Introduction to Network Visualization and Analysis

Márton Ölbei

September 30, 2021

1. **Setting up**
   Download the practice materials from the GitHub repository (`https://github.com/olbeimarton/PPKE_course`), and open a New Session in Cytoscape.

   DummyNetwork.cys

2. **Importing networks from files:**

   2.1. Import the *DummyNetwork.cys* file as a network

   File → Open...

3. **Wrangling your data:**

   3.1. Before we start visualizing our data, it is preferable to get it into a shape where we can really focus on the phenomenon we would like to study. To do this Cytoscape lets you *Merge* and/or *Filter* your data.

   3.2. **Filtering**: Click on the *Select* tab of the Control Panel, and look at the settings. You can save and create filters that you can apply quickly to your networks later on.

   3.3. Try filtering your data. Click on the '+' icon, select *Column filter* and select a field you want to filter your data on, e.g. *organism*.

   Select → + → Column Filter

   3.4. Cytoscape also lets you perform set operations on you tables or networks (union, intersect, merge). To do this, select Tools, and click on the Merge option.

   Tools → Merge → Networks.../Tables...

   3.5. A common problem is having the nodes of your network annotated with an ID type you cannot match a different dataset on. Thankfully there is now a built-in ID mapper in Cytoscape. To use it, right click on the column header of the nodes you want to map from (e.g. canonicalName), and select *Map column* from the options.

   Right click on node table coulm header → Map column ...

4. **Styles**

   4.1. One of the strongest points of Cytoscape are its easy to use and versatile visualization options. We can use preset styles for our network or create our own.

   Click on the Style tab in the Control Panel

   4.2. On the Style panel you can see three columns on the left side for each property: Default, Mapping and Bypass.

   4.2.1. **Default**: sets the default value for all entities, a global setting

4.2.2. **Mapping**: discrete mapping lets you set a visual encoding for all values separately,
continuous mapping allows you to set an encoding (e.g. colour) along a function (i.e. from white to black, from small to large)
passthrough mapping is mostly used at names, it uses the value in the selected column as output

4.2.3. **Bypass**: bypass overwrites the former two and allows you to manipulate / highlight values manually

4.3. **Customizing styles**

4.3.1. Make sure the *Node* tab is selected on the bottom of the Control Panel.

4.3.2. Change the default colour of the nodes.

4.3.3. Change the default size of the nodes.

4.3.4. Colour part of the network manually using **bypass**.

4.3.5. Select the **Edge** tab on the bottom, and change the edge thickness.

4.3.6. Select the **Network** tab on the bottom, and change the background colour

4.3.7. Save the style you created. These can be re-used any time.

Click on the drop-down menu→ Create new style

Delete the existing mapping settings from the Style

4.4. Create a clear style for the nodes and edges.

5. **Expression analysis example**

5.1. A very common network analysis involves overlaying expression values over your nodes, making our network context specific. Our DummyNetwork has three expression value columns (with completely made up data). Try to visualize the differences in expression.

5.2. Make sure the *Node* tab is selected on the bottom of the Control Panel.

5.3. Try changing the colour of the nodes according to one of the expression values using **continuous mapping.**

5.4. Try selecting a different layout to help exploration. Try multiple ones: Prefuse Force Directed, Group Attributes.

6. **Network clustering** We are going to install a network clustering app from the Cytoscape app store, and use it on our networks, to get closely connected subgraphs of our data.

6.1. Open up the Cytoscape app store menu in Cytoscape.

6.2. Search for MCODE and click on install.

6.3. Once installed, the app is available from the "Apps" menu.

6.4. Select MCODE. We are going to cluster our network with the default settings.

6.5. On the resulting page, select the clusters to select their corresponding nodes in the network.

7. **Anti-pattern search**

   How you visualize a network is really context dependent, it is hard to define best practices that fit all cases. Because of this we are going to do the opposite. In the next 10-15 minutes try to create the *ugliest* layouts you possibly can. This is a good way to find out what works for you and what does not.

Try out every option you can find. There are no wrong answers!

Useful links:

1. Up-to-date Cytoscape user manual: `http://manual.cytoscape.org/en/stable/`
2. Tutorials: `https://github.com/cytoscape/cytoscape-tutorials/wiki`
3. Cytoscape main webpage (downloads, apps): `http://www.cytoscape.org/`
4. Tamas' e-mail address: Tamas.Korcsmaros@earlham.ac.uk
5. Marton's e-mail address: Marton.Olbei@earlham.ac.uk
6. Accompanying GitHub repository: `https://github.com/olbeimarton/PPKE_course`