Supplementary Material for Braun et al.

<u>User Manual for PedigreeNet</u>

Introduction

The PedigreeNet was developed to display pedigree relationships between plant varieties as a network representation. This manual is based on the PedigreeNet instance at MaizeGDB (https://www.maizegdb.org/breeders_toolbox). The tool allows users to apply a number of filters, select or upload their own breeding relationships, center a pedigree network on a maize variety, and display the shortest path(s) between two maize varieties on a pedigree network.

The code for the PedigreeNet is freely and publicly available at GitHub at the following location: https://github.com/Maize-Genetics-and-Genomics-Database/PedigreeNet. The installation guide for PedigreeNet can be found under the PedigreeNet folder at GitHub.

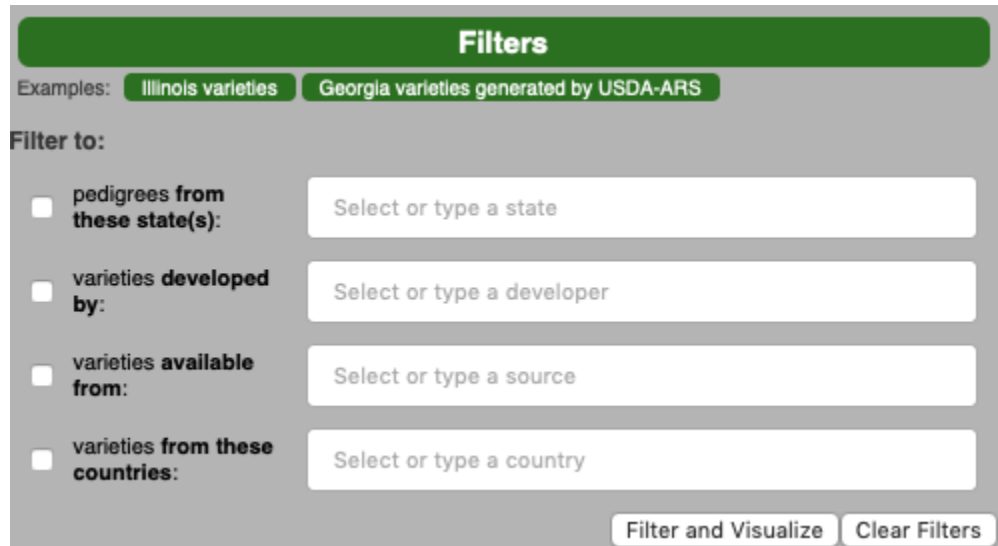Please cite the following article for reference: Braun BL et al, Bioinformatics, under review.

Front page of the PedigreeNet instance at MaizeGDB

Pre-loaded network
When the PedigreeNet site at MaizeGDB page is reached by users, it automatically pre-loads a pedigree network of 5,487 maize lines that are available in the MaizeGDB Stock Pages as of December 2018.

Filters

PedigreeNet offers filters that allow users to visualize the subnetworks that they are interested in. The following filters are available on the right-hand side of the PedigreeNet page and the available options are:
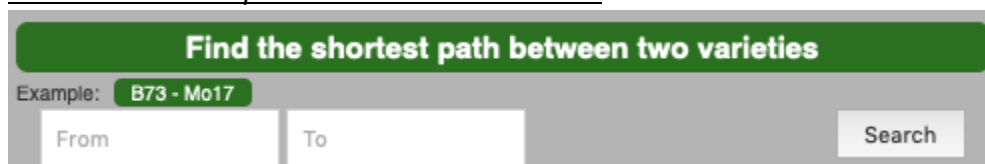
- Filter to pedigrees from state
- Filter to stocks developed by
- Filter to stocks available from
- Filter to stocks from country

The options in the drop-down menus are dynamically-generated. Multiple options can be selected for each filter.

Tools:
In addition to filtering, several PedigreeNet tools are available to help breeders to understand genetic relationships between plant varieties. These tools can be found on the left-hand side of the PedigreeNet page.

1) *"Find the shortest path between two varieties"*

Any two varieties in the network can be entered in the boxes. The tool then searches the shortest path in the network connecting the nodes representing these two nodes. This tool is especially useful when an agronomically important region is identified in two varieties and genetic connections are sought out for other plant varieties that may have the same region of interest, and can be used as candidates for crop improvement.

