Cytoscape Training:
Biological Network Analysis

6th Annual Cytoscape Retreat

Donnelly Centre for Cellular and Biomolecular Research,
University of Toronto, Canada

Friday 18th July, 2008

Yeyejide Adeleye

Safety & Environmental Assurance Centre
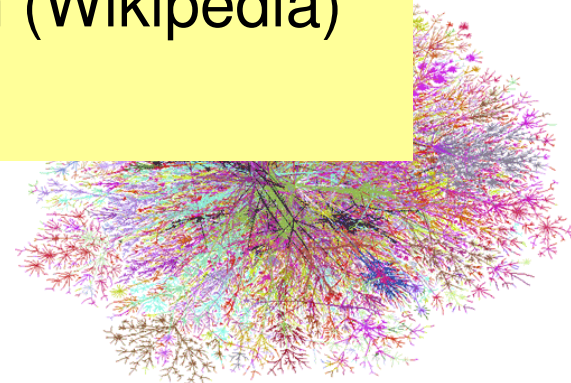
Unilever

Schedule of Training

Introduction

A large system consisting of many similar parts that are connected together to allow movement or communication between or along the parts or between the parts and a control centre
(Oxford English Dictionary)

In general, the term network can refer to any interconnected group or system (Wikipedia)
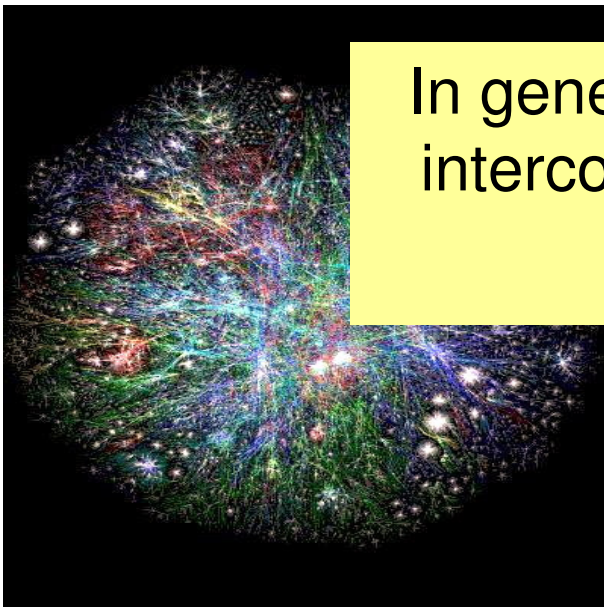
Introduction

- Typically made up of nodes (vertices) and edges (arcs)

- Directed and Undirected

- Nodes (determines what type of network)
    - People
    - Bio-molecules
    - Computers
    - Processes
    - Applications
    - Concepts
    - (Anything you want)
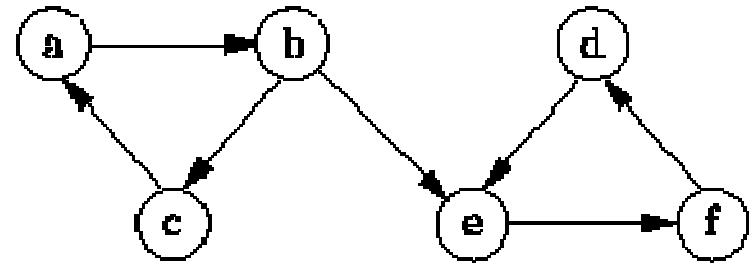
Introduction - Terms

- **Degree**
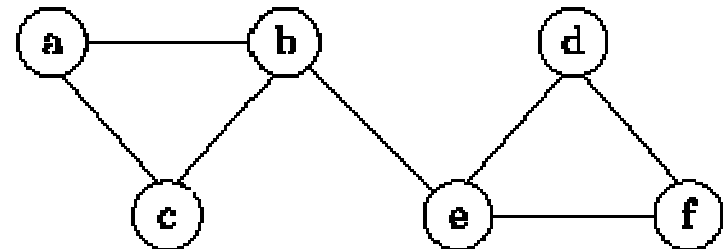 - How many connections a node has
- **Attributes**
  - Information associated with a node or an edge
  - Example
    - nodes on our colleagues social network are coloured according to their own networks within FaceBook
      - Gayle is a node and the attribute is London
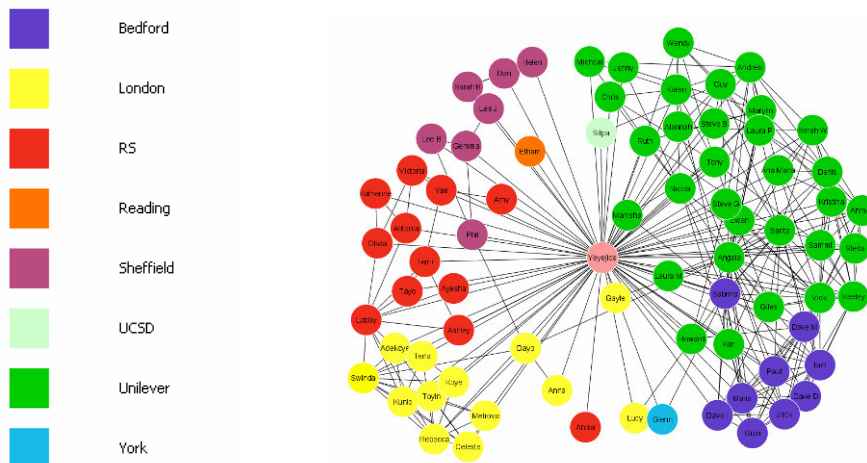
Cytoscape

