

# **TopoLayout: Layout of Graphs by Topological Feature**

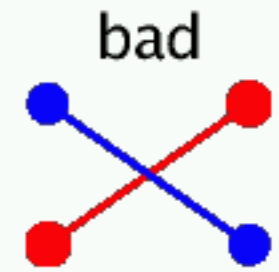
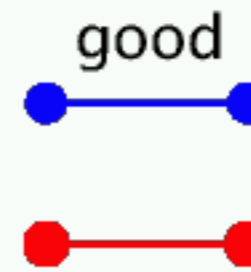
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Tamara Munzner  
University of British Columbia**

**David Auber  
Universite Bordeaux**

# Graph Drawing Criteria

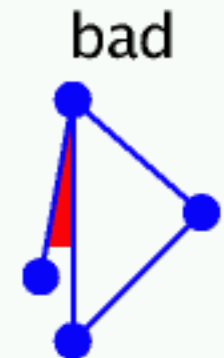
minimize

- crossings, area, bends/curves



maximize

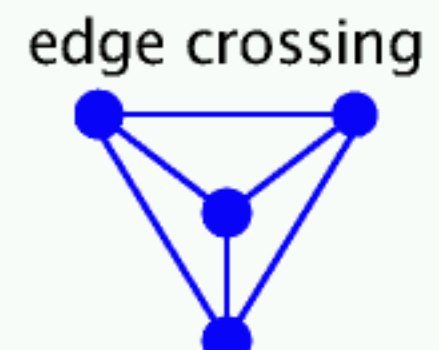
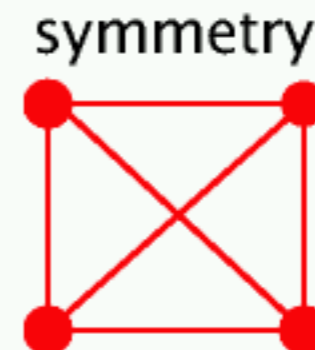
- angular resolution, symmetry



most criteria individually NP-hard

- cannot just compute optimal answer
- heuristics: try to find something reasonable

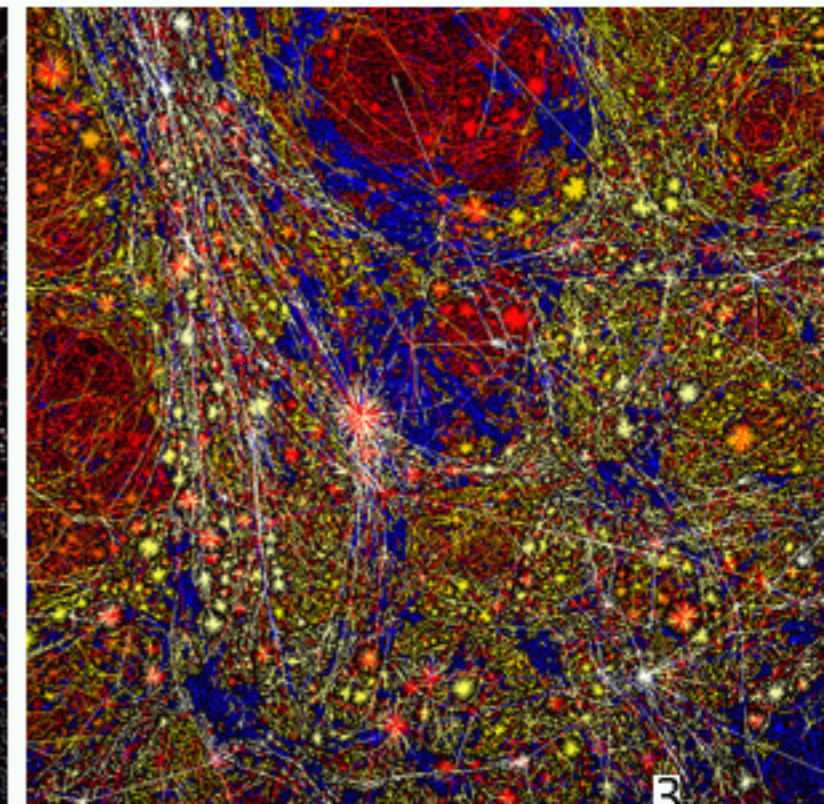
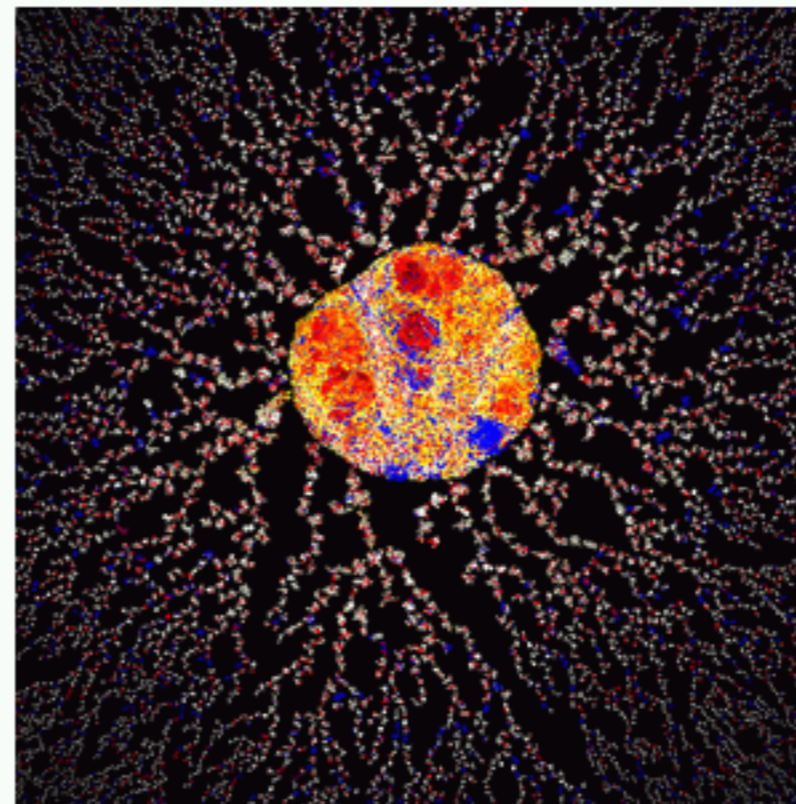
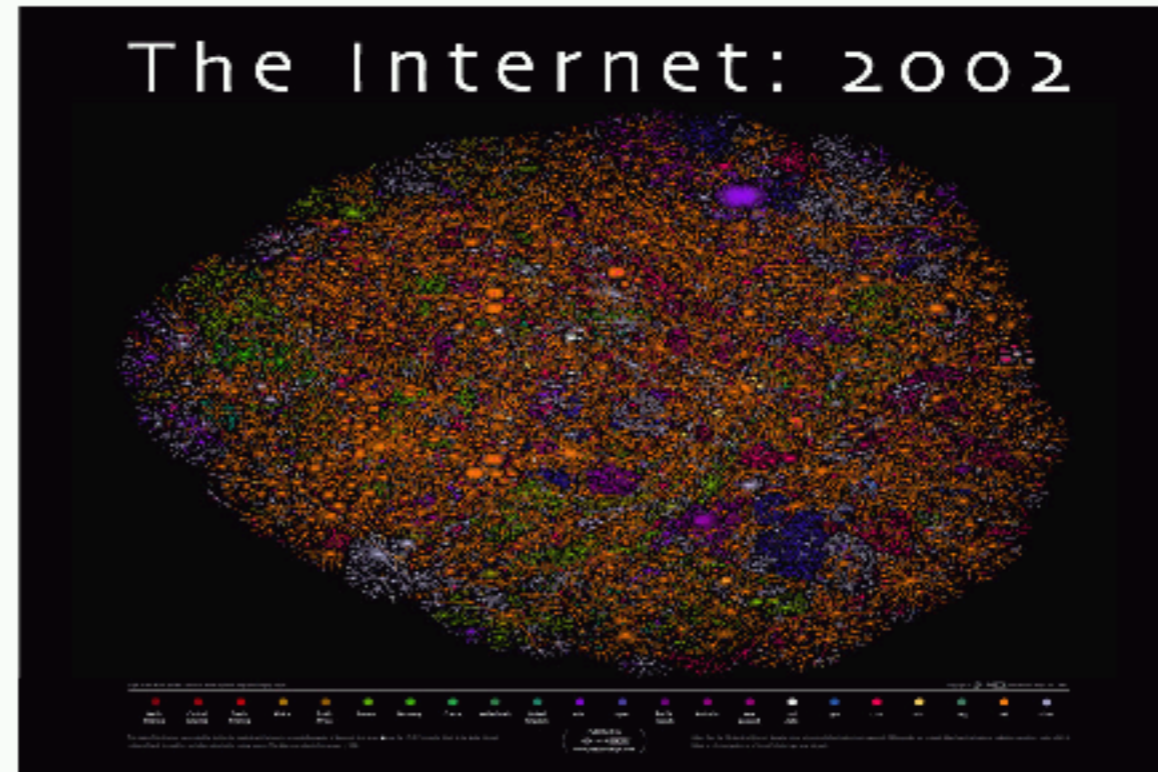
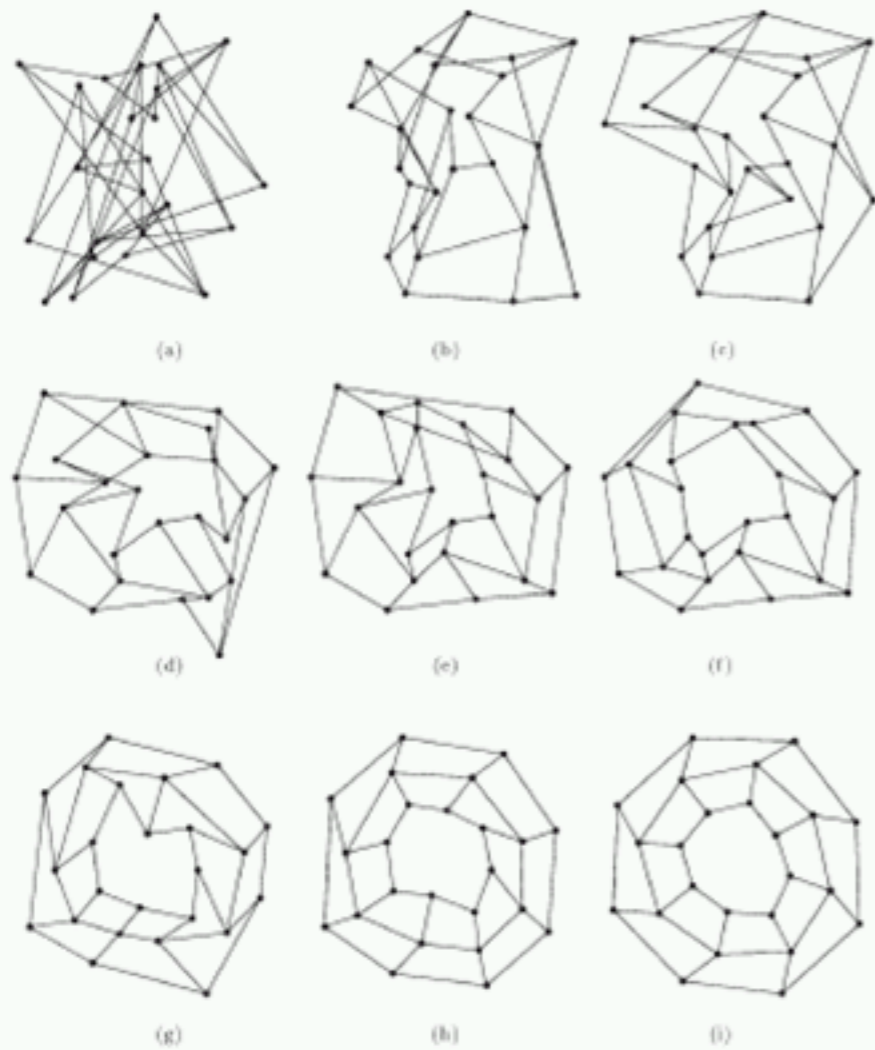
criteria mutually incompatible



