CS540 Introduction to Artificial Intelligence

Lecture 18

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

August 2, 2022

River Crossing Problem

Quiz

Homework

Admin

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