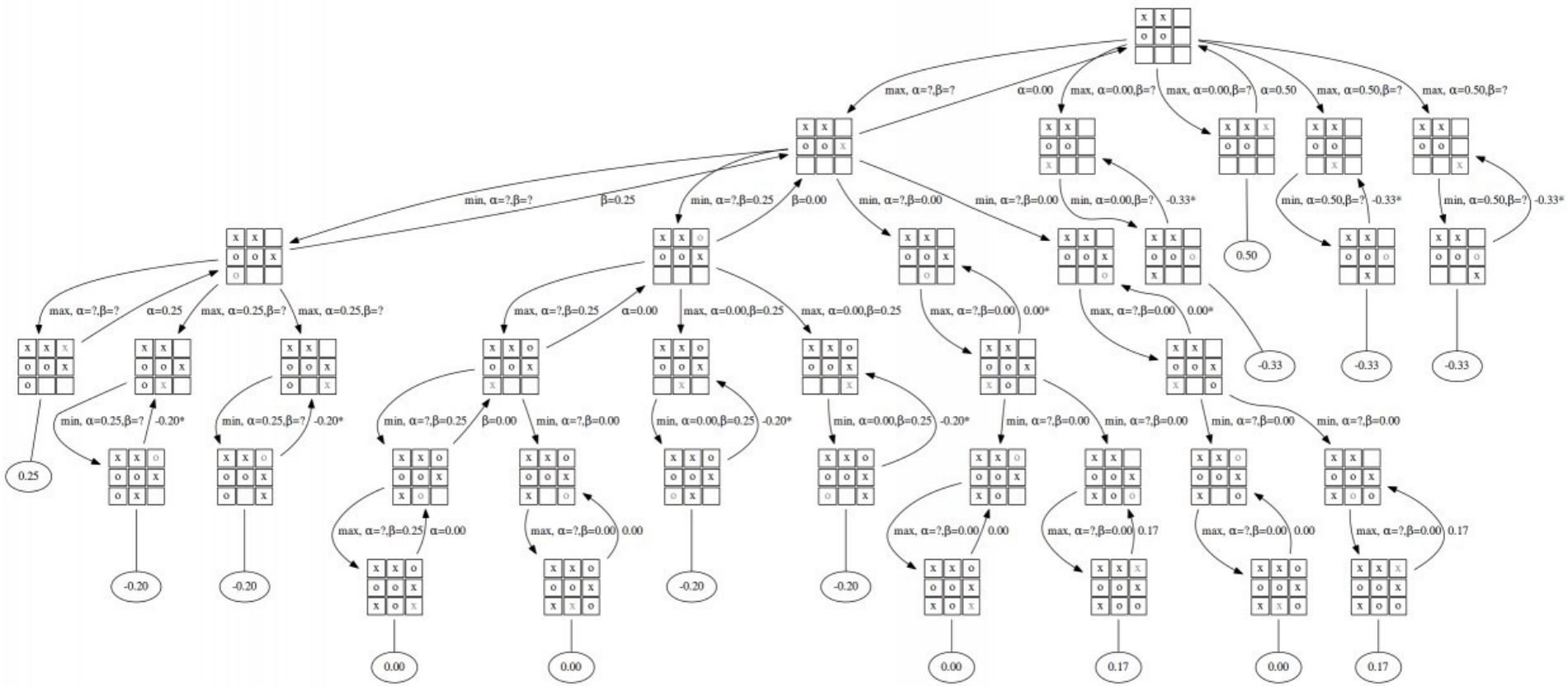
Monte Carlo Tree Search



MCTS Steps

1. **Selection**: Do one rollout of length *L* following the *Tree Policy* (may be random, authored, or learned).
2. **Expansion**: If we don't have a pre-authored tree, add each node to the tree as we encounter it.
3. **Simulation**: Either literally play/pathfind from here, or *approximate* the cost of pathfinding from here.
4. **Backpropagation:** Whatever the cost/reward of the final node, backpropagate that all the way to the first edge.

Tic-Tac-Toe MCTS Example



…but Deep Blue didn’t use MCTS!

…but it did use a similar “Monte Carlo” method, based on repeatedly sampling different actions to predict the best one.

