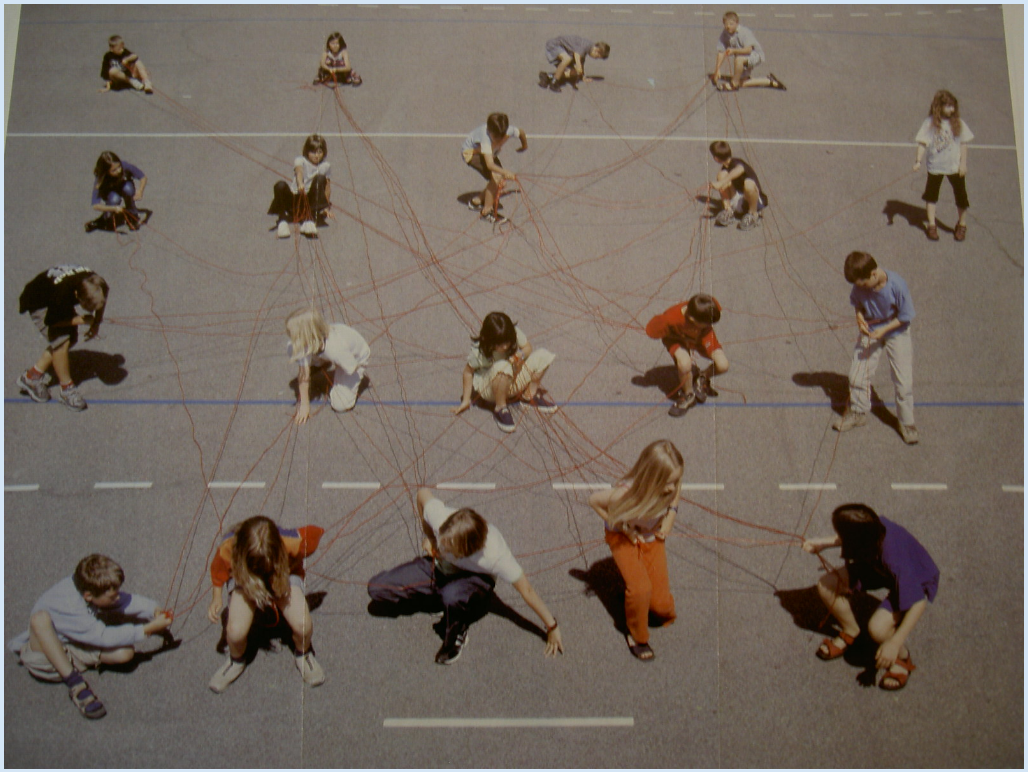

Visualization of large networks and Pajek

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Slovenia

Workshop on Complex objects visualization
November 16-19, 2005, Koper, Slovenia

Outline

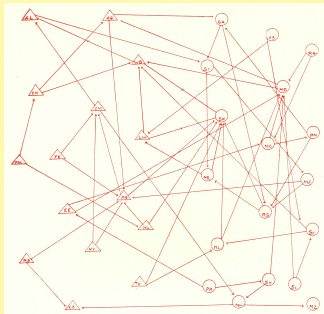
Networks in social sciences

Moreno

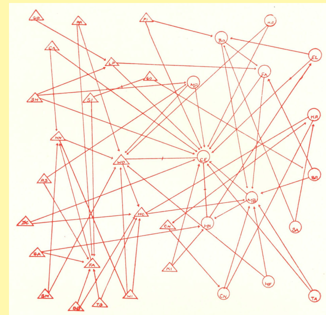
The use of networks was introduced in sociology by Moreno developing the sociometry (1934, 1953, 1960). An overview of visualization of social networks was prepared by Lin Freeman (1, 2).

Moreno: Who shall survive?

K:



1:



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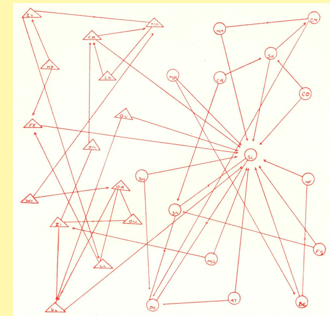

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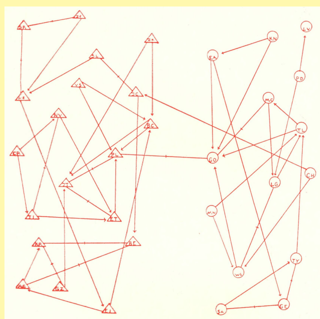

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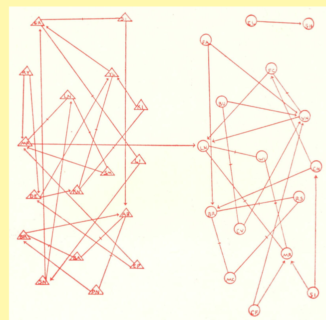

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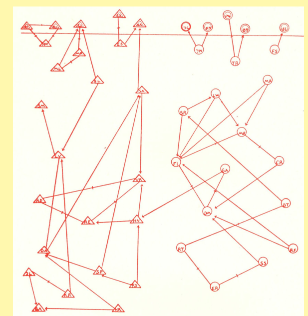

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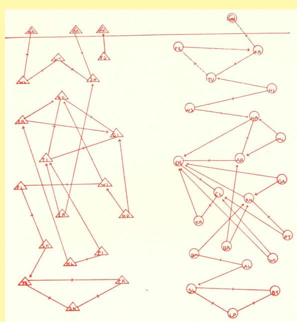

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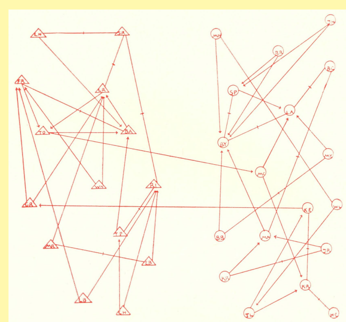

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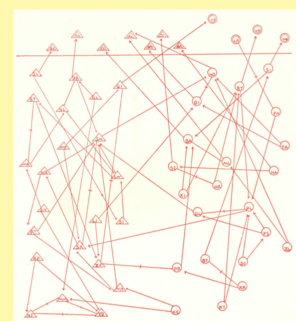
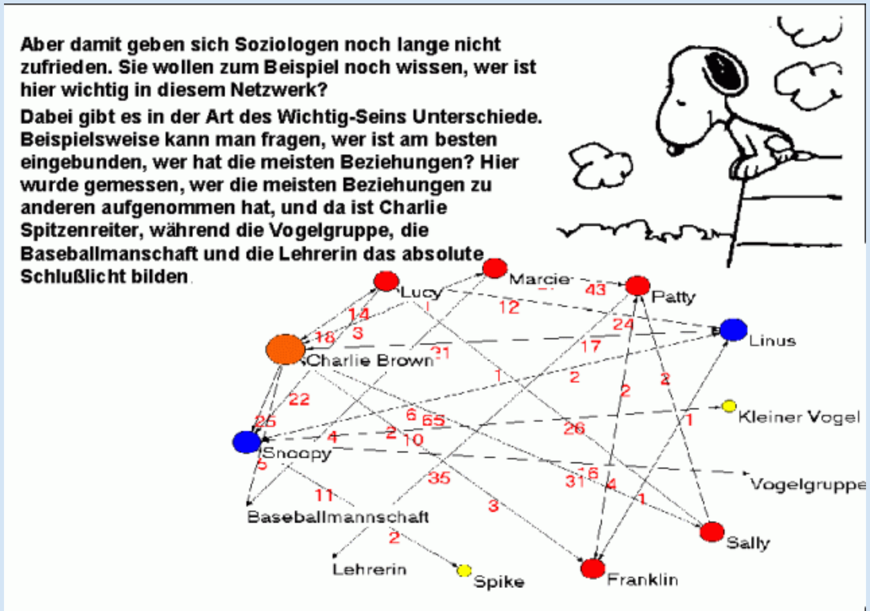


Networks



Alexandra Schuler/ Marion Laging-Glaser:
Analyse von Snoopy Comics

A *network* is based on two sets – set of *vertices* (nodes), that represent the selected *units*, and set of *lines* (links, ties), that represent *relations* between units. They determine a *graph*. A line can be *directed* – an *arc*, or *undirected* – an *edge*.

Additional data about vertices or lines can be known – their *properties* (attributes). For example: name/label, type, value, . . .

Network = Graph + Data

The data can be measured or computed.

Networks / Formally

A *network* $\mathbf{N} = (\mathcal{V}, \mathcal{L}, \mathcal{P}, \mathcal{W})$ consists of:

- a *graph* $\mathcal{G} = (\mathcal{V}, \mathcal{L})$, where $\mathcal{V}$ is the set of vertices, $\mathcal{A}$ is the set of arcs, $\mathcal{E}$ is the set of edges, and $\mathcal{L} = \mathcal{E} \cup \mathcal{A}$ is the set of lines. $n = \mathrm{card}(\mathcal{V})$, $m = \mathrm{card}(\mathcal{L})$
- $\mathcal{P}$ *vertex value functions* / properties: $p : \mathcal{V} \to A$
- $\mathcal{W}$ *line value functions* / weights: $w : \mathcal{L} \to B$

Types of networks

Besides ordinary (directed, undirected, mixed) networks some extended types of networks are also used:

- *2-mode networks*, bipartite (valued) graphs – networks between two disjoint sets of vertices.
- *multi-relational networks*.
- *temporal networks*, dynamic graphs – networks changing over time.
- specialized networks: representation of genealogies as *p-graphs*; *Petri's nets*, ...

The network (input) file formats should provide means to express all these types of networks. All interesting data should be recorded (respecting privacy).

Deep South

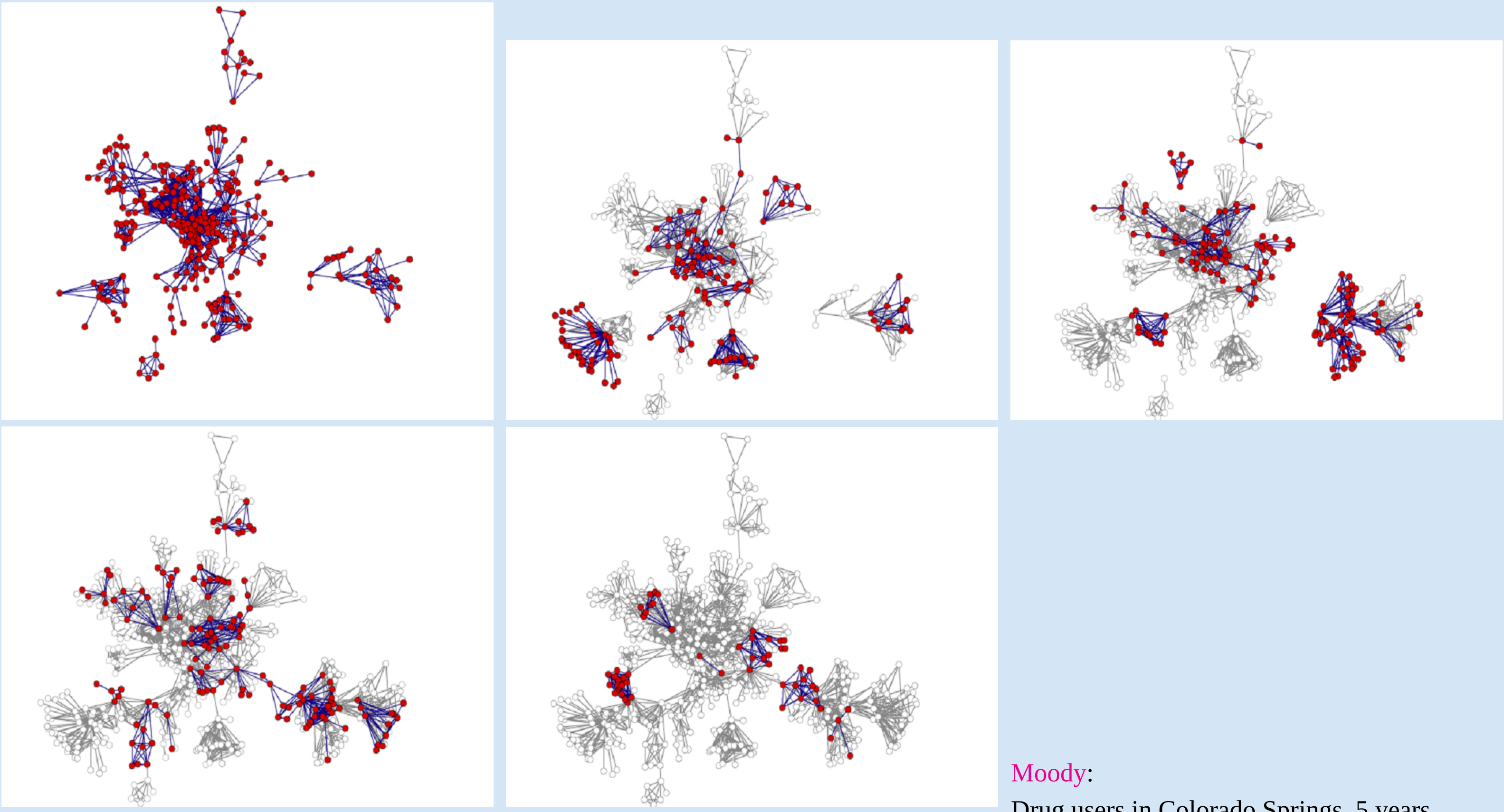
Classical example of two-mode network are Southern women (Davis 1941).

Davis.paj. Freeman's overview.

Names of Participants of Group I	Code Numbers and Dates of Social Events Reported in *Old City Herald*													
	(1) 6/27	(2) 3/2	(3) 4/12	(4) 9/26	(5) 2/25	(6) 5/19	(7) 3/15	(8) 9/16	(9) 4/8	(10) 6/10	(11) 2/23	(12) 4/7	(13) 11/21	(14) 8/3
1. Mrs. Evelyn Jefferson	×	×	×	×	×	×	....	×	×	....	....	....	....	....
2. Miss Laura Mandeville	×	×	×	....	×	×	×	×	....	....	....	....	....	....
3. Miss Theresa Anderson	....	×	×	×	×	×	×	×	×	....	....	....	....	....
4. Miss Brenda Rogers	×	....	×	×	×	×	×	×	....	....	....	....	....	....
5. Miss Charlotte McDowd	....	....	×	×	×	....	×	....	....	....	....	....	....	....
6. Miss Frances Anderson	....	....	×	....	×	×	....	×	....	....	....	....	....	....
7. Miss Eleanor Nye	....	....	....	....	×	×	×	×	....	....	....	....	....	....
8. Miss Pearl Oglethorpe	....	....	....	....	....	×	....	×	×	....	....	....	....	....
9. Miss Ruth DeSand	....	....	....	....	×	....	×	×	×	....	....	....	....	....
10. Miss Verne Sanderson	....	....	....	....	....	....	×	×	×	....	....	×	....	....
11. Miss Myra Liddell	....	....	....	....	....	....	....	×	×	×	....	×	....	....
12. Miss Katherine Rogers	....	....	....	....	....	....	....	×	×	×	....	×	×	×
13. Mrs. Sylvia Avondale	....	....	....	....	....	....	×	×	×	×	....	×	×	×
14. Mrs. Nora Fayette	....	....	....	....	....	×	×	....	×	×	×	×	×	×
15. Mrs. Helen Lloyd	....	....	....	....	....	....	×	×	....	×	×	×	....	....
16. Mrs. Dorothy Murchison	....	....	....	....	....	....	....	×	×	....	....	....	....	....
17. Mrs. Olivia Carleton	....	....	....	....	....	....	....	....	×	....	×	....	....	....
18. Mrs. Flora Price	....	....	....	....	....	....	....	....	×	....	×	....	....	....

Temporal networks

In a *temporal network* the presence/activity of vertex/line can change through time. Two types of descriptions of temporal networks are used – based on *presence* and based on *events*.



