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

Topic Progression

- **Weeks 1-3:** Principles of Visual Design and Human Perception; Visualization for Communication
- **Weeks 4-7:** Data Types and Visualization Methods
- **Weeks 8-13:** 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 8-13:** 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 8-13:** 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

October **16th**
October **23rd**

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

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

Simple Budget

Search Sheet

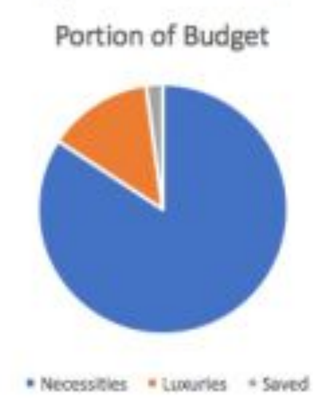
Home | Insert | Page Layout | Formulas | Data | Review | View | Share

Paste | Cut | Copy | Format | Calibri (Body) | 12 | Wrap Text | Merge & Center | General | Conditional Formatting | Format as Table | Cell Styles | Insert | Delete | Format | AutoSum | Fill | Clear | Sort & Filter

Q17

		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	$ 2,400.00
	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	$ 18,000.00
	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	$ 930.00
	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	$ 2,980.00
	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	$ 6,000.00
	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	$ 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	$ 1,240.00
	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	$ 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	$ 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

	Portion of Budget
Necessities	$ 30,310.00
Luxuries	$ 4,920.00
Saved	$ 770.00



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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 degenerated?

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

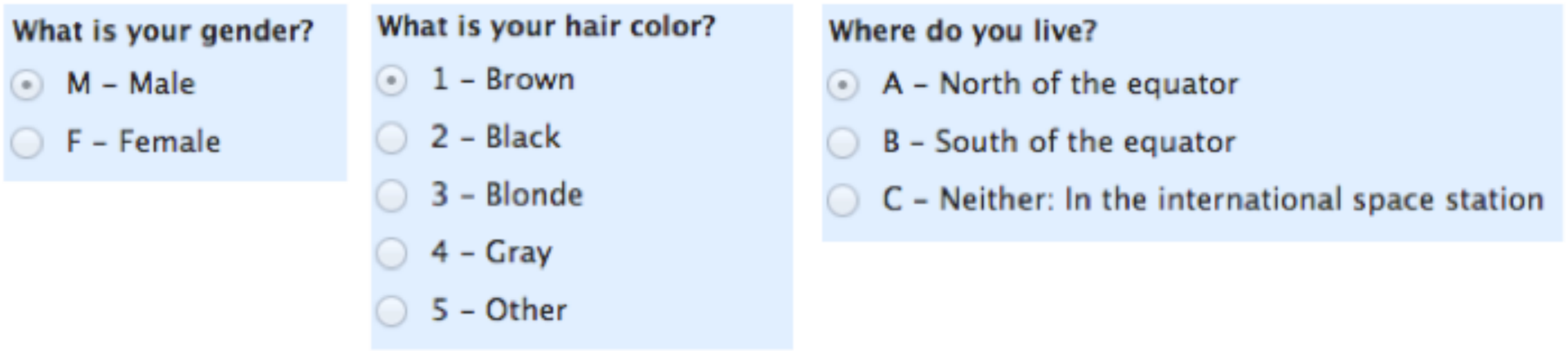
Quantitative

- Interval
- Ratio

Data types — **Qualitative**

1. **Nominal —**

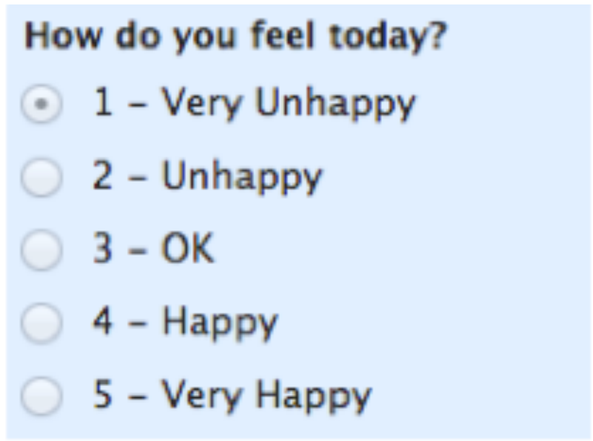
   Nominal scales are used to ***name***, or label, variables without any quantitative value.

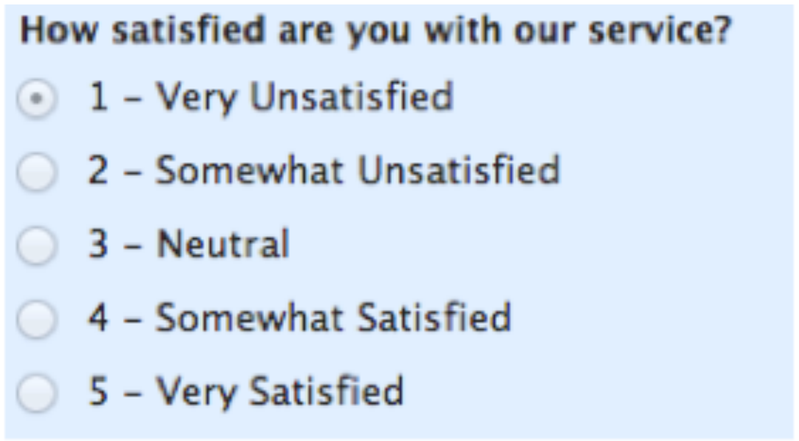


Data types — **Qualitative**

2. **Ordinal —**

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





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?