- Two factors are important
- Visualisation
- Analysis
- Cytoscape
  - www.cytoscape.org
  - Open source
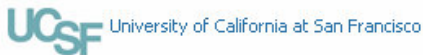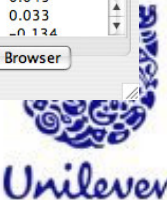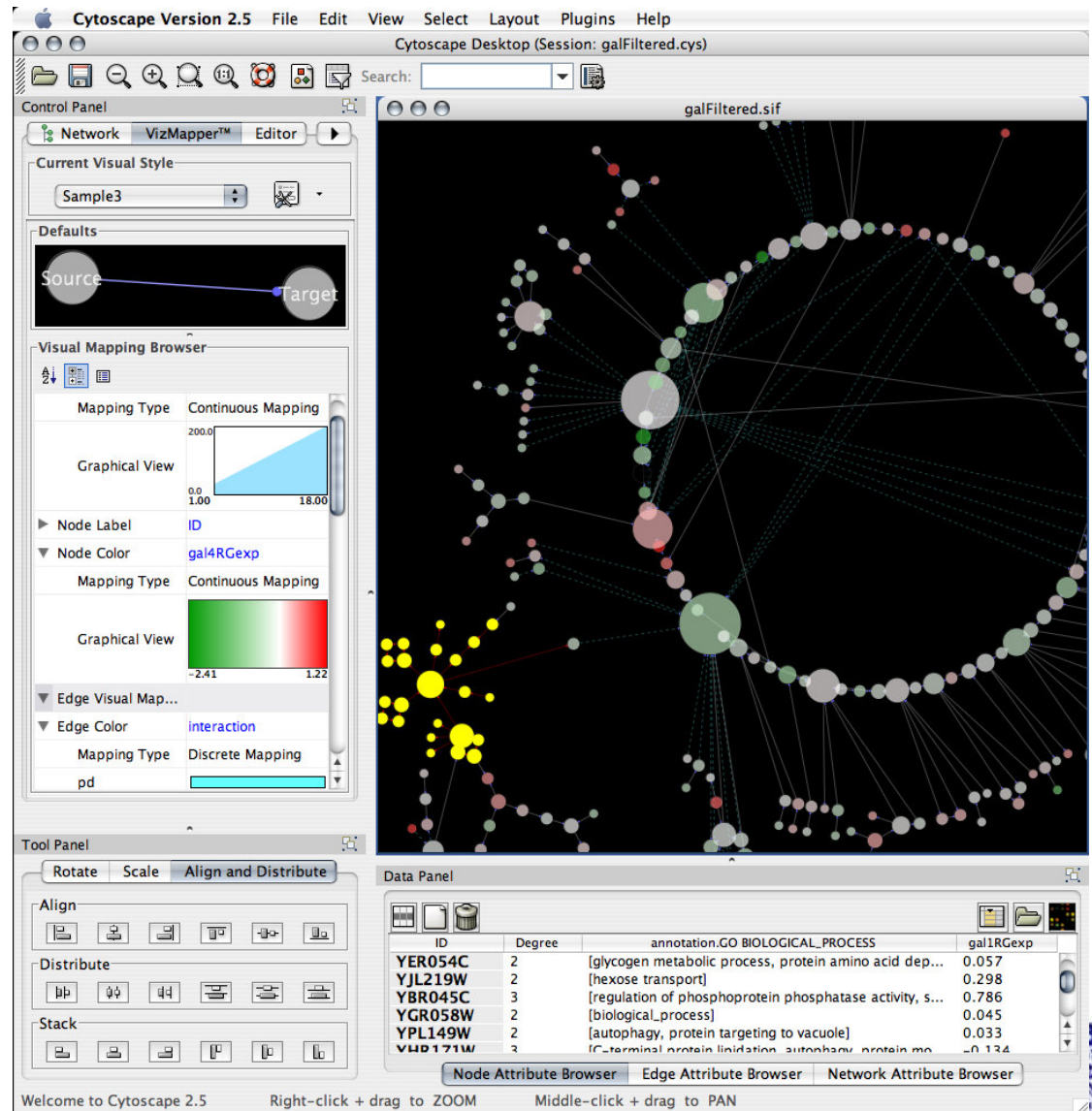
1. Introduction to Cytoscape Software

