



ELECTRONIC PUBLISHING
AND DIGITAL STORYTELLING
Lesson 2

PRELIMINARY CONCEPTS

TABLE OF CONTENTS

01

DATA

Data, data attributes, data visualisation

02

VISUALISATION DIMENSIONS

Graphic aspects relevant to data visualisation

03

VISUALISATION TECHNIQUES

Tables, charts, graphs and much more!

04

RESOURCES

Famous good and bad examples

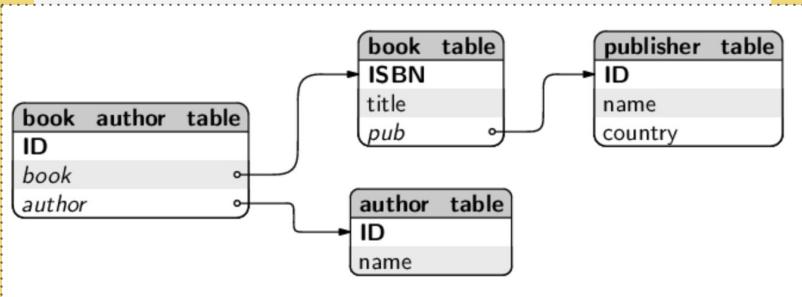


ELECTRONIC PUBLISHING
AND DIGITAL STORYTELLING
Lesson 2

DATA

DATA

```
<book id="b002" year="2000">  
  <title>Data on the Web</title>  
  <author><last>Abiteboul</last><first>Serge</first></author>  
  <author><last>Buneman</last><first>Peter</first></author>  
  <author><last>Suciu</last><first>Dan</first></author>  
  <publisher>Morgan Kaufmann</publisher>  
</book>
```



A datum is an abstraction of a real-world **entity** (e.g. a person, a book, an artwork).

Data are characterised by **attributes** (also called features or variables).

For instance: *author*, *title*, *ISBN* are all attributes of a book.

DATASET

	ISBN	bookTitle	bookAuthor	yearOfPublication	publisher	imageUrls
0	0195153448	Classical Mythology	Mark P. O. Morford	2002	Oxford University Press	http://images.amazon.com/images/P/0195153448.0...
1	0002005018	Clara Callan	Richard Bruce Wright	2001	HarperFlamingo Canada	http://images.amazon.com/images/P/0002005018.0...
2	0060973129	Decision in Normandy	Carlo D'Este	1991	HarperPerennial	http://images.amazon.com/images/P/0060973129.0...
3	0374157065	Flu: The Story of the Great Influenza Pandemic...	Gina Bari Kolata	1999	Farrar Straus Giroux	http://images.amazon.com/images/P/0374157065.0...
4	0393045218	The Mummies of Urumchi	E. J. W. Barber	1999	W. W. Norton & Company	http://images.amazon.com/images/P/0393045218.0...

A dataset is a collection of entities and their attributes.

A dataset can be seen as a **n*m matrix**, where n are the entities (rows) and m are the attributes (columns).



ELECTRONIC PUBLISHING
AND DIGITAL STORYTELLING
Lesson 2

DATA ATTRIBUTES

TYPES OF DATA ATTRIBUTES

Measurable quantities represented by integers (e.g. temperature, price).

NUMERIC

Or (Nominal) are names from non-overlapping sets of categories, classes, or states (e.g. title, sex)

CATEGORICAL

Nominal or numeric attributes that can be ranked (e.g. days, years, Likert: “strongly like” to “strongly dislike”).

ORDINAL

* NUMERIC ATTRIBUTES

Interval attributes are measured on the basis of a scale with an interval and an origin (e.g. time, temperature). They have **no true-zero**.

INTERVAL SCALE

Ratio attributes have a true-zero - meaning no quantity is measured in that point (e.g. price)

RATIO SCALE

ANOTHER WAY OF SEEING IT

→ CATEGORICAL



→ ORDERED

→ Ordinal



→ Quantitative



→ Sequential



→ Diverging



→ Cyclic



Cannot be ordered

Can be ordered according to their magnitude, quantity, order in a sequence, etc.

WHAT OPERATIONS CAN BE DONE ON DATA ATTRIBUTES

interval attributes cannot be multiplied or divided

Potentially, can be **ordered** (interval) and arithmetic operations can be performed (ratio).

NUMERIC

Can be **sorted** (e.g. alphabetically). Cannot be ordered and arithmetic operations cannot be performed.

CATEGORICAL

Can be naturally **ordered**, but arithmetic operations are not possible

ORDINAL

WHICH ANALYTICAL METHODS CORRESPOND TO DATA ATTRIBUTES

Statistical analysis

NUMERIC

Counting and proportion
of occurrences
(distribution) in the
dataset

CATEGORICAL

Counting and proportion
of occurrences
(distribution) in the
dataset

ORDINAL

OTHER CHARACTERISTICS OF DATA

A parenthesis on higher level
aspects

STRUCTURED AND UNSTRUCTURED DATA

Can be stored in a **table**.
Data have a similar
(attributes) structures and
are easy to query, store,
merge with other structured
data.

STRUCTURED

Every instance of the
dataset may have a
different internal
structure (e.g. web
pages).

UNSTRUCTURED

RAW AND DERIVATIVE DATA

Raw abstractions of events and objects (e.g. weight, height).

RAW

Derived from the **interaction** of other pieces of data (e.g. percentage, average).

DERIVATIVE

* RAW DATA

Collected by means of
direct measurement or
observation (e.g. surveys).

CAPTURED

By-product of the
original collected data
(e.g. social media
interactions) or
metadata.

EXHAUST

DATABASES

Based on relations between
tables.

SQL

Based on object-oriented
flexible structures

No SQL



ELECTRONIC PUBLISHING
AND DIGITAL STORYTELLING
Lesson 2

INTRODUCTION TO DATA VISUALISATION

DATA VISUALISATION



At the end of the 18th century, **William Playfair** invented statistical graphics.

He designed line charts and area charts (time-series data), bar charts (quantitative or categorical comparison), and pie charts (proportions within a set)

DATA VISUALISATION

Since visualisations allow to have a view of large and complex datasets, these are fundamental aid in data science in all the phases, such as **exploring, understanding** and **presenting** results.

A Disclaimer

Visualisations rarely give precise answers to a question (e.g. low-level precision of areas in bubble charts).

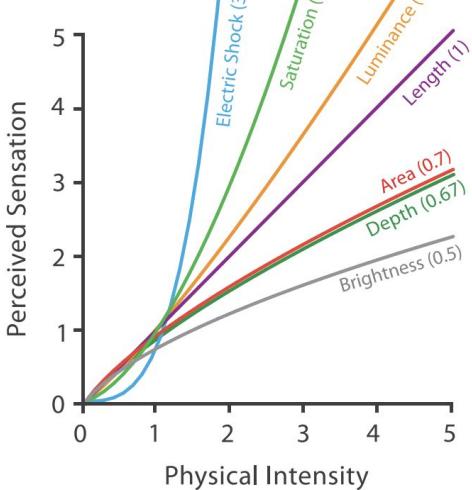
Rather, they frame phenomena and contribute to give a precise answer.



DATA VISUALISATION DIMENSIONS

What are the recurring graphical aspects and how these interact with the viewer's perception and data attributes

PERCEPTION OF VISUAL ASPECTS



Steven's Psychophysical Power Law: $S = I^n$

Stevens, 1975

Visual aspects have a **functional** role in the interpretation of data rather than aesthetic.

The idea of visualising data in graphical forms is to **replace cognition with perception**.

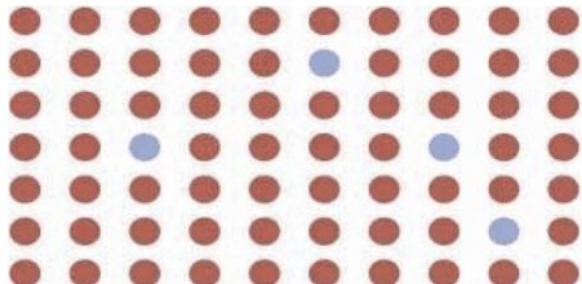
The human eye **perceives** visual dimensions in different ways, with more or less effort, and users' **knowledge background** can affect the perception.

TIDWELL'S PREATTENTIVE VARIABLES

0.103	0.176	0.387	0.300	0.379	0.276	0.179	0.321	0.192	0.250
0.333	0.384	0.564	0.587	0.857	1.064	0.698	0.621	0.232	0.316
0.421	0.309	0.654	0.729	0.228	0.529	0.832	0.935	0.452	0.426
0.266	0.750	1.056	0.936	0.911	0.820	0.723	1.201	0.935	0.819
0.225	0.326	0.643	0.337	0.721	0.837	0.682	0.987	0.984	0.849
0.187	0.586	0.529	0.340	0.829	0.835	0.873	0.945	1.103	0.710
0.153	0.485	0.560	0.428	0.628	0.335	0.956	0.879	0.699	0.424

Some visual aspects work preattentively, meaning they are able to communicate something **before** the user pays conscious attention to it.

Effective and impactful data visualisations work extensively on these aspects.



TIDWELL'S PREATTENTIVE VARIABLES

Color HSL
(hue, saturation,
lightness)

Form
(size, shape)

Movement

Positioning

Color hue



Color brightness



Color saturation



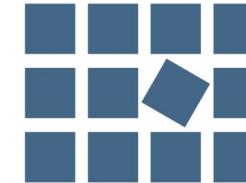
Texture



Position



Orientation



Size



Shape



GRAPHICAL PROPERTIES

Graphical properties are properties which can be applied to the graphical elements which make them more (or indeed less) noticeable/valuable to the user of the representation.

