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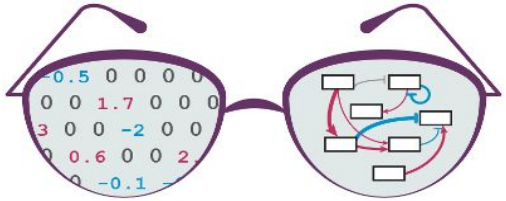

Design and Layout Improvement to GRNsight v2.0: a Web Application and Service for Visualizing Small- to Medium-Scale Gene Regulatory Networks

Nicole Anguiano and Anindita Varshneya
Department of Biology and Department of Electrical Engineering and Computer Science
Loyola Marymount University
LMU Undergraduate Research Symposium
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Outline

1. Gene regulatory networks (GRNs) consist of genes, transcription factors, and the regulatory relationships between them.
2. GRNsight is an open source web application and service for visualizing models of gene regulatory networks.
3. Version 1.0 expanded on the testing framework and made changes to the existing errors and warnings library.
4. Version 2.0 is in active development and will allow for greater customization of the graph visuals.

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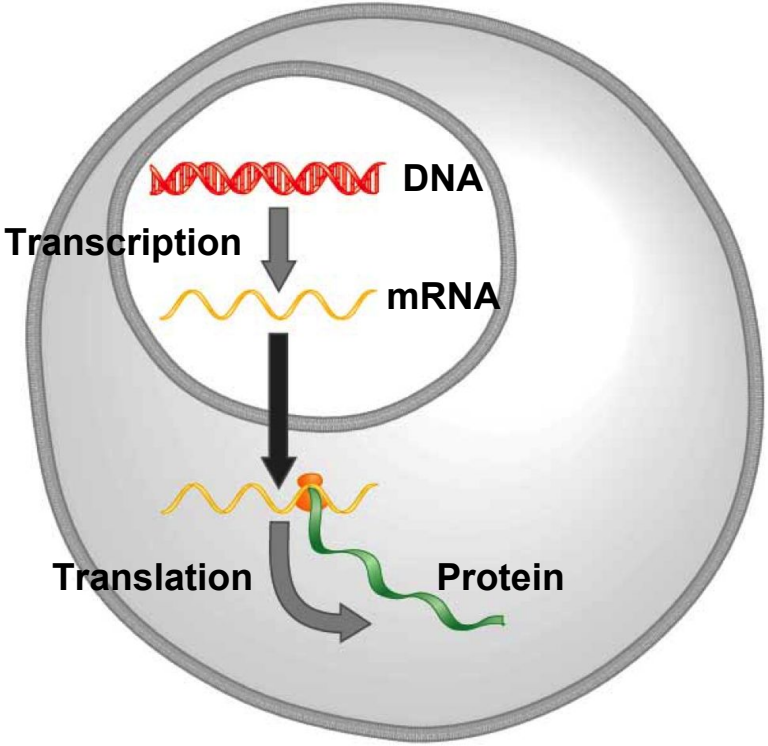
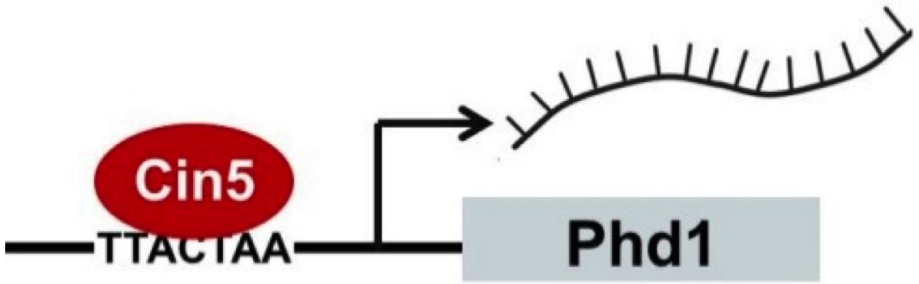
The Central Dogma of Molecular Biology is DNA to RNA to Protein

