Zoe Hartland **@HartlandZoe**
zoe.hartland@ons.gov.uk

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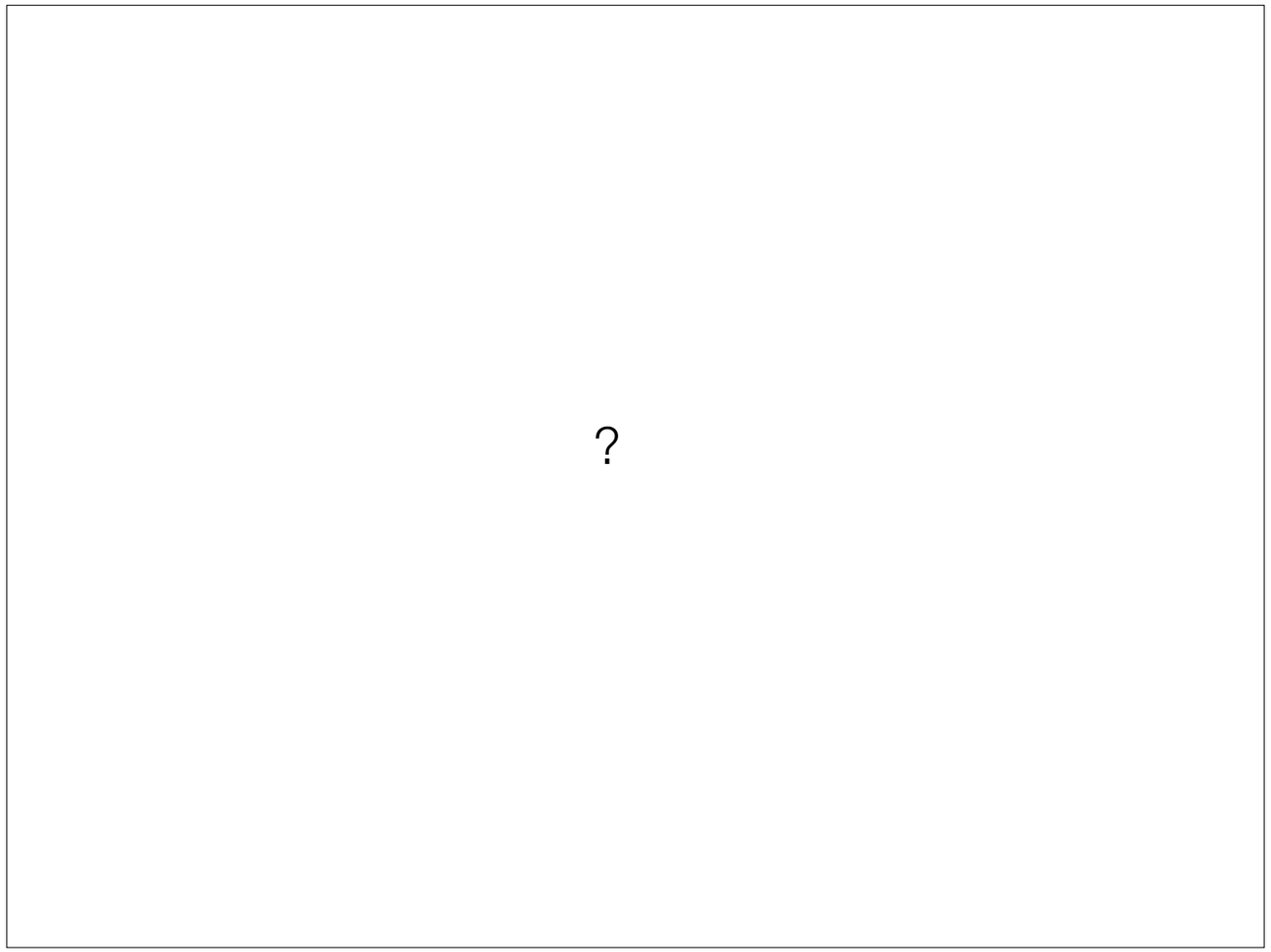


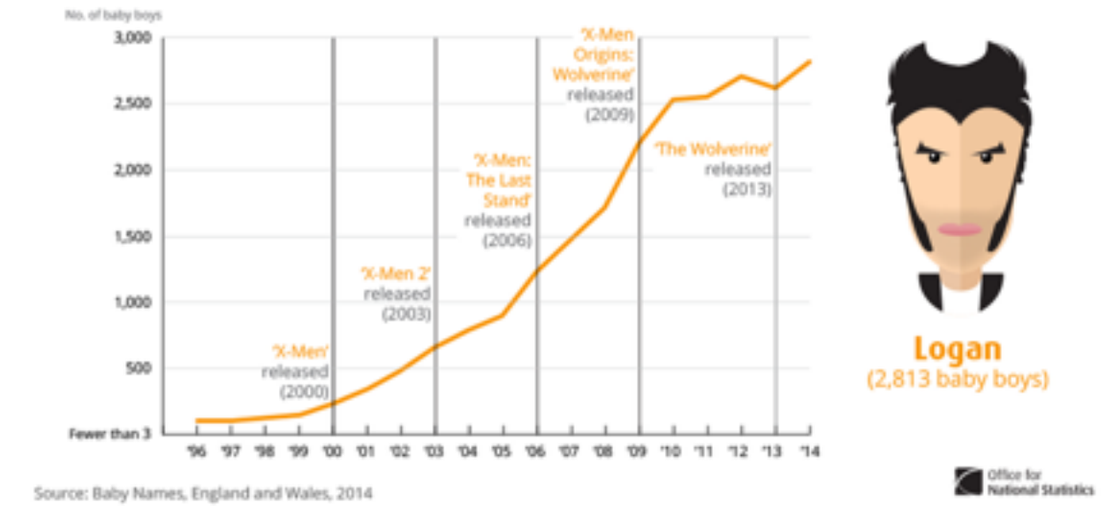
What are you hoping to learn. Tell us about your experience.

what’s the most popular output?

Baby names - consistently ONS's most popular output

used to be very dry and featureless. Also notoriously hard to front load important information

http://visual.ons.gov.uk/baby-names/

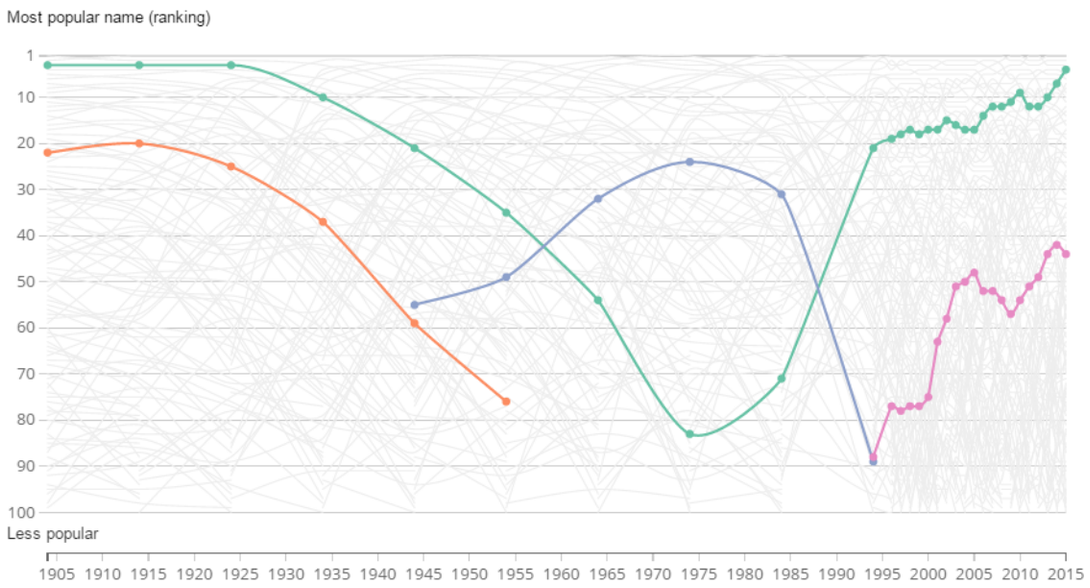


with visual.ONS, we could produce more bespoke and engaging (and occasionally light hearted) content

♂ Baby boy names ♀ Baby girl names

Start typing some names, or click the lines to select up to 6 names

George ✖ Leonard ✖ Stuart ✖ Toby ✖



Source: Baby Names - England and Wales, ONS

Share this:

more recent content - interactive & searchable top 100 baby names

Introduction

Aims

- Think about and understand the information content of your graphs through the eyes of your reader
- Provide an understanding of the basic design principles you need to convey the message you intended in a static image.
- (The ability to critique an infographic)
- An overview of where interactive approaches can be useful

Provide introduction and key principles fundamental to good data presentation.

- The fundamentals of table design
- The fundamentals of graph design
- Designing effective colour schemes

Human perception/vision is not straightforward - plays tricks

Manage expectations of course - only covering statics information, not interactive

style.ons.gov.uk
ons.gov.uk
visual.ons.gov.uk
https://blog.ons.digital/
@ONS

https://blog.ons.digital/category/dataviz/
https://blog.ons.digital/tag/charting-tips/

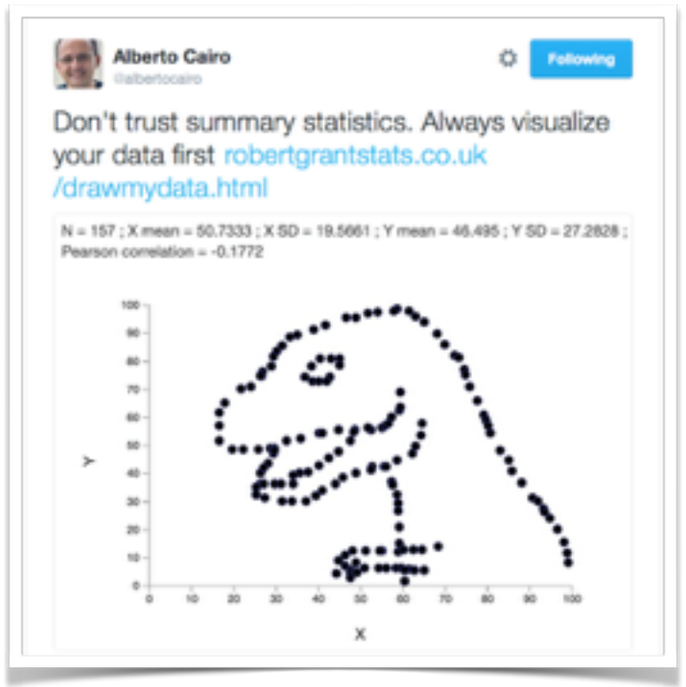
Why visualise data?

- To give a fast overview or summary of a dataset
- Communicate memorable or important stories in a dataset(s)
- To reveal insight (that would otherwise be hidden)
- For quality assurance and error detection

How does the MOD use data visualisation? Policy makers / Decision makers

Stress that good data vis is vital to the communication.

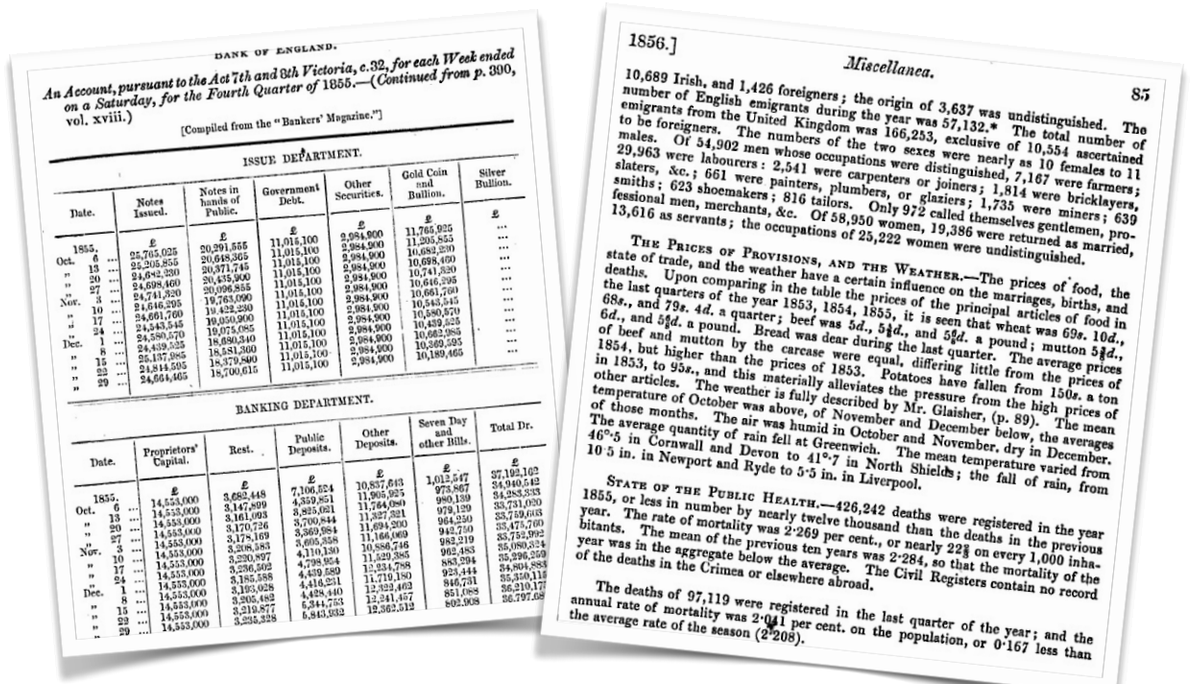
Why visualise data?



You can’t see patterns in a table!!!!

Historical Perspective

Statistics in the 19th Century



BANK OF ENGLAND.

An Account, pursuant to the Act 7th and 8th Victoria, c. 32, for each Week ended on a Saturday, for the Fourth Quarter of 1855.—(Continued from p. 300, vol. xviii.)

[Compiled from the "Bankers' Magazine."]

ISSUE DEPARTMENT.

Date.	Notes Issued.	Notes in hands of Public.	Government Debt.	Other Securities.	Gold Coin and Bullion.	Silver Bullion.
1855.	£	£	£	£	£	£
Oct. 6 ...	25,705,025	20,291,555	11,015,100	2,984,900	11,765,925	...
„ 13 ...	25,205,855	20,648,365	11,015,100	2,984,900	11,205,855	...
„ 20 ...	24,682,320	20,371,745	11,015,100	2,984,900	10,682,320	...
„ 27 ...	24,698,460	20,435,960	11,015,100	2,984,900	10,698,460	...
Nov. 3 ...	24,741,820	20,096,855	11,015,100	2,984,900	10,741,820	...
„ 10 ...	24,646,295	19,763,090	11,014,100	2,984,900	10,646,295	...
„ 17 ...	24,601,760	19,422,230	11,015,100	2,984,900	10,601,760	...
„ 24 ...	24,543,545	19,050,900	11,015,100	2,984,900	10,543,545	...
Dec. 1 ...	24,580,570	19,075,585	11,015,100	2,984,900	10,580,570	...
„ 8 ...	24,439,525	18,690,340	11,015,100	2,984,900	10,439,525	...
„ 15 ...	25,137,985	18,581,360	11,015,100	2,984,900	10,662,985	...
„ 22 ...	24,814,595	18,379,890	11,015,100	2,984,900	10,189,595	...
„ 29 ...	24,664,465	18,700,615	11,015,100	2,984,900	10,189,465	...

BANKING DEPARTMENT.

Date.	Proprietors' Capital.	Rest.	Public Deposits.	Other Deposits.	Seven Day and other Bills.	Total Dr.
1855.	£	£	£	£	£	£
Oct. 6 ...	14,553,000	3,682,448	7,106,524	10,857,643	1,012,547	37,192,162
„ 13 ...	14,553,000	3,147,899	4,359,851	11,965,927	973,867	34,940,543
„ 20 ...	14,553,000	3,161,093	3,825,031	11,764,080	980,139	34,283,333
„ 27 ...	14,553,000	3,170,726	3,700,844	11,327,321	979,129	33,731,020
Nov. 3 ...	14,553,000	3,178,169	3,369,984	11,694,200	964,250	33,759,603
„ 10 ...	14,553,000	3,208,383	3,695,358	11,166,069	942,750	33,475,769
„ 17 ...	14,553,000	3,230,897	4,110,130	10,886,746	982,219	33,752,992
„ 24 ...	14,553,000	3,236,502	4,799,854	11,529,285	962,483	35,080,324
Dec. 1 ...	14,553,000	3,185,588	4,439,589	12,234,788	883,294	35,296,259
„ 8 ...	14,553,000	3,193,028	4,418,251	11,710,180	923,444	34,804,883
„ 15 ...	14,553,000	3,205,482	4,428,840	12,323,462	846,781	35,350,115
„ 22 ...	14,553,000	3,219,877	5,344,753	12,241,457	851,088	36,210,17
„ 29 ...	14,553,000	3,235,328	5,843,932	12,362,512	802,908	36,797,68

1856.] *Miscellanea.* 85

10,689 Irish, and 1,426 foreigners; the origin of 3,637 was undistinguished. The number of English emigrants during the year was 57,132.* The total number of emigrants from the United Kingdom was 166,253, exclusive of 10,554 ascertained to be foreigners. The numbers of the two sexes were nearly as 10 females to 11 males. Of 54,902 men whose occupations were distinguished, 7,167 were farmers; 29,963 were labourers: 2,541 were carpenters or joiners; 1,814 were bricklayers, slaters, &c.; 661 were painters, plumbers, or glaziers; 1,735 were miners; 639 smiths; 623 shoemakers; 816 tailors. Only 972 called themselves gentlemen, professional men, merchants, &c. Of 58,950 women, 19,386 were returned as married, 13,616 as servants; the occupations of 25,222 women were undistinguished.

THE PRICES OF PROVISIONS, AND THE WEATHER.—The prices of food, the state of trade, and the weather have a certain influence on the marriages, births, and deaths. Upon comparing in the table the prices of the principal articles of food in the last quarters of the year 1853, 1854, 1855, it is seen that wheat was 69*s.* 10*d.*, 68*s.*, and 79*s.* 4*d.* a quarter; beef was 5*d.*, 5¼*d.*, and 5½*d.* a pound; mutton 5¼*d.*, 6*d.*, and 5½*d.* a pound. Bread was dear during the last quarter. The average prices of beef and mutton by the carcase were equal, differing little from the prices of 1854, but higher than the prices of 1853. Potatoes have fallen from 150*s.* a ton in 1853, to 95*s.*, and this materially alleviates the pressure from the high prices of other articles. The weather is fully described by Mr. Glaisher, (p. 89). The mean temperature of October was above, of November and December below, the averages of those months. The air was humid in October and November, dry in December. The average quantity of rain fell at Greenwich. The mean temperature varied from 46°·5 in Cornwall and Devon to 41°·7 in North Shields; the fall of rain, from 10·5 in. in Newport and Ryde to 5·5 in. in Liverpool.

STATE OF THE PUBLIC HEALTH.—426,242 deaths were registered in the year 1855, or less in number by nearly twelve thousand than the deaths in the previous year. The rate of mortality was 2·269 per cent., or nearly 22⅝ on every 1,000 inhabitants. The mean of the previous ten years was 2·284, so that the mortality of the year was in the aggregate below the average. The Civil Registers contain no record of the deaths in the Crimea or elsewhere abroad.

The deaths of 97,119 were registered in the last quarter of the year; and the annual rate of mortality was 2·041 per cent. on the population, or 0·167 less than the average rate of the season (2·208).

Dry - inaccessible

William Playfair (1759-1823)

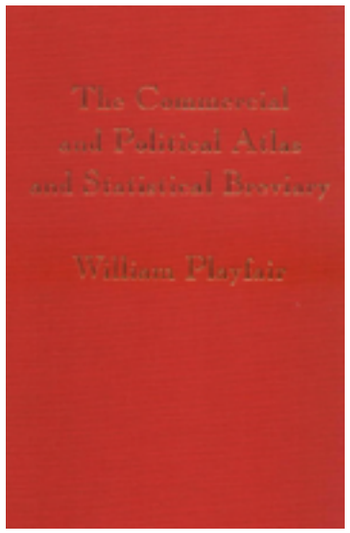


Table 1:

The cost of a Quarter of Wheat compared to the Wages of a Good Mechanic

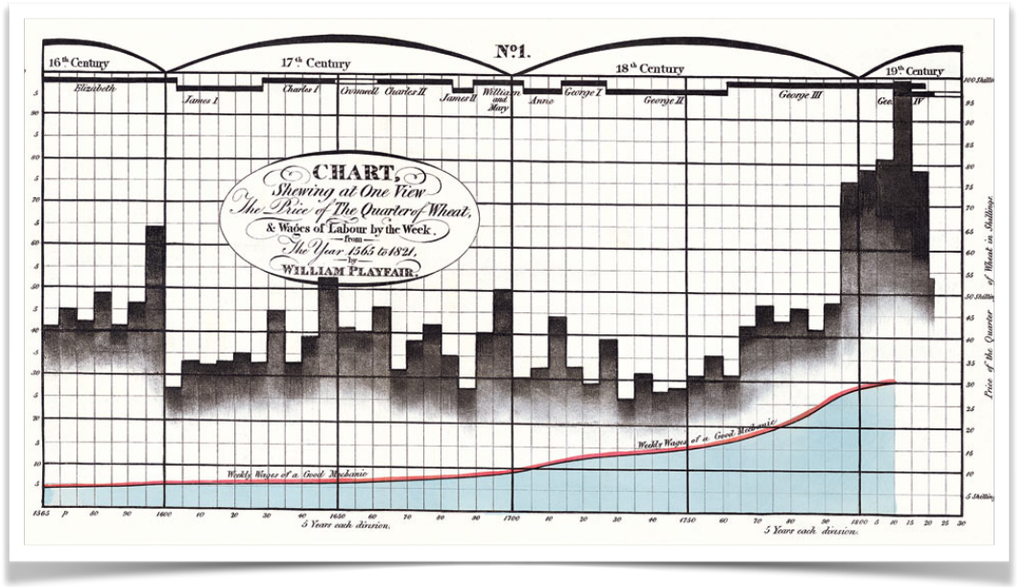
England, 1565-1820 — £ Shilling

Year	Cost of Wheat	Mechanic's Wage	Year	Cost of Wheat	Mechanic's Wage	Year	Cost of Wheat	Mechanic's Wage
1565	41.56	5.01	1655	40.10	6.51	1745	28.56	14.48
1570	45.43	5.01	1660	46.31	6.79	1750	31.82	15.28
1575	43.87	4.98	1665	32.50	7.12	1755	36.14	15.89
1580	48.89	5.11	1670	38.28	7.10	1760	32.56	16.89
1585	41.01	5.24	1675	42.02	7.49	1765	43.51	18.36
1590	46.33	5.18	1680	35.84	8.07	1770	48.00	19.48
1595	64.87	5.48	1685	27.93	8.37	1775	44.23	20.13
1600	27.69	5.52	1690	41.46	8.64	1780	47.09	23.13
1605	33.86	5.38	1695	51.27	9.03	1785	42.16	23.99
1610	32.61	5.52	1700	30.02	9.32	1790	48.56	25.12
1615	33.98	5.64	1705	33.34	10.04	1795	77.00	27.63
1620	35.72	5.62	1710	44.49	10.78	1800	79.30	28.08
1625	33.94	5.78	1715	33.39	11.53	1805	81.15	29.11
1630	45.58	6.12	1720	28.39	11.92	1810	99.05	30.01
1635	32.09	6.04	1725	38.62	12.01	1815	78.17	na
1640	38.50	6.29	1730	26.81	12.40	1820	53.57	na
1645	53.90	6.21	1735	32.66	12.97			
1650	41.81	6.47	1740	27.76	13.51			

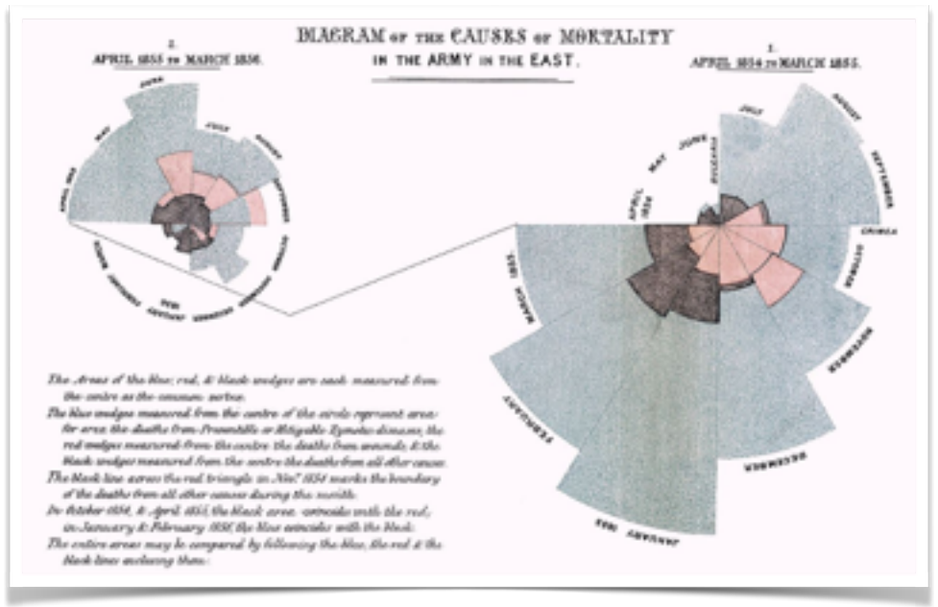
na: Data not available

Source: The Commercial and Political Atlas, 1786

William Playfair (1759-1823)



Florence Nightingale (1820-1910)



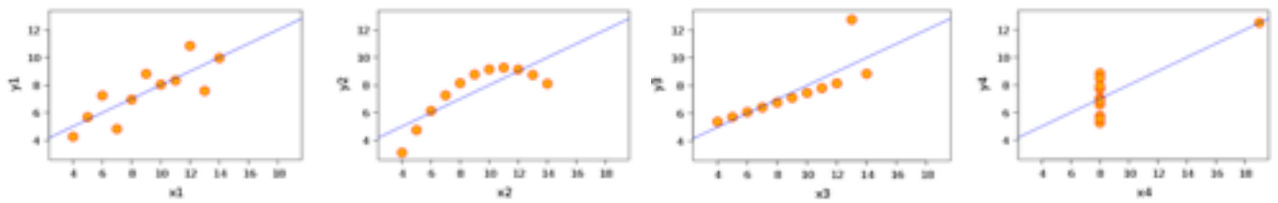
Blue: preventible or mitigable diseases
Red: deaths from wounds
Black: deaths from other causes

Frank Anscombe (1918-2001)

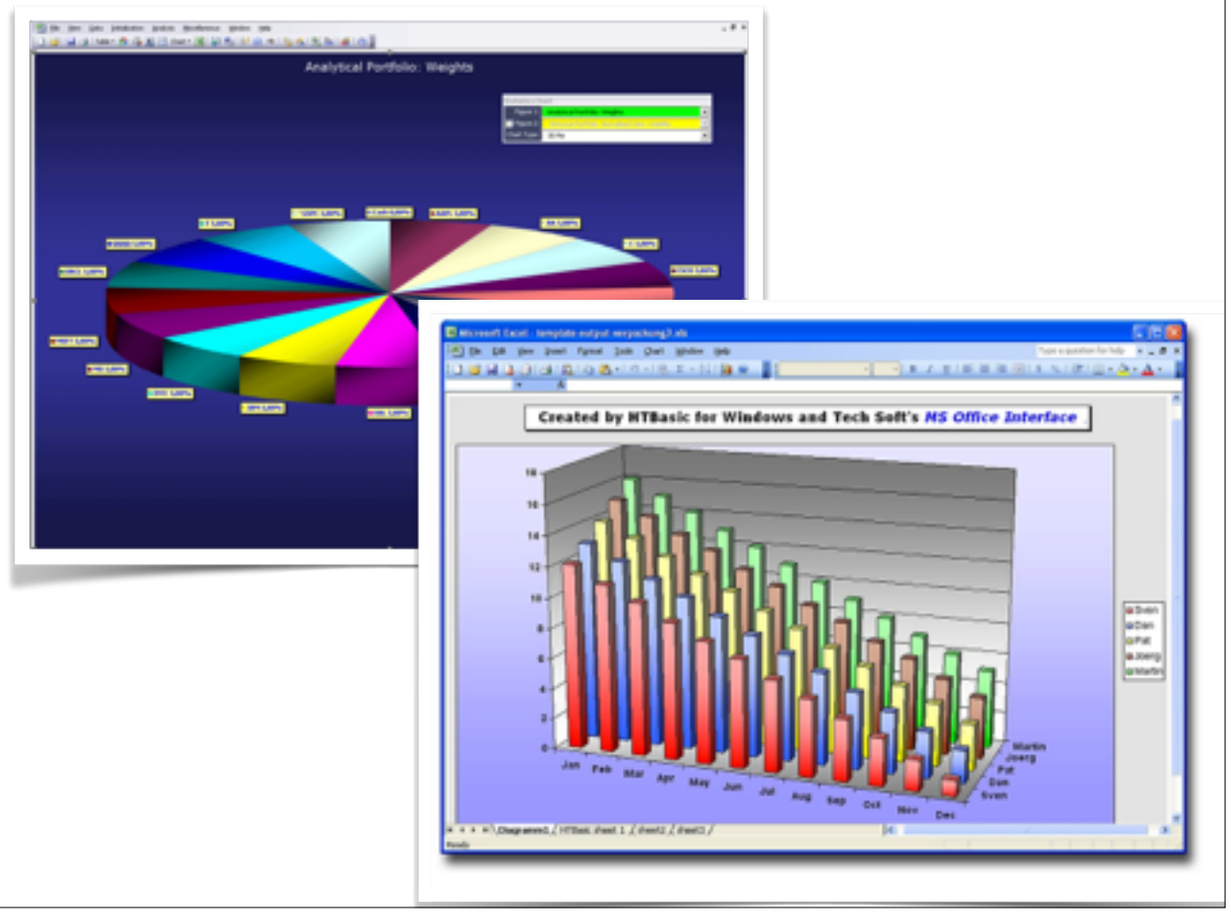
Anscombe's Quartet

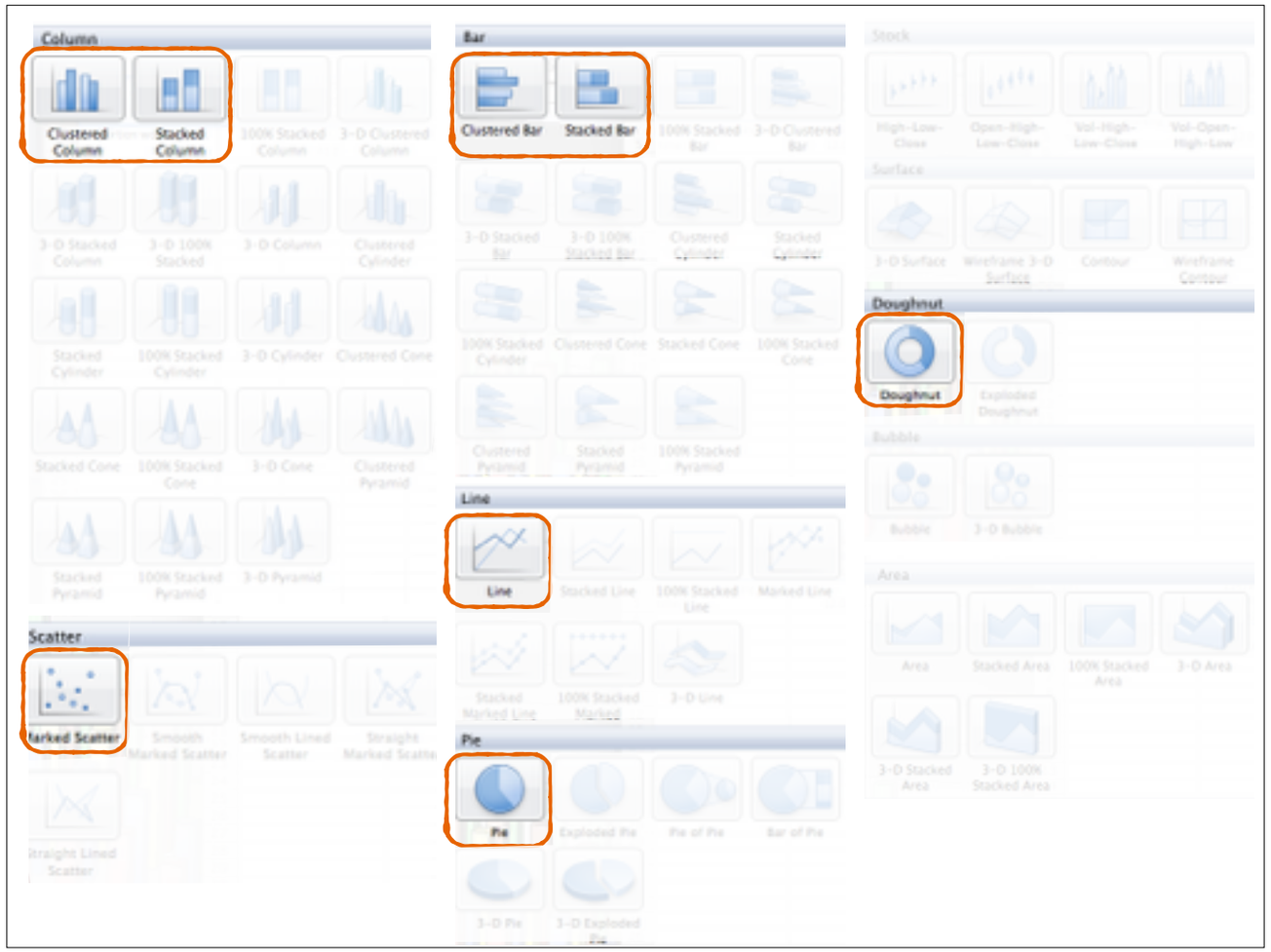
I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Property	Value
Mean of x in each case	9.0
Variance of x in each case	11.0
Mean of y in each case	7.5
Variance of y in each case	4.12
Correlation between x and y in each case	0.816
Linear regression line in each case	$y = 3 + 0.5x$



And then something happened...


Analytical Portfolio: Weights
Created by HTBasic for Windows and Tech Soft's MS Office Interface
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Martin
Joerg
Pat
Dan
Sven


Columns
Clustered Column
Stacked Column
100% Stacked Column
3-D Clustered Column
3-D Stacked Column
3-D 100% Stacked
3-D Column
Clustered Cylinder
Stacked Cylinder
100% Stacked Cylinder
3-D Cylinder
Clustered Cone
Stacked Cone
100% Stacked Cone
3-D Cone
Clustered Pyramid
Stacked Pyramid
100% Stacked Pyramid
3-D Pyramid
Scatter
Marked Scatter
Smooth Marked Scatter
Smooth Lined Scatter
Straight Marked Scatter
Straight Lined Scatter
Bar
Clustered Bar
Stacked Bar
100% Stacked Bar
3-D Clustered Bar
3-D Stacked Bar
3-D 100% Stacked Bar
Clustered Cylinder
Stacked Cylinder
100% Stacked Cylinder
Clustered Cone
Stacked Cone
100% Stacked Cone
Clustered Pyramid
Stacked Pyramid
100% Stacked Pyramid
Line
Line
Stacked Line
100% Stacked Line
Marked Line
Stacked Marked Line
100% Stacked Marked Line
3-D Line
Pie
Pie
Exploded Pie
Pie of Pie
Bar of Pie
3-D Pie
3-D Exploded Pie
Stock
High-Low-Close
Open-High-Low-Close
Vol-High-Low-Close
Vol-Open-High-Low
Surface
3-D Surface
Wireframe 3-D Surface
Contour
Wireframe Contour
Doughnut
Doughnut
Exploded Doughnut
Bubble
Bubble
3-D Bubble
Area
Area
Stacked Area
100% Stacked Area
3-D Area
3-D Stacked Area
3-D 100% Stacked Area

A call from history

Stop being technology-led… ...be technology-enabled

Focus on best practice...

- Principles NOT rules
- Context NOT constraint
- Consistency NOT regimentation

Further study

- Anscombe’s Quartet. http://en.wikipedia.org/wiki/Anscombe's_quartet
- Playfair, William (1801, reprinted 2005). The Commercial and Political Atlas and Statistical Breviary. Cambridge University Press
- Milestones in the history of thematic cartography, statistical graphics and data visualization (2009), Michael Friendly www.math.yorku.ca/SCS/Gallery/milestone/milestone.pdf

Societal Perspective

Numeracy and Statistical Literacy

In 2003, **46.9%** of working age adults in England lacked Level 1 numeracy skills.

In 2011, **49.1%** of working age adults in England lacked Level 1 numeracy skills.

Level 1 numeracy skills: calculating simple percentages and converting units of measure.

For example adults without Level 1 skills may not be able to understand their payslip .

“More than 15 million adults in Britain have poor numeracy – the equivalent of a G or below at GCSE maths”

Worryingly there is false confidence in numeracy skills. In England in 2011 31% of adults surveyed rated their numeracy skills as very good but performed poorly.

Numeracy is a societal barrier

“I phoned Camelot and they fobbed me off with some story that -6 is higher, not lower, than -8, but I’m not having it”

Tina Farrel, 23, Manchester

A reporter with Fox News just called looking for some help calculating percentages for a story he's preparing for tonight's broadcast. He's looking for someone who can help him explain what percentage of $60 billion would $325,000 be. It's for a story about the NY State $60 billion budget, of which $325,000 was found in fraud. It's not a controversial story and he's just looking for someone who can help him explain how much this is in lay terms. It does not have to be on the record.

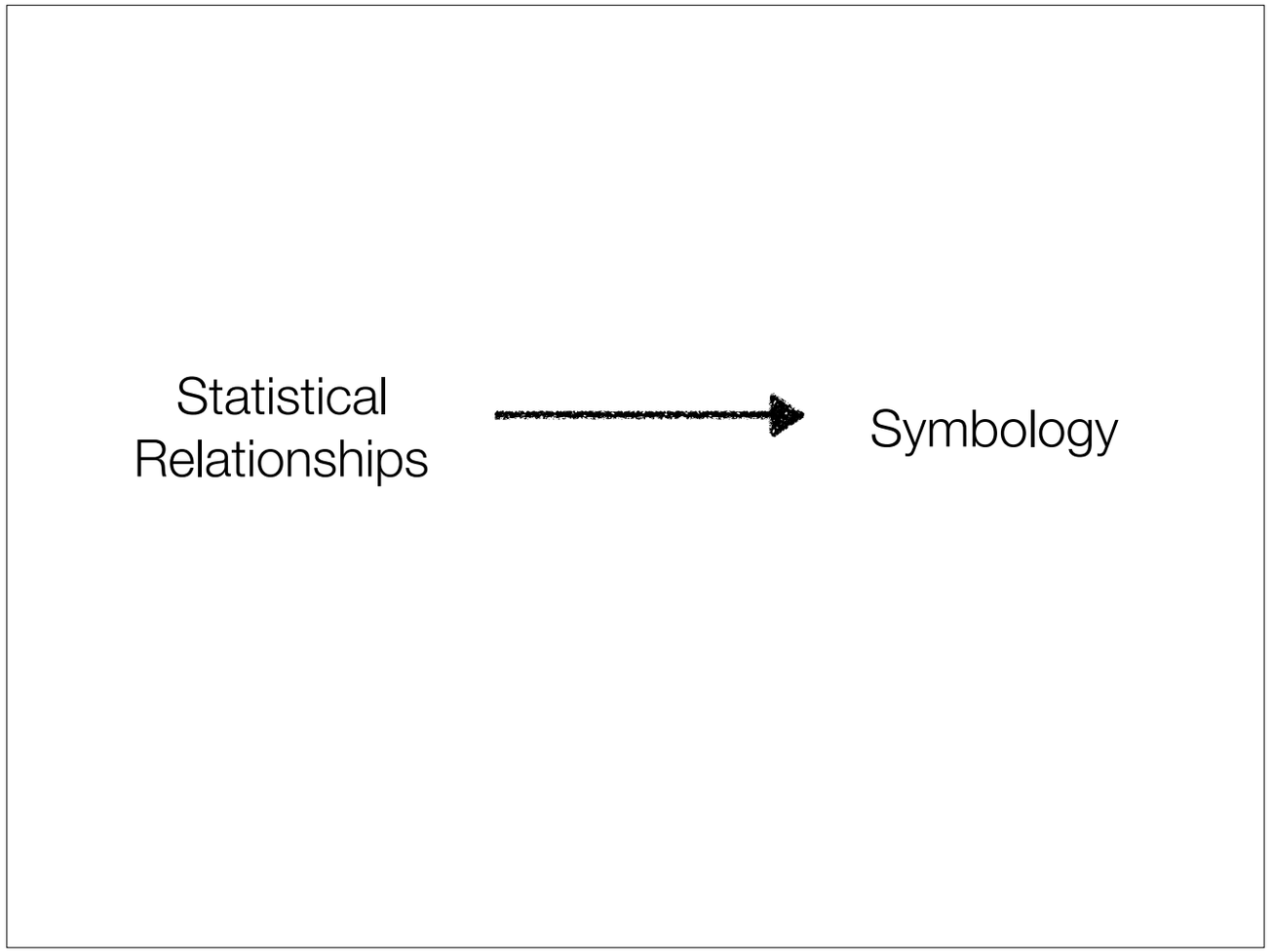
Do we have any mathematics professors who could help with this calculation in the next hour or so? Thanks!