Moody:
Drug users in Colorado Springs, 5 years

Multi-relational temporal network – KEDS/WEIS

```
% Recoded by WEISmonths, Sun Nov 28 21:57:00 2004
% from http://www.ku.edu/~keds/data.dir/balk.html
*vertices 325
1 "AFG" [1-*]
2 "AFR" [1-*]
3 "ALB" [1-*]
4 "ALBMED" [1-*]
5 "ALG" [1-*]
 ...
318 "YUGGOV" [1-*]
319 "YUGMAC" [1-*]
320 "YUGMED" [1-*]
321 "YUGMTN" [1-*]
322 "YUGSER" [1-*]
323 "ZAI" [1-*]
324 "ZAM" [1-*]
325 "ZIM" [1-*]
*arcs :0 "*** ABANDONED"
*arcs :10 "YIELD"
*arcs :11 "SURRENDER"
*arcs :12 "RETREAT"
 ...
*arcs :223 "MIL ENGAGEMENT"
*arcs :224 "RIOT"
*arcs :225 "ASSASSINATE TORTURE"
*arcs
224: 314 153 1 [4]                890402  YUG     KSV     224  (RIOT)  RIOT-TORN
212: 314 83 1 [4]                 890404  YUG     ETHALB  212  (ARREST PERSON) ALB ETHNIC JAILED IN YUG
224: 3 83 1 [4]                   890407  ALB     ETHALB  224  (RIOT)  RIOTS
123: 83 153 1 [4]                 890408  ETHALB  KSV     123  (INVESTIGATE)   PROBING
 ...
42: 105 63 1 [175]                030731  GER     CYP     042  (ENDORSE)       GAVE SUPPORT
212: 295 35 1 [175]               030731  UNWCT   BOSSER  212  (ARREST PERSON) SENTENCED TO PRISON
43: 306 87 1 [175]                030731  VAT     EUR     043  (RALLY) RALLIED
13: 295 35 1 [175]                030731  UNWCT   BOSSER  013  (RETRACT)       CLEARED
121: 295 22 1 [175]               030731  UNWCT   BAL     121  (CRITICIZE)     CHARGES
122: 246 295 1 [175]              030731  SER     UNWCT   122  (DENIGRATE)     TESTIFIED
121: 35 295 1 [175]               030731  BOSSER  UNWCT   121  (CRITICIZE)     ACCUSED
```

Kansas Event Data System *KEDS*

Size of Networks

The size of a network/graph is expressed by two numbers: number of vertices $n = |\mathcal{V}|$ and number of lines $m = |\mathcal{L}|$.

In a *simple undirected* graph (no parallel edges, no loops) $m \leq \frac{1}{2}n(n-1)$; and in a *simple directed* graph (no parallel arcs) $m \leq n^2$. The quotient $\gamma = \frac{m}{m_{max}}$ is a *density* of graph. In large networks more intuitive density measure is the *average degree* $\bar{d} = \frac{1}{n}\sum_{v \in V} deg(v) = \frac{2m}{n}$.

Small networks (some tens vertices) – can be represented by a picture and analyzed by many algorithms (***UCINET***, ***NetMiner***).

Also *middle size* networks (some hundreds vertices) can still be represented by a picture (!?), but some analytical procedures can't be used.

Till 1990 most networks were small – they were collected by researchers using surveys, observations, archival records, ... The advances in IT allowed to create networks from the data already available in the computer(s). Large networks became reality.

Large Networks

Large network – several thousands or millions of vertices. Can be stored in computer's memory – otherwise *huge* network.

Usually sparse $m \ll n^2$; typical: $m = O(n)$ or $m = O(n \log n)$.

Examples:

network	size	$n = \|V\|$	$m = \|L\|$	source
ODLIS dictionary	61K	2909	18419	ODLIS online
Citations SOM	168K	4470	12731	Garfield's collection
Molecula 1ATN	74K	5020	5128	Brookhaven PDB
Comput. geometry	140K	7343	11898	BiBTEX bibliographies
English words 2-8	520K	52652	89038	Knuth's English words
Internet traceroutes	1.7M	124651	207214	Internet Mapping Project
Franklin genealogy	12M	203909	195650	Roperld.com gedcoms
World-Wide-Web	3.6M	325729	1497135	Notre Dame Networks
Actors	3.9M	392400	1342595	Notre Dame Networks
US patents	82M	3774768	16522438	Nber
SI internet	38M	5547916	62259968	Najdi Si

Pajek

Large networks are too big to be displayed in details; special algorithms are needed for their analysis.

Pajek is a program, for Windows, for analysis and visualization of *large networks* having some ten or houndred of thousands of vertices.

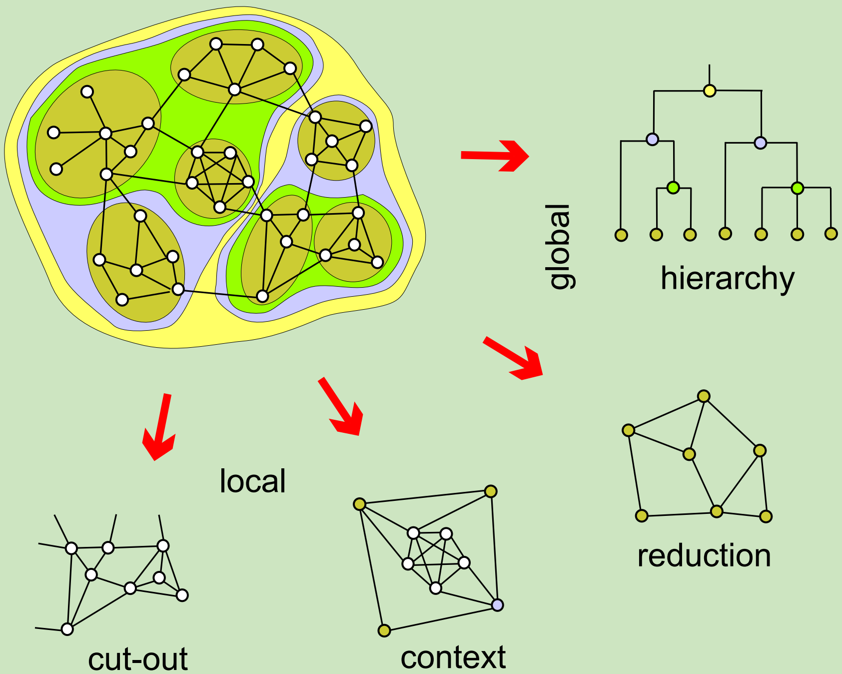
In Slovenian language *pajek* means spider.

The latest version of **Pajek** is freely available, for noncommercial use, at its home page:

http://vlado.fmf.uni-lj.si/pub/networks/pajek/

Book: W. de Nooy, A. Mrvar, V. Batagelj: *Exploratory Social Network Analysis with Pajek*, CUP, 2005. Amazon. ESNA page.

Main design goals

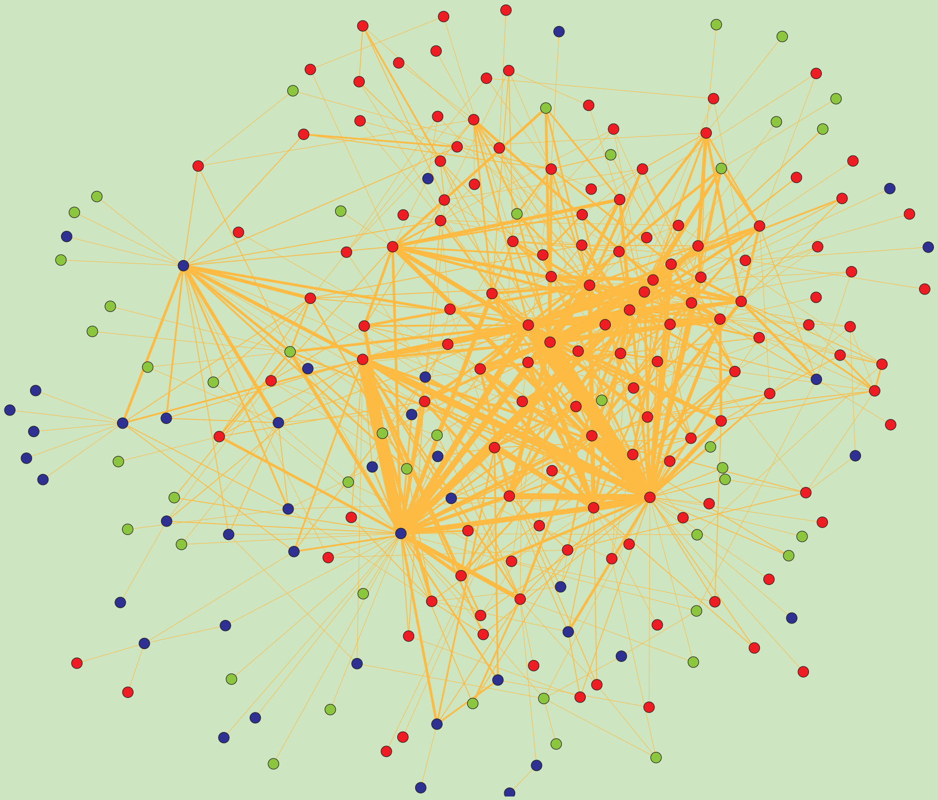


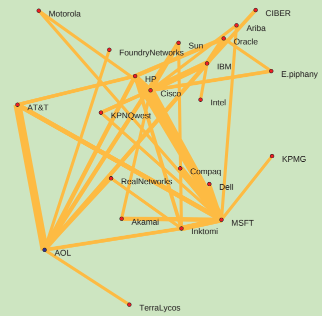
The main goals in the design of **`Pajek`** are:

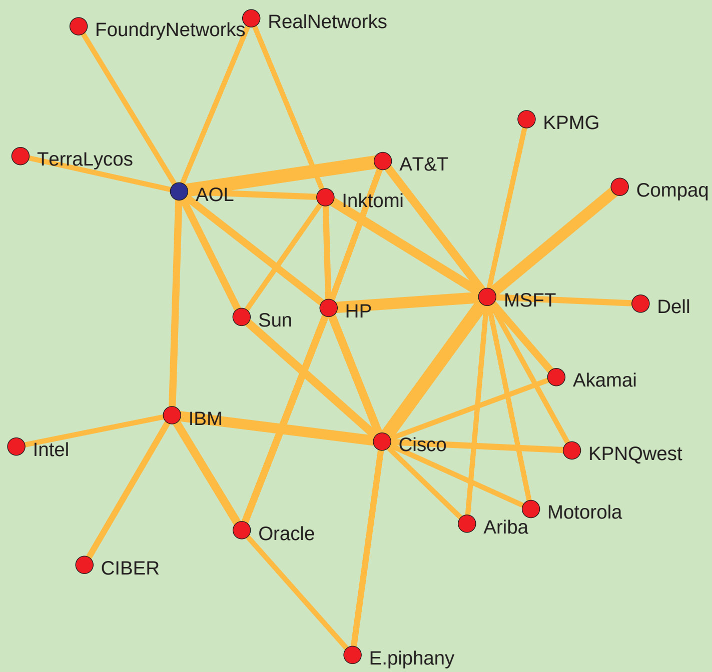
- to support abstraction by (recursive) *decomposition* of a large network into several smaller networks that can be treated further using more sophisticated methods;
- to provide the user with some powerful *visualization* tools;
- to implement a selection of efficient *subquadratic* algorithms for analysis of large networks.

With **`Pajek`** we can: *find* clusters (components, neighbourhoods of 'important' vertices, cores, etc.) or patterns (motifs) in a network, *extract* vertices that belong to the same clusters and *show* them separately, possibly with the parts of the context (detailed local view), *shrink* vertices in clusters and show relations among clusters (global view).

Line-cut: Krebs Internet Industries, $w_3 \geq 5$







Representations of properties

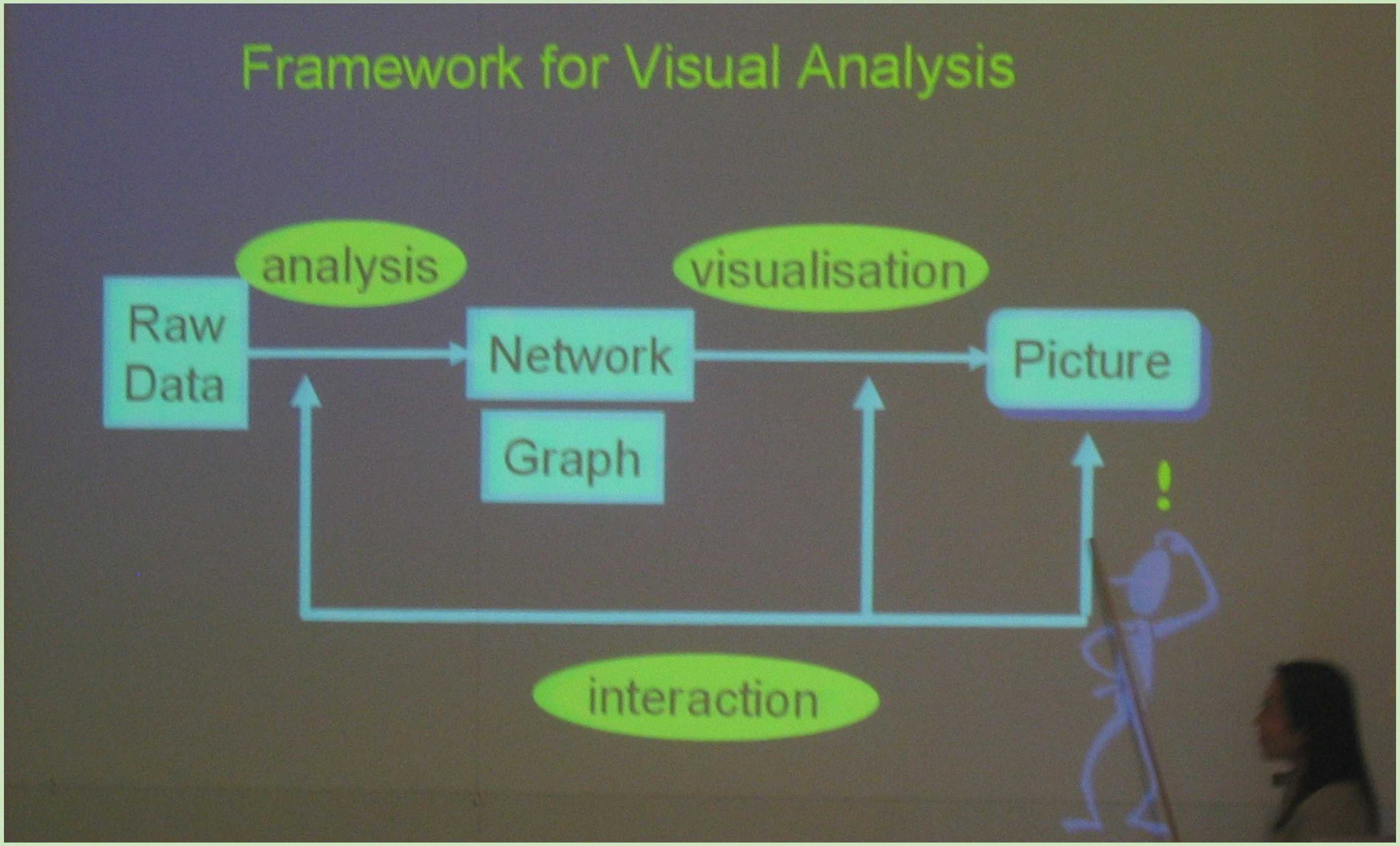
Properties of vertices $\mathcal{P}$ and lines $\mathcal{W}$ can be measured in different scales: numerical, ordinal and nominal. They can be *input* as data or *computed* from the network.

In **Pajek** numerical properties of vertices are represented by *vector*s, nominal properties by *partitions* or as *label*s of vertices. Numerical property can be displayed as *size* of vertex (figure), as its *coordinate*; and a nominal property as *color* or *shape* of the figure, or as a vertex *label*.

We can assign in **Pajek** numerical values to links. They can be displayed as *value*, *thickness* or *grey level*. Nominal vales can be assigned as *label*, *color* or *line pattern* (see Pajek manual, section ***4.3***).

Analysis and Visualization

The network visualization is an iterative process that combines analysis and creation of layouts.



Some comments

While the technical graph drawing problems could ask for a single 'the best' picture, the social network analysis is a part of data analysis. Its goal is to get insight into the structure and characteristics of a given network, but also how it influences related social processes.

What is the goal: exploration of network data (*layout editor*), presentation of the obtained results (*layout viewer*), . . . ?

What is a GD result: picture or layout ?

What is the medium of the result: static picture on 'paper', interactive layout, . . . ?

What kind of user will use the result: simple, advanced, . . . ?

Most methods are 'paper' oriented. In larger/denser networks there is often too much information to be presented at once. A possible answer are interactive layouts where the user controls what (s)he wants to see.

