Data Visualization (DSC 530/CIS 568)

Introduction

Dr. David Koop
What is Data Visualization?
How is it different from Computer Graphics?
The purpose of computing is about insight, not numbers

- R. W. Hamming
The purpose of visualization is about insight, not pictures

- Card, Mackinlay, Schneiderman
Why do we visualize data? (vs. looking at tables?)
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MTA Fare Data Visualization
Why do we visualize data?

**Why Graphics?**

- Figures are richer; provide more information with less clutter and in less space.
- Figures provide the *gestalt* effect: they give an overview; make structure more visible.
- Figures are more accessible, easier to understand, faster to grasp, more comprehensible, more memorable, more fun, and less formal.

*List adapted from: [Stasko et al. 1998](#)*

[via A. Lex]
What are the purposes for visualization?
Exploration: Subway Ridership Density
Why Peyton Manning's Record Will Be Hard to Beat

By GREGOR AISCH and KEVIN QUEALY OCT. 19, 2014

The Broncos quarterback set the all-time N.F.L. touchdown passing record — and is still going strong.

[G. Aisch and K. Quealy, NYTimes]
Exploration <-> Communication Spectrum

Consecutive Starts by a Quarterback for a Single Team

Each week line shows consecutive starts by a quarterback for a single team. Ties are included in the graph.

Exploration

Confirmation

Communication

[K. Quealy, 2013]
Exploration <-> Communication Spectrum

Consecutive Starts by a Quarterback for a Single Team

Questions

Answers/Persuasion

[K. Quealy, 2013]
What types of data can we visualize?
Types of Data

- Tables
- Networks (Graphs)
- Spatial Data
  - Geography
  - Physical (e.g. Scientific, Medical)
- Text
- Sets
Where have you seen visualizations?
Books / Posters

Here is a musical streams-of-story, an appealing history of "marketing trends and stylistic patterns in the development of pop/rock music."

Topping the chart is a time-series that tracks sales of popular and rock music as a share of total record sales, although the names are not scaled in proportion to their contributions to the grand total. Bold letters indicate some 24 stylistic categories, fountains flowing into musical streams (e.g., SONG, ROCK, lower left). Several fusions, including BUBBLEGUM and SURF, did not last, to the relief of a grateful world.

In these overlapping parallel time-series, a few names of the 470 artists are repeated, as they resurface in fresh currents. The multiple, parallel flows locate music-makers in two dimensions—linking musical parents and offspring from 1915 to 1974, and listing contemporaries for each year. 10 With an intense richness of detail (measuring in at 20% of the typographic density of a telephone book), this nostalgic and engaging chart fascinates many viewers—at least those of a certain age. Also the illustration presents a somewhat divergent perspective on popular music: songs are not merely singles—unique, one-time, le nouveau happenings—rather, music and music-makers share a pattern, a context, a history.

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[Rock 'N' Roll is Here to Pay, R. Garofalo, 1977]
Books / Posters

[Rock 'N' Roll is Here to Pay, R. Garofalo, 1977]
Music Timeline

Album or artist: Search...

[Music Timeline, Google Research]
What is the advantage of the second version?
Interaction
How do we create modern visualizations?
Tools

• Desktop Applications:
  - Excel (see excelcharts.com)
  - Tableau
  - ...

• Programming Frameworks
  - Processing
  - d3.js
  - deck.gl, MapboxGL
  - ...

• Advantages and disadvantages
  - Speed, customization, understanding, dissemination
**D3.js** is a JavaScript library for manipulating documents based on data. **D3** helps you bring data to life using HTML, SVG, and CSS. D3’s emphasis on web standards gives you the full capabilities of modern browsers without tying yourself to a proprietary framework, combining powerful visualization components and a data-driven approach to DOM manipulation.

See more examples.
Why do we care about the design of visualizations?
Design: Focus on only the y-axis

Average Annual Global Temperature in Fahrenheit
1880-2015

[S. Hayward, 2015]
Design: Year on the y-axis
Design: Different y-axis

Average Annual Global Temperature in Fahrenheit
1880-2015

[S. Hayward, 2015]
Visualization Exploration and Communication
Transportation Data - NYC MTA
# MTA Fare Data Exploration

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East 161st Street and River Avenue

Date

Full Fares Purchased

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MTA Fare Data Exploration

East 161st Street and River Avenue

New York Yankees

- 2013 REGULAR SEASON SCHEDULE

ALL GAMES ARE EASTERN TIME.
Administrivia

- Course Web Site
- Syllabus
  - Plagiarism
  - Accommodations
- Textbook:
  - Required: Munzner (VAD)
  - Rec'd: Murray, 2nd ed. (IDV)
- Assignments
- Tests: March 6 and April 10
- Registration:
  - Add/Drop is Wednesday
Administrivia

• Research:
  - Also investigate some topics in depth
  - Research papers as assigned reading
  - Topics:
    • Trajectories
    • Network Summaries
    • Progressive Visualization
• Project: Create an interactive visualization (or vis research)
  - Design
  - Data analysis
  - Insight
  - Presentations: May 6 @3pm
Programming

- "Programming is blindly manipulating symbols." - B. Victor
- "Code is often the best tool we have because it is the most general tool we have; code has almost unlimited expressiveness" - M. Bostock
- You will write code in this class
  - Your assignments will involve code
  - Your project will involve code
- JavaScript is the language of the Web
  - Somewhat forgiving, not always the easiest to debug
  - Lots of references out there
  - A quickly-changing environment of frameworks
Questions?
Office Hours & Email

• Scheduled office hours are open to all students
  - MW: 10-11am, Th: 3-5pm

• You do not need an appointment to stop in during scheduled office hours

• If you need an appointment outside of those times, please email me with specific details about what you wish to discuss

• Many questions can be answered via email. **Do not** waste my time scheduling an appointment to ask a question that could be answered via email
Do not cheat!
Do not plagiarize

- **It is cheating.** It violates the Academic Honesty Policy at UMassD.
- Do your own work
- Do not copy anyone else's work, text, sentences, ...
  - Anyone = another student, an internet source, book, blog, ...
- Never quote text unless there is a specific need.
  - Usually, only famous quotes or very specific definitions
  - "I think there is a world market for maybe five computers."
    —Thomas Watson (1874-1956), Chairman of IBM, 1943
- **Cite** sources that back up your claims or reflect the origin of an idea
  - Vertex cover is an NP-Complete problem [1].
    ...

Do not cheat

- Cheating on assignments, projects, and exams is not allowed
- You will receive a zero on the assignment/project/exam
- It will be reported to the department and university
- If it repeats, you will fail the course
- You can be kicked out of the university
Do ask questions!
Do ask questions

- If you are stuck on a specific issue with an assignment:
  - Do email me with **specific** questions
  - Do consult books, online documentation, tutorials
  - Do discuss that specific issue with a classmate

- If you are asked about a question:
  - Do not share your code
  - If the questioner is trying to cheat, walk away
  - If you see an obvious mistake, kindly point it out
  - Suggest a specific function or library that may be useful
Do not cheat!
Questions?
Homework: Reading

- Munzner, Ch. 1
- HTML/JavaScript Material:
  - MDN Tutorials
  - Murray's book