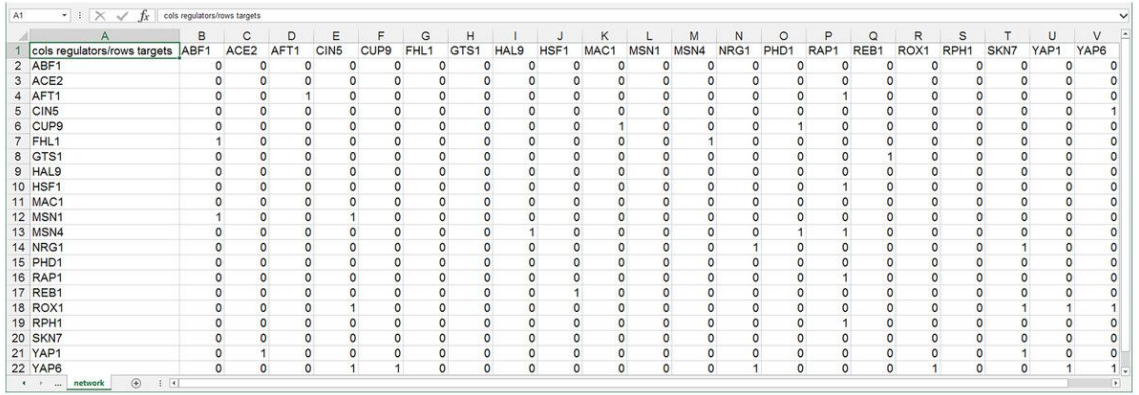


- Transcription factors control gene expression by binding to regulatory DNA sequences
- Activators increase gene expression
- Repressors decrease gene expression
- GRNs govern the level of expression of mRNA and proteins from those genes.

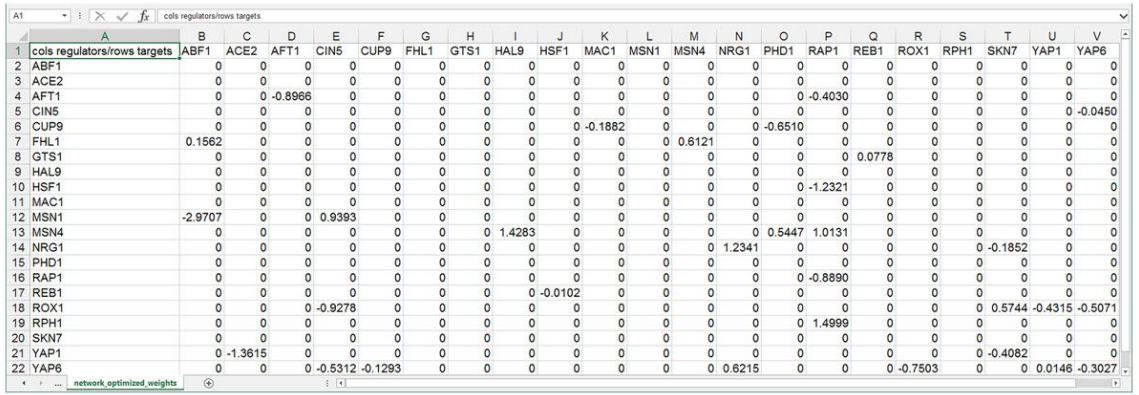


GRNsight Accepts Microsoft Excel Spreadsheets in the Correct Format

- Regulators and targets are in columns and rows respectively
- Excel workbooks need a “network” sheet or a “network_optimized_weights” sheet
- The adjacency matrix can be symmetrical or asymmetrical



cols regulators/rows targets	ABF1	ACE2	AFT1	CIN5	CUP9	FHL1	GTS1	HAL9	HSF1	MAC1	MSN1	MSN4	NRG1	PHD1	RAP1	REB1	ROX1	RPH1	SKN7	YAP1	YAP6
ABF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ACE2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AFT1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
CIN5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
CUP9	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
FHL1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
GTS1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
HAL9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HSF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
MAC1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSN1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSN4	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0
NRG1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
PHD1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RAP1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
REB1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
ROX1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
RPH1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
SKN7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YAP1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
YAP6	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1