Sociograph

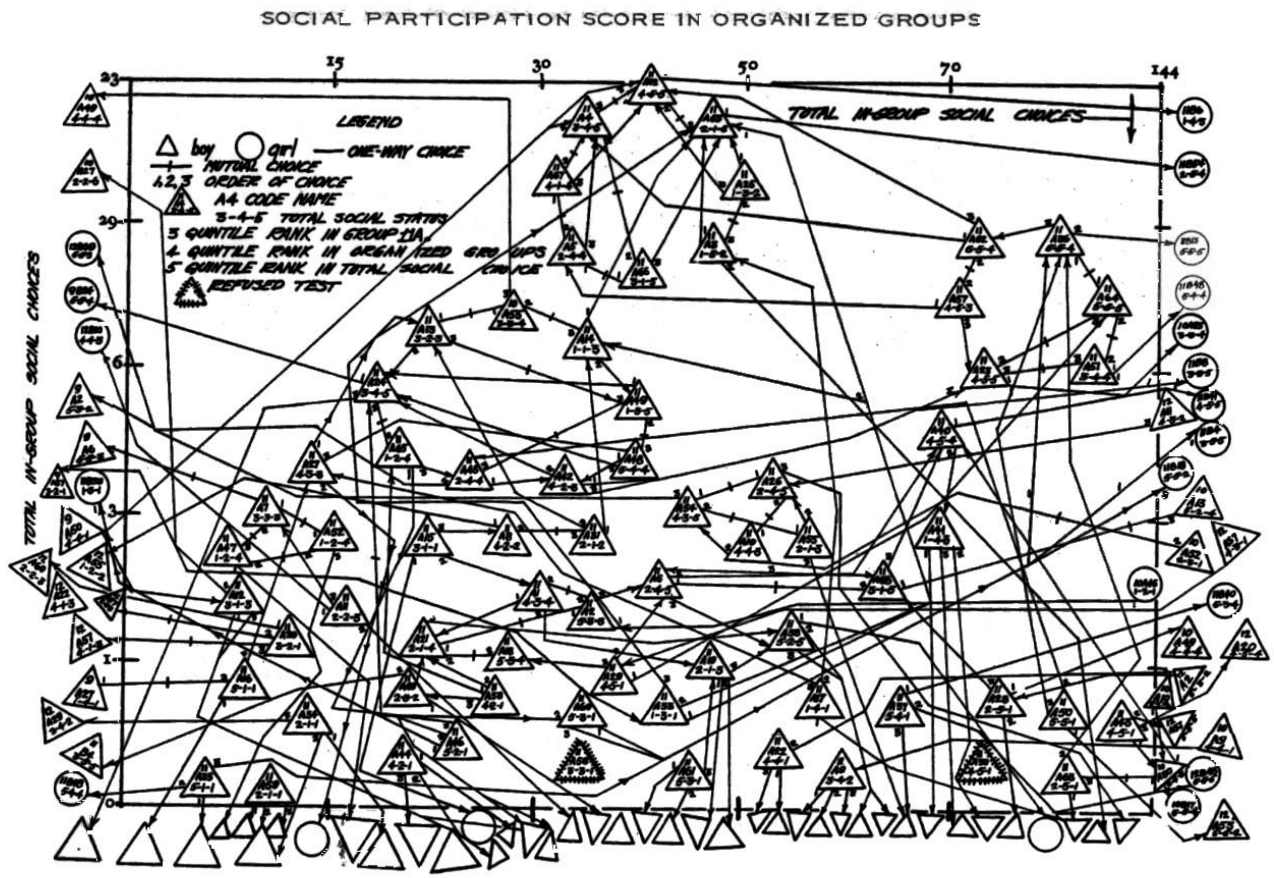
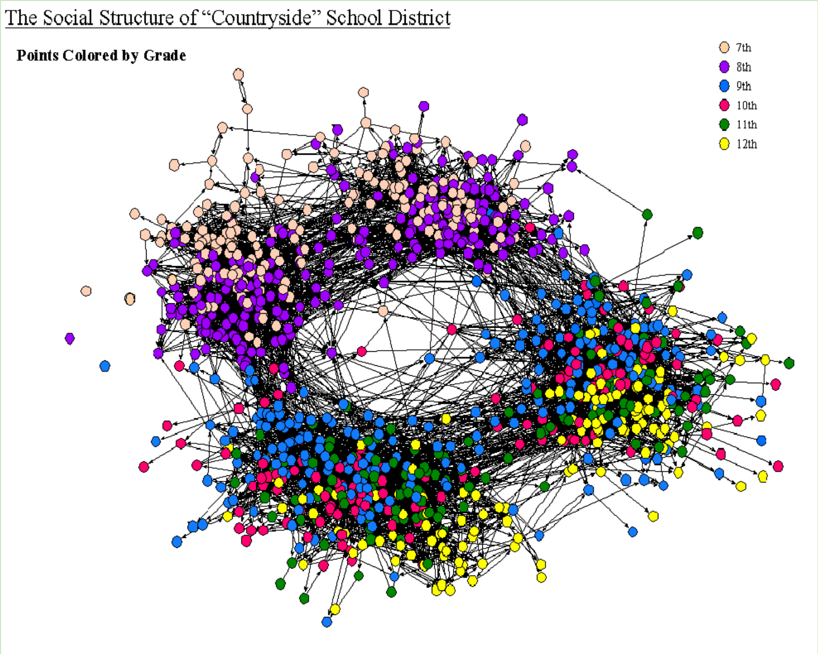
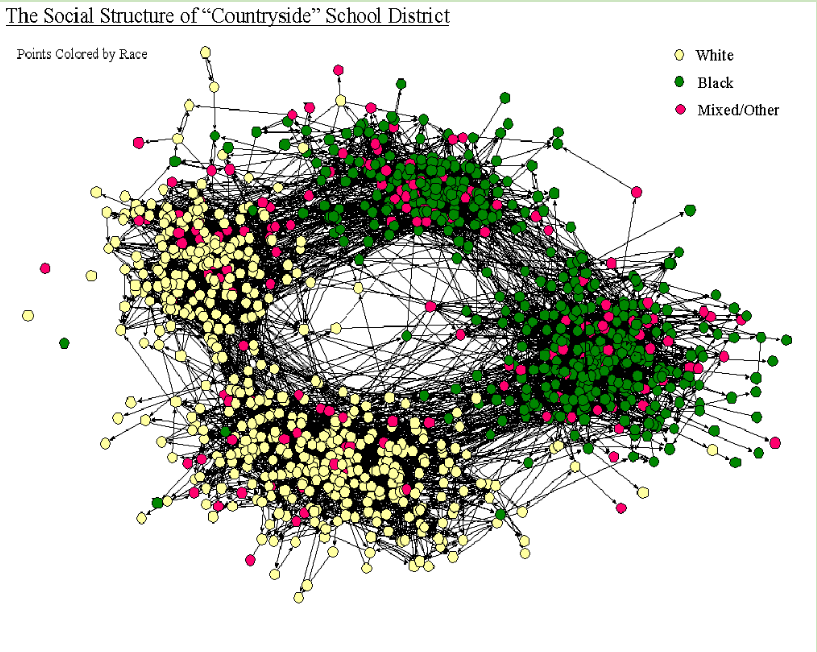


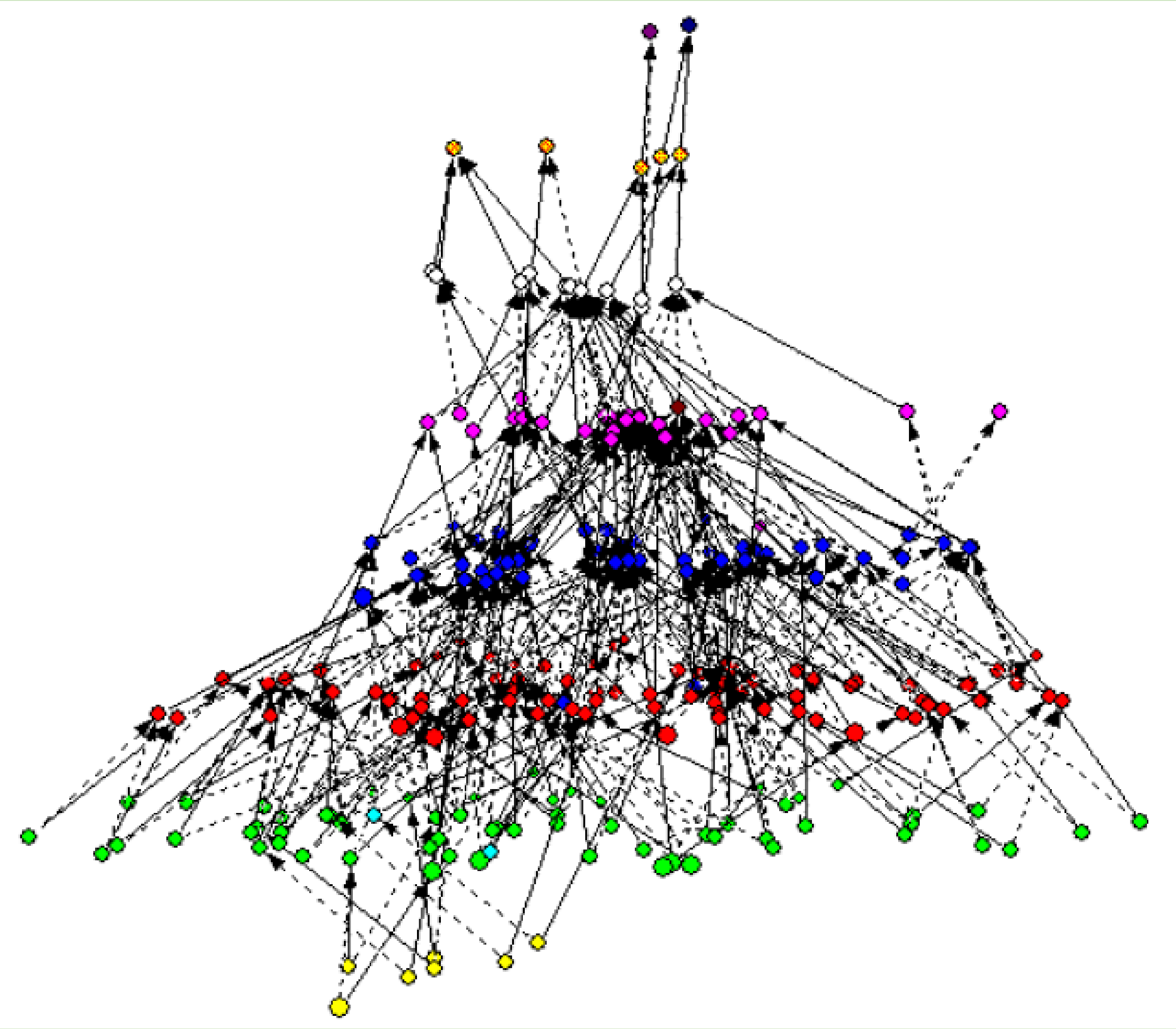
FIGURE 3. GROUP 11A. A SOCIAL STATUS SOCIOGRAPH OF THE 68 BOYS OF THE 11TH GRADE. IT SHOWS QUINTILE POSITIONS FOR: (1) GRADE AVERAGE, (2) SOCIAL PARTICIPATION SCORES IN STUDENT ORGANIZATIONS, AND (3) TOTAL FRIENDSHIP CHOICES ON A SOCIOMETRIC TEST (TOTAL CHOICES INCLUDE DIRECT AND INDIRECT CHOICES). THE STUDENT'S POSITION ON THE CHART IS THAT OF HIS CLIQUE GROUP AVERAGE FOR BOTH SOCIAL PARTICIPATION SCORES AND TOTAL FRIENDSHIP CHOICES. OUT-OF-CLASS CHOICES APPEAR IN THE SIDE MARGIN; OUT-OF-SCHOOL CHOICES IN THE LOWER MARGIN.

James Moody: Display of properties – school

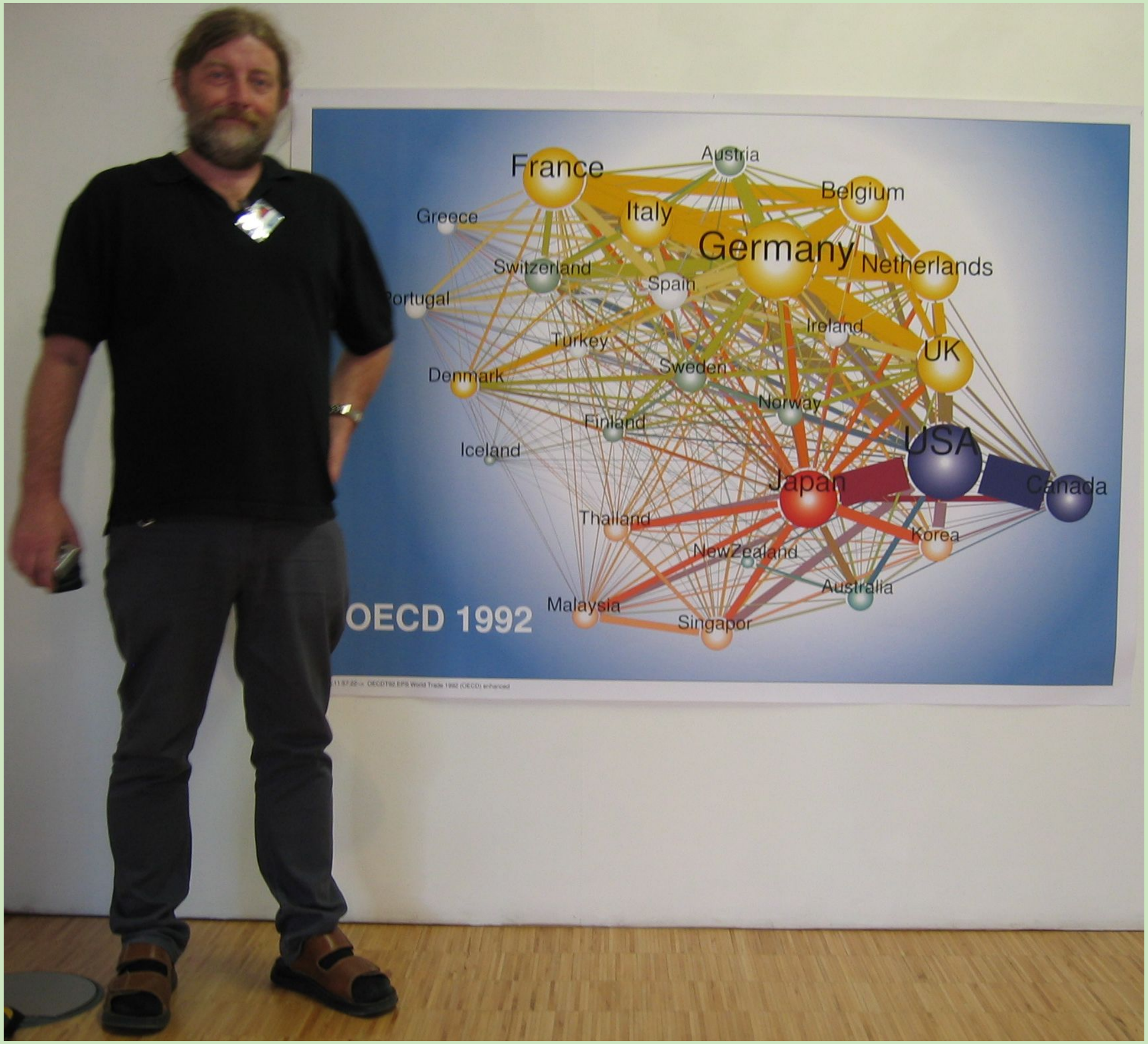




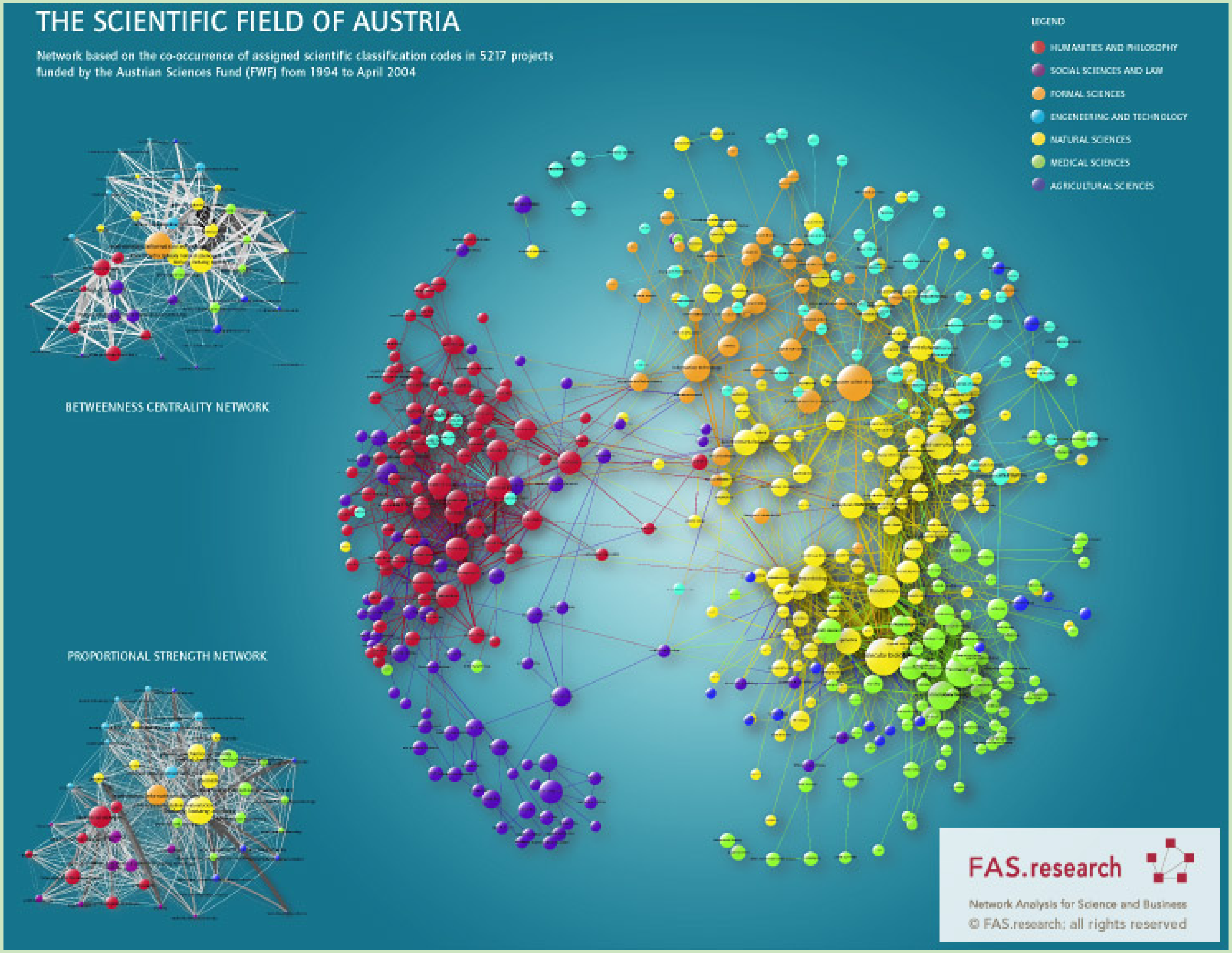
Douglas White: relinking marriages among the Aydinli



