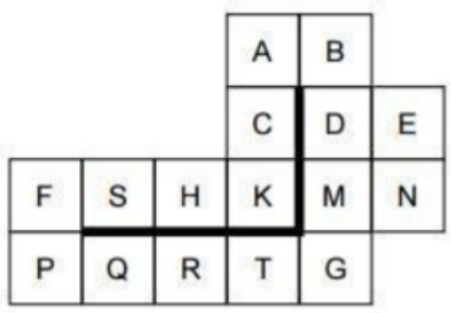
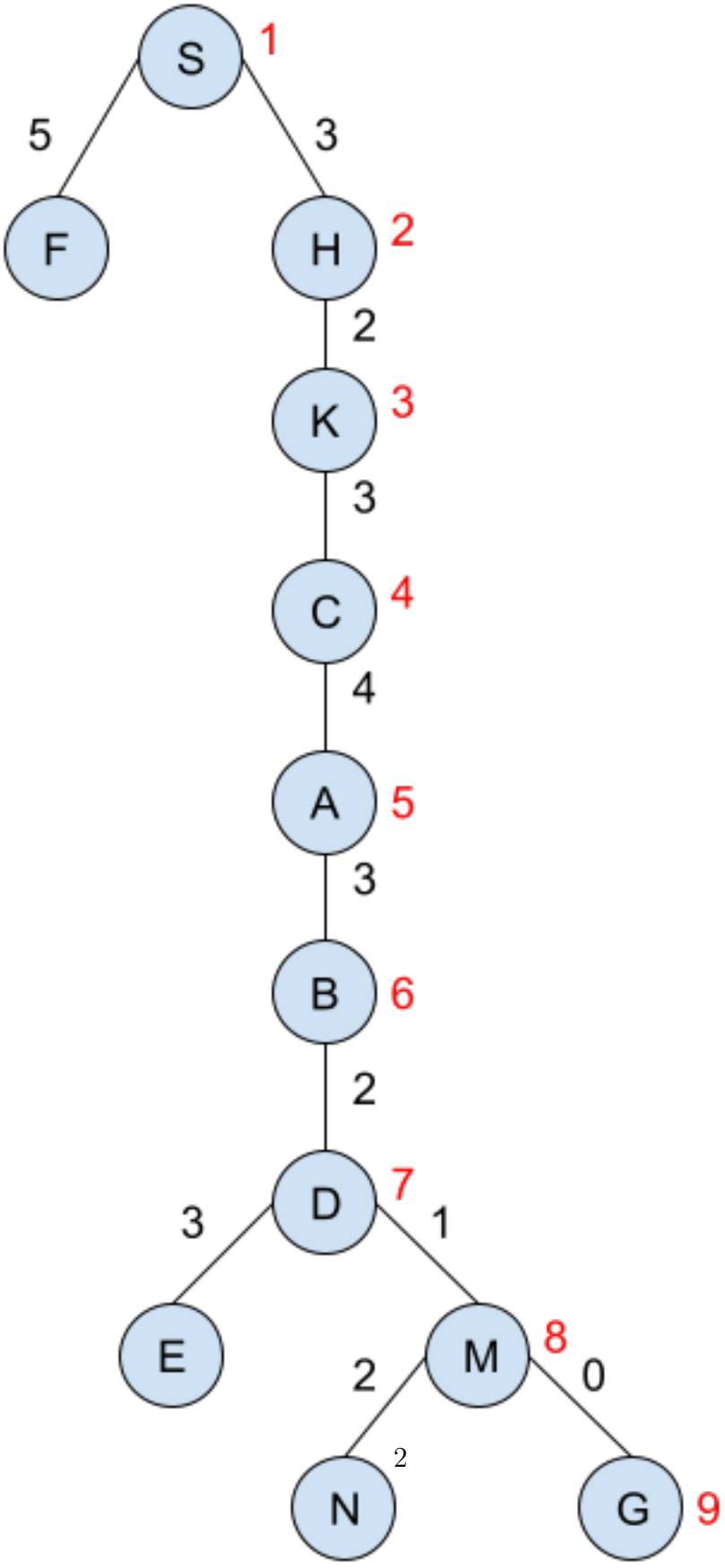
Sheet 2 Solutions
Informed Search

