Information Visualization
Aggregate & Filter 1

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Lect 17, 10 Mar 2020

https://www.cs.ubc.ca/~tmm/courses/436V-20

Upcoming

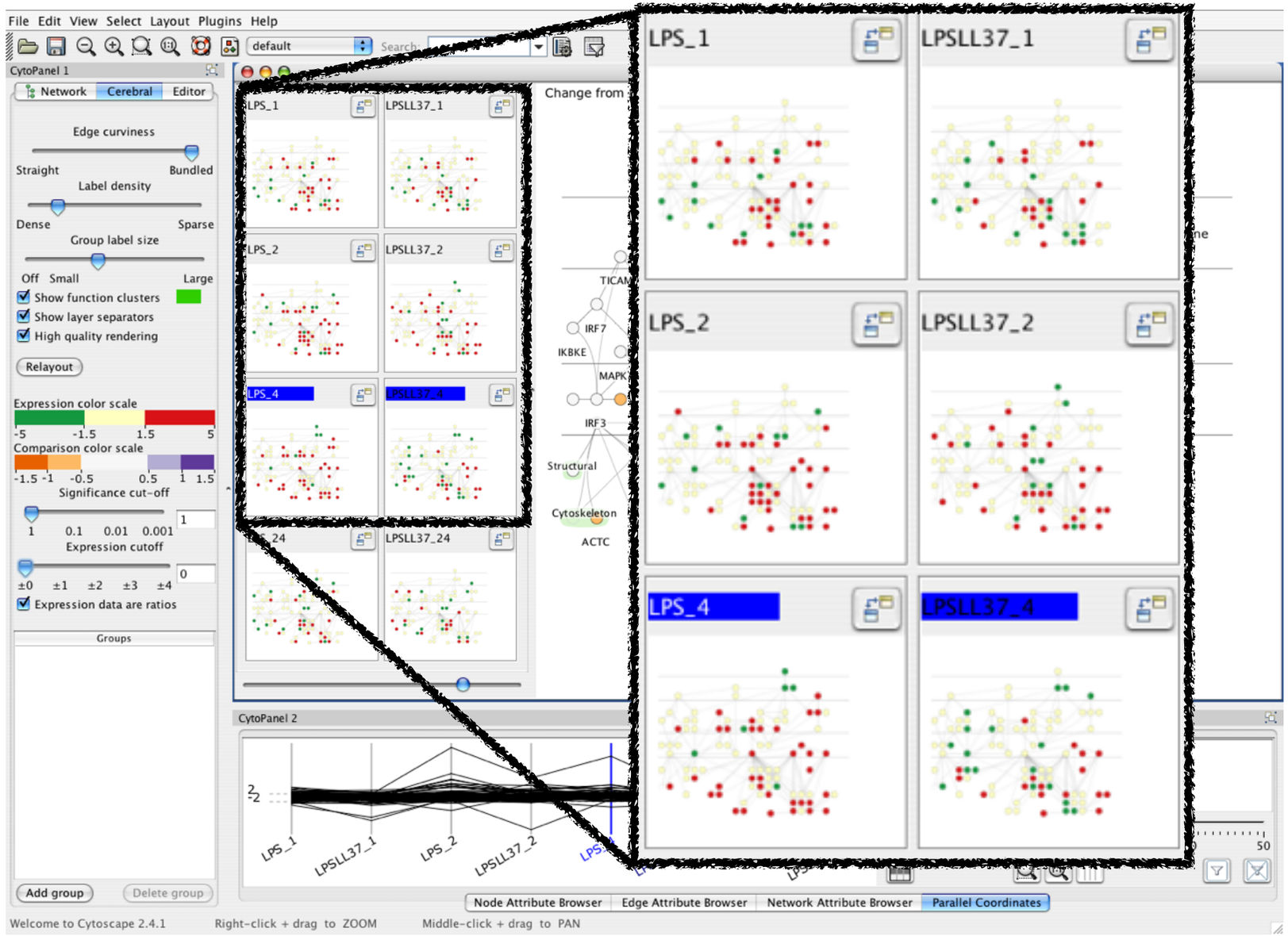
- Foundations 5: out Thu Mar 12, due Wed Mar 18 11:59pm
- Milestone 2: due Wed Mar 25 11:59pm
  - (with update announce last week, schedule status component)

Correction

Idiom: **Small multiples**

System: **Cerebral**

- encoding: same
- data: none shared
  - ~~different attributes~~ **different items (different condition keys, same gene keys), same attributes: expression values** for node colors
  - (same network layout **for nodes=genes**)
- navigation: shared



[Cerebral:Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14:6 (2008), 1253–1260.]

Reminder

Beyond slides: Textbook for further reading (optional)

- Intro
  - Ch 1. What's Vis, and Why Do It?
- Data Abstraction
  - Ch 2. What: Data Abstraction
  - Ch 4. Analysis: Four Levels for Validation
- Task Abstraction
  - Ch 3. Why: Task Abstraction
- Marks & Channels
  - Ch 5. Marks and Channels
- Multivariate Tables
  - Ch 7. Arrange Tables
- Interactive Views
  - Ch 11. Manipulate View
  - Ch 12. Facet into Multiple Views
- Maps
  - Ch 8. Arrange Spatial Data (only 8.1-8.3)
- Color
  - Ch 10. Map Color and Other Channels
- Networks & Trees
  - Ch 9. Arrange Networks and Trees
- Aggregation
  - Ch 13. Reduce Items and Attributes
  - Ch 14. Embed: Focus+Context
- *Rules of Thumb (upcoming)*
  - *Ch 6. Rules of Thumb*

Visualization Analysis & Design, free through library: catalog page EZProxy direct link

Filter & Aggregate

Exercise: Too much stuff

- Cars dataset: 7 attributes
  - MPG quantitative
  - Cylinders ordinal
  - Horsepower quantitative
  - Weight quantitative
  - Acceleration quantitative
  - Model Year ordinal
  - Origin categorical
- This table has 100 million items
- Pair up, discuss how to have scalable approach, create sketch to illustrate
  - [8 min]
  - Socrative: true when done

How to handle complexity: 1 previous strategy + 3 more

→ *Derive*

- derive new data to show within view
- change view over time
- facet across multiple views
- reduce items/attributes within single view

Manipulate

→ Change

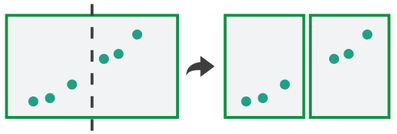
→ Select

→ Navigate

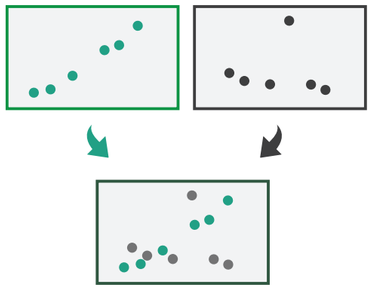
Facet

→ Juxtapose

→ Partition



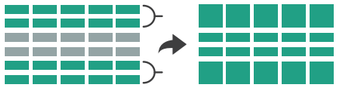
→ Superimpose



Reduce

→ Filter

→ Aggregate



→ Embed

How?

Encode

Arrange

- Express
- Separate
- Order
- Align
- Use

Map

from categorical and ordered attributes

- Color
  - *Hue*
  - *Saturation*
  - *Luminance*
- Size, Angle, Curvature, ...
- Shape
- Motion

Direction, Rate, Frequency, ...

Manipulate

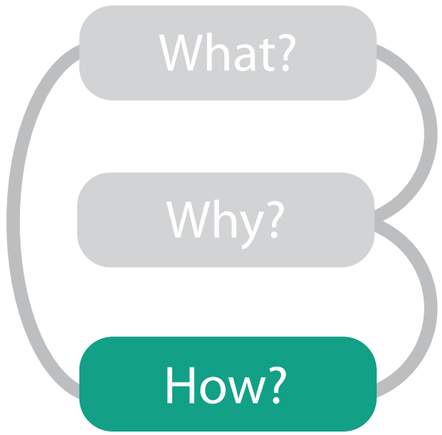
- Change
- Select
- Navigate

Facet

- Juxtapose
- Partition
- Superimpose

Reduce

- Filter
- Aggregate
- Embed

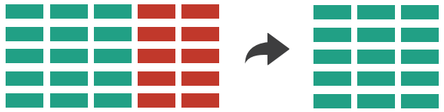


Reducing Items and Attributes

Filter

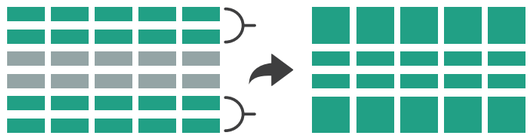
- Items

- Attributes

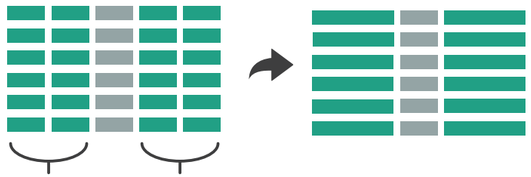


Aggregate

- Items



- Attributes



Reduce items and attributes

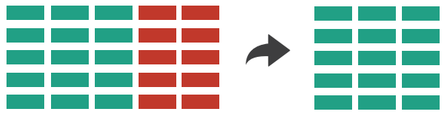
- reduce/increase: inverses
- filter
  - pro: straightforward and intuitive
    - to understand and compute
  - con: out of sight, out of mind
- aggregation
  - pro: inform about whole set
  - con: difficult to avoid losing signal
- not mutually exclusive
  - combine filter, aggregate
  - combine reduce, change, facet