Monte Carlo Sampling

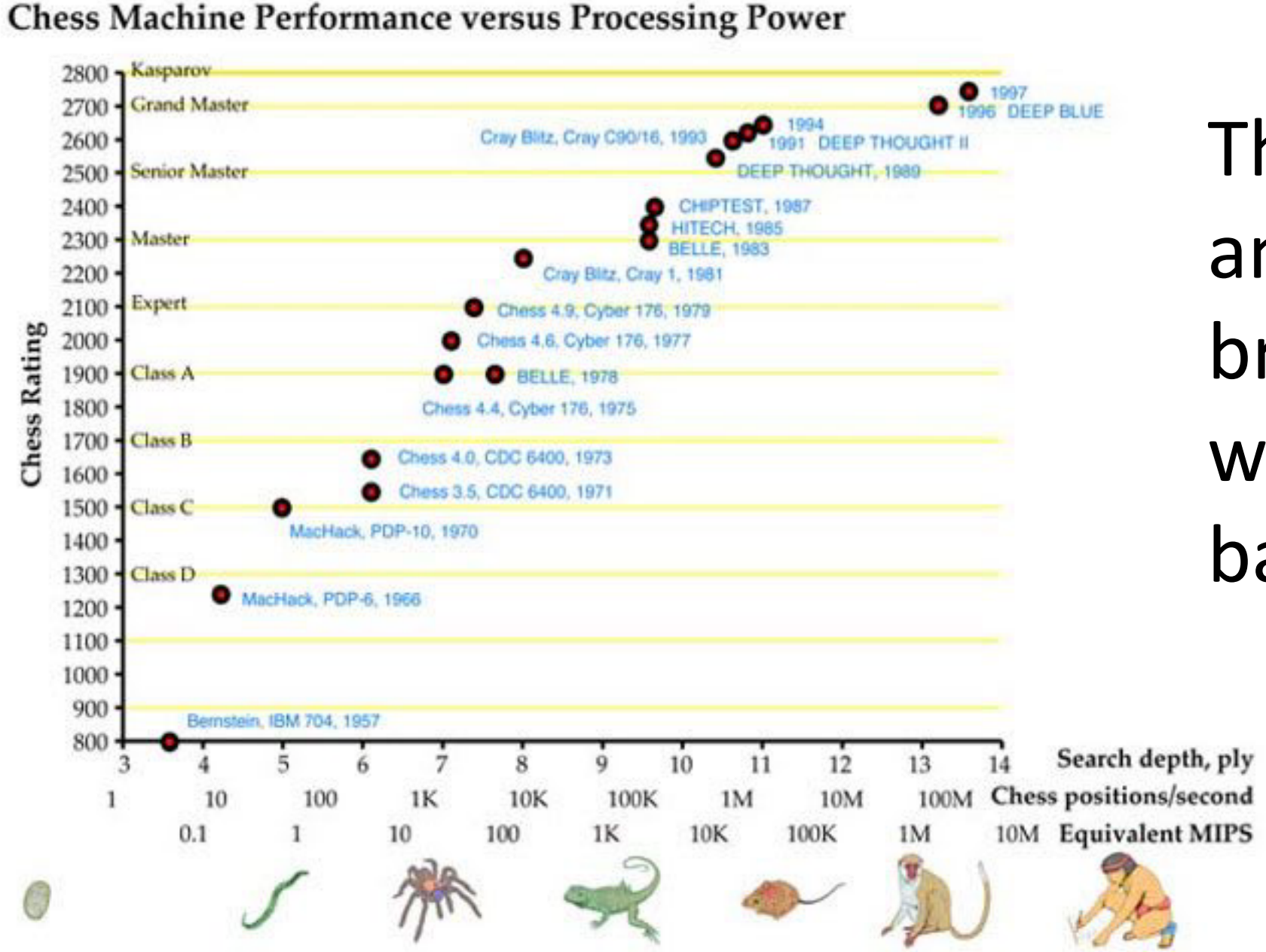
Pull #	Response	Believed Probability of Jackpot
1	WIN (1.0)	1.0
2	LOSS (0.0)	0.5
3	LOSS (0.0)	0.33…
4	LOSS (0.0)	0.25
…	…	…
N.	LOSS (0.0)	0.1

Unknown True Probability

PQ1: MCTS didn’t get formalized till the 2000s, but Monte Carlo methods like those used by Deep Blue had been around since the 1940s. Why did it take till 1997 for a chess bot to beat a grand master?

https://forms.gle/zCxJGNWkhQyyZkzz6

https://tinyurl.com/guz-pq32a



This is all search, and the major breakthroughs were hardware-based!

