Graph Drawing

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Reviewed Papers

- Effective Graph Visualization via Node Grouping
  Janet M. Six and Ioannis G. Tollis. Proc InfoVis 2001
- Visualization of State Transition Graphs
  Frank van Ham, Huub van de Wetering, Jarke J. van Wijk. Proc InfoVis 2001.
- FADE: Graph Drawing, Clustering, and Visual Abstraction
  Aaron J. Quigley and Peter Eades, Proc. Graph Drawing 2000

Effective Graph Visualization via Node Grouping

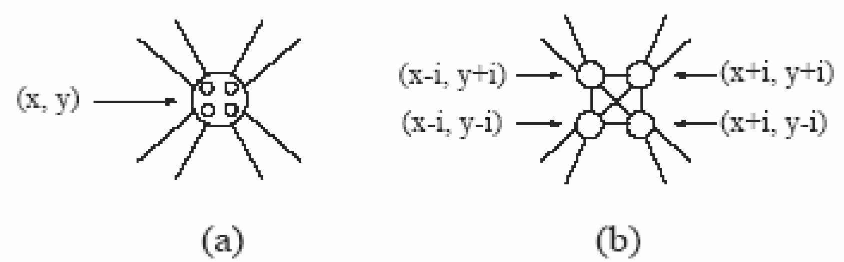
- visualizes large graphs
- 2D drawing
- assumes the existence of complete or almost complete subgraphs in the graph to be visualized
- use of two type of techniques:
  - force directed
  - orthogonal drawing

Levels of Abstraction

- total abstraction
- proximity abstraction
- explicit proximity abstraction
- interactive abstraction

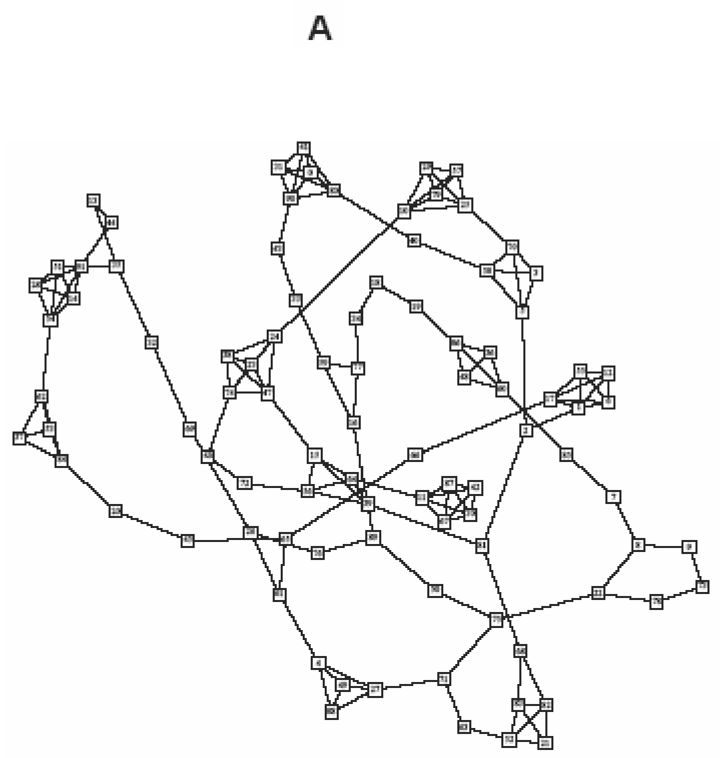
Force Directed Layout Technique with Node Grouping

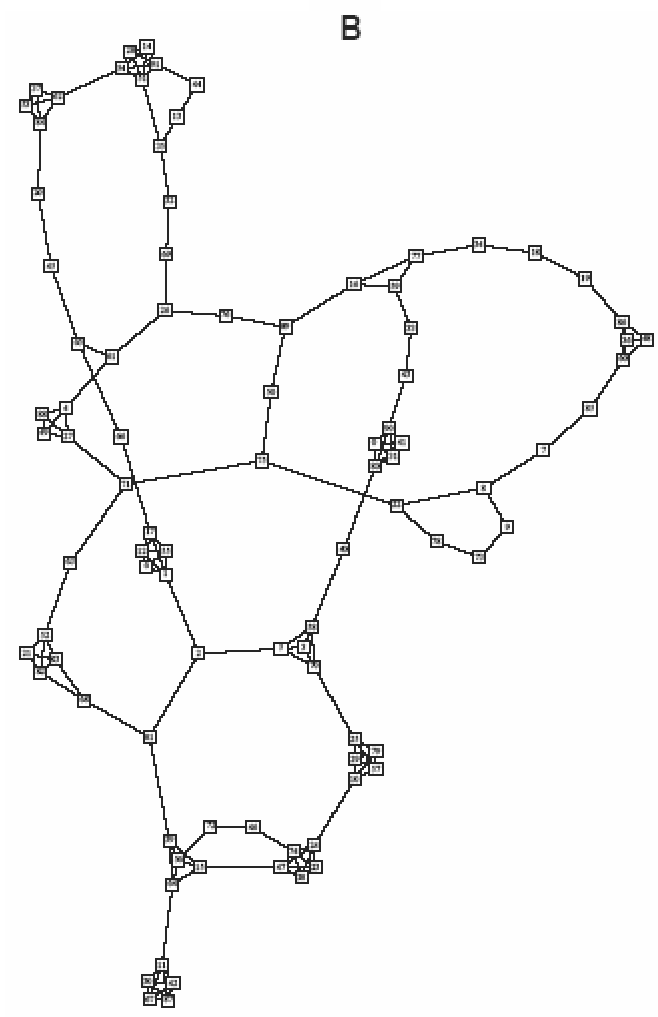
1. find node grouping (by using the triangle or coloring technique)
2. use total abstraction to get the superstructure G_s
3. apply force directed layout technique on G_s to obtain a layout of G_s
4. replace all supernodes in G_s with the group of nodes it represents and place these nodes at the position of the supernode



