

Showing Complex Data

Alex Pantaleev, SUNY Oswego Dept of Computer Science

1

Basic User Questions

- How is this data organized?
- What's related to what?
- How can I explore this data?
- Can I rearrange this data to see it differently?
- Show me only what I need to know.
- What are the specific data values?

Data Organization

- Linear: List or single-variable plot
- Tabular: Spreadsheet, multi-column list, Sortable Table, Multi-Y Plot, or other multi-variable plots
- Hierarchical: Tree, Cascaded Lists, Tree Table, Treemap
- Network: Directed graph or flowchart
- Geographical/spatial: Map or schematic
- Other: Plots of various sorts, such as parallel coordinate plots, or Treemaps

What's Related to What?



And Again

| 0.103 | 0.176 | 0.387 | 0.300 | 0.379 | 0.276 | 0.179 | 0.321 | 0.192 | 0.250 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.333 | 0.384 | 0.564 | 0.587 | 0.857 | 1.064 | 0.698 | 0.621 | 0.232 | 0.316 |
| 0.421 | 0.309 | 0.654 | 0.729 | 0.228 | 0.529 | 0.832 | 0.935 | 0.452 | 0.426 |
| 0.266 | 0.750 | 1.056 | 0.936 | 0.911 | 0.820 | 0.723 | 1.201 | 0.935 | 0.819 |
| 0.225 | 0.326 | 0.643 | 0.337 | 0.721 | 0.837 | 0.682 | 0.987 | 0.984 | 0.849 |
| 0.187 | 0.586 | 0.529 | 0.340 | 0.829 | 0.835 | 0.873 | 0.945 | 1.103 | 0.710 |
| 0.153 | 0.485 | 0.560 | 0.428 | 0.628 | 0.335 | 0.956 | 0.879 | 0.699 | 0.424 |

How about now?

| 0.103 | 0.176 | 0.387 | 0.300 | 0.379 | 0.276 | 0.179 | 0.321 | 0.192 | 0.250 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.333 | 0.384 | 0.564 | 0.587 | 0.857 | 1.064 | 0.698 | 0.621 | 0.232 | 0.316 |
| 0.421 | 0.309 | 0.654 | 0.729 | 0.228 | 0.529 | 0.832 | 0.935 | 0.452 | 0.426 |
| 0.266 | 0.750 | 1.056 | 0.936 | 0.911 | 0.820 | 0.723 | 1.201 | 0.935 | 0.819 |
| 0.225 | 0.326 | 0.643 | 0.337 | 0.721 | 0.837 | 0.682 | 0.987 | 0.984 | 0.849 |
| 0.187 | 0.586 | 0.529 | 0.340 | 0.829 | 0.835 | 0.873 | 0.945 | 1.103 | 0.710 |
| 0.153 | 0.485 | 0.560 | 0.428 | 0.628 | 0.335 | 0.956 | 0.879 | 0.699 | 0.424 |

Preattentive Variables

| | Colo | r hue | | Position and alignment |
|----------------------------|----------------------------|----------------------------|----------------------------|------------------------|
| | | | | |
| | Color br | ightness | | Orientation |
| | | | | |
| | Color sa | aturation | | Size |
| abcdef abcdef abcdef | abcdef abcdef abcdef | abcdef abcdef abcdef | abcdef abcdef abcdef | |
| abcdef abcdef abcdef | abcdef abcdef abcdef | abcdef abcdef abcdef | abcdef abcdef abcdef | |
| | Tex | ture | | Shape |

Example



Navigation and Browsing

- Scroll and pan: interactively move the visible part of the graphic
- Zoom: change the scale
- Open and close points of interest
- Drill down into points of interest (open + zoom in)

Sorting and Rearrangement

1. Galveston

2. Beaumont

Confidence Interval off Scale

No bar indicates 0 deaths

US rate 69.40 (69.29 - 69.50) 1,690,373

State rate 70.80 (70.35 - 71.25) 95.372

95% confidence interval for mortality rates per 100,000 person-years by State Economic Area

Age-adjusted 1970 US Population





Sorting and Rearrangement



Searching and Filtering: Show me only what I need to know



- Interactive: respond as quickly as possible
- Iterative: let a user define the search/filter
- Contextual: show results with surrounding data (keyword embedded in a sentence)

Actual Data: Show the Values

- Labels: directly on the graphic (town names on a map)
- Legends: show the user what represents what
- Axes, rulers, scales, timelines: tell the user the relationship between values and position
 - Less precise, also less clutter
- Datatips: tooltips that show data values
- Data brushing: select a subset of the data, put it in another context (another graphic)
 - e.g., select outliers in a scatter plot -> color the values in a spreadsheet

Patterns

- Overview plus detail
- Datatips
- Dynamic Queries
- Data brushing
- Local zooming
- Row striping
- Sortable table

