Flows and Network Package
Methodological paper n° 5 (December 2010)

Visualizing Networks

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In the 'Flows and Network' package, we focus on different types of relations between countries on a world scale (economic, political, financial, and diplomatic). Therefore, working with tools from 'Social Network Analysis' (SNA) seemed quite obvious. The aim of these methodological papers is to explain, as simply as possible, what is the principle, the vocabulary and the methods employed. Each paper will provide example taken from the EuroBroadMap project.

If the 'science of networks' became this last decade incredibly popular, the reason is quite simple; networks can provide readable images of a lot of social phenomena. From airflows to the internet structure or the structure of living entities, with some computer skills, even the more complex reality can be transformed in a simple (and often beautiful) image. This success has its drawback; the process used to produce images remains a black box barely explored.

A single fact must be reminded: from a mathematical point of view, a graph is a non empty set of finite nodes and a set of finite links. If the graph is valued or signed (see Methodological paper n°1), a third set gives the strength or the sign of the links. But in every case, its visual representation is irrelevant. Unfortunately, it's not exactly the case in social sciences where all images produced involve a given picture of a social fact.

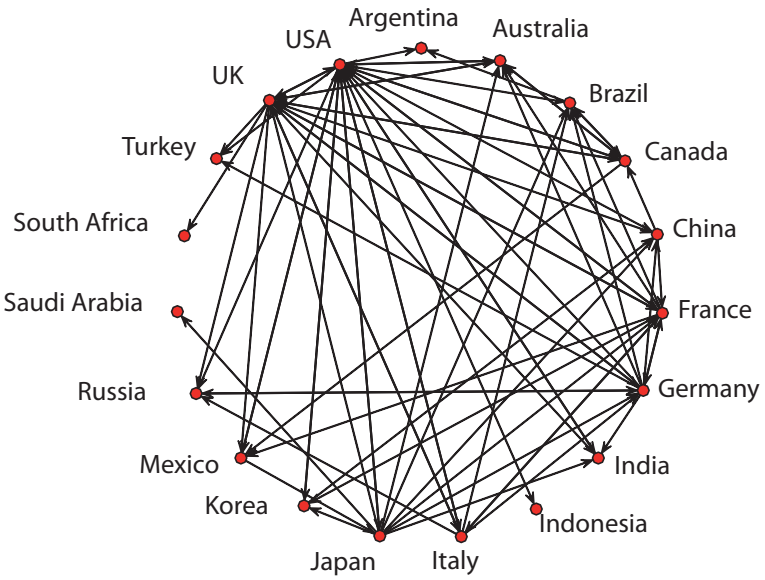
1. The way it looks

To illustrate our demonstration, let's take a small graph regarding Foreign Direct Investments between OECD countries[1]. On the following graphs, each relation involves a FDI flow greater than 500 Millions US$ in 2007. So the matrix is directed (*Fij* might be different from *Fji*) and binary (0, flow below 500 US$M - 1, flow equal or greater than 500US$M).
These graphs were made with R and the package 'statnet' . If the matrix remains the same, images produced deliver different messages[2].

[1] This matrix comes from the FDI database build at the ULB-IGEAT by Geoffrey Pion, 2009, *FDI database 2006-2008*, EuroBroadMap.
[2] An issue not treated here regards differences between softwares using the same algorithm but producing slightly different graphs.

