STORYTELLING WITH DATA

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COURSE DESCRIPTION

This course is for participants who wish to become savvy consumers of data presentations and learn how to work with teams to communicate useful, evidence-based messages and ideas. The focus is on understanding how dashboards, reports and data visualizations convey descriptive, diagnostic, predictive, and prescriptive data insights to decision-makers.

The course will also include specific activities, including:

- identifying and gathering data presentation requirements
- storyboarding
- critiquing dashboards and data presentations

COURSE DESCRIPTION

Topics covered include:

- definition of a story
- relationship between data and story
- identifying and holding the audience's attention
- lessons in storytelling with data
- anatomy of dashboards and data visualizations
- effective visuals
- decluttering
- thinking like a designer with the Gestalt principles
- making data presentations accessible

LEARNING OBJECTIVES

Understand why stories are important in the communication of data and information

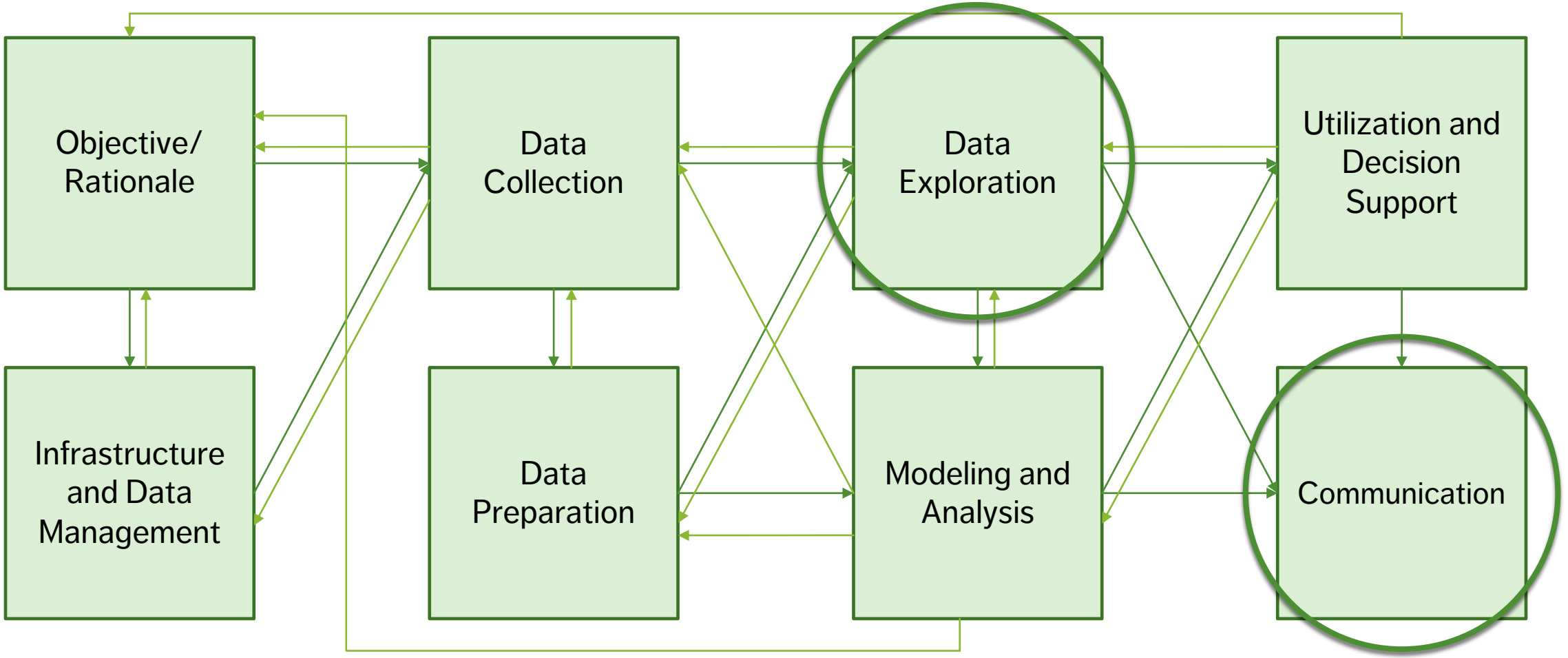
Understand how data stories differ from other types of stories

Identify best practices when building visualizations for storytelling

Understand what tools are useful when building data stories

Learn techniques for maximizing the effectiveness of storytelling visualizations

THE (MESSY) ANALYSIS PROCESS



OUTLINE

Part I – Stories and Storytelling

1. What Are Stories?
2. Elements of Storytelling
3. Form and Structure
4. How to Tell a Story
5. Stories and Illustrations

Part II – Effective Storytelling Visuals

6. Data Visualization ABC
7. Data and Stories
8. Evolving a Storytelling Chart
9. Anatomy of Storytelling Dashboards
10. Chart Aesthetics
11. Data Stories in the Wild

RECOMMENDED...

Something to take notes on (about e.g. definitions, story examples)

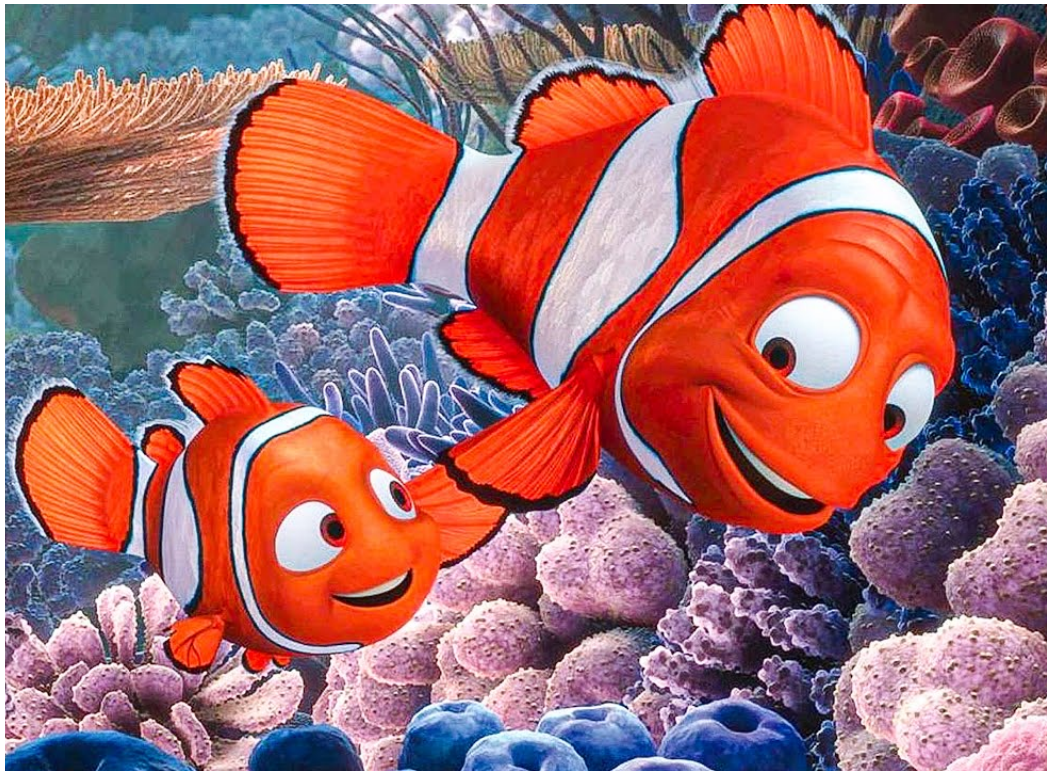
Access to Zoom emojis for polling and interaction purposes

Story listening props (popcorn?)

PART I – STORIES AND STORYTELLING

STORYTELLING WITH DATA

STORIES AND STORYTELLING



There once was a fish named Marlin, who loved his son Nemo more than anything. Every day he tried to protect Nemo from the ocean, which Marlin feared.

One day Nemo decided his dad was wrong and he swam away. But he was captured by a diver.

Because of that, Marlin had to leave the safety of his reef to find his son.

And because of that, he learned to let go of his fears and trust that Nemo had what it takes to take care of himself.

Ever since that day, Marlin gave Nemo the space to learn on his own.

STORIES AND STORYTELLING

Is this a **story**?

If so, what is its **purpose**?

Its **moral or message**?

WHAT ARE STORIES?

PART I – STORIES AND STORYTELLING

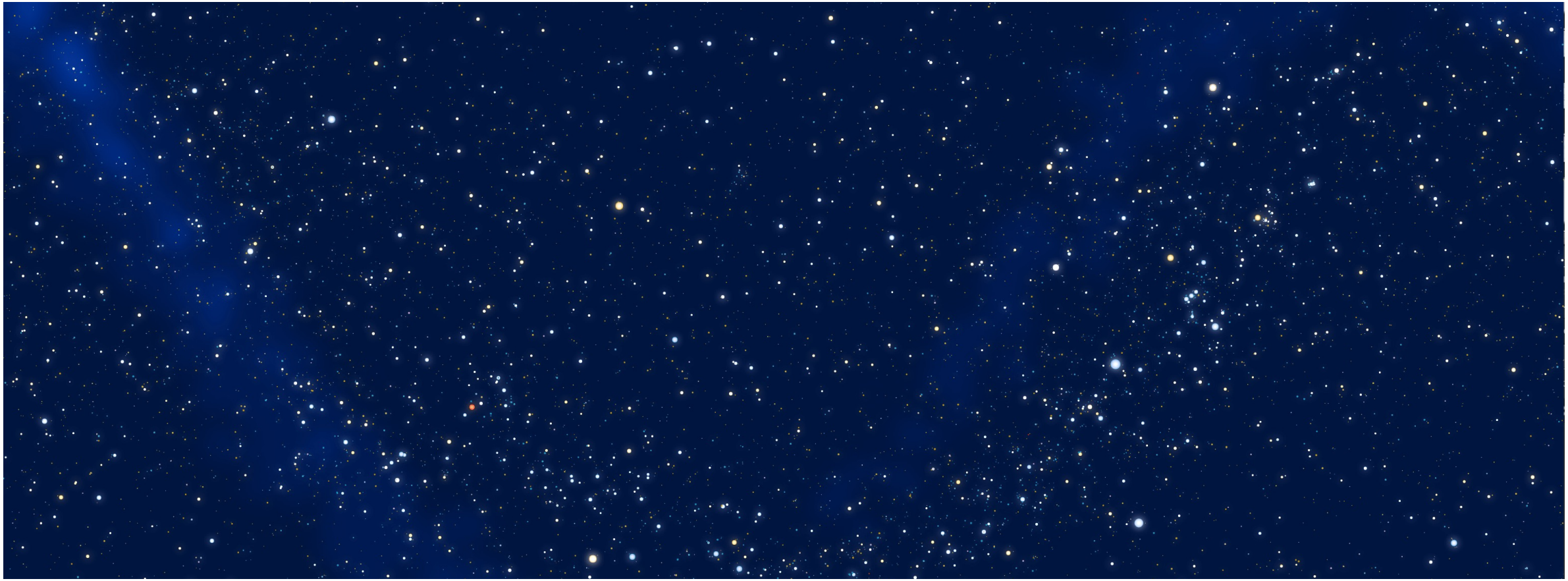
WHY STORIES?

Human beings are **social animals**, and they **communicate with each other**.

Communication is an evolutionary trick, which played a crucial role in the brain's development and its ability to house a mind: transfer of ideas is **much quicker** than the transfer of genes.

And how do we communicate? **We tell stories**.

Are there other ways to communicate? Other modes? Other tools?



A SKY FULL OF STARS

We have always had a drive to paint stories onto the Universe. When humans first looked at stars, which are great flaming suns an unimaginable distance away, they saw amongst them giant bulls, dragons, and local heroes. [...] Humans think in stories. [Cohen, Pratchett, Stewart]

STORY TIME

Queen Cassiopeia was the wife of King Cepheus of Ethiopia. She boasted that she was more beautiful than the Nereids, the 50 sea nymphs. They were enraged by her comments and appealed to Poseidon to punish Cassiopeia for her boastfulness.

The sea god obliged and sent Cetus, a sea monster, to ravage the coast of Cepheus' kingdom. Cepheus turned to an oracle for help: in order to appease Poseidon, he and Cassiopeia had to sacrifice their daughter Andromeda to the sea monster.

They did so reluctantly, leaving Andromeda chained to a rock for Cetus to find. However, she was saved in the last minute by Perseus, a Greek hero.

[constellation-guide.com; Ontario Parks]

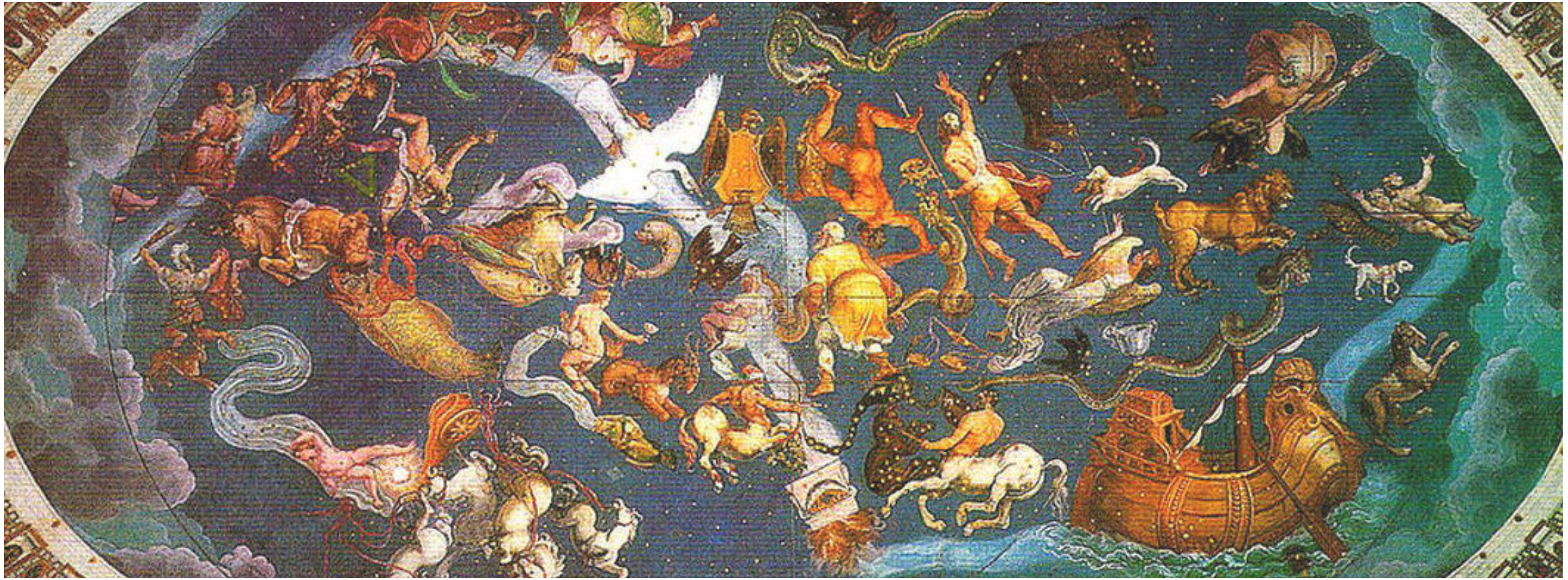
STORY TIME

Perseus and Andromeda were later married. At the wedding, one of her former suitors claimed that he was the only one who had the right to marry her.

There was a fight and Perseus, outnumbered, used the head of Medusa to defeat his opponents. One look at Medusa's head turned them all into stone. The king and queen also met their end.

Poseidon then placed Cassiopeia and Cepheus in the sky: Cassiopeia was condemned to circle the celestial pole forever, and spends half the year upside down in the sky as punishment for her vanity.

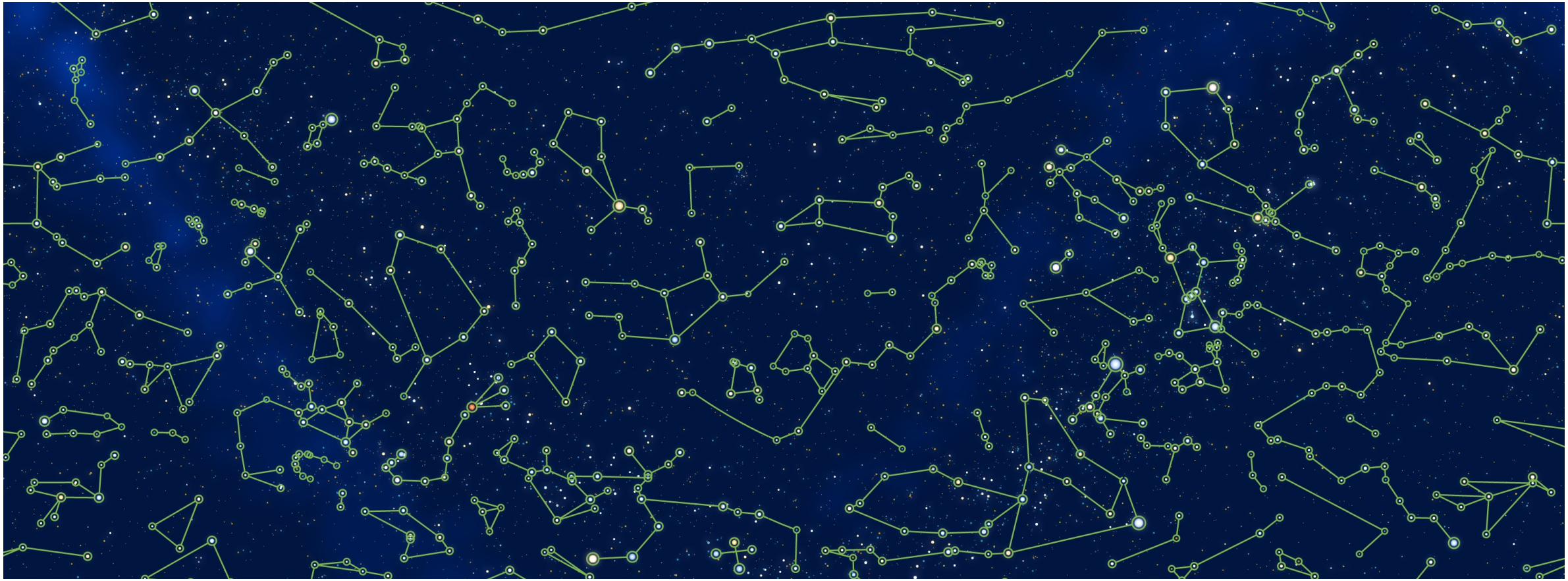
[Giovanni Antonio da Varese, c. 1575]



A SKY FULL OF STARS – ANCIENT GREEK STORIES

We have always had a drive to paint stories onto the Universe. When humans first looked at stars, which are great flaming suns an unimaginable distance away, they saw amongst them giant bulls, dragons, and local heroes. Humans think in stories. [Cohen, Pratchett, Stewart]

[figuresinthesky.visualcinnamon.com]



A SKY FULL OF STARS – WESTERN [MODERN] CONSTELLATIONS

We have always had a drive to paint stories onto the Universe. When humans first looked at stars, which are great flaming suns an unimaginable distance away, they saw amongst them giant bulls, dragons, and local heroes. Humans think in stories. [Cohen, Pratchett, Stewart]

WHAT IS A STORY?

To paraphrase U.S. judge Potter Stewart: “I may not be able to define what a story is, but I know one when I see one”.

A **story** is the telling of a temporal sequence of “events”, either true or fictional. It is “told” so that the audience experiences or learns something from it. It is a means of transferring information, experiences, attitudes, or points of view. [M.W. Travis, *The Wrap*]

Stories are used to **explain**, **describe**, **argue**, **persuade**, **teach**, **entertain**, etc.

[Entry for “meme”, *Wikipedia*]

STORIES AS MEMES

Stories are **memes** (in the Dawkins sense): ideas, behaviours, styles

- spreads by means of imitation from person to person within a culture
- often carries symbolic meaning representing a particular phenomenon or theme.

Memes act as **unit** for carrying:

- cultural ideas, symbols, or practices,
- transmitted from one mind to another through writing, speech, gestures, rituals, etc.

Memes are cultural analogues to **genes**:

- they self-replicate, mutate, and respond to selective pressures

PRACTICAL DEFINITION OF STORIES

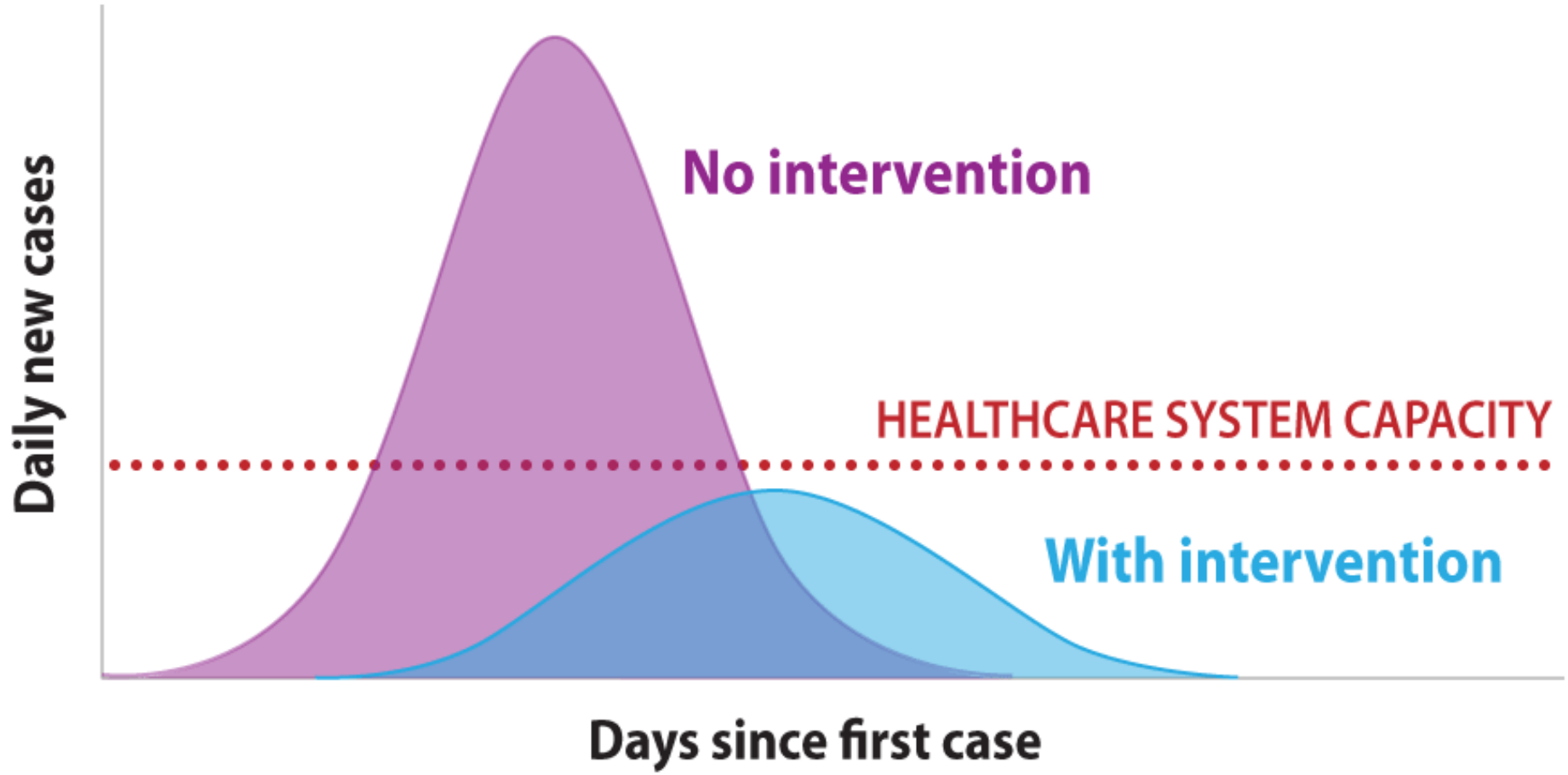
A story consists of:

- context,
- series of events, and
- outcome, result, consequence, or resolution.

Is the next slide showing a story according to this definition?

FLATTENING THE CURVE

A look at the importance of slowing the spread of a virus, so that the rate of infection doesn't outpace the resources to fight against it.



SOURCE: CDC

THE CANADIAN PRESS

SIDE NOTE: WHAT'S THE STORY?

A note about the phrase "What's **the** story?"

We often use this as a short-hand for asking:

- What's the conclusion of the story?
- What's the current situation? Or the explanation for the current situation.

Not necessarily the same as "What's the *whole* story?"

WHERE DO STORIES ARISE?

- news
- books, magazines
- art and music industry
- television, movie studios, Netflix, HBO, Disney+, etc.
- social media: Facebook, Instagram, Snapchat, etc.
- sports and video games
- evidence: data, science experiments, etc.
- religions, ideologies, belief systems, etc.
- enduring coherent groups: cultures, countries, cities, etc.
- commerce: adverts

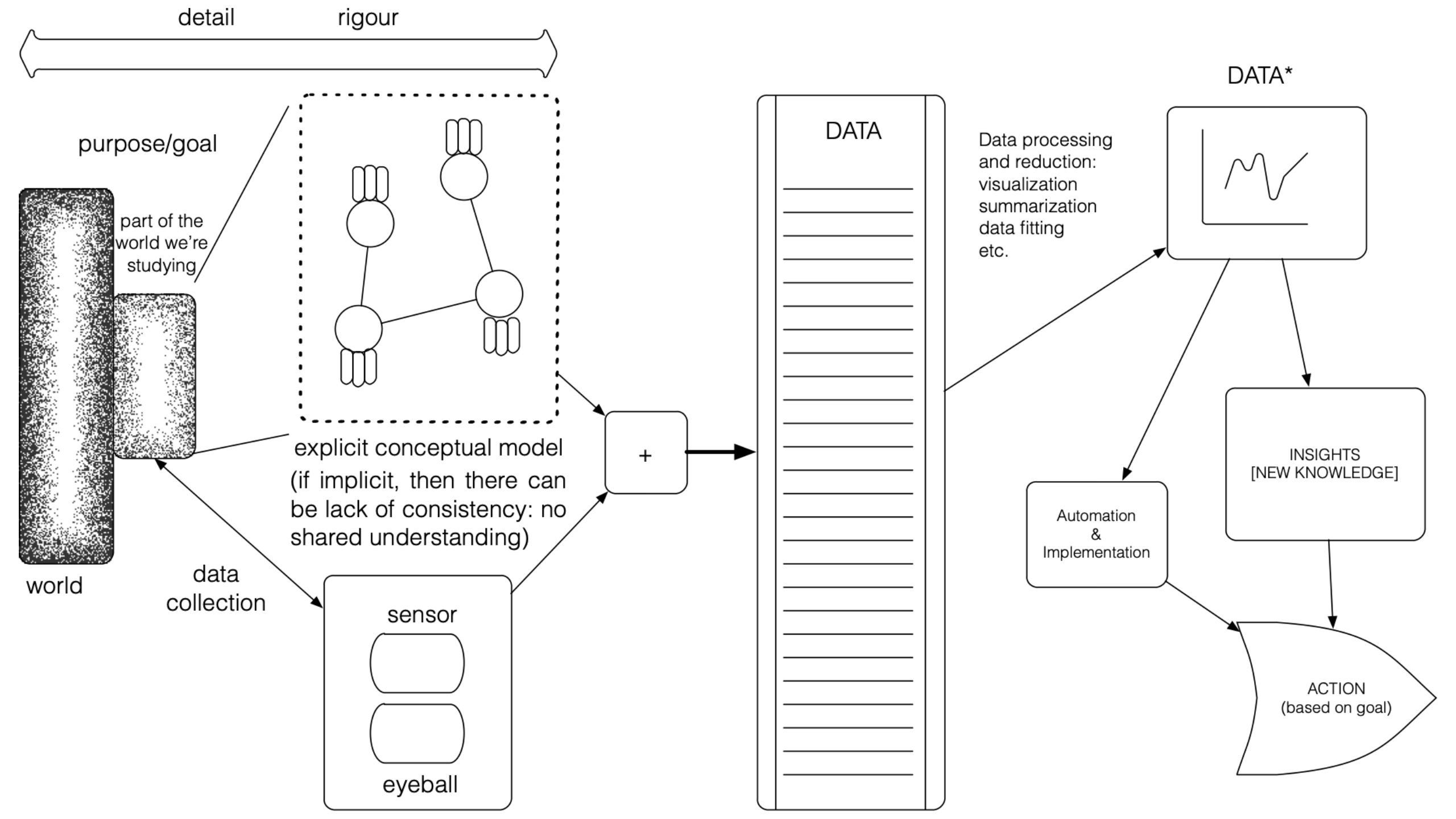
WHAT IS A STORY?

"A literate human being can look at a sequence of letters and spaces [and colours, sounds, lines, dots, etc.] and decide whether it constitutes a story; they know how to 'read' the code and work out its meaning, if it's a language they understand.

They can make a stab at deciding whether it's a good story or not. However, we do not know how to transfer this ability to a computer. The rules that our minds use to decide whether what we're reading is a story are implicit in the networks of nerve cells in our brains.

Nobody has yet been able to make these rules explicit."

[Cohen, Pratchett, Stewart]


detail
rigour
purpose/goal
part of the world we're studying
world
explicit conceptual model (if implicit, then there can be lack of consistency: no shared understanding)
data collection
sensor
eyeball
+
DATA
DATA*
Data processing and reduction:
visualization
summarization
data fitting
etc.
Automation & Implementation
INSIGHTS [NEW KNOWLEDGE]
ACTION (based on goal)

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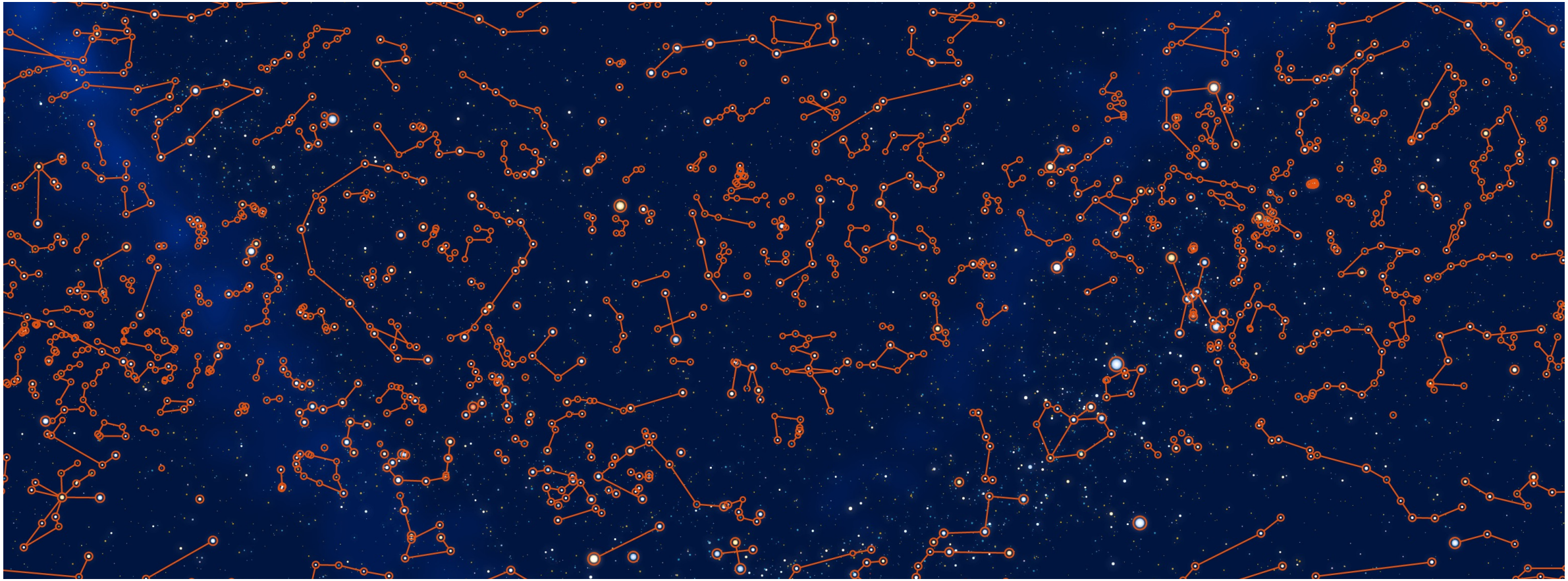


A SKY FULL OF STARS – CHINESE CONSTELLATIONS

We have always had a drive to paint stories onto the Universe. When humans first looked at stars, which are great flaming suns an unimaginable distance away, they saw amongst them giant bulls, dragons, and local heroes. Humans think in stories. [Cohen, Pratchett, Stewart]

WHAT IS NOT A STORY?

Sometimes it's easier to get a sense of what something is by looking at examples of what it is not!

Edge cases are helpful too...

WHAT IS NOT A STORY?

That's not easy to determine. Is a **list** a story?

Is a **theorem**?

A **newspaper heading**?

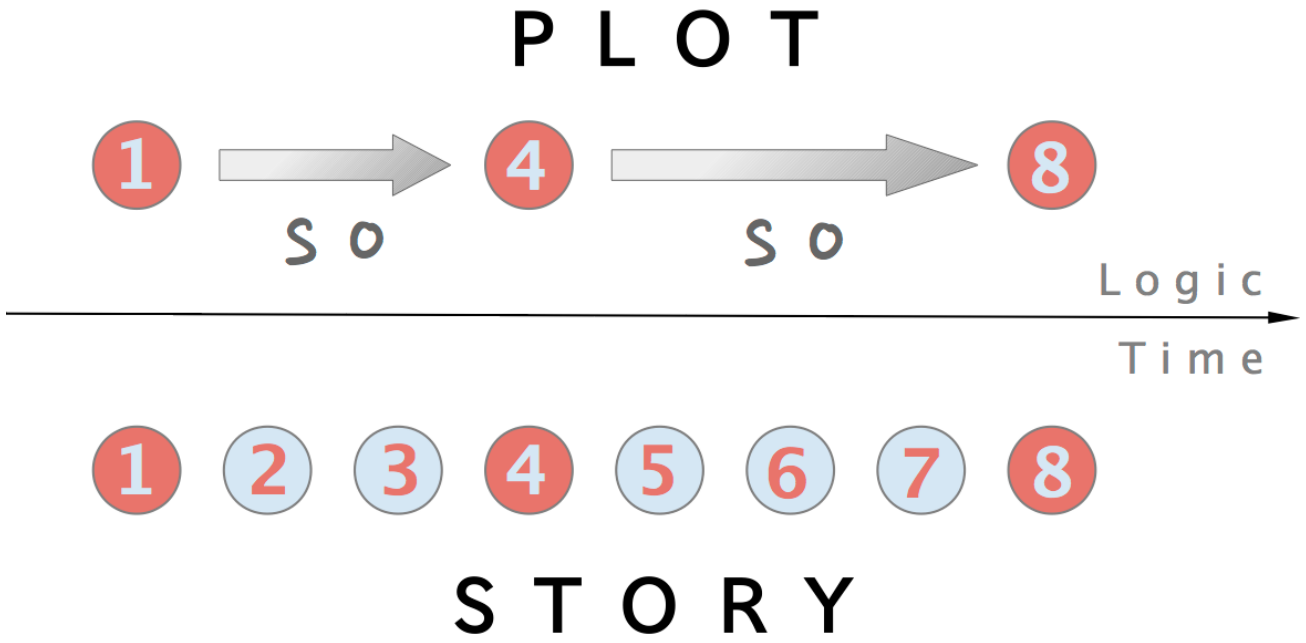
A **joke**?

A **chart**?

PLOT VS. STORY

A story's **plot** is the essential sequence of its elements.

The plot lives in **logical space**, the story in **sequential space**.



THE CLOWNFISH AND THE DEVILFISH

There once was a fish named Marlin, who loved his son Nemo more than anything. Every day he tried to protect Nemo from the ocean, which he feared.

When he died, his father looked into the vast, terrible sea and he could not find him.

Then a great monster, the Devilfish, saw Marlin's mourning face and he cackled, “You’re mine!“

Suddenly, the devilfish attacked Marlin, dragging him to his death, and Marlin has never looked back.

[https://www.youtube.com/watch?v=O_UWRUacluk]

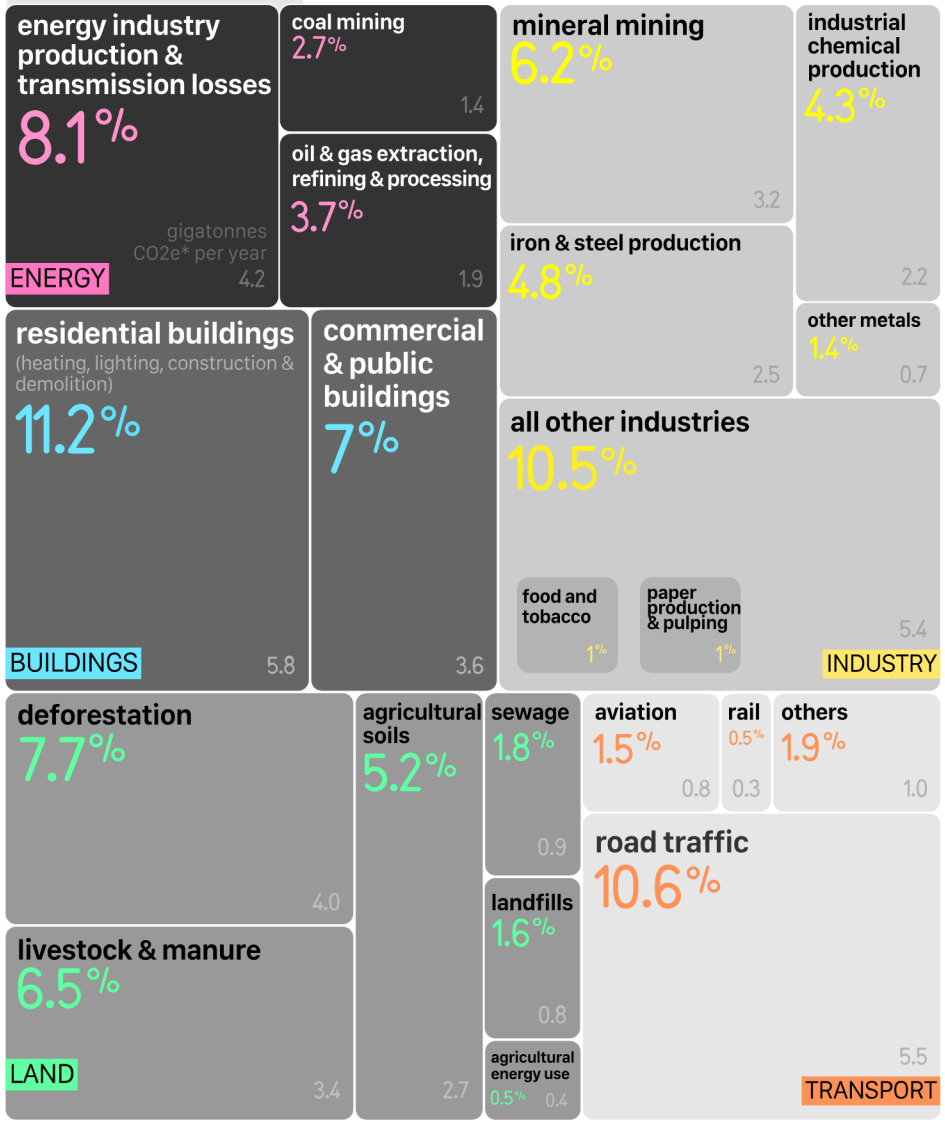
LA MUNKYA

How Do We Get to Zero Greenhouse Gas Emissions?

ENERGY | INDUSTRY | BUILDINGS | TRANSPORT | LAND | OTHER

Current Emissions

*CO_2e (carbon dioxide equivalent) is a unit for measuring the impact of multiple greenhouse gases



YEARLY EMISSIONS (gigatonnes of CO_2e*) 51.8

Emissions from where they are used, not where they are produced.

Halving by 2030

gigatonnes reduced per year

increased solar energy	-1.1
widespread wind energy	-1.4
other renewables	-0.7
better recyling of raw materials	-3.2
less materials to make the same things (product materials efficiency)	-1.0
disassembling old products to make new ones (circular business models)	-1.1
waste reduction in production of steel, plastics and other industrial materials	-1.9
reduced use of refrigeration gases (CFCs and HFCs)	-1.6
low-carbon heating and cooling	-2.1
low-carbon construction	-0.9
retrofitting buildings with better insulation, energy efficient lighting, etc.	-1.5
automation of temperature and lighting	-0.4
electric vehicles	-1.3
increased use of public transport	-0.7
bikes, car-sharing, scooters	-0.5
more efficient shipping of goods with reduced air transport	-1.0
low-emission trucks	-0.5
halting deforestation, planting trees	-2.0
sustainable agriculture techniques	-0.9
plant-based diets	-1.7
reduced food waste	-0.7
other measures	-0.9

EMISSIONS REMAINING 24.3

Policies to Zero by 2050

Global Carbon Tax / Carbon Pricing
- A progressive tax on fossil fuel producers and users dramatically reduces global emissions.

Energy
- % renewable electricity by law and subsidies.
- Early retirement of fossil-fuel power plants.
- Grid-scale electrical storage.
- Reduced individual consumption in richer countries.

Industry
- New efficiency standards.
- Switch from coal to biogas, biomass and other sustainable alternatives.
- Facilities designed to reduce waste.

Buildings
- Solar incentives.
- Electrification of heating, furnaces, stoves.
- Higher energy-efficiency standards.

Transport
- Fossil fuel vehicles phased out.
- Taxes on inefficient vehicles and fuel.
- Higher fuel economy standards.

Land
- Methane capture and destruction.
- Improved forest and livestock management.
- More reforestation.

Justice and Equity
- Climate finance flows to Global South.
- New jobs and training for affected workers.
- International co-operation secures strong climate deal.

EMISSIONS REMAINING 0.0

version 1.0 / May 2019
created by David McCandless, Duncan Geere, Hazel Healy, New Internationalist Magazine

informationisbeautiful

sources: ECOFYS, Exponential Climate Action Roadmap, Project Drawdown, IEA
data: bit.ly/CarbonZero

30 YEARS

A fellow went to a Zen master and said, “If I work very hard, how soon can I be enlightened?”

The Zen master looked him up and down and said, “Ten years.”

The fellow said, “No, listen, I mean if I really work at it, how long—”

The Zen master cut him off. “I’m sorry. I misjudged. Twenty years.”

”Wait!” Said the young man, “You don’t understand! I’m—”

“Thirty years,” said the Zen master.

EXERCISE: IS THIS A STORY?

1. Two identical infants lay in a cradle. “One you bore, the other is a Changeling. Choose wisely,” the Fae’s voice echoed from the shadow. “I’m taking both my children,” the mother said defiantly.

2. Solomon was required to decide which of two women was the mother of a baby, when each of them claimed parenthood. Both had recently given birth, but one child had died. Solomon announced that the child should be cut in two, so that each mother should have half. The real mother, unable to bear her son being killed, immediately offered it to the other woman, to save the child's life, whereas the other agreed to the proposal. The false mother was thus exposed, and Solomon returned the living child to its real mother.

EXERCISE: IS THIS A STORY?

4. For sale: baby shoes. Never worn.

5. Doctors think that they may have improved the diagnosis of liver disease by 1%.

6. Scientists claims cure for cancer.

7. Spiritualist medium claims cure for cancer.

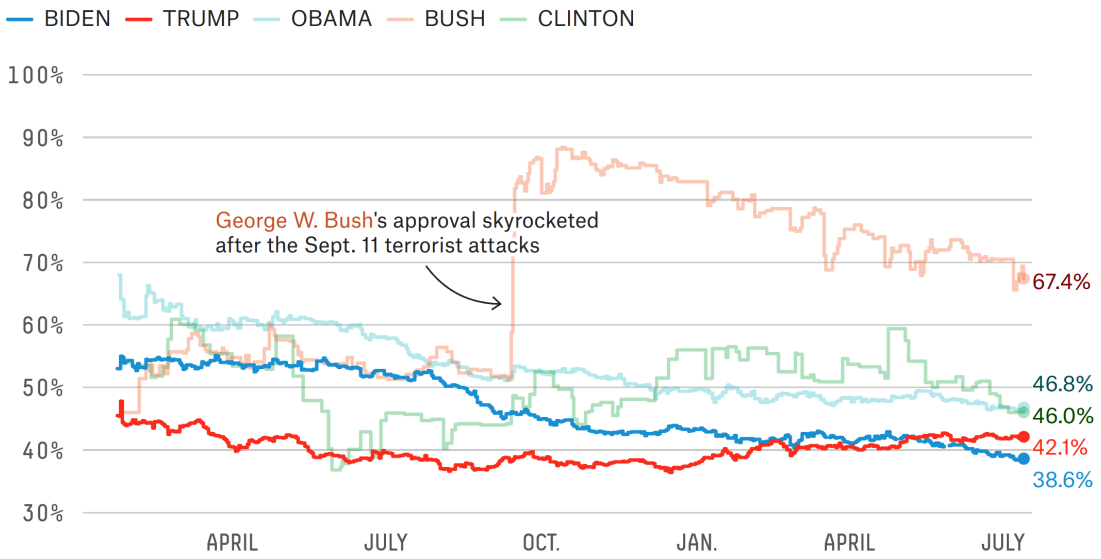
8. Sens rally after blowing lead; beat Leafs to gain on Habs.

9. Macbeth and his wife
   Want to become the royals
   So they kill 'em all.

EXERCISE: IS THIS A STORY?

Biden could have the lowest midterm approval rating

FiveThirtyEight's historical presidential approval ratings for Biden and the four most recent presidents in their first 18 months in office, 1993-2022



The first data point for each president reflects when there was enough polling data to produce an average. All data is current as of July 13, 2022, at 5 p.m. Eastern.

FiveThirtyEight

IDLEWYLD Sysabee DAVHILL uOttawa

Associated Press Feb 19, 2017

TORONTO -- The Ottawa Senators have the Atlantic Division lead in their sights.

Mark Stone had a goal and four assists, Derick Brassard scored twice in the third period and the Senators recovered after blowing a two-goal lead to beat the Toronto Maple Leafs 6-3 on Saturday night.

The Senators pulled within two points of Montreal for first place in the Atlantic Division with three games in hand.

"We like where we're at. We're in a good spot," Stone said. "But there's a little bit more that we want. Obviously, there's teams coming and we want to try and create separation, so the only way to do that is keep winning hockey games."

Ottawa led 2-0 after one period but trailed 3-2 in the third before getting a tying goal from Mike Hoffman and a power-play goal from Brassard. Stone and Brassard added empty-netters, and Chris Wideman and Ryan Dzingel also scored for the Senators.

PHANTOM TIME HYPOTHESIS

What: the years 614–911 AD never existed, so the year 2017 AD is really 1820 AD!

How: straight up jump of 297 years done by a 1st millennium cabal!

Why: HRE Otto III, Pope Sylvester II wanted to live in 1000 AD in order to legitimize power!

But: records of solar eclipses, comets, tree rings

ADJACENT STORIES (PETER DODDS)

Storytelling converges to **story logic:** irrelevant aspects are **discarded** in favour of aspects which are likely to **carry more weight.**

Adjacent stories (of which there can be infinitely many, at least in theory) afford "better" stories, which is to say, stories that are:

- more **engaging**;
- more **motivating to spread** (more memetic), and
- more **durable** (robust) under spreading.

[online.hbs.edu/blog/post/data-storytelling, C. Cote]

WHAT IS A DATA STORY?

Data storytelling is the ability to effectively communicate insights from a dataset using narratives and visualizations. It can be used to put data insights into context for and inspire action from your audience (Catherine Cote).

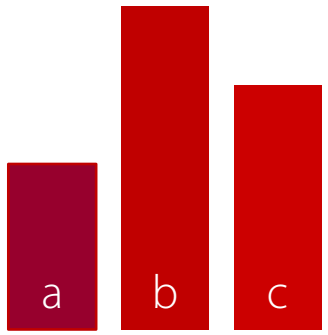
There are 3 key components:

1. **data:** foundation of data story (descriptive, diagnostic, predictive, prescriptive analysis)
2. **narrative:** storyline used to communicate the insights gleaned from data and context, and recommended actions
3. **visuals:** representations of data, analysis results, and narratives, which are used to communicate stories clearly and memorably (charts, graphs, diagrams, pictures, or videos)

ANALYTICS MODES

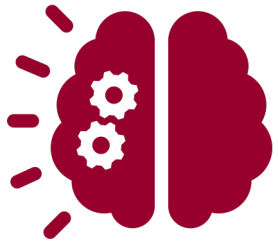
Analytics can be broken down into four core **key modes:**

Descriptive



Show **what** happened

Diagnostic



Explain **why** something happened

Predictive

Guess **what will** happen

Prescriptive

Suggest **what should** happen

Low Value
Low Difficulty

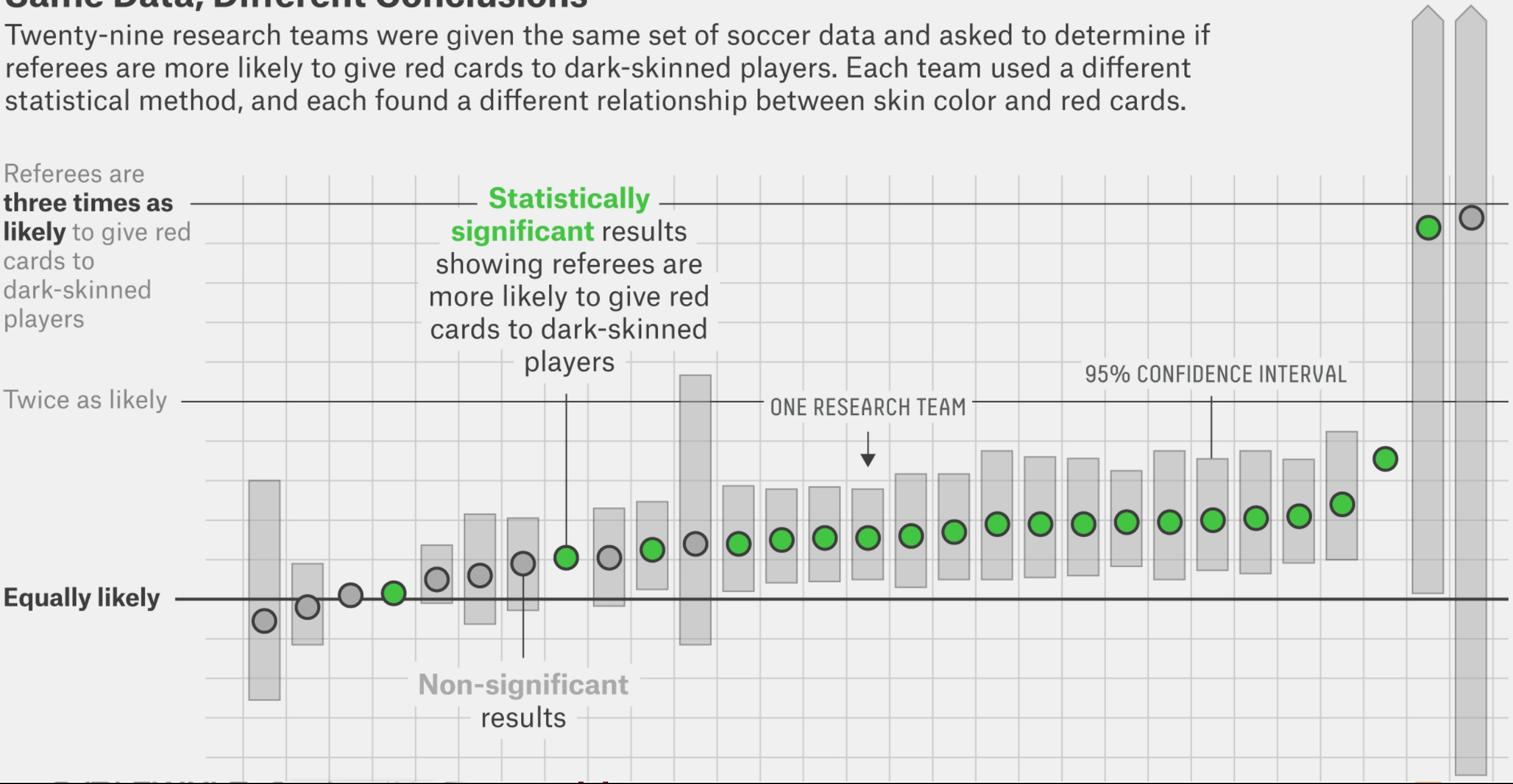
High Value
High Difficulty

IDLEWYLD Sysabee DAVHILL uOttawa

data-action-lab.com

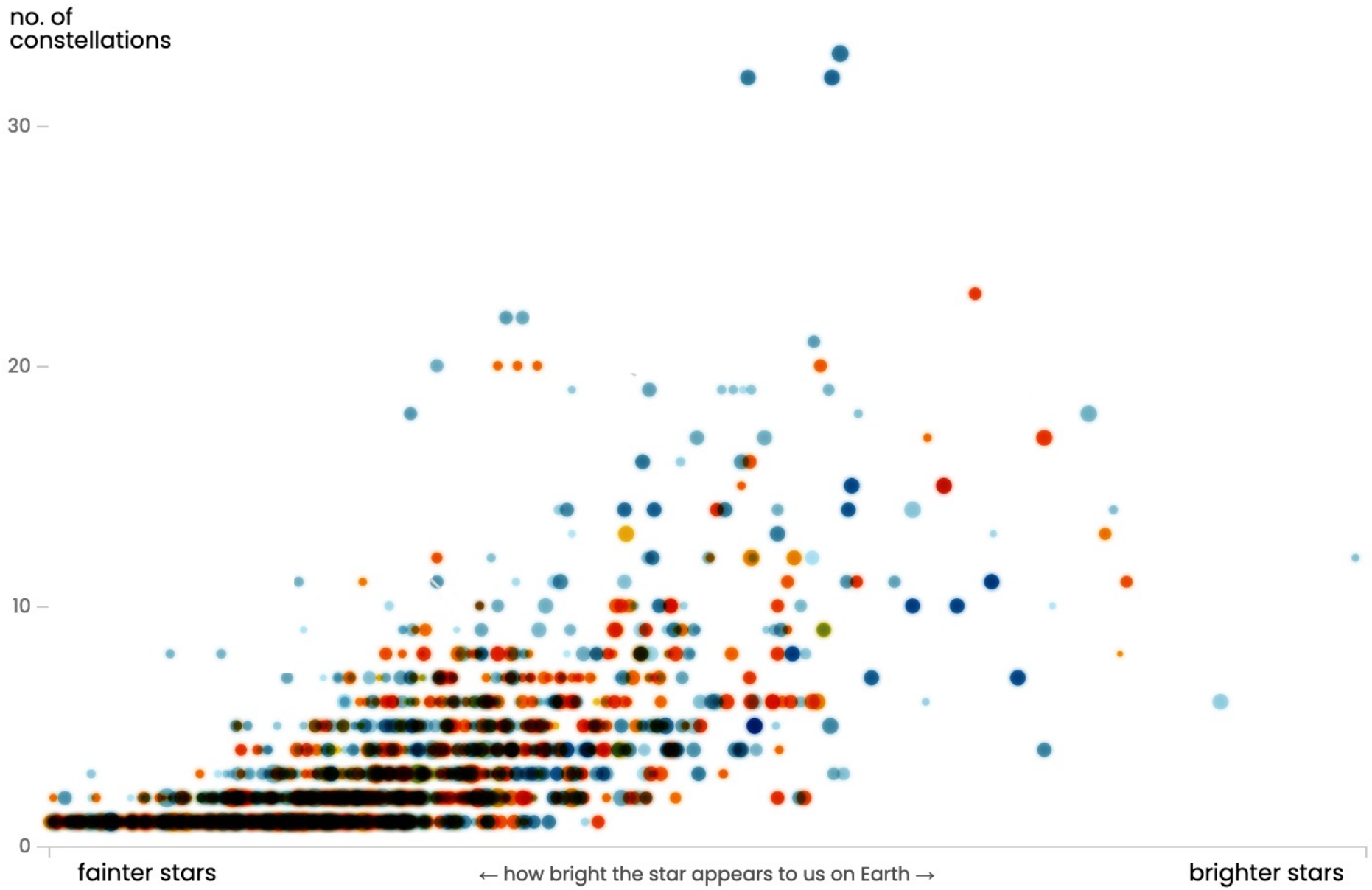
Same Data, Different Conclusions

Twenty-nine research teams were given the same set of soccer data and asked to determine if referees are more likely to give red cards to dark-skinned players. Each team used a different statistical method, and each found a different relationship between skin color and red cards.



