visone – Analysis and Visualization of Social Networks

Jürgen Lerner

University of Konstanz

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Outline

1. visone– people, purpose, history.
2. visone basics.
3. **Scene 1** Juan draws a network.
4. **Scene 2** José analyzes a personal network.
5. **Scene 3** Jorge explores a random network.

Each scene introduces a researcher who wants to perform a specific task.

- We're going to help him to do this step by step in visone; intermingled with notes on the methods applied.

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visone – people, purpose, history.

Developed by groups at

- University of Karlsruhe (Dorothea Wagner) and
- University of Konstanz (**Ulrik Brandes**).

Highly involved: Michael Baur, Martin Mader, Uwe Nagel.

Main purpose: making novel network analysis and visualization techniques available to social scientists.

- Ease of use: **visual** creation, interaction, exploration, analysis, and representation of networks.
- Current focus on small and medium size networks.
- Convenient handling of actor and tie attributes.

Started around 2001 – gets constantly extended, improved, . . .

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VISONE basics.

Getting it, installing it, running it.

Import, export.

Network model.

Overview of analysis and visualization methods.

visone– getting it, installing it, running it.

http://visone.info/

Requires Sun **Java** Runtime Environment (JRE) 6 (`http://java.sun.com/`)

Works on Windows, Linux, Unix, MacOS, ...

Running: either

- click on webstart visone or
- download `visone-2.5.jar` and execute it (e. g.) by double-clicking.

$\Rightarrow$ visone

visone – import, export.

Import and export **network**-formats

- GraphML – main format, in XML
- UCINET, Pajek, (Siena)
- adjacency matrix in `.txt` or `.csv`
- GML, LEDA GraphWin, (centering resonance analysis)

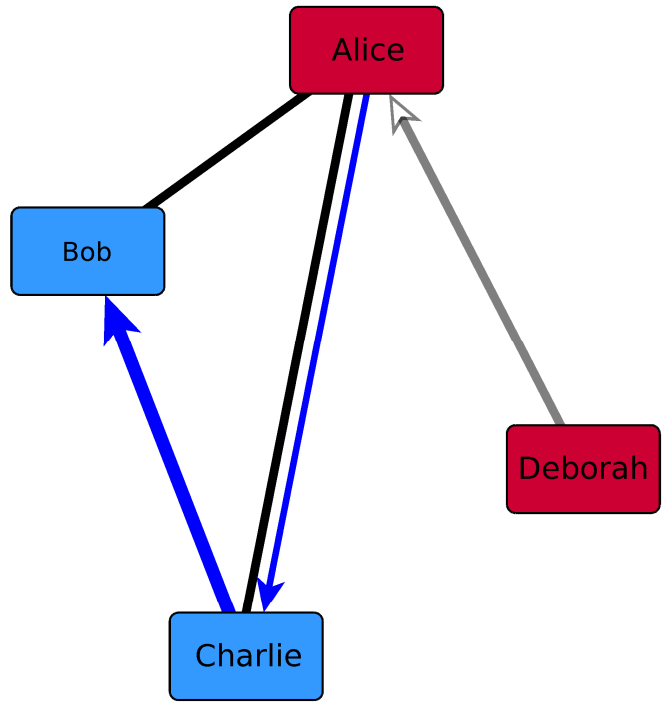
Export **image**-formats

- PNG, JPEG, GIF, BMP, SVG, PDF, ...
- printing

$\Rightarrow$ visone

visone– network model.

- mixed multigraph: (un-)directed, multiple ties
- actor and tie **attributes**: properties, numerical indicators, ...
- confirmed and un-confirmed ties



Confirmed and un-confirmed ties.

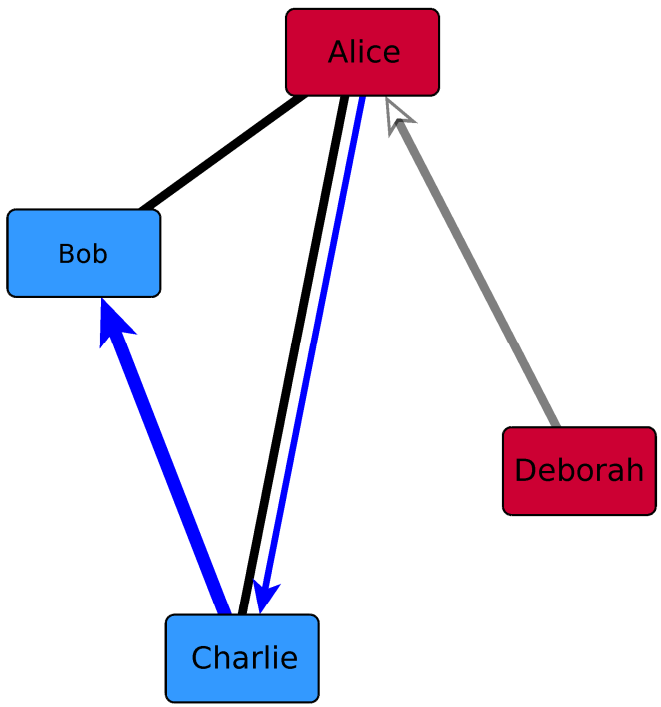
"Name your best friends."

Friendship (symmetric relation) encoded in black lines.

B names *A* and *A* names *B*.
C names *A* and *A* names *C*.

D names *A*, but *A* **does not** name *D*.