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ABF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ACE2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AFT1	0	0	-0.8966	0	0	0	0	0	0	0	0	0	0	0	-0.4030	0	0	0	0	0	0
CIN5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.0450
CUP9	0	0	0	0	0	0	0	0	0	-0.1882	0	0	0	-0.6510	0	0	0	0	0	0	0
FHL1	0.1562	0	0	0	0	0	0	0	0	0	0	0	0.6121	0	0	0	0	0	0	0	0
GTS1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0778	0	0	0	0	0
HAL9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HSF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1.2321	0	0	0	0	0	0
MAC1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSN1	-2.9707	0	0	0.9393	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSN4	0	0	0	0	0	0	0	1.4283	0	0	0	0	0	0.5447	1.0131	0	0	0	0	0	0
NRG1	0	0	0	0	0	0	0	0	0	0	0	0	1.2341	0	0	0	0	0	-0.1852	0	0
PHD1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RAP1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.8890	0	0	0	0	0	0
REB1	0	0	0	0	0	0	0	0	-0.0102	0	0	0	0	0	0	0	0	0	0	0	0
ROX1	0	0	0	-0.9278	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5744	-0.4315	-0.5071
RPH1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4999	0	0	0	0	0	0
SKN7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YAP1	0	-1.3615	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.4082	0	0
YAP6	0	0	0	-0.5312	-0.1293	0	0	0	0	0	0	0	0.6215	0	0	0	-0.7503	0	0	0.0146	-0.3027

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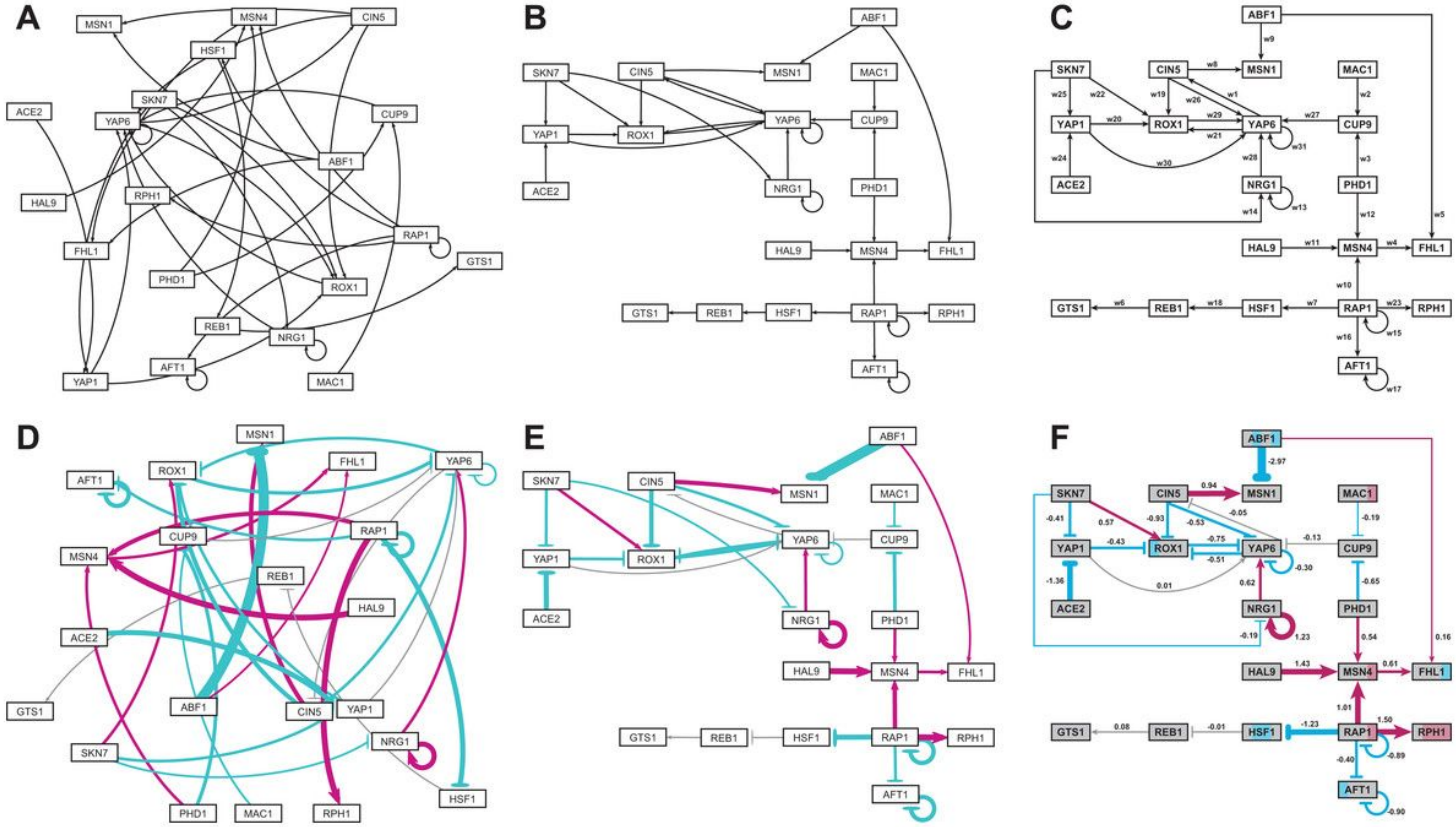
GRNsight Automatically Lays Out Weighted and Unweighted Networks

