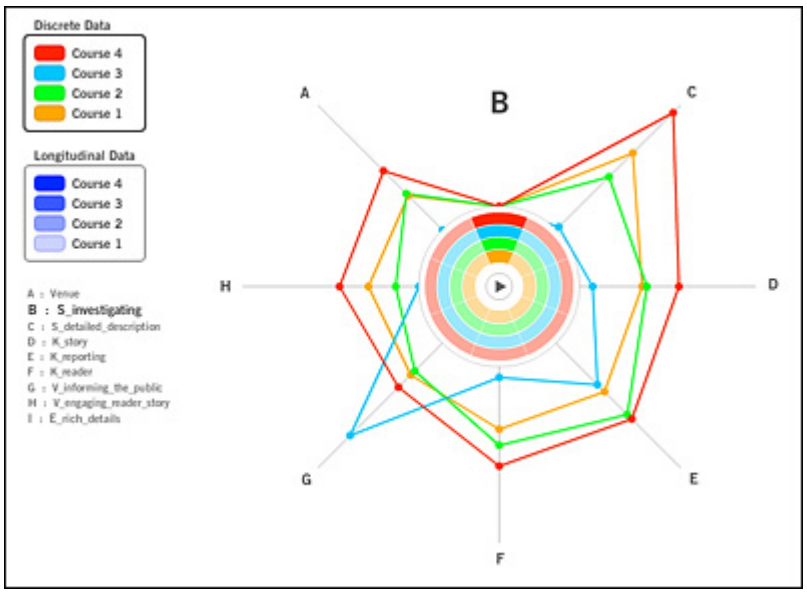
Team of Jeremy, Adrian and Leslie.

Connected Spokes

http://www.blueshirt.com/clients/cs/

The concept places all study samples on the same set of spokes and allows the user to select the study and variable by clicking the 'wedges' near the center. The user may choose individual data sets by selecting the legends for either discrete data or longitudinal data. A list of the labels and corresponding frame elements occupies the left side of the visualization, just below the selectable legends, which highlights the currently selected element by increasing the font size. Lines connect the frame elements so that a closed shape exists that can be used for comparison across the different frames.



The spoke wheel will reorient itself if a new frame element is selected that is not grouped under the same label. For example, selecting any of the wedges for the D label will rotate the wheel so that all of the D wedges are on top. Selecting wedges that are already on the top of the wheel will not produce any rotation. The data points, represented by circles, can be displayed by selecting any of the individual wedges, or by selecting any of the labels along the outer edge of the spokes. Retrieving the raw numbers can be accomplished by mousing over the data circles that appear along each spoke. Also, a circle will appear when mousing over each data point in order to easily make comparisons between points along other spokes.

A play button is available to the user in order to see the differences between frames. Each data circle will animate along its spoke until it reaches the point represented by the following frame. A pause button appears once the user has initiated the animation.

Feedback

The feedback mostly covered the design aspects of the visualization. Some suggestions were quite helpful and were implemented in the final version. The addition of the legend was based on Nate's suggestions for an easy way to view the classed information. The play button builds upon the different suggestions to cycle through the data in a meaningful way. The biggest problem, as seen by several people, is the potential limit to the number of frames that can be present at once. The concentric circles radiating out from the center may limit the total number of frames because of the static size of the allotted space.

Problems the Visualization Addresses

The connected spokes visualization presents the information without overwhelming the user with large sets of tabular data. The restrictive nature of some of the interaction ensures that comparisons are made between elements that should be compared. The use of animation can show slight variations between frames while the relative position of the data circles gives the user a quick impression of the data.

Strengths and Weaknesses

This visualization is heavy on design, which can be considered both a strength and a weakness. On one hand, creating a visually appealing design can draw the user into the experience and potentially increase the length of engagement. On the other hand, the simplistic approach can come across as less scientific and therefore diminish the importance of the findings. Overall, the design simplifies the problem into a highly visual solution that can be used to easily make comparisons across frames.

