Experiment No: 3

Aim: Implementation of BFS and UCS

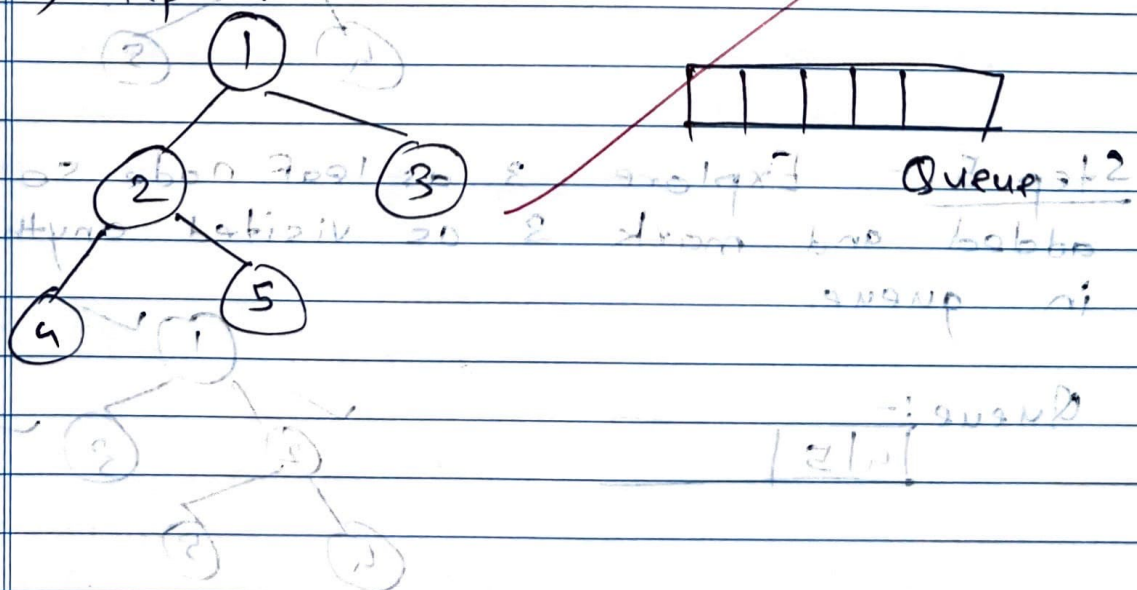
Theory:

1) Breadth first search (BFS)

⇒ BFS is a type of uniformed search, in this the search in horizontal. It's a level search algorithm.

- In BFS, queue data structure is used. In this first the root is pushed to the stack and then the front element is dequeued and then the children are pushed into the queue.
- This steps are repeated till the queue is empty.
- It's time complexity → $O(b^d)$
- It's space complexity → $O(b^d)$
- For e.g.;

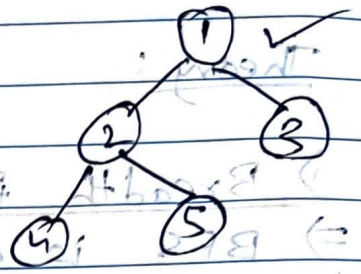
1) Step 1:



Step 2 :- Push the root node into a queue.

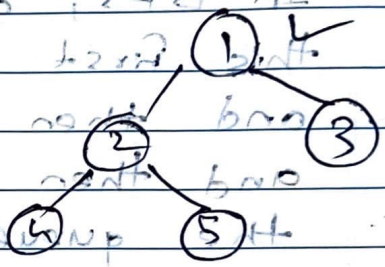
visited :- | 1 |

Queue :- | 1 |



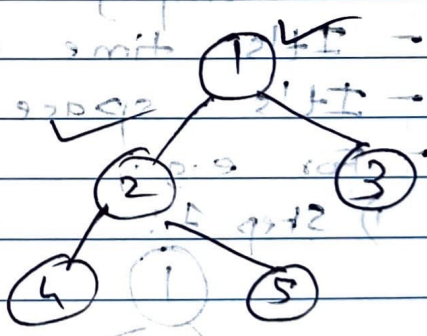
Step 3 :- Explore the children of queue.front() so push 2 and 3 into and pop 1 and mark it visited.