Axes (Orientation)	Color
Layout	Size
Shape	Typography

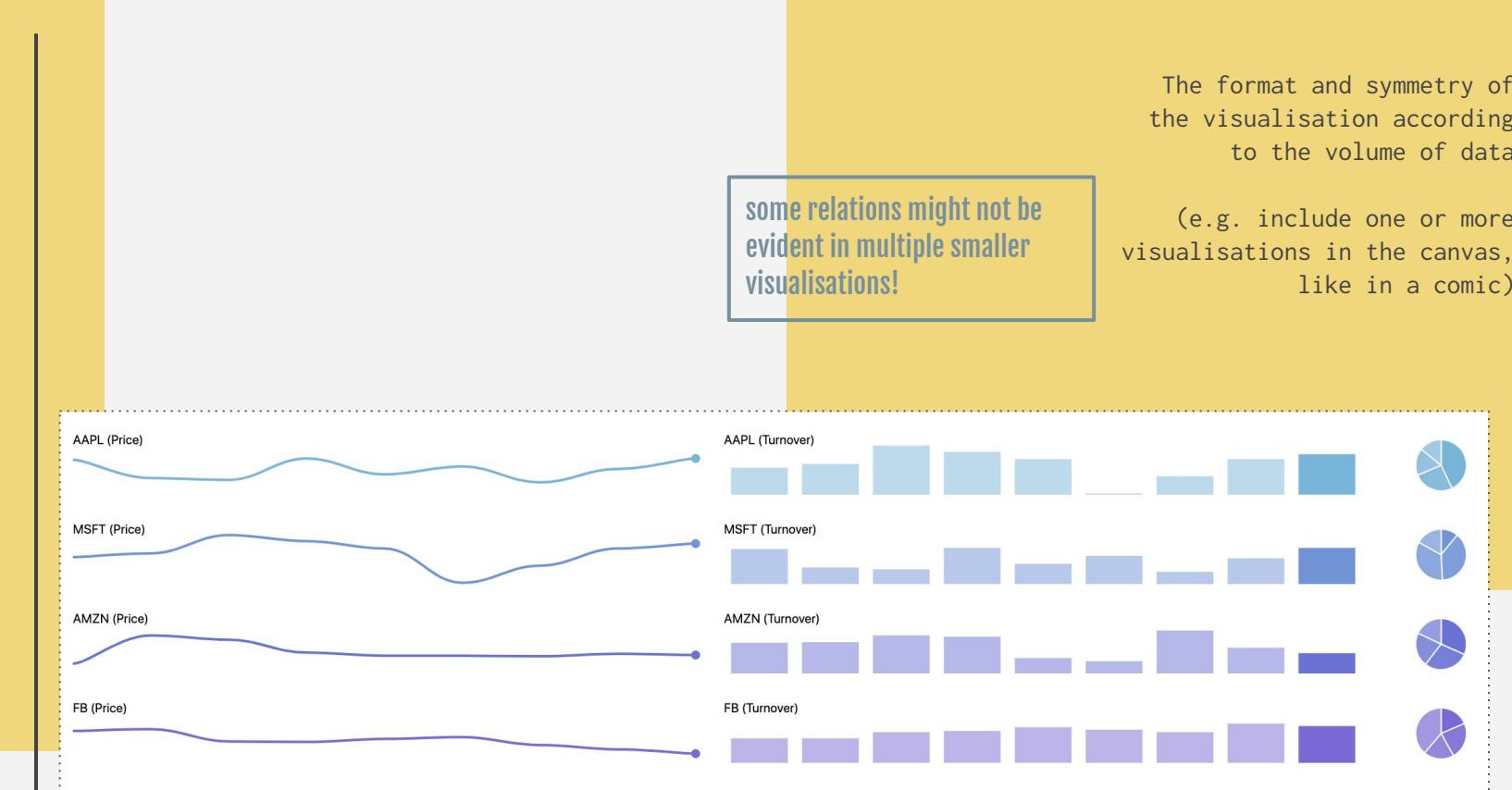
AXES



A visual guide for the placement of elements composing the visualisation.



LAYOUT



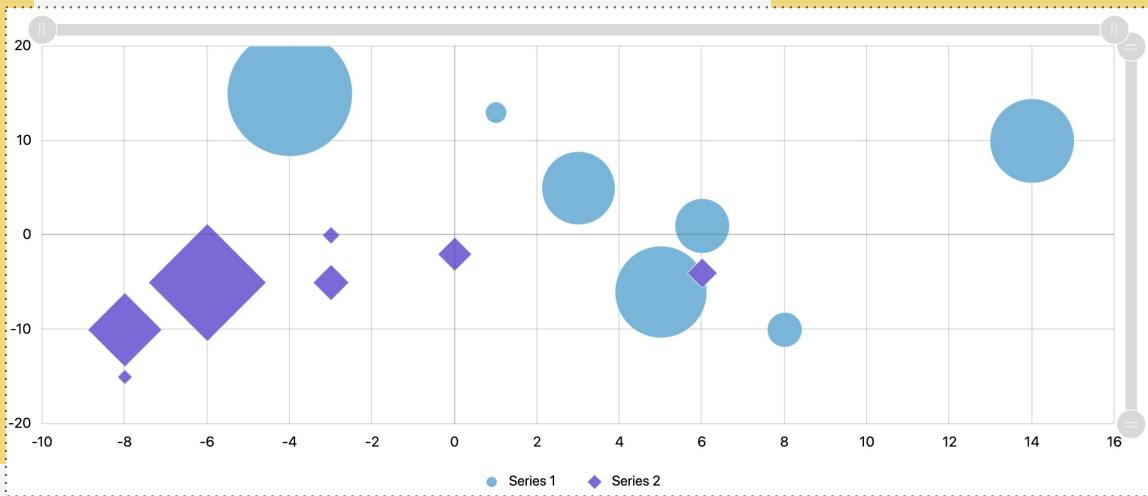
SHAPE

require supporting text to explain the meaning and may be less immediate

Can be realistic (e.g. icons) or abstracts (circles, rectangles)

Shapes and glyphs demand more attention (icons can mitigate the effort)

Lines are particularly effective shapes that can demonstrate a fact (e.g. a trend)



COLOR

may require high resolution and attention for colorblindness

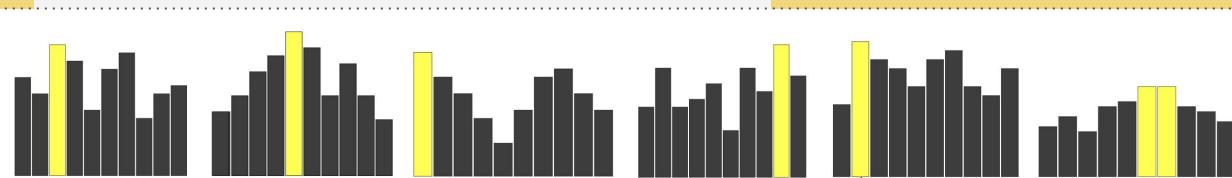
Used in big datasets to distinguish elements or patterns, it's less useful in small datasets.

In smaller datasets one color is sufficient. When data dimensions are only two, 2-dimension color palette is sufficient.

Color differences are detected in <200 milliseconds (preattentive perception)

Colors must be natural (e.g. those found in nature)

Luminosity immediately highlights relevant patterns (bright colors pop out, while dark colors recede)

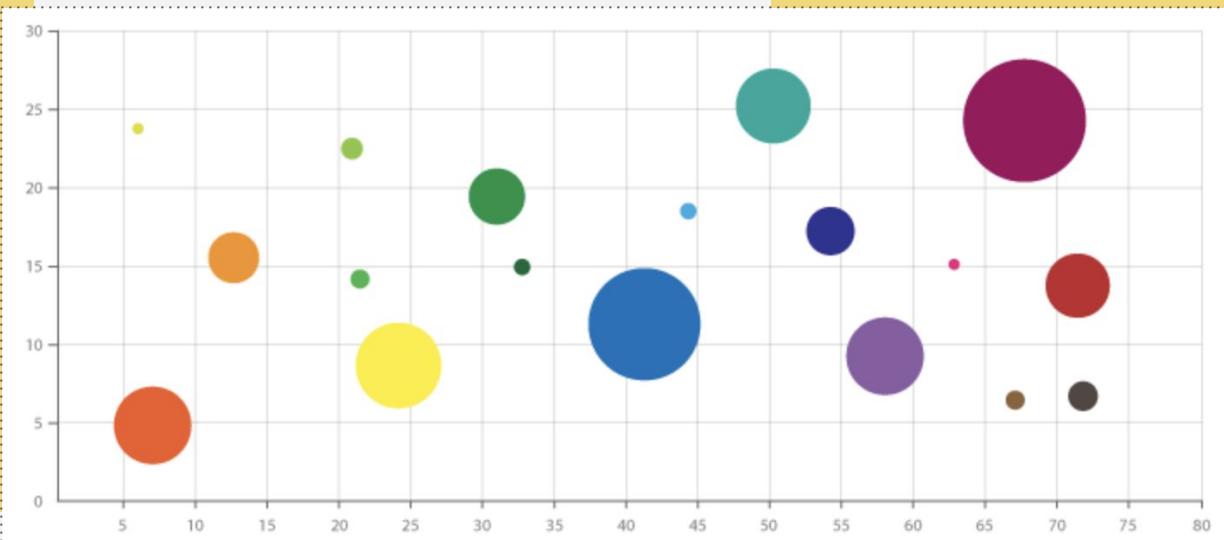


Zenbait jokalarik euren 10 urteko ibilbidean,
denboraldi bakoitzean egindako gol-kopurua.

Denboraldi goreneko gol-kopurua

SIZE

Identify **variations** between similar elements by size (regardless other dimensions) is the quickest way.

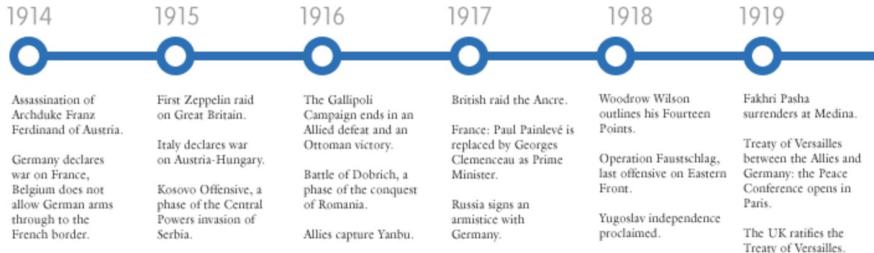


TYPOGRAPHY



Can be a primary aspect (e.g. wordle) or secondary along with other dimensions (e.g. size).

Timeline of World War I



INTERACTION OF VISUAL DIMENSIONS

Visual dimensions can be summed up to convey the same data dimension (**redundancy** helps to understand faster) and can **interact** with each other in different ways.

CONTEXTUAL ASPECTS

The placement of data in maps (geographical or not, e.g. airplane seats) help to familiarise with contents.

LOCATION

Construct connections between data rather focusing on data points.

NETWORK

intuitive but not always carefully constructed

can be replaced by animations, vertical/horizontal layout help to contextualise sequences

An axis-based visualisation of other dimensions (e.g. timeline).

SEQUENCE

**VISUAL ASPECTS +
CONTEXT =
VISUAL PATTERN**

THE ULTIMATE GOAL: IDENTIFY VISUAL PATTERNS

By means of graphical and contextual aspects, what should emerge from visualisations is mainly a **visual pattern**. Several co-occurring dimensions can contribute to highlight patterns.

VISUAL PATTERNS

size and colors work better
with 2-dimensional data

Contrast boolean
dimensions (e.g. sold
VS unsold paintings)

DIFFERENTIATION

size does not work well
when differences are not
significative

A gradation of
quantitative
information (e.g.
temperatures).