Reducing Items and Attributes

Filter

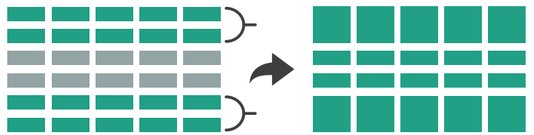
- Items

- Attributes

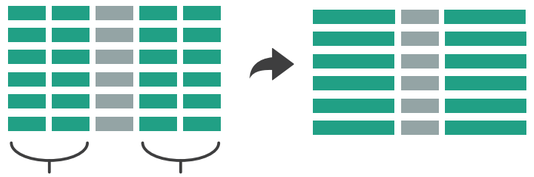


Aggregate

- Items



- Attributes



Reduce

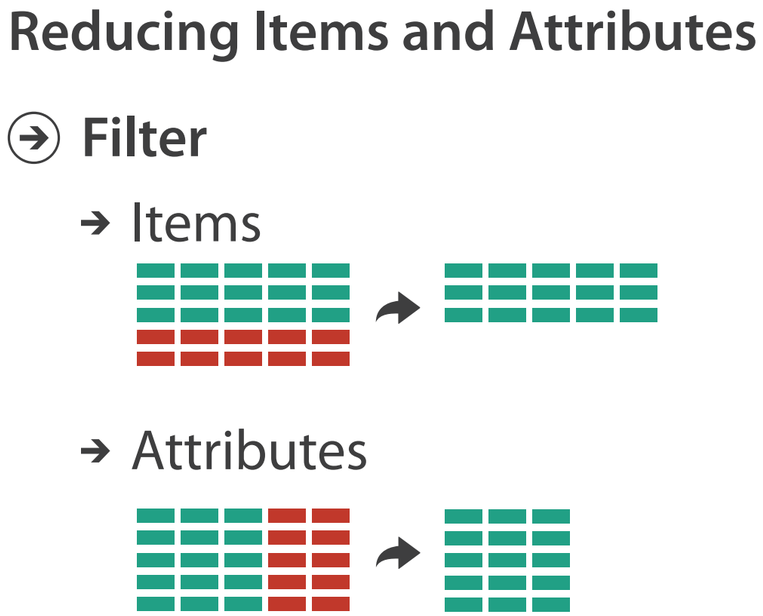
Filter

Aggregate

Embed

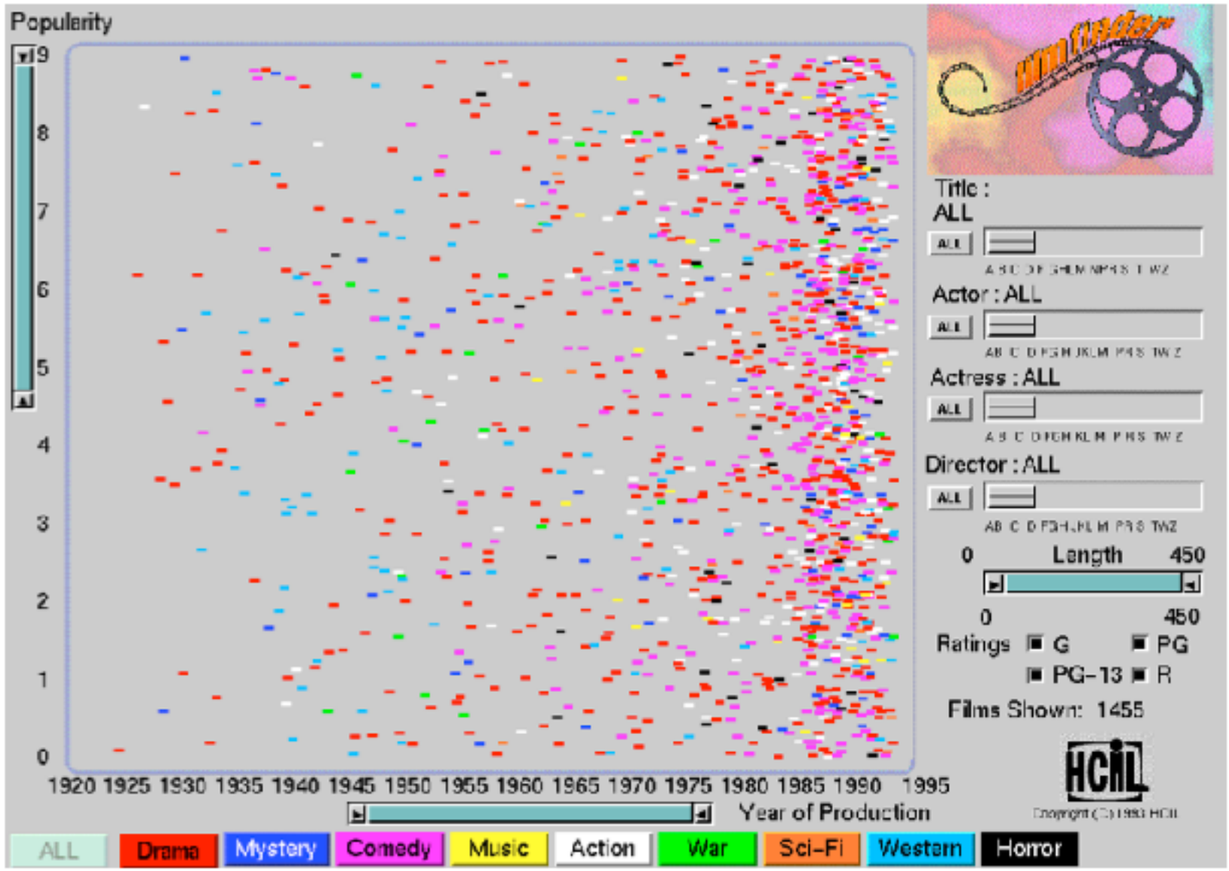
Filter

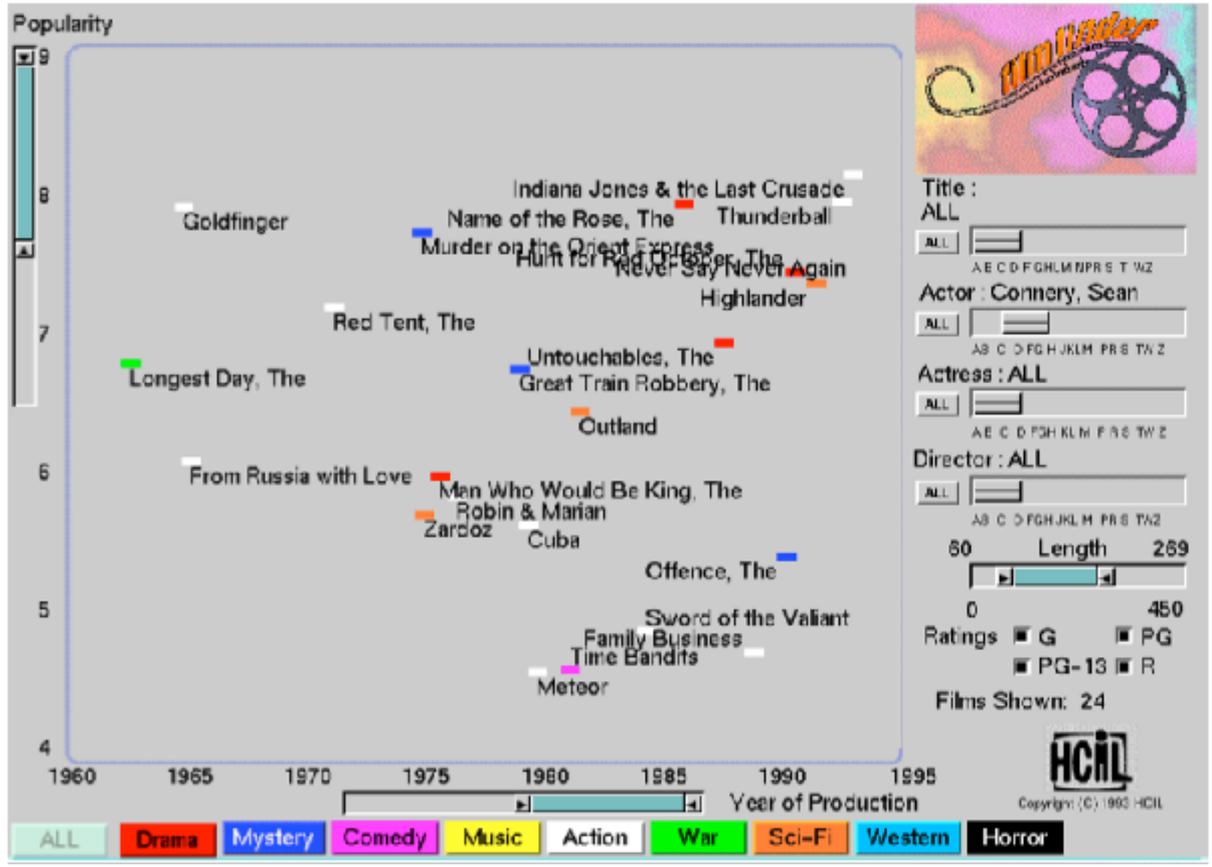
- eliminate some elements
  - either items or attributes
- according to what?
  - any possible function that partitions dataset into two sets
    - attribute values bigger/smaller than x
    - noise/signal
- filters vs queries
  - query: start with nothing, add in elements
  - filters: start with everything, remove elements
  - best approach depends on dataset size



Idiom: **FilmFinder**

- dynamic queries/filters for items
  - tightly coupled interaction and visual encoding idioms, so user can immediately see results of action

