Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

DEPARTMENT OF INFORMATION TECHNOLOGY

COURSE CODE: DJ19ITL504 **DATE:22/10/22**
COURSE NAME: Artificial Intelligence Laboratory **CLASS: TY-IT**

EXPERIMENT NO.04

CO/LO: Formulate the problem as a state space and select appropriate technique from blind, heuristic or adversarial search to generate the solution.

AIM / OBJECTIVE: To implement informed search techniques on a given problem. (Greedy BFS & A*)

DESCRIPTION OF EXPERIMENT:
We need to implement Best First Search and A* Search and study them based on Time Complexity, Space Complexity, Optimality and Completeness.

Algorithm astar(graph,h):

1. Append a touple of start state and its heuristic(h) to queue
2. While front of queue doesn't contain goal state do:
    1) Dequeue front
    2) Calculate the fx value for all next node as fx = gx + h
    3) Sort queue based on fx value
    4) Remove cycles
    5) Remove overlapping paths

Algorithm bestFirst(graph,h):

1. Append start state to queue
2. If path contains goal node:
    Success
   Else if leaf node reached with no goal node encounter:
    Terminate search goal not found
   Else:
    Find the neighbor with minimum heuristic
    Add this neighbor to traversal path
    Traverse bestFirst(neighbours of the last added node)

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Explanation/Solutions(Design):

Code:

A*:

```
#graph={"s":[("b",3),("c",4)] , "b":[("c",1),("d",2),("g",3),("s",3)] ,
"c":[("e",1),("f",3),("g",4),("s",4),("b",1)] , "d":[("g",1),("b",2)] , "e":[("c",1)],
"f":[("c",3)], "g":[("b",3),("c",4),("d",1)]}
#h={"s":11,"b":2,"c":4,"d":6,"e":4,"f":1,"g":0}

graph={}
h={}
n=int(input("enter the number of states : "))
for i in range(0,n):
    state=input("enter the state : ")
    huristic=int(input("enter the heurixtic of current state : "))
    h[state]=huristic
    n_line=input("enter the neighbours,distance of neighbour : ")
    neighbours=n_line.split()
    ni=[]
    for i in neighbours:
        ele=i.split(",")
        ni.append((ele[0],int(ele[1])))
    graph[state]=ni


q=[]
def dq(q):
    top=q[0]
    del q[0]
    return top[0]

def calculatefx(top,h,graph):
    f=0
    for i in range(1,len(top),1):
        n1=graph[top[i-1]]
        for j in n1:
            if(top[i]==j[0]):
                f=f+j[1]

    return f+h[top[-1]]

def removecycle(q):
    cycli=[]
    for i in range(0,len(q)):
        if(len(q[i][0])!=len(set(q[i][0]))):
            print("removing cycle " ,q[i])
            cycli.append(q[i])
    for i in cycli:
        del q[q.index(i)]
    print("--> ",q)

def removeoverlap(q):
    olapi=[]
    for i in range(0,len(q)-1):
        for j in range(i+1,len(q)):
            if(q[i][0][0]==q[j][0][0] and q[i][0][-1]==q[j][0][-1]):
                print("removing overlap " ,q[j])
                olapi.append(q[j])
    for i in olapi:
```

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```
        del q[q.index(i)]
    print("--> ",q)

def traverse(graph,h):
    q.append(("s",h["s"]))
    #print(q)
    #print(q[0][0])

    while(True):
        top=dq(q)
        #print("top ",top)
        n=graph[top[-1]]
        for i in n:
            f=calculatefx(top+i[0],h,graph)
            q.append((top+i[0],f))
        q.sort(key = lambda x: x[1])
        print("--> ",q)
        removecycle(q)
        removeoverlap(q)
        if(q[0][0][-1]=="g"):
            return q[0]


print(traverse(graph,h))
```

best first search:

```
'''
graph={"s":["b","c"] , "b":["c","d","g","s"] , "c":["e","f","g","s","b"] , "d":["g","b"] ,
"e":["c"], "f":["c"], "g":["b","c","d"]}
h={"s":11,"b":2,"c":4,"d":6,"e":4,"f":1,"g":0}
'''
graph={}
h={}
n=int(input("enter the number of states : "))
for i in range(0,n):
    state=input("enter the state : ")
    huristic=int(input("enter the heurixtic of current state : "))
    h[state]=huristic
    n_line=input("enter the neighbours: ")
    neighbours=n_line.split()
    graph[state]=neighbours


