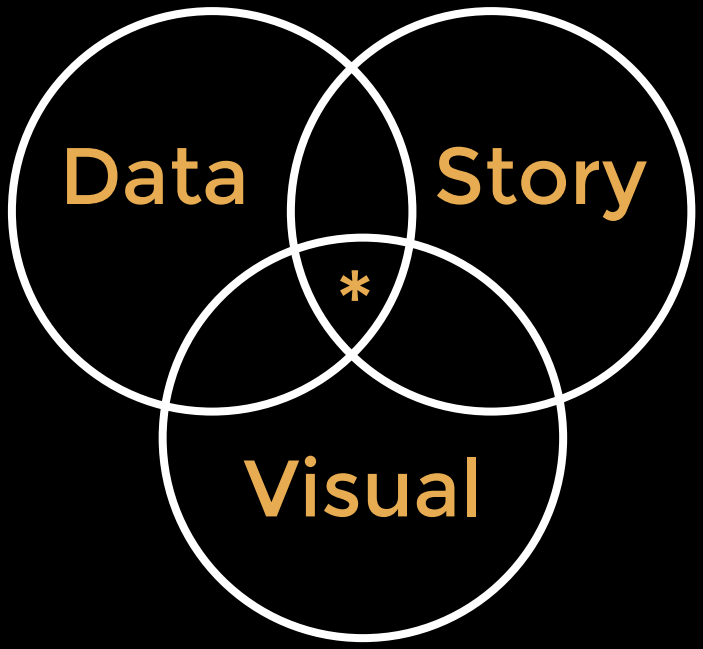
Storytelling with Data



Amit Kapoor
narrativeVIZ

How many 5's can you find?

14253678925136478924536917 8

41935672849512678314935672 8

24536917814567289314567293 8

49512678314935672842369851 7

35916478214567293845167293 8

46513297842369851745916378 2

14576293845167293835916478 2

43156729845916378243156729 8

Proximity

142 5 367892 5 136478924 5 369178
4193 5 672849 5 1267831493 5 6728
24 5 36917814 5 67289314 5 672938
49 5 1267831493 5 6728423698 5 17
3 5 916478214 5 6729384 5 1672938
46 5 132978423698 5 174 5 9163782
14 5 7629384 5 16729383 5 9164782
431 5 672984 5 9163782431 5 67298

Alignment

555 1423678921364789243691 78
555 4193672849126783149367 28
555 2436917814672893146729 38
555 4912678314936728423698 17
555 3916478214672938416729 38
555 4613297842369817491637 82
555 1476293841672938391647 82
555 4316729849163782431672 98

Repetition

123456789 123456789 123456789
123456789 123456789 123456789
123456789 123456789 123456789
123456789 123456789 123456789
123456789 123456789 123456789
123456789 123456789 123456789
123456789 123456789 123456789
123456789 123456789 123456789

Enclosure

142 5 367892 5 136478924 5 369178

4193 5 672849 5 1267831493 5 6728

24 5 36917814 5 67289314 5 672938

49 5 1267831493 5 6728423698 5 17

3 5 916478214 5 6729384 5 1672938

46 5 132978423698 5 174 5 9163782

14 5 7629384 5 16729383 5 9164782

431 5 672984 5 9163782431 5 67298

Contrast

1425367892513647892453691781
4193567284951267831493567281
2453691781456728931456729381
4951267831493567284236985171
3591647821456729384516729381
4651329784236985174591637821
1457629384516729383591647821
4315672984591637824315672981

Contrast

1425367892513647892453691781
4193567284951267831493567281
2453691781456728931456729381
4951267831493567284236985171
3591647821456729384516729381
4651329784236985174591637821
1457629384516729383591647821
4315672984591637824315672981

Subtraction

Design Principles

Subtraction

Contrast

Repetition

Alignment

Proximity

Enclosure

War Stories & Killer Charts

Approach

Fundamentals

Learn from first principles

Know the science

Understand the art

Experiential

I hear and I forget

I see and I remember

I do and I understand

I experience and I learn (for life)

Learning the Djembe

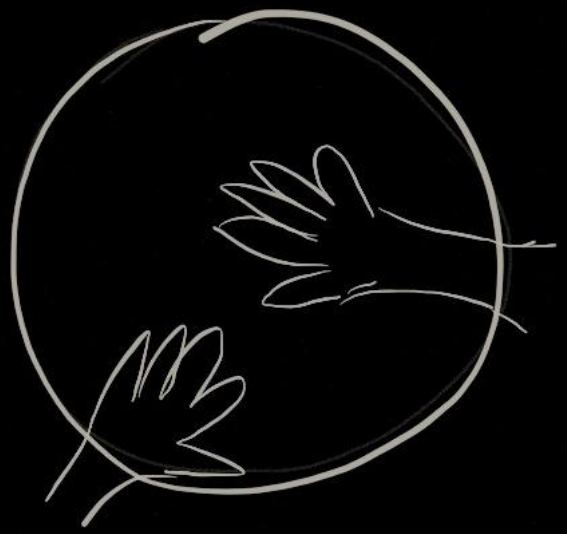
Source: The Visitor - Learning the Djembe

