Sequential Decision-Making

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Informed Search

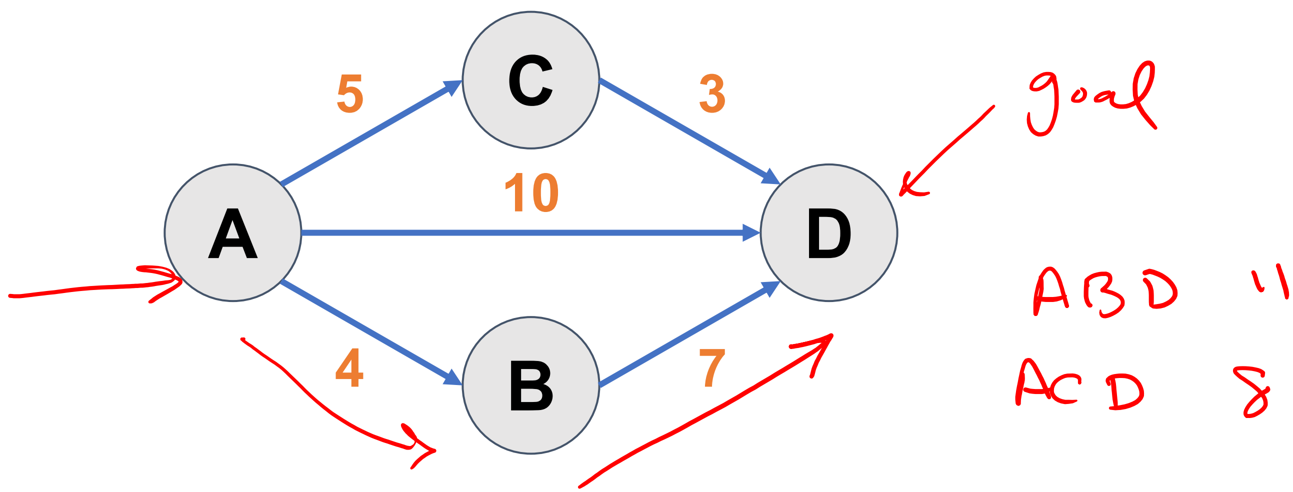
- We are informed about the goal
- We need an **estimation** about **how close** a state is to **goal** → heuristic function
- Manhattan distance and Euclidean distance in path finding

Best First Search

- **Strategy:**
  - Use heuristic for each node as an estimation to its "desirability"
  - Expand the most desirable unexpanded node