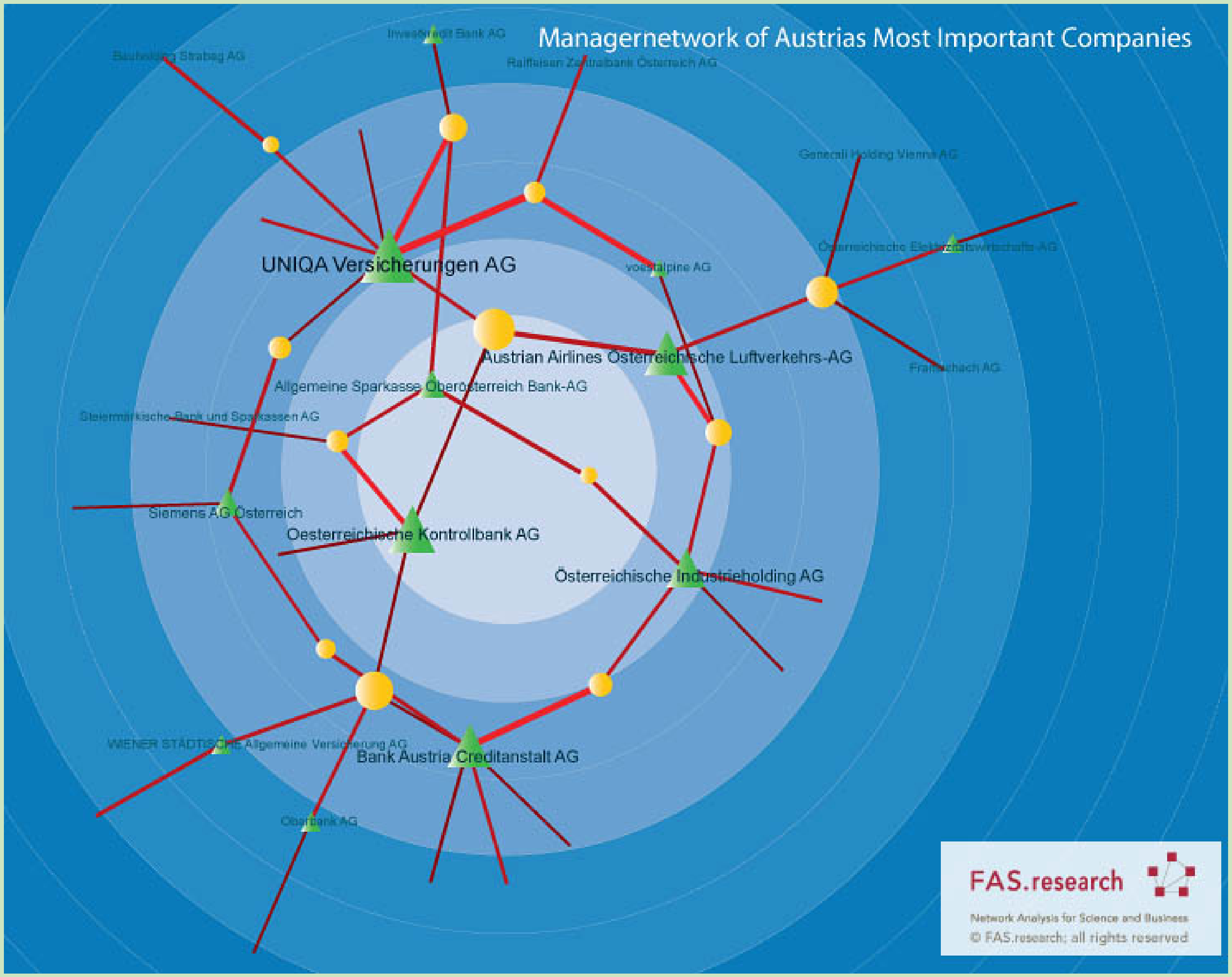
Lothar Krempel



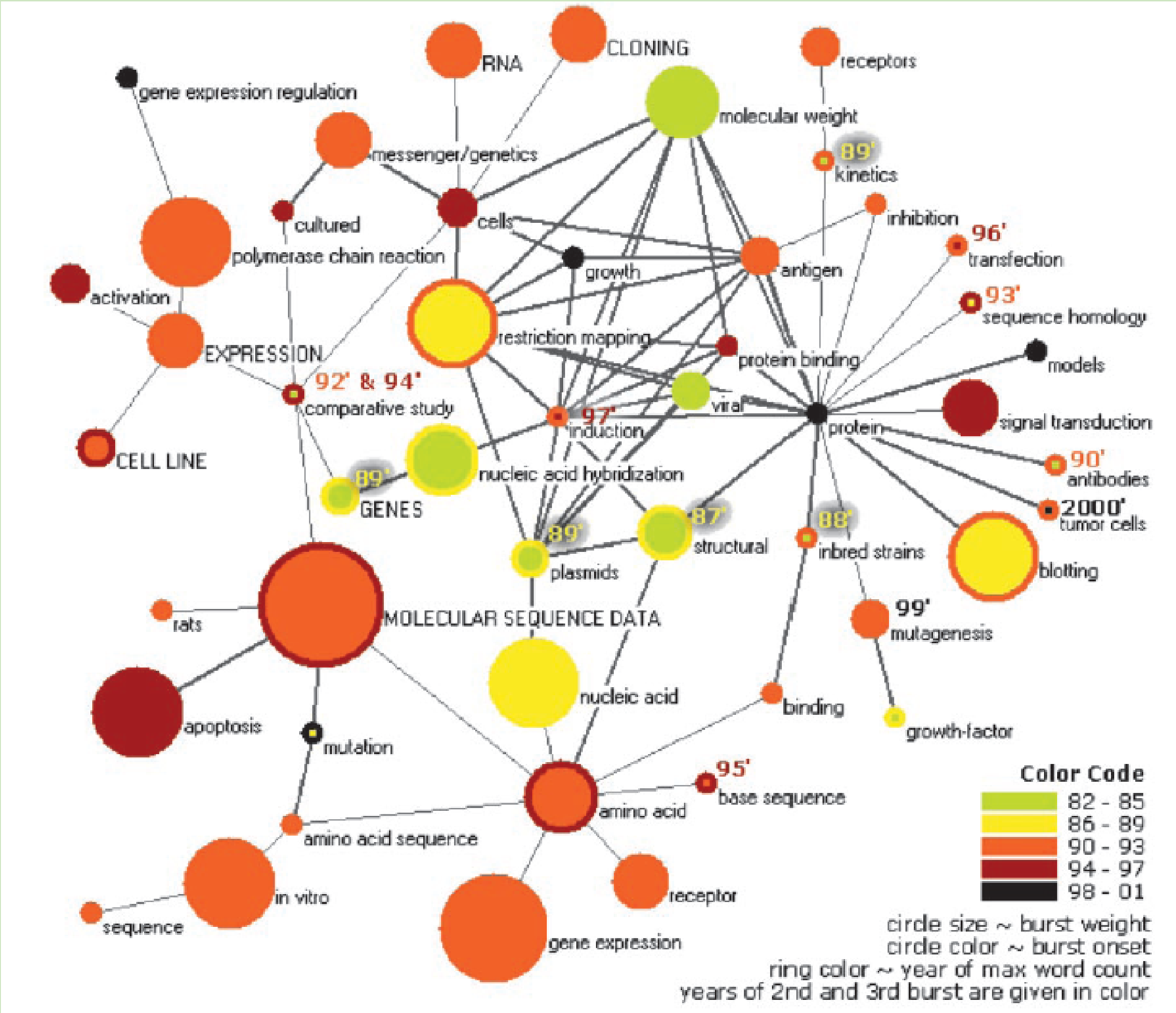
FAS: The scientific field of Austria



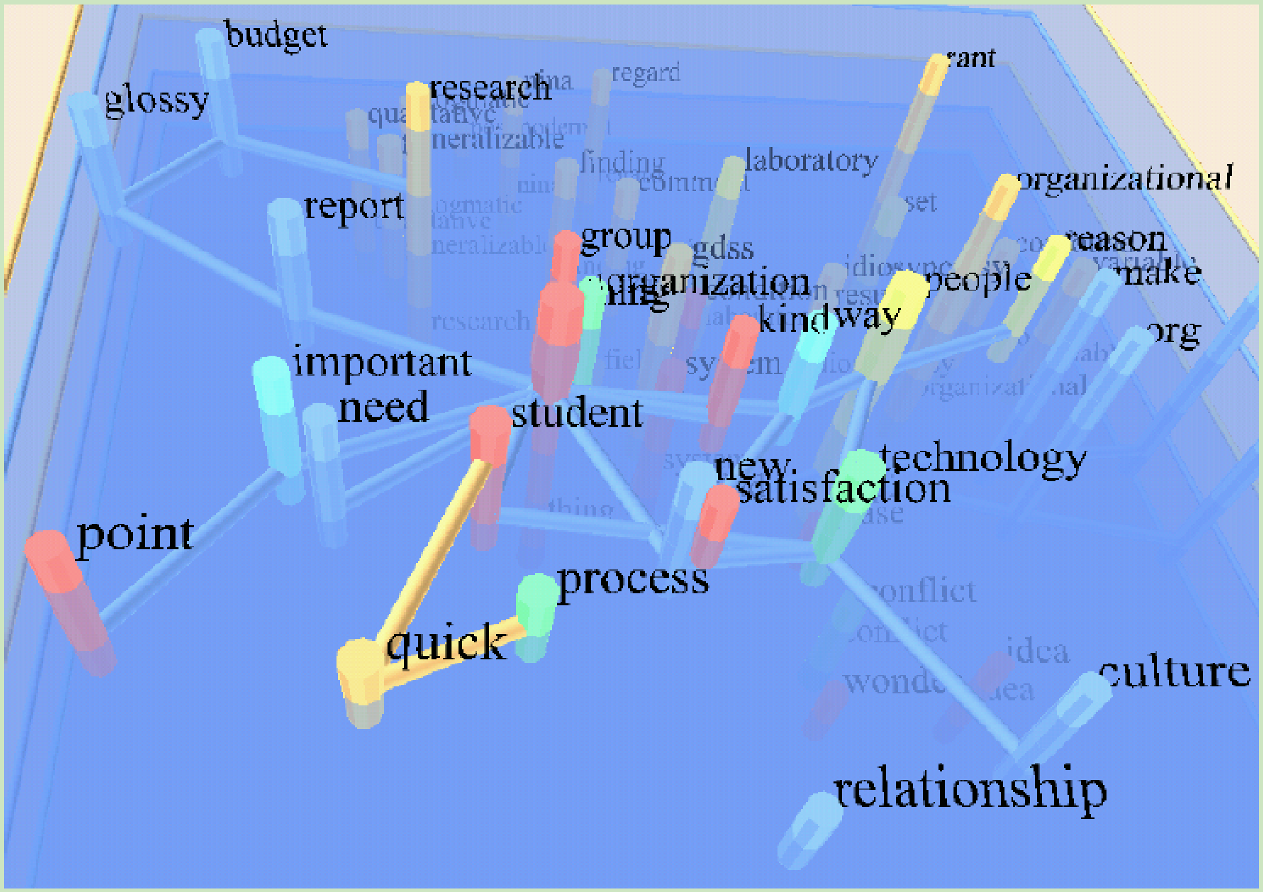
FAS: Austria's most important Companies



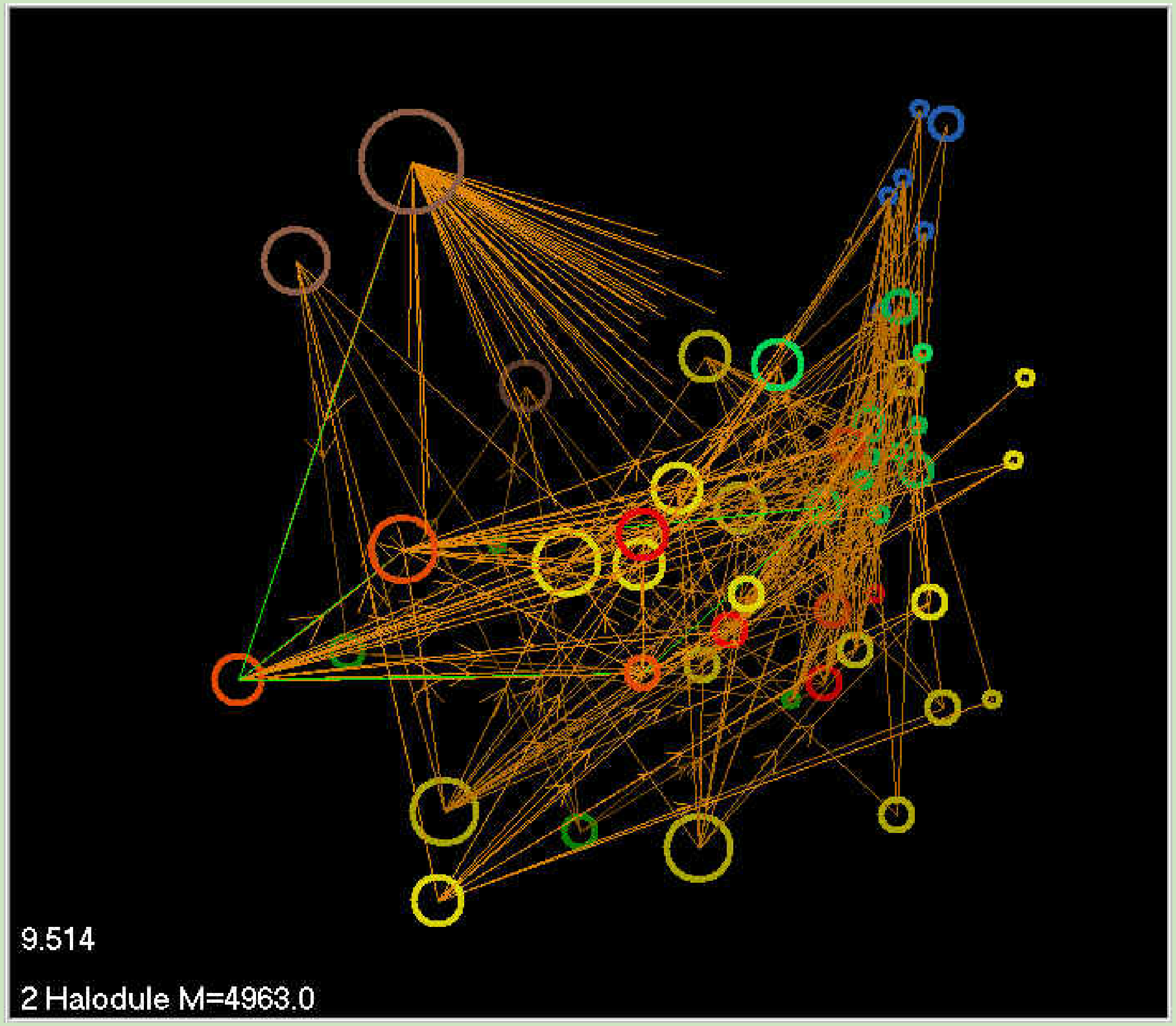
Katy Börner: Text analysis



Ulrik Brandes: Discourse network



Jeffrey Johnson: St Marks food web



Large networks

The simplest solution would be to take very large ’paper’.

