CSE 442 - Data Visualization

Narrative Visualization

Matthew Conlen  University of Washington

(with material from Jeff Heer, Edward Segel, and Jessica Hullman)
STORYTELLING
as ancient as mankind

Going forward
I carried wax along the line, and laid it thick on their ears. **They tied me up**, then, plumb amidships, **back to the mast**, lashed to the mast, and took themselves again to rowing. Soon, as we came smartly within hailing distance, the two **Sirens**, noting our fast ship, off their point, **made ready, and they sang**...
STORYTELLING across various media

PEOPLE TELL STORIES

WORDS TELL STORIES

IMAGES TELL STORIES

COMICS TELL STORIES

MOVIES TELL STORIES
narrative (n): An account of a series of events, facts, etc., given in order and with the establishing of connections between them.

Effective story-telling “require[s] skills like those familiar to movie directors, beyond a technical expert’s knowledge of computer engineering and science.” - Gershon & Page ‘01
Generals Wary of Move to Cut Their Ranks

By GINGER THOMPSON and THOM SHANKER

WASHINGTON — Maj. Gen. Paul D. Eaton, a retired Army officer, is familiar with the perks and pitfalls of power, having commanded tens of thousands of troops at Fort Benning, Ga., managed budgets exceeding $2 billion in Iraq, and overseen layers upon layers of staff members who helped manage both his professional duties and his personal life.

He has experienced the full range of lifestyles that come with military leadership, living at one point in an elegant antebellum mansion, and at another, with eight other officers crowded in a marble bathhouse behind one of Saddam Hussein’s old palaces.

When he traveled, he was occasionally able to justify the use of military aircraft, but most times, he said, he flew coach. And today he lives on a pension worth 75 percent of his military salary, with health benefits that cover everything except dental and eye care for himself and his wife.

“We are well compensated, and we live very comfortable lives,” General Eaton said, referring to the military’s most senior leaders. “But when you look at all the things going on around a general, the nation is getting a very, very high return on its money.”

Not everyone at the Pentagon agrees. Two weeks ago, Defense Secretary Robert M. Gates announced a sweeping effort to improve efficiency that, among other things, takes aim at the military’s sacrosanct corps of generals and admirals, ordering his staff to cut at least 50 positions, and making clear that he would be happier if they cut more.
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Anecdotal Lead

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Topics

Narrative visualization design
Navigation in interactive documents
Chart sequence models
Automatic augmentation for communication
Storytelling
… with data?
Obesity Map Vadim Ogievetsky
Privacy and the internet

Lives of others

Jennifer Stodder, Canada's privacy commissioner, said that Facebook, in August 2013, was the social networking site that stood out, agreeing to change its policies within a year to comply with the country's privacy laws. She says that, despite this agreement, the company appears to be goading an independent group of experts, which issued a scathing report and called for an independent review of the company's privacy practices.

The report noted that Facebook, which claims to have half a billion users, and which claims to have more users in a week than the number of Facebook users, had failed to provide clear and consistent information about how personal data is used and shared with third parties. It also said that Facebook was not transparent about how it collected and used personal data.

Facebook has repeatedly said that it shares data with third parties in order to provide users with a better service. The company also said that it has made changes to its privacy settings and that it will continue to work with privacy experts to improve its data protection practices.

However, privacy experts say that Facebook's handling of personal data remains a concern. They say that the company needs to be more transparent about how it uses personal data and that it needs to provide users with clearer choices about how their data is used.

Experts say that Facebook's handling of personal data is a concern because it has a large user base and because it is a global company. They say that Facebook needs to be more transparent about how it uses personal data and that it needs to provide users with clearer choices about how their data is used.

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Gun Deaths In America

By Ben Casselman, Matthew Conlen and Reuben Fischer-Baum

CLICK to advance

This interactive graphic is part of our project exploring the more than 33,000 annual gun deaths in America and what it would take to bring that number down. See our stories on suicides among middle-age men, homicides of young black men and accidental deaths, or explore the menu for more coverage.
A sport measured in centuries

Sumo may be more than a thousand years old. Professional sumo dates back to 1684. The results of nearly every tournament since 1761 have been collected into the greatest historical data set in sports.
SHENANIGANS

Change in teen shenanigans from 1993 to 2013. Showing % difference from 2003 levels.
Candidate campaign stops

Sept. 1

Trump

Clinton
Health

1877

Life expectancy in years

GDP per capita in US$
Narrative Devices for Storytelling with Data

What devices communicate effectively?