5. apply force directed algorithm to graph

Comparison





Comparison

- Technique uses the same amount of space as the original force directed algorithm

Improvements:

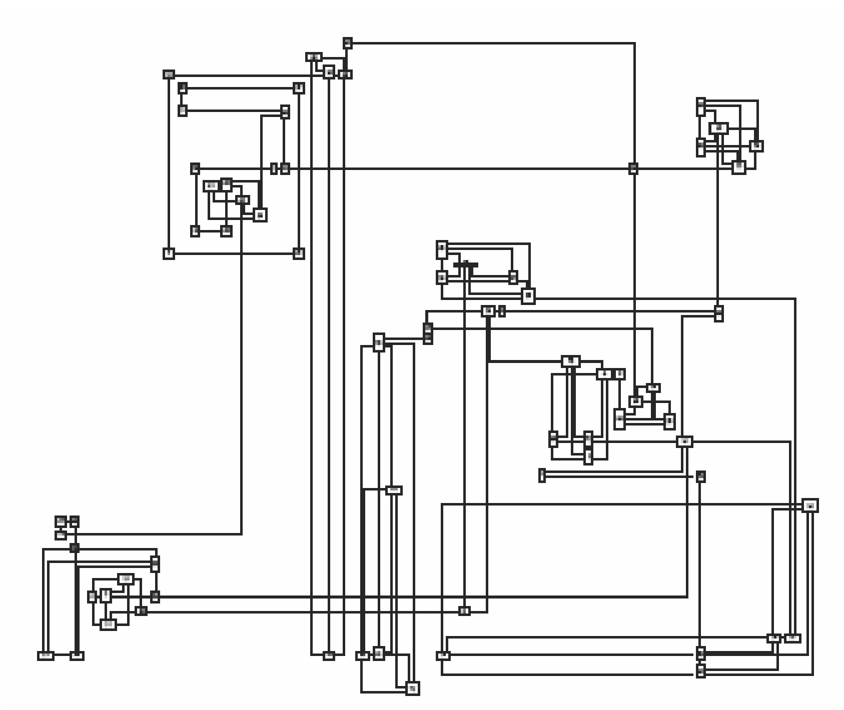
- 22% in edge crossings
- 17 % in in average edge length
- 12 % in maximum edge length
- 17 % in total edge length
- 35 % in average clique edge length
- 15 % in average neighbourhood edge length

Orthogonal Drawing with Node Grouping

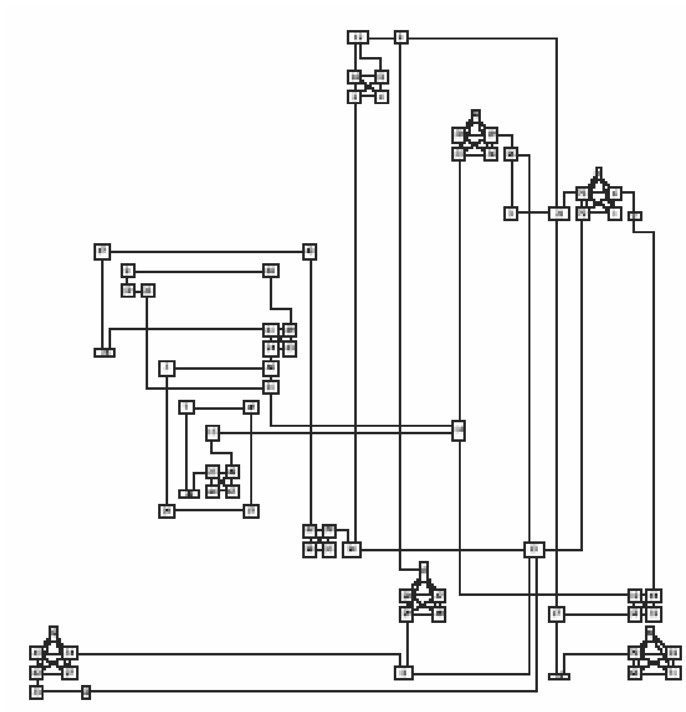
1. find node grouping
2. use total abstraction to get the superstructure G_s
3. create orthogonal layout of G_s
4. replace all supernodes in G_s with the group of nodes it represents and place these nodes at the position of the supernode
5. route the edges incident to group nodes

