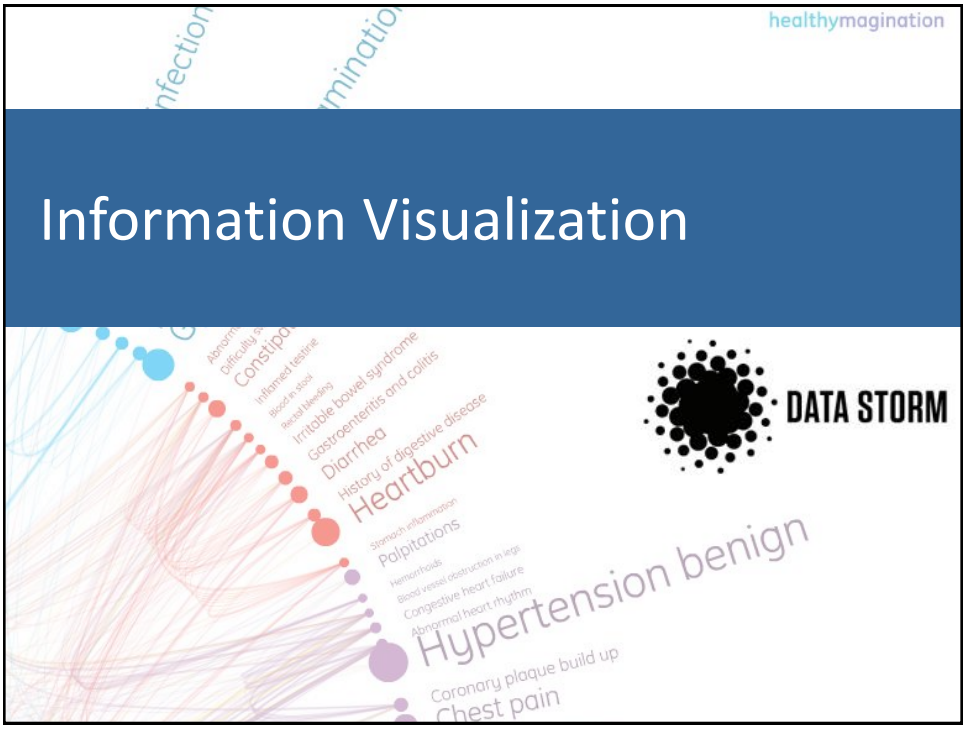


Contact Info

daniel.goncalves@inesc-id.pt

http://danielgoncalves.info

01

WHAT IS INFOVIS?

Visualization

Visualize

form a mental image of something

to make perceptible to the mind

Information Visualization

"The use of computer-supported, interactive visual representations of data to amplify cognition."

- Card, Mackinlay Shneiderman 98

Transform Data into Information

peteralbre@sxc.hu

Visualize gives us insights

I		II		III		IV	
x	y	x	y	x	y	x	y
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.10	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.10	4	5.39	19	12.50
12	10.84	12	9.13	12	8.15	8	5.56
7	4.82	7	7.26	7	6.42	8	7.91
5	5.68	5	4.74	5	5.73	8	6.8

http://astro.swarthmore.edu/astro121/anscombe.html

Visualize gives us insights

mean of the x values = 9.0

mean of the y values = 7.5

equation of the least-squared regression line is: y = 3 + 0.5x

sums of squared errors (about the mean) = 110.0

regression sums of squared errors (variance accounted for by x) = 27.5

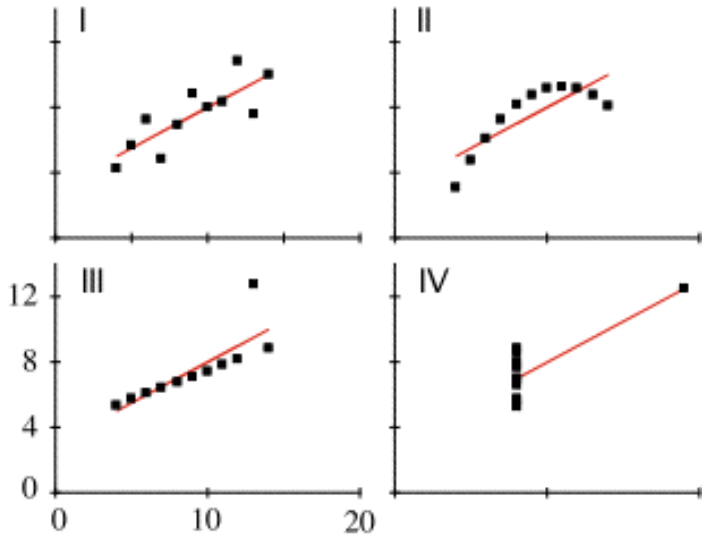
residual sums of squared errors (about the regression line) = 13.75

correlation coefficient = 0.82

coefficient of determination = 0.67

http://astro.swarthmore.edu/astro121/anscombe.html

Visualize gives us insights



http://astro.swarthmore.edu/astro121/anscombe.html

Interactivity

Different Views on the Data

Infovis Goals

Record

Analysis

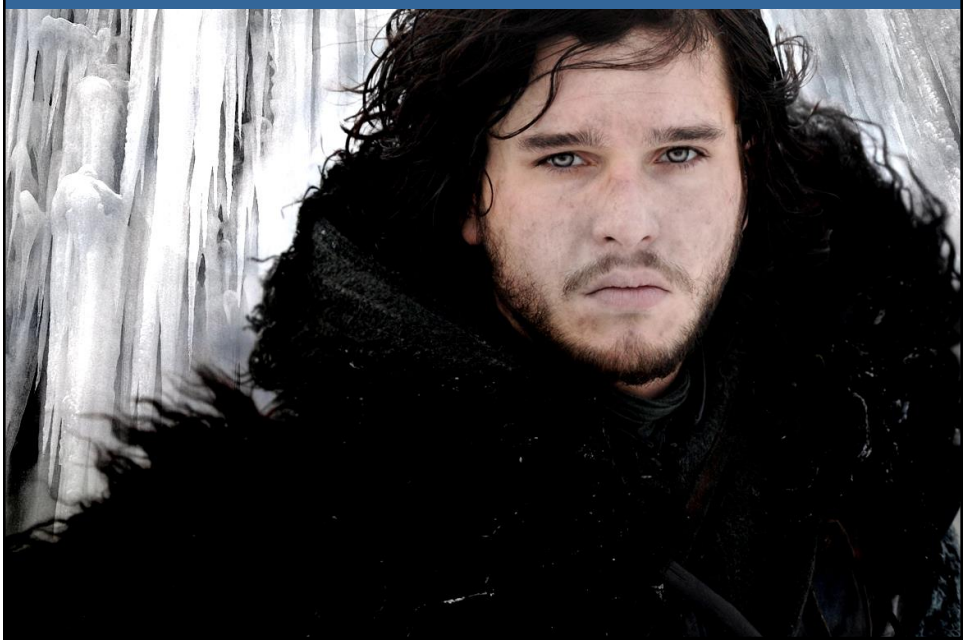
Presentation

Communicate Effectively

Clarify, Provide Insights

Cholera Deaths (John Snow, 1854)

Not this one…

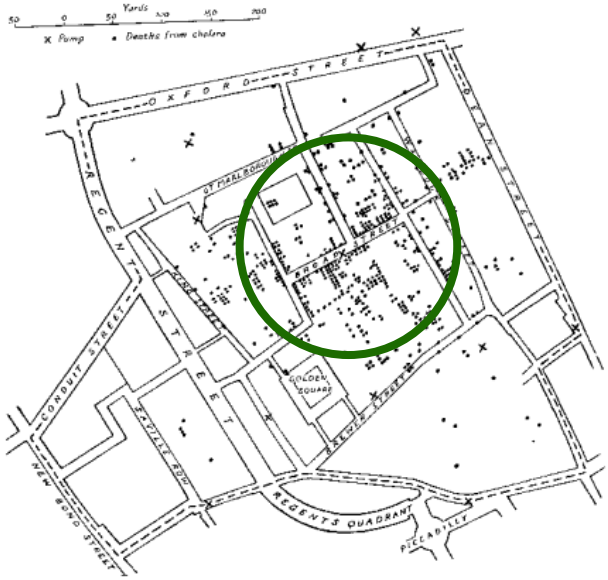


Not this one…

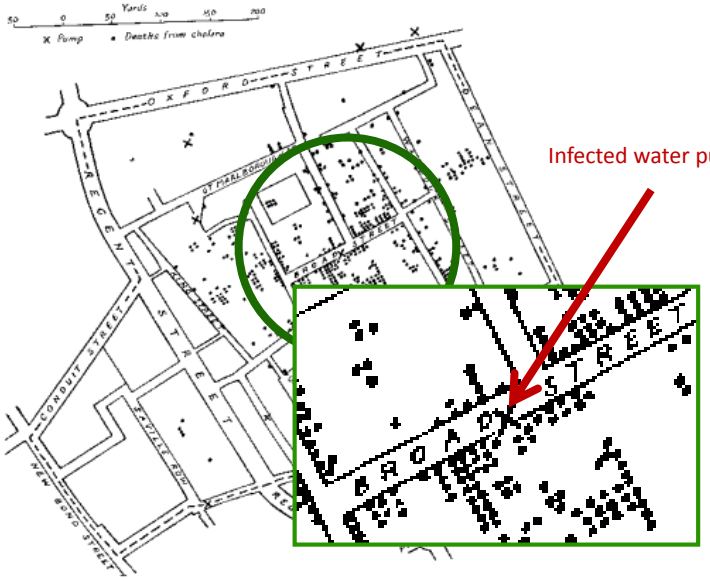
This one!

Cholera Deaths (John Snow, 1854)

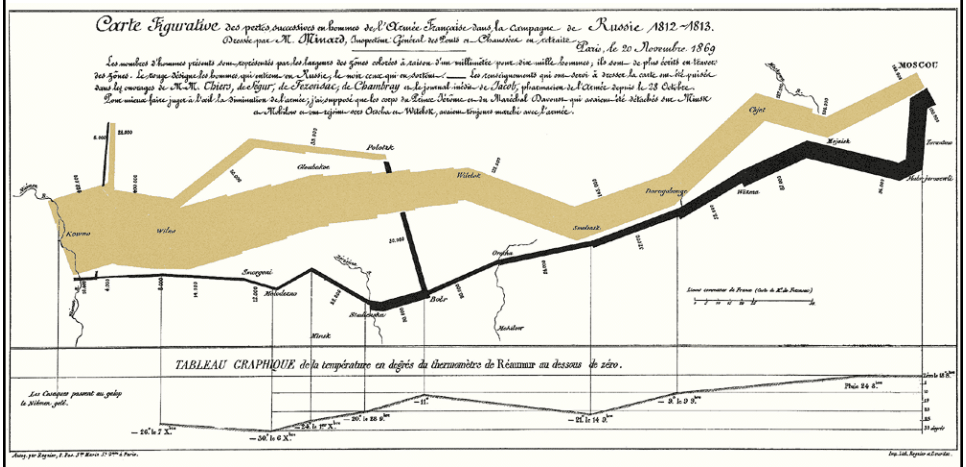
Cholera Deaths (John Snow, 1854)



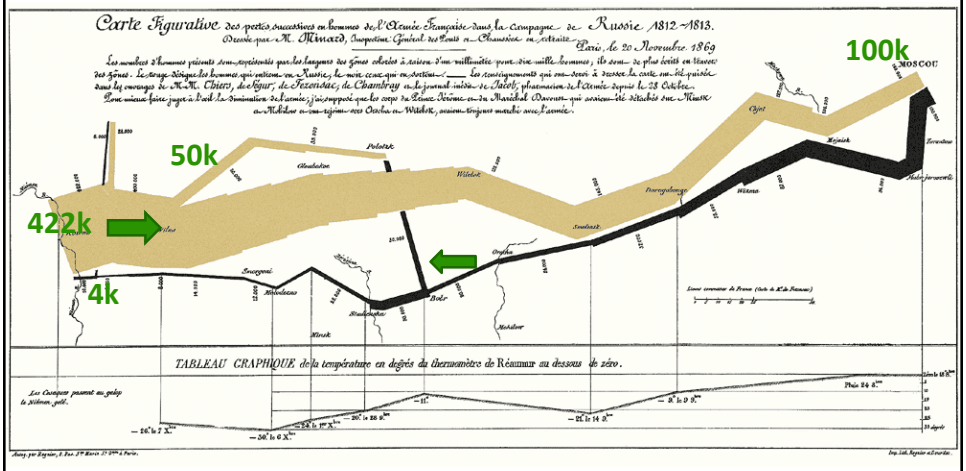
Cholera Deaths (John Snow, 1854)



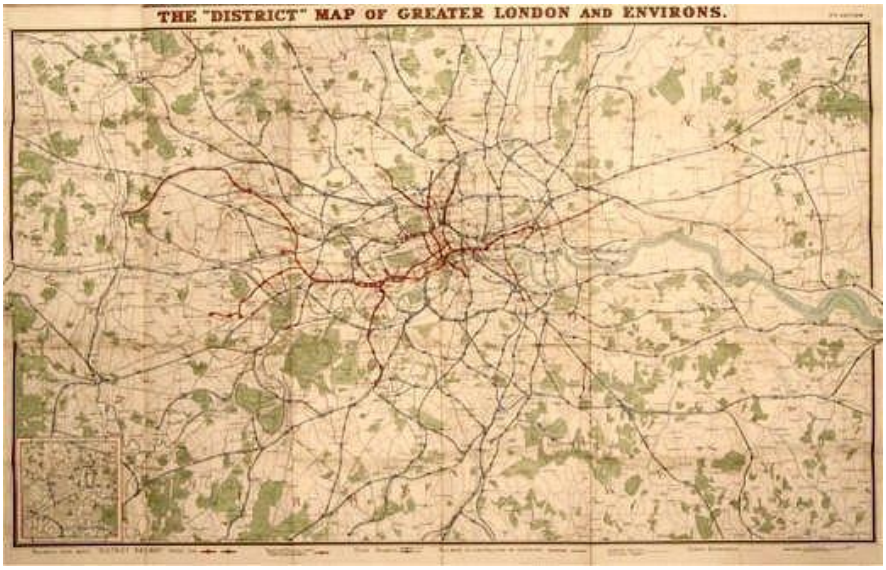
Napoleon's March (Minard, 1861)



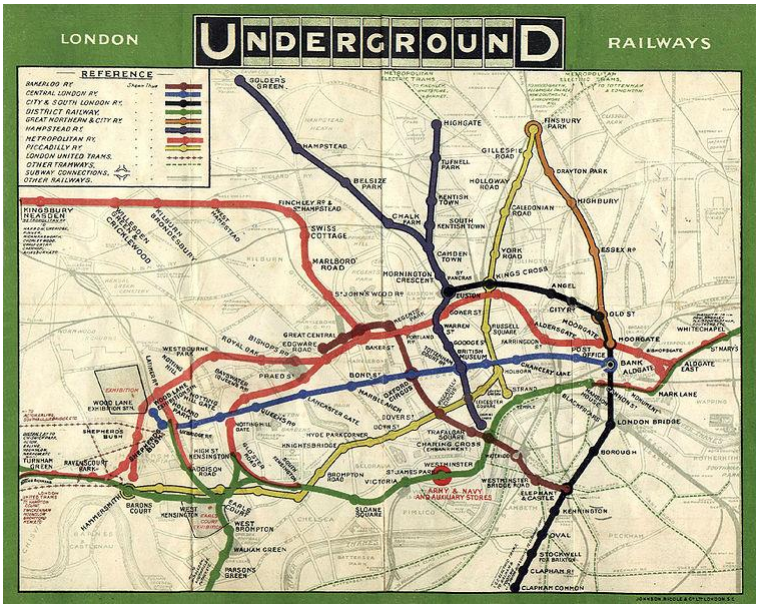
Napoleon's March (Minard, 1861)



Clarify (London Underground)



Clarify (London Underground)



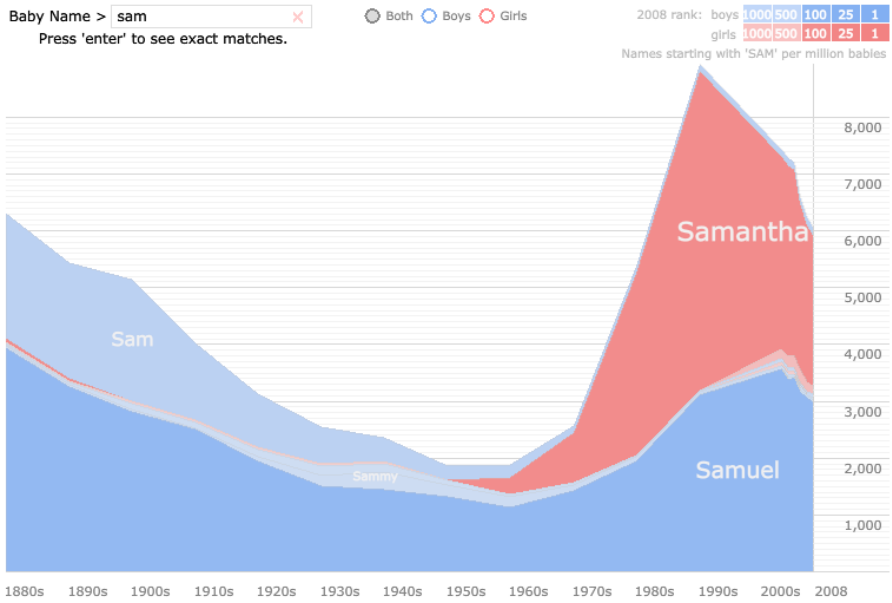
1908

London Underground

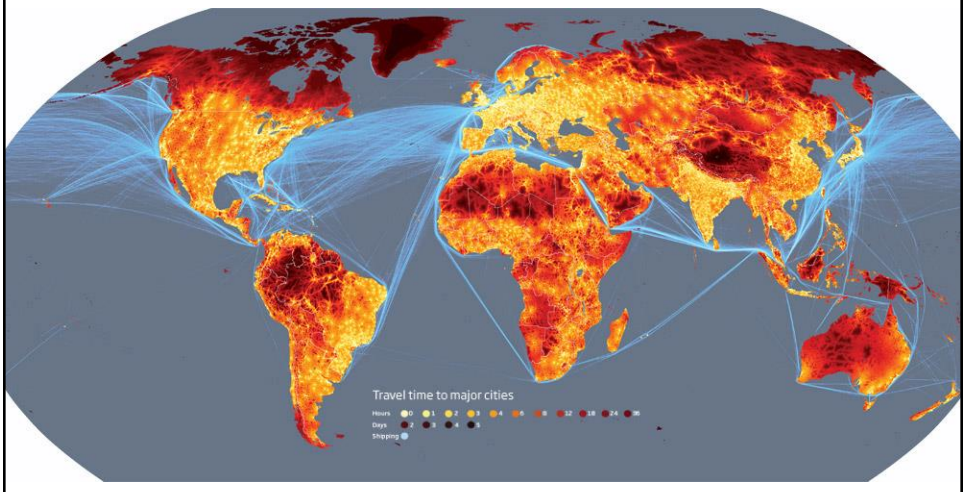
Harry Beckin, 1931

Name Voyager

http://www.babynamewizard.com/voyager

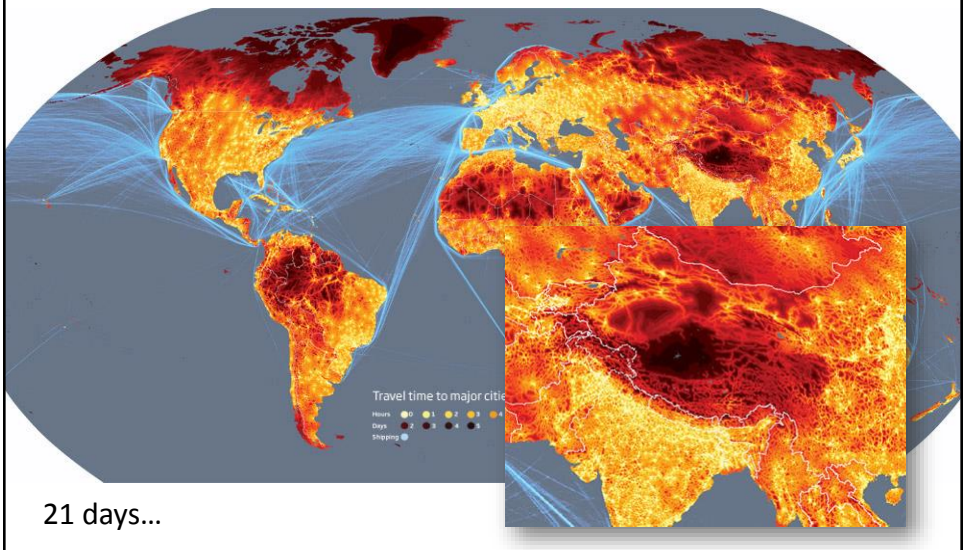


Remotest Place on Earth



http://www.newscientist.com/gallery/small-world

Remotest Place on Earth



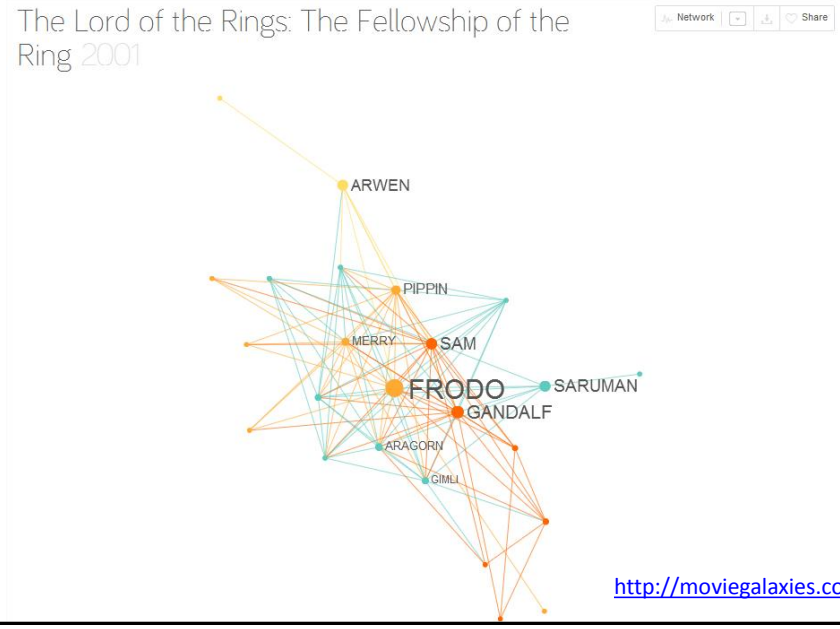
21 days…

http://www.newscientist.com/gallery/small-world

Facebook Friendships

http://www.facebook.com/notes/facebook-engineering/visualizing-friendships/469716398919

