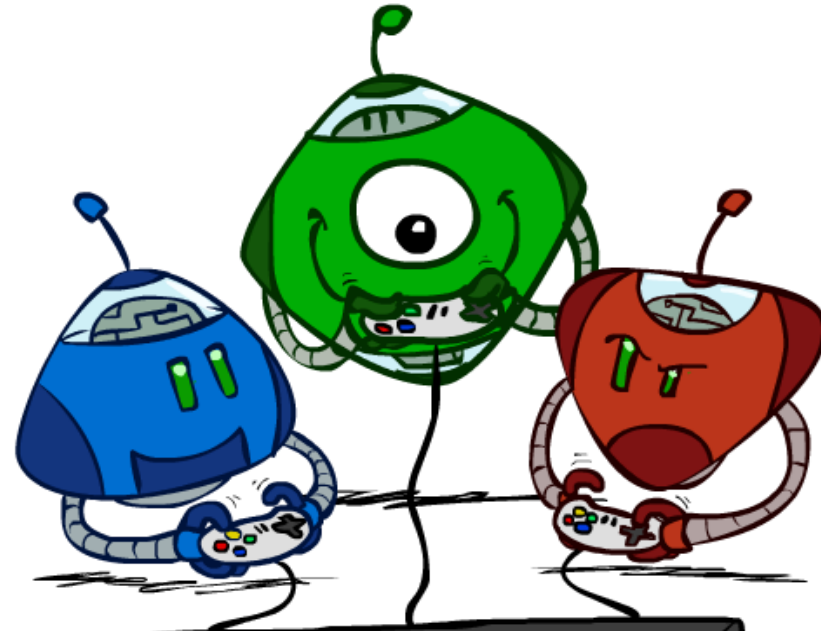# Advanced Topics in AI

Uncertainty & Expectimax

Instructor:
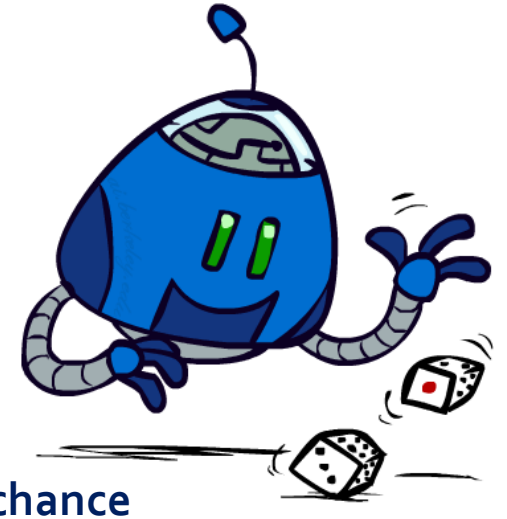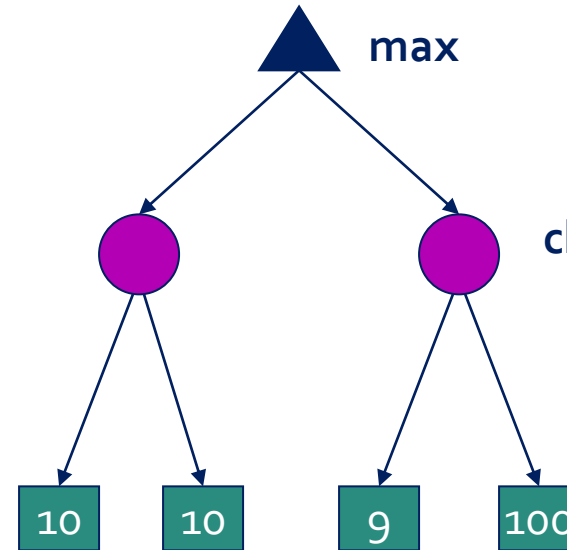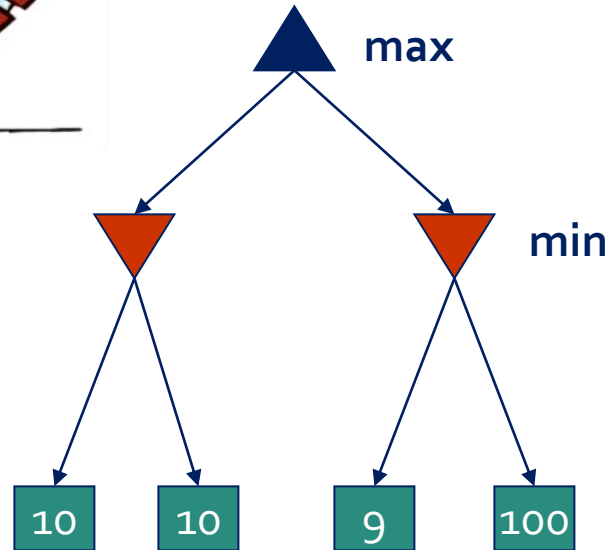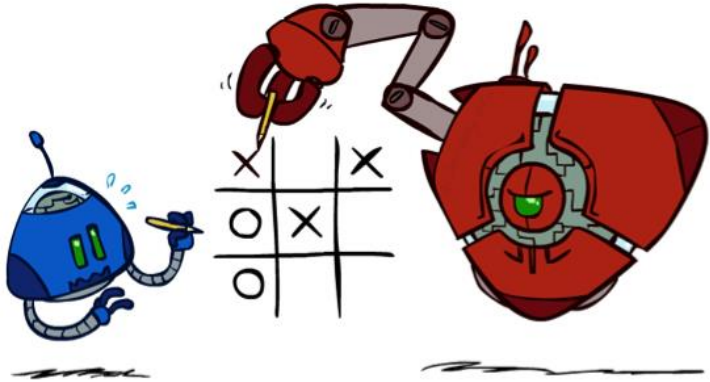
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Worst-Case vs. Average Case

Idea: Uncertain outcomes controlled by chance, not an adversary!

Expectimax Search

- Why wouldn't we know what the result of an action will be?
    - Explicit randomness: rolling dice