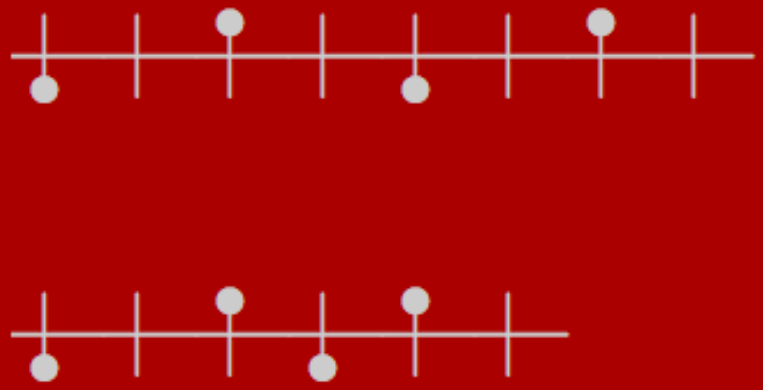
da - da - da - da

1 - 2 - 3 - 4

tak - tak - tak

1 - 2 - 3





Linguistic
(Verbal)

Symbolic
(Math-Logic)

Interactive
(Kinesthetic)

Geometric
(Visual-Spatial)

Linguistic (Verbal)

The Pythagoras' theorem is a relation in Euclidean geometry among the three sides of a right triangle. It states:

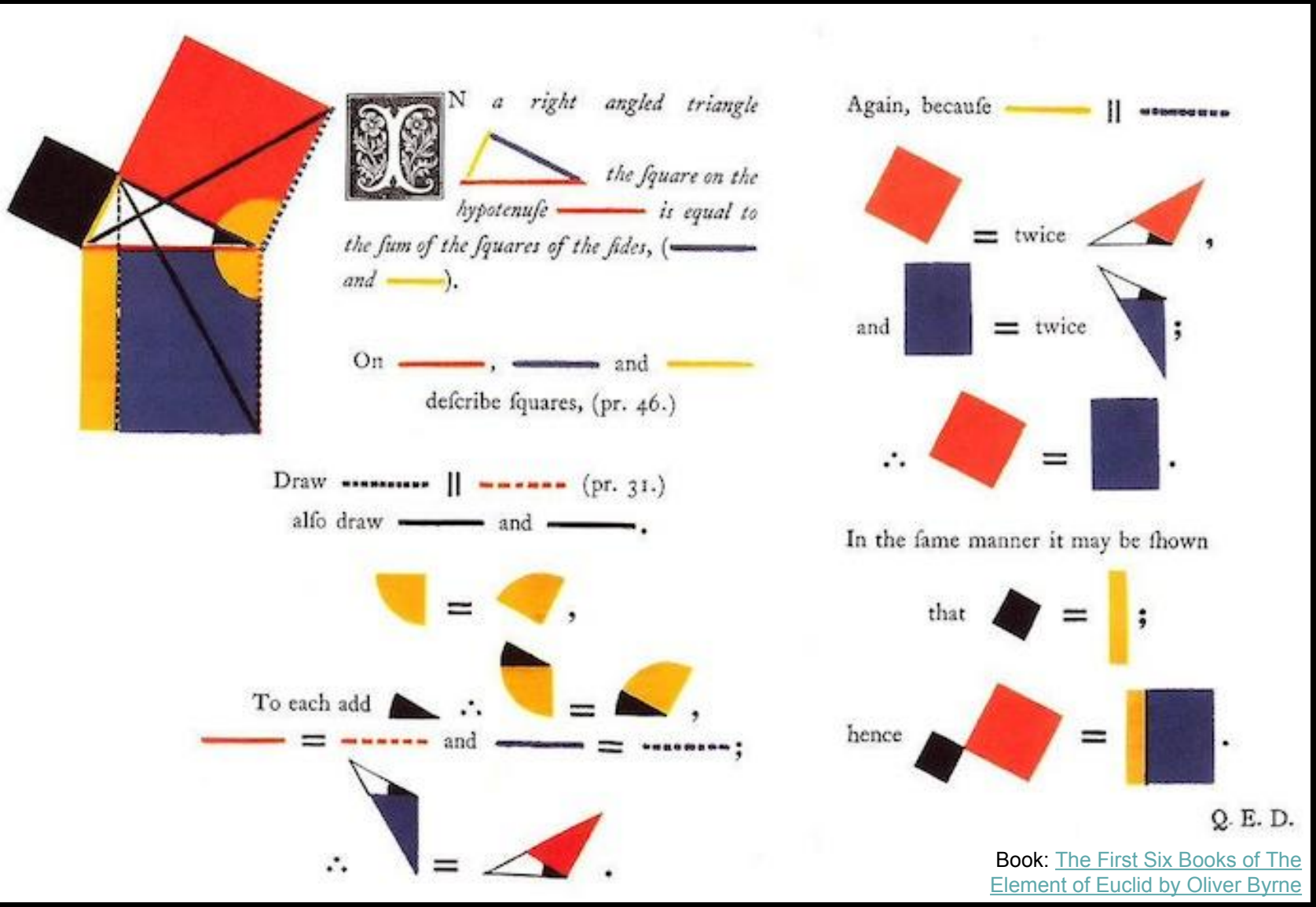
“The square of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the other two sides.”