[Ware, Purchase, Colpys, and McGill. Cognitive Measures of Graph Aesthetics. Information Visualization 1(2):103–110, Palgrave 2002]

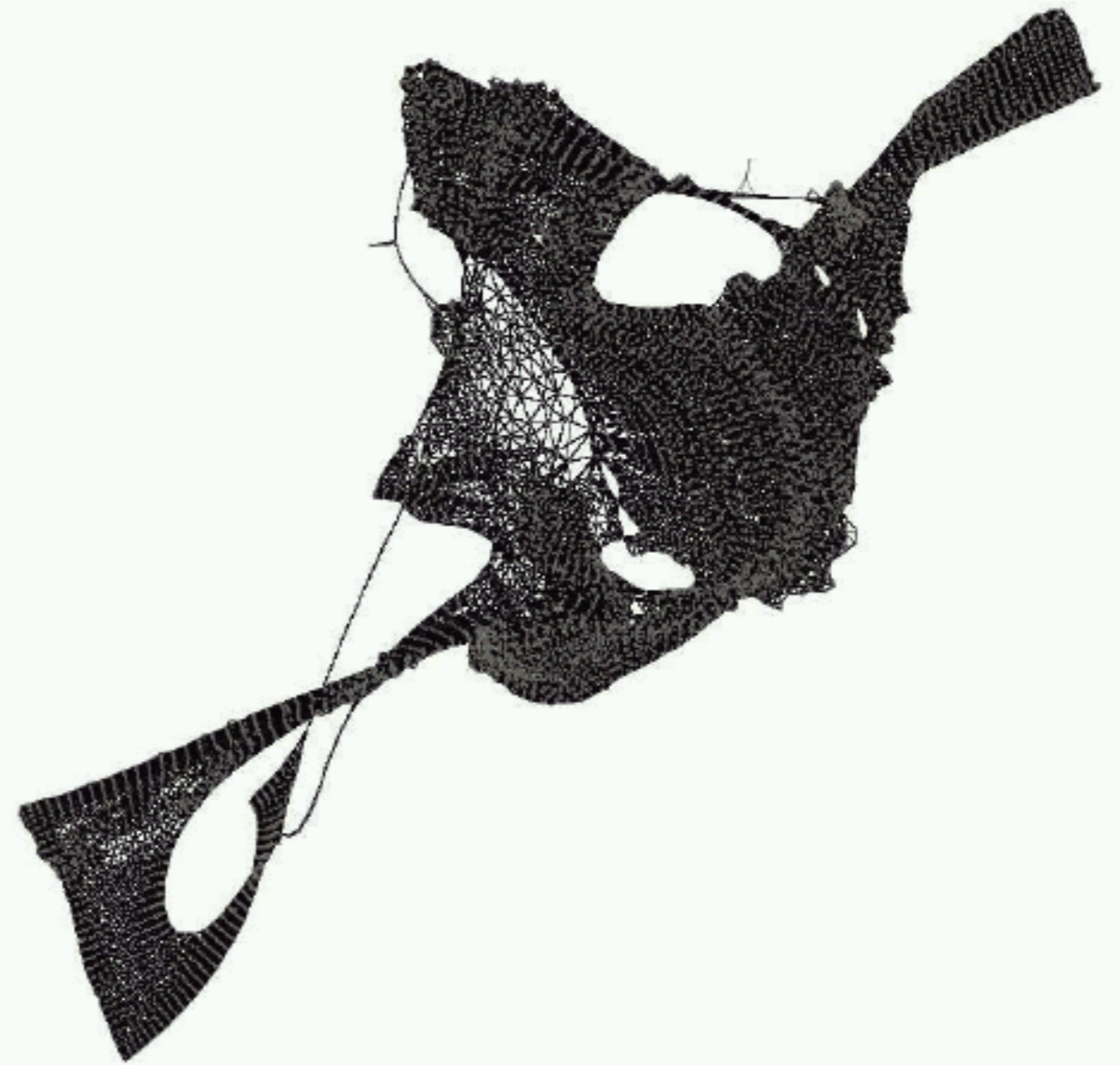
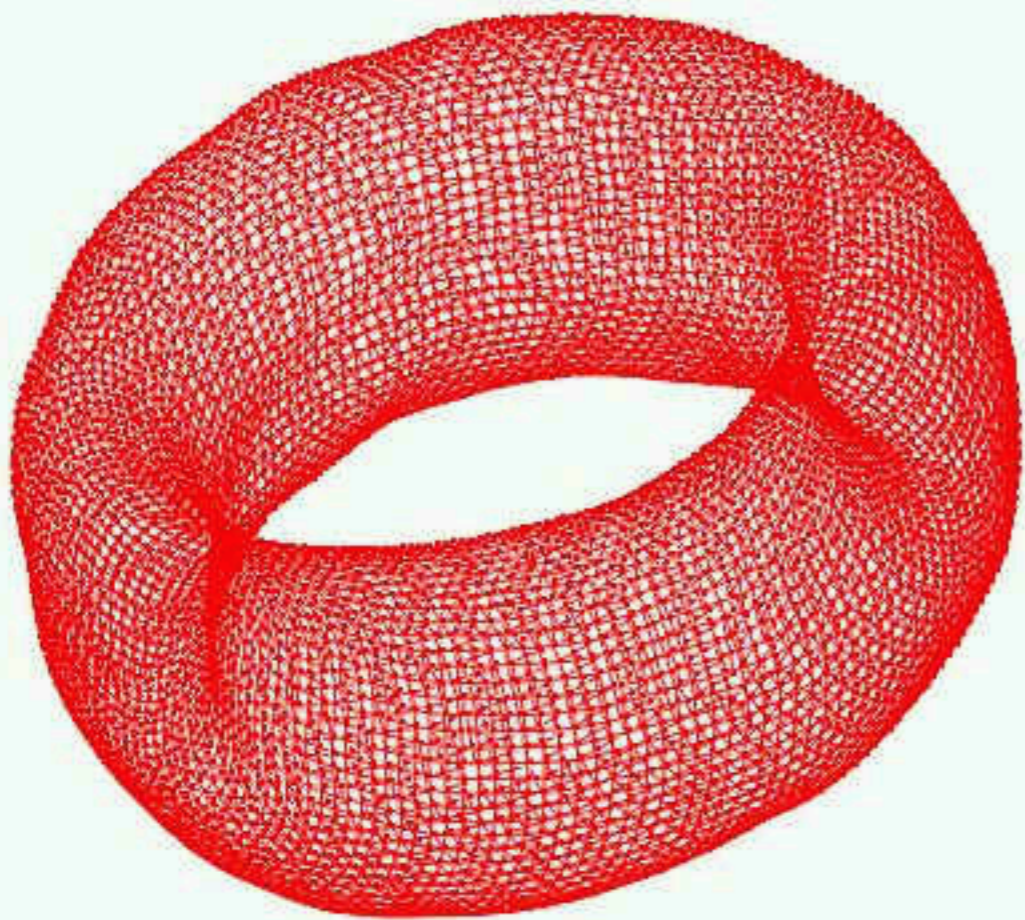
[Brandenburg. Nice Drawings of Graphs are Computationally Hard. Visualization in Human-Computer Interaction, Springer Verlag 1988]

