Basic Algorithms Implementation

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A. BFS:

BFS also known as breadth first search works on the principle of exploring nodes that are visited first. To implement this algorithm using python, following pseudo code is used.

BFS Pseudo code:

```
add start to queue
loop:
    item ← pop first element in the queue
    for node in graph(item)
        If node not visited
            add node to visited
            add node to queue
            keep track of parent of node
            if node is goal
                break

until the goal is found or no item in the queue
```

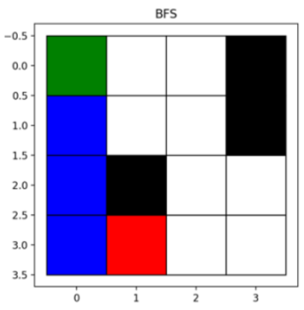
Using the above pseudo code, program is implemented in python. Steps are counted every time a node is explored. It is simply the size of visited. Later the path is constructed using the following pseudo code

Path pseudo code:

```
node ← goal
if found
    while node is not start
        node = parent(node)
        add node to path
else
    path is empty
reverse the path
```

In this pseudo code, I am backtracking parents of each node starting from the goal to start node. If the path is not found, an empty path is returned.

BFS is tested with various test cases. Results are shown in the following figures.



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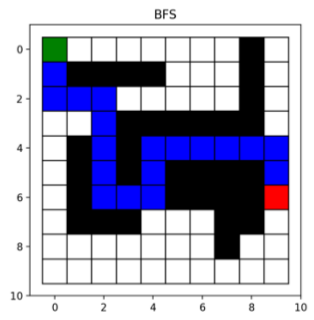
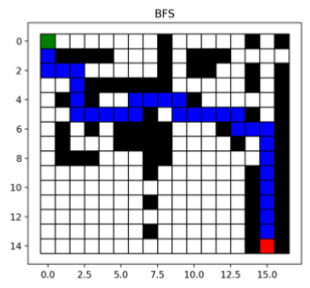
For this given grid and obstacles, the BFS takes 10 steps to find the path.



BFS takes 64 steps to find the path in the above grid.



For another test map shown in the above picture, BFS finds path in 188 steps.

B. DFS:

DFS is similar to BFS, but the order of exploration is a little different. We can achieve the functionality of DFS by popping the last element of the queue instead of the first element. We need to make sure of the correct queue formation as well.

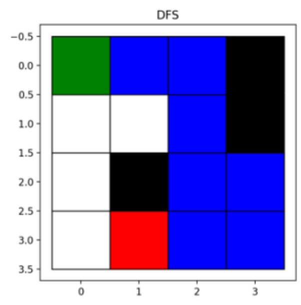
Following pseudo code explains the DFS implementation.

DFS Pseudo code:

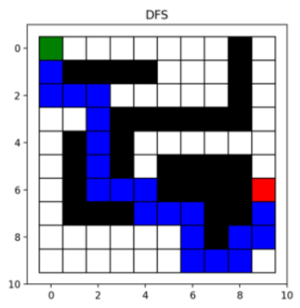
```
add start to the queue
loop
    item ←pop last element in the queue
    if item not visited
        index=-1
        for node in graph(item)
            insert node to the queue at index
            decrease index
            keep track of parent
            if node is goal
                break
until the goal is reached and or no item in the queue
```

The path is constructed using the same method that is explained for BFS.

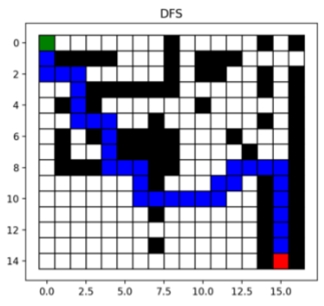
Results with DFS are shown in the below pictures.



It takes 9 steps for DFS to find the path in above grid.



It takes 41 steps for DFS to find the path for the above grid.



It takes 127 steps for DFS to find the path in the above grid.

C. Dijkstra:

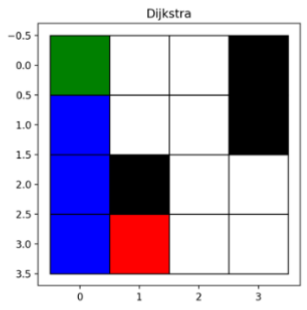
In Dijkstra, we use cost to come as the criterion to select the best possible node to explore. In many ways Dijkstra is same as BFS, but here we consider cost as well. Pseudo code for it is explained below.

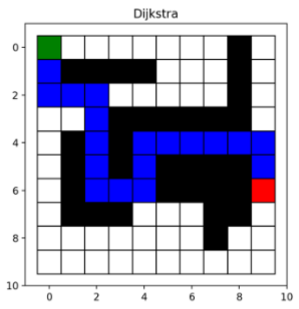
Pseudo Code:

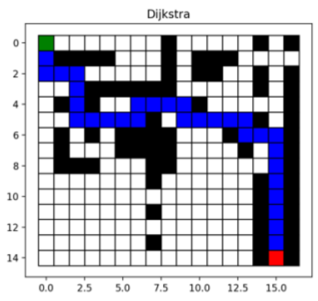
```
initialize all the nodes' cost as infinity
change start node cost as 0.
add start to the queue
loop
    item ← minimum cost node out of the queue
    remove item from queue
    for node in graph(item)
        if node not visited
            update the cost for node

            add node to visited
            add node to queue
            keep track of parent
            if node is goal
                break
until goal is found or no element in queue
```

Results with Dijkstra are shown below.







It takes 10, 64 and 188 steps respectively for Dijkstra to find the path in the above grids.

D. A*:

A star is same as Dijkstra but while computing the best possible node to explore, we use heuristic distance as well. Here Manhattan distance is used as heuristic function.

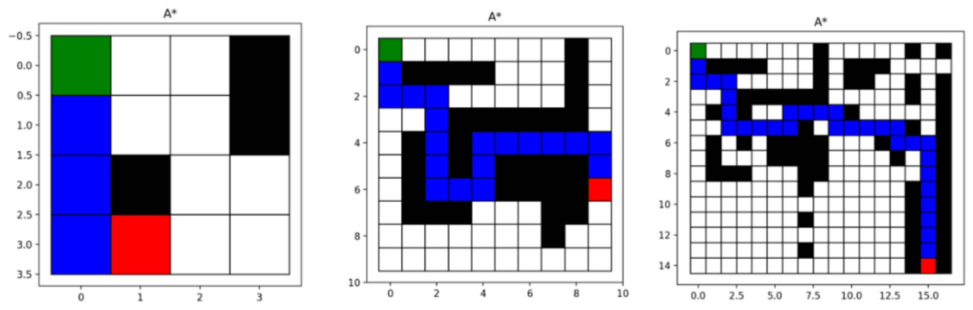
Pseudo Code:

```
initialize all the nodes' cost as infinity
change start node cost as 0.
add start to the queue
loop
    item ← minimum (cost+heuristic) node out of the queue
    remove item from queue
    for node in graph(item)
        if node not visited
            update the cost for node
            add node to visited
            add node to queue
            keep track of parent
            if node is goal
                break
until goal is found or no element in queue
```

For computing heuristic, following pseudo code is used.

```
Initialize node
Initialize goal
x_goal,y_goal ← goal
x_node,y_node ← node
heuristic ← abs(x_goal-x_node)+abs(y_goal-y_node)
```

Results of A* are shown below.



It takes 7, 50 and 156 steps respectively for A* to find the path in the above grids.