

Curs 01 – Why

Știința datelor vs. analiza statistică

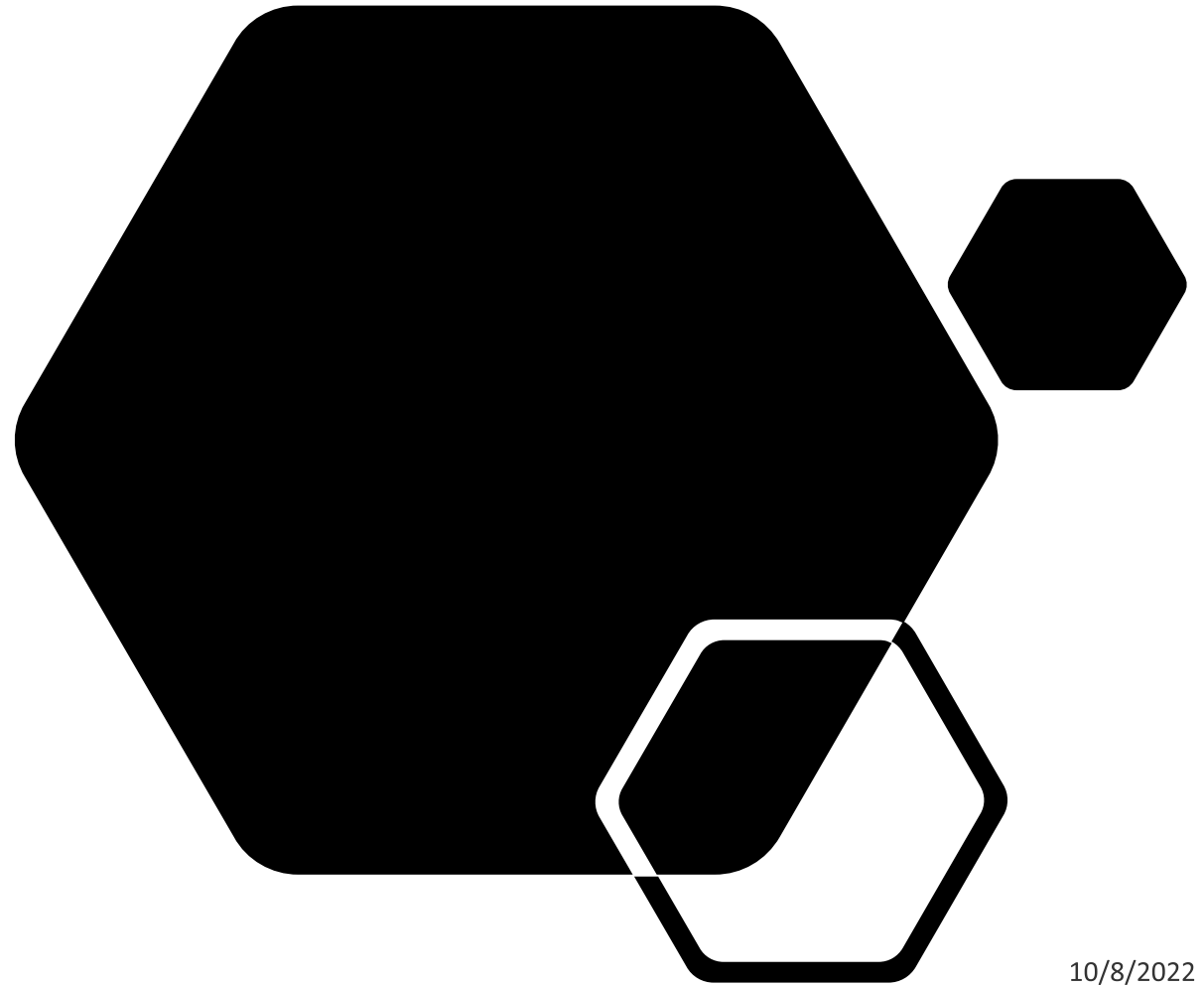
Why?

Obiective ale analizei statistice

Structura cursului

1. Why?
 - Știința datelor vs. analiza statistică
 - Why?
 - Obiective ale analizei statistice
2. Cauzalitate
3. Măsurare
4. Modelare și eșantionare
5. Tehnici de analiză
6. Predicție
7. Programare și ML
8. ML și Deep Learning
9. Producția
10. Why Privacy?
11. Privacy Preserving Algorithms
12. Privacy Architectures and Federated Learning

Știința datelor vs. analiza statistică



10/8/2022



Ce este o știință?

- Studiul prin metode falsificabile al unei forme de ordine a lumii
 - Științe ale **naturii**: chimie, fizică, biologie, geografie, meteorologie, ecologie
 - Științe ale **minții umane**: psihologie
 - Științe ale **creațiilor oamenilor**: istorie, istoria artei, lingvistică, economie, sociologie, științe politice, știința calculatoarelor...
 - Și **știința datelor**?
 - Din acest pdv. nu sunt științe: matematica, filosofia, teologia (?), arta

Care este obiectul științei datelor?

- Analiza statistică a datelor este folosită în practic toate științele naturii, omului și societății – de ex.
 - Încălzirea globală
 - „personalitatea”, „IQ”
 - Inegalitatea socială, mobilitatea socială
- Știința datelor studiază formele de ordine din date
 - „patternuri”



Analiza statistică vs. știința datelor /ML

Analiza statistică a datelor

- Date structurate
 - Unități și variabile coerente
- Modele explicative vin din disciplinele științifice
 - **Nu** din date
- Obiectul analizei: fenomenul
- Scop: înțelegere și predicție

Știința datelor / ML

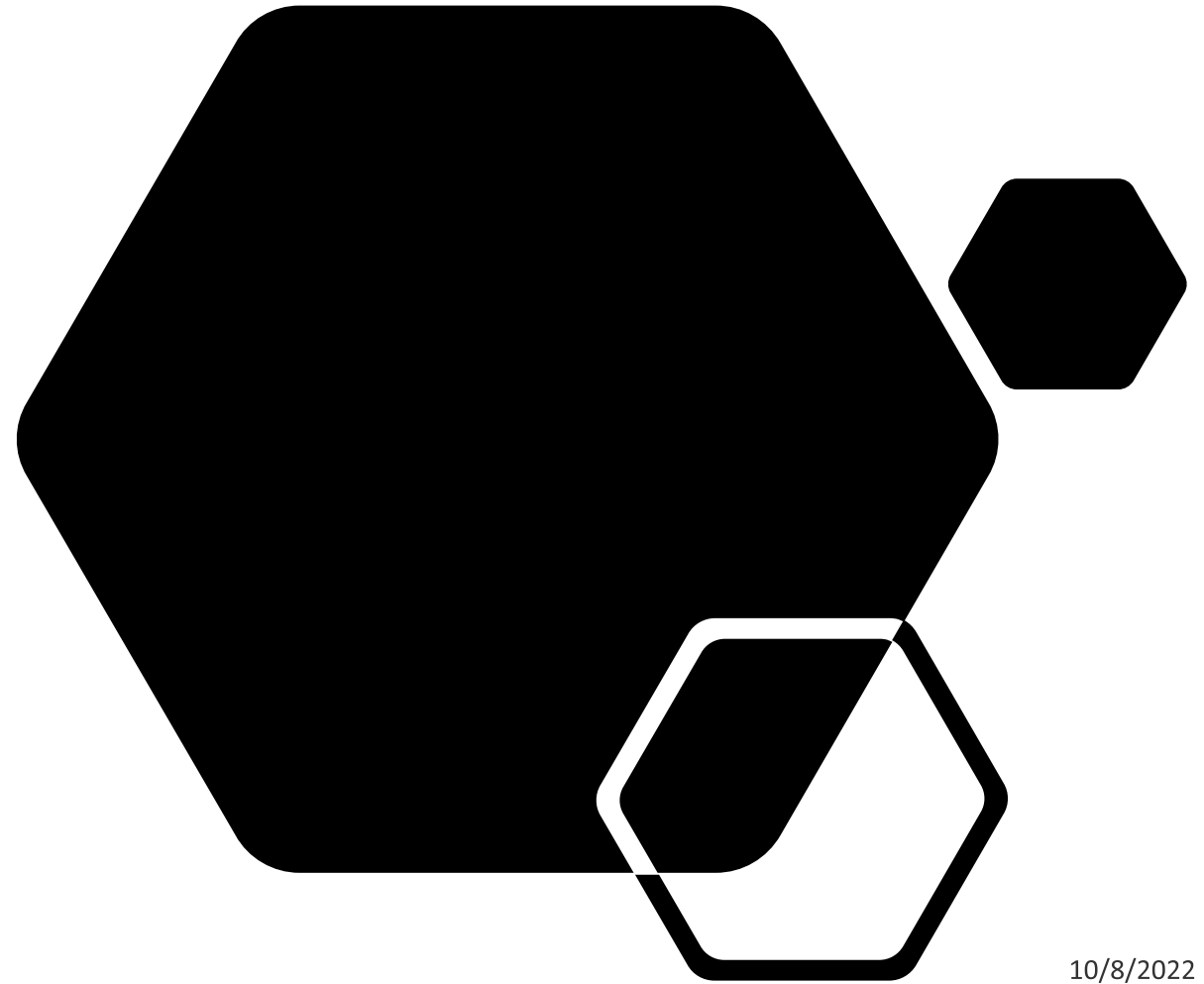
- Date vaste / nestructurate
 - Structuri eterogene
 - Unități și variabile diverse
- Modelele sunt generate automat, ad-hoc din date
- Obiectul analizei: patternuri
- Scop: clasificare și predicție

Importanța analizei statistice pentru DS

- Analiza statistică oferă modelul conceptual pentru DS
- Ce sunt pattern-urile?
 - Distribuții
 - Tendințe
 - Asocieri și corelații
 - Dimensiuni
 - Inegalități
 - Estimări cauzale
 - Categori
- Interpretări, limitări, mod de folosire



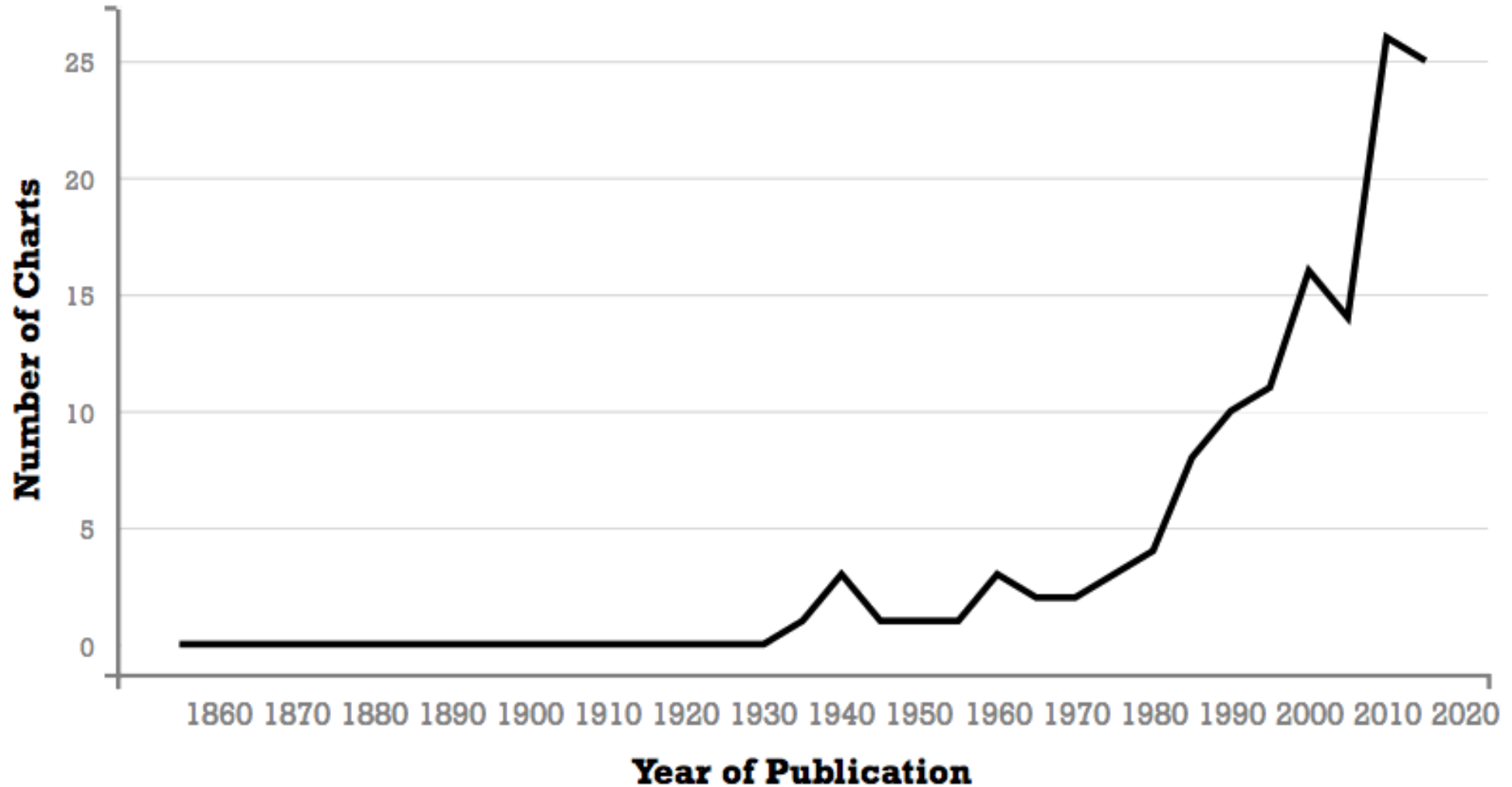
Why?



10/8/2022

The Rise of the Chart in the Newspaper

The # of Charts in a September Issue of the New York Times (Checked Every Five Years)



● **Big Data**
Search term

● **Data Science**
Search term

● **Data Analytics**
Search term

+ Add comparison

Worldwide ▾

1/1/09 - 8/10/22 ▾

All categories ▾

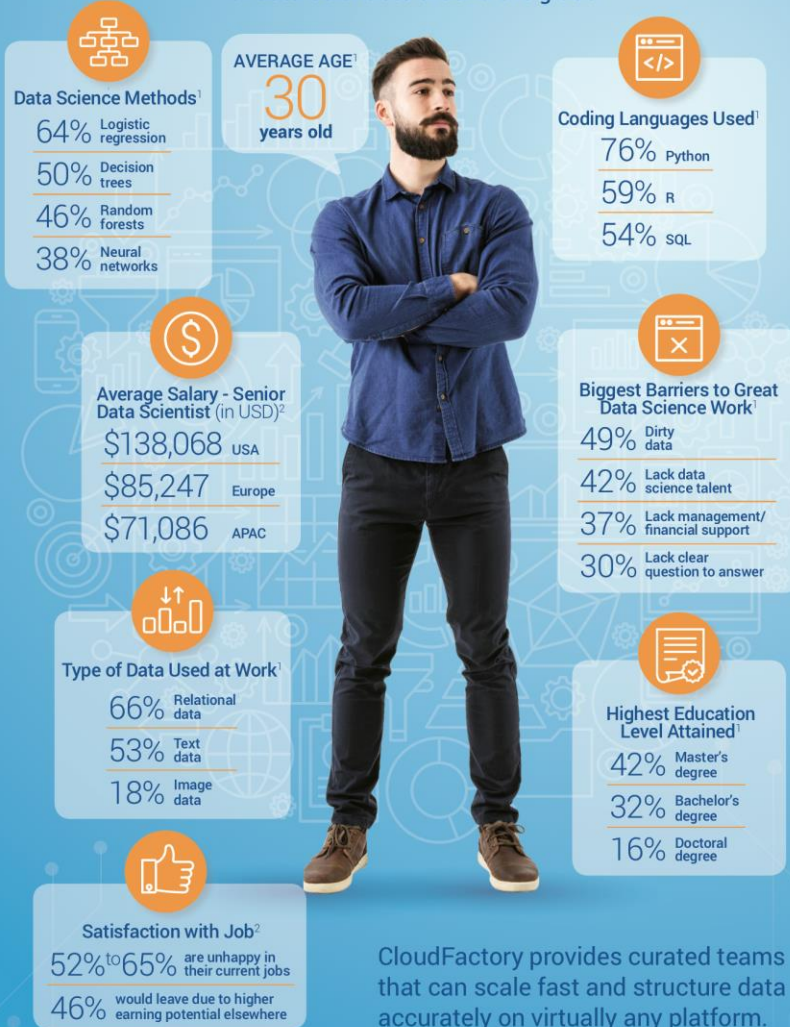
Web Search ▾

Interest over time ⓘ



The Life of a DATA SCIENTIST

Data scientists extract knowledge, insights, or solutions from big data. Here's a look at the life of a data scientist, based on two surveys of data scientists around the globe.



Sursa

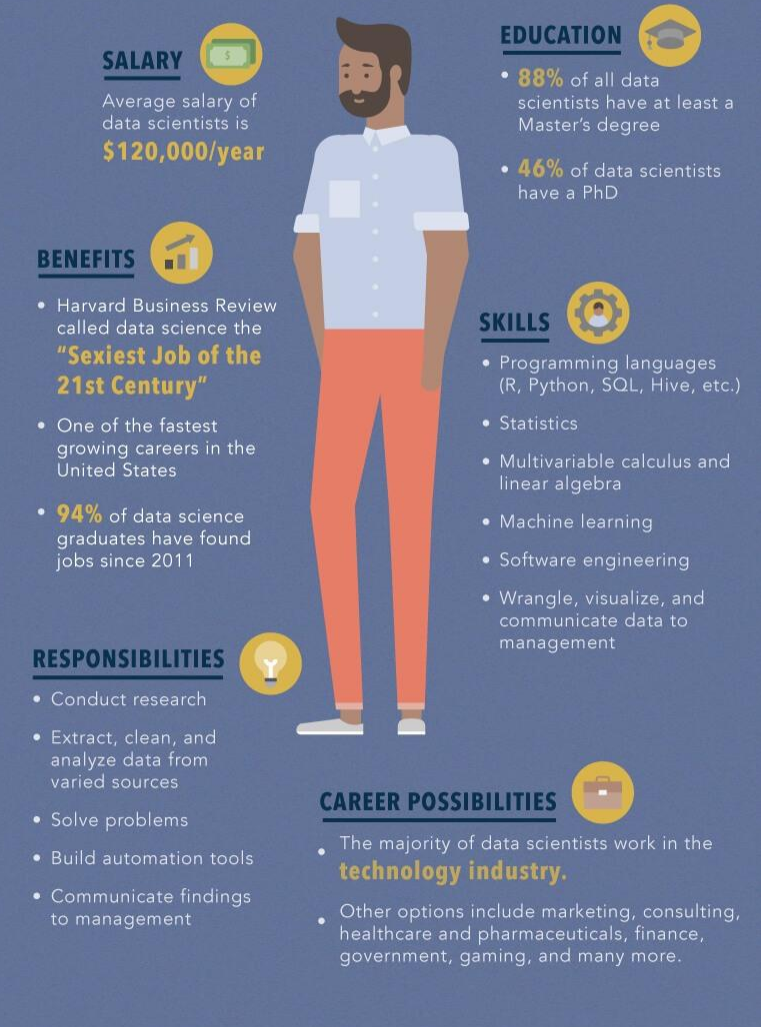
10/8/2022

Sources:
1 - 2017 State of Data Science & Machine Learning, Kaggle
2 - 2018 Data Science Salary Report, Big Cloud

cloudfactory.com



ANATOMY OF A DATA SCIENTIST



Sursa

RESOURCES:

<https://insidebigdata.com/2017/08/05/benefits-data-scientist-career/>
https://www.glassdoor.com/Salaries/us-data-scientist-salary-SRCH_IL_02_IN1_KO3,17.htm
<https://blog.udacity.com/2014/11/data-science-job-skills.html>
<https://online.rutgers.edu/resources/infographics/what-can-you-do-with-a-career-in-data-science/?program=mi>









THE COMPUTER MERCHANT, LTD.
THE IT STAFFING COMPANY

11

De la analiza
datelor la
știința
datelor

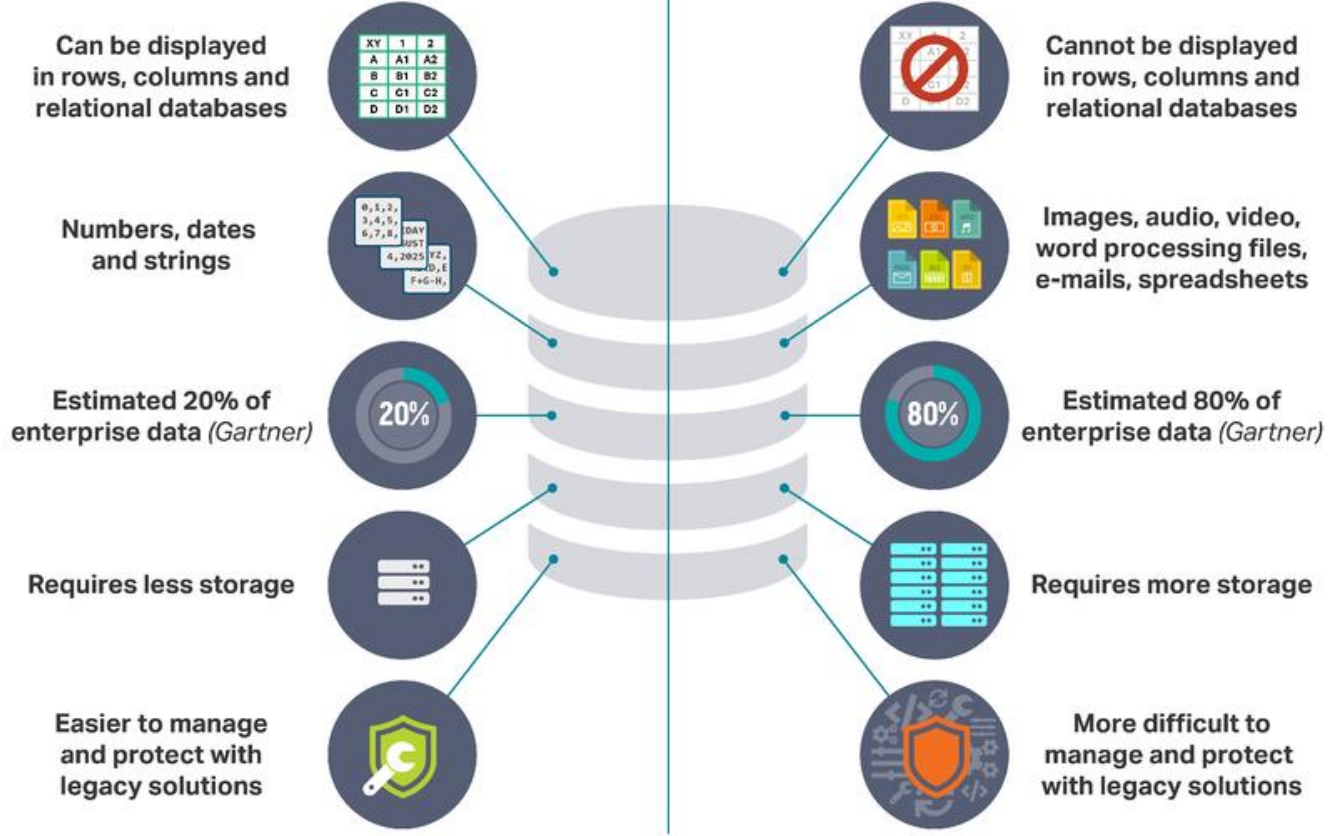
The six Vs of big data

Big data is a collection of data from various sources, often characterized by what's become known as the 3Vs: *volume*, *variety* and *velocity*. Over time, other Vs have been added to descriptions of big data:

VOLUME	VARIETY	VELOCITY	VERACITY	VALUE	VARIABILITY
The amount of data from myriad sources.	The types of data: structured, semi-structured, unstructured.	The speed at which big data is generated.	The degree to which big data can be trusted.	The business value of the data collected.	The ways in which the big data can be used and formatted.
					

