Visone—Analysis and Visualization of Social Networks

Jürgen Lerner

University of Konstanz

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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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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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.
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

⇒ 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.
  ⇒ 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.
  ⇒ 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)

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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 \( c : V \rightarrow C \) 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 vertex \( w' \)

that has the same color as \( w \)

Such images can easily be created with \textsc{visone}.

Wasserman/Faust (1994)
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.

⇒ 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 *incoming* lines connected to a node
- **outdegree**: number of *outgoing* lines connected to a node
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

⇒ visone
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⇒ Visone
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

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⇒ visone
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** – arrange 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

⇒ visone
Spring embedder.

**physical analogy**: nodes repulse each other and edges have a preferred length (like springs);
layout determined by equilibrium state

$\Rightarrow \text{visone}$
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);

$$\Rightarrow \text{visone}$$
Classical MDS.

distance between nodes should correspond to graph distance;
best two-dimensional representation (computed by spectral means)

⇒ visone
Circular.

nodes arranged on a circle;
ordered such that crossings are reduced;

$\Rightarrow \text{visone}$
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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.

⇒ 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, $\ldots$
Generating process

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

Enormous variation in degrees, small diameter, \ldots

$\Rightarrow$ 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, ...
That’s it!