Visual Network Analysis

From network data to maps

Floriana Gargiulo

Network science

Approaches	Original discipline	Focus	Objects
Graph theory	Mathematics ~1750 Euler	Algorithms for graph topology	Usually small regular graphs without attributes
Social Network Analysis (SNA)	Sociology and Economics ~1900 Durkheim ~1930 Moreno	• Global indicators for network structure (i.e. connectivity), centrality measures • correlation between the attributes and the structure	Small real graphs with several attributes (rich)
Complex Networks	Physics and Computer Science (Complex Systems) ~1998 Watts - Strogats ~1999 Barabasi - Albert	• statistical properties of networks • role of topology on dynamical processes • Morphogenesis	Large real graphs with no (or few) attributes (poor)

Networks are mathematical objects, abstract tools used in a multitude of domains.

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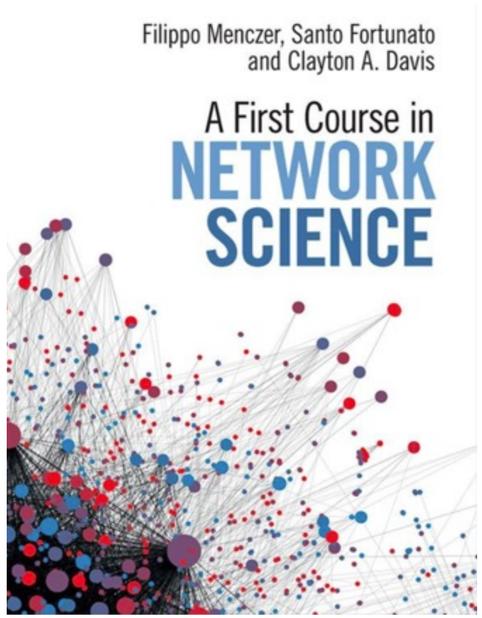
Visual Network Analysis		Make networks readable by humans: network cartography	

Networks are mathematical objects, abstract tools used in a multitude of domains.

Networks are maps

Visual Network analysis



258 pages

1 page about
network drawings

1.10 Drawing Networks

We can learn a lot about a network by drawing it and inspecting its graphical representation. This requires a *network layout algorithm* to place each node on a plane. (There are also sophisticated 3D layouts, but we do not discuss them in this book.) There are many layout algorithms that are appropriate for representing different kinds of networks; for example, we used a *geographic layout* to draw the air transportation network in Figure 0.7. For relatively small networks, layouts that place nodes along concentric circles or layers can reveal important hierarchical structure. The most popular class of network layout algorithms are *force-directed layout algorithms*, which are used to visualize most of the example networks in Chapter 0. The inset of Figure 0.7 uses a force-directed layout as well.

The goals of a force-directed layout algorithm are to place the nodes so that connected nodes are positioned close to each other, all the links are of similar length, and the number of link crossings is minimized. To get an idea of how force-directed layout works, imagine a force that repels any two nodes from each other, like the force between two particles with the same electrical charge. Further imagine a spring connecting any two linked nodes, generating an attractive force when they are too far from each other. Force-directed layout algorithms simulate such a physical system so that nodes move to minimize the energy of the system: connected nodes will move toward each other and away from nodes not connected to them.

The result is not only an aesthetically pleasing drawing, but also, sometimes, a visualization of the most obvious communities in the network, as we have seen in Chapter 0. For example, in Figure 0.3, because people in a community (progressive or conservative) are densely connected to each other, they end up clustered together in the layout.

NetworkX has a function to draw a network, which uses a rudimentary network layout algorithm:

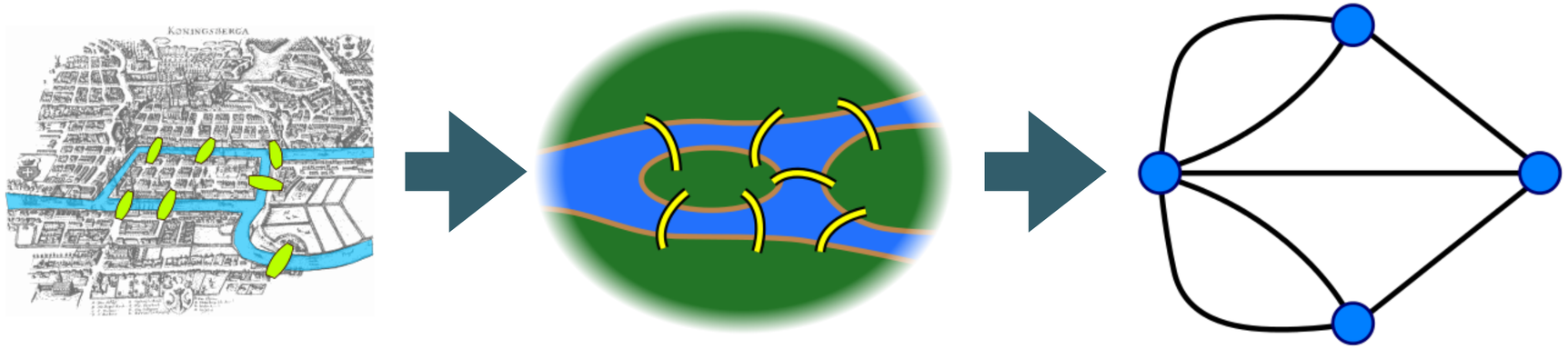
```
import matplotlib.pyplot
nx.draw(G)
```

Note that drawing requires a plot interface, such as Matplotlib's. This works reasonably well for small networks with, say, less than 100 nodes. For larger networks, there are better visualization tools. The examples in Chapter 0 are visualized with Gephi's *ForceAtlas2* layout algorithm.

From geography to networks

...where this history begins

In 1736 **Euler** wanted to solve the problem of the Seven Bridges of Königsberg: *does it exist a walk through the city that crosses each of those bridges once and only once?*



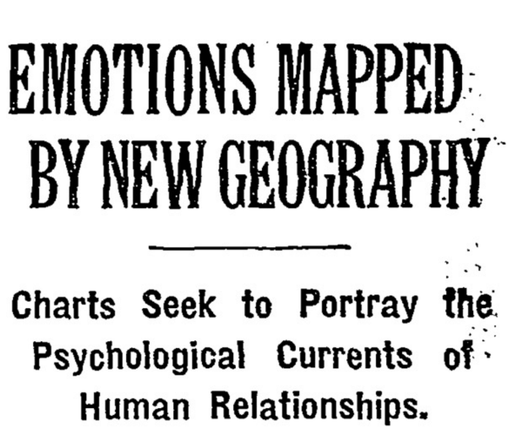
*No, Euler wrote the **first theorem in graph theory** demonstrating that it is not possible! You can do this kind of walk only if you have at most 2 nodes with at an odd number of sorting links.*

FROM A MAP TO A MATHEMATICAL OBJECT

Relations matter

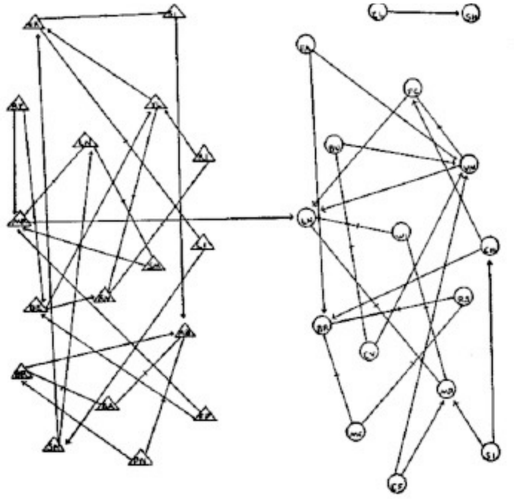
...how the history continues

- In the late 1890s, **Emile Durkheim, Ferdinand Tonnies and Georg Simmel** foreshadowed the idea of studying patterns of relationships that connect social actors.
- In 1930 **Jacob Moreno** introduced the concept of SOCIOGRAM