The example provided with the tool for B73 and Mo17 shows the following network

Direct URLs can be used to display the shortest path between varieties as follows: https://www.maizegdb.org/breeders_toolbox?node-from=B73&node-to=Mo17

2) *"Build a network around a variety"*

After identifying a region of interest in a plant variety, it may be desirable to cast a wider net to identify a large number of plants that have genetic connections to that variety. PedigreeNet provides a tool that builds a network of immediate progenies and pedigrees around a plant variety. In the example provided by the PedigreeNet instance at MaizeGDB, B37 is used. When B37 is selected by a user, this tool displays the following network:
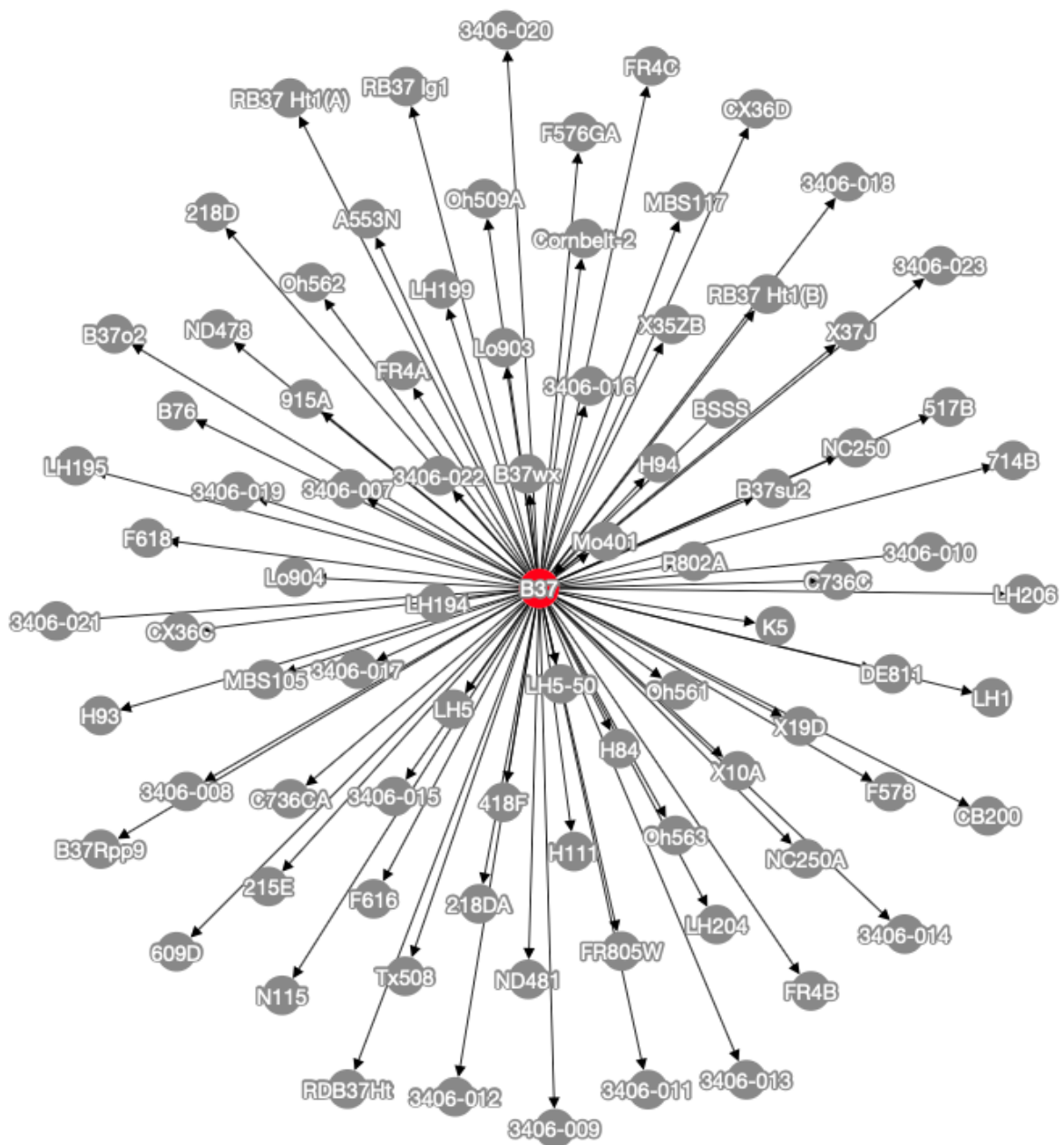
Direct URLs can be used to display the networks around a variety as follows:
https://www.maizegdb.org/breeders_toolbox?input-area=B37