Symbolic (Math-Logic)

For all $\triangle XYZ$, where $\angle XYZ = 90^\circ$ and the length of side $XY = a$, $YZ = b$ and $ZX = c$, there exist a relationship such that:

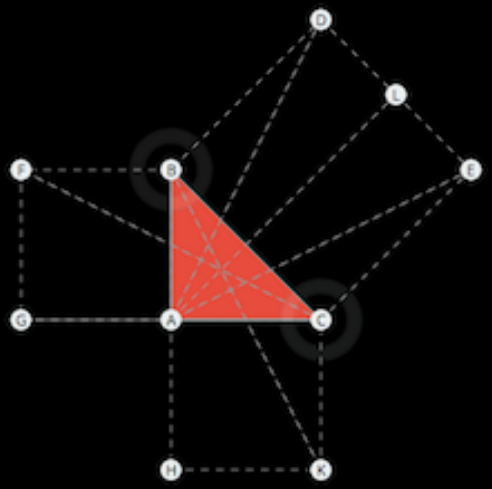
$$a^2 + b^2 = c^2$$

Geometric (Visual)



Book: [The First Six Books of The Element of Euclid by Oliver Byrne]

Interactive (Kinesthetic)



Pythagorean theorem

Tweet 102

A visual explanation by Victor Powell for Setosa

What follows in an interactive walk through of Euclid's proof of the Pythagorean Theorem.

$$a^2 + b^2 = c^2$$

Let ABC be a right-angled triangle having the angle BAC right.

I say that the square on BC equals the sum of the squares on BA and AC.

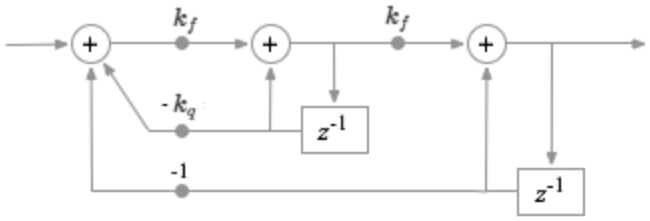
Describe the square BDEC on BC, and the squares GB and HC on BA and AC. Draw AL through A parallel to either BD or CE, and join AD and FC.

Since each of the angles BAC and BAG is right, it follows that with a straight line BA, and at the point A on it, the two straight lines AC and AG not lying on the same side make the adjacent angles equal to two right angles, therefore CA is in a straight line with AG.

For the same reason BA is also in a straight line with AH.

Source: Setosa.io - Pythagorean

Below is a simplified digital adaptation of the analog state variable filter.



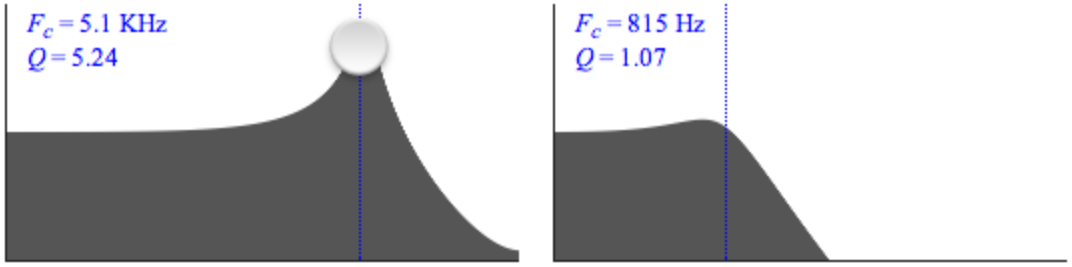
This topology is particularly useful for embedded audio processing, because F_c (cutoff frequency) and Q (resonance) are controlled by independent coefficients, k_f and k_q. (With most filters, the coefficients are functions of both parameters, which precludes pre-calculated lookup tables.)

The coefficients and transfer function are:

$$k_f = 2sin(\pi\frac{F_c}{Fs}) \qquad k_q = \frac{1}{Q}$$

$$H(z) = \frac{{k_f}^2}{1-(2-k_f(k_f+k_q))z^{-1}+(1-k_fk_q)z^{-2}}$$

Some example frequency responses:

