Search

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1 Defining Search Problems

1. Initial state
2. Successor
3. Goal test
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1.1 Successor Function

Tells us where we can go from a state:

$$S(s_0) = \{(a_1, s_1), ..., (a_n, s_n)\} \tag{1}$$

When actions are inferrable from states:

$$S(s_0) = \{s_1, ..., s_n\} \tag{2}$$

1.2 Goal Test Function

Tells when solution has been reached. **Explicit** defines which state is a goal. **Implicit** is some set of conditions that could happen at various states under various conditions.

1.3 Step Cost Function

Tells how much a single step costs:

$$c(s_1, a, s_2) \geq 0 \tag{3}$$

1.4 Solution

Any path from initial state to goal state:

$$\{a_1, ..., a_n\}$$

When actions are inferrable from states:

$$\{s_1, ..., s_n\}$$

2 Basic Search

A **node** is an abstract data structure that contains information about a state, parent node, action, path cost, and depth (optional).

The **frontier** is the collection of nodes that have been *generated*, but *not expanded*.

Table 1: Comparison of Basic Search Strategies

	BFS	UCS	DFS
Node ADS	Queue	Min queue[3]	Stack
Nodes to Expand First	Shallowest	Cheapest	Deepest
Complete?	Yes[1]	Yes[4]	No
Optimal?	Yes[2]	Yes	No
Time Complexity	$O(b^{d+1})$	$O(b^{\lceil C^*/\varepsilon \rceil})$[5]	$O(b^m)$
Space Complexity	$O(b^{d+1})$	$O(b^{\lceil C^*/\varepsilon \rceil})$	$O(bm)$

[1] If b infinite
[2] If step costs equal
[3] Path cost
[4] If step cost > 0
[5] C^* cost of solution

DLS is exactly like DFS except with the depth limited.
IDS is exactly like DLS except it tries all depths starting at 0.
IDS is *complete*.
IDS is *optimal* if the step cost is 1.

3 Informed Search

3.1 Best-First Search

3.2 A*

3.3 Heuristics