Lab 2: Implement Informed Searching Strategies

Informed Search: Informed Search algorithms have information on the goal state which helps in more efficient searching. This information is obtained by a function that estimates how close a state is to the goal state. In this lab, we are going to implement A* search.

A* search is the most commonly known form of best-first search. It uses heuristic function h(n), and cost to reach the node n from the start state g(n). A* search algorithm finds the shortest path through the search space using the heuristic function

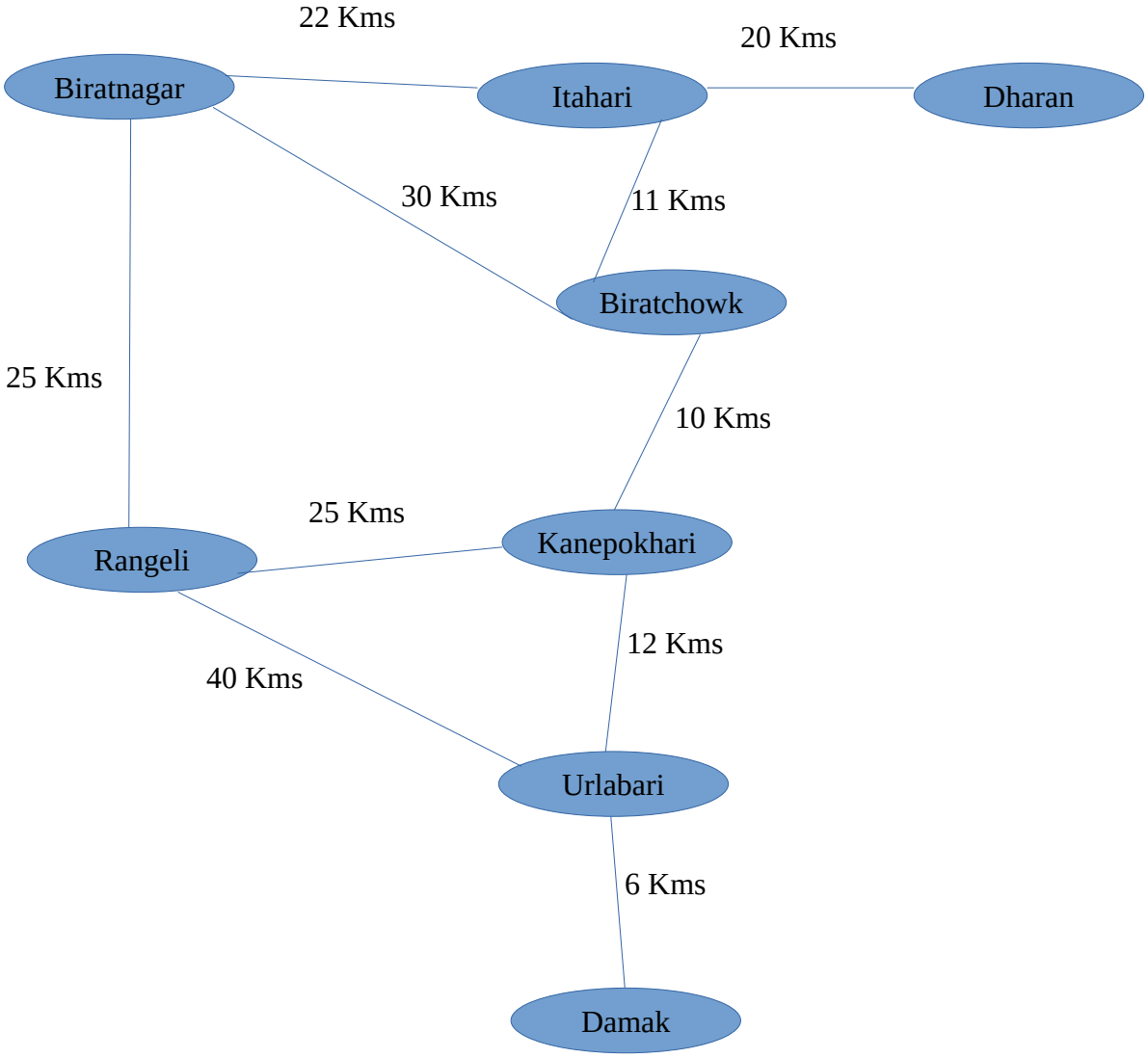
$$f(n) = g(n) + h(n).$$

This search algorithm expands less search tree and provides optimal result faster.

