More Robust Testing of Data and UI for GRNsight: a Web Application for Visualizing Models of GRNs

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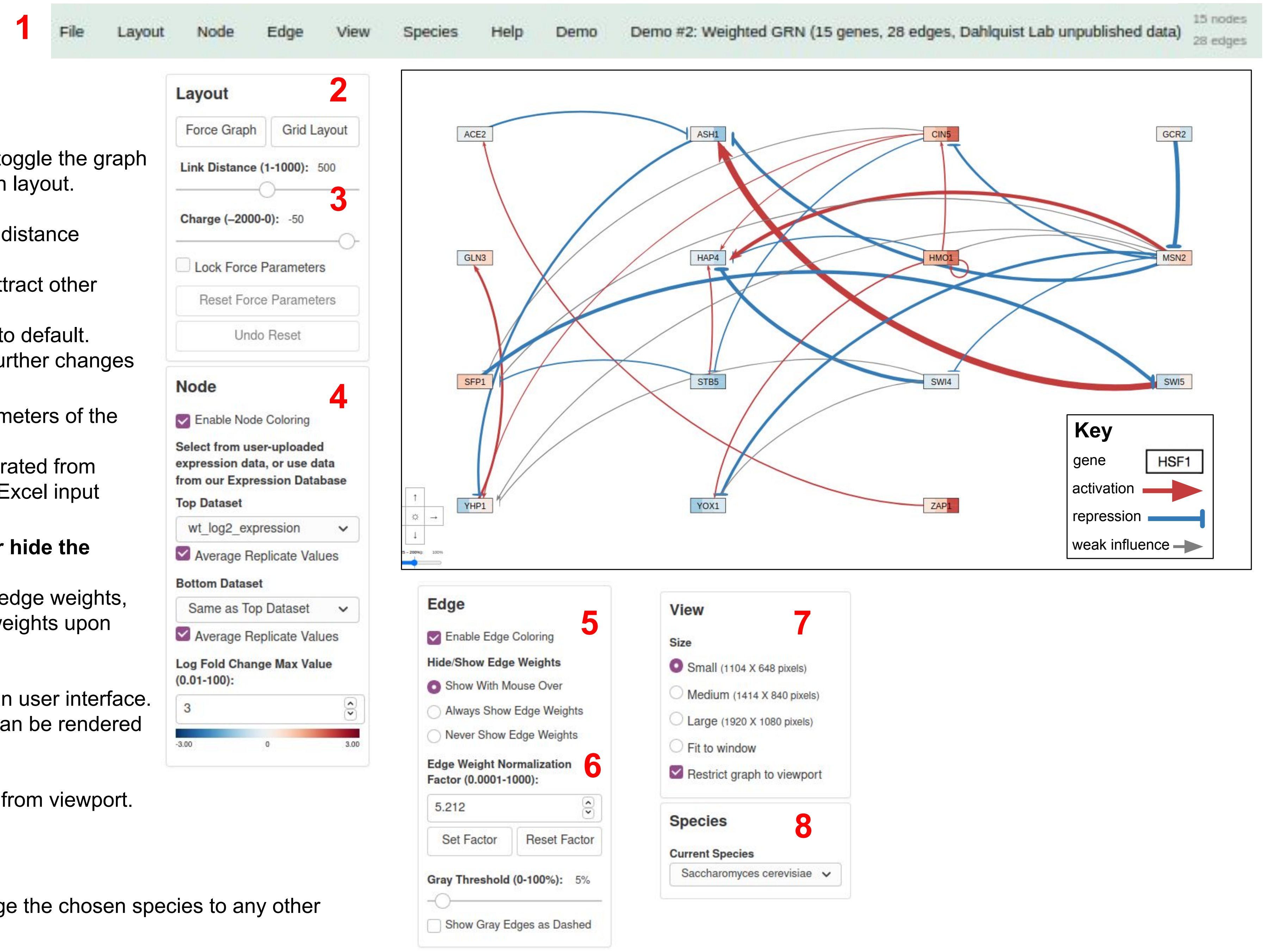
http://dondi.github.io/GRNsight/

