

InfoVis & Visual Analytics

25 years of visualization design and development

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→ Some confidential info!



Uncharted Software

- ~90 people
- Downtown Toronto HQ
- Visual Analytics focus



State of the Art Visual Analytics

SALT: Big Data directly visualized plus analytics

1B+ datapoints

1. taxi pickup (red), dropoff (blue)
2. top Twitter hashtags.
 - Local patterns otherwise invisible
 - Spatiotemporal text analytics
 - Superimposition shows visual correlations between divergent data
 - Zoom to street corners, layer, filter, etc
 - Click tags for detailed content

150m financial transactions across 2m accounts

Account: [redacted]y

Image:

Name:

ID:

Type: lender

Country: NO

Inbound Transfers: 592

Outbound Transfers: 593

Transactions: 8383

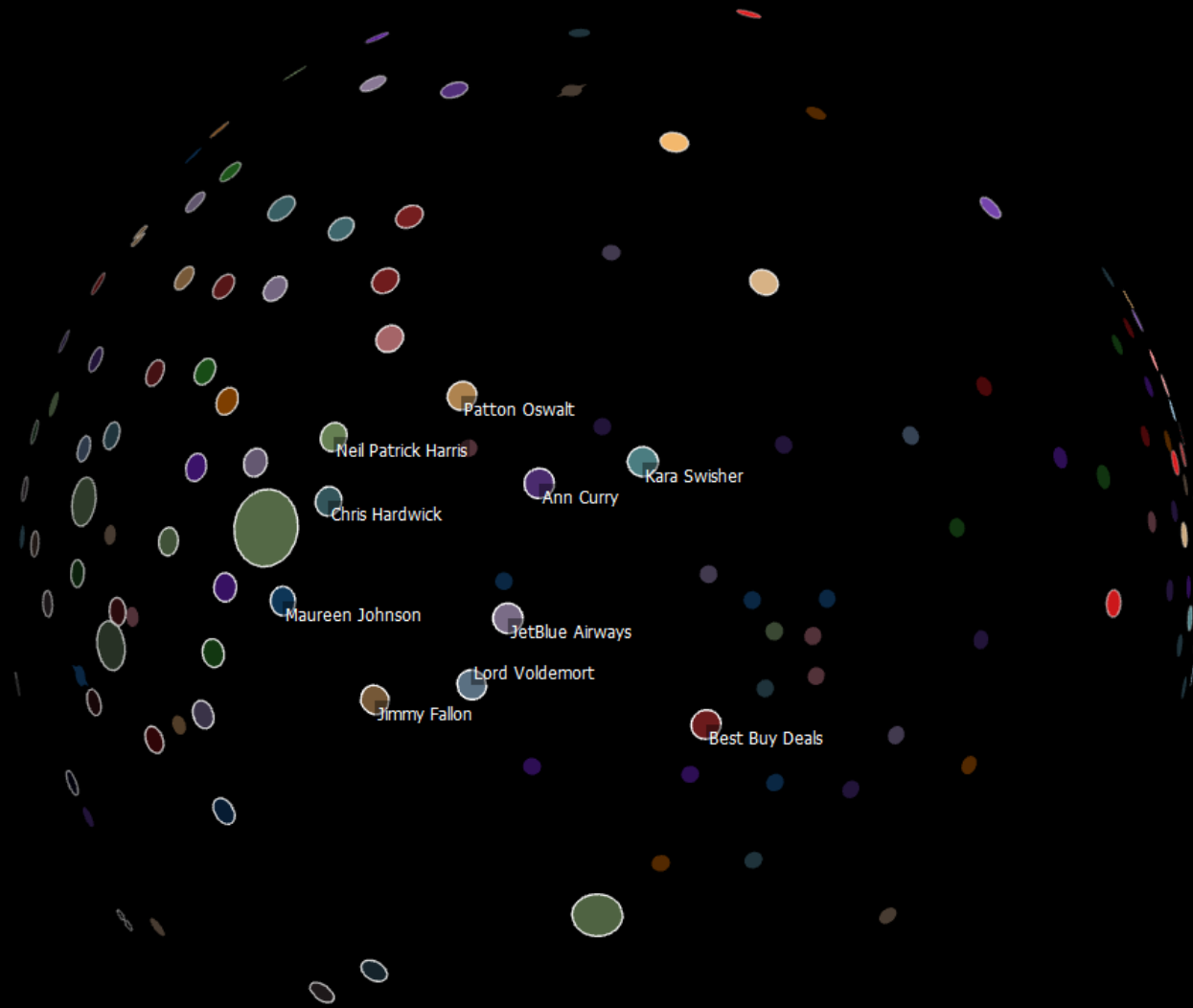


Transaction Table

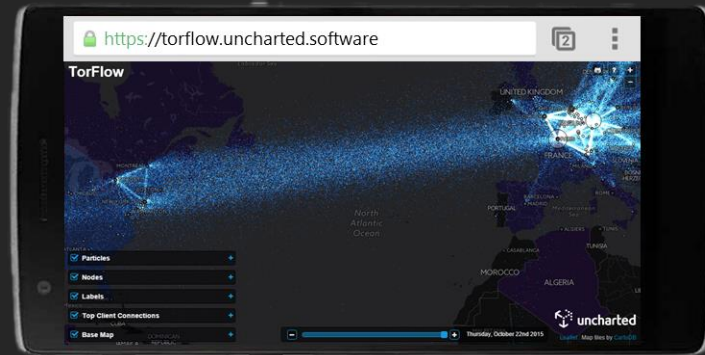
Transaction Chart

#	Date	Comment	In (USD)	Out (USD)
1	Dec 27, 2011 7:00pm	status: paid; loan: 100000 (in KES)	-	\$34.00
2	Dec 27, 2011 7:00pm	status: paid; loan: 1.87374e+006 (in CLP)	-	\$29.00
3	Dec 26, 2011 7:00pm	status: in_repayment; loan: 2.35544e+006 (in PYG)	-	\$29.00
4	Dec 22, 2011 7:00pm	status: paid; loan: 1e+006 (in COP)	-	\$29.00
5	Dec 22, 2011 7:00pm	status: in_repayment; loan: 15000 (in NIO)	-	\$35.00

250,000
correlations
in social
networks



Network Flow



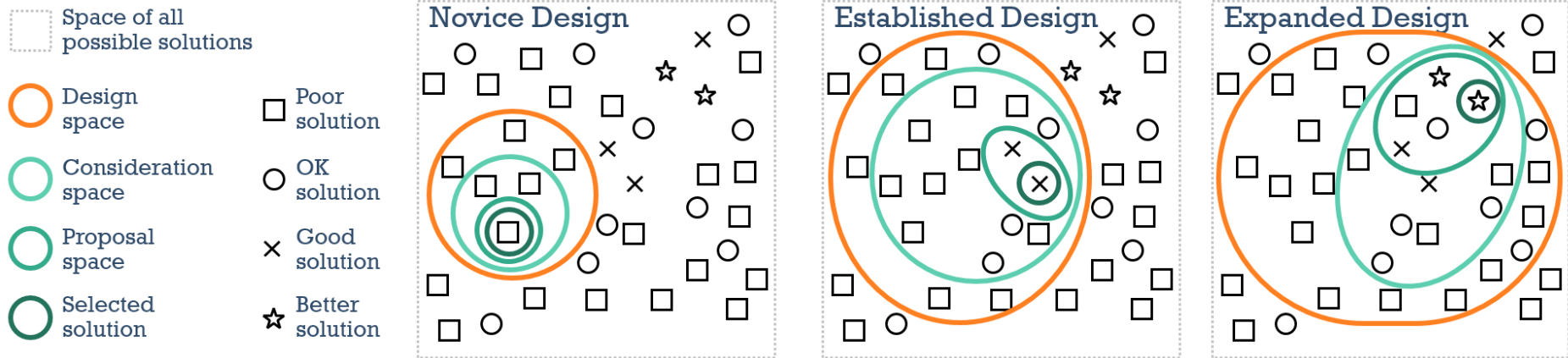
All different designs!

So what is the
design space of
visual analytics?

Design Space?

