COMP90054 – Week 3 tutorial

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Evaluating search strategies

Guarantees

- Completeness: Guaranteed to find a solution where there is one
- Optimality: Solution found guaranteed to be optimal

Complexity

- Time complexity
- Space complexity
- Features governing complexity:
    - b Branching factor
    - d Goal depth

Blind search algorithms

	BrFS	**DFS**	**ID**
Feature	FIFO frontier	LIFO frontier	Use depth-limited search
Complete?	Yes	No^	Yes
Optimal?	Yes*	No	Yes*
Time complexity	$O(b^d)^\dagger$	$O(b^m)^\ddagger$	$O(b^d)$
Space complexity	$O(b^d)$	$O(bm)^\ddagger$	$O(bd)$

* Optimal if action costs are uniform

† $O(b^{d+1})$ if goal check is performed at node-expansion time

^ Complete if state space is acyclic, or if state space is finite and we check for cycles

‡ m stands for the maximum depth reached by DFS

Informed/Heuristic search

Heuristic function

- Heuristic function $h: S \rightarrow \mathbb{R}_0^+ \cup \{\infty\}$
- h estimates the cost of an optimal path to the goal
- h^* is the perfect heuristic/actual cost of an optimal path
- $h(s)$ is the heuristic value/h-value given a state $s \in S$

Properties of heuristic functions

Safe

- $\forall s \in S$ with $h(s) = \infty, h^*(s) = \infty \Rightarrow h$ is **safe**
- h never tells me infinite when there is a solution

Goal-aware

- $\forall s \in S^G, h(s) = 0 \Rightarrow h$ is **goal-aware**
- h knows if I have reached any goal

Admissible

- $\forall s \in S, h(s) \leq h^*(s) \Rightarrow h$ is **admissible**
- h never yields cost larger than actual optimal cost

Consistent

- $\forall$transitions $s \xrightarrow{a} s', h(s) \leq h(s') + c(a) \Rightarrow h$ is **consistent**
- Cost of performing any action a is larger than the difference in heuristic values of old state s and new state s'

Relationship

- consistent + goal-aware → admissible
- admissible → goal-aware
- admissible → safe

Dominance

- If h_1 and h_2 are both admissible and $h_2(s) \geq h_1(s)\ \forall s \in S$, then h_2 dominates h_1

Heuristics search algorithms

- Use a priority queue/min heap with key f to determine the order of search node expansion

Greedy Best-first Search

- $f(s) = h(s)$
- Complete for safe heuristics and duplicate detection
- Not optimal, even for perfect heuristics

A* (with re-opening)

- $f(s) = g(s) + h(s)$
- Complete for safe heuristics
- Optimal for admissible heuristics

Weighted A*

- $f(s) = g(s) + W \times h(s)$
- $W \in \mathbb{R}_0^+$ is an algorithm parameter
  - $W = 0 \Rightarrow$ Uniform-cost search
  - $W = 1 \Rightarrow$ A* search
  - $W \rightarrow \infty \Rightarrow$ Greedy best-first search