... for which contexts and audiences?
Narrative Visualization
Design Space
CASE STUDIES

70% Journalism
20% Business
10% Research
Homer Pace After Age 34

If the accusations are correct, Bonds was 34 in his first season on steroids. Here are projected home run paces for each player after age 34.

**PROJECTED PACE BASED ON AVERAGE OF PREVIOUS FIVE SEASONS**

**Aaron**
Actual homers slightly outpace projected homers for five seasons.

**Ruth**
Averaged 46.4 homers a season from age 30 to 34. Averaged 42.5 for next four seasons.

**Bonds**
From age 35 to 39, he averaged 14 more homers a season than projected.

Note: Ages as of July 1 of each season.
Steroids or Not, the Pursuit Is On

Bonds takes lead
- Home runs after 16 seasons
- Bonds 567
- Aaron 554
- Ruth 456

Bonds was injured last season. He played 14 games and hit 6 home runs.

Homer Pace After Age 34
- If the allegations are correct, Bonds was 34 in his first season on steroids.
- Here are projected home run pages for each player after age 34.

According to allegations in a book about Bonds, he began taking steroids before the 1989 season. His 14th in the league. Two seasons later, he hit 73 home runs, surpassing Aaron's career pace.

Differing Paths to the Top of the Charts
- The top seven players on the career home run list, along with a look at Griffey (12th), Rodriguez (37th) and Pujols (tied 257th).

Beginning
Human Development Trends 2005

Interactive presentation of some of the messages in the Human Development Report 2005

1 Income
   World population 6.1 billion
   Income in very unequal distribution around the world

2 Regions
   Number of people on different income levels by region, in 2000
   South Asia
   East Asia
   Latin America

3 Poverty
   Income below one dollar per day

4 Health
   Child mortality (%) 2003
   Sub-Saharan Africa
   Asia
   Latin America

5 Countries
   GDP per capita ($) 2003

6 Differences
   Child mortality (%) 2003
   South Asia
   East Asia
   Latin America

7 Trends
   Trends in child mortality
   North America
   Europe

8 Gaps
   Comparison of GDP per capita
   North America
   Latin America

9 Deaths
   Deaths of children under age 5 (millions)
   Current trend
   Goal

Produced in collaboration with:
GAPMDNER
www.gapminder.org

English translation: Claes Johansson, UNDP

Start
Development Trends 2005

Interactive presentation of some of the messages in the Human Development Report 2005.

1. Income
   - World population 6.1 billion
   - Income is very unequally distributed around the world

2. Regions
   - Number of people on different income levels by region

3. Poverty
   - Income below one dollar per day

4. Health
   - 2003

5. Countries
   - Child mortality (%)

6. Differences
   - 2003

7. Trends
   - GDP per capita (US)

8. Gaps
   - Child mortality (%)

9. Deaths
   - Deaths of children under 5 million

Produced in collaboration with: UNDP at

English translation: Claes Johansson, UNDP
**Annotations Tell Story**

**Animated Transitions**

**Timeline Slider**

**Tacit Tutorial**

**Interactive Slide Show**
Budget 2010: reaction from around the UK

People in key constituencies around the country give their responses to Alistair Darling's budget.

Shilpa Wymer, 40, is managing director of two branches of Pitman Training Ltd, a training school specialising in secretarial and PA training.

Enquiries from individuals suddenly dropped off a cliff from October 2008 and in January last year we had to lay off a couple of people, though things have picked up since. The budget seems very positive and shows the government are thinking about small and medium sized businesses at last. I think the measures will help businesses be more confident, which will have a knock-on effect on us. It has turned my head and made me think about which way I will vote.