EMOTIONS MAPPED BY NEW GEOGRAPHY

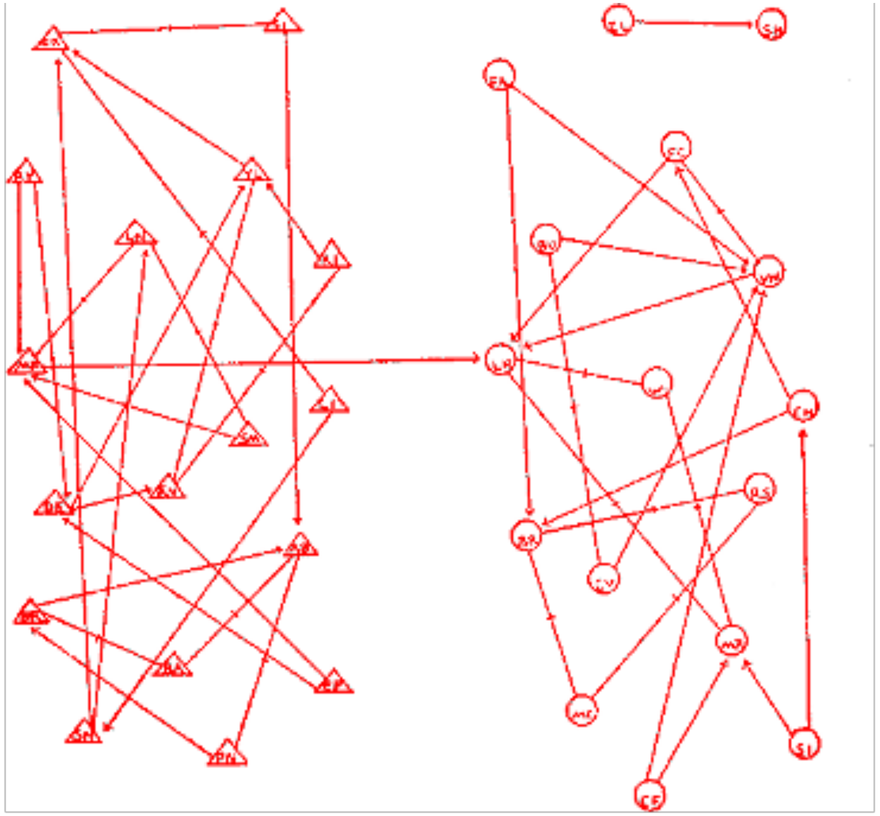
Charts Seek to Portray the Psychological Currents of Human Relationships.



If we ever get to the point of ***charting*** a whole city or a whole nation, we would have an intricate ***maze*** of psychological reactions which would ***present*** a ***picture*** of a vast solar system of intangible structures powerfully influencing conduct, as gravitation does bodies in space. Such an ***invisible*** structure underlies society and has in influence in determining the conduct of society as a whole...

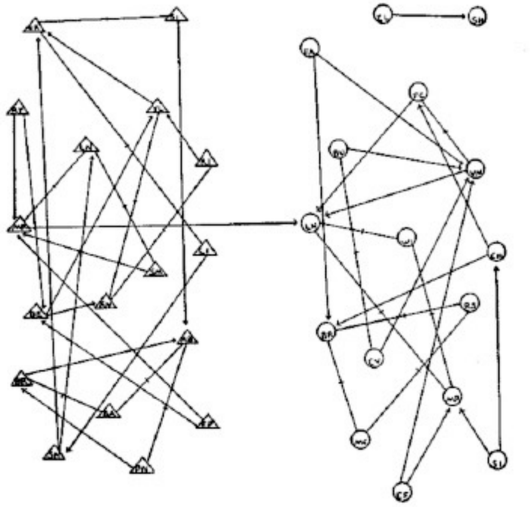
FROM RELATIONAL DATA TO MAPS

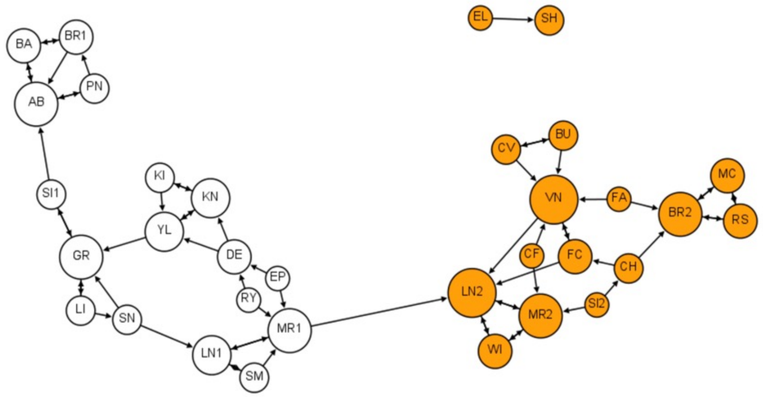
The problem of mapping networks



If you see a tangled mass of nodes and links that are impossible to analyze, you've got a hairball