Algorithm

1. Declare the visited list
2. Declare the unvisited list
3. For each node in graph:
   – Add the node to the unvisited list with a g-score of infinity, an f-score of infinity and previous node of null.
4. Set the start node's g-score to 0 in the unvisited list
5. Set the start node's f-score to its h-score in the unvisited list
6. Set finished to False
7. While finished is False:
   – Set current node to the node in the unvisited list with the lowest f-score
   – If the current node is the target node
      – Set finished to True
      – Copy the values for the current node from the unvisited list to the visited list
   – Else
      – For each neighbor of current node:
         – If neighbor is not in the visited list
            – Calculate new g-score = weight of edge + g-score of current node
            – If new g-score is less than neighbor's g-score in unvisited list
               – Update the neighbor's g-score with the new g-score
               – Update the neighbor's f-score to new g-score + h_score
               – Update the neighbor's previous node to the current node
      – Copy the values for the current node from the unvisited list to the visited list
      – Remove the current node from the unvisited list
8. Return the visited list

We will use the A* algorithm to find the best path from Biratnagar to Damak in the following map.



The straight line distance from each of the city to Damak is shown below:

Heuristic function h(n)	
Biratnagar	46 Kms
Itahari	39 Kms
Dharan	41 Kms
Rangeli	28 Kms
Biratchowk	29 Kms
Kanepokhari	17 Kms
Urlabari	6 Kms
Damak	0 Kms

Source Code

```
gScore = 0 #use this to index g(n)
fScore = 1 #use this to index f(n)
previous = 2 #use this to index previous node

inf = 10000 #use this for value of infinity

#we represent the graph usind adjacent list
#as dictionary of dictionaries
G = {
    'biratnagar' : {'itahari' :  22, 'biratchowk' : 30, 'rangeli': 25},
    'itahari' : {'biratnagar' : 22, 'dharan' : 20, 'biratchowk' : 11},
    'dharan' : {'itahari' : 20},
    'biratchowk' : {'biratnagar' : 30, 'itahari' :  11, 'kanepokhari' :10},
    'rangeli' : {'biratnagar' : 25, 'kanepokhari' : 25, 'urlabari' : 40},
    'kanepokhari' : {'rangeli' : 25, 'biratchowk' : 10, 'urlabari' : 12},
    'urlabari' : {'rangeli' : 40, 'kanepokhari' : 12, 'damak' : 6},
    'damak' : {'urlabari' : 6}
    }



def h(city):
    #returns straight line distance from a city to damak
    h = {
        'biratnagar' : 46,
        'itahari' : 39,
        'dharan' : 41,
        'rangeli' : 28,
        'biratchowk' : 29,
        'kanepokhari' : 17,
        'urlabari' : 6,
        'damak' : 0
        }
    return h[city]

def getMinimum(unvisited):
    #returns city with minimum f(n)
    currDist = inf
    leastFScoreCity = ''
    for city in unvisited:
        if unvisited[city][fScore] < currDist:
            currDist = unvisited[city][fScore]
            leastFScoreCity = city
    return leastFScoreCity
```

```
def aStar(G, start, goal):
    visited = {} #we declare visited list as empty dict
    unvisited = {} #we declare unvisited list as empty dict

    #we now add every city to the unvisited
    for city in G.keys():
        unvisited[city] = [inf, inf, ""]

    hScore = h(start)
    #for starting node, the g(n) is 0, so f(n) will be h(n)
    unvisited[start] = [0, hScore, ""]

    finished = False
    while finished == False:
        #if there are no nodes to evaluate in unvisited
        if len(unvisited) == 0:
            finished = True

        else:
            #find the node with lowest f(n) from open list
            currentNode = getMinimum(unvisited)
            if currentNode == goal:
                finished = True
                #copy data to visited list
                visited[currentNode] = unvisited[currentNode]


          else:
              #we examine the neighbors of currentNode
              for neighbor in G[currentNode]:
                  #we only check unvisited neighbors
                  if neighbor not in visited:
                      newGScore = unvisited[currentNode][gScore] + G[currentNode][neighbor]
                      if newGScore < unvisited[neighbor][gScore]:
                          unvisited[neighbor][gScore] = newGScore
                          unvisited[neighbor][fScore] = newGScore + h(neighbor)
                          unvisited[neighbor][previous] = currentNode

              #we now add currentNode to the visited list
              visited[currentNode] = unvisited[currentNode]
              #we now remove  the currentNode from unvisited
              del unvisited[currentNode]
    return visited

def findPath(visitSequence, goal):
    answer = []
    answer.append(goal)
    currCity = goal
    while visitSequence[currCity][previous] != '':
        prevCity = visitSequence[currCity][previous]
        answer.append(prevCity)
        currCity = prevCity
    return answer[::-1]
start = 'biratnagar'
goal = 'damak'
visitSequence = aStar(G, start, goal)
path = findPath(visitSequence, goal)
print(path)
```

Output

```
Python 3.9.7 (tags/v3.9.7:1016ef3, Aug 30 2021, 20:19:38) [MSC v.1929 64 bit (AM
D64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
================ RESTART: C:\Users\Pukar Karki\Desktop\astar.py ================
['biratnagar', 'biratchowk', 'kanepokhari', 'urlabari', 'damak']
```