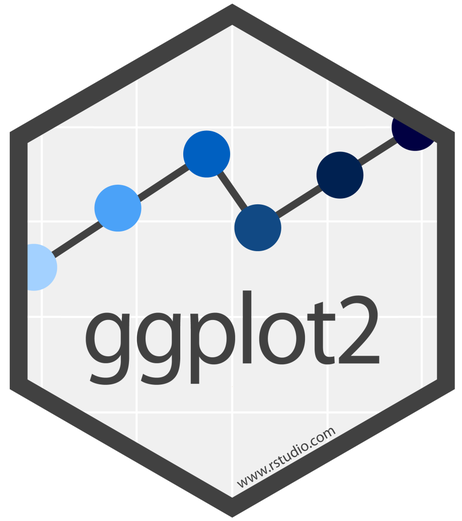
Programme for today

- Introductory lecture
- Hands-on dataviz tutorial
- Individual exercises



At the end of the day you should be familiar with making visualisations in R using the ggplot2 package


The greatest value of a picture is when it forces us to notice what we never expected to see.
John Tukey
quotefancy

Data visualisation - Telling a story with data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iso_code,continent,location,date,total_cases,new_cases,new_cases_smoothed,total_deaths,new_deaths,new_deaths_smoothed,total_cases_per_million,new_cases_per_million,new_cases_smoothed_per_million,total_deaths_per_million,new_deaths_per_million,new_deaths_smoothed_per_million
,reproduction_rate,icu_patients,icu_patients_per_million,hosp_patients,hosp_patients_per_million,weekly_icu_admissions,weekly_icu_admissions_per_million,weekly_hosp_admissions,weekly_hosp_admissions_per_million,new_tests,total_tests,total_tests_per_thousand,new_tests_per_th
ousand,new_tests_smoothed,new_tests_smoothed_per_thousand,positive_rate,tests_per_case,tests_units,total_vaccinations,people_vaccinated,people_fully_vaccinated,total_boosters,new_vaccinations,new_vaccinations_smoothed,total_vaccinations_per_hundred,people_vaccinated_per_hun
dred,people_fully_vaccinated_per_hundred,total_boosters_per_hundred,new_vaccinations_smoothed_per_million,new_people_vaccinated_smoothed,new_people_vaccinated_smoothed_per_hundred,stringency_index,population,population_density,median_age,aged_65_older,aged_70_older,gdp_per_
