Robotics Assignment 2

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Answer to Question 1

If we consider a very tall building we will get the trilateral distance(d) that can be considered as the Hypotenuse with the Height of the building(H) as height. Thus we can calculate the horizontal radial distance(x) using Pythagoras' theorem.
The Marina Bay Sands is a building with 3 towers. As the towers are very high we can consider each tower as a separate landmark and locate the point by locating the intersection of three horizontal radii (x1,x2,x3).

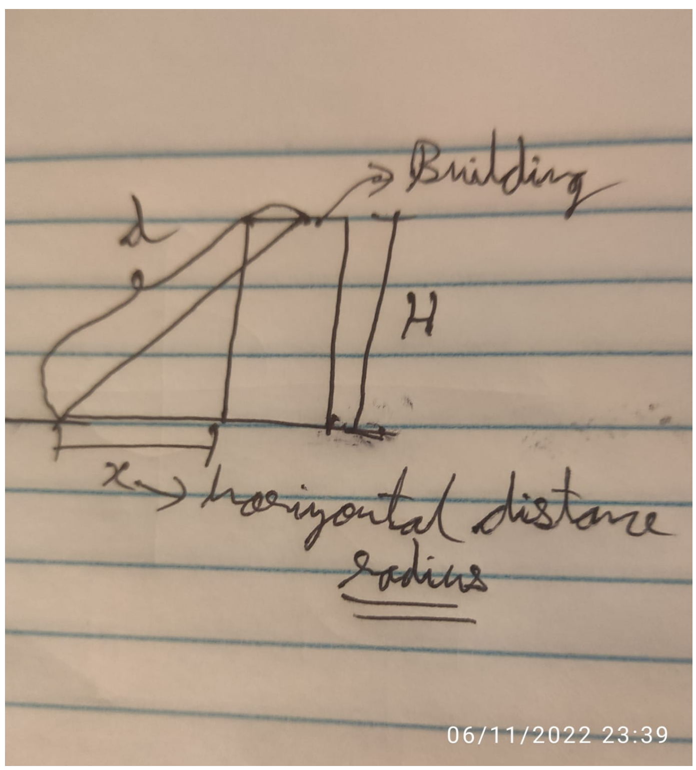


Figure 1

Answer to Question 2

Search space is the total number of possible configurations of the game. In the given case it is the number of ways to arrange 9 items(8 different, 1 pair) in 9 slots.

$$\therefore\ Search\ space = \frac{9!}{2}$$

Answer to Question 3

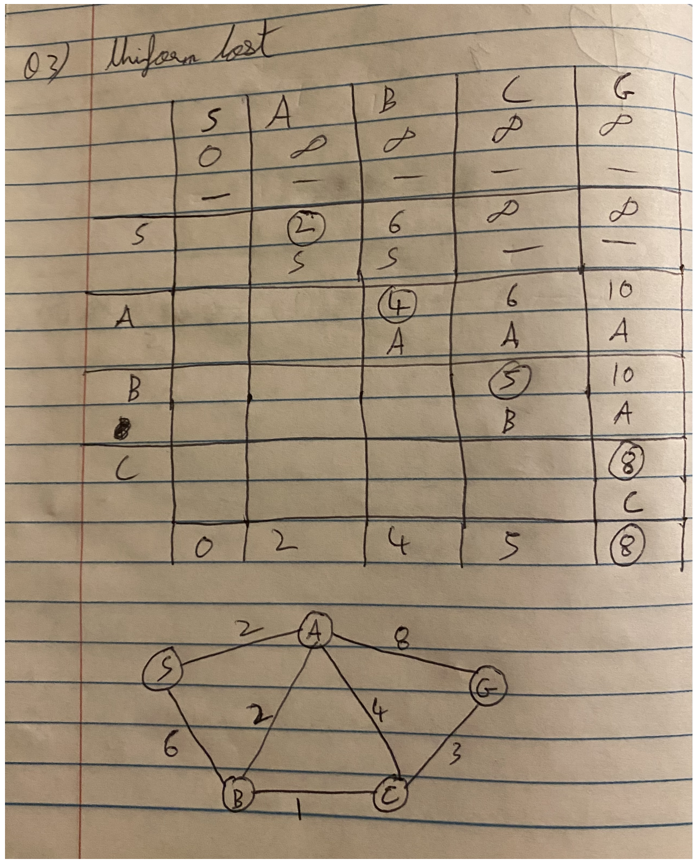
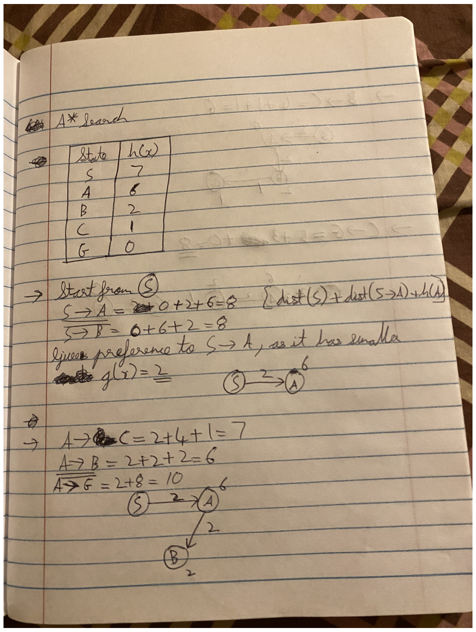
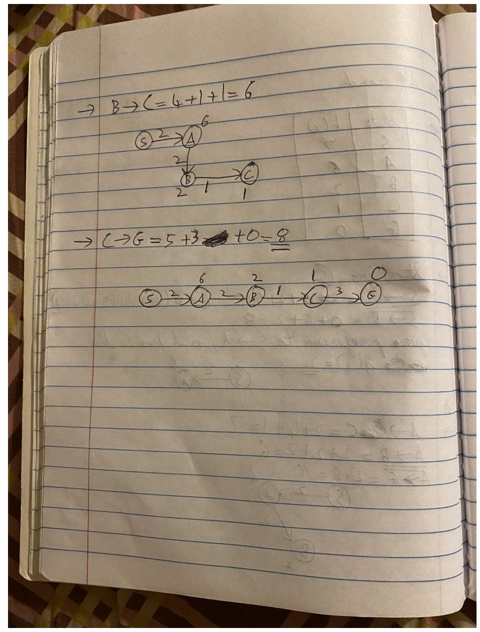