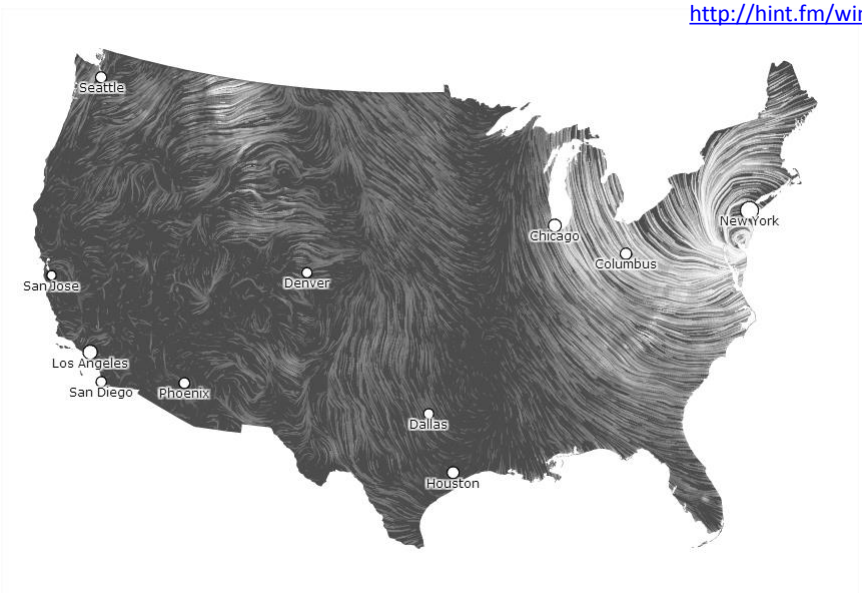
moviegalaxies



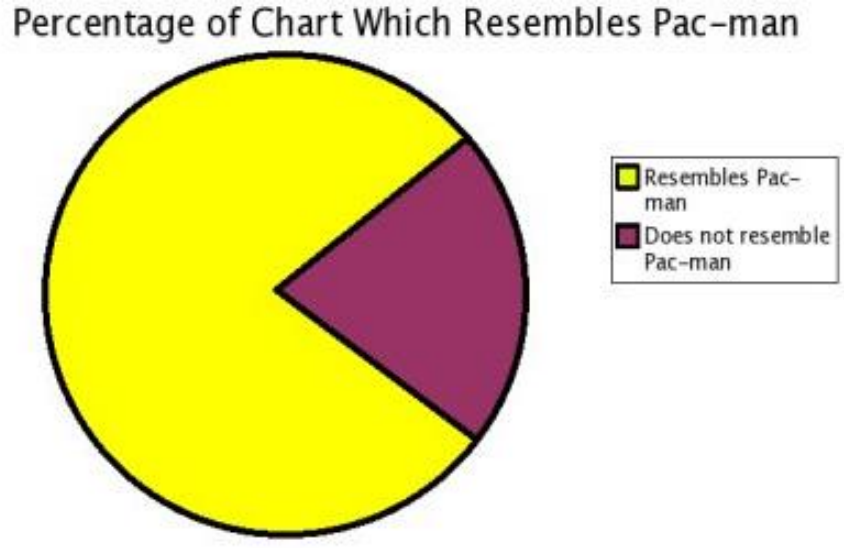
http://moviegalaxies.com/

Wind Map

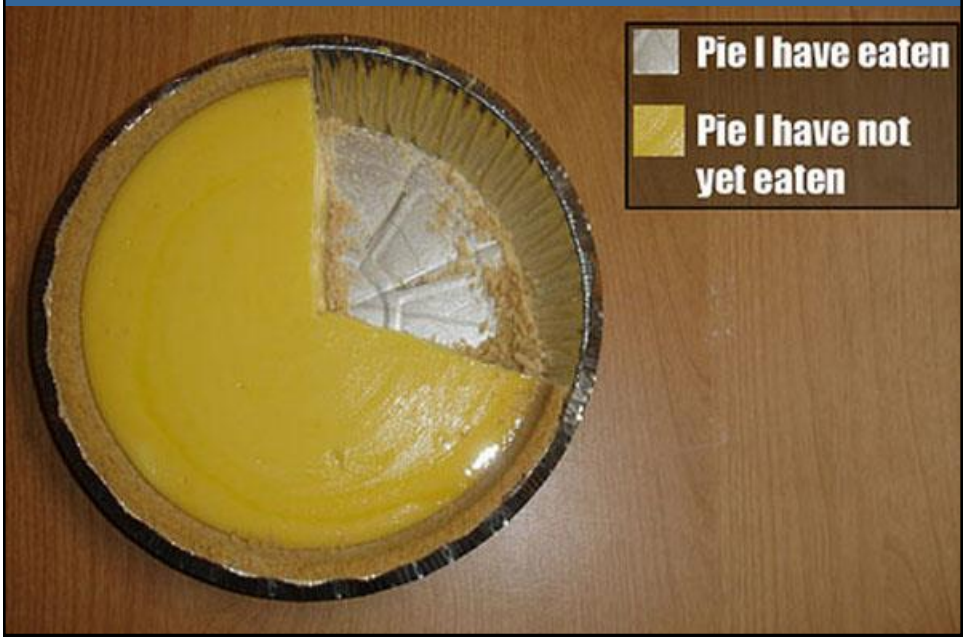
http://hint.fm/wind/



For Fun



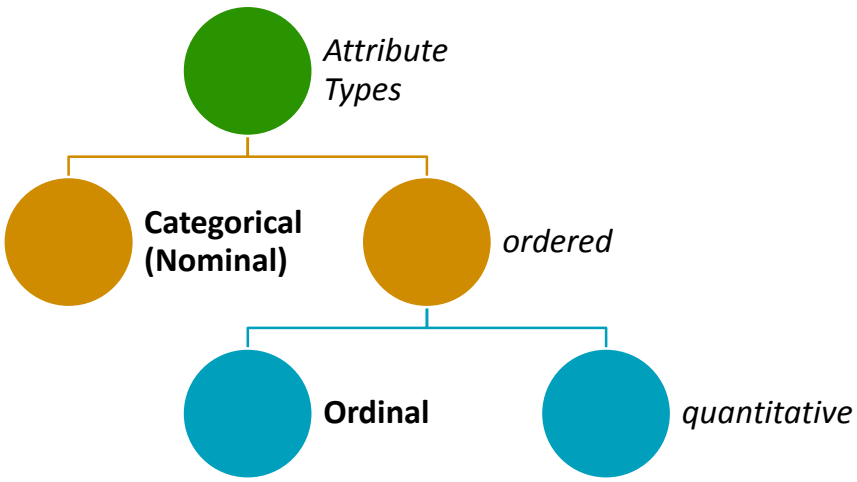
For Fun



02

DATA → VIS

Attribute Types



Three (main) Kinds of Data

Quantitative – discrete or continuous, ratio

Height, weight, age, GDP

Ordinal – ordered but not measurable

Small/medium/large, hot/warm/cold, like/neutral/dislike

Nominal (Categorical) – No inherent order

cars/boats/planes

Attribute Semantics

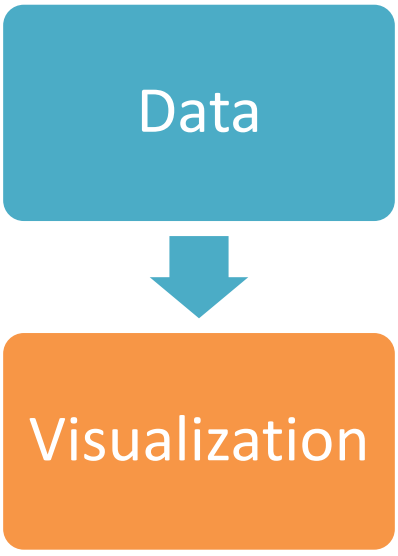
spatial/nonspatial

temporal/nontemporal

independent/dependent

continuous/discrete

How to Craft a Visualization?



Data

Domain Knowledge

Original Data

Ex: author, term frequency, mortality rate

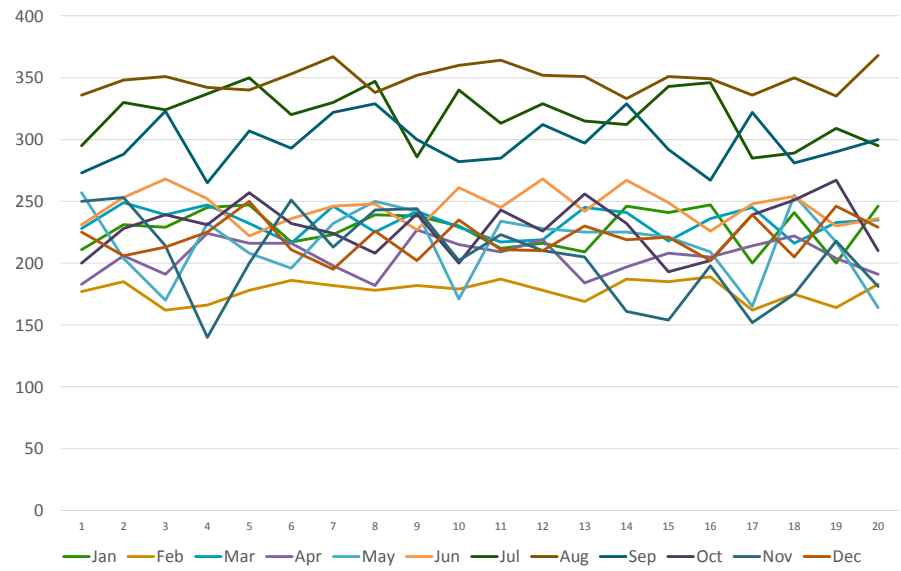
Derived attributes

Ex: papers by the same author, solo or group, etc?

Derived Attributes (ex.) – Number of Car Accidents

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	211	177	228	183	257	231	295	336	273	200	250	225
2	231	185	249	206	204	253	330	348	288	228	253	206
3	229	162	239	191	170	268	324	351	323	239	214	213
4	245	166	247	224	232	252	337	342	265	231	140	225
5	247	178	232	216	208	222	350	340	307	257	200	250
6	217	186	216	216	196	236	320	353	293	232	251	211
7	223	182	246	198	232	246	330	367	322	224	213	195
8	239	178	225	182	250	248	347	338	329	208	243	226
9	238	182	242	227	242	227	286	352	300	240	244	202
10	230	179	229	215	171	261	340	360	282	200	202	235
11	212	187	217	209	234	245	313	364	285	243	223	211
12	216	178	219	219	228	268	329	352	312	226	210	210
13	209	169	245	184	225	242	315	351	297	256	205	230
14	246	187	241	197	225	267	312	333	329	232	161	219
15	241	185	218	208	221	249	343	351	292	193	154	221
16	247	189	236	205	209	226	346	349	267	202	198	202
17	200	162	245	214	165	248	285	336	322	239	152	239
18	241	175	216	222	255	254	289	350	281	251	175	205
19	200	164	233	204	217	230	309	335	290	267	218	246
20	246	183	235	191	164	236	295	368	300	210	181	229

Derived Attributes (ex.) – Number of Car Accidents



Derived Attributes (ex.) – Number of Car Accidents

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	211	177	228	183	257	231	295	336	273	200	250	225
2	231	185	249	206	204	253	330	348	288	228	253	206
3	229	162	239	191	170	268	324	351	323	239	214	213
4	245	166	247	224	232	252	337	342	265	231	140	225
5	247	178	232	216	208	222	350	340	307	257	200	250
6	217	186	216	216	196	236	320	353	293	232	251	211
7	223	182	246	198	232	246	330	367	322	224	213	195
8	239	178	225	182	250	248	347	338	329	208	243	226
9	238	182	242	227	242	227	286	352	300	240	244	202
10	230	179	229	215	171	261	340	360	282	200	202	235
11	212	187	217	209	234	245	313	364	285	243	223	211
12	216	178	219	219	228	268	329	352	312	226	210	210
13	209	169	245	184	225	242	315	351	297	256	205	230
14	246	187	241	197	225	267	312	333	329	232	161	219
15	241	185	218	208	221	249	343	351	292	193	154	221
16	247	189	236	205	209	226	346	349	267	202	198	202
17	200	162	245	214	165	248	285	336	322	239	152	239
18	241	175	216	222	255	254	289	350	281	251	175	205
19	200	164	233	204	217	230	309	335	290	267	218	246
20	246	183	235	191	164	236	295	368	300	210	181	229
AVG	228,4	177,7	232,9	205,6	215,3	245,5	319,8	348,8	297,9	228,9	204,4	220,0

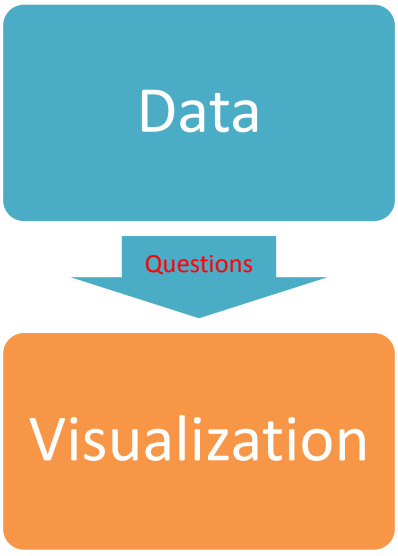
Derived Attributes (ex.) – Number of Car Accidents

Derived Attributes (ex.) – Number of Car Accidents

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	211	177	228	183	257	231	295	336	273	200	250	225
2	231	185	249	206	204	253	330	348	288	228	253	206
3	229	162	239	191	170	268	324	351	323	239	214	213
4	245	166	247	224	232	252	337	342	265	231	140	225
5	247	178	232	216	208	222	350	340	307	257	200	250
6	217	186	216	216	196	236	320	353	293	232	251	211
7	223	182	246	198	232	246	330	367	322	224	213	195
8	239	178	225	182	250	248	347	338	329	208	243	226
9	238	182	242	227	242	227	286	352	300	240	244	202
10	230	179	229	215	171	261	340	360	282	200	202	235
11	212	187	217	209	234	245	313	364	285	243	223	211
12	216	178	219	219	228	268	329	352	312	226	210	210
13	209	169	245	184	225	242	315	351	297	256	205	230
14	246	187	241	197	225	267	312	333	329	232	161	219
15	241	185	218	208	221	249	343	351	292	193	154	221
16	247	189	236	205	209	226	346	349	267	202	198	202
17	200	162	245	214	165	248	285	336	322	239	152	239
18	241	175	216	222	255	254	289	350	281	251	175	205
19	200	164	233	204	217	230	309	335	290	267	218	246
20	246	183	235	191	164	236	295	368	300	210	181	229
AVG	228,4	177,7	232,9	205,6	215,3	245,5	319,8	348,8	297,9	228,9	204,4	220,0
STDEV	16,2	8,7	11,4	14,0	29,3	14,2	21,4	10,6	20,0	21,2	34,9	15,3

Derived Attributes (ex.) – Number of Car Accidents

How to Craft a Visualization?



From Data to Vis

What is the problem?

What questions do we want to answer?

Vis

Choose Vis technique

How to encode the different metrics

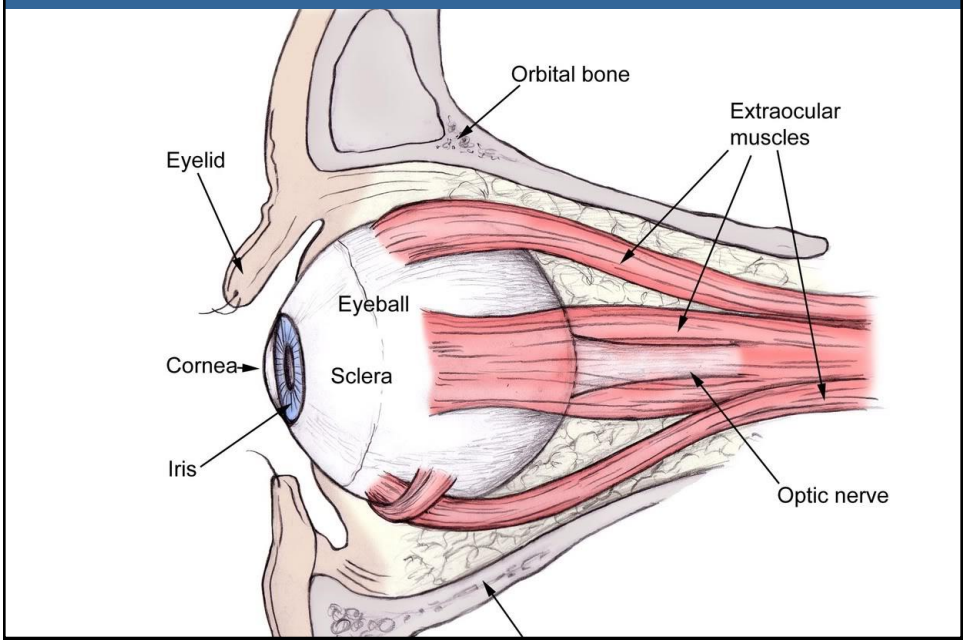
Interactivity

03

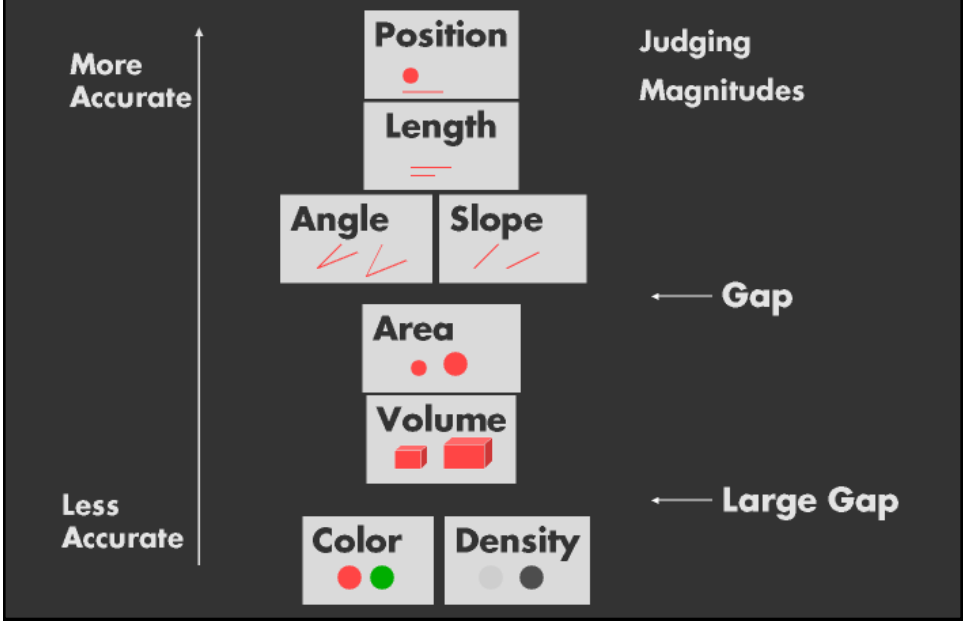
VISUAL FUNDAMENTALS

We're All Human...

We're built the same way



Not all are equally discriminative



What works best?

QUANTITATIVE	ORDINAL	NOMINAL
Position	Position	Position
Length	Density	Color Hue
Angle	Color Saturation	Texture
Slope	Color Hue	Connection
Area	Texture	Containment
Volume	Connection	Density
Density	Containment	Color Saturation
Color Saturation	Length	Shape
Color Hue	Angle	Length
Texture	Slope	Angle
Connection	Area	Slope
Containment	Volume	Area
Shape	Shape	Volume

Notice that…

QUANTITATIVE	ORDINAL	NOMINAL
Position	Position	Position
Length	Density	Color Hue
Angle	Color Saturation	Texture
Slope	Color Hue	Connection
Area	Texture	Containment
Volume	Connection	Density
Density	Containment	Color Saturation
Color Saturation	Length	Shape
Color Hue	Angle	Length
Texture	Slope	Angle
Connection	Area	Slope
Containment	Volume	Area
Shape	Shape	Volume

Notice that…

QUANTITATIVE	ORDINAL	NOMINAL
Position	Position	Position
Length	Density	Color Hue
Angle	Color Saturation	Texture
Slope	Color Hue	Connection
Area	Texture	Containment
Volume	Connection	Density
Density	Containment	Color Saturation
Color Saturation	Length	Shape
Color Hue	Angle	Length
Texture	Slope	Angle
Connection	Area	Slope
Containment	Volume	Area
Shape	Shape	Volume

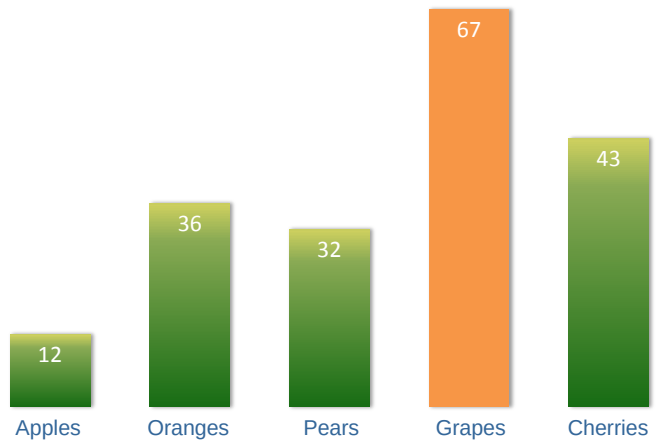
Notice that…

QUANTITATIVE	ORDINAL	NOMINAL
Position	Position	Position
Length	Density	Color Hue
Angle	Color Saturation	Texture
Slope	Color Hue	Connection
Area	Texture	Containment
Volume	Connection	Density
Density	Containment	Color Saturation
Color Saturation	Length	Shape
Color Hue	Angle	Length
Texture	Slope	Angle
Connection	Area	Slope
Containment	Volume	Area
Shape	Shape	Volume

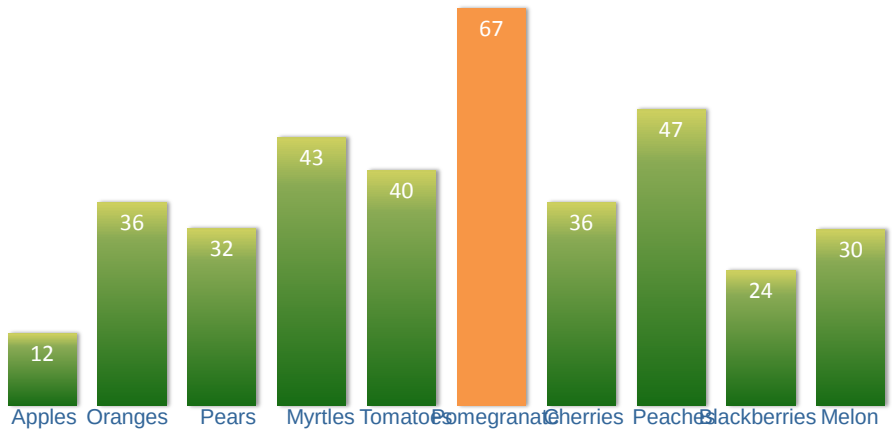
04

THE BASICS – GRAPHS

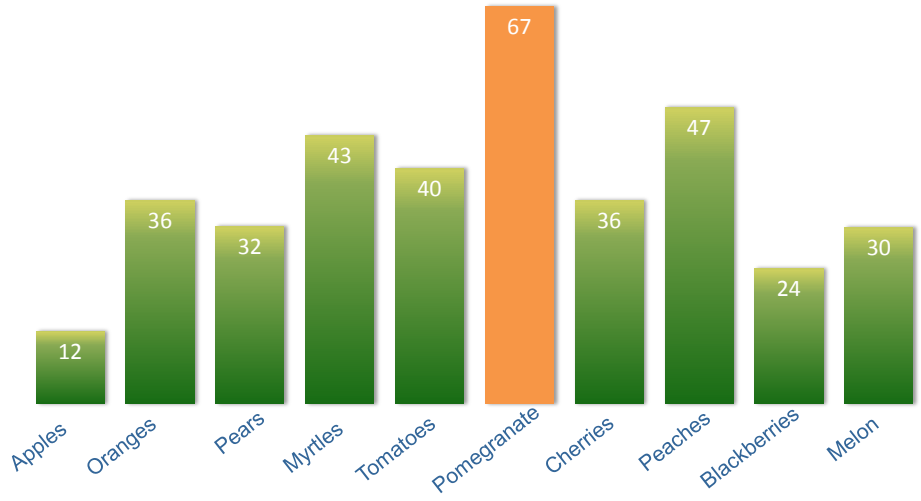
Bar Graphs – Comparison among Values



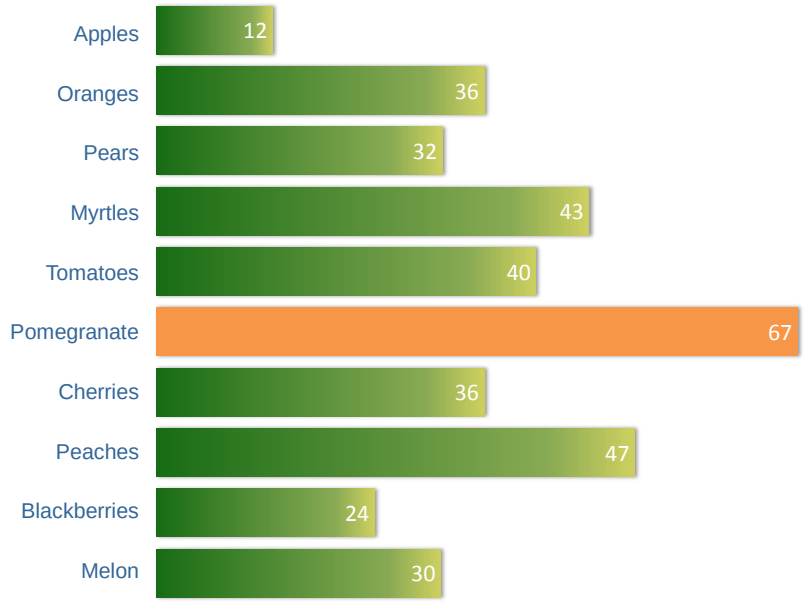
Ensure Labels Are Legible



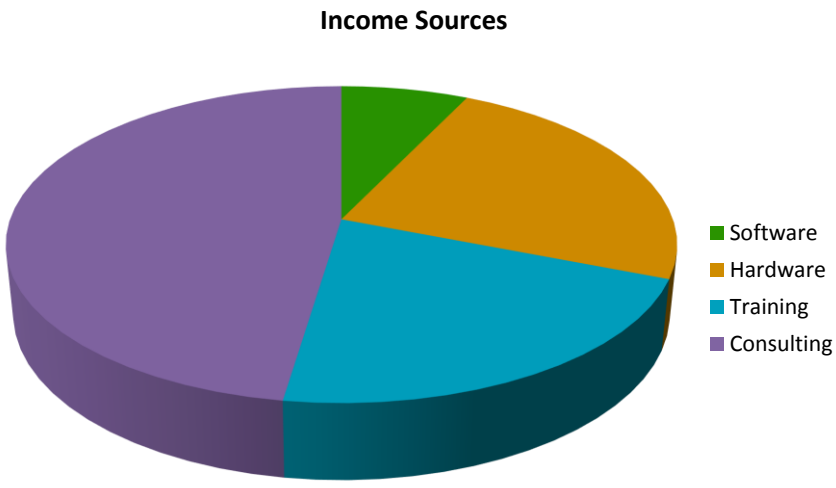
Harder to Read



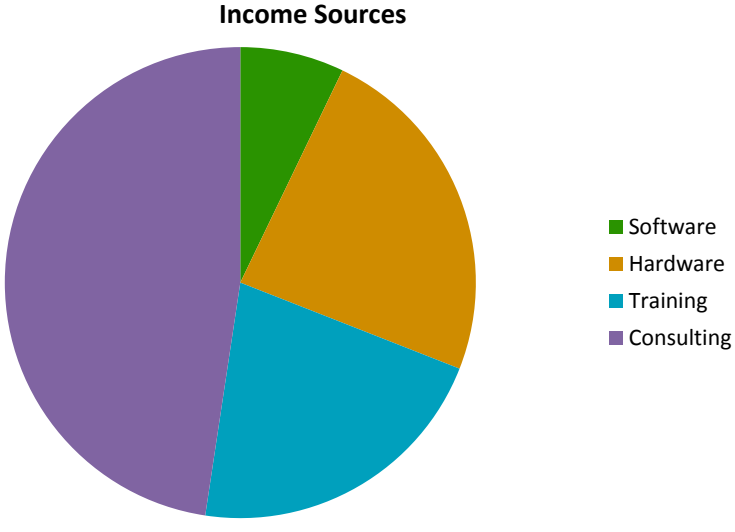
Better like this…



Pie Charts – Part of a Whole



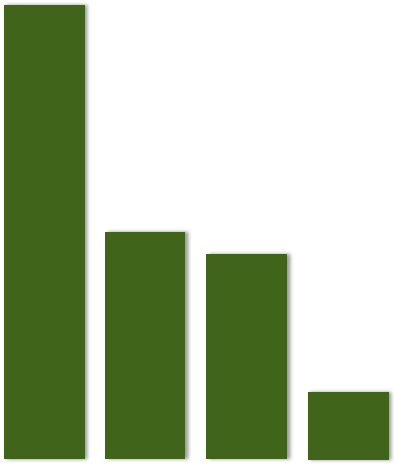
NO 3D!!!!!!!!!