capita,extreme_poverty,cardiovasc_death_rate,diabetes_prevalence,female_smokers,male_smokers,handwashing_facilities,hospital_beds_per_thousand,life_expectancy,human_development_index,excess_mortality_cumulative_absolute,excess_mortality_cumulative,excess_mortality,excess_mo
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AFG,Asia,Afghanistan,2020-04-21,1026.0,30.0,51.571,36.0,3.0,2.0,25.756,0.753,1.295,0.904,0.075,0.05,1.48,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,84.26,39835428.0,54.422,18.6,2.581,1.337,1803.987,,597.029,9.59,,,37.746,0.5,64.83,0.511,,,,
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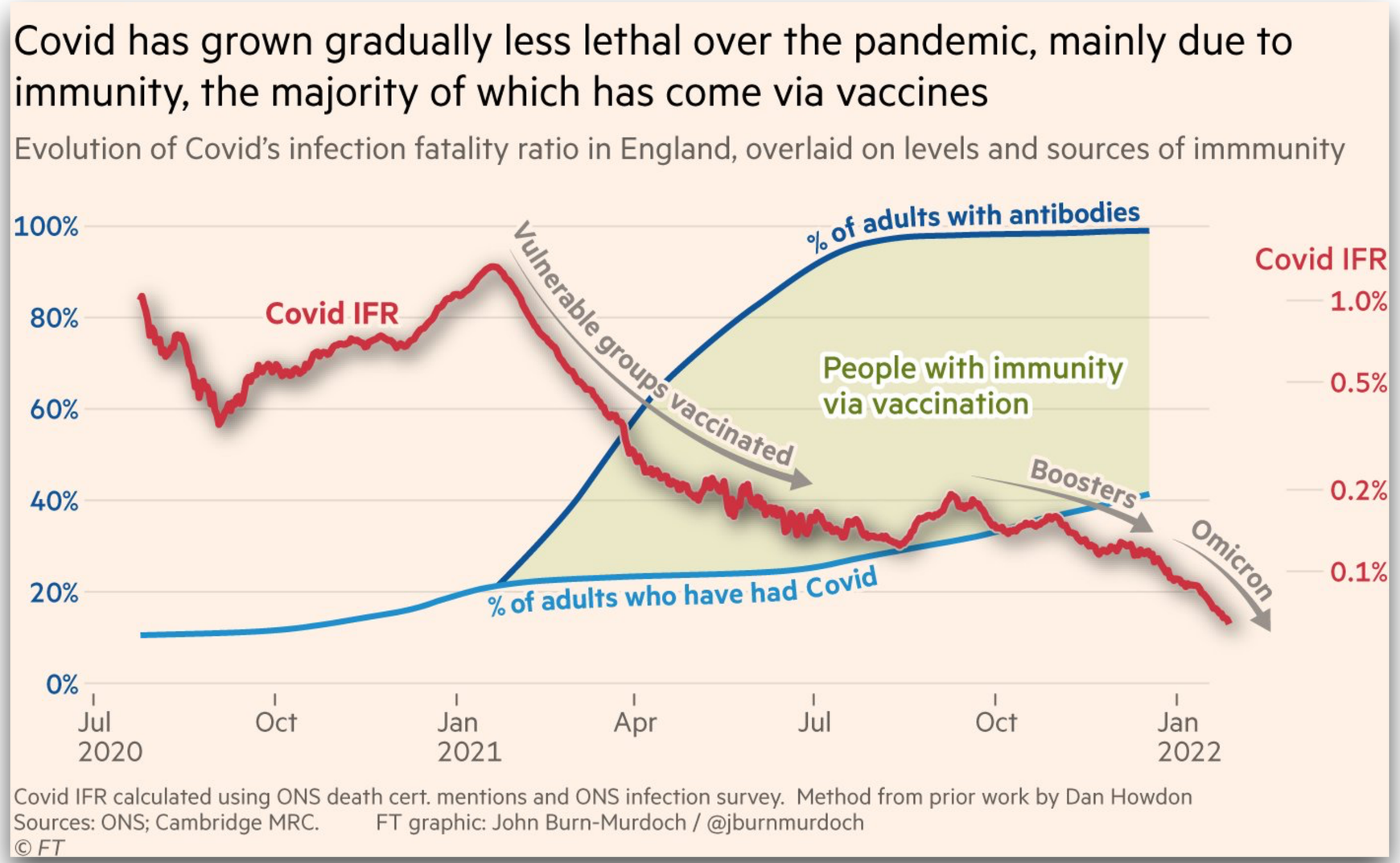
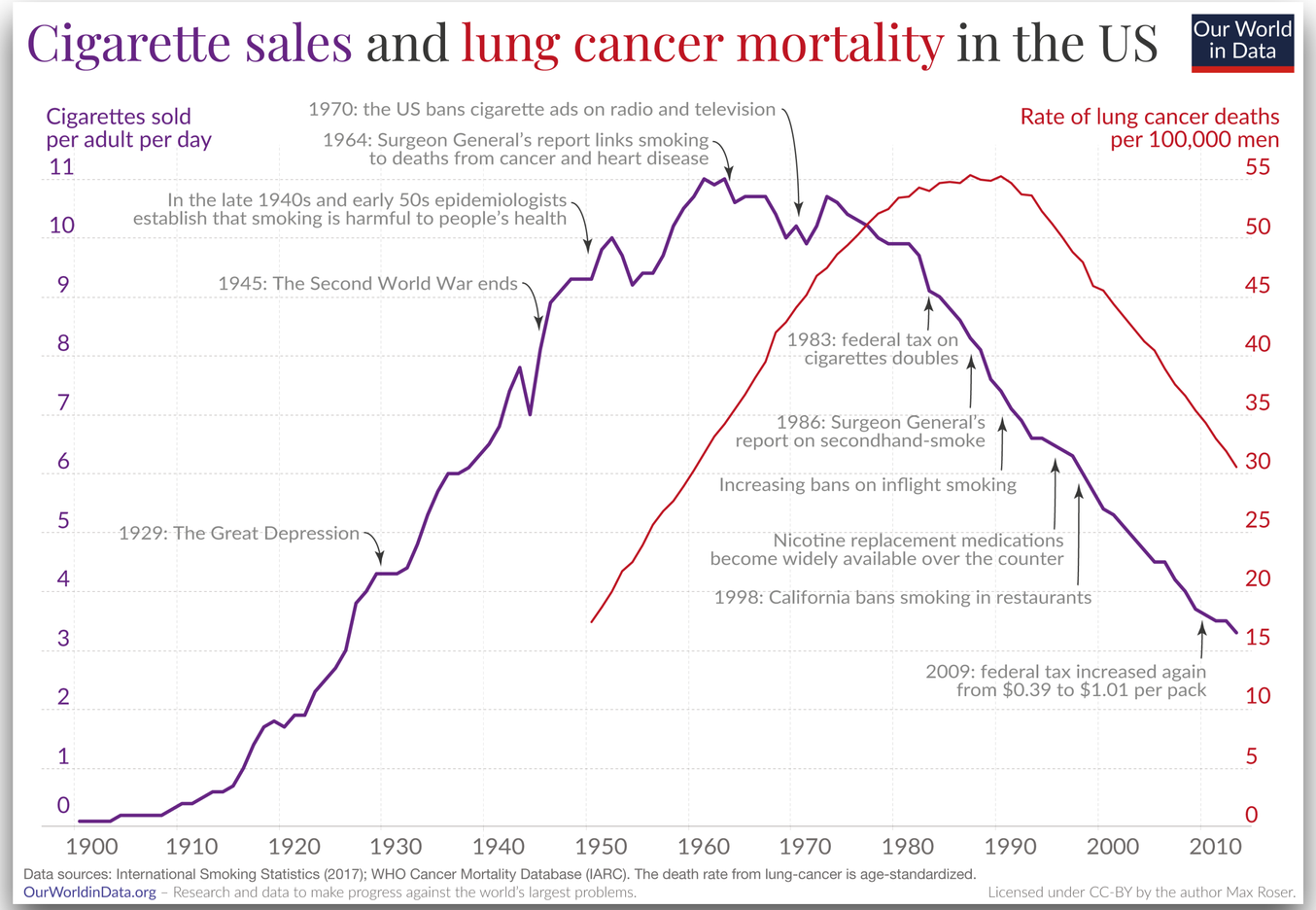
```

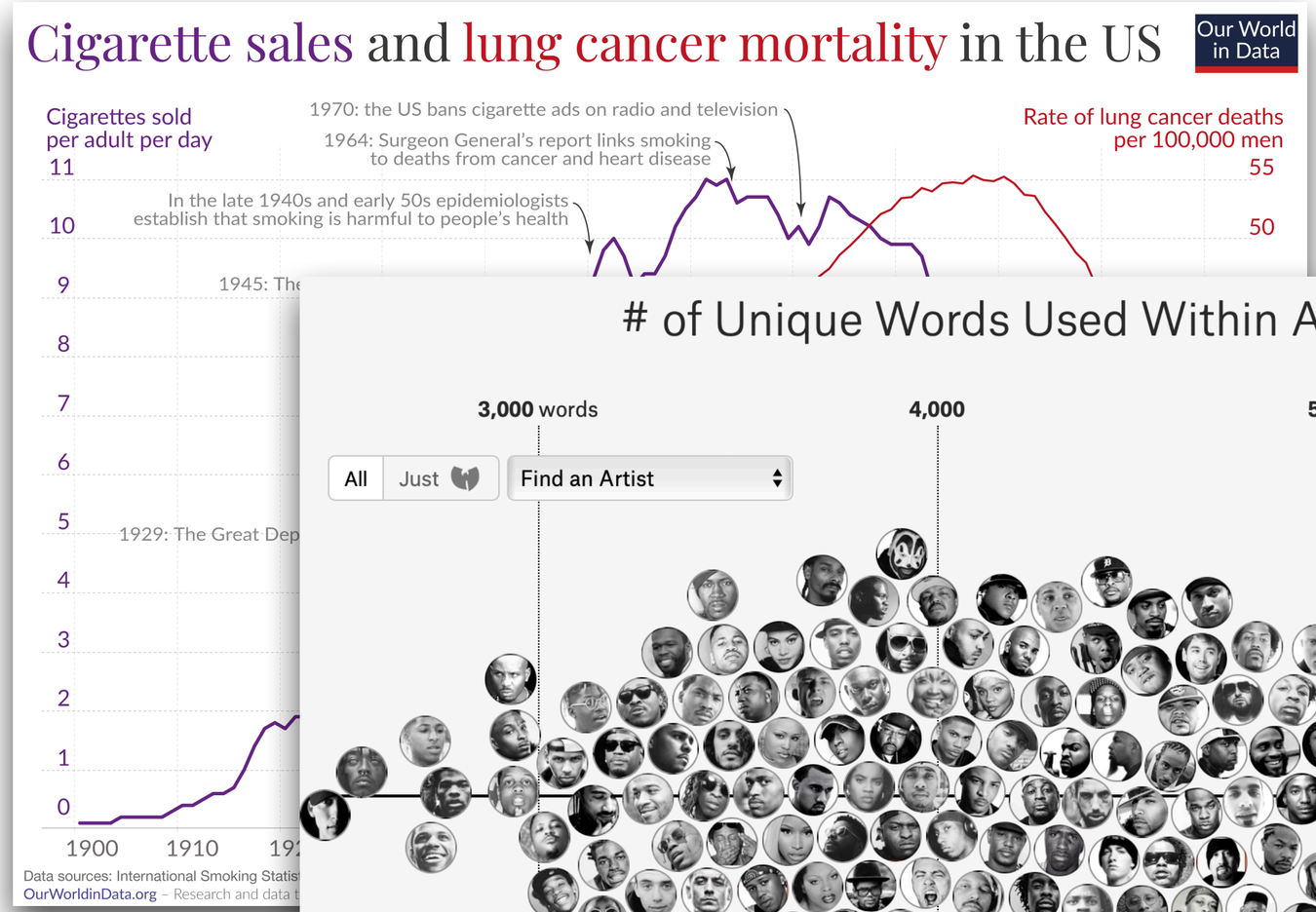
Data visualisation - Telling a story with data



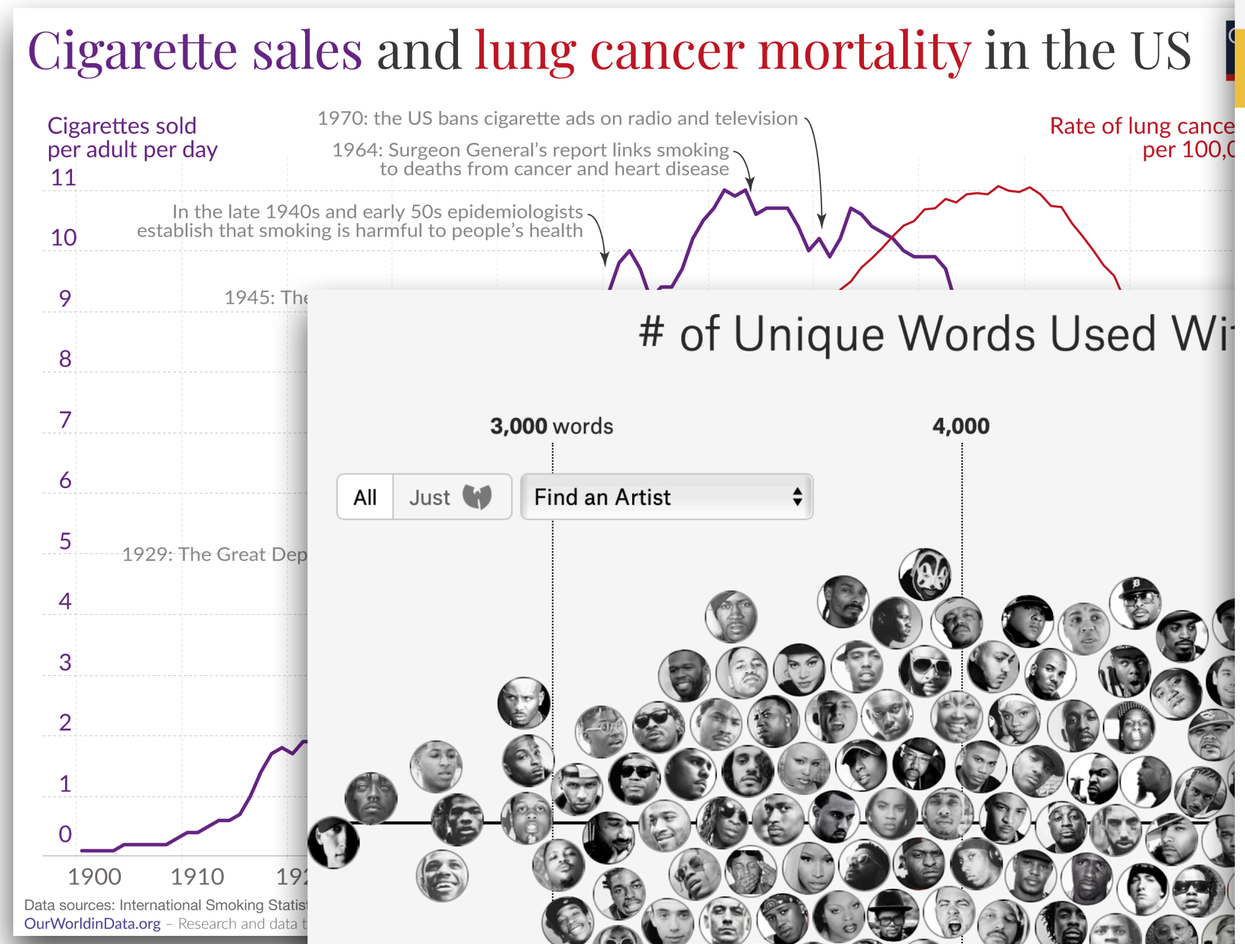
Data visualisation - Telling a story with data



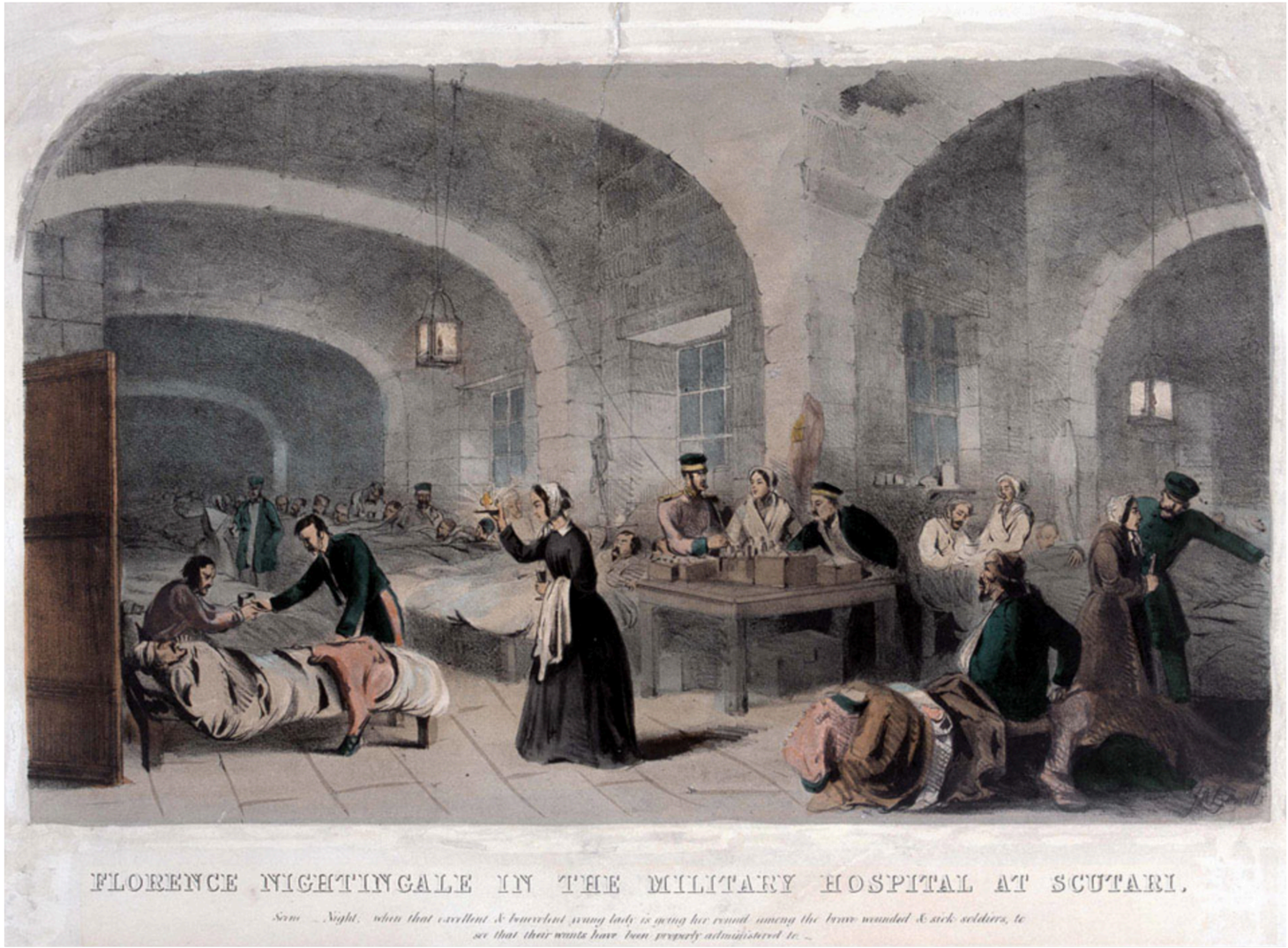
Data visualisation - Telling a story with data



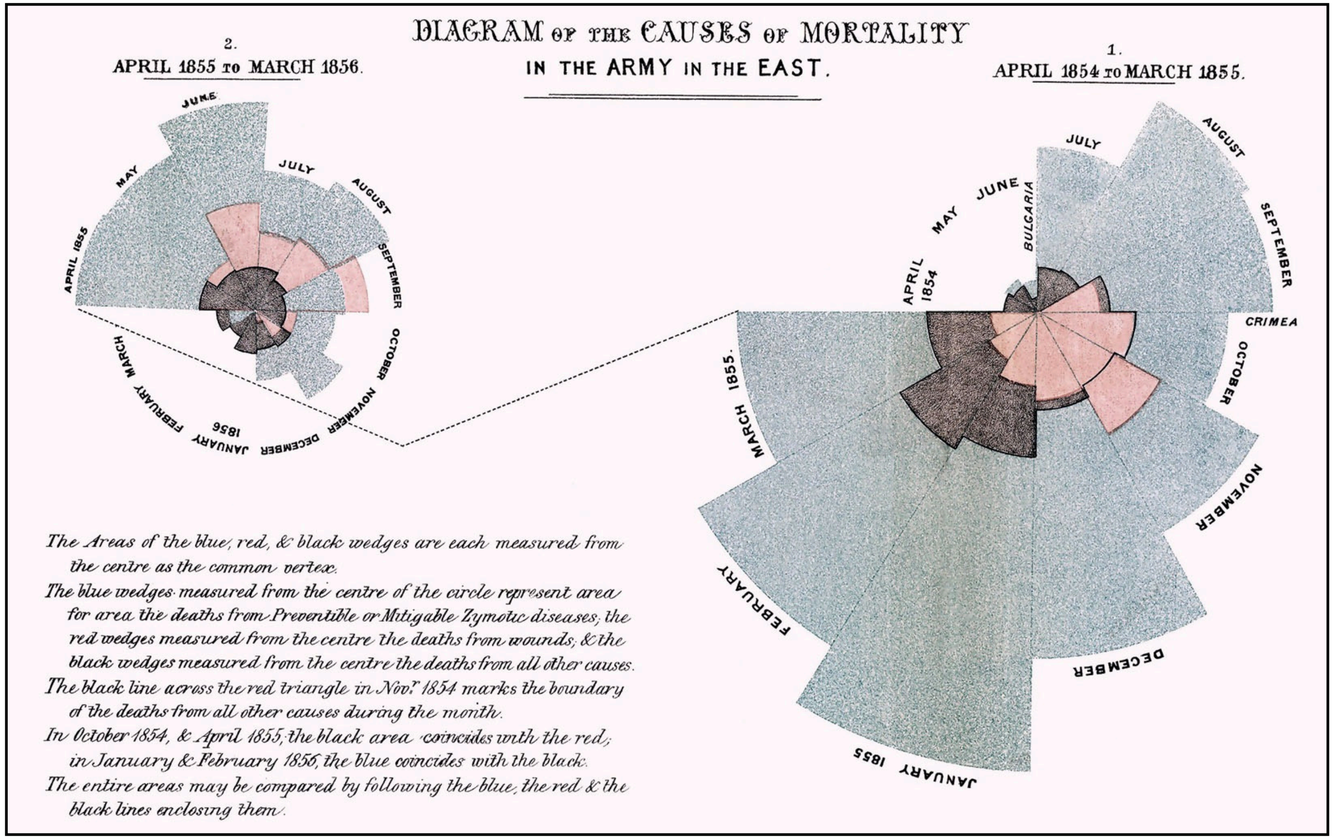
Data visualisation - Telling a story with data



Florence Nightingale - “The lady with the lamp”



Florence Nightingale - Data visualisation pioneer

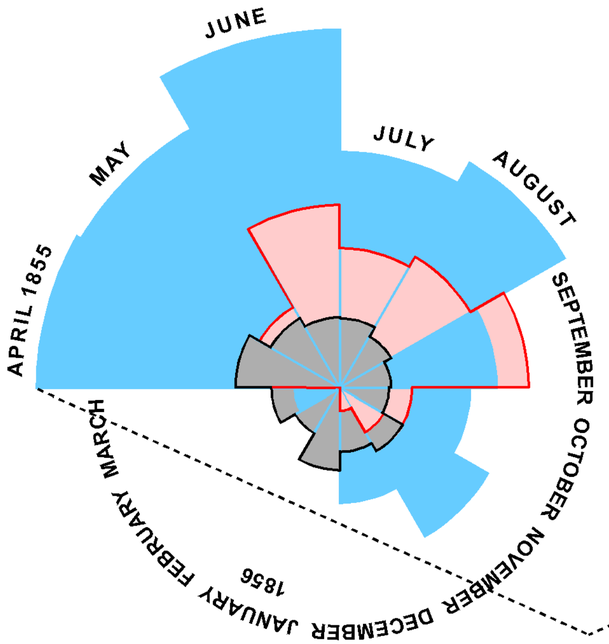


First woman to become a member of the Royal Statistical Society (1858)

http://www.Florence-Nightingale-Avenging-Angel.co.uk/Coxcomb.htm

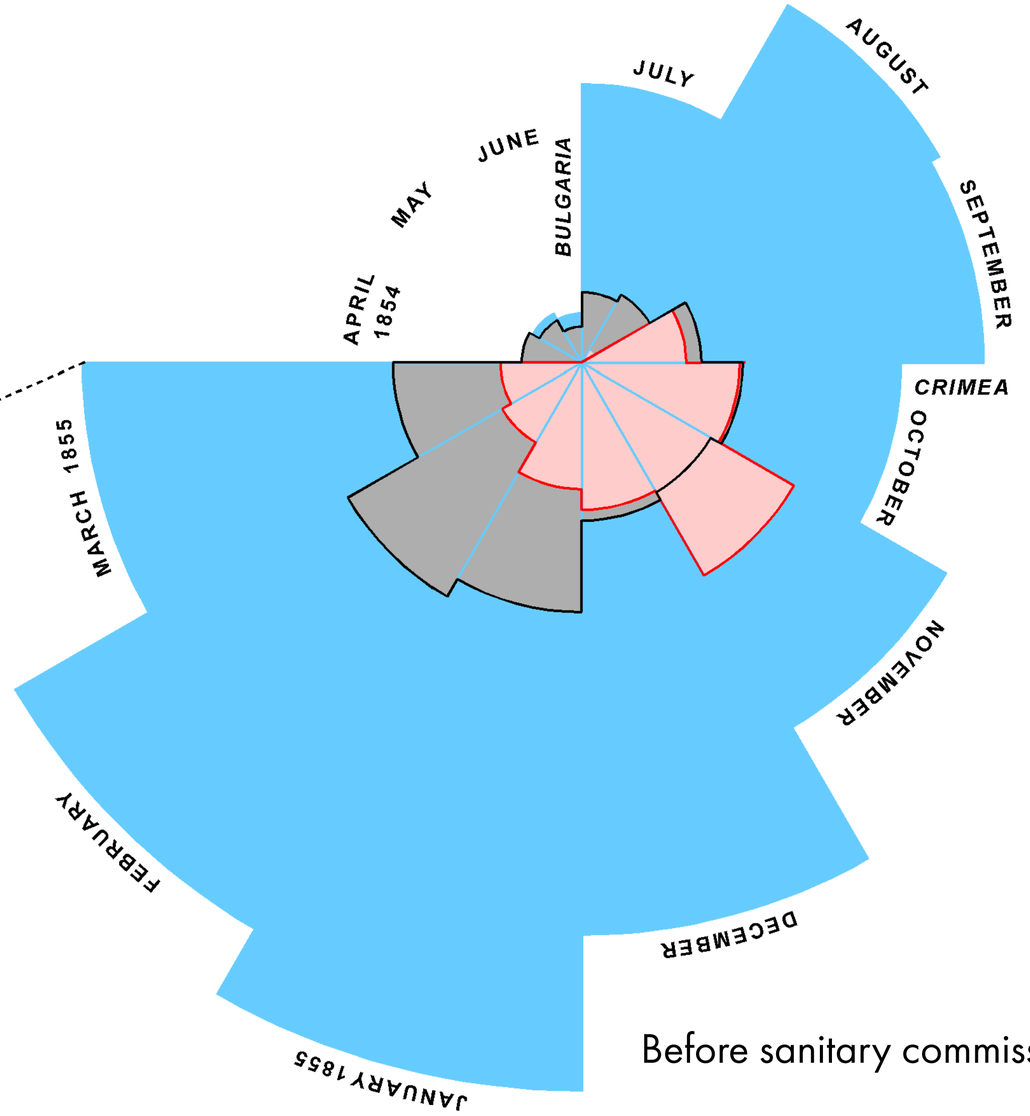
DIAGRAM OF THE CAUSES OF MORTALITY IN THE ARMY IN THE EAST.