Comparison

A



B



Comparison

- Slightly slower, on average, than the interactive graph drawing technique

Improvements:

- 52% in area
- 60% in bends
- 45% in edge crossings
- 59% in average edge length
- 38% in maximum edge length
- 59% in total edge length
- 90% in average clique length
- 52% in average neighbourhood edge length

Comparison

Higher quality with respect to:

- clarity of groups
- separation of groups from other portions of the graph
- better layout of the superstructure
- ease of seeing some structure
- ease of seeing flow into and out of the groups

Critique

Pros:

- easy to understand
- no occlusion
- ran experiments over a set of almost 600 graphs

Cons:

- no user study
- no explanation of basic techniques
- no mention of what a large graph means
- comparison is not done with the most recent techniques
- no conclusion

FADE: Graph Drawing, Clustering, and Visual Abstraction

- fast algorithm for the drawing of large undirected graphs
- is based on
  - the force directed approach
  - clustering
  - space decomposition
- 2D drawing

Main Concepts

Clustering:

- performed based on the structure of graph
- allows performance improvement
- allows multi-level viewing

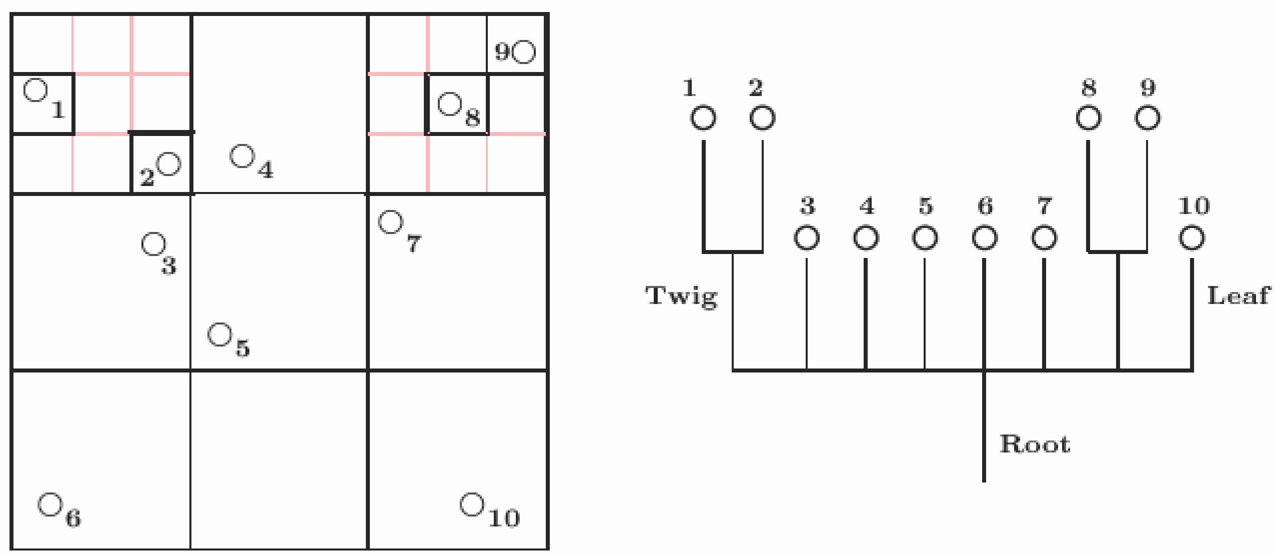
Geometric clustering:

- points close to each other belong to the same cluster
- points far apart belong to different clusters

Main Concepts (cont.)

