Lab06-Graph Exploration

CS214-Algorithm and Complexity, Xiaofeng Gao, Spring 2019.

∗ If there is any problem, please contact TA Mingran Peng.

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1. Given a graph, find the number of Strongly Connected Components in the graph.

   (a) Complete the implementation in the provided C/C++ source code. Notice that in the source code there will be more detailed explanation.(The source code *SCC.cpp* is attached on the course webpage.)

   (b) Use the *Gephi* to draw the graph. If you think the data provided is not beautiful, you can generate your own data. Notice that result of *Gephi* will be taken into consideration of Best Lab.

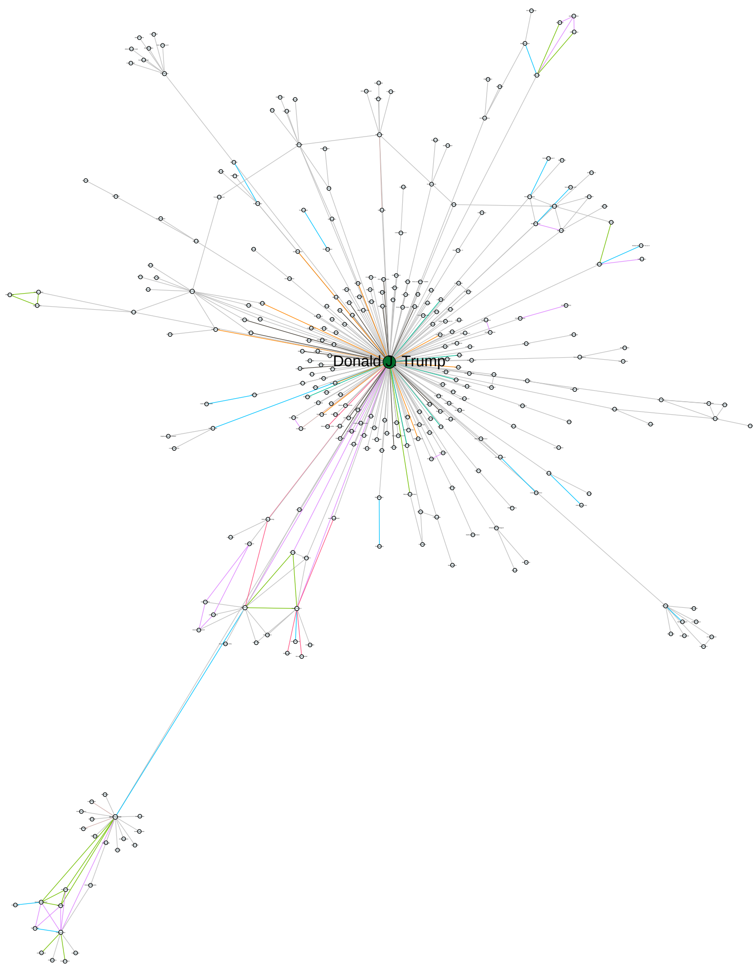

Figure 1: Trump World

Proof.

We use Gephi to show the network data for relationships President Donald Trump and other people. The full dataset can be accessed as a Google sheet and also includes information about organizations and agencies.

There are 303 nodes and 366 undirected edges. The nodes represent 303 different people, and the edges represented 366 unweighted relationships between those people.

And we use the degree of the node as a ranking of its label size. And the edge color represents different relationships as depicted in Figure 2.

Parent/child	(6.01%)
Siblings	(4.92%)
Married	(4.37%)
Special assistant	(4.37%)
Deputy assistant	(2.46%)
Business partners	(1.64%)
Member of Trump's Strategic and Policy forum	(1.64%)
Friends	(1.37%)
"Leader" in the transition team per CNN	(1.09%)

Figure 2: The relationship and corresponding color

□

2. Remember the lemma introduced in the course: : $\forall u, v \in V$, intervals $[PRE(u), POST(u)]$, $[PRE(v), POST(v)]$ are either disjoint or one is contained within the other.

   Prove the lemma.

   Proof.

   Assume w.l.o.g that $PRE(u) < PRE(v)$, then vertex u is visited before vertex v. And there are two different cases with u and v.

   (a) If $EXPLORE(G, v)$ invoked before $EXPLORE(G, u)$ finished, $POST(v) < POST(u)$ and one iterval is contained within the other.

   (b) If $EXPLORE(G, v)$ invoked after $EXPLORE(G, u)$ finished, $POST(u) < PRE(v)$ and two intervals are disjoint.

   So we have proved the correctness of the statement.

□

3. Consider there is a network consists n computers. For some pairs of computers, a wire exists in the pair, which means these two computers can communicate with delay t.

   Assume that computer s wants to issue a message to computer t, we want to know the minimum time needed to send this message.

   You need to provide the pseudo code and analyze the time complexity.

Proof.

Algorithm 1: Find-Min-Delay(G, s, t)

Input: A graph about the network, the source vertex s, the destination vertex t
Output: The minimum time needed to send from s to t

```
Min-time = 0 ;                                   /* The total delay time */
n = the number of vertices in graph G
dis[1..n] = ∞ ;                     /* Initialize the distance of each vertices */
dis[s] = 0
Q = [s] ;                                        /* Queue containing just s */
while Q is not empty do
    u = EJECT(Q)
    for edge(u, v) ∈ E do
        if DIST[v] == ∞ then
            INJECT(Q, v);
            dis[v] = dis[u] + 1
Min-time = dis[t] · t
output Min-time;
```

Notice that we can only use BFS to solve this problem, so the time complexity is $O(|V|+|E|)$. $|V|$ denoted the number of vertices and $|E|$ denoted the number of edges in the graph G. ☐

Remark: You need to include your .pdf and .tex files in your uploaded .rar or .zip file.