



Data visualisations for clinical and patients use

The Kleefstra Syndrome Scientific Conference 2023

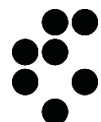
Alenka Guček, PhD

Department for artificial intelligence, JSI, Ljubljana, Slovenia

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[alenka_gucek](#); alenka_gucek@vis.social

June 1st, 2023



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Institute



UPPSALA
UNIVERSITET

Department for
Artificial Intelligence

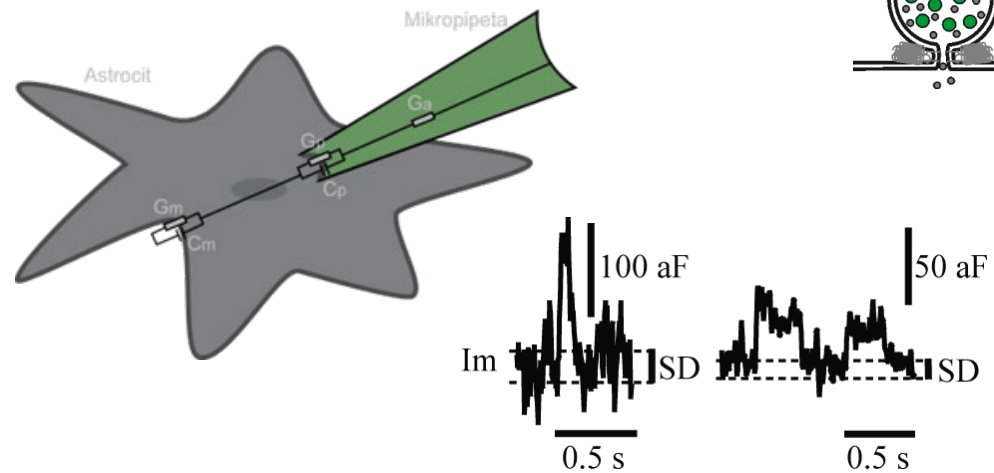
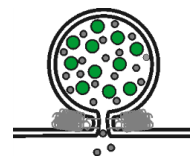




Shifting the focus



Alenka Guček

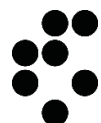
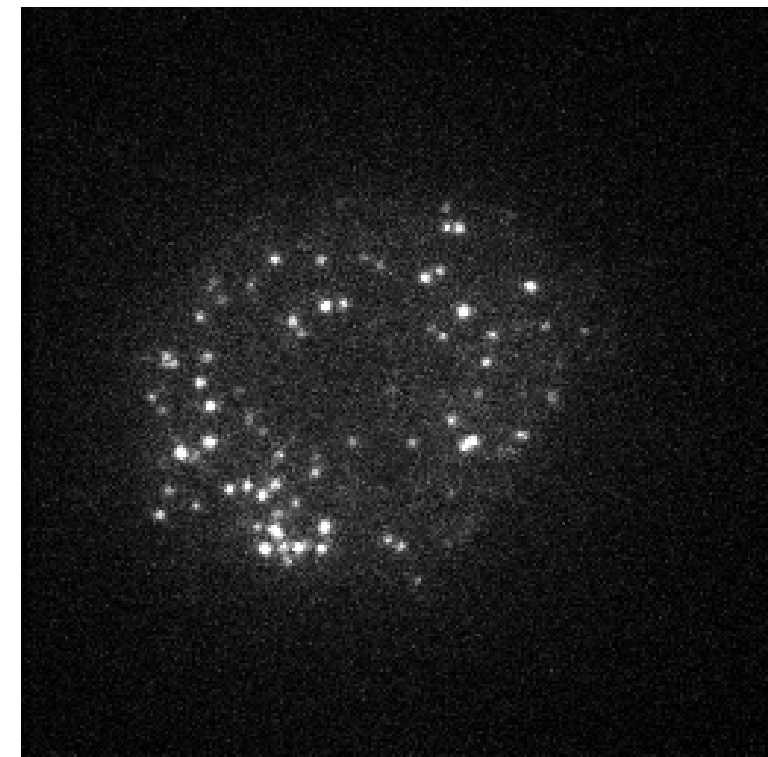
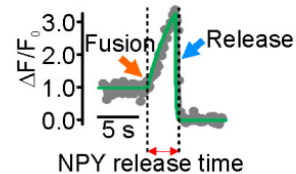
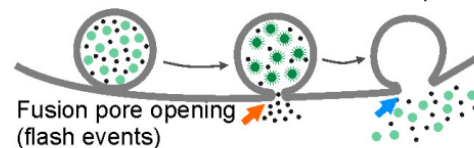
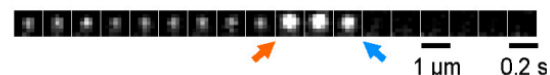
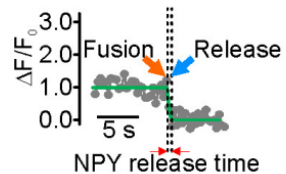
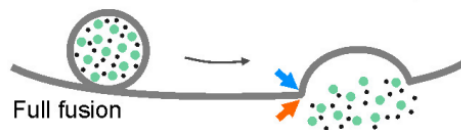


Biochemistry,
UL, Slovenia

PhD in neuroscience & cell biology,
UL, Slovenia

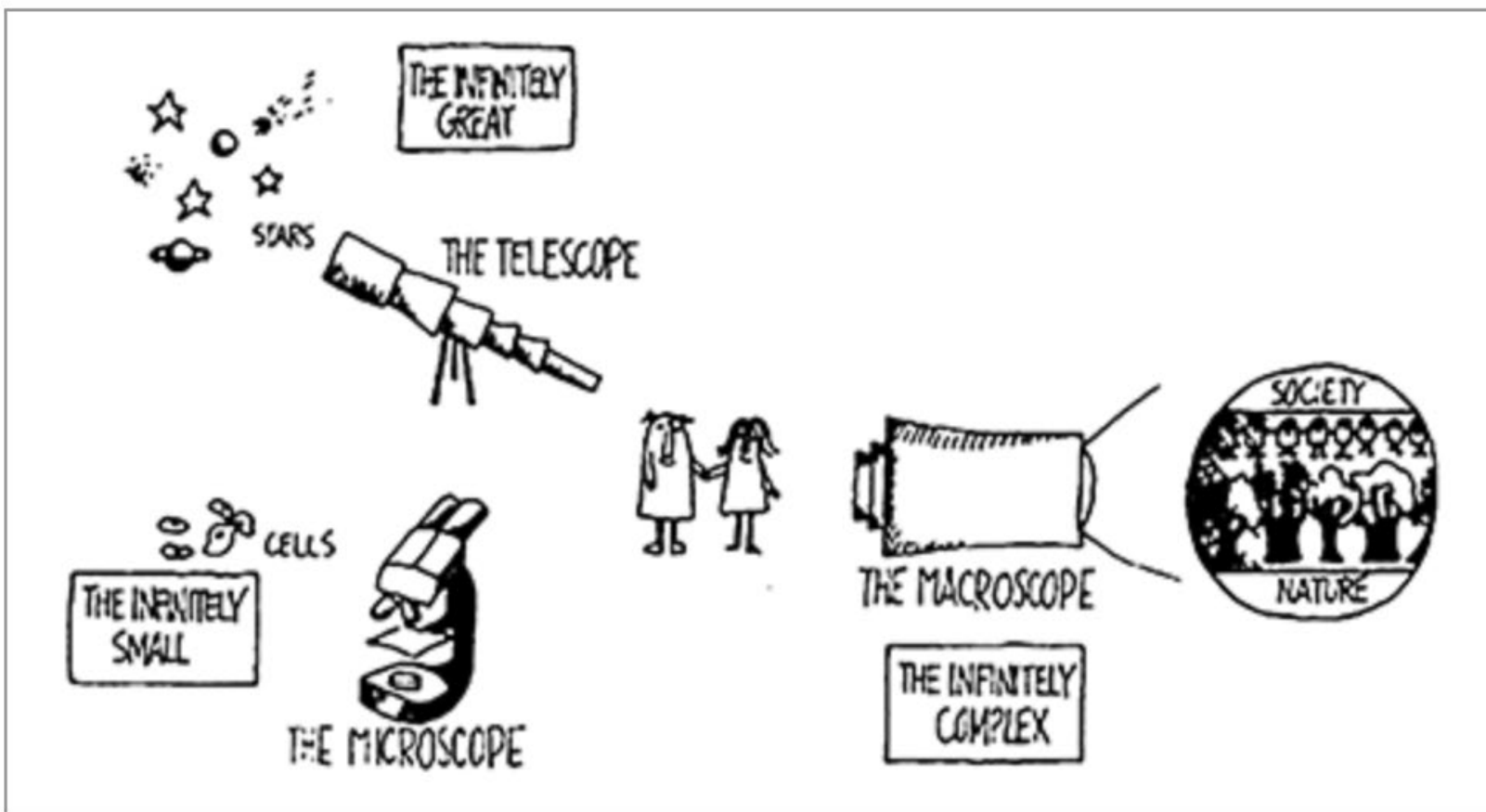
Postdoc in diabetes & mol cell biology,
Uppsala University, Sweden

Data visualization & researcher,
AI lab, JSI, Slovenia

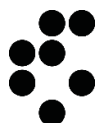


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data visualization today: to provide us with **new kinds of “glasses”** to see the world.

