

Data Visualization & Design

Week 1

General introductions

1. Introduction to **This Course**
2. Introduction to **Data Visualization**

1. Introduction to **This Course**
2. Introduction to **Data Visualization**

- **Canvas**
- **Github** [https://github.com/emilyfuhrman/
datavis_design](https://github.com/emilyfuhrman/datavis_design)

Topic Progression

- **Weeks 1-3:** Principles of Visual Design and Human Perception; Visualization for Communication
- **Weeks 4-7:** Data Types and Visualization Methods
- **Weeks 8-14:** Visualization for Analysis: Creating Dashboards and Visualization Applications

Topic Progression + *Tools*

- **Weeks 1-3:** Principles of Visual Design and Human Perception; Visualization for Communication (**Powerpoint or Canva, Excel and Infogram, color tools**)
- **Weeks 4-7:** Data Types and Visualization Methods (**Tableau, R**)
- **Weeks 8-14:** Visualization for Analysis: Creating Dashboards and Visualization Applications (**Tableau, D3.js**)

Topic Progression + *Assignments*

- **Weeks 1-3:** Principles of Visual Design and Human Perception;
Visualization for Communication (***Assignment #1***)
- **Weeks 4-7:** Data Types and Visualization Methods (***Assignment #2,***
Assignment #3)
- **Weeks 8-14:** Visualization for Analysis: Creating Dashboards and
Visualization Applications (***Assignment #3, Assignment #4***)

Assignments

- *Weekly homework assignments & participation (25%)*
- **Assignment #1 (10%):** Visual Semantics
- **Assignment #2 (15%):** Truth and Lies in Visualization Graphic
- **Assignment #3 (20%):** Team Project
- **Assignment #4 (30%):** Visualization Application

Expectations

- Attend and participate in all classes
- Complete homework assignments thoroughly and thoughtfully
- Submit **only your own work**
- Communicate with Instructor/Associates to address any questions

1. Introduction to **This Course**
2. Introduction to **Data Visualization**

Data is a set of values of quantitative or qualitative variables.

Simple Budget

Q Search Sheet

Home Insert Page Layout Formulas Data Review View

Cut Copy Paste Format Calibri (Body) 12 A = Wrap Text General \$ % Conditional Formatting Insert AutoSum

Copy A Fill

Format as Table Delete Sort & Filter

Cell Styles Format Clear

Share

Q17 fx

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Q	R	
			January	February	March	April	May	June	July	August	September	October	November	December	Total			
Necessities	Car Payment	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 2,400.00	Portion of Budget		
	Rent	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 1,500.00	\$ 18,000.00	Necessities	\$ 30,310.00	
	Utilities	\$ 70.00	\$ 50.00	\$ 80.00	\$ 70.00	\$ 50.00	\$ 100.00	\$ 110.00	\$ 100.00	\$ 80.00	\$ 50.00	\$ 80.00	\$ 90.00	\$ 90.00	\$ 930.00	Luxuries	\$ 4,920.00	
	Groceries	\$ 100.00	\$ 300.00	\$ 300.00	\$ 400.00	\$ 400.00	\$ 300.00	\$ 300.00	\$ 100.00	\$ 80.00	\$ 300.00	\$ 300.00	\$ 100.00	\$ 100.00	\$ 2,980.00	Saved	\$ 770.00	
	Insurance	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 500.00	\$ 6,000.00	Portion of Budget		
	Subtotal	\$ 2,370.00	\$ 2,550.00	\$ 2,580.00	\$ 2,670.00	\$ 2,650.00	\$ 2,600.00	\$ 2,610.00	\$ 2,400.00	\$ 2,360.00	\$ 2,550.00	\$ 2,580.00	\$ 2,390.00	\$ 2,390.00	\$ 30,310.00			
Luxuries	Going Out	\$ 60.00	\$ 80.00	\$ 60.00	\$ 40.00	\$ 40.00	\$ 20.00	\$ 20.00	\$ 500.00	\$ 80.00	\$ 40.00	\$ 100.00	\$ 200.00	\$ 1240.00				
	Hobbies	\$ 10.00	\$ 10.00	\$ 10.00	\$ 10.00	\$ 200.00	\$ 300.00	\$ 500.00	\$ 200.00	\$ 10.00	\$ 10.00	\$ 20.00	\$ 20.00	\$ 1,300.00				
	Shopping	\$ 100.00	\$ 50.00	\$ 50.00	\$ 50.00	\$ 50.00	\$ 50.00	\$ 50.00	\$ 80.00	\$ 50.00	\$ 50.00	\$ 600.00	\$ 200.00	\$ 1,380.00				
	Travel	\$ 1,000.00	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,000.00			
	Subtotal	\$ 1,170.00	\$ 140.00	\$ 120.00	\$ 100.00	\$ 290.00	\$ 370.00	\$ 570.00	\$ 780.00	\$ 140.00	\$ 100.00	\$ 720.00	\$ 420.00	\$ 420.00	\$ 4,920.00			
	Total	\$ 3,540.00	\$ 2,690.00	\$ 2,700.00	\$ 2,770.00	\$ 2,940.00	\$ 2,970.00	\$ 3,180.00	\$ 3,180.00	\$ 2,500.00	\$ 2,650.00	\$ 3,300.00	\$ 2,810.00	\$ 35,230.00				
	Budget	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 3,000.00	\$ 36,000.00			
	Saved	\$ (540.00)	\$ 310.00	\$ 300.00	\$ 230.00	\$ 60.00	\$ 30.00	\$ (180.00)	\$ (180.00)	\$ 500.00	\$ 350.00	\$ (300.00)	\$ 190.00	\$ 770.00				

* Necessities * Luxuries * Saved

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Today:

- [] grocery shop
- [x] clean
- [x] walk dog

Tomorrow:

- [] pick up car
- [x] do laundry
- [] bake cake
- [] fix alarm

Next week:

- [] finish report
- [] book meeting
- [] mow lawn

But may it not be, that while the whales of the present hour are an advance in magnitude upon those of all previous geological periods; may it not be, that since Adam's time they have de-generated?

