International Trade Network

5 August 2015

The size and structure of international trade flows varies significantly over time. This exercise is based in part on Luca De Benedictis and Lucia Tajoli. (2011). 'The World Trade Network.' *The World Economy*, 34:8, pp.1417-1454. The trade data are from Katherine Barbieri and Omar Keshk. (2012). *Correlates of War Project Trade Data Set*, Version 3.0. available at http://correlatesofwar.org.

The volume of goods traded between countries has grown rapidly over the past century, as technological advances lowered the cost of shipping and countries adopted more liberal trade policies. At times, however, trade flows have decreased due to disruptive events such as major wars and the adoption of protectionist trade policies. In this exercise, we will explore some of these changes by examining the network of international trade over several time periods. The data file `trade.csv` contains the value of exports from one country to another in a given year. The names and descriptions of variables in this data set are:

Name	Description
`country1`	Country name of exporter
`country2`	Country name of importer
`year`	Year
`exports`	Total value of exports (in tens of millions of dollars)

The data are given for years 1900, 1920, 1940, 1955, 1980, 2000, and 2009.

Question 1

We begin by analyzing international trade as an unweighted, directed network. For every year in the data set, create an adjacency matrix whose entry (i, j) equals 1 if country i exports to country j. If this export is zero, then the entry equals 0. We assume that missing data, indicated by `NA`, represents zero trade. Plot the 'network density', which is defined over time as follows,

$$\text{network density} = \frac{\text{number of edges}}{\text{number of potential edges}}$$

The `graph.density` function can compute this measure given an adjacency matrix. Interpret the result.

Question 2

For the years 1900, 1955, and 2009, compute the measures of centrality based on degree, betweenness, and closeness (based on total degree) for each year. For each year, list the five countries that have the largest values of these centrality measures. How do the countries on the lists change over time? Briefly comment on the results.

Question 3

We now analyze the international trade network as a weighted, directed network in which each edge has a non-negative weight proportional to its corresponding trade volume. Create an adjacency matrix for such network data. For the years 1900, 1955, and 2009, compute the centrality measures from above for the

weighted trade network. Instead of degree, however, compute the *graph strength*, which in this case equals the sum of imports and exports with all adjacent nodes. The `graph.strength` function can be used to compute this weighted version of degree. For betweenness and closeness, we use the same function as before, i.e., `closeness` and `betweenness`, which can handle weighted graphs appropriately. Do the results differ from those of the unweighted network? Examine the top five countries. Can you think of another way to calculate centrality in this network that accounts for the value of exports from each country? Briefly discuss.

Question 4

Apply the PageRank algorithm to the weighted trade network separately for each year. For each year, identify the 5 most influential countries according to this algorithm. In addition, examine how the ranking of PageRank values has changed over time for each of the following five countries – US, United Kingdom, Russia, Japan, and China. Briefly comment on the patterns you observe.