The NWB Tool: Visualizing Tree Data

Goals

This tutorial introduces the basic concepts of tree graphs and various tree visualization algorithms. You will learn how to load and visualize trees using the following features of Network Workbench:

1. Directory Hierarchy Reader to create tree graphs
2. Tree Map visualization
3. Tree View visualization
4. Radial Tree/Graph visualization
5. Balloon Graph visualization

1. What is a Tree?

Many data sets come in tree format. Examples include family trees, organizational charts, classification hierarchies, and directory structures. Read also "To Draw a Tree" by Pat Hanrahan at http://www-graphics.stanford.edu/~hanrahan/talks/todrawatree/ToDrawATree.2up.pdf.

A tree graph is a set of straight line segments (edges) connected at their ends containing no closed loops (cycles). You can also call it a simple, undirected, connected, acyclic graph (or, equivalently, a connected forest). A tree with *n* nodes has *n-1* graph edges. All trees are bipartite graphs.

Many trees have a root node and are called rooted trees. Trees without a root node are called free trees. Subsequently, we will only consider rooted trees. In rooted trees, all nodes except the root node have only one parent node. Nodes which have no children are called leaf nodes. All other nodes are referred to as intermediate nodes.

2. Creating a Tree

You can use the Directory Hierarchy Reader (DHR) algorithm to read a file directory hierarchy and then create a tree graph. A file directory can be thought of as a tree with a specific folder at its root and its subfolders and the files within them as its branches.

Click **File➔ Directory Hierarchy Reader** from the menu of the NWB tool. A pop-up window asks you to specify the following input parameters:

- define a root directory from where the reader should begin to crawl the subfolders and the files inside
- how many levels (how deep) to recurse (iteratively search) or to recurse the entire tree
- whether to read only directories or to crawl the directories to the specified level

Change the default input by checking "Recurse the entire tree," and uncheck "Read directories only (skips files)," shown in Figure 1. After clicking "OK," a tree graph should show up in the Data Manager window. Be sure to always highlight this dataset before you select any visualization algorithm discussed in the following sections.
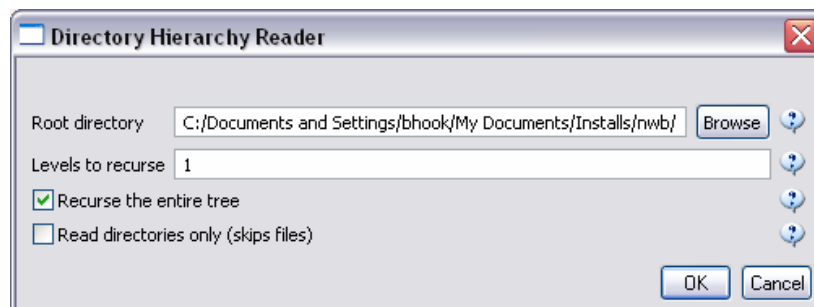

Figure 1: Directory Hierarchy Reader parameter settings window

3. Tree Map Visualization

Tracing its ancestry to Venn diagrams (http://iv.slis.indiana.edu/treemap.html#Venn), the Treemap algorithm was developed in the HCI Lab at the University of Maryland (http://www.cs.umd.edu/projects/hcil/). It uses a space filling technique to map a tree structure (e.g. file directory) into nested rectangles with each rectangle representing a node. A rectangular area is first allocated to hold the representation of the tree, and this area is then subdivided into a set of rectangles that represent the top level of the tree. This process continues recursively on the resulting rectangles to represent each lower level of the tree, with each level alternating between vertical and horizontal subdivisions.

The parent-child relationship is indicated by enclosing the child-rectangle by its parent-rectangle. That is, all descendents of a node are displayed as rectangles inside its rectangle. Associated with each node is a numeric value (e.g. size of a directory) and the size of a node's rectangle is proportional to its value. Ben Shneiderman's 'Treemaps for space-constrained visualization of hierarchies' webpage (http://www.cs.umd.edu/hcil/treemaps/) provides the full story.