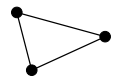
- inconsistencies often treated as "error"
- might encode valuable information
- do not "correct" it



Overview of visualization methods.

General purpose: draw networks to visualize structure.

- MDS, stress minimization, spring embedder, spectral, circular, random.

$\Rightarrow$ quick layout button 

Show properties: draw networks to emphasize attributes.

- **map attributes** to color, size, shape, width, . . .
- **centrality** layouts (draw central actors in the center)
- **status** layouts (draw high status actors on top)

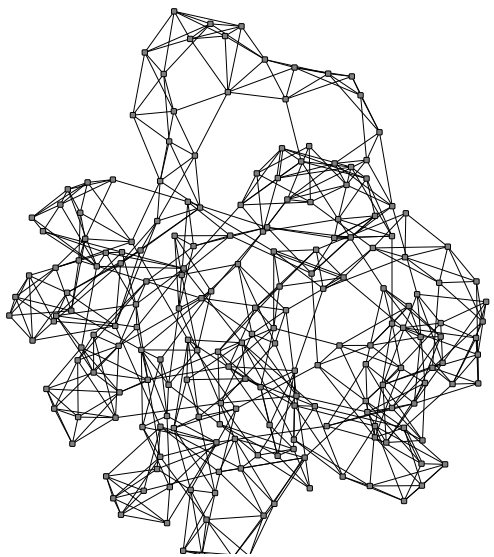
Geometric transformation

- rotate, translate, scale, reflect.

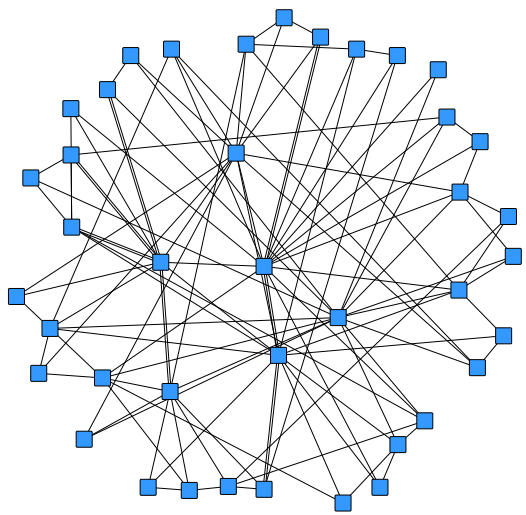
$\Rightarrow$ visone

Comparison of visualization methods.

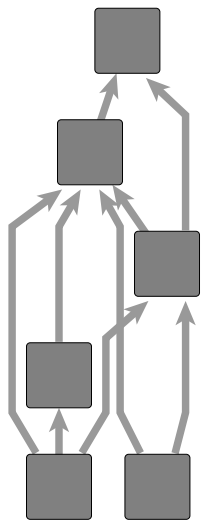
general purpose



centrality layout



status layout



Overview of analysis methods.

Indexing: computing properties of actors and ties.

- node and link **centrality**: degree, eigenvector, betweenness, closeness, status, page rank, ...
- **density**: clustering coefficient
- **distance** to selected actors

Grouping: computing groups of actors (in development)

- **clustering** (groups of densely connected actors)
- **role equivalence** (groups of similar actors)

Modeling (SIENA) (new feature)

$\Rightarrow$ visone

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Scene 1 Juan draws a network for presentation.

Scenario: Juan writes a term paper on ***regular equivalence***.

For the presentation he wants to illustrate this concept on a small example network.

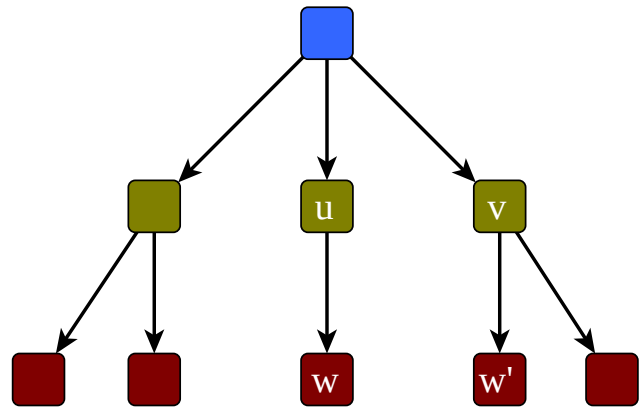
An network image helps understanding.

A vertex-coloring $c\colon V \to C$ is *regular* for a graph $G = (V, E)$ if

whenever two vertices u and v have the same color

and one of them is connected to another vertex $(u, w) \in E$

then v is connected to a vertext w' that has the same color as w



Wasserman/Faust (1994)

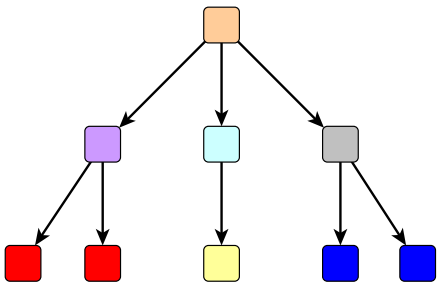
Such images can easily be created with visone.

Wrapping up.

- To create a small network that you have in mind, chose the new empty network option.
- Nodes and lines can be created in edit mode by use of the mouse – node and line templates can be defined.
- Node and tie indices are computed internally – can be mapped to visual characteristics.
- Export in various image formats is supported.

