

Cytoscape Training: Biological Network Analysis

5th Annual Cytoscape Retreat & Public Symposium

AMC, University of Amsterdam, Netherlands

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Guy Warner & Andrew Garrow

**Safety & Environmental
Assurance Centre**



Schedule of Training

- 1. Introduction to Cytoscape Software**
 - 1.1 Cytoscape Layout and User Interface
 - 1.2 Loading Networks
 - 1.3 Cytoscape menus
 - 1.4 Manipulating Networks

- 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
 - 2.4 Fetching data from external sources using other databases
 - 2.5 Saving Sessions

- 3. Working with Attributes**
 - 3.1 Importing Node Attributes
 - 3.2 Viewing Attributes
 - 3.3 Deleting Attributes
 - 3.4 Editing Attributes

- 4. Working with Data**
 - 4.1 File format
 - 4.2 Loading Expression Data

- 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 – How to Use Utilities for Discrete Mappers*
 - 5.4 Other aspects of visual styles

- 6. Filtering and Searching Networks**
 - 6.1 Quick Find
 - 6.2 Filters
 - 6.3 Finding Complexes



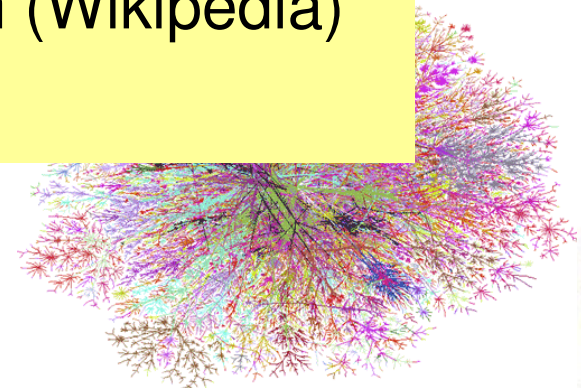
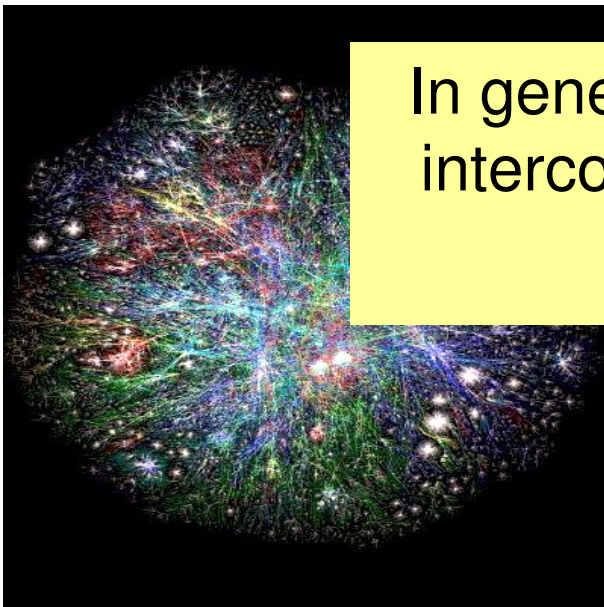
Introduction



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)

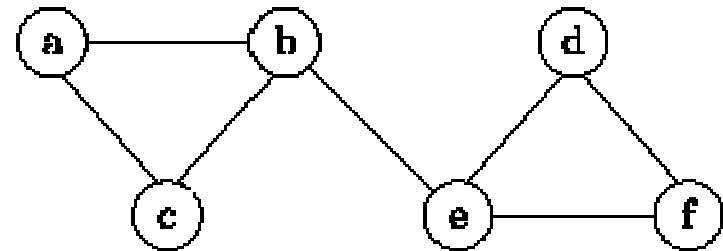
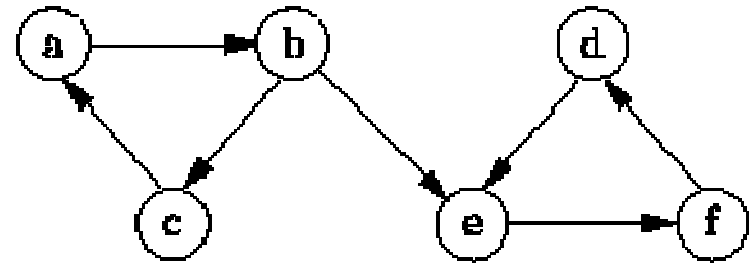
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In general, the term network can refer to any interconnected group or system (Wikipedia)