GRADATION

color and location highlight
anomalies

Data points that do
not follow a pattern
(this are the
interesting data)

ANOMALIES

WHAT TO LOOK FOR IN PATTERNS



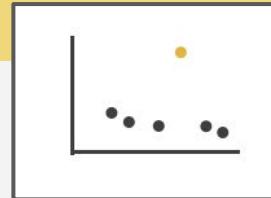
Overall picture of
data over time

TRENDS



Some sample of
overall data

FEATURES



Some data point in
the dataset

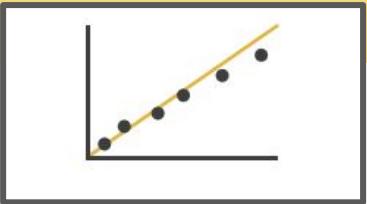
OUTLIERS

WHAT TO LOOK FOR IN PATTERNS



Presence of an attribute in the dataset

DISTRIBUTION



Relations between attributes

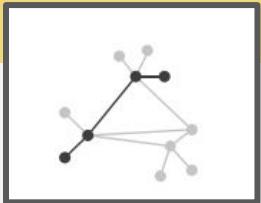
CORRELATION



Common features of data points

SIMILARITY

WHAT TO LOOK FOR IN PATTERNS



Relations between
data points or
position of clusters

PATHS

DATA VISUALISATION BEST PRACTICES

OBJECTIVES OF DATA VISUALIZATION

Effective visualisations are able to **identify, summarise and prioritise** information.

These can be aimed at **exploring** a dataset or to **discover** knowledge



KNOWLEDGE DISCOVERY

The designer has a **question** to answer, and a **hypothesis** and wants to demonstrate.

HYPOTHESIS

The validation consists of the **visual evidence** of a trend, a behaviour, or a relationship.

VALIDATION

some visualisations provide an intuitive validation but do not allow a precise assessment

YOU CAN SEE EXPLORATION AS A FORM OF DISCOVERY

Select data that **may characterise** the dataset (the added value).

A PRIORI INTEREST

Find what data are **available, significant, interesting and at scale** for further analysis.

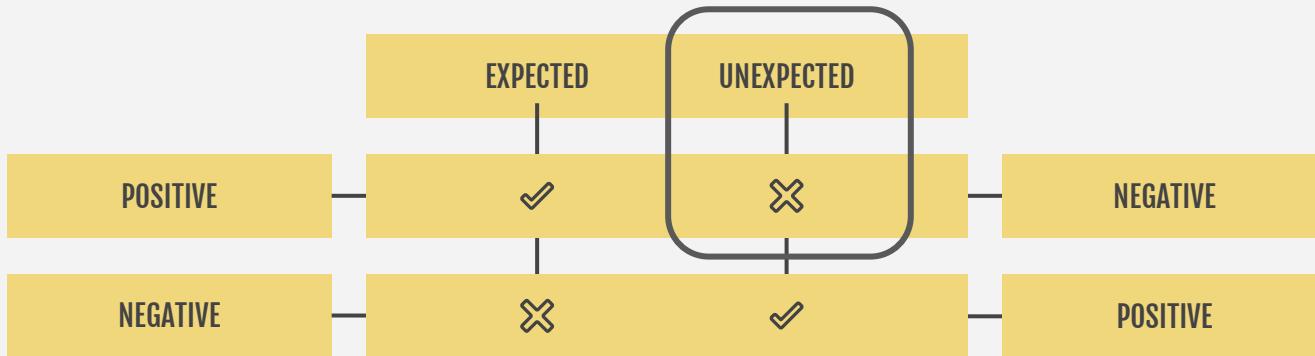
DATA DIVERSITY

DISCOVERY MATRIX



Outcomes of data analysis/discovery techniques fall into two categories:
expected/unexpected,
positive/negative

DISCOVERY MATRIX



Unexpected negative results are the most insightful patterns that can effectively support decision-making

HOW GOOD VISUALISATIONS SHOULD BE



NOVEL

A byproduct of informative and efficient visualisations

INFORMATIVE

Make explicit an **intended message** and the **context of use** of data.

EFFICIENT

Free from non informative data (noise). The learning time to understand the graphics is low.

* INFORMATIVE

The knowledge conveyed, telling a **story** or answering a **question**.

INTENDED MESSAGE

How the knowledge is going to be used by users, such as a **presentation** of known information, the **exploration** or the **discovery** of unknown information.

CONTEXT OF USE

WHAT VISUALISATIONS SHOULD ALWAYS ACHIEVE



SHOW PATTERNS

Arrange data in a way that reveals relations between data.



ACCESS PERTINENT DATA

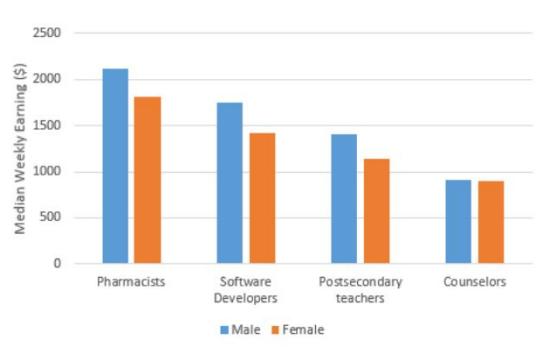
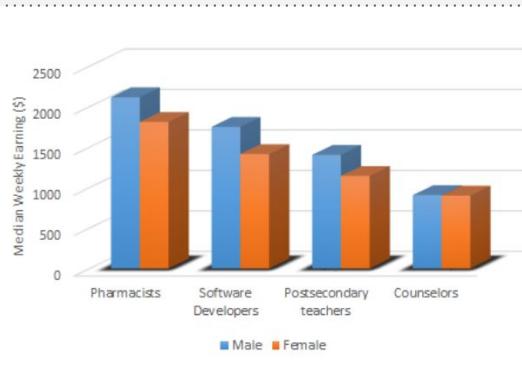
Strip away irrelevant information so that pertinent data is highlighted.



GET EXCEPTIONAL DATA

Relevant, exceptional data should be easy to be read.

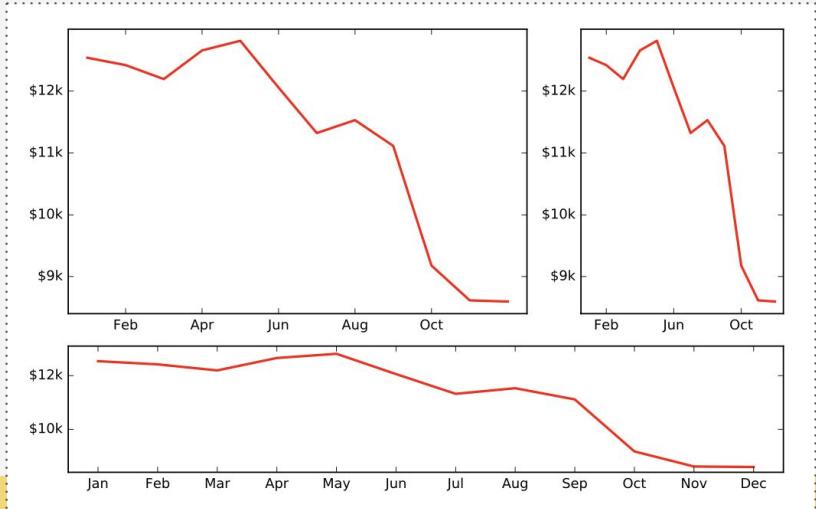
EDWARD TUFTE'S PRINCIPLES



The ink used to represent data should be minimal, so that the intended message is clear.

MINIMIZE DATA-INK RATIO

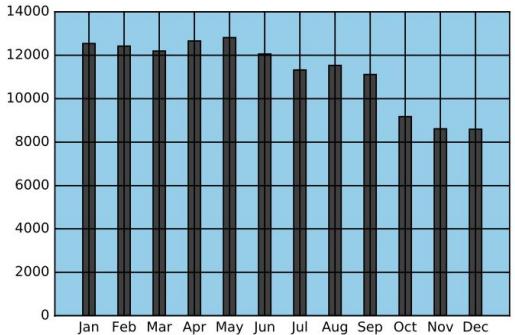
EDWARD TUFTE'S PRINCIPLES



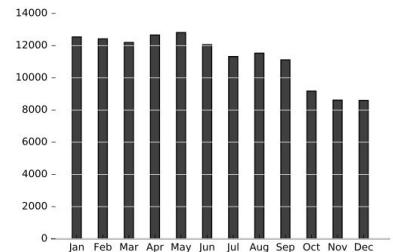
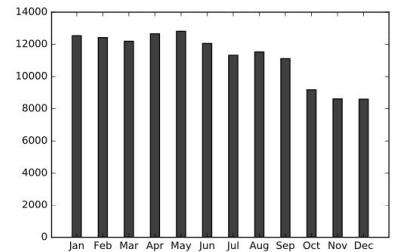
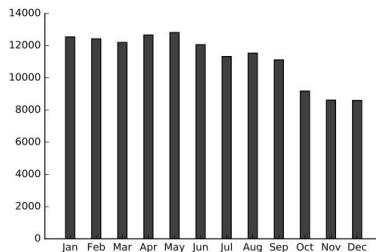
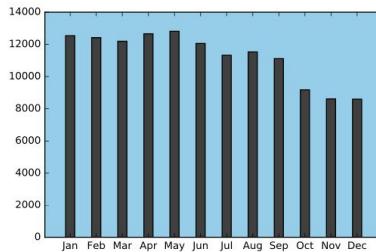
Omitting data or changing proportions in the visualisation can tell different stories.

MINIMIZE THE LIE FACTOR

EDWARD TUFTE'S PRINCIPLES

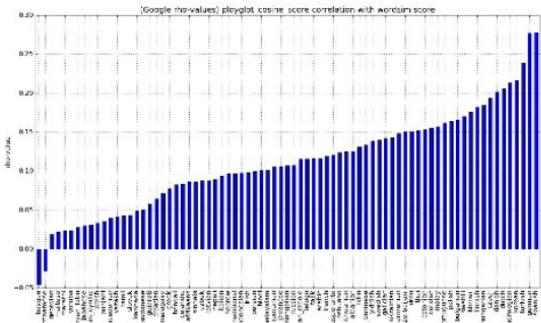
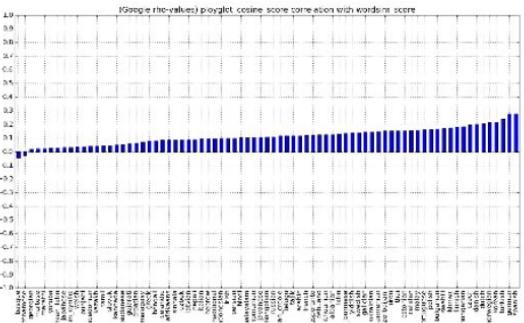


Visual elements
should not hide the
data.



MINIMIZE CHARTJUNK

EDWARD TUFTE'S PRINCIPLES



Data should be scaled so as to fill all the space allotted to it. Labels should be high resolution.

PROPER SCALES AND LABELS

EDWARD TUFTE'S PRINCIPLES

Use colors to distinguish values and represent **difference** - rather than representing linear, numerical scales.