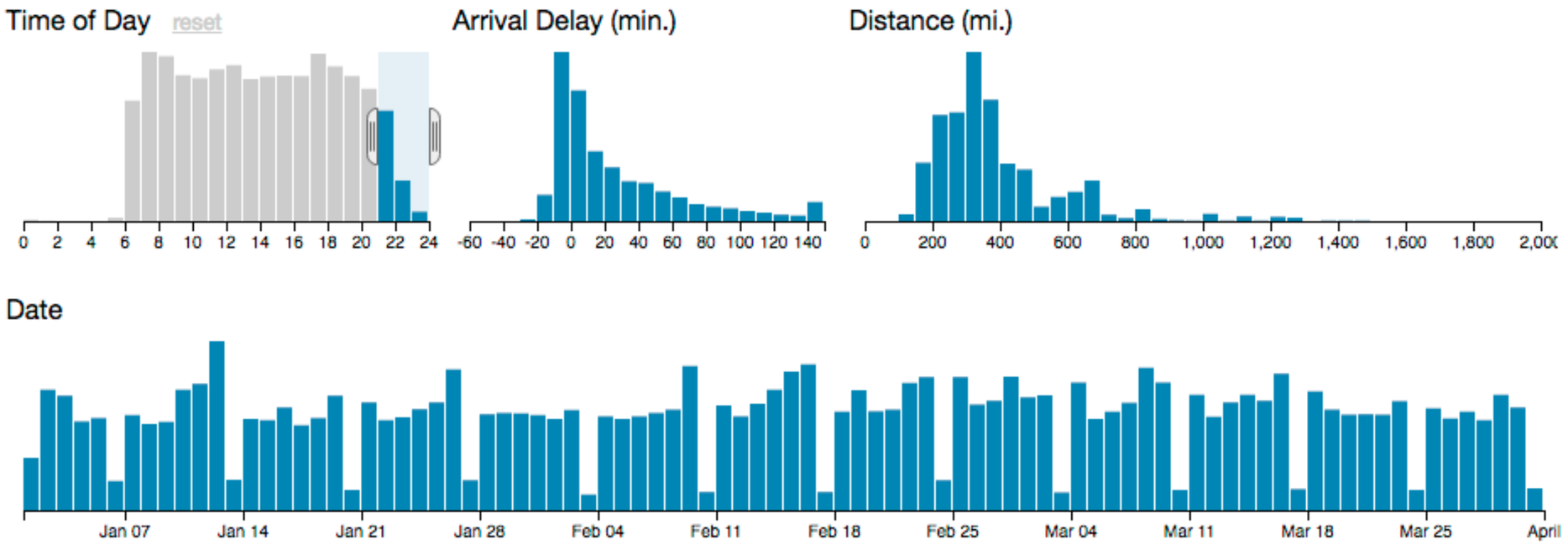




[Ahlberg & Shneiderman, Visual Information Seeking: Tight Coupling of Dynamic Query Filters with Starfield Displays. CHI 1994.]

Idiom: **cross filtering** System: **Crossfilter**

- item filtering
- coordinated views/controls combined
  - all scented histogram bisliders update when any ranges change



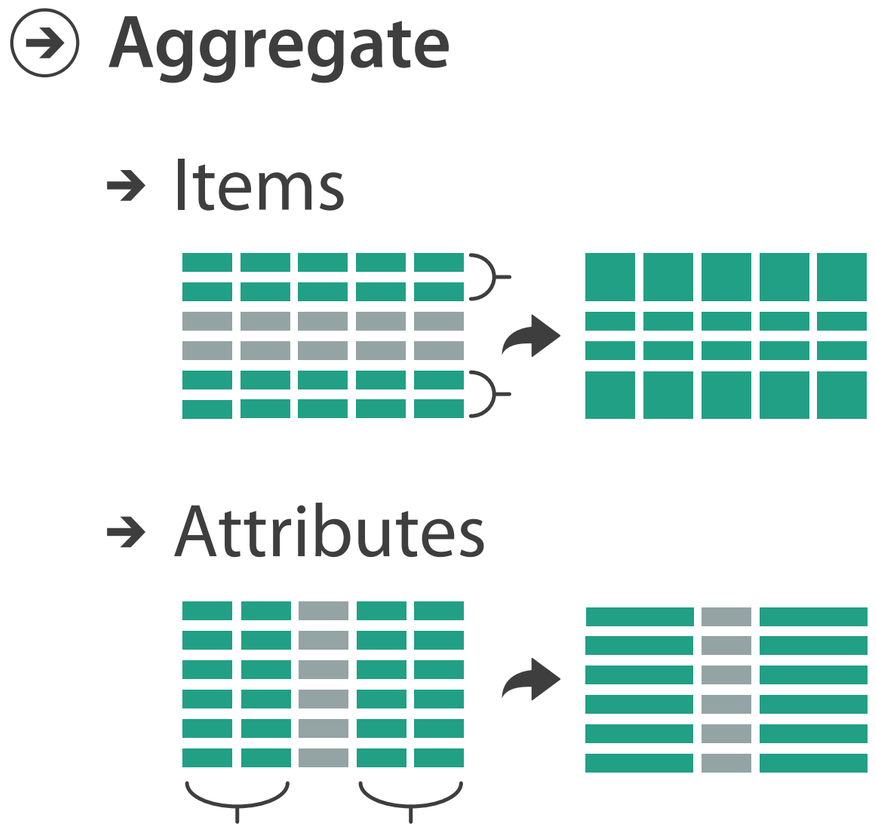
[http://square.github.io/crossfilter/]

Idiom: **cross filtering**

[https://www.nytimes.com/interactive/2014/upshot/buy-rent-calculator.html?_r=0]

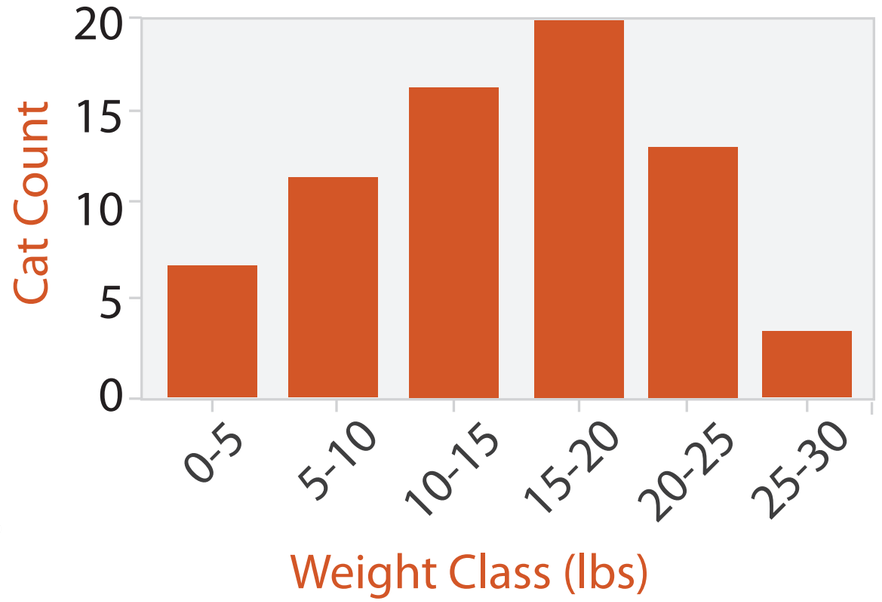
Aggregate

- a group of elements is represented by a smaller number of derived elements



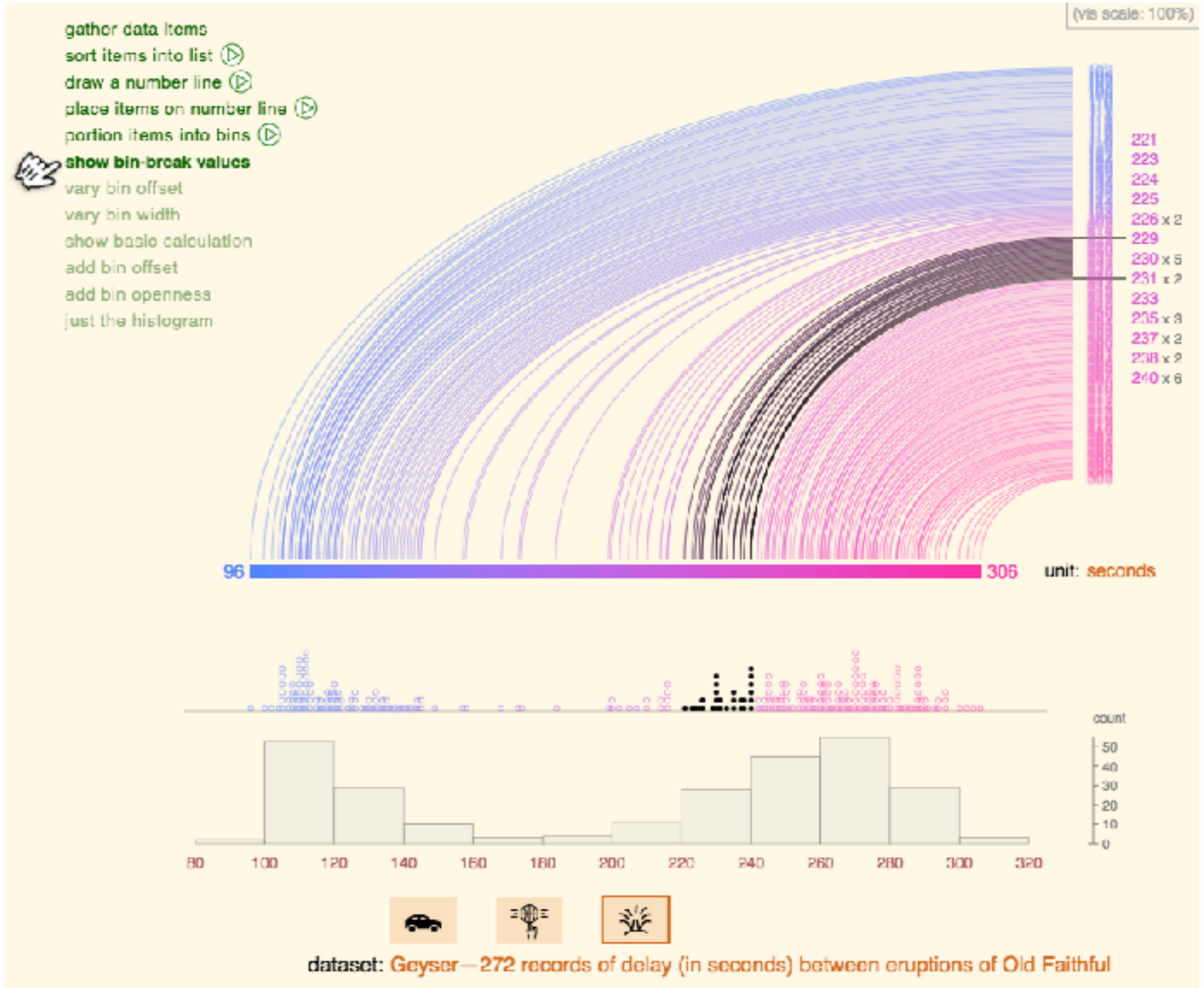
Idiom: **histogram**

- static item aggregation
- task: find distribution
- data: table
- derived data
  - new table: keys are bins, values are counts
- bin size crucial
  - pattern can change dramatically depending on discretization
  - opportunity for interaction: control bin size on the fly



Histograms explained

- also great example of scrollytelling!



