

G53FIV: Fundamentals of Information Visualization

Lecture 9: Interactions

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<https://moodle.nottingham.ac.uk/course/view.php?id=68644>

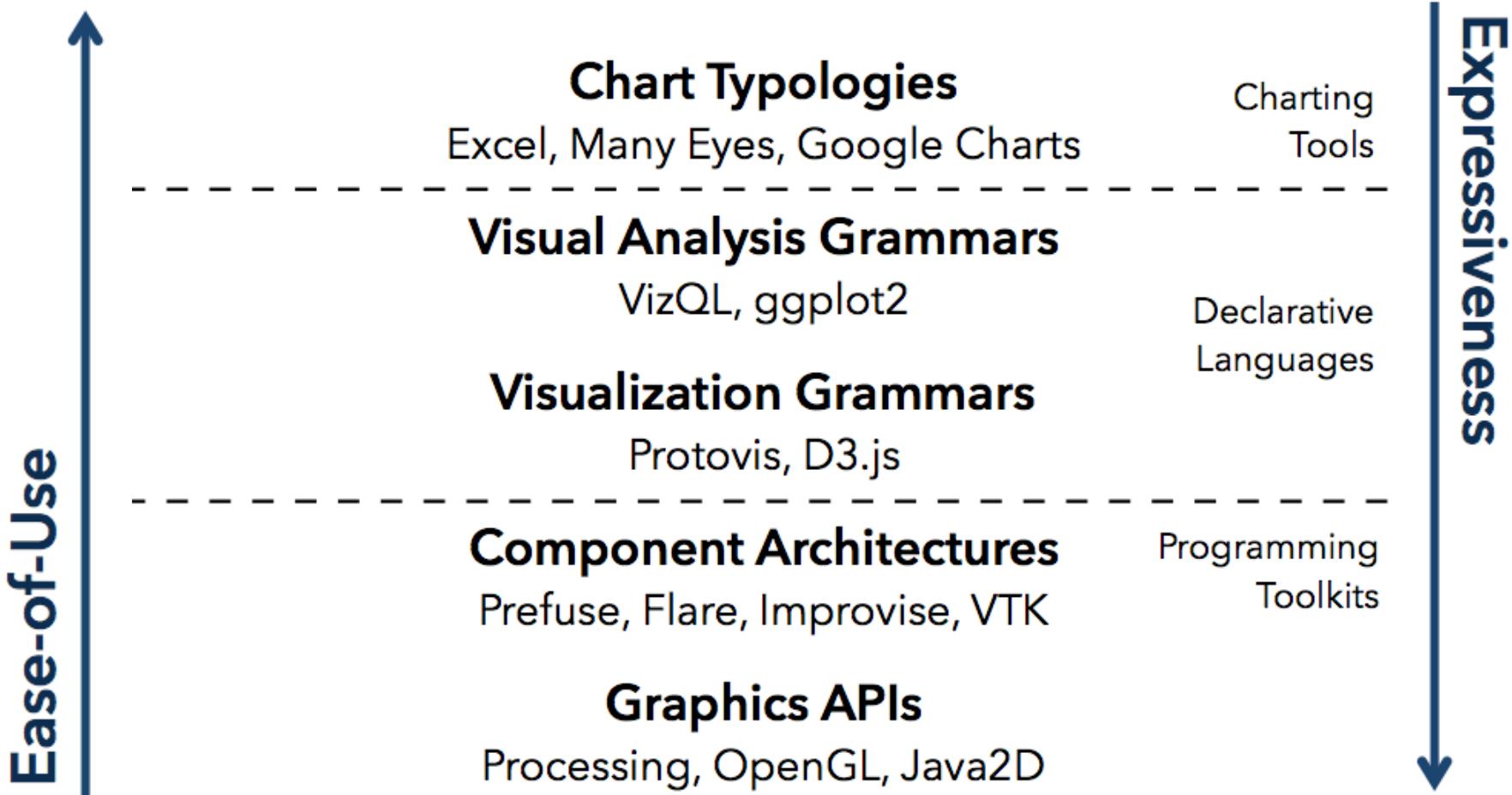
Administria

- Course work issue sheet made available on Moodle, with marking criteria
- Second optional lab session at 2:00 - 3:00 PM Monday in A32
 - for those who can not make it on the 9:00 - 10:00 AM Monday session

Last Lecture

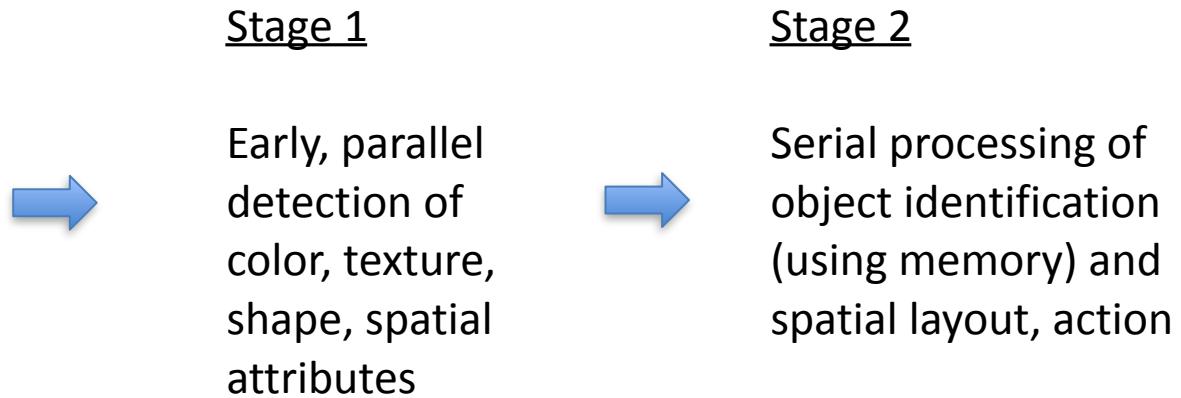
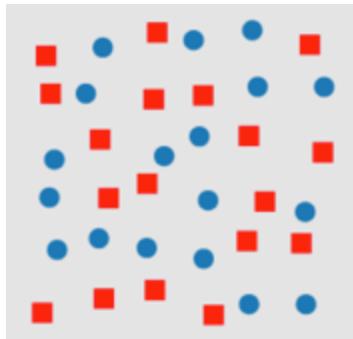
Visualization Tools and Visual Perception

