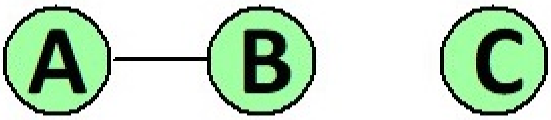
第二週建議作業

1. 以 UCS 找尋圖3.15中Sibiu 到 Bucharest 的最短路徑。
2. 以圖3.7的標準來看，loop do 執行過多少次？
3. 你的演算法停下來的時候，部分路線(partial path) S-F-B 有沒有在 frontier 裡面？
4. 假設我們有甲和乙兩個四面的骰子。丟擲甲骰子時，看到 1、2、3、4 的機率分別是 0.1、0.4、0.2、0.3。丟擲甲骰子時，看到 1、2、3、4 的機率分別是 0.3、0.2、0.4、0.1。依照這一些數據回答下列問題。
5. 以這甲乙兩個骰子，在某一次試擲實驗，投擲其中一個，我們看到 3。這一個骰子是甲骰子的機率是多少？
6. 以這甲乙兩個骰子，在某一次試擲實驗中，我們任意選擇了甲或者乙其中一個骰子，連續試擲兩次，我們看到 3 和 4。假設這兩次投擲是完全獨立的，則這一個骰子是甲骰子的機率是多少？
7. 以下這一題是補充上星期最後一題建議作業的。改變題目來點出要大家注意的地方。
8. 現在我們使用以下這一個極度簡單也奇怪的地圖，其中 A、B 和 C 是三個地點。
9. map 

10. 以 AIMA 圖 3.7 的演算法，來實踐 BFS 或者 DFS，尋找從 A 到 C 的路線的話，顯然是一個沒有答案的問題。
11. 但是程式如何知道沒有答案？
    1. 針對這一問題，圖 3.7 的演算法會停在甚麼地方？
        1. 停止的時候 frontier 的內容是甚麼？

