Pathfinder 9.0 – Quick Guide

Contents (Ctrl click opens section)

Pathfinder 9.0 – Quick Guide 1
Quick Start 1
Introduction: Pathfinder APP 1
Pathfinder APP 2
Derive Networks 3
Options 3
Network Layouts (Pictures) 4
Node Labels 5
Proximity Data File Formats 5
Matrices (including half matrices) and Lists 7
Menu Bar 7
Proximity Info 7
Network Info 7
Network Similarity 8

Quick Start

When you run Pathfinder for the first time on a computer, two folders will be created in your user folder, MATLAB and pfdir in the MATLAB folder. MATLAB may already exist if you have MATLAB installed. The pfdir folder is used to keep track of your project folders and to hold some sample data sets to illustrate the working of the APP. You can "Add Data" by clicking on that button and then selecting one or both of the sample proximity data files. Then "Derive Networks" by clicking that button, and the Pathfinder Networks (q = n-1, and r = infinity) will be created and will appear in the Networks list. Select one of these and click "Display Net" to see the selected network. The "Help" menu opens documents like this one.

To prepare data files for Pathfinder analysis, you must follow the conventions described in the section on Proximity Data File Formats. As the data are read in, the node labels are obtained from a file (usually terms.txt) described in the section on Node Labels.

Introduction: Pathfinder APP

A Pathfinder network is derived from proximities for pairs of entities. Proximities can be obtained from similarities, correlations, distances, conditional probabilities, or any other measure of the relationships among entities. The entities are usually concepts of some sort, but they can be anything with a pattern of relationships. In the Pathfinder network, the entities correspond to the nodes of the generated network, and the links in the network are determined by the patterns of proximities. For example, if the proximities are similarities, links will connect nodes of high similarity. With distance data, the network will connect close nodes. The links in the network will be undirected (lines) if the proximities are symmetrical for every pair of entities. Symmetrical proximities mean that the order of the entities is not important, so the proximity of i and j is the same as the proximity of j and i for all pairs of i,j. If the proximities are not symmetrical for every pair, the links will be directed (arrows).

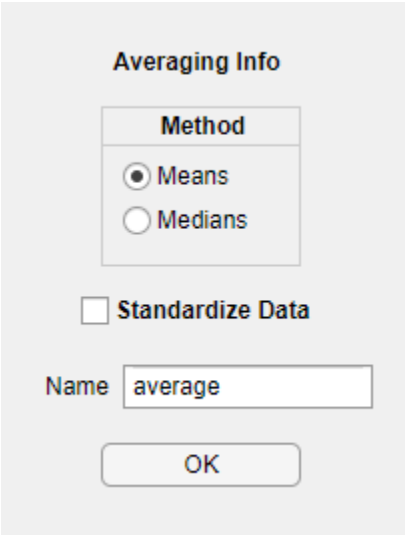
Pathfinder uses two parameters. (1) The q-parameter which constrains the number of indirect proximities examined in generating the network. The q- parameter is an integer value between 2 and n-1, inclusive where n is the number of nodes. (2) The r-parameter defines the metric used for computing the distance of paths (cf. the Minkowski r-metric). The r-parameter is a real number between 1 and infinity, inclusive. A network generated with particular values of q and r is called a PFnet(q, r). Both of the parameters have the effect of decreasing the number of links in the network as their values are increased. The network with the minimum number of links is obtained when q = n-1 and r = infinity, i.e., PFnet(n-1,infinity). With ordinal data, the r-parameter should be infinity (inf). Other values of r require data measured on a ratio scale. This level of measurement is difficult to achieve, so usually r should be set to infinity. The q-parameter can be set to the value that yields the desired number of links in the network. As q decreases, links may be added to the network.

Pathfinder APP

The Pathfinder APP allows you to initiate the functions accomplished by the software. Let's review the various controls and options. Each new window launched by the software will be described in detail in subsequent sections. The **Bold Items** below refer to sections of the interface and action you can take..

Project Folder is where the data you analyze and the results you create are stored. Select this folder as you begin a project. Different projects should be located in different folders. It's best to keep all of the data files in this same folder, but you can retrieve them from other folders as you work if you prefer. In any case, the results of your work will be stored in the Project Folder. This folder should also contain the terms.txt file or other term files as discussed below. You can change projects by selecting one in the drop-down menu which remembers the previous projects you have worked on. Start a new project with **Open New Folder** which will allow you to select the project folder you wish to work on. You should select the folder containing your proximity data and terms file. The next time you start Pathfinder, the last project you worked on will load automatically. View Current Folder will just open an Explorer window with that folder allowing you work on files in that folder including opening files with results of Pathfinder analysis.