    - Unpredictable opponents: the ghosts respond randomly
    - Unpredictable humans: humans are not perfect
    - Actions can fail: when moving a robot, wheels might slip

- Values should now reflect average-case (expectimax) outcomes, not worst-case (minimax) outcomes

- Expectimax search: compute the average score under optimal play
    - Max nodes as in minimax search
    - Chance nodes are like min nodes but the outcome is uncertain
    - Calculate their expected utilities
    - I.e. take weighted average (expectation) of children

- Later, we'll learn how to formalize the underlying uncertain-result problems as Markov Decision Processes
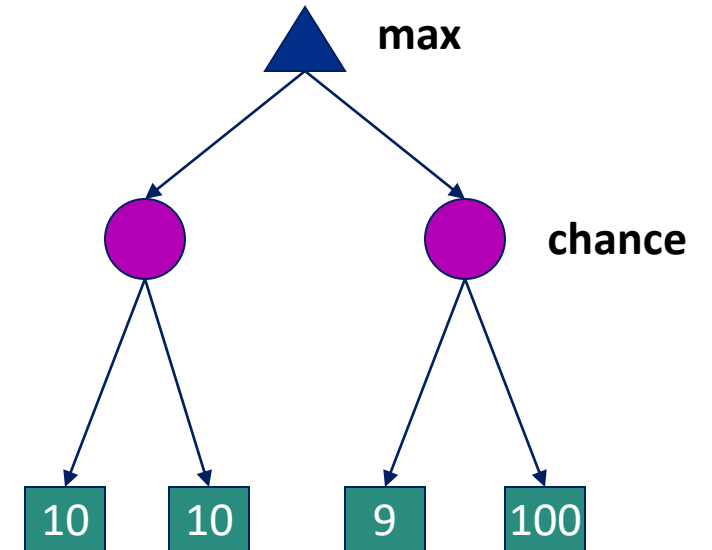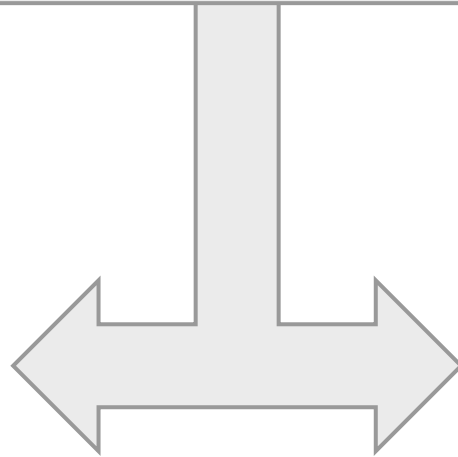
Expectimax Pseudocode

```
def value(state):
    if the state is a terminal state: return the state's utility
    if the next agent is MAX: return max-value(state)
    if the next agent is EXP: return exp-value(state)
```
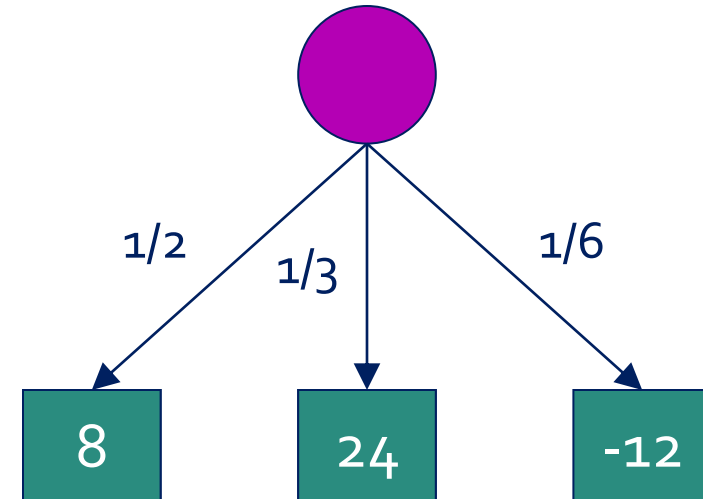
```
def max-value(state):