def traversal(path,graph,h):
    if(path[-1]=="g"):
        print("search complete goal reached : ",path)
        return
    elif len(graph[path[-1]])==0:
        print("search terminated at :",path)
        return
    else:
        min=(h[graph[path[-1]][0]],graph[path[-1]][0])
        for i in graph[path[-1]]:
            if(h[i]<min[0]):
                min=(h[i],i)
        return traversal(path+min[1],graph,h)
```

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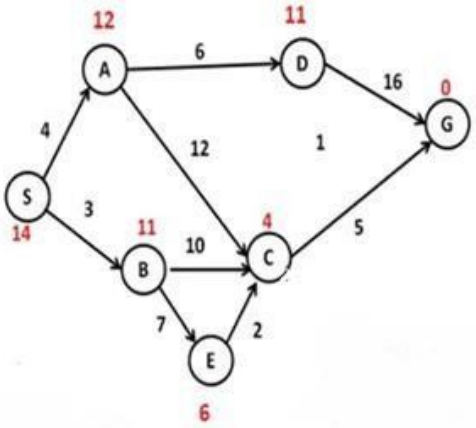
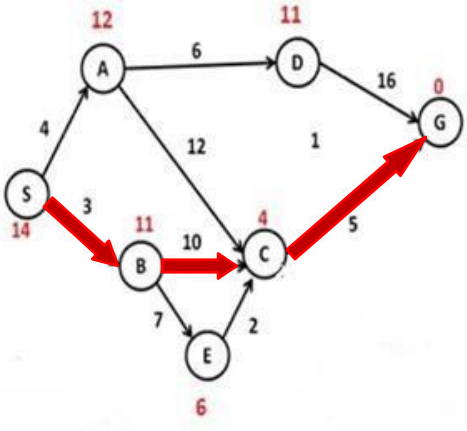
```
traversal("s",graph,h)
```

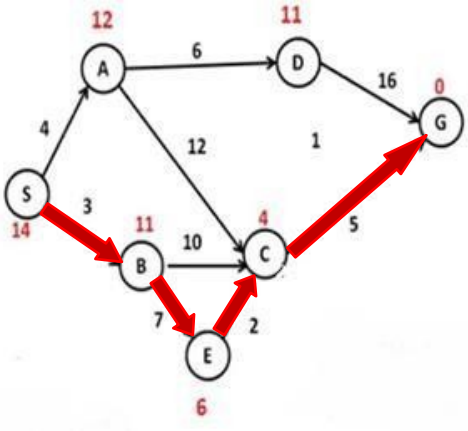
traversal paths:

example





Best first search



A*

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Output:

Best first search:

```
PS C:\Users\SHREE RAM\Desktop\ai> python -u "c:\Users\SHREE RAM\Desktop\ai\bestfirsrt.py"
enter the number of states : 7
enter the state : s
enter the heurixtic of current state : 14
enter the neighbours: a b
enter the state : a
enter the heurixtic of current state : 12
enter the neighbours: s d c
enter the state : b
enter the heurixtic of current state : 11
enter the neighbours: s c e
enter the state : c
enter the heurixtic of current state : 4
enter the neighbours: a b e g
enter the state : d
enter the heurixtic of current state : 11
enter the neighbours: a g
enter the state : e
enter the heurixtic of current state : 6
enter the neighbours: b c
enter the state : g
enter the heurixtic of current state : 0
enter the neighbours: d c
search complete goal reached :  sbcg
PS C:\Users\SHREE RAM\Desktop\ai>
```

A*:

```
PS C:\Users\SHREE RAM\Desktop\ai> python -u "c:\Users\SHREE RAM\Desktop\ai\astar.py"
enter the number of states : 7
enter the state : s
enter the heurixtic of current state : 14
enter the neighbours,distance of neighbour : a,4 b,3
enter the state : a
enter the heurixtic of current state : 12
enter the neighbours,distance of neighbour : s,4 d,6 c,12
enter the state : b
enter the heurixtic of current state : 11
enter the neighbours,distance of neighbour : s,3 c,10 e,7
enter the state : c
enter the heurixtic of current state : 4
enter the neighbours,distance of neighbour : b,10 a,12 e,2 g,5
enter the state : d
enter the heurixtic of current state : 11
enter the neighbours,distance of neighbour : a,6 g,16
enter the state : e
enter the heurixtic of current state : 6
enter the neighbours,distance of neighbour : b,7 c,2
enter the state : g
enter the heurixtic of current state : 0
enter the neighbours,distance of neighbour : d,16 c,5
-->  [('sb', 14), ('sa', 16)]
-->  [('sb', 14), ('sa', 16)]
-->  [('sb', 14), ('sa', 16)]
-->  [('sa', 16), ('sbe', 16), ('sbc', 17), ('sbs', 20)]
removing cycle  ('sbs', 20)
-->  [('sa', 16), ('sbe', 16), ('sbc', 17)]
-->  [('sa', 16), ('sbe', 16), ('sbc', 17)]
-->  [('sbe', 16), ('sbc', 17), ('sac', 20), ('sad', 21), ('sas', 22)]
removing cycle  ('sas', 22)
-->  [('sbe', 16), ('sbc', 17), ('sac', 20), ('sad', 21)]
removing overlap  ('sac', 20)
-->  [('sbe', 16), ('sbc', 17), ('sad', 21)]
-->  [('sbec', 16), ('sbc', 17), ('sad', 21), ('sbeb', 28)]
removing cycle  ('sbeb', 28)
```

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```
removing cycle  ('sbeb', 28)
-->  [('sbec', 16), ('sbc', 17), ('sad', 21)]
removing overlap  ('sbc', 17)
-->  [('sbec', 16), ('sad', 21)]
-->  [('sbecg', 17), ('sbece', 20), ('sad', 21), ('sbecb', 33), ('sbeca', 36)]
removing cycle  ('sbece', 20)
removing cycle  ('sbecb', 33)
-->  [('sbecg', 17), ('sad', 21), ('sbeca', 36)]
-->  [('sbecg', 17), ('sad', 21), ('sbeca', 36)]
('sbecg', 17)
PS C:\Users\SHREE RAM\Desktop\ai>
```

comparison for Greedy best first search & A*:

Parameters	**Best first search**	**A***
completeness	No	Yes
Time complexity	O(b^d)	O(b^d)
Space complexity	O(b^d)	O(b^d)
optimality	No	Yes

CONCLUSION:

Hence, we have successfully implemented A* and Best First Search