In the **Proximity Data** panel, there is a button to **Add Data** and a list box which will show the data sets that have been added to the project. Clicking **Add Data** will open a file selection window pointing to the **Current** folder. It is set to look for txt files with prx in the name, like bio.prx.txt, but you can change the files listed if the default is not appropriate for your data file names. Just select the data file or files you wish to add and click **Open**. The selected files will be read to create the appropriate data for further analysis.



Clicking the **Average Data** button after selecting the data sets to be averaged will open a dialog window for you to select some options for averaging the distances for each pair of items across the selected data sets. You can use either **Means** or **Medians** and can determine whether to **Standardize Data** or not. Medians are best if there are any missing data items or values outside the min and max data values because that leads to infinite distances. Standardizing is especially appropriate if the data sets to be averaged differ in scale or variance. Modify the **Name** box to a name appropriate for your data sets. Your name will have the number of data sets appended to it after the averaging is complete. The averaged data set will appear in the **Proximity Data** list after you click **OK**.

Derive Networks

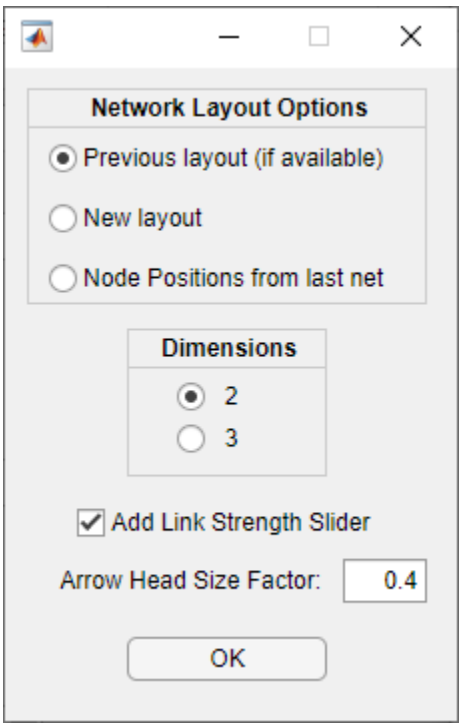
There are three different methods for deriving networks: **Pathfinder**, **Threshold**, and **Nearest Neighbor**. If you **select** data sets to analyze, networks for those sets will be derived. If you do net select data sets, all data sets will hace netwoeks derived from them. When you select a method, parameters for the method are made available for editing. When you **select** *Pathfinder Networks*, you can **edit** the values of the *q parameter* and the *r parameter*. The default values for the parameters are shown in the figure. Networks created with these parameters will have the same names as the data sets they are derived from. Any change in the parameters will lead to the creation of a new network, and the name will include the values of the changed parameters. For example if we analyzed the data, bio, with q set to 2, the name of the network would be bio_q2. If we used the default values, the network name would be the same as the data set, bio.

The Threshold Method allows you to specify how many links you would like to see in the network by providing a multiplyer for the number of nodes (1 yields the number of nodes). The resulting network will have at least that many links by linking all nodes whose proximity data value is within a cutoff value yielding the desired number of links (smallest for dissimilarity or largest for similarity). There will be more links than requested when tied proximity values exist at the cutoff.

Nearest Neighbor Networks simply identify the closest (or most similar for similarity data) node to each node. Nearest Neighbor nets are directed networks with arrows pointing from a node to its nearest neighbor. If there are ties, a node may have more than one nearest neighbor. Nearest Neighbor Networks are usually disconnected. Nearest Neighbors have _nn appended to the data name.

Clicking **Derive Network** will initiate the network creation and the names of the nets will appear in the **Networks** list panel.

When a network is selected, the nodes for that network are shown in the **Nodes** panel. Clicking **Display Net** will create and display a picture of the network. Selecting a node will produce a picture of the part of the network focused on that node. All nodes within the **Focus Links** number of links from the selected node will be included in the focus picture. If multiple networks are selected, then **Merge Nets** will produce a network which merges the links from all selected networks (the union of the links in the selected networks).



