Interaction

CS 7450 - Information Visualization
February 16, 2006
John Stasko

“Little Brother”

- Two main components in an infovis
  - Representation
  - Interaction

- Representation gets all the attention
- Interaction is where the action is (no pun intended)
Research Focus

• Very challenging to come up with innovative, new visual representations
• But can do interesting work with how user interacts with the view or views
  – It’s what distinguishes infovis from static visual representations on paper

• Analysis is a process, often iterative with branches and side bars

Interaction

• Neglected aspect of infovis

• Call for “Science of interaction”
Interaction

• How do you define “interactive”?

Response Time

• .1 sec
  – animation, visual continuity, sliders
• 1 sec
  – system response, conversation break
• 10 sec
  – cognitive response
Example

Even simple interaction can be quite powerful

Stacked histogram

http://www.hiraeth.com/alan/topics/vis/hist.html

Example

www.digitalhistory.uh.edu/timeline/timeline.cfm
Interaction Types

• Dix and Ellis (AVI ’98) propose
  – Highlighting and focus
  – Accessing extra info – drill down and hyperlinks
  – Overview and context – zooming and fisheyes
  – Same representation, changing parameters
  – Linking representations – temporal fusion

Interaction Types

• Keim’s taxonomy (TVCG ’02) includes
  – Projection
  – Filtering
  – Zooming
  – Distortion
  – Linking and brushing
Examples

- Let’s take a look at what different systems provide
  - Focus on generalizing techniques

Selection

- Using pointer (typically) to select or identify an element
  - Often leads to drill-down for more details
Pop-up tooltips

- Hovering mouse cursor brings up details of item

Mouse Selection

Clicking on an item selects it and attributes of the data point are shown

Selected item
Attributes
Paper Recap

“Excentric Labeling: Dynamic Neighborhood Labeling for Data Visualization”

Jean-Daniel Fekete, Catherine Plaisant

SIGCHI conference on Human Factors in Computing systems in 1999

Sugandha Pahwa

Spring 2006 CS 7450 15

In this paper....

- Difficulties of labeling in Information abundant InfoViz applications.
- Informal Taxonomy of Labeling Techniques
- Excentric Labeling method introduced
Labeling Challenges...

- Readable
- Non-ambiguously related to its graphical object
- Does not hide any pertinent information.

Taxonomy of labeling...

- Broadly into static and dynamic.
- Problems with static: Label-at-all-cost
  - Rapid Label All
  - Label what you can
- Dynamic techniques: Cursor sensitive Balloon label
  - All or nothing
  - Overview and Detail view
  - Dynamic Sampling
  - Temporal Brushing
Excentric Technique: Demo

More on Excentric ....

- Dealing with too many labels
- Dealing with long labels
- Limiting discontinuities
- Facilitating selection of objects
Evaluation of Excentric

- Comparison of excentric with virtual instantaneous zoom.
- A 60% speed advantage for the excentric.
- Easily learnable after a little practice.
- No of operations in zoom was much more.

Details-on-Demand

- Term used in infovis when providing viewer with more information/details about data case or cases.
- May just be more info about a case.
- May be moving from aggregation view to individual view.
  - May not be showing all the data due to scale problem.
  - May be showing some abstraction of groups of elements.
  - Expand set of data to show more details, perhaps individual cases.
Direct Walk

- Linkages between cases
- Exploring one may lead to another
- Example:
  - Following hyperlinks on web pages

Rearrange View

- Keep same fundamental representation and what data is being shown, but rearrange elements
  - Alter positioning
  - Sort
**Rearrange**

In TableLens you can move columns (attributes) left and right.

**Sorting**

Can sort data with respect to a particular attribute in Table Lens.
Changing Representation

- May interactively change entire data representation
  - Looking for new perspective
  - Limited real estate may force change

Example

Selecting different representation from options at bottom
Highlighting Connections

- Viewer may wish to examine different attributes of a data case simultaneously
- Alternatively, viewer may wish to view data case under different perspectives or representations
- But need to keep straight where the data case is

Brushing

- Applies when you have multiple views of the same data
- Selecting or highlighting a case in one view generates highlighting the case in the other views
- Very common technique in InfoVis
Brushing

Filtering/Limiting

- Fundamental interactive operation in infovis is changing the set of data cases being presented
  - Focusing
  - Narrowing/widening
Zooming/Panning

- Many infovis systems provide zooming and panning capabilities on display
  - Pure geometric zoom
  - Semantic zoom

- Will be a focus of ours later this term...
  - Day devoted to topic

Dynamic Query

- Probably best-known and one of most useful infovis techniques
- Let’s explore more details...
DB Queries

- Query language
  - **Select** house-address
  - **From** atl-realty-db
  - **Where** price >= 200,000 and price <= 400,000 and bathrooms >= 3 and garage == 2 and bedrooms >= 4

DB Queries

- Pluses?
- Minuses?
**Typical Query Response**

- 124 hits found
  - 1. 748 Oak St. - a beautiful ...
  - 2. 623 Pine Ave.
  - ...

- 0 hits found

**Problems**

- Must learn language
- Only shows exact matches
- Don’t know magnitude of results
- No helpful context is shown
- Reformulating to a new query can be slow
- ...
Dynamic Query

- Specifying a query brings immediate display of results
- Responsive interaction (< .1 sec) with data, concurrent presentation of solution
- “Fly through the data”, promote exploration, make it a much more “live” experience
  - Timesharing vs. batch

---

Dynamic Query Constituents

- Visual representation of world of action including both the objects and actions
- Rapid, incremental and reversible actions
- Selection by pointing (not typing)
- Immediate and continuous display of results

Shneiderman
IEEE Software ’94

Ahlberg & Shneiderman
CHI ’94
Imperfection

• Idea at heart of Dynamic Query
  – There often simply isn’t one perfect response to a query
  – Want to understand a set of tradeoffs and choose some “best” compromise
  – You may learn more about your problem as you explore

Software Demo

• HomeFinder - Univ. of Maryland
New HouseFinder site

http://www.housingmaps.com

FilmFinder

Video
What Did We See?