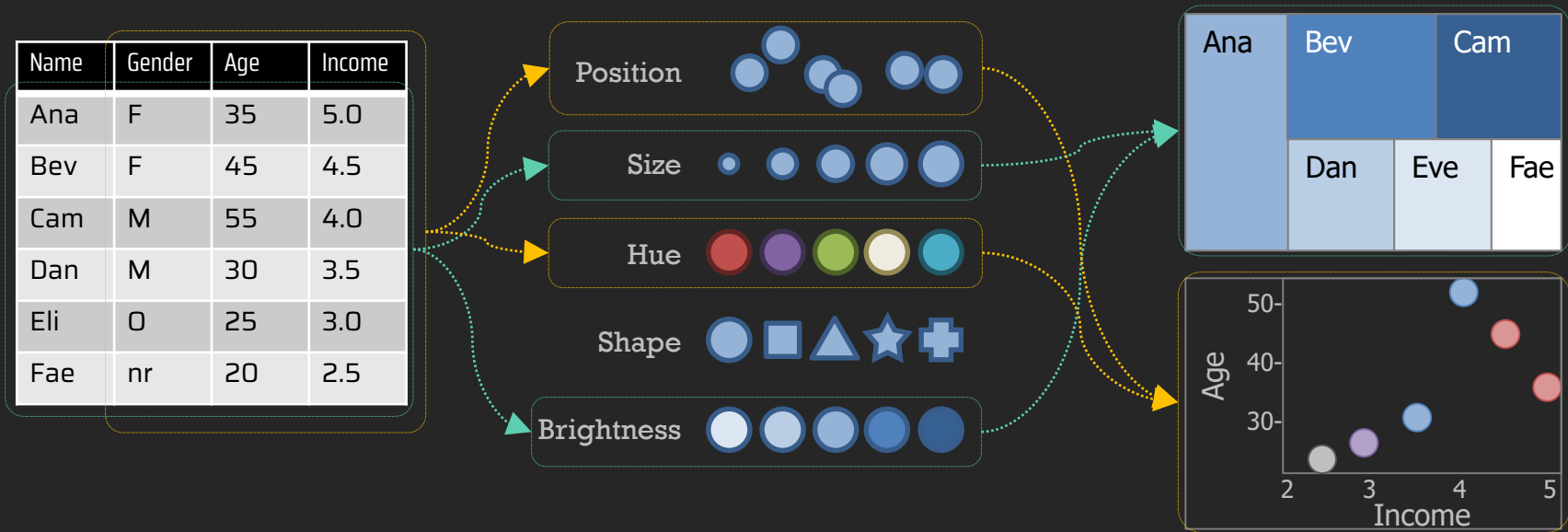
The set of possible design elements, parameters and configurations that meet the specific application objectives.

Why does the design space matter?



Is this the design space of infovis?

Data maps to **Visual Attribute** and plot to **Screen**



Design space of vis

Visualization Encoding Pipeline

Structured Data

Nominal

Apple, Banana, Pear

Ordered

Mint, Good, Fair, Poor

Quantitative

0, 3, 4.2, -31.2, 6.6×10^6

map to **Visual Attributes**

Position



Size



Hue



Rotation



Brightness



Etc



draw as **Marks**

Point



Line

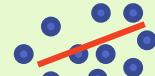


Area



plot on a **Layout**

Scatter



Graph



Line



Tree

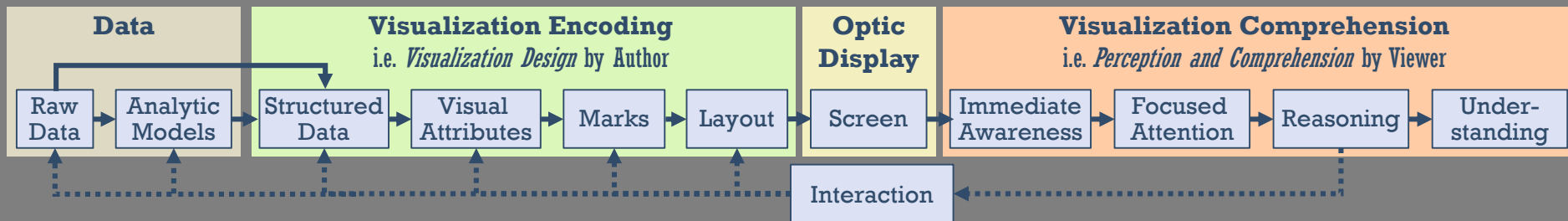


Etc



Design space of vis

VISUAL ANALYTICS PIPELINE



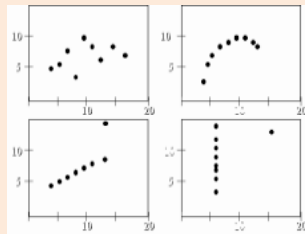
The design space of information visualization is all the visual and interactive elements together with data and analytics in all possible combinations.

“The vast majority of the possibilities in the design space will be ineffective for any specific usage context.”