EFFECTIVE USE OF COLOR

Use multiple smaller charts to facilitate comparison (while losing the big picture)

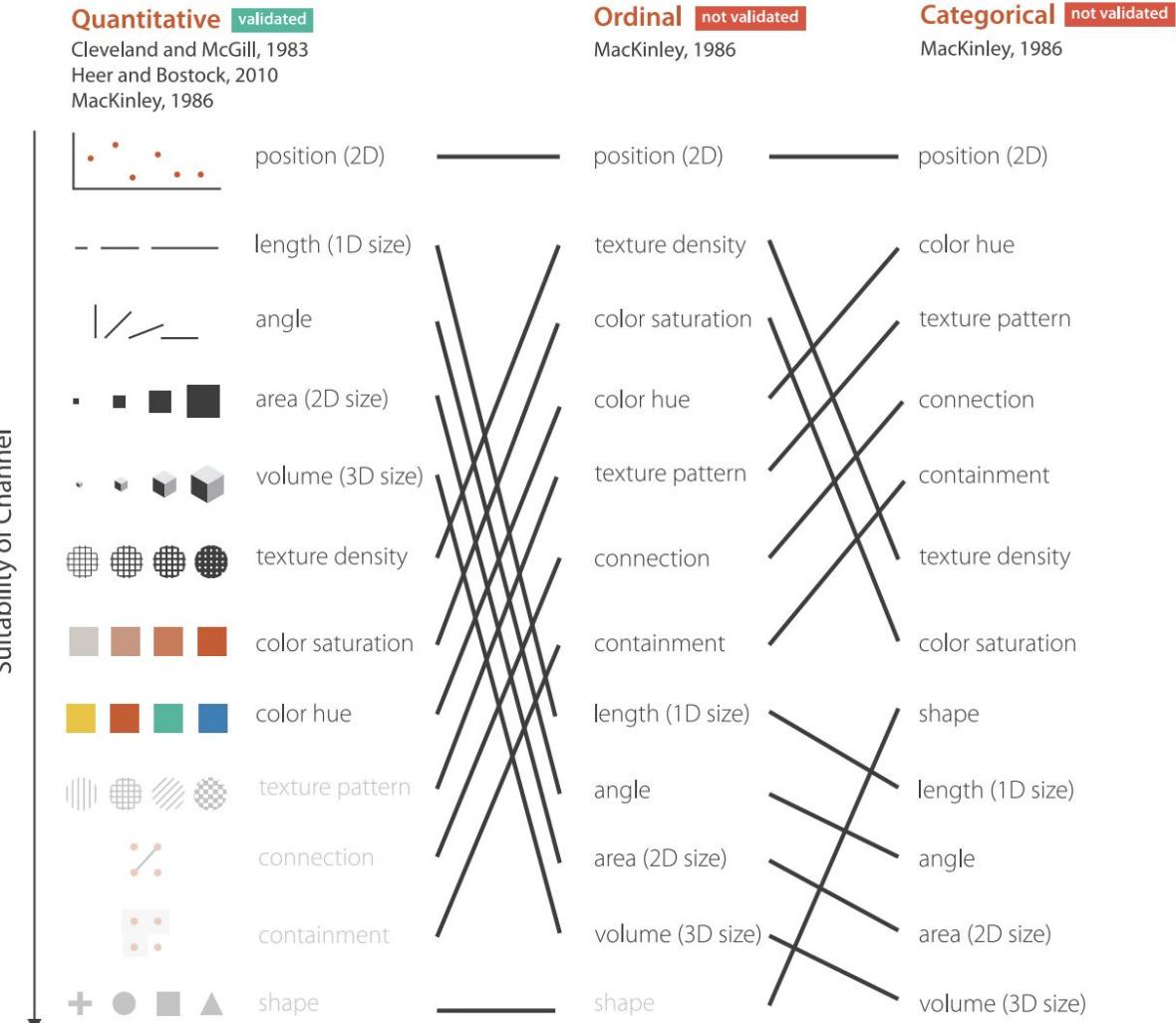
REPETITION

VISUAL MAPPING

The process of associating visual aspects (such as preattentive properties) to data attributes is called **visual mapping**.



VISUAL MAPPING



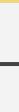
THE TOP BEST PRACTICES



Design several different **visualisations** to understand which one works better.



Redundancy of encodings (e.g. using color and shape for one dimension) helps users' perception.



Use **familiar** colors, icons, layouts as visual hooks and reduce users' effort in understanding the intended message.

AN OVERVIEW OF DATA VISUALISATION SOLUTIONS

From simple to complex plots, an
inspirational journey rather
than a complete survey

SUMMARY OF TYPES OF DATA VISUALISATIONS

TYPES OF DATA VISUALISATION

- static
- animated
- interactive
- direct manipulation

VISUALISATIONS BASED ON DATA ATTRIBUTES

- quantitative data
- categorical data
- mixed data

TASKS

- exploration
- presentation
- discovery

AFFORDANCE

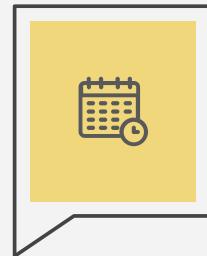
- identification
- comparison
- summarisation



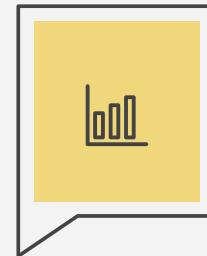
MOST COMMON VISUALISATION TYPES



CHARTS



TABLES



GRAPHS



MAPS



NETWORK GRAPHS

TABLES

Based on carbon-12											
1	H	2	18	He							
1	1.00794	9.0122									
2	Li	Be									
3											
4	Na	Mg									
5											
6	K	Ca	3	4	5	6	7	8	9	10	11
7	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	12
8	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	
9	Cs	Ba									
10											
11	Fr	Ra	Acb	Unq	Unp	Unh	Uns	Uno	Une		
12	87	88	89	104	105	106	107	108	109		
IPTE9007											
a	140.115	140.977	144.24	146.9151	150.38	151.965	157.25	158.9253	162.50	164.9303	173.04
n=6	58	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er
b	232.038	231.0359	238.0289	237.0482	244.0642	243.0614	247.0103	247.0703	251.0786	252.0829	257.0959
n=7	90	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es
	91	92	93	94	95	96	97	98	99	Fm	Md
										No	Lr

0.103	0.176	0.387	0.300	0.379	0.276	0.179	0.321	0.192	0.250	
0.333	0.384	0.564	0.587	0.857	1.064	0.698	0.621	0.232	0.316	
0.421	0.309	0.654	0.729	0.228	0.529	0.832	0.935	0.452	0.426	
0.266	0.750	1.056	0.936	0.911	0.820	0.723	1.201	0.935	0.819	
0.225	0.326	0.643	0.337	0.721	0.837	0.682	0.987	0.984	0.849	
0.187	0.586	0.529	0.340	0.829	0.835	0.873	0.945	1.103	0.710	
0.153	0.485	0.560	0.428	0.628	0.335	0.956	0.879	0.699	0.424	

Simple and effective. They allow a **precise comparison** of heterogeneous data.

If you want to demonstrate and convince anybody of your scientific results, you are very likely to need a table.

You can always start from a table and then experiment more sophisticated and suitable visualisations



TABLES

Good for **multivariate values**,
heterogeneous data
(categorical, numeric,
ordinal, etc.)

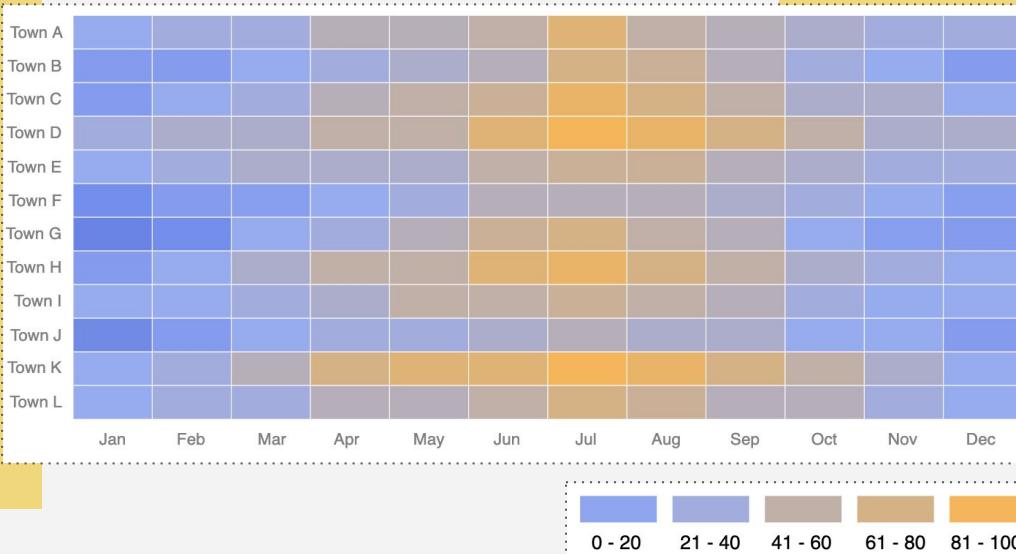
The **order of rows** should
invite comparison (e.g. apply
descending order to a
column).

The **order of columns**
highlight importance.

Can include icons, colors,
changes in typography to add
emphasis.

Frequency (Hertz)	Scientific Pitch	Helmholtz/ German	Octave Name	Pipe Length
8.176	C-1	CCCC		64'
16.352	C0	CCC	sub-contra	32'
32.703	C1	CC	contra	16'
65.406	C2	C	great	8'
130.81	C3	c	small	4'
261.63	C4	c'	1-line	2'
523.25	C5	c''	2-line	1'
1046.5	C6	c'''	3-line	1/2'
2093.0	C7	c''''	4-line	
4186.0	C8	c'''''	5-line	
8372.0	C9	c''''''		

HEATMAPS



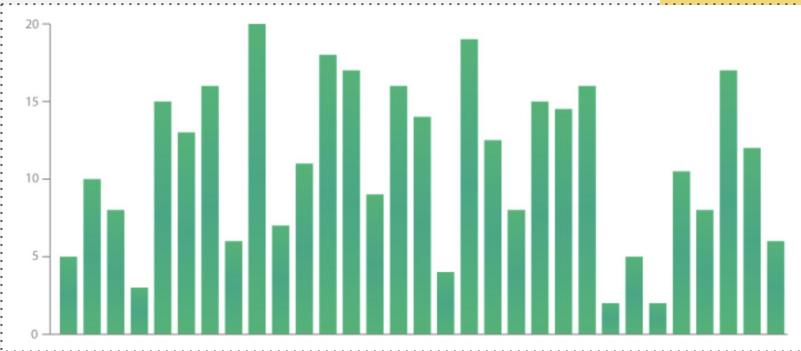
A special type of tables where **multivariate data** are mapped to colours. The map highlights the **variance across variables**, patterns like correlation.



While it gives a good overview, it's hard to get a precise comparison of underlying numerical values.



BAR CHARTS



Often used with **bivariate** values, especially to combine a categorical value and a numeric value, and **highlight differences between categories** (their occurrence in the dataset).

Categorical data need to be **independent** (if there are changes in one of those, these do not affect the other categories).

