Graph Theory and its Applications

Output Screenshots :

n = 28


```
D:\GTA>python PES1UG20CS684_Graph_Colouring.py
[[0 0 1 0 1 1 0 0 0 0 1 1 1 0 1 0 1 1 1 1 0 0 0 0 0 1 1]
 [1 0 1 1 1 1 1 1 1 1 0 1 0 1 0 1 0 1 1 1 0 0 0 1 0 1 0 1]
 [0 1 0 1 0 1 1 0 1 1 1 0 0 0 0 0 1 0 0 0 0 0 1 0 1 1]
 [1 0 0 0 1 1 0 1 0 0 0 1 1 0 0 1 1 1 1 1 1 0 1 1 1 0 1 1]
 [0 0 0 0 0 0 1 1 0 1 0 1 0 1 1 0 1 1 0 0 1 1 0 0 1 1 1]
 [0 0 1 1 0 0 1 1 1 1 1 0 1 0 1 0 1 0 0 0 0 0 1 0 1 0 1 1]
 [1 1 1 0 0 0 0 1 0 1 0 0 1 1 0 1 1 0 0 1 0 1 1 1 1 1 0 0]
 [0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 0 1 0 1 1 0 1 0 1 1 0 0]
 [1 0 1 0 1 1 1 0 0 0 1 0 1 0 1 1 1 1 0 1 0 0 1 1 0 0 1 0]
 [1 1 0 1 0 0 0 0 0 0 0 1 0 0 1 1 0 1 0 1 0 0 1 1 1 0 0]
 [0 1 0 1 0 1 0 1 1 1 0 1 0 0 0 0 0 0 1 1 1 0 0 0 0 0]
 [0 0 1 1 0 1 0 1 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 1 0 1 0 1]
 [1 0 1 1 0 0 1 0 0 0 0 0 0 1 0 1 1 0 0 0 0 1 1 1 0 0 1 0]
 [1 1 1 0 1 1 1 0 0 1 1 0 0 0 1 0 0 0 1 1 1 0 0 1 0 1 0 1]
 [1 0 0 1 1 1 1 1 1 0 0 0 0 0 0 1 1 0 1 0 0 0 1 0 1 1 1 1]
 [0 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 1 0 0 1 0 1]
 [1 1 1 0 0 0 1 1 0 1 1 0 1 1 1 1 0 0 1 0 0 0 0 1 0 0 0 0]
 [0 0 0 1 0 1 1 0 1 1 1 0 1 1 1 1 0 0 0 1 0 0 0 0 1 1 1 0]
 [0 1 0 0 0 1 1 0 0 1 1 0 1 0 1 0 1 1 0 0 0 0 0 1 1 1 1 1]
 [1 0 0 0 1 0 0 1 1 0 1 0 0 0 1 1 1 1 1 0 1 1 1 1 0 1 0 1]
 [0 1 1 0 1 1 0 0 0 1 0 0 1 1 0 0 1 1 1 1 0 0 0 0 0 1 1]
 [0 0 1 0 1 0 1 1 1 0 0 1 0 1 1 1 1 1 1 0 0 0 1 0 0 0 1 0]
 [0 1 1 0 0 0 1 0 1 0 1 1 1 1 1 1 0 1 1 1 1 0 0 1 1 0 0 1]
 [0 0 0 0 1 0 0 1 1 0 1 1 0 0 1 1 1 1 0 1 1 0 0 0 1 0 1]
 [0 0 0 0 1 1 1 1 1 0 0 1 1 0 1 1 0 0 0 1 1 0 1 1 0 0 0 0]
 [1 1 0 1 1 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 1 0 1 0 0 0]
 [0 1 1 1 1 0 0 1 0 0 0 0 1 1 1 1 0 0 0 0 0 1 0 0 0 0 0 0]
 [1 0 0 0 0 1 1 0 1 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 1 0]]

Greedy Algo:
Chromatic number :  10
Indices are vertices and values are colors of vertices :  [1, 2, 1, 2, 1, 3, 3, 1, 2, 3, 4, 5, 4, 5, 4, 3, 6, 1, 5, 7, 8, 7, 6, 9, 10, 4, 6, 8]
134.300 micro secs

Welsh Powell Algo:
Chromatic number :  10
Indices are vertices and values are colors of vertices :  [5, 1, 8, 2, 6, 5, 2, 10, 2, 7, 9, 8, 7, 3, 4, 10, 6, 4, 5, 3, 4, 4, 1, 4, 6, 9, 9, 9]