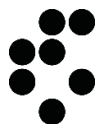
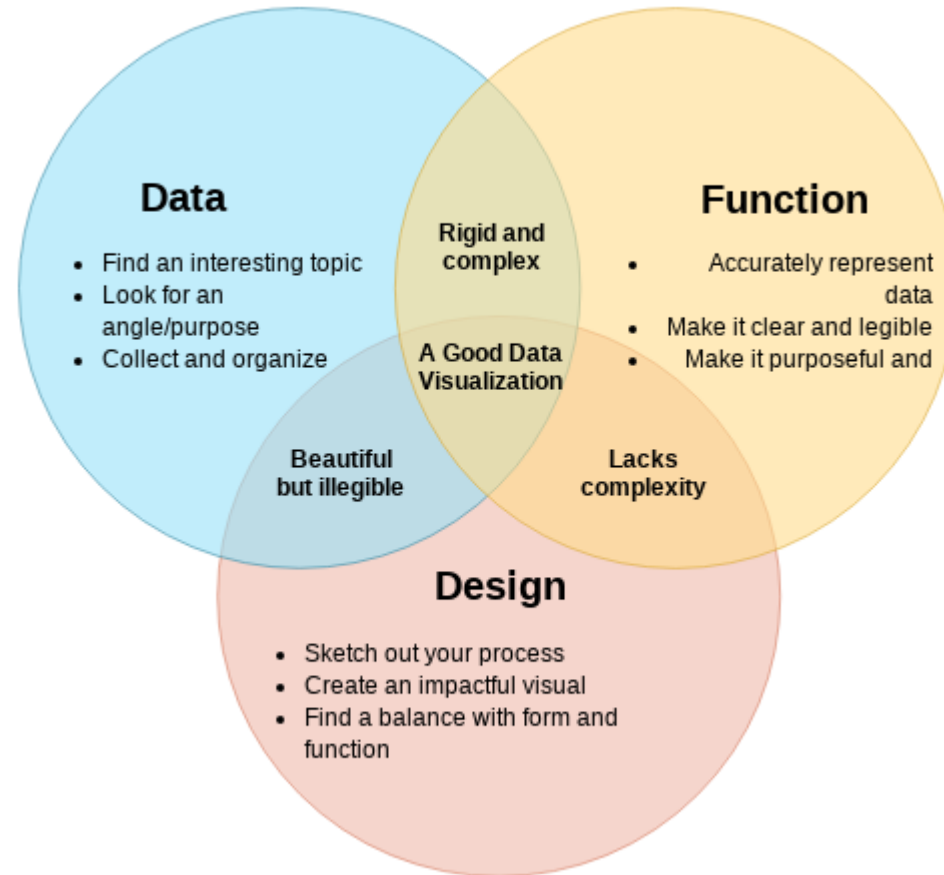


Joel de Rosnay [described](#) a fascinating, futuristic device in 1979: the **macroscope**. Just

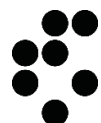
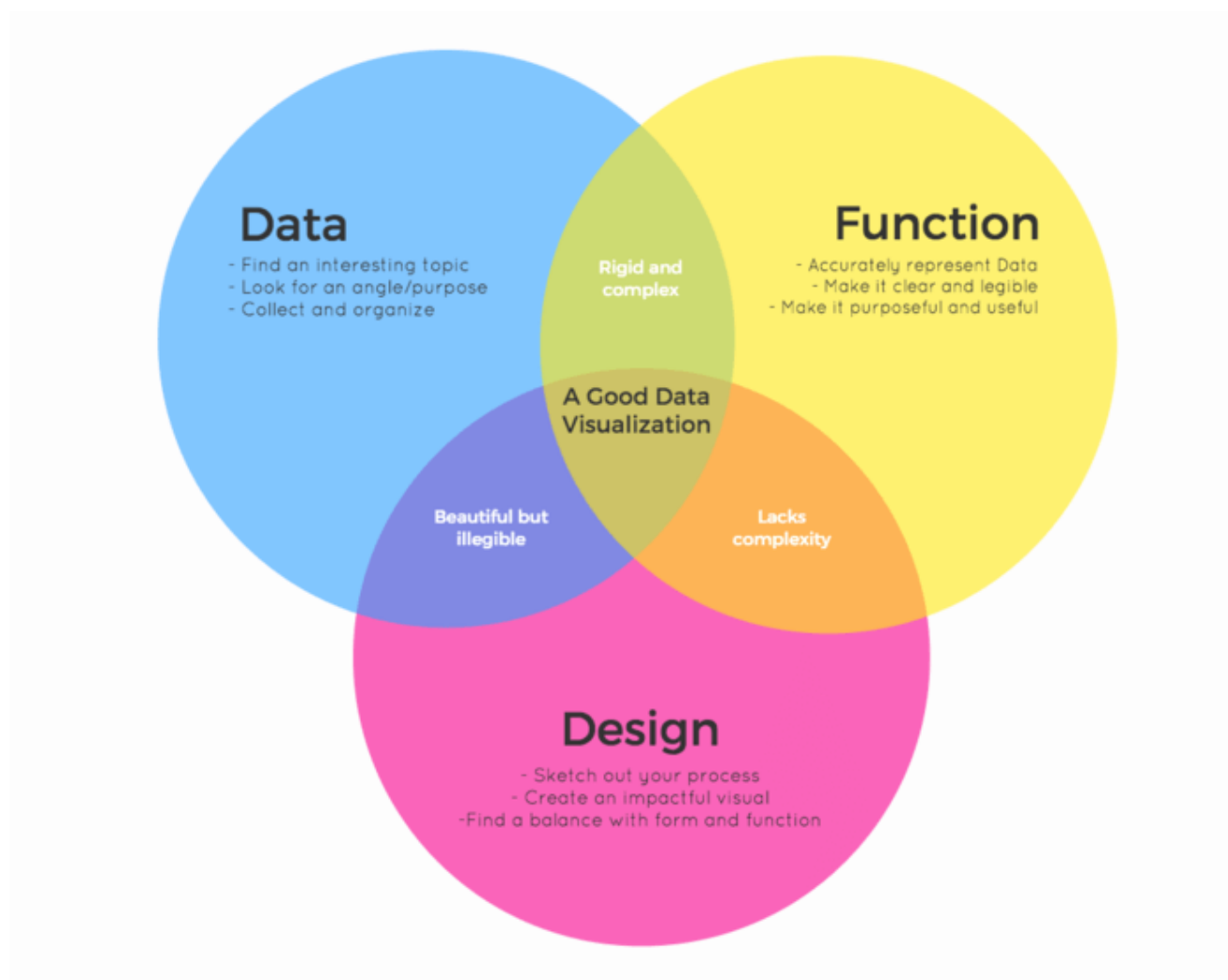