From: Science isn't broken - It's just a hell of a lot harder than we give it credit for. **(Christie Aschwanden, 2015)**

[figuresinthesky.visualcinnamon.com]



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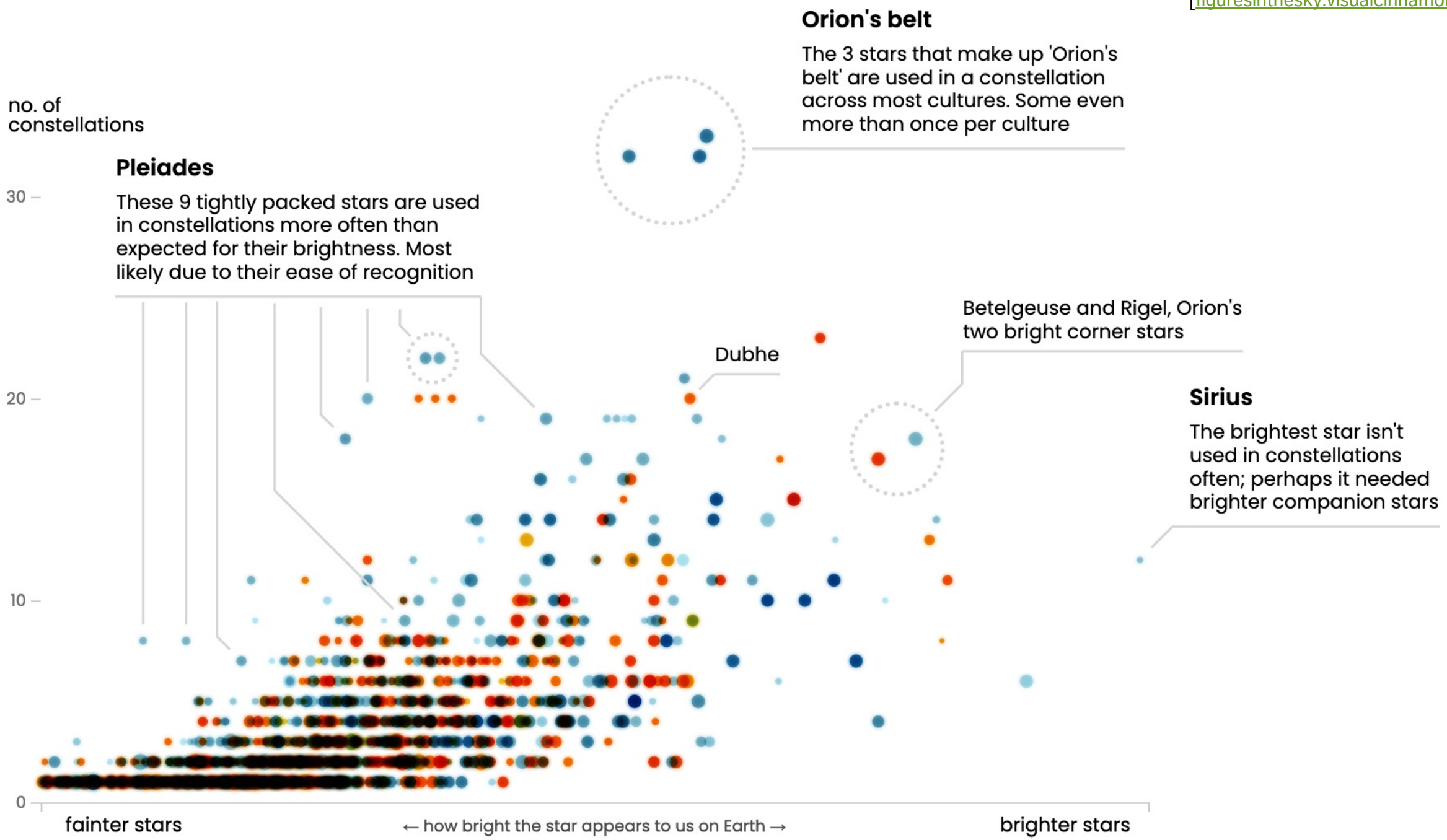


STORYTELLING RISKS

A good story can help shed insights on a situation, but storytelling requires **choices**, and the outcome is affected by what is **included** and what is **omitted** in the telling.

It is easy to mislead by **accident**; it is also easy to mislead by **design**.

With data stories, there is an additional complication: we usually only have access to the **available data**. The data that was not collected is, by definition, not available. Some of the data that was collected may also be unavailable for a variety of reasons.

This implicit bias can lead to compelling yet **fundamentally flawed** data stories.

During WWII, mathematician **A. Wald** undertook a study to help protect British bombers flying over enemy territory.

Data included: the **number** and **location** of **bullet holes** on returning aircraft, and the goal was to use this information to determine where to add armor to best protect the plane's structure.

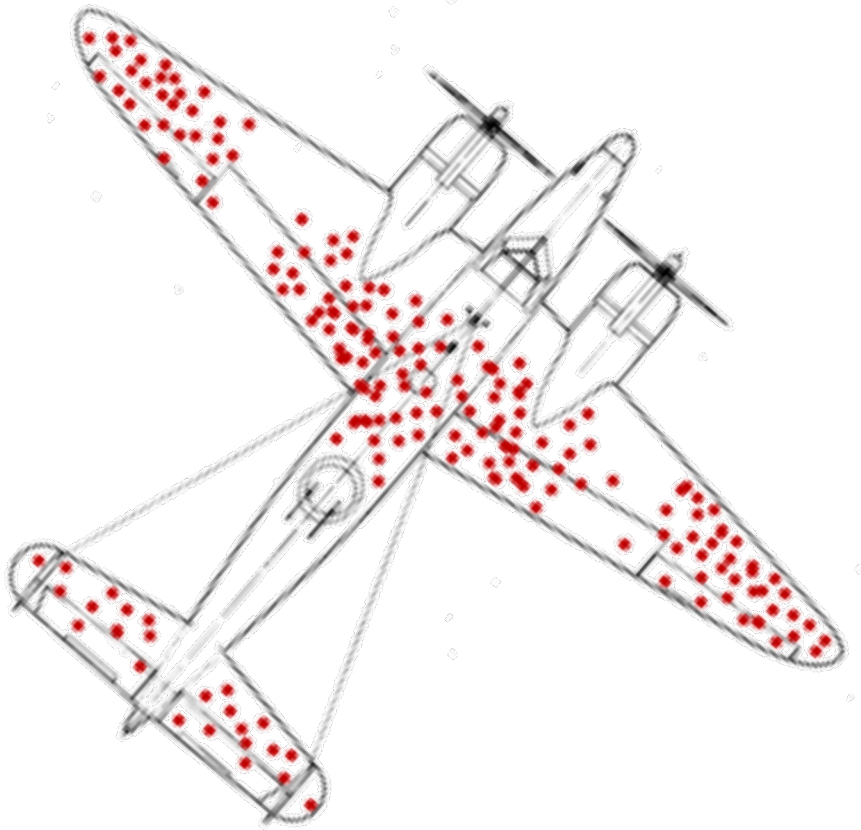
A chart was created to show where the maximum number of bullet holes were located on **returning aircraft**. This chart showed greatest damage on the **aircraft extremities**, not on the main wing and tail spars, engines, and core fuselage areas.

STORYTELLING RISKS

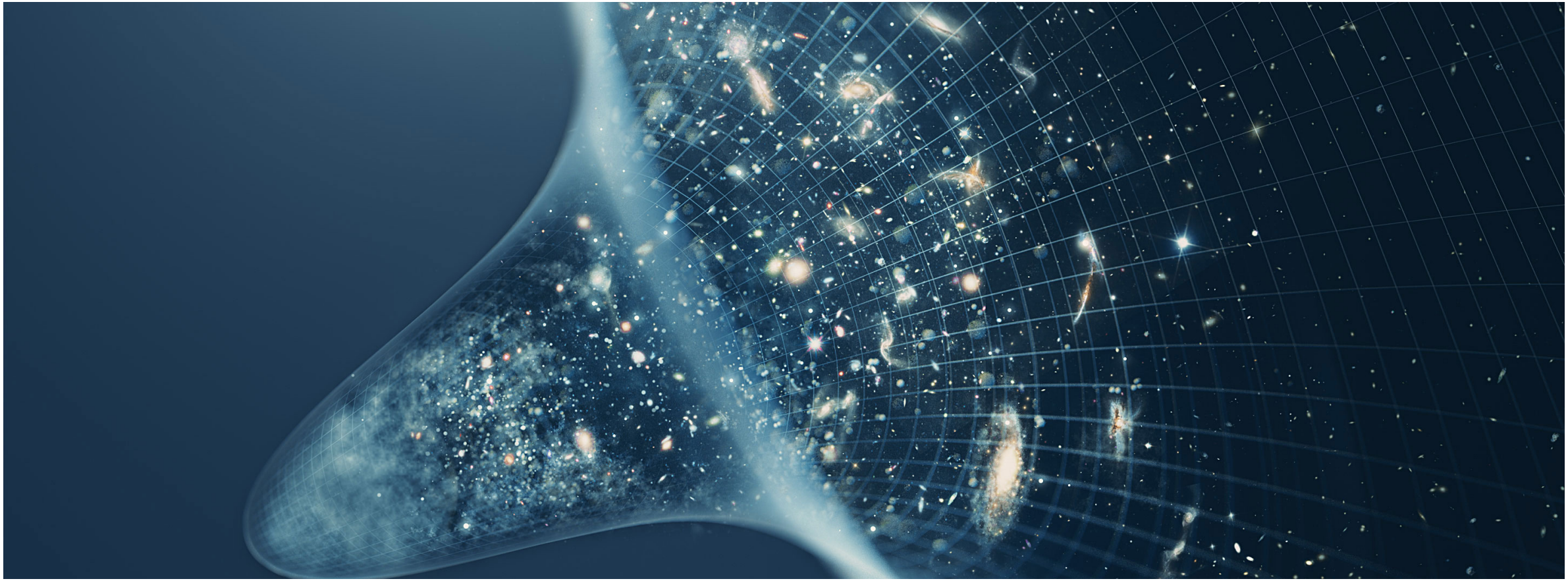
As such, the Air Ministry wanted to add armor to the **extremities**. Wald suggested they were **dead wrong**.

To avoid **"survivorship bias",** armor should be added to the areas with the **fewest holes**: if no returning planes had holes in their wing spars and engines, then even a few holes in those locations were **deadly**.

Take-Away: the data that is missing may be as important to story than the data that is there. Storytelling is not always an obvious endeavour.



[M. Zeng]



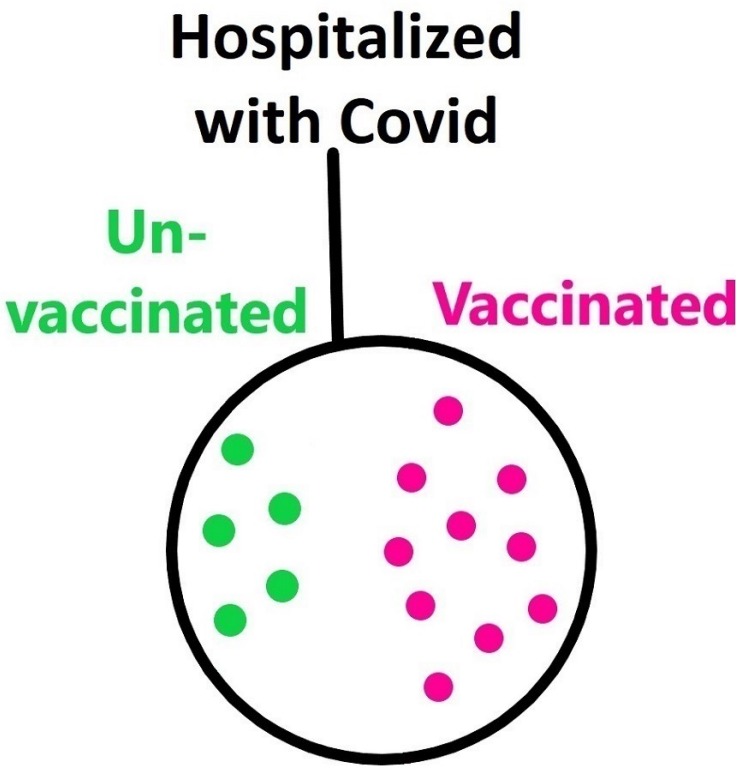
STORYTELLING RISKS

"...we might wonder if the ultimate intelligibility of the universe will be determined not so much by the capacity of our minds to formulate the appropriate concepts and equations, but by whether we can find a meaningful story to tell about it." [P. Ball, *The Story Trap*]

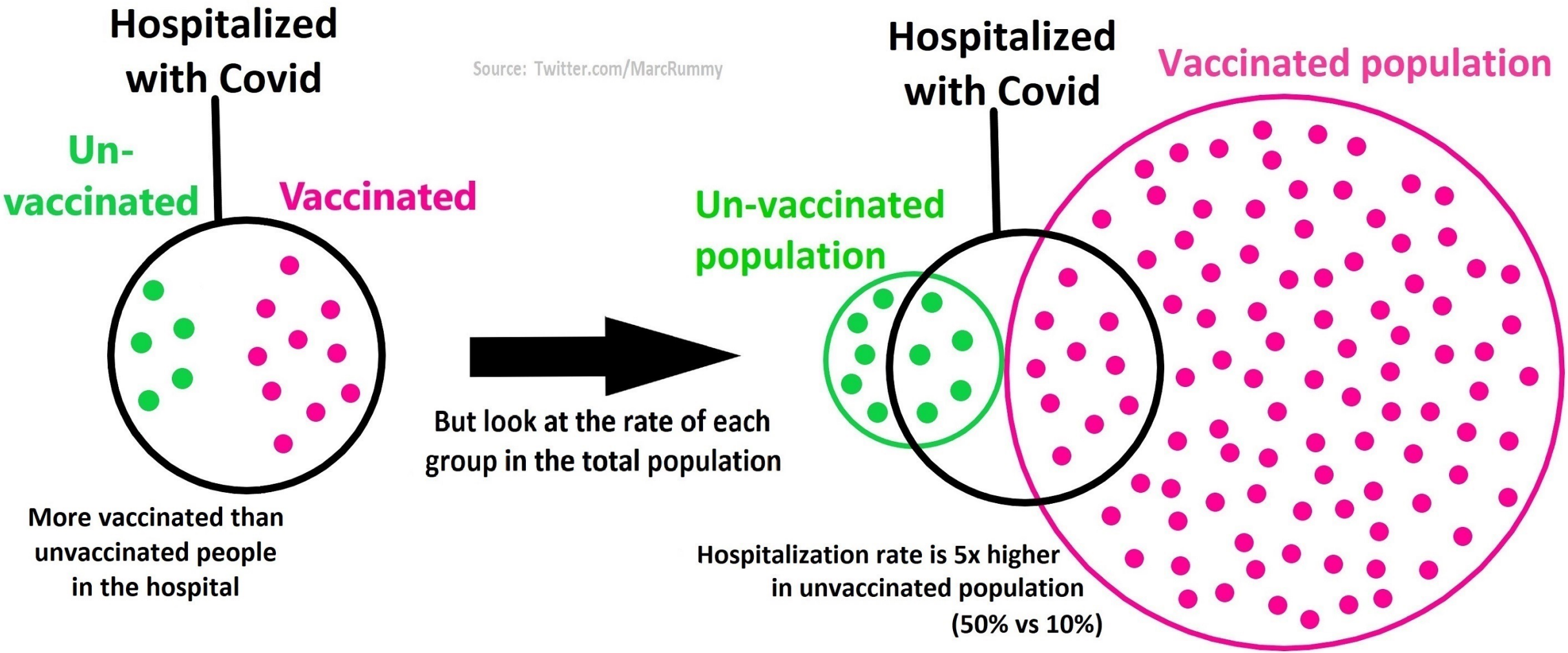
STORYTELLING RISKS

"Open any newspaper, watch any TV news show, and you find experts who forecast what's coming. Some are cautious. Most are bold and confident. A handful claim to be Olympian visionaries able to see decades into the future. With few exceptions, they are not in front the camera because they possess any skill at forecasting.

Accuracy is seldom even mentioned. [...] The one undeniable talent that talking heads have is their skill at **telling a compelling story with conviction**, and that is enough. Many have become wealthy peddling forecasting of untested value to corporate executives, government officials and ordinary people who would never think of swallowing medicine of unknown efficacy and safety but who routinely pay for forecasts that are as dubious as elixirs sold from the back of a wagon." [Tetlock]



More vaccinated than unvaccinated people in the hospital



Note: The ratios presented are made to illustrate the concept of the base rate fallacy when the vaccination rate is high

"We are ambivalent [...] about **beginnings** – their 'creation myth' aspect appeals to our sense of narrative imperative, but we sometimes find that the 'first it wasn't, then it was' lie-to-children unpalatable.

We have even more trouble with **becomings**. Our minds attach labels to things in the surrounding world, and we interpret those labels as discontinuities. If things have different labels, then we expect there to be a clean line of demarcation between them.

The Universe, however, runs on processes rather than things, and a process starts as one thing and **becomes** another without ever crossing a clear boundary.

Worst, if there is some apparent boundary, we are likely to point at it and shout '**that's it**!' just because we can't see anything else worth getting agitated about."

[Cohen, Pratchett, Stewart]

EXERCISES

12. Find examples of stories that are about individuals; about organizations; about cultures/societies.

13. Find examples of stories that are used to persuade; to educate; to entertain.

14. Find examples of data stories that are about individuals; about organizations; about cultures/societies.

15. Find examples of data stories that are used to persuade; to educate; to entertain.

ELEMENTS OF STORYTELLING

PART I – STORIES AND STORYTELLING

HUMAN STORIES

Humans *love* humans! They can't get enough of themselves. They crave the company of humans, they value the opinions of humans, and they love hearing stories about humans! [McCloud]

STORYTELLING GOALS

Cultural Stories

- entertain, inform, teach, explore, shock

Data (Scientific) Stories

- describe, diagnose, predict, prescribe, persuade

Any overlap?

Anything missing?

STORYTELLING AUDIENCE

Storytelling requires a **teller** and a **story**, but also an **audience.**

The **teller**'s job is to convince the audience to accept:

1. the premise ("I'm about to tell you a really interesting story, so listen up!")
2. the contents ("All these things happened, honest!")
3. the conclusion ("And that's why you should never put peanut butter in your laundry.")

The **story**'s must first and foremost not come in the way of the teller's job.

STORYTELLING AUDIENCES

The **audience** is a more nebulous entity.

In many cases, the teller never interacts directly with the audience. For all they know, the audience could be a single child, or the entire nation of Finland.

This **ambiguity** typically leads to storytellers imagining the largest possible audience. A story for the ages, which will be all things to all people.

This is a common mistake: **less is more**. It pays to know the audience (we will discuss this further at a later stage).

STORYTELLING AUDIENCES

What is required of a storytelling audience?

What is expected of a storytelling audience?

What kind of audiences exist for stories?

For storytelling with data? (we will discuss this again at a later stage)

STORYTELLING CONTEXT

A given action may be seen as positive or as negative by audiences with different pre-existing feelings/knowledge concerning the agent/situation.

- Would you be able to recognize nobility in a political enemy's actions?
- Could a fan of the Maple Leafs/Habs ever have something worthy to say about hockey?

Similarly, a story may have different **outcomes/impacts** in different contexts.

Trevor Greenway · Feb 9 · 5 min read

[https://www.lowdownonline.com/post/wakefield-nurse-fires-up-freedom-convoy]

Wakefield nurse fires up Freedom Convoy

Wakefield's Bethan Nodwell is known in the Gatineau Hills for many things: being the hospital's former head nurse, singing onstage at the Black Sheep Inn, and more recently, disseminating debatable facts and anti-vax sentiments on social media. Now she's running the main stage at the Freedom Convoy in downtown Ottawa, firing up the crowd as seen here Feb. 4. Trevor Greenway photo

Bethan Nodwell had thousands of demonstrators in Ottawa hanging onto her every word.

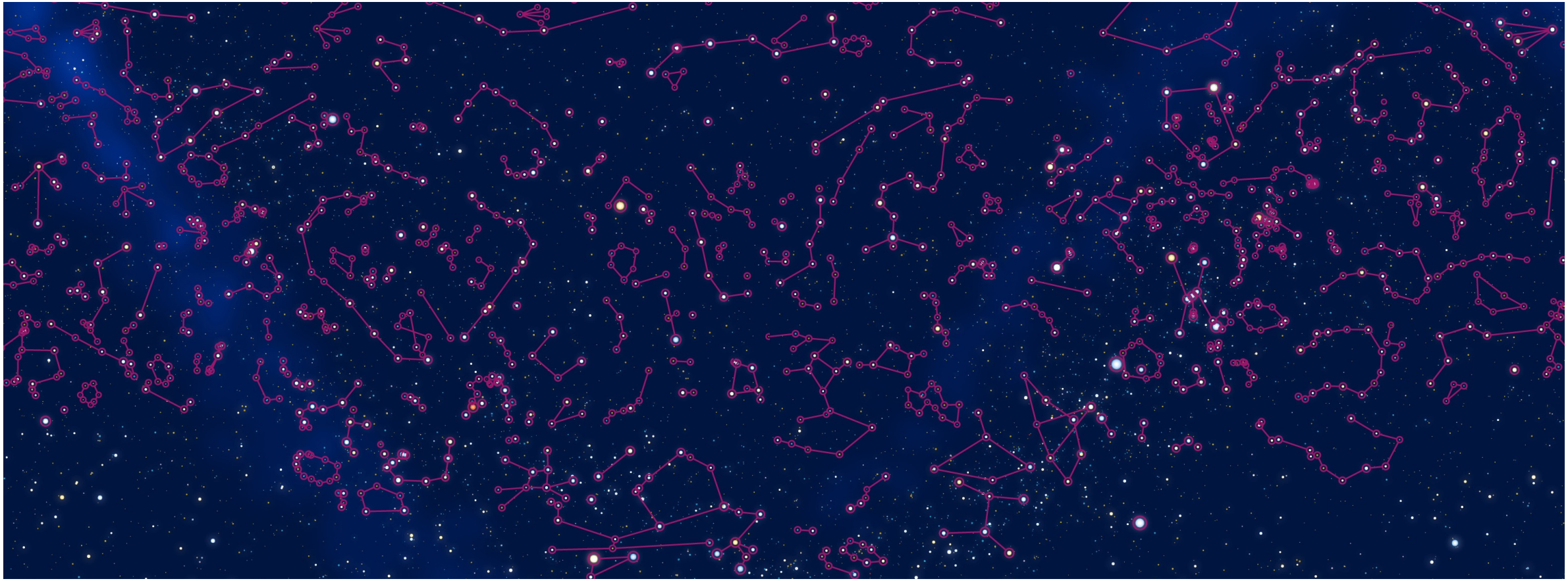
What might lead one to view the **subject** of this article in a positive light?

A negative light? A neutral light?

What might lead one to view the **author** of this article in a positive light?

A negative light? A neutral light?

[figuresinthesky.visualcinnamon.com]



A SKY FULL OF STARS – KOREAN CONSTELLATIONS

We have always had a drive to paint stories onto the Universe. When humans first looked at stars, which are great flaming suns an unimaginable distance away, they saw amongst them giant bulls, dragons, and local heroes. Humans think in stories. [Cohen, Pratchett, Stewart]

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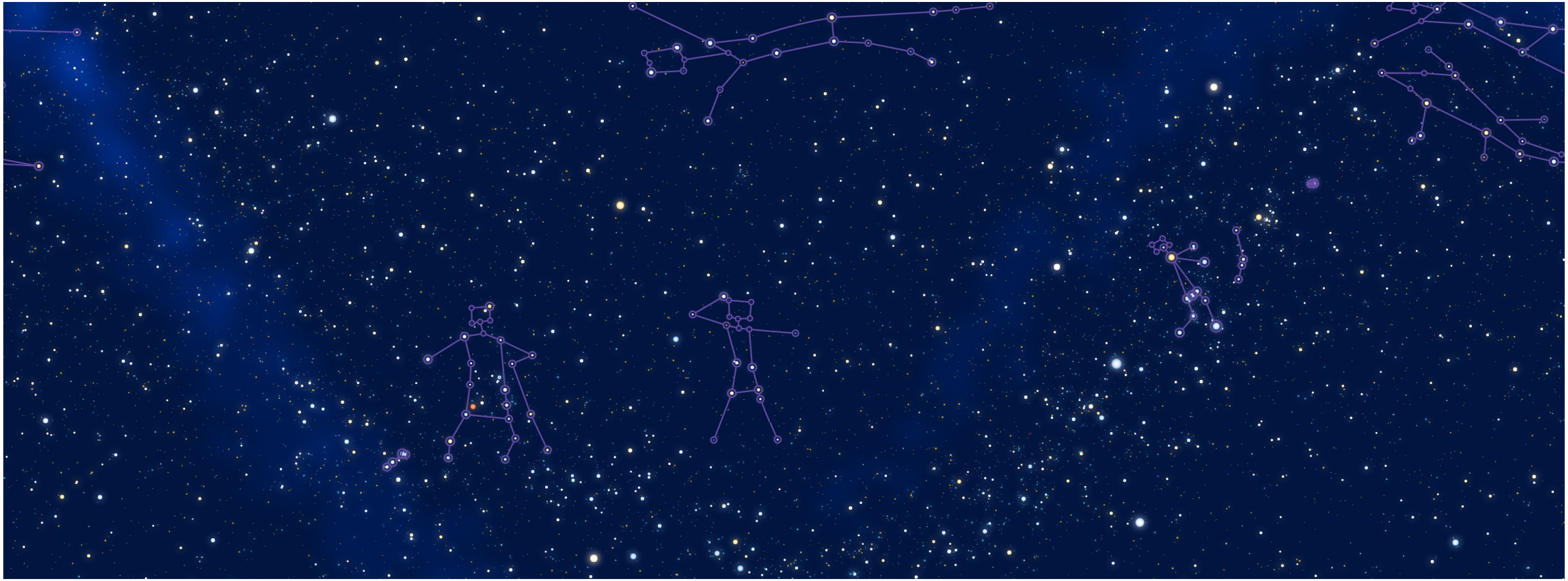


A SKY FULL OF STARS – (SOME) NAVAJO CONSTELLATIONS

We have always had a drive to paint stories onto the Universe. When humans first looked at stars, which are great flaming suns an unimaginable distance away, they saw amongst them giant bulls, dragons, and local heroes. Humans think in stories. [Cohen, Pratchett, Stewart]

[Illustrations: V. Jaskina]

STORYTELLING UNIVERSALITY

There once was a shepherd boy who was bored as he sat on the hillside watching the village sheep. To amuse himself he took a great breath and sang out, "Wolf! Wolf! The Wolf is chasing the sheep!"

The villagers came running up the hill to help the boy drive the wolf away. But when they arrived at the top of the hill, they found no wolf. The boy laughed at the sight of their angry faces. "Don't cry 'wolf', shepherd boy," said the villagers, "when there's no wolf!" They went grumbling back down the hill.

Later, the boy sang out again, "Wolf! Wolf! The wolf is chasing the sheep!" To his naughty delight, he watched the villagers run up the hill to help him drive the wolf away.

When the villagers saw no wolf they sternly said, "Save your frightened song for when there is really something wrong! Don't cry 'wolf' when there is NO wolf!"

[Illustrations: V. Jaskina]

STORYTELLING UNIVERSALITY

But the boy just grinned and watched them go grumbling down the hill once more.

Later, he saw a REAL wolf prowling about his flock. Alarmed, he leaped to his feet and sang out as loudly as he could, "Wolf! Wolf!" But the villagers thought he was trying to fool them again, and so they didn't come.

At sunset, everyone wondered why the shepherd boy hadn't returned to the village with their sheep. They went up the hill to find the boy. They found him weeping.

"There really was a wolf here! The flock has scattered! I cried out, "Wolf!" Why didn't you come?"

An old man tried to comfort the boy as they walked back to the village. "We'll help you look for the lost sheep in the morning," he said, putting his arm around the youth, "Nobody believes a liar ... "

STORYTELLING UNIVERSALITY

... even when they are telling the truth.

STORYTELLING UNIVERSALITY

… so don’t get caught telling the same lie twice.

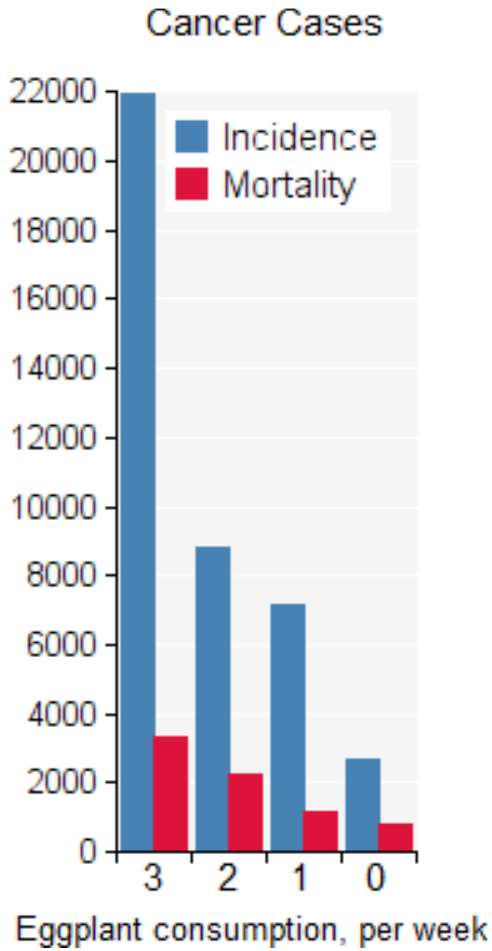
UNIVERSALITY

Ambiguity can also occur in data stories.

What is the **take-away** here?

Is increased eggplant consumption linked to:

- increased cancer incidence, or
- diminishing mortality rates?



EXERCISES

1. In your organization, who makes up the audience? Is there only one audience? What are the storytelling goals? Is the storytelling context clear? Constant? Universal?

2. **The Death of the Author:** Isaac Asimov once sat anonymously in a class where the topic of discussion was one of his stories. He introduced himself afterwards to the teacher, saying that he had found his interpretation of the story interesting, but it wasn't really what he had meant at all. The teacher's response was "Just because you wrote it, what makes you think you have the slightest idea what it's about?" How could this come into play when telling stories with data?

EXERCISES

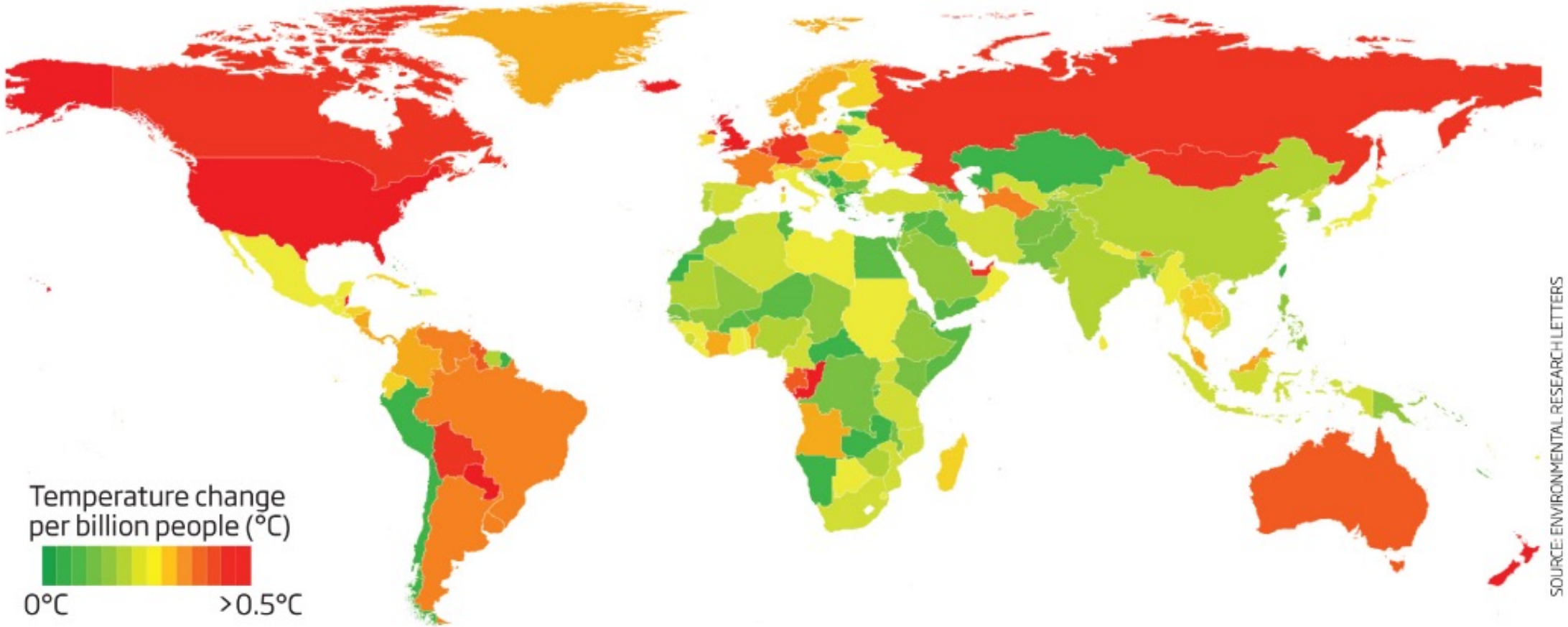
3. Guess the story:
   a) A group of friends spends 9 hours returning jewellery.
   b) A talking frog convinces a son to kill his father.
   c) A young woman with mental illness talks to furniture and marries her kidnapper.
   d) A depressed, widowed father teams up with a mentally-challenged woman to find his disabled son.

4. In the following charts, who is the intended audience? What are the goals? Are the outcomes universal?

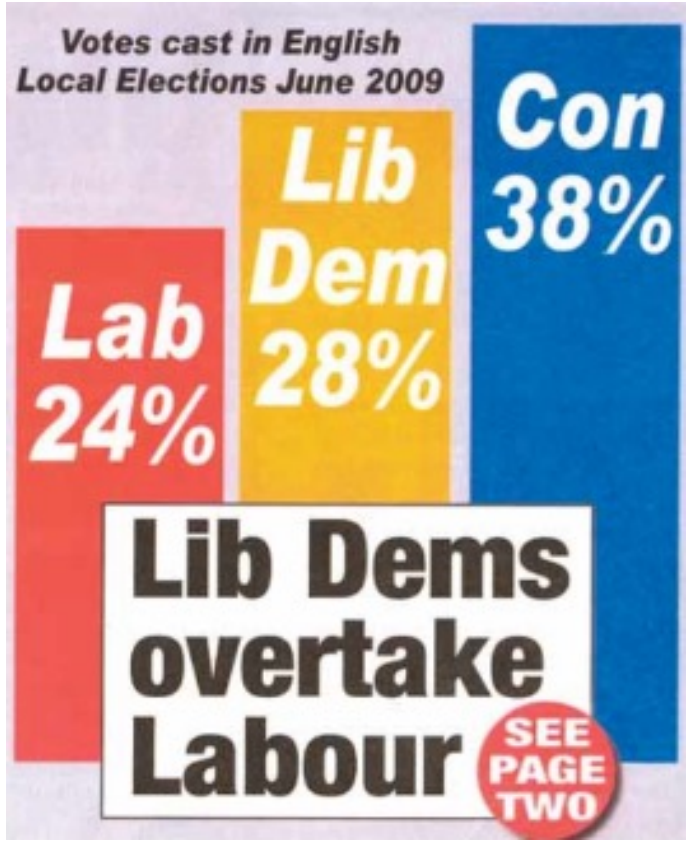
[New Scientist, Jan 2014]

Global warming culprits, judged by population

Countries that have caused more global warming per billion people are coloured red and low-emitters are dark green



[mediamatters.org, simplystatistics.org, badgraphs.tumblr.com]

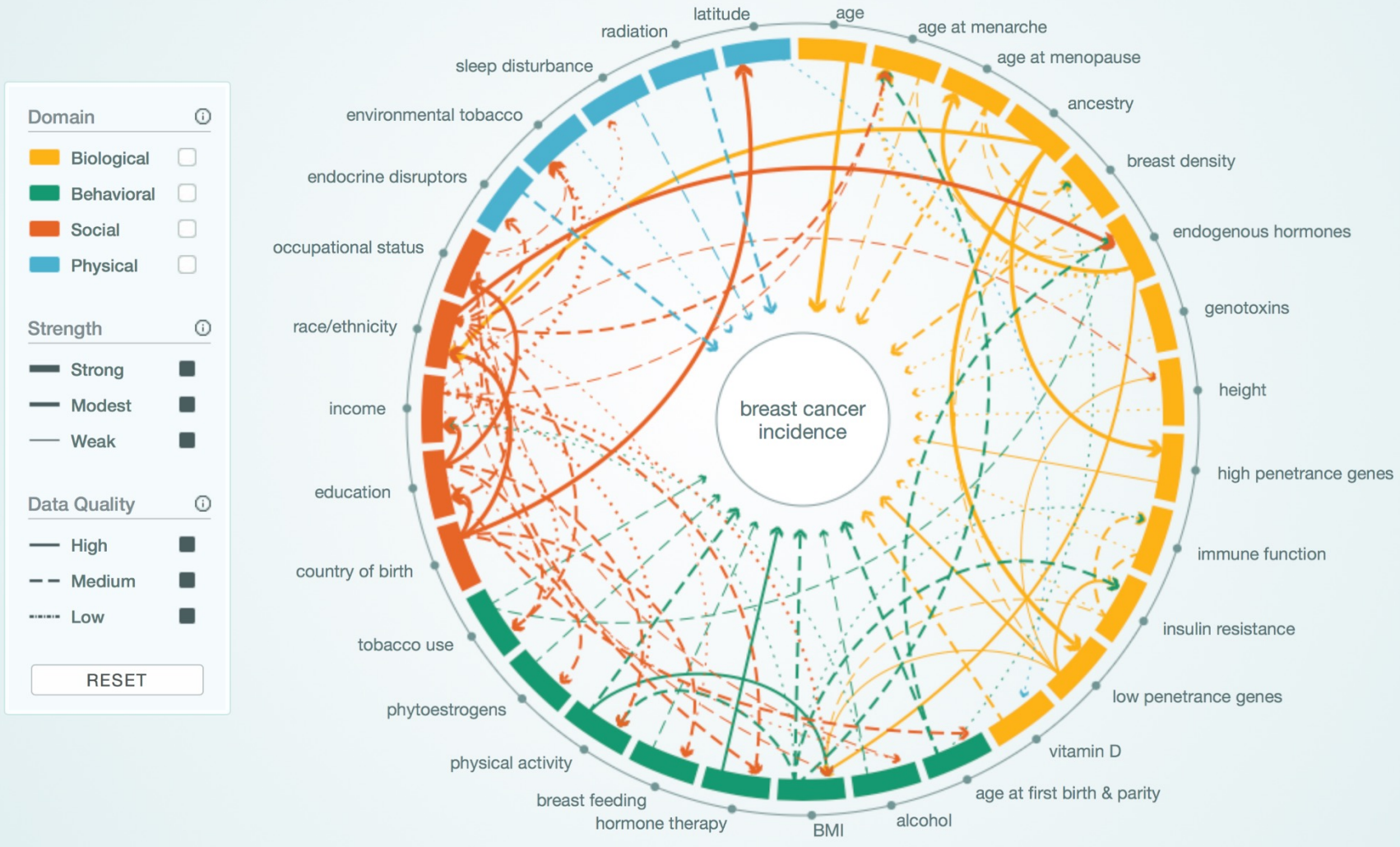


[http://www.cbcrp.org/causes/index.php]

A Model of Breast Cancer Causation

Visualizing the many factors and relationships influencing breast cancer incidence in postmenopausal women

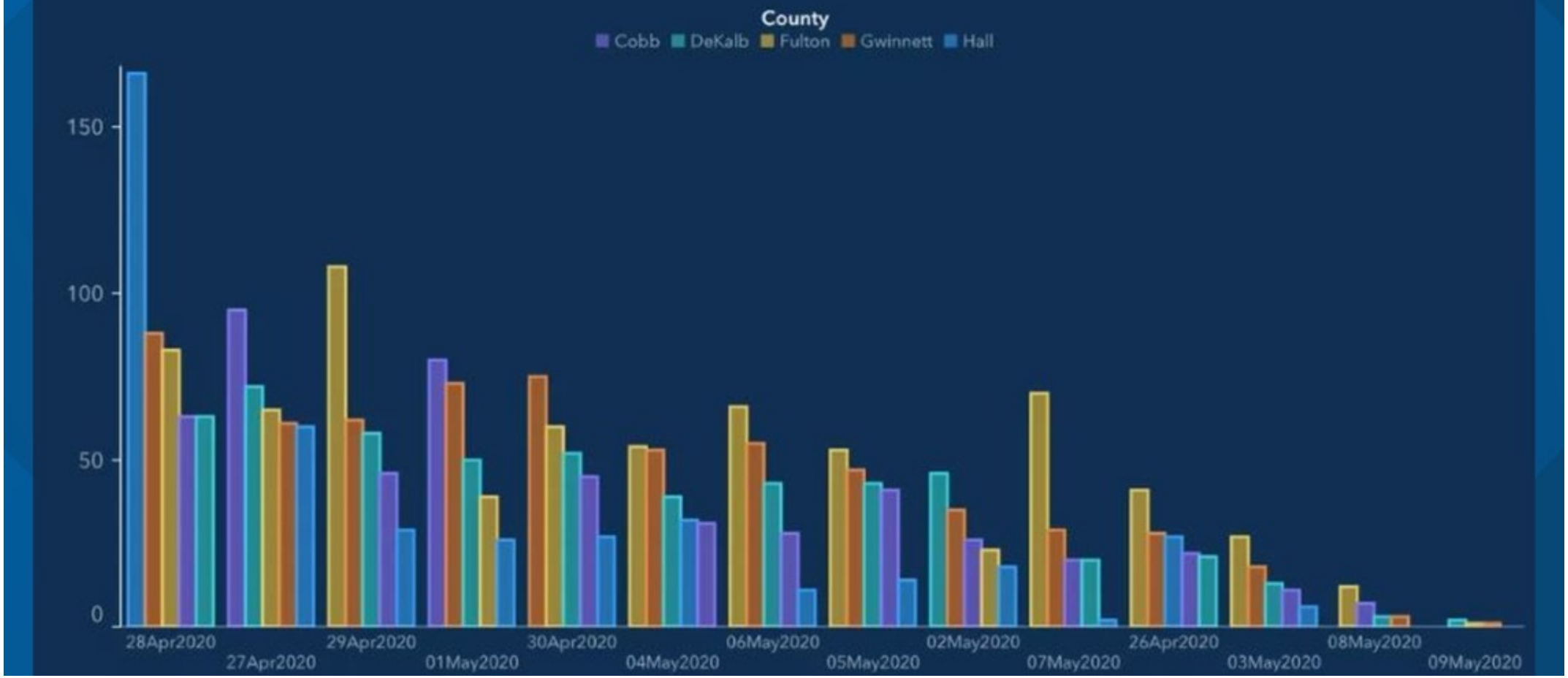
Definitions | References



[State of Georgia, Department of Public Health]

Top 5 Counties with the Greatest Number of Confirmed COVID-19 Cases

The chart below represents the most impacted counties over the past 15 days and the number of cases over time. The table below also represents the number of deaths and hospitalizations in each of those impacted counties.



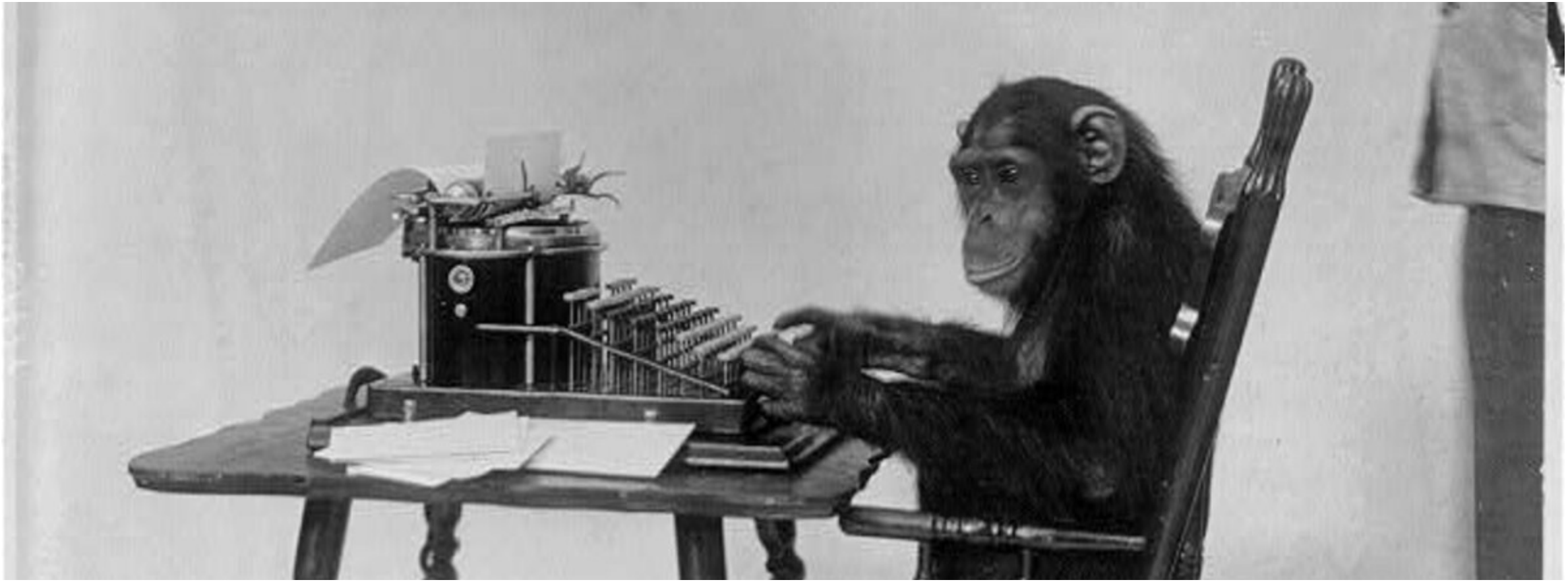
EXERCISES

5. Consider a story titled *The Ozone Hole*.
   - give a summary of this story
   - what is its beginning? it's end?
   - what's the narrative?
   - who is the audience? the teller?
   - is it robust? is it the same story now than it was when it was first told?
   - is it applicable to other situations?

STORY FORMS AND STRUCTURES

PART I – STORIES AND STORYTELLING

[Unknown]



STORYTELLING IS IN OUR BLOOD

The anthropologists got it wrong when they named our species *Homo sapiens* ('wise man'). [...] In reality, we are *Pan narrans*, the storytelling chimpanzee. [Cohen, Pratchett, Stewart]

THE ROLE OF TIME IN STORIES

Stories are (necessarily?) **dynamic**.

There must be events happening for a story to be a story, even if the sequence of these events is presented out of order.

Story illustrations may depict one or several moments of a story (graphic novels and comics take this to the next level).

[tvtropes.org]

TROPES

In storytelling, a **trope** is a conceptual figure of speech, a storytelling shorthand for a concept that the audience will recognize and understand instantly (e.g., convention):

- plot trick;
- setup;
- narrative structure;
- character type;
- linguistic idiom;
- etc.

Commonly-used tropes become **clichés**: elements that are expected to be part of any story in a given genre.

TROPES

Tropes are **patterns** in storytelling, not only within the works themselves, but also:

- behind-the-scenes aspects of creation;
- technical features of a medium, and
- audience experience and expectations

The idea being that storytelling is not just writing, it is the **whole process of creating** and **telling/showing a story**.

We have been identifying and discussing patterns in media **for centuries**. Aristotle wrote the *Poetics*, studying tragic plays and epics, making him the first troper of whom we have knowledge. He first diagnosed many of the tropes still in use.

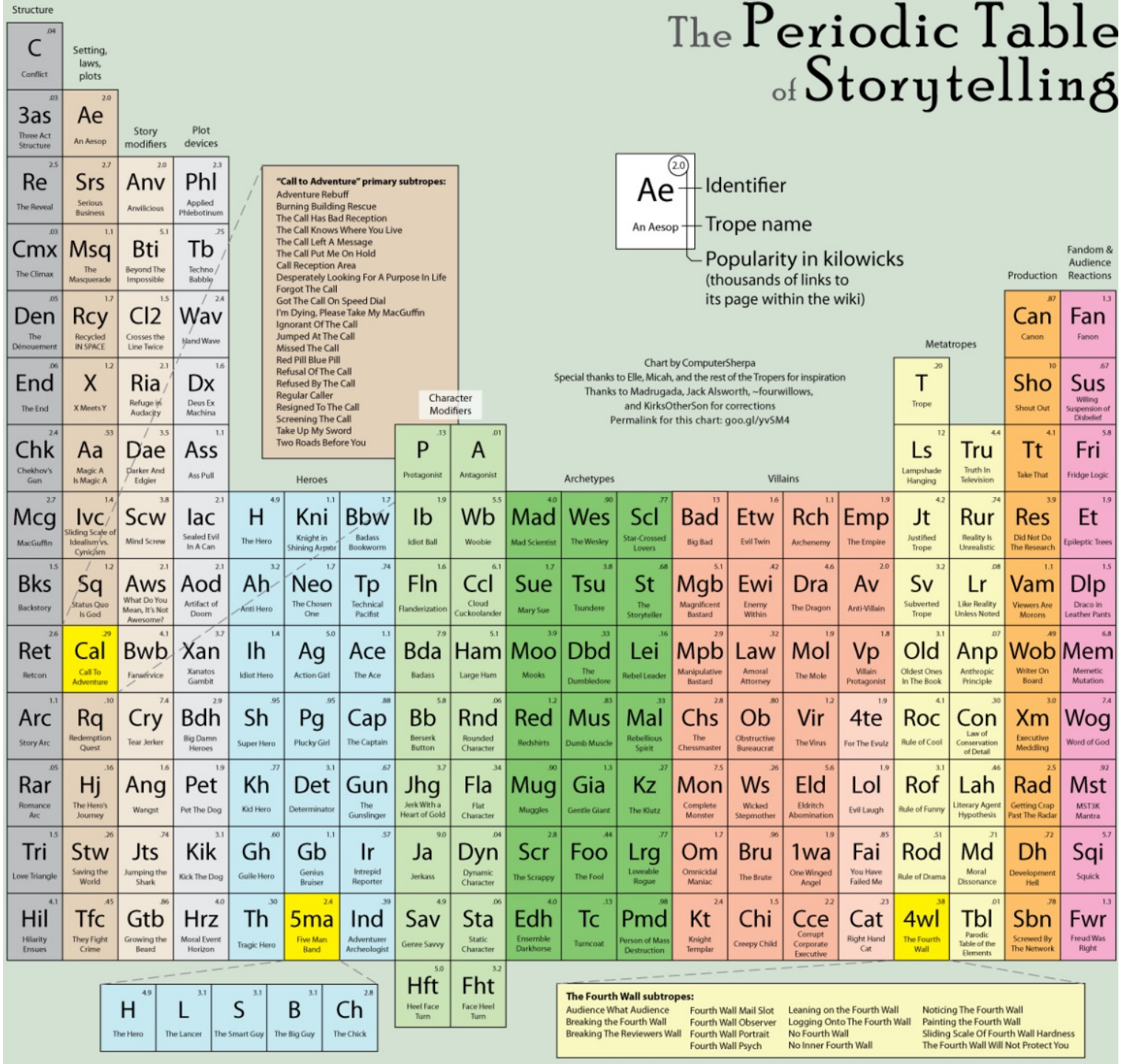
[tvtropes.org]

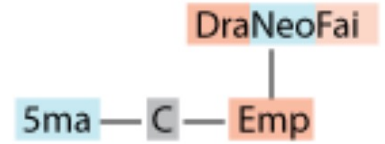
TROPES DISCUSSED IN ARISTOTLE'S *POETICS*

- Acceptable Breaks from Reality
- Anti-Hero
- Bittersweet Ending
- Contrived Coincidence
- Deus ex Machina
- Downer Ending
- Emotional Torque
- Happy Ending
- Random Events Plot
- Reality Is Unrealistic
- The Reveal
- Rule of Cool
- Special Effects Failure
- Spectacle
- Three-Act Structure
- Twist Ending
- Unsympathetic Comedy Protagonist
- Willing Suspension of Disbelief

The Periodic Table of Storytelling

[SonicLover]





[tvtropes.org]

PLAYING WITH TROPES

Tropes are most useful when they are **played with**.

Since the conventions are known and understood by the audience, any departure from a trope can be used to convey special information.

In data stories, this often takes the form of looking for **what is missing** or **what differs from expectations**.

(We will discuss this further when we talk about the **Gestalt principles**.)

[tvtropes.org]

PLAYING WITH TROPES: THE BUTLER DID IT

The Butler Did It is one of the most familiar tropes (clichés) of **mystery fiction**.

The stereotypical example is that a group of individuals are invited to dinner in a wealthy person's house, who ends up being poisoned during the meal.

All the guests had some reason to kill the host, and each is placed in a situation that lets the reader think that they could *conceivably* be the guilty party.

The murder is debated among the guests; in the climactic summation gathering, the murderer is identified as none other than... the **butler**, whom no one would have suspected since he's just *part of the furniture* (obviously an old trope).

[tvtropes.org]

PLAYING WITH TROPES: THE BUTLER DID IT

- **Played Straight:** the butler is the murderer, which genuinely surprises everyone when the fact is revealed.
- **Justified:** the butler decided to get revenge because his sister was killed by his employer.
- **Inverted:** every suspect except the butler was part of the crime.
- **Backfired:** the butler is the murderer, but didn't know that the victim had left him all his riches.
- **Subverted:** the butler did do it, but it was an accidental murder.
- **Double Subverted:** the butler is the prime suspect at the beginning, but then eliminated as a suspect... except he did do it, and the exonerating evidence is false.
- **Parodied:** butlers learn their trade at butler college where they are taught cleaning, cooking, and murdering.
- **Deconstructed:** the butler and his victim were lifelong friends who never got in conflict with one another. It wouldn't make sense for the butler to just murder his best friend for no apparent reason.

[tvtropes.org]

PLAYING WITH TROPES: THE BUTLER DID IT

- **Reconstructed:** the butler didn't kill his best friend out of personal motivation, but for a large sum of money to improve his poor livelihood, and the rest of the story is about figuring out who paid him to murder his friend.
- **Zig Zagged:** the butler did it, but he was under mind control at the time. And it later turns out that the one mind controlling the butler looked exactly like the butler. And then we find out that it was actually his evil twin, who was also a butler. But it turns out it was a conspiracy hatched by the butler and his evil twin, one born out of necessity because the victim was going to do something monstrous.
- **Averted:** a butler appears but no crime occurs.
- **Enforced:** the writer hates butlers, so decides to cast the butler as the killer.
- **Implied:** the detective rules out all the guests one-by-one, but in the end he fails to find the real killer. The astute reader notices he never bothered to investigate the butler.
- **Logical Extreme:** all butlers are in a conspiracy to commit murder.
- **Exaggerated:** all the butlers in the city go on a killing spree, and nobody suspects a thing.
- **Downplayed:** the butler did indeed do it... "it" being leaving the toilet seat up.

PLAYING WITH TROPES: THE BUTLER DID IT

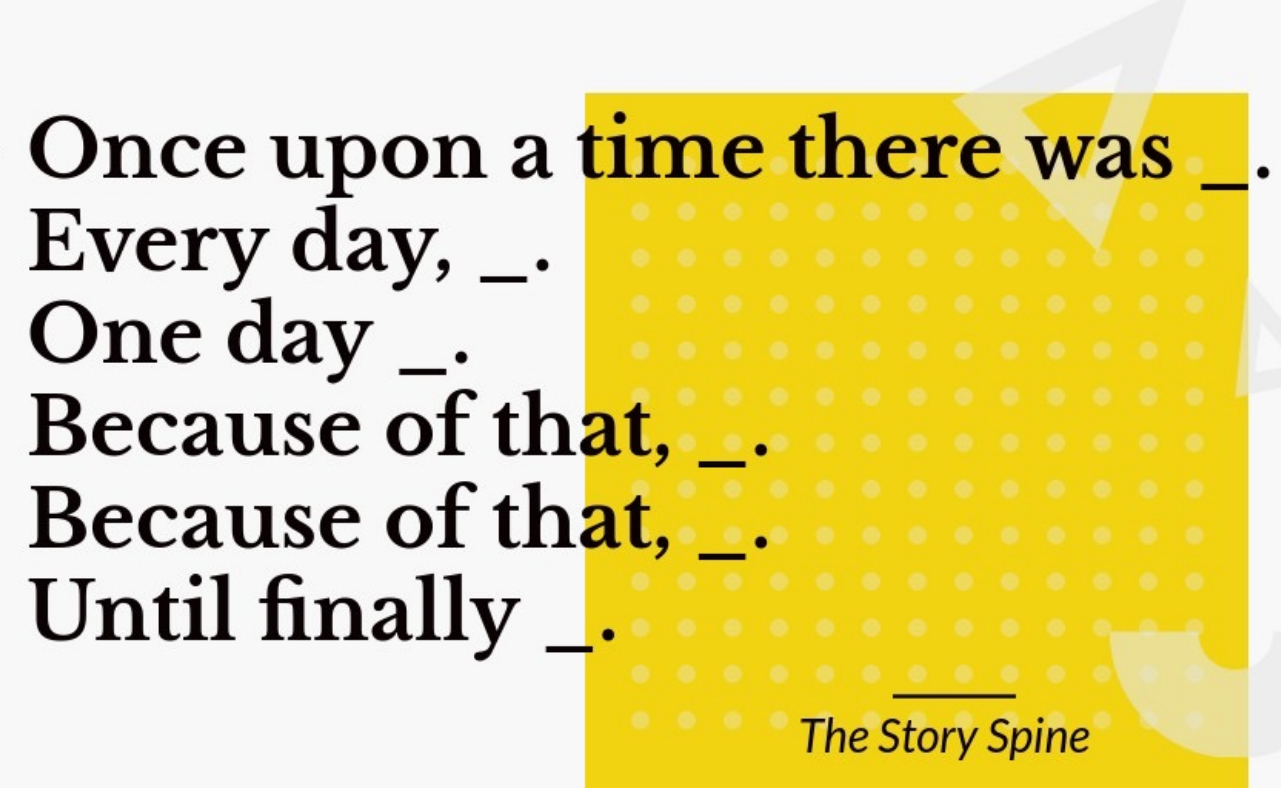
- **Played for Laughs:** the butler did it, but it took him three hundred and seventeen tries, all of which his master escaped without realizing anything was happening.
- **Played for Drama:** the butler did it, but is quite sympathetic, and the reasons he did it are gone into in great detail.
- **Played for Horror:** the butler killed the family he was working for in sadistic fashion, which he does to every master that doesn't live up to his unreasonably strict standards of how "proper" rich people should act.
- **Other Variations on a Trope:** the murderer isn't called a butler in the story, because the role as we know it doesn't exist in that place or time — but most of their responsibilities or their relationship to their employer-turned-victim are basically the same.
- **Lampshaded:** "So the butler did it! I always wanted to say that."
- **Invoked:** ex-butlers are employed as assassin trainers because of their experience as potential murderers.

[tvtropes.org]

PLAYING WITH TROPES: THE BUTLER DID IT

- **Exploited:** the detective purposely investigates the butler first, because the butler always does it in the mystery books he reads.
- **Discussed:** "Unlike what you may read in detective stories, the butler is an unlikely suspect in any murder investigation of this sort."
- **Untwisted:** the butler is shown early on as the suspect with the flimsiest alibi, like a typical red herring with a big secret, but after a series of twists and turns the detective reveals to everyone's surprise that he was the murderer after all.
- **Defied:** "We have to lock all the butlers up before they can kill!"
- **Conversed:** "These murder mysteries are too predictable. The butler always does it."
- **Unparodied:** there is an evil butler suit that brainwashes the wearer into committing murder. Someone dumb puts the suit on and, next thing he knows, he has committed 100 murders. He then ends up serving a longer-than-life sentence.

STORY SPINE: PIXAR



We can have various spines in a given work, one for each story.

Where does Dory come in?

The sharks?

Nemo's friends in the dentist's aquarium?

