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LAYOUTS FOR GRAPH DRAWING CONTESTS 1995-2001

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Layouts for Graph Drawing Contests 1995-2001

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Graph drawing contests

Since 1994 graph drawing contests are organized as a part of the Graph Drawing Conferences. The rules and data are described on Internet and participants send their drawings till the specified date. They can use any technique to get layouts of graphs. The primary judging criterion is how well the drawings convey the information in the graphs: vertex identifiers, vertex types, and vertex interconnectivity. A secondary criterion is the degree to which manual editing was employed to produce the layout: the less manual intervention, the better.

The purpose of the contests is to monitor and challenge the current state of the art in graph-drawing technology.

Data (vertices and lines) for 3 or 4 graphs are given each year. A winning entry for each graph is chosen by a panel of experts.

In this paper we collected our submissions to the contests in the years 1995–2001. They are available also at

http://vlado.fmf.uni-lj.si/pub/gd/gd95.htm

and the original data (and their versions in Pajek format) at

http://vlado.fmf.uni-lj.si/pub/networks/data/gd/gd.htm

There you will find also pictures in some (dynamical) graphical formats (VRML, SVG) that can not be adequately reproduced in the paper form.

Layouts for Graph Drawing Contest 1995

In 1995 the Graph Drawing Conference was helt in Passau and the contest was organized by Peter Eades and Joe Marks. Rules and data are described at:
`http://www.uni-passau.de/agenda/gd95/contest.html`

Graph A95

- First layout was obtained automatically using our program `COORD` (positioning vertices on the rectangular net so that the number of crossings of lines is as low as possible).
- Manual editing was performed to reposition vertices using our graph picture editor `DRAW`.

Graph B95

- Analysing graph B using our program `RELCALC` two central vertices were found (1 and 34).
- Feasible possitions for vertices were generated (two families of concentric circles).
- Vertices 1 and 34 were fixed in the centre of the concentric circles mentioned.
- Other vertices were automatically positioned around using program `COORD` so that the total length of the lines was minimized.
- Layout was then edited manually using `DRAW` to reposition vertices to minimize crossings (concentric circles cannot be seen any more).

  The layout was awarded the honorable mention.

Graph C95

- First layout was obtained automatically using our program `ENERG` (minimisation of `ENERG`y).
- Some manual editing using `DRAW` was performed to reposition vertices.

  The layout was awarded the first prize.

See: `http://vlado.fmf.uni-lj.si/pub/gd/gd95.htm`
The complete report of the contest is available in [6] and:
`http://www.merl.com/reports/TR95-14/index.html`

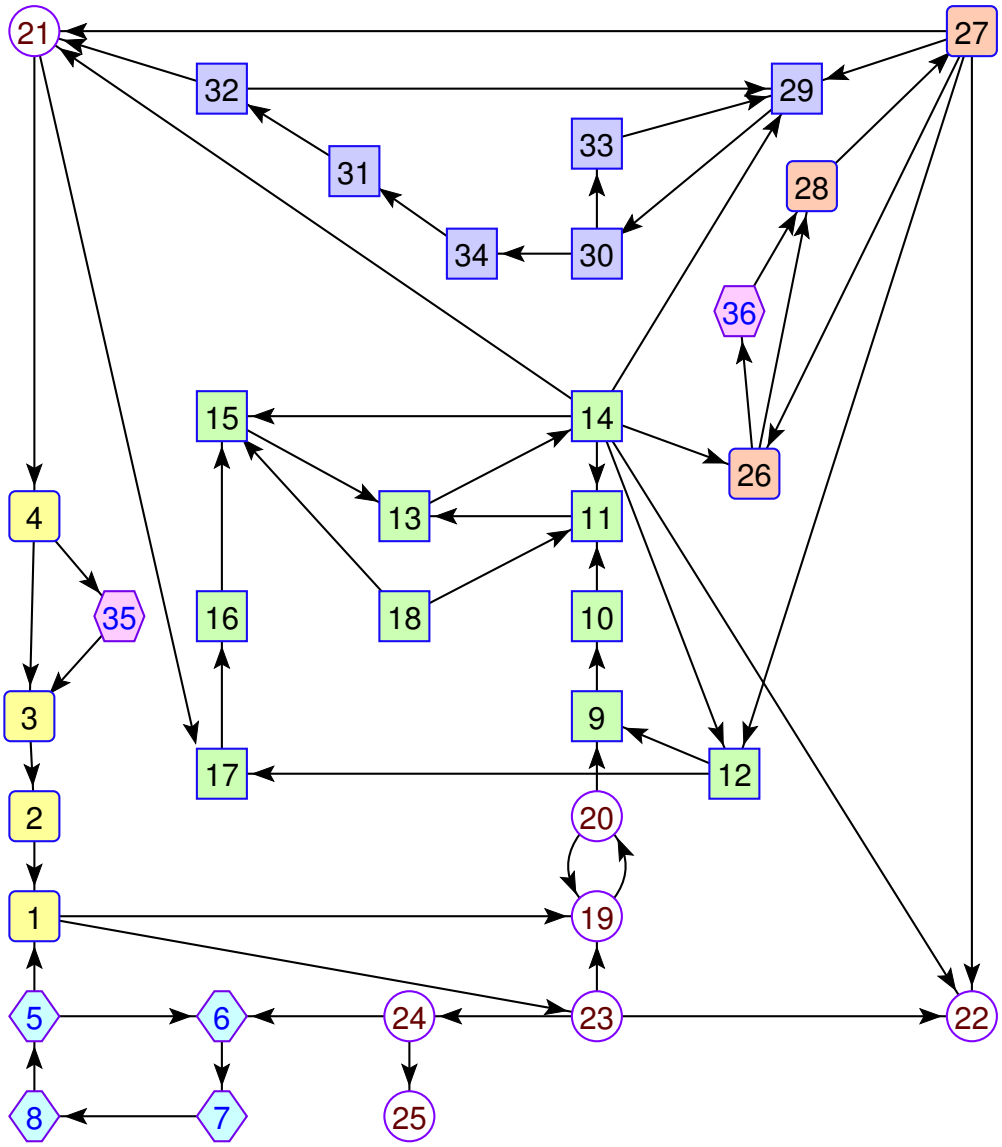


Figure 1: Graph A95.

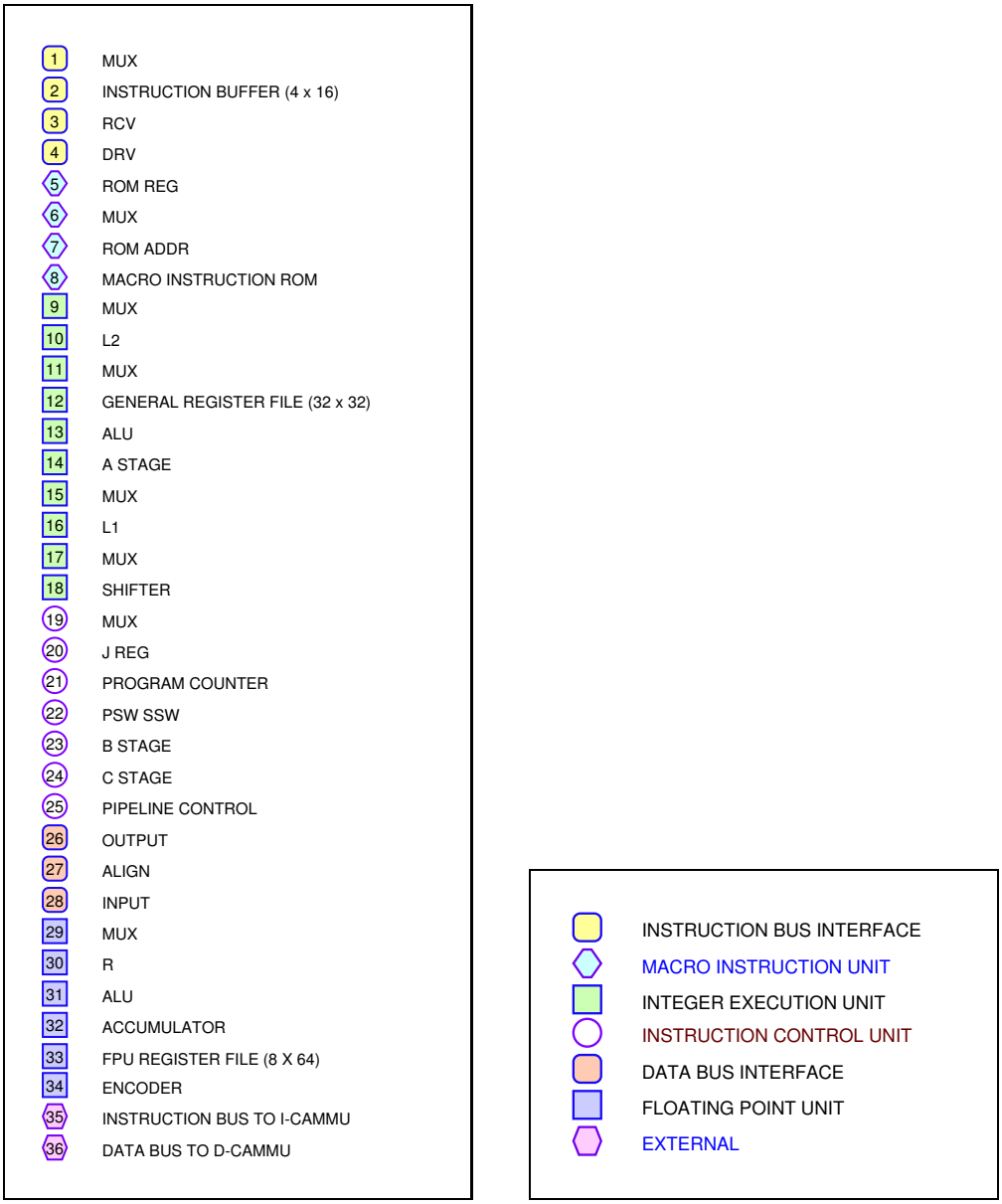


Figure 2: Graph A95 descriptions.

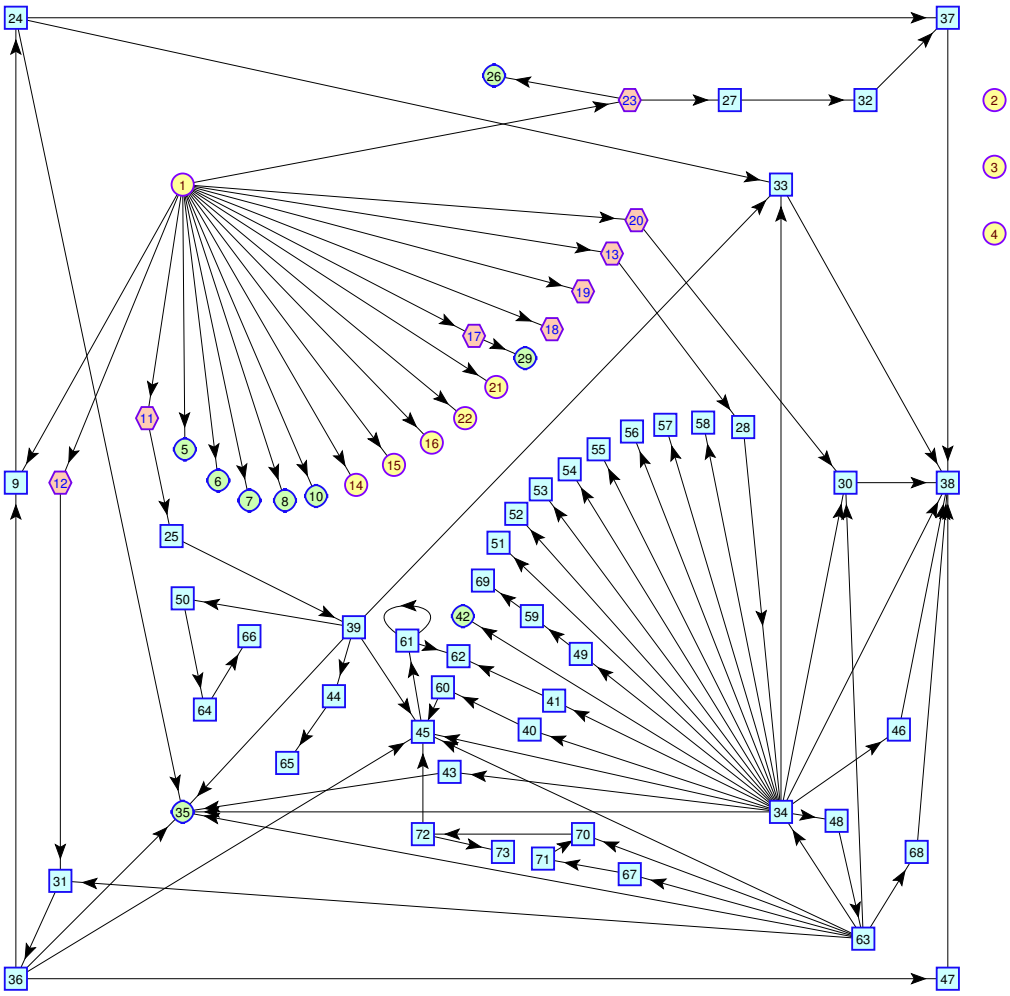


Figure 3: Graph B95 (***honorable mention***).

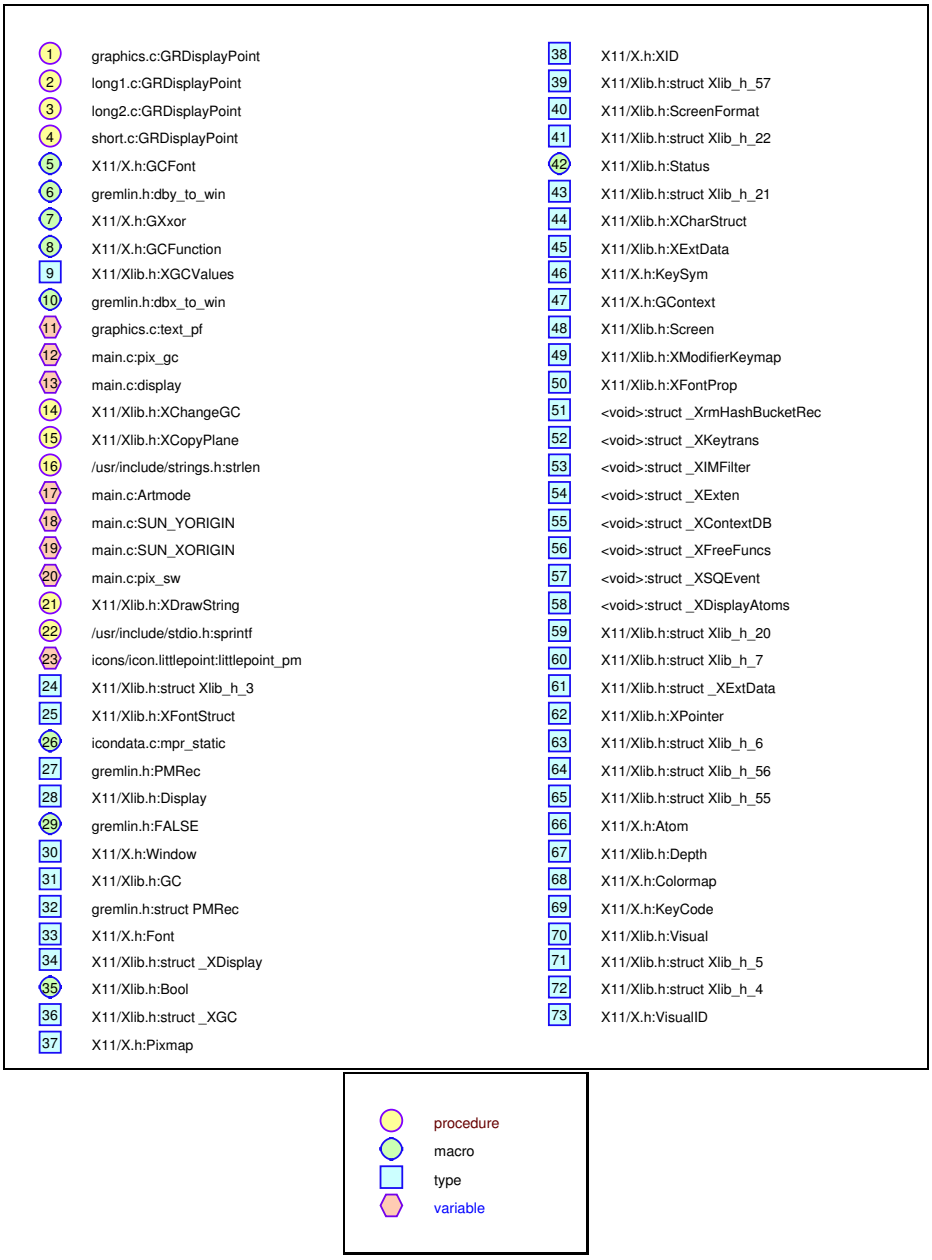


Figure 4: Graph B95 descriptions.

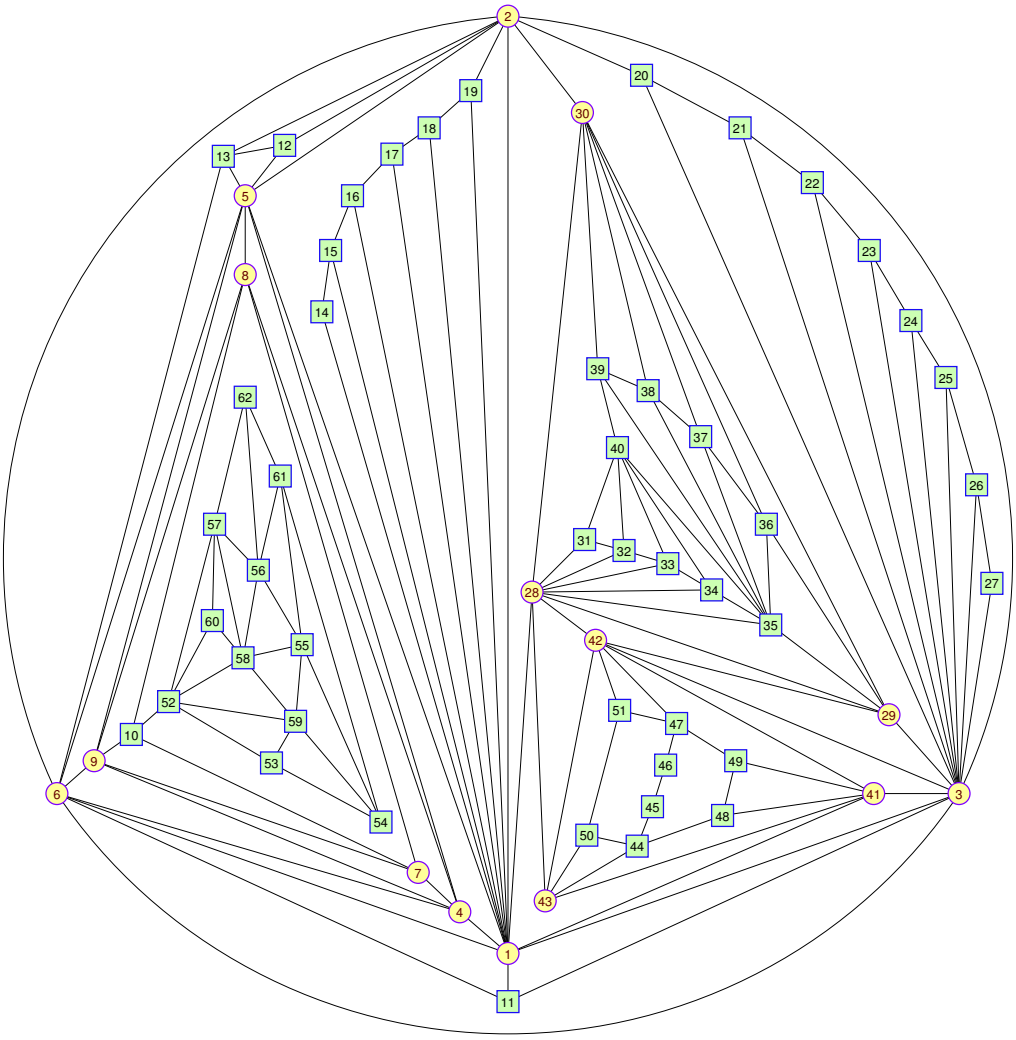


Figure 5: Graph C95 (***first prize***).

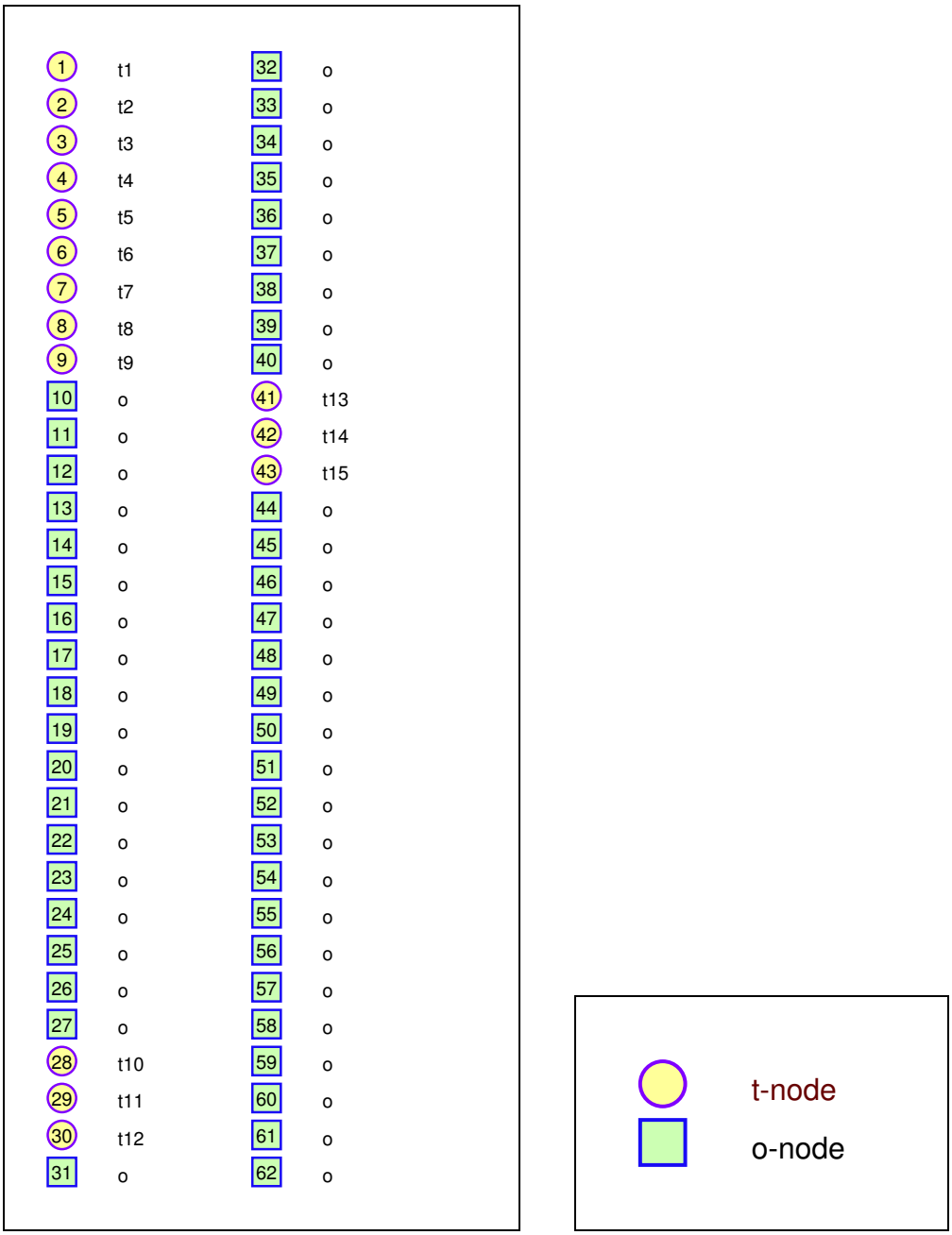


Figure 6: Graph C95 descriptions.

Layouts for Graph Drawing Contest 1996

In 1996 Graph Drawing Conference was helt in Berkeley, and the contest was organized by Peter Eades, Joe Marks, and Stephen North. Rules and data are desribed at:

`http://portal.research.bell-labs.com/orgs/ssr/people/north/contest.html`

Graph B96

- First layout was obtained automatically using our program `COORD`. (positioning vertices on the rectangular net so that the number of crossings of lines is as low as possible).
- Manual editing was performed to reposition vertices using our graph picture editor `DRAW`.

  The layout was awarded the honorable mention.

