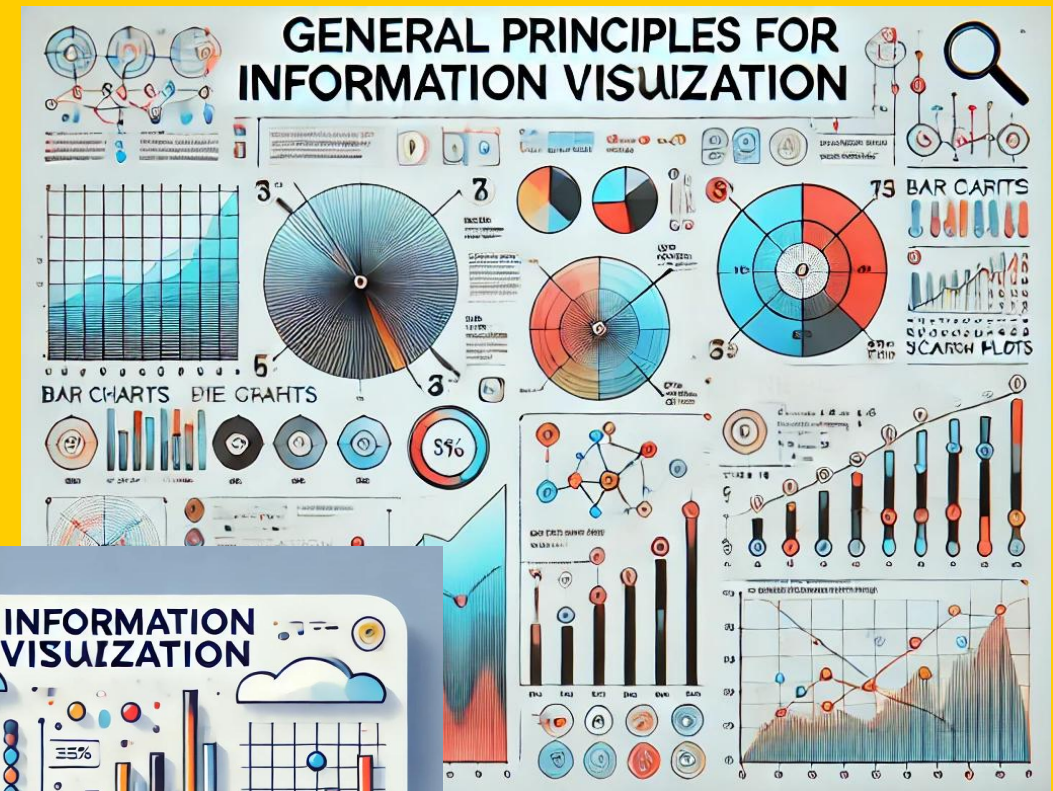
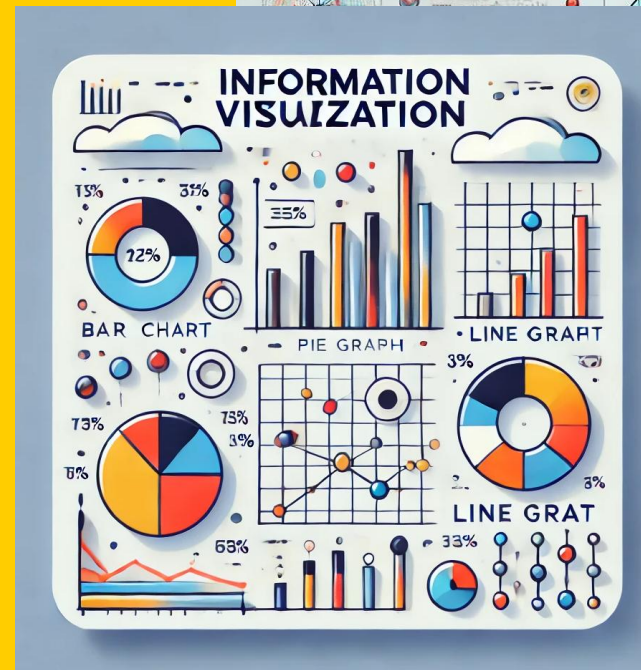


Hoorcollege 1

Algemene principes en visualisatietypes

Informatie-uitwisseling:
informatievisualisatie

Jeroen Ooge



Over mij

*Human-centred
explainable AI met
visualisaties*

Mijn korte carrière

MSc fundamentele wiskunde
MSc toegepaste informatica
2012-2019

KU LEUVEN

PhD in computer science
2019-2023

Assistent professor
in computer science
2023-nu

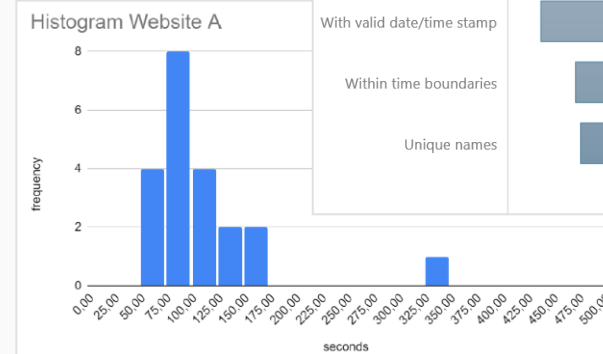
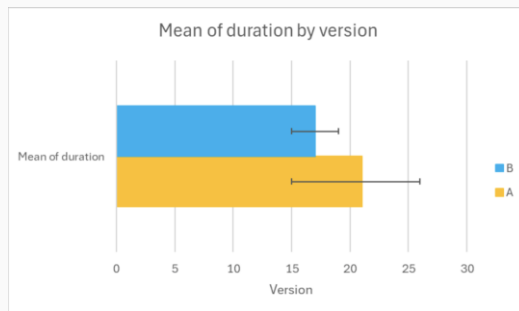
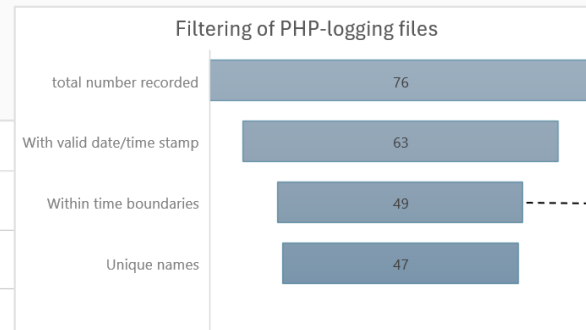
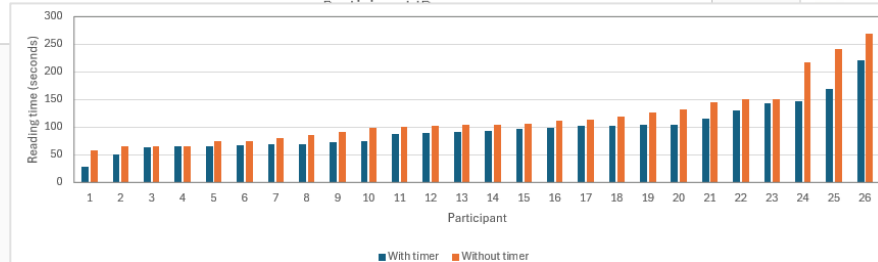
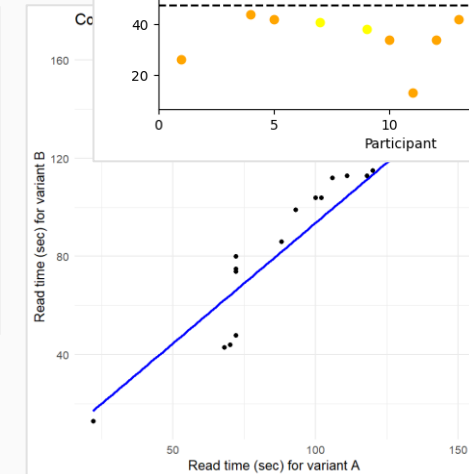
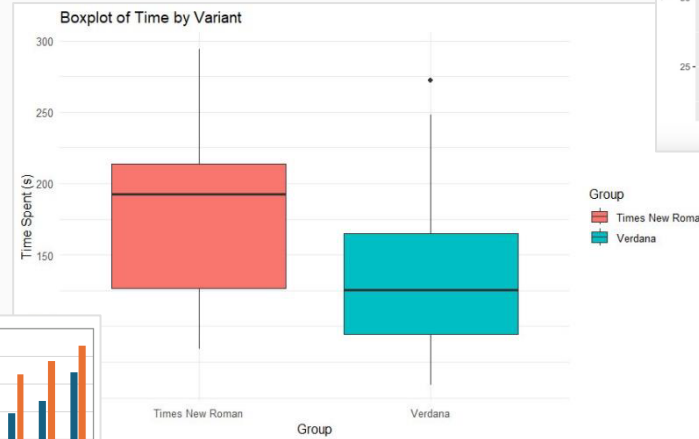
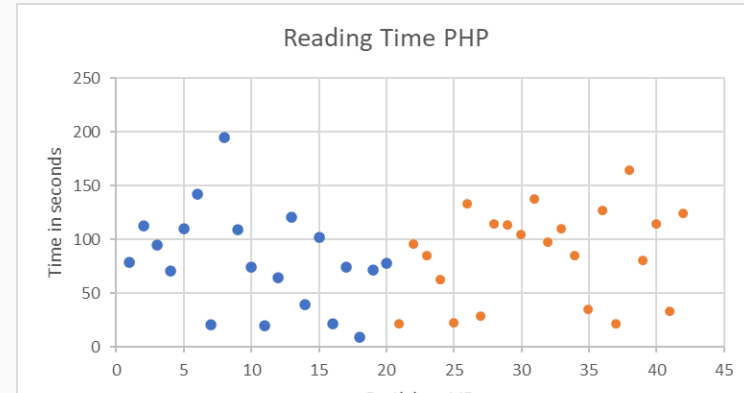
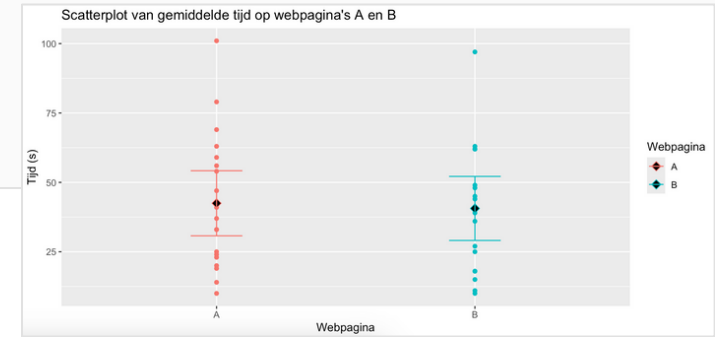


Universiteit
Utrecht



Jeroen Ooge
jeroenooge.be

2de BA-studenten vorig jaar 🤔





Studenten vinden data
voorstellen en grafieken
interpreteren vaak moeilijk

Daarom deze inleiding tot
informatievisualisatie



Jeroen Ooge
jeroenooge.be

Algemene principes en visualisatietypes

1. Voorbeelden en geschiedenis
2. Algemene vis-principes
3. Klassieke vis-types
4. Tools voor vis

Wat is visualisatie?

“Computer-based visualization systems provide **visual representations** of datasets designed to help people carry out tasks more effectively.”

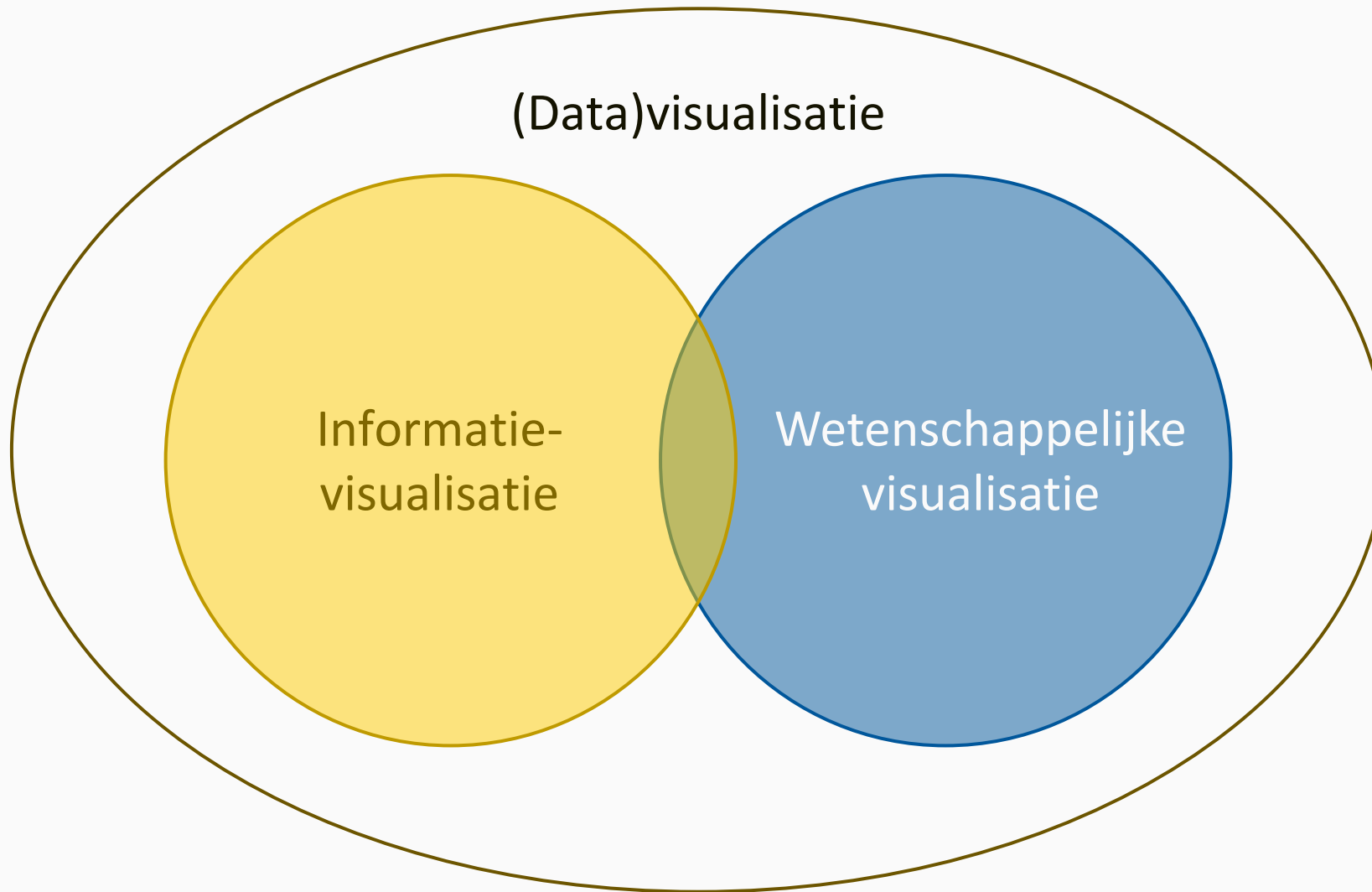
Tamara Munzner. 2014. Visualization Analysis and Design. A K Peters/CRC Press, New York. <https://doi.org/10.1201/b17511>

“... visually display measured quantities [with] **points, lines, a coordinate system, numbers, symbols, words, shading, and color.**”

Tufte, E. R., & Graves-Morris, P. R. (1983). The visual display of quantitative information (Vol. 2, No. 9). Cheshire, CT: Graphics press.

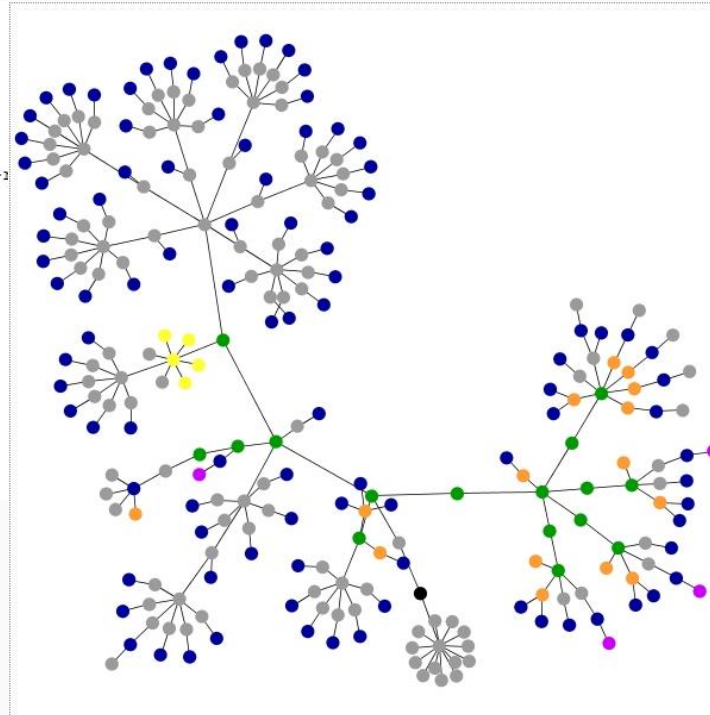
“... computer-supported interactive visual representations of **abstract data** to amplify cognition. Its purpose is ... **insight** (or rapid information assimilation or monitoring large amounts of data).”

Card, S. K., Mackinlay, J. D., & Shneiderman, B. (1999). Readings in information visualization: using vision to think. Morgan Kaufmann.



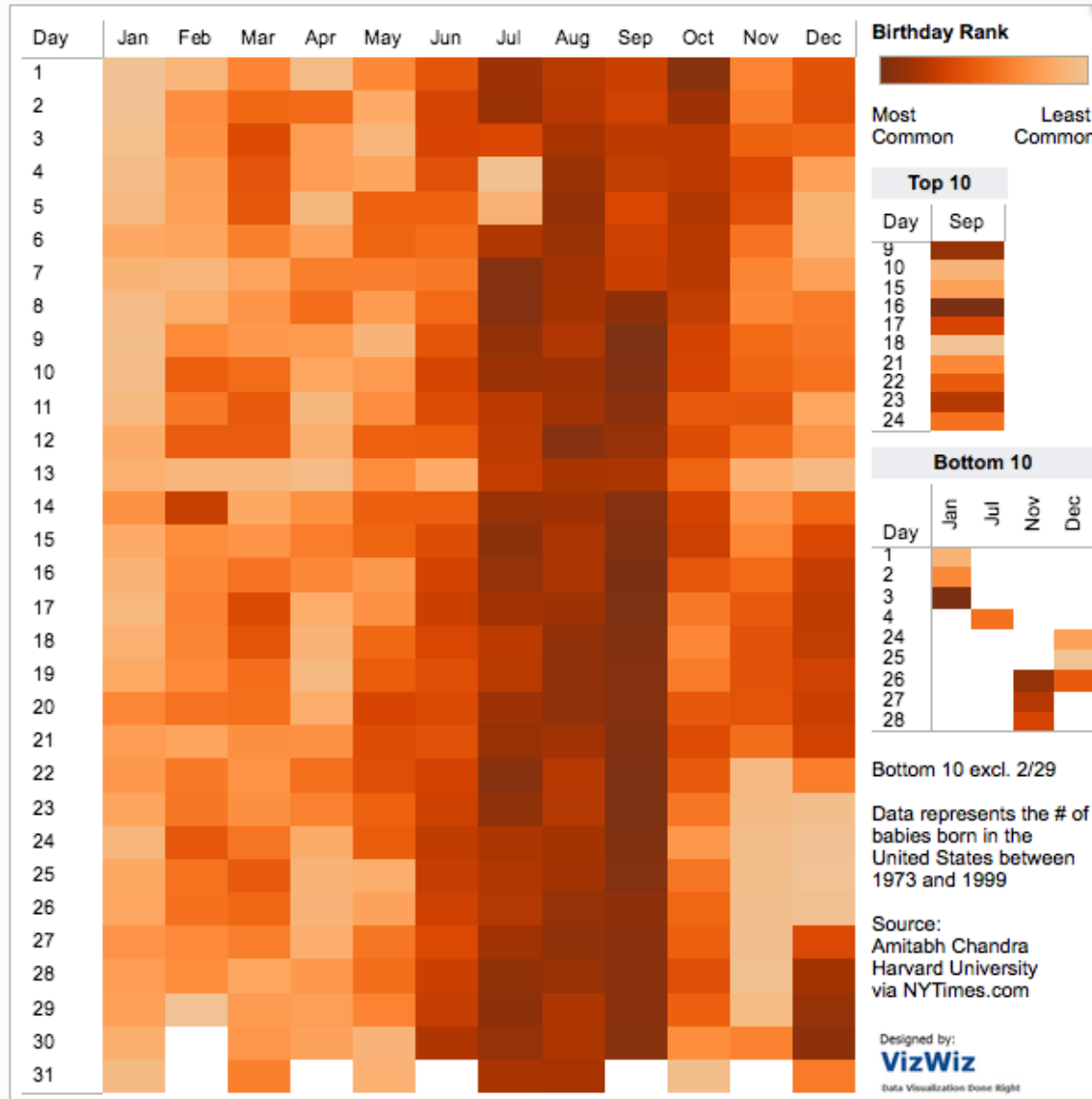
Data **zonder** welgedefinieerde representatie in 2D of 3D (= “abstracte data”)

```
http://www.bu.edu/students/life/  
http://www.bu.edu/students/life/housing/  
http://www.bu.edu/students/life/dining-vending/  
http://www.bu.edu/students/life/phone/  
http://www.bu.edu/students/life/safety/  
http://www.bu.edu/students/life/transportation/  
http://www.bu.edu/students/life/activities/  
http://www.bu.edu/students/life/bu-global-orientation-  
http://www.bu.edu/students/academics/  
http://www.bu.edu/students/academics/link/  
http://www.bu.edu/students/academics/admissions/  
http://www.bu.edu/students/academics/registration/  
http://www.bu.edu/students/academics/advising/  
http://www.bu.edu/students/academics/grades/  
http://www.bu.edu/students/academics/services/  
http://www.bu.edu/students/academics/support/  
http://www.bu.edu/students/health/  
http://www.bu.edu/students/health/services/  
http://www.bu.edu/students/health/counseling/  
http://www.bu.edu/students/health/facilities/  
http://www.bu.edu/students/health/clubsports/  
http://www.bu.edu/students/health/varsitysports/
```



Informatie-
visualisatie

Wetens-
visu



HOW GROUPS OF PEOPLE LIVE

Select among the following demographics.

SEX

Female

Male

AGE GROUP

18 to 24

25 to 44

45 to 64

65+

RACE OR ORIGIN

White

Black

Asian

Native

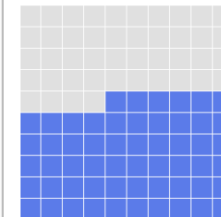
Hispanic

There are about this many people in this group...

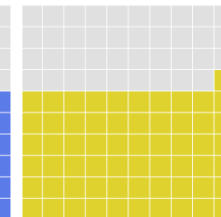
29,248,303

...and of these people, here are their percentage breakdowns.

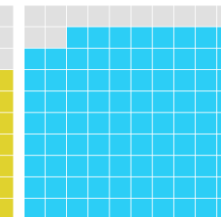
MARRIED



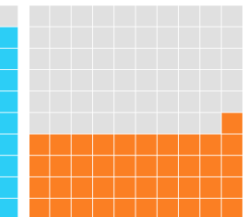
OWN CHILDREN IN HOUSEHOLD

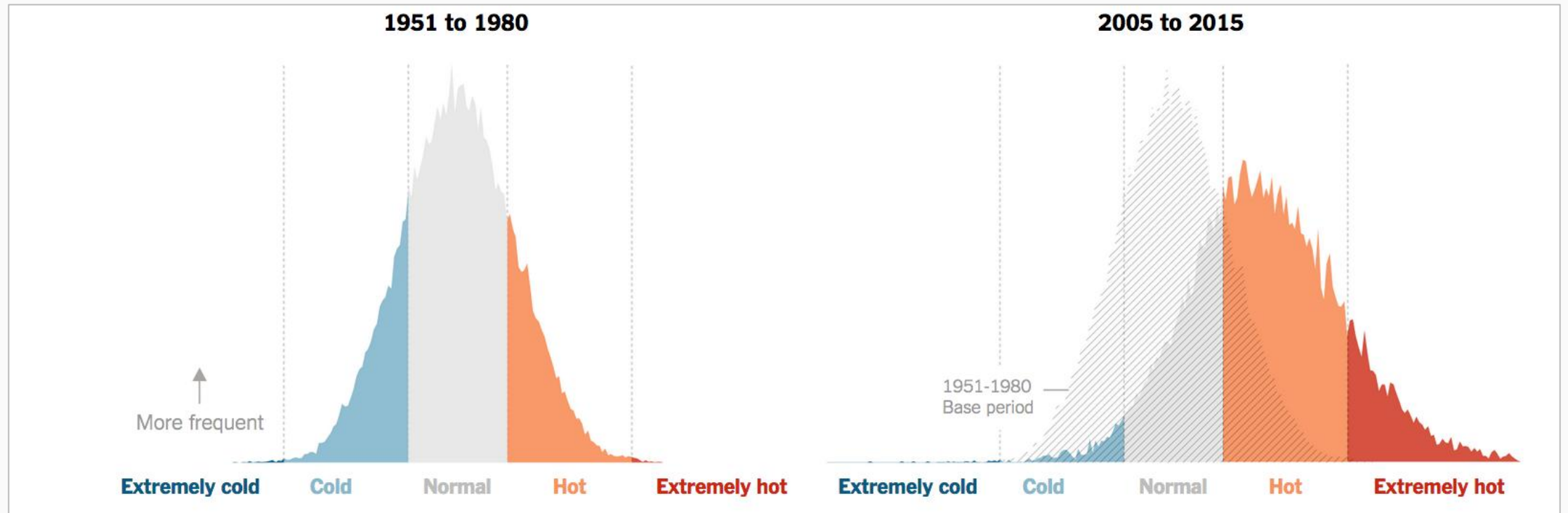


HAS HEALTHCARE COVERAGE



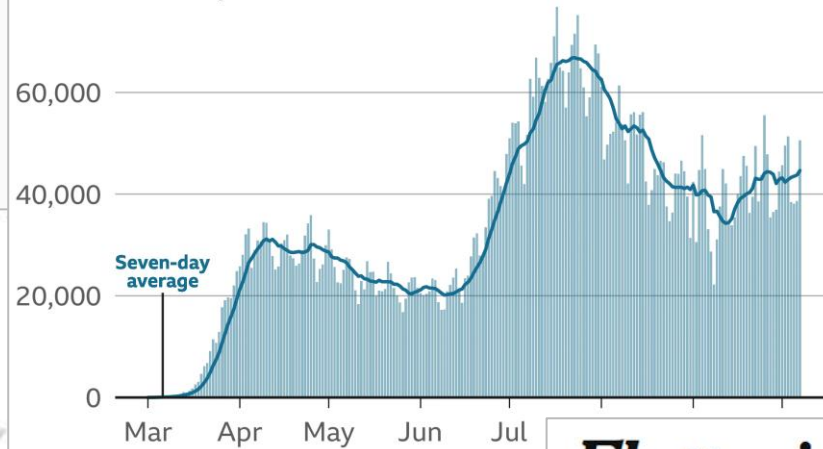
BACHELOR'S DEGREE OR MORE



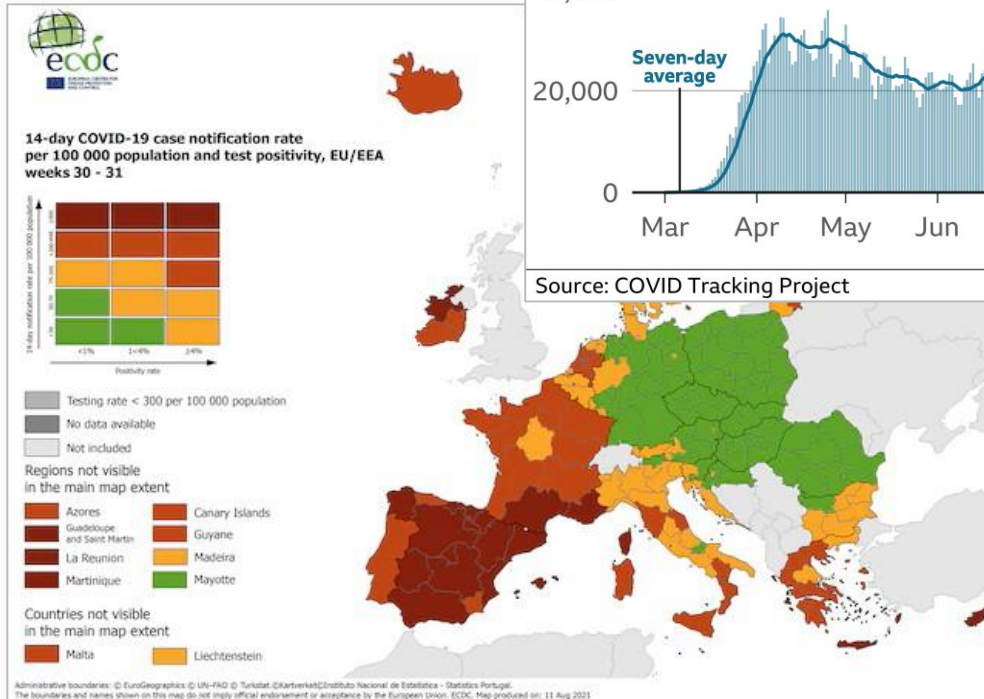


Cases have been rising again recently

Number of daily confirmed coronavirus cases in the US

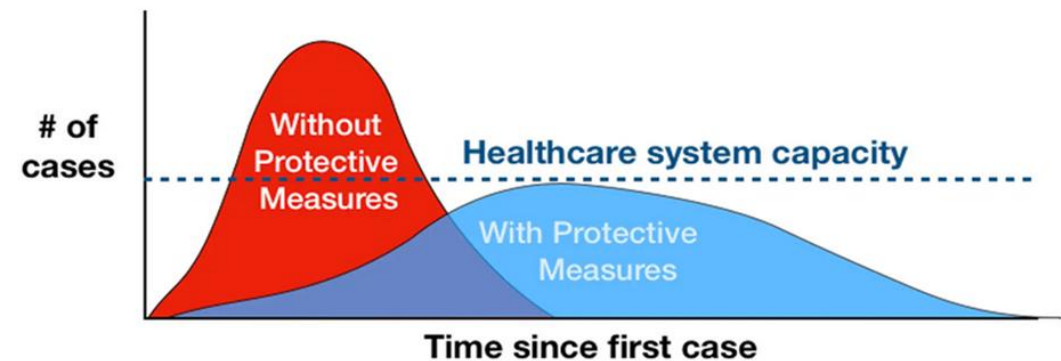


Source: COVID Tracking Project



Flattening the Coronavirus Curve

One chart explains why slowing the spread of the infection is nearly as important as stopping it.



Adapted from CDC / The Economist

HR ATTRITION DASHBOARD

SHOW ONLY ATTRITION



● RETENTION ● ATTRITION

OVERVIEW (27 May, 2021 to 8 May, 2022)



16.1%

ATTRITION RATE



237

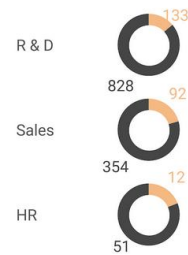
TOTAL ATTRITION



1,233

CURRENT EMPLOYEES

DEPARTMENT



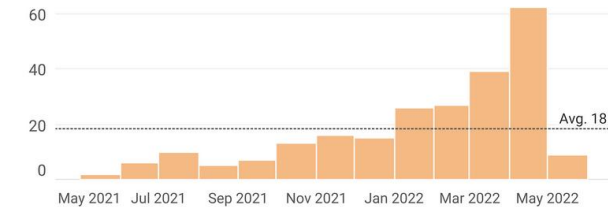
JOB ROLE



ATTRITION TREND

▼ 85.5% vs. previous month

SELECT PERIOD: W M Q Y



DESIGN: PRADEEP KUMAR G | #RWFD



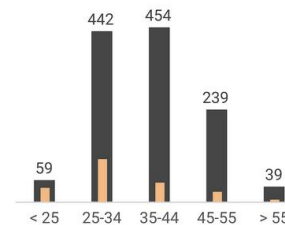
DEMOGRAPHICS

Click data point(s) to filter dashboard.