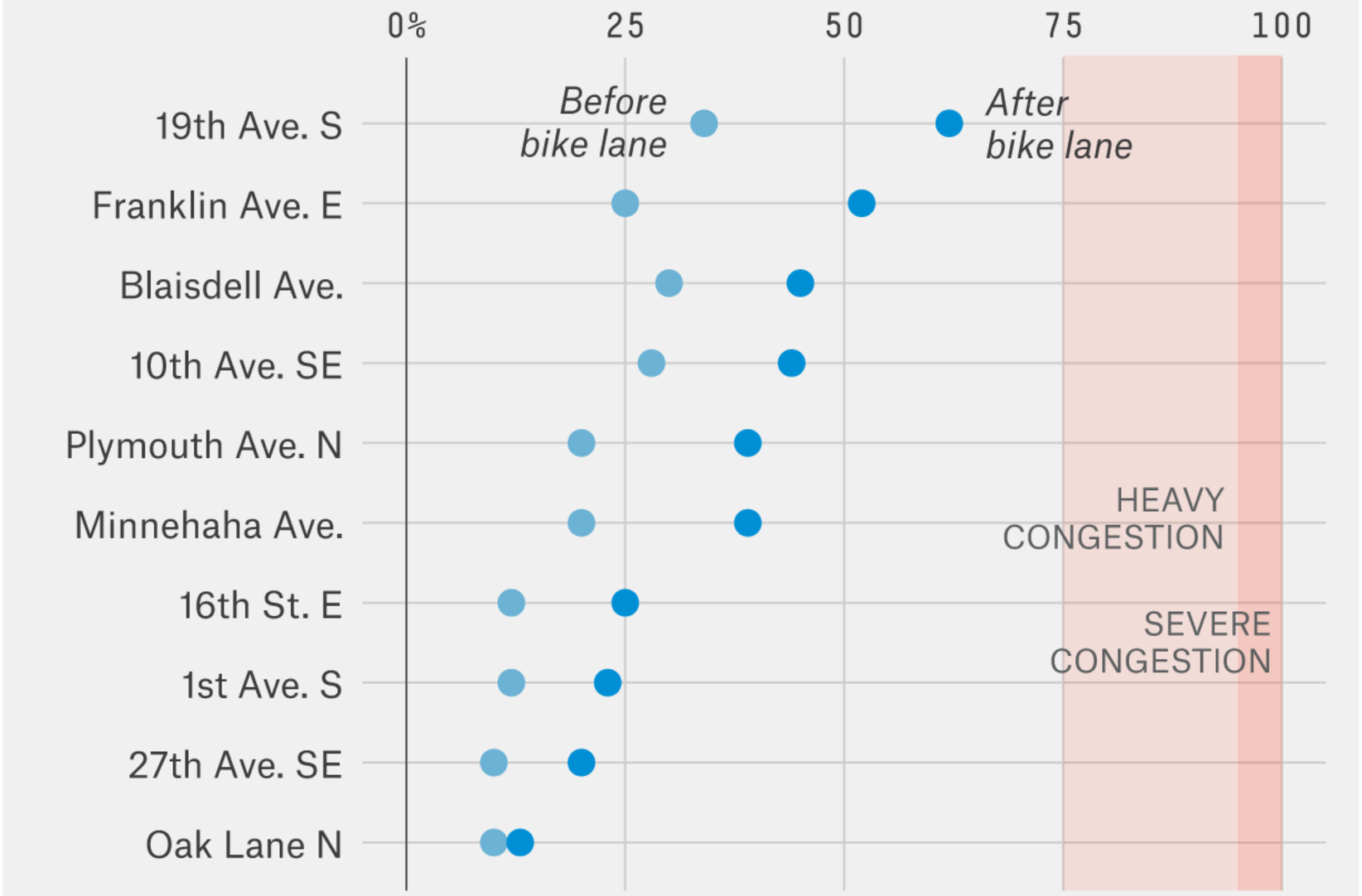
Forms

- **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

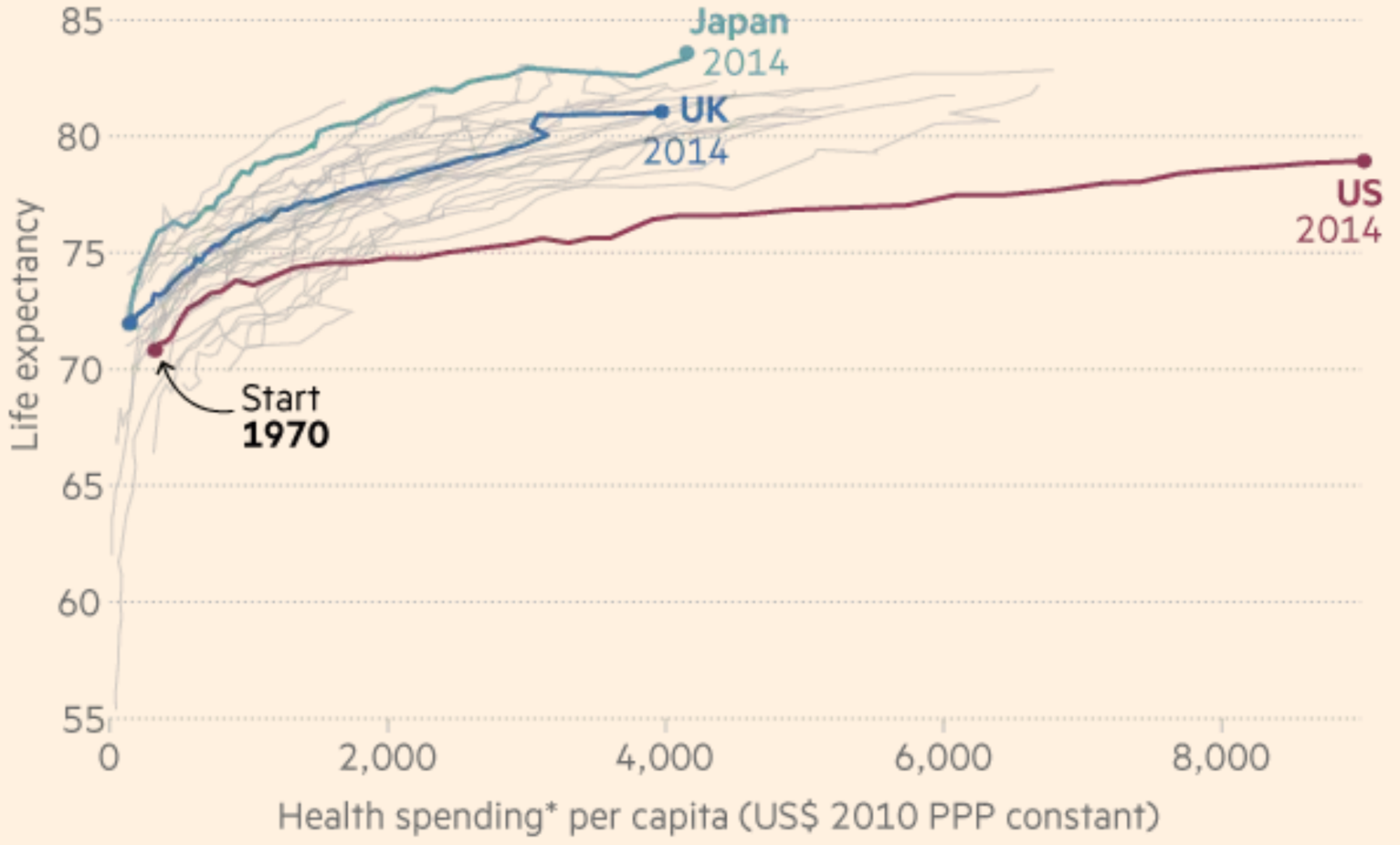


FIVETHIRTYEIGHT

BASED ON MINNESOTA DEPARTMENT OF TRANSPORTATION DATA

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

