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Netzcope - A Tool to Display and Analyze Complex Networks

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1 Introduction

Netzcope is intended as a user-friendly tool to display complex networks and to exhibit details of their structure. It is originally geared to analyzing collaborative research networks of "*organizations*" collaborating via joint "*projects*" under the auspices of EU Framework Programmes FP1 to FP6 [2]. These generate bipartite graphs with some 10^4 vertices of each type, and up to 10^5 edges between them.

2 Features

1. Netzcope first extracts the connected components of the network.
Then for any chosen component it
2. produces a 2D plot of the network in accordance with these proximities, with various options. In particular pointing onto nodes, their labels and those of their neighbors are read out.
3. displays the adjacency matrix graphically
4. re-orders the nodes according to their strength of interaction (algebraic connectivity, as given by the "Fiedler vector" [4]) thus transforming an initial (e.g. alphabetical) listing into one with enhanced proximity of successive
5. finds communities within the network following Newman [5], and
6. calculates the corresponding modularity which describes the quality of the decomposition into communities
7. uses the BRIM algorithm [3] to enhance the modularity

8. produces a scatter plot of nodes in a community w.r. to the number of their internal vs. external lines which allows to identify central players and gate keepers
9. displays the composition of communities in terms of frequency inside any community, of labels attached to the nodes.
10. displays the graph portrait following Bagrow et al. [1], which exhibits the distribution of degrees, i.e. number of neighbors, but also numbers of next-to-nearest neighbors, etc. and finally the diameter of the network
11. exhibits degree and eigenvalue centralities.

3 How To

To obtain the Netzcope software for WINDOWS go to the website
<http://193.136.232.58/code/bin/netzcope/win32/>

Click on
 netzcope_demo.exe

This should produce a program "netzcope_demo" on your desktop. Run it to create a folder with the same name. Inside this folder you find the program "netzcope" which you open by a double click.

The menu "File" has an item "Load network" which will accept bipartite networks in Pajek format with less than 10^6 vertices. A number of examples are available in the folder "netzcope_demo", as "*.net"-files..

Load one of them. The program will list first the total network, then the connected components, numbered 1,2,... and ordered by size, each in one line.

Right-click on one line (except the 1st one which is pertinent to the whole graph), and a menu of options opens for this component.

1. To draw the network, choose "2D plot". The nodes O are colored according to their labels ("subject indices"). Pointing with the mouse, Netzcope reads out the organizations and, in the box below, the projects that they are involved in.
2. Choosing "adjacency matrix", Netzcope displays the projected adjacency matrix for the nodes of type O as given by the Pajek listing
3. Choosing "Fiedlerize" does just that; the re-ordered adjacency matrix reveals structural information which, again, you can explore by pointing with the mouse.
4. To obtain the community structure for the biggest component,
 - (a) choose "Find BP modules". This will create a folder labelled by 5 numbers the last of which is the modularity Q of the best decomposition.

- (b) In the "Toolbar" menu choose "Communities' statistics"
- (c) In the window which opens, choose the folder created above.
- (d) A number of files appear with labels containing "xc". x is the number of communities. Click on the file with the preferred number of communities to display it in Netzcope

With the vertical scale you can zoom in and out. With the horizontal scale you rotate. Play with "Labels' fuzziness" to have more or less labels written to the communities.

5. Now you find in the folder netzcope_demo files which carry the name of the loaded network followed by a number.io , the number is that of a community. Click to open and find a scatter plot of internal versus external links for the members of this community: small "degree inside" and large "degree out" is characteristic of gatekeepers, the converse signals central players.
6. There are also files labelled "histogram". They serve to display (in red) the subject index distribution for a given community. Large values of d_c in a histogram (lower left corner!) indicate a large degree of specialization (in comparison with the overall thematic spectrum - grey - in the FP).
7. Right-clicking on a community in the display obtained by the procedure 4. (d) above allows you to save the (internal) network of this community as a new .net-file which you can then analyze like the original one (and so forth by iteration).

(to be continued)

4 ToDo

- Histograms for geographic distribution
- Histograms for organization types
- Shortcut to 2D display of a community
- Shortcut to community structure of a community
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5 Limitations

At this point NetzCope opens only one network in one session.
 (...labels, bipartite, number of vertices, ...)

References

- [1] J. P. Bagrow, E. M. Bollt, J. D. Skufca, and D. ben-Avraham: Portraits of Complex Networks. <http://arxiv.org/abs/cond-mat/0703470v1>
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- [4] M. Fiedler, Algebraic connectivity of graphs. *Czech. Math. J.* 23 (98) (1973), 298-305.
- [5] M. E. J. Newman, Finding community structure in networks using the eigenvectors of matrices.