COMP3211 Tutorial 3: Search

Fengming ZHU

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Department of CSE
HKUST

Outline

Search

Simple Agents

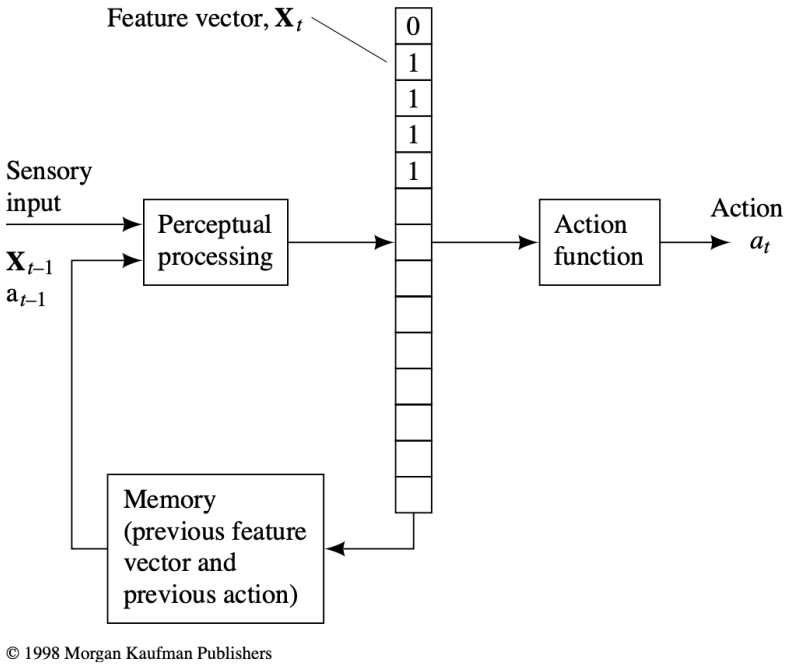


Figure 1: Simple agents

Simple Agents

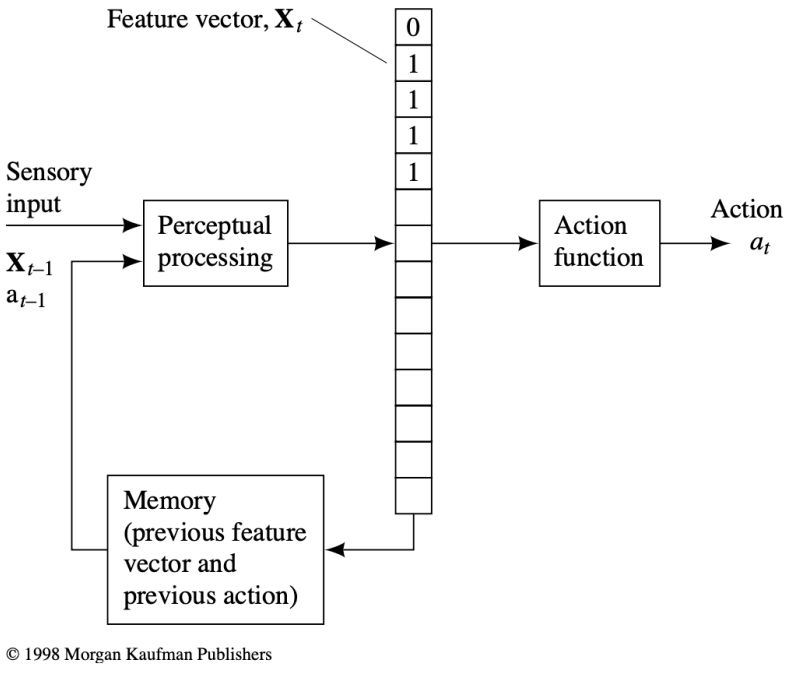
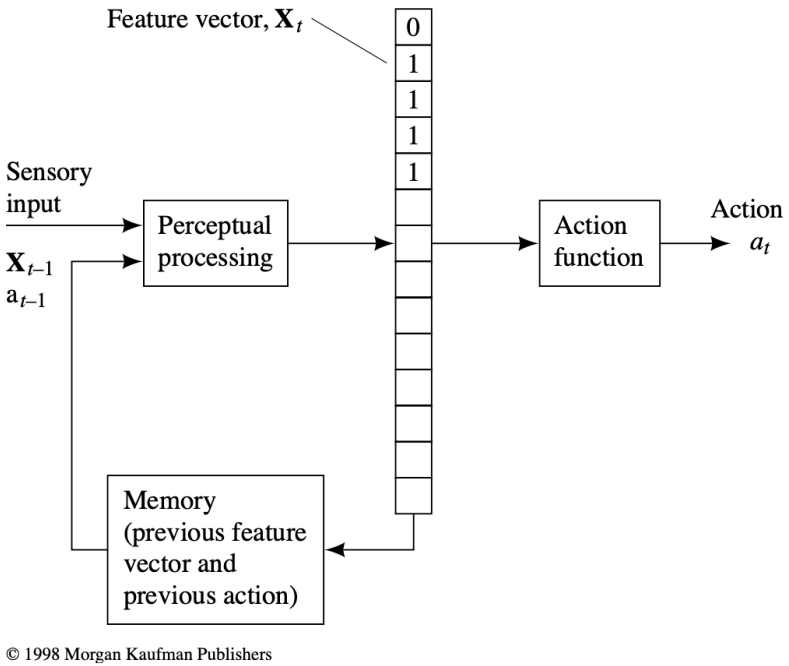