Each line represents an OECD country



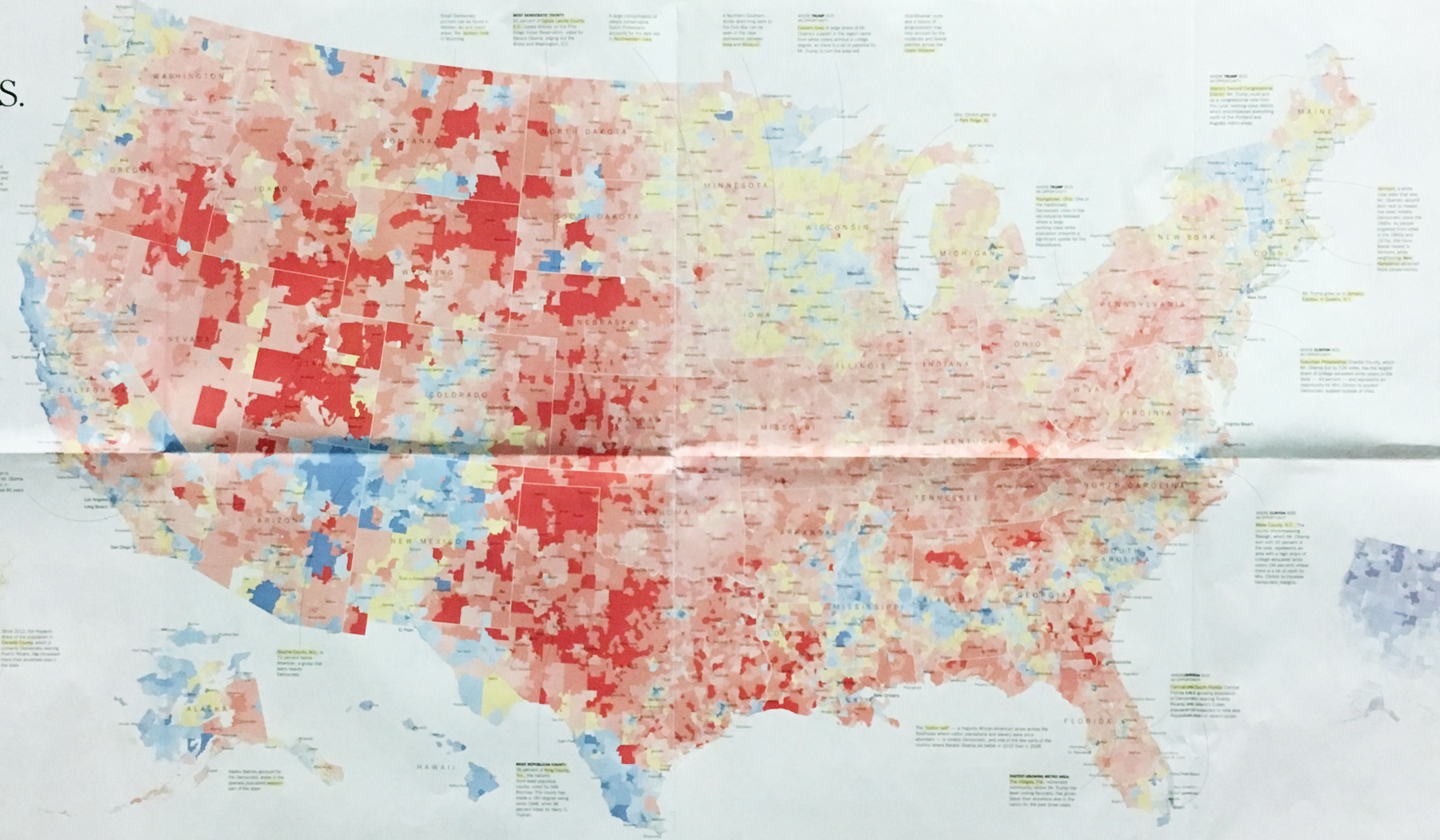
FT graphic Sources: United Nations Population Division, OECD

*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

The Upshot

A Detailed Political Geography of the U.S.