Modern Automated Game Playing

Two Major Groups

1) Industry Automated Game Playing Research

- Advertisement

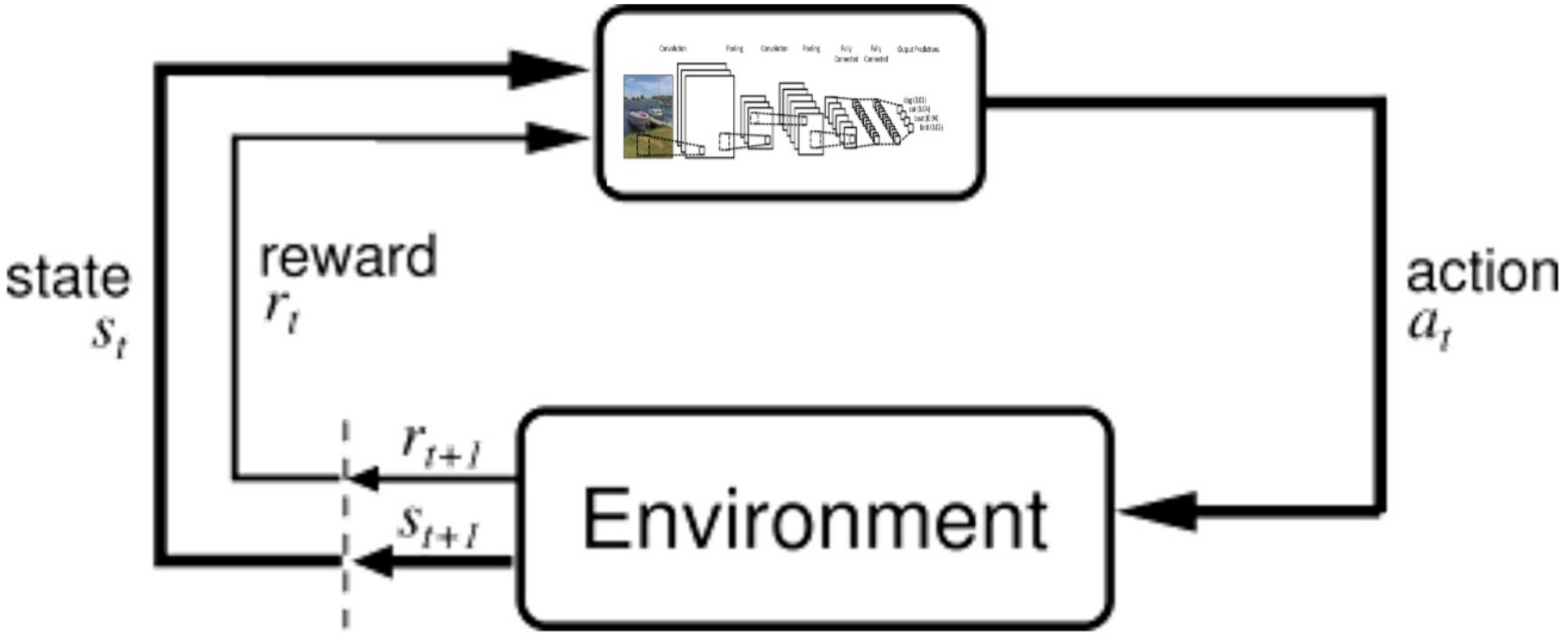
2) Academic Automated Game Playing Research

- Solve unsolved problems

DOTA2 (Open AI Five, **2019**)

Deepstack Team, 2017

Both Employ Deep RL



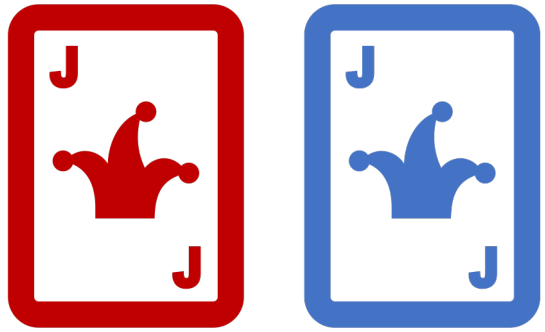
Perfect vs. Imperfect Games

- Modern automated gameplaying methods (MCTS, Deep RL, etc.) are good at **perfect information games**
- **Perfect Information Games**: We have complete knowledge of the game state
- **Imperfect Information Games**: Some of the game state is hidden

How can we deal with a non-Markovian state due to imperfect or hidden information?

