6
Uncertainty & Utilities

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

* Expectimax Search

⇒ Value should now reflect average-case (expectimax) outcome, not worst-case (minmax) outcomes.

⇒ Expectimax Search: Compute the average score under optimal play.

→ Max nodes as in minmax search
→ Chance nodes are like min nodes but the outcome is uncertain.
→ Calculate their expected utilities
(i.e. take weighted average (expectation) of children)

★ Expectimax Pseudo code

```
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
```

★ Reminder: Probabilities

Random variable
↳ Represents an event whose outcome is unknown

Probability distribution
↳ Assignments of weights to outcomes.

⇒ The expected value of a function of a random variable is the average, weighted by the probability distribution over outcomes.