INTERACTION
CS 448B | Fall 2023
MANEESH AGRAWALA

READING RESPONSE: QUESTIONS/THOUGHTS

How can micro/macro design principles be harnessed to address information overload while retaining the richness of data? Are there instances where simplification could be more beneficial than a high-density micro/macro design?

It would be interesting to me to learn more about how micro and macroscopic designed visualizations have changed over time, especially because interactive visualizations may be able to help readers do things such as zoom in .... How might we leverage interactivity to enhance otherwise static visualizations?

Tufte champions clarity, precision, and efficiency, advising against ornamental designs. Yet, while Micro/Macro compositions epitomize precision, they don’t always align with clarity and efficiency. Do I embrace comprehensive data for its precision, or do I curate what I deem most pertinent, risking the omission of outliers?
Learning Objectives

1. How to choose good visual encodings from the large set of possibilities.

2. How scales, axes, aspect ratios, fitting and sorting can emphasize different aspects of the data.

SELECTING ASPECT RATIO
Sunspots
from William S. Cleveland
*The Elements of Graphing Data, 1985*
**BANKING TO 45° [Cleveland 1985]**

To facilitate perception of trends and maximize the discriminability of line segment orientations

Line segments are maximally discriminable when the absolute angle between them is 45°

**Method:** Optimize the *aspect ratio* such that the average absolute angle between all segments is 45°

**CO₂ Measurements**

from William S. Cleveland
*Visualizing Data*, 1993

Trends may occur at different scales! Apply banking to the original data or to fitted trend lines. [Heer & Agrawala 2006]
FITTING THE DATA

from The Elements of Graphing Data [Cleveland 1994]
By Eye ...

from The Elements of Graphing Data [Cleveland 1994]

Linear regression ...

from The Elements of Graphing Data [Cleveland 1994]
TRANSFORMING DATA

How well does curve fit data?

from The Elements of Graphing Data [Cleveland 1994]
TRANSFORMING DATA

Residual graph
Plot vertical distance from best fit curve
Residual graph shows accuracy of fit

SORTING
**Panel variables**
- type, yield

**Condition variables**
- location, year

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**Trellis**

[Becker 1996]
Alphabetical ordering

Trellis [Becker 1996]

Main-effects ordering

Trellis [Becker 1996]
SUMMARY

Well designed visualizations
   Use expressive and effective encodings
   Avoid over-encoding
   Emphasize features of the data most relevant to the task

Rarely does a single visualization answer all questions. Instead, the ability to generate appropriate visualizations quickly is critical!
ASSIGNMENT 2: EXP. DATA ANALYSIS

Due 10/16  11:30am

Use Tableau or Vega-Lite to formulate & answer data questions

First steps
   Step 1: Pick domain & data
   Step 2: Pose questions
   Step 3: Profile data
   Iterate as needed

Create visualizations
   See different views of data
   Refine questions

Author a report
   Screenshots of most insightful views (8+)
   Include titles and captions for each view

ASSIGNMENT 3: INTERACTION

Due 10/30  11:30am

Create a small interactive dynamic query application similar to HomeFinder, but for local software companies data.

1. Implement interface
2. Submit the application as a website and a short write-up on canvas

Can work alone or in pairs
D3 NOTEBOOKS WED & MON

**Data**
- Enter
- Update
- Exit

**Elements**

**DESIGN EXERCISE**
How many visualizations can you think of for conveying these two numbers? Feel free to invent tasks or contexts. **Sketch as many as you can!**

Don’t stress over quality, go for quantity.
Time: ~5 minutes

Share your designs with fellow students. Introduce yourselves! Then compare your designs. How many ideas are the same? How many are different?

Capture your favorite images and post them on the Slack channel #in-class-design-activity
Learning Objectives

1. Conceptual models, system models and the gulfs of execution and evaluation

2. Common interaction techniques: Selection, Brushing and Linking and Dynamic Queries

Interaction between people and machines requires *mutual intelligibility* or *shared understanding*
GULFS OF EXECUTION AND EVALUATION

Gulf of Execution
The difference between the user’s intentions and the allowable actions.

[Norman 1986]
**Gulf of Execution**
The difference between the user’s intentions and the allowable actions.

**Gulf of Evaluation**
The amount of effort that the person must exert to interpret the state of the system and to determine how well the expectations and intentions have been met.

[Norman 1986]
GULF OF EVALUATION

Conceptual model $x, y$ correlated?

Evaluation

Real world

$\rho = -0.29$

35

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GULF OF EXECUTION

Conceptual model
Draw a scatterplot

Real world
Move 90 30
Rotate 35
Pen down
...

GULF OF EXECUTION

Conceptual model
Draw a scatterplot

Real world

Gulf
**Gulf of Execution**
The difference between the user’s intentions and the allowable actions.

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[Norman 1986]
Graphics and Graphic Information Processing [Bertin 81]

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Graphics and Graphic Information Processing [Bertin 81]

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GROUP SIMILAR ROWS AND COLUMNS

Choose a row with a particular visual aspect
Move to extremity of matrix

Move similar rows close, opposite rows to bottom
Creates two opposing groups and a middle group

Repeat for columns (can only do this with some kinds of data)
Iterate

Graphics and Graphic Information Processing [Bertin 81]
Bertifier [Perin 2014]

SELECTION
BASIC SELECTION METHODS

Point Selection
Mouse Hover / Click
Touch / Tap
Select Nearby Element (e.g., Bubble Cursor)
BASIC SELECTION METHODS

Point Selection
Mouse Hover / Click
Touch / Tap
Select Nearby Element (e.g., Bubble Cursor)

Region Selection
Rubber-band or Lasso
Area Cursors (“Brushes”)

BRUSHING AND LINKING
BRUSHING

Direct attention to a subset of the data [Wills 95]

BRUSHING & LINKING

Select ("brush") a subset of data
See selected data in other views

The component views must be linked
   by tuple (matching same data point across views), or
   by query (matching range or values of fields)
BASEBALL STATISTICS [Wills 1995]

select high salaries

BASEBALL STATISTICS [Wills 1995]
BASEBALL STATISTICS [Wills 1995]

- Select high salaries
- Avg career HRs vs avg career hits (batting ability)
- How long in majors

BASEBALL STATISTICS [Wills 1995]

- Select high salaries
- Avg career HRs vs avg career hits (batting ability)
BASEBALL STATISTICS [Wills 1995]

- How long in majors
- Average assists vs. average putouts (fielding ability)
- Distribution of positions played
- Select high salaries
- Average career HRs vs. average career hits (batting ability)
BASEBALL STATISTICS  [Wills 1995]

CROSS-FILTERING
DYNAMIC QUERIES

SELECT house FROM east bay
WHERE price < 1,000,000 AND bedrooms > 2
ORDER BY price

Issues
1. For programmers
2. Rigid syntax
3. Only shows exact matches
4. Too few or too many hits
5. No hint on how to reformulate the query
6. Slow question-answer loop
7. Results returned as table
Direct Manipulation
1. Visual representation of objects and actions
2. Rapid, incremental, reversible actions
3. Selection by pointing (not typing)
4. Immediate and continuous display of results

The yellow dots above are homes in the DC area for sale. You may get more information on a home by selecting it. You may draw the 'A' and 'B' distance markers to your office or any other location you want to live near. Select distances, bedrooms, and cost ranges by dragging the corresponding slider boxes on the right. Select specific home types and services by pressing the labeled buttons on the right.