# Force-directed Placement



# Multilevel Approaches

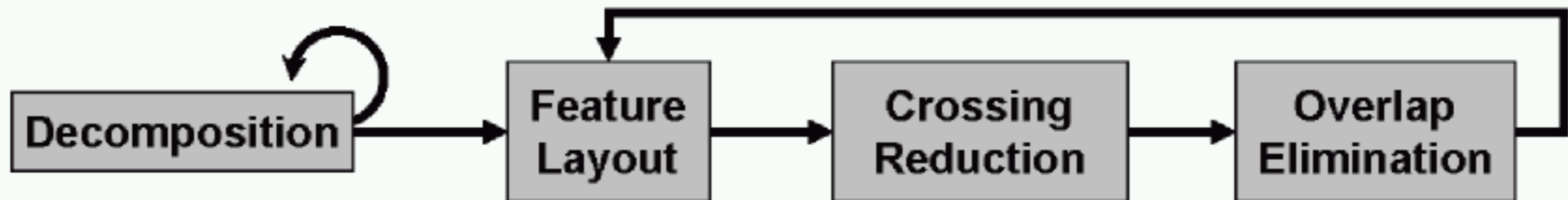
most approaches only work on some graphs



[GRIP: [www.cs.arizona.edu/~kobourov/GRIP/torus.jpg](http://www.cs.arizona.edu/~kobourov/GRIP/torus.jpg)]

[FM3: [www.informatik.uni-koeln.de/ls\\_juenger/people/hachul/diss\\_hachul.pdf](http://www.informatik.uni-koeln.de/ls_juenger/people/hachul/diss_hachul.pdf)]

# Topological Multilevel Decomposition



recursively chop up by feature

- detectors

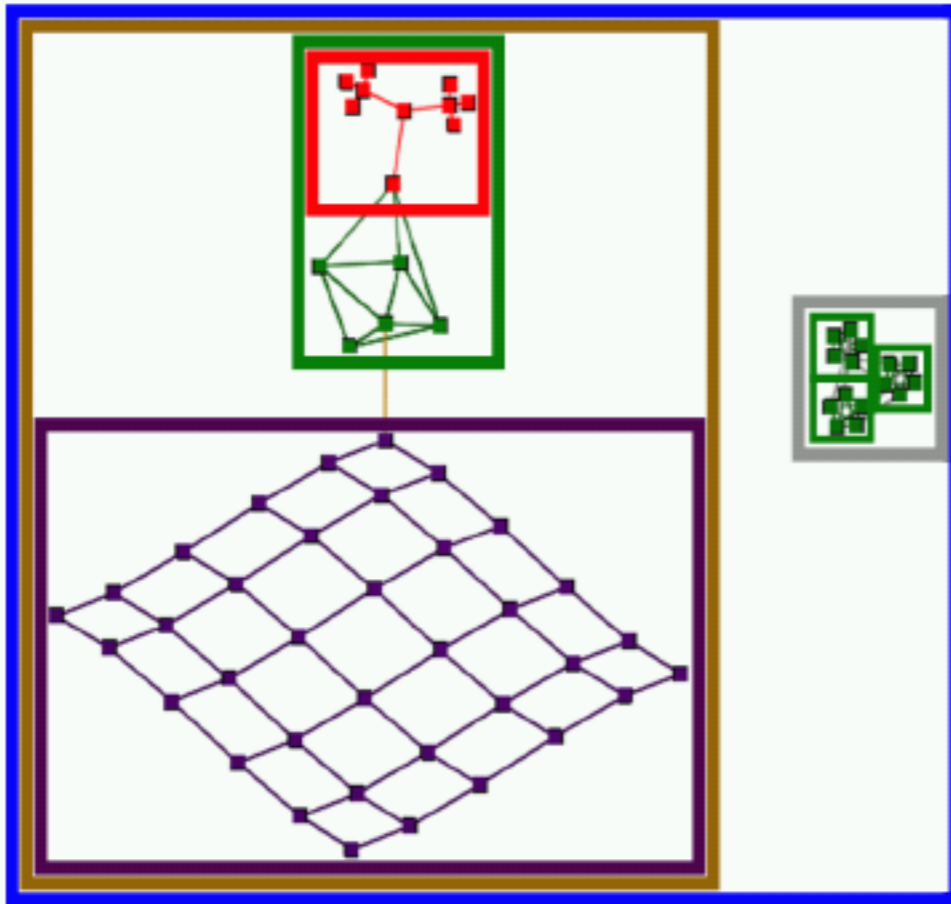
construct hierarchy

- entire subgraph collapsed into single node at higher level

lay out piece using appropriate algorithms

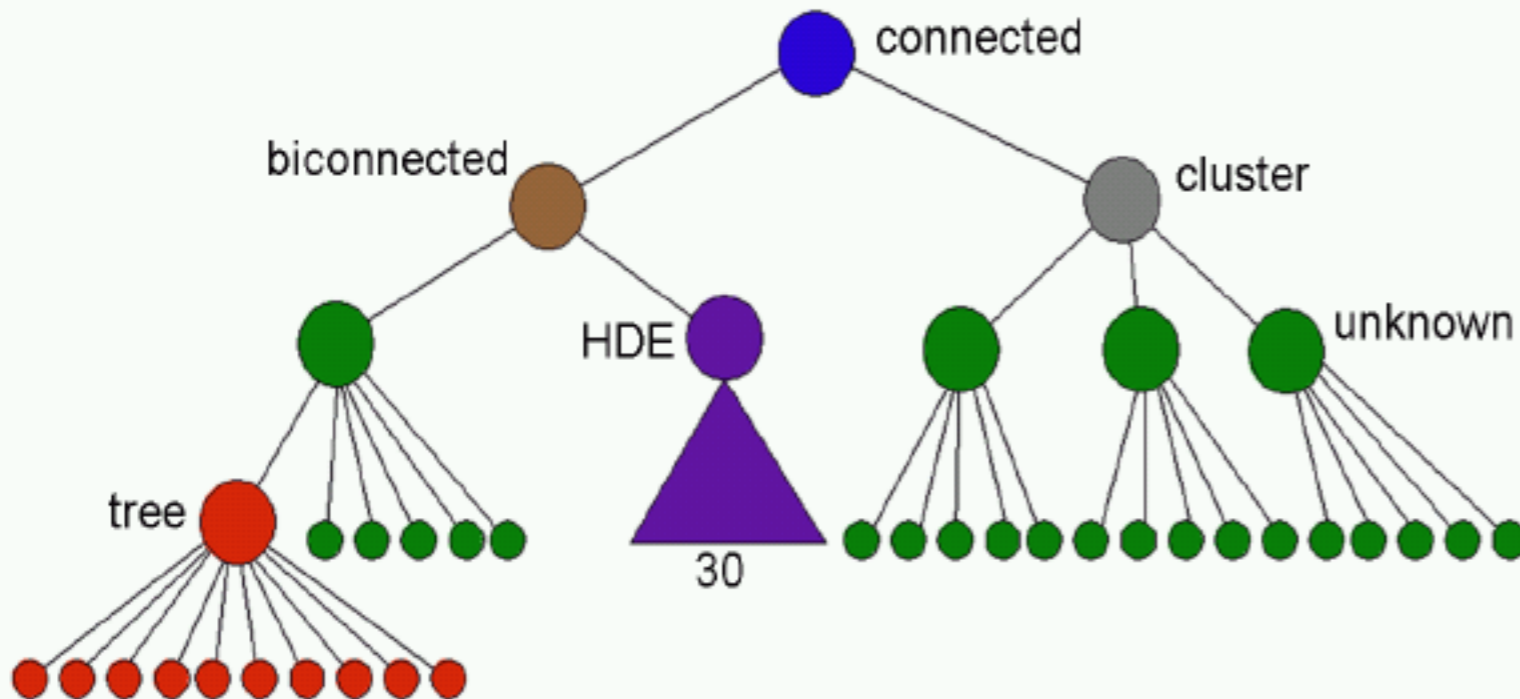
fix it up: torques, overlaps

# Subgraph Hierarchy



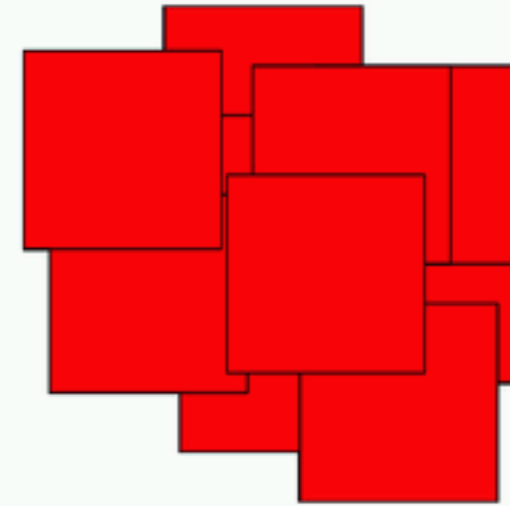
Topology Detection Order

connected  
trees  
biconnected  
HDE  
cluster  
unknown



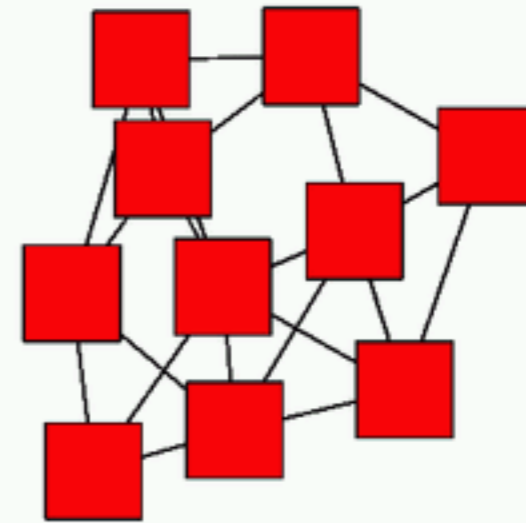
# Area-Aware FDP

tweaking GEM



$$f_{\text{repulsive}}(n_i, n_j) = \frac{l + \lceil \mathbf{r}_i + \mathbf{r}_j \rceil}{\|p_i - p_j\|^2} (p_i - p_j)$$

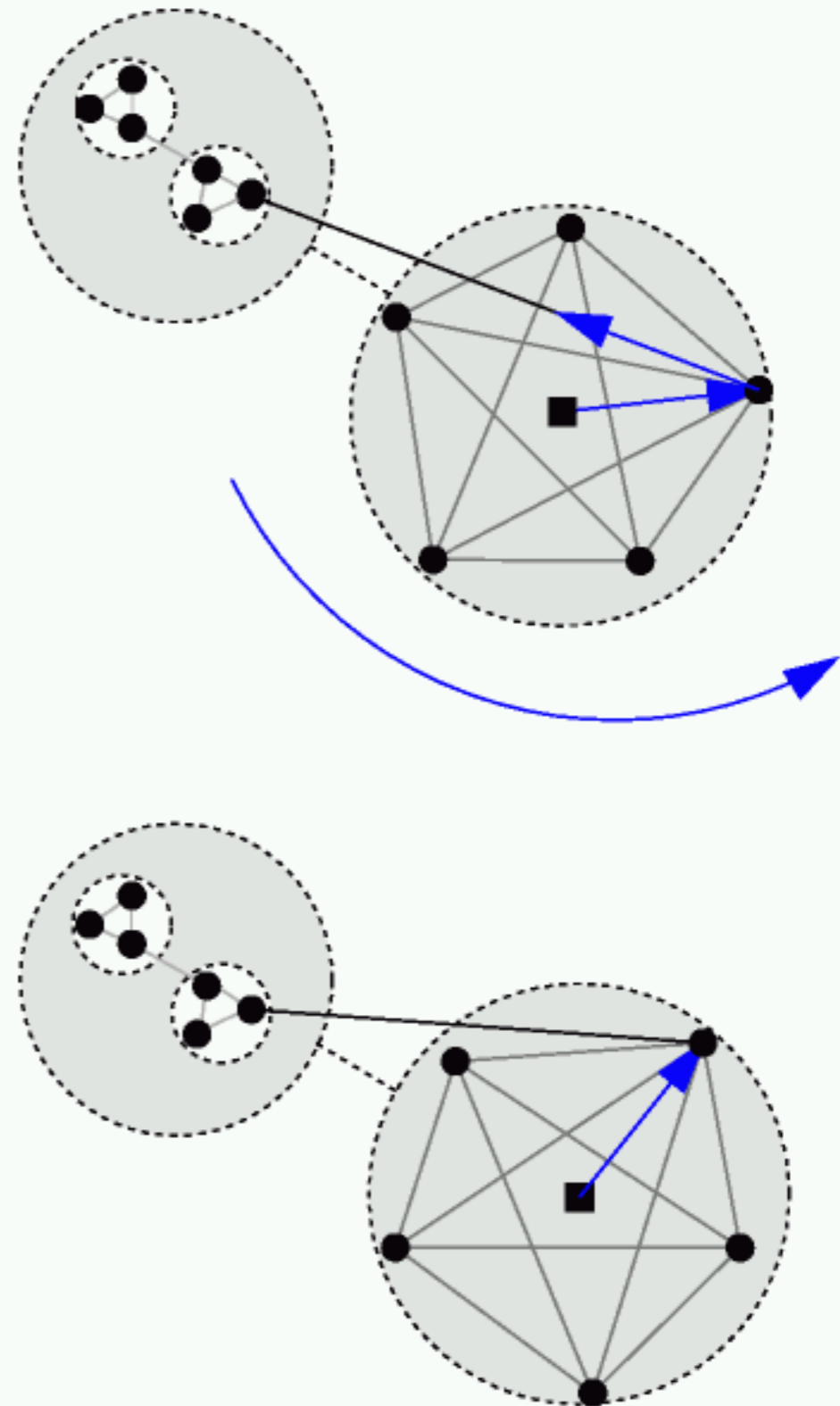
$$f_{\text{attractive}}(n_i, n_j) = \frac{\|p_i - p_j\|^2}{l + \lceil \mathbf{r}_i + \mathbf{r}_j \rceil} (p_j - p_i)$$



