

24F-0040
Laiba
Assignment 01
Artificial Intelligence
Question 07

Github Link:

<https://github.com/laibaaliraza/AI-path-finder.git>

Comprehensive Report:

AI Path Finding Project using Different Search Algorithms

Introduction:

This project is about using AI search techniques to find path from start to goal on a grid. It shows how different search algorithms explore the grid and find goal. we also use matplotlib to show grid so that we can see how nodes are visited step by step and also some of the dynamic obstacles are added randomly to make it more real like working.

Problem Definition as search problem:

Initial State:

start position is 0 0 top left corner

Actions:

Agent can move in 8 directions
Up, down, left, right, top-left, bottom-right

Transition Model:

Agent moves to next cell if its not wall or obstacle

Goal State:

goal position is 14 14 bottom right corner

Path Cost:

Each move cost 1

Grid and Visualization:

Grid is 15 by 15 implemented using numpy array

each cell value means:

- 0 empty
- 2 start
- 3 goal
- 5 visited node
- 6 final path
- 7 obstacle

Library matplotlib shows the grid and updates each step so we can see how it works

Dynamic Obstacles

Random obstacles are added while algorithm is running. This make problem harder and more like real world. obstacles appear with some probability

Explanation:

Breadth First Search (BFS):

BFS works level by level

uses queue

explore all neighbors first then go deeper

guarantee shortest path if all moves equal cost

implemented using deque visited set and parent dict

Depth First Search (DFS):

DFS goes deep in one path before backtracking

uses stack

fast sometimes but not guarantee shortest path

implemented using stack list visited set parent dict

Uniform Cost Search (UCS):

UCS expand node with lowest cost
uses priority queue
in this project cost is same so behaves like BFS but always optimal
implemented using heapq cost etc

Depth Limited Search (DLS):

DFS with depth limit
stop if depth limit reached
may fail if goal far
implemented using stack of (node,depth) visited set and parent

Iterative Deepening DFS (IDDFS):

run DLS repeatedly with increasing depth
combines BFS and DFS advantage
optimal solution with less memory
implemented with loop calling DLS for depth 0 to 20

Bidirectional Search

search from start and goal at same time
stop when both search meet
faster because search space reduced
implemented using two queues two visited sets and parent dict

Pros and Cons

BFS

pros find shortest path complete
cons high memory slow for large grid

DFS

pros low memory simple
cons not shortest path can stuck

UCS

pros always optimal
cons slower and high memory

DLS

pros prevent infinite loops low memory

cons may miss solution hard to choose limit

IDDFS

pros optimal less memory than BFS

cons repeated searching slower

Bidirectional

pros very fast less search space

cons more complex not always work

Test Cases

Best Case

few obstacles path mostly free

algorithm reach goal fast

nodes visited less

final path short

GUI shows fast completion

Worst Case

many obstacles appear

algorithm search almost whole grid

search takes long

lots of visited nodes

final path long

GUI shows struggle or failure

Conclusion:

This project shows AI search algorithms and how they explore the grid

Dynamic obstacles make problem real

Visualization help understand how each algorithm works

Screenshots:

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JupyterLab Python 3 (ipykernel)

```
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Path finder using different search Algorithms.
```

```
[14]: import numpy as np #used for grid handling
import matplotlib.pyplot as plt #for GUI
import random # for dynamic obstacles
import time #measures time
from collections import deque #for search Algorithms
import heapq # for uniform cost search
from matplotlib import colors #used to import colors

#draw grid on screen
def make_grid(grid,title):
    plt.clf() #clear screen(clf=clear the current figure)
    plt.imshow(grid,cmap='gray') #shows image
    plt.title(title)
    plt.axis('off')
    plt.pause(0.2)

#check the walls
def walls(r,c):
    if r<0 or c<0 or r>=rows or c>=col:
        return False
    if grid[r][c]==1 or grid[r][c]==7:
        return False
    return True

#check obstacles
def obst():
    if random.random()<obs:
        r=random.randint(0,rows-1)
        c=random.randint(0,col-1)
        if grid[r][c]==0:
```

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JupyterLab Python 3 (ipykernel)

```
while stack:
    curr=stack.pop()
    if curr==goal:
        return parent
    if curr in visited:
        continue
    visited.add(curr)
    r,c=curr
    if grid[r][c]==0:
        grid[r][c]=5
    obst()
    make_grid(grid,"DFS searching")
    for dr,dc in reversed(DIRECTIONS):
        nr,nc=r+dr,c+dc
        if walls(nr,nc) and (nr,nc) not in visited:
            stack.append((nr,nc))
            parent[(nr,nc)]=curr
return None

#UCS(uniform cost search)
def UCS():
    pq=[]
    heapq.heappush(pq,(0,start))
    parent={}
    cost={}
    cost[start]=0

    while pq:
        curr_cost,curr=heapq.heappop(pq)
        if curr==goal:
            return parent
        r,c=curr
        if grid[r][c]==0:
            grid[r][c]=5
        obst()
        make_grid(grid,"UCS searching")
        for dr,dc in DIRECTIONS:
            nr,nc=curr+dr,c+dc
```

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JupyterLab Python 3 (ipyk)

```
        nr,nc=r+dr,c+dc
    if walls(nr,nc):
        stack.append((nr,nc),depth+1))
        parent[(nr,nc)]=curr
    return None

#IDDFS
def IDDFS():
    for depth in range(20):
        temp=grid.copy()
        result=DLS(depth)
        if result:
            return result
    return None

#BDS

def Bidirectional():
    q1=deque([start])
    q2=deque([goal])
    p1={}
    p2={}
    v1={start}
    v2={goal}
    while q1 and q2:
        n1=q1.popleft()
        for dr,dc in DIRECTIONS:
            nxt=(n1[0]+dr,n1[1]+dc)
            if walls(nxt[0],nxt[1]) and nxt not in v1:
                v1.add(nxt)
                p1[nxt]=1
                q1.append(nxt)
            if nxt in v2:
                p1.update(p2)
                return p1
        n2=q2.popleft()
        for dr,dc in DIRECTIONS:
            nxt=(n2[0]+dr,n2[1]+dc)
            if walls(nxt[0],nxt[1]) and nxt not in v2:
```

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Code

JupyterLab Python 3 (ipykernel)

```
(1, 1), # Bottom-Right
(0, -1), # Left
(-1, -1), # Top-Left
]
obs=0.05
plt.figure(figsize=(6,6))
make_grid(grid,"Starting grid")
print("Choose Algorithm")
print("1 BFS")
print("2 DFS")
print("3 UCS")
print("4 DLS")
print("5 IDDFS")
print("6 BIDIRECTIONAL")
choice=input("Enter choice: ")
if choice=="1":
    parent=BFS()
elif choice=="2":
    parent=DFS()
elif choice=="3":
    parent=UCS()
elif choice=="4":
    parent=DLS(20)
elif choice=="5":
    parent=IDDFS()
elif choice=="6":
    parent=Bidirectional()
else:
    parent=None
if parent:
    make_path(parent)
else:
    print("No path found")
plt.show()
```

Starting grid

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Code

JupyterLab Python 3 (ipykernel)

Starting grid

Choose Algorithm

1 BFS
2 DFS
3 UCS
4 DLS
5 IDDFS
6 BIDIRECTIONAL

Enter choice: ↵ for history. Search history with c-↑/c-↓