Assuredly, we must conclude so, if we are to credit the accounts of such gentlemen as Pliny, and the ancient naturalists generally. For Pliny tells us of whales that embraced acres of living bulk, and Aldrovandus of others which measured eight hundred feet in length—Rope Walks and Thames Tunnels of whales! And even in the days of Banks and Solander, Cooke's naturalists, we find a Danish member of the Academy of Sciences setting down certain Iceland Whales (*reydan-siskur*, or Wrinkled Bellies) at one hundred and twenty yards; that is, three hundred and sixty feet. And Lacépède, the French naturalist, in his elaborate history of whales, in the very beginning of his work (page 3), sets down the Right Whale at one hundred metres, three hundred and twenty-eight feet. And this work was published so late as

A. D. 1825.

But will any whaleman believe these stories? No. The whale of to-day is as big as his ancestors in Pliny's time. And if ever I go where Pliny is, I, a whaleman (more than he was), will make bold to tell him so. Because I cannot understand how it is, that while the Egyptian mummies that were buried thousands of years before even Pliny was born, do not measure so much in their coffins as a modern Kentuckian in his socks; and while the cattle and other animals sculptured on the oldest Egyptian and Nineveh tablets, by the relative proportions in which they are drawn, just as plainly prove that the high-bred, stall-fed, prize cattle of Smithfield, not only equal, but far exceed in magnitude the fattest of



Data visualization maps **values** to **visual forms**.

As a practice, visualization is the mapping of qualitative and quantitative data onto **shapes**, **patterns** and **colors**...

...in a way that **enables communication and insight** into the underlying patterns in the data.

Data **types**

Qualitative

- Nominal
- Ordinal

Quantitative

- Interval
- Ratio

Data types — Qualitative

1. Nominal —

Nominal scales are used to ***name***, or label, variables without any quantitative value.

What is your gender?

- M – Male
- F – Female

What is your hair color?

- 1 – Brown
- 2 – Black
- 3 – Blonde
- 4 – Gray
- 5 – Other

Where do you live?

- A – North of the equator
- B – South of the equator
- C – Neither: In the international space station

Data types — Qualitative

2. Ordinal —

For ordinal scales, **order** is significant, even though the differences between values may not really be known.

How do you feel today?

- 1 – Very Unhappy
- 2 – Unhappy
- 3 – OK
- 4 – Happy
- 5 – Very Happy

How satisfied are you with our service?

- 1 – Very Unsatisfied
- 2 – Somewhat Unsatisfied
- 3 – Neutral
- 4 – Somewhat Satisfied
- 5 – Very Satisfied

Data types — **Quantitative**

1. **Interval** —

Interval scales give us the **order** as well as the **exact differences** between values. However, there is **no “true zero.”** This means that we can add and subtract, but not multiply or divide.

Examples: temperature, dates

Data types — **Quantitative**

2. **Ratio** —

Ratio scales tell us about the ***order***, the ***exact value between units***, and ***do have a “true zero,”*** allowing us to apply descriptive and inferential statistics to the data.

Examples: height, weight

Interval vs. Ratio

10 degrees + 10 degrees = 20 degrees

20 degrees is not “twice as hot” as 10 degrees; the value of the attribute is just twice as large. Here, meaningful fractions cannot be computed.

10 pounds + 10 pounds = 20 pounds

20 pounds is “twice as heavy” as 10 pounds. Here, meaningful fractions can be computed.

Qualitative

- Nominal
- Ordinal

Quantitative

- Interval
- Ratio

Exploration and analysis **vs.**
communication and persuasion

Challenges

- Communication implies **simplification**
- Data exploration implies **exhaustivity**

Visualization for **data exploration** supports a range of *unanticipated* questions...

...while visualization for **communication and presentation** answers specific, *anticipated* questions.

Considerations

- **Format** Printed report? Dashboard? Poster?
- **Mode of interaction** Static? Interactive?
- **Intended audience** Analyst? Board member?

