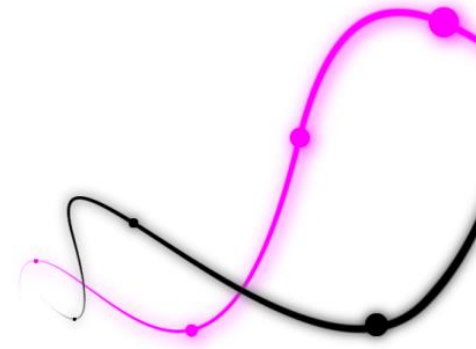# Foundations

By Clement Levallois, EMLYON Business School

V 1.5 - 2016

Bio notes

- Education in economics, management, history of science (Ph.D.)

- Turned to digital methods for research.
  - data visualization, network analysis, natural language processing, web applications and more.
  - **Member of the "Gephi Community Support" team**
  - **Gephi certified trainer**

  http://www.clementlevallois.net

- **Contact, feedback welcome**: on twitter @seinecle or www.clementlevallois.net

THE GEPHI TEAM

Gephi

- Created in 2008 by a core team of 4 French computing engineers inspired by a professor.
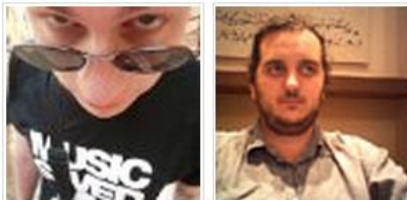
The initial Gephi Team

- Mathieu Bastian / www
- Sebastien Heymann / www
- Julian Bilcke / www
- Mathieu Jacomy
- Franck Ghitalla / www

Gephi

- In 2016,
  - 11 core developers
  - 15 developers of plugins
  - 4 Google Summer of Code
  - One Java Duke Award

- **1.5 million downloads since 2013**

- Localization is available in **French**, **Spanish**, **Japanese**, **Russian**, **Polish, Brazilian Portuguese**, **Chinese** and **Czech**.

- About 1,600 academic papers citing Gephi

- Very active Facebook group (https://www.facebook.com/groups/gephi/)
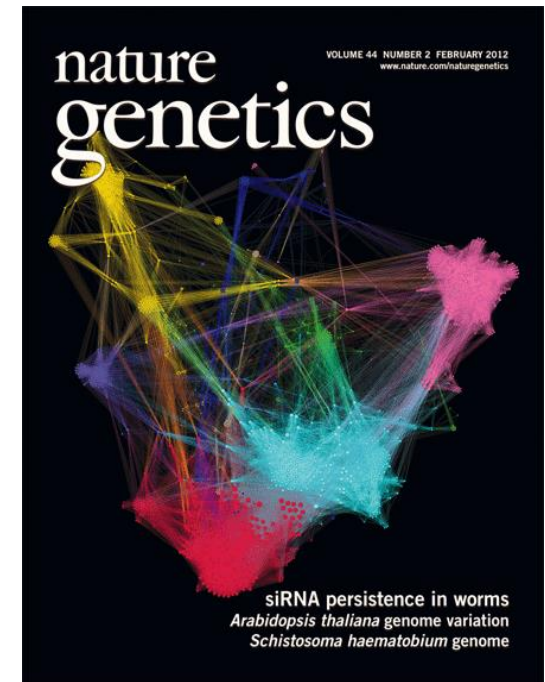
Gephi

- A software written in Java for Mac, PC and Linux

- A headless version (the Gephi Toolkit) to generate graphs automatically via API

- An ecosystem of plugins and related tools

- A commitment to open source, quality, and freedom to use.

The future of Gephi

- In version beta 0.9 since Dec. 20, 2015
  - Close to the final, stable version
  - Comparison with version 0.8:
    - Quicker
    - Cleaner code, easier to maintain and evolve
    - Accomodates larger graphs
    - Time / dynamic graphs handled differently

A note on the slides

Signals an important feature,
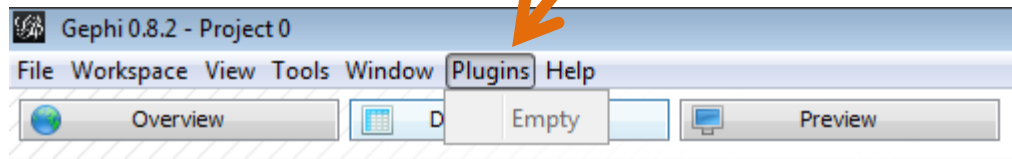or an error to avoid.

SETUP

Check list

- Make sure you have the latest version of Gephi installed

- In the menu, **choose** Help -> Check for updates

- You need a mouse with a scrolling wheel, to zoom ( )

- In the menu of Gephi, **go to** Tools -> Options -> Visualization -> OpenGL
There, increasing the anti-aliasing factor can improve the quality of the view on your screen.

- We are going to download some stuff. Check your internet connection.

- In case you manipulate large networks, Gephi might need to draw on more memory on your laptop. Keep this link in your bookmarks when comes the time to increase the memory that is made available to Gephi:

- https://gephi.org/users/install/
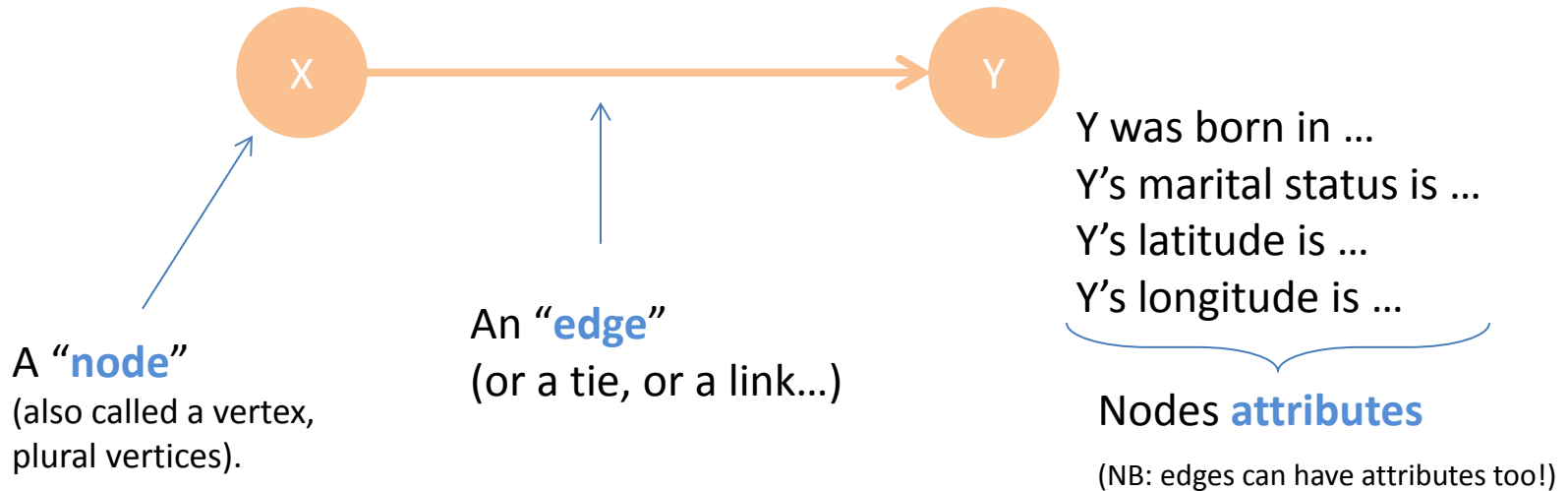
Adding plugins

- In the menu, go to
  Tools -> Plugins -> Available plugins

- Select with the tick box the following plugins:

  Circular Layout, OpenOrd Layout, alphabeticalsorter, Force Atlas 3D, SigmaExporter

- Click install and follow the instructions.

Note: You will remark there is a "Plugins" item in the menu as well, which is empty. That's a secret feature. Or just a very misleading UI design.

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A note on the terminology

X ———→ Y

A "**node**"
(also called a vertex,
plural vertices).

An "**edge**"
(or a tie, or a link…)

Y was born in …
Y's marital status is …
Y's latitude is …
Y's longitude is …

Nodes **attributes**

(NB: edges can have attributes too!)

A **directed** network
(the direction of the relation
matters)

An **undirected** network
(the direction of the relation does
not matter)

3

A **weighted** network
(the edges have a "strength"
represented by a numerical value)