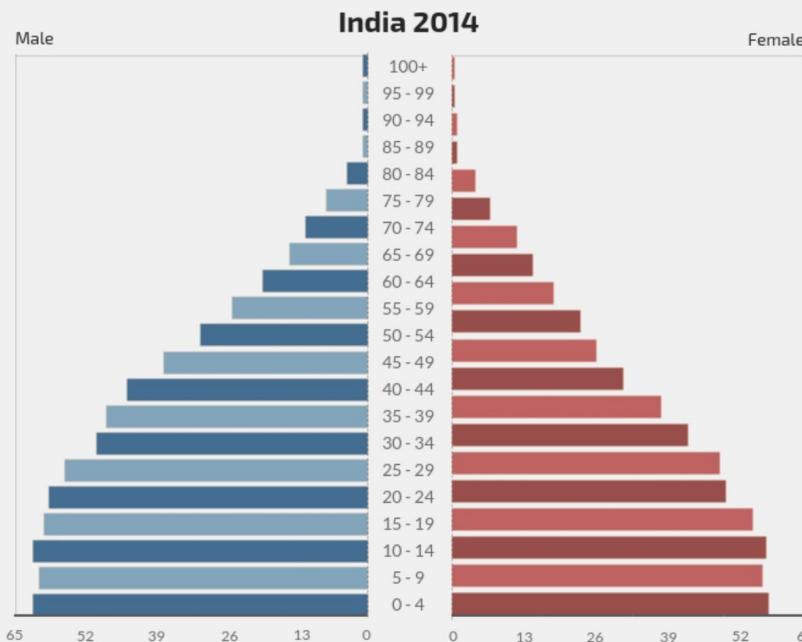


BAR CHARTS

>> PYRAMIDS

Vertical or horizontal layout usually does not matter much.

In few cases, sorting variables by ascending/descending order (e.g. by age) helps to grasp a better overview in the comparison.



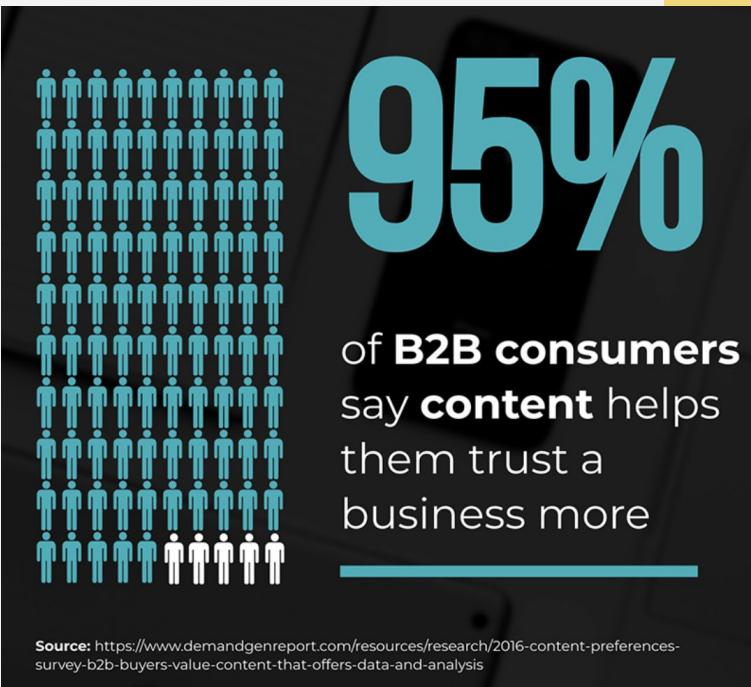
BAR CHARTS

>> PICTOGRAMS

A special type of bar charts where one of the axis is replaced by a certain number of icons.

The number can be representative of the actual value on that axis, or being a proportional approximation.

Particularly engaging when comparing categories.



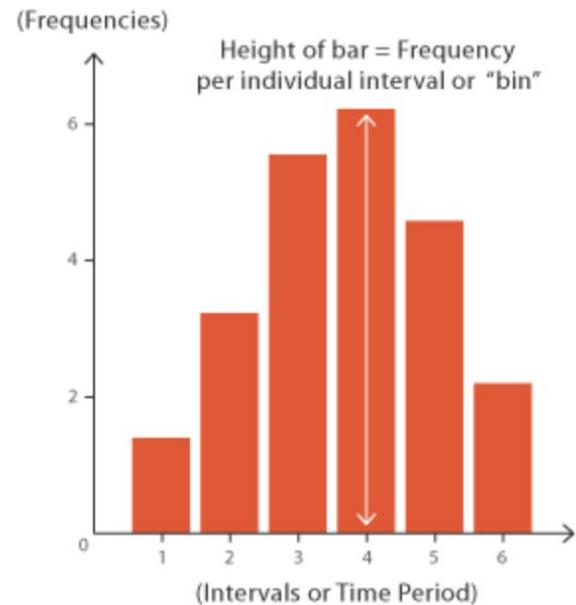
BAR CHARTS

>> HISTOGRAMS

A special type of bar chart where categories are replaced by numeric continuous data (e.g. time).



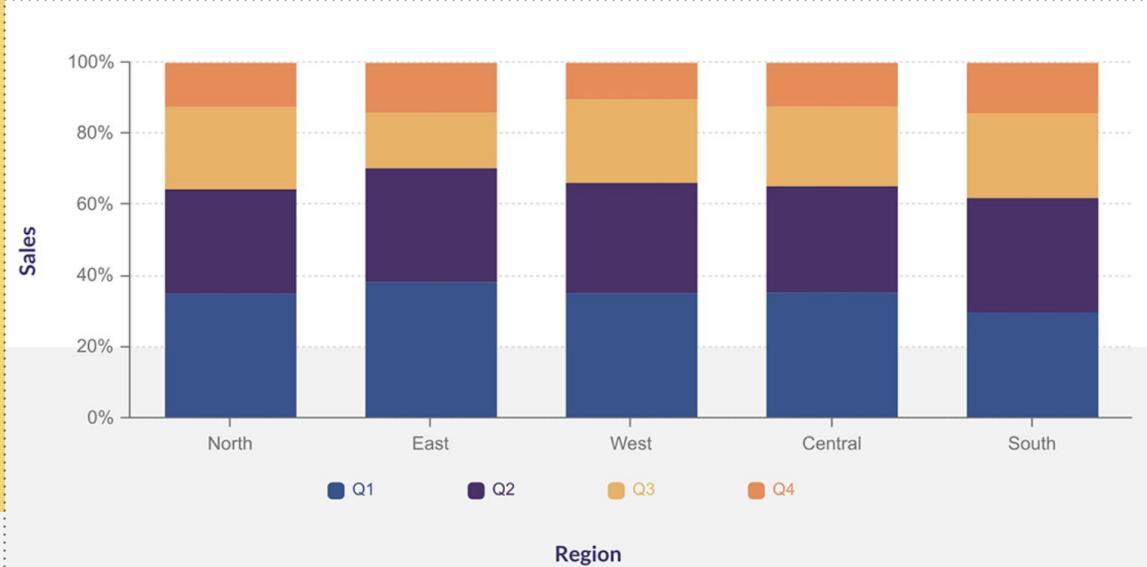
Usually used to show **distribution** of one variable in a dataset, meaning where that variable concentrates, whether there are gaps, and what are the extreme points of occurrence.



BAR CHARTS

>> STACKED BAR CHARTS

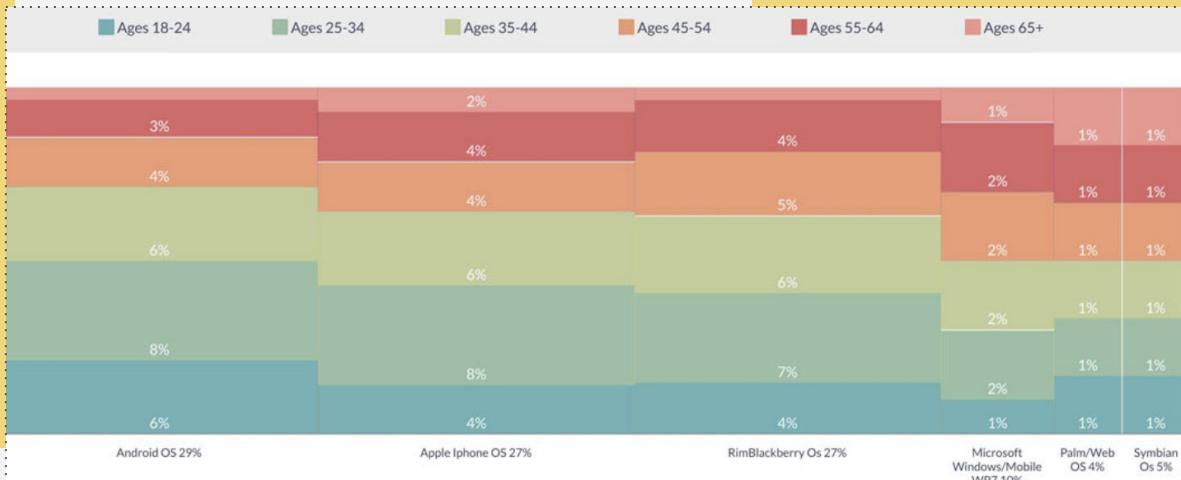
A special type of bar chart where **multiple categories are grouped and compared against a numeric value.**



BAR CHARTS

>> MOSAIC OR MARIMEKKO CHARTS

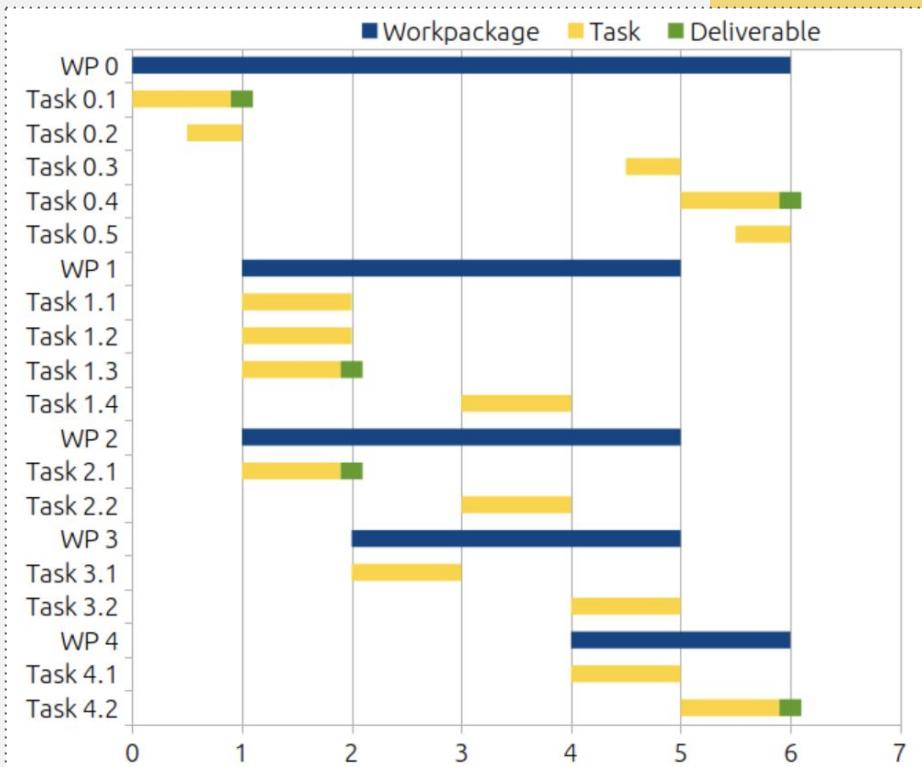
A special type of bar chart where you can compare multivariate categories against multiple variables.