Visualization Tools

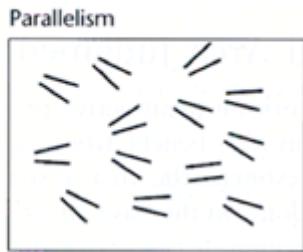
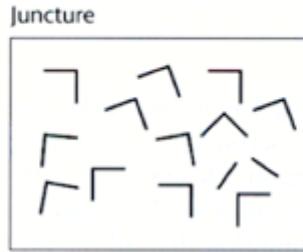
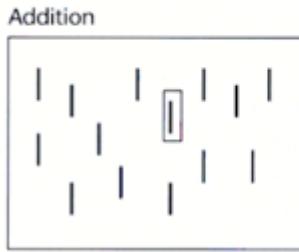
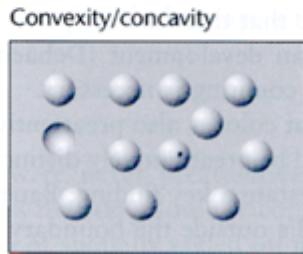
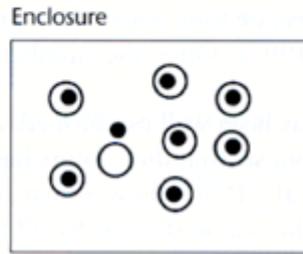
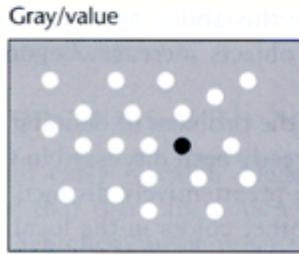
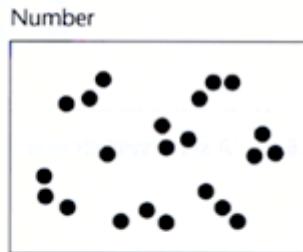
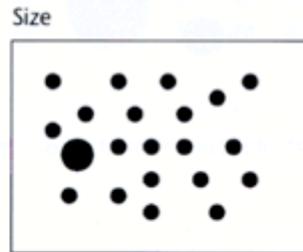
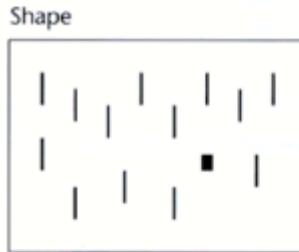
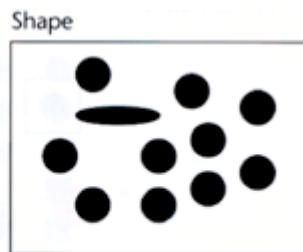
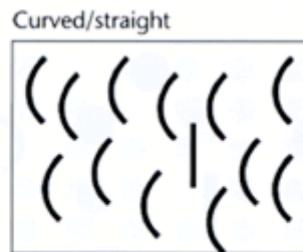
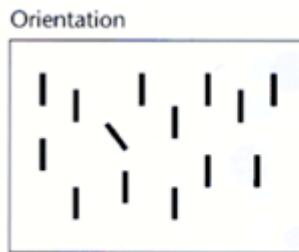


Perceptual Processing Model

- Two stage process
 - Parallel extraction of low-level properties of scene
 - Sequential goal-directed processing



Pre-Attentive Features



- length
- width
- size
- curvature
- number
- terminators
- intersection
- closure
- hue
- intensity
- flicker
- direction of motion
- binocular lustre
- stereoscopic depth
- 3-D depth cues
- lighting direction

Gestalt Grouping Principles

“All else being equal, elements that are related by X tend to be grouped perceptually into higher-order units.”

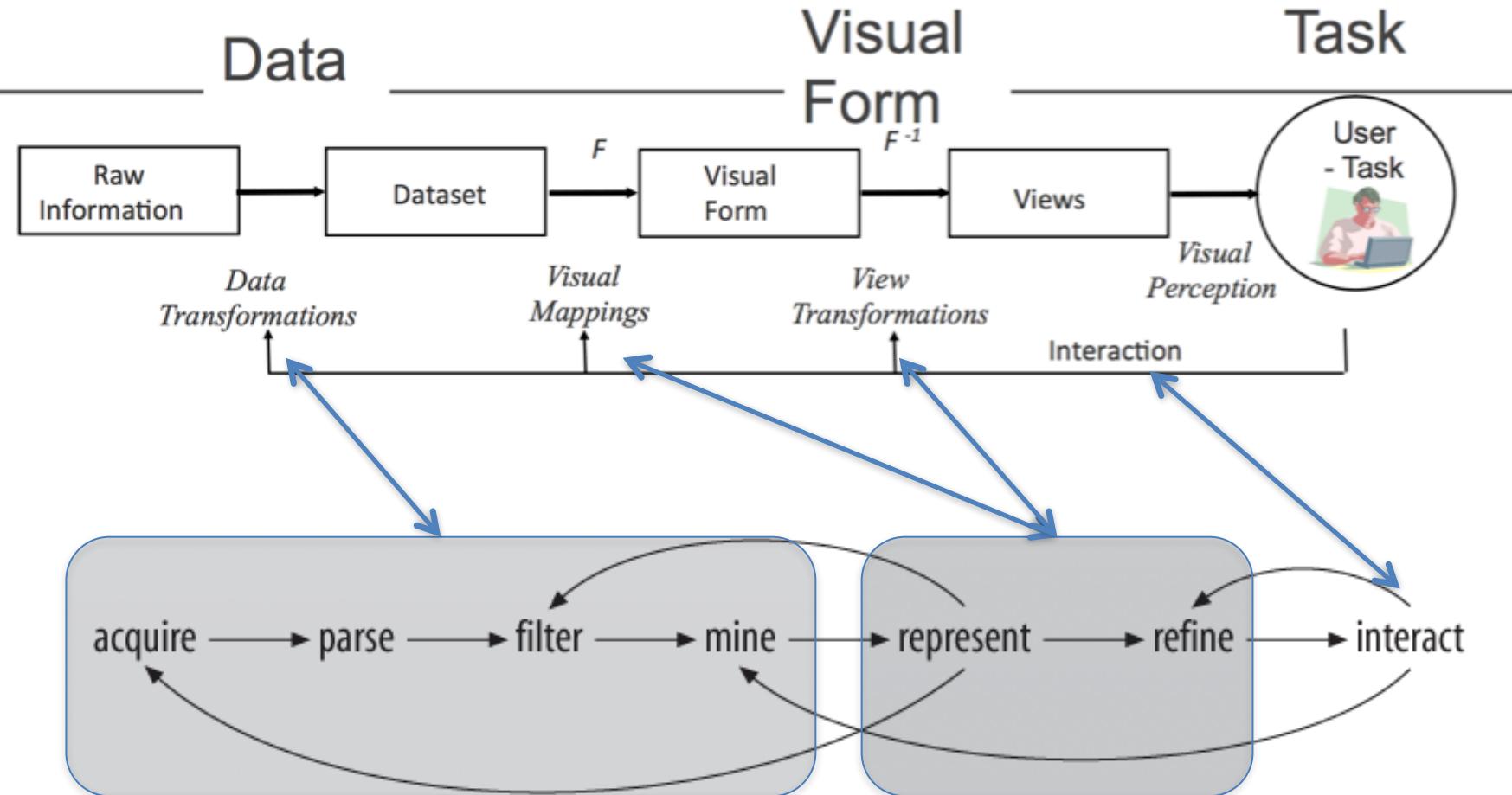
— Stephen Palmer

- Proximity
- Similarity
- Connectedness
- Continuity
- Symmetry
- Closure
- Figure/Ground
- Common Fate