3) *"Build a network around the lowest common ancestor of two varieties"*
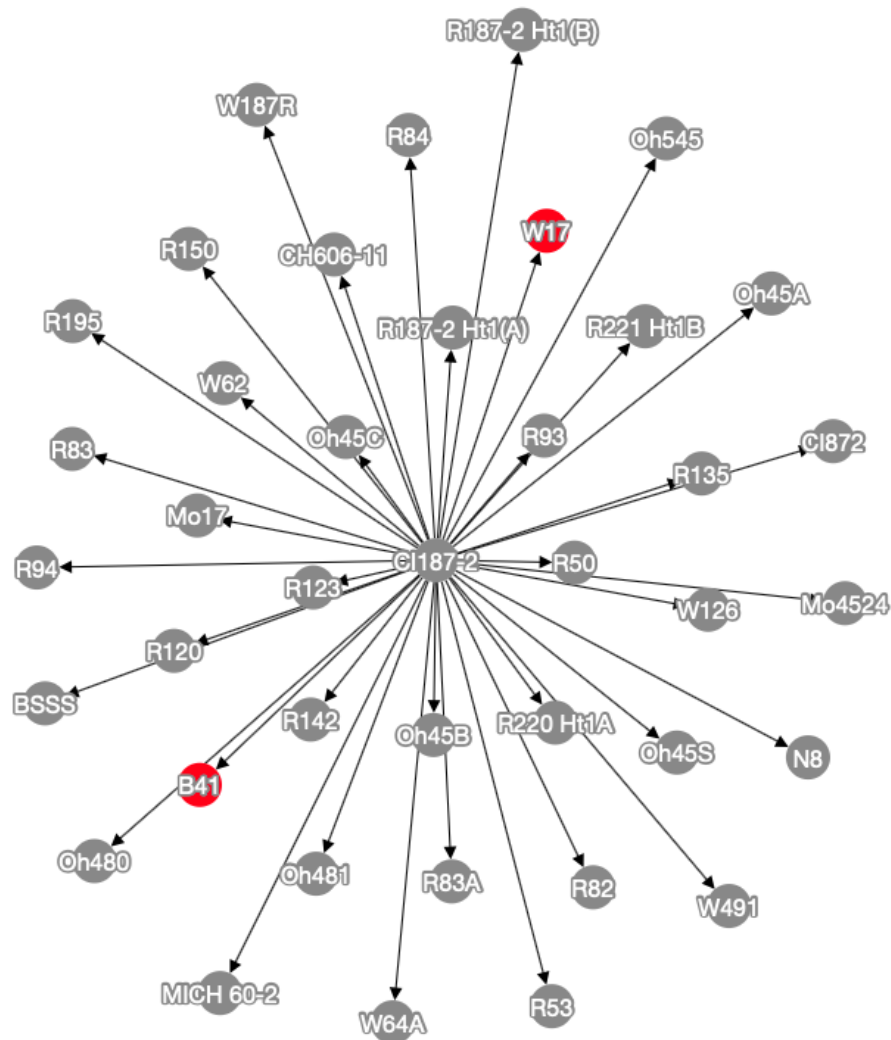

Similar to Tool #2, a wider net can be cast around the lowest common ancestor for two varieties. After an ancestor is identified by PedigreeNet, then the tool shows other immediate progenies of the ancestor. In the example provided with PedigreeNet, the following network is obtained when the lowest common ancestor is identified and displayed for B41 and W17:


Direct URLs can be used to display a network around the lowest common ancestor of two stocks as follows: https://www.maizegdb.org/breeders_toolbox?lca=1&node1=B41&node2=W17

Links to the MaizeGDB Stock Pages

After a pedigree network is displayed on the page, users may want to get more information for any of the varieties shown in the network. They can accomplish this by left-clicking the node and following the provided link to go to the appropriate MaizeGDB Stock Page.