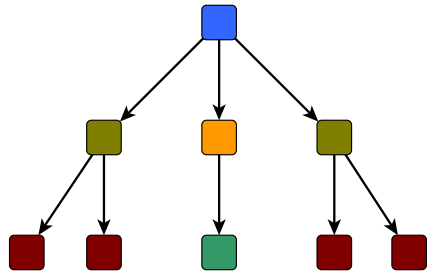
Intermezzo – different notions of role equivalence.

structural



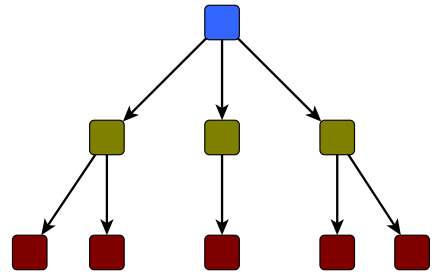
connected to the **same** others

exact regular



connected to the same number of **equivalent** others

regular



connected to **equivalent** others

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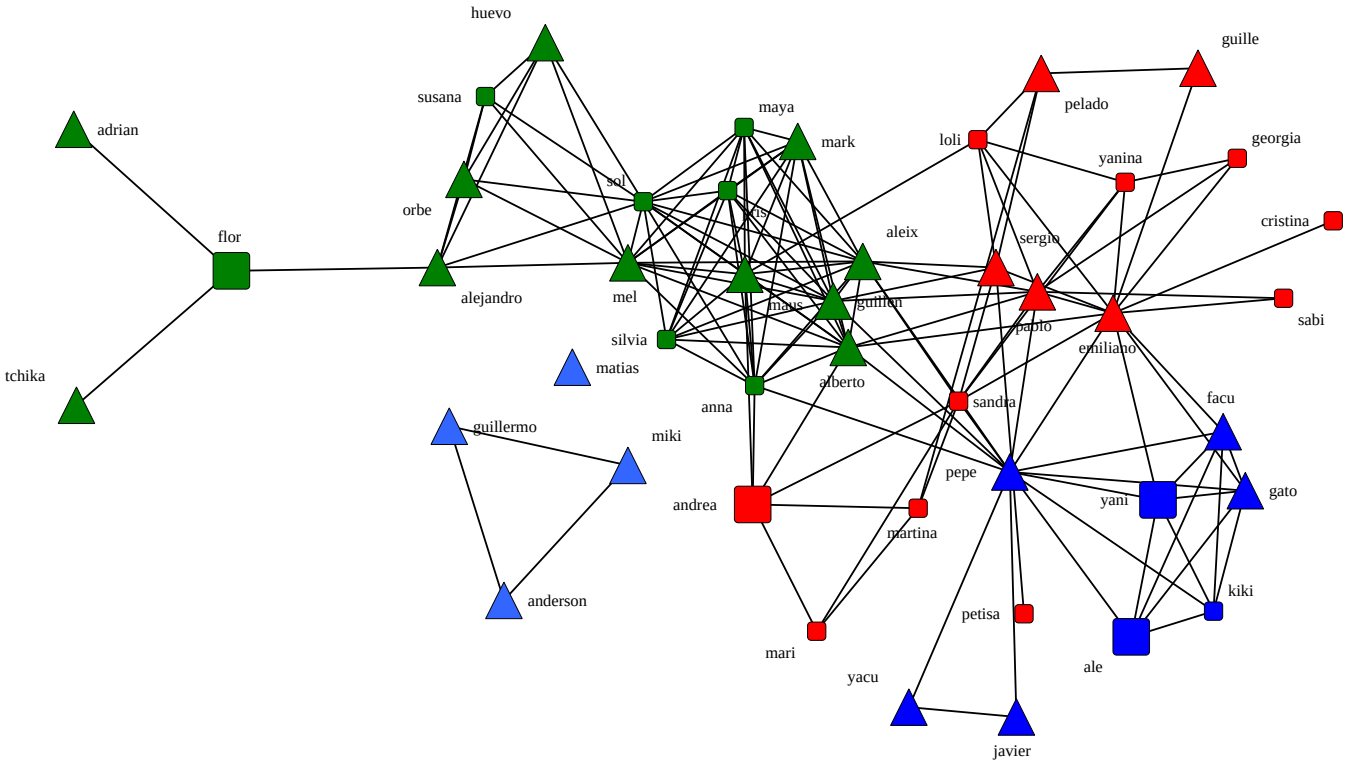
Scene 2 José analyzes a personal network.

Scenario José collected many personal networks containing various actor attributes.



$\Rightarrow$ visual exploration and analysis in Visone.

Wrapping up.

Collected node and link attributes can be

- used to define classes of actors and ties;
- mapped to color, shape, label, size, . . .
- exported to attribute tables (`.csv`) for further analysis.

Network indices (e. g., centrality) again define attributes

- are computed internally and can then be treated as any other attributes (mapping to visual properties, . . .).

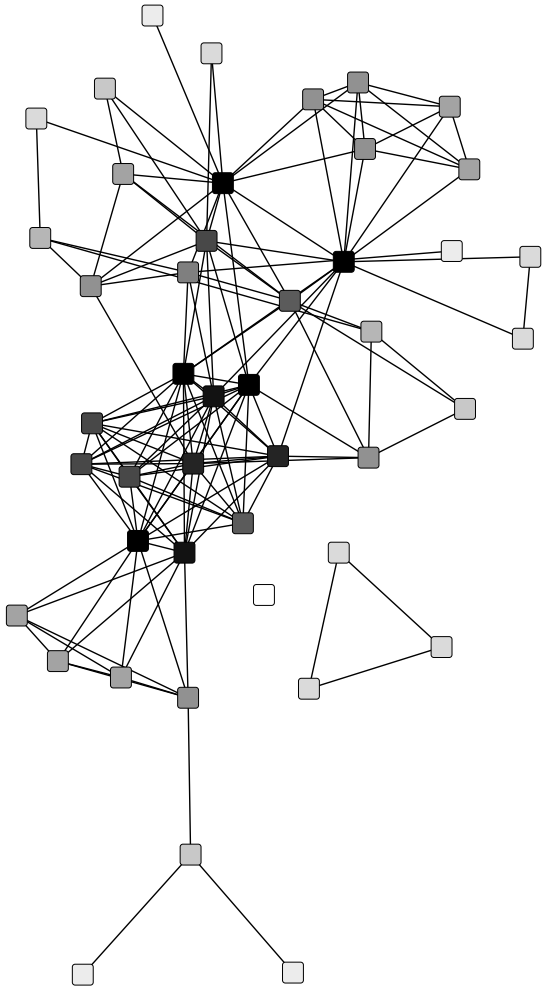
Intermezzo – centrality measures in networks.

degree indegree, outdegree

shortest path centralities
closeness, current flow closeness, betweenness, current flow betweenness, radiality, stress, eccentricity

feedback centralities (eigenvector)
eigenvector, hubs & authorities, PageRank, Katz' status

Degree centralities.



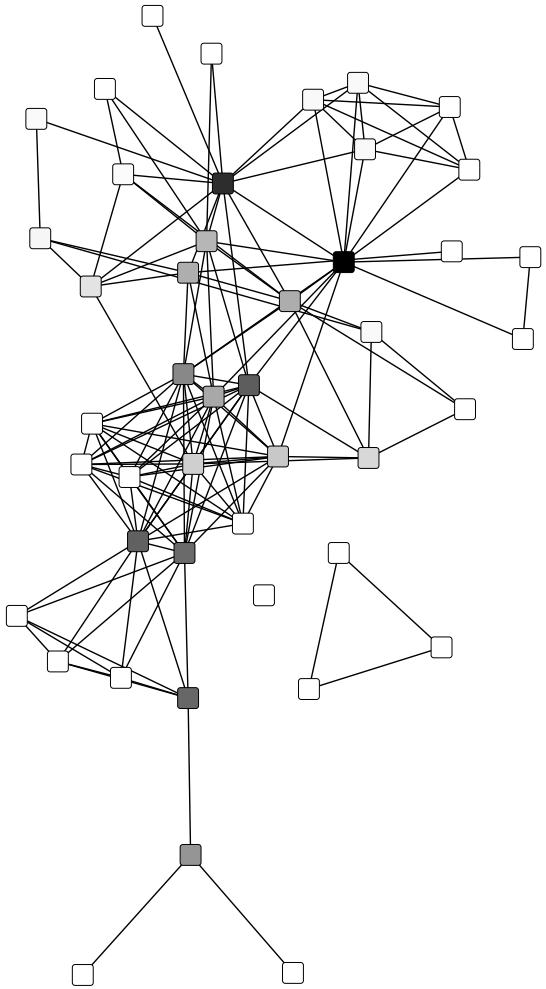
degree: number of lines connected to a node

indegree: number of *incomming* lines connected to a node

outdegree: number of *outgoing* lines connected to a node

$\Rightarrow$ visone

Shortest path centralities.



betweenness: being on shortest paths between alters

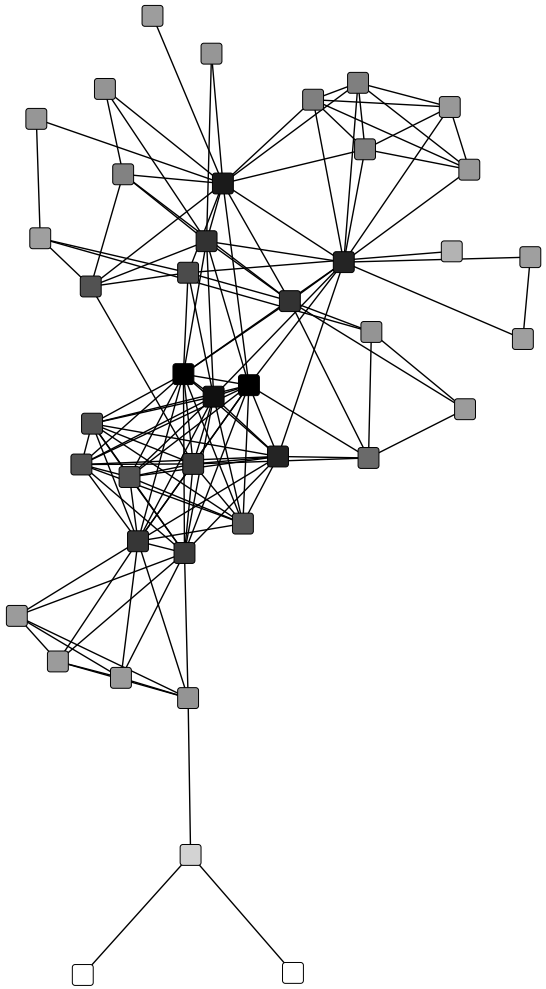
closeness: short distance to alters

current flow betweenness: high throughput of electric current
(also called **information centrality**)

current flow closeness: small potential difference when seen as an electric network

$\Rightarrow$ visone

Shortest path centralities.



