# Gephi Tutorial Layouts

Welcome to this advanced tutorial. It will teach you the fine art of network layout in Gephi: how to use algorithms that place the nodes inside the graphic space.

Gephi version 0.8alpha was used to do this tutorial.

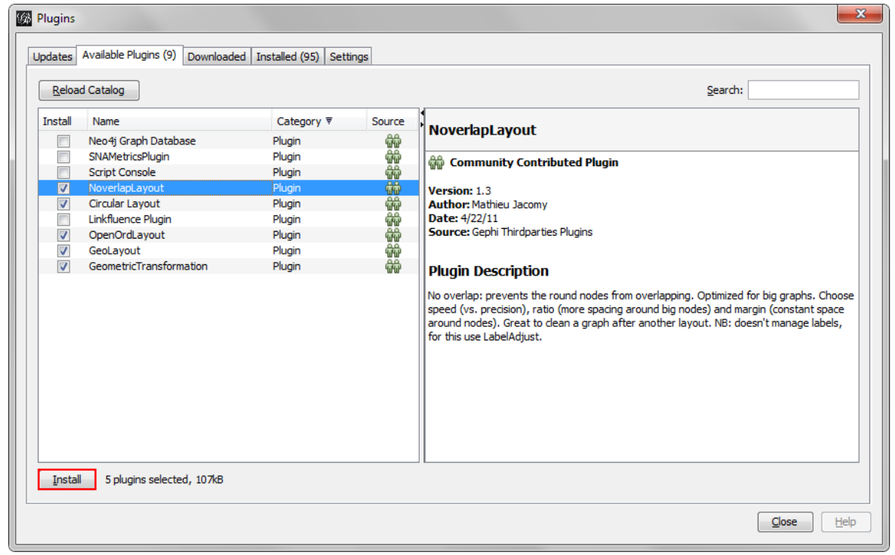
Get Gephi

Last updated June 13th, 2011

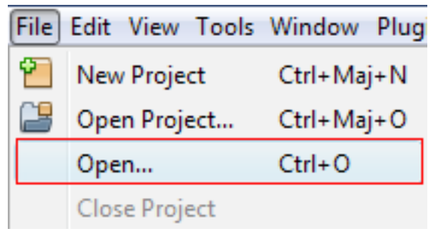
# Install layout plugins

We need to install additional plugins.

- Go to the Tools menu and then Plugins.
- In the Available Plugins tab check:
  - OpenOrdLayout
  - CircularLayout
  - GeoLayout
  - Geometric Transformation
  - NoverlapLayout
- Click on Install. The plugins are installed and you are asked to reboot Gephi. Click OK.



# Open Graph File



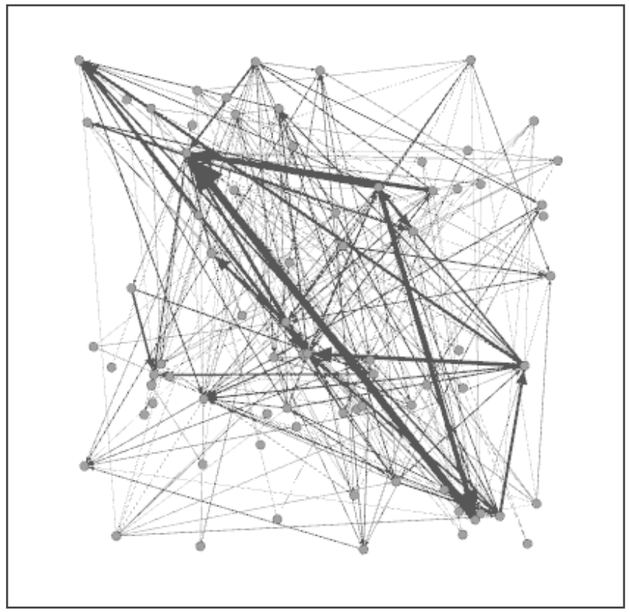

- Download the file LesMiserables.gexf
- In the menubar, go to File Menu and Open...
- When your file is opened, the report sums up data found and any issues.
  - Number of nodes
  - Number of edges
  - Type of graph
- Click on OK to validate and see the graph.

## Graph Format

- GEXF
- GraphML
- Pajek NET
- GDF
- GML
- Tulip TLP
- CSV
- Netdraw VNA
- Compressed ZIP/GZ

# You should now see a graph

We imported the "Les Miserables" dataset[1]. This is a coappearance weighted network of characters in the novel "Les Miserables" from Victor Hugo.



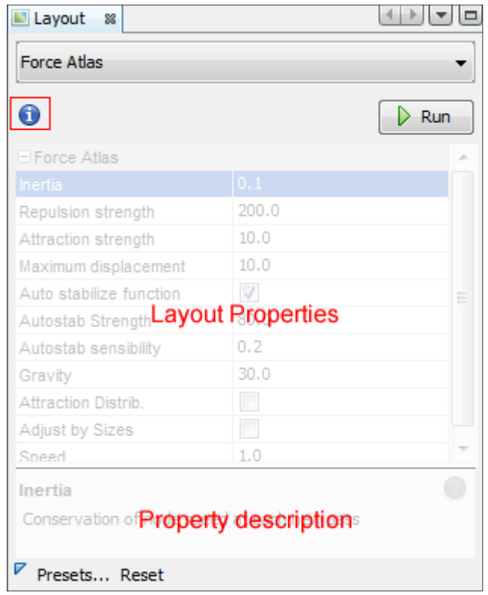
Node position is random at first, so you may see a slighty different representation.

[1] D. E. Knuth, The Stanford GraphBase: A Platform for Combinatorial Computing, Addison-Wesley, Reading, MA (1993).

# Run a layout

Layout algorithms set the graph shape, it is the most essential operation.

- Locate the Layout module, on the left panel.




- Choose “Force Atlas”

You can see the layout properties below, leave default values.

- Click on Run to launch the algorithm.

- You see now the positions of nodes changing in real time.

## Layout algorithms

Graphs are usually laid out with “Force-based” algorithms. They follow a simple principle: linked nodes attract each other and non-linked nodes are pushed apart.

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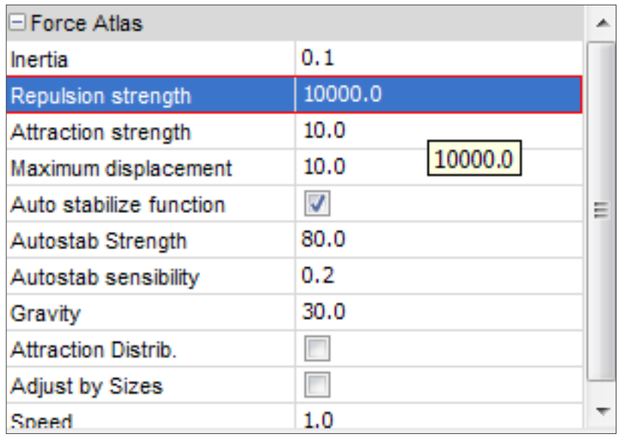
# Control the layout

The purpose of Layout Properties is to let you control the algorithm in order to make a readable representation.




- Set the “Repulsion strengh” at 10 000 to expand the graph.

- Type “Enter” to validate the changed value.

- And now Stop the algorithm.

## Tips

Click on the icon “Center on Graph” on the bottom left of the Visualization panel if you don’t see the graph anymore.