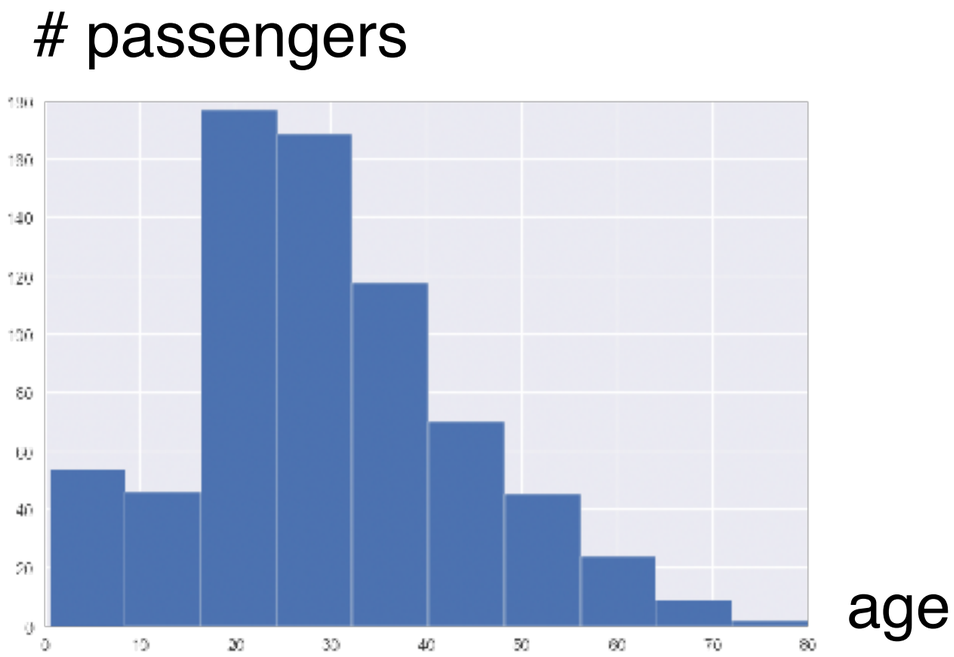
http://tinlizzie.org/histograms/

Histogram bins

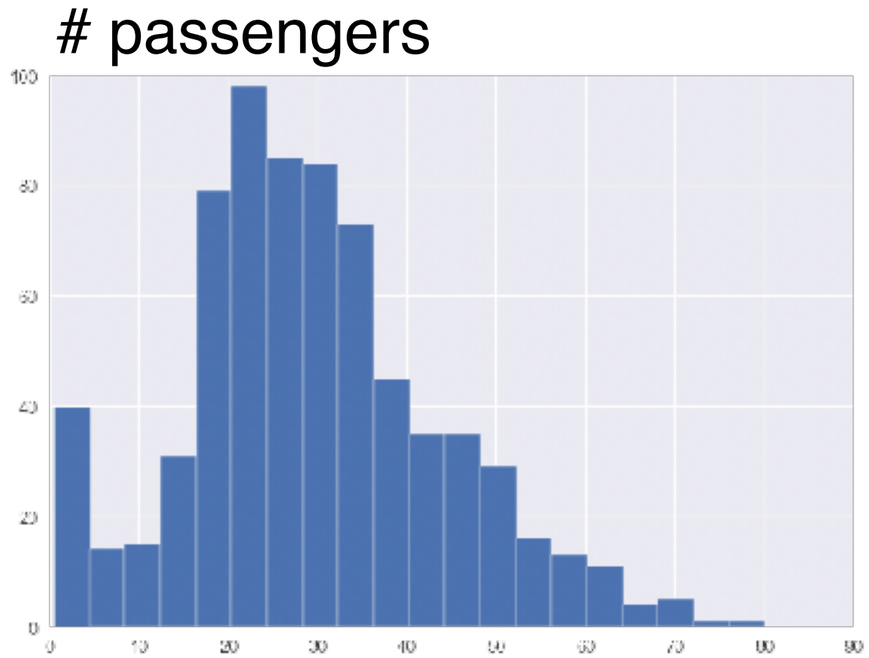
- good # bins hard to predict
  - make it interactive when possible

- rules of thumb
  - # bins = sqrt(n)
  - # bins = log2(n)+1

10 bins

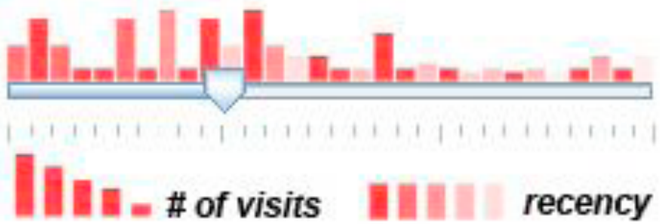


20 bins

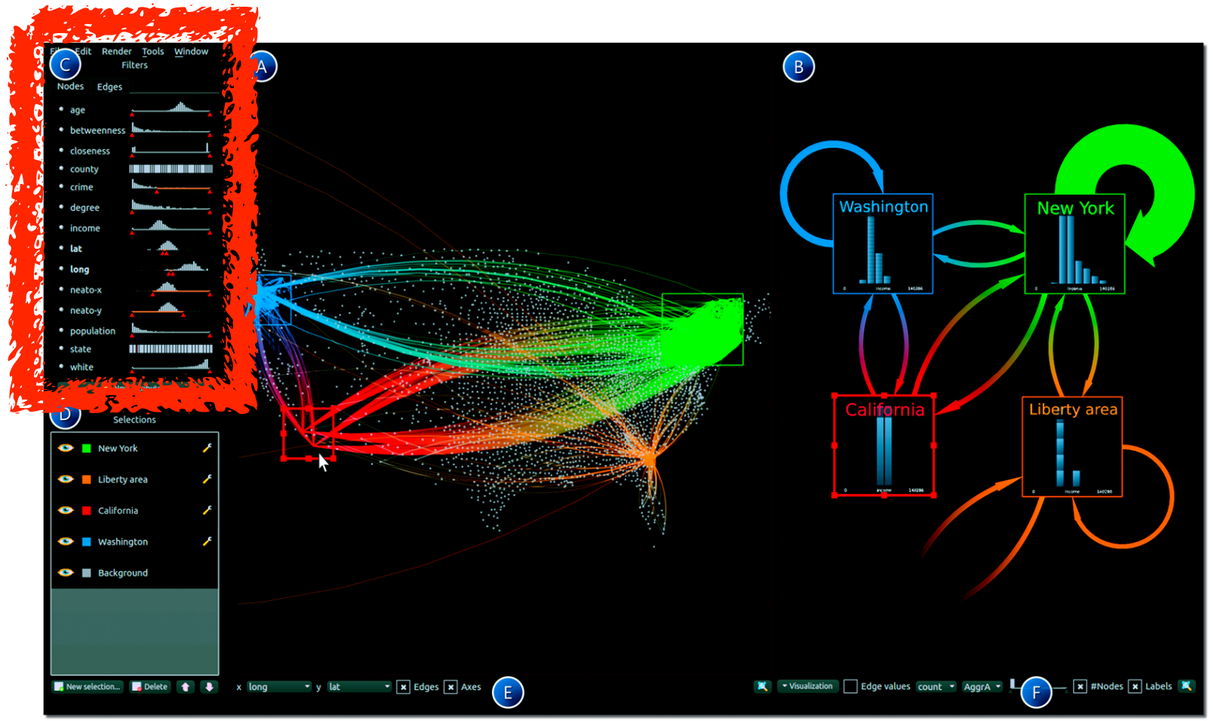


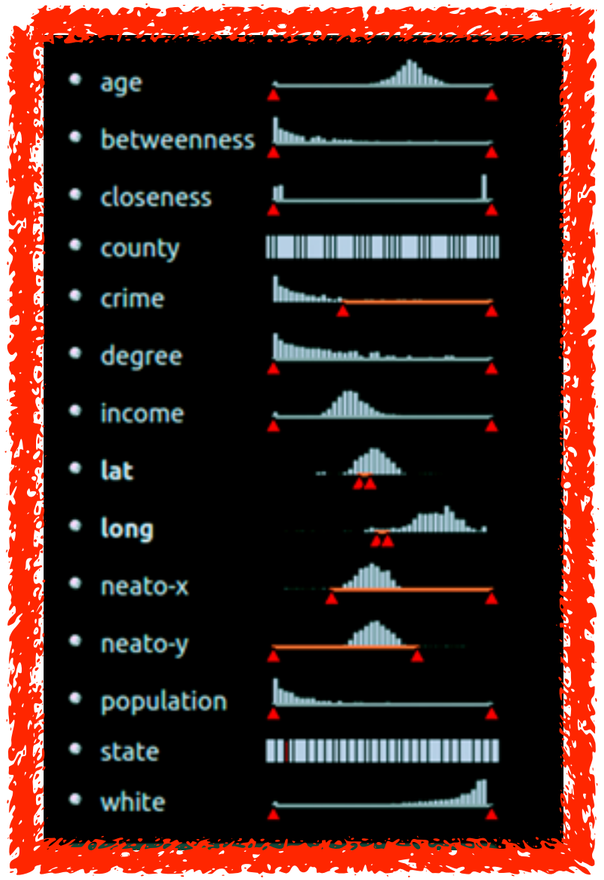
Idiom: **scented widgets**

- augmented widgets show *information scent*
  - better cues for *information foraging*: show whether value in drilling down further vs looking elsewhere
- concise use of space: histogram on slider