Alberto Cairo @albertocairo · 1h
Wait what? "A reporter called looking for some help calculating percentages" @mathbabedotorg
mathbabe.org/2015/11/06/fox...

6 11 •••

Further study

- Skills for Life Survey 2011. http://www.bis.gov.uk/assets/BISCore/further-education-skills/docs/0-9/11-1367-2011-skills-for-life-survey-findings.pdf
- IDC - The Digital Universe in 2020: Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East. http://www.emc.com/collateral/analyst-reports/idc-the-digital-universe-in-2020.pdf
- Cool Cash/Tina Farrel interview in Manchester Evening News. http://www.manchestereveningnews.co.uk/news/greater-manchester-news/cool-cash-card-confusion-1009701
- Sir Ken Robinson. Changing Paradigms of Education (RSA Animate) http://www.youtube.com/watch?v=zDZFcDGpL4U



2 decisions which need to be made before you create a design!!

What is the story?

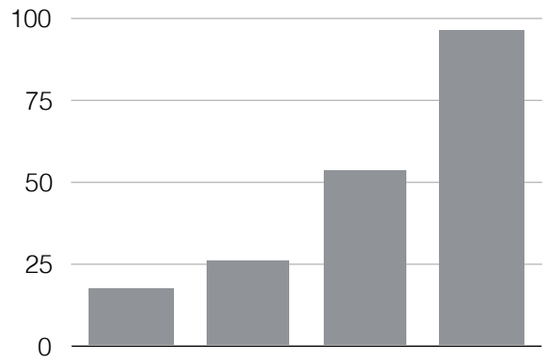
What’s the best chart for the job?

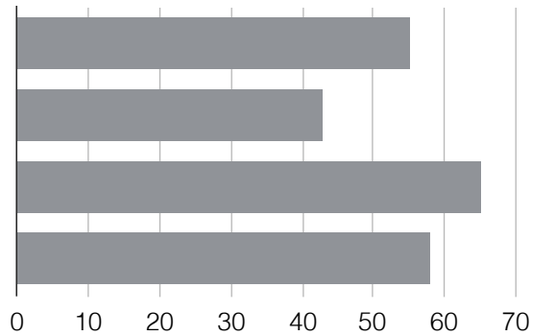
Statistical relationships

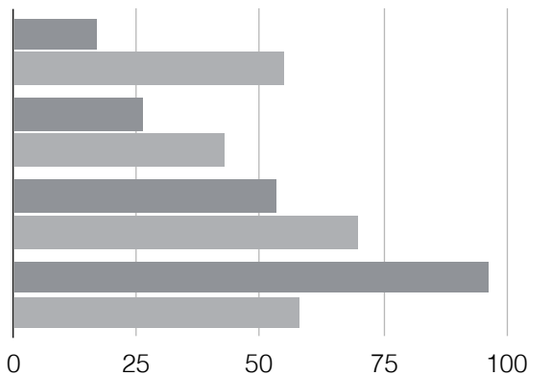
- Magnitude
- Change over time
- Distribution
- Part-to-whole
- Correlation
- Deviation
- Ranking
- (Spatial)

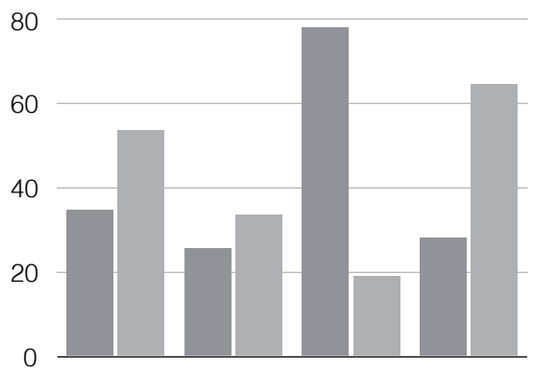
Magnitude - comparisons in size

difference between number of full-time and part-time workers



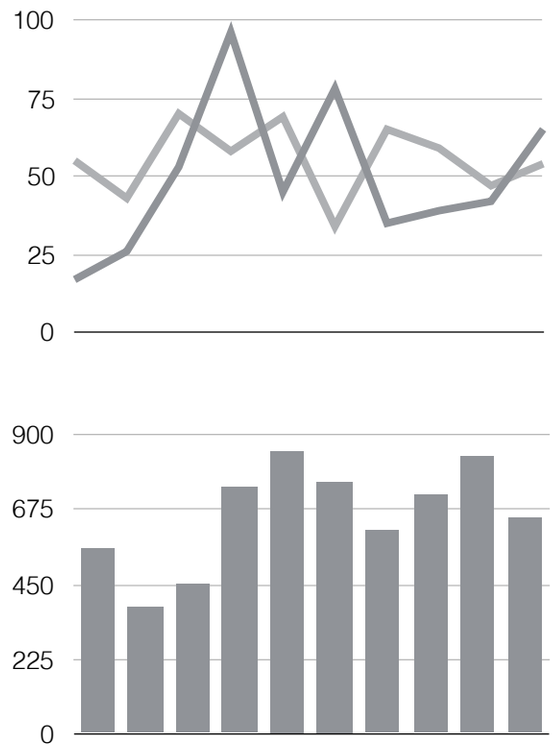


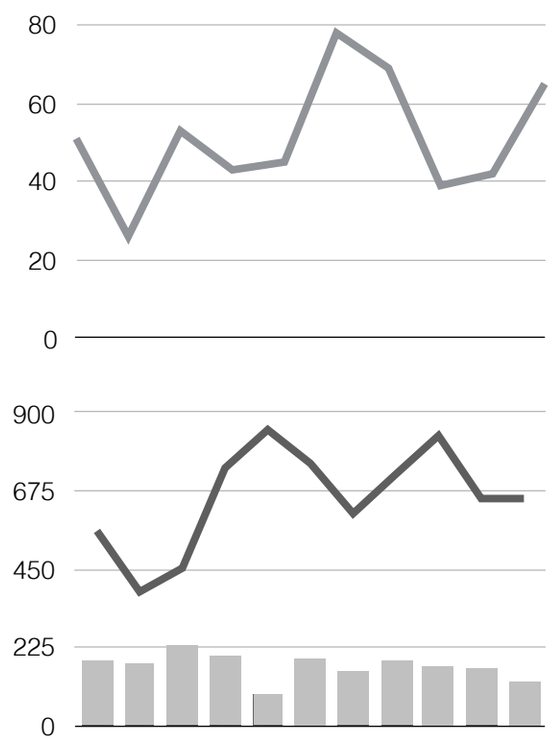




Time series/change over time - highlights past/future trends

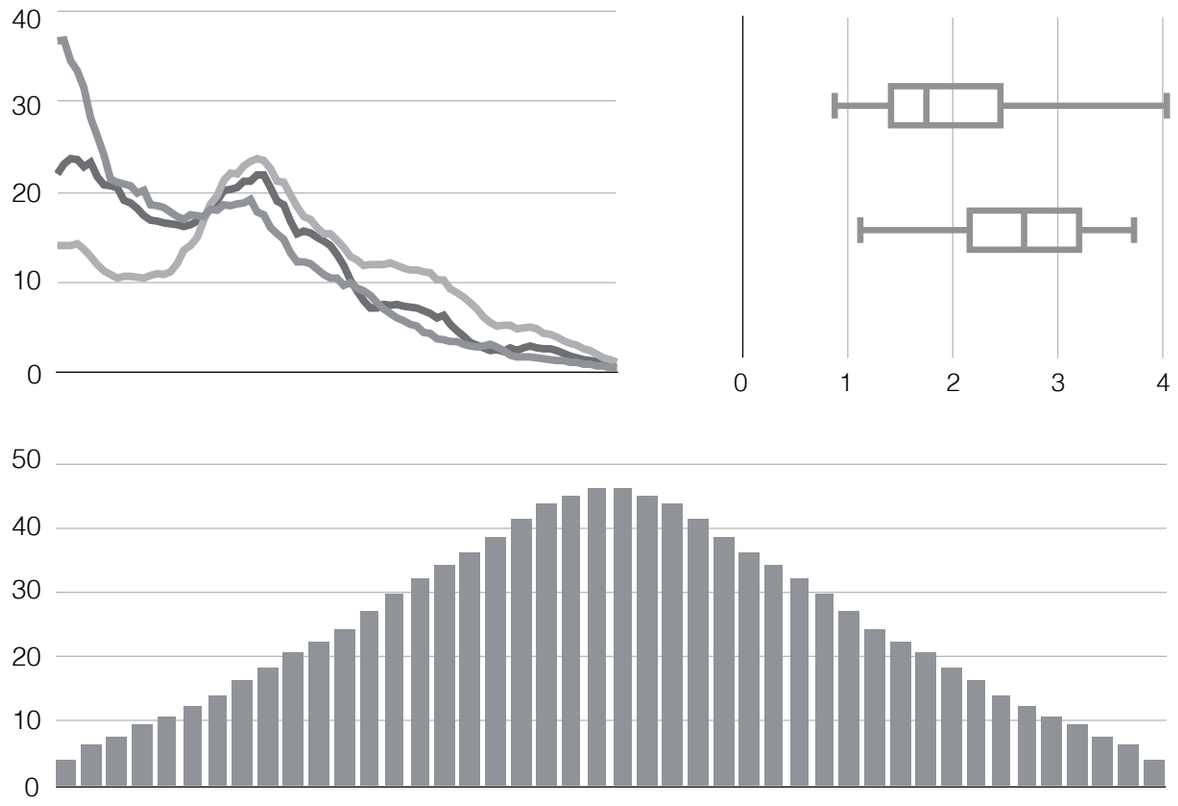
variation in GDP from 2003 to 2015





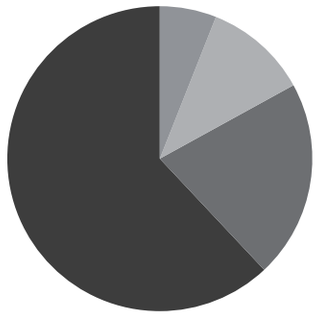
Distribution - shows the shape of categorical data

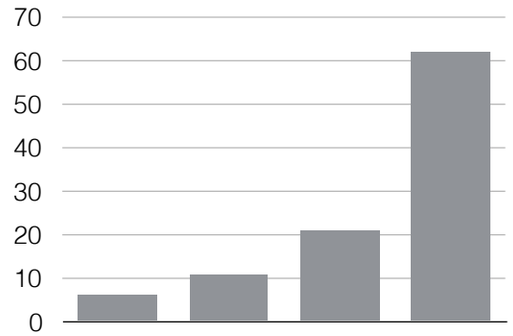
age structure of the UK

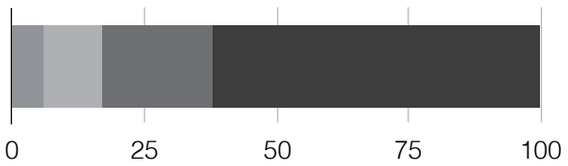


Part to whole - show the components of a whole population

composition of labour market

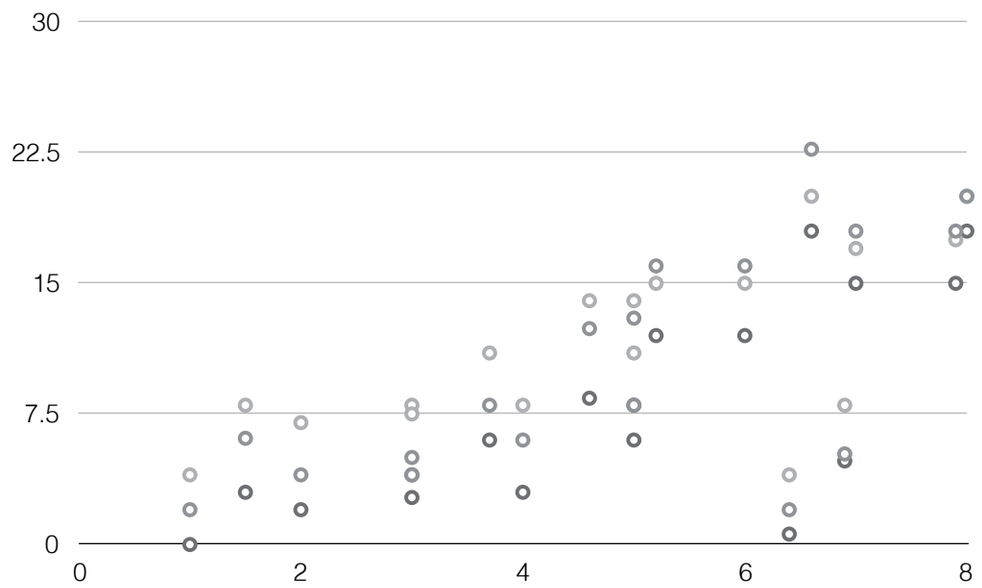






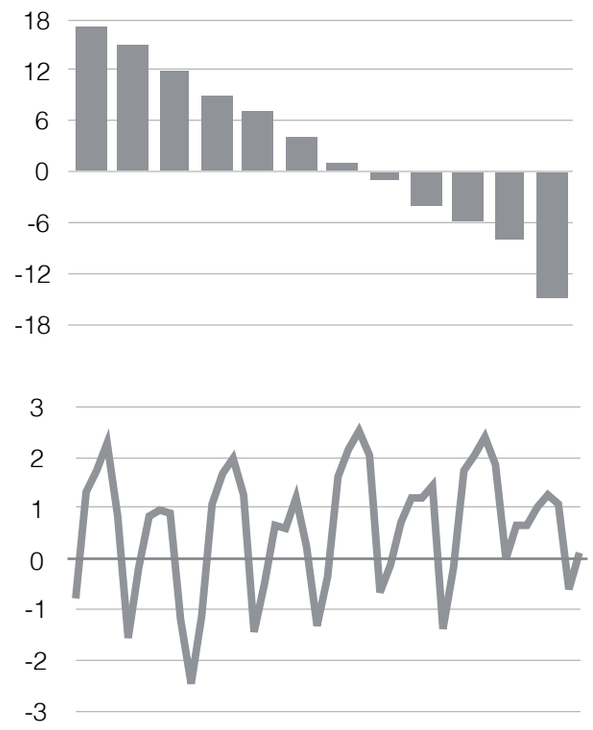
Correlation - shows relationships between variables

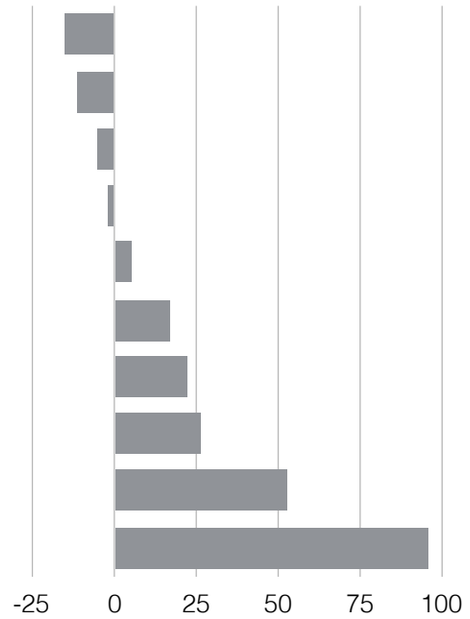
link between house prices and rental prices



Deviation - the difference from another value

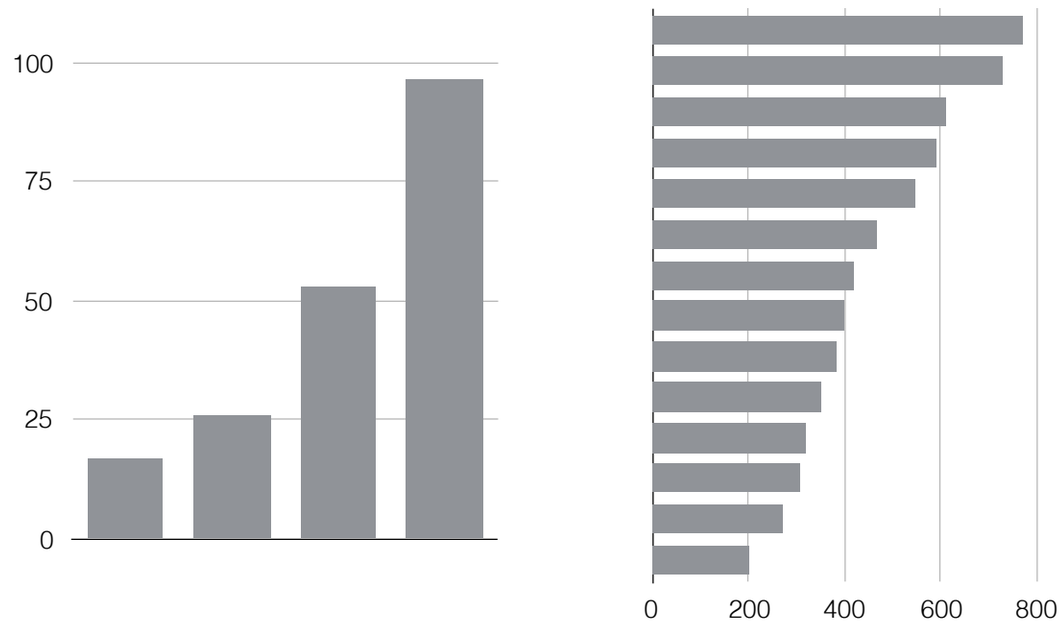
regional life expectancy as a difference from UK average





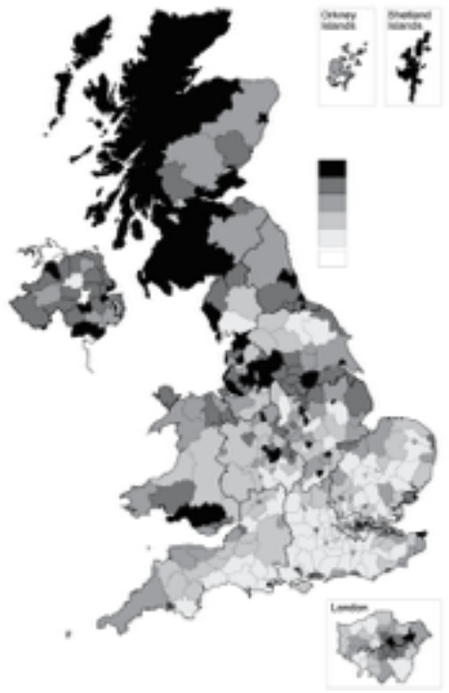
Ranking - ordered data

popularity of baby names

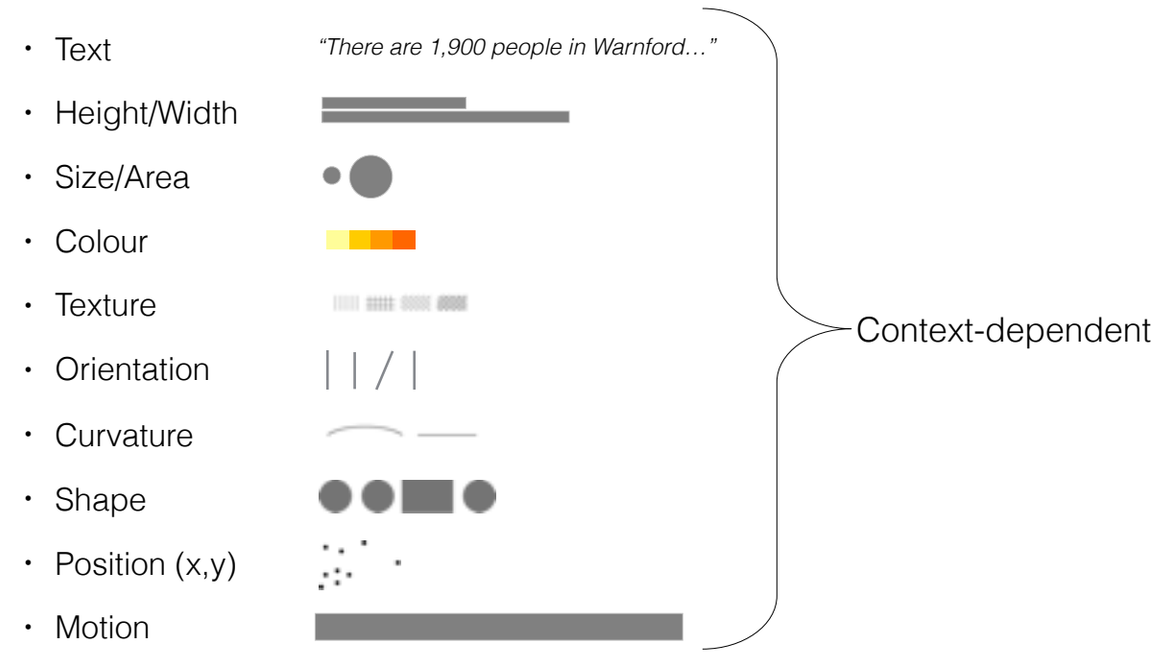


Spatial - geographical distribution of data

variation in life expectancy by output area



A limited number of coding strategies…



What are the aims of data vis?

Reveal trends, patterns

- gaps
- outliers

Provide context ("compared to x")

Compare scales ("this is x times bigger than y")

Describe geography

These are the different types of coding which can be used to visualise data and highlight patterns and stories.

Use singularly or multiples

Position - spacial placement most useful

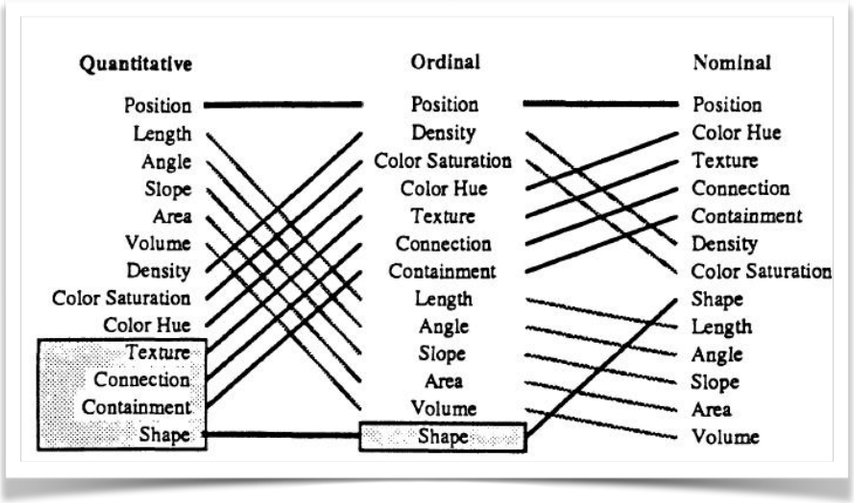
Quantitative - how much bigger

Ranks - 1, 2, 3, ….

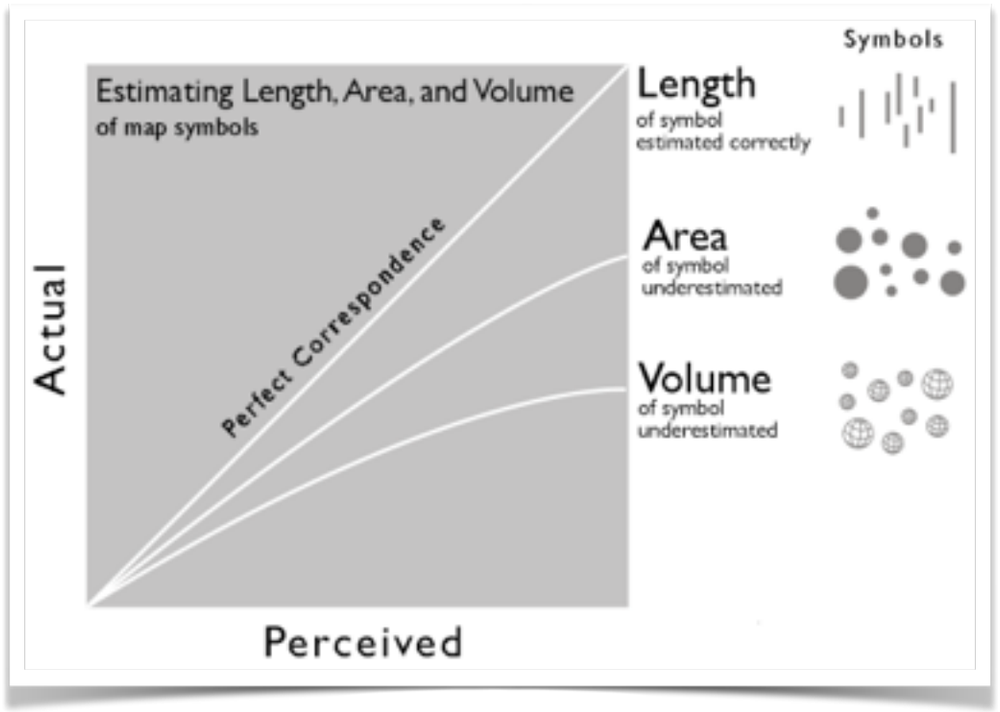
Relational - clumped or grouped together

The Visual Variables - expanded

- Jock D. Mackinlay expanded Bertin's list and suggested a ranking of their usefulness based on the type of data being represented



Caution: Interpreting visual variables



Example: Length v Area

The most effective graphs make the most efficient use of visual encoding

Charts

Text, tables, graphs and maps represent a toolkit for statistical communication.

Being able to spot when and where to use each is an important component in producing quality content, tailored to your audience.

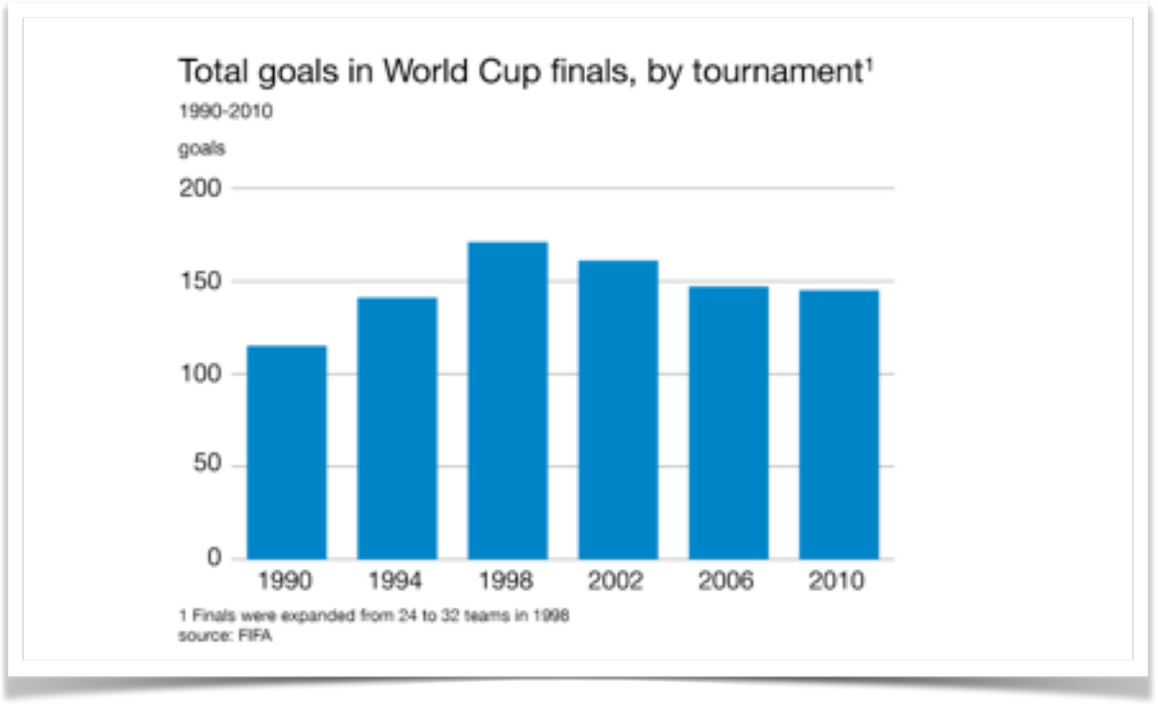
Choosing a graph type - ‘safety first’

- Graphs display information about **relationships in data**
- Getting to the right graph is a **two-step process:**

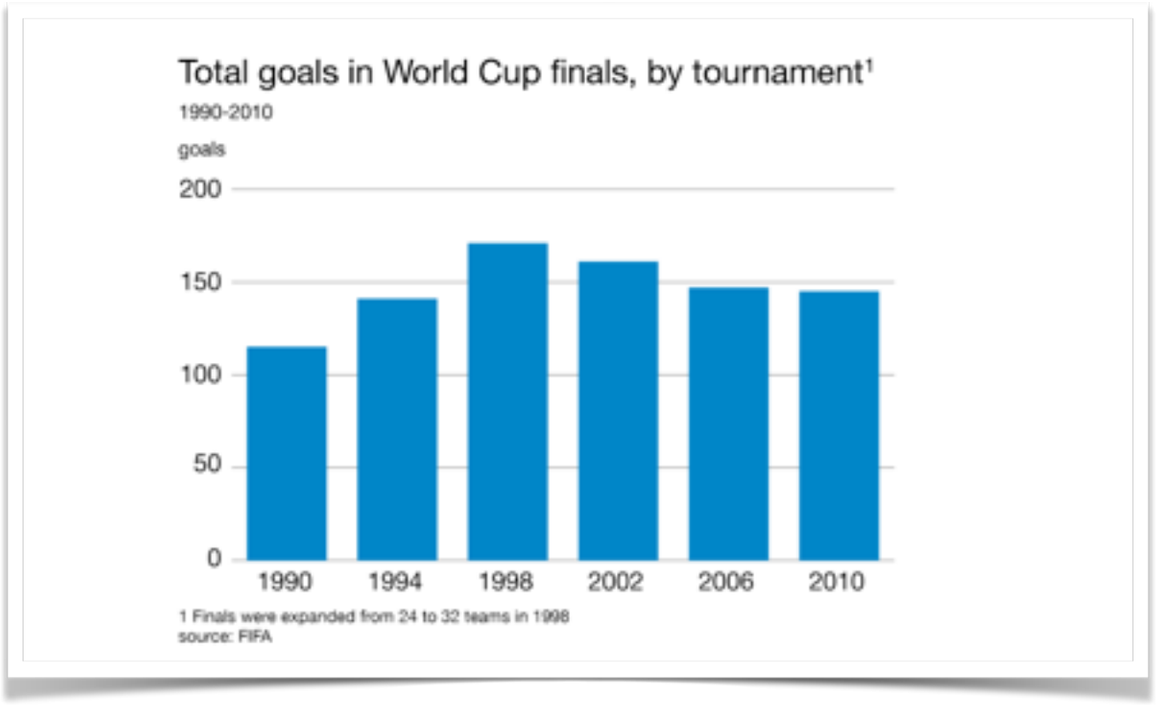
1. **identify** and **prioritise** the statistical relationships
2. choose the symbology that gives **visual emphasis** to the highest priority relationships

So what basic statistical relationships in the data should we look for?

Magnitude?



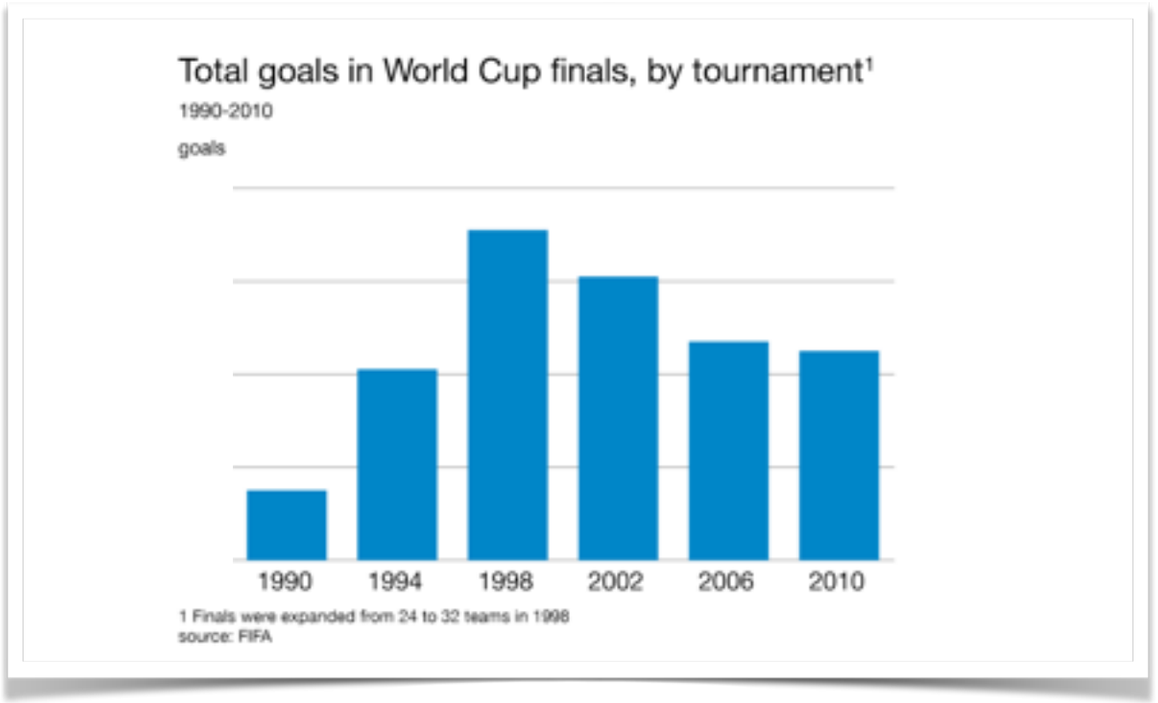
Magnitude | bars are best



Magnitude

does the y axis have to start at 0?

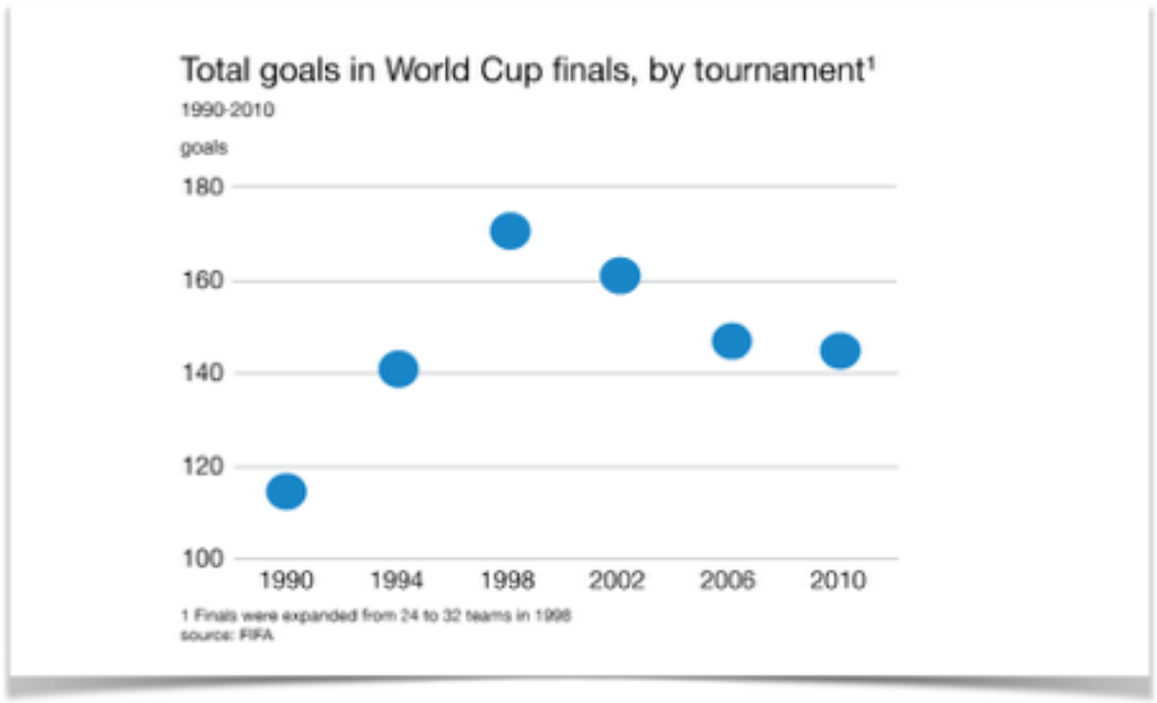
does the y axis have to start at 0??



Magnitude

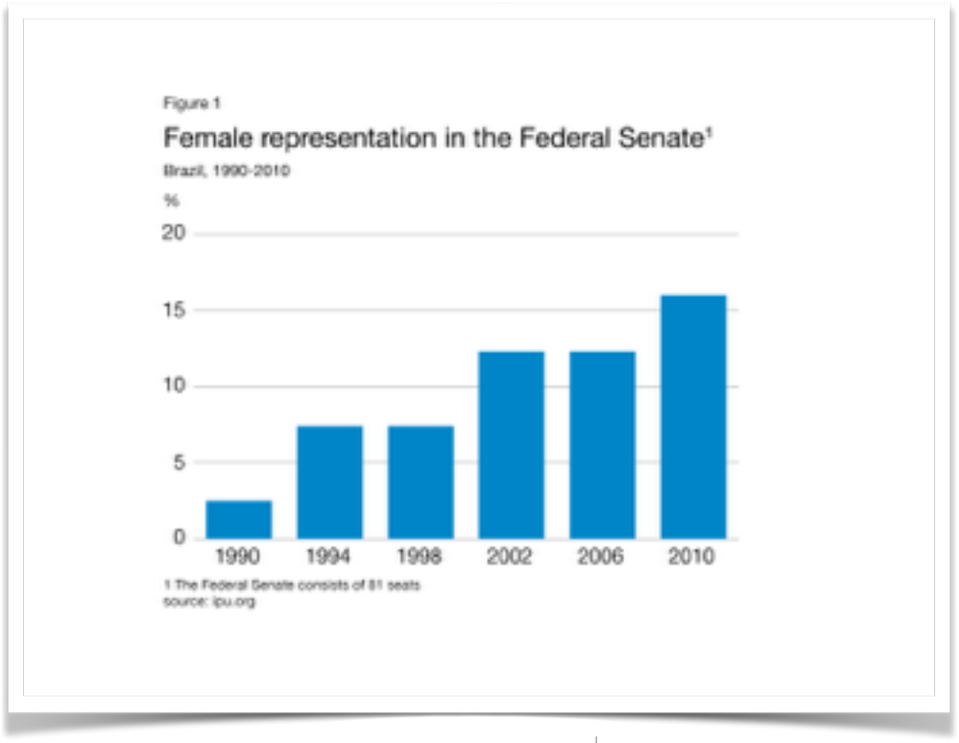
does the x axis have to start at 0?

yes it does!!