Source: The Nielsen Company

BAR CHARTS

>> GANTT CHART

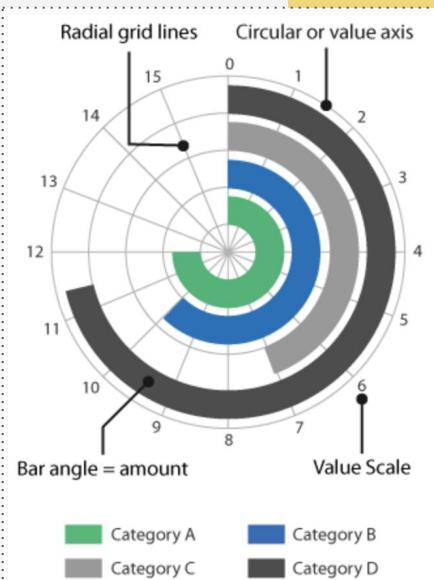


Halfway between a table and a bar chart, gantt charts allow to see **dependencies between variables** (e.g. activities) with respect to another (e.g. time).



BAR CHARTS

>> RADIAL BAR CHARTS



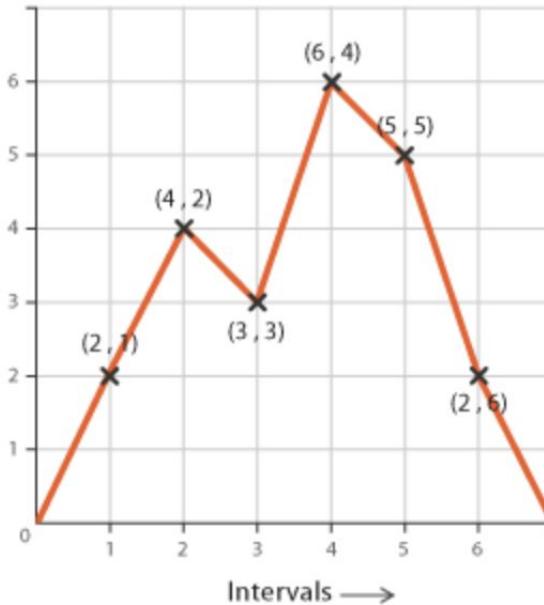
A bar chart where one of the axes is radial, meaning the cartesian system is substituted by a polar system.

Reading these charts can be misleading, since the outer bars tend to be seen as bigger/longer.



DOT AND LINE PLOTS

Value Scale



Line plots are used to show **dependent data**, usually between a categorical value and a numeric one (when changes occur in one variable, these affect the other variables).

For each category is shown a point value.

Useful to show **trends**.

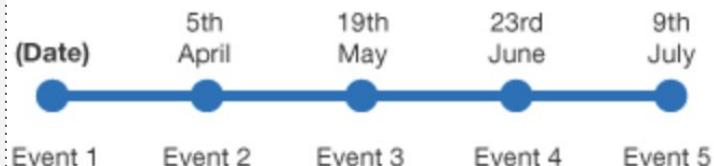


TIMELINES

A list of data points displayed on a line, according to a scale or in sequence.



Sequential Timeline:

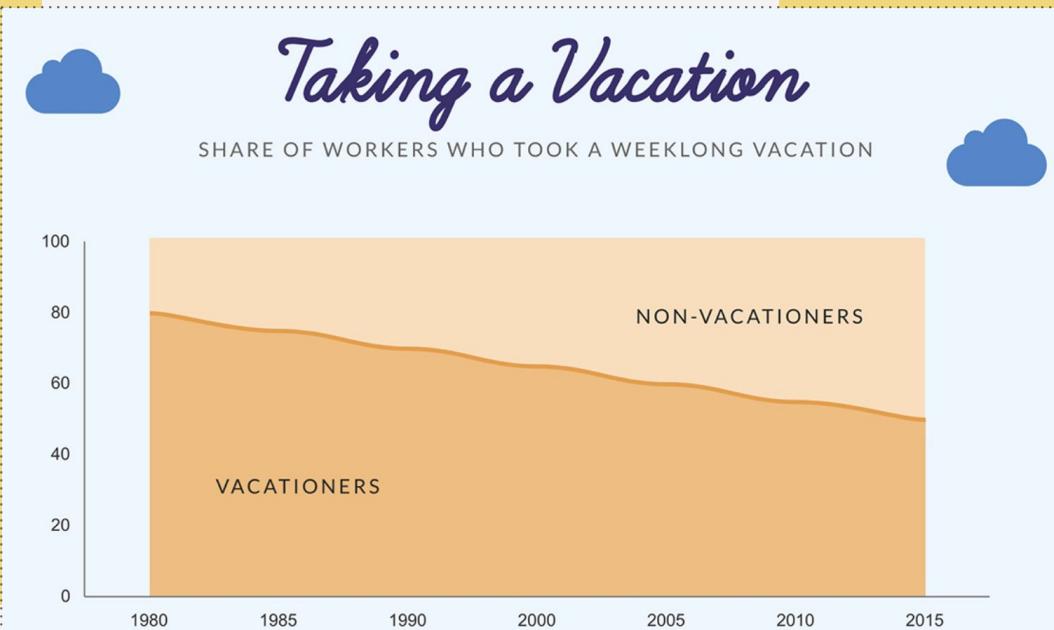


In a scale-based timeline it's possible to see the distribution of data points.

Scaled Timeline:



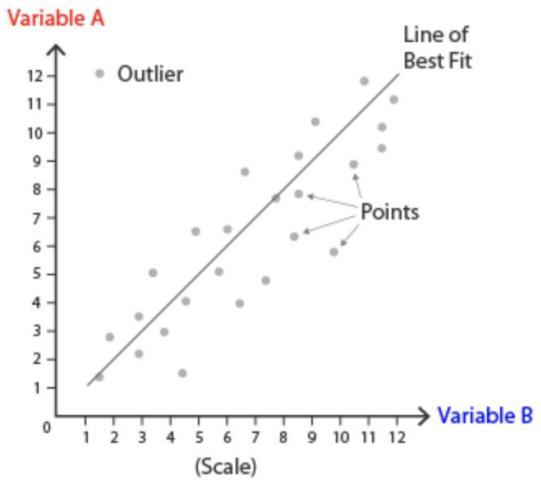
AREA CHARTS



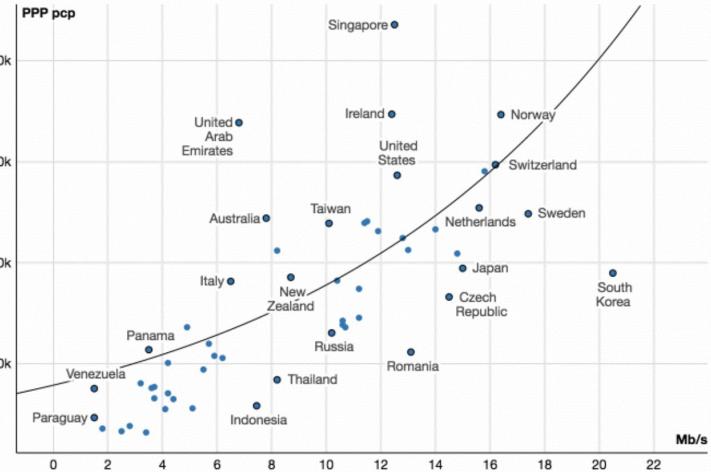
A special type of line chart where areas divided show a **comparison of variables and their dependency** (e.g. inverse proportion) and of the “size” of a phenomenon.



SCATTER PLOTS



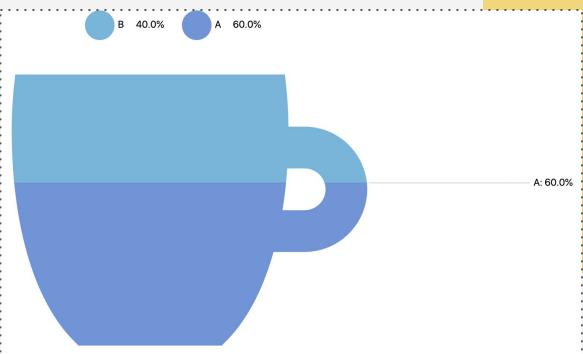
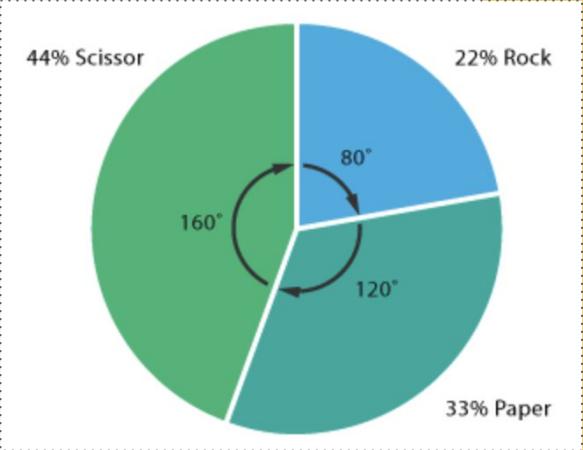
Comparing GDP per capita with internet speeds



Allows to show the correlation between two independent numeric variables and the outliers.

Patterns (highlighted by a best fit line) include: **positive** (values increase together), **negative** (one value decreases as the other increases), **null** (no correlation), **linear**, **exponential** and **U-shaped**.

PIE CHARTS

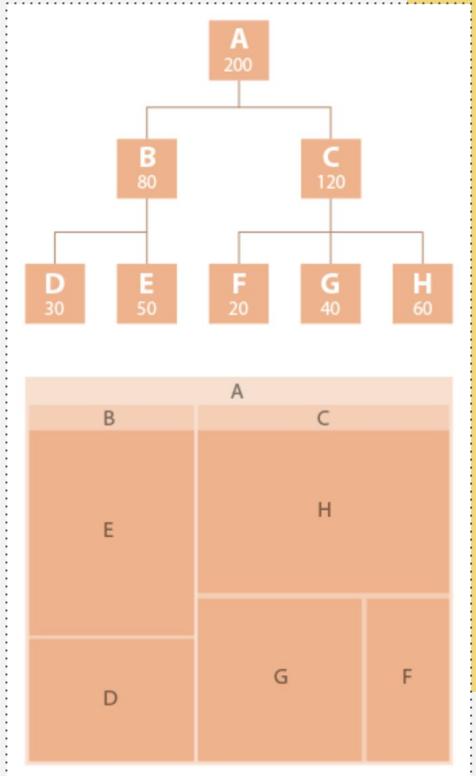


Circles cut in segments to show parts and their proportion with respect (1) to the whole, and (2) to other parts.