figures

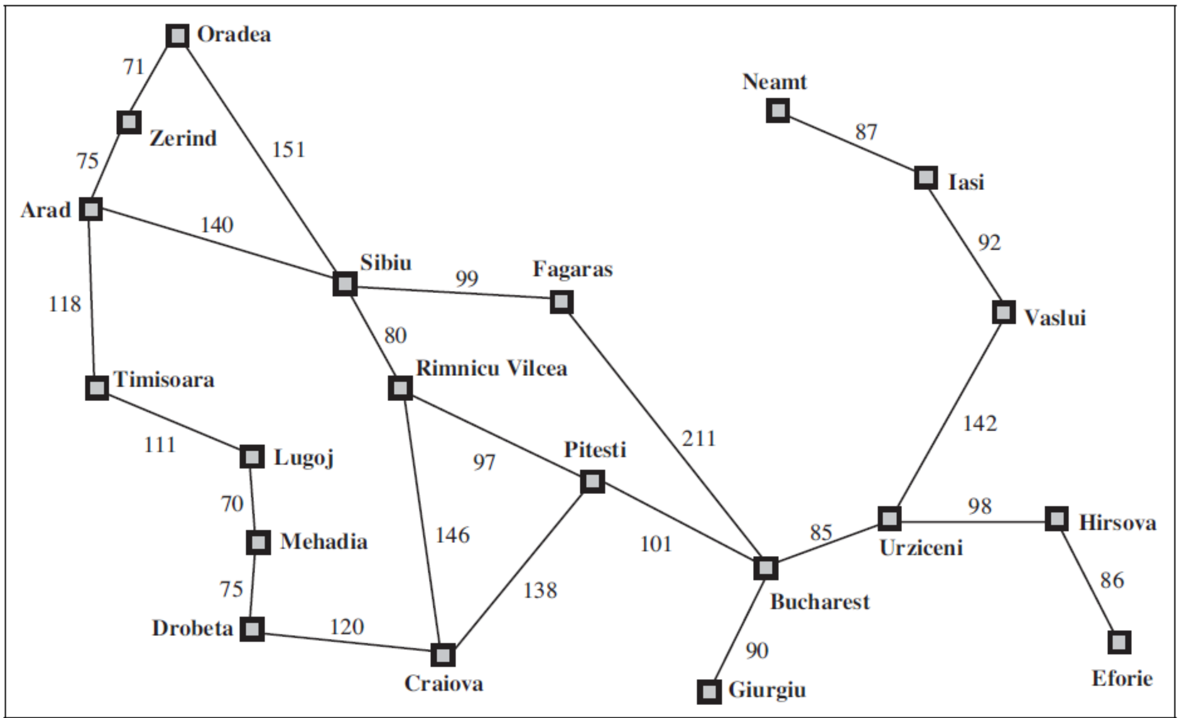
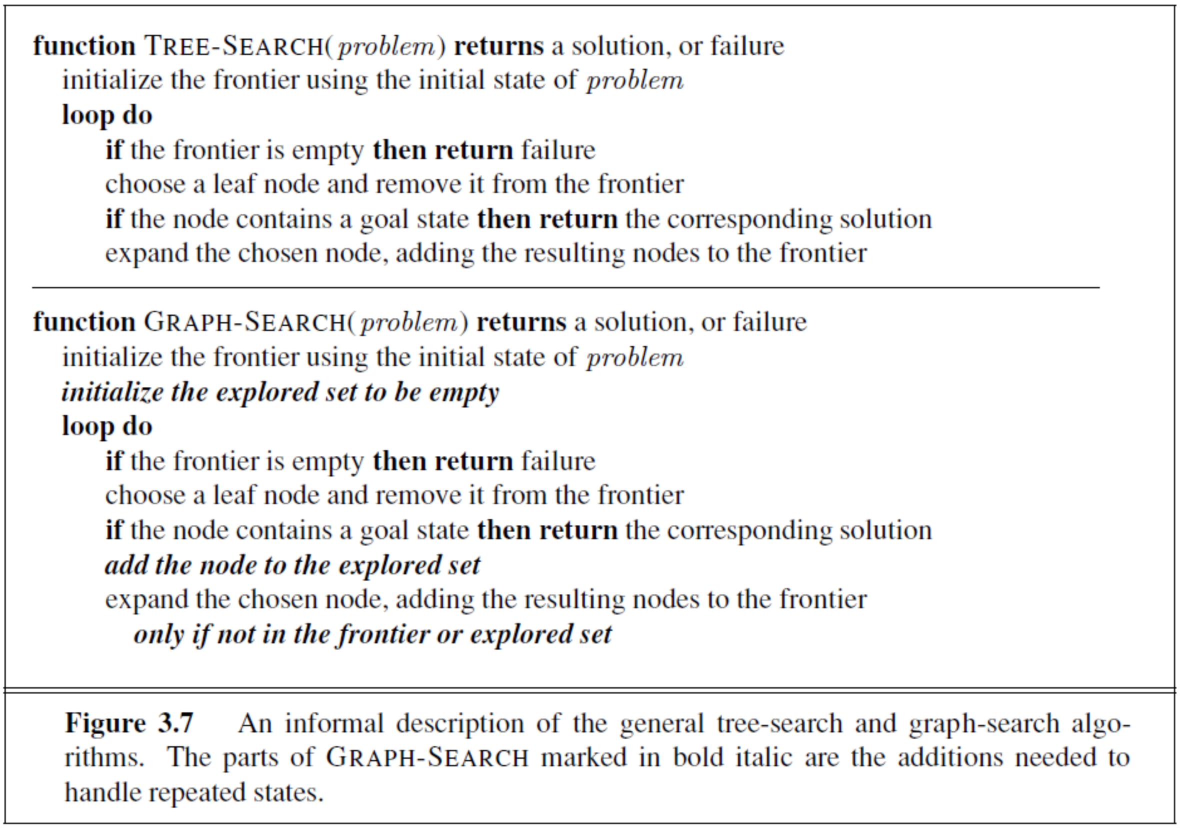