Figure 1: Simple agents

Key points:

- Respond to the environment,

Simple Agents



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- Respond to the environment,
- Consider how the world IS, or HAVE BEEN,

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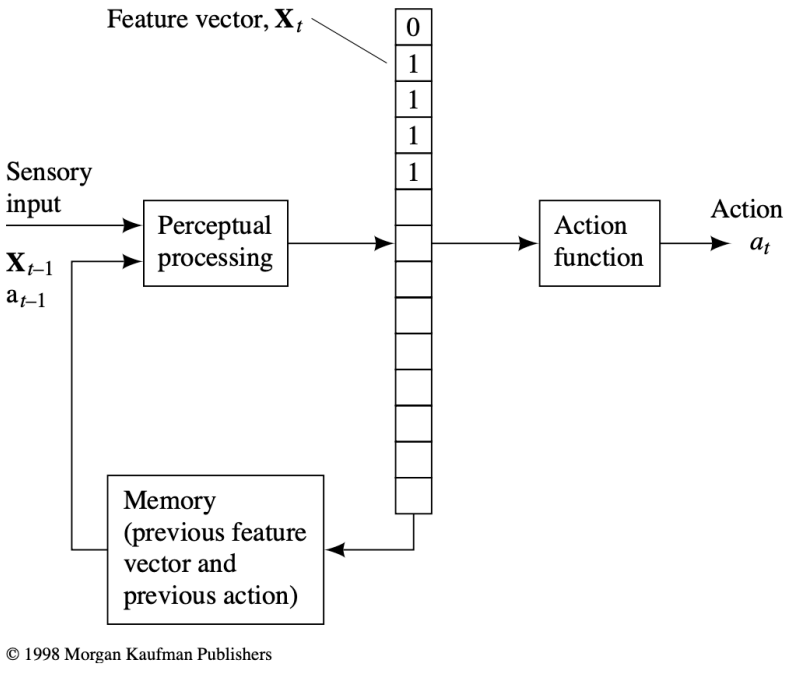

Figure 1: Simple agents

Key points:

- Respond to the environment,
- Consider how the world IS, or HAVE BEEN,
- Cannot imagine how the world WOULD BE.

Formulation

Notations:

- A set of states $\mathcal{S}$
- An initial state $I \in \mathcal{S}$
- A goal state $G \in \mathcal{S}$ (sometimes a goal test)
- A set of actions $\mathcal{A}$
- Deterministic transitions $T : \mathcal{S} \times \mathcal{A} \to \mathcal{S}$ { function / graph
- Cost function $c : \mathcal{S} \times \mathcal{A} \to \mathbb{R}$
- A solution (path) is a sequence of actions from I to G.

Follow-up Questions

Question #1:
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For agent 1, who can compute a feasible plan (path), if you extract her plan and deploy to agent 2 under the same setting, who has no sensing ability and no computing power, can she successfully reach the goal?