Queue :- | 2 | 3 |



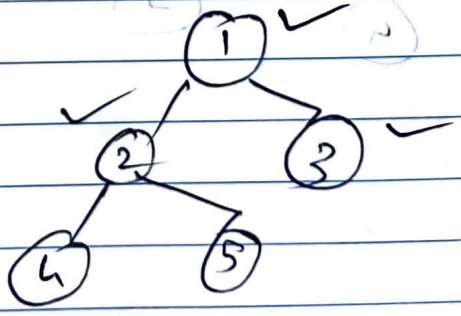
Step 4 :- Explore 2 so push 4 and 5

Queue :- | 3 | 4 | 5 |



Step 5 :- Explore 3 as leaf node so not added and mark 3 as visited anything in queue.

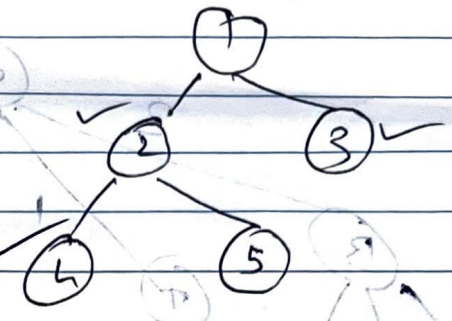
Queue :- | 4 | 5 |



Step 6:- Explore 4.

Queue :-

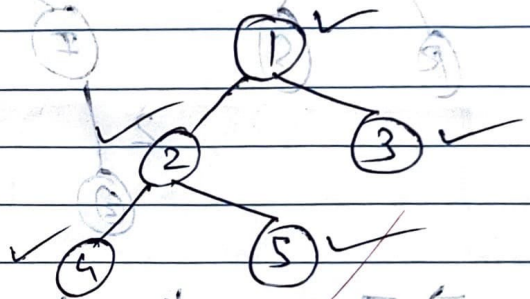
| 5 |



Step 7 :-

Queue :-

Empty



2) Uniformed Cost Search (UCS)

⇒ UCS is variant of Dijstra's algorithm.

- Then instead of inserting all vertices into a priority queue, we insert only the same then one by one, we check if item is already in priority queue.