Date structurate vs. nestructurate

Structured Data vs Unstructured Data



Business intelligence vs. știința datelor

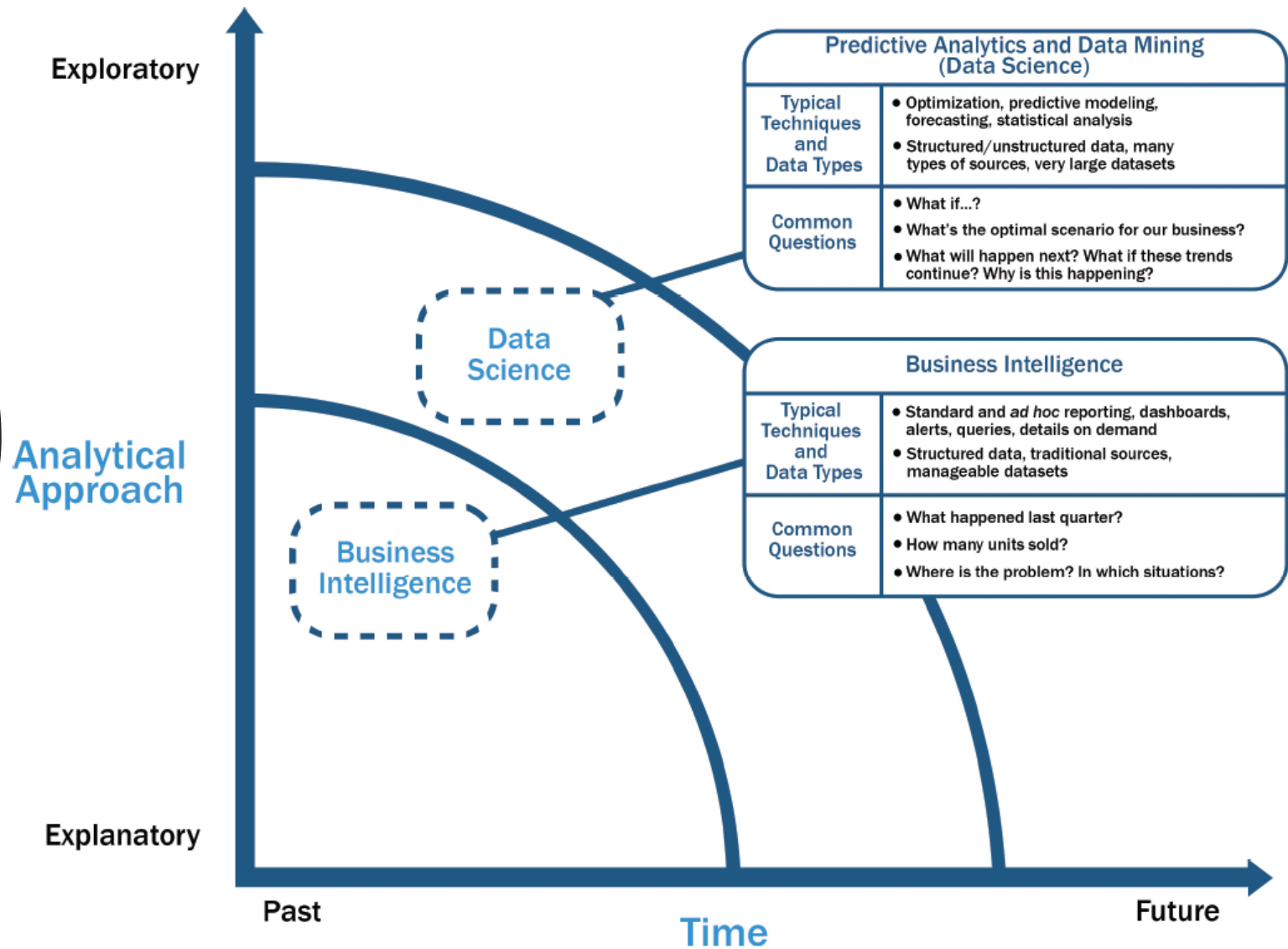


FIGURE 1-8 Comparing BI with Data Science

Utilitatea în
business a
științei
datelor

TABLE 1-2 *Business Drivers for Advanced Analytics*

Business Driver	Examples
Optimize business operations	Sales, pricing, profitability, efficiency
Identify business risk	Customer churn, fraud, default
Predict new business opportunities	Upsell, cross-sell, best new customer prospects
Comply with laws or regulatory requirements	Anti-Money Laundering, Fair Lending, Basel II-III, Sarbanes-Oxley (SOX)

Ecosistemul științei datelor

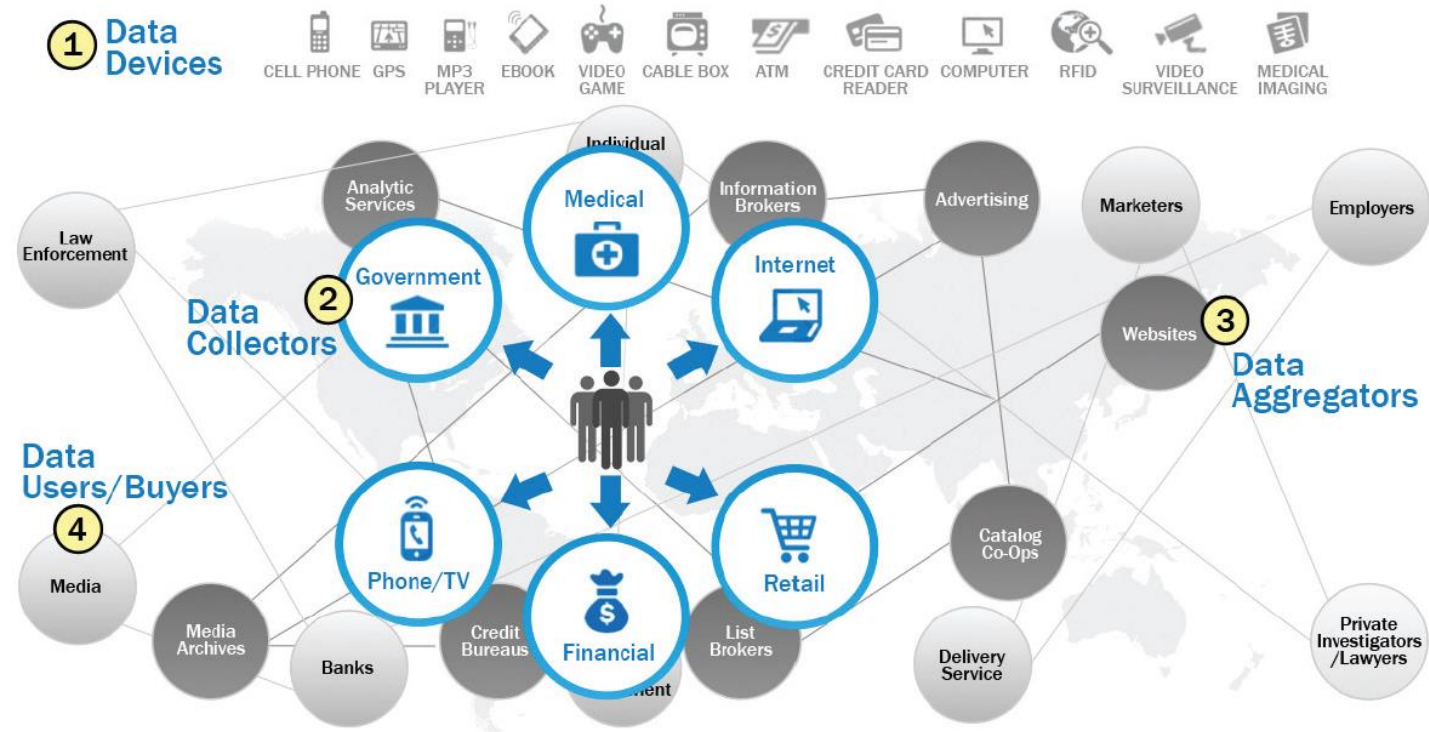


FIGURE 1-11 Emerging Big Data ecosystem

MIT Career Handbook

Skills for working with people

Communicate

Coordinate

Plan

Skills for working with objects

Use instruments

Measure

Repair/Maintain

Skills for working with information

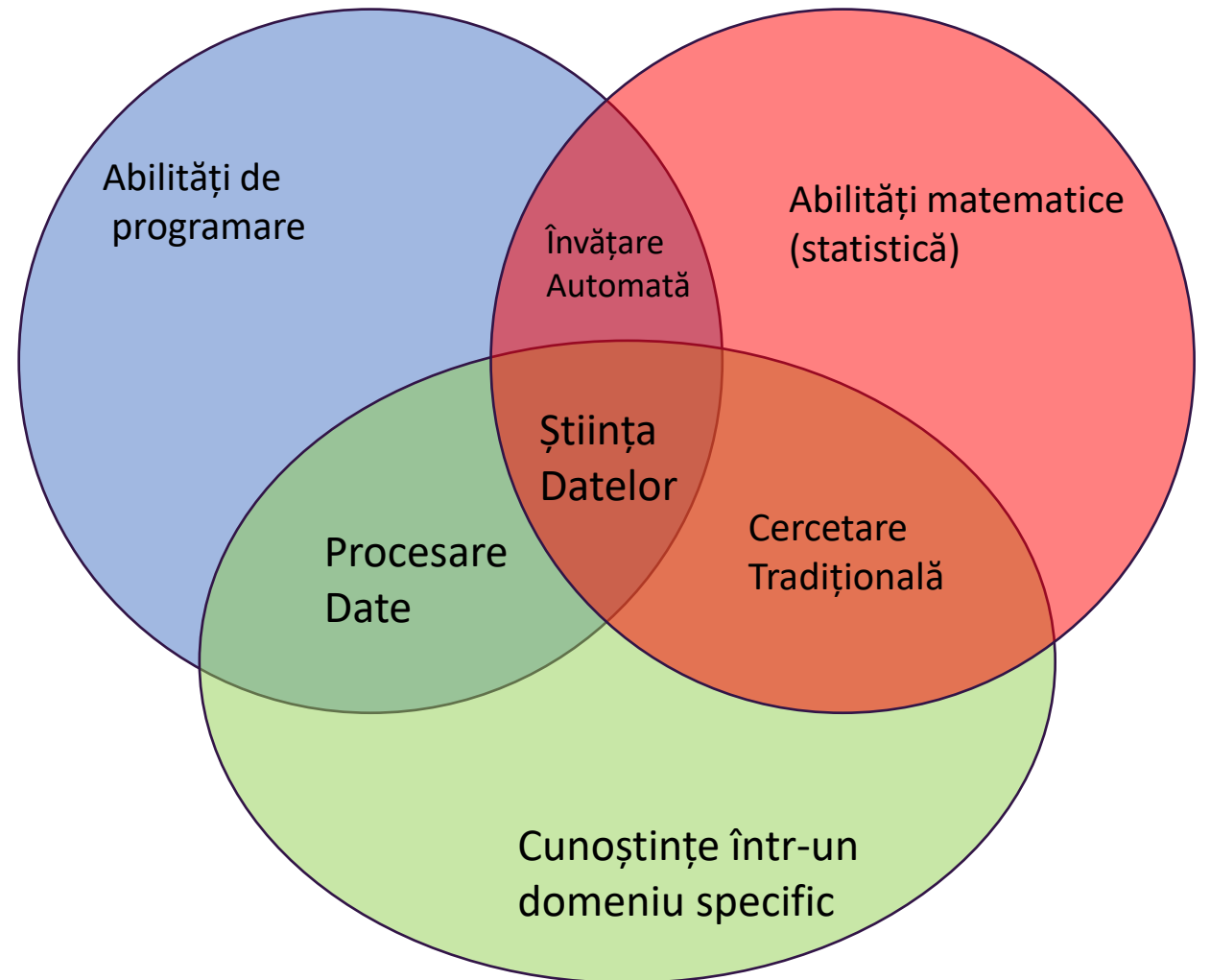
Scientific methodology

Statistical analysis

Forecast

Abilități specifice DS

- Design-ul cercetării
 - Formularea a întrebărilor
 - Colectarea & analiza a datelor
 - Definirea modelului
- Automatizarea analizei
 - Programare
 - Procesarea datelor
- Comunicare
 - Formularea diagnozei, deciziei, predicției etc
 - Comunicarea cu beneficiarii



Importanța Științei Datelor – personalități

Daryl Morey [[Wiki](#), [Interview](#)]

- MIT Sloan Sports Analytics.
- Directorul general al Houston Racket (baschet)

Mircea Lucescu

- Antrenor român de fotbal [[Wiki](#)]

Nate Silver [[Wiki](#), [FiveThirtyEight](#)]

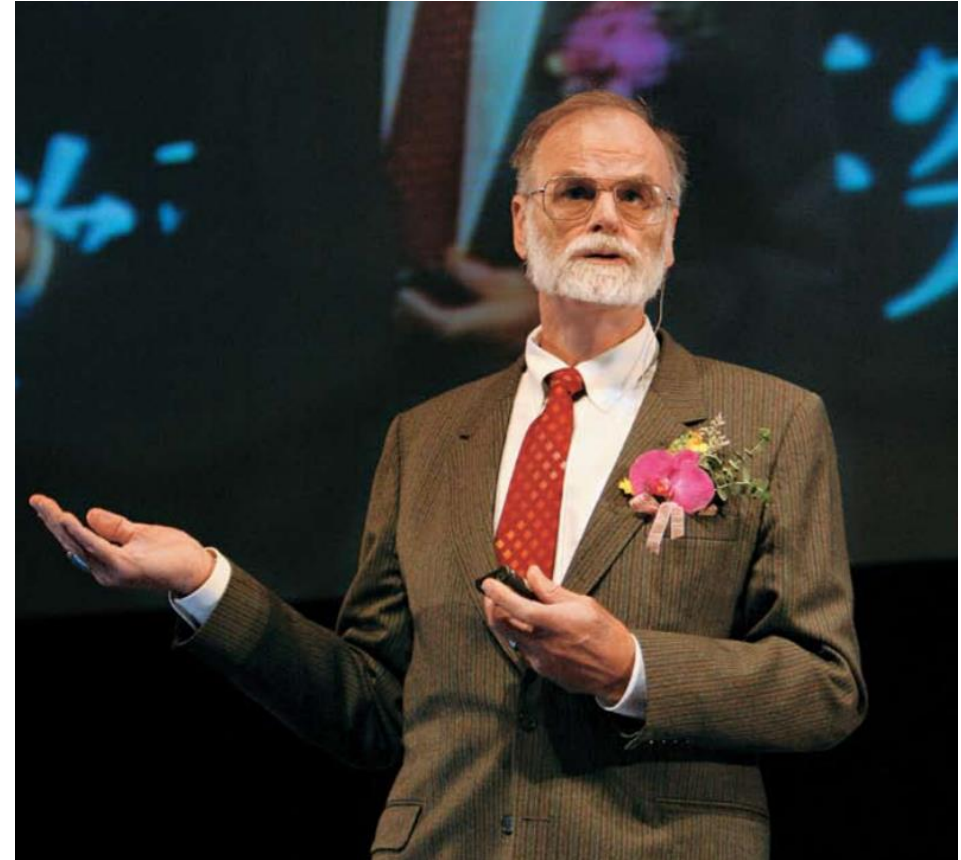
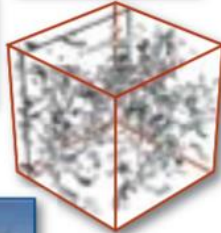
- Predicții cu ajutorul datelor publice
- Cine o să câștige alegerile ?

Science Paradigms

- Thousand years ago:
science was **empirical**
describing natural phenomena
- Last few hundred years:
theoretical branch
using models, generalizations
- Last few decades:
a **computational** branch
simulating complex phenomena
- Today: **data exploration** (eScience)
unify theory, experiment, and simulation
 - Data captured by instruments
or generated by simulator
 - Processed by software
 - Information/knowledge stored in computer
 - Scientist analyzes database/files
using data management and statistics



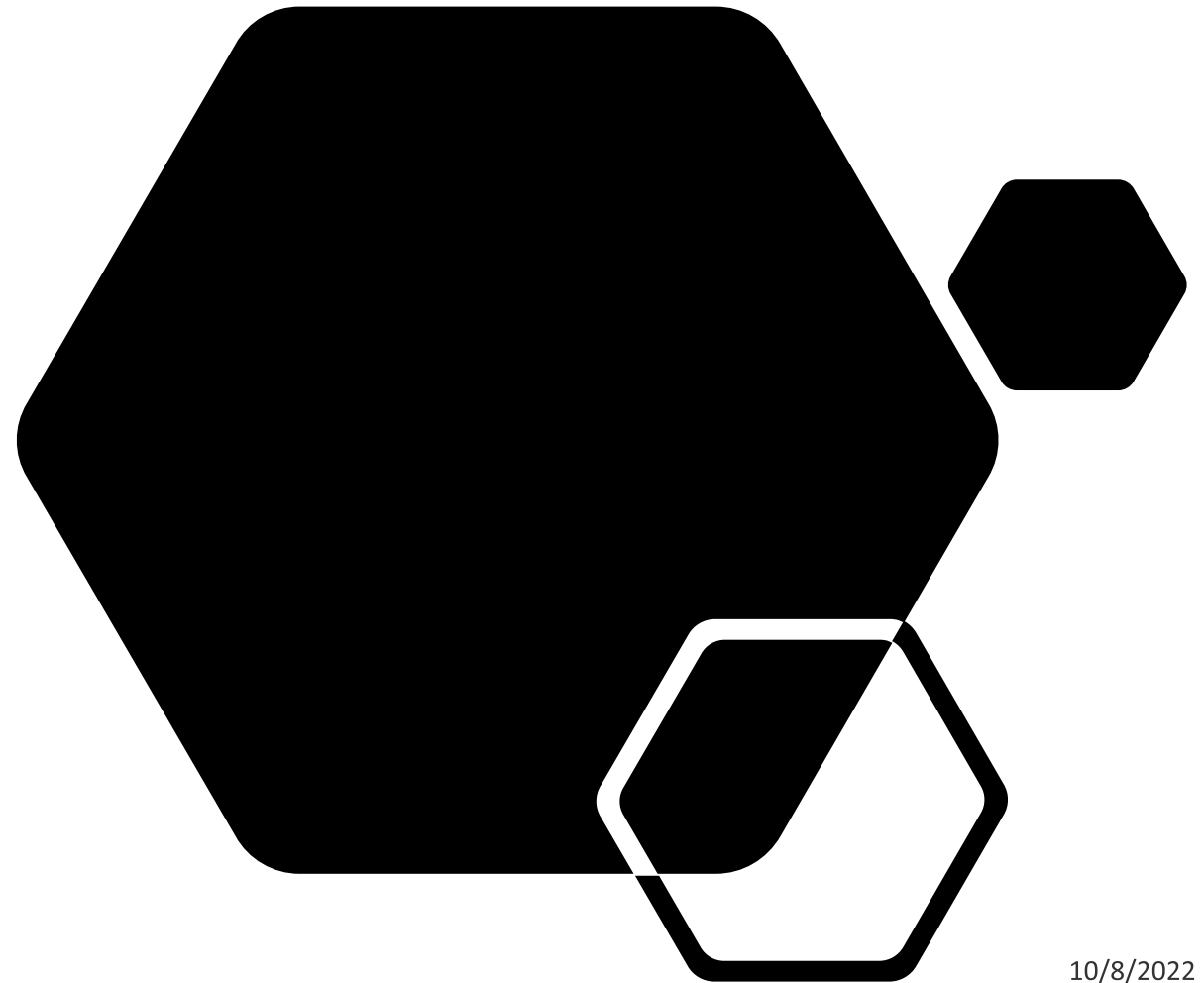
$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{4\pi G\rho}{3} - K\frac{c^2}{a^2}$$



Jim Gray's Fourth paradigm of science
[[Hey et al.](#)]

Obiective ale analizei datelor

Utilizarea datelor... de la străbunii Big
Data până azi



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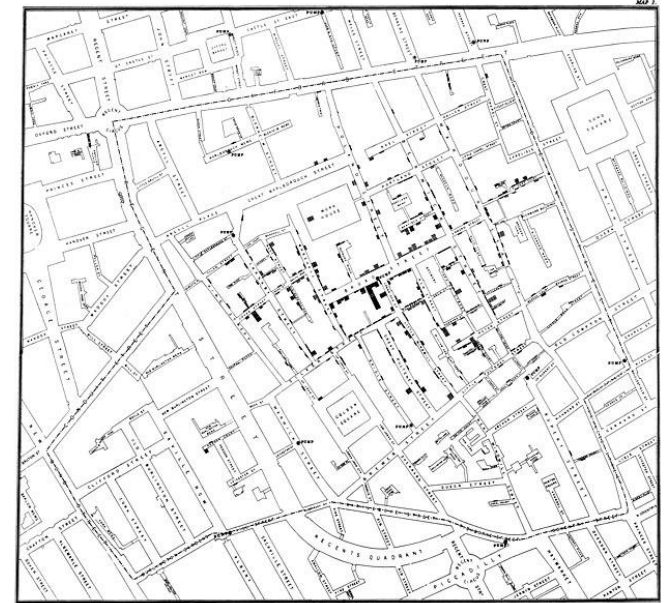
Focus pe esențial

Similitudini remarcabile în ultimii 250 de ani

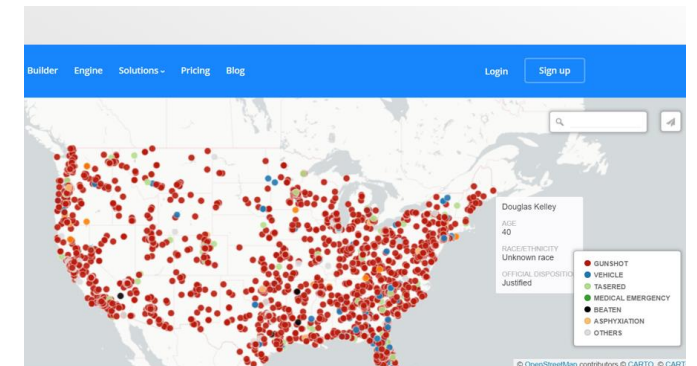
- Reducerea complexității – găsirea esențialului
- Evidențierea mesajului

Transformări datorate tehnologiei

- Sinteza unui volum mult mai mare de date
- Vizualizări dinamice
 - Includerea timpului ca dimensiune
- Vizualizări interactive
 - Stratificarea variabilelor prezentate
- „Eye candy”



John Snow, 1854



Fatal encounters, 2015

Datele permit...