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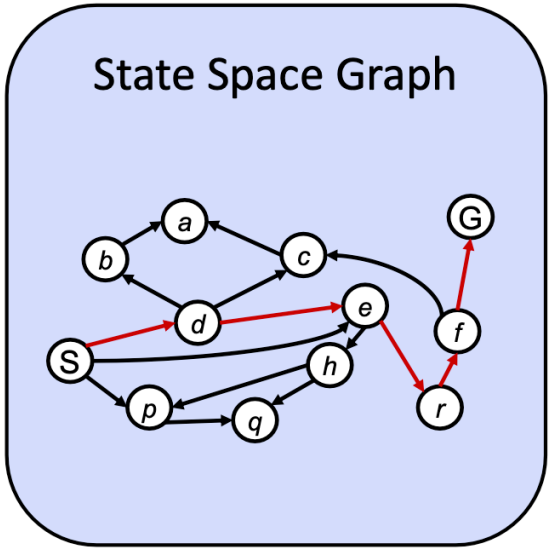
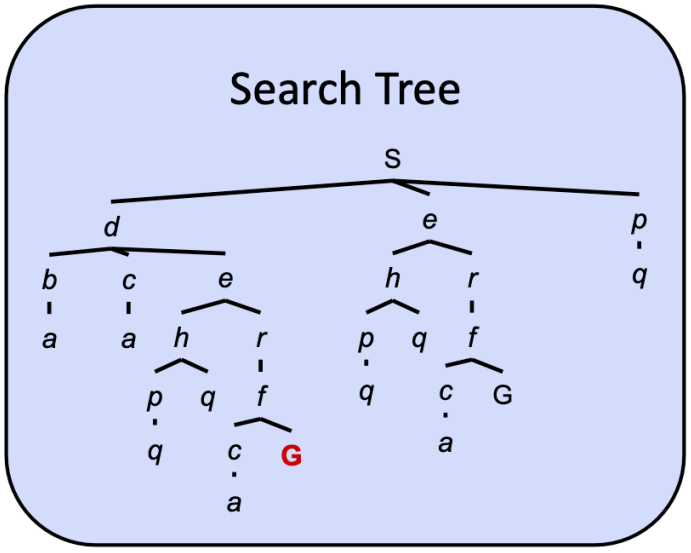
For agent 1, who can compute a feasible plan (path), if you extract her plan and deploy to agent 2 under the same setting, who has no sensing ability and no computing power, can she successfully reach the goal?

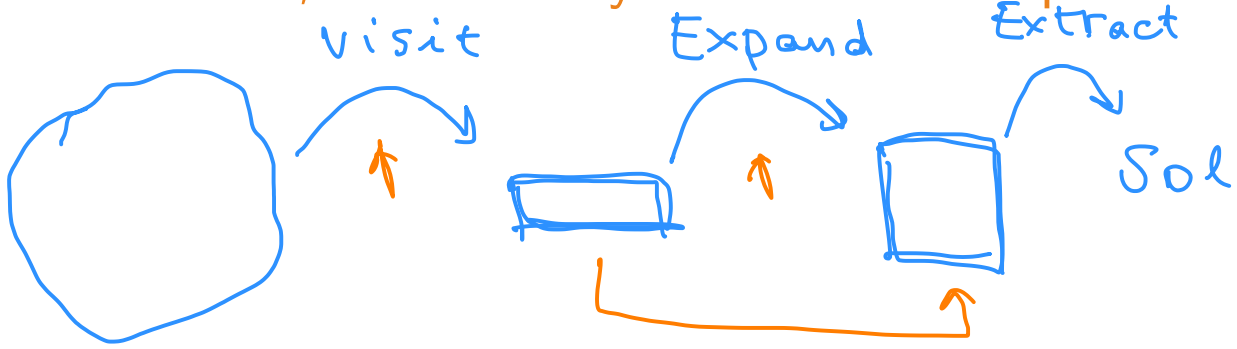
– Yes, once computed, just blindly execute it.

General Idea: Graph/Tree Search





A node can only be expanded once, while it may be visited multiple times!



Key concepts:

- Fringe (frontier)
- Expansion
- Exploration strategy

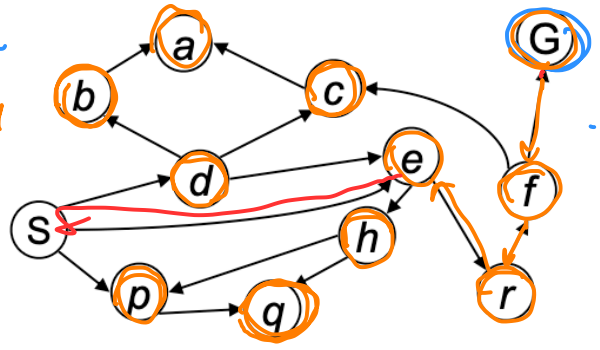
Breadth-First Search

Strategy: expand a shallowest node first

Implementation: Fringe is a FIFO queue

Candidate

Expanded



1 d e p

2 e p b c e d

3 p b c e h r d e

4 b c e h r q d e p

5 c e h r q a d e p b

6 e h r q a a d e p b c

7 x h r q a a d e p b c

8 r q a a q d e p b c h

9 q a a q f d e p b c h r

10 a a q f d e p b c h r q

11 a q f d e p b c h r q a

12 x q f d e p b c h r q a

x f d e p b c h r q a

✓ (1) → G d e p b c h r q a f

(2) → d e p b c h r q a f G

S → e → r → f → G

Breadth-First Search

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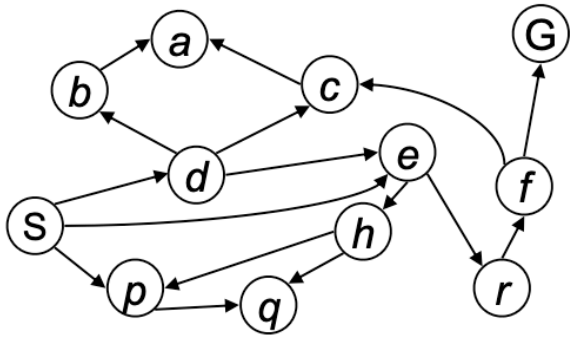
Implementation: Fringe is a FIFO queue