Magnitude

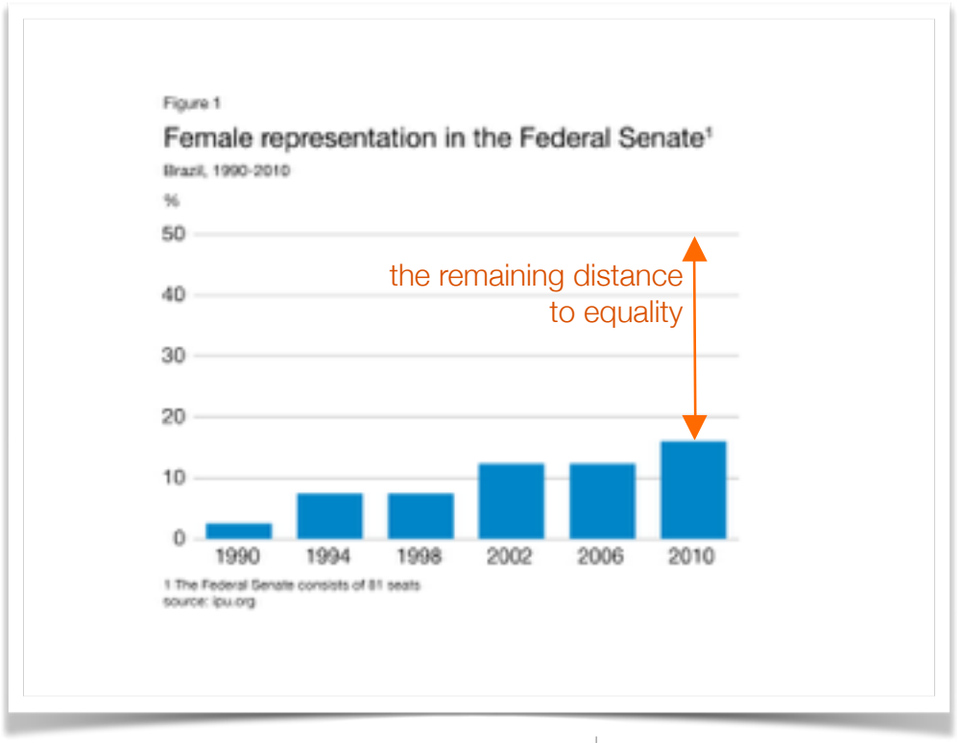
bar alternative



A perfect graph?

anything wrong?

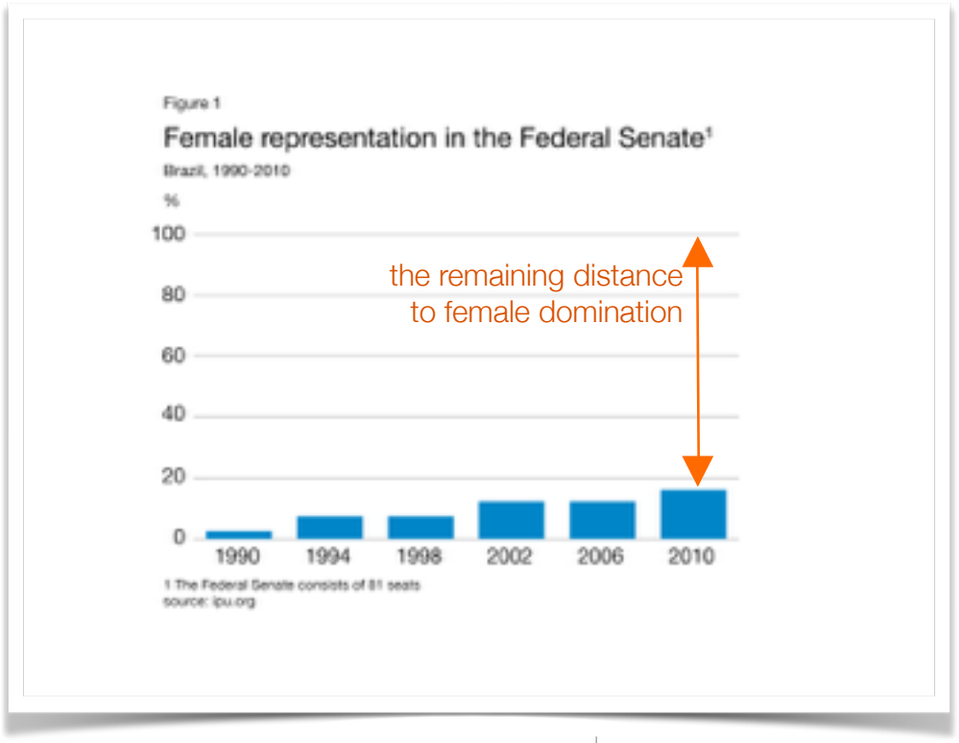
what's this chart getting at? what's the story or policy here?



White space is important!

the story can be in the
‘no data’ space

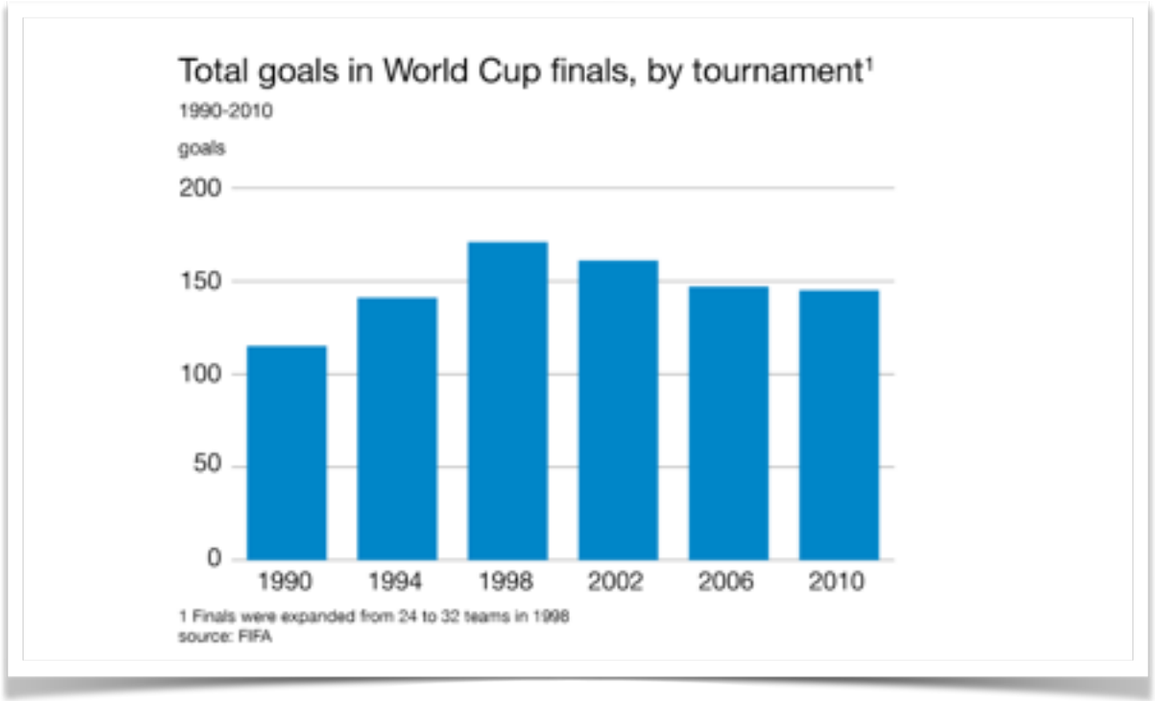
now we’re using something as simple as your y scale to add important context!



Understand the implications

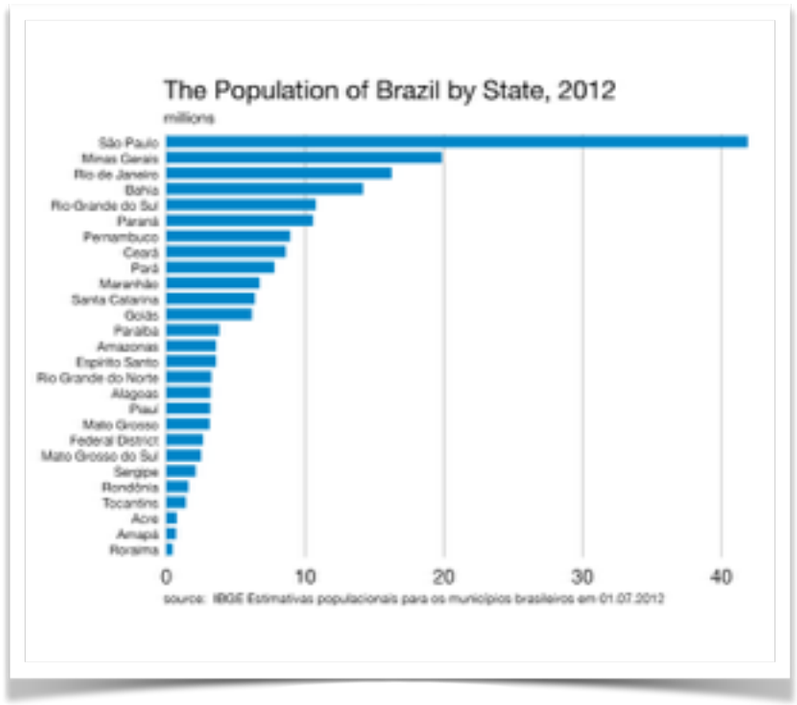
scaling is an editorial control

we've adjusted it again, for another angle. still a legit thing to do! depends on your story



Magnitude

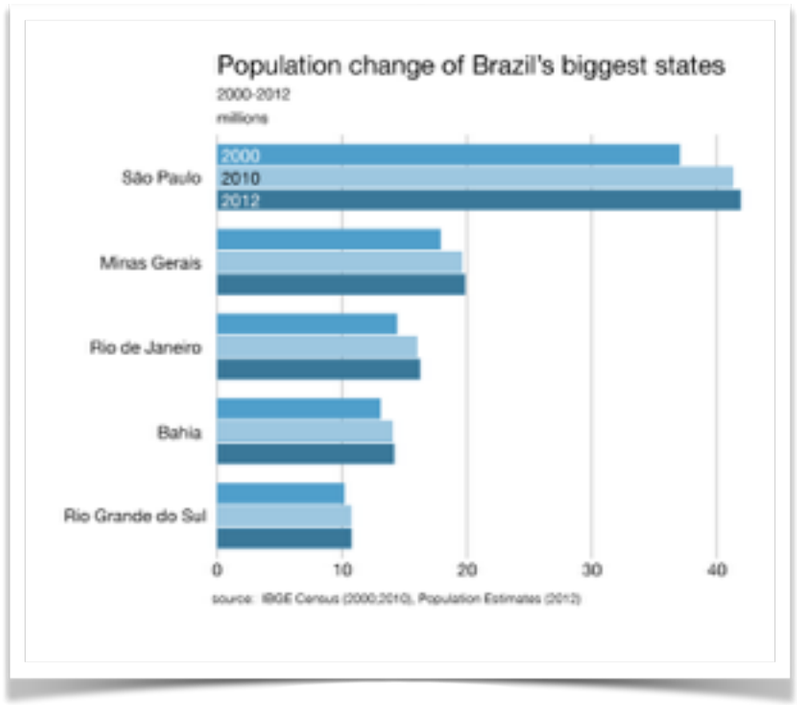
always vertical bars?



Magnitude

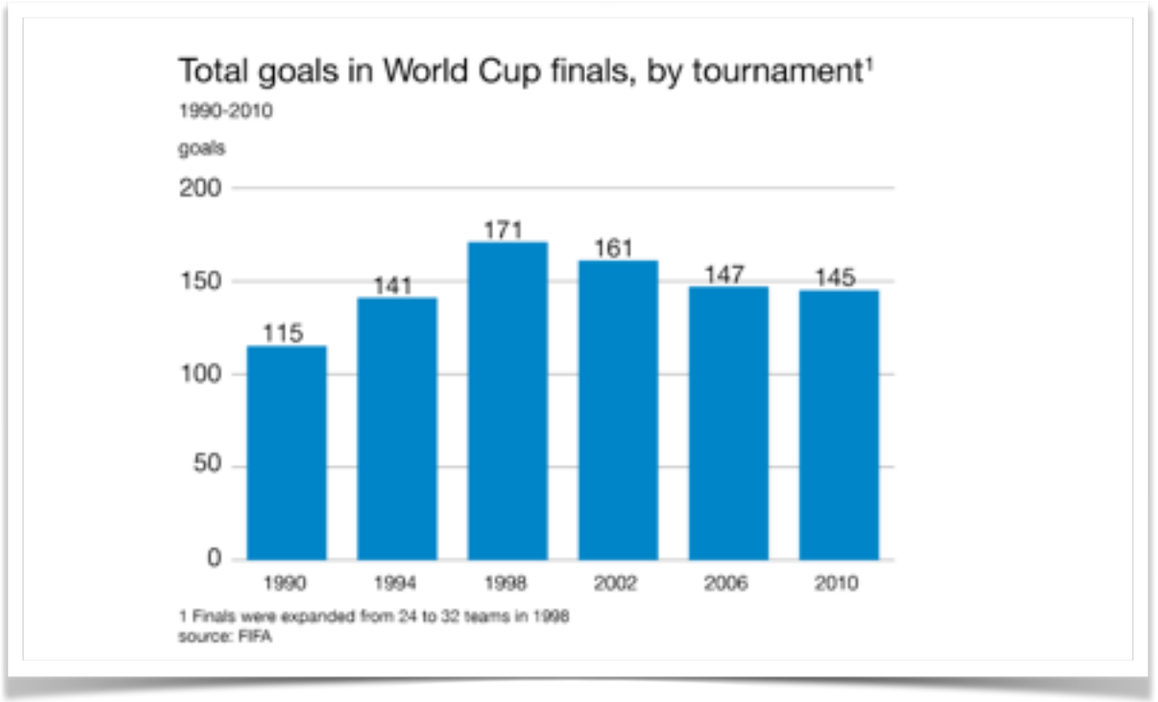
horizontal is fine

better for categorical data – labels too long for vertical bars and lends itself to ranking



Magnitude | horizontal clustered bars

I'm not a huge fan - i'd go for a slope chart. easier to see the change and overall context

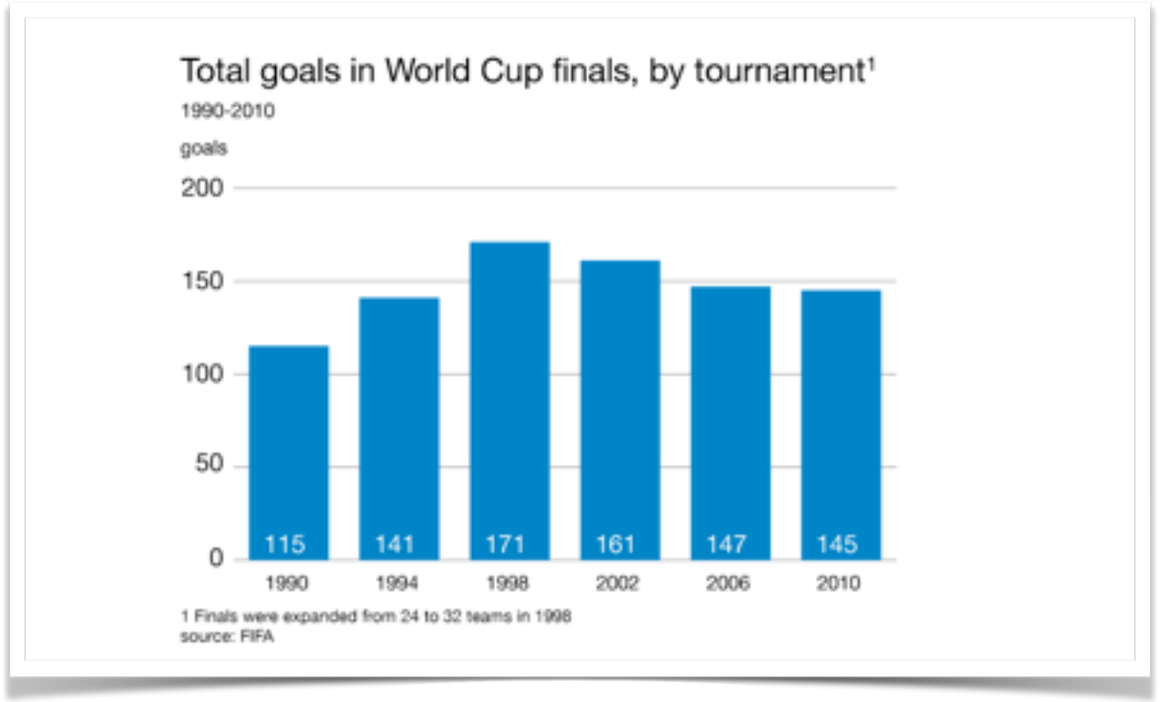


Magnitude

can I label the bars?

yeah why not

could be a tad better though

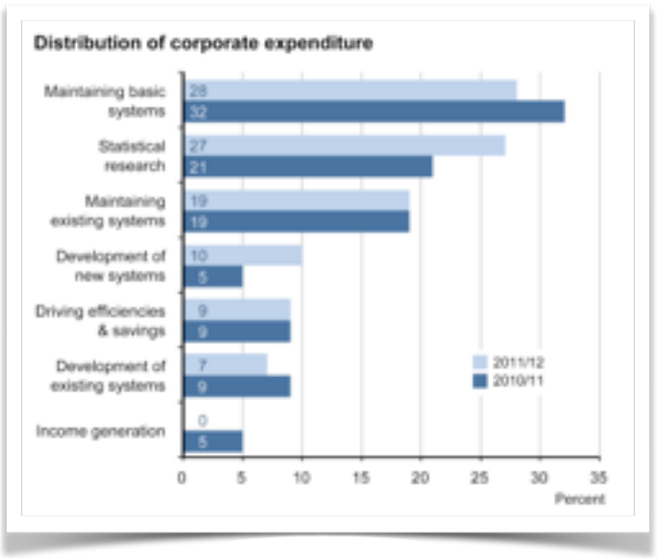


Magnitude

keep labels away from bar tops

a bit cleaner and offers “common horizon”

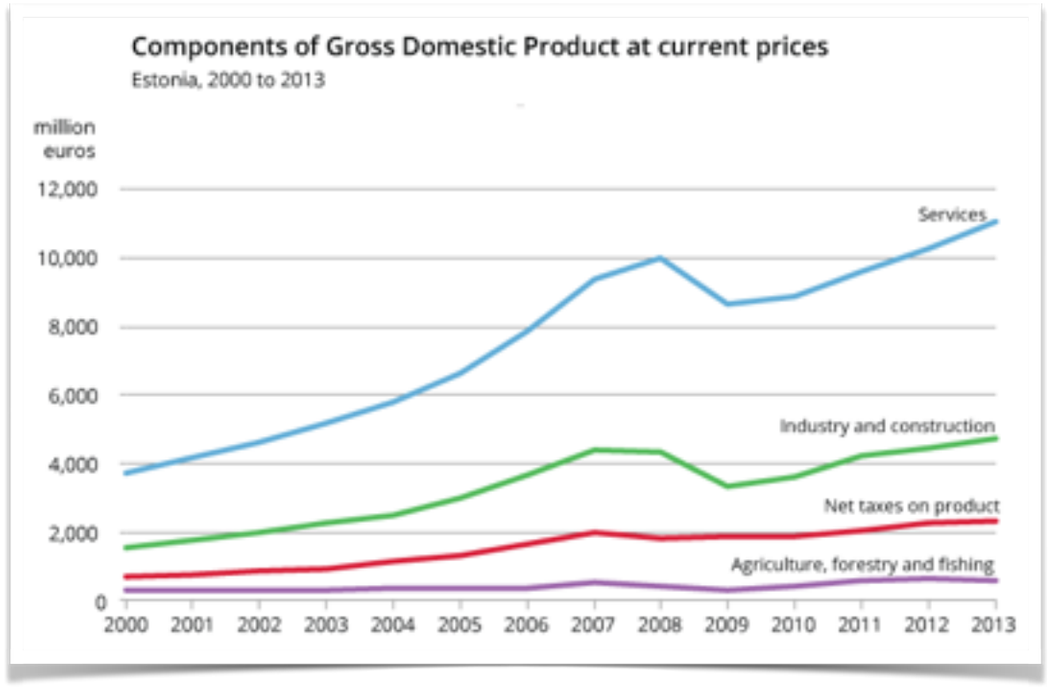
table/graph hybrids that work



quite clean, adding visual context to a simple table not a bad idea.

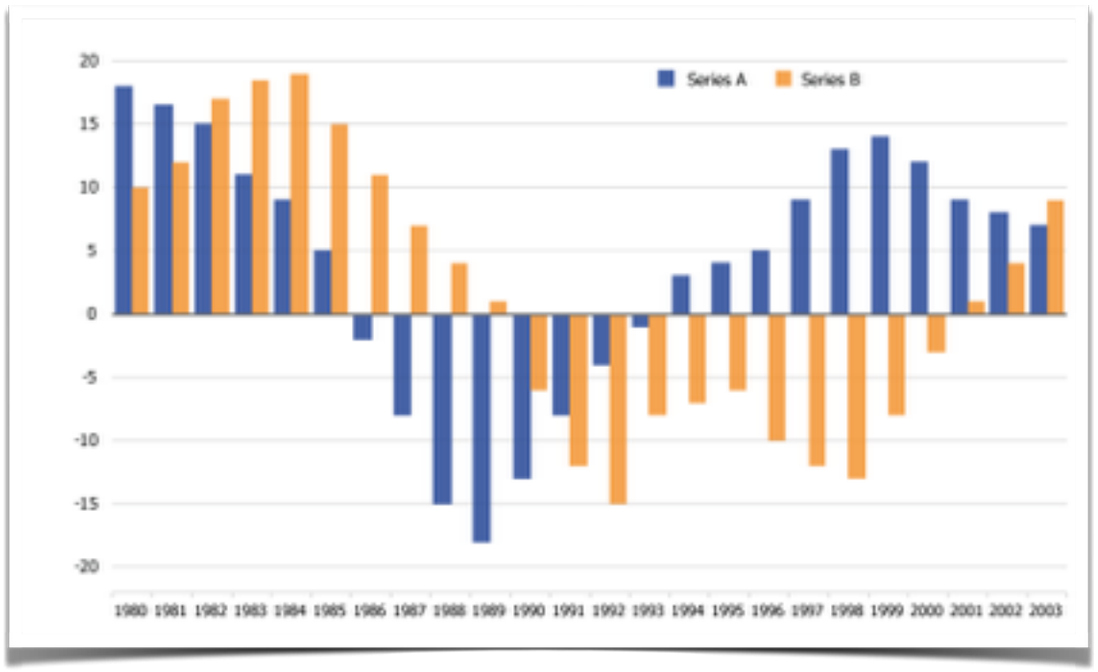
bar equivalent to a spark line?

Change over time?



Change over time | line chart

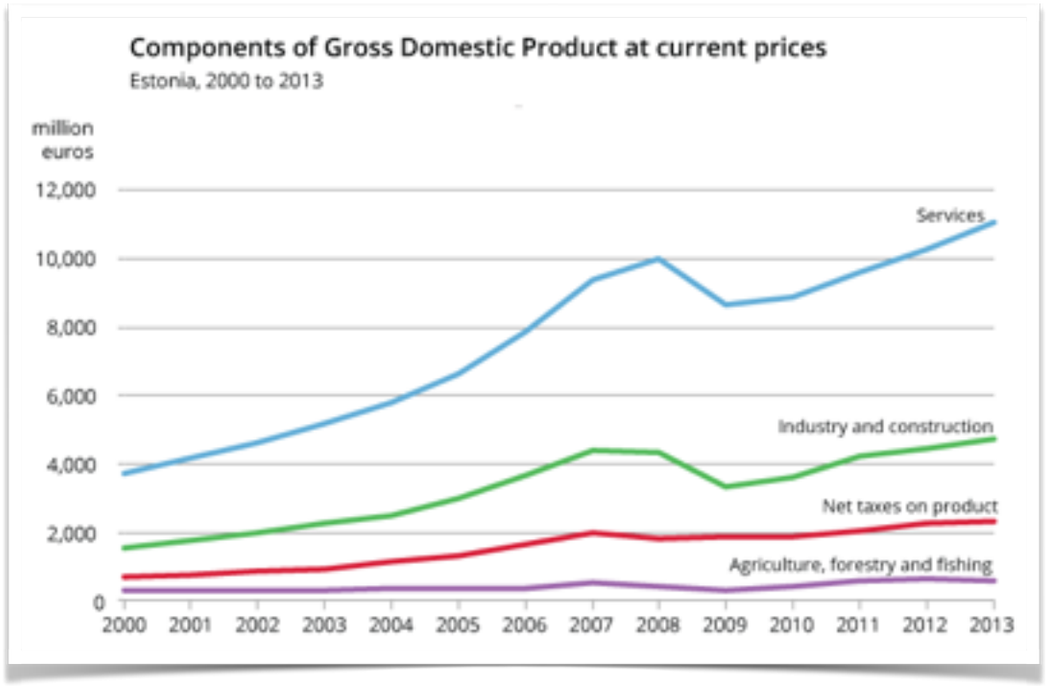
passable line chart - red and green not great practice but lines labelled so no harm done



Change over time

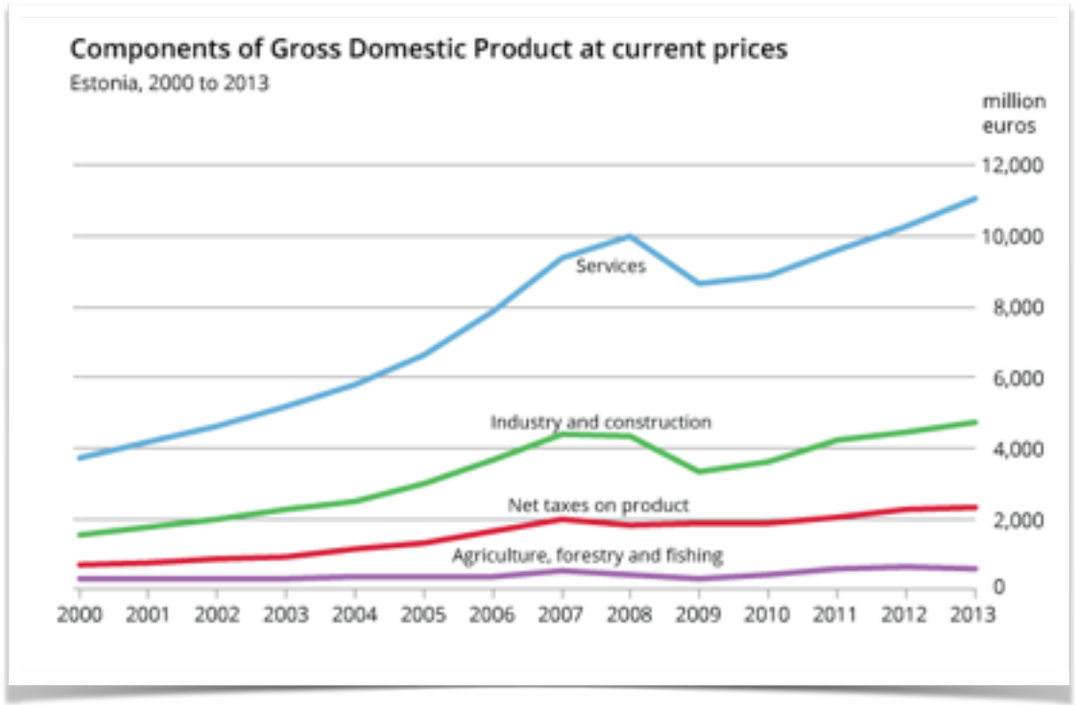
can I use a bar chart?

yes, why not. probably more than 2 series on the chart would be stretching it though



Change over time

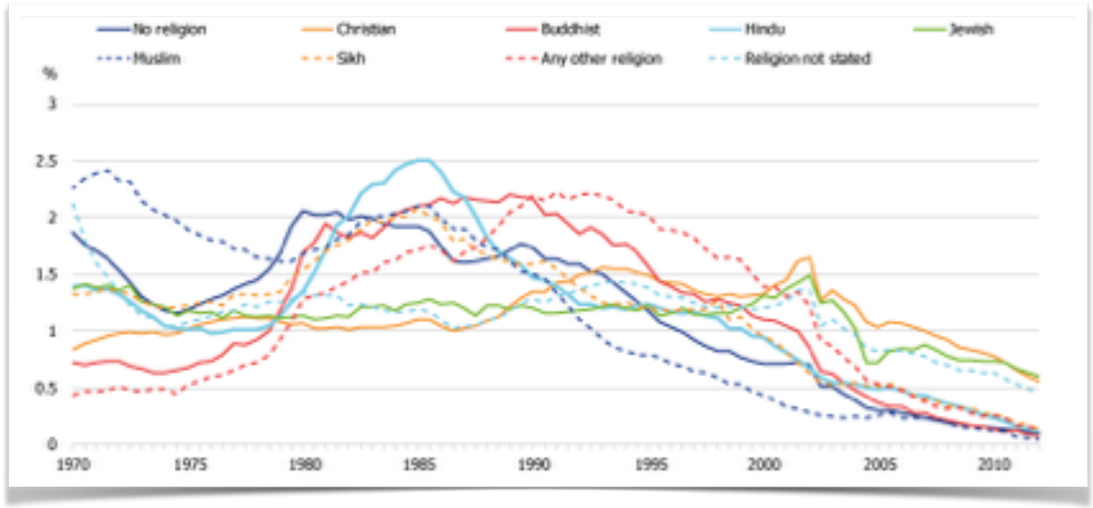
y axis labels always on left?



Change over time

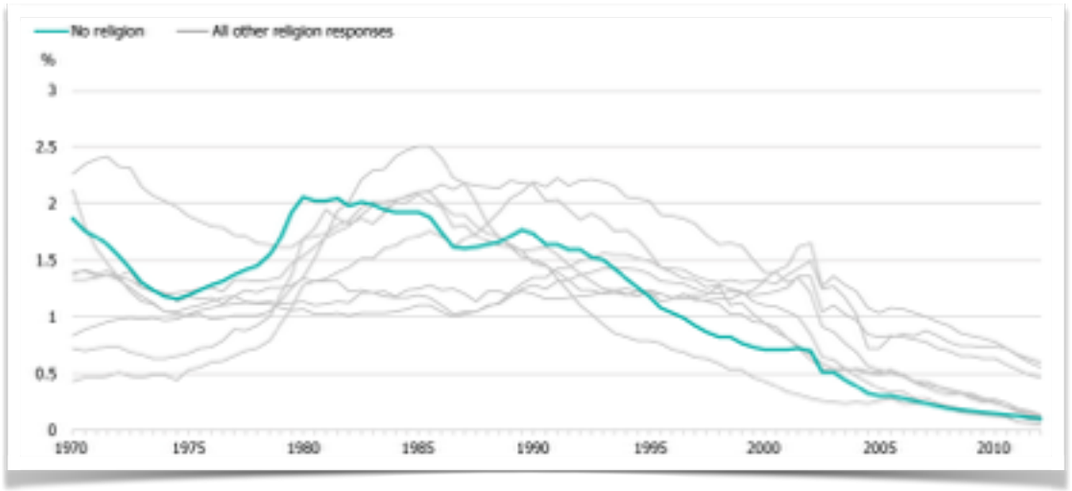
attention now drawn to most recent values

no reason why you can’t do this. could make most recent values easier to read



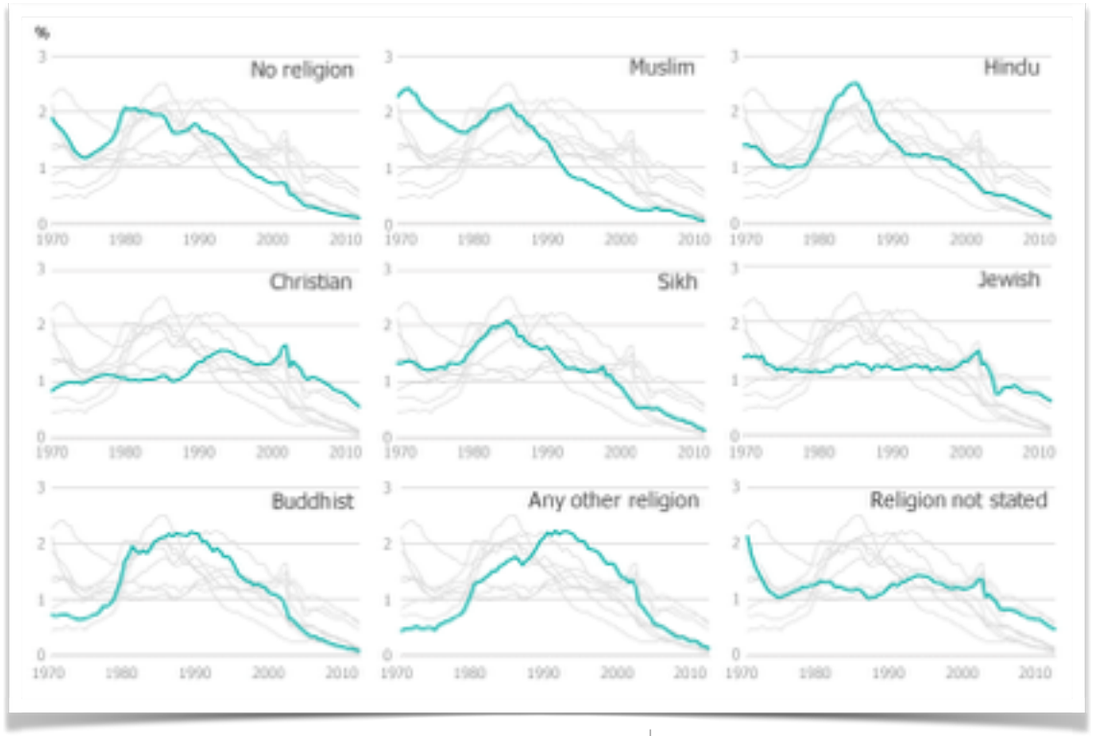
Change over time | spot the problem

see way too much of this

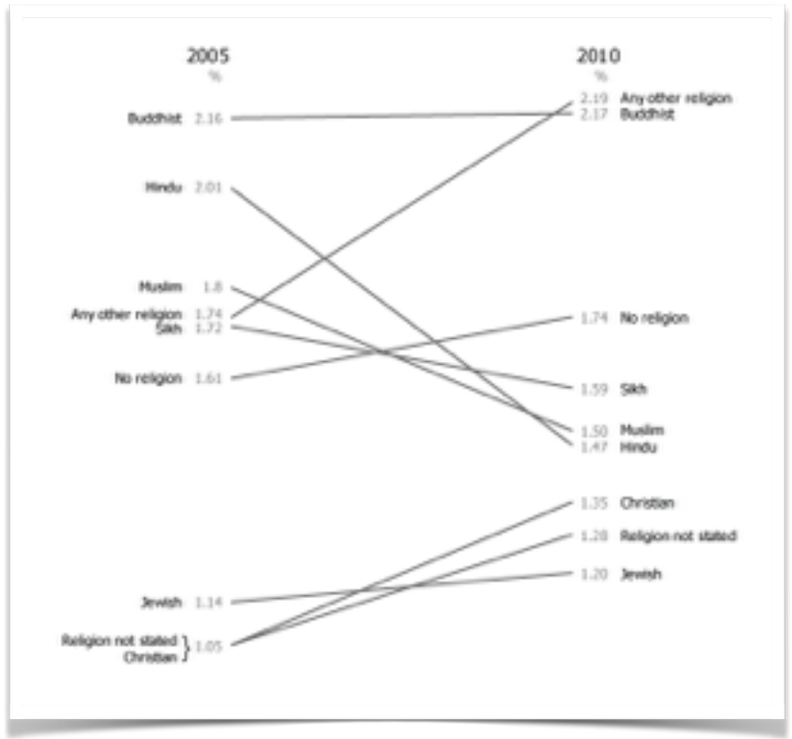


Change over time

focus on selected lines...