Graph C96

- Analysing graph C using our program `RELCALC` two parts and 2 connecting vertices were found.
- Each part was handled separately using our program `ENERG` (minimisation of energy). One part consists of a lattice structure, and the second of a planar graph of cylindric symmetries. This spatial picture was realized in VRML (produced from the description in our graph description language `NetML` based on `SGML`).
- Some manual editing was done for planar representation.

  The layout was awarded the first prize.

Graph D96

- Analysing graph D using program `RELCALC` 17 important vertices of 'kernel graph' were found.
- The first layout for these 17 vertices was obtained automatically using program `COORD`.
- Other vertices were added to the obtained picture.
- Some manual editing using `DRAW` was performed to reposition vertices to avoid crossings.

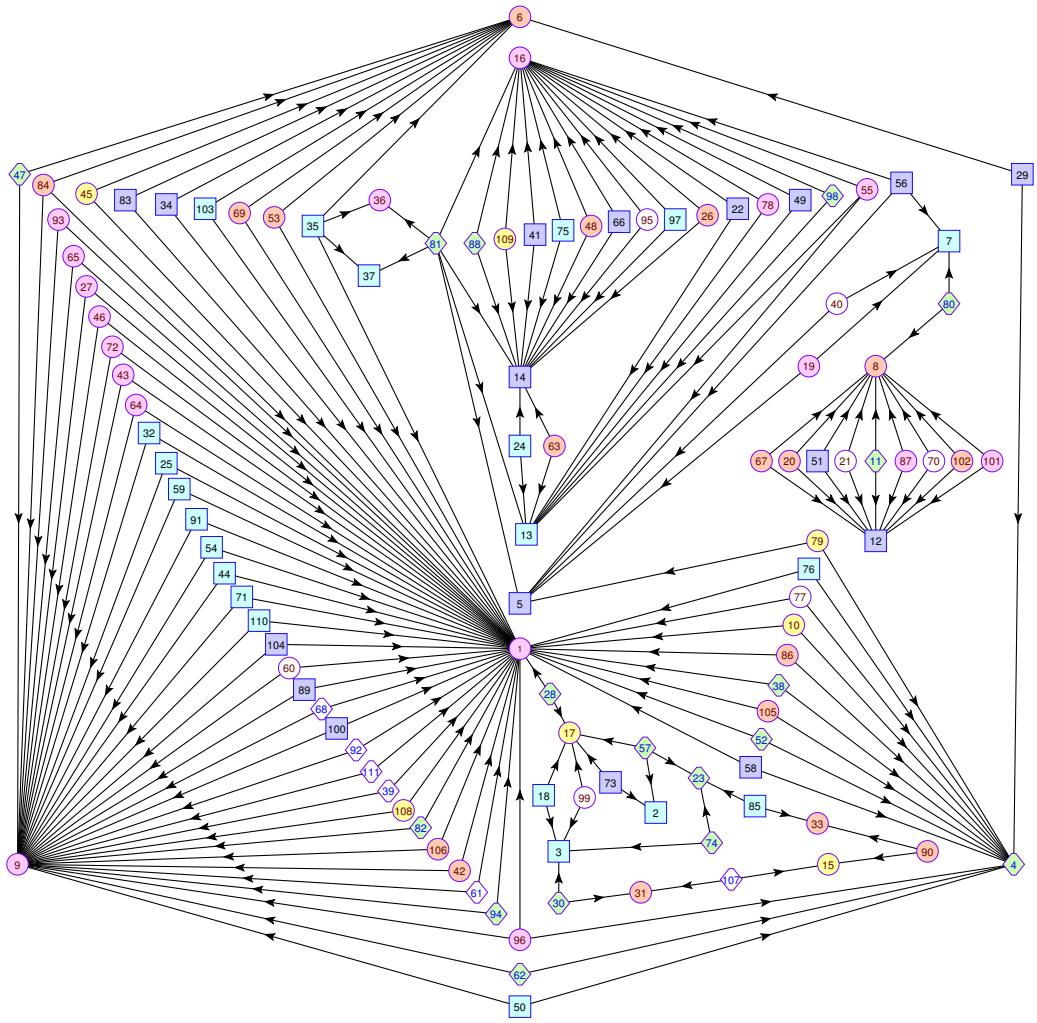


Figure 7: Graph B96 (***honorable mention***).

See: `http://vlado.fmf.uni-lj.si/pub/gd/gd96.htm`
The complete report of the contest is available in [10] and:
`http://www.merl.com/reports/TR96-24/index.html`

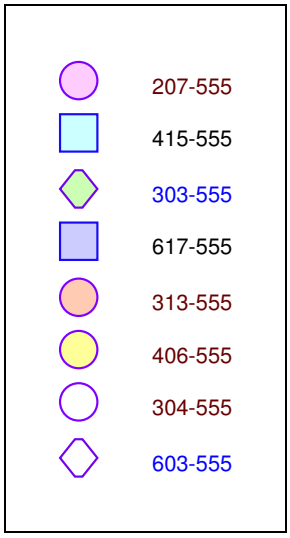


Figure 8: Graph B96 types.

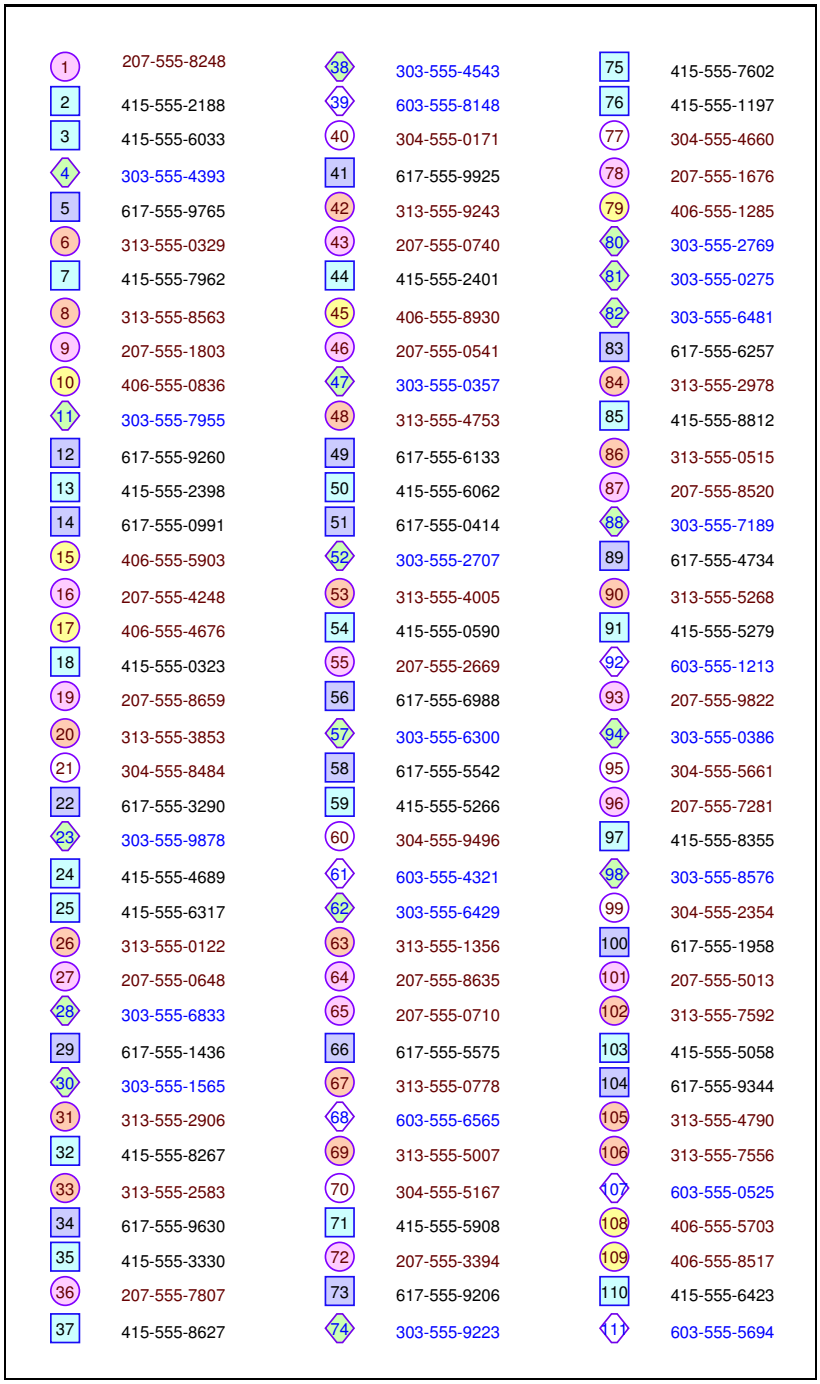


Figure 9: Graph B96 labels.

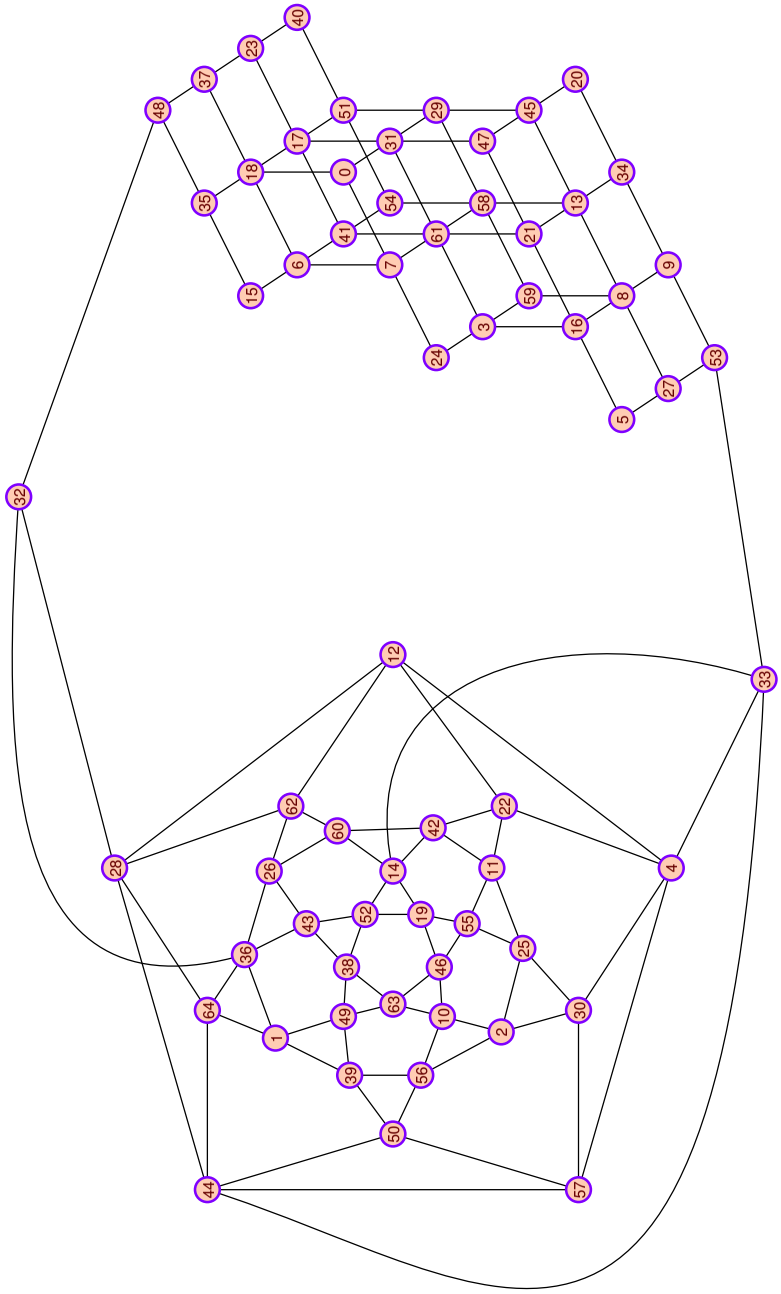


Figure 10: Graph C96 (***first prize***).

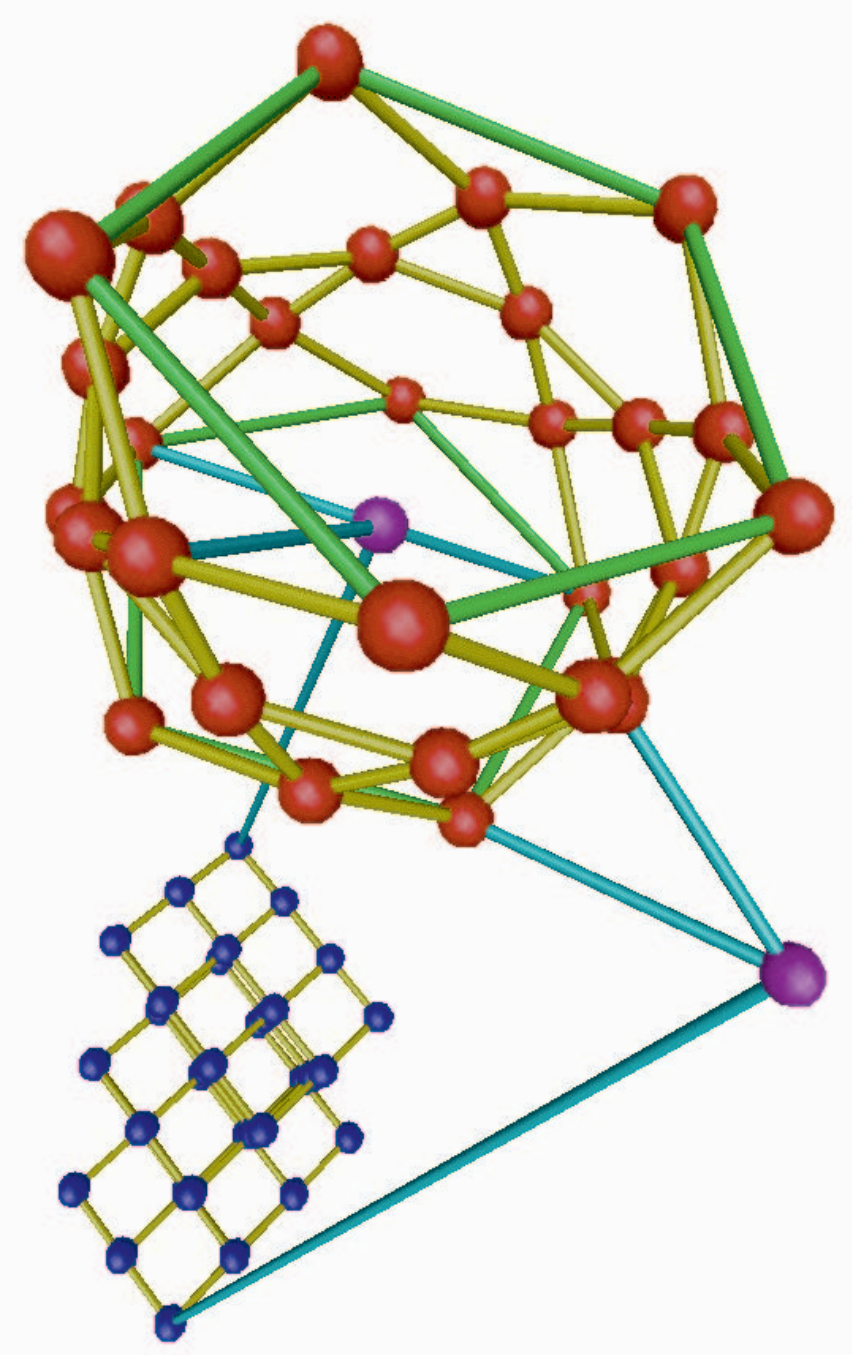


Figure 11: Graph C96 / VRML snapshot.

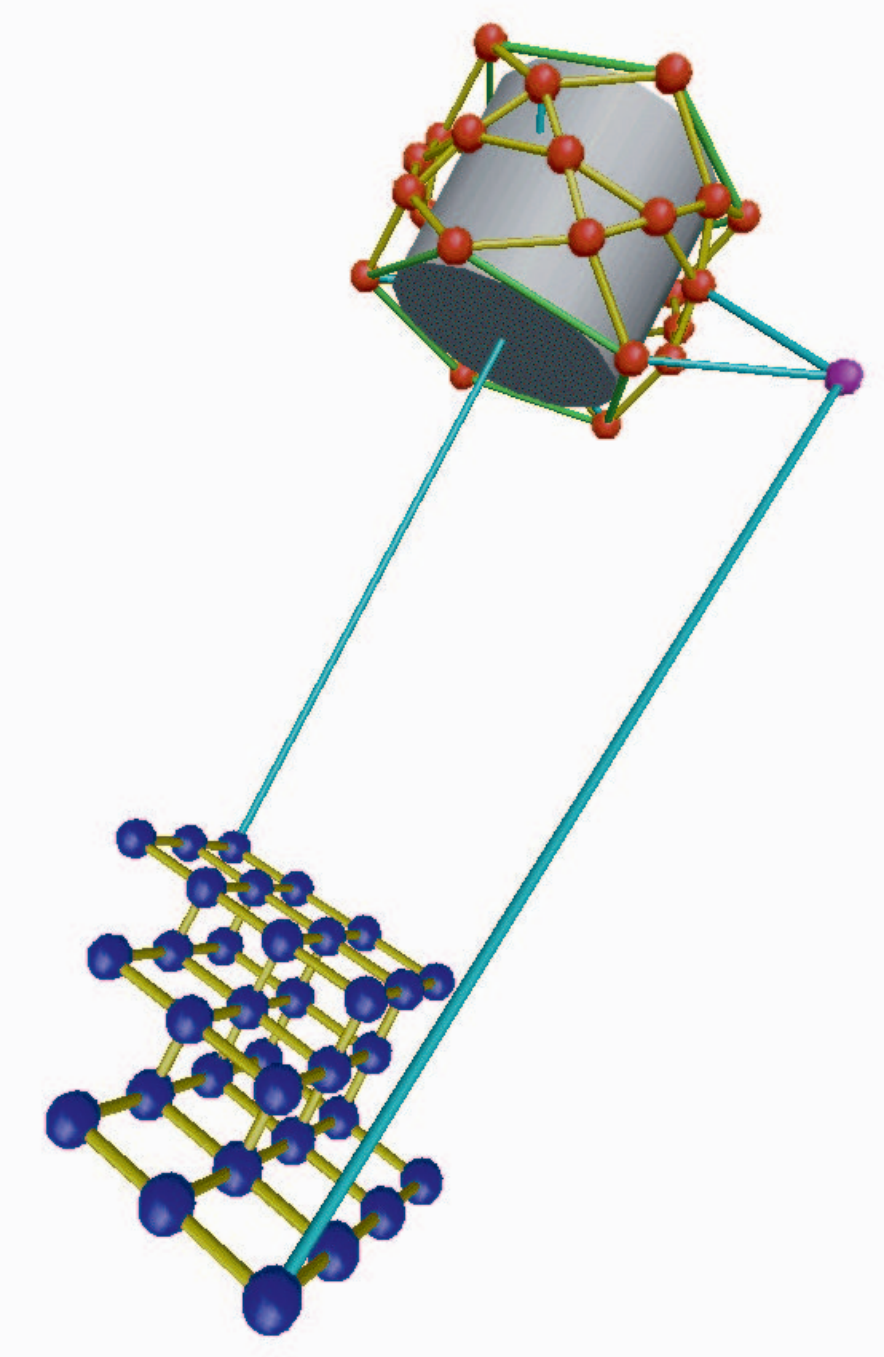


Figure 12: Graph C96 with cylinder / VRML snapshot.

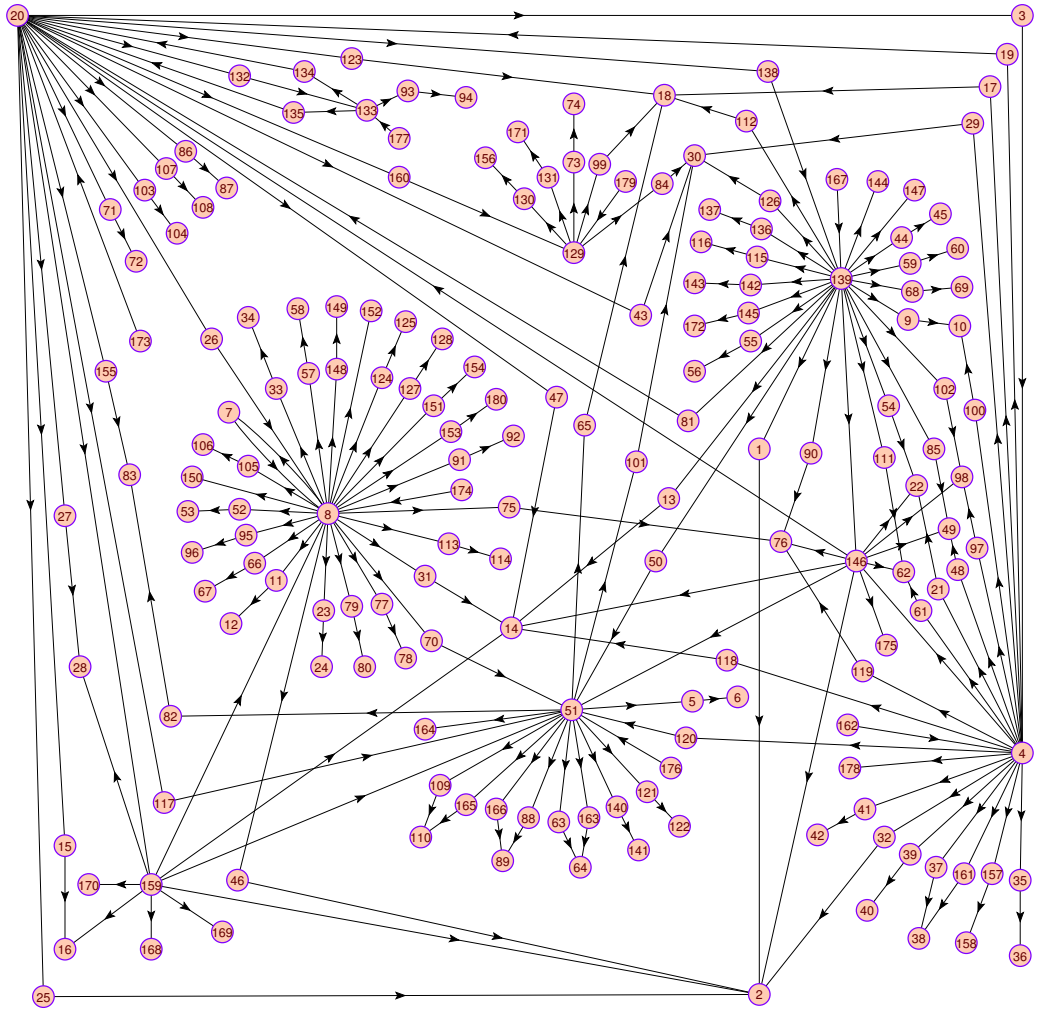


Figure 13: Graph D96.

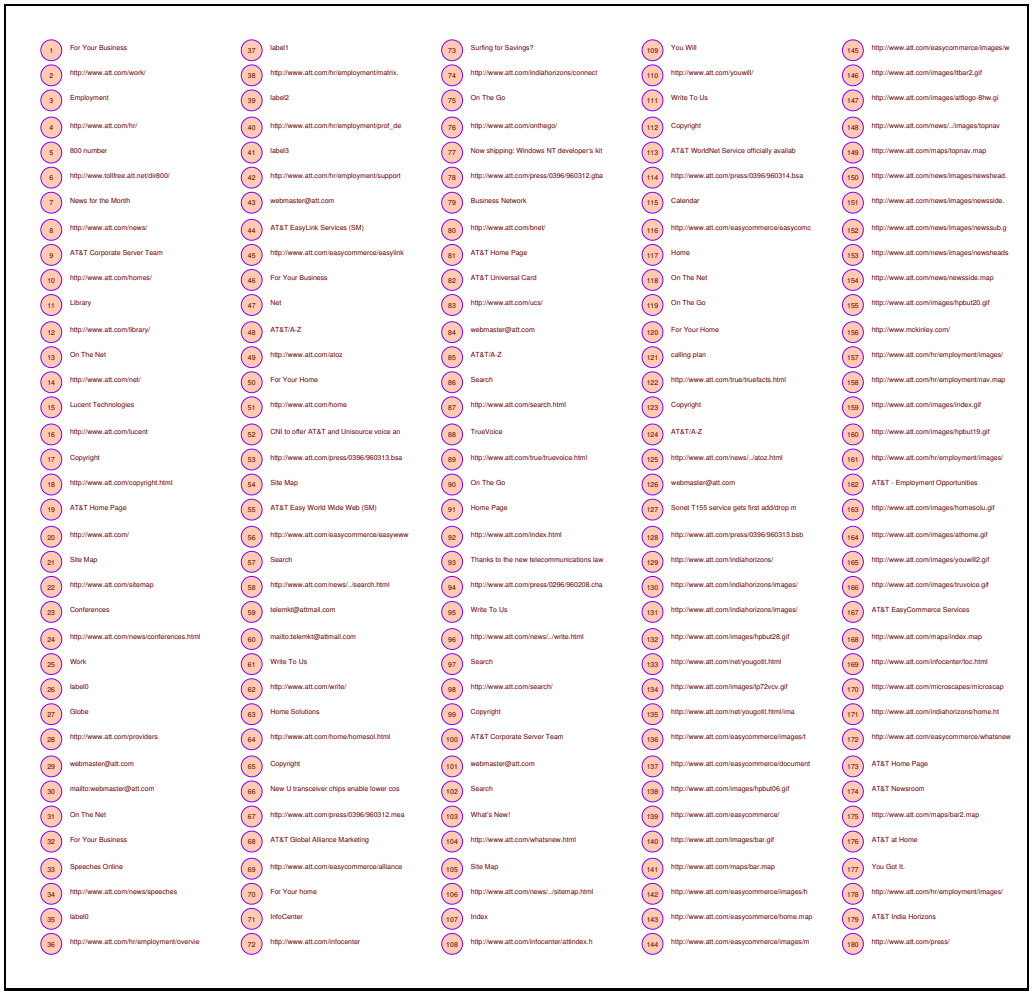


Figure 14: Graph D96 labels.