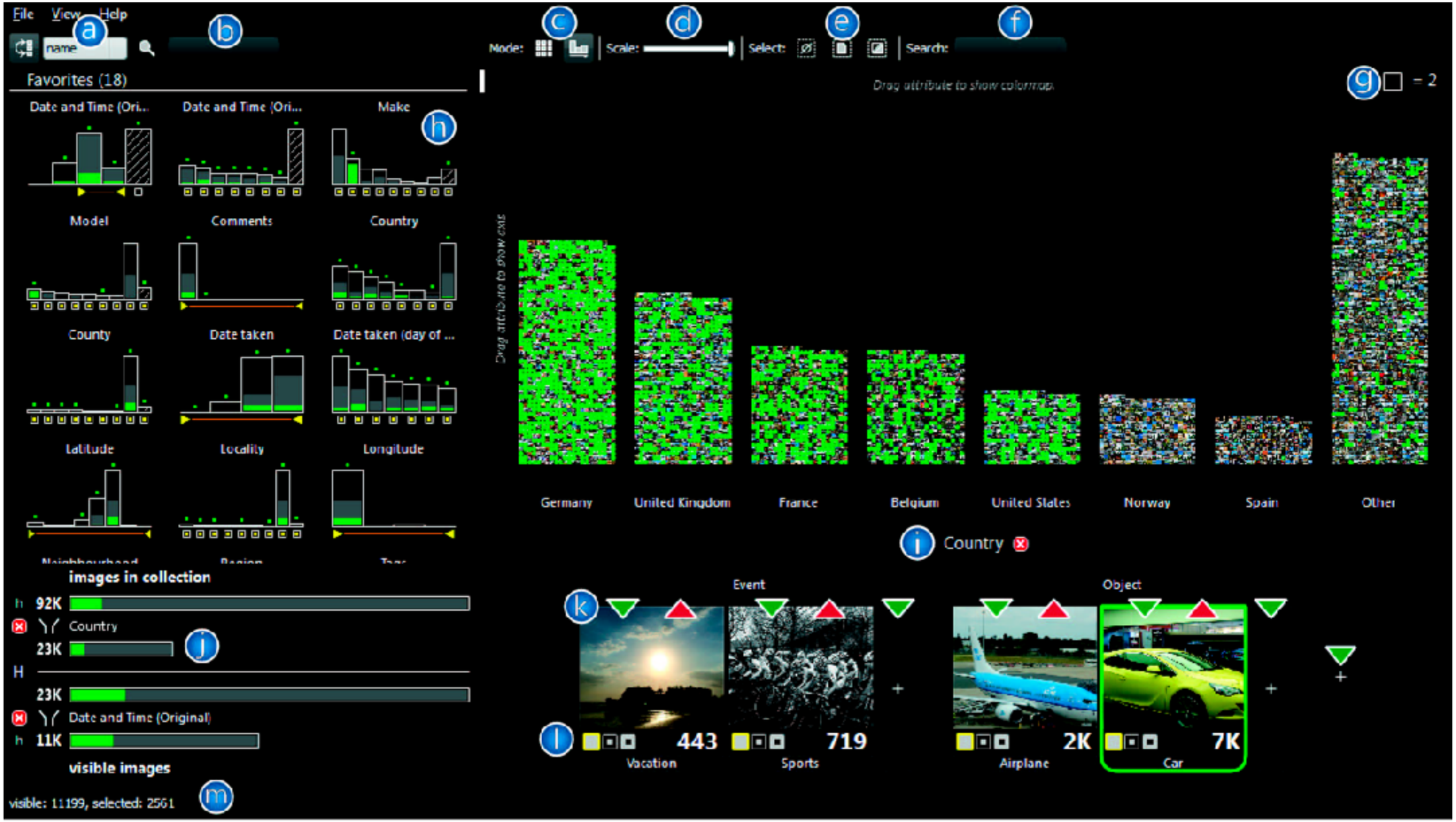
[Scented Widgets: Improving Navigation Cues with Embedded Visualizations. Willett, Heer, and Agrawala. IEEE TVCG (Proc. InfoVis 2007) 13:6 (2007), 1129–1136.]





[Multivariate Network Exploration and Presentation: From Detail to Overview via Selections and Aggregations. van den Elzen, van Wijk, IEEE TVCG 20(12): 2014 (Proc. InfoVis 2014).]

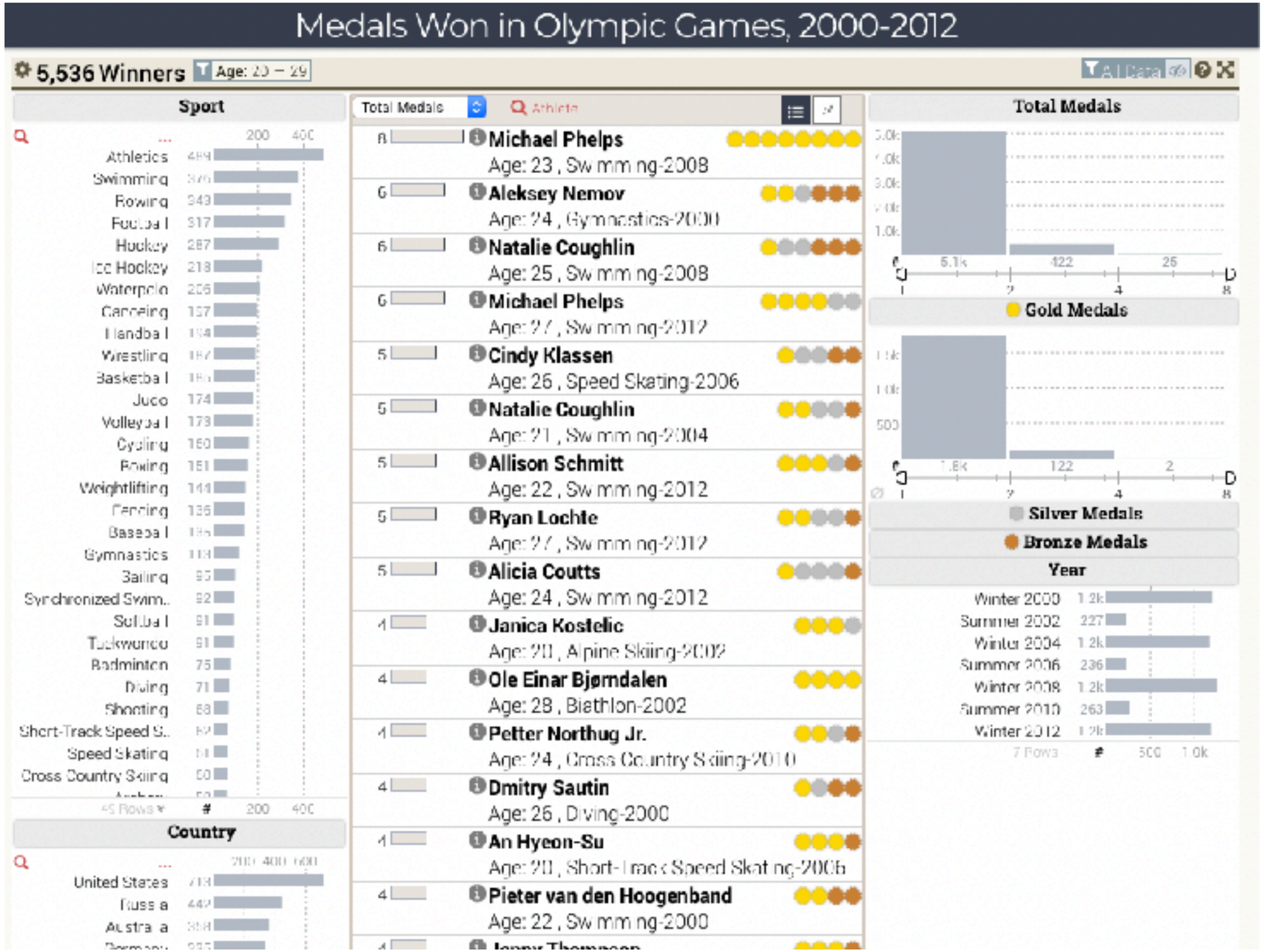
Scented histogram bisliders: detailed



[ICLIC: Interactive categorization of large image collections. van der Corput and van Wijk. Proc. PacificVis 2016.]

Example: Keshif

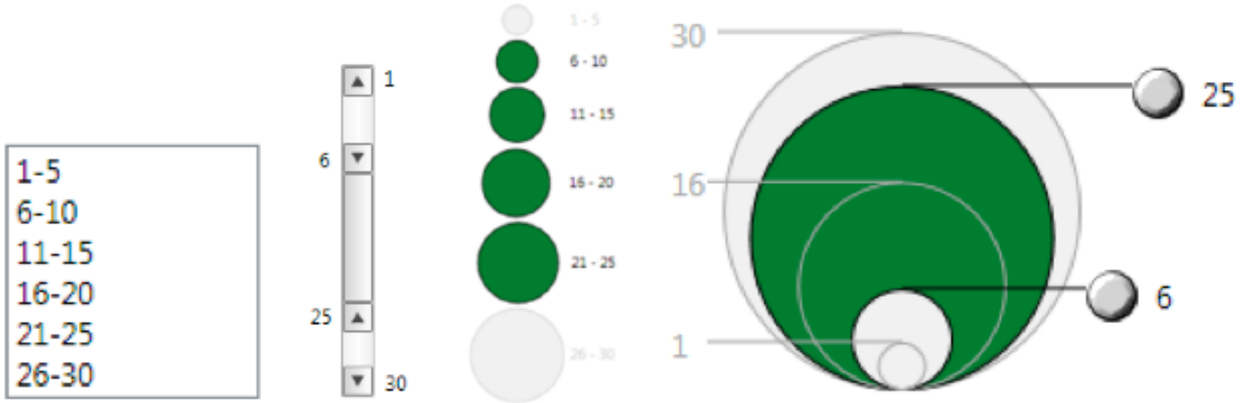
- interactive item filtering with scented widgets
  - also: interaction speed w/ scatterplot vs list view