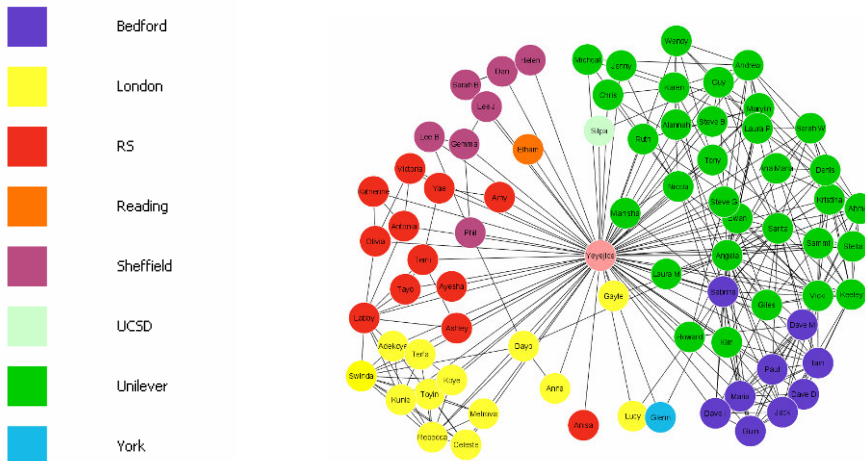
Introduction

- 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)