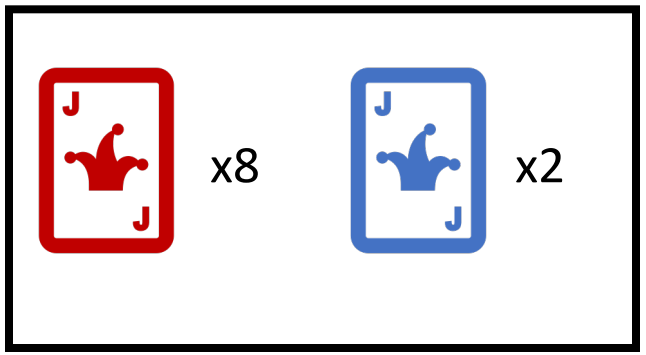
Modelling other kinds of belief

- All that traditional RL does is model belief in value of actions/states.
- Imagine a simple card game with only 2 kinds of cards: red or blue
- The card game has a deck of 100 cards: 50 red and 50 blue.
- Your opponent and you both have 10 cards in your hands.
- You could guess the distribution in your opponents hand, and update that as you see more!

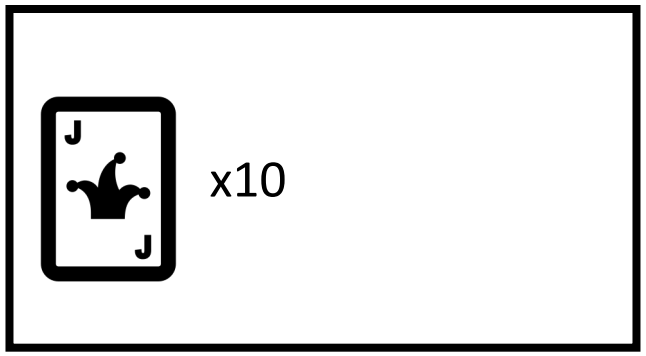


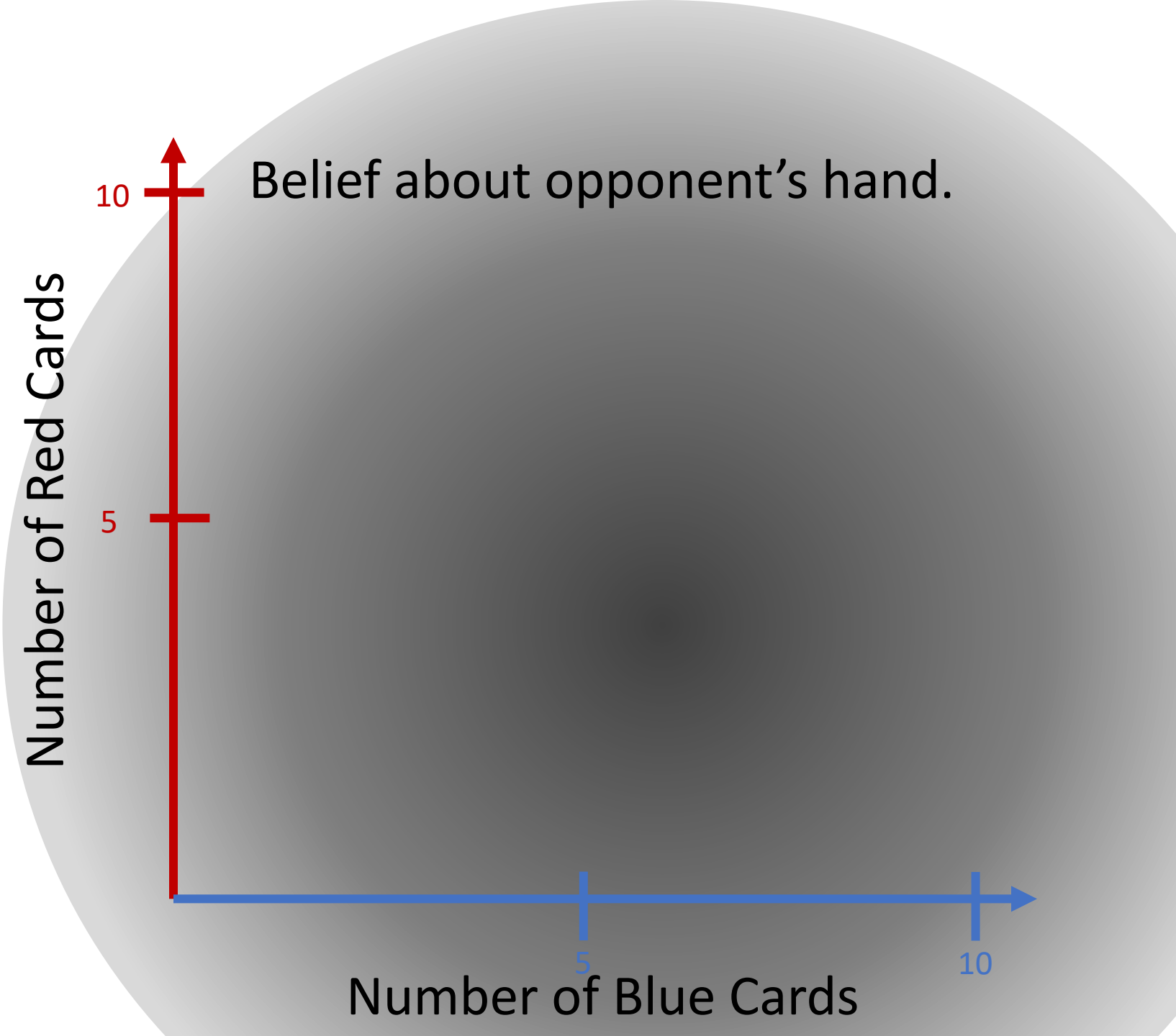
Step 0.