Layouts for Graph Drawing Contest 1997

In 1997 Graph Drawing Conference was helt in Rome and the contest was organised by Peter Eades, Joe Marks, and Stephen North. Rules and data are described at:
`http://portal.research.bell-labs.com/orgs/ssr/people/north/contest.html`

Graph A97

- First layout was obtained automatically using `draw/eigenvalues` option in program `Pajek`. Manual editing was used to reposition vertices in the grid to obtain orthogonal layout in plane.

  The layout was awarded the first prize.

- Manual editing in 3D was performed to get orthogonal embeddings in space: minimal, symmetric and cube.

Graph B97

- Analysing graph B using our program `MODEL` we obtained (almost) regular partition in 3 classes. The third class contains only vertex `Harmony Central`. The second class, represented by squares, contains 11 vertices that are connected only to the vertices in the class 1 (represented by circles). Vertices in class 1 are also connected to other vertices in the same class. We first drew all vertices in the class 1 in the center and vertices in class 2 separately – using class shrinking and circular drawing options in `Pajek`. Afterward we manually moved vertices of class 1 connected to only one vertex of class 2 close to this vertex. Finally we manually arranged the remaining vertices of class 1.

- We transformed given similarities s on arcs to dissimilarities $d = \frac{1}{1+s}$ and applied Ward's hierarchical clustering method to the obtained dissimilarity matrix. We produced a clustering into 12 clusters, shrank the graph using `Pajek`, and draw the obtained skeleton minimizing the number of crossings. Finally we manually arranged the vertices of original graph.

  The layout was awarded the first prize.

See also
`http://vlado.fmf.uni-lj.si/pub/gd/gd97.htm`
The complete report is available in [7] or at
`http://www.merl.com/reports/TR97-16/index.html`

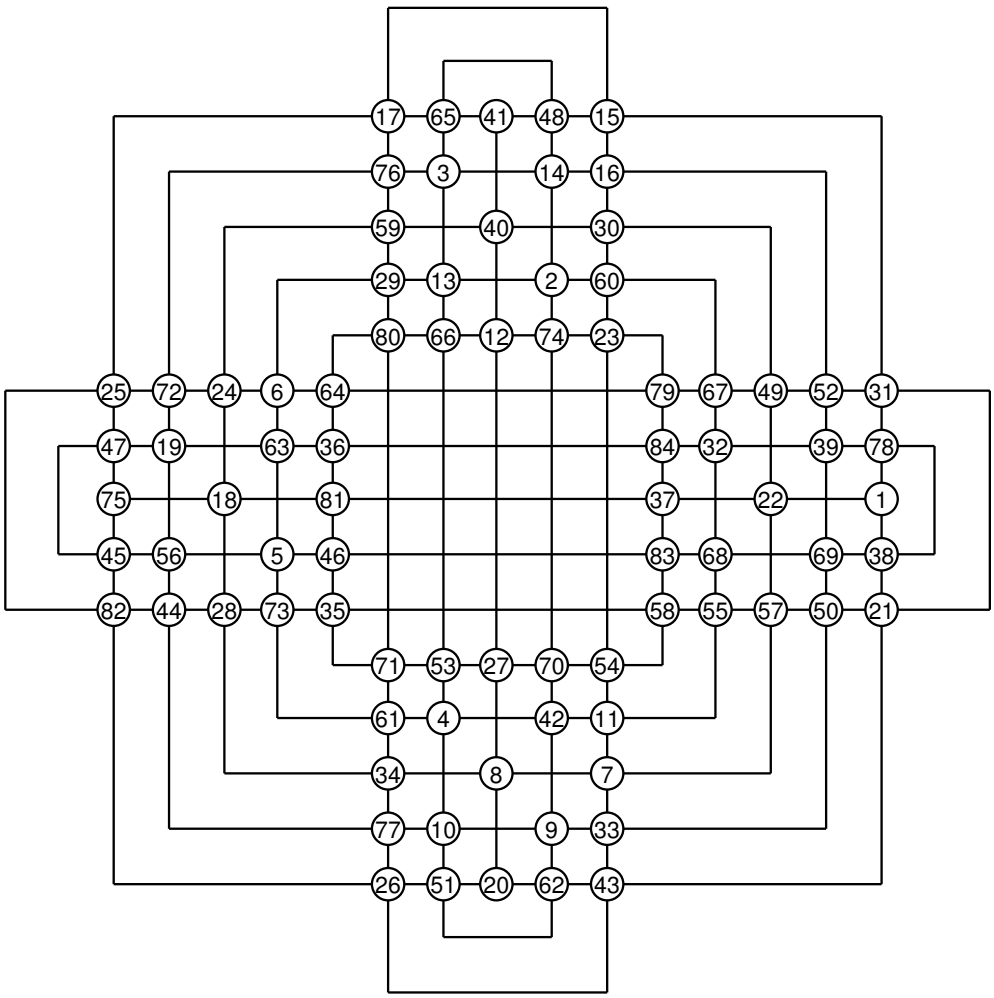


Figure 15: Graph A97 – orthogonal layout in plane (***first prize***).

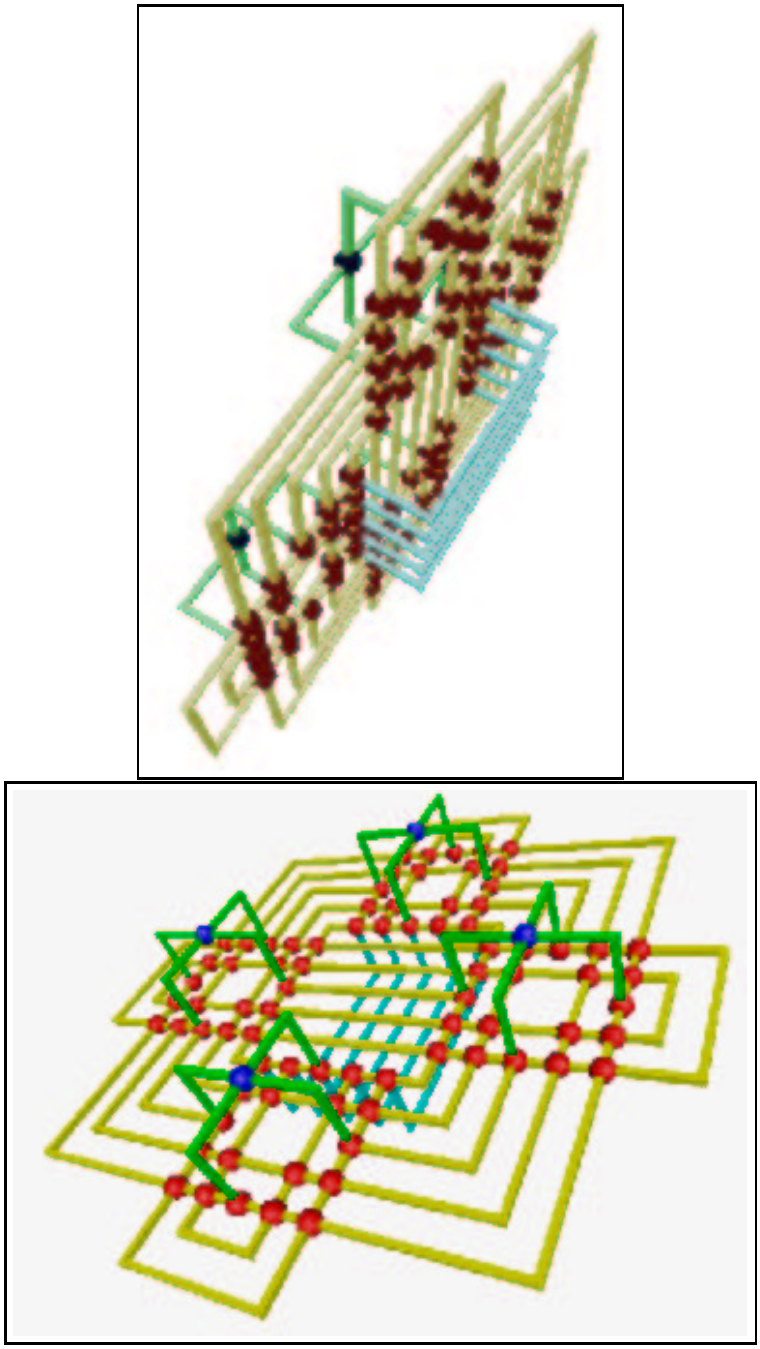


Figure 16: Graph A97 – 3D minimal / VRML snapshot.

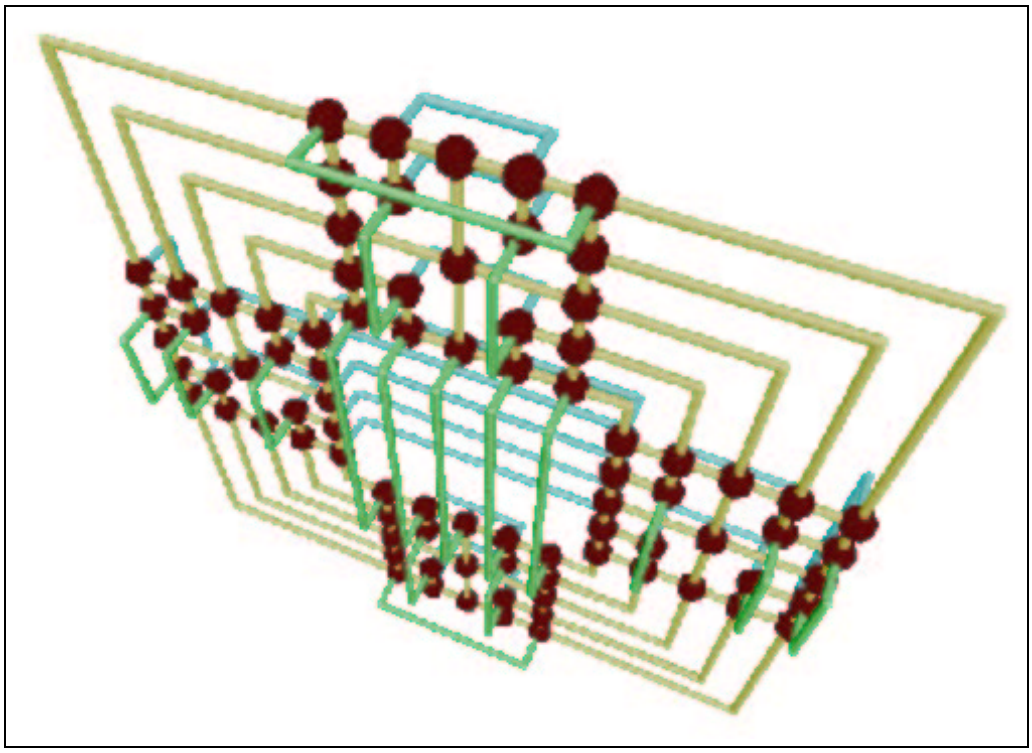


Figure 17: Graph A97 – 3D symmetric / VRML snapshot.

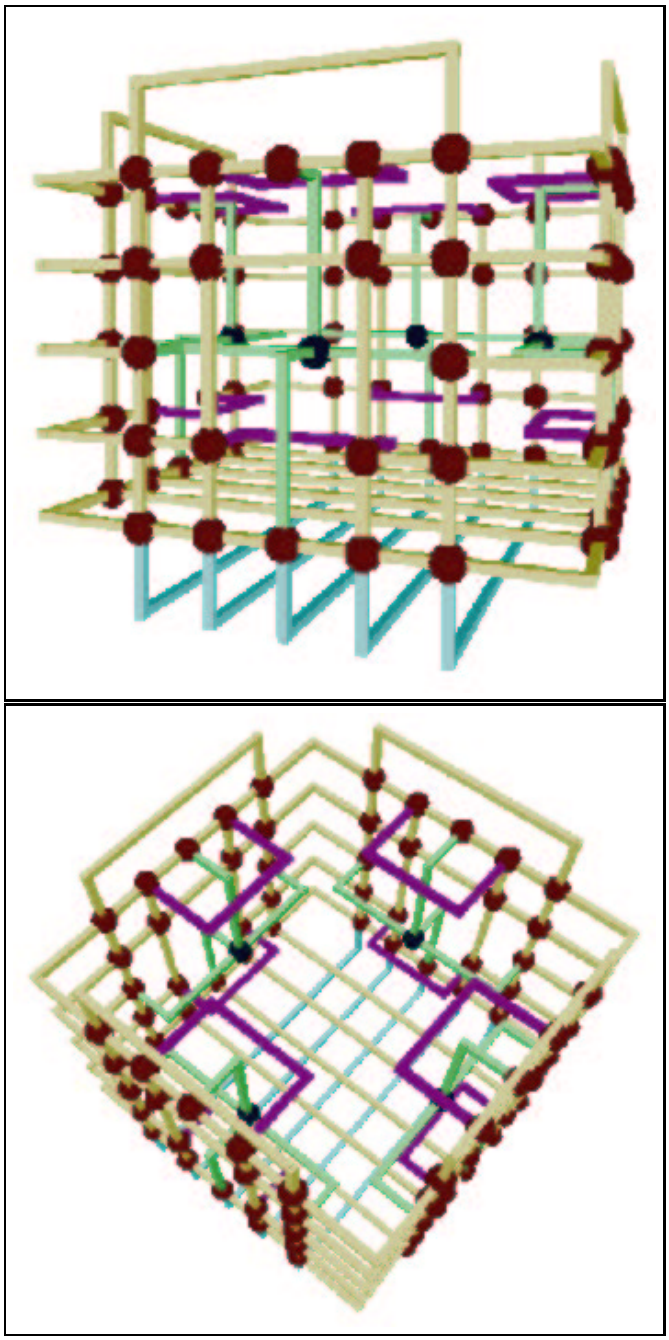


Figure 18: Graph A97 – 3D cube / VRML snapshot.

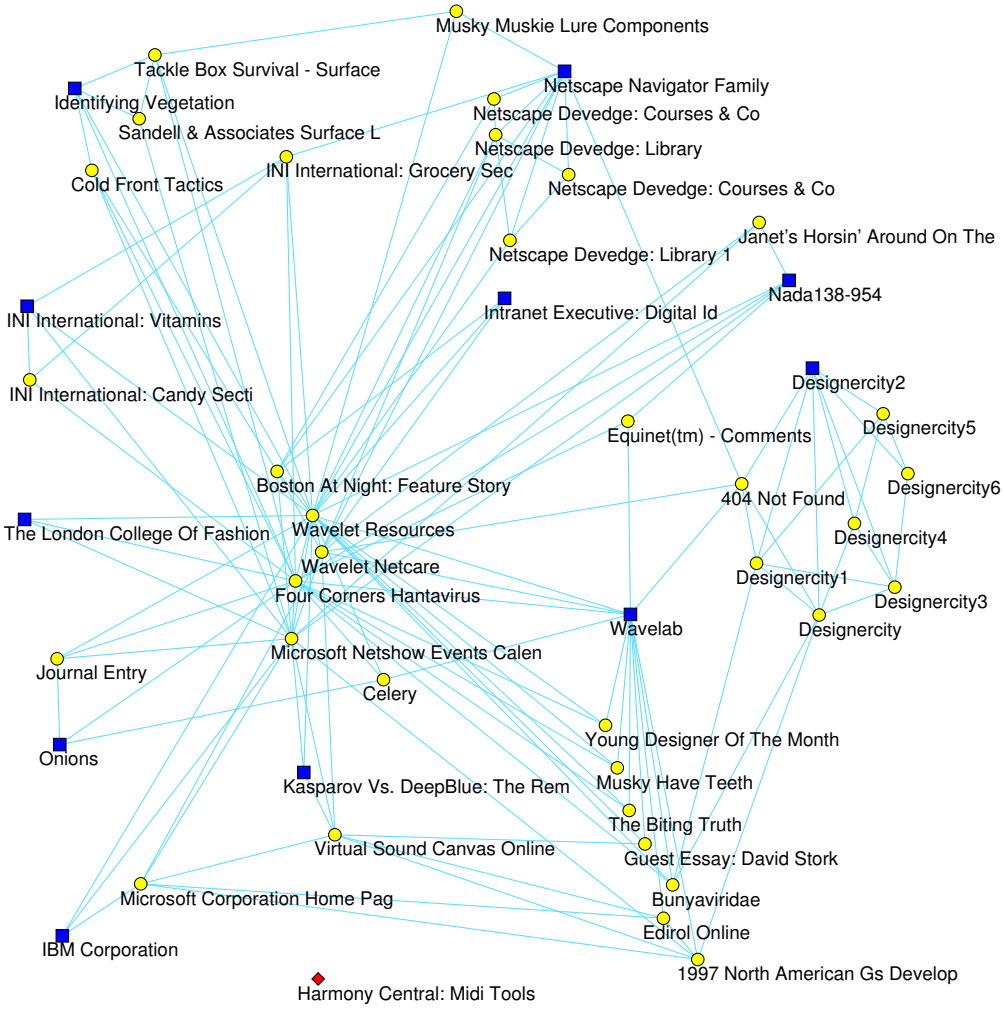


Figure 19: Graph B97 – regular equivalence.

CLUSE – ward [0.0, 4.80] Sep- 8-1997
Graph B / GD'97

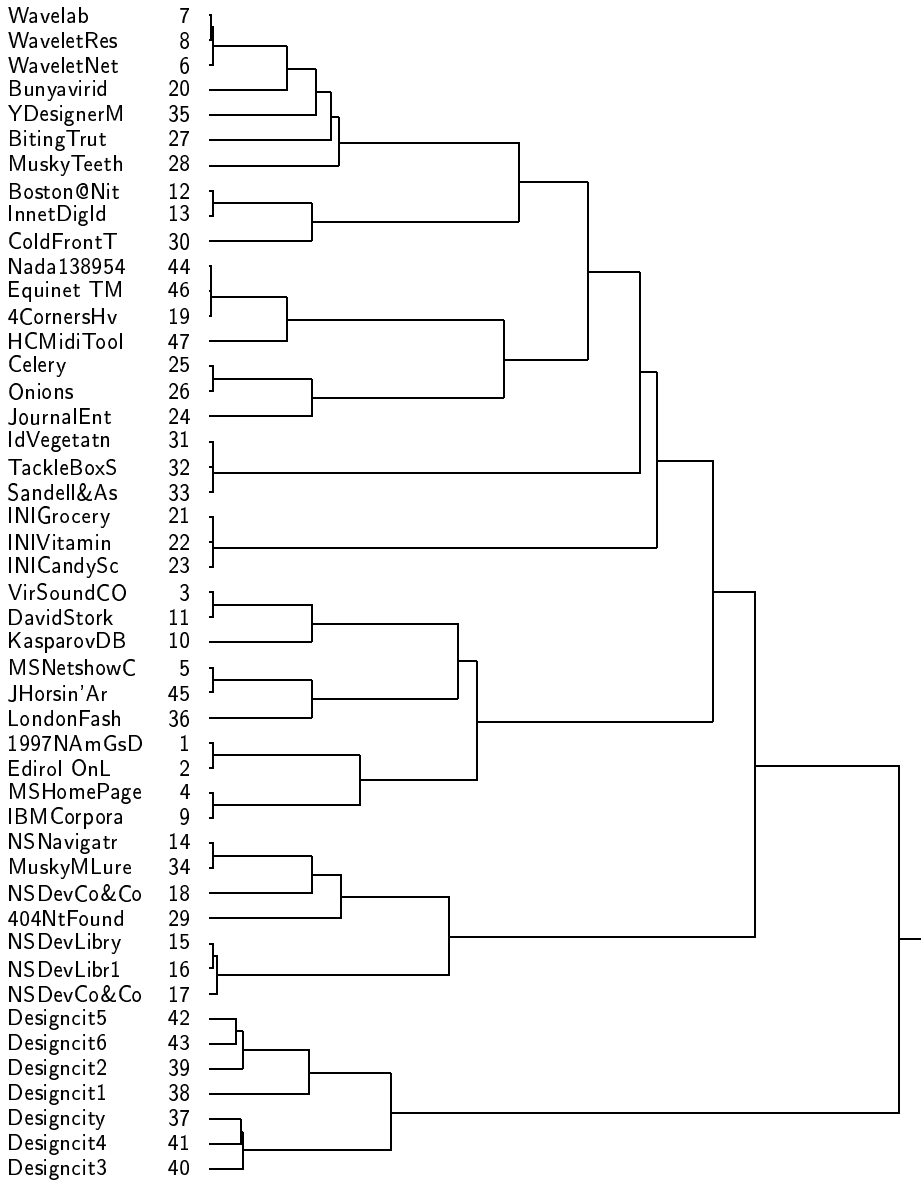


Figure 20: Graph B97 – Dendrogram for Ward's method.

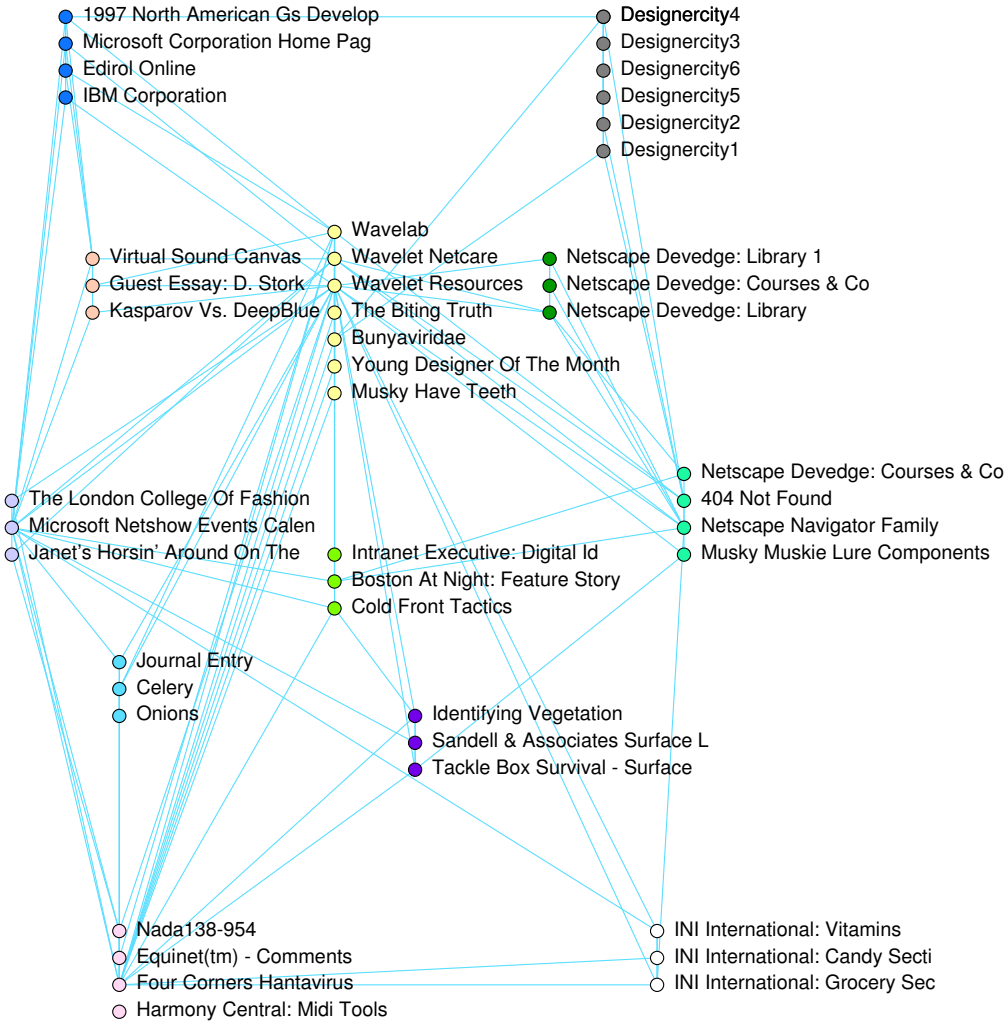


Figure 21: Graph B97 – Ward's clustering (***first prize***).