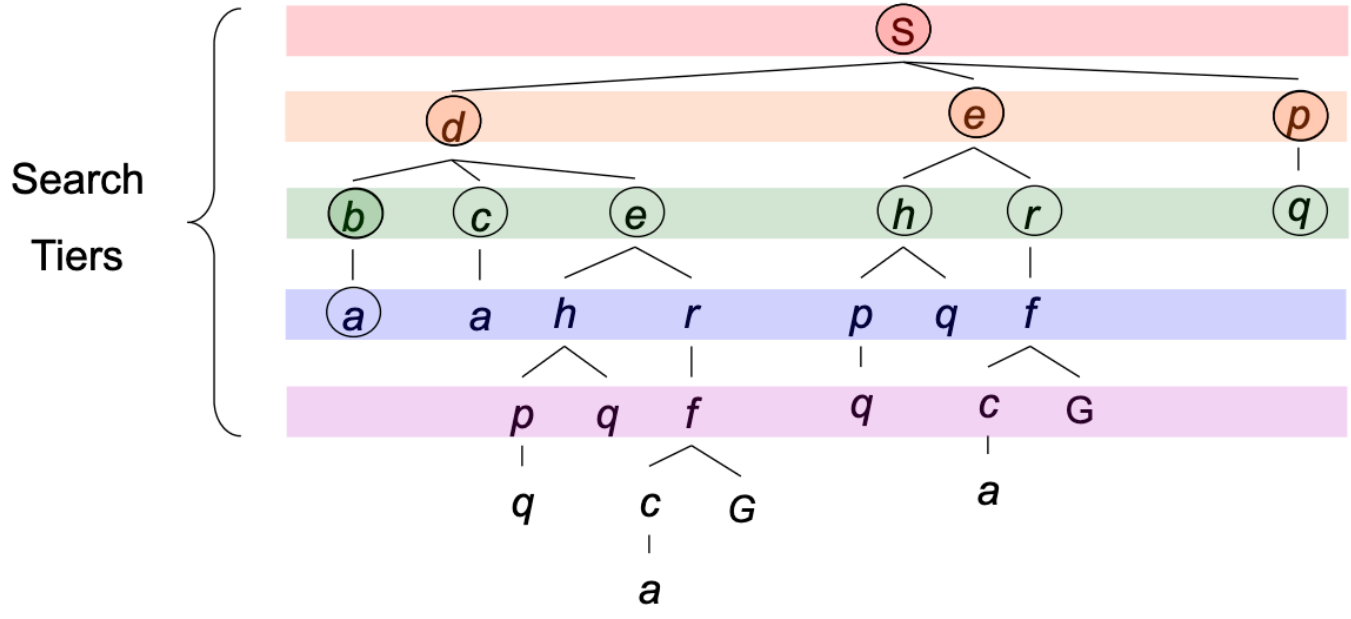


Figure 2: Breadth-First Search

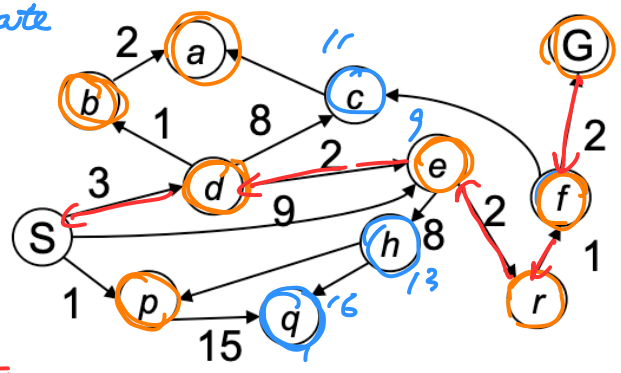
Uniform Cost Search WEIGHTED - BFS

Candidate

Expand

Strategy: expand a cheapest node first:

Fringe is a priority queue (priority: cumulative cost)