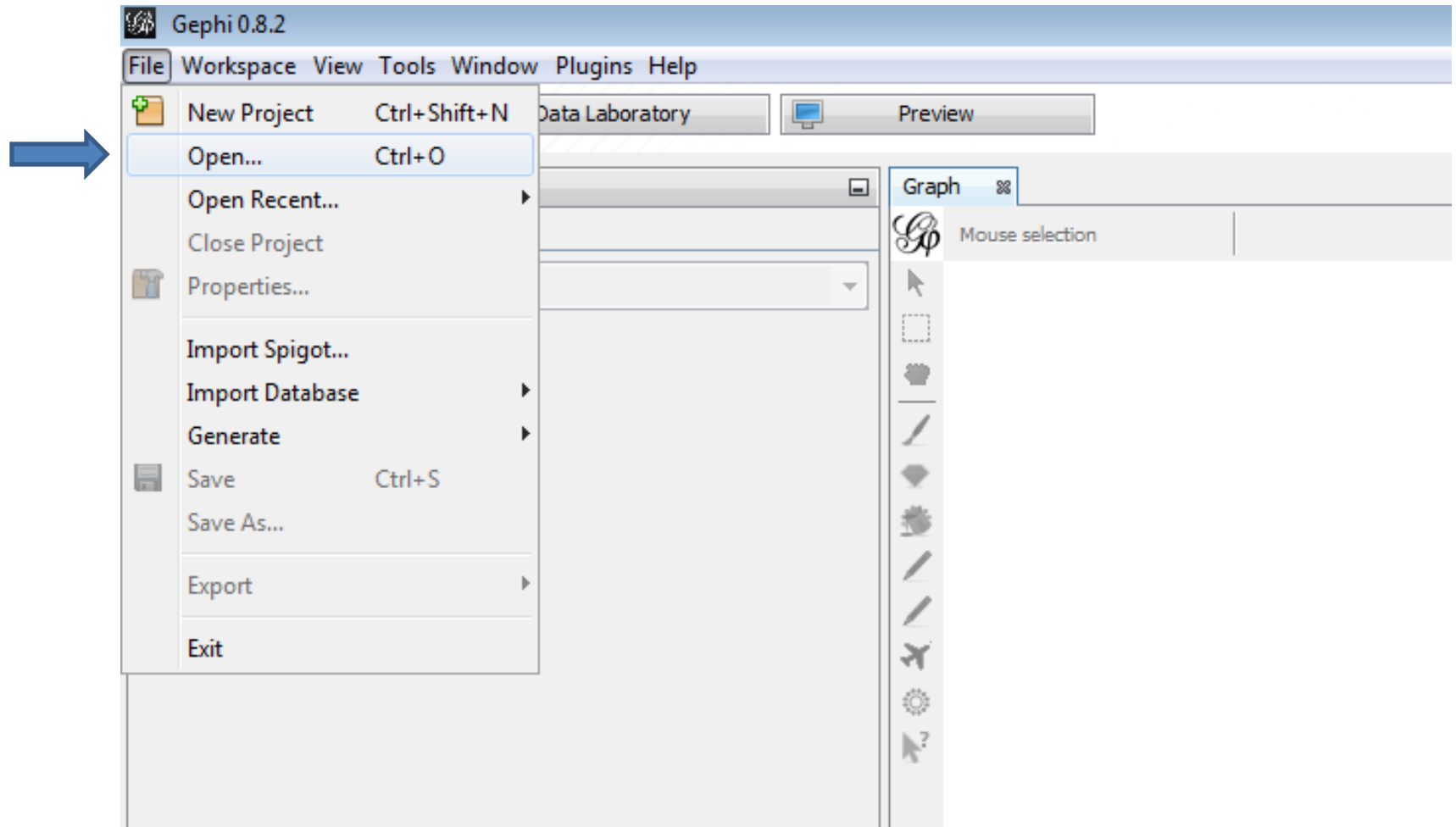# PRACTICE A WORKFLOW IN GEPHI

From A to Z

Steps

- Import the network

- Spatialize the network

- Visualize attributes of your data

- Visualize attributes created by Gephi

- Export a visualization as a picture or pdf

The dataset

- **Co-occurrence network from Les Miserables, by Victor Hugo**

- 2 characters are connected if they are mentioned close to each other in the text

- Download and unzip this file
  www.clementlevallois.net/gephi/tuto/miserables.zip

Source: Dataset originally provided byThe Stanford GraphBase,
http://www.ctan.org/tex-archive/support/graphbase/

1. Importing the dataset in Gephi

2. Import Report

This report provides information on the file you just opened

This tab gives additional info on the attributes found in the graph – useful to spot errors in the file

Scales nodes size. Don't select if your network file specifies node sizes!

Should an edge A-B be seen actually as A->B? You decide it here.

If you want to merge the graph with one that is already open in Gephi

Number of nodes found

Number of edges found

Is the graph time evolving?

Is the graph a meta-graph?
we will ignore hierarchical graphs in this tutorial

If your have a time-stamped graph. Importing the same graph with different time-stamps creates a "time evolving" (dynamic) graph

Often, networks files are simply a list of nodes (ex: A, B and C), and a list of edges connecting these nodes (ex: A –B, B-C) . What if Gephi finds an edge A-D in the file? Since D is not present in the list of nodes, you are given here a choice to add it now. If not, the edge A-D will be ignored.

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3. The graph, opened
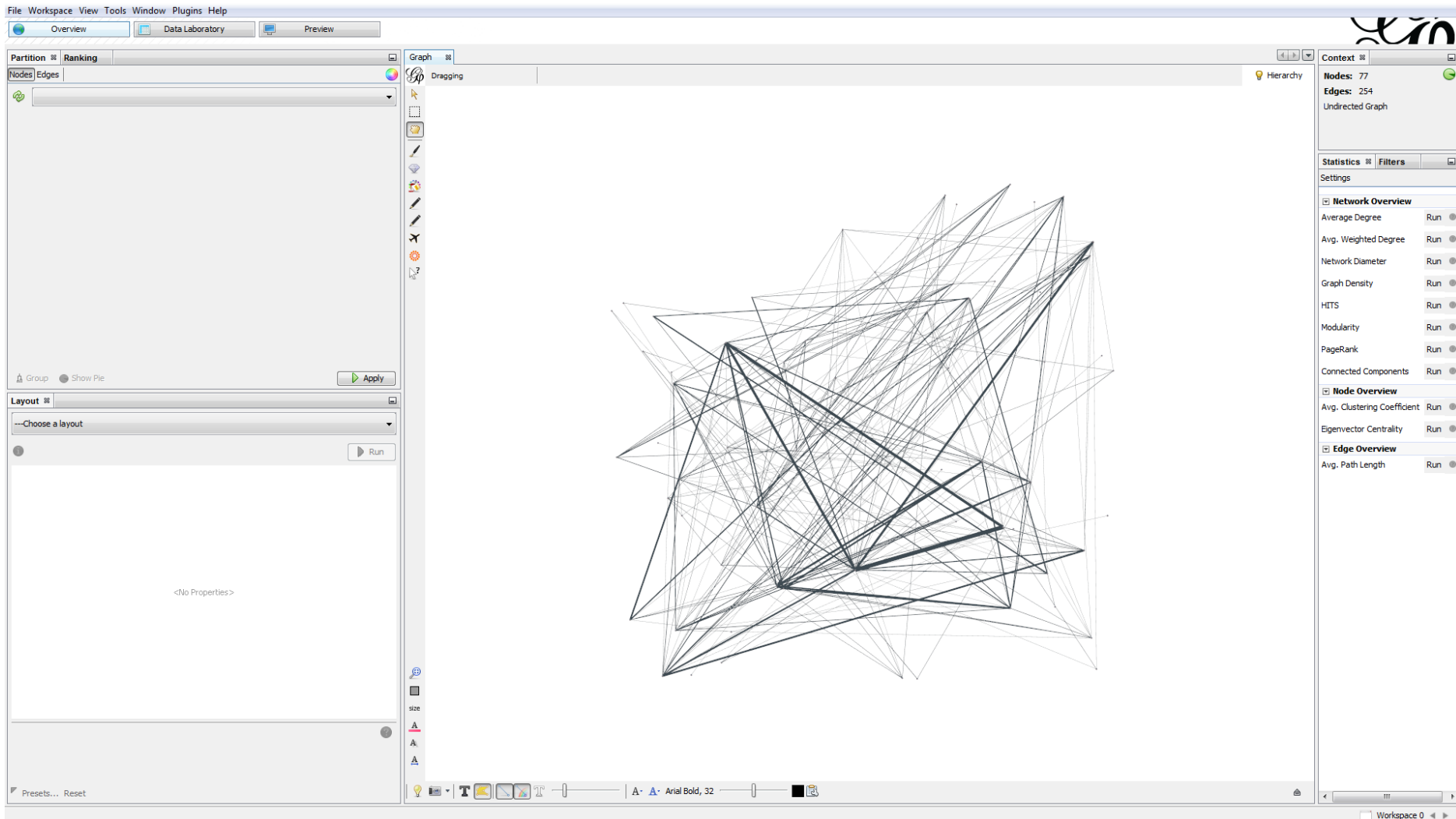
4. Saving a Gephi project

- Gephi can save projects under the .gephi extension.
    - These files can only be opened in Gephi, and contain all information about your project. **Click File -> Save**.
    - There are a number of reports of this files to be unstable, so **always also export your network** as indicated just below.

- The bare network itself can be exported as a file, in different formats.
    - gexf and graphML are two network formats which can store attributes for nodes and edges.

   => **Click File -> Export -> Graph File** to save your network.

5. Mouse controls

- Left click: accomplishes the action you previously selected

- Right click: move the graph around ("panning")

- Scrolling wheel: zooming in and out

- "Alt" key + keep left click down while on the graph: moves the graph in the 3rd dimension (gives an effect of depth and perspective)

# 6. Rearranging windows, tabs, panels
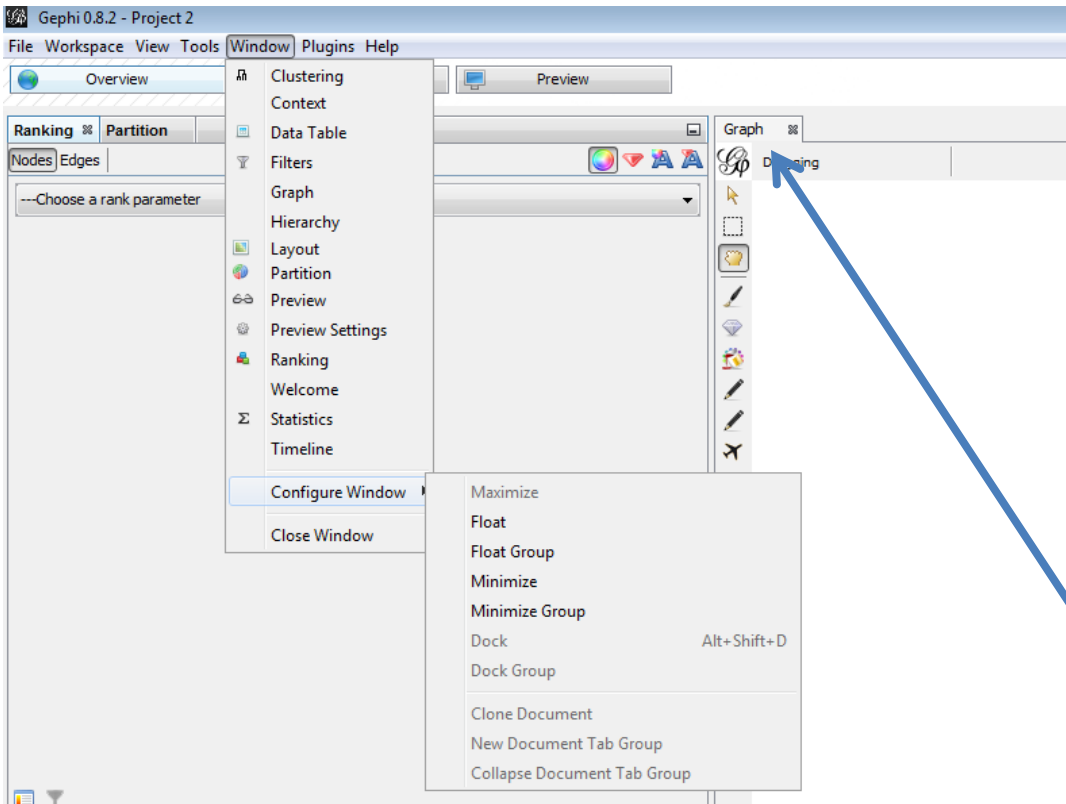
My experience: don't use this "Configure Window" menu.

Just drag, drop and resize the tabs with the mouse as you find most convenient.

