A* and Heuristic Search

Xiang Zhuoya

zxiang@cs.ust.hk

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More about the project

- Use "**chmod**" to make bidder executables accessible before calling them, or the server will raise "Permission denied" error
  e.g. "**chmod 777 00**" will make the RANDOM (00) bidder accessible.
- If there're two or more winners in one round, the reward will be evenly distributed to every winner.
  e.g. Two bidders, both bid 0.6, then everyone gets (1-0.6)/2 = 0.2.

Tree Search

Basic Idea:

- Exploration of state space by generating successors of already-explored states. (a.k.a expanding states)
- Every state is evaluated: is it a goal state?

Search strategies

The search strategy determines the order in which nodes in the search tree are expanded.

- Breadth-first Search
- Depth-first Search
- Iterative Deepening Search
- Heuristic or *Best-first* Search
- A^* Search

Heuristic function

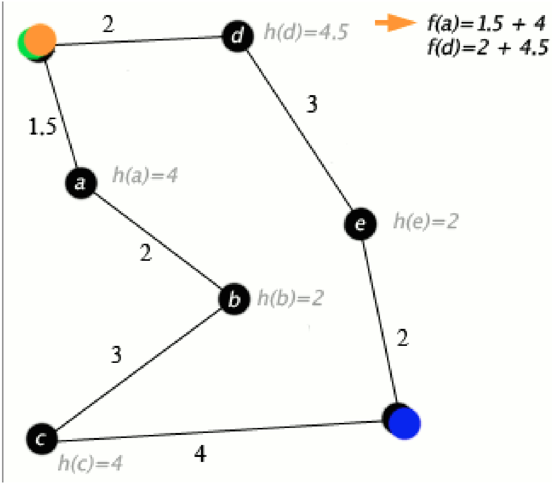
The heuristic can be used to control A^*'s behavior. Recall that A^* use $g(n) + h(n)$.
Let $h^*(n)$ be the *actual* cost of moving from n to the goal, and then consider the following cases:

1. At one extreme, if $h(n) = 0$
2. if $h(n) \leq h^*(n)$
3. if $h(n) = h^*(n)$
4. if $h(n)$ is sometimes greater than $h^*(n)$
5. At another extreme, if $h(n) \gg g(n)$

Heuristic function Cont'd

1. At one extreme, if $h(n) = 0$, then only $g(n)$ plays a role, and A^* turns into Dijkstra's algorithm if by graph search, or Breadth-first Search if by tree search, which are all guaranteed to find a shortest path.
2. If $h(n) \leq h^*(n)$, then A^* is guaranteed to find a shortest path. The lower $h(n)$ is, the more node A^* expands, making it slower.
3. If $h(n) = h^*(n)$, then A^* will only follow the best path and never expand anything else, making it very fast.
   Although you can't make this happen in all cases, you can make it exact in some special cases. It's nice to know that given perfect information, A^* will behave perfectly.
4. If $h(n)$ is sometimes greater than $h^*(n)$, then A^* is not guaranteed to find a shortest path, but it can run faster.
5. At another extreme, if $h(n) \gg g(n)$, then only $h(n)$ plays a role, and A^* turns into Best-first Search.

Map Example - Find a path



Nodes are cities connected with roads and h(x) is the straight-line distance to target point.

Map Example - a Formulation

- States: the map with any path on it.
- Initial state: the map with no path on it.
- Goal test: the map with a path from the starting point to the end point.
- Actions: Extend the current path by one step.
- Path cost: the length of the path.

Exercise: Find a path using
1. Interative Deepenning
2. A* by tree
Detailed solutions will be uploaded later.