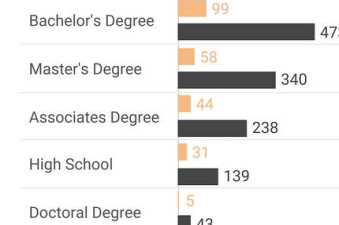
GENDER



AGE GROUP



EDUCATION



SURVEY SCORE



Score >>	1	2	3	4
Environment Satisfaction	72	43	62	60
Job Satisfaction	223	234	369	407
Job Involvement	28	71	125	13
Relationship Satisfaction	219	258	388	368
Work Life Balance	25	58	127	27

RECENT ATTRITION

EMP ID: All

ATTR. DATE: All

E_780 Research Scientist R & D	Attrition date: 8 May, 2022 Avg. Satisfaction Score: 3.2 Performance Rating: 3 Monthly Income: \$2,686 Salary Hike: 13%
E_45 Research Scientist R & D	Attrition date: 6 May, 2022 Avg. Satisfaction Score: 2.4 Performance Rating: 3 Monthly Income: \$2,293 Salary Hike: 16%
E_896 Sales Representative Sales	Attrition date: 6 May, 2022 Avg. Satisfaction Score: 2.6 Performance Rating: 3 Monthly Income: \$2,800 Salary Hike: 19%

Interactieve vis
Migratie naar de VS

Meer interactieve vis
in hoorcollege 4!

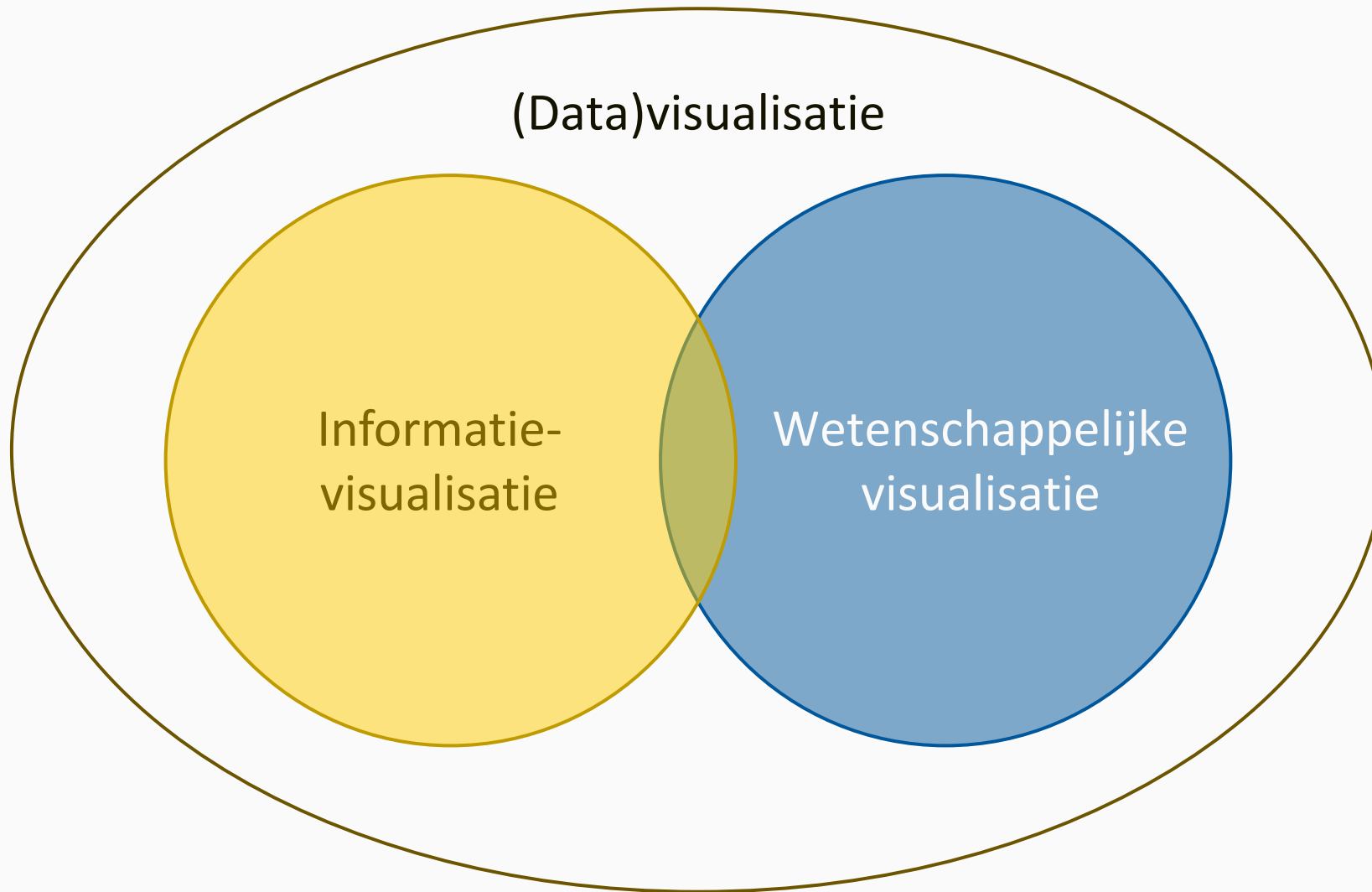
1960 to 1969

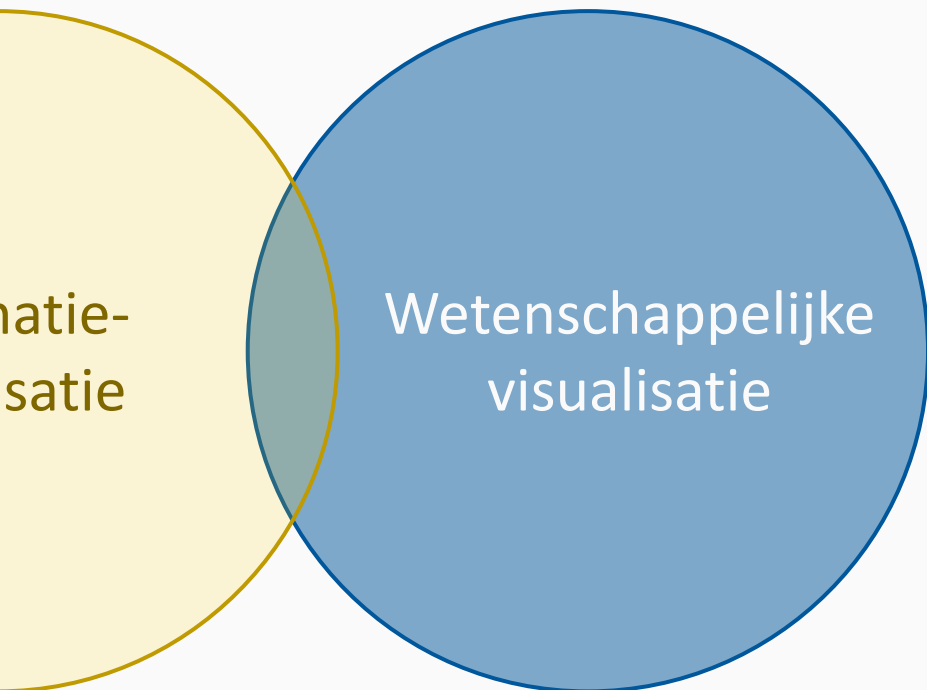
Total Migration
3,213,749

Top Countries

1. Mexico
2. Canada
3. United Kingdom

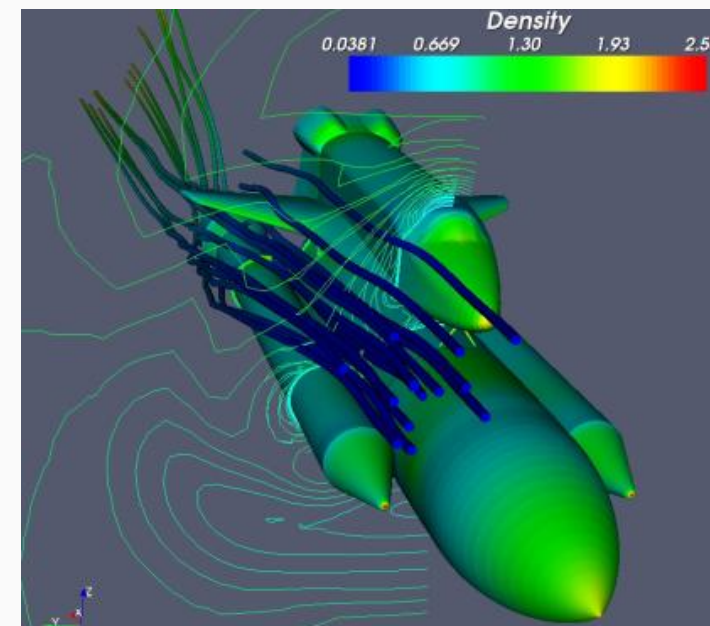
1968

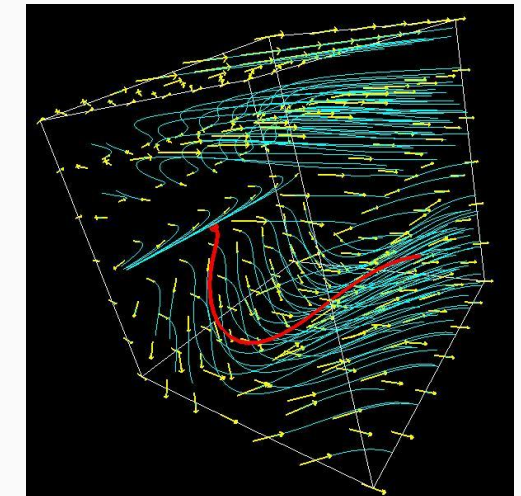
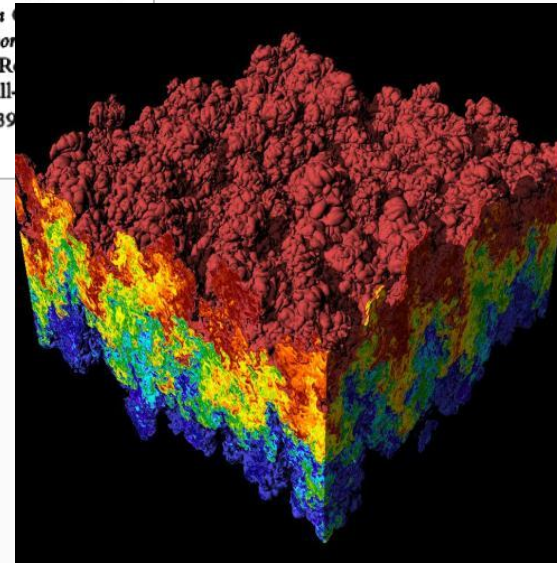
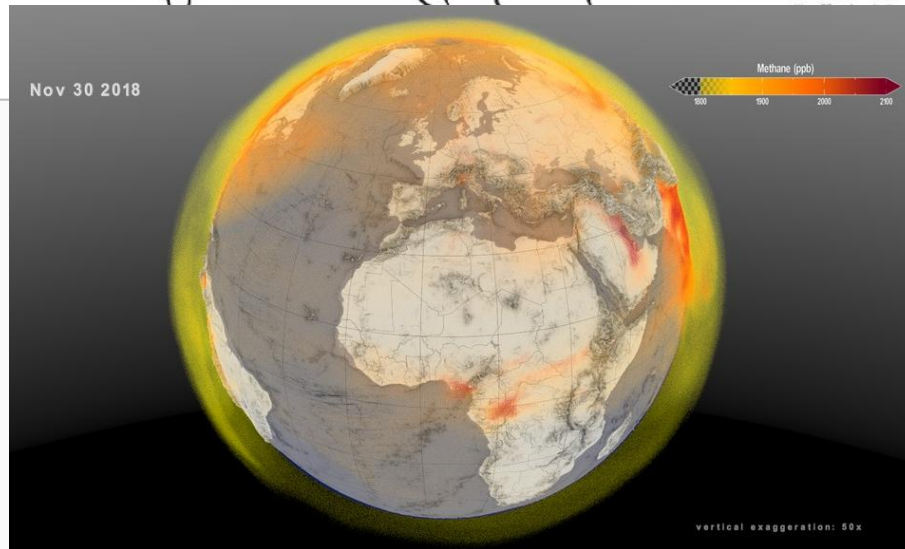
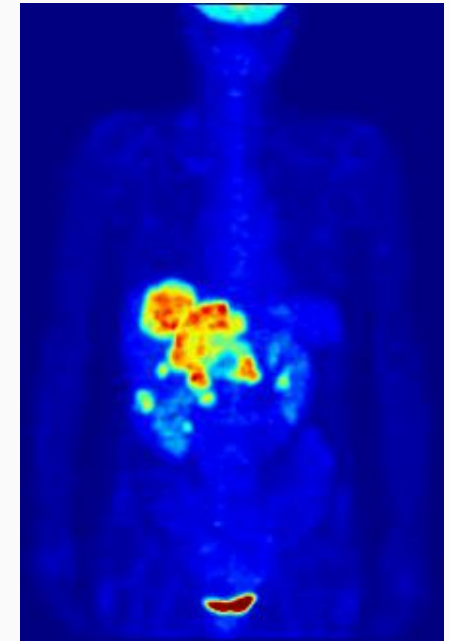
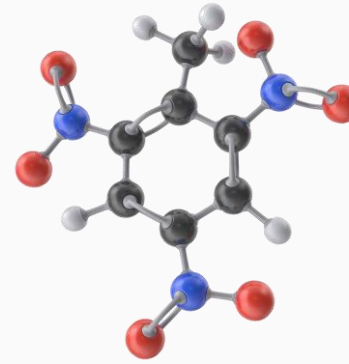
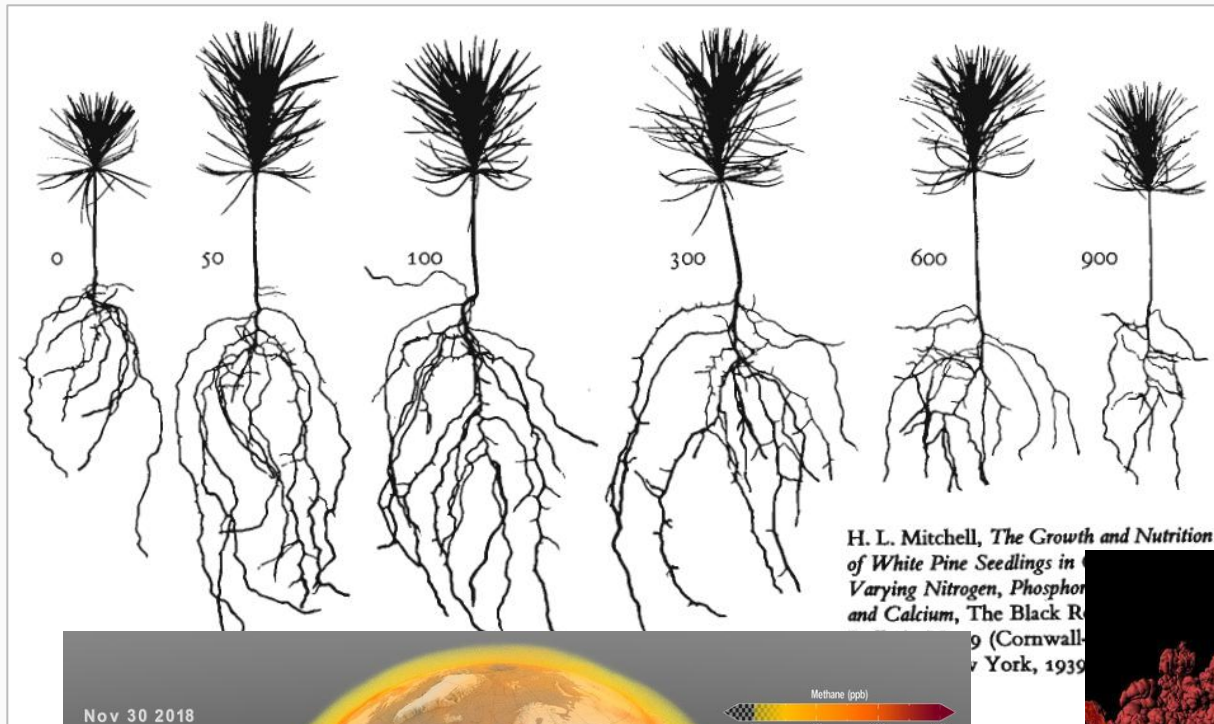


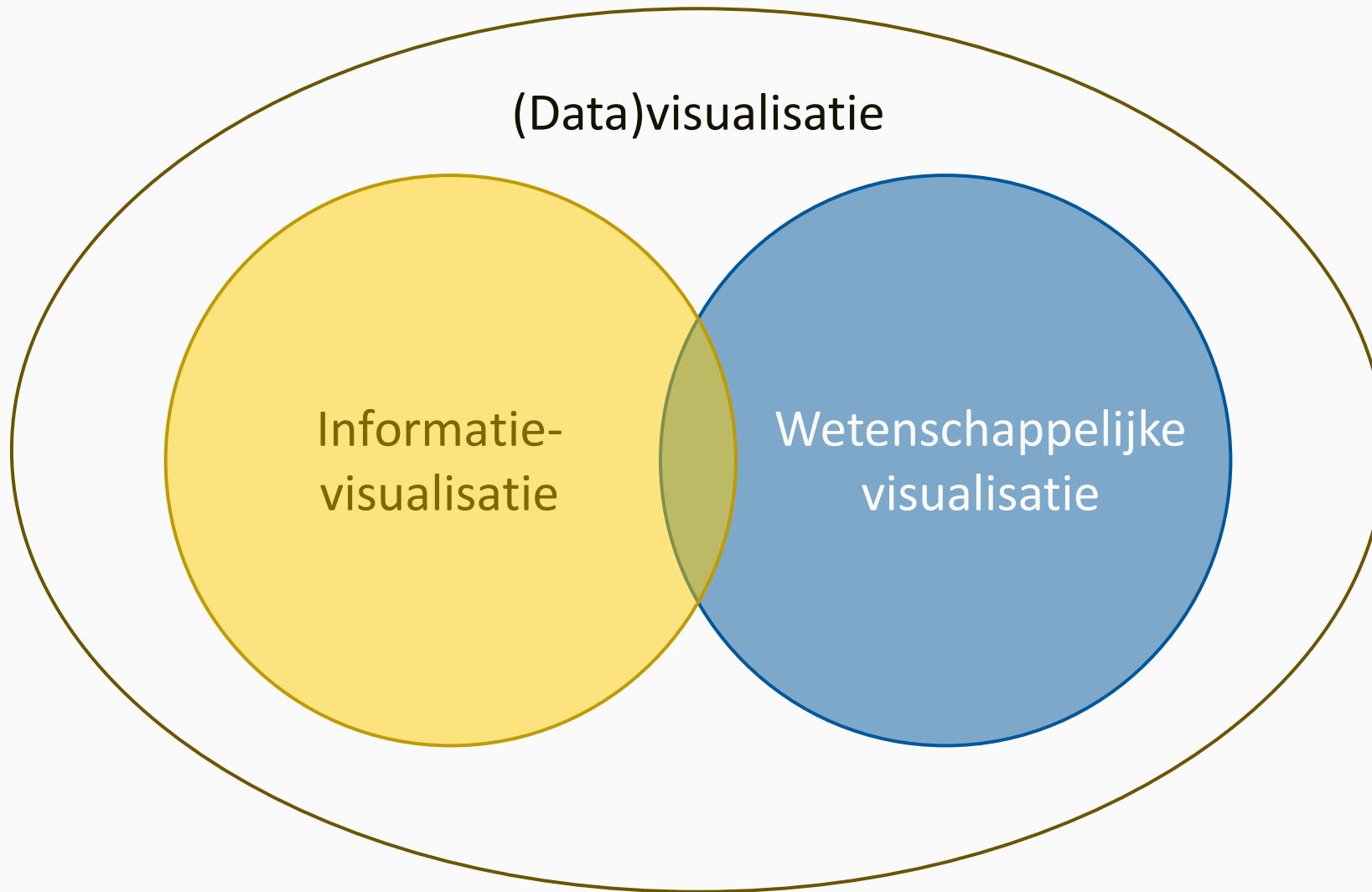


Data **met** welgedefinieerde representatie
in 2D of 3D (vb. scan, simulaties ...)

```
0265640 132304 133732 032051 037334 024721 015013 052226 001662
0265660 025537 064563 054606 043244 074076 124153 135216 126614
0265700 144210 056426 044700 042650 165230 137037 003655 006254
0265720 134453 124327 176005 027034 107614 170774 073702 067274
0265740 072451 007735 147620 061064 157435 113057 155356 114603
0265760 107204 102316 171451 046040 120223 001774 030477 046673
0266000 171317 116055 155117 134444 167210 041405 147127 050505
0266020 004137 046472 124015 134360 173550 053517 044635 021135
0266040 070176 047705 113754 175477 105532 076515 177366 056333
0266060 041023 074017 127113 003214 037026 037640 066171 123424
0266100 067701 037406 140000 165341 072410 100032 125455 056646
0266120 006716 071402 055672 132571 105645 170073 050376 072117
0266140 024451 007424 114200 077733 024434 012546 172404 102345
0266160 040223 050170 055164 164634 047154 126525 112514 032315
0266200 016041 176055 042766 025015 176314 017234 110060 014515
0266220 117156 030746 154234 125001 151144 163706 136237 164376
0266240 137055 062276 161755 115466 005322 132567 073216 002655
0266260 171466 126161 117155 065763 016177 014460 112765 055527
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0266320 072074 000007 040627 070652 173011 002151 125132 140214
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0266360 170601 170106 040437 127277 124446 136631 041462 116321
0266400 020243 005602 004146 121574 124651 006634 071331 102070
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0266440 133614 106171 144160 010652 007365 026416 160716 100413
0266460 026630 007210 000630 121224 076033 140764 000737 003276
0266500 114060 042647 104475 110537 066716 104754 075447 112254
0266520 030374 144251 077734 015157 002513 173526 035531 150003
0266540 146207 015135 024446 130101 072457 040764 165513 156412
0266560 166410 067251 156160 106406 136770 030516 064740 022032
0266600 142166 123707 175121 071170 076357 037233 031136 015232
0266620 075074 016744 044055 102230 110063 033350 052765 172463
```







Waarom is vis belangrijk?

A picture can sometimes say more than a complicated explanation. Translating large amounts of information and complex structures into coherent images is important in science.

Diagrams, illustrations and models are different ways of visualising things that are hard to understand.

VISUALISERA • VISUALISING

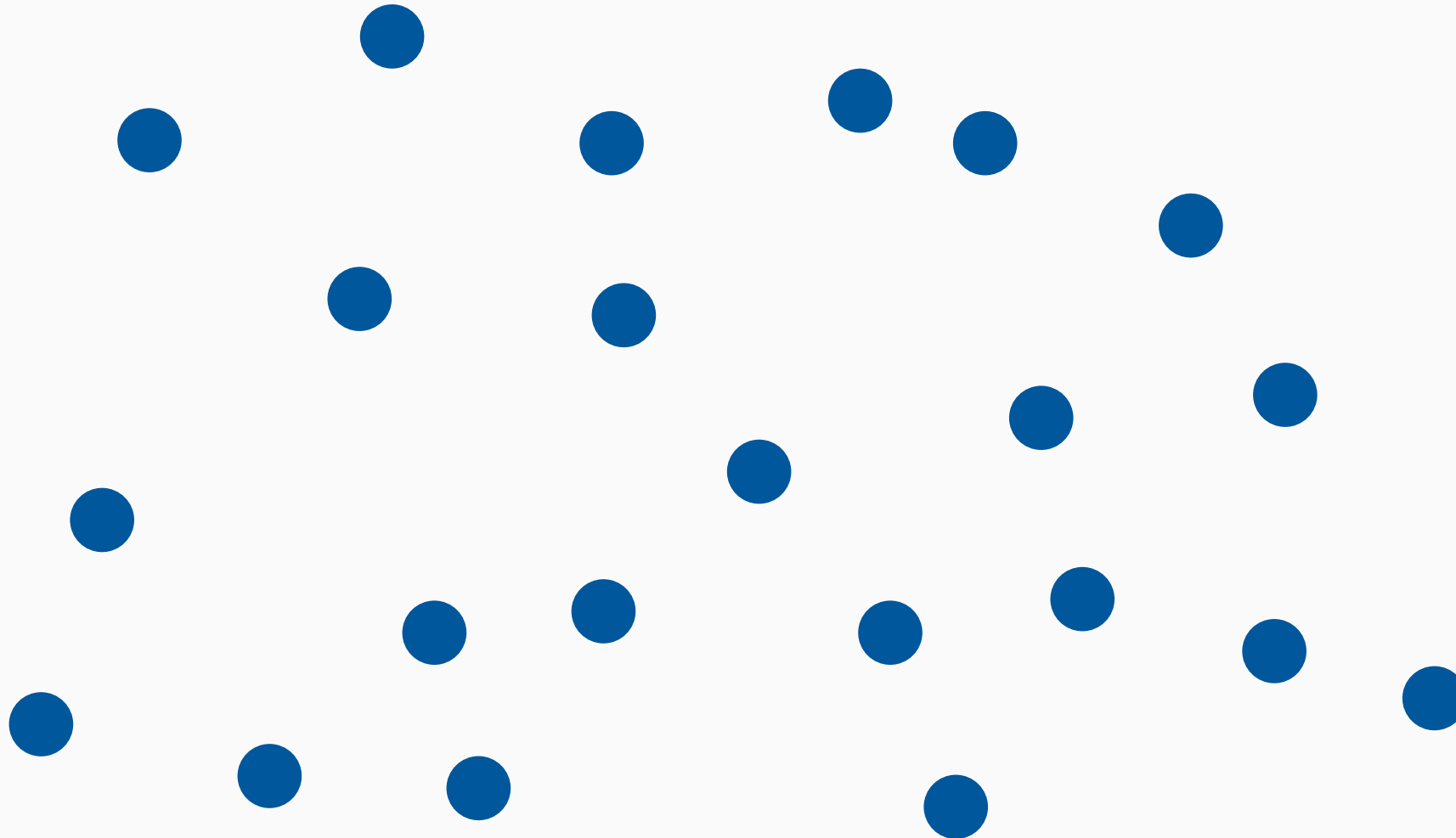
En bild är ofta mer klargörande än en komplicerad
förklaring. Att föreslå stora mängder information
och komplexa strukturer till begripliga bilder
är viktigt i vetenskap.

A picture can sometimes say more than a complicated
explanation. Translating large amounts of information
and complex structures into coherent images is
important in science.

Diagram, illustration och modeller är olika sätt
att visualisera svåra saker.

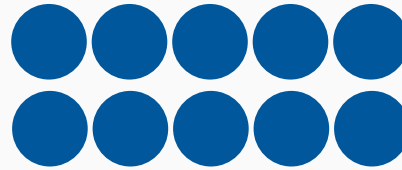
Diagrams, illustrations and models are different ways
of visualising things that are hard to understand.

Hoeveel cirkels zijn er?

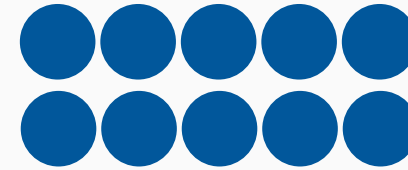


Hoeveel cirkels zijn er?

Mensen hebben sterke perceptuele vaardigheden
en kunnen erg goed patronen herkennen



10

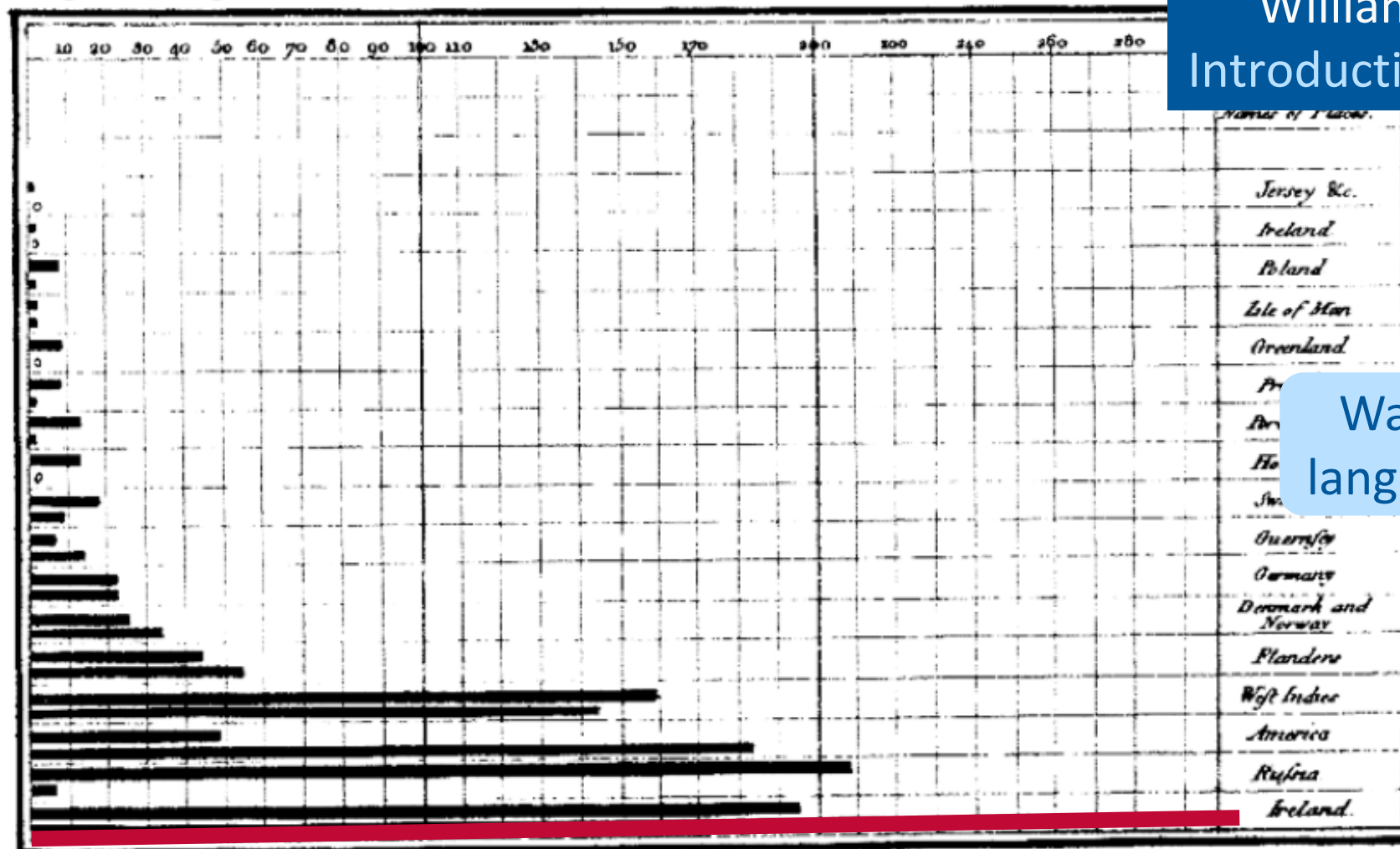


10



2

Exports and Imports of SCOTLAND to and from different parts for one Year from Christmas 1780



William Playfair (1786)
Introductie van bar charts

Wat is de
langste bar?