Try to maximize the space for the main tab – the one where the graph is displayed!
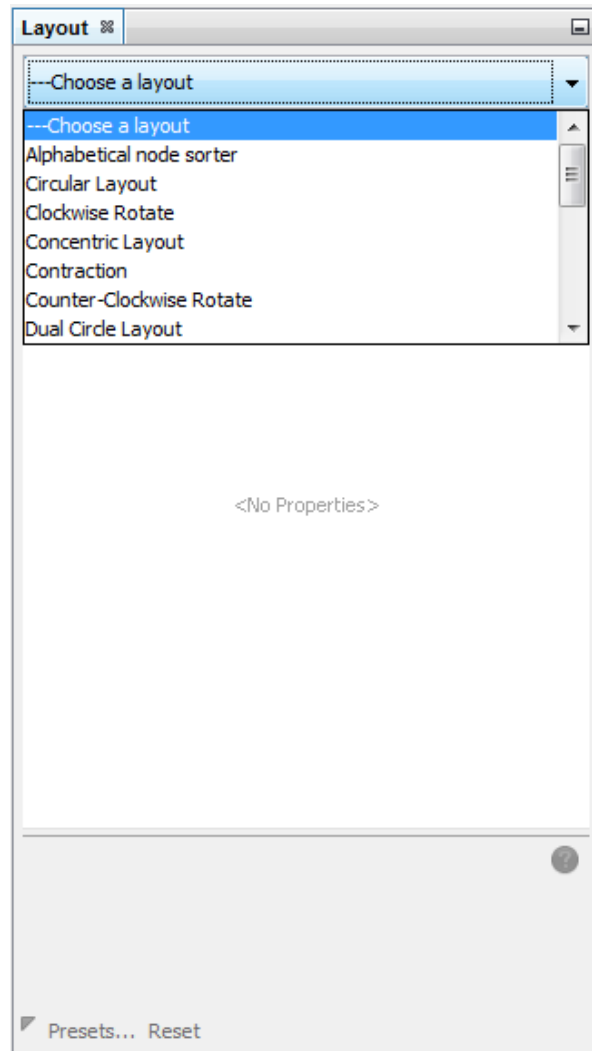
7. Switching on labels

- Please refer to the cheat sheet ① in appendix of this slide deck.

- Notice the panel at the bottom of the screen, and its "Labels" tab.

- Edges and nodes can have labels but in most use cases, only nodes have them.
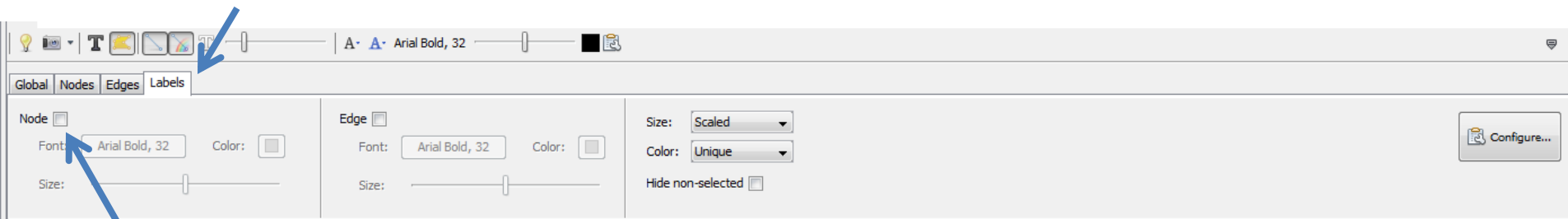
Tick here to display node labels

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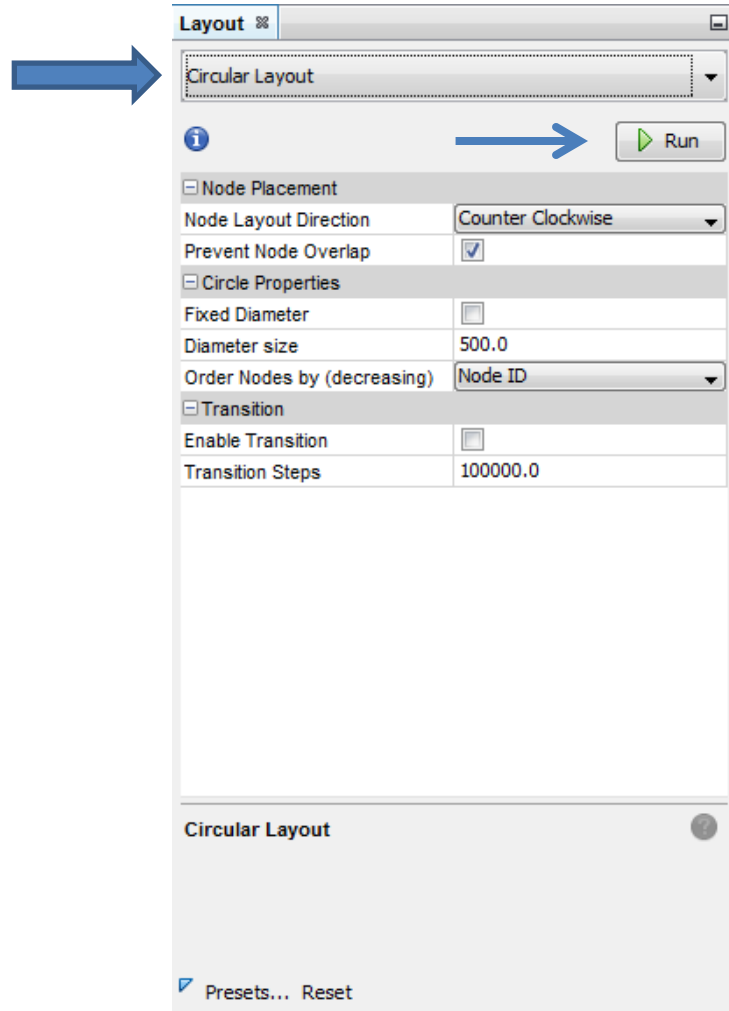
8. What a layout is

- A layout is simply a procedure to position nodes on the screen according to some logic.

- Many procedures exist – you could create your own if you'd wish

9. Example of a simple layout

- Select the "Circular Layout" in the drop down menu of layouts.

- Don't change any setting and click "run"

10. Example of a simple layout (continued)
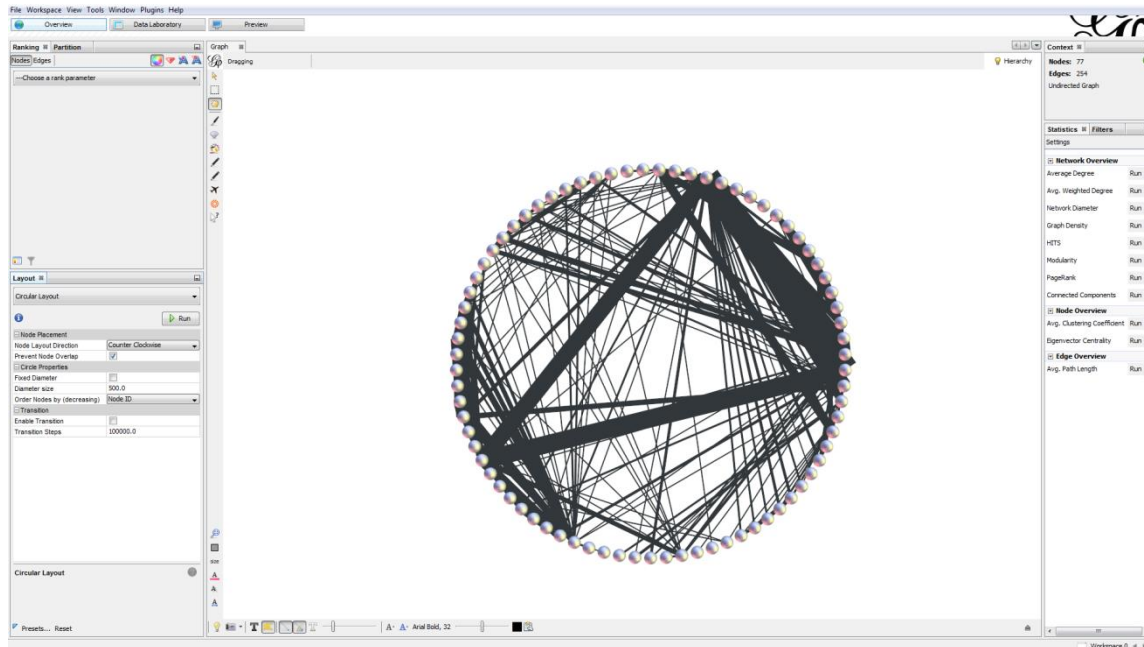
The "circular layout" applies the following procedure: "spread nodes on a circle, at an equal distance from each other."

Can we distribute nodes according to different procedures, yielding more insights?

11. A insightful layout: Force Atlas 2
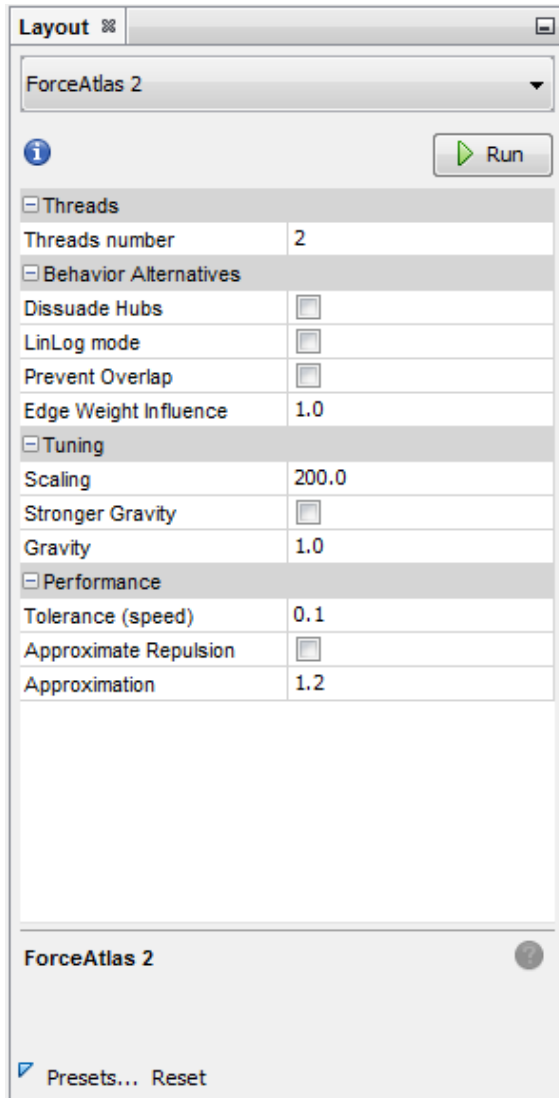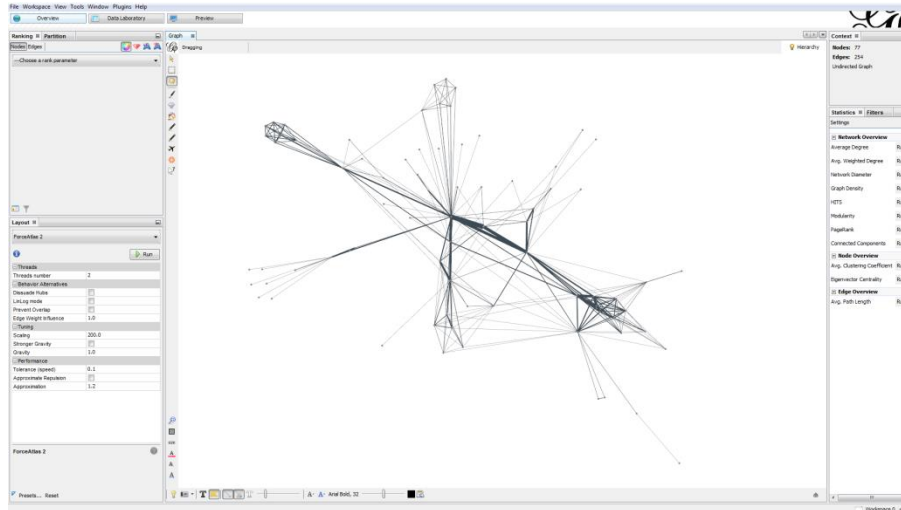

- Select "Force Atlas 2" in the drop down menu of the layouts.