Used to show univariate dependant data.

Circles can be replaced with pictograms.

TREEMAPS

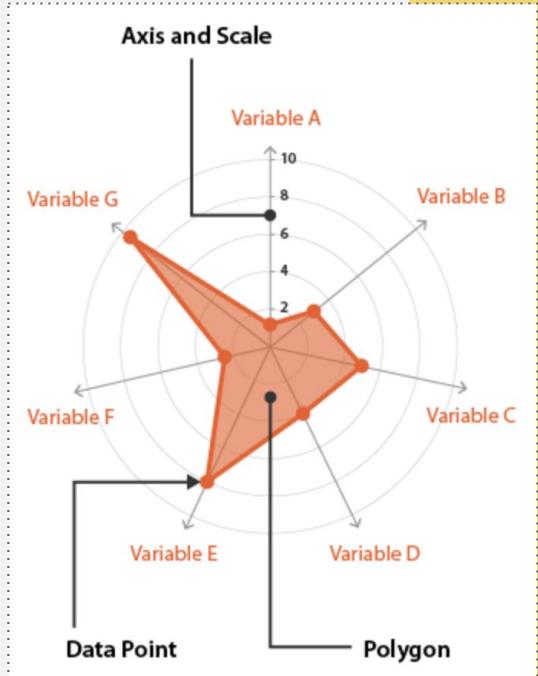


Like a pie chart, a treemap allows to **show proportions** of categorical variables in a dataset in a space-efficient way.

It is a different way to visualise tree diagrams (even though the hierarchy is not shown).



RADAR CHARTS



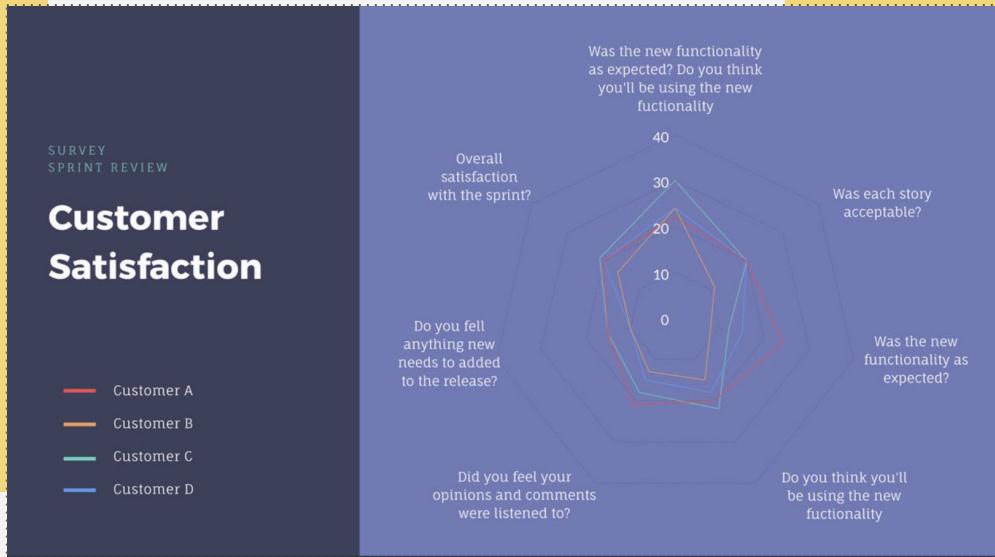
Compare multiple quantitative variables and give them a unique shape.
Useful to **show similarities between variables and outliers**.

Each **ordinal variable** (e.g. a question in a survey) has one axis that starts from the center. All axes are displayed radially, and a grid (e.g. the circles) connects the axes for the sake of readability.

The polygon represents the collection of variables grouped by another variable (e.g. the person that answered the survey).



RADAR CHARTS

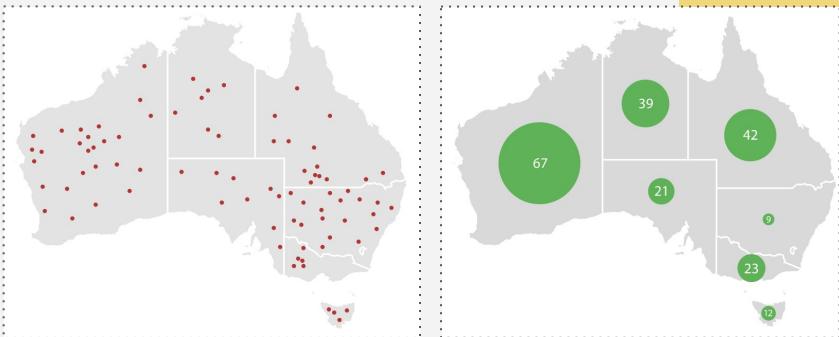


Having multiple polygons helps to compare variables and show outliers.

But too many polygons and too many axes make the chart **too cluttered** and unreadable. Plus it is not easy to compare values across each variable.



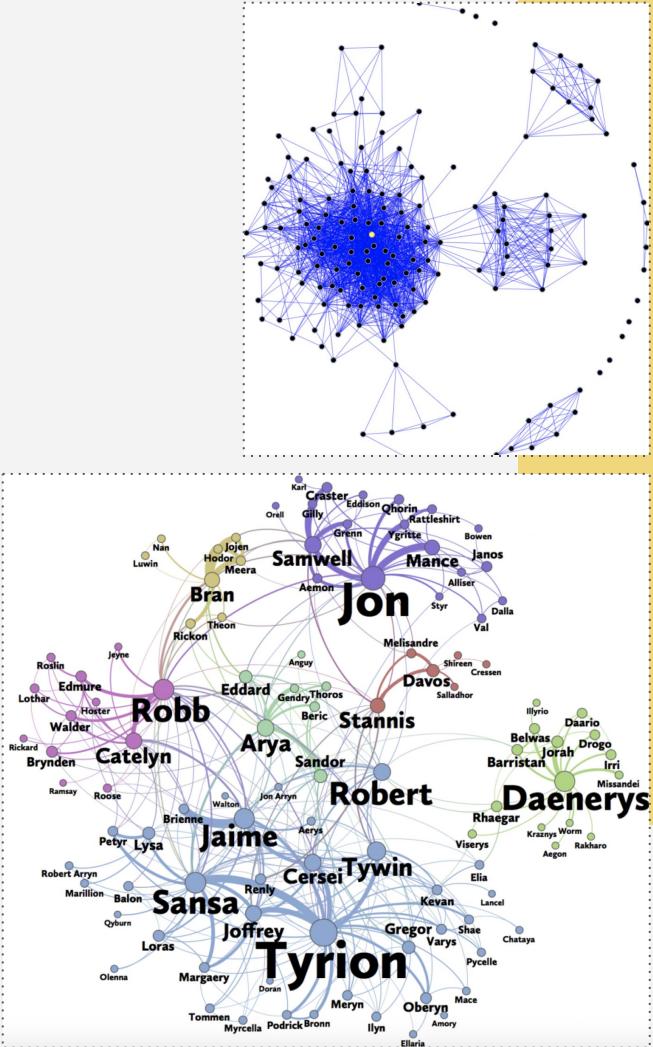
MAPS



If one of the data variables regards a geolocation, geographical maps can be more intuitive than other axes systems.

Maps can be **combined with other visual strategies** (e.g. flows, trajectories, dots, bubbles).

NETWORKS



Categorical data are mapped to nodes and relations (co-occurrence) become links between nodes.

The number of links related to a node is important.

Nonetheless, is often the location of clusters of nodes to be more relevant, showing similarities between groups of data.

The drawback of networks is that they are **unreadable** (label placement problem) and can only intuitively suggest patterns.

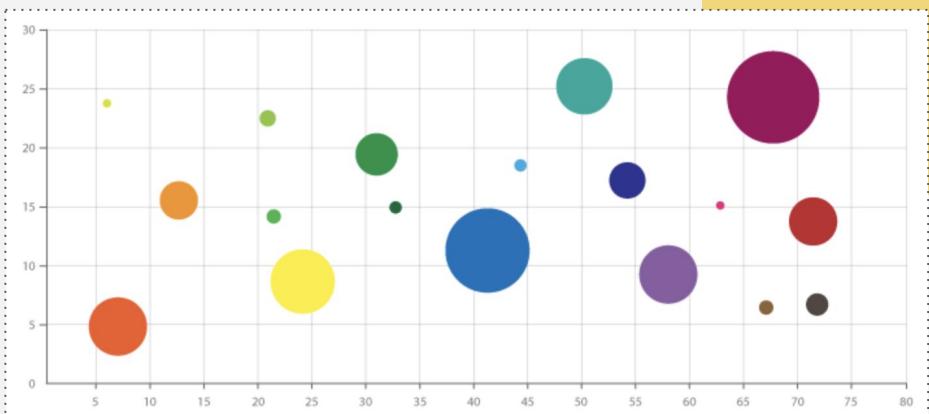


BUBBLE CHARTS

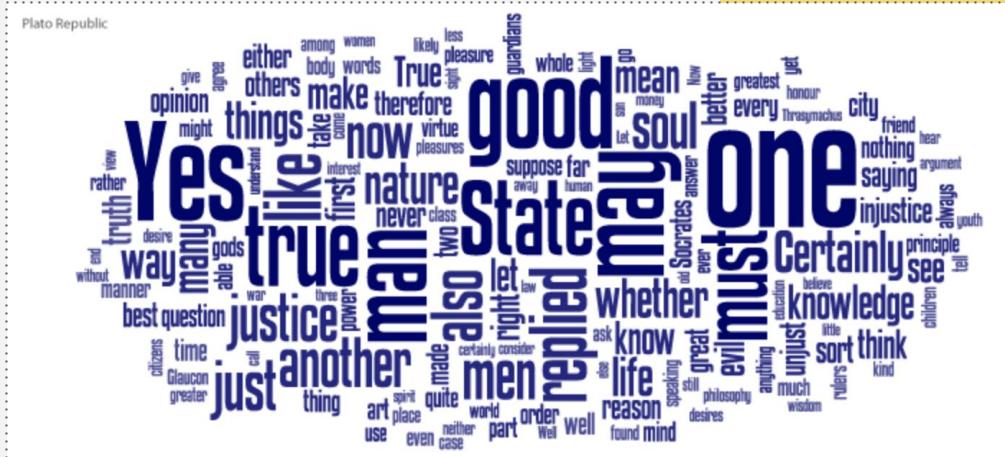
Halfway between a scatterplot and an area chart, it allows to compare **multivariate** values in a cartesian system, show relationships such as **correlation**, by means of position and proportion.