Layouts for Graph Drawing Contest 1998

In 1998 Graph Drawing Conference was helt in Montreal and the contest was organised by Peter Eades, Joe Marks, Petra Mutzel, and Stephen North. Rules and data are described at:

`http://gd98.cs.mcgill.ca/contest/`

All work was done using our program package `Pajek`, which is freely available at:

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

Graph A98

The data for graph A consist of addition and deletion operations that specify how the graph changes over time. In our solution addition and deletion operations were performed using macro language which is recognized by program package `Pajek`. Then we used `Microsoft Camcorder` (free software) to record the process. Selected layouts in three different time points are shown.

Graph B98

Symmetries in graph (with some exceptions) can easily be noticed. We started the drawing using the layout obtained using Fruchterman-Reingold spring embedder. Later we used manual editing to maximize symmetries and made some displacements according to different sizes and shapes of nodes. `Pajek` was used to do all the work.

The layout was awarded the first prize.

Graph C98

Using spring embedders we could not get any nice layouts. Analysing graph we found that it is a symmetric cubic graph. Later we used eigenvectors approach and computed eigenvectors of neighbourhood matrix that correspond to the largest eigenvalue (which is multiple). In this way we got nice symmetric picture in space (3D). According to symmetries (equivalences) some of the nodes are drawn on the same positions and some are overlapping when selecting the certain view to see the symmetries. Since some vertices are overlapping we built a list of overlapping vertices drawn in different colors:

Graph D98

There were no data available for this graph. The participants could send any picture that is inspired or related to graph drawing. We decided to generate graph from dictionary and sent some interesting subgraph of it.

Table 1: Overlapping vertices in graph C98

Group	Color	Vertices
1.	Yellow	13, 76
2.	Green	9, 12, 33,106
3.	Pink	39, 65, 88,112
4.	Blue	5, 20, 51, 63
5.	Fuchsia	68, 75, 85, 92
6.	White	36, 99
7.	Orange	21, 42
8.	Purple	23, 24, 55, 89
9.	NavyBlue	30, 44, 54, 57
10.	TealBlue	3, 11, 43,101
11.	OliveGreen	1, 18, 64, 74, 91,103,104,107
12.	Gray	19, 26, 47, 59
13.	Black	17, 40, 70, 79
14.	Maroon	48, 53
15.	LightGreen	25, 32, 35, 60, 66, 71, 73,105
16.	Cyan	10,102
17.	Yellow	2, 22, 81, 90
18.	Green	14, 58, 61, 83
19.	Pink	4, 15, 46, 52, 77, 78,109,110
20.	Blue	7, 8, 27, 41
21.	Fuchsia	6, 50, 67, 96
22.	White	82, 84, 95, 97
23.	Orange	31, 80
24.	Purple	16, 29, 98,108
25.	NavyBlue	38, 72, 86, 87
26.	TealBlue	37, 45
27.	OliveGreen	28, 62, 93,111
28.	Gray	34, 49, 56,100
29.	Black	69, 94

Large graph can be generated from words in a dictionary. We constructed a graph in which two words are connected iff one can be obtained from the other by changing single character (e. g. WORK – WORD) or by adding/deleting one character (e.g. EVER – FEVER). Then we took english words `graph-drawing-contest`, find all shortest paths between `graph` and `drawing` and between `drawing` and `contest`, draw the obtained graph using layers option in `Pajek` (layers are determined by distance from `drawing`). Additionally we added two puzzles:

- one difficult: find shortest paths alone,

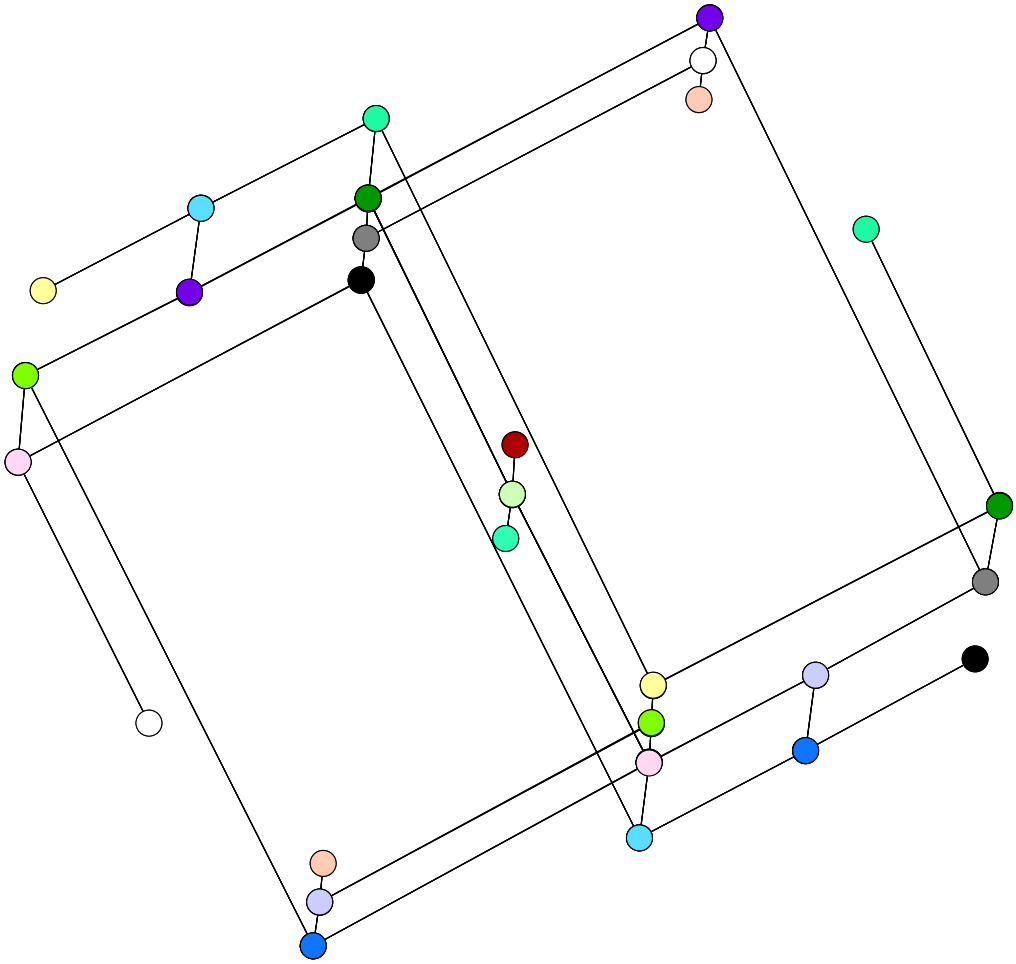


Figure 22: Graph C98.

- one easy: find only missing words on the paths.

See also: `http://vlado.fmf.uni-lj.si/pub/gd/gd98.htm`

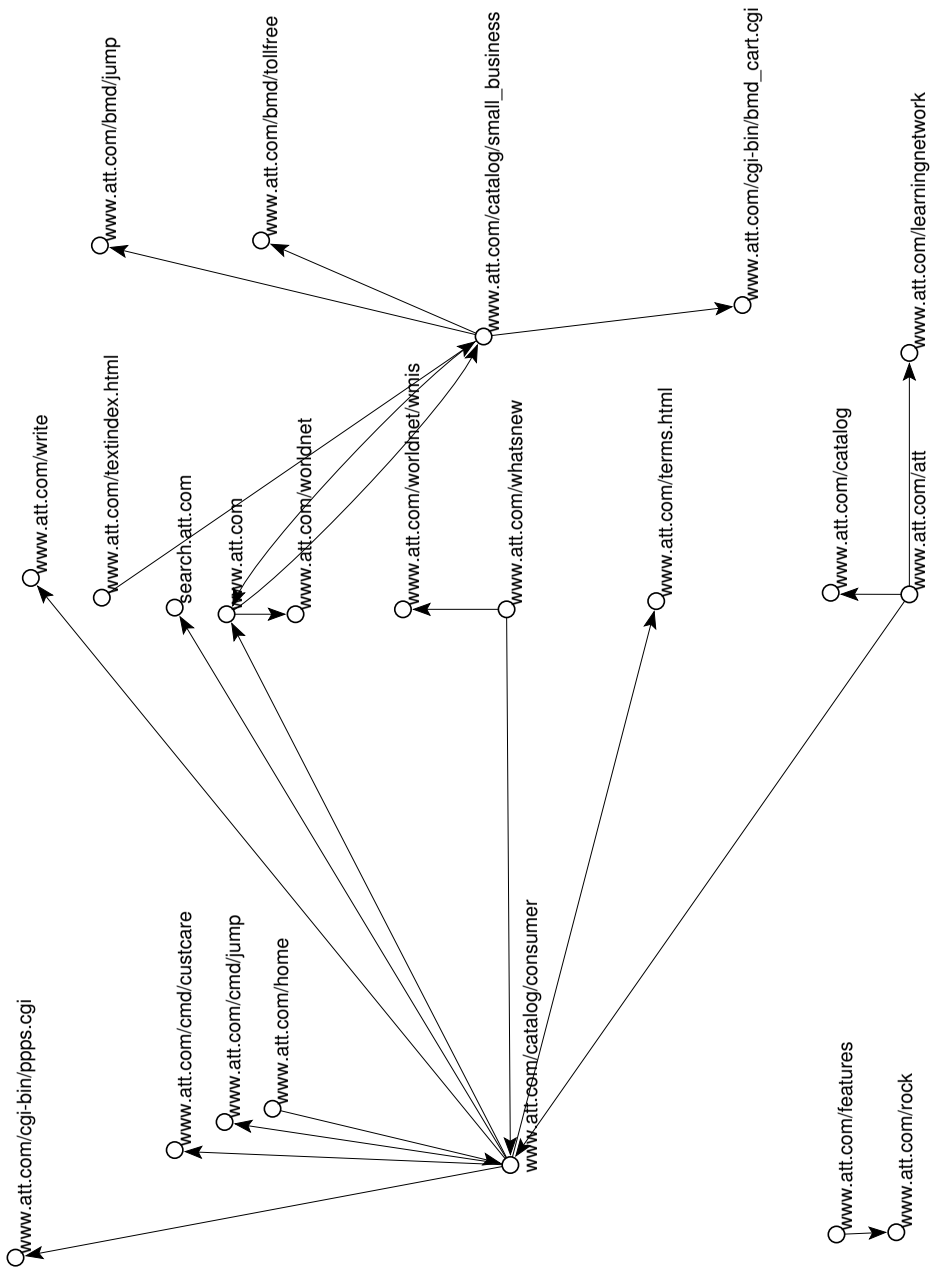


Figure 23: Graph A98, after executing deletion:
`delete www.att.com -> www.att.com/catalog/consumer`
(23 operations executed).

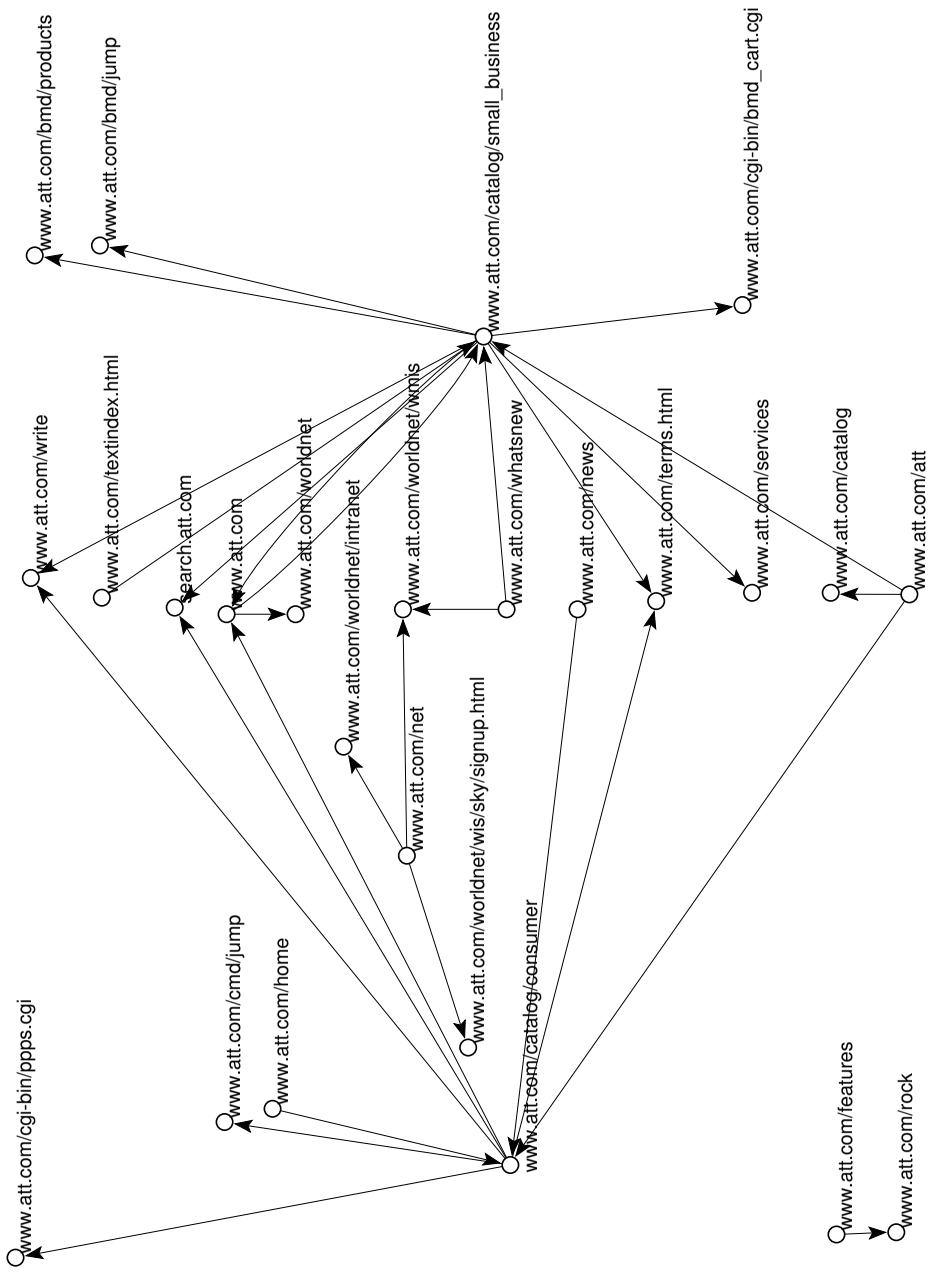


Figure 24: Graph A98, after executing deletion:
`delete www.att.com/whatsnew -> www.att.com/catalog/consumer`
(38 operations executed).

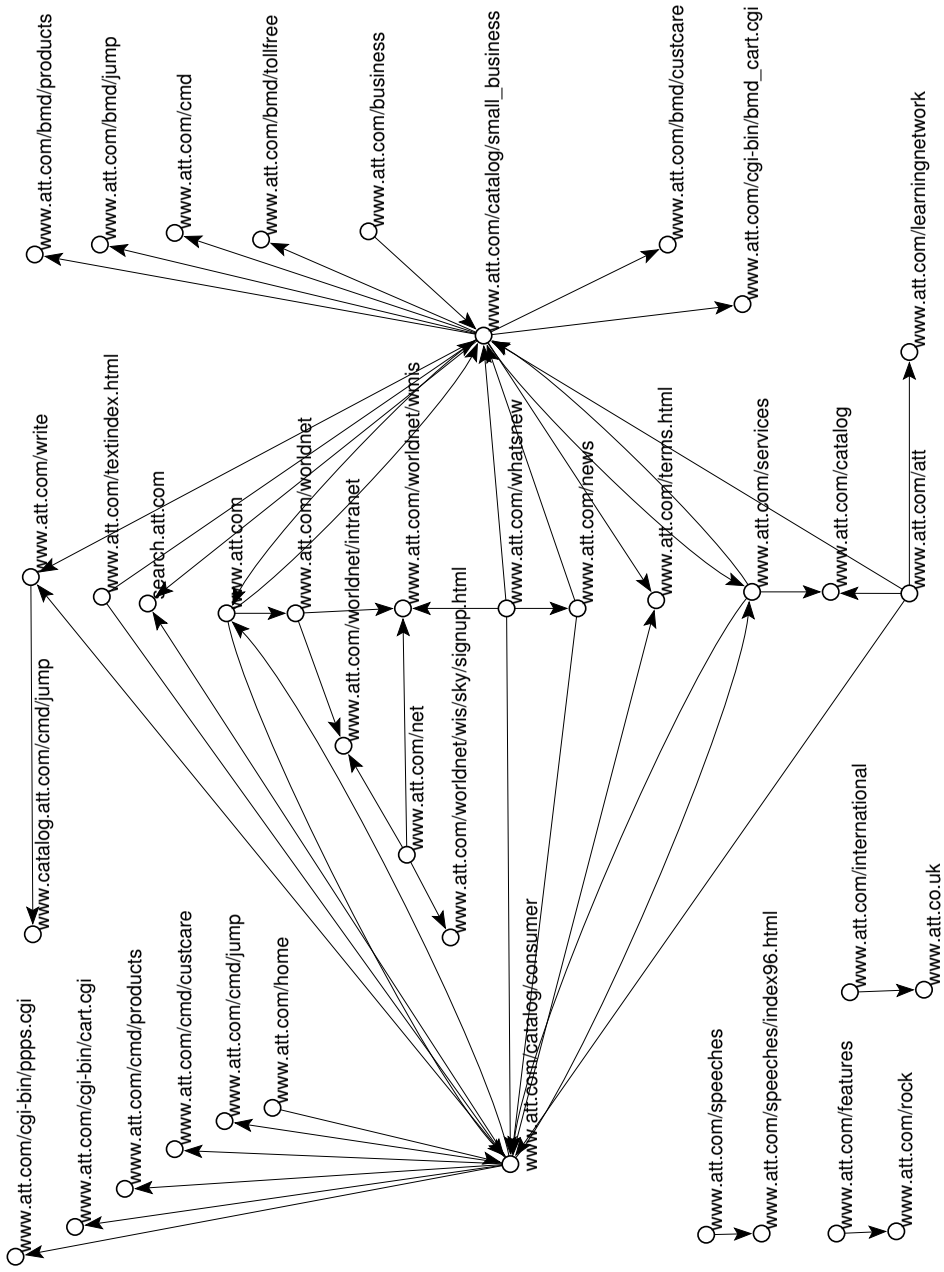


Figure 25: Graph A98, after all additions/deletions done (65 operations executed).

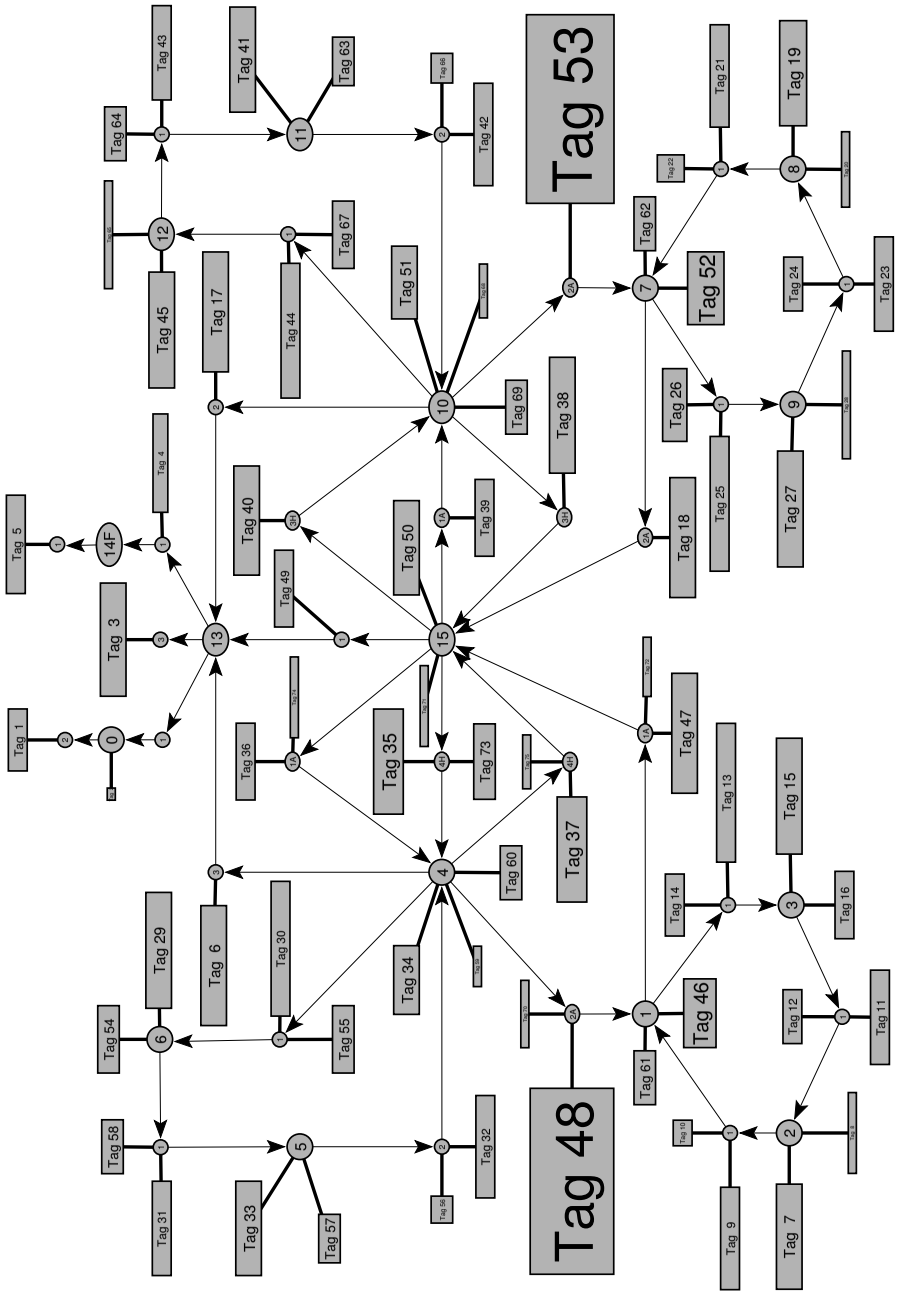


Figure 26: Graph B98 (*first prize*).

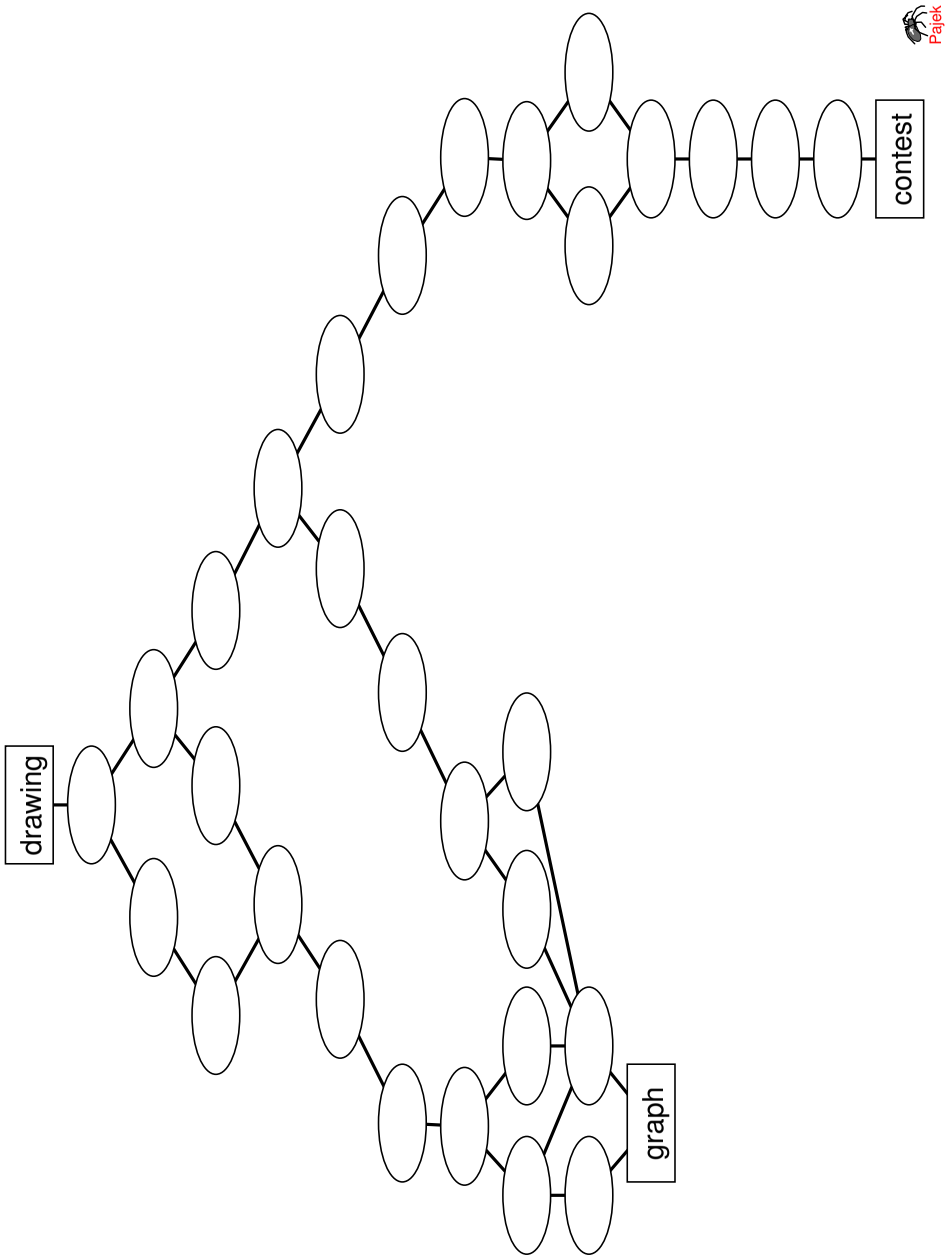


Figure 27: Graph D98: Difficult puzzle.