Tree code:

- recursive division of space into a series of cell calculations



Nono-tree space decomposition and data structure

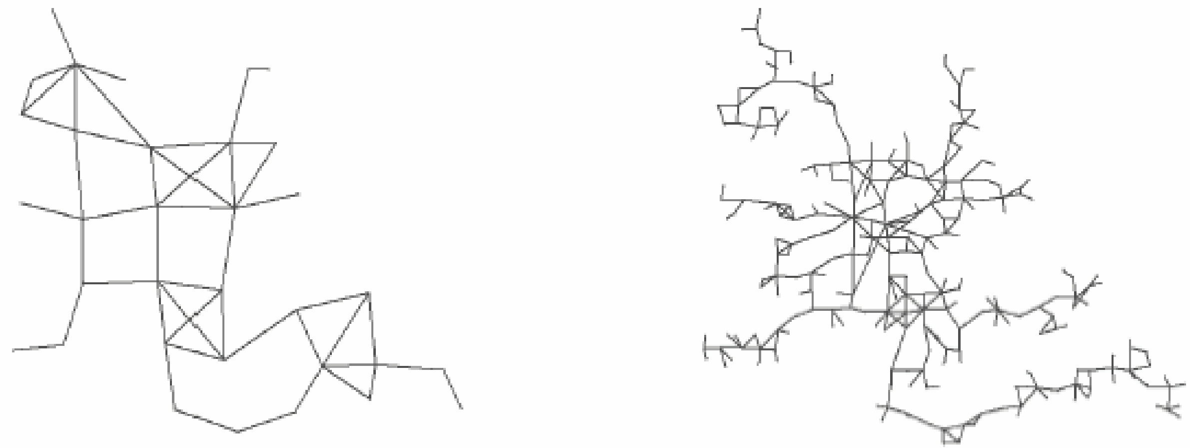
- can speed up force calculation

FADE Algorithm

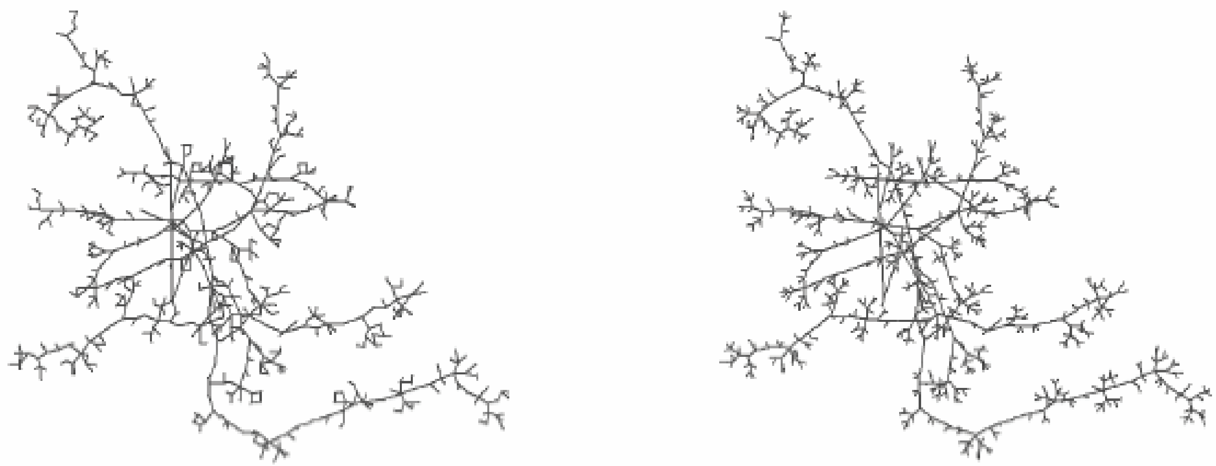
REPEAT

1. Construct geometric clustering using space decomposition
2. Compute edge forces
3. Compute non-edge forces
4. Move nodes

