K-partite and Bipartite Graph

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Table of Contents

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K-partite, Bipartite ... What is it ?

Most of the time, when you create a graph, all the nodes are representing the same « kind » of object.

- In a Social Network : Persons

- In a Route Netowork : Bus Stops, Airports, Stations etc...

- In a Geographical Network : Countries

But sometimes, you will encounter graphs that will have 2, 3 or multiple « kinds » of nodes where the links are almost exclusively going from one type to the other. These graphs are called **Multipartite Graphs** :

- If you have **2** kinds of nodes, it's a **Bi**partite Graph (or **2**-partite)

    - Example : Social Network : Persons < - > Companies

- If you have **3** kinds of nodes it's a **3**-partite Graph

    - Example : Movie Network : Actors < - > Movies < - > Movie Companies

- If you have **k** kinds of nodes it's a **k**-partite Graph

If you want a proper scientific definition, you can check the Wikipedia page about the subject.

The Dataset

We will use a well known data set : The Cac 40 Administrators relationship from www.citoyennumerique.fr.

The files for Gephi are accessible here : Gexf files

The tutorial will be based on the **SimpleGraph**, but you also have access to the **FullGraph** to play with.

The CAC 40 represents the 40 most valuable company on the french stock market. A **company** has several **administrators** and nothing prevent an **administrator** to be in multiple **companies**. So

the graph is build such as **companies** are sources of edges and targets are the **administrators**.

This is a typical bi-partite graph. If you look on the data, part of the node has a property type **Administrator** and the other part has a property type **Company**.
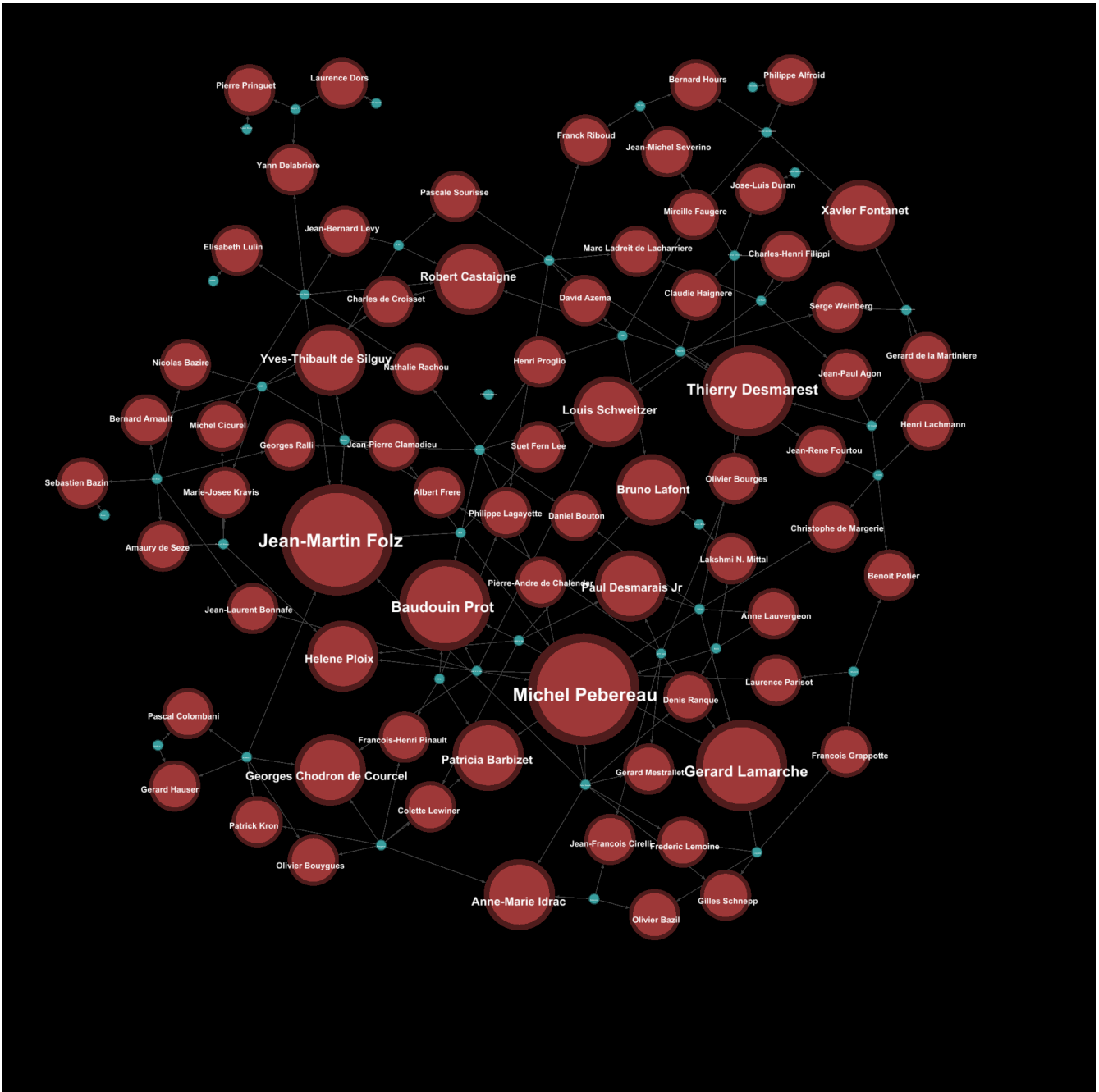
We can get quick observations:

- Filtering by InDegree, we can check that Michel Pebereau and Jean-Martin Folz are in **5 companies** at the same time.
- Filtering by OutDegree, we can check that St-Gobain and Total have **8 administrators** that are in other companies.

But that could be done without graph, an ordered list on excel would have done the job.

How to deal with multipartite graphs ?

Having a k-partite graph makes somehow the graph unfriendly to read. Usually, the metrics will be difficult to interpret, and generating a good visualisation from it won't be trivial.

One method here is to **reduce** the **bi-partite** graph into a **mono-partite** graph.

> By reducing, we will « lose » information but we gain in **readability** and **synthesis**, that's part of the work in data visualisation to see at which level we want to go and how to deal with this trade of information. This will mostly be driven by the question you want to answer.

The principle of the reduction is to consider a type of **nodes** as **edges** and build a new graph based on this rule. In our example we have 2 ways to go :

- Either we decide that the nodes of type « Company » are the edges. It will generate a "**graph** of **Persons** "
- Either we decide that the nodes of type « Person » are the edges. It will generate a "**graph** of **Company** "

> Here both graphs generated makes « sense » (network of entities) but it might appears that in some other case, one of the generated graph won't really be 'interesting'. That's part of your work to judge this aspect.

Now, how to perform the transformation ?

Using a Plugin

The easiest way is to use the Multimode Network Transformation plugin. The plugin is available on the Gephi app market and in the plugin manager in Gephi.

It is authored by Jaroslav Kuchar
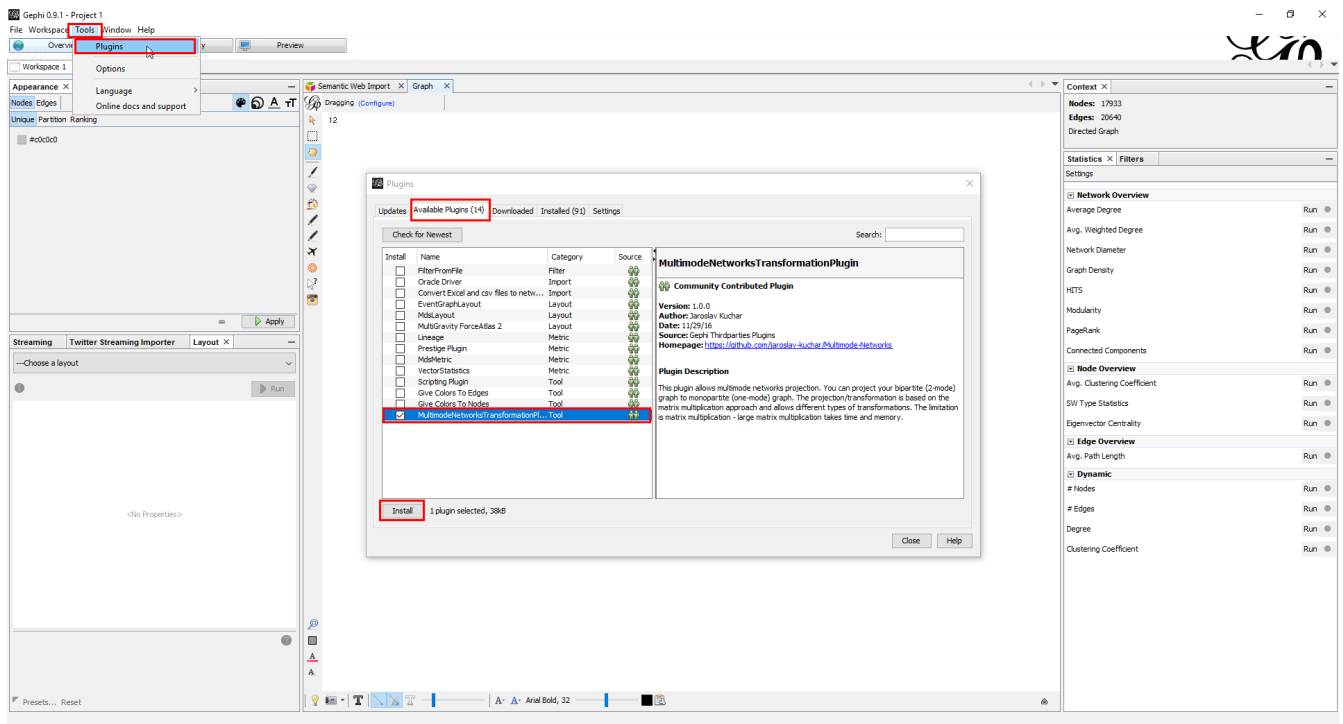
When it's installed, you should be able to see or display the **Multimode Network Transformation** tab.