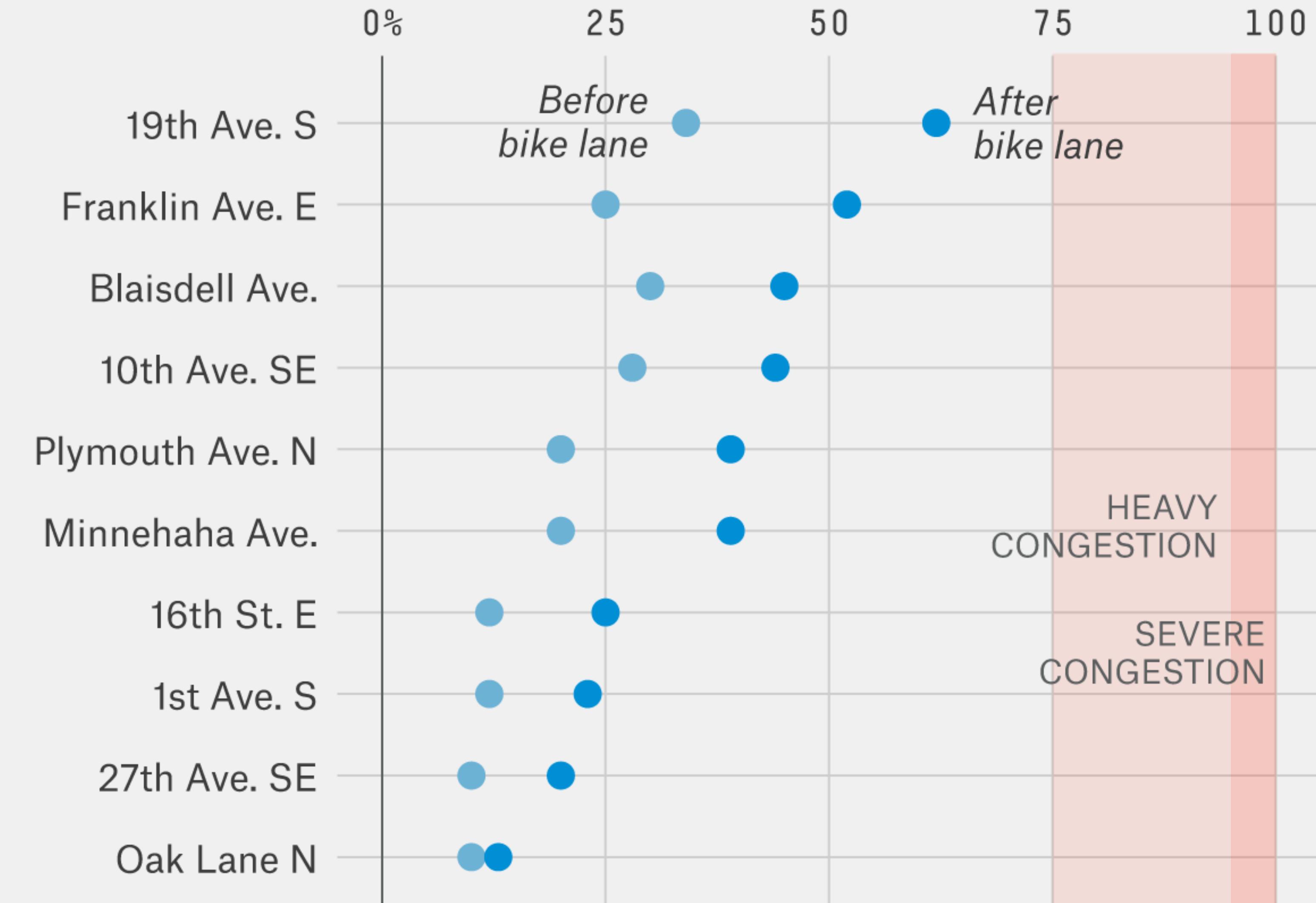
Forms

- **Charts, graphs, and maps** (statistical data representations)
- **Infographics** (data-driven storytelling)
- **Interactive dashboards** (e.g. Tableau)

Charts, graphs, and maps are statistical representations of data that are integrated into static and interactive compositions.