To learn more about Tree Map, please read the learning module at http://iv.slis.indiana.edu/sw/treemap.html. In the NWB tool, highlight the tree dataset (created by Directory Hierarchy Reader) shown in the Data Manager window, then click **Visualization→ Tree Map (prefuse beta)**; a window similar to Figure 2 will appear displaying the Tree Map visualization.
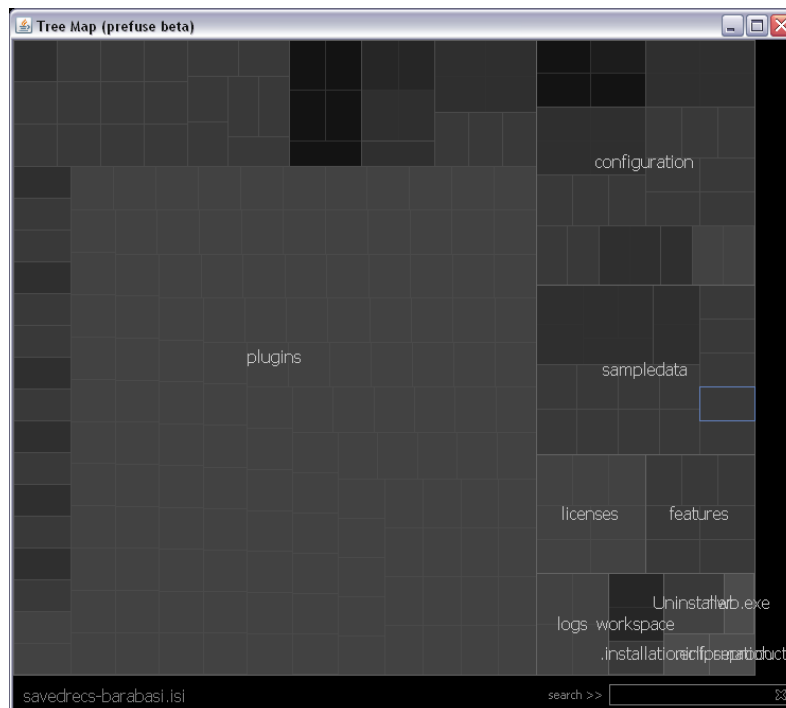

Figure 2: Tree Map Visualization

4. Tree View Visualization

The tree view is similar to the traditional family tree layout. Highlight the tree dataset (created by Directory Hierarchy Reader) shown in the Data Manager window, then click **Visualization→ Tree View (prefuse beta)**; a window similar to Figure 3 will appear displaying the Tree View visualization. If you press and hold the right or middle button of the mouse while moving it back and forth, you can zoom in and out on the Tree. By clicking a folder name such as "sampledata," all sub-folders and files inside the sampledata folder will display (shown in Figure 3).
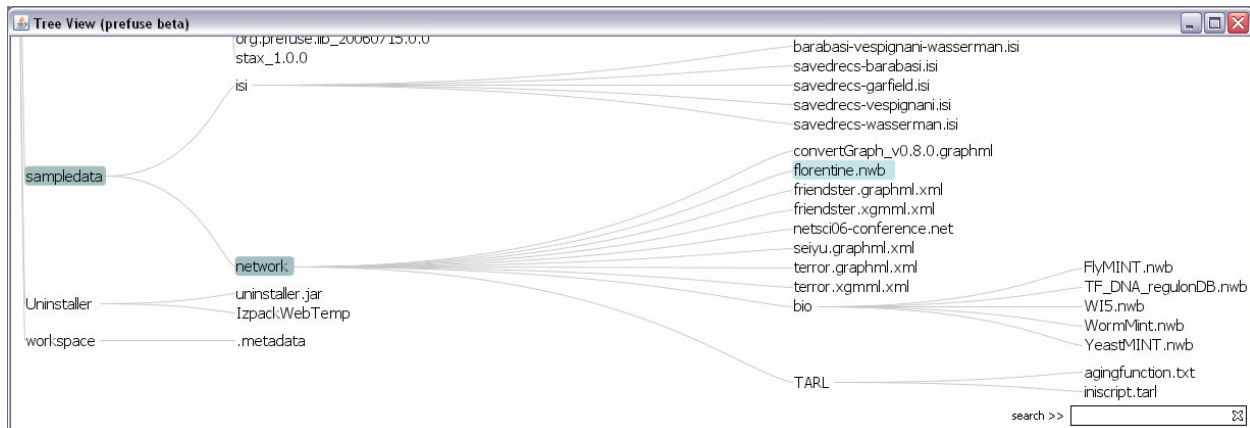
Figure 3: Tree View Visualization

Note: There is a search box in the bottom right corner of both the Tree Map and Tree View visualizations. Just enter a directory (folder) name or file name and the "search" feature will highlight the query result in the visualization window.