Your hand



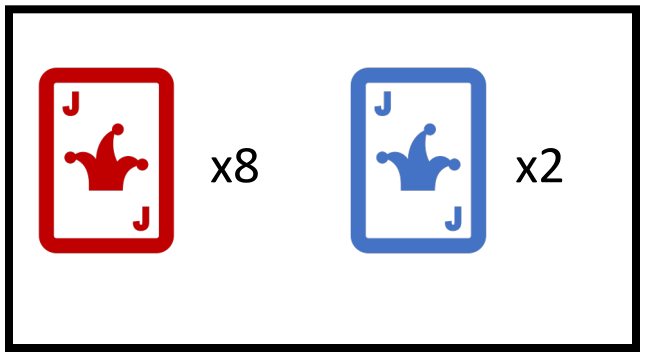
Your opponent's hand



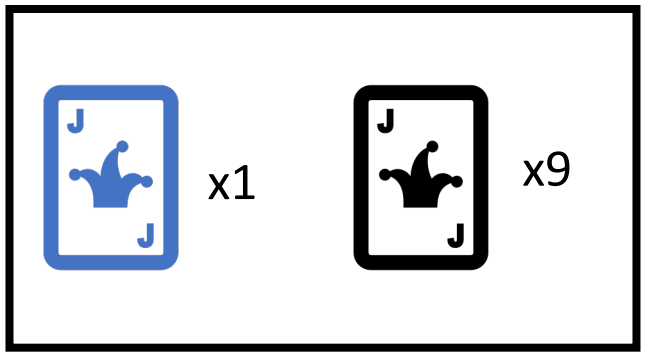


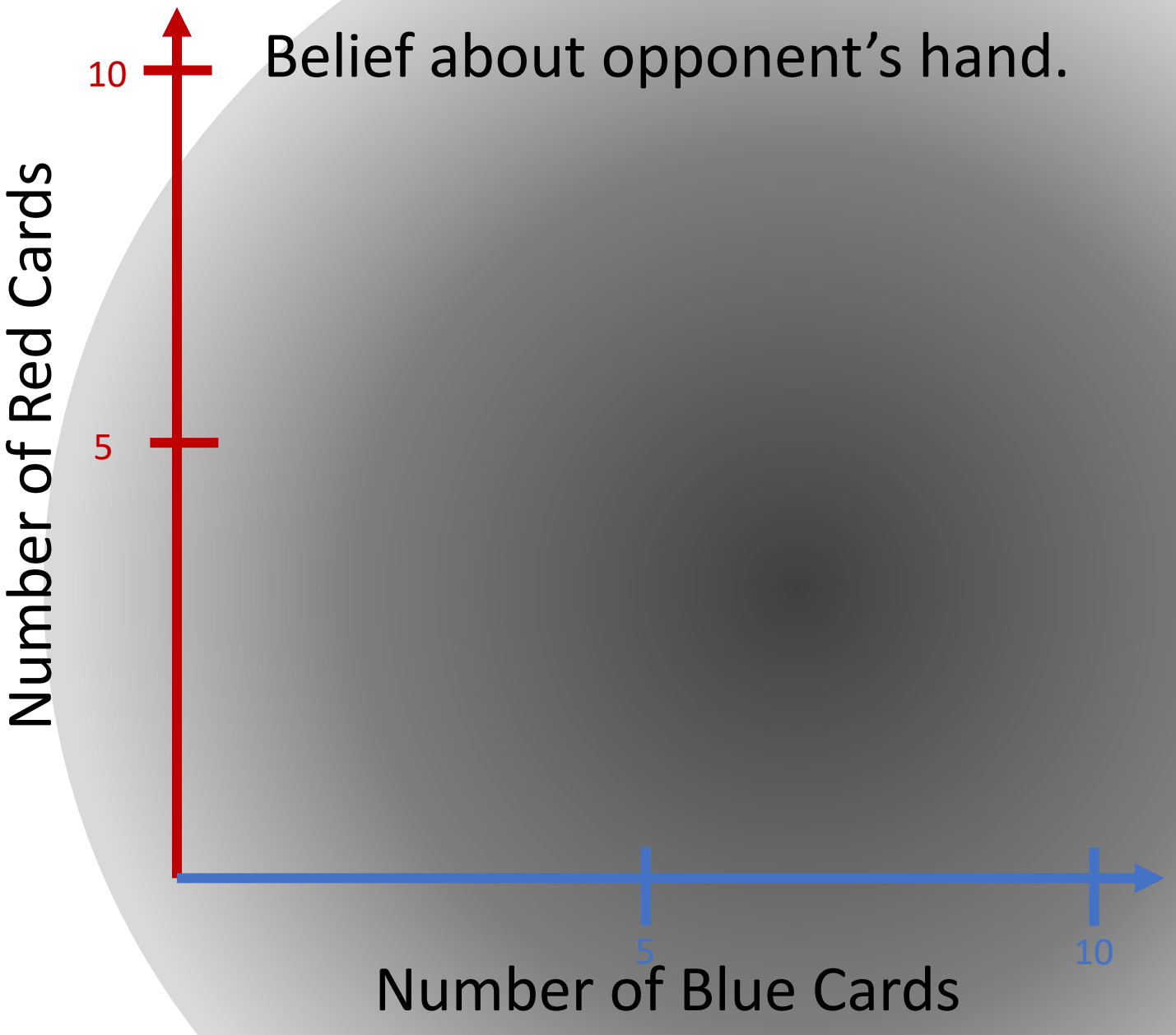
Step 1.