1 p' d³ e⁹

2 d³ e⁹ q¹⁶ p

3 b⁴ e⁵ e⁹ c'' q¹⁶ p d

4 e⁵ a⁶ e⁹ c'' q¹⁶ p d b

5 a⁶ r⁷ e⁹ c'' h¹³ q¹⁶ p d b e

6 r⁷ e⁹ c'' h¹³ q¹⁶ p d b e a

7 f⁸ e⁹ c'' h¹³ q¹⁶ p d b e a r

(1) →

8 e⁹ G¹⁰ c'' h¹³ q¹⁶ p d b e a r f

9 ~~e~~ G¹⁰ c'' h¹³ q¹⁶ p d b e a r f

√ (2) →

c'' h¹³ q¹⁶ p d b e a r f G

S → d → e → r → f → G

Uniform Cost Search

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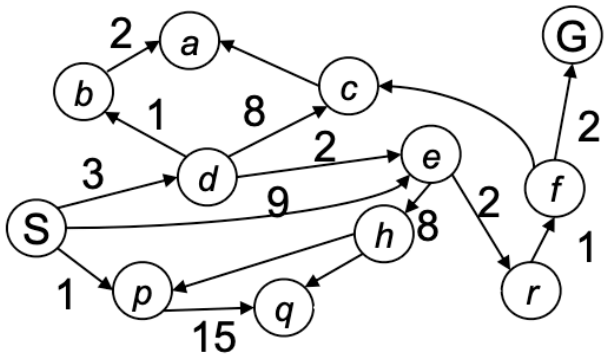

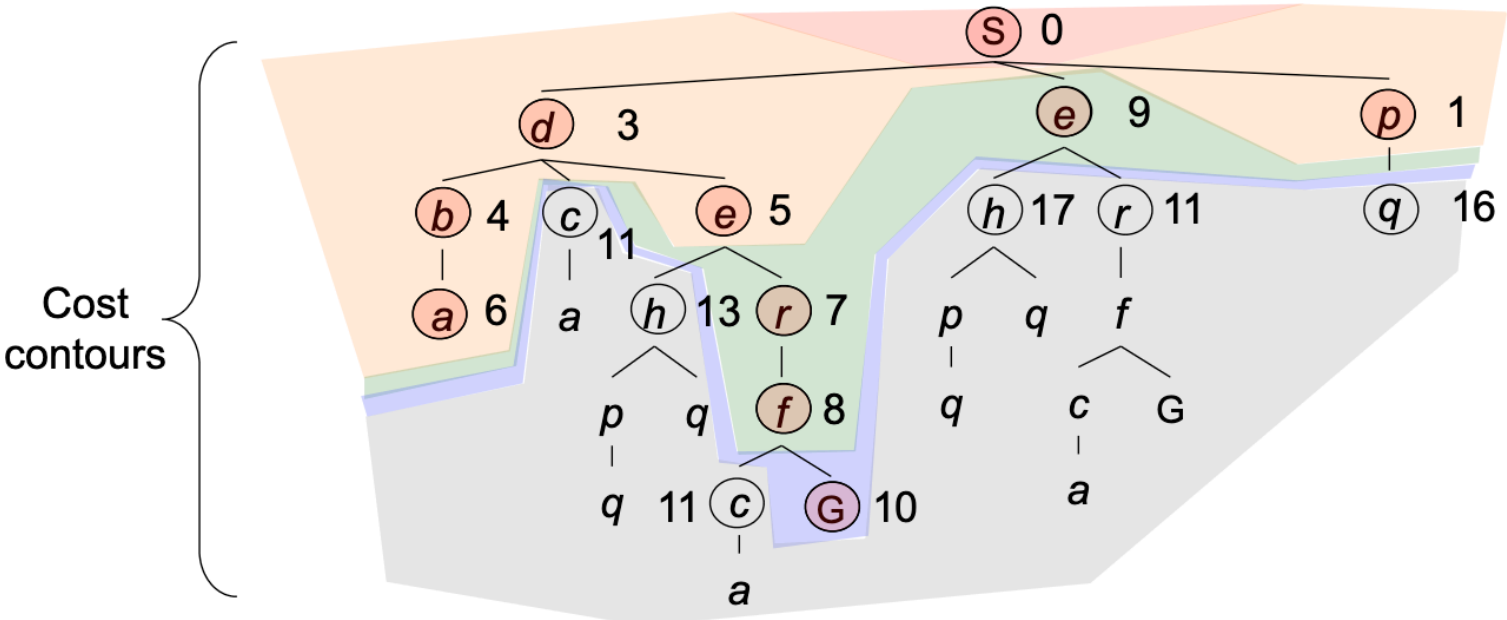

Figure 3: Uniform Cost Search

Greedy Search

- Strategy: expand a node that you think is closest to a goal state.
- Best case: every time you make a perfect guess.
- Worst case: turn around until you get into a dead end.