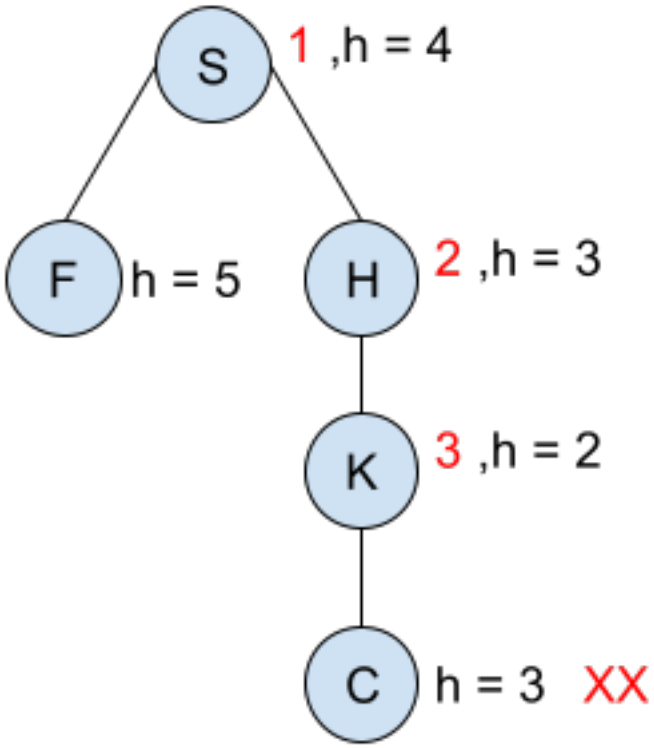
1. Consider the following maze in which the successors of a cell include any adjacent cell in the directions North, South, East, and West of the current cell, except at the boundary of the maze or when a barrier (thick line) exists. For example, successors(M) = D,N,G. Assume each move has cost 1.
   The problem is to find a path from cell S to cell G.
   From (a) to (f) What is the order of nodes expanded (plus the goal node if it is found) by each of the following search methods? Show the steps.



   (a) Greedy Search. Use as the heuristic function h(state) = Manhattan distance from state to G assuming there is no barriers. For example, h(K) = 2 and h(S) = 4.
   Answer:
   S - H - K - C - A - B - D - M - G