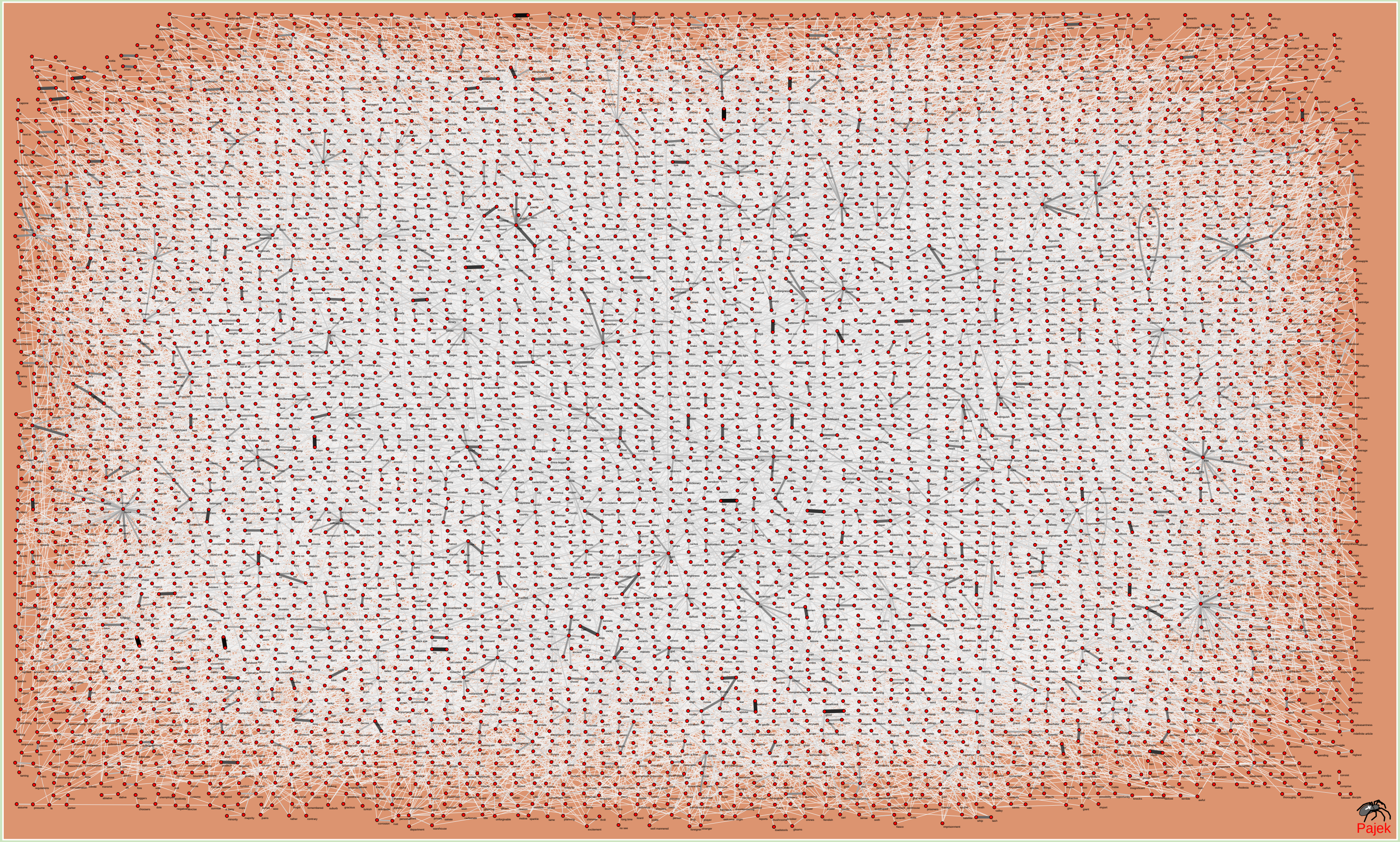
The standard solution is abstraction – clustering. We could also introduce different new graphical objects representing typical parts of network, LOD.

The other possibility is dynamic navigation through network: visualization of the neighborhood with indications of position in the global network (darker/brighter background – distribution of neighbors) complemented with a global map.

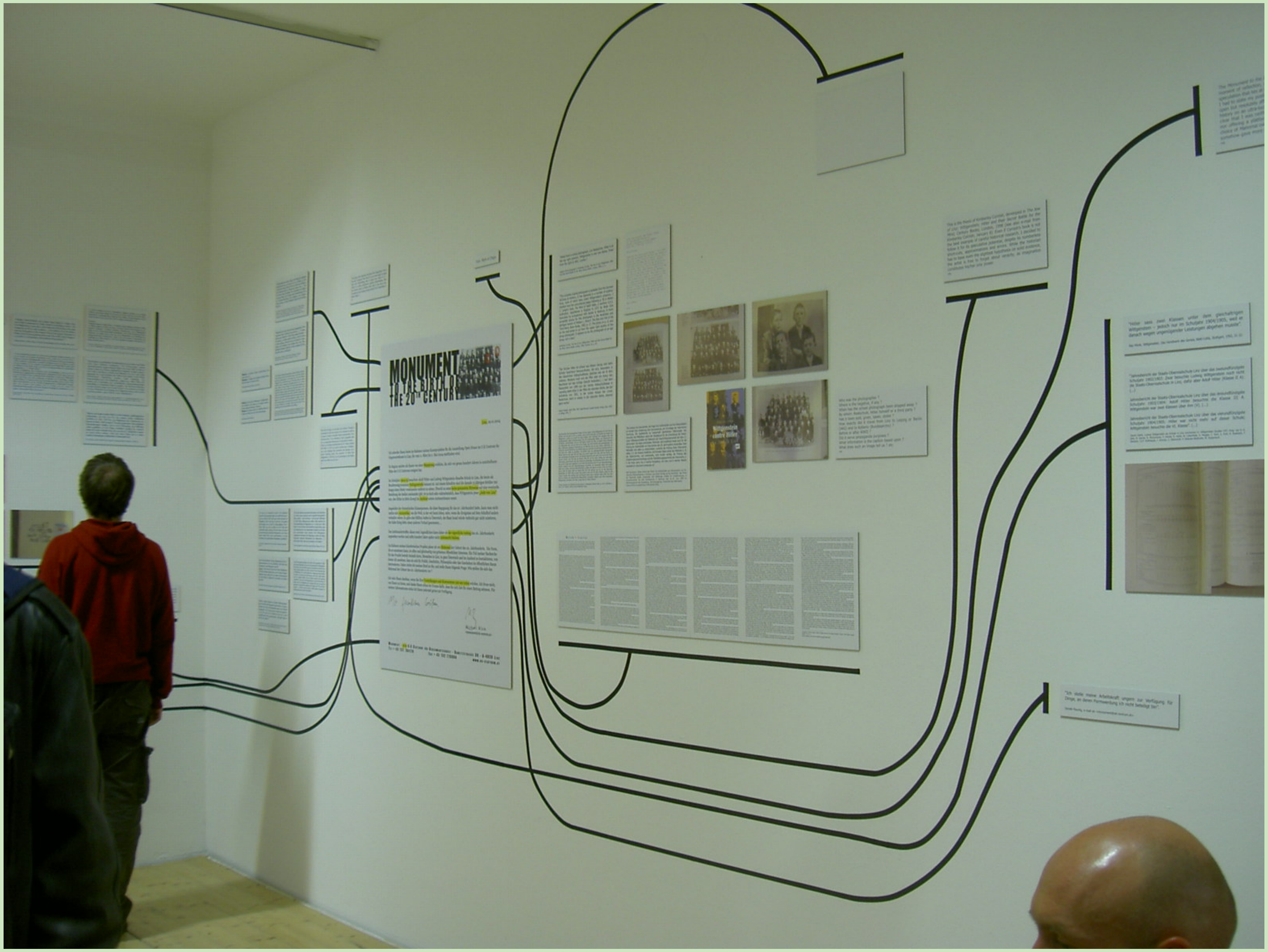
Big picture, V. Batagelj, AE'04

subnetwork ($n = 5952$, $m = 18008$) of the symmetrized Edinburgh Associative Thesaurus

Big picture



Michael Blum



Internet Movie Database http://www.imdb.com/

12th Annual Graph Drawing Contest, 2005. The IMDB network is bipartite (2-mode) and has $1324748 = 428440 + 896308$ vertices and 3792390 arcs.

Bipartite cores

The subset of vertices $C \subseteq V$ is a *(p, q)-core* in a bipartite (2-mode) network $N = (V_1, V_2; L)$, $V = V_1 \cup V_2$ iff

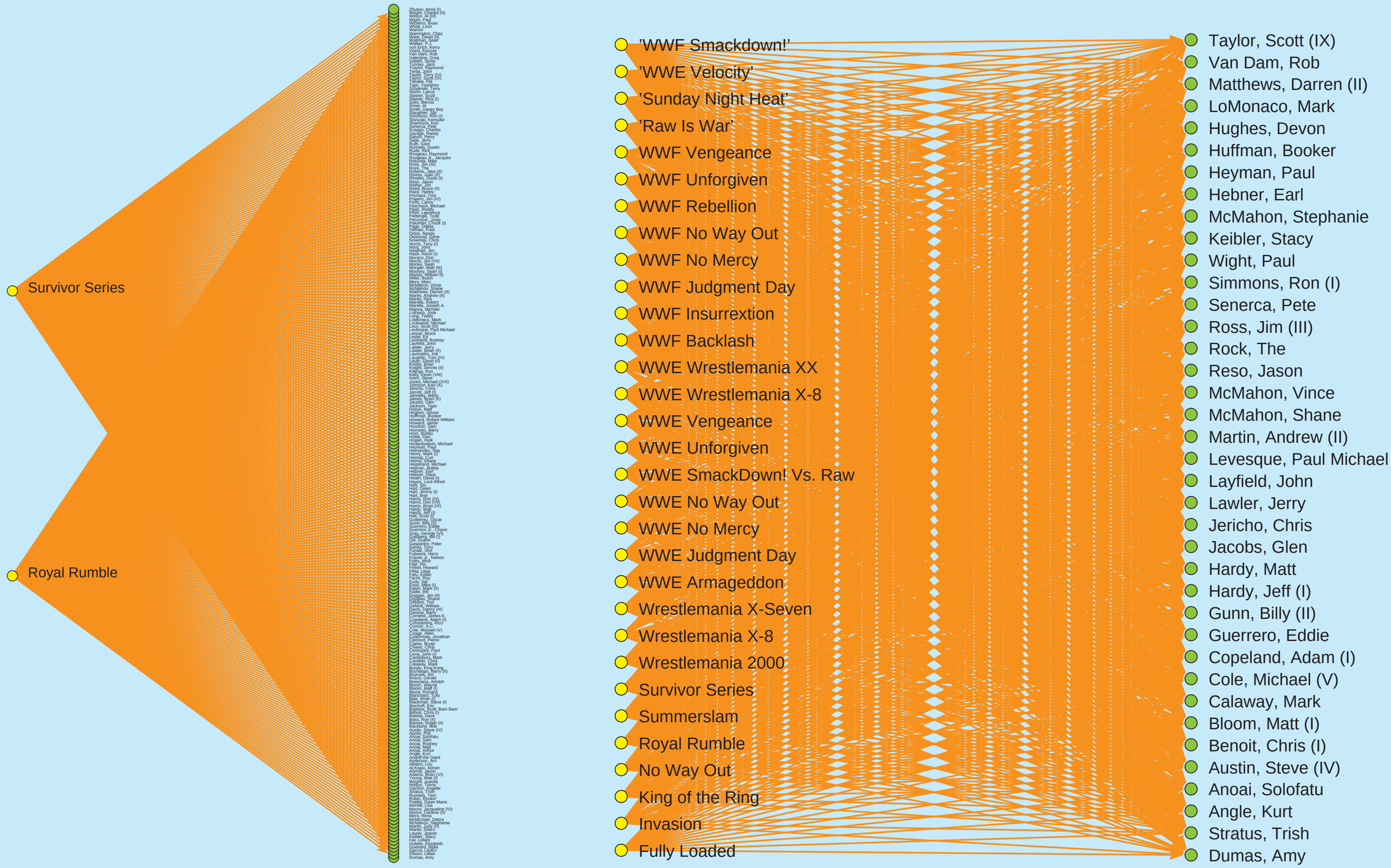
a. in the induced subnetwork $K = (C_1, C_2; L(C))$, $C_1 = C \cap V_1$, $C_2 = C \cap V_2$ it holds $\forall v \in C_1 : \deg_K(v) \geq p$ and $\forall v \in C_2 : \deg_K(v) \geq q$;

b. C is the maximal subset of V satisfying condition **a**.

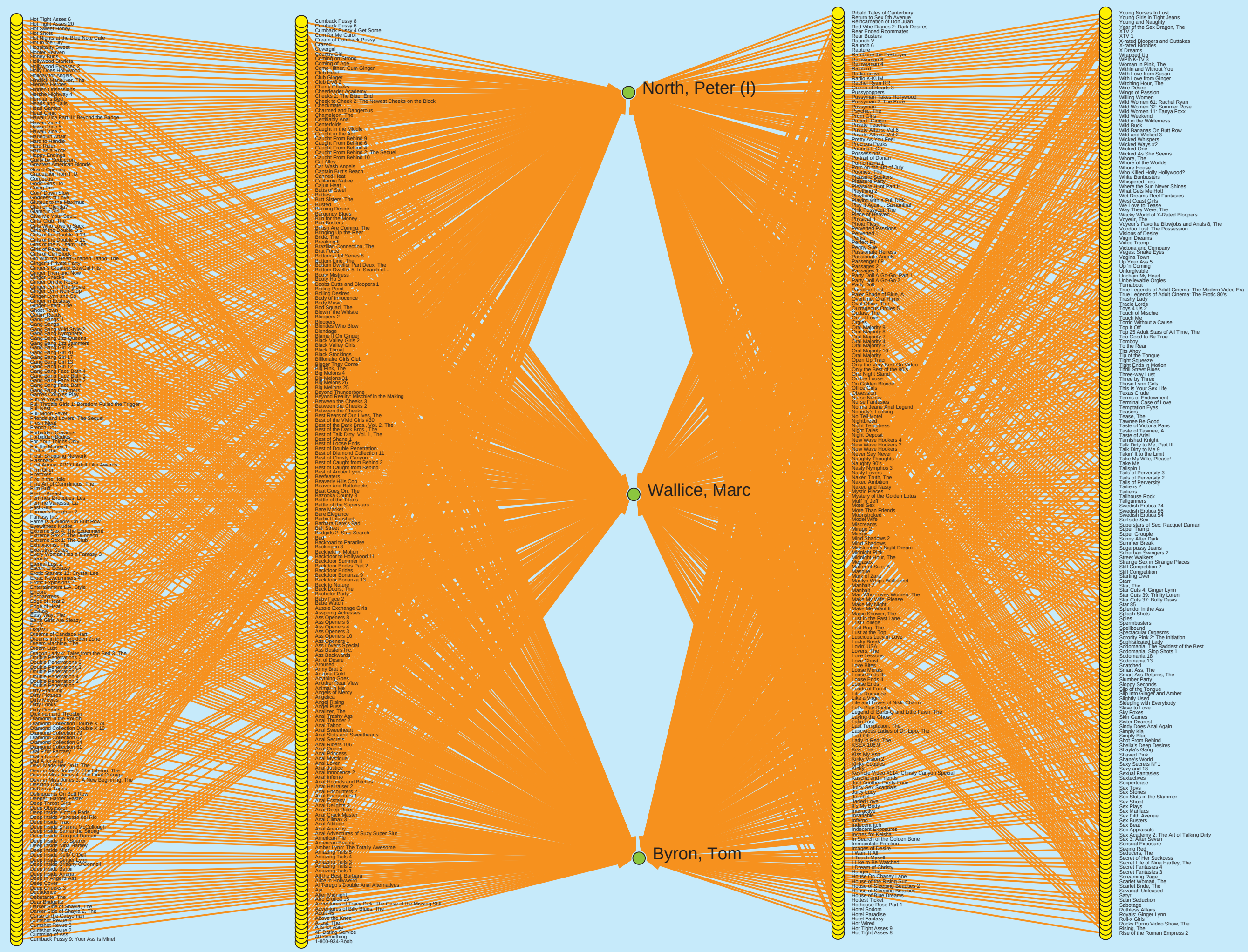
Properties of bipartite cores:

- $C(0, 0) = V$
- $K(p, q)$ is not always connected
- $(p_1 \leq p_2) \wedge (q_1 \leq q_2) \Rightarrow C(p_1, q_1) \subseteq C(p_2, q_2)$
- $\mathcal{C} = \{C(p, q) : p, q \in \mathbb{N}\}$. If all nonempty elements of $\mathcal{C}$ are different it is a lattice.
- To determine a (p, q)-core the procedure similar to the ordinary core procedure can be used.

(247,2)-core and (27,22)-core

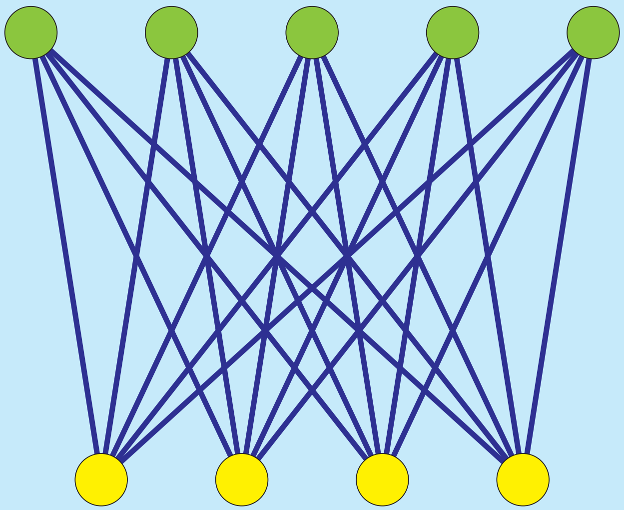


(2,516)-Hard core



4-rings and analysis of 2-mode networks

In bipartite (2-mode) network there are no 3-rings. The densest substructures are complete bipartite subgraphs $K_{p,q}$. They contain many 4-rings.

