CS325 Artificial Intelligence
Ch. 5, Games!

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vs.


Spring 2013

AI in Games

A lot of work is done on it. Why?

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- Also, simpler than life: toy problems

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Types of game AIs:

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zerg rush

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- Simulated reality (non-playable characters, world reaction to player).
- Game theory (next class)

zerg rush

Entry/Exit Surveys

Exit survey: Hidden Markov Models

- In the mining robot example, when is the uncertainty of the robot's trajectories reduced?
- How is Particle Filtering like and unlike a water filter?

Entry survey: Adversarial Games (0.25 points of final grade)

- What algorithm would be useful in games? Give examples with two different algorithms you learned in class.
- How would you help an agent solve a problem against an adversary? Think of a game like chess or checkers for starters.

Previously on AI for Games. . .

Can previous algorithms help in games?

- Single-state agent:

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- HMMs, Particle Filter:

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None for adversaries?

Properties of Games as Agent Environment

Stochastic	Part.-Observ.	Unknown	Adversarial	Game
				Chess, Checkers
				Robot Soccer
				Poker
				Hide-and-go-seek
				Starcraft
				Battle for Wesnoth
				Halo/CoD/MoH
				Solitaire
				Minesweeper
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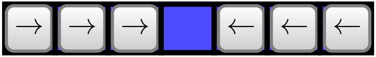
Single Player Games



Deterministic, single-state agent → Single-player game using **tree search**

- initial state
- player state
- possible actions
- results of actions
- utility values
- goal test

Adversarial Games

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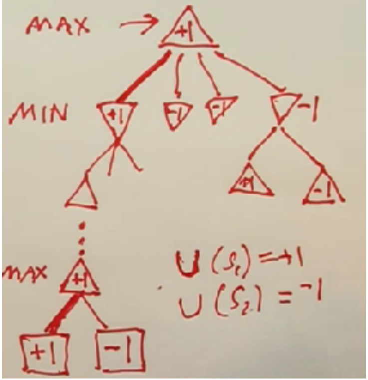

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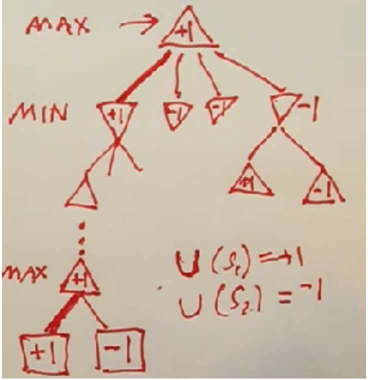

2-Player Value Function

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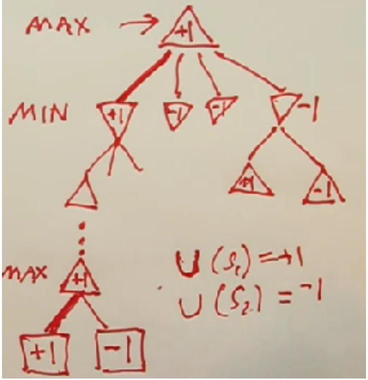

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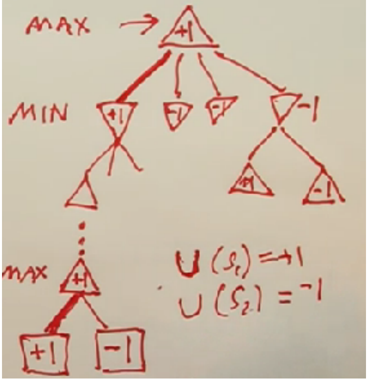
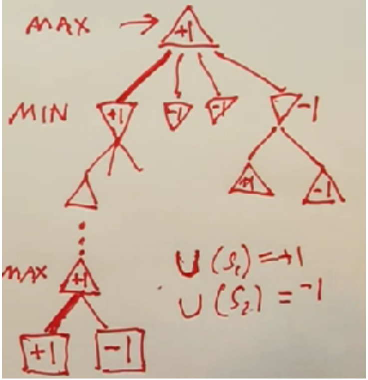


Assumes opponent is perfect!

Time Complexity

For a tree with
branching factor, b, and depth, m?

