answer: 0xFFF0C1C

CS 188 HW 1

1) a) i) Representation of the state space:

$(A_x, A_y, A_f, S_x, S_y, S_d)$ where

A_x: Agent's x coordinate A_y: Agent's y coordinate A_f: Where the agent faces
S_x: Skull's x coordinate S_y: Skull's y coordinate S_d: Skull's direction

ii) $N \cdot 2 \cdot M \cdot 2 = 4NM$

Counts for (A_x, A_y) from A_f from (S_x, S_y) from S_d

Explanation is above

iii) Is $(A_x, A_y) = (K_x, K_y)$ where (A_x, A_y) represents the agent's coordinate and (K_x, K_y) represents the key's coordinate.

b) i) BFS; Orders are expanded in the order: C-A-B-D-E-F-G-H

8 Nodes are expanded; path returned: C-E-H

Length of path: 2 Cost of path: 4 (1+3)

State s	A	B	C	D	E	F	G	H
d(s)	1	1	0	1	1	1	2	2

ii) Uniform-cost graph search

Order of node expansion: C-A-D-E-B-F-G-H

Number of nodes expanded: 8 Path returned: C-E-F-H

Length of the path: 3 Cost of the path: 3 (1+1+1)

State s	A	B	C	D	E	F	G	H
g(s)	1	2	0	1	1	2	2	3

iii) A^* graph search (with Manhattan distance as the heuristic)

Order of node expansion: C-D-E-F-G-H

Number of nodes expanded: 6 Path returned: C-D-F-H

Length of path: 3 Cost of path: 3 (1+1+1)

State s	A	B	C	D	E	F	G	H
f(s)	5	5	3	3	3	3	3	3

c) Shortest path (in # of steps) is returned by BFS and optimal cost is returned by UCS and A^*. Main difference between BFS and UCS or A^* is BFS does not take into account that steps have costs (potentially different) whereas UCS and A^* do. The difference between UCS and A^* is basically A^* makes use of a heuristic to ideally expand the correct nodes earlier than the incorrect ones; though this really depends on the heuristic

d) i) Admissible and consistent Heuristic (Manhattan Distance)

State s	A	B	C	D	E	F	G	H
Heuristic h(s)	4	3	3	2	2	1	1	0

Admissibility $\Rightarrow$ $0 \leq h(n) \leq h^*(n)$

Consistency $\Rightarrow$ $h(A) - h(C) \leq c(A,C)$

I just assigned the true cost of reaching goal from the state which is trivially admissible and consistent. Also this is simply the Manhattan Distance.

ii) Admissible but inconsistent (moves required) Except at starting point

State s	A	B	C	D	E	F	G	H
Heuristic h(s)	3	3	1	2	1	1	1	0

Admissible since $0 \leq h(s) \leq h^*(s)$ for all states (Except C) because h(s) just returns the least moves required to reach the goal. Inconsistent because h(s) does fail $h(A) - h(C) \leq c(A,C)$

$= 3 - 1 \leq 1$ $\nleq$

iii)

State s	A	B	C	D	E	F	G	H
Heuristic h(s)	5	5	5	5	5	5	5	5

(Constant 5)

Inadmissible since $h(n) > h^*(n)$ for all states and since Consistency $\Rightarrow$ Admissibility we can also conclude Inconsistency

e) i) 1) It adds a new parameter T to the state space which takes two values either True or False and represents whether the agent has teleported in the current game.

2) Yes and I will give an example below

Choose the Manhattan Distance to be the heuristic for instance

For reference the heuristic table is as follows:

State s	A	B	C	D	E	F	G	H
h(s)	4	3	3	2	2	1	1	0

Let's investigate states C and G previously $h(C) - h(G) \leq c(C,G)$

$3-1 \leq 2$ held but with teleportation we can see that

$c(C,G) = 1$ (potentially) thus $h(C) - h(G) \leq c(C,G)$ ↯

∴ Inconsistent

ii) It adds a new parameter S to the state space which takes two values either E or F, indicating the Skull's current location.

2) No and I will give a proof below. Again choose any previously consistent h to be the heuristic then

$h(u) - h(v) \leq c(u,v)$; Direct Proof: Since by adding the skull we potentially increased the costs of some moves (i.e moving to a tile occupied by the skull) the increase can be arbitrary by some h

Since previously $h(u) - h(v) \leq c(u,v)$ held increasing $c(u,v)$ cannot make this inequality not hold thus all consistent heuristics stay consistent