Visualizing Dense Dynamic Networks with Matrix Cubes

Social networks, trading flows between countries, connectivity in the brain and signals between devices can be understood and represented as dynamic networks, where topology and edge attributes change over time. To facilitate visual exploration of such networks we introduce Matrix Cubes, a visualization and navigation model that results from stacking adjacency matrices, one for each time step in the network. Exploring the cube builds on our familiarity with cubes in the physical world and offers intuitive ways to look at, manipulate and decompose them. We describe a set of operations to decompose the Matrix Cube and interact with the resulting views as well as several visual mappings, implemented in our interface called Cubix.

Edges
Any edge in the network, between two nodes at one time is represented by a cell inside the cube. Cell size can encode, for example, edge weight.

Nodes
Nodes correspond to horizontal and vertical slices, called node slices.

Time Slice Rotation
Individual time slices can be be rotated like books in a bookshelf to get a quick preview on any time step's topology.

3D View
The 3D view can be rotated, panned and zoomed in/out. When hovering cells, the corresponding labels for nodes and time get highlighted to make their identification easier.

Value Encoding
Edges can be filtered by their weight. Here weight is encoded using a scale from blue (low) to red (high). While filtering, edge scale and coloring gets adapted to the current range.

Node Slice Rotation
Individual node slices can be be rotated like books in a bookshelf. A node's connections are shown in the context of the network's topology.

Transitions
All view changes in Cubix are performed as animated transitions. Here, the cube is decomposed and the slices are laid out in a juxtaposed way.

Time Multiples
Shows all node slices side by side. Cells have equal size and edge weight is encoded as values from light to dark blue, for better readability.

Co-authorship network

Shows all node slices side by side. Cells have equal size and edge weight is encoded as values from light to dark blue, for better readability.

Filtering
Edges can be filtered by their weight. Here edge weight is encoded using a scale from blue (low) to red (high). While filtering, edge scale and coloring gets adapted to the current range.