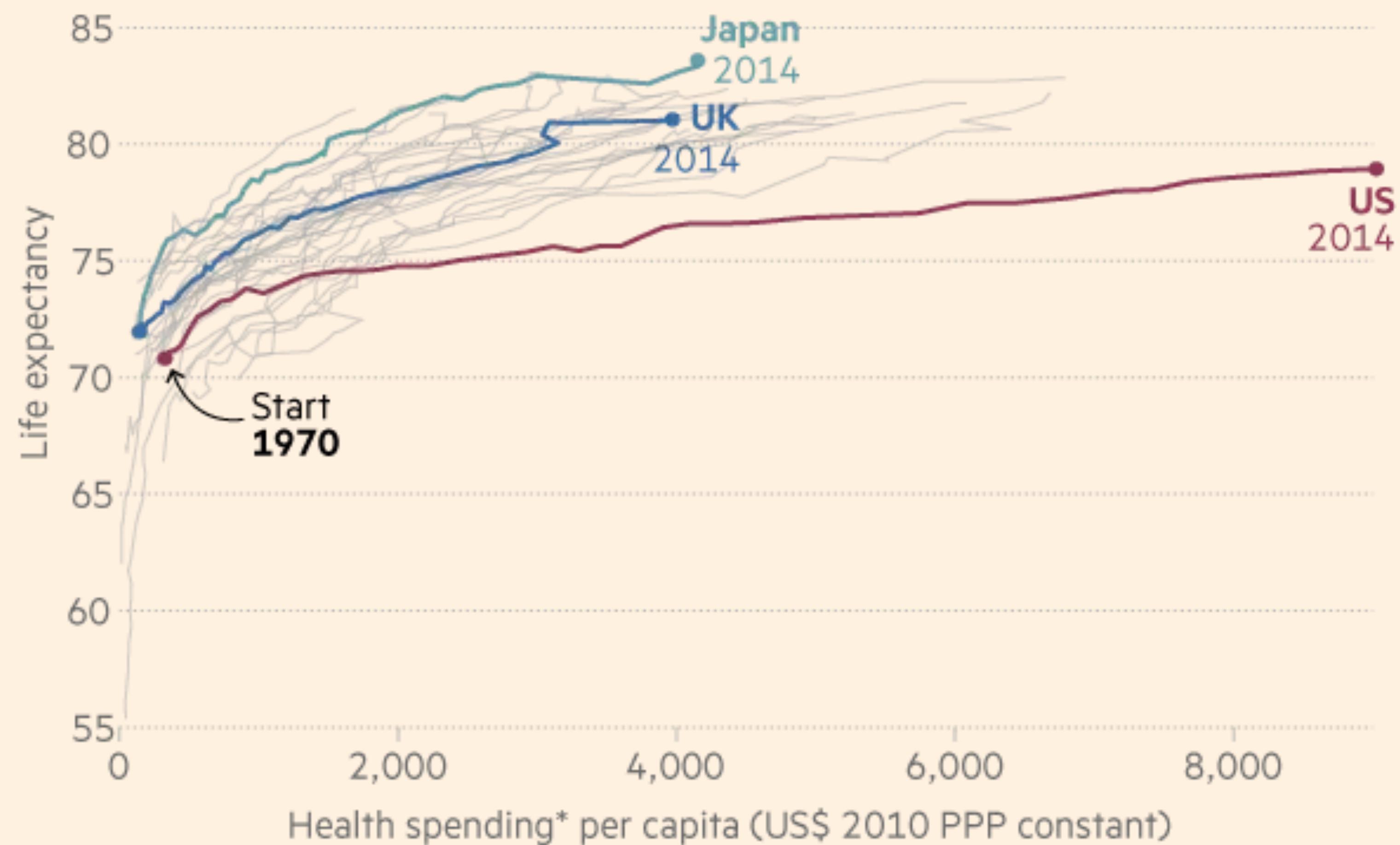
Bike Lanes and Traffic in Minneapolis

Ratio of traffic volume to capacity on 10 roads



Life expectancy in the US has not risen in line with spending on healthcare

Each line represents an OECD country



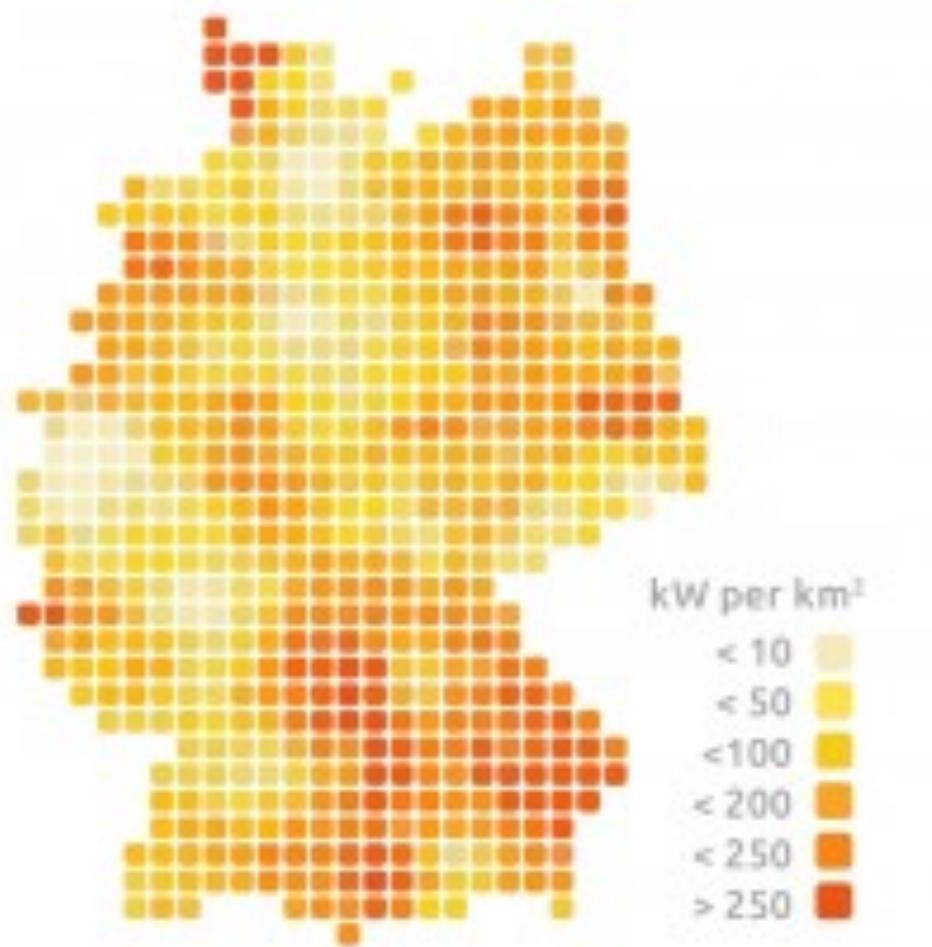
FT graphic Sources: United Nations Population Division, OECD

*Final consumption of health care goods and services (i.e. current health expenditure) including personal health care and collective services but excluding spending on investments

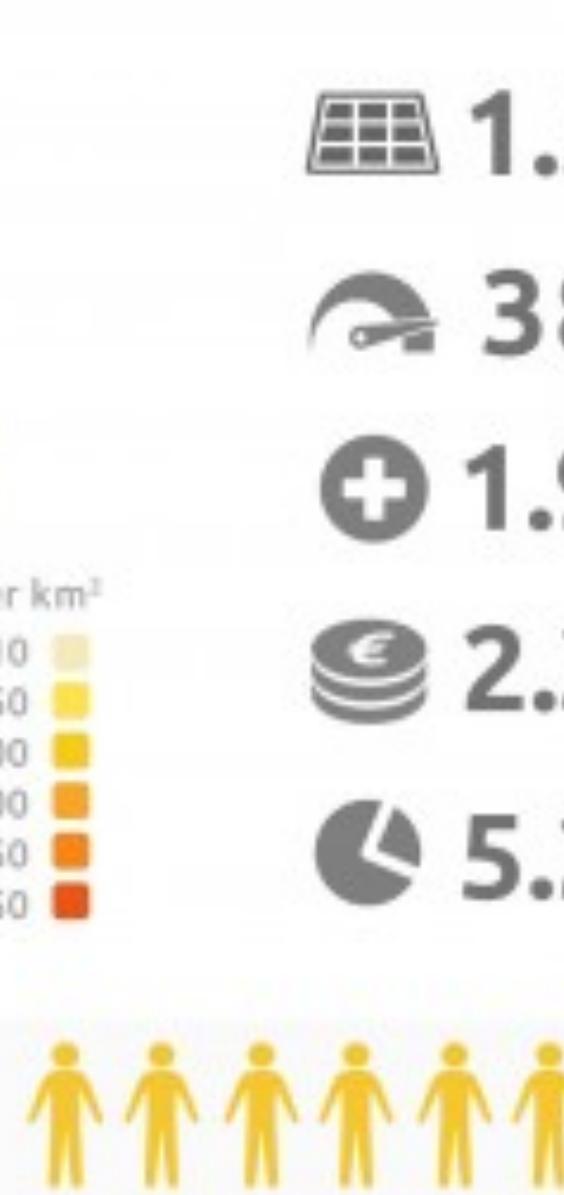
FT

Infographics are static compositions that focus on data-driven storytelling.

INSTALLED CAPACITY PER KM²



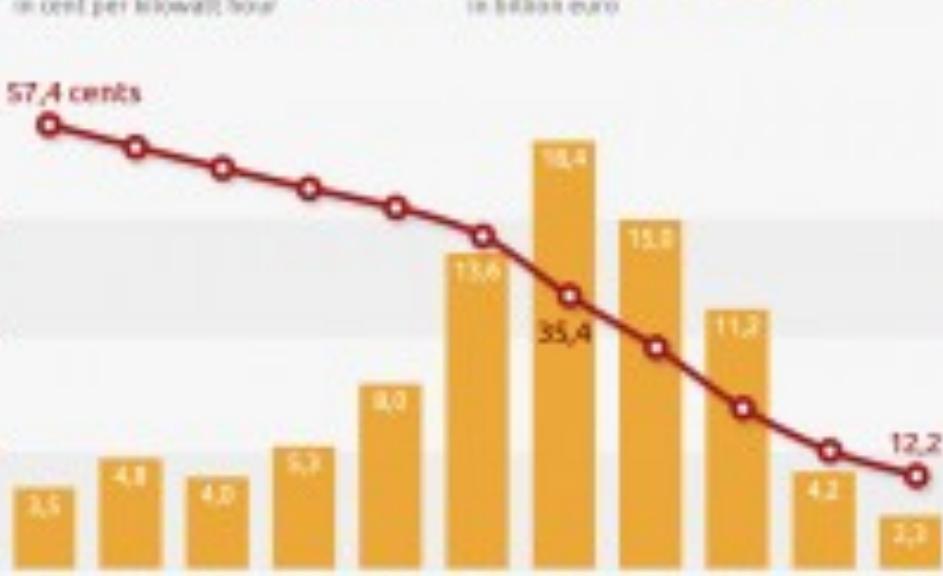
Acceptance of solar farms
in the neighborhood



SOLAR ENERGY GENERATION 2014



FIT PAYMENTS & INVESTMENTS



2015 Sports Clubs

CAMPUS
RECREATION
STAY ACTIVE

TOTAL MEMBERS ACTIVE:

1,361



49 SPORTS CLUB Teams

46%
Female
MEMBERS

54%
Male
MEMBERS



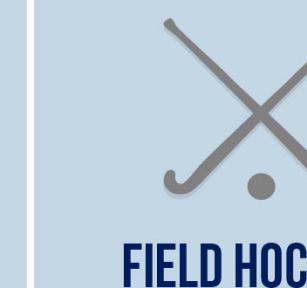
70% OF OFFICERS HAVE ENHANCED THEIR ABILITY TO THINK CRITICALLY THROUGH SPORTS CLUBS PARTICIPATION

2 NATIONAL INDIVIDUAL CHAMPIONS

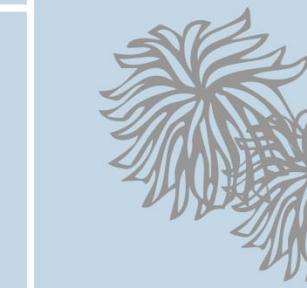
Sydney Boukedes
BALLROOM
LATIN DANCE
CHA CHA & RUMBA

Luke Vrouwenvelder
CYCLING MEN'S
COLLEGIATE
MOUNTAIN BIKE DIVISION I

3 NATIONAL TEAM CHAMPIONS



FIELD HOCKEY



ALL-GIRL CHEER



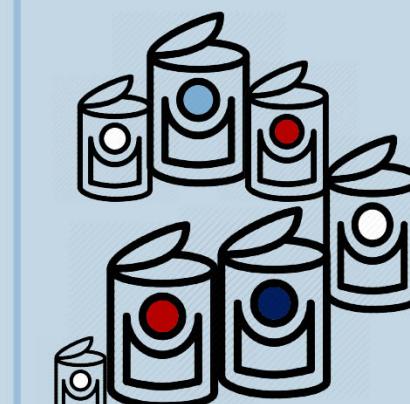
MEN'S ULTIMATE

PARTICIPANTS DONATED

MORE THAN

5,676

CANS OF FOOD TO THE FOOD BANK OF CENTRAL AND EASTERN NORTH CAROLINA



BLOOD PLATELET DONATIONS FROM SPORTS CLUBS

PARTICIPANTS:

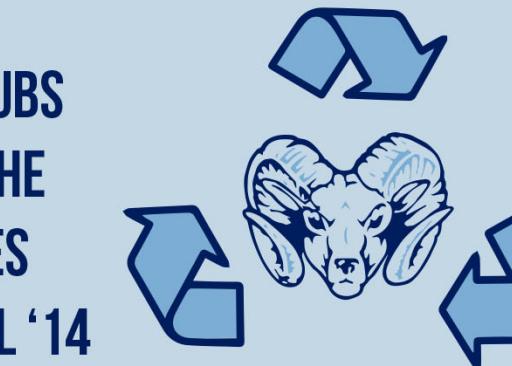
204

SPORTS MEDICINE HELD CLINIC VISITS FOR SPORT CLUB ATHLETES

802

CLINIC VISITS FOR SPORT CLUB ATHLETES

71 SPORTS CLUBS PARTICIPATED IN THE RAMSES RECycles PROGRAM FOR FALL '14



COFFEE FACTS

TOP 5 COFFEE PRODUCERS

1. BRAZIL
2. VIETNAM
3. COLOMBIA
4. INDONESIA
5. ETHIOPIA

TOP 5 COFFEE CONSUMERS

1. UNITED STATES
2. GERMANY
3. ITALY
4. JAPAN
5. FRANCE

33% OF THE WORLD'S COFFEE IS PRODUCED IN BRAZIL

56% OF ADULTS IN THE UNITED STATES DRINK COFFEE
NONE OF THE ABOVE COUNTRIES ARE LOCATED IN THE BEAN BELT

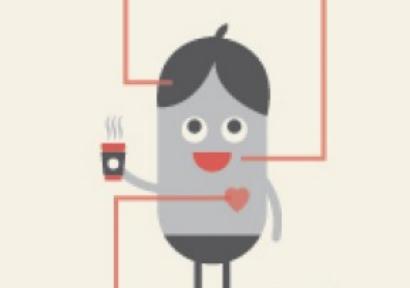


2ND MOST
TRADED COMMODITY
IN THE WORLD
SECOND TO OIL

COFFEE BEANS CONTAIN CAFFEINE
A WHITE CRYSTALLINE XANTHINE ALKALOID THAT ACTS AS A STIMULANT DRUG

WHICH HELPS
(WHEN TAKEN IN MODERATION)

INCREASES ATTENTION & MEMORY PERFORMANCE
INCREASES DOPAMINE LEVEL, MAKING YOU FEEL HAPPIER



DECREASES RISK OF HEART DISEASES
INCREASES PHYSICAL PERFORMANCE & MUSCULAR RECOVERY

CAFFEINE CONSUMPTION ABOVE 80MG, ABOUT 8 TO 9 CUPS OF COFFEE A DAY CAN CAUSE LONG TERM EFFECTS LIKE CHRONIC INSOMNIA, PERSISTENT ANXIETY, DEPRESSION AND STOMACH ULCERS.

SEPT

29

SEPTEMBER 29TH
IS NATIONAL COFFEE DAY
IN THE UNITED STATES

65%
OF COFFEE CONSUMPTION TAKES PLACE DURING BREAKFAST HOURS

MOST EXPENSIVE COFFEE IN THE WORLD "KOPI LUWAK"

COUNTRY OF ORIGIN: INDONESIA

MADE FROM COFFEE BEANS EATEN, PARTLY DIGESTED AND THEN EXCRETED BY THE COMMON PALM CIVET, A WEASEL-LIKE ANIMAL

EATEN & PARTLY DIGESTED → EXCRETED

IT SELLS FOR MORE THAN \$600 A POUND
AVERAGING \$50 A CUP OF COFFEE

Interactive dashboards enable the exploration
of dynamic data.