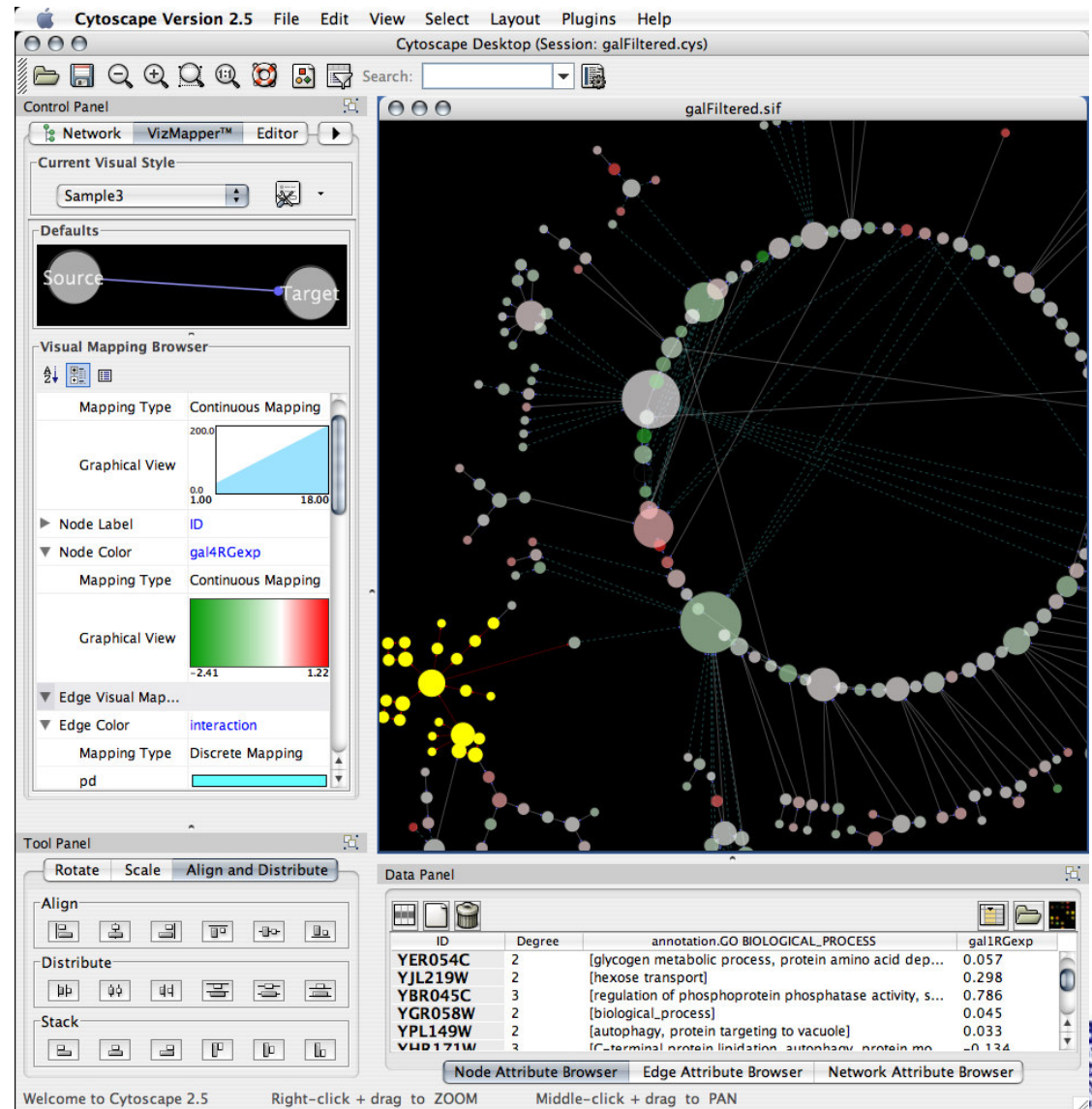
Introduction - Terms

- 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



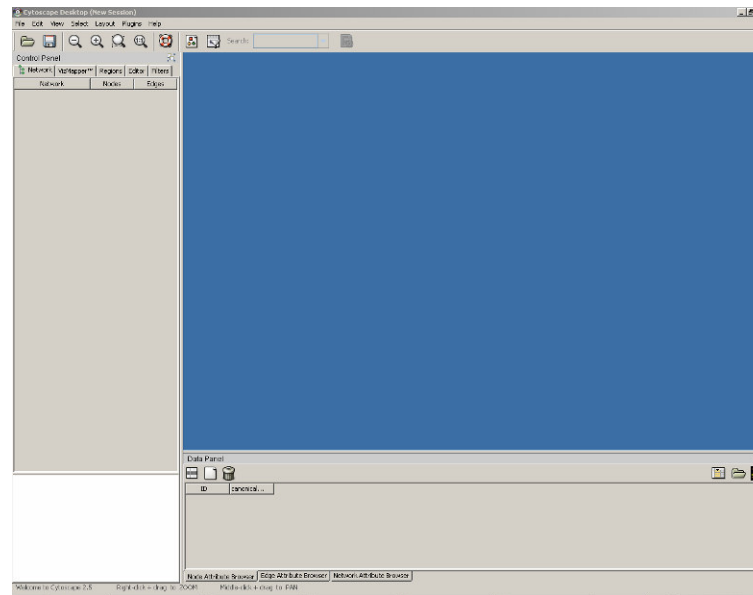
Cytoscape

- Two factors are important
- Visualisation
- Analysis
- Various software
 - Pajek
 - Anacubis
 - Netdraw
 - Cytoscape
 - ▶ www.cytoscape.org
 - ▶ Open source
 - ▶ Developed by Cytoscape Consortium
 - ▶ Funded by Unilever



1. Introduction to Cytoscape Software

1.1 Cytoscape Layout and User Interface



- 1.2 Loading Networks
- 1.3 Cytoscape menus
- 1.4 Manipulating Networks

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
- 2.4 Fetching data from external sources

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

2.2 Importing text or Excel files

2.3 Creating an empty network and manually adding nodes and edges

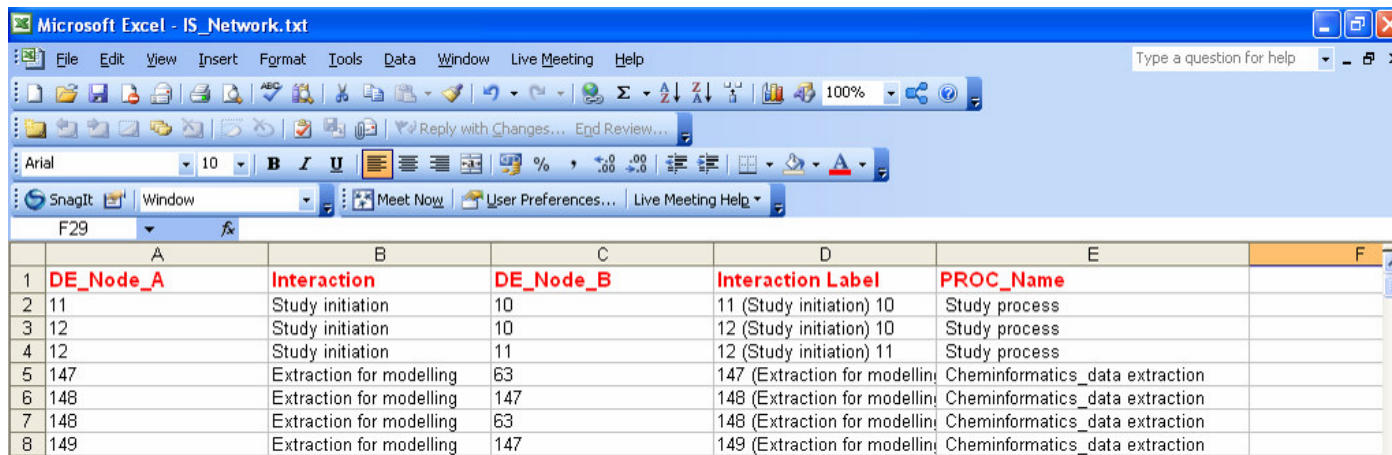
2.4 Fetching data from external sources



2. Constructing and Loading Biological Networks into Cytoscape

2.1 Importing network files into Cytoscape

2.2 Importing text or Excel files



The screenshot shows a Microsoft Excel window titled "IS_Network.txt". The spreadsheet contains a table with 8 rows and 6 columns. The columns are labeled: DE_Node_A, Interaction, DE_Node_B, Interaction Label, PROC_Name, and an empty column F. The data rows contain numerical IDs for nodes and interactions, along with descriptive labels for the interactions and the processes they represent.

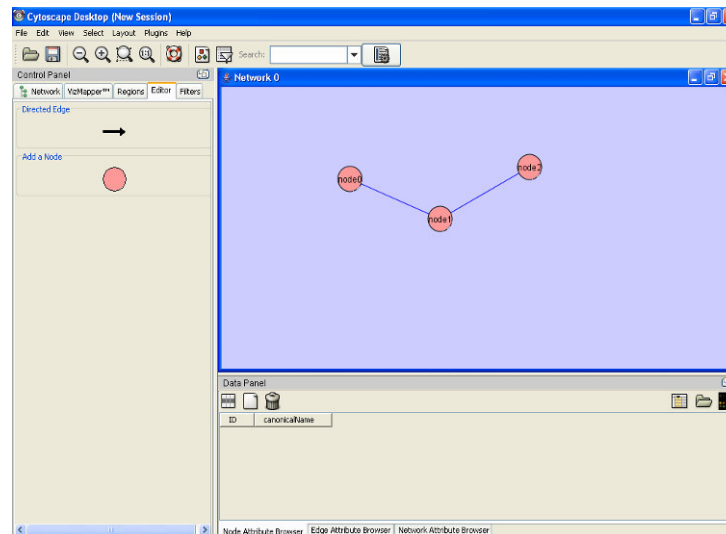
	A	B	C	D	E	F
1	DE_Node_A	Interaction	DE_Node_B	Interaction Label	PROC_Name	
2	11	Study initiation	10	11 (Study initiation) 10	Study process	
3	12	Study initiation	10	12 (Study initiation) 10	Study process	
4	12	Study initiation	11	12 (Study initiation) 11	Study process	
5	147	Extraction for modelling	63	147 (Extraction for modelling)	Cheminformatics_data extraction	
6	148	Extraction for modelling	147	148 (Extraction for modelling)	Cheminformatics_data extraction	
7	148	Extraction for modelling	63	148 (Extraction for modelling)	Cheminformatics_data extraction	
8	149	Extraction for modelling	147	149 (Extraction for modelling)	Cheminformatics_data extraction	