- Change the scaling parameter to "200" (not necessary, actually…)

- Run it!

12. Force Atlas 2 – the result

The result is that densely connected nodes tend to be grouped in the same regions of the screen.

This property is very useful to interpret a graph:
- groups of nodes can be spotted immediately,
- Relations between groups are also visible.

Recent works have demonstrated analytically this result (that with certain kinds of layouts, densely connected groups of nodes find a visual translation in a 2D plane). See Noack (2009) and Waltman, van Eck and Noyons (2010) in the reference list.

13. How do force-based layouts work

- "Nodes repulse each other like magnets, while edges attract their nodes, like springs"

- "These forces create a movement that converges to a balanced state."

- Force Atlas 2 specificity:

"[We] tweak the repulsion ["magnet"] force so that poorly connected nodes and very connected nodes repulse less"

(see Jacomy et al. 2014 in the reference list).

14. Algorithms "force-based"

- Force Atlas and Force Atlas 2
  - Force Atlas 2 has just been explained, the differences with Force Atlas are explained in the next slide

- Fruchterman-Rheingold
  - The classic one. Nodes that are connected attract each other

- Kamada – Kawai
  - More elaborated: the attraction force between any 2 nodes is proportional to the length of the shortest path joining them

- Yifan Hu
  - Gathers nodes in groups, then applies a force-based logic to the groups

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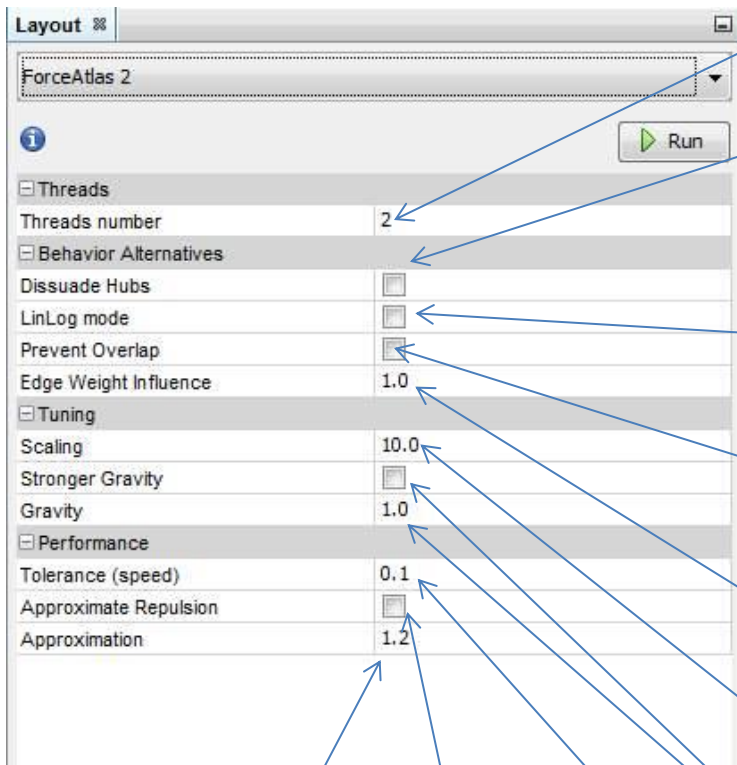
Increase the speed
Each « core » of a computer processor has 2 threads. For a computer with a dual core, choose a thread number of 4.

Pushes to the periphery the nodes with many outbound links
Interesting only when the network is directed. Exemple for a network of webpages: websites with many outbound links, but few inbound links, could end up at the center of the network. But when this option is selected they are pushed to the periphery.

Increases the repulsion force
Repulsion force between unconnected nodes decreases with distance. When this option is selected, the repulsion force remains constant – leading to a network which is more expanded in space.

Prevents nodes from overlapping
Very convenient to keep the network readable. Choose and apply the layout « Label Adjust » (not shown here) to make that node labels as well don't overlap.

Controls the strength of the links connecting nodes
If the links have weights, makes these weights overall stronger or weaker

Controls the intensity of the repulsion and attraction forces btween nodes

Controls the force driving nodes to the center of the screen.
A constant, light gravity force always pulls nodes to the center of the screen. Select this option to make this « gravity » force much stronger - convenient option when nodes have drifted away out of screen view. Control the pull of the gravity by increasing or decreasing the value.

Degree of approximation
Increasing this factor increases speed (if the option above is selected), but at the cost of flickering of node positions if the value is too high

Increases dramatically the speed
By approximating the calculus of the repulsing force, instead of computing it exactly at each step.

Determines by how much nodes can « swing »
Useful when a network is flickering: diminishing this value can « freeze » it.

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15. Force Atlas or Force Atlas 2?

- Force Atlas 2 is a reworked version of Force Atlas.
    - Its implementation has been reworked to make it faster
    - The algortithm is faster thanks to multithreading

- Parameters are slightly different:
    - The force of attraction and force of repulsion in « Force Atlas » have been merged in a single parameter (« scale ») in « Force Atlas 2 ».

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16. A way to misread a layout

- Are the nodes in the center more central?
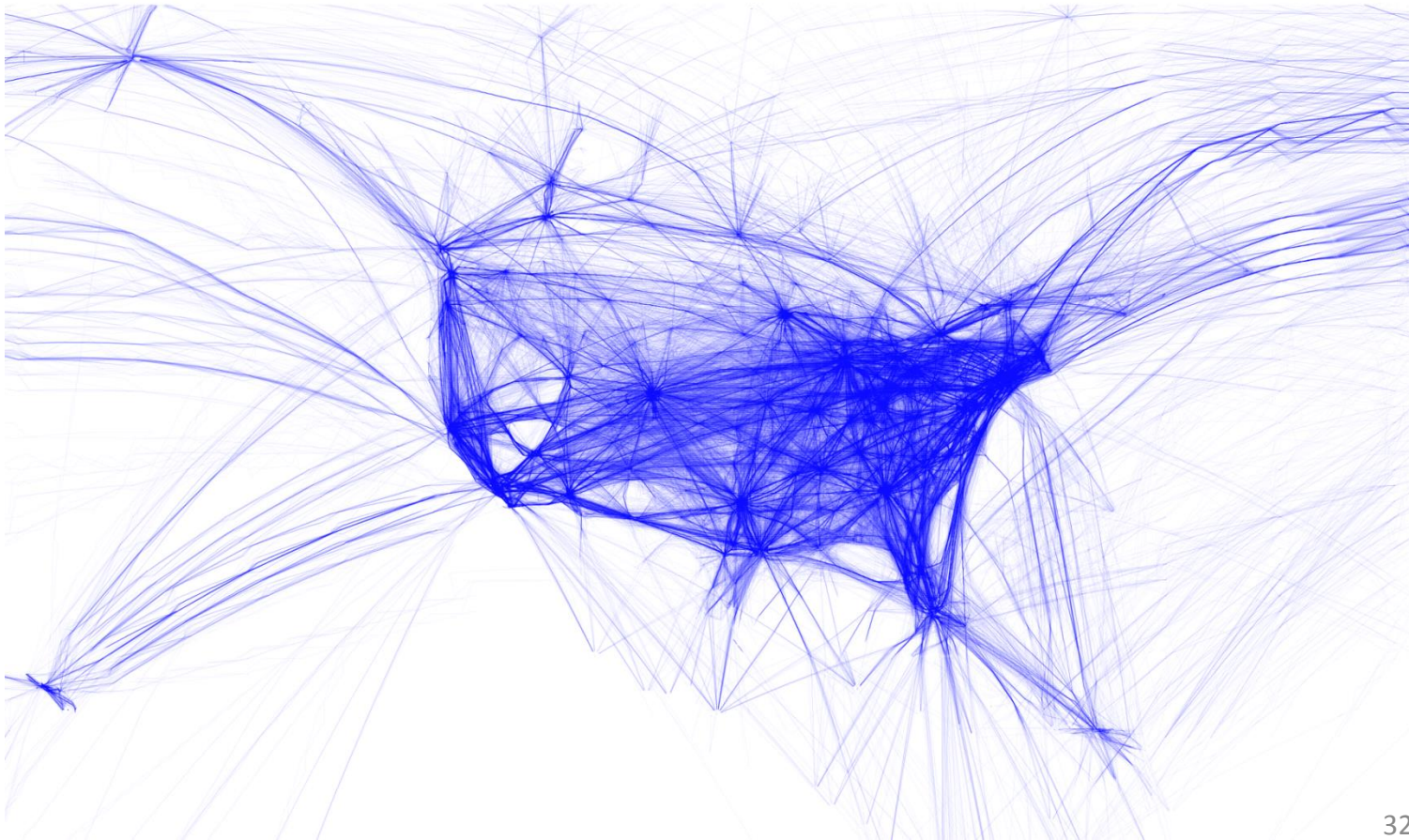
This slide is based on Scott Weingart's blog post: « Networks Demystified 8: When Networks are Inappropriate ») – See refs at the end.
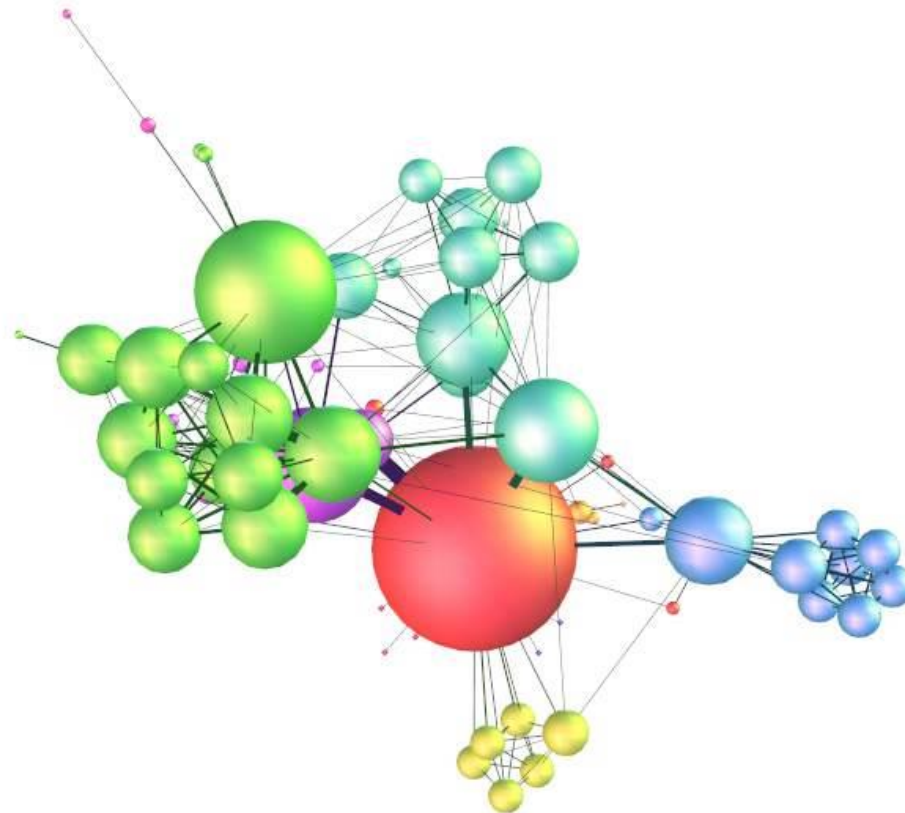
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17. The trap, explained