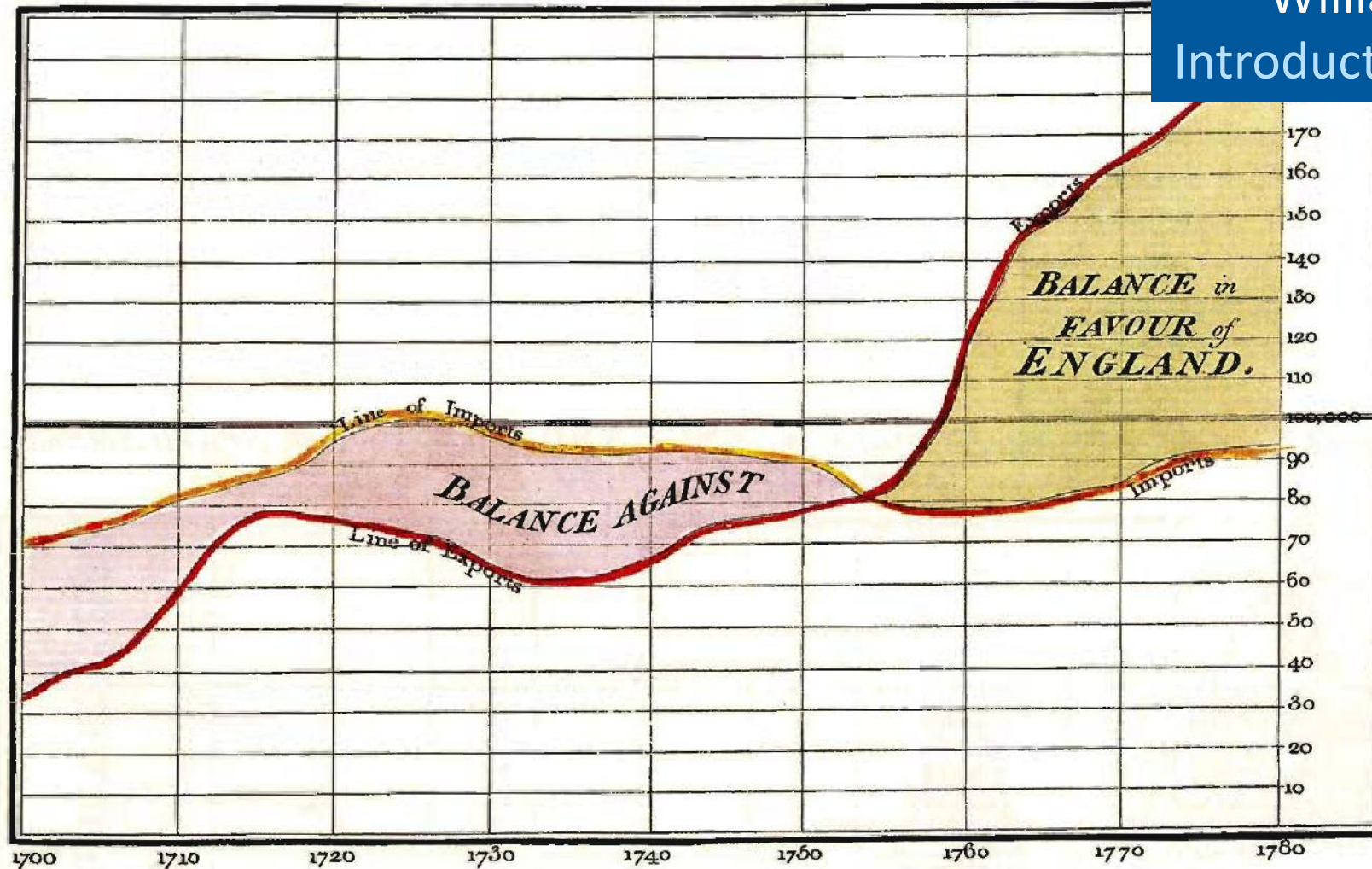
The Upright divisions are Ten Thousand Pounds each. The Black Lines are Exports the Red Lines Imports.

Published in the Act done June 7th 1781 by W^m Playfair

Printed by J. Smith, Strand, London.

Exports and Imports to and from DENMARK & NORWAY from

William Playfair (1786)
Introductie van area charts

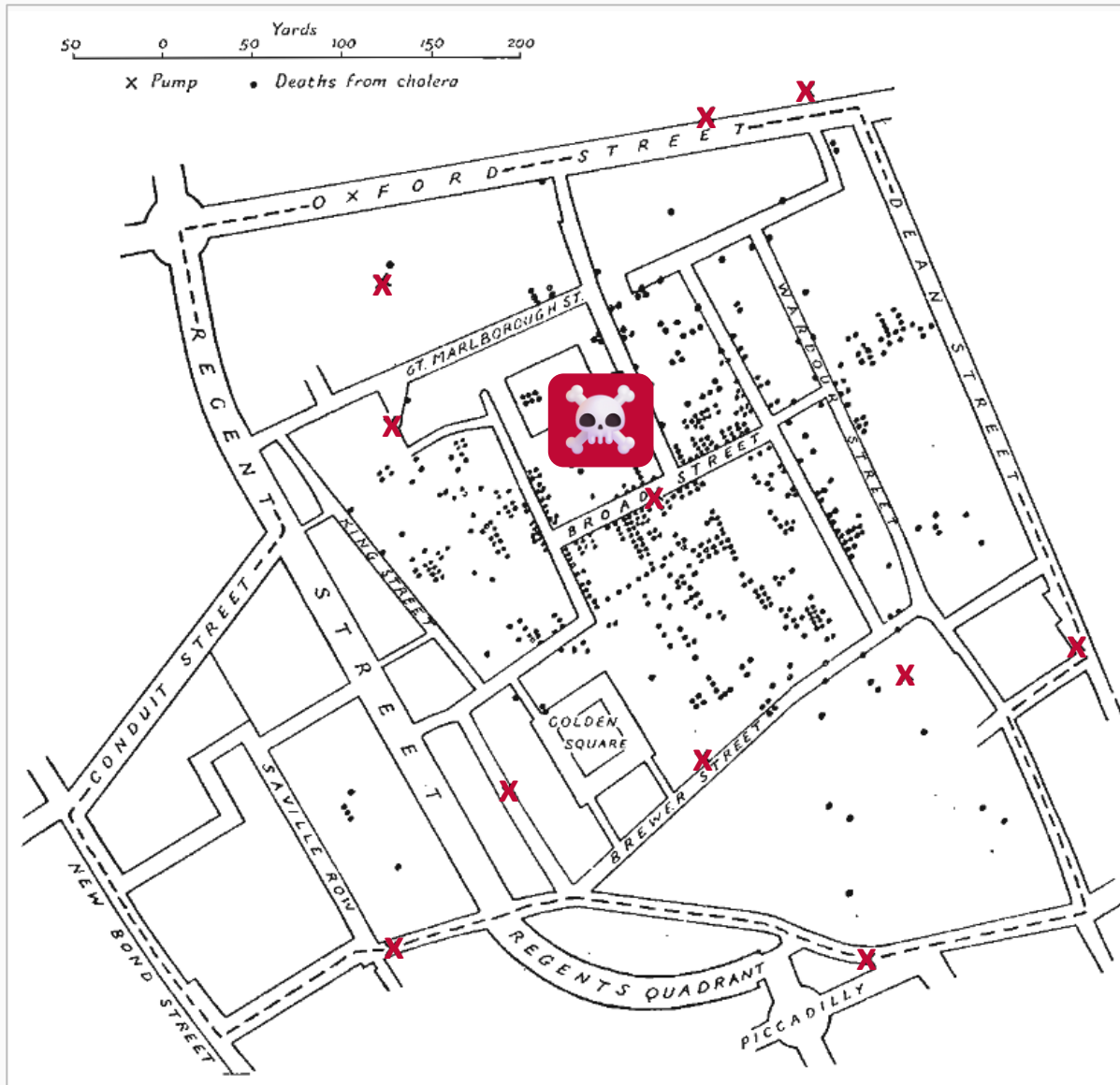


The Bottom line is divided into Years, the Right hand line into £10,000 each.
Published as the Act directs, 1st May 1786, by W^m Playfair
Neale sculpt 392, Strand, London.

John Snow (1854) Oorzaak cholera-uitbraak

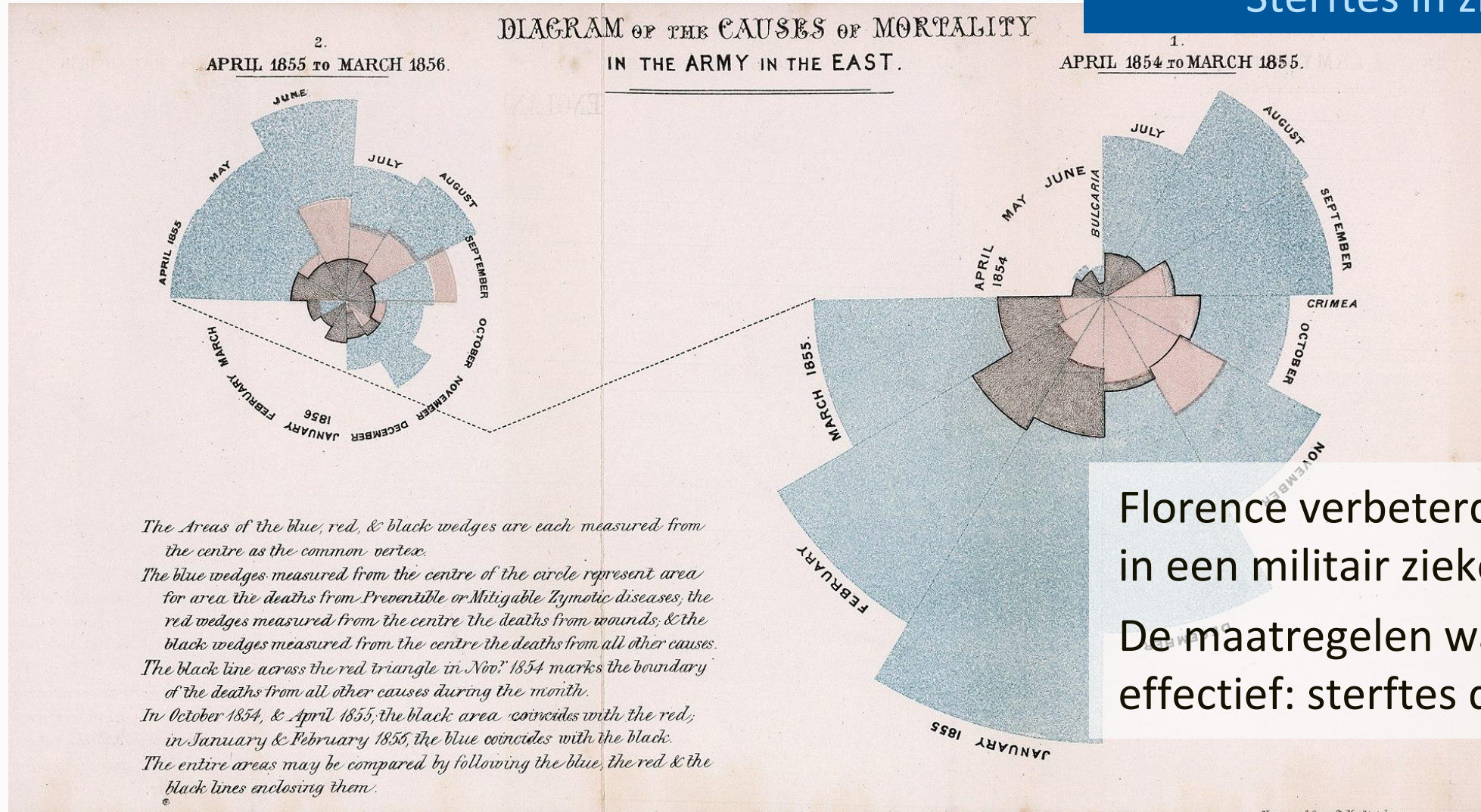
Link tussen • choleraslachtoffers
en x waterpompen

Afsluiting van de pomp in Broad
Street stopte de cholera-uitbraak



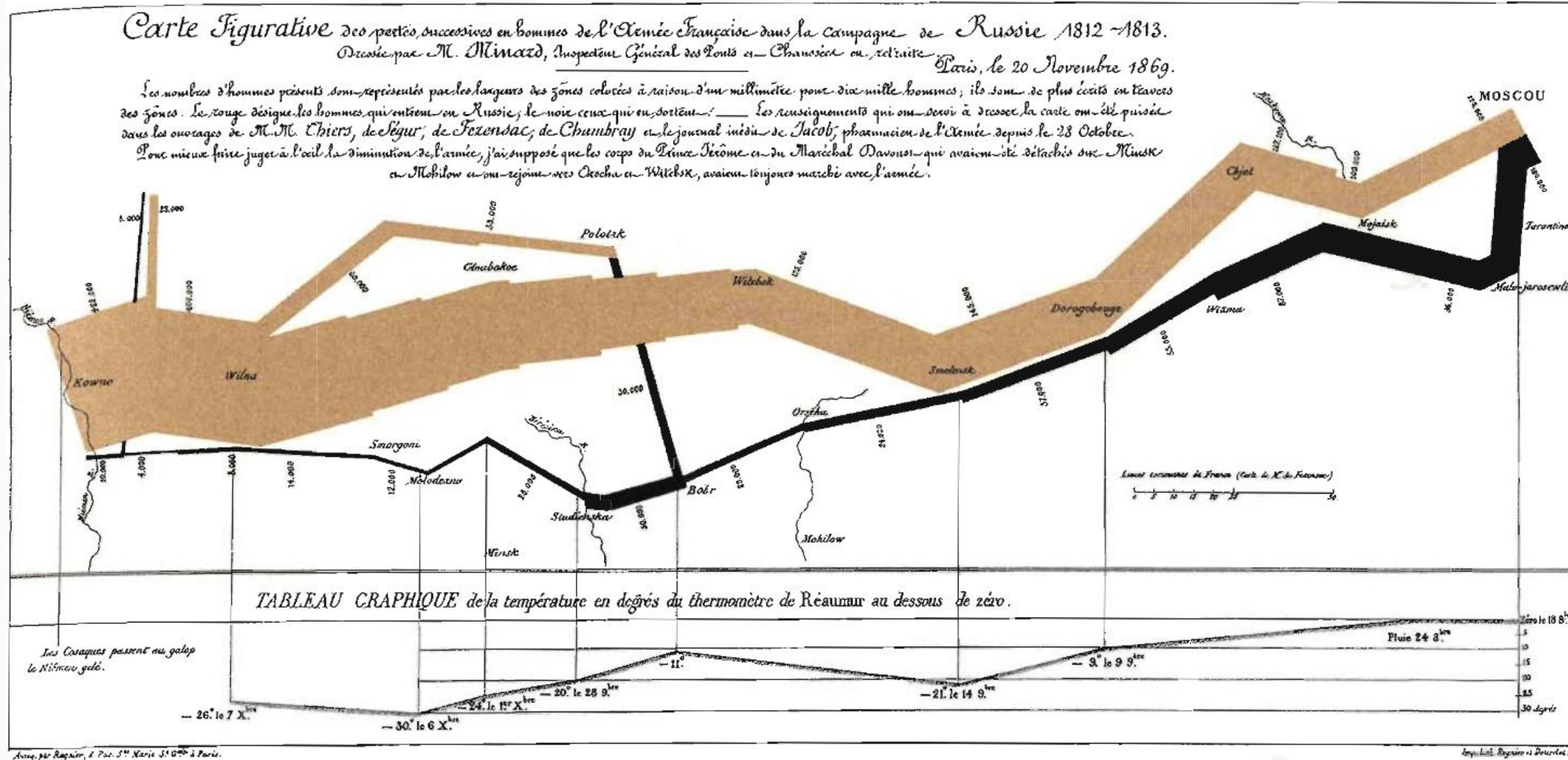
Florence Nightingale (1858)

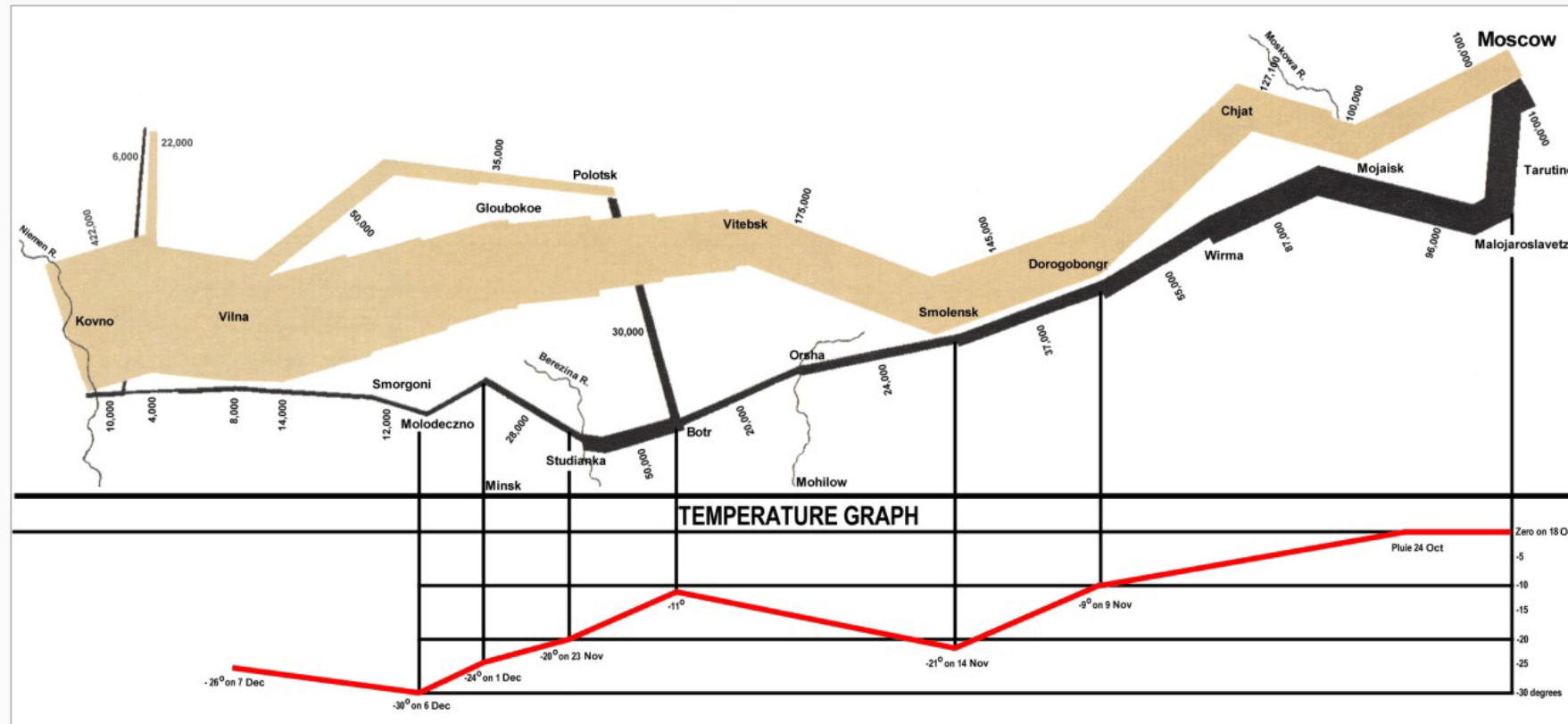
Sterftes in ziekenhuis



Florence verbeterde hygiëne
in een militair ziekenhuis
De maatregelen waren
effectief: sterftes daalden

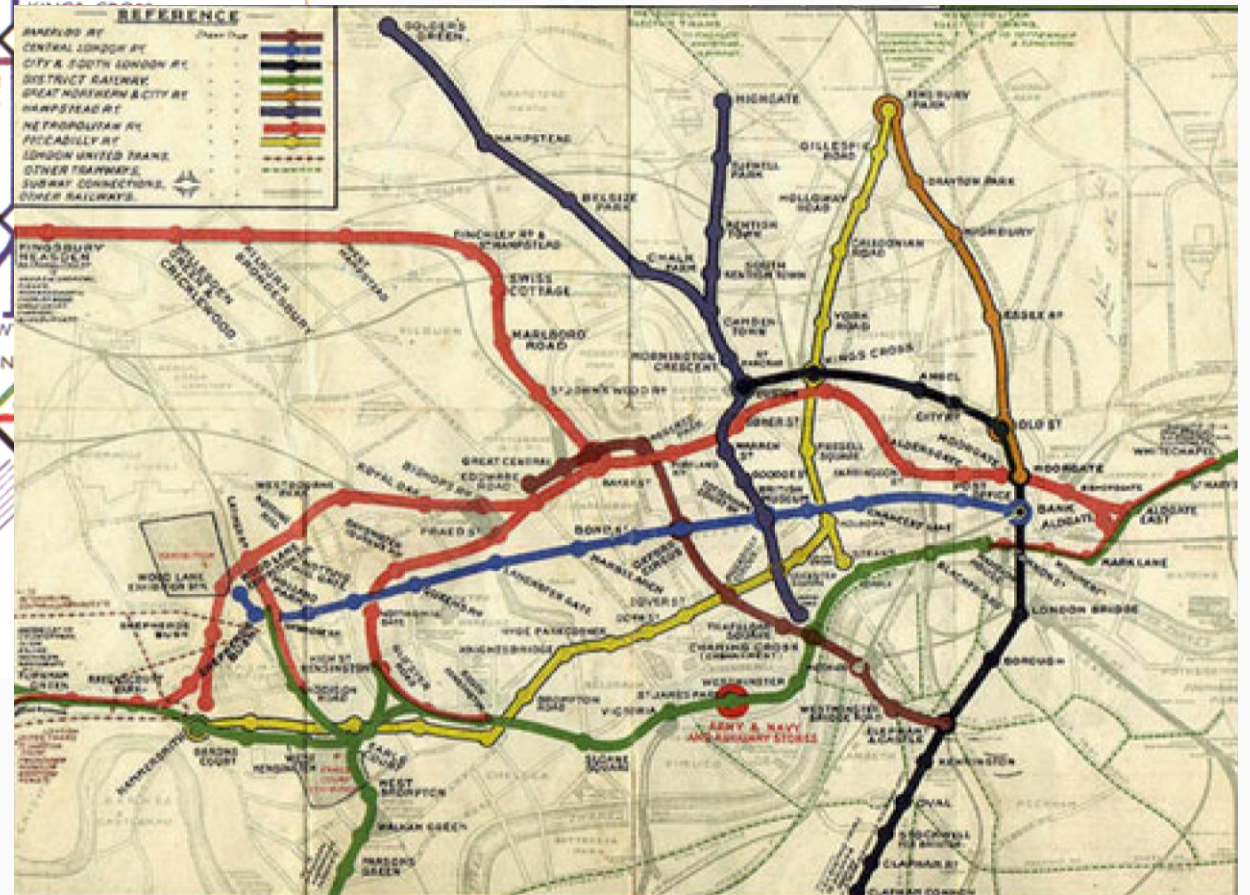
Charles Minard (1869) Napoleons leger





Bruine lijn = soldaten bij de inval (422.000 vertrekken)
 Zwarte lijn = soldaten bij terugtrekking (10.000 keren terug)
 De vriestemperaturen (rode lijn) leidden tot veel doden

Harry Beck (1933) Metro in London

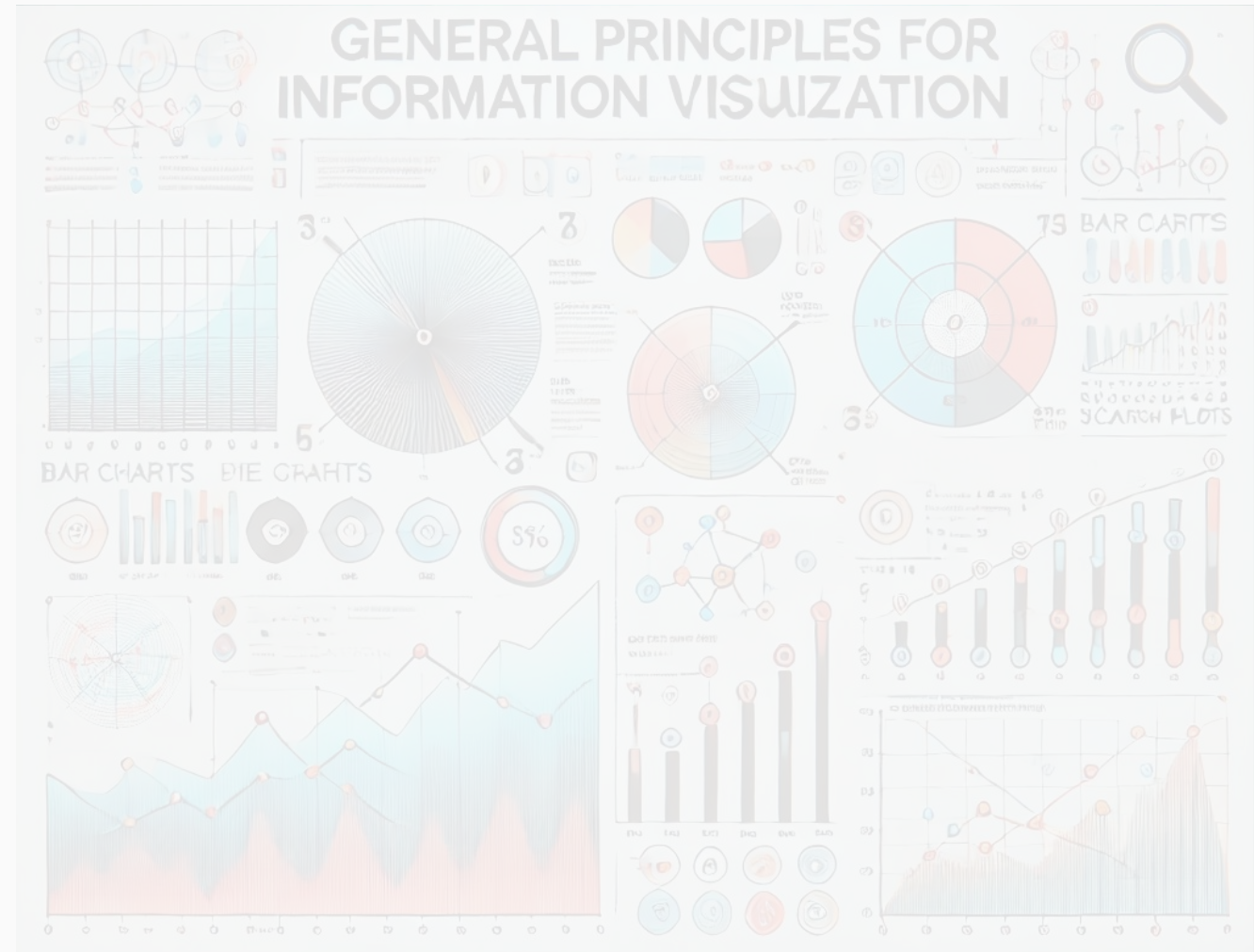
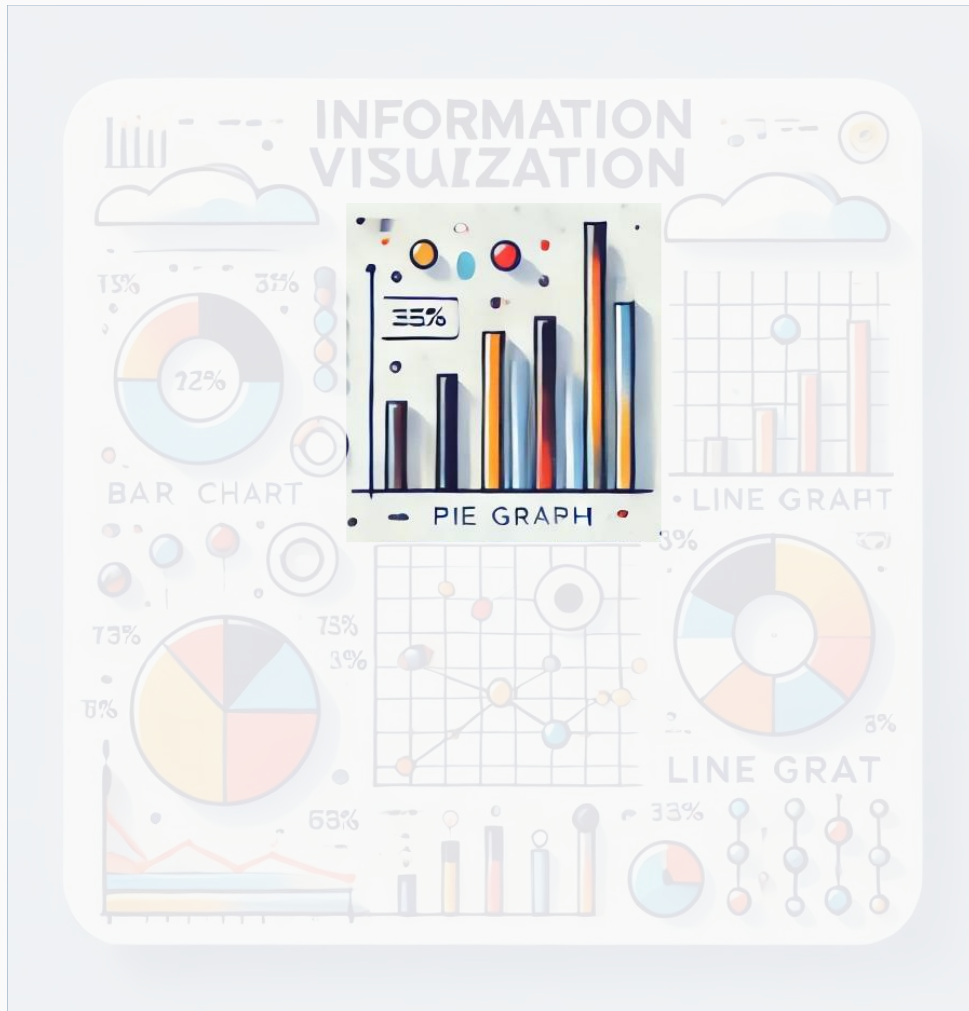




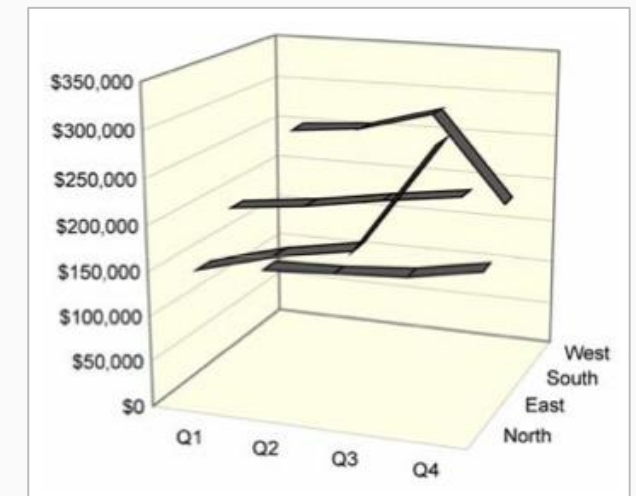
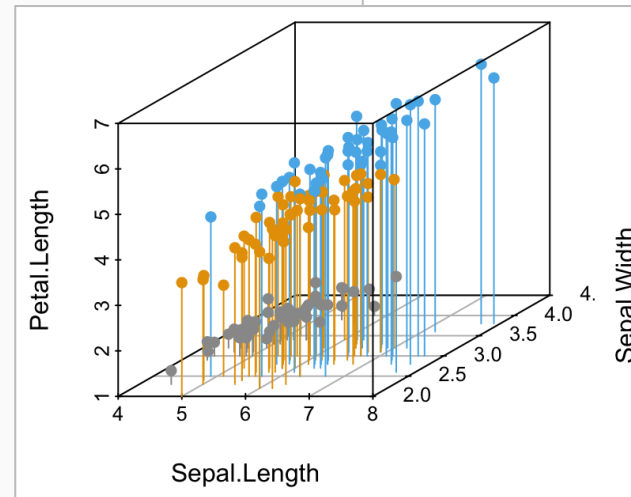
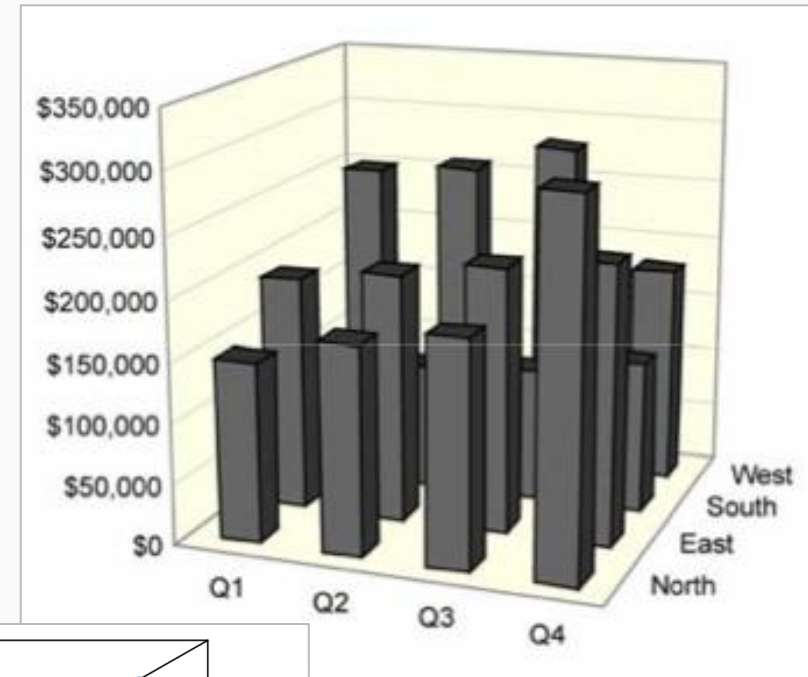
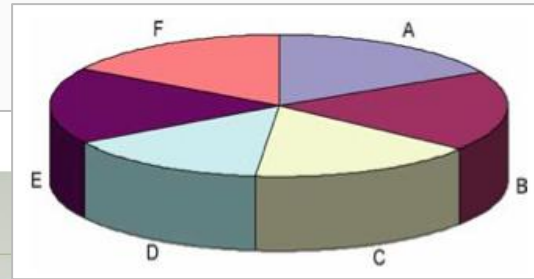
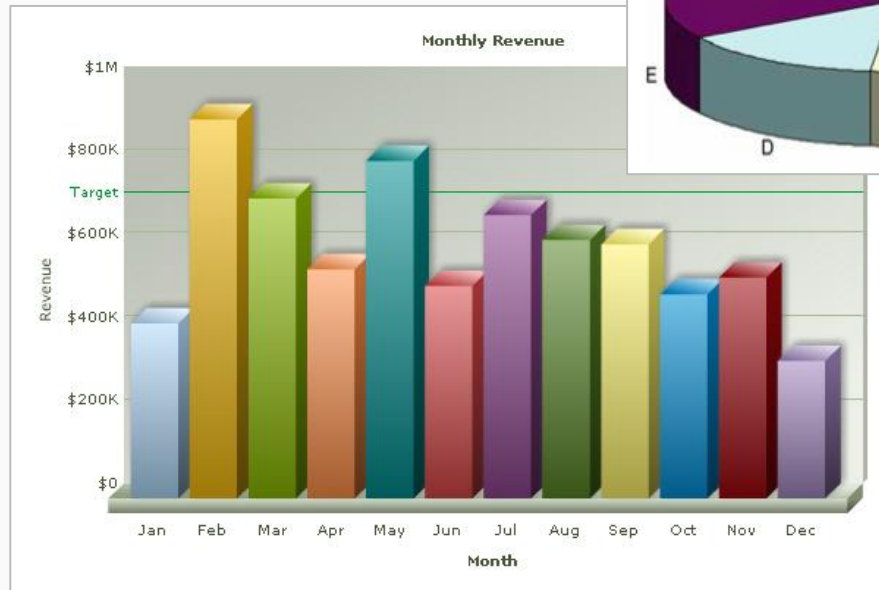
The beauty of data visualization. David McCandless. <http://www.youtube.com/watch?v=5Zg-C8AAIGg>

Algemene principes en visualisatietypes

1. Voorbeelden en geschiedenis
2. Algemene vis-principes
3. Klassieke vis-types
4. Tools voor vis

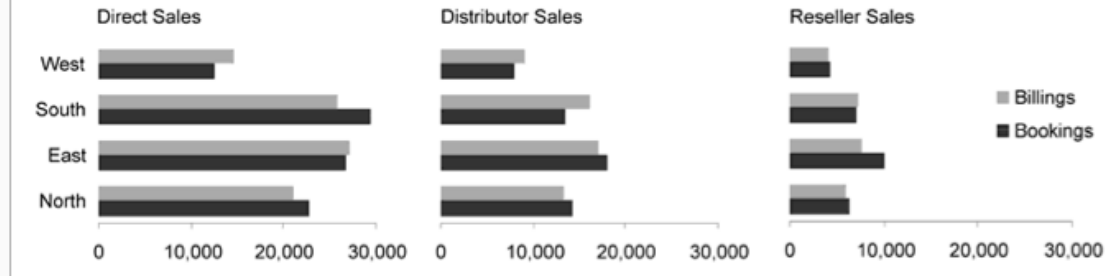
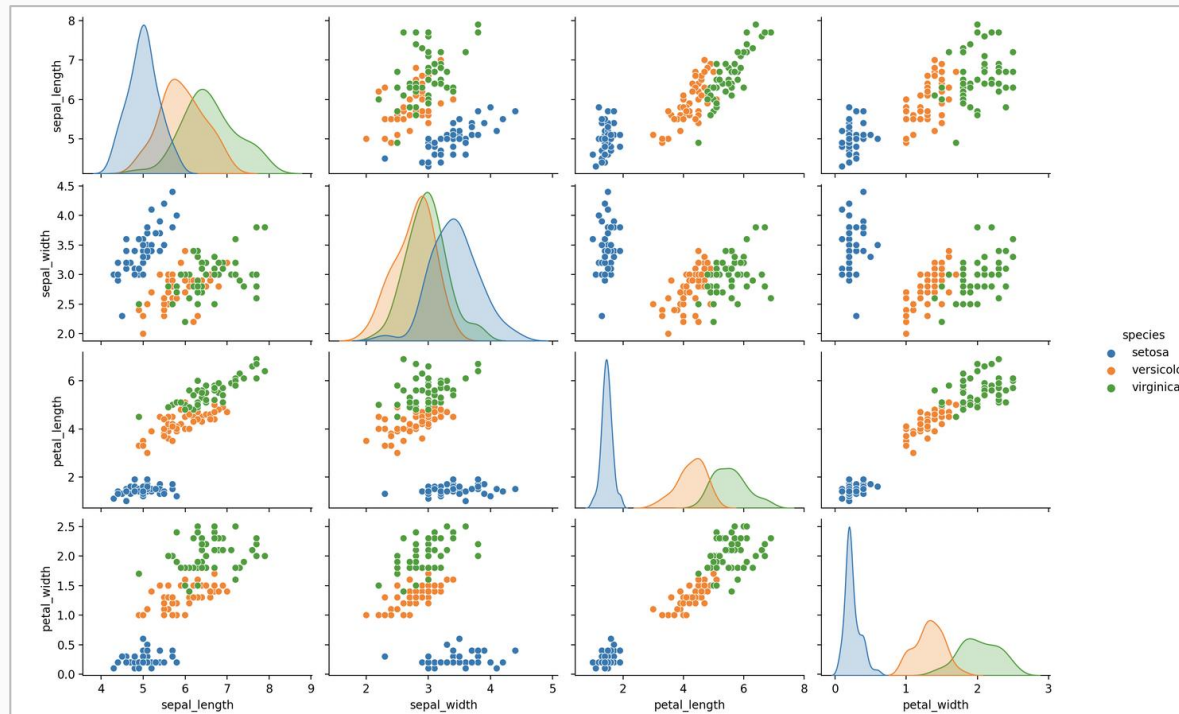


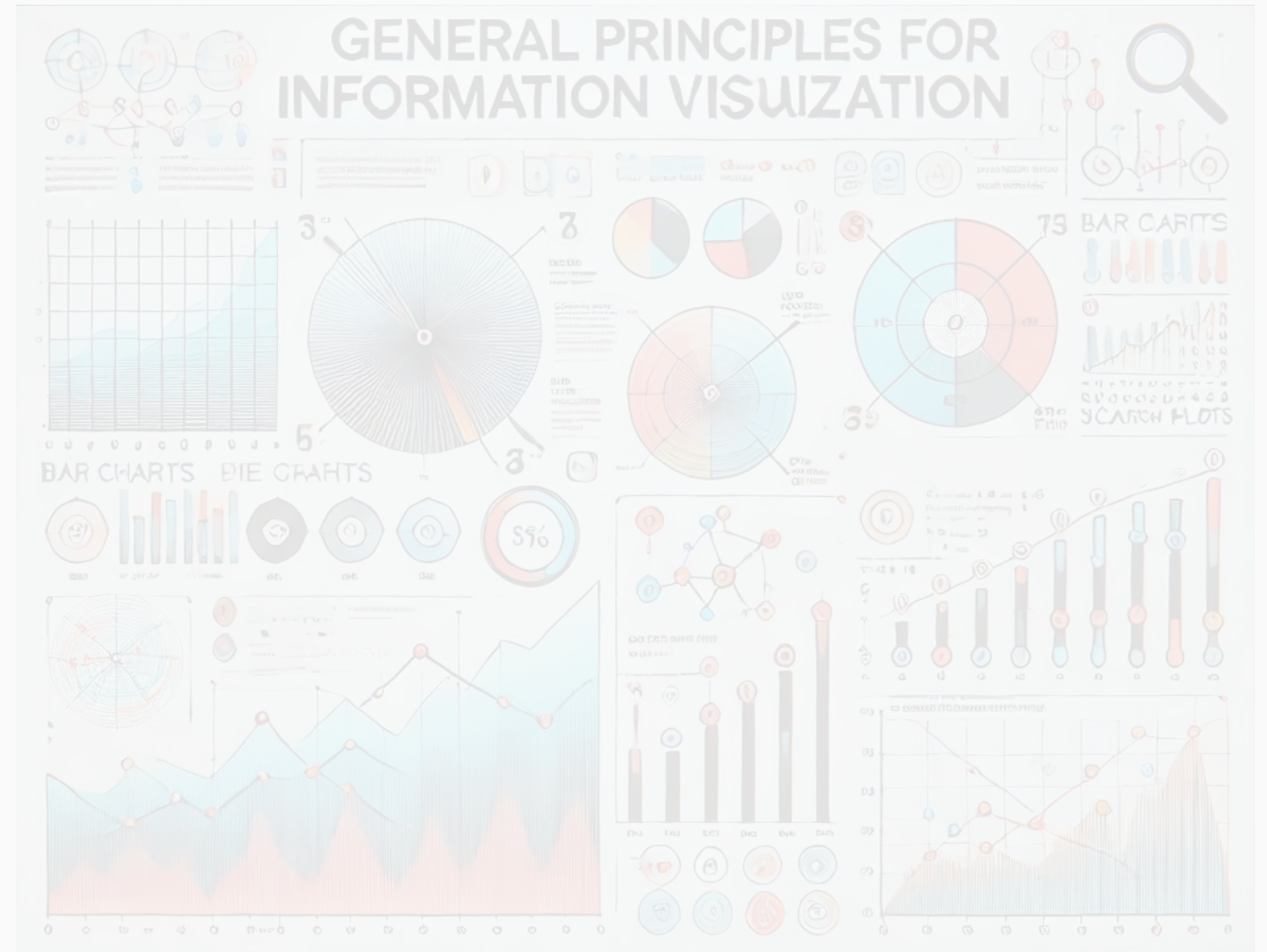
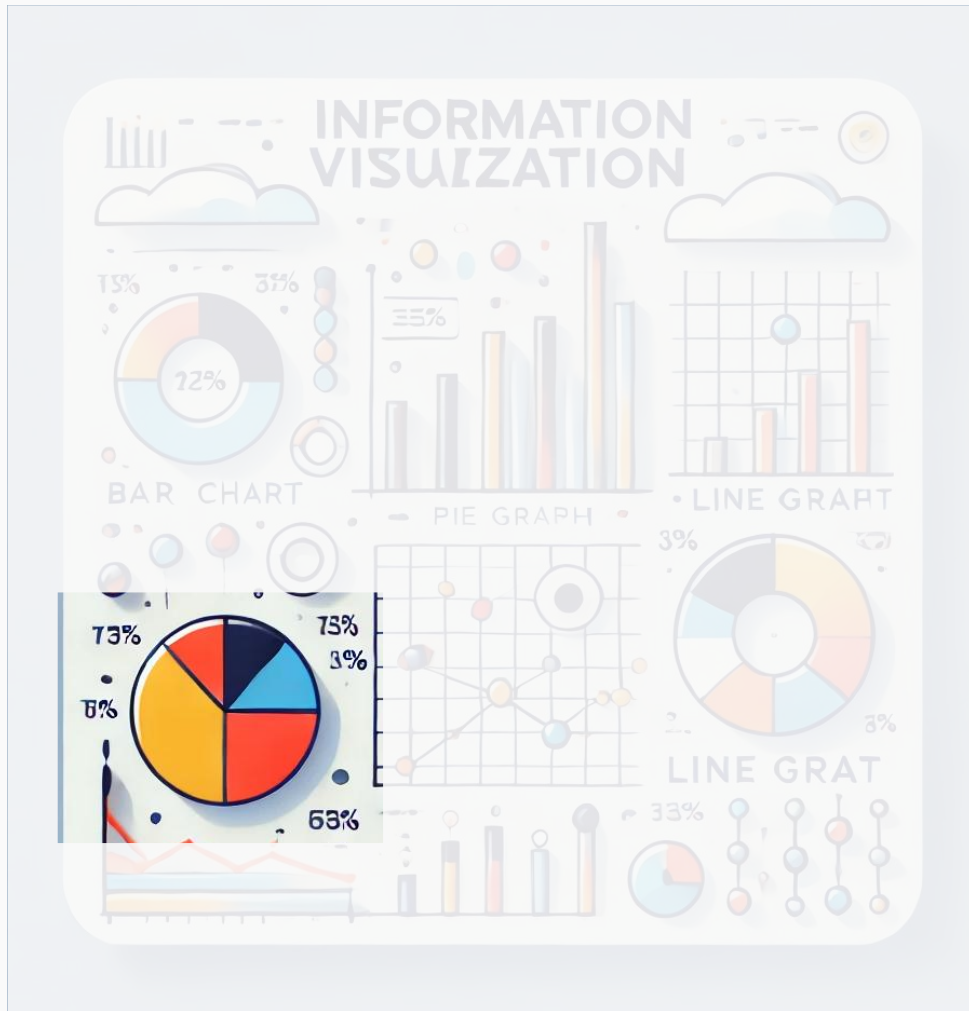
Vermijd 3D 🤮



Perspectief vertekent
lengtes en posities

Oplossingen voor 3 of meer variabelen

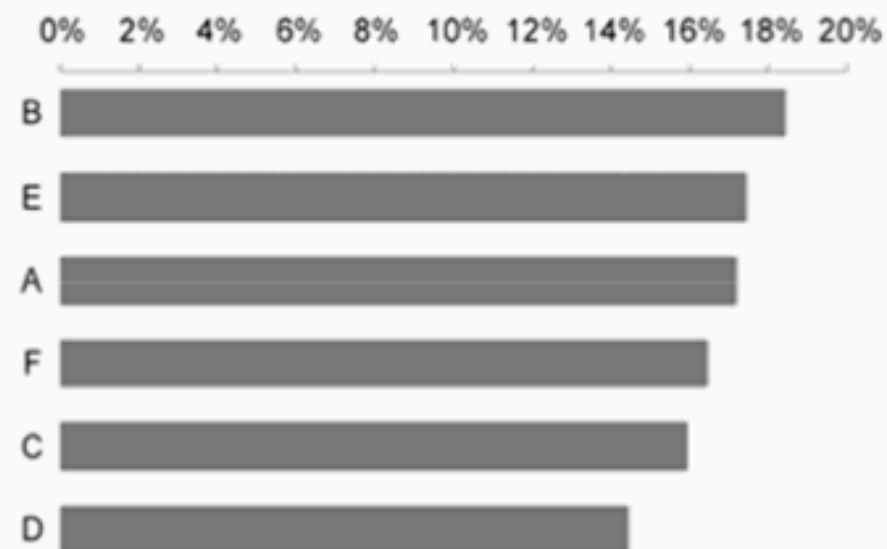


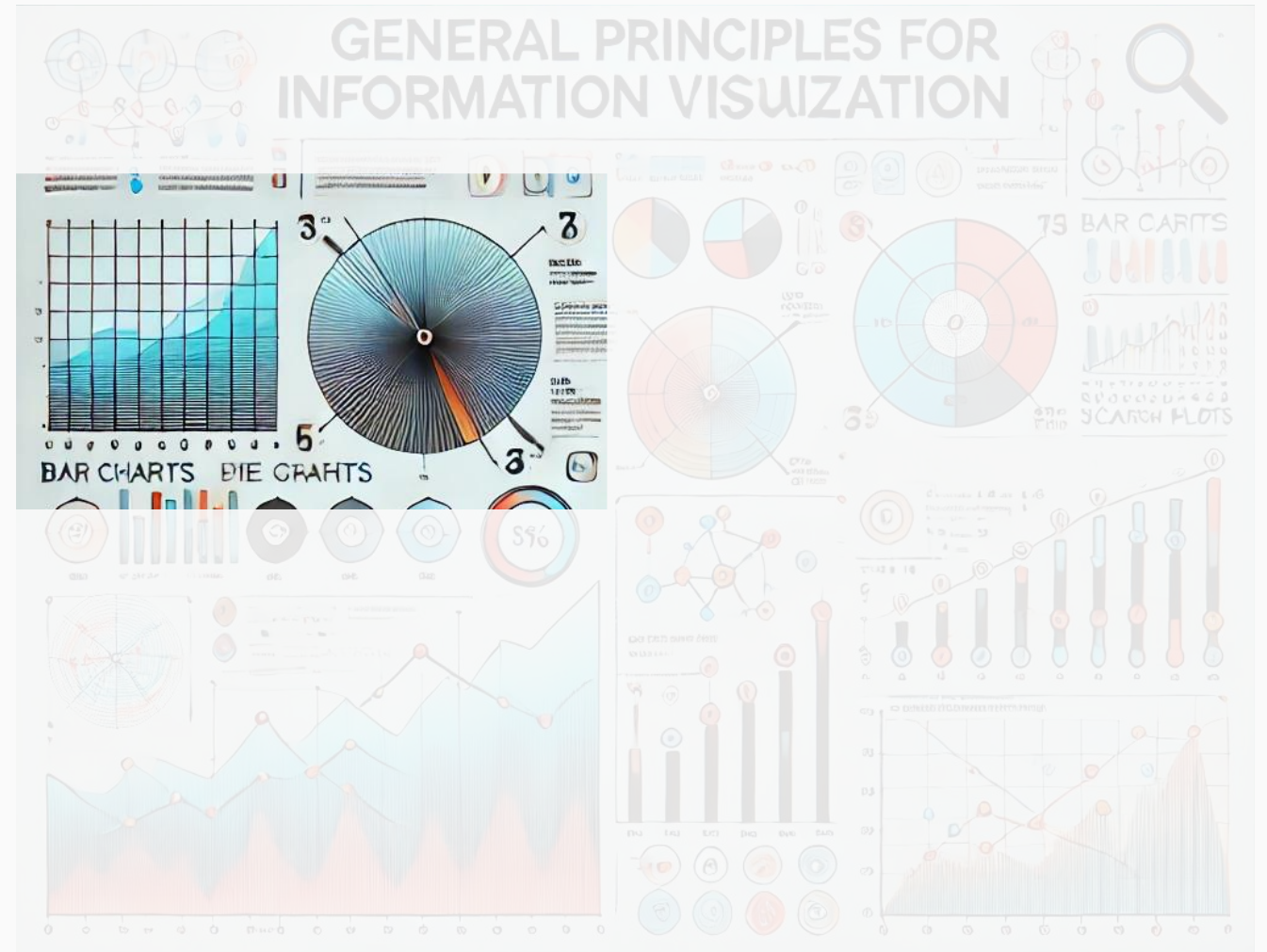
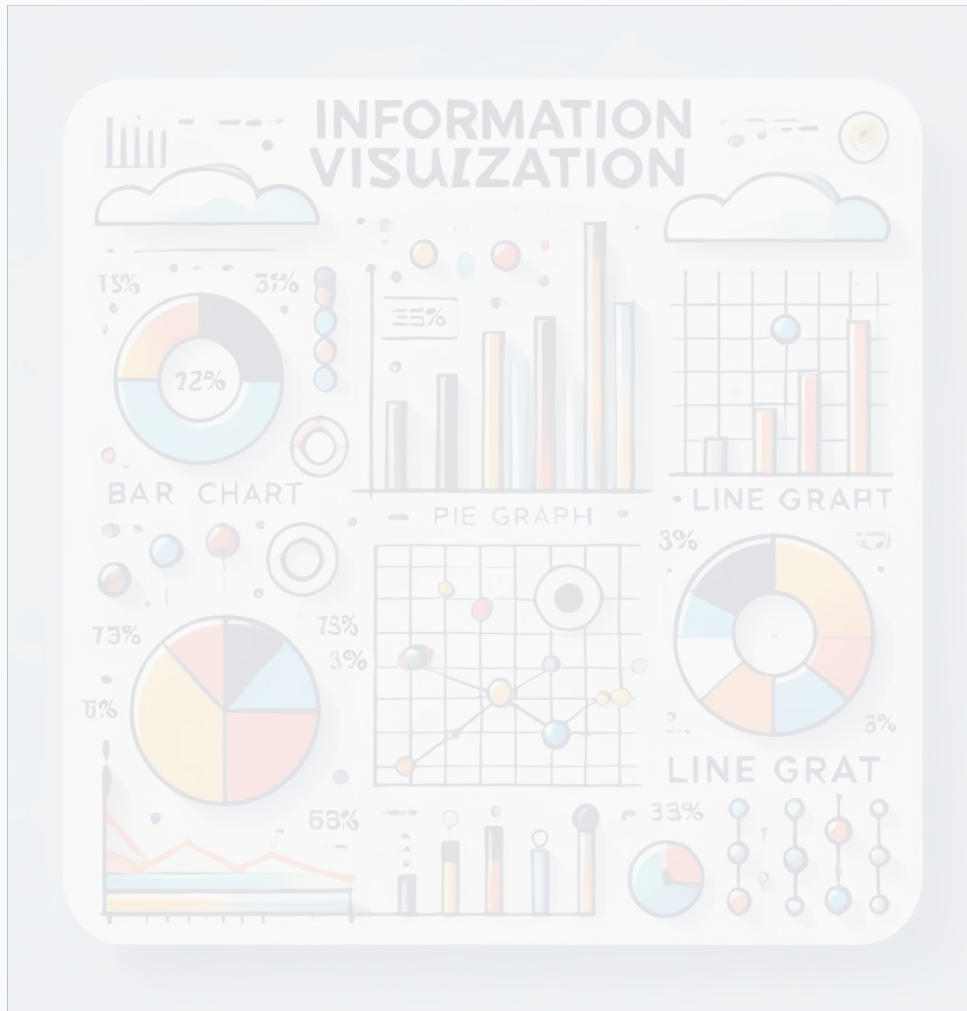


Vermijd (vaak) pie charts

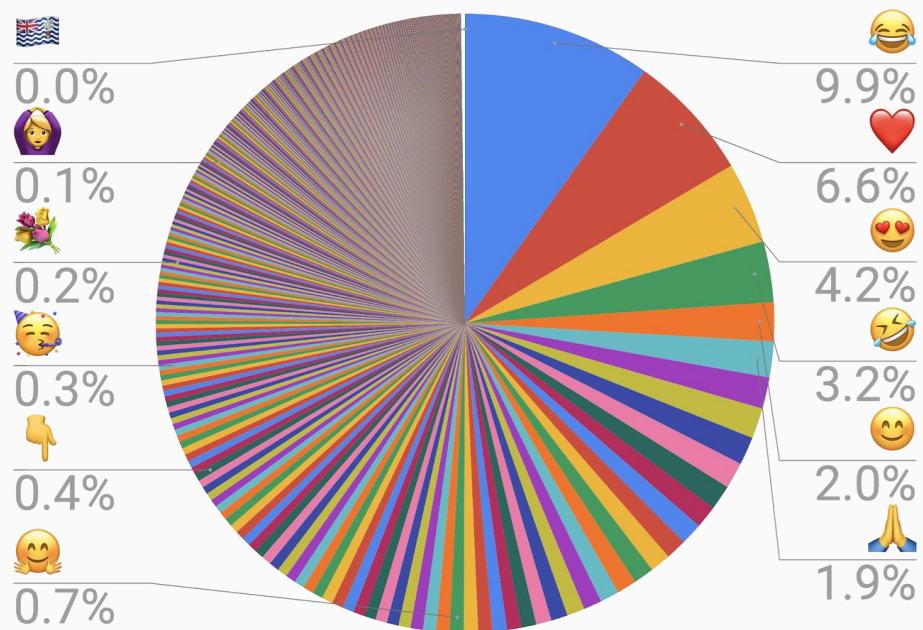


Wat is het
grootste stuk?





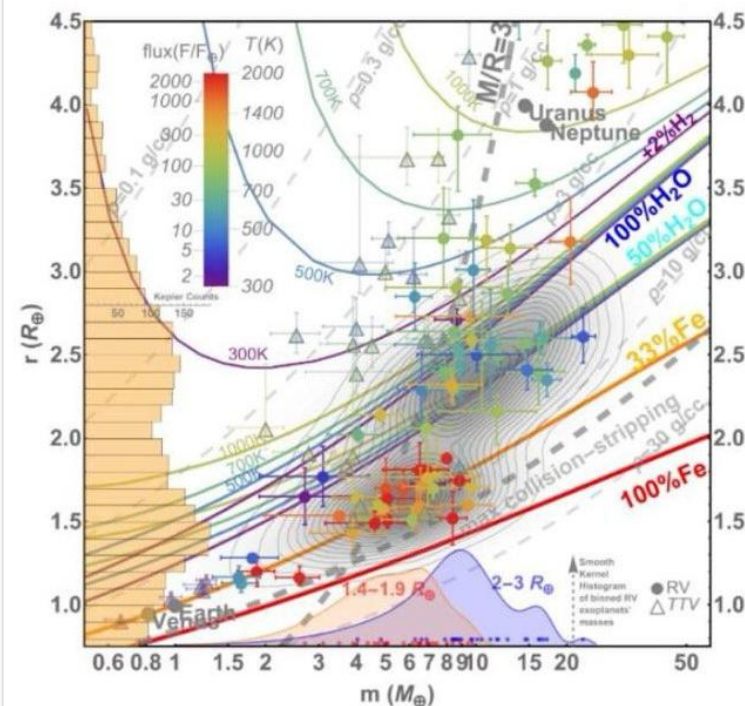
Zorg voor een duidelijke boodschap



Pie charts met te veel categorieën of vis met te veel data zijn niet inzichtelijk

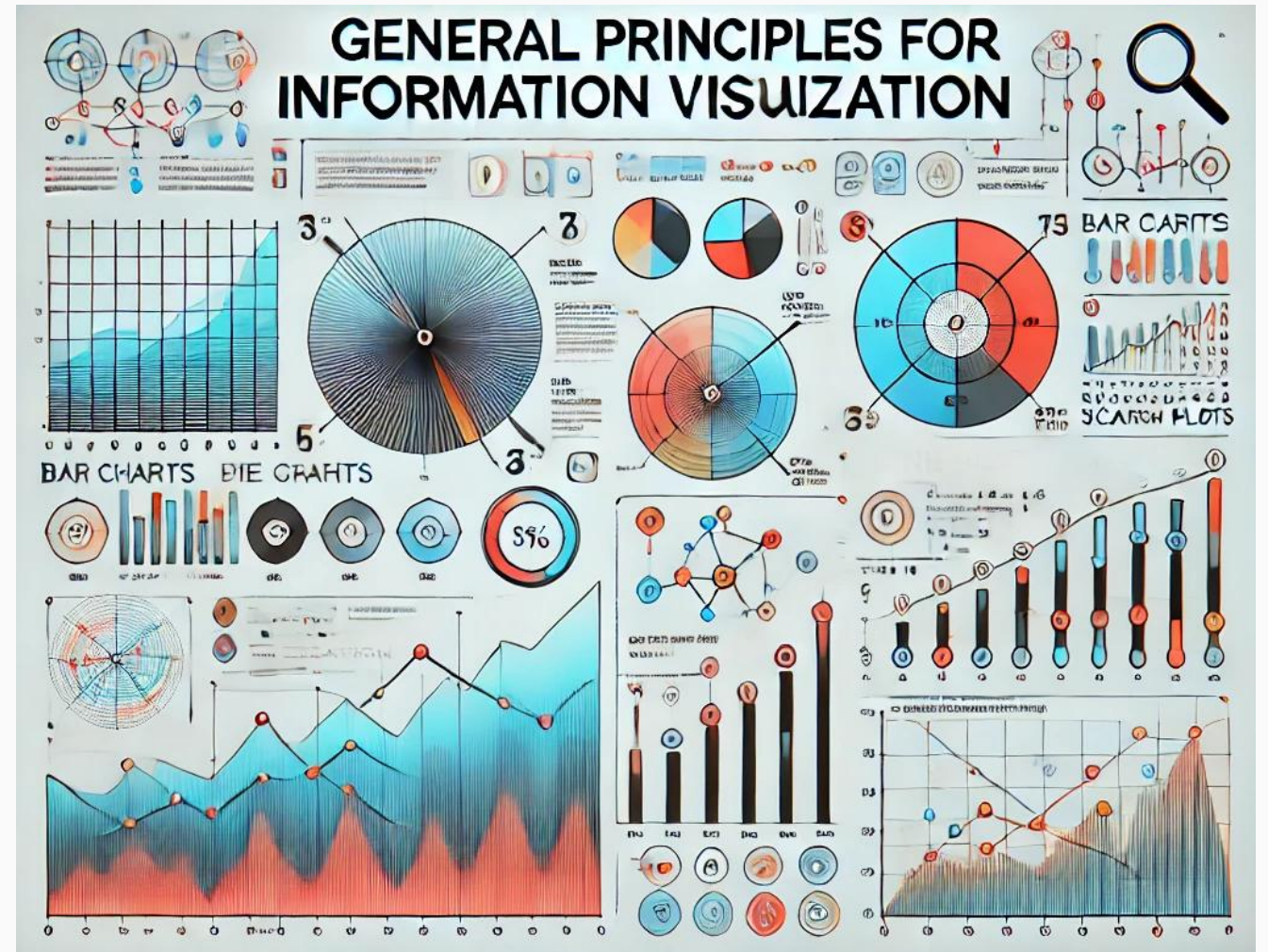
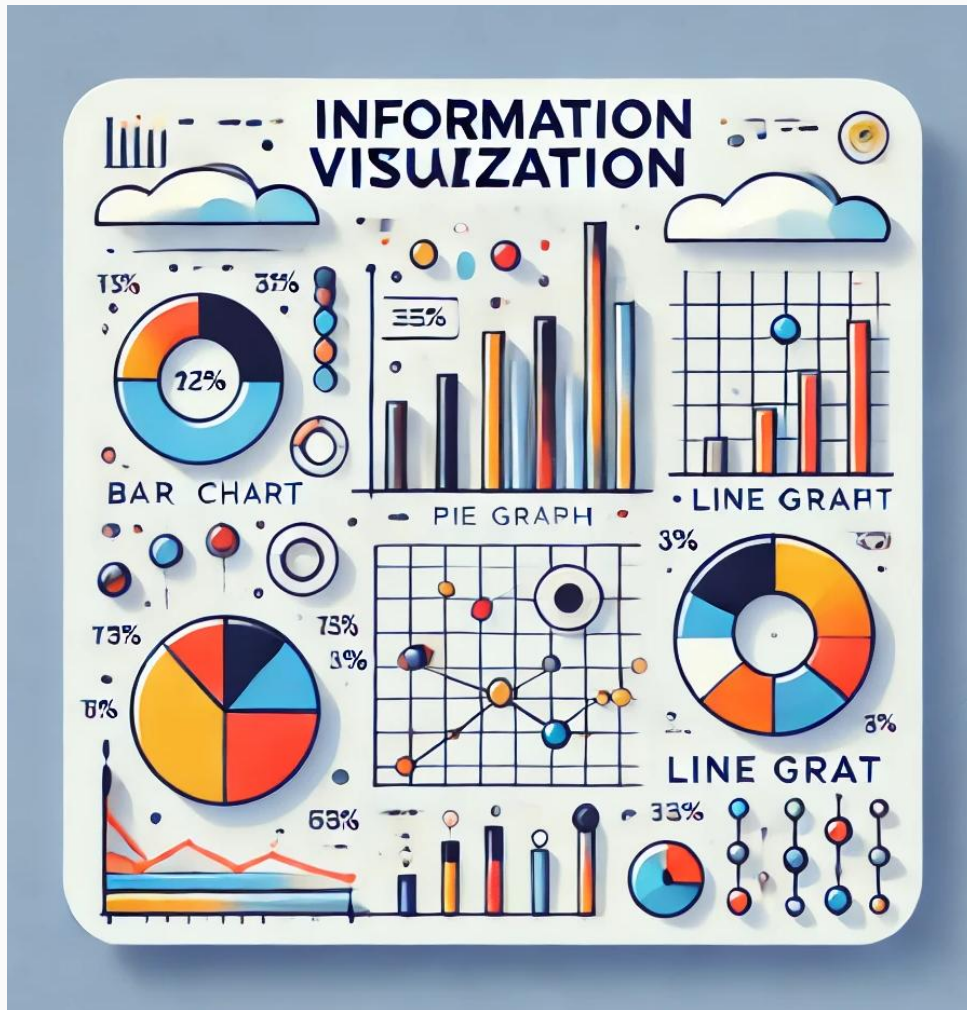
How much information do you want in your graph?