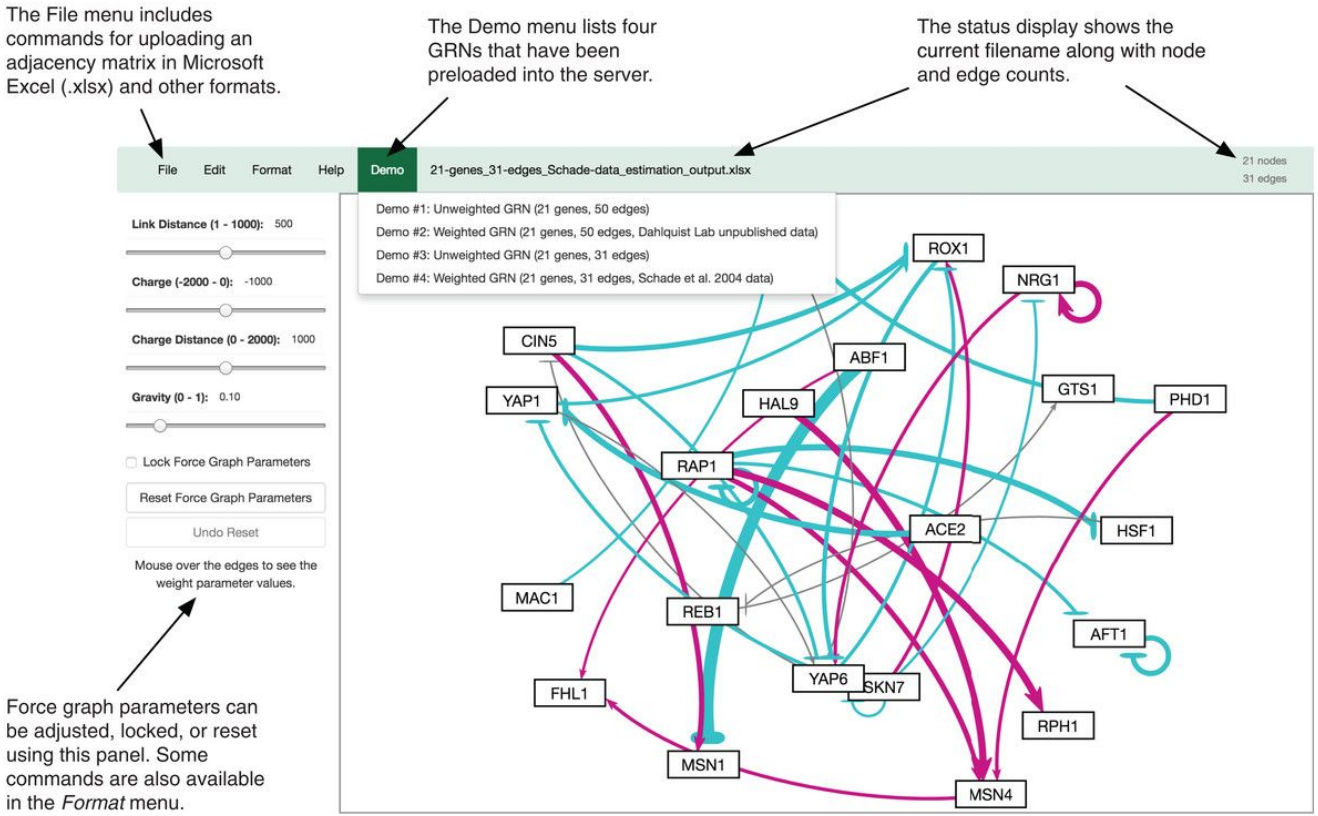


A and D. GRNsight automatic, unweighted and weighted