Constituency profile

MP: Greg Hands, Conservative. Majority: 5,029
Unemployment benefit claimants, Feb 2010: 3,281 (up 13% over last year)
Genres for Narrative Visualization (2010)

Missing “scrolly-telling” designs…
Genres + Interactivity + Messaging = DESIGN SPACE

Author Driven
- strong ordering
- heavy messaging
- limited interactivity

Reader Driven
- weak ordering
- light messaging
- free interactivity

STORYTELLING
CLARITY
SPEED
ASK QUESTIONS
EXPLORE
FIND

martini
glass
interactive slideshow
drill-down story
Other techniques: simulation, games, rhetorical, draw the trend
Watch how the measles outbreak spreads when kids get vaccinated – and when they don’t

- **Vaccinated**
- **Susceptible**
- **Vaccinated but susceptible**
- **Infected**
- **Contact with an infected person**

**Not Protected**
- 10.0% vaccine rate
- 30.0% vaccine rate
- 50.0% vaccine rate
- 58.5% vaccine rate, similar to Okanagan County, WA
- 68.9% vaccine rate, similar to Thurston County, WA
Who Should Get Parole?

Even the best risk assessments yield probabilities, not certainties. That means they label as “high risk” some people who won’t commit another crime and label as “low risk” some people who will. This simulation lets you sort offenders into risk categories based on the results of an assessment. Think we should rarely lock up anyone who wouldn’t reoffend? Set the “low risk” threshold high and the “high risk” threshold even higher. Have little tolerance for recidivism? Try the opposite. In the real world, policymakers have to strike a balance. Read more »

1
The prisoners in this simulation are up for parole. Some will reoffend if released and some won’t. They each take an assessment, which estimates the chance they will reoffend.

2
Prisoners are placed in one of three categories based on these estimates. Move the slider to change the cutoffs for each category. “Low risk” prisoners will be awarded parole. “High risk” prisoners will be denied.

3
Some people you let out reoffended. Some people you left in prison wouldn’t have. Are you OK with the results?

Parole-Eligible Prisoners

LOW RISK

AWARDED PAROLE

0%
AWARDED PAROLE AND THEN REOFFENDED

MEDIUM RISK

DENIED PAROLE

HIGH RISK
Change voters’ political loyalties to build a winning coalition.

White evangelical Protestant, no college degree
15% of voters, expected to shrink
Members of this group are strongly anti-immigrant, not accepting of gay identity, and do not believe that racial discrimination is a significant issue. They are very skeptical of government and prefer military action to diplomacy. They are concerned about corporate greed.

White women, college education or more
13% of voters, expected to shrink
Members of this group support immigrants, environmental protections, and business regulation. They prefer diplomacy to military action and are very accepting of gay identity.

White men, college education or more
12% of voters, expected to shrink
Members of this group support immigrants. They are very accepting of gay identity and are more pro-business than any other group.

White, no religious affiliation, no college degree
9% of voters, minimal change expected
Members of this group are the most supportive of gay identity. They prefer diplomacy to military action and support business regulations and environmental protections.

White non-evangelical Protestant, no college degree
9% of voters, expected to shrink

White Catholics, no college degree
8% of voters, expected to shrink
You Draw It: What Got Better or Worse During Obama’s Presidency

By LARRY BUCHANAN, HAEYOUN PARK and ADAM PEARCE  JAN. 15, 2017

Draw your guesses on the charts below to see if you’re as smart as you think you are.

Under President Obama, the unemployment rate …

Draw the line for the Obama years.
Interactive Documents: Steppers, Scrollers, …
Budget Forecasts, Compared With Reality

Just two years ago, surpluses were predicted by 2012. How accurate have past White House budget forecasts been?

Today, with a better understanding of the severity of the economic downturn, the deficit situation is much more dire.

Stepper

Latest forecast

The 1995 forecast for 1999 did not predict a surplus ...

... but the 2008 forecast for 2012 did.

Use the slider to isolate a single year's forecast.
Ramadi: The Government Provides an Opening for ISIS

Tensions between this city’s residents, who are mostly Sunni, and the central government had been brewing here for at least a year. Then in December, Iraq’s prime minister, Nuri Kamal al-Maliki, ordered security forces to dismantle a protest camp — an outlet for disenchanted Sunnis angered at their treatment by the Shiite-dominated government. The action ignited days of violence and created the opening ISIS needed to seize parts of the city, the provincial capital.

Falluja: A Symbolic Fall

Just days after the raid on the camp in Ramadi, ISIS fighters destroyed the Police Headquarters and mayor’s office here, planted their flag on government buildings and decreed the city to be theirs. Ten years earlier, American forces had captured this city from Qaeda-style insurgents at a considerable cost of American lives.
A visual introduction to machine learning

In machine learning, computers apply statistical learning techniques to automatically identify patterns in data. These techniques can be used to make highly accurate predictions.