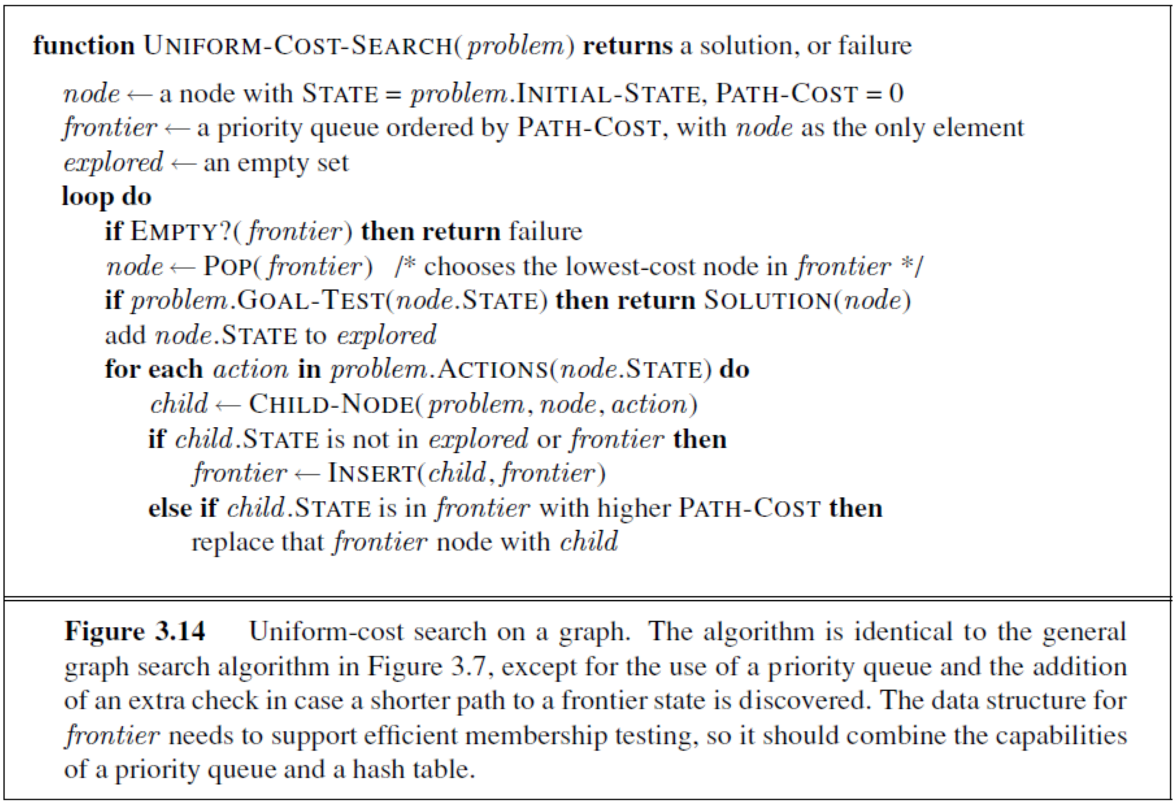
Figure 3.2 A simplified road map of part of Romania.



```
function TREE-SEARCH(problem) returns a solution, or failure
  initialize the frontier using the initial state of problem
  loop do
      if the frontier is empty then return failure
      choose a leaf node and remove it from the frontier
      if the node contains a goal state then return the corresponding solution
      expand the chosen node, adding the resulting nodes to the frontier
```

```
function GRAPH-SEARCH(problem) returns a solution, or failure
  initialize the frontier using the initial state of problem
  initialize the explored set to be empty
  loop do
      if the frontier is empty then return failure
      choose a leaf node and remove it from the frontier
      if the node contains a goal state then return the corresponding solution
      add the node to the explored set
      expand the chosen node, adding the resulting nodes to the frontier
        only if not in the frontier or explored set
```

Figure 3.7 An informal description of the general tree-search and graph-search algorithms. The parts of GRAPH-SEARCH marked in bold italic are the additions needed to handle repeated states.



```
function UNIFORM-COST-SEARCH(problem) returns a solution, or failure

  node ← a node with STATE = problem.INITIAL-STATE, PATH-COST = 0
  frontier ← a priority queue ordered by PATH-COST, with node as the only element
  explored ← an empty set
  loop do
      if EMPTY?(frontier) then return failure
      node ← POP(frontier)  /* chooses the lowest-cost node in frontier */
      if problem.GOAL-TEST(node.STATE) then return SOLUTION(node)
      add node.STATE to explored
      for each action in problem.ACTIONS(node.STATE) do
          child ← CHILD-NODE(problem, node, action)
          if child.STATE is not in explored or frontier then
              frontier ← INSERT(child, frontier)
          else if child.STATE is in frontier with higher PATH-COST then
              replace that frontier node with child
```

Figure 3.14 Uniform-cost search on a graph. The algorithm is identical to the general graph search algorithm in Figure 3.7, except for the use of a priority queue and the addition of an extra check in case a shorter path to a frontier state is discovered. The data structure for *frontier* needs to support efficient membership testing, so it should combine the capabilities of a priority queue and a hash table.