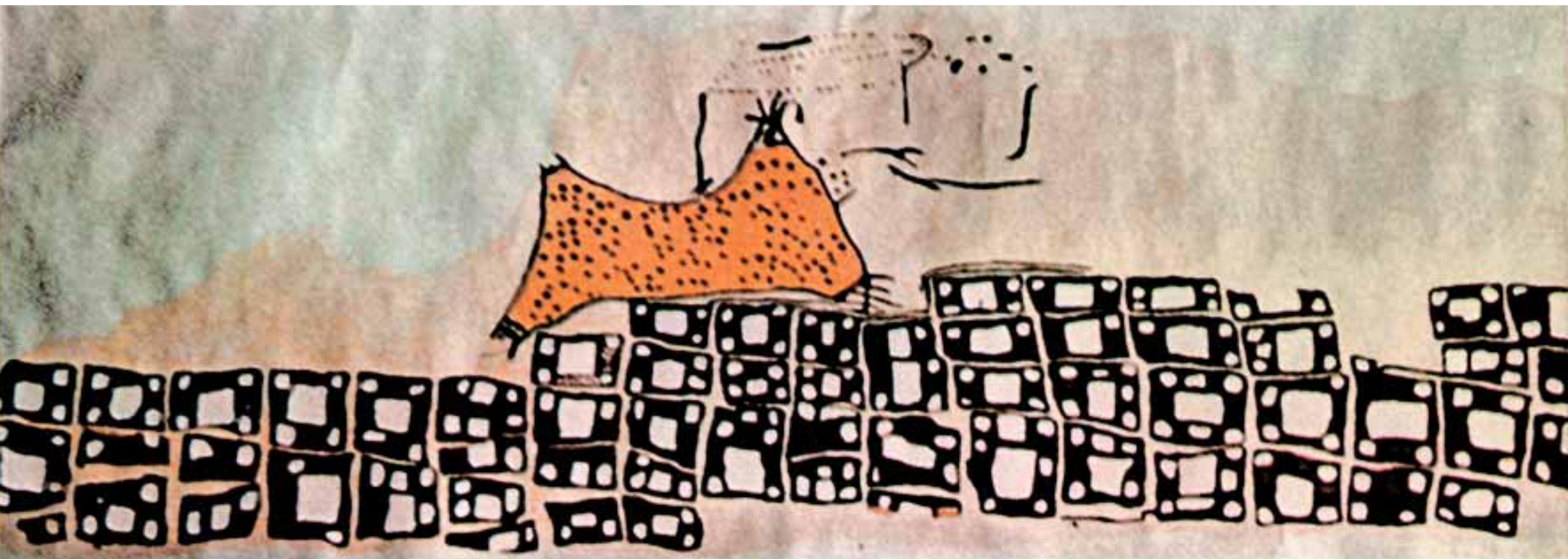


The same visualization methods may appear
across **any of these forms**...

...implying that ***data informs method***, while
purpose informs form.

Data visualization has a **rich**
history.

Map of Çatalhöyük, Turkey (6200 BC) (The first map ever?)



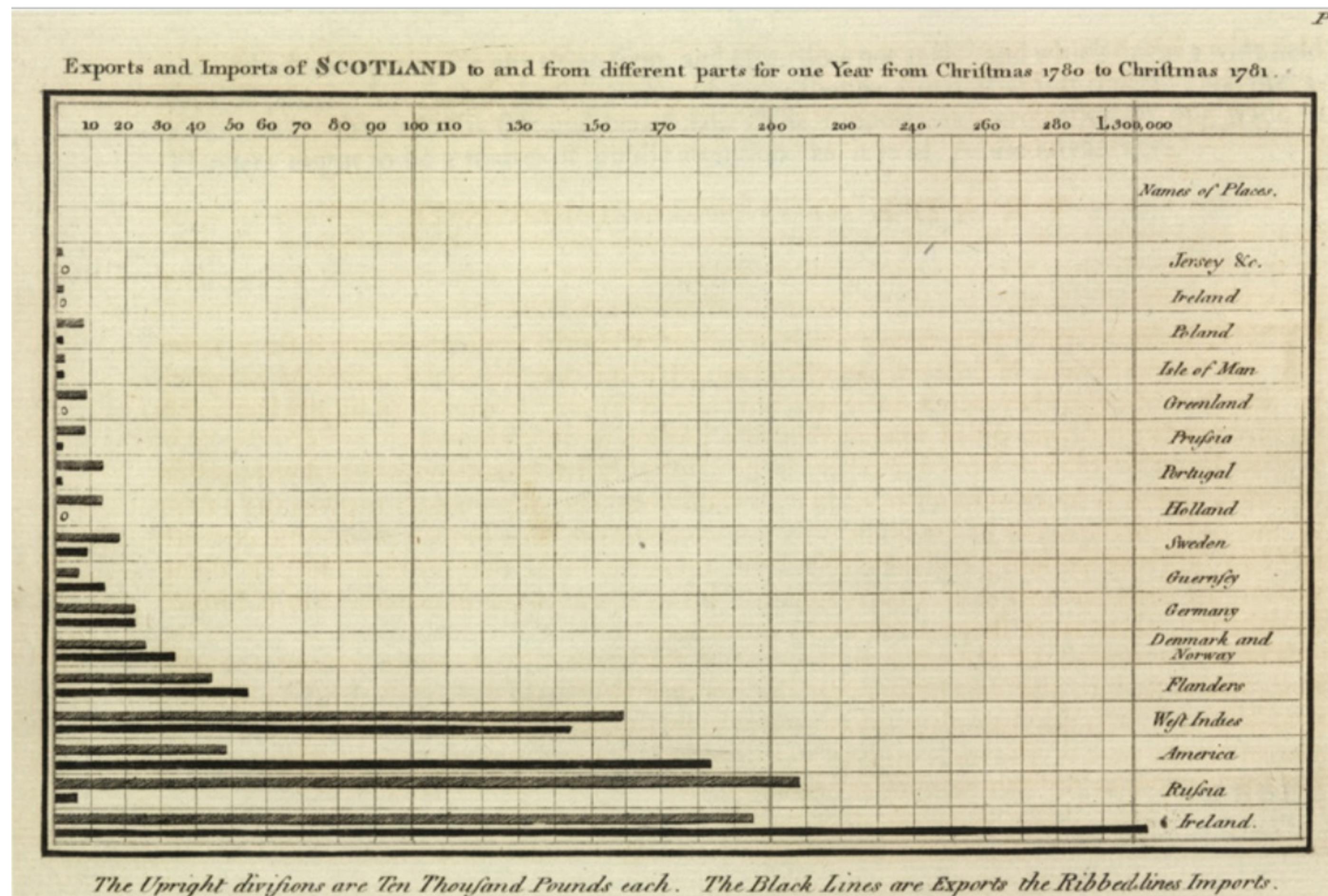
Key figures

- **William Playfair**
- **John Snow**
- **Florence Nightingale**
- **Charles Joseph Minard**

William Playfair (1759-1823)