Since CI187-2 is identified as the lowest common ancestor of B41 and W17 in the previous example, this is what users would see if they click on the CI187-2 node:
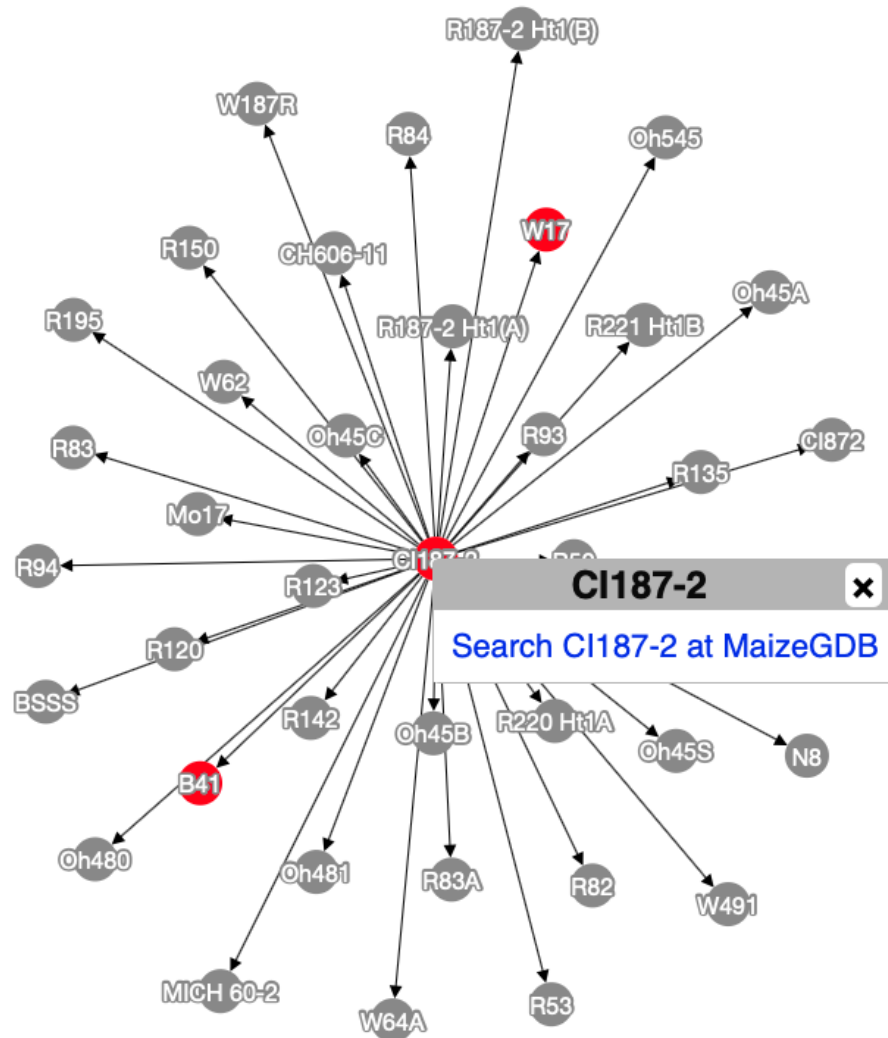
After clicking "Search CI187-2 at MaizeGDB" link, the MaizeGDB Stock Page for CI187-2 opens up in a new tab:

Downloading the Whole Pre-loaded Network
If users would like to download the pre-loaded network in its entirety, they can use the link at the bottom of the page ("Download Full Network (nodes, edges)") in the CSV (i.e., comma-separated values) format.

Downloading a Network Image
Users can download the network diagram shown on the PedigreeNet page in the PNG (i.e., Portable Network Graphic) image format to use in manuscripts and presentations.