Comprehension

FASTER UNDERSTANDING

- Parallel processing - see some patterns instantaneously
- Supports perceptual inferences that are easy to recognize
- Visual grouping reduces visual scanning and searching



The data sets shown in these four charts have the same statistics: same average in both x and y, same regression line, same sum of squares, same correlation coefficient. But visually the differences are immediately obvious.
(image originally by F.J. Anscombe 1973)

INCREASED COGNITIVE CAPACITY

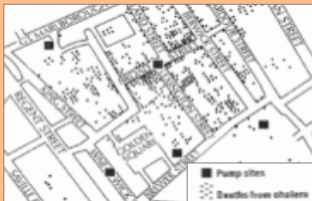
- Perceptual inference off-loads cognitive processes
- Data organized visually improves access and expands working memory beyond 6 +/- 2 limitation



The map of Napoleon's disastrous Russian campaign allows exploration of many dimensions of data including: location (x & y), direction, number of troops, temperature, and geographic features.
(image originally by C. Minard 1869)

BIG PICTURE

- Large visual field enables view across more data and more variables than otherwise comprehensible: visible big data



Dr. John Snow's map of cholera locations and water pump locations provides an easy to comprehend visual relationship between the two: i.e. deaths are mostly clustered near the Broad Street pump.
(image originally by J. Snow 1865)

UNDERSTAND COMPLEXITY

- Interactive integrated analytics enables exploration of complex relationships and parameter values to create a cognitive model.



This printed map of Africa has several translucent layers that the viewer can combine to add or remove information.
(image originally by N. Nakagaki 1968)

Working in the Design Space

Design space of vis

Visualization Encoding Pipeline

**Realtime
Structured
Data**

Nominal

Apple, Banana, Pear

Ordered

Mint, Good, Fair, Poor

Quantitative

0, 3, 4.2, -31.2, 6.6×10^6

Analytic Models

map to **Visual Attributes**

3D Position

Size

Hue

Rotation

Brightness

Etc

draw as **Marks**

Point

Line

Area

plot on a **Layout**

Scatter

Graph

Line

Tree
map

Etc

Is that all?

There's so much detail to get into?

- How do the visual attributes work?
- What about layout?
- What interactions?
- Simplicity vs. complexity?
- Broader workflow?

Implementation?

- Scale, speed, responsiveness, code complexity?

The rest of the vis ecosystem borrows from other fields:

- Data management
- Analytics, ML, AI
- UX and application
- Evaluation

Pop-out

Preattentive
perception...

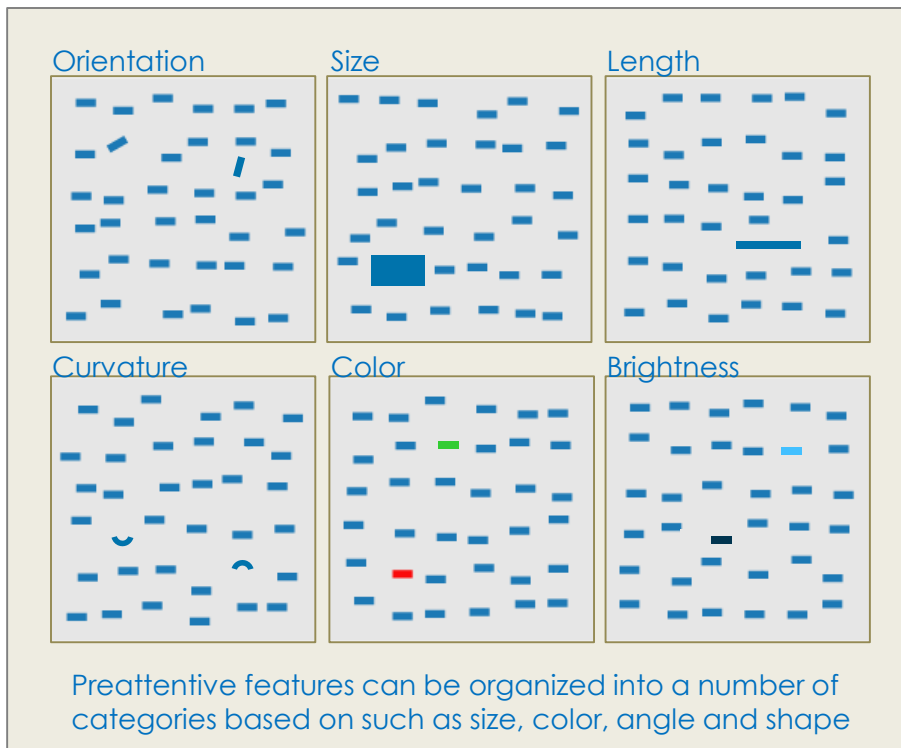


Source: Colin Ware

Visual POP-OUT

“Preattentive Perception”