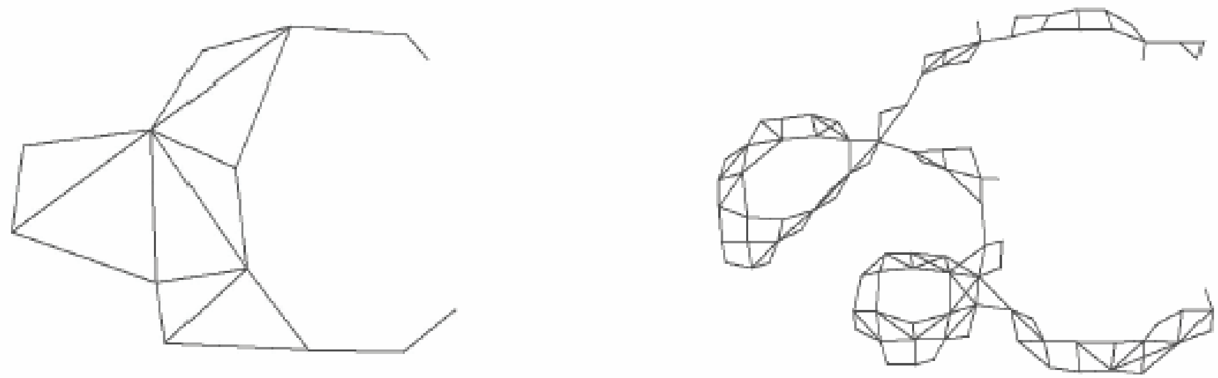
UNTIL convergence



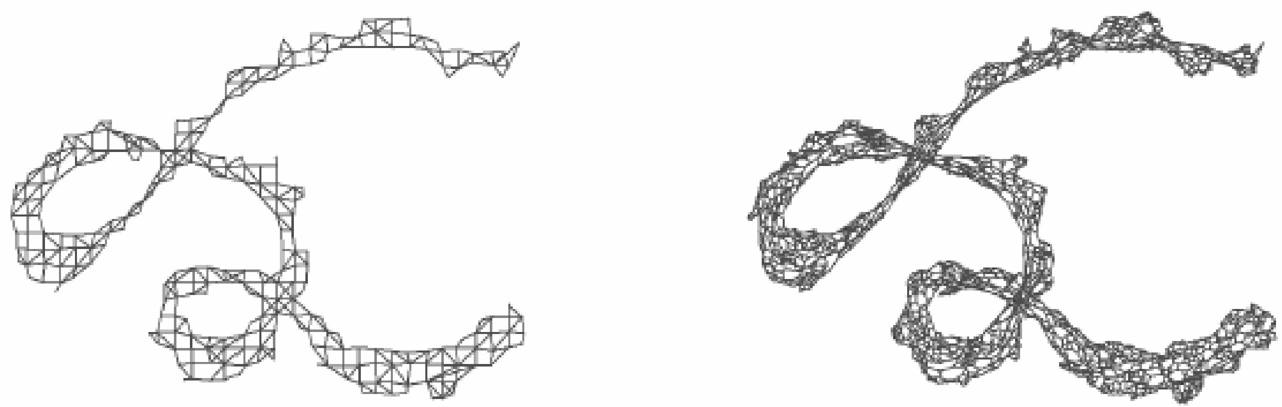
Graph of 1400 nodes shown on levels 4 and 6 of the decomposition tree



Graph of 1400 nodes shown on level 8 and the lowest level of the decomposition



Graph of 4700 nodes shown on levels 3 and 5 of the decomposition tree



Graph of 4700 nodes shown on level 8 and the lowest level of the decomposition

Comparison

Nodes	Direct (sec)	FADE (sec)	% Error
512	0.455	0.04	0.513
1020	1.82	0.088	0.592
1442	3.61	0.168	0.675
2500	10.88	0.202	0.622
6000	62.66	0.676	0.673
10510	192	1.704	0.449
22800	920	3.36	0.561
30000	1593	3.546	0.517
40960	2979	5.592	0.567
49284	4316	6.730	0.628
105233	19604	13.371	0.481

Experimental Comparison of tree-code Vs direct force calculation

- error: vector measure computed from the direct non-edge forces and the approximate non-edge forces computed in FADE

Critique

Pros:

- main concepts are clearly stated
- novel method for multi-level viewing
- run time improvement

Cons:

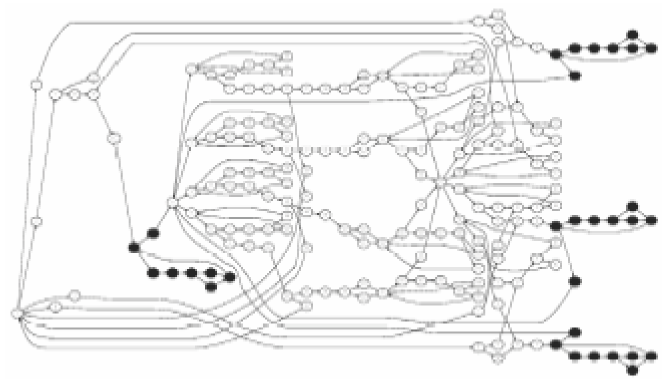
- no user study
- comparison is not done with the most recent techniques
- no mention of what a large graph means

Visualization of State Transition Graphs

- visualizes large graphs
- uses ranking
- uses clustering
- 3D visualization

Based on the Principles:

1. enable user to identify symmetrical and similar substructures



2. provide the user with overview of entire graph’s structure

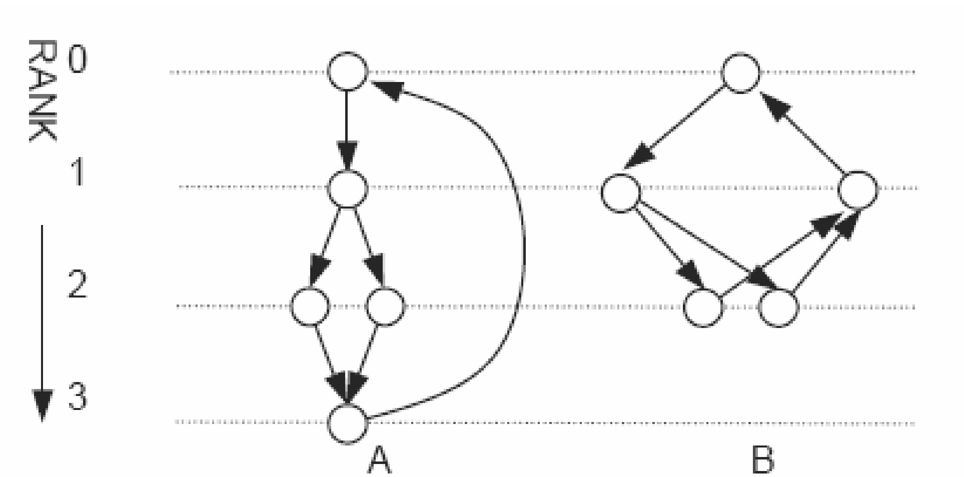
Steps of the Visualization Process

1. Assign a rank to all nodes
2. Cluster graph based on structural property
3. Visualize structure using cone trees
4. Place individual nodes and edges on graph

Assigning Ranks

The two ranking methods used are:

- iterative
- cyclic



Steps of the Visualization Process

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Clustering

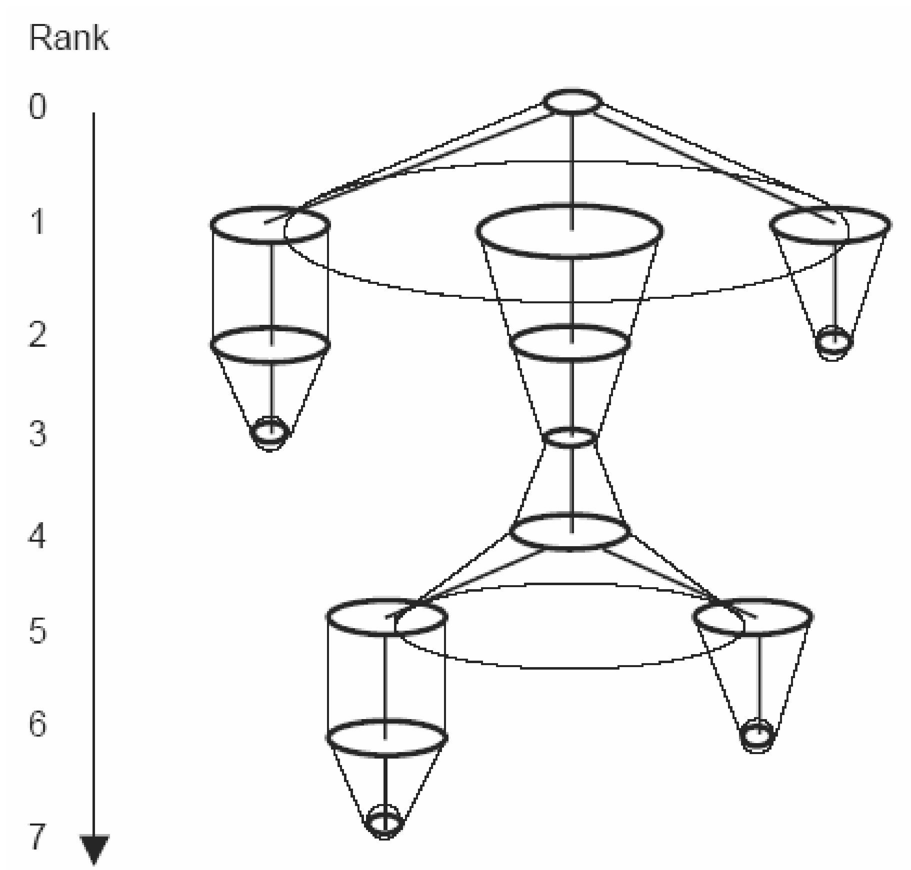
- is based on an equivalence relation between nodes
- all nodes in a cluster have the same rank
- rank of a cluster containing node x = rank of x
- every node is in exactly one cluster

Steps of the Visualization Process

1. Assign a rank to all nodes
2. Cluster graph based on structural property
3. Visualize structure using cone trees
4. Place individual nodes and edges on graph

Visualizing the Structure

- symmetry (clusters are placed on the graph according to some structure based rules)
- clear visual relationship between backbone structure and actual graph
- clusters with many nodes are represented by bigger circles


Rank
0
1
2
3
4
5
6
7

Steps of the Visualization Process

1. Assign a rank to all nodes
2. Cluster graph based on structural property
3. Visualize structure using cone trees
4. Place individual nodes and edges on graph