Yes.



288

36 opmerkingen • 19 keer gedeeld



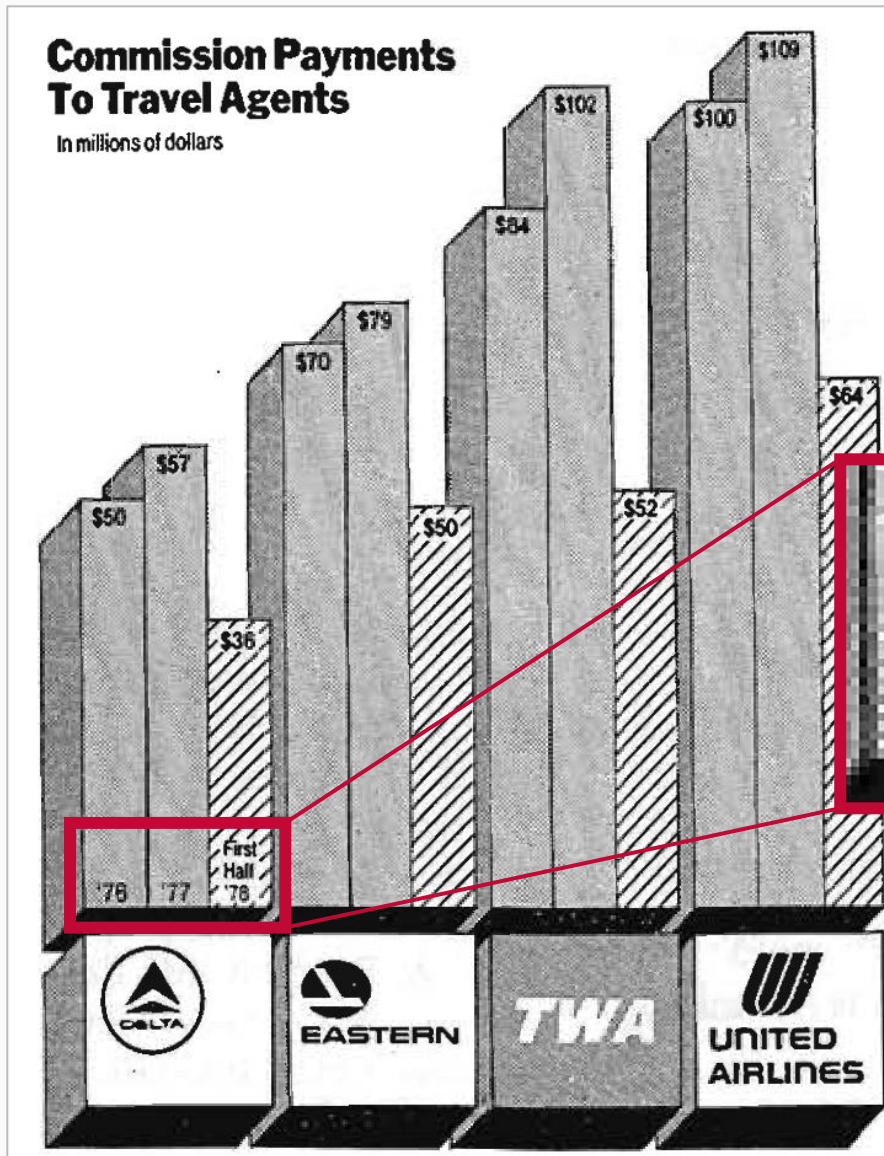
Visualisatieprincipes van Tufte

Grafische integriteit = vertel de waarheid met vis

Designesthetiek = maak vis duidelijk en precies

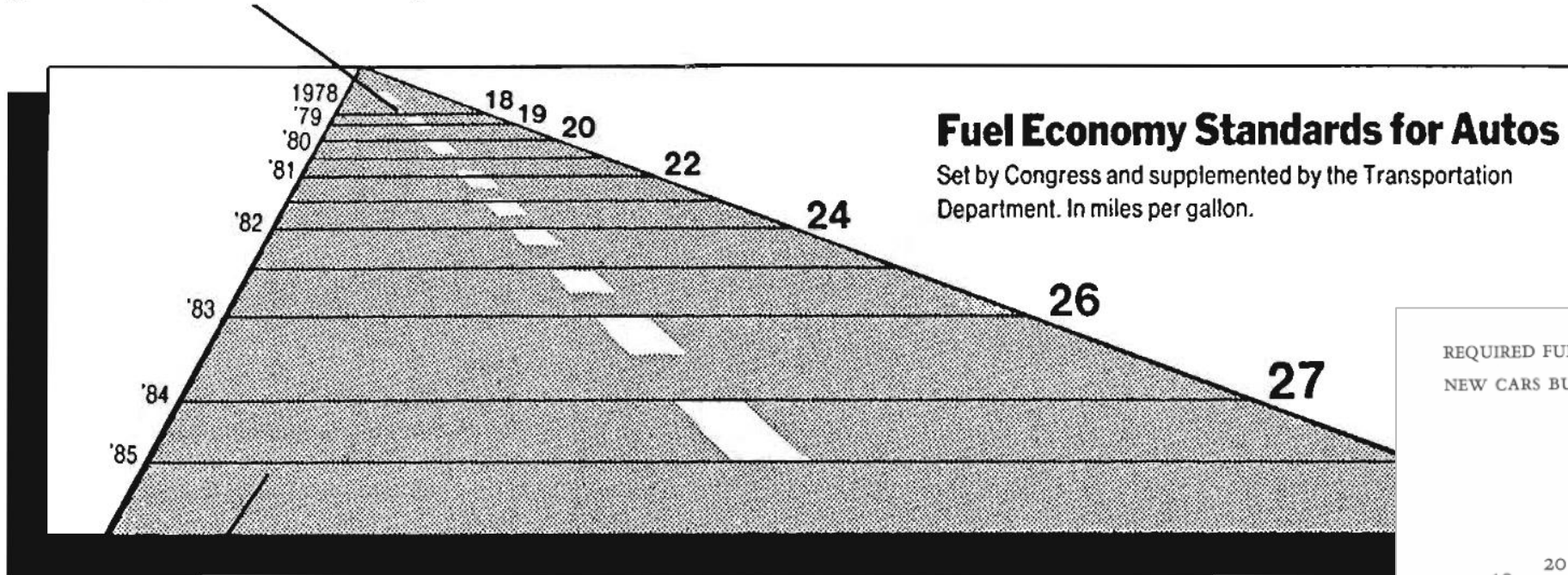
Hoorcollege 3 gaat
uitgebreider in op
grafische integriteit



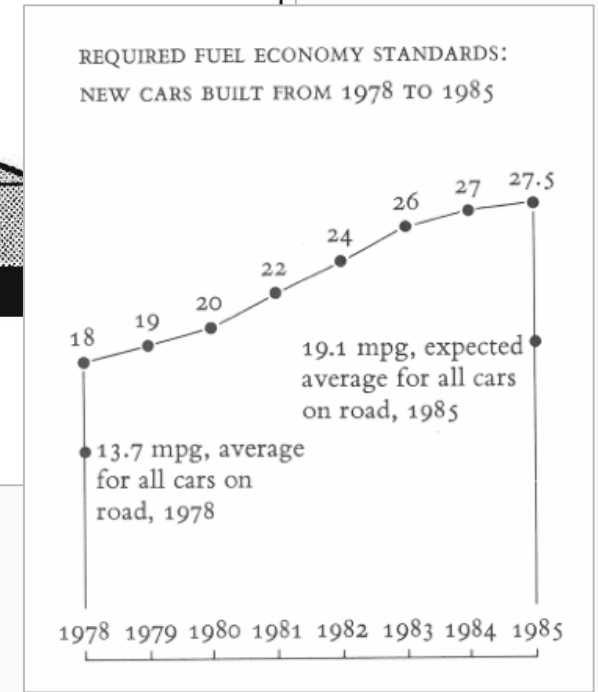


Er wordt een daling gesuggereerd, maar de data is afkomstig van slechts 1/2 jaar

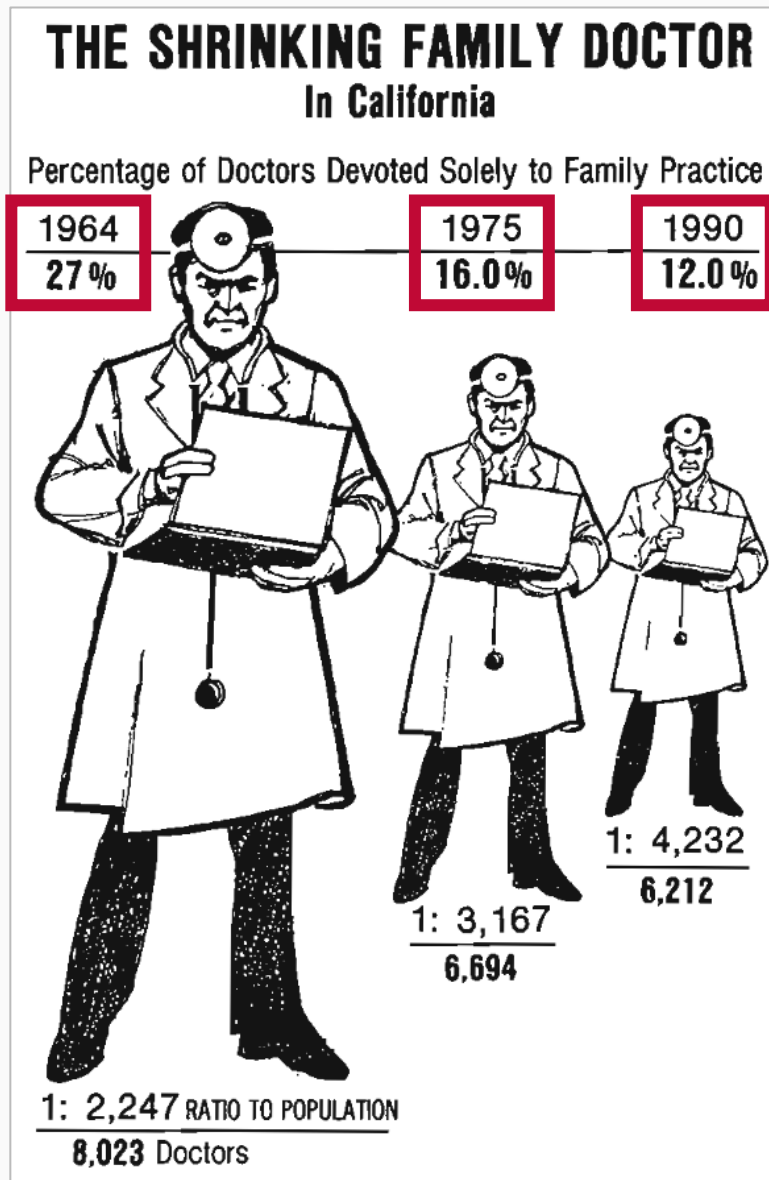
This line, representing 18 miles per gallon in 1978, is 0.6 inches long.



This line, representing 27.5 miles per gallon in 1985, is 5.3 inches long.



Door het perspectief wordt de toename sterk overdreven



Figuren zijn 2D, maar coderen 1D data

Perspectief overdrijft de afname

Foute horizontale spatiëring overdrijft de snelheid van de afname

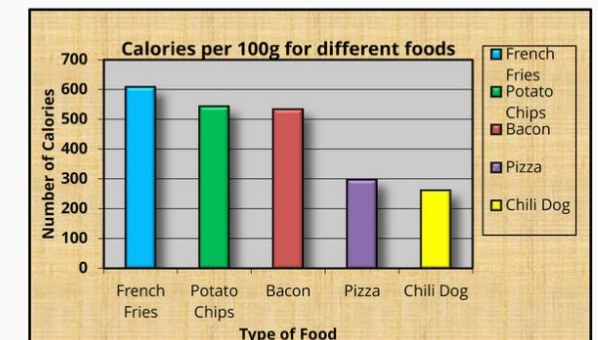
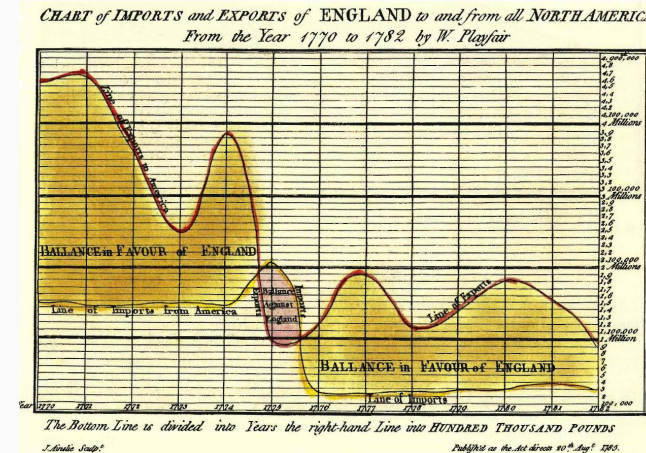
Visualisatieprincipes van Tufte

Grafische integriteit = vertel de waarheid met vis

Designesthetiek = maak vis duidelijk en precies



Waarom zijn deze vis slecht?



Tuftes principes voor designesthetiek

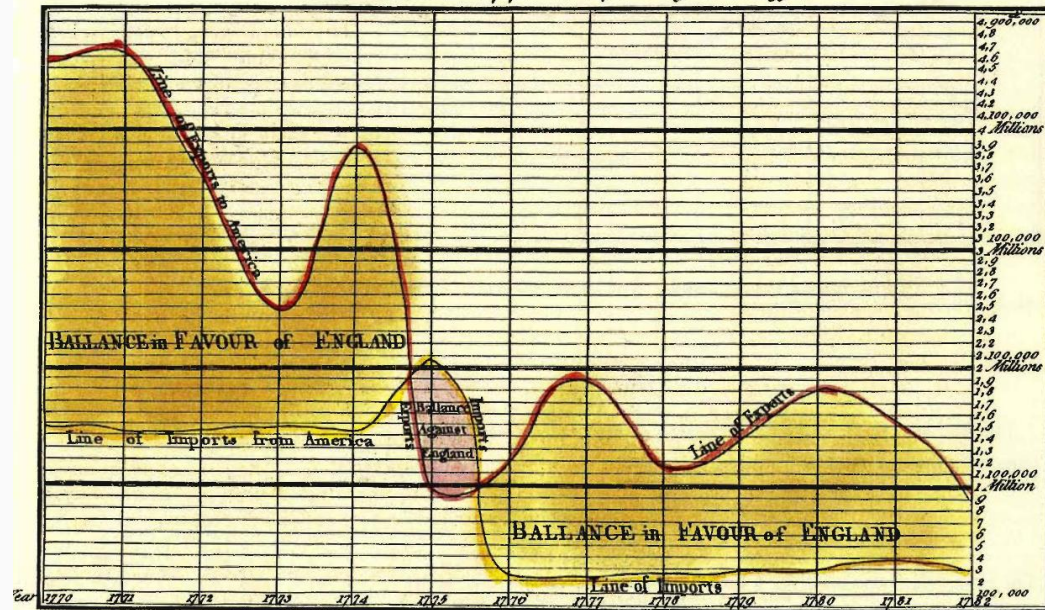
1. Laat vooral de data zien
2. Maximaliseer redelijkerwijs de **data-inkt ratio**
3. Wis redelijkerwijs inkt die geen data codeert
4. Verwijder overbodige data-inkt
5. Herwerk iteratief

“Perfectie is niet bereikt wanneer er niets meer is om toe te voegen, maar wanneer er niets meer is om weg te nemen.”

Antoine de Saint-Exupery (Franse schrijver)

$$\begin{aligned}\text{Data-inkt ratio} &= \frac{\text{data-inkt}}{\text{totale hoeveelheid inkt in de vis}} \\ &= \text{proportie van de inkt in de vis} \\ &\quad \text{gebruikt voor niet-redundante data} \\ &= 1 - \text{proportie van de vis die verwijderd} \\ &\quad \text{kan worden zonder info te verliezen}\end{aligned}$$

CHART of IMPORTS and EXPORTS of ENGLAND to and from all NORTH AMERICA
From the Year 1770 to 1782 by W. Playfair

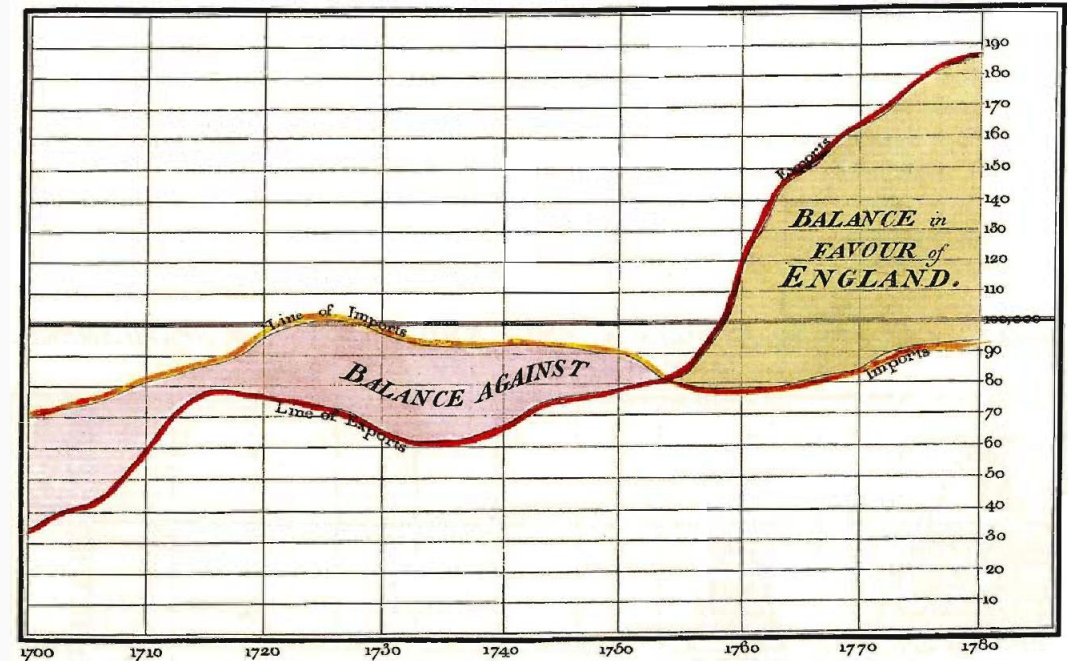


The Bottom Line is divided into Years the right-hand Line into HUNDRED THOUSAND POUNDS

J. Arnot Sculp.

Published as the Act directs 20th Aug^o 1783.

Exports and Imports to and from DENMARK & NORWAY from 1700 to 1780.

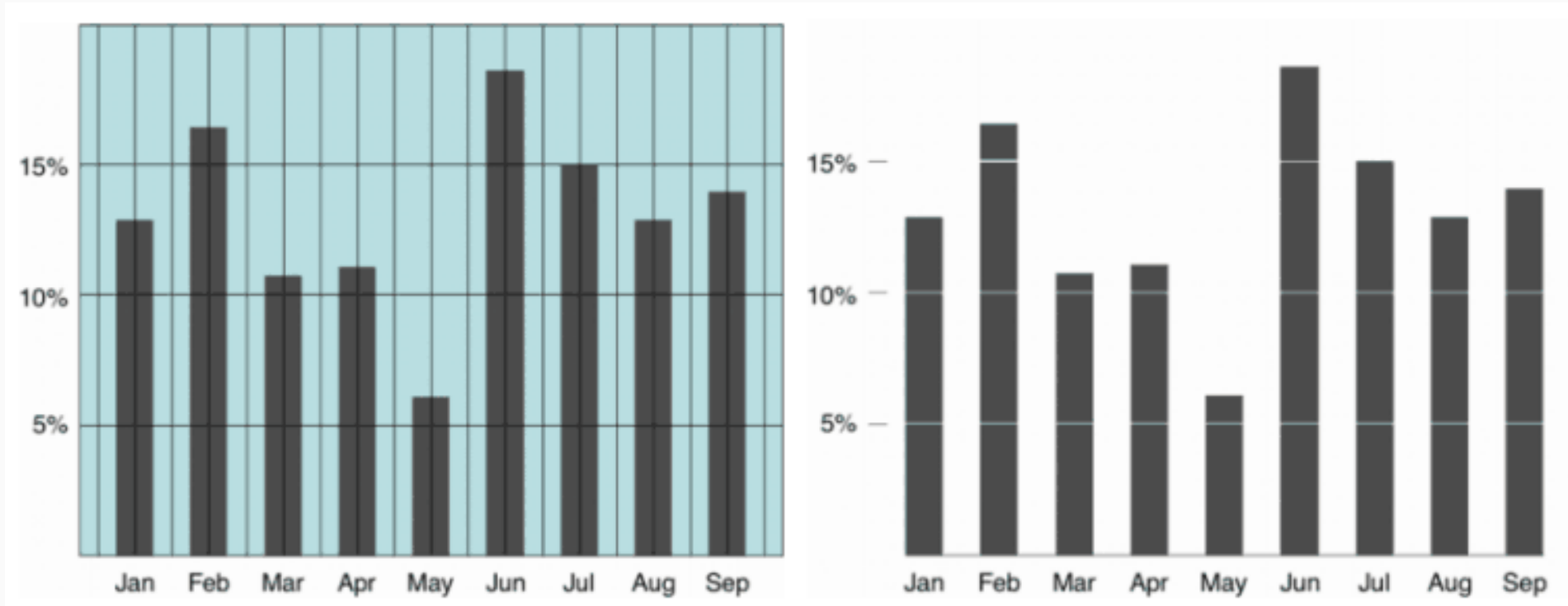


The Bottom line is divided into Years, the Right hand line into £10,000 each.

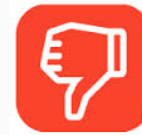
Published as the Act directs 1st May 1786. by W^m Playfair

Needle script 332 Strand, London.

Minder nadruk op roosterlijnen en
minder gedetailleerde labels



Betere data-inkt ratio



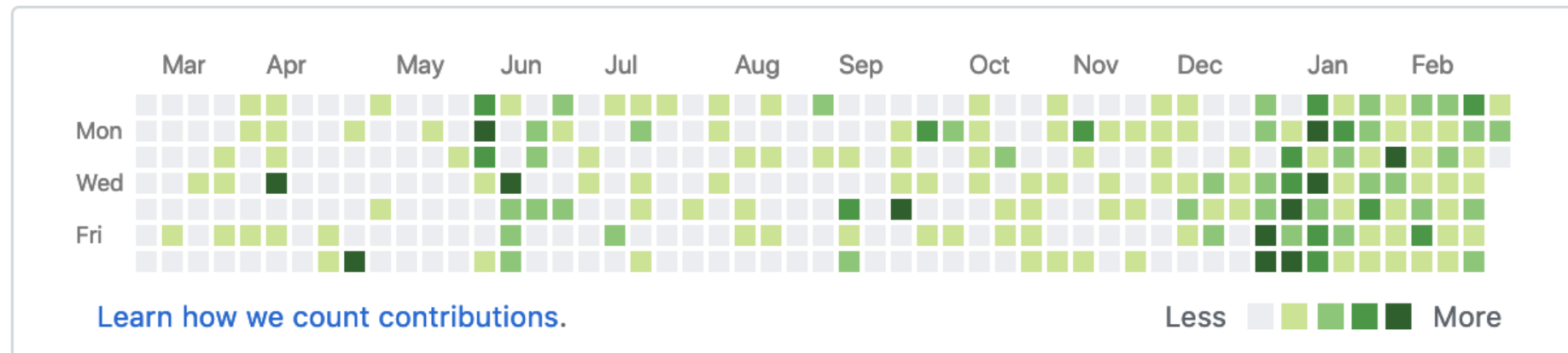
Lage data-inkt ratio: de enige relevante data zijn de percentages



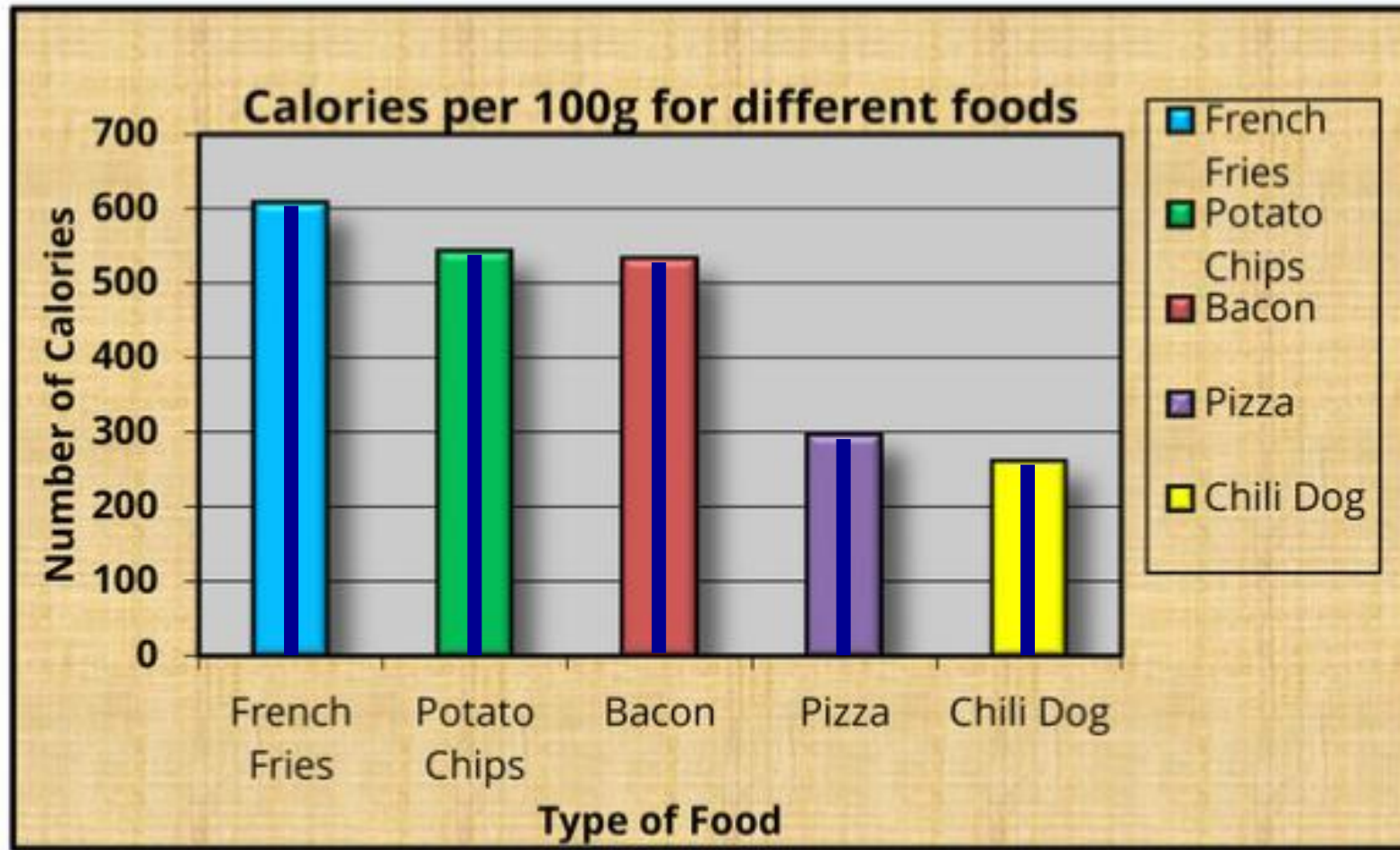
Hoge data-inkt ratio: elke pixel is een datapunt

1,250 contributions in the last year

Contribution settings ▾

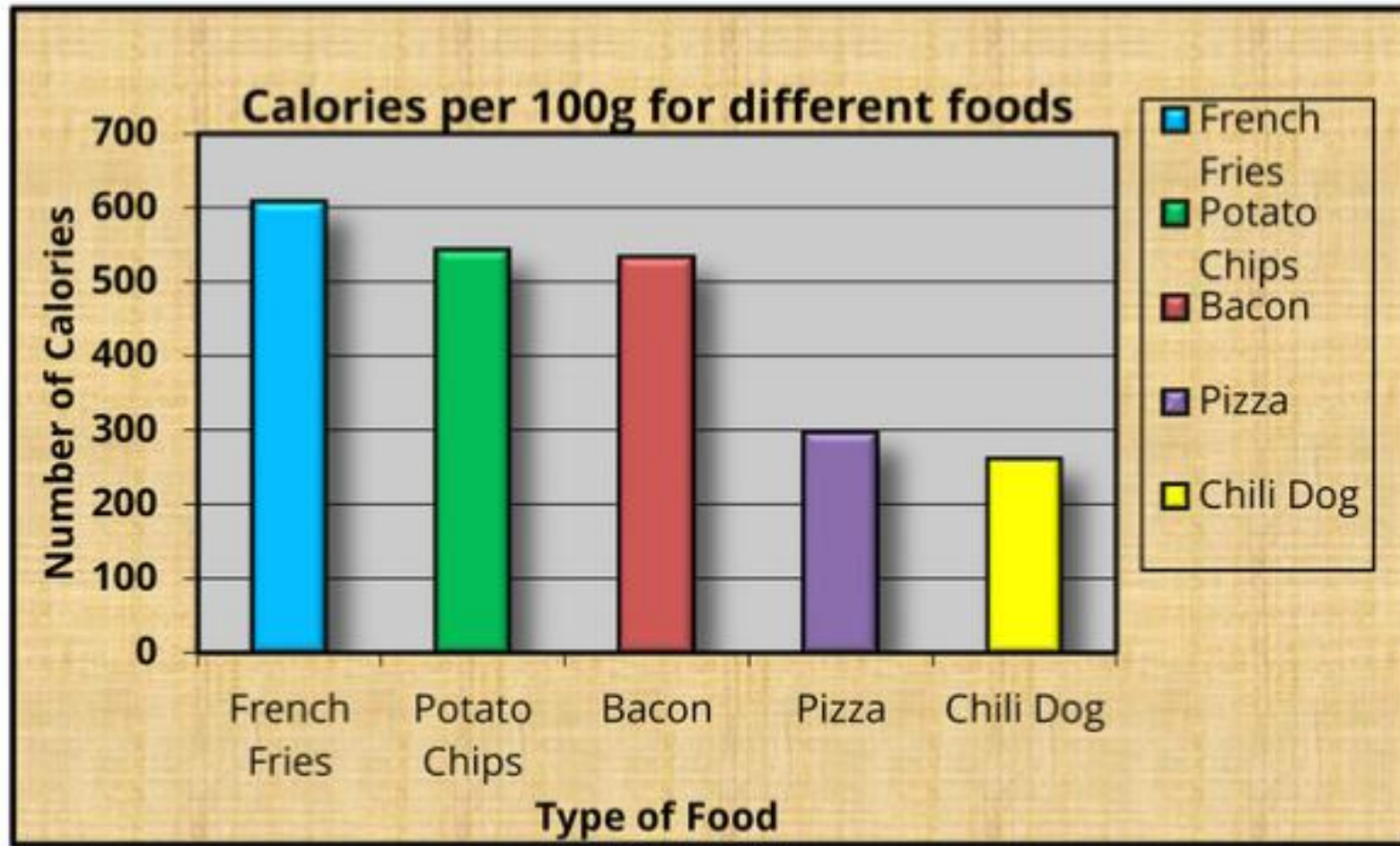


Wat is de data-inkt ratio?