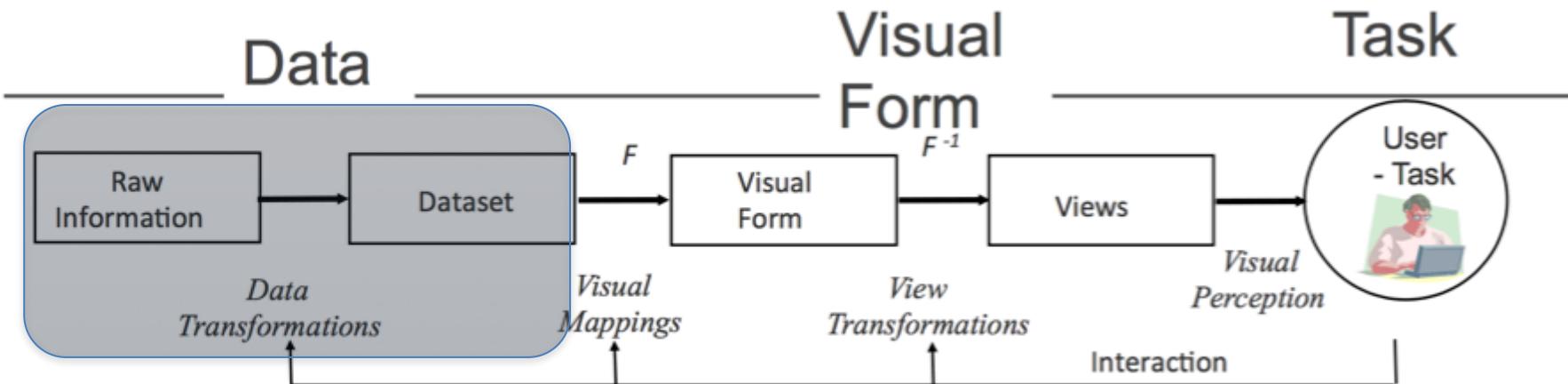
Overview

- Interaction
 - Definition
 - Taxonomy of Interactions
 - Pros and Cons

Different Stages of Visualization



Different Stages of Visualization



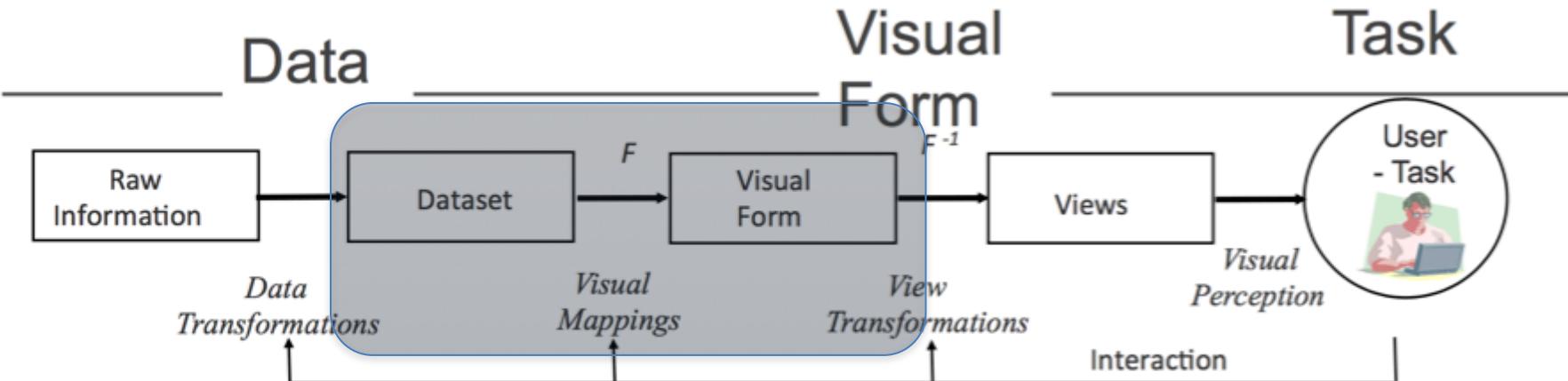
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00605	+18.465162	-067.141486		AGUADILLA	72	005
00606	+18.172947	-066.944111		MARICAO	72	093
00610	+18.288685	-067.139696		ANASCO	72	011



- FILTER Rows
- SELECT Column Types
- ArRANGE Rows (SORT)
- Mutate (into something new)
- Summarize by Groups



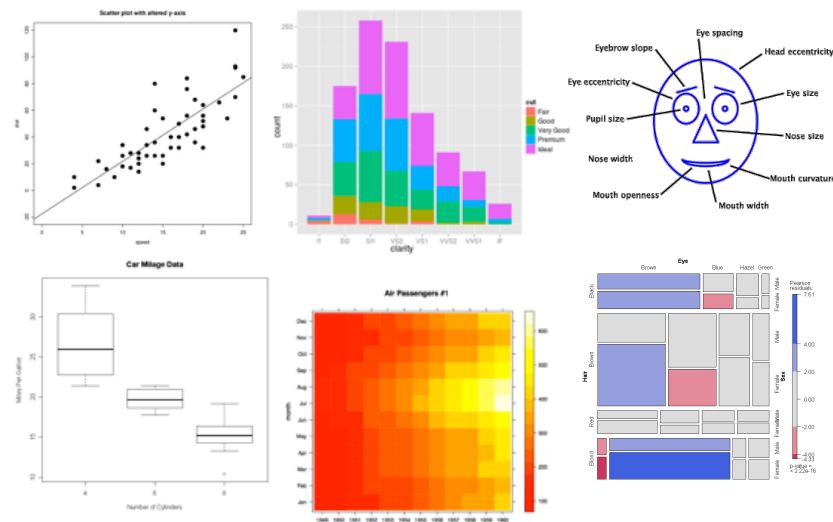
Different Stages of Visualization



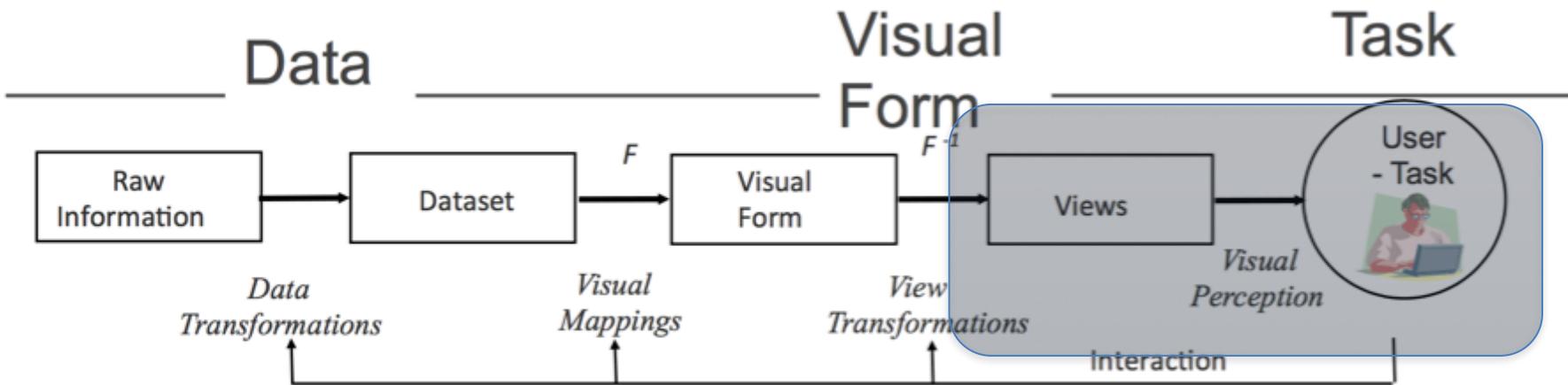
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00214	+43.005895	-071.013202	U	PORTRSMOUTH	33	015
00215	+43.005895	-071.013202	U	PORTRSMOUTH	33	015

	Nominal	Ordinal	Quantitative
Position	✓	✓	✓
Size	✓	✓	~
(Grey)Value	✓	✓	~
Texture	✓	~	✗
Color	✓	✗	✗
Orientation	✓	✗	✗
Shape	✓	✗	✗

✓ = Good
 ~ = OK
 ✗ = Bad



Different Stages of Visualization



“The effectiveness of information visualization hinges on two things: its ability to clearly and accurately **represent** information and our ability to **interact** with it to figure out what the information means.”

S. Few, <*Now you see it*>

Representation and Interaction

- Two main components of information visualization
- Very challenging to come up with innovative, new visual representations
- But can do interesting work with how user interacts with the view or views
 - Analysis is a process, often iterative with different interactions

Why we need interaction?

- For larger data, there is simply too much to show in a coherent manner
 - With more variables, more data cases, it will be hard for users to perceive everything in one go.
 - Limited screen, limited cognitive ability, limited time, etc.
- Interaction helps us address that challenge
 - We want to help users to better accomplish their tasks

What is “interactive”?