Loyola Marymount University

GRNsight Automatically Lays Out Unweighted and Weighted Gene Regulatory Network Graphs

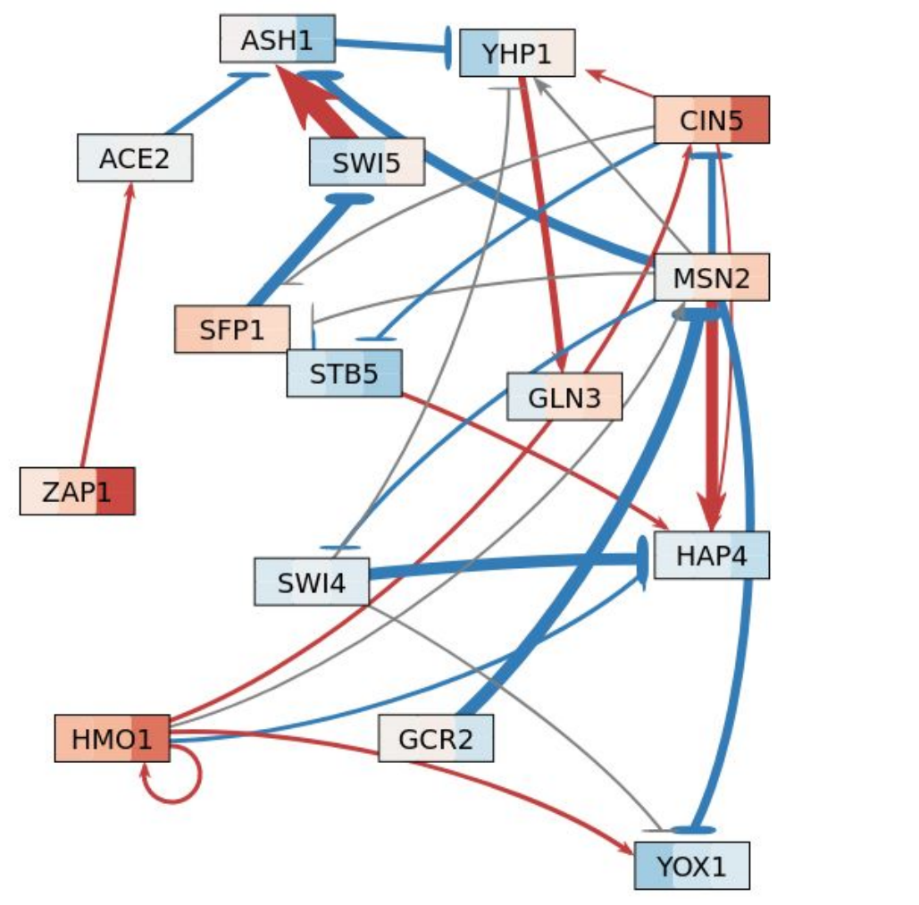
1. **File Formats**
   - Can import and export Excel, SIF, or GraphML files.
   - Demo files are provided.
2. **Grid Layout**
   - Grid Layout button allows the users to toggle the graph between a grid layout and a force graph layout.
3. **Force Graph Parameter Sliders**
   - Link distance determines the minimum distance between nodes.
   - Nodes have a charge, which repel or attract other nodes.
   - Reset functionality sets all parameters to default.
   - Locking the parameters prevents any further changes
4. **Node Coloring**
   - This menu allows users to modify parameters of the node coloring visualization.
   - Dataset options are automatically generated from expression data sheets detected in an Excel input workbook.
5. **GRNsight includes options to show or hide the weight values**
   - Buttons enable the user to always see edge weights, never see edge weights, or see edge weights upon mouseover of the edges.
6. **Edge Weight Normalization**
   - Allows user to set normalization factor in user interface.
   - Edge thicknesses for different graphs can be rendered on the same scale.
7. **Viewport**
   - Graph bounding box can be separated from viewport.
   - Multiple viewport sizes available.
   - Zooming and scrolling enabled.
8. **Species Selection**
   - This dropdown allows the user to change the chosen species to any other species supported by GRNsight


