Assignment 5: Graph Partitioning

Spring 2016

100 points

Released: 4/7/2016

Due: 11:59pm, 4/21/2016

A. Problem

In this assignment, you will implement the Girvan-Newman (GN) algorithm for computing the betweenness of edges in a graph. Here, we consider the betweenness of an edge e as the sum of the fraction of shortest paths between nodes x and y that pass through e, over all pairs of nodes in the graph. The algorithm takes as the input a graph and outputs the betweeness for each edge in the graph. You may assume that the input graph is connected.

Recall that the GN algorithm works as follows.

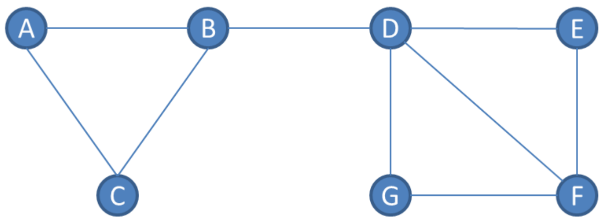
- **[Step A]** for each node X in the graph G,
  1. Run BFS, starting at the node X; form a DAG graph G' that contains edges between different levels of BFS.
  2. For each node Y in the graph, compute the number of shortest paths from X to Y. Recall that this is done by a top-down traversal of G'.
  3. Based on the results in step 2, for each edge e in G', compute the sum of the fraction of shortest paths from X that pass through e. Recall that this is done by a bottom-up traversal of G'.

- **[Step B]** for each edge e in the graph G,
  1. Sum up the fractions obtained in Step A for e.
  2. Divide the sum by 2 to give the betweeneness of e.

Name your script `firstname_lastname_Betweenness.py`.

A. Input format

The input graph will be provided in a JSON file where each line represents an edge in the graph. For example, the input for the graph below is as follows:



```
["a","b"]
["a","c"]
["b","c"]
["b","d"]
…
```

"a" and "b" are the nodes and each line represents an edge between the two nodes (in alphabetic order).

Note: you may make use of the networkx library to help present the graph/record edges & nodes; However, **DO NOT** use the betweenness function from networkx. It is the main purpose for this homework and you must implement the Girvan-Newman algorithm step-by-step on your own.

You can test your solution to this problem using the sample data file input1.json/input2.json:

```
Python firstname_lastname_Betweenness.py input1.json
```
(or: `Python firstname_lastname_Betweenness.py input2.json`)

B. Output format

You should print the betweenness of edges to stdout in a format as follows:

```
["a", "b"]: 5.0
["a", "c"]: 1.0
["b", "c"]: 5.0
["b", "d"]: 12.0
…
```

The order among edges (i.e. each line) is not important; however, you should sort every edge (i.e. node pair) in alphabetic order. That is, `["a", "b"]` instead of `["b", "a"]`.

Refer to output1.json/output2.json for sample output for this assignment.

C. Submission

Submit the following Python script:

```
firstname_lastname_Betweenness.py
```

DO NOT make it into .zip.

B. General Instructions:

1. Please submit your Python code with clear structure and comments for each module. Try to make the code modular and easy for the graders to go through, as it will help to give partial credits.
2. Make sure your code compiles before submitting
3. Make sure to follow the output format and the naming format.
4. Make sure not to write the output to any files. Use standard output to print them.
5. We will be using Moss for plagiarism detection.