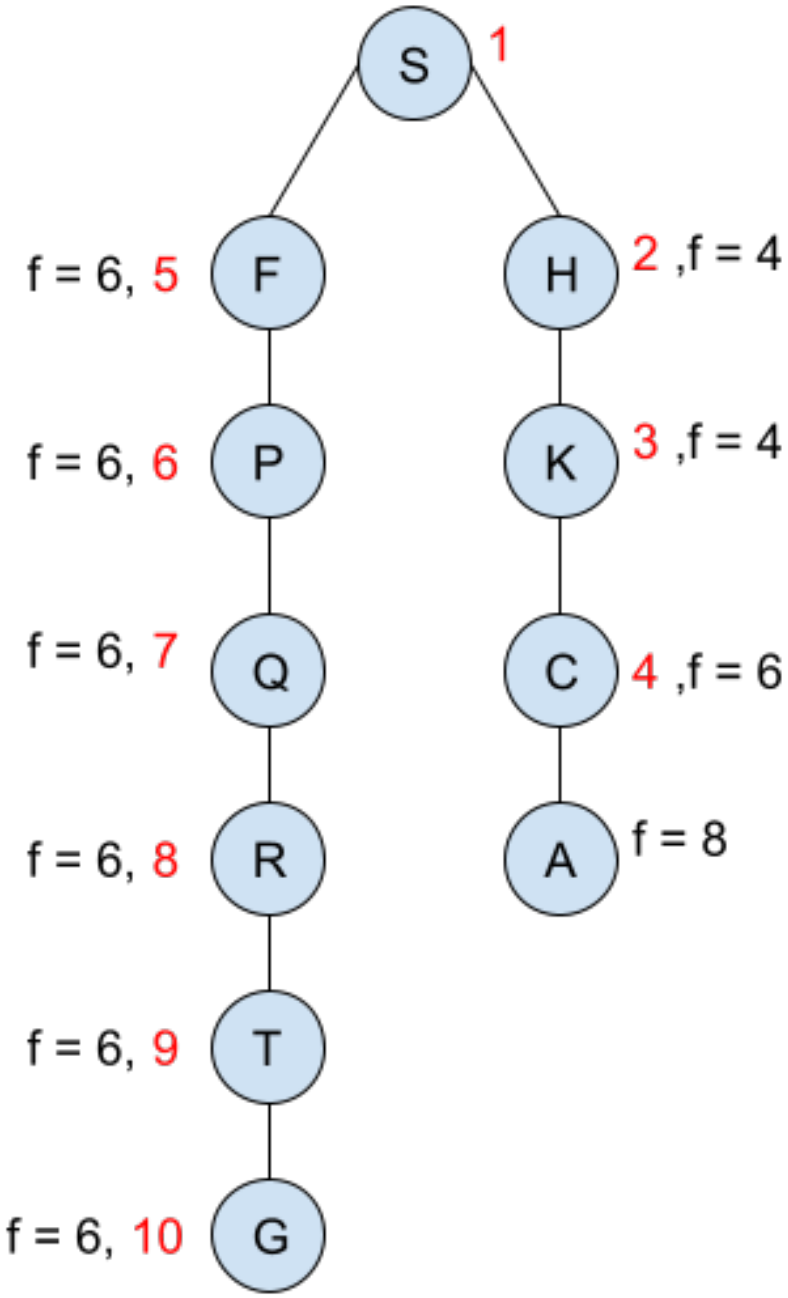

S
1
5
3
F
H
2
2
K
3
3
C
4
4
A
5
3
B
6
2
D
7
3
1
E
M
8
2
0
N
2
G
9

(b) Hill-Climbing Search. Use the same heuristic function as in(a).
Answer:



S - H - K then stop because h(C) > h(K) so, stop hill climbing (local search).

(c) A*Search. Use the same heuristic function as in (a). Remove redundant states.
Answer:
h $\Longrightarrow$ heuristic, g $\Longrightarrow$ moves cost till now, f = g + h



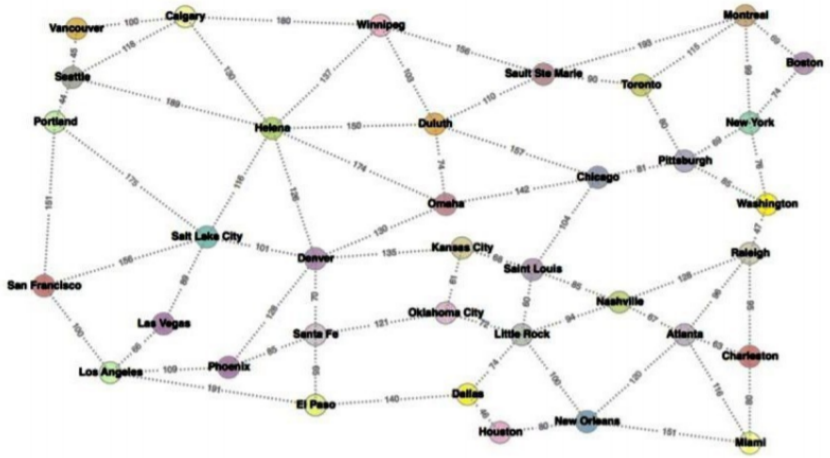
S - H - K - C - F - P - Q - R - T - G

(d) Is h an admissible heuristic? Justify your answer.
Answer:
Yes. because we move on the same way as manhattan computed also we have barrier in the problem that may increase the optimal distance of some nodes than manhattan distance so h(state) $\leq$ h*(state) for all states.

(e) Is h2(state) = min(2; h(state)) an admissible heuristic? Justify your answer.
Answer:
Yes. because h2(state) = h(state) $\leq$ h*(state) when h(state)$\leq$ 2
and h2(state) = 2 $<$ h(state) $\leq$ h*(state) when h(state)$>$ 2

(f) Is h3(state) = max(2; h(state)) an admissible heuristic? Justify your answer.
Answer:
No, because h3(M) = max(2; h(M)) = max(2; 1) = 2
h*(M) = 1
so, h3(M) $>$ h*(M).
and simillarly, h3(T) $>$ h*(T)