1. Priviri de ansamblu („bird’s eye view”)

- Sinteza situației în câteva dimensiuni („variabile” și „unități”)
- Problematika măsurării și a reducerii dimensionalității

2. Evidențierea deficitului și excesului

- Distribuții: ce e prea mult? Ce e prea puțin?

3. Tendințe (evoluții, involuții): încotro merge lumea?

- Serii de timp (Predicții, extrapolări)

4. Inegalități

- Asocieri și corelații

5. Clasificări

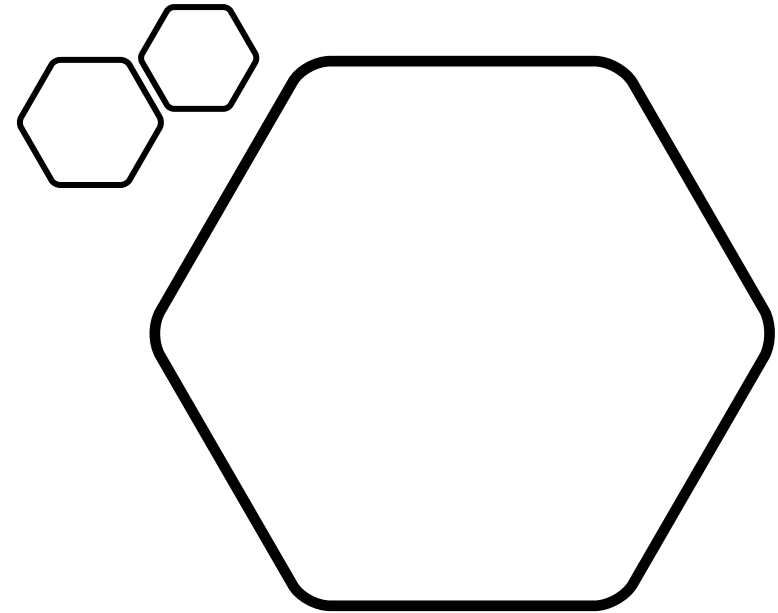
- Analiza cluster

6. Cauzalitate

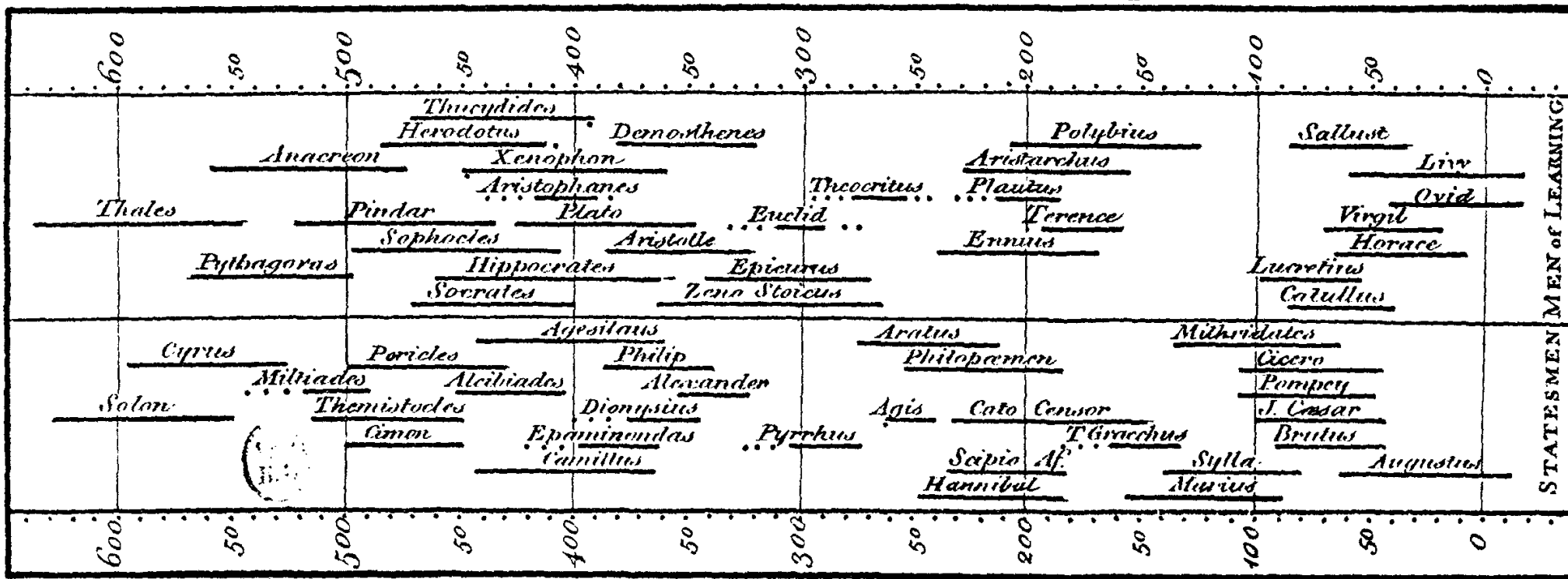
- Analiza de regresie, path

1. Priviri de ansamblu

Reducerea dimensionalității



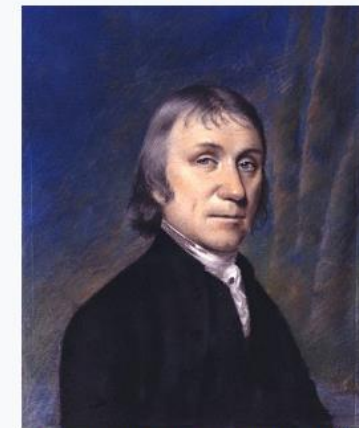
A Specimen of a Chart of Biography.



J. Priestley I.L.D. F.R.S. inv. et del.

Joseph Priestley

FRS



Priestley by Ellen Sharples (1794)^[1]

Born 24 March [O.S. 13 March] 1733
Birstall, Yorkshire, England

Died 6 February 1804 (aged 70)
Northumberland, Pennsylvania, U.S.

Occupation Chemist · natural philosopher · theologian · grammarian · teacher

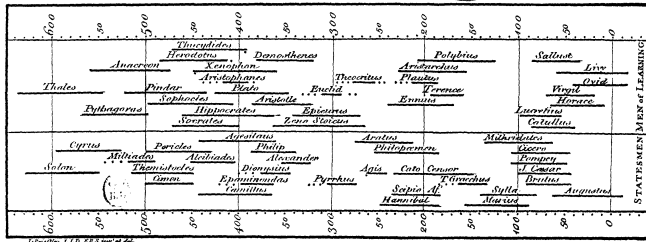
Known for

- Discovery of oxygen (O₂) and nine other gases (including carbon monoxide (CO), nitric oxide (NO), nitrous oxide (N₂O), ammonia (NH₃), sulphur dioxide (SO₂), and nitrogen peroxide (N₂O₄))
- Discovery of the carbon cycle

Awards

- Fellow of the Royal Society (1766)^[2]

A Specimen of a Chart of Biography.



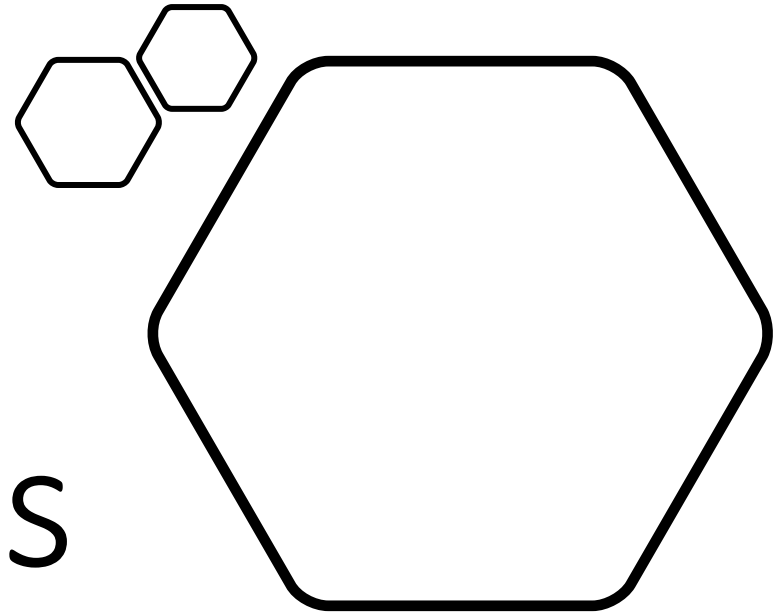
Sursă: [Notable People](#)



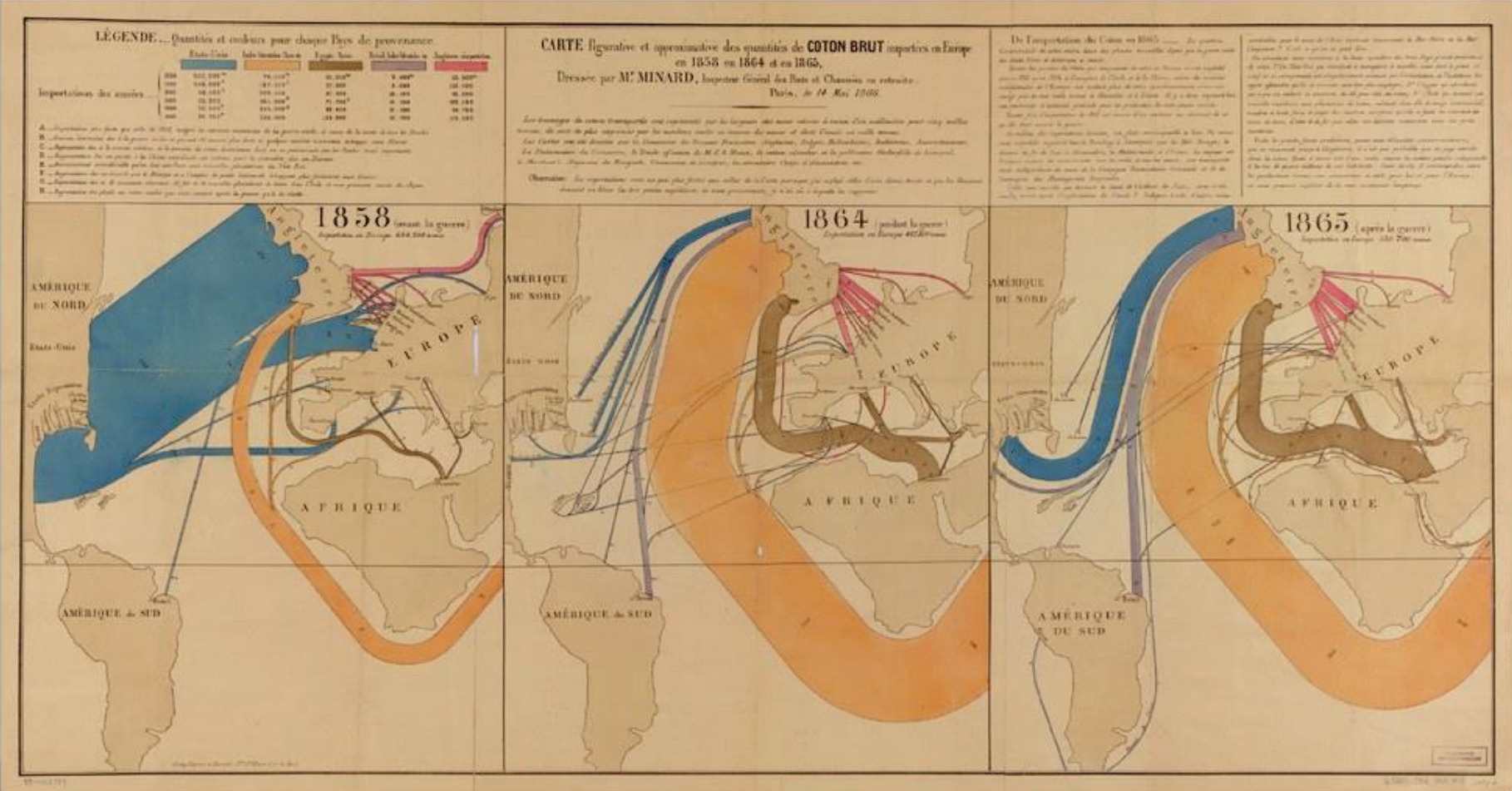
2. Deficit și exces

Distribuții:

- Ce este prea mult? Ce este prea puțin?
- Cazuri limită, anomalii



Vizualizarea deficitului: comerțul cu bumbac



1865
[Discuție](#)

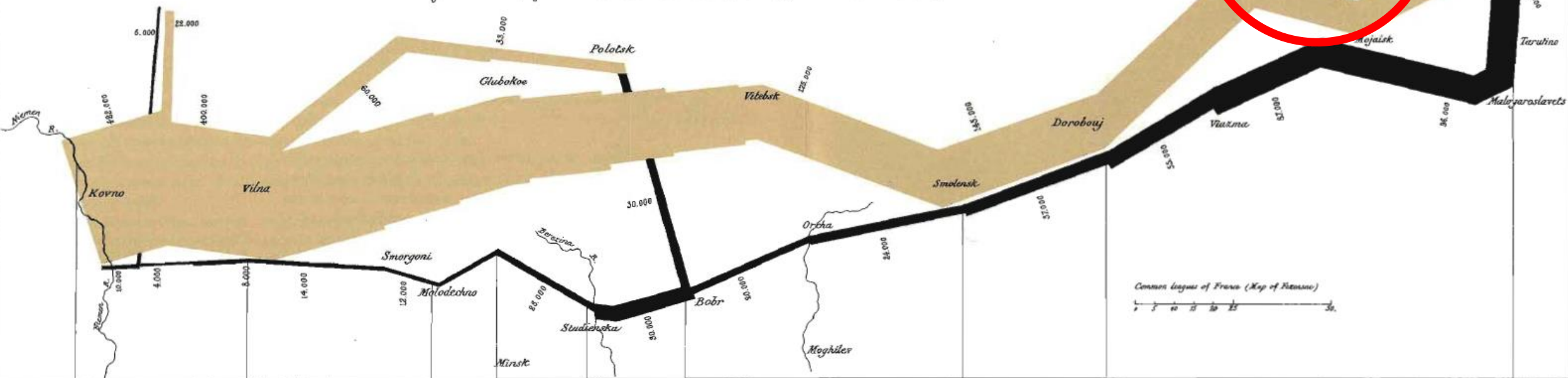
Vizualizarea excesului: ororile războiului

[Discuție](#)

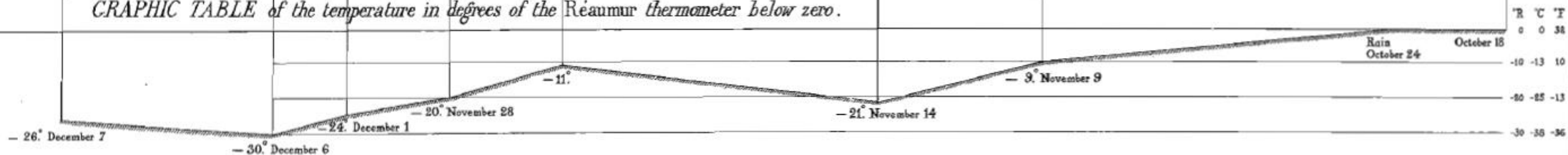
Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812-1813.

Drawn up by M. Minard, Inspector General of Bridges and Roads in retirement. Paris, November 20, 1869.

The numbers of men present are represented by the widths of the colored zones at a rate of one millimeter for every ten thousand men; they are further written across the zones. The red designates the men who enter into Russia, the black those who leave it. The information which has served to draw up the map has been extracted from the works of M. M. Thiers, of Ségur, of Fezensac, of Chambray and the unpublished diary of Jacob, physician of the Army since October 28th. In order to better judge with the eye the diminution of the army, I have assumed that the troops of Prince Jérôme and of Marshal Davoust who had been detached at Minsk and Moghilev and have rejoined around Orcha and Vittebsk, had always marched with the army.



GRAPHIC TABLE of the temperature in degrees of the Réaumur thermometer below zero.



The Cossacks pass the frozen Niemen at a gallop.

Belligerents

 French Empire	 Russian Empire
 Confederation of Poland	Supported by:
 Kingdom of Italy	 United Kingdom
 Kingdom of Naples	
 Kingdom of Saxony	
 Kingdom of Bavaria	
 Kingdom of Westphalia	
 Kingdom of Württemberg	
 Grand Duchy of Hesse	
 Grand Duchy of Berg	
 Grand Duchy of Baden	
 Swiss Confederation	
 Austrian Empire	
 Kingdom of Prussia	
 Kingdom of Spain ^[1]	
 Kingdom of Denmark	

Strength

612,000 ^[2] - 685,000 ^[3] total:	488,000 - 623,000 total: ^[2]
<ul style="list-style-type: none"> • 449,000 First wave^[4] • 134,000 Borodino^[5] • 108,000 Maloyaroslavets^[6] • 33,000 Berezina^[7] 	<ul style="list-style-type: none"> • 98,000 First wave^[4] • 118,000 Borodino^[8] • 129,000 Maloyaroslavets^[9] • 126,000 Berezina^[7]

Casualties and losses

400,000–484,000	350,000–410,000
<ul style="list-style-type: none"> • 200,000^{[10][11]}–284,000 dead^{[12][13]} <ul style="list-style-type: none"> • 100,000 killed in combat^{[11][10]} • 50,000 died in captivity^{[14][12][2]} • 50,000 wounded^[13] • 50,000 deserted^{[13][12]} • 50,000 prisoners^{[2][12]} 	<ul style="list-style-type: none"> • 210,000 dead^[15] • 150,000 wounded^[16] • 50,000 deserted^[16]

Total military and civilian deaths:

c. 1,000,000^[17]

[Sursa](#)

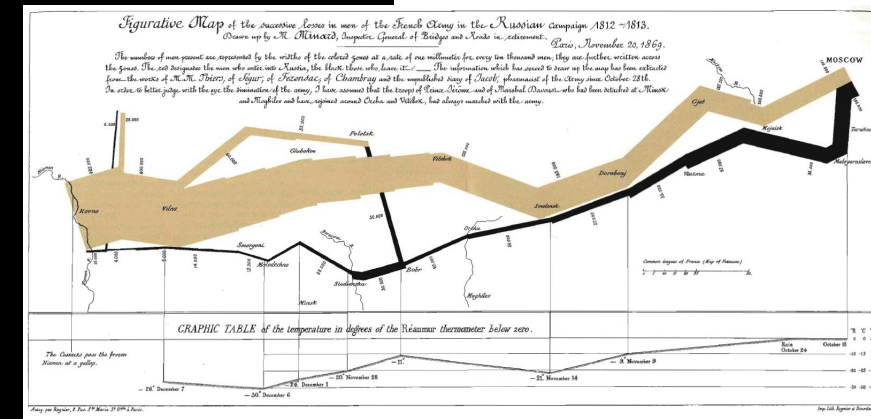
Vizualizarea excesului: ororile războiului

Not secure | fallen.io/ww2/

The Fallen of World War II
Neil Halloran

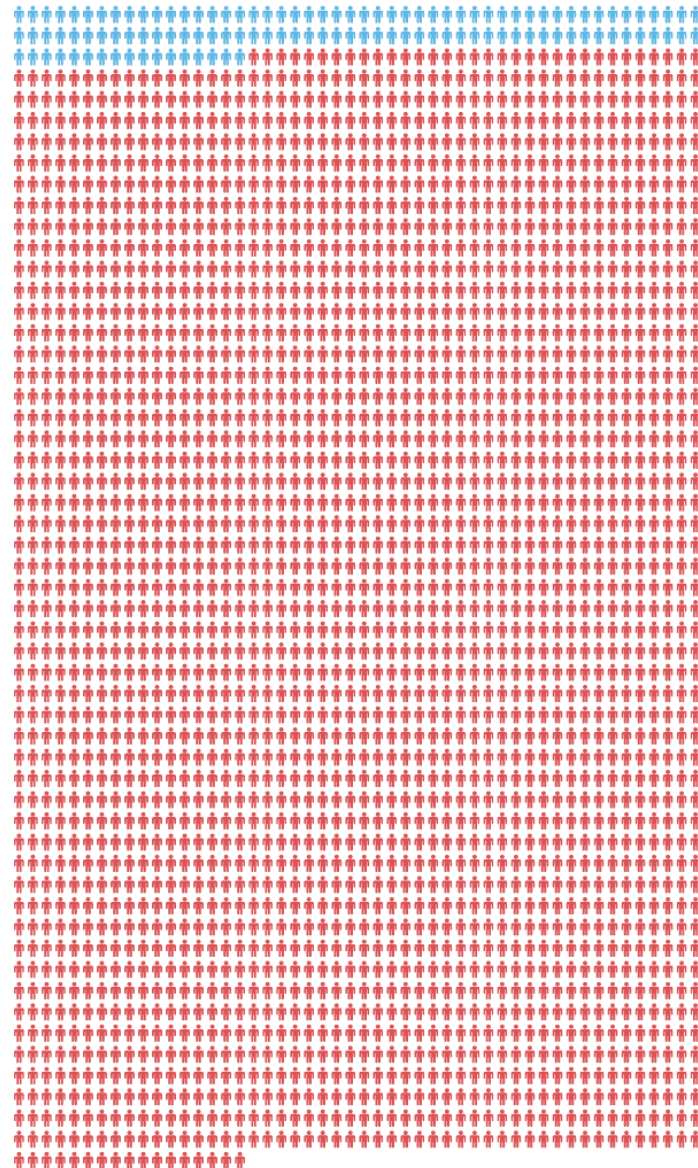
STALINGRAD

YUGOSLAVIA UNITED KINGDOM USA SOVIET UNION



Sursă:
[The Fallen of WW2](#)
(video)

Vizualizarea excesului: victime în atacuri teroriste



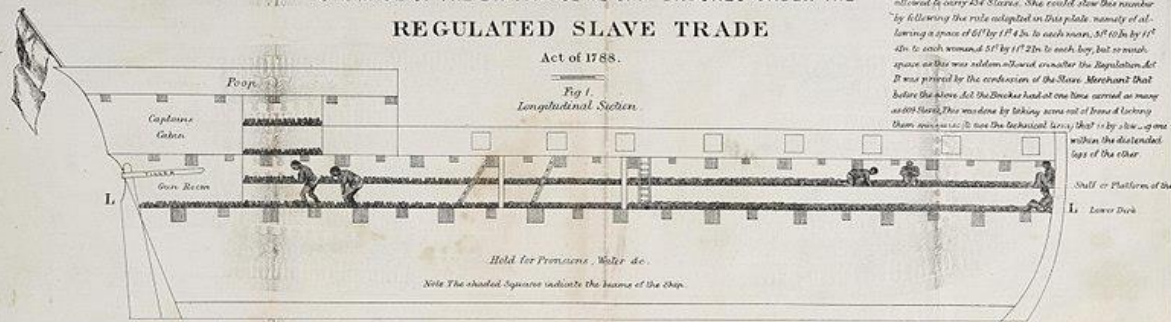
People killed in terrorist attacks in 2017:
Europe (Blue) vs Africa (Red)

[Sursa](#)

STOWAGE OF THE BRITISH SLAVE SHIP 'BROOKES' UNDER THE REGULATED SLAVE TRADE

Act of 1788.