2.3 Creating an empty network and manually adding nodes and edges

2.4 Fetching data from external sources

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- 2.1 Importing network files into Cytoscape
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- 2.3 Creating an empty network and manually adding nodes and edges



- 2.4 Fetching data from external sources

3. Working with Attributes

3.1 Importing Node Attributes

3.2 Viewing Attributes

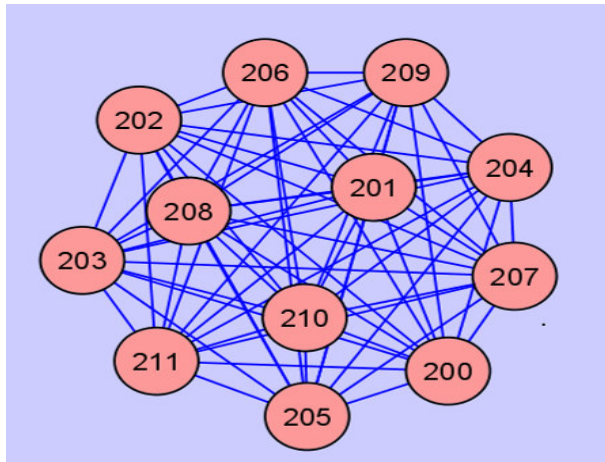
3.3 Deleting Attributes

3.4 Editing Attributes

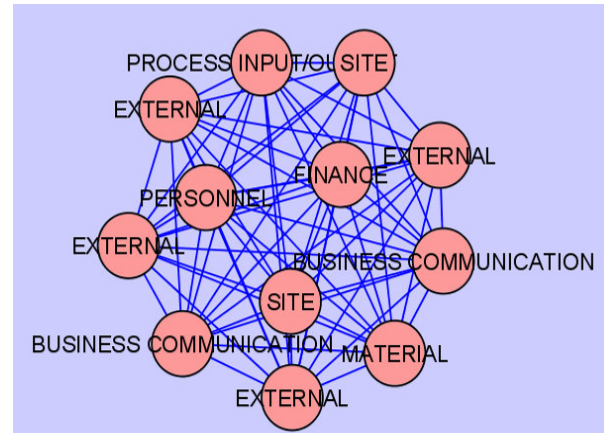


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3. Working with Attributes



Ok for Cytoscape but means nothing!



Much better!

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

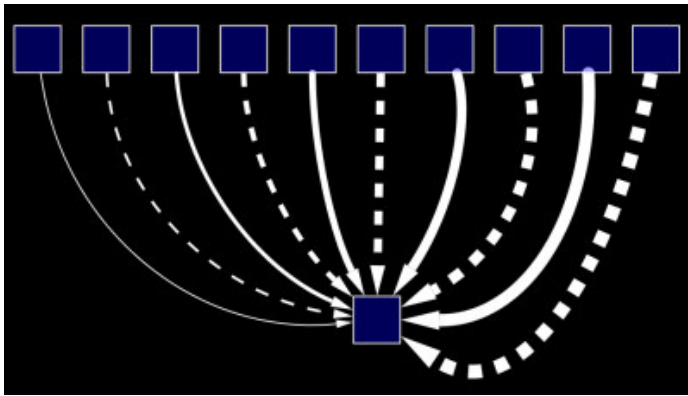
5.3.2 Example 2 – Creating a New Visual Style with a Discrete Mapper