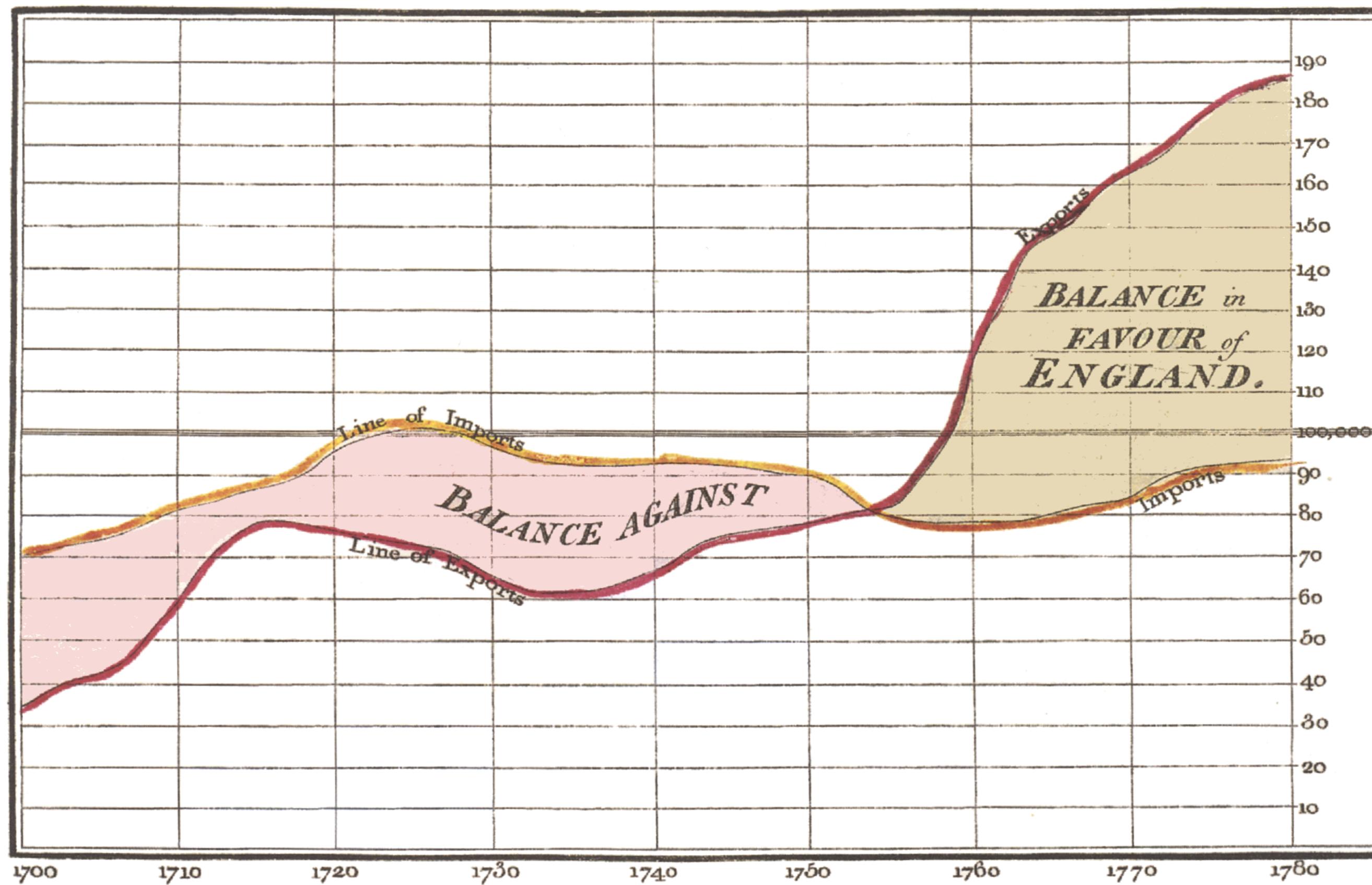
- Scottish engineer and political economist
- Considered the father of statistical graphics
- Invented several common representations:
 - Bar chart
 - Line chart
 - Area chart
 - Pie chart
- Published *The Commercial and Political Atlas* in 1786

William Playfair (1786) – [Bar chart] Scottish imports and exports



William Playfair (1786) – [Area chart] Imports and exports to and from Denmark & Norway

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
Neale sculpt^r 352, Strand, London.

John Snow (1813-1858)

- London physician who plotted the locations of cholera deaths on a map, during a cholera epidemic in London in 1954
- Dots were concentrated around the town water pump, which helped identify the cause of the infection

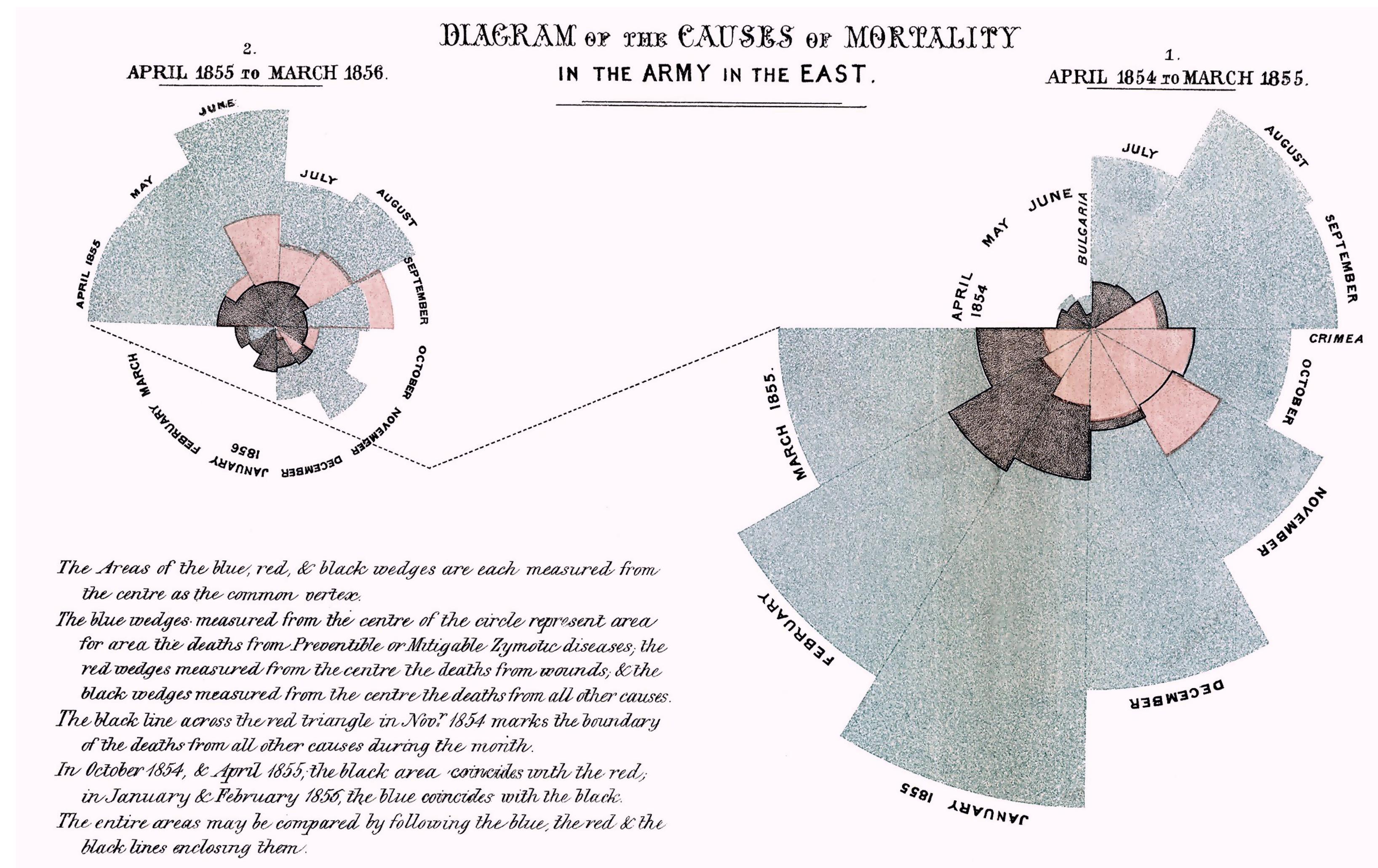
John Snow (1854) – [Map] Broad Street cholera outbreak