5. Radial Tree Visualization

The radial tree layout uses a focus + context (fisheye) technique for visualizing and manipulating large hierarchies. In a radial tree, the focused node is placed in the center of the display and all other nodes are rendered on appropriate circular levels around that selected node. The further away a node is from the center, the smaller it is rendered. This way, very large hierarchies can be displayed.

Many hierarchies, such as controlled vocabularies or file directory structures, are too large to display in their entirety on a computer screen. Radial trees display potentially very large rooted or unrooted trees. Users can focus on particular parts of those trees without losing context. Crossing of edges during the animated focus change appears to be confusing for users. User studies are needed to (dis)confirm this.

To learn more about Radial Tree, please read the learning module at http://iv.slis.indiana.edu/sw/radialtree.html.

In the NWB tool, highlight the tree dataset (created by the Directory Hierarchy Reader) shown in the Data Manager window, then click **Visualization→ Radial Tree/Graph (prefuse alpha)**; a window similar to Figure 4 will appear displaying the Radial Tree/Graph visualization. Double-click on a node and observe the change of the layout.
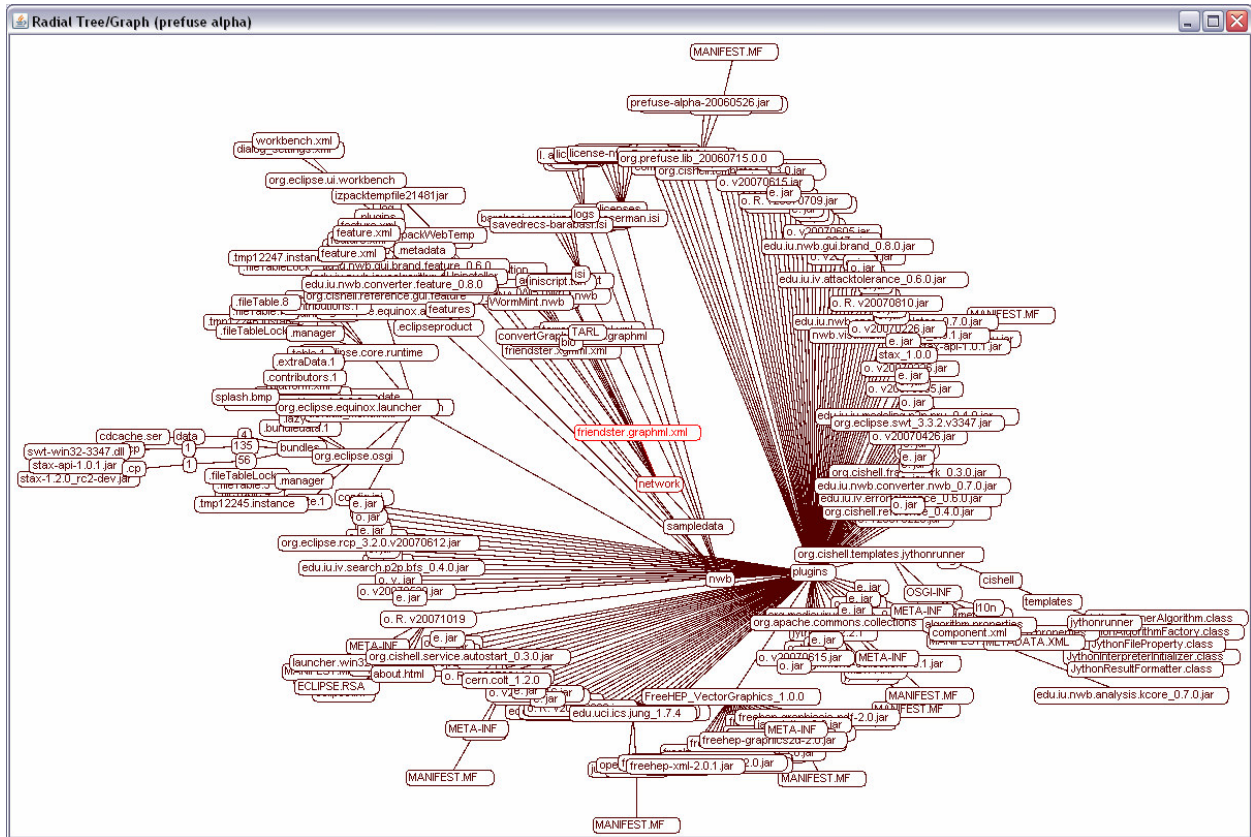
Figure 4: Radial Tree/Graph Visualization

