

network *visualization*

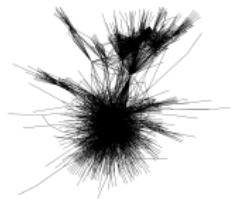
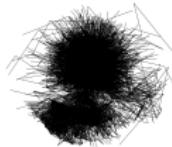
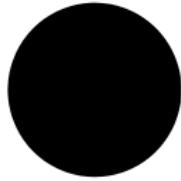
introduction to *network science in Python* (*NetPy*)

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visualization *overview*

network *visualization* with *wiring diagram**

- 1st compute *network layout* as node *coordinates* in Euclid. plane etc.
- 2nd *representation of network links?* strength, pattern, shape, color etc.
- 3rd *representation of network nodes?* size, shape, color, label etc.

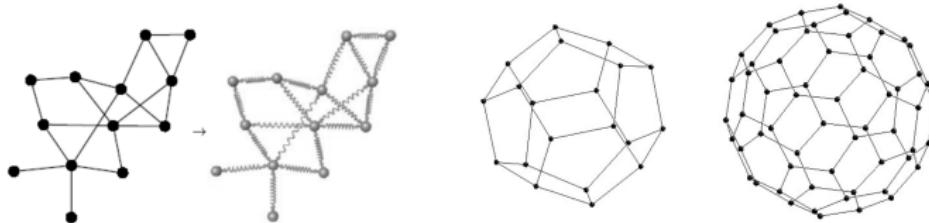


similar link lengths, no crossings, displays symmetry, even node distribution etc.

* small/dense graphs better visualized with block models

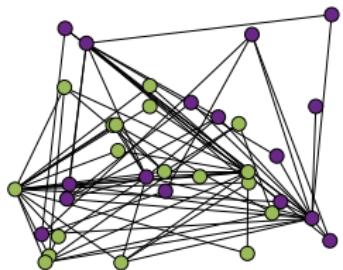
visualization *framework*

- Eades *spring embedded layout* [Ead84]
- Fruchterman-Reingold *force-directed layout* [FR91]
- Kamada-Kawai *graph theoretic layout* [KK89]
- *attractive forces* between *neighbors* using Hooke's law
- *repulsive force* between *nodes* using Coulomb's law
- move nodes thus to *minimize layout energy*

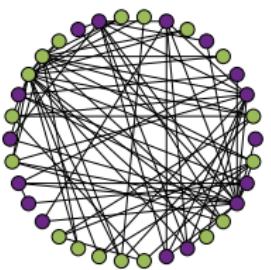


pleasing with similar link lengths, symmetry & even distribution

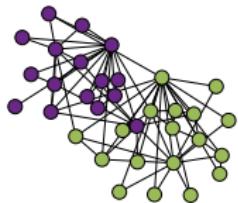
visualization *karate*



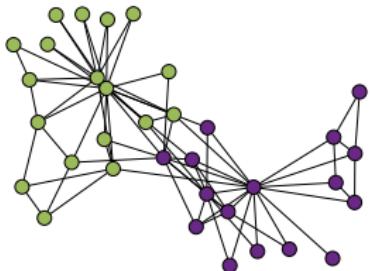
random layout



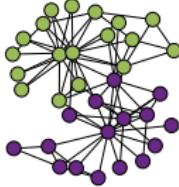
circular layout



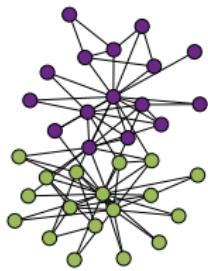
spring embedded layout [Ead84]



Fruchterman-Reingold layout [FR91]

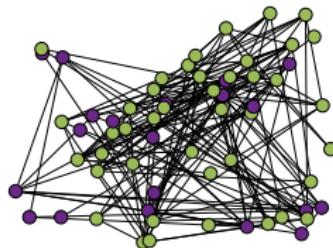


Kamada-Kawai layout [KK89]

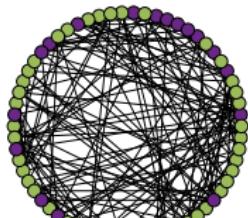


LGL layout [ADWM04]