2.
APRIL 1855 TO MARCH 1856.



After sanitary commission arrival

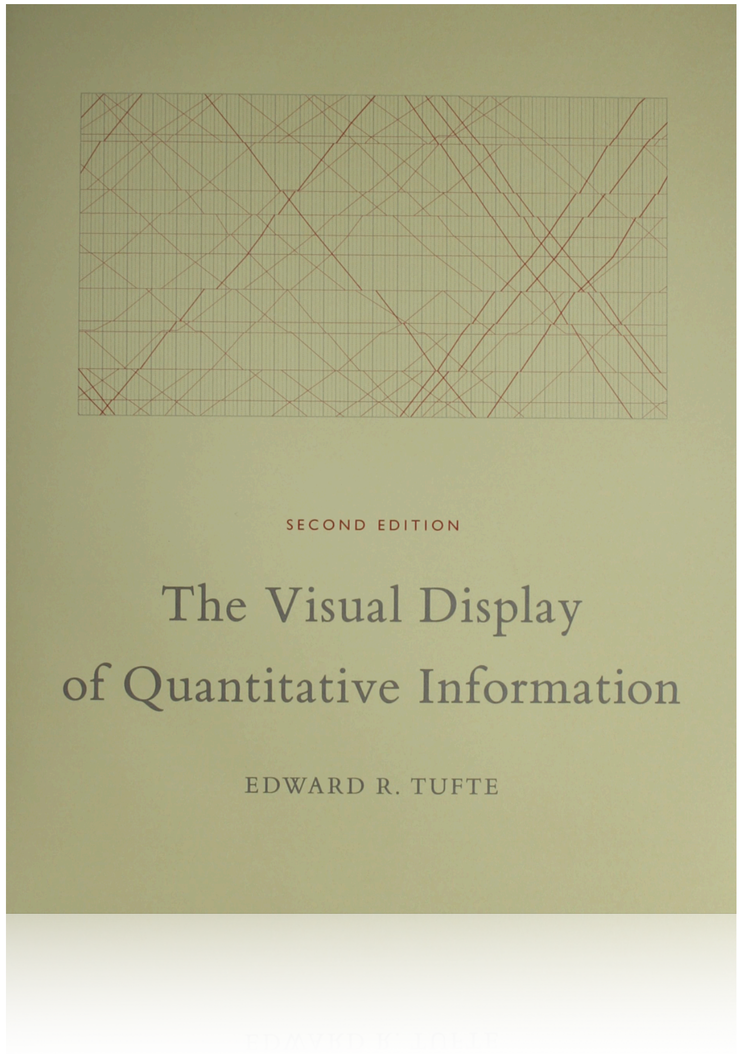
1.
APRIL 1854 TO MARCH 1855.



Before sanitary commission arrival

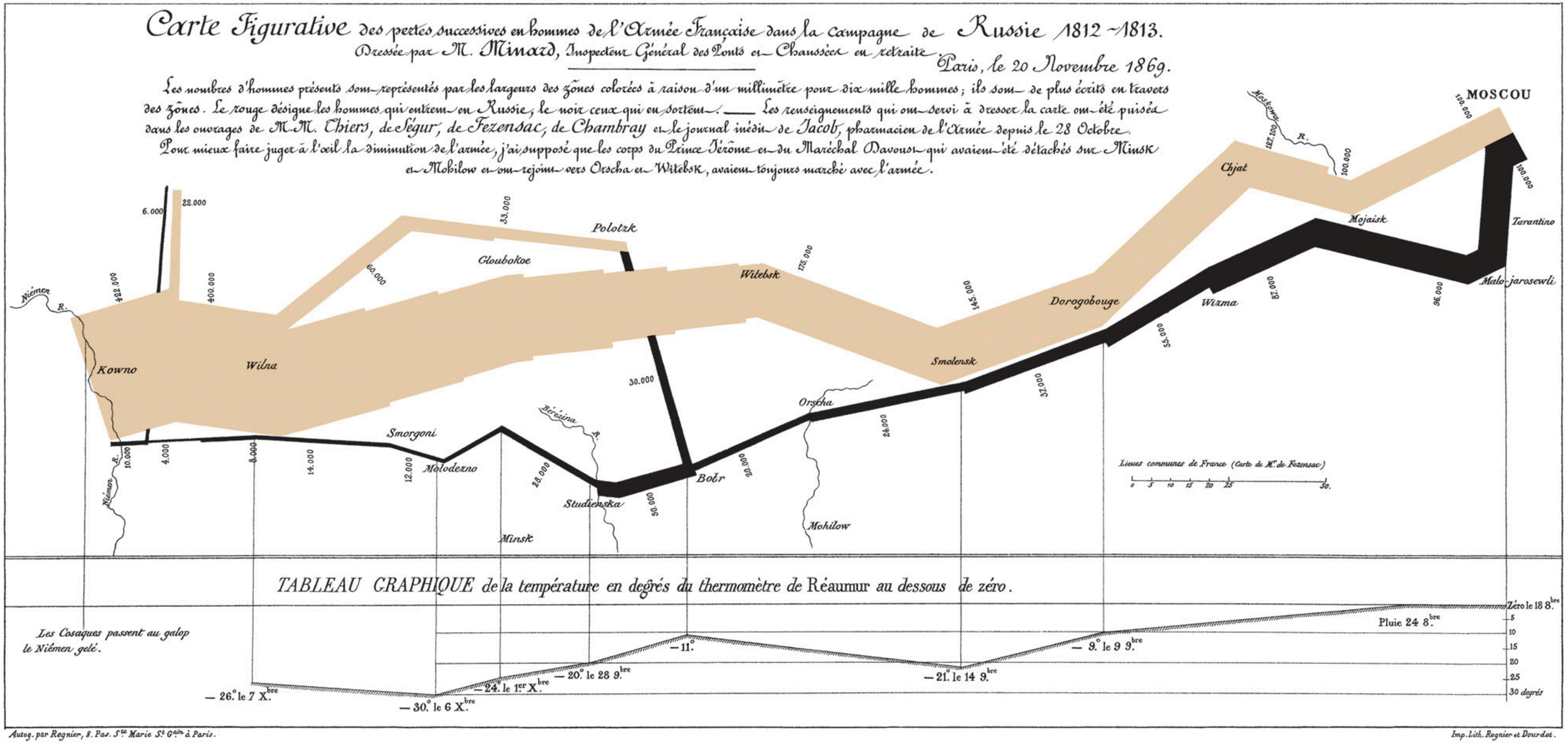
The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex
The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic Diseases, the red wedges measured from the centre the deaths from wounds, & 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 1856, the blue coincides with the black
The entire areas may be compared by following the blue, the red & the black lines enclosing them

Pioneers of data visualisation - Edward Tufte (“ET”)



www.edwardtufte.com

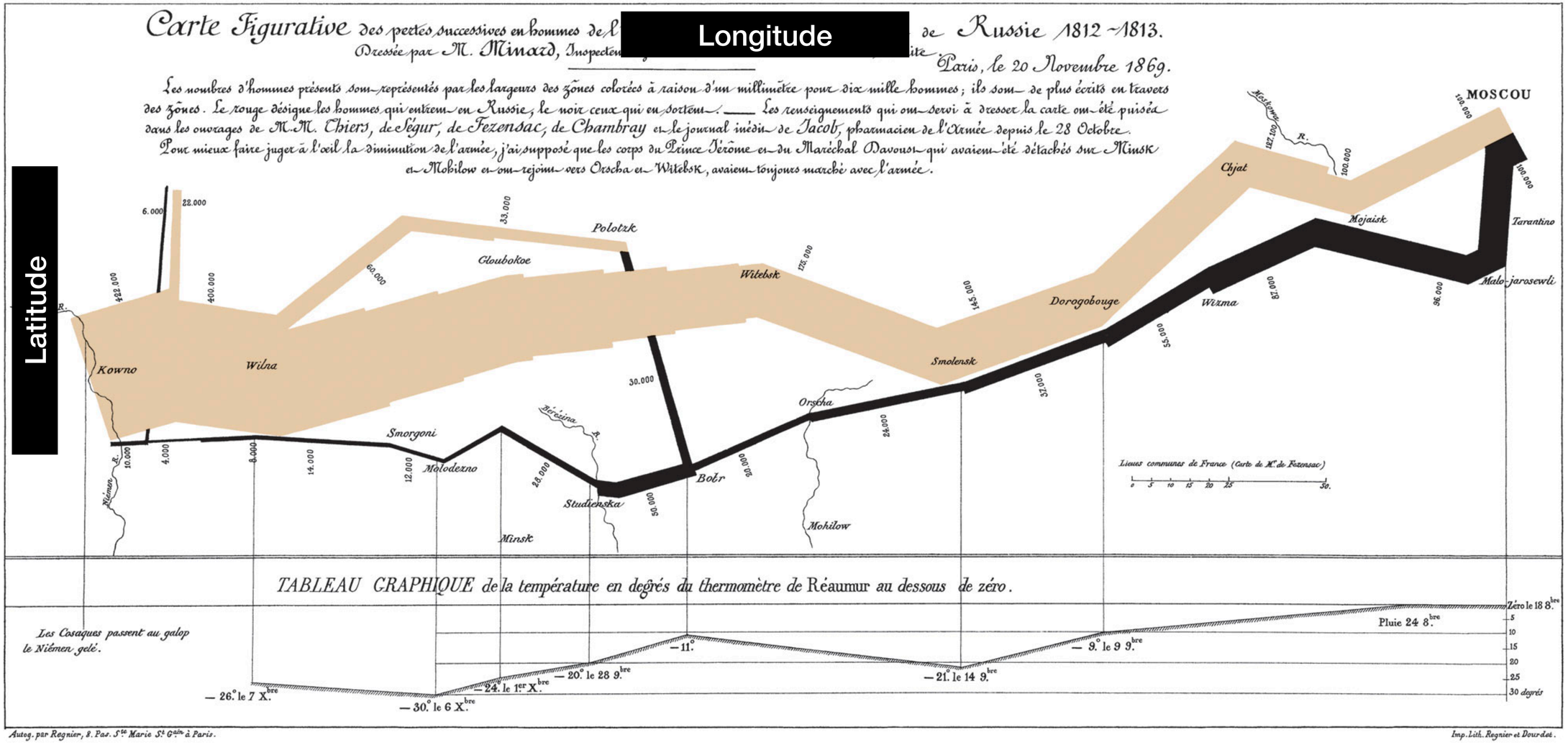
“The best statistical graph ever drawn”



Charles Joseph Minard

“Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813”

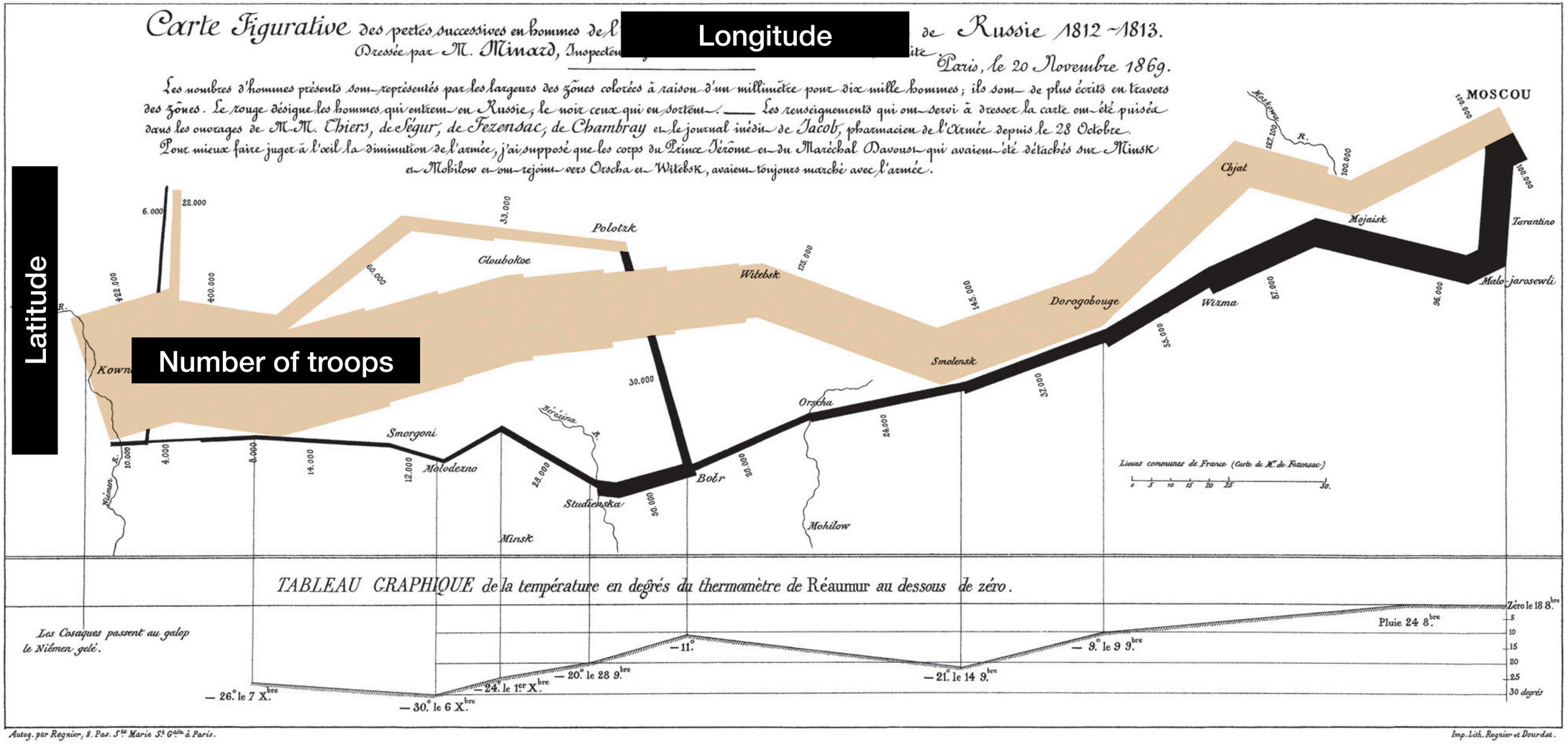
“The best statistical graph ever drawn”



Charles Joseph Minard

“Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813”

“The best statistical graph ever drawn”



Charles Joseph Minard

“Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813”

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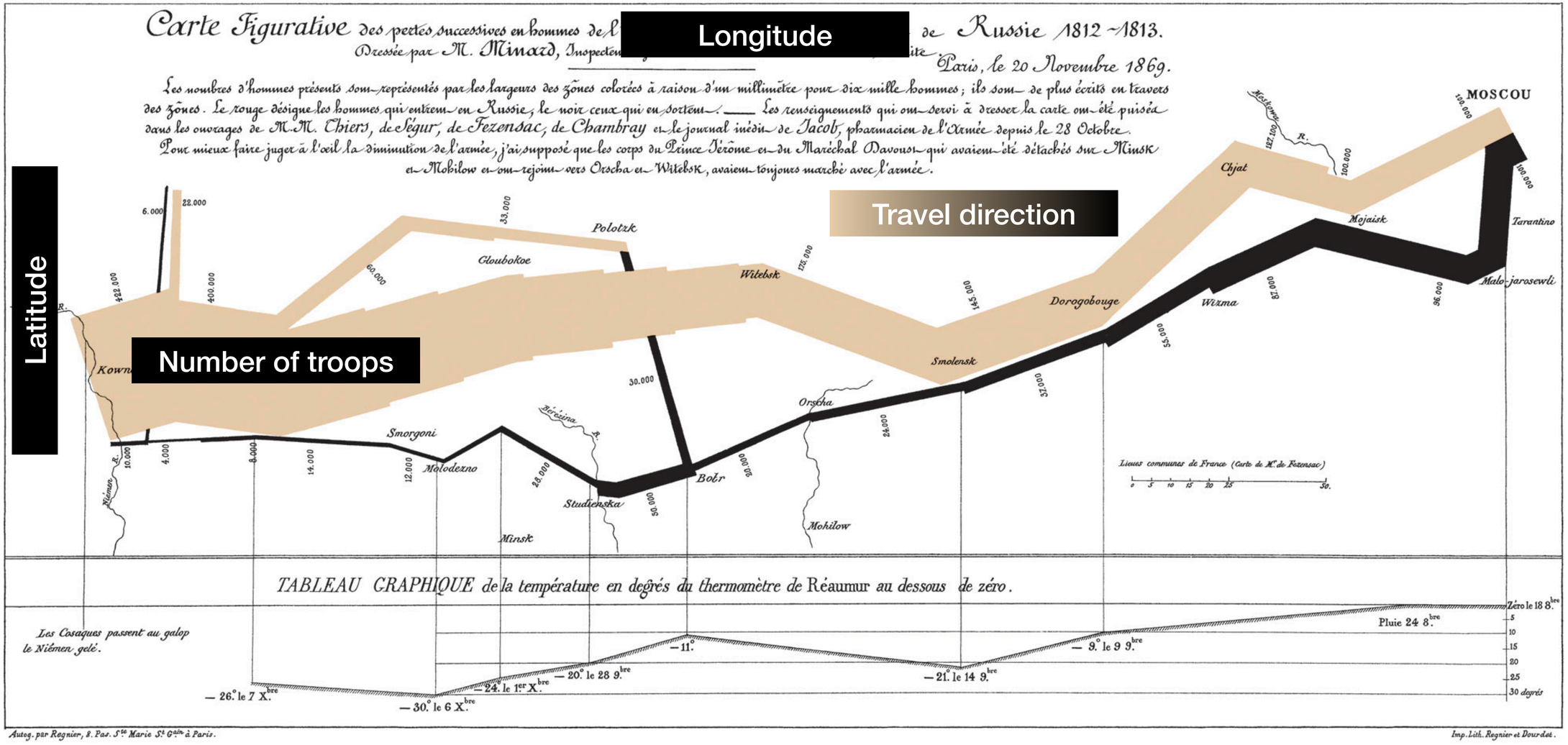
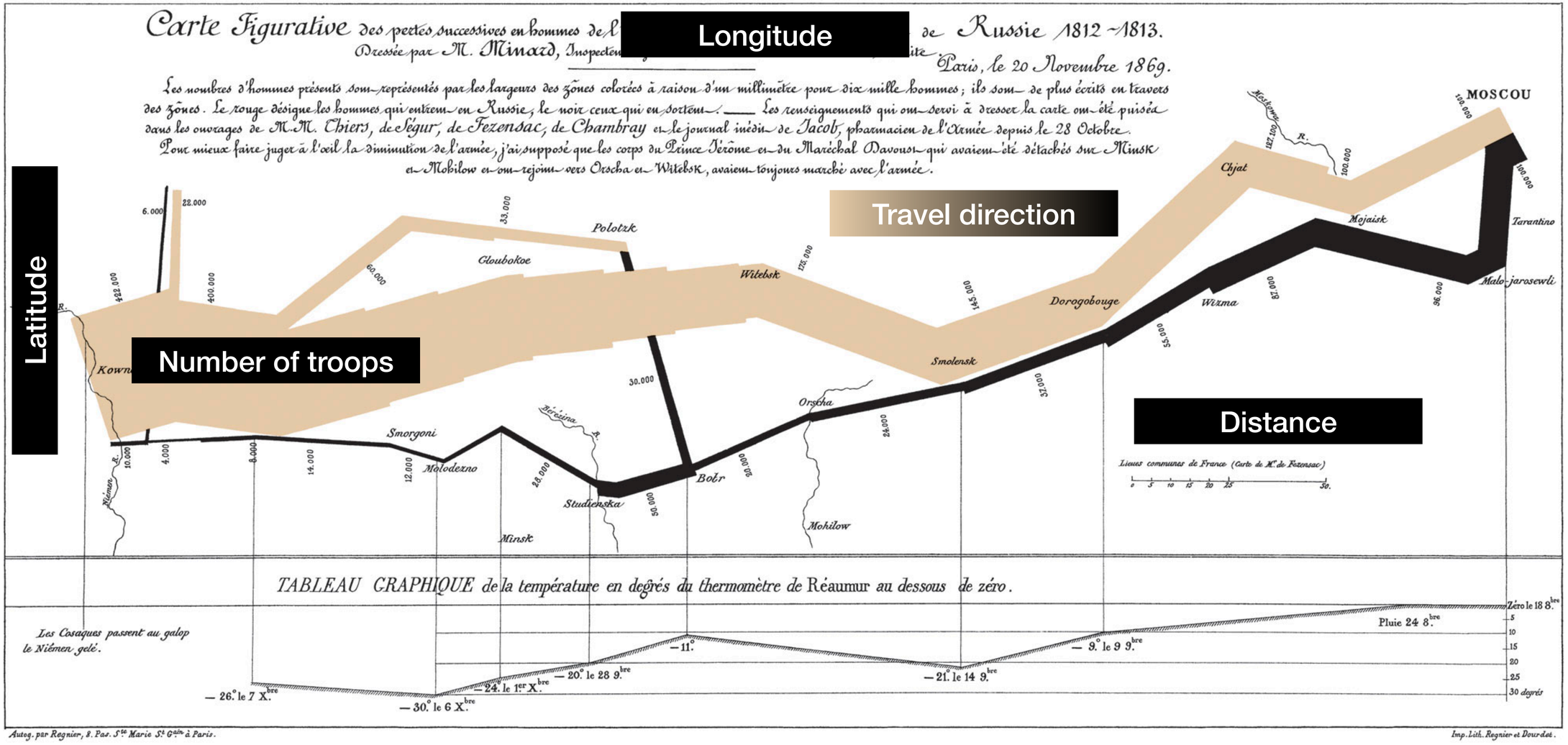


Charles Joseph Minard

“Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813”

“The best statistical graph ever drawn”



Charles Joseph Minard

“Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813”

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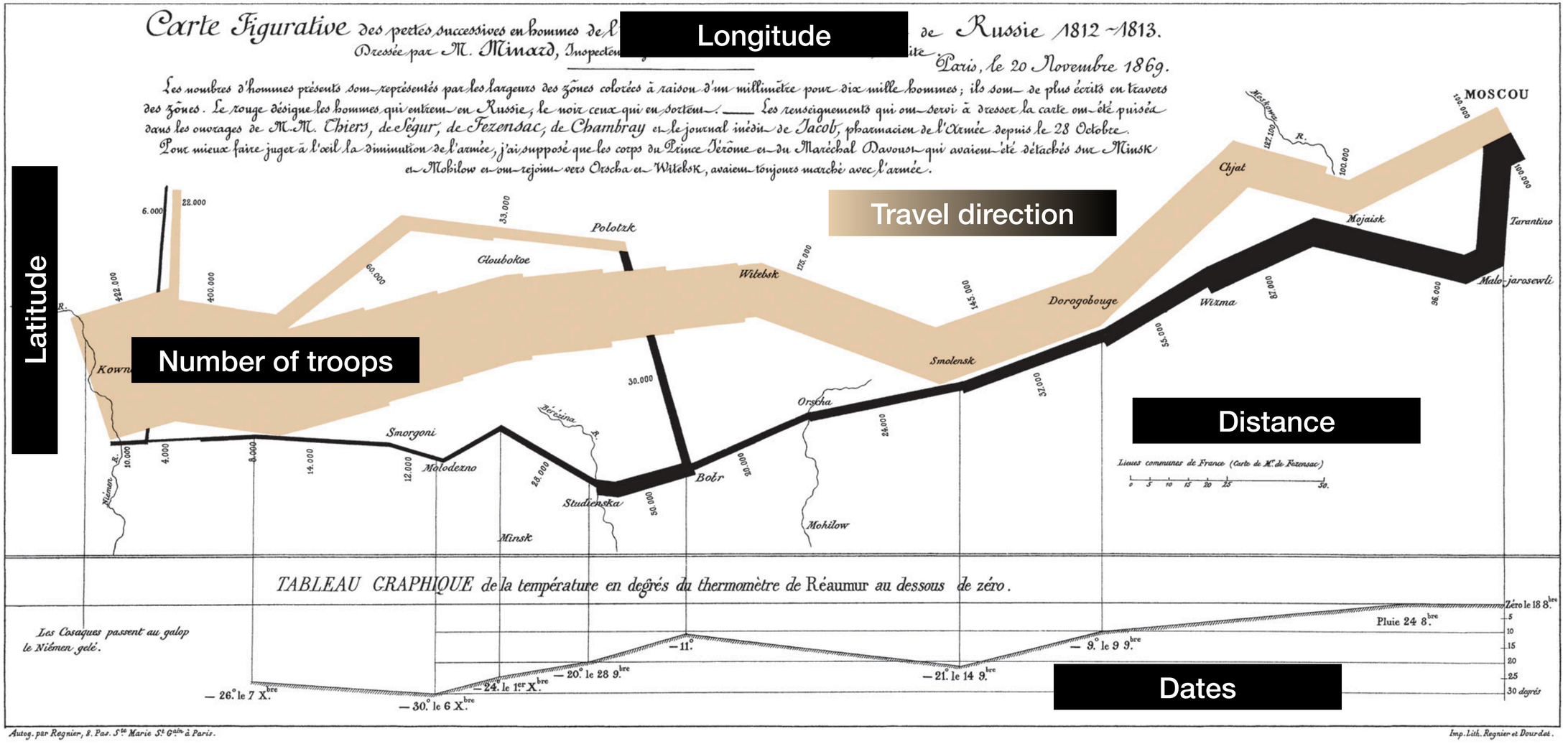
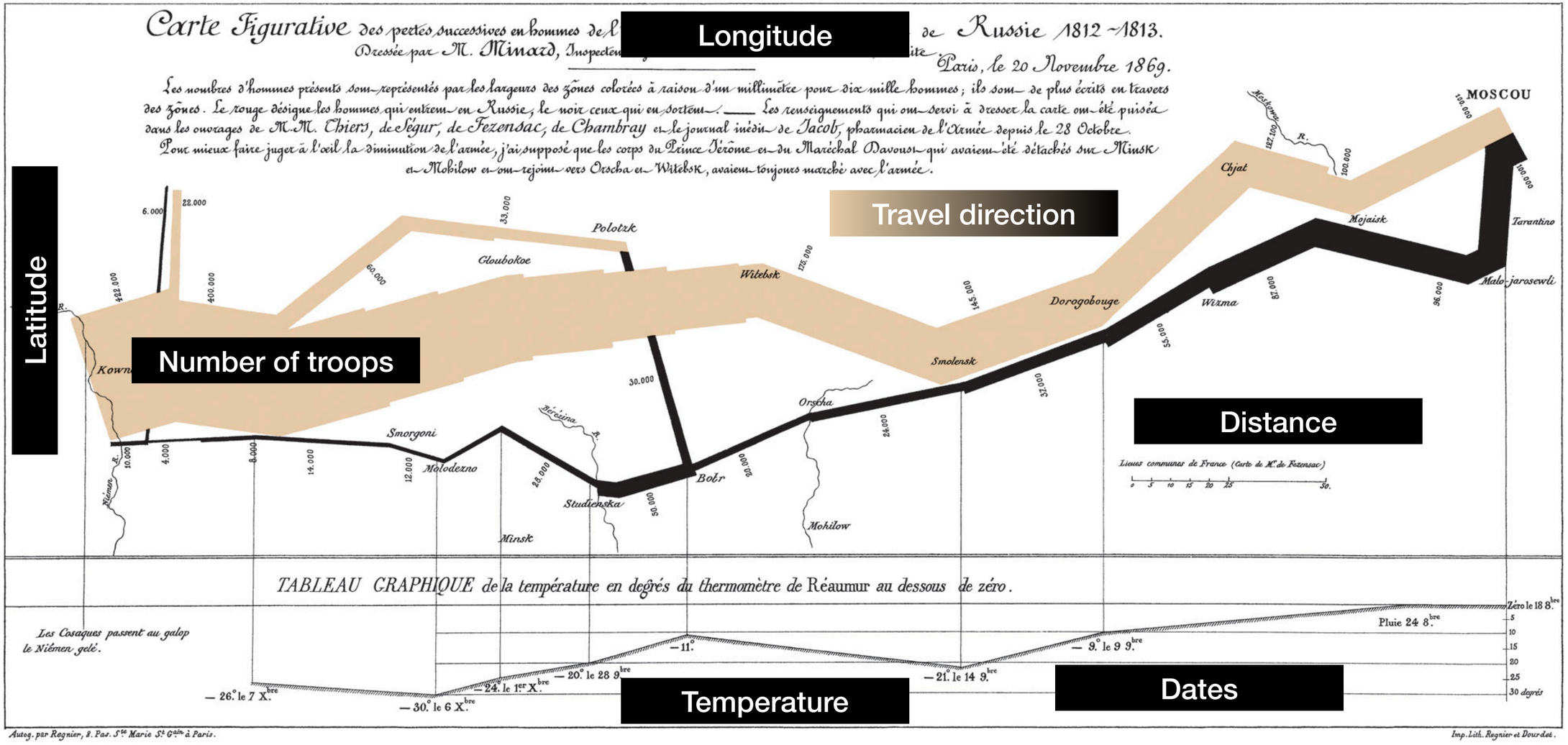