265.400 micro secs
```



```
D:\GTA>python PES1UG20CS684_Graph_Colouring.py
[[0 1 1 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 1 1 0 1 0 0 1]
 [0 0 0 1 0 0 1 1 1 0 0 1 0 1 0 0 0 0 0 1 1 1 1 0 0 1 0]
 [0 1 0 1 1 1 1 1 0 0 1 0 1 1 1 0 1 0 1 1 1 1 0 1 1 1 0 1 0]
 [0 0 0 0 0 1 1 1 0 0 0 1 1 1 0 0 0 0 0 1 0 0 0 1 0 1 0 1]
 [0 1 0 0 0 1 0 1 1 0 0 0 1 1 1 1 0 0 1 1 0 0 1 1 0 1 1 1]
 [0 1 1 1 1 0 0 1 1 0 0 0 1 1 0 0 0 0 1 1 1 0 0 1 1 0 1 1]
 [1 1 1 1 1 1 0 1 0 1 0 0 0 1 0 1 0 0 1 0 1 1 1 1 0 0 1 0]
 [1 0 0 1 0 0 0 1 0 1 1 0 1 0 0 1 0 0 0 0 1 1 1 0 0 1 0 1 0]
 [0 1 1 1 0 0 0 0 0 0 0 1 1 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1]
 [0 0 1 0 1 0 1 0 0 0 0 1 0 1 0 1 0 1 0 1 1 0 0 0 0 1 1 1]
 [0 0 1 1 1 1 1 0 1 1 0 1 0 0 1 0 1 0 1 0 1 1 0 0 0 1 0 0 1 0]
 [1 0 1 0 1 0 0 1 1 1 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 1]
 [1 1 1 0 1 0 0 0 0 0 0 1 0 1 0 0 1 1 1 0 0 1 1 1 0 1 0 1]
 [1 0 1 0 1 1 1 1 0 0 0 1 1 0 0 1 1 0 0 1 0 0 1 0 1 1 1 0]
 [0 0 1 1 1 1 0 1 0 0 0 1 1 1 0 1 0 1 0 1 0 1 0 0 0 0 0]
 [0 1 0 0 0 1 0 1 0 1 1 1 0 0 1 0 1 1 1 1 1 1 0 1 0 1 0 0]
 [1 0 0 1 1 0 1 0 1 0 0 0 1 1 1 0 0 0 1 1 1 0 0 1 1 1 0 1]
 [1 1 1 1 0 0 1 0 0 1 1 0 1 0 1 1 0 1 0 1 0 0 1 0 0 1 0 1]
 [0 1 0 0 0 0 0 0 0 1 1 0 1 0 1 0 1 0 1 1 1 0 0 0 0 1 0 0 1]
 [1 1 1 0 1 1 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 1 0 0 1 0 0 1 0]
 [0 1 1 0 0 1 0 0 0 0 0 1 1 1 1 1 1 1 0 0 0 1 0 1 0 0 1]
 [1 0 1 0 0 0 1 1 1 1 0 0 1 0 0 1 1 0 1 0 1 0 0 0 1 1 1 0]
 [1 0 1 1 0 1 1 0 0 1 1 0 1 1 0 1 1 0 0 1 1 1 1 0 1 0 1 0]
 [0 0 1 0 0 0 1 0 1 1 1 0 0 0 1 1 0 1 0 1 0 1 1 1 0 0 0 0]
 [0 1 0 1 1 1 1 1 0 1 0 1 0 1 1 0 0 0 1 0 1 0 0 1 1 0 1 0 1]
 [1 1 1 0 0 0 0 1 1 0 1 0 1 1 0 1 1 0 0 1 1 1 1 0 1 0 1 0]
 [1 0 1 0 1 1 1 0 0 0 1 1 0 1 1 0 0 1 0 0 1 0 1 0 1 0 1 1 0 1]
 [1 0 1 0 1 1 1 0 1 0 1 1 1 1 0 0 1 0 1 1 0 0 0 1 0 1 0]]

Greedy Algo:
Chromatic number :  10
Indices are vertices and values are colors of vertices :  [1, 1, 2, 1, 2, 3, 4, 2, 3, 1, 5, 4, 3, 5, 6, 7, 7, 8, 2, 6, 4, 5, 9, 6, 7, 8, 10, 9]
95.700 micro secs

Welsh Powell Algo:
Chromatic number :  11
Indices are vertices and values are colors of vertices :  [9, 9, 1, 10, 3, 4, 2, 6, 11, 7, 5, 8, 6, 5, 7, 4, 2, 3, 9, 8, 8, 5, 4, 10, 2, 1, 6, 1]
257.300 micro secs
```