Downloading the (Sub)Network Relationships as a CSV File:
Users can download the network diagram shown on the PedigreeNet page as a CSV (i.e., comma-separated values) text file.

Formatting the Graphical Properties of Networks

The graphical properties of the network can be modified. The network itself can be zoomed in and zoomed out using by either pressing "Expand Network" / "Compress Network" buttons or the wheel that comes with many mouse types. In addition, the following properties of the display can be adjusted using Cytoscape.js properties:

1. Network Layout
   a. Random
   b. Circle
   c. Grid
   d. Concentric
   e. Breadthfirst
   f. Cose
2. Node Color
   a. Gray
   b. Red
   c. Blue
   d. Green
   e. Yellow
3. Line color
   a. Gray
   b. Red
   c. Blue
   d. Green
   e. Yellow
4. Node Size
   a. Small
   b. Medium
   c. Large
5. Node Shape
   a. Circle
   b. Rectangle
   c. Round rectangle
   d. Triangle
   e. Pentagon
   f. Hexagon
   g. Heptagon
   h. Octagon
   i. Star
   j. Diamond
   k. Vee
   l. Rhomboid
6. Line Thickness
   a. Thin
   b. Medium

c. Thick

Besides the network layout options, the options are straightforward to understand. Since the network layout options are not intuitive, and users are encouraged to experiment to understand how different options change the network layout or refer to the Cytoscape.js manuals at http://js.cytoscape.org/.
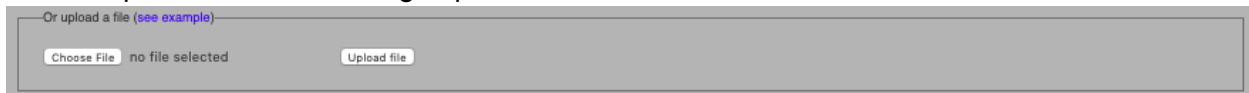
Displaying Customized Networks:
PedigreeNet can display customized networks two ways:
1. Manually entered in the box at the bottom of the page
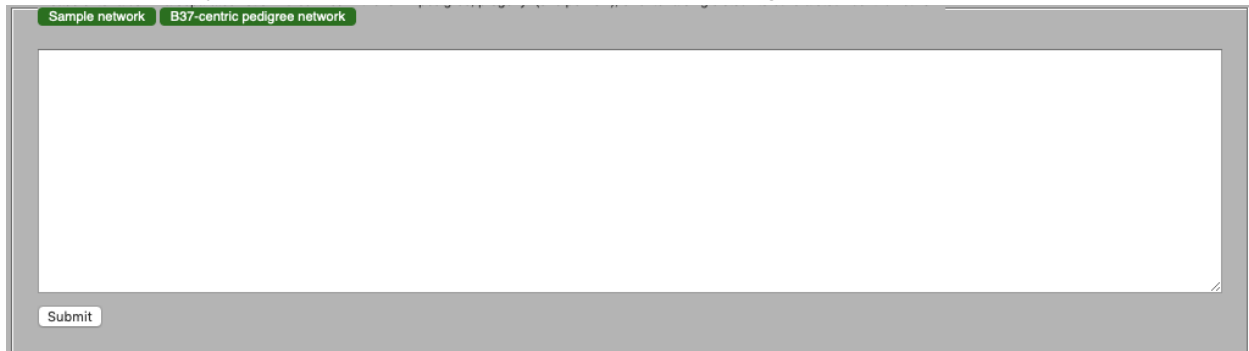
2. Uploaded as a file using "Upload File" button

In both cases, the entry should be in the CSV (i.e., comma-separated values) format. A sample network is provided in PedigreeNet: when users press "Sample Network" button, the following dummy network is shown in the box:

> parent,child
> child,child1
> child,child2
> child1,child3
> child2,child4
> child3,child5
> child4,child5

Also, when a single entry is put in the box, such as B37, a network centered on that variety is displayed. A button "B37-centric pedigree network" above the box is put to guide users.

Contact for more information for PedigreeNet:
Please send a feedback at MaizeGDB (a link is on the upper right corner on any webpage) or contact the corresponding author Taner Sen (taner.sen@ars.usda.gov) for your questions.