- Las Vegas does appear as relatively central on the map: lots of connections to other cities, and in the middle of the South West region

- Travelers often go to Vegas, stay a bit, then go back home.

- So Las Vegas is not a connector between airports (« hub »). It is not central in the sense of a favorite place to transit from one place to another.

- As Scott Weingart says, that's more of a « sink ».

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18. Local minima:
another way force-based layouts can be misleading

- The layout can « remain stuck » in a position which does not represent the most definitive equilibrium of forces.

- Solution:
  - Keep this possibility in mind: for large graphs (~200+ nodes or more), the precise position of an individual node must be critically intepreted. Being in the neighborhood of another node might not reflect belonging to the same community (especially if they are not connected, and if the community detection algo places them in different communities).

  - However, the positioning of groups / communities of nodes remains a robust indicator of who sits in the same connectivity region.

  - I personally start with a very expanded network (large value of the « scale » parameter in Force Atlas 2) before shrinking the network to a decent size, in order to give maximum space/freedom to the nods to move around and end up in a global minima.

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19. Trying out Force Atlas 3D

https://marketplace.gephi.org/plugin/force-atlas-3d/

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20. OpenOrd for very large graphs?

- My personal opinion:

  - The logic of OpenOrd can't be explained easily

    If you'd like to try:

    OpenOrd: an open-source toolbox for large graph layout. Shawn Martin, W. Michael Brown, Richard Klavans, Kevin W. Boyack. Proc SPIE 01/2011; 7868:786806. DOI:10.1117/12.871402

    Available here:

    http://www.researchgate.net/publication/253087985_OpenOrd_an_open-source_toolbox_for_large_graph_layout

  - The resulting layout is not the best
    - Communities are not clearly separated
    - Compare with Force Atlas 2 to see.

  - And Force Atlas 2 is actually quicker on a network of 5,000 nodes and 24,000 links.

  - ➢ So I always recommend to use Force Atlas 2 instead.

21. Making nodes bigger

- Please refer to the cheat sheet ② in appendix to this slide deck.

- **Right**-click on the icon marked "size" and set the number to 15 or higher. Validate.

- Then **left**-click on the same "size" icon.

22. Visualizing attributes in your data

- Nodes in our example network have one attribute: the gender of the character in "Les Miserables".

- We can overlay this information on the network by **color-coding** the nodes according to the values of this attribute.

- Note: we have 2 values for this attribute (male or female), but this could be many more.
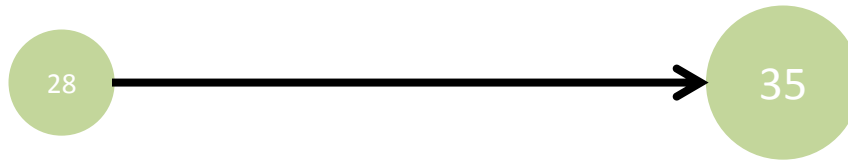
23. Partitioning or ranking?

- Partitioning is this:
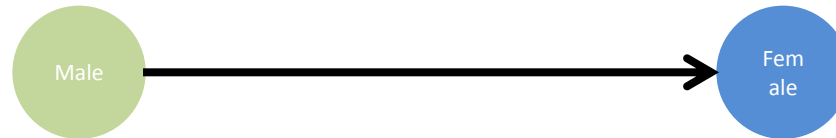
Works for attributes that classify nodes **in categories**: "male or female", "East, West, South or North", "country of residence". Each category is represented by a different color, as above.
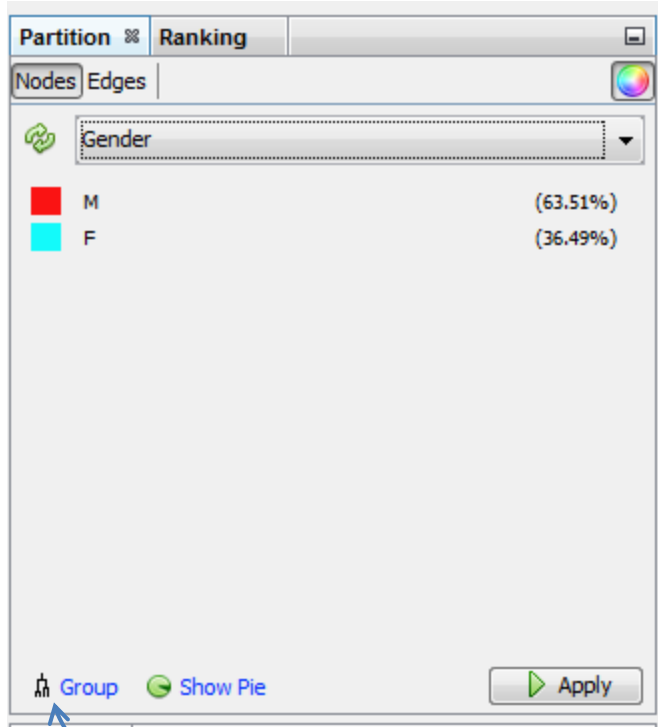
- Ranking is this:

or this:

Works for attributes that are **gradual, not categorical** (age, etc… any numerical attribute).
The graduation is represented visually either by bigger sizes, or by changes in shades of color (from light to dark, or from light colors to warm colors, usually).

24. Example of partitioning in Gephi 0.8.2

- In the "partition" tab, **hit the refresh ⟳ button** to make sure Gephi loads all avail. attributes.

- In the drop down menu, we then select "Gender" which is anyway the only available attribute available for partition in our case.
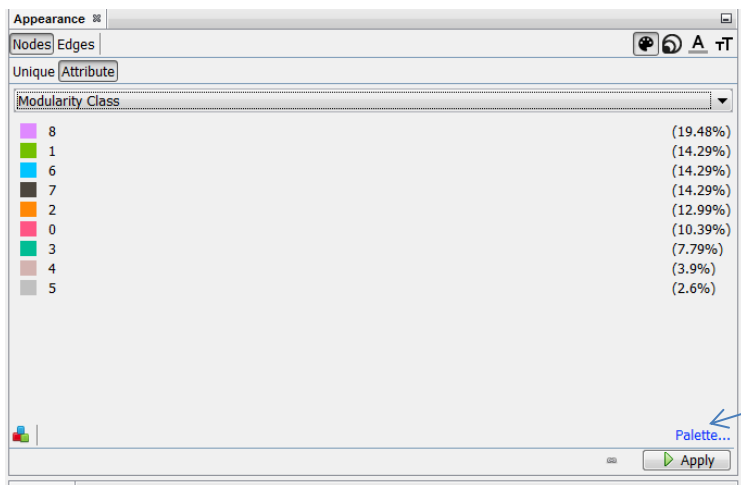
- **Click on** "**apply**"!

- ✋ Note that if we had had a categorical attribute for an edge (relation btw 2 character: friend, enemy or neutral?), we could have colorized edges according to the same principle. ✋

- Note that if we wanted to group all nodes from the same category as one big node, we would have gone here. (that's hierarchical graphs)

24. Example of partitioning in Gephi 0.9

- In the "Appearance" select "Gender" which is anyway the only available attribute available for partition in our case.

- Modify the color of each group individually by clicking on each colored square

- Or choose among preselected palette of colors, defined to use colors easy to distinguish

- **Click on** "**apply**"!

- If you had a numerical attribute (not distinct groups, but nodes with varying ages, scores, temperatures… then you'd have to choose "ranking" here

25. Visualizing new attributes with Gephi

- Gephi can compute metrics, such as "how central is each node" in the network.

The key insight is: these metrics are attributes to nodes (or edges), and **can in turn be visualized just as any other attribute**.

- Visualizing these metrics (instead of reading them in a tabular form as is usually done) stimulates / speeds up insight.

26. Detecting communities & visualizing them

- **Go** to the statistics panel and run the **Modularity** algorithm.

- This algo identifies relatively densely connected groups of nodes in the network.

- As a result, each node ends up being attributed to one of these groups (called "class" here).

- The same way we have colorized nodes by their genders, we can colorize them by the group ("class") they belong to.

- **Go** to the Appaerance panel, select "modularity class", and "apply"!

Note: by clicking on the colored squared next to each category in the partition tab, you can change and choose the colors you prefer.