Then, load the graph and :

- Click on **Load Attributes** and select **Type** on **Attribute Type**.
- For left matrix select **Administrator – Company** and right matrix **Company – Adminstrator**
- Enable **Remove Edges** and **Remove Nodes**, and Click** Run

> The plugin will modify directly the graph on the current workspace. If you want' to keep the original graph, be sure you've done a clone of your workspace.
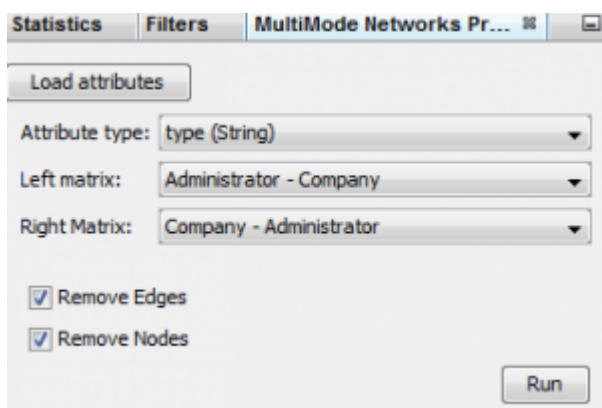
The plugins will actually to transform each relation like:

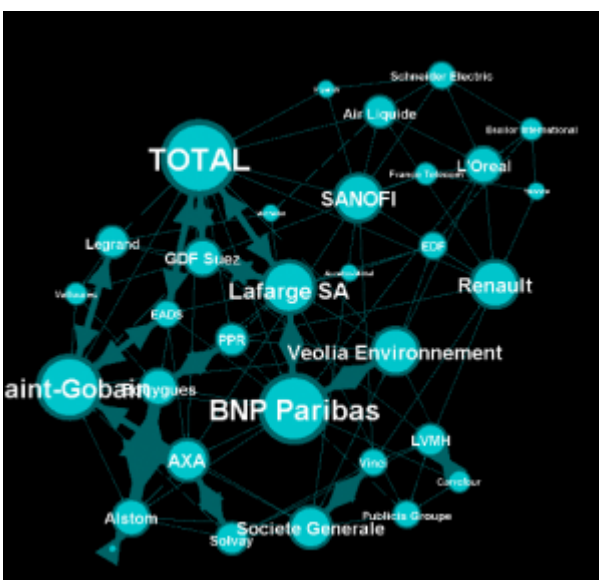$(Administrator) \leftarrow (Company) \rightarrow (Administrator)$

to

(Administrator)←**[{weight=Nb of Common Companies}]**→(Administrator)

Now you should have a graph with only administrators on the graph preview.

To generate the relation between companies, replay the same steps from the original graph (duplicate the workspace0 again) and in the **Multimode Network Transformation** use :

- Left Matrix : Company – Administrator
- Right Matrix : Administrator – Company

With the 2 new graphs, and playing with the weighted degree of the nodes, we are able to see some particularities:

- The maximum of **common administrator** between company is **3** : Bouygues and Alstom with Olivier Bouygues, Patrick Kron, Georges Chodron de Courcel

- **Half of the companies** are sharing at least 2 administrators .

- The maximum of **common company** between person is **3** : Gerard Lamarche and Paul Demaray Jr see each other when Total, GDF

Suez and Lafarge SA have a meeting with Board of Directors. *   From all administrators that are in at least 2 companies, **1/3 of them are at least in the *same* 2 companies**.

Theses statements could have been deduced from the original graph, but now, the information is more visible and accessible, especially if you want to share it to a large public.

> The works now is mostly to look at graphs, and resume all the particularities within a production (poster, interactive graph, newspaper etc...)

Limitations

The plugin works quite well, but sometime it has some limitation on large graph. Or sometime you may want to reduce your graph and have a custom metric computed. Then the only alternative to that is to use a script that will generate you the graph.

Conclusion

Multipartite graph are complex to analyse, but synthesising it to lower partite graphs gives you more vision to get insight about your data.