- Can be captured and measured by the response time
 - .1 sec
 - animation, visual continuity, sliders
 - 1 sec
 - system response, conversation break
 - 10 sec
 - cognitive response



An Example

- Dust and Magnet

Video: [Dust & Magnet](#)

<https://www.youtube.com/watch?v=wLXwL38xek0>

Let's be interactive 😊

An Exercise

- List the different “categories” of interaction in information visualization
- Work in pairs

Taxonomy of Interactions

- Dix and Ellis (1998)
 - Highlighting and focus;
 - accessing extra info;
 - overview and context;
 - same representation, changing parameters;
 - Linking representations
- Keim (2002)
 - Projection
 - Filtering
 - Zooming
 - Distortion
 - Linking and brushing
- Few's Principles
 - Comparing
 - Sorting
 - Adding variables
 - Filtering
 - Highlighting
 - Aggregating
 - Re-expressing
 - Re-visualizing
 - Zooming and panning
 - Re-scaling
 - Accessing details on demand
 - Annotating
 - Bookmarking

Challenges

- Interaction seems to be a difficult thing to pin down and characterize
- User-centered versus system-centered characterizations
 - User intent: what a user wants to achieve through a specific interaction technique

A Summary of Interactions

- Survey
 - 59 papers
 - Papers introducing new interaction systems
 - Well-known papers in subareas of information visualization
 - 51 systems
 - Commercial Infovis Systems (SeeIT, Spotfire, TableLens, InfoZoom, etc.)
 - Collected 311 individual interaction techniques
- Affinity Diagram Method

Yi, Ji Soo, Youn ah Kang, and John Stasko. "Toward a deeper understanding of the role of interaction in information visualization." IEEE transactions on visualization and computer graphics 13.6 (2007): 1224-1231.

Categorization based on User Intent

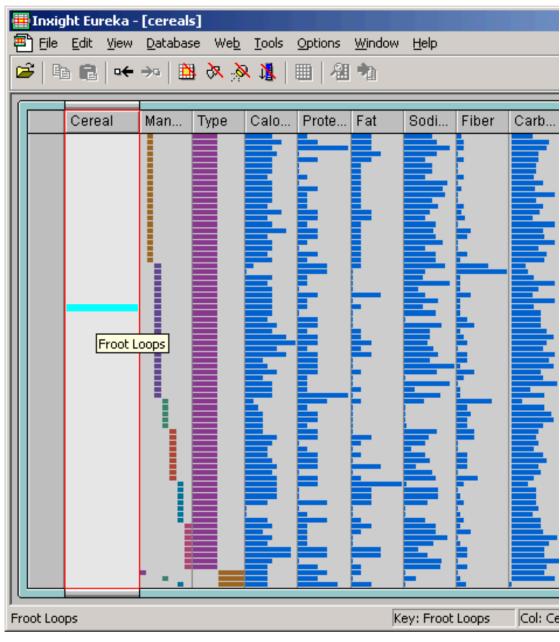
- Don't focus so much on particular interactive operations and how they work
- Interaction is ultimately being done by a person for a purpose
 - Seeking more information, solving a problem
 - Fundamental aspect of exploratory, analytic discourse
- Taxonomy based on **User Intent**
 - What a user wants to achieve through a specific interaction technique

Taxonomy of Interactions based on User Intent - 7 Categories

- Select
- Explore
- Reconfigure
- Encode
- Abstract/Elaborate
- Filter
- Connect

1. Select

- “Mark something as interesting”
- Mark items of interest to keep track
- Seems to often work as a preceding action to subsequent operations.
- Selecting a placemark in Google Map
- The Focus feature in TableLens

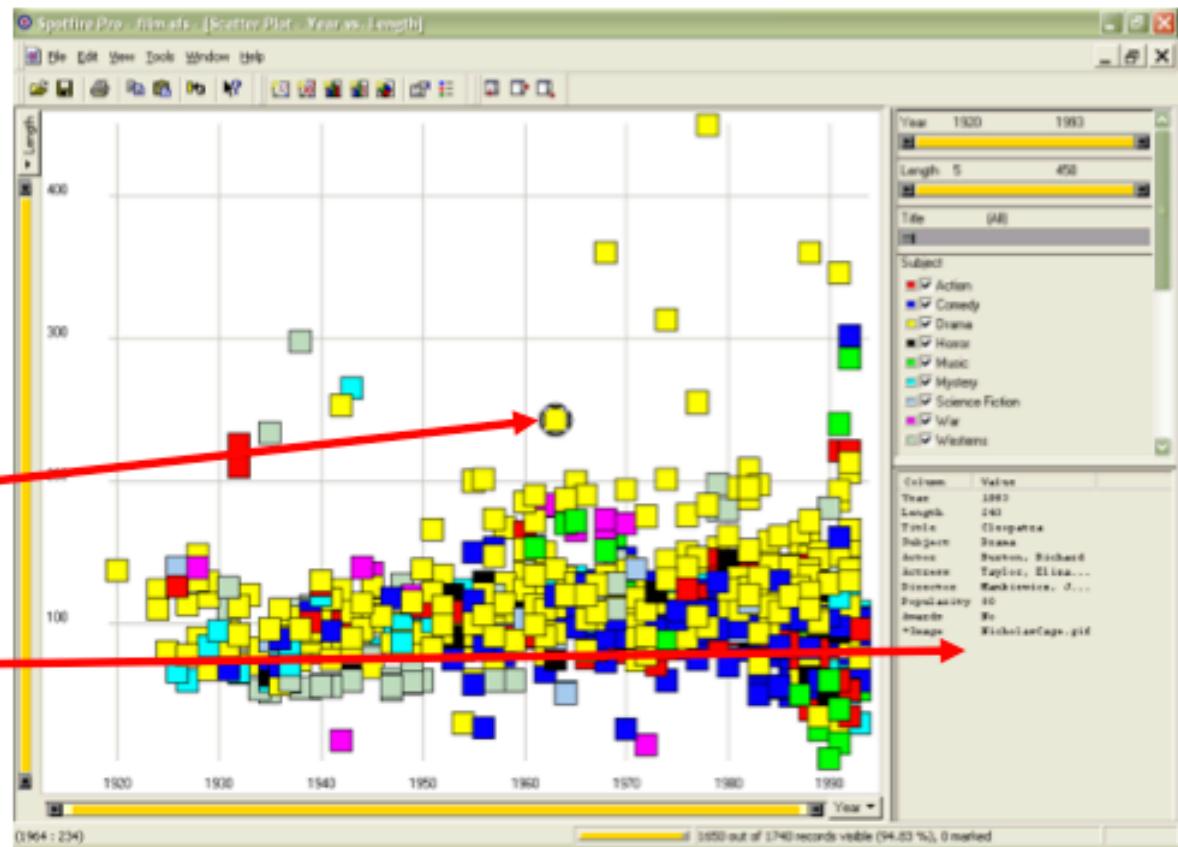


Mouse Selection

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

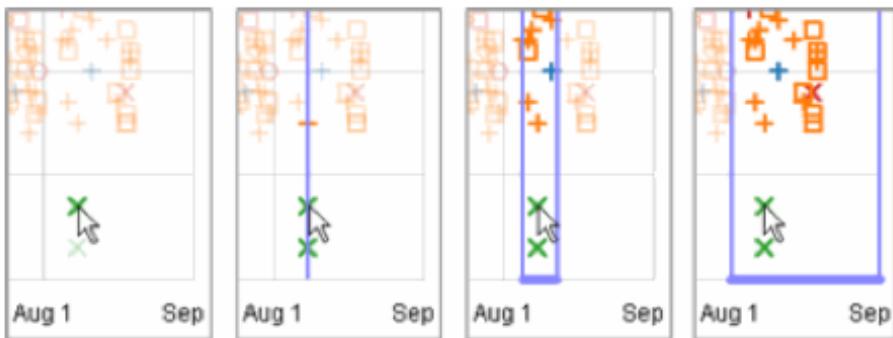
Selected item

Attributes



Generalized Selection

- The idea: you want to select items matching some attribute(s) of that item (rather than caring only about the precise item)