1
File
Layout
Node
Edge
View
Species
Help
Demo
Demo #2: Weighted GRN (15 genes, 28 edges, Dahlquist Lab unpublished data)
15 nodes
28 edges
Layout
2
Force Graph
Grid Layout
Link Distance (1-1000): 500
3
Charge (–2000-0): -50
☐ Lock Force Parameters
Reset Force Parameters
Undo Reset
Node
4
☑ Enable Node Coloring
Select from user-uploaded expression data, or use data from our Expression Database
Top Dataset
wt_log2_expression
☑ Average Replicate Values
Bottom Dataset
Same as Top Dataset
☑ Average Replicate Values
Log Fold Change Max Value (0.01-100):
3
-3.00
0
3.00
ACE2
ASH1
CIN5
GCR2
GLN3
HAP4
HMO1
MSN2
SFP1
STB5
SWI4
SWI5
YHP1
YOX1
ZAP1
Key
gene
HSF1
activation
repression
weak influence
Edge
5
☑ Enable Edge Coloring
Hide/Show Edge Weights
● Show With Mouse Over
○ Always Show Edge Weights
○ Never Show Edge Weights
Edge Weight Normalization Factor (0.0001-1000):
6
5.212
Set Factor
Reset Factor
Gray Threshold (0-100%): 5%
☐ Show Gray Edges as Dashed
View
7
Size
● Small (1104 X 648 pixels)
○ Medium (1414 X 840 pixels)
○ Large (1920 X 1080 pixels)
○ Fit to window
☑ Restrict graph to viewport
Species
8
Current Species
Saccharomyces cerevisiae

Graph Visualization Was Refined

Feature Addition

- Improved edge detection for nodes, eliminating issues with nodes going out of the viewport
- Gray Edge Threshold was fixed to properly gray out all edges at 100% threshold
- Toggle buttons were fixed so that all buttons properly represent the state of the program
- Viewport resizing was modified to account for window resizing



Acknowledgments

- We would like to thank the prior developers on this project: Alexia M. Filler, Kevin B. Patterson, Mihir Samdarshi, John L. Lopez, Justin Kyle T. Torres, Eileen J. Choe, Yeon-Soo (Jen) Shin, Edward B. Bachoura, Nicole A. Anguiano,Anindita Varshneya, Katrina Sherbina, Britain J. Southwick.

Availability

- GRNsight is free and open to all users and there is no login requirement.
- Web site content is available under the Creative Commons Attribution Non-Commercial Share Alike license.
- GRNsight code is available under the open source BSD license.
- Usage is being tracked through Google Analytics.

Sessions: 17412

New users: 7160

Pageviews: 36413

Library Updates Protect against Security Vulnerabilities

Updated Dependencies

- GRNsight directly uses 52 libraries. Including dependencies of those libraries, GRNsight relies on 1533 libraries.
- Dependencies had grown out of date and were updated
- Security vulnerabilities were identified within the dependencies as a result of outdated versions

Began Migration of Deprecated Dependencies

- Some dependencies, notably Jade, have been deprecated, threatening future iterations of GRNsight.
- Migration of these libraries to their contemporary versions has begun to address this problem.

