Jackson State University
Department of Computer Science
CSC 323 Algorithm Design and Analysis
Spring 2015
Instructor: Dr. Natarajan Meghanathan
Programming Project 3: Computing the Number of Paths of a Certain Length in a Graph using Matrix Multiplication

Due: March 5, 2015, 1 PM **Maximum Points: 100**

Project Description

In this project, you will implement the "Transform and Conquer" algorithm of determining the number of paths of certain length between any two nodes in a graph, using matrix multiplication. Each student is given a separate file comprising of the list of edges of the input graph. Your code should first read the edge file (assigned to you below) and construct an adjacency matrix. The code also inputs the number of nodes in the graph as well as the target path length. Your objective will be to compute the number of paths of the target path length between any two nodes. You will determine this through a series of matrix multiplications involving the adjacency matrix. For example if A is the adjacency matrix and if you are asked to find the number of paths of length 5 between any two nodes, you need to determine A^5. You will determine this sequentially by determining A^2 (= A*A), A^3 (=A^2 *A), A^4 (=A^3 *A) and A^5 (=A^4 *A).

Your program should print the contents of the adjacency matrix before performing the sequence of matrix multiplications and then print the contents of the matrix containing the values for the number of paths of the target path length. Run your program multiple times, and print the number of paths of path lengths 1, 2, 3, …, target path length assigned to you.

Student-Graph File

Student Name	***Graph File Name*, Targeted Path Length**
Leon Anderson	Graph1.txt, 4
Jeffery Taylor	Graph2.txt, 5
Jonathan Dallas	Graph3.txt, 3
Fred Clovis	Graph4.txt, 5
Andrew Villarrubia	Graph5.txt, 4
Raymond Triplett	Graph6.txt, 5

What to Submit:

1) Video: Record your explanation of the complete program and show the execution for the inputs specified above. You should explain your code to read the edges from the text file assigned to you and construct the graph, how you populate the adjacency matrix, the sequence of matrix multiplications and the logic behind it, and interpret the output. Your explanation should last for at least 7 minutes.
Share the video through Google Drive to my e-mail address: natarajan.meghanathan@jsums.edu
You could try using one of the **desktop recording software** (or anything of your choice): CamStudio: http://sourceforge.net/projects/camstudio/files/legacy/
Debut: http://www.nchsoftware.com/capture/index.html

2) Hard copy

- Complete Java code for the project

- Screenshots of the input adjacency matrix and the number of paths of particular length (varied from 2, 3, …, target path length assigned to you).
- Comment on the magnitude of increase that you observe for the number of paths as you increase the path length.

Pseudo Code for Matrix Multiplication:

ALGORITHM *MatrixMultiplication*$(A[0..n-1, 0..n-1], B[0..n-1, 0..n-1])$

```
//Multiplies two square matrices of order n by the definition-based algorithm
//Input: Two n × n matrices A and B
//Output: Matrix C = AB
for i ← 0 to n − 1 do
    for j ← 0 to n − 1 do
        C[i, j] ← 0.0
        for k ← 0 to n − 1 do
            C[i, j] ← C[i, j] + A[i, k] * B[k, j]
return C
```

Sample Output:

A sample execution screenshot for Graph7.txt with 6 nodes and path length 3 is shown below:

```
C:\3300-laptop\JSU-Teaching\Spring-Semesters\Spring2014\CSC323\Projects>java Gra
ph_MatrixMultiplication
Enter the name of your adjacency list file
Graph7.txt
Enter the number of nodes in your graph
6
Enter the path length you want to work with
3

 Input Adjacency Matrix

        0       1       2       3       4       5
0       0       1       0       1       1       0
1       1       0       1       1       0       0
2       0       1       0       1       1       1
3       1       1       1       0       1       0
4       1       0       1       1       0       0
5       0       0       1       0       0       0


Number of paths of length 3

        0       1       2       3       4       5
0       24      16      27      24      16      4
1       16      25      17      25      25      9
2       27      17      31      26      17      4
3       24      25      26      33      25      9
4       16      25      17      25      25      9
5       4       9       4       9       9       4

C:\3300-laptop\JSU-Teaching\Spring-Semesters\Spring2014\CSC323\Projects>
```