On election night, the most detailed map you are likely to see will show results by county. **This map shows 2012 presidential election results for every ZIP code in the country.** This level of detail reveals patterns that are otherwise masked — like the presence of small, Democratic urban areas even in the reddest states, and the stripes of red, yellow and blue along Long Island in New York.

What Hillary Clinton Sees in This Map

More Hispanic Voters

Mrs. Clinton is polling much better with the nation's growing Hispanic population than Mr. Trump. That's giving her a significant boost in battleground states like Nevada and Colorado, and even putting Romney states like Arizona within her reach.

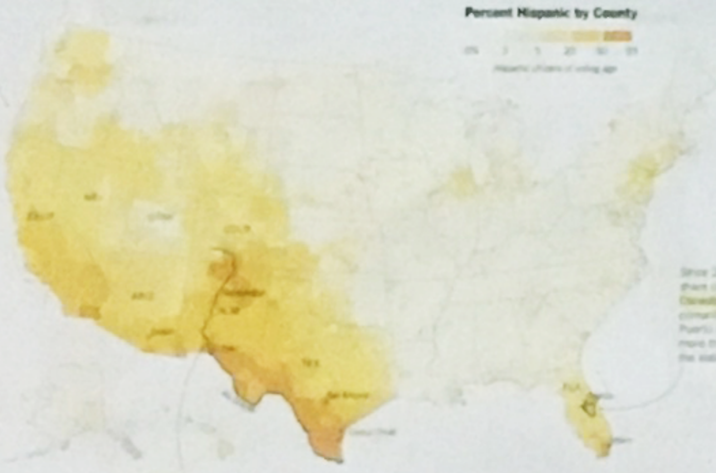
Hispanic support will be particularly important in Florida, which Mr. Trump probably needs to take to win the election. Little Havana, in Miami, has been one of the few densely populated Republican-leaning areas in the country, but there are signs that its Cuban-American voters are more divided this year. There's also a growing Puerto Rican population in the central part of the state, and they vote more Democratic.

Mrs. Clinton is also counting on African-Americans, who overwhelmingly support her, to vote at rates similar to those in 2008 and 2012, when the turnout of black voters surpassed that of whites. This will be especially important in North Carolina and Georgia, two battleground states in the "cotton belt" — a majority African-American, reliably Democratic stripe across the Southeast.

Urban Support That Could Spread

Democratic presidential candidates get the bulk of their support from cities, whose influence isn't always obvious on a big national map. Illinois and Pennsylvania, for instance, were won by Barack Obama with outsize margins in just one urban county each.

Mrs. Clinton, who is polling well with educated white voters, could do even better. She has an opportunity to expand that Democratic support into the suburbs of several cities, like Raleigh, N.C.; Denver; and Atlanta, where college-educated whites who tended to support Mitt Romney in 2012 live.



And What It Means for 2016

For the most part, the nation's center is ablaze with red — people who voted overwhelmingly for Mitt Romney. Along the coasts and in large cities, you find just a few dense blue counties that delivered major electoral victories to Barack Obama. Yellow shows where neither candidate won more than 55 percent of the major-party vote.

When Donald J. Trump and Hillary Clinton look at this map, they see where they have a chance to perform better, or worse, in their quest for the White House.

What Donald Trump Sees in This Map

Reliably Red States

The majority of states that have become reliably Republican will stay that way. Even though Bill Clinton twice won West Virginia, Kentucky, Tennessee, Louisiana and his home state of Arkansas in the 1990s, those states have for the most part become Republican redoubts.

But Mr. Trump faces peril in places with increasingly diverse populations. Hillary Clinton's support from Hispanics in Arizona and college-educated white voters and African-Americans in Georgia has tightened the races in those states, which last voted Democratic in the 1990s. He could also lose ground in Utah, where a large Mormon population is unsettled by his candidacy and where several lawmakers have come out against him.

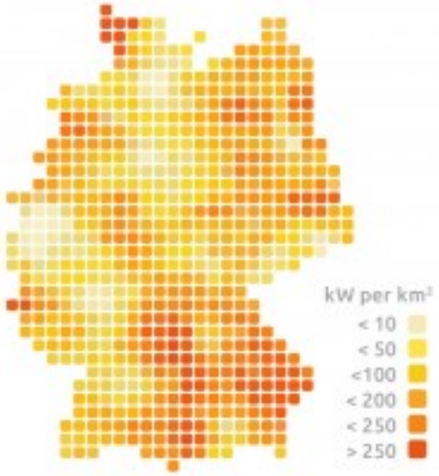
The White Working Class

Barack Obama was strong among white working-class voters across the North, from former industrial strongholds to working-class suburbs of major cities. Mr. Trump has tapped into the anger and anxiety of workers who have fallen behind as manufacturing and union jobs have disappeared. He is expected to do well in places with a high percentage of white voters without a college degree, even in areas that have been reliably Democratic, such as the industrial Midwest.

These voters have tightened the race in Iowa, and to a lesser extent in Ohio, where many people in this group voted for Mr. Obama in 2008 and 2012. The white working-class voters in parts of Minnesota, Wisconsin and Illinois are less likely to make a difference, because they will be canceled out by different demographic groups in major cities that support Mrs. Clinton.