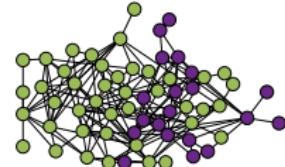
visualization *dolphins*



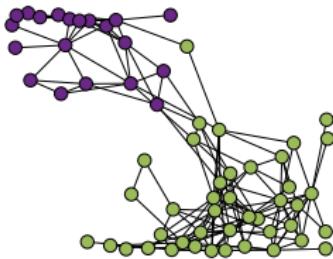
random layout



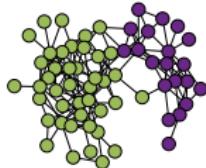
circular layout



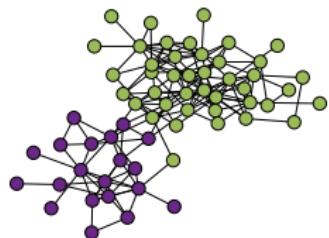
spring embedded layout [Ead84]



Fruchterman-Reingold layout [FR91]

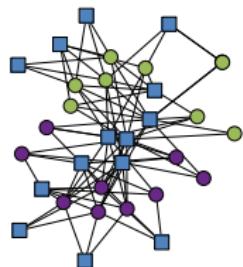
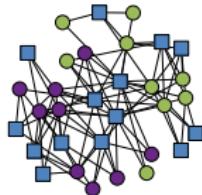
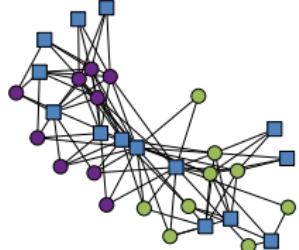
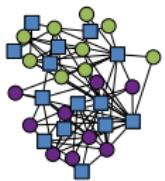
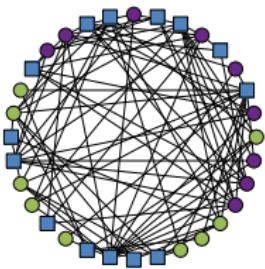
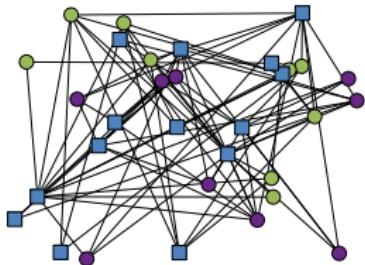


Kamada-Kawai layout [KK89]

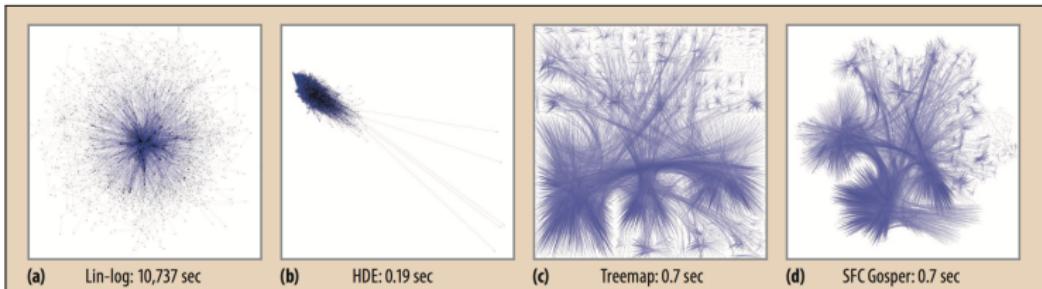


LGL layout [ADWM04]