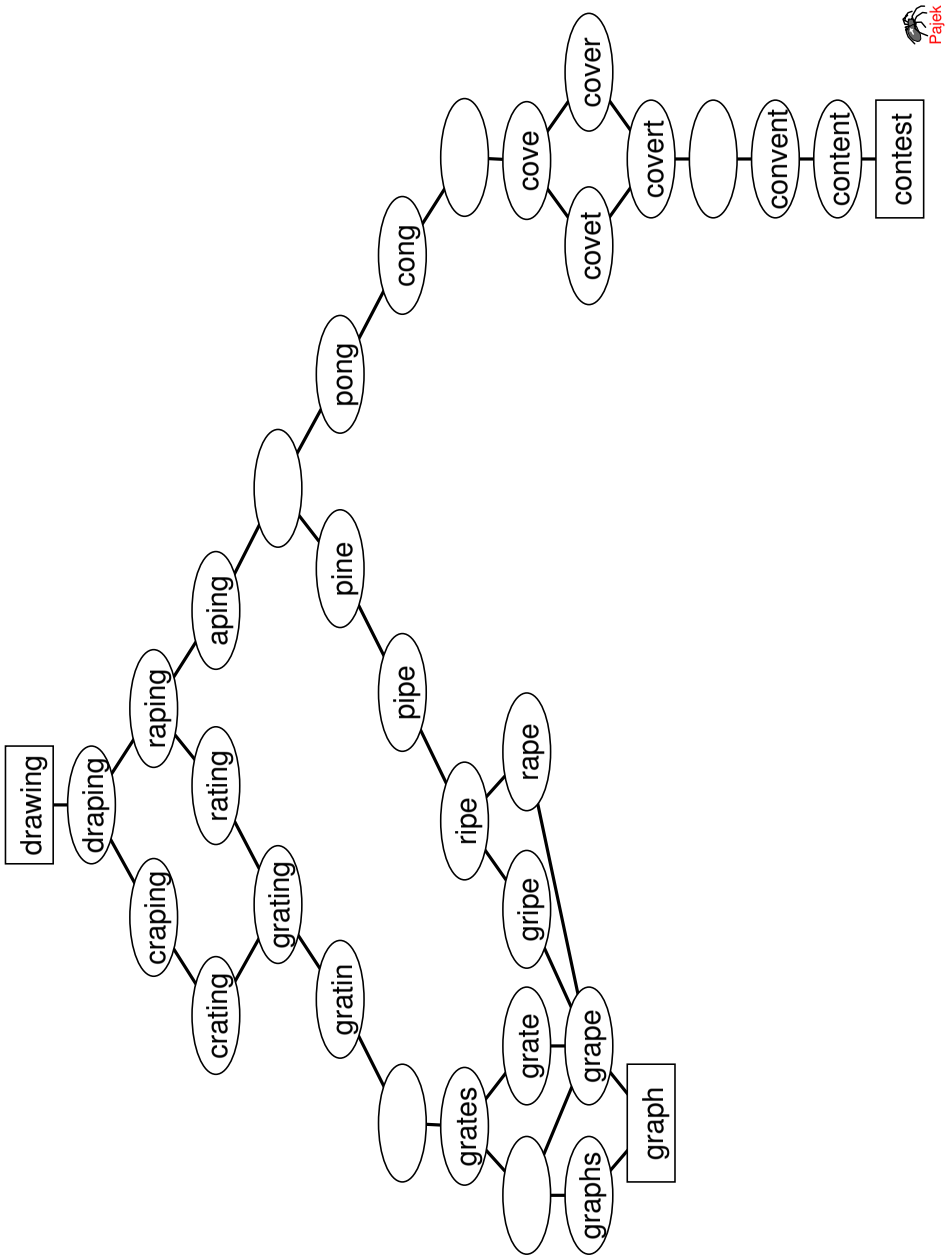


Figure 28: Graph D98: Easy puzzle.

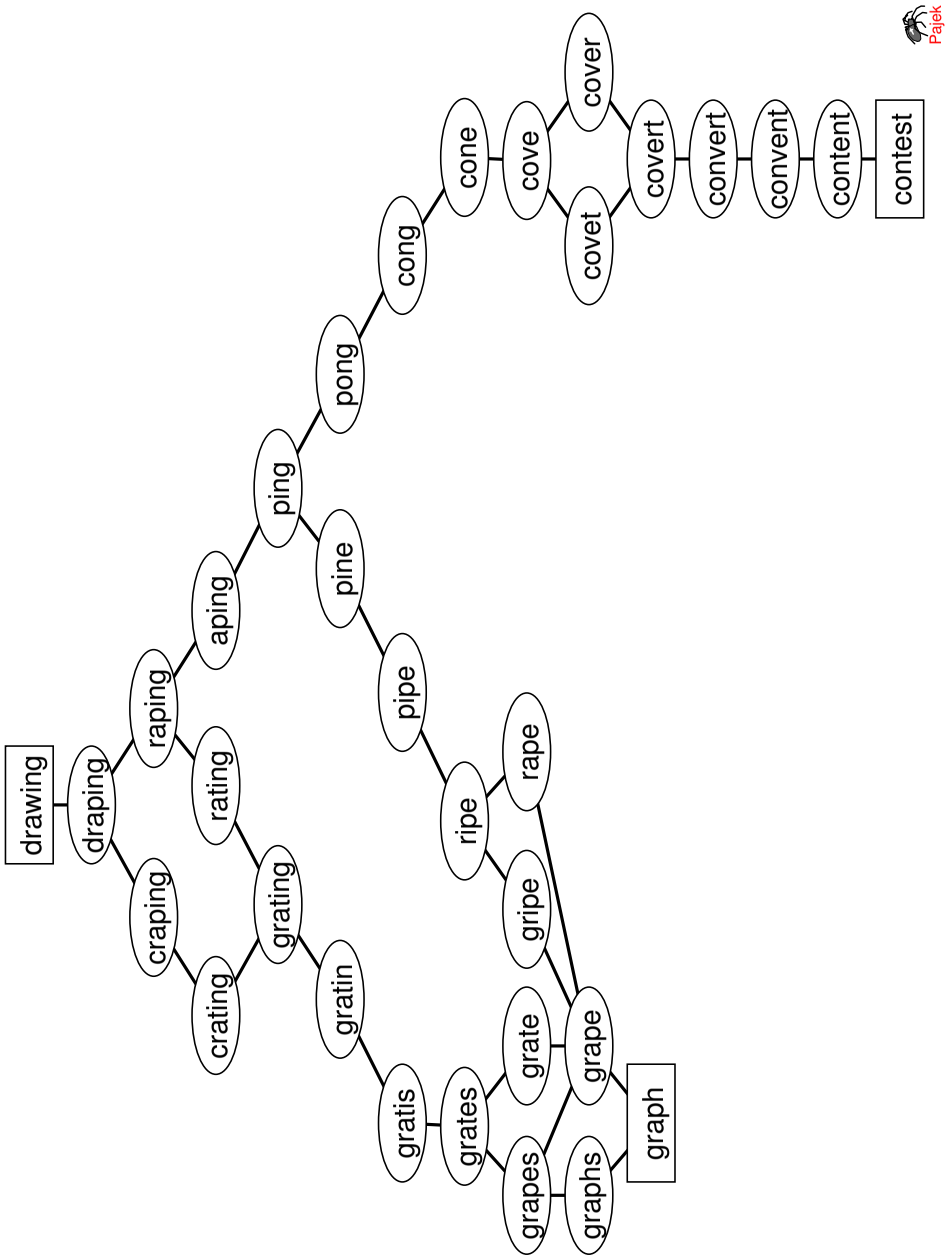


Figure 29: Graph D98: Solution.

Layouts for Graph Drawing Contest 1999

In 1999 Graph Drawing Conference was helt in Stirin (Czeck Republic) and the contest was organised by Franz Brandenburg, Michael Juenger, Joe Marks, Petra Mutzel, and Falk Schreiber. Rules and data are described at:

`http://www.ms.mff.cuni.cz/acad/kam/conferences/GD99/contest/rules.html`

All work was done using our program package `Pajek`, which is freely available at:

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

Graph A99

Graph data were transformed to Pajek format, which enables to handle graph changes over time. The following coding of actors is used:

- Shapes
  - circle: =f= female
  - triangle: =m= male
  - yellow box: =b= female+male (Ernst+Lisl Wiesenhuber)
  - green box: =a= women+grandchildren (Julia von der Marwitz)
  - black diamond: =w= widowed
  - pink diamond: =d= divorced marriage
  - orange diamond: =m= still existing marriage
  - empty: =i= invisible node (white)
- Sizes
  - 0.8 - big
  - 0.4 - small
  - 0.6 - artificial
- Colors
  - =y= unactive characters (yellow)
  - =a= 2 persons in 2 different colors (green)
  - =b= active characters (blue)
  - =d= divorced marriage (pink)

  - =w= characters that never showed up personally (white)
  - =m= still existing marriage (orange)
  - =g= already dead characters (grey)
  - =w= widowed (black)

- Border widths
  - =p= picture - border width = 2
  - =s= symbol - border width = 0.5

Drawing of the current situation We started the drawing using the layout obtained by Kamada-Kawai spring embedder. Later we used manual editing to arrange them on rectangular net.

Development of the graph over time We used the Pajek option for drawing graphs in different time points. Only time points where at least one vertex or one line changes according to last layout were drawn (e.g. 1, 2, 4, 5,...). After each change time the layout of the new graph was optimized starting with the previous positions.

The layout was awarded the first prize.

Graph B99

We used eigenvectors approach and computed eigenvectors of Laplacean matrix that correspond to the 1st, 2nd and 5th largest eigenvalue. No additional manual editing was used on the obtained spatial picture. Suitable view was selected to get planar EPS picture. Picture was exported to formats for the following 3D viewers: VRML (CosmoPlayer), kinemages (Mage), and MDLMOLfile (Chime).

The layout was awarded the second prize.

Graph C99

We started the drawing using the layout obtained by Fruchterman-Reingold spring embedder. Later we used manual editing to maximize 'rectangularity' and made some displacements to accommodate for different sizes of nodes.

See: `http://vlado.fmf.uni-lj.si/pub/gd/gd99.htm`.

The complete report of the contest is available in [8].

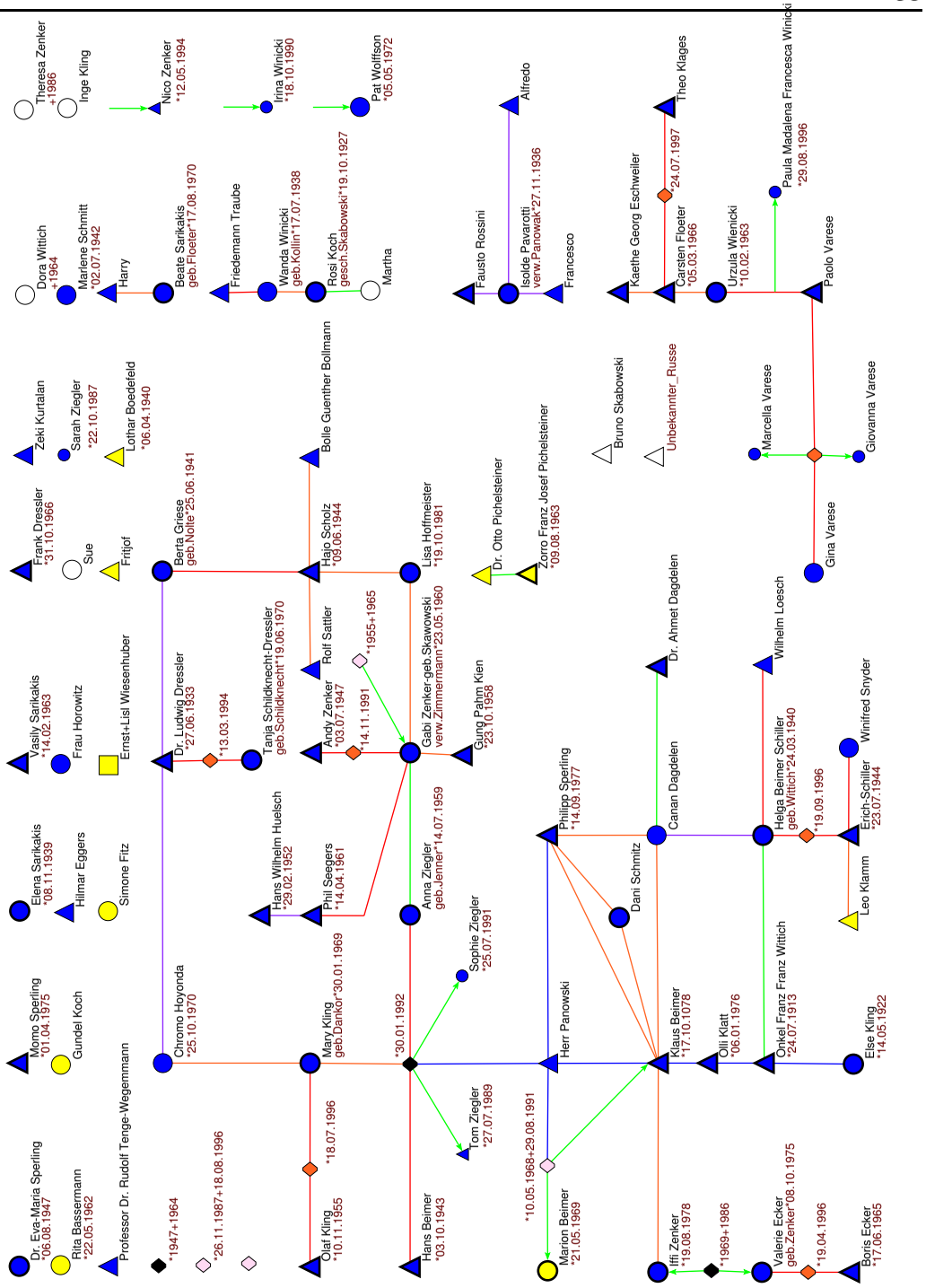


Figure 30: Graph A99, current situation.

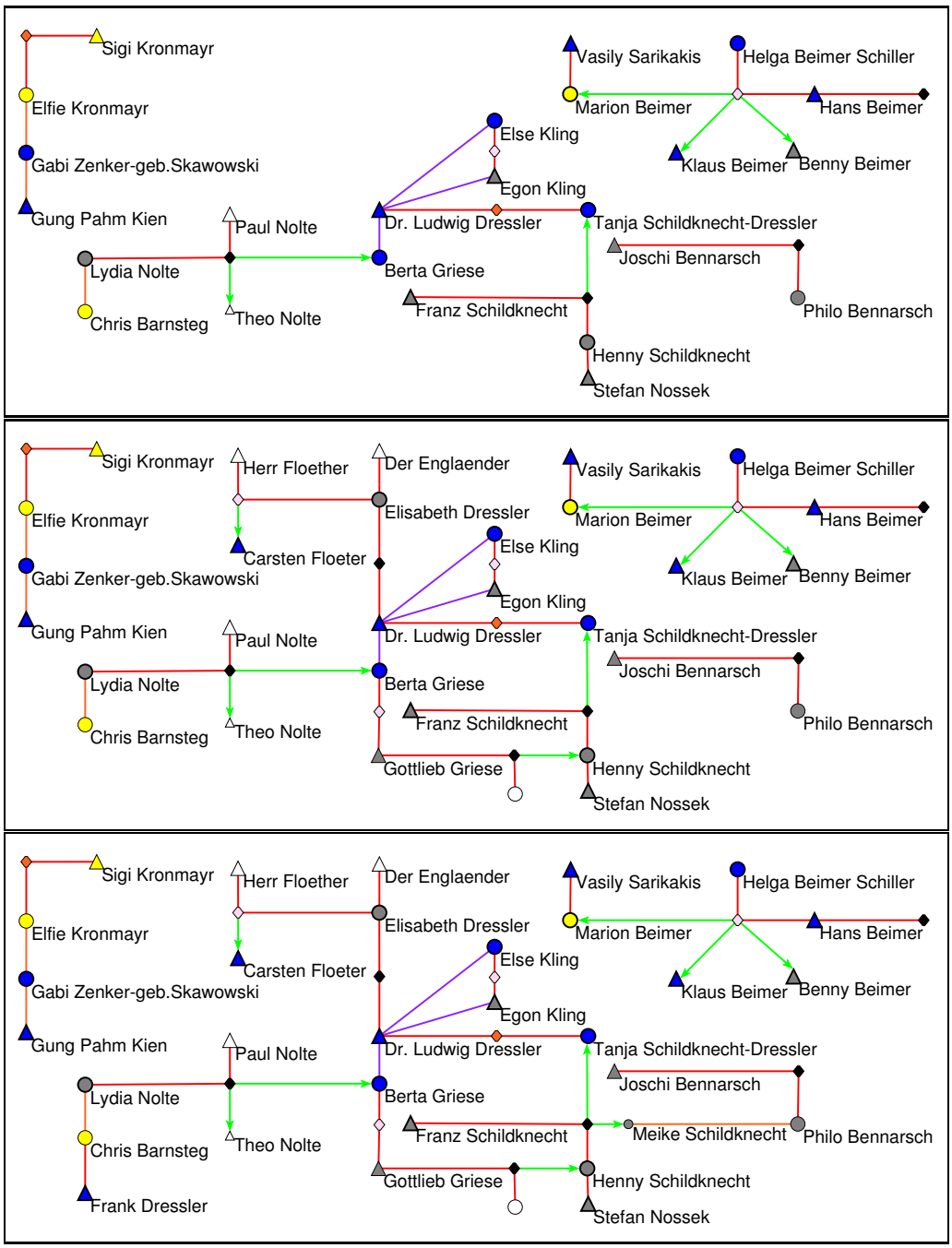


Figure 31: Graph A99, time points 5, 6 and 7 (***first prize***).

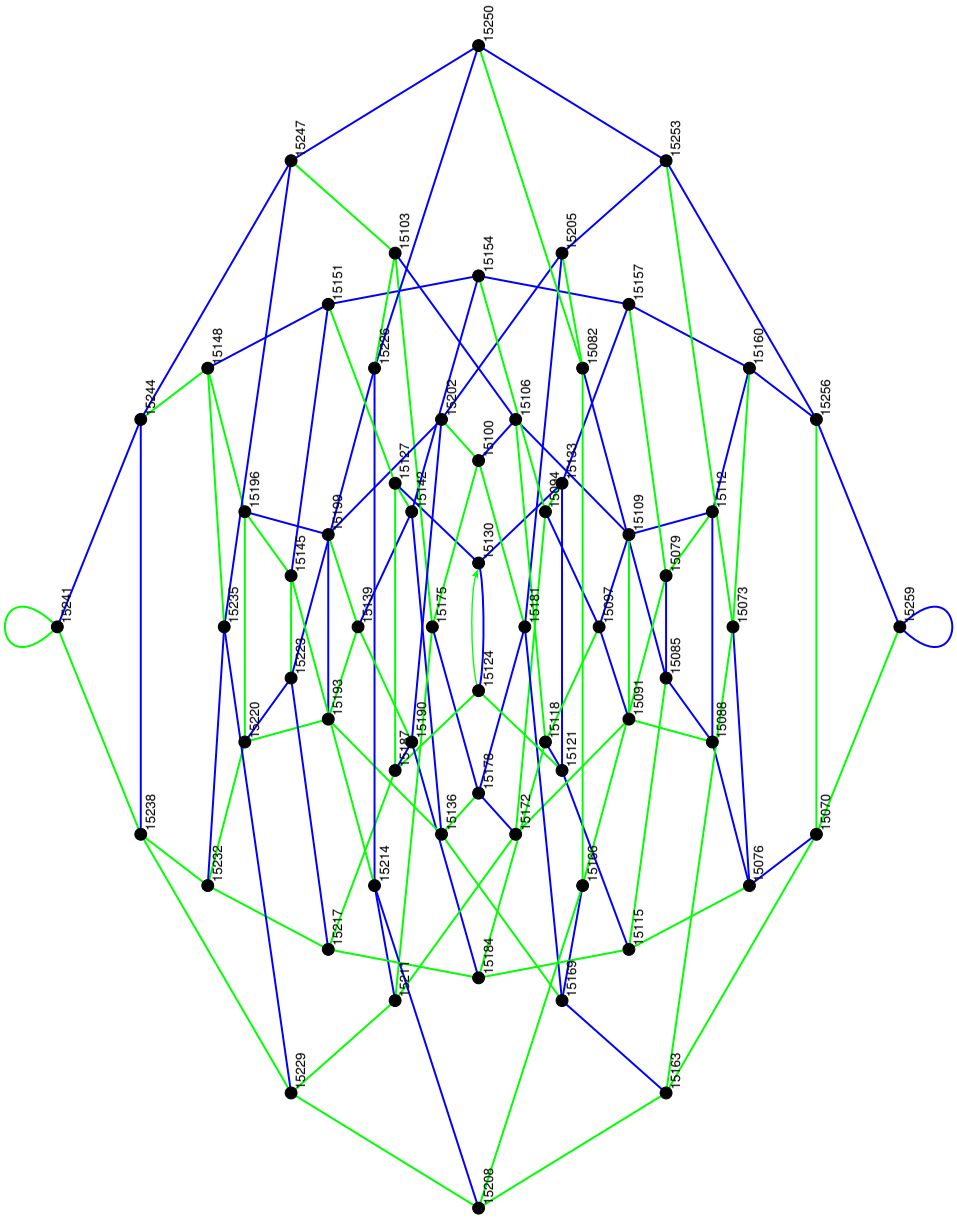


Figure 32: Graph B99 (***second prize***).

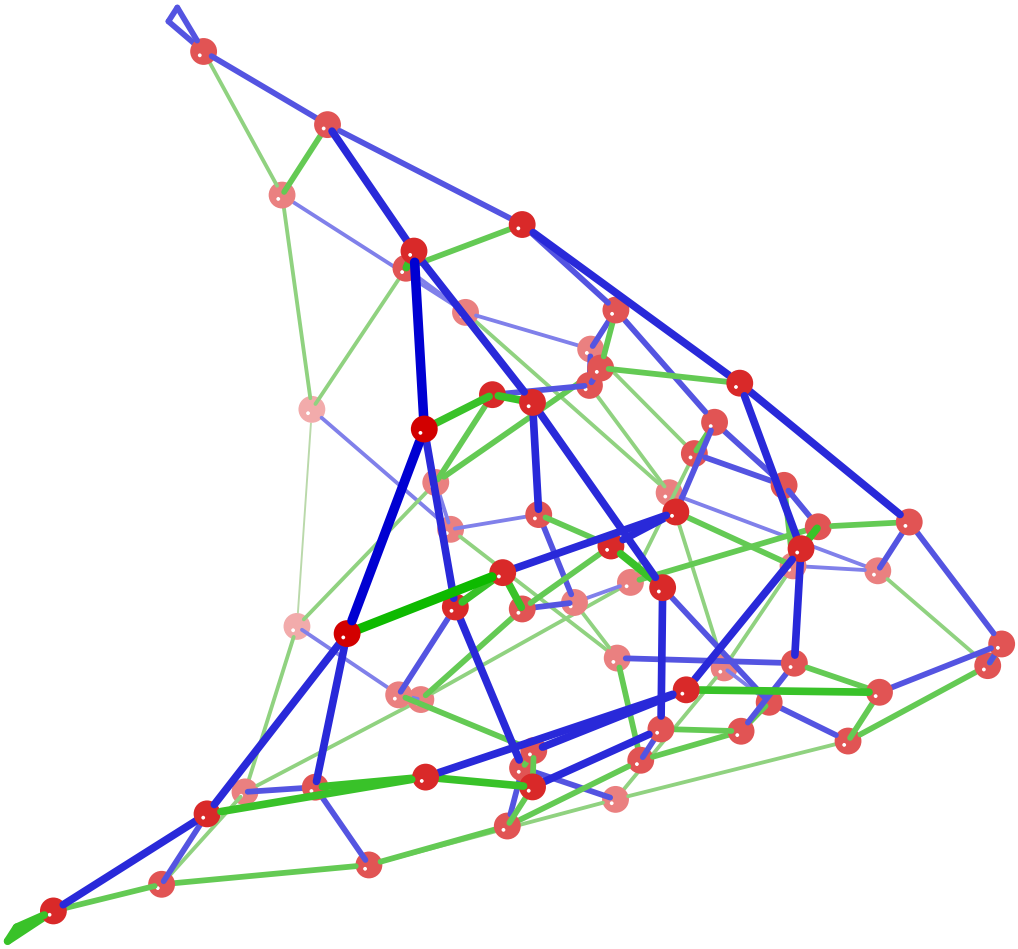


Figure 33: Graph B99 – general view.