Keep scrolling. Using a data set about homes, we will create a machine learning model to distinguish homes in New York from homes in San Francisco.
Discrete step vs. Continuous scroll

Different means for narrative navigation. A source of debate among practitioners!
Discrete step vs. Continuous scroll

Different means for narrative navigation. A source of debate among practitioners!

**Step:** sequential frames as in a slideshow
Simple and familiar, but less engaging?
Different means for narrative navigation. A source of debate among practitioners!

**Step:** sequential frames as in a slideshow
Simple and familiar, but less engaging?

**Scroll:** continuous navigation of page
Parameterize content by scroll position
May cause usability / scrolljacking issues
Different means for narrative navigation. A source of debate among practitioners!

**Step:** sequential frames as in a slideshow
Simple and familiar, but less engaging?

**Scroll:** continuous navigation of page
Parameterize content by scroll position
May cause usability / scrolljacking issues

**Hybrids:** scroller with discrete sections
Narrative Implementation

Do-It-Yourself
Monitor scroll position & element positions
Guidance: M. Bostock, J. Vallandingham

Third-Party Support
Helper Libraries
Interactive Document Formats: Idyll
Chart Sequence Models
Multiple Charts in Data Analysis

Executive Overview - Profitability (All)

- Sales: $2,297,201
- Profit: $286,397
- Profit Rate: 12.5%
- Profit per Order: $57.18
- Sales per Customer: $2,896.85
- Avg. Discount: 15.62%

Monthly Sales by Segment - States: All

- Consumer
- Corporate
- Home Office

Monthly Sales by Product Category - States: All

- Furniture
- Office Supplies
- Technology
Multiple Charts in Story Telling

Copenhagen: Emissions, Treaties and Impacts

At the Copenhagen climate conference, discussions are likely to cover emissions levels, the legacy of the Kyoto Protocol and the risks of inaction on global warming. Explore each issue in the tabs below.

<table>
<thead>
<tr>
<th>Global Emissions</th>
<th>Lessons From Kyoto</th>
<th>Possible Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 NEXT ▶</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Almost every country in the world signed and ratified the protocol. The treaty’s aim was to provide a starting point for reducing global carbon dioxide emissions.

Countries that ratified Kyoto
In many cases, data is conveyed via a sequence of charts. How might we evaluate different orderings of visualizations?
GraphScape: A Directed Graph Model

Nodes are Vega-Lite specifications. Edges represent edit operations, weighted by estimated transition costs.

[Kim, Wongsuphasawat, Hullman, Heer, CHI'17]
Design Alternatives

“Too many data points!”

- Add Filter
- Bin
- Random Sample

Binned Scatter Plot

- Add Size(count)

...
GraphScape

Previously we’ve discussed approaches for automatic design of a **single visualization**. GraphScape supports automated design methods for **collections of visualizations**. Plenty of future work to do here!
Automatic Augmentation of Charts for Communication
Given existing visualizations, can we adapt them to communicate more effectively?
Graphical Overlays  [Kong et al. ‘12]

Add (interactive) reading aids to bitmap charts!
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Apple Passes Microsoft as No. 1 in Tech

SAN FRANCISCO — Wall Street has called the end of an era and the beginning of the next one: The most important technology product no longer sits on your desk but rather fits in your hand.

The moment came Wednesday when Apple, the maker of iPods, iPhones and iPads, shot past Microsoft, the computer software giant, to become the world’s most valuable technology company.

This changing of the guard caps one of the most stunning turnarounds in business history for Apple, which had been given up for dead only a decade earlier. The rapidly rising value attached to Apple by investors also heralds an important cultural shift: Consumer tastes have overtaken the needs of business as the leading force shaping technology.

Microsoft, with its Windows and Office software franchises, has dominated the relationship most people had with their computers for almost two decades, and that was reflected in its stock market capitalization. But the click-deal of the keyboard has ceded ground to the swipe of a finger across a smartphone’s touch screen.
Can we produce an automated solution?
Contextifier System [Hullman et al.]

Input: news article about a company

(processing text)
Query

Corpus

Generate features, Select annotations

(obtain stock data)

Closing price

Volume sold