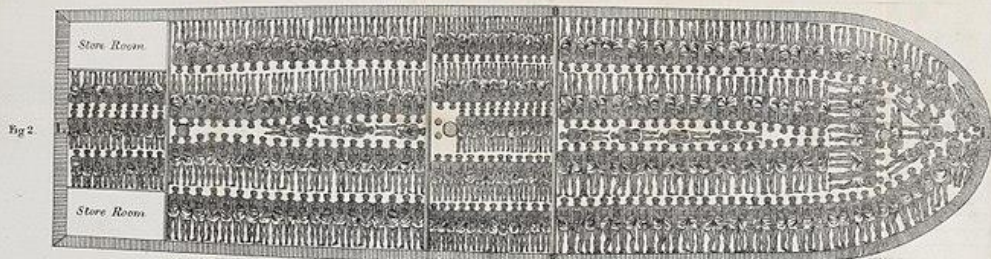
Fig 1. Longitudinal Section.



Note. That Brookes after the Regulation, Act of 1788, was allowed to carry 454 Slaves. She could stow this number by following the rule adapted on this plate, namely of allowing a space of 61" by 17" 4 in. to each man, 51" 6 in. by 17" 4 in. to each woman, 51" by 17" 2 in. to each boy, but so much space as this was seldom allowed, even after the Regulation Act. It was proved by the credence of the Slave Merchants that before the above Act the Brookes had at one time carried as many as 609 Slaves. This was done by taking some out of berths & lodging them in rows to use the technical term; that is by 2 in. or more within the distanced legs of the other.

PLAN OF LOWER DECK WITH THE STOWAGE OF 292 SLAVES

130 OF THESE BEING STOWED UNDER THE SHELVES AS SHEWN IN FIGURE 4 & FIGURE 5.



PLAN SHEWING THE STOWAGE OF 130 ADDITIONAL SLAVES ROUND THE WINGS OR SIDES OF THE LOWER DECK BY MEANS OF PLATFORMS OR SHELVES (IN THE MANNER OF GALLERIES IN A CHURCH) THE SLAVES STOWED ON THE SHELVES AND BELOW THEM HAVE ONLY A HEIGHT OF 2 FEET 7 INCHES BETWEEN THE BEAMS AND FAR LESS UNDER THE BEAMS. See Fig 1.

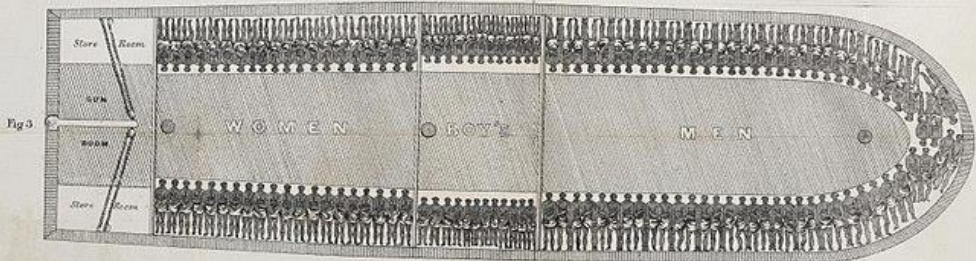


Fig 4. Cross Section at the Poop.



Fig 5. Cross Section amidships.

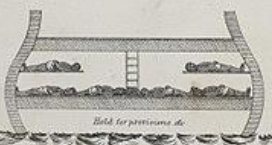


Fig 6.

Lower tier of Slaves under the Poop.

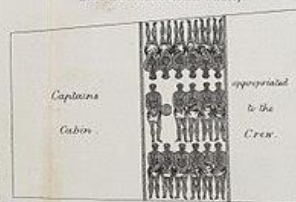
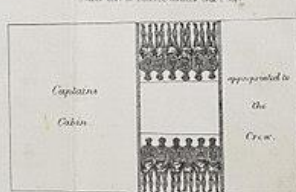


Fig 7.

Shelf tier of Slaves under the Poop.

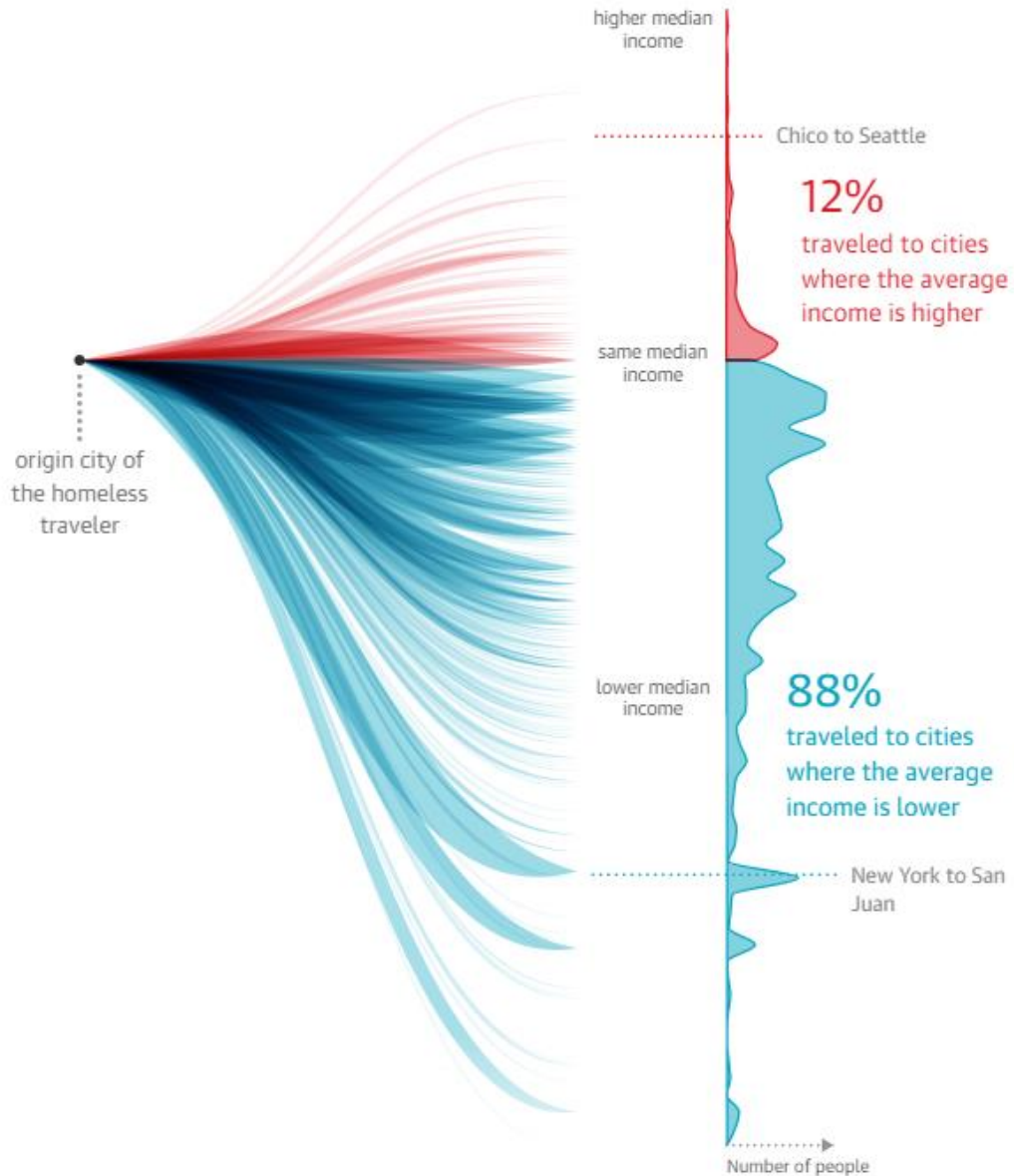


Scale of Feet

Vizualizarea excesului: suferința



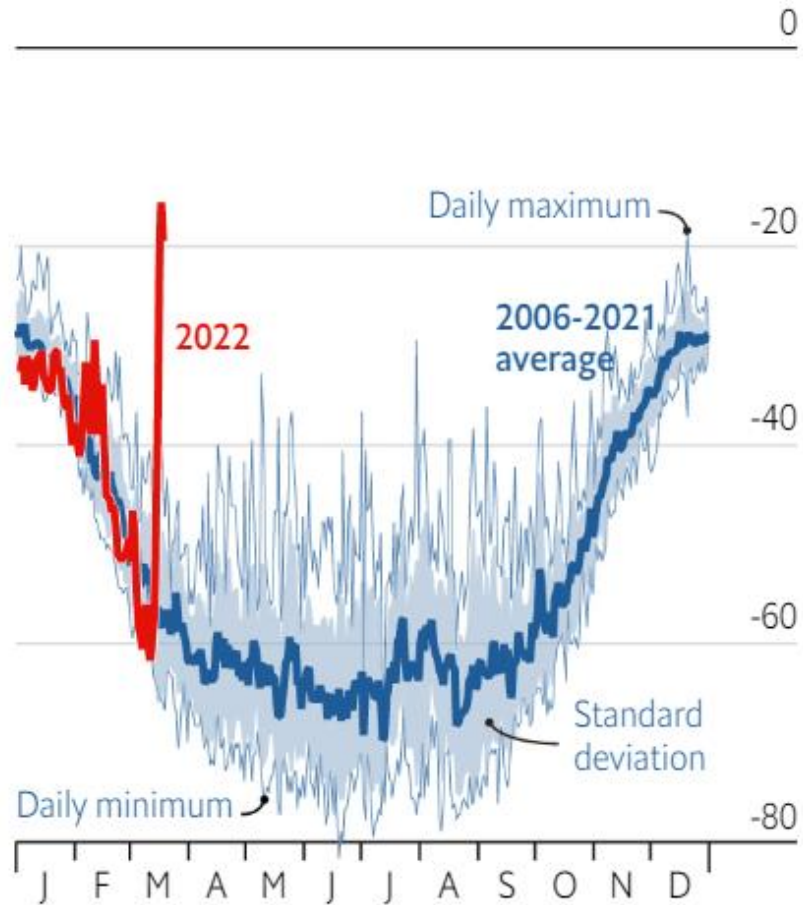
Most ticket recipients are relocated to places with a lower median income



[Sursa](#)

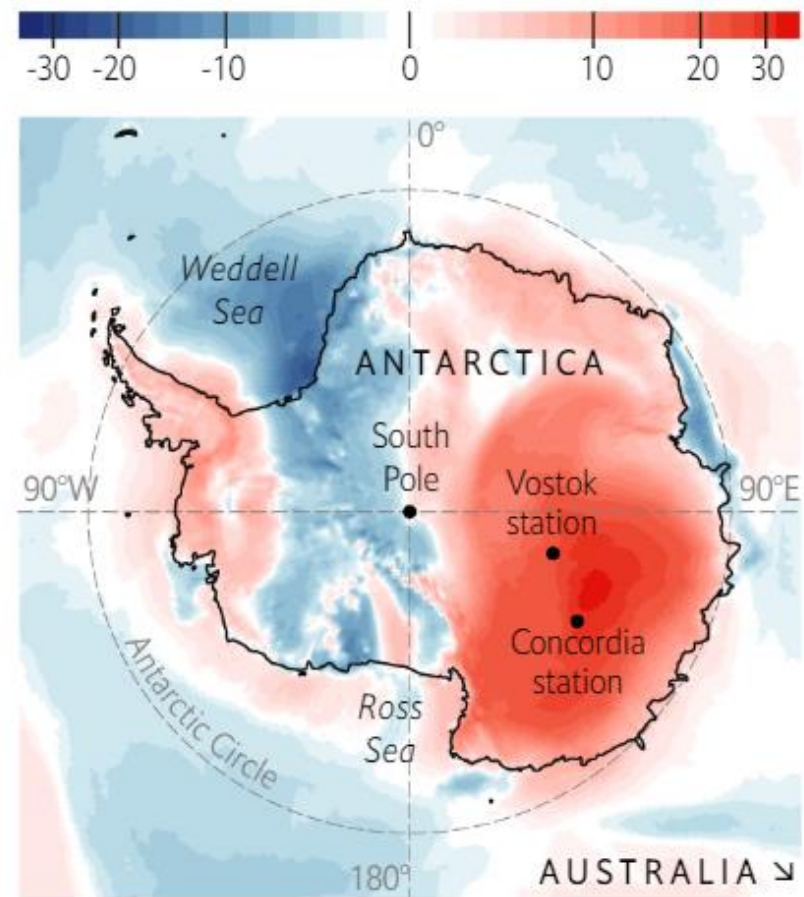
Baby, it's (a lot less) cold outside

Antarctica, daily average temperature, Concordia station, °C



Sources: ClimateReanalyzer.org; National Centres for Environmental Information; National Oceanic and Atmospheric Administration

Temperature anomalies, March 19th 2022 compared to 1979-2000 baseline, °C

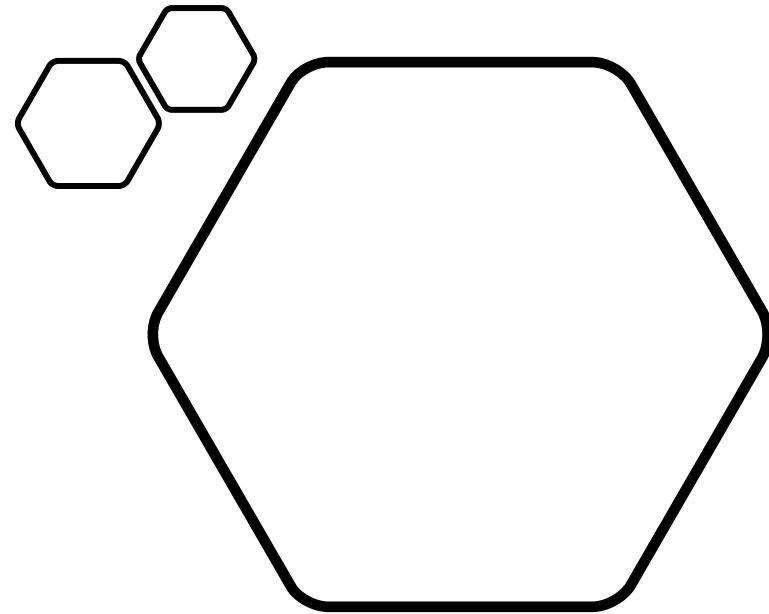


[Source:](#)
The Economist

3. Tendințe

Serii de timp:

- Bani și viața
- Evoluția civilizațiilor
- Evoluția tehnologiei



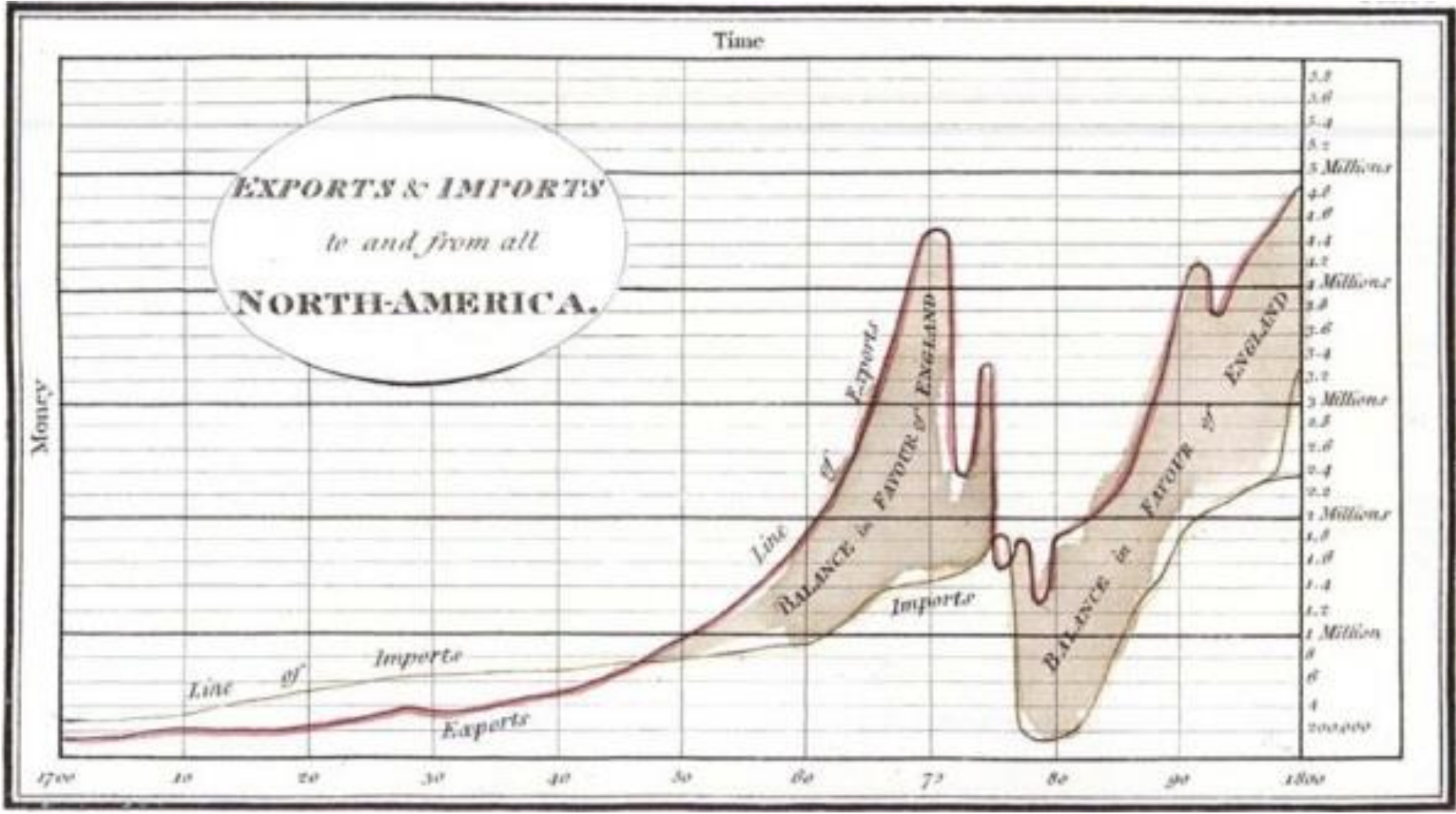
Like an ice age, in reverse; CO₂ levels are far higher than previous interglacial periods, and have risen remarkably fast