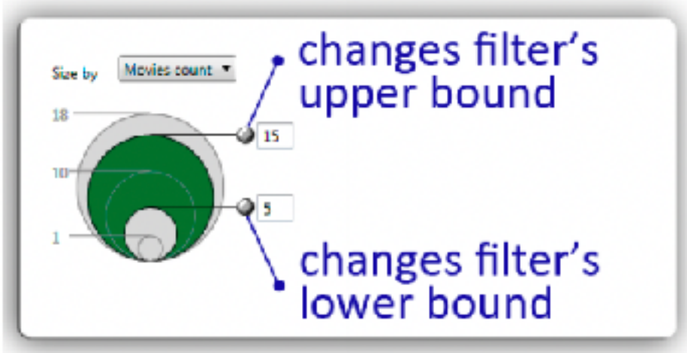


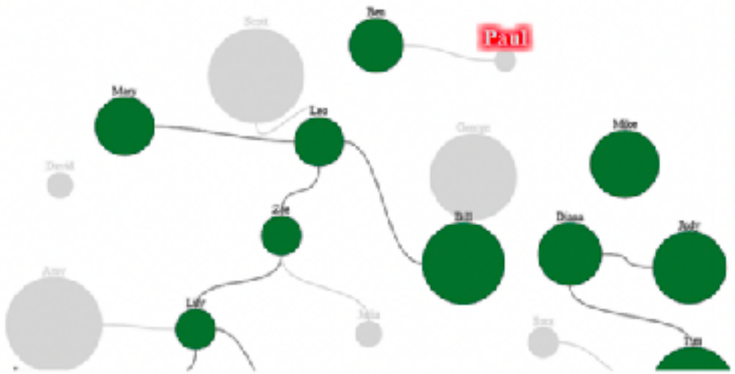
https://keshif.me/gallery/olympics

Interactive legends

- controls combining
  - visual representation of static legends w/
  - interaction mechanisms of widgets
- define & control visual display together



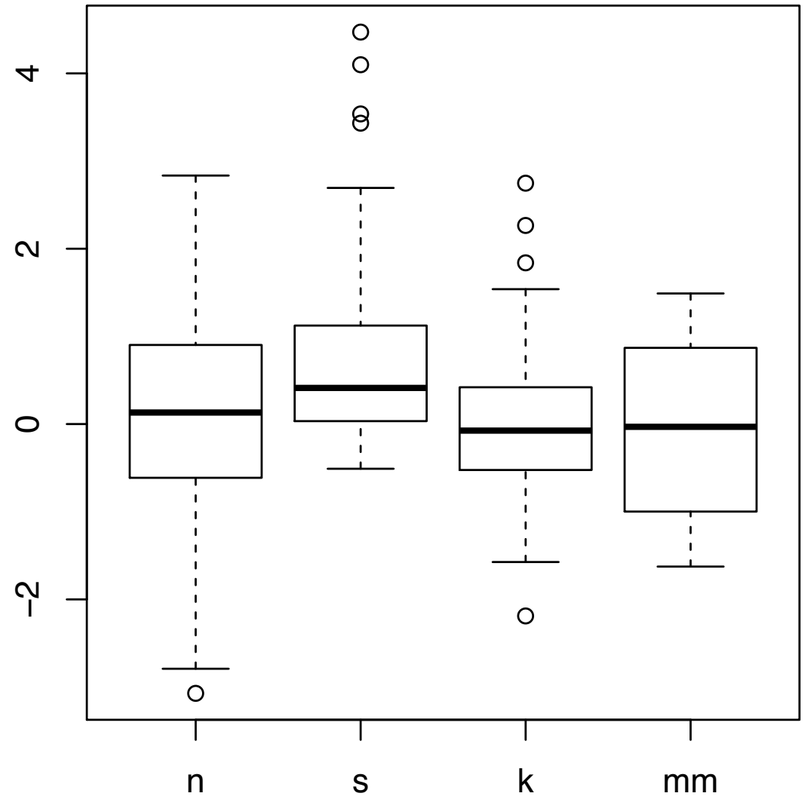




Riche 2010

Idiom: **boxplot**

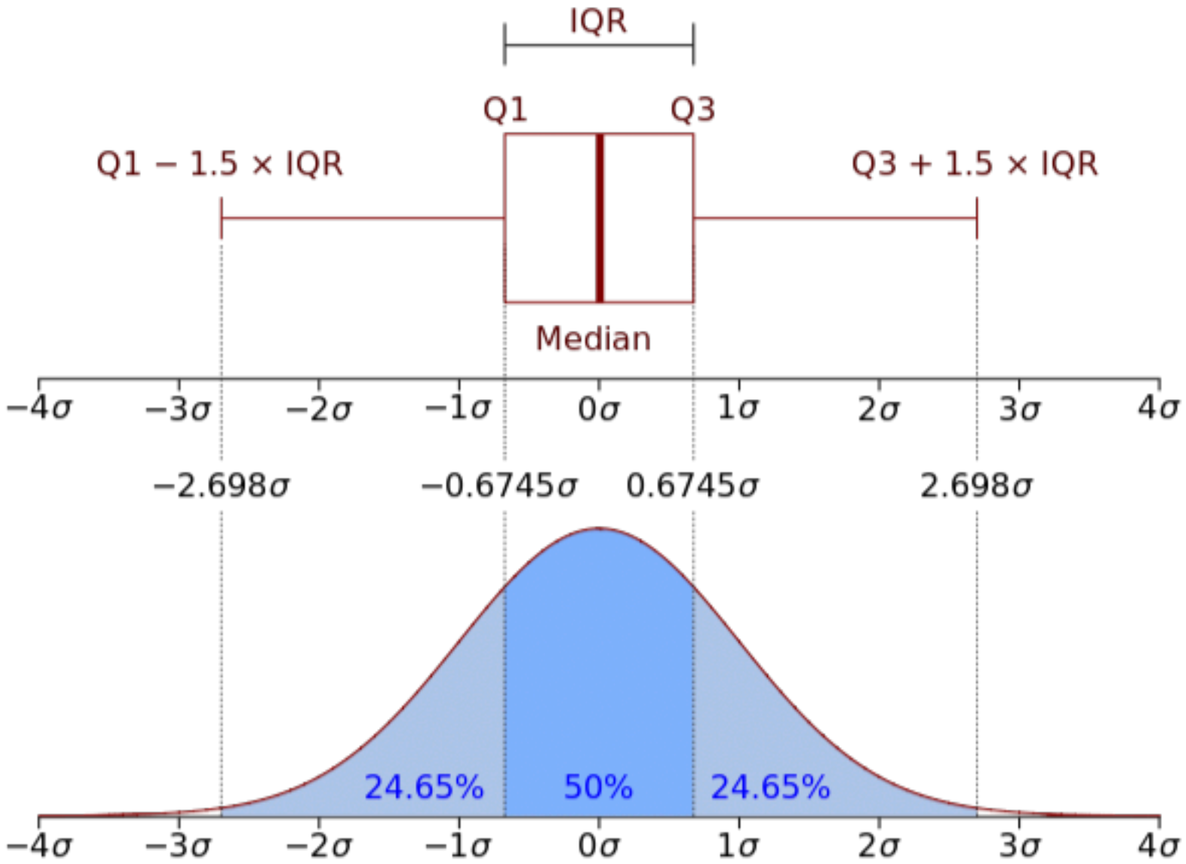
- static item aggregation
- task: find distribution
- data: table
- derived data
  - 5 quant attribs
    - median: central line
    - lower and upper quartile: boxes
    - lower upper fences: whiskers
      - values beyond which items are outliers
  - outliers beyond fence cutoffs explicitly shown
- scalability
  - unlimited number of items!



[40 years of boxplots. Wickham and Stryjewski. 2012. had.co.nz]

Boxplots

- aka box-and-whisker plots
  - show outliers as points
- bad for non-normal distributions
- really bad for bimodal or multimodal distributions



[wikipedia]

Boxplots: Drawbacks

- four distributions with same boxplot

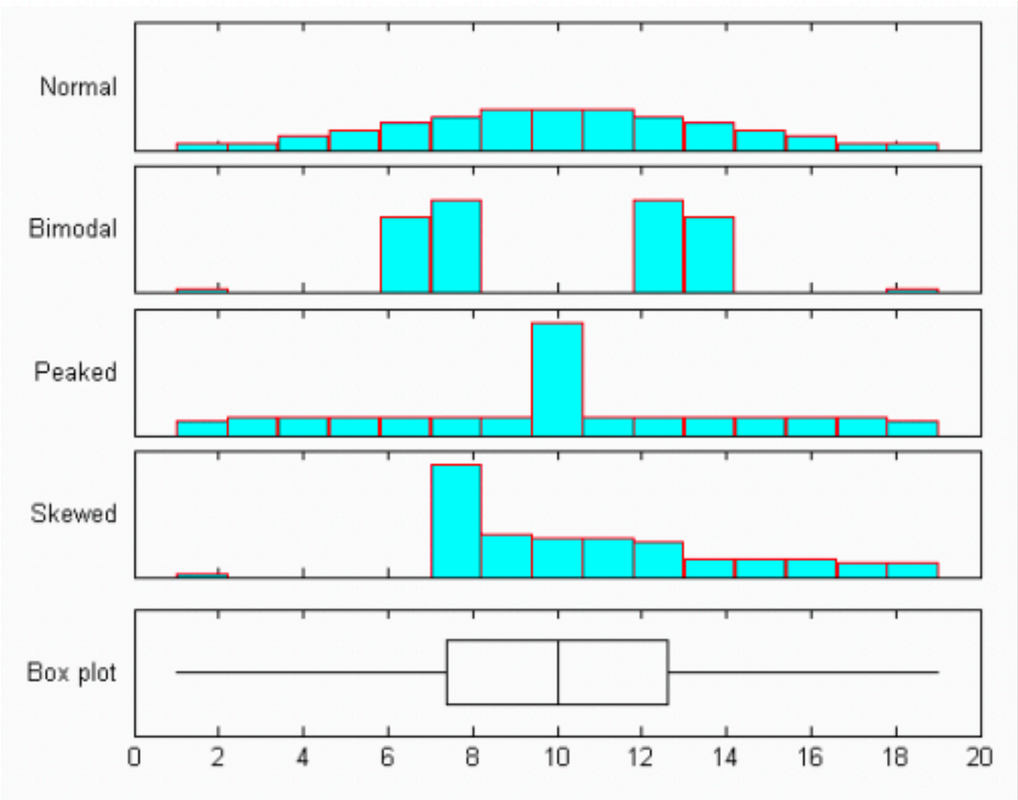


Figure 1: Histograms and box plot: four samples each of size 100

http://stat.mq.edu.au/wp-content/uploads/2014/05/Can_the_Box_Plot_be_Improved.pdf