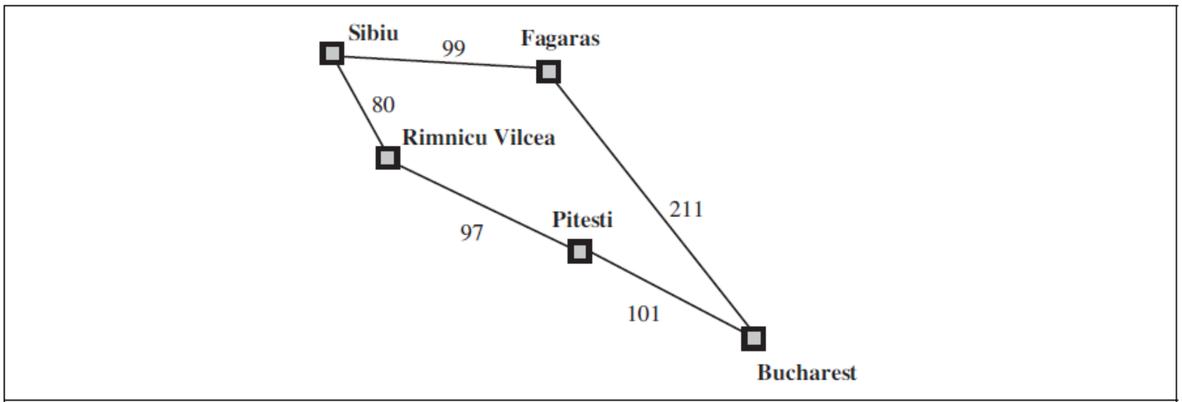


Figure 3.15 Part of the Romania state space, selected to illustrate uniform-cost search.

```python
# 1
from collections import namedtuple

Node = namedtuple('Node', ['name', 'edges'])
Edge = namedtuple('Edge', ['start', 'end', 'length'])
Path = namedtuple('Path', ['nodes', 'length'])

NULL = Node('', [])

def build_node(name):
    node = Node(name, [])
    return node


def build_nodes():
    cities = ['Arad', 'Bucharest', 'Craiova', 'Drobeta', 'Fagaras',
              'Lugoj', 'Mehadia', 'Oradea', 'Pitesti', 'Rimnicu Vilcea',
              'Sibiu', 'Timisoara', 'Zerind', 'VOID']
    return {city: build_node(city) for city in cities}


def link_nodes(nodes, start, end, length):
    start_node = nodes[start]
    end_node = nodes[end]
    start_node.edges.append(Edge(start_node, end_node, length))


def build_map():
    nodes = build_nodes()

    link_nodes(nodes, 'Sibiu', 'Fagaras', 99)
    link_nodes(nodes, 'Fagaras', 'Bucharest', 211)
    link_nodes(nodes, 'Sibiu', 'Rimnicu Vilcea', 80)
    link_nodes(nodes, 'Rimnicu Vilcea', 'Pitesti', 97)
    link_nodes(nodes, 'Pitesti', 'Bucharest', 101)


    return nodes['Sibiu']


def valid_path(path, start_name, end_name):
    start = path.nodes[0]
    end = path.nodes[-1]
    return start.name == start_name and end.name == end_name


def sort_paths(paths):
    if len(paths) == 1:
        return paths
    else:
        new_paths = paths.copy()
        for i in range(1, len(new_paths)):
            temp = new_paths[i]
            j = i - 1
            while j >= 0 and temp.length < new_paths[j].length:
                new_paths[j + 1] = new_paths[j]
                j -= 1
            new_paths[j + 1] = temp

        return new_paths


def extend_path(path):
    paths = []

    path_nodes = path.nodes
    start = path_nodes[0]
    end = path_nodes[-1]
    edges_of_end = end.edges

    orig_length = path.length

    for edge in edges_of_end:
        new_nodes = path_nodes.copy()
        new_nodes.append(edge.end)
        paths.append(Path(new_nodes, orig_length + edge.length))

    return paths


def ucs(frontier, es, times):
    if len(frontier) == 0 or frontier is None:
        raise Exception()
    else:
        frontier = sort_paths(frontier)

        path = frontier.pop(0)

        if valid_path(path, 'Sibiu', 'Bucharest'):
            return path, times, frontier
        else:
            es.append(path)
            frontier.extend(extend_path(path))
            return ucs(frontier, es, times + 1)

def print_path(path):
    print("路徑節點: ")

    for node in path.nodes:
        print("=>", node.name)
    print("路徑長: ", path.length)


start = build_map()
path, times, frontier = ucs([Path([start, start], 0)], [], 0)

print('1.')

print('UCS 路徑： ')
print_path(path)

print("最少執行步數：", times)

print('剩餘的 frontier: ')
for remain_path in frontier:
    print_path(path)

print('剩餘的 frontier 沒有 SRB')

print("本路徑為最短路徑")
```

```
1.
UCS 路徑：
路徑節點:
=> Sibiu
=> Sibiu
=> Rimnicu Vilcea
=> Pitesti
=> Bucharest
路徑長:  278
最少執行步數： 4
剩餘的 frontier:
路徑節點:
=> Sibiu
=> Sibiu
=> Rimnicu Vilcea
=> Pitesti
=> Bucharest
路徑長:  278
剩餘的 frontier 有 SRB
本路徑為最短路徑
```