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* Radial Axis Layout
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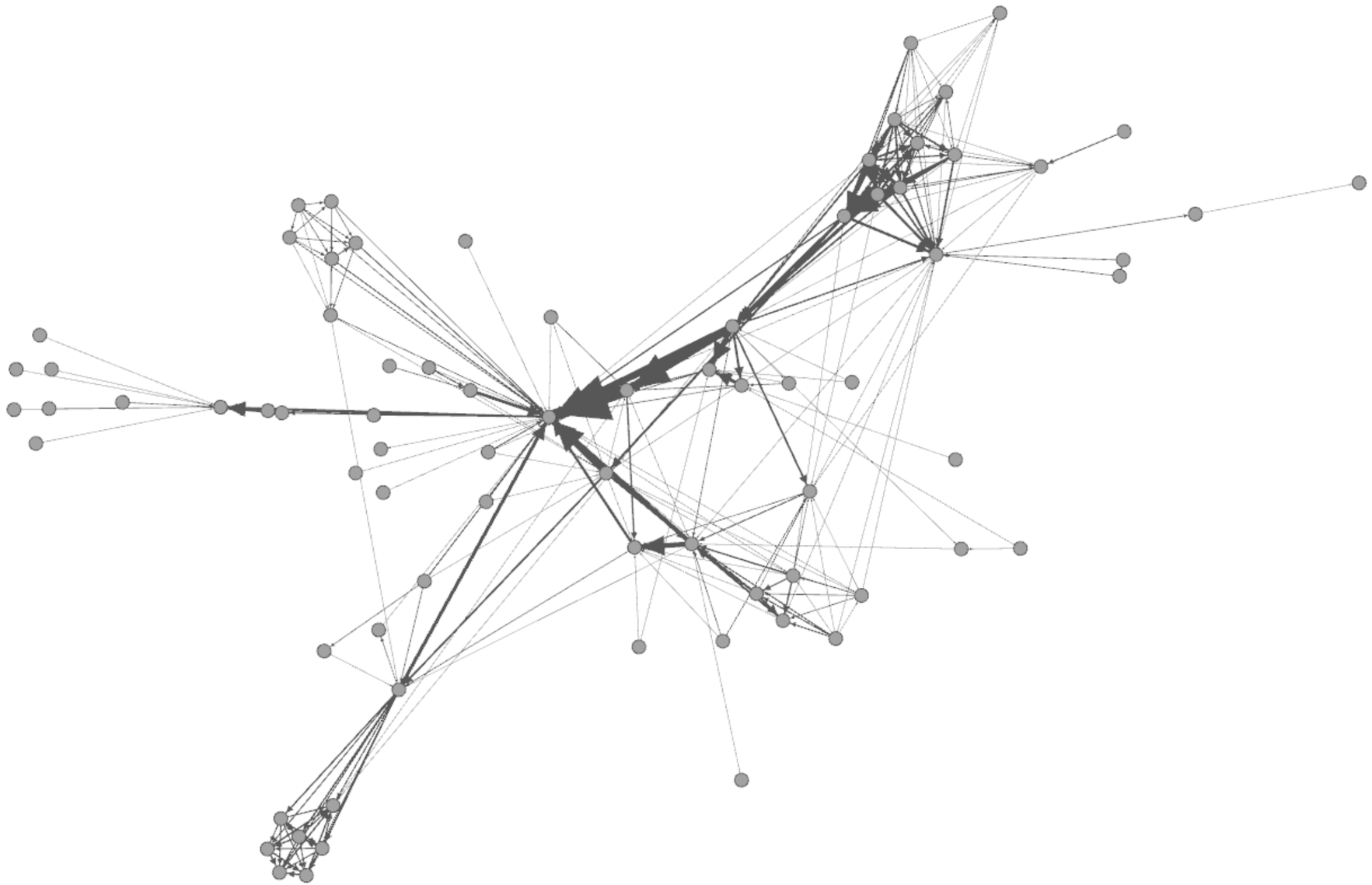
# You should now see a graph with the layout applied



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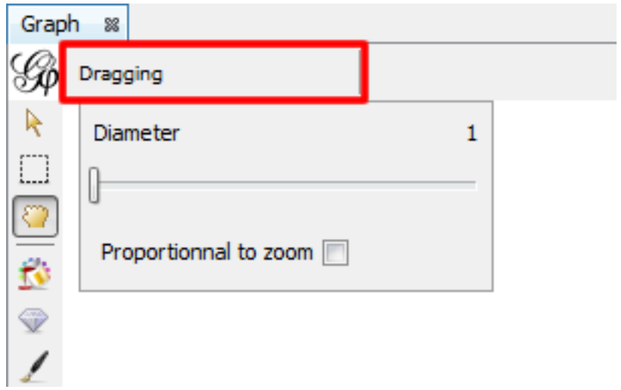
# Play against the algorithm!

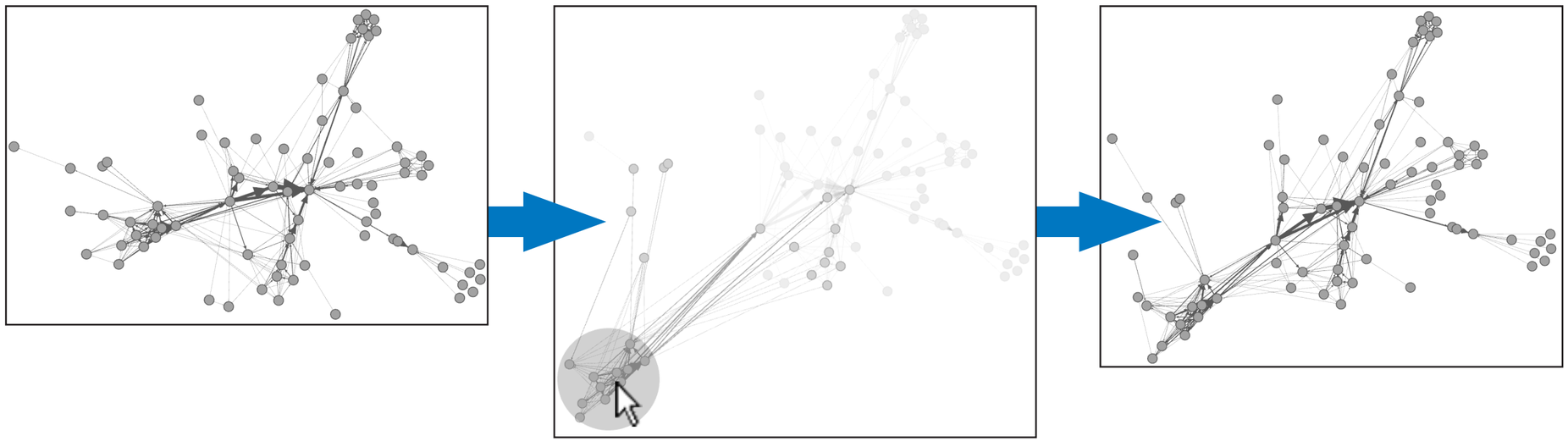
Run the layout again and drag the nodes to stress it.




- Locate Dragging action, in the top left of the Visualization panel.
- Ajust the selection diameter in the panel or by using the shortcut “Ctrl + Mouse Wheel”.

Increase the “Autostab strength” in the Layout Properties to 100 000, then drag the nodes. The graph becomes less deformed.

- And now Stop the algorithm.



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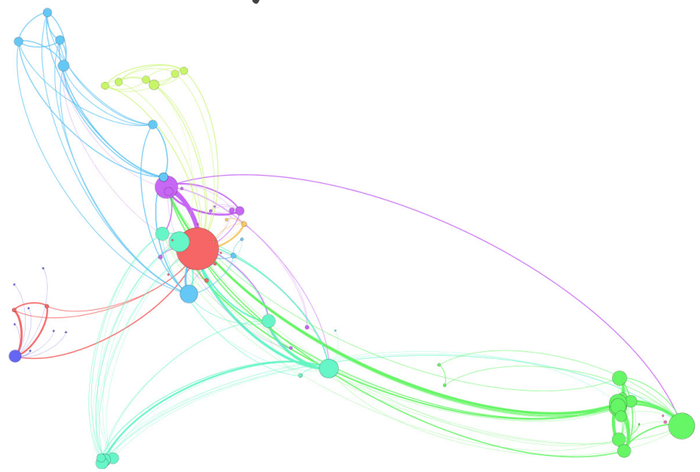
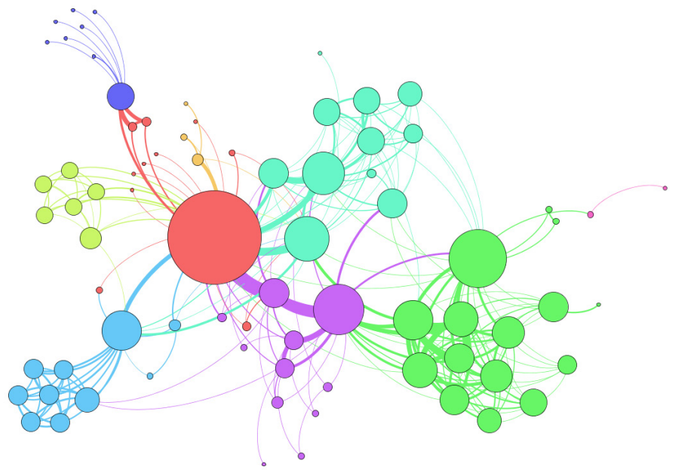
# Various layouts exist

Gephi implements various layout algorithms. They set the shape of the graph.

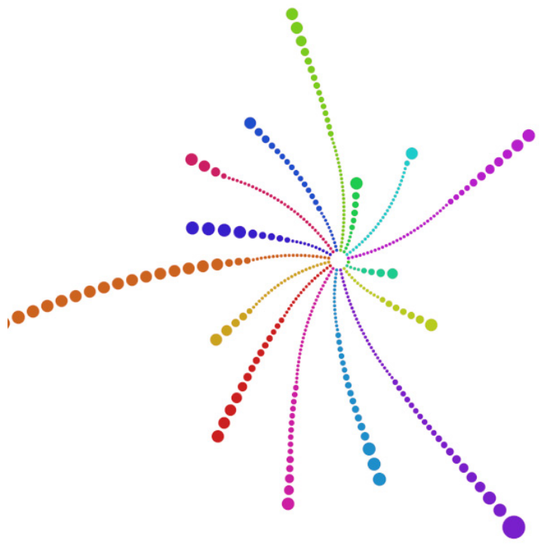
## OpenOrd



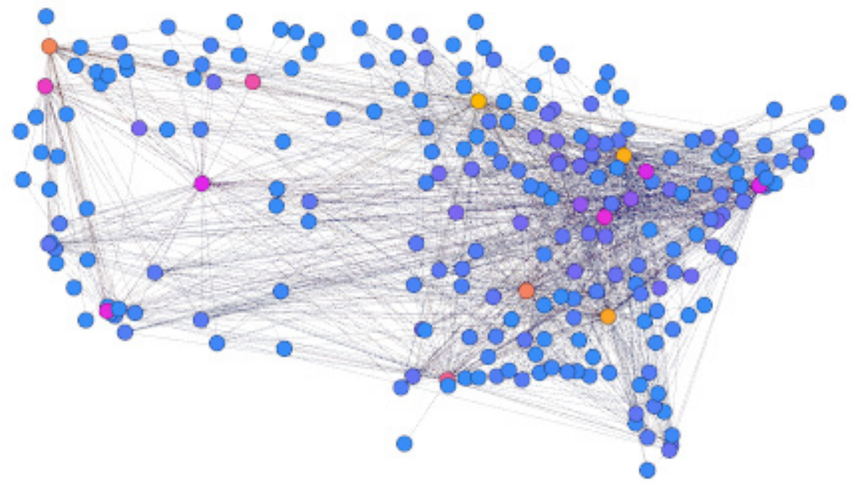
## ForceAtlas 2



## Radial Axis



## GeoLayout



Airlines sample dataset: http://gephi.org/datasets/airlines-sample.gexf

# So how to choose a layout?

In general, select one according to the feature of the topology you want to highlight:

| | |
|---|---|
| *emphasis* DIVISIONS<br>*OpenOrd* | *emphasis* COMPLEMENTARITIES<br>*ForceAtlas, Yifan Hu, Frushterman-Reingold* |
| *emphasis* RANKING<br>*Circular, Radial Axis* | *emphasis* GEOGRAPHIC REPARTITION<br>*GeoLayout* |

### Graphic Adjustements

- Label Adjust
- Noverlap
- Expansion
- Contraction

# ForceAtlas layout

Home-brew layout of Gephi, it is made to spatialize Small-World / Scale-free networks. It is focused on quality (meaning “being useful to explore real data”) to allow a rigorous interpretation of the graph (e.g. in SNA) with the fewest biases possible, and a good readability even if it is slow.

| | |
|---|---|
| Author: | Mathieu Jacomy |
| Date: | 2007 |
| Kind: | Force-directed |
| Complexity: | $O(N^2)$ |
| Graph size: | 1 to 10 000 nodes |
| Use edge weight: | Yes |

# Run ForceAtlas


the layout by applying the following settings step by step:

| | |
|---|---|
| • Autostab strength = 2 000 | Increase to move the nodes slowly. |
| • Repulsion strength = 1 000 | How strongly does each node reject others. |
| • Attraction strength = 1 | How strongly each pair of connected nodes attract each other. |
| • Gravity = 100 | Attract all nodes to the center to avoid dispersion of disconnected components. |
| • Attraction Distrib. = checked | Push hubs (high number of output links) at the periphery and put authorities (high number of input links) more central. |

And now 


the algorithm.

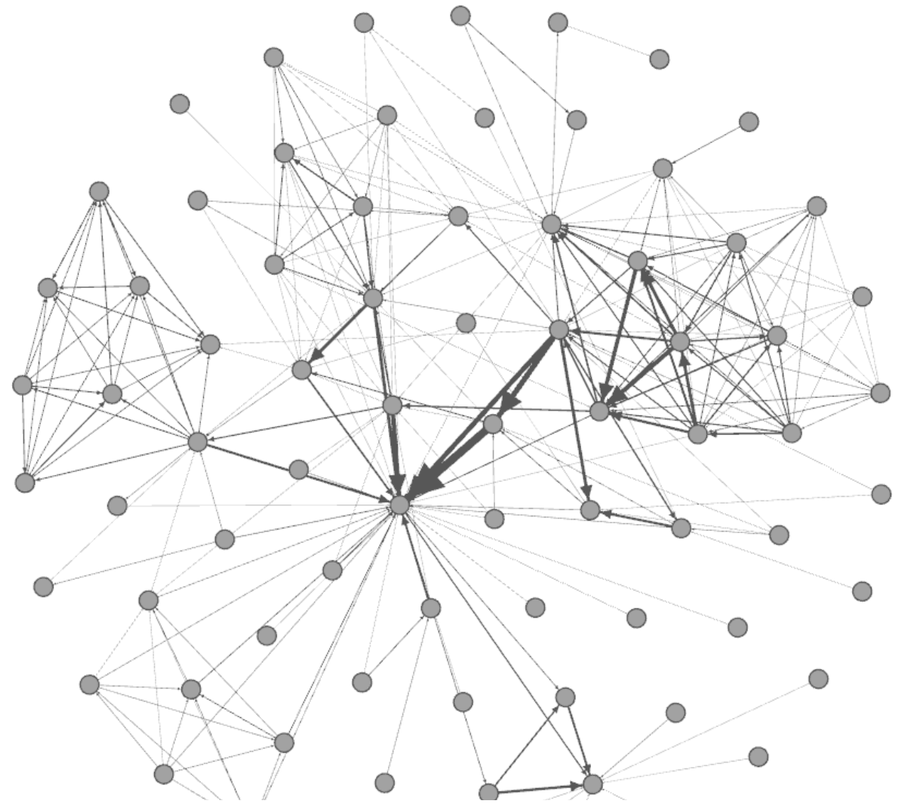
## Adjust by Sizes

This option avoids node overlapping, depending on the size of each node.

# Fruchterman-Reingold layout

It simulates the graph as a system of mass particles. The nodes are the mass particles and the edges are springs between the particles. The algorithms try to minimize the energy of this physical system. It has become a standard but remains very slow.

| | |
|---|---|
| Author: | Thomas Fruchterman & Edward Reingold[1] |
| Date: | 1991 |
| Kind: | Force-directed |
| Complexity: | $O(N^2)$ |
| Graph size: | 1 to 1 000 nodes |
| Use edge weight: | No |



[1] Fruchterman, T. M. J., & Reingold, E. M. (1991). Graph Drawing by Force-Directed Placement. Software: Practice and Experience, 21(11).

# Run Fruchterman-Reingold

Run the layout by applying the following settings step by step:

- Area = 100
- Area = 100 000

Graph size area.

- Gravity = 1 000
- Gravity = 100

Attract all nodes to the center to avoid dispersion of disconnected components.

And now Stop the algorithm.

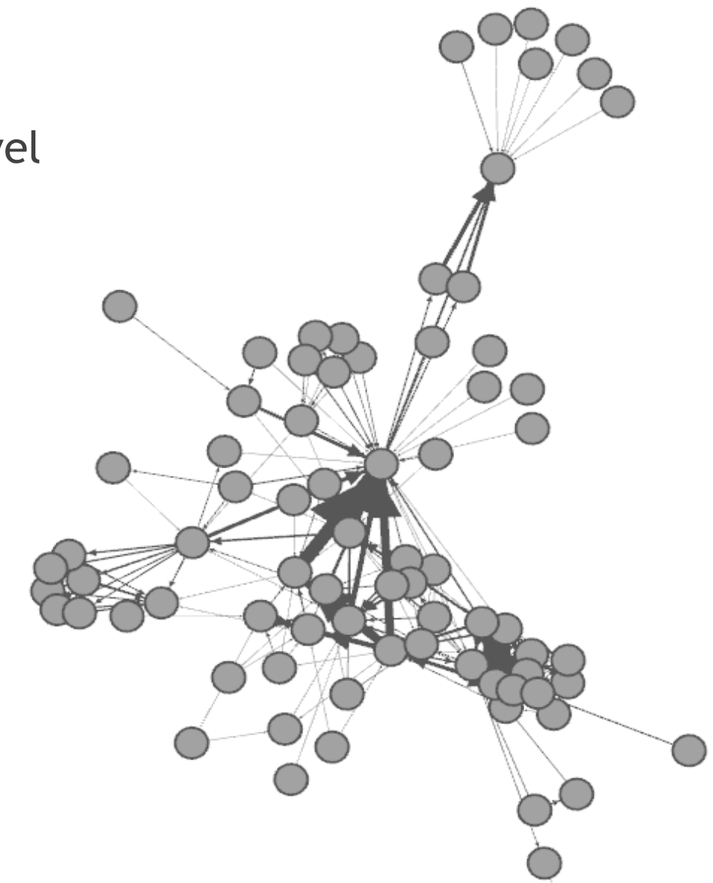
**Unstable nodes position!**

Sometimes the algorithm does not converge, resulting in an unstable graph. Reduce the “Speed” setting to gain precision.

# Yifan Hu Multilevel layout

It is a very fast algorithm with a good quality on large graphs. It combines a force-directed model with a graph coarsening technique (multilevel algorithm) to reduce the complexity. The repulsive forces on one node from a cluster of distant nodes are approximated by a Barnes-Hut calculation, which treats them as one super-node. It stops automatically.

| | |
|---|---|
| Author: | Yifan Hu[1] |
| Date: | 2005 |
| Kind: | Force-directed + multilevel |
| Complexity: | O(N*log(N)) |
| Graph size: | 100 to 100 000 nodes |
| Use edge weight: | No |



[1] Y. F. Hu, Efficient and high quality force-directed graph drawing. The Mathematica Journal, 10 (37-71), 2005.

# Run Yifan Hu Multilevel

Launch the layout by applying the following settings step by step:

- Step ratio = 0.99 

Ratio used to update the step size. Increase it for a better quality (vs speed).