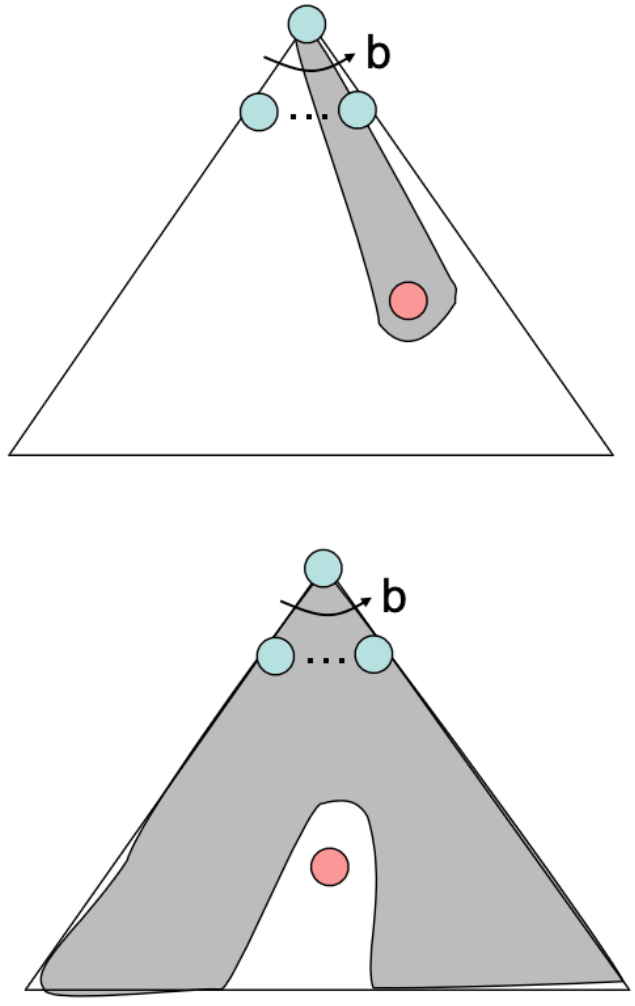

Figure 4: Uniform Cost Search

A^* Search

- Uniform-cost orders by path cost, or backward cost g(n)
- Greedy orders by goal proximity, or forward cost h(n)

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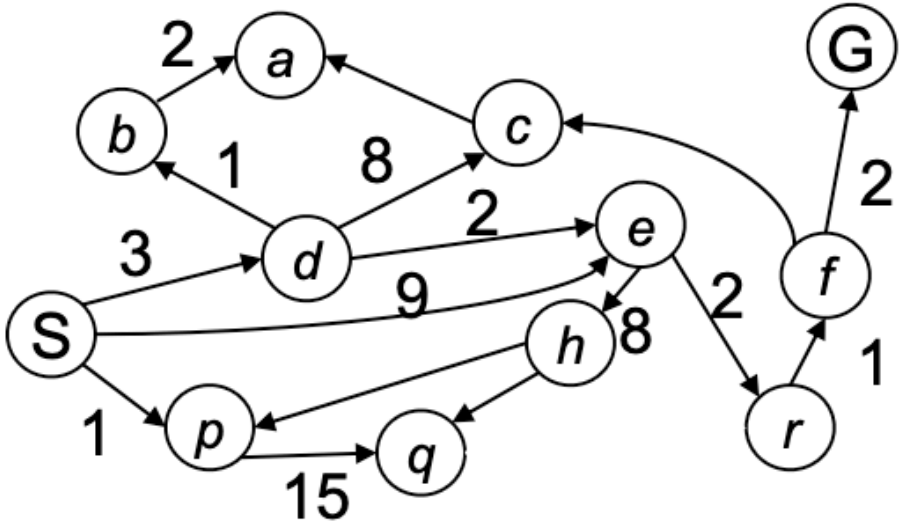