Making network data readable

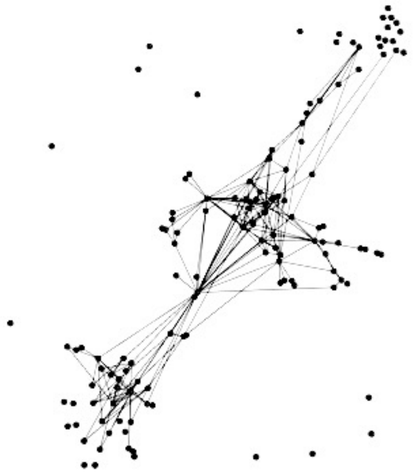




Grandjean, Martin (2015)
Social network analysis and visualization: Moreno's Sociograms revisited
www.martingrandjean.ch/social-network-analysis-visualization-morenos-sociograms-revisited/

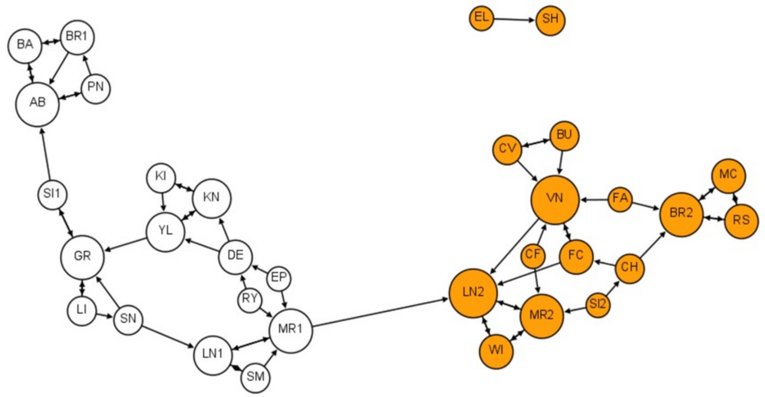
Force layout algorithms

NODES REPULSE



EDGES ATTRACT

What matters for visualization



- Nodes' **position**
- Nodes' **size**
- Nodes' **color**

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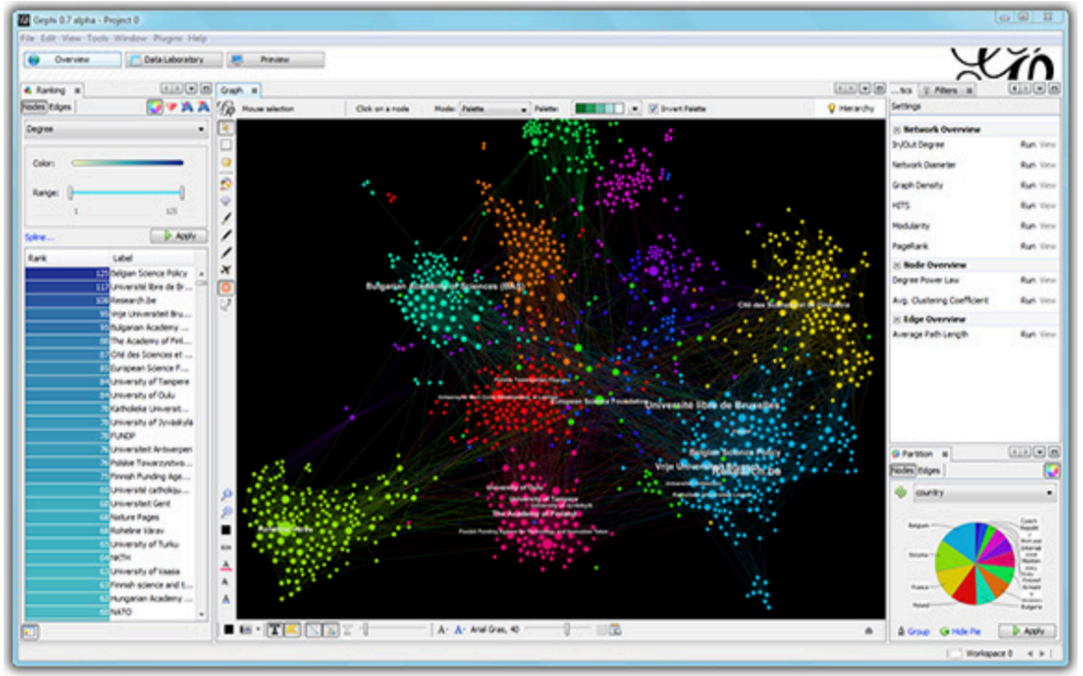