Charles Joseph Minard

“Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813”

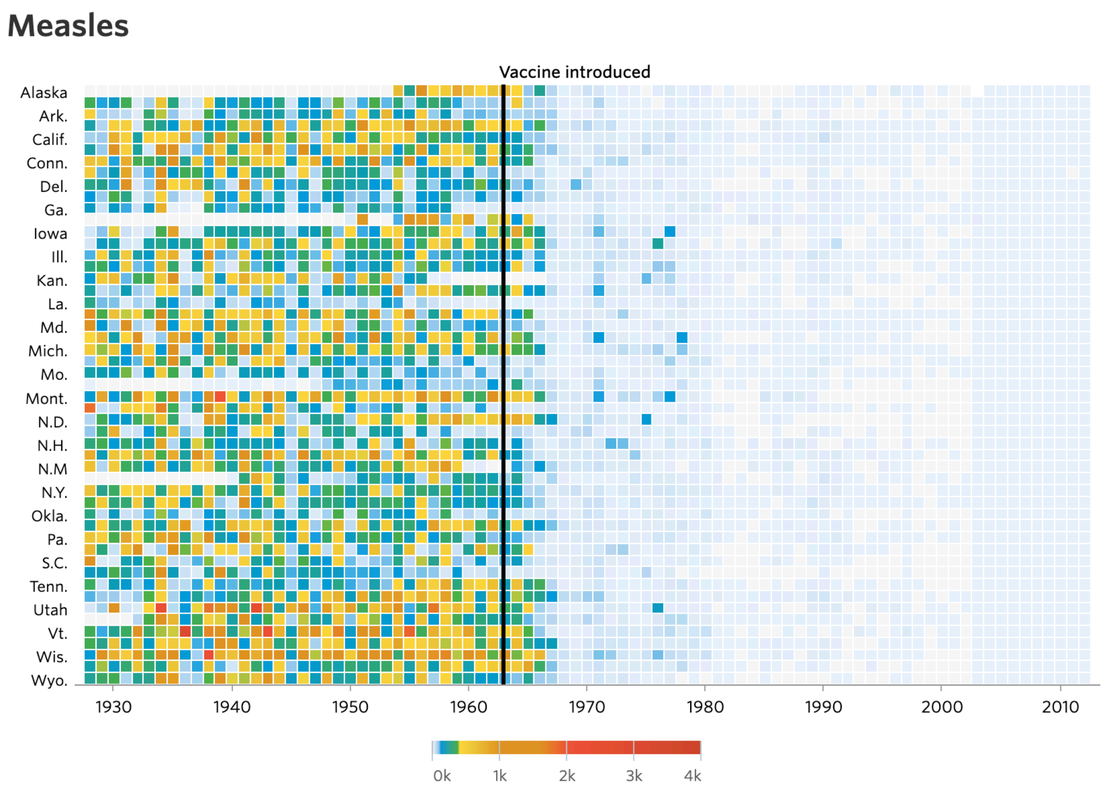
“The best statistical graph ever drawn”

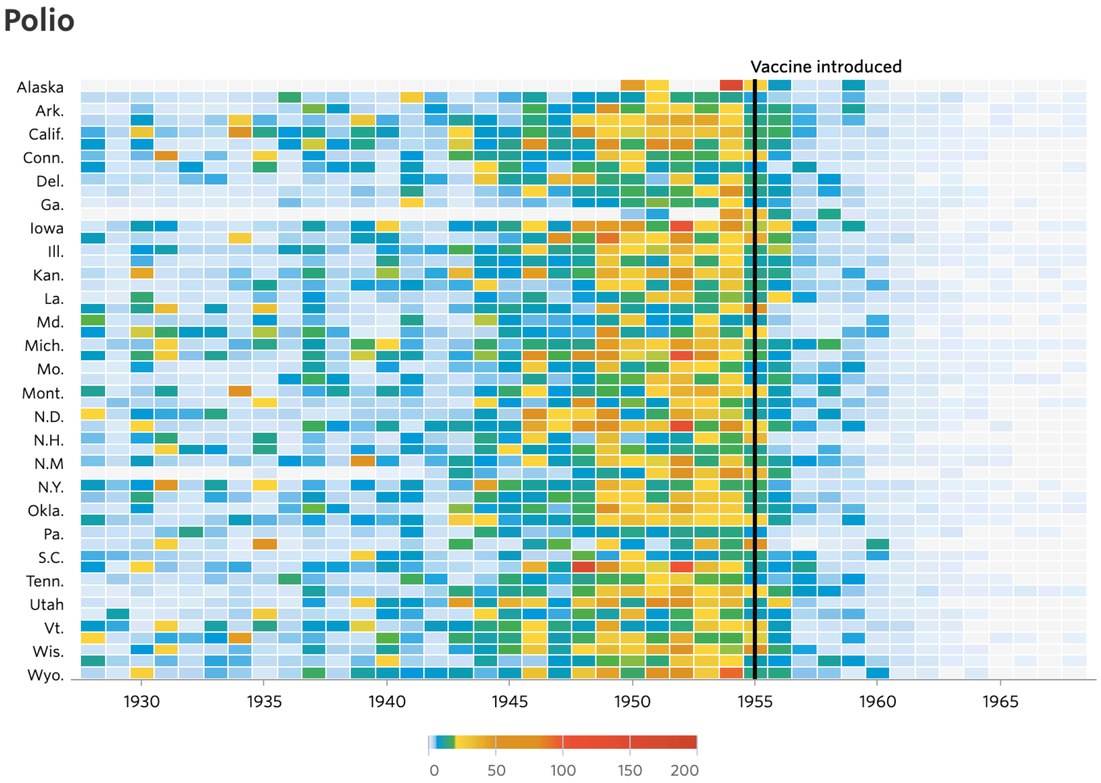


Charles Joseph Minard

“Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813”

The impact of vaccines on infectious diseases





Battling Infectious Diseases in the 20th Century: The Impact of Vaccines

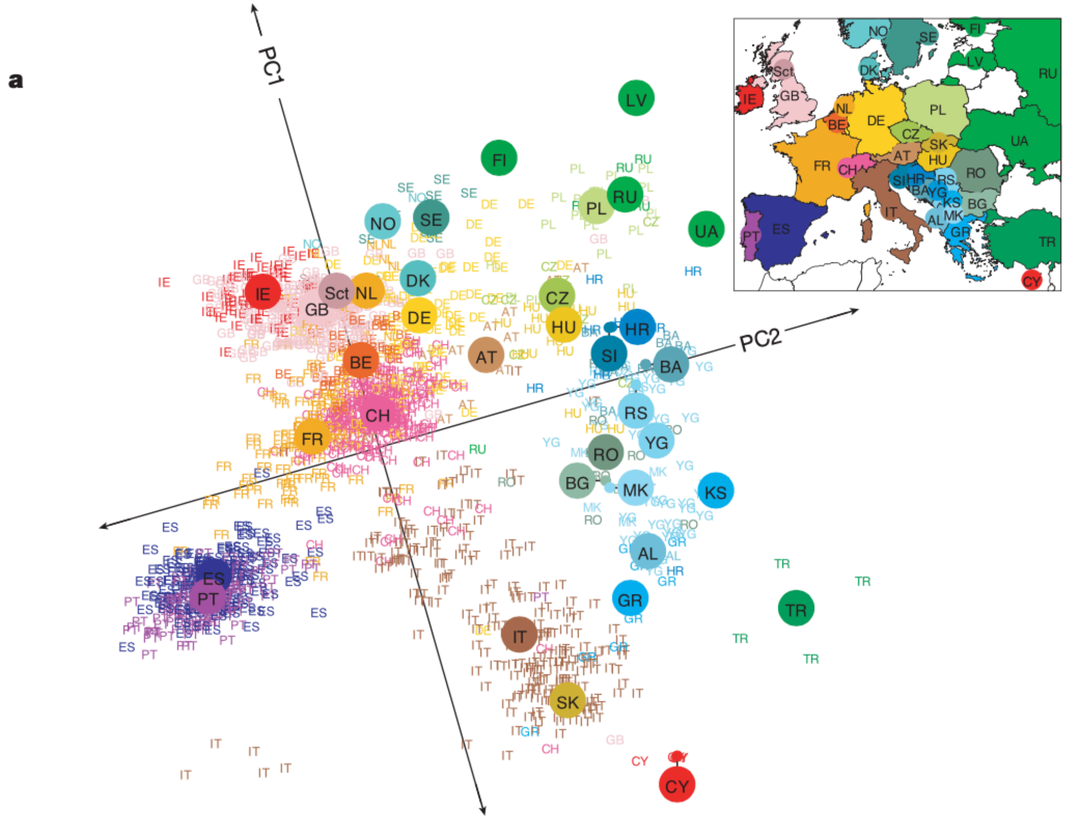
By **Tynan DeBold** and **Dov Friedman**

Published Feb. 11, 2015 at 3:45 p.m. ET

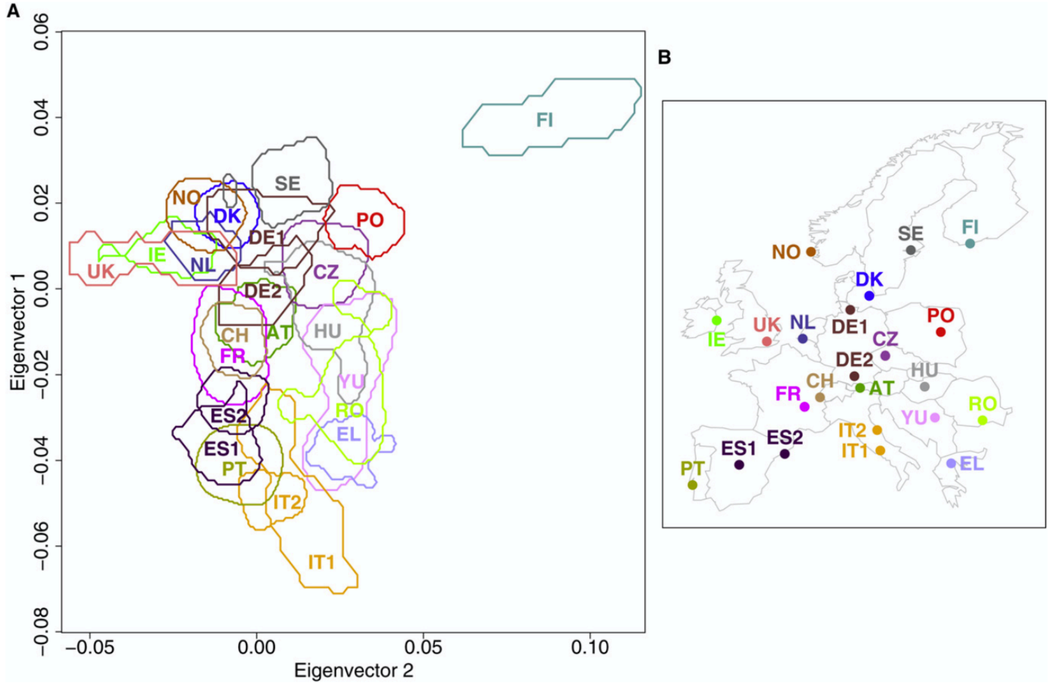
graphics.wsj.com/infectious-diseases-and-vaccines/

A tale of two visualisations

Novembre et al 2008



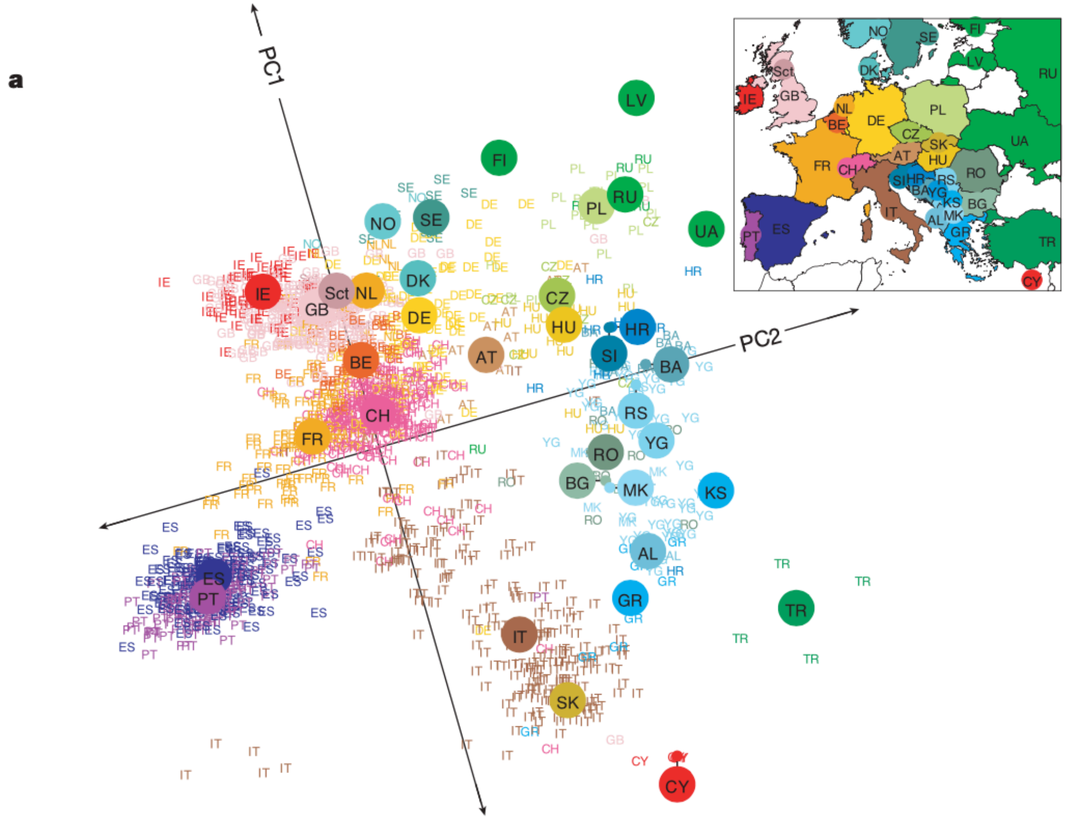
Lao et al 2008



Which visualisation do you prefer?