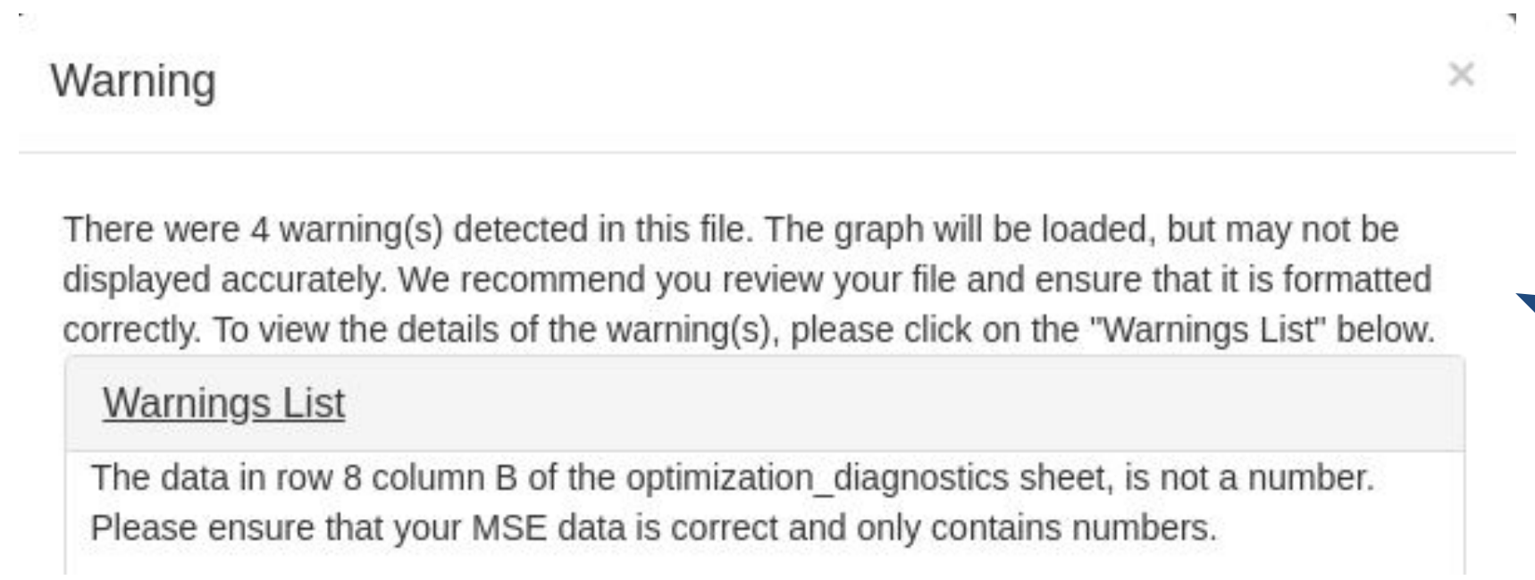
Future Directions

- Complete the testing and refinement of the graph visualization and user interface, including expanded client side testing.
- Expand the export functionality to include additional worksheets not used by GRNsight, but used by GRNmap.
- Add more species to the data base.

References

- Dahlquist, K.D., Fitzpatrick, B.G., Camacho, E.T., Entzminger, S.D., and Wanner, N.C. (2015) Parameter Estimation for Gene Regulatory Networks from Microarray Data: Cold Shock Response in Saccharomyces cerevisiae. *Bulletin of Mathematical Biology*, *77*(8), 1457-1492, DOI: 10.1007/s11538-015-0092-6
- GRNmap: http://kdahlquist.github.io/GRNmap/
- GRNsight: https://dondi.github.io/GRNsight/
- GRNsight's GitHub: https://github.com/dondi/GRNsight
- Kam D. Dahlquist, John David N. Dionisio, Ben G. Fitzpatrick, Nicole A. Anguiano, Anindita Varshneya, Britain J. Southwick, Mihir Samdarshi. (2016) GRNsight: a web application and service for visualizing models of small- to medium-scale gene regulatory networks. *PeerJ Computer Science* 2:e85 https://doi.org/10.7717/peerj-cs.85