Video: [http://vis.berkeley.edu/
papers/generalized_selection/](http://vis.berkeley.edu/papers/generalized_selection/)

- As you dwell on your mouse pick, the selection criteria broaden and you can choose sets of items

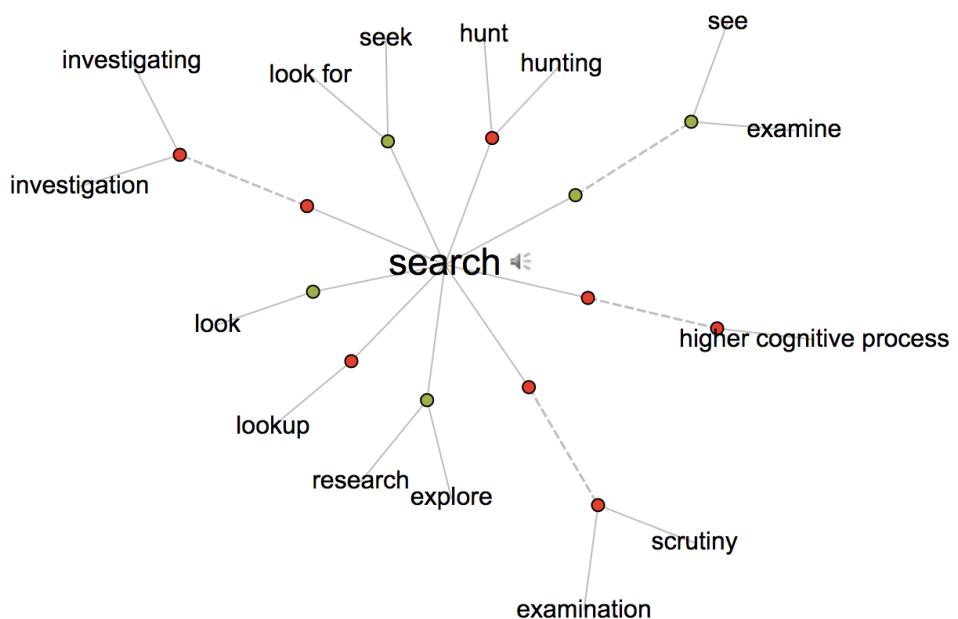
2. Explore

- “Show me something different”
- Enable users to examine a different subset of data
- Overcome the limitation of display size
- Panning in Google Earth
- Direct Walking in Visual Thesaurus



Direct Walk

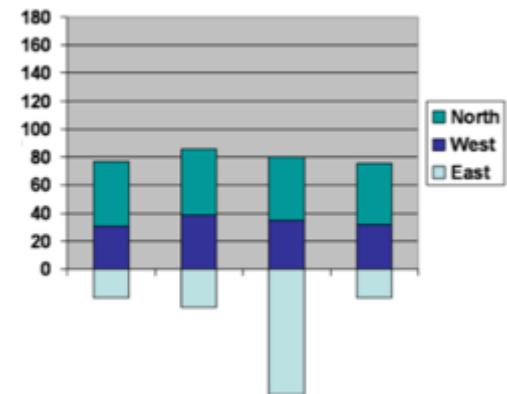
- Linkages between cases
- Exploring one may lead to another
- Example:
 - Visual Thesaurus



Demo: <https://www.visualthesaurus.com/app/view>

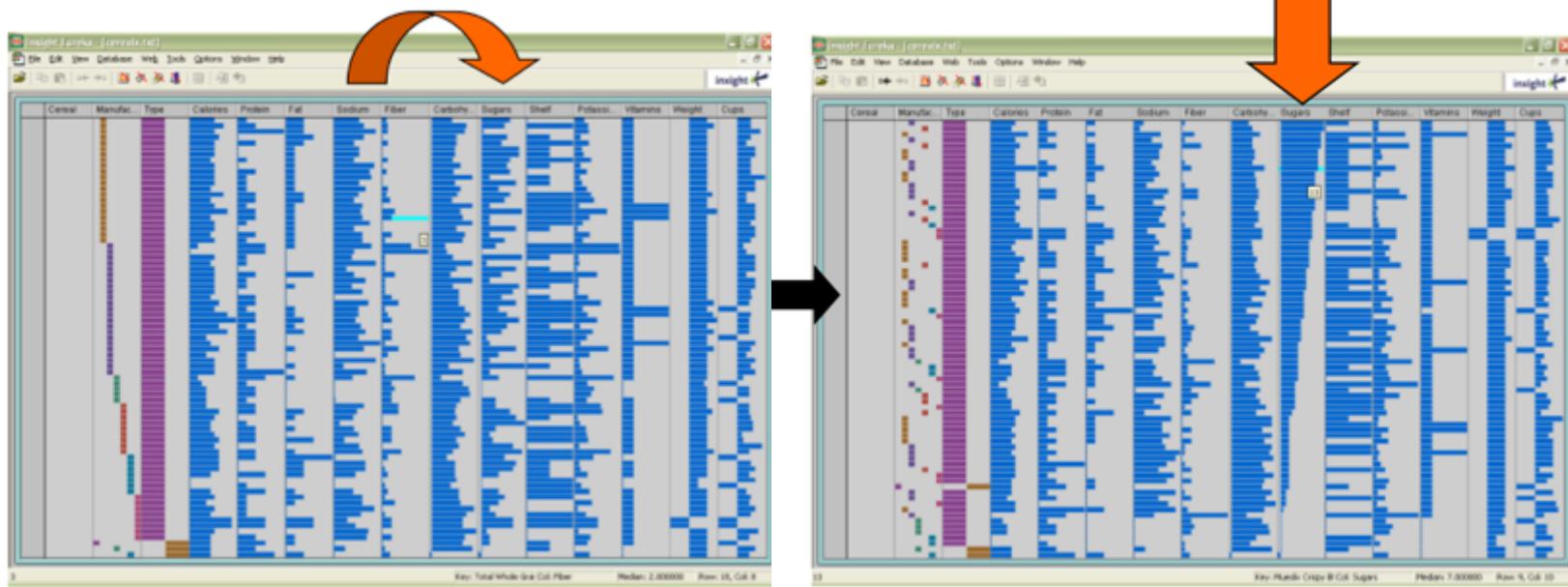
3. Reconfigure

- “Show me a different arrangement”
- Provide different perspectives by changing the spatial arrangement of representation
- Sorting and rearranging columns in TableLens
- Changing the attributes in a scatter plot
- The baseline adjustment feature in Stacked Histogram:
 - <http://meandeviation.com/dancing-histograms/>
- The “Spread Dust” feature in Dust & Magnet