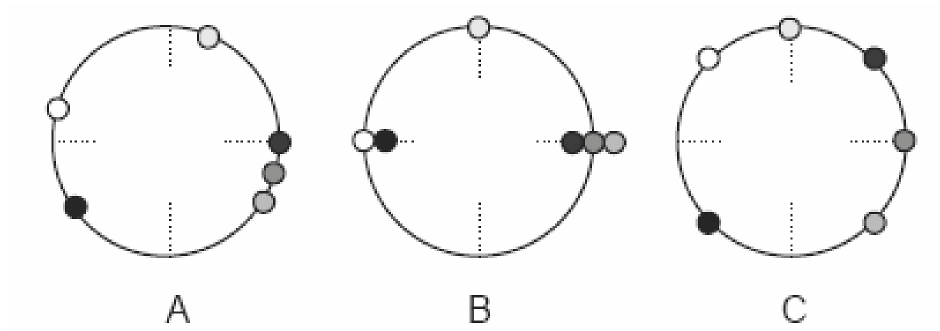
Placing the Nodes

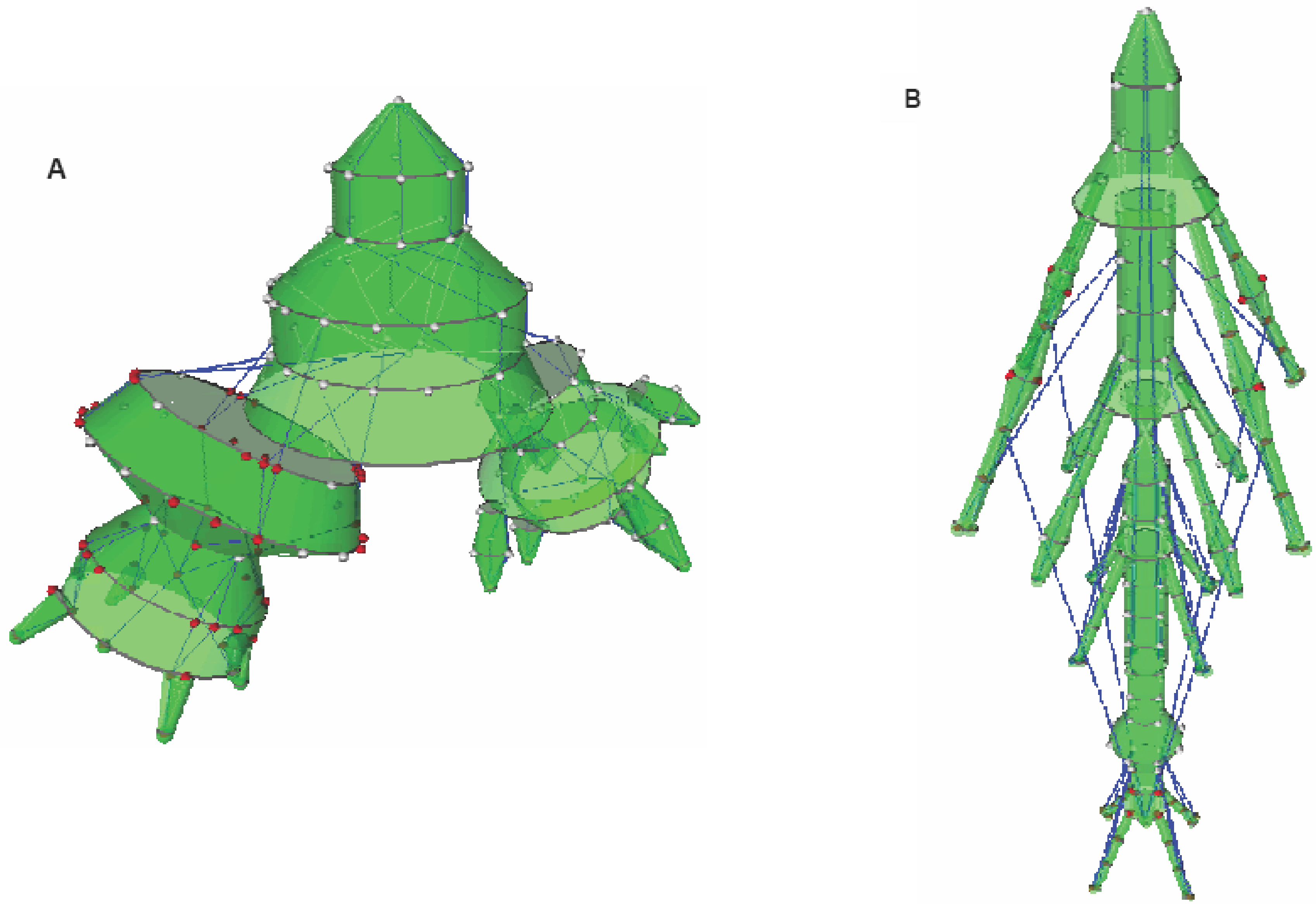
- emphasizes symmetry in the structure (nodes with the same properties are positioned the same way)
- short edges between nodes
- maximum possible distance between nodes within the same cluster (to reduce clutter and to avoid coinciding of nodes)