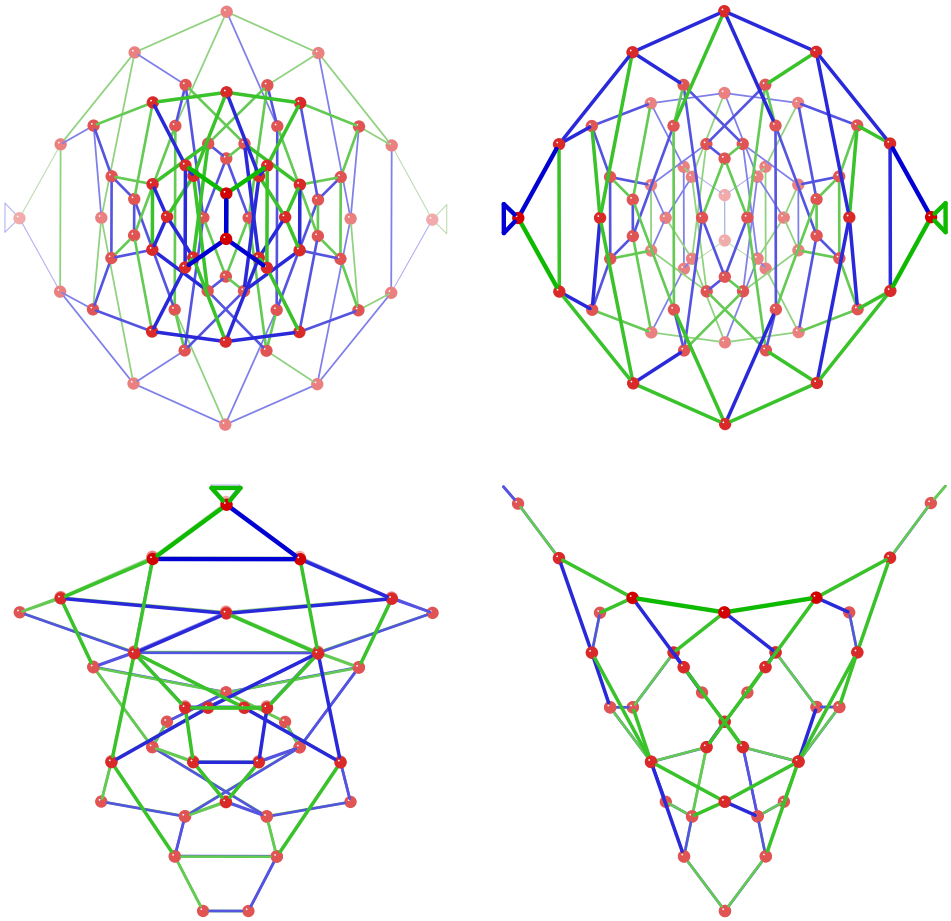


Figure 34: Graph B99 – different views.

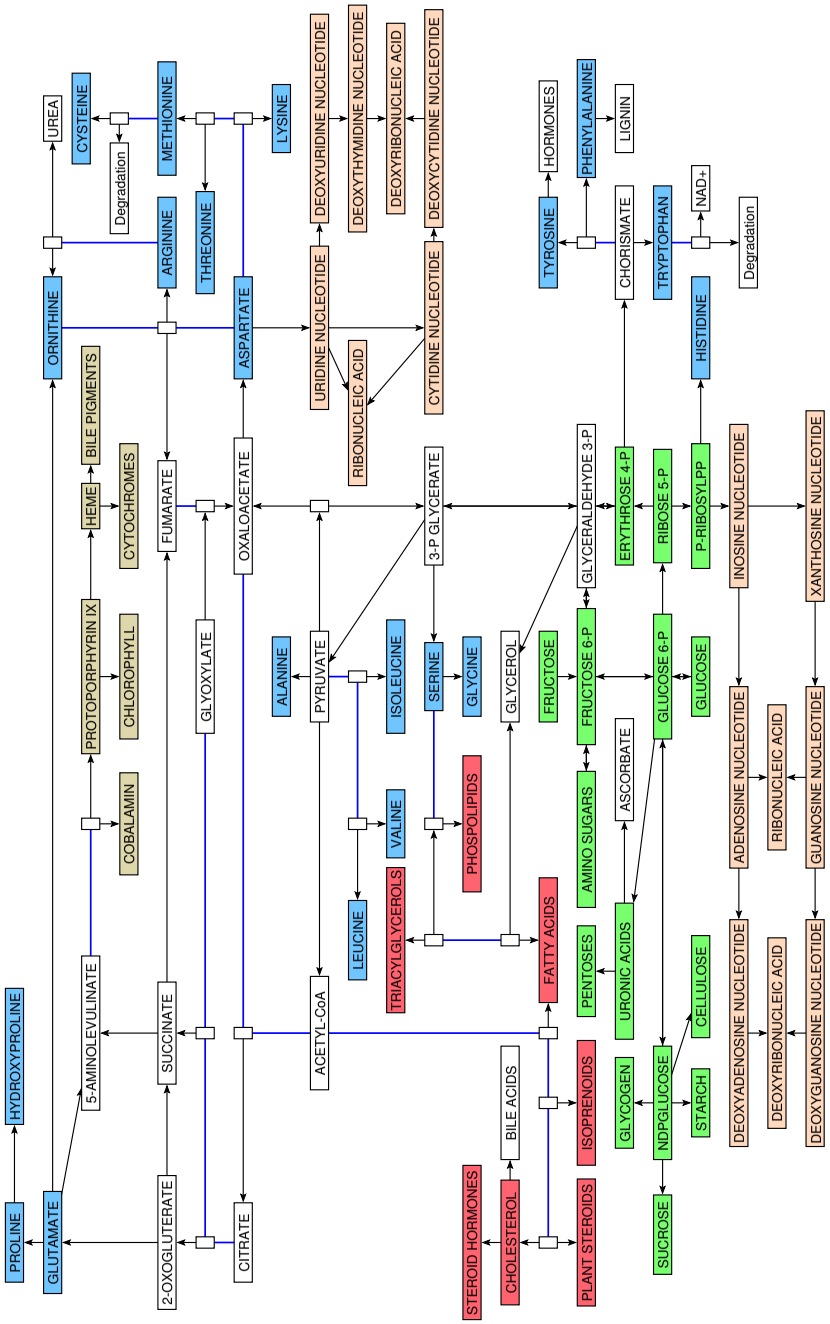


Figure 35: Graph C99.

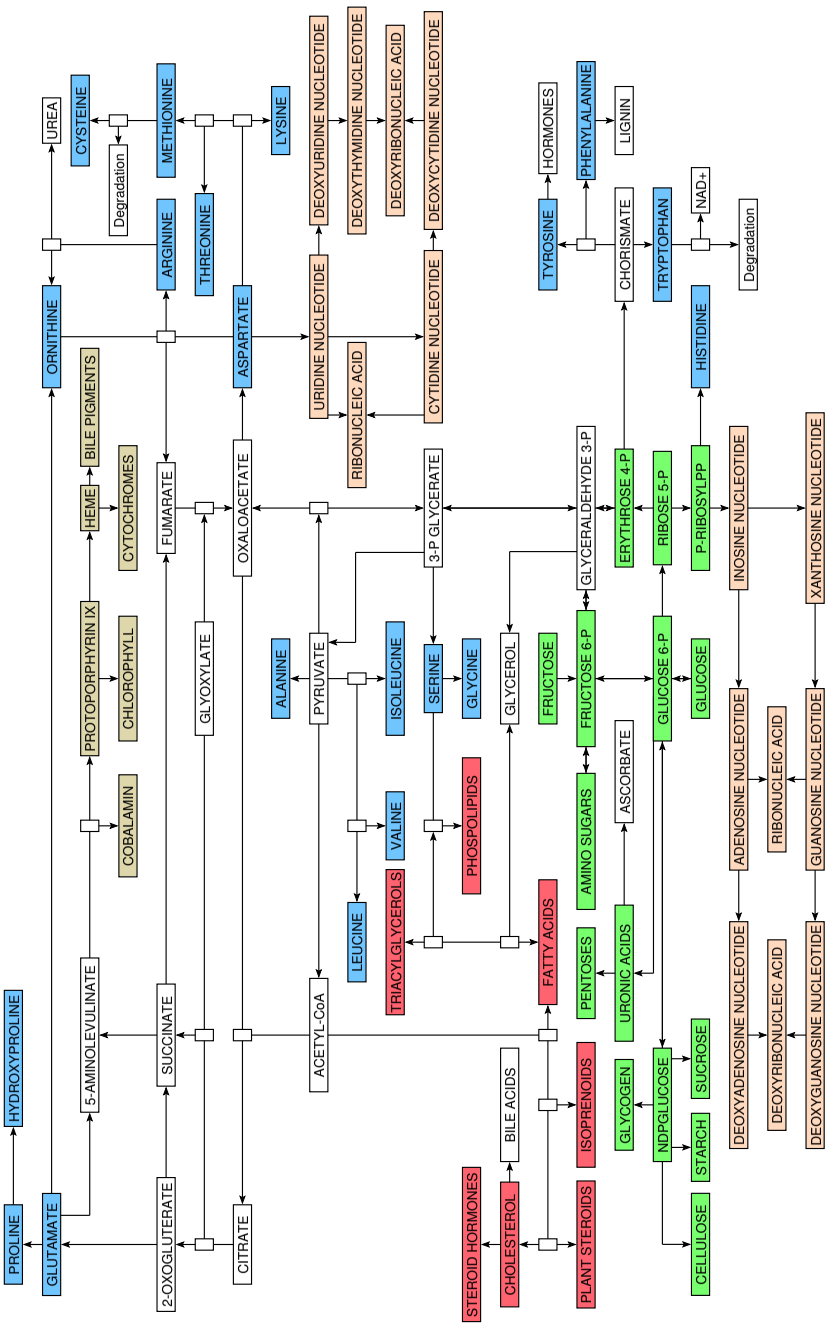


Figure 36: Graph C99 - orthogonal layout.

Layouts for Graph Drawing Contest 2000

In 2000 Graph Drawing Conference was helt in Colonial Williamsburg (USA) and the contest was organised by Franz Brandenburg. Rules and data are described at:
`http://www.infosun.fmi.uni-passau.de/GD2000/index.html`

Graph A00

Graph A00 was proposed by M. Himsolt.

First we found out that graph consists of 26 weakly connected components. After removing loops from the graph we got acyclic graph. On the acyclic graph we used standard algorithms to compute layers and position vertices into layers in order to minimize total length of lines. Some manual repositioning of vertices was used to avoid some line crossings. Vertices having loops are drawn as ellipses other as rectangles. Since graph consists of several components and labels are very small, some additional layouts of parts of network (top, middle and bottom) containing some components are shown.

We also produced pictures of this graph in Scalable Vector Graphics (SVG) format besides EPS pictures (see `http://vlado.fmf.uni-lj.si/pub/gd/gd00.htm`).

Graph B00

Graphs B00-A and B00-B were proposed by Ulrik Brandes.

The essential part of both graphs A and B are the green vertices. But there are to many arcs among them to produce a clear picture.

We first tried with circular presentation. To reveal internal structure of green subgraph and to determine the ordering of vertices on the circle we computed d_2 on the green subgraph and applied TSP (Travelling Salesman Problem) algorithm on this matrix.

$$d_2(u,v) \quad = \quad \frac{|N(u) \oplus N(v)|}{|N(u) \cup N(v)|} \tag{1}$$

$N(v)$ is the *neighborhood* of vertex $v \in V$:

$$N(v) = \{u \in V : (v : u) \in E\}$$

($\oplus$ denotes the symmetric difference, $\cup$ denotes union)

Since there can exist different clusters inside the green set of vertices we extended the d_2 matrix with some additional vertices with equal distance to all green vertices. Some vertices were repositioned manually according to connections to yellow and blue vertices on the circular net. From obtained pictures we can see that neighbouring vertices have similar patterns of arcs. Vertices having loops are drawn as boxes (vertices 5 and 11 in graph A) other as circles. Different gray colors are used to show the frequency of contact:

- Black: 1 - weekly
- 75% Gray: 2 - biweekly
- 50% Gray: 3 - monthly
- 25% Gray: 4 - quarterly

The ordering of green vertices obtained by TSP algorithm we used also in matrix representation of graphs A and B. It seems that the matrix representation is more appropriate for dense (parts of) graphs. In the matrix representation the same shadowing is used as in the graph layout.

The layout was awarded the first prize.

The complete report of the contest is available in [9].

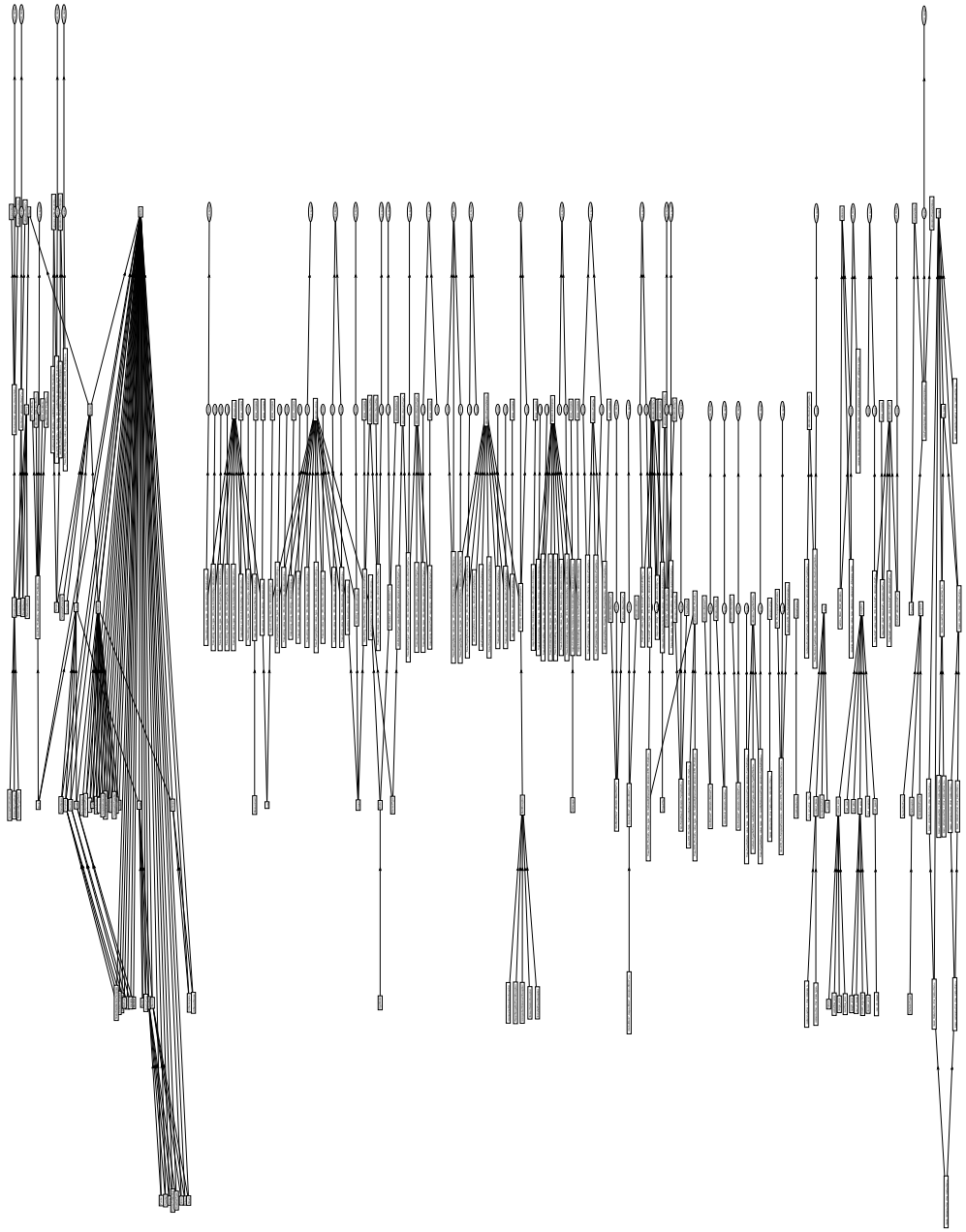


Figure 37: Complete layout of Himsolt graph A00.

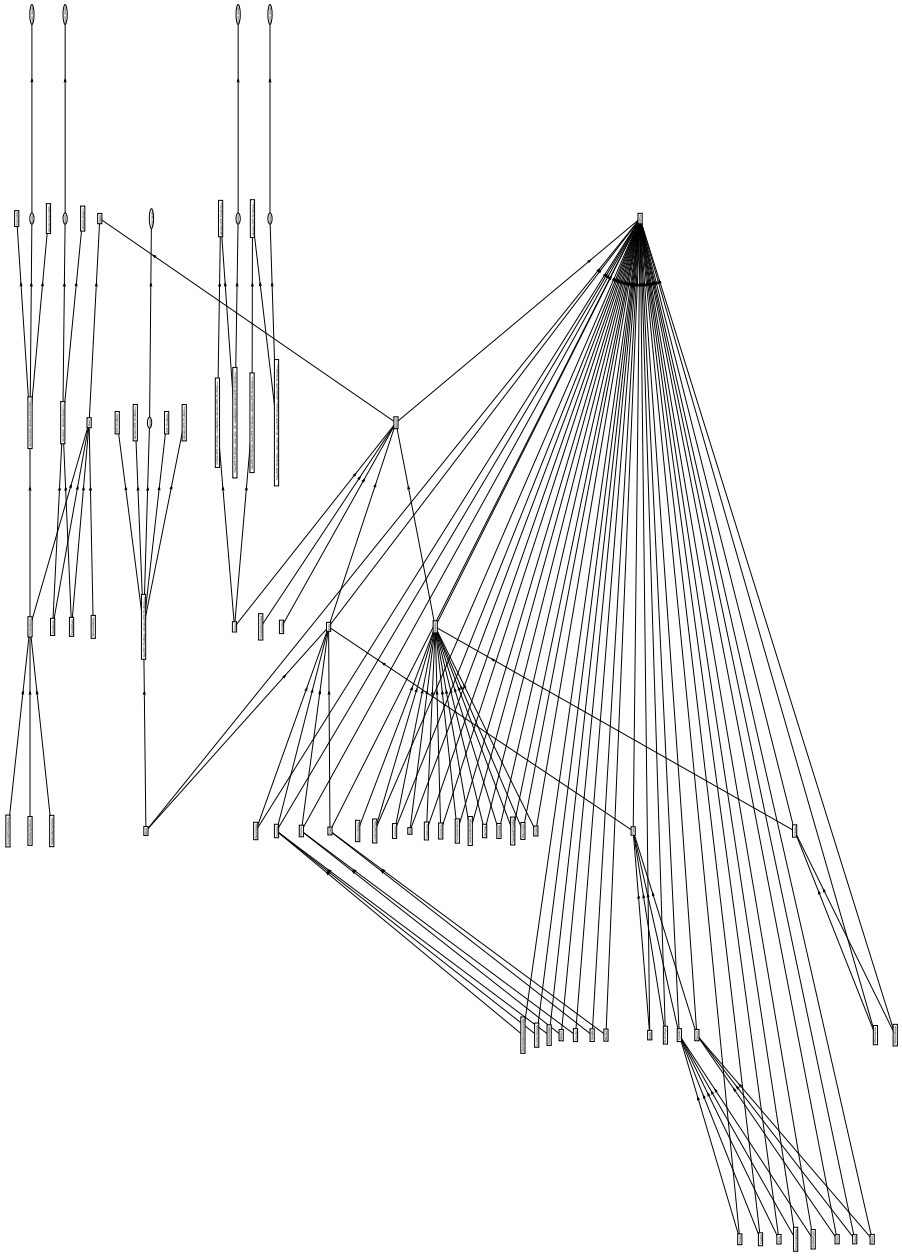


Figure 38: Upper part of Himsolt graph A00.

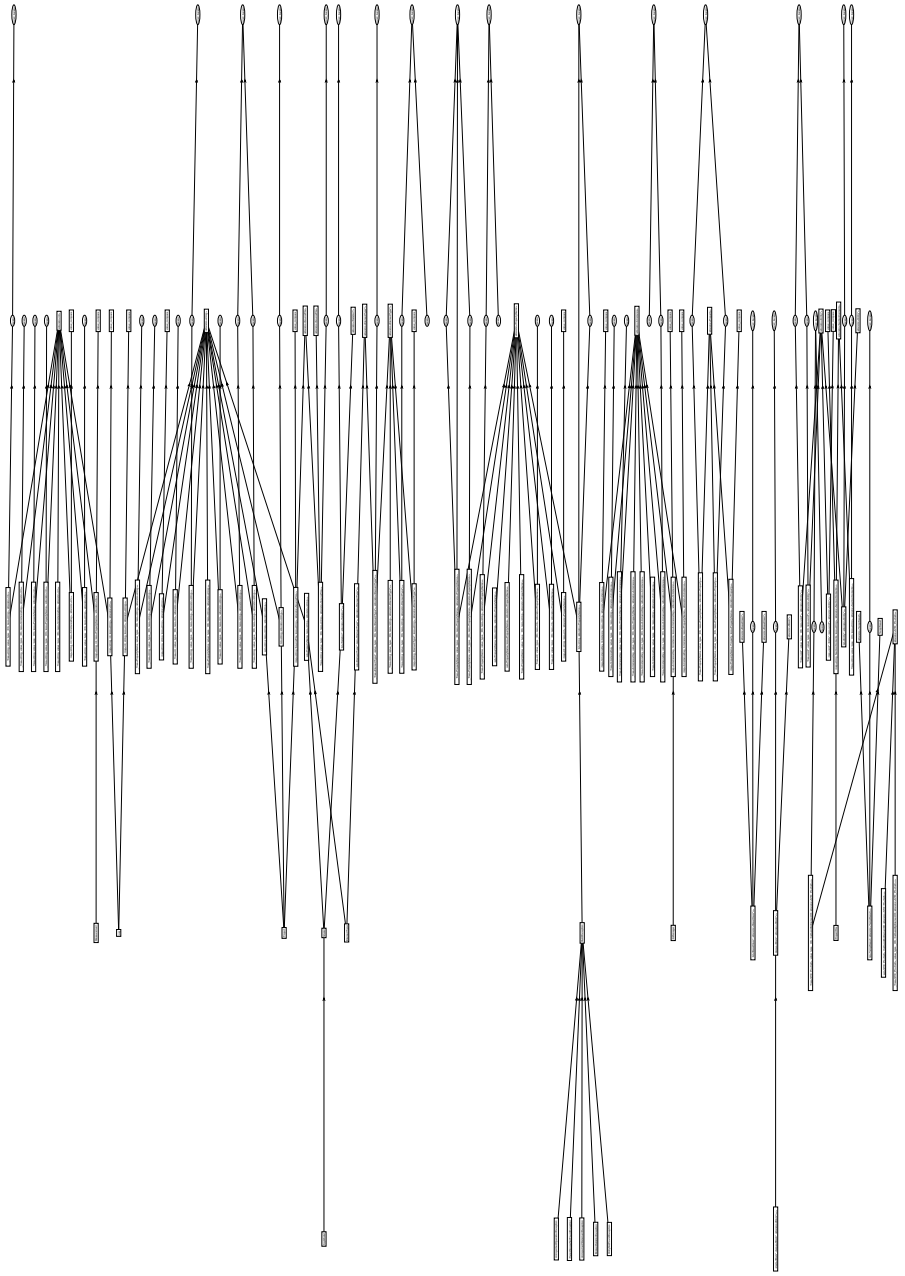


Figure 39: Middle part of Himsolt graph A00.