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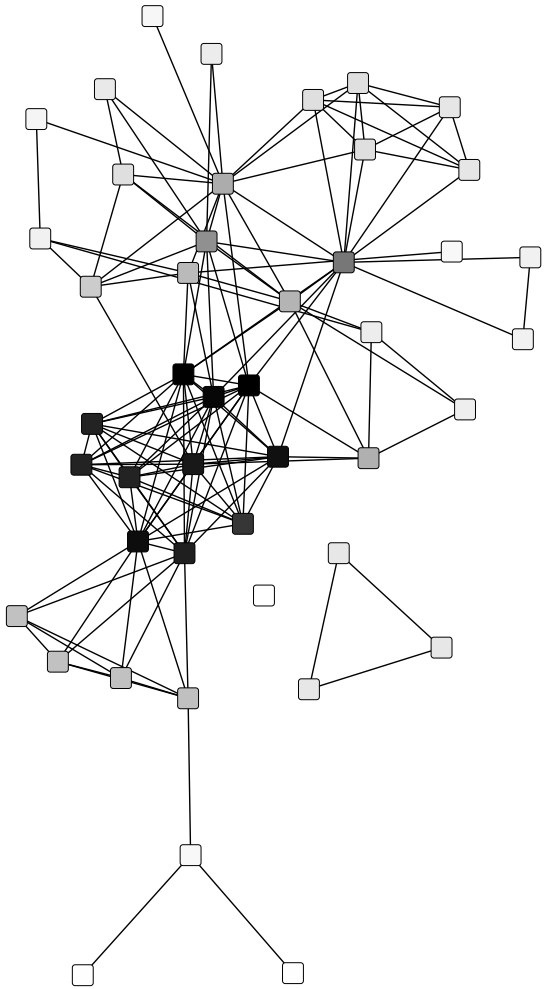
Feedback centralities.

Idea: node important if connected to (many) important others.



eigenvector of adjacency matrix

page rank: stable distribution in a random surfer model

hubs & authorities: a strong hub points to many strong authorities;
a strong authority is pointed at by many strong hubs

Katz' status: nodes give status to nodes they point at – directly or indirectly

$\Rightarrow$ visone

Feedback centralities.

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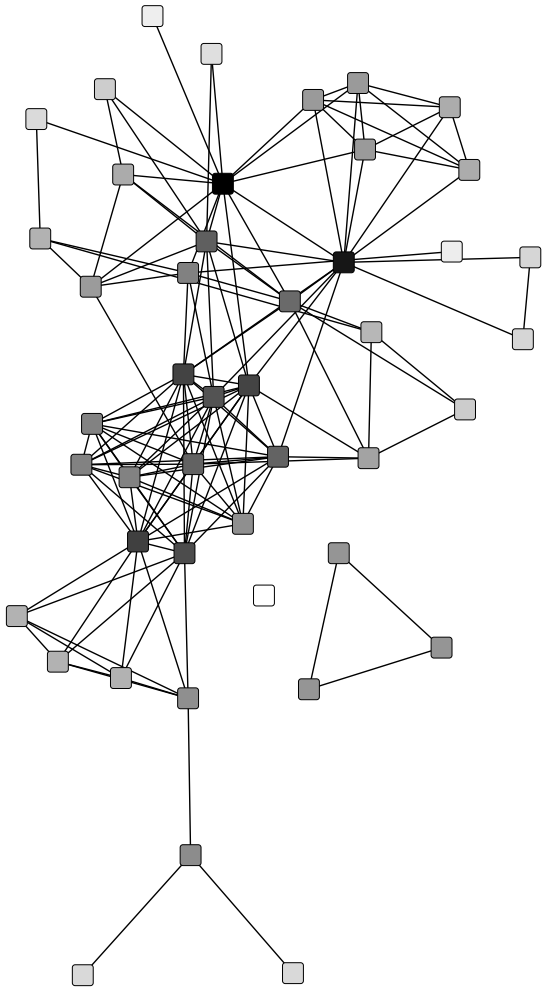

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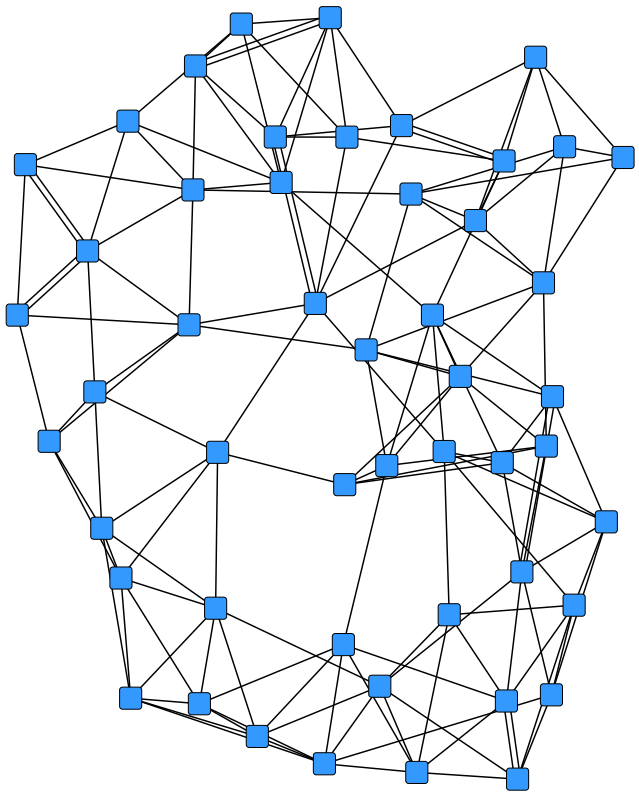
Intermezzo – network visualization methods.

