National University of Computer and Emerging Sciences, Lahore Campus

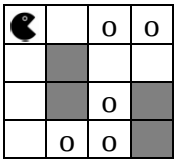
Course Name:	Artificial Intelligence	Course Code:	AI2002
Program:	BS (CS) BS(DS)	Semester:	Spring 2023
Duration:	60 Minutes	Total Marks:	60
Paper Date:	27-Feb-2023	Weight	15
Section:	ALL	Page(s):	2
Exam Type:	Mid I		

Question	Part a (CLO:3)	Part b (CLO:3)	Part c (CLO:2,3)	Total Marks
Marks	15	25	20	60
Obtained Marks				

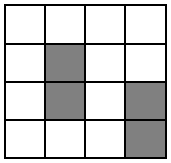
Student Name: _____ **Section:** _____ **Roll No.**_____

Attempt all questions. Do not use pencil or red ink to answer the questions**.** In case of confusion or ambiguity make a reasonable assumption. Use answer sheets for Part a and Part b, *but attempt **Part c** on the question paper* provided space. *Submit the question paper with answer sheets*.

QUESTION: Given below the configurations of simplified Pacman game without ghosts. The objective of the game is to eat all of the dots placed in the maze. The Pacman can move in four directions (up, down, left, and right). Whenever Pacman enters in a cell with the dot it immediately consumes it. The Grey cells in the maze are blocked.



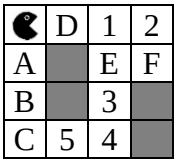
Initial State



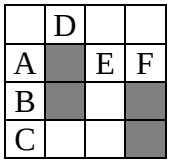
Goal State

Part a.

Execute the state space search algorithms on the following maze where, numbers represent food cells and alphabets represents empty cells. You can build the tree with current position of Pacman instead of drawing complete states. You should create the nodes from left to right in **alphabetical order**.



Initial State



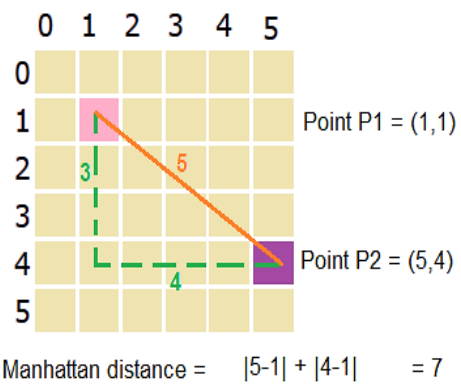
Goal State

1. Depth First Search (DFS) **(Marks: 5)**
2. Breadth First Search (BFS) **(Marks: 5)**
3. Iterative Deepening Search (IDS) **(Marks: 5)**

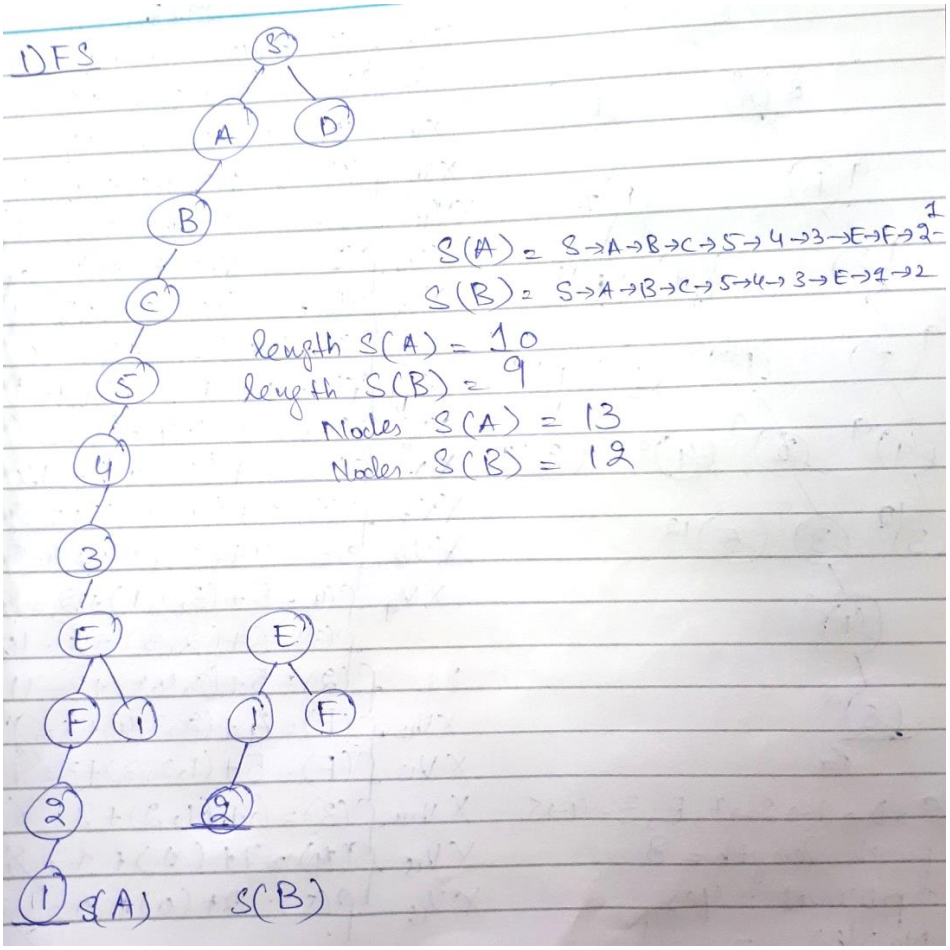
Part b. Apply A* search on the maze provided in **Part a**. and build the search tree with the heuristic function provided below. Clearly indicate the order in which each state is expanded with open list (frontier) and closed list (visited nodes) updates.