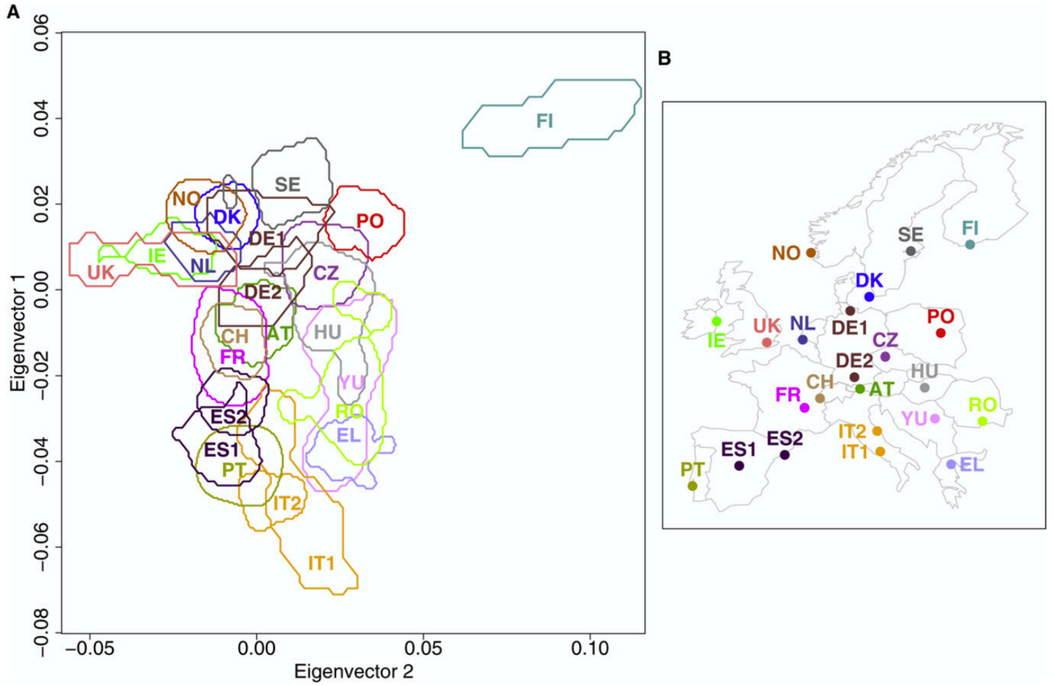
A tale of two visualisations

Novembre et al, 31/8/2008
"Genes mirror geography in Europe"



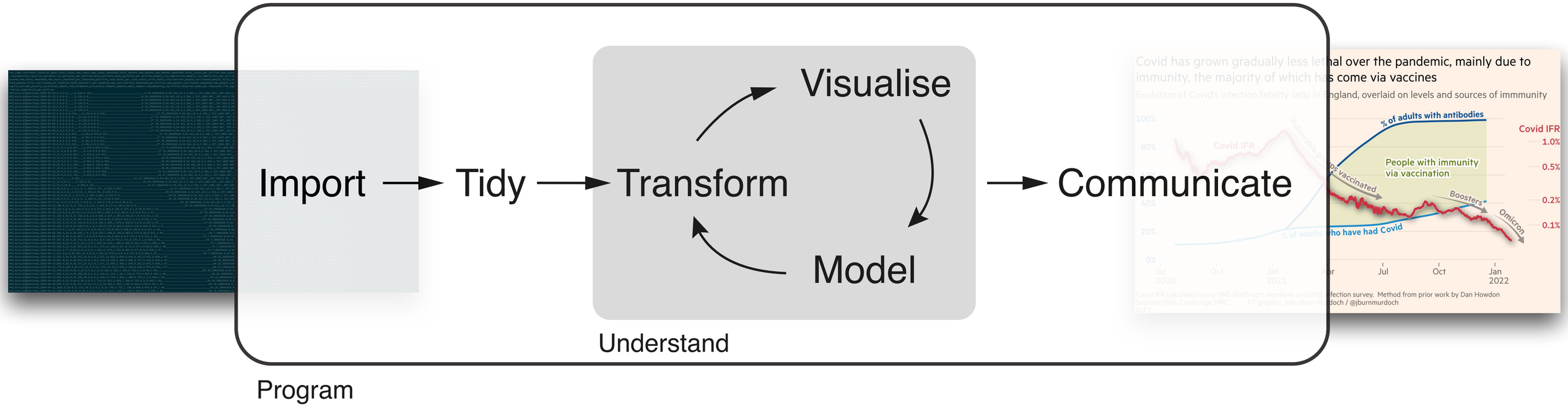
1,822 citations (Nature)

Lao et al, 26/8/2008
"Correlation between Genetic and Geographic Structure in Europe"



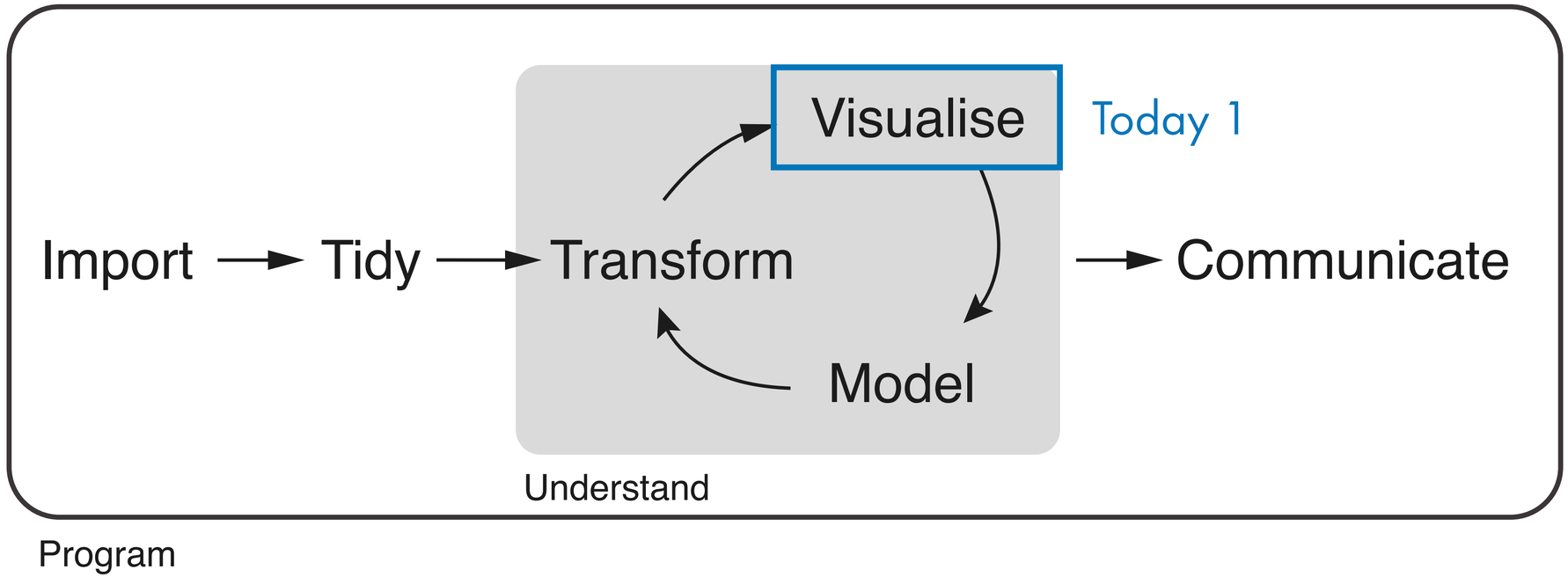
610 citations (Current Biology)

A data science project workflow



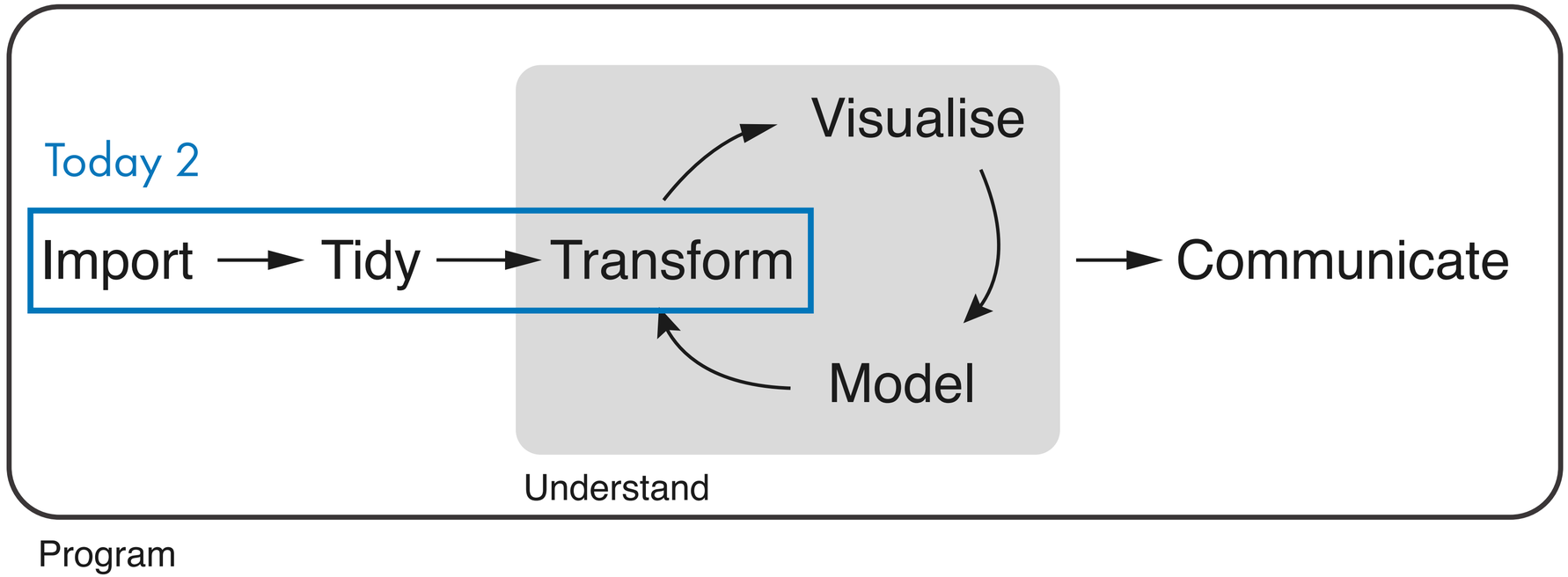
https://r4ds.had.co.nz/introduction.html

A data science project workflow



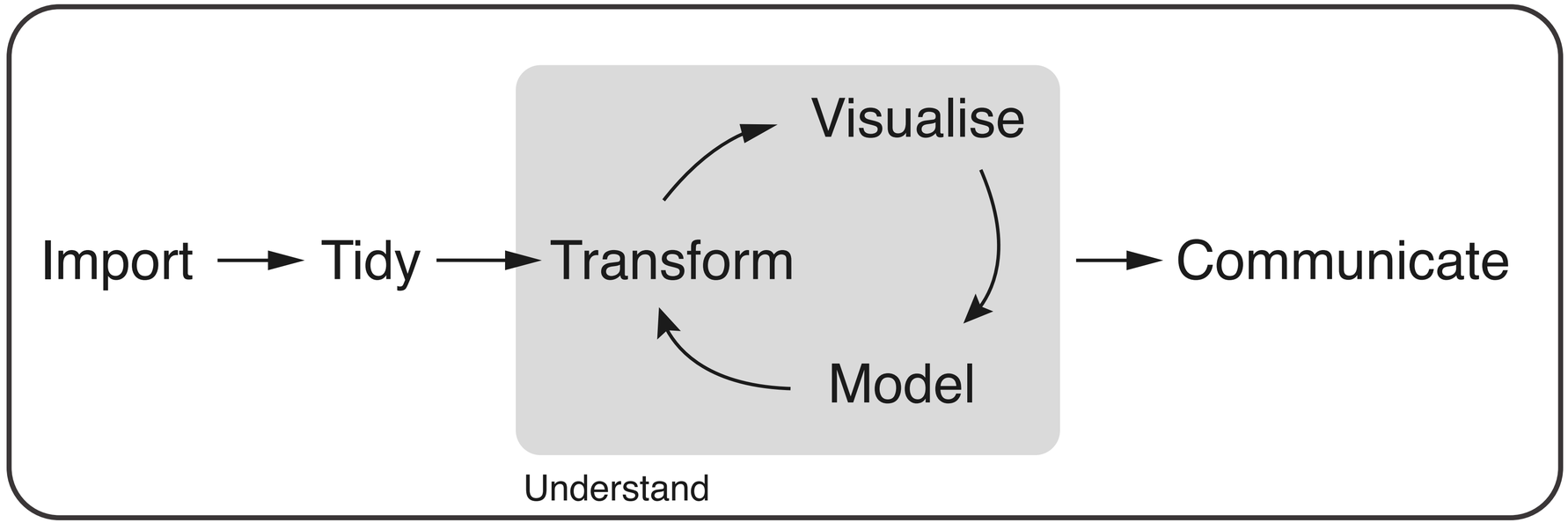
https://r4ds.had.co.nz/introduction.html

A data science project workflow



https://r4ds.had.co.nz/introduction.html

A data science project workflow

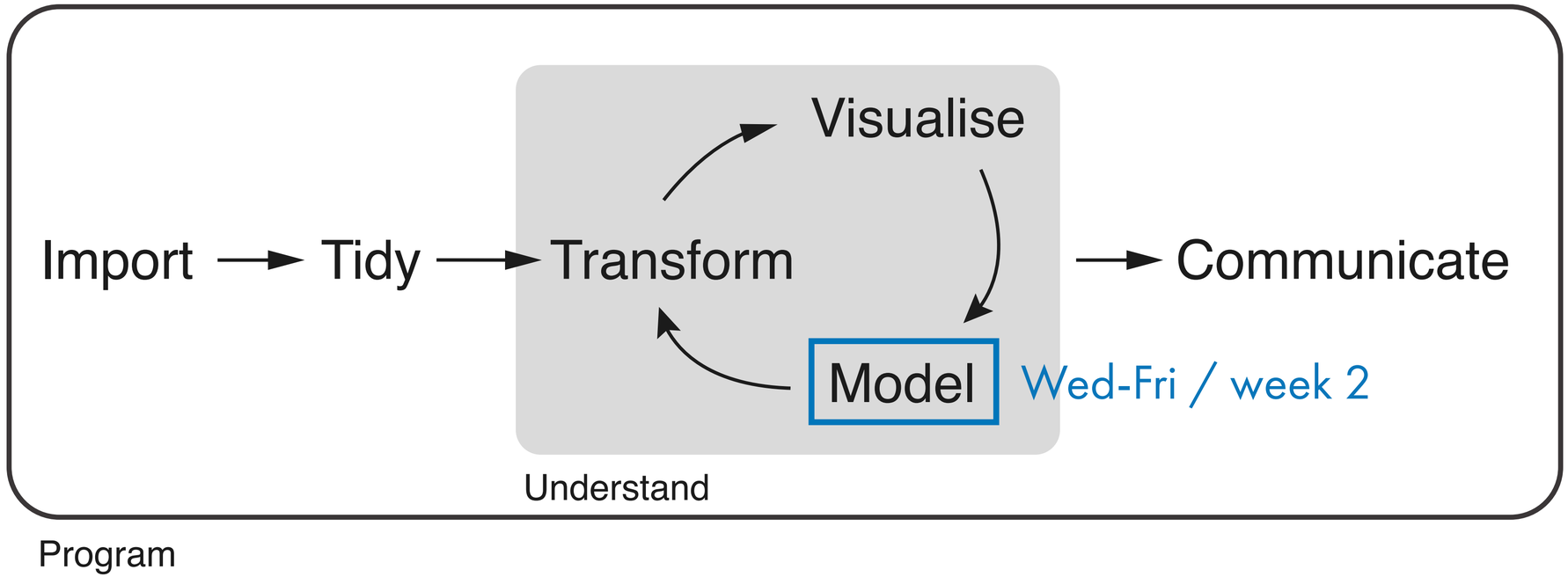


Program

Week 2

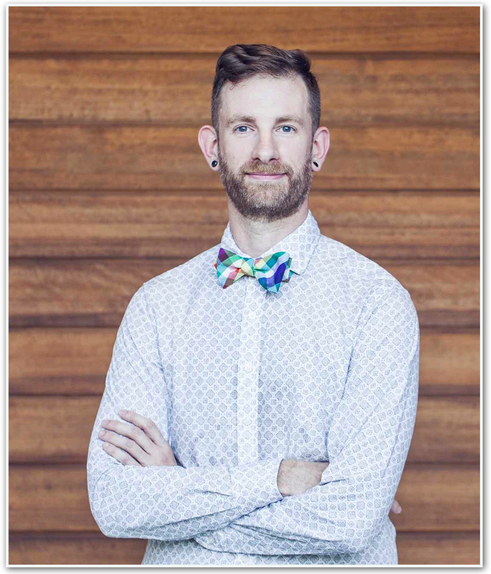
https://r4ds.had.co.nz/introduction.html

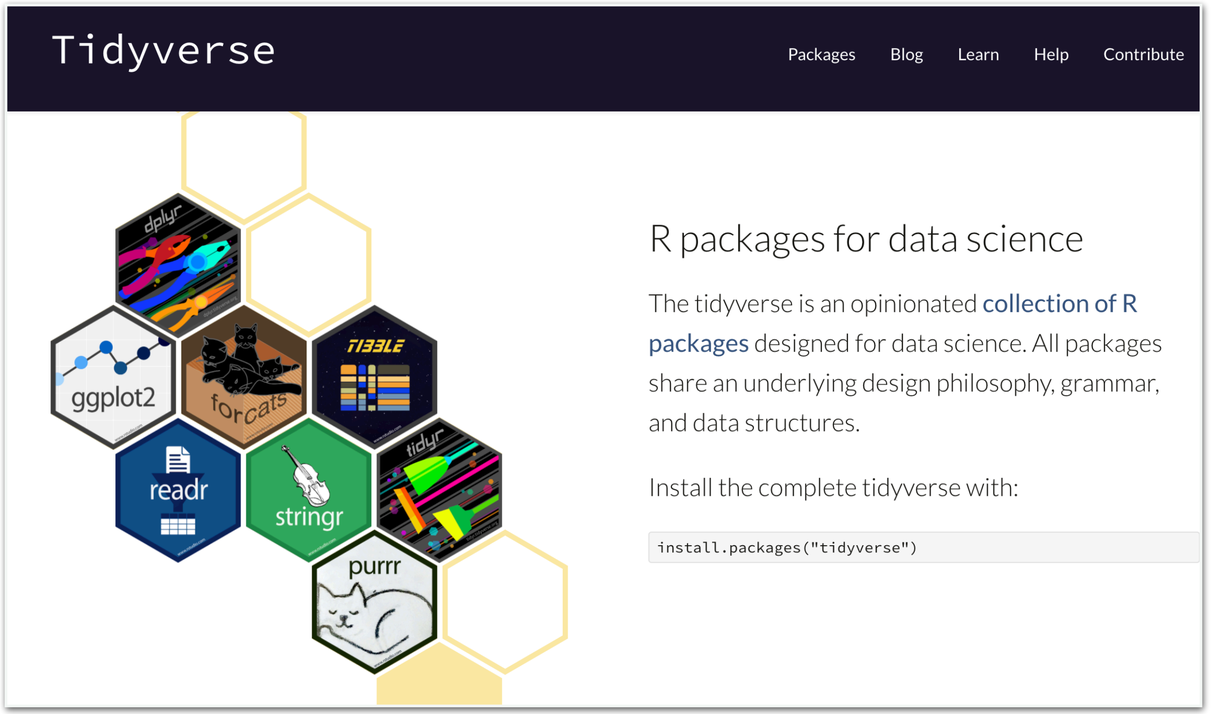
A data science project workflow



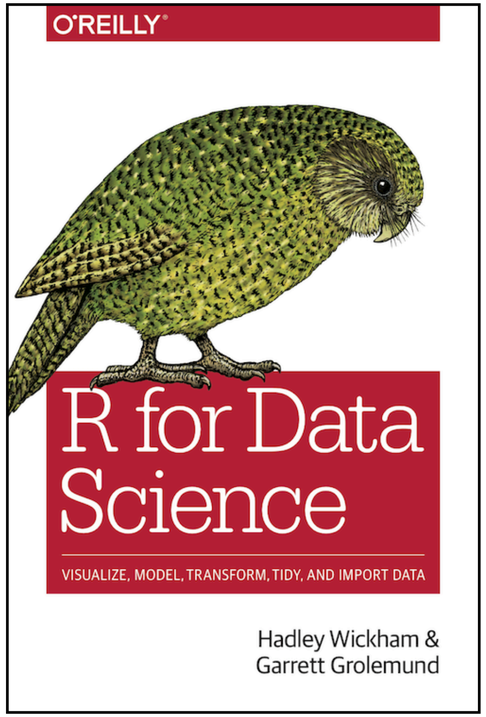
https://r4ds.had.co.nz/introduction.html

The tidyverse



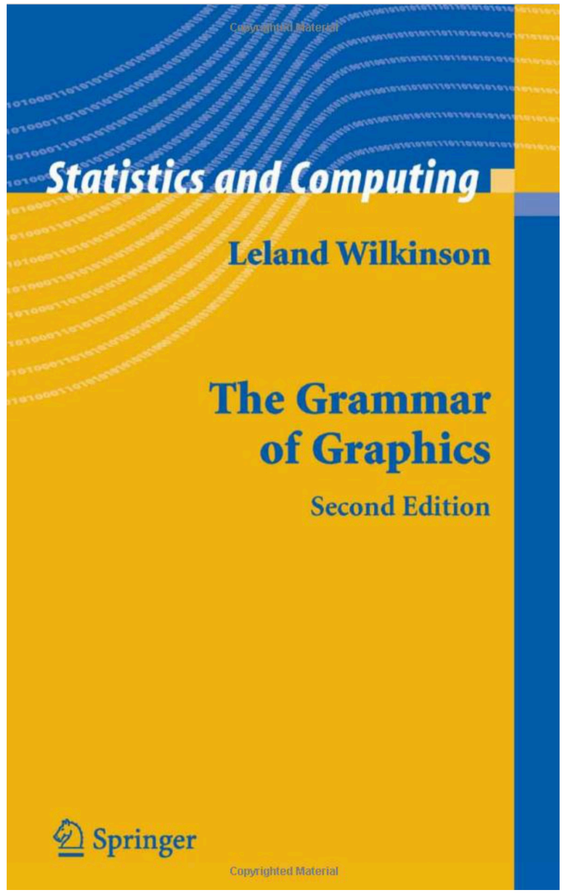


www.tidyverse.org

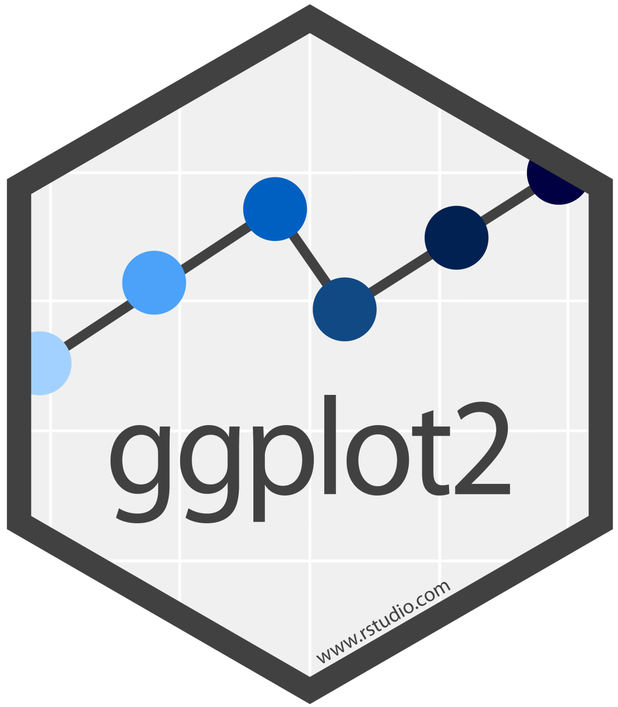


r4ds.had.co.nz

A layered grammar of graphics



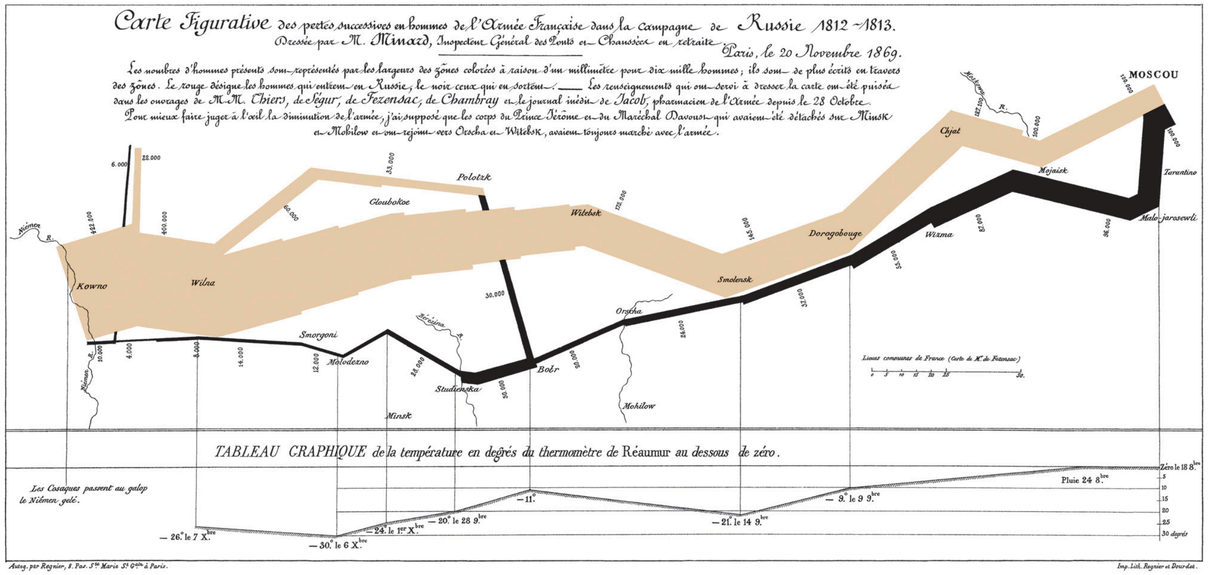
A description of the fundamental features that underlie all statistical graphics



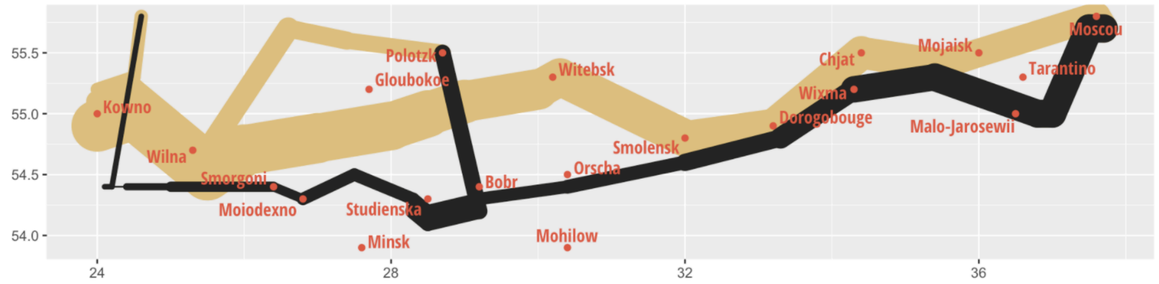
A toolkit implementing the grammar of graphics in R

A layered grammar of graphics

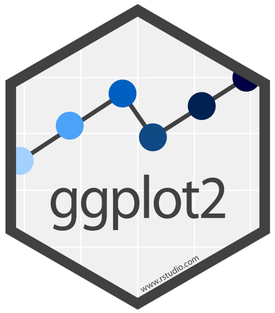
Original



ggplot2 version

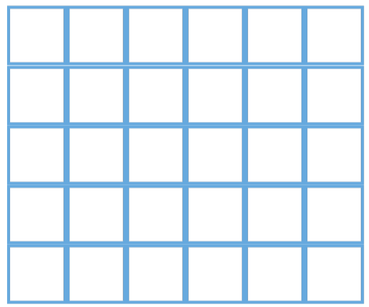



```
ggplot() +
  geom_path(data = troops, aes(x = long, y = lat, group = group,
                               color = direction, size = survivors),
            lineend = "round") +
  geom_point(data = cities, aes(x = long, y = lat),