1.1 Cytoscape Layout and User Interface
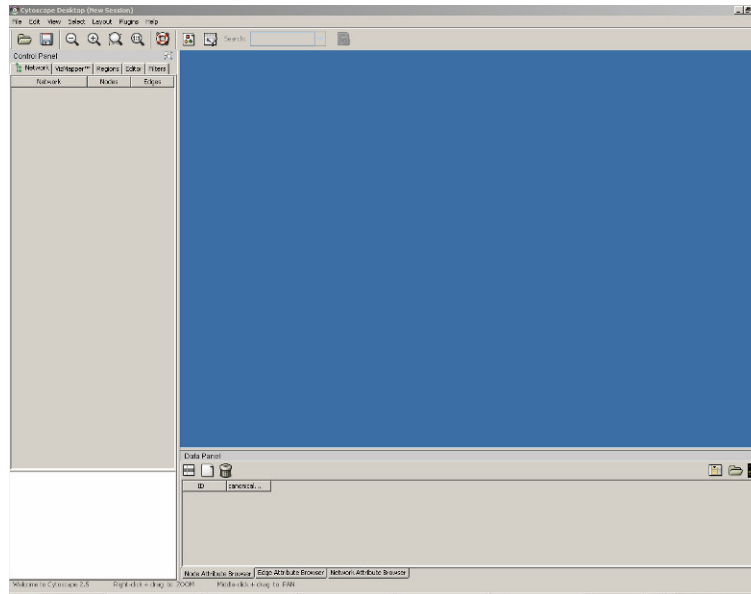
1.2 Loading Networks
1.3 Cytoscape menus
1.4 Manipulating Networks
1.5 Plug-ins

2. Constructing and Loading Biological Networks into Cytoscape

2. Constructing and Loading Biological Networks into Cytoscape

2.1 Importing network files into Cytoscape

- Cytoscape can read network/pathway files written in the following formats:
  - ‣ Simple interaction file (SIF or .sif format)
  - ‣ Graph Markup Language (GML or .gml format)
  - ‣ XGMML (extensible graph markup and modelling language).
  - ‣ SBML
  - ‣ BioPAX
  - ‣ PSI-MI Level 1 and 2.5
  - ‣ Delimited text table and Excel

2.2 Importing text or Excel files
2.3 Creating an empty network and manually adding nodes and edges
2.4 Fetching data from external sources

2. Constructing and Loading Biological Networks into Cytoscape

2.1   Importing network files into Cytoscape
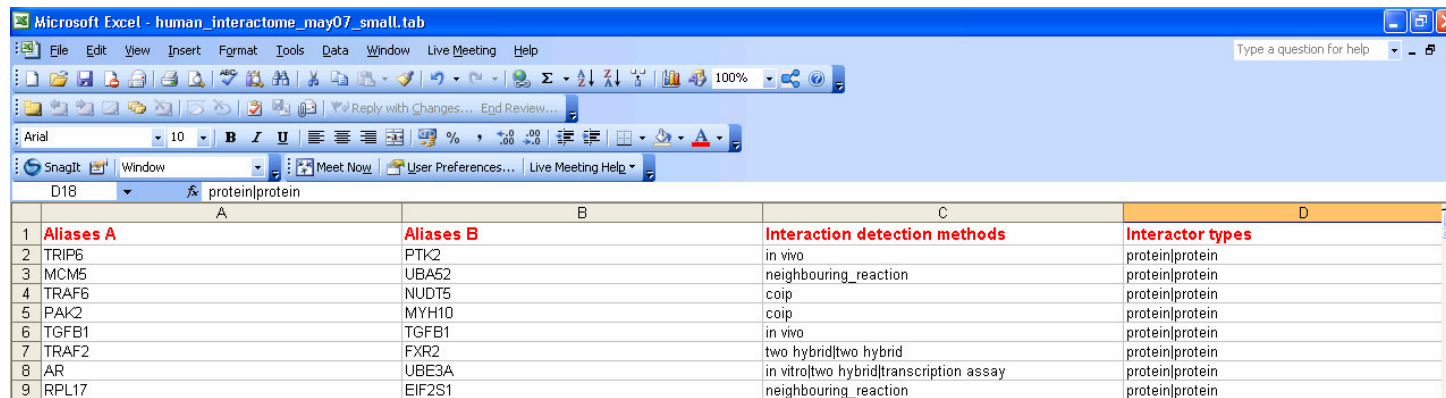
2.2   Importing text or Excel files