Click on it to choose a different color

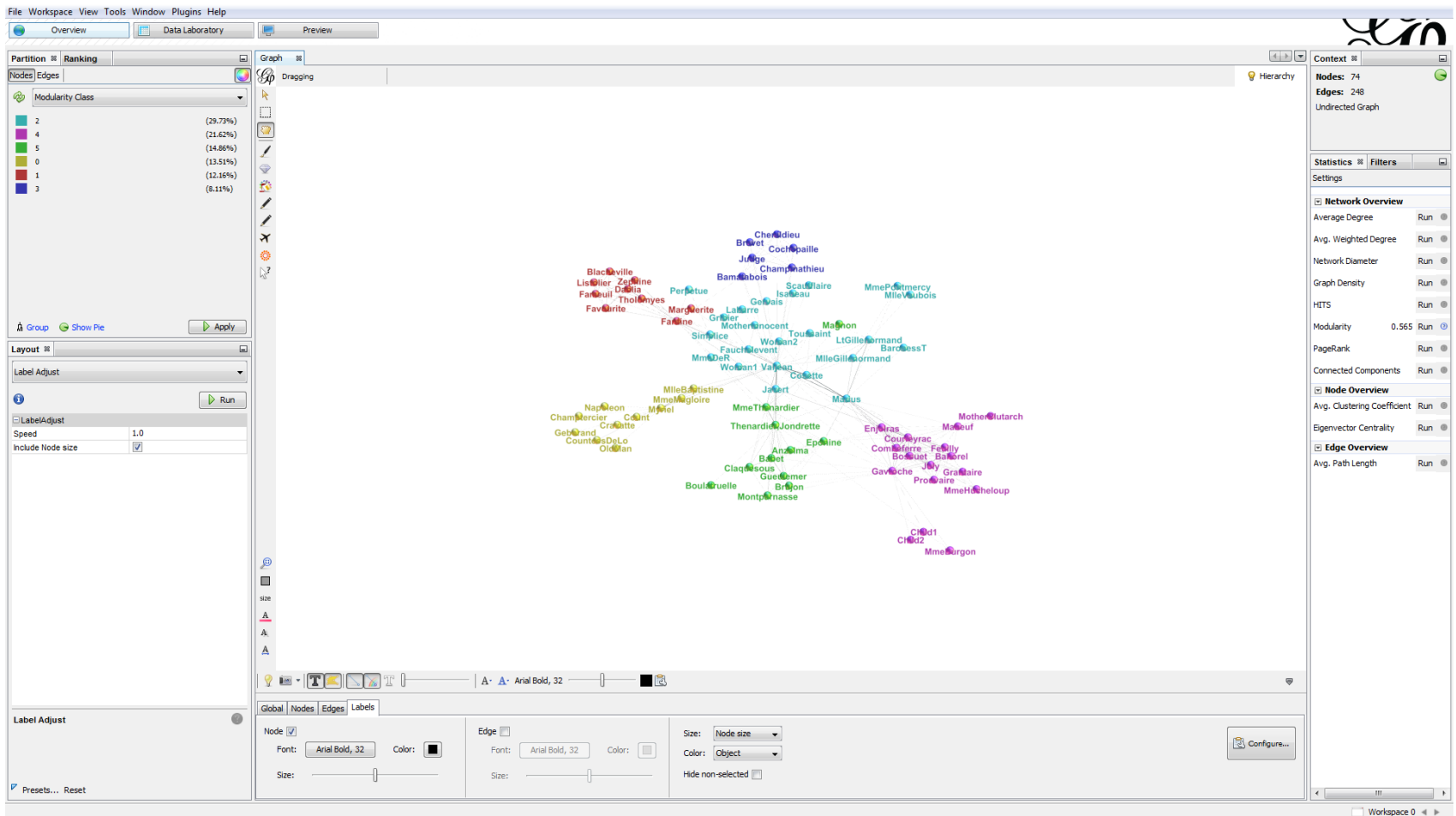|		
2		(29.73%)
5		(21.62%)
4		(14.86%)

27. Communities and "modularity"

- Modularity (Newman 2004)
  - Number of links in each community minus the number of links in the same groups in a graph where the links would have been redistributed randomly.

  - Finding communities in a graph = define groups in a manner that the modularity score is the highest.

28. Visualization of communities: the result

29. Tips to clean up the appearance

- Apply the layout "Label adjust"
  - To clean up overlapping labels
  - Find it in the drop down menu of the layouts

- Switch to a black background?
  - Check the bottom left corner of cheat sheet ②

- Decrease the thickness of edges?
  - A slider makes it easy

30. Gephi: what's the output?

- The next slide shows how to export your viz to a picture file. Is it what Gephi is for, ultimately?

- In my view, the value added is before all in the insights you gain in the process of exploring the viz interactively, and iteratively, *in Gephi*.

- Exporting the view to a file or a webpage meets different needs, such as communicating the insights you gained.

- Jer Thorp, a reference in data visualization, has a short blog post in the *Harvard Business Review* making a closely related point:

http://blogs.hbr.org/cs/2013/04/visualization_as_process.html

31. Export your visualization!

- Directly from the overview panel with the screenshot option (see cheat sheet ②).

- Or as a web page! With the SigmaExporter plugin.
  - Do File -> Export -> Sigma.js template and then simply upload the folder to a server

- Or in the preview panel (see cheat sheet ⑤).

Why do the views in the overview and preview panels don't exactly match?

- Visualizing a graph in real time as in the overview panel requires a technology (OpenGL) which is incompatible with an export in the pdf or svg file formats.

- The preview panel provides this bridge towards pdf and svg, by using a different technology to render the graph.

- This difference in technology means that some visual features in the overview panel don't translate exactly to the preview mode.

32. Les Miserables network
just before export to pdf
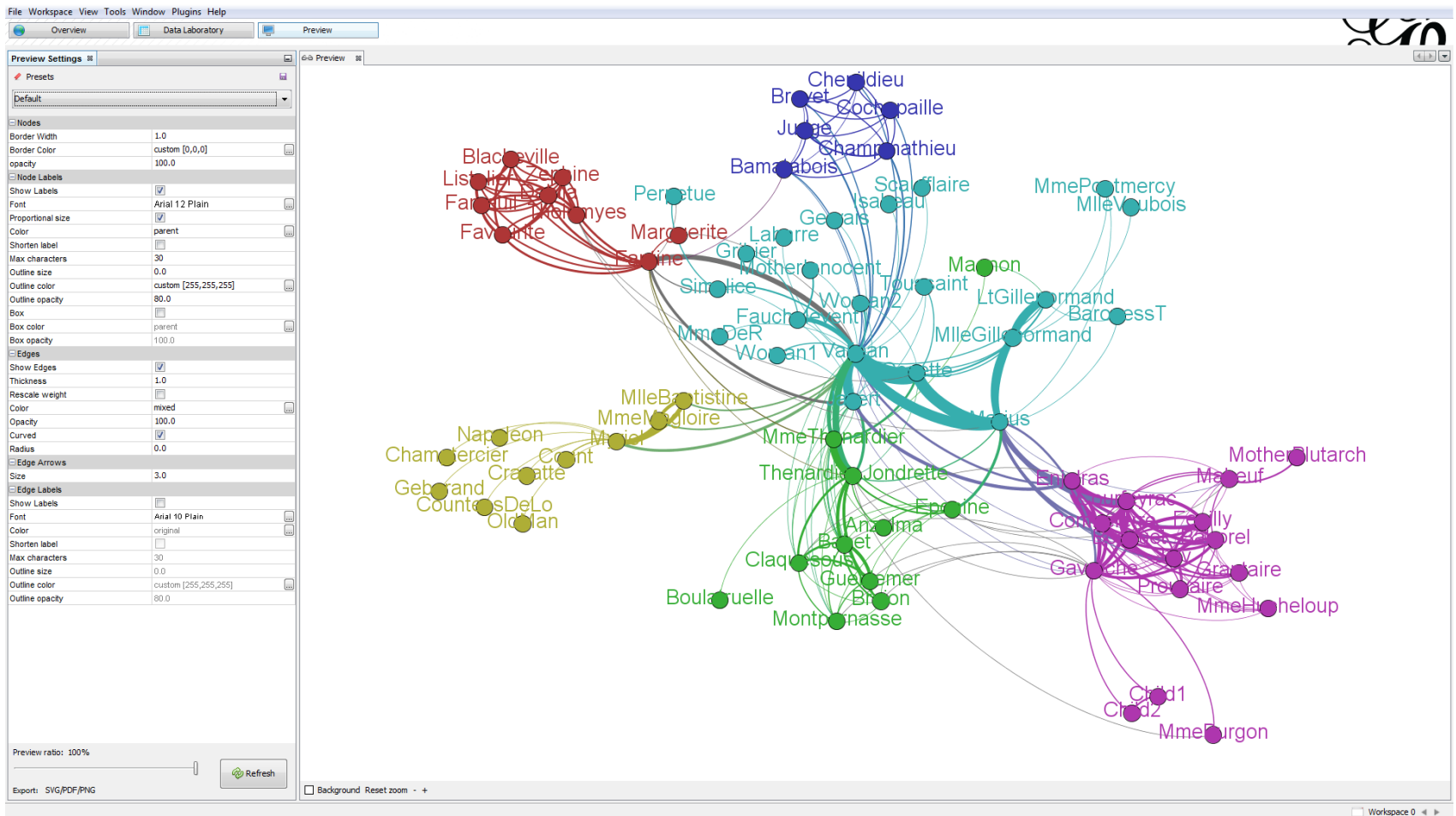
33. To adjust labels, add a legend:

Inkscape

Adobe Illustrator

34. We've learned how to…

- Configure Gephi.
- Read an import report
- Use the Gephi interface
- Interpret a layout
- Understand the logic of force based algos
- Be careful about misinterpretations in reading graphs.
- Use the ranking, partitioning, and metrics panels
- Export a network as a picture

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Next step:
importing data into Gephi

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Gephi Cheat Sheet ①

The Overview Panel in **Gephi 0.9**

Where all the functions are available to explore the network visually.

Appearance

To change the size and color of the network according to some values.

Example:
to color all nodes representing males in yellow, and all nodes representing females in green

Use the "Unique" tab to color / resize all nodes and edges uniformly (all in green, all in a given size…)