Greedy Search

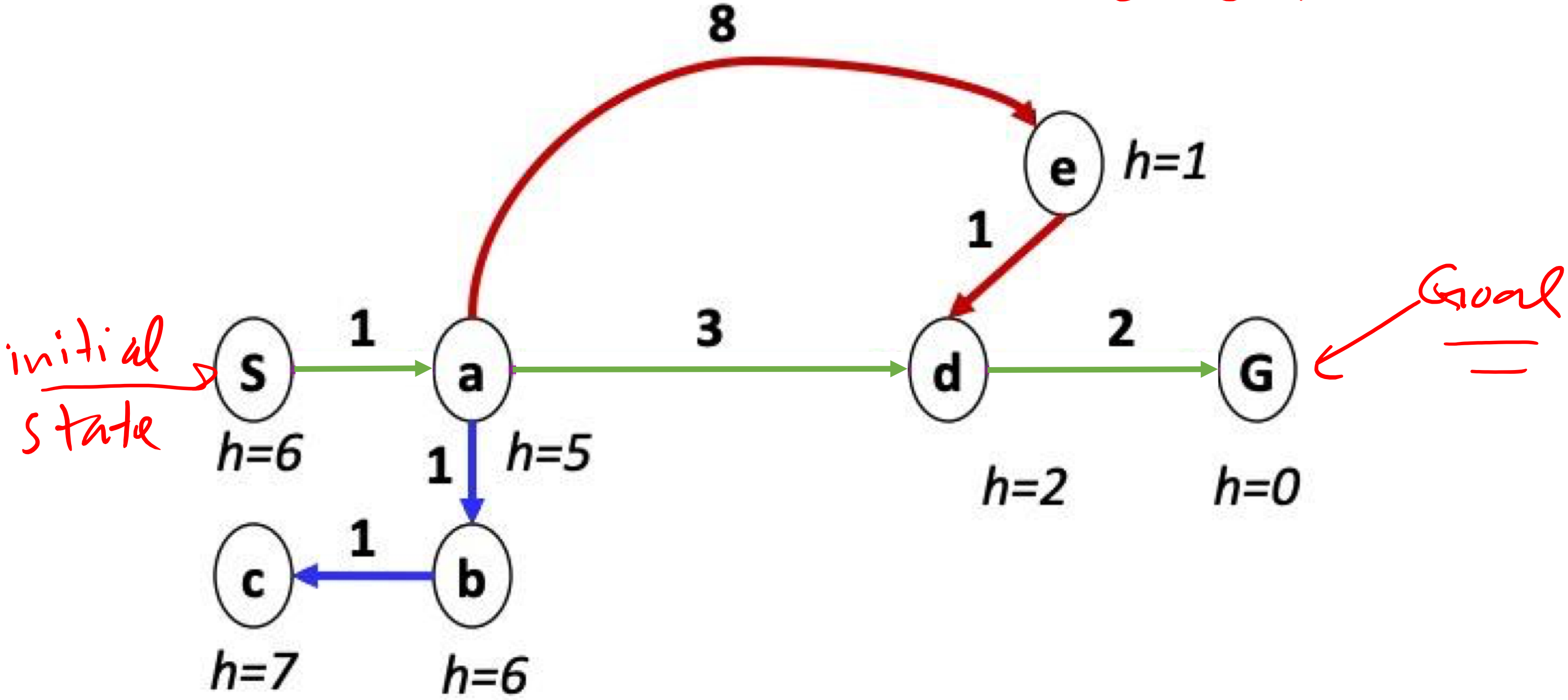
- **Strategy:**
  - Expand a node which has the best (smallest) heuristic
  - Heuristic: estimate of distance to nearest goal for each state
- **Common case: closest distance to the goal is not always the optimal solution**
- **Not optimal**
- **It is not complete (might stock in loops)**



Combining UCS and Greedy

- **Uniform-cost**: orders by **path cost** $\underline{g(n)}$ Sabc
- **Greedy**: orders by **goal proximity** $\underline{h(n)}$ SaedG
- **A* search**: orders by the sum of $f(n) = \underline{g(n)} + \underline{h(n)}$

SadG



Admissible Heuristic

- A heuristic h is **admissible** (optimistic) if:

$$0 \leq \underline{h(n) \leq h^*(n)}$$

- Where $h^*(n)$ is the **true cost** to the nearest goal

- Is it possible using the actual cost as a heuristic?

  As heuristics get closer to the true cost, you will expand fewer nodes but usually do more work per node to compute the heuristic itself

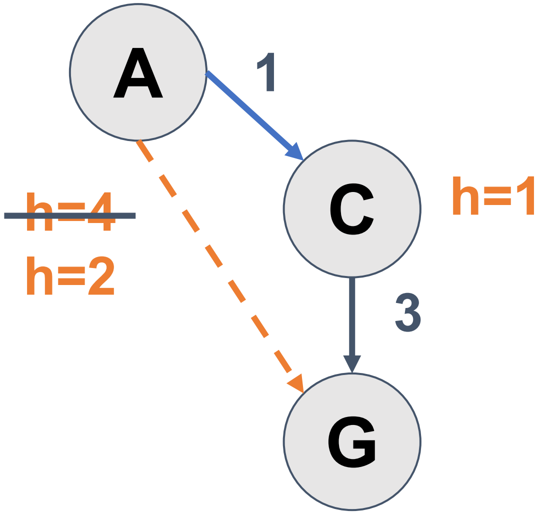
Consistency

- Heuristic “arc” cost is less than or equal to the actual cost for each arc

$$h(A) - h(c) \leq cost(AC)$$

- The f value along a path never decreases

- A* graph search is optimal



Optimality of A* Graph Search

- **Assumption: A* with a consistent heuristic**
  - A* expands nodes in increasing total f value (f-contours)
  - For every state s, nodes that reach s optimally are expanded before s is expanded
- **Uniform Cost Search (UCS) is optimal since $h=0$ is a consistent heuristic**

$0 \leq h(n)$

$h(n) = 0$

Summary

- Informed search
- Best first search
- Greedy search
- A* search
- Admissibility
- Consistency
- A* optimality