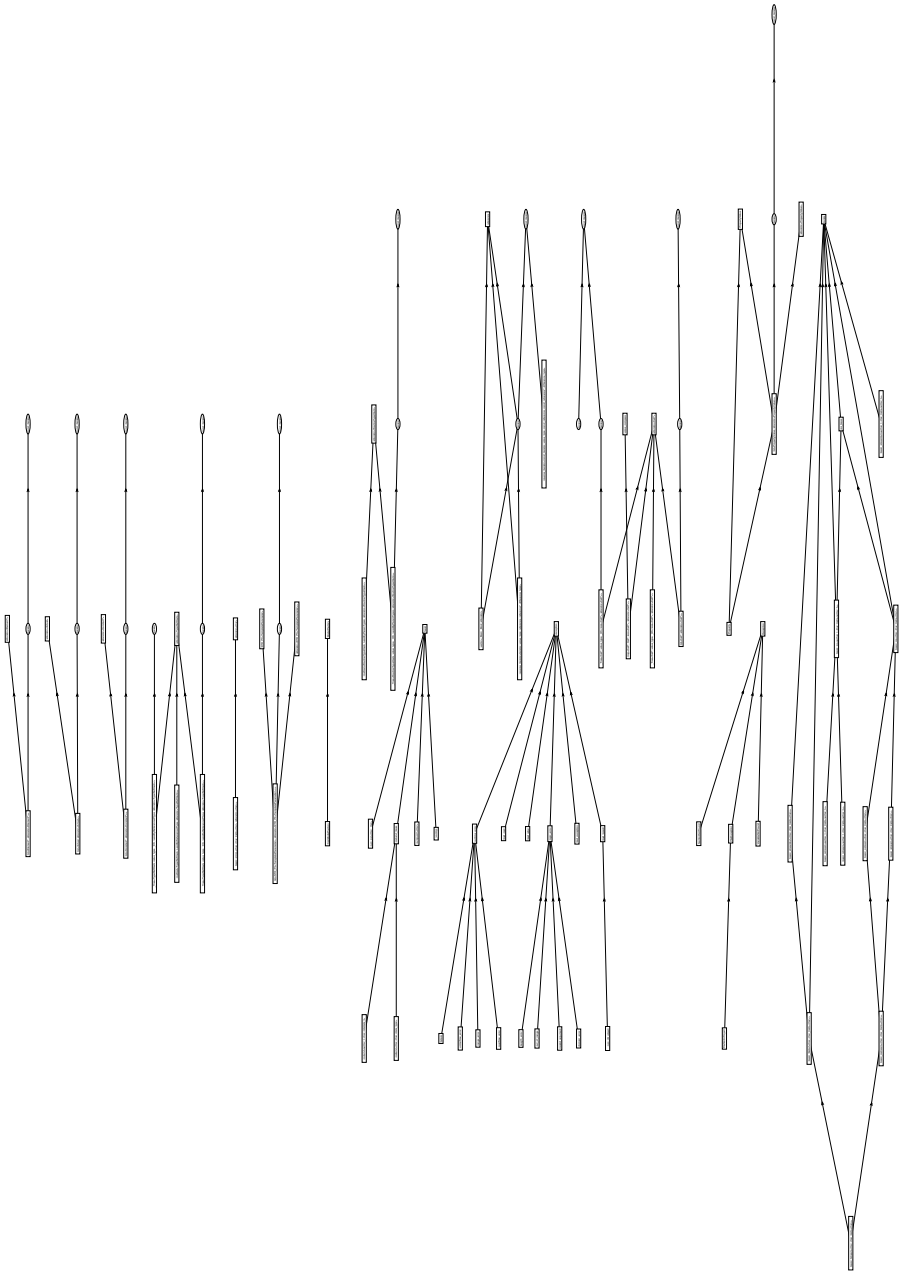


Figure 40: Bottom part of Himsolt graph A00.

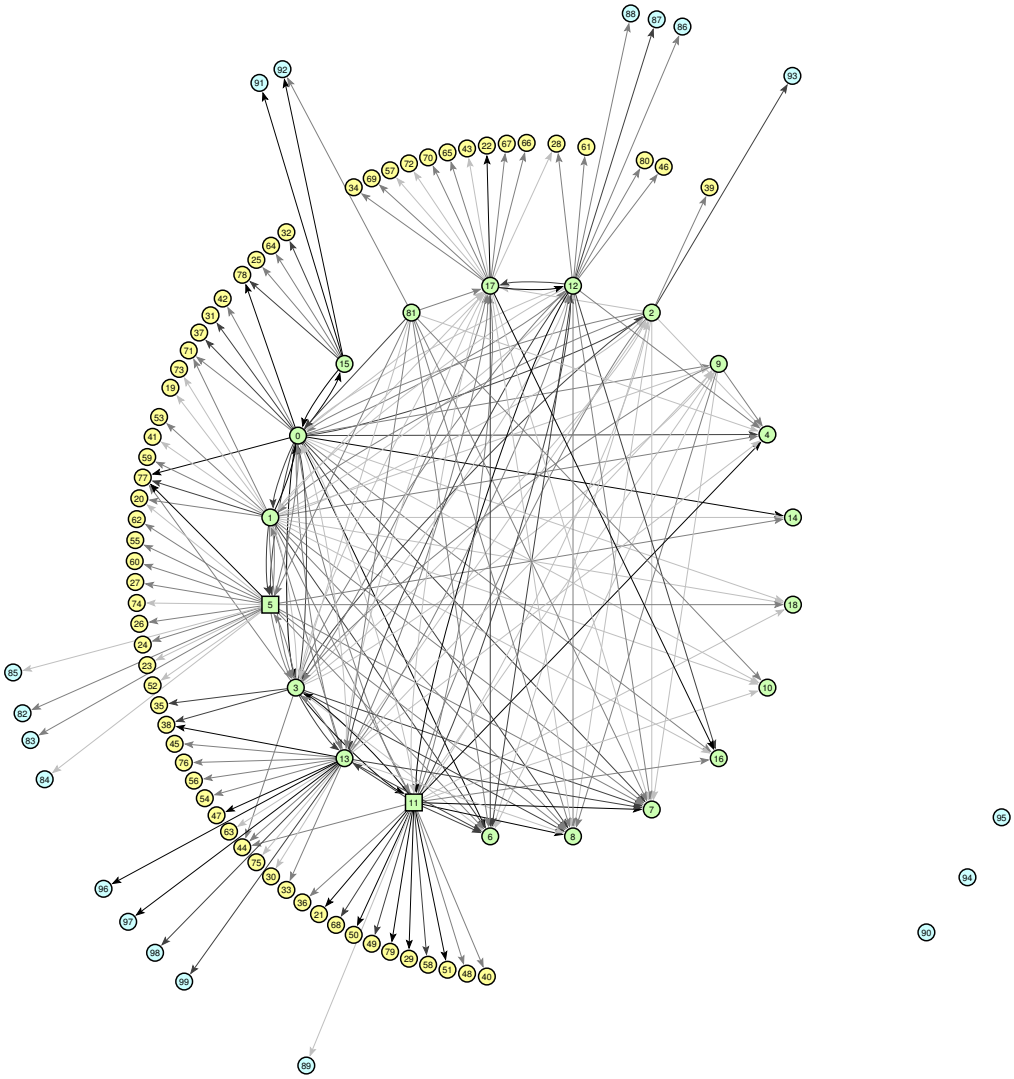


Figure 41: Graph B00-A - circular layout (***first prize***).

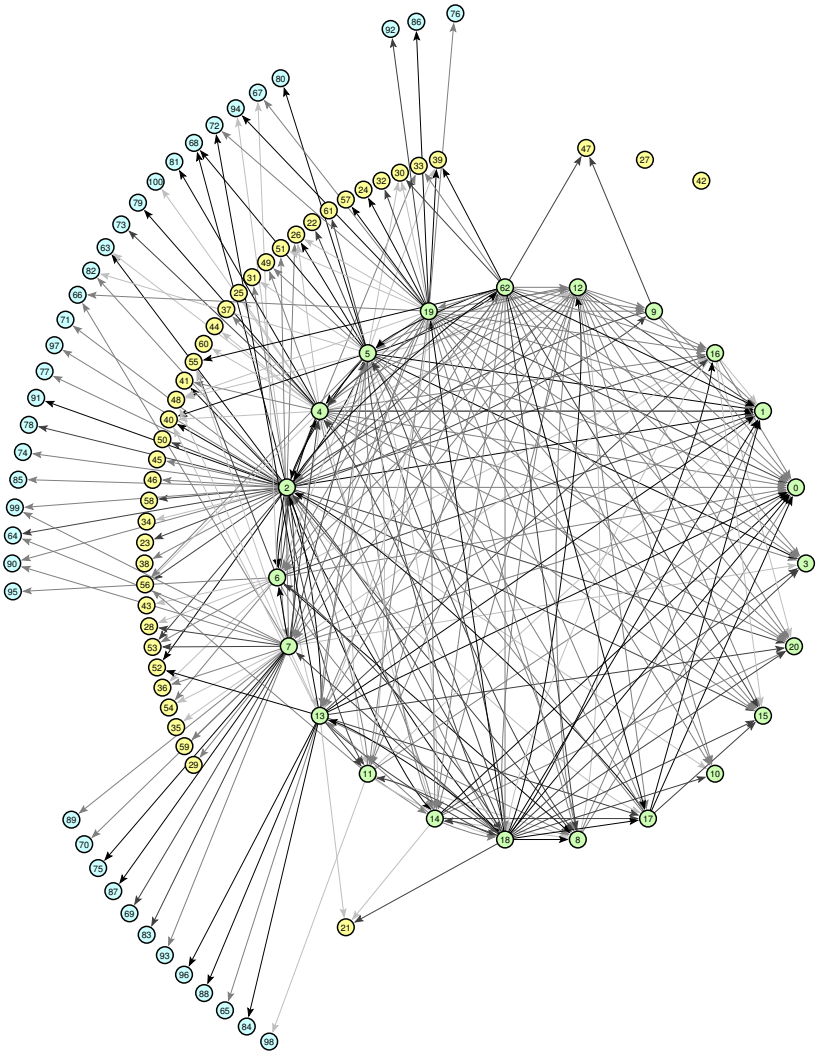


Figure 42: Graph B00-B - circular layout.

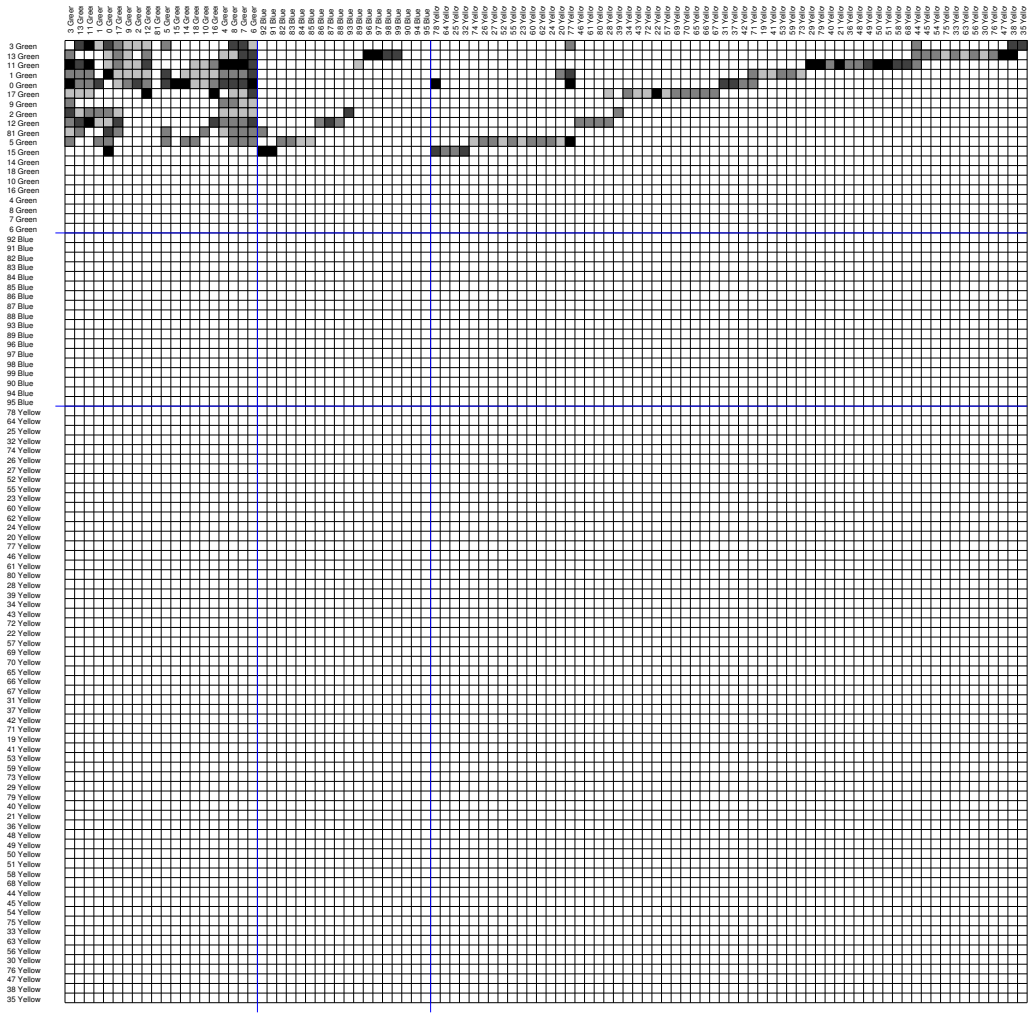


Figure 43: Matrix representation of graph B00-A.

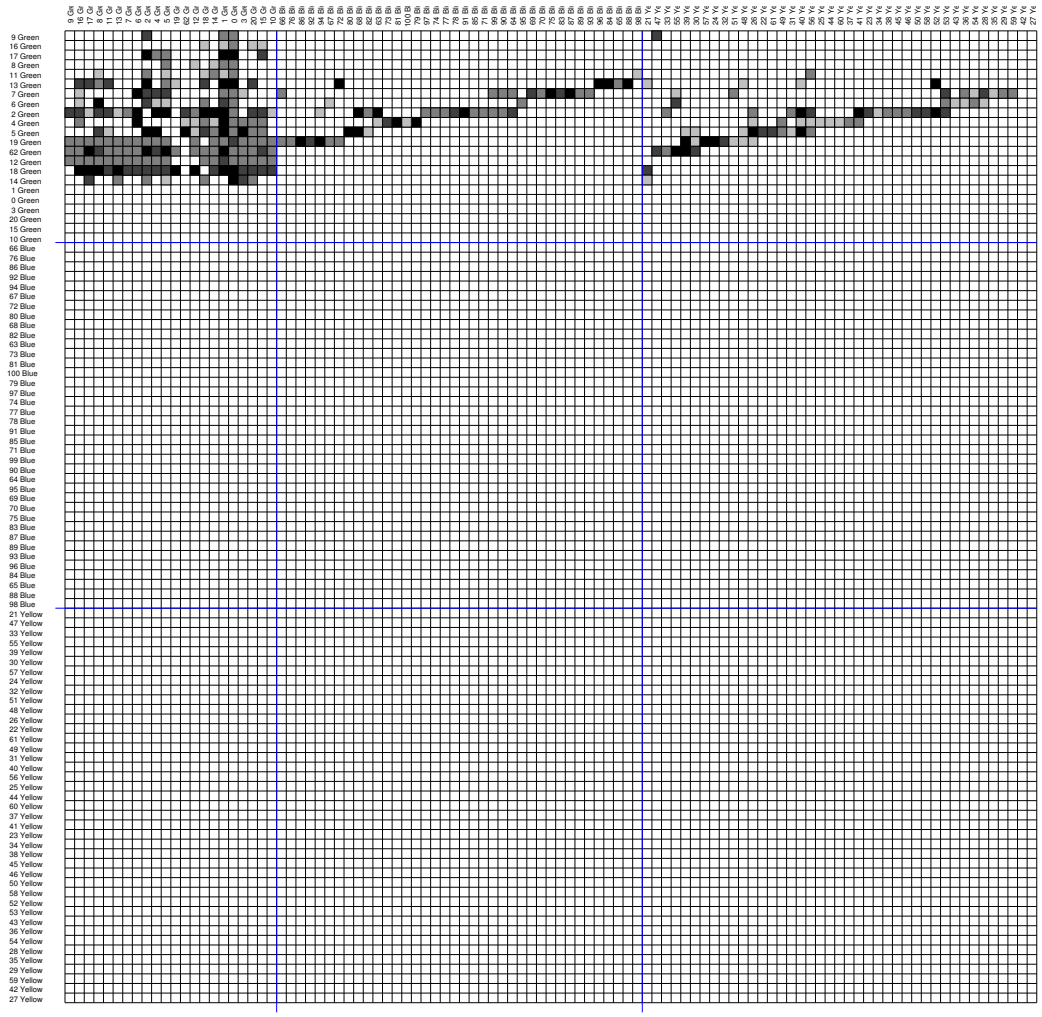


Figure 44: Matrix representation of graph B00-B.

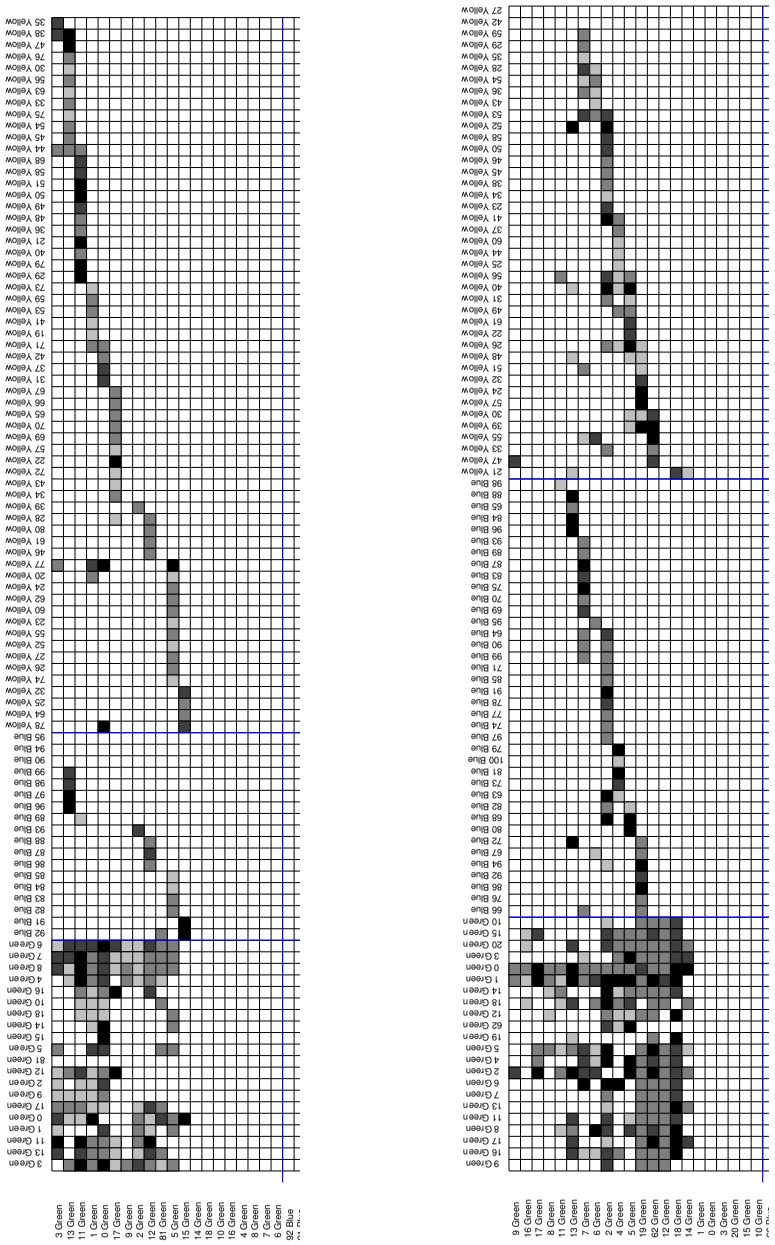


Figure 45: Matrix representation of non empty part of graphs B00-A and B00-B.

Layouts for Graph Drawing Contest 2001

In 2001 Graph Drawing Conference was helt in Vienna and the contest was organised by Franz Brandenburg. Rules and data are described at:

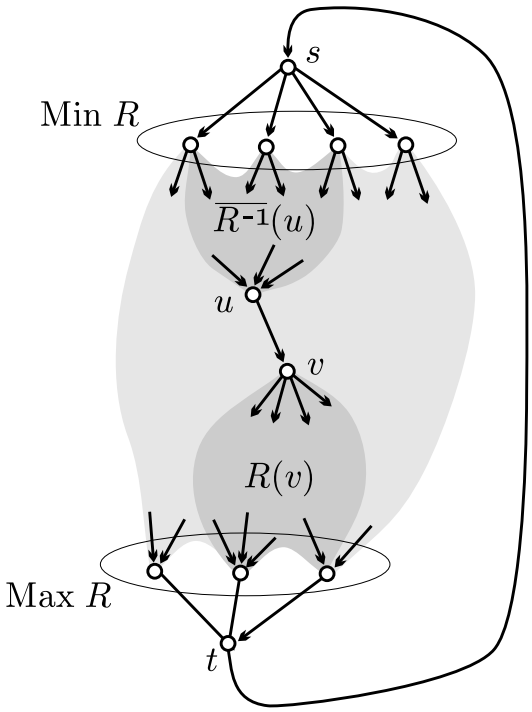
`http://www.ads.tuwien.ac.at/gd2001/`

Graph A01

In a given set of units E (articles, books, works, ...) we introduce a *citing* relation $R \subseteq E \times E$

$$xRy \equiv y \text{ cites } x$$

which determines a *citation network* (E, R). A citing relation is usually *irreflexive*, $\forall x \in E : \neg xRx$, and (almost) *acyclic*, $\forall x \in E \forall k \in \mathbb{N}^+ : \neg xR^k x$. The citation network is *standardized* by adding, if necessary, artificial *source* vertex s and *sink* or *terminal* vertex t and the arc (t, s) (see figure).



An approach to the analysis of citation network is to determine for each unit / arc its *importance* or *weight*. These values are used afterwards to determine the essential substructures in the network. Hummon and Doreian (1989, 1990) [1, 2, 3] proposed three methods of assigning weights $w : R \to \mathbb{R}_0^+$ to arcs:

- NPCC method: $w_1(u,v) = |\overline{R^{-1}}(u)| \cdot |\overline{R}(v)|$
- Paths count method: $w_2(u,v) = N(u,v)$, where $N(u,v)$ denotes the number of different paths from $\mathrm{Min}\, R$ to $\mathrm{Max}\, R$ (or from s to t) through the arc (u,v)
- SPLC method: $w_3(u,v) = N'(u,v)$, where $N'(u,v)$ equals to $N(u,v)$ from paths count method over the network (E,R'), $R' := (R \cup \{s\}) \times (E \setminus \{s,t\})$

The last two methods are efficiently (Batagelj, 1991, 1994) [4] implemented in Pajek and can be applied also on (very) large acyclic networks. Let $N^-(v)$ denotes the number of different paths from s to v, and $N^+(v)$ denotes the number of different paths from v to t. Then $N(u,v) = N^-(u) \cdot N^+(v),\ (u,v) \in R$.

N and N' are flows in the network since they obey the *Kirchoff's node law*:

For every node v in a citation network (E,R) in standard form it holds

$$\text{incoming flow} = \text{outgoing flow}$$

Therefore the *total flow* through the citation network equals $N(t,s)$. This gives us a natural way to normalize the weights

$$w(u,v) = \frac{N(u,v)}{N(t,s)} \quad \Rightarrow \quad 0 \le w(u,v) \le 1$$

If C is a minimal cut-set it also holds

$$\sum_{(u,v)\in C} w(u,v) = 1$$

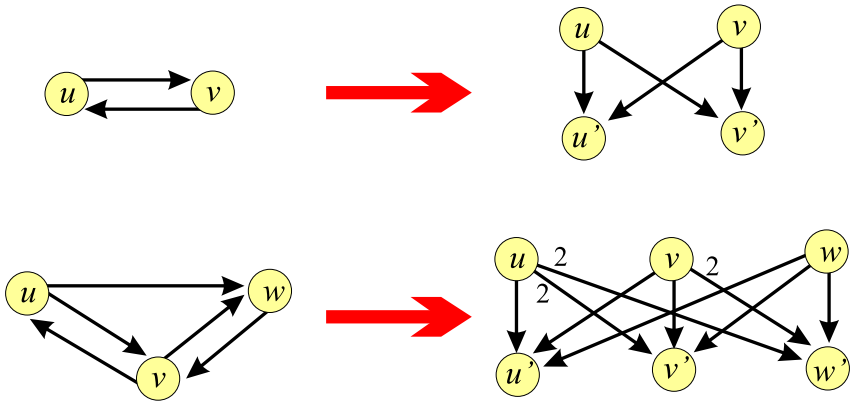
We can assign weights also to vertices

$$w(v) = \frac{N^-(v) \cdot N^+(v)}{N(t,s)}$$

References

Layouts of graph A

In graph A the relation is the reverse of the citing relation. The original graph A has 311 vertices. It has 6 weak components. Searching for strong components (testing acyclicity) it turns out that the graph A is not acyclic. A large strong component was generated by an erroneous arc (GD94/143 Eades, GD98/423 Eades). After reversing it 4 small strong components remained, corresponding to mutual references { GD94/286 Garg, GD94/298 Papakostas }, { GD94/328 Di Battista, GD94/340 Bose, GD94/352 ElGindy }, { GD95/8 Alt, GD95/234 Fekete } and { GD95/140 Chandramouli, GD95/300 Heath } . To obtain an acyclic graph, required by citations analysis method, we applied the following 'preprint' transformation:



Each paper from a strong component is duplicated with its 'preprint' version. The papers inside strong component cite preprints.