- Very fast, parallel perceptual operation to separate a scene by low-level attributes
- Simple visual attributes can make elements **pop out**
- Allows us to find targets as fast as 1/100th of a second
 - Useful for showing things “at-a-glance” e.g. monitoring uses
- Alpha-numerics do not pop:
8973905709279
0802808508083
- Color pops:
8973905709279
0802808508083
- Too many colors distract:
8973905709279
0802808508083



Source: <http://www.csc.ncsu.edu/faculty/healey/PP/>

Color

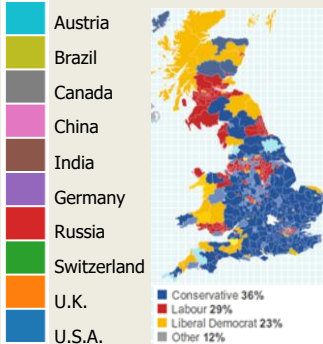
For any attribute, need to look at HOW you are using it. E.g. COLOR

1. Use **brightness** to separate foreground data from the background reference
 - e.g. Blue line on black background is not effective
2. Use **hue** to attract attention & convey urgency
 - Use bright colors sparingly, e.g. bright red on alerts
3. Take into account **color blindness**
 - For a red-green color ramp, add a bit of blue to the green
4. Be aware of **cultural biases** (green = good, blue = authoritative, etc.)
5. Match **color scales** with your data type:

Categorical data

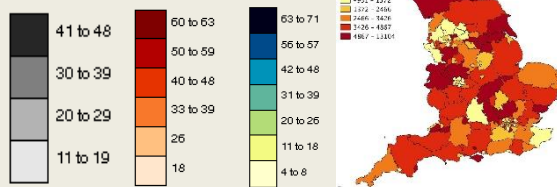
(no natural ordering)

- Assign colors by type
- Goal: All colors demand equal attention and are easily discriminable



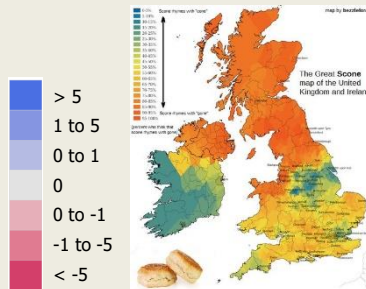
Magnitude data

- Assign colors by brightness
- Goal: Intuitive relationship between color and value