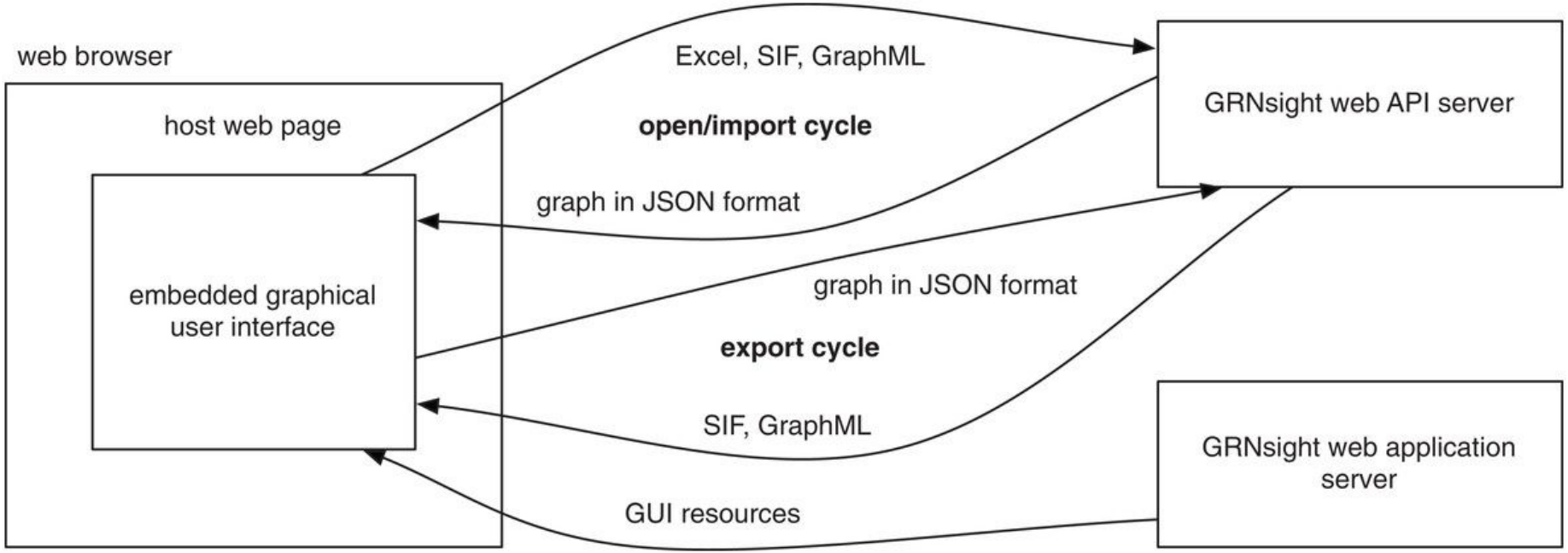
B and E. GRNsight, manually manipulated, unweighted and weighted