1. $O(bm)$
2. $O(b^m)$
3. $O(m^b)$



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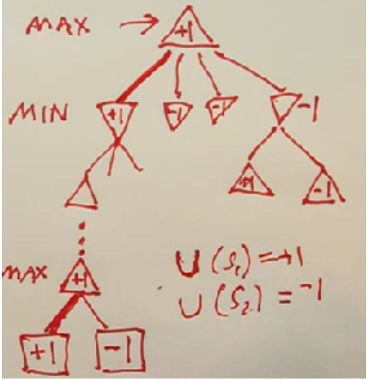

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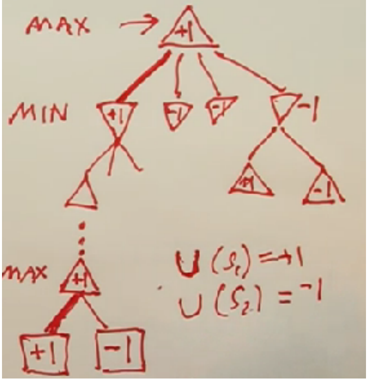
For chess: $b \simeq 30$, $m \simeq 40$
How long would it take with:

- 1 billion processors $\times 1$ billion/s evals?

1. seconds
2. minutes
3. hours
4. years
5. forever



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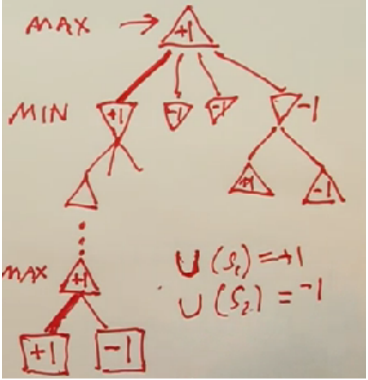

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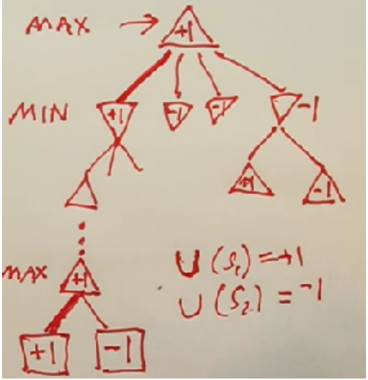

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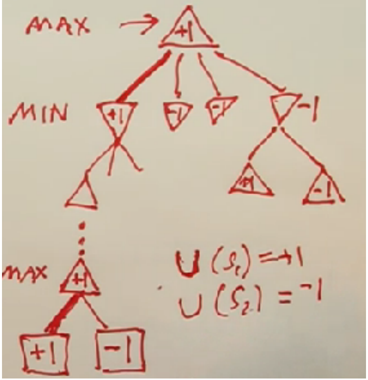

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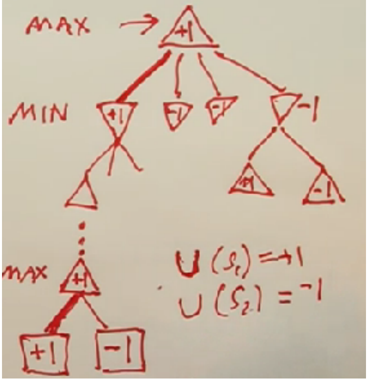
Do not need more than total number of nodes.



Complexity Reduction?

How to do it?

1. Reduce b
2. Reduce m
3. Tree $\rightarrow$ graph

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All of the above!

Example

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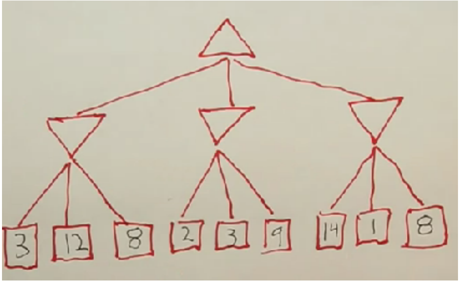

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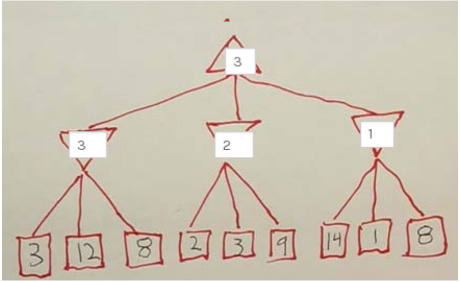
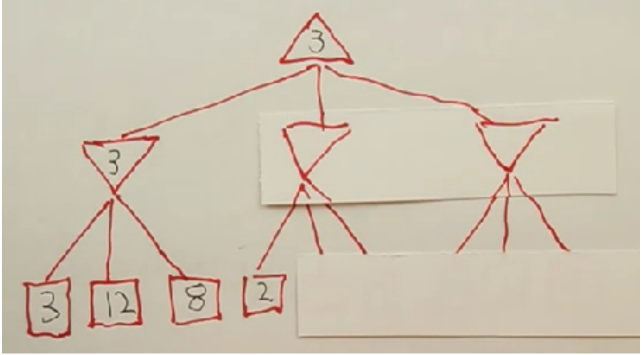


