Introduction to Artificial Intelligence

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1 Search Problems

Definition 1.1 (Reflex Agent)**.** A reflex agent chooses actions based on its current perception of the world.

Definition 1.2 (Planning Agent)**.** A planning agent chooses actions based on hypothesized consequences of actions.

Definition 1.3 (Search Problem)**.** A search problem consists of a state space, a successor function, a start state, and a goal test.

2 Search Algorithms

2.1 Heuristics

Definition 2.1 (Heuristic)**.** A heuristic $h(n)$ is a function that estimates the distance from state n to the goal state for a particular search problem. It is often solutions of relaxed problems.

Definition 2.2 (Admissibility)**.** A heuristic is admissible, or optimistic, if $0 \leq h(n) \leq h^*(n)$ where h^* is the true cost to goal state.

Definition 2.3 (Consistency)**.** A heuristic is consistent if $h(n) - h(n+1) \leq c(n, n+1)$ where c is the cost between states n and $n+1$.

Remark. Consistency necessarily implies admissibility.

Table 1: Search algorithms.

	Fringe	Complete	Optimal	Time	Space
Depth-First Search	Stack	*iff* no cycle	No	$O(b^m)$	$O(bm)$
Breadth-First Search	Queue	Yes	*iff* uniform cost	$O(b^s)^1$	$O(b^s)^1$
Uniform Cost Search	PQ $(g(n))^2$	*iff* positive cost	Yes	$O(b^{c^*/\epsilon})^3$	$O(b^{c^*/\epsilon})^3$
Greedy Search	PQ $(h(n))$	-	No	-	-
A^* Tree Search	PQ $(h(n)+g(n))$	-	*iff* $h(n)$ admissible	-	-
A^* Graph Search[4]	PQ $(h(n)+g(n))$	-	*iff* $h(n)$ consistent	-	-

[1] s = depth of solution.
[2] $g(n)$ = cumulative path cost.
[3] c^*/ϵ = effective solution depth (c^* = cost of the cheapest solution; ϵ = minimum cost of cost-contour arcs).
[4] Compared to tree search, graph search keeps a closed set of expanded states to check against to prevent duplicate expansions.

Remark. Implementation of search algorithms differ only in fringe strategies.

3 Constrained Satisfaction Problems

Definition 3.1 (Constrained Satisfaction Problems)**.** Constrained Satisfaction Problems (CSPs) are a type of **identification problem** defined by variable $X_0, \ldots, X_n$ with values from a domain D that satisfies a set of constrains.

3.1 Ordering

Definition 3.2 (Minimum Remaining Values)**.** The MRV policy chooses an unassigned variable that has the fewest valid remaining values in order to induce backtracking earlier and reduce potential node expansions.

Definition 3.3 (Least Constraining Value)**.** The LCV policy chooses a value assignment that violates the least amount of constraints, which requires additional computation such as running arc consistency test on each value.