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

INSTALLED CAPACITY PER KM²



1.5
38
1.9
2.3
5.2

Acceptance of solar farms in the neighborhood

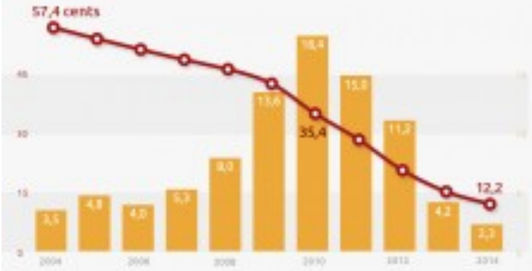
SOLAR ENERGY GENERATION 2014

billion kilowatt hours (bn kWh)

YEAR 2014
SOLAR POWER
32.6 BN KWH
5.3%

FIT PAYMENTS & INVESTMENTS

in cent per kilowatt hour | in billion euro



2010 - 2014
INVESTMENTS
87%
FEED-IN TARIFFS
79%
JOBS

2015 Sports Clubs

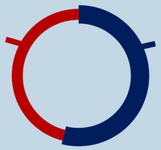
CAMPUS RECREATION
STAY ACTIVE

TOTAL MEMBERS ACTIVE: 1,361

- 1,165 UNDERGRAD STUDENTS
- 90 GRADUATE STUDENTS
- 27 FACILITY/ STAFF
- 79 COMMUNITY MEMBERS

49 SPORTS CLUB *Teams*

46% *Female* MEMBERS



54% *Male* MEMBERS

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

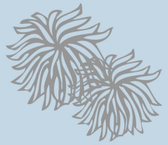
2 NATIONAL INDIVIDUAL CHAMPIONS

Sydney Boukedes
BALLROOM
LATIN DANCE
CHA CHA & RUMBA

Luke Vrouwenvelder
CYCLING MEN'S
COLLEGIATE
MOUNTAIN BIKE DIVISION I

3 NATIONAL TEAM CHAMPIONS

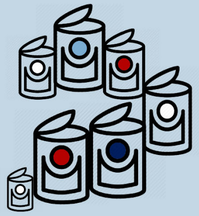
FIELD HOCKEY



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 **802** CLINIC VISITS FOR SPORT CLUB ATHLETES

71 SPORTS CLUBS PARTICIPATED IN THE RAMESES RECYCLES PROGRAM FOR FALL '14

COFFEEFACTS

TOP 5 COFFEE PRODUCERS
1. BRAZIL
2. VIETNAM
3. COLOMBIA
4. INDONESIA
5. ETHIOPIA

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

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

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

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

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

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 450MG (ABOUT 8 TO 9 CUPS OF COFFEE A DAY) CAN CAUSE LONGER TERM EFFECTS LIKE CHRONIC INSOMNIA, PERSISTENT ANXIETY, DEPRESSION AND STOMACH ULCERS.

SEPTEMBER 29TH IS NATIONAL COFFEE DAY IN THE UNITED STATES

Interactive dashboards enable the exploration of dynamic data.


Bloomberg
Bloomberg

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?)

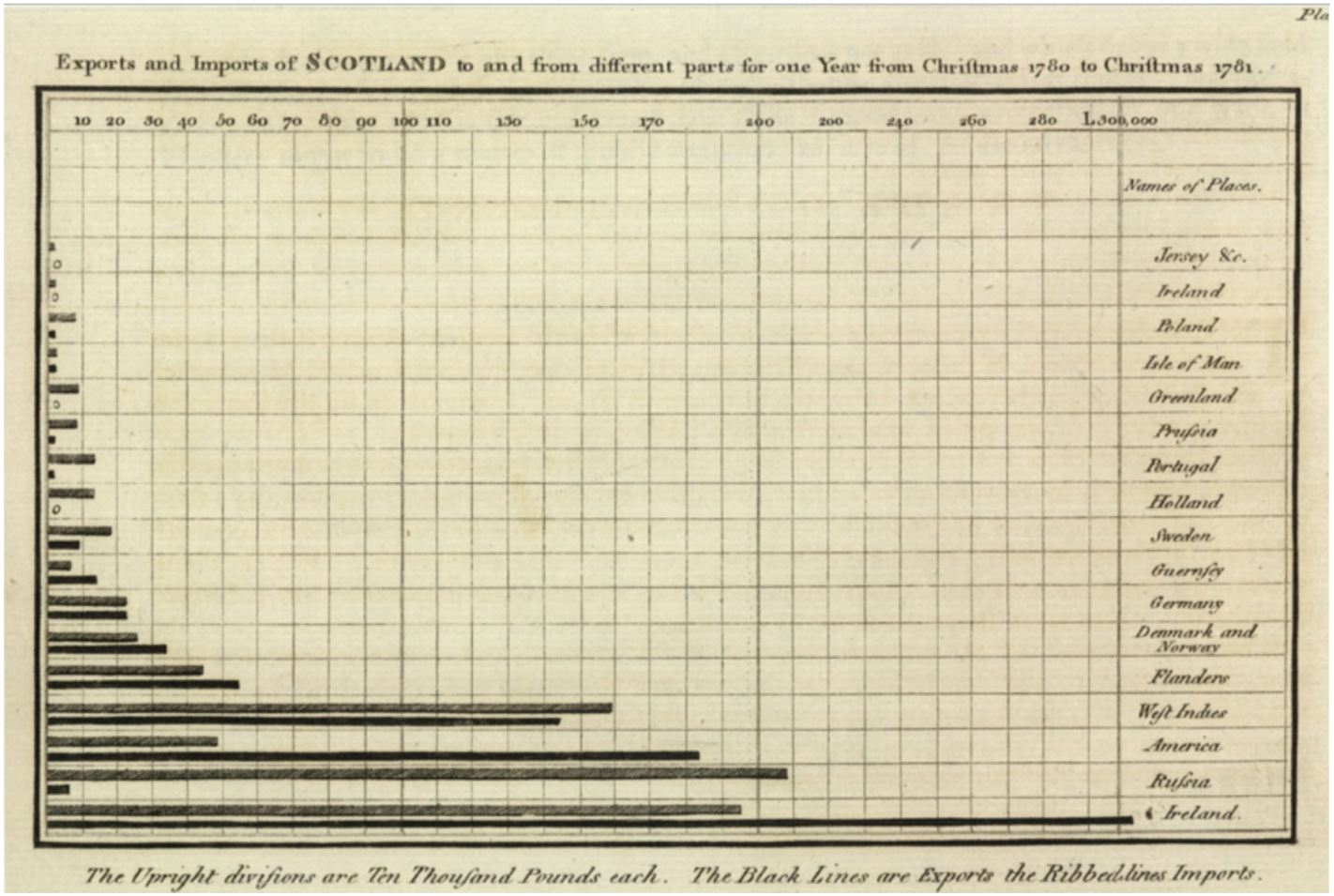
Key figures

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

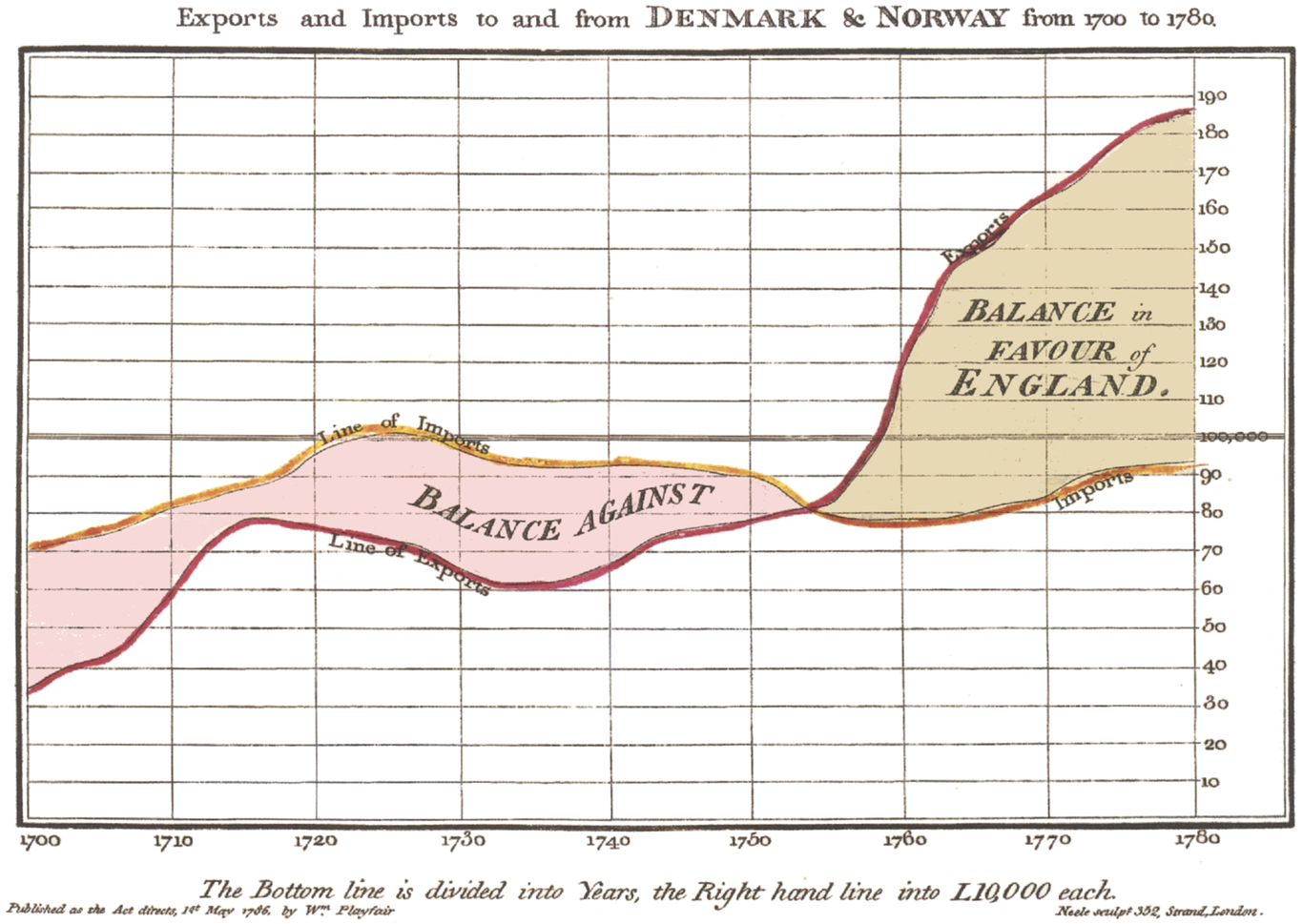
William Playfair (1759-1823)