Violin plots

- boxplot + probability density function

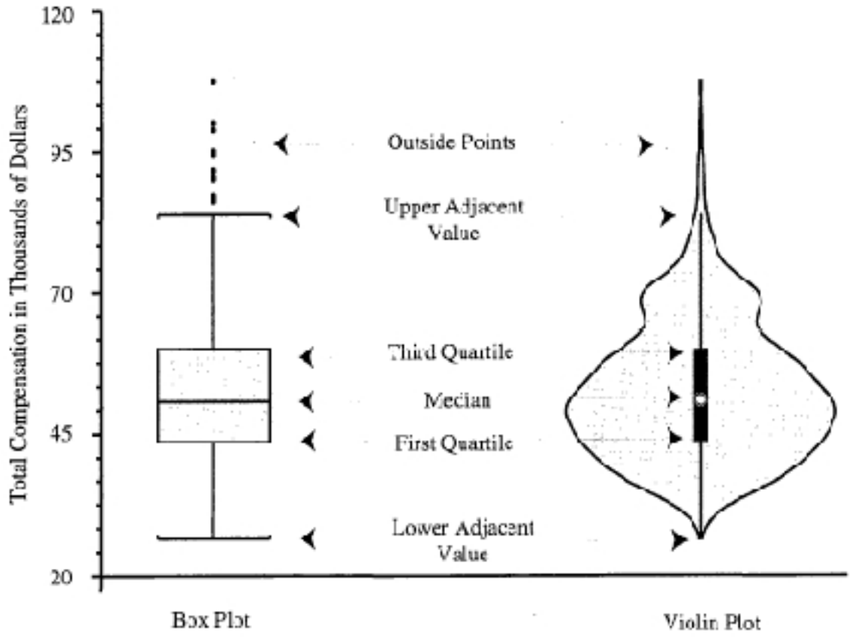
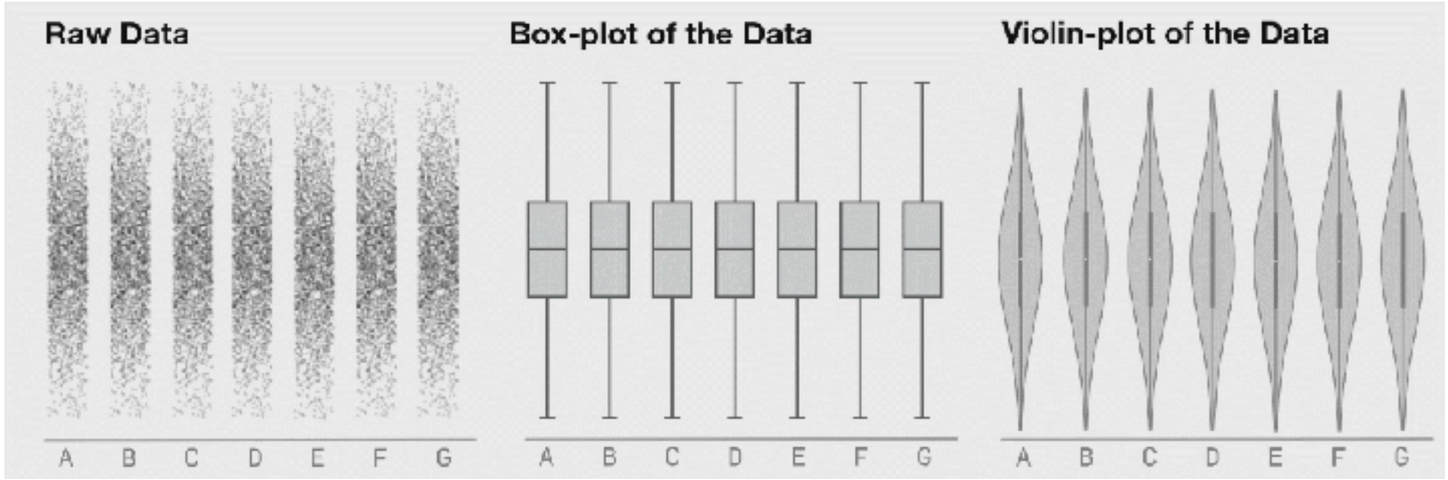
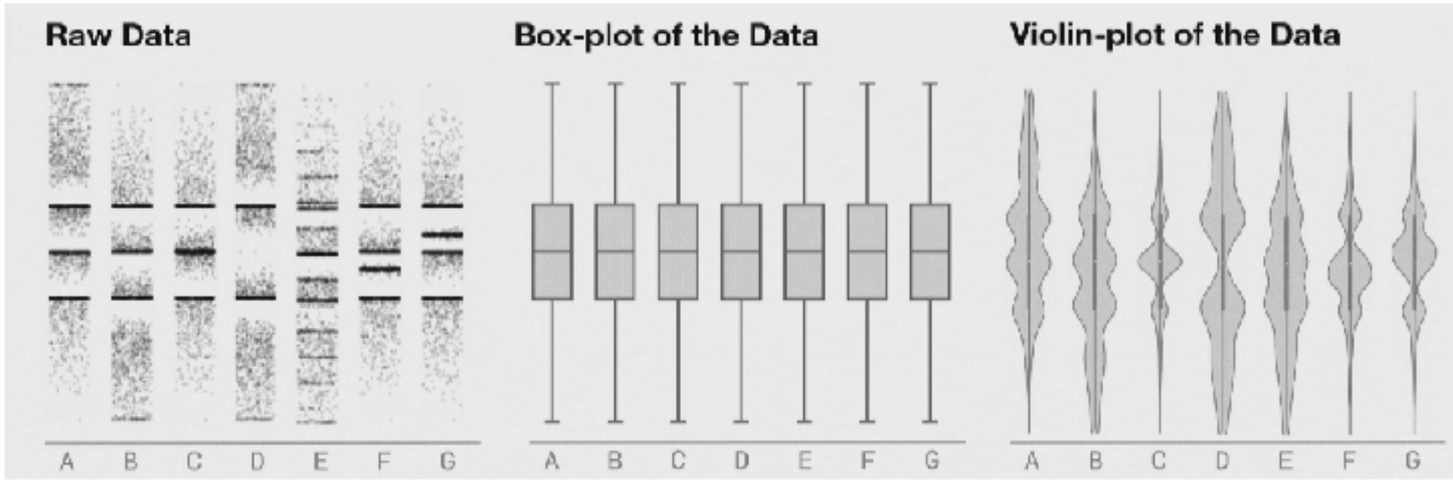


Figure 1. Common Components of Box Plot and Violin Plot. Total compensation for all academic ranks.

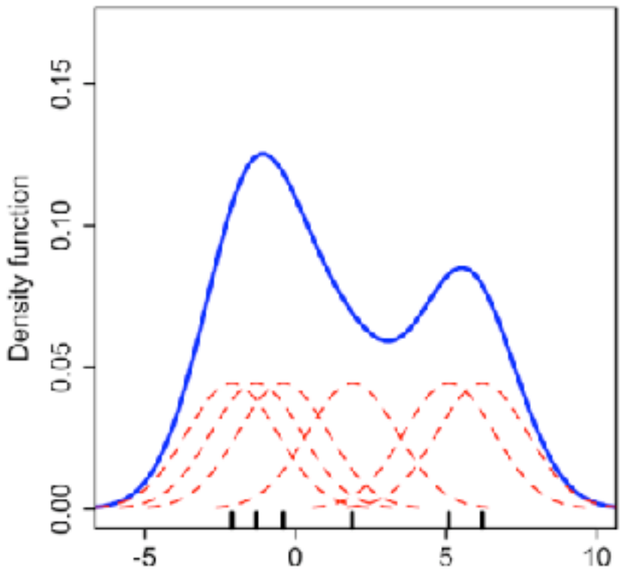


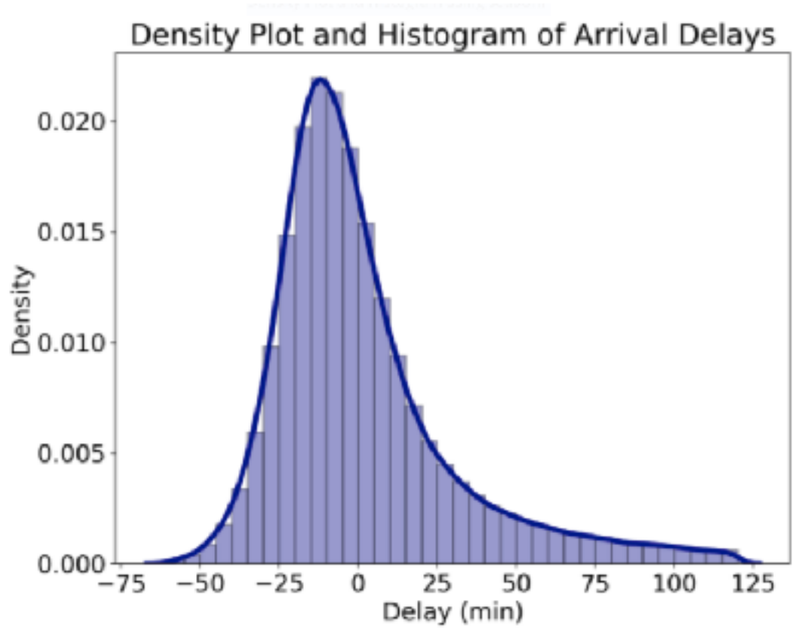


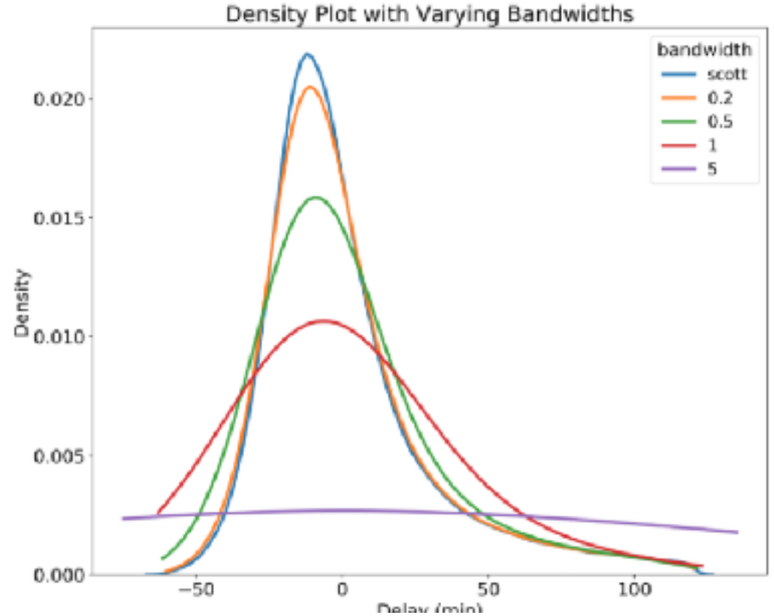
https://towardsdatascience.com/violin-plots-explained-fb1d115e023d