Testing Suite Can Test Import and Export Functionality

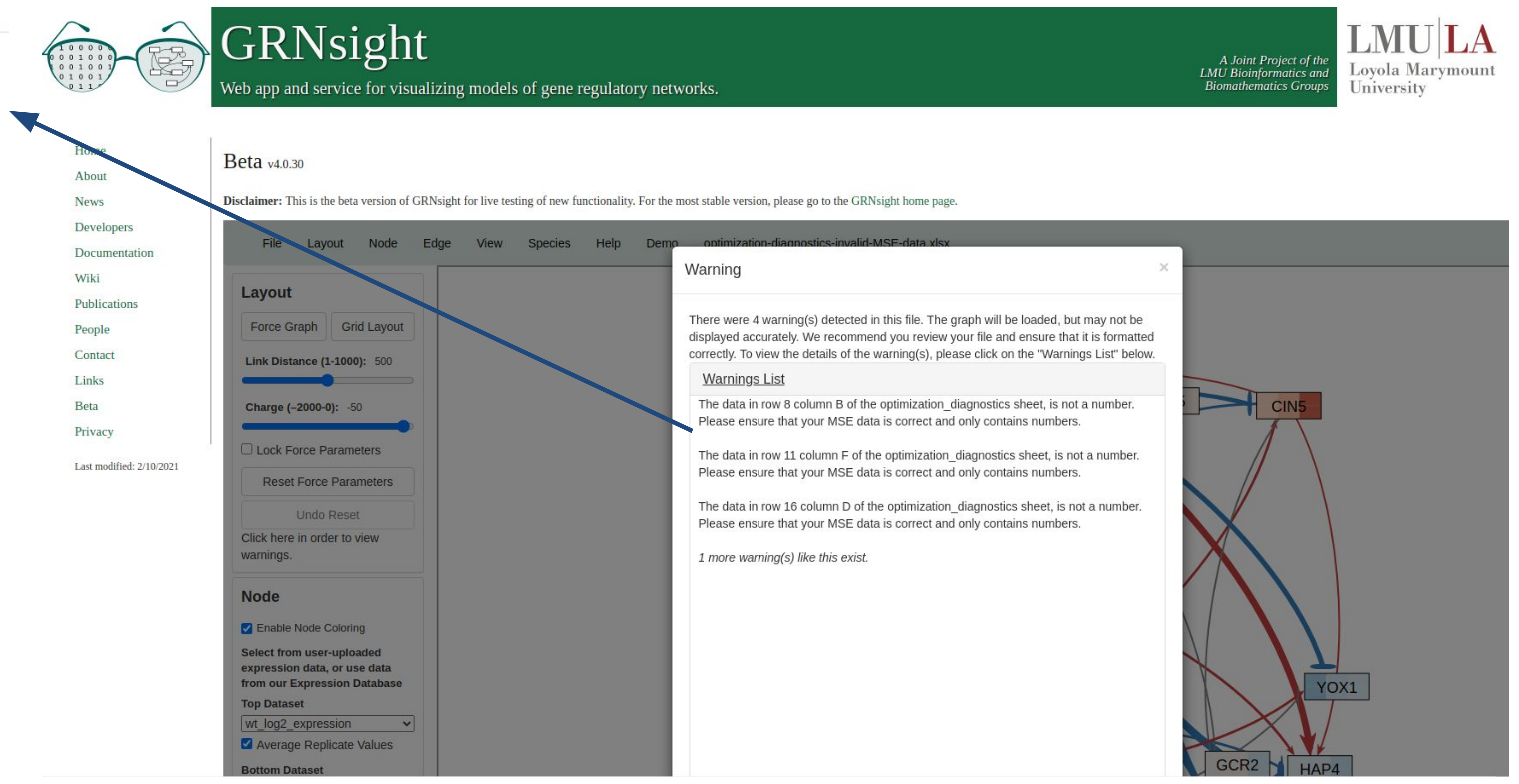


Warning

There were 4 warning(s) detected in this file. The graph will be loaded, but may not be displayed accurately. We recommend you review your file and ensure that it is formatted correctly. To view the details of the warning(s), please click on the "Warnings List" below.

Warnings List

The data in row 8 column B of the optimization_diagnostics sheet, is not a number. Please ensure that your MSE data is correct and only contains numbers.


GRNsight
Web app and service for visualizing models of gene regulatory networks.
A Joint Project of the LMU Bioinformatics and Biomathematics Groups
LMU|LA Loyola Marymount University
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Beta
Privacy
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Node
Edge
View
Species
Help
Demo
optimization-diagnostics-invalid-MSE-data.xlsx
Layout
Force Graph
Grid Layout
Link Distance (1-1000): 500
Charge (–2000-0): -50
☐ Lock Force Parameters
Reset Force Parameters
Undo Reset
Click here in order to view warnings.
Node
☑ Enable Node Coloring
Select from user-uploaded expression data, or use data from our Expression Database
Top Dataset
wt_log2_expression
☑ Average Replicate Values
Bottom Dataset
CIN5
YOX1
GCR2
HAP4

Beta v4.0.30

Disclaimer: This is the beta version of GRNsight for live testing of new functionality. For the most stable version, please go to the GRNsight home page.