Atmospheric CO₂ levels, parts per million

Source — Vostok ice core — Law Dome ice core — Mauna Loa Observatory



Source:
The Economist



William Playfair

Born September 22, 1759
Benvie, Forfarshire, Scotland

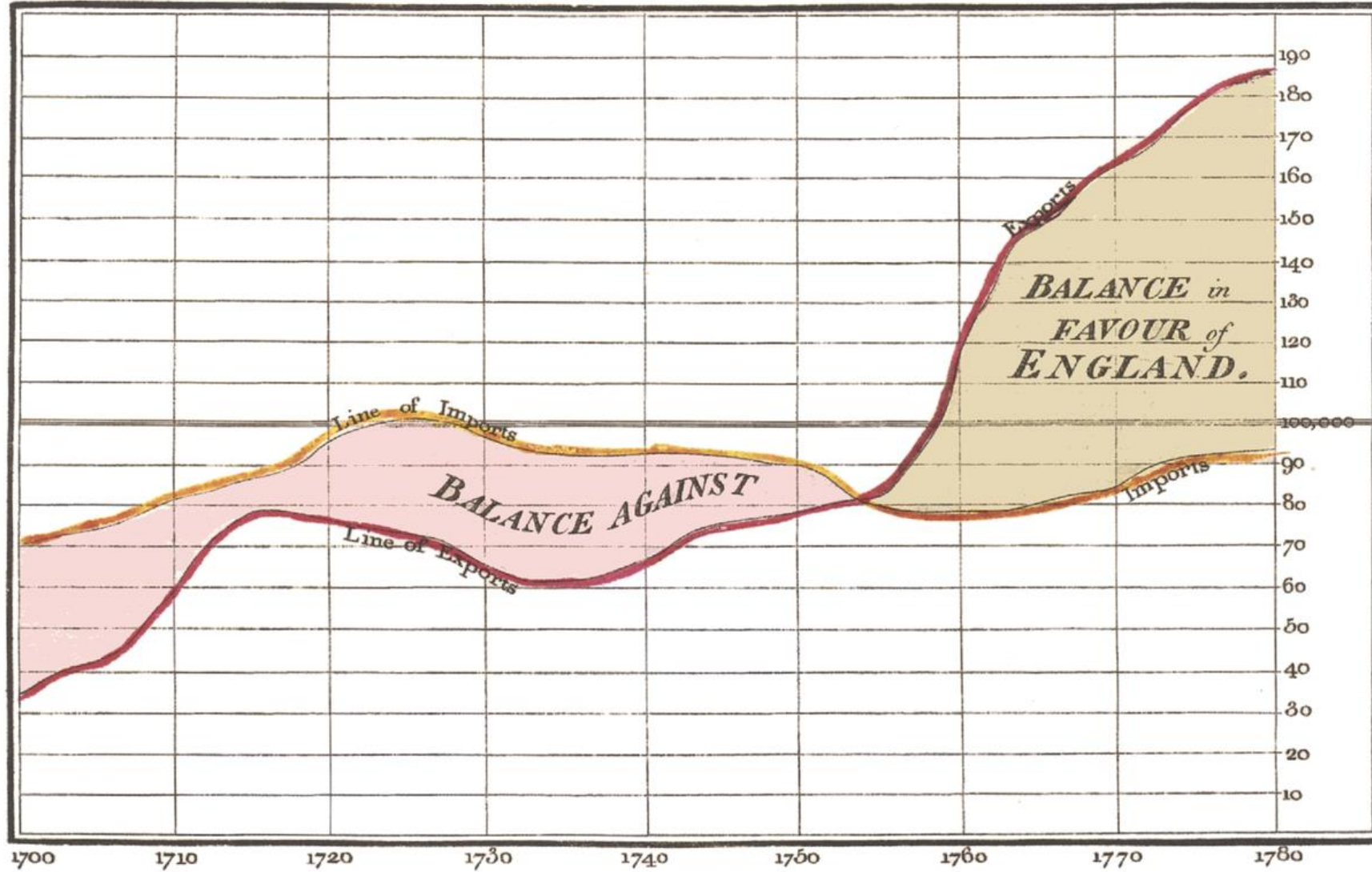
Died 11 February 1823 (aged 63)
London, England

Nationality Scottish

Known for inventor of [statistical graphs](#), writer on [political economy](#), and secret agent for Great Britain

Family [John Playfair](#) (brother)
[James Playfair](#) (brother)
[William Henry Playfair](#) (nephew)

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

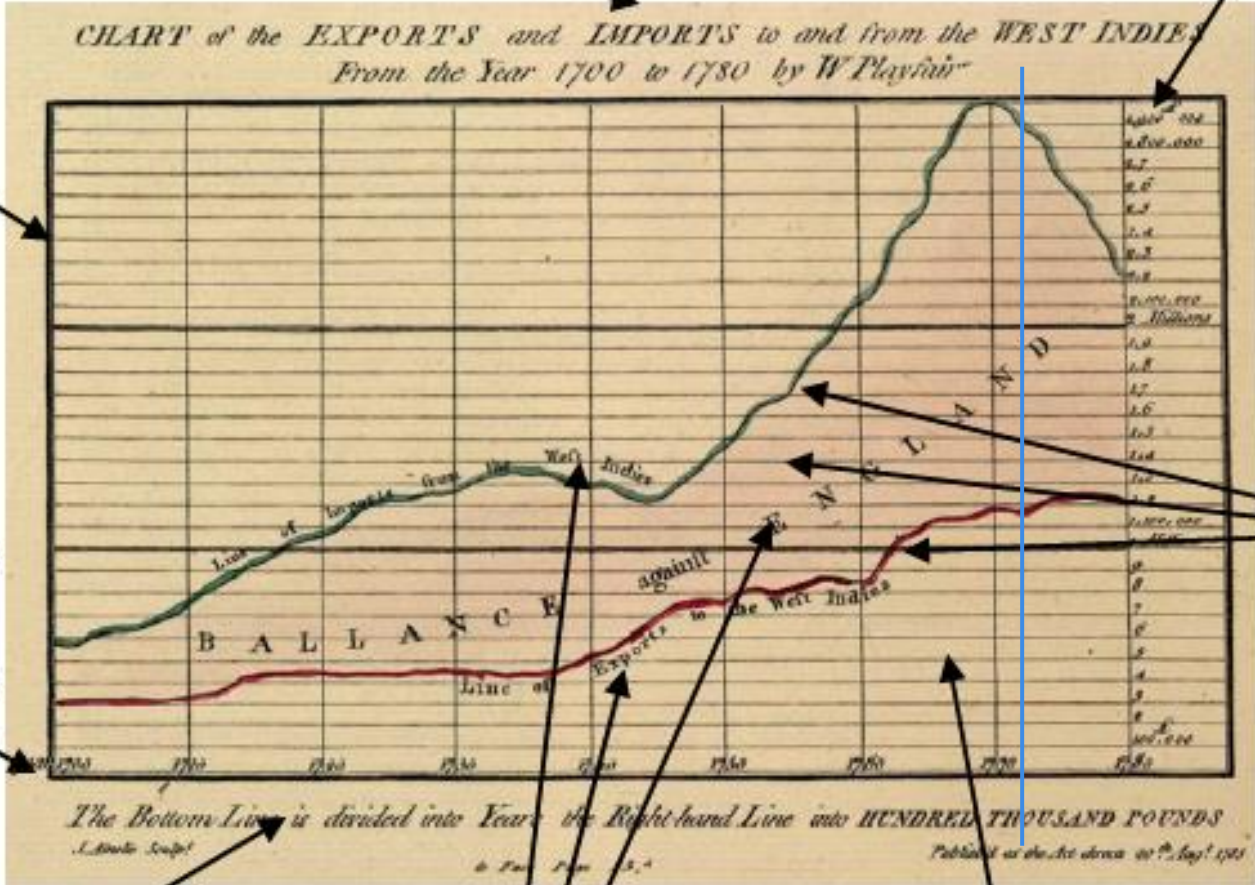
Keble sculpt 352, Strand, London.

Title

Labelled Ordinate

Frame

Playfair's charts are almost always constructed so that comparisons in different domains (lines, colors, labels, etc) do not exceed attentional and working memory capacity. Time series in the line graphs never exceed three or four in number; no more than three or four colors are used in a chart; labels are positioned next to the lines themselves rather than in legend boxes distant from the time series; similarly areas are labeled directly rather than being referenced in legends in some other region. Fig. 13 highlights the typical basic elements of a Playfair chart.



Labelled Abscissa

Color

Caption

Labels

Grid Lines

Pound sterling to United States Dollar

1.1150

↓ 14.98% -0.1965 6M

Oct 1, 4:46:25 PM UTC · Disclaimer

1D 5D 1M 6M YTD 1Y 5Y MAX



Pound sterling to United States Dollar

1.1150

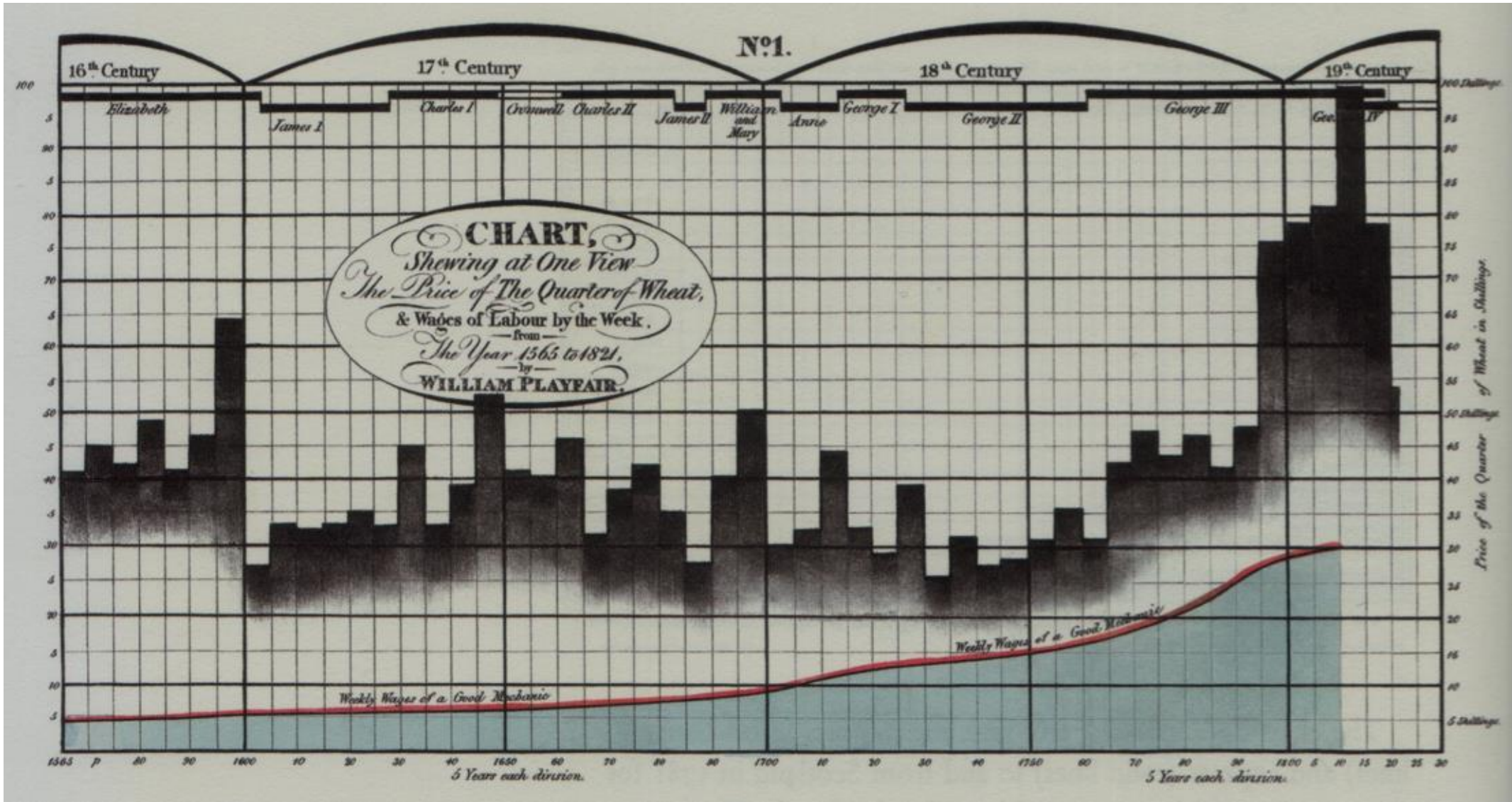
↓ 34.89% -0.5975 MAX

Oct 1, 4:47:25 PM UTC · Disclaimer

1D 5D 1M 6M YTD 1Y 5Y MAX



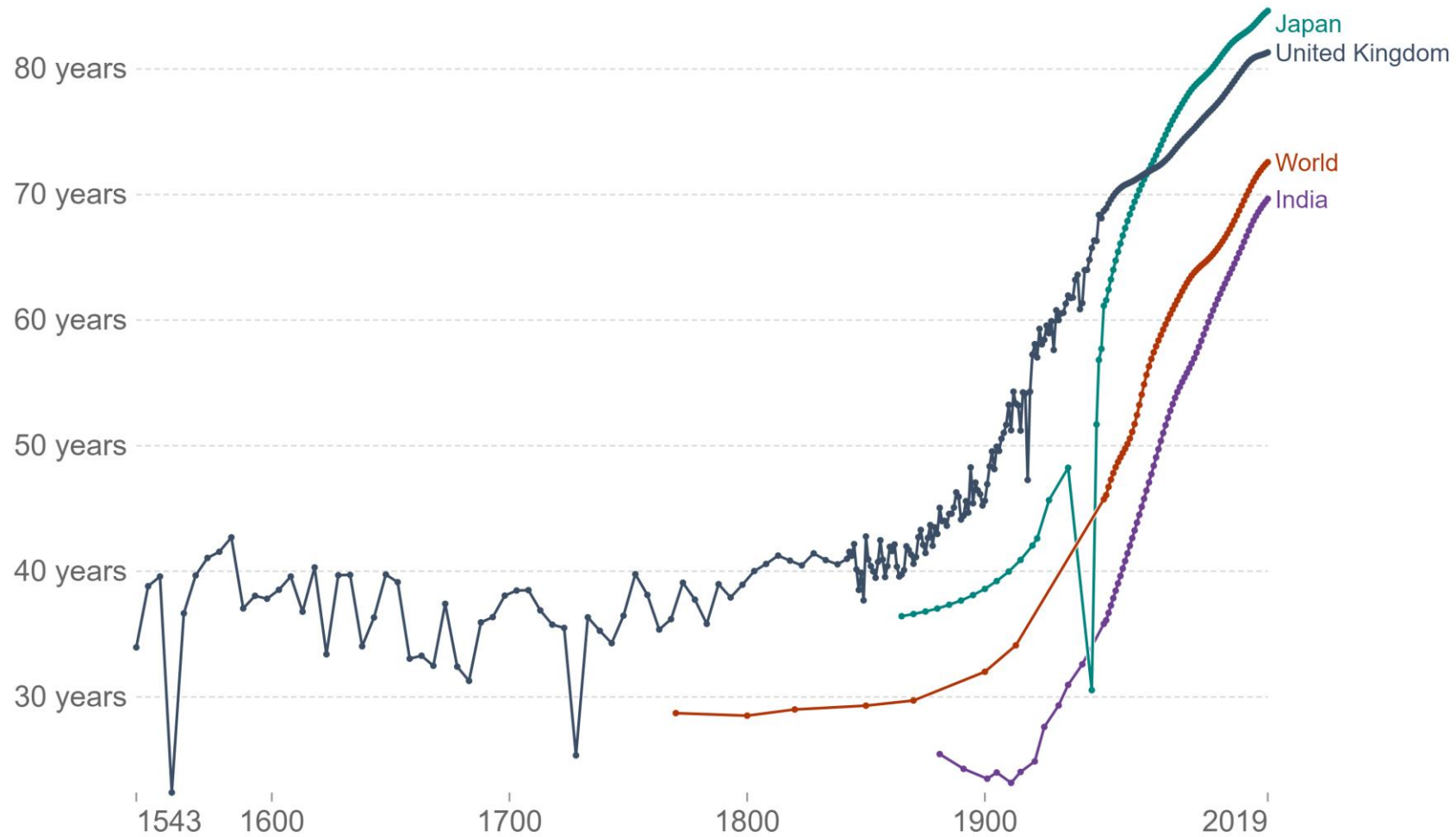
[Sursă](#)



Discuție în [The Economist](#)

[Sursă](#)

Life expectancy, 1543 to 2019



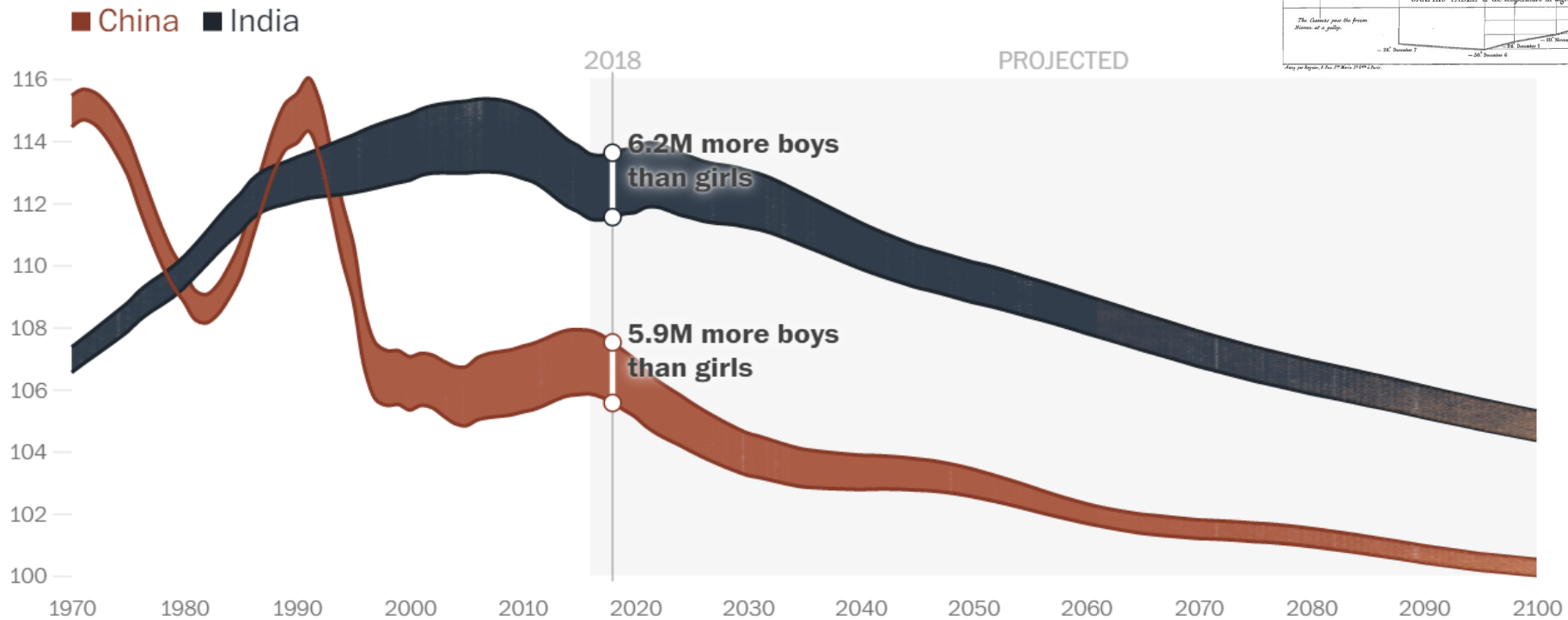
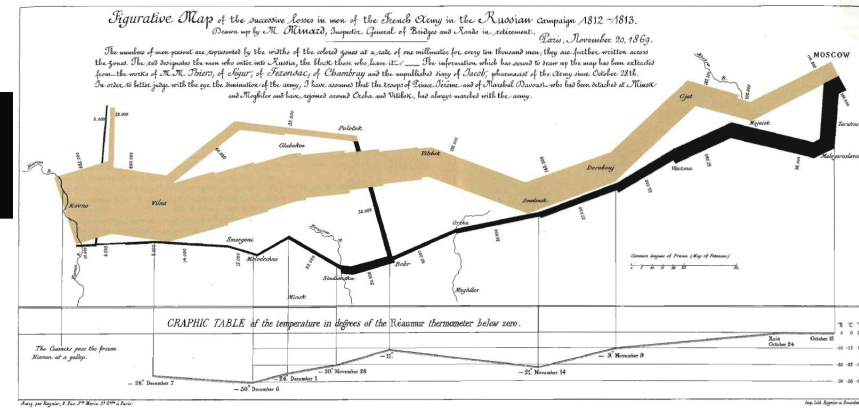
Source: Riley (2005), Clio Infra (2015), and UN Population Division (2019)

OurWorldInData.org/life-expectancy • CC BY

Note: Shown is period life expectancy at birth, the average number of years a newborn would live if the pattern of mortality in the given year were to stay the same throughout its life.