5.3.3 Example 3 - Visualizing Expression Data on a Network

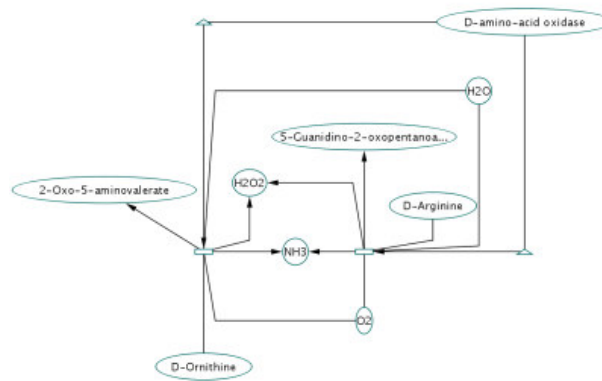
5.3.4 Example 4 – How to Use Utilities for Discrete Mappers

5.4 Other aspects of visual styles

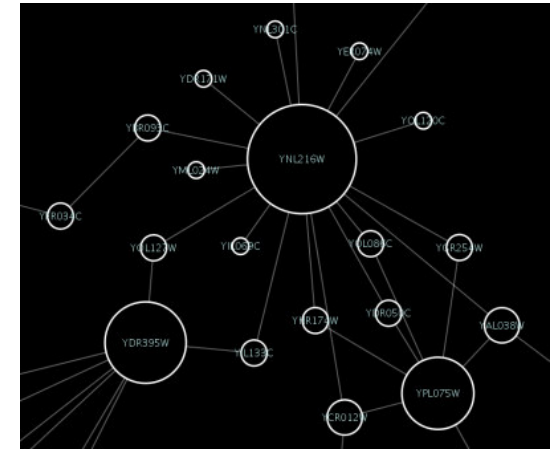
Visual Styles (VizMapper)



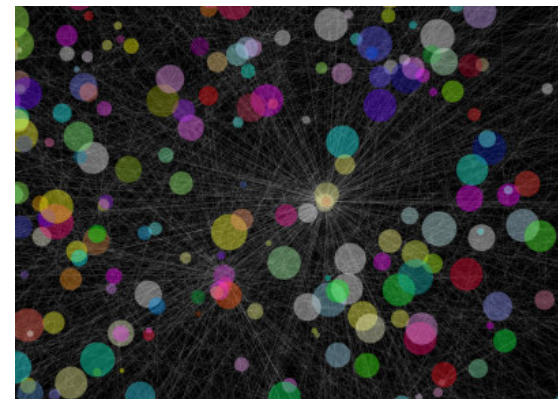
Use specific line types to indicate different types of interactions



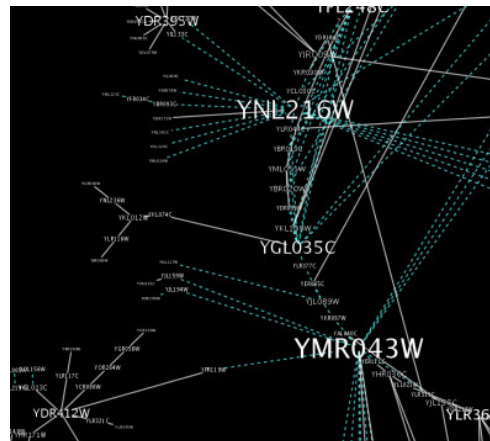
Encode specific physical entities as different node shapes.



