CS540 Introduction to Artificial Intelligence

Lecture 18

Young Wu

Based on lecture slides by Jerry Zhu, Yingyu Liang, and Charles Dyer

August 3, 2022

River Crossing Problem

Quiz

Summary

Discussion

Uniformed vs. Informed Search

Motivation

- Uninformed search means only the goal G and the successor functions s' are given.
- Informed search means which non-goal states are better is also known.

Heuristic Diagram

Motivation

Uniform Cost Search

Description

- Expand the vertices with the lowest current path cost $g(s)$ first.
- It is BFS with a priority queue based on $g(s)$.
- It is equivalent to BFS if $c = 1$ is constant on all edges.
- It is also called Dijkstra's Algorithm.

UCS Example 1

Quiz

UCS Example 1 Diagram

Quiz

UCS Example 1 Expansion Path

Quiz

UCS Example 2

Quiz

UCS Example 2 Diagram

Quiz

Uniform Cost Search Performance

Discussion

- UCS is complete.
- UCS is optimal with any c.

Best First Greedy Search

Description

- Expand the vertices with the lowest heuristic cost $h(s)$ first.
- Use a priority queue based on $h(s)$.
- BFGS is not an abbreviation of Best First Greedy Search: BFGS is the Broyden Fletcher Goldfarb Shanno algorithm (a version of gradient descent).

Greedy Example 1

Quiz

Greedy Example 1 Diagram

Quiz

Greedy Example 2

Quiz

Greedy Example 2 Diagram

Quiz

Best First Greedy Search Performance

Discussion

- Greedy is incomplete.
- Greedy is not optimal.

A Search

Description

- Expand the vertices with the lowest total cost $g(s) + h(s)$ first.
- Use a priority queue based on $g(s) + h(s)$.
- A stands for Always be optimistic?

A Search Example 1

Quiz

A Search Example 1 Diagram

Quiz

A Search Example 2

Quiz

A Search Example 2 Diagram

Quiz

A Search Performance

Discussion

- A is complete.
- A is not optimal.

A Star Search

Description

- $A^\star$ search is A search with an admissible heuristic.

Admissible Heuristic

Definition

- A heuristic is admissible if it never over estimates the true cost.

$$0 \leqslant h(s) \leqslant h^{\star}(s)$$

Admissible Heuristic 8 Puzzle Example

Definition

Admissible Heuristic 8 Puzzle Example

Quiz

A Star Search Example 1

Quiz

A Star Search Example 1 Diagram

Quiz

Admissible Heuristic General Example 1

Quiz

A Search Performance

Discussion

- $A^\star$ is complete.
- $A^\star$ is optimal.

Iterative Deepening A Star Search

Discussion

- $A^\star$ can use a lot of memory.
- Do path checking without expanding any vertex with $g(s) + h(s) > 1$.
- Do path checking without expanding any vertex with $g(s) + h(s) > 2$.
- ...
- Do path checking without expanding any vertex with $g(s) + h(s) > d$.

Iterative Deepening A Star Search Performance

Discussion

- IDA* is complete.
- IDA* is optimal.
- IDA* is more costly than $A^\star$.

Beam Search

Discussion

- Version 1: Keep a priority queue with fixed size k. Only keep the top k vertices and discard the rest.
- Version 2: Only keep the vertices that are at most ε worse than the best vertex in the queue. ε is called the beam width.

Beam Search Performance

Discussion

- Beam is incomplete.
- Beam is not optimal.

Summary

Discussion