2

甲骰子

number	prob
1	0.1
2	0.4
3	0.2
4	0.3

乙骰子

number	prob
1	0.3
2	0.2
3	0.4
4	0.1

2-A

甲骰子出現 3 的機率為 0.2，乙骰子出現 3 的機率為 0.4，當今天任一骰子擲出 3，
其為甲骰子的機率為 0.33

2-B

甲骰子出現 3 -> 4 的機率為 0.2 * 0.3 = 0.06
乙骰子出現 3 -> 4 的機率為 0.4 * 0.1 = 0.04

當今天任一骰子擲出 3 -> 4，其為甲骰子的機率為 0.67

```
## 3

from collections import namedtuple

Node = namedtuple('Node', ['name', 'children'])
Path = namedtuple('Path', ['nodes', 'size'])

NULL = Node('', [])

def build_node(name):
    node = Node(name, [])
    return node


def build_nodes():
    cities = ['A', 'B', 'C']
    return {city: build_node(city) for city in cities}


def link_nodes(nodes, start, *ends):
    start_node = nodes[start]
    for end in ends:
        start_node.children.append(nodes[end])
        # end.parent = start

def build_bfs_map():
    nodes = build_nodes()

    link_nodes(nodes, 'A', 'B')

    return nodes['A']


def valid_path(path, start_name, end_name):
    start = path.nodes[0]
    end = path.nodes[-1]

    return start.name == start_name and end.name == end_name


def extend_path(path):
    paths = []

    path_nodes = path.nodes
    start = path_nodes[0]
    end = path_nodes[-1]
    children_of_end = end.children

    size = path.size

    for child in children_of_end:
        new_nodes = path_nodes.copy()
        new_nodes.append(child)
        paths.append(Path(new_nodes, size + 1))

    return paths


def bfs(frontier, es, times):
    if len(frontier) == 0 or frontier is None:
        print('forntier: ')
        for path in frontier:
            print_path(path)

        raise Exception()
    else:
        path = frontier.pop(0)

        if valid_path(path, 'A', 'C'):
            return path, times
        else:
            es.append(path)
            frontier.extend(extend_path(path))
            return bfs(frontier, es, times + 1)

start = build_bfs_map()
path, times = bfs([Path([start, start], 0)], [], 0)
```

```
forntier:
```

```
---------------------------------------------------------------------------

Exception                                 Traceback (most recent call last)

<ipython-input-17-4330640f9bd0> in <module>
     75
     76 start = build_bfs_map()
---> 77 path, times = bfs([Path([start, start], 0)], [], 0)
```

```
<ipython-input-17-4330640f9bd0> in bfs(frontier, es, times)
     72             es.append(path)
     73             frontier.extend(extend_path(path))
---> 74             return bfs(frontier, es, times + 1)
     75
     76 start = build_bfs_map()
```

```
<ipython-input-17-4330640f9bd0> in bfs(frontier, es, times)
     72             es.append(path)
     73             frontier.extend(extend_path(path))
---> 74             return bfs(frontier, es, times + 1)
     75
     76 start = build_bfs_map()
```

```
<ipython-input-17-4330640f9bd0> in bfs(frontier, es, times)
     63             print_path(path)
     64
---> 65         raise Exception()
     66     else:
     67         path = frontier.pop(0)
```

```
Exception:
```

3

frontier 最終為空