- Interface
  - buttons
  - sliders (nominal --> ordinal)
  - alphasliders

Query Controls

- Variable types
  - Binary nominal - Buttons
  - Nominal with low cardinality - Radio buttons
  - Ordinal, quantitative - sliders
**Alphaslider**

- Goldfinger
- Current selection
- Slider thumb
- Slider area
- Index

**Rangeslider**

- Low selection thumb
- Real data range
- High selection thumb

Spring 2006 CS 7450 47
Spotfire

Spotfire Features

- Starfield display
- Tight coupling
  - features to guide the user
  - rapid, incremental, reversible interactions
  - display invariants
  - continuous display
  - progressive refinement
  - details on demand
Nice Application

www.myrateplan.com/cellphones

Another Example

www.bluenile.com/diamond_search.asp?track=dss
DQ Strengths

- Work is faster
- Promote reversing, undo, exploration
- Very natural interaction
- Shows the data
DQ Weaknesses

• ?

DQ Weakness

• Operations are fundamentally conjunctive
• Can you formulate an arbitrary boolean expression?
  − !(A1 V A2) ^ A3 V (A4 V A5 ^ A6) V ...

• But do people really do this often?
DQ Weakness

- Controls are global in scope
  - They affect everything

- Controls must be fixed in advance

DQ Weakness

- Controls take space!
  - How much in Spotfire?

- Put data in controls...
Data Visualization Sliders

![Diagram of Data Visualization Sliders](image)

From: Eick, UIST '94

---

DQ Weakness

- As data set gets larger, real-time interaction becomes increasingly difficult
- Storage - Data structures
  - linear array
  - grid file
  - quad, k-d trees
  - bit vectors

Tanin et al
InfoVis '97
**Brushing Histograms**

- Special case of brushing
- Data values represented in histograms that can be clicked on and selected (controls region)
- When items selected there, the corresponding item(s) are highlighted in main view windows

**BH Example**

DataMaps
Maryland & Va Tech
DQ vs. BH

- Empirical Study
  - Use DataMaps, a geographic (US states) data visualization tool
  - Have participants do different tasks with both methods
    - How many states have pop between x and y in 1970?
    - Given 3 states, which has the lowest median income?
    - What's the relationship between education and income?
    - List states with pops. 0->x and y->z.
    - What kind of a state is Florida?

Li & North
InfoVis '03

Findings

- Brushing histograms better and more highly rated for more complex discovery tasks
  - Attribute correlation, compare, and trend evaluation
- Dynamic queries better for more simple range specification tasks
  - Single range, multiple ranges, multiple criteria

Functioned more as its own infovis tool

Functioned more as auxiliary control for other vizzes
DQ vs. BH

- Fundamental Differences:
  - BH highlights data of interest;
    DQ filters unwanted data
  - DQ does single range query;
    BH allows multiple ranges
  - DQ users interact with the query (low, hi);
    BH users interact directly with data
  - DQ visualizes query formulation (1 way);
    BH displays query results too (I/O)

Li & North, ’03

Paper Recap

“The Attribute Explorer: information synthesis via exploration”

Robert Spence and Lisa Tweedie

Interacting with Computers, 1998

Jeonghwa Yang
Problem

• What’s the problem with dynamic query?

Attribute Explorer: Features

• Attribute histogram
• All objects on all attribute scales
• Interaction with attributes limits
Attribute Explorer: Features

- Inter-relations between attributes – brushing

Attribute Explorer: Features

- Color-encoded sensitivity
### Attribute Explorer: Video

**Attribute Explorer for Home Finder**

### Summary

- **Summary**
  - Attribute histogram
  - Attribute relationship
  - Sensitivity information
  - Especially useful in “zero-hits” situations or when you are not familiar with the data at all

- **Limitations**
  - Limits on the number of attributes
DQ Disadvantage

- Operations are global in scope
- Can we do something to fix that...?

Paper Recap

Enhanced Dynamic Queries via Movable Filters

Ken Fishkin, Maureen C. Stone
CHI '95

Arvind Venkataramani
**Basics: Scatterplot + Magic Lens**

- Good for visualizing multi-dimensional data
- Patterns are easy to interpret
- Selected area = query set
- Desired information can then be displayed for the set
- **zoom + filter + context** in the same step

---

**Composition**

Figure 1(a): High salaries AND low taxes.
Multiple ranges

Visual lenses
Distribution of Results

Boolean (all or nothing)

Distribution of values

Sorting

Spring 2006 CS 7450 79

Spring 2006 CS 7450 80
Missing Data

Aggregation

- Interactively select many data cases on display and aggregate them together to be represented as one unit or cluster
Supporting Representation

- Interaction in many cases is vital to representation
  - Provides useful perspective
    Many, many examples:
    Parallel coords, InfoZoom, anything 3D
  - Necessary for clarifying representation
    Dust & Magnet

---

Dust & Magnet

Yi et al
*Information Visualization '05*
Upcoming

• Time Series Data
  – Reading
    Müller and Schumann
• Overview and Detail
  – Papers to discuss

Sources Used

• Spence, CMS books
• Shneiderman; Ahlberg et al; Tweedie et al articles
• Chiu & Wang F99 slides