- Optimal distance = 200 

Natural length of the springs. Increase it to place nodes farther apart.

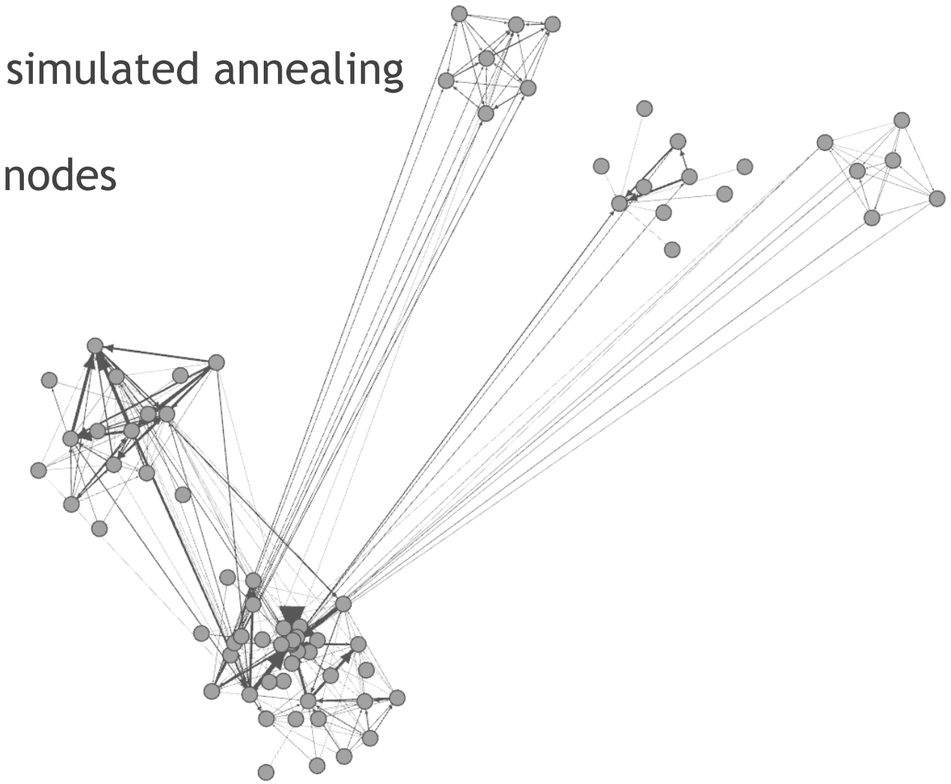
- Theta = 1.0 

Approximation for Barnes-Hut calculation. Smaller values mean more accuracy.

# OpenOrd layout

It expects undirected weighted graphs and aims to better distinguish **clusters**. It can be run in parallel to speed up computing, and stops automatically. The algorithm is originally based on Frutcherman-Reingold and works with a fixed number of iterations controlled via a simulated annealing type schedule (liquid, expansion, cool-down, crunch, and simmer). Long edges are cut to allow clusters to separate.

| | |
|---|---|
| Author: | S. Martin, W. M. Brown, R. Klavans, and K. Boyack[1] |
| Date: | 2010 (VxOrd) |
| Kind: | Force-directed + simulated annealing |
| Complexity: | O(N*log(N)) |
| Graph size: | 100 to 1 000 000 nodes |
| Use edge weight: | Yes |



[1] S. Martin, W. M. Brown, R. Klavans, and K. Boyack, “OpenOrd: An Open-Source Toolbox for Large Graph Layout,” SPIE Conference on Visualization and Data Analysis (VDA)., 2011

# Run OpenOrd

Launch the layout by applying the following settings step by step:

- Edge cut = 0.95


From 0 (standard Frutcherman-Reingold) to 1. Percentage of the greatest distance between two nodes in the drawing. A higher cutting means a more clustered result.

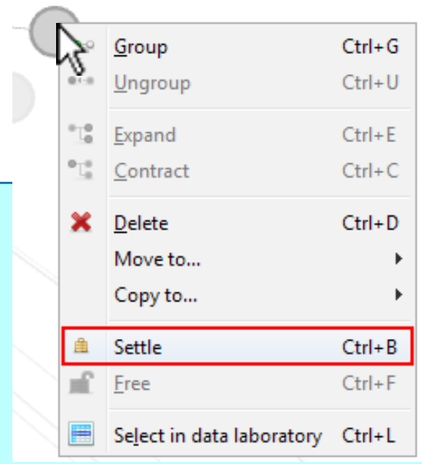
- Num iterations = 100
- Num iterations = 850



Contract the clusters.
Expand the clusters.

- Random seed = -6308261588084905834

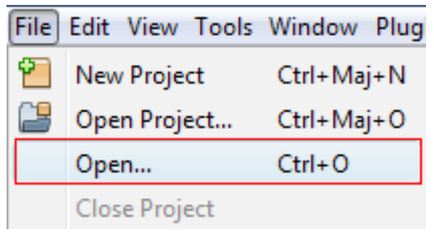

Use this value to produce exactly the same shape as shown before.




## Fix node placement

Fix the position of a node (or a group of selected nodes) by “Right-click on it > Settle”. It works for all layouts except Yifan Hu. For OpenOrd, use the “fixed time” setting on the Layout panel to configure the time the fixed nodes will not move.

# Run OpenOrd on a large graph




OpenOrd is really helpful on large graphs.

- Import the file internet_routers-22july06.gml.zip

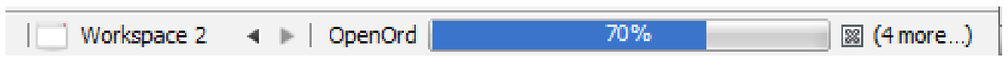
This network has 22 963 nodes and 48 436 edges. It is a symmetrized snapshot of the structure of the Internet at the level of autonomous systems, reconstructed from BGP tables posted by the University of Oregon Route Views Project. This snapshot was created by Mark Newman from data on July 22, 2006.

If you have a multi-core computer:
Increase the number of threads to execute it in parallel and therefore speed up the execution of the algorithm. It is recommended to set the number of core minus 1 to keep a thread for display.

- Set the “Num Threads” setting or leave default parameters.

- Click on 

and wait until it stops.




OpenOrd executes in a finite number of iterations, so you can see the progress on the bottom-right of the screen.

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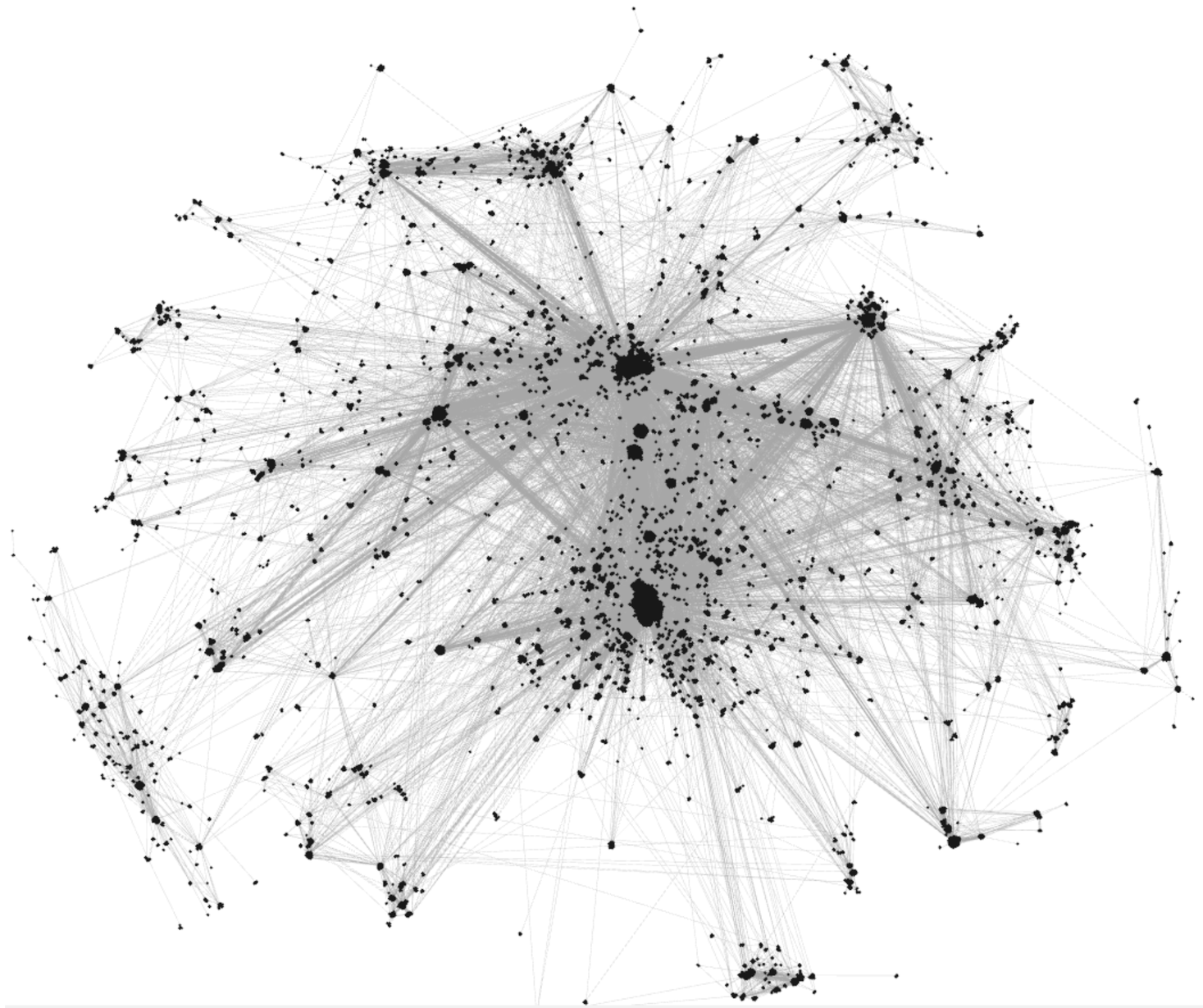
* Circular Layout
* Radial Axis Layout
* Geographic map
* Node overlapping
* Geometric transform
* Save
* Conclusion