# Minimizing Crossings

edge/edge or edge/node

inspired by torques

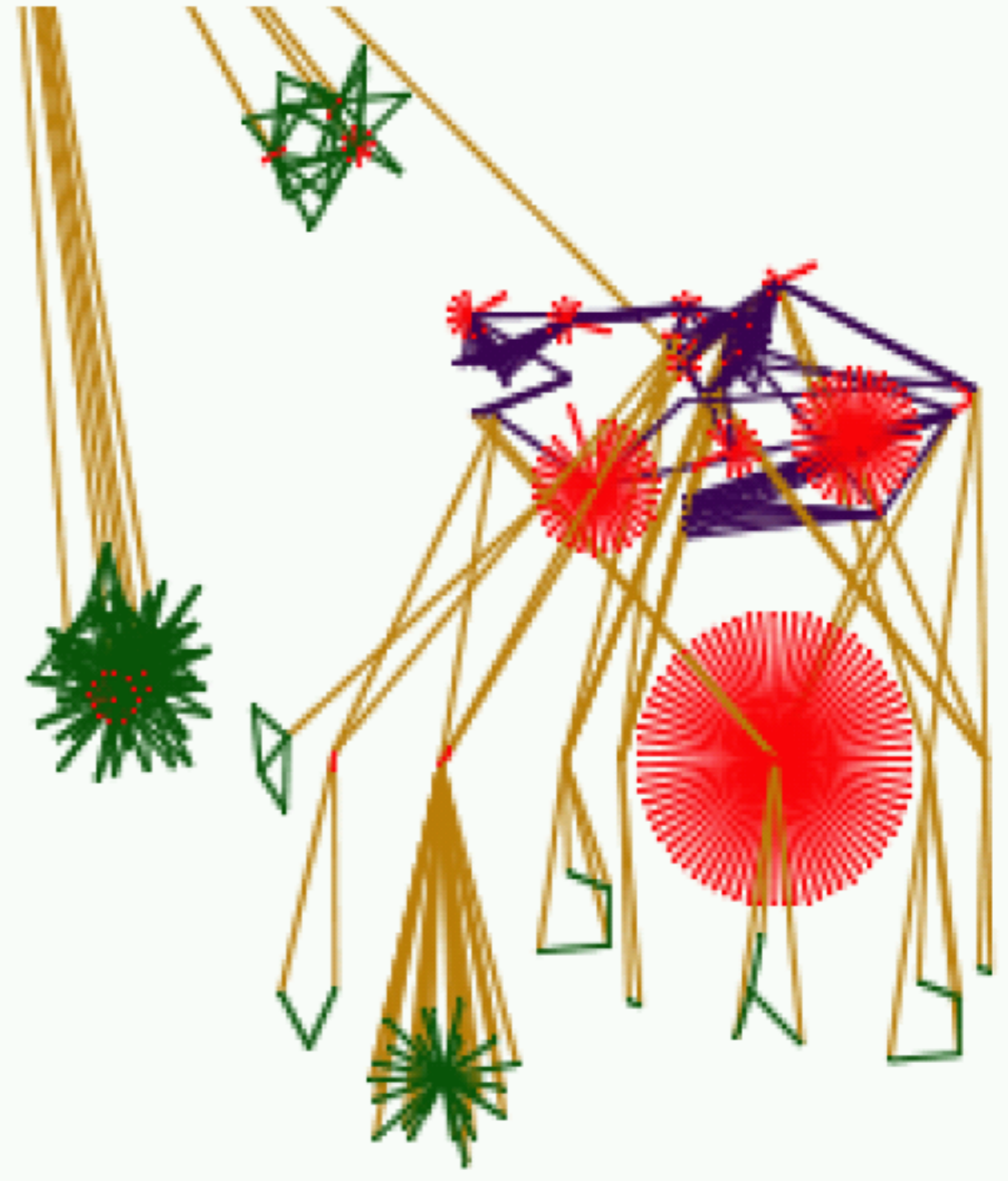




# Eliminate Overlaps


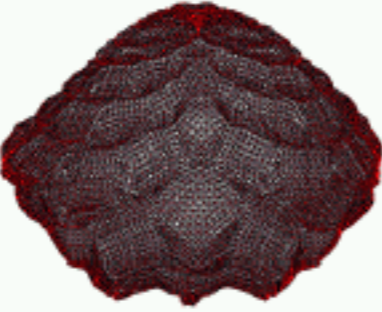
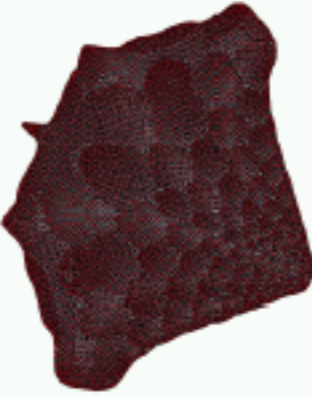
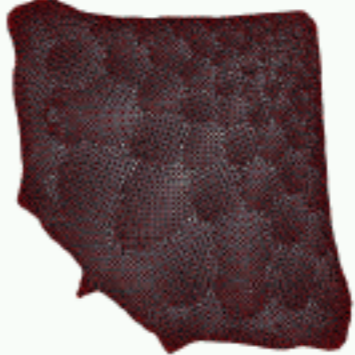
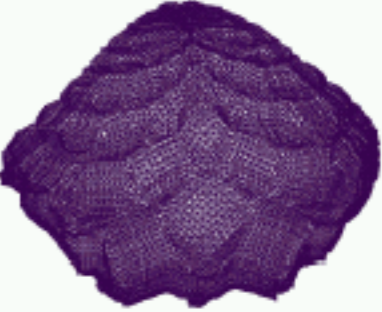

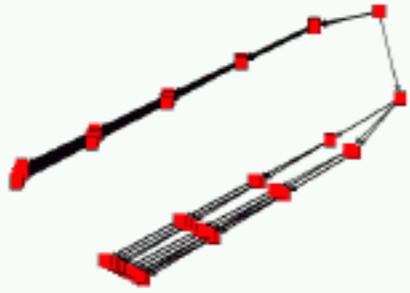
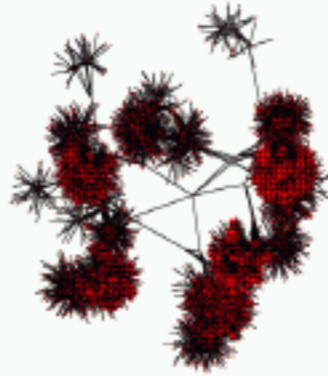
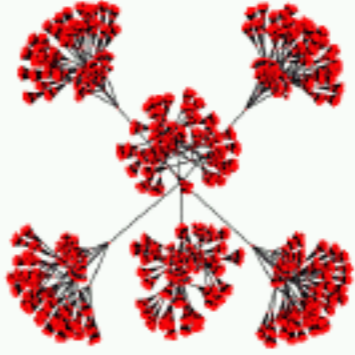
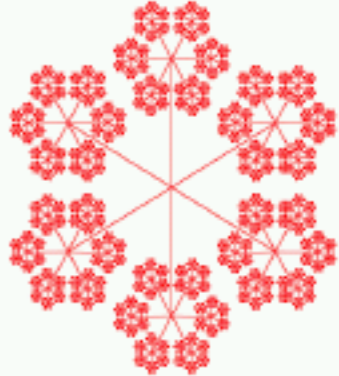
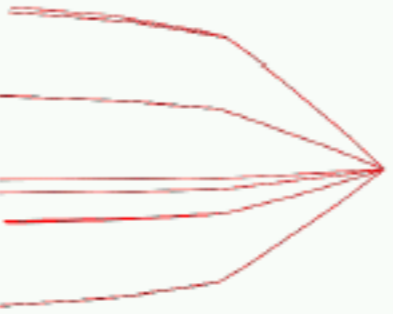