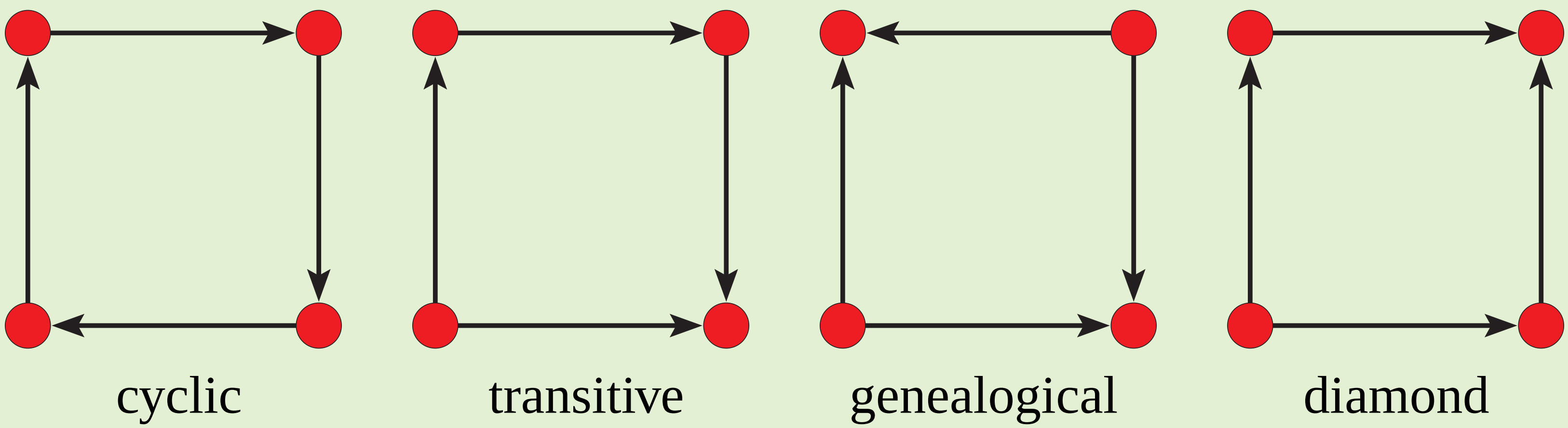


$$w_4(K_{p,q}) = (p-1)(q-1)$$

The 4-rings weights were implemented in **Pajek** only recently, in August 2005.

Directed 4-rings

There are 4 types of directed 4-rings:



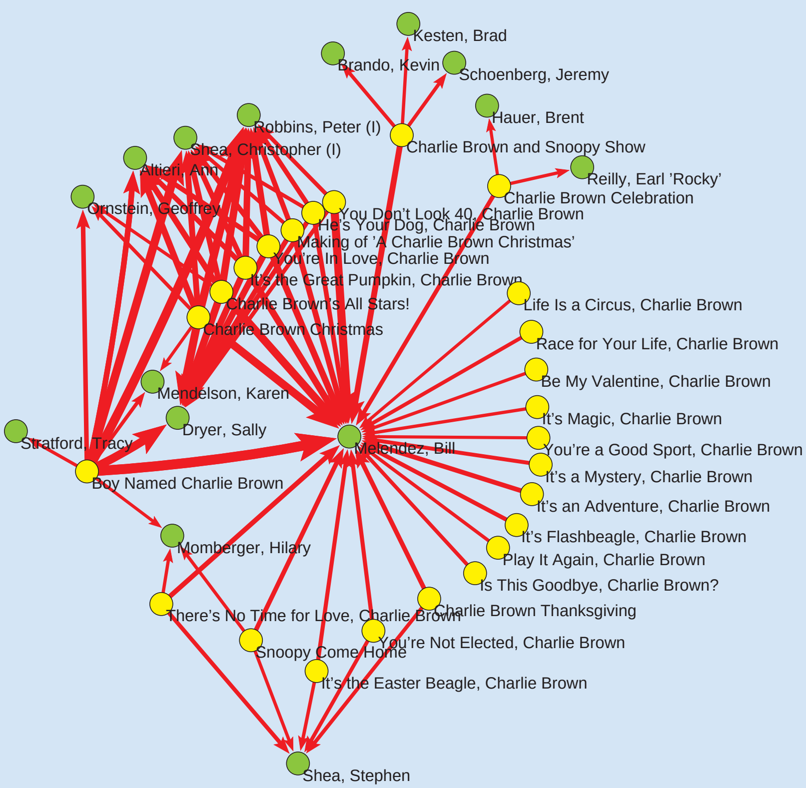
In the case of transitive rings **Pajek** provides a special weight counting on how many transitive rings the arc is a *shortcut*.

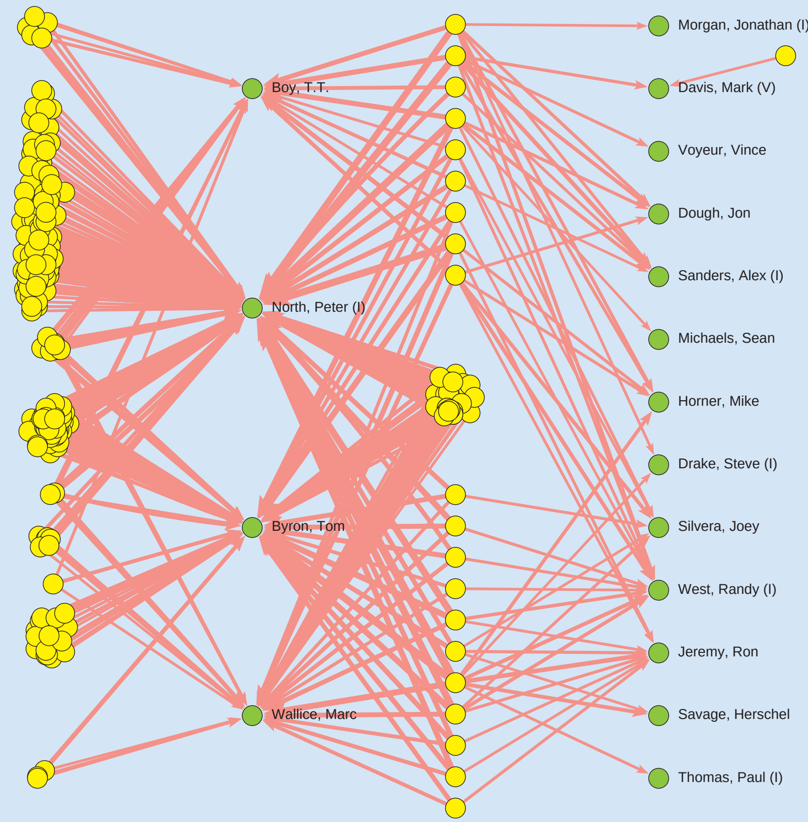
Simple line islands in IMDB for w_4

We obtained 12465 simple line islands on 56086 vertices. Here is their size distribution.

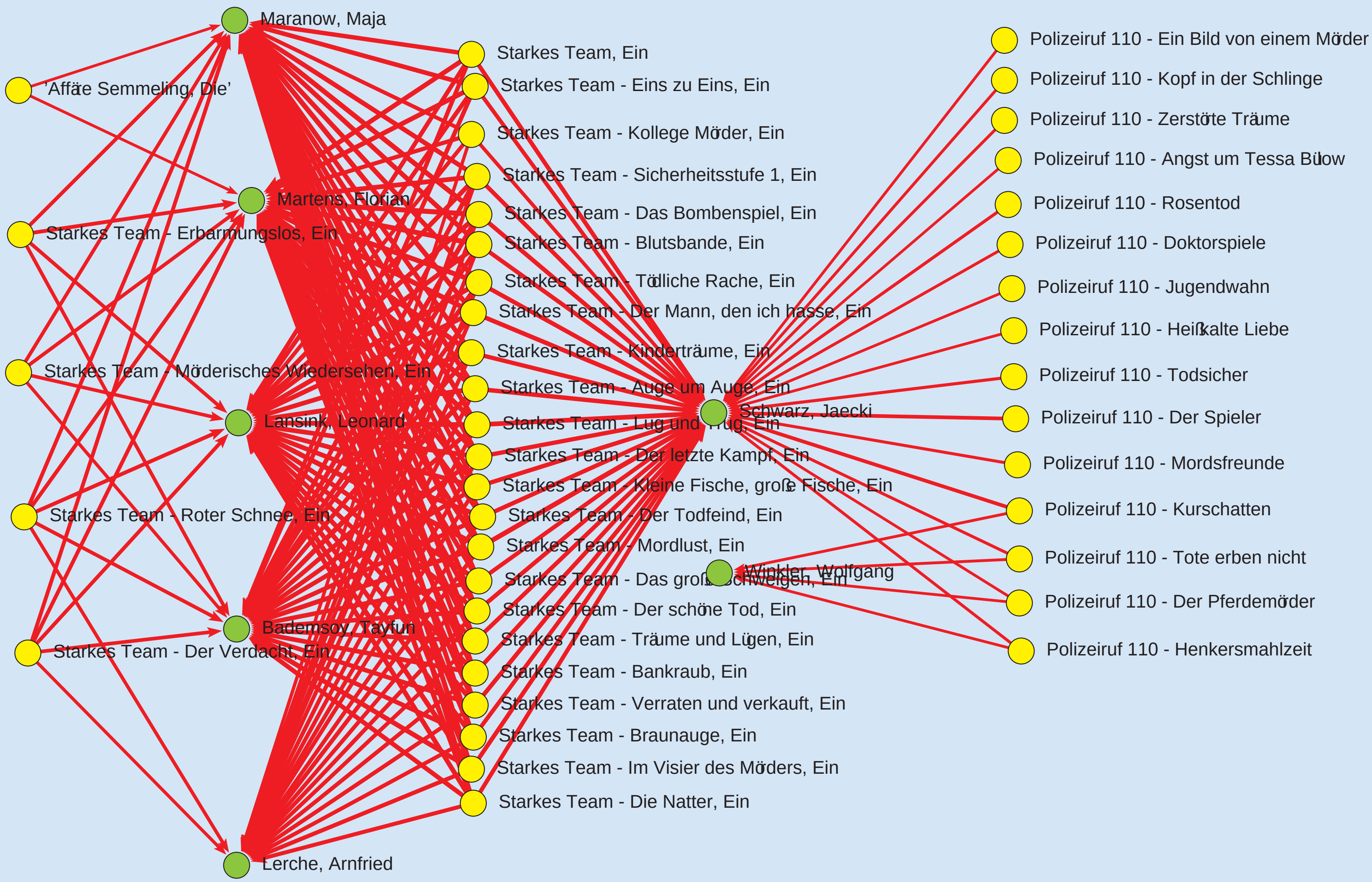
Size	Freq	Size	Freq	Size	Freq	Size	Freq
2	5512	20	19	38	4	59	2
3	1978	21	18	39	3	61	1
4	1639	22	15	40	2	64	1
5	968	23	9	42	2	67	1
6	666	24	13	43	3	70	1
7	394	25	12	45	3	73	1
8	257	26	6	46	4	76	1
9	209	27	6	47	5	82	1
10	148	28	5	48	1	86	1
11	118	29	6	49	2	106	1
12	87	30	3	50	2	122	1
13	55	31	6	51	1	135	1
14	62	32	5	52	2	144	1
15	46	33	3	53	1	163	1
16	39	34	1	54	2	269	1
17	27	35	5	55	1	301	1
18	28	36	4	57	1	332	2
19	29	37	7	58	1	673	1

Example: Islands for w_4 / Charlie Brown and Adult





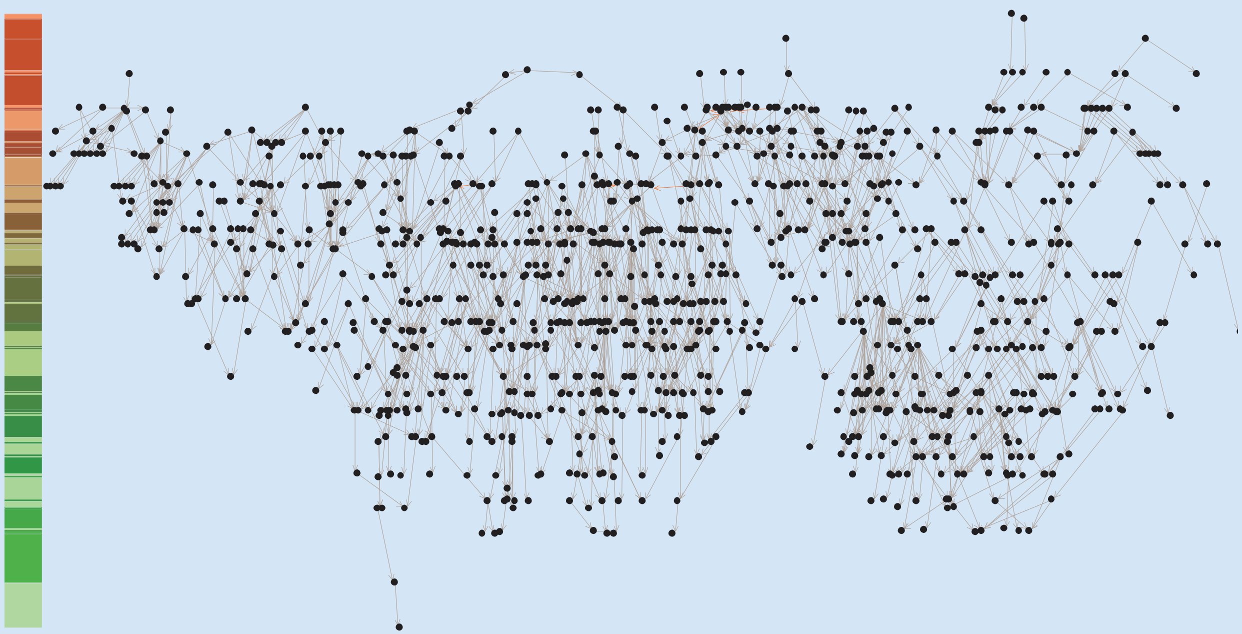
Example: Island for w_4 / Polizeiruf 110 and Starkes Team



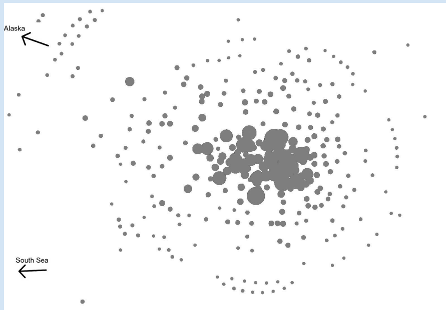
New drawing algorithms from GD'05

Tim Dwyer, Yehuda Koren, and Kim Marriott: Stress Majorization with Orthogonal Ordering Constraints.

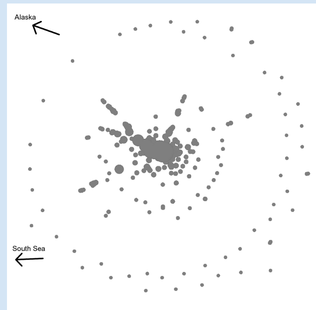
The *1138bus* graph (1138 vertices, 1458 arcs).



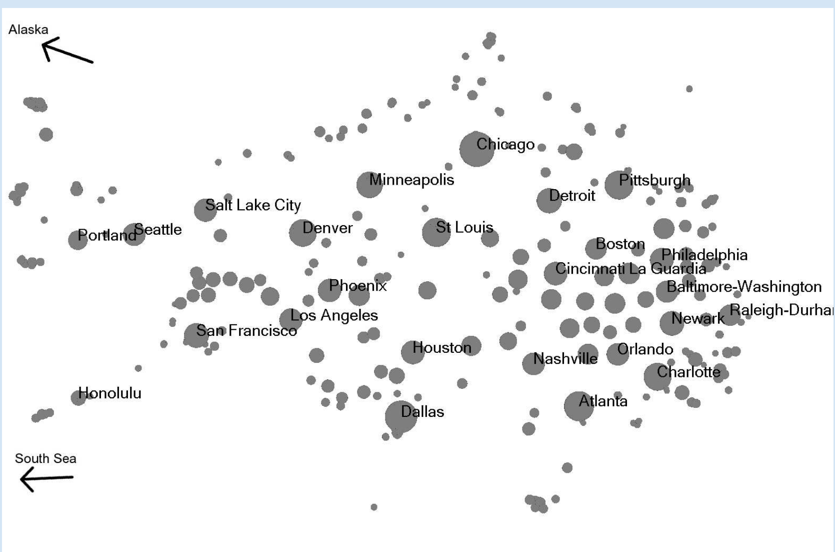
New drawing algorithms from GD'05



(a) Fruchterman-Reingold model



(b) Node-repulsion LinLog model



(c) Edge-repulsion LinLog model

Andreas Noack:

Energy-Based Clustering of Graphs with Nonuniform Degrees.

