Project 5 - Virus Propagation

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Project Details:
This project is an efficient implementation of an algorithm to determine whether a virus will result in an epidemic or die quickly in a static network.

One python file mainly,

1. **`virus_propagation.py`** - Contains an algorithm in the file that helps us
    a. **Calculate the Effective Strength of the Virus.**
    b. **Simulation of the Virus Propagation in the network.**
    c. **Implementation of 4 different immunization policies to prevent the spread of the virus in the network.**

The program also finds the minimum number of vaccines needed in each policy to reduce the strength of the virus below threshold 1.

1. Software Requirements:
Python 3.8.2

Libraries:

- sys: comes default with python
- operator: comes default with python
- networkx - 2.8.7: to install networkx, run `pip install networkx` in the terminal.
- numpy - 1.18.4 : to install numpy, run "`pip install numpy`" in the terminal
- matplotlib - 3.4.3 : to install matplotlib, run "`pip install matplotlib`" in the terminal

2. Environment Variables: None

3. Instructions To Run:
Command: python virus_propagation.py

4. Result Interpretation:

After running the command in **3. Instructions To Run,** algorithm is run, and plots are created in the following sequence,

1. Calculate Effective Strength
2. Calculate beta(transmission probability) with different delta(healing probability)
    a. **Strength vs different delta values for beta = 0.01.png**
    b. **Strength vs different delta values for beta = 0.2.png**
3. Calculate delta(healing probability) with different beta(transmission probability)
    a. **Strength vs different beta values for delta= 0.6.png**
    b. **Strength vs different beta values for delta= 0.7.png**
4. Simulating Virus Propagation model for beta 1 and delta1
    a. Plot Created with name: **Simulation with beta = 0.01 and delta =0.6.png**
5. Simulating Virus Propagation model for beta 2 and delta 2
    a. Plot Created with name: **Simulation with beta = 0.2 and delta =0.7.png**
6. Running Immunization policies, Effective strength of the virus, and the simulation. The following plots are created.
    a. **Policy A Simulation with beta = 0.2 and delta = 0.7.png**
    b. **Policy B Simulation with beta = 0.2 and delta = 0.7.png**
    c. **Policy C Simulation with beta = 0.2 and delta = 0.7.png**
    d. **Policy D Simulation with beta = 0.2 and delta = 0.7.png**
7. Calculating the minimum number of vaccines for the policy models A, B, C, D. Plots are created with names,
    a. **Number of vaccines for policy A.png**
    b. **Number of vaccines for policy B.png**
    c. **Number of vaccines for policy C.png**
    d. **Number of vaccines for policy D.png**

5. Input and Output Files:

Input:

The input file is **static.network** graph file where each line represents nodes that have edges between them

After running the command as given in **3. Instructions To Run**, outputs are written to the output folder. An output file with the name as a description of the graph is present in the **output** folder.

NOTE: Please check the '**output**' folder for the plots generated.

We receive the values of effective strength in the terminal for the respective alpha and beta values:

Example:
For beta = 0.2 and delta = 0.7,
effective strength = 12.529913074497653
.....
Terminal Output:

```
For beta = 0.2 and delta = 0.7, effective strength = 12.52991307449845
For beta = 0.01 and delta = 0.6, effective strength = 0.7309115960124095
```

Immunization using Policy A, k=200
For beta = 0.2 and delta = 0.7, effective strength = 12.308842563118665
For beta = 0.01 and delta = 0.6, effective strength = 0.718015816181922
.....
Terminal Output:

```
Immunization using Policy A, k=200
For beta = 0.2 and delta = 0.7, effective strength = 12.308842563118215
For beta = 0.01 and delta = 0.6, effective strength = 0.7180158161818957
Simulation for Policy A

Immunization using Policy B, k=200
For beta = 0.2 and delta = 0.7, effective strength = 1.0802754802352497
For beta = 0.01 and delta = 0.6, effective strength = 0.06301606968038956
Simulation for Policy B

Immunization using Policy C, k=200
For beta = 0.2 and delta = 0.7, effective strength = 1.0845205395194362
For beta = 0.01 and delta = 0.6, effective strength = 0.06326369813863378
Simulation for Policy C

Immunization using Policy D, k=200
For beta = 0.2 and delta = 0.7, effective strength = 3.5392879901659318
For beta = 0.01 and delta = 0.6, effective strength = 0.20645846609301266
```

6. Report:

We have described our project along with the calculated metrics in the report named “P5 _Virus Propagation.pdf” which can be found in the home/base directory.