Click here f your attributes are numerical.
Example: the older the individual, the bigger the node. Works with gradients of colors too (ex: the older the indiv., the pinker it is).
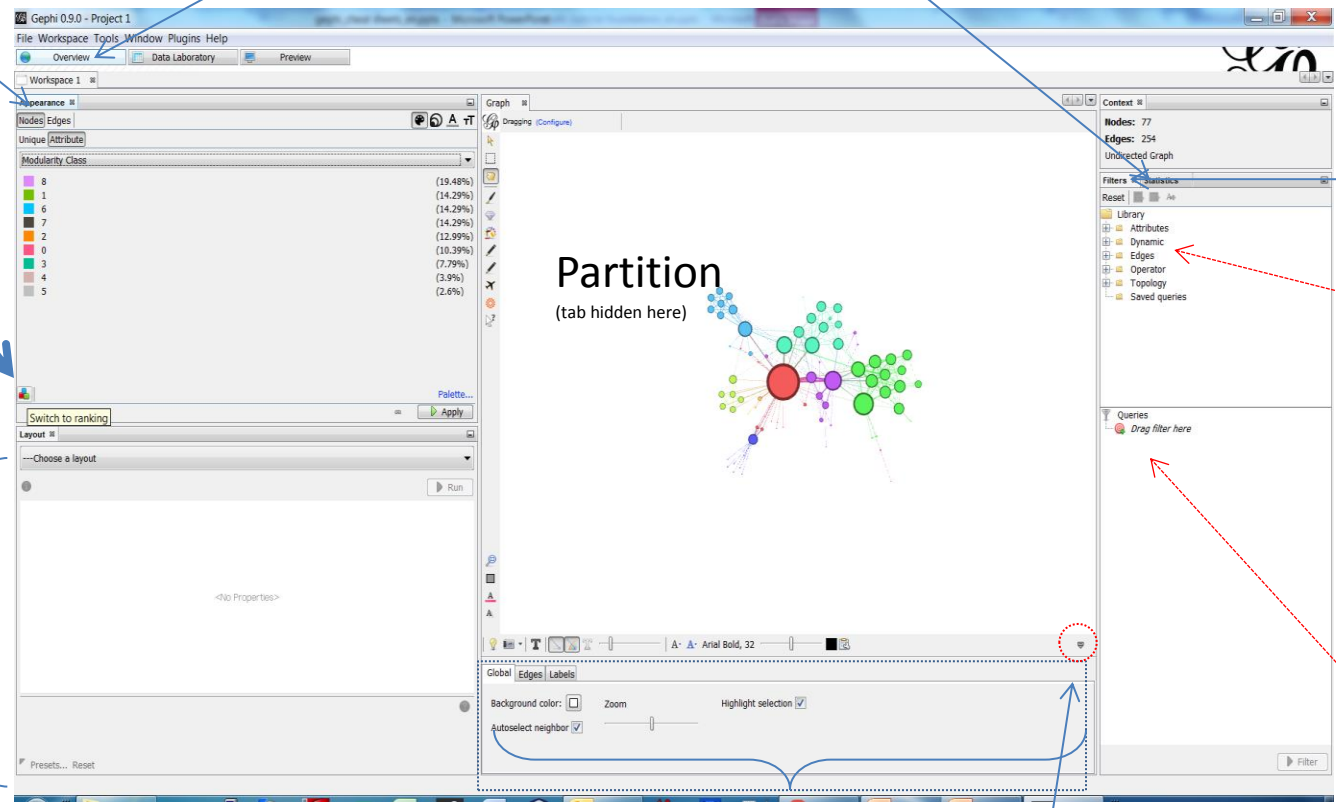
Statistics
(tab hidden here)

Statistics help you compute metrics on the network. These metrics are recorded, and can then be used to be displayed on the graph. Ex: compute the centrality of nodes. Then use the Appearance panel to make central nodes, bigger.

Layout

Changes how the network is spread on the screen.
Select one of the layouts in the drop-down menu and apply it to see how the position of nodes is changed.

Partition
(tab hidden here)

Filters

To hide or display only part of the network.
The "library" and its folders contain the filters. For example, filter out nodes which have less than 3 edges. Or filter out edges which have a weight above some value.

Drag and drop the filter you choose in the "queries" window. Several filters can be combined (ex: filter out male indiv. that have less than 3 connections to others).

General settings and options for the look of edges and labels. Access them by clicking on the small arrow

This box of settings can be shown / hidden with the little arrow circled in red on the top right. Here, you can set if nodes are visible in 2D or 3D, what is the default color of edges, etc. The "labels" tab is particularly useful: should they be displayed or not, and at which size.

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Gephi Cheat Sheet ① The Overview Panel in **Gephi 0.8.2**

Where all the functions are available to explore the network visually.

Partition

(tab hidden here)

<u>For categorical attributes</u>. Example: to color all nodes representing males in yellow, and all nodes representing females in green

Ranking

<u>For numerical attributes.</u> Example: the older the individual, the bigger the node. Works with gradients of colors too (ex: the older the indiv., the pinker it is).

Statistics

(tab hidden here)

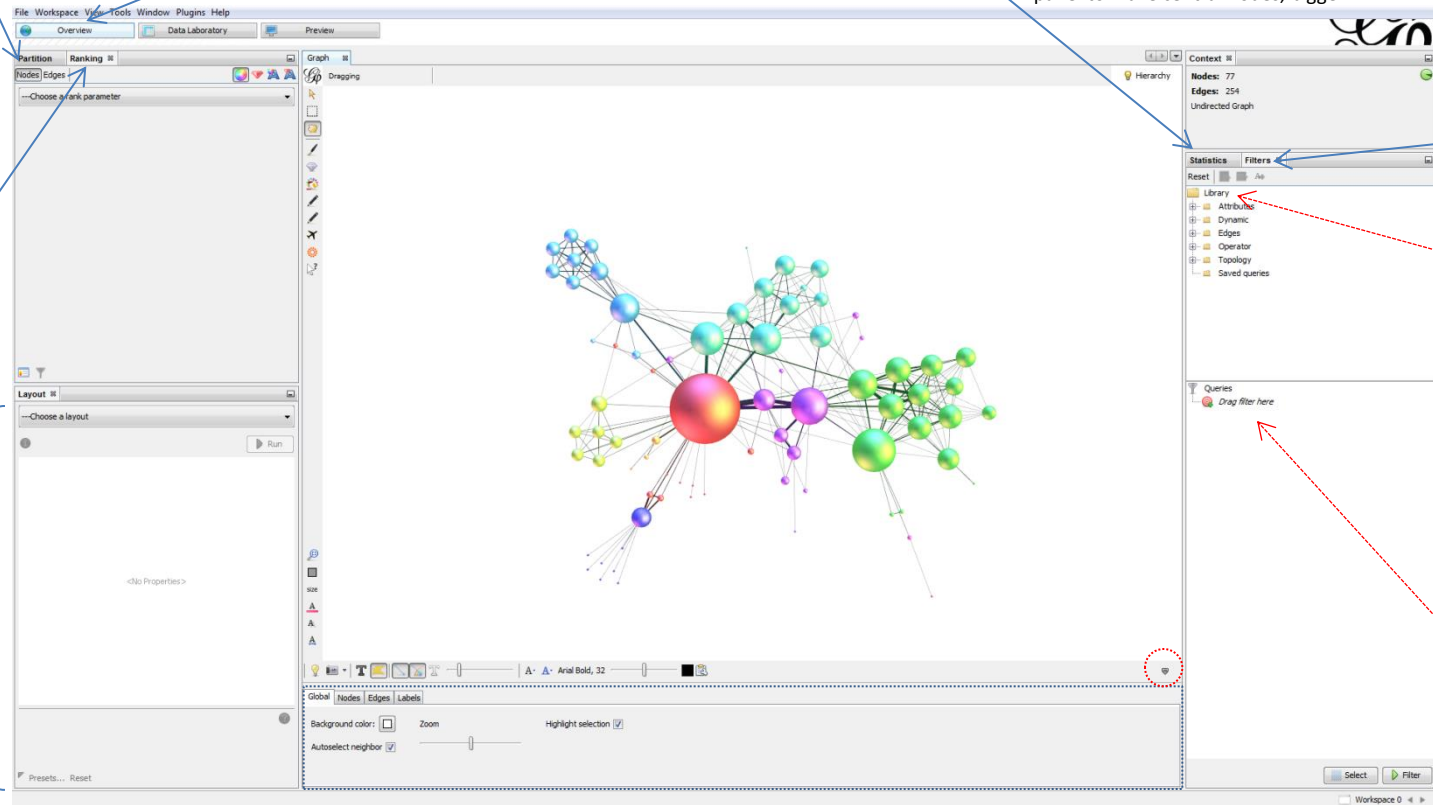<u>Computes metrics on the network</u>. These metrics are recorded, and can then be used to be displayed on the graph. Ex: compute the centrality of nodes. Then use the ranking panel to make central nodes, bigger.

Filters

To hide or display only part of the network. The "library" and its folders contain the filters. For example, filter out nodes which have less than 3 edges. Or filter out edges which have a weight above some value.
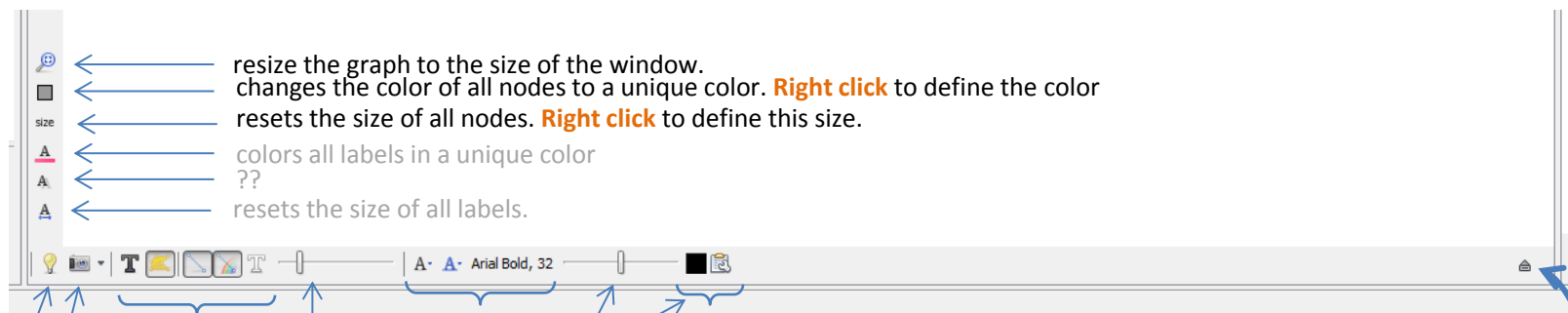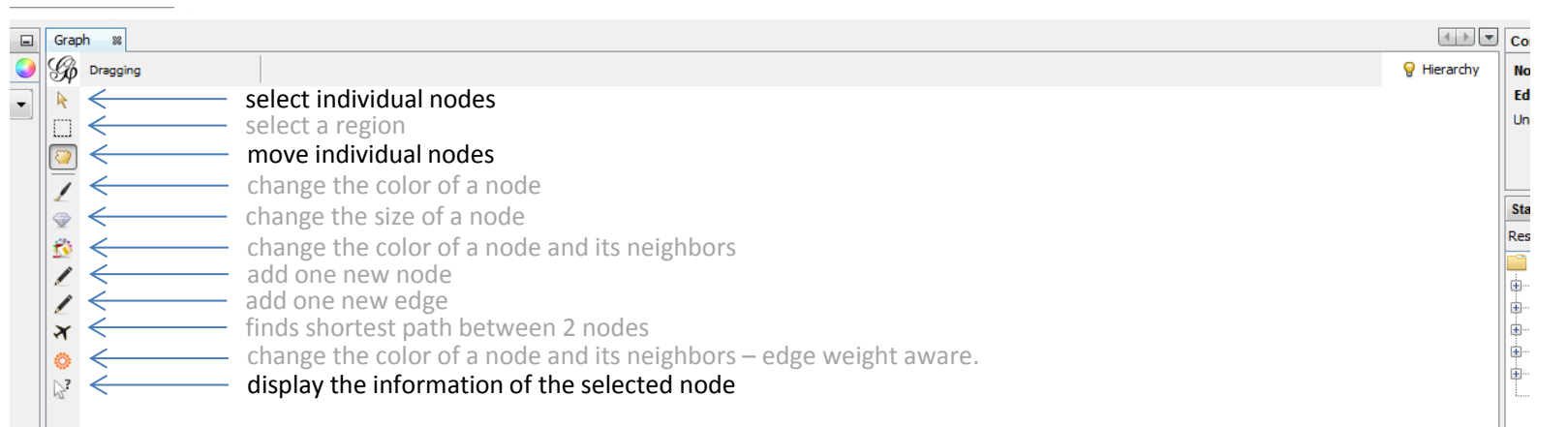
Drag and drop the filter you choose in the "queries" window. Several filters can be combined (ex: filter out male indiv. that have less than 3 connections to others).