Reducing Branching Factor, b



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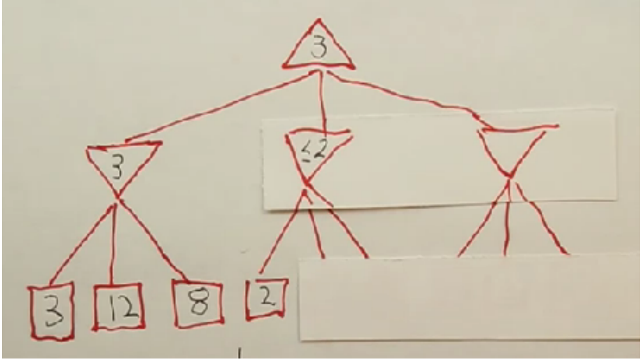

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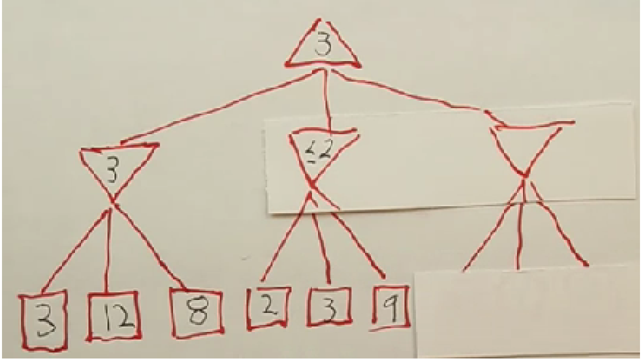

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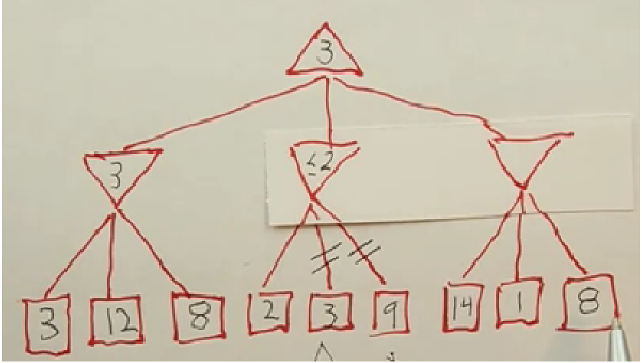

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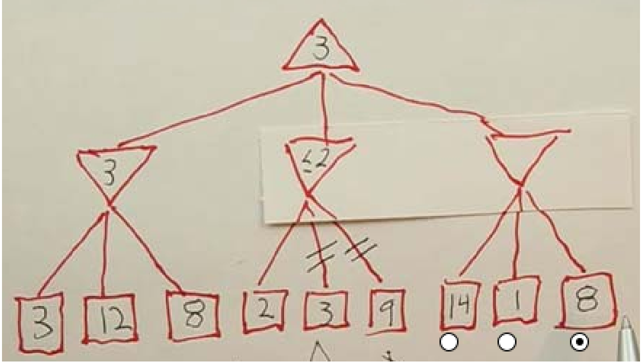

Which one to prune?

Reducing Depth, m

Select a cutoff:

- Limit m (e.g., plan 3 steps ahead in chess)
- Estimate terminal nodes' utility with evaluation function
  - like heuristics
- Learn from experience
- In chess, use board state, value of pieces, etc.
- For value of pieces: $\text{eval}(s) = \sum_i w_i p_i$
  - can use machine learning for w_i

Formalize as Alpha-Beta Pruning

defun $\mathrm{value}(s)$:
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where α, β are overall max and min values, resp.

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Can cut up to $O(b^{m/2})$!

Complexity Reduction by Tree → Graph

Convert into graph search problem:

- to reach special **opening and closing states**
- to make and protect from **killer-moves**

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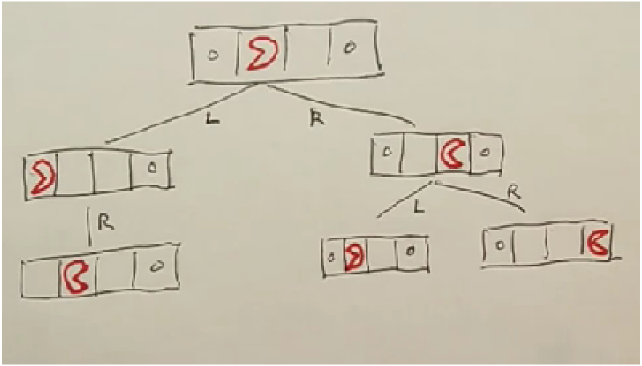
Utility: How many food particles can pacman eat?