n = 26

C:\Windows\System32\cmd.exe

D:\GTA>python PES1UG20CS684_Graph_Colouring.py
[[0 1 0 0 1 0 1 1 0 0 0 0 1 1 0 0 1 1 0 0 1 1 1 1 1 1]
 [1 0 0 1 1 1 0 0 0 1 0 0 1 1 0 1 1 0 0 0 1 1 0 1 0 1]
 [0 1 0 1 0 0 0 1 0 1 0 0 1 0 1 0 0 0 1 0 0 0 0 1 1 0]
 [1 0 0 0 0 1 1 0 0 0 1 0 0 1 0 1 0 1 0 1 0 0 1 0 1 0]
 [0 1 1 1 0 1 0 0 0 0 1 1 0 1 0 0 0 1 1 1 1 0 1 0 0 1]
 [0 0 0 1 0 0 0 1 1 0 1 0 0 1 1 1 1 1 1 1 1 0 1 1 0 0]
 [0 0 0 0 1 1 0 1 0 0 0 0 0 1 1 0 1 1 1 1 0 0 1 0 1]
 [0 0 1 1 1 1 0 0 1 1 1 0 1 0 0 0 1 0 0 0 1 0 0 1 1 1]
 [1 1 0 0 1 1 1 0 0 1 1 0 0 0 0 1 1 1 1 0 0 1 0 0 0 1]
 [0 1 1 1 0 1 1 0 1 0 1 1 1 0 1 0 1 0 0 1 0 1 0 0 0 1]
 [0 1 0 1 1 0 1 0 1 0 0 0 0 1 1 1 1 0 1 0 1 1 0 0 1 0]
 [0 1 0 0 0 0 0 0 1 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 1 1]
 [1 0 1 1 0 0 0 0 0 0 1 1 0 1 0 1 1 0 1 1 0 0 1 0 0 0]
 [0 1 1 1 0 0 1 1 1 1 1 1 1 0 0 1 0 1 0 1 0 1 1 1 0 0]
 [0 1 0 1 0 0 1 1 0 0 1 1 1 1 0 1 0 0 0 0 1 1 1 0 0 0]
 [1 0 1 1 1 0 0 0 1 1 1 0 1 0 1 0 0 1 1 0 1 1 1 1 1 0]
 [0 0 1 0 1 1 0 0 0 0 1 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0]
 [1 0 1 1 1 1 0 0 1 0 1 1 0 0 1 0 1 0 1 1 0 0 0 0 0 0]
 [1 1 0 1 0 1 0 0 1 0 0 1 1 1 1 1 0 1 0 1 1 0 0 0 0 0]
 [1 0 0 1 0 1 1 1 1 1 0 1 0 1 1 0 0 0 1 0 0 1 1 0 0 1]
 [0 1 1 0 0 1 1 1 1 0 1 1 0 1 1 1 1 1 1 0 0 0 0 0 0 1]
 [0 1 0 0 0 0 1 0 1 1 1 1 0 1 0 1 0 0 1 0 0 0 1 0 0 1]
 [1 1 0 0 1 1 0 0 1 1 0 0 1 0 1 1 0 1 0 0 1 1 0 1 0 1]
 [0 1 1 1 1 0 0 1 1 0 0 1 0 1 0 0 0 1 1 1 1 1 0 0 0 0]
 [0 0 1 1 1 0 1 1 0 1 1 0 0 0 0 0 0 1 1 1 1 0 1 1 0 1]
 [0 0 0 1 0 1 0 0 1 1 1 0 1 1 0 1 1 1 1 1 1 0 0 1 1 0]]

Greedy Algo:
Chromatic number : 10
Indices are vertices and values are colors of vertices : [1, 2, 1, 2, 3, 1, 2, 4, 4, 3, 1, 1, 3, 5, 6, 5, 2, 5, 7, 8, 3, 6, 7, 9, 6, 10]
78.600 micro secs