2.3   Creating an empty network and manually adding nodes and edges

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2. Constructing and Loading Biological Networks into Cytoscape
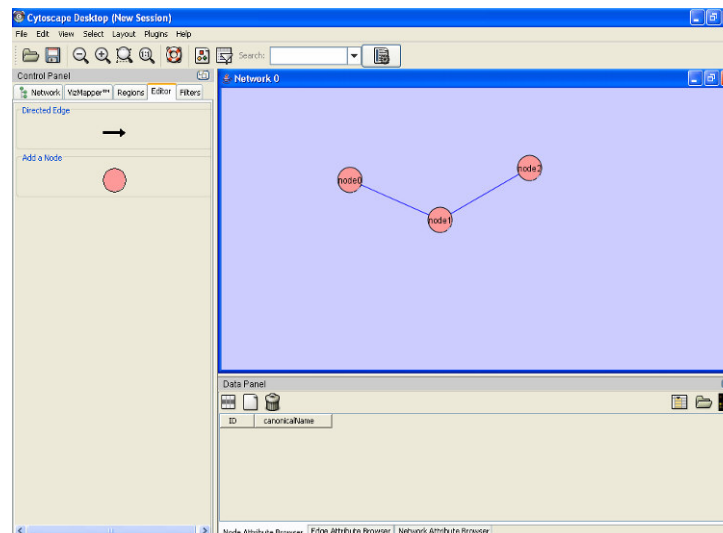
3. Working with Attributes
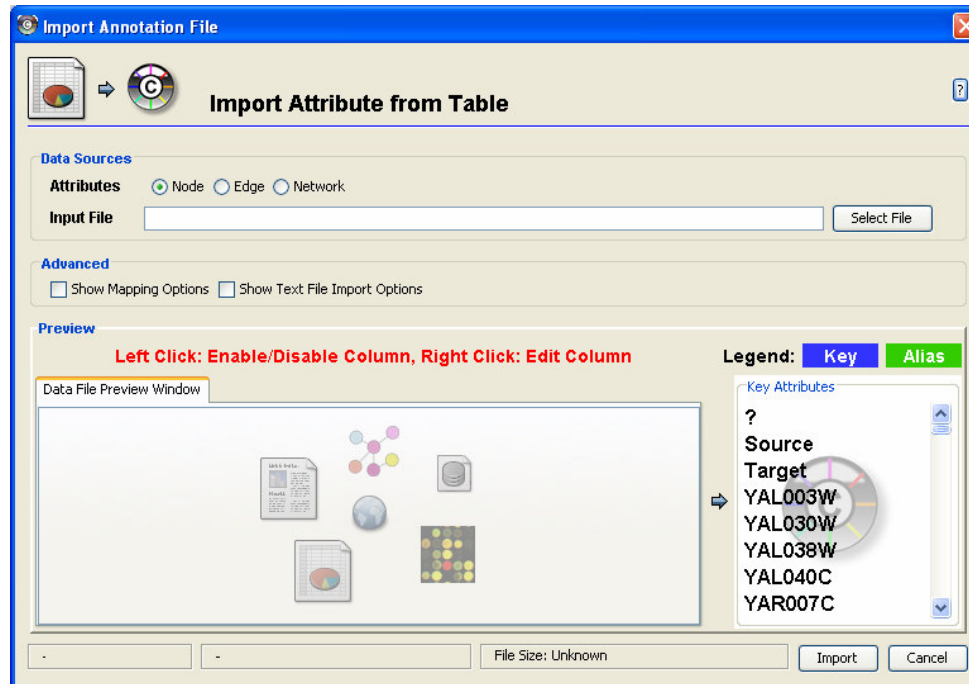
3.   Working with Attributes
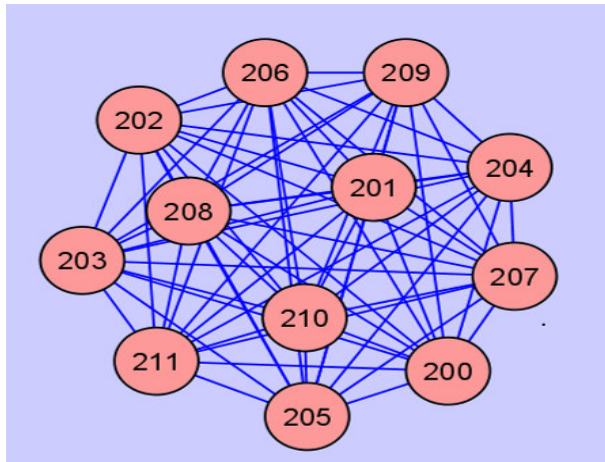
Ok for Cytoscape but
means nothing!
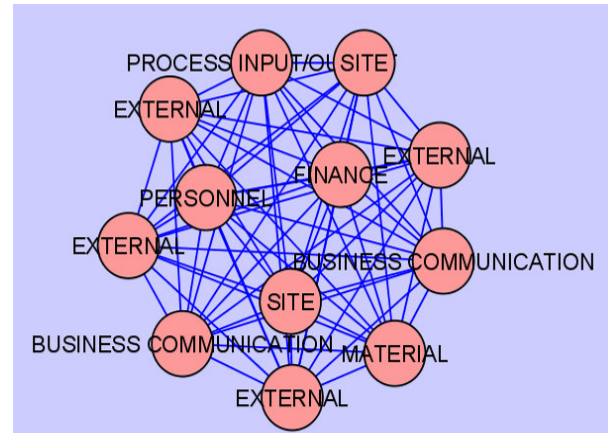
Much better!