[https://blog.reedsy.com/guide/story-structure]

NARRATIVE STRUCTURES

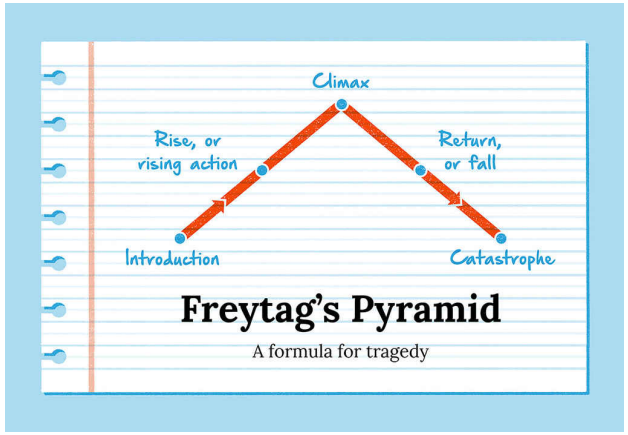
"Narrative structure is the **order** in which events are organized into a beginning, middle, and ending. A story's structure directly affects the way the plot **unfolds** and how its **driving forces** (characters, obstacles, setting, etc.) are introduced.

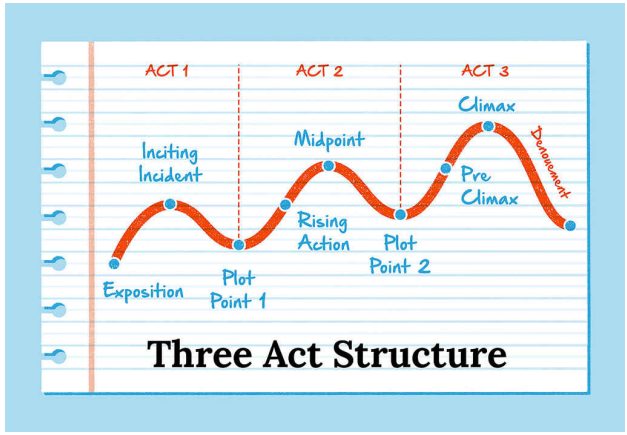
Tightly controlled narrative structure results in all questions being answered, provides a climax followed by resolution and information at the end of the story, furthers the characters' development, and unravels any central conflicts (**humans prefer those**).

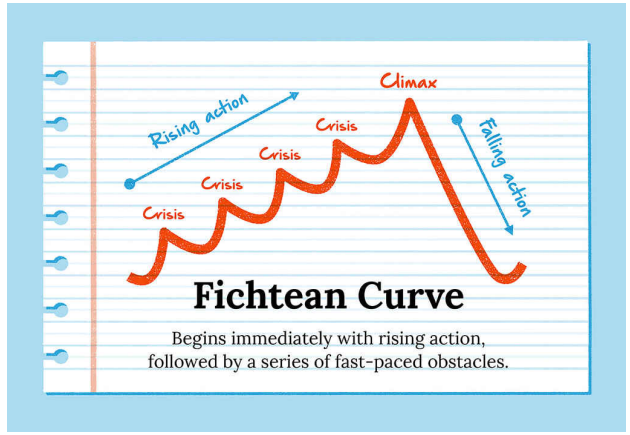
Structure helps creators draw connections between 'things that happen' and 'things that matter.' For instance, a tale about two vastly different people falling in love **can also** be about the value of compromise."

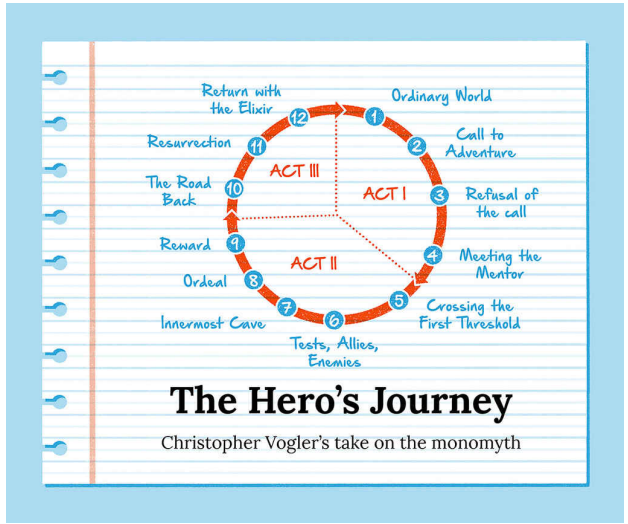
[https://blog.reedsy.com/guide/story-structure]

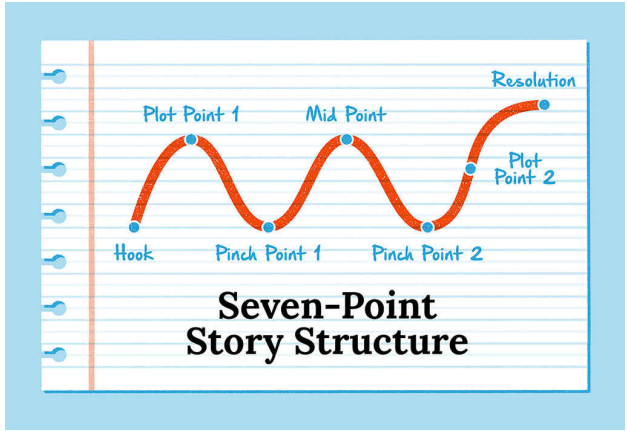
NARRATIVE STRUCTURES

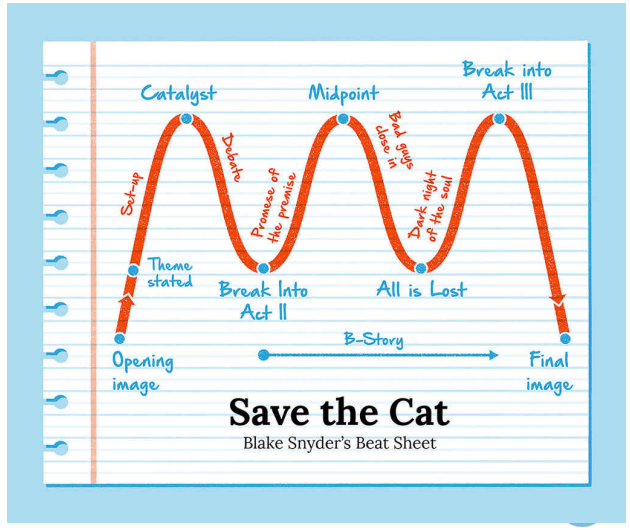












NARRATIVE STRUCTURE FOR DATA STORIES

In practice, these narrative structures might not easily apply to data stories.

The take-away here is that if a **chart element** (a “dot” in the narrative paths) can be removed without changing the nature of the data story, then the chart element was **not needed** in the first place and **should be removed**.

EXERCISES

1. Select a few stories of your liking (all genres, media, formats are on the table) and build the corresponding story spines.

2. Select a few stories of your liking (all genres, media, formats are on the table) and identify some of their storytelling tropes.

3. Select a few stories of your liking (all genres, media, formats are on the table) and build the corresponding storytelling molecules.

HOW TO TELL A STORY

PART I – STORIES AND STORYTELLING

MINING FOR CONTENT

Stories are born when storytellers decide to tell them (persuasion, entertainment, ...).

Where do **story ideas** come from?

- memories
- data and analysis
- anything else?

Think of moments when conscious **decisions** were made: what happened as a result? How is the story **impacting** you? Your organization? Your audience?

MINING FOR CONTENT

What **triggered** the story?

- internal act
- external factors

Think of moments when **things went wrong**:

- recovery
- lessons learned

Trauma, struggle, challenges, difficulties define the **story context**, not the story itself. Stories need to go beyond “a bad thing happened”.

STORY FOUNDATION

What is at **stake?** What do people/organizations/countries/NHL teams/etc. stand to lose or to gain as a result? Stakes tell audiences **why they should care**.

Is the story at-best an **anecdote**? Stories have messages and impact, anecdotes usually lack depth (but they can form the basis of a story).

What is the **arc** of the story? How are things **transformed** in the story? How must things be done **differently** after the transformation? Are the changes **permanent**?

What is the story ultimately about? Can it be **distilled down** to 1 or 2 sentences (**focus/clarity**)? Is it the only story that can be told for the events/memories/data?

STORY MATERIALS

Identify the **important information** needed to build the story arc

- create a bulleted list of **narrative stepping stones**
- some become scenes/chart elements, some summaries, some are discarded

What is the story **building up to**? How will it **resolve**?

What role (if any) should **hindsight** play in the story's telling?

STORY MATERIALS

Avoid **detail overload**

- misleading and/or irrelevant tidbits
- too many dates, colours, characters, shapes, etc.

When in doubt, return to distilled story & determine if the details support the story

Does your audience have the required **backstory** to understand the message? Does it need to be weaved into the story?

Does the story arc **land**? (tsarina of common sense)

BEGINNINGS AND ENDINGS

Chose the beginning and closing points of the story **carefully**.

Beginnings can be *in media res*, if necessary.

Endings that leave the audience wondering ‘what was that about?’ are **unsatisfying**.

Endings that come to a definite stop are **satisfying**.

No need to be coy: **make the message clear** and **don’t make the audience guess**.

SHARING THE STORY

First passes are long, convoluted, complicated, but **that's ok**!

Share the story with your tsarina of common sense, and decide if the story needs to be **restructured:**

- are there **redundancies** to remove?
- are there **too many details**, causing **confusion**?
- are there **too few details**, leading to **ambiguity**?
- is the message **clear**?
- are there **competing** (contradictory?) interpretations/insights to be drawn from the story?

COMMUNICATION

Communication involves our senses: **anything that conveys the message** is in play.

Does the communication mode have an impact on the type of story that can be told? On how they are built? On the messages that can be conveyed?

Stories can be communicated:

- **orally** (in person, conversation, play, radio, etc.)
- **with text** (newspaper, books, tweets, etc.)
- **visually** (graphic novels, infographics, posters, etc.)
- **with charts** (dashboards, visualizations, etc.)
- **in combination** (movies, memes, etc.)

HOW TO TELL A STORY

How we tell a story depends on:

- the **subject matter**
- the **audience** (how much they know, how they are likely to receive the message, etc.)
- the **teller** (personality, preferences, etc.)
- format **constraints** (number of characters, number of pages, allotted time, etc.)

We use levity, seriousness, humour, terseness, flowery language, exaggerations, dramatic pauses, soundtracks, technologies, n –steps plans, charts, dashboards, etc.

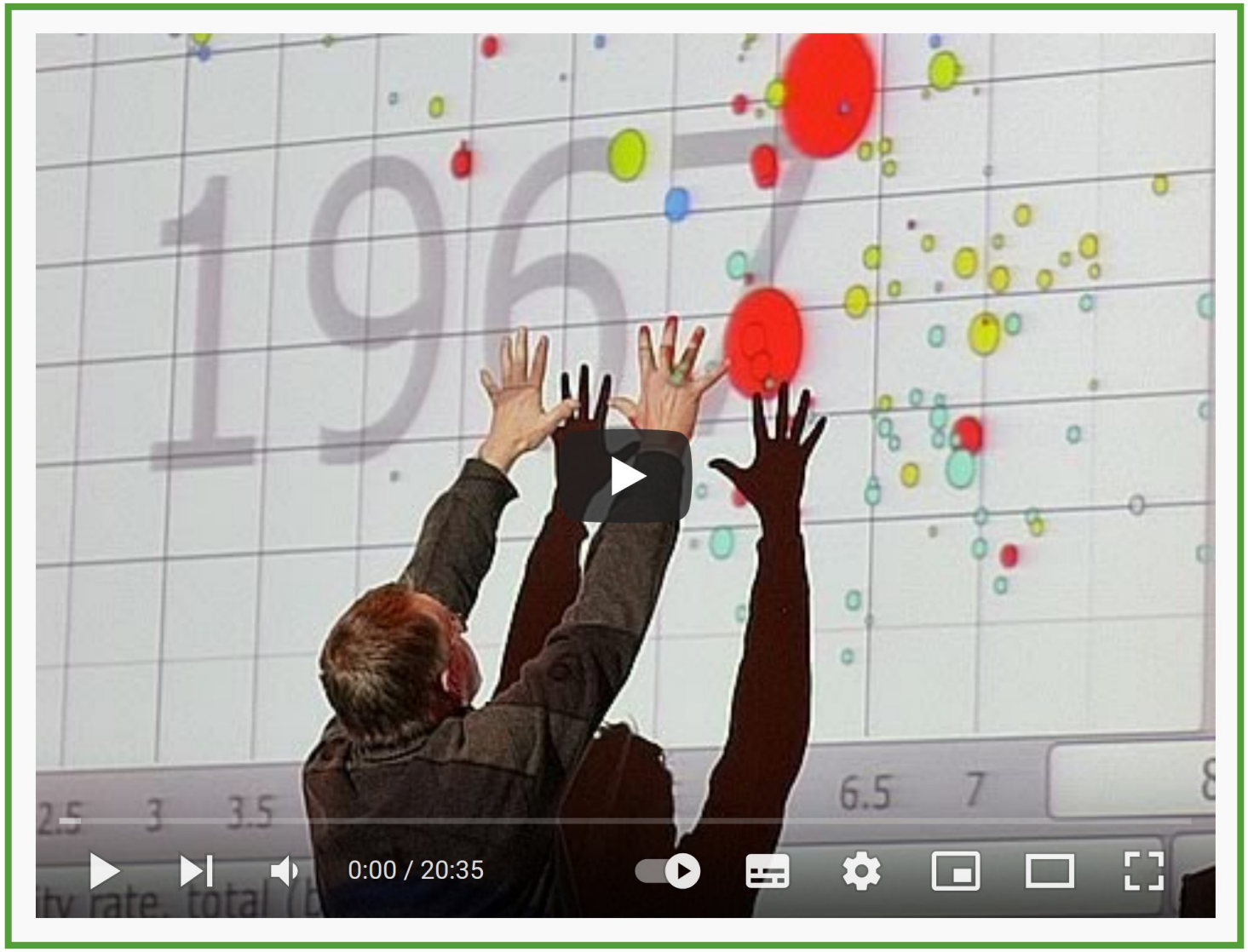
HOW TO TELL A STORY

Some **storytelling formats** have themselves become stories:

- infographics
- tweets and other social media products
- memes
- TED Talks
- The Moth
- news report
- rap battles
- etc.

[Robinah Babirye, This Is Just The Beginning, The Moth]

[Hans Rosling, The Best Stats You've Ever Seen, TED Talk]

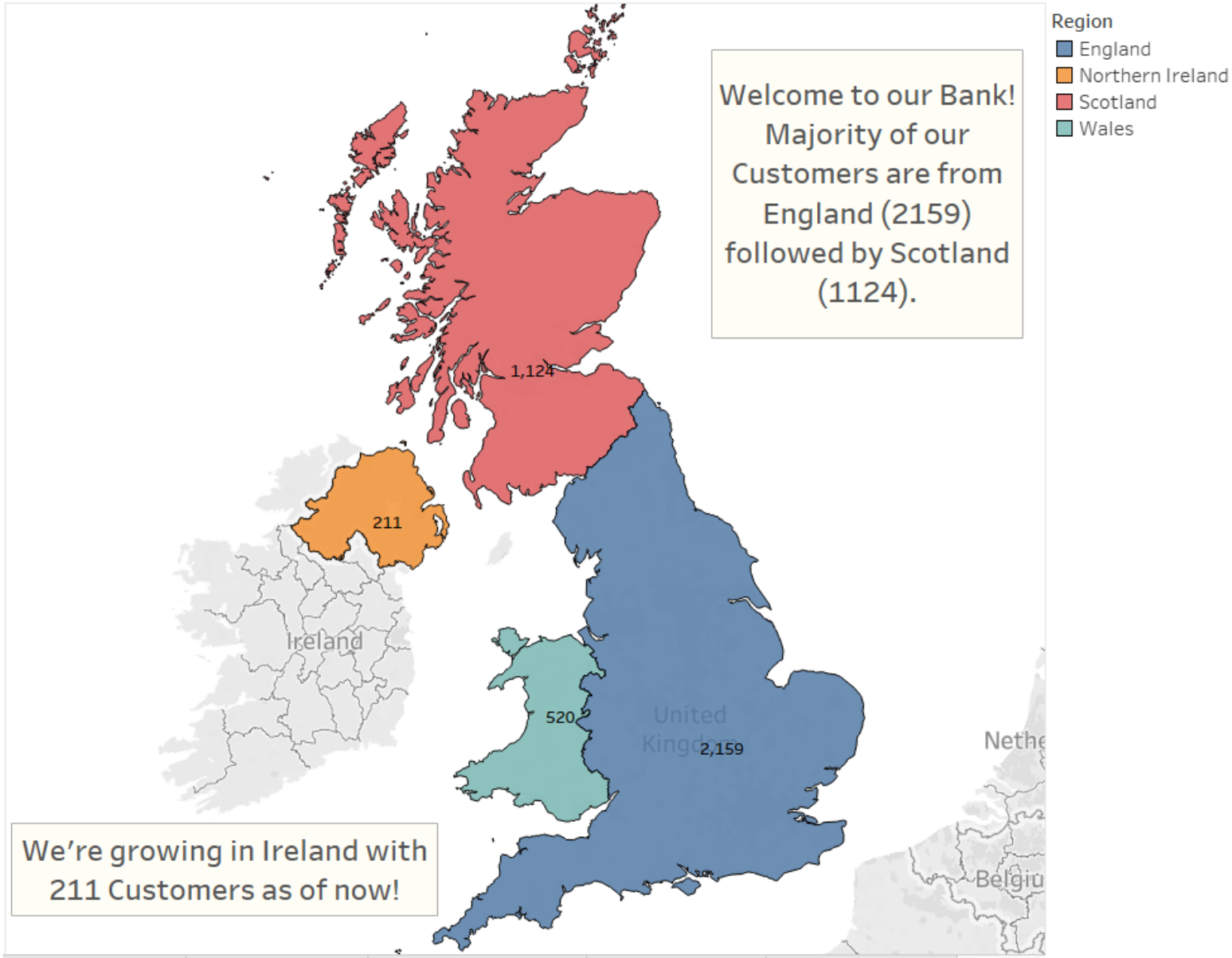


Bank Story

[Y. Gupta]

Welcome to our Bank, we serve the following number of customers in all of UK!

We also have customers in Wales (520) who are gene 30 to 40 years.



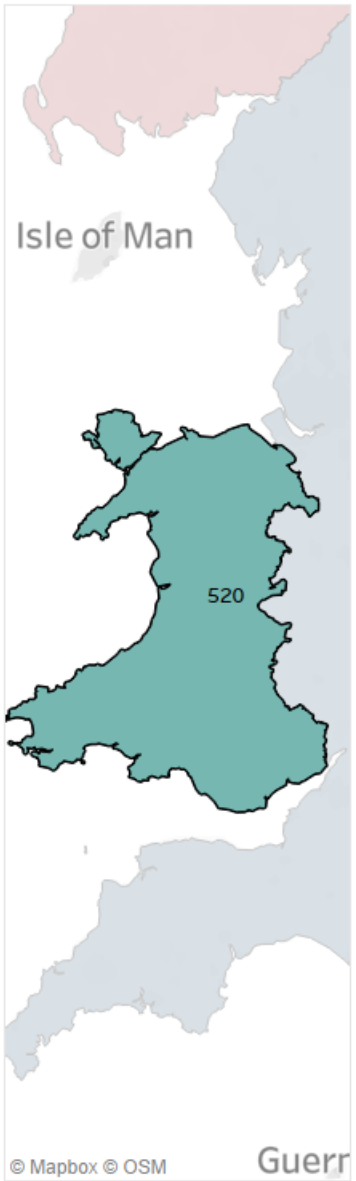
Bank Story

[Y. Gupta]

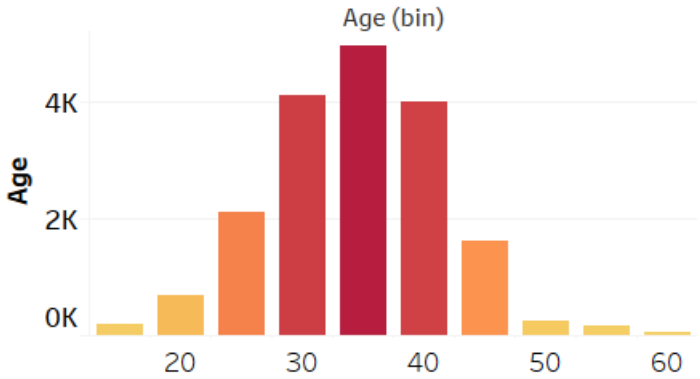
the following number of customers in all of

We also have customers in Wales (520) who are generally in the age group of 30 to 40 years.

We al
30 to



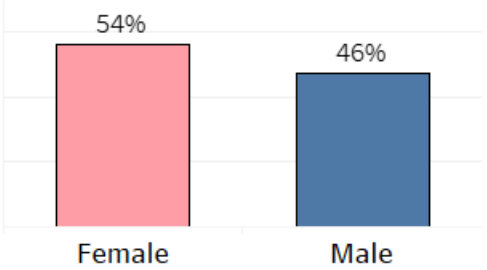
Age Classification



Age
5

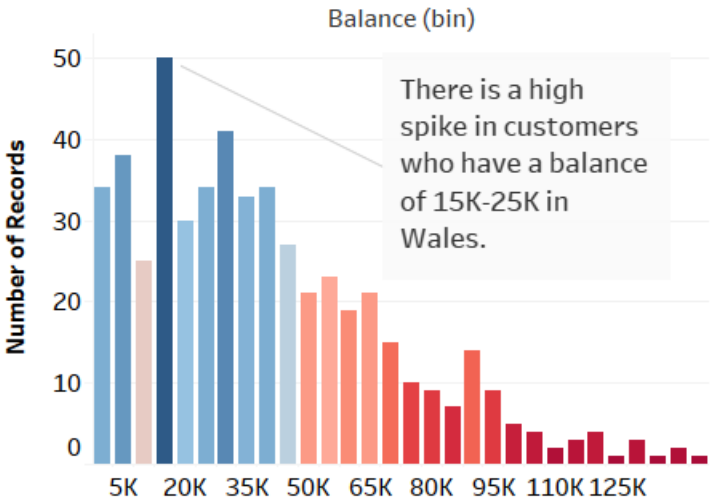
Balance
5,000

Gender

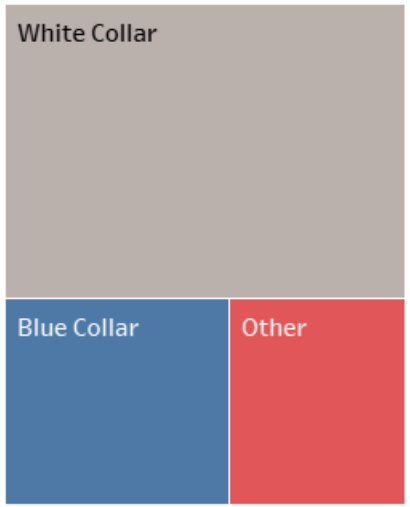


The balance of accounts situated in Wales are unevenly distributed.

Balance Classification



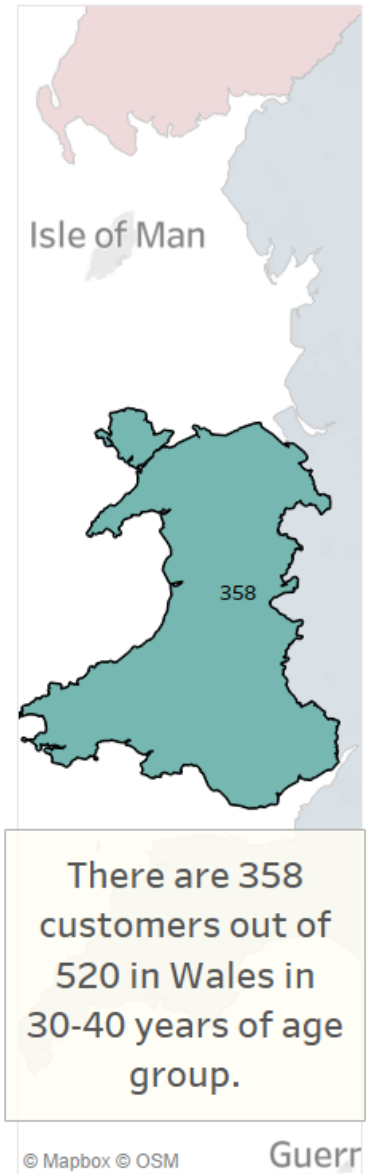
There is a high spike in customers who have a balance of 15K-25K in Wales.



Bank Story

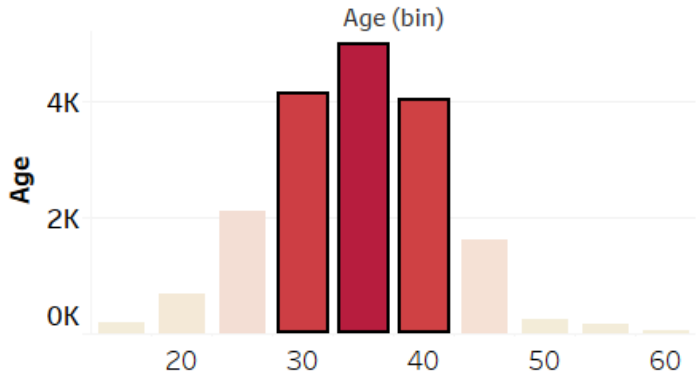
[Y. Gupta]

s (520) who are generally in the age group of | We also have customers in Wales (520) who are generally in the age group of 30 to 40 years. | Upon



There are 358 customers out of 520 in Wales in 30-40 years of age group.

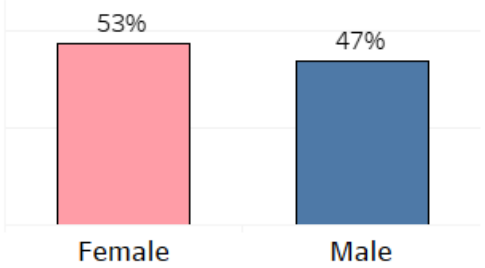
Age Classification



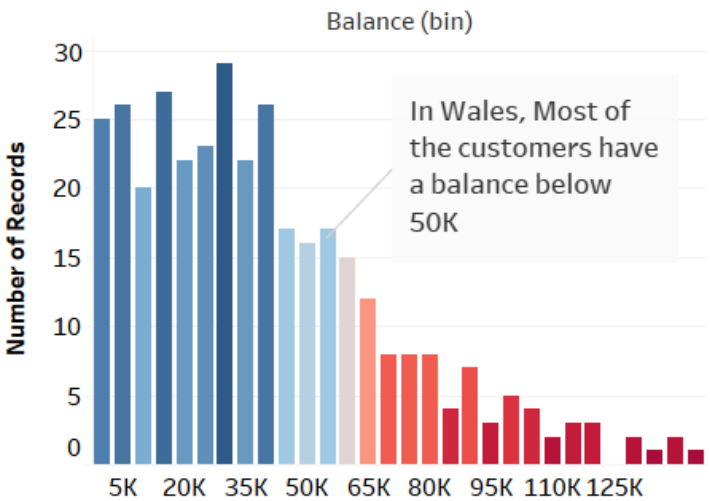
Age
5

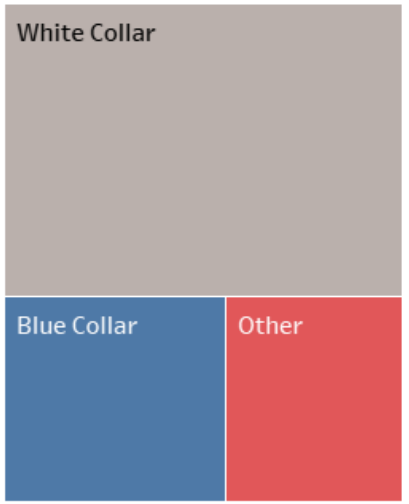
Balance
5,000

Gender



Balance Classification



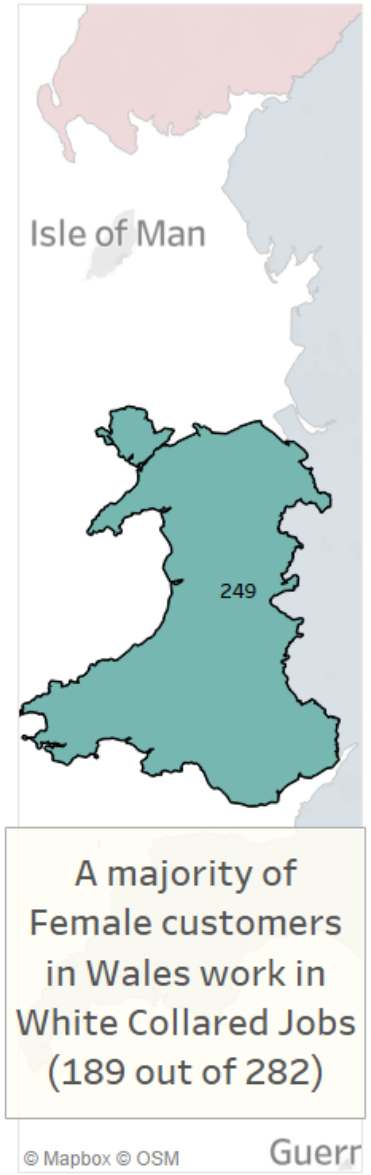


Bank Story

[Y. Gupta]

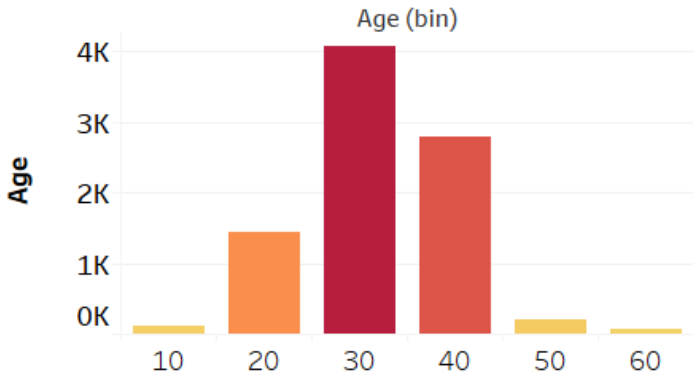
in Wales (520) who are generally in the age group of

Upon examining further the Female Customers in Wales



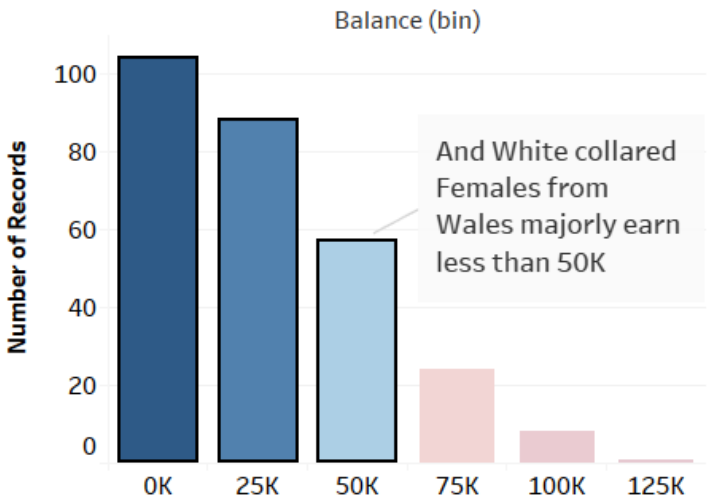
A majority of Female customers in Wales work in White Collared Jobs (189 out of 282)

Age Classification

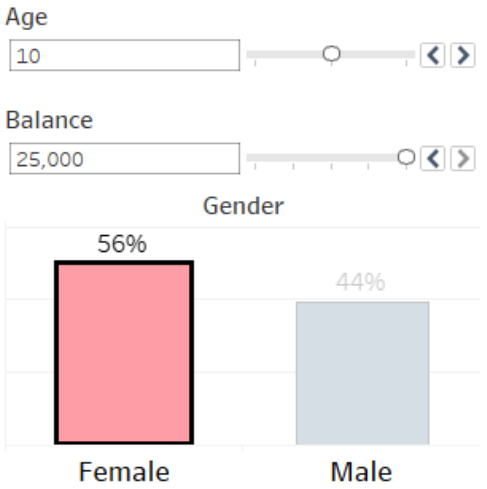


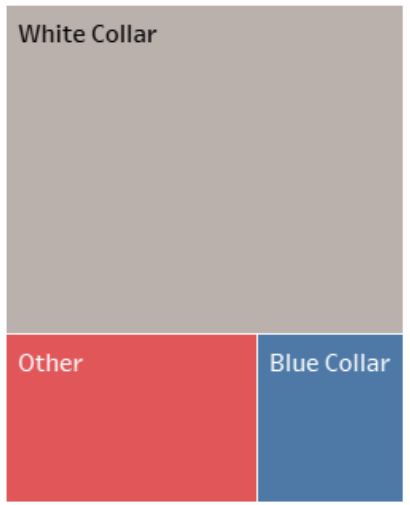
A significantly low number of Females from Wales earn more than 75K i.e. 33

Balance Classification



And White collared Females from Wales majorly earn less than 50K





a picture of my kids getting ready to leave the house.

closetoclassy.com

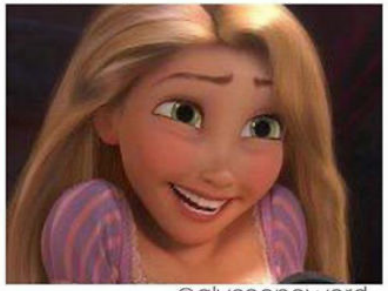
WHERE IS YOUR OTHER SHOE?

- EVERY PARENT EVER

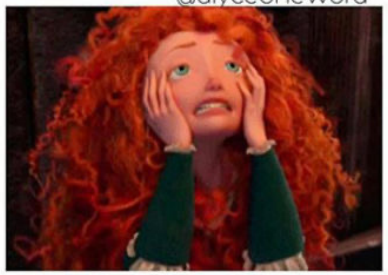
Parent: Please try not to get any water outside the tub.

Kid:

The **FIRST** time you hear "Mom!"



@alyceoneword



The **7,567TH** time.

kid: please don't embarrass me.

parent:

@alyceoneword

SocialFeed

The Most Frustrating Thing About Parenting

Not. One. Match

HOW TO TELL A STORY

Even to the point of parody...

[Thought Leader, This and That, CBC Radio]

HOW NOT TO TELL A STORY

We suggest **avoiding** certain tropes:

- audience-alienating premise
- author filibuster/tract
- emphasize EVERYTHING!!!
- redundant tautology
- viewers are geniuses

But in truth, what matters is **getting the message across**. Everything that helps in that endeavour is allowable, everything that hinders that goal is not recommended (get an outsider's perspective!).

EXERCISES

How would you fix the following stories, using the concepts presented in this section?

1. One day I woke up. I went outside and there was weather. I came back inside and did things.

2. Once upon a time there was a hero. She left on an adventure and fought a giant dragon. Then she fought another giant dragon. Then she fought another giant dragon. Then she fought another dragon. Then she went home, victorious.

3. The rain was bucketing down in immense impenetrable sheets of torrential freezing water. “Oh woe is me!”, the brave but sobbing child screamed. How shall I ever manage to dash as quickly as humanly possible into the terrible wreck of an ancient schoobus without completely mangling my magnificent hair. Indeed, the desolate child failed. She was the laughingstock of all of the pompous fools on the school bus.

EXERCISES

4. Start by taking a few moments to think of a very short story you can tell (context, events, outcome).
    a. Pair up: one of you will be the storyteller, the other person is the audience.
    b. Pair up again: the storytellers should become the audience for someone who was an audience of another group in part a.
    c. Pair up a third time and repeat parts a. and b., with different teammates if possible.
    d. How did the story change the second time you told it? What made you change it?

STORIES AND ILLUSTRATIONS

PART I – STORIES AND STORYTELLING

[S. McCloud, *Making Comics*]

VISUAL STORYTELLING

Visual storytelling requires us to make a constant stream of choices regarding imagery, pacing, dialogue, composition, gesture, and a ton of other options. These choices break down into 5 basic types: choice of **moment**, choice of **frame**, choice of **image**, choice of **word**, choice of **flow**. These are the 5 areas where your choices can make the difference between clear, convincing storytelling and a confusing mess. [McCloud]

[based on an idea from S. McCloud, *Making Comics*]

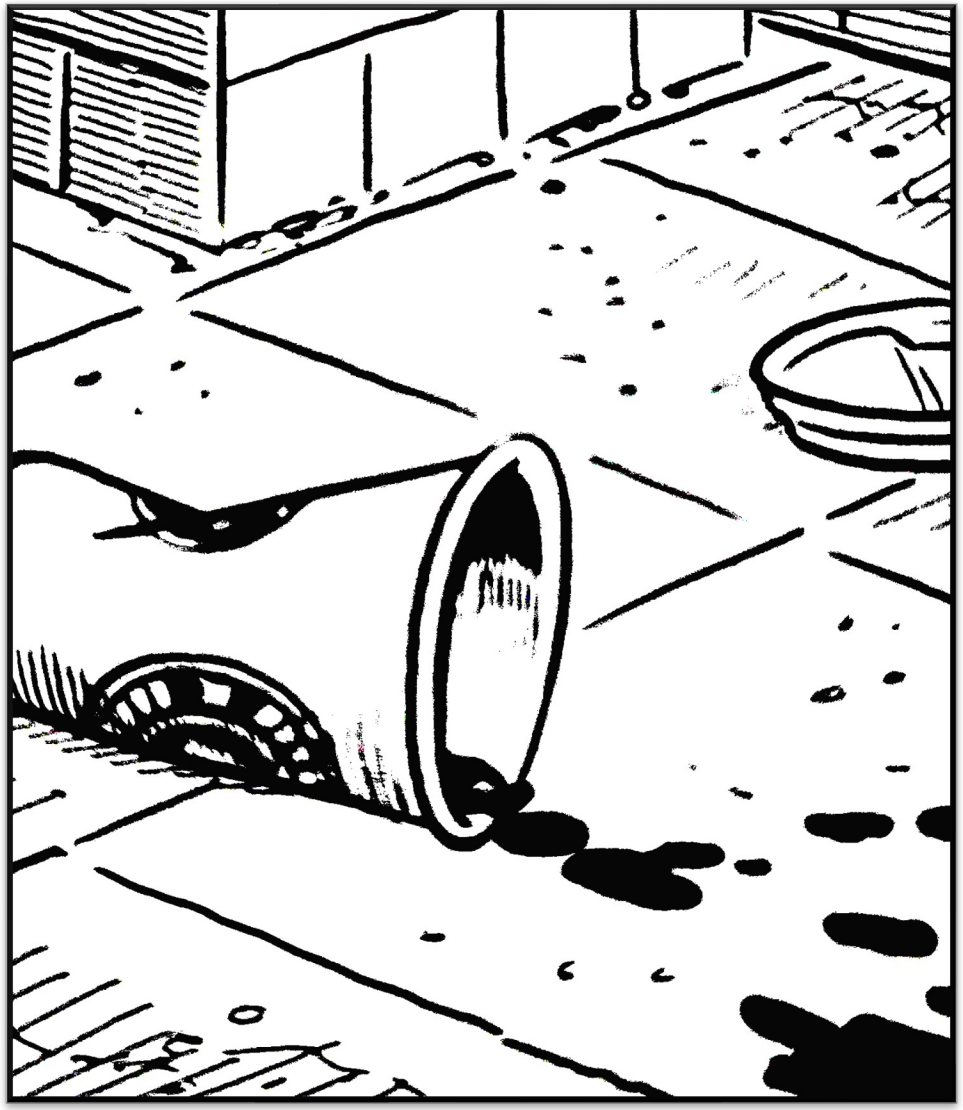
WORDS AND IMAGES

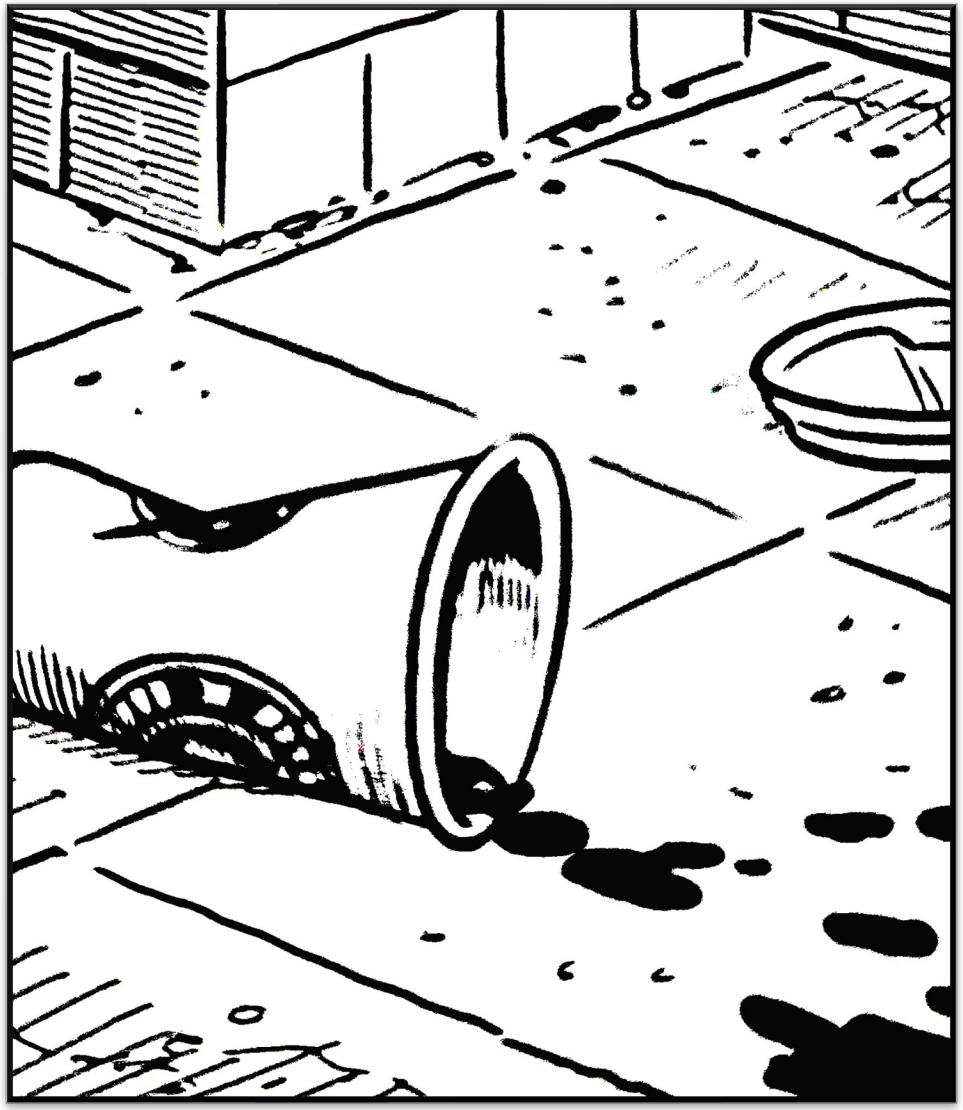
A picture is worth a thousand words (compare with: a picture is worth 1000 words).

Words bring an unparalleled level of **specificity**. There is no image so vague that words cannot lock it into a **desired meaning**.

Some specific concepts and names can only be **clearly** expressed through words.

[S. McCloud, *Making Comics*]





"On the bright side, I got my caffeine. On the not-so-bright side, we got mugged on the way home."

[S. McCloud, *Making Comics*]

[S. McCloud, *Making Comics*]

"It's Kelly Donovan, twin brother of the Xander actor on *Buffy the Vampire Slayer*, plus Humphrey Bogart wearing a Freddy Mercury mask, and a robot duplicate of former U.N. Secretary General Boutros Boutros-Ghali!"

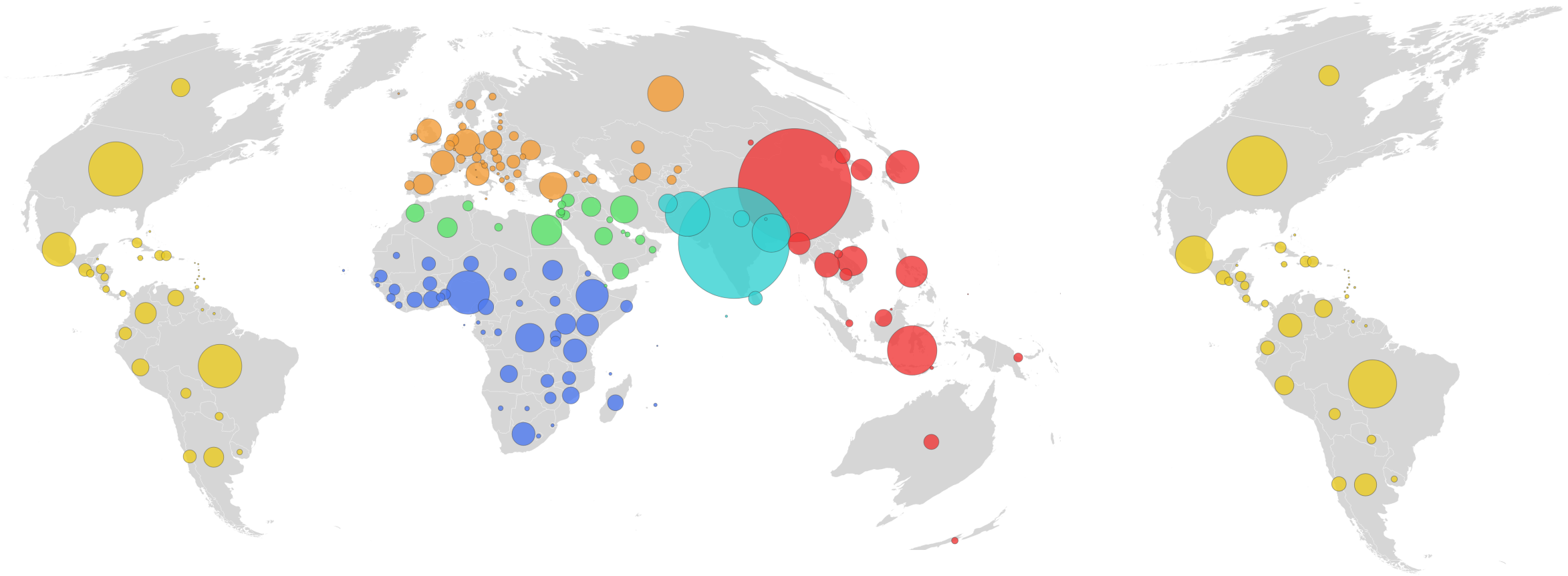
[based on an idea from S. McCloud, *Making Comics*]

VISUAL STORYTELLING CHOICES (PRE-GESTALT PRINCIPLES)

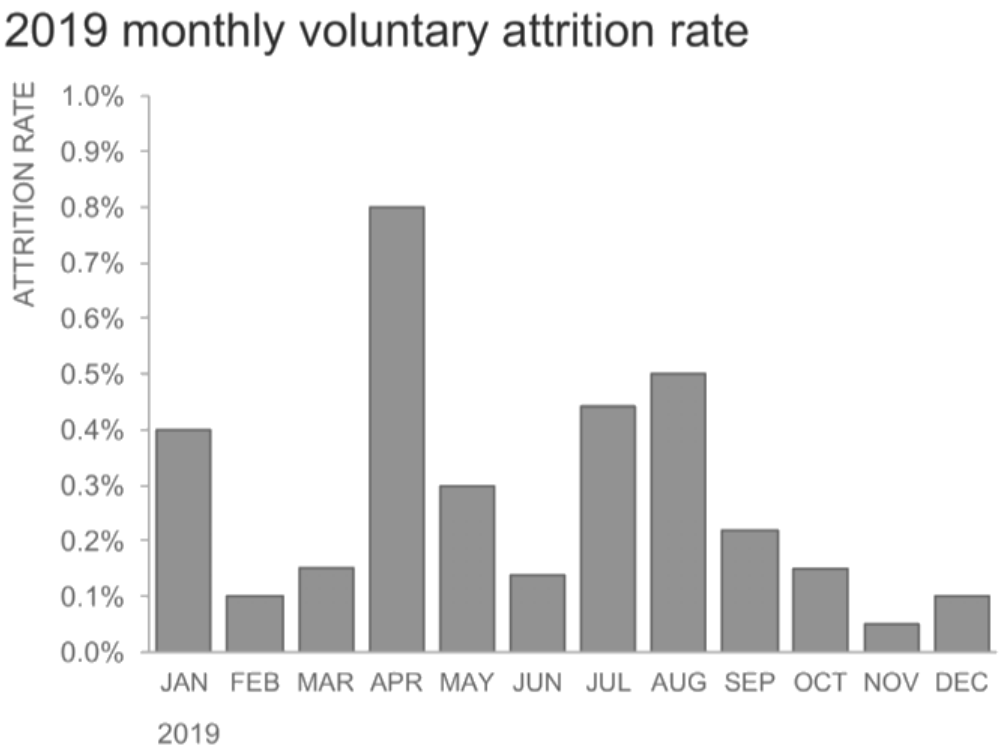
Communicating with **clarity** means that audience comprehension the **ultimate goal:**

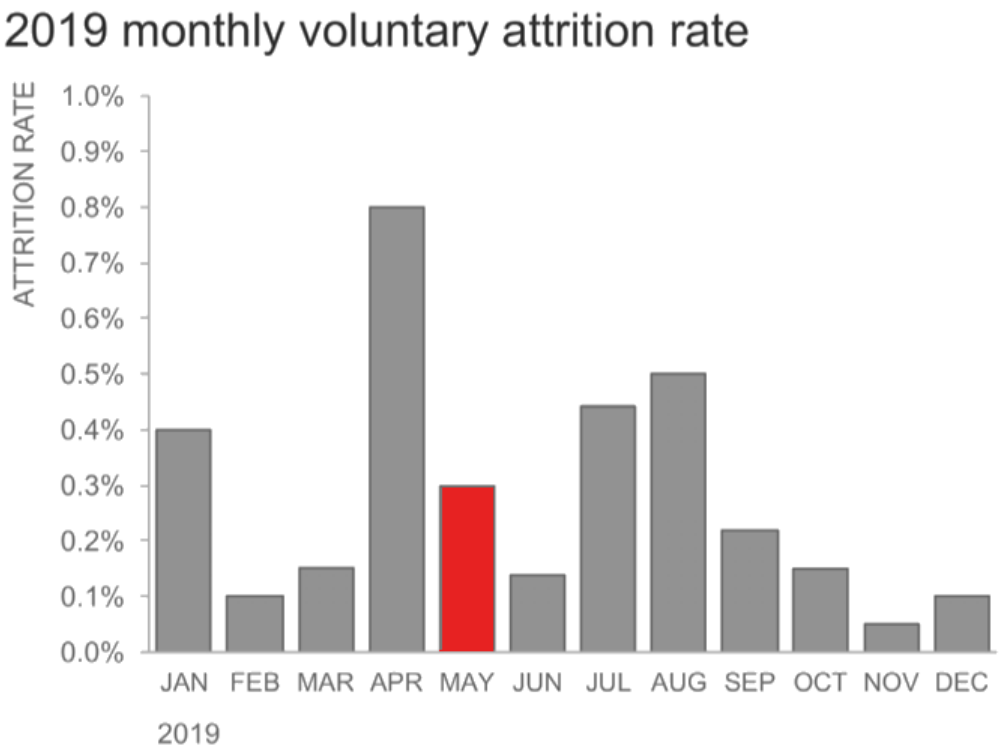
- choice of **moment** is 'connecting the dots', showing only what matters to the story;
- choice of **frame** is creating and directing the audience's focus;
- choice of **image** is selecting the right charts for the story, with emphasis on simplicity and ability to convey the message;
- choice of **word** is clearly and persuasively communicating ideas in seamless combination with the charts;
- choice of **flow** is guiding the audience from one chart to the next, from one page to the next, and creating a transparent and intuitive 'reading' experience, by arranging pages in a dashboard, charts on a page, and elements within charts intelligently.

CHOICE OF MOMENT

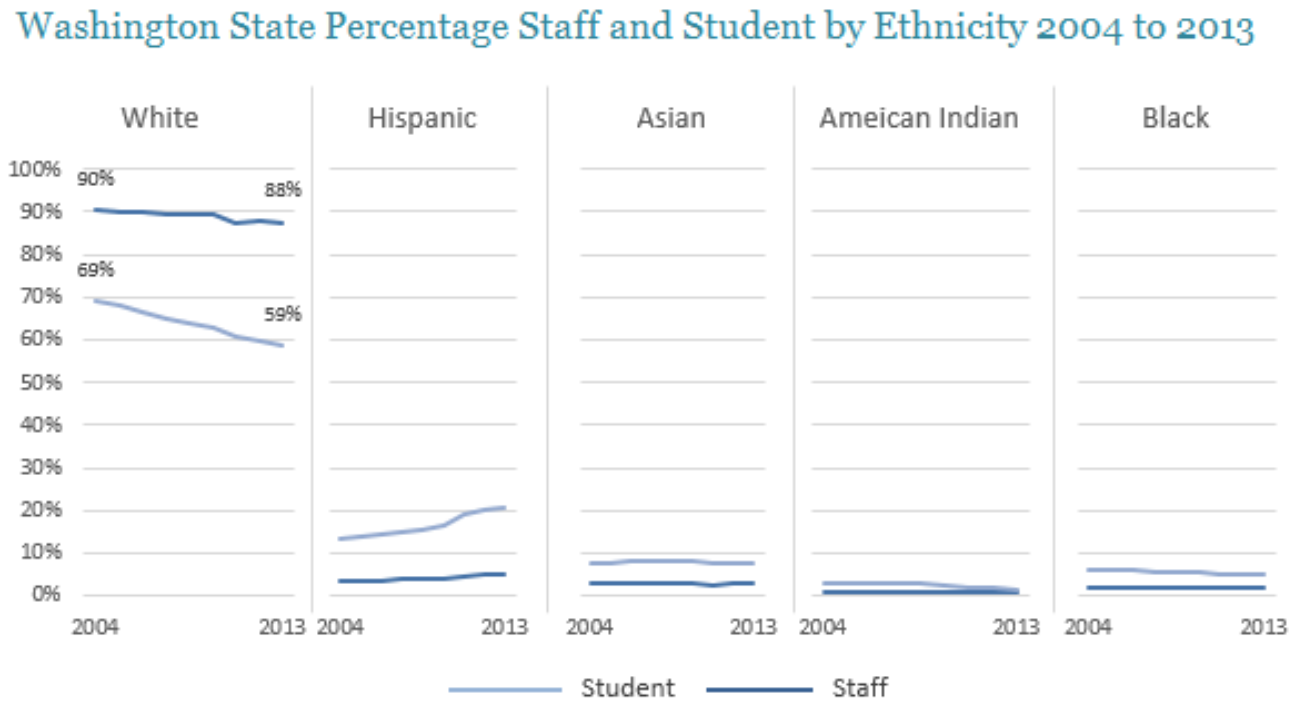


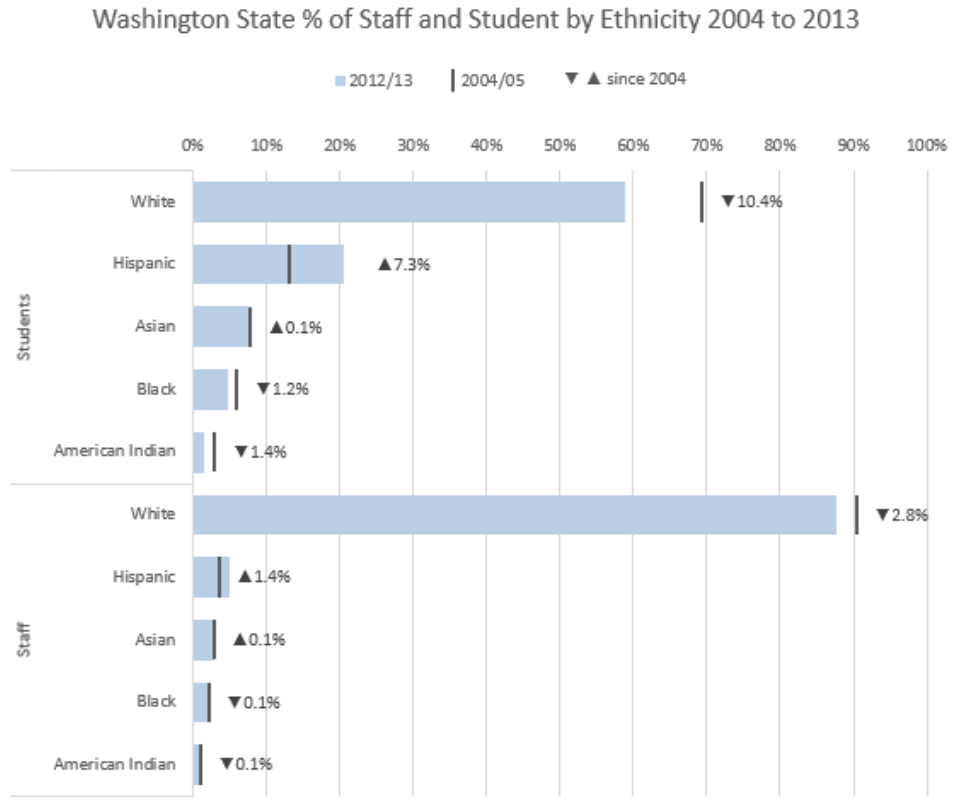
CHOICE OF FRAME



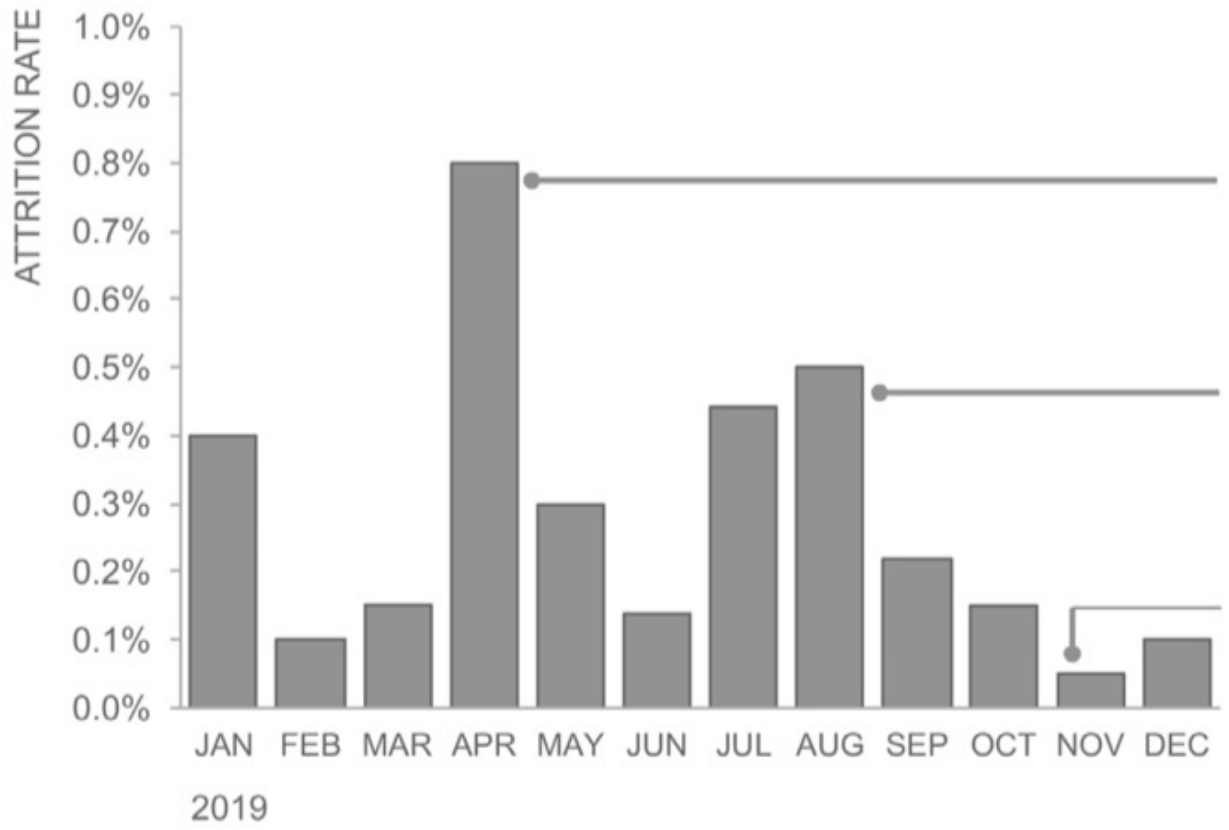


CHOICE OF IMAGE





CHOICE OF WORD



Highlights:

In April there was a reorganization. No jobs were eliminated, but many people chose to leave.