- 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



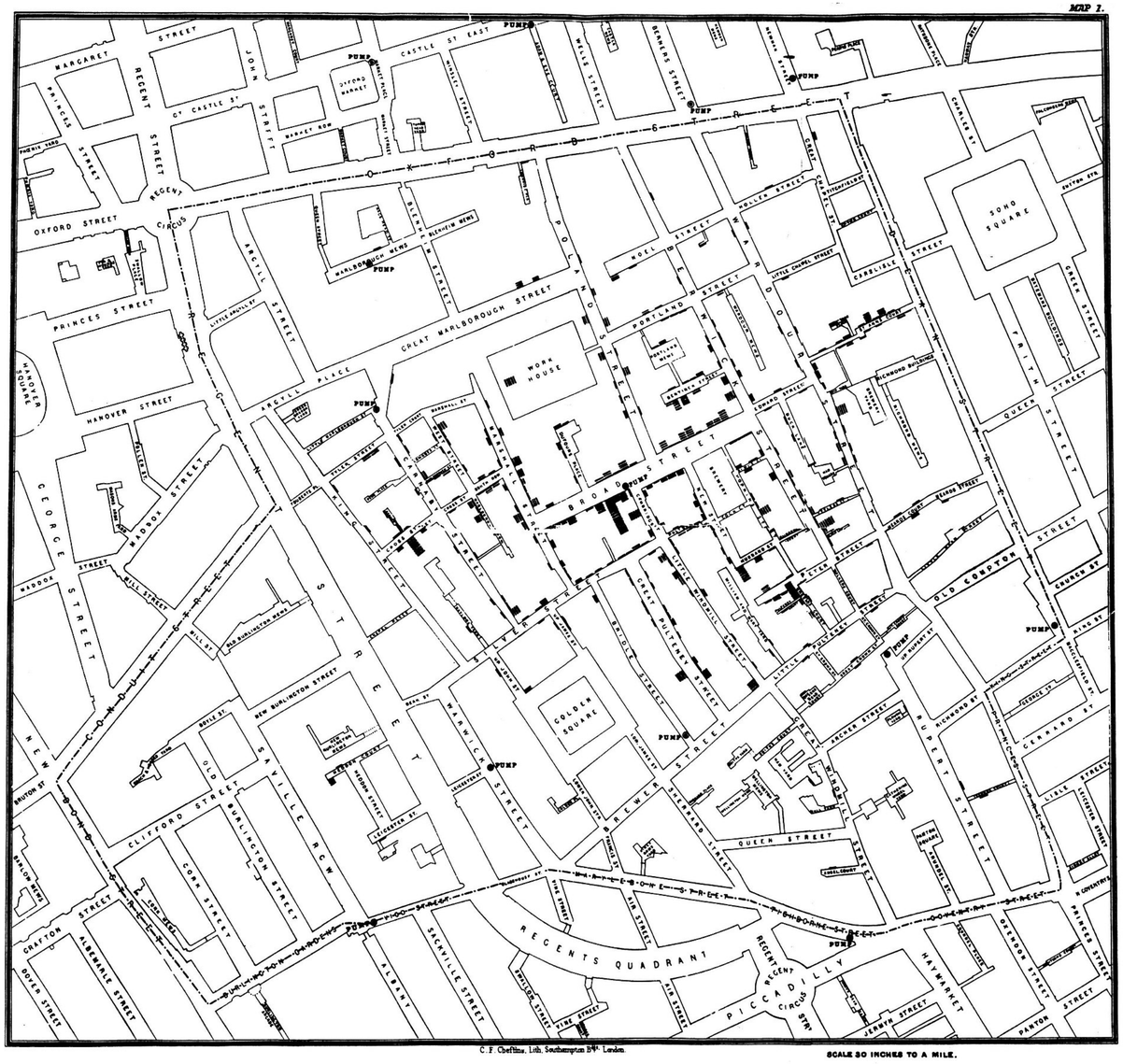
William Playfair (1786) — *[Area chart]* Imports and exports to and from Denmark & Norway



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

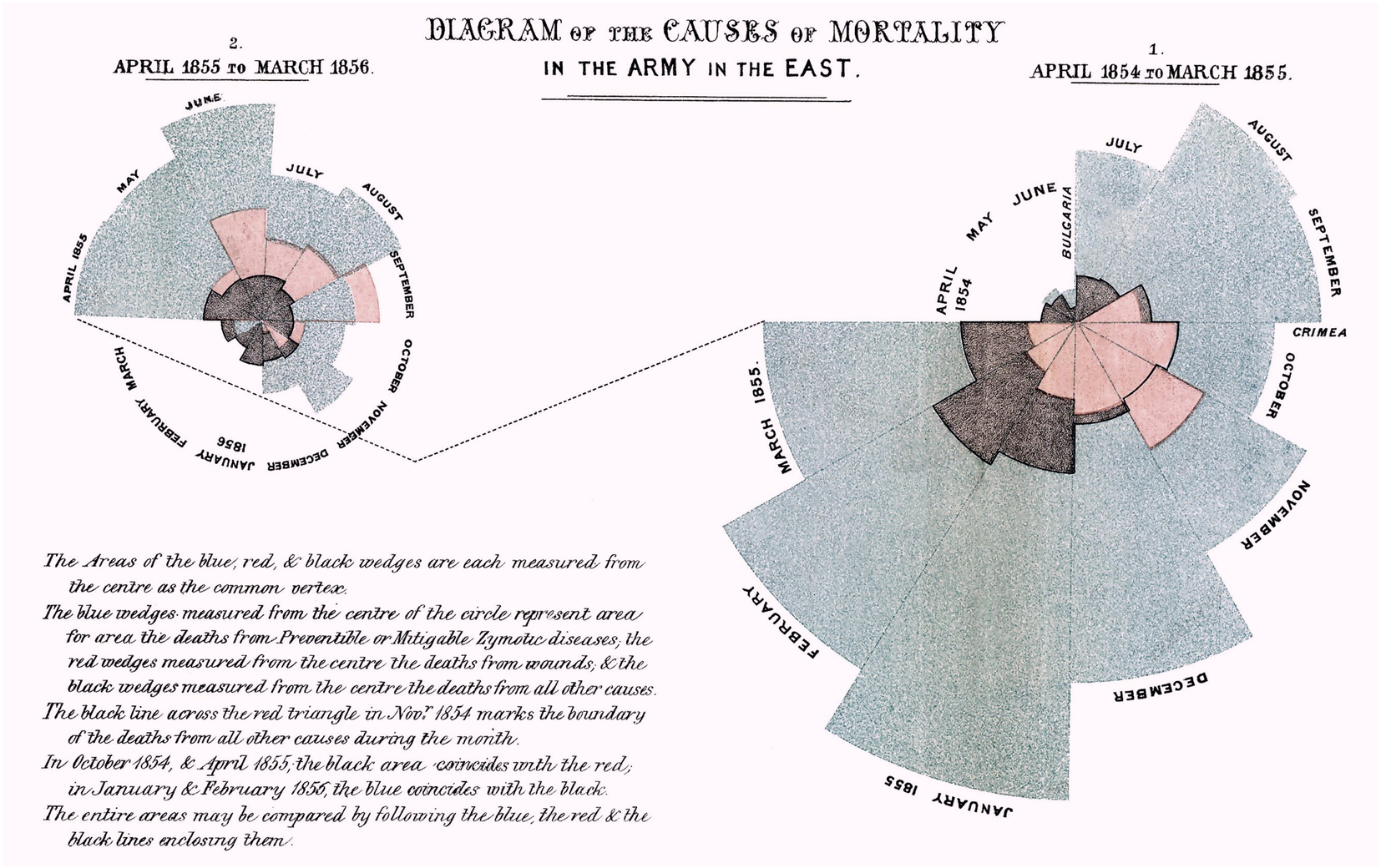
John Snow (1854) — *[Map]* Broad Street cholera outbreak