Data visualization

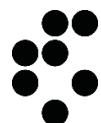
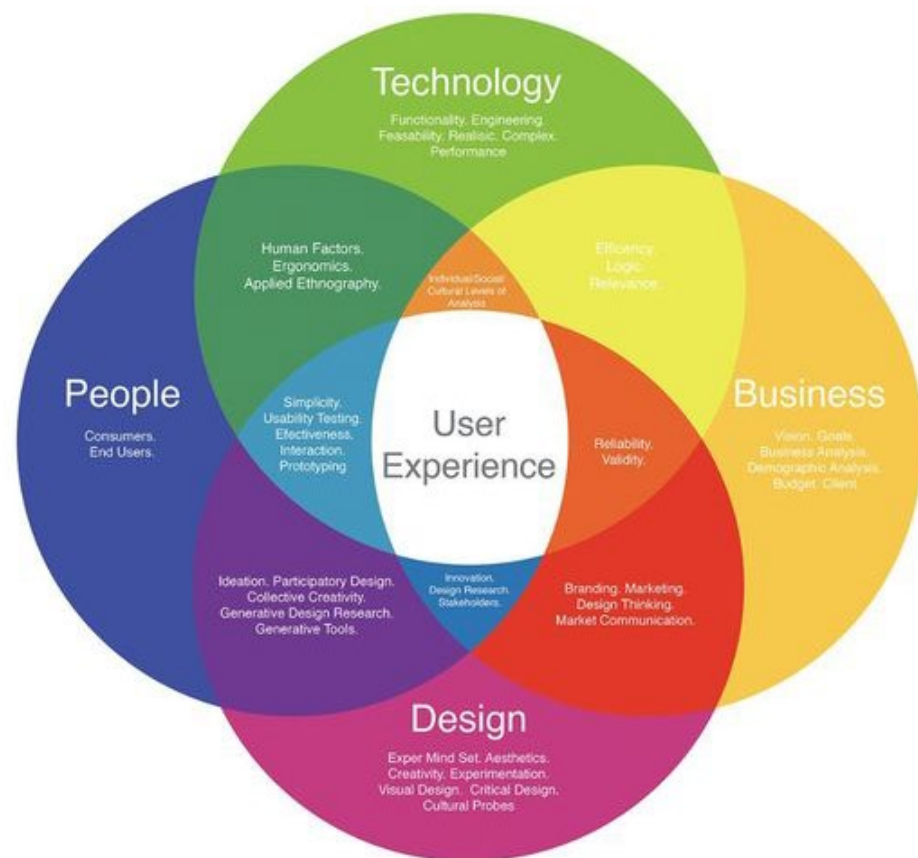
The science of visual representation of data



Data visualization



Human centered design



Asking the “right” questions

- What is the ultimate goal? => **info that needs to go through; action; decision to be made**
- Who do we want to communicate it to? => **AUDIENCE**
- How do we want to communicate the message? => **chart type**

You are the content expert and are responsible for all the design decisions!

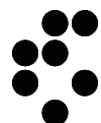
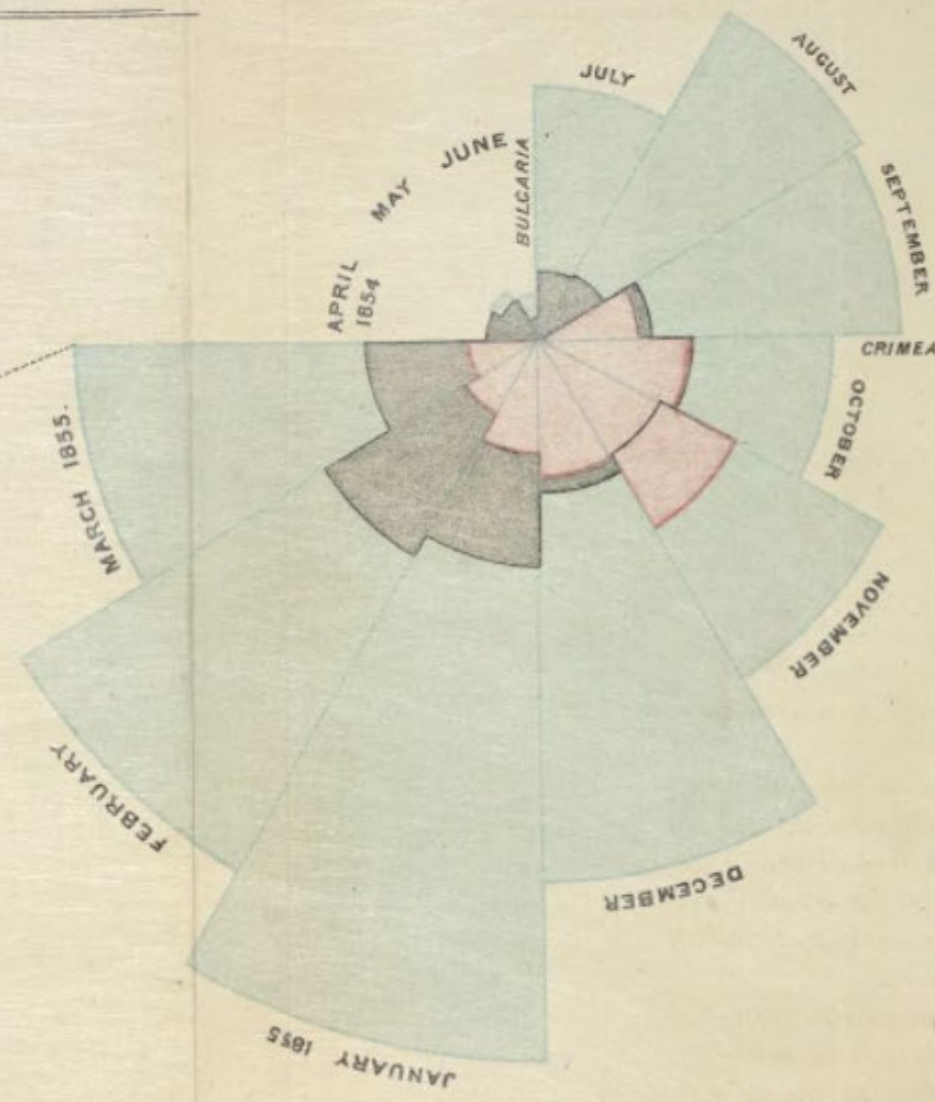
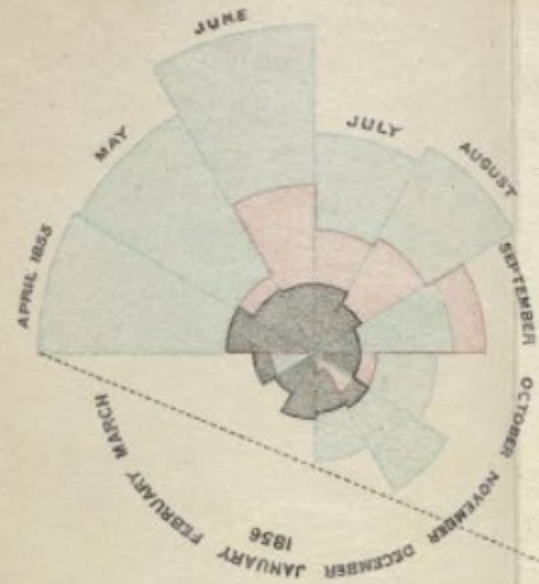




DIAGRAM OF THE CAUSES OF MORTALITY
IN THE ARMY IN THE EAST.