There are two numeric variables (x, y axes), the points are labelled with a categorical data, and the area represents another numeric variable. Colors may represent another categorical value or sum up to the label.



WORDLE



A tag explorer where the **size** of words represents a univariate quantitative aspect of categories.

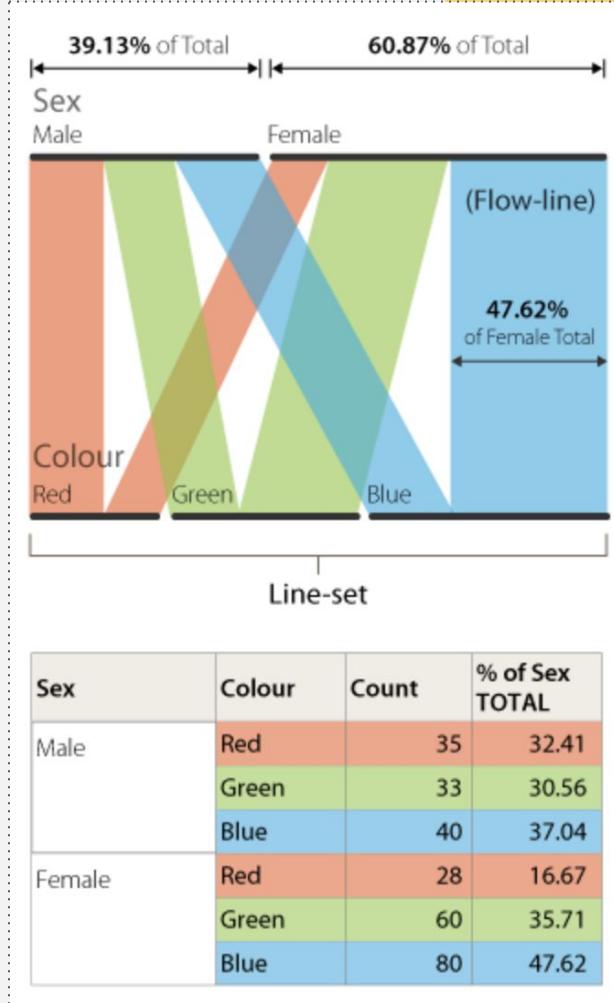


The **layout** is based on a randomised greedy algorithm that positions words so that they fill empty spaces and words do not overlap.

Tag clouds can be misleading (long words, letters with ascending lines seem bigger) and do not allow precise comparison.



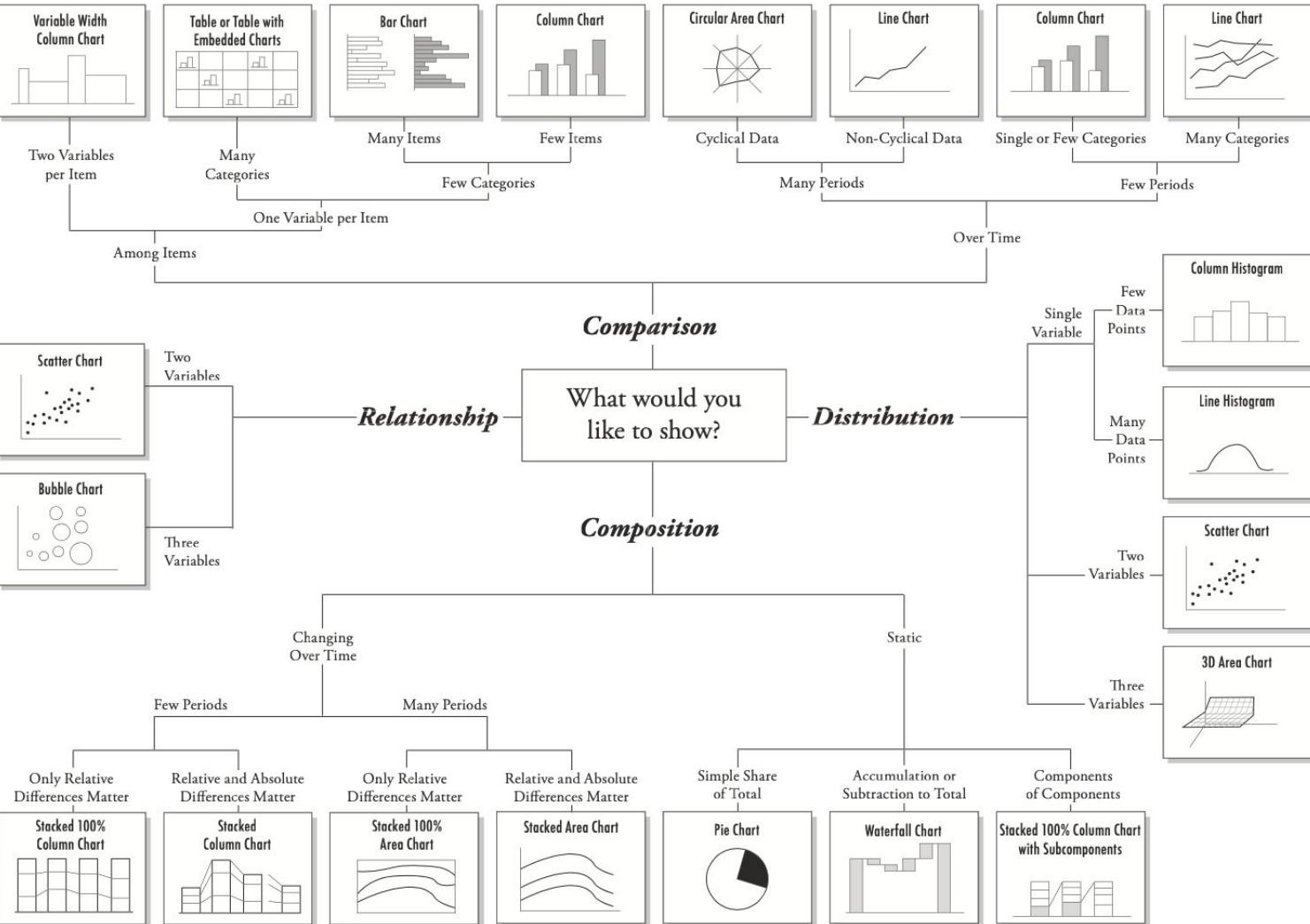
PARALLEL SETS



Allow to compare proportions and **relations between multivariate categorical values**. Relations are shown as flows between pairs of values.



A DECISION TABLE





ELECTRONIC PUBLISHING
AND DIGITAL STORYTELLING
Lesson 2

DYNAMIC DATA VISUALISATION

DYNAMIC DATA VISUALISATION



<https://wattenberger.netlify.app/>

In dynamic data visualisations users can:

select and filter data to be displayed
interactive

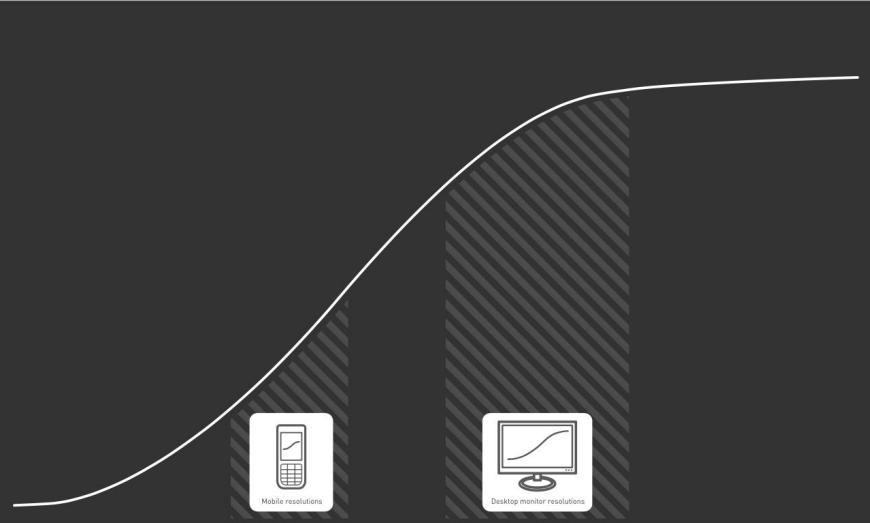
select, filter and change the view
direct manipulation



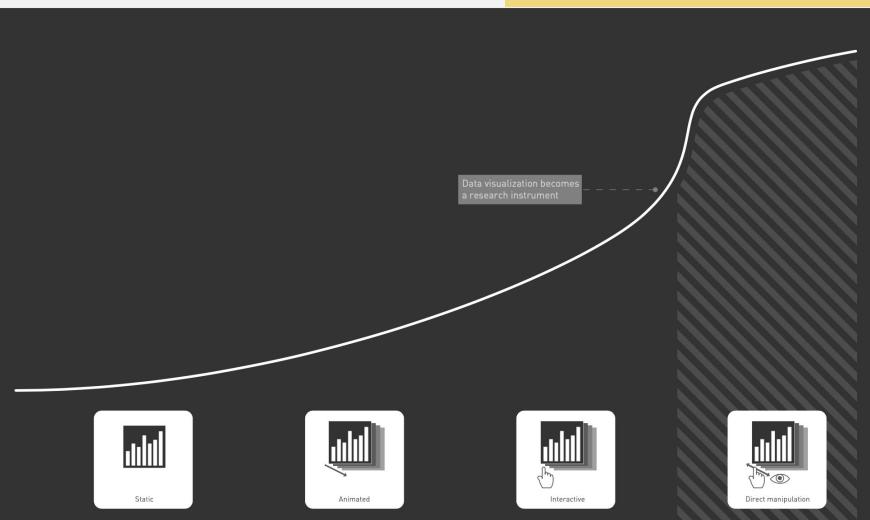
Read more:

https://medium.com/@GT_Vis/evaluating-interactive-graphical-encodings-for-data-visualization-b9b8b4bf47f8

DYNAMIC DATA VISUALISATION



The **effectiveness** of the data visualisation is directly proportional to the resolution of the screen.



The **meaningfulness** of data is directly proportional to the interactivity allowed by the visualisation.



ELECTRONIC PUBLISHING
AND DIGITAL STORYTELLING
Lesson 2

HOMEWORK

FILL IN THE QUESTIONNAIRE AND GET READY FOR THE NEXT CLASS

FILL IN THE QUESTIONNAIRE BY THE NEXT CLASS

<https://forms.gle/d8UbNJfVoMxF9iz86>

GET READY FOR THE FIRST HANDS-ON CLASS:

- Come with your **laptop**
- Be sure you have installed **Python3** and a **IDE** (such as [PyCharm](#), [Sublime Text](#), [Atom](#))
- Be sure you are able to run a python script via **shell** (read [here](#))
- Be sure you know you are able to install a Python library with **pip** (or directly install [RDFlib](#) by the next class)
- Contact us for any doubt: [francesca.giovannetti6 / bruno.sartini3 / marilena.daquino2] @unibo.it



THANKS

Does anyone have any questions?

marilena.daquino2@unibo.it

[github](#)