The pictures were exported as nested partitions into SVG format that allows interactive display of different *slices* – subgraphs induced by arcs with weights larger than a threshold value. These pictures are available at

`http://vlado.fmf.uni-lj.si/pub/GD/GD01.htm`.

In the paper form we can present only some snapshots.

The first picture displays complete network after 'preprint' transformations (320 vertices). The vertices are put in layers (vertical position and color of vertices) according to the years of publication. The placement of vertices inside the layer was determined by local optimization. The width and the color density of an arc and the size of a vertex are proportional to their citation weights.

The second and the third picture display the main parts (slices) of the citation network at threshold values 0.02 and 0.05. The red arcs belong to the 'main path'.

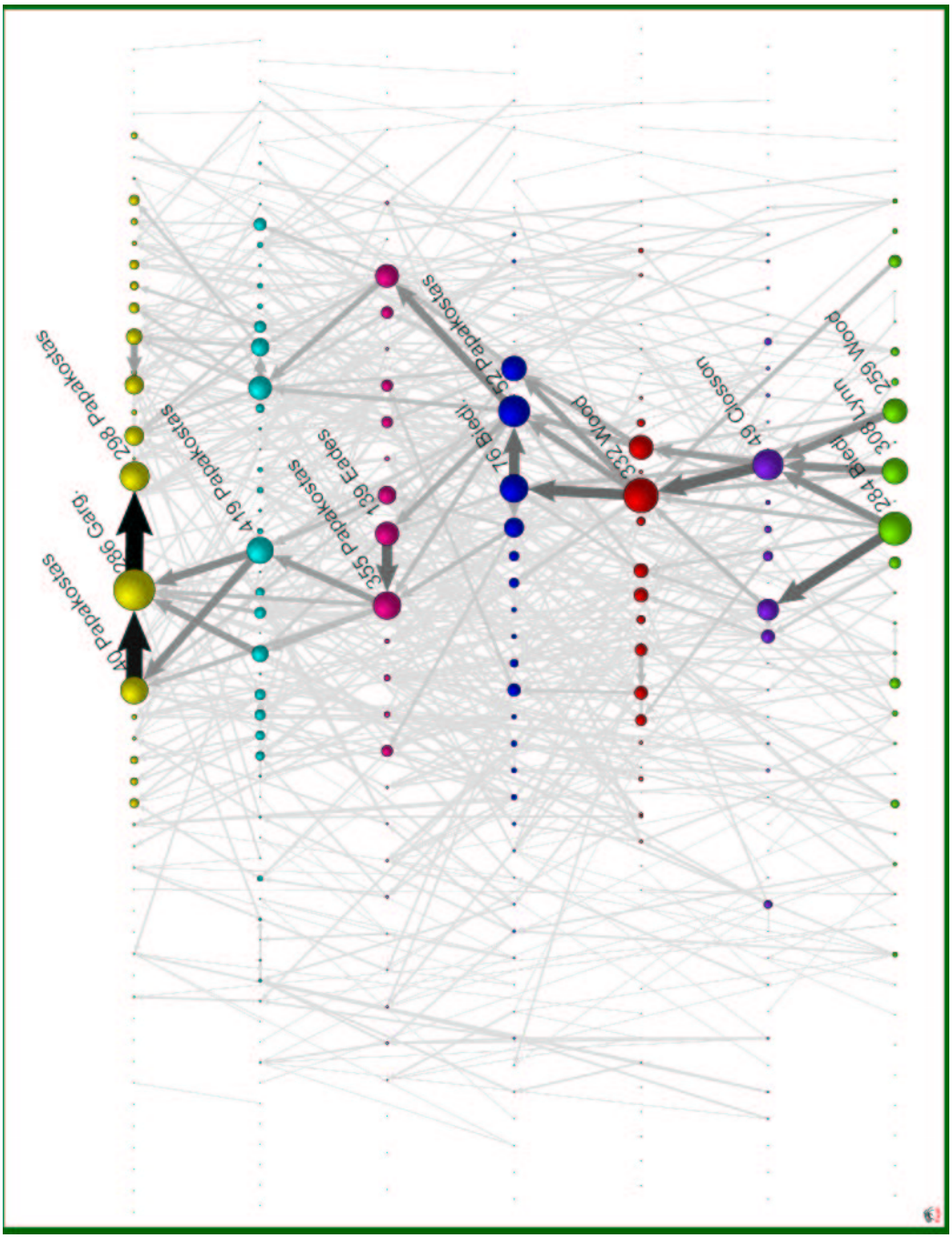


Figure 46: Graph A – complete graph.

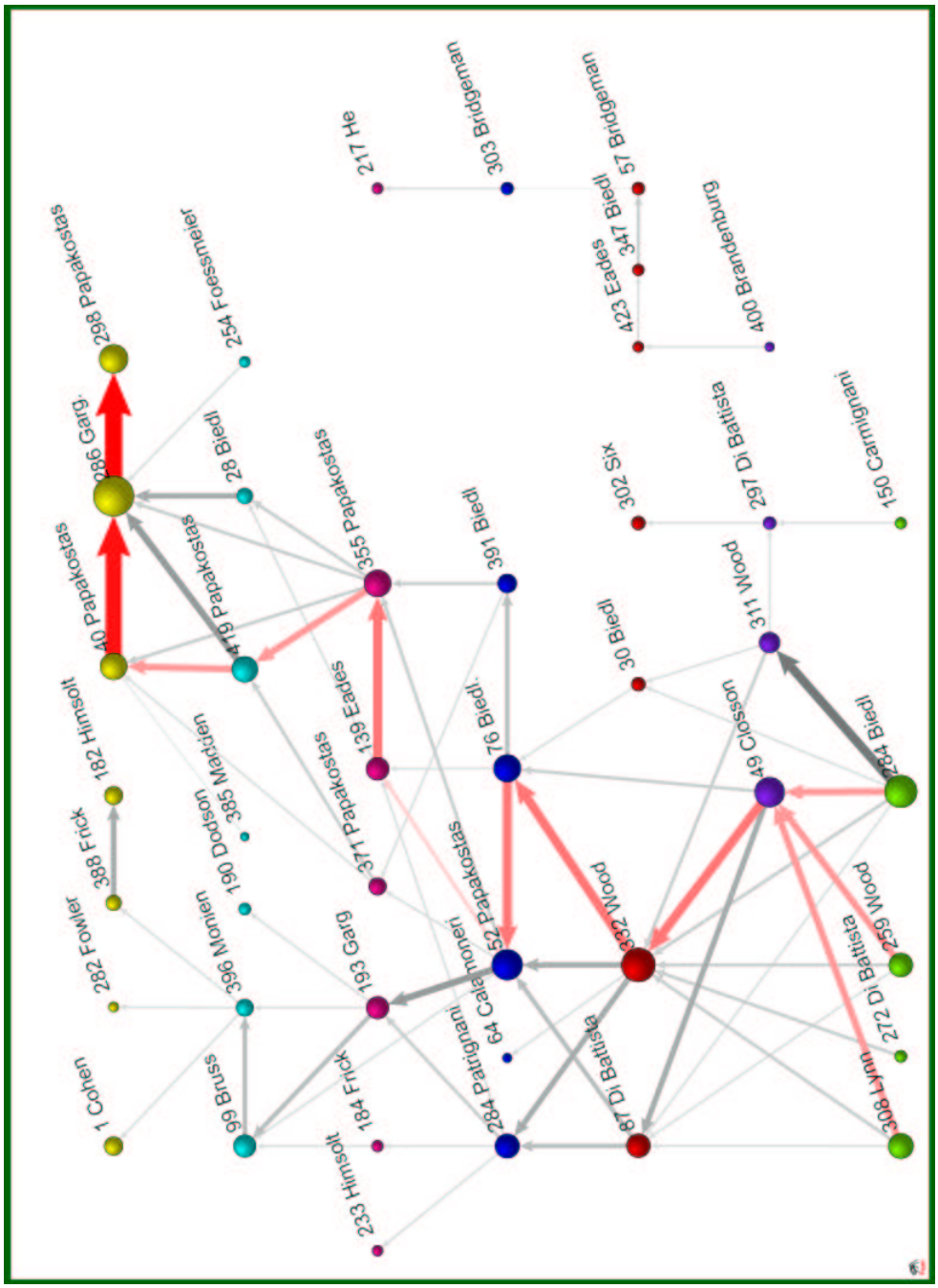


Figure 47: Graph A – level 0.02.

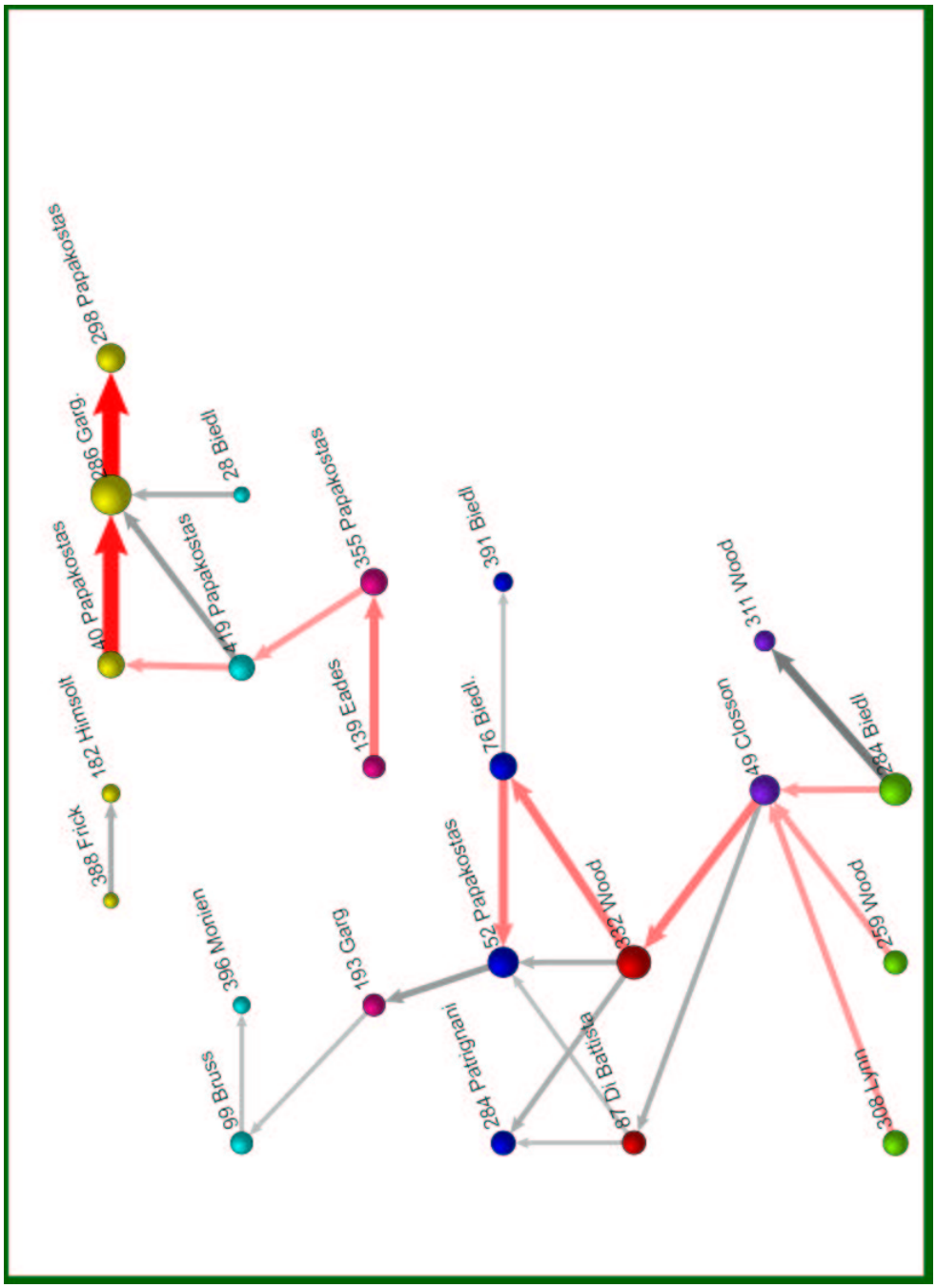


Figure 48: Graph A – level 0.05.

Graph B

To obtain the 'central symmetric' picture of graph B energy drawing was used, followed by manual grid positioning of vertices. To save the space the lower part of the picture was manually mirrored across the vertical axis.

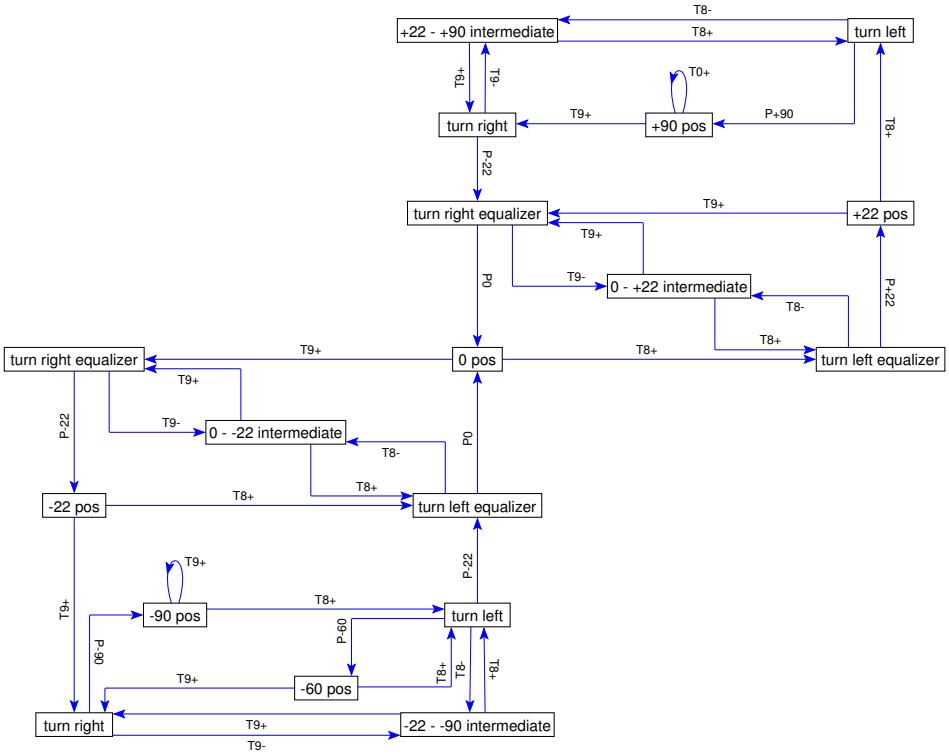


Figure 49: Graph B – 'central symmetric'.

Graph C

Graph C is an acyclic directed graph. Such graphs can be topologically sorted. The corresponding adjacency matrix has zero lower triangle and diagonal. Since the graph is rather dense we decided to use the matrix representation to visualize the graph structure. Layers are represented by blocks divided by blue lines.

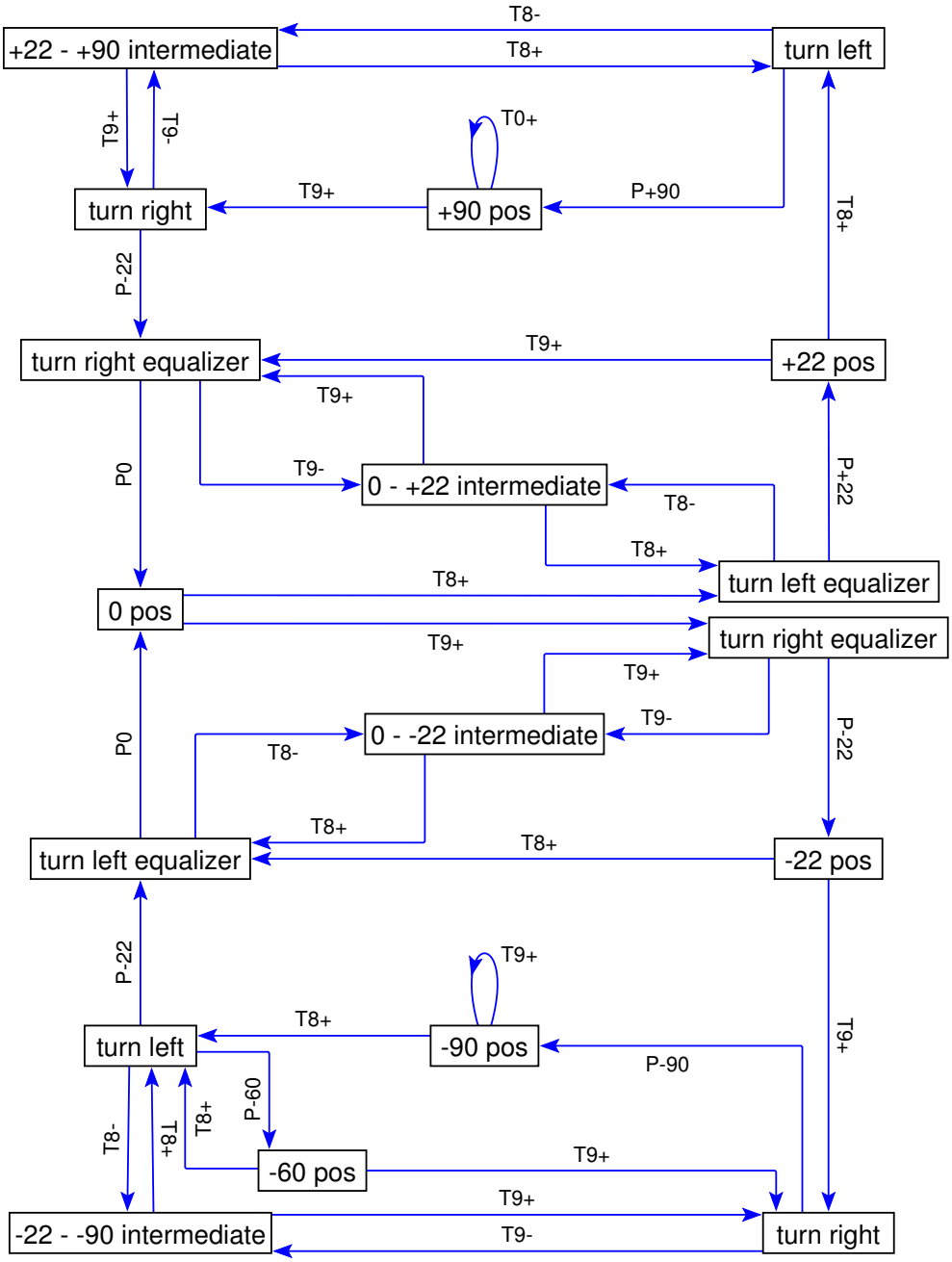


Figure 50: Graph B – mirror.

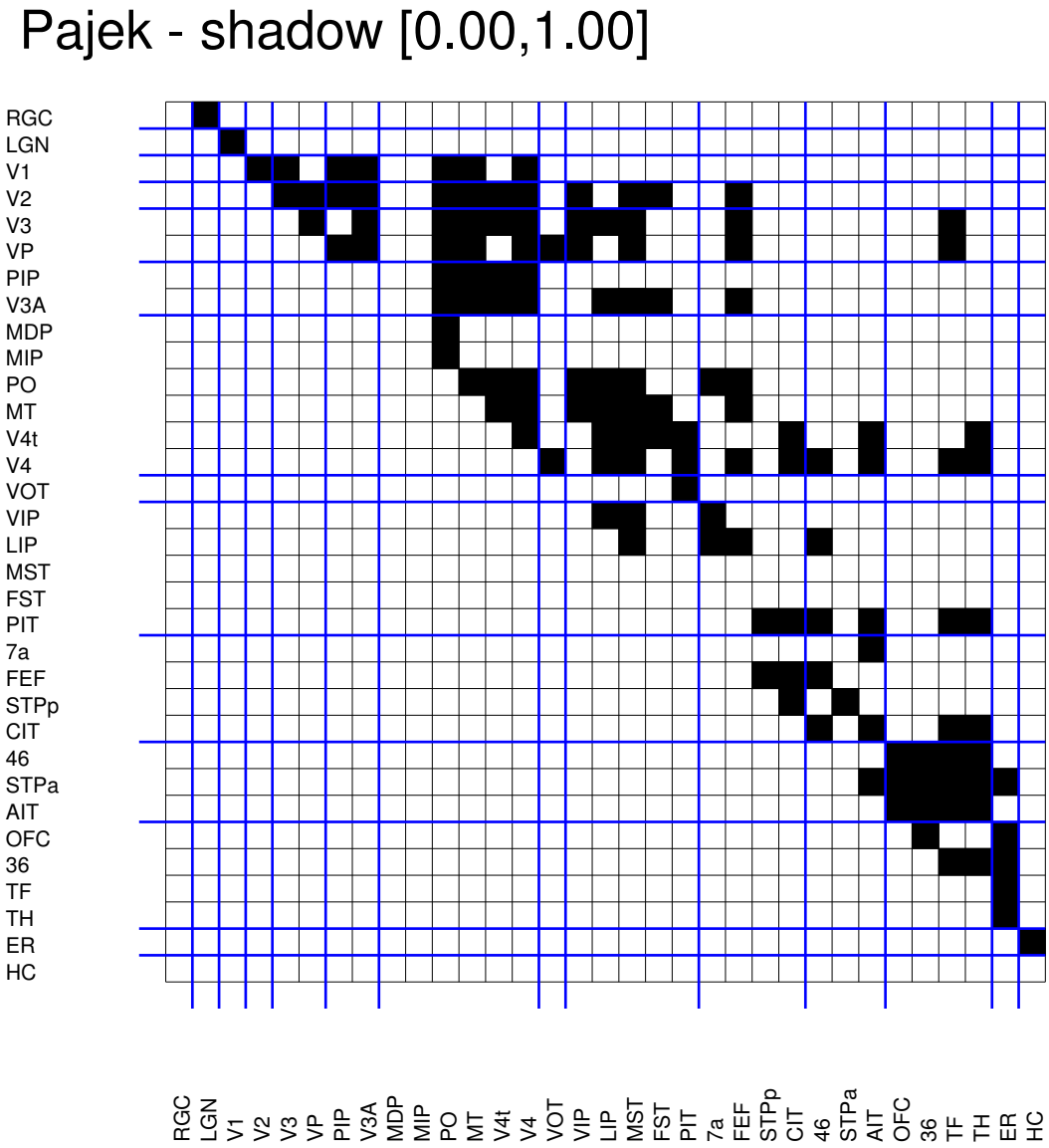


Figure 51: Graph C – matrix representation.

References

[1] Hummon N.P., Doreian P. (1989): Connectivity in a Citation Network: The Development of DNA Theory. Social Networks, **11** 39-63.

[2] Hummon N.P., Doreian P. (1990): Computational Methods for Social Network Analysis. Social Networks, **12** 273-288.

[3] Hummon N.P., Doreian P., Freeman L.C. (1990): Analyzing the Structure of the Centrality-Productivity Literature Created Between 1948 and 1979. Knowledge: Creation, Diffusion, Utilization, **11**(4), 459-480.

[4] Batagelj V. (1991): An Efficient Algorithm for Citation Networks Analysis. Presented at EASST'94, Budapest, Hungary, August 28-31, 1994. First presented at the Seminar on social networks. University of Pittsburgh, January 1991.

[5] Batagelj V., Doreian P., and Ferligoj A. (1992): *An Optimizational Approach to Regular Equivalence*. Social Networks **14**, 121-135.

[6] Brandenburg, F. J. (1996): *Graph Drawing. Proceedings of Symposium on Graph Drawing, GD95*, Passau, Germany, September 1995, Springer-Verlag, Lecture Notes in Computer Science, vol. 1027, 224-233.

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[8] Kratochvil, J. (1999): *Graph Drawing. Proceedings of Symposium on Graph Drawing, GD99*, Stirin Castle, Czeck Republic. September 15-19, 1999. Springer-Verlag, Lecture Notes in Computer Science, vol. 1731, 400-409.

[9] Marks, J. (2001): *Graph Drawing. Proceedings of the 8th Symposium on Graph Drawing, GD00*, Colonial Williamsburg, USA. September 20-23, 2000. Springer-Verlag, Lecture Notes in Computer Science, vol. 1984, 410-418.

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