- **stress minimization** – drawing short paths straight (MDS)
- **spring embedder** – equilibrium of physical forces
- **spectral** – minimizing edge lengths
- **classical MDS** – spectral approach to MDS
- **circular** – arange on circle, minimizing crossings
- **random** – *no comment*

Stress minimization.

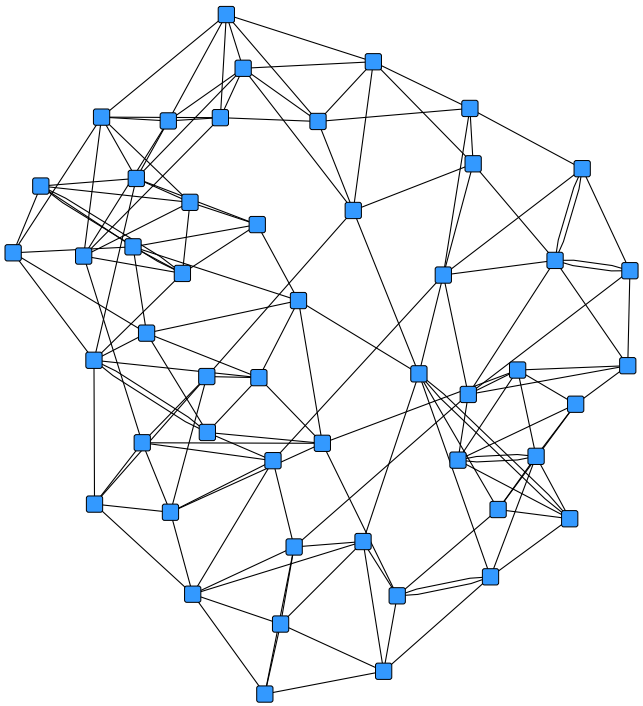


distance between nodes should correspond to graph distance
. . . especially for close nodes;

started by the quick layout button

$\Rightarrow$ visone

Spring embedder.

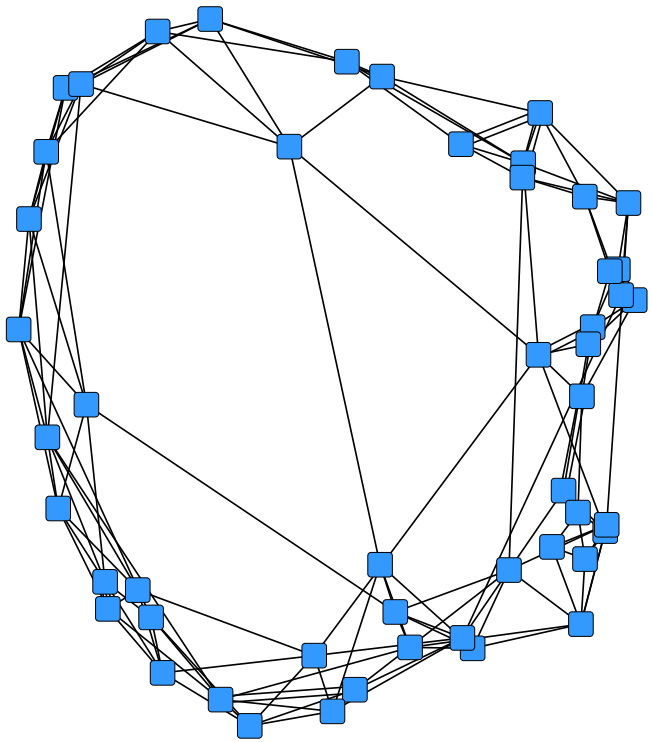


physical analogy: nodes repulse each other and edges have a preferred length (like springs);

layout determined by equilibrium state

$\Rightarrow$ visone

Spectral.



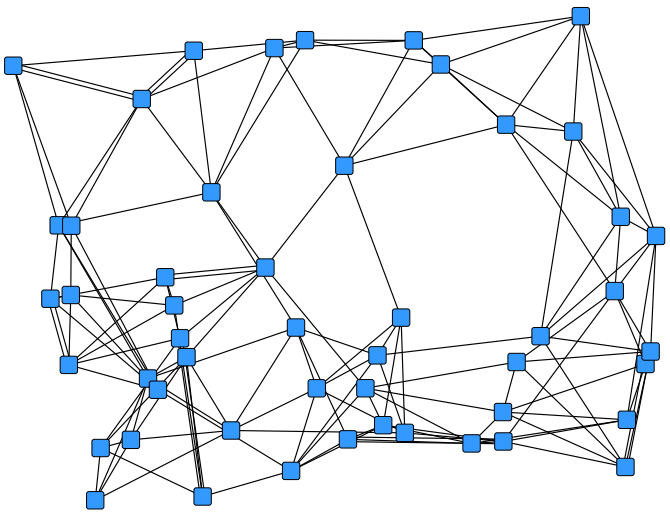
coordinates determined by eigenvectors of graph-matrices;

Laplacian: minimizing sum of squared edge lengths;

adjacency: draw nodes close if connected to the same others (structural similarity);

$\Rightarrow$ visone

Classical MDS.