# You should now see a graph with the layout applied



# Go back to the previous workspace

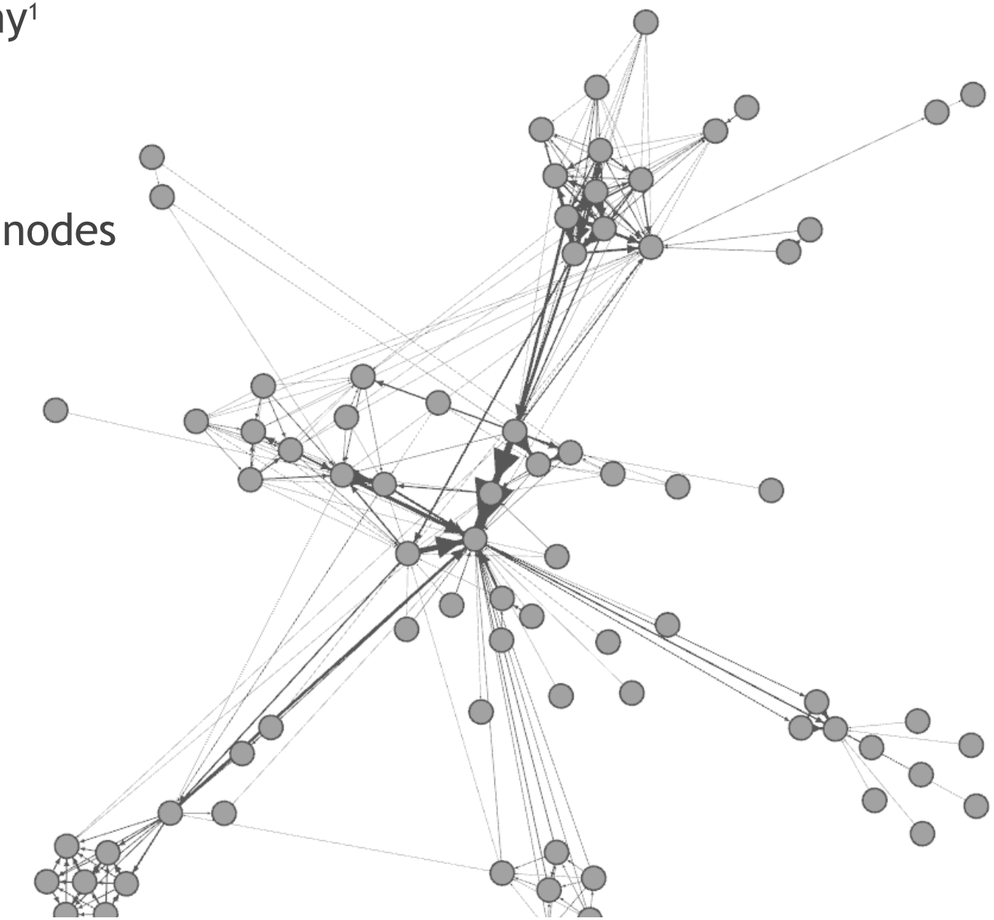
When you imported the second dataset, a new workspace was automatically created. You are now in the “Workspace 2”. We go back now to the “Workspace 1” where the graph of Les Miserables still exists.


- Locate the workspace switcher on the bottom-right of the screen.
- You see the name of the current workspace.
- Click on it and select “Workspace 1”. You can either click on the arrows to switch.

# ForceAtlas 2 layout

Improved version of the Force Atlas to handle large networks while keeping a very good quality. Nodes repulsion is approximated with a Barnes-Hut calculation, which therefore reduces the algorithm complexity. Replace the “attraction” and “repulsion” forces by a “scaling” parameter.

| | |
|---|---|
| Author: | Mathieu Jacomy[1] |
| Date: | 2011 |
| Kind: | Force-directed |
| Complexity: | O(N*log(N)) |
| Graph size: | 1 to 1 000 000 nodes |
| Use edge weight: | Yes |



[1] http://gephi.org/2011/forceatlas2-the-new-version-of-our-home-brew-layout/

# Run ForceAtlas 2

Run the layout by applying the following settings step by step:

- LinLog mode = checked
- LinLog mode = unchecked

Linear attraction & logarithmic repulsion (lin-lin by default), makes clusters tighter.

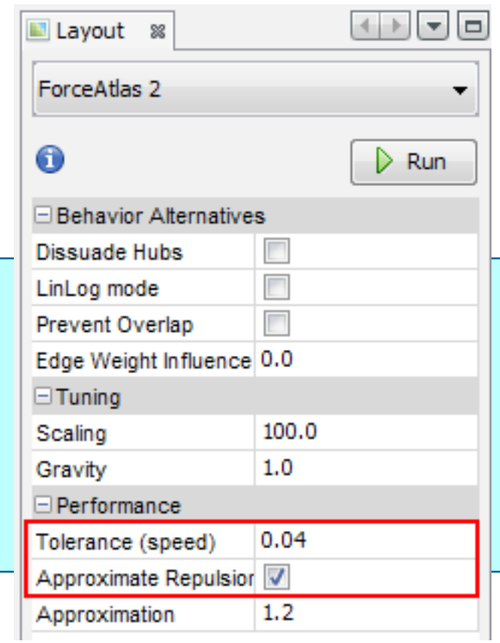
- Scaling = 100

Increase to make the graph sparser.

- Edge weight influence = 0

From 0 (no influence) to 1 (normal). Set 0 to calculate forces without edge weight.

And now Stop the algorithm.



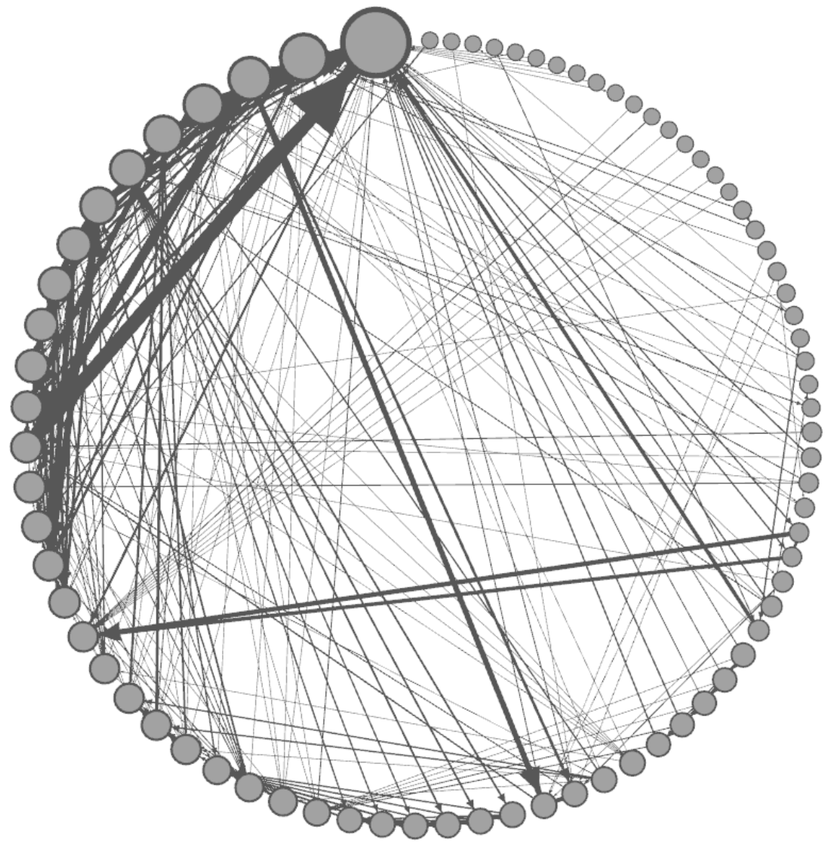

## Performance

Activate “Approximate Repulsion” on large graphs only, but let’s try it in this tutorial. Check it, set the “Tolerance” option to 0.04 and run the algorithm to see how nodes are swinging!