2. Given the following map.



Atlanta	272
Boston	240
Calgary	334
Charleston	322
Chicago	107
Dallas	303
Denver	270
Duluth	110
El Paso	370
Helena	254
Houston	332
Kansas City	176
Las Vegas	418
Little Rock	240
Los Angeles	484
Miami	389
Montreal	193
Nashville	221
New Orleans	322
New York	195
Oklahoma City	237
Omaha	150
Phoenix	396
Pittsburgh	152
Portland	452
Raleigh	251
Saint Louis	180
Salt Lake City	344
San Francisco	499
Santa Fe	318
Sault Ste Marie	0
Seattle	434
Toronto	90
Vancouver	432
Washington	238
Winnipeg	156

If "Dallas" is the starting city and the goal destination is "Sault Ste Marie". Use A* search algorithm to find a route from the start to goal destination.

The table on the right is the estimated heuristic distance from each city to the goal. Show the sequence of the nodes that the algorithm will consider and f, g and h score for each node.

Answer:

Dallas $\implies$ g = 0, h = 303, f = 303

New Queue $\implies$ Houston, 380 - Little Rock, 314 - El paso, 510

Little Rock $\implies$ g = 74, h = 240, f = 314

New Queue $\implies$ Houston, 380 - El paso, 510 - New orleans, 496 - Nashville, 389 - Saint louis, 314 - Oklahoma city, 383

Saint louis $\implies$ g = 134, h = 180, f = 314

New Queue $\implies$ Houston, 380 - El paso, 510 - New orleans, 496 - Nashville, 389 - Oklahoma city, 383 - Chicago, 345 - Kansas city, 378

Chicago $\implies$ g = 238, h = 107, f = 345

New Queue $\implies$ Houston, 380 - El paso, 510 - New orleans, 496 - Nashville, 389 - Oklahoma city, 383 - Kansas city, 378 - Pittsburgh, 471 - Duluth, 505 - Omaha, 530

Kansas city $\implies$ g = 202, h = 176, f = 378

New Queue $\implies$ Houston, 380 - El paso, 510 - New orleans, 496 - Nashville, 389 - Oklahoma city, 383 - Pittsburgh, 471 - Duluth, 505 - Omaha, 530 - Denver, 607

Houston $\Longrightarrow$ g = 48, h = 332, f = 380
New Queue $\Longrightarrow$ El paso, 510 - New orleans, 450 - Nashville, 389 - Oklahoma city, 383 - Pittsburgh, 471 - Duluth, 505 - Omaha, 530 - Denver, 607

Oklahoma city $\Longrightarrow$ g = 146, h = 237, f = 383
New Queue $\Longrightarrow$ El paso, 510 - New orleans, 450 - Nashville, 389 - Pittsburgh, 471 - Duluth, 505 - Omaha, 530 - Denver, 607 - Santa fe, 585

Nashville $\Longrightarrow$ g = 168, h = 221, f = 389
New Queue $\Longrightarrow$ El paso, 510 - New orleans, 450 - Pittsburgh, 471 - Duluth, 505 - Omaha, 530 - Denver, 607 - Santa fe, 585 - Atlanta, 507 - Raleigh, 520

New orleans $\Longrightarrow$ g = 128, h = 322, f = 450
New Queue $\Longrightarrow$ El paso, 510 - Pittsburgh, 471 - Duluth, 505 - Omaha, 530 - Denver, 607 - Santa fe, 585 - Atlanta, 507 - Raleigh, 520 - Miami, 668

Pittsburgh $\Longrightarrow$ g = 319, h = 152, f = 471
New Queue $\Longrightarrow$ El paso, 510 - Duluth, 505 - Omaha, 530 - Denver, 607 - Santa fe, 585 - Atlanta, 507 - Raleigh, 520 - Miami, 668 - Washington, 642 - New york, 583 - Toronto, 489

Toronto $\Longrightarrow$ g = 399, h = 90, f = 489
New Queue $\Longrightarrow$ El paso, 510 - Duluth, 505 - Omaha, 530 - Denver, 607 - Santa fe, 585 - Atlanta, 507 - Raleigh, 520 - Miami, 668 - Washington, 642 - New york, 583 - Sault ste marie, 489 - Montreal, 707

Sault ste marie (goal) $\Longrightarrow$ g = 489, h = 0, f = 489

Good Luck