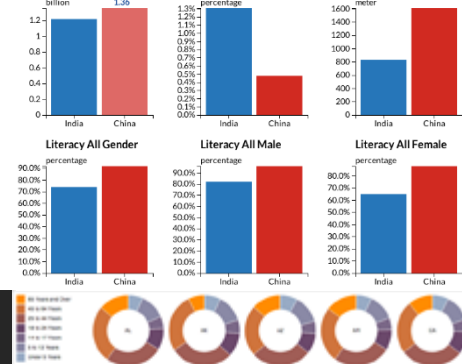
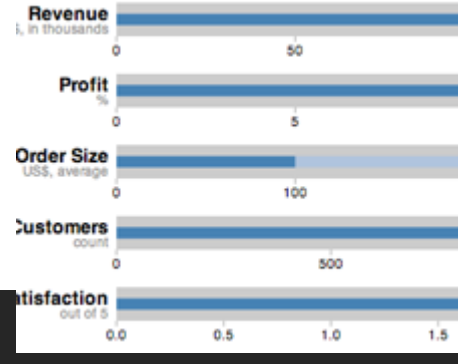
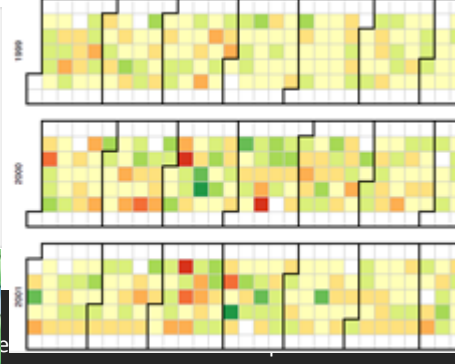
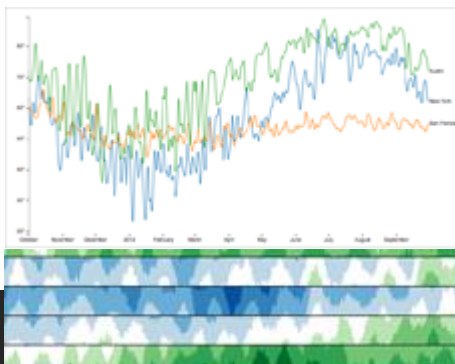
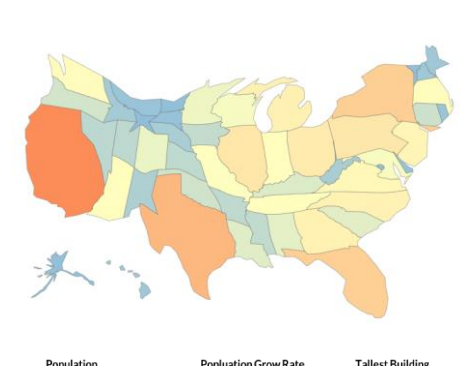
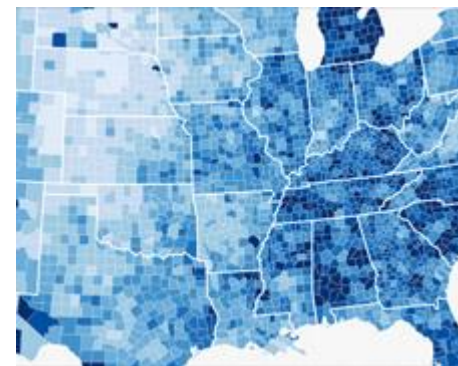
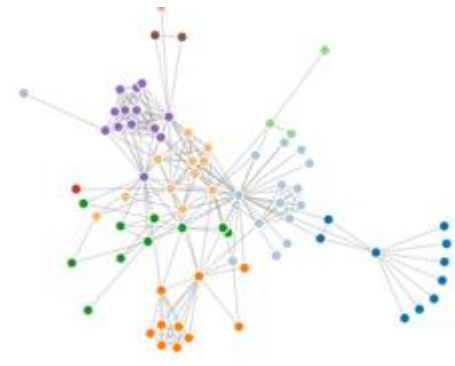
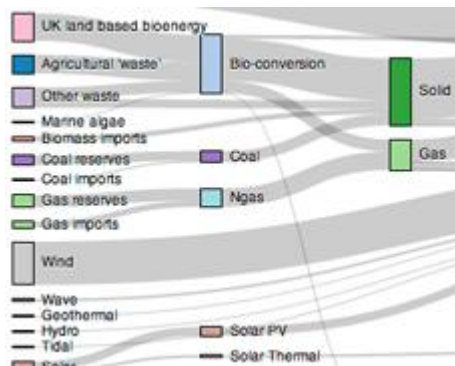
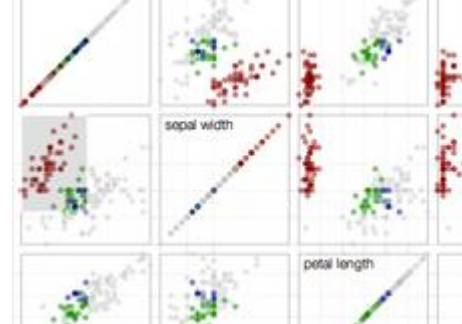


Diverging Ratios data

- Sometimes, a threshold e.g. 0, need to separate those above/below the special value.
- Assign two different gradient hues



Layout?



Interaction?

- Tap/click
- Double click, shift-click, ctrl-click, alt-click, tap and hold
- Click and drag, alt-click and drag, shift-click and drag, pinch...
- Context menu, radial menu, select marquee, lasso
- Zoom, pan, scroll, rotate, and 3D
- Slider bars, handles, radars
- Tooltips, pop-ups, transitions, re-center
- Layers, filters, transparency
- Sketching, annotation
- Multi-touch, gestures, two-handed, proxemics, sensors
- More...

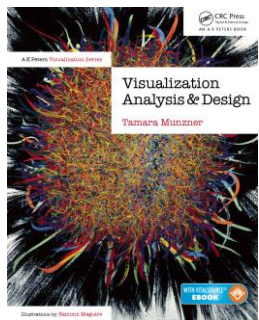
Interaction?