Florence Nightingale (1820-1910)

- Nurse during the Crimean War
- Kept records of death tolls in hospitals and visualized the data
- Invented the “coxcomb” diagram, which helped fight for better hospital conditions

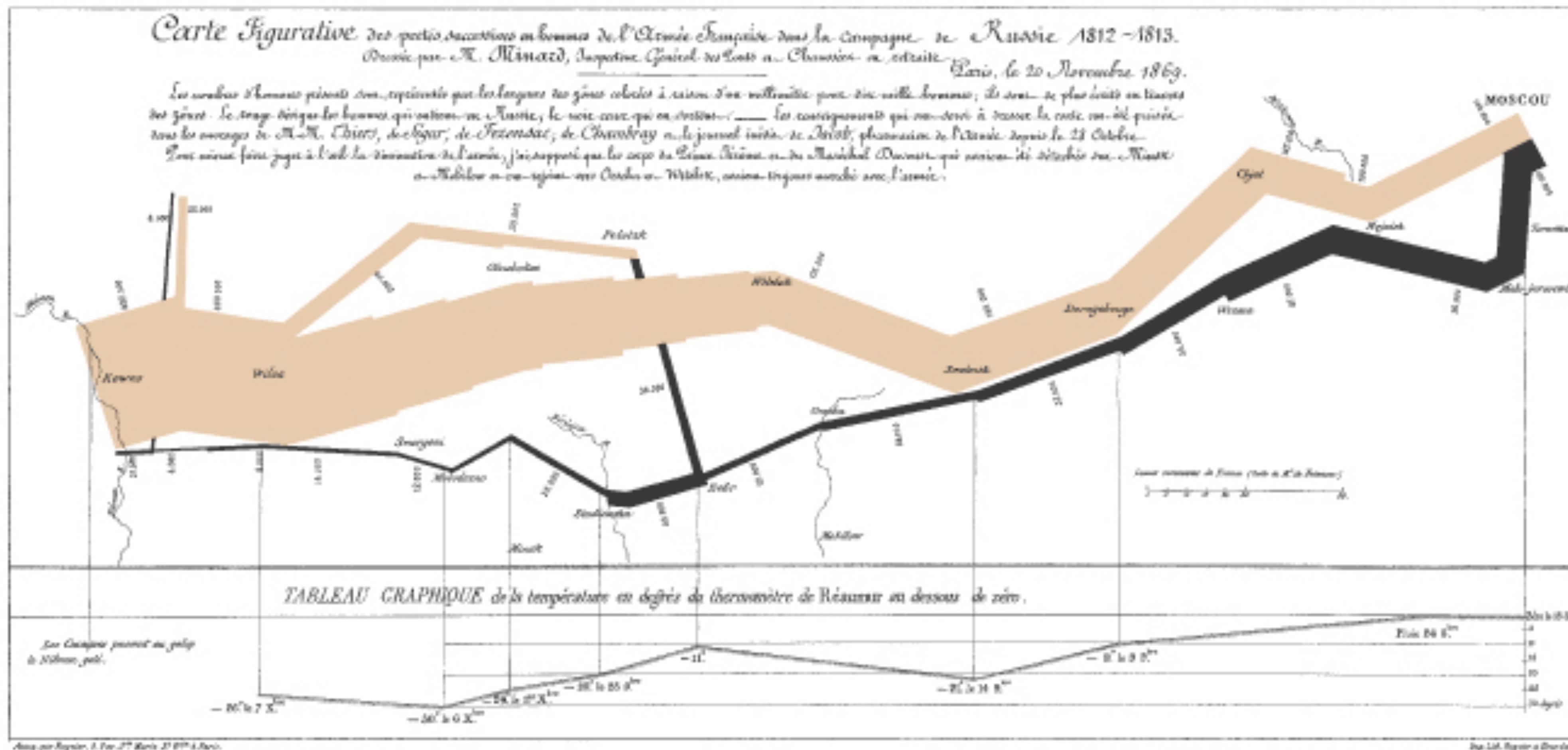
Florence Nightingale (1858) – [Coxcomb] Mortality in the British Army



Charles Joseph Minard (1781-1870)

- French civil engineer
- Noted for his representation of numerical data on maps
- Best known for his map of “Napoleon’s March,” which visualizes the losses suffered by Napoleon’s army during the Russian campaign of 1812

Charles Joseph Minard (1869) — [Sankey diagram] Napoleon's March



Charles Joseph Minard (1869) — [Sankey diagram] Napoleon's March

- Visualizes **six types of data** in two dimensions:
 - Number of troops
 - Distance traveled
 - Temperature
 - Latitude and longitude
 - Direction of travel
 - Location over time