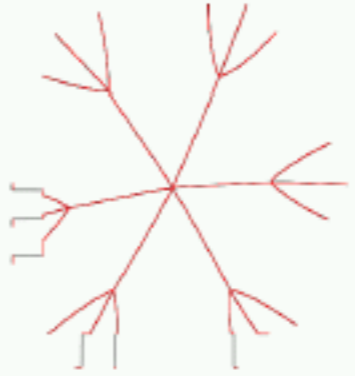



global

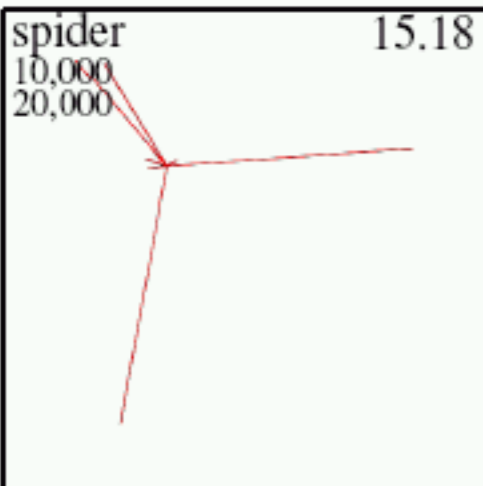
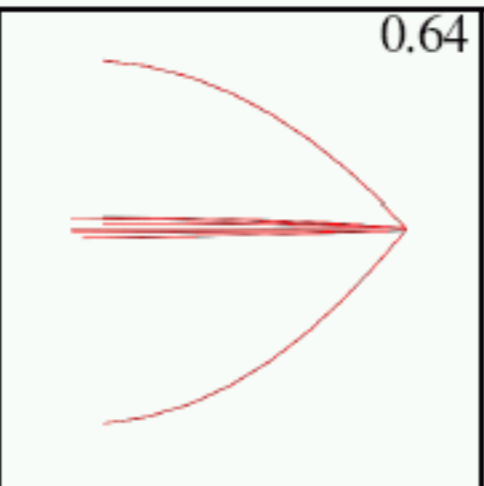
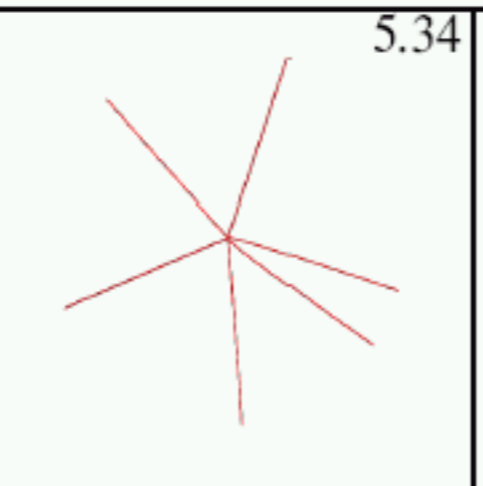
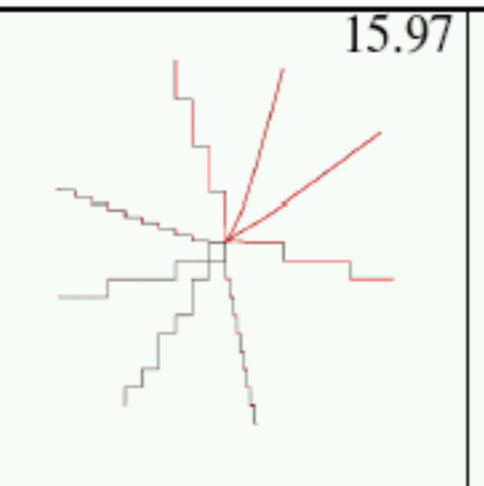
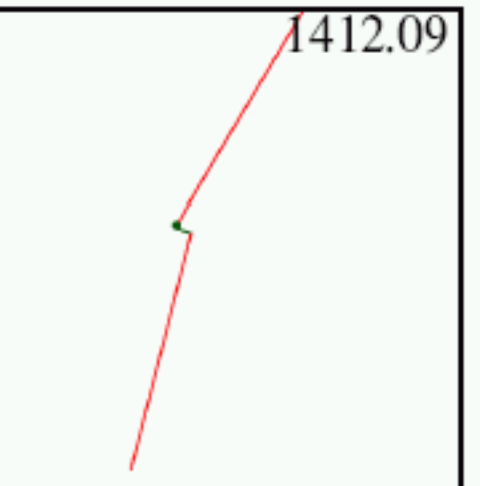
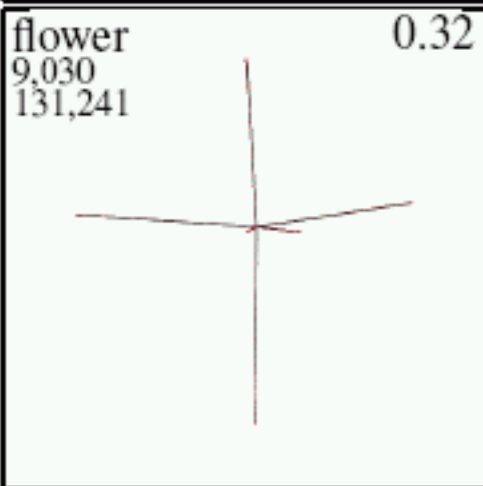
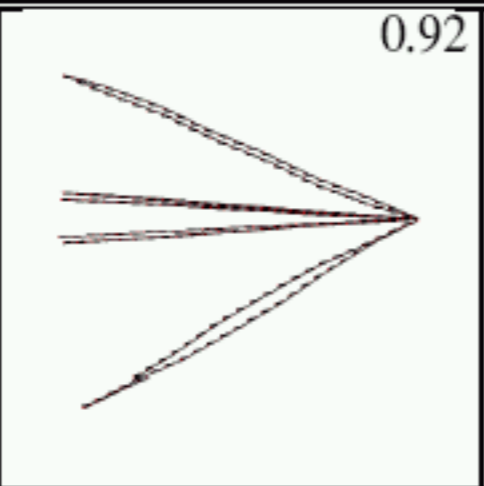
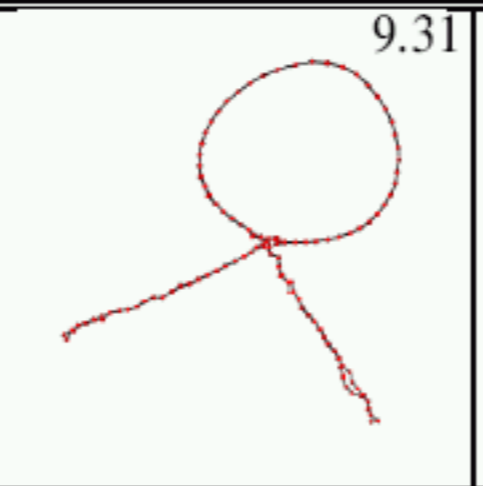
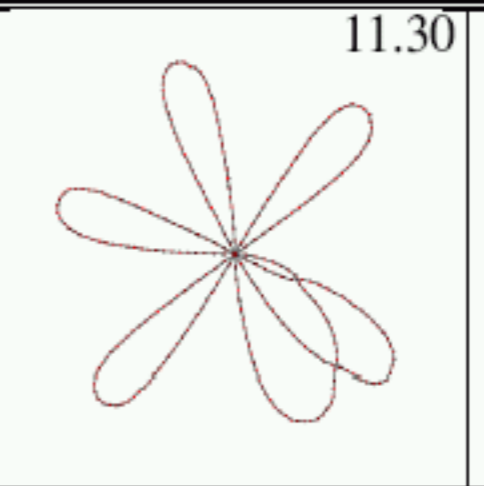
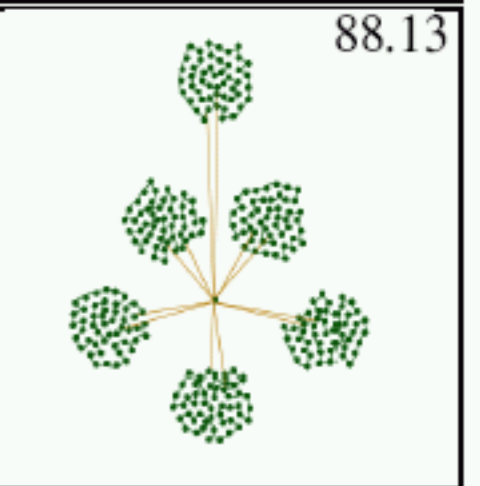
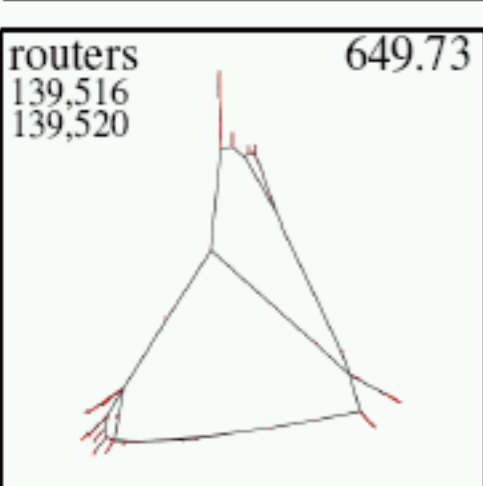
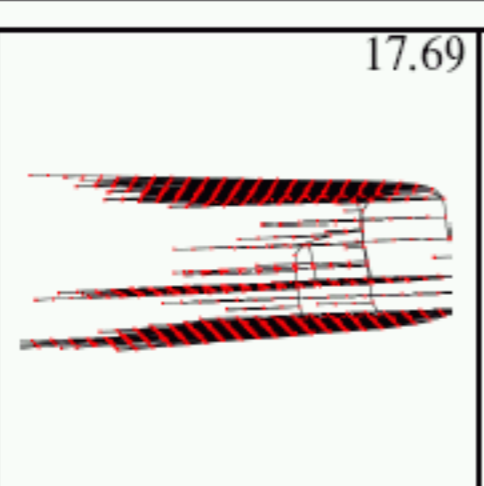
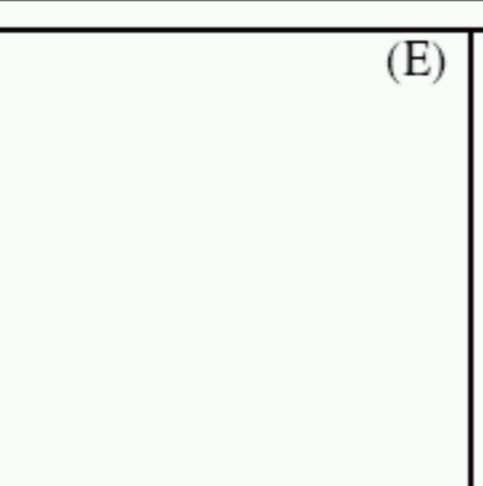
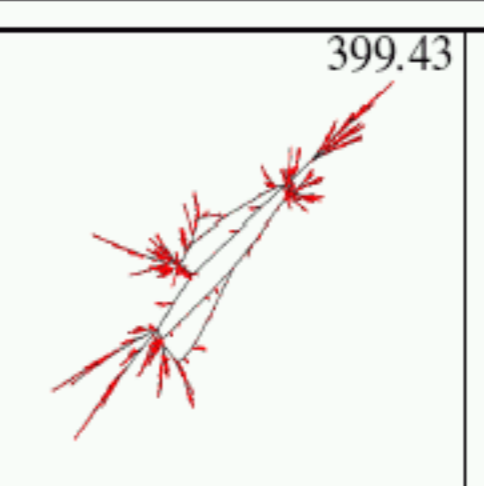
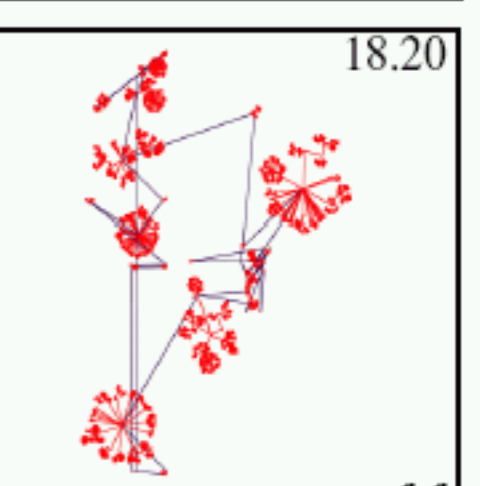


per-subgraph<sub>9</sub>


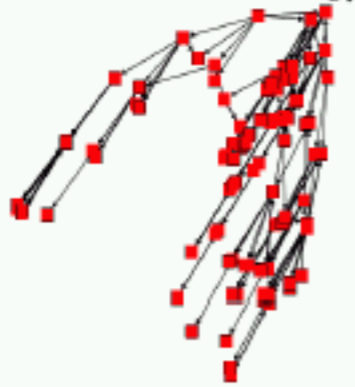




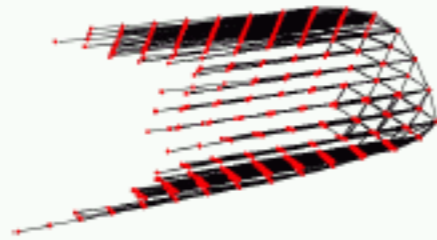
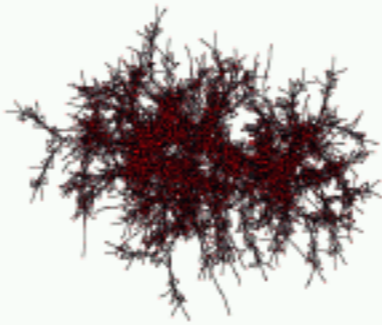




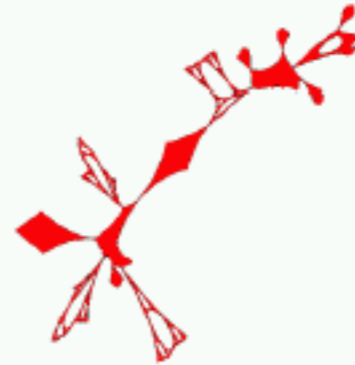
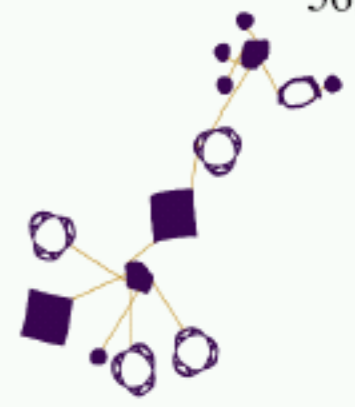
# Results

	ACE	HDE	GRIP	FM <sup>3</sup>	TopoLayout
crack 10,240 30,380	0.84 	0.84 	4.30 	21.26 	7.20 
6-ary 9,331 9,330	1.09 	0.37 	1.78 	16.62 	0.87 
snowflake (T) 9,701 9,700	0.59 	3.66 	16.86 	0.93 	