< 0.05

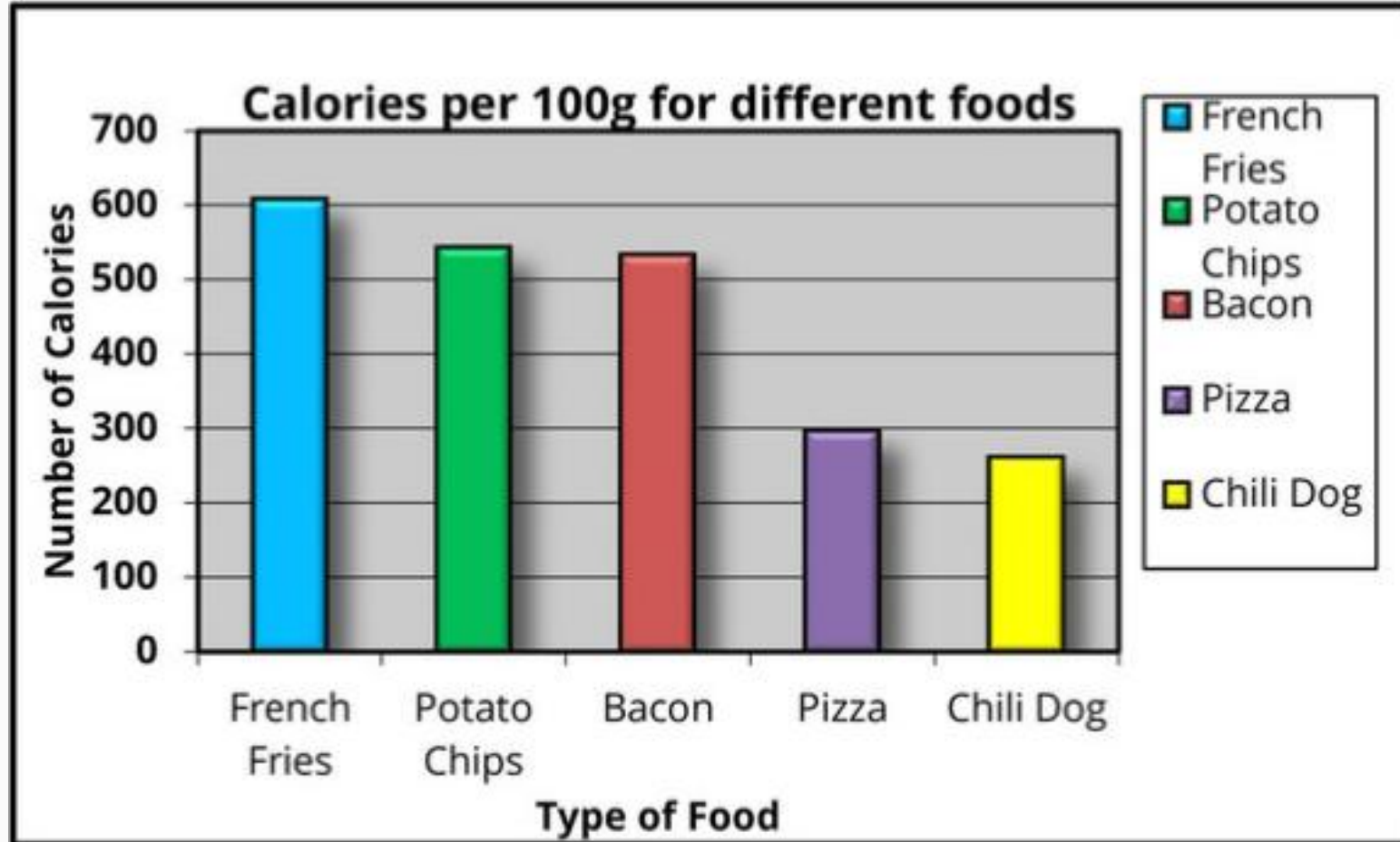
Oefening: verbeter de data-inkt ratio



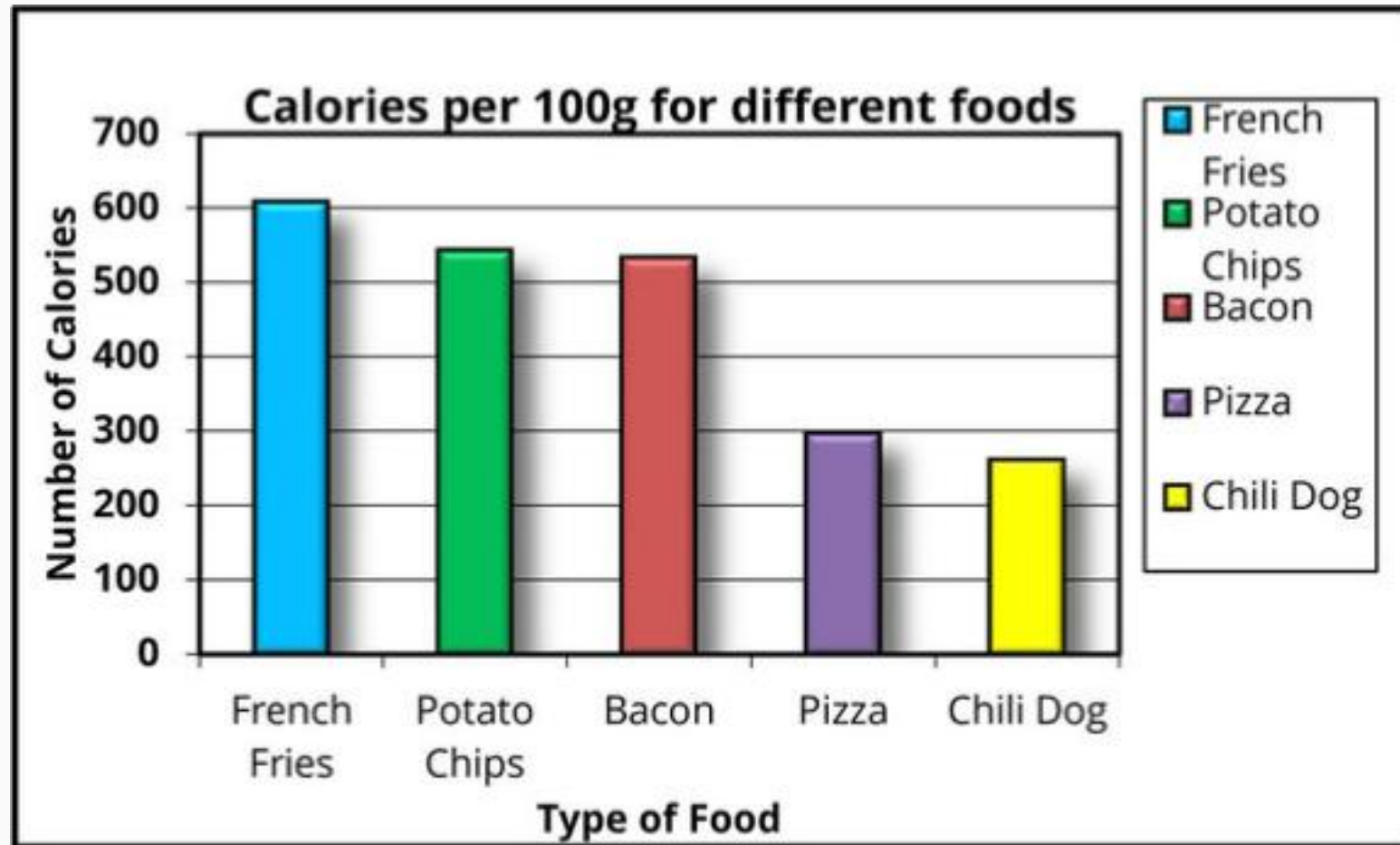
Er zijn een 10-tal verbeterpunten



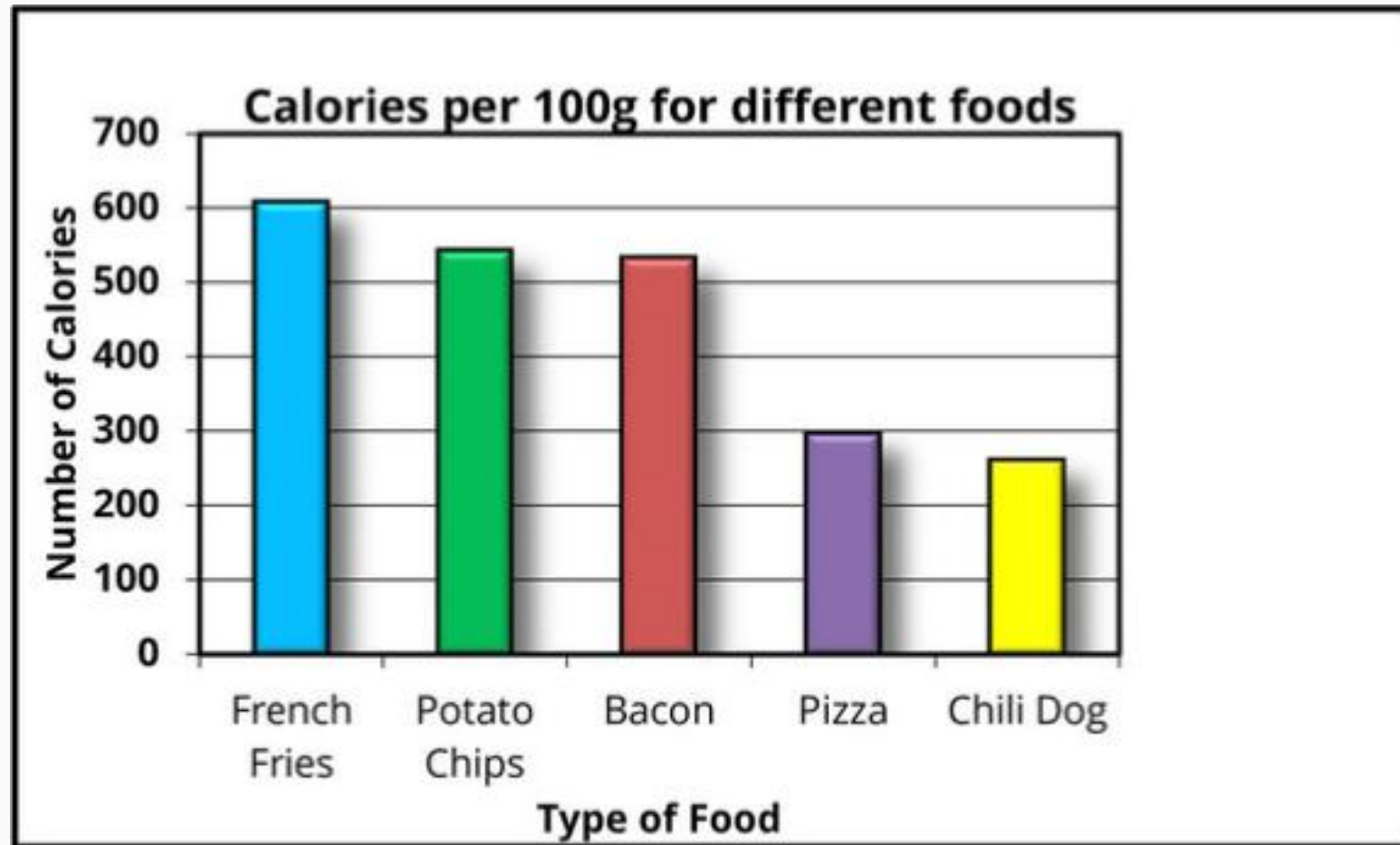
Verwijder achtergrond



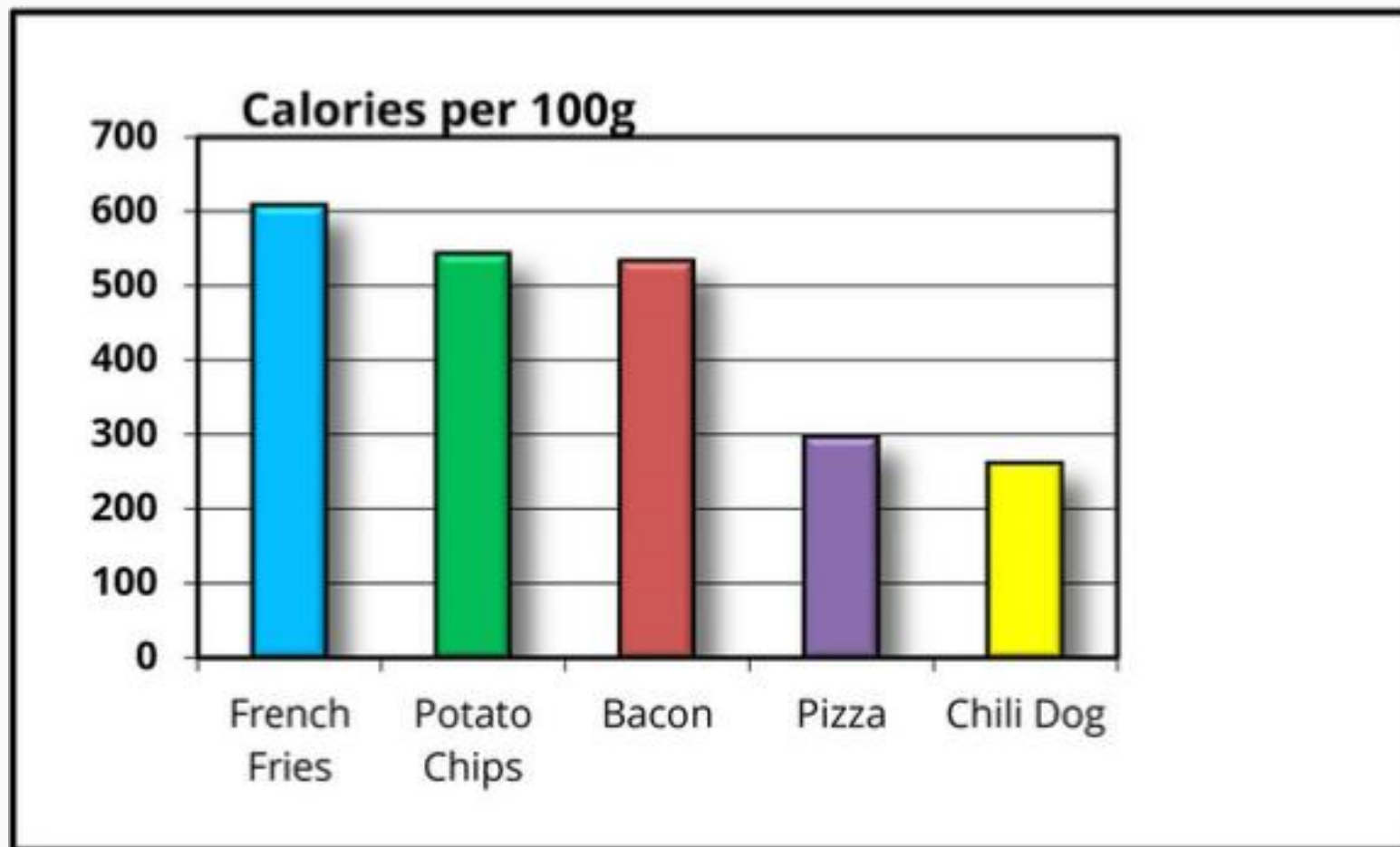
Verwijder achtergrondkleur



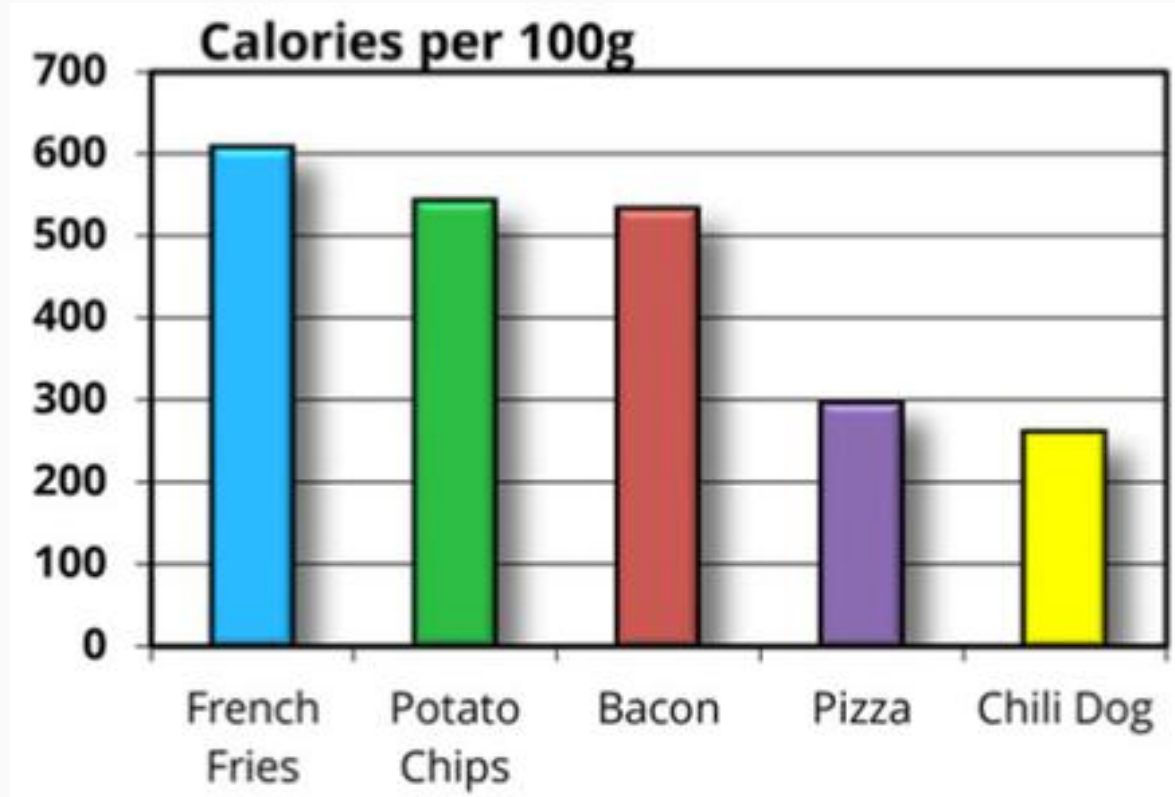
Verwijder de overbodige legende



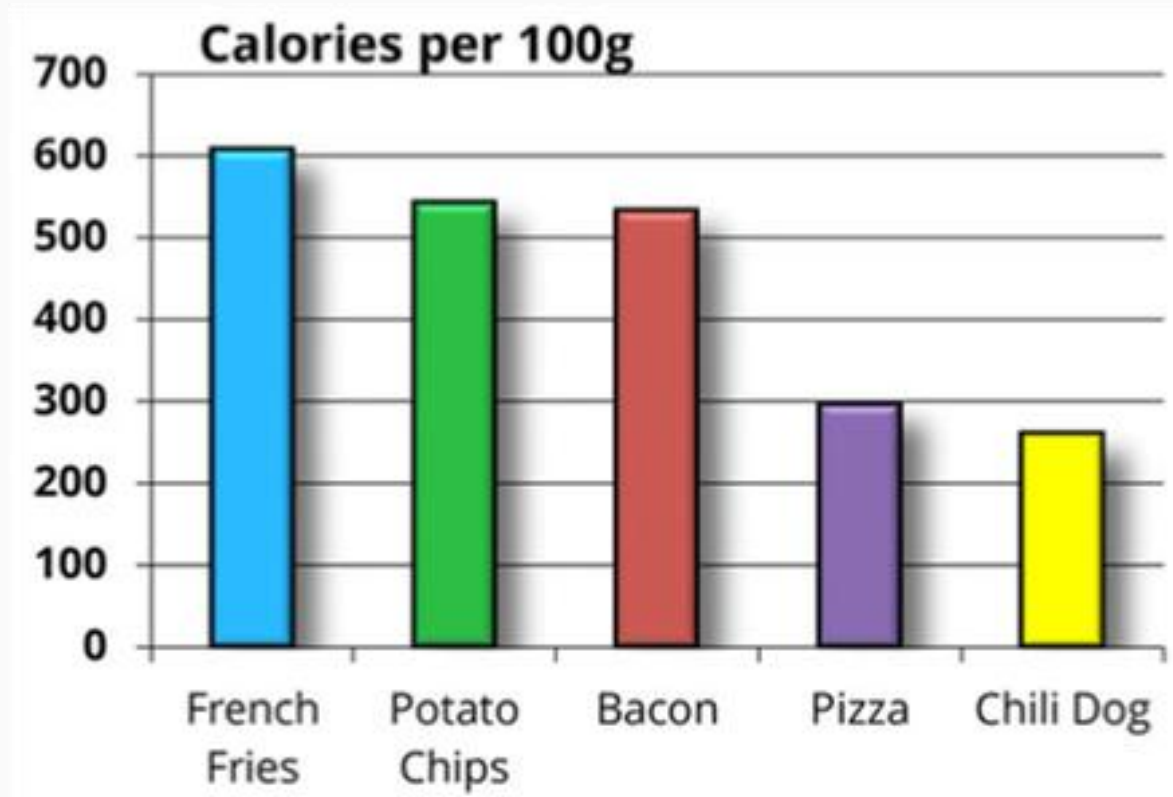
Verwijder overbodige labels



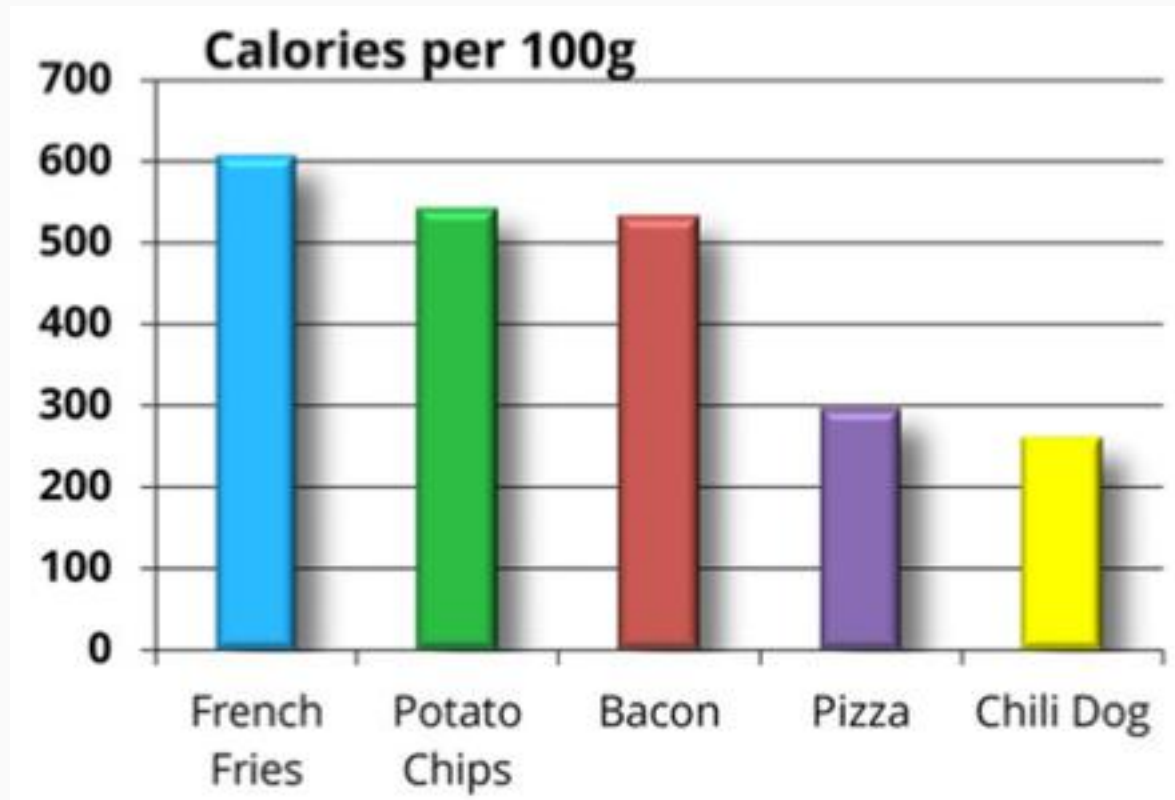
Verwijder de rand van de vis



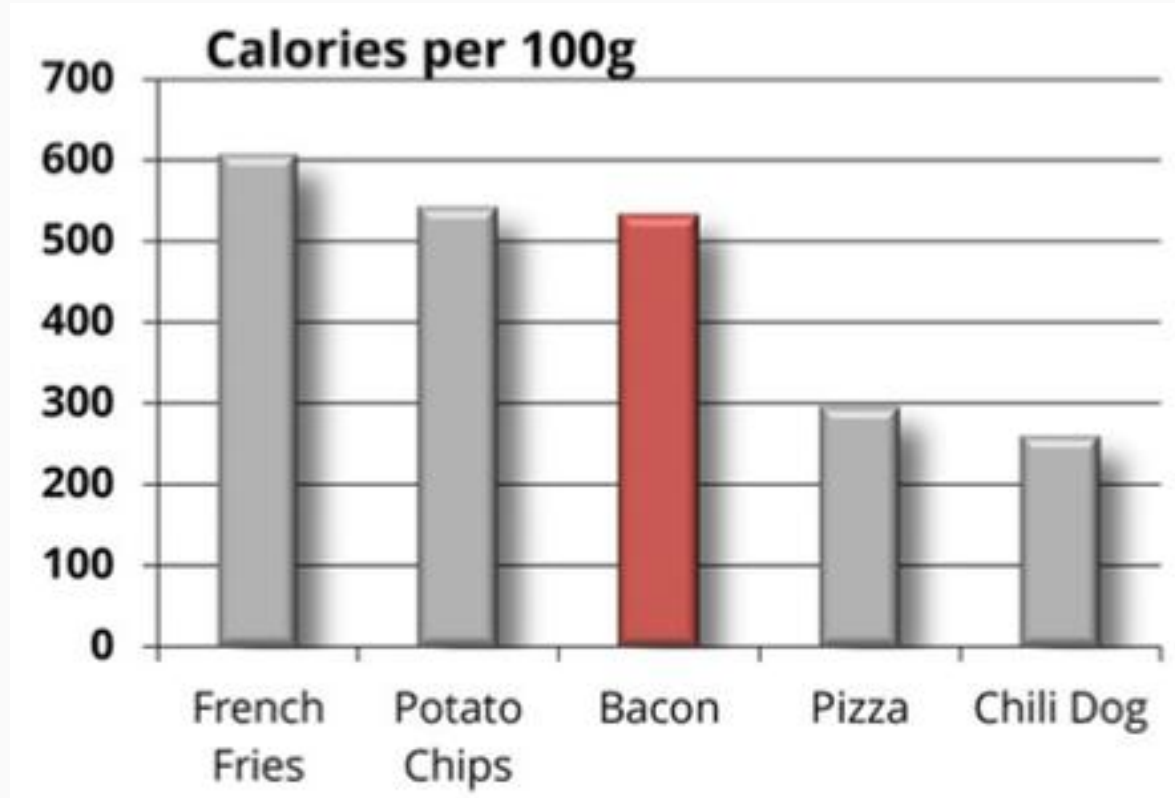
Verwijder de rand van het assenstelsel



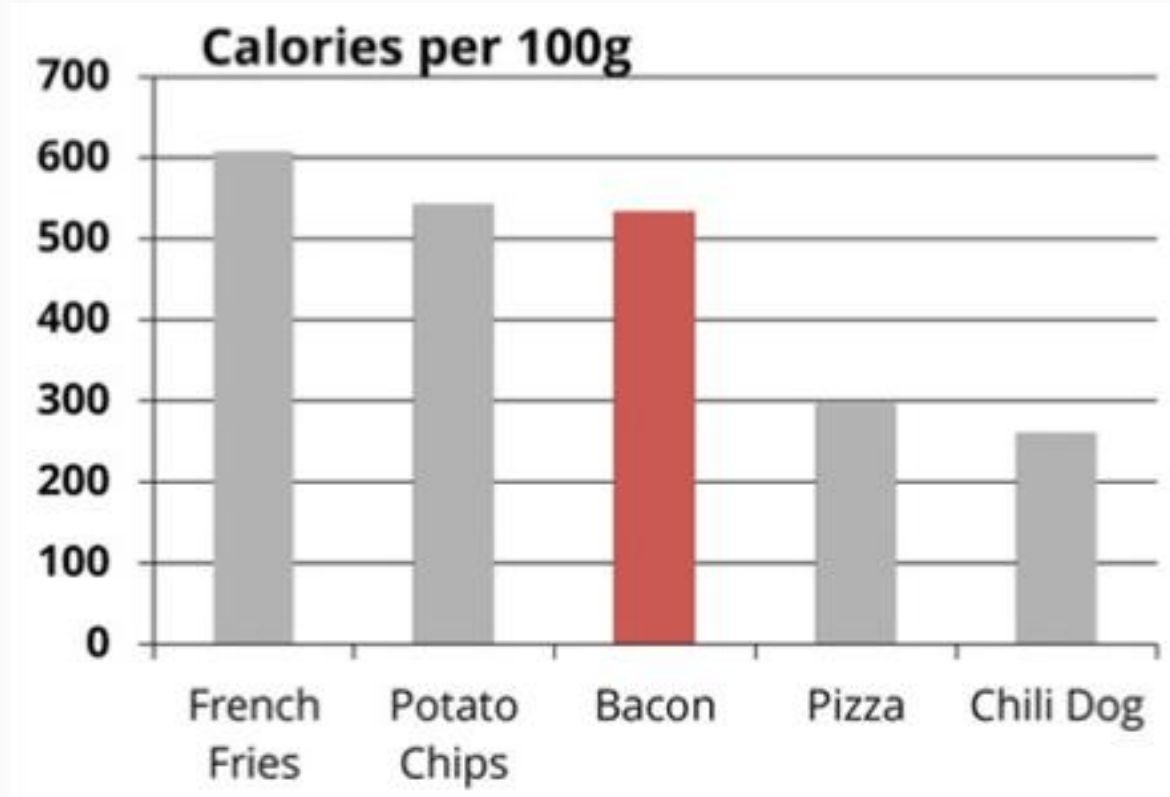
Verwijder randen van de bars



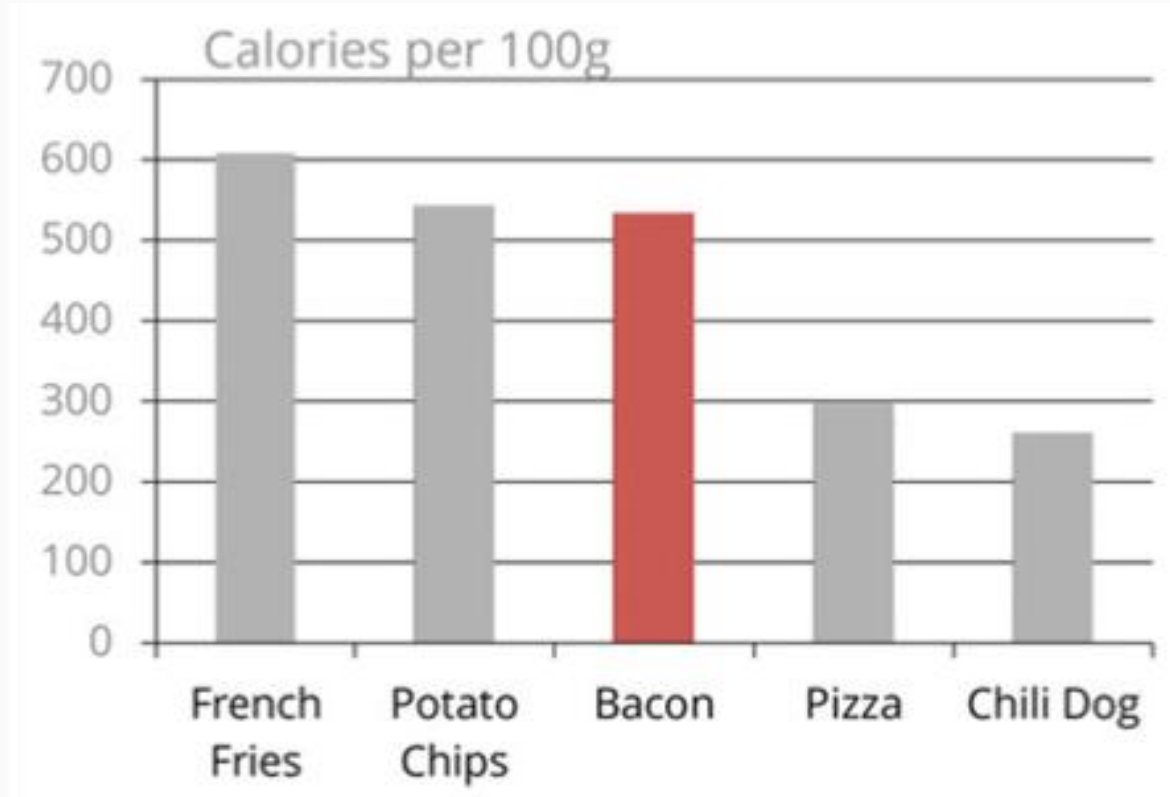
Reduceer betekenisloze kleuren



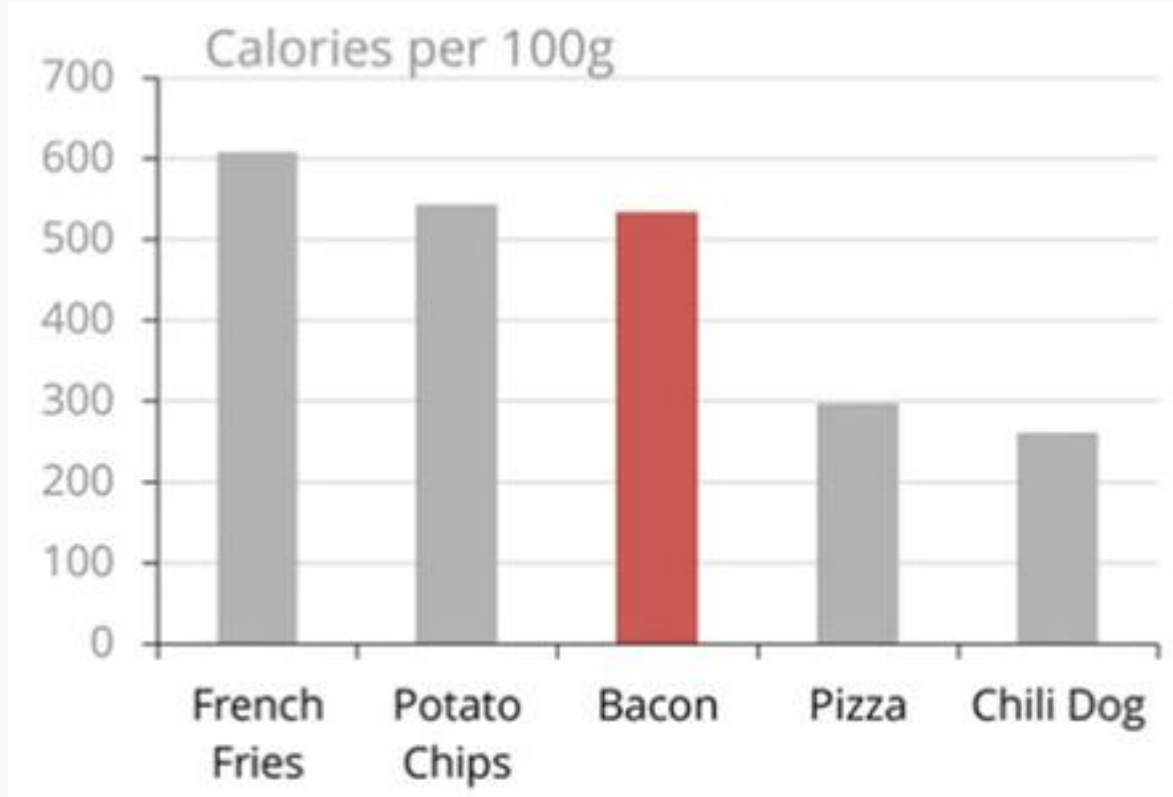
Verwijder schaduwen en highlights van bars



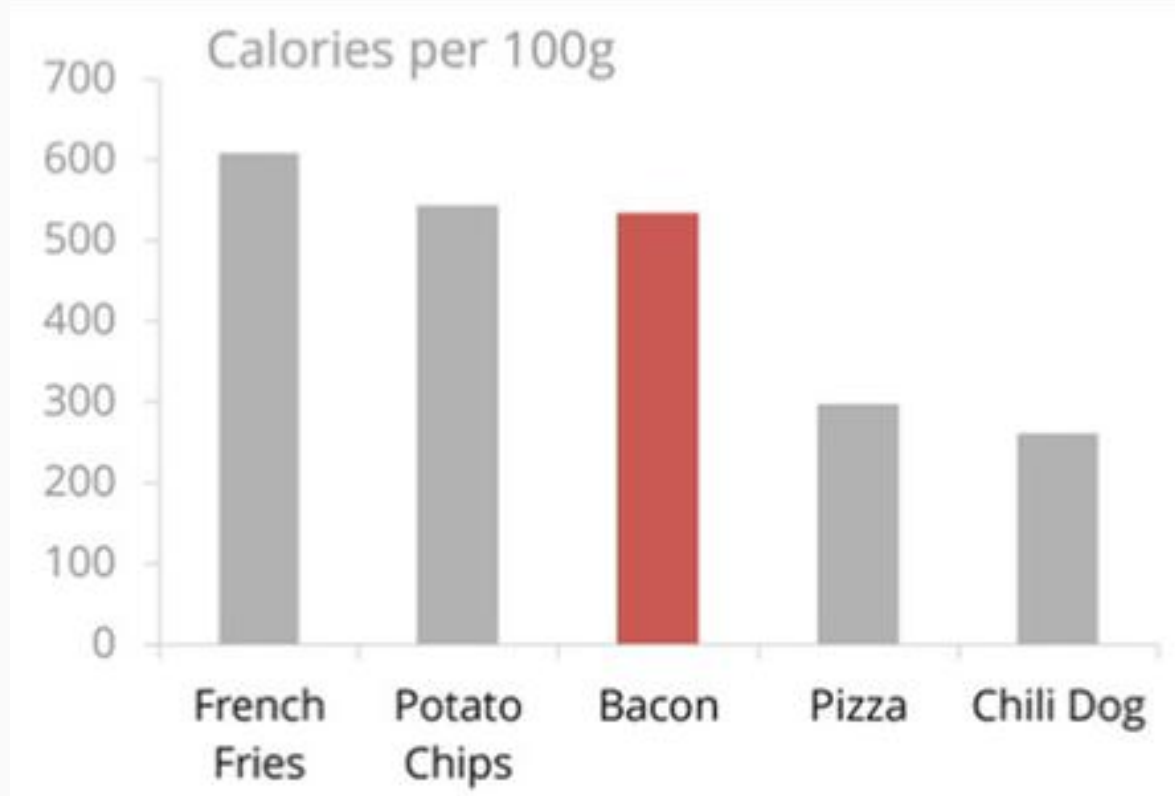
Maak details minder prominent



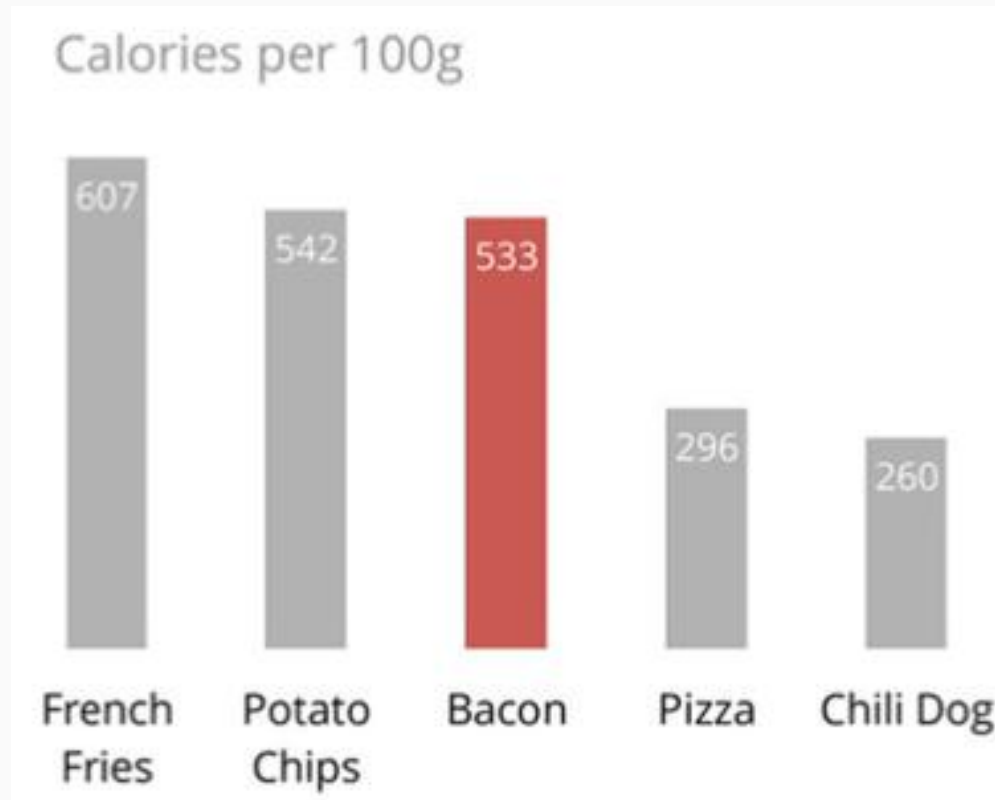
Maak rasterlijnen minder prominent



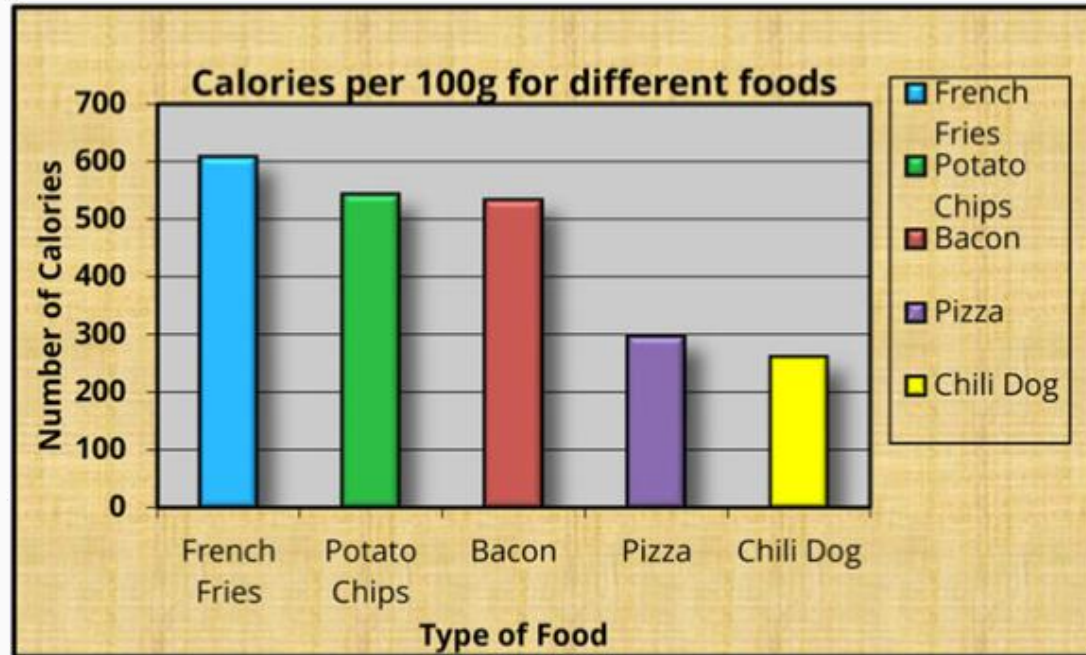
Beter: verwijder rasterlijnen



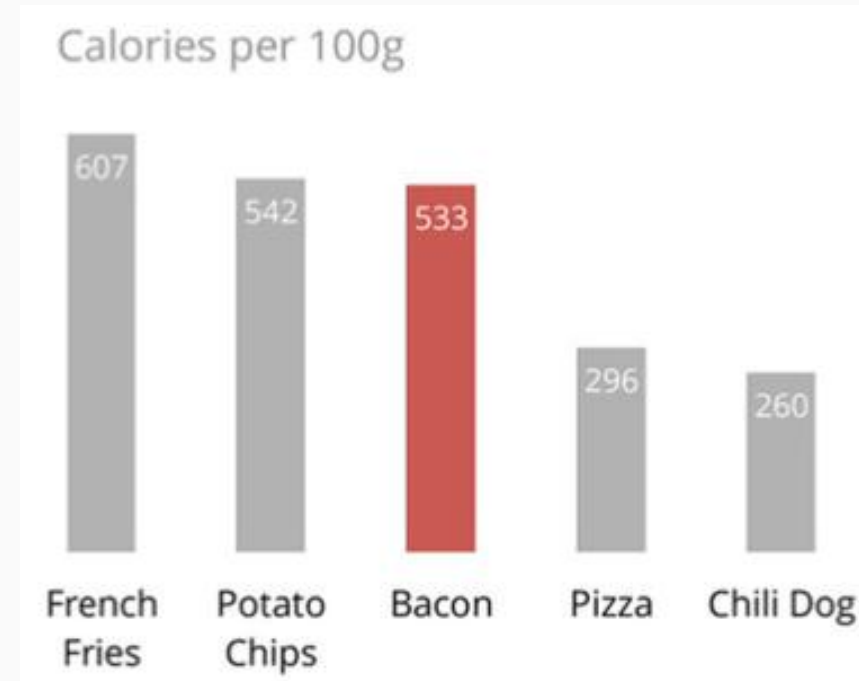
Beter: labels de bars direct



Conclusie: less is more



Voor

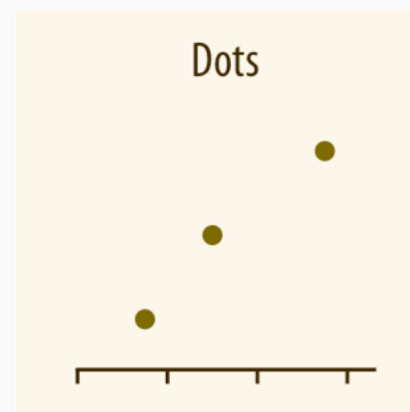
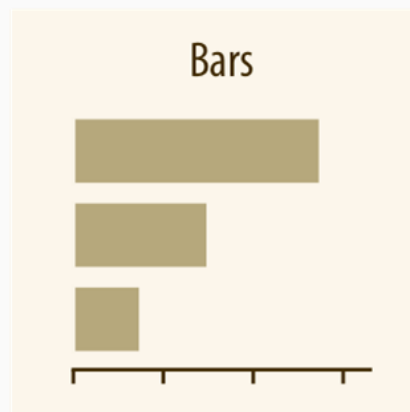
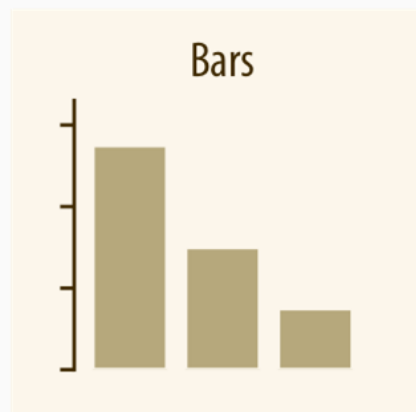


Na

Algemene principes en visualisatietypes

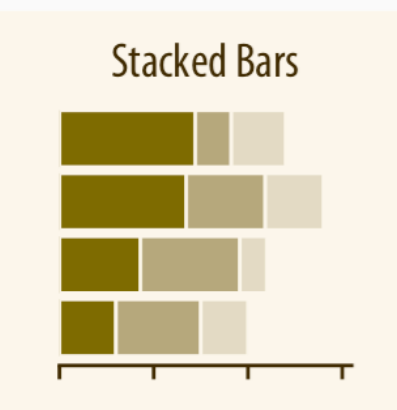
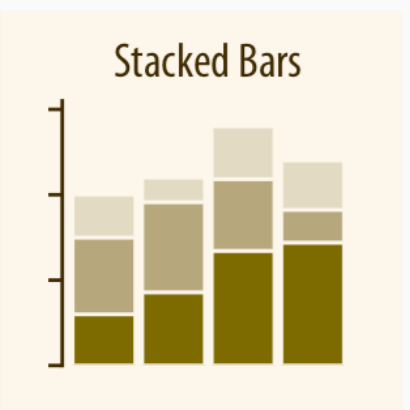
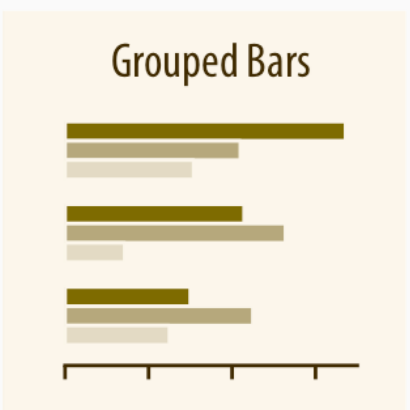
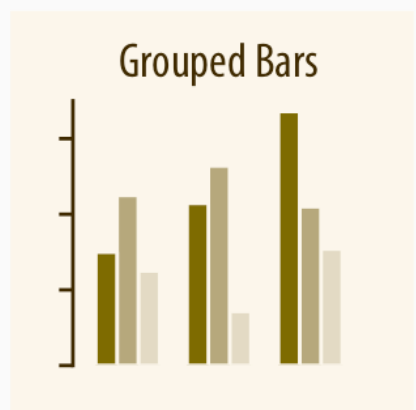
1. Voorbeelden en geschiedenis
2. Algemene vis-principes
3. Klassieke vis-types
4. Tools voor vis

Aantallen



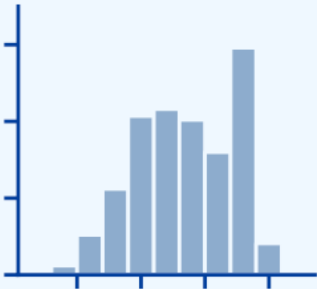
1 categorie

meerdere categorieën

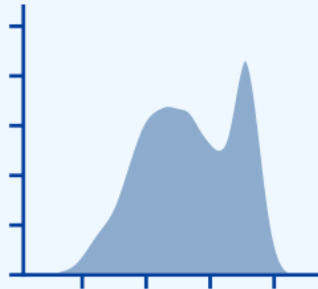


Distributies