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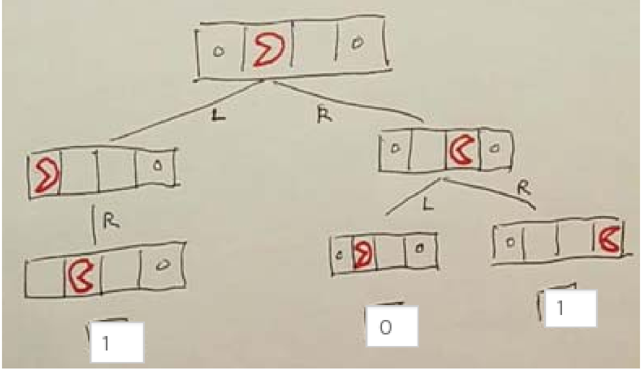

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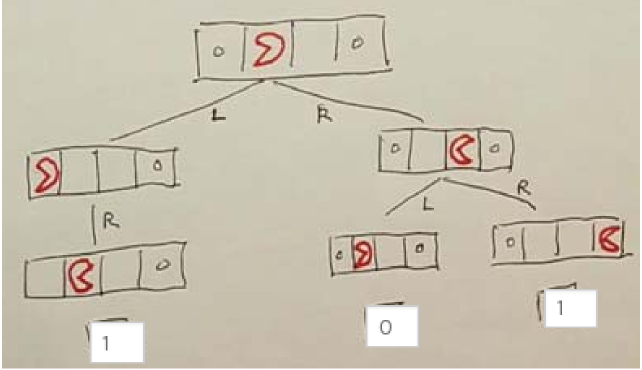
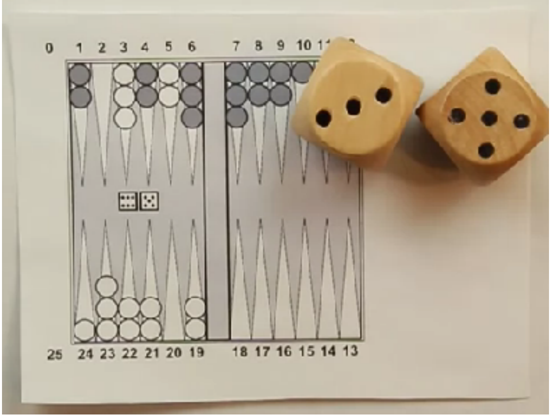


2-step limit causes **horizon effect**?

Stochastic Games



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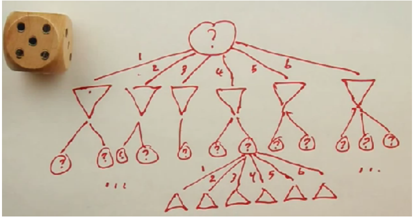
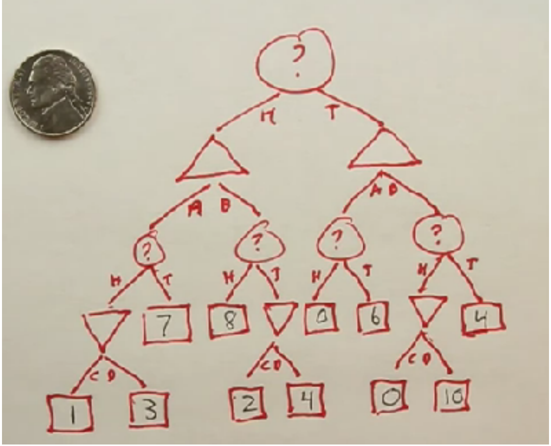
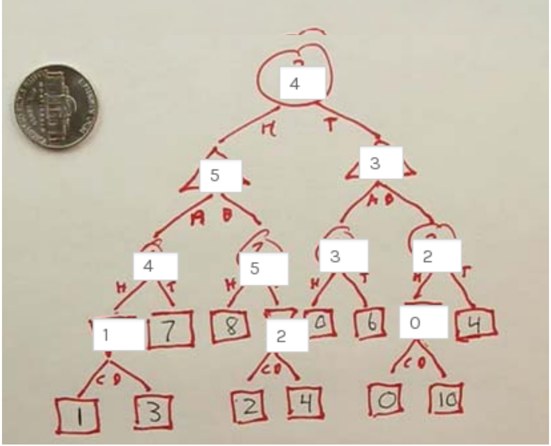
if s is ?: $\text{expValue}(s, \textit{depth}, \alpha, \beta)$



Coin-flip Game

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