- Jump to item
- New-item row
- Cascading lists
- Tree table
- Multi-Y graph
- Small multiples
- Treemap

Overview Plus Detail



- Place an overview next to a zoomed-in detail view
- Micro and macro readings: users can scroll, compare, move at their own pace through the interface
- One of the best ways to deal with visual complexity
- "You are here" sign

Datatips

| | | OFFE | NSE | | |
|--|---|---|---|--|---|
| | Running Back C. Dillon K. Faulk R. Abdulah | | Fullback <u>P. Pass</u> • | | |
| Wide Receiver D. Patten T. Brown • P. Sam • | <u>u. coods</u> * | Quarterback T. Brady R. Daves J. Miller • GCMF 5 58 | Prady % PYDS PTDS INT 7 1159 10 5 | RTDS | Wide Receiver D. Givens D. Branch + B. Johnson K. Kasper |
| Right Tackle T. Ashworth + B. Gorin | Right Guard <u>S. Neal</u> J. Andruzzi | Center D. Koppen G. Mruczkowski | Left Guard J. Andruzzi R. Hochstein | Left Tackle <u>M. Light</u> <u>B. Gorin</u> <u>A. Klemm</u> + | Tight End D. Graham C. Fauria J. Weaver B. Watson • Z. Flemister • |

- Solving complexity: present the overview, put details in tooltips
- Put the detail where the attention is (mouse)
- Inside the tooltip, you can afford to format densely
- Make the tooltip as small as possible, obscuring as little as possible Alex Pantaleev, SUNY Oswego Dept of Computer Science

Dynamic Queries

- Provide ways to filter the data set immediately and interactively
- Use for large datasets, with predictable interesting parameters
- Controls: single/double sliders, radio buttons...
- Can also directly manipulate display data
 - Drawback: depends on spatial rendering of data



Data Brushing



- Let the user select data items in one view; show the same data selected simultaneously in another view
- Use for multivariate data
- Helps users gain insight
- Coordinated/linked views (larger pattern)

Local Zooming



Row Striping

Here are the top women finishers in the 2004 Boston Marathon.

| 1 | Catherine Ndereba | 31 | Kenya | 2:24:27 |
|----|--------------------------|----|-----------------------|---------|
| 2 | Elfenesh Alemu | 28 | Ethiopia | 2:24:43 |
| 3 | Olivera Jevtic | 26 | Serbia and Montenegro | 2:27:34 |
| 4 | Jelena Prokopcuka | 27 | Latvia | 2:30:16 |
| 5 | Nuta Olaru | 33 | Romania | 2:30:44 |
| 6 | Lyubov Denisova | 32 | Russian Federation | 2:31:17 |
| 7 | Malgorzata Sobanska | 34 | Poland | 2:32:23 |
| 8 | Victoria Klimina | 28 | Russian Federation | 2:33:20 |
| 9 | Ramilia Burangulova | 42 | Russian Federation | 2:34:08 |
| 10 | Ai Yamamoto | 25 | Japan | 2:34:32 |
| 11 | Rika Tabashi | 22 | Japan | 2:41:41 |
| 12 | Jessica Rodriguez Galvan | 27 | Mexico | 2:50:57 |
| 13 | Andrea Niggemeier | 34 | Germany | 2:50:59 |
| 14 | Greta Varchi | 31 | Italy | 2:54:15 |
| 15 | Yumiko Une | 32 | Japan | 2:54:59 |
| 16 | Julie S. Spencer | 27 | Baraboo, WI | 2:56:39 |
| 17 | Angela M. Batsford | 23 | Canada | 2:57:06 |
| 18 | Mary Ann Protz | 47 | St. Petersburg, FL | 2:57:58 |
| 19 | Kim A. Donaldson | 42 | St. Petersburg, FL | 2:58:15 |
| 20 | Lee Di Pietro | 46 | Ruxton, MD | 2:58:59 |
| 21 | Tracy Fischer | 35 | Jamul, CA | 2:59:36 |
| 22 | Stephanie Hodge | 38 | Canada | 3:00:00 |
| 23 | Simonetta Piergentili | 39 | Woburn, MA | 3:01:00 |

Here are the top women finishers in the 2004 Boston Marathon.