2.
APRIL 1855 TO MARCH 1856.

1.
APRIL 1854 TO MARCH 1855.



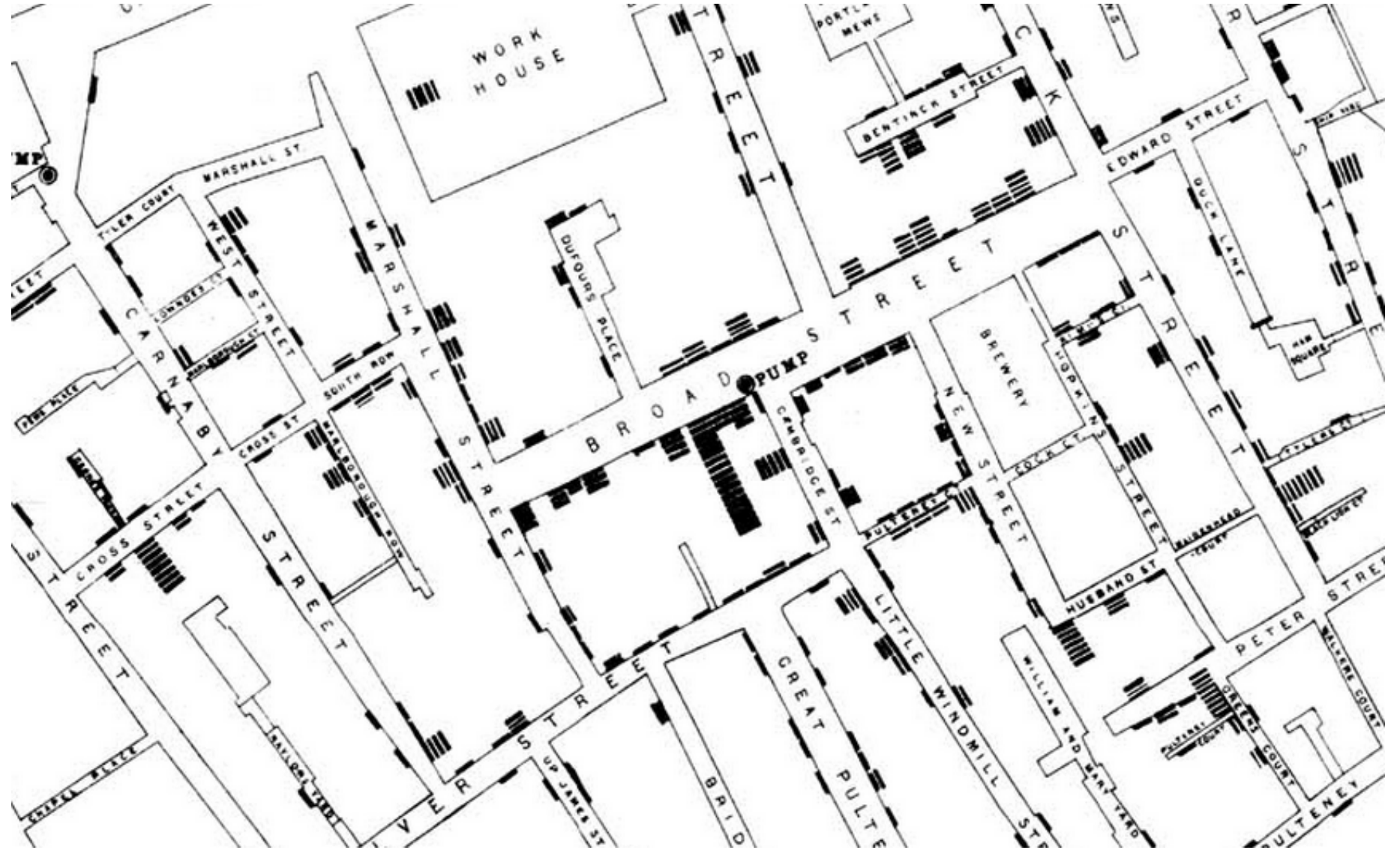
The Areas of the blue, red, & black wedges are each measured from the centre, as the common vertex.
The blue wedges measured from the centre of the circle represent area for area the deaths from Preventable or Mitigable Zymotic diseases, the red wedges measured from the centre the deaths from wounds, & the black wedges measured from the centre the deaths from all other causes.
The black line across the red triangle in Nov. 1854 marks the boundary of the deaths from all other causes during the month.
In October 1854, & April 1855, the black area coincides with the red, in January & February 1855, the blue coincides with the black.
The entire areas may be compared by following the blue, the red & the black lines enclosing them.

Florence Nightingale

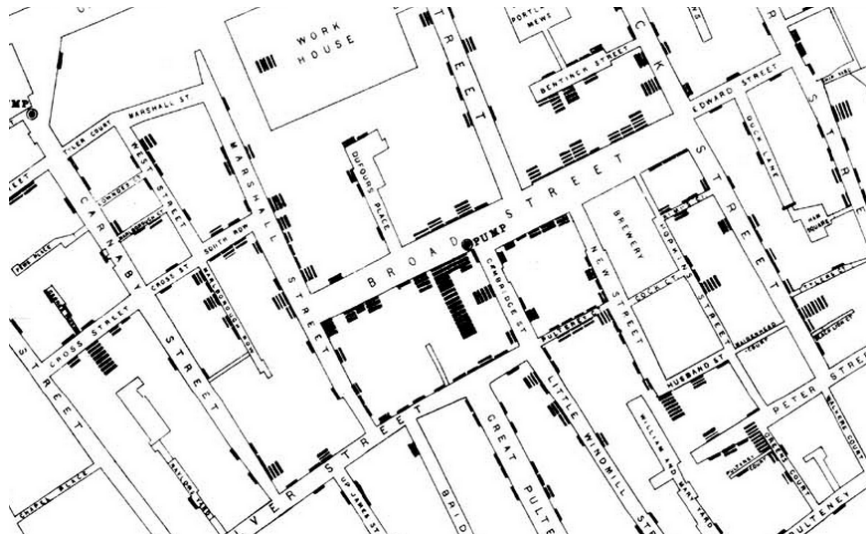




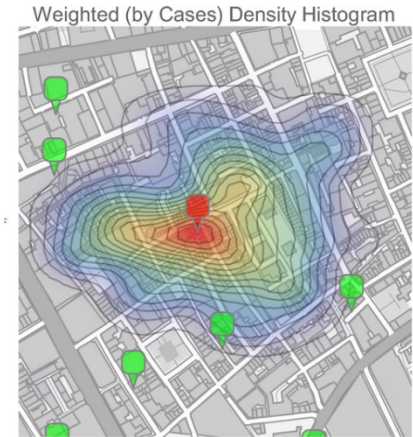
John Snow



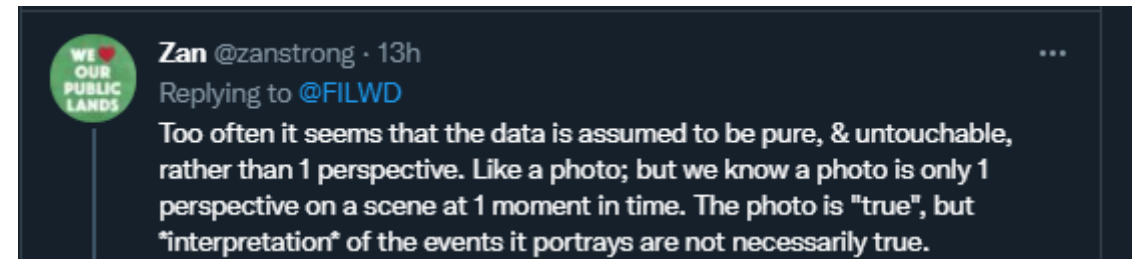
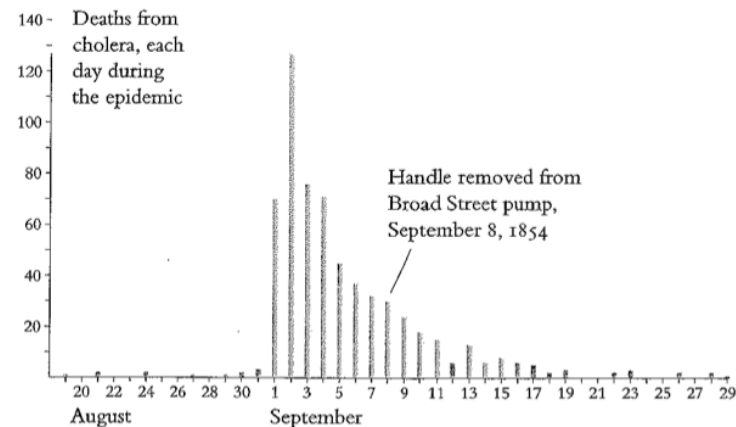
Choosing the “right” visualization to present data



<https://blog.wolfram.com/2021/08/03/john-snow-the-birth-of-epidemiology-data-analysis-visualization/>



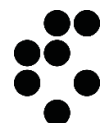
Edward Tufte [Visual and Statistical Thinking](#)





Fast forward

- Context of reserach papers: pdfs with static figures
- Databases on patient reported outcomes