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

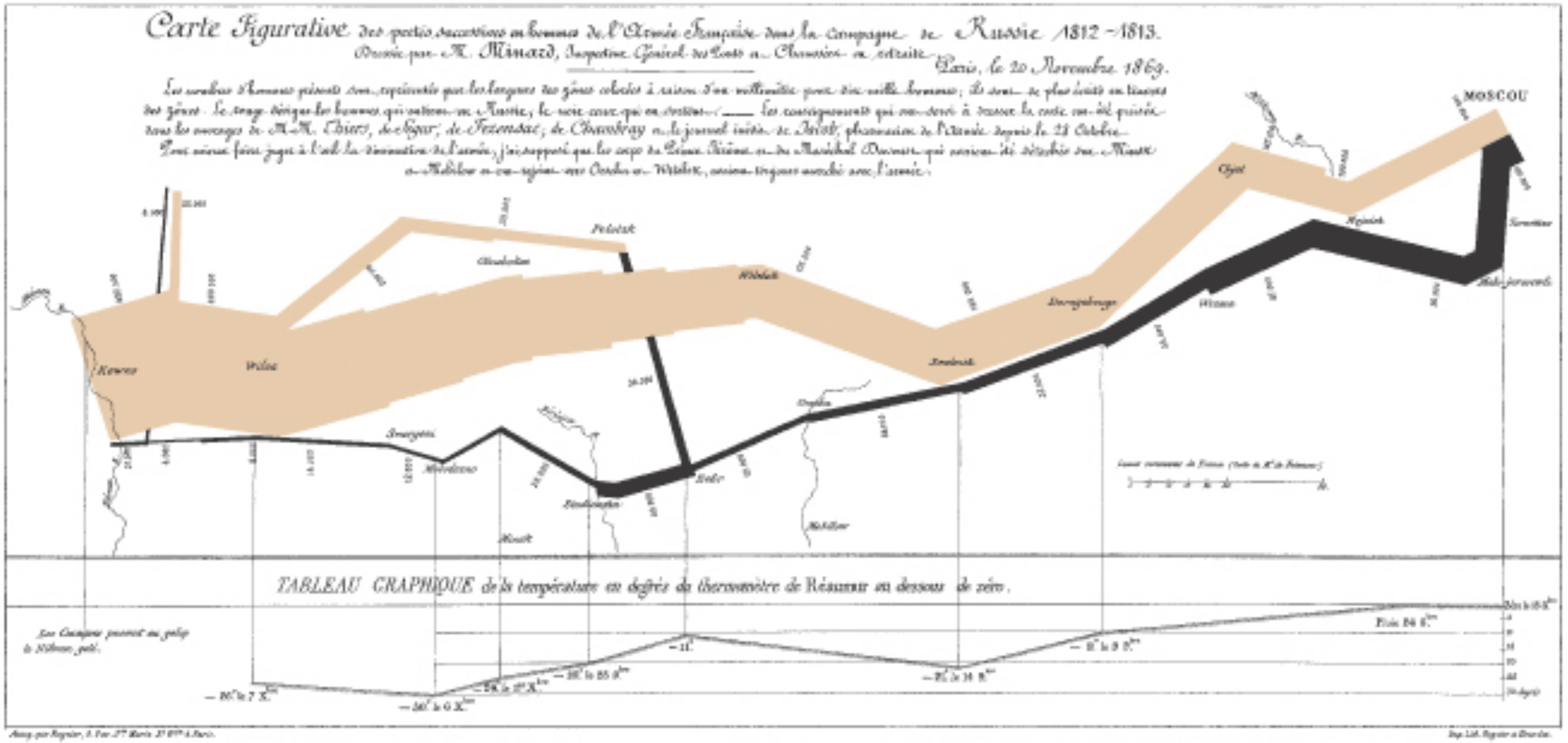
Florence Nightingale (1858) — *[Coxcomb]* Mortality in the British Army



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