             color = "#DC5B44") +
  geom_text_repel(data = cities, aes(x = long, y = lat, label = city),
                  color = "#DC5B44", family = "Open Sans Condensed Bold") +
  scale_size(range = c(0.5, 15)) +
  scale_colour_manual(values = c("#DFC17E", "#252523")) +
  labs(x = NULL, y = NULL) +
  guides(color = FALSE, size = FALSE)
```



https://www.andrewheiss.com/blog/2017/08/10/exploring-minards-1812-plot-with-ggplot2/

A layered grammar of graphics



data

MAPPED TO

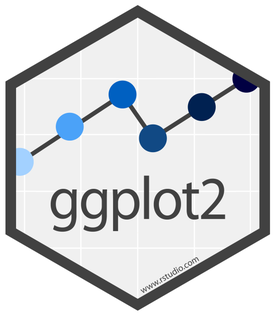
aesthetic properties

OF

geometric objects

- **x + y** → **geom_point**
- **color** → **geom_histogram**
- **fill** → **geom_bar**
- **alpha** → **geom_line**

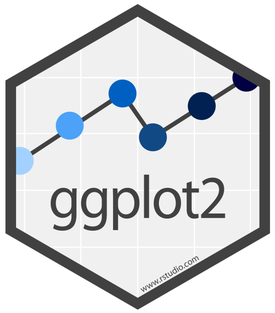
statistical transformations (sometimes)



https://rfortherestofus.com/2019/07/a-short-overview-of-the-grammar-of-graphics/

A layered grammar of graphics

```
ggplot (data = <DATA>) +                                    ] required
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>),
```



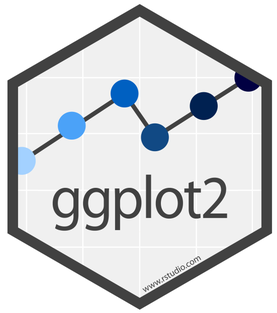
https://posit.co/wp-content/uploads/2022/10/data-visualization-1.pdf

A layered grammar of graphics

```
ggplot (data = <DATA>) +
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>),
 stat =<STAT>, position =<POSITION>) +
<COORDINATE_FUNCTION>+
<FACET_FUNCTION>+
<SCALE_FUNCTION>+
<THEME_FUNCTION>
```

required

Not required, sensible defaults supplied



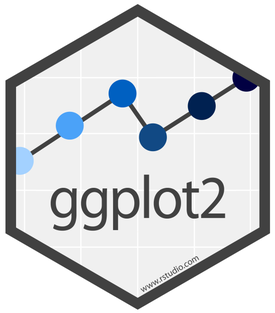
https://posit.co/wp-content/uploads/2022/10/data-visualization-1.pdf

Aesthetics

Geometric shapes

Scales

Themes



Aesthetics

Geometric shapes

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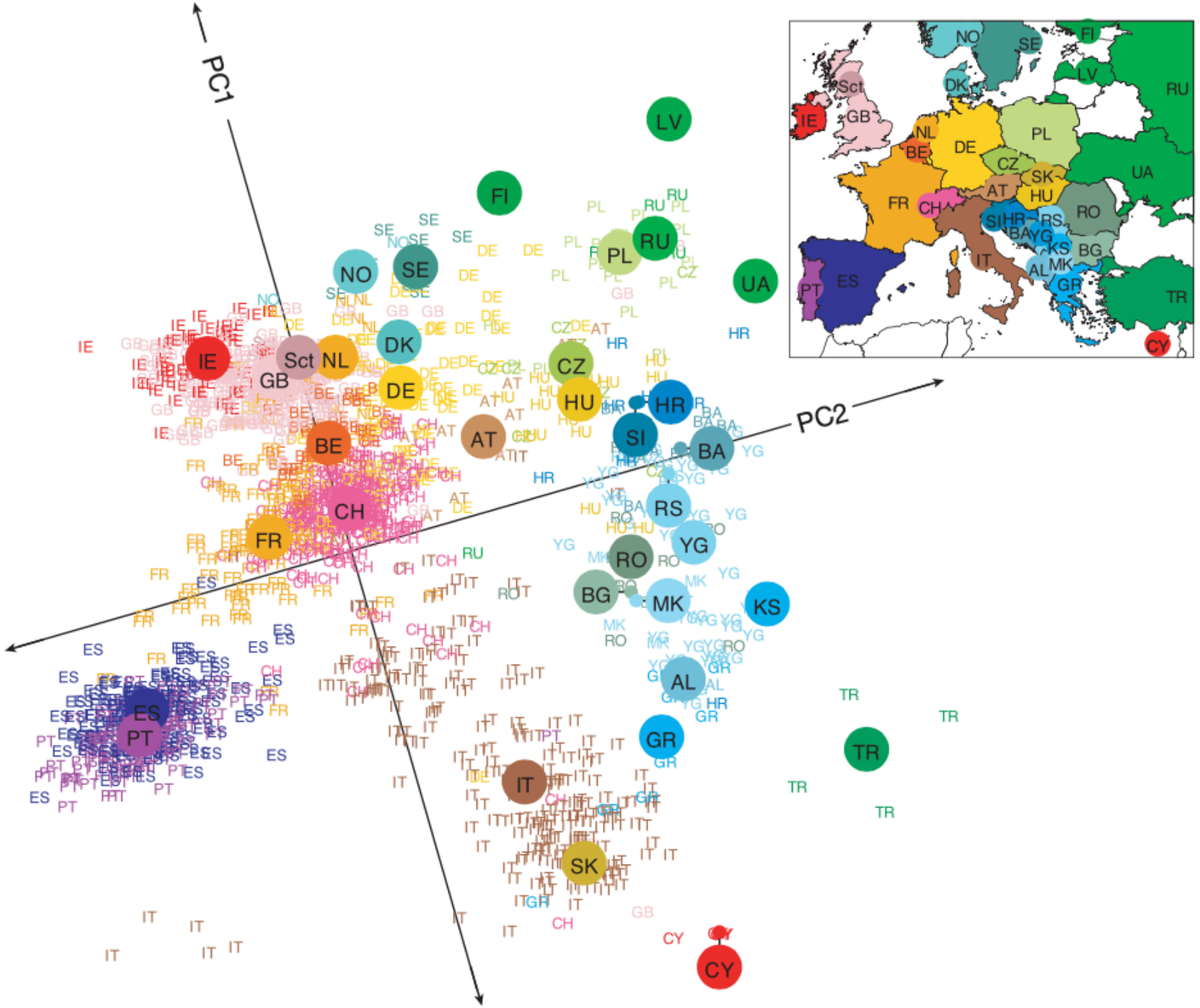

Which aesthetic attributes are used here to visualise attributes of the dataset?

Aesthetics

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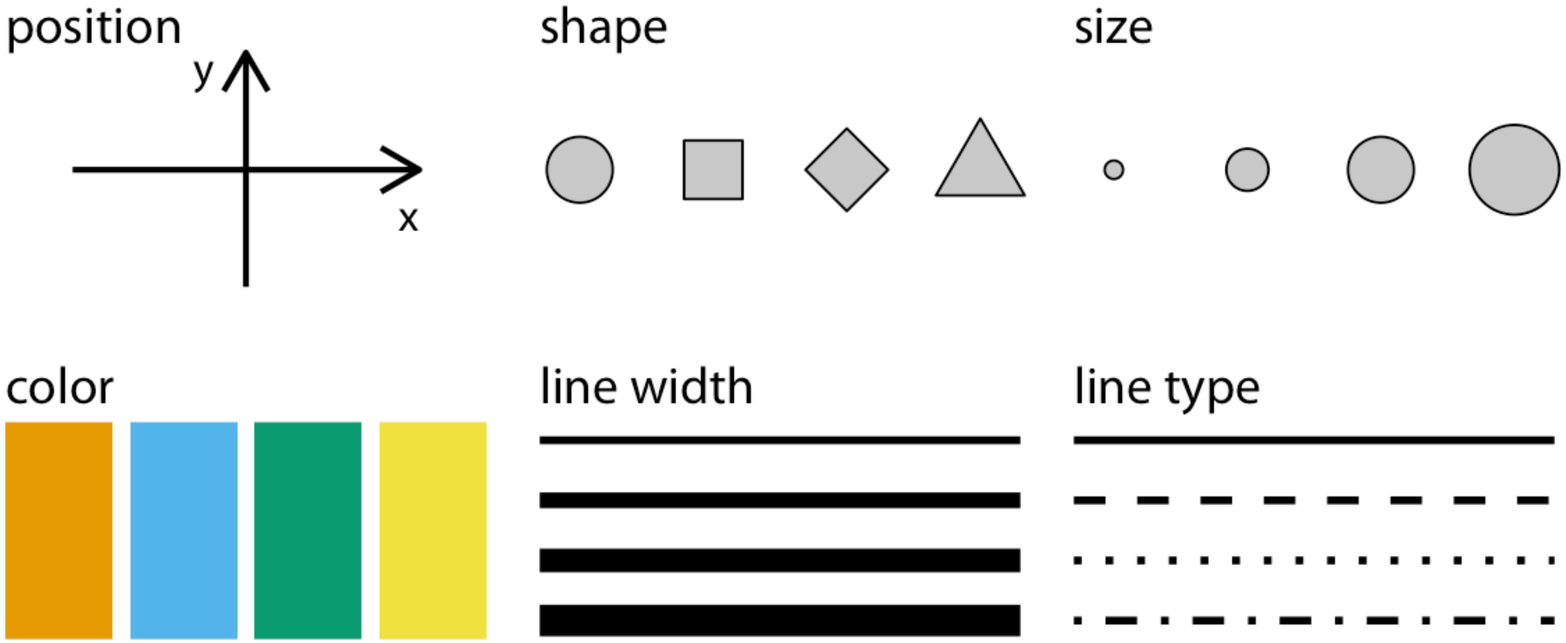

Commonly used aesthetics

https://clauswilke.com/dataviz/aesthetic-mapping.html#aesthetics-and-types-of-data

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Aes Common aesthetic values.

color and **fill** - string ("red", "#RRGGBB")

linetype - integer or string (0 = "blank", 1 = "solid", 2 = "dashed", 3 = "dotted", 4 = "dotdash", 5 = "longdash", 6 = "twodash")

lineend - string ("round", "butt", or "square")

linejoin - string ("round", "mitre", or "bevel")

size - integer (line width in mm)

shape - integer/shape name or a single character ("a")

Values for commonly used aesthetics

https://posit.co/wp-content/uploads/2022/10/data-visualization-1.pdf

Aesthetics

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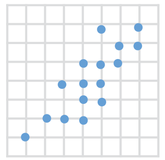
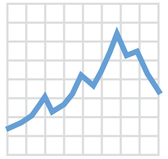
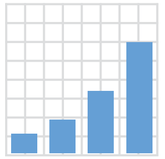


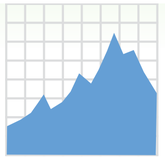
e + geom_point()
x, y, alpha, color, fill, shape, size, stroke



i + geom_line()
x, y, alpha, color, group, linetype, size



f + geom_col()
x, y, alpha, color, fill, group, linetype, size



c + geom_area(stat = "bin"**)**
x, y, alpha, color, fill, linetype, size

Individual geoms - one distinct object per data point

https://posit.co/wp-content/uploads/2022/10/data-visualization-1.pdf

Aesthetics

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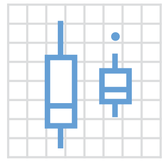
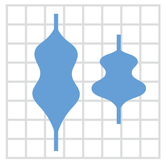
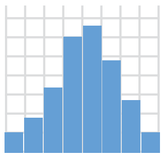


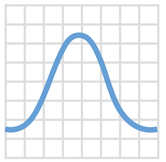
f + geom_boxplot()
x, y, lower, middle, upper, ymax, ymin, alpha,
color, fill, group, linetype, shape, size, weight



f + geom_violin(scale = “area"**)**
x, y, alpha, color, fill, group, linetype, size, weight

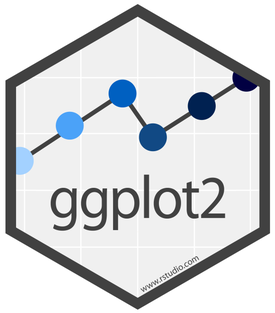


c + geom_histogram(binwidth = 5**)**
x, y, alpha, color, fill, linetype, size, weight



c + geom_density(kernel = "gaussian"**)**
x, y, alpha, color, fill, group, linetype, size, weight

Collective geoms - one distinct object for multiple data points



Aesthetics

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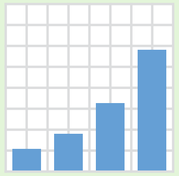
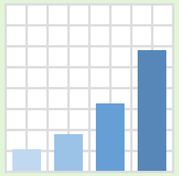
Scales map data values to the visual values of an aesthetic. To change a mapping, add a new scale.



```
n <- d + geom_bar(aes(fill = fl))
```



```
n + scale_fill_manual(
    values = c("skyblue", "royalblue", "blue", "navy"),
    limits = c("d", "e", "p", "r"), breaks =c("d", "e", "p", “r"),
    name = "fuel", labels = c("D", "E", "P", "R"))
```

scale_

aesthetic to adjust

prepackaged scale to use

scale-specific arguments

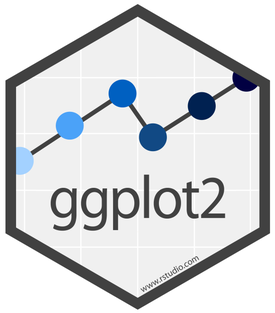
range of values to include in mapping

title to use in legend/axis

labels to use in legend/axis

breaks to use in legend/axis

Example of manually setting a scale for aesthetic `fill`



https://posit.co/wp-content/uploads/2022/10/data-visualization-1.pdf

Aesthetics

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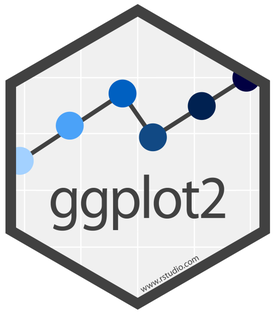
scale_*_continuous() - Map cont' values to visual ones.
scale_*_discrete() - Map discrete values to visual ones.
scale_*_binned() - Map continuous values to discrete bins.
scale_*_identity() - Use data values as visual ones.
scale_*_manual(values = c()**)** - Map discrete values to manually chosen visual ones.

scale_x_log10() - Plot x on log10 scale.
scale_x_reverse() - Reverse the direction of the x axis.
scale_x_sqrt() - Plot x on square root scale.

Examples of different scales



https://posit.co/wp-content/uploads/2022/10/data-visualization-1.pdf

Aesthetics

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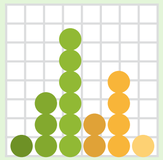
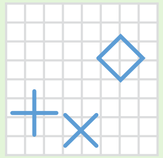
o + scale_fill_gradient(low="red", high="yellow"**)**

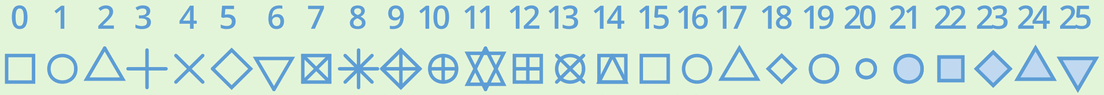
o + scale_fill_gradient2(low = "red", high = "blue", mid = "white", midpoint = 25**)**

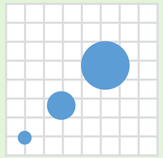


o + scale_fill_gradientn(colors = topo.colors(6)**)**
Also: rainbow(), heat.colors(), terrain.colors(), cm.colors(), RColorBrewer::brewer.pal()



p + scale_shape() + scale_size()
p + scale_shape_manual(values = c(3:7)**)**





p + scale_radius(range = c(1,6)**)**
p + scale_size_area(max_size = 6**)**

Examples of different scales

https://posit.co/wp-content/uploads/2022/10/data-visualization-1.pdf

Aesthetics

Geometric shapes

Scales

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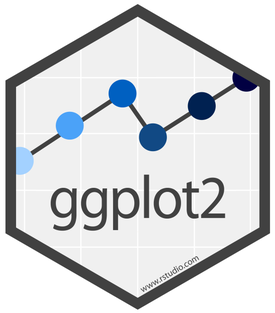
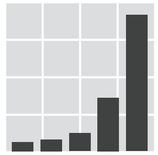


r + theme() Customize aspects of the theme such as axis, legend, panel, and facet properties.



r + theme_gray()
Grey background
(default theme).

Themes control the non-data elements of a plot

Aesthetics

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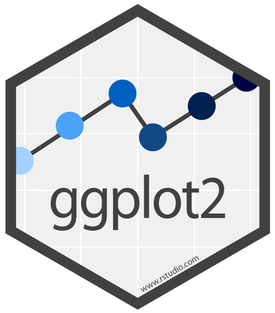

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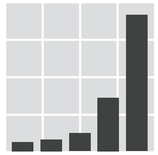
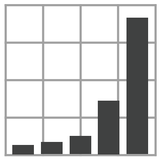
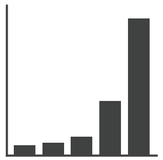


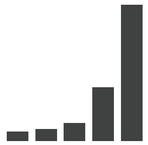
r + theme_gray()
Grey background
(default theme).



r + theme_bw()
White background
with grid lines.



r + theme_classic()

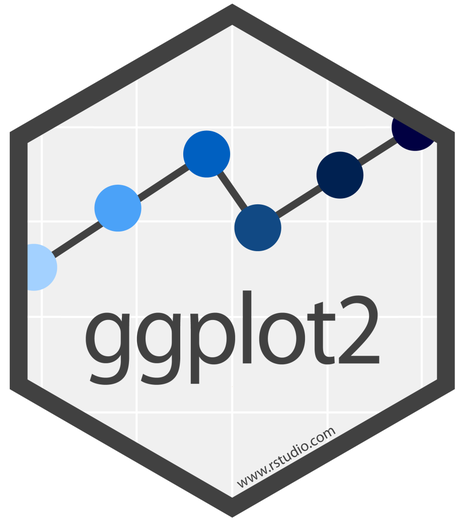


r + theme_void()
Empty theme.

Examples of available pre-defined themes

Programme for today

- Introductory lecture
- Hands-on dataviz tutorial
- Individual exercises



At the end of the day you should be familiar with making visualisations in R using the ggplot2 package