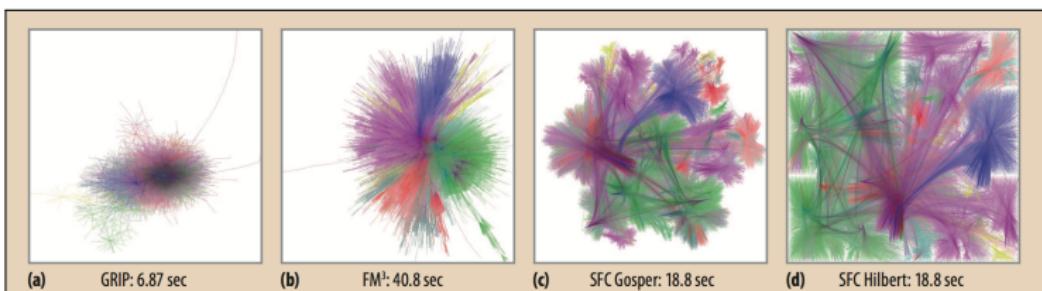
visualization *women*



visualization *static*

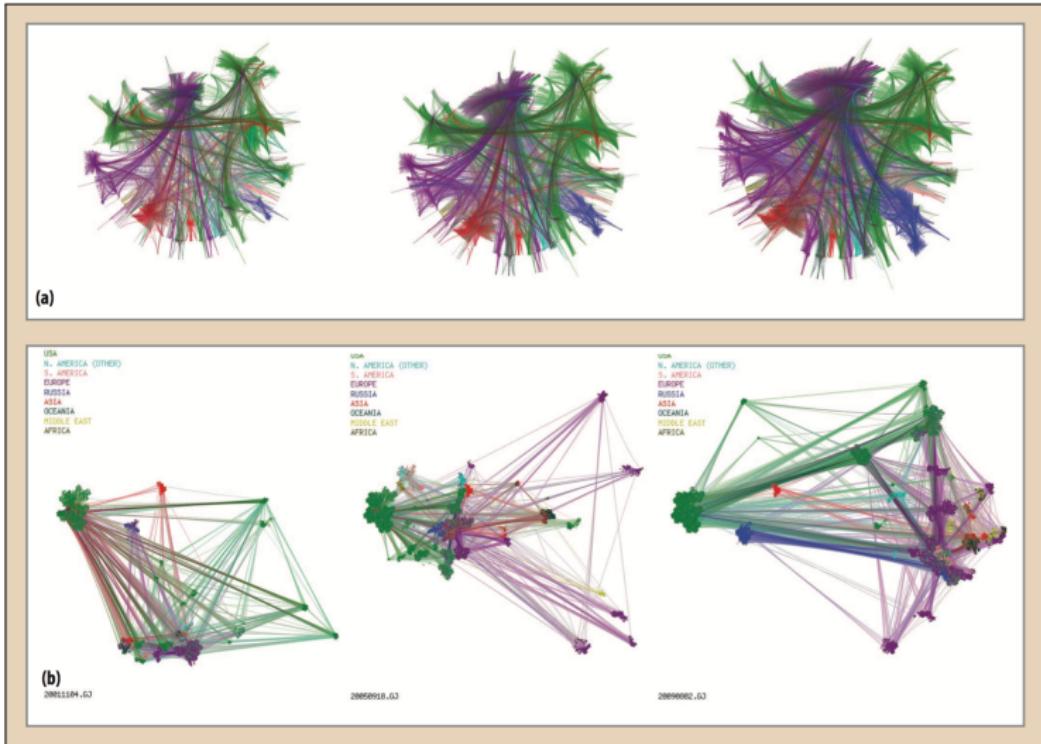


(a) *traditional* (b) *algebraic* (c) *hierarchical* and (d) *clustering-based force-directed layouts* of web graph



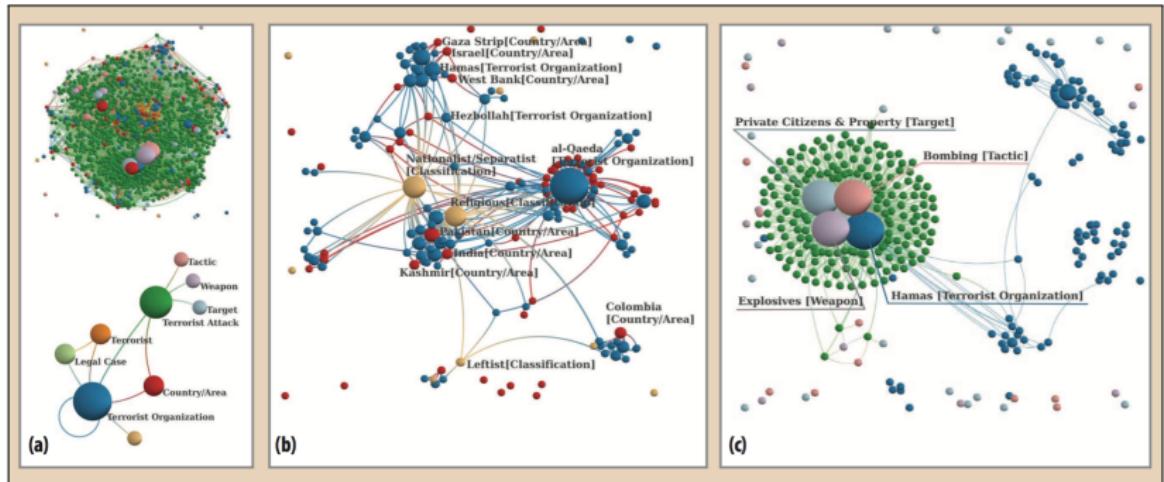
(a,b) *multilevel* and (c,d) *clustering-based force-directed layouts* of autonomous systems by continent

visualization *dynamic*



(a) *incremental* and (b) *global* clustering-based *force-directed layouts* of Internet by continent

visualization *heterogeneous*



terrorist network (a) *force-directed layout* with *semantic ontology* and (b) *active organizations* (c) *attack behaviour*

visualization *references*

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