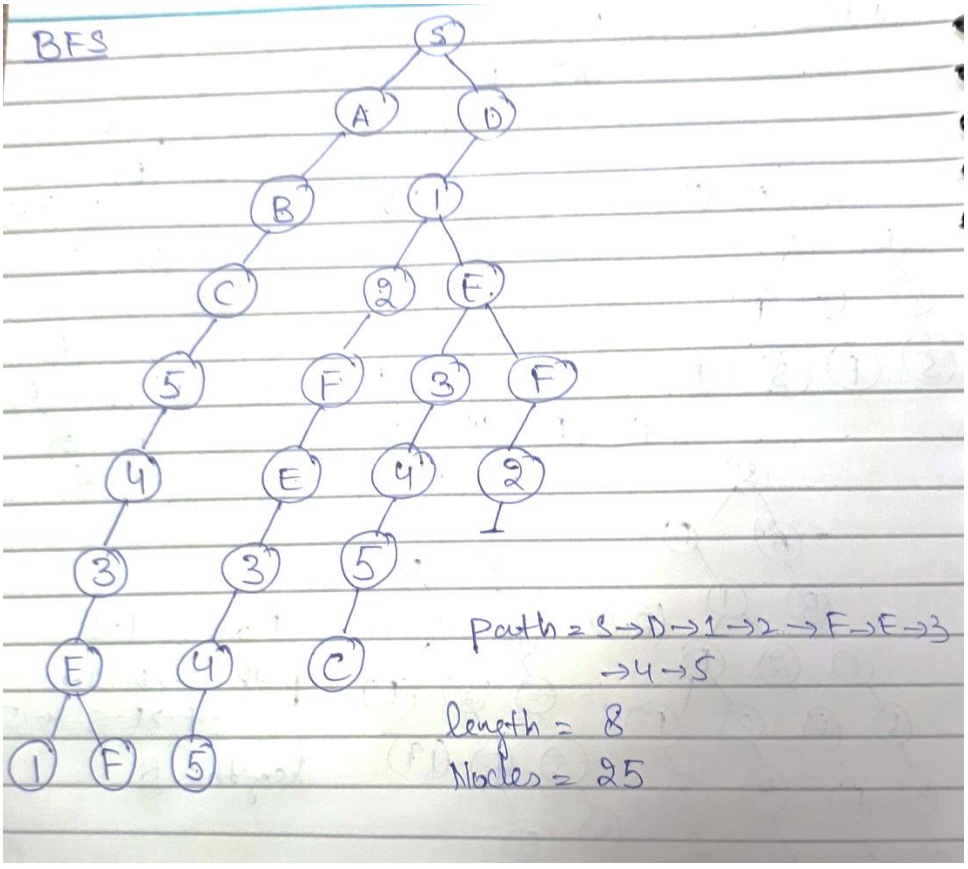
h(n) = Calculate Manhattan distance from current position to each dot and select the minimum distance + Number of remaining dots

