* Uniform Cost Search

* Complete
* optimal

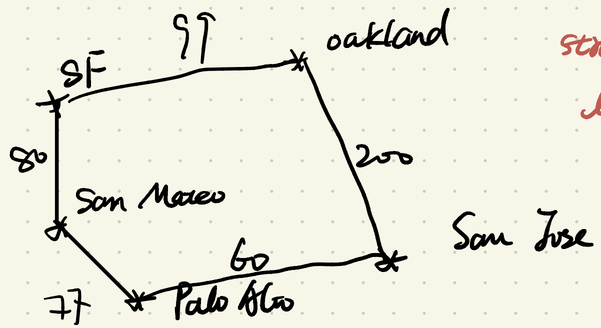
- priority queue ordered by path cost function g(n)
- check whether a node is a goal node

speed up the process of finding the optimal solution

Informed Search Algorithms

heuristic function : h(n)

estimate cost from node n to a goal node



straight line distance between

Oakland ⟷ SJ

SF ⟷ SJ

heuristic function by itself is not a good candidate as we will lose optimality example above: Los Gatos would have been selected over Santa Clara since $h(\text{Los Gatos}) < h(SC)$

Let's combine the path cost function $g(n)$ and a heuristic function $h(n)$

$f(n) = g(n) + h(n)$

$f(n)$ → total estimated cost from start to goal going through n

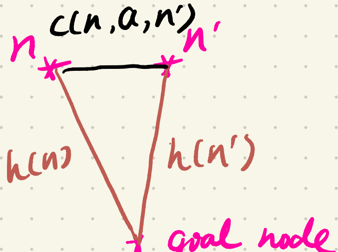
$g(n)$ → path cost start → n

$h(n)$ → estimated cost from n to cost

Conditions on h(n) to still get optimality

1) heuristic is admissible if it does not overestimate the actual cost

2)



n': successor of node n that you get by applying an action a

$h(n) \leq c(n,a,n') + h(n')$

$c(n,a,n')$: actual cost of going from node n to node n' by applying an action a

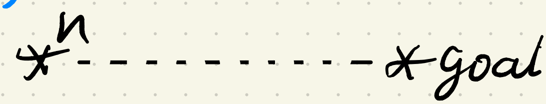
Assuming (by contradiction that $h(n) > c(n, a, n') + h(n')$

$\Rightarrow$ overestimating the cost from n to goal note

$\Rightarrow$ we want $h(n)$ to not be an overestimate

Condition : A heuristic has to be consistent which means that for any node n and any sucessor n' of n, we must have $h(n) \le c(n, a, n') + h(n')$

Exercise: Show that a consistent heuristic is admissible (induction)

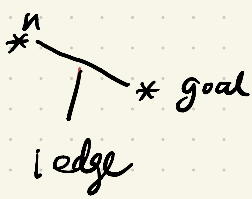


Base Case

$k=1$

$\downarrow$

# of edge between n and goal



$$h(n) \le c(n, a, goal) + \overset{0}{\overset{\parallel}{h(goal)}}$$

$\Rightarrow h(n) \le c(n, a, goal)$

$h(n)$ $\downarrow$ estimated cost $n \rightarrow$ goal

$c(n, a, goal)$ $\downarrow$ actual cost $n \rightarrow$ goal

$\Rightarrow$ base case is proven

Indution step

Assume that if node n is d edges away from the goal node $(k=d)$, then estimated cost < actual cost

we want to show that the property will still hold if n is dth edge away $(k = d+1)$

Let $c(n)$ = actual cost from node n to a goal node

Assum $h(n') \le c(n')$ for any node n' that is d edges away from goal.

Show $h(n) \le c(n)$ for any node n that is d+1 edges away from goal

Let's first start by finding another expression for $c(n)$

$f(n)$ $(n+)$

$$c(n) = \min_{n' \in \text{neighbours}(n)} c(n, a, n') + c(n')$$

$h(n) \le \underline{c(n, a, n') + h(n')}$ for any neighbor n' of n

$h(n') \le c(n')$ (Induction hypothesis)

n' : d steps away from the goal

$$h(n) \le c(n, a, n') + h(n') \le c(n, a, n') + c(n')$$

true for every node n'

must also be true for the node n'

that minimens the quantity

$c(n, a, n') + c(n')$

$$\Rightarrow h(n) \le \min_{n' \in \text{neighbors}(n)} c(n, a, n') + c(n')$$

$$\Rightarrow h(n) \le c(n)$$

I mainly need to check for consistency to get a valid heuristic.

Why is it that a consistent heuristic will lead to an optimal Solution