Design Principles

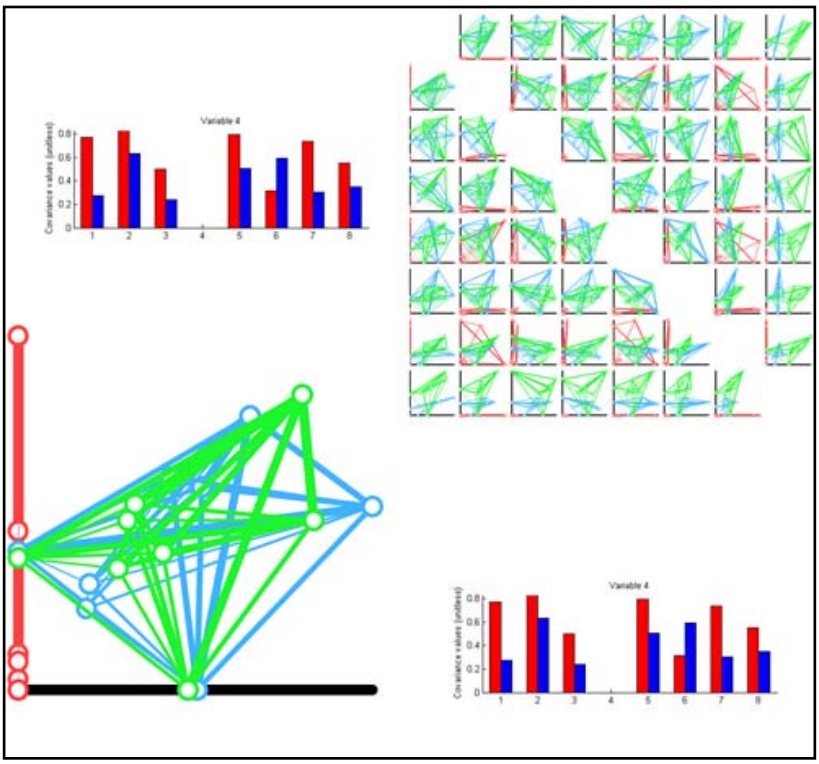
The design relies mostly on position, hue and shape to accomplish its tasks. Following Tufte's lead, very few extra pixels are used beyond what was necessary. Comparisons can be made easily with this approach. A lot of whitespace is used to focus the user's attention on the areas where non-breaking lines and hue represent important information. Animation is used to show movement between frames and allows the user to distinguish large variations in the data easily. In terms of the problem,

abstraction, encoding and implementation of this design, the process yielded an approach that resulted in a simplification of the data, rather than introducing unnecessary complexity.

Exploration Matrix

http://pages.cs.wisc.edu/~adrm/cs838/dc/applet/

The visualization can be broken into 3 parts, the exploration matrix, the full size scatter plot, and a pair of 1D comparisons (bar charts or parallel coordinates)



Exploration Matrix:

An NxN matrix, where N is the number of dimensions in the frames. Each cell represents a 2 dimensional projection of an 8 dimensional object. Here, instead of showing full detail, only the outline (convex hull) is shown. Clicking on a particular cell changes the focus to that projection, which is reflected in the full size scatter plot

Full Size Scatterplot:

A 2D scatterplot where each node represents a row in the original matrix, whose position is given by 2 different row elements. The nodes are connected to each other with lines, whose width represents the strength of their co-expression . On the right and above the plot are 1D projections

1D projections:

These views show the strength of the co-expression of a single dimension with all others, across all frames. If there are 3 or 2 frames, then we use bars to compare the values. Because of scalability issues (visual clutter) we switch to parallel coordinates when comparing 4 or more.

Feedback

For Leslie's design:

- Negative
    - Too literal, using matrix as a matrix
        - Response: Combine this design with Adrian's overall shape design
    - Would not scale to more than two matrices (frames)
        - Response: same as above (See bar graph vs. parallel coordinates debate)
    - Grayscale color ramp difficult to interpret
        - Response: use color brewer (use multiple "color" channels)
- Positive
    - Coordinated interaction is good, keeps user focused.
    - Bar chart lends itself to easy comparisons
        - Concern: what about more than 2 or 3 frames?

For Adrian's design

- Negative
    - Small scatter plots in large matrix hard to read
        - Response: Summarize graphs by using only the convex hull
    - Generally too busy
        - Use dimensionality reduction (PCA) to reduce the number of variables
    - May lead to false pattern recognition
        - Use PCA to automatically analyze data for meaningful dimensions
    - Too much whitespace, hard to read nodes
        - Combine with parts of Leslie's design to fill out whitespace and make node labels
- Positive
    - Animation keeps user engaged
    - Matrix as an object leads to easier comparison
    - Good for exploration

Problems the Visualization Addresses

Our visualization allows the user to perform comparisons of frames across every possible 2D and 1D configuration. Also because of the hierarchical nature of the design, it lends itself to data exploration. Additionally, one can perform simultaneous comparisons on the order of 5 frames.

By providing a mechanism for hierarchical exploration, coupled with 2D and 1D projections, the complicated task of comparing multidimensional objects is broken down into a series of simple 1 and 2D visual comparisons, while retaining context.

Strengths and Weaknesses

- Weaknesses
    - Too busy, requires a high level of user involvement
    - Takes up too much screen space
- Strengths
    - Can browse the data at different scales
    - Novel way to visualize the dataset, forces a new perspective on the data

Design principles

By using the convex hull to display the shape of the frames in the exploration matrix, we make use of pre-attentive boundary and shape comparison. This frees up cognitive power so that the user can absorb the overall structure of the data.

To make each different frame even more distinct, we have opted to use color pallets from ColorBrewer, which offers sets of perceptually distinct colors.

For the 1D projections, we believe that using bar charts is a better way to visually encode the data, but it has the downside of not scaling past 3. For that reason, we will use a series of bar charts if comparing 3 or 2 frames. When comparing 4 or more, our system will fall back on parallel coordinates.

Development Process

Initially we all got together to brain storm about ideas. At the end of the meeting, we had each settled on a different type of visualization to explore, which we expanded upon for the prototype presentations. After feedback and further discussion, Adrian and Leslie combined their approaches into a single visualization that incorporates elements from both. Jeremy expanded on his design independently. Due to limited resources, we were unable to perform enough testing on our ideas, but we tried to follow visual and perceptual principles, along with the received feedback.