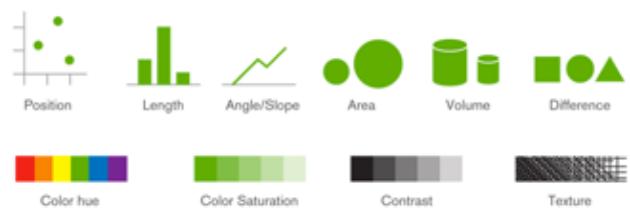
Rearrange View and Sorting

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

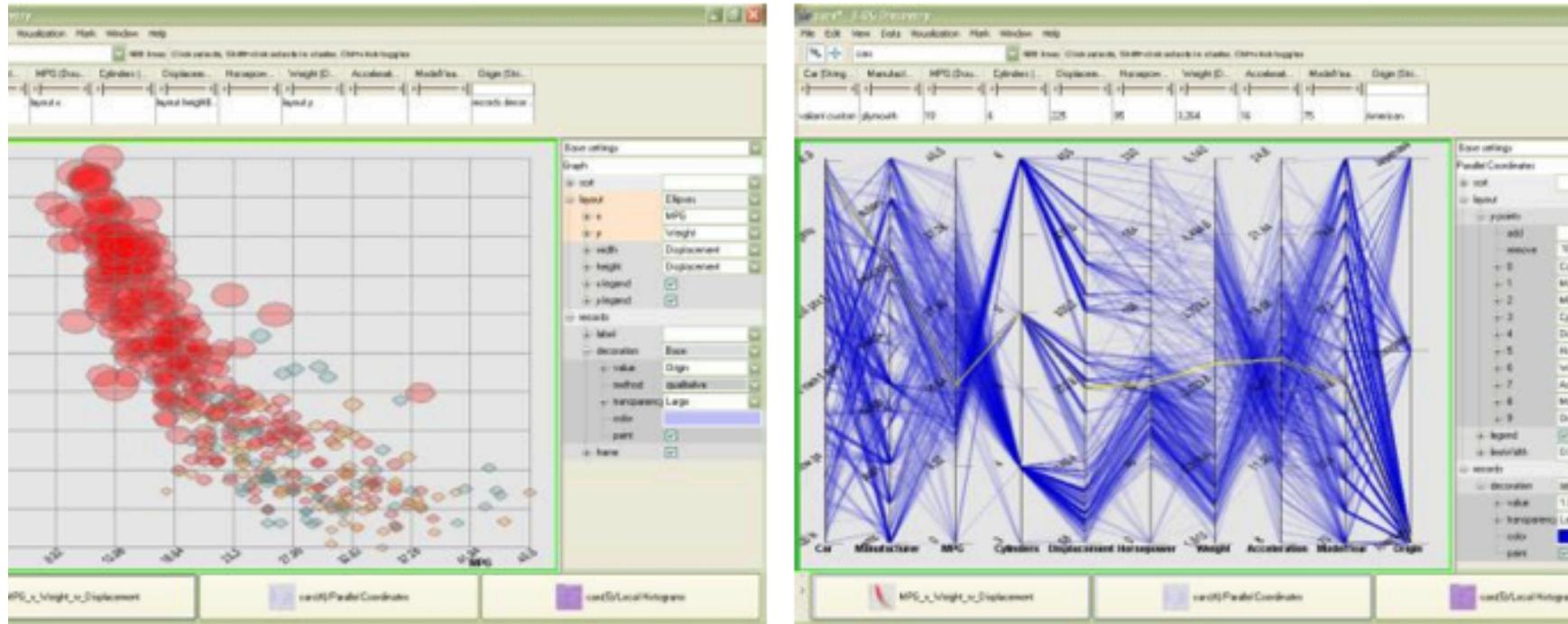


4. Encode

- “Show me a different representation”
- Change visual appearances
 - color encoding, size, orientation, font, shape
- May interactively change entire data representation
 - Looking for new perspective
 - Limited real estate may force change



Looking for New Perspective



Selecting different representation from options at bottom

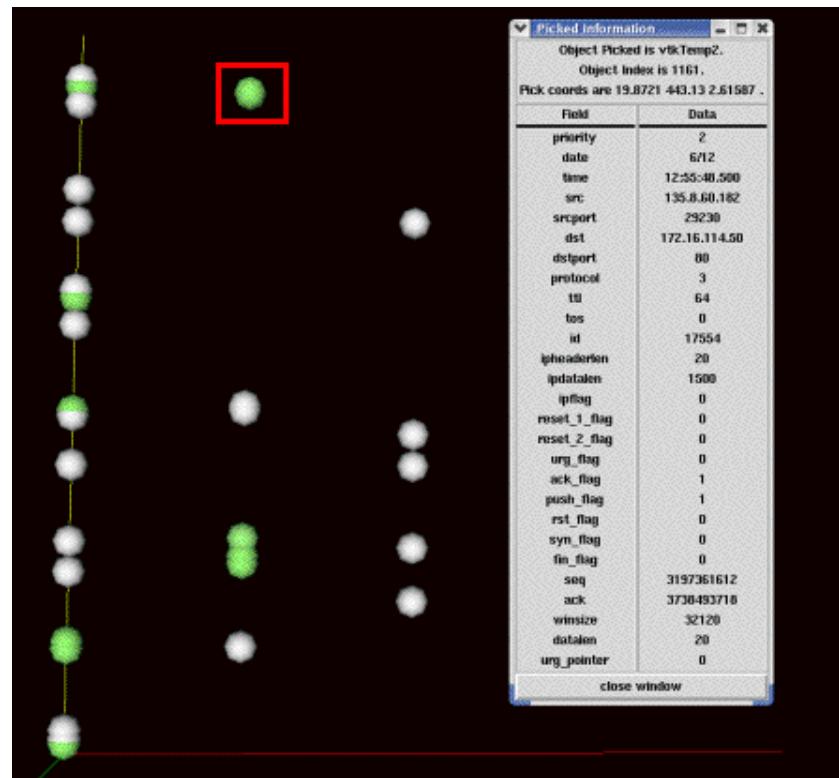
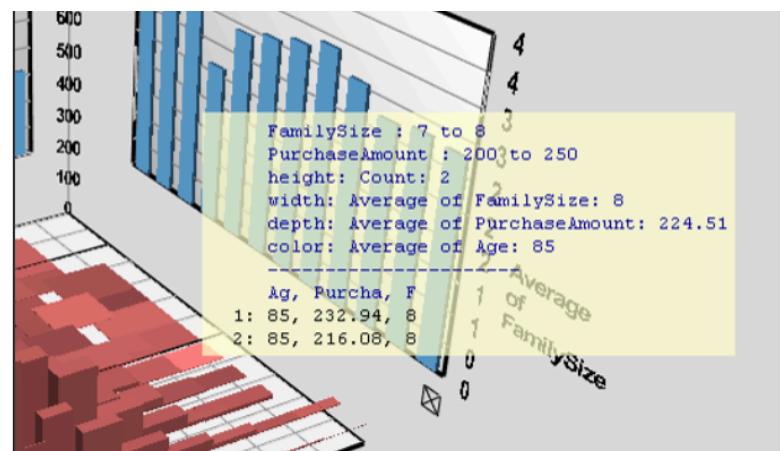
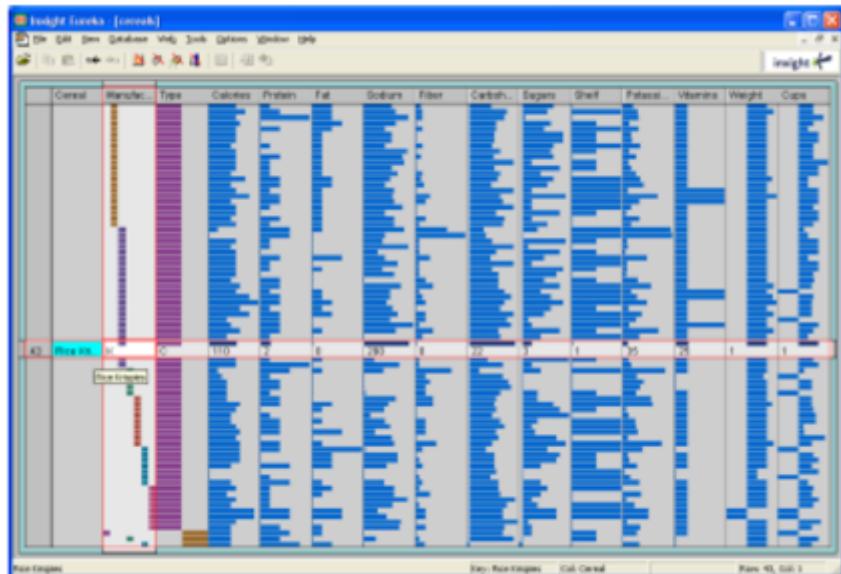
5. Abstract/Elaborate