Don't count on interaction...

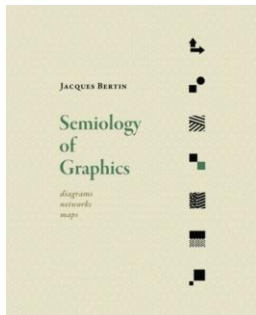
- PDF in email
- Image on poster
- Presentation to audience
- Big wall / some ambient displays
- Magazine
- Installation
- Television
- Some mobile environments

Good resources...

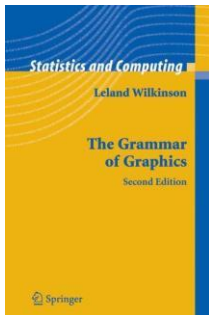
Theory



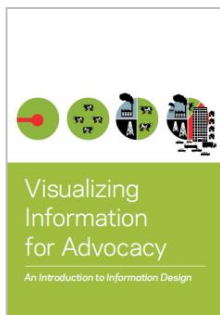
Vis Analysis & Design
Tamara Munzner



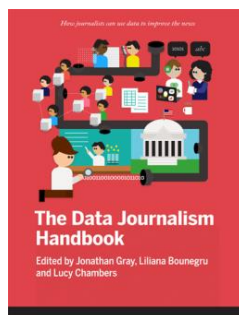
Semiology of Graphics
Jacques Bertin



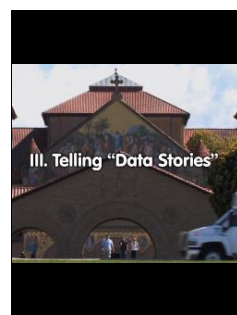
Grammar of Graphics
Leland Wilkinson



Visualizing Information for Advocacy
visualizingadvocacy.org



Data Journalism Handbook
Gray, Bounegru & Chambers
<http://datajournalismhandbook.org/1.0/en/index.html>



Journalism in the Age of Data
<http://datajournalism.stanford.edu/>

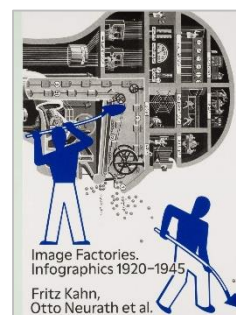


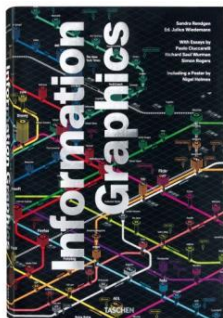
Image Factories. Infographics 1920-1945
Fritz Kahn, Otto Neurath et al.

Visualization and Journalism

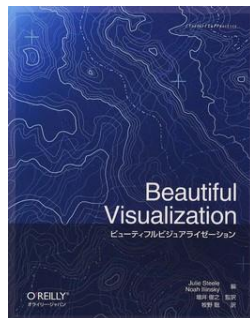
Concepts



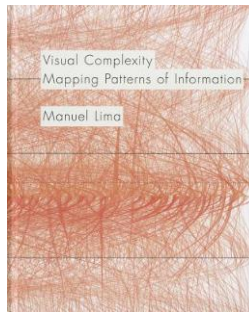
Envisioning Information
Edward Tufte



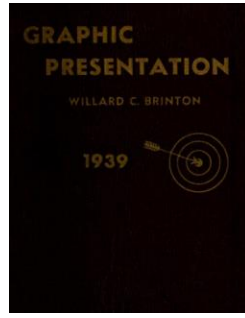
Information Graphics
Sandra Rendgen



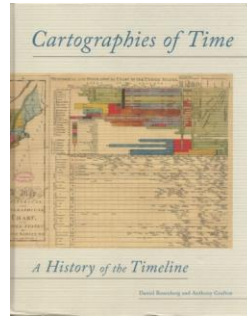
Beautiful Visualization
Steele & Illinsky



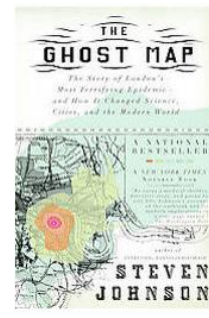
Visual Complexity
Manuel Lima



Graphic Methods
Willard Brinton



Cartographies of Time
Rosenberg & Grafton



The Ghost Map
Steven Johnson

Nice Read