Attrition rates tend to be higher in the Summer months when it is common for associates to leave to go back to school.

Attrition is typically low in November & December due to the holidays.

[based on an idea from S. McCloud, *Making Comics*]

VISUAL STORYTELLING CHOICES

Decisions having to do with *moment*, *frame*, and *flow* are likely to be made in the dashboard **planning stages**, while *image* and *word* decisions are usually being made right **up to the finish line**.

We can:

- start with a rough sketch of the dashboard (moment, frame, flow), then come up with the narrative (word), then populate the dashboard with charts (image);
- start with a full 'script'/storyboard (moment, word), then use that to do a rough layout of the dashboard (frame, flow), then populate the dashboard with charts (image);
- create a finished chart (moment, frame, image, word) with no idea as to what else will show up on the dashboard until you create another chart (flow), and so on (not recommended)!

[based on an idea from S. McCloud, *Making Comics*]

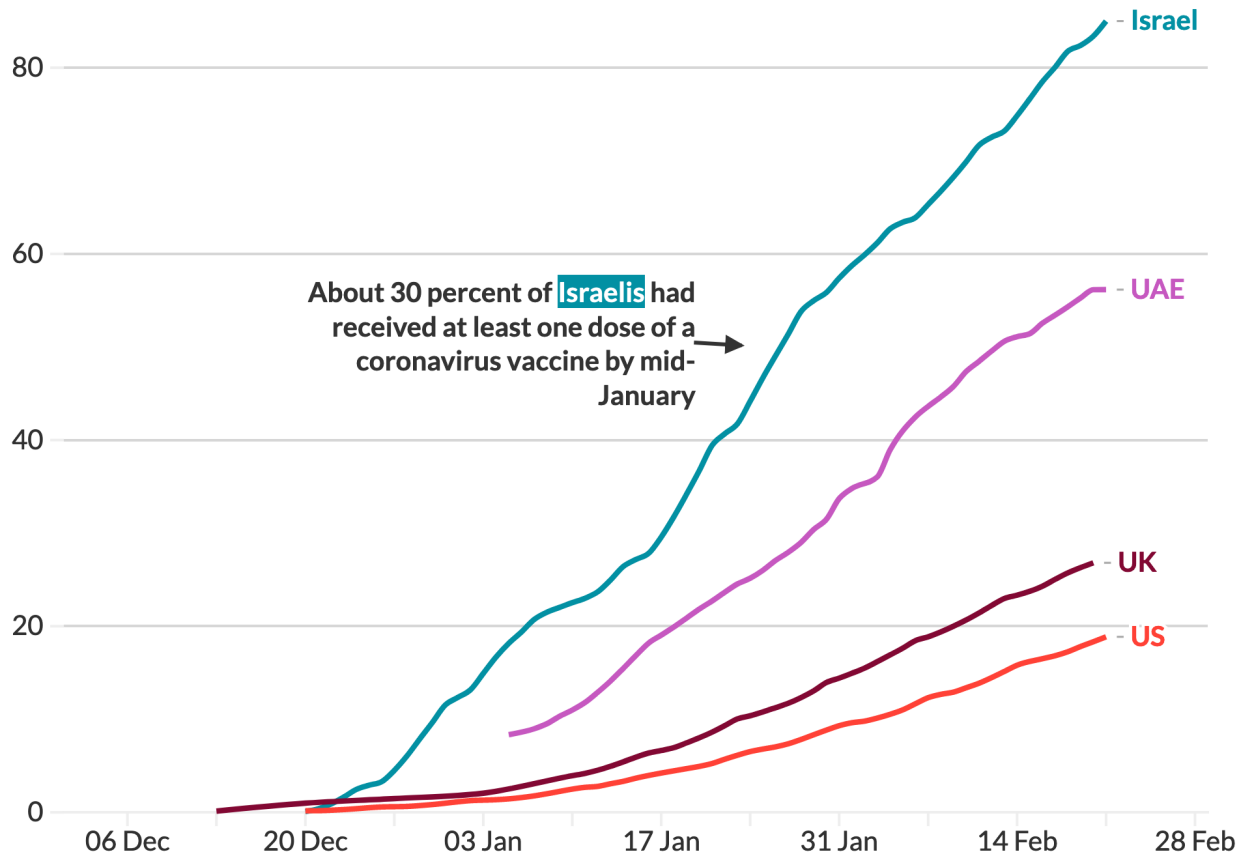
VISUAL STORYTELLING COMBINATIONS

- **text-specific**, where text provides all that is needed to know and the charts illustrate some aspects of the story that is described
- **chart-specific**, where the charts provide all that is needed to know and the text accentuates some aspects of the story that is shown
- **duo-specific**, where text and charts are both telling roughly the same story
- **intersecting**, where text and charts work together in some respects but also contribute to the story independently
- **interdependent**, where text and charts combine to convey an aspect of the story that neither could convey alone
- **parallel**, where words and charts follow seemingly different storylines, without intersecting

[https://flourish.studio/blog/accessible-chart-design]

Cumulative vaccination doses administered in Israel, UAE, UK and US

Cumulative doses administered per 100 residents • Data last updated 24 Feb



Source: ECDC/OWID • Graphic: Flourish • Embed this

[P. Tickell, The Story of the Impossible Train]

I have a story I'd like to tell you. It's about a train, and a group of people who live on that train and know of nothing else.

This train has been moving since anyone can remember. The people on the train can't imagine a time when the train wasn't moving, and when they were not on the train. Everyone works to keep the train moving. The train never stops.

It never stops. It cannot stop.

People on the train live in constant churn. The work to keep the train moving is hard, and inhumane. On the train, people are treated with cruelty and oppression. Some are treated worse than others. But nobody is truly living.

Sometimes they get breaks, but it is hard.

One day, a fire breaks out in one of the carriages of the train.

There is panic. The fire spreads throughout the whole train… Without getting off the train everyone is going to die.

Then the impossible happens.

The brakes no-one believed existed start to work. In the emergency, no-one notices how extraordinary it is that the train is stopping. They're too focused on the fire. The old rules go out the window.

For years on the train, the "worker class" of people have been dying from the awful conditions of the work they have to do on the train. They sleep in the aisles and sometimes have nowhere to sleep at all.

Suddenly, there are orders to house them and treat their ailments.

The train stops, and people begin to get off. Apart from the sound of the fire, suddenly there is a great silence.

A HISTORY OF THE ATOM: THEORIES AND MODELS

How have our ideas about atoms changed over the years? This graphic looks at atomic models and how they developed.

SOLID SPHERE MODEL

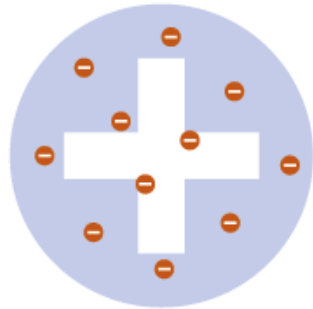
JOHN DALTON

1803

Dalton drew upon the Ancient Greek idea of atoms (the word 'atom' comes from the Greek '*atomos*' meaning indivisible). His theory stated that atoms are indivisible, those of a given element are identical, and compounds are combinations of different types of atoms.

- ⊕ RECOGNISED ATOMS OF A PARTICULAR ELEMENT DIFFER FROM OTHER ELEMENTS
- ⊖ ATOMS AREN'T INDIVISIBLE - THEY'RE COMPOSED FROM SUBATOMIC PARTICLES

PLUM PUDDING MODEL



J.J. THOMSON

1904

Thomson discovered electrons (which he called 'corpuscles') in atoms in 1897, for which he won a Nobel Prize. He subsequently produced the 'plum pudding' model of the atom. It shows the atom as composed of electrons scattered throughout a spherical cloud of positive charge.

- ⊕ RECOGNISED ELECTRONS AS COMPONENTS OF ATOMS
- ⊖ NO NUCLEUS; DIDN'T EXPLAIN LATER EXPERIMENTAL OBSERVATIONS

NUCLEAR MODEL

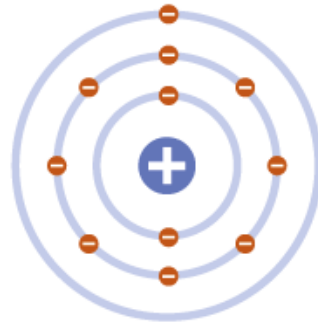
ERNEST RUTHERFORD

1911

Rutherford fired positively charged alpha particles at a thin sheet of gold foil. Most passed through with little deflection, but some deflected at large angles. This was only possible if the atom was mostly empty space, with the positive charge concentrated in the centre: the nucleus.

- ⊕ REALISED POSITIVE CHARGE WAS LOCALISED IN THE NUCLEUS OF AN ATOM
- ⊖ DID NOT EXPLAIN WHY ELECTRONS REMAIN IN ORBIT AROUND THE NUCLEUS

PLANETARY MODEL



NIELS BOHR

1913

Bohr modified Rutherford's model of the atom by stating that electrons moved around the nucleus in orbits of fixed sizes and energies. Electron energy in this model was quantised; electrons could not occupy values of energy between the fixed energy levels.

- ⊕ PROPOSED STABLE ELECTRON ORBITS; EXPLAINED THE EMISSION SPECTRA OF SOME ELEMENTS
- ⊖ MOVING ELECTRONS SHOULD EMIT ENERGY AND COLLAPSE INTO THE NUCLEUS; MODEL DID NOT WORK WELL FOR HEAVIER ATOMS

QUANTUM MODEL

ERWIN SCHRÖDINGER

1926

Schrödinger stated that electrons do not move in set paths around the nucleus, but in waves. It is impossible to know the exact location of the electrons; instead, we have 'clouds of probability' called orbitals, in which we are more likely to find an electron.

- ⊕ SHOWS ELECTRONS DON'T MOVE AROUND THE NUCLEUS IN ORBITS, BUT IN CLOUDS WHERE THEIR POSITION IS UNCERTAIN
- ⊕ STILL WIDELY ACCEPTED AS THE MOST ACCURATE MODEL OF THE ATOM

EXERCISES

1. **Think of a work story. Create a sketch that could illustrate this work story. What visual storytelling choices and combinations would you consider using?** Would accessibility considerations change the way in which the story is presented to the audience?

2. Re-cast the stories presented in this presentation (or other stories, as required) using different visual storytelling choices and combinations.

3. Re-cast the data stories presented in this presentation (or other data stories, as required) using different visual storytelling choices and combinations.

A WORD ABOUT ACCESSIBILITY

A table can be translated to Braille, but that's not always possible for charts.

Describing the features and emerging structures in a visualization is a possible solution... **if they can be spotted.**

Analysts must produce clear and meaningful visualizations, but they must also describe them and their features in a fashion that allows all to "see" the insights.

This requires them to have "seen" all the insights, which is not always necessarily the case (if at all possible).

A WORD ABOUT ACCESSIBILITY

Data Perception:

- texture-based representations
- text-to-speech
- sound/music
- odor-based or taste-based representations (?!?)

Sonifications:

- TRAPPIST Sounds : TRAPPIST-1 Planetary System Translated Directly Into Music
- Listening to data from the Large Hadron Collider, L. Asquith

A WORD ABOUT ACCESSIBILITY

Frank ↯ @FrankElavsky · 1h

Resources we could use more of (1/?):
Low vision (~30% of all people):
- High contrast text
- High contrast elements
- Using texture, shape, units
- Designing with zoom/magnification
- Using Hierarchy and Focus
- Using annotations or guides

1 7 42

A WORD ABOUT ACCESSIBILITY

Frank @FrankElavsky · 1h

Resources we could use more of (2/?):
Functional/motor impairment (~13% of all people in US):
- Keyboard interactivity/navigation
- UI alternatives to in-chart controls (brushing, subselecting, etc)
- Alternative data navigation schemes
- Scrollytelling alternates

1 5 30

A WORD ABOUT ACCESSIBILITY

Frank ↯ @FrankElavsky · 1h

Resources we could use more of (3/?):
Cognitive disability (~11% of all people in US):
- Captions, summaries, clear titles, and plain text alternatives
- Reducing visual complexity
- Forgivable user interactions
- Use of hierarchy
- Assistive design (how-to-read guides, help)

1 6 31

A WORD ABOUT ACCESSIBILITY

Frank ⇝ @FrankElavsky · 1h

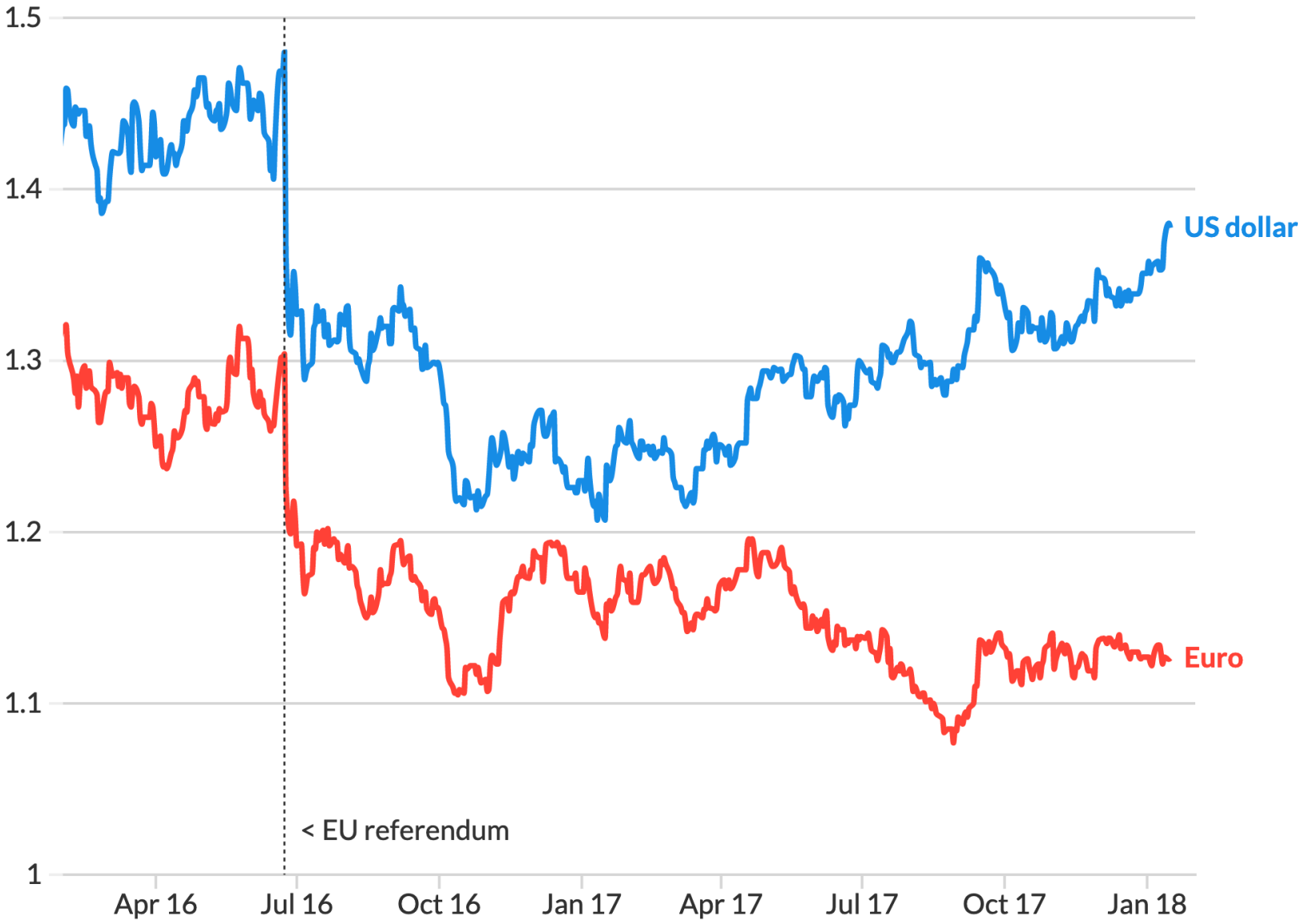
Resources we could use more of (4/?):
Attention deficit/hyperactive disorder (~9% of all people in US):
- Clear, short text summaries
- Object constancy
- Motion design and animation
- Use of breadcrumbs
- Interaction history (with undo/redo functions)

2 4 21

[https://flourish.studio/blog/accessible-chart-design]

The value of the pound has fallen, particularly since the EU referendum

Euros and US $ per £



A line chart showing the value of the pound in relation to euros and US dollars. A large drop is visible after the EU referendum in June 2016. Just before the referendum you could get 1.48 US dollars and 1.3 euros for each pound. After the referendum it fell to 1.29 US dollars and 1.16 euros – a fall of around 12%.

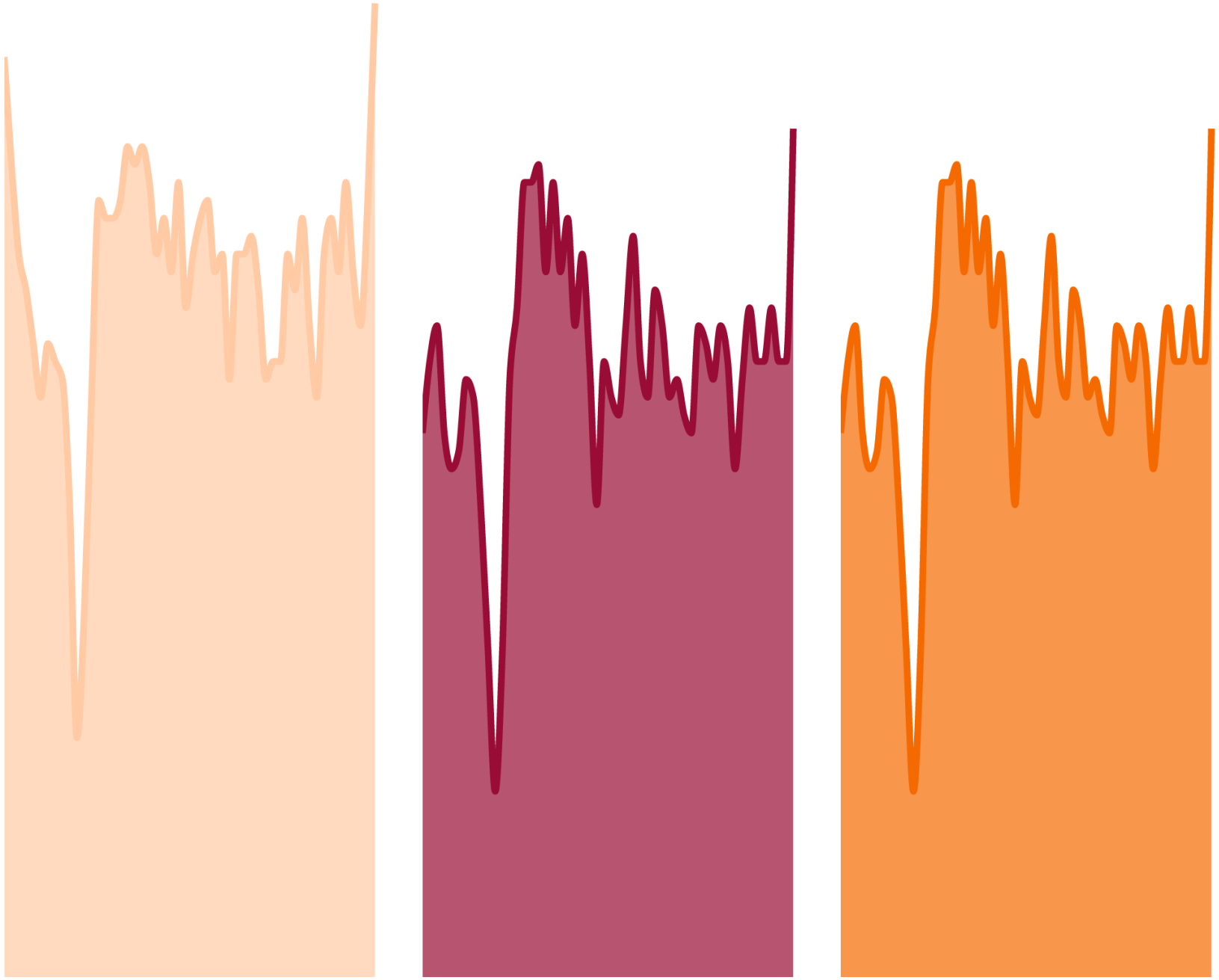
Source: Bank of England

Fail (1.46:1)

Pass (8.52:1)

Partial pass (3.02:1)

[https://flourish.studio/blog/accessible-chart-design]



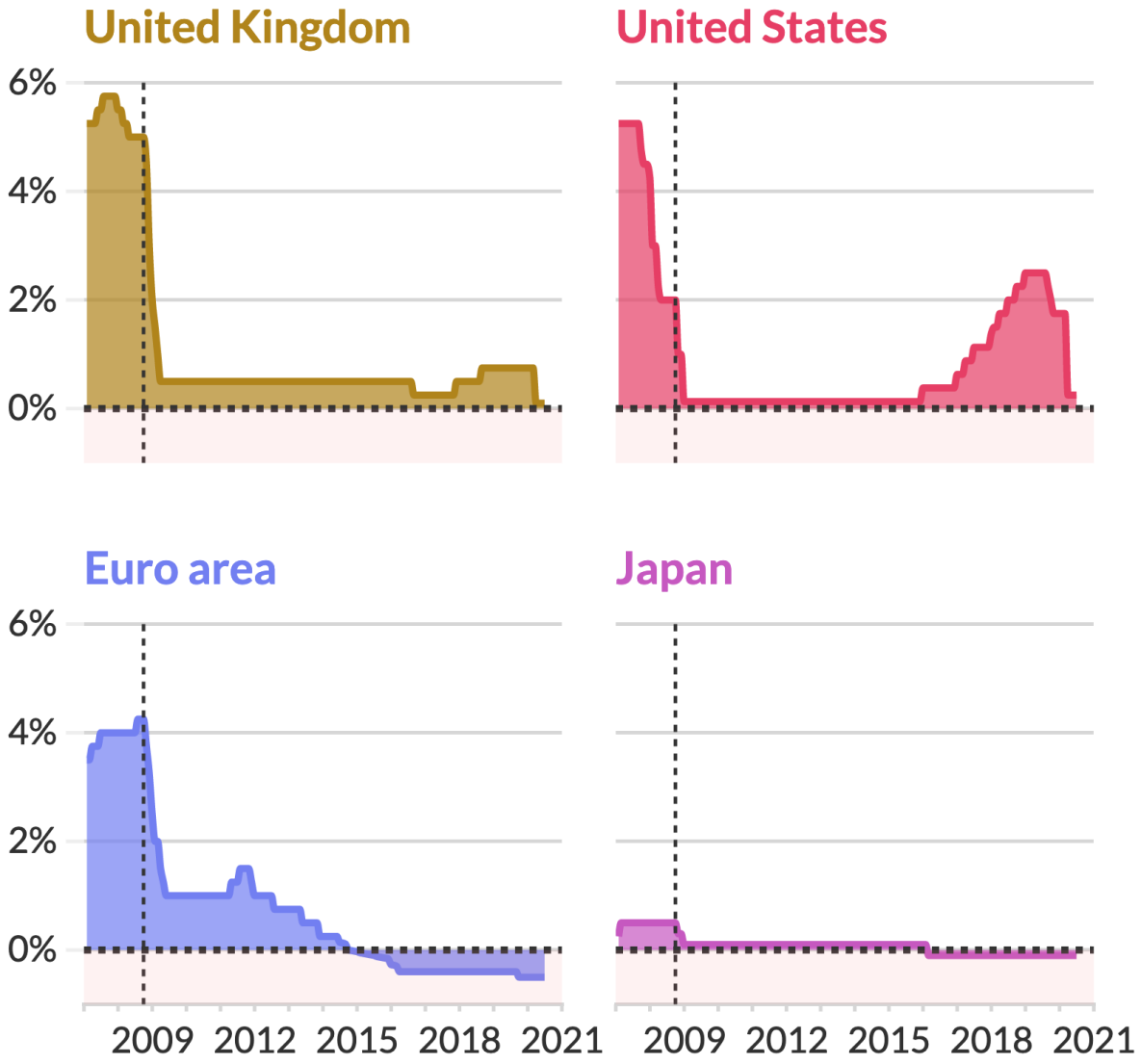
Use colors that are bold and clear enough for people to see both text and graphical elements.

Web Content Accessibility Guidelines (WCAG) suggest meeting the WCAG AA requirements.

To check if your color (and font size) choices are AA accessible you can use a contrast checker website.

For colours to be AA accessible they need to have a contrast ratio of at least **3:1** for **graphical elements**, and **4.5:1** for **normal text**.

Interest rates have been falling since the financial crisis, and have even gone negative in some countries



Source: ONS

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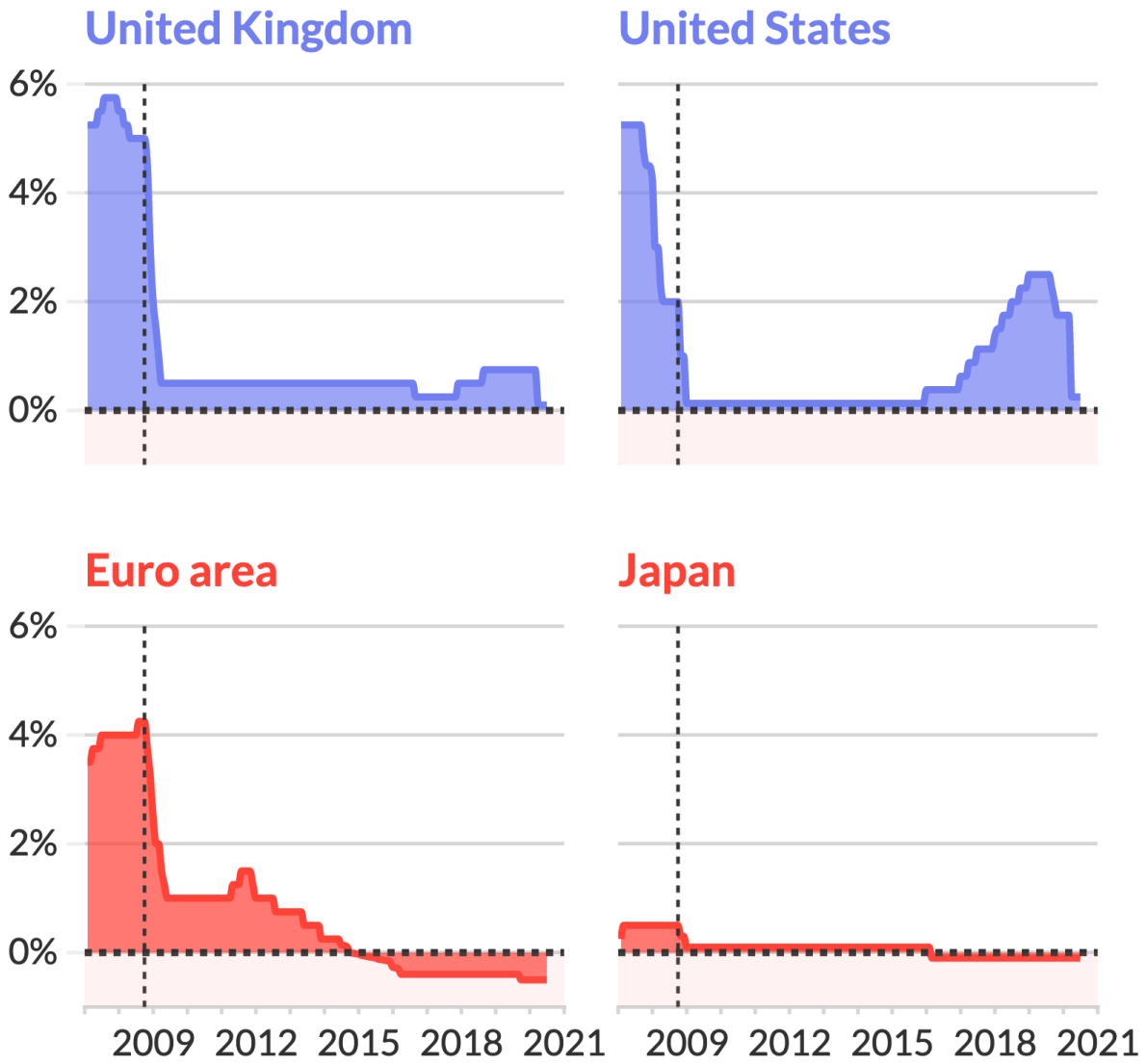
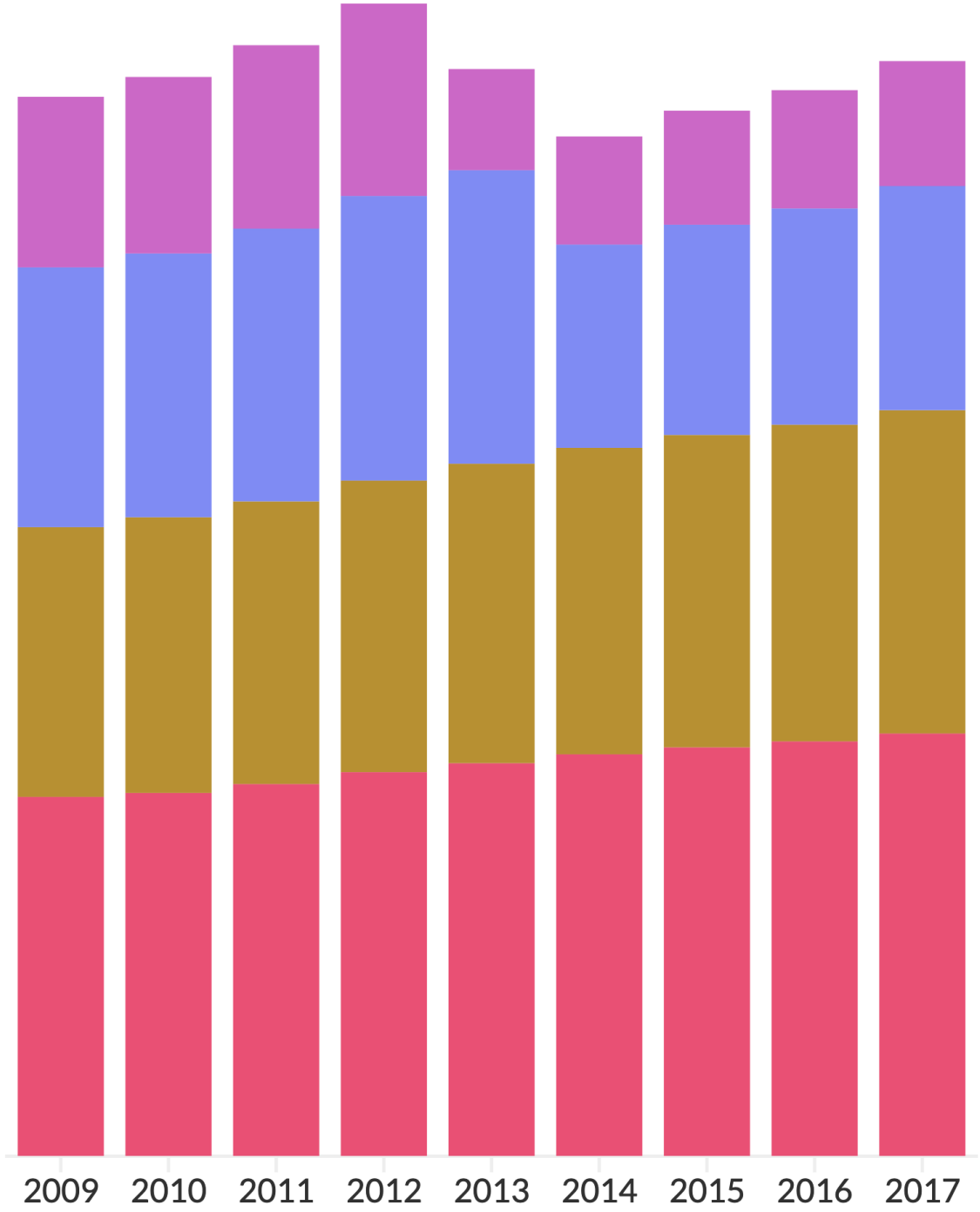
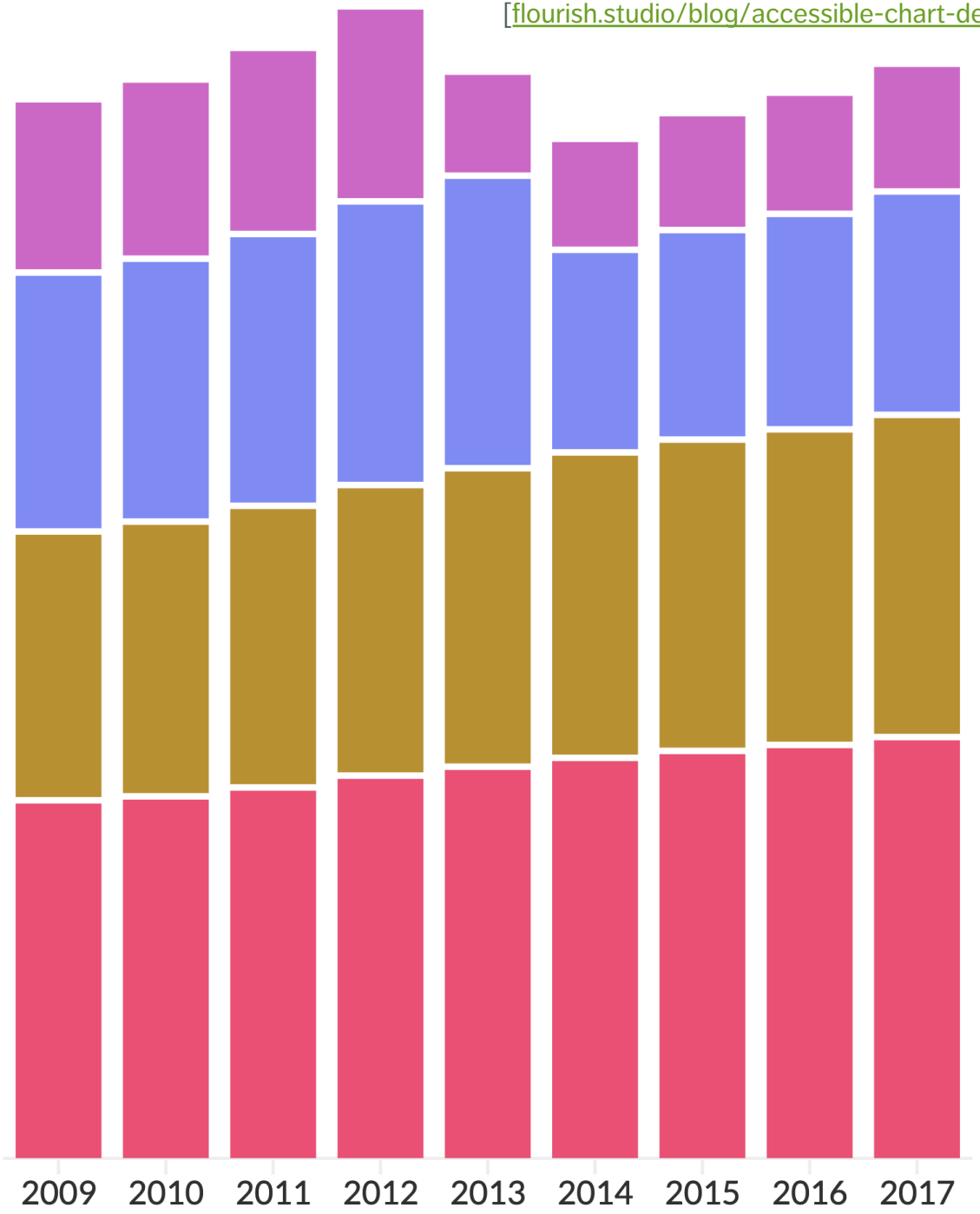


Source: ONS

[https://flourish.studio/blog/accessible-chart-design]

[flourish.studio/blog/accessible-chart-design]

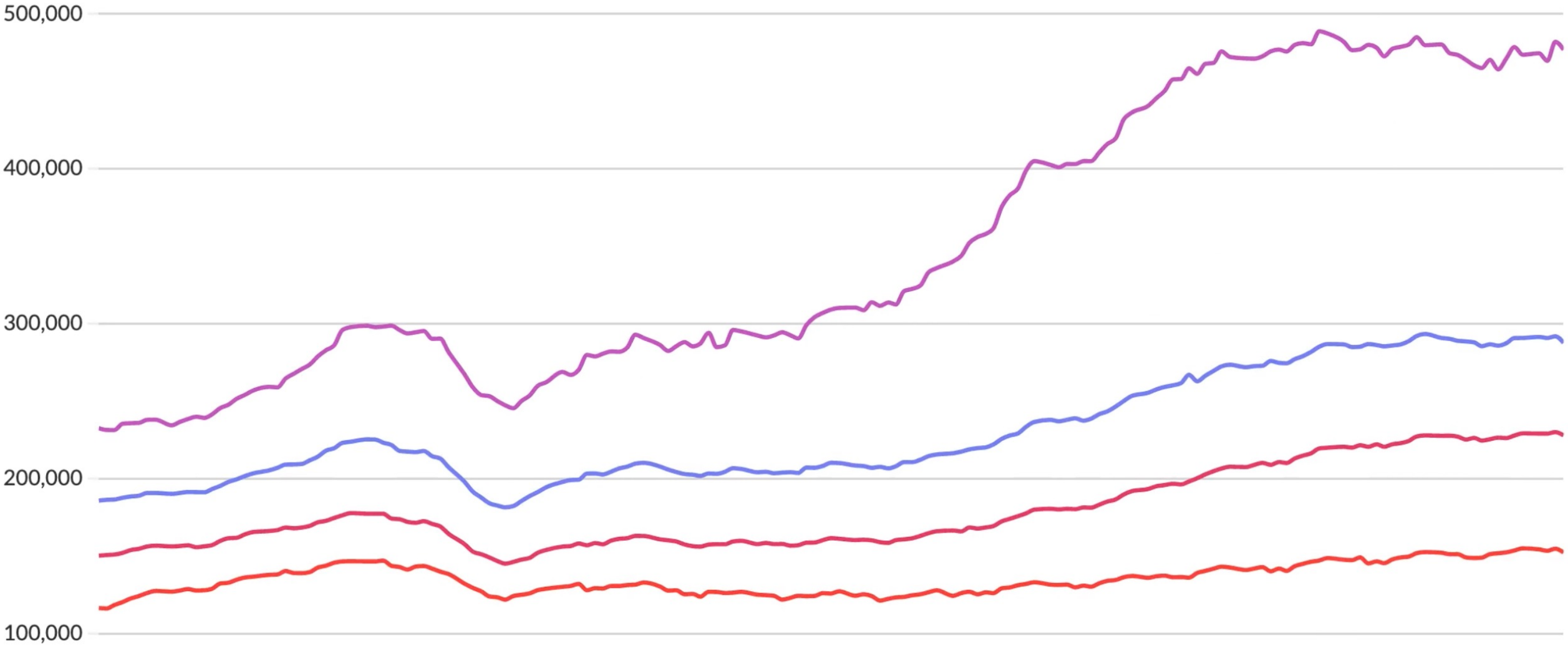




[https://flourish.studio/blog/accessible-chart-design]

House prices have been increasing in England since 2005, but vary across regions

House prices in England



IDLEWYLD Sysabee DAVHILL uOttawa

data-action-lab.com

[https://flourish.studio/blog/accessible-chart-design]

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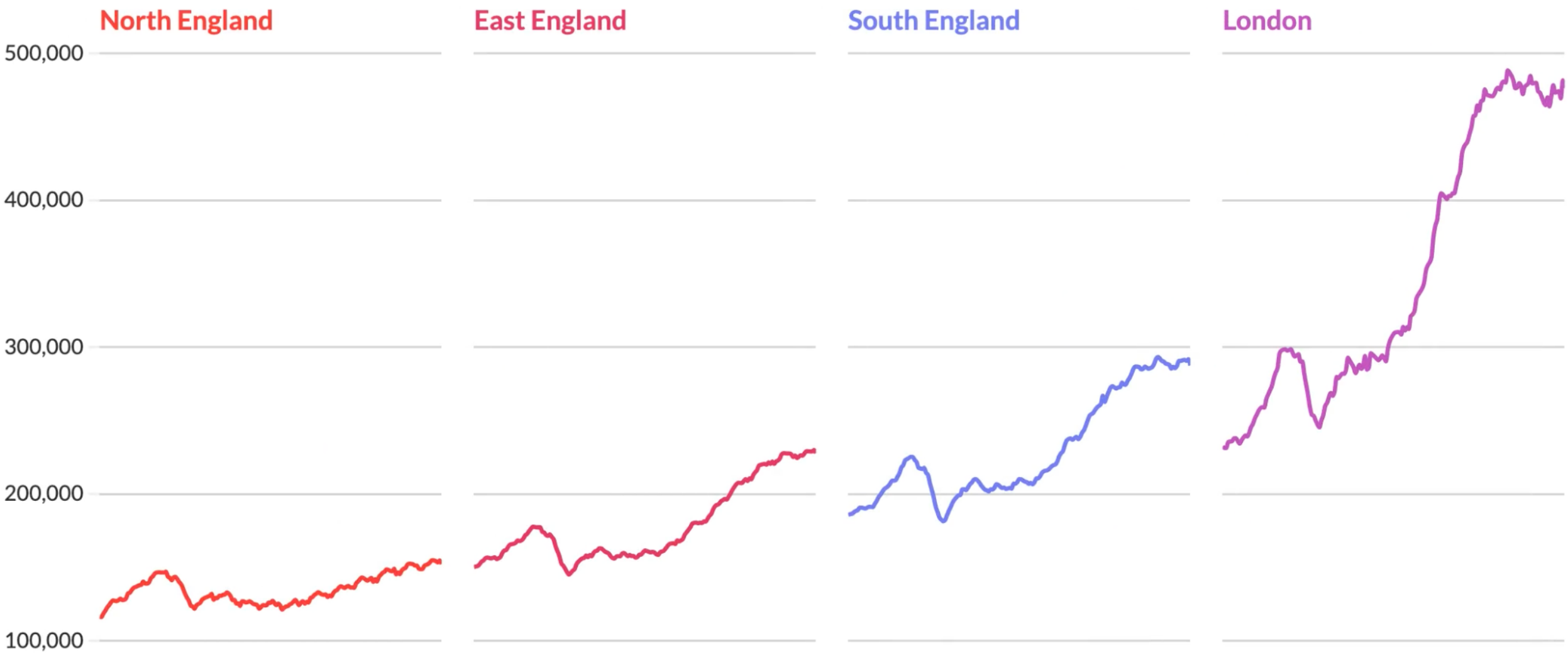


EXERCISES

1. Think of a work story. Create a sketch that could illustrate this work story. What visual storytelling choices and combinations would you consider using? **Would accessibility considerations change the way in which the story is presented to the audience?**

2. Re-cast the stories presented in this presentation (or other stories, as required) using different visual storytelling choices and combinations.

3. Re-cast the data stories presented in this presentation (or other data stories, as required) using different visual storytelling choices and combinations.

PART II – EFFECTIVE STORYTELLING VISUALS

STORYTELLING WITH DATA

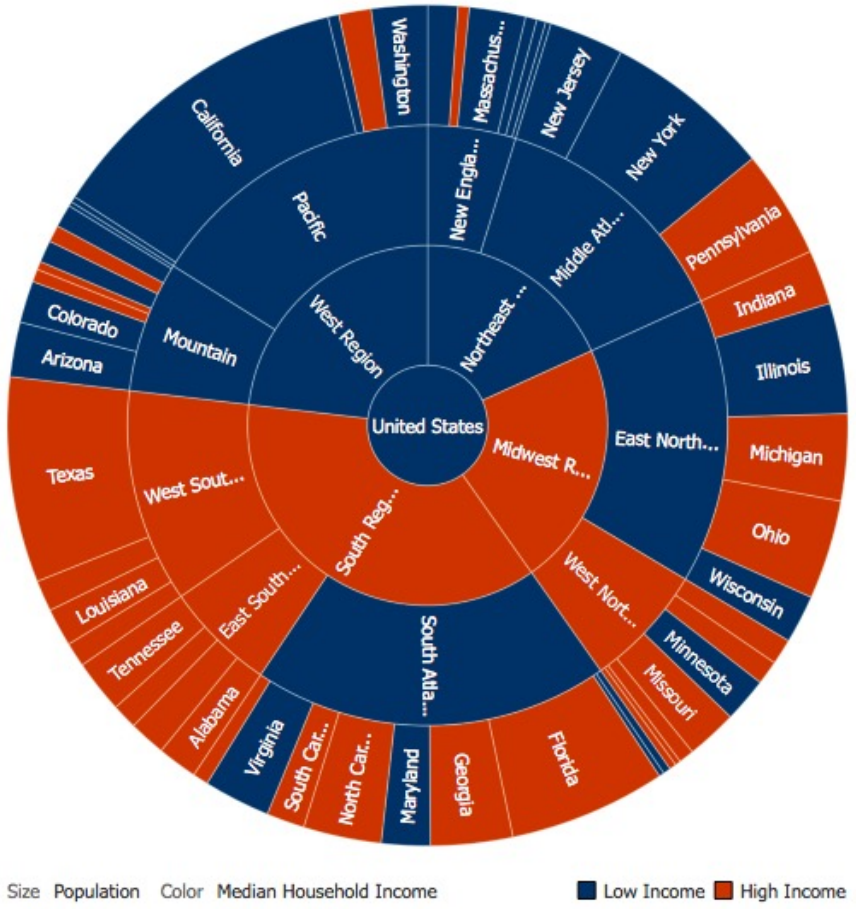
THE ABC OF DATA VISUALIZATION

PART II – EFFECTIVE STORYTELLING VISUALS

DATA VISUALIZATION AND INFOGRAPHICS

Data Visualization

- A **method**, as well as an item (**objective**)
- Typically focuses on the **quantifiable**
- Used to make sense of the data or to make it **accessible** (datasets can be massive and unwieldy)
- May be generated **automatically**
- The look and feel are less important than the **insights conveyed** by the data



DATA VISUALIZATION AND INFOGRAPHICS

Infographics

- Created for **story-telling** purposes (**subjective**)
- Intended for a **specific** audience
- **Self-contained** and discrete
- **Graphic design** aspect is key
- **Cannot** usually be re-used with other data
- Can incorporate **unquantifiable** information

HISTORICAL CHARTS

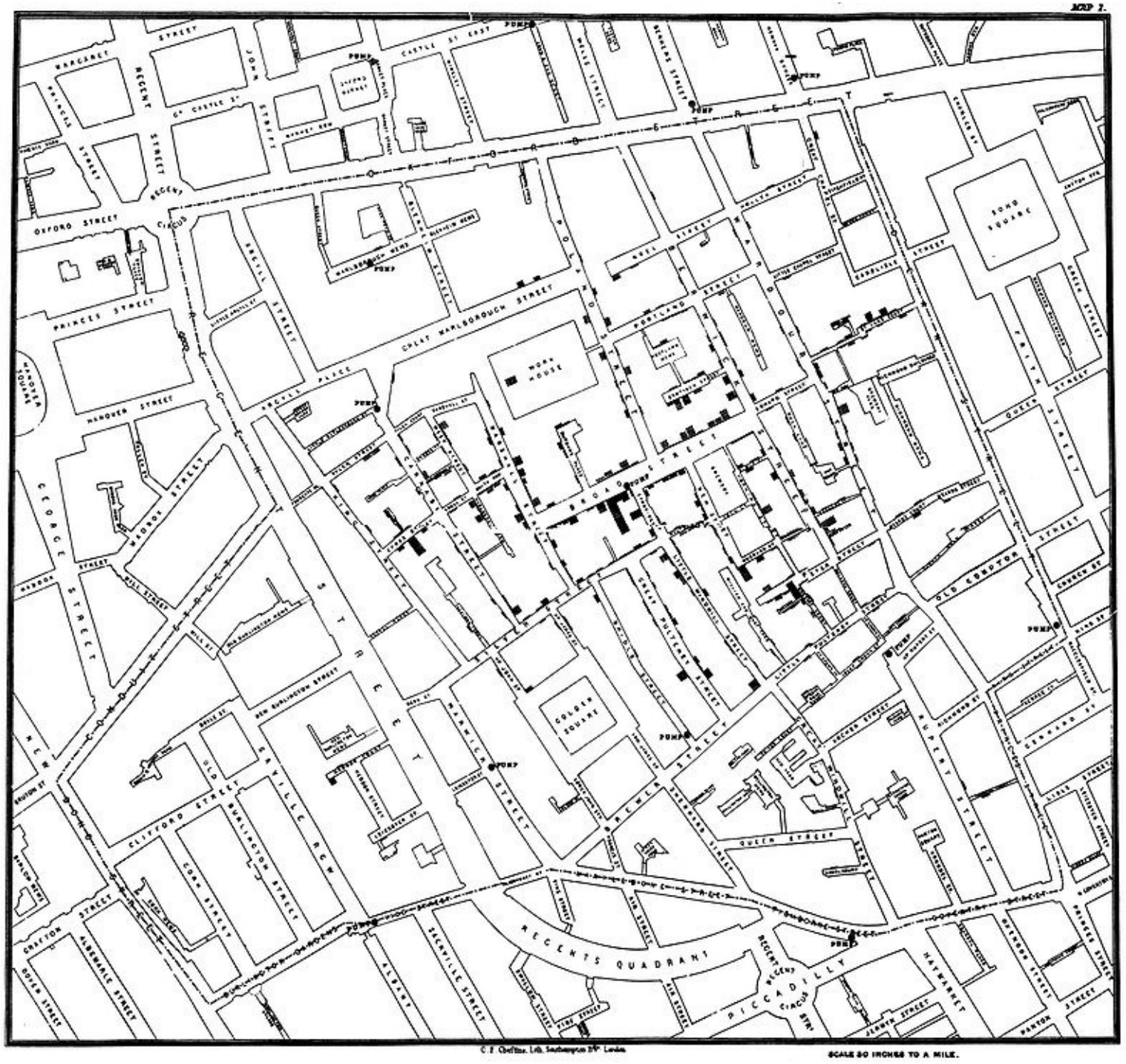
Data visualization is not confined to the recent past: charts have been used for many years to help **communicate information** and **tell stories**.

Due to the absence of technical tools, a lot of thought had to go into the design and creation of these visualizations.

Consequently, there is a lot we can (and **should**) learn to bring into the development of charts from a **design and storytelling perspective**.

London's Cholera Outbreak of 1854

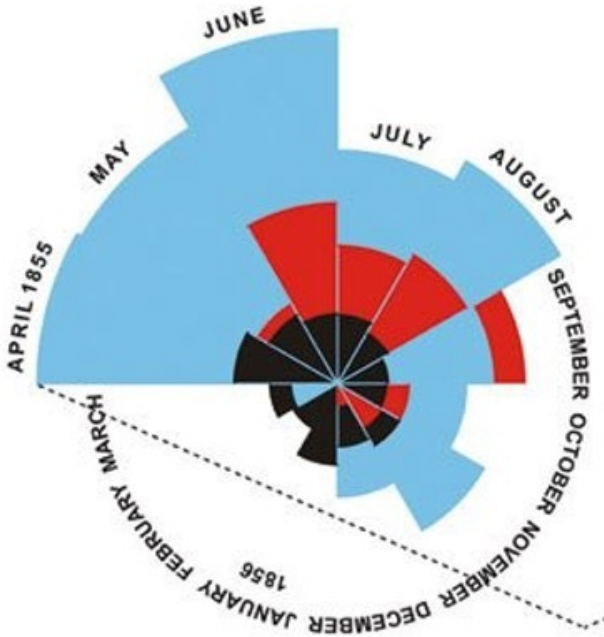
Physician John Snow links the outbreak to a contaminated well by plotting number of cases on a map, jump-starting the science of epidemiology.