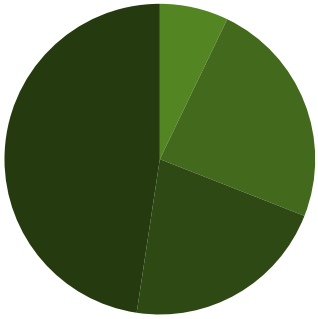


3D Graphs

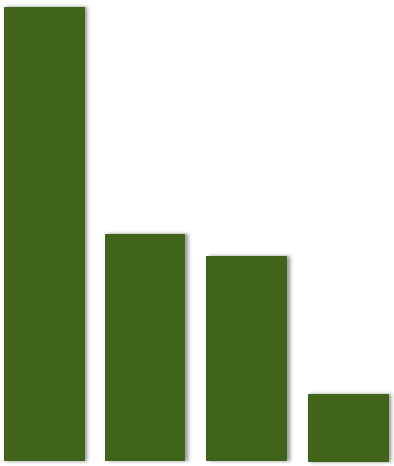
3D Graphs

Which one is the second larger?



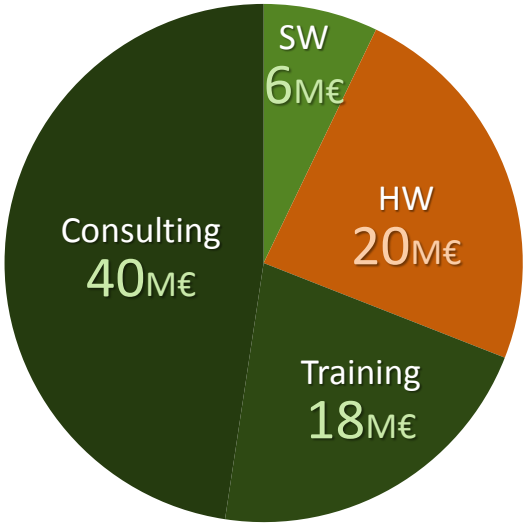


We might want to stick to bars…

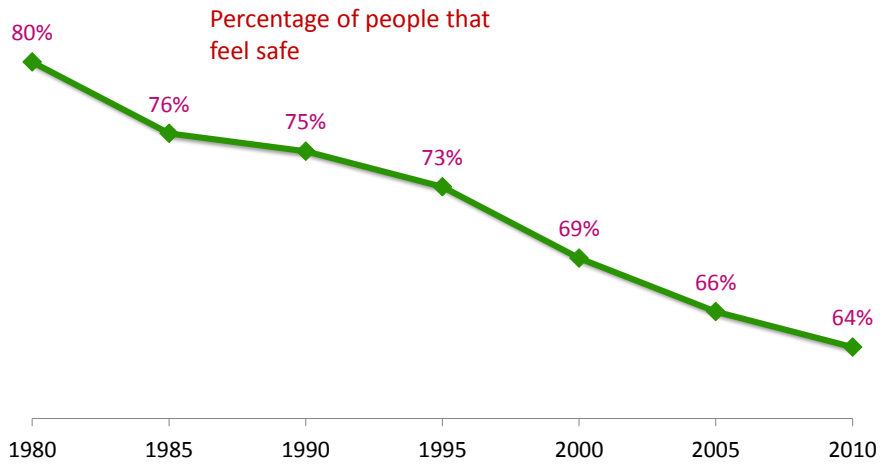


Use Labels, not Legends

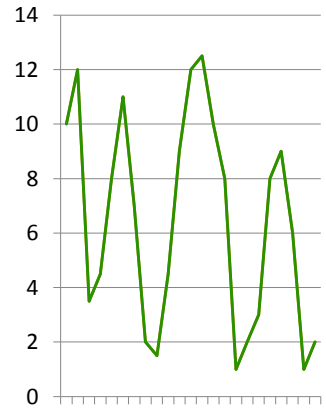
Highlight what is important…

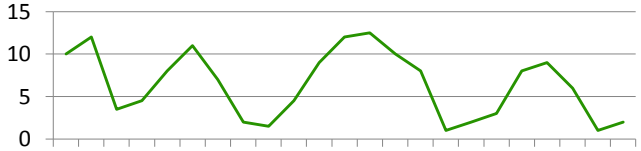


Line Graphs – Trends Over Time



Banking to 45 degrees

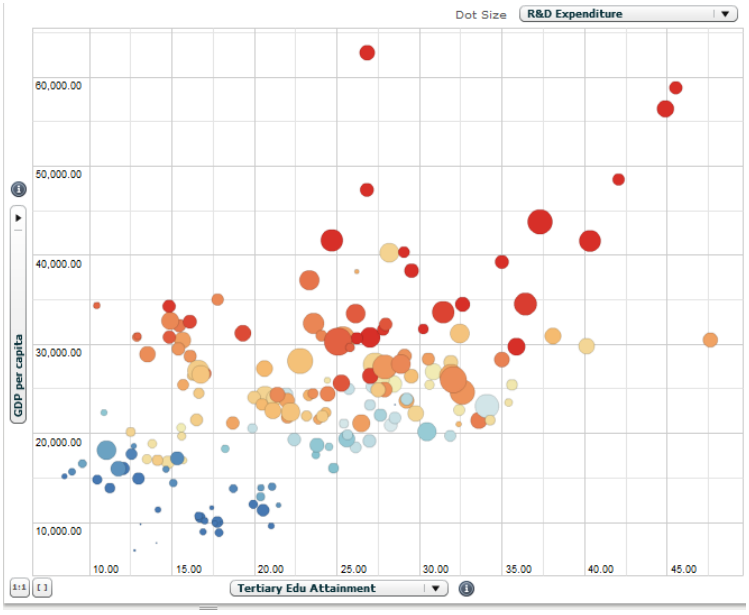




most accurate angle judgment at 45 degrees

pick line graph aspect ratio accordingly

Scatter Plot



Self Sufficiency Test

If you need to write the numbers anyway, the Vis isn't working

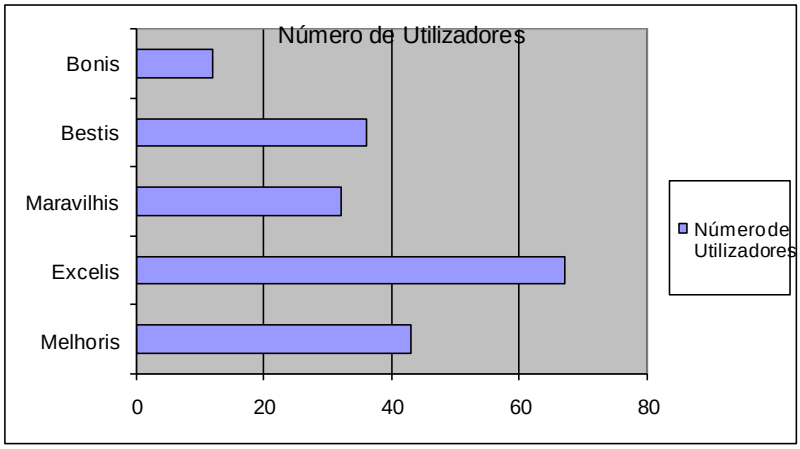
Self Sufficiency Test

"If you need numbers, use a table"

05

KEEPING IT LEGIBLE (AND TRUE!)

Signal-To-Noise



Maximize the data-ink ratio (Tufte)

$$\text{Data-ink ratio} = \frac{\text{data ink}}{\text{total ink used in graphic}}$$

Avoid "chart junk"

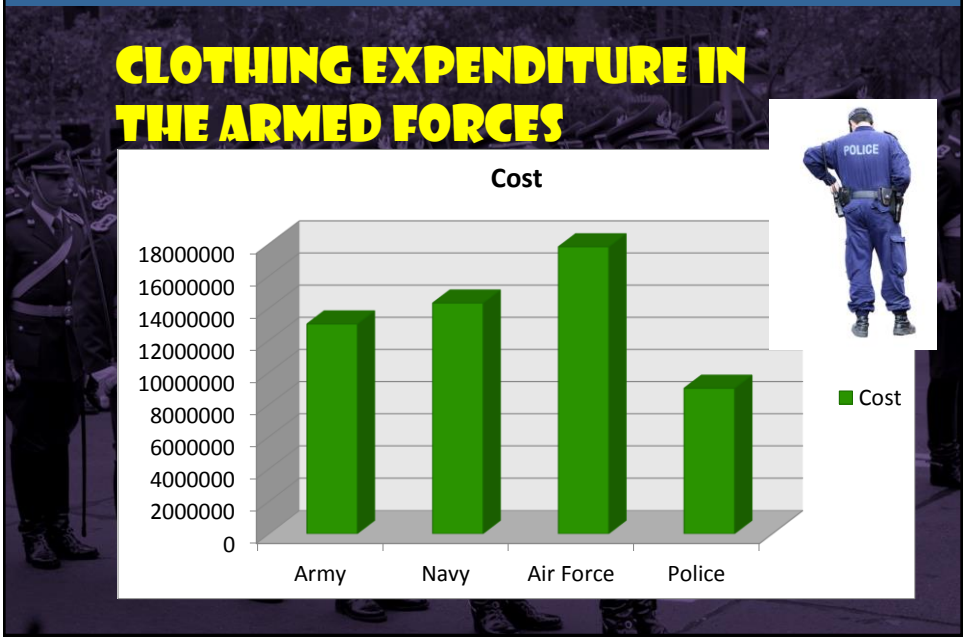
Edward Tufte, *The Visual Display of Quantitative Information*

Example

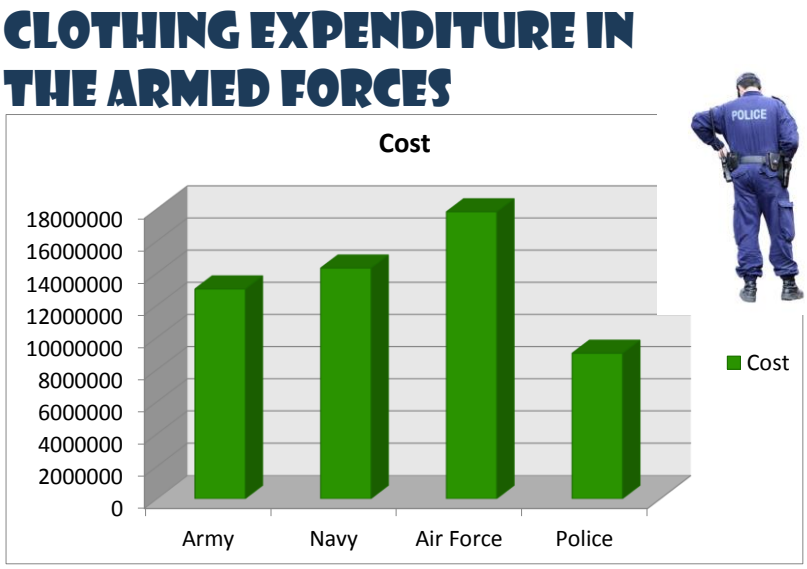
Convey the Message:

"Clothing Expenditure is higher in the Air Force"

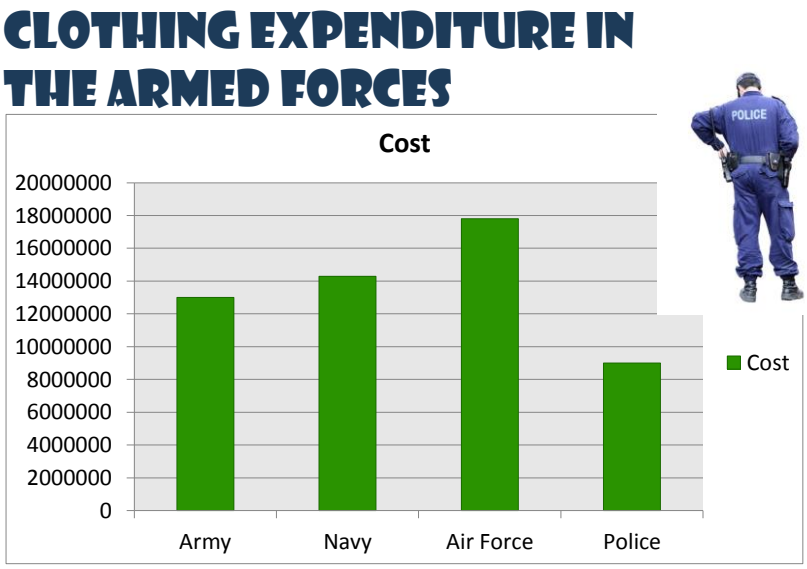
Default Approach



No need for a pic. background…



3D Graphs – Just Say NO!



Bizarre Font…

Clothing Expenditure in the Armed Forces

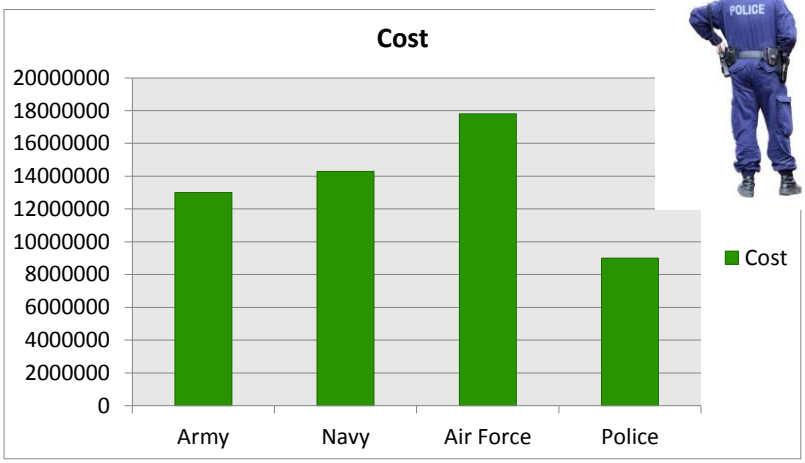
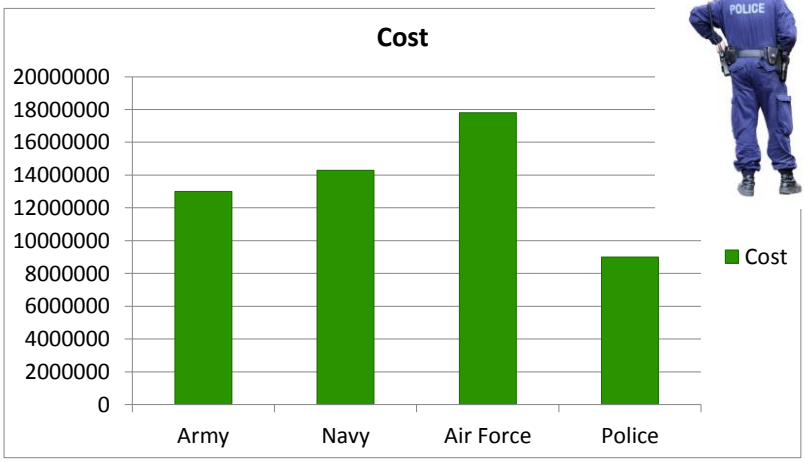
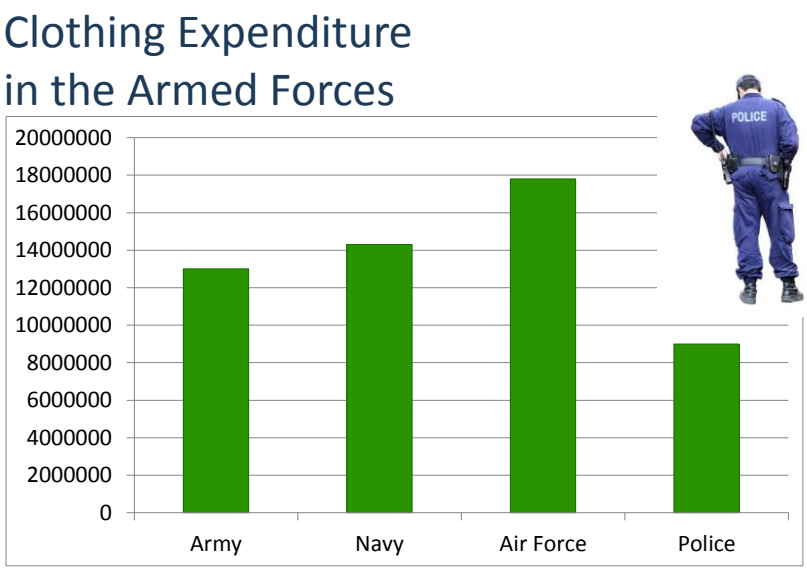


Chart background

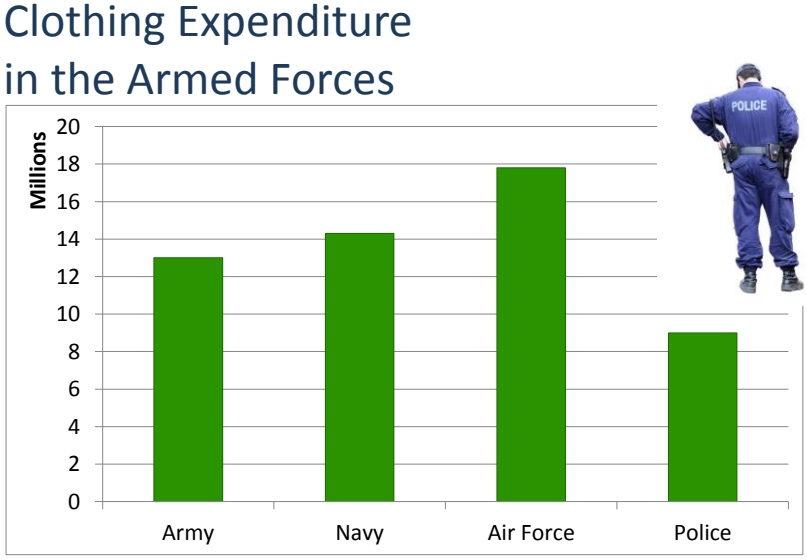
Clothing Expenditure in the Armed Forces



Redundant Title and Legend

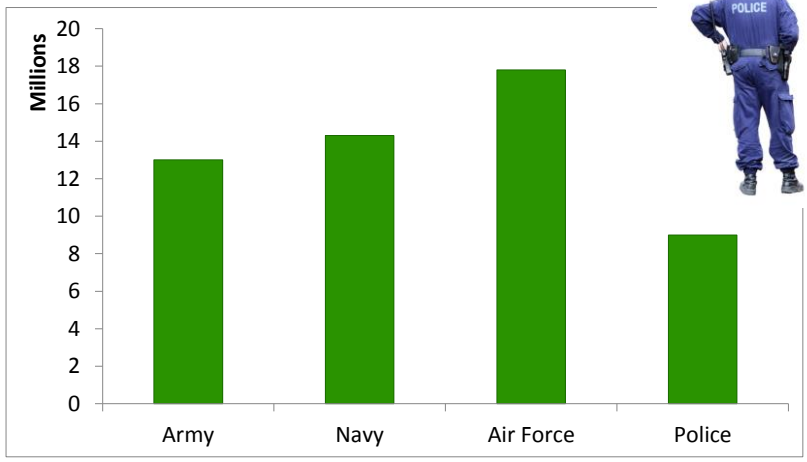


Hard to Read Values



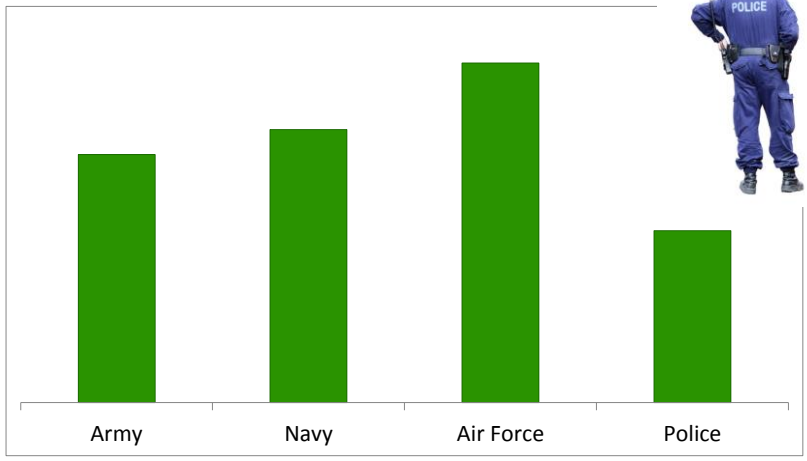
Useless Gridlines

Clothing Expenditure in the Armed Forces

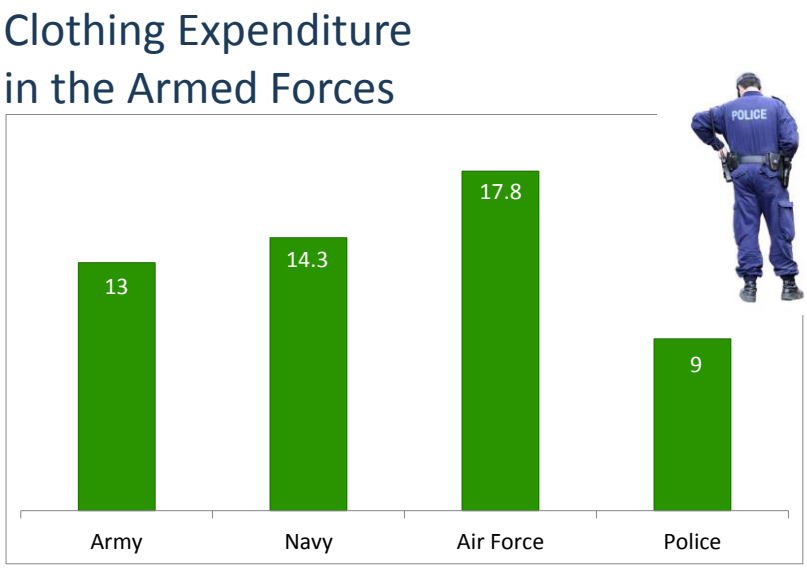


Actually, without the gridines…

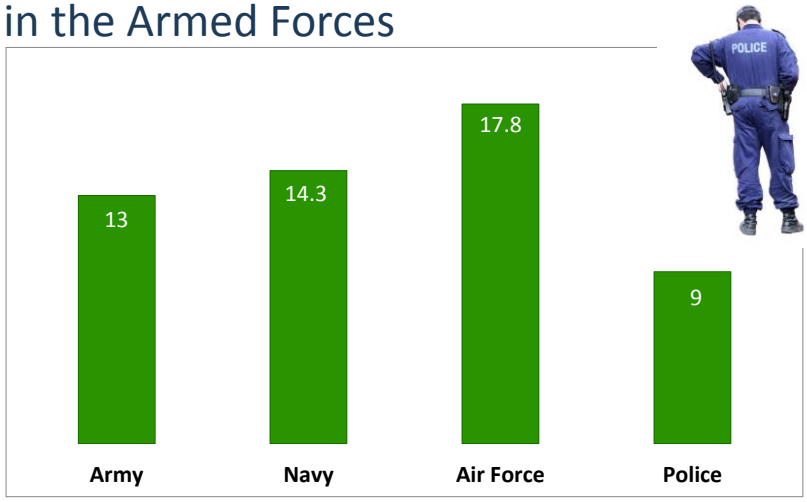
Clothing Expenditure in the Armed Forces



Get the Values Back, if relevant

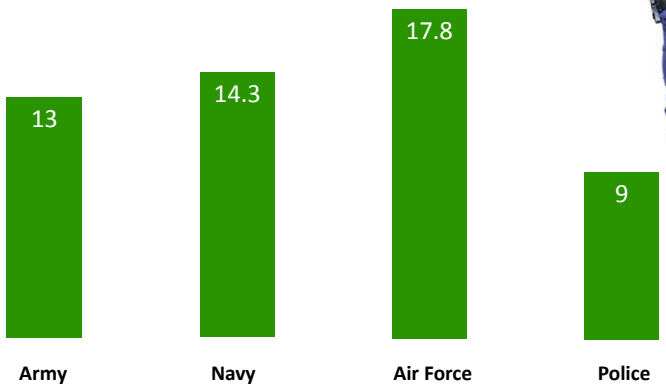


Bottom Axis…



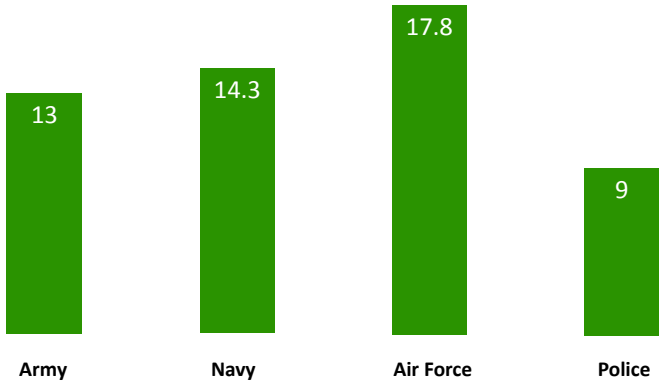
White background…

Clothing Expenditure in the Armed Forces



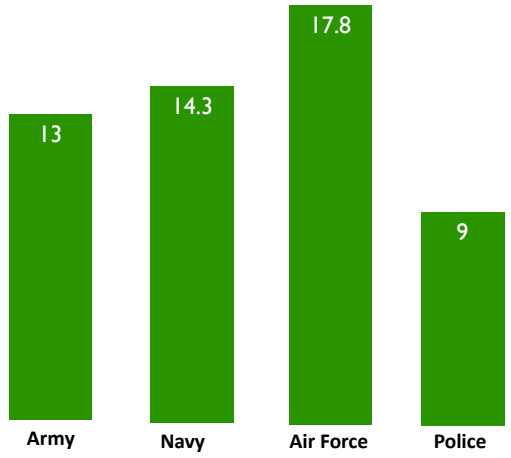
Get Rid of the Image

Clothing Expenditure in the Armed Forces



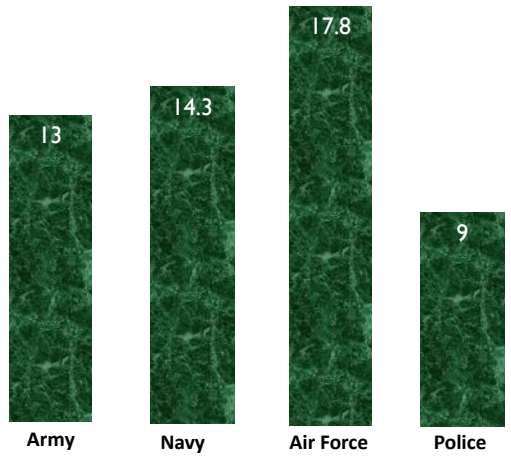
Tidy Things Up

Clothing Expenditure
In the armed forces (M€)