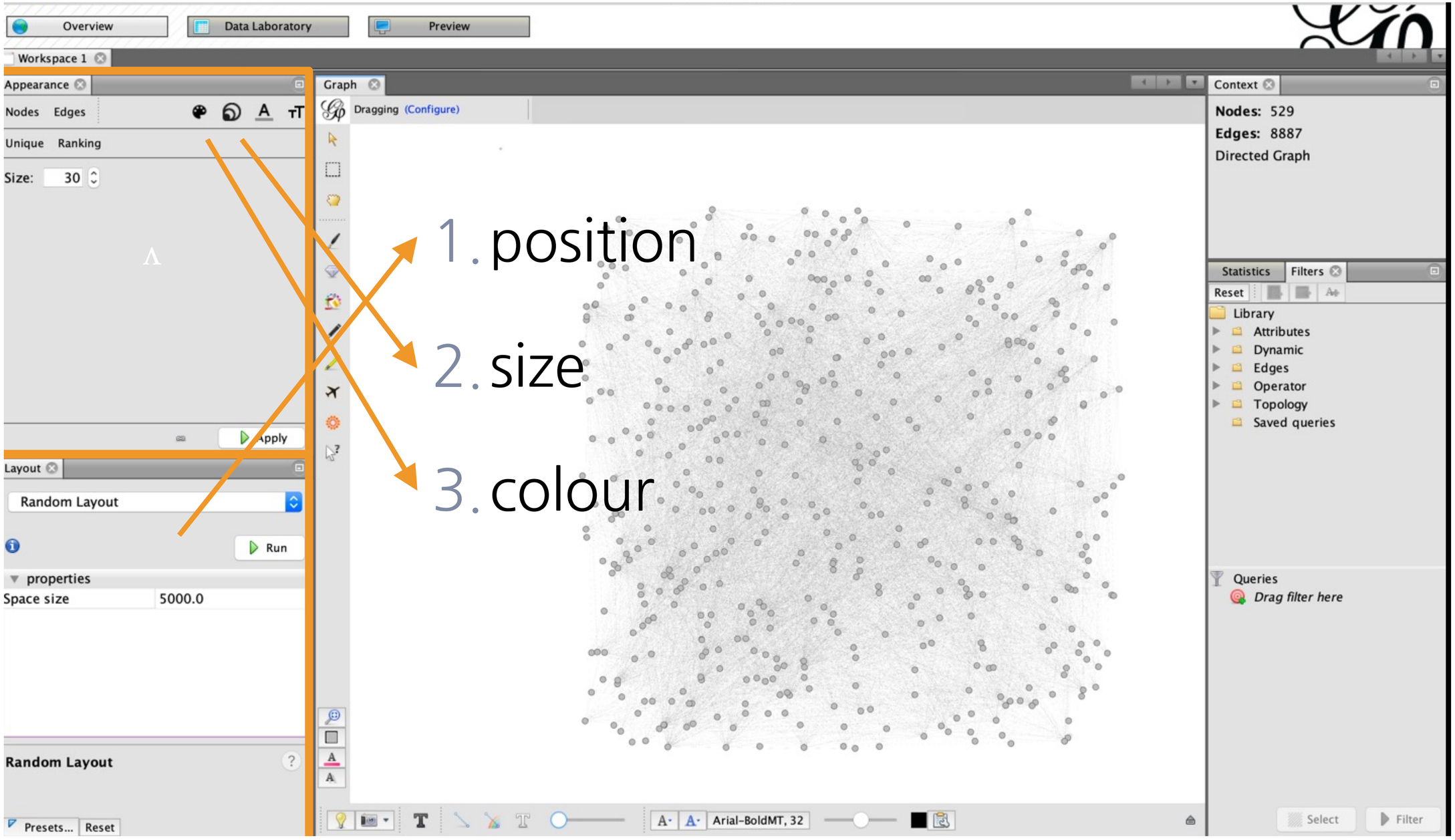
Release Notes | System Requirements

- **Features**
- **Quick start**
- **Screenshots**
- **Videos**




Overview
Data Laboratory
Preview
Workspace 1
Appearance
Nodes Edges
Unique Ranking
Size: 30
Apply
Layout
Random Layout
Run
properties
Space size 5000.0
Random Layout
Presets... Reset
Graph
Dragging (Configure)
1. position
2. size
3. colour
Arial-BoldMT, 32
Context
Nodes: 529
Edges: 8887
Directed Graph
Statistics
Filters
Reset
Library
Attributes
Dynamic
Edges
Operator
Topology
Saved queries
Queries
Drag filter here
Select
Filter