4.   Working with 'Expression Data'

- Cytoscape also supports importing gene expression data (and any other molecular state data)

- ***PLEASE NOTE***: DNA microarray data will be used as an example in this section of the tutorial however other types of data can be used

- Gene expression data are imported using a different file format than normal attributes

5   Customising Visualisation of Networks

5.1   The basics of VizMapper in Cytoscape

5.2   Different types of Visual Mapping in Cytoscape

5.3   VizMapper Examples

5.3.1   Example 1 – Creating a basic visual style and setting default values

5.3.2   Example 2 – Creating a New Visual Style with a Discrete Mapper

5.3.3   Example 3 - Visualizing Expression Data on a Network

5.3.4   Example 4 – Visualizing Expression Data on a Network (Continuous-Continuous Mapper)

5.4   Other aspects of visual styles

Visual Styles (VizMapper)
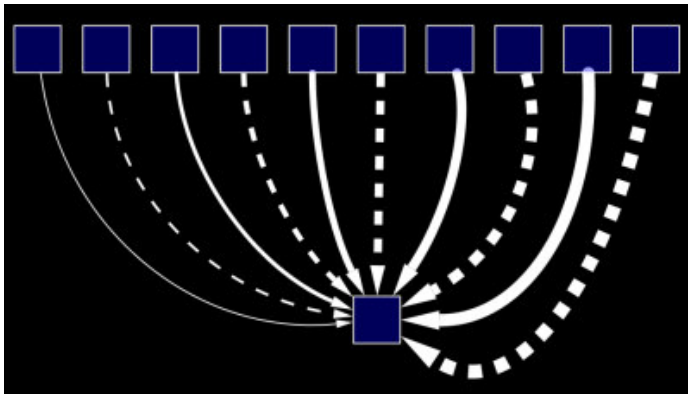
Use specific line types to indicate different types of interactions
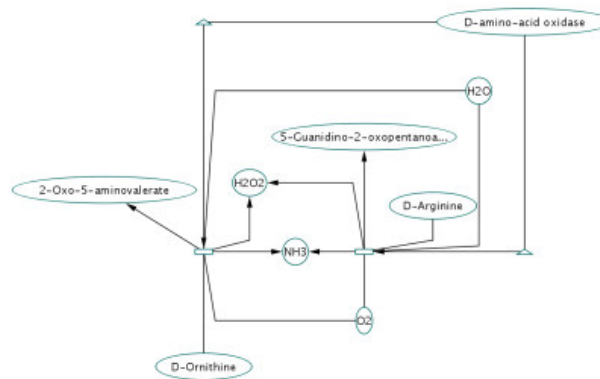
Encode specific physical entities as different node shapes.
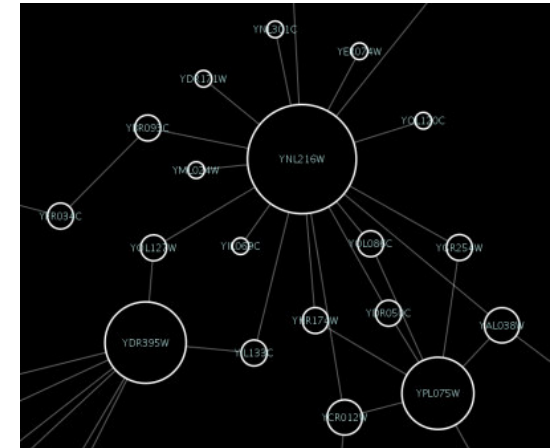
Set node sizes based on the degree of connectivity of the nodes.
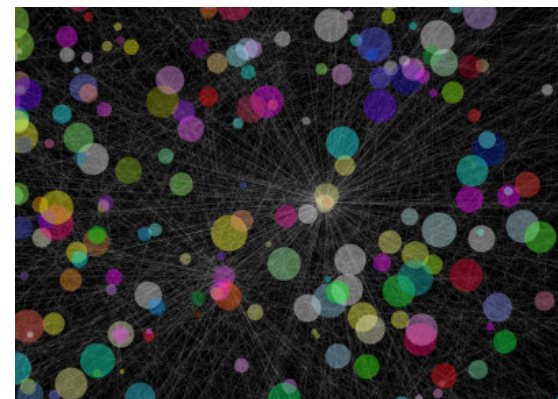
Browse extremely dense networks by controlling for the opacity of nodes
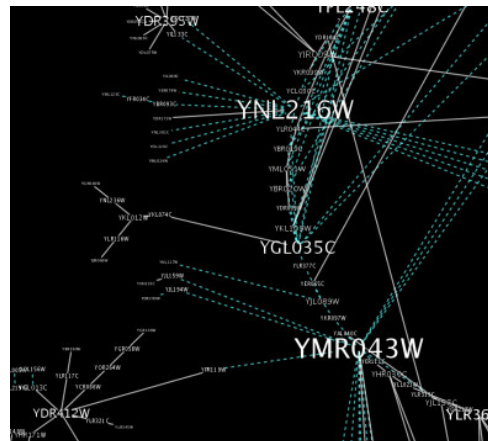
Set node font sizes based on the degree of connectivity of the nodes.
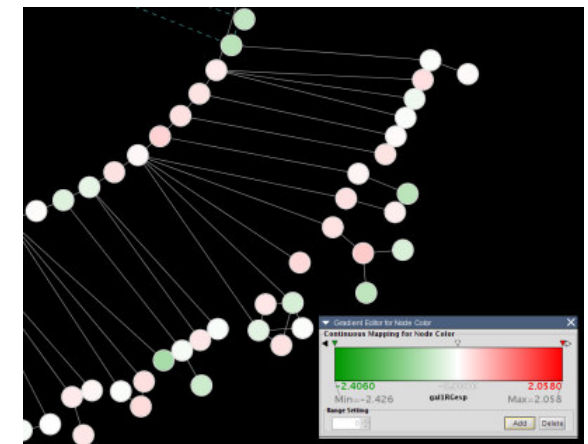
Expression data

Visual Styles (VizMapper)

- The Cytoscape VizMapper uses three core concepts:
  - **Visual attribute** is any visual setting that can be applied to your network
    - ‣ For example, altering nodes from circles to squares by changing the node shape visual attribute.
  - **Network attribute** is any data attribute associated with a node or an edge.
    - ‣ For example, each edge in a network may be associated with a label, such as "pp"
  - **Visual mapper** maps network attributes to visual attributes.
    - ‣ For example, a visual mapper can map all pp interactions to the colour blue,

Visual Styles (VizMapper)

- Cytoscape allows a wide variety of visual attributes to be controlled. Examples include:
  - Nodes
    - ‣ Node Colour
    - ‣ Node Opacity
    - ‣ Node Border Colour
    - ‣ Node Shape
  - Edges
    - ‣ Edge Label: the text label for each edge.
    - ‣ Edge Label Colour
    - ‣ Edge Label Opacity
  - Global Visual Properties
   - ‣ Background Colour
    - ‣ Selected Node Colour
    - ‣ Selected Edge Colour

Visual Styles (VizMapper)

- For each visual attribute, you can specify a default value or define a dynamic visual mapping. Cytoscape currently supports three different types of visual mappers:
- **Pass-through Mapper**
  - The values of network attributes are passed directly through to visual attributes.
    - ‣ Only used to specify node/edge labels. Discrete Mapper
- **Discrete network attributes**
  - Mapped to discrete visual attributes.
    - ‣ For example, a discrete mapper can map all 'Microbiology' interactions to the colour blue.
- **Continuous Mapper**
  - Continuous graph (usually numerical) attributes are mapped to visual attributes.

