AI Planning for Autonomy

Problem Set III: Choosing Heuristics

1. Consider a $m \times m$ manhattan grid, and a set of coordinates V to visit in any order, and a set of inaccessible coordinates (walls) W.
   Using the state space below:

$$
\begin{aligned}
S &= \{\langle x, y, v\rangle \,|\, x, y \in [0..m] \wedge v \subseteq V\} \\
S_0 &= \langle 0, 0, V\rangle \\
A(\langle x, y, v\rangle) &= \{\langle dx, dy\rangle \,|\, dx, dy \in \{-1, 0, 1\} \\
&\qquad \wedge\ |dx| + |dy| = 1 \\
&\qquad \wedge\ \langle x + dx, y + dy\rangle \notin W\} \\
t(\langle dx, dy\rangle, \langle x, y, v\rangle) &= \langle x + dx, y + dy, \\
&\qquad v - \{\langle x + dx, y + dy\rangle\}\rangle \\
c(a, s) &= 1 \\
G &= \{\langle x, y, v\rangle \,|\, \langle x, y, v\rangle \in S \wedge v = \emptyset\}
\end{aligned}
$$

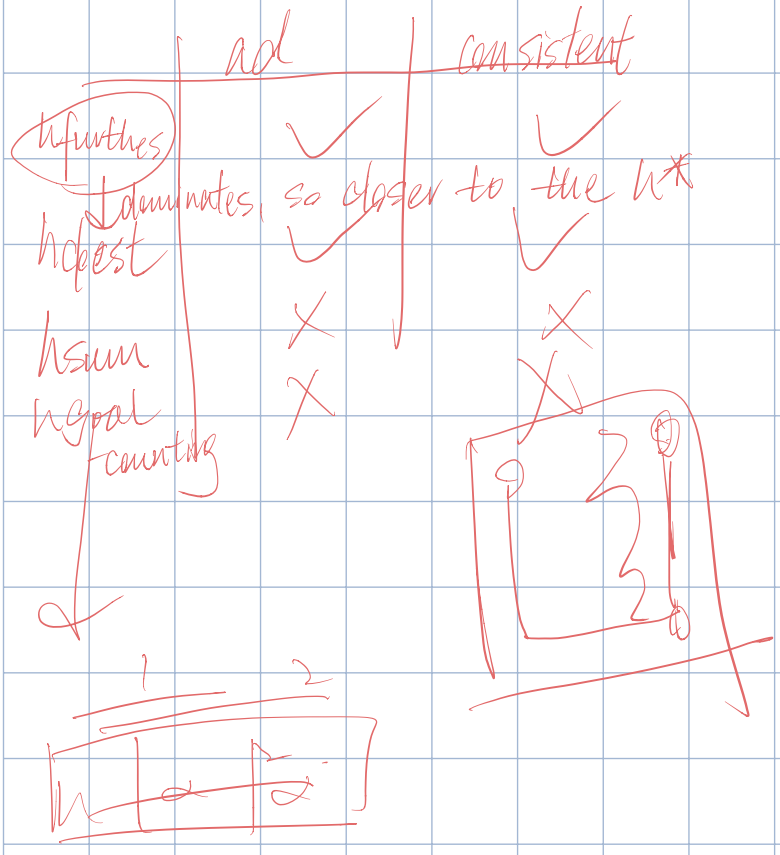
   - Explain the meaning of x, y and v in each state $s \in S$
   - Define 3 different heuristics for this problem.
   - Which of your heuristics is admissible? consistent? dominates the others?
   - Estimate the complexity of calculating each of your heuristics.
   - Which would you use in A*? Why?

2. Reformulate the state-model from Q1 as a STRIPS problem $P = \langle F, O, I, G\rangle$.
3. Write pseudo code for the following search algorithms:
   Feel free to implement these in python in the appropriate places in search.py for assignment 1.
   - Breadth First
   - Depth First
   - A Star
   - Uniform Cost

- Explain the meaning of x, y and v in each state $s \in S$

x is the row of the grid, and y is the column of the grid
v represents whether the node (x, y) belongs to the V

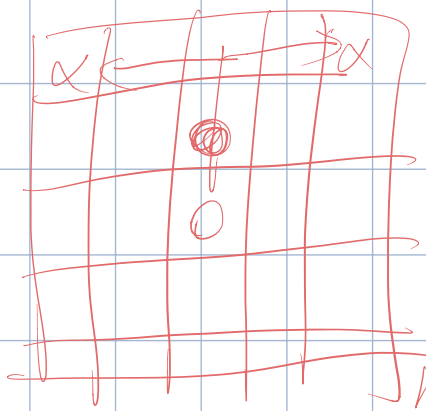
- Define 3 different heuristics for this problem.



we need to calculate
$\max(|x-x'|+|y-y'|)$
$x', y' \in V$
x, y = current

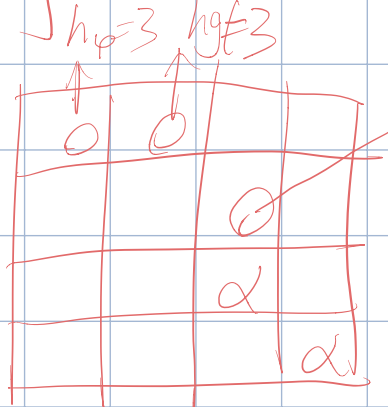
$h^* = cost_{furthest} + 0$

$h_{furthest} = cost_{furthest}$



$h_{sum} = 4+4 = 8$
$h'_{sum} = 3+3 = 6$
$\Big\} h - h' < cost$

goal-counting



$h_g = 2$

$h^* = 1 \times cost(a)$

$h_g = 1 < 1$
$h'_g = 0$

2. Reformulate the state-model from Q1 as a STRIPS problem $P = \langle F, O, I, G \rangle$.

$P = \langle F, O, I, G \rangle$

$F = \{at(x,y), visited(x,y) \mid (x,y) \in \{0,\dots,m\} \times \{0,\dots,n\}\}$

set of facts

operands

$I = \{at(0,0)\} \subseteq F$

$O = move((x,y),(x',y'))$

DEL

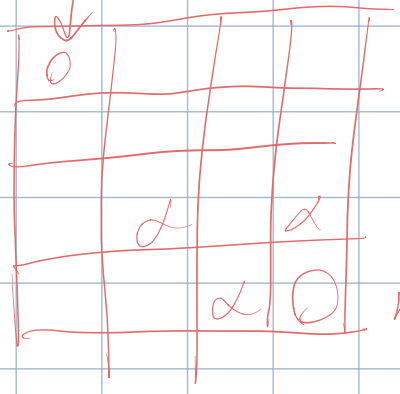
ADD

Pre

ADD $= at(x',y'), visited(x',y')$

DEL $= at(x,y)$

Pre $= at(x,y) \subseteq F$



m x n

$G = \{visited(x,y) \mid (x,y) \in V\} \subseteq F$

a set of cities I need to visit

$G = \{visited(2,1), visited(2,3), visited(3,2)\} \subseteq F$

current previous

$F' = F + ADD(a) - DEL(a)$

s.t $pre(a) \subseteq F$