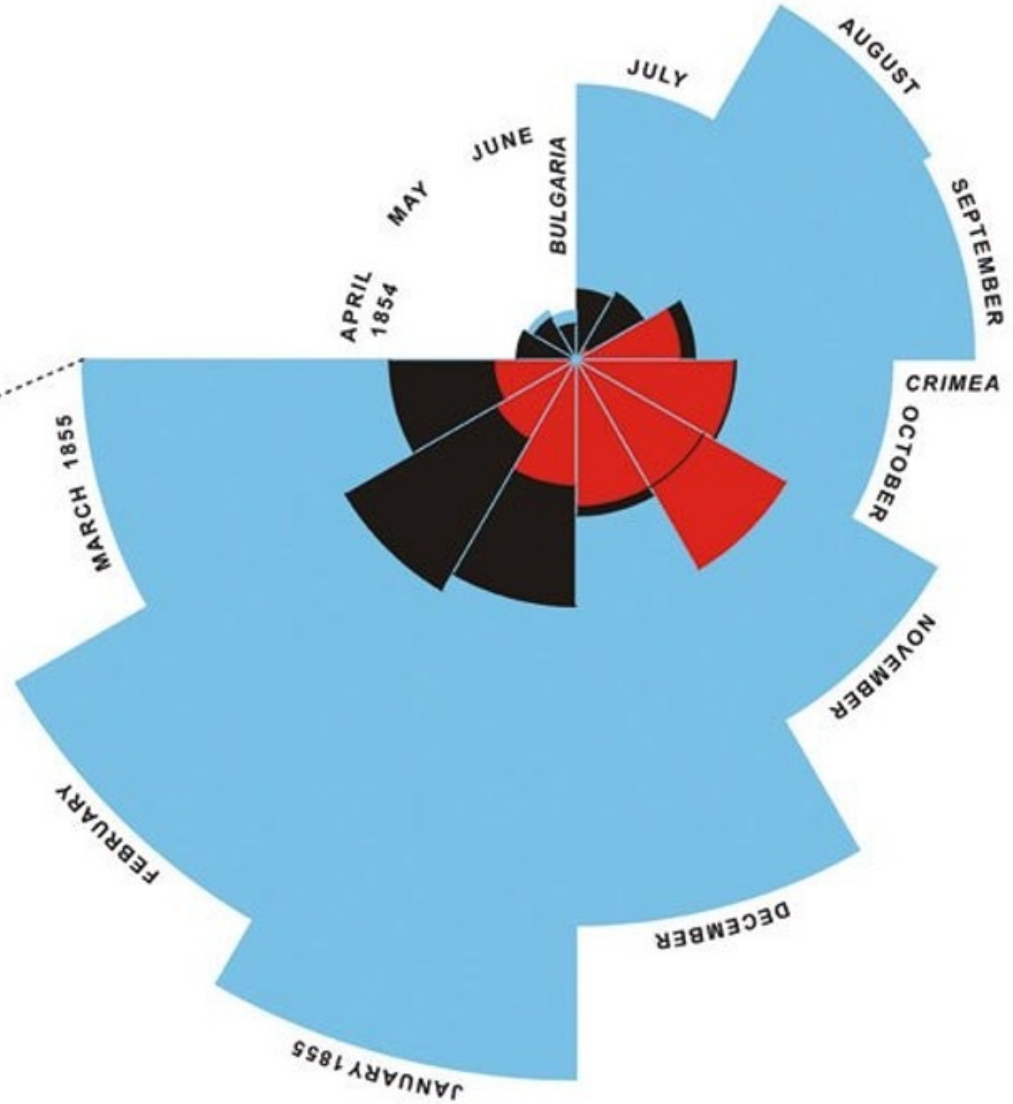
[F. Nightingale]

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

2.
APRIL 1855 TO MARCH 1856.

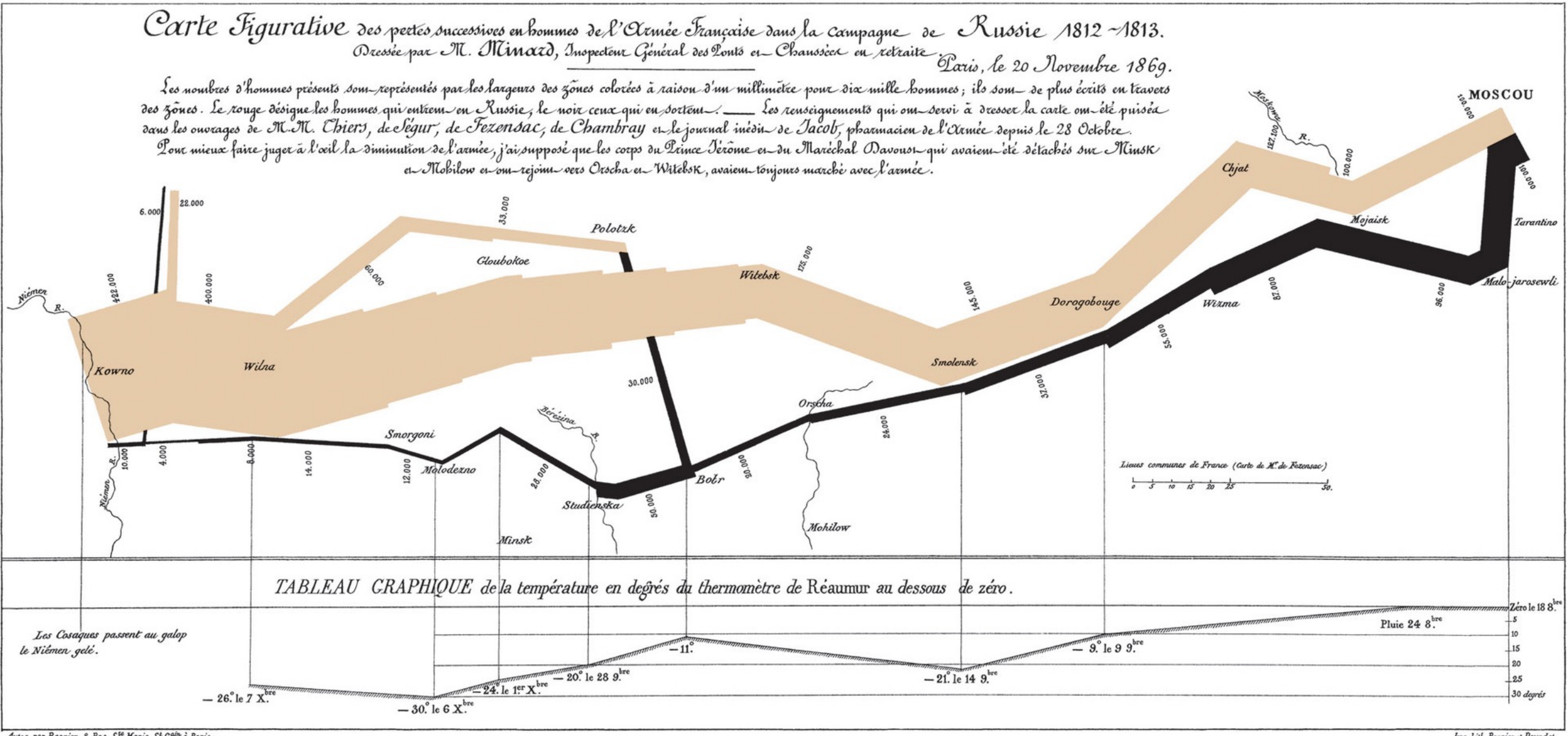


1.
APRIL 1854 TO MARCH 1855.



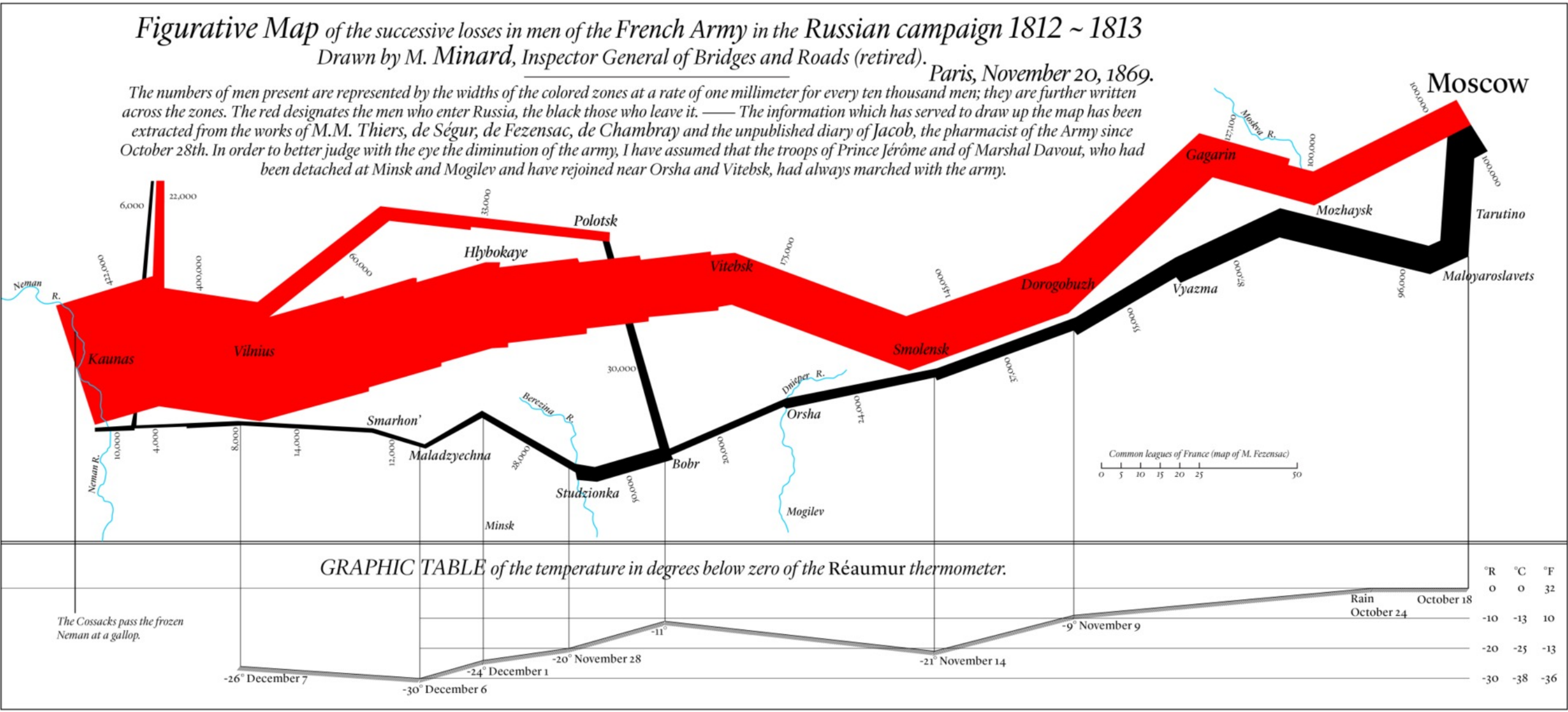
The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex
The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic Diseases, the red wedges measured from the centre the deaths from wounds, & 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.

[Minard, 1869]



Minard's March to Moscow

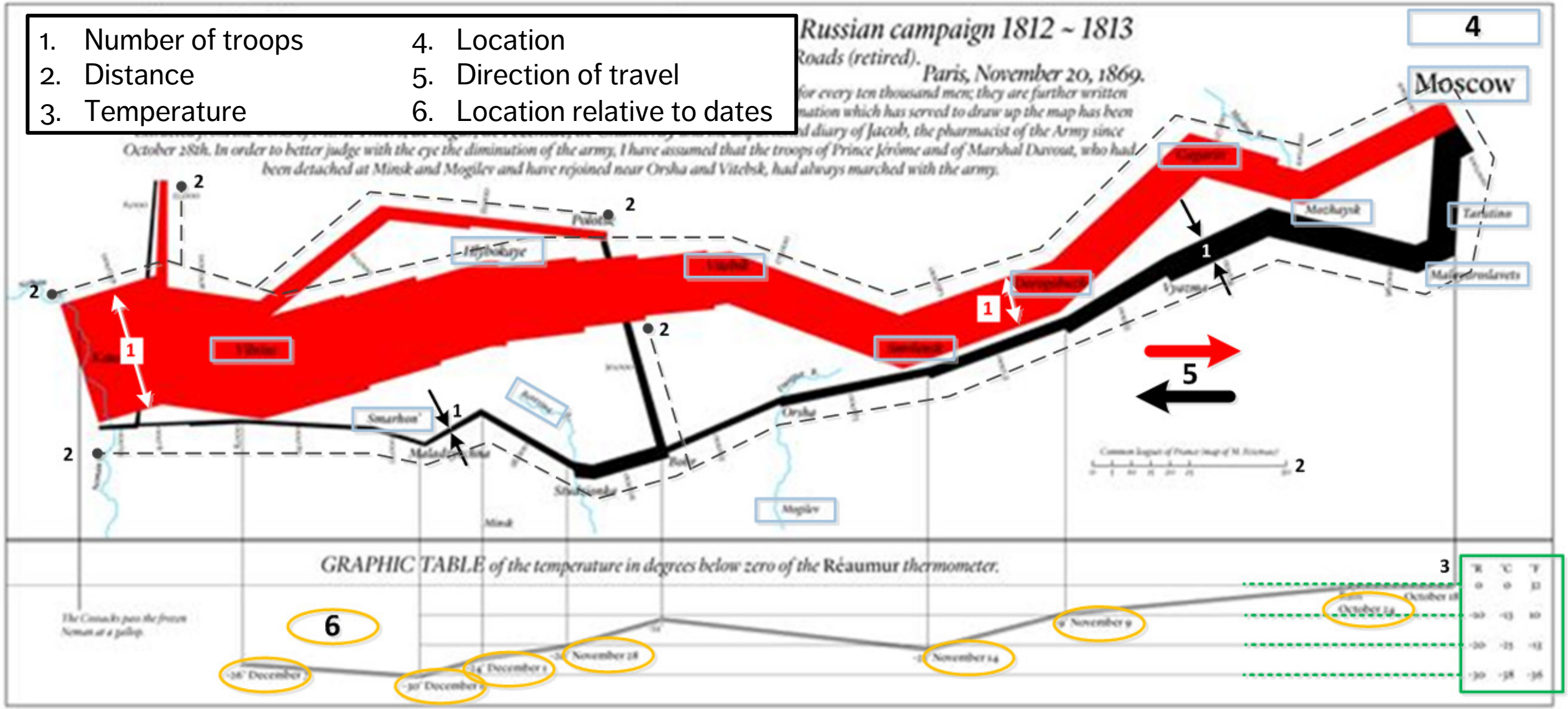
[DAL Podcast #3: https://youtu.be/tS_2_lQ5gRw]



Minard's March to Moscow

[S.Davies – Visualizations that changed history - part 1 - https://www.data-action-lab.com/2018/10/22/data-visualizations-that-changed-history-part-1]

1. Number of troops
2. Distance
3. Temperature
4. Location
5. Direction of travel
6. Location relative to dates



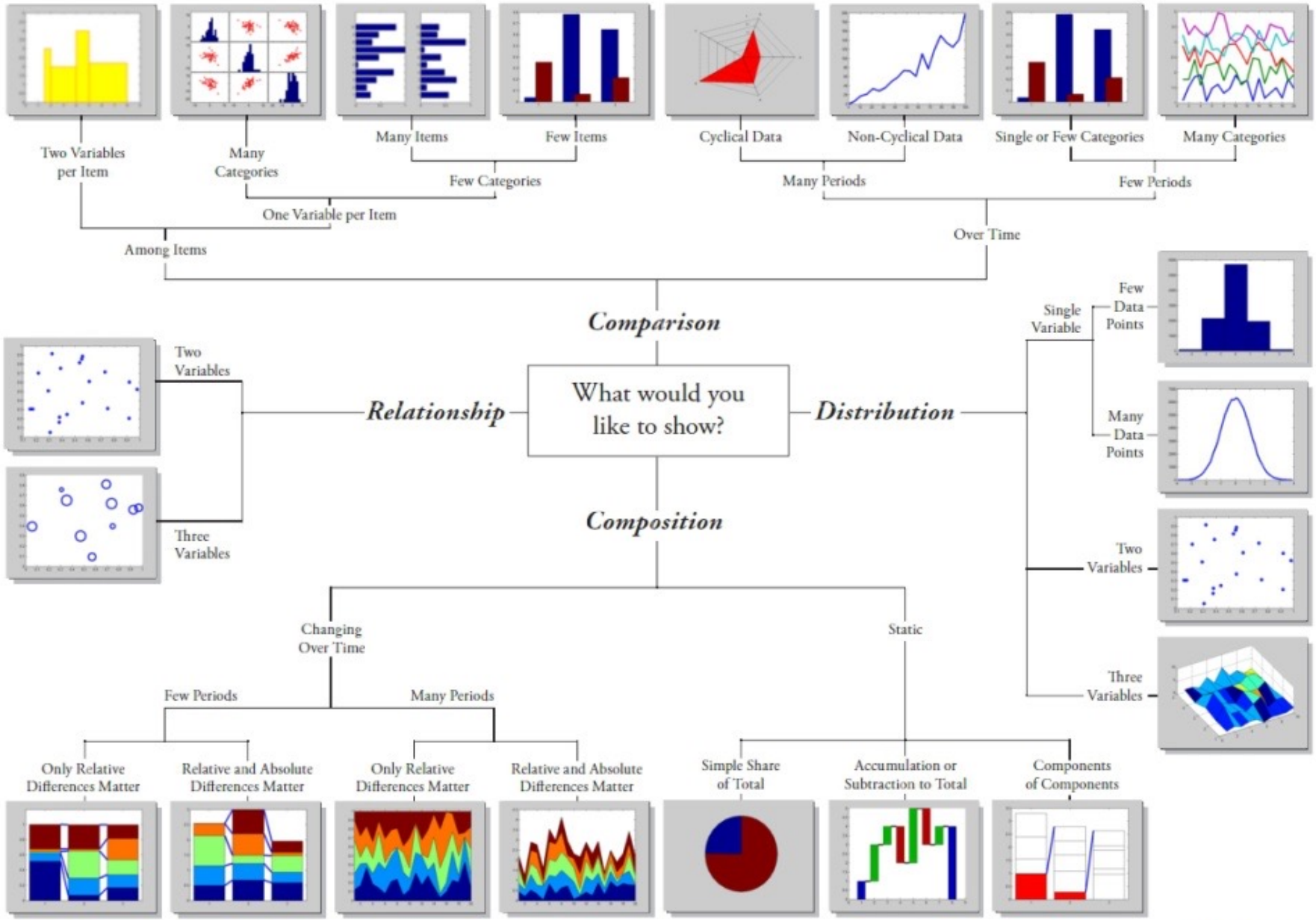
Minard's March to Moscow

TYPES OF CHARTS

With data visualizations, we want to highlight:

1. a **relationship** – show a connection or correlation between two or more variables, such as the impact of an aging population on health care;
2. a **comparison** – set some variables apart from others, and display how those two variables interact, or merely differ, such as the number of fans attending hockey games for different teams in a season;
3. a **composition** – collect different types of information that make up a whole and display them together, such as the various search terms that visitors used to land on your site, or how many visitors came from various sources (links, search engines, or direct traffic), and
4. a **distribution** – lay out a collection of related or unrelated information to see how it correlates (if at all), and to understand if there's any interaction between the variables, such as the number of bugs reported during each month after a new software release.

Chart Suggestions—A Thought-Starter



Modified with permision -Doug Hull
blogs.mathworks.com/videos
hull@mathworks.com 2009

www.ExtremePresentation.com

TYPES OF CHARTS

Workhorse Data Visualizations

- Line Chart/Rug Chart/Number Line (data exploration)
- Histogram (data exploration)
- Boxplots (data exploration)
- Line Graph (data presentation + data exploration)
- Bar Chart (data presentation + data exploration)
- Scatterplot (data presentation + data exploration)

EXERCISES

Find good candidates for the type of chart that could be used with the following:

1. A dataset with information about financial transactions throughout the year.
2. A dataset with the results of a survey of employee work satisfaction.
3. A dataset with showing levels of regulatory compliance with a set of government regulations (e.g., regulations relating to environmental reporting).
4. Any other dataset of your choosing.

RELATIONSHIP BETWEEN DATA AND STORIES

PART II – EFFECTIVE STORYTELLING VISUALS

LIMITATIONS OF DATA STORIES

What **constraints** exist on data stories?

Some constraints may be tied to the **function** (education vs. entertainment, say).

In this case, we are constrained to only tell stories that are **supported by the data**.

We can't tell just any old story we want to, even if we think it is the "right" story.

IMPACT OF CHOICES WHEN STORYTELLING WITH DATA

Data analysts have **agency.** They select:

- the question to answer;
- what data to collect;
- how to clean that data;
- which analytical method(s) to use;
- on what part(s) of the data to focus, etc.

This impacts the stories that **can be told** with data, relative to the stories that **could be told** about the situations and events represented by the data.

SCOPING VS. EXPLORATION VS. EXPLANATION VS. PERSUASION

When working with data, we create visualizations at **multiple stages** in the process.

This is reminiscent of the process behind **investigative journalism**:

1. initially, we **scope out** the area of investigation (data collection, story);
2. then we **explore** the situation and then **explore** the data we have collected about it
3. we may use the outcome of this exploration to **explain** the situation to our satisfaction;
4. and/or to **persuade** others about some course of action that should be taken with respect to the situation.

FALSIFICATION

Karl Popper differentiated science and pseudo-science by saying that scientific theories had to be **falsifiable** – this didn't mean they *had* to be false, but that it had to be *possible* for them to be false.

Similarly, with data storytelling, it should be possible for us to imagine some type of data that could *in principle* falsify the story we are telling.

If we cannot do that, then the story and the data are not really connected.

EXERCISES

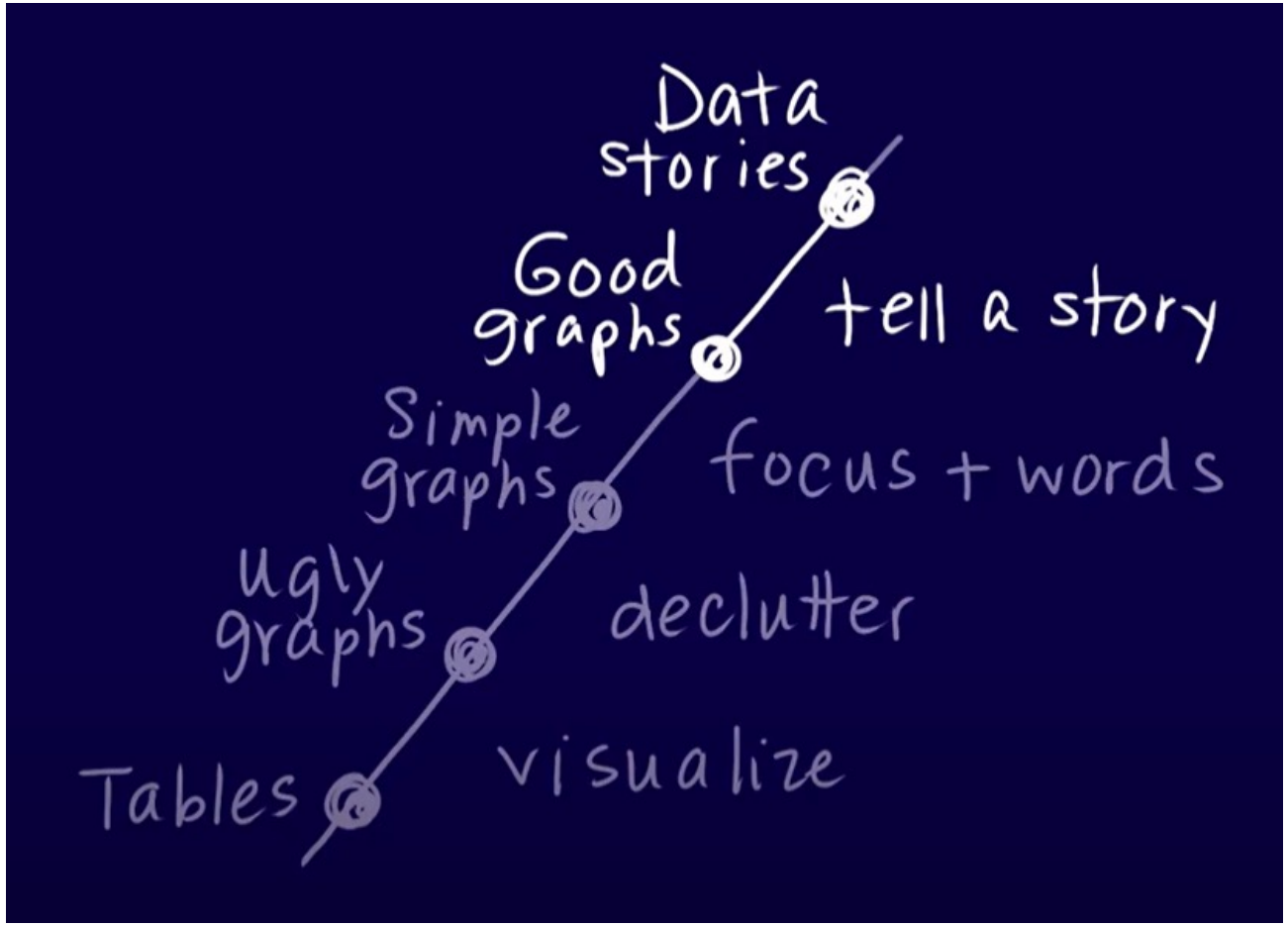
1. Identify instances of scoping, exploration, explanation, persuasion among the dashboards and charts from the two previous sections (main and exercises).
2. What do you think the underlying dataset structure and limitations are?
3. What analytical and data focus choices are at play?
4. Are the charts falsifiable?

EVOLVING A STORYTELLING CHART

PART II – EFFECTIVE STORYTELLING VISUALS

[C. Nussbaumer Knaflic, *Storytelling with Data*]

EVOLVING A VISUALIZATION



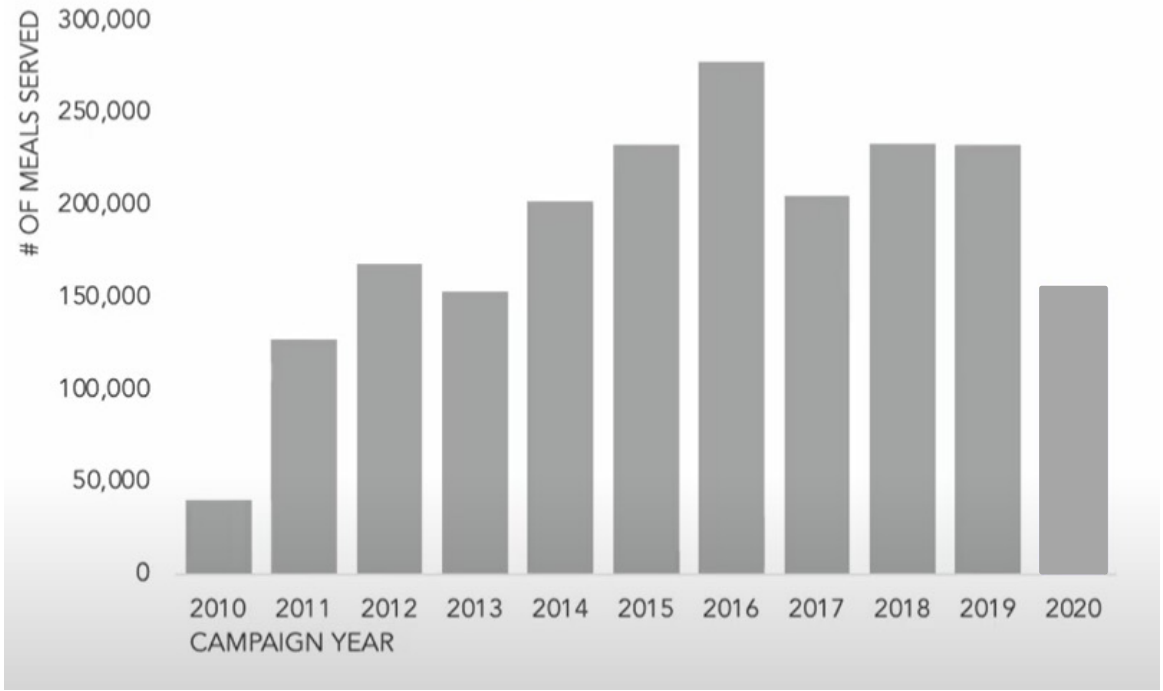
EVOLVING A VISUALIZATION – TABLE

Meals served over time

Campaign Year	Meals Served
2010	40,139
2011	127,020
2012	168,193
2013	153,115
2014	202,102
2015	232,897
2016	277,912
2017	205,350
2018	233,389
2019	232,797
2020	154,830

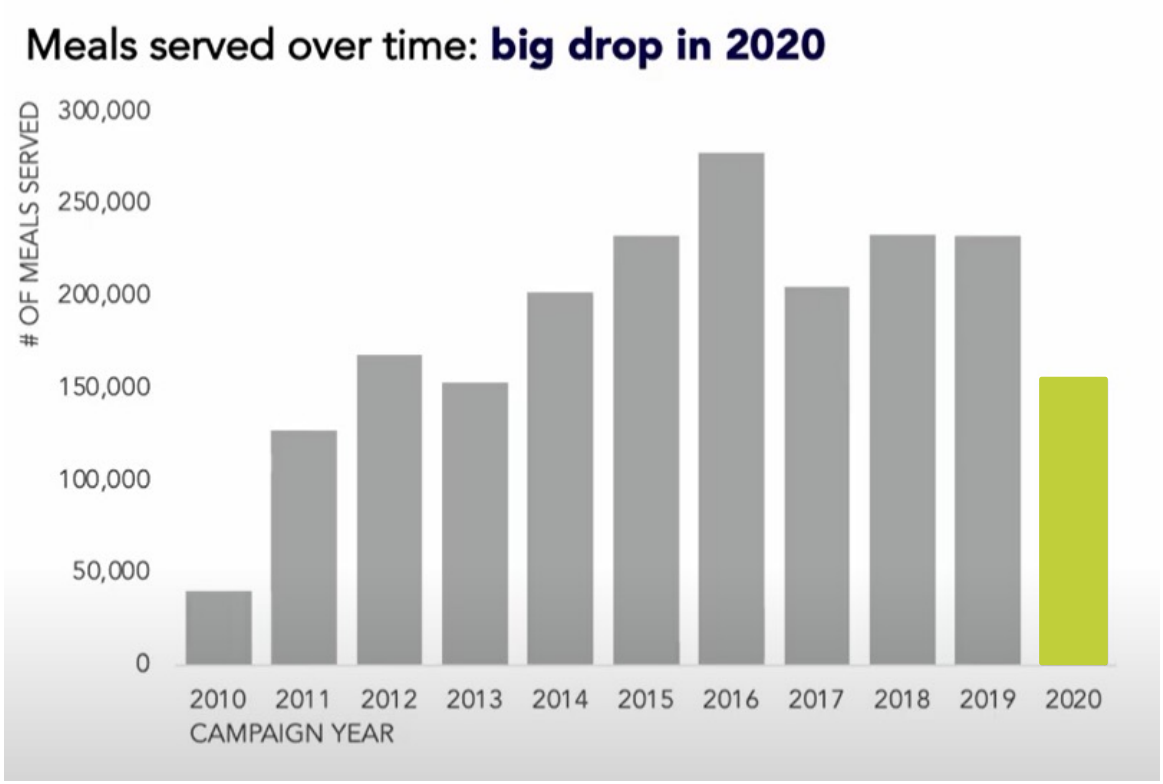
EVOLVING A VISUALIZATION – UGLY GRAPH

EVOLVING A VISUALIZATION – SIMPLE GRAPH

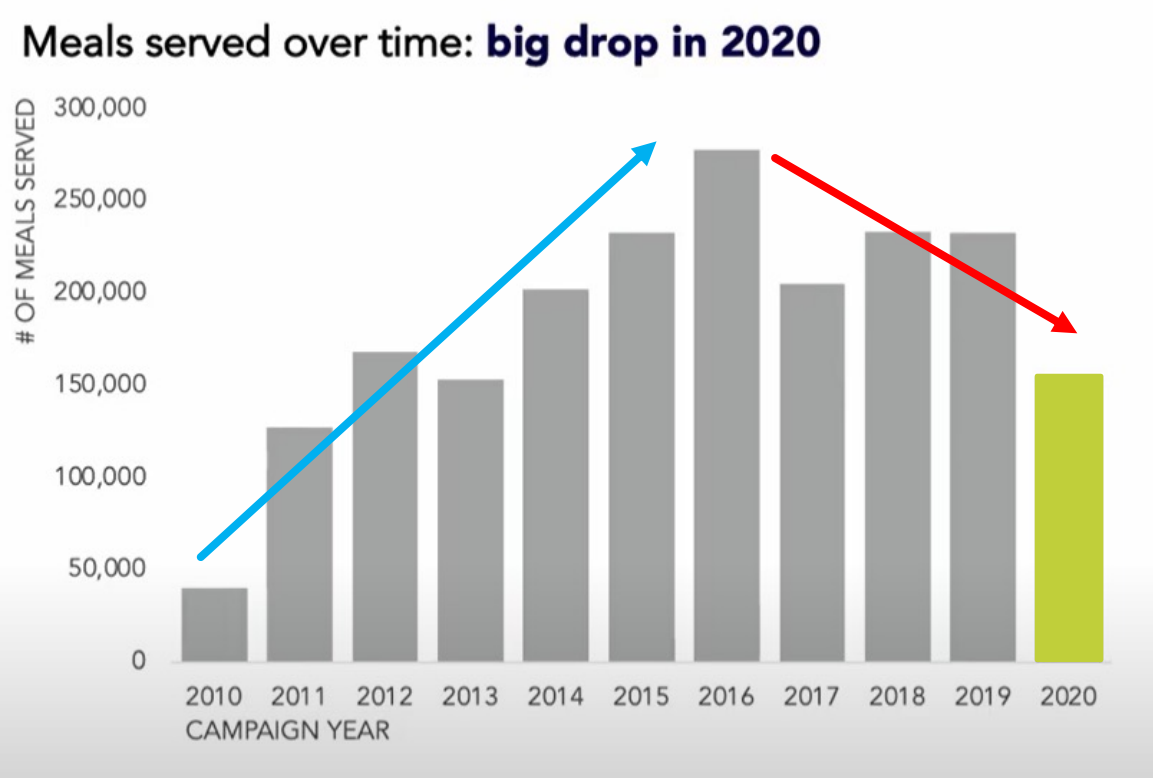


[Based on C. Nussbaumer Knaflic, *Storytelling with Data*]

EVOLVING A VISUALIZATION – GOOD GRAPH



EVOLVING A VISUALIZATION – DATA STORY

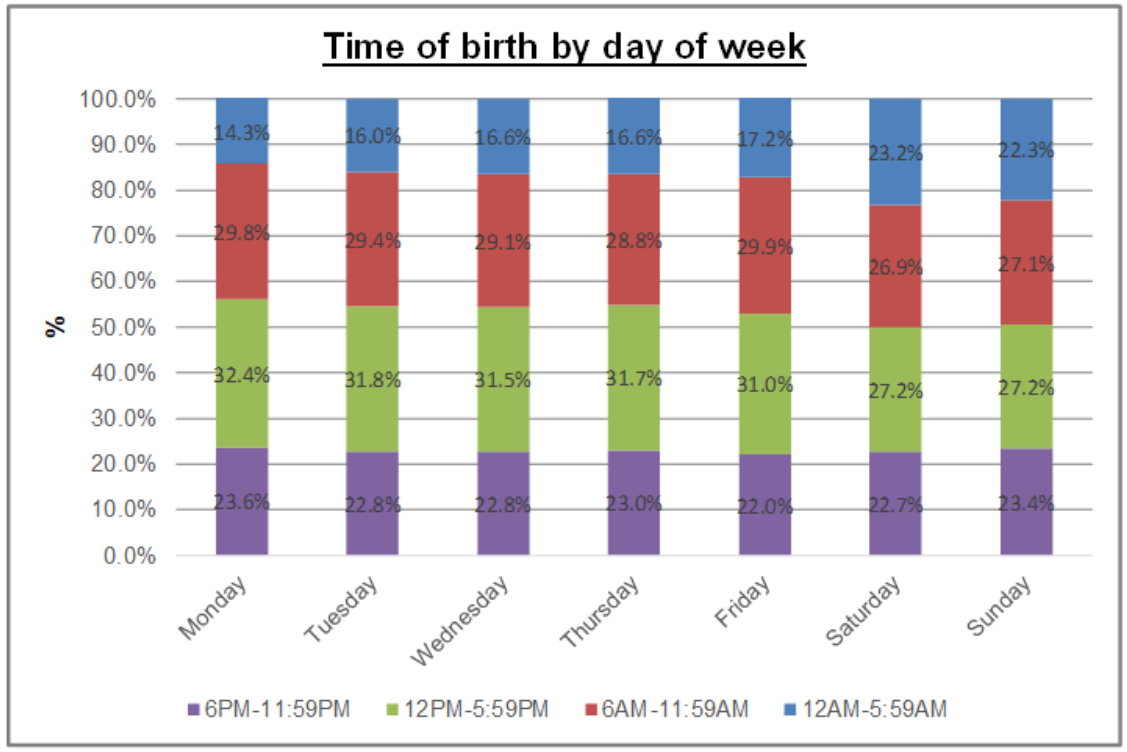


Even though it might seem obvious that there would be a **big drop in meals served in 2020** due to the pandemic, note that the **2017-2019 numbers** were already going against the **2010-2016 trend** – we should not be planning for a return to 2016 levels without first understanding what happened in 2017-2019.

[E. Ricks, https://www.storytellingwithdata.com/blog/2019/5/13/declutter-and-question-defaults]

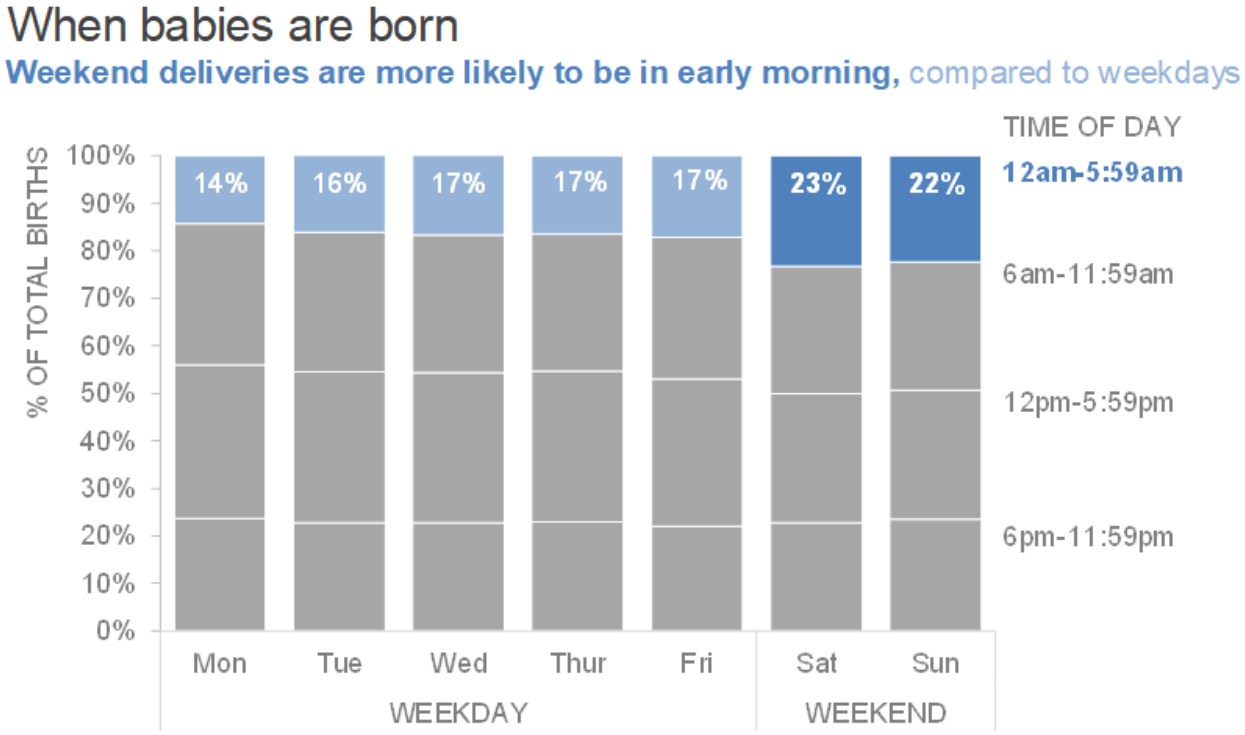
EXAMPLES

BEFORE



Data source: CDC (National Vital Statistics Reports, Vol. 67, No. 1, January 31, 2018)

AFTER



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[C. Nussbaumer Knaflic, *Storytelling with Data*]

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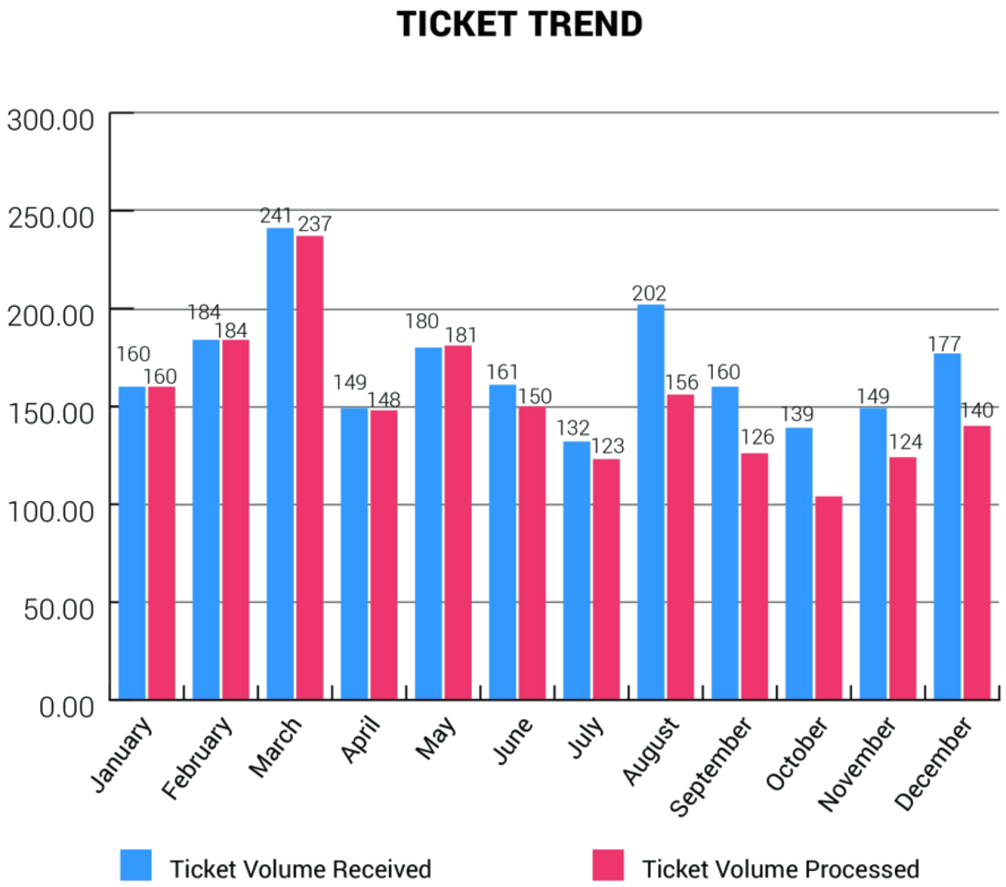

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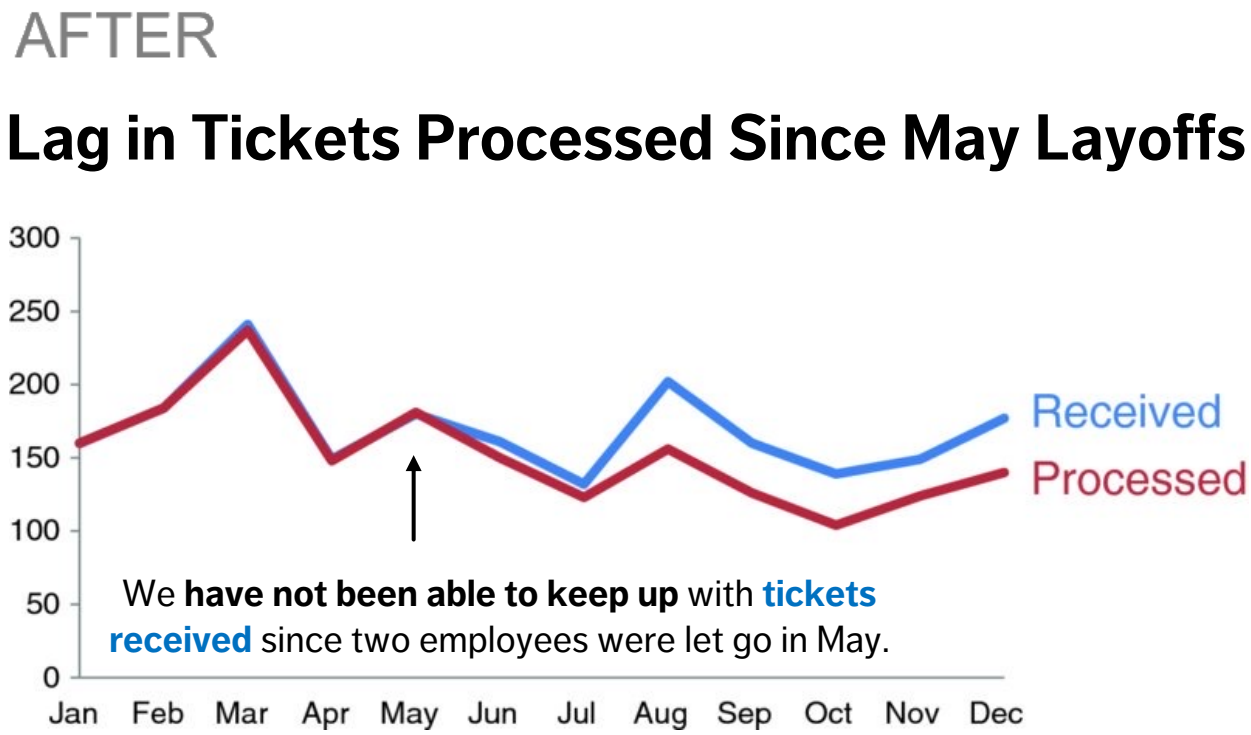

[C. Nussbaumer Knaflic, *Storytelling with Data*]

EXAMPLES

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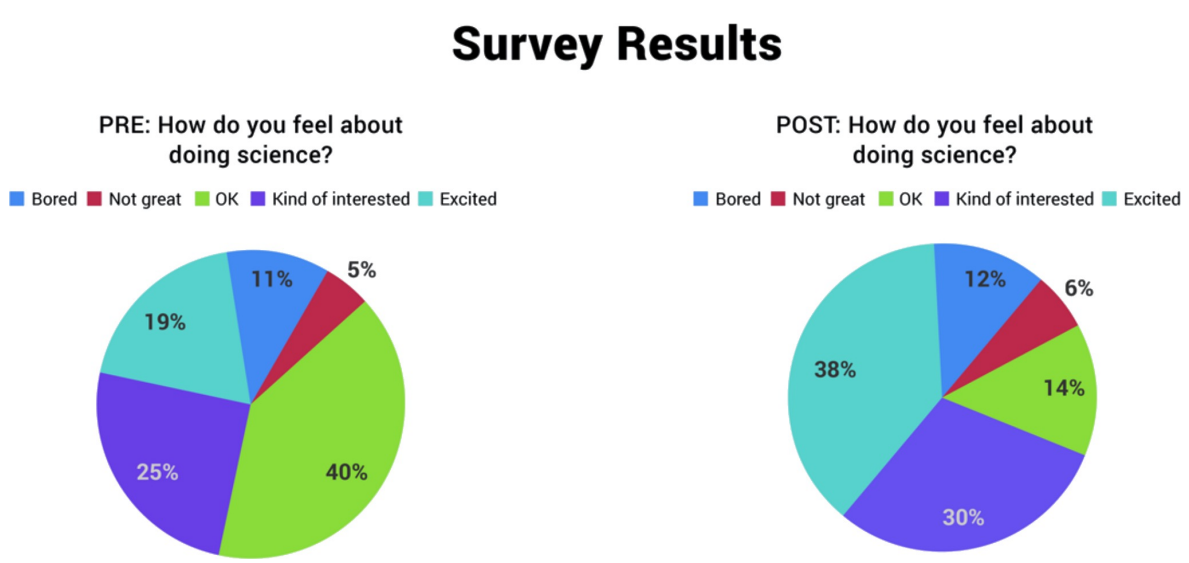

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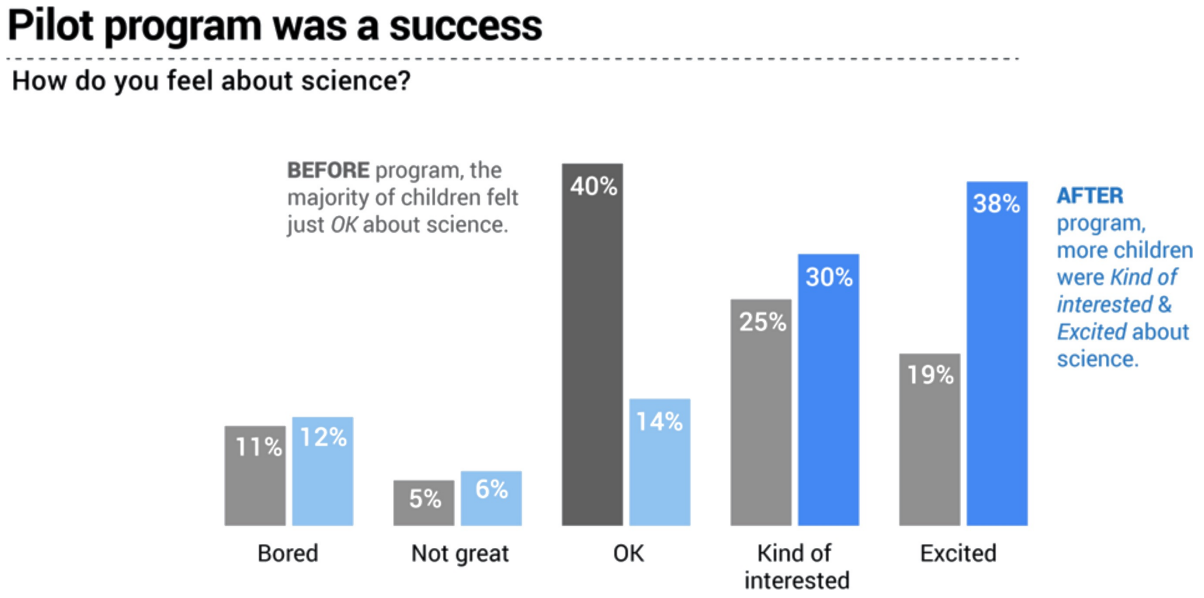
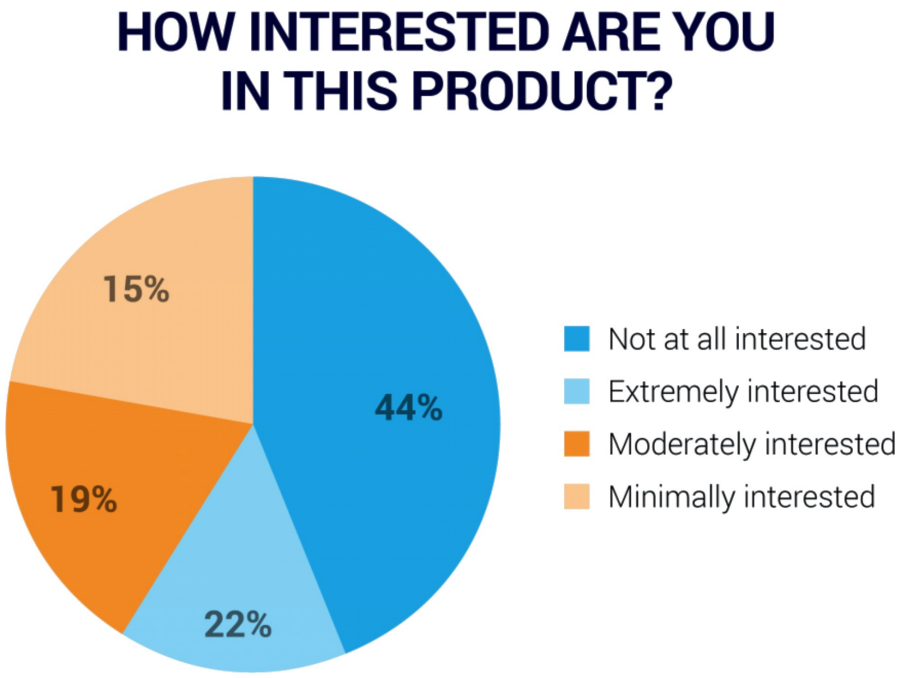


EXAMPLES

BEFORE



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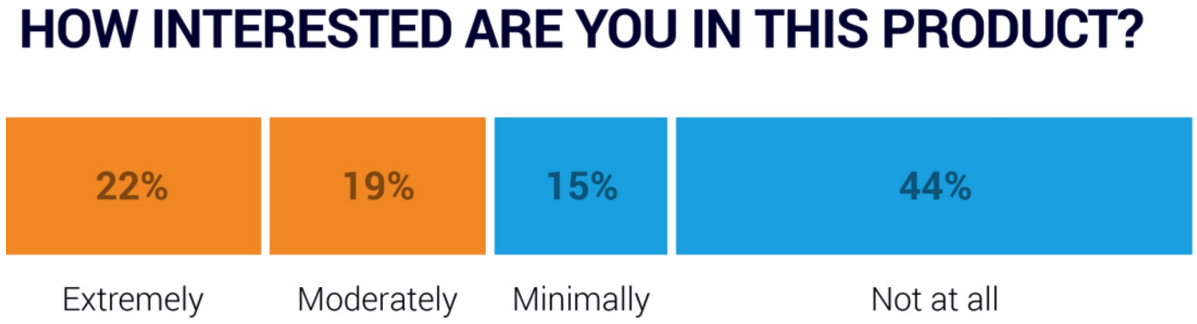
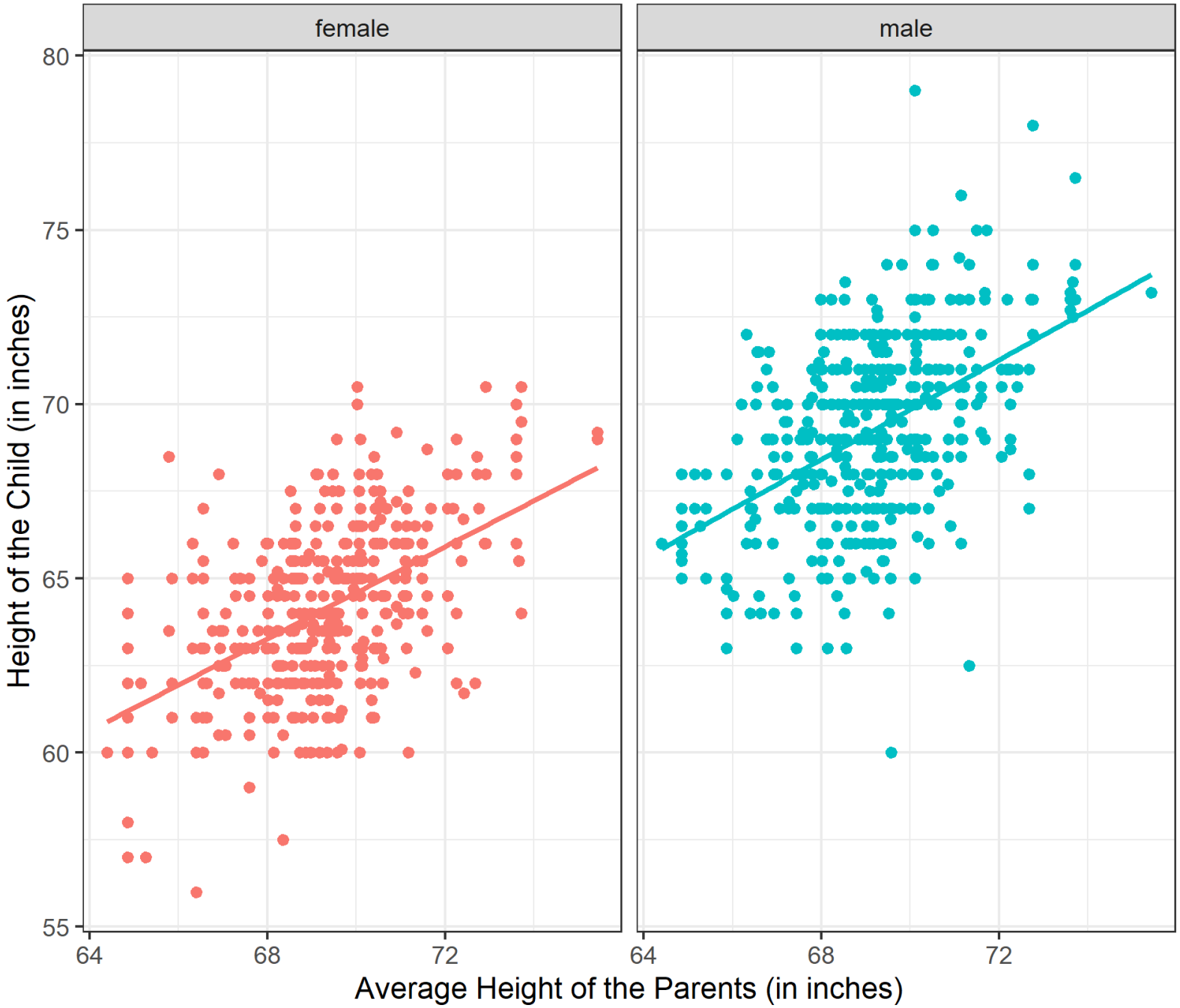


DATA STORYTELLING TROPES

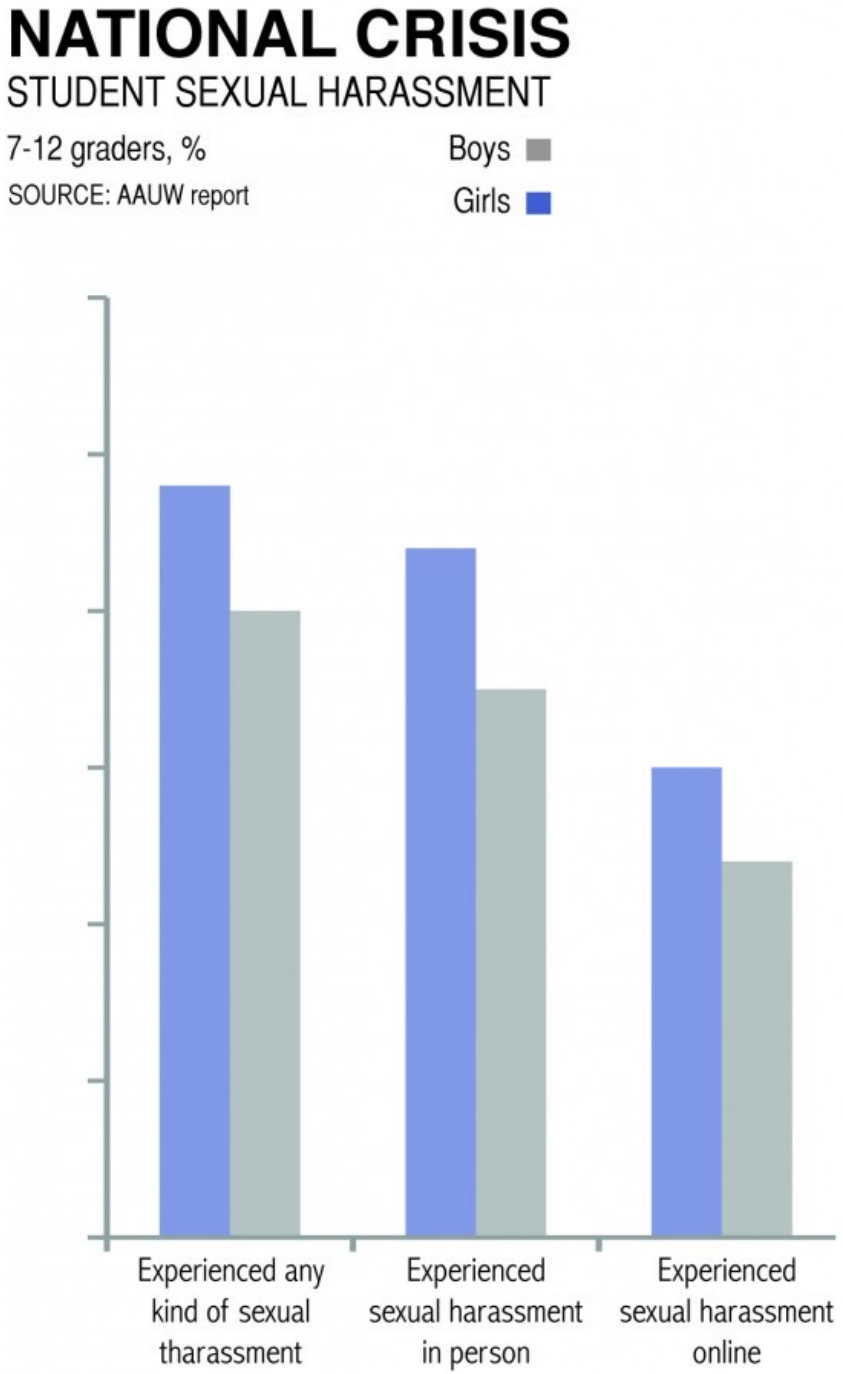
Some data visualizations patterns are so familiar they have become **tropes** (icons):

- a scatterplot with a trend line going straight up or straight down
- a cluster bar chart with two categories where one is always lower than the other
- a line chart with the two lines crossing in one place
- pie charts being used all over the place
- red for republican, blue for democrat (US); red for left-leaning, blue for right-leaning (ROW)
- using broken axes to exaggerate effects
- etc.