C and F. Adobe Illustrator, manually created, weighted and unweighted

GRNsight Automatically Lays Out Weighted and Unweighted Networks



GRNsight Has a Service-Oriented Architecture



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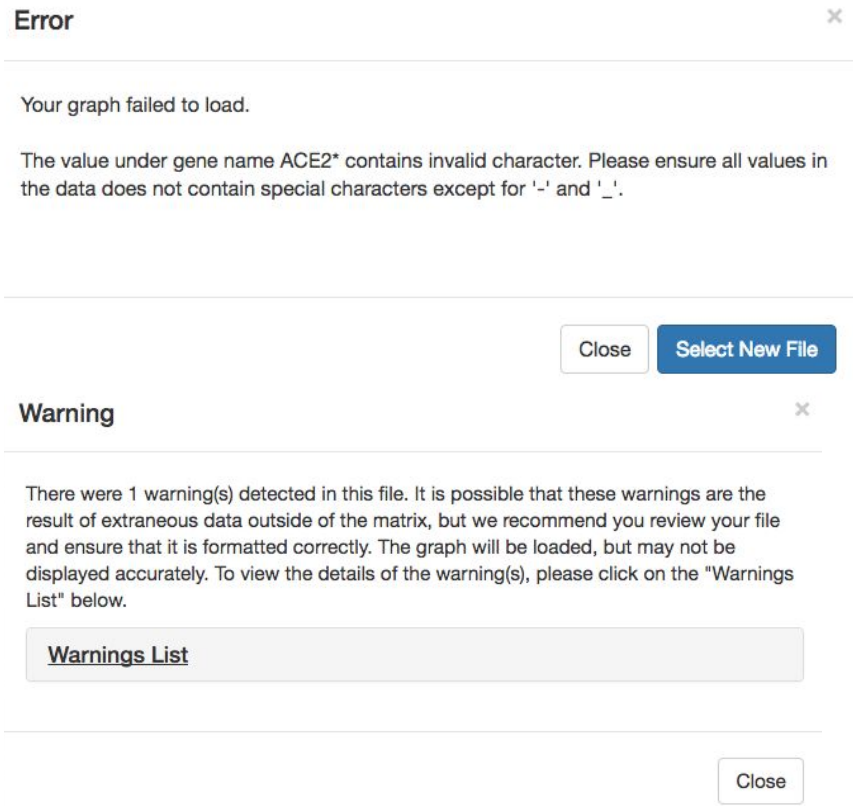
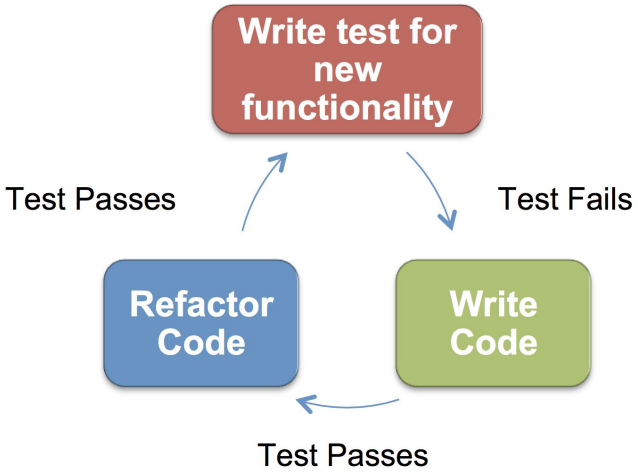
The Errors and Warnings Library Improved v1.0

- **Fatal format and file errors return an error in a modal window**
- **Non-fatal errors in the format or matixof return a warning box**
- **Warnings clearly state which row(s) or cell(s) may have incorrect data**
- **Warning box can be closed and reopened at any time via a hyperlink underneath Force Graph Parameter sliders.**



Test Driven Development (TDD) Ensures Data Presented in GRNsight is Accurate

- **Consists of 161 passing tests covering over 500 test files**
- **Executed through Mocha, a JavaScript test framework running on node.js and written in Chai, an assertion library for node.js**



Aspect of the code	Test coverage (%)
Statements	???
Branches	???
Functions	???
Lines	???

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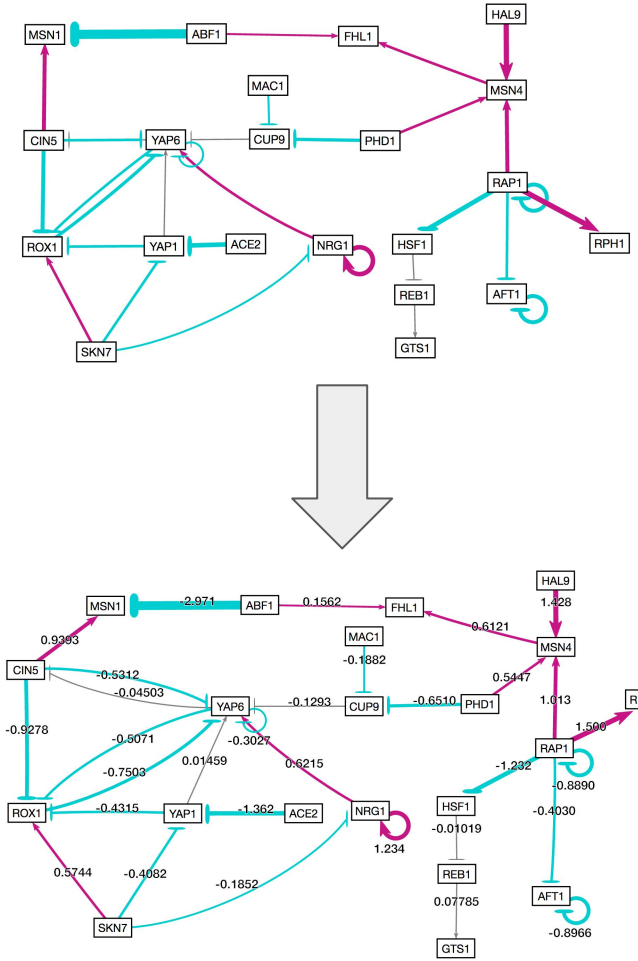
Major Improvements to v2.0