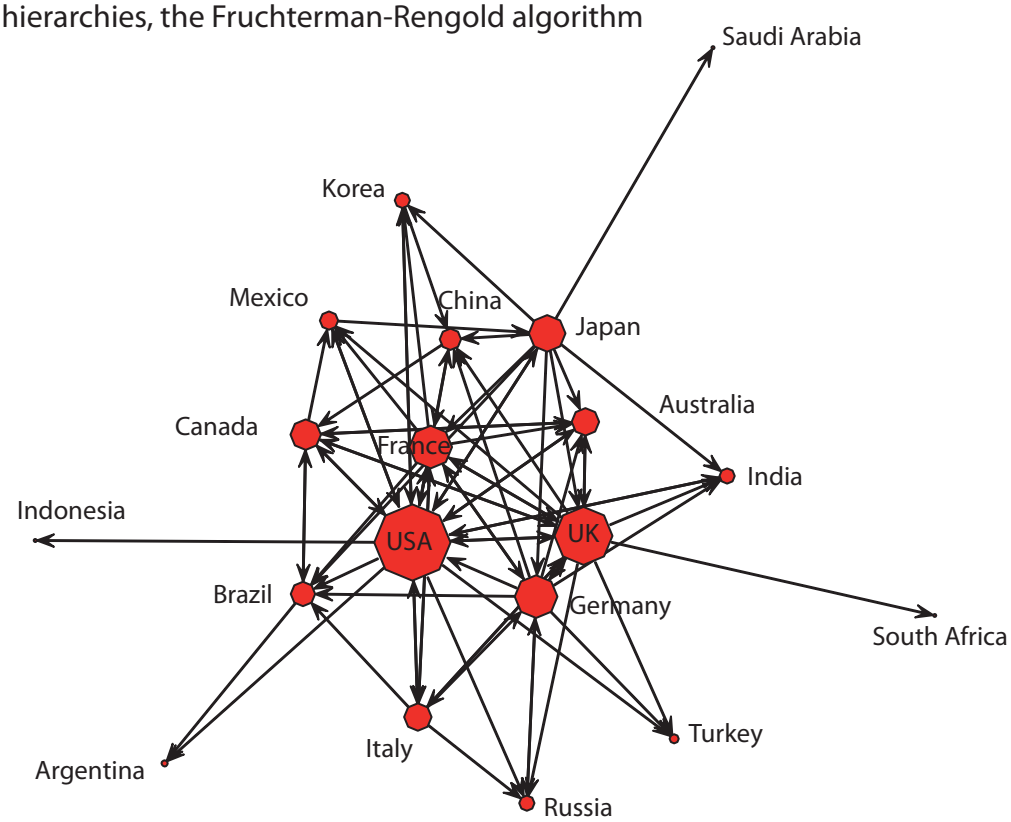
The figure 1 provides the result of one of the most simple algorithm used to position nodes: all are disposed on a circle. Softwares often place on the same side of the circle nodes more related with each other. Even if a gap between number ol links can be perceived, it provides an egalitarian view of relations.

Figure 1: Minoring relational discrepancies, the circle representation



Reversely, the figure 2 uses a more complex algorithm, frequently used, the Fruchterman-Reingold one. To highlight inegalies between countries, size of nodes is related to their respective degree. But the strating matrix remains the same...

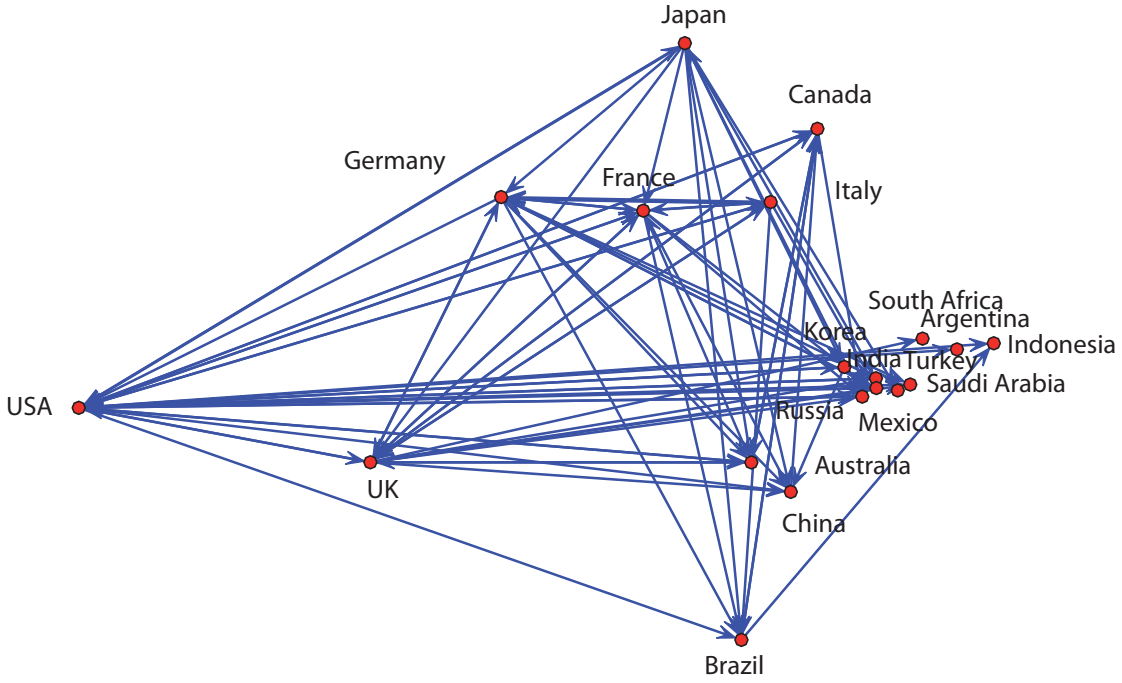
Figure 2: Highligthing hierarchies, the Fruchterman-Rengold algorithm