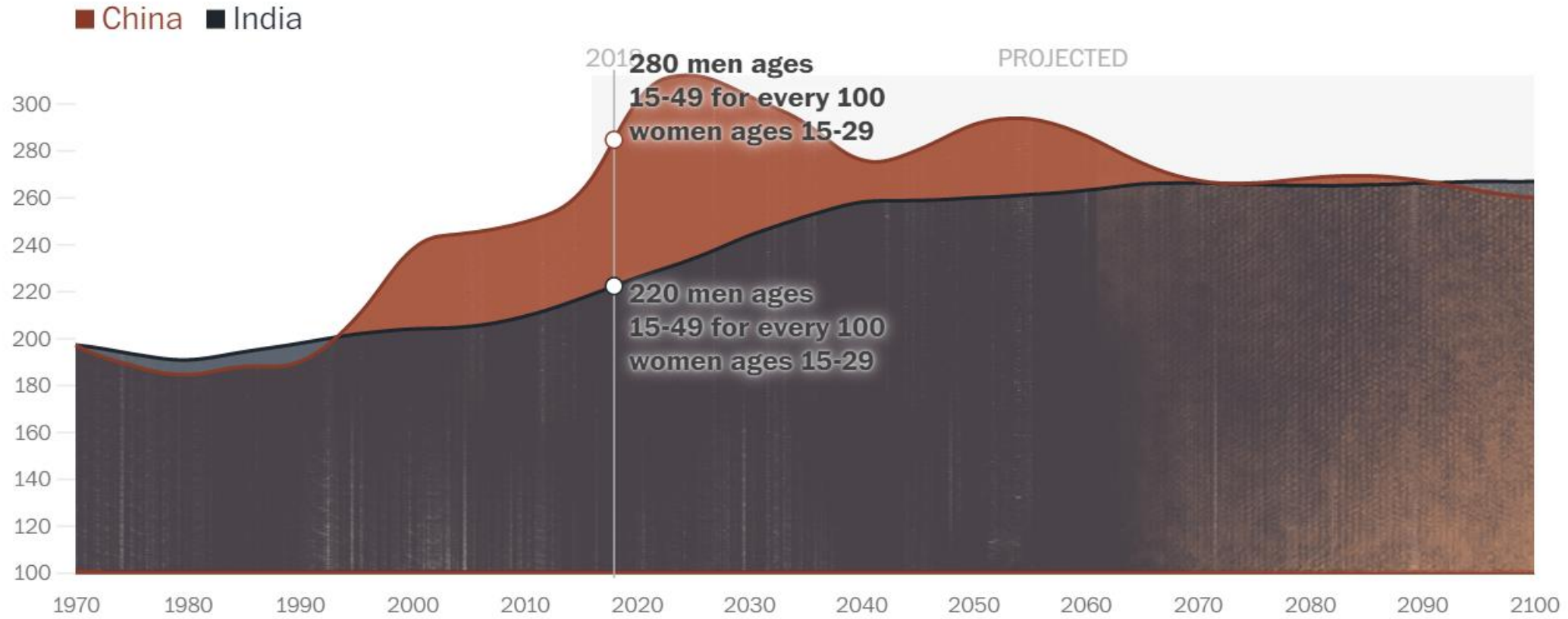
Sursă

The Washington Post
Democracy Dies in Darkness



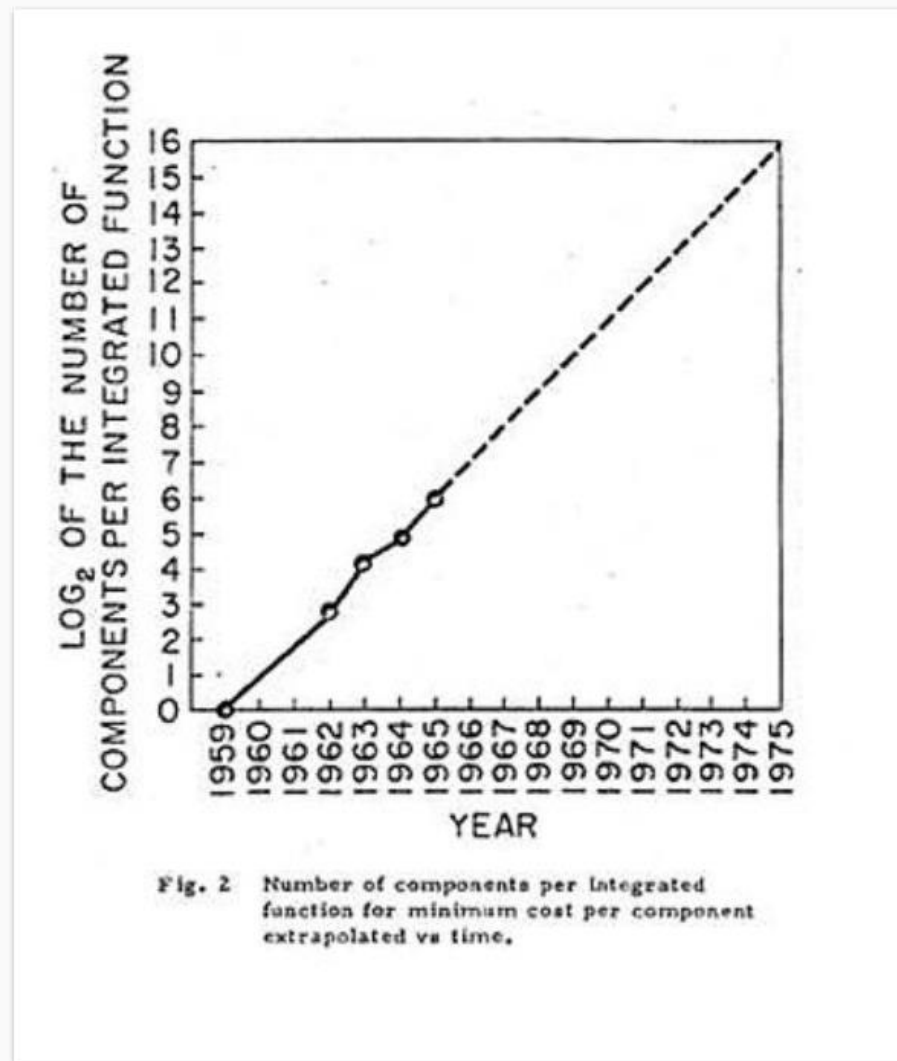
Source: United Nations World Population Prospects

The shaded area is the difference between these boys and girls. The number of young boys in India and China has outpaced the number of young girls



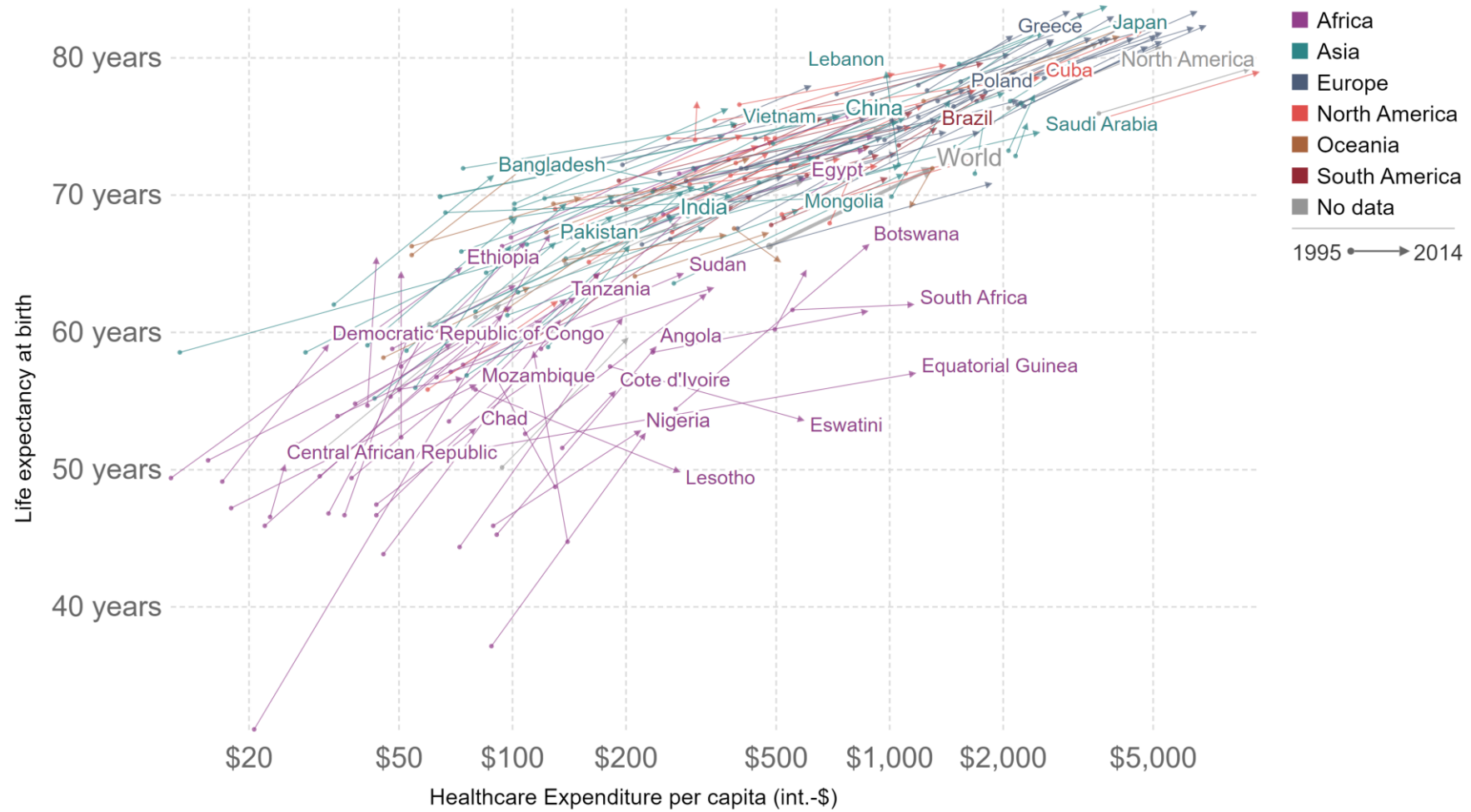
Source: United Nations World Population Prospects

Moore's original graph from 1965: 'The Number of Components per Integrated Function'³



Life expectancy vs. healthcare expenditure, 1995 to 2014

Total healthcare expenditure per capita is adjusted for price differences between countries and for inflation and measured in international-\$.
Our World in Data



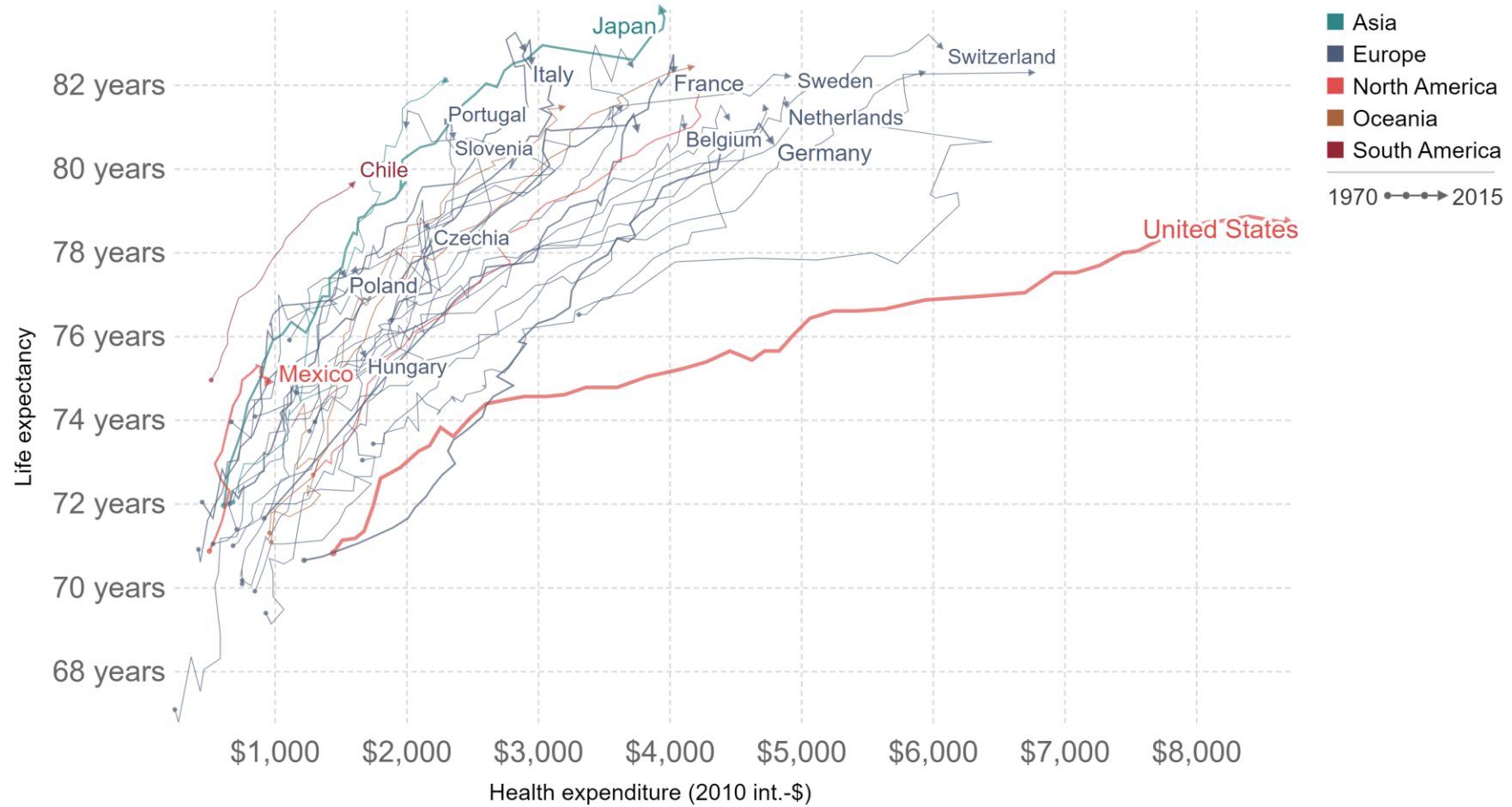
Source: World Bank

CC BY

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Life expectancy vs. health expenditure, 1970 to 2015

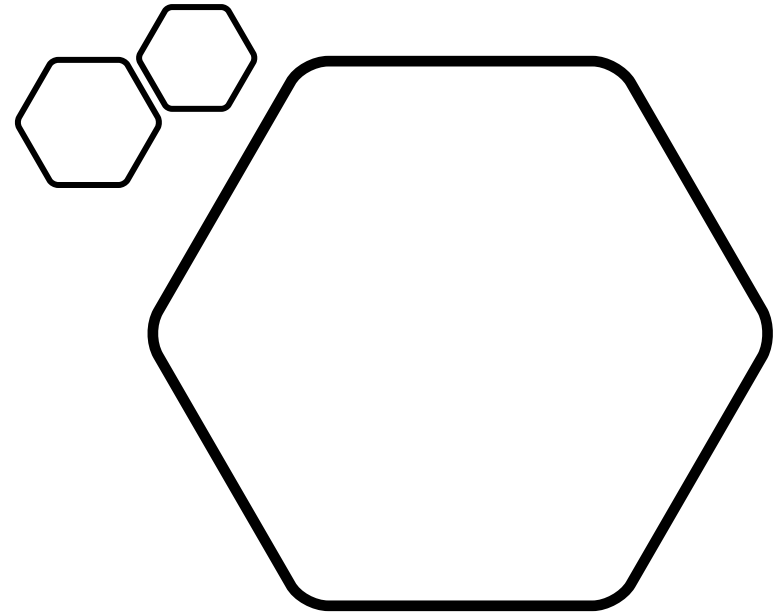
Health financing is reported as the annual per capita health expenditure and is adjusted for inflation and price level differences between countries (measured in 2010 international dollars).



Source: Data compiled from multiple sources by World Bank, Health Expenditure and Financing - OECDstat (2017)
OurWorldInData.org/the-link-between-life-expectancy-and-health-spending-us-focus • CC BY

4. Inegalități

Asocieri, corelații



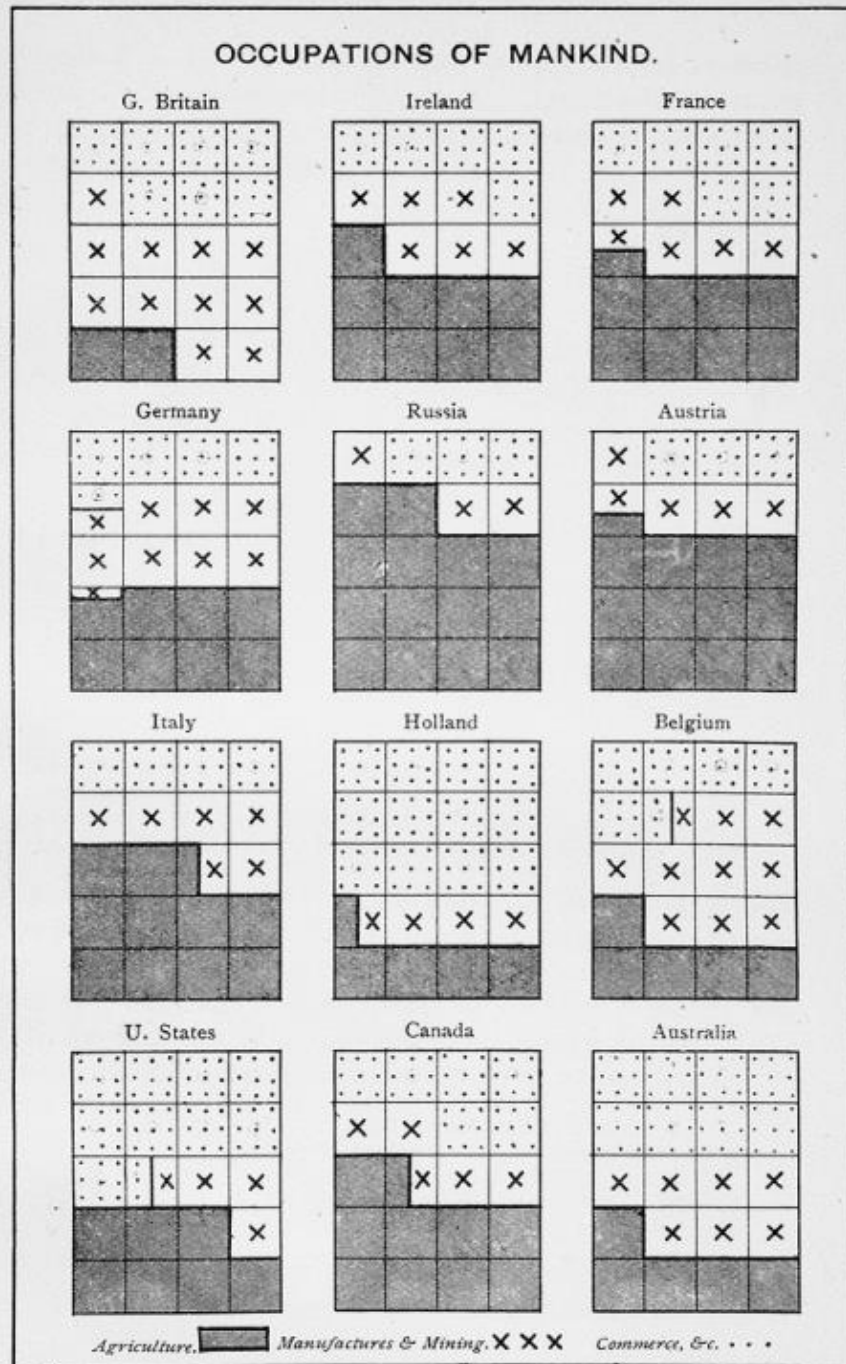
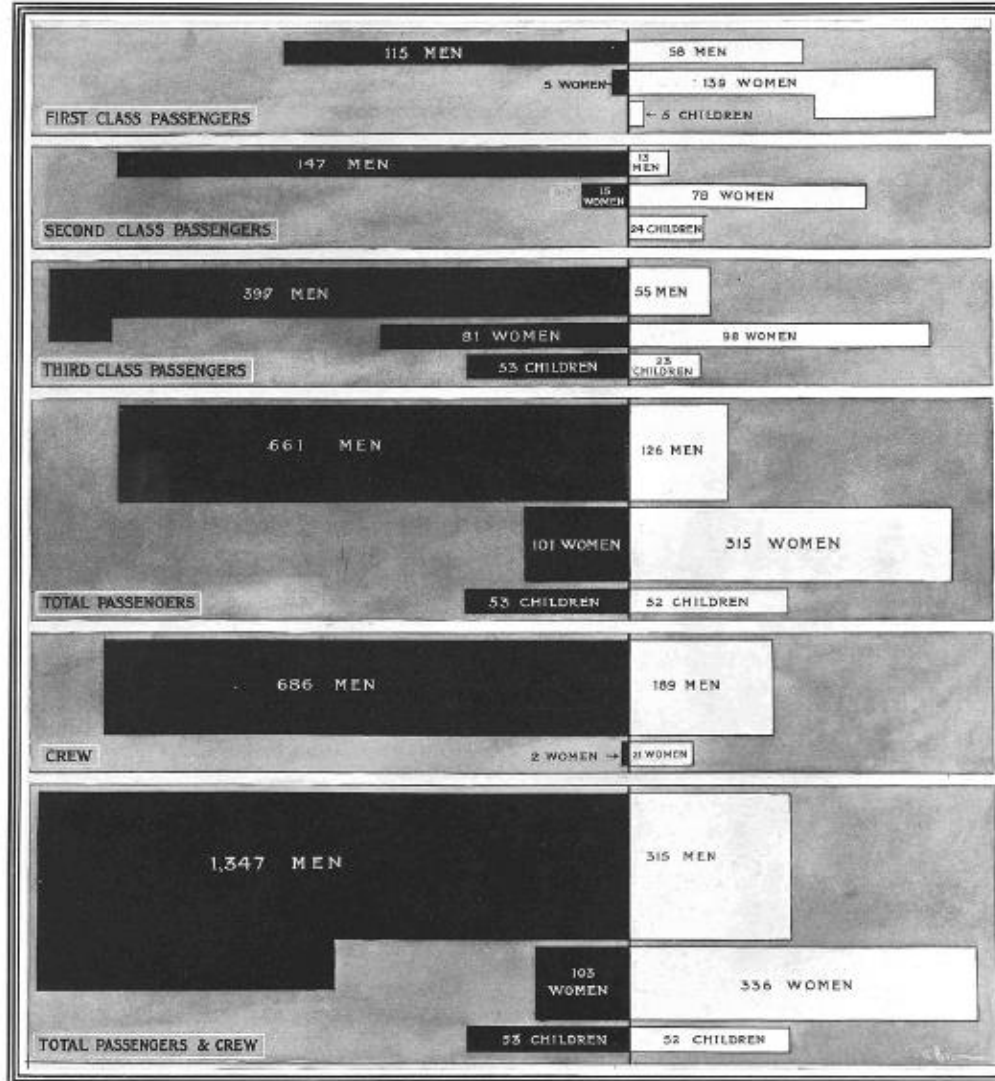


Figure 8.2 Square area diagrams showing occupations in several countries
 Source: Mulhall, *Industries*, Plate III.

THE LOSS of the "TITANIC."