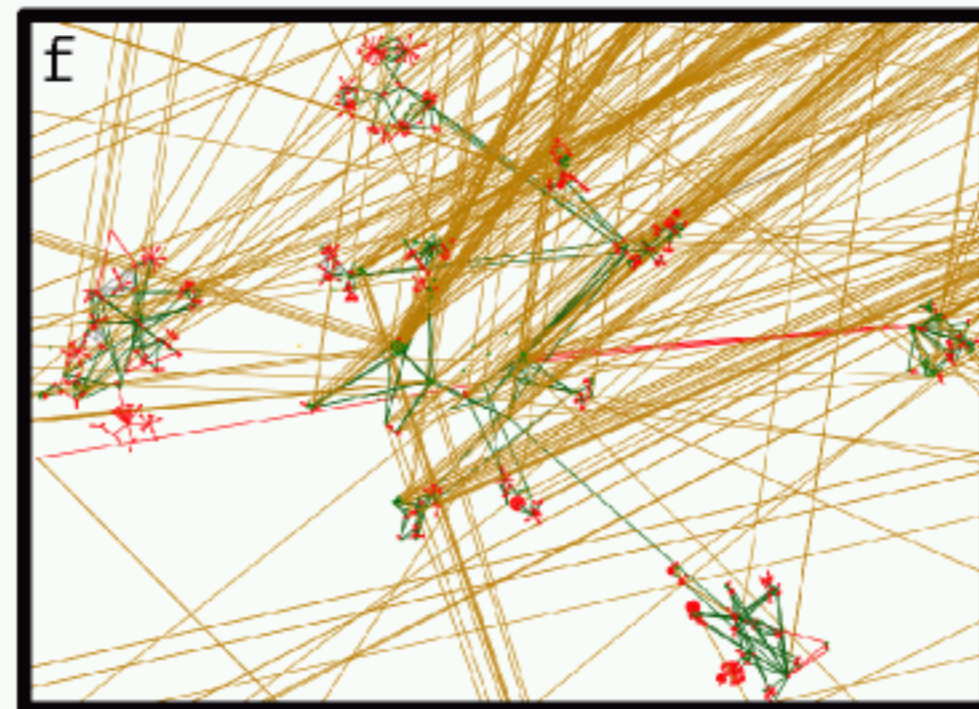
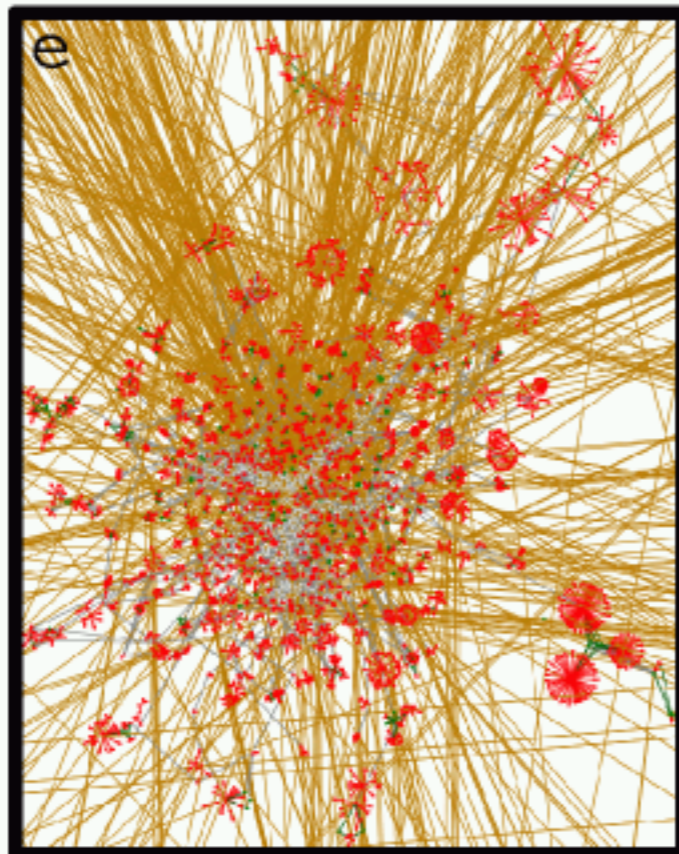
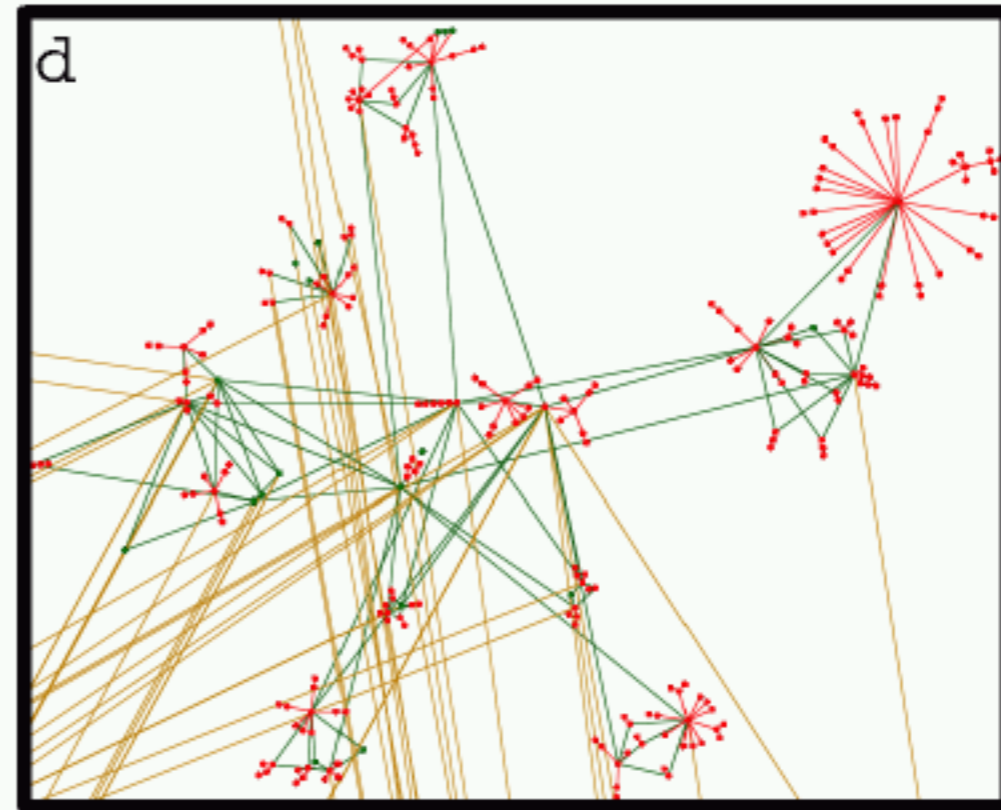
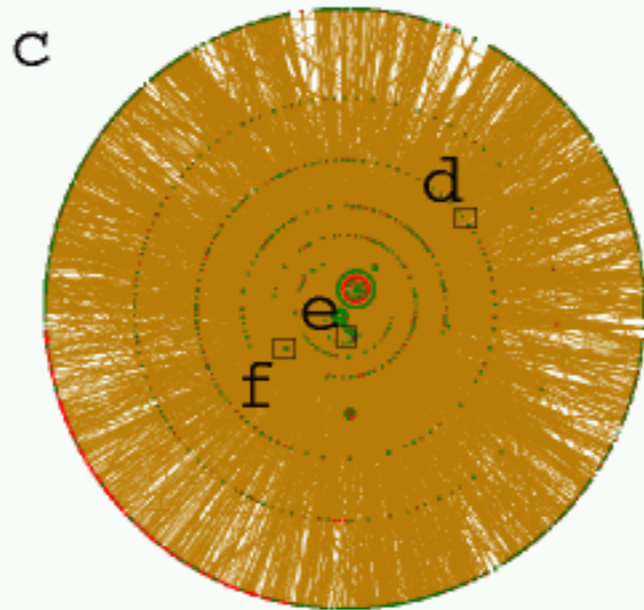
# Results

ACE	HDE	GRIP	FM <sup>3</sup>	TopoLayout
spider 10,000 20,000 15.18 	0.64 	5.34 	15.97 	1412.09 
flower 9,030 131,241 0.32 	0.92 	9.31 	11.30 	88.13 
routers 139,516 139,520 649.73 	17.69 	(E) 	399.43 	18.20 

# Results

	ACE	HDE	GRIP	FM <sup>3</sup>	TopoLayout
labri 578 1,178	 0.16	 0.03	 0.21	 0.74	 0.81
add32 4,960 9,462	 1.00	 0.35	 1.52	 11.37	 14.62
bico_walshaw 77,251 183,945	 54.46	 6.66	(E)	 155.54	 56.91

# NonResults: Feature Set Insufficient



# Challenges

information density

intractable core

quasi-features

application-specific features