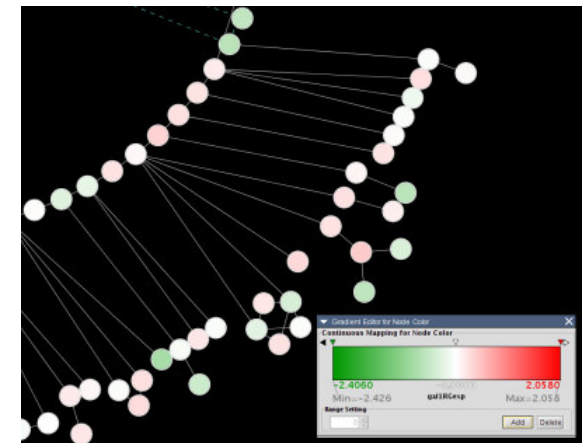
Set node sizes based on the degree of connectivity of the nodes.



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
 - All 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 “microbiology”
 - **Visual mapper** maps network attributes to visual attributes.
 - For example, a visual mapper can map all microbiology 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



The screenshot shows the Cytoscape Desktop interface with the VizMapper tool active. The main window displays a network graph with nodes and edges. The left sidebar contains the Control Panel, Visual Mapping Browser, and Data Panel.

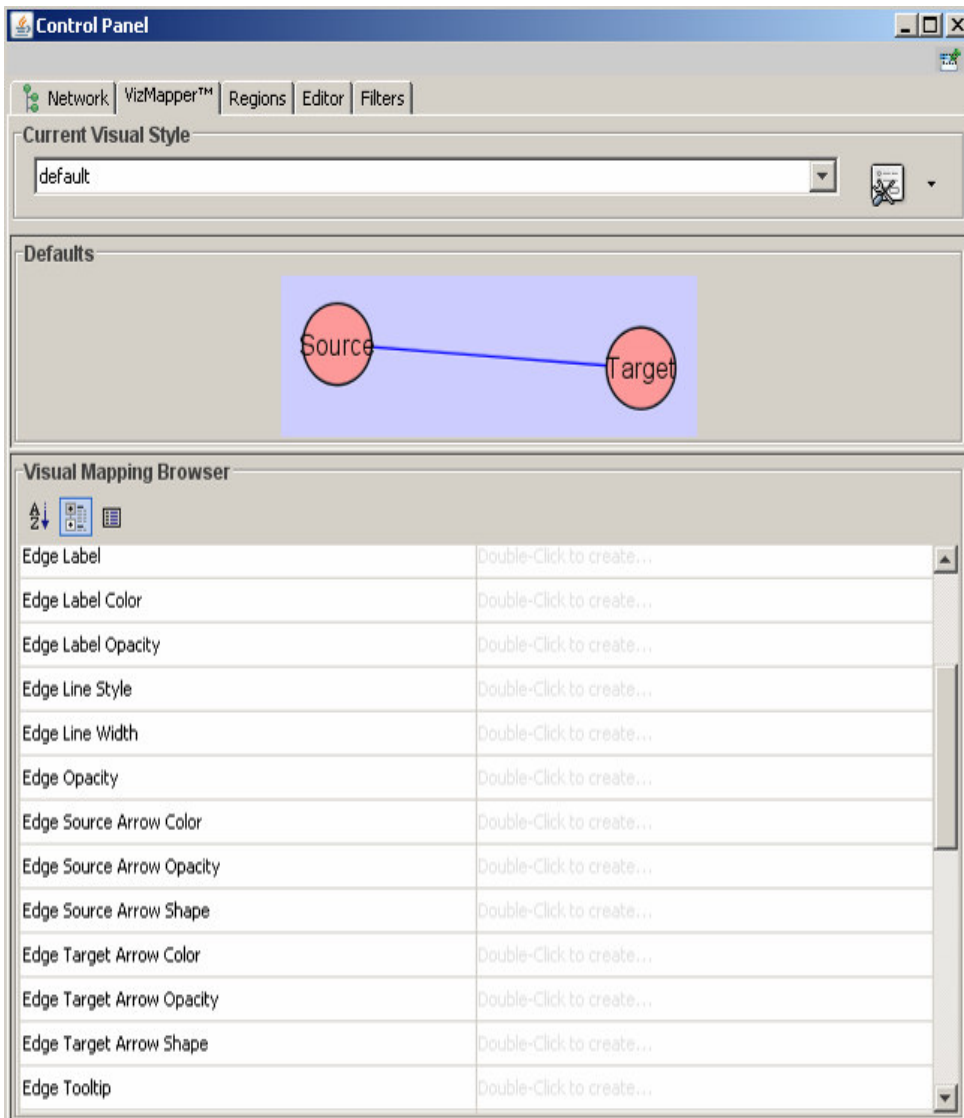
Visual Mapping Browser

Node Label	DATA_AREA
Mapping Type	Passthrough Mapping
75	UNILEVER GUIDANCE
74	UNILEVER GUIDANCE
72	MODEL
69	BUSINESS COMMUNIC...
68	BUSINESS COMMUNIC...
67	BUSINESS COMMUNIC...
66	BUSINESS COMMUNIC...
65	STUDY
58	BUSINESS COMMUNIC...
56	BUSINESS COMMUNIC...

Data Panel

ID	COUNT_PROC_O...	DATA_AREA	DA_ID	DE_ID	DE_NAME
211	1	BUSINESS COMMUNICATION	12	211	SHE report
200	1	MATERIAL	1	200	Product categories