Figure 5: $h(n) = shorst\_path\_length(n, G)$

A^* Search

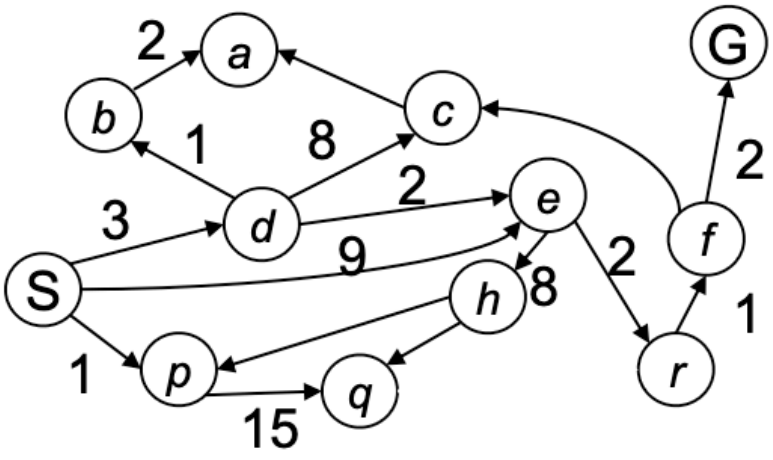
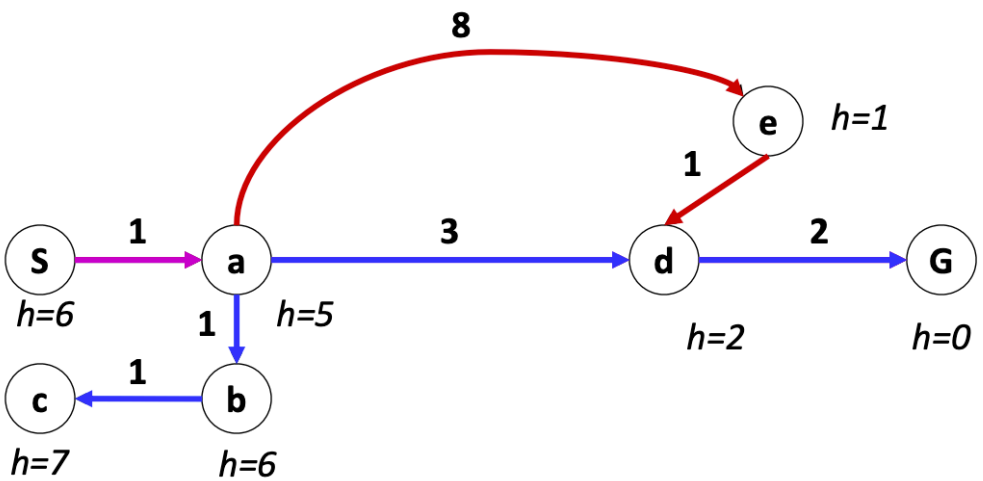
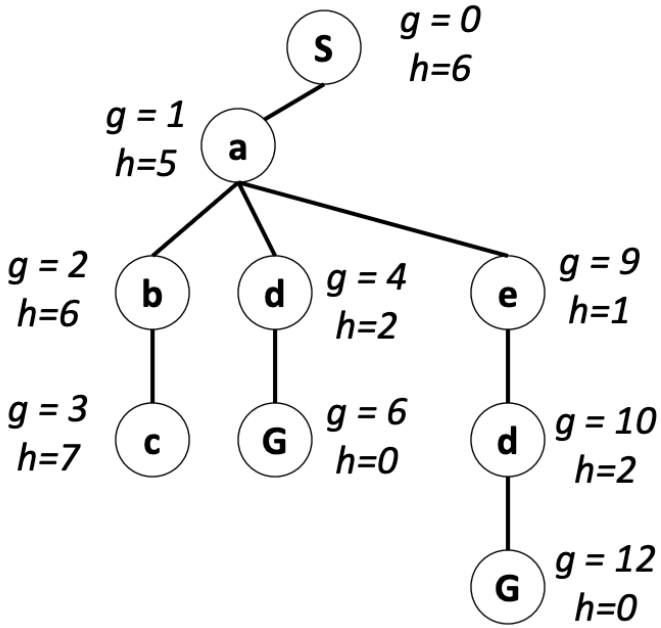


Figure 6:
$h(n) = shorst\_path\_length(n, G)$

A^* Search – another example





A^* Search – demo

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- Live demo: https://www.movingai.com/SAS/index.html

Exercise

A^* search:

- An offline process – when the map changes: need to replan the whole solution.

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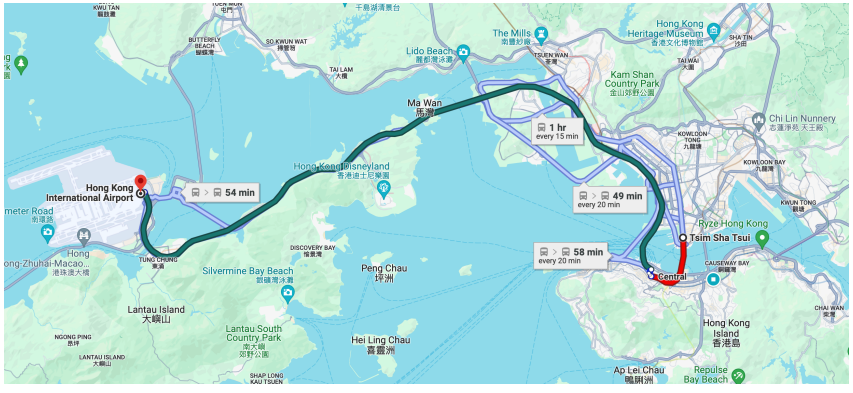