# Circular layout

It draws nodes in a circle ordered by ID, a metric (degree, betweenness centrality...) or by an attribute. Use it to show a distribution of nodes with their links.

| | |
|---|---|
| Author: | Matt Groeninger[1] |
| Date: | 2010 |
| Kind: | Circular |
| Complexity: | O(N) |
| Graph size: | 1 to 1 000 000 nodes |



[1] http://gephi.org/plugins/circular-layout/

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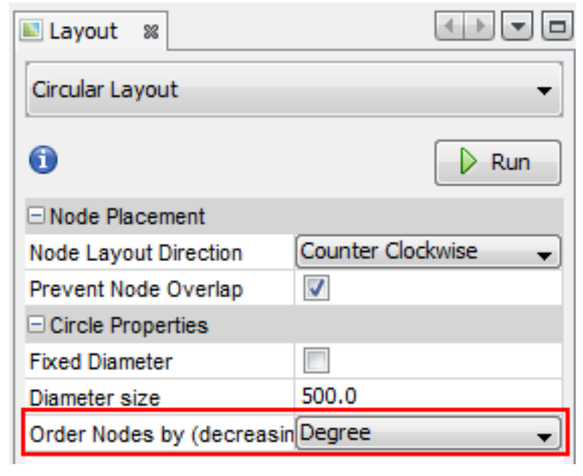
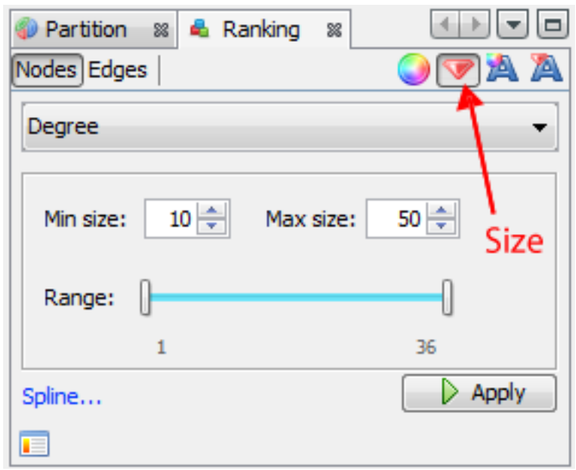
# Run Circular Layout

- Select the “Circular Layout” in the Layout panel.
- Set the “Order nodes by” setting to “Degree”.
- Run the layout.



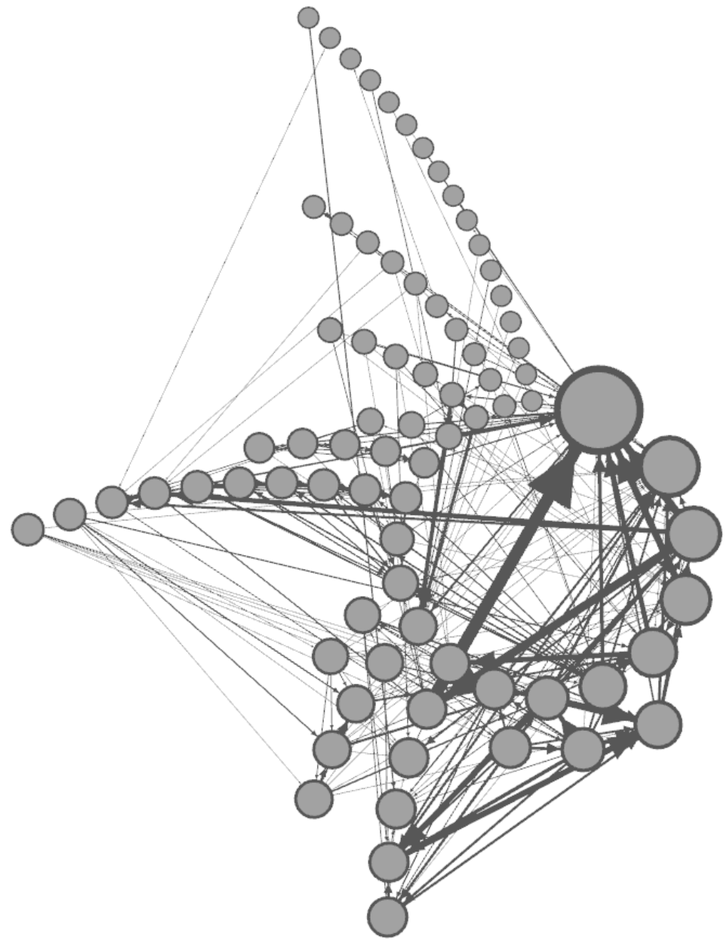




- In the Ranking panel, choose “Degree” as a rank parameter.
- Select the diamond icon in the toolbar for size.
- Set a min size at 10 and a max size at 50.
- Click on Apply to see the distribution of degree.
- Run the layout again to avoid node overlap.

# Radial Axis Layout

It is provided with the Circular Layout plugin. It groups nodes and draws the groups in axes (or spars) radiating outwards from a central circle. Groups are generated using a metric (degree, betweenness centrality...) or an attribute. Use it to study homophily by showing distributions of nodes inside groups with their links.

| | |
|---|---|
| Author: | Matt Groeninger[1] |
| Date: | 2011 |
| Kind: | Circular |
| Complexity: | O(N) |
| Graph size: | 1 to 1 000 000 nodes |



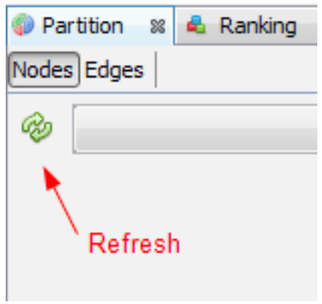
[1] http://gephi.org/plugins/circular-layout/

# Detect communities

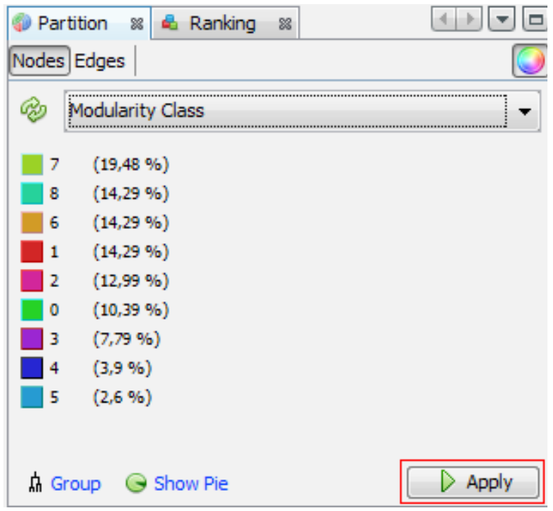
We now want to study the community structure in this network: does it divide naturally into groups of nodes with dense connections within groups and sparser connections between groups?

In the Σ Statistics panel, click on Run near the "Modularity"[1] line. 


The community detection algorithm created a "Modularity Class" value for each node. The partition module can use this new data to colorize communities.




- Locate the Partition module on the left panel.
- Click on the "Refresh" button to populate the partition list.
- Select "Modularity Class" in the partition list.




You can see that 9 communities were found, could be different for you. A random color has been set for each community identifier.

- Click on Apply to colorize nodes.

[1] Blondel V, Guillaume J, Lambiotte R, Mech E (2008) Fast unfolding of communities in large networks. J Stat Mech: Theory Exp 2008:P10008. (http://findcommunities.googlepages.com)

# Run Radial Axis Layout

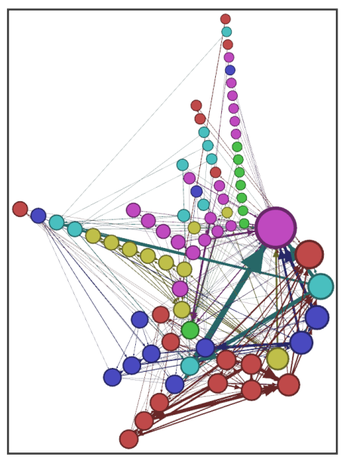
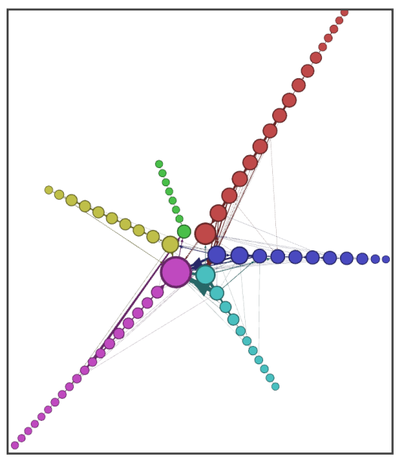
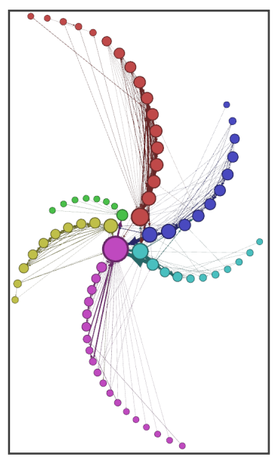
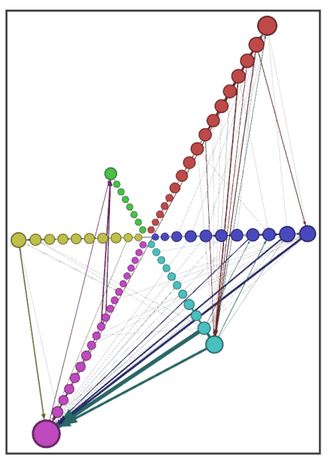
Run the layout by applying the following settings step by step:

- Group nodes by = “Degree” — Run — Homophily by degree?