Options

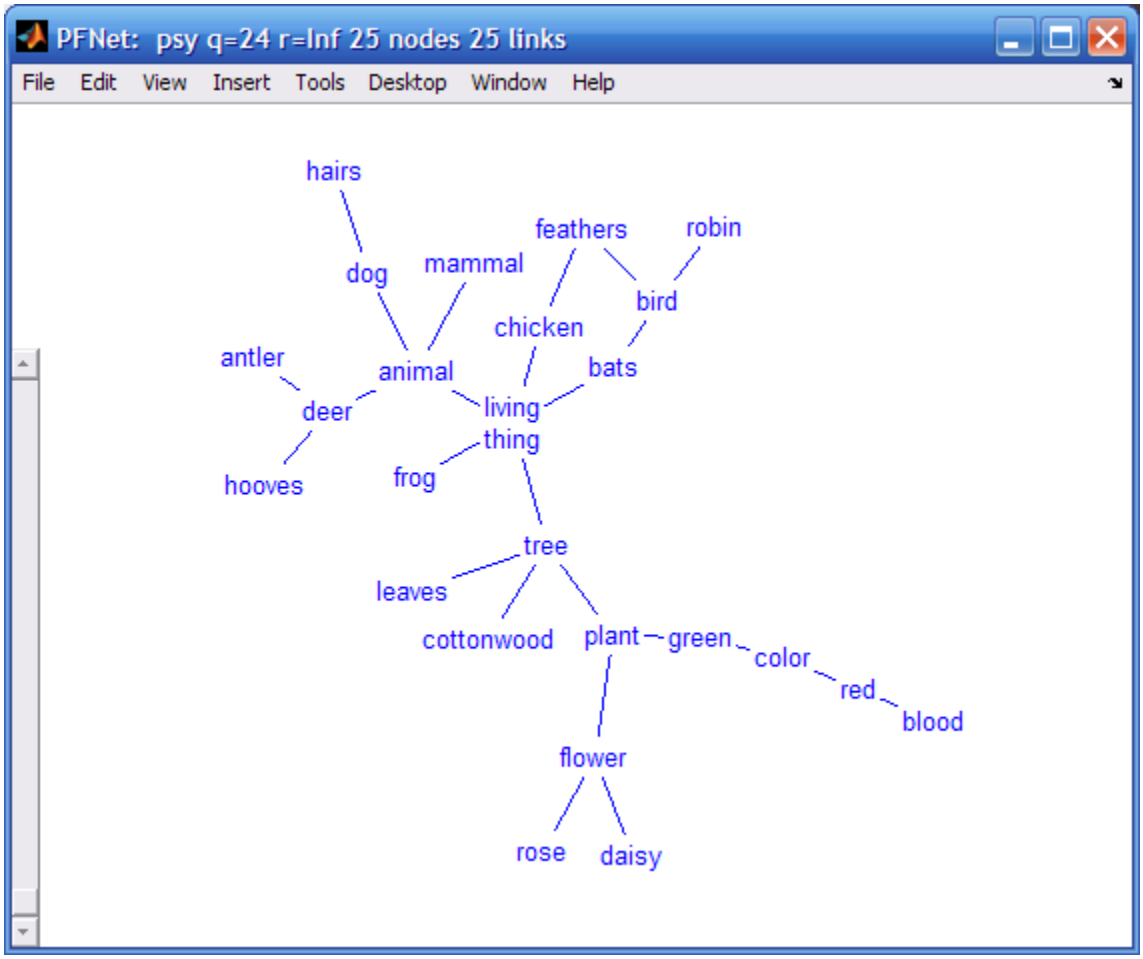
Checking the Options box will allow you to change options for drawing networks. You can **select** whether to provide a 2 or 3 dimensional display. Because you can rotate the pictures, 3D can often be useful. However, 3D is not available for directed networks. There are various options for determining the positions of the nodes in the picture. Select **Previous layout (if available)** if you want to recall the positions from an earlier display of the same network. If the positions are not available, it will compute new ones. **New layout** will discard the old positions and generate new ones. **Node**

Positions from last net will keep the nodes in the same position as the last displayed network. This can facilitate comparing different networks by keeping the nodes in the same position. If you first generate a merged network with two network you want to compare, then layout the merged network, next Retain Node Positions while drawing each of the two networks in turn. **Add Link Strength Slider** adds a slider to the drawing of a network. The slider allows you to selectively remove the weakest links in a network in steps until all of the links are removed.