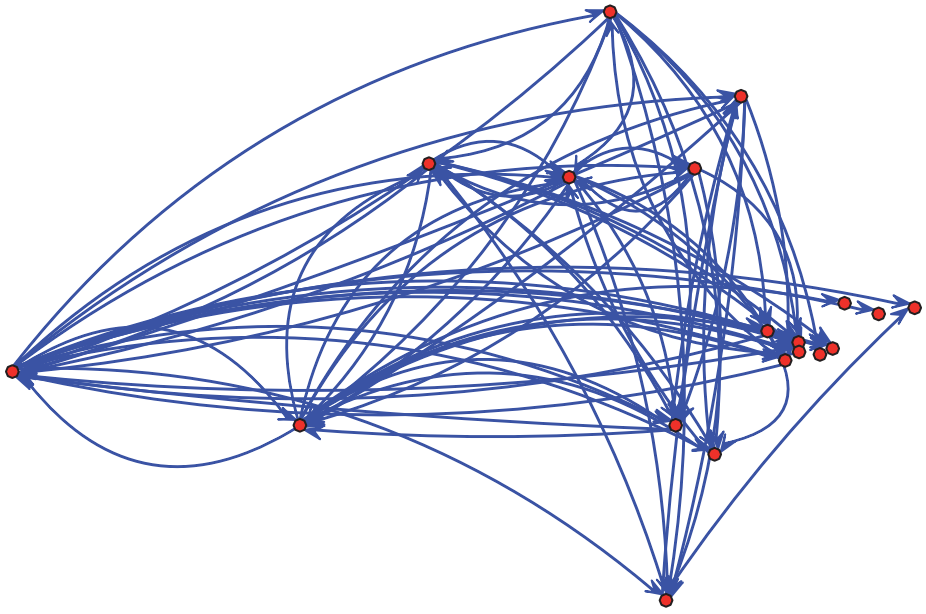


2. From aesthetic to reproducibility

Graphs, like maps, are selected and oriented images of a social phenomena. Authors barely indicate which algorithms they choose to represent their data. Few tricks are common and often used: the first one is to slightly move some nodes in order to improve the readability of the figure. Using color or size depending on some node (or link) attributes is a convenient way to deliver a message properly. In all cases, the images produced can't be reproduced… Unfortunately, the method using statistical method (notably the MDS) are not the ones which produce the 'more beautiful' graphs.

Figures 3 and 4: Same algorithm (MDS) and curves to improve the visual effect





To go further...

The reference collection regarding this issue is *Graph drawing* from Springer. It remains mostly technical and for programmers. The couple of papers on this topic deal with ways to improve readability of large graphs. But, to my knowledge, the equivalent of M. Monmonnier regarding graphs is not written yet.

V. Batagelj, A. Mrvar and M. Zaveršnik, M., 1999, Partitioning Approach to Visualization of Large Graphs, *Graph Drawing*, Springer, p.90-97. (http://vlado.fmf.uni-lj.si/pub/networks/doc/part/CorePart.pdf)
L. Freeman, 2000, 'Visualizing Social Networks', *Journal of Social Structure*, 1(1) (http://www.cmu.edu/joss/content/articles/volume1/Freeman.html)
M. Monmonier, 1996 (2ed.), *How to Lie with Maps*, University of Chicago Press.
M. Withall, I. Phillips and D. Parish, 2007, 'Network visualization: A review', *Communications*, IET, 1(3), p.365-372.

Figures realized with the 'statnet' package: Mark S. Handcock, David R. Hunter, Carter T. Butts, Steven M. Goodrea, Pavel N. Krivitsky and Martina Morris , 2003, statnet: Software Tools for the Statistical Modeling of Network Data, version 2.1-1. Project home page at http://statnet.org

The following program can be copied and pasted in the R software to reproduce figures from pages 2-3 (except label positions).

```
#Depending on the system you're working on, you might obtain results
#slightly different from the figures proposed in the methodological paper

#initialisation
rm(list=ls())
library(statnet)
g<-read.paj(file=»dataset_mp5.net»)

#Circle (figure 1)
gplot(g, gmode=»digraph», mode=»circle», displaylabels=TRUE, label.
cex=0.8)

#fruchtermanreingold + size related to degree (figure 2)
gplot(g, gmode=»digraph», mode=»fruchtermanreingold»,
displaylabels=TRUE, label.cex=0.7, vertex.cex=degree(g)/6)

#MDS - straight edges (figure 3)
gplot(g, gmode=»digraph», mode=»mds», displaylabels=TRUE, label.cex=0.7,
vertex.cex=0.7, edge.col=»blue», edge.cex=0.3)

#MDS - curve edges (figure 4)
gplot(g, gmode=»digraph», mode=»mds», displaylabels=TRUE, label.cex=0.7,
vertex.cex=0.7, edge.col=»blue», edge.cex=0.3, usecurve=TRUE)
```

✓ **Coming next:** Methodological paper n°6 - World-Trade and Social Network Analysis (Feb. 2011)