Figure 2: Uniform-cost search



(a)



(b)

Figure 3: A* Search

Answer to Question 4

As the Car has to move on the surface of the earth(sphere), if we consider the Car to be a point object, its C-space would be S*S.
Considering 3-dimensional space it would be S*S*S, where 2 two angles would be in reference to the position of the car w.r.t to the center of the earth(latitude and longitude), and one would be the direction that the car is moving in.

Answer to Question 5

We can solve these questions by using the Grubler formula.
a)
m=3, N=8, J=10
By Grubler formula,
$DoF = m(N - 1 - J) + \sum_{i=1}^{J} f_i$
$\therefore DoF = 3(8 - 1 - 10) + 1 * 10 = 1$
b)
m=3, N=12, J=16
By Grubler formula,
$DoF = m(N - 1 - J) + \sum_{i=1}^{J} f_i$
$\therefore DoF = 3(12 - 1 - 16) + 1 * 16 = 1$
c)
m=3, N=8, J=11
By Grubler formula,
$DoF = m(N - 1 - J) + \sum_{i=1}^{J} f_i$
$\therefore DoF = 3(8 - 1 - 11) + 1 * 11 = -1$
Here the -ve dof means that unnecessary links are added to a fully constrained system, and makes it over-constrained.

Answer to Question 6

A) We can solve this question by using the Grubler formula.
Here,
m=6, N=8, J=9
By Grubler formula,
$DoF = m(N-1-J) + \sum_{i=1}^{J} f_i$
$\therefore DoF = 6(8-1-9) + 1*3 + 3*9 = 9$

b)
m=6, N=2n+2, J=3n
By Grubler formula,
$\therefore DoF = 6(2n+2-1-3n) + n + 6n = n_6$

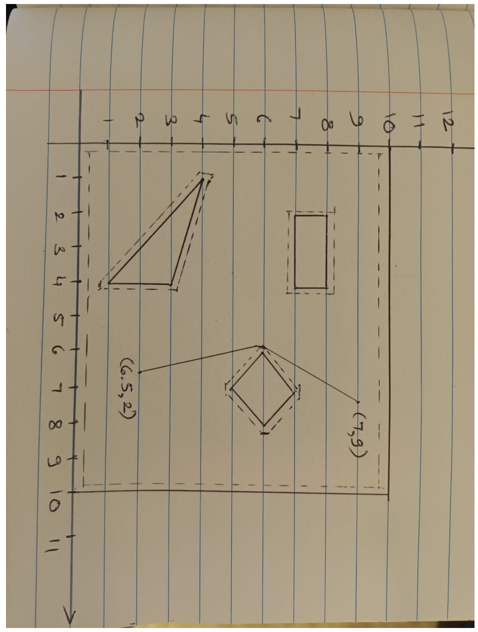
c)It has n+12 DoF.

Answer to Question 7

1. Vertices that describe boundries clockwise are:
OB : (0.3,0.4), (0.3,0.6), (9.7,9.6),(9.7,0.4)
O1: ((0.7,3.6), (0.7,4.4), (4.3,3.4), (4.3,0.6), (3.7,0.6)
O2: (5.7,5.6), (5.7,6.4), (6.7,7.4), (7.3),7.4), (8.3,6.4), (8.3,5.6), 7.3,4.6), (6.7,4.6)
O3: (1.7,8.4), (4.3,8.4), (4.3,6.6), (1.7,6.6)

2. C_free is connected.

3. The path is (6.5,2) - (5.7,5.6) - (5.7,6.4) - (7.9)



(a)

Answer to Question 8

a) The transformation matrix is:

$$A = \begin{pmatrix} cos(40) & -sin(40) & 3 \\ sin(40) & cos(40) & 4 \\ 0 & 0 & 1 \end{pmatrix}$$

b) The points after transformation are:
A(6.5572,12.2064), B(6.80372,15.02404), C(8.97858,15.54356), D(9.4981,13.3687), E(8.6088,11.3171)

c) The edges AE and ED of the rigid collides/intersect with HG and FG of the polygon.

d) The transformation matrix here would be:

$$\text{T'} = \begin{pmatrix} 6.4801 & 1.314 & 8.9341 \\ 2.3640 & 7.9137 & 4.6910 \\ 0.981 & 8.015 & 1.7963 \end{pmatrix}$$