Change over time | small multiples

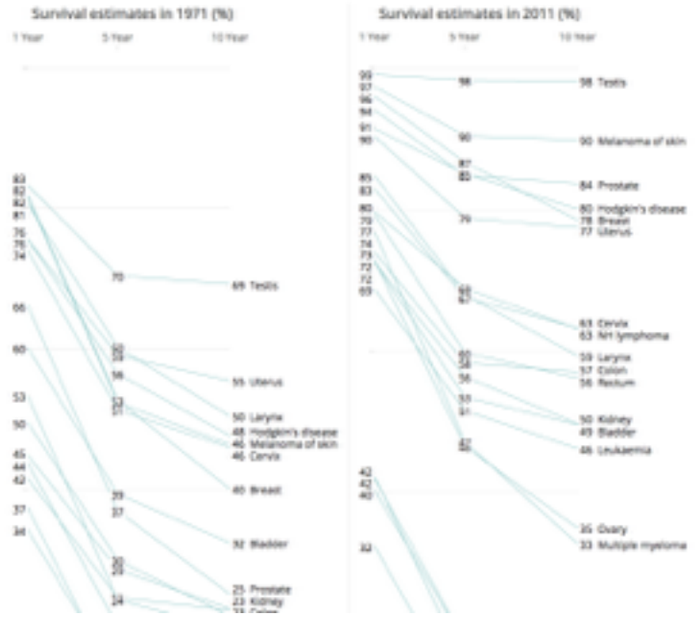


Slopegraphs

reduce the granularity
of the time component

go back to slide 46 - can you see how it applies?

http://visual.ons.gov.uk/how-do-survival-estimates-compare-for-common-cancers/



Slopegraphs

http://visual.ons.gov.uk/how-do-survival-estimates-compare-for-common-cancers/

source: Edward Tufte

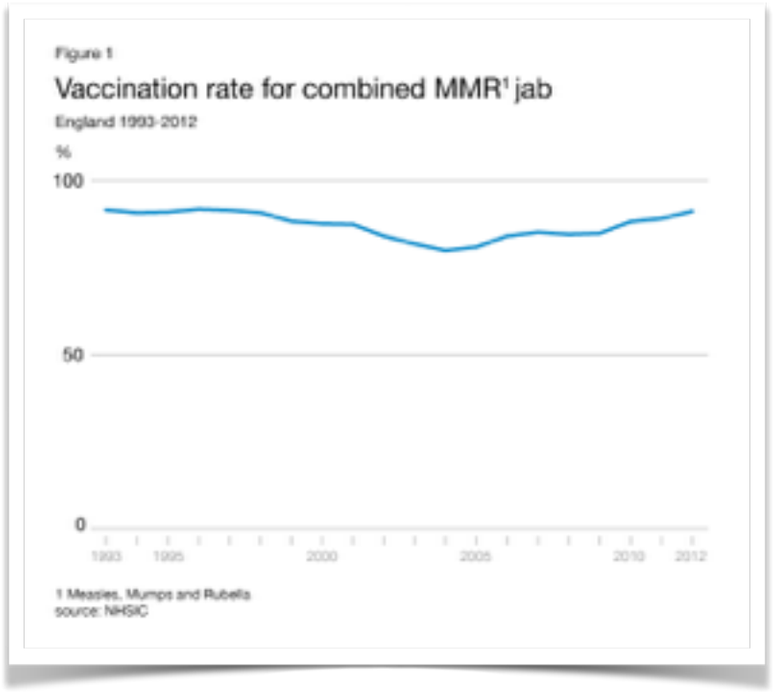
Sparklines

"Intense, simple, word-sized graphics"

useful for some context "at a glance"

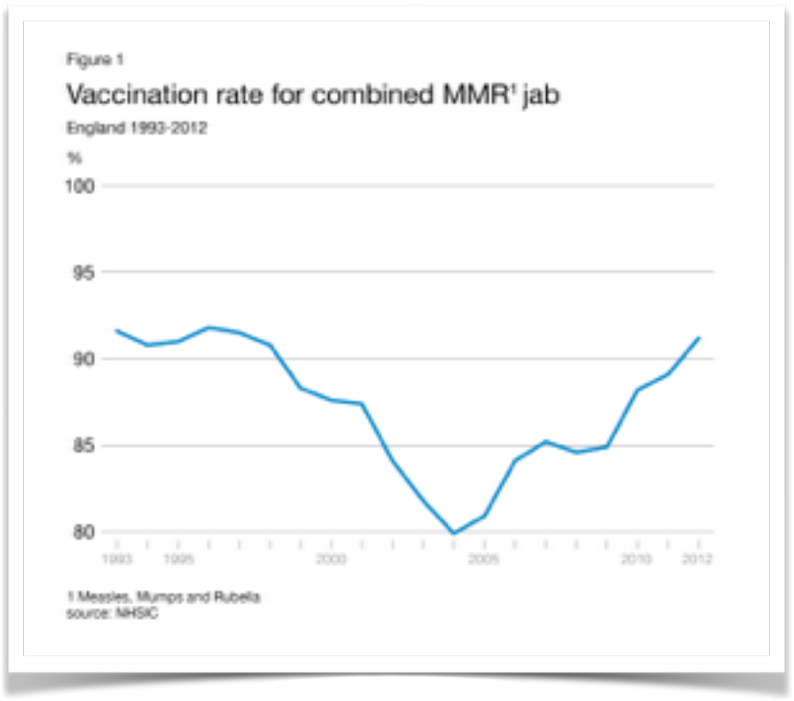
practical in size

easy to represent multiple series



Change over time

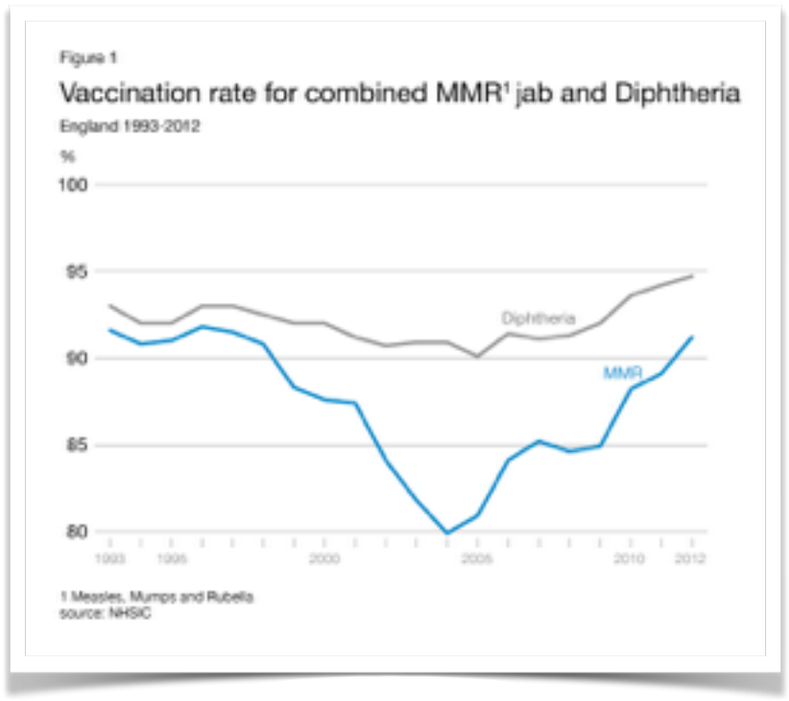
does the y axis have to start at 0?



Change over time

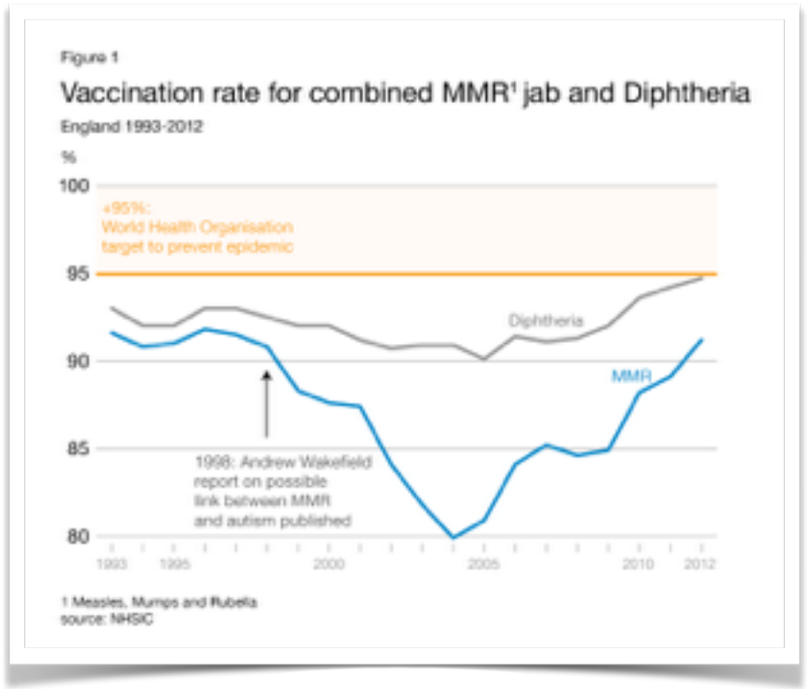
use scaling like a lens
for non-count data

not as criminal as with bar chart. probably more criminal to miss the opportunity for context



Change over time | add context...

add context – what's the story? add something more stable as a "control"?



Change over time

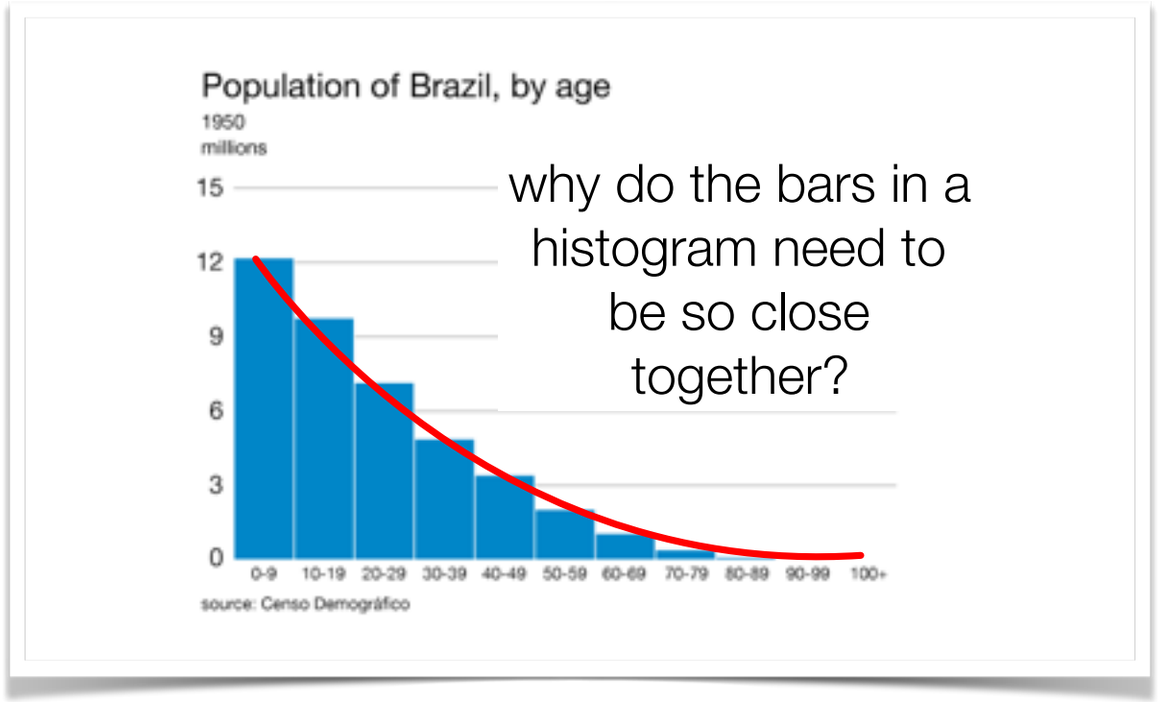
add context...until the message in the data is clear

All of the context!!

Don’t be afraid to write on your chart and be inventive with annotations.

especially important what with policy agenda!!

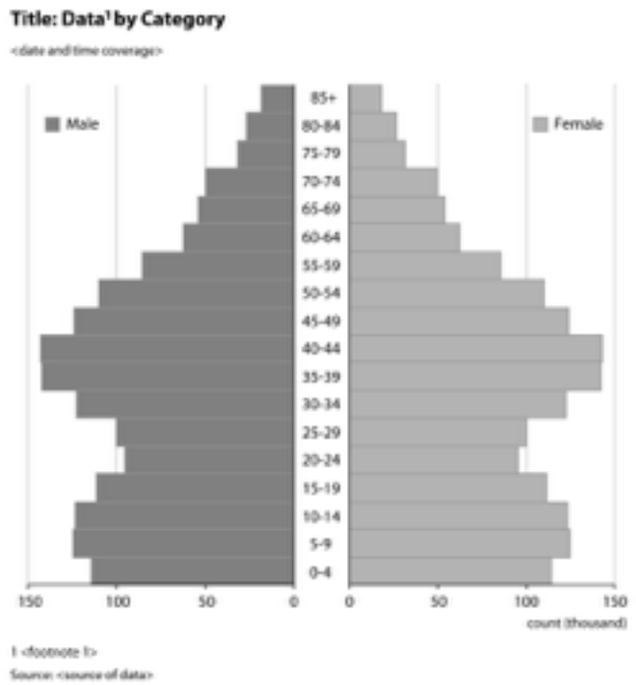
Distribution?



Single Distribution | a ‘histogram’

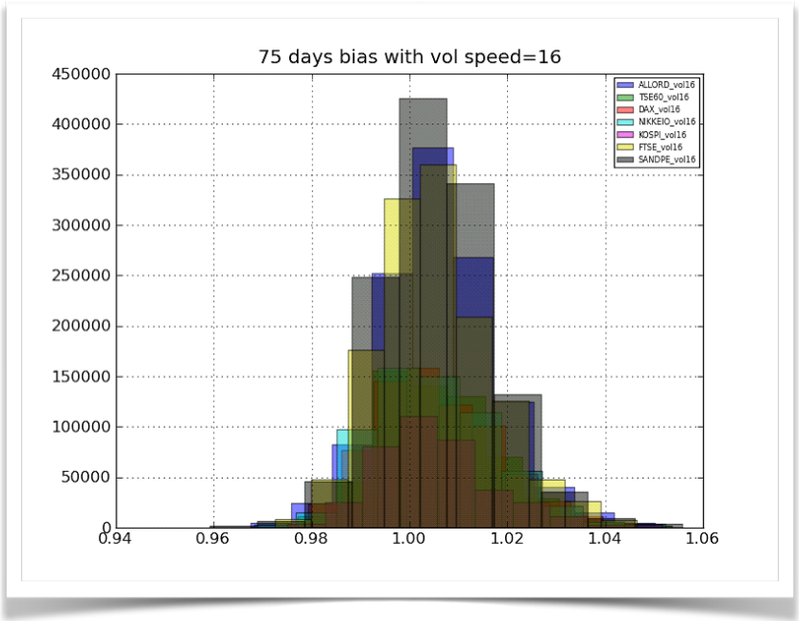
continuous data

Multiple Distributions?



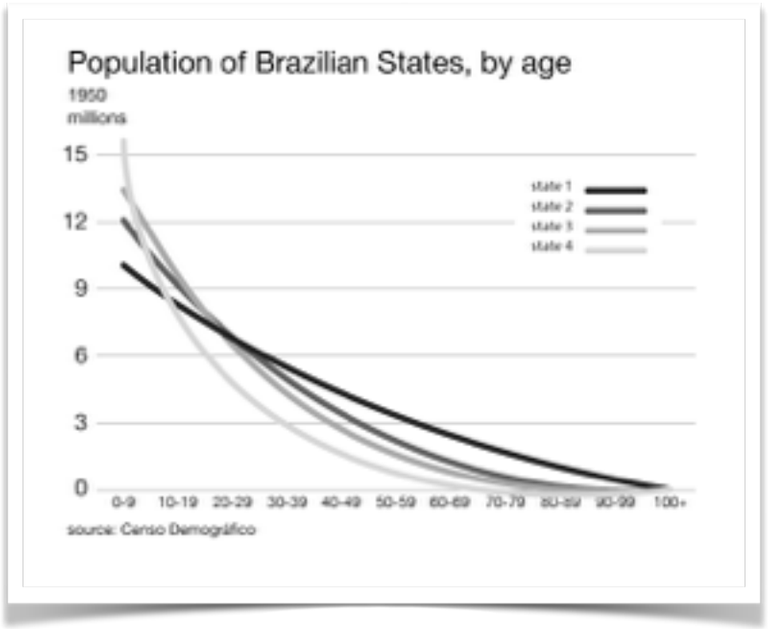
classic example of more than one distribution.

Multiple Distributions?



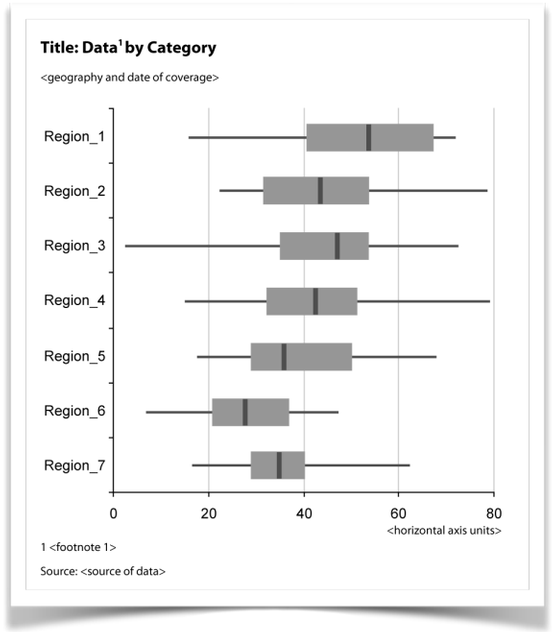
how not to show it!!

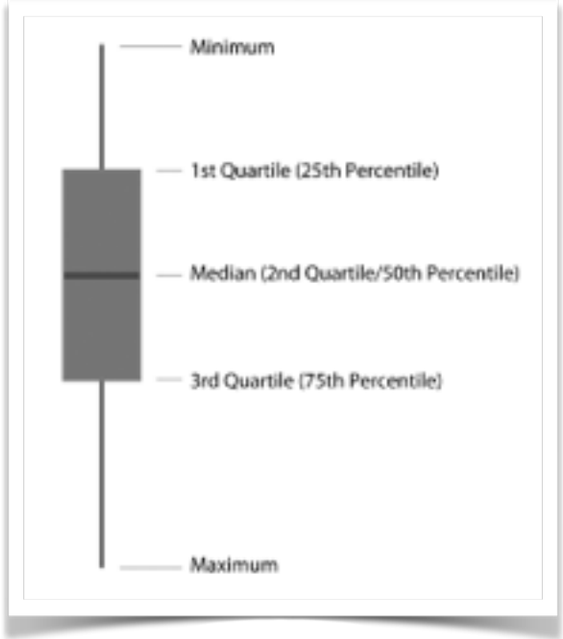
Multiple Distributions?



line charts are a legit approach - good for showing change over time, but no more than 3-4 lines

Multiple Distributions?





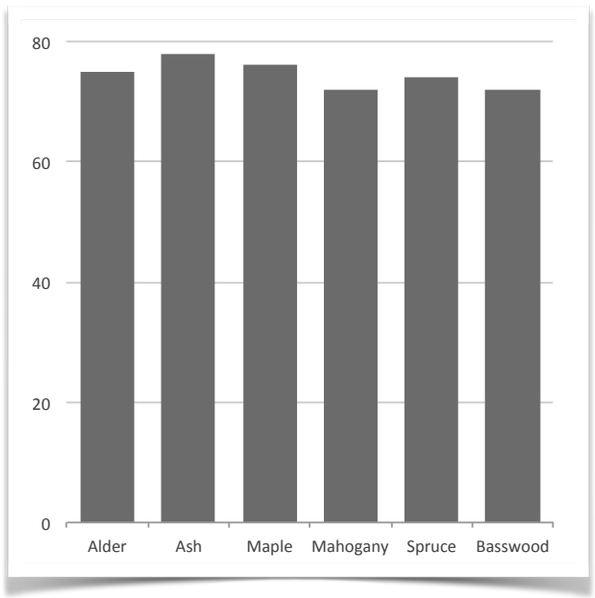
Perfectly fine, but going back to the social context and lack of numerical literacy.

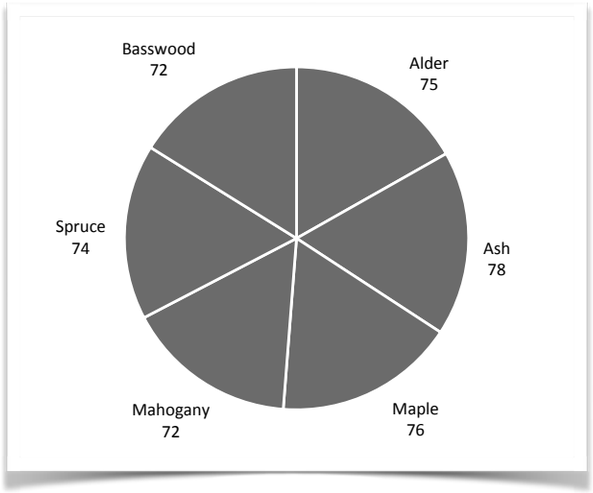
I’m not sure i’d like to see this in anything but the most specialist output

Multiple Distributions?

small multiples ftw!

Part-to-whole?

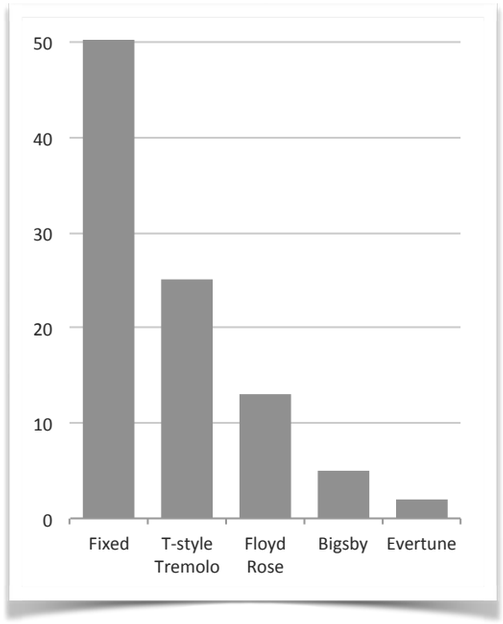


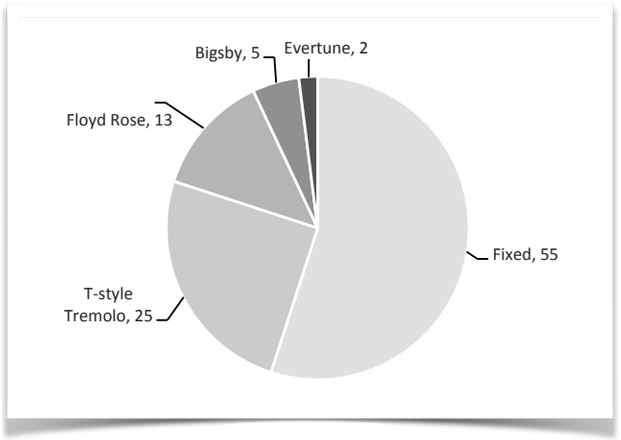


Part-to-whole

When might a bar graph be better than a pie chart?

tiny differences? try a bar?





Part-to-whole

When might a pie chart be better than a bar graph?

pie charts get some hate, but it’s not really justified.

great for this sort of data where there is disparity in categories.

Use a bar chart

when there are more than 5 categories

for showing small changes in the data accurately

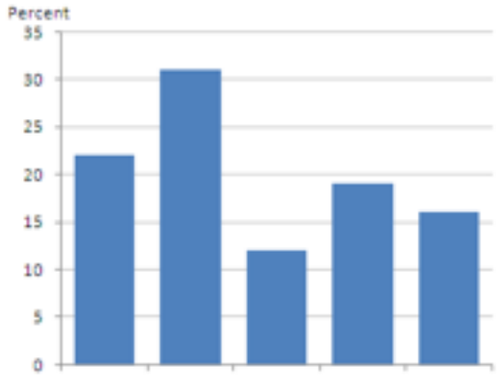
Use a pie chart

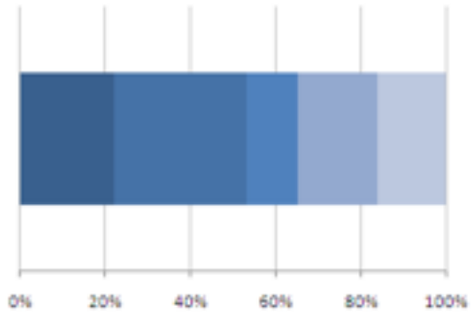
when there in a dominant value in the data series

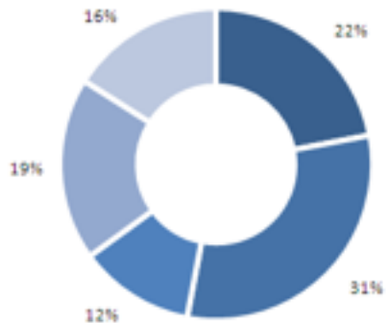
when there are fewer than 6 categories

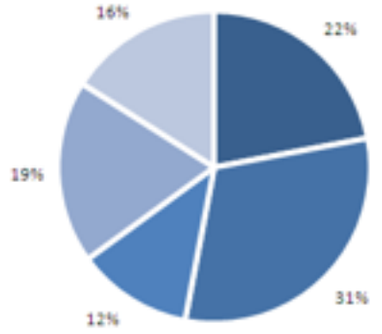
Part-to-whole

the trade-off









Part-to-whole

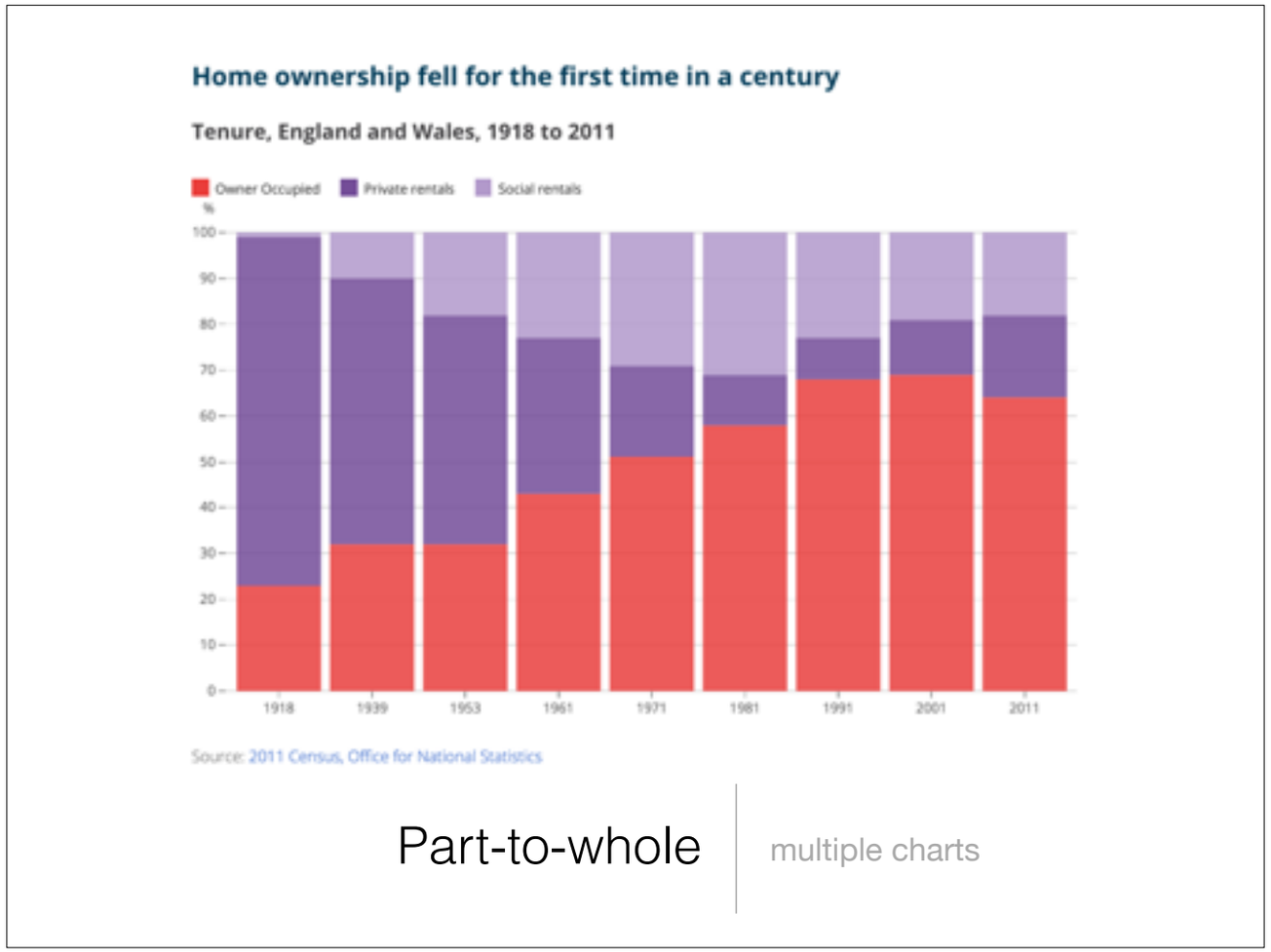
other chart types

Bar - comparisons easily made length 1D -length

Part to whole - comparisons difficult as no shared horizon 1D - length

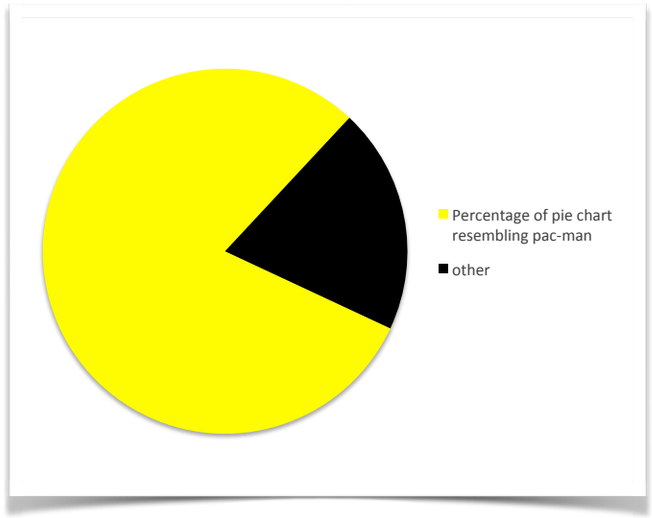
Pie - comparisons difficult because trying to compare differences in angles 2D- 2 sets of x,y coordinates in relation to the origin

Donut - Comparisons easier as seeing each sector as a curved bar so comparing (a distorted) length 1D



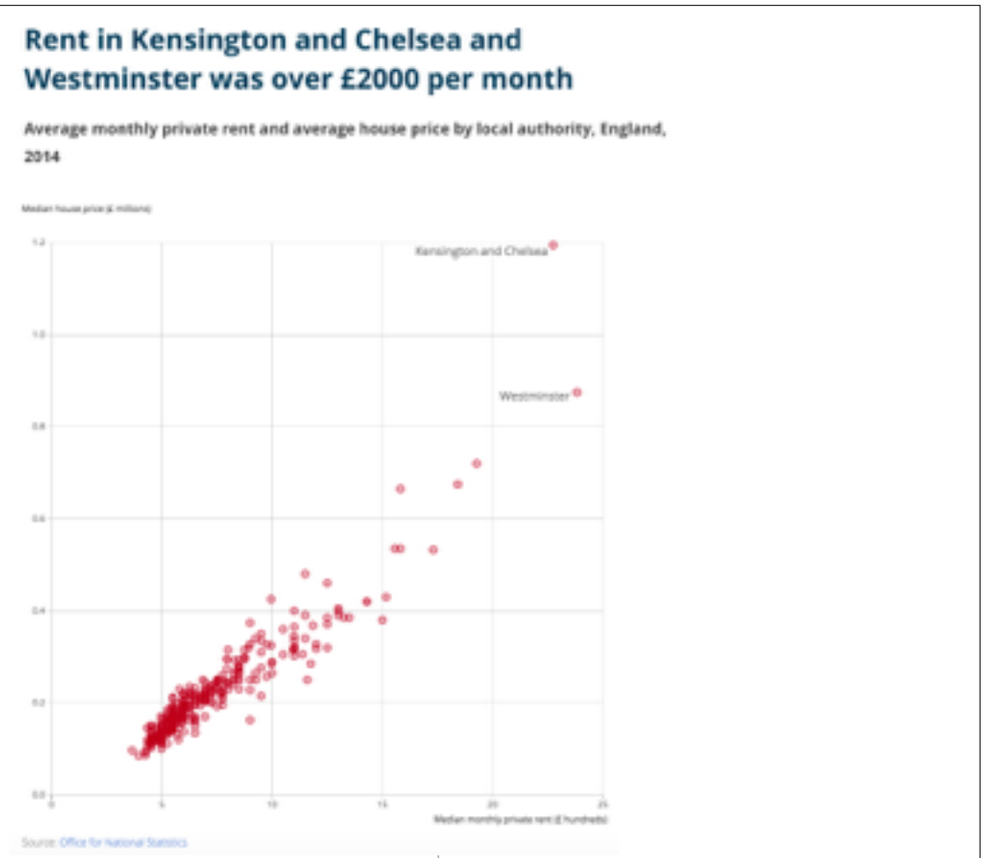
Part-to-whole | multiple charts

despite the lack of a “common horizon”, still a great chart because of the clear change over time.



Part-to-whole

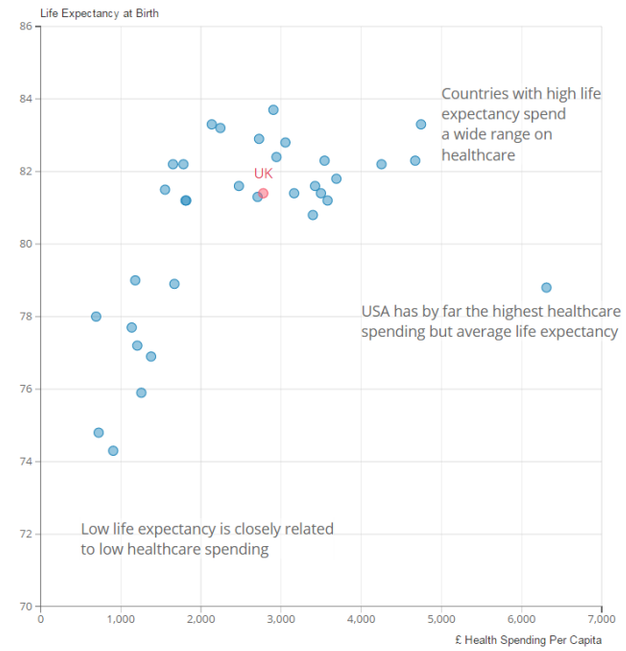
Correlation?



Correlation | scatterplot

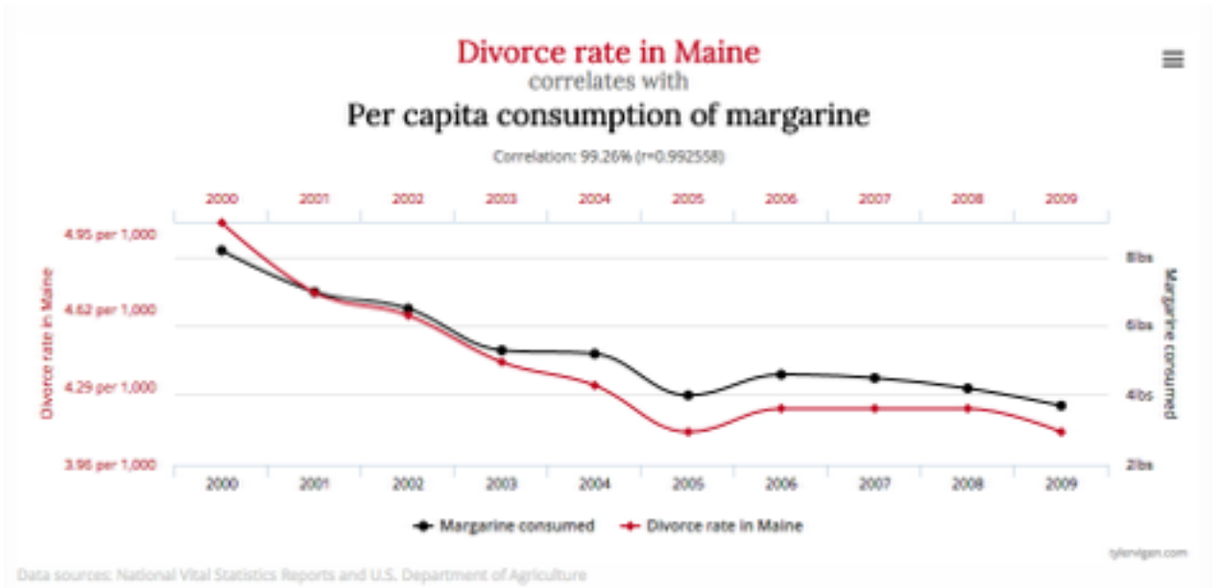
scatterplots great for showing trends and outliers

Life expectancy at birth and current healthcare expenditure, per person for OECD member-states (current PPPs), 2014

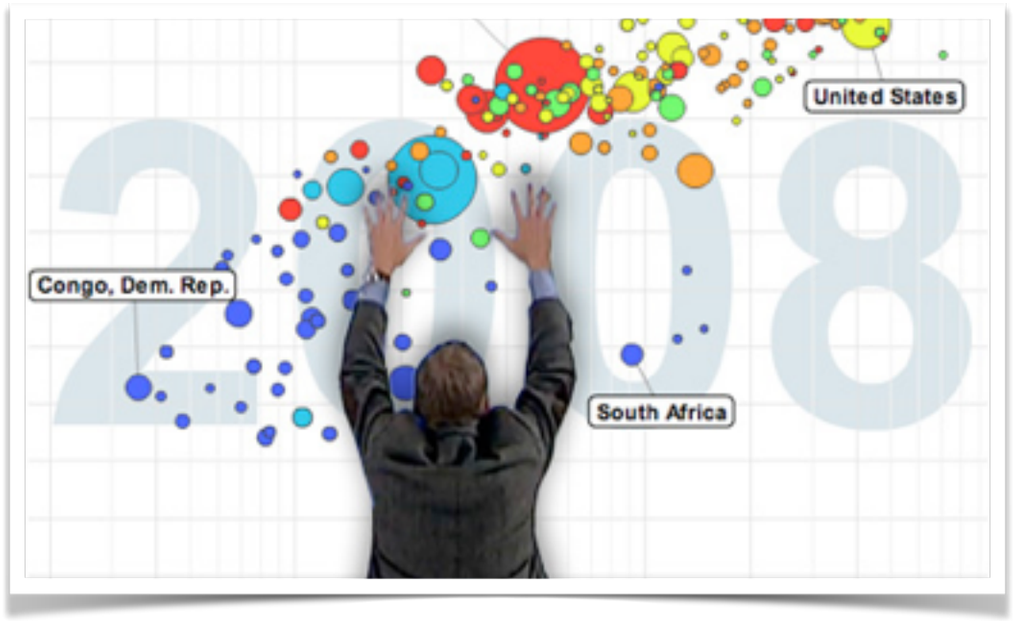


Correlation | scatterplot

my favourite recent scatterplot - USA an easy target



beware though - correlation does not imply causation!



Correlation

adding extra variables

x =income
y = lifespan

bubble size = population size
colours = continents

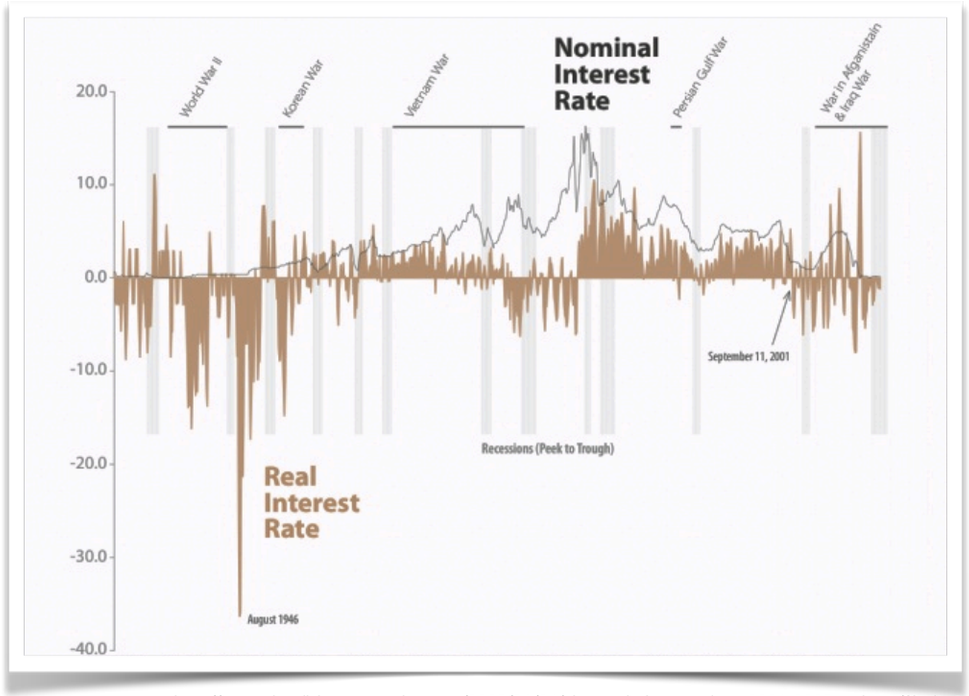
animates through time

https://www.youtube.com/watch?v=jbkSRLYSojo

Deviation?

