CS 540-1: Introduction to Artificial Intelligence **Fall 2014-15**

Homework Assignment 5

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1 Question 1

In the next pages are the images with the answers of Question 1 (letters A,B,C and E).

1.1 a) Depth-First Search

1.2 b) Breadth First Search

1.3 c) Iterative Deepening Search

D = 1 – A

D = 2 – A,B

D = 3 – A,B,C,G

D = 4 – A,B,C,D,H,G,L

D = 5 – A,B,C,D,E,H,G,L,Q,K

D = 6 – A,B,C,D,E,J,H,G,L,Q,V,P,K

D = 7 – A,B,C,D,E,J,O,H,G,L,Q,V,W,P,K

D = 8 – A,B,C,D,E,J,O,T,**N (goal reached)**

1.4 d) Is heuristic *h(n)* given by the Manhattan distance between squares a good heuristic function?

The heuristic function, *h(n)*, calculated using the Manhattan distance looks reasonable in a sense that it is no possible to make diagonal moves, it is a good strategy to use this method of calculate the distance.

1.5 e) A*

Using *h(n) =* Manhattan distance from a square to the Goal state. Function *g(n) = 1*, then *f(n) = g(n)+h(n)*.

Question 1

a)

DFS -

Stack	Path
K=0 [~~A~~]	A, B, G, L, K, P, Q, V, W, X, S, N
K=1 [~~B~~]	
K=2 [C~~G~~]	
K=3 [CH~~L~~]	
K=4 [CHQ~~K~~]	
K=5 [CHQ~~P~~]	
K=6 [CH~~Q~~]	
K=7 [CH~~V~~]	
K=8 [CH~~W~~]	
K=9 [CH~~X~~]	
K=10 [CH~~S~~]	
K=11 [CHT~~N~~] => Goal reached	

b)

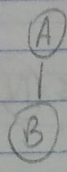
BFS

Queue	Path
[~~A~~]	A, B, C, G, D, H, L, F, Q, K, J, V, P, O, W, T, N
[~~B~~] → A	
[~~C~~G] → B	
[~~G~~DH] → C	
[~~D~~HL] → G	
[~~H~~LF] → D	
[~~L~~F] → H	
[~~F~~QK] → L	
[~~Q~~KJ] → F	
[~~K~~JVP] → Q	
[~~J~~VP] → K	
[~~V~~PO] → J	
[~~P~~OW] → V	
[~~O~~W] → P	
[~~W~~TN] → O	
[~~T~~NX] → W	
[~~N~~XS] → T => Goal Reached	

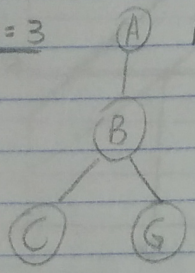
c)