Radial Tree/Graph with Annotation

Highlight the same tree dataset (created by the Directory Hierarchy Reader) shown in the Data Manager window, then click **Visualization➔ Radial Tree/Graph (prefuse beta)**; a window similar to Figure 5 will appear, asking you to specify the following annotations: node size, node color, node shape, ring color, edge size, and edge color. In the example, we specify **Ring Color = label** shown in Figure 5. After clicking "OK," a Radial Tree visualization with color coded node rings will be displayed (shown in Figure 6). You can see that the major node is called Plugins, near the nwb node in the center.
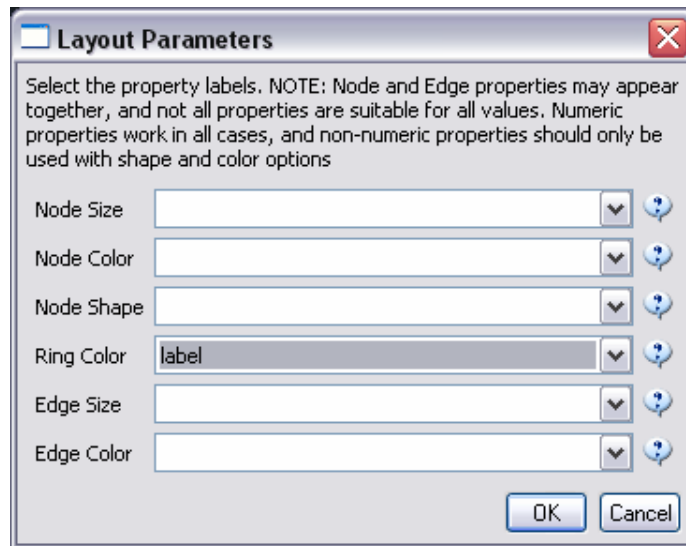
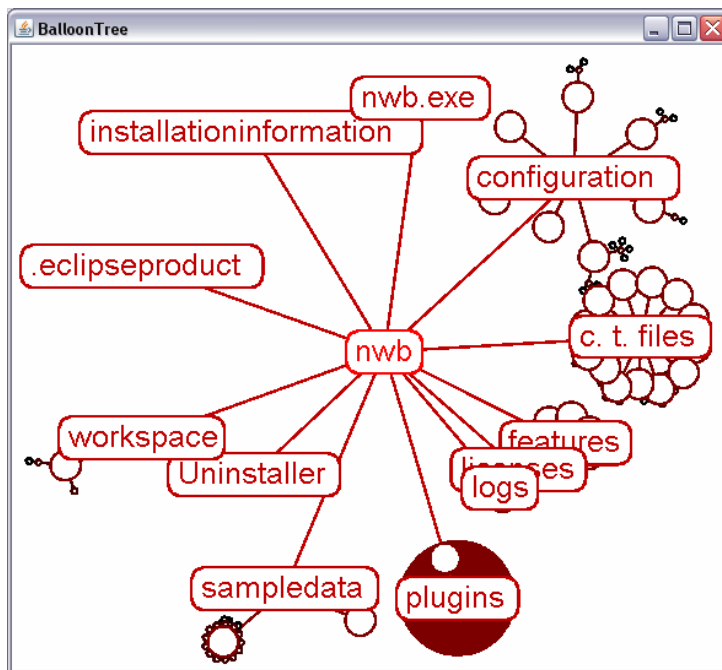

Figure 5: Annotate a Tree Graph

Figure 6: Radial Tree with Annotation Visualization

You can move the nodes around in the visualization window to view how they are connected.

6. Balloon Graph Visualization

Highlight the tree dataset (created by the Directory Hierarchy Reader) shown in the Data Manager window, then click **Visualization➔ Balloon Graph (prefuse alpha)**; a window similar to Figure 7 will appear displaying the Balloon Graph visualization. If you press and hold the right or middle button of the mouse while moving it back and forth, you can zoom in and out on the Tree. Double-click on a node and observe the change of the layout.

Figure 7: Balloon Graph Visualization

Acknowledgements