Layout

<u>Changes how the network is spread on the screen.</u> Select one of the layouts in the drop-down menu and apply it to see how the position of nodes is changed.

General settings for the appearance of nodes, edges and labels

This box of settings can be shown / hidden with the little arrow circled in red on the top right. Here, you can set if nodes are visible in 2D or 3D, what is the default color of edges, etc. The "labels" tab is particularly useful: should they be displayed or not, and at which size.

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Gephi Cheat Sheet ②

Focus on the icons of the Overview panel

Functions which are less frequently used have been grayed out

Graph | Dragging | Hierarchy

- select individual nodes
- select a region
- move individual nodes
- change the color of a node
- change the size of a node
- change the color of a node and its neighbors
- add one new node
- add one new edge
- finds shortest path between 2 nodes
- change the color of a node and its neighbors – edge weight aware.
- display the information of the selected node

- resize the graph to the size of the window.
- changes the color of all nodes to a unique color. **Right click** to define the color
- resets the size of all nodes. **Right click** to define this size.
- colors all labels in a unique color
- ??
- resets the size of all labels.

A· A· Arial Bold, 32

1   **2**   **3**

change edge thickness

More label settings:

export a screenshot. **Click** the arrow for resolution settings

from left to right, switch on or off the display of:
- nodes labels
- hulls (not implemented yet)
- edges
- edge of the color of the source node
- edge labels

1, the 3 buttons on the left:
- label size – should it track the node size?
- label color – should it track the node color?
- label font

2, the slider: label size

3, the 2 buttons on the right:
- label color
- text to be displayed in the label

switch background color! (useful for prints)

How to memorize all these icons??

All these controls are also available with a more explicit description in the panel here.

Once you know these controls well, the icons are a quick way to access them.

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Gephi Cheat Sheet ③

The Data Laboratory

Where the numerical and textual data for nodes and edges can be examined and modified.

Import function

Opens a dialog window to import nodes and edges from a csv file into Gephi

To switch between views of nodes & edges

Extra columns

Each node can have extra information, besides its id and label.

This extra info is written in additional columns.

Example: here, each node is characterized by a number, recorded in a column we choose to call "Modularity class".

Columns can contain numbers, text or booleans (true / false).

3 default columns for nodes

<u>Node</u>: simply a copy of the label column (or the id if there are no labels).

<u>Id</u>: the unique identifier of the node

<u>Label</u>: the name of the edge which will be displayed next to it if we choose to.

Nodes	Id	Label	Modularity Class
Myriel	0	Myriel	0
Napoleon	1	Napoleon	0
MlleBaptistine	2	MlleBaptistine	1
MmeMagloire	3	MmeMagloire	1
CountessDeLo	4	CountessDeLo	0
Geborand	5	Geborand	0
Champtercier	6	Champtercier	0
Cravatte	7	Cravatte	0
Count	8	Count	0
OldMan	9	OldMan	0
Labarre	10	Labarre	1
Valjean	11	Valjean	1
Marguerite	12	Marguerite	1
MmeDeR	13	MmeDeR	1
Isabeau	14	Isabeau	1
Gervais	15	Gervais	1
Tholomyes	16	Tholomyes	2
Listolier	17	Listolier	2
Fameuil	18	Fameuil	2
Blacheville	19	Blacheville	2
Favourite	20	Favourite	2
Dahlia	21	Dahlia	2
Zephine	22	Zephine	2
Fantine	23	Fantine	2
MmeThenardier	24	MmeThenardier	7
Thenardier	25	Thenardier	7
Cosette	26	Cosette	6
Javert	27	Javert	7
Fauchelevent	28	Fauchelevent	4
Bamatabois	29	Bamatabois	3
Perpetue	30	Perpetue	2
Simplice	31	Simplice	2
Scaufflaire	32	Scaufflaire	1
Woman1	33	Woman1	1
Judge	34	Judge	3
Champmathieu	35	Champmathieu	3
Brevet	36	Brevet	3

Helper functions to quickly edit columns

EDGE VIEW

The Data Laboratory

Where the numerical and textual for nodes and edges can be examined and modified.

Import function

Opens a dialog window to import nodes and edges from a csv file into Gephi

To switch between views of nodes & edges

6 default columns for edges

<u>Source and Target</u>: the two connected nodes forming the edge.

<u>Type</u>: Is the direction of the edge meaningful?

<u>Id</u>: the unique identifier of the edge.

<u>Label</u>: the name of the edge which will be displayed next to it if we choose to.

<u>Weight</u>: how "strong" is the tie between the two nodes forming the edge? This is a numerical value.

Extra columns

Each edge can have extra information, besides its id and label, type and weight.

For example here, I added a column to characterize the connection between the 2 characters of the Miserables: friends or enemies in the novel?

Helper functions to quickly edit columns

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The Preview panel

Where you make final adjustments before exporting your visualization to an image file (PDF, SVG or PNG)
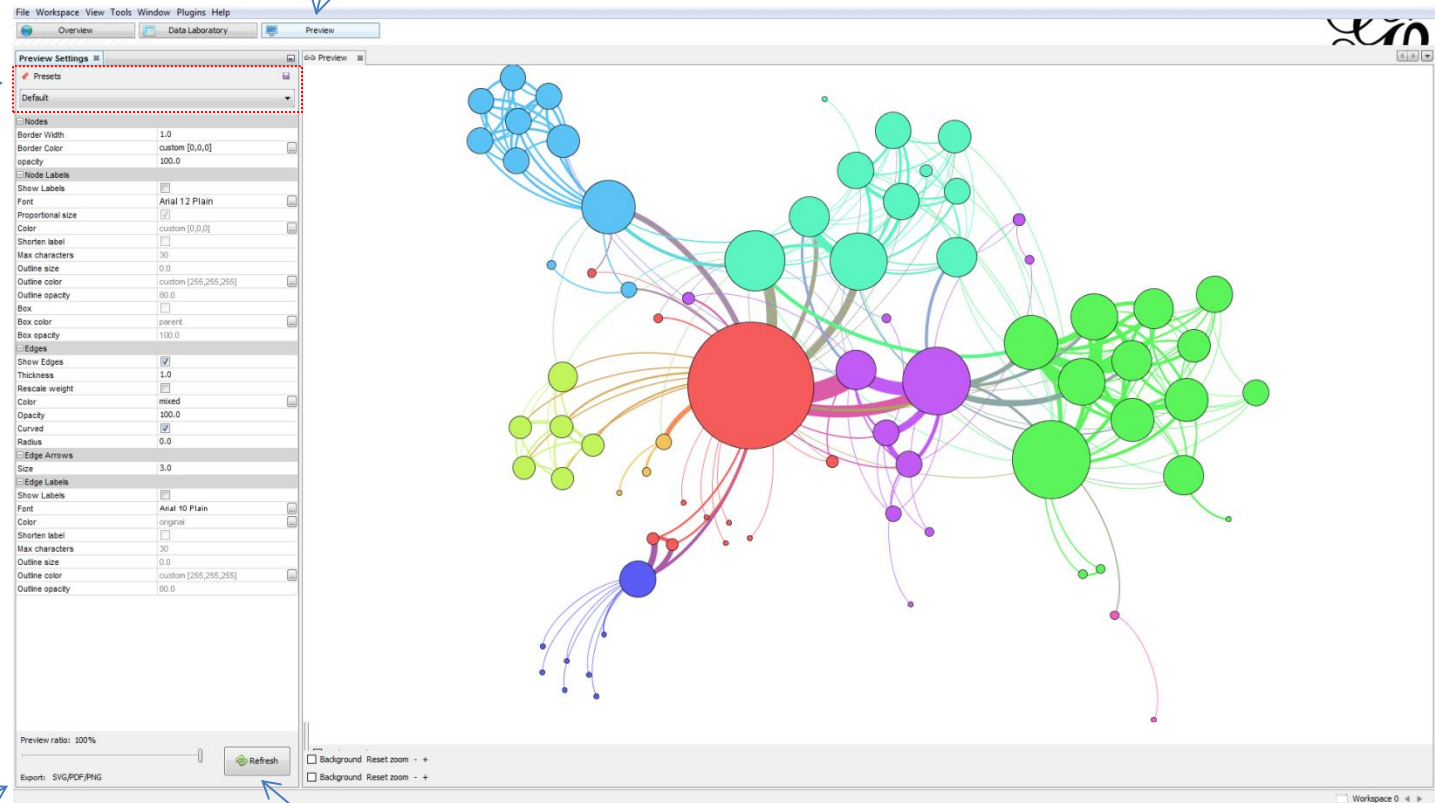

Load or save parameters

1. Setting the parameters

3. Export to a picture file format

2. Hit refresh!

After changing a parameter, you must hit "refresh" to see the effects.

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References

Bastian M., Heymann S., Jacomy M. (2009). *Gephi: an open source software for exploring and manipulating networks.* International AAAI Conference on Weblogs and Social Media. http://gephi.org/publications/gephi-bastian-feb09.pdf

Jacomy M., , Venturini T., Heymann S., Bastian M. (2014): "ForceAtlas2, a Continuous Graph Layout Algorithm for Handy Network Visualization Designed for the Gephi Software". Plos One, June 10. DOI: 10.1371/journal.pone.0098679

http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0098679

Noack A. (2009). "Modularity clustering is force-directed layout," *Physical Review E*, vol. 79(2).

Thorp J. (2013). Visualization as Process, Not Output. HBR Blog Network, April 3. http://blogs.hbr.org/cs/2013/04/visualization_as_process.html

Waltman L., van Eck N. J., Noyons E. C.M. (2010). "A unified approach to mapping and clustering of bibliometric networks", Arxiv, http://arxiv.org/abs/1006.1032

Flight patterns

http://www.aaronkoblin.com/work/flightpatterns/

Scott Weingart on pitfalls of reading networks:

http://www.scottbot.net/HIAL/?p=39600

Force-based algorithms for network layouts:

T. Kamada and S. Kawai. An algorithm for drawing general undirected graphs. Inform. Process. Lett., 31:7–15, 1989.

Fruchterman, Thomas M. J.; Reingold, Edward M. (1991), "Graph Drawing by Force-Directed Placement", *Software – Practice & Experience* (Wiley) **21** (11): 1129–1164,doi:10.1002/spe.4380211102.

Y. F. Hu, Efficient and high quality force-directed graph drawing. The Mathematica Journal, 10 (37-71), 2005. (high resolution version (30 MB))

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