Welsh Powell Algo:
Chromatic number : 9
Indices are vertices and values are colors of vertices : [1, 4, 8, 9, 5, 2, 8, 5, 6, 3, 7, 9, 7, 1, 6, 2, 8, 7, 8, 4, 3, 8, 3, 6, 3, 1]
212.600 micro secs

D:\GTA>

n=27

C:\Windows\System32\cmd.exe

D:\GTA>python PES1UG20CS684_Graph_Colouring.py
[[0 0 0 0 0 0 0 0 1 1 1 0 0 0 1 1 0 1 0 0 1 0 0 0 1 0 1]
 [1 0 1 1 1 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 1 1]
 [1 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 1 1 0 0 0 1 1 1 1 1 0]
 [0 1 0 0 1 1 1 0 1 0 1 1 0 1 0 0 1 0 0 1 1 0 0 0 0 1 1]
 [1 1 0 0 0 1 0 0 0 1 1 1 1 1 1 1 1 0 1 1 0 1 0 1 0 1 0]
 [1 1 0 0 0 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 0 1 1 1]
 [0 1 1 0 1 0 0 1 1 1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 1]
 [1 0 1 1 0 1 1 0 1 0 0 1 1 0 0 0 0 1 1 1 0 0 1 0 1 0 1]
 [1 1 1 1 0 1 1 0 0 1 0 0 0 1 0 1 1 1 1 1 1 1 0 1 1 1]
 [1 1 0 1 1 0 1 0 1 0 0 0 0 1 0 1 1 1 1 0 1 1 0 1 0 0]
 [1 1 1 1 1 1 0 1 1 0 0 1 0 1 0 1 0 1 1 1 1 0 0 0 1 0 1]
 [0 0 1 0 1 0 1 1 0 0 1 0 1 0 0 1 1 0 0 1 0 0 1 1 1 1 0]
 [1 1 1 0 1 0 1 1 0 0 0 1 0 0 0 0 1 1 0 0 0 0 1 0 0 1 1 1]
 [0 0 0 1 1 1 0 0 0 1 0 1 0 0 1 1 0 1 0 1 0 0 0 0 1 0]
 [0 1 0 1 0 0 1 0 0 0 0 0 1 0 0 1 0 1 1 1 1 1 1 1 0 1 1]
 [0 0 0 0 0 1 1 0 1 0 0 1 0 0 0 0 0 0 0 1 0 0 1 1 1 1 1]
 [0 1 0 1 1 0 1 1 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 1 1 1 1]
 [0 0 1 0 0 1 0 0 0 1 0 1 0 1 1 1 1 0 0 0 0 1 0 0 1 1 1]
 [1 1 1 0 0 0 0 1 1 0 0 1 0 0 0 1 1 0 0 1 1 0 1 1 0 1 0]
 [1 0 1 1 0 1 1 0 1 0 1 0 1 0 0 0 1 1 1 0 1 1 0 0 1 1 0 1]
 [0 0 0 1 0 1 0 0 1 1 0 0 1 0 1 0 0 0 0 0 0 0 1 1 1 0 0 0]
 [1 0 1 1 1 1 1 0 1 1 1 0 1 0 1 0 0 1 0 0 1 0 1 0 0 1 0 0]
 [0 0 1 0 1 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0]
 [1 0 0 1 0 1 0 0 1 1 1 1 0 1 1 0 1 1 1 1 1 0 0 1 0 0 0]
 [1 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 1 0 0 0 1 1 0 0 0 0]
 [0 1 1 1 1 1 1 0 1 1 1 1 0 1 0 1 0 0 1 1 0 0 1 0 0 0 0]]

Greedy Algo:
Chromatic number : 9
Indices are vertices and values are colors of vertices : [1, 2, 2, 1, 3, 3, 1, 4, 4, 5, 5, 6, 5, 2, 3, 1, 6, 4, 3, 7, 6, 2, 8, 1, 8, 3, 9]
134.900 micro secs

Welsh Powell Algo:
Chromatic number : 9
Indices are vertices and values are colors of vertices : [8, 1, 7, 7, 3, 5, 8, 1, 2, 4, 2, 4, 5, 8, 4, 7, 5, 6, 6, 4, 5, 9, 6, 8, 1, 9, 3]
209.400 micro secs

D:\GTA>python PES1UG20CS684_Graph_Colouring.py