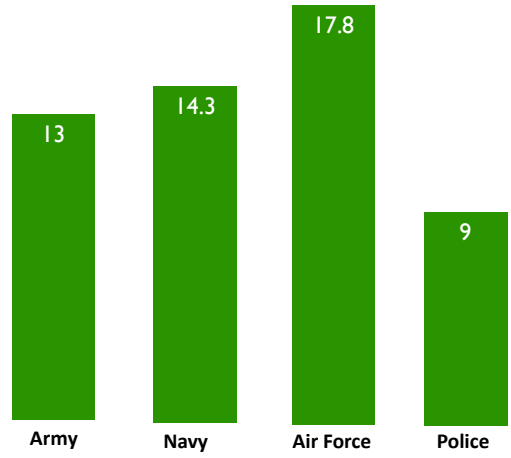
Seldom does this make sense…

Clothing Expenditure
In the armed forces (M€)



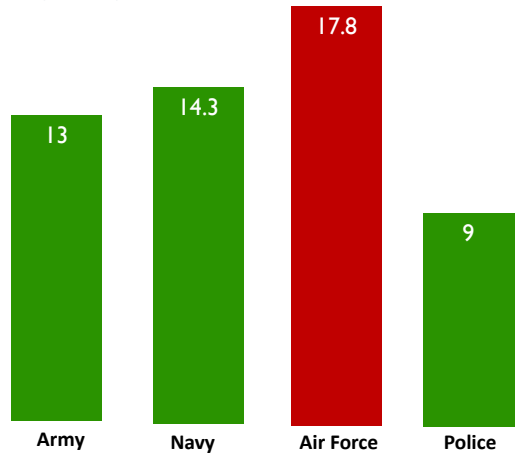
Keep to the (mostly) solid colors…

Clothing Expenditure
In the armed forces (M€)



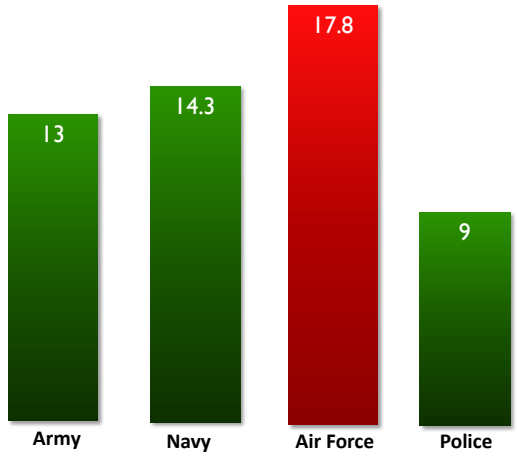
Highlight What's Important

Clothing Expenditure
In the armed forces (M€)

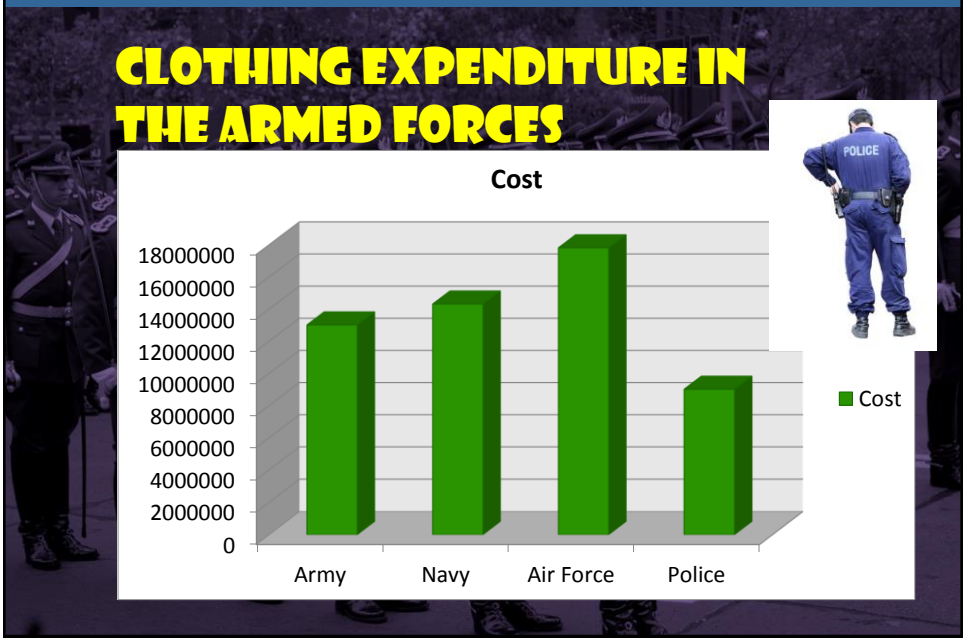


Spice it up a bit (if you want)

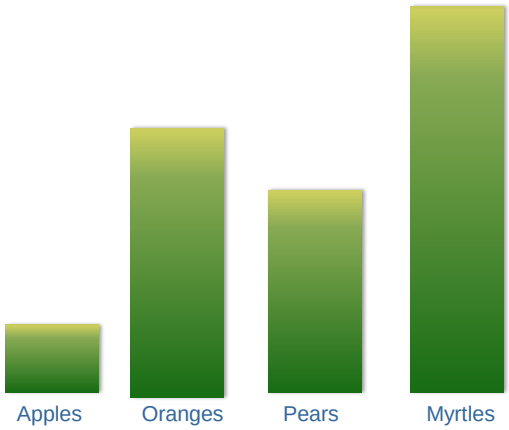
Clothing Expenditure
In the armed forces (M€)



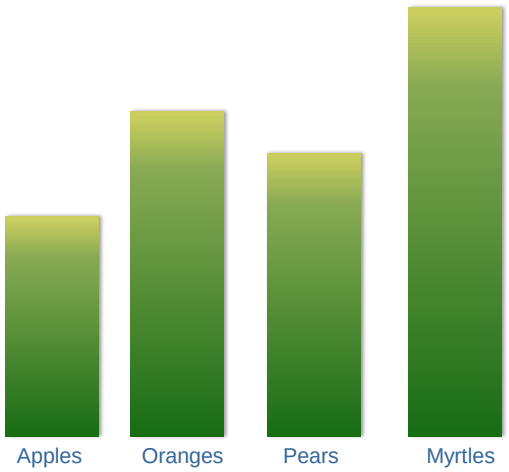
Much tidier than the original…



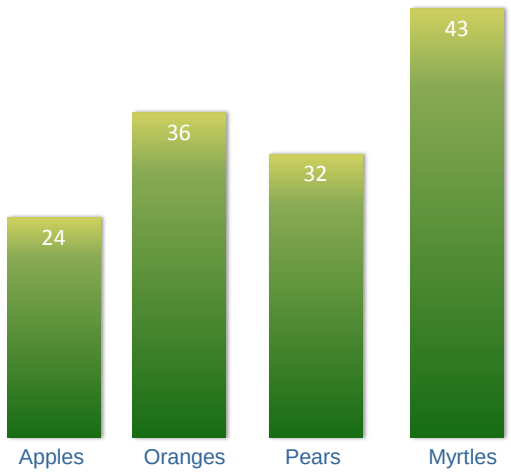
What about Orange production?



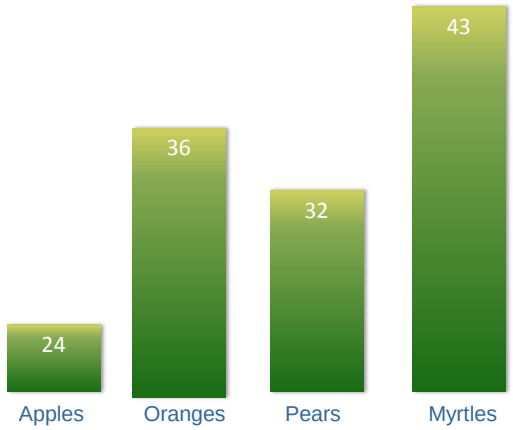
What about now?



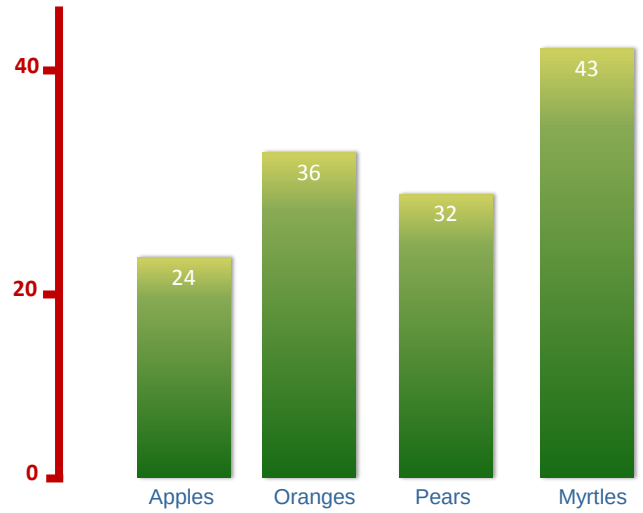
What is going on?



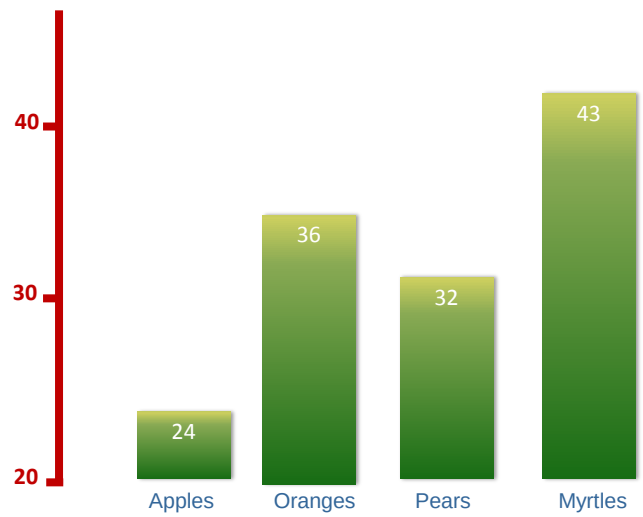
What is going on?



What is going on?



What is going on?

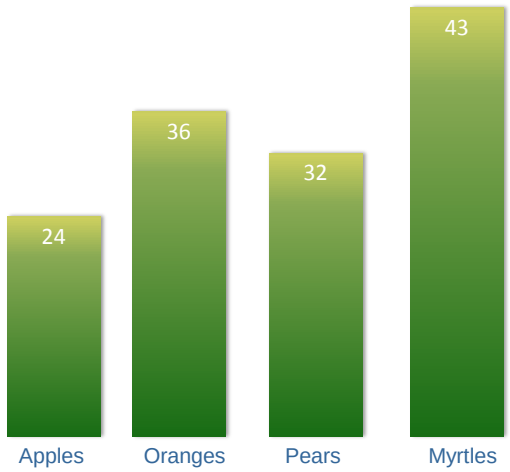


DON'T LIE!

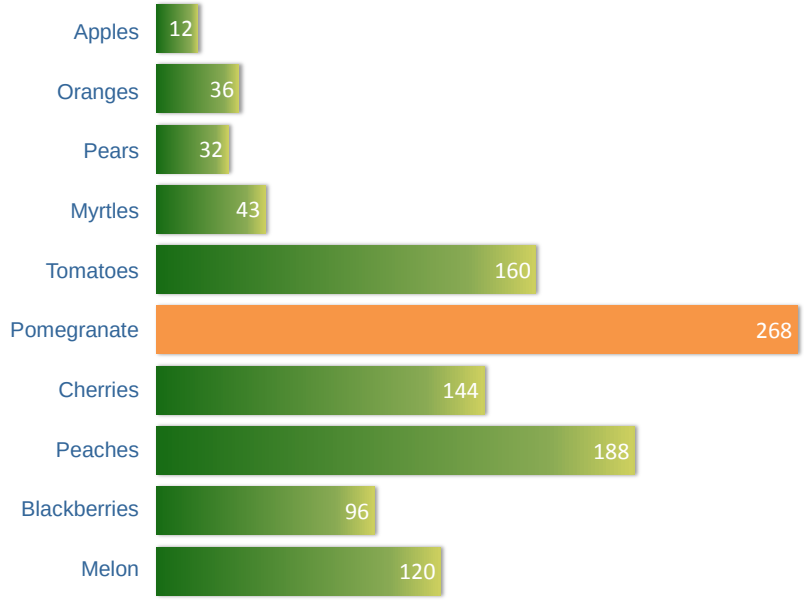
Scales start at ZERO!

0

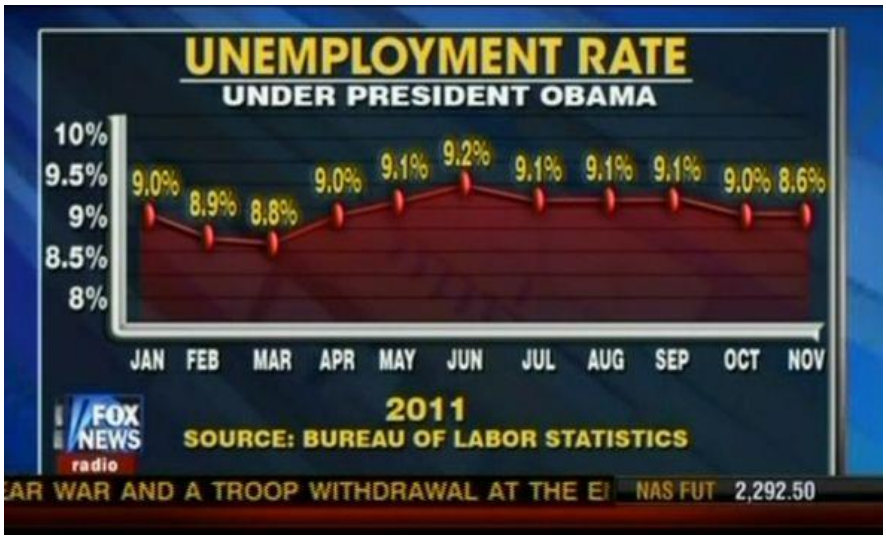
Myrtles are selling really well, right?



Show data in context!

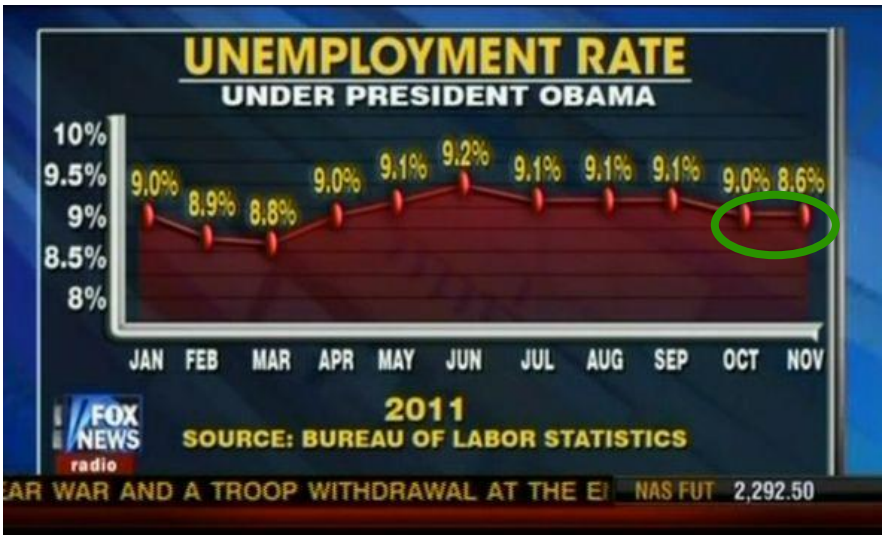


Fox News: Take 1



http://mediamatters.org/blog/201112120005

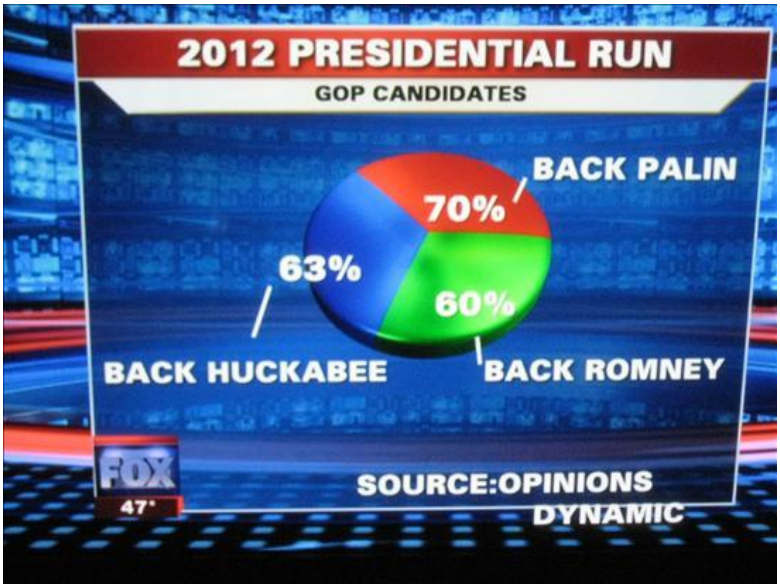
Fox News: Take 1



http://mediamatters.org/blog/201112120005

Fox News: Take 2

Yet some more Fox…



06

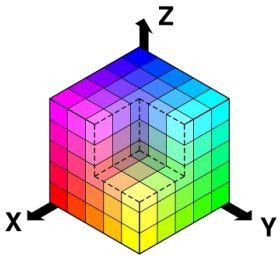
COLOR

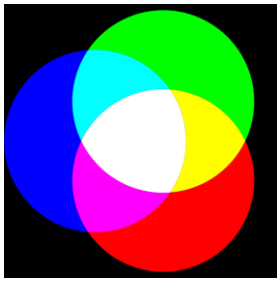
RGB Model

Specifies color as a combination of RED, GREEN, & BLUE

Used in computer monitors

Additive primaries





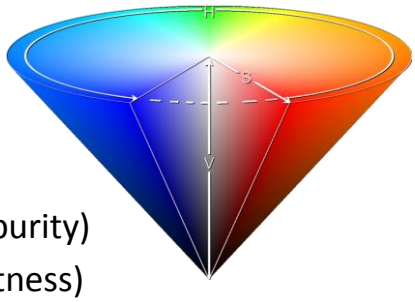
HSV Model

Closely related to artistic intuition

H – Radial axis

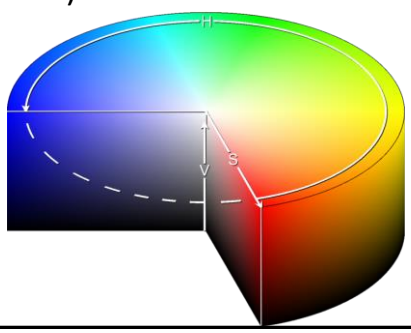
S – Distance to center axis (purity)

V – Distance along axis (lightness)



Inverted cone or cylinder

Ex: Pure Red: (0, 1, 1)

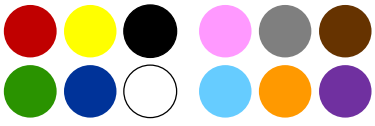


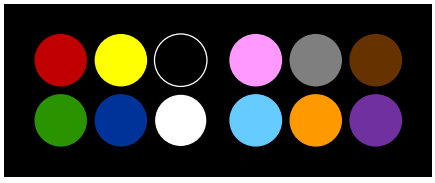
Color & Infovis

Can you order these (low -> hi)?

Nominal Variables

[Ware04] suggests max 12

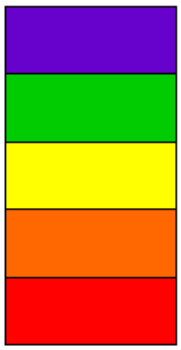




Ware, C. (2004) Information Visualization: Perception for Design. (2nd Edition) Morgan Kaufman. December, 435 pages.

Rainbows…

Full spectral scale



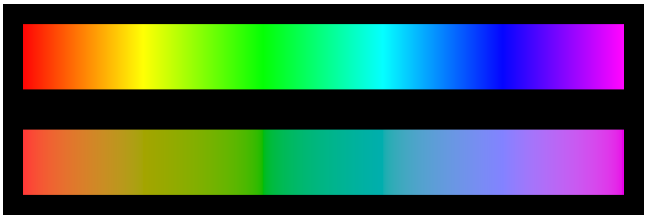
Usually to be avoided

low-frequency segmentation

the red part, the orange part, the green part, …

popular interpolation perceptually nonlinear!

solution: create perceptually linear colormap, lose vibrancy



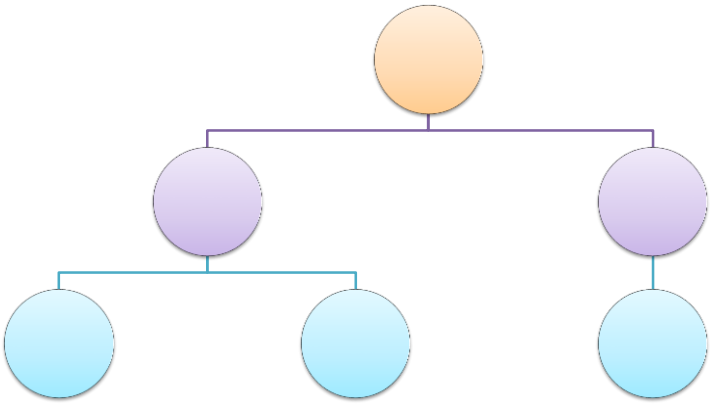
07

TECHNIQUES

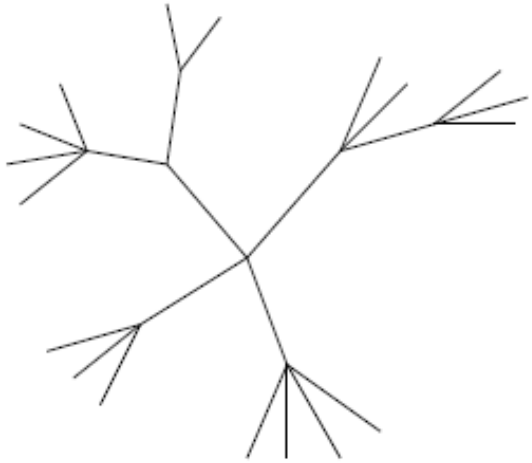
Link-Node: Hierarchies

Link-Node Representations

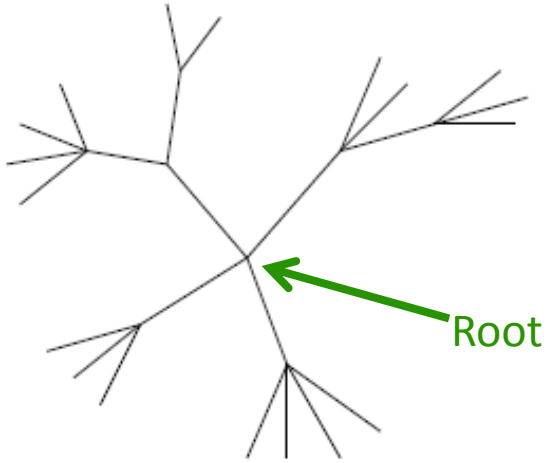
Nodes = data
Links = relationships between data



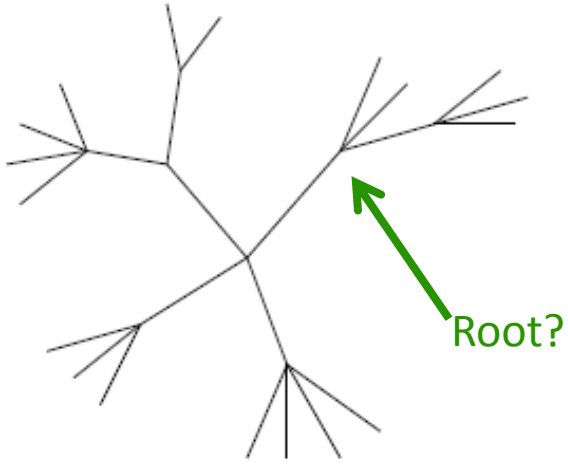
Radial Trees: Root doesn't need to be on top…



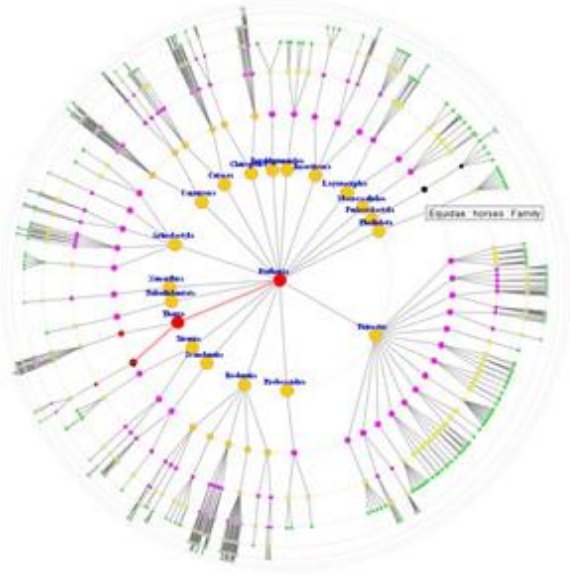
Seen like this…



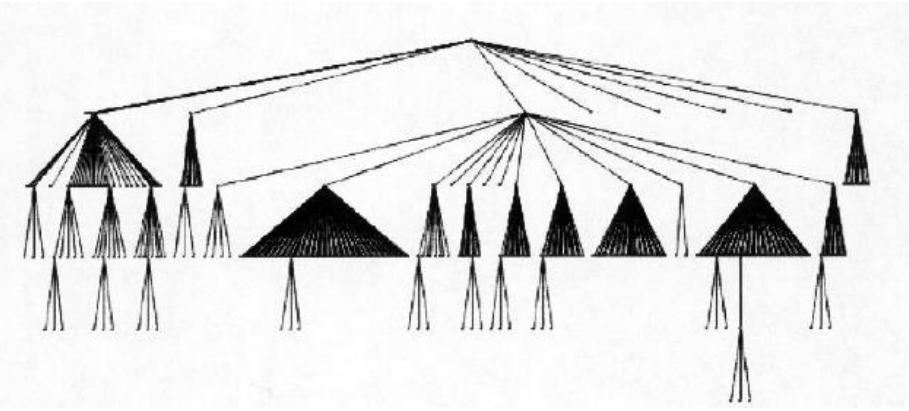
Why can't this guy be the root?



