**Reg No - 19BCE1327**

**Name : Kartikey Gautam**

**Lab 7+8**

*Random walk algorithm*

```
adjacency_matrix = [

[0, 1, 0, 0, 0, 1, 0, 0],

[0, 0, 0, 0, 0, 0, 0, 0],

[0, 1, 0, 0, 0, 0, 0, 0],

[1, 0, 0, 0, 1, 0, 1, 0],

[0, 1, 1, 0, 0, 0, 0, 1],

[0 ,0 ,0, 0, 1, 0, 0, 0],

[1, 1, 1, 0, 0, 1, 0, 0],

[0, 1, 0, 1, 0, 0, 0, 0]

]

num_vertices = 8

# list of nodes

vertices_list = ['A', 'B', 'C', 'D', 'E', 'F', 'G', 'H']

# Import the Networkx Library for forming the graph
import networkx as nx

# Import the Pyplot library for plotting the created graph
from matplotlib import pyplot as plt

# Create an instance of the Graph class

# We are using a Directed graph due to the nature of our problem.

graph = nx.DiGraph()

#Load the nodes into the graph

graph.add_nodes_from(vertices_list)
```

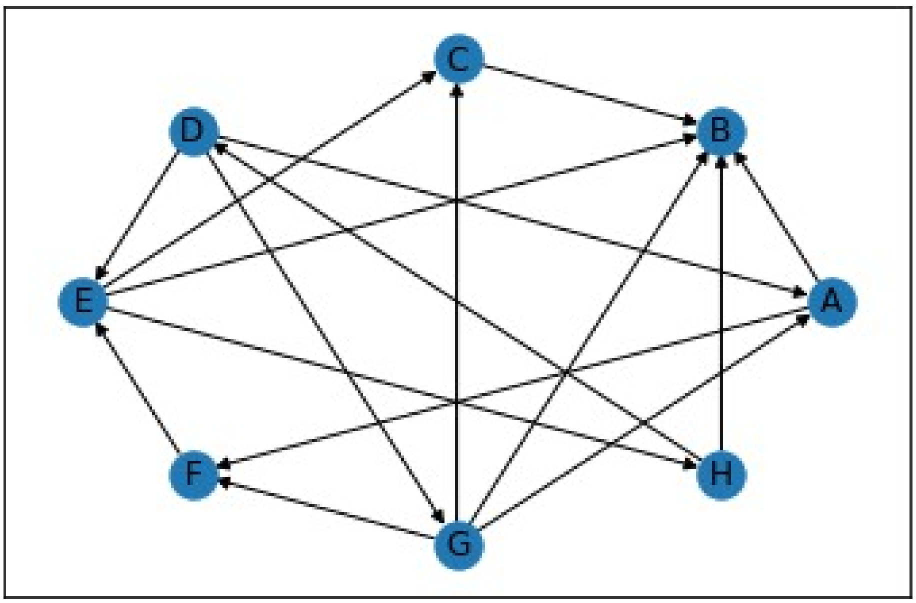
```
# Add the edges from the adjacency matrix

for i in range(num_vertices) :
    for j in range(num_vertices) :
        if adjacency_matrix[i][j] == 1 :
            graph.add_edge(vertices_list[i], vertices_list[j])

# Draw generated graph

nx.draw_networkx(graph, pos=nx.circular_layout(graph), arrows=True,
with_labels= True)

plt.show()
```




```
page_ranks_networkx = nx.pagerank(graph, alpha=0.85)
print("The page ranks are :\n")
page_ranks_networkx
```

```
The page ranks are :


{'A': 0.08941499371129827,
 'B': 0.28120563198030324,
 'C': 0.10983011816321761,
 'D': 0.08864644387947536,
 'E': 0.1606990303925196,
 'F': 0.10229957241772619,
 'G': 0.07374454250177016,
 'H': 0.09415966695368949}
```

```
# Sort the pages by their ranks
```

```
page_ranks_networkx = dict(sorted(page_ranks_networkx.items(),
key=lambda item:

item[1], reverse=True))

page_ranks_networkx
```

```
{'A': 0.08941499371129827,
 'B': 0.28120563198030324,
 'C': 0.10983011816321761,
 'D': 0.08864644387947536,
 'E': 0.1606990303925196,
 'F': 0.10229957241772619,
 'G': 0.07374454250177016,
 'H': 0.09415966695368949}
```

```
# Print the pages by the order of their ranks

print("The Pages in the order of importance with the page rank scores
obtained b y using NetworkX are : ")

for k, v in page_ranks_networkx.items() :
    print(k, "=", v)
```

```
The Pages in the order of importance with the page rank scores
obtained b y using NetworkX are :
B = 0.28120563198030324
E = 0.1606990303925196
C = 0.10983011816321761
F = 0.10229957241772619
H = 0.09415966695368949
A = 0.08941499371129827
D = 0.08864644387947536
G = 0.07374454250177016
```

```
# Calculate the number of out-bound links for each vertex

outbound_vertices_count = [0 for _ in range(num_vertices)]
print("The Out-Bound vertices count for each vertex is as follows : ")
for i in range(num_vertices) :
    outbound_vertices_count[i] = sum(adjacency_matrix[i])
    print(vertices_list[i], " : ", outbound_vertices_count[i])
```

```
The Out-Bound vertices count for each vertex is as follows :
A  :  2
B  :  0
C  :  1
D  :  3
E  :  3
F  :  1
```

```
G  :  4
H  :  2
```

```
# List and store all the in-bound vertices for a particular vertex

in_bound_vertices_list = {}