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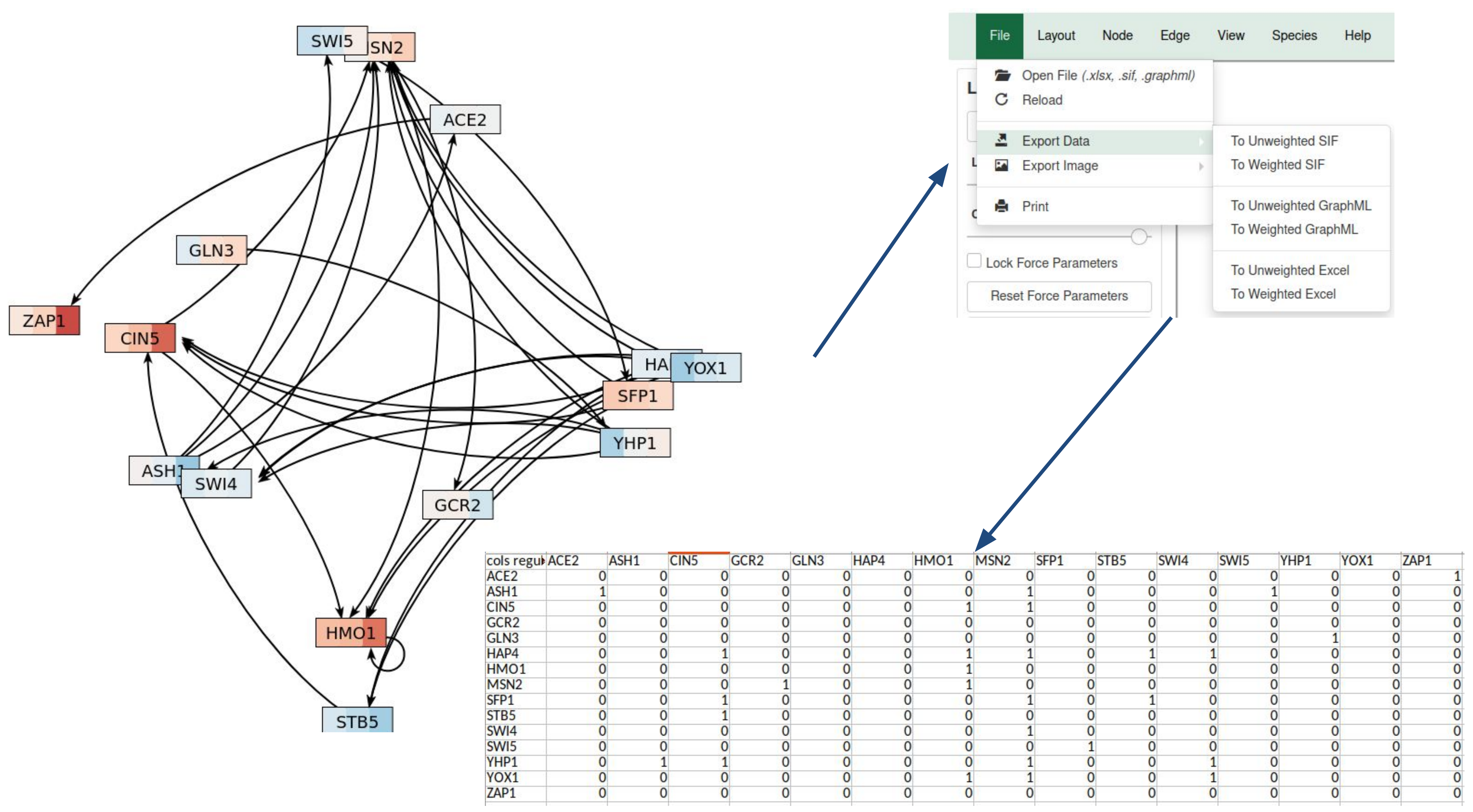
The data in row 11 column F of the optimization_diagnostics sheet, is not a number. Please ensure that your MSE data is correct and only contains numbers.