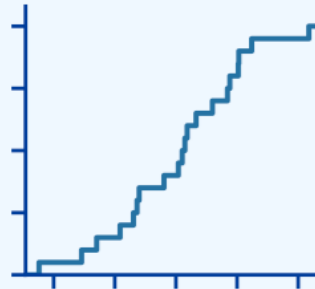
Histogram



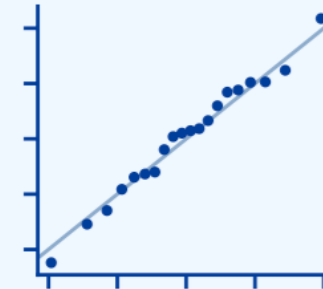
Density Plot



Cumulative Density



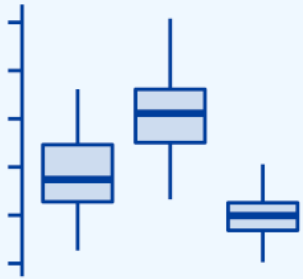
Quantile-Quantile Plot



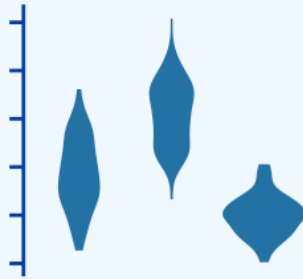
1 distributie

Distributies

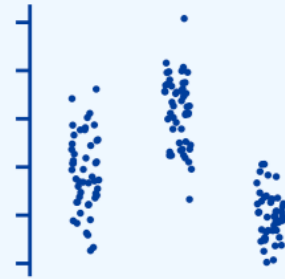
Boxplots



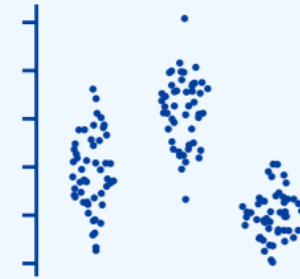
Violins



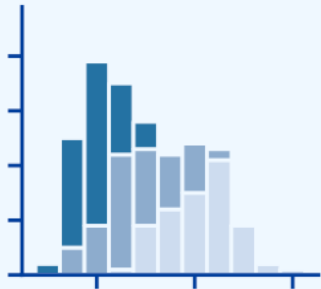
Strip Charts



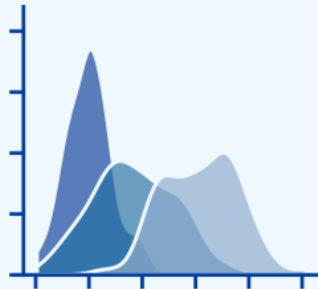
Sina Plots



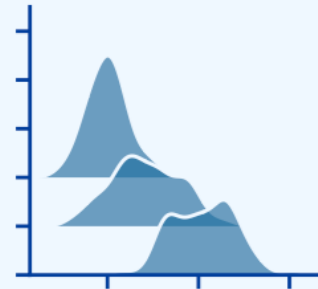
Stacked Histograms



Overlapping Densities



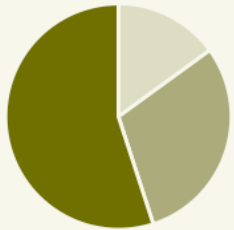
Ridgeline Plot



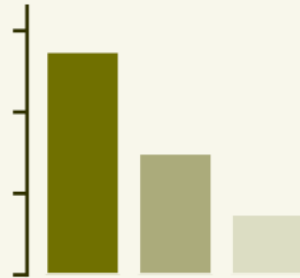
meerdere
distributies

Properties

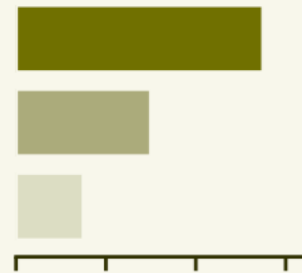
Pie Chart



Bars



Bars



Stacked Bars

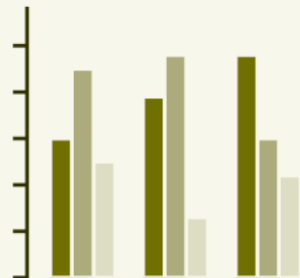


1 conditie

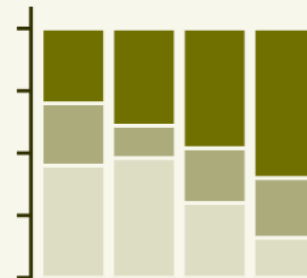
Multiple Pie Charts



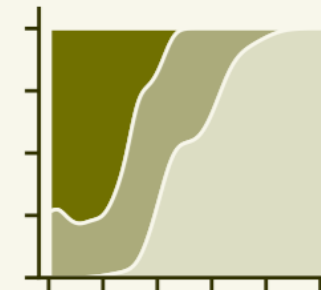
Grouped Bars



Stacked Bars



Stacked Densities



meerdere
condities

Properties

Mosaic Plot



Treemap

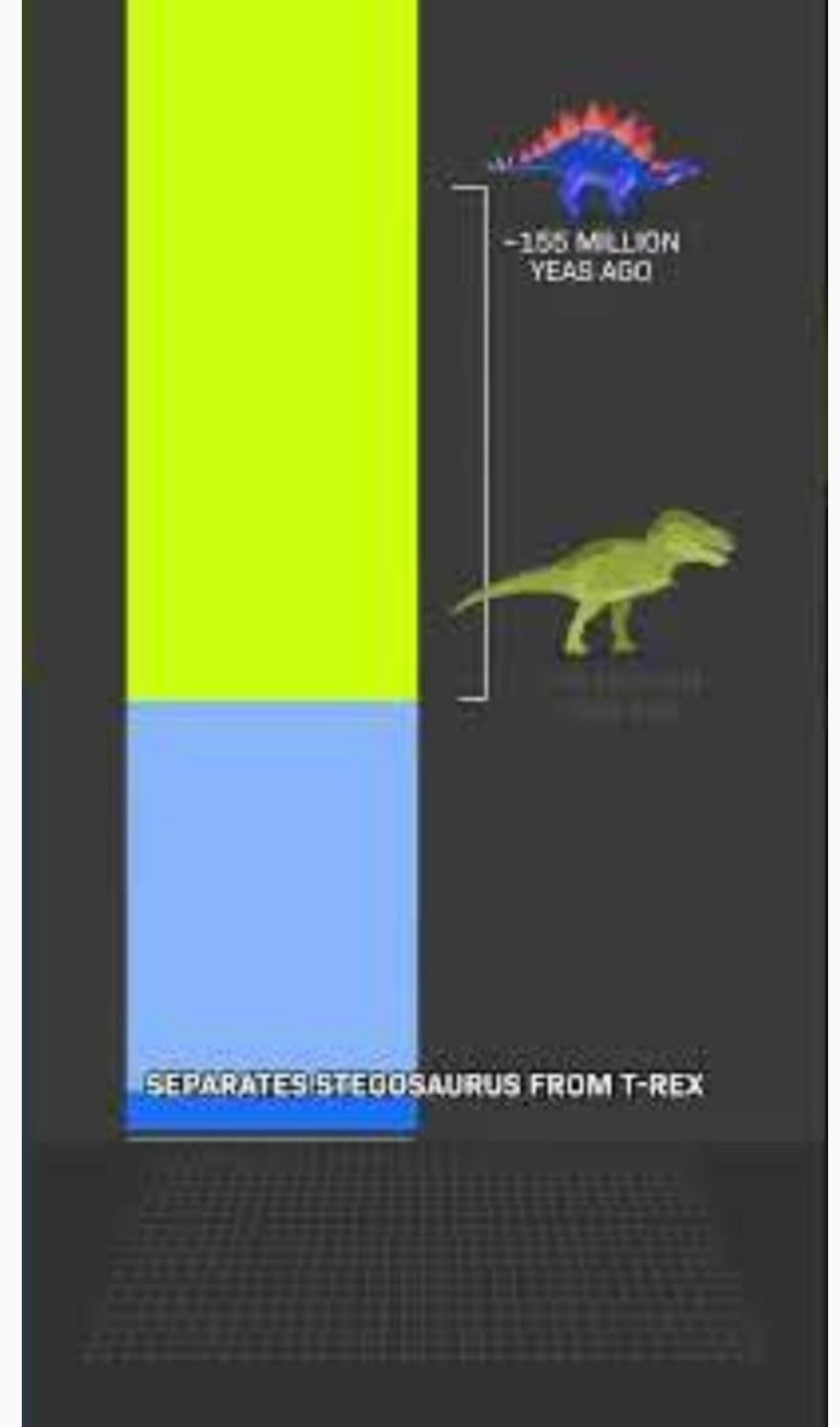


Parallel Sets



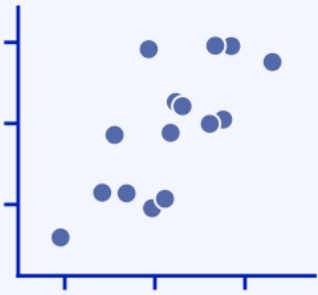
meerdere
grouping variables

Voorbeeld van een inzichtelijke stacked bar

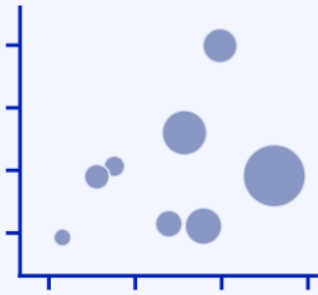


Verbanden tussen 2 variabelen

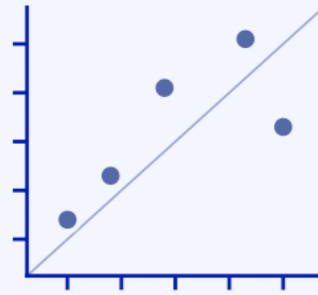
Scatterplot



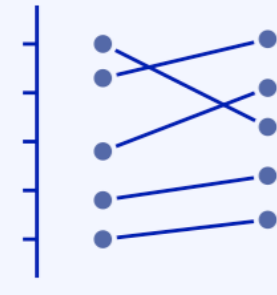
Bubble Chart



Paired Scatterplot

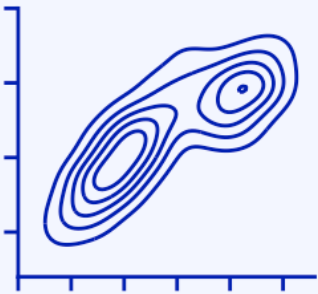


Slopegraph

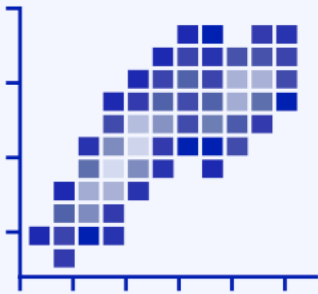


bepoekt aantal
datapunten

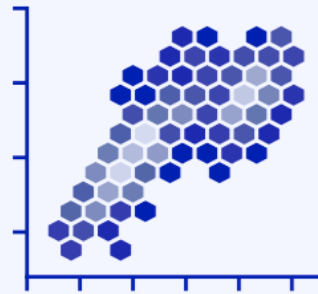
Density Contours



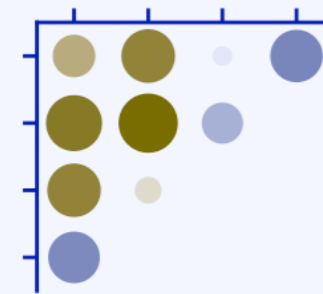
2D Bins



Hex Bins

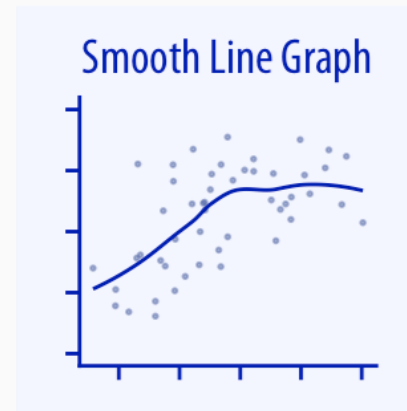
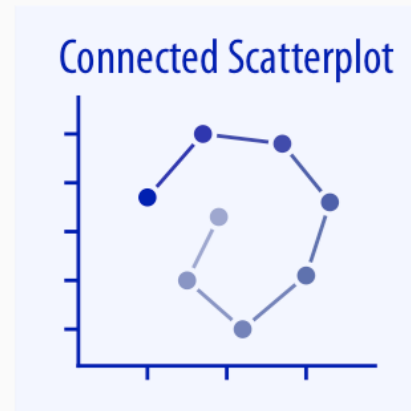