Scatterplot matrix of Galton Family Data by Gender of the Child



[https://www.chsglobe.com/13376/cover-stories/sexualharassment]



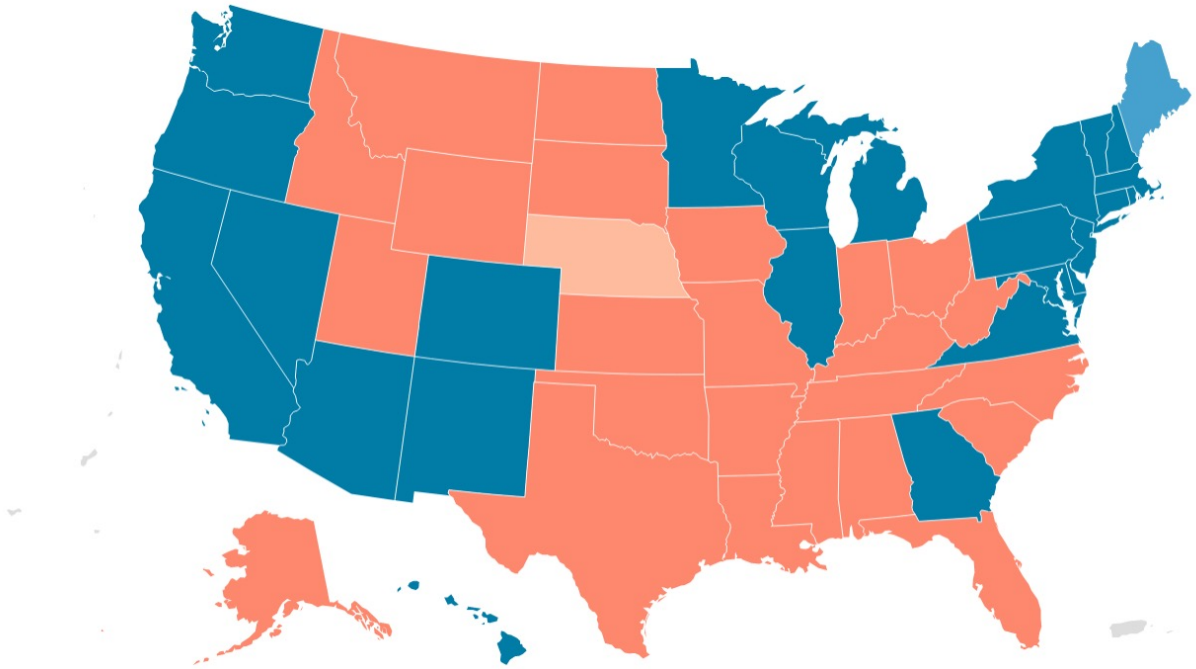
[https://handsondataviz.org/spatial-bias.html]

DATA STORYTELLING TROPES – EXAMPLES

Conventional Map of 2020 US Presidential Election Results

Maine and Nebraska allow some electoral votes to be split by district

Biden | Biden + Trump | Trump | Trump + Biden

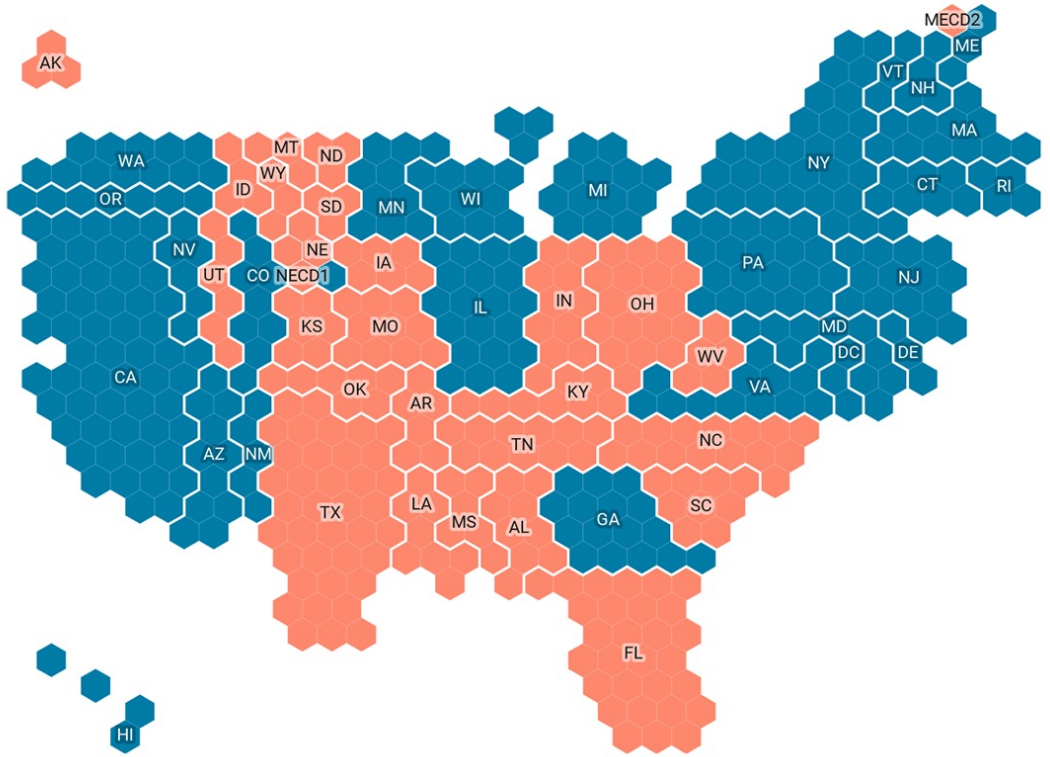


Created with Datawrapper

Cartogram of 2020 US Presidential Election Results

Each hexagon represents one electoral college vote

Biden | Trump



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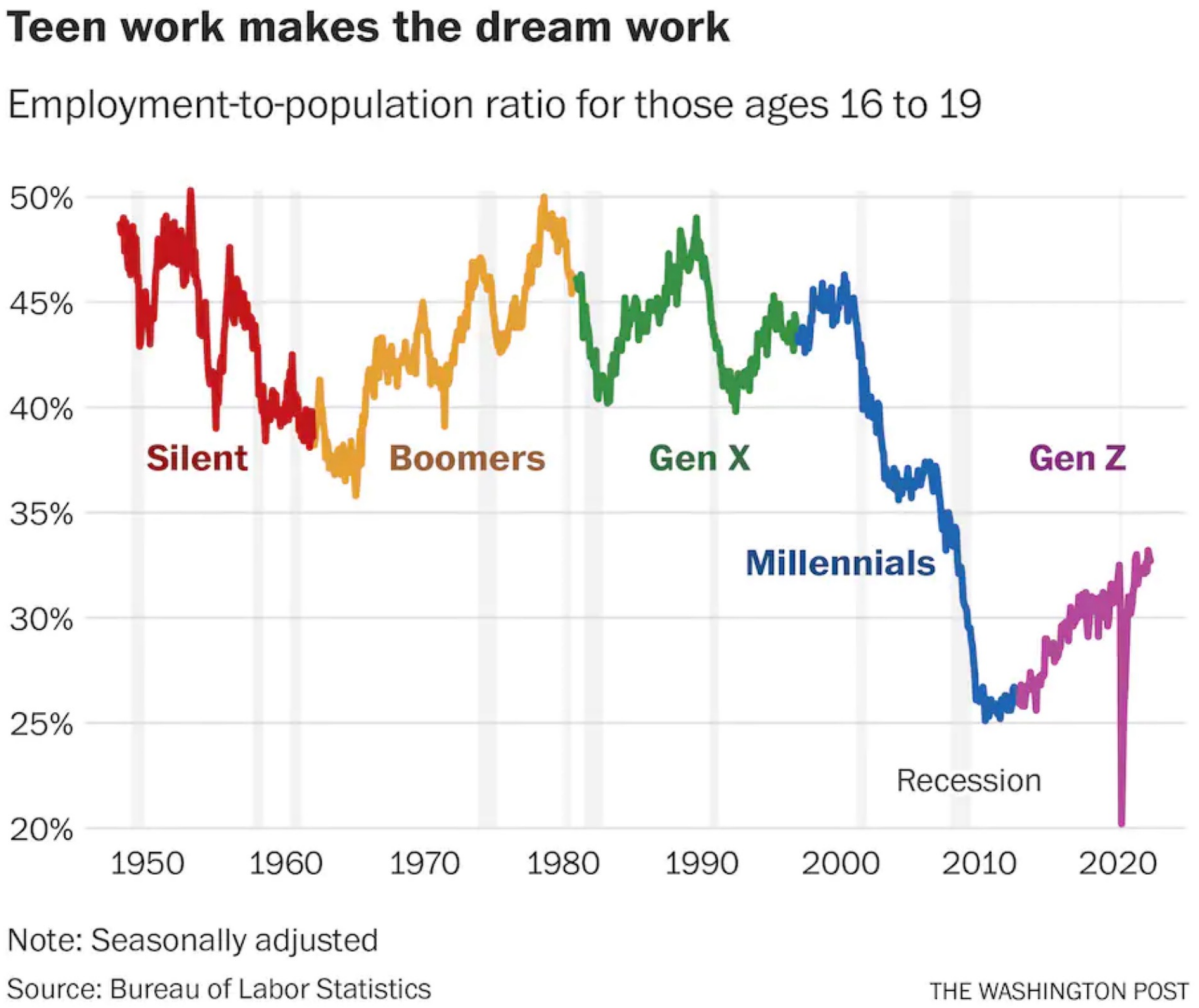
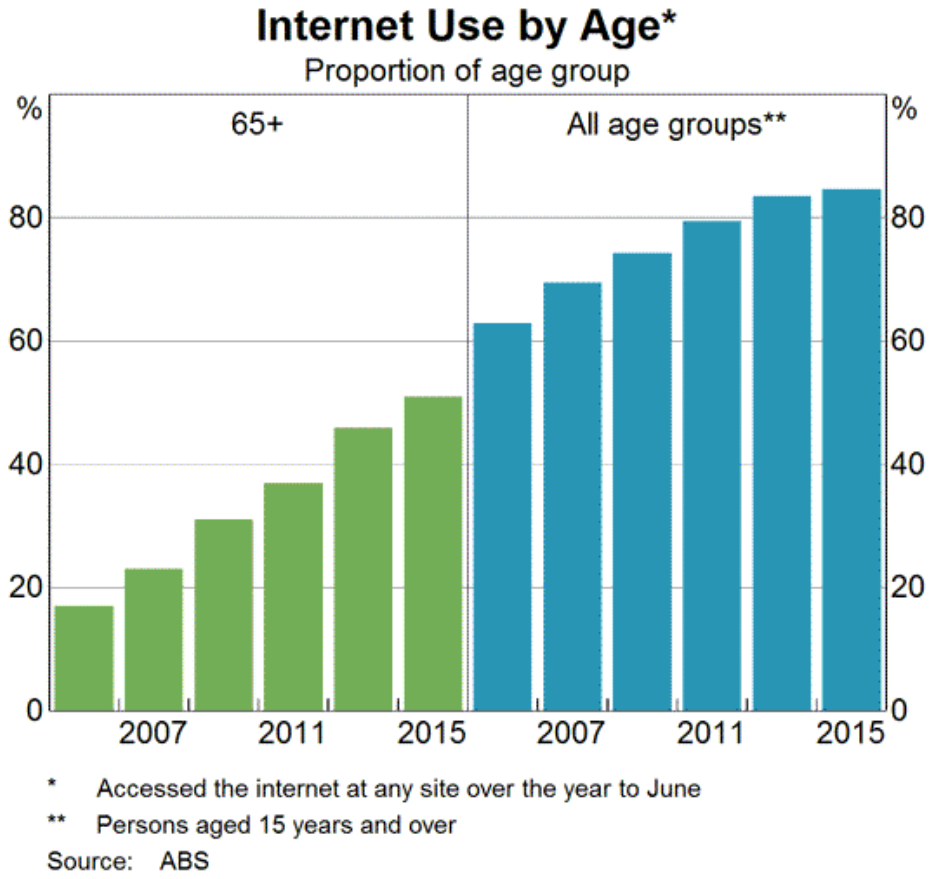
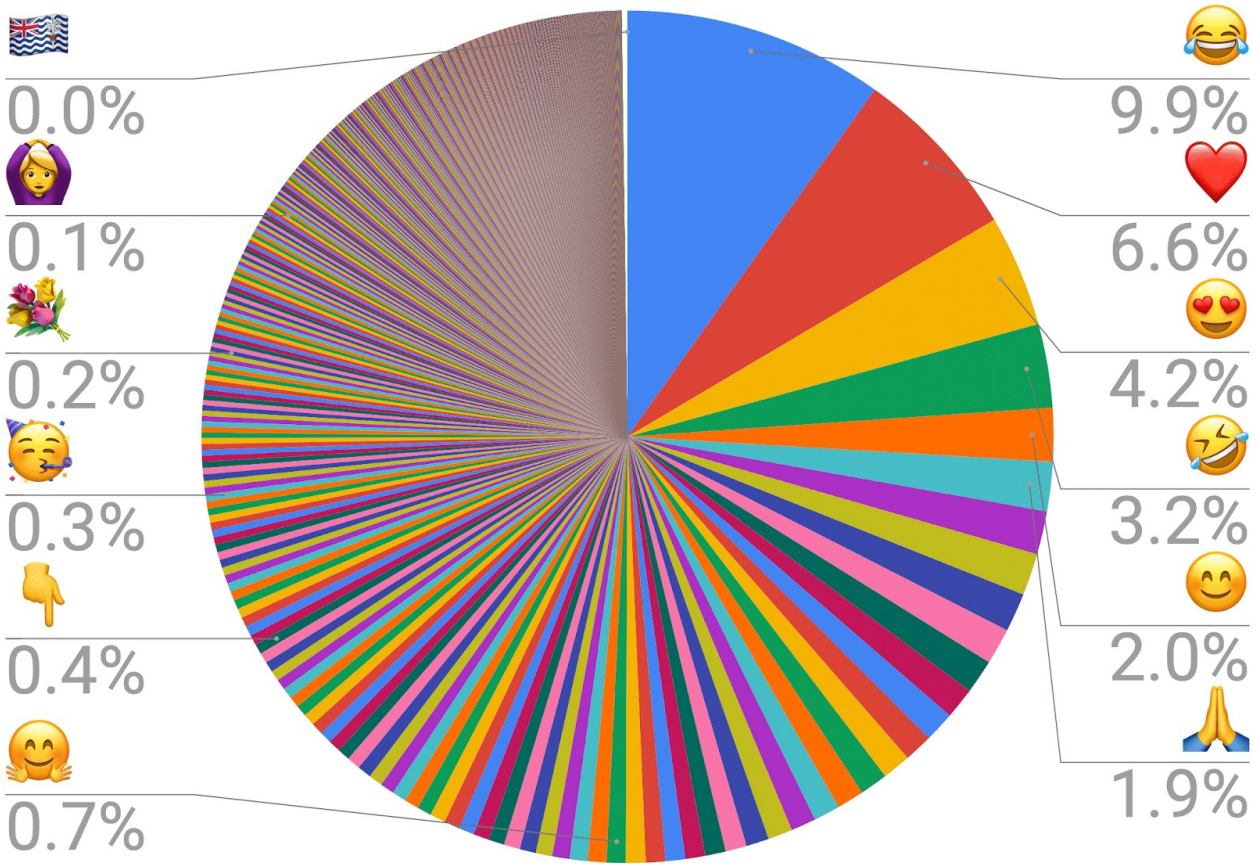
EXERCISES

Evolve the following charts into data stories. Focus on the message and how to avoid misleading the audience.



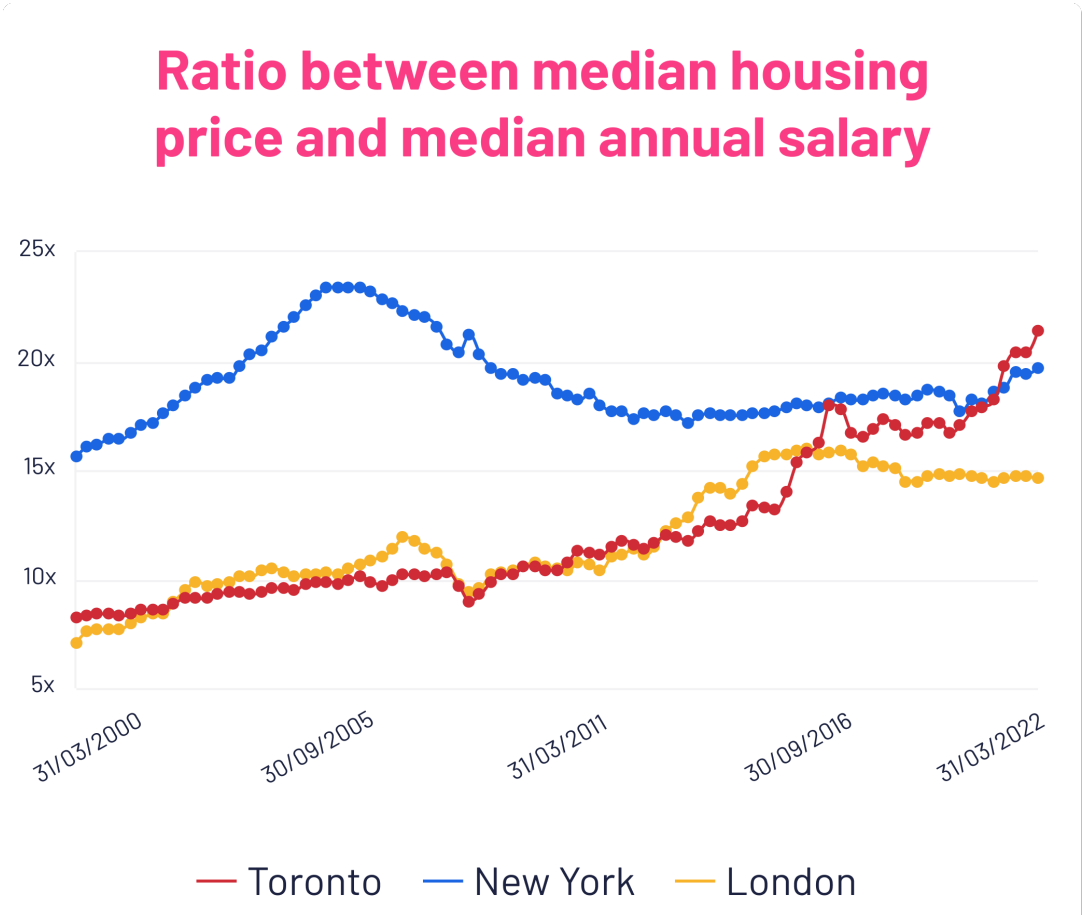
EXERCISES

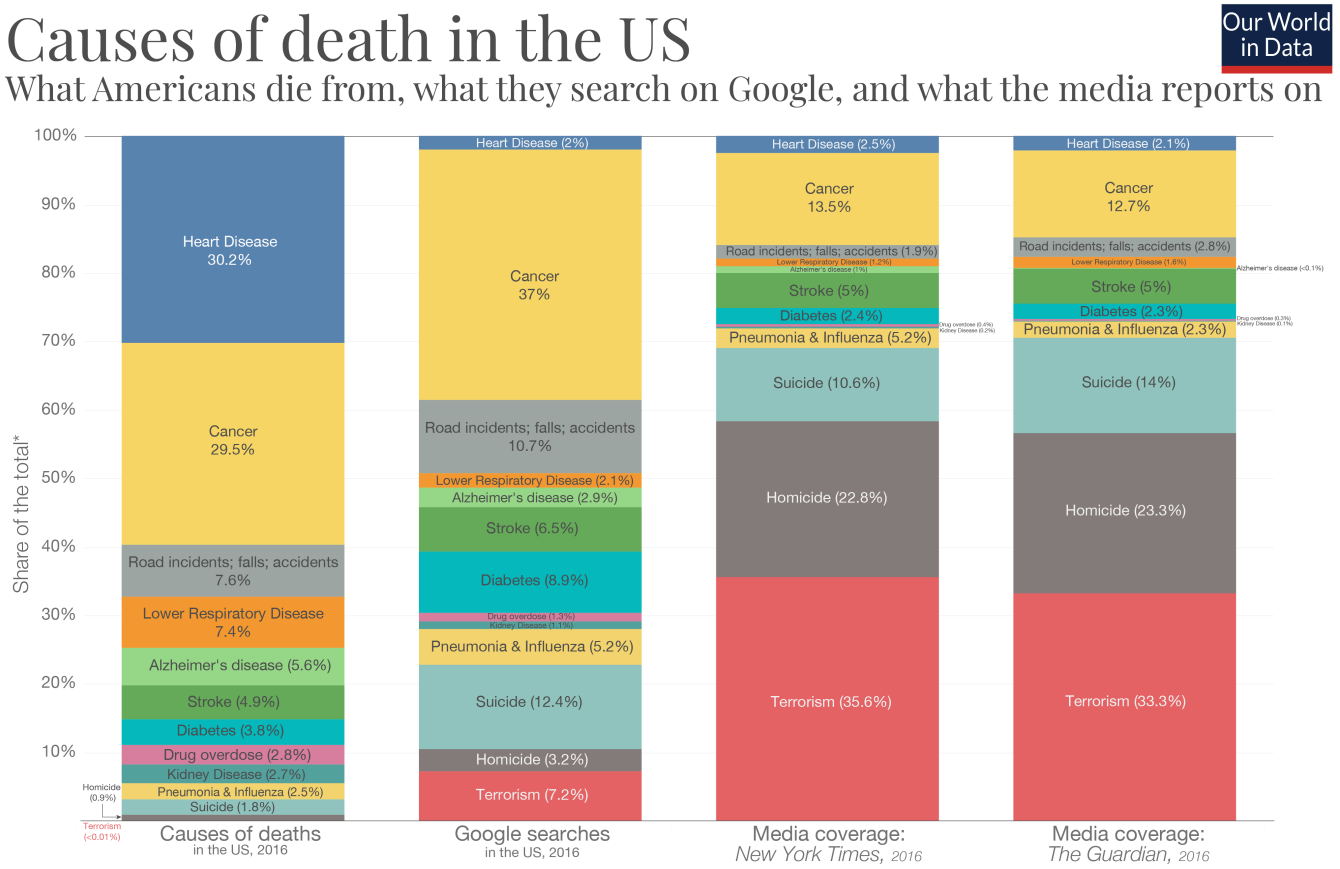

Internet Use by Age*
Proportion of age group
65+
All age groups**
%
80
60
40
20
0
2007
2011
2015
* Accessed the internet at any site over the year to June
** Persons aged 15 years and over
Source: ABS


0.0%
0.1%
0.2%
0.3%
0.4%
0.7%
9.9%
6.6%
4.2%
3.2%
2.0%
1.9%

[https://www.dailywire.com/news/chart-heres-what-americans-actually-die-compared-ashe-schow]

EXERCISES





ANATOMY OF STORYTELLING DASHBOARDS

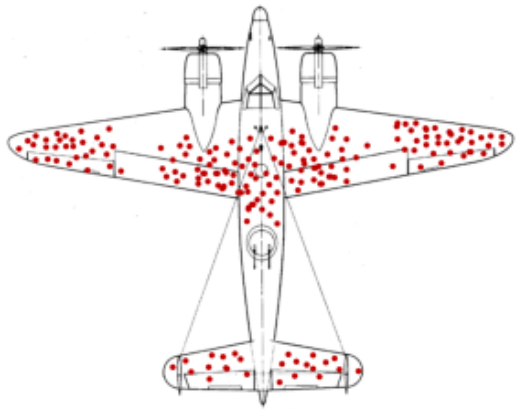
PART II – EFFECTIVE STORYTELLING VISUALS

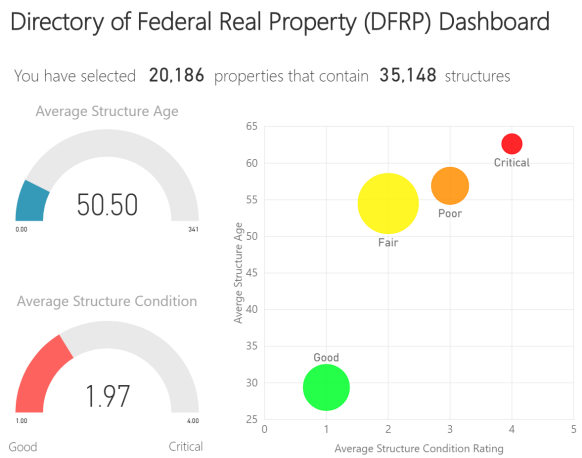
ANATOMICAL CONSIDERATIONS

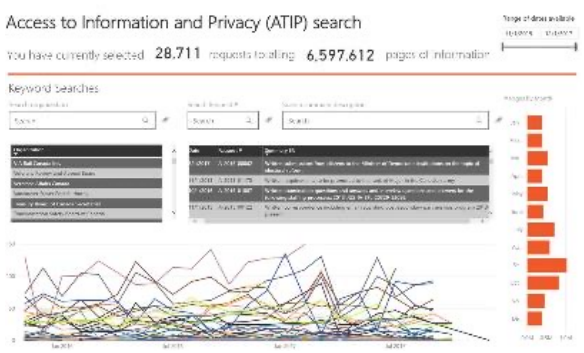
The composition of a (storytelling) dashboard must consider various components:

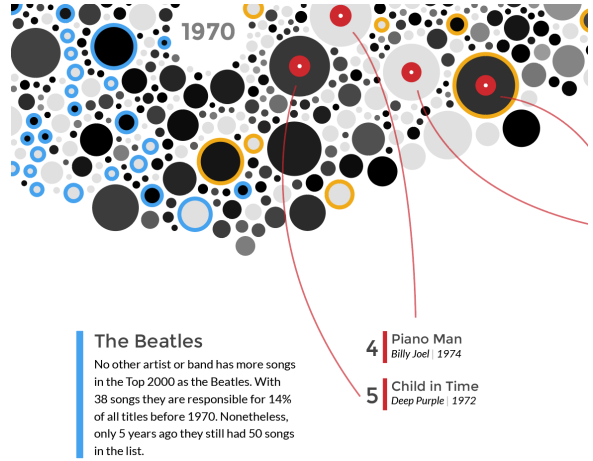
- the audience
- the goals
- the dashboard's narrative
- the narrative's logic
- iconic memory
- short-term memory
- long-term memory

DEFINING CONTEXT









Seconds | **Minutes** | **Fraction of Hour** | **Hours**

← **Infographics/Data Viz** →

← **Dashboards** →

← **Reports and Exploration** →

← **Data Art** →

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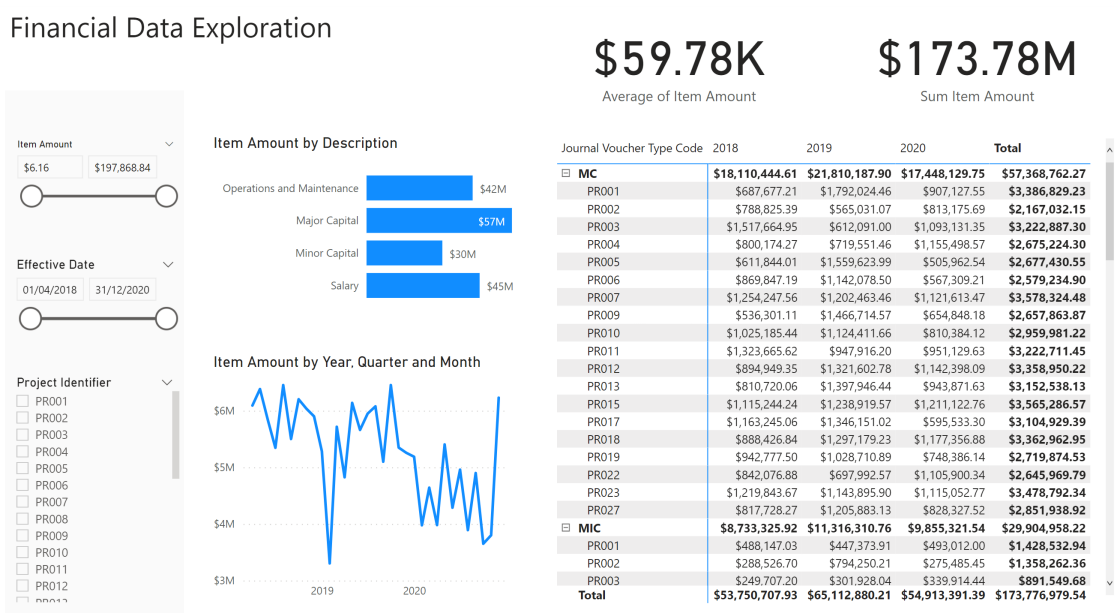
EXPLORATION VS STORYBOOK VS SITUATIONAL AWARENESS

Exploration: using visualizations as a tool to explore data

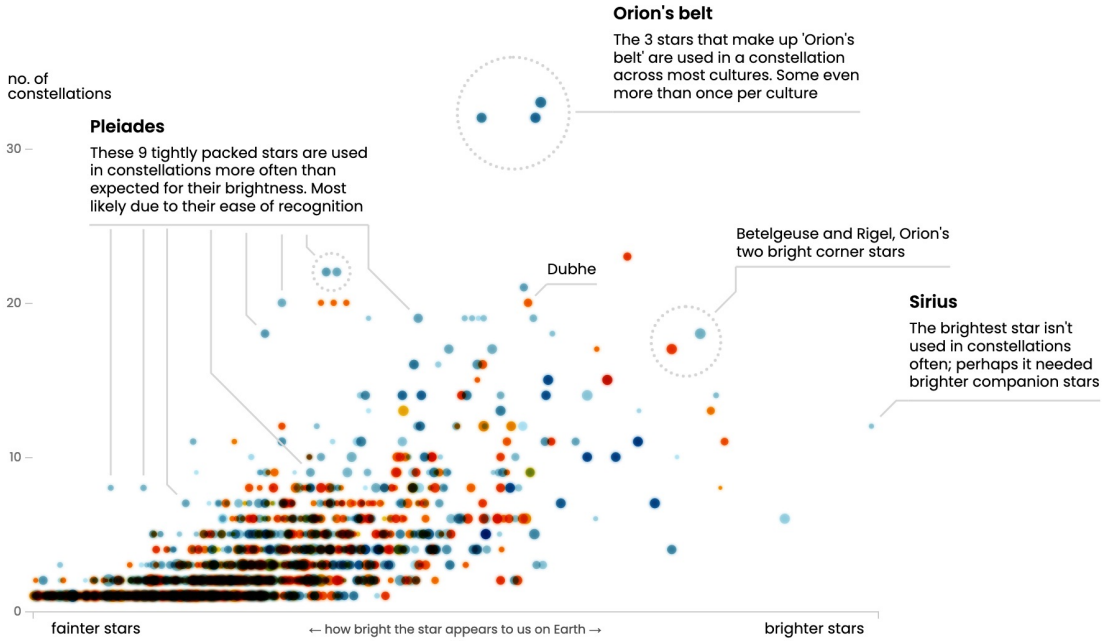
- high level of interactivity
- high level of detail
- **all** aspects of data should be represented (tables, columns, calculations etc.)
- no annotations or explanations required



EXPLORATION VS STORYBOOK VS SITUATIONAL AWARENESS

Storybook: using visualizations as a tool to explain data

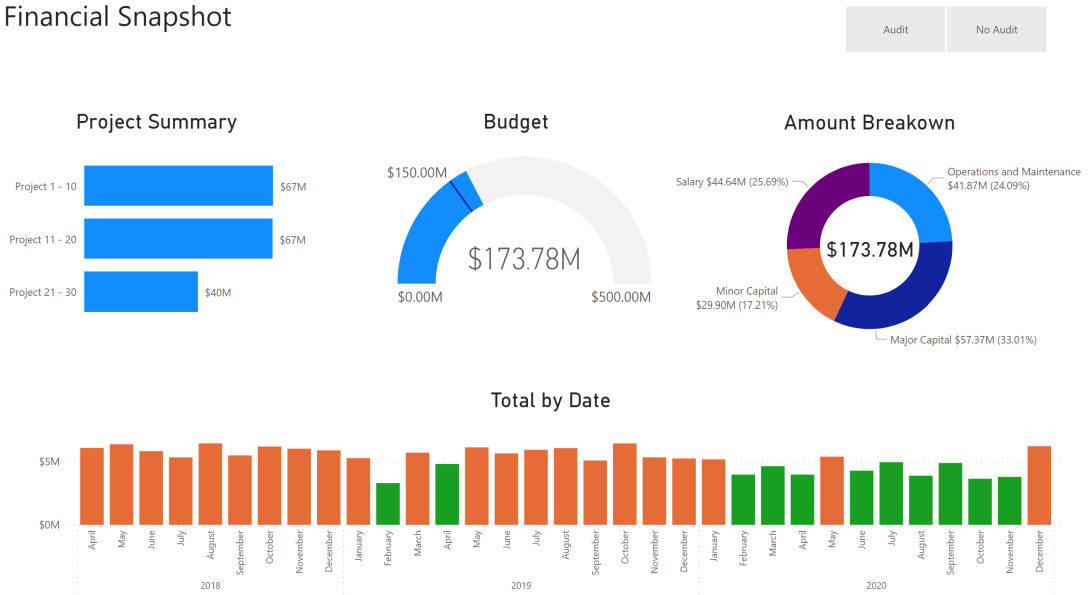
- low level of interactivity
- low level of detail
- key aspects of data should be represented
- annotations and explanations drive the "story"



EXPLORATION VS STORYBOOK VS SITUATIONAL AWARENESS

Situational Awareness: using visualizations as a tool to provide a snapshot of the data

- medium level of interactivity
- not “scripted” but well organized (e.g., categorized)
- summary data should be represented
- anomalies are highlighted



AUDIENCES AND GOALS

Who is the audience?

Avoid general audiences: address **Lines of Business** (finance, engineering, HR, etc.)

Identify **decision-makers** and the various audience **roles.**

Ask the following questions:

- what relationship do you have with them?
- how do they perceive you?
- how do you establish trust and credibility?

AUDIENCES AND GOALS

What does the audience need the data storytelling to do?

To answer this question, we need to know how the results will be used **(actions):**

- what decisions are people going to make from the analysis?
- how often are they going to be looking at the data?
- how often do they expect the data to be refreshed?

What does the audience **need to know**?

AUDIENCES AND GOALS

What does the audience need to know about data **availability**?

- is the data clean?
- can it be accessed?
- is it being “massaged”, used to paint a rosy picture?

How much will the audience need/want to **interact** with the charts?

- are they passive?
- can they run limited filtering?
- what data can they download (if any)

IDENTIFYING AND GATHERING PRESENTATION REQUIREMENTS

The requirements for a dashboard, report, or presentation are driven by the **primary consumers** (the stakeholders that will primarily be getting "value" from using it).

A very common mistake is to **cast the net too wide** and to build something for too many consumer types (all things to all people). Care needs to be taken to identify the primary consumers.

Once that group has been identified, a **formal process** should be followed to gather requirements as accurately as possible

IDENTIFYING AND GATHERING PRESENTATION REQUIREMENTS

Typical requirement questions include (but should not be limited to):

- what is the proposed name of the product?
- who are the target data consumers?
- what is the product high-level objective?
- when does it need to be published?
- what is the data update frequency?
- what kind of business decisions will be made by the target consumer group?
- what is the source of the data?
- is the data/information duplicated anywhere else (e.g., by a 3rd party)?
- what is the sensitivity level of the source data?
- what is the sensitivity level of the final product?
- how is the source data gathered?
- what quality assurance is performed on it?

STORYBOARDING

Once we have a set of well defined requirements we are in a position to perform and **storyboarding** exercise.

Storyboarding is a way to summarize the flow of information into a **coherent whole**.

It helps us determine **how many pages/elements per page** we might need.

This is **NOT** the same as designing the **layout** of a dashboard.

Storyboarding is used to **define the story** and the dashboard's **content**.

STORYBOARDING

Example

1. State intended hiring goal for the year

2. Describe what is driving the hiring (Fed Gov't Init)

3. Show how close/far the goal is as of today

4. Show which departments have the highest requirements

5. Demonstrate which groups are impacted the most

6. Ask/tell the reader how they can help

CREATING A NARRATIVE

There are a number of ways of constructing a **narrative**, including:

- chronological
- most important first, or least important first
- begin with the end
- success first, bad news last, or bad new first, success last

Advice: tell the story of the data in a number of different ways

Some dashboards are temporary but some will be a constant reference: this has an impact on how the data should be presented.

MAINTAINING A CLEAR NARRATIVE

Horizontal logic:

- if your visualizations span many pages then the title of each page should tell you the story
- reinforce with an executive summary dashboard or report at the beginning

Vertical logic:

- one page or many, the content should reinforce the title and *vice versa* (self-reinforcement)
- there should be a logical link between all the elements, tags and visual aids on the page

VISUAL PROCESSING

Perception is fragmented – eyes are continuously scanning.

Visual thinking seeks patterns

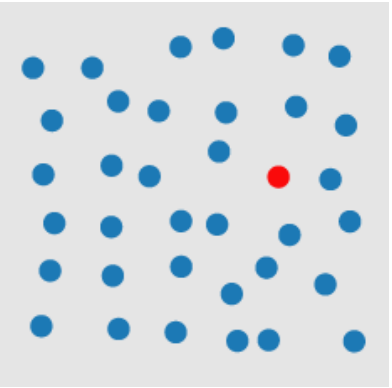
- **pre-attentive processes:** fast, instinctive, efficient, multitasking gather information and build patterns:

  features → patterns → objects

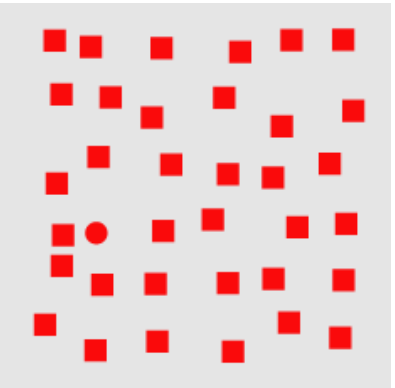
- **attentive process:** slow, deliberate, focused discover features in the patterns:

  objects → patterns → features

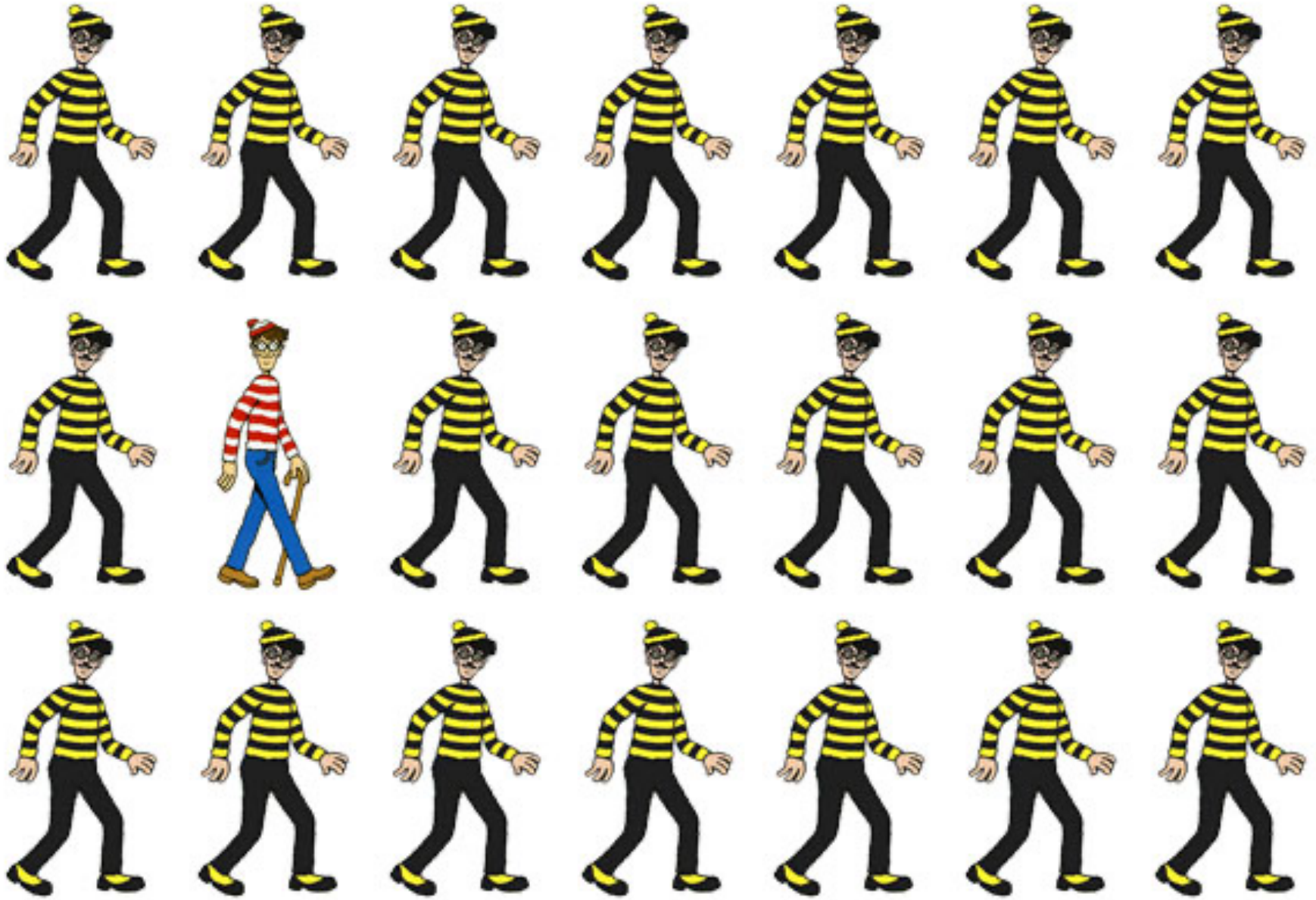
pre-attentive



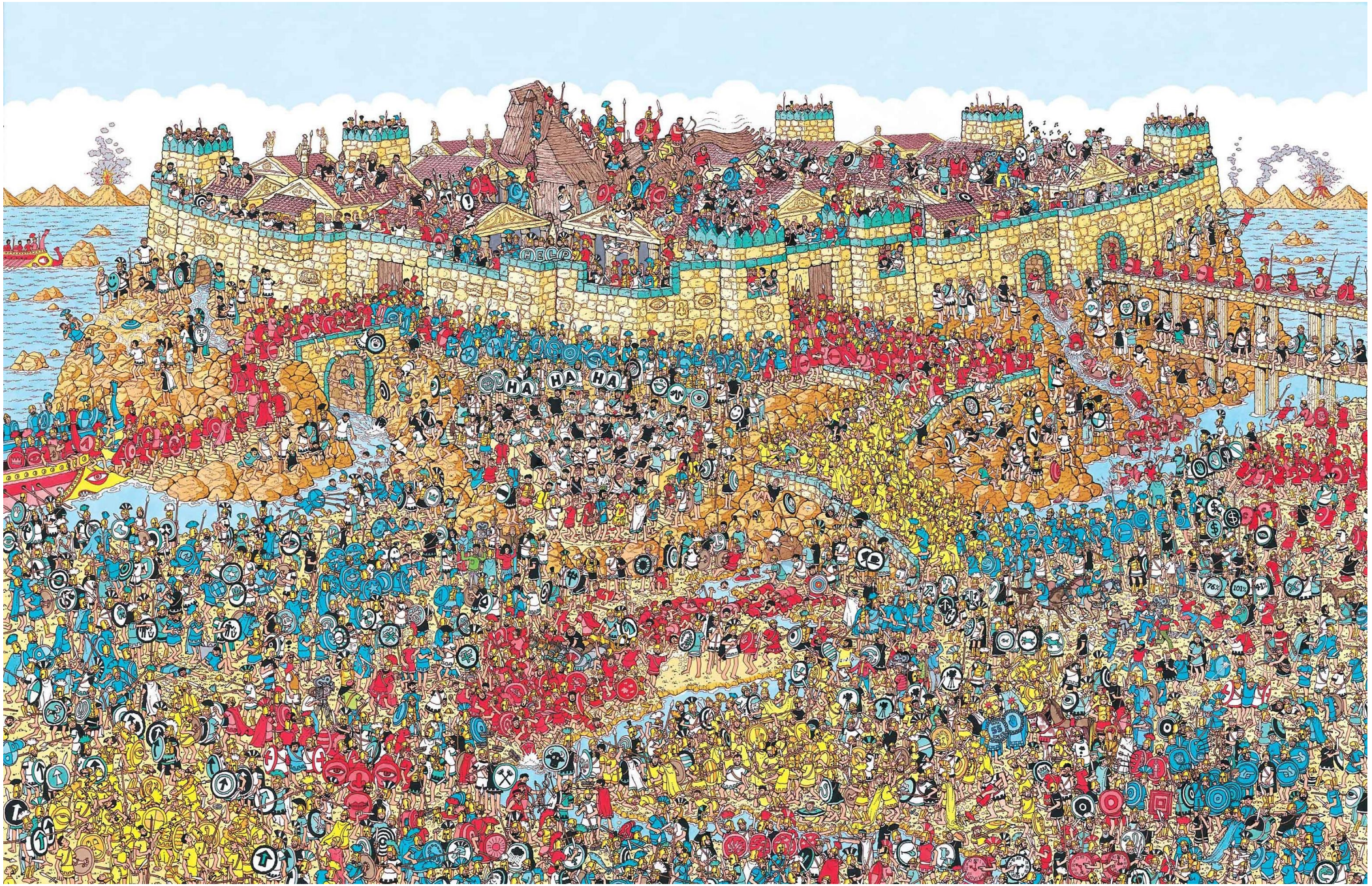
attentive



[L. Groeger, A Big Article About Wee Things, ProPublica.com]



[L. Groeger, A Big Article About Wee Things, ProPublica.com]



ENGAGING MEMORY

Different types of memories are engaged when we tell stories:

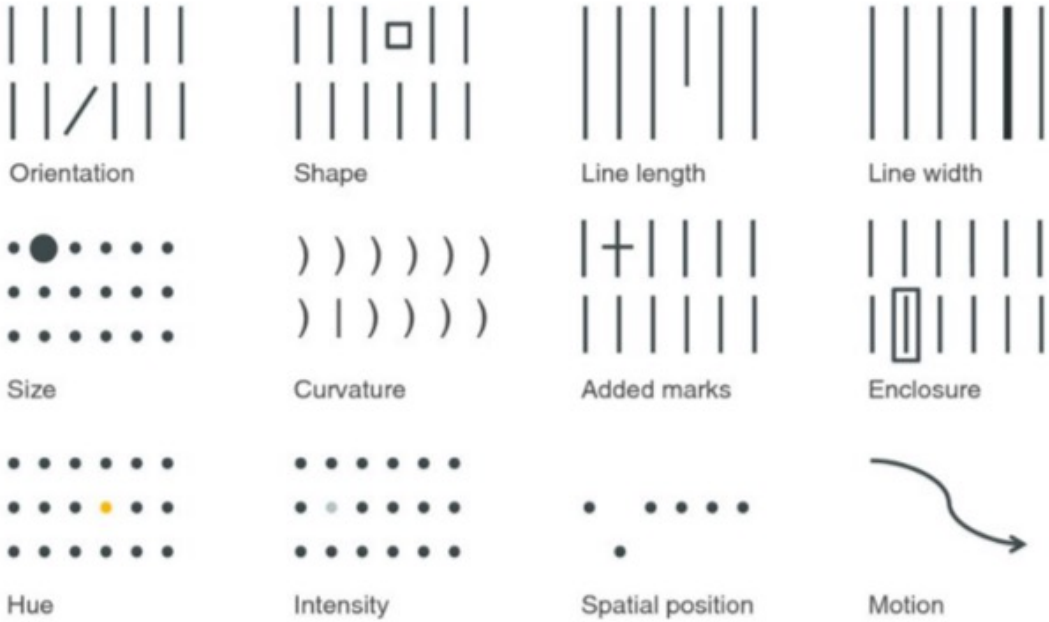
1. **iconic memory** – directs the eye
2. **short-term memory** – limits how many charts are found in dashboards
3. **long-term memory** – helps the audience remember what they saw

ENGAGING MEMORY

Iconic memory is the **visual sensory memory** (SM) register relating to the visual domain and a fast-decaying, high-capacity store of visual information.

Iconic memory is **very brief** (< 1000 ms) and provides a **coherent representation of our entire visual perception**.

Tuned to **pre-attentive attributes** (subconscious accumulation of information from the environment).



ENGAGING MEMORY

Short Term Memory can hold ~4 chunks of visual information in **short-term memory** at a given time.

When presented with more chunks (such as data points on a graph), chunks need to be **processed in and out of memory**.

Generally, we try to form **bigger**, **focused** hierarchies of chunks (Gestalt principles).

ENGAGING MEMORY

Long-term memory is built up over a lifetime and is the basis for pattern recognition and general cognitive processing.

It is an aggregate of **visual** memory and **verbal** memory.

Images help us recall long-term memory, making the story **“stick”**.

Context-providing text also makes a difference:

You have currently selected 28,711 ATIP requests totaling 6,597,612 pages of information

VS

ENGAGING MEMORY

Long-term memory is built up over a lifetime and is the basis for pattern recognition and general cognitive processing.

It is an aggregate of **visual** memory and **verbal** memory.

Images help us recall long-term memory, making the story **“stick”**.

Context-providing text also makes a difference:

vs

ATIP Requests		
30K requests	6.6M pages	230 pages/request

[Based on a idea by C. Nussbaumer Knaflic, *Storytelling With Data*]

WEEKLY number of boats sold (20X6) – Store #16

2869408609876
9348586748676
2967303986739
3967496749674

Yearly goal: **290**
20X6 total: **307**

Do these numbers look **reasonable?**

2869408609876
9348586748676
2967303986739
3967496749674

Most frequent weekly number of boats sold: **6** **(11 times)**

Occurred: **randomly** (as expected)

2869408609876
9348586748676
2967303986739
3967496749674

Another frequent weekly number of boats sold: **8**

Occurred: **5 times immediately before a 6 (out of 7)** (surprising)

2869408609876
9348586748676
2967303986739
3967496749674

Another frequent weekly number of boats sold: **7**

Occurred: **7 times immediately after a 6 (out of 8)** (surprising)

VERDICT: The two last charts suggest that the weekly sale numbers **are not random**, and that they may have been falsified. We recommend **performing an audit** of sales for store #16.

EXERCISES

1. Consider a data question of interest to you personally, your organization, or your society. Identify the target audience and the goals for your dashboard.

2. Do you require an exploration dashboard? A storybook? A situational awareness dashboard? Some combination of the above?

3. Identify the presentation requirements for your dashboard.

4. Create a storyboard for your dashboard.

5. What type of narrative and logic do you think would best serve your needs?

CHART AESTHETICS

PART II – EFFECTIVE STORYTELLING VISUALS

[www.interaction-design.org/literature/topics/gestalt-principles]

GESTALT PRINCIPLES

The **Gestalt principles** are the “laws” of human perception.

They describe how humans group similar elements, recognize patterns and simplify complex images when they perceive objects.

Designers use them to organize content on charts, dashboards, websites, and other interfaces so that they be **aesthetically pleasing** and **easy to understand**.

[www.interaction-design.org/literature/topics/gestalt-principles]

GESTALT PRINCIPLES

"Gestalt" is German for "unified whole".

The first principles were devised in the 1920s by German psychologists Wertheimer, Koffka ("the whole is greater than the sum of the parts") and Kohler.

Aim: understand how humans gain meaning from the chaotic stimuli around them.

The Gestalt principles are a set of "laws" which address the natural compulsion to find order in disorder. According to this, the mind "informs" what the eye sees by **perceiving a series of individual elements as a whole**.

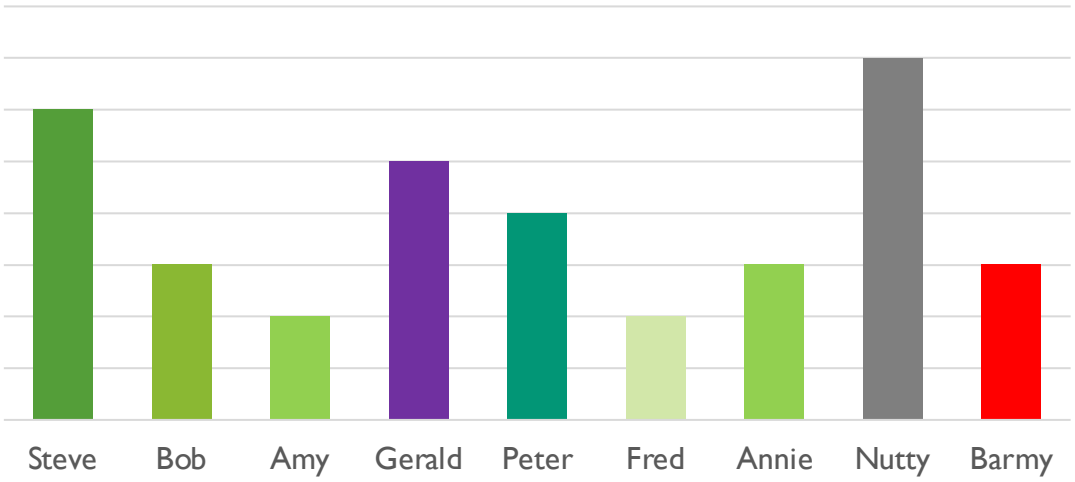
GESTALT PRINCIPLES

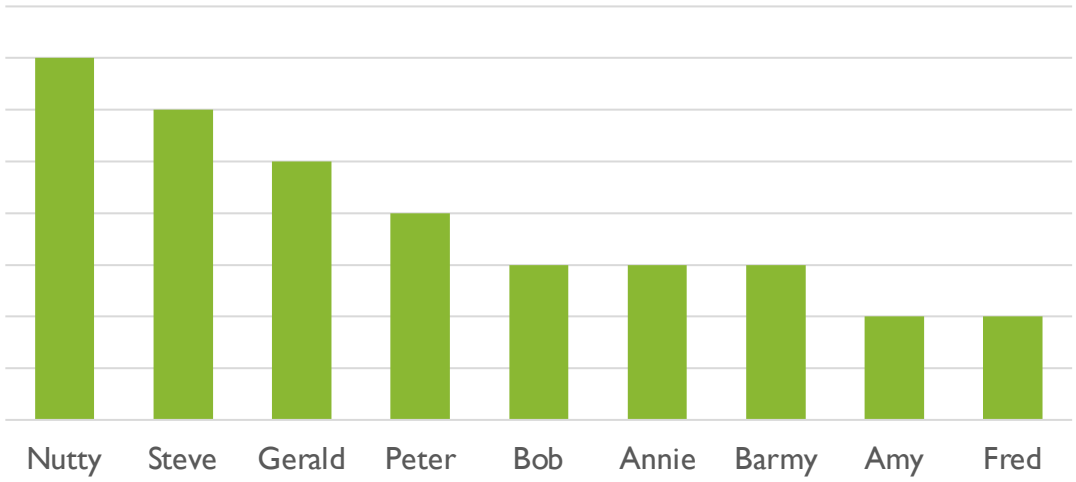
- simplicity
- continuation
- proximity
- similarity (invariance)
- focal point
- isomorphic correspondence
- figure / ground duality
- common fate*
- closure*
- uniform connectedness*

GESTALT PRINCIPLES – SIMPLICITY

The brain has a preference for **simplicity** – it tends to process simple patterns faster than patterns that are more complex.

Lesson: arrange data simply and logically wherever possible.



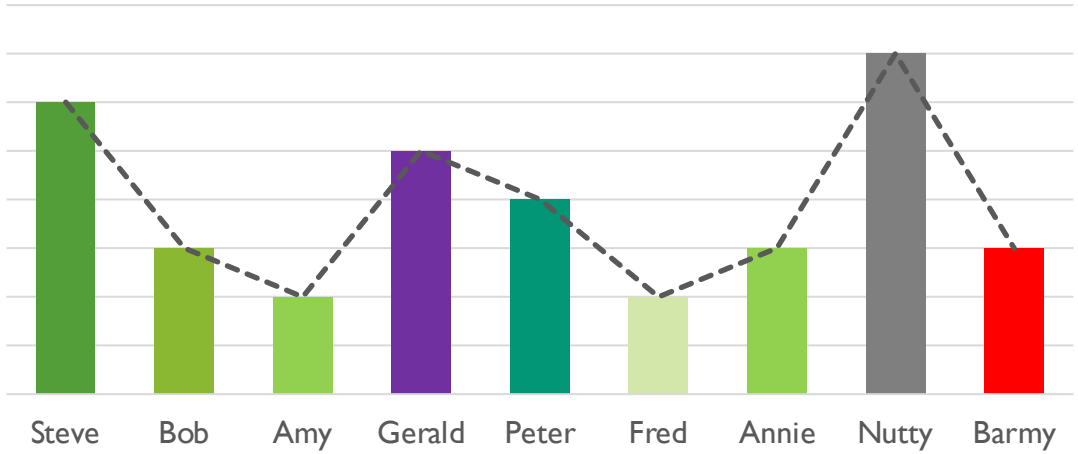


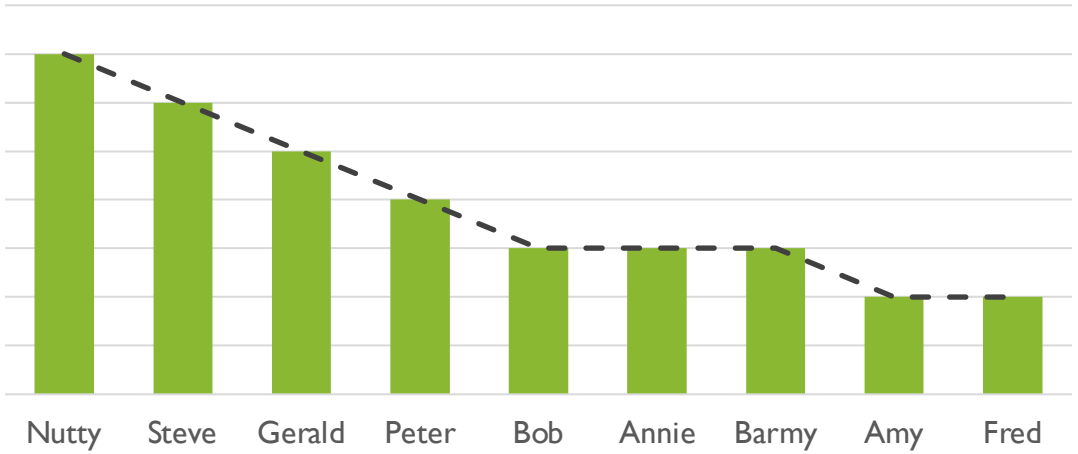
GESTALT PRINCIPLES – CONTINUATION

Our eyes group things that are **aligned** (e.g. sorted from high to low) with each other.

In the chart on the right the eyes follow a **continuous path**; it makes the whole chart more readable because of the continuous downward direction

Lesson: arrange objects in a line to facilitate grouping and comparison.