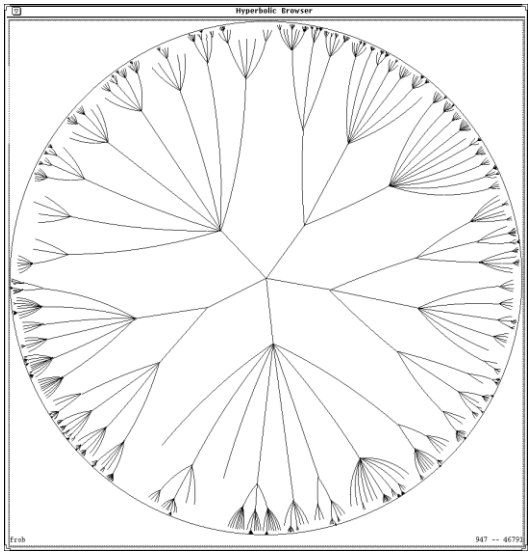
Radial Trees



Huge Branching = Clutter!



Hyperbolic Trees



Lay out the hierarchy on the hyperbolic plane and map this plane onto a display region.

A standard 2D browser:

100 nodes (w/3 character text strings)

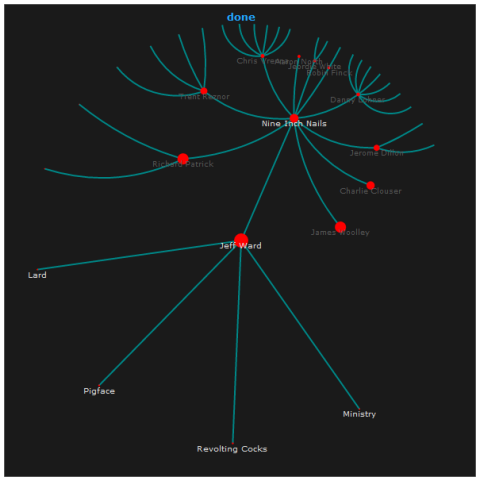
Hyperbolic browser:

1000 nodes, about 50 nearest the focus can show from 3 to dozens of characters

Lamping, John; Rao, Ramana; Pirolli, Peter (1995). "A Focus+Context Technique Based on Hyperbolic Geometry for Visualizing Large Hierarchies". *Proc. CHI95*. ACM. pp. 401–408.

Live Example

http://thejit.org/static/v20/Jit/Examples/Hypertree/example1.html



Link-Node limitations for hierarchies

Difficult to encode more variables

Clutter

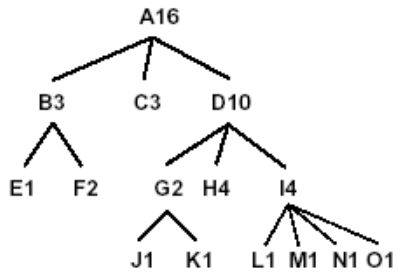
Wasted Space

Space Filling: Treemap

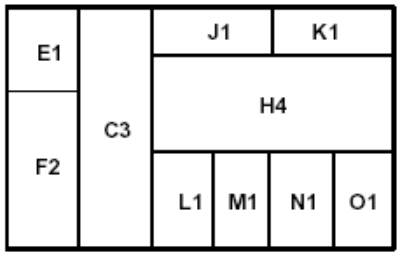
http://www.cs.umd.edu/hcil/treemap-history/index.shtml

Containment, not connection

emphasize node attributes, not topological structure

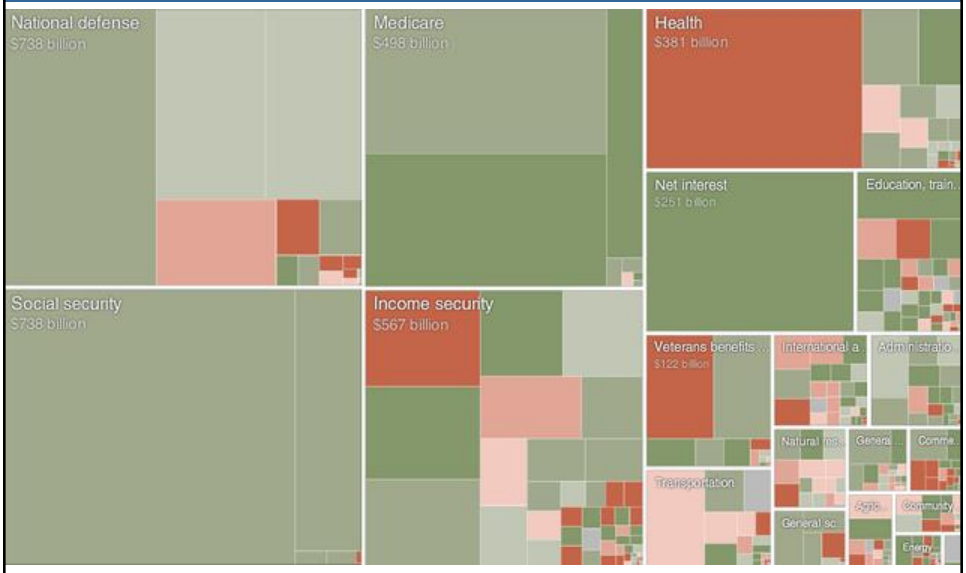


Node and link diagram



Treemap

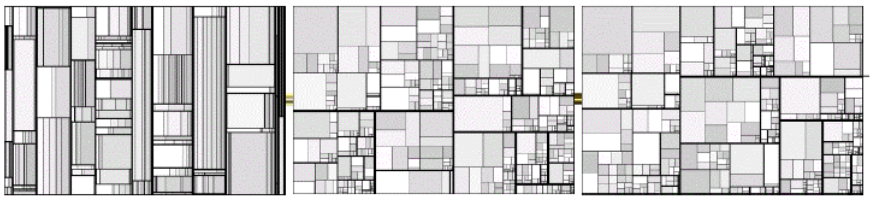
Obama's 2011 Budget Proposal



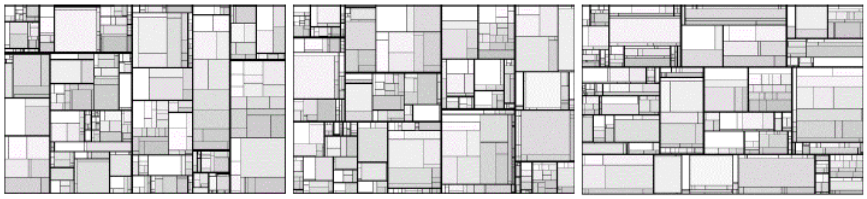
Size = Relative amount of $$$ Color: variation since 2010

http://www.nytimes.com/interactive/2010/02/01/us/budget.html

Several Algorithms



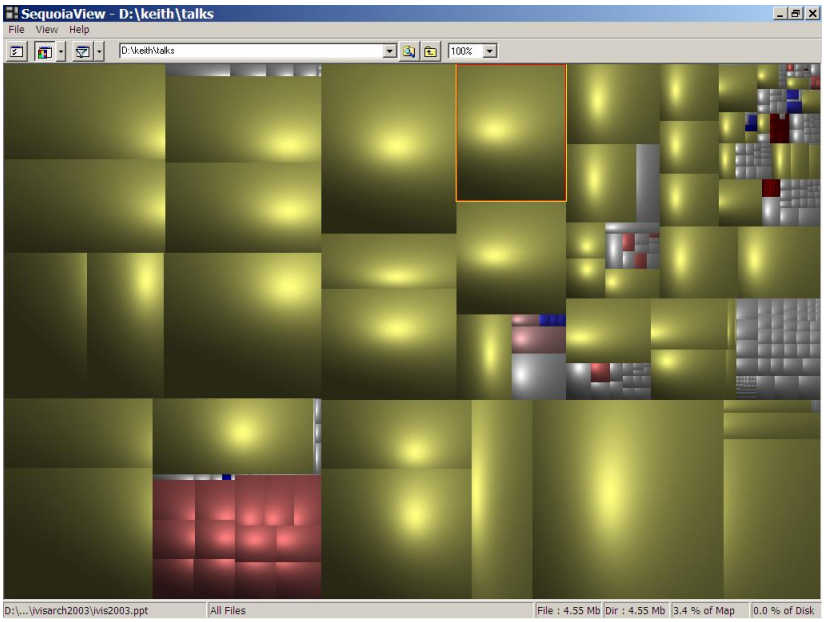
Slice-and-dice Cluster Squarified



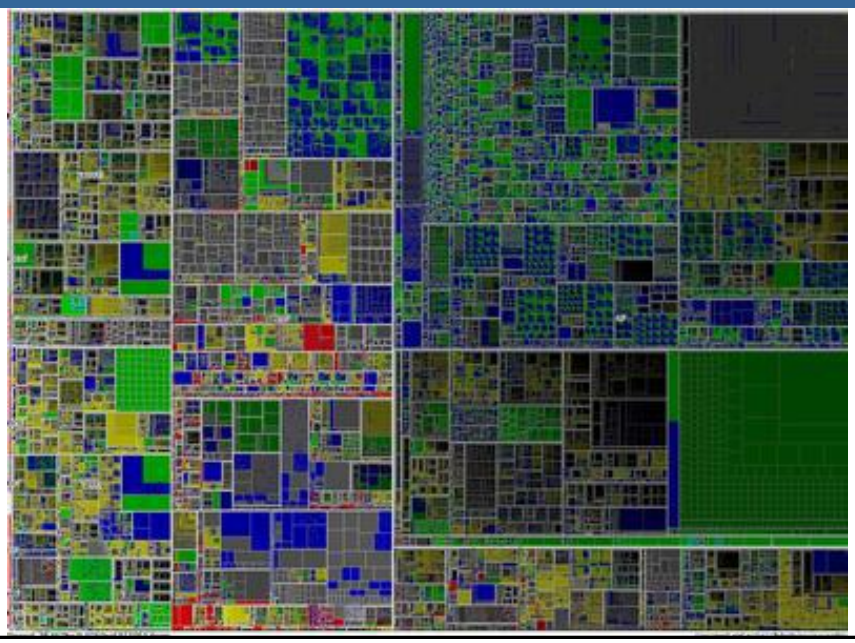
Pivot-by-middle Pivot-by-size Strip

www.cs.umd.edu/hcil/treemap-history/java_algorithms/LayoutApplet.html

Cushioned Treemap (no borders!)



Millions of items!



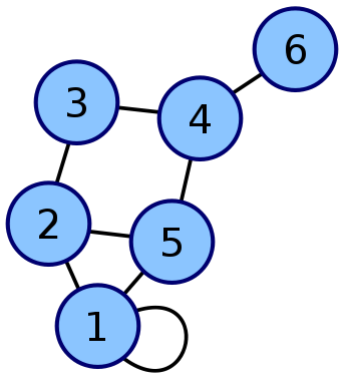
Live Example

http://keminglabs.com/ukuni/

Link-Node: Graphs / Networks

Graphs

Vertices (nodes) connected by Edges (links)



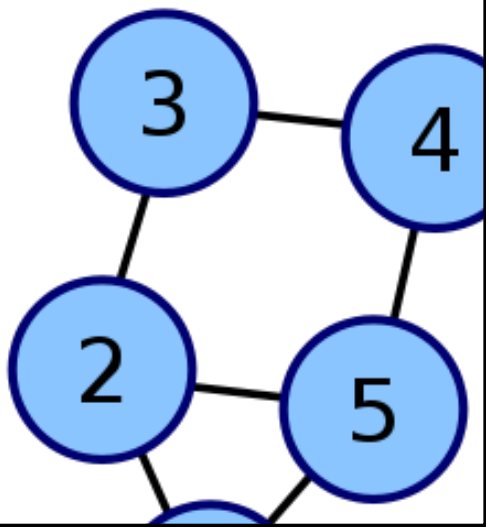
Node & Edge Properties (each 1 var?)

Node

- Shape
- Color
- Size
- Location
- Label

Edge

- Color
- Size
- Label
- Form



Lots of different algorithms

Planar

grid-based

Force-Directed

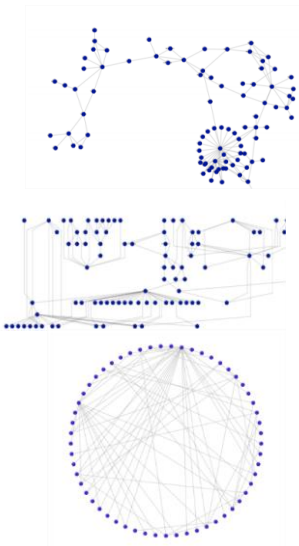
Orthogonal

curved lines

Hierarchies

Circular

…



http://www.cse.ust.hk/~weiwei/PQE/WeiweiPQE.pdf

Lots of different algorithms

Planar

grid-based

Force-Directed

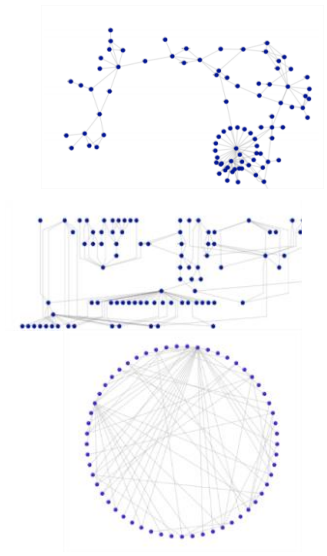
Orthogonal

curved lines

Hierarchies

Circular

…

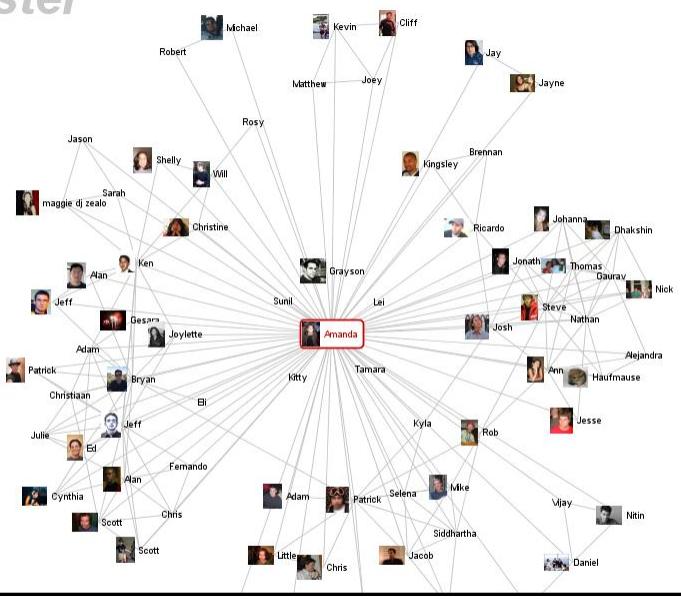


http://www.cse.ust.hk/~weiwei/PQE/WeiweiPQE.pdf

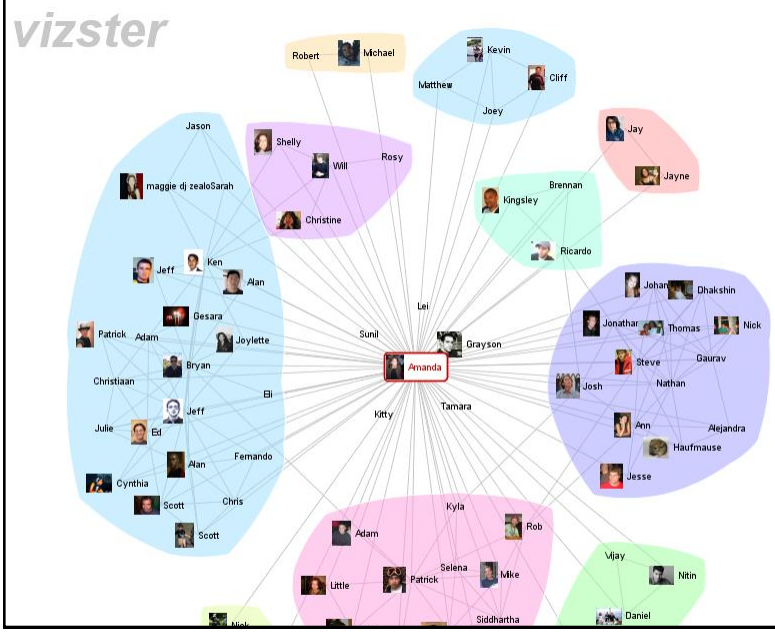
Often used for social networks

vizster

http://hci.stanford.edu/jheer/projects/vizster/

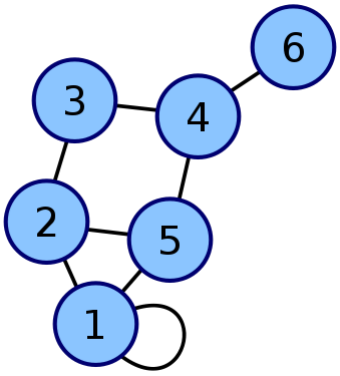


Community (clusters)



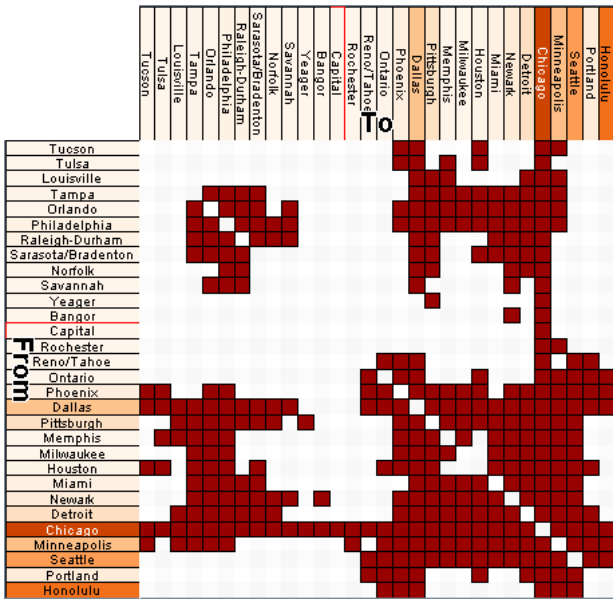
Tables / Matrices

Adjacency Matrix

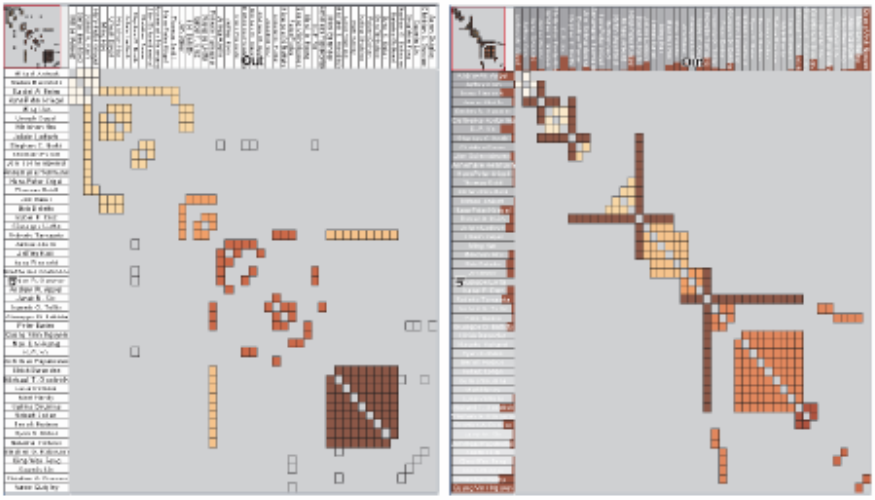


$$\begin{pmatrix} 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix}$$

Alternative to Node-Link

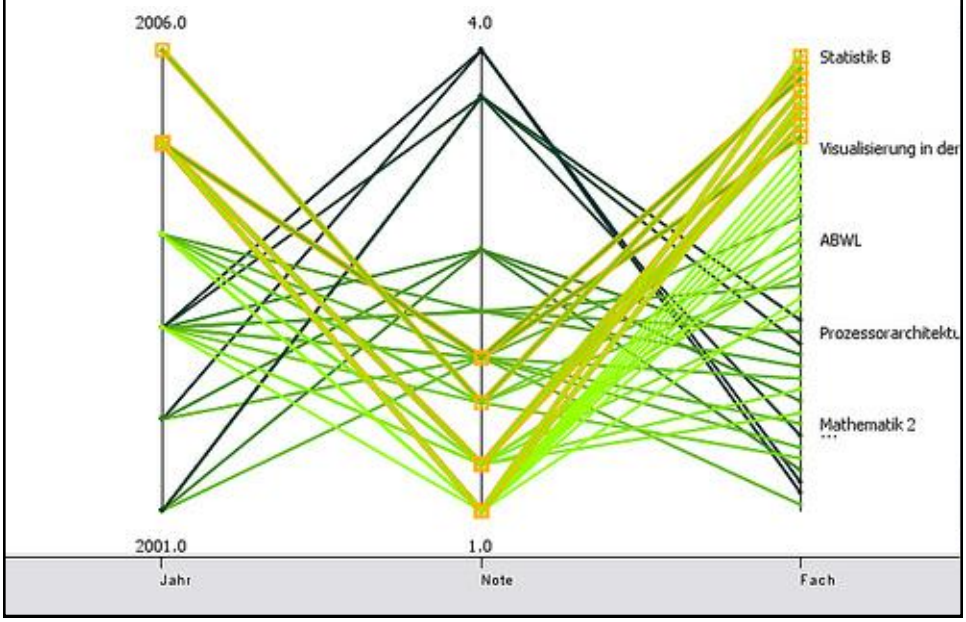


Reorder lines/columns for insights



Parallel Coordinates

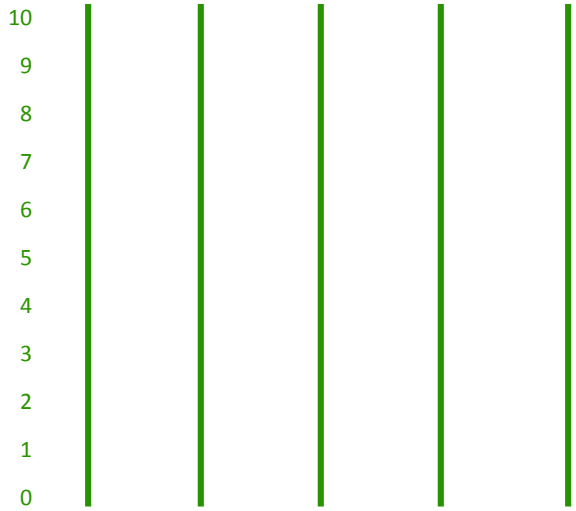
Parallel Coordinates



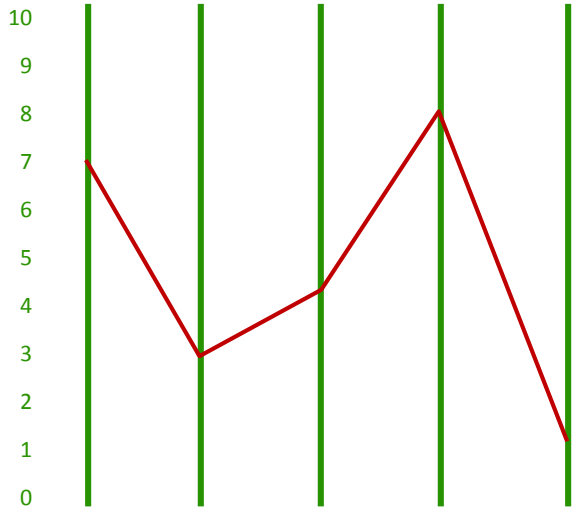
N-dimensional space (in this case, 5)