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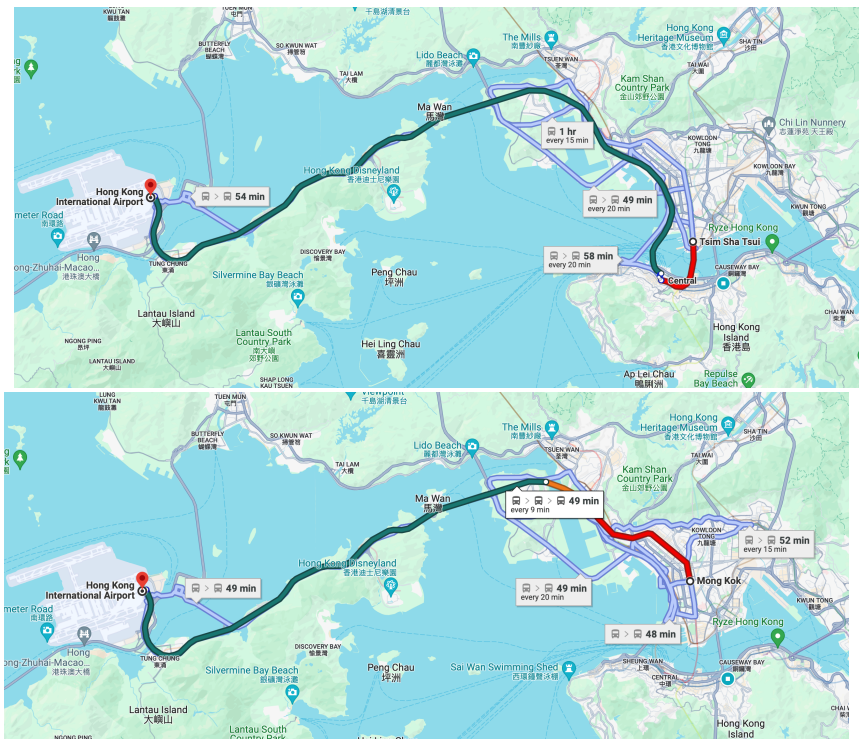

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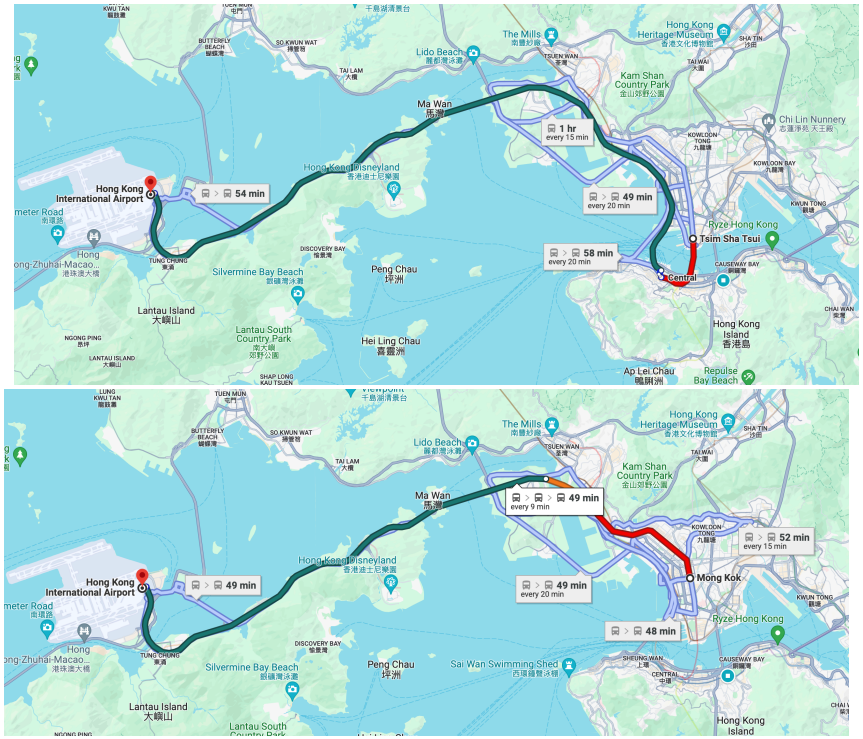

Figure 7: Plan backwrads from the goal to the start: D^* Lite

Thanks!