Density plots

- aka kernel density plots, kernel density estimation (KDE)
  - smoothed, continuous version of a histogram estimated from data
  - continuous curve (the kernel, usually Gaussian bell curve) drawn at each data point
  - add curves together for single smooth density estimation
    - bandwidth influences estimate



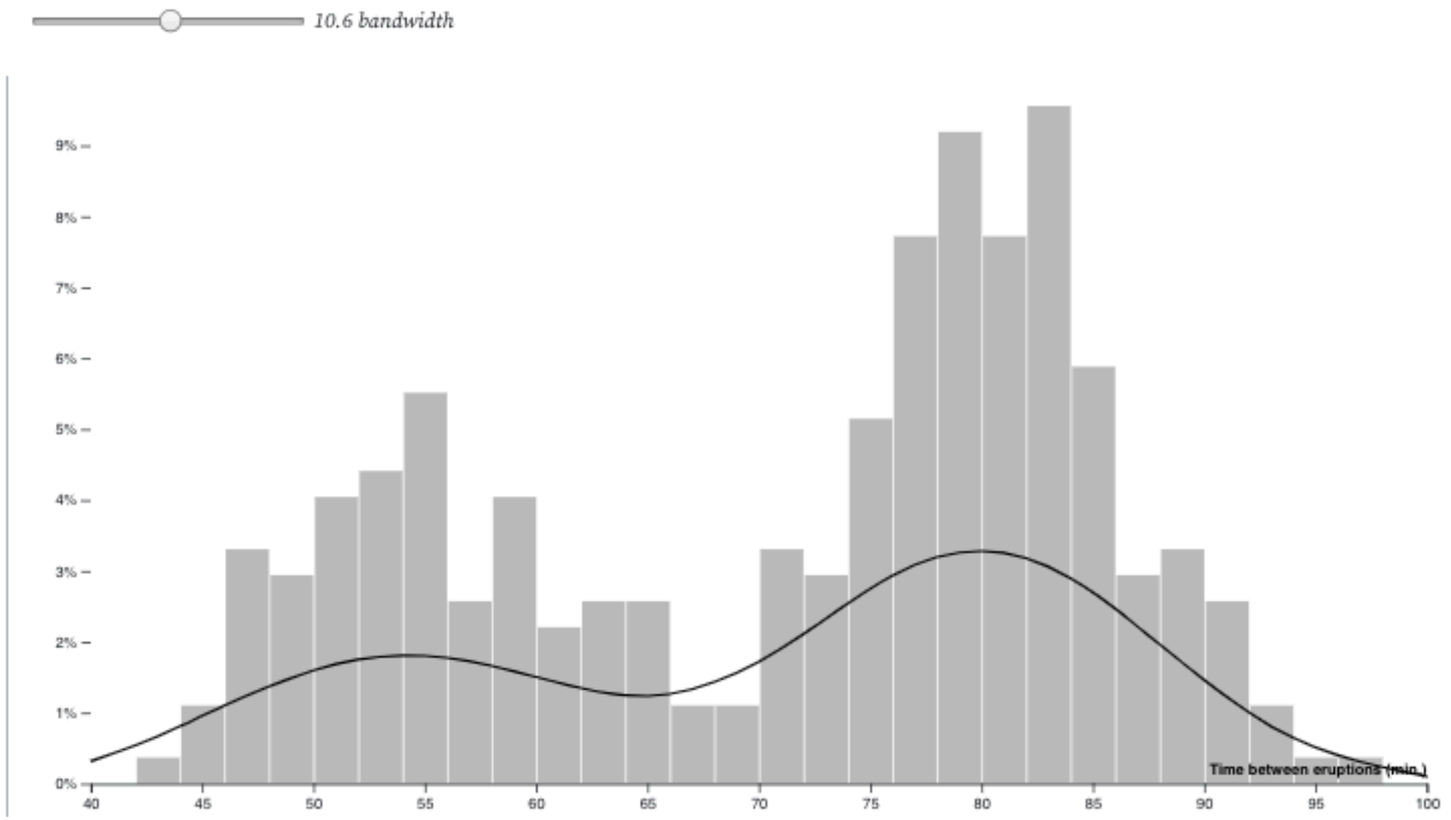




KDE wikipedia

https://towardsdatascience.com/histograms-and-density-plots-in-python-f6bda88f5ac0

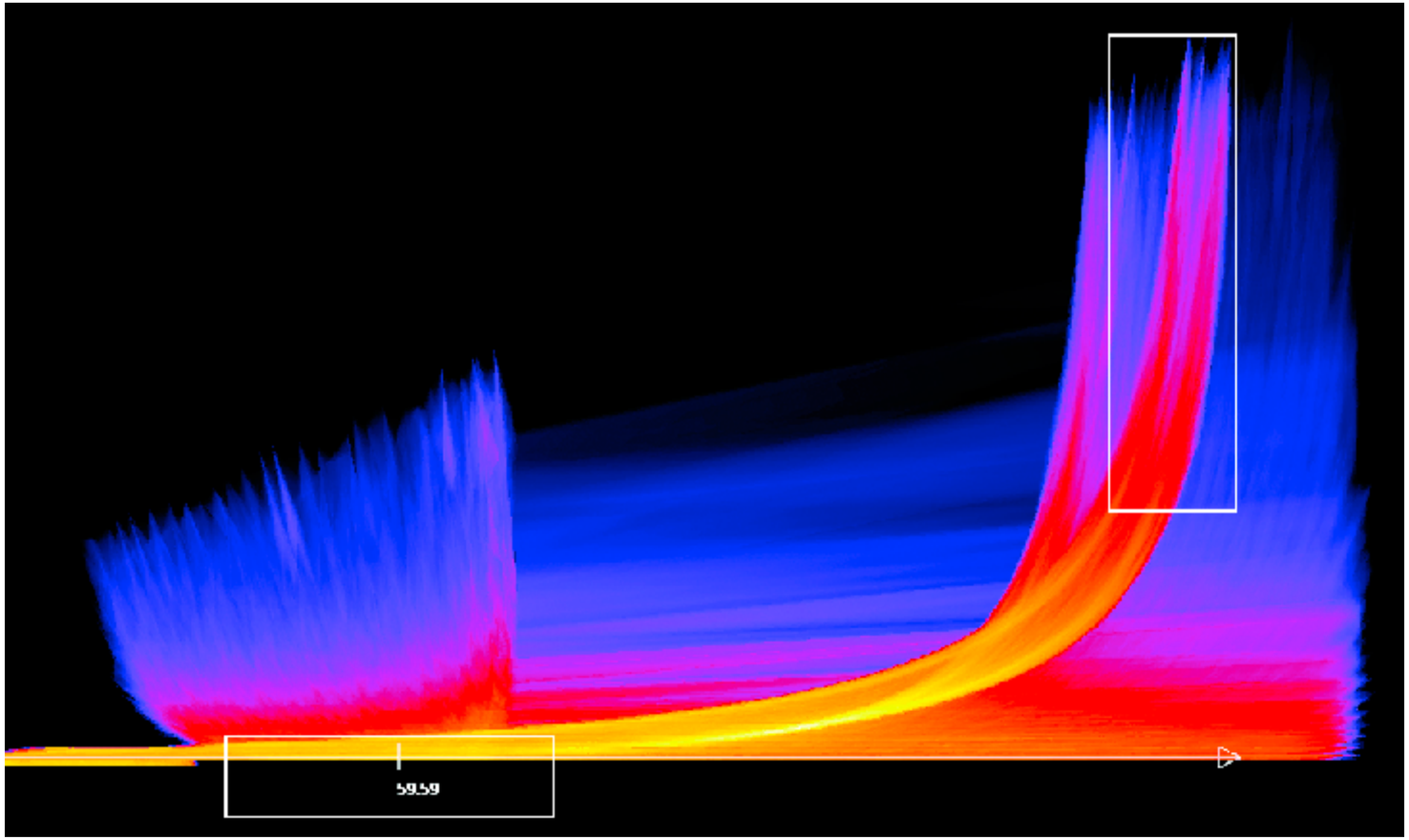
KDE in D3: Interactive bandwidth controls



https://observablehq.com/@d3/kernel-density-estimation

Idiom: **Continuous scatterplot**

- static item aggregation
- data: table
- derived data: table
  - key attribs x,y for pixels
  - quant attrib: overplot density
- dense space-filling 2D matrix
- color: sequential categorical hue + ordered luminance colormap
- scalability
  - no limits on overplotting: millions of items



[Continuous Scatterplots. Bachthaler and Weiskopf. IEEE TVCG (Proc. Vis 08) 14:6 (2008), 1428–1435. 2008.]

Credits

- Visualization Analysis and Design (Ch 13, 14)
- Alex Lex & Miriah Meyer, http://dataviscourse.net/