Pajekto3DStereo: Enabling Generation and Interaction with 3D Stereo Networks

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Abstract
Although 2D networks have been useful in revealing complex associations in a wide range of biomedical applications, they are often too dense to comprehend. In such situations, a 3D layout of the same network provides an extra degree of freedom in the z-plane, often resulting in a more accurate representation of the associations in the data. However, 3D layouts displayed in 2D occlude nodes that are further away in the z-plane, and therefore require the network to be rotated in order to view the nodes and comprehend their relationships in 3D space. Unfortunately, this rotation leads to disorientation and therefore requires a stereo version of the 3D layout to enable rapid comprehension. Because tools to develop such 3D stereo layouts are either proprietary or expensive, we developed Pajekto3DStereo, a simple interface in R that enables researchers to convert a 3D network layout into a format that can be used by a freely available stereo-visualizing tool called VMD. Pajekto3DStereo has enabled the discovery of a complex pattern related to two intersecting biological pathways that was missed using a 2D network layout.

Introduction
Numerous projects have demonstrated the utility of 2D network layouts to help researchers comprehend complex multivariate relationships. However, network layouts are often too dense, resulting in the infamous “hairball” network with apparently no discernable pattern. In prior research, we have argued that 3D network layouts provide an extra degree of freedom on the z-plane, force-directed algorithms such as Fruchterman Reingold (FR) generate network layouts that more accurately reflect complex associations in the data. However, 3D network layouts displayed in 2D lead to node occlusion or disorientation when the model is rotated to view the occluded nodes. Such networks need to be displayed in 3D stereo which enables comprehension of the 3D layout without having to rotate the model. Here we describe a tool that enables the rapid generation of 3D stereo network models.

Method and Results
As shown in Figure 1, we have developed a tool in R called Pajekto3DStereo which takes as input a network layout file containing the X,Y,Z coordinates of nodes laid out by a 3D network layout algorithm (e.g., FR available in Pajek). Through this interface, the user can also specify (1) color and size of the nodes, (2) number of edges to be displayed, and (3) display parameters that are critical for a high fidelity layout. Pajekto3DStereo then converts the network layout data into a format that can be read by VMD (a well-known freeware used to display molecules, nodes, and edges in stereo). As shown in Figure 2, the converted file can then be displayed and interacted with in 3D stereo. Such visualizations generated with Pajekto3DStereo have enabled the discovery of a sub-topology that was missed when using 2D network layouts. In future research we intend to expand the features provided by Pajekto3DStereo, and user test the interface with the goal of enabling a wide range of researchers to freely and rapidly convert 2D network data into 3D stereo views that enable discoveries in complex multivariate data.

References