- Group nodes by = “Modularity Class”
- Order nodes by = “Degree” — Run — Distribution of nodes by degree inside each community.

- Draw spar/axis as spiral = checked — Run — Better show links inside communities

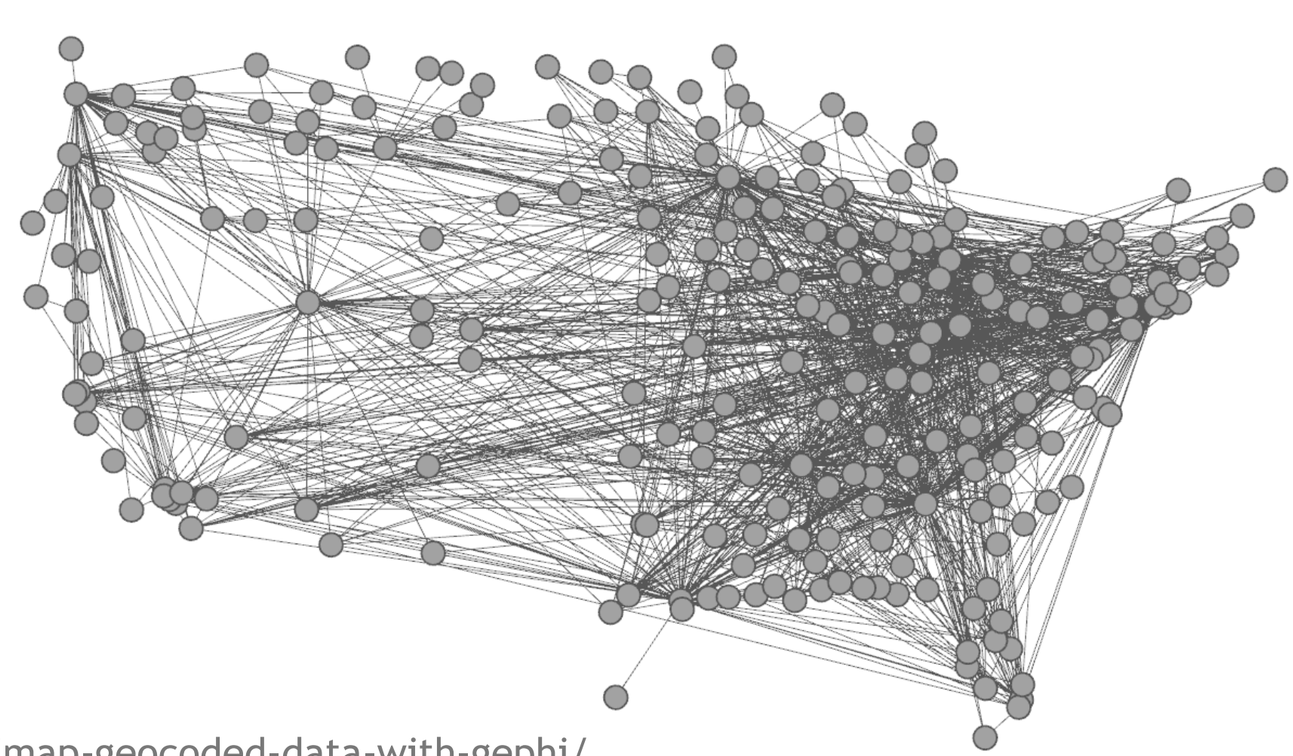
- Draw spar/axis as spiral = unchecked
- Ascending order = checked — Run — Better show links between communities

# Geographic map with GeoLayout

The GeoLayout uses latitude/longitude coordinates to set nodes position on the network. Several projections are available, including Mercator which is used by Google Maps and other online services. The two node attribute columns for coordinates should be in numeric format.

| | |
|---|---|
| Author: | Alexis Jacomy[1] |
| Date: | 2010 |
| Kind: | Geographic |
| Complexity: | O(N) |
| Graph size: | 1 to 1 000 000 nodes |

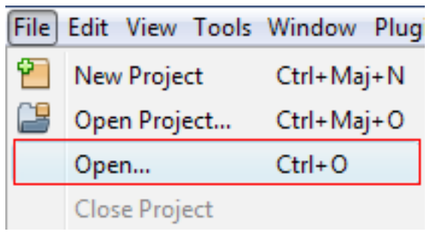


[1] http://gephi.org/2010/map-geocoded-data-with-gephi/

Tutorial Layouts



# Run GeoLayout

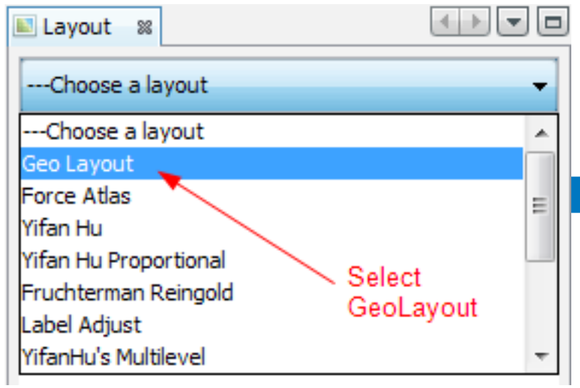


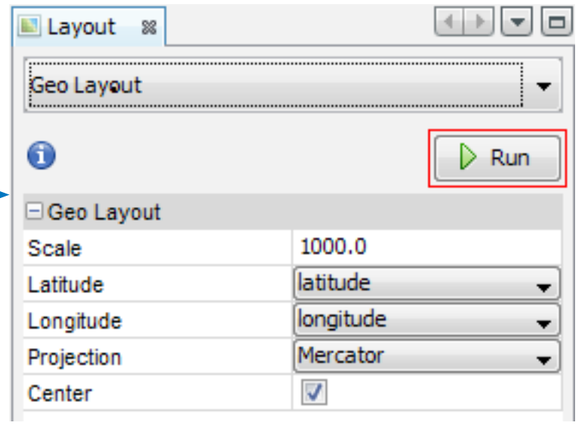

- Download the file airlines-sample.gexf and open it.

The network is an undirected graph with 235 nodes and 1297 edges. For each node there are two additional pieces of information - latitude and longitude, both expressed in degrees.

- Go to the Layout module and choose “Geo Layout” in the list.

- Click on Run



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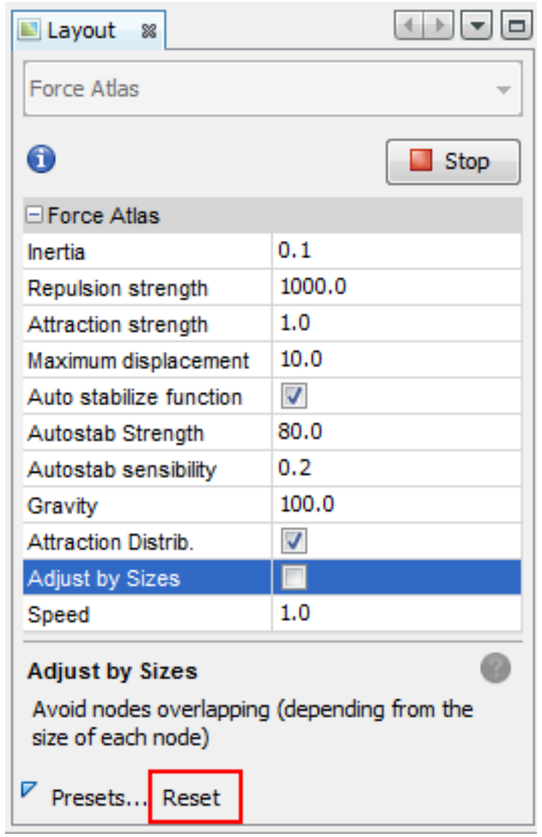
# How to avoid node overlap?

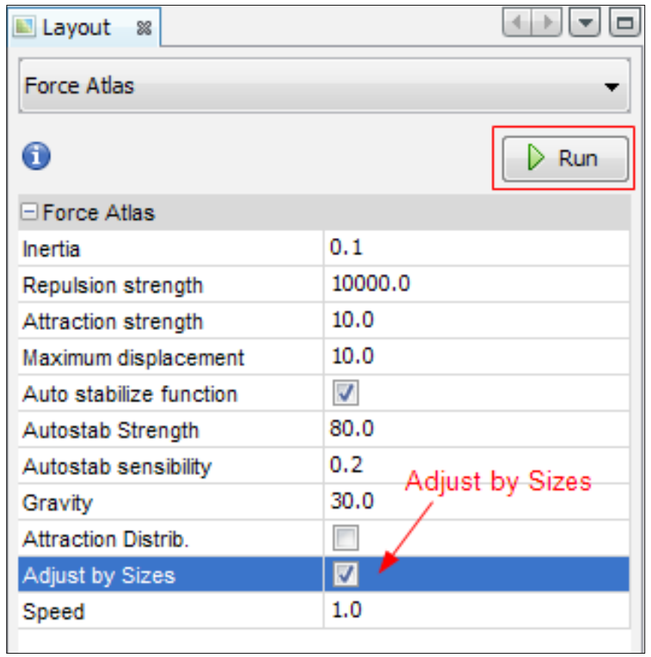
Sometimes the layout is not completely satisfying, as big nodes can overlap smaller. Three different techniques are available to avoid it.