The data in row 16 column D of the optimization_diagnostics sheet, is not a number. Please ensure that your MSE data is correct and only contains numbers.

1 more warning(s) like this exist.

GRNsight as a validator for GRNmap

- GRNmap is a user-hostile MATLAB software that models the dynamics of small- to medium-scale GRNs.
- GRNsight expanded it's testing capabilities to check sheets that are not necessary to display a gene regulatory network model, but are used in the GRNmap MATLAB software.
- Users of GRNmap are able to upload a workbook through GRNsight and use the error and warning messages to fix their workbook before running it through the more user hostile software.
- Error and warning messages became more descriptive and pinpointed which sheet the issue was found in, and the row, column, or cell that the error was located.



cols regul	ACE2	ASH1	CIN5	GCR2	GLN3	HAP4	HMO1	MSN2	SFP1	STB5	SWI4	SWI5	YHP1	YOX1	ZAP1
ACE2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ASH1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0
CIN5	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
GCR2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLN3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
HAP4	0	0	1	0	0	0	1	1	0	1	1	0	0	0	0
HMO1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
MSN2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
SFP1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0
STB5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SWI4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
SWI5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
YHP1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0
YOX1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
ZAP1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

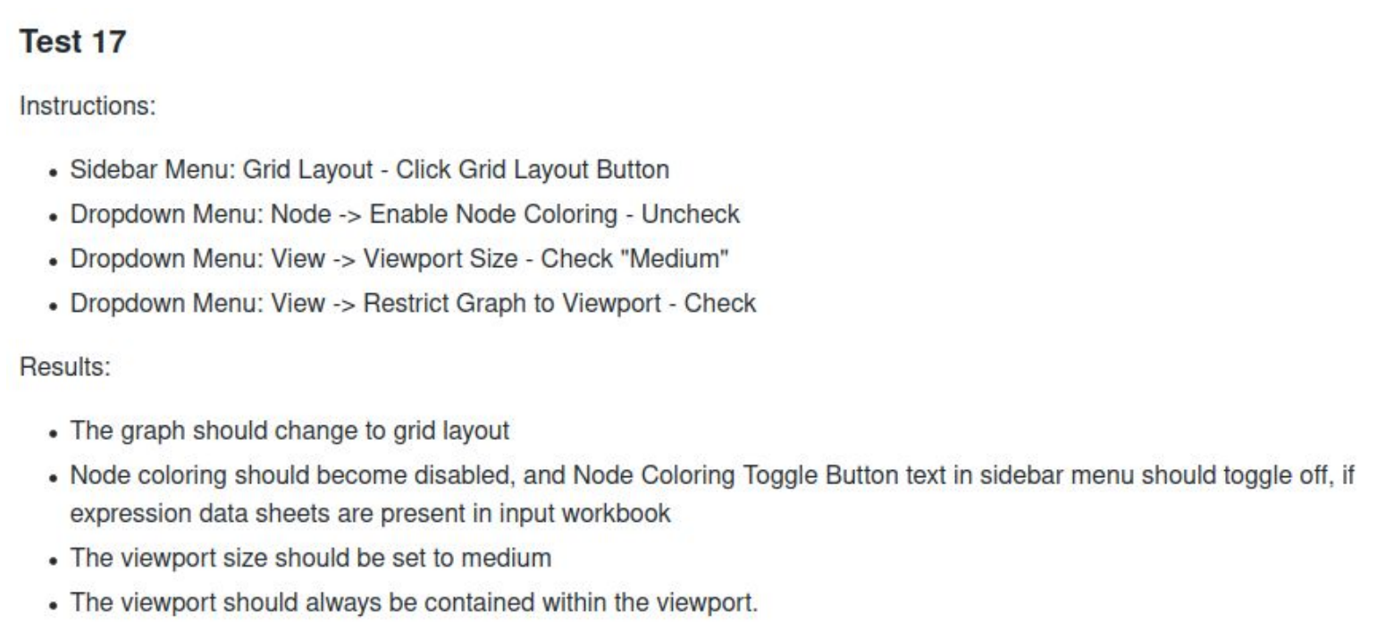
Refactored Existing GRNsight import test, and expanded export tests

- Refactored existing GRNsight code to consolidate error and warning messages, as well as added new tests for additional sheets in a GRNsight workbook.
- Updated test to reflect additional features that GRNsight recently developed.
- Expanded export tests to increase user visibility on possible errors that occurred during the import process.
- Fixed bugs within the existing GRNsight export functionality and created a system to automatically fix minor issues within a workbook, alert the user of issues within a file that they must fix, or send an error message that something went wrong with the export process.