	V1	V2	V3	V4	V5
D1	7	3	4	8	1
D2	2	7	6	3	4
D3	9	8	1	4	2

Each dimension, a vertical line

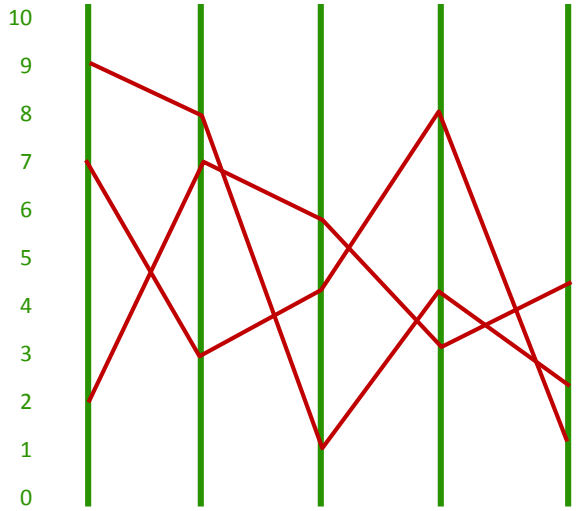


Each vector a polyline



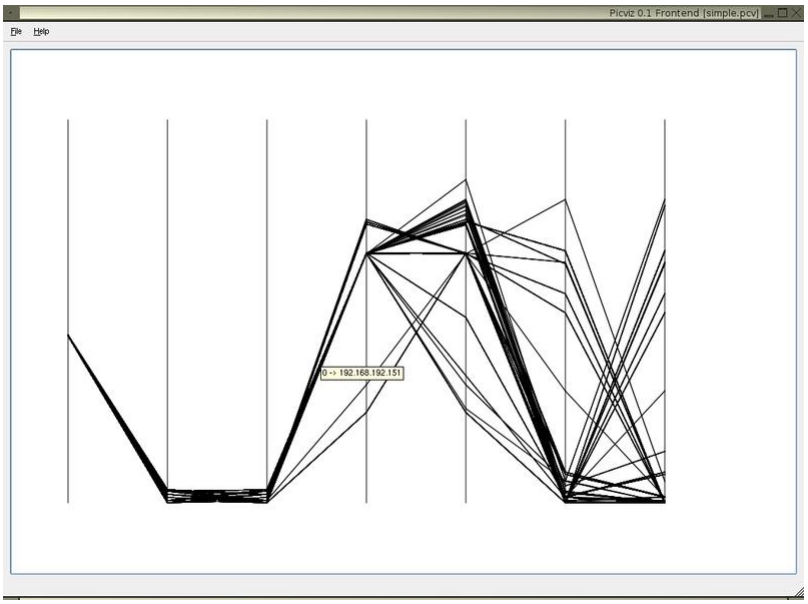
D1 = 7, 3, 4, 8, 1

Each vector a polyline

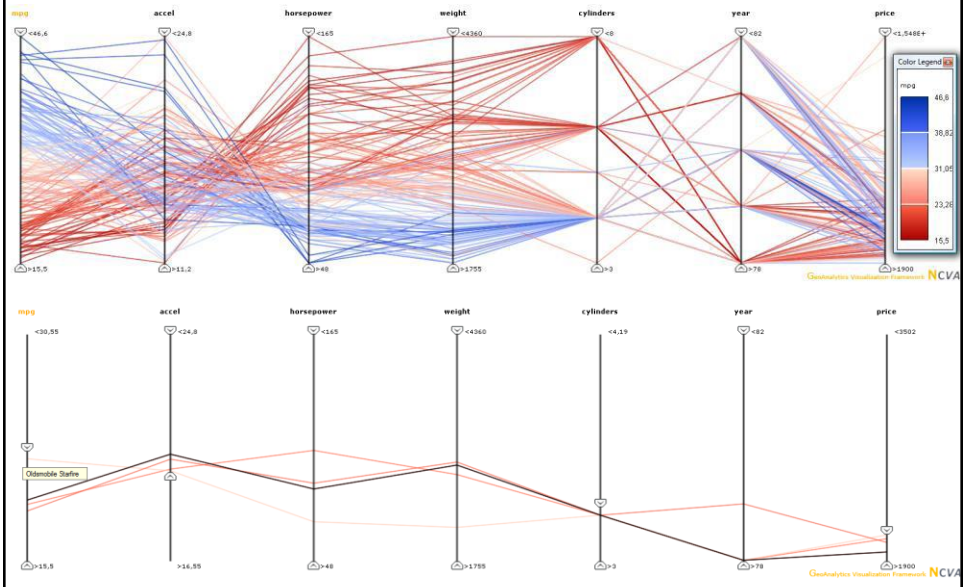


	V1	V2	V3	V4	V5
D1	7	3	4	8	1
D2	2	7	6	3	4
D3	9	8	1	4	2

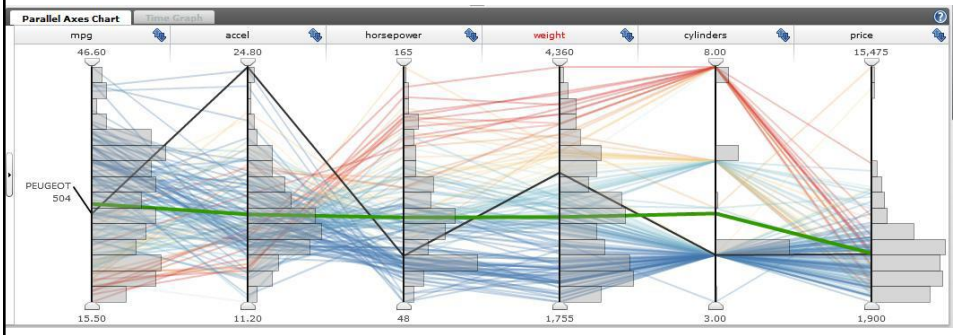
Get information from overall shape



Usually interactive, filtering, etc.



Combined with other information

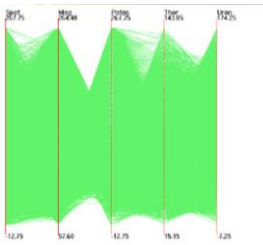


Issues

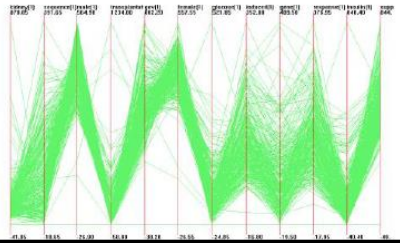
If variables have different ranges, must normalize (0-1)

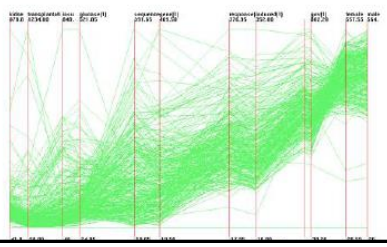
Too much data…

Order is important



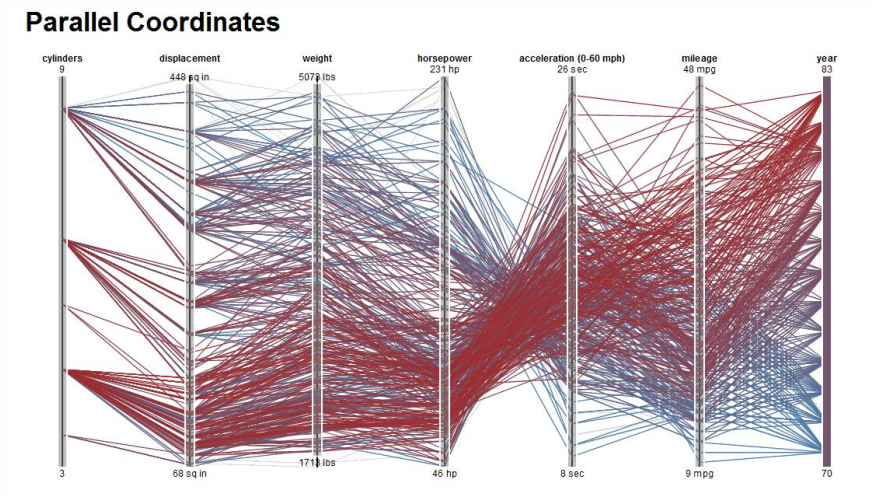
Out5d dataset (5 dimensions, 16384 data items)





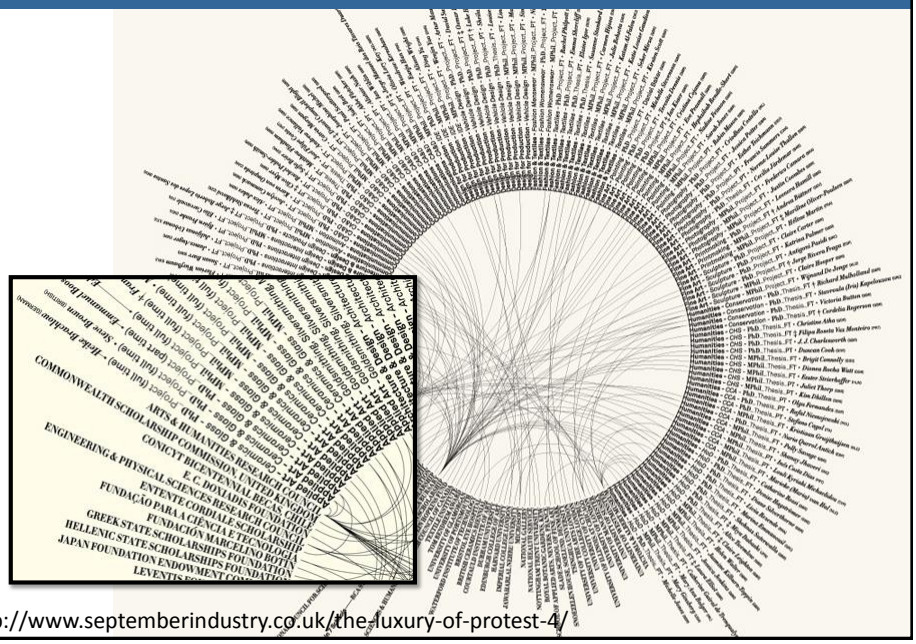
Live Demo - Cars

http://mbostock.github.com/protovis/ex/cars.html



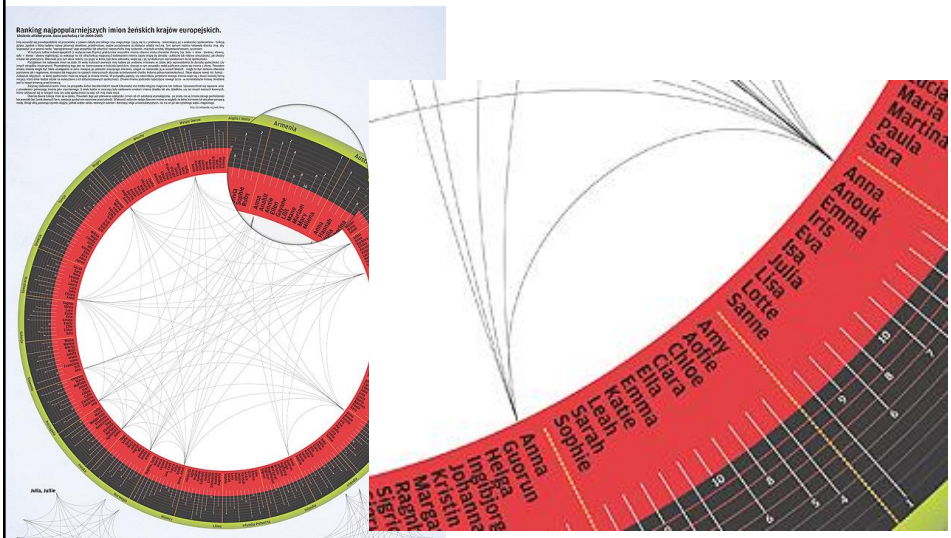
Radial Diagrams

A way to display relationships…



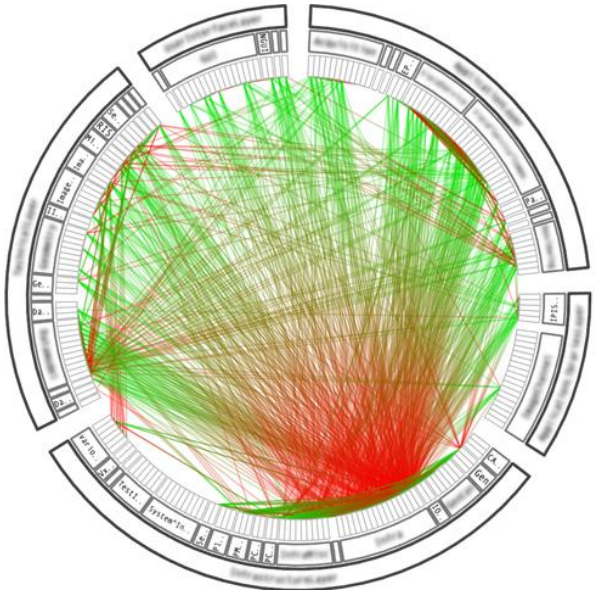
http://www.septemberindustry.co.uk/the-luxury-of-protest-4/

Popularity of names in Europe

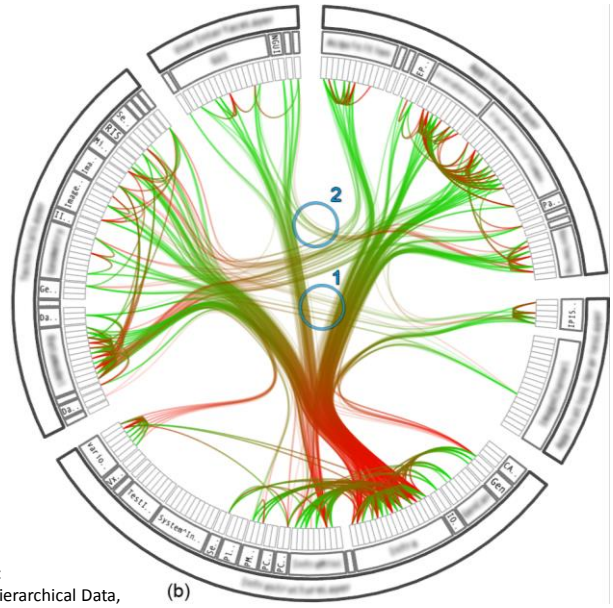


http://datavisualization.ch/showcases/what-are-europes-most-popular-names

Clutter



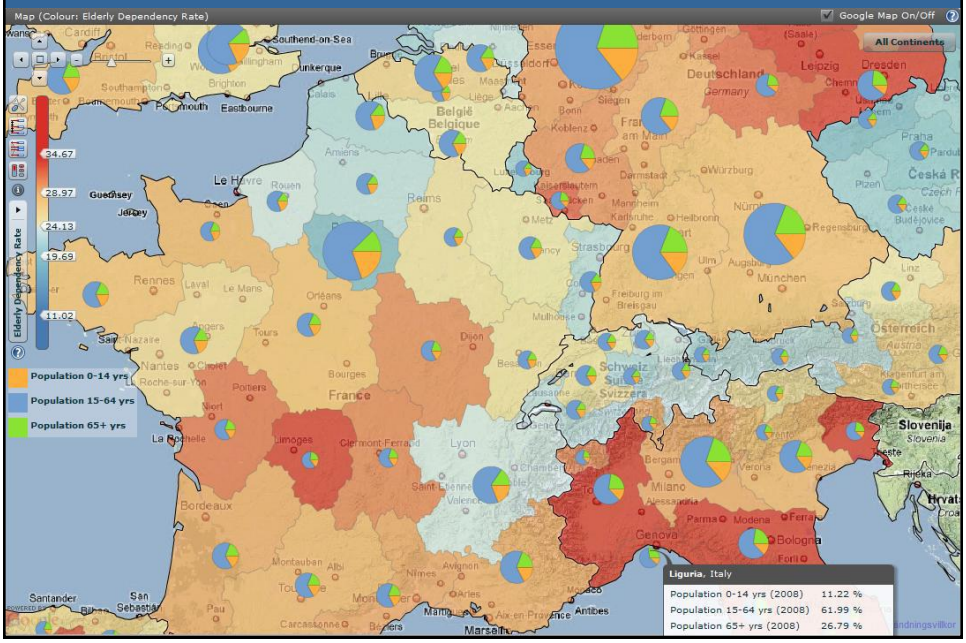
Hierarchical Edge Bundles



Danny Holten, Hierarchical Edge Bundles:
Visualization of Adjacency Relations in Hierarchical Data,
IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS, VOL. 12, NO. 5, SEPTEMBER/OCTOBER 2006

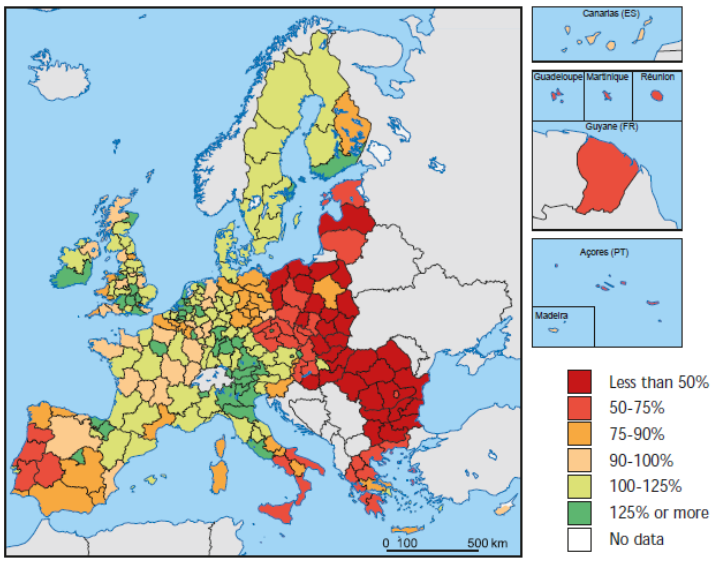
Maps

Links to Real Geography

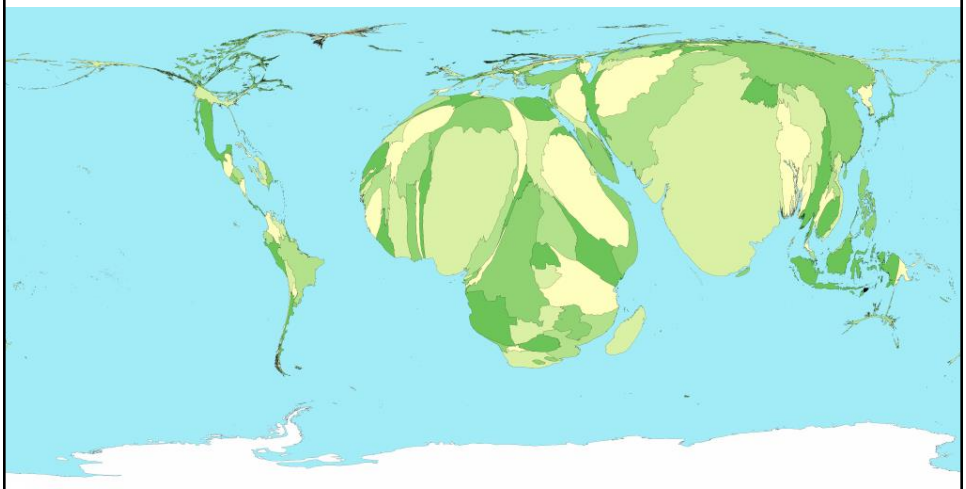


Choropleth map

GDP per inhabitant in PPS as a percentage of the EU-27 average (2004)



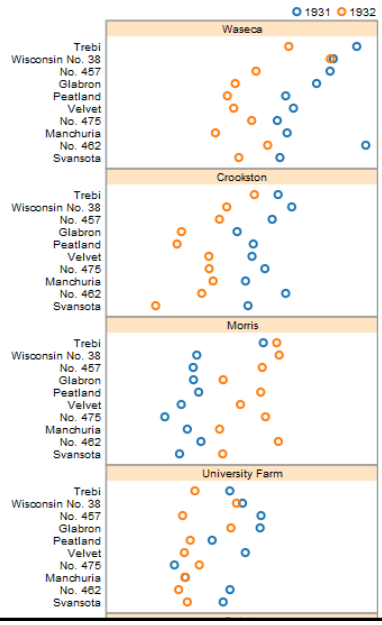
Cartogram



Childhood Mortality
http://www-personal.umich.edu/~mejn/cartograms/

Small Multiples

Small Multiples

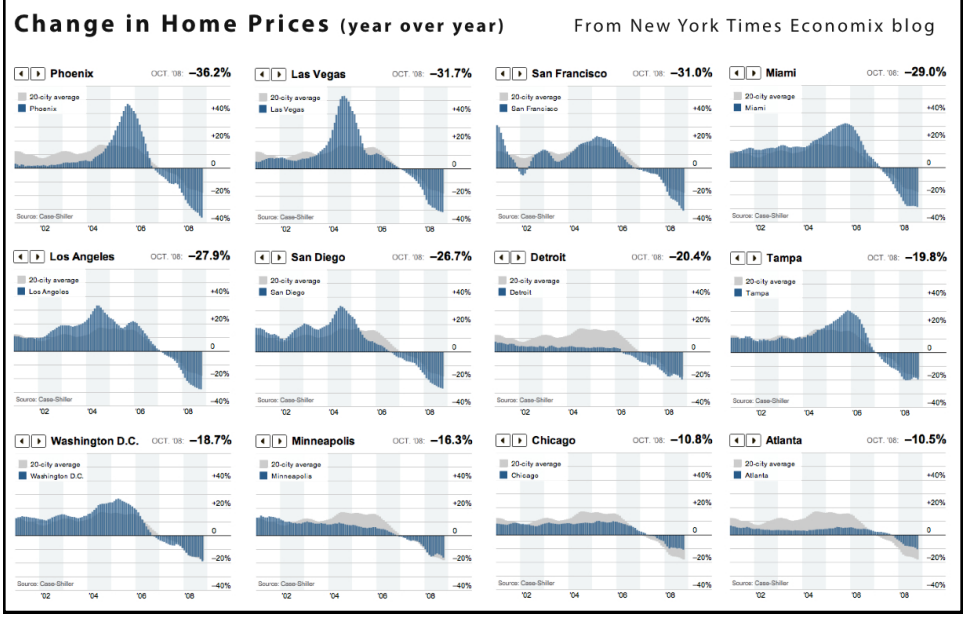


Same visual encoding

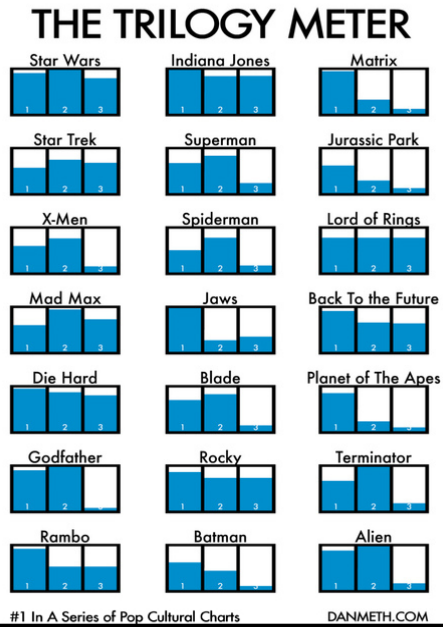
Shown side-by-side

different (but related!) data

Small Multiples



Movie Trilogies



08

BIG DATA

Big Data + High Dimensionality

Very large number of dimensions hard to visualize!

As are huge datasets

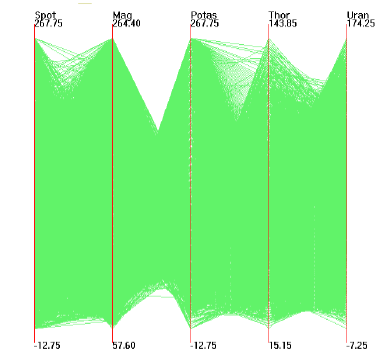
Interactivity is often the key!

CURSE OF DIMENSIONALITY

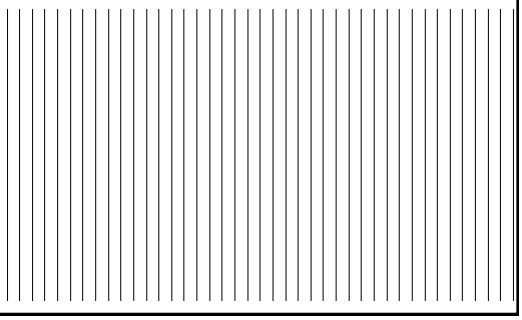
Sparse data

Not representative data

Big Data + High dimensionality



Out5d dataset (5 dimensions, 16384 data items)



Curse of Dimensionality

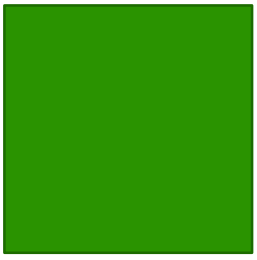
Number of points at 0.01 distance to evenly cover the interval?

Curse of Dimensionality

Number of points at 0.01 distance to evenly cover the interval?

100

Curse of Dimensionality



Number of points at 0.01 distance to evenly cover the square?

$100x100 = 10^4$

Curse of Dimensionality

Unit hypercube, n=10

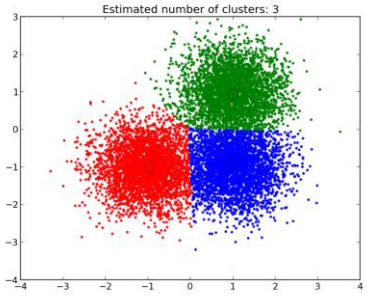
Number of points at 0.01 distance to evenly cover the cube?

10^{20}

Reduce Items - Clustering

(takes into account all dimensions)

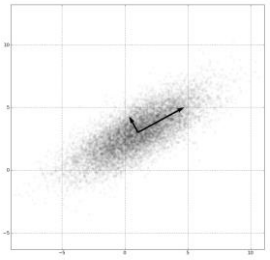
- Affinity propagation
- k-means
- Expectation maximization
- Hierarchical clustering



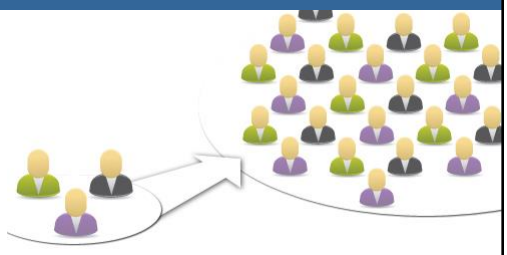
Reduce dimensions - Projection

(from n-dim to 2-dim)

- Multi-dimensional scaling (MDS)
- Principal component analysis
- Linear discriminant analysis
- Factor analysis



Filtering

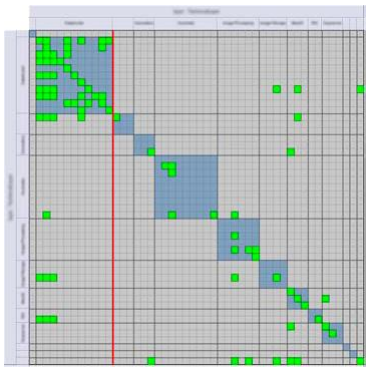


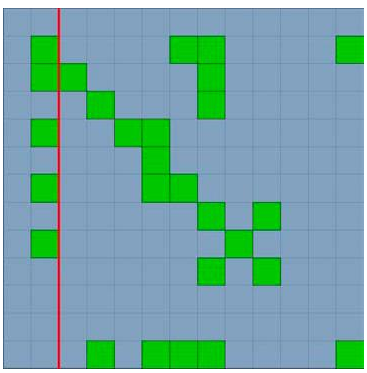
Select only a few data cases or variables

Filter Items (sampling)

Aggregation

Combine several into fewer





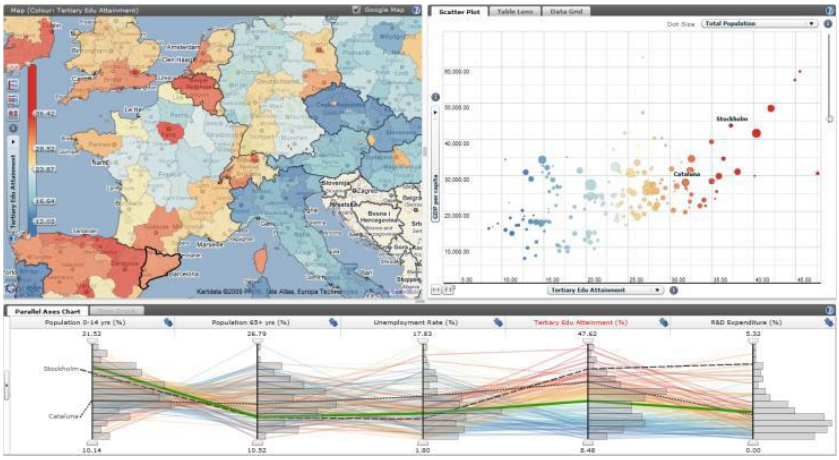
09

ALL TOGETHER NOW!