RARE DISEASES OBSERVATORY



Our World in Data

Exploratory

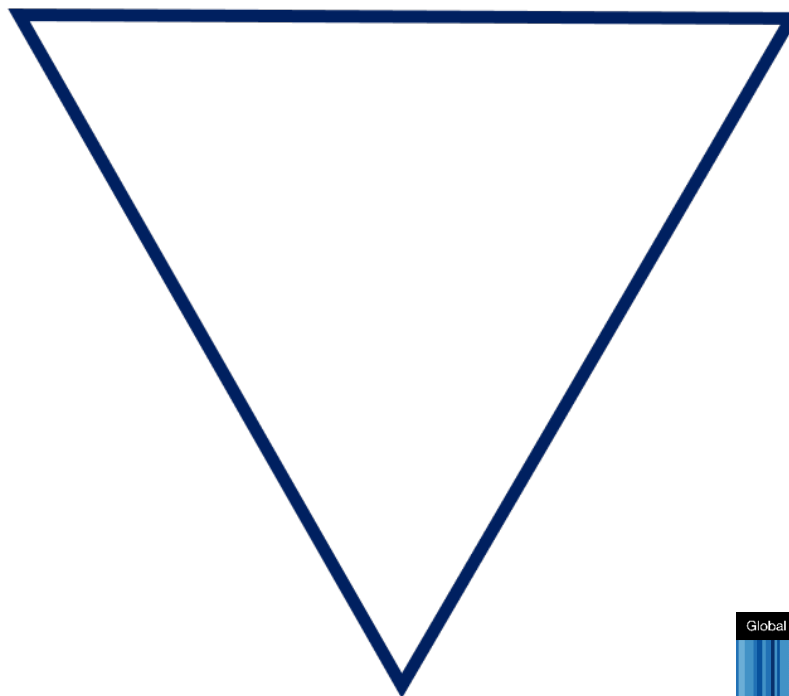
Discovery

Priority: finding new insights

Explanatory

Communication

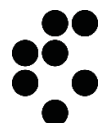
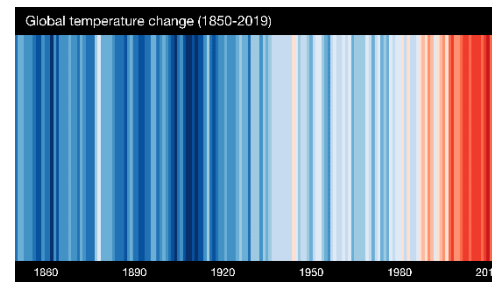
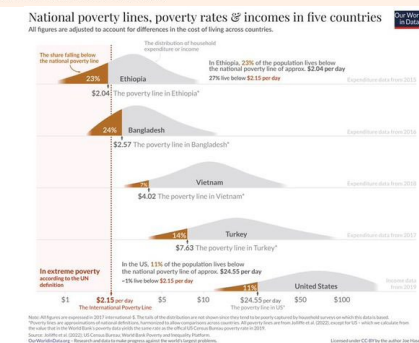
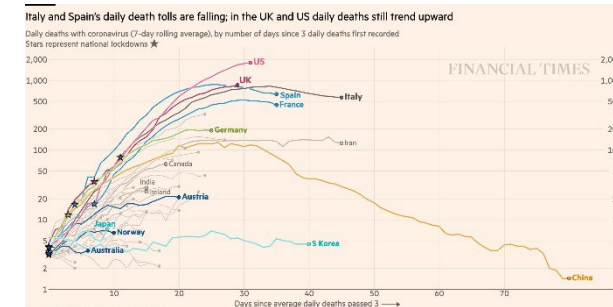
Priority: efficiency + effectiveness



Affective

Emotion

Priority: creativity + novelty



Jožef Stefan Institute

Modified from Cédric Scherer & Alberto Cairo

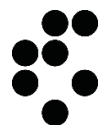
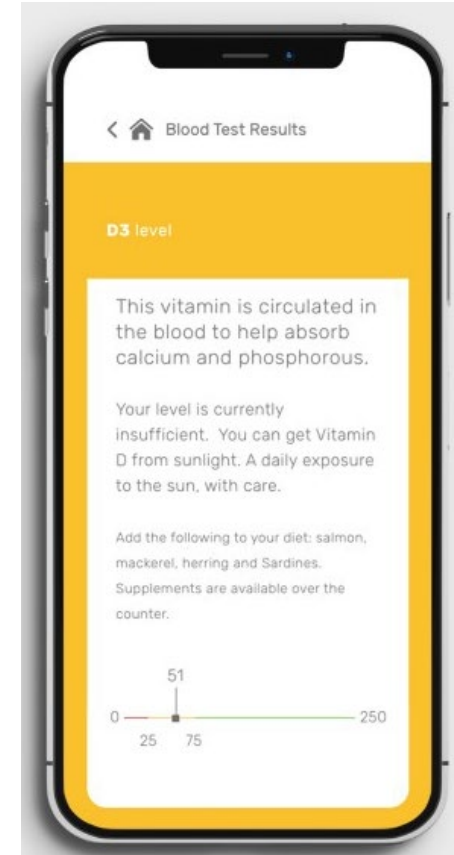
Ed Hawkins, Federica Fragapane

Patient-oriented approach



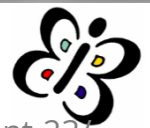
****FULL REPORT****

BIOCHEMISTRY			Reference Range	HAEMATOLOGY			Reference Range
SODIUM	142	mmol/L	(139 - 153)	RBC	6.3	$\times 10^{12}/L$	(4.9 - 8.2)
POTASSIUM	4.9	mmol/L	(3.9 - 5.9)	HAEMOGLOBIN	148	g/L	(100 - 206)
CHLORIDE	109	mmol/L	(101 - 118)	HAEMATOCRIT	0.40	L/L	(0.35 - 0.58)
BICARBONATE	17	mmol/L	(12 - 26)	RETICULOCYTE %	1.0	%	(0.0 - 1.5)
NA:K RATIO	29.0		(26.0 - 35.0)	RETICULOCYTE ABS	63	$\times 10^9/L$	(10 - 110)
ANION GAP	20.9	mmol/L	(14.0 - 32.0)	MCV	63	L fL	(64 - 76)
GLUCOSE, SERUM	3.2	L mmol/L	(3.3 - 6.8)	MCH	23	pg	(21 - 26)
UREA	9.1	mmol/L	(2.5 - 10.0)	MCHC	370	H g/L	(310 - 360)
CREATININE	0.08	mmol/L	(0.05 - 0.15)	PLATELET COUNT	460	$\times 10^9/L$	(200 - 500)
SDMA	14	ug/dL	(0 - 14)	WBC	12.5	$\times 10^9/L$	(4.5 - 17.0)
CALCIUM	2.6	mmol/L	(1.9 - 2.9)	NEUTROPHILS%	67	%	
PHOSPHATE	1.4	mmol/L	(0.8 - 2.1)	NEUTROPHILS	8.4	$\times 10^9/L$	(3.5 - 12.0)
CA:P RATIO	1.9		(1.2 - 3.0)	LYMPHOCYTES%	25	%	
PROTEIN, TOTAL	68	g/L	(52 - 80)	LYMPHOCYTES	3.1	$\times 10^9/L$	(0.9 - 3.5)
ALBUMIN	35	g/L	(23 - 40)	MONOCYTES%	5	%	
GLOBULIN	33	g/L	(25 - 45)	MONOCYTES	0.6	$\times 10^9/L$	(0.0 - 1.1)
A:G RATIO	1.1		(0.6 - 1.4)	EOSINOPHILS%	3	%	
BILIRUBIN, TOTAL	0	umol/L	(0 - 7)	EOSINOPHILS	0.4	$\times 10^9/L$	(0.0 - 1.4)
ALP	112	IU/L	(1 - 150)	BASOPHILS%	0	%	
ALP STEROID ISOENZYME	31	IU/L		BASOPHILS	0.0	$\times 10^9/L$	(0.0 - 0.1)
AST	48	IU/L	(18 - 80)	BLOOD SMEAR	Automated CBC.		
ALT	93	H IU/L	(16 - 90)	EXAMINATION			
CK	214	IU/L	(73 - 510)				
CHOLESTEROL	6.4	mmol/L	(3.5 - 9.0)				
AMYLASE	751	IU/L	(333 - 1500)				
LIPASE	494	IU/L	(77 - 750)				
GAMMA GT	6	IU/L	(0 - 9)				
SAMPLE APPEARANCE	Mild haemolysis Moderate lipaemia						