- “Show me more or less detail”
- Adjust the level of abstraction (overview and details)
- Details-on-demand
- Unfolding sub-categories in an interactive pie chart
- Drill-down in Treemap
- Zooming (geometric zooming)

Details on Demand

- Term used in information visualization when providing viewer with more information/details about data case or cases
- May just be more information 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

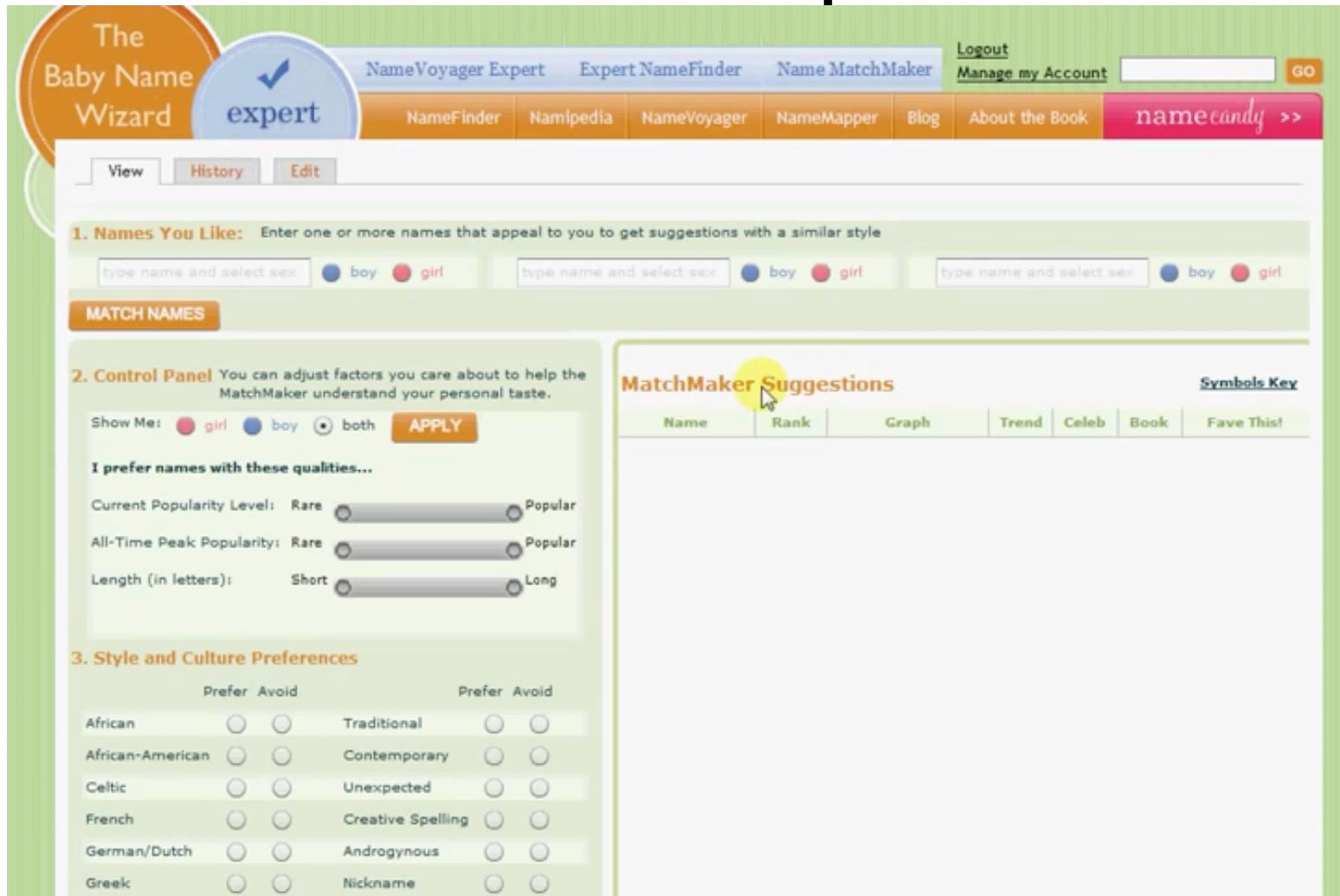
Example



6. Filter

- “Show me something conditionally”
- Change the set of data items being presented based on some specific conditions.
- Fundamental interactive operation in information visualization is changing the set of data cases being presented
 - Focusing
 - Narrowing/widening

An Example



The screenshot shows the Baby Name Wizard interface. On the left, there's a sidebar with sections for "Names You Like" (three input fields for boy/girl names), "Match Names" (a button), "Control Panel" (radio buttons for Show Me: girl, boy, both, with an "APPLY" button), and "Style and Culture Preferences" (a grid of 12 items with "Prefer" and "Avoid" checkboxes). On the right, the main area is titled "MatchMaker Suggestions" with a "Symbols Key" header. It features a table with columns for Name, Rank, Graph, Trend, Celeb, Book, and Fave This!. The first row of data in the table is partially visible.

Name	Rank	Graph	Trend	Celeb	Book	Fave This!
[Data]						

Video: <http://www.babynamewizard.com/baby-names-expert-upgrade-video-1>

Dr. Ke Zhou (<http://www.cs.nott.ac.uk/~pszkz/>)

Dynamic Query

- Dynamic Query
 - Probably best-known and one of most useful infovis techniques
- Database query: SQL
 - **Select** house-address
From atl-realty-db
Where price >= 200,000 **and** price <= 400,000
- Pros
 - Powerful, flexible
- Cons
 - 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

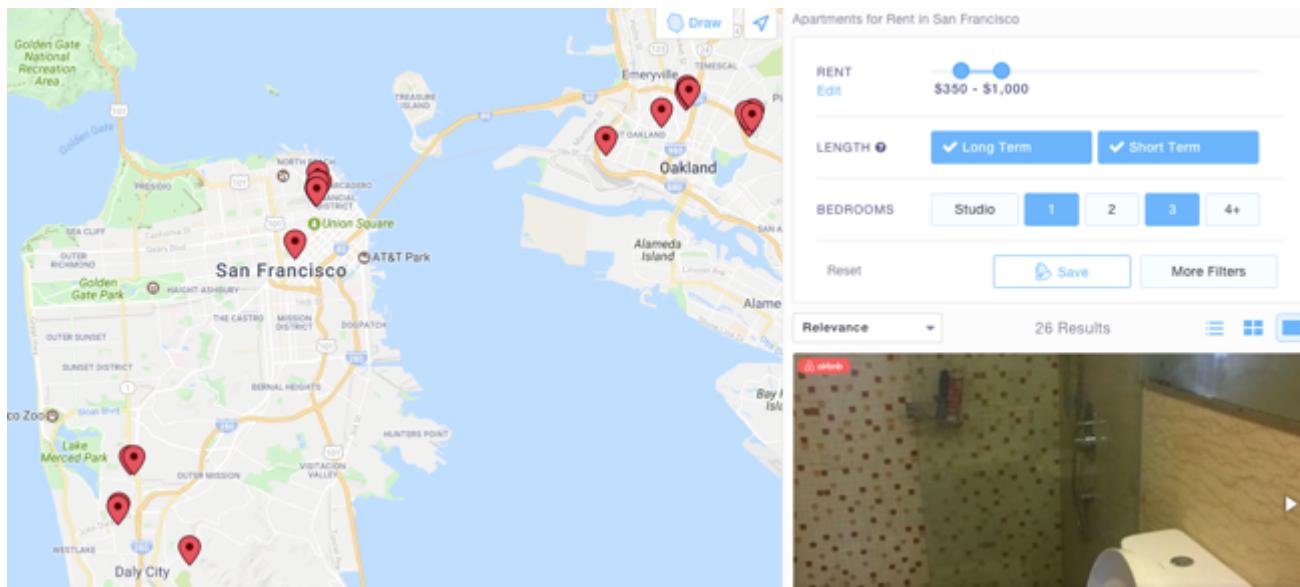
Dynamic Query

- 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
- There often simply isn’t one perfect response to a query
- Want to understand a set of tradeoffs and choose some “best” compromise