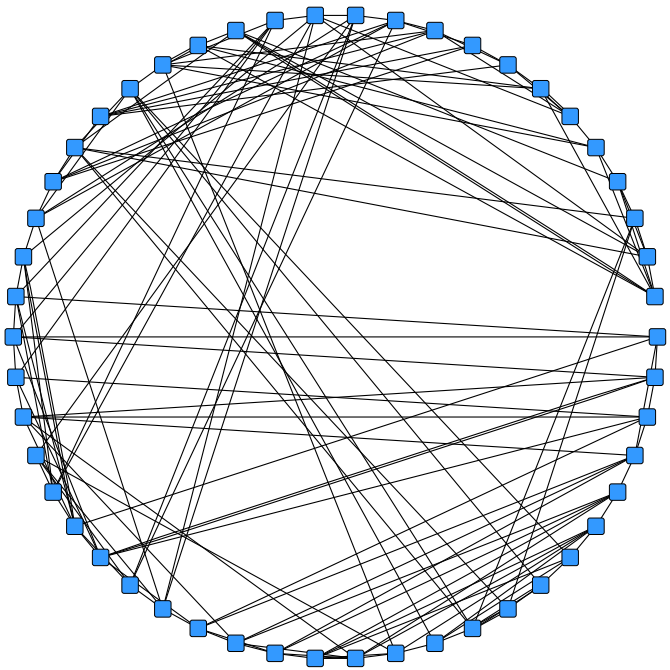


distance between nodes should correspond to graph distance;

best two-dimensional representation (computed by spectral means)

$\Rightarrow$ visone

Circular.



nodes arranged on a circle;

ordered such that crossings are reduced;

$\Rightarrow$ visone

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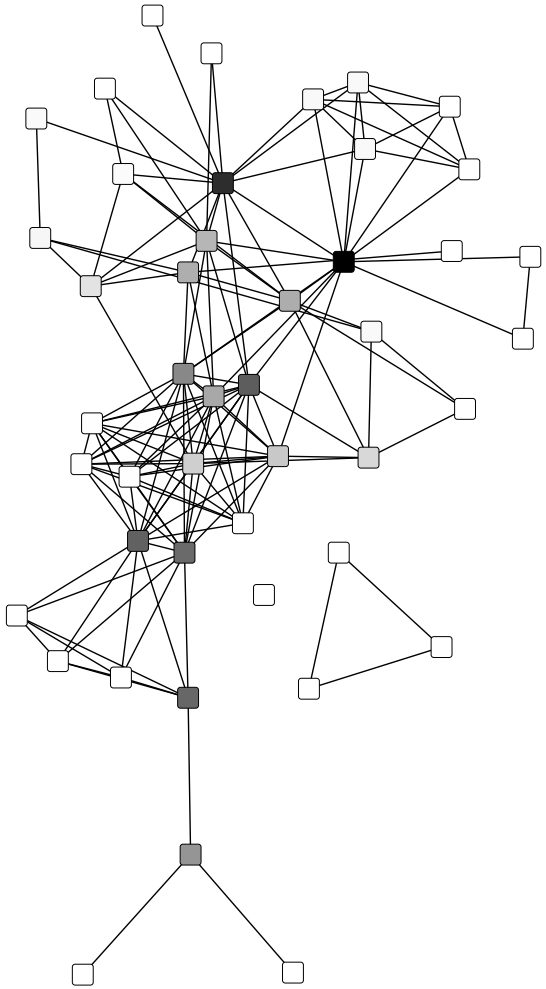
Scene 3 Jorge explores random networks.



Scenario Jorge computed betweenness centrality on some network (dark nodes: more central).

He's wondering whether the observed centralization is higher than one would expect randomly.

$\Rightarrow$ random network generation in visone.

Wrapping up.

- Random networks from various distributions can be generated via the create network option.
  - **(uniform)** just varying density
  - **(preferential** attachment) skewed degree distribution
  - **(small world)** local clustering, small diameter, little degree variance
  - **(planar)** rare for social networks
- Node attributes (e. g., centrality) are computed internally
  (a) mapping of attributes to visual characteristics
  (b) export of attribute tables (`.csv`) for further analysis

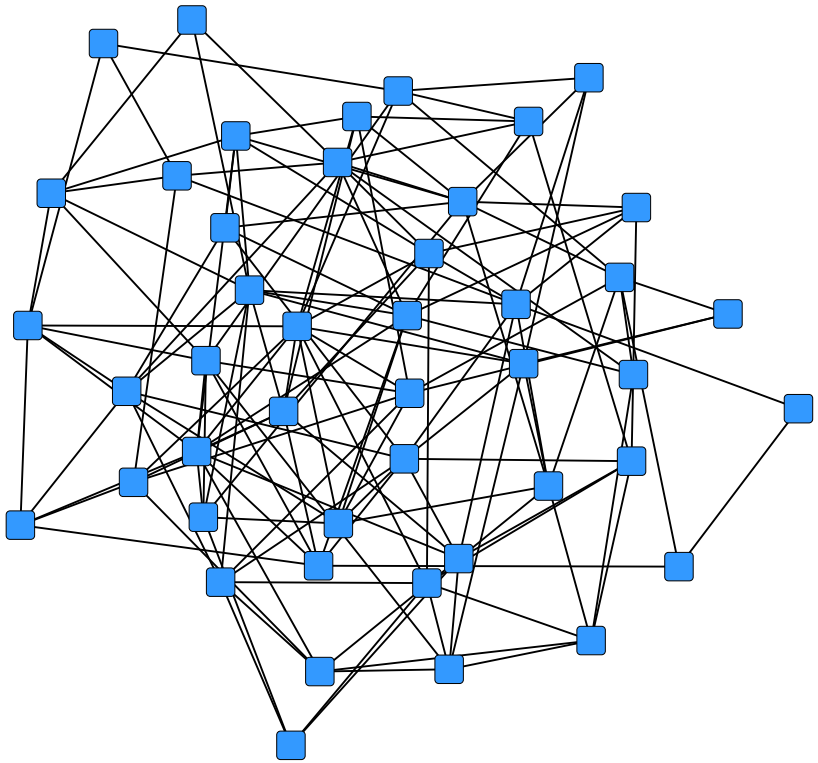
Intermezzo – random graph distributions.