for i in range(num_vertices) :
    in_bound_vertices_list[i] = []
    for j in range(num_vertices) :
        if adjacency_matrix[j][i] == 1 :
            in_bound_vertices_list[i].append(j)

in_bound_vertices_list
```

```
{0: [3, 6],
 1: [0, 2, 4, 6, 7],
 2: [4, 6],
 3: [7],
 4: [3, 5],
 5: [0, 6],
 6: [3],
 7: [4]}
```

```
print("The In-bound vertices for each vertex is as follows : ")

for i in range(num_vertices) :\
    print(vertices_list[i], " : ", end="")

print(", ".join([vertices_list[j] for j in
in_bound_vertices_list[i]]))
```

```
The In-bound vertices for each vertex is as follows :
A  : B  : C  : D  : E  : F  : G  : H  : E
```

```
def pageRank(graph, vertices_names, in_bound_vertices_list,
outbound_vertices_count, tolerance=1.0e-6, max_iterations=100) :
    num_vertices = len(vertices_names)
    page_rank = [(1/num_vertices) for _ in range(num_vertices)]
    epsilon = num_vertices * tolerance
    converged = False
    for i in range(max_iterations) :
        page_rank_old = page_rank[:]
        for j in range(num_vertices) :
            page_rank[j] = 0
            for k in in_bound_vertices_list[j] :
                page_rank[j] += page_rank_old[k] /
outbound_vertices_count[k]
        error = sum([abs(page_rank[j] - page_rank_old[j]) for j in
range(num_vertices)])
        if error < epsilon :
```

```
            converged = True
            break
    if converged :
        page_rank_manual = {}
        for i, pr in enumerate(page_rank) :
            page_rank_manual[vertices_names[i]] = pr
        return page_rank_manual
```

```
page_rank_manual = pageRank(graph, vertices_list,
in_bound_vertices_list, outbound_vertices_count)
page_rank_manual   #calling the function
```

```
{'A': 5.563153515756733e-07,
 'B': 3.82433438572732e-06,
 'C': 1.00735866138683e-06,
 'D': 6.873407767188322e-07,
 'E': 1.4964646055945424e-06,
 'F': 6.333961839903499e-07,
 'G': 3.9271032903466525e-07,
 'H': 8.437536388458218e-07}
```

```
# Sort the pages by their ranks using dict

page_rank_manual = dict(sorted(page_rank_manual.items(), key=lambda
item: item[1

], reverse=True))

page_rank_manual
```

```
{'A': 5.563153515756733e-07,
 'B': 3.82433438572732e-06,
 'C': 1.00735866138683e-06,
 'D': 6.873407767188322e-07,
 'E': 1.4964646055945424e-06,
 'F': 6.333961839903499e-07,
 'G': 3.9271032903466525e-07,
 'H': 8.437536388458218e-07}
```

```
# Print the pages by the order of their ranks

print("The Pages in the order of importance with the page rank scores
obtained b y performing Random Walk are : ")
for k, v in page_rank_manual.items() :
    print(k," > ",end=" ")
print("\n")
for k, v in page_rank_manual.items() :
    print(k, "=", v)
```

```
The Pages in the order of importance with the page rank scores
obtained b y performing Random Walk are :
```

B > E > C > H > D > F > A > G >

B = 3.82433438572732e-06
E = 1.4964646055945424e-06
C = 1.00735866138683e-06
H = 8.437536388458218e-07
D = 6.873407767188322e-07
F = 6.333961839903499e-07
A = 5.563153515756733e-07
G = 3.9271032903466525e-07