American airports.

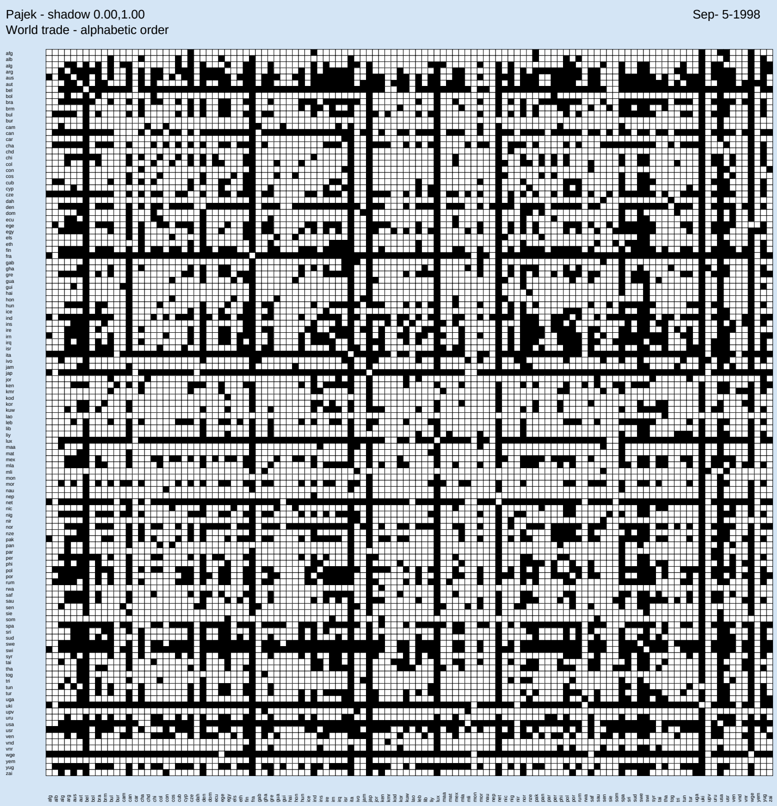
Dense networks

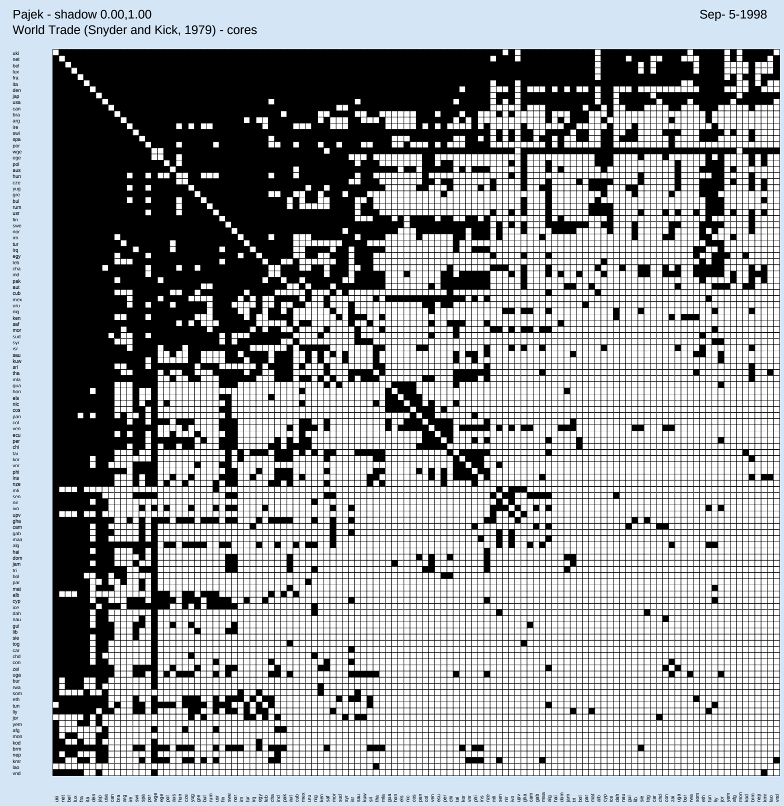
Dense(r) networks with more than 15 vertices usually can't be clearly presented. For such networks a more appropriate display is using *matrix representation*. Properly reordering vertices can reveal *patterns* in corresponding matrix display.

Matrix representation can be supplemented with display of properties of vertices. It is also compatible with shrinking/ expanding with respect to a given hierarchy (see papers 1, 2).

There are different approaches how to determine good orderings: weak, strong components; topological sort in acyclic networks; special heuristics (Reverse Cuthill-McKee); seriation and clumping (Murtagh, 1985); clustering; blockmodeling.

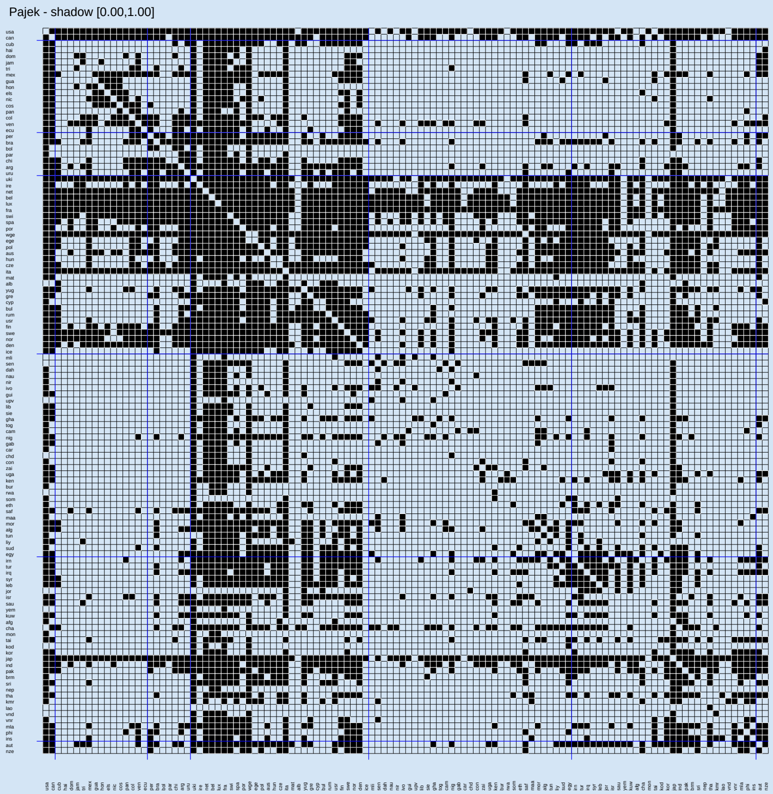
Snyder & Kick's World trade network / $n = 118$, $m = 514$

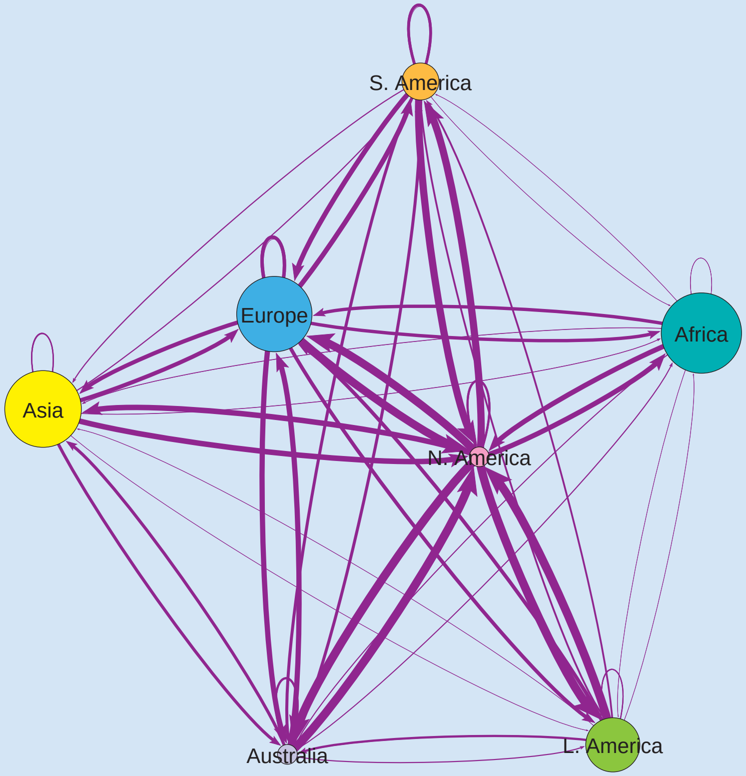




Alphabetic order of countries (left) and rearrangement (right)

Contracted clusters – international trade



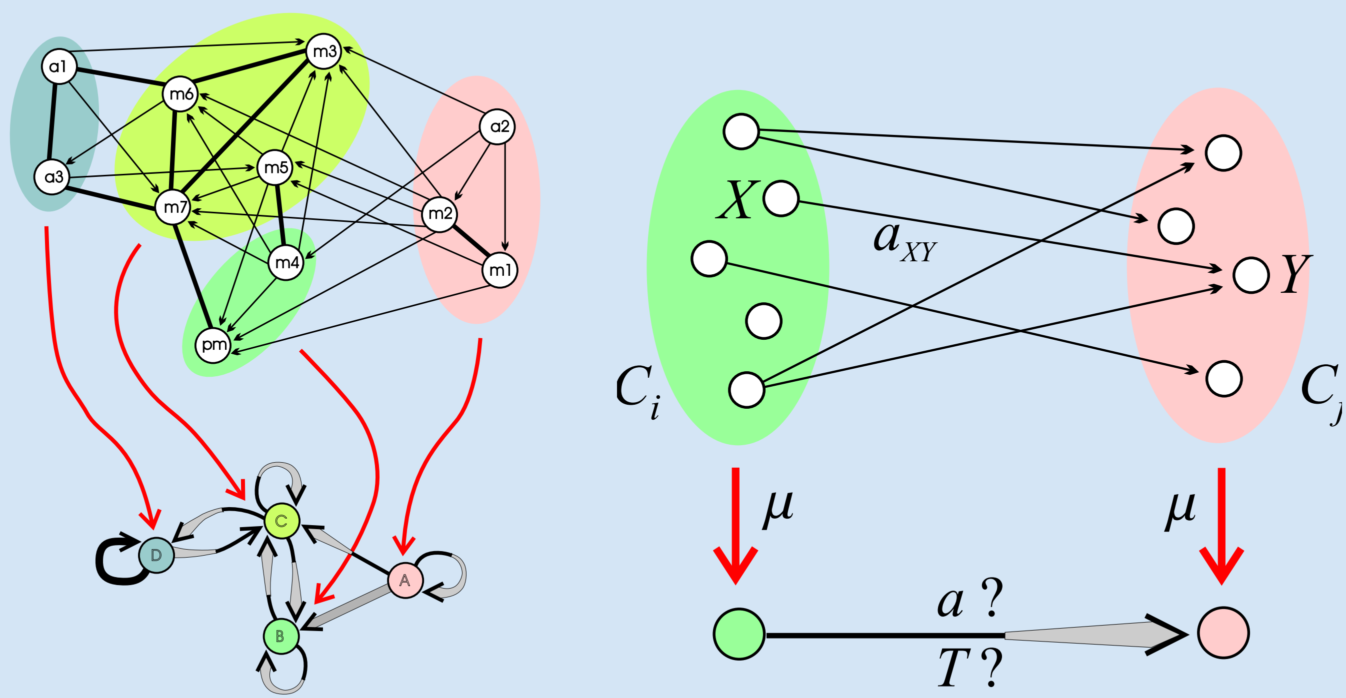


Snyder and Kick's international trade. Matrix display of dense networks.

$$w(C_i, C_j) = \frac{n(C_i, C_j)}{n(C_i) \cdot n(C_j)}$$

Generalized Blockmodeling

A *blockmodel* consists of structures obtained by identifying all units from the same cluster of the clustering **C**. For an exact definition of a blockmodel we have to be precise also about which blocks produce an arc in the *reduced graph* and which do not, and of what *type*.



Book: P. Doreian, V. Batagelj, A. Ferligoj: *Generalized Blockmodeling*, CUP, 2004. Amazon.

New graphical elements

To improve the pictures new graphical elements could be introduced:

- Almost clique or bipartite complete graph could be replaced by the circle/quadrangle with the inverse drawing of missing edges.
- 'multiedges'

Core based layout

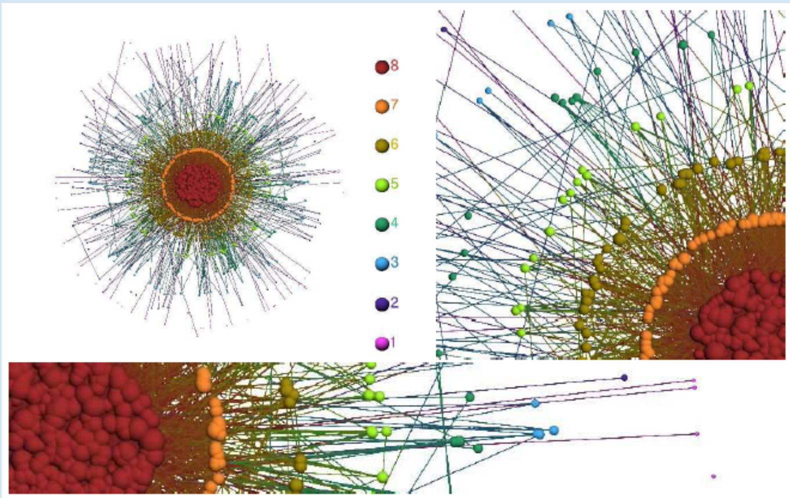


Figure 3: Graphical representation of a BA network with a random $m \in [1 : 10]$, and n=1000

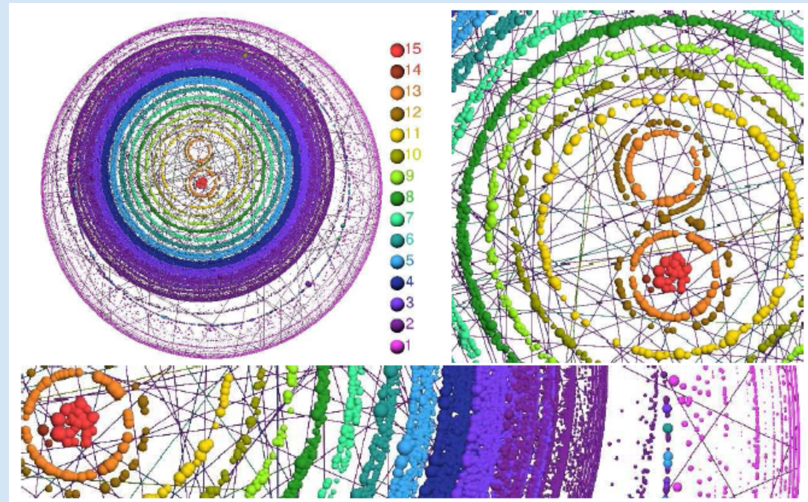


Figure 11: Graphical representation of a fraction of the `.fr` domain of the WWW

I. Alvarez-Hamelin, L. DallAsta, A. Barrat, and A. Vespignani: k-core decomposition: a tool for the visualization of large scale networks arXiv:cs 0504107

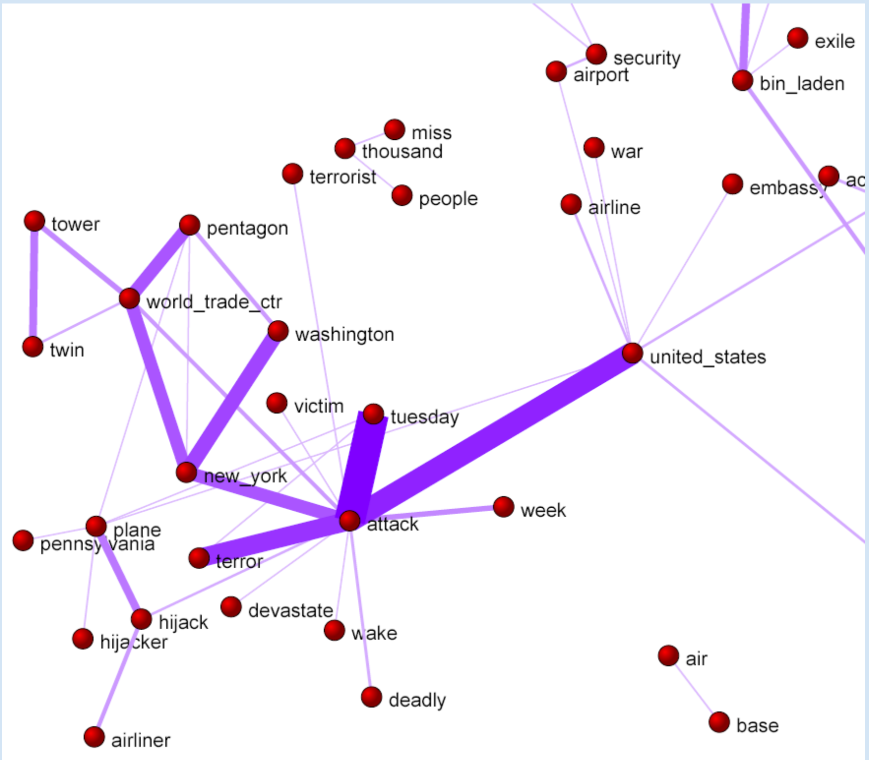
Graphical representation should be simplified into icon omitting details.