Your hand

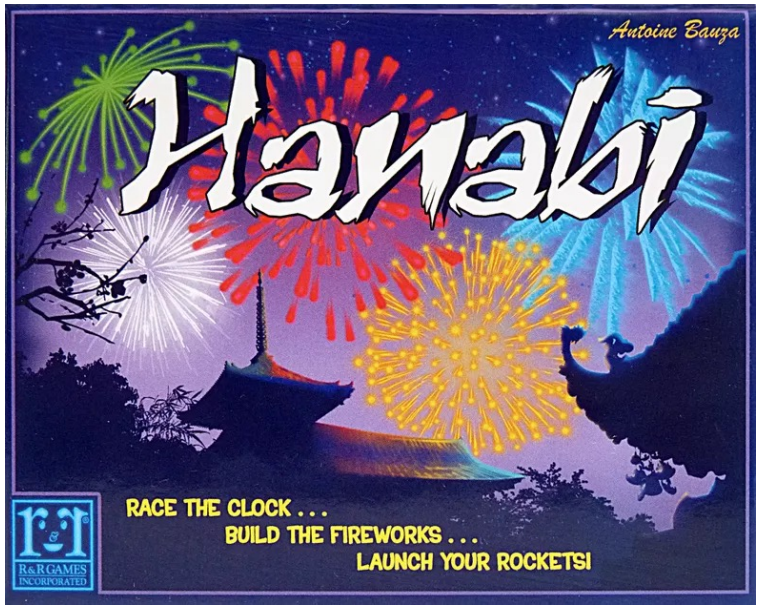


Your opponent's hand



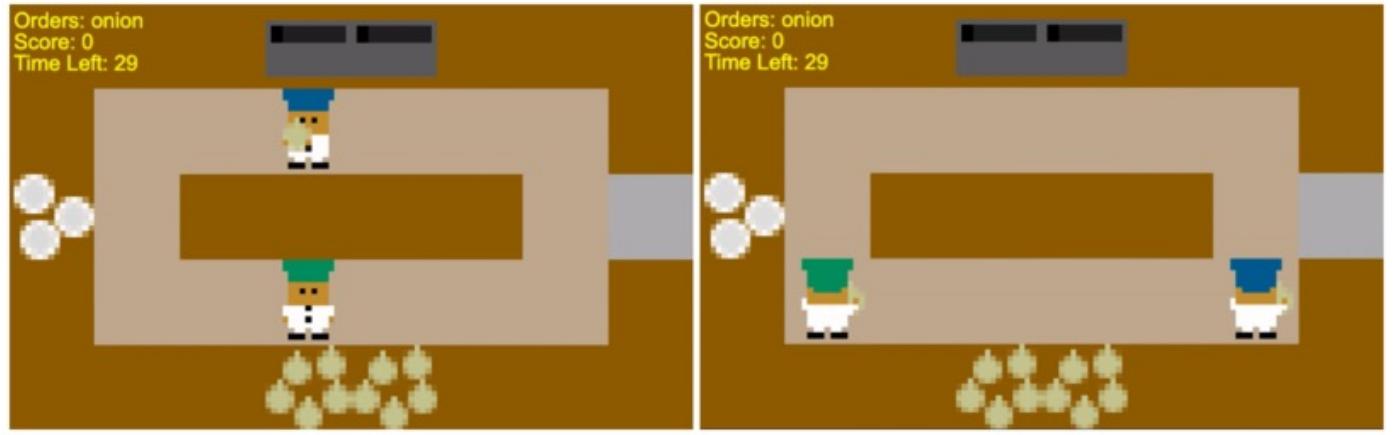


Modern Research Games



Hanabi - Hidden Information

Bard, Nolan, et al. "The hanabi challenge: A new frontier for ai research." *Artificial Intelligence* 280 (2020): 103216.



Overcooked 2 – Cooperating with Humans

Bishop, Justin, et al. "CHAOPT: a testbed for evaluating human-autonomy team collaboration using the video game overcooked! 2." *2020 Systems and Information Engineering Design Symposium (SIEDS)*. IEEE, 2020.

Angry Birds – Reasoning over Physics

Renz, Jochen, et al. "Ai meets angry birds." *Nature Machine Intelligence* 1.7 (2019): 328-328.

https://aibirds.org

If you wanted a automated game playing agent (bot), how would you make it?

- Is it a perfect information game with a small state space?
  - Planning!
    - Example: https://www.youtube.com/watch?v=DlkMs4ZHHr8
    - More info on the competition: https://youtu.be/bBZ7kEphv3s
- Is it a perfect information game with a large state space?
  - Some Monte Carlo method (MCTS, Deep RL)
- Is it an imperfect information game with a small state space?
  - Simple belief methods like representing belief as a gaussian
- Is it an imperfect information game with a large state space?
  - Unclear! Maybe just throw a lot of computing power at it?

Applications? Same as Deep RL generally

- Playtesting/balancing new content for an existing game!
  - Hearthstone New Card Balance Checking https://youtu.be/t5MUuCmm81k?t=831
  - Automated space testing (speculative, not yet in games) https://youtu.be/DKdQFajLfzk

More Info

- **CMPUT 355 - Games, Puzzles, Algorithms**
- **CMPUT 455 - Search, Knowledge and Simulation**
- Most “Game AI” stuff outside of this class
  - https://school.gameaibook.org