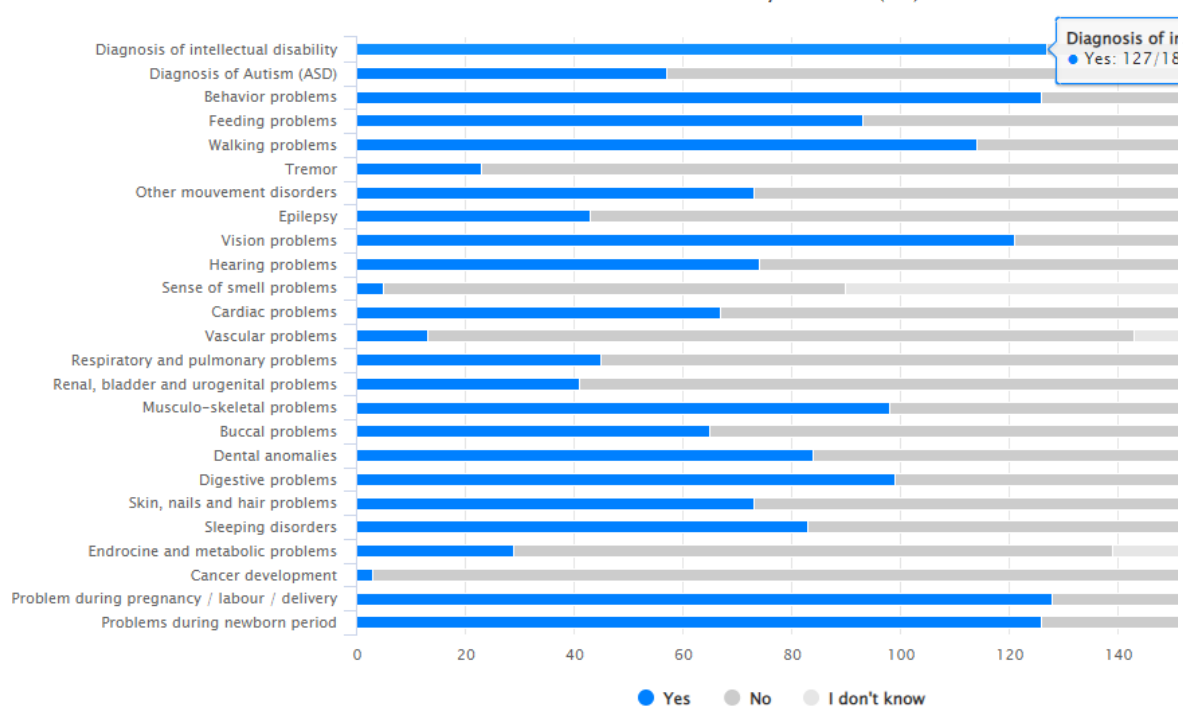
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GenIDA exploration

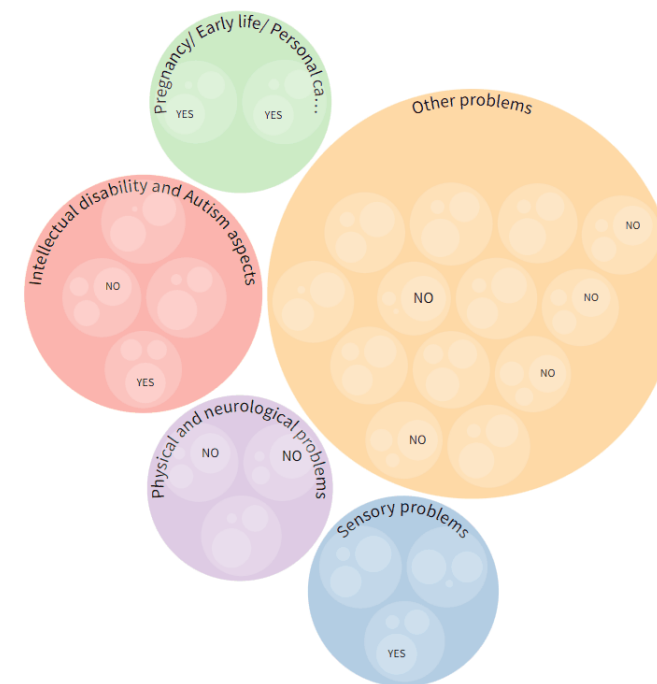
Kleefstra syndrome (KS)



Kleefstra syndrome patient reported outcomes

Source: GENIDA database

All



<https://genida.unistra.fr/>

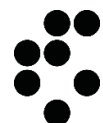




GENIDA

<https://public.flourish.studio/visualisation/12906970/>

- ▶ Pregnancy/ Early life/ Personal care
 - ▶ Intellectual disability and Autism aspects
 - ▶ Physical and neurological problems
 - ▶ Sensory problems
 - ▶ Other problems
-





Take away

Shifting the focus from data => audience

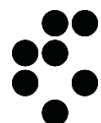
- What is the ultimate goal of visualization?
- Who is the audience? What do they care about?



The purpose of the type of visualizations I make isn't visualization per se. The purpose fo those visualizations is to help people **make sense of the world** through a combination of visuals and words.

Alberto Cairo

Thank you!

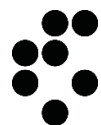


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from Data to Viz

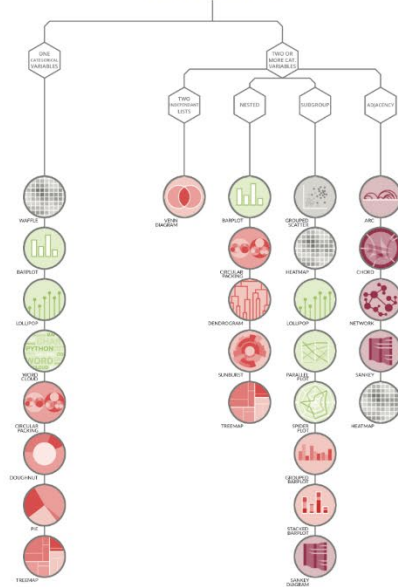
'From Data to Viz' is a classification of chart types based on input data format. It will help you find the perfect chart in three simple steps:

- 1 Identify what type of data you have.
- 2 Go to the corresponding decision tree and follow it down to a set of possible charts.
- 3 Choose the chart from the set that will suit your data and your needs best.

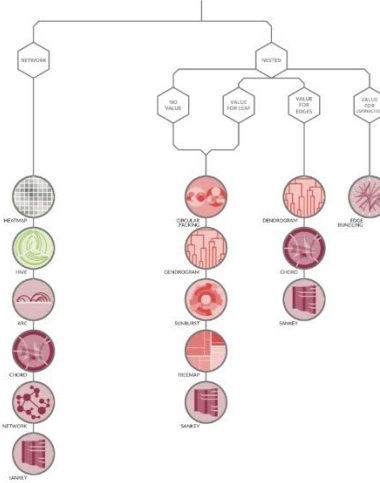
Dataviz is a world with endless possibilities and this project does not claim to be exhaustive. However it should provide you with a good starting point. For an interactive version and much more, visit:

data-to-viz.com

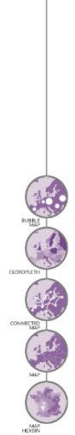
CATEGORIC



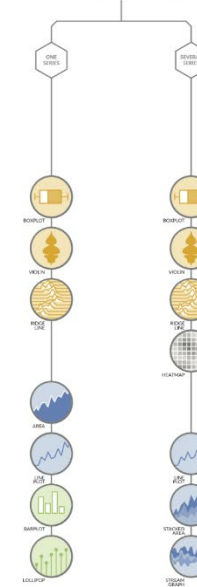
RELATIONAL



MAP



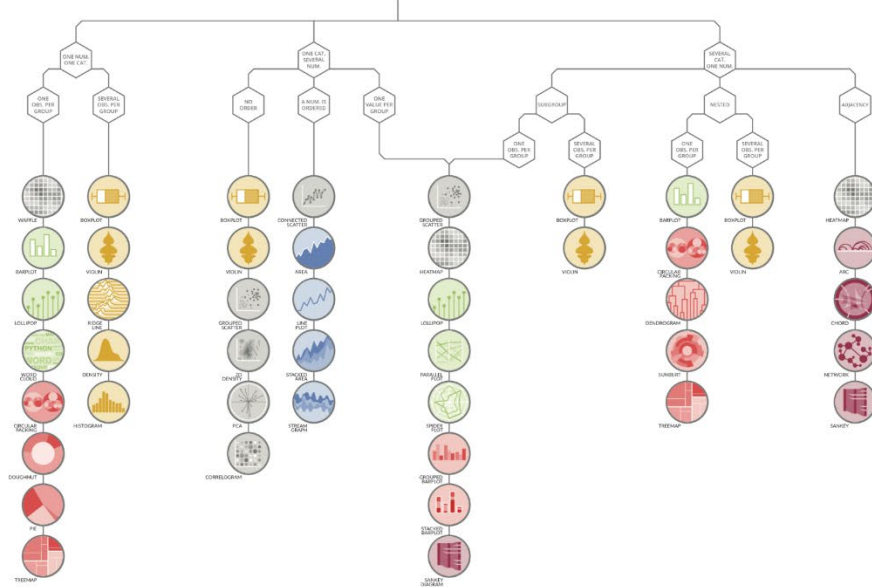
TIME SERIES



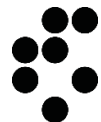
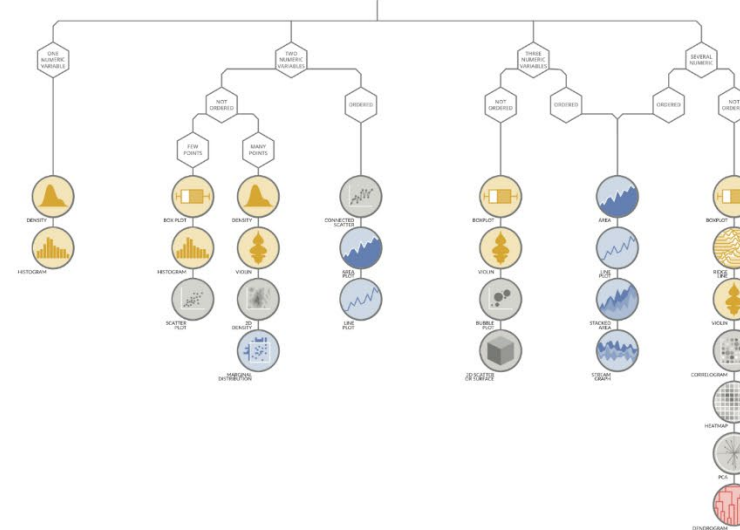
WHAT DO YOU WANT TO SHOW ?

- Distribution
- Correlation
- Ranking
- Part of a whole
- Evolution
- Maps

CATEGORIC AND NUMERIC



NUMERIC



Jr
It



Deviation	Correlation	Ranking	Distribution	Change over Time	Magnitude	Part-to-whole	Spatial	Flow
<p>Emphasize variations (+/-) from a fixed reference point. Typically the reference point is zero but it can also be a target or a long term average. Can also be used to show sentiment (positive/negative/neutral).</p> <p>Example FT uses Trade surplus/deficit, climate change</p>	<p>Show the relationship between two or more variables. Be mindful that, unless you tell them otherwise, many readers will assume the relationships you show there to be causal (i.e. one causes the other).</p> <p>Example FT uses Inflation and unemployment, income and life expectancy</p>	<p>Use where an item's position in an ordered list is more important than its absolute or relative value. Don't be afraid to highlight the top positions of interest.</p> <p>Example FT uses Wells, oil reserves, league tables, constituency election results</p>	<p>Show values in a dataset and how often they occur. The shape for 'skew' of a distribution can be a memorable way of highlighting the lack of uniformity or equality in the data.</p> <p>Example FT uses Income distribution, population (age) distribution, inequality</p>	<p>Give emphasis to changing trends. These can be short (intra-day) movements or a memorable series of traversing decades or centuries. Choosing the correct time period is important to provide suitable context for the reader.</p> <p>Example FT uses Share price movements, economic time series, sectoral changes in a market</p>	<p>Show size comparisons. These can be relative (eg being able to see larger/smaller) or absolute (forced to see the differences). Usually these show a 'counted' number (for example, barrels, dollars or people) rather than a calculated rate or per cent.</p> <p>Example FT uses Commodity production, market capitalisation, volumes in general</p>	<p>Show how a single entity can be broken down into its component elements. If the reader's interest is solely in the size of the component, consider a magnitude-type chart instead.</p> <p>Example FT uses Fiscal budgets, company structures, national election results</p>	<p>Aside from locator maps only used when precise locations or geographical patterns in data are more important to the reader than anything else.</p> <p>Example FT uses Population density, natural resource locations, natural disaster risk/impact, catchment areas, variation in election results</p>	<p>Show the reader volumes or intensity of movement between two or more states or conditions. These might be logical sequences or geographical locations.</p> <p>Example FT uses Movement of funds, trade, migrants, lawsuits, information, relationship graphs.</p>
<p>Diverging bar A simple standard bar chart that can handle both negative and positive magnitude values.</p>	<p>Scatterplot The standard way to show the relationship between two continuous variables, each of which has its own axis.</p>	<p>Ordered bar Standard bar charts showing the ranks of values much more easily when sorted into order.</p>	<p>Histogram The standard way to show a statistical distribution - keep the bars between columns small to highlight the 'shape' of the data.</p>	<p>Line The standard way to show a changing time series. Keep things irregular, consider markers to represent data points.</p>	<p>Column The standard way to compare the size of things. Things should always start at 0 on the axis.</p>	<p>Stacked column bar A simple way of showing part-to-whole relationships but can be difficult to read with more than a few components.</p>	<p>Basic choropleth (count/ratio) The standard approach for putting data on a map - should always be rates rather than totals and use a sensible base geography.</p>	<p>Sankey Shows changes in flows from one condition to at least one other, good for tracing the eventual outcome of a complex process.</p>
<p>Diverging stacked bar Perfect for presenting survey results which involve sentiment (eg disagree/neutral/agree).</p>	<p>Column + line timeline A good way of showing the relationship between an amount (columns) and a rate (line).</p>	<p>Ordered column See above.</p>	<p>Dot plot A simple way of showing the change or range (between data across multiple categories).</p>	<p>Column Columns work well for showing change over time, but usually best with only one series of data at a time.</p>	<p>Bar See above. Good when the data are not time series and labels have long category names.</p>	<p>Marmiteko A good way of showing the size and proportion of data of the same time - as long as the data are not too complicated.</p>	<p>Proportional symbol (count/magnitude) Use for totals rather than rates - be wary that small differences in data will be hard to see.</p>	<p>Waterfall Designed to show the sequencing of data through a flow process, typically budgets. Can include +/- components.</p>
<p>Spine Splits a single value into two contrasting components (eg male/female).</p>	<p>Connected scatterplot Usually used to show how the relationship between 2 variables has changed over time.</p>	<p>Ordered proportional symbol Use when there are big variations between values and/or seeing fine differences between data is not so important.</p>	<p>Dot strip plot Good for showing individual values in a distribution, can be a problem when too many data have the same value.</p>	<p>Column + line timeline A good way of showing the relationship over time between an amount (columns) and a rate (line).</p>	<p>Paired column As per standard column but allows for multiple series. Can become tricky to read with more than 2 series.</p>	<p>Pie A common way of showing part-to-whole data - but be aware that it's difficult to accurately compare the size of the segments.</p>	<p>Flow map For showing unambiguous movement across a map.</p>	<p>Chord A complex but powerful diagram which can illustrate 2-way flows (and not winner) in a matrix.</p>
<p>Surplus/deficit filled line The shaded area of these charts allows a balance to be shown - either against a baseline or between two series.</p>	<p>Bubble Like a scatterplot, but adds additional detail by sizing the circles according to a third variable.</p>	<p>Dot strip plot Data placed in order on a strip are a space-efficient method of laying out multiple categories.</p>	<p>Barcode plot Like dot strip plots, good for displaying all the data in a table, they work best with 2 or 3 points without creating a key part of styling.</p>	<p>Slope Good for showing changing data as long as the data can be specified into 2 or 3 points without creating a key part of styling.</p>	<p>Paired bar See above.</p>	<p>Donor Similar to a pie chart - but the centre can be a good way of making space to include more information about the data (eg text).</p>	<p>Contour map For showing areas of equal value on a map. Can use deviation colour schemes for showing +/- values.</p>	<p>Network Used for showing the strength and inter-connectedness of relationships of varying types.</p>
<p>XY heatmap A good way of showing the patterns between 2 categories of data, less effective at showing fine differences in amounts.</p>	<p>XY heatmap A good way of showing the patterns between 2 categories of data, less effective at showing fine differences in amounts.</p>	<p>Slope Perfect for showing how ranks have changed over time or vary between categories.</p>	<p>Boxplot Summarise multiple distributions by showing the median, quartiles and range of the data.</p>	<p>Area chart Use with care - these are good at showing changes to total, but seeing change in components can be very difficult.</p>	<p>Marmiteko A good way of showing the size and proportion of data at the same time - as long as the data are not too complicated.</p>	<p>Treemap Use for hierarchical part-to-whole relationships, can be difficult to read when there are many small segments.</p>	<p>Equalised cartogram Converting each unit on a map to a regular and equally-sized shape - good for representing voting regions with equal value.</p>	
<p>Lollipop Lollipop draw more attention to the data value than standard barplots and can also show rank and value effectively.</p>	<p>Violin plot Similar to a box plot but more effective with complex distributions (data that cannot be summarised with simple averages).</p>	<p>Lollipop Lollipop draw more attention to the data value than standard barplots and can also show rank and value effectively.</p>	<p>Violin plot Similar to a box plot but more effective with complex distributions (data that cannot be summarised with simple averages).</p>	<p>Candlestick Usually focused on day-to-day activity, these charts show opening/closing and high/low points of each day.</p>	<p>Proportional symbol Use when there are big variations between values and/or seeing fine differences between data is not so important.</p>	<p>Veronoi A way of turning points into areas - any point within each area is closer to the central point than any other centroid.</p>	<p>Scaled cartogram (value) Stretching and shrinking a map so that each area is sized according to a particular value.</p>	
<p>Bump Effective for showing changing rankings across multiple dates. For larger datasets, consider grouping lines using colour.</p>	<p>Population pyramid A standard way for showing the age and sex breakdown of a population distribution; effectively back to back histograms.</p>	<p>Bump Effective for showing changing rankings across multiple dates. For larger datasets, consider grouping lines using colour.</p>	<p>Population pyramid A standard way for showing the age and sex breakdown of a population distribution; effectively back to back histograms.</p>	<p>Fan chart (proportion) Use to show the uncertainty in future projections - usually the green the further forward to projection.</p>	<p>Isotype (pictogram) Excellent solution in some instances - use only with whole numbers (do not also off an arm to represent a decimal).</p>	<p>Arc A hemicircle, often used for illustrating parliamentary composition by number of seats.</p>	<p>Dot density Used to show the location of individual events/locations - makes sure to annotate any patterns the reader should see.</p>	
<p>Cumulative curve A good way of showing how unequal a distribution is; y axis is always cumulative frequency, x axis is always a measure.</p>	<p>Cumulative curve A good way of showing how unequal a distribution is; y axis is always cumulative frequency, x axis is always a measure.</p>	<p>Cumulative curve A good way of showing how unequal a distribution is; y axis is always cumulative frequency, x axis is always a measure.</p>	<p>Cumulative curve A good way of showing how unequal a distribution is; y axis is always cumulative frequency, x axis is always a measure.</p>	<p>Fan chart (proportion) Use to show the uncertainty in future projections - usually the green the further forward to projection.</p>	<p>Lollipop Lollipop charts draw more attention to the data value than standard barplots - does not have to start at zero (but preferable).</p>	<p>Gridplot Good for showing 'E' information, they work best when used on whole numbers and work well in small multiple layout form.</p>	<p>Heat map Grid-based data values mapped with an intensity colour scale. As choropleth map - but not snapped to an administrative unit.</p>	
<p>Frequency polygons For displaying multiple distributions of data. Like a regular line chart, best limited to a maximum of 3 or 4 datasets.</p>	<p>Frequency polygons For displaying multiple distributions of data. Like a regular line chart, best limited to a maximum of 3 or 4 datasets.</p>	<p>Frequency polygons For displaying multiple distributions of data. Like a regular line chart, best limited to a maximum of 3 or 4 datasets.</p>	<p>Frequency polygons For displaying multiple distributions of data. Like a regular line chart, best limited to a maximum of 3 or 4 datasets.</p>	<p>Calendar heatmap A great way of showing temporal patterns (daily, weekly, monthly) - at the expense of showing precision in quantity.</p>	<p>Radar A space-efficient way of showing values of multiple variables - but make sure they are organised in a way that makes sense to reader.</p>	<p>Venn Generally only used for schematic representation.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	
<p>Bee swarm Use to emphasize individual points in a distribution. Points can be sized to an additional variable, best with multi-sized datasets.</p>	<p>Bee swarm Use to emphasize individual points in a distribution. Points can be sized to an additional variable, best with multi-sized datasets.</p>	<p>Bee swarm Use to emphasize individual points in a distribution. Points can be sized to an additional variable, best with multi-sized datasets.</p>	<p>Bee swarm Use to emphasize individual points in a distribution. Points can be sized to an additional variable, best with multi-sized datasets.</p>	<p>Calendar heatmap A great way of showing temporal patterns (daily, weekly, monthly) - at the expense of showing precision in quantity.</p>	<p>Parallel coordinates An alternative to radar charts - again the arrangement of the variables is important. Usually benefits from highlighting values.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	
<p>Prisley timeline Great when date and duration are key elements of the story in the data.</p>	<p>Prisley timeline Great when date and duration are key elements of the story in the data.</p>	<p>Prisley timeline Great when date and duration are key elements of the story in the data.</p>	<p>Prisley timeline Great when date and duration are key elements of the story in the data.</p>	<p>Circle timeline Good for showing discrete values of varying size across multiple categories (eg earthquakes by continent).</p>	<p>Bullet Good for showing a measurement against the context of a target or performance range.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	
<p>Vertical timeline Presents time on the Y axis. Good for displaying detailed time series that work especially well when scrolling on mobile.</p>	<p>Vertical timeline Presents time on the Y axis. Good for displaying detailed time series that work especially well when scrolling on mobile.</p>	<p>Vertical timeline Presents time on the Y axis. Good for displaying detailed time series that work especially well when scrolling on mobile.</p>	<p>Vertical timeline Presents time on the Y axis. Good for displaying detailed time series that work especially well when scrolling on mobile.</p>	<p>Calendar heatmap A great way of showing temporal patterns (daily, weekly, monthly) - at the expense of showing precision in quantity.</p>	<p>Grouped symbol An alternative to barplots - charts when being able to count data or highlight individual elements is useful.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	
<p>Seismogram Another alternative to the circle timeline for showing series where there are big variations in the data.</p>	<p>Seismogram Another alternative to the circle timeline for showing series where there are big variations in the data.</p>	<p>Seismogram Another alternative to the circle timeline for showing series where there are big variations in the data.</p>	<p>Seismogram Another alternative to the circle timeline for showing series where there are big variations in the data.</p>	<p>Calendar heatmap A great way of showing temporal patterns (daily, weekly, monthly) - at the expense of showing precision in quantity.</p>	<p>Grouped symbol An alternative to barplots - charts when being able to count data or highlight individual elements is useful.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	
<p>Streamgraph A type of area chart; use when seeing changes in proportions over time is more important than individual values.</p>	<p>Streamgraph A type of area chart; use when seeing changes in proportions over time is more important than individual values.</p>	<p>Streamgraph A type of area chart; use when seeing changes in proportions over time is more important than individual values.</p>	<p>Streamgraph A type of area chart; use when seeing changes in proportions over time is more important than individual values.</p>	<p>Calendar heatmap A great way of showing temporal patterns (daily, weekly, monthly) - at the expense of showing precision in quantity.</p>	<p>Grouped symbol An alternative to barplots - charts when being able to count data or highlight individual elements is useful.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	<p>Waterfall Can be useful for showing part-to-whole relationships where some of the components are negative.</p>	

Visual vocabulary

Designing with data

There are so many ways to visualise data - how do we know which one to pick? Use the categories across the top to decide which data relationship is most important in your story, then look at the different types of chart within the category to form some initial ideas about what might work best. This list is not meant to be exhaustive, nor a wizard, but is a useful starting point for making informative and meaningful data visualisations.

17 graphics: Alan Smith, Chris Campbell, Ian Hunt, Lou Pavesi, Graham Perrett, Billy Thompson, Sherron Paul McCallum, Martin Sledge. Inspired by the Graphic Cookbook by Jon Schwabedissen and Severin Wiltschko.



Search by Function

View by List



Arc Diagram



Area Graph



Bar Chart



Box & Whisker Plot



Brainstorm



Bubble Chart



Bubble Map



Bullet Graph



Calendar



Candlestick Chart



Chord Diagram



Choropleth Map



Circle Packing



Connection Map



Density Plot



Donut Chart



Dot Map



Dot Matrix Chart



Error Bars



Flow Chart



Flow Map



Gantt Chart



Heatmap



Histogram



Illustration Diagram



Kagi Chart



Line Graph



Marimekko Chart



Multi-set Bar Chart



Network Diagram



Jožef Stefan
Institute

<https://datavizcatalogue.com/index.html>

Department for
Artificial Intelligence