Deviation | bars

Rank deviation – we've just changed the common horizon to a value other than 0

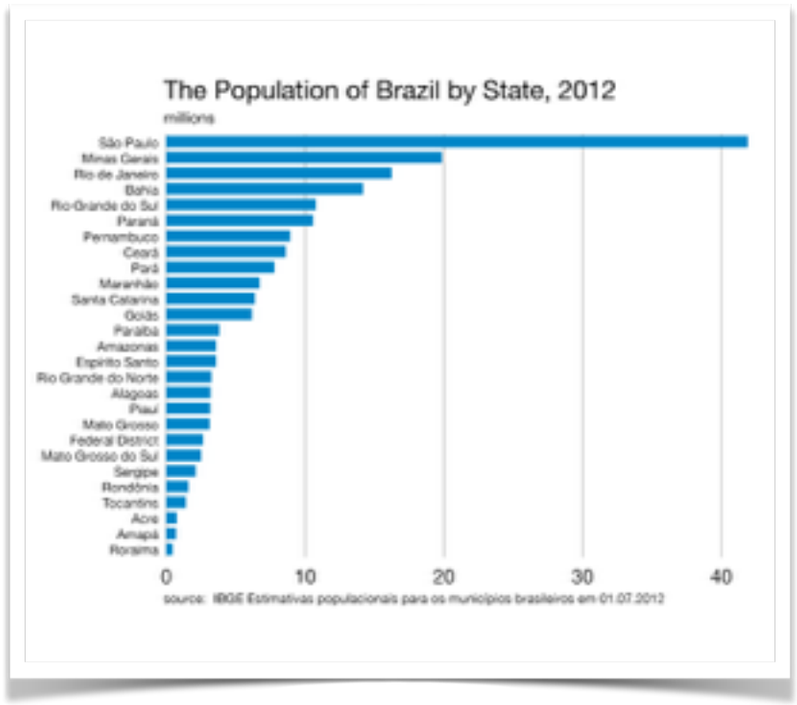


source: http://www.visualizingeconomics.com/2009/01/04/change-in-home-prices-2001-2008-nytimes/?isalt=0

Deviation | over time,annotated

great example of complicated data brought to life by annotation.

Ranking?



Ranking

ordered bars

Further study

- Few, S. (2012 2nd ed). Show Me the Numbers: Designing Tables and Graphs to Enlighten. Analytics Press
- Tufte, E.R. (1985). The Visual Display of Quantitative Information. Graphics Press.
- Tufte, E.R. (1997). Visual Explanations. Graphics Press.
- Tufte, E.R. (2006). Beautiful Evidence.
- Bertin, J (1967). Sémiologie Graphique. Les diagrammes, les réseaux, les cartes. With Marc Barbut [et al.]. Paris : Gauthier-Villars. (Translation 1983. Semiology of Graphics by William J. Berg.)
- Wilkinson, L. (2005). The Grammar of Graphics. Springer.
- Good essay on slopegraphs. http://charliepark.org/slopegraphs/

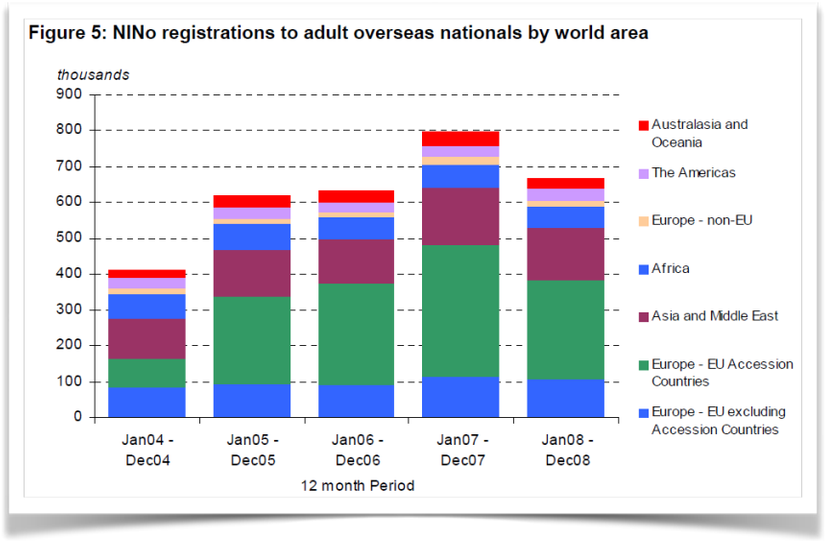
Colour

two main things to remember

Roy Lichtenstein

“Colour is crucial in painting, but it is very hard to talk about. There is almost nothing you can say that holds up as a generalization, because it depends on too many factors”

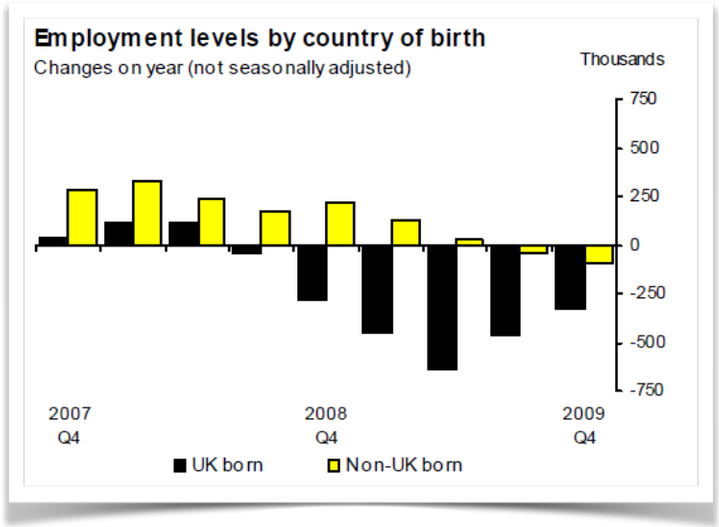
Exhibit A



What the first thing you do when you get a long report? Print it?

GET IT RIGHT IN B&W!!

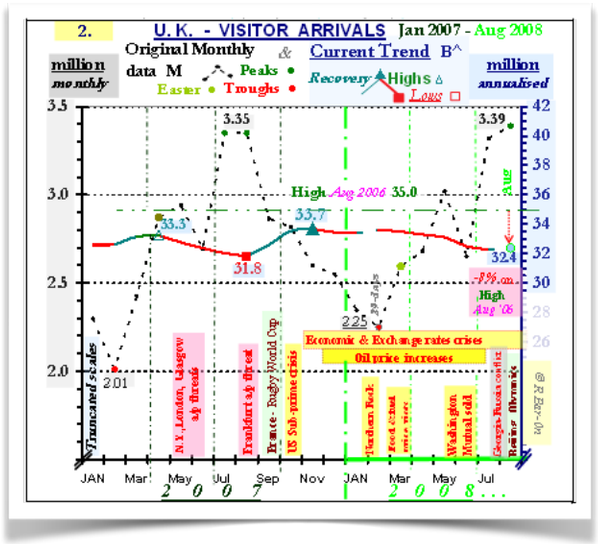
Exhibit B

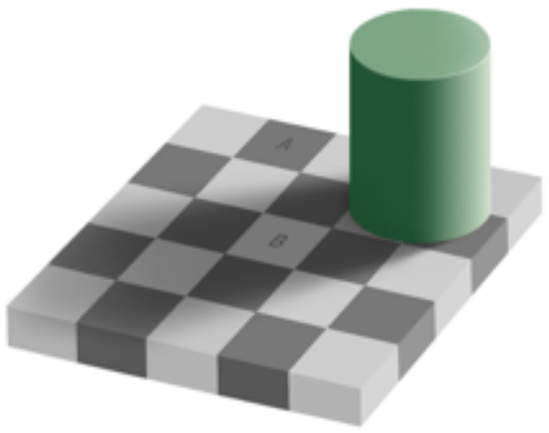


weird choice of colour for most, but for somebody who has difficulty perceiving colour, actually not bad.

Exhibit C

We use colour codes *(optional, p. 11)* to enliven reports and assist in explanations….

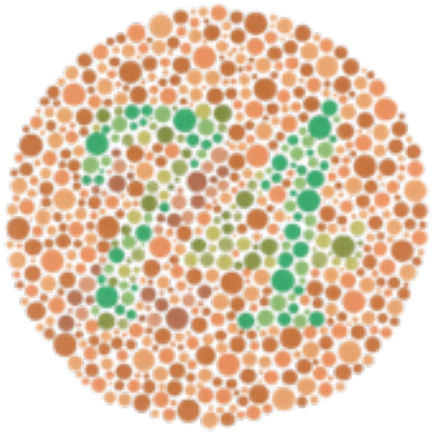



A
B

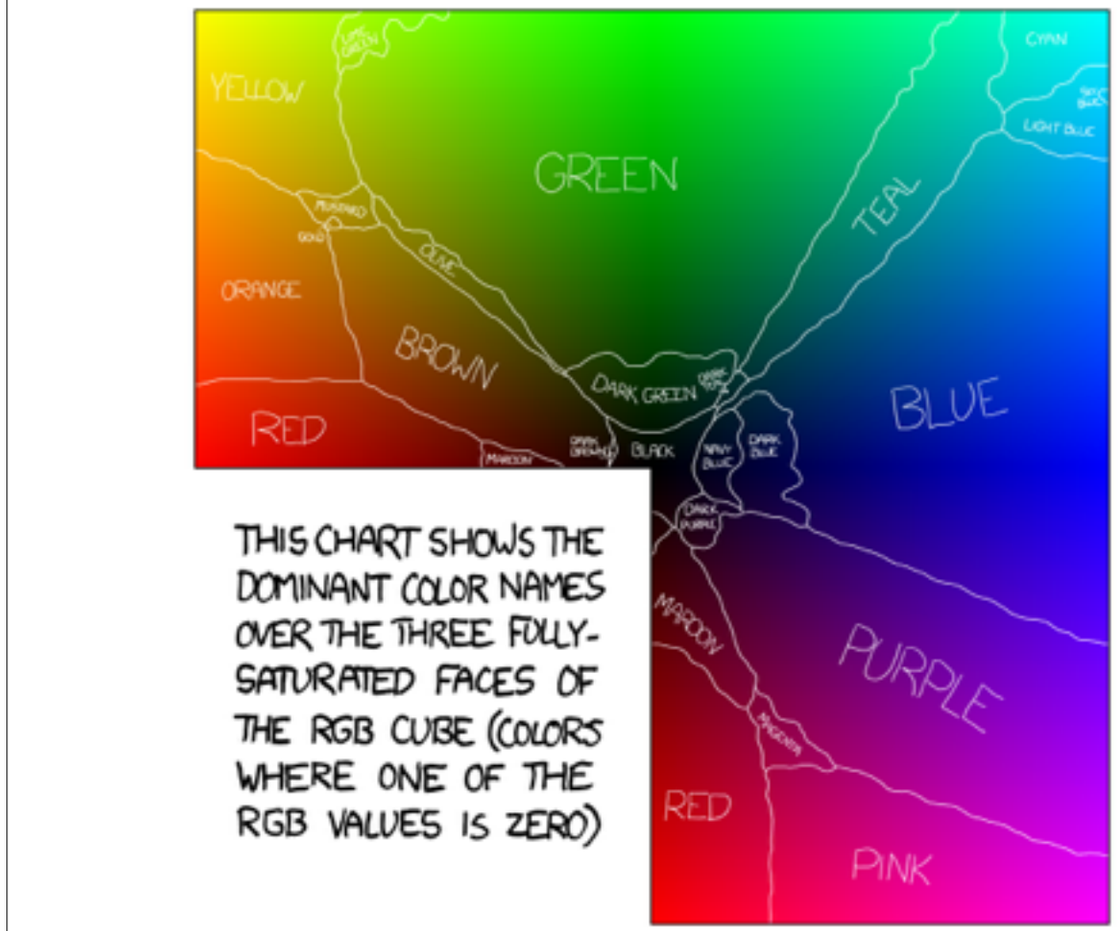

A
B

Ishihara Colour Test

- A series of 38 test plates to diagnose colour blindness
- Between 7-10% of males suffer from a form of red/green colour-blindness
- Other forms of colour-blindness rarer - but can be found in females
- Form part of W3C requirements on accessibility



which colour is the least ambiguous??

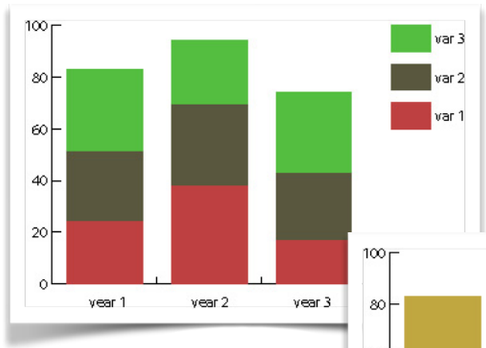


of the nameable colours, which ones occupy the most space?

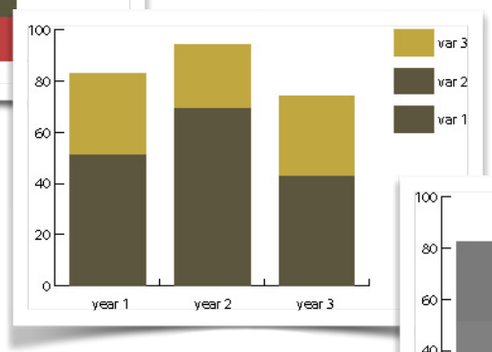
yellow is very small

blue is very big

The abuse of colour

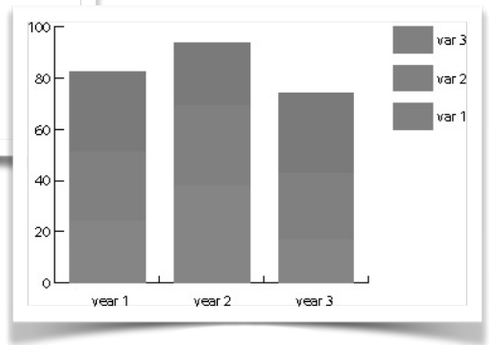


standard graph
(corporate colours)



red/green
colour blind

grey print



Introducing colour models

What colour is this?

RGB(255, 147, 0)

HTML traditionally uses hexadecimal conversions of the RGB value to define colour.

#FF9300

HSB(35°,100%, 100%)

CMYK(74%, 71%, 64%, 87%)

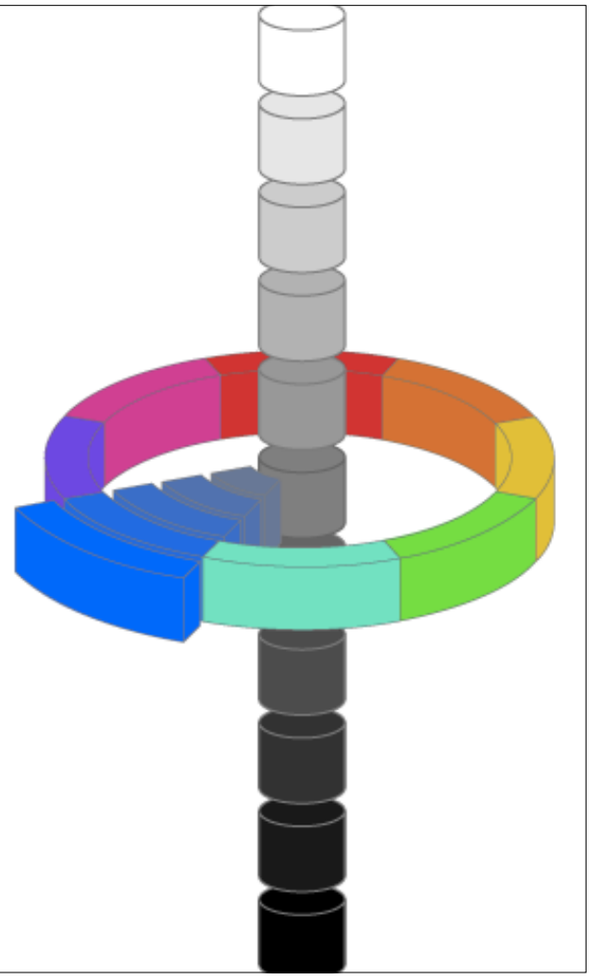
introducing HSL

Use the HSL cylindrical co-ordinate system for RGB colourspace to make accessible yet functional colour palettes

H = Hue (nameable colour)

S = Saturation

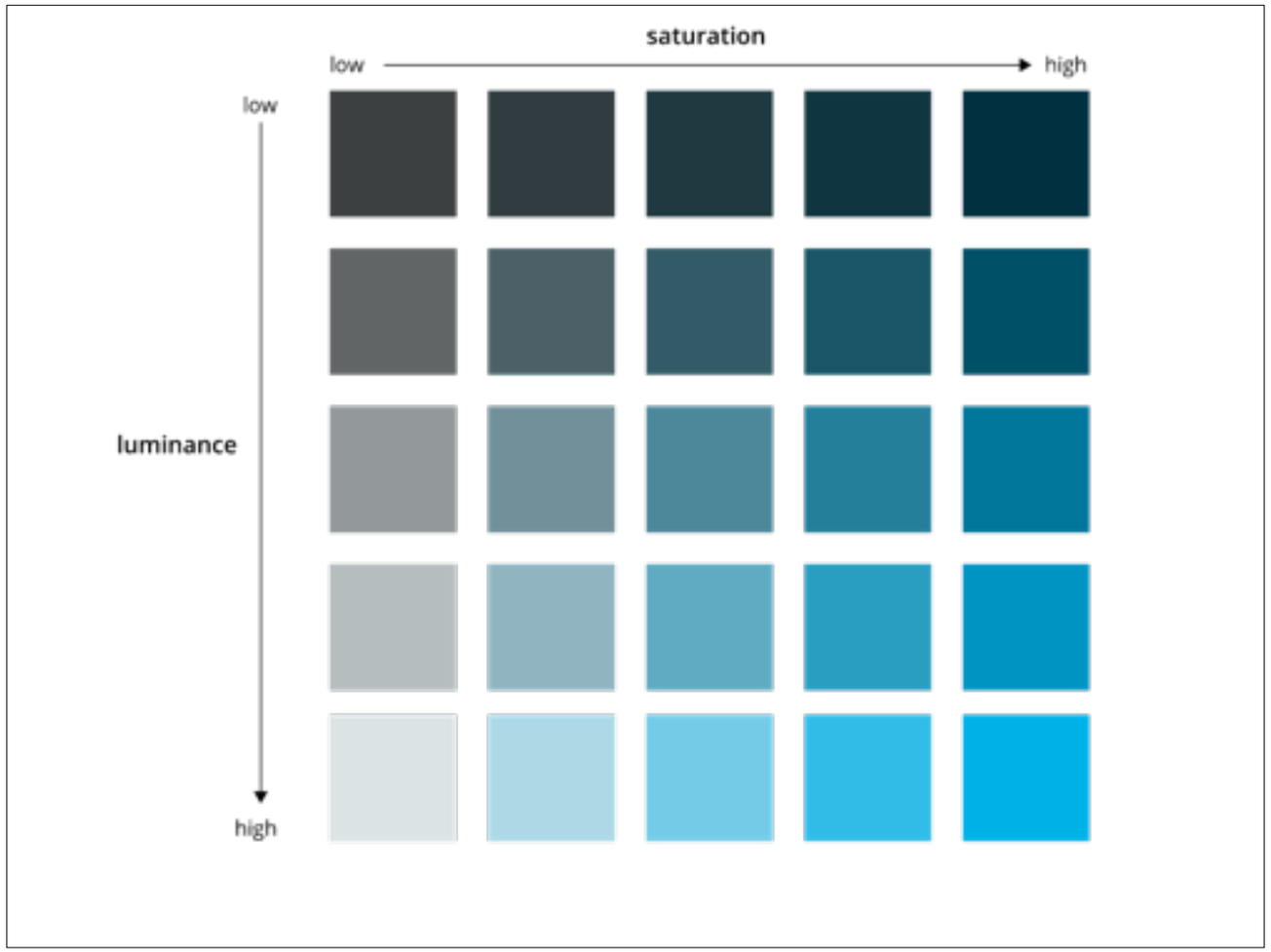
L = Luminance (lightness)



Hue - which is greater? red or green?

you can’t rank hue

you can rank sat and lum

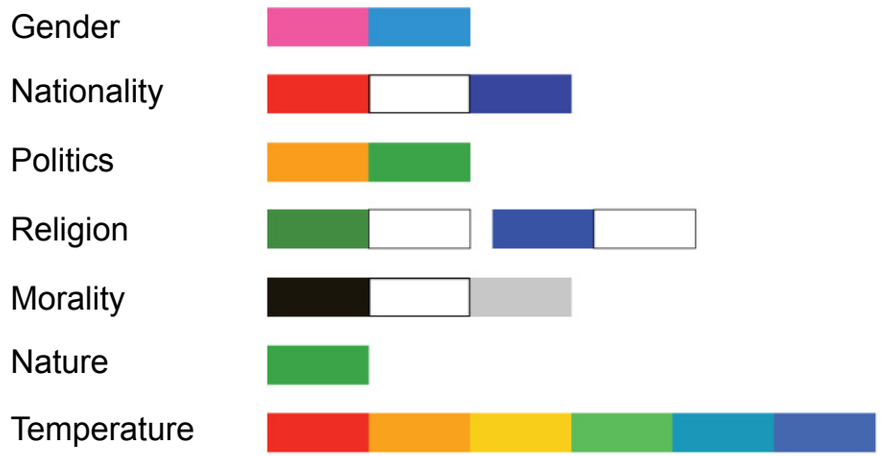

saturation
low
high
low
luminance
high

Principles for use of Colour

- Design everything in grey-scale (luminance contrast) and add colour as a secondary process
- Use colour (hue) sparingly - and never on its own to specify something in the data. Mid-luminance, highly saturated colours are your highlight colours
- Hue best for qualitative, luminance and saturation contrast best for quantitative differences.
- The safest starting point when picking an appropriate hue is blue
- “Red and Green should rarely be seen”

Think about where your eye’s drawn to…

Colour is meaningful



colour and context!

Further study

- Simulate colour blindness on images. http://www.etre.com/tools/colourblindsimulator

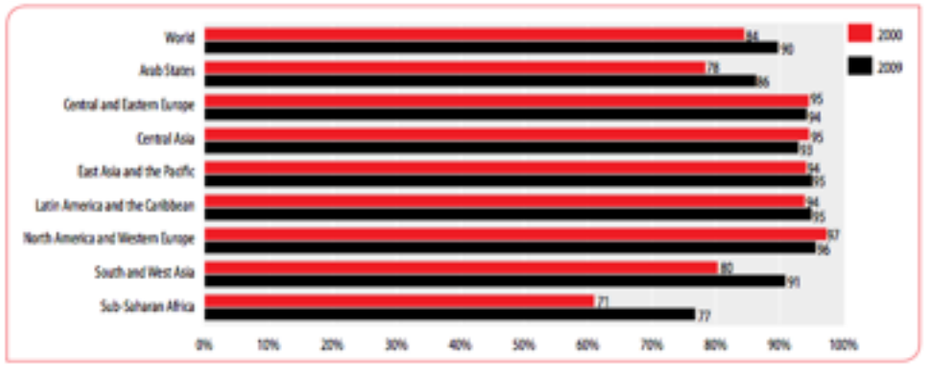
- Colorbrewer - online color-palette generator. http://colorbrewer2.org

Exercise

The visual variables in action - discussion in groups

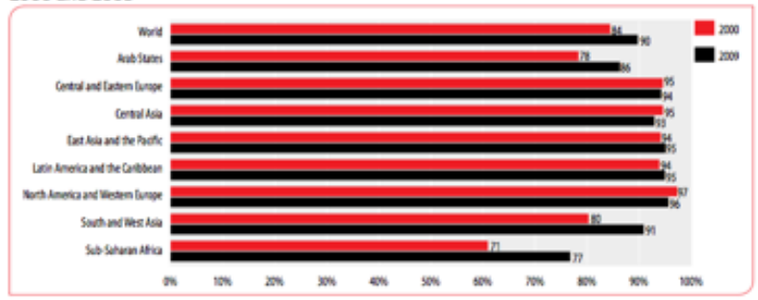
1. What are the statistical relationships being symbolised?
2. What is the overall message of the graph?
3. Is it ‘successful’?
4. Can you think of any other ways of visualising some or all of the data in the graph - and what impression would it give the reader?

Figure 1: Progress in participation in primary education, by adjusted net enrolment rate, 2000 and 2009



Source: Statistical Annex, UIS, 2011.

Figure 1: Progress in participation in primary education, by adjusted net enrolment rate, 2000 and 2009



Source: Statistical Annex, UIS, 2011.

Magnitude, part to whole, change over time, ranking, spatial all present

magnitude

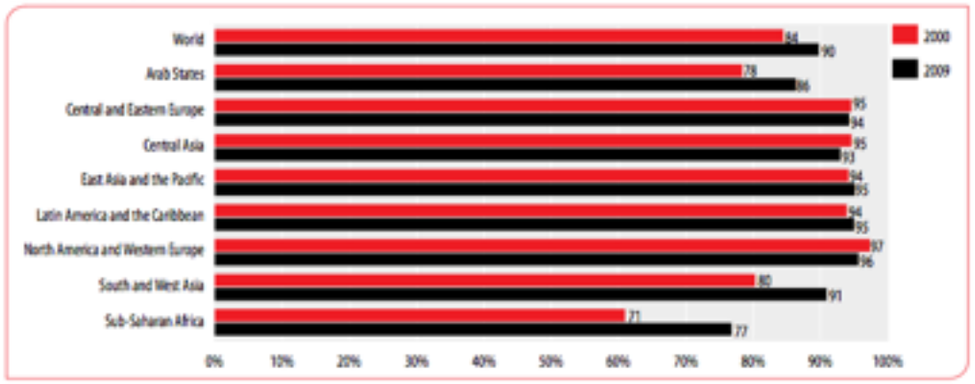
change over time

part-to-whole

ranking

spatial

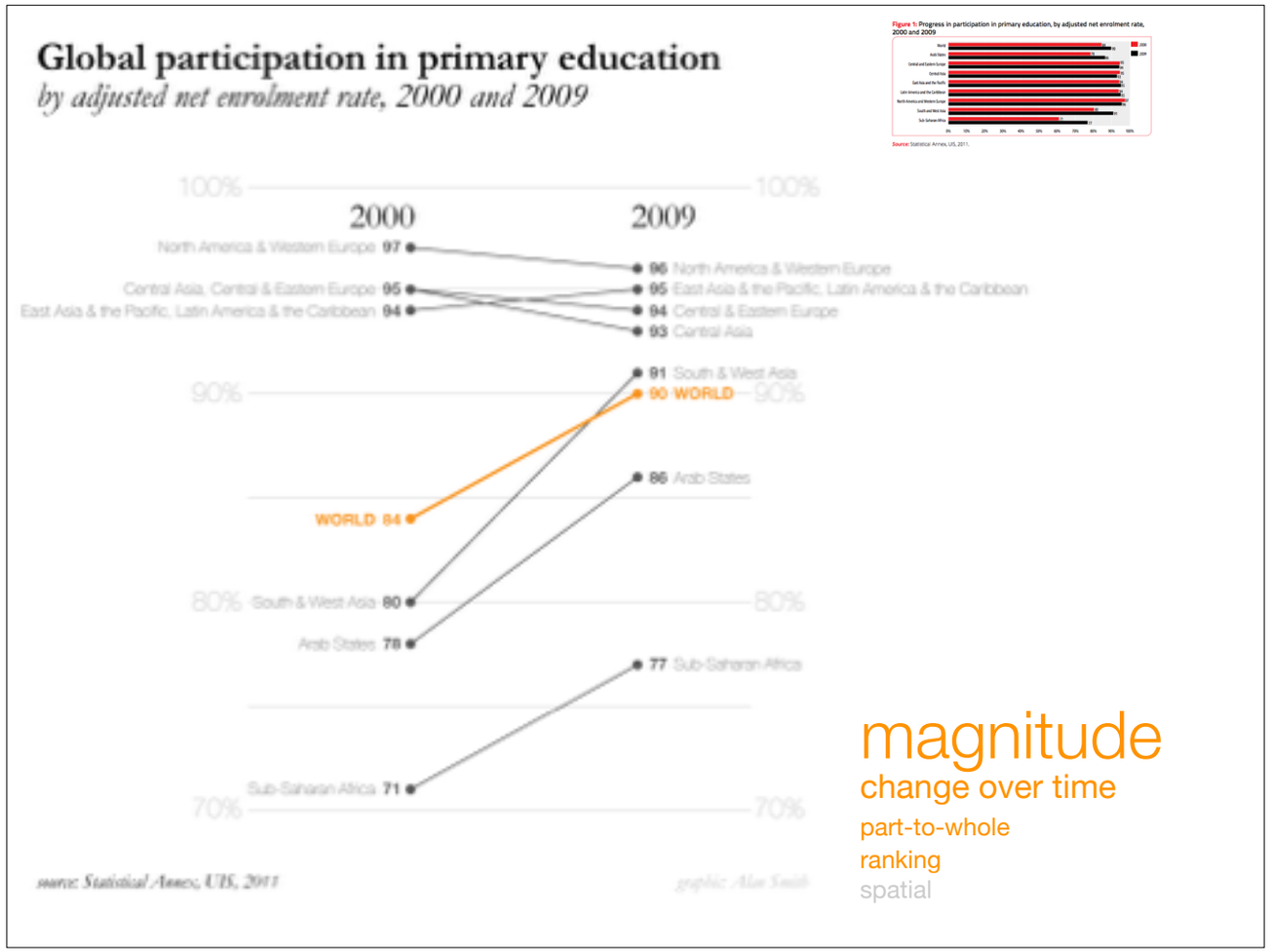
Figure 1: Progress in participation in primary education, by adjusted net enrolment rate, 2000 and 2009



Source: Statistical Annex, UIS, 2011.

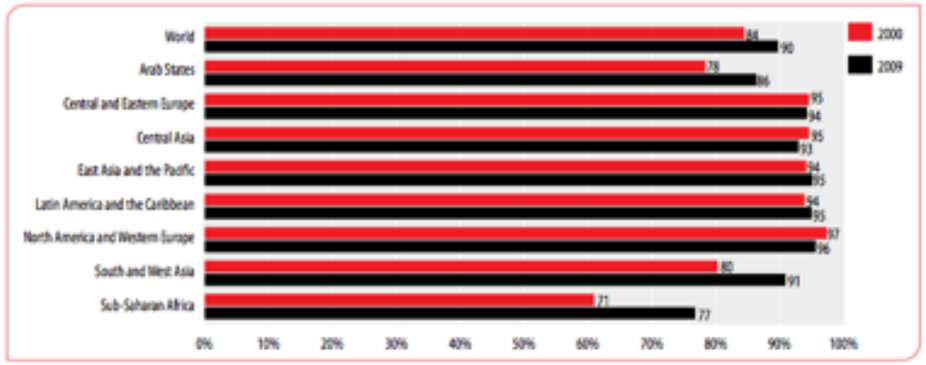
But magnitude is the relationship give priority.

Is this the most important relationship? How about change over time?



4 of the relationship are now covered and messages/patterns are clearer

Figure 1: Progress in participation in primary education, by adjusted net enrolment rate, 2000 and 2009



Source: Statistical Annex, UIS, 2011.

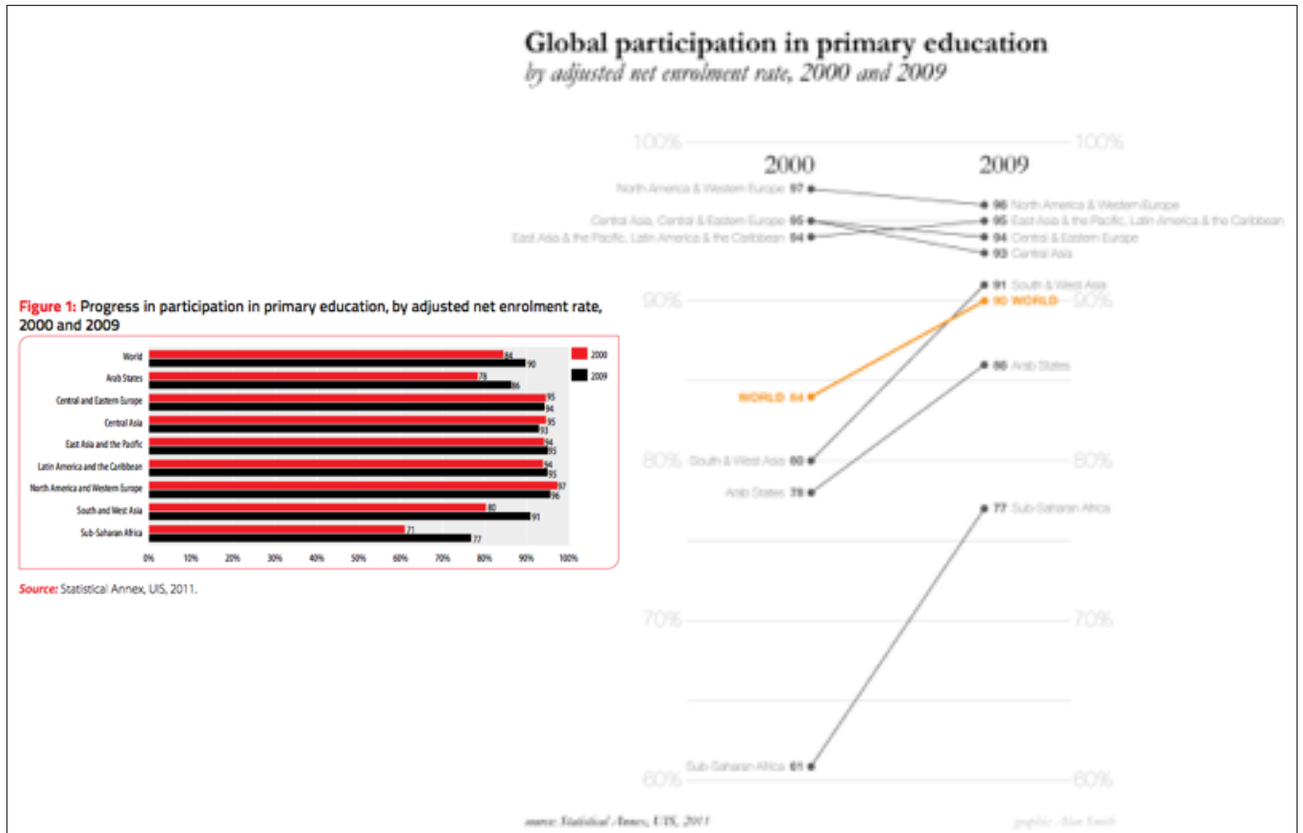
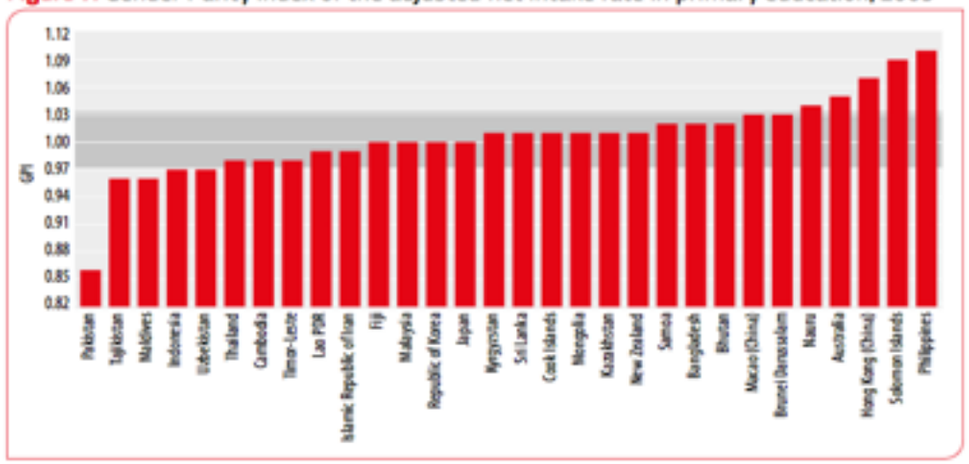


Figure 1: Progress in participation in primary education, by adjusted net enrolment rate, 2000 and 2009

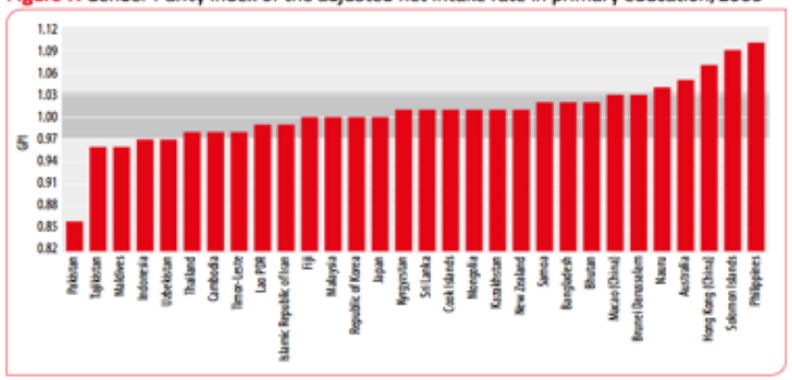
Source: Statistical Annex, UIS, 2011.

Figure 7: Gender Parity Index of the adjusted net intake rate in primary education, 2009



Source: UIS, 2011, Statistical Table 2.