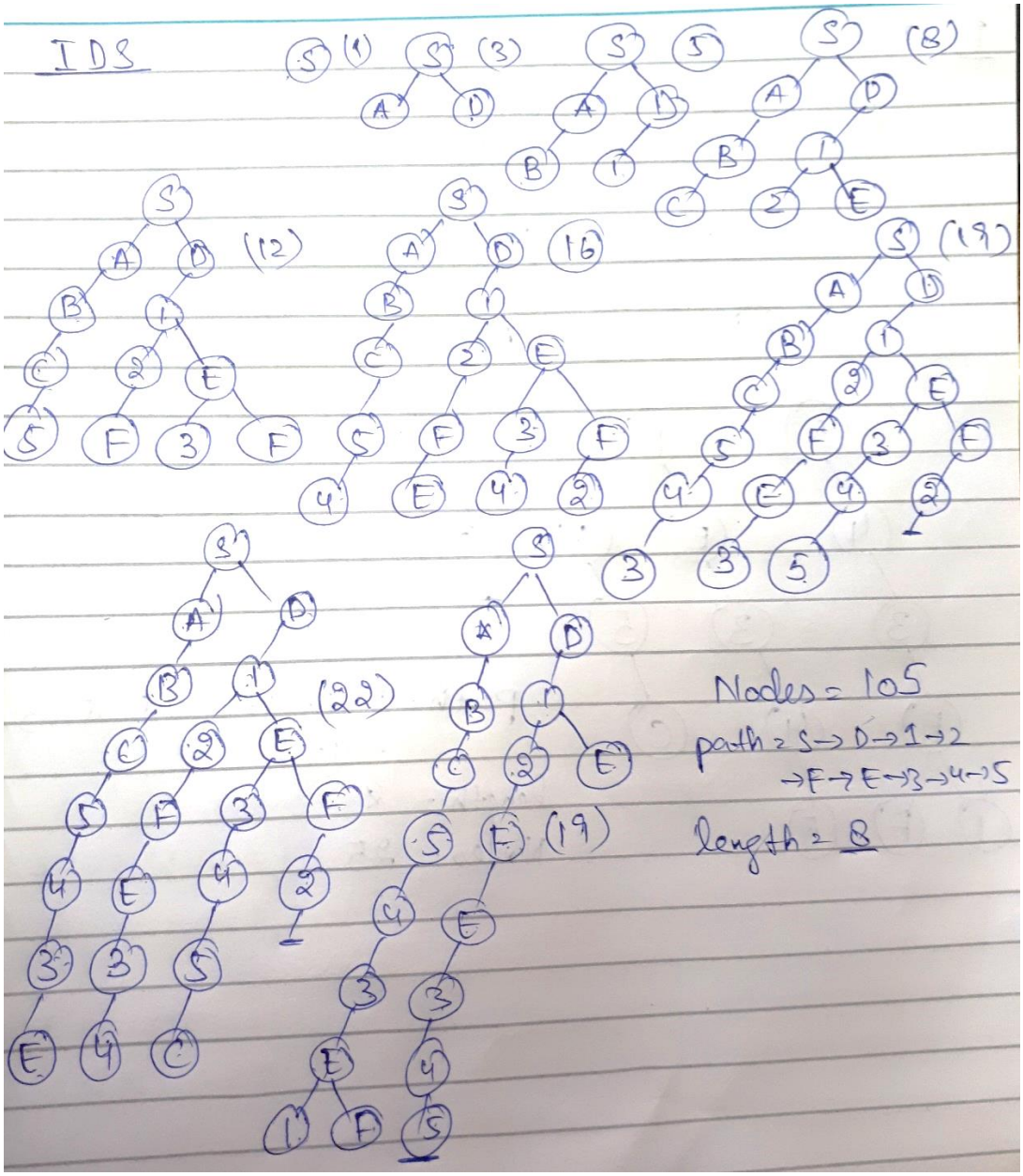
(Marks:25)



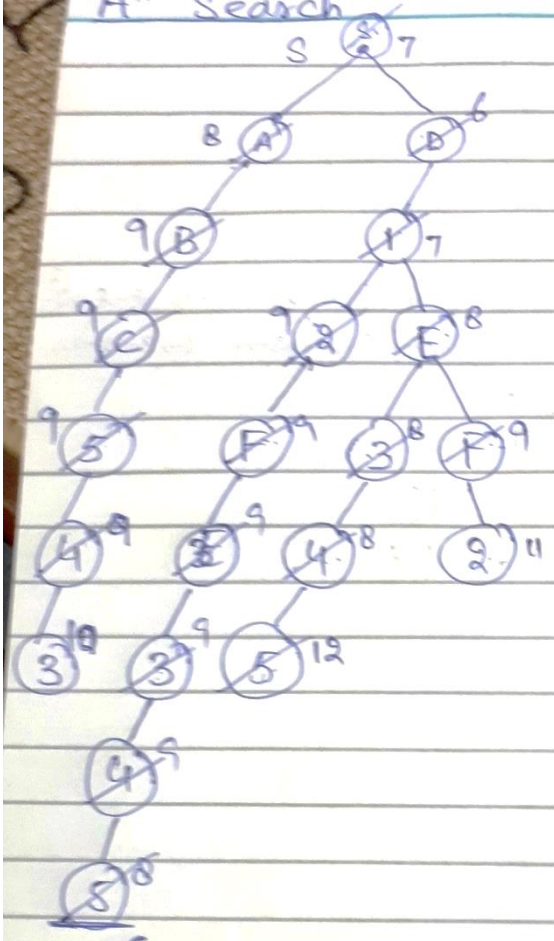
Note: Manhattan distance will be the number of horizontal and vertical moves without considering the blocked cells.