Placing the Nodes

To position the nodes:

- nodes are placed on graph based on the position of ancestor and descendent nodes
- adjust position of nodes to increase space between nodes in the same cluster




A
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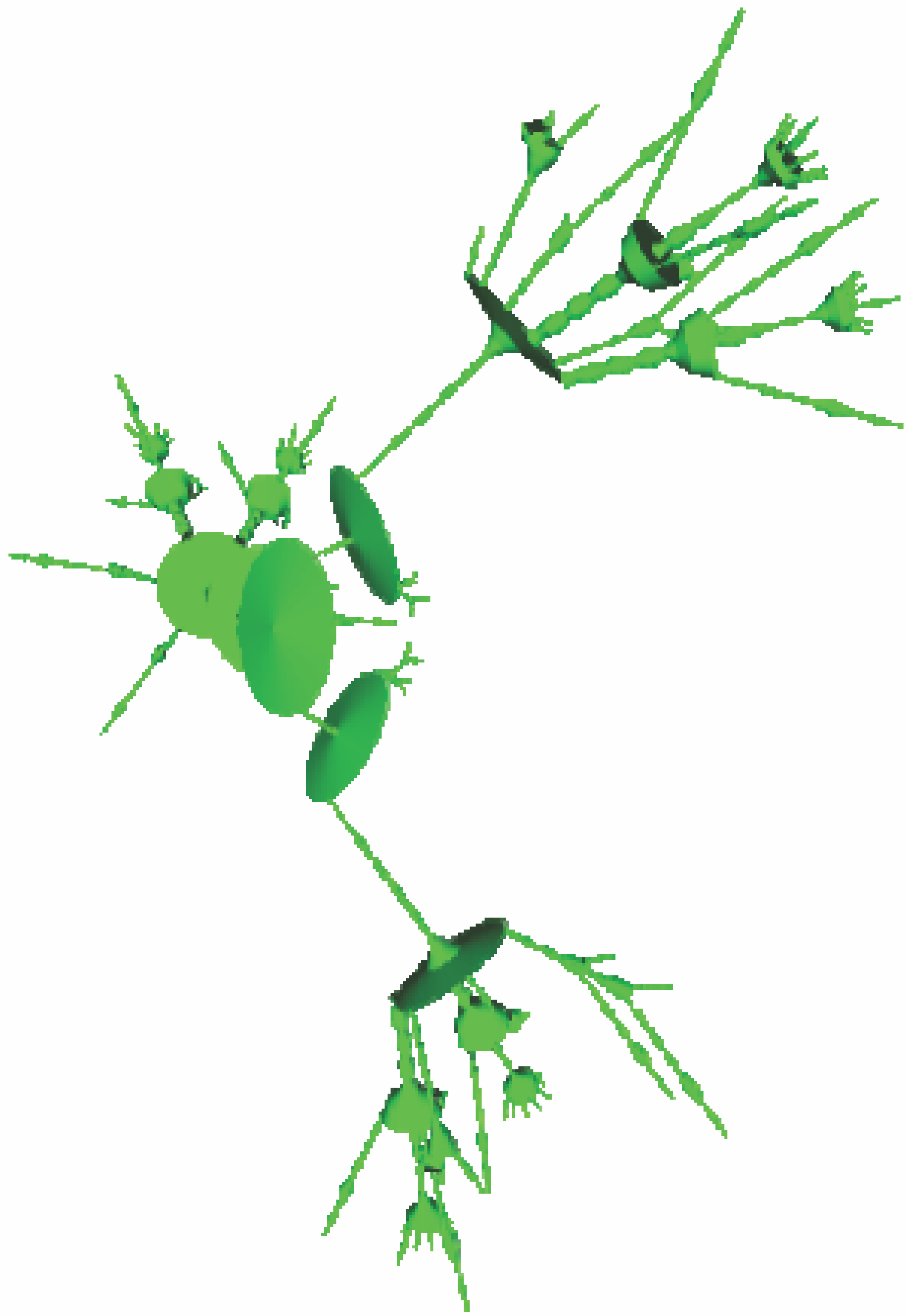

Critique

Pros:

- easy to read (provides good examples)
- occlusion is avoided (by rotating the non-centered clusters and by using transparency)
- authors state when is the cyclic and when is the iterative ranking more efficient
- real data is used at testing

Cons:

- no user study
- method not good when visualizing highly connected graphs