Figure 7: Gender Parity Index of the adjusted net intake rate in primary education, 2009



Source: UIS, 2011, Statistical Table 2.

magnitude **deviation**

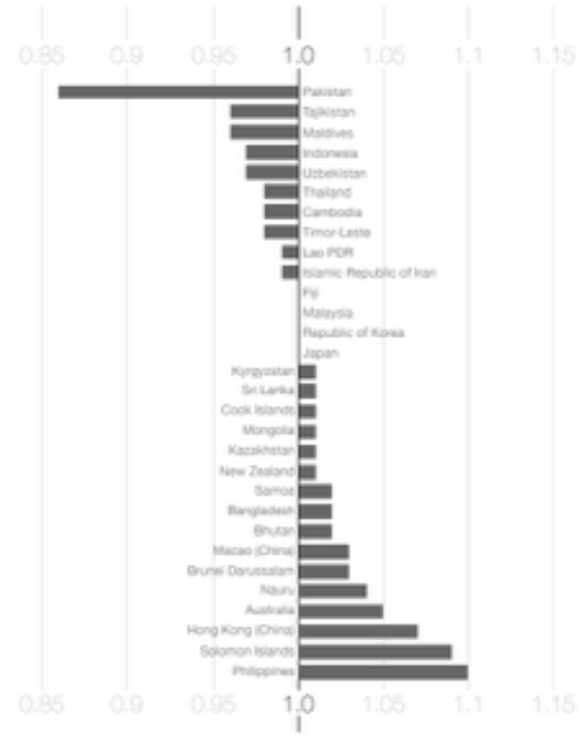
part-to-whole **change over time**

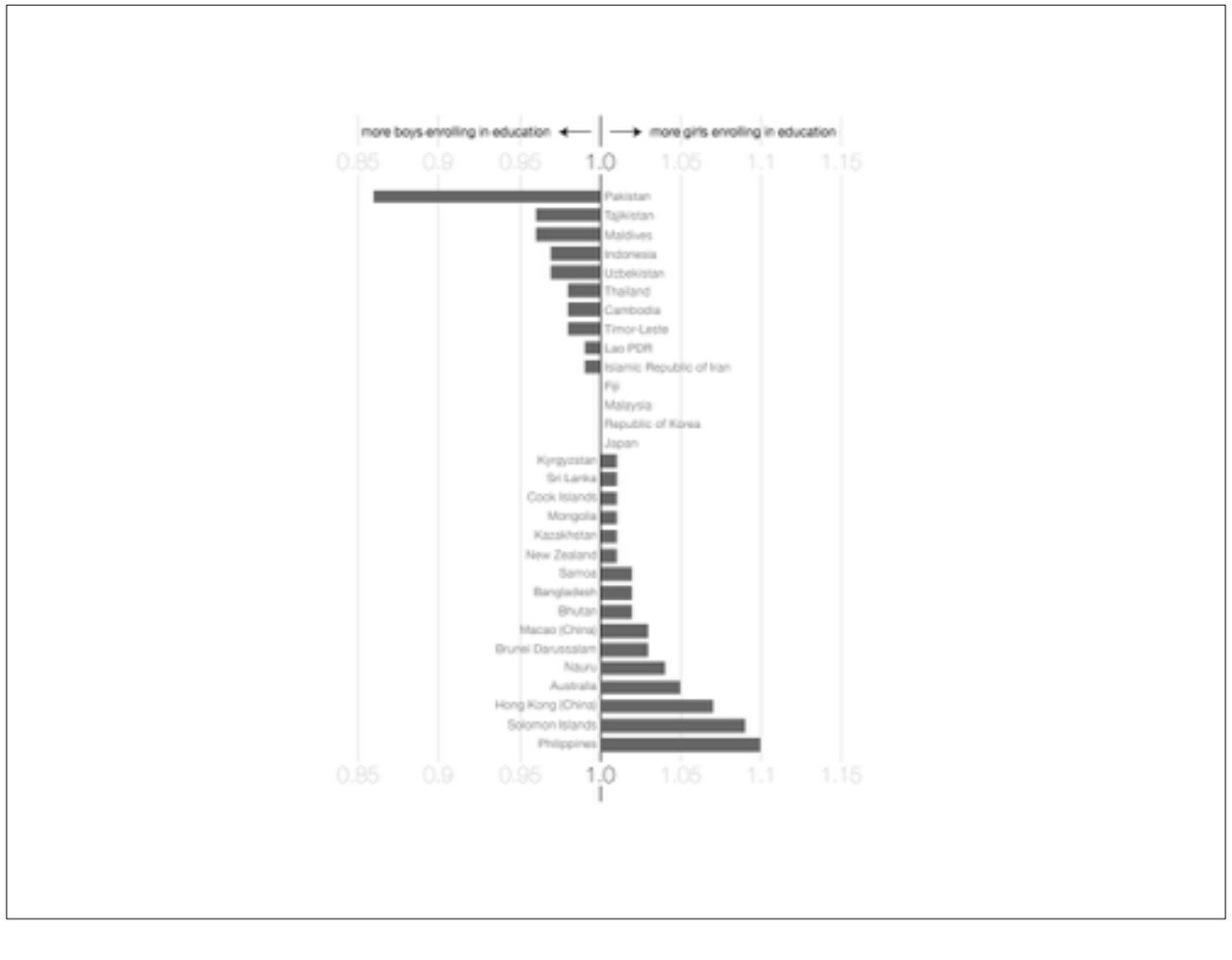
uncertainty ranking spatial

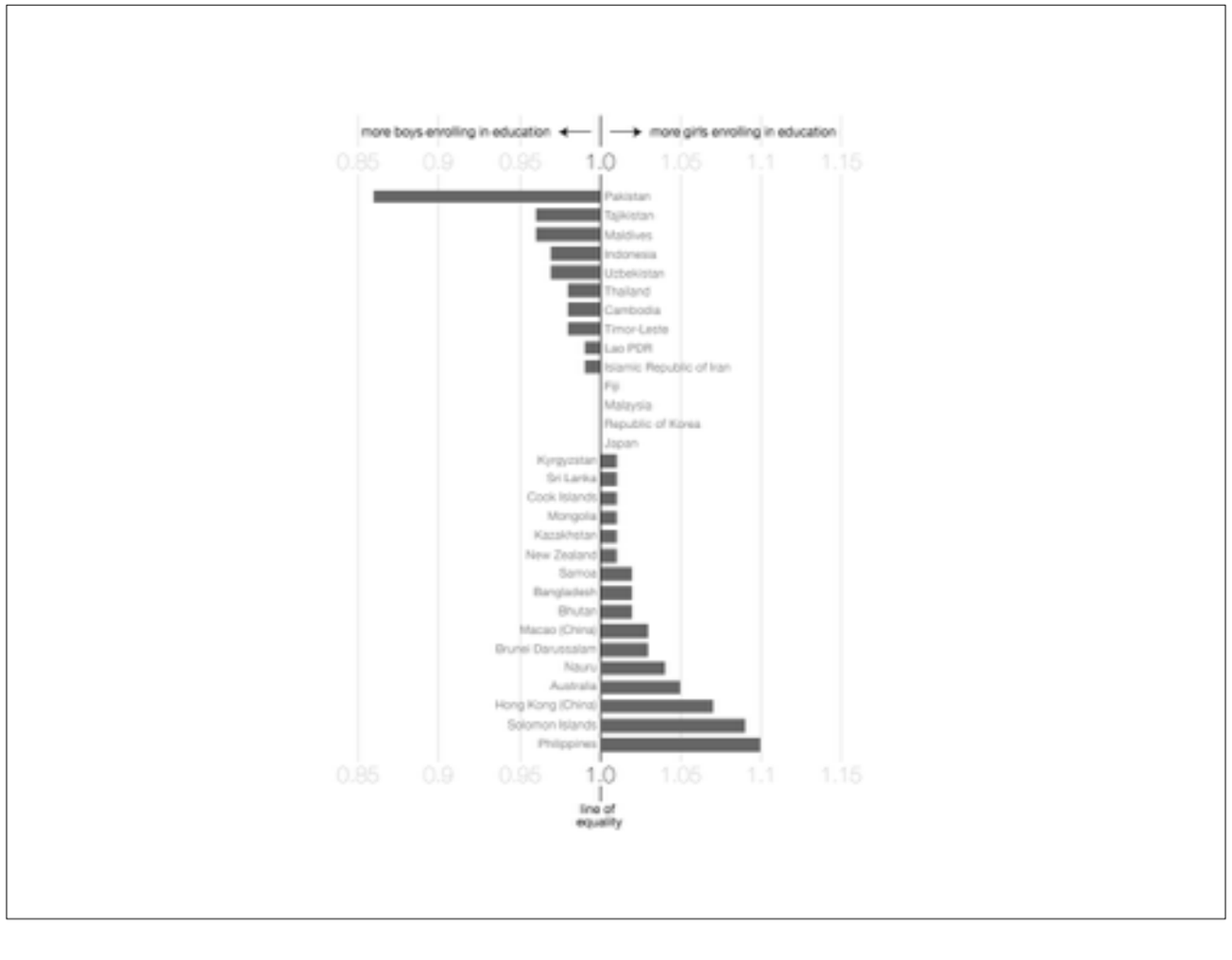
correlation **distribution**

magnitude, deviation and ranking all in data but only ranking and magnitude considered. Flip on head and think about deviation as primary relationship

deviation ranking




more boys enrolling in education
more girls enrolling in education
0.85
0.9
0.95
1.0
1.05
1.1
1.15
Pakistan
Tajikistan
Maldives
Indonesia
Uzbekistan
Thailand
Cambodia
Timor-Leste
Lao PDR
Islamic Republic of Iran
Fiji
Malaysia
Republic of Korea
Japan
Kyrgyzstan
Sri Lanka
Cook Islands
Mongolia
Kazakhstan
New Zealand
Samoa
Bangladesh
Bhutan
Macao (China)
Brunei Darussalam
Nauru
Australia
Hong Kong (China)
Solomon Islands
Philippines
0.85
0.9
0.95
1.0
1.05
1.1
1.15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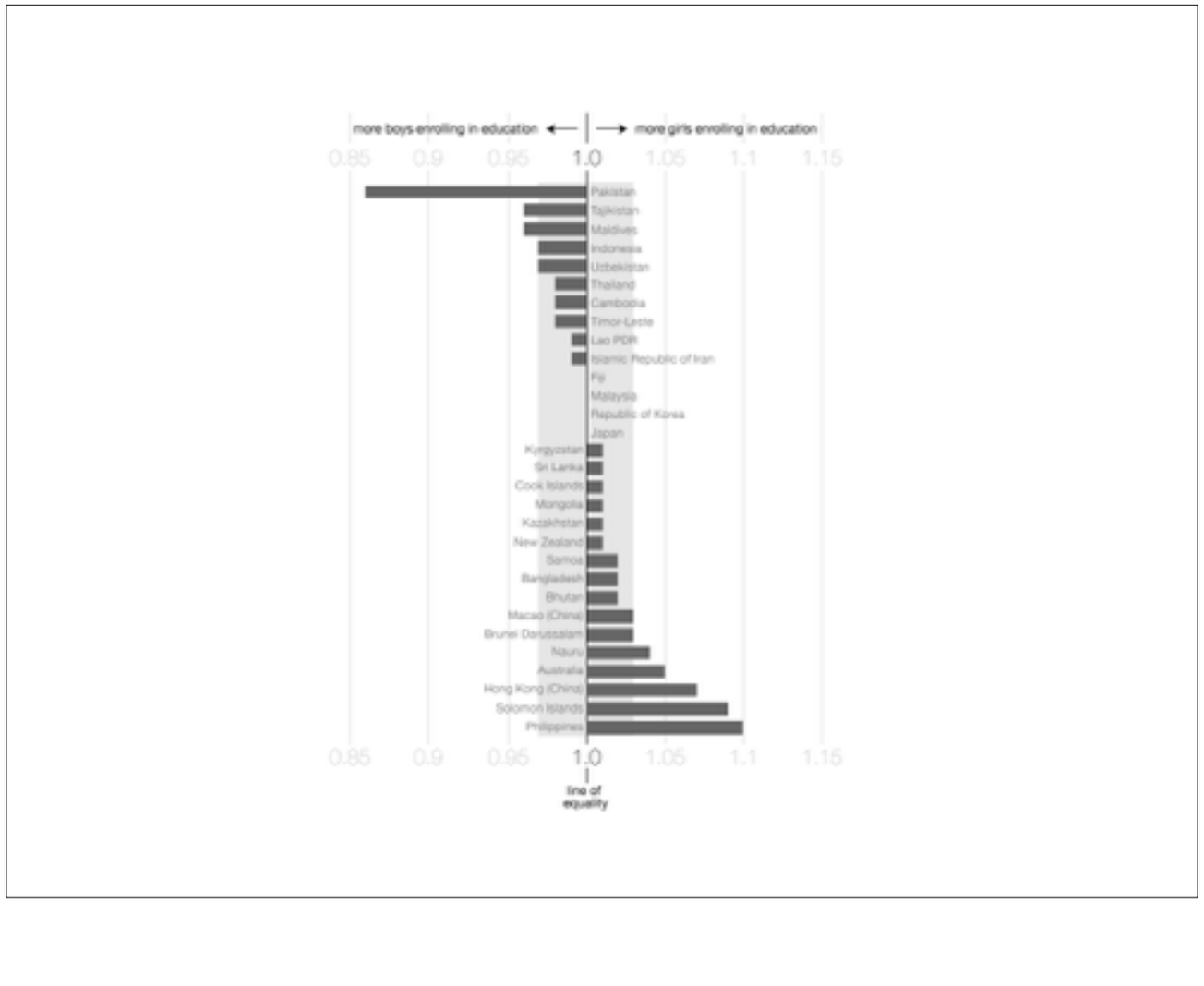
Fiji
Malaysia
Republic of Korea
Japan
Kyrgyzstan
Sri Lanka
Cook Islands
Mongolia
Kazakhstan
New Zealand
Samoa
Bangladesh
Bhutan
Macao (China)
Brunei Darussalam
Nauru
Australia
Hong Kong (China)
Solomon Islands
Philippines
0.85
0.9
0.95
1.0
1.05
1.1
1.15
line of equality


more boys enrolling in education
more girls enrolling in education
0.85
0.9
0.95
1.0
1.05
1.1
1.15
Pakistan
Tajikistan
Maldives
Indonesia
Uzbekistan
Thailand
Cambodia
Timor-Leste
Lao PDR
Islamic Republic of Iran
Fiji
Malaysia
Republic of Korea
Japan
Kyrgyzstan
Sri Lanka
Cook Islands
Mongolia
Kazakhstan
New Zealand
Samoa
Bangladesh
Bhutan
Macao (China)
Brunei Darussalam
Nauru
Australia
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Solomon Islands
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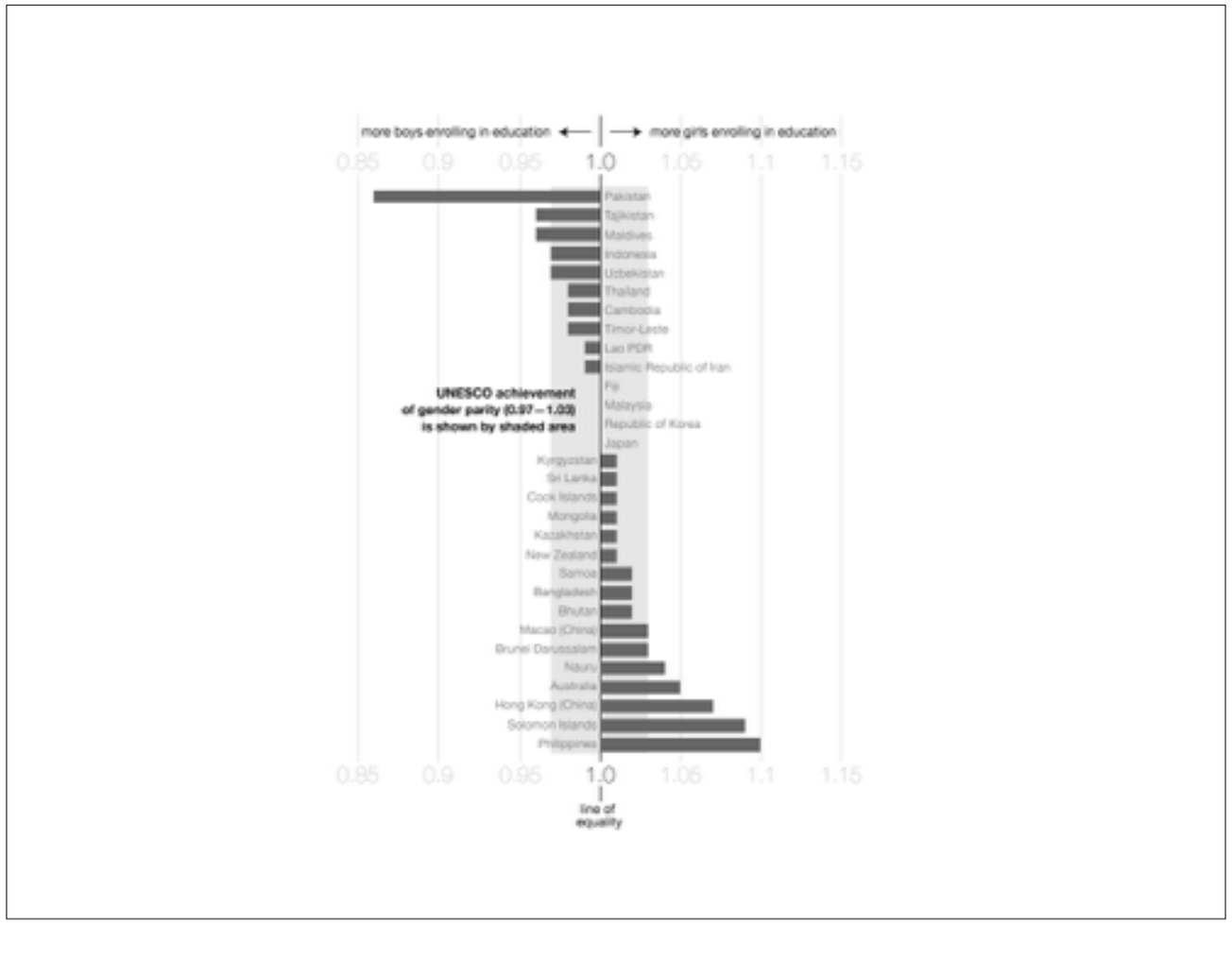
line of equality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Pakistan
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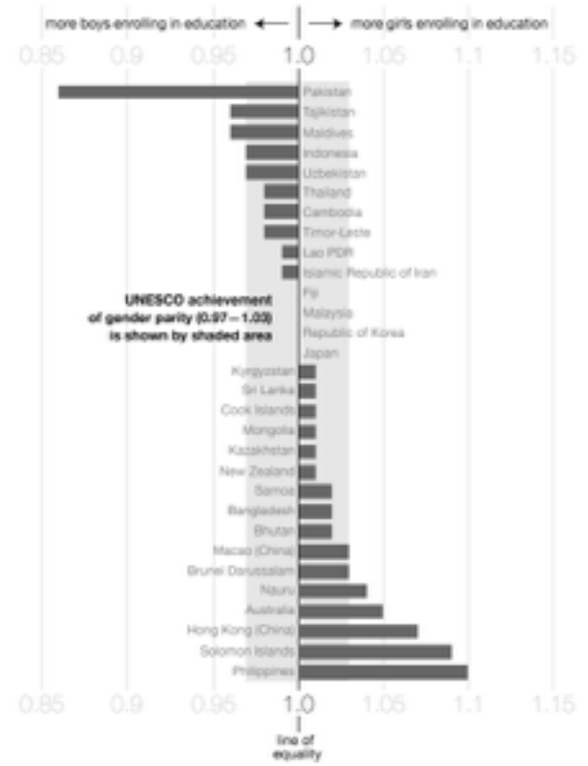
Islamic Republic of Iran
Fiji
Malaysia
Republic of Korea
Japan
Kyrgyzstan
Sri Lanka
Cook Islands
Mongolia
Kazakhstan
New Zealand
Samoa
Bangladesh
Bhutan
Macao (China)
Brunei Darussalam
Nauru
Australia
Hong Kong (China)
Solomon Islands
Philippines
UNESCO achievement
of gender parity (0.97 – 1.03)
is shown by shaded area
line of
equality

Gender Equality in Primary Education*

Selected Asia-Pacific Countries, 2009



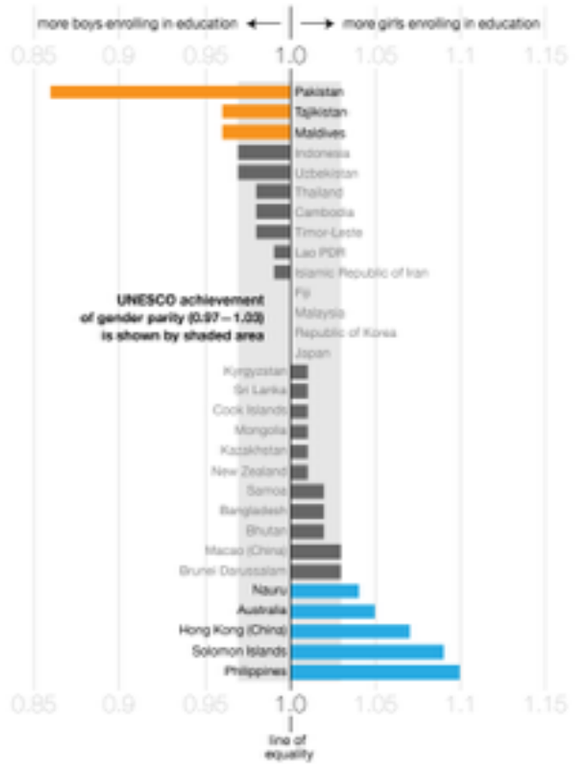
* Gender Parity Index (GPI) of adjusted net intake rate

source: UIS, 2011, Statistical Table 2

graphic: Alan Smith

Gender Equality in Primary Education*

Selected Asia-Pacific Countries, 2009



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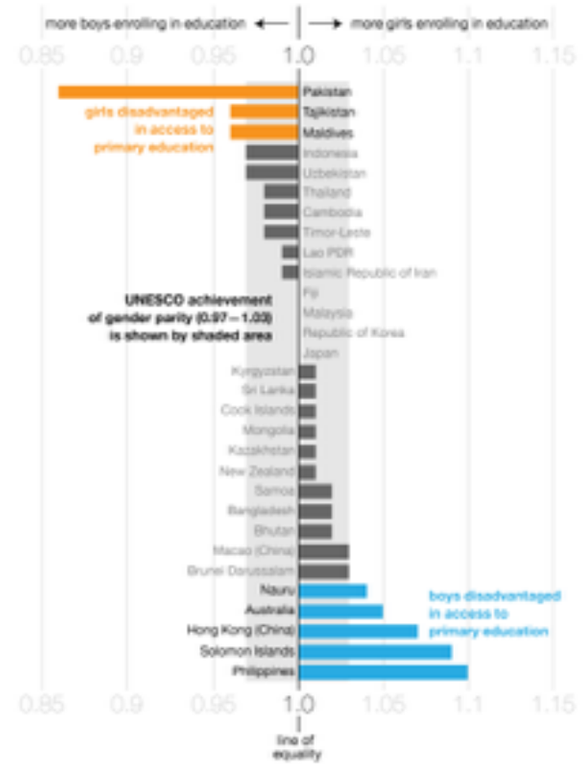

* Gender Parity Index (GPI) of adjusted net intake rate

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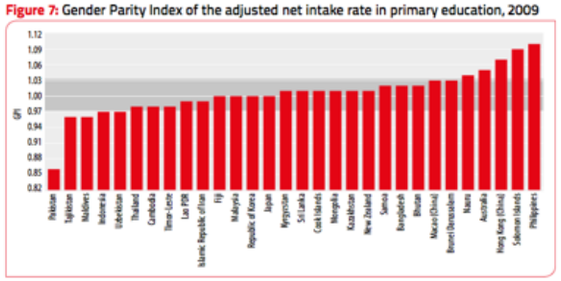
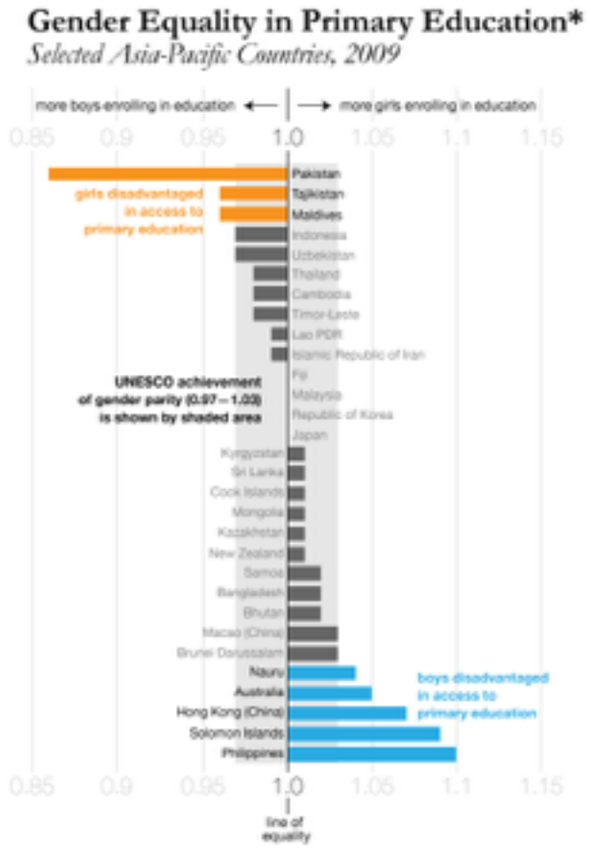
Figure 7: Gender Parity Index of the adjusted net intake rate in primary education, 2009



Source: UIS, 2011, Statistical Table 2.



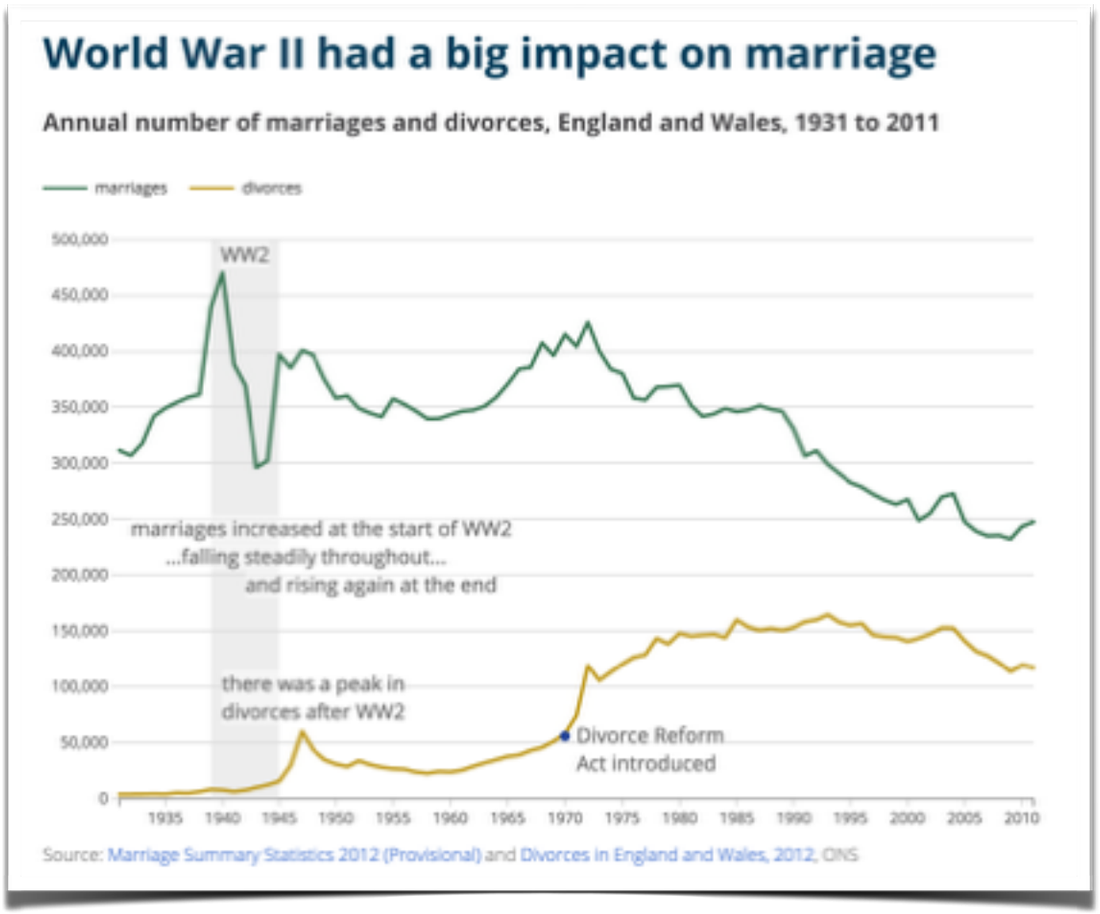
Annotations

Highlighting patterns and stories in a data set

David McCandless & Lee Byron - Information is beautiful

http://www.informationisbeautiful.net/2010/peak-break-up-times-on-facebook/

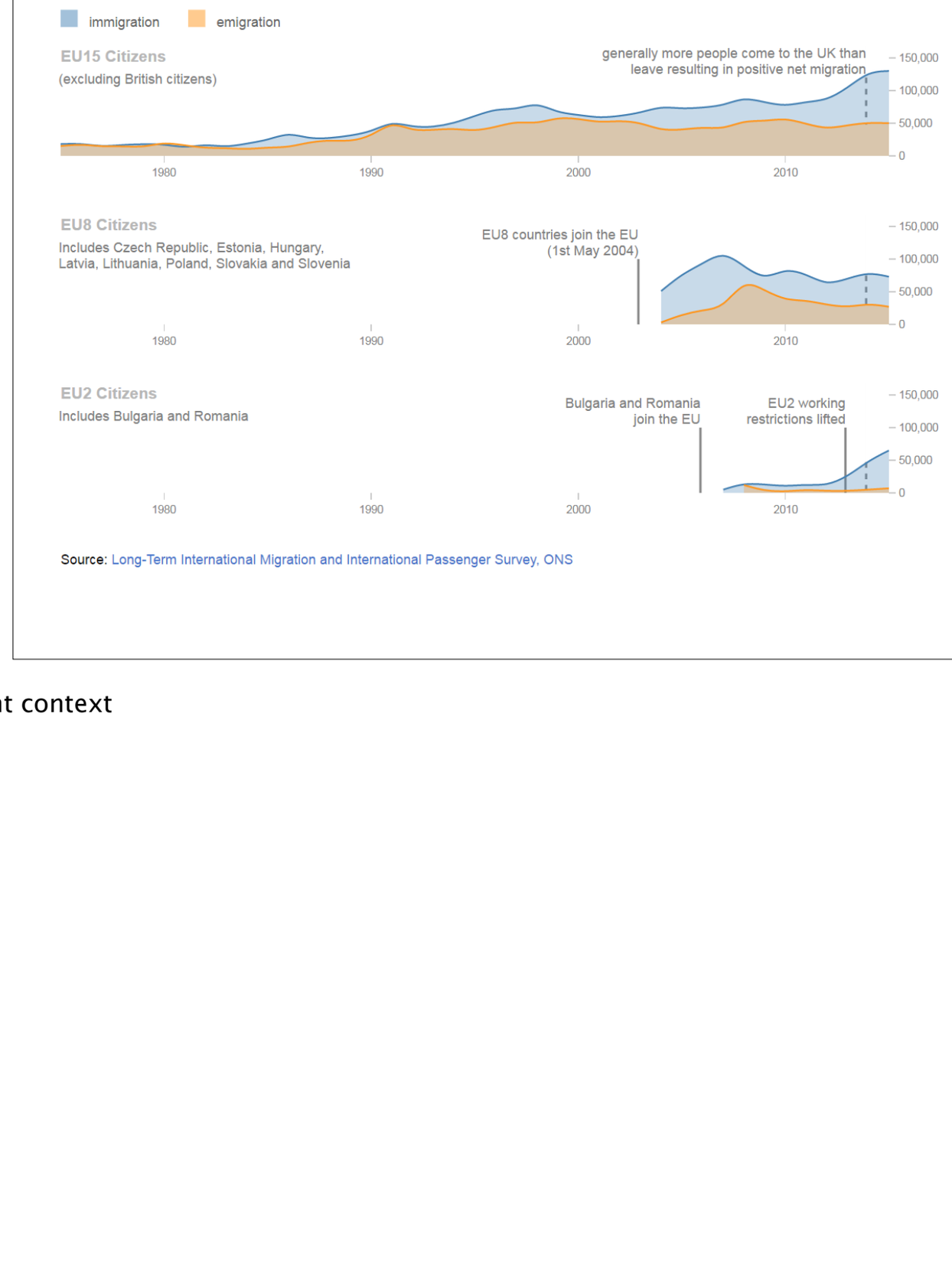
A big peak right before Spring Break
Most breakups are announced on Mondays
People like to start the summer being single
A big peak right before Christmas
The lowest day throughout the whole year is Christmas Day (thank God)



great use of annotation

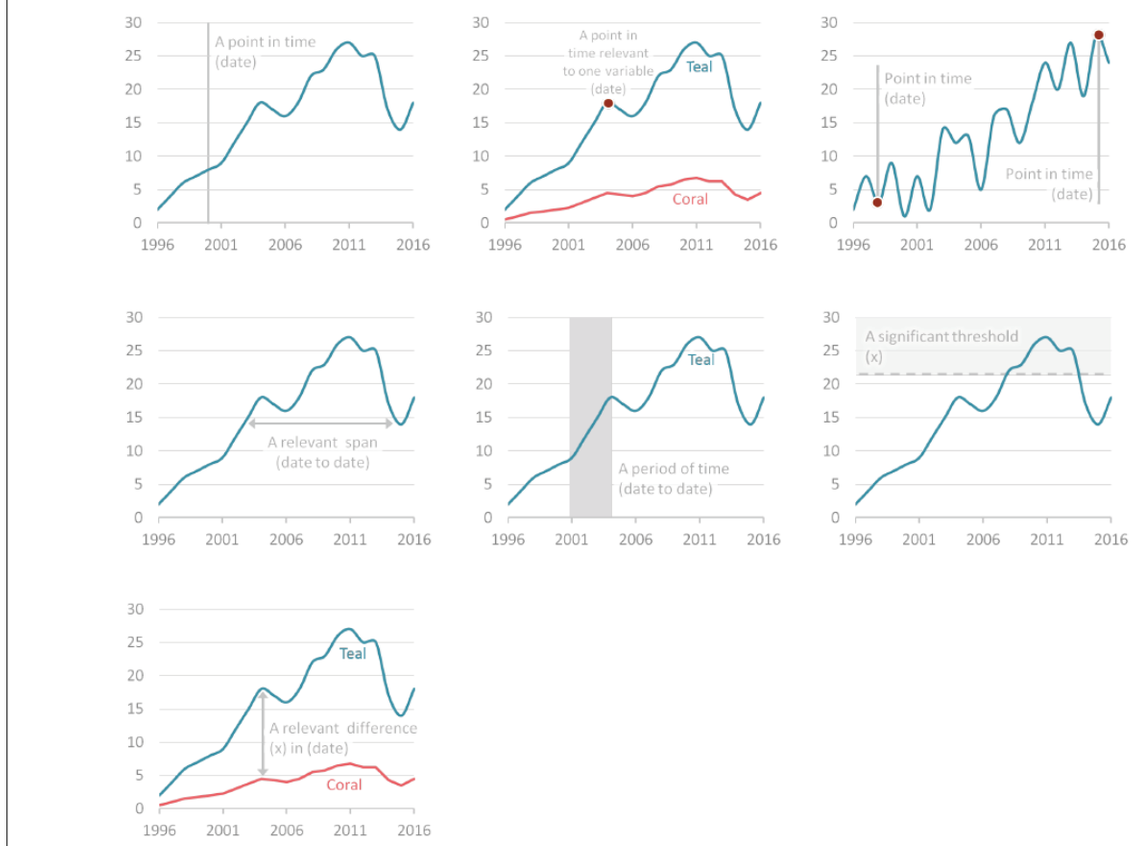
words and shapes both providing context

never underestimate a good title! your chart may not always be viewed in situ



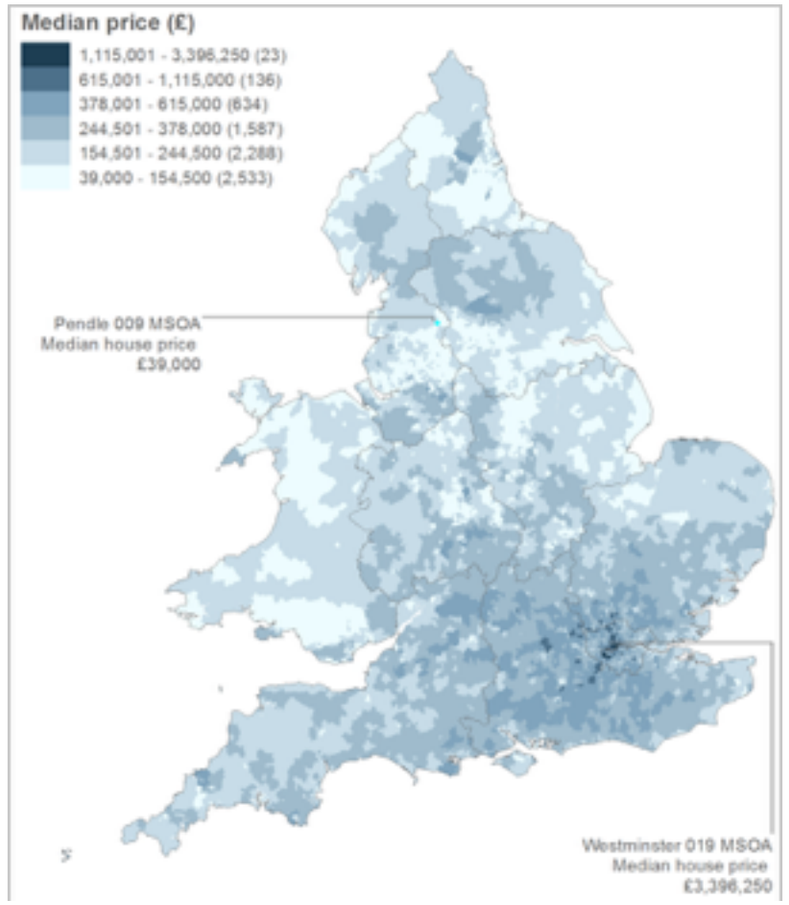
Source: Long-Term International Migration and International Passenger Survey, ONS

more annotation providing important context



Some examples of very simple but effective annotations on a chart.

Use them!


Median price (£)
1,115,001 - 3,396,250 (23)
615,001 - 1,115,000 (136)
378,001 - 615,000 (634)
244,501 - 378,000 (1,587)
154,501 - 244,500 (2,288)
39,000 - 154,500 (2,533)
Pendle 009 MSOA
Median house price
£39,000
Westminster 019 MSOA
Median house price
£3,396,250

Design decisions

Allow users to explore the data and find stories for themselves

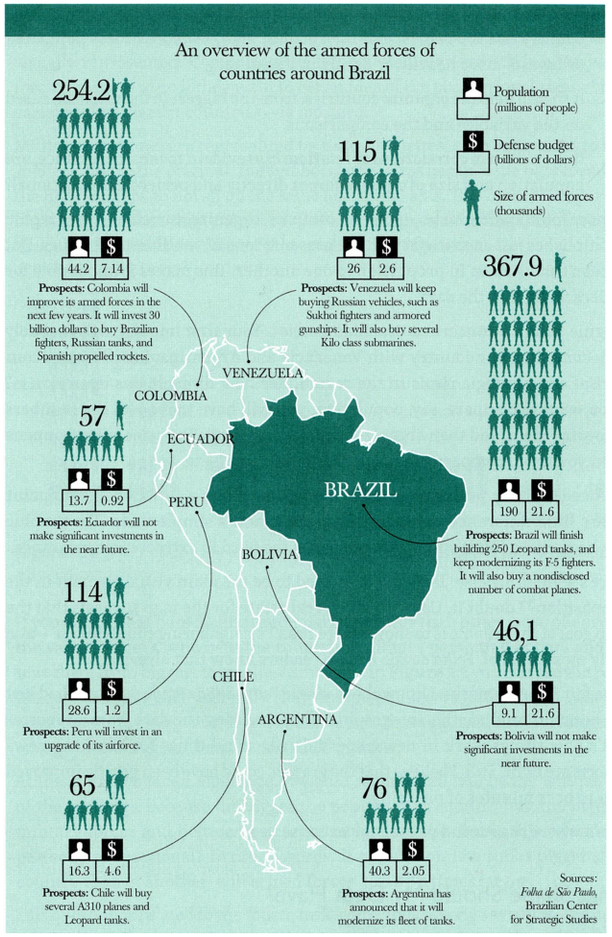
Pick out the interesting stories from the data and present to the user

Two very different objectives which will lead to different outcomes.

What do you want to do?

Graphic is a tool.

What tasks should it help with?



Alberto Cairo - The Functional Art http://www.thefunctionalart.com

1 Present - several variables - size of armed forces, size of population, defence budget, future investments

2 Compare - should be immediately obvious which country has the largest or smallest of each variable

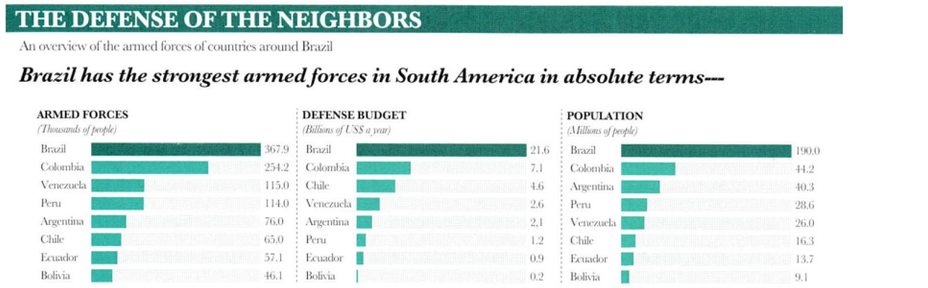
3 Organise - Rank so top 3 can be found

4 Correlate - what relationships are evident?

Does 1 well - presents data

What is most important ? - map takes up most room

Say you live in Brazil and you're concerned about Brazil's rivals - Argentina and Venezuela. How easy is it to compare their defines budgets?

