Lecture 3: Decision analysis as a computational model: Decision Trees

Principles of Artificial Intelligence

CS 530:
Making decisions

In order to use utility & probability in a program to make decisions we want a general representation of problems & decisions. One simple example: decision tree.
Decision Tree

Decision node - agent chooses action
Alternate actions

Observation node - agent senses world
Alternate observations

Reward node - utility of resulting state

Decision node - agent chooses action

Alternate actions

Observation node - agent senses world
Alternate observations
Decision Tree as Model

- Context: world state vs agent state
- Decision tree is a model of possible histories
- Markov property
Policy

• A policy is a nested conditional algorithm

  \( \text{do}(w; \text{switch}(x; \text{if}(y; \text{do}(f; \text{end}); \text{end}); \text{end}); \text{end}); \text{end}) \)

• Feasible Policies

  \( h \rightarrow 3 \)
  \( f \rightarrow 2 \)
  \( w \rightarrow 1 \)

Decision nodes \( \rightarrow \) decisions

\begin{align*}
\text{Policy} & \rightarrow \text{Feasible Policies} \rightarrow \text{A policy is a nested conditional algorithm} \rightarrow \text{Decision nodes} \rightarrow \text{decisions}
\end{align*}
Optimal policy
Evaluation

- Against model
  - Of policy
    - Compare
      - Formal
        - Monte Carlo
  - Predict with model
- Observe world
- Of model
Making Tree Explicit

- Easier to prove general theorems
- Clearer what behavior depends on
- Program & data reusable