Visual Styles (VizMapper)

■ Accessed via the tool bar

■ Control Panel

■ View-> Open Vizmapper
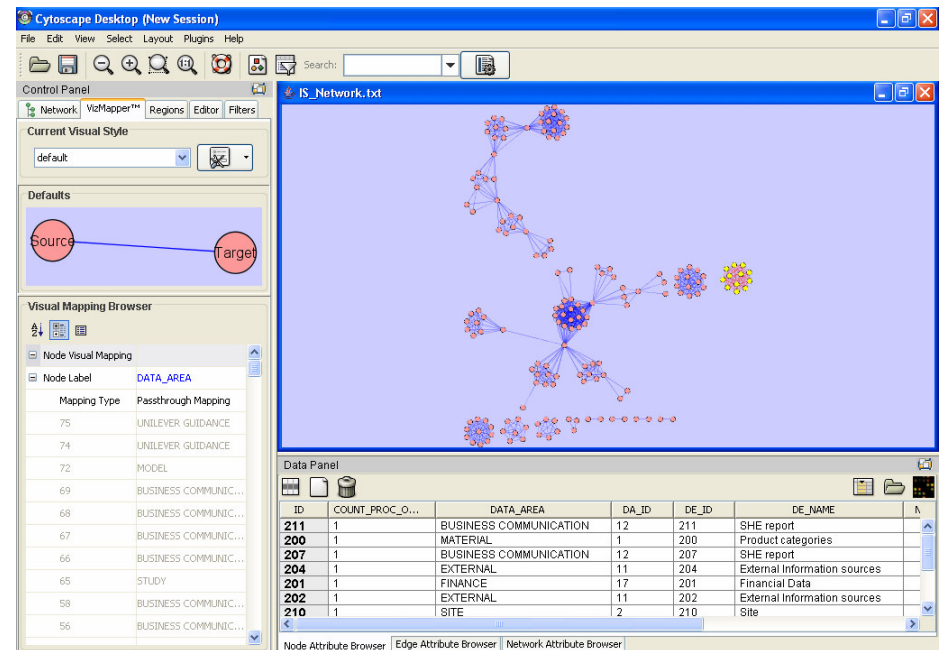
Visual Styles (VizMapper)
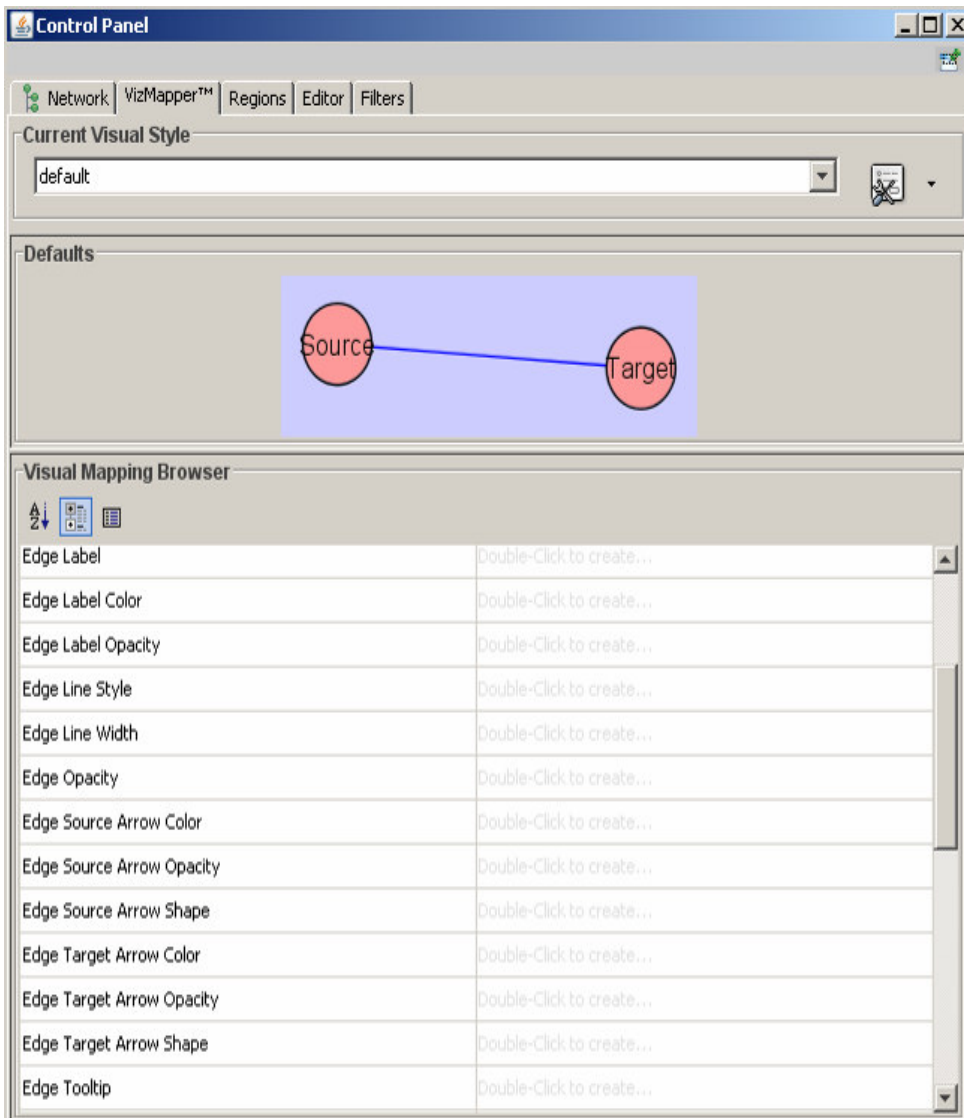
- **Current Visual style**
  - This panel allows you to create/delete/view/switch between different visual styles
- **Defaults Appearance Style**
  - Visually edit the default appearance of nodes and edges for the selected visual style.
- **Visual Mapping Browser**
  - Displays the mapping details for a given visual style and is used to edit these details as well.