    initialize v = -∞
    for each successor of state:
        v = max(v, value(successor))
    return v
```

```
def exp-value(state):
    initialize v = 0
    for each successor of state:
        p = probability(successor)
        v += p * value(successor)
    return v
```
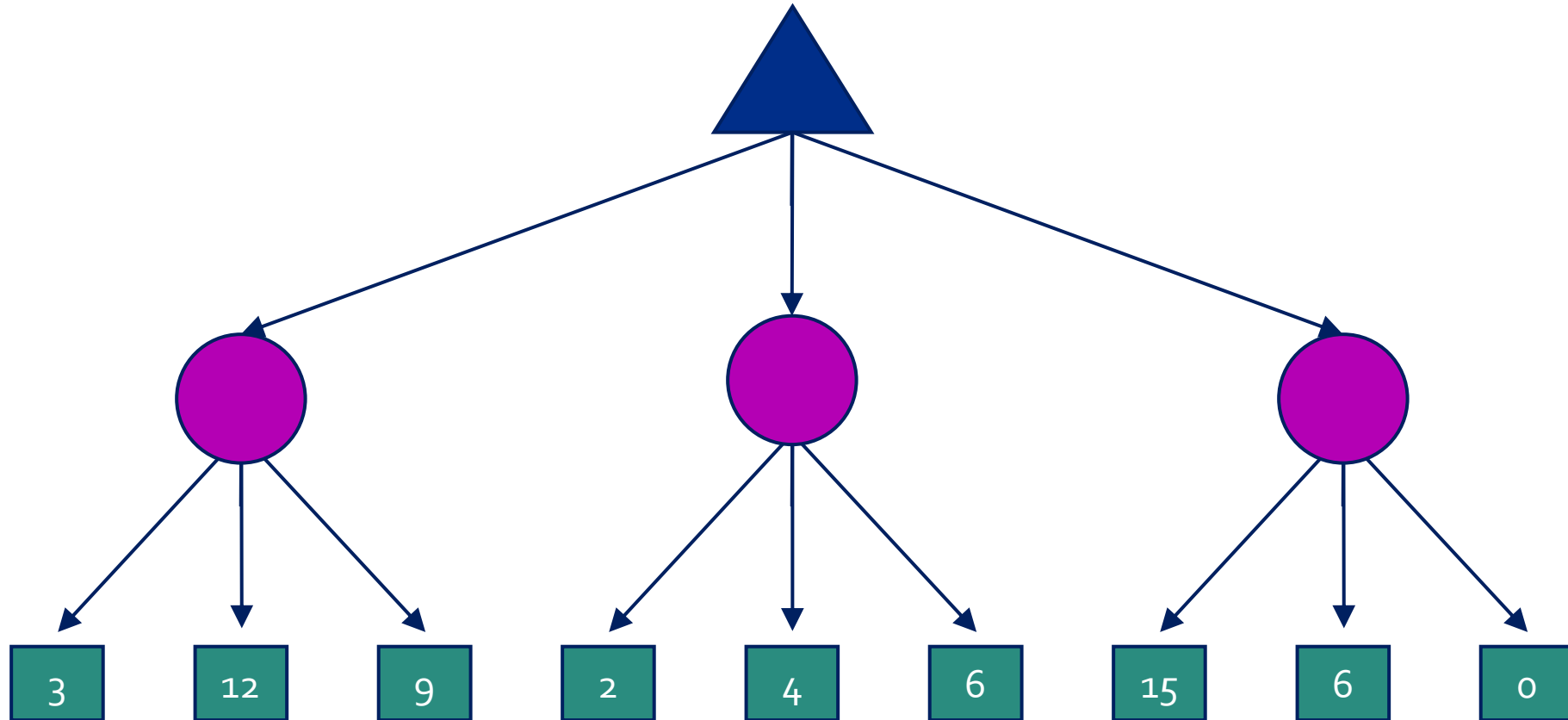
Expectimax Pseudocode

```
def exp-value(state):
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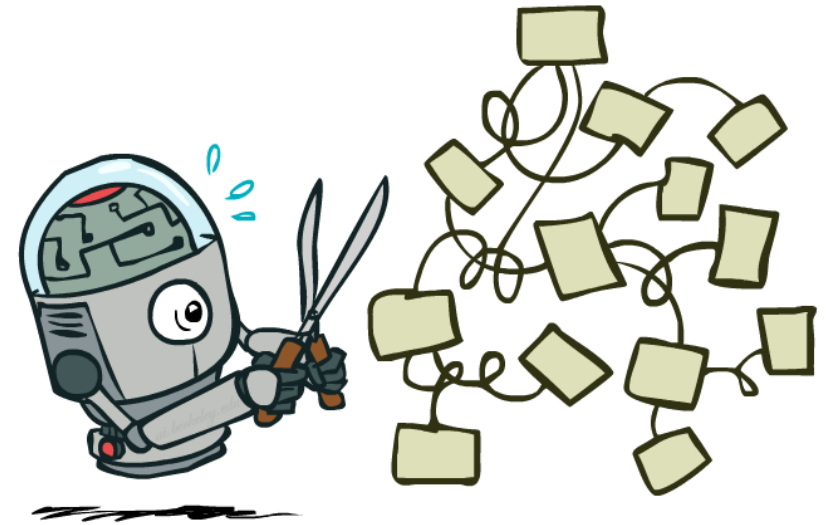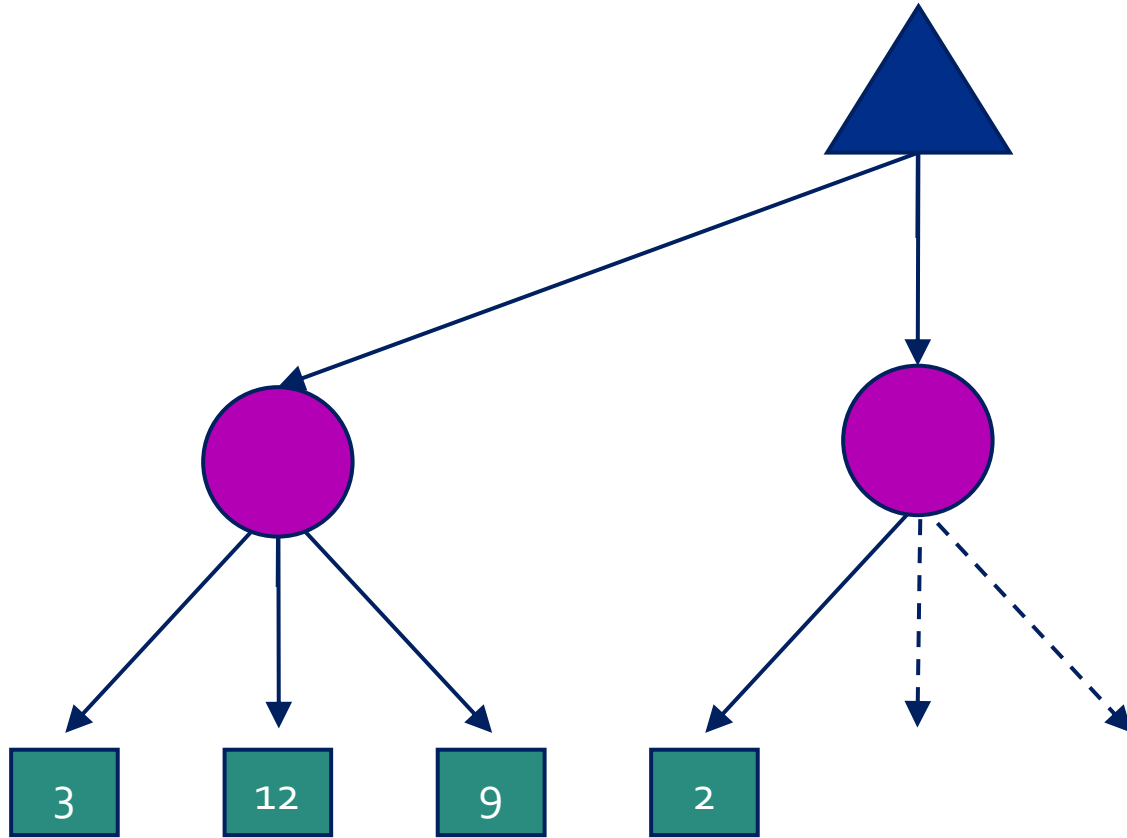