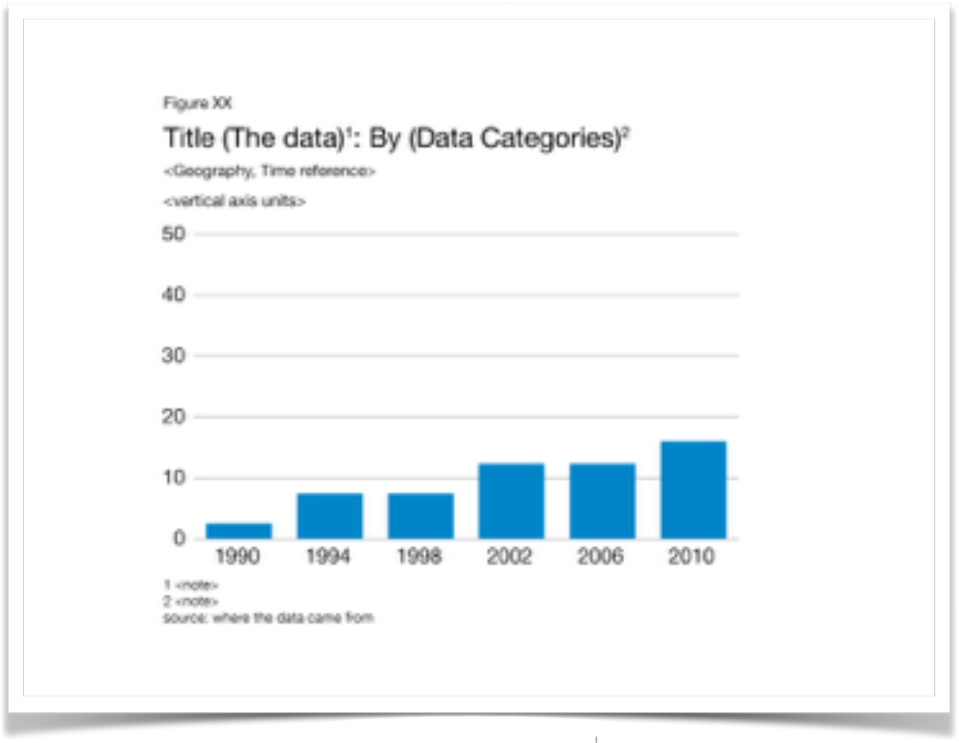


Shared axis for all variables
Graphical representation for all variables

Variables all expressed in absolute terms - derived variables - show a different story
Additional secondary info can then be included - future investments, Correlation amongst variables?

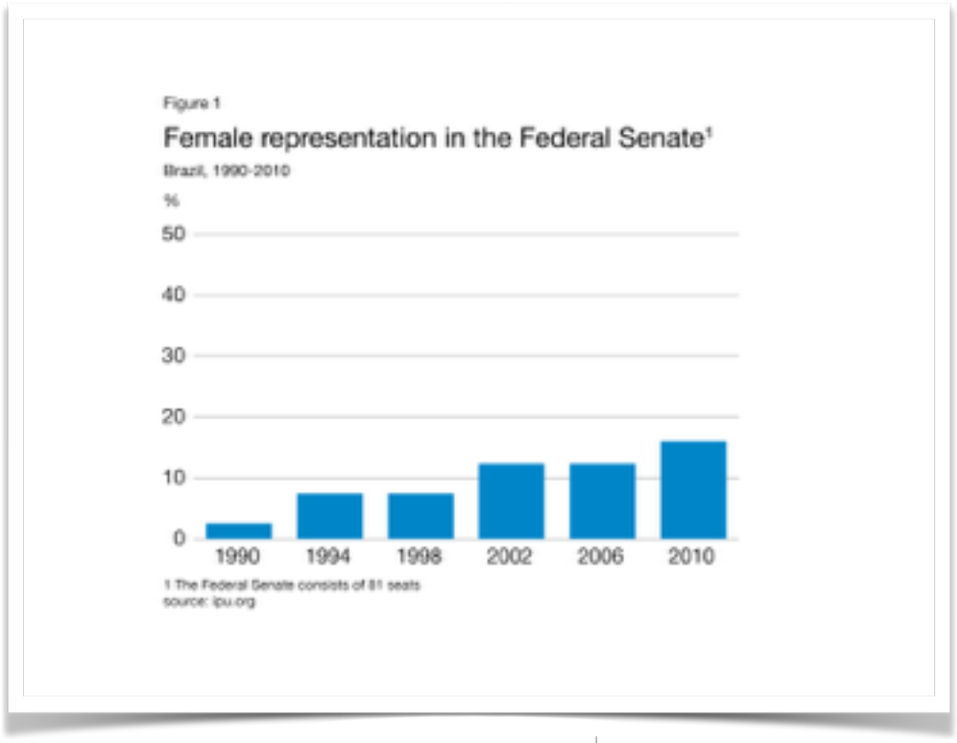
If the population is x times larger in one country than an other, are the armed forces also x times bigger?

Elements of a Complete Chart



Elements of a chart

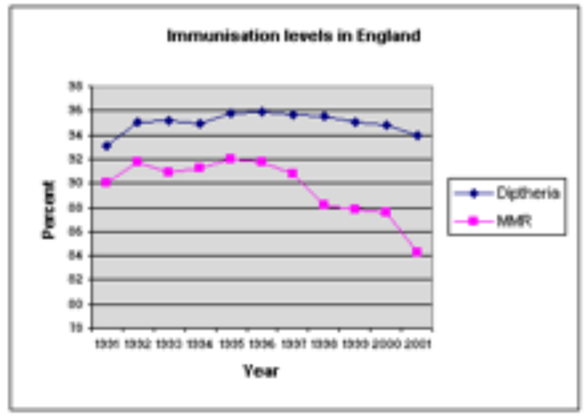
include secondary information

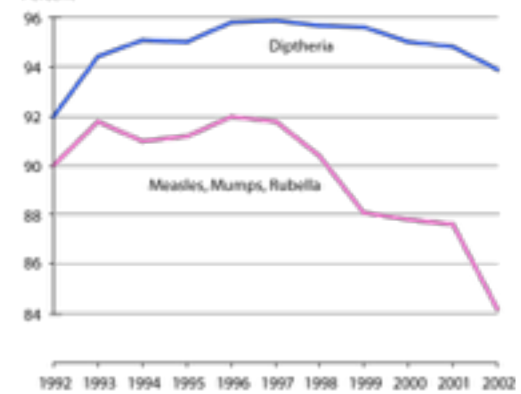


Elements of a chart

be pragmatic

Minimise secondary elements / Tone down the 'non-data ink'





1 On year of 2nd birthday

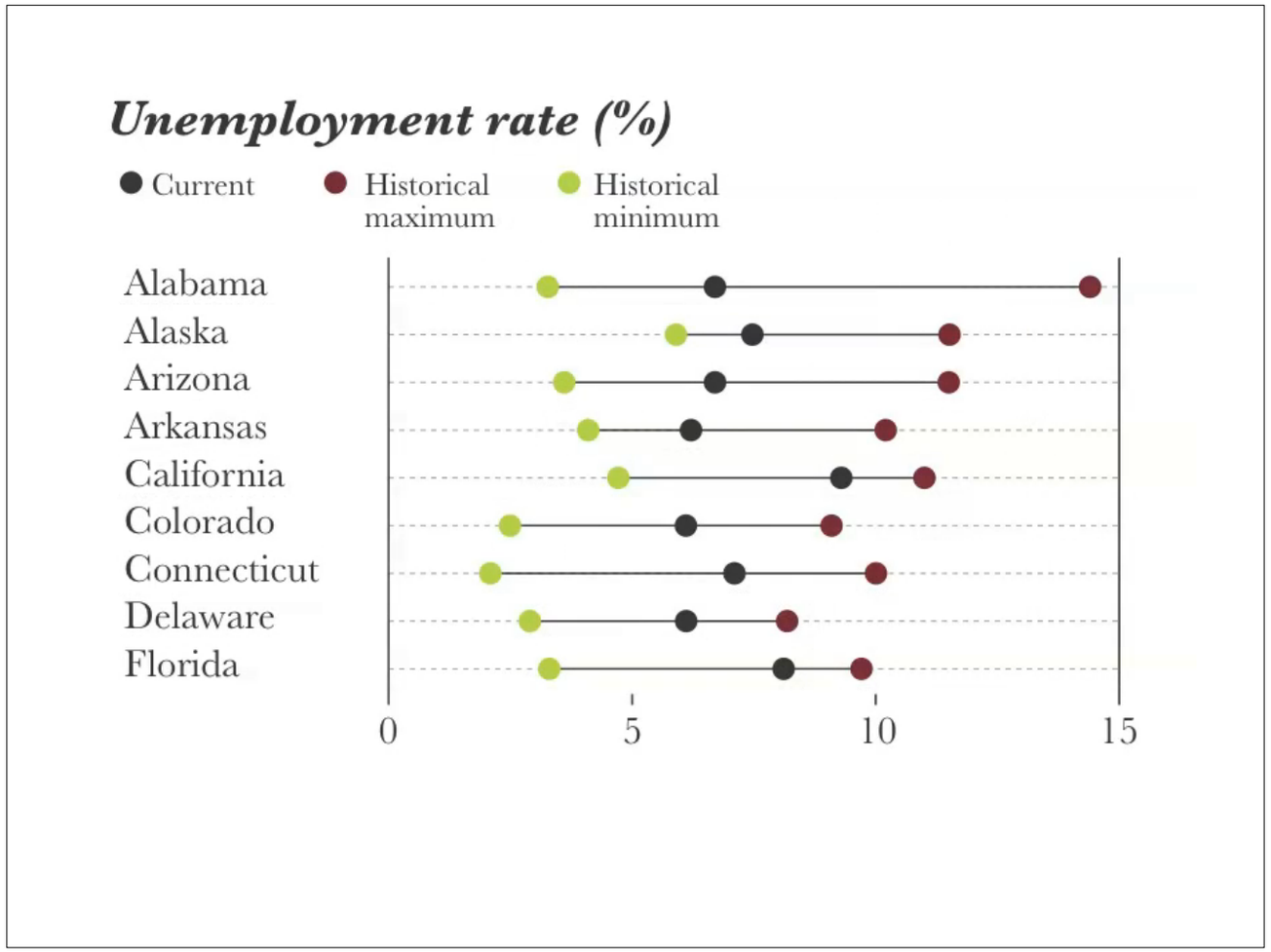
Source: http://www.doh.gov.uk/public/sb0218.htm

No clear graph type?

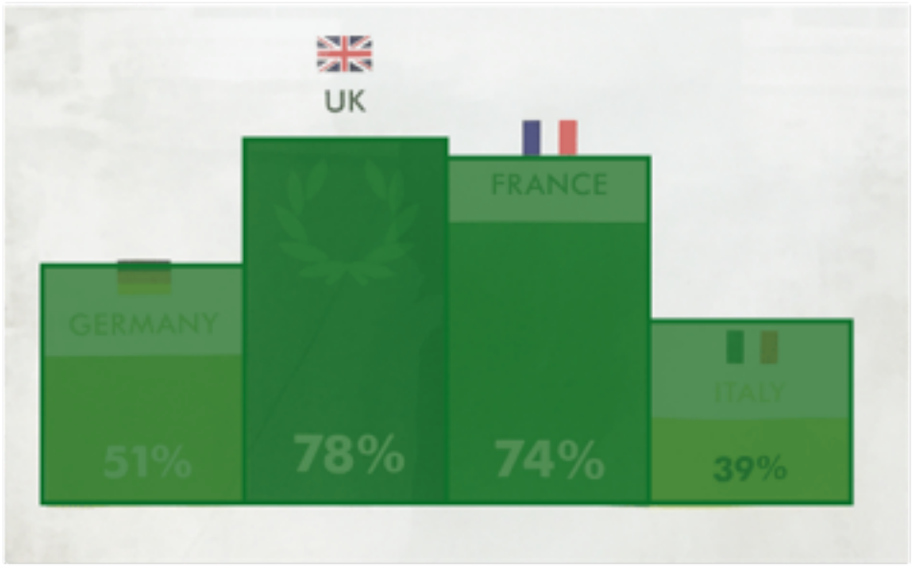
Be creative but be careful - always consider the basic principles

Unemployment rate (%)

	CURRENT	Historical maximum	Historical minimum
Alabama	6.7	14.4	3.3
Alaska	7.5	11.5	5.9
Arizona	6.9	11.5	3.6
Arkansas	6.2	10.2	4.1
California	9.3	11.0	4.7
Colorado	6.1	9.1	2.5
Connecticut	7.1	10.0	2.1
Delaware	6.1	8.2	2.9
Florida	8.1	9.7	3.3


Unemployment rate (%)
Current
Historical maximum
Historical minimum
Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
Florida
0
5
10
15

No scale whatsoever


UK
FRANCE
GERMANY
ITALY
51%
78%
74%
39%

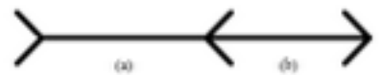
Visual Perception

do we all perceive colours the same?

are some easier to perceive than others?

should we try to choose the least ambiguous colours?

The Importance of Context



colour can have contextual meaning

Perceptual Tuning

what can you see?

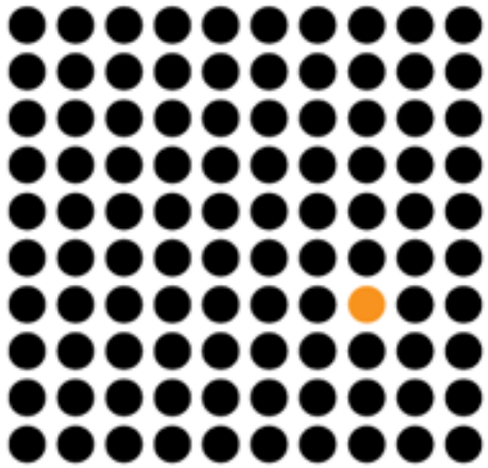
Perceptual Tuning

what can you see?

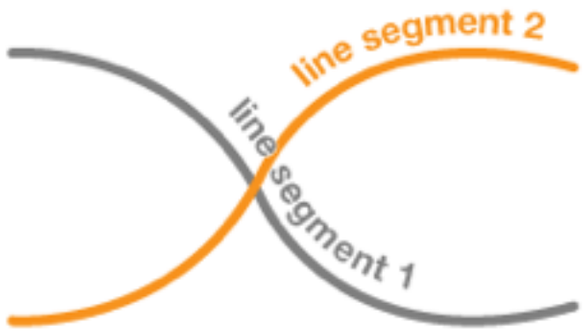
Gestalt Principles

- Developed by German psychologists in the 1920s
- The principles describe how humans tend to perceive individual elements as groups
- Profound impact on visual design
- Gestalt principles are fundamental – not just in infographic design, but in the world around us
- They recognise the natural propensity in human perceptual systems for pattern recognition

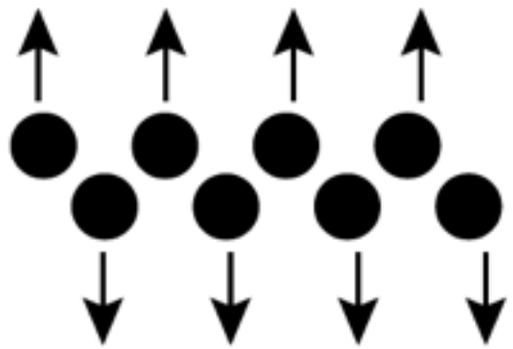
Similarity



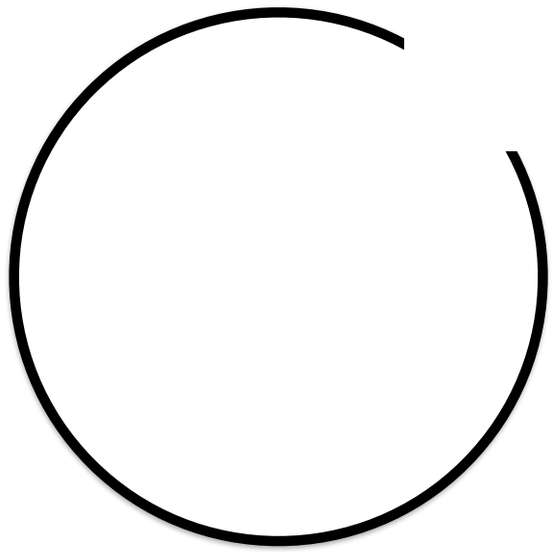
Good continuation



Common Fate

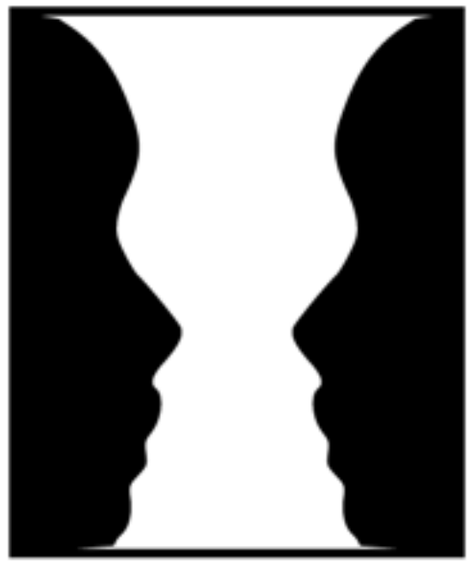


Enclosure



Proximity

Figure and Ground



Gestalt: Summary

- …we just need to make sure that we aren't encouraging readers to see patterns that aren't there!
- Effective visualisation and design layout will help guide readers to follow what you are showing them.

Further study

- Gordon, Ian E. (2004). Theories of Visual Perception. Psychology press.
- http://www.andyrutledge.com/gestalt-principles-1-figure-ground-relationship.php

Function & Aesthetics

Q. Are you happy with the customer service you received today?

A. YES/NO

RESULTS: 85% said YES 15% said NO

TOTAL pixels: 76,523
pixels ‘NO’: 11,579

=15%

TOTAL pixels: 61,621
pixels ‘NO’: 7,557

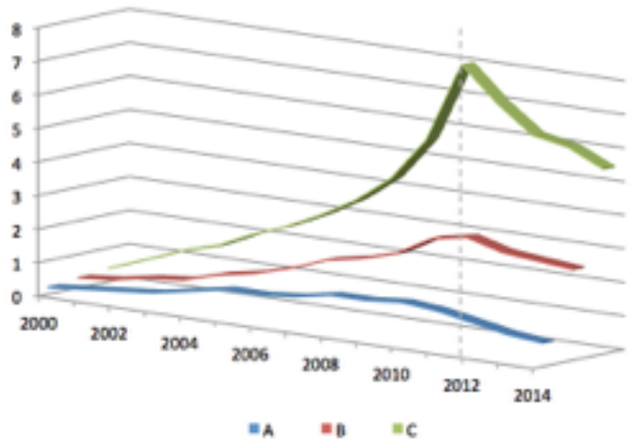
=12%

TOTAL pixels: 29,002
pixels ‘NO’: 2,154

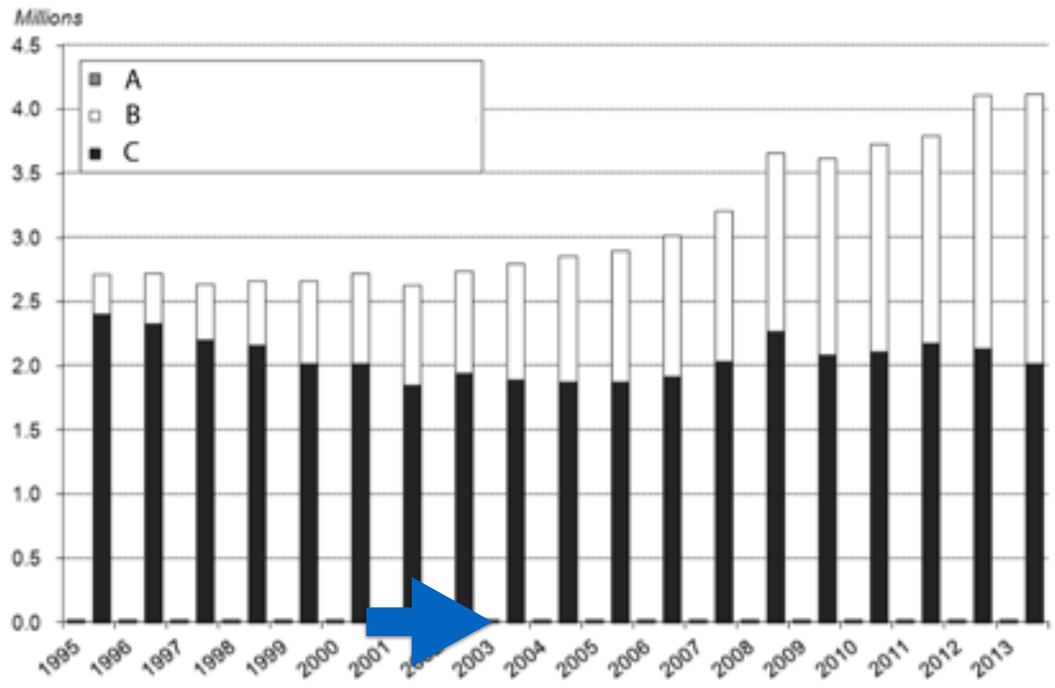
=7%

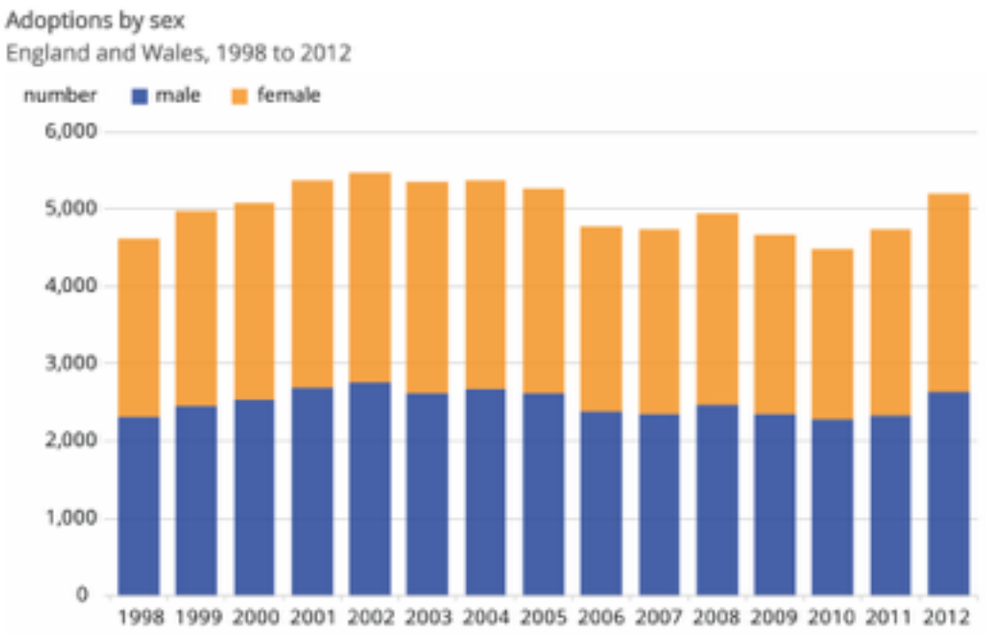
Segment B = E?

Highest value?
7.9 in 2012?

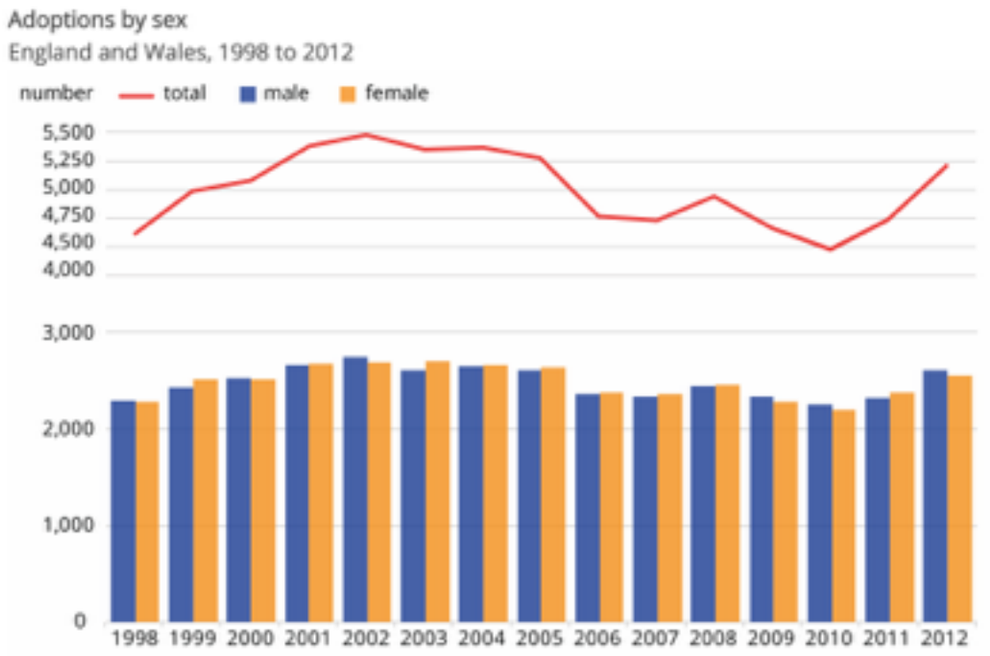


Function & Aesthetics



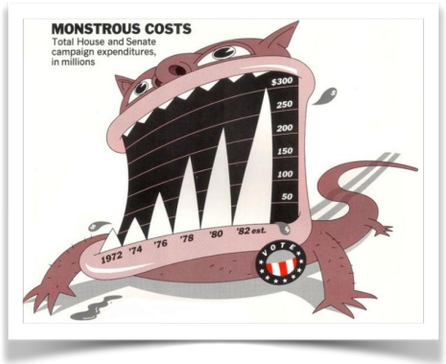


Shared horizon | stacked bar



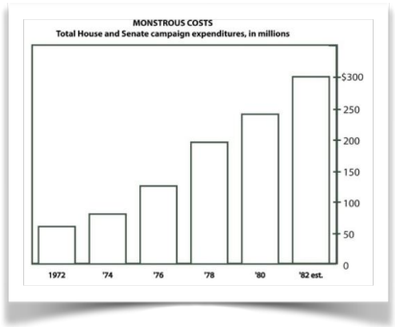
Shared horizon | clustered bar

Bateman et al



"...people's accuracy in describing the embellished charts was no worse than for plain charts, and that their recall after a two-to-three-week gap was significantly better."

"Although we are cautious about recommending that all charts be produced in this style, our results question some of the premises of the minimalist approach to chart design.



Few
v
Rogers


INFORMATION
DASHBOARD
DESIGN
The Effective Visual Communication of Data
Stephen Few


e the Numbers
esigning Tables and Graphs to Enlighten
Stephen Few

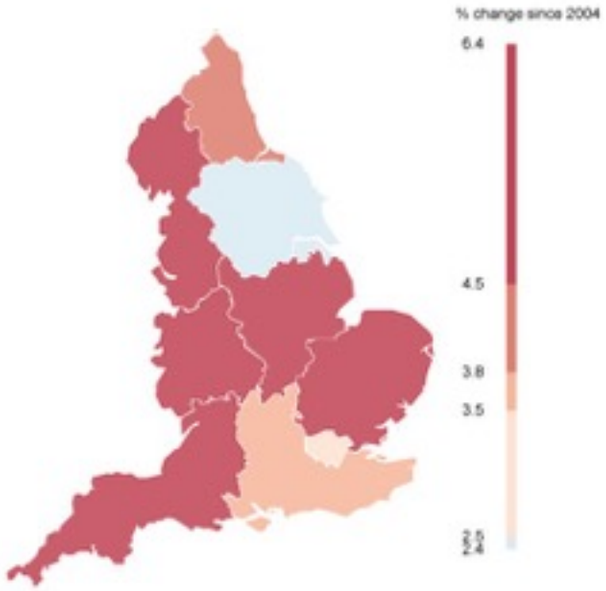

DATA BLOG
Facts are sacred
World Cup 2010 statistics: all the key data for each team

Further study

- Bateman et al (2010) Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts. http://dmrussell.net/CHI2010/docs/p2573.pdf
- Interview with Amanda Cox. http://blogs.hbr.org/hbr/hbreditors/2013/03/power_of_visualizations_aha_moment.html
- Guardian Datablog. http://www.guardian.co.uk/news/datablog
- Stephen Few's blog. http://www.perceptualedge.com/blog/
- A conversation with Stephen Few about data visualisation. Kind of. http://simonrogers.net/2013/03/15/a-conversation-with-stephen-few-about-data-visualisation-kind-of/

Spatial

Regional data?



Spatial

How would you visualise this?

How would you visualise this?

Map?

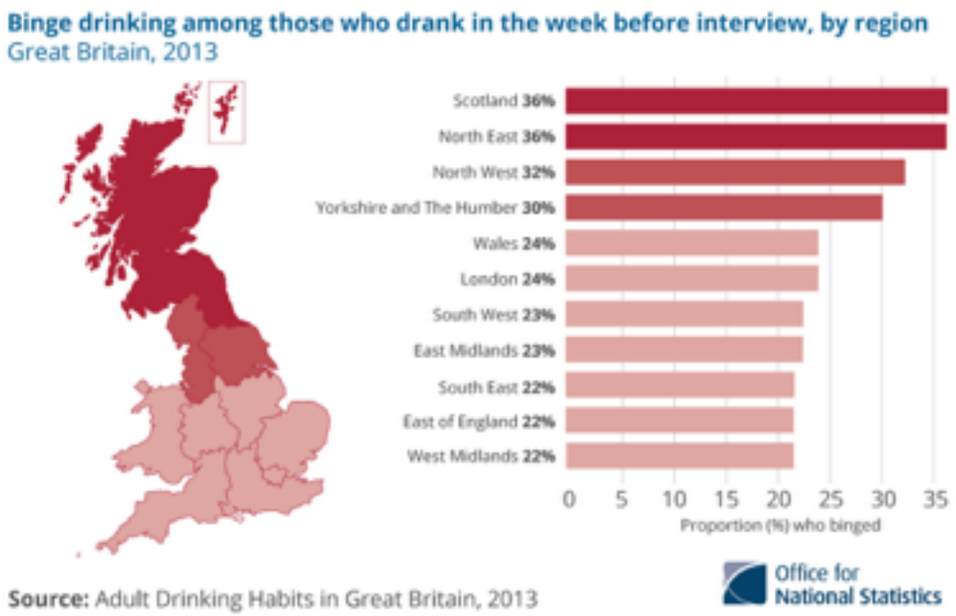
Table?

Chart?

Show regional map and ask people to order the regions from top to bottom

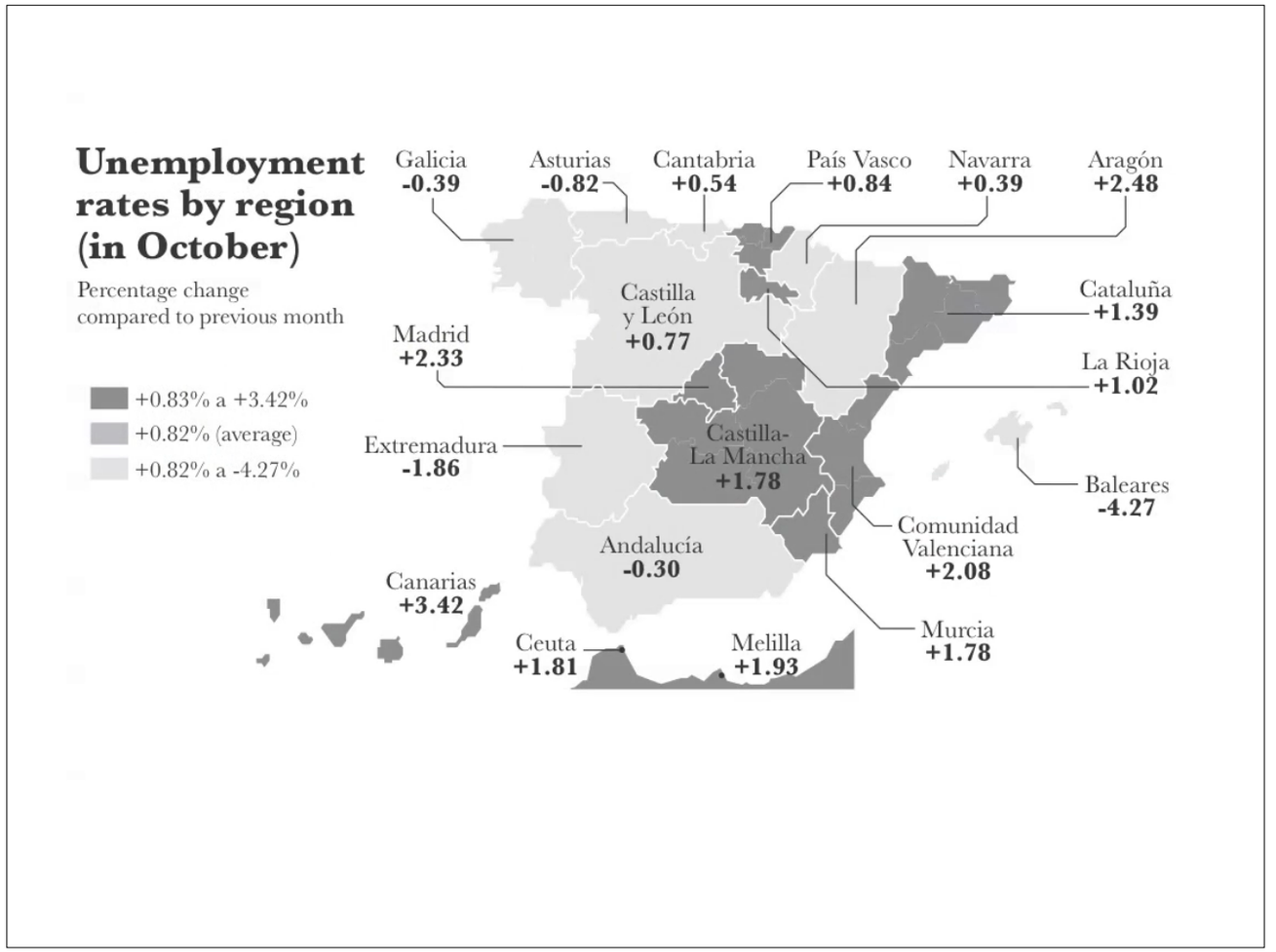
Only use maps when there is a clear spatial pattern. E.g. a clear North/South divide

If you have a limited number of observations use a bar chart



Spatial

Use regional maps when there is a clear spatial pattern


Unemployment rates by region (in October)
Percentage change compared to previous month
+0.83% a +3.42%
+0.82% (average)
+0.82% a -4.27%
Galicia -0.39
Asturias -0.82
Cantabria +0.54
País Vasco +0.84
Navarra +0.39
Aragón +2.48
Castilla y León +0.77
Cataluña +1.39
Madrid +2.33
La Rioja +1.02
Extremadura -1.86
Castilla-La Mancha +1.78
Baleares -4.27
Comunidad Valenciana +2.08
Andalucía -0.30
Canarias +3.42
Murcia +1.78
Ceuta +1.81
Melilla +1.93

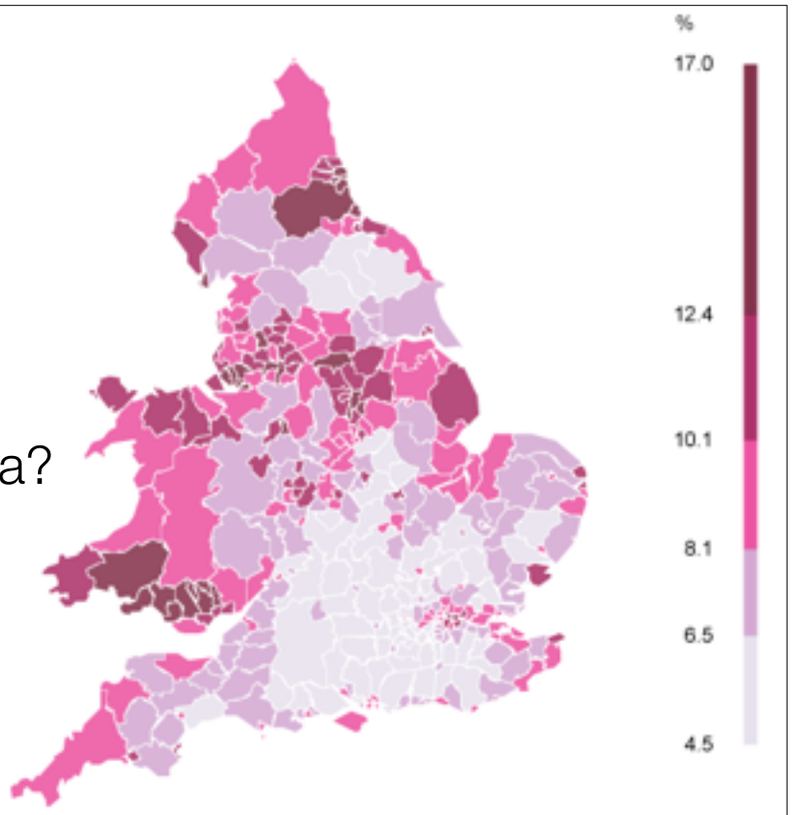
Unemployment rates by region (in October)

Percentage change compared to previous month

Average: +0.82

Canarias	+3.42
Aragón	+2.48
Madrid	+2.33
C. Valenciana	+2.08
Melilla	+1.93
Ceuta	+1.81
Murcia	+1.78
C.-La Mancha	+1.78
Cataluña	+1.39
La Rioja	+1.02
País Vasco	+0.84
C. y León	+0.77
Cantabria	+0.54
Navarra	+0.39
Andalucía	-0.30
Galicia	-0.39
Asturias	-0.82
Extremadura	-1.86
Baleares	-4.27

Local authority data?



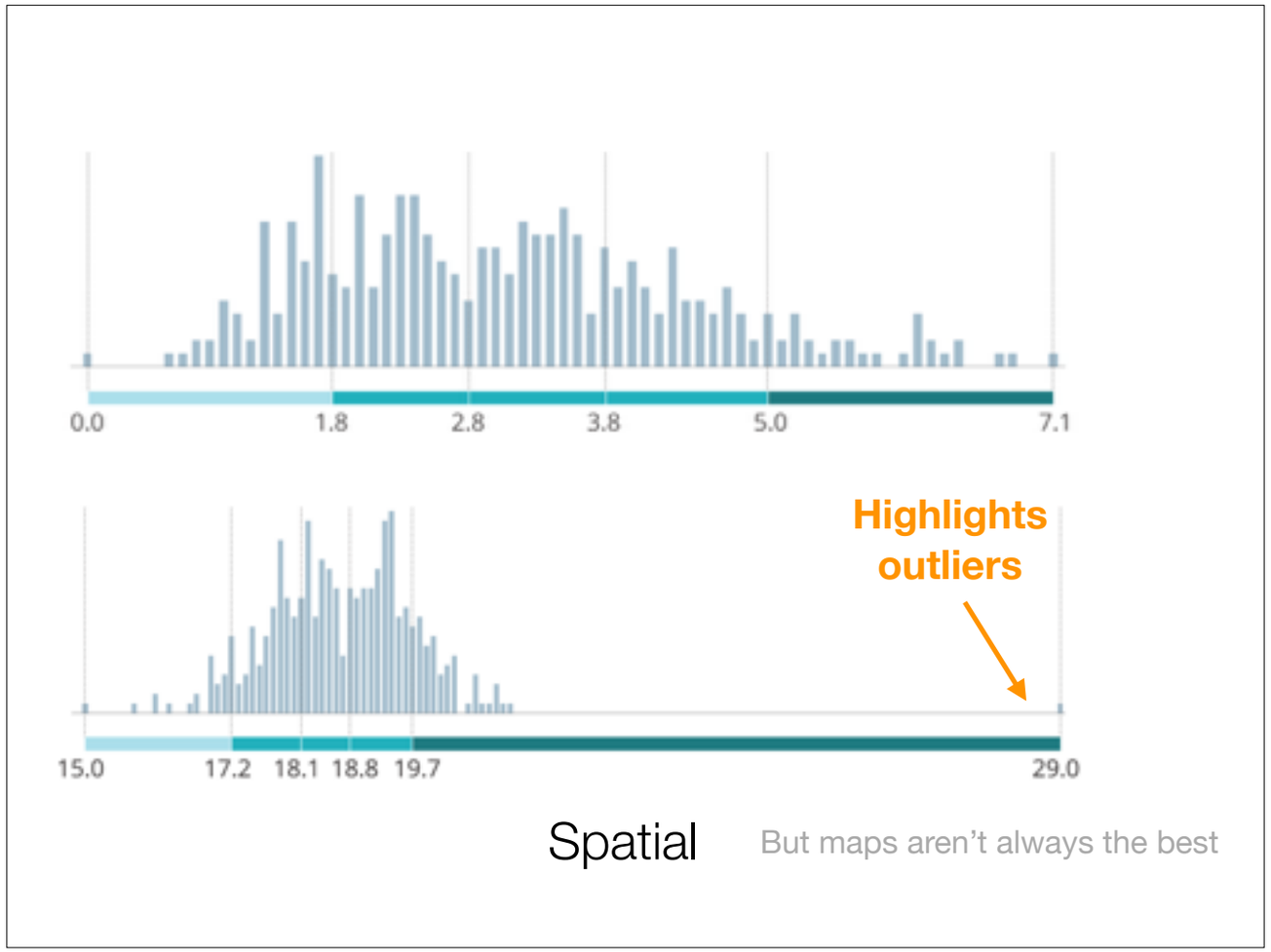
Spatial

What would you use to visualise local authority data?