207	1	BUSINESS COMMUNICATION	12	207	SHE report
204	1	EXTERNAL	11	204	External information sources
201	1	FINANCE	17	201	Financial Data
202	1	EXTERNAL	11	202	External information sources
210	1	SITE	2	210	Site

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 Complexes



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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

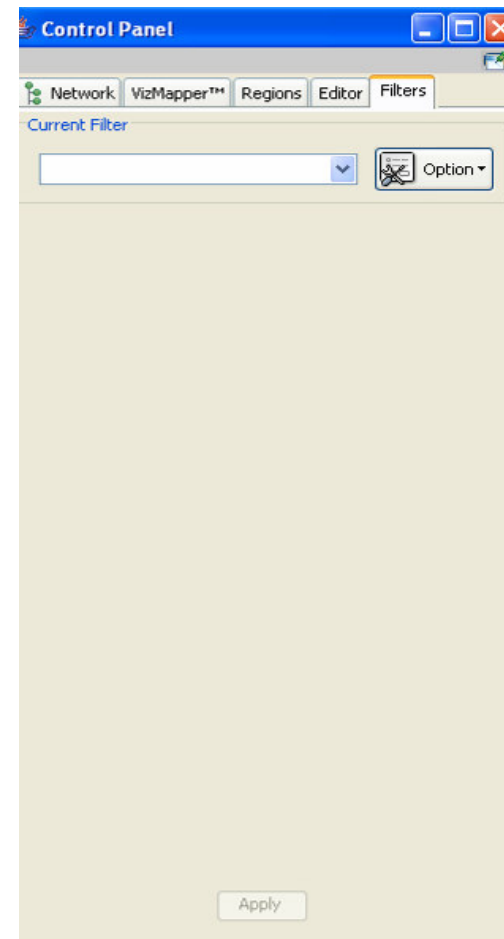
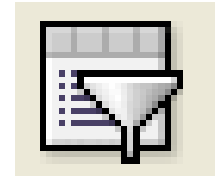
- Cytoscape includes a Quick Find feature, which enables you to quickly find nodes and edges



- Matching nodes/edges within the network will be highlighted and zoomed in
 - *Exercise*
 - ▶ *Can you find node 160?*
 - ▶ *What is its SUB_DE_NAME?*

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



Review

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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 on the CytoRetreat website next week

Acknowledgements

- Cytoscape Development Team
- Unilever Bioinformatics Group, Yeyejide Adeleye





Thank you

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our assurance - your confidence