The “**Force Atlas**” algorithm has an option to take node size into account when applying a layout.

- Go back to the Workspace 1.
- Choose “Force Atlas” on the Layout panel.
- Click on “Reset” at the bottom of the panel to reset the layout parameters.



# How to avoid node overlap?




- Run the algorithm.
- Check the “Adjust by Sizes” (“Prevent Overlap” in ForceAtlas 2) option and run it again for a short moment.
- Set the “Repulsion Strength” to 1 000.
- Set the “Autostab Strength” to 500.
- Stop the algorithm.

You can see nodes are not overlapping anymore.

**Instability!**

This option makes node positions very unstable and disturbs the layout process. Use it at the end of the layout to refine it.

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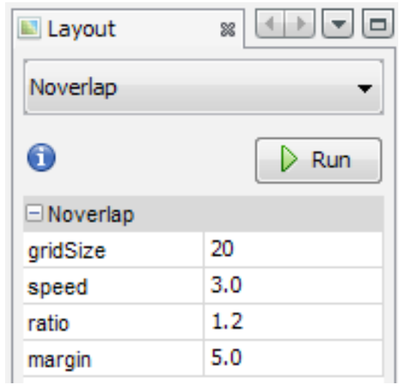
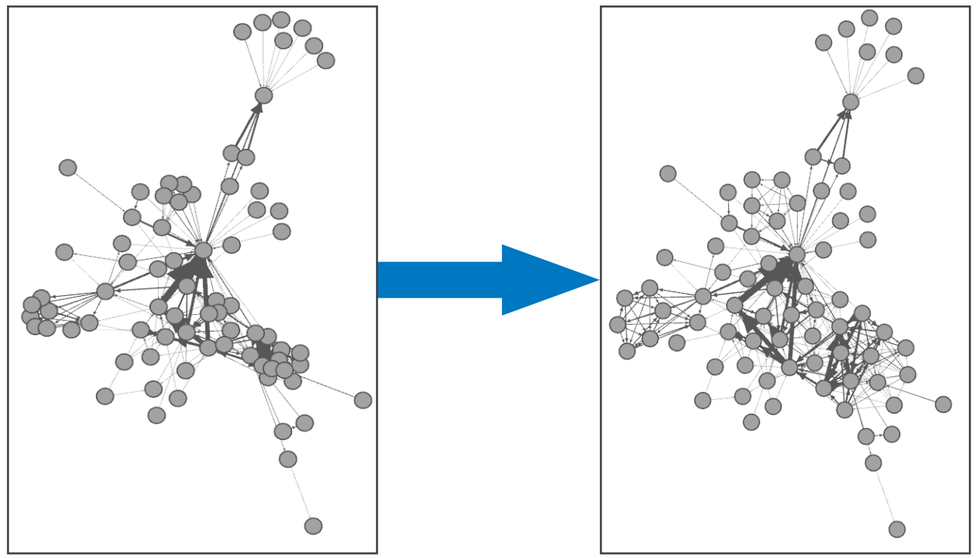
# Noverlap layout

Use it after any layout to prevent node overlap while keeping the shape of the graph. It is optimized for big graphs.




- First, run the “YifanHu” layout.
- Select the “Noverlap” algorithm and run it until it stops.
- Reduce the “speed” setting to 0.1 to increase quality.
- Increase the “ratio” at 2 and “margin” at 10 for more spacing around nodes.

You can see nodes are not overlapping anymore.



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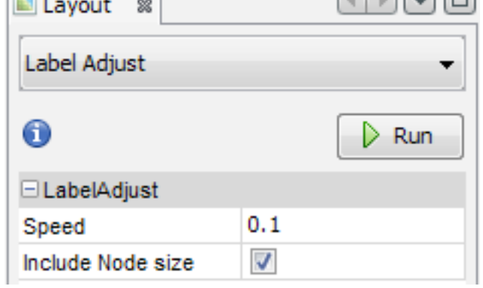
# Label Adjust layout

It works on text size to repulse nodes and therefore makes every label readable. It only runs on the visible nodes in the Visualization panel.

- Locate the Visualization settings.
- Click on T to activate text display.


- Increase the text size to the maximum.




- Go to the Layout panel.
- Select the “Label Adjust” algorithm and run it until it stops.

# Geometric transformations

There is no North-South-East-West directions for layouts, and distances are always relative. The same layout on the same graph can produce shapes with different orientations and scale. Transformation are sometimes useful to compare laid out graphs.

Use the following layouts to do basic transformations on the graph:

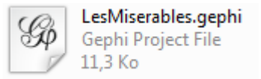
- “Clockwise Rotate” with angle -90°
- “Counter-Clockwise Rotate” with angle 45°
- “Expansion” with scale factor 1.2
- “Contraction” with scale factor 0.8

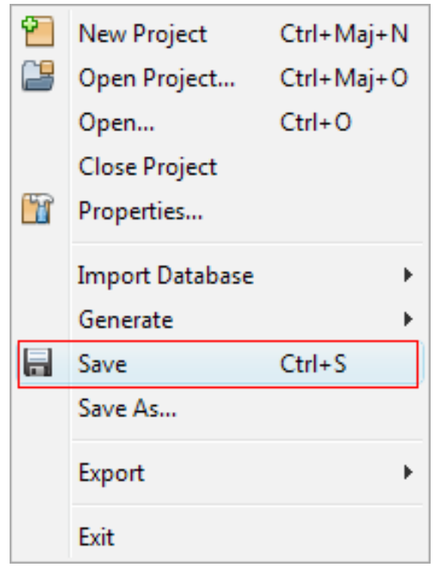
### Transformation layout

The plugin “Geometric Transformation” allows to combine rotations, homothetic transformations and translations at the same time.

# Save your project

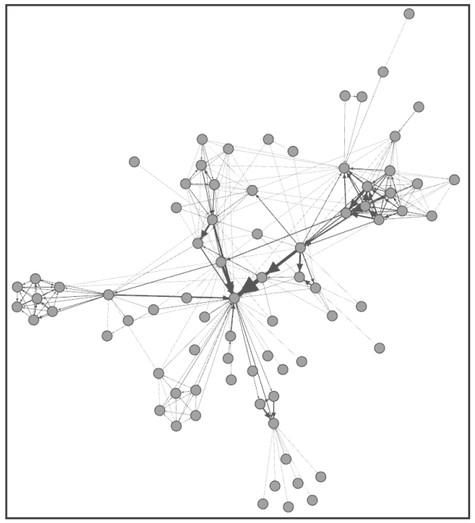
Saving your project encapsulates all data and results in a single session file.

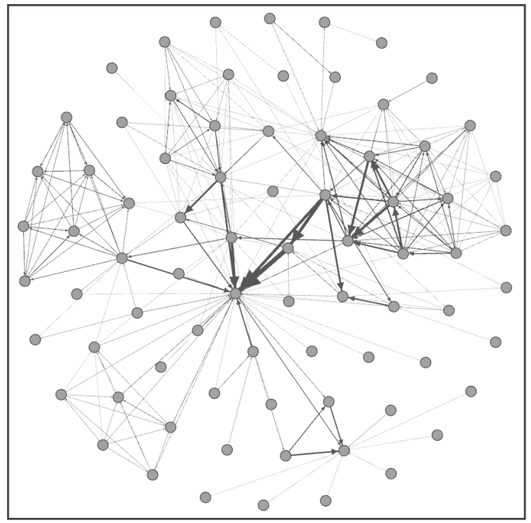


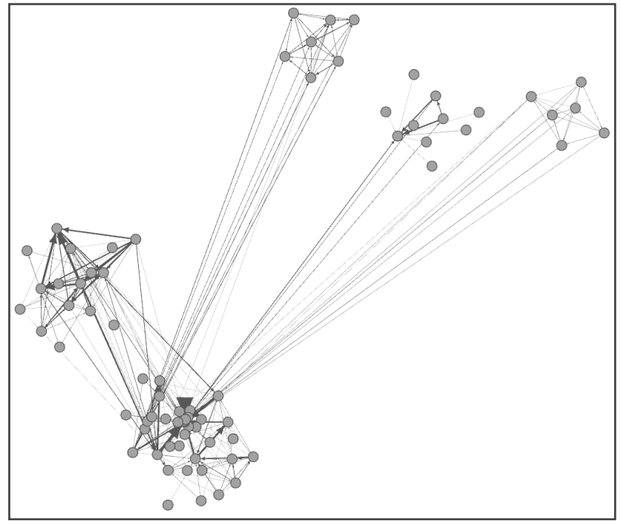



# Conclusion

In this tutorial you learned how to use various layouts in Gephi according to the feature you want to emphasis in the topology and the size of the network, how to avoid node overlapping and how to do some geometric transformations.







Other layout plugins are available through the Gephi Plugins Center.

Go further:

- Gephi Website
- Gephi Wiki
- Gephi forum