GESTALT PRINCIPLES – PROXIMITY

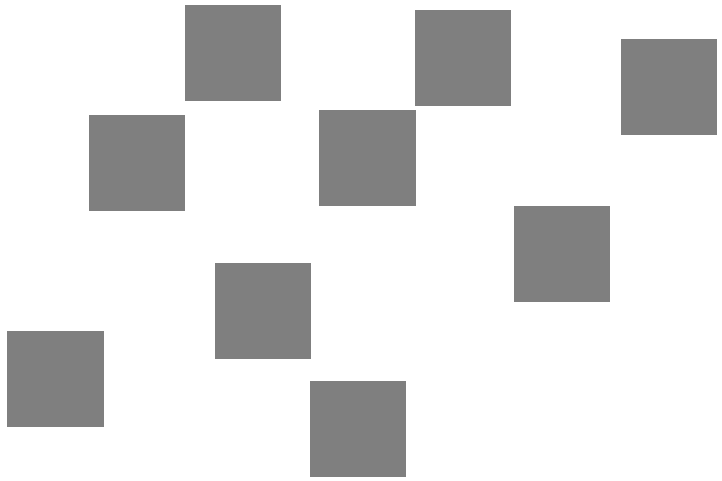
Objects/shapes that are **in proximity** (close) to one another appear to form **groups**.

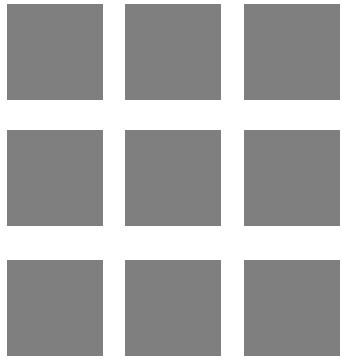
The effect generated by the collected group is more “powerful” than that generated by separate elements.

Elements which are grouped together create the **illusion** of shapes/planes in space, even if the elements are not touching.

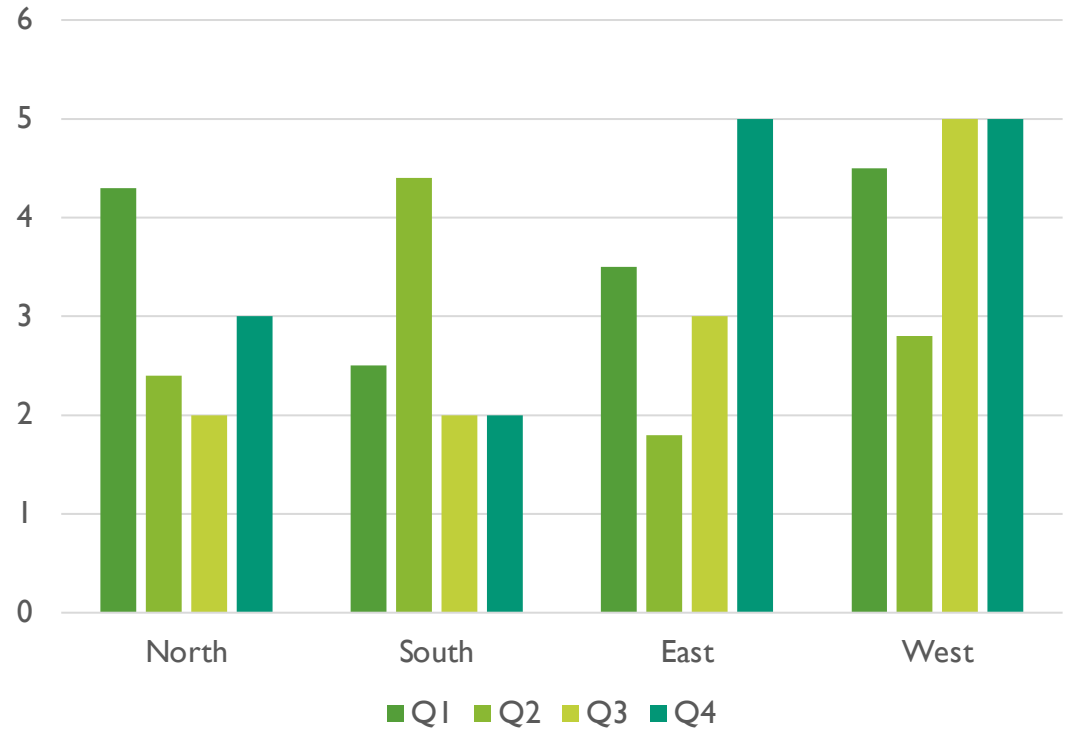
Lesson: understand the chart’s priorities and create groupings through proximity that support those priorities.

GESTALT PRINCIPLES – PROXIMITY





GESTALT PRINCIPLES – PROXIMITY



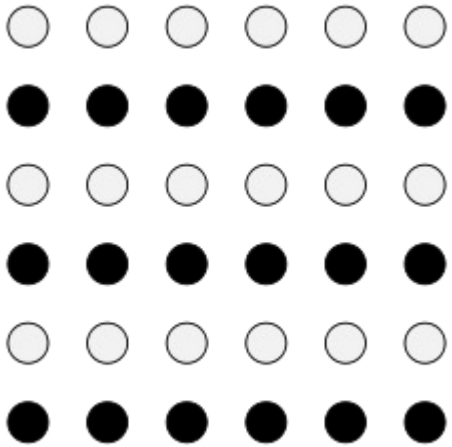
GESTALT PRINCIPLES – SIMILARITY (INVARIANCE)

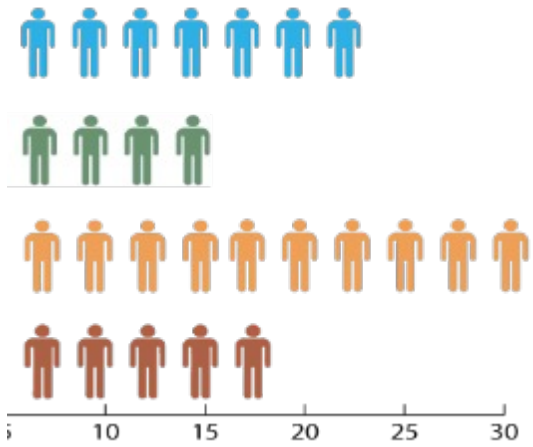
Similarity: stimuli that physically resemble each other are viewed as part of the same object; stimuli that don't are viewed as part of a different object.

Similarity and proximity often come together to form a **Visual Hierarchy**. Either principle can dominate the other, depending on their application and combination.

Lesson: use similar characteristics to establish relationships and to encourage groupings of objects.

GESTALT PRINCIPLES – SIMILARITY (INVARIANCE)

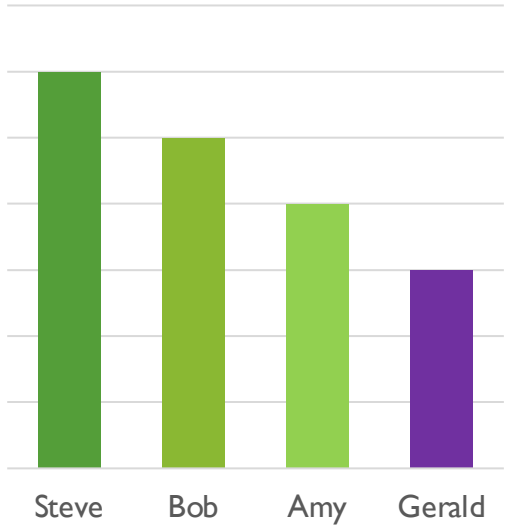


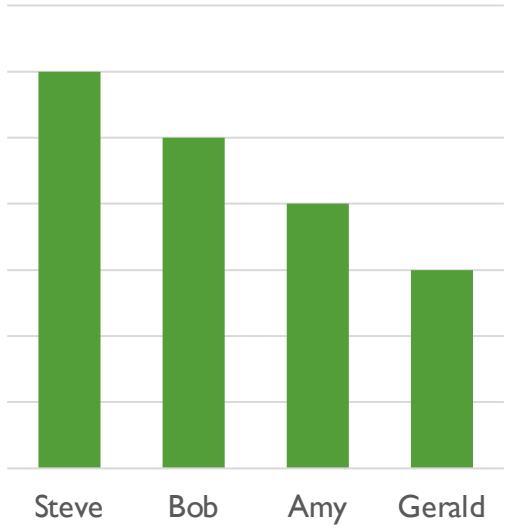


In these examples, similarity dominates over proximity: we see rows before we see columns.

GESTALT PRINCIPLES – SIMILARITY (INVARIANCE)

Making things similar can reduce cognitive load (cf. last graph colour).



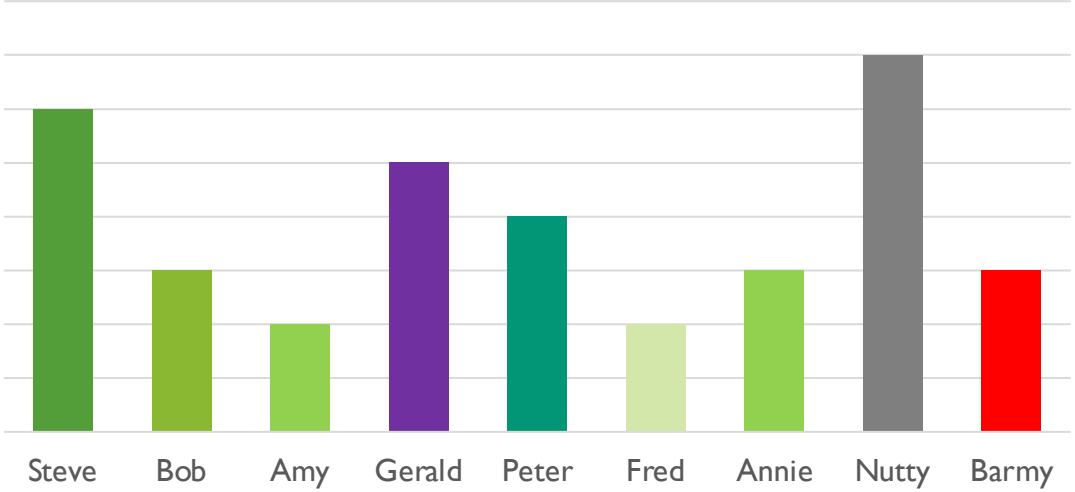


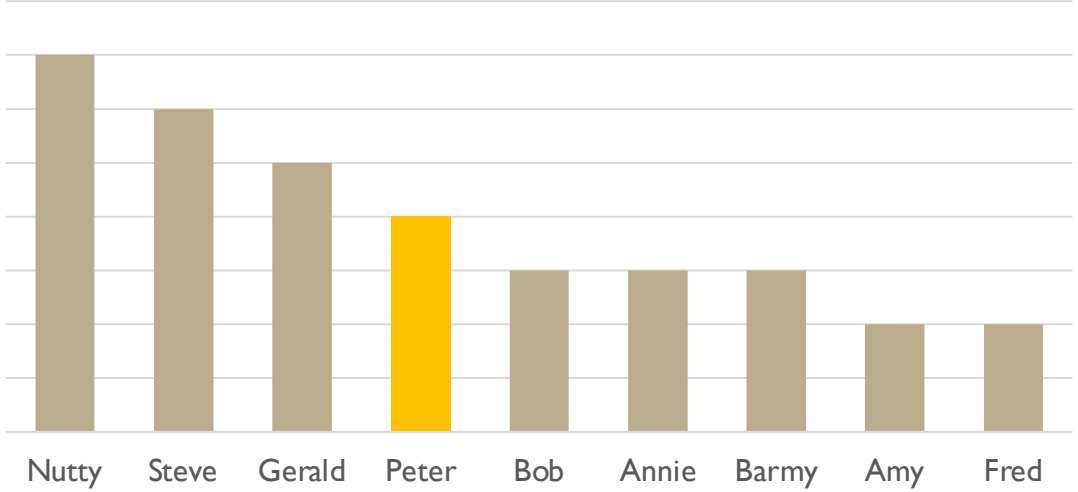
GESTALT PRINCIPLES – FOCAL POINT

In opposition to similarity, the **focal point** principle states that distinctive-looking objects can create a focal point.

To highlight one salesperson's performance, make their bar graph color different.

Lesson: use different characteristics to highlight and create focal points.



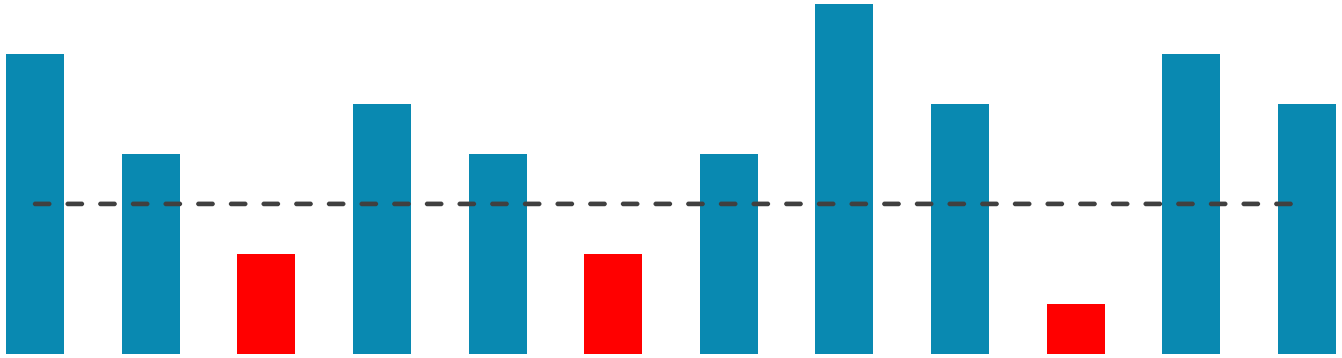


GESTALT PRINCIPLES – ISOMORPHIC CORRESPONDENCE

People interpret and respond to images based on past/shared experiences (in particular, for the selection of chart colours).

Red is often associated with **bad** and **green** with **good** (colour-blindness?). We can colour-code charts accordingly.

Lesson: stick to well-established conventions and best practices (even if boring!)



GESTALT PRINCIPLES – FIGURE/GROUND DUALITY

Chart elements are either perceived as **figures** (focus) or as (back)**ground**.

Foreground objects are **promoted** by the brain, background objects are **demoted**.

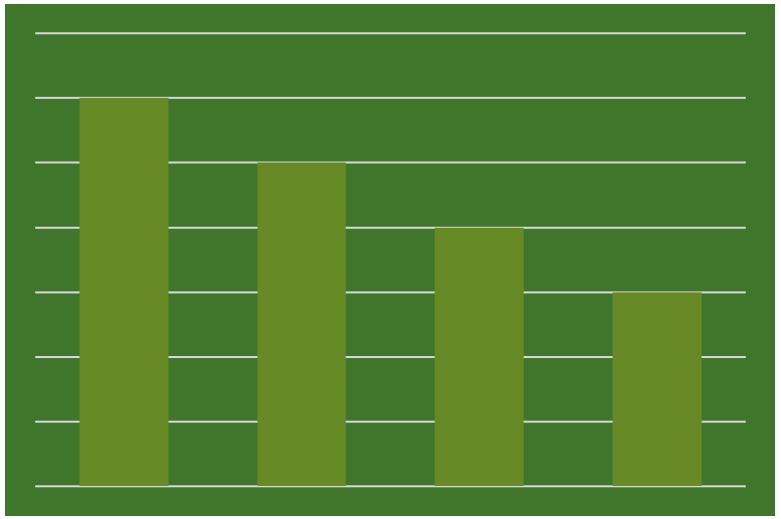
Strong contrast makes it easier to distinguish between the two types of objects.

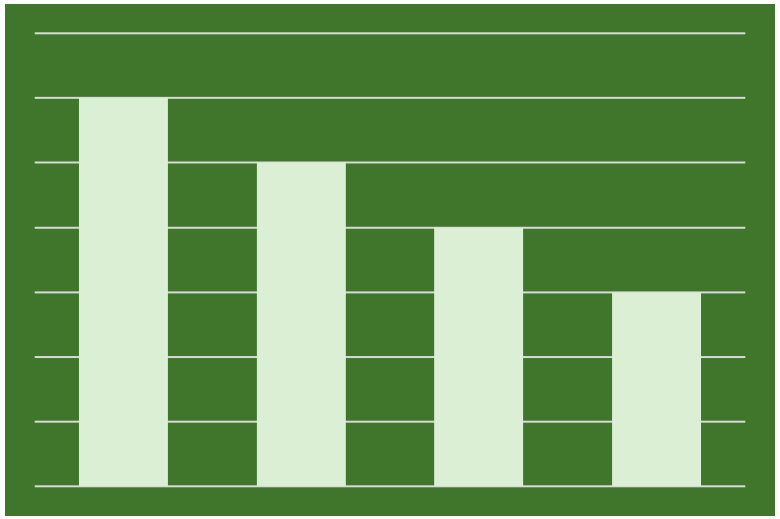
Lesson: ensure there is enough contrast between the chart foreground (figures) and their background.

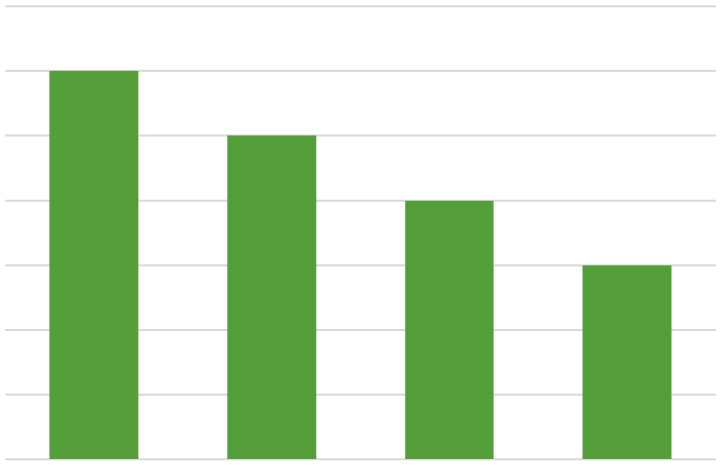
GESTALT PRINCIPLES – FIGURE/GROUND DUALITY

Because of the low contrast between the figure and background in the chart on the left, there is an **additional cognitive load**.

Increasing the contrast on the right improves readability.







DECLUTTERING

CLUTTER IS THE ENEMY!

Every element on a page adds **cognitive load**

- identify and **remove** anything that isn't adding value
- think of cognitive load as mental effort required to process information (lower is better)

Tufte refers to the **data to ink ratio** – "the larger the share of a graphic's ink devoted to data, the better"

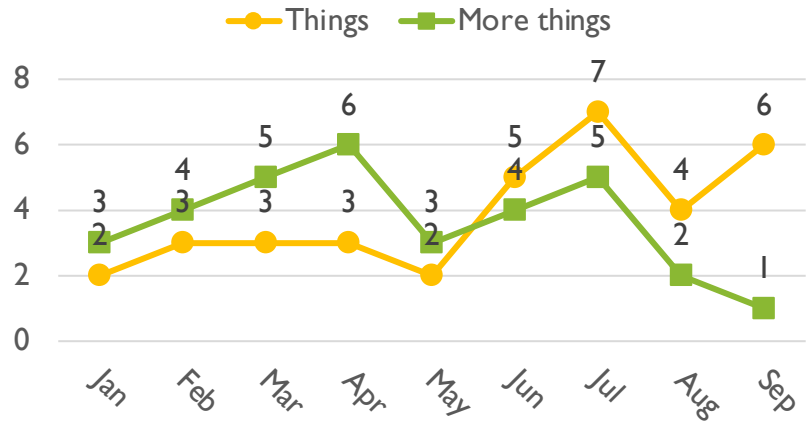
In *Resonate*, Duarte refers to this as "**maximizing the signal-to-noise ratio**" where the signal is the information or the story we want to communicate.

DECLUTTERING

Use the **Gestalt Principles** to organize/highlight data in the chart.

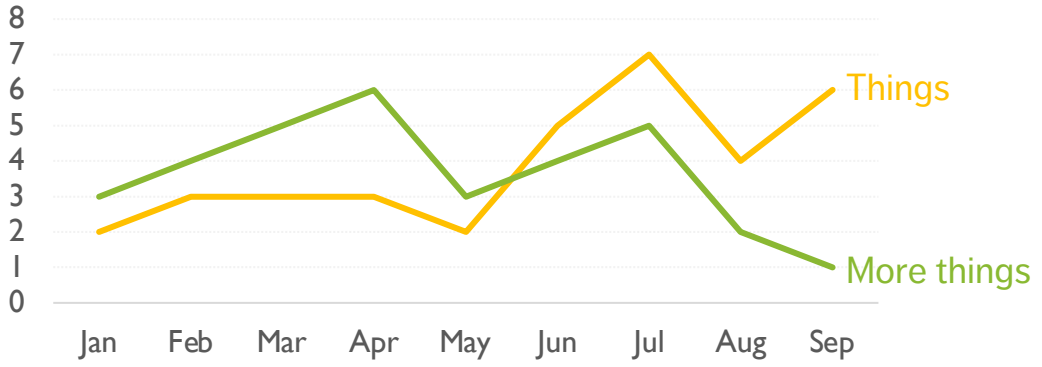
Align all the elements (graphs, text, lines, titles, etc).

- DON'T rely on eye, use position boxes and values



Charts:

- remove border, gridlines, data markers
- clean up axis labels
- label data directly



DECLUTTERING

Use **consistent** font, font size, colour and alignment.

Don’t rotate text to anything other than 0 or 90 degrees.

Use **white space:**

- margins should remain free of text and visuals
- don’t stretch visuals to edge of page or too close to other visuals
- think of white space as a border

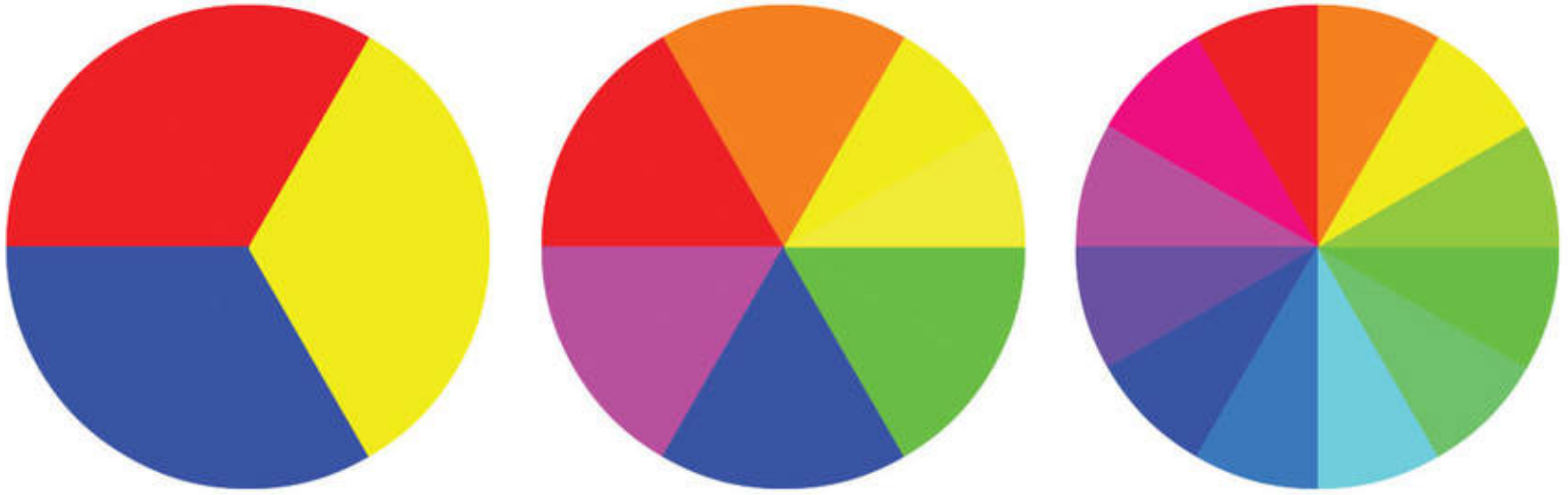
[akshaymishra.weebly.com/colour-theory.html]

COLOUR THEORY

Colour theory (complicated topic – here is a start):

- http://www.deanenettles.com/webexamples/colorexamples/
- https://www.sessions.edu/color-calculator/

Colour wheels:



Primary Colours | Secondary Colours | Tertiary Colours

COLOUR SCHEMES

Achromatic (colourless, using only blacks, whites and grays)

Monochromatic (1-colour schemes)

Complementary (colours directly across from each other on the colour wheel)

Split complementary (2 of the 3 colors are adjacent; 1 of the colours is opposite)

COLOUR TIPS

When it comes to colour, **less is more**: use it sparingly (graphic designers are taught to “get it right, in black and white”).

Based on the Gestalt Principles, **monochrome** schemes can be particularly effective.

When appropriate, pick scheme based on corporate identity (this maximizes buy in).

Create a template (and stick to it).

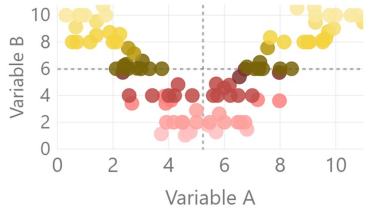
Upload images to see what charts look like in various flavours of colour-blindness:

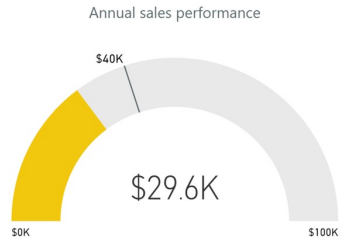
- https://www.color-blindness.com/coblis-color-blindness-simulator (there are other tools)

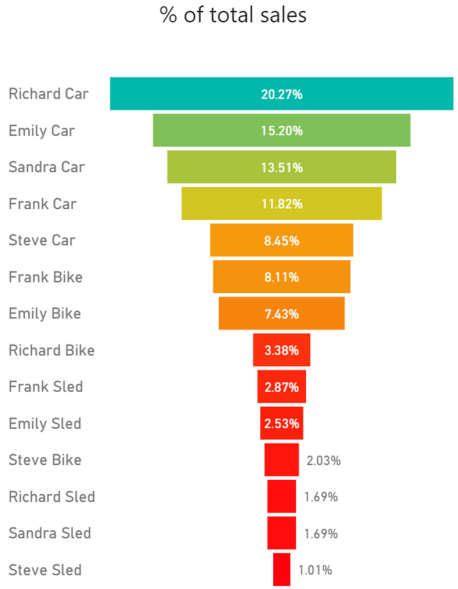
SIZE CONSIDERATIONS

Size: assuming that the chart has been decluttered

- things of equal importance size similarly
- other things scale to importance



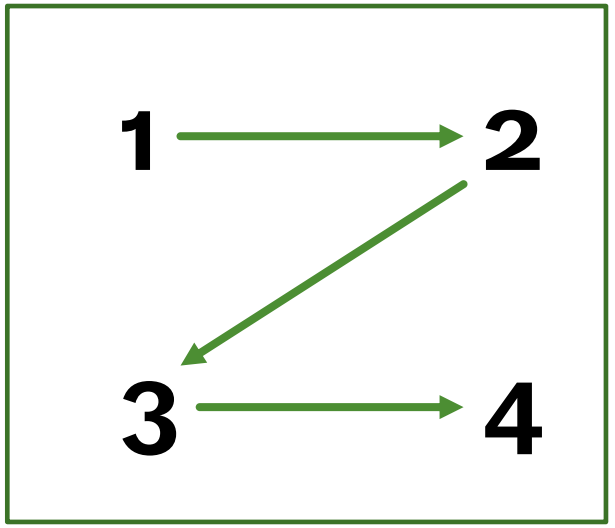




POSITION CONSIDERATIONS

How should the elements be placed in a chart/dashboard?

In the West, most people start at the top left and zig-zag all the way to the bottom right.



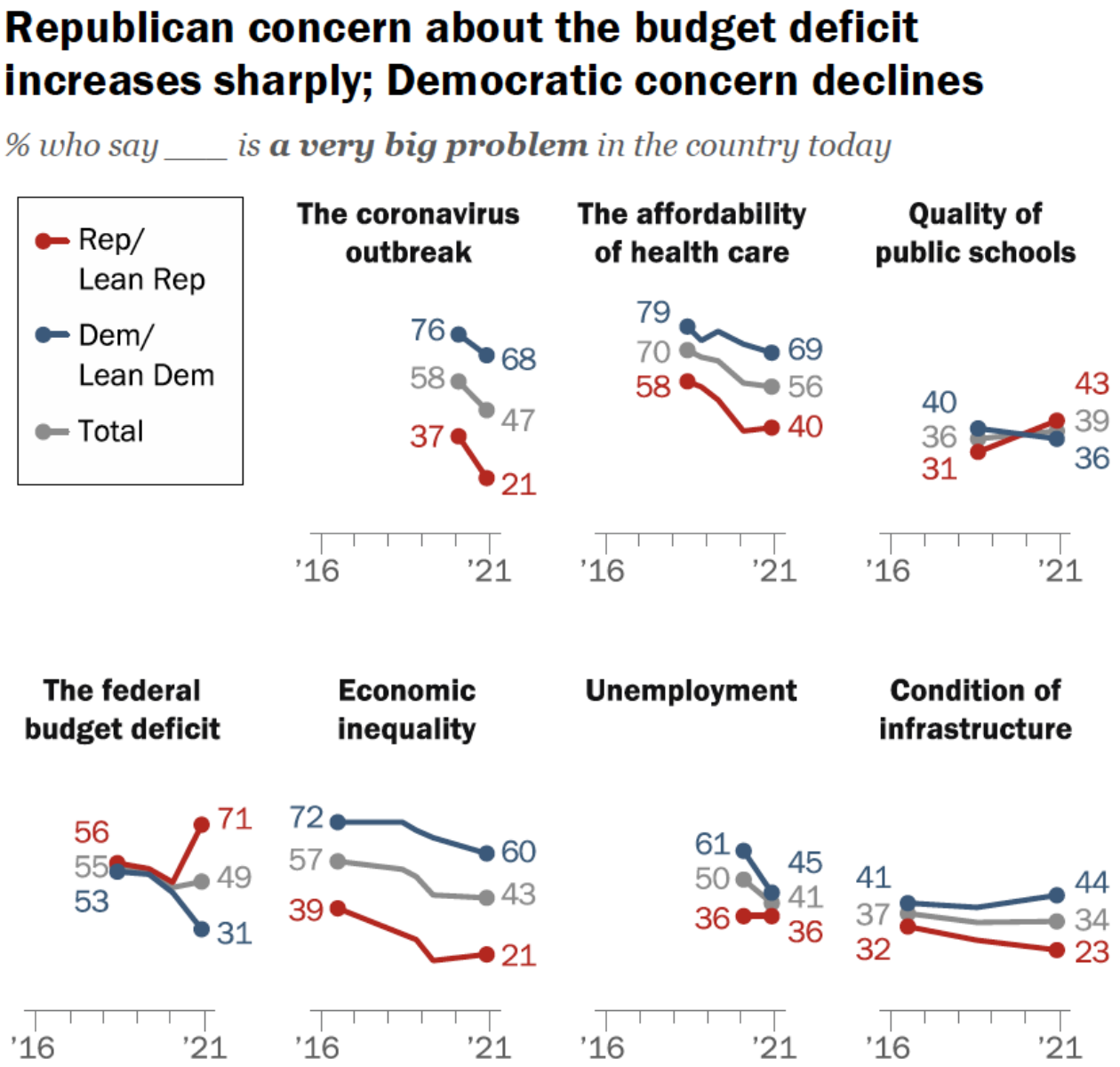
Simple rule: don't make people work too hard

- main message: top left/top right
- info in order of preference
- people concentrate less as they scan so get less complex as you move to bottom corner

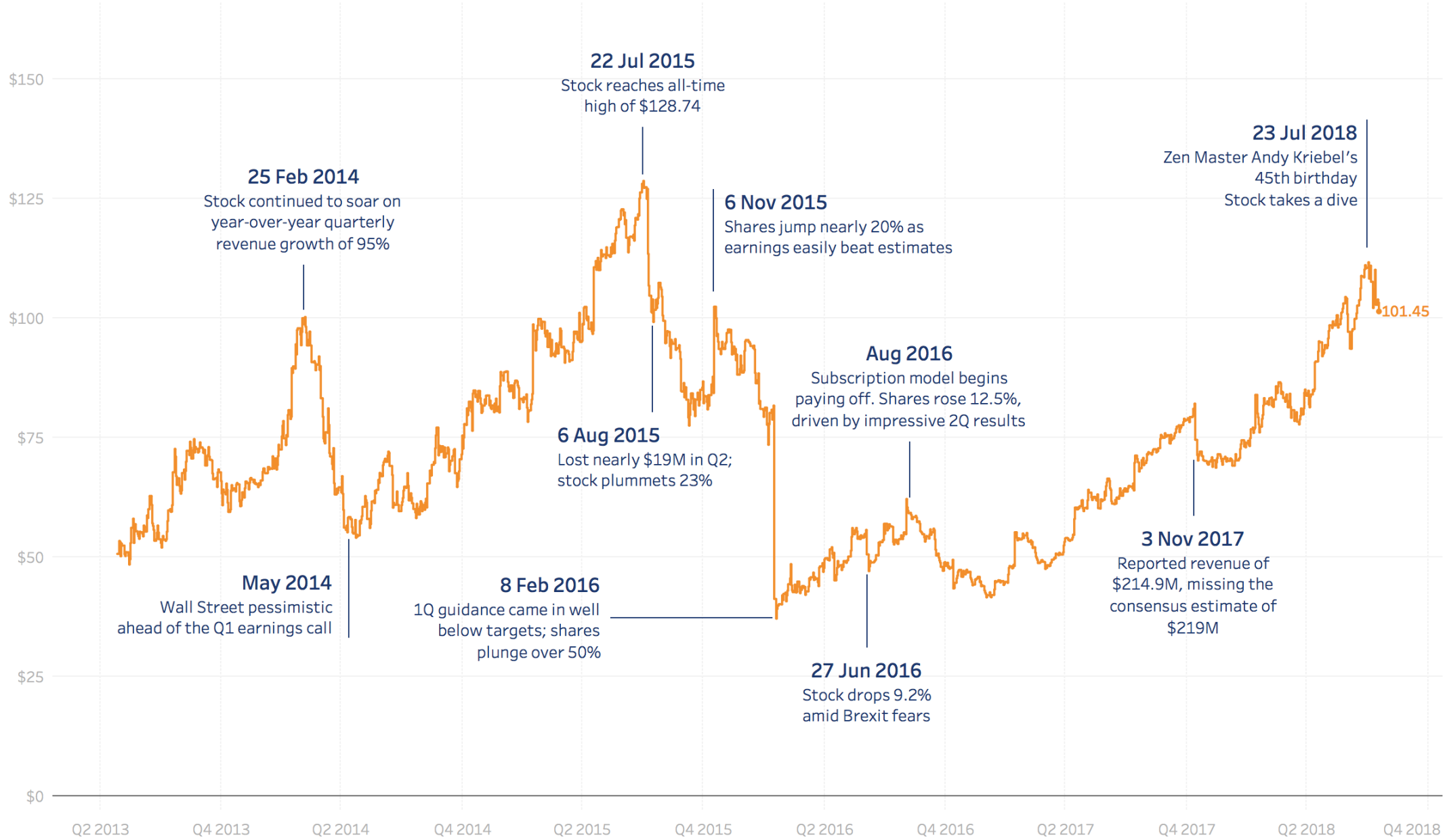
EXERCISES

Comment on the aesthetics of the following charts, according to:

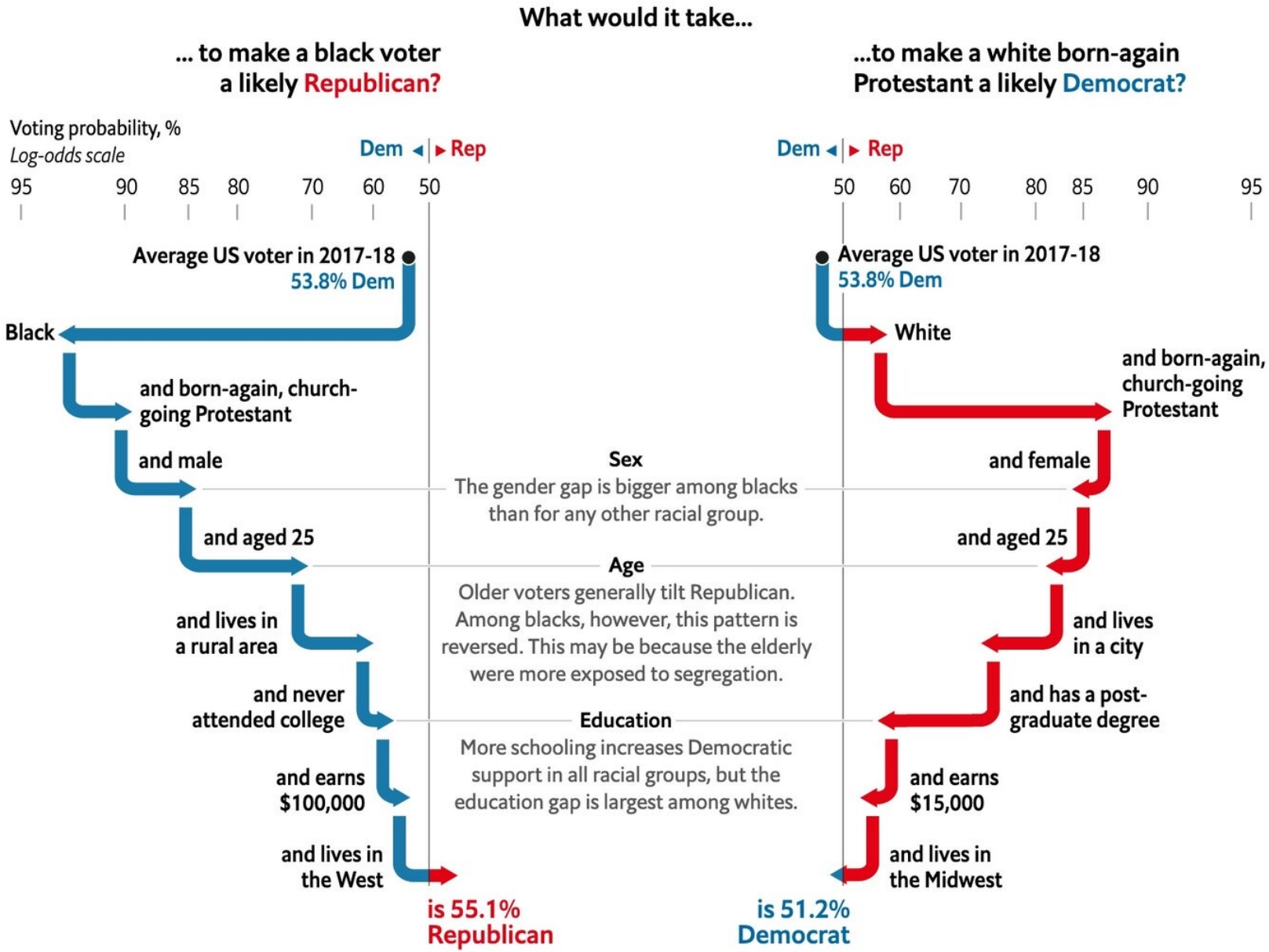
- Gestalt principles
- use of colours
- lack of clutter
- size and position
- etc.



The Roller Coaster Ride of Tableau's Stock



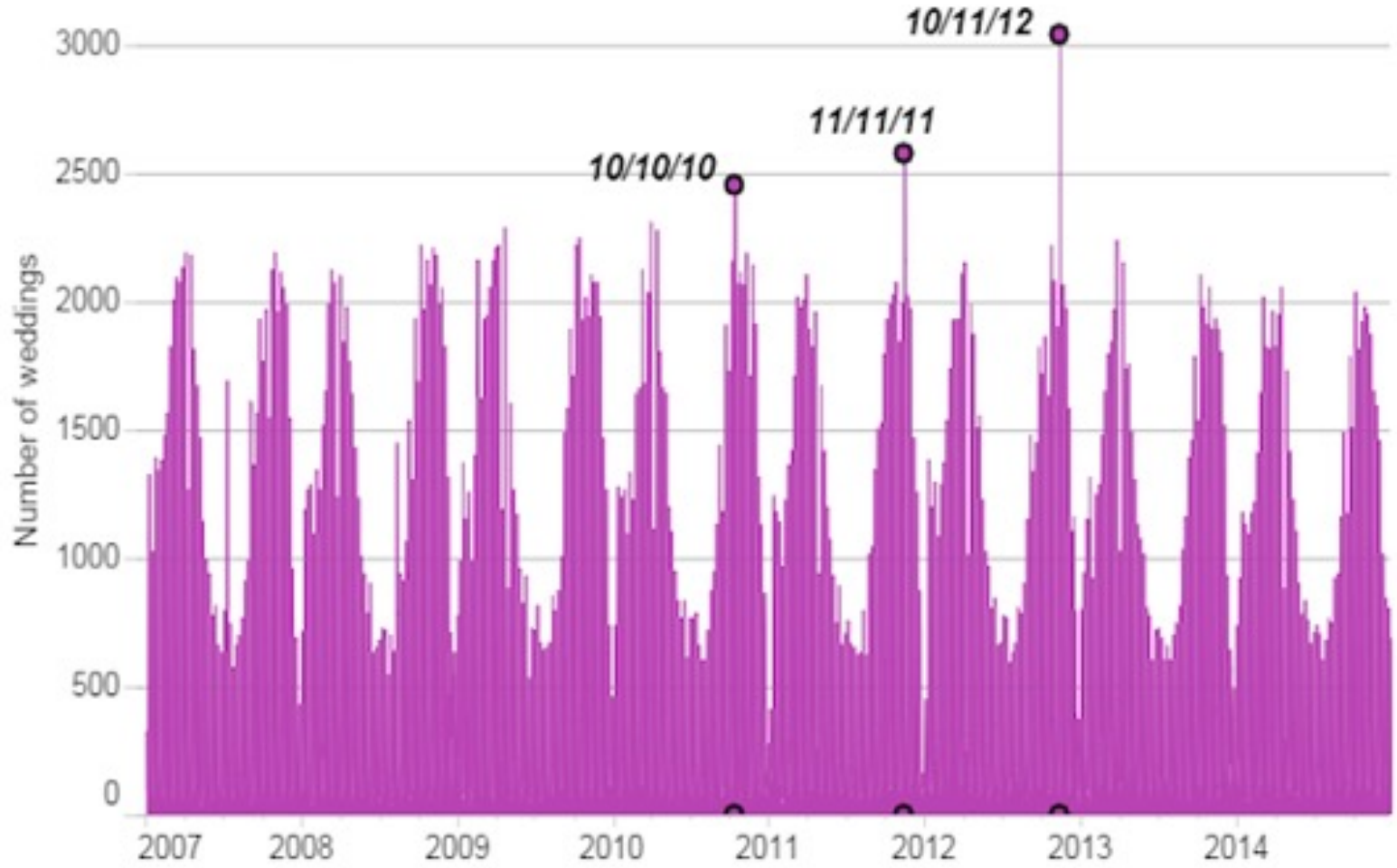
SOURCE: Yahoo! Finance **DESIGNED BY:** Andy Kriebel | @VizWizBI



Sources: YouGov; *The Economist*

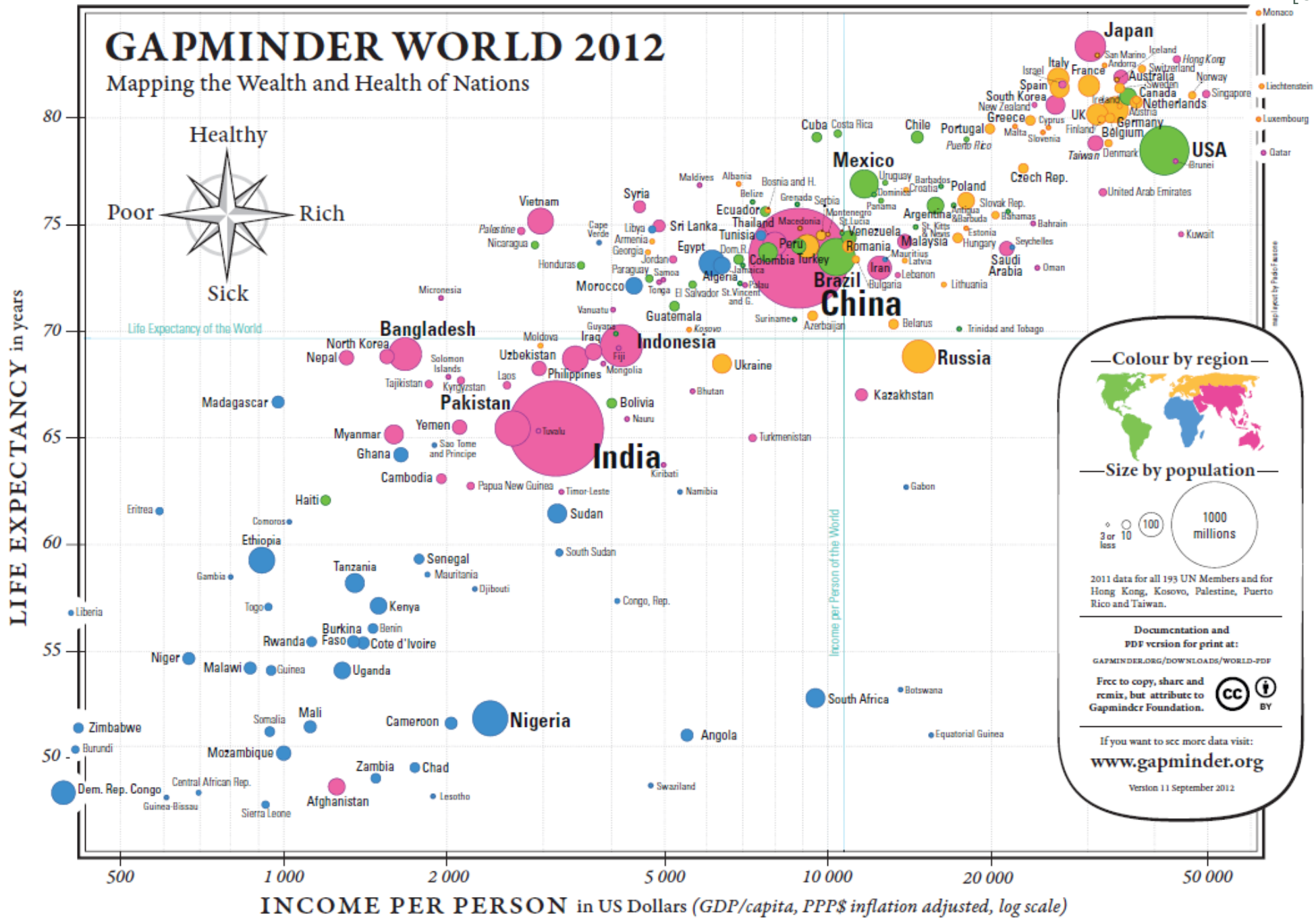
Weddings in Australia

The most popular wedding dates form repeating or sequential number patterns.



Graphic: Inga Ting | Source: ABS 2015

[Gapminder Foundation]



DATA STORIES IN THE WILD

PART II – EFFECTIVE STORYTELLING VISUALS

EXERCISES

Consider the following examples of charts found in the wild.

Are they examples of exploration, storytelling, situational awareness with data?

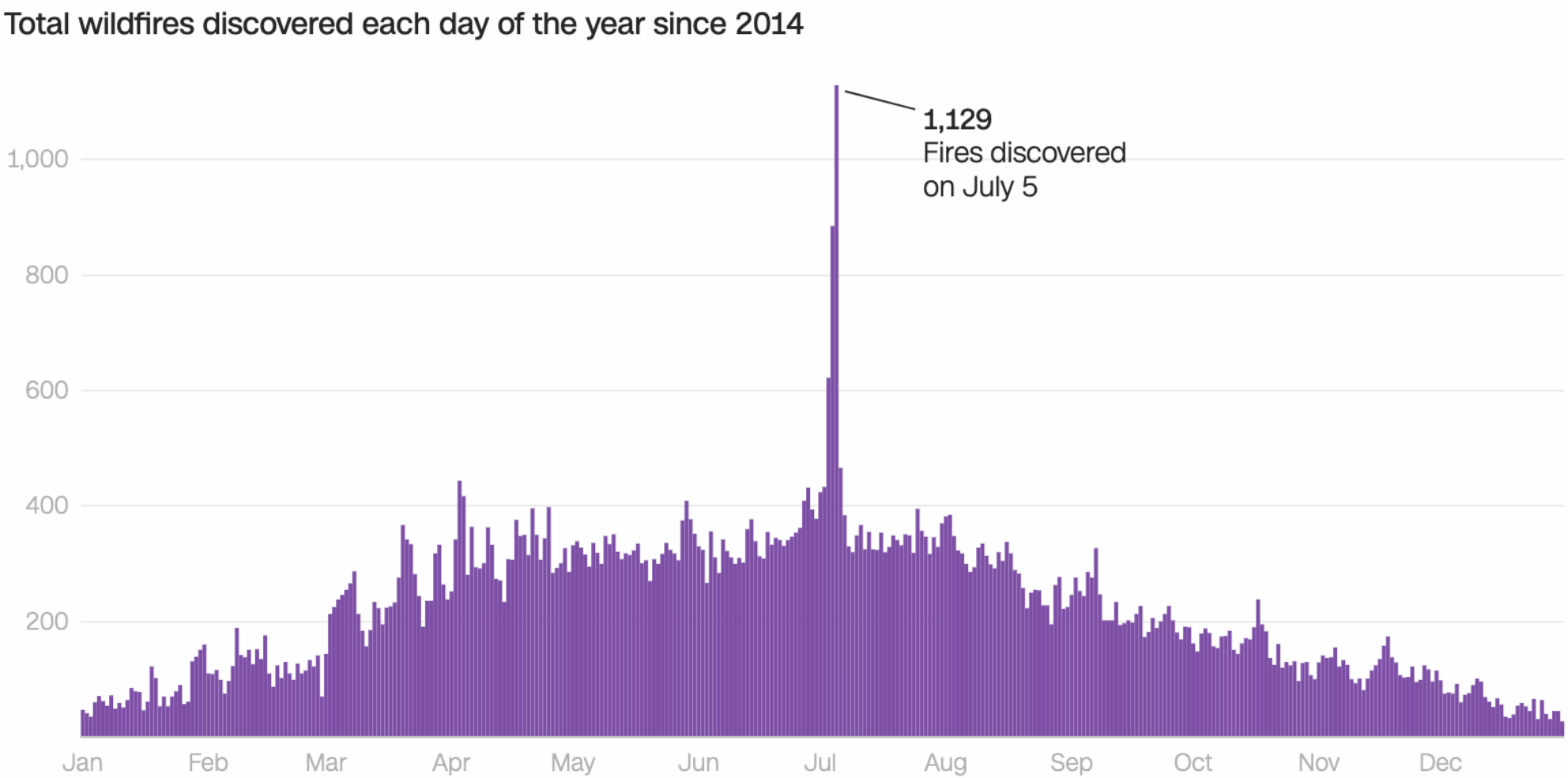
Are they data stories? If not, how would you turn them into stories?

If so, are they good stories? Bad ones? Ugly ones?

If they are not good stories, how would you improve them?

Wildfires spike around July 4 holiday

Human-caused wildfires in the United States jump around Independence Day.

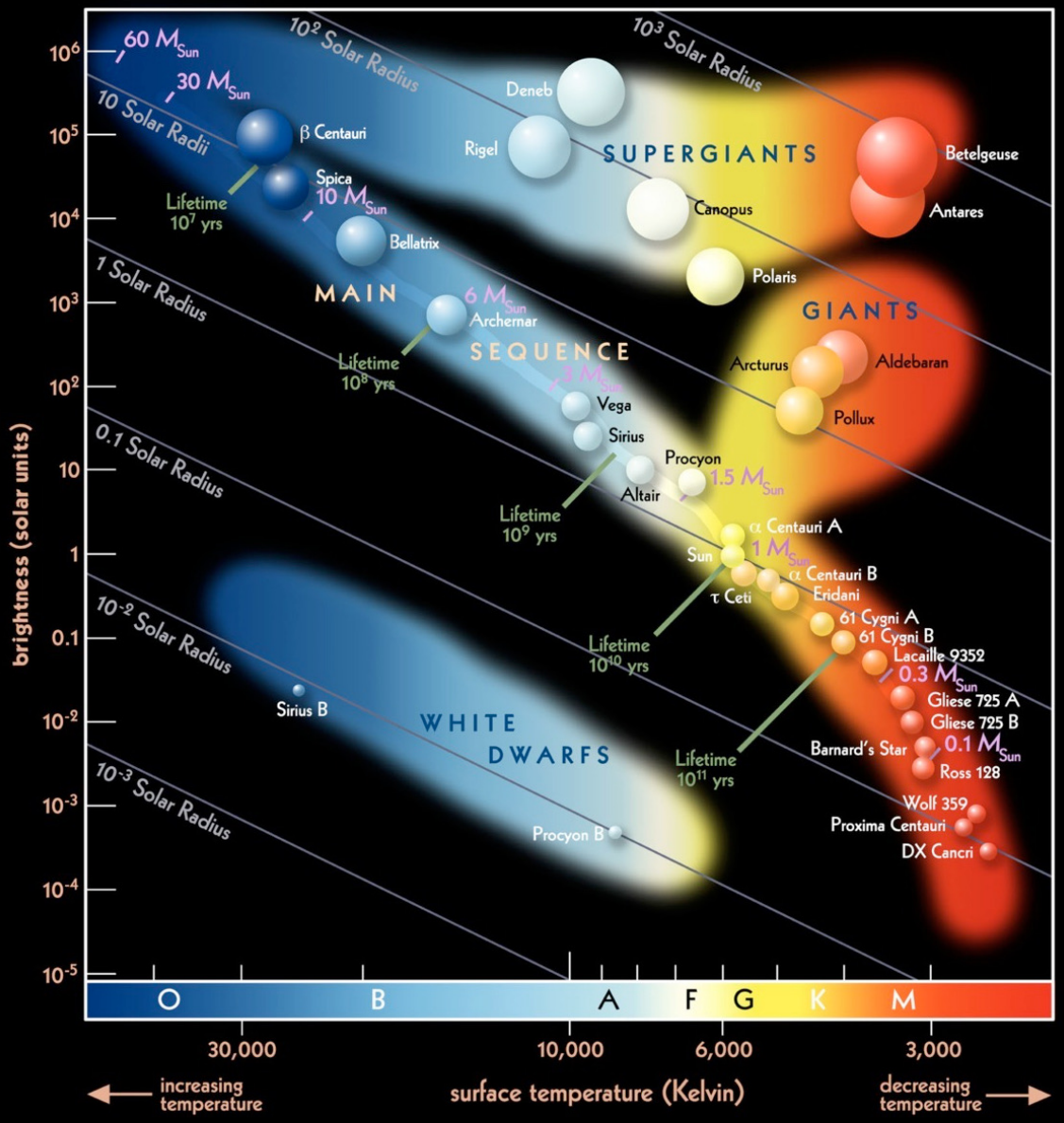


Human-caused fires, excluding prescribed fires. 2022 fires included through June 30. All incident times Eastern.

Sources: CNN analysis of data from the National Interagency Fire Center
Graphic: John Keefe, CNN

[European Southern Observatory]

Hertzprung-Russell Diagram



Data Elements

- star radius (x 2)
- surface temperature (x 2)
- spectral class
- brightness
- mass
- lifetime
- name

Underlying Structure

- 4 clusters/group
- lifetime, mass and radius are related to brightness and surface temperature on the Main Sequence

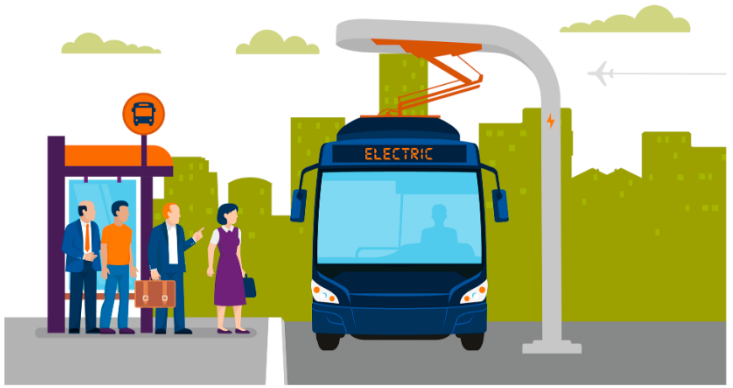
Only a subset of all the stars is shown in the HR diagram.

[https://old.reddit.com/r/dataisbeautiful/comments/vvsi16/oc_complete_street_policies_and_auto_fatalities]

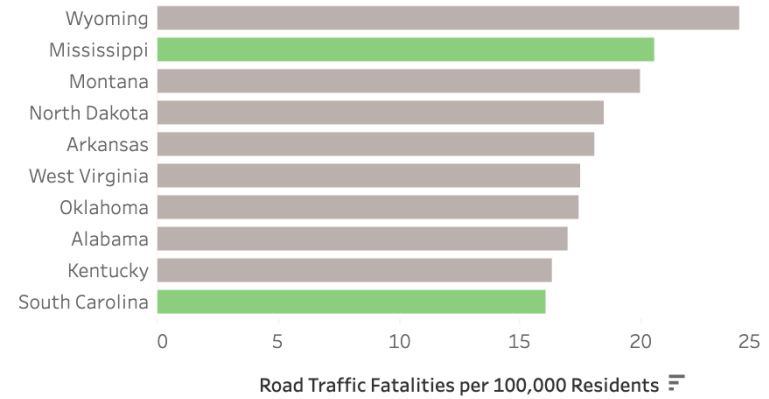
Public Transit and Complete Streets — How Do They Relate to Safety?