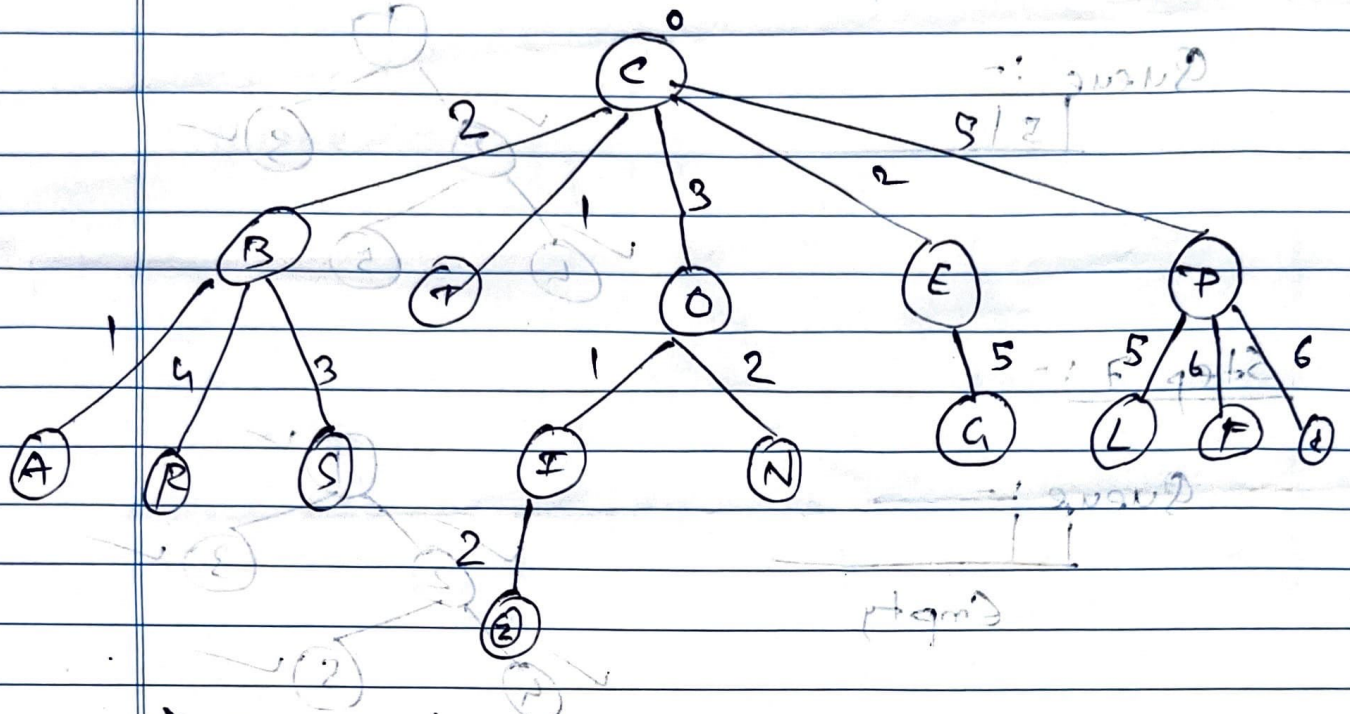
- Time complexity :-

$$O\left(b^{(1+c/2)}\right)$$

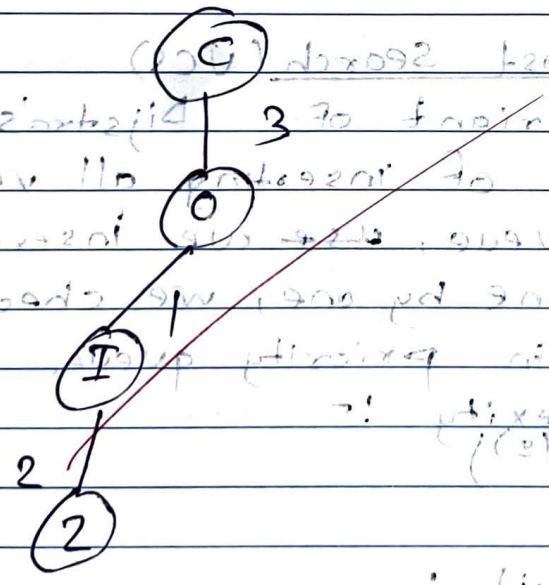
- Space complexity :-

$$O\left(b^{(1+c/2)}\right)$$

- For e.g.,



⇒ The path is the -



∴ The path cost = 3 + 1 + 2
= 6

∴ Traversal path ⇒ C - O - I - 2

- Conclusion: In this experiment, we learnt about BFS and UCS algorithm.

Code: (BFS)

```
from collections import deque

graph = {
    '5': {
        '3': 2,
        '7': 1
    },
    '3': {
        '2': 3,
        '4': 4
    },
    '7': {
        '8': 5
    },
    '2': {},
    '4': {
        '8': 6
    },
    '8': {}
}
visited = set()
partial_explored = set()


def bfs_with_cost(graph, start_node, goal_node):

  queue = deque([(start_node, 0)])

  while queue:
    node, path_cost = queue.popleft()

    if node not in visited:
      print(f"{node} (Cost: {path_cost})")
      visited.add(node)

      if node == goal_node:
        print(f"Goal node {goal_node} reached!")
        return

      partial_explored.add(node)
```

```
      for neighbour, edge_cost in graph[node].items():
        if neighbour not in visited:
          queue.append((neighbour, path_cost + edge_cost))

    print(
        f"Nodes with partially explored children in current iteration:
{partial_explored}"
    )

goal_node = '8'
print(
    f"Following is the Breadth-First Search with Path Cost to reach
goal node {goal_node}"
)
bfs_with_cost(graph, '5', goal_node)

print("\nNodes with partially explored children in each iteration:")
print(partial_explored)
```

Output:

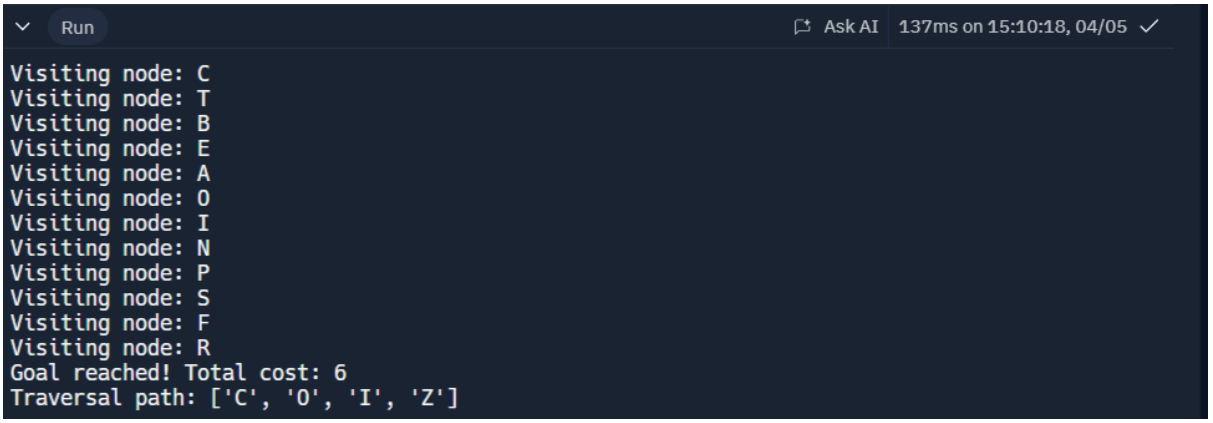
```
Following is the Breadth-First Search with Path Cost to reach goal node 8
5 (Cost: 0)
Nodes with partially explored children in current iteration: {'5'}
3 (Cost: 2)
Nodes with partially explored children in current iteration: {'3', '5'}
7 (Cost: 1)
Nodes with partially explored children in current iteration: {'7', '3', '5'}
2 (Cost: 5)
Nodes with partially explored children in current iteration: {'7', '3', '2', '5'}
4 (Cost: 6)
Nodes with partially explored children in current iteration: {'4', '3', '7', '2', '5'}
8 (Cost: 6)
Goal node 8 reached!

Nodes with partially explored children in each iteration:
{'4', '3', '7', '2', '5'}
```

Code: (UCS)

```
import heapq



def ucs(graph, start, goal):
  priority_queue = [(0, start, [start])]
  visited = set()
```

```
  while priority_queue:
    cost, current_node, path = heapq.heappop(priority_queue)

    if current_node == goal:
      print("Goal reached! Total cost:", cost)
      print("Traversal path:", path)
      return

    if current_node not in visited:
      print("Visiting node:", current_node)
      visited.add(current_node)

      for neighbor, edge_cost in graph[current_node]:
        if neighbor not in visited:
          heapq.heappush(priority_queue,
                         (cost + edge_cost, neighbor, path +
[neighbor]))


graph = {
    'A': [('B', 1)],
    'B': [('C', 2), ('A', 1), ('R', 4), ('S', 3)],
    'C': [('B', 2), ('T', 1), ('O', 3), ('E', 2), ('P', 5)],
    'R': [('B', 4)],
    'S': [('B', 3)],
    'T': [('C', 1)],
    'O': [('C', 3), ('I', 1), ('N', 2)],
    'I': [('O', 1), ('Z', 2)],
    'N': [('O', 2)],
    'Z': [('I', 2)],
    'E': [('C', 2), ('G', 5)],
    'G': [('E', 5)],
    'P': [('C', 5), ('L', 5), ('F', 1), ('D', 3)],
    'L': [('P', 5)],
    'F': [('P', 1)],
    'D': [('P', 3)]
}

ucs(graph, 'C', 'Z')
```

Output:


Run
Ask AI
137ms on 15:10:18, 04/05
Visiting node: C
Visiting node: T
Visiting node: B
Visiting node: E
Visiting node: A
Visiting node: O
Visiting node: I
Visiting node: N
Visiting node: P
Visiting node: S
Visiting node: F
Visiting node: R
Goal reached! Total cost: 6
Traversal path: ['C', 'O', 'I', 'Z']