Good to use maps for local authority level data (or any data that you have many observations for)

You couldn't use a bar chart here and you wouldn't really expect people to rank each area from top to bottom. You get the broad ability to look at patterns across the country…still work best if there is a spatial pattern.

Again, if you're interested in extremes you might want to accompany this with a top 10 / bottom 10 bar chart or table.



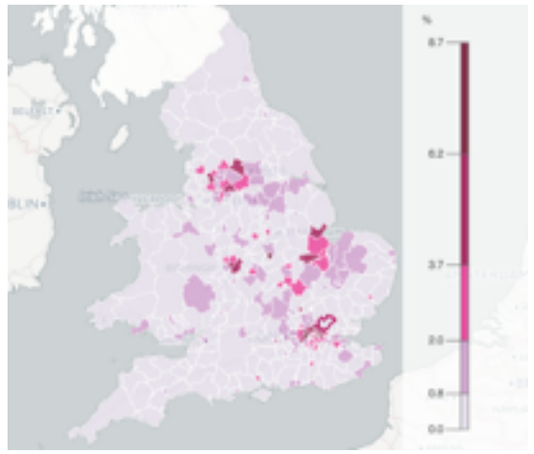
Spatial

But maps aren’t always the best

Want to get a sense of the overall distribution and aren’t worried about values for particular areas

Choose your ranges on the map carefully

When would you use
a sequential palette?

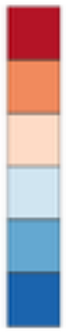


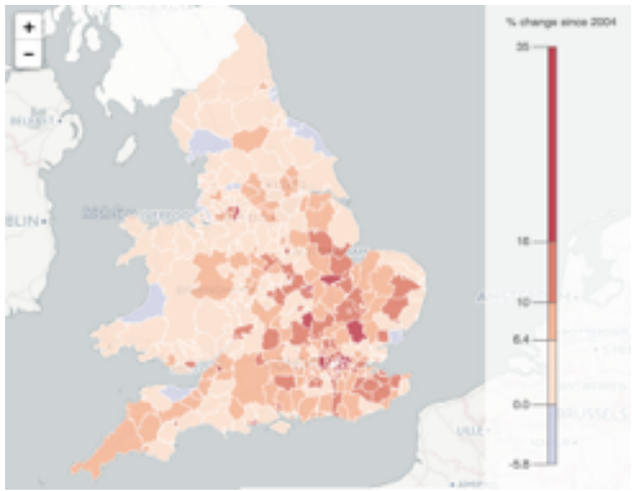
Spatial What colours should I use?

Colour - diverging scale - negative to positive

sequential scale - low to high (generally)

When would you use a diverging palette?





Spatial

What colours should I use?

Infographics

Things to consider

Is there a story/key message?

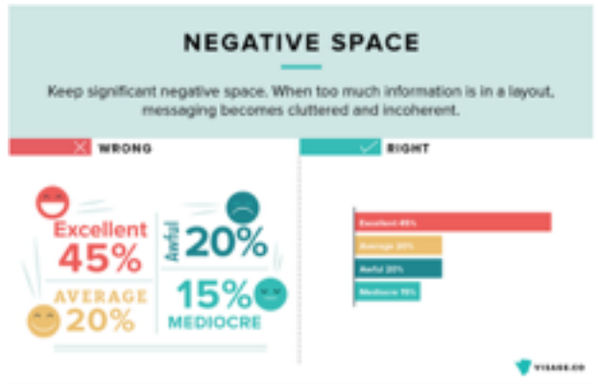
Will the data update?

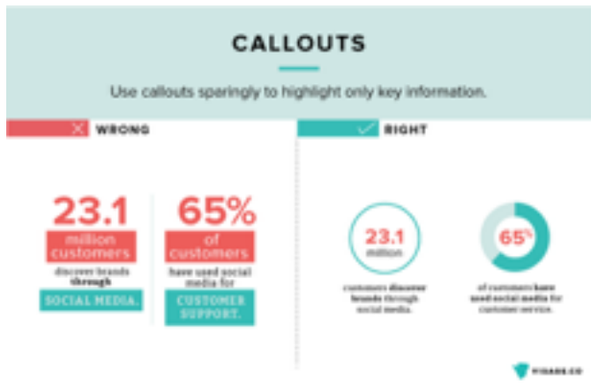
Who are the users?

Where will the image be used?

If social media- perhaps break down into smaller images

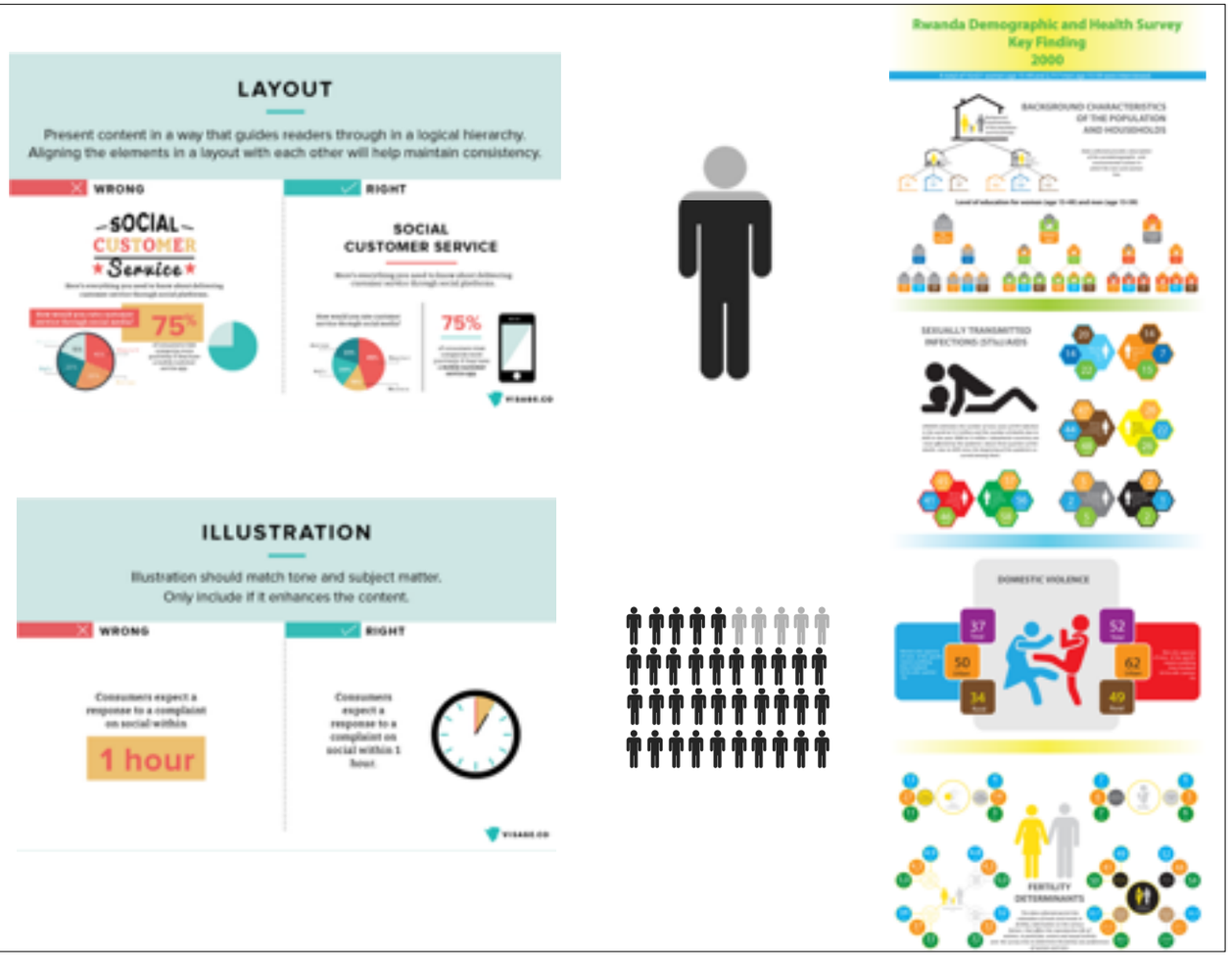

10 TIPS FOR DESIGNING EFFECTIVE VISUAL COMMUNICATION
VISAGE.CO

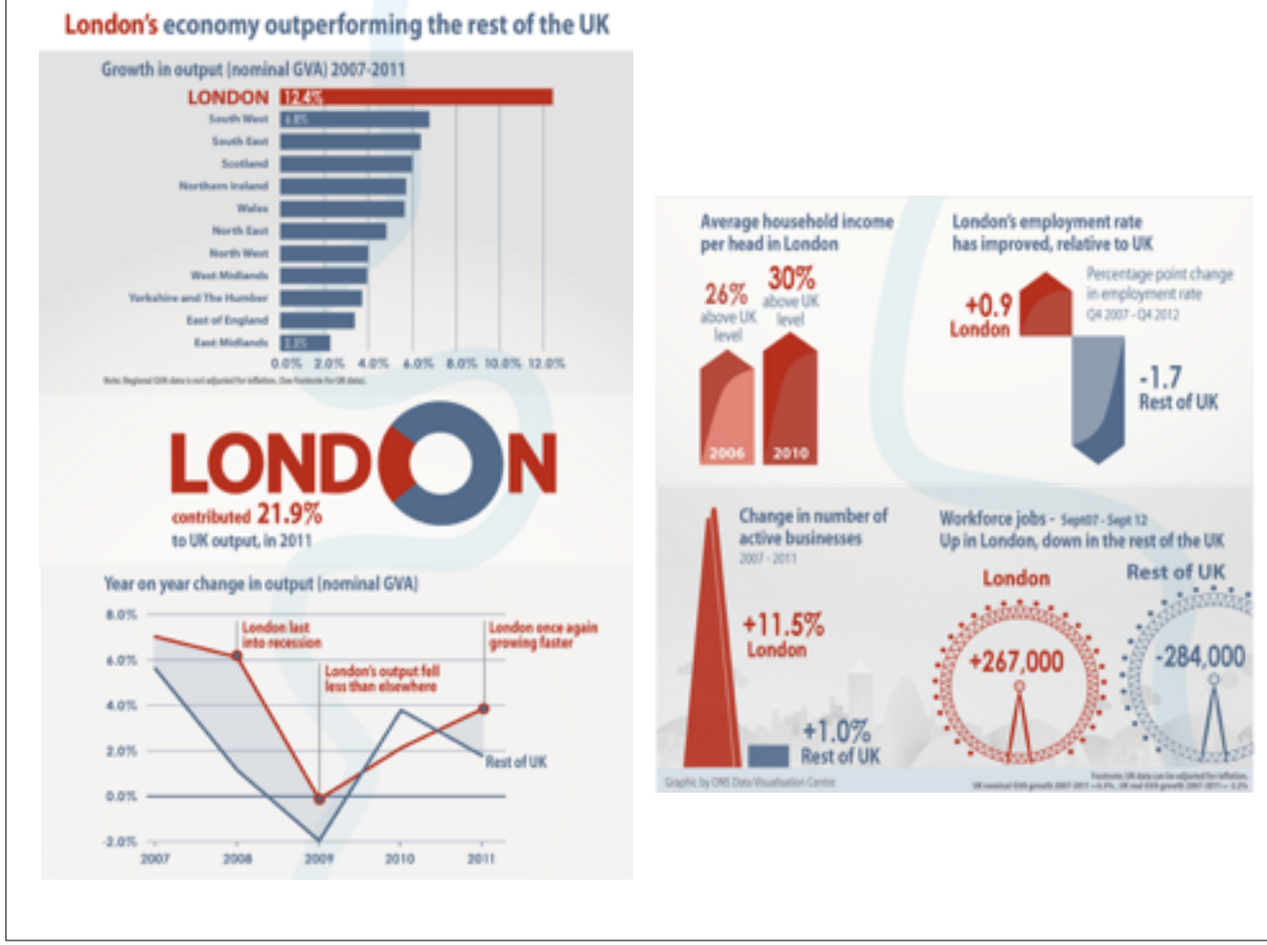

NEGATIVE SPACE
Keep significant negative space. When too much information is in a layout, messaging becomes cluttered and incoherent.
WRONG
RIGHT
Excellent 45%
Awful 20%
AVERAGE 20%
15% MEDIOCRE

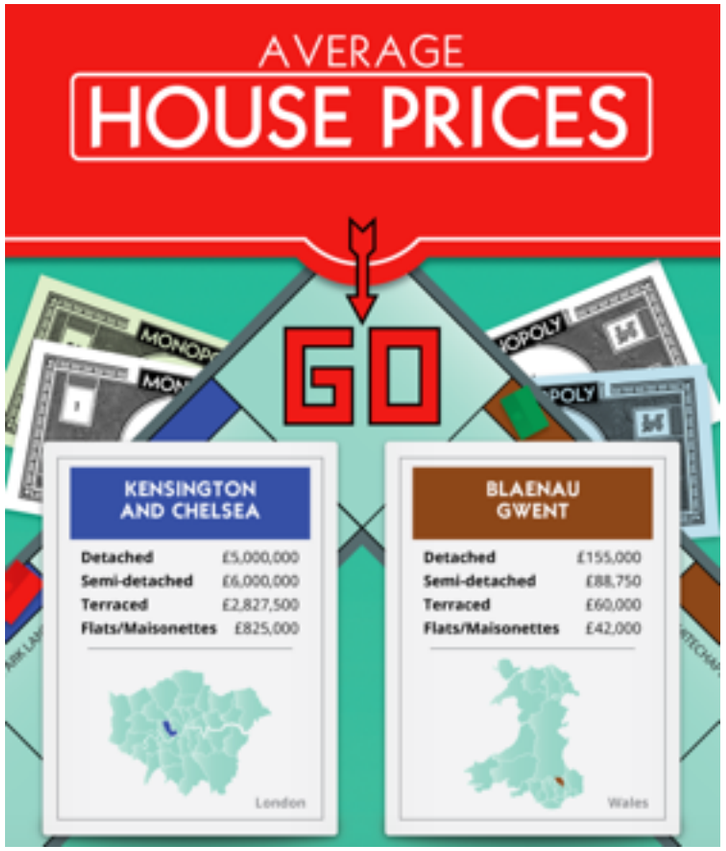

CALLOUTS
Use callouts sparingly to highlight only key information.
WRONG
RIGHT
23.1 million customers
65% of customers
SOCIAL MEDIA.
CUSTOMER SUPPORT.


ICONOGRAPHY
Icons should be simple, easy to understand and universal. They're meant to enhance comprehension, never distract.
WRONG
RIGHT


ACCURACY
Visualizations should represent their values proportionately.
Inaccurate representations can deceive viewers.
WRONG
RIGHT
14
6
14
6
COMPARISON
Visualize data in a way that is easy for the viewer to compare values.
WRONG
RIGHT
What do Facebook users want from brands?
52%
48%
37%
Entertainment
Discounts
Customer Service
What do Facebook users want from brands?
SIMPLICITY
Avoid unneccessary design, including 3D charts, ornamental illustration or extraneous elements.
WRONG
RIGHT
Top 3 Most Popular Brands on Facebook
Red Bull
CONVERSE
Top 3 Most Popular Brands on Facebook
Red Bull
CONVERSE
TYPOGRAPHY
All fonts should be legible and appropriate for what you are communicating.
WRONG
RIGHT
SOCIAL CUSTOMER Service
SOCIAL CUSTOMER SERVICE


LAYOUT
Present content in a way that guides readers through in a logical hierarchy.
Aligning the elements in a layout with each other will help maintain consistency.
WRONG
RIGHT
SOCIAL
CUSTOMER
Service
75%
SOCIAL
CUSTOMER SERVICE
75%
ILLUSTRATION
Illustration should match tone and subject matter.
Only include if it enhances the content.
WRONG
RIGHT
Consumers expect a response to a complaint on social within
1 hour
Consumers expect a response to a complaint on social within 1 hour.
Rwanda Demographic and Health Survey
Key Finding
2000
BACKGROUND CHARACTERISTICS OF THE POPULATION AND HOUSEHOLDS
SEXUALLY TRANSMITTED INFECTIONS (STIs)/AIDS
DOMESTIC VIOLENCE
57
52
50
62
34
49
FERTILITY DETERMINANTS


London's economy outperforming the rest of the UK
Growth in output (nominal GVA) 2007-2011
LONDON 12.5%
South West 8.8%
South East
Scotland
Northern Ireland
Wales
North East
North West
West Midlands
Yorkshire and The Humber
East of England
East Midlands 8.3%
0.0% 2.0% 4.0% 6.0% 8.0% 10.0% 12.0%
LONDON
contributed 21.9%
to UK output, in 2011
Year on year change in output (nominal GVA)
8.0%
6.0%
4.0%
2.0%
0.0%
-2.0%
London last into recession
London's output fell less than elsewhere
London once again growing faster
Rest of UK
2007 2008 2009 2010 2011
Average household income per head in London
26% above UK level
30% above UK level
2006
2010
London's employment rate has improved, relative to UK
Percentage point change in employment rate
Q4 2007 - Q4 2012
+0.9 London
-1.7 Rest of UK
Change in number of active businesses
2007 - 2011
+11.5% London
+1.0% Rest of UK
Workforce jobs - Sept07 - Sept 12
Up in London, down in the rest of the UK
London
Rest of UK
+267,000
-284,000
Graphic by ONS Data Visualisation Centre

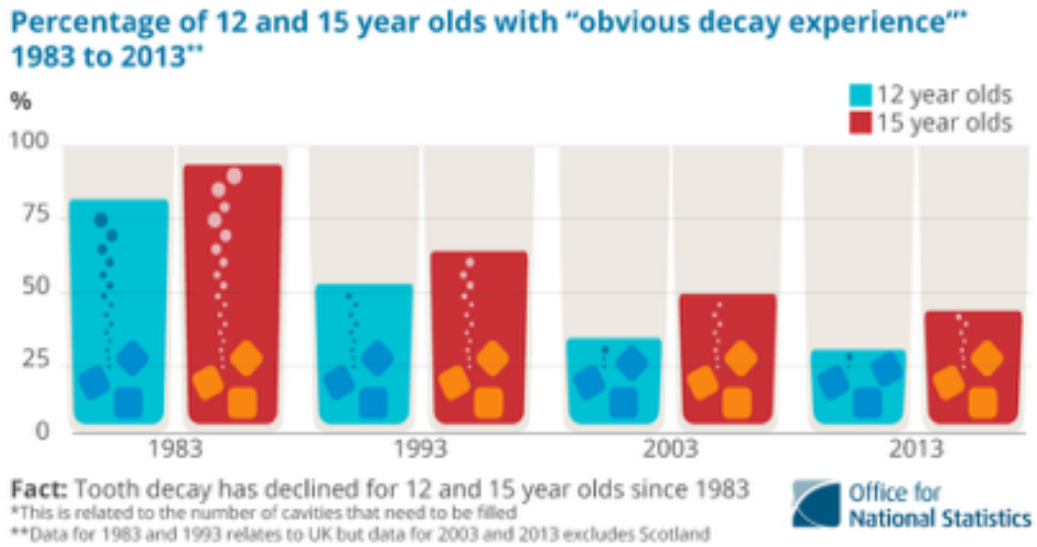


http://visual.ons.gov.uk/regional-monopoly-house-prices/

http://visual.ons.gov.uk/regional-monopoly-house-prices/

http://visual.ons.gov.uk/7-facts-about-child-dental-health-in-2013/

4. Tooth decay has declined for 12 and 15 year olds since 1983 [4]



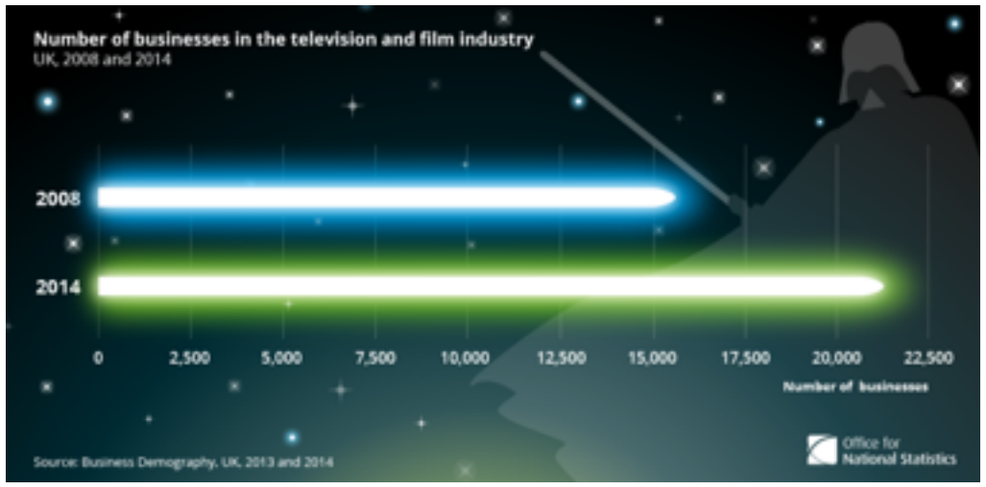
Fact: Tooth decay has declined for 12 and 15 year olds since 1983

*This is related to the number of cavities that need to be filled

**Data for 1983 and 1993 relates to UK but data for 2003 and 2013 excludes Scotland

Office for National Statistics

http://visual.ons.gov.uk/the-stats-are-strong-with-this-one-the-uk-film-industry-and-star-wars-in-society/



The Design Process

ONS Content Strategy

Principles

1. User-Centred, not producer oriented
2. Less devolved, more collaborative
3. Digital-native product design and delivery
4. Less, but better and more consistent
5. Evidence-based commissioning
6. AGILE – fast, fluid, dynamic

Our Design Process

Inspired by Andy Kirk @visualisingdata

Approach projects differently - some need different skills, sometimes you already have the analysis, other times you need to do the digging. Sometimes you understand exactly the audience you're aiming at.

The design process (recap)

1. Establish the purpose of the visualisation
2. Acquire, familiarise with and prepare your data
3. Determine the editorial focus of your subject matter
4. Confirm your design, data representation and presentation
5. Construct and complete your design solution

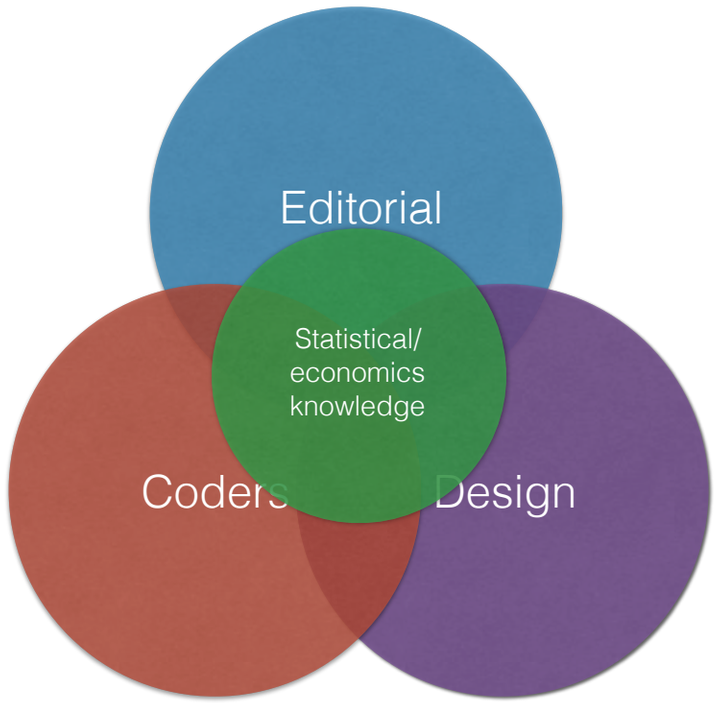
Why are we looking at this data?
What's the timescale, pressures etc?
What resource do we have available?
Who is the intended user? Is it for policy makers?
Is it an idea worth spending lots of time on?
Does it have a limited audience?
———————
Get your data (sometimes this can be hard!), learn what it 'means' and what relationships it contains, consolidate with other data/info for context/to enhance. Begin researching more about the subject/data to enhance your intimate familiarity with the task
———————
Get to know the persona of your target audience - if you were them, what you want to know and discover about this subject? What data questions will the task/project aim to answer? Start to undertake exploratory visual and statistical analysis of the data, moving from looking at it (mechanical nature of stage 2) towards seeing it for yourself. Stages 2 and 3 very iterative/related.
———————
You're now ready to come up with some more formal designs.
Sketches etc
At the heart of this is choosing the right data representation choices.
Then think about presentational aspects colour, animation, annotation, layout etc.
————
Implementation… quite a lot of subprocesses within this
Construction of the visualisation,
Iterate, evaluate, user testing, launch and post-evaluation.

Scott Murray @alignedleft

We hosted a data visualisation conference last year in Winchester England

Google, Adobe, Twitter, Financial Times etc

Set out some of the skills for data visualisation



“Put our statistical/economics skills and knowledge at the heart of our content”

Diagram of different skills…

We’re at a point now within ONS where several digital content teams are merging into one. This is exciting and challenging for a lot of reasons, we’re bringing more people together which means we’re going to need to be clearer about our design process and how we’re all going to work together. But also opens up exciting possibilities for better visualisation. We have a wider skill set to rely on.

You can see how many different skills are needed here…data analysts, people with ideas, editorial, designers and coders - there are probably others.

Placing statistical and economics knowledge at the heart of our visualisation we can bring knowledge to the market.

What can we offer that others can’t?

Hands up who would see themselves as a good writer, can spot a good story, can help people relate to their data?

Animation and Interactivity

Animation

source: http://www.socsci.uci.edu/~ddhoff/

The literature is still divided on the effectiveness of animations:

“It is worth reminding ourselves that just because we can make an animated map does not mean that we should” (Mark Harrower)

“animated transitions can significantly improve graphical perception” (Heer and Robertson)

Data-Driven Documents

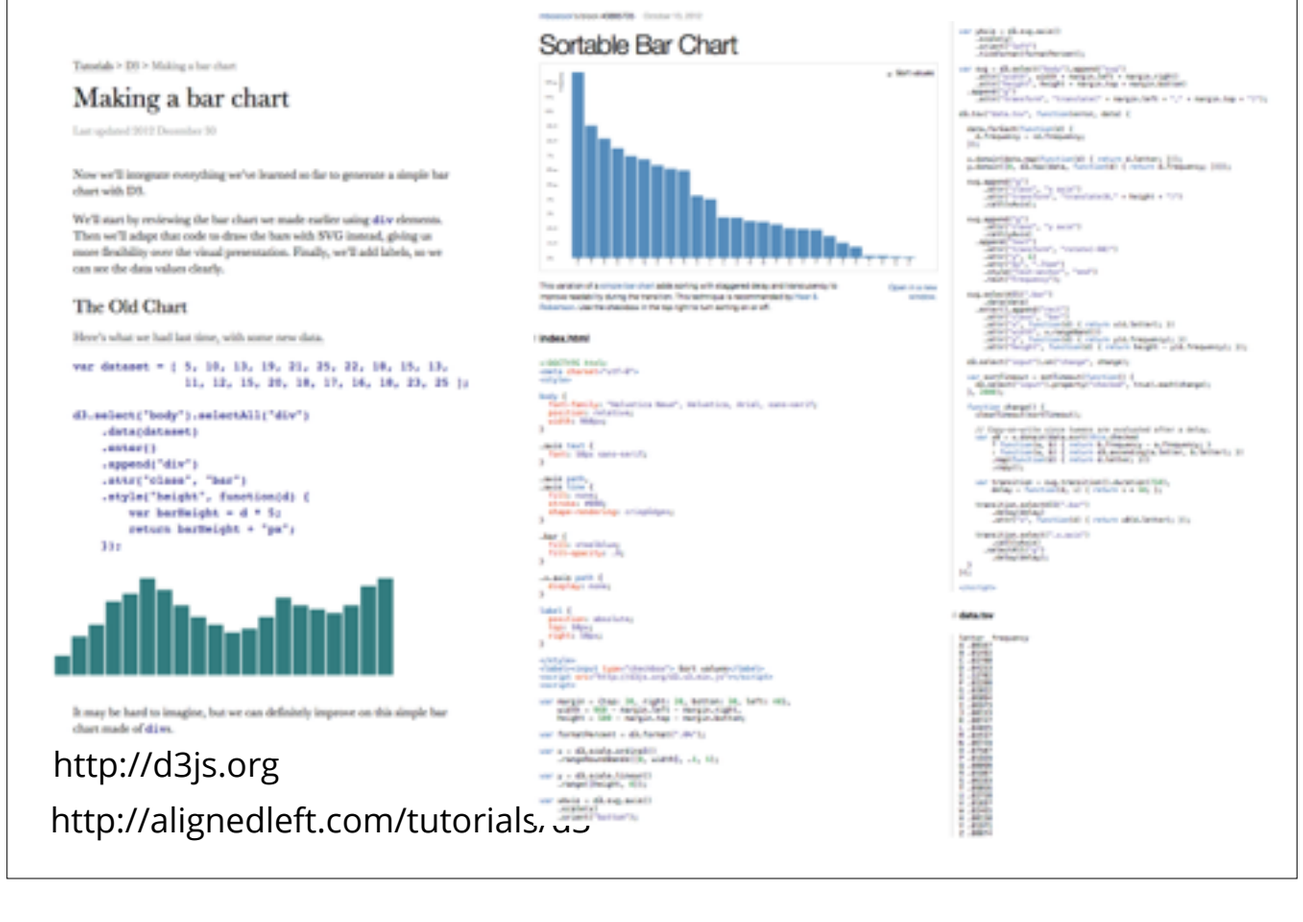
http://d3js.org

http://alignedleft.com/tutorials/d3

http://d3js.org

https://github.com/mbostock/d3/wiki/Gallery

Open source - free to use, extensive help available but way of examples, forums and tutorials

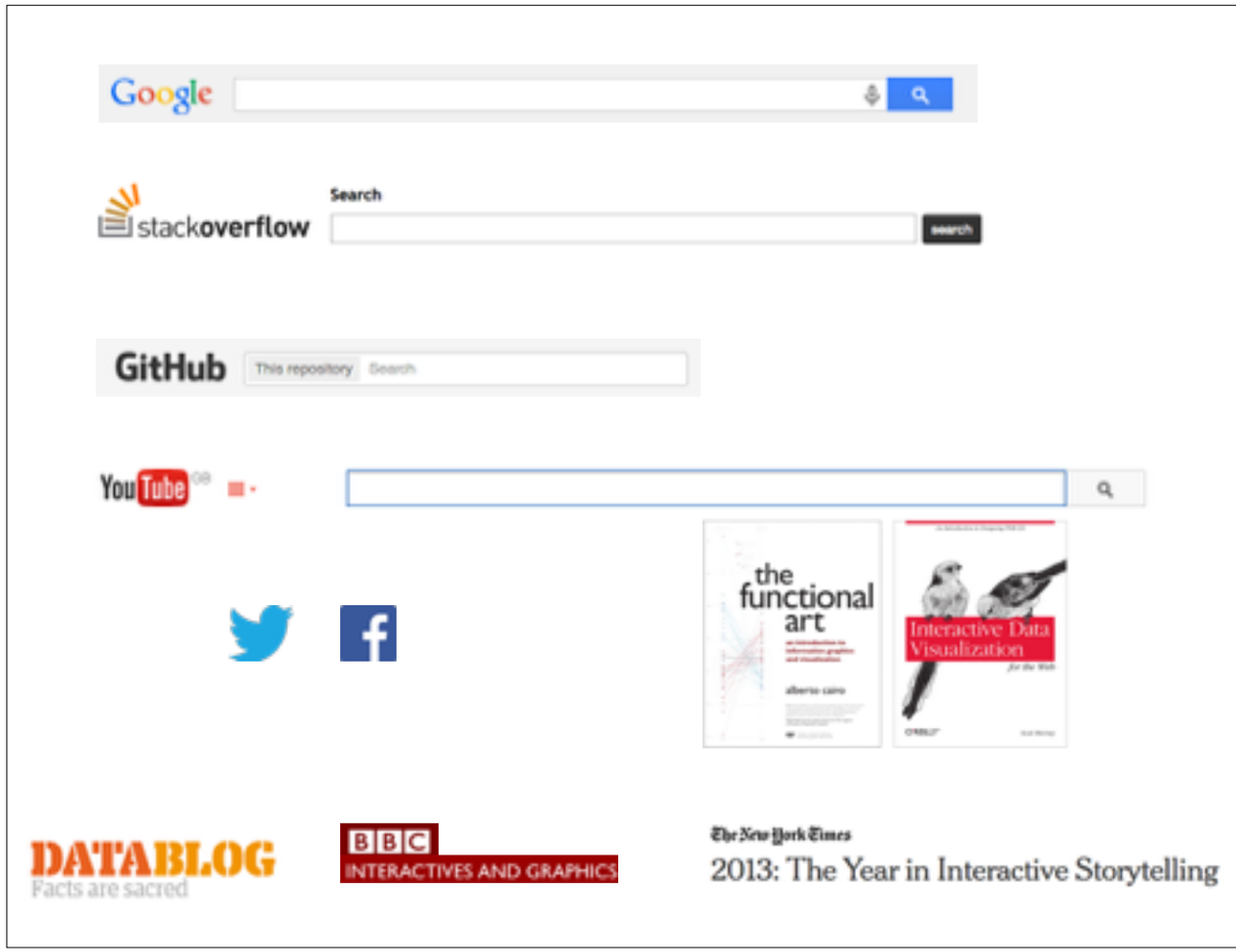


http://d3js.org

http://alignedleft.com/tutorials/d3

http://d3js.org Mike Bostock - author of language

http://alignedleft.com/tutorials/d3 Scott Murray - Author of “d3 bible”



So much open source - free software and support

Brackets

Read up on topics, ask questions on forums, get involved in communities

Watch tutorials on YouTube

Follow good practitioners of data viz on social media/digital media

Quizes

http://visual.ons.gov.uk/test-your-knowledge-on-the-gender-pay-gap/

http://visual.ons.gov.uk/what-are-migration-levels-like-in-your-area-2/

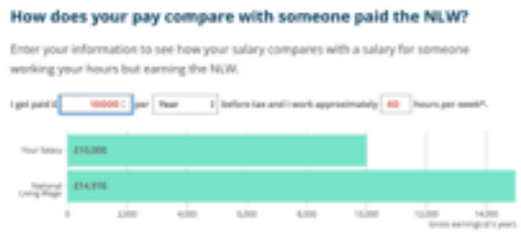
http://visual.ons.gov.uk/who-is-the-happiest-country-in-europe/

http://visual.ons.gov.uk/million-pound-properties/

http://visual.ons.gov.uk/how-much-farther-can-you-travel-on-a-tank-of-fuel/

http://visual.ons.gov.uk/the-value-of-your-unpaid-work/#calculator

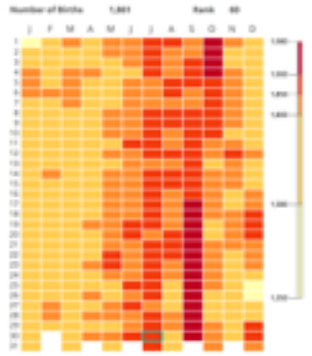
Personal calculators



http://visual.ons.gov.uk/how-will-the-national-living-wage-affect-employees-and-businesses-in-the-uk/

http://visual.ons.gov.uk/how-long-will-my-pension-need-to-last/

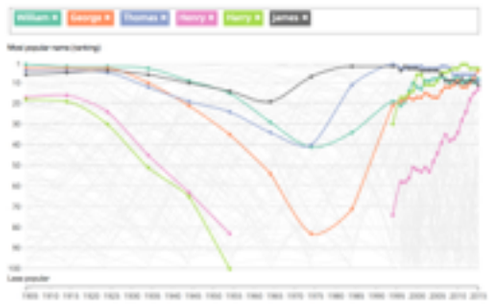
http://visual.ons.gov.uk/find-out-the-gender-pay-gap-for-your-job/



http://visual.ons.gov.uk/how-popular-is-your-birthday/

Explorer tools

http://visual.ons.gov.uk/households-spend-the-most-on-transport/



http://visual.ons.gov.uk/baby-names-since-1904-how-has-yours-performed/

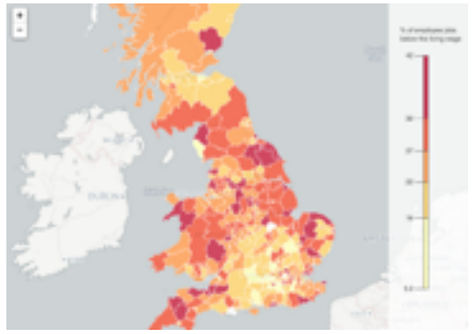
http://visual.ons.gov.uk/uk-perspectives-2016-the-uk-contribution-to-the-eu-budget/

http://visual.ons.gov.uk/whats-in-the-basket-of-goods-80-years-of-shopping-history/

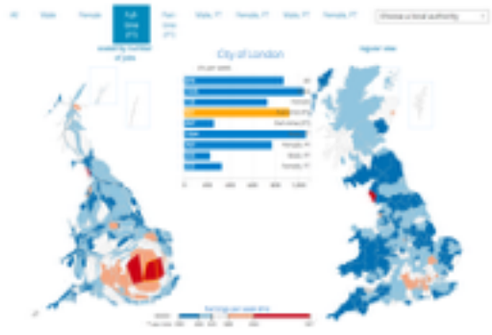
Explainers

http://visual.ons.gov.uk/welfare-spending/

http://visual.ons.gov.uk/more-jobs-being-paid-close-to-the-minimum-wage/



http://visual.ons.gov.uk/how-many-jobs-are-paid-less-than-the-living-wage-in-your-area/



http://visual.ons.gov.uk/interactive-how-do-earnings-vary-across-the-country/

Mapping

http://visual.ons.gov.uk/where-do-single-people-live-in-england-and-wales/

http://visual.ons.gov.uk/million-pound-properties/

Thank you!