Arrowhead Size Factor allows you to control the size of arrowheads in layouts of directed networks – values less than one will decrease the size, values greater than one will increase the size.

Network Layouts (Pictures)

Here is a picture of a displayed network. The title shows the name of the networks and the q and r parameters used to generate it. The tools allow you to move it, resize it, and rotate it. The changes you make to its appearance are saved so when you view it again with **Previous layout (if available),** it will show up just as you left it. Rotations with 3-D layouts are especially impressive. The *File* menu has the usual options for printing and saving. You can save the figure using various formats to enable you to get the image into other applications.



You can **click** on a node and **drag** it to move it to a new position (links follow). When you move the nodes to new positions, the new node positions are saved so future layouts of the same network will appear as you left it provided you select **Previous layout (if available)** in the **Options**. If you **double click** on a node, a network focused on the clicked node will appear.

As you **move the slider** on the left-hand side, links will drop out of the network in the inverse order of strength. Weaker links will disappear first. At the top, no links will be present. As the slider is moved down. The strongest links will appear in order of strength.

Loops (links from a node to itself) are shown with a border around the name of the node.

Node Labels

Nodes is a list of node labels for a selected network. It shows a list of the terms taken from a file, "terms.txt" or "terms," if it exists in the Project Folder. If different data sets have different terms, they should be in files called "<data>.trm" or "<data>.trm.txt" where <data> is the name of the corresponding data file, "<data>.prx" or "<data>.prx.txt". In this case, a list of these ".trm" files is shown in the terms window. The terms are the node labels for drawings of the networks. **It pays to keep the labels short so the networks look reasonable.** The terms file must follow a simple format. The label for each node is placed on a separate line in a text file. The first line is the label for the first node and so on. If you are using only one set of labels for one or more networks, use terms.txt as the name of the file. If you have different terms for different data sets in a single directory (folder) on your disk, use the name prxfile.trm.txt where prxfile is the name of the proximity data file. For example, if you have proximity data files called foo1.prx.txt and foo2.prx.txt, the corresponding terms files should be named foo1.trm.txt and foo2.trm.txt. These naming conventions are used by the Pathfinder software. If an appropriate terms file cannot be located for a given data set, the nodes will be numbered consecutively. The number of lines in the terms file must match the number of nodes exactly. Blank lines at the end may prevent the file from being recognized as appropriate.

Proximity Data File Formats

The data may be in the form of similarities, dissimilarities, probabilities, distances, coordinates, or features. With dissimilarities or distances, smaller numbers represent pairs of entities that are close or similar or related and larger numbers represent pairs of entities that are distant or dissimilar or unrelated. The opposite is true of similarities, probabilities, or relatedness i.e., smaller numbers represent entities that are distant or dissimilar or unrelated and larger numbers represent pairs of entities that are close or similar or related.

With distance measures, the distance between an entity and itself (the major diagonal entries in a data matrix) is usually 0 (zero). Pathfinder will handle non-zero entries on the diagonal, however. Such values will lead to "loops" (links from a node to itself) in the network, although they will not be displayed. Data derived from transition probabilities may lead to such non-zero entries for the diagonal. You must be certain that the diagonal in a matrix contains meaningful values. If all diagonal values are equal, they are taken to have 0 distance (or maximum similarity). All entries in the data must be positive or zero. Negative numbers are not allowed. Values outside the minimum – maximum range (see below) will never produce links in the networks generated.

A strictly formatted text file is required for proximity data. Here is a small example of such a file:

data
similarity
5 nodes
comment
10 minimum value
90 maximum value
lower triangular matrix

32
40 49
32 38 53
73 63 77 18

The required format of a data file is described below.

Data file format. / indicates alternatives:

Line 1: Identification as data file = Data/DATA/data
Line 2: Type of data = dissimilarity /distance /dis/similarity/sim/probability/prob/
Line 3: Number of nodes = integer
Line 4: comment: short description
Line 5: Minimum data value = real number
Line 6: Maximum data value = real number
Line 7: Order of data values = matrix/upper/lower/list/coord/featur/attrib
Line 8: Data
Line 9: Data ...
.
.
Line ?: Data

The lines in the file must be organized as shown above. For the first six lines, the program reads only the first entry on the line and then goes to the next line. Anything can follow the first entry on the line; the program doesn't use it. Some descriptive information on the line can help to keep things straight, especially after some time has elapsed. Details on the required input are as follows:

Line 1. "Data," "DATA," or "data" is used to identify the file type

Line 2. "similarity," "dissimilarity," "probability," or "distance," (or "sim," "dis," or "prob,") are used to indicate the direction of the data. With similarity data, larger values represent greater similarity. With distance data, smaller numbers mean closer (or more similar).