All data taken from The Bureau of Transportation Statistics (BTS), part of the Department of Transportation (DOT)

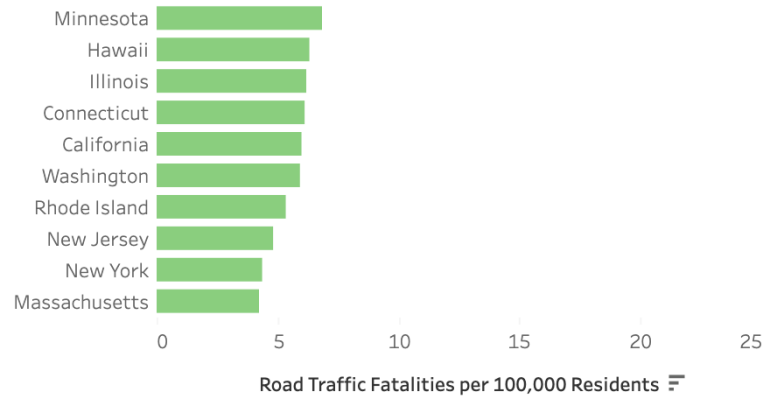
Complete Streets Policy?
- Policy in Place
- No Active Policy



Top 10 Highest Auto Fatalities per 100k



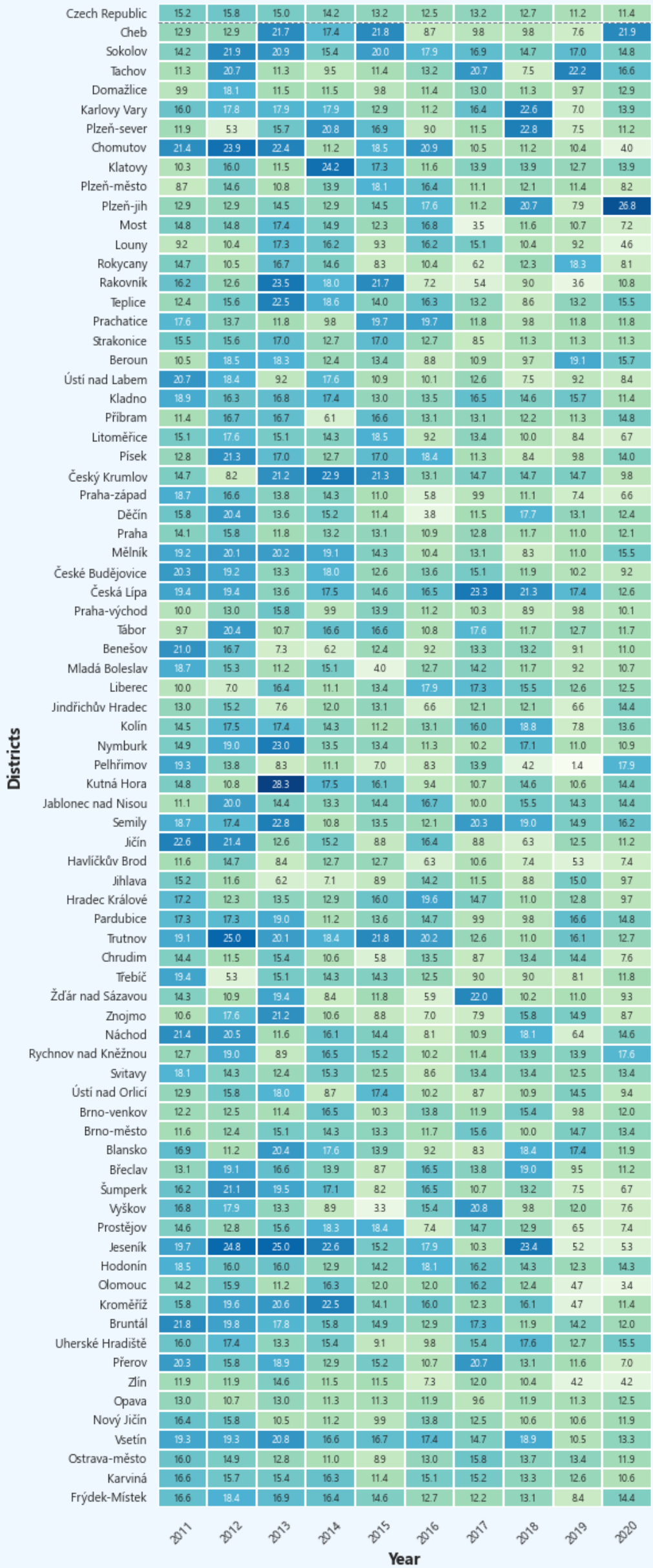
Top 10 Lowest Auto Fatalities per 100k



IDLEWYLD Sysabee DAVHILL uOttawa

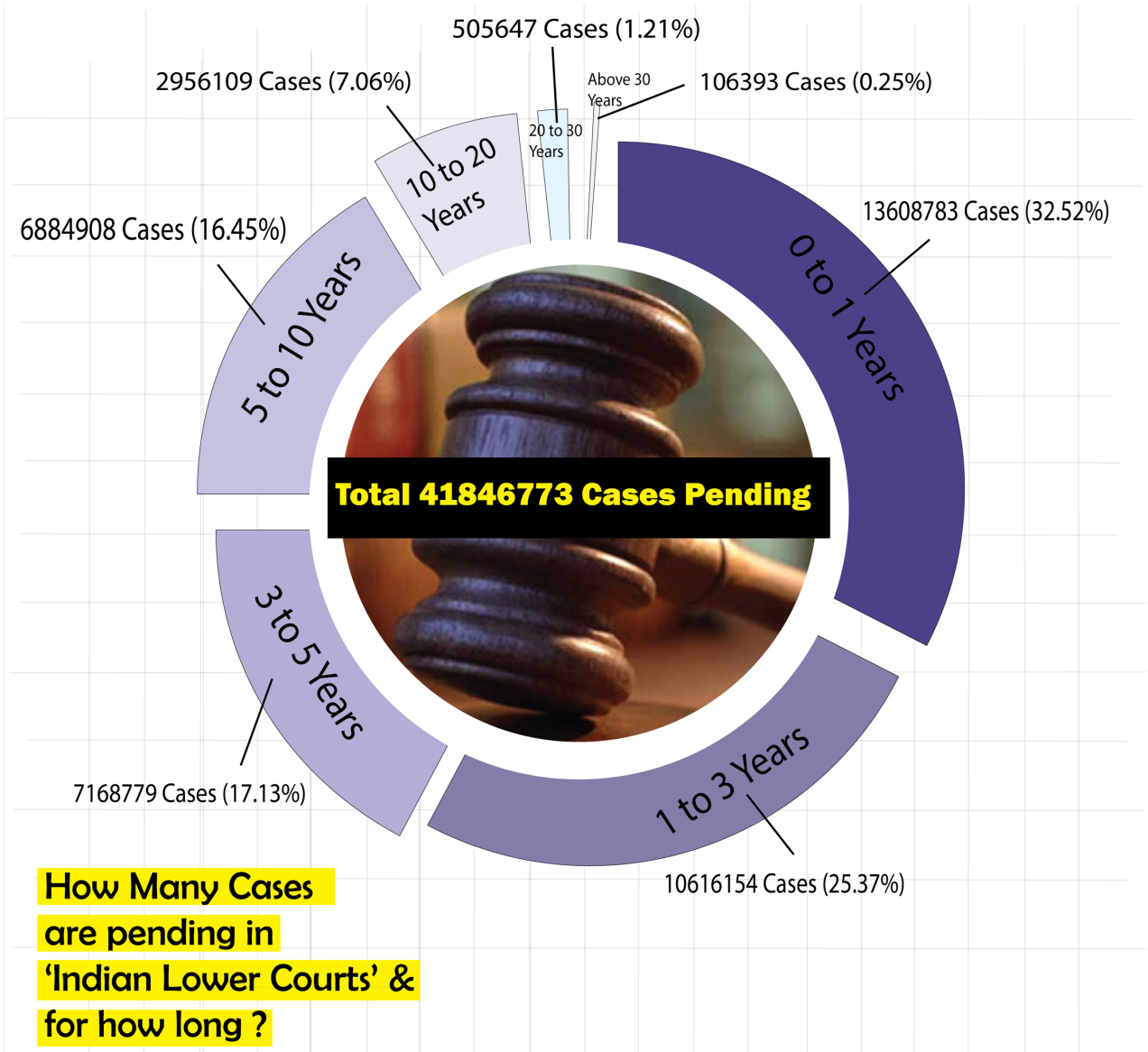
data-action-lab.com

Heatmap for Suicide Rate 2011-2020



Districts	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Czech Republic	15.2	15.8	15.0	14.2	13.2	12.5	13.2	12.7	11.2	11.4
Cheb	12.9	12.9	21.7	17.4	21.8	8.7	9.8	9.8	7.6	21.9
Sokolov	14.2	21.9	20.9	15.4	20.0	17.9	16.9	14.7	17.0	14.8
Tachov	11.3	20.7	11.3	9.5	11.4	13.2	20.7	7.5	22.2	16.6
Domažlice	9.9	18.1	11.5	11.5	9.8	11.4	13.0	11.3	9.7	12.9
Karlovy Vary	16.0	17.8	17.9	17.9	12.9	11.2	16.4	22.6	7.0	13.9
Plzeň-sever	11.9	5.3	15.7	20.8	16.9	9.0	11.5	22.8	7.5	11.2
Chomutov	21.4	23.9	22.4	11.2	18.5	20.9	10.5	11.2	10.4	4.0
Klatovy	10.3	16.0	11.5	24.2	17.3	11.6	13.9	13.9	12.7	13.9
Plzeň-město	8.7	14.6	10.8	13.9	18.1	16.4	11.1	12.1	11.4	8.2
Plzeň-jih	12.9	12.9	14.5	12.9	14.5	17.6	11.2	20.7	7.9	26.8
Most	14.8	14.8	17.4	14.9	12.3	16.8	3.5	11.6	10.7	7.2
Louny	9.2	10.4	17.3	16.2	9.3	16.2	15.1	10.4	9.2	4.6
Rokycany	14.7	10.5	16.7	14.6	8.3	10.4	6.2	12.3	18.3	8.1
Rakovník	16.2	12.6	23.5	18.0	21.7	7.2	5.4	9.0	3.6	10.8
Teplice	12.4	15.6	22.5	18.6	14.0	16.3	13.2	8.6	13.2	15.5
Prachatice	17.6	13.7	11.8	9.8	19.7	19.7	11.8	9.8	11.8	11.8
Strakonice	15.5	15.6	17.0	12.7	17.0	12.7	8.5	11.3	11.3	11.3
Beroun	10.5	18.5	18.3	12.4	13.4	8.8	10.9	9.7	19.1	15.7
Ústí nad Labem	20.7	18.4	9.2	17.6	10.9	10.1	12.6	7.5	9.2	8.4
Kladno	18.9	16.3	16.8	17.4	13.0	13.5	16.5	14.6	15.7	11.4
Příbram	11.4	16.7	16.7	6.1	16.6	13.1	13.1	12.2	11.3	14.8
Litoměřice	15.1	17.6	15.1	14.3	18.5	9.2	13.4	10.0	8.4	6.7
Písek	12.8	21.3	17.0	12.7	17.0	18.4	11.3	8.4	9.8	14.0
Český Krumlov	14.7	8.2	21.2	22.9	21.3	13.1	14.7	14.7	14.7	9.8
Praha-západ	18.7	16.6	13.8	14.3	11.0	5.8	9.9	11.1	7.4	6.6
Děčín	15.8	20.4	13.6	15.2	11.4	3.8	11.5	17.7	13.1	12.4
Praha	14.1	15.8	11.8	13.2	13.1	10.9	12.8	11.7	11.0	12.1
Mělník	19.2	20.1	20.2	19.1	14.3	10.4	13.1	8.3	11.0	15.5
České Budějovice	20.3	19.2	13.3	18.0	12.6	13.6	15.1	11.9	10.2	9.2
Česká Lípa	19.4	19.4	13.6	17.5	14.6	16.5	23.3	21.3	17.4	12.6
Praha-východ	10.0	13.0	15.8	9.9	13.9	11.2	10.3	8.9	9.8	10.1
Tábor	9.7	20.4	10.7	16.6	16.6	10.8	17.6	11.7	12.7	11.7
Benešov	21.0	16.7	7.3	6.2	12.4	9.2	13.3	13.2	9.1	11.0
Mladá Boleslav	18.7	15.3	11.2	15.1	4.0	12.7	14.2	11.7	9.2	10.7
Liberec	10.0	7.0	16.4	11.1	13.4	17.9	17.3	15.5	12.6	12.5
Jindřichův Hradec	13.0	15.2	7.6	12.0	13.1	6.6	12.1	12.1	6.6	14.4
Kolín	14.5	17.5	17.4	14.3	11.2	13.1	16.0	18.8	7.8	13.6
Nymburk	14.9	19.0	23.0	13.5	13.4	11.3	10.2	17.1	11.0	10.9
Pelhřimov	19.3	13.8	8.3	11.1	7.0	8.3	13.9	4.2	1.4	17.9
Kutná Hora	14.8	10.8	28.3	17.5	16.1	9.4	10.7	14.6	10.6	14.4
Jablonec nad Nisou	11.1	20.0	14.4	13.3	14.4	16.7	10.0	15.5	14.3	14.4
Semily	18.7	17.4	22.8	10.8	13.5	12.1	20.3	19.0	14.9	16.2
Jičín	22.6	21.4	12.6	15.2	8.8	16.4	8.8	6.3	12.5	11.2
Havlíčkův Brod	11.6	14.7	8.4	12.7	12.7	6.3	10.6	7.4	5.3	7.4
Jihlava	15.2	11.6	6.2	7.1	8.9	14.2	11.5	8.8	15.0	9.7
Hradec Králové	17.2	12.3	13.5	12.9	16.0	19.6	14.7	11.0	12.8	9.7
Pardubice	17.3	17.3	19.0	11.2	13.6	14.7	9.9	9.8	16.6	14.8
Trutnov	19.1	25.0	20.1	18.4	21.8	20.2	12.6	11.0	16.1	12.7
Chrudim	14.4	11.5	15.4	10.6	5.8	13.5	8.7	13.4	14.4	7.6
Třebíč	19.4	5.3	15.1	14.3	14.3	12.5	9.0	9.0	8.1	11.8
Žďár nad Sázavou	14.3	10.9	19.4	8.4	11.8	5.9	22.0	10.2	11.0	9.3
Znojmo	10.6	17.6	21.2	10.6	8.8	7.0	7.9	15.8	14.9	8.7
Náchod	21.4	20.5	11.6	16.1	14.4	8.1	10.9	18.1	6.4	14.6
Rychnov nad Kněžnou	12.7	19.0	8.9	16.5	15.2	10.2	11.4	13.9	13.9	17.6
Svitavy	18.1	14.3	12.4	15.3	12.5	8.6	13.4	13.4	12.5	13.4
Ústí nad Orlicí	12.9	15.8	18.0	8.7	17.4	10.2	8.7	10.9	14.5	9.4
Brno-venkov	12.2	12.5	11.4	16.5	10.3	13.8	11.9	15.4	9.8	12.0
Brno-město	11.6	12.4	15.1	14.3	13.3	11.7	15.6	10.0	14.7	13.4
Blansko	16.9	11.2	20.4	17.6	13.9	9.2	8.3	18.4	17.4	11.9
Břeclav	13.1	19.1	16.6	13.9	8.7	16.5	13.8	19.0	9.5	11.2
Šumperk	16.2	21.1	19.5	17.1	8.2	16.5	10.7	13.2	7.5	6.7
Vyškov	16.8	17.9	13.3	8.9	3.3	15.4	20.8	9.8	12.0	7.6
Prostějov	14.6	12.8	15.6	18.3	18.4	7.4	14.7	12.9	6.5	7.4
Jeseník	19.7	24.8	25.0	22.6	15.2	17.9	10.3	23.4	5.2	5.3
Hodonín	18.5	16.0	16.0	12.9	14.2	18.1	16.2	14.3	12.3	14.3
Olomouc	14.2	15.9	11.2	16.3	12.0	12.0	16.2	12.4	4.7	3.4
Kroměříž	15.8	19.6	20.6	22.5	14.1	16.0	12.3	16.1	4.7	11.4
Bruntál	21.8	19.8	17.8	15.8	14.9	12.9	17.3	11.9	14.2	12.0
Uherské Hradiště	16.0	17.4	13.3	15.4	9.1	9.8	15.4	17.6	12.7	15.5
Přerov	20.3	15.8	18.9	12.9	15.2	10.7	20.7	13.1	11.6	7.0
Zlín	11.9	11.9	14.6	11.5	11.5	7.3	12.0	10.4	4.2	4.2
Opava	13.0	10.7	13.0	11.3	11.3	11.9	9.6	11.9	11.3	12.5
Nový Jičín	16.4	15.8	10.5	11.2	9.9	13.8	12.5	10.6	10.6	11.9
Vsetín	19.3	19.3	20.8	16.6	16.7	17.4	14.7	18.9	10.5	13.3
Ostrava-město	16.0	14.9	12.8	11.0	8.9	13.0	15.8	13.7	13.4	11.9
Karviná	16.6	15.7	15.4	16.3	11.4	15.1	15.2	13.3	12.6	10.6
Frýdek-Místek	16.6	18.4	16.9	16.4	14.6	12.7	12.2	13.1	8.4	14.4

[https://old.reddit.com/r/dataisbeautiful/comments/vuma6b/how_many_court_cases_are_pending_in_lower_courts]



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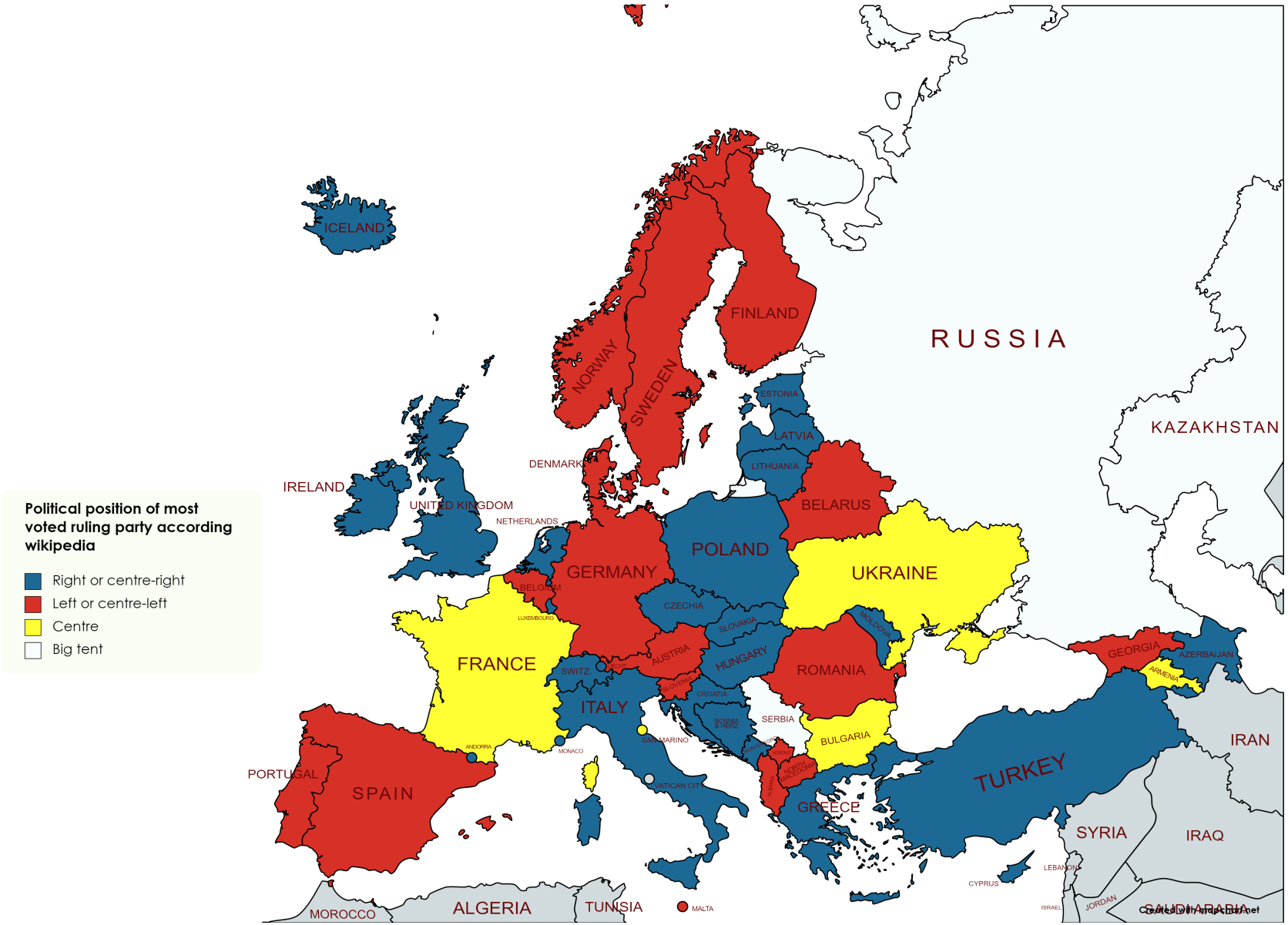

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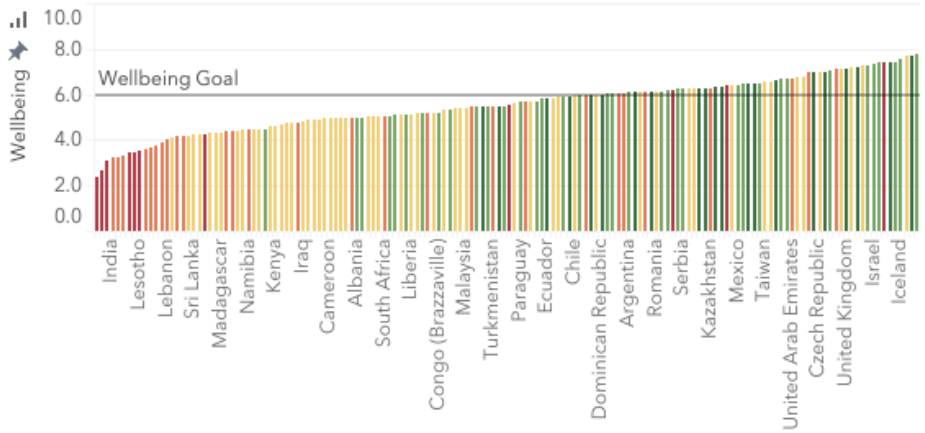
[https://public.tableau.com/app/profile/antonio2517/viz/HappyPlanetIndexVizualizationStory/HappyPlanetIndexVisualizationStory]

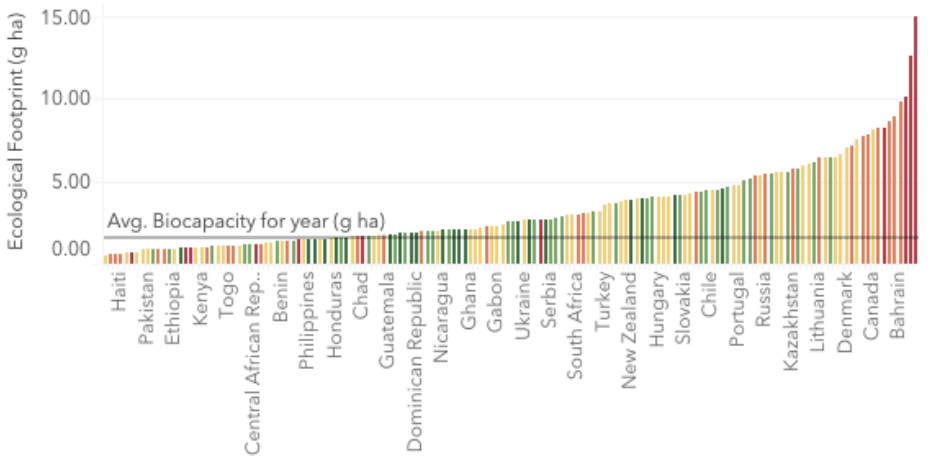
Happy Planet Index Vizualisation Story

Intro | HPI per Country (Map) | Top 10 Countries by Year | HPI by Region | HPI, GDP per capita & Population by country | HPI broken down by Life Expectancy, Ecological Footprint &

Wellbeing & HPI per Country - 2019



Ecological Footprint per Country & Avg. Biocapacity - 2019

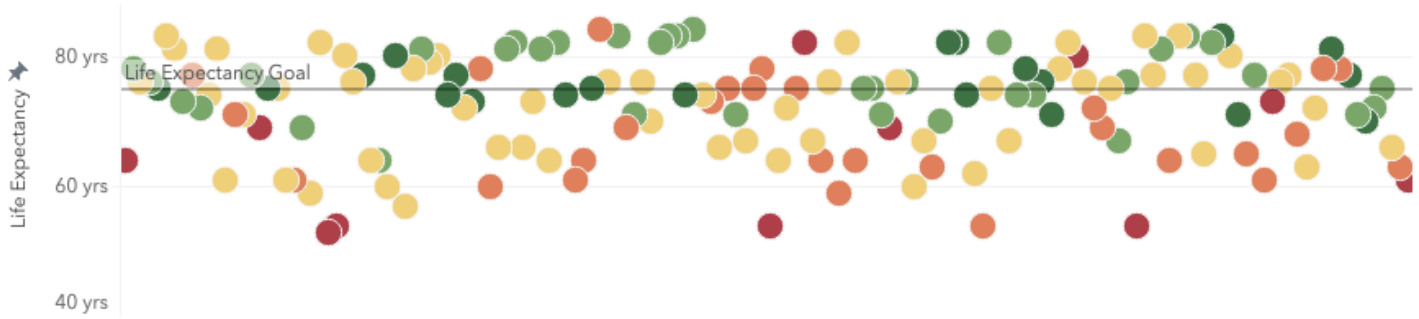


Year
2019

Happy Planet Index
24.33 62.06

Highlight Country
Highlight Country

Life Expectancy & HPI per Country



What is the Happy Planet Index?

The Happy Planet Index is a measure of sustainable wellbeing, ranking countries by how efficiently they deliver long, happy lives using our limited environmental resources.

"Is it possible to live good lives without costing the Earth?"

*Learn more by clicking the HPI logo >

HAPPY PLANET INDEX

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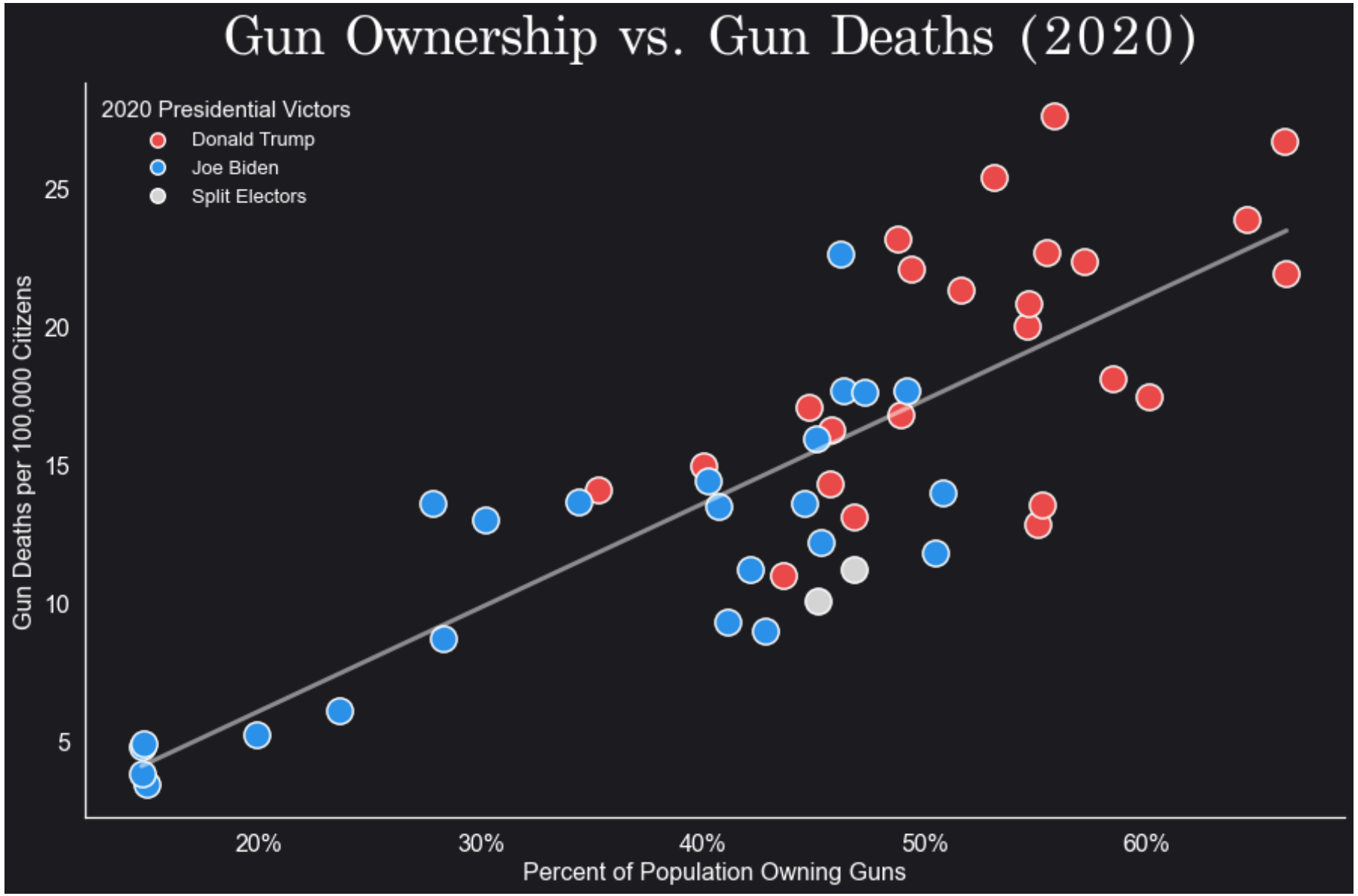
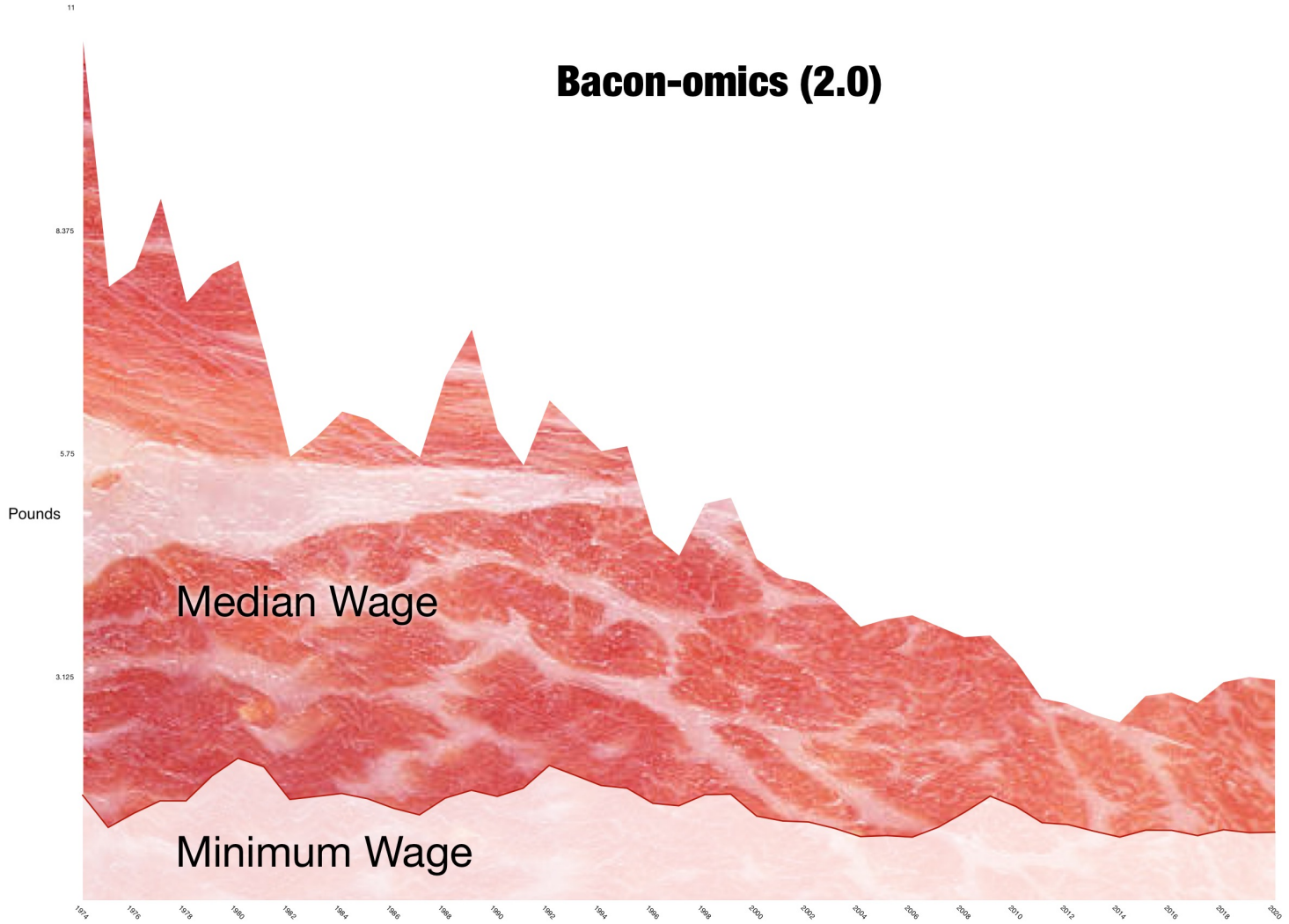
[https://old.reddit.com/r/dataisbeautiful/comments/vuef1i/oc_gun_ownership_vs_gun_deaths_colorcoded_by_2020]



[https://old.reddit.com/r/dataisbeautiful/comments/vtlcyr/baconomics_20_oc_the_price_of_bacon_versus_the]



How Many Pounds of Bacon (12mo average price) you could buy working 1 hour @ Median Wage and Minimum Wage

Source: CPI Data for Price of Bacon Per Pound 1970 to Present (BLS Beta Labs)

Minimum Wage for dol.gov

Data for Median Wage: fred.stlouisfed.org - Real Median Personal Income Table Median Wage divided by 2080 hours (40 hours per week, 52 Weeks Per Year) To Get Hourly Rate

2022 Chess Candidates Tournament

[https://old.reddit.com/r/dataisbeautiful/comments/vsuy99/oc_i_visualized_the_games_from_the_2022]

u/boxer-collar ebemunk ThinkingThroughTheParty

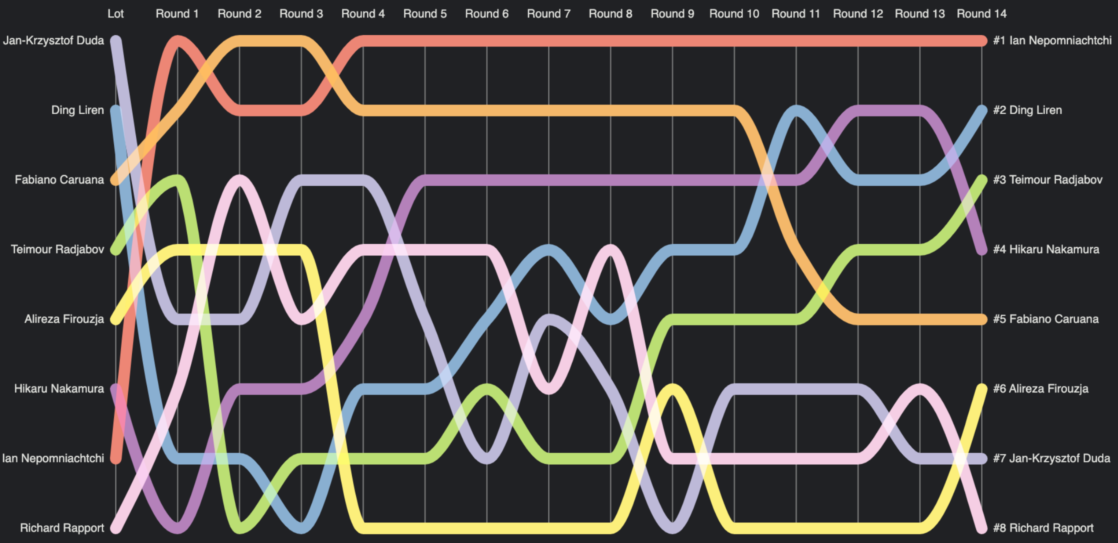
data from lichess.org

Nepomniachtchi wins for a second time, **Radjabov** surprises in the last minute, **Caruana** implodes in the latter half. It will be **Nepomniachtchi** vs **Ding** if **Carlsen** doesn't defend his title.

Only Rounds 3 and 5 saw all-draws. **Nepomniachtchi** was the only player with no back-to-back black games while **Ding** had 2 pairs and **Firouzja** had 2 pairs of back-to-back whites. **Caruana** was the only one with no back-to-back whites.

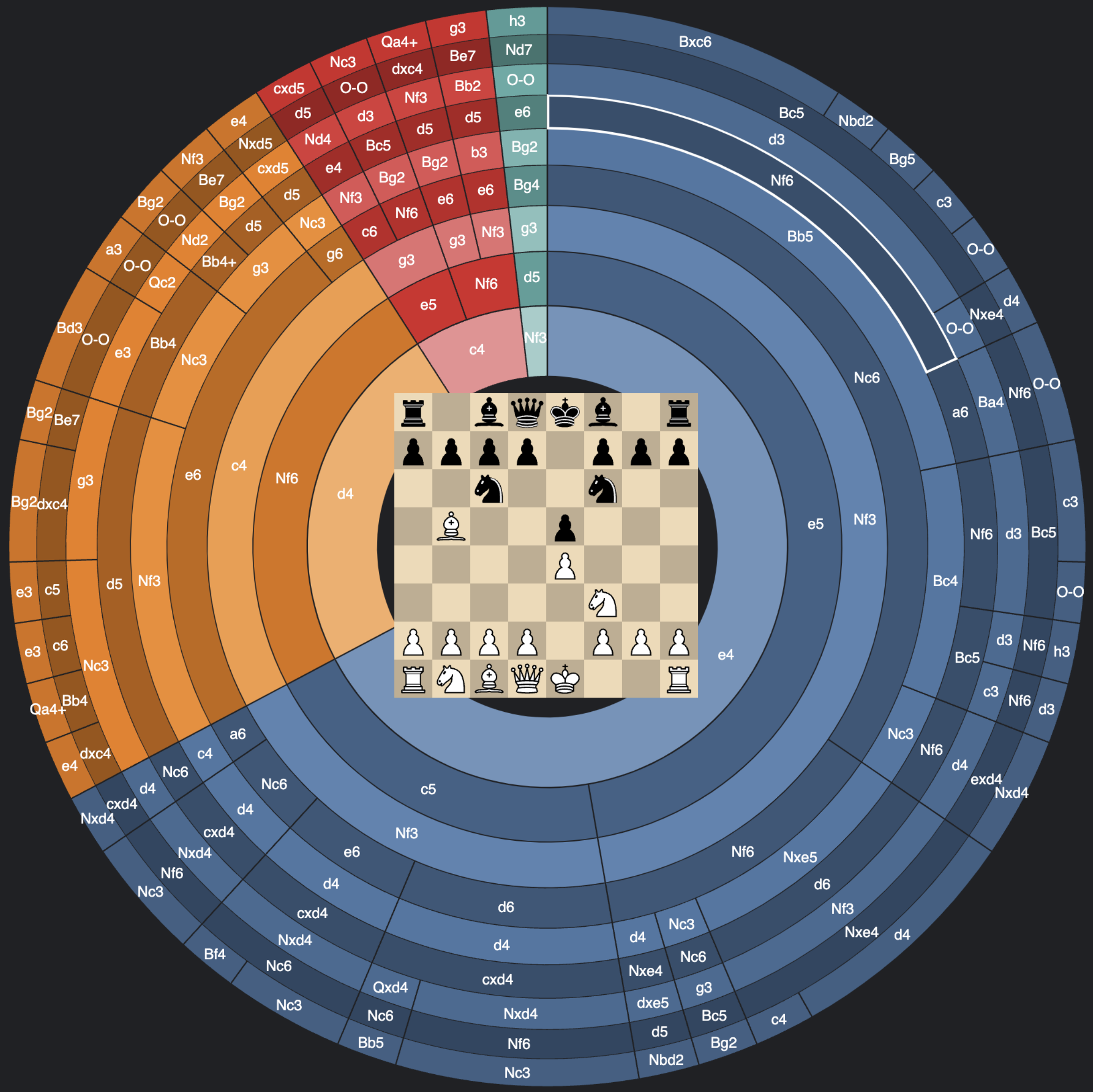
Rank	Player	Game Results	Points
1	Ian Nepomniachtchi		9.5
2	Ding Liren		8
3	Teimour Radjabov		7.5
4	Hikaru Nakamura		7.5
5	Fabiano Caruana		6.5
6	Alireza Firouzja		6
7	Jan-Krzysztof Duda		5.5
8	Richard Rapport		5.5

Nepomniachtchi kept his lead throughout the whole tournament without a single loss. **Caruana** had good chances but nosedived after Round 10. **Ding** had a slow burn but finished 2nd. **Radjabov** started winning after round 9 to end up 3rd. **Nakamura** lost out on €31,000 with his last round loss.



Openings

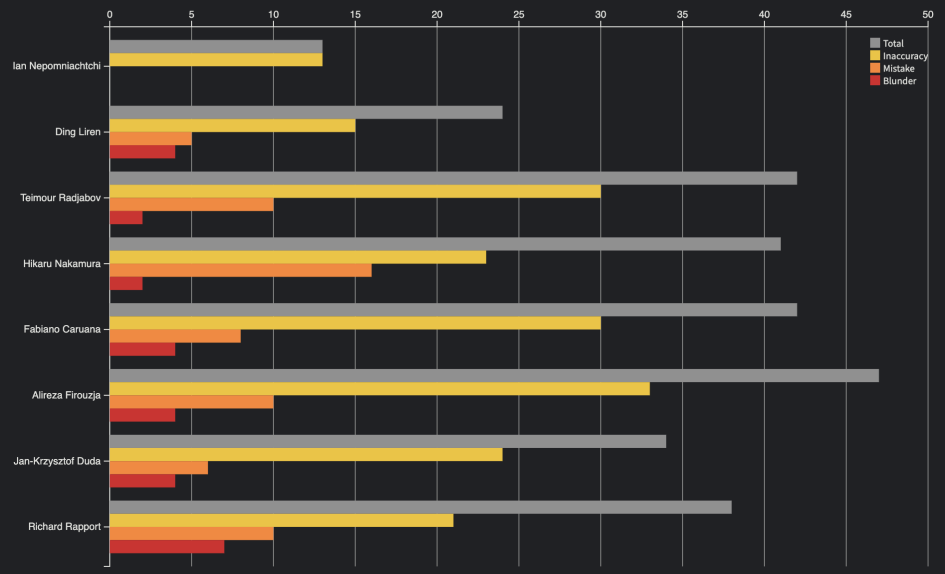
Berlin Defense (C65) is still a favorite at this level, followed by **Petrov Defense (C42)** and **Sicilian Najdorf (B90)**. Below is the openings chart of the first 9-ply from every game, with the most popular line highlighted.



[https://old.reddit.com/r/dataisbeautiful/comments/vsuy99/oc_i_visualized_the_games_from_the_2022]

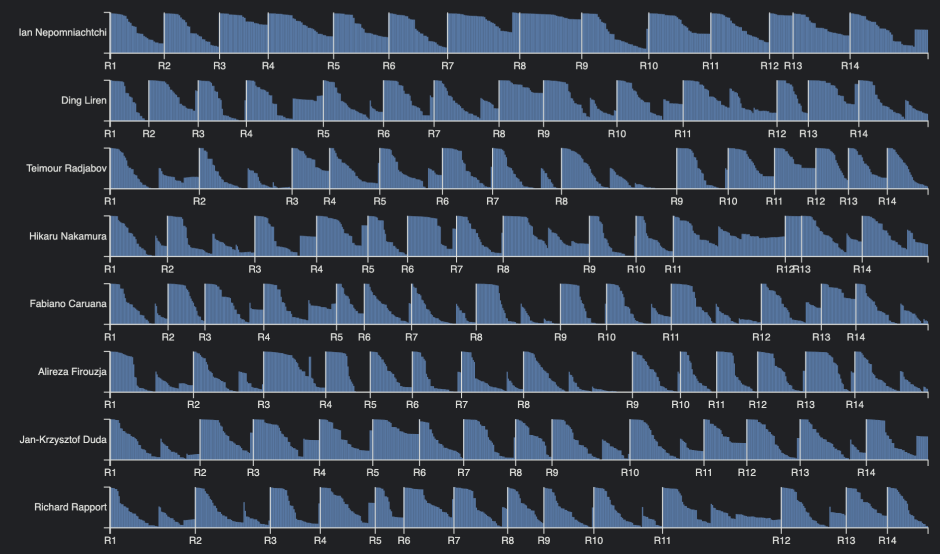
Inaccuracies, Mistakes and Blunders

Count of mistakes from engine evaluation. **Nepomniachtchi** outclassed the field with <1 inaccuracy per game throughout the tournament. Even though **Firouzja** had more total mistakes, his second win gave him the edge over **Duda** and **Rapport**.



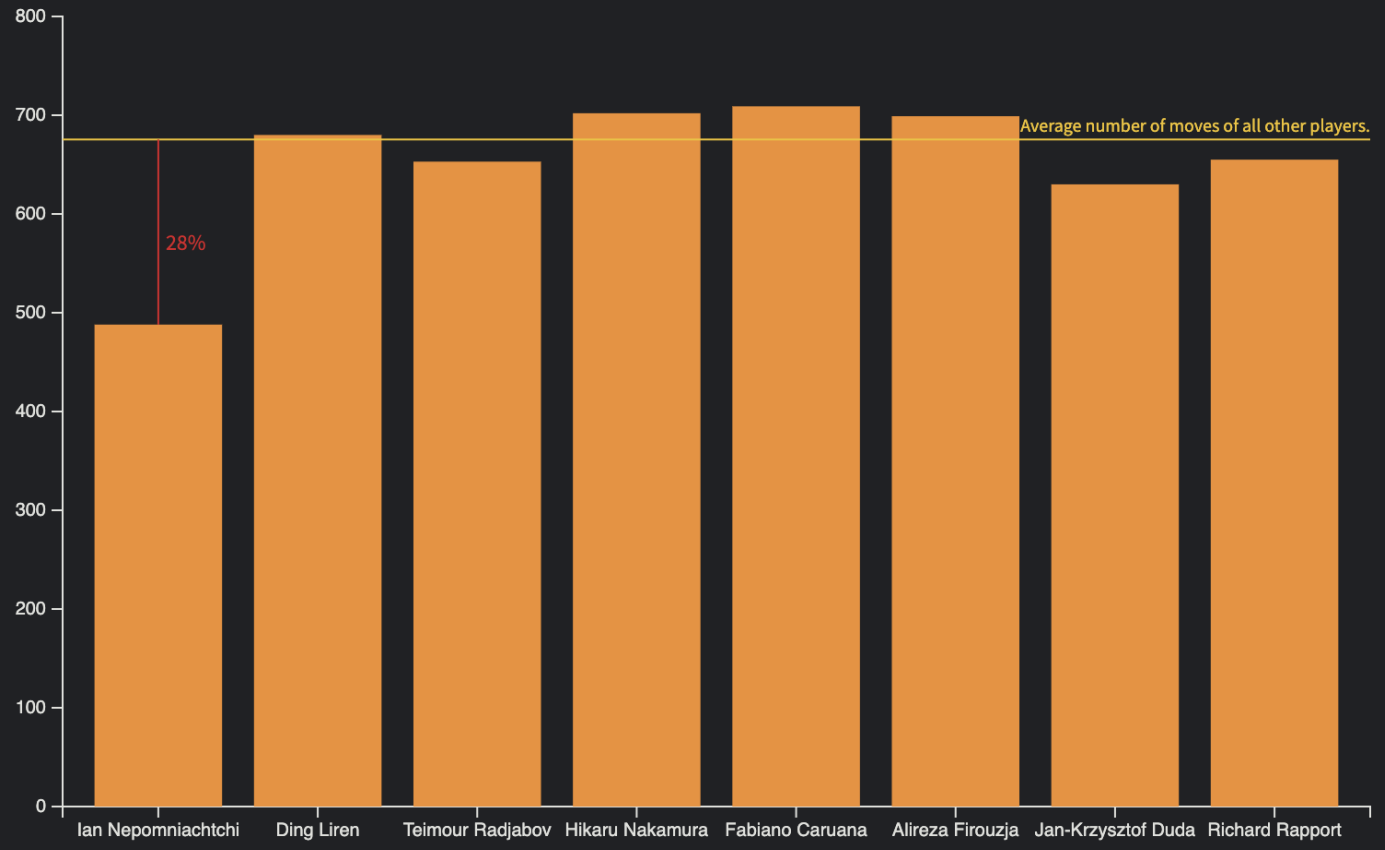
Time Management

Remaining time after every move in each round. Players generally got better after every round.



Number of Moves

Nepomniachtchi's trick to winning? Just play less! He made **28%** fewer moves than the other players.



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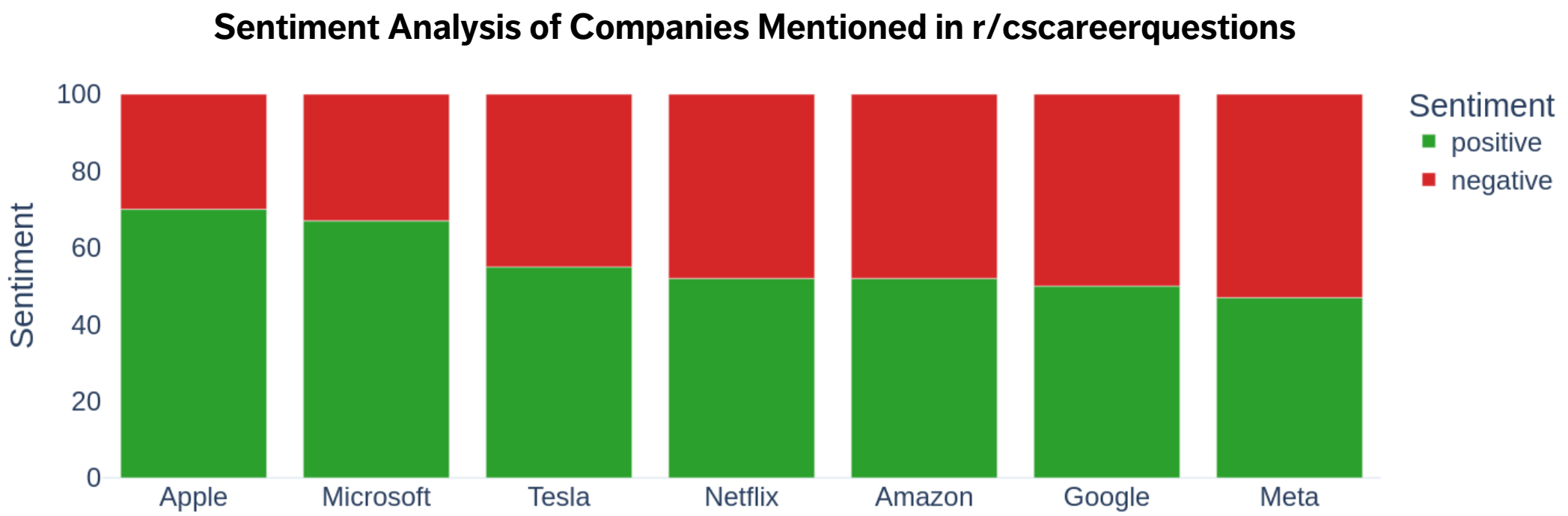
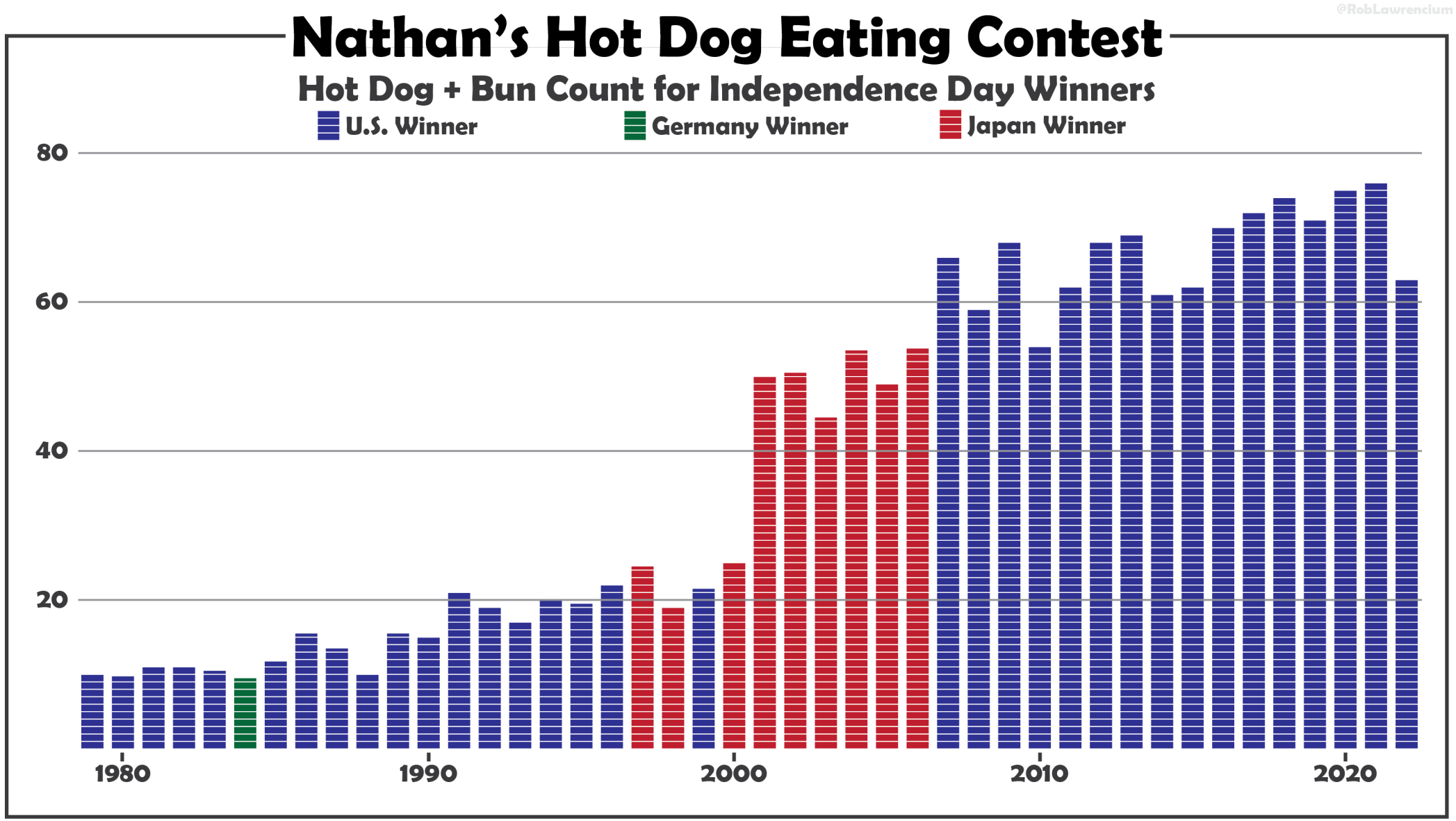


[https://old.reddit.com/r/dataisbeautiful/comments/vsgvks/nathans_hot_dog_eating_contest_winning_number_of]



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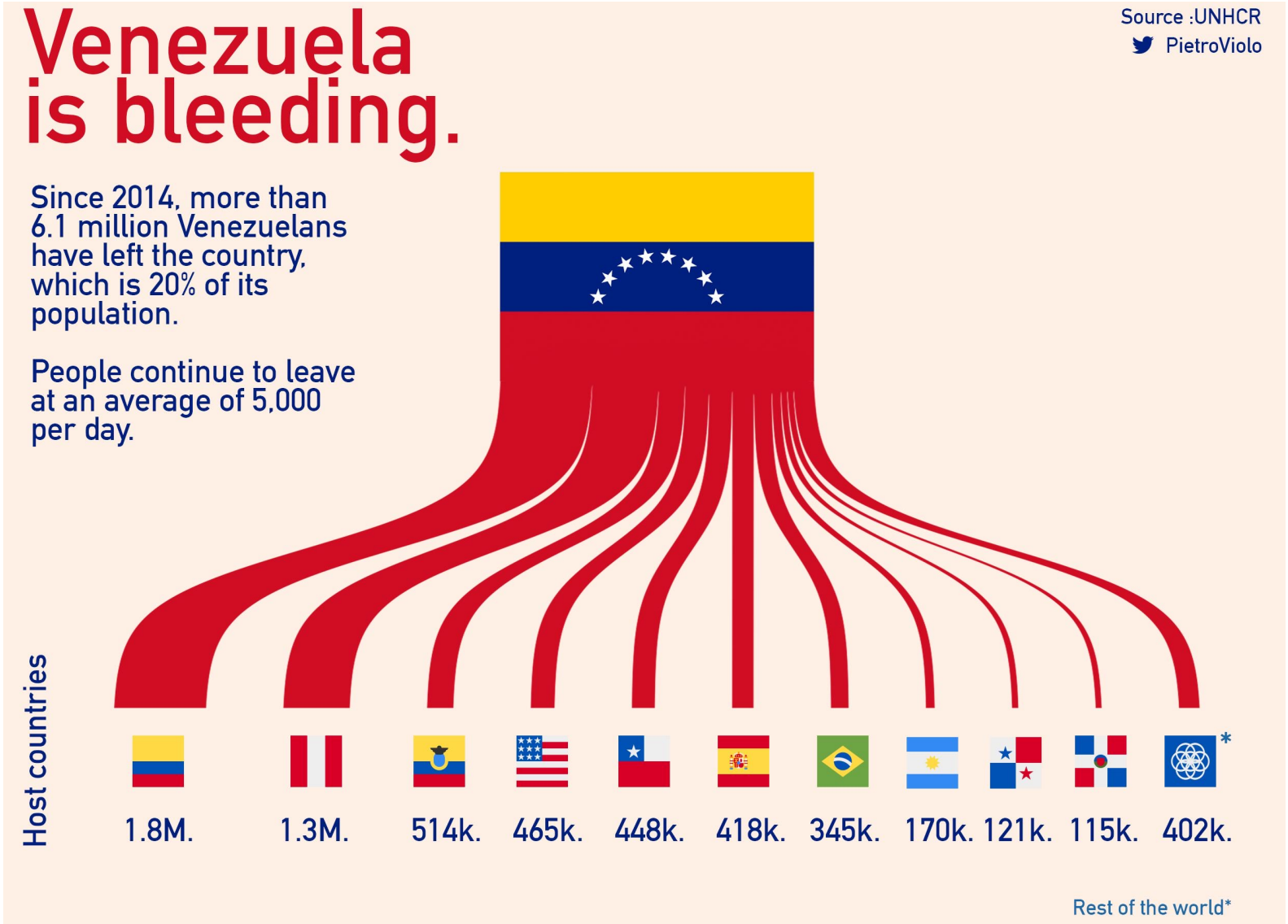

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