- **Version 2.0 of GRNsight is currently in active development.**
- **Currently implemented features include changes to the viewport (bounding box) and the ability to show and hide weights.**
- **Among the additional features yet to be added include additional customization to the drafting board, as well the ability to change the normalization factor.**
- **Planned future features and current development is tracked using Github Issues**

Visualization of Edge Weights is User Customizable

- By default, weights are shown only upon mouse-over of the edge
- Users can choose to always show or always hide weights
- Option exists in sidebar menu, and under Format tab in the File menu



Hide/Show Edge Weights

- (•) Show With Mouse Over
- ( ) Always Show Edge Weights
- ( ) Never Show Edge Weights

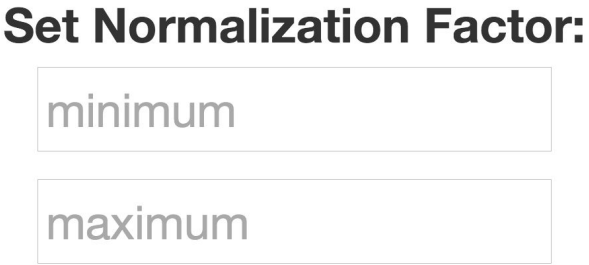
The viewport was enlarged to allow for easier visualization on different screen sizes

- **Three different viewport (visible area) sizes were added to adjust for different screen sizes.**
  - **Small is best for 13-15” laptops**
  - **Medium is best for 24” screens**
  - **Large is best for 32”+ screens**

- **The initial size of the viewport is chosen automatically based on the amount of available space on the user’s screen.**
  - **It can also be changed via toggle switch.**

A Customizable Normalization Factor Allows Users to Compare Graphs

- **Relationship data is normalized to fit within 12 distinct edge thicknesses**
- **Data from each graph is normalized according to matrix data**
- **In order to compare graph visualizations, normalization factor must be the same**
- **User inputs smallest value and largest value in all comparable matrices, and edge thicknesses adjust accordingly**



The Drafting Board was Enlarged for Optimal Graph Loading

- The drafting board (drawable area) was initially too small to allow for the graph to fully expand to an optimal layout.
- Larger viewport sizings allow for the graph to fully expand on load.
- An automatic drafting board resizing algorithm is in development to allow graphs of all sizes to come to an optimal layout.
    - The drafting board will expand past the size of the viewport, and can be fully seen with zooming and scrolling.
- The option of a hard (fixed to viewport) or adaptive (dynamic resizing) drafting board can be selected.

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Eileen Choe
Edward Bachoura

GRNmap Team
Trixie Anne Roque
Edward Azinge
Natalie Williams
Kristen Horstmann
Maggie O'Neil
Brandon Klein

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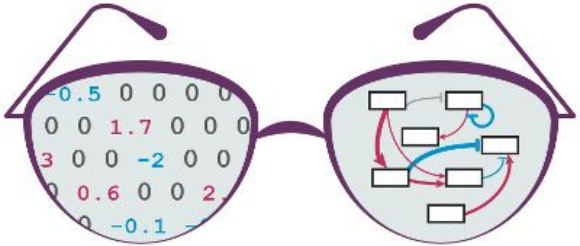

Any Questions?