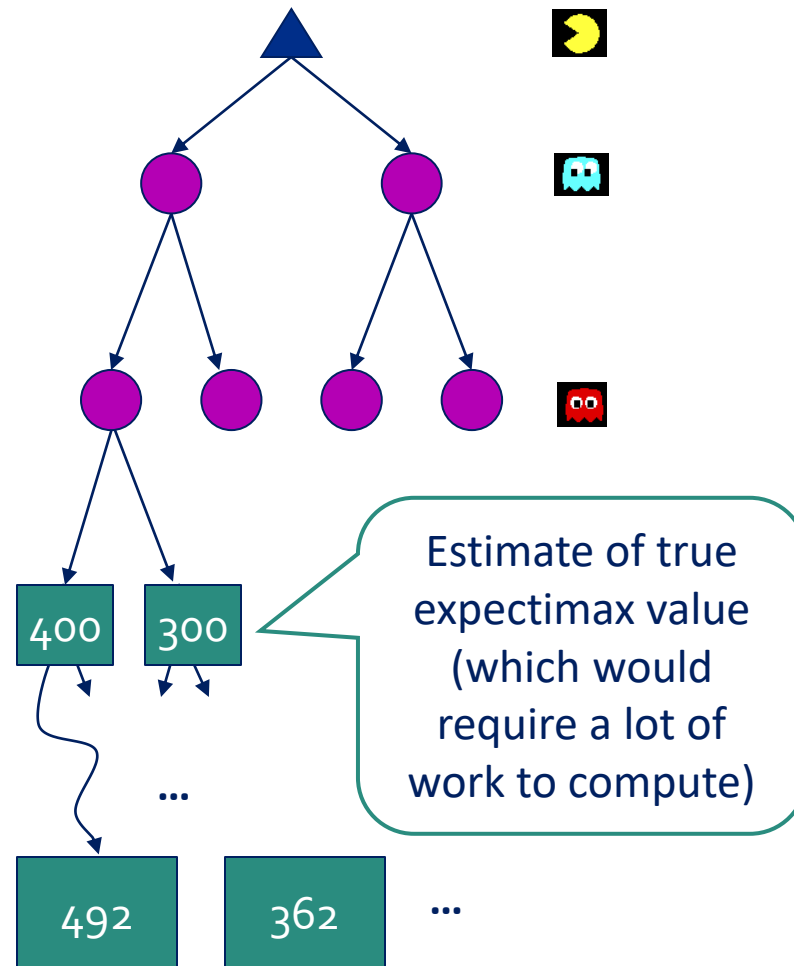$$v = (1/2)\ (8) + (1/3)\ (24) + (1/6)\ (-12) = 10$$

Expectimax Example

Expectimax Pruning?

Depth-Limited Expectimax

Estimate of true expectimax value (which would require a lot of work to compute)
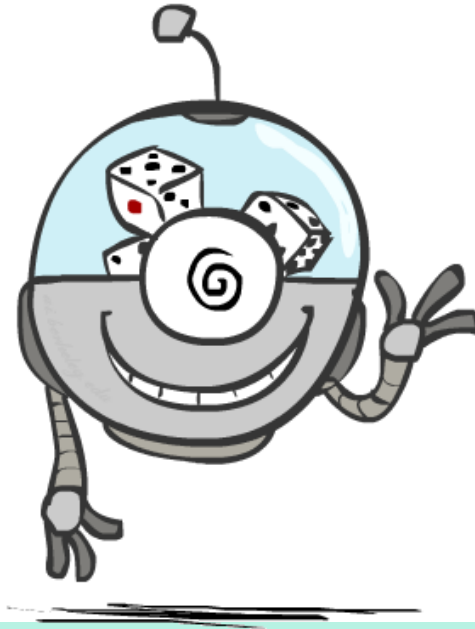
Advanced Topics in AI

Next: Probabilities

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[These slides were created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley. All materials are available at http://ai.berkeley.edu.]