Example: <https://www.padmapper.com>

Query Control vs. Variable Type

- Binary nominal – Buttons
- Nominal with low cardinality - Radio buttons
- Ordinal, quantitative - Sliders



Dynamic Query: Pros and Cons

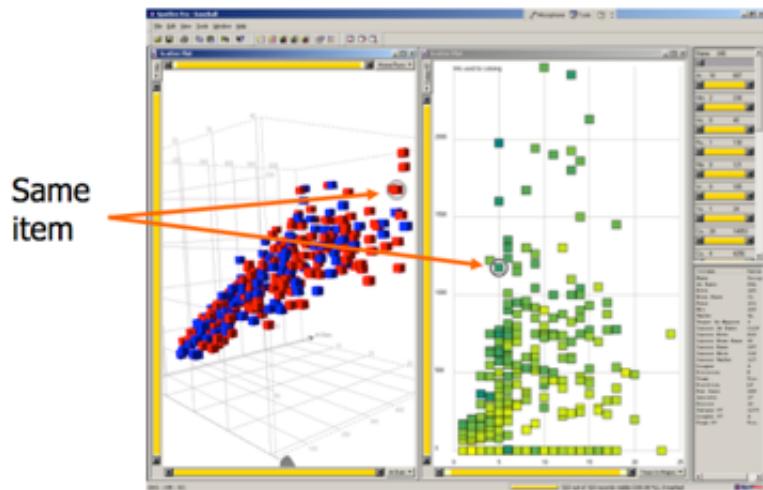
- Pros
 - Work is faster
 - Promote reversing, undo, exploration
 - Very natural interaction
 - Shows the data
- Cons
 - Operations are fundamentally conjunctive
 - Less flexible (can not formulate any boolean expression)
 - Controls are global in scope
 - Controls must be fixed in advance
 - Big data vs. real-time (more challenging)

7. Connect

- “Show me related items”
- Highlight associations and relationships
- Show hidden data items that are relevant to a specified item
- Viewer may wish to
 - examine different attributes of a data case simultaneously
 - view data case under different perspectives or representations

Brushing

- Very common technique in Information Visualization
- 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



An Example: Baseball Statistics



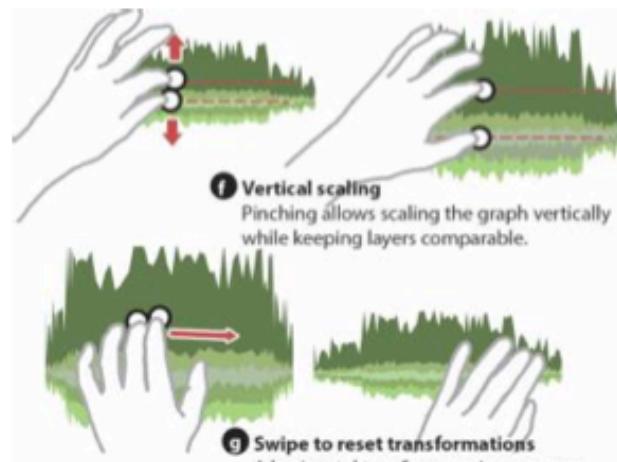
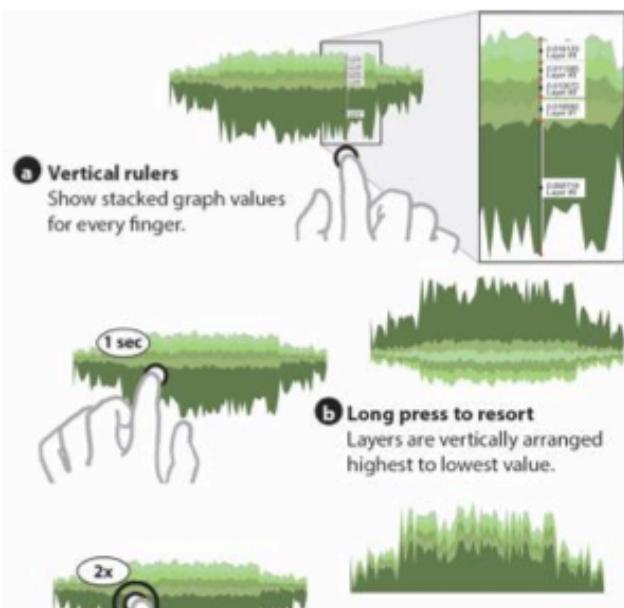
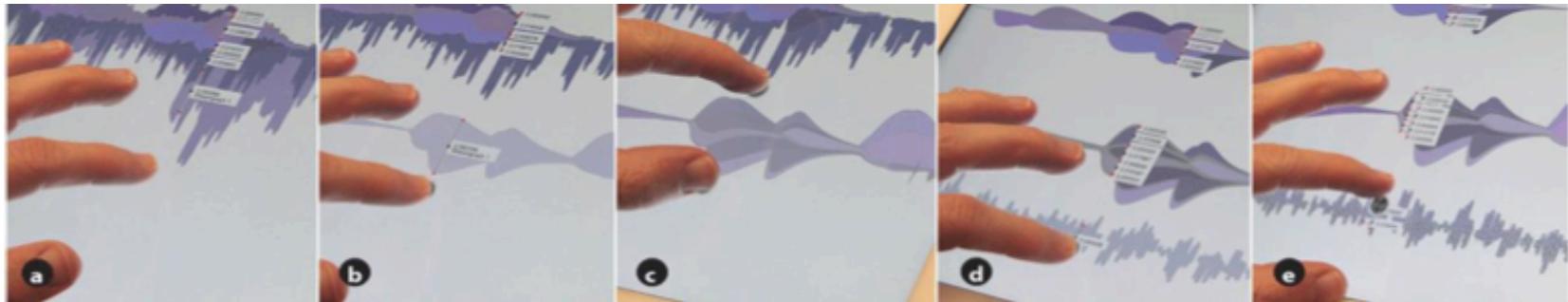
Interaction to Support Representation

- 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

Video: Dust & Magnet

[https://www.youtube.com/watch?
v=wLXwL38xek0](https://www.youtube.com/watch?v=wLXwL38xek0)

Other Interactions



Baur, Dominikus, Bongshin Lee, and Sheelagh Carpendale. "TouchWave: kinetic multi-touch manipulation for hierarchical stacked graphs." Proceedings of the 2012 ACM international conference on Interactive tabletops and surfaces. ACM, 2012.

Dr. Ke Zhou (<http://www.cs.nott.ac.uk/~pszkz/>)

Summary

- Interaction facilitates a dialog between the user and the visualization system
- Multiple views amplify importance of interaction
- Interaction often helps when you just can't show everything you want

Next Lecture

- Topic:
 - Evaluation