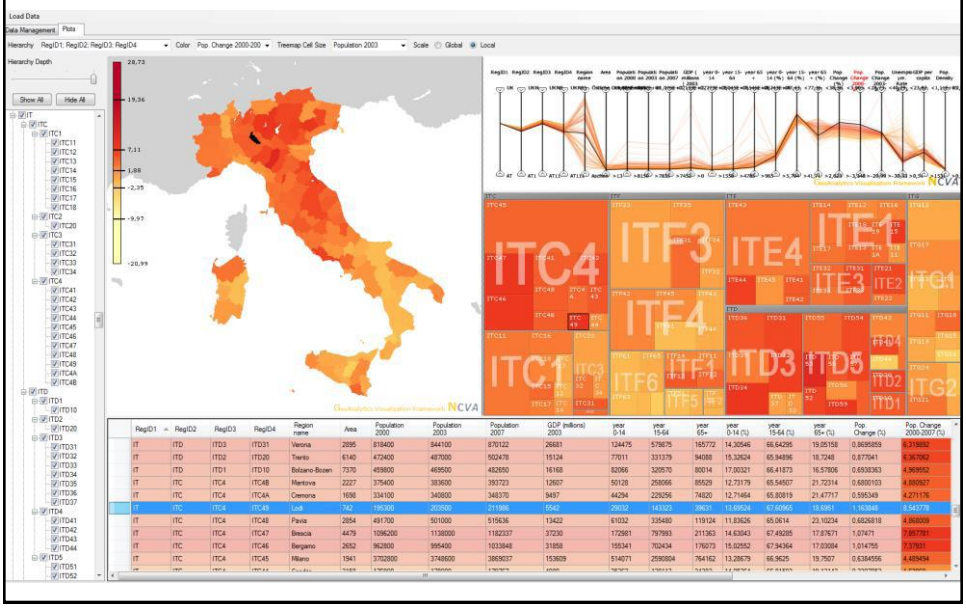
Synchronized Views

http://stats.oecd.org/OECDregionalstatistics/

Multiple linked views of the same data, for better insights



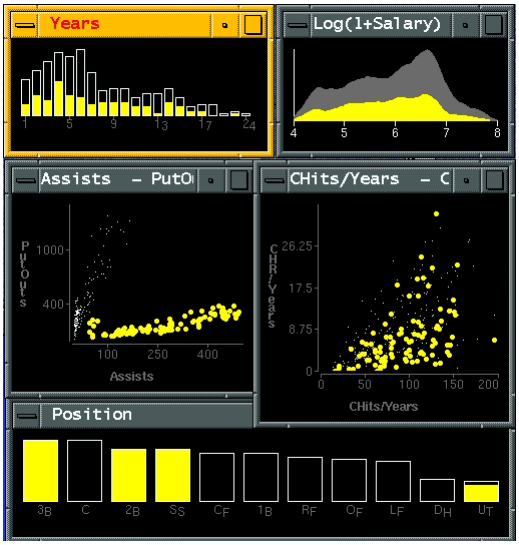
Synchronized Views



Brushing

Select one part, highlight on all

Mouse over will suffice



Limited Screen Real Estate

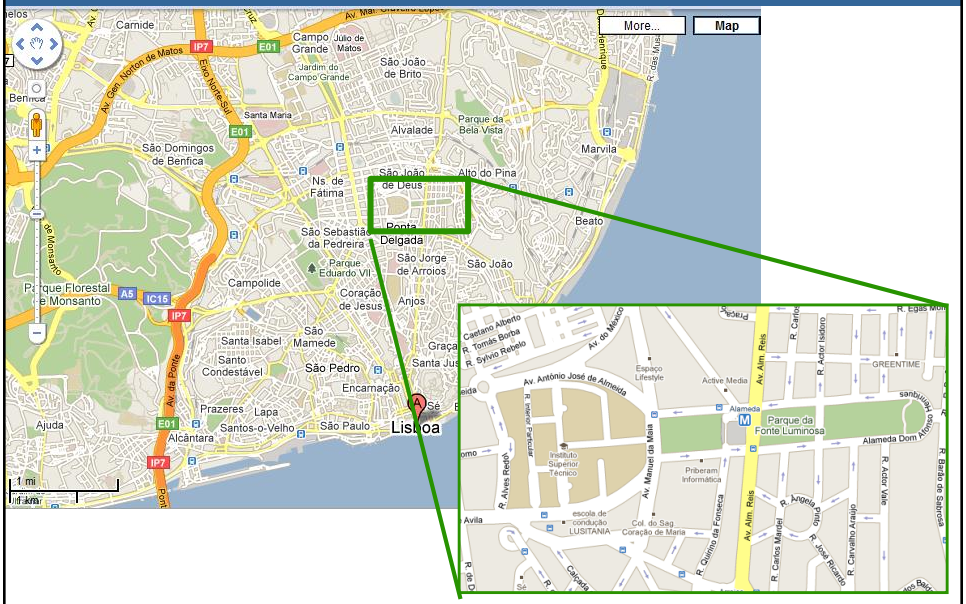
Usually

- Either Detail or Full Picture
- Lose Context when Zooming
- Zoom In and Out a lot

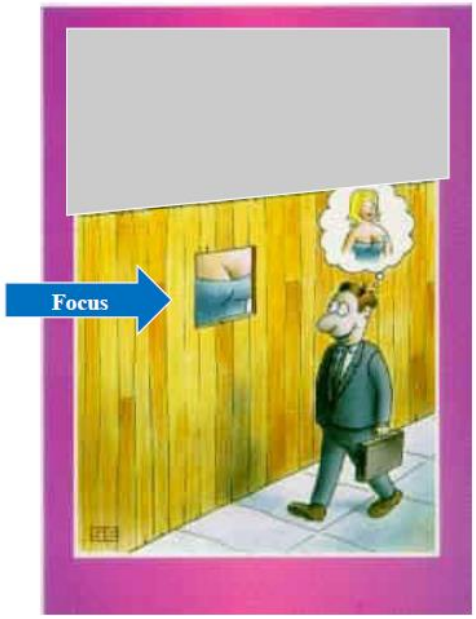
Focus + Context

- Integrate Detail and Big Picture
- Make better use of available Screen Space

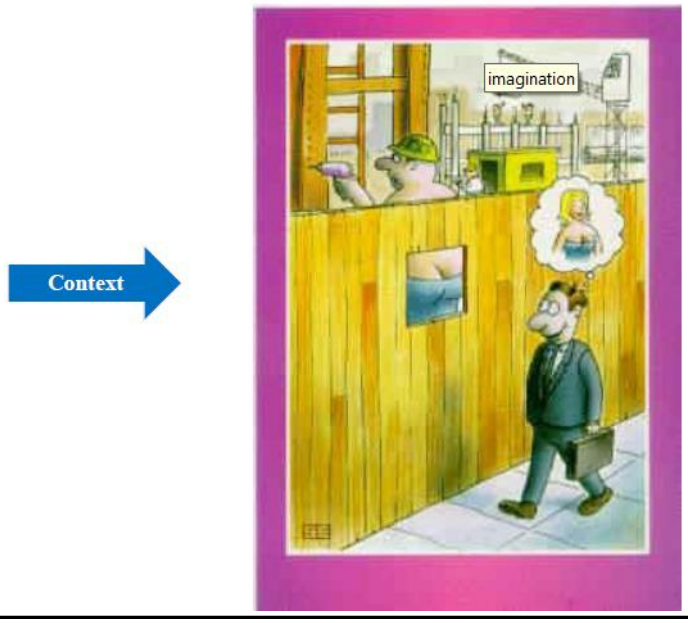
Pan + Zoom



Context is Important!

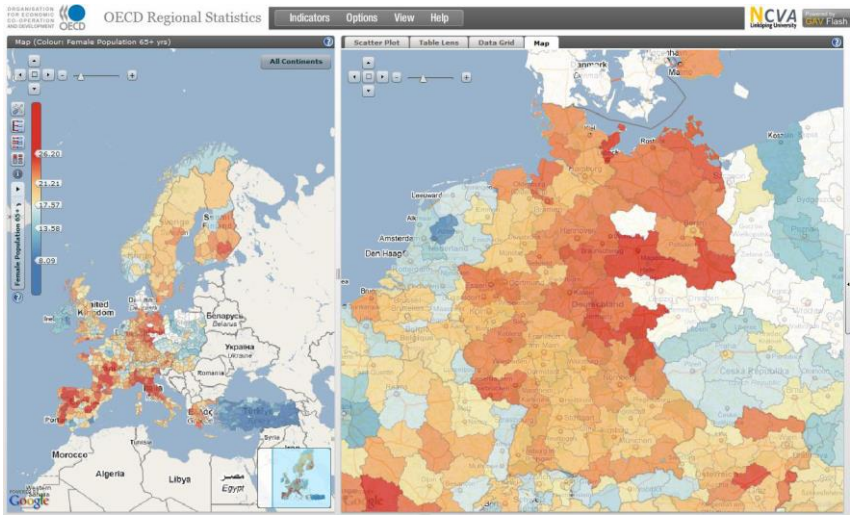


Context is Important!



Overview + Detail

Overview first, Zoom and Filter, then Details-on-Demand



Animation

Tell stories / scenarios: cartoons

Illustrate dynamic process / simulation

Create a character / an agent

Navigate through virtual spaces

- Continuity
- Not getting lost

Draw attention

Delight

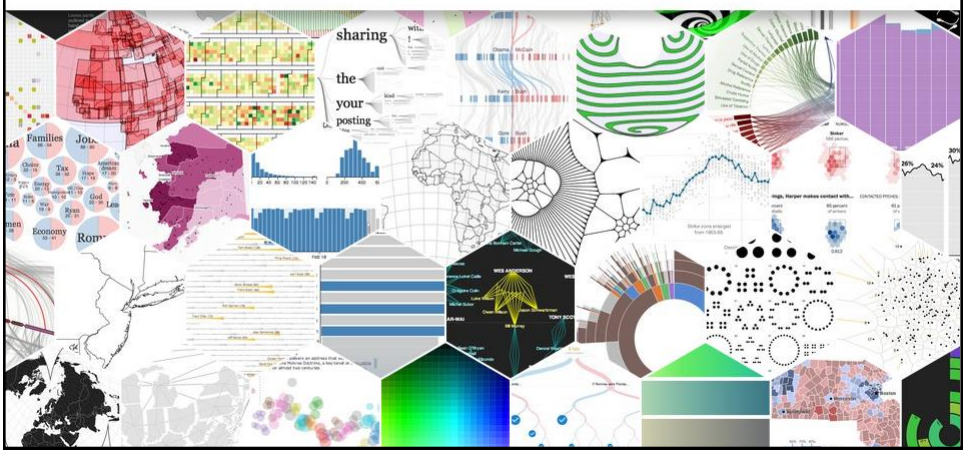
10

D3 – A TUTORIAL

d3 - http://d3js.org/

Overview Examples Documentation Source

Data-Driven Documents



Web Tech!

A document where to place the vis

```
<html>

  <head>
   <title>Oscar Winners</title>
   <link rel="stylesheet" href="oscars.css">
   <script src="d3.v3.min.js" charset="utf-8"></script>
   <script src="oscars.js"></script>
  </head>

  <body>
    <h1>Oscar Best Picture Winners as rated in IMDB!</h1>
    <div id="the_chart"></div>
    <div id="second_chart"></div>
  </body>

</html>
```

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   <title>Oscar Winners</title>
   <link rel="stylesheet" href="oscars.css">
   <script src="d3.v3.min.js" charset="utf-8"></script>
   <script src="oscars.js"></script>
  </head>

  <body>
    <h1>Oscar Best Picture Winners as rated in IMDB!</h1>
    <div id="the_chart"></div>
    <div id="second_chart"></div>
  </body>

</html>
```

Some data…

```
[
  {
    "oscar_year":2014,
    "title":"12 Years a Slave",
    "year":2013,
    "rating":"8,2",
    "budget":20000000,
    "budget_adj":20000000
  },
  {
    "oscar_year":2013,
    "title":"Argo",
    "year":2012,
    "rating":"7,8",
    "budget":44500000,
    "budget_adj":45390000
  },

…
```

Loading the data

```
var dataset;

d3.json("oscar_winners_recent.json", function (data) {
   dataset = data;


})
```

Loading the data

```
var dataset;

d3.json("oscar_winners_recent.json", function (data) {
    dataset = data;

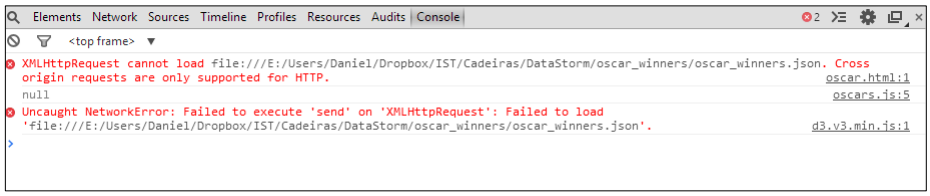

})
```

Loading the data

```
var dataset;

d3.json("oscar_winners_recent.json", function (data) {
    dataset = data;


})
```



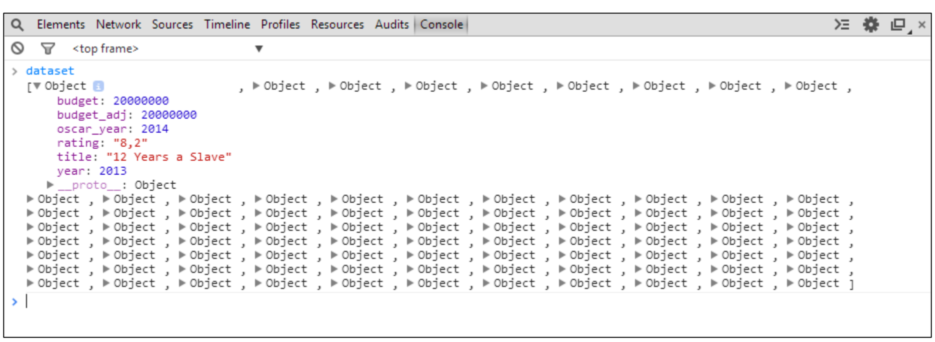
Security!

Start a local server!

> python -m SimpleHTTPServer 8888

It works!

http://localhost:8888/oscar1.html



Let's make something

```
var dataset;

d3.json("oscar_winners_recent.json", function (data) {
    dataset = data;

    gen_vis();
})


function gen_vis() {

}
```

Selectors!

#foo // <any id="foo">

foo // <foo>

.foo // <any class="foo">

[foo=bar] // <any foo="bar">

foo bar // <foo><bar></foo>

foo.bar // <foo class="bar">

foo#bar // <foo id="bar">

A W3C standard. Find them in CSS, Jquery, … , D3!

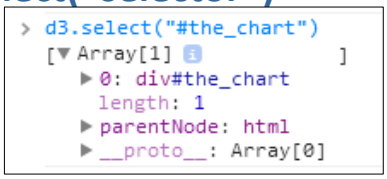
d3 Selections

d3.select(<selector>)

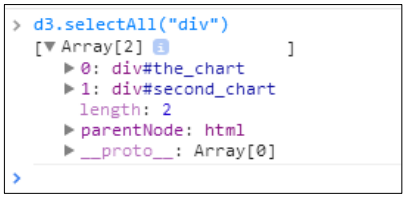
d3.selectAll(<selector>)

d3 Selections

d3.select(<selector>)



d3.selectAll(<selector>)



Let's add somewhere to draw

```
function gen_vis() {
    var w = 800;
    var h = 400;

    var svg = d3.select("#the_chart");

    svg = svg.append("svg");
    svg = svg.attr("width",w);
    svg = svg.attr("height",h);
}
```

Let's add somewhere to draw

```
function gen_vis() {
    var w = 800;
    var h = 400;

    var svg = d3.select("#the_chart");

    svg = svg.append("svg");
    svg = svg.attr("width",w);
    svg = svg.attr("height",h);
}
```

Let's add somewhere to draw

```
function gen_vis() {
    var w = 800;
    var h = 400;

    var svg = d3.select("#the_chart");

    svg = svg.append("svg");
    svg = svg.attr("width",w);
    svg = svg.attr("height",h);
}
```

Let's add somewhere to draw

```
function gen_vis() {
    var w = 800;
    var h = 400;

    var svg = d3.select("#the_chart");

    svg = svg.append("svg");
    svg = svg.attr("width",w);
    svg = svg.attr("height",h);
}
```

Let's add somewhere to draw

```
function gen_vis() {
    var w = 800;
    var h = 400;

    var svg = d3.select("#the_chart");

    svg = svg.append("svg");
    svg = svg.attr("width",w);
    svg = svg.attr("height",h);
}
```

```
<svg width="800" height="400"></svg>
```

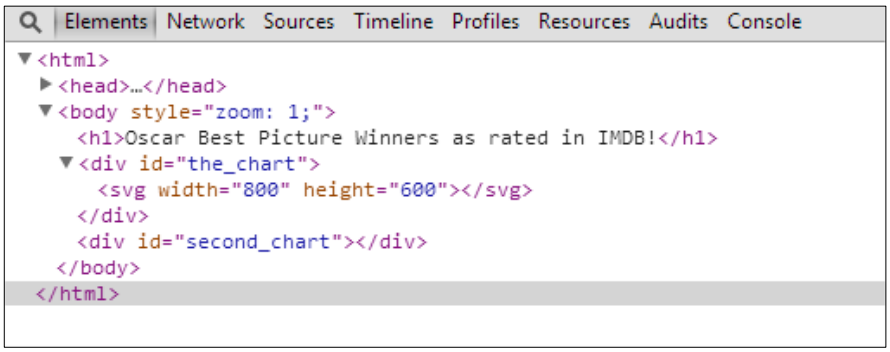
Chaining!

```
function gen_vis() {
    var w = 800;
    var h = 400;

    var svg = d3.select("#the_chart")
                .append("svg")
                .attr("width",w)
                .attr("height",h);
}
```

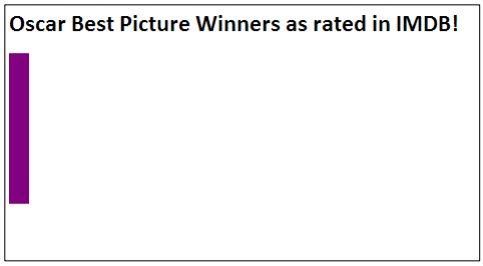
An SVG!

http://localhost:8888/oscar2.html



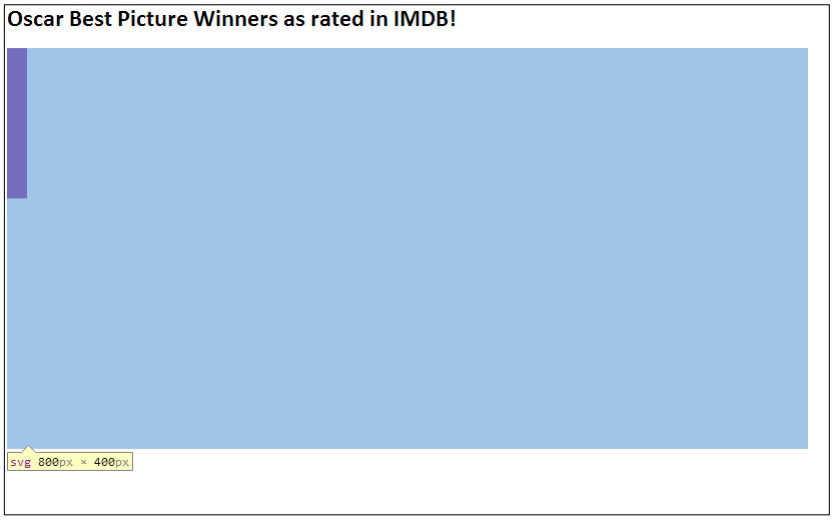
Let's draw a rectangle

```
svg.append("rect")
      .attr("width",20)
      .attr("height",150)
      .attr("fill","purple");
```

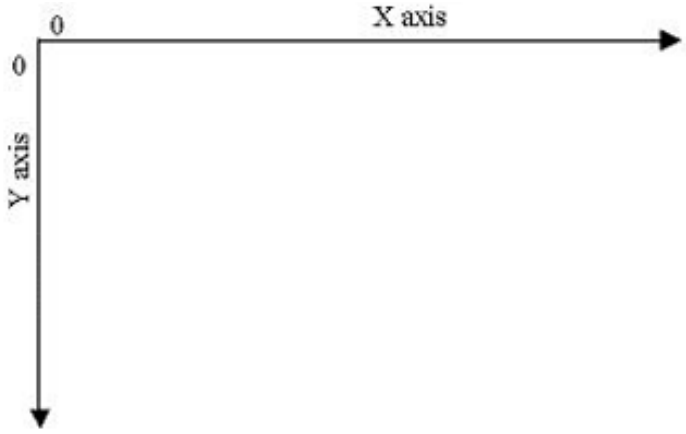


Hmm… out of place?

http://localhost:8888/oscar3.html



SVG Coordinate system

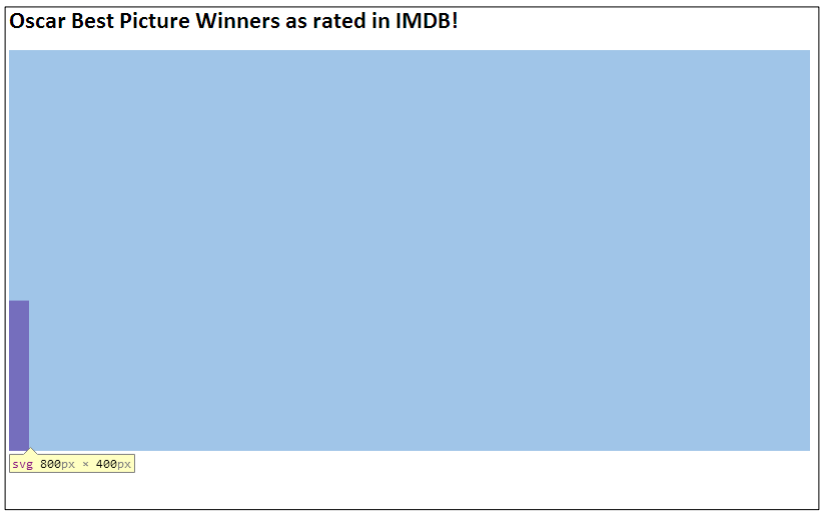


Small change…

```
svg.append("rect")
      .attr("width",20)
      .attr("height",150)
      .attr("fill","purple")
      .attr("y",h-150);
```

Small change…

http://localhost:8888/oscar4.html



Draw Many… From DATA!

data()

Let's bind data to graphical elements!

```
svg.selectAll("rect")
        .data(dataset)
      .enter().append("rect")
        .attr("width",20)
        .attr("height",150)
        .attr("fill","purple")
        .attr("y",h-150);
```

Whoa… select *what??!*

```
svg.selectAll("rect")
        .data(dataset)
      .enter().append("rect")
        .attr("width",20)
        .attr("height",150)
        .attr("fill","purple")
        .attr("y",h-150);
```

Nothing to begin with…

dataset = [1, 2, 3, 4];

`svg.selectAll("rect") = []`

When we bind the data…

dataset = [1, 2, 3, 4];

```
svg.selectAll("rect")
    .data(dataset)
```

d3 knows there should be new elements in the selection

New elements: enter()

dataset = [1, 2, 3, 4];

```
svg.selectAll("rect")
      .data(dataset)
    .enter()
```

What comes after is called for each new element

For each datapoint, append a rect!