D=1 A

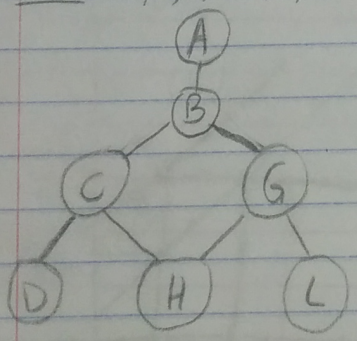
D=2 A,B



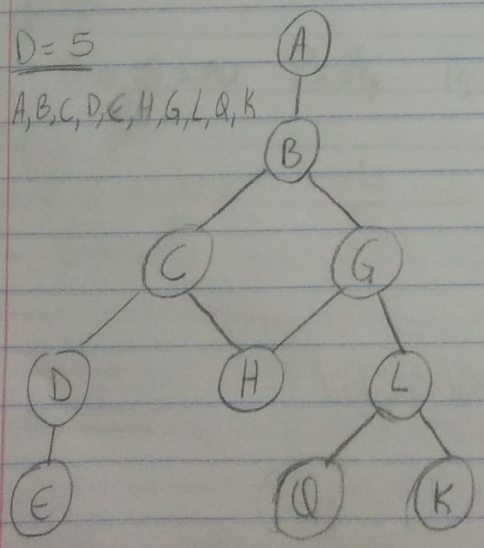
D=3 A,B,C,G



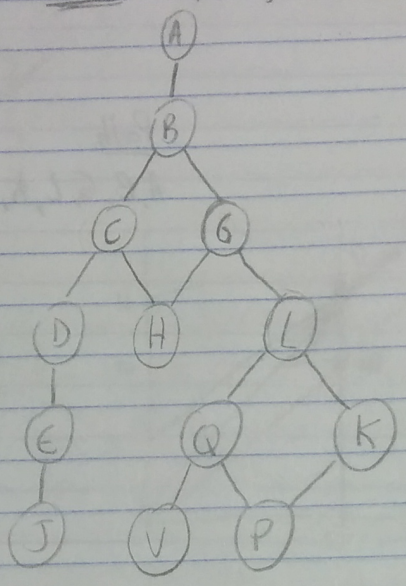
D=4 A,B,C,D,H,G,I



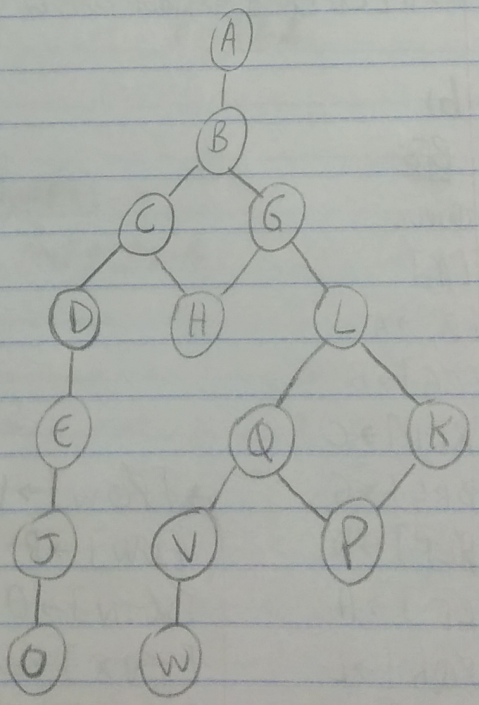
D=5
A,B,C,D,E,H,G,L,Q,K



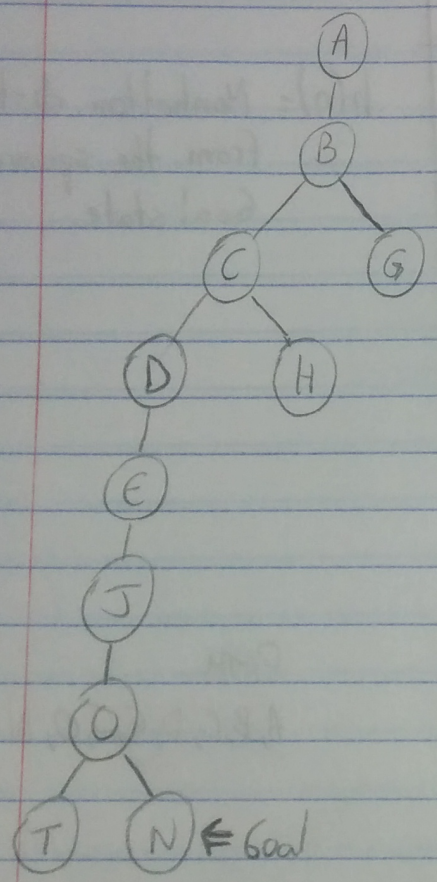
D=6 A,B,C,D,E,J,H,G,L,Q,V,P,K



D=7 A,B,C,D,E,J,O,H,G,L,Q,V,W,P,K



D=8 A, B, C, D, E, J, O, T, N



d) The heuristic function, h(n), calculated using Manhattan distance looks reasonable in a sense that it is not possible to make diagonal moves, it a good strategy to use this method of calculating the distance.

e)

A R h=5	B h=4	C h=3	D h=2	E h=3
F F	G h=3	H h=2	I F	J h=2
K h=3	L h=2	M F	N G h=0	O h=1
P h=4	Q h=3	R F	S h=1	T h=2
U F	V h=4	W h=3	X h=2	Y F

h(n) = Manhattan distance from the square and the Goal state.

$g(n)=1$ $f(n) = g(n)+h(n)$

OPEN	CLOSED
~~A~~ f=5	A
~~B~~ f=5 → A	B
~~C~~ f=5 → B	C
~~G~~ f=5 → B	D
~~D~~ f=5 → C	G
~~H~~ f=5 → G	H
~~E~~ f=7 → D	L
~~K~~ f=5 → G	E
Q f=7 → L	J
~~K~~ f=7 → L	K
~~J~~ f=7 → E	O
~~O~~ f=7 → J	N ⇒ goal reached
P f=9 → K	
~~N~~ f=7 → O	

PATH

A, B, C, D, E, J, O, N

Question 2 - Programming Assignment

Heuristic Function - Explanation

$$h(3) = 3 - (sum/8)$$

Where **sum** is the sum of all the 8 values in the central block, and the division part (**sum/8**) is the integer part of the division of sum per 8. The *h(3)* will never be negative because the biggest value of sum is 24 and the division by 8 is 3, so the min value will be 0.

In the function that calculates the sum there is a clause to verify if the state is a goal state. If so, it will return 24, which divided by 8 is 3. Then the H for that goal state is going to be 0.

Example:

If the numbers in the central block are 21223131, the SUM will be 15. Then the heuristic will be:

$$sum = 2 + 1 + 2 + 2 + 3 + 1 + 3 + 1 = 15$$

$$h(3) = 3 - IntegerPart(15/8)$$

$$h(3) = 3 - 1$$

$$h(3) = 2$$