DFS
S
A
D
B
C
5
4
3
E
F
1
2
1
S(A)
E
1
F
2
S(B)
S(A) = S→A→B→C→5→4→3→E→F→2→1
S(B) = S→A→B→C→5→4→3→E→2→1
length S(A) = 10
length S(B) = 9
Nodes S(A) = 13
Nodes S(B) = 12


BFS
S
A
D
B
1
C
2
E
5
F
3
F
4
E
4
2
3
3
5
E
4
C
1
F
5
path = S→D→1→2→F→E→3→4→5
length = 8
Nodes = 25


IDS
Nodes = 105
path = S → D → 1 → 2
→ F → E → 3 → 4 → 5
length = 8

A* Search



$S \to D \to 1 \to 2 \to F, E, 3 \to 4 \to 5$

path length = 8

optimal = yes

Nodes = 21

XV_1 f(S) = 0+(2,3,4,5,4)+5 = 7

X_4 f(A) = 1+(3,4,3,4,3)+5 = 8

XV_2 f(D) = 1+(1,2,3,4,5)+5 = 6

XV_3 f(1) = 2+(1,3,4,5)+4 = 7

XV_{11} f(2) = 3+(3,4,5)+3 = 9

XV_4 f(E) = 3+(1,2,3)+4 = 8

XV_7 f(B) = 2+(4,5,2,3,2)+5 = 9

XV_5 f(3) = 4+(1,2)+3 = 8

XV_8 f(F) = 4+(1,2,3,4)+4 = 9

XV_6 f(4) = 5+(1,5)+2 = 8

f(5) = 6+(5)+1 = 12

XV_7 f(C) = 3+(6,5,3,2,1)+5 = 9

XV_8 f(5) = 4+(5,4,2,1)+4 = 9

XV_9 f(4) = 5+(3,4,1)+2 = 9

f(3) = 6+(2,3)+2 = 10

f(2) = 5+(3,4,5)+3 = 11

XV_{10} f(F) = 4+(2,3,4)+3 = 9

XV_{13} f(E) = 5+(1,2,3)+3 = 9

XV_{14} f(3) = 6+(1,2)+2 = 8

XV_{15} f(4) = 7+(1)+1 = 9

XV_{16} f(5) = 8+(0)+0 = 8

Part c.

1. Which of the following searches are Incomplete? **(Marks:3)**

a) Iterative deepening search

b) Breadth first search

c) Greedy best first search with admissible heuristics

d) All of the above

2. Which of the following searches are optimal in case all actions have equal cost. **(Marks:3)**

a) Uniform cost search

b) Breadth first search

c) A* search with admissible heuristics

d) All of the above

3. What is the difference between Completeness and Optimality? **(Marks:4)**

Completeness - does the search always find a solution if one exists?

Optimality - does it always find a least-cost solution?

4. Heuristic function used in **Part b** is admissible or not? Why? **(Marks:4)**

Yes, the heuristic function is admissible because the actual cost to reach a dot is greater than or equal to the estimated heuristic value of H(n). Actual cost is greater because it incorporates the cost of hurdles placed in the path but H(n) is always underestimating this value.

5. Provide the comparison of all search strategies used for Pacman in the following table. **(Marks:8)**

Algorithms	**DFS**	**BFS**	**IDS**	**A***
Total No. of Nodes	**13/12**	**25**	**105**	**21**
Solution Path Found	**SABC543EF21/ SABC543E12**	**SD12FE345**	**SD12FE345**	**SD12FE345**
Solution Path Length	**10/9**	**8**	**8**	**8**
Optimal	**No/No**	**Yes**	**Yes**	**Yes**