Managing Visual Styles

- Styles are automatically saved when you save a session
- It is also possible to save your visual styles in a file separate from the session file.
  - File → Export → Vizmap Property File menu option and save the properties as a file.
    - ‣ This feature can be used to share visual styles with other users.
- Importing visual Styles
  - File → Import → Vizmap Property File menu option and select a vizmap.props file.
- Imported properties will supplement existing properties or override existing properties if the properties have the same name.

6   Filtering and Searching Networks

6.1   Quick Find

6.2   Filters

6.3   Finding 'Active' Sub-networks (jActiveModules)

6   Filtering and Searching Networks

- Powerful feature of Cytoscape
- Quickly select multiple nodes or edges of interest. For example:
  - You can select all the nodes whose name contains a specific pattern
  - Select nodes whose numeric attribute value falls within a certain range.
- Users can perform complex selection by
  - Defining basic filters (selection based on a single attribute)
  - Defining compound or Boolean filters (combining basic filters for selection based on multiple attributes).

Quick Find

- Cytoscape includes a Quick Find feature, which enables you to quickly find nodes and edges

- Matching nodes/edges within the network will be highlighted and zoomed in

Filters

- Click on the filter icon on the tool bar

- Alternatively click on the **Filters** tab on the **Control Panel**

- Or Select-> Use filters

- Steps
  - Create a Filter
  - Select the attribute you wish to filter on
  - Set the attribute values
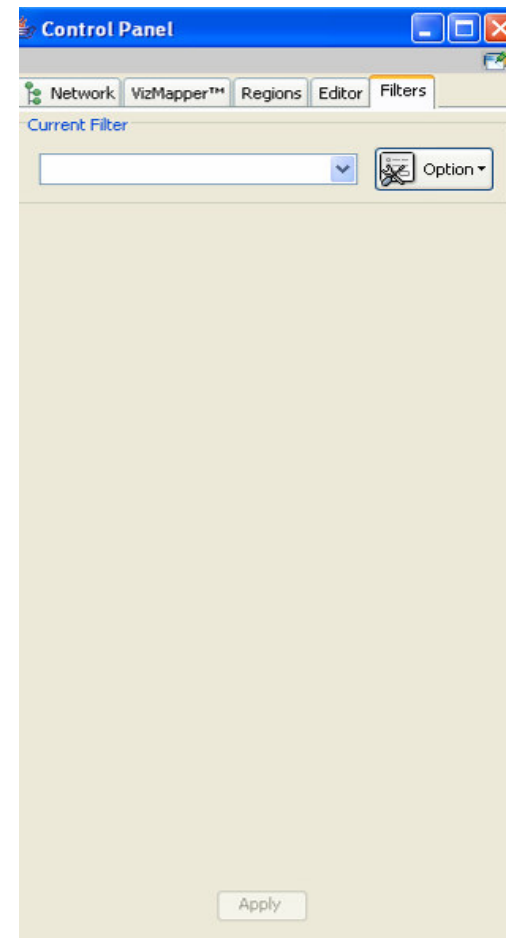
More Info

- Plug-ins
- Information
  - www.cytoscape.org
  - Online Help manual
  - Of course feel free to contact us if you need any more help!!
  - Course notes, tutorials and data will be posted

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Schedule of Training

Acknowledgements

- Cytoscape Development Team
- Unilever Bioinformatics Team

Thank you

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