Line 3. The number of nodes (or entities) to be analyzed. The word nodes is optional

Line 4. Comment: a shrot description of the data

Line 5. the minimum value in the data set. Words are optional.

Line 6. the maximum data value. Words are optional.
The minimum and maximum values are used as cutoffs in handling the data. Any value in the data outside the minimum - maximum range will never become a link in networks. In other words, two nodes with a proximity value outside the range can never be linked in any network generated by the program. Missing data can be handled by using values outside the range, or by using the "list" format for your data.

Line 7. "matrix" or "upper" or "lower" or "list" or "coord" or "featur." This line specifies the nature of the data following this line. Various ways of supplying proximities are possible based on a full matrix, an upper triangle, a lower triangle, a list, or vectors of features, attributes, or coordinates. The upper and lower (half-matrix) methods do not include the major diagonal (the proximity of an item with itself). Such values can lead to "loops" in the networks. If loops are appropriate, either a matrix or a list format must be used. The lines of data in the file do not have to have these shapes, but the data must be in the same order as they would if the lines did

have those shapes when we characterize order as reading across each line in turn. The following examples may be of help.

Matrices (including half matrices) and Lists

matrix:	lower:	upper:	list:
0 1 3 2 3 1 0 1 4 6 3 1 0 5 5 2 4 5 0 4 3 6 5 4 0	1 3 1 2 4 5 3 6 5 4	1 3 2 3 1 4 6 5 5 4	10 pairs symmetric 2 1 1 3 1 3 3 2 1 4 1 2 4 2 4 4 3 5 5 1 3 5 2 6 5 3 5 5 4 4

These four sets of data are all the same. Of course, if your data are asymmetric, they must be input as a matrix or a list with "nonsymmetric" or “asymmetric” specified. If the data are symmetric, any of the four shapes is acceptable. With the list format, the number of pairs in the list must be specified on the line following "list." The next line specifies whether the pairs define symmetric or nonsymmetric data. With the list format, missing pairs will never be linked.

Following the header lines, the data must occur as discussed above. With n nodes (or entities), a matrix must contain n^2 data elements, upper or lower triangles must contain n(n-1)/2 data elements. The list data must contain 3 numbers for each pair listed, the source entity, the destination entity, and the proximity.

See Pathfinder.doc for information about using the coordinates option for proximity data.

Menu Bar

The Menu Bar gives access to Information about **Proximity** Data, **Networks**, and Network **Similarity** as well as a means to **Delete** various data sets and networks from the project and to get added **Help**. Delete and Help are self explanatory.

Proximity Info

Proximity Details provides information about the proximity data in the project including a measure of the coherence of the data. **Coherence** reflects the consistency of the data. **Proximity Correlations** are simply the Pearson product-moment correlations of the data sets. **Proximity Distance Matrix** shows a table with the distances between all pairs of nodes.

Network Info

Net Details provides information about the networks. **Net Properties** shows graph theoretic properties of a selected network. This includes the number of links to each node (Degree) of a node, the node or nodes with maximum degree, the Eccentricity (the maximum number of links between the node and all other nodes), the Center (the node or nodes with minimum Eccentricity), the Average Minimum

Distance between each node and all other nodes, and the Median (the node or nodes with minimum Average Minimum Distance). **Net Link List** is a table showing the links in a network with the distance associated with each link and the type of link. **Net Links Between Nodes** is a matrix with the minimum number of links between nodes in a network.

Network Similarity

The similarity between two networks is determined by the correspondence of links in the two networks. The **Net Similarity** is the **Number of Common Links** divided by the total number of unique links in the two networks. Two identical networks will yield a similarity of 1 and two networks that share no links will yield similarity of 0. The measure is the proportion of all the links in the two networks that are in both networks. Also some statistical information is computed about the similarity. The **Net Similarity Above Chance** is the similarity minus the chance similarity. The **Probability Sim or Greater** is the probability that the two networks would share the given number of links or more by chance. It can be used as a statistical test of the similarity of two networks. These values reflect how much more (or less for negative values) similar two networks are than would be expected by chance.