| 1 | Catherine Ndereba | 31 | Kenya | 2:24:27 |
|----|--------------------------|----|-----------------------|---------|
| 2 | Elfenesh Alemu | 28 | Ethiopia | 2:24:43 |
| 3 | Olivera Jevtic | 26 | Serbia and Montenegro | 2:27:34 |
| 4 | Jelena Prokopcuka | 27 | Latvia | 2:30:16 |
| 5 | Nuta Olaru | 33 | Romania | 2:30:44 |
| 6 | Lyubov Denisova | 32 | Russian Federation | 2:31:17 |
| 7 | Malgorzata Sobanska | 34 | Poland | 2:32:23 |
| 8 | Victoria Klimina | 28 | Russian Federation | 2:33:20 |
| 9 | Ramilia Burangulova | 42 | Russian Federation | 2:34:08 |
| 10 | Ai Yamamoto | 25 | Japan | 2:34:32 |
| 11 | Rika Tabashi | 22 | Japan | 2:41:41 |
| 12 | Jessica Rodriguez Galvan | 27 | Mexico | 2:50:57 |
| 13 | Andrea Niggemeier | 34 | Germany | 2:50:59 |
| 14 | Greta Varchi | 31 | Italy | 2:54:15 |
| 15 | Yumiko Une | 32 | Japan | 2:54:59 |
| 16 | Julie S. Spencer | 27 | Baraboo, WI | 2:56:39 |
| 17 | Angela M. Batsford | 23 | Canada | 2:57:06 |
| 18 | Mary Ann Protz | 47 | St. Petersburg, FL | 2:57:58 |
| 19 | Kim A. Donaldson | 42 | St. Petersburg, FL | 2:58:15 |
| 20 | Lee Di Pietro | 46 | Ruxton, MD | 2:58:59 |
| 21 | Tracy Fischer | 35 | Jamul, CA | 2:59:36 |
| 22 | Stephanie Hodge | 38 | Canada | 3:00:00 |
| 23 | Simonetta Piergentili | 39 | Woburn, MA | 3:01:00 |

Sortable Table

inxight + ? R n: 0 谯 MLS# Price (\$) Bedroom Baths Square Foot Status Address City Zip Realtor -Bedroom Click to sort Drag to change position Drag to left edge to group E Bedroom

Jump to Item / Continuous Filter

| Temacs@TIDWELLJ | - 🗆 × |
|--|-------|
| File Edit Options Buffers Tools HTML SGML Help | |
| | |
| You are designing a UI that contains several discrete tasks or content elements: forms, demos, games, articles, transactions, entire applications, etc. All are reachable from one central page or window. But you don't want to link all the sections or "spokes" to every other one, for several possible reasons: | |
| <1i>> absence of visual and/or cognitive clutter, | |
| > restricted workflow to force the completion (or explicit cancellation) of a task. | |
| | |
| | |
| | |
| | |
| <h4> Why:</h4> | |
| Primarily, you are using navigation to structure | |
| the user experience into something different from the | |
| free-form hypertext browsing offered by the Web. You are asking the user to focus on one section at a time, then go back to the hub and navigate to another section. This | |
| certainly reduces clutter on the "spoke" pages the user | |
| has less to look at, and less to think about. | |
| | |
| -1** hub-and-spoke.html (HTML Isearch)L5456% | |
| I-search: the | ÷ |

New-Item Row

- Use the last row in the table to create a new item in place
- Use for interfaces with vertical lists
- Conceptually coherent
- Avoids opening another UI for item creation
- Uses less screen, reduces navigation, is less work



Cascading Lists

- Hierarchy: show lists for each level
- Selecting an item shows children at next level
- Use for broad shallow trees (otherwise, use tree outline)
- Shows more of the hierarchy at once
- Organizes it visually



Tree Table

| 🕑 Bookmarks Manager | | _ 0 | X | |
|---|--|--|----|--|
| <u>Eile E</u> dit <u>V</u> iew | | | | |
| New Bookmark New Folder New | Eparator Move Properties Rer | ame <u>D</u> elete | | |
| Search: | | | | |
| Name | Location | Description | E, | |
| Bookmarks Bookmarks Toolbar Folder Firefox Help Firefox Support Plug-in FAQ | http://texturizer.net/firefox/ http://forums.mozillazine.org/viewforum http://plugindoc.mozdev.org/faqs/ | Add bookmarks to this folder to see them di David Tenser's Firefox help site . MozillaZine's Firefox Support forum Firefox Plug-in Frequently Asked Questions | | |
| 😑 📴 Firefox & Mozilla Information | | Information about Firefox and Mozilla | | |
| - Direfox Extensions | http://texturizer.net/firefox/extensions/ | Firefox add-ons and extensions | | |
| Firefox Themes | http://texturizer.net/firefox/themes/ | Firefox themes | | |
| Firefox Discussions | http://forums.mozillazine.org/index.php? http://www.mozillazine.org/ | MozillaZine's Firefox discussion forums Mozilla community news and advocacy | | |
| 🗉 🛅 Quick Searches | | Handy searches that can be performed in th | | |
| http://texturizer.pet/firefox/themes/ | | | | |

Multi-Y Graph



Small Multiples



Treemap



Alex Pantaleev, SUNY Oswego Dept of Computer Science