```
svg.selectAll("rect")
        .data(dataset)
      .enter().append("rect")
        .attr("width",20)
        .attr("height",150)
        .attr("fill","purple")
        .attr("y",h-150);
```

Let's make them different…

```
svg.selectAll("rect")
        .data(dataset)
      .enter().append("rect")
        .attr("width",20)
        .attr("height",function(d) {
                        return d.rating*30;
                })
        .attr("fill","purple")
        .attr("x",function(d, i) {
                        return i*21;
                })
        .attr("y",function(d) {
                return h-(d.rating*30);
                });
```

Let's make them different…

```
svg.selectAll("rect")
        .data(dataset)
      .enter().append("rect")
        .attr("width",20)
        .attr("height",function(d) {
                        return d.rating*30;
                  })
        .attr("fill","purple")
        .attr("x",function(d, i) {
                        return i*21;
                  })
        .attr("y",function(d) {
                  return h-(d.rating*30);
                  });
```

Let's make them different…

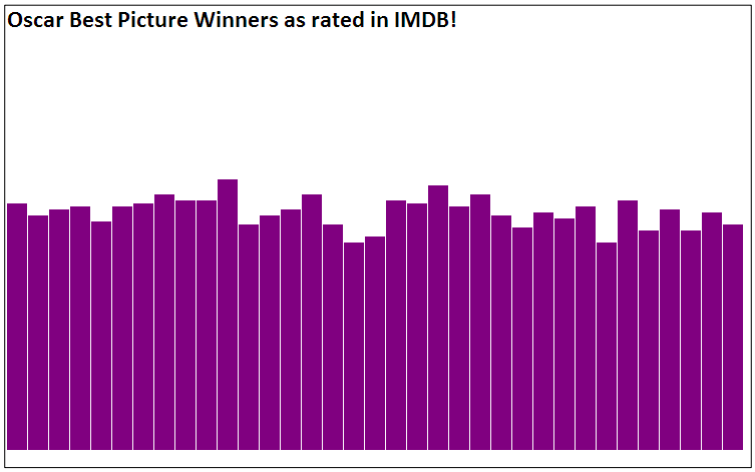
```
svg.selectAll("rect")
        .data(dataset)
      .enter().append("rect")
        .attr("width",20)
        .attr("height",function(d) {
                        return d.rating*30;
                  })
        .attr("fill","purple")
        .attr("x",function(d, i) {
                        return i*21;
                  })
        .attr("y",function(d) {
                  return h-(d.rating*30);
                  });
```

The datum

Index in the data array

Our vis so far

http://localhost:8888/oscar5.html



Scales!

```
var hscale = d3.scale.linear()
                    .domain([0,10])
                    .range([0,h]);
```

hscale(5) = 200

It scales!

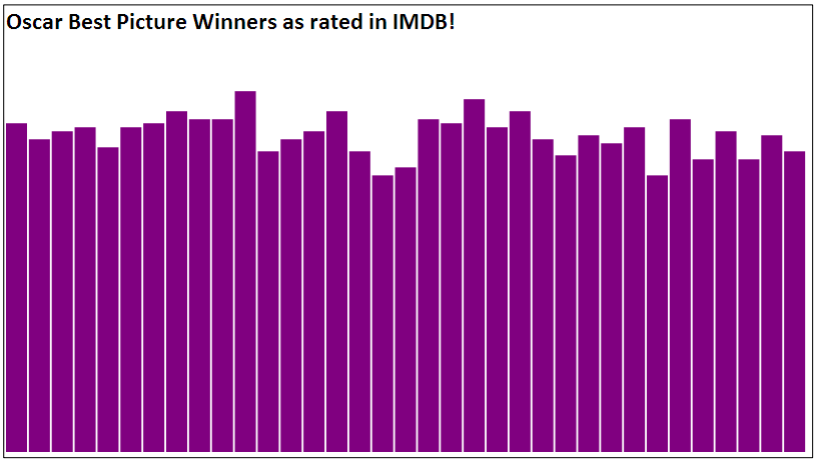
```
var hscale = d3.scale.linear()
                        .domain([10,0])
                        .range([h,0]);

   var xscale = d3.scale.linear()
                        .domain([0,dataset.length])
                        .range([0,w]);

   svg.selectAll("rect")
        .data(dataset)
      .enter().append("rect")
        .attr("width",Math.floor(w/dataset.length)-1)
    .attr("height",function(d) {
                        return hscale(d.rating);
                    })
    .attr("fill","purple")
    .attr("x",function(d, i) {
                        return xscale(i);
                    })
    .attr("y",function(d) {
                    return h-hscale(d.rating);
                    });
```

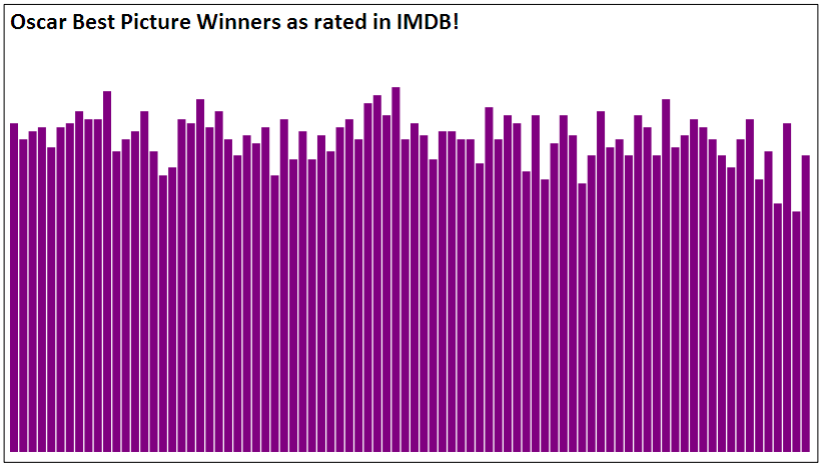
Our data…

http://localhost:8888/oscar6.html



MORE data

http://localhost:8888/oscar6a.html



d3.json("oscar_winners_recent.json“ → d3.json("oscar_winners.json“

Axes

```
var yaxis = d3.svg.axis()
                  .scale(hscale)
                  .orient("left");
```

Axis – They actually *draw* something!

```
var yaxis = d3.svg.axis()
                  .scale(hscale)
                  .orient("left");

svg.append("g")
   .attr("transform","translate(30,0)")
   .call(yaxis);
```

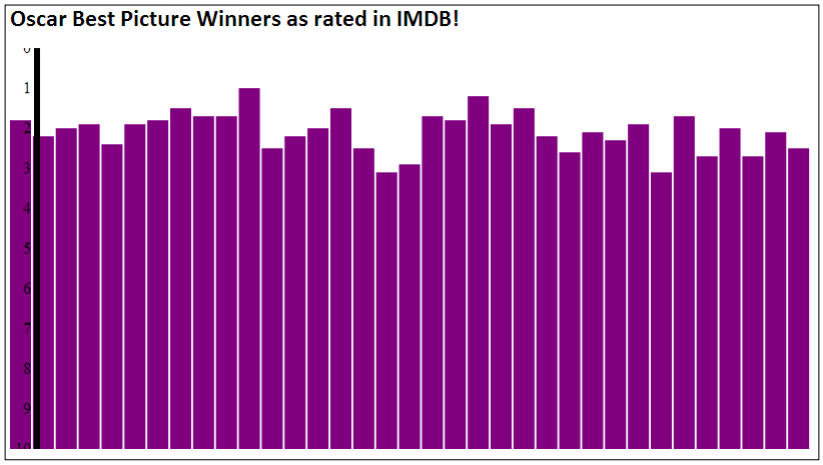
Axis – In the right place!

```
var yaxis = d3.svg.axis()
                  .scale(hscale)
                  .orient("left");

svg.append("g")
   .attr("transform","translate(30,0)")
   .call(yaxis);
```

Hmmm…

http://localhost:8888/oscar7.html



Add some padding!

```
var padding=30;

var hscale = d3.scale.linear()
                    .domain([0,10])
                    .range([padding,h-padding]);

var xscale = d3.scale.linear()
                    .domain([0,dataset.length])
                    .range([padding,w-padding]);

svg.selectAll("rect")
 …
     .attr("width",Math.floor((w-padding*2)/dataset.length)-1)
 …
     .attr("y",function(d) {
               return h-padding-hscale(d.rating);
               });
```

Add some padding!

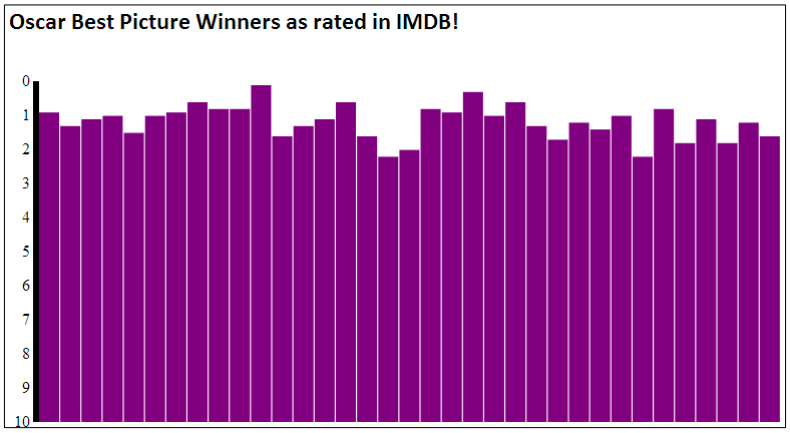
```
var padding=30;

var hscale = d3.scale.linear()
                    .domain([0,10])
                    .range([padding,h-padding]);

var xscale = d3.scale.linear()
                    .domain([0,dataset.length])
                    .range([padding,w-padding]);

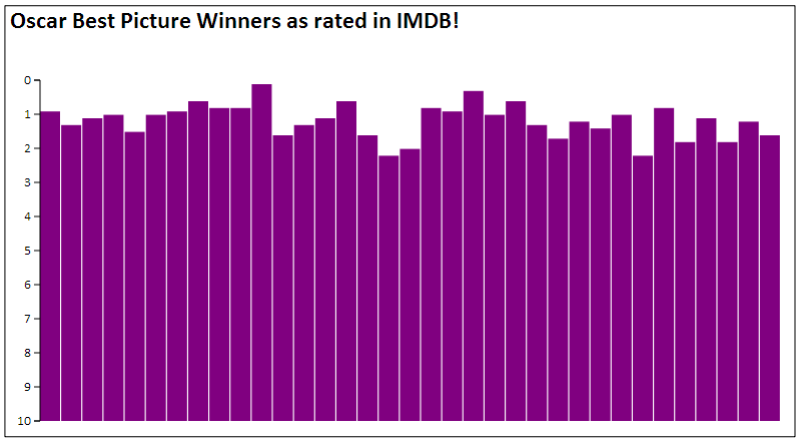
svg.selectAll("rect")
 …
     .attr("width",Math.floor((w-padding*2)/dataset.length)-1)
 …
     .attr("y",function(d) {
               return h-padding-hscale(d.rating);
               });
```

Better!



Some CSS

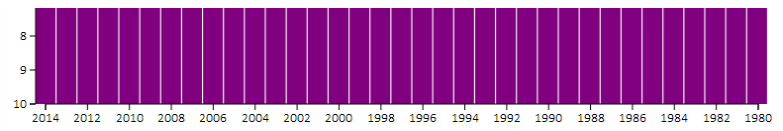
```
svg.append("g")
    .attr("transform","translate(30,0)")
    .attr("class",“y axis")
    .call(yaxis);
```



Some More Info

http://localhost:8888/oscar8.html

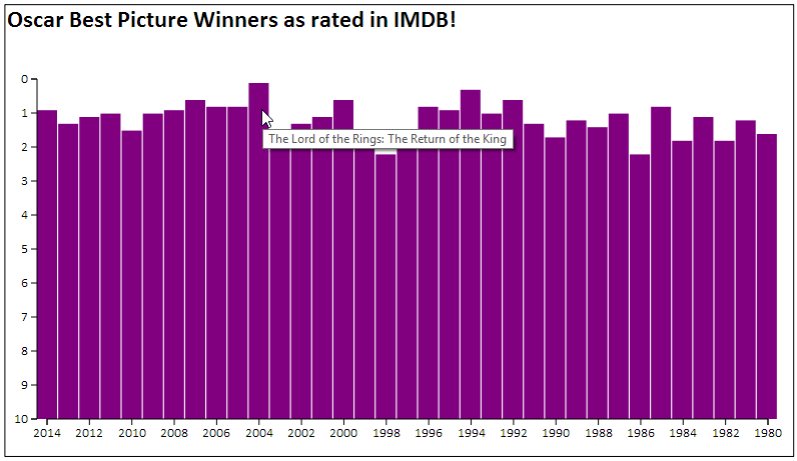
```
var xaxis = d3.svg.axis()
              .scale(d3.scale.linear()
              .domain([dataset[0].oscar_year,dataset[dataset.length-1].oscar_year])
              .range([padding+bar_w/2,w-padding-bar_w/2]))
              .tickFormat(d3.format("f"))
              .ticks(dataset.length/2)
              .orient("bottom");
```



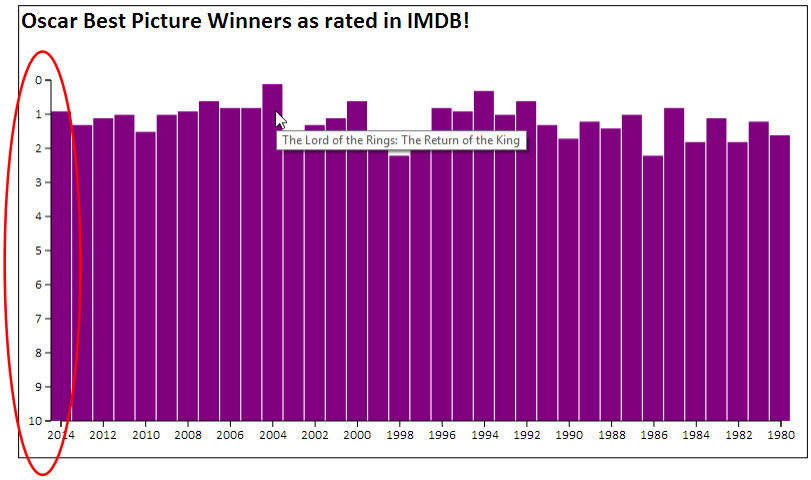
Some more Info…

http://localhost:8888/oscar8.html

```
.append("title")
      .text(function(d) { return d.title;});
```



Hmmm…



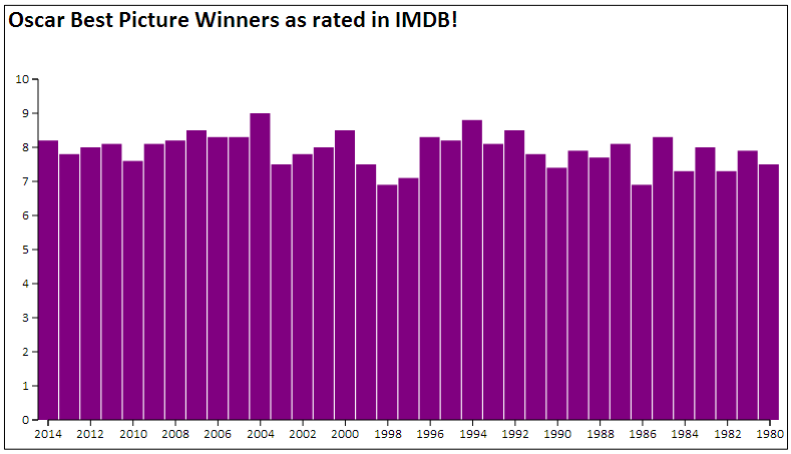
Invert the scale!

```
var hscale = d3.scale.linear()
                    .domain([10,0])
                    .range([padding,h-padding]);

svg.selectAll("rect")
 …
    .attr("height",function(d) {
                return h-padding-hscale(d.rating);
                })
    .attr("y",function(d) {
                return hscale(d.rating);
                });
```

Better!

http://localhost:8888/oscar8a.html



Interactivity

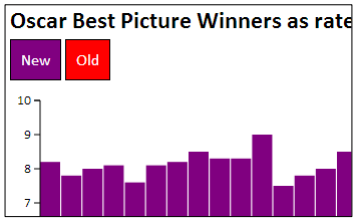
http://localhost:8888/oscar9.html

```
<span class="btn" id="new">New</span>
<span class="btn" id="old">Old</span>
```

```
.btn {
  width: 100px;
  font-family: calibri, sans serif;
  padding: 10px;
  border: solid 1px black;
  color: white;
}

#new {
  background-color: purple;
}

#old {
  background-color: red;
}
```



More Data

```
var dataset, full_dataset;

d3.json("oscar_winners.json", function (data) {
    full_dataset = data;
    dataset = full_dataset.slice(0,35);
    gen_vis();
})
```

Events

```
d3.selectAll("#old")
  .on("click", function() {
    dataset = full_dataset.slice(35,70);

…
```

Events

```
d3.selectAll("#old")
  .on("click", function() {
    dataset = full_dataset.slice(35,70);

…
```

Bind new data – UPDATE

```
d3.selectAll("#old")
  .on("click", function() {
    dataset = full_dataset.slice(35,70);
    bar_w = Math.floor((w-padding*2)/dataset.length)-1;

    svg.selectAll("rect")
       .data(dataset)
         .attr("height",function(d) {
                          return h-padding-hscale(d.rating);
                  })
         .attr("fill","red")
         .attr("y",function(d) {
                  return hscale(d.rating);
                  })
         .select("title")
            .text(function(d) { return d.title;});
```

Bind new data – UPDATE

```
d3.selectAll("#old")
  .on("click", function() {
    dataset = full_dataset.slice(35,70);
    bar_w = Math.floor((w-padding*2)/dataset.length)-1;

    svg.selectAll("rect")
       .data(dataset)
         .attr("height",function(d) {
                          return h-padding-hscale(d.rating);
                  })
         .attr("fill","red")
         .attr("y",function(d) {
                  return hscale(d.rating);
                  })
         .select("title")
            .text(function(d) { return d.title;});
```

Bind new data – UPDATE

```
d3.selectAll("#old")
  .on("click", function() {
    dataset = full_dataset.slice(35,70);
    bar_w = Math.floor((w-padding*2)/dataset.length)-1;

    svg.selectAll("rect")
       .data(dataset)
         .attr("height",function(d) {
                        return h-padding-hscale(d
                  })
         .attr("fill","red")
         .attr("y",function(d) {
                  return hscale(d.rating);
                  })
         .select("title")
            .text(function(d) { return d.title;});
```

No **enter()**

Size of data[] is the same, so there are no new elements.

Could be enter() or exit() if num elements differs

Code for what changed

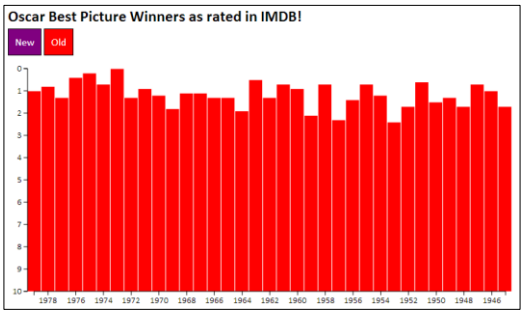
```
d3.selectAll("#old")
  .on("click", function() {
    dataset = full_dataset.slice(35,70);
    bar_w = Math.floor((w-padding*2)/dataset.length)-1;

    svg.selectAll("rect")
       .data(dataset)
         .attr("height",function(d) {
                        return h-padding-hscale(d.rating);
                  })
         .attr("fill","red")
         .attr("y",function(d) {
                  return hscale(d.rating);
                  })
         .select("title")
            .text(function(d) { return d.title;});
```

Also update the axis!

```
xaxis.scale(d3.scale.linear()
              .domain([dataset[0].oscar_year,dataset[dataset.length-1].oscar_year])
              .range([padding+bar_w/2,w-padding-bar_w/2]));

d3.select(".x.axis")
  .call(xaxis);
```



Too sudden? transition()!

http://localhost:8888/oscar10.html

```
d3.selectAll("#old")
  .on("click", function() {
    dataset = full_dataset.slice(35,70);
    bar_w = Math.floor((w-padding*2)/dataset.length)-1;

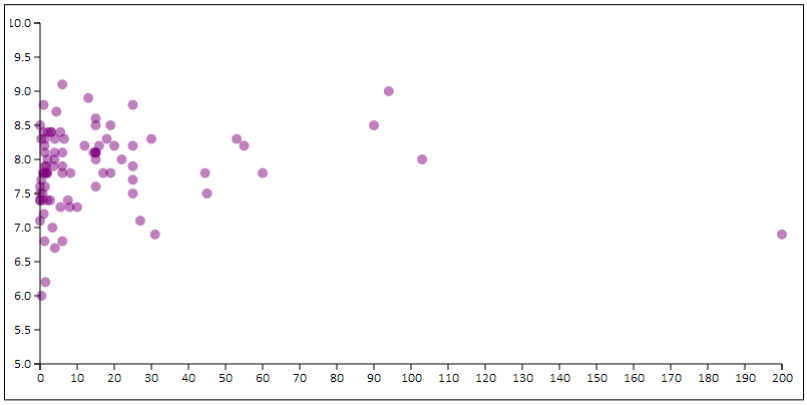
    svg.selectAll("rect")
       .data(dataset)
       .transition()
       .duration(1000)
       .attr("height",function(d) {
                          return h-padding-hscale(d.rating);
                      })
         .attr("fill","red")
      .attr("y",function(d) {
                      return hscale(d.rating);
                      })
         .select("title")
            .text(function(d) { return d.title;});
```

Just for fun… a scatterplot!

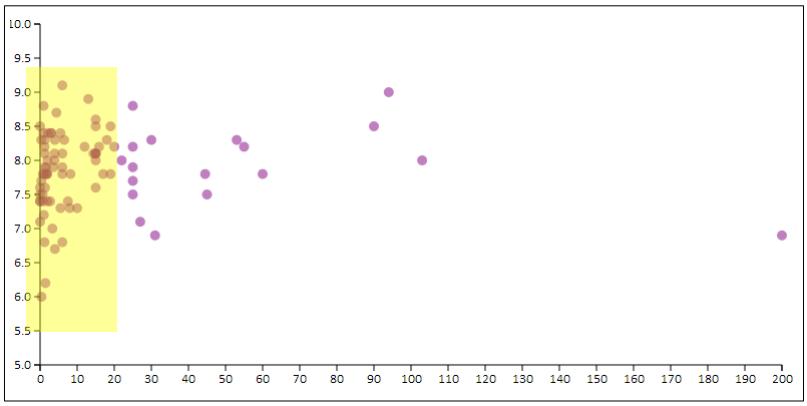
http://localhost:8888/oscar11.html

```
var xscale = d3.scale.linear()
                    .domain([0,d3.max(full_dataset, function(d) {
                                    return d.budget;})/1000000])
                    .range([padding,w-padding]);
 var r = 5;
 svg.selectAll("circle")
     .data(full_dataset)
   .enter().append("circle")
     .attr("r",r)
     .attr("fill","rgba(128,0,128,0.5)")
     .attr("cx",function(d, i) {
                     return xscale(d.budget/1000000);
                 })
     .attr("cy",function(d) {
                return hscale(d.rating);
                })
     .append("title")
       .text(function(d) { return d.title;});
```

More $$$!= better movie…



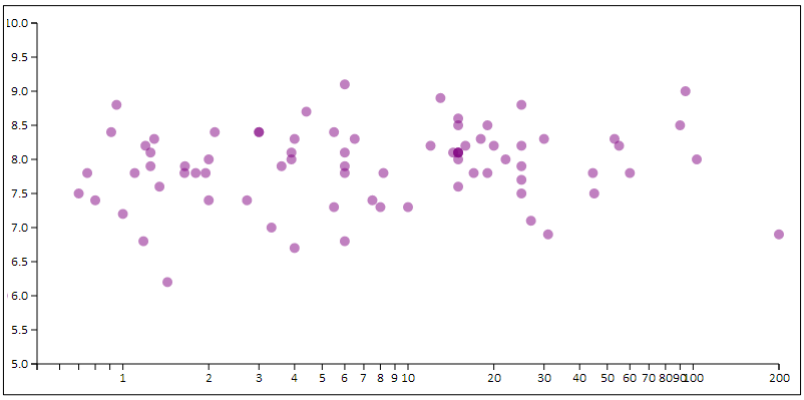
Hard to see…



Log scale!

http://localhost:8888/oscar12.html

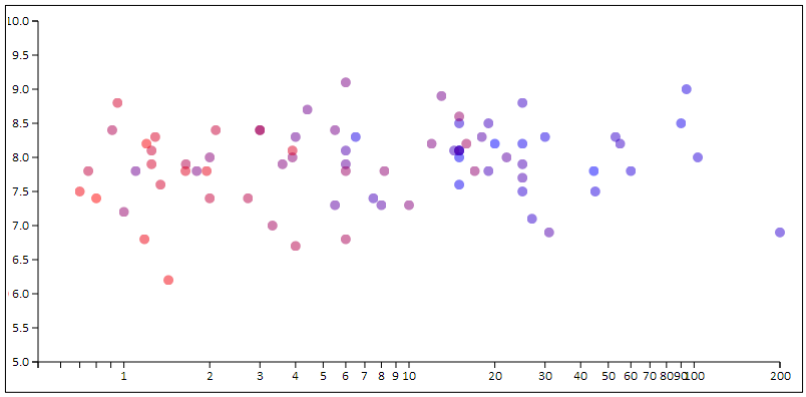
```
var xscale = d3.scale.log()
                        .domain([0.5,d3.max(full_dataset, function(d) {
                                        return d.budget;})/1000000])
                        .range([padding,w-padding]);
```



Color interpolation

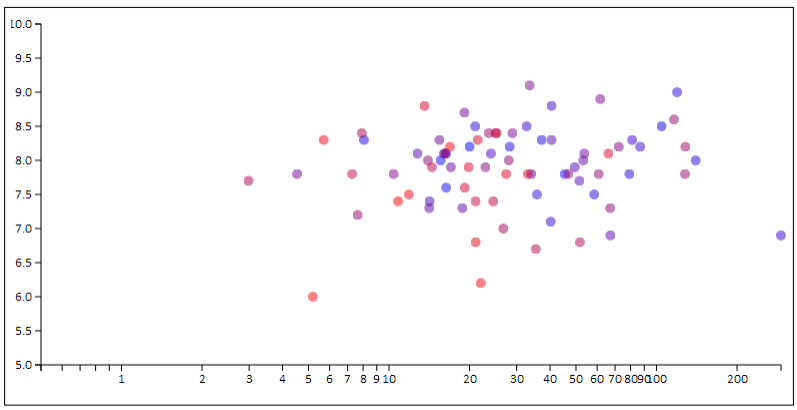
http://localhost:8888/oscar13.html

```
var cscale = d3.scale.linear()
        .domain([d3.min(full_dataset, function(d) { return  d.year;}),
                 d3.max(full_dataset, function(d) { return d.year;})])
        .range(["red", "blue"]);
```



Adjust for Inflation!

http://localhost:8888/oscar14.html



QUESTIONS?