CS540 Introduction to Artificial Intelligence

Lecture 17

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Bridge and Torch Game

Motivation

Due Dates and Grades

Admin

Bridge and Torch Game States

Motivation

Search Problem Applications

Motivation

Wolf, Sheep, Cabbage Example

Motivation

8 Puzzle Example

Motivation

Sizes of State Space

Motivation

- Tic Tac Toe: 10^3
- Checkers: 10^{20}
- Chess: 10^{50}
- Go: 10^{170}

Water Jugs Example

Definition

Performance

Definition

- A search strategy is complete if it finds at least one solution.
- A search strategy is optimal if it finds the optimal solution.
- For uninformed search, the costs are assumed to be 1 for all edges $c = 1$.

Complexity

Definition

- The time complexity of a search strategy is the worst case maximum number of vertices expanded.
- The space complexity of a search strategy is the worst case maximum number of states stored in the frontier at a single time.
- Notation: the goals are d edges away from the initial state. This means assuming a constant cost of 1, the optimal solution has cost d. The maximum depth of the graph is D.
- Notation: the branching factor is b, the maximum number of actions associated with a state.

$$b = \max_{s \in V} \left| s'(s) \right|$$

Breadth First Search

Description

- Use Queue (FIFO) for the frontier.
- Remove from the front, add to the back.

BFS Example 1

Quiz

BFS Example 1 Diagram

Quiz

BFS Example 2

Quiz

BFS Example 3

Quiz

Breadth First Search Performance

Discussion

- BFS is complete.
- BFS is optimal with $c = 1$.

Breadth First Search Complexity

Discussion

- Time complexity: the worst case occurs when the goal is the last vertex at depth d.

$$T = b + b^2 + ... + b^d$$

- Space complexity: the worst case is storing all vertices at depth d is in the frontier.

$$S = b^d$$

Depth First Search

Description

- Use Stack (LIFO) for the frontier.
- Remove from the front, add to the front.

DFS Example 1

Quiz

DFS Example 1 Diagram

Quiz

DFS Example 2

Quiz

DFS Example 3

Quiz

Depth First Search Performance

Discussion

- DFS is incomplete if $D = \infty$.
- DFS is not optimal.

Depth First Search Complexity

Discussion

- Time complexity: the worst case occurs when the goal is the root of the last subtree expanded in the whole graph.

$$T = b^{D-d+1} \ldots + b^{D-1} + b^{D}$$

- Space complexity: the worst case is storing all vertices sharing the parents with vertices in the current path.

$$S = (b-1) D + 1$$

Iterative Deepening Search

Description

- DFS but stop if path length > 1
- repeat DFS but stop if path length > 2
- ...
- repeat DFS but stop if path length $> d$

IDS Example 1

Quiz

IDS Example 1 Diagram

Quiz

Iterative Deepening Search Performance

Discussion

- IDS is complete.
- IDS is optimal with $c = 1$.

Iterative Deepening Search Complexity

Discussion

- Time complexity: the worst case occurs when the goal is the last vertex at depth d.

$$T = db + (d-1)\,b^2 + \ldots + 3b^{d-2} + 2b^{d-1} + 1b^d$$

- Space complexity: it has the same space complexity as DFS.

$$S = (b-1)\,d$$

Configuration Space

Discussion

Summary

Discussion