uniform random graphs no structure at all

preferential attachment “the rich get richer”

small world locally clustered, small diameter

Uniform random graphs $G(n, p)$



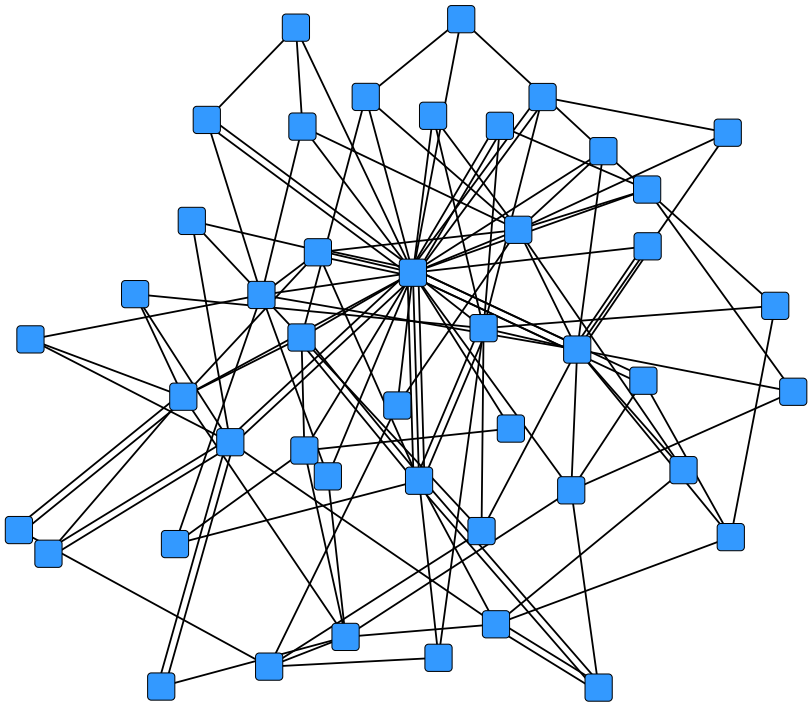
Generating process

1. fix a number n of nodes;
2. independently include edges $\{1, 2\}, \{1, 3\}, \ldots, \{n-1, n\}$ with the same probability p.

Very little variation in degrees, no clusters, small diameter, ...

$\Rightarrow$ visone

Preferential attachment.



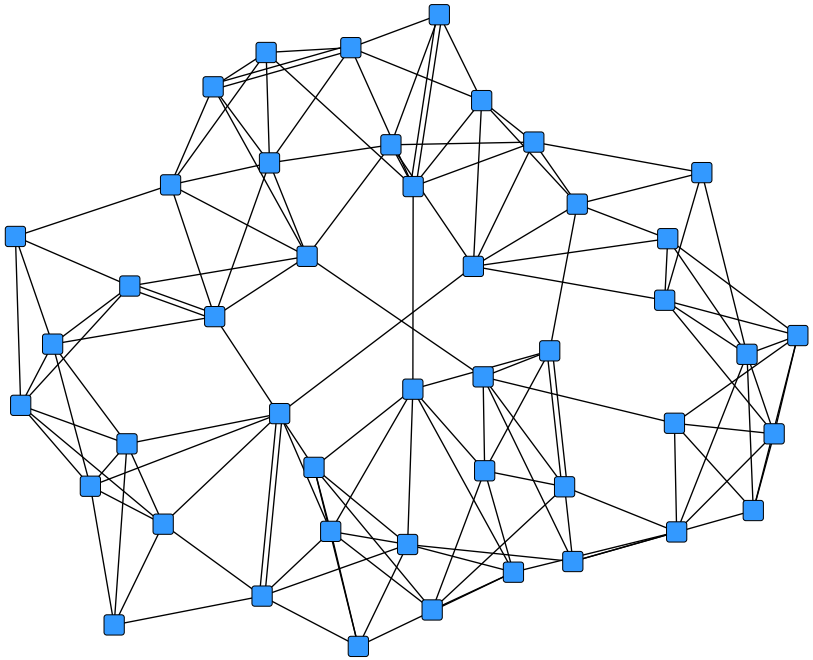
Generating process

1. insert nodes $v_1, \ldots, v_n$ one by one;
2. each node v_i choses d neighbors in $\{v_1, \ldots, v_{i-1}\}$
3. . . . with probability proportional to their current degree.

Enormous variation in degrees, small diameter, . . .

$\Rightarrow$ visone

Small worlds.



Generating process

1. circularly connect nodes with the k next neighbors
2. rewire each edge with probability p

Little variation in degrees, local clustering, small diameter if p is sufficiently large, . . .

$\Rightarrow$ visone

That’s it!