Dynamic/temporal networks

There are different types of temporal networks:

- networks with implicit time dimension: genealogies
- (recorded) sequence of time slices: Sampson's monks
- (recorded) sequence of events changing the network: KEDS
- online networks: They rule

Temporal networks / September 11

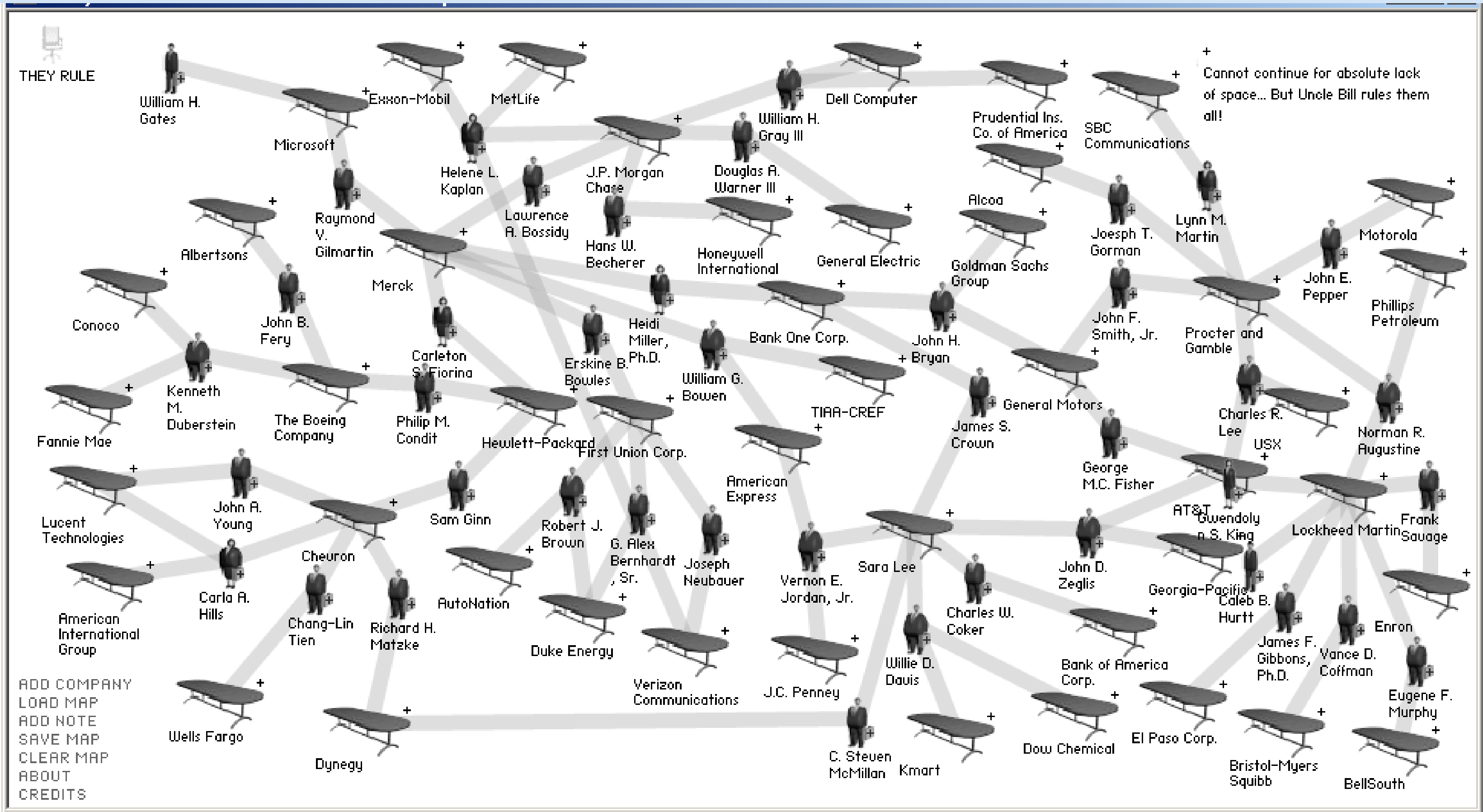


Steve Corman with collaborators from Arizona State University transformed, using his Centering Resonance Analysis (***CRA***), daily Reuters news (66 days) about September 11th into a temporal network of words coappearance. This network was a challange network for *Viszards* 2002 session.

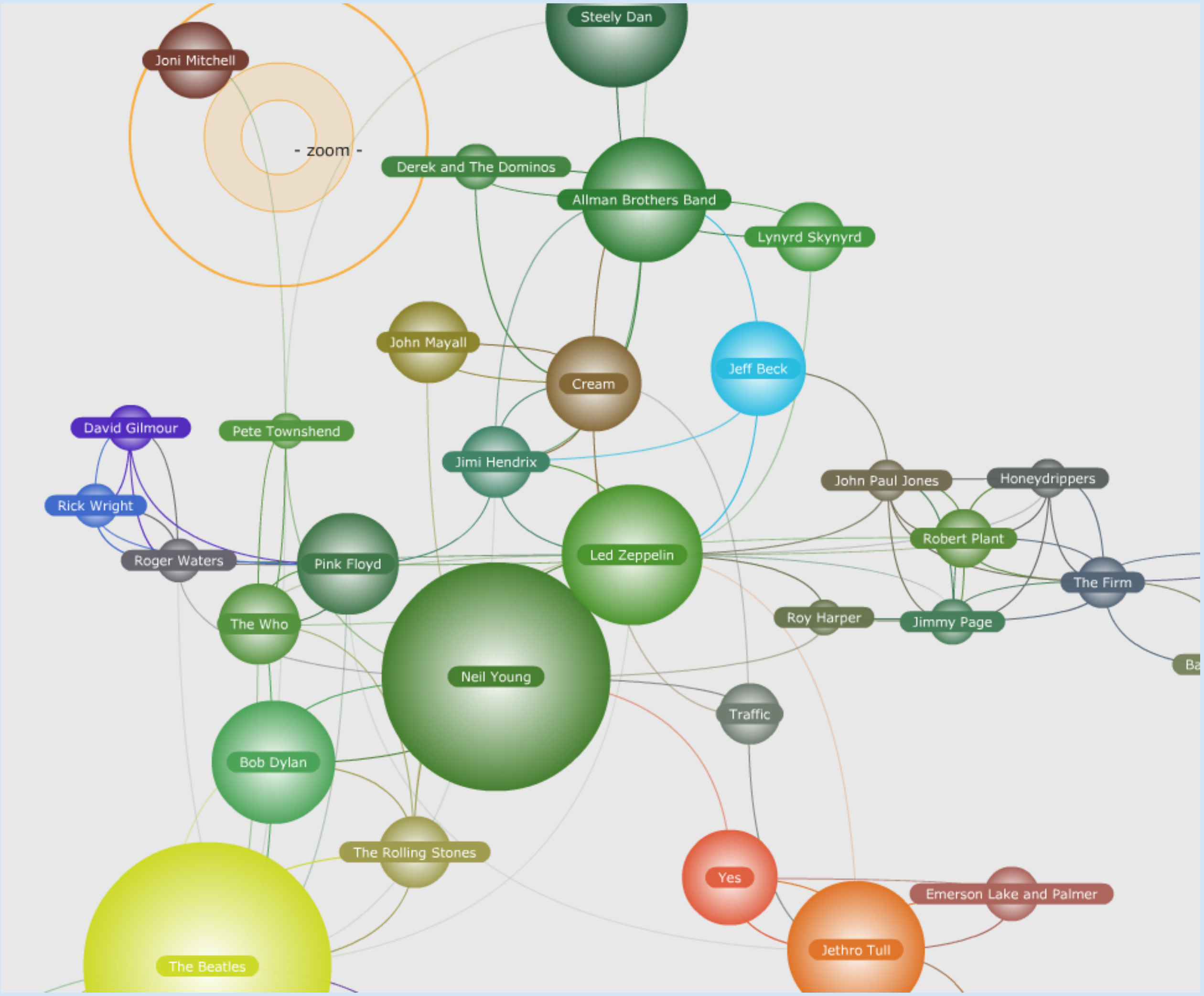
Pictures in SVG: ***66 days***. (SVG viwer)

Every year (from 2002) we have at the Sunbelt conference a Viszards session presenting solutions of Viszards group to a visualizations of selected network or type of networks.

They Rule


THEY RULE
William H. Gates
Microsoft
Exxon-Mobil
MetLife
Helene L. Kaplan
J.P. Morgan Chase
William H. Gray III
Douglas A. Warner III
Dell Computer
Prudential Ins. Co. of America
SBC Communications
Cannot continue for absolute lack of space... But Uncle Bill rules them all!
Raymond V. Gilmartin
Lawrence A. Bossidy
Albertsons
Hans W. Becherer
Honeywell International
General Electric
Alcoa
Goldman Sachs Group
Joesph T. Gorman
Lynn M. Martin
Motorola
Merck
Conoco
John B. Fery
Heidi Miller, Ph.D.
Carleton S. Fiorina
Erskine B. Bowles
William G. Bowen
Bank One Corp.
John H. Bryan
John F. Smith, Jr.
Procter and Gamble
John E. Pepper
Phillips Petroleum
Kenneth M. Duberstein
The Boeing Company
Philip M. Condit
Fannie Mae
Hewlett-Packard
First Union Corp.
TIAA-CREF
James S. Crown
General Motors
Charles R. Lee
USX
Norman R. Augustine
George M.C. Fisher
Lucent Technologies
John A. Young
Sam Ginn
Robert J. Brown
American Express
G. Alex Bernhardt, Sr.
Joseph Neubauer
AT&T
Gwendoly n S. King
Lockheed Martin
Frank Savage
Chevron
American International Group
Carla A. Hills
Chang-Lin Tien
Richard H. Matzke
AutoNation
Vernon E. Jordan, Jr.
Sara Lee
John D. Zeglis
Georgia-Pacific
Caleb B. Hurtt
Charles W. Coker
Duke Energy
Verizon Communications
J.C. Penney
Willie D. Davis
Bank of America Corp.
James F. Gibbons, Ph.D.
Vance D. Coffman
Enron
Eugene F. Murphy
ADD COMPANY
LOAD MAP
ADD NOTE
SAVE MAP
CLEAR MAP
ABOUT
CREDITS
Wells Fargo
Dynegy
C. Steven McMillan
Kmart
Dow Chemical
El Paso Corp.
Bristol-Myers Squibb
BellSouth

MusicPlasma



Musicvine

Networks from the Internet

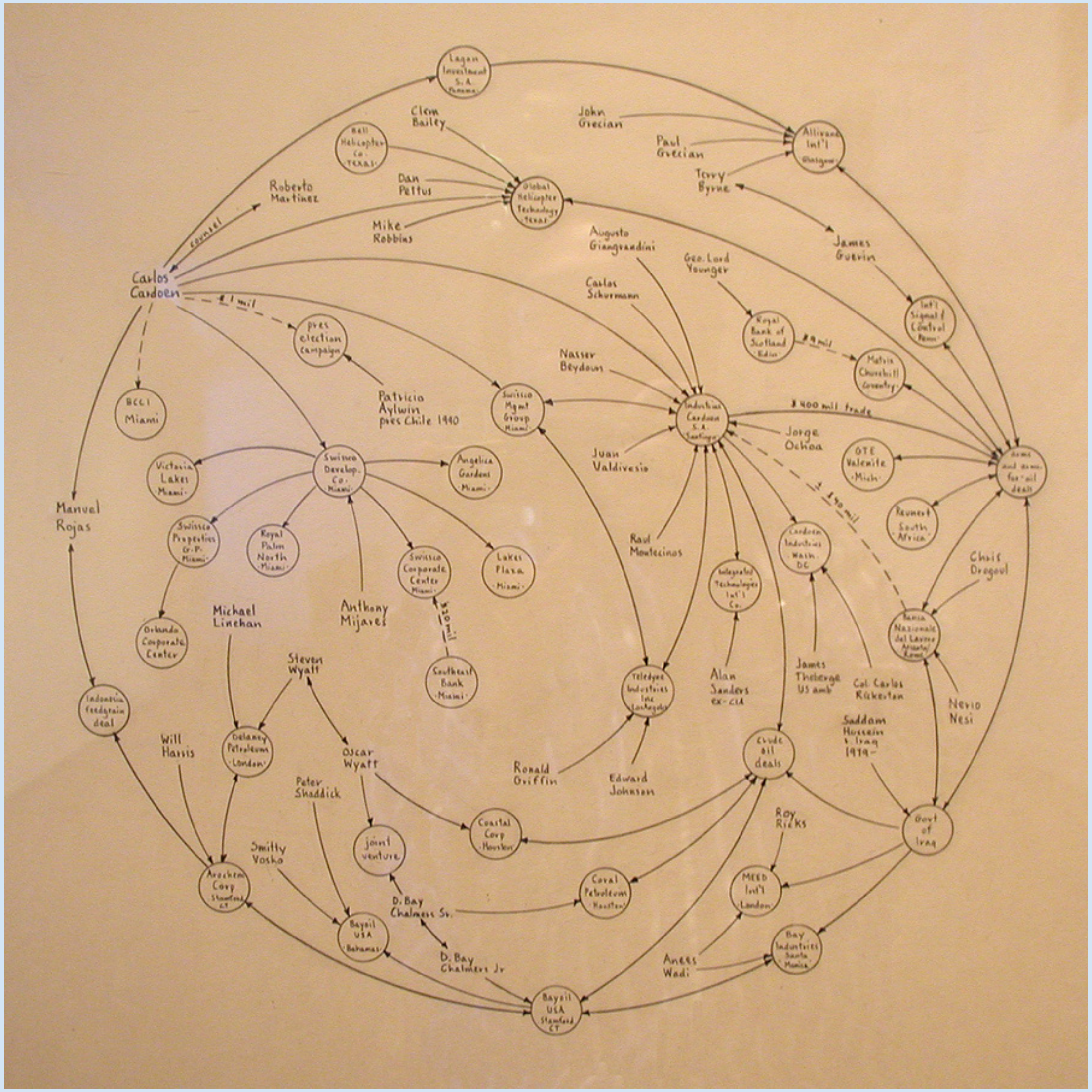
KartOO network

Internet Mapping Project. Links among WWW pages. KartOO, TouchGraph. Derived from archives of E-mail, blogs, . . . , server's logs. *Cybergeography*, *CAIDA*.

Challenges

- Visualization of properties
- Drawing/display styles
- Interactive layouts, common format(s) ?
- Matrix layout, generalized blockmodeling of large networks
- Additional graphical elements to improve layouts
- Visualization (and analysis) of multi-relational networks
- Visualization (and analysis) of dynamic/temporal networks
- Visualization of dense acyclic networks (genealogies, citation networks)

Lombardi's networks



Mark Lombardi
(1951-2000)
transformed business relations into art.

Context


Paradigma
sozio-logisch
genealogisch
Ge-Schichten
geschichtsbewußt
Plateau
- Plateau als Kontext
Rolle
Inszenierung
- Re-Inszenierung
Ersatz
Indexikalität
Umstände
Umraumbezug
Schichtung
- Geschichten
- episodisch
- narrativ
- geschichtsbewußt
Regelverletzung
Sprachspiel
- Spiel
Szene
- szenischer Rahmen
- szenischer Zusammenhang
- szenisches Verstehen
situativ
ortsbezogen
Situation
induktiv
Metakommunikation
Kontext
- context
- Kontextualismus
Schema / Script
verfremdet
Sinnverschiebung
Kontextverletzung
Lebenswelt
Kontrast
Umfeld
öko-logisch
Rahmen
- frame
- in diesem Rahmen von Bedeutung
Ganzheit
Konnotation
Bedeutung
zitiert
Zitat
Verweisungs-
zusammenhang
unangemessen
angemessen
Gestalt
Hintergrund
- Grund
Zusammenhang
- correalismus
- syntagmatisch
(die Relationen betreffend)
vernetzt
bezüglich
Phantasie
Horizont
intertextuell
- Ko-Text
Erwartung
Zwischenraum
Polykontexturalität
Perspektive
unerwartet
Feld
- Beziehungsfeld
- Spannungsfeld
- Feldlinien
Instruktion
beziehungsorientiert
Binnenkontext
Relevanz
Funktion
Markt
Kanal
Konfiguration
strukturbewußt

Barcelona / Peter Davies – Joseph Beuys: Text painting