Correlogram



veel
datapunten

Verbanden tussen 2 variabelen



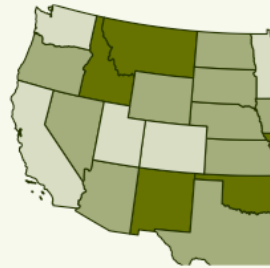
evoluties en trends

Geospatiale data

Map



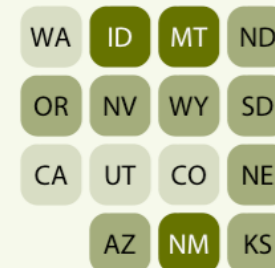
Choropleth



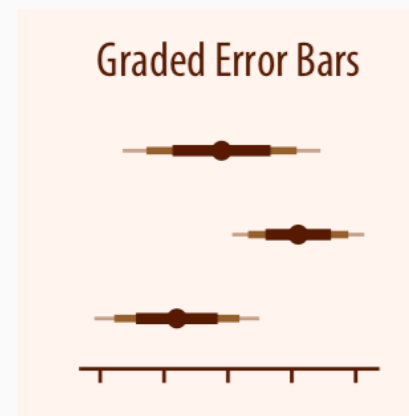
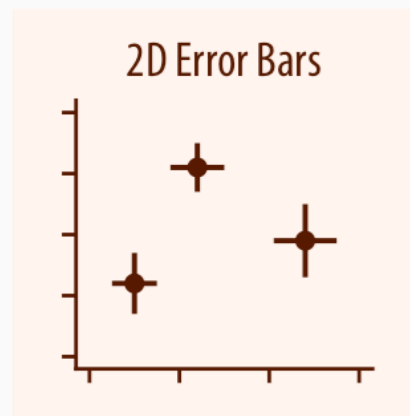
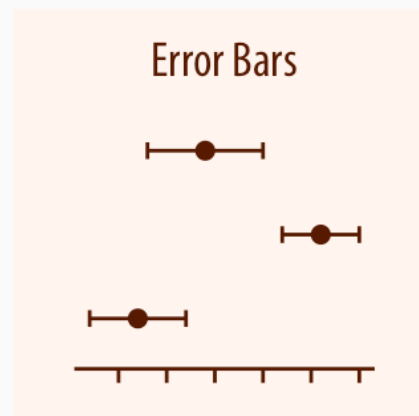
Cartogram



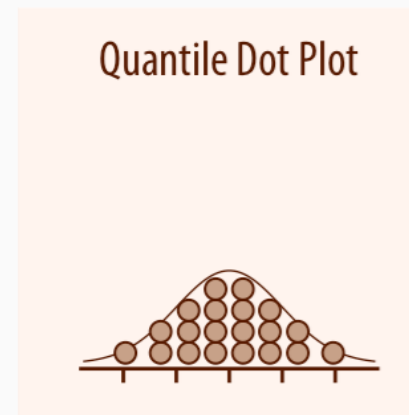
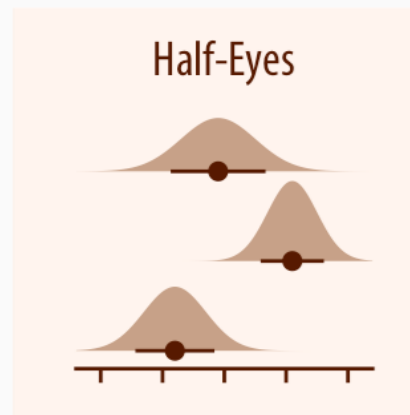
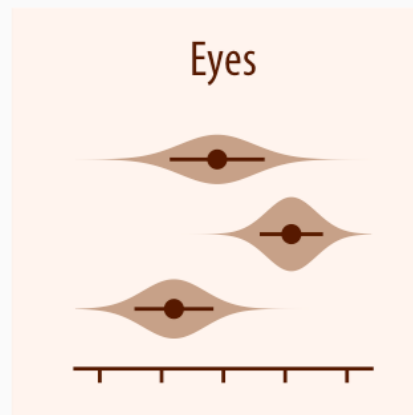
Cartogram Heatmap



Onzekerheid

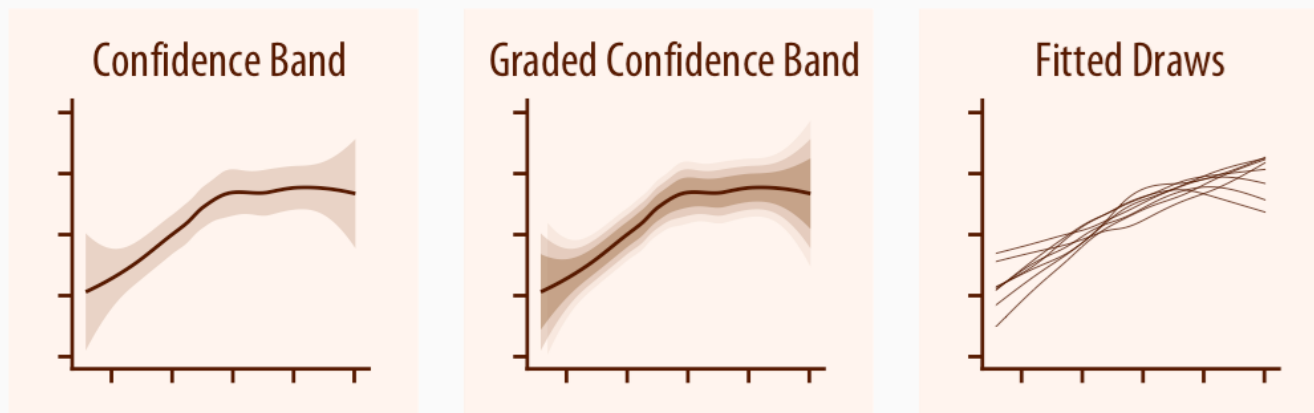


onzekere
waardes



onzekere
distributies

Onzekerheid



onzekere evoluties

Algemene principes en visualisatietypes

1. Voorbeelden en geschiedenis
2. Algemene vis-principes
3. Klassieke vis-types
4. Tools voor vis

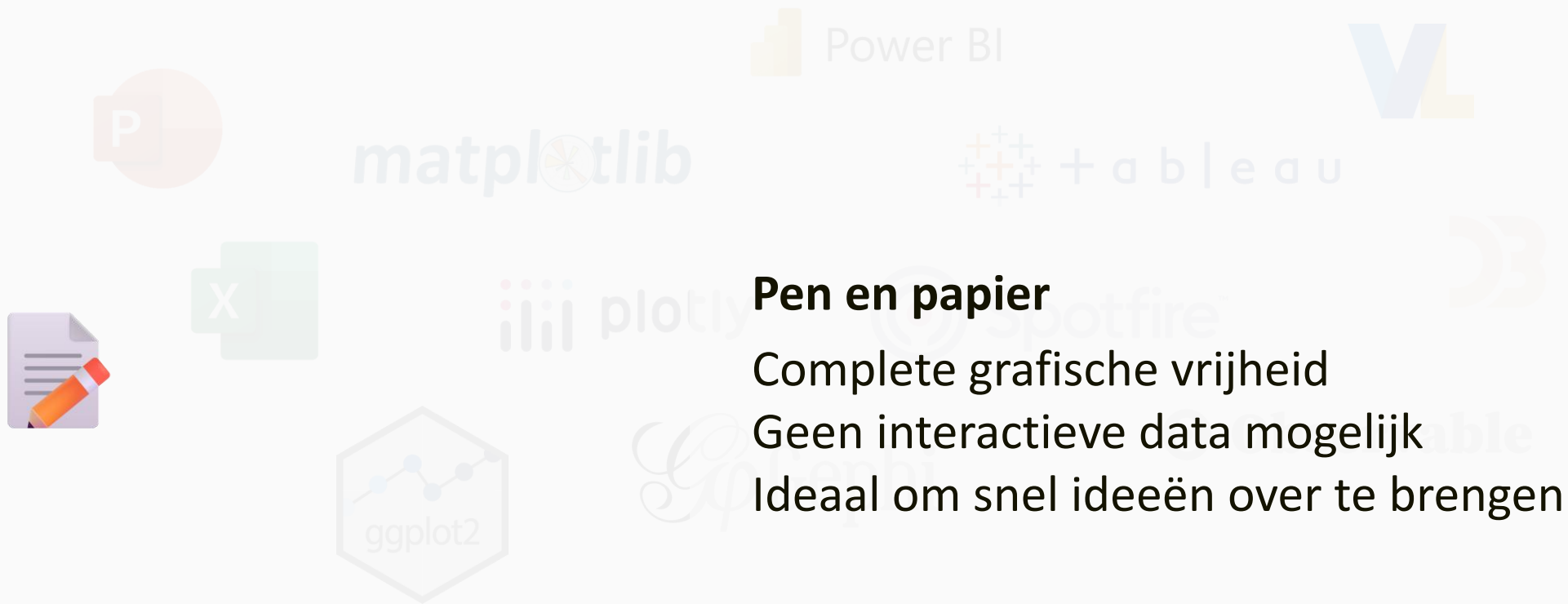


Enkele bekende vis-tools



→ meer interactie,
meer flexibiliteit,
stijlere leercurve

Enkele bekende vis-tools



Pen en papier

Complete grafische vrijheid

Geen interactieve data mogelijk

Ideaal om snel ideeën over te brengen

Enkele bekende vis-tools



matplotlib



Power BI



PowerPoint, Excel, ggplot2, matplotlib ...

Standaardvis met aanpassingsopties

Data aanpassen is mogelijk

Snel statische visualisaties bouwen

Enkele bekende vis-tools



plotly, Gephi ...

Geavanceerdere interacties met data zijn mogelijk

Kan op specifieke datatypes toegespitst zijn



Enkele bekende vis-tools

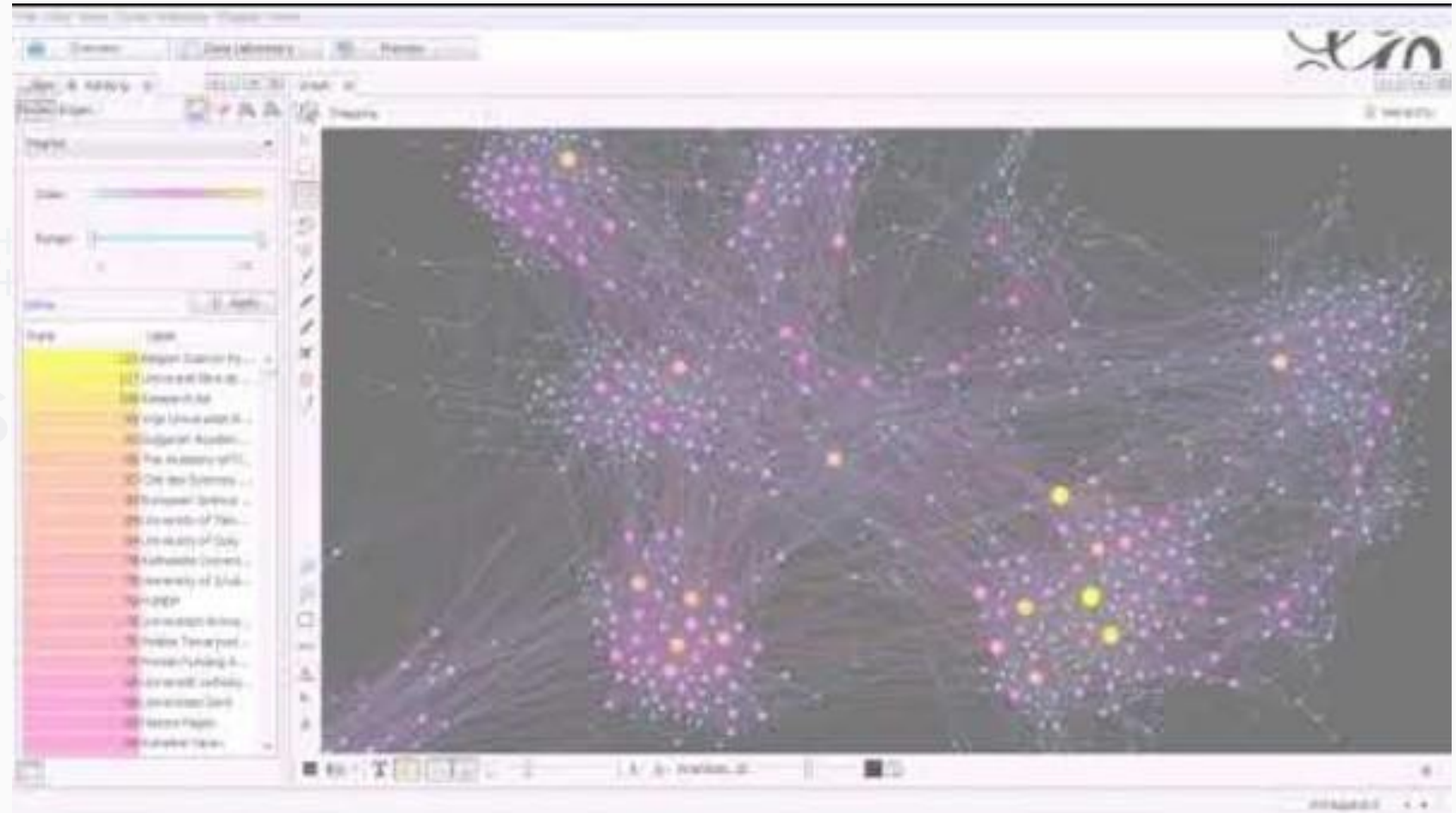
Power BI

matplotlib

plotly

ggplot2

Gephi



Enkele bekende vis-tools



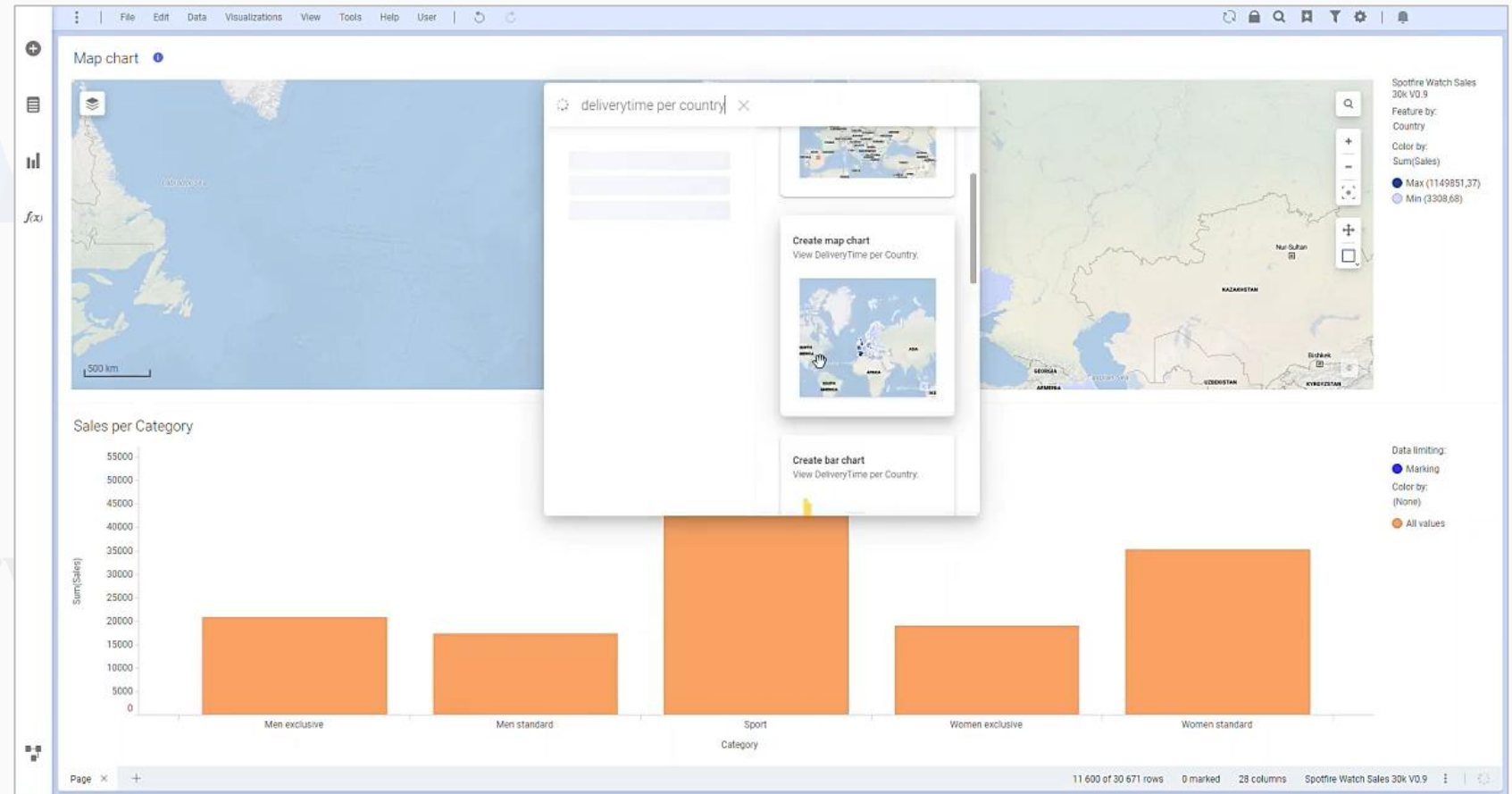
Power BI, tableau, Spotfire ...

Geavanceerdere interacties met data zijn mogelijk

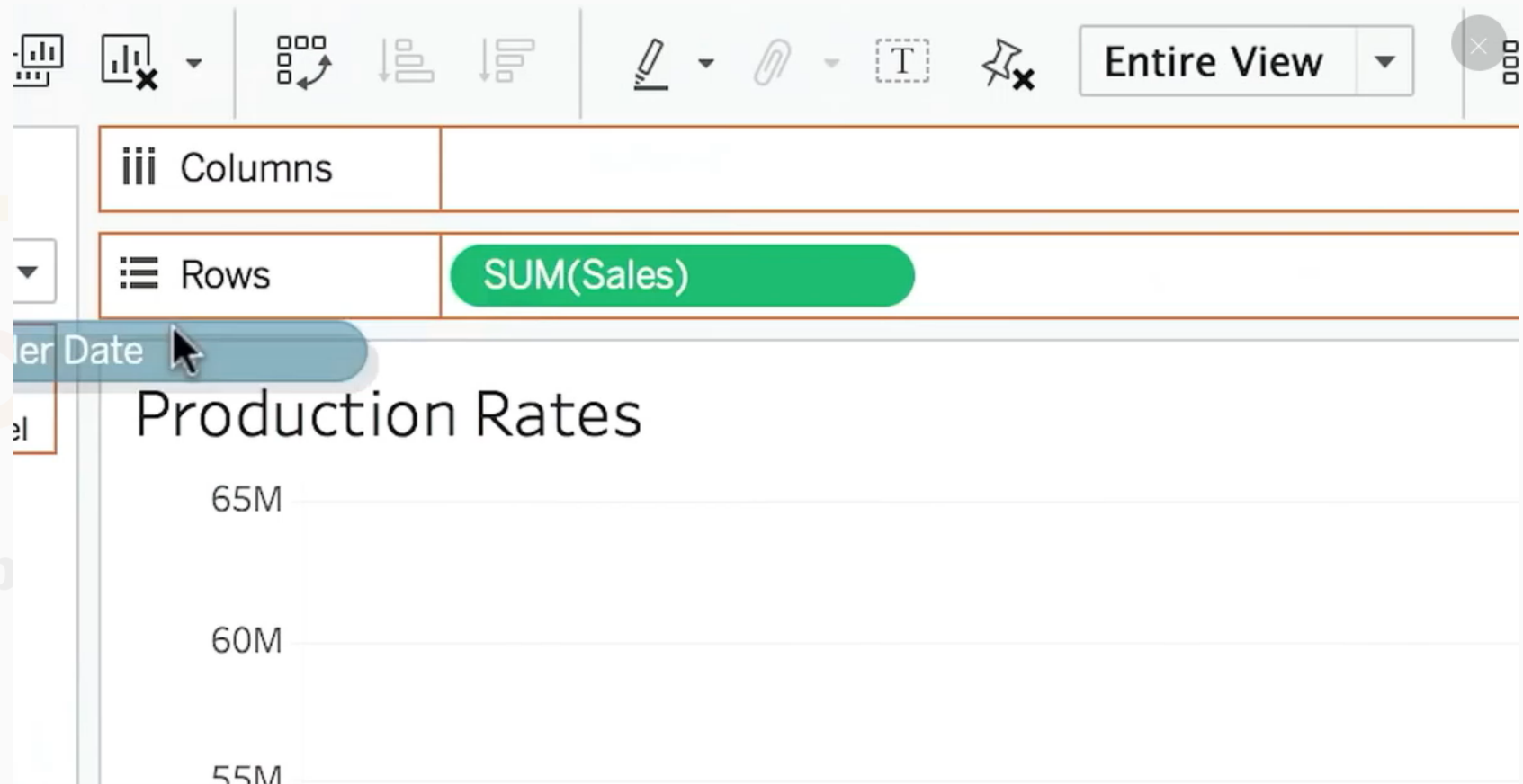
Ondersteunt veel datatypes

Typisch met *drag and drop* dashboards bouwen

Enkele bekende vis-tools



Enkele bekende vis-tools



Enkele bekende vis-tools



+ a b | e a u



spotfire™

 **Observable**

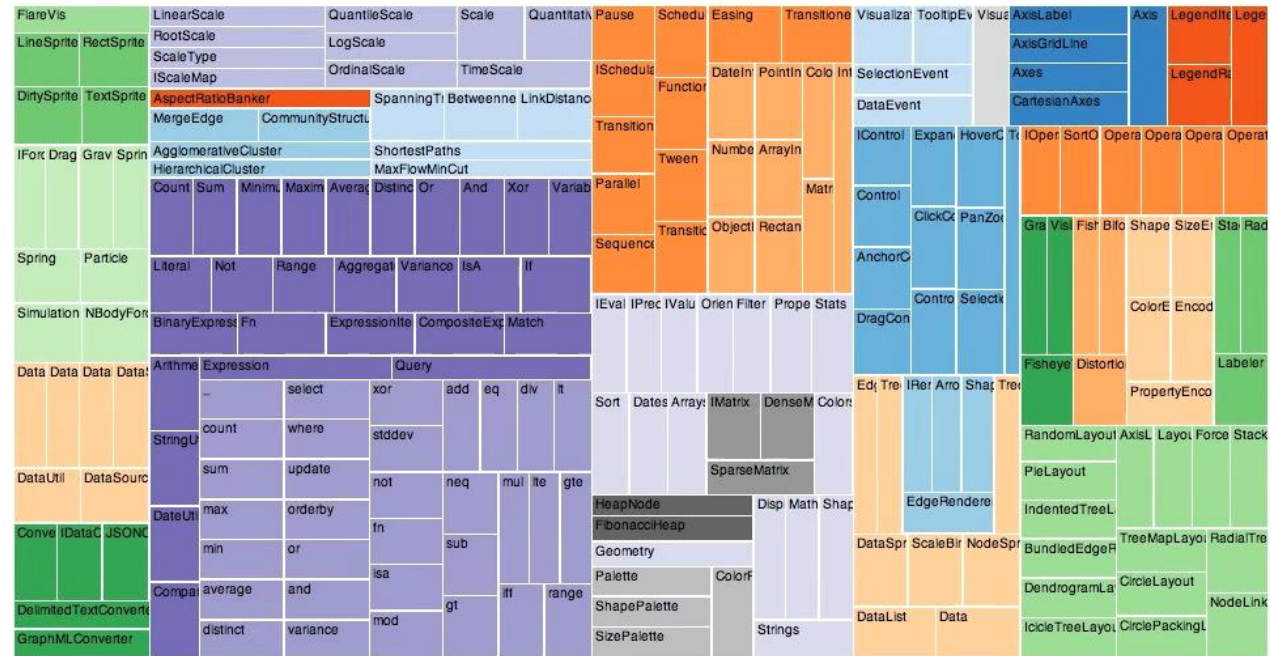
D3, Vega (Lite), Observable ...

Geavanceerdere interacties met data zijn mogelijk

Grote grafische flexibiliteit

Typisch stijle leercurve

D3 Treemap



↑ Today ^ ▼ 2025 January ▼						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Dec 30	31	Jan 1	02	03	04	05
			Blok 2			
		Wintervakantie				
06	07	08	09	10	11	12
			Blok 2			
	HOC 1		HOC 2			
	LAB 1		LAB 2			
13	14	15	16	17	18	19
			Blok 2			
			HOC 3			
			LAB 3			
20	21	22	23	24	25	26
			Blok 2			
			HOC 4			
			LAB 4			
27	28	29	30	31	Feb 1	02
			Blok 2			
	Opdracht		Tentamen			

👂 4 hoorcolleges

HOC 1: Algemene vis-principes en vis-types

HOC 2: Theoretische fundamenten van vis

HOC 3: Inleiding ggplot2 + hoe vis kan misleiden

HOC 4: Vis in rapporten + interactieve vis

💪 4 werkcolleges

Hands-on ervaring met kleine datasets

Vis ontwerpen op papier

Vis implementeren in Excel en R

Bestaande (interactieve) vis analyseren

🎓 Leerdoelen

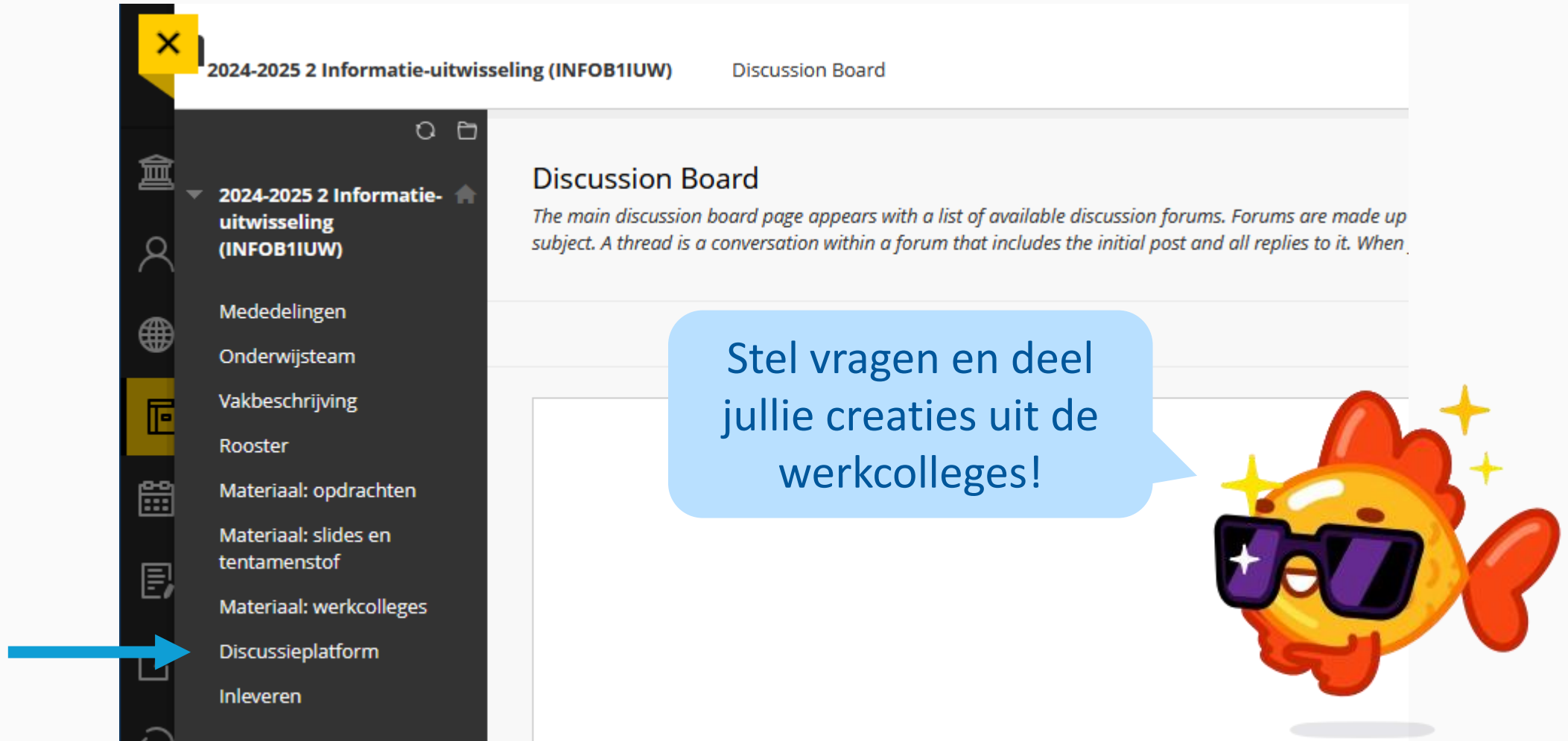
Fundamenten van vis kennen en toepassen

Vis kunnen ontwerpen en implementeren

Sterktes en zwaktes van concrete vis herkennen

Kritisch kunnen reflecteren over misleidende vis

Gebruik het discussieplatform op Blackboard



2024-2025 2 Informatie-uitwisseling (INFOB1IUW) Discussion Board

Discussion Board

The main discussion board page appears with a list of available discussion forums. Forums are made up subject. A thread is a conversation within a forum that includes the initial post and all replies to it. When,

Stel vragen en deel
jullie creaties uit de
werkcolleges!

Mededelingen
Onderwijsteam
Vakbeschrijving
Rooster
Materiaal: opdrachten
Materiaal: slides en tentamenstof
Materiaal: werkcolleges
Discussieplatform
Inleveren

Universiteit Utrecht

Hoorcollege 1

Algemene principes en visualisatietypes

Informatie-uitwisseling:
informatievisualisatie

Jeroen Ooge