The Client Side Testing Documents Streamline Testing of User Interface

Update Client Side Test Generator Script

- Automated user interface testing is difficult as it requires data analysis of the graph state to determine if the desired feature was changed. Instead, a set of instructions can be given to a human to perform these tests.
- Client Side tests are generated for a subset of features by permuting all possible combinations of feature states, creating steps for the user to follow.
- These features are listed in JSON files, separated by their location in the user interface. These JSON files are read by the script and the requested features are used to generate the tests
- Each feature is given a unique static ID that is used to reference it easily.
- The generator script can include features based on an activation state in the features JSON, by command line arguments, or by a separate JSON file created by the tester.
- The client side testing document was updated so that the features include their ID and the wiki was updated.



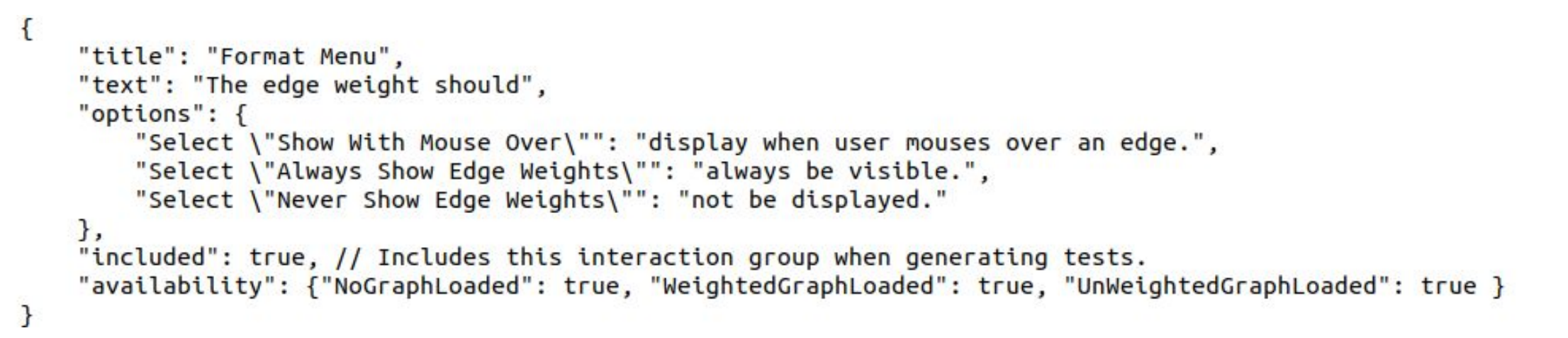
Test 17

Instructions:

- Sidebar Menu: Grid Layout - Click Grid Layout Button
- Dropdown Menu: Node -> Enable Node Coloring - Uncheck
- Dropdown Menu: View -> Viewport Size - Check "Medium"
- Dropdown Menu: View -> Restrict Graph to Viewport - Check

Results:

- The graph should change to grid layout
- Node coloring should become disabled, and Node Coloring Toggle Button text in sidebar menu should toggle off, if expression data sheets are present in input workbook
- The viewport size should be set to medium
- The viewport should always be contained within the viewport.



```
{
    "title": "Format Menu",
    "text": "The edge weight should",
    "options": {
        "Select \"Show With Mouse Over\"": "display when user mouses over an edge.",
        "Select \"Always Show Edge Weights\"": "always be visible.",
        "Select \"Never Show Edge Weights\"": "not be displayed."
    },
    "included": true, // Includes this interaction group when generating tests.
    "availability": {"NoGraphLoaded": true, "WeightedGraphLoaded": true, "UnWeightedGraphLoaded": true }
}
```