The Results Analysed and Shown in a Special "Sphere" Diagram

Drawn from the Official Figures Given in the House of Commons



The Black Indicates Passengers and Crew NOT SAVED, the White Indicates the SAVED



Sursa

[Sursa](#)

American exceptionalism

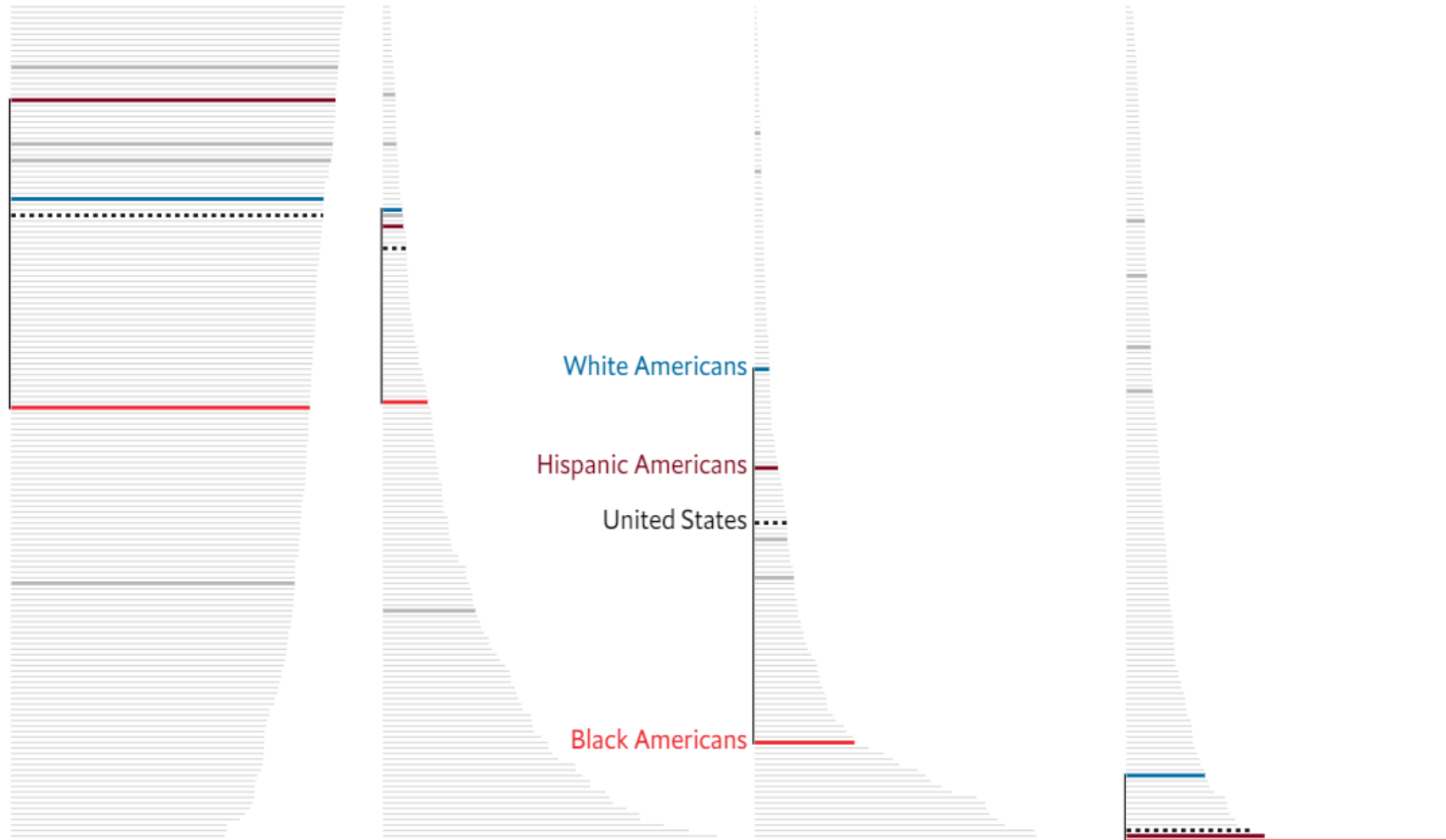
United States and its individual races and ethnicities, compared with other countries
Rank out of 146 countries, 2019 or latest available figure

Life expectancy
Years, at birth

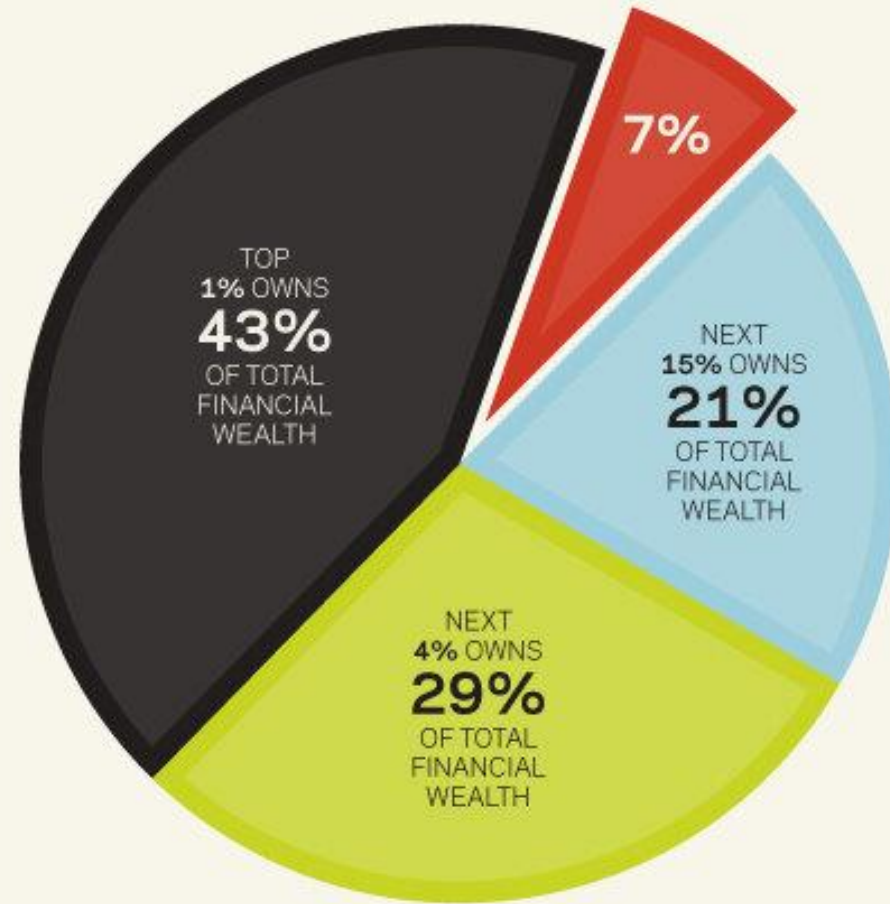
Infant mortality
Deaths per 1,000 births

Murders
Per 100,000 people

Prison population
Per 100,000 people



80% OF AMERICANS SHARE ONLY 7% OF ALL THE MONEY IN AMERICA

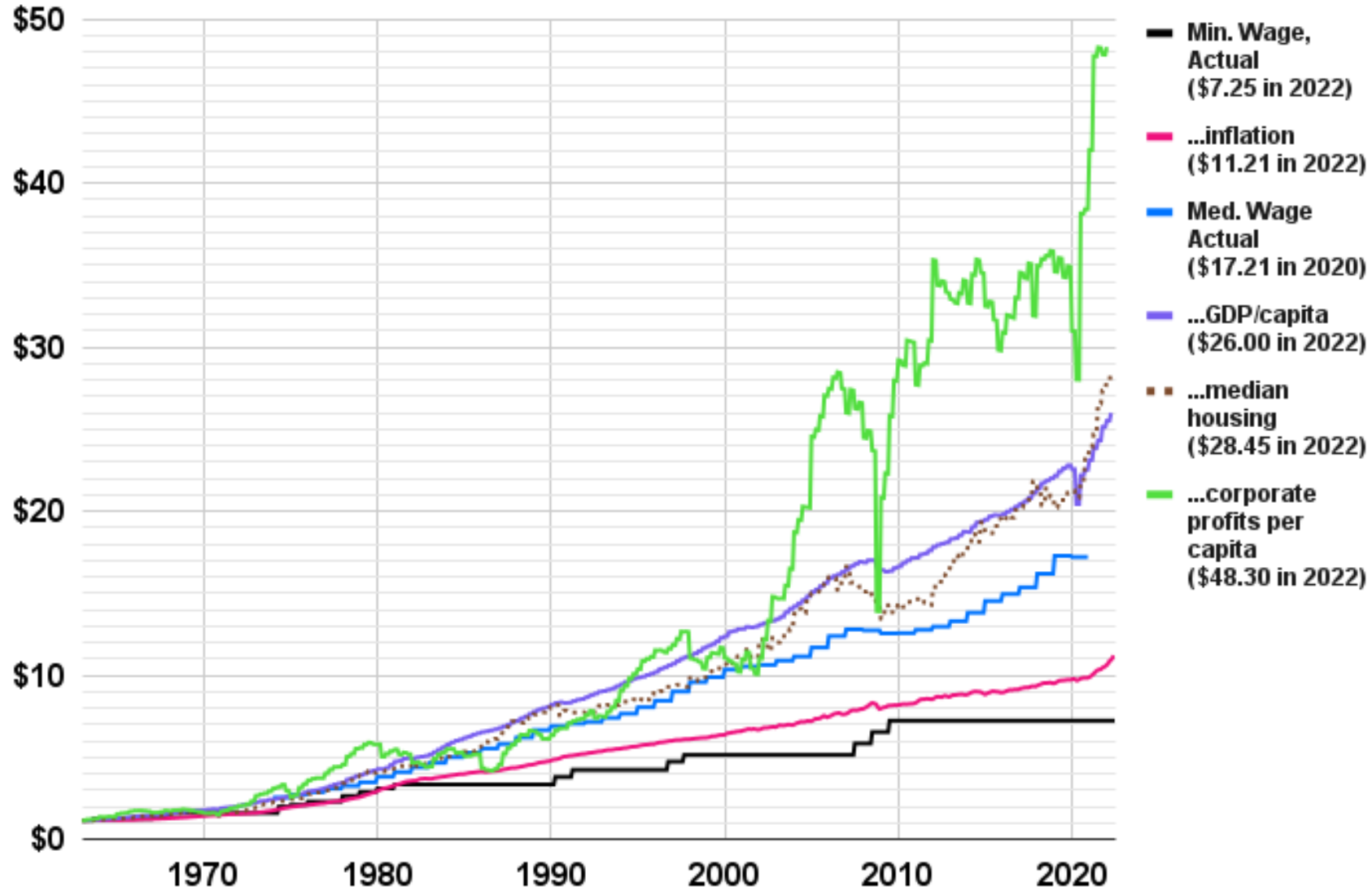


THIS IS **NOT** WHAT DEMOCRACY LOOKS LIKE
DISTRIBUTION OF FINANCIAL WEALTH IN THE UNITED STATES

<http://sociology.ucsc.edu/whorulesamerica/power/wealth.html>

[Sursa](#)

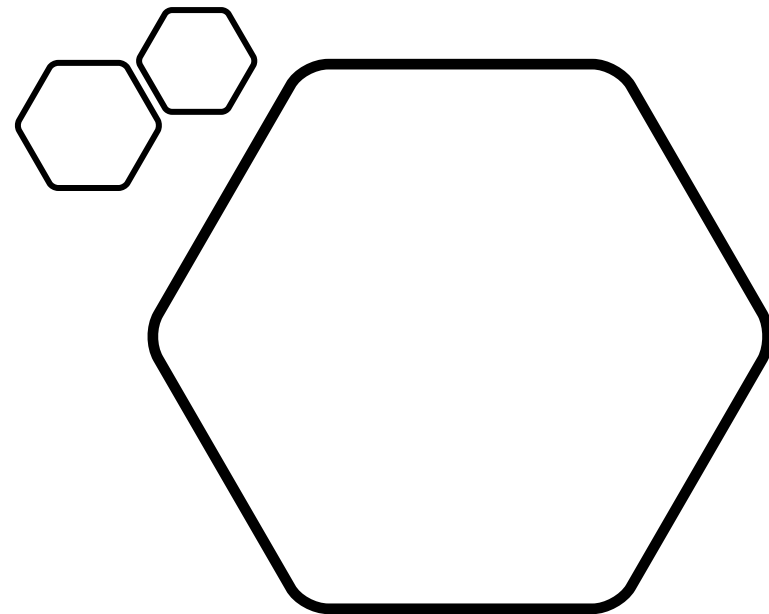
What would minimum wage be if it kept up with...?



[Sursa](#)

5. Clasificări

Clasificări emergente și profilări



FEAR



E. C. Zeeman, "Catastrophe Theory,"
Scientific American, 234 (April 1976), 67;
based on Konrad Z. Lorenz, *King
Solomon's Ring* (New York, 1952).

Sursă:
Tufta, 2001

RAGE

Clasificări

Clasificări emergente

- Identificarea tipurilor pe baza unor criterii
- Analiză cluster
- Exemple
 - Specii
 - Personalități
 - Genuri muzicale noi

Profilări

- Detalierea profilului unor tipuri pre-existente
- Tabele de contingență
- Exemple
 - Profilul culinar al orașelor
 - Profilul ocupațional al femeilor și bărbaților
 - Profilul utilizatorilor Android vs. iOS

How to Read the Circle of Life

Primordial life begins at the center and branches out in all directions, leading to the groups of species that exist today (*colored rings*)

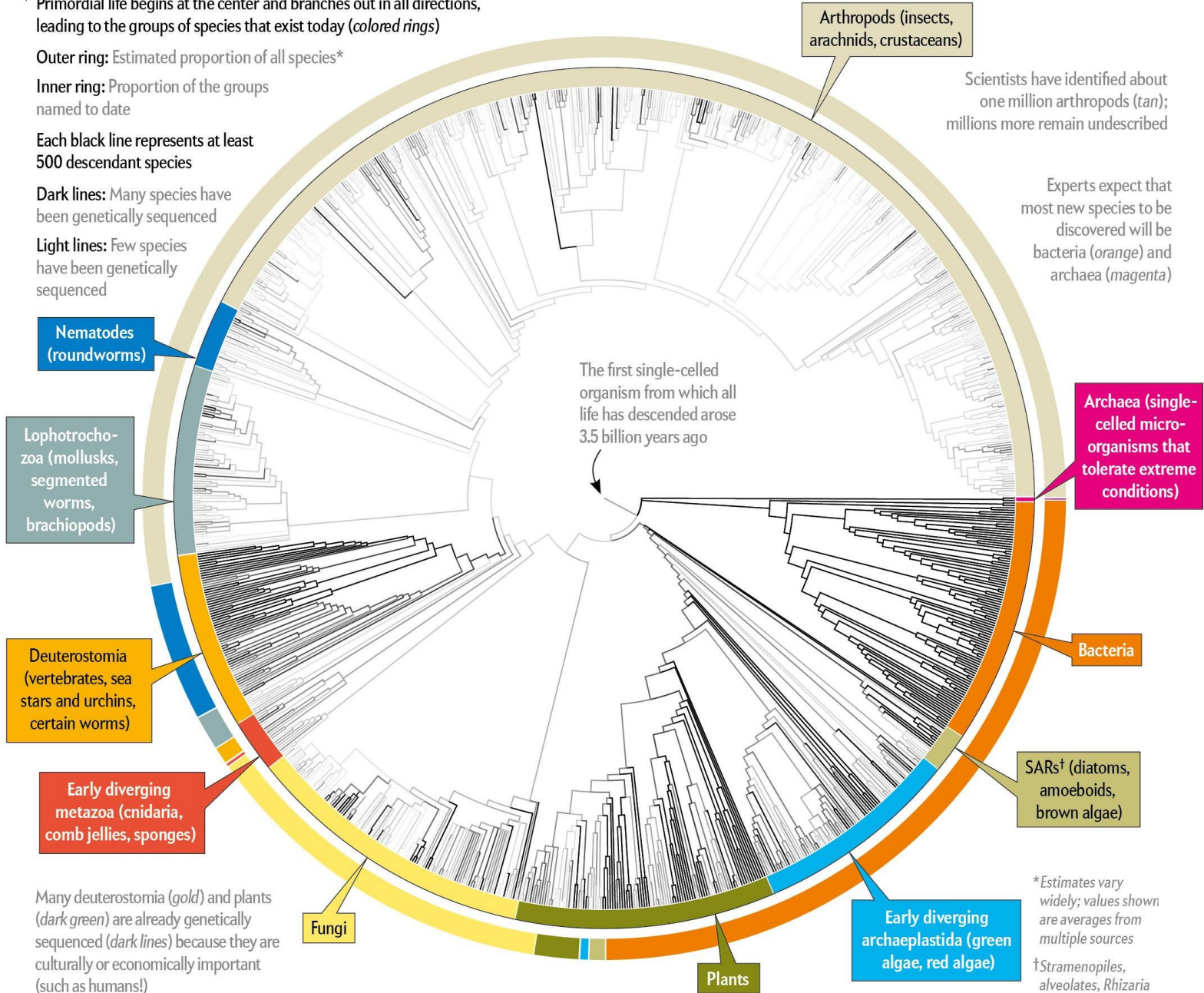
Outer ring: Estimated proportion of all species*

Inner ring: Proportion of the groups named to date

Each black line represents at least 500 descendant species

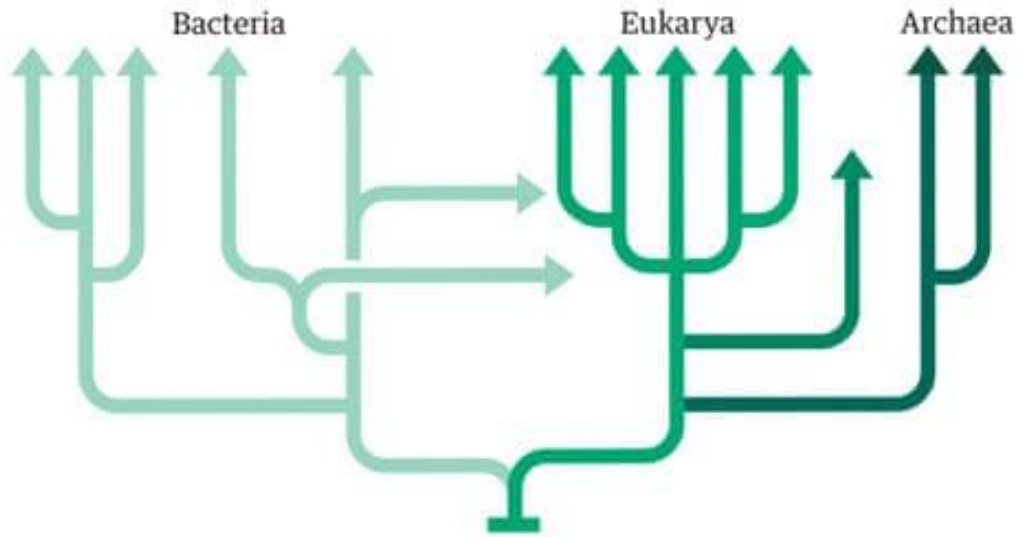
Dark lines: Many species have been genetically sequenced

Light lines: Few species have been genetically sequenced

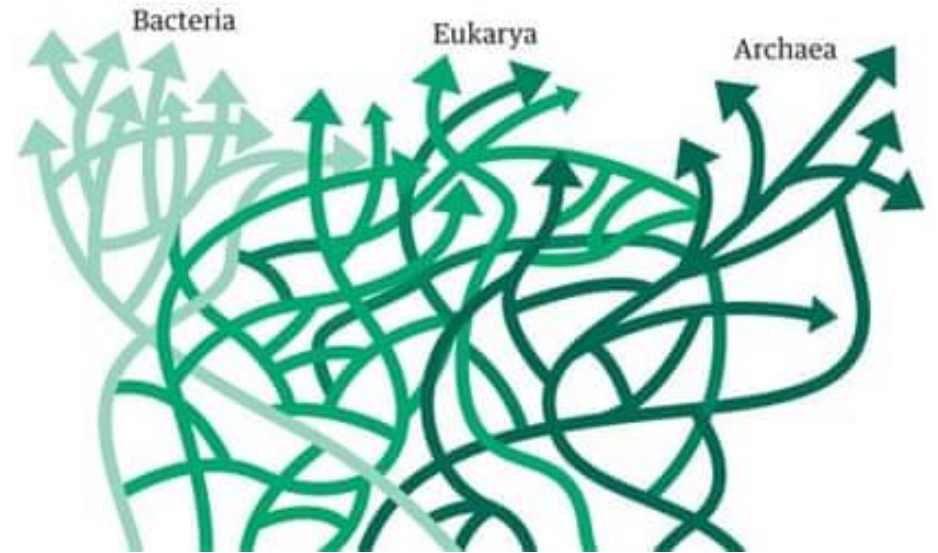


*Estimates vary widely; values shown are averages from multiple sources

†Stramenopiles, alveolates, Rhizaria

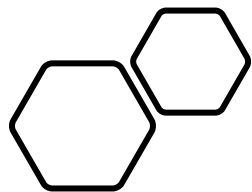


The Tree of Life (Ch. Darwin)

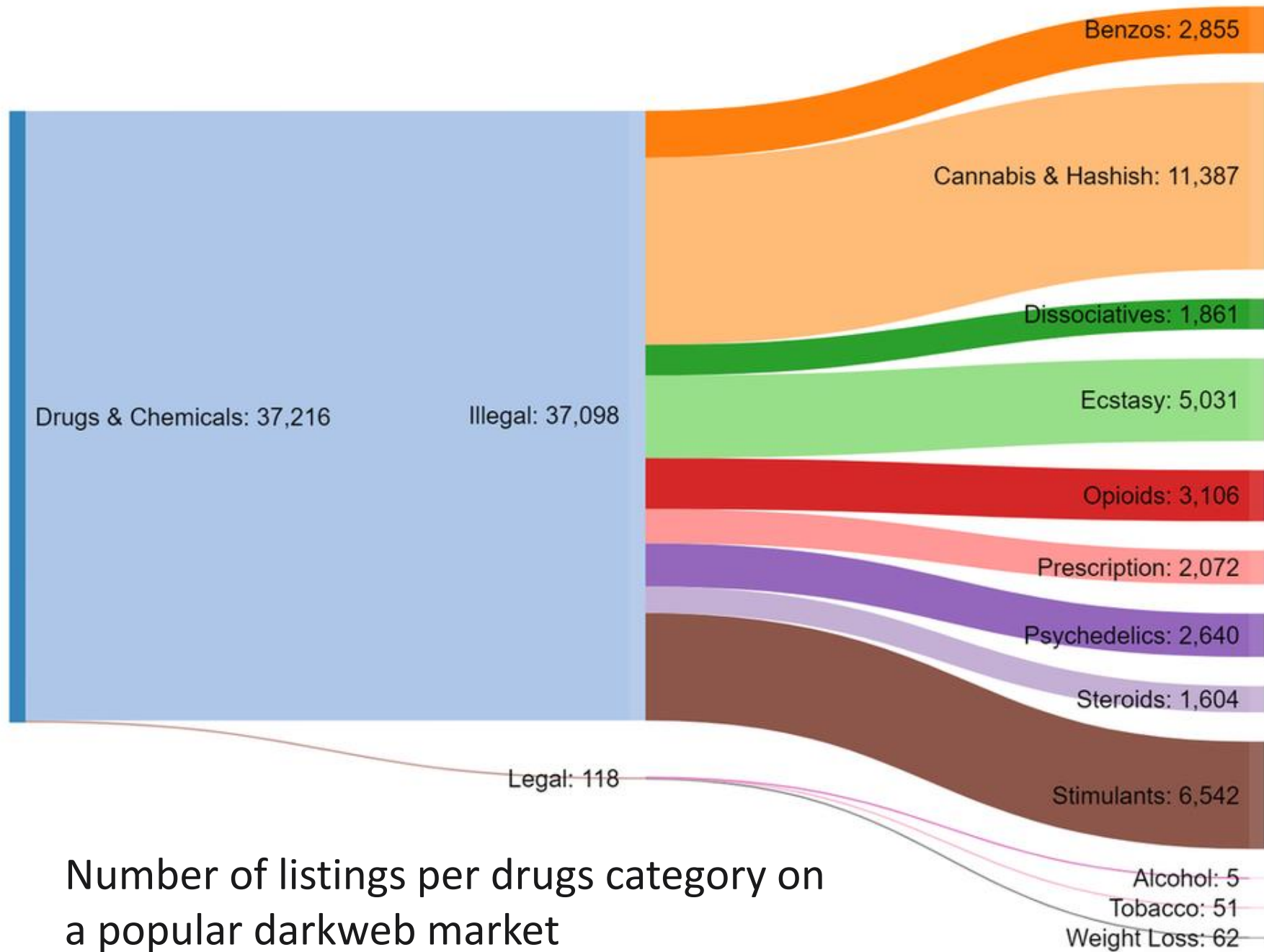


The Impenetrable Thicket of Life
(W Ford Doolittle)

[Sursă](#)



Profilări

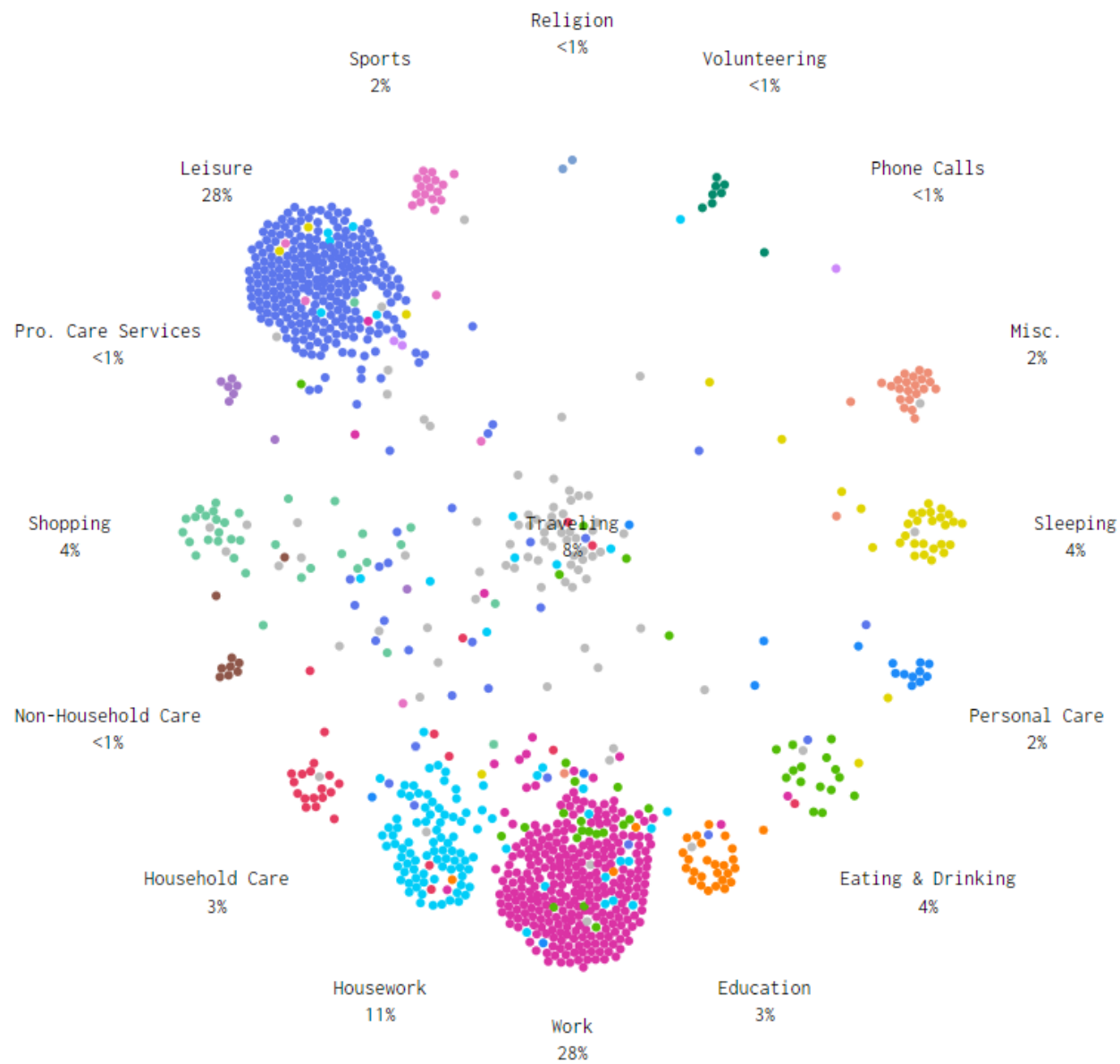


Number of listings per drugs category on a popular darkweb market

3:22pm

SLOW MEDIUM **FAST**

Coffee break? Again, at the top of the hour, you see a shift in activity.

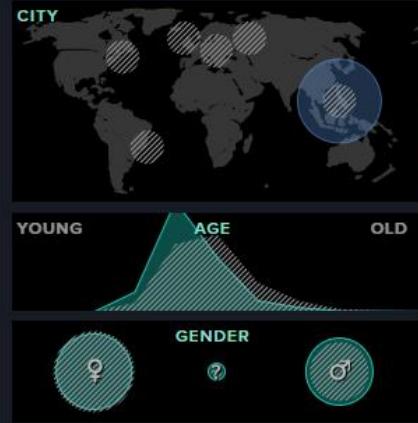


This is a simulation of 1,000 people's average day. It's based on 2014 data from the [American Time Use Survey](#), made way more accessible by the [ATUS Extract Builder](#).

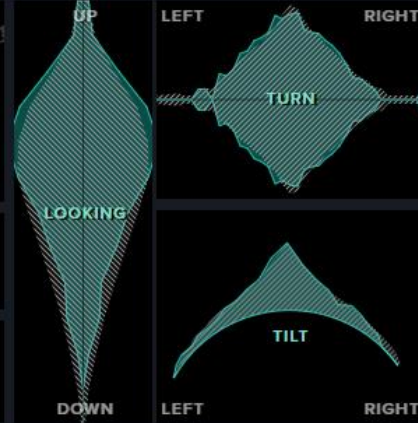
The **SELFIEEXPLORATORY** is part of **SELFIECITY**

🔗 Help 🔄 Share ✖ Reset filters

DEMOGRAPHICS



POSE



FEATURES



MOOD



640 of 3840 selfies.



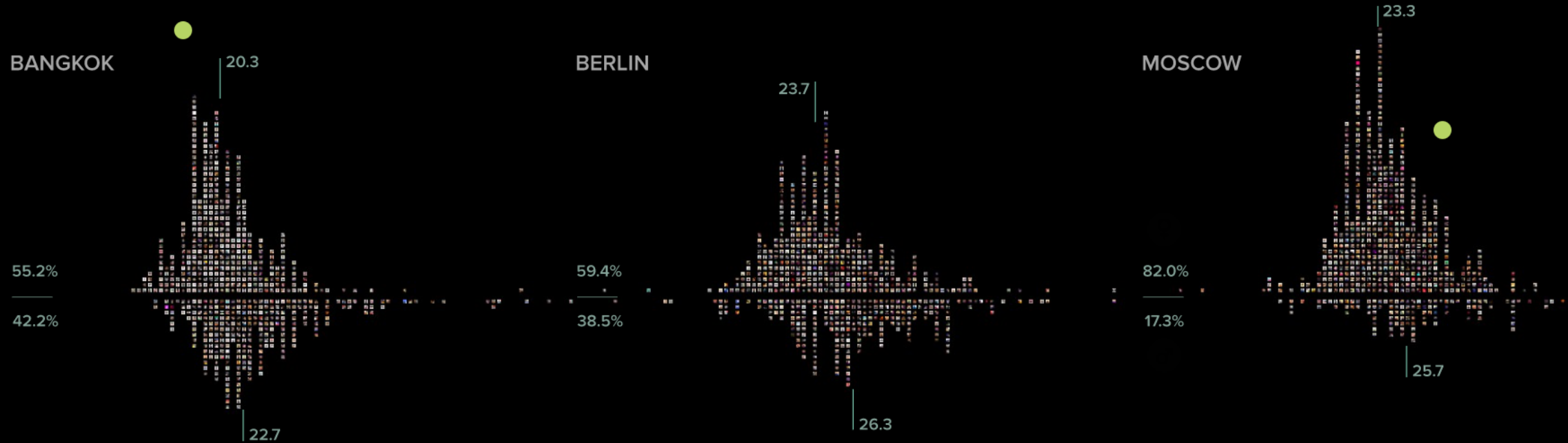
[Sursa](#)
(interactiv)

GENDER AND AGE PROFILES PER CITY

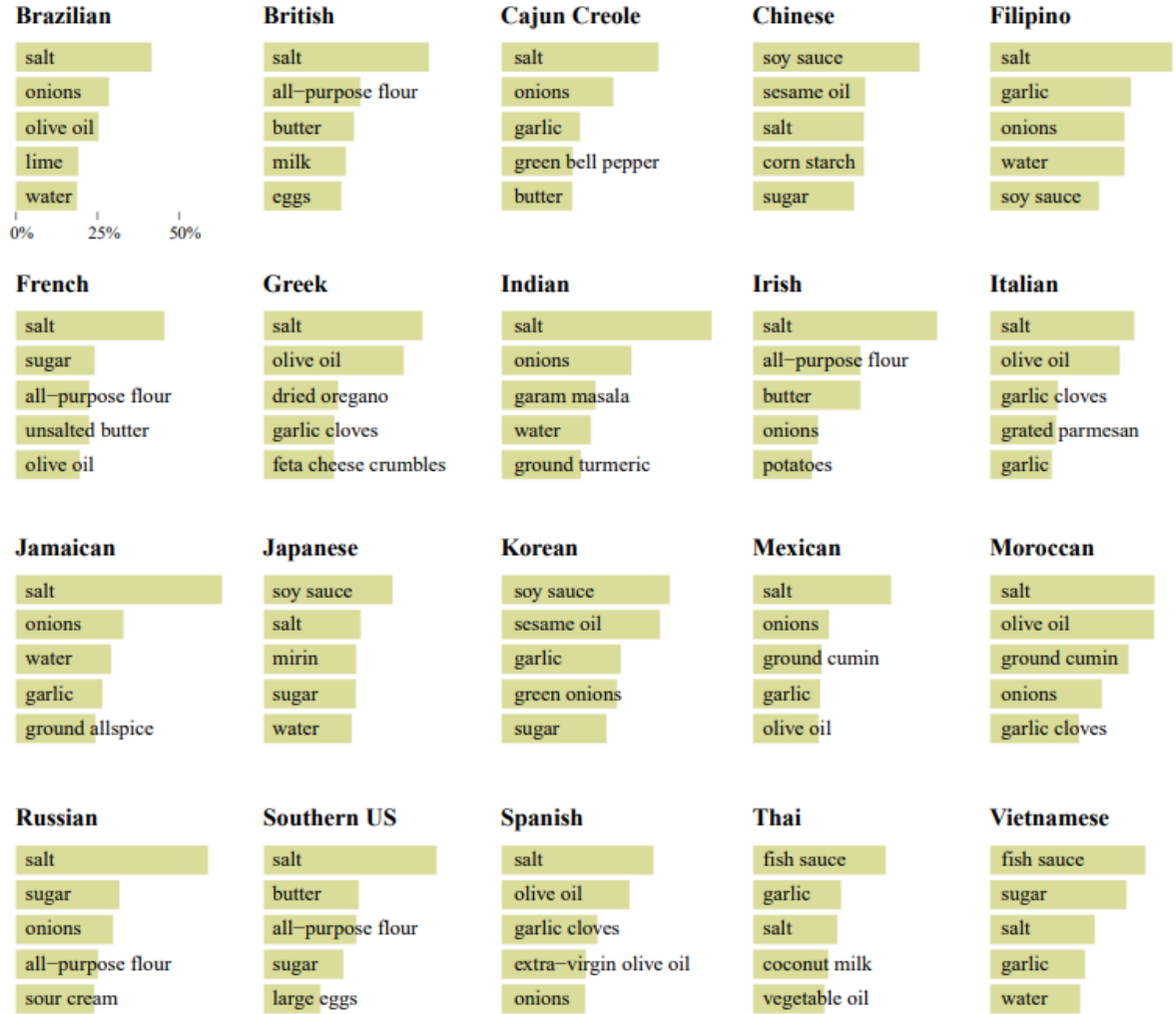
Case by case inspection of photos can reveal a lot of detail, but it is difficult to quantify the patterns observed.

"Is it just me, or do Sao Paulo women actually tilt their heads more? Do New Yorkers or Berliners look older?"

In order to answer these questions, and supplement our rudimentary automatic face analysis with human judgment, we had thousands of photos inspected by Mechanical Turk workers, who estimated age and gender of the people on the photos. Here are the results:



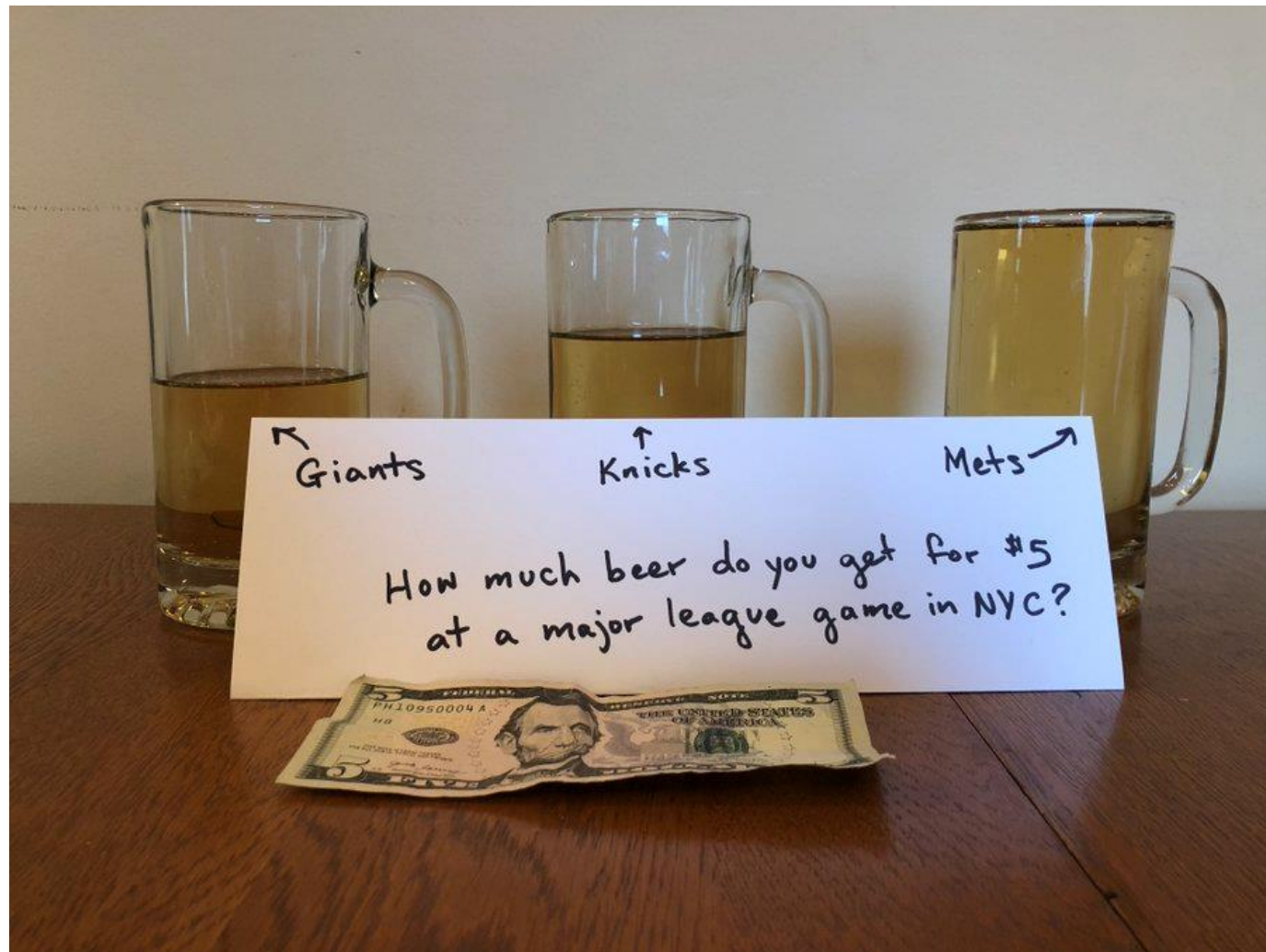
Most Used Ingredients



Most Cuisine-Specific Ingredients



Books in my Living Room



6. Cauzalitate

Corelația nu înseamnă (musai) cauzalitate!

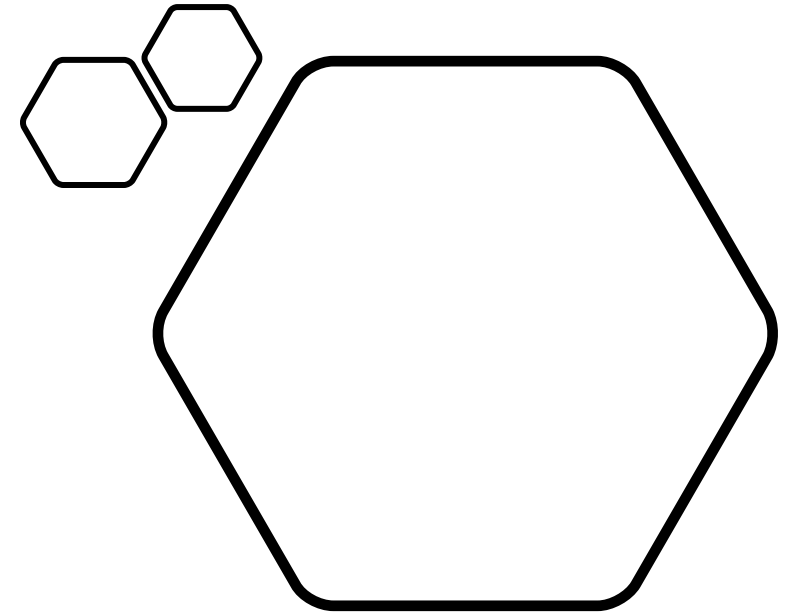
Analiză de regresie

Analiză path



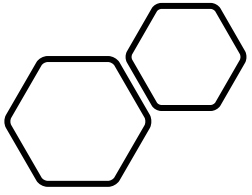
Concluzii

- Știința datelor (învățare automată) vs. analiză statistică
 - Transformare dinspre explicație spre predicție
 - Utilizarea datelor vaste și nestructurate
- Analiza statistică a datelor oferă vocabularul conceptual pentru știința datelor
- Pattern-urile au surse, utilizări și riscuri multiple



Referințe

1. Cao L. [Data science: a comprehensive overview](#). ACM Computing Surveys (CSUR). 2017 Jun 29;50(3):1-42.
2. The Economist. [Worth a Thousand Words](#). 2003 [[Site](#)]
3. Edward R. Tufte, [The graphical display of quantitative information](#). Graphics Press. 2001
4. Edward R. Tufte, [Beautiful evidence](#). Graphics Press, 2006.
5. Zach Gemignani. [20 Best examples of charts and graphics](#).
6. Tableau. [Data is beautiful: 10 of the best data visualisation examples from history to today](#)
7. [Gapminder](#)
8. Walt Hickey. [The 27 worst charts of all time](#). Business Insider, 2013.



Administrativ

Calendar

05 Oct	Why?	06 Oct	Cauzalitate
		13 Oct	Măsurare
18 Oct	Analiza datelor și COVID	20 Oct	Modelare și eșantionare
		27 Oct	Tehnici de analiză
02 Noi	Test lab 1-3	03 Noi	Predicția
		10 Noi	Programare și ML
16 Noi	Grilă curs 1-6	17 Noi	ML și Deep Learning
		24 Noi	Producția în arhitecturi ML
07 Dec	Q&A	08 Dec	Why privacy?
		17 Dec	Privacy Preserving Algorithms
11 Ian	Test Lab 4-9	12 Ian	Privacy Architectures and Federated Learning
		19 Ian	Studiu de caz

Notare

- Curs 5p
 - 2.5p – Grilă curs 1-6 [16.11.2022]
 - 2.5p – Grilă curs 7-12 [sesiune]
- Lab 5p
 - 2p – participarea la laborator
 - 1p – test lab 1-3 [02.11.2022]
 - 2p – test lab 4-9 [11.01.2023]

PR Pins Awards

- 2 primele două scoruri la grila de midterm (departajare prin punctaj și apoi timp)
- 8 pentru implicare în laboratoare (negociate de asistenți)
- 2 pentru implicare în cursuri
- 2 primele două scoruri la grila din sesiune
- 2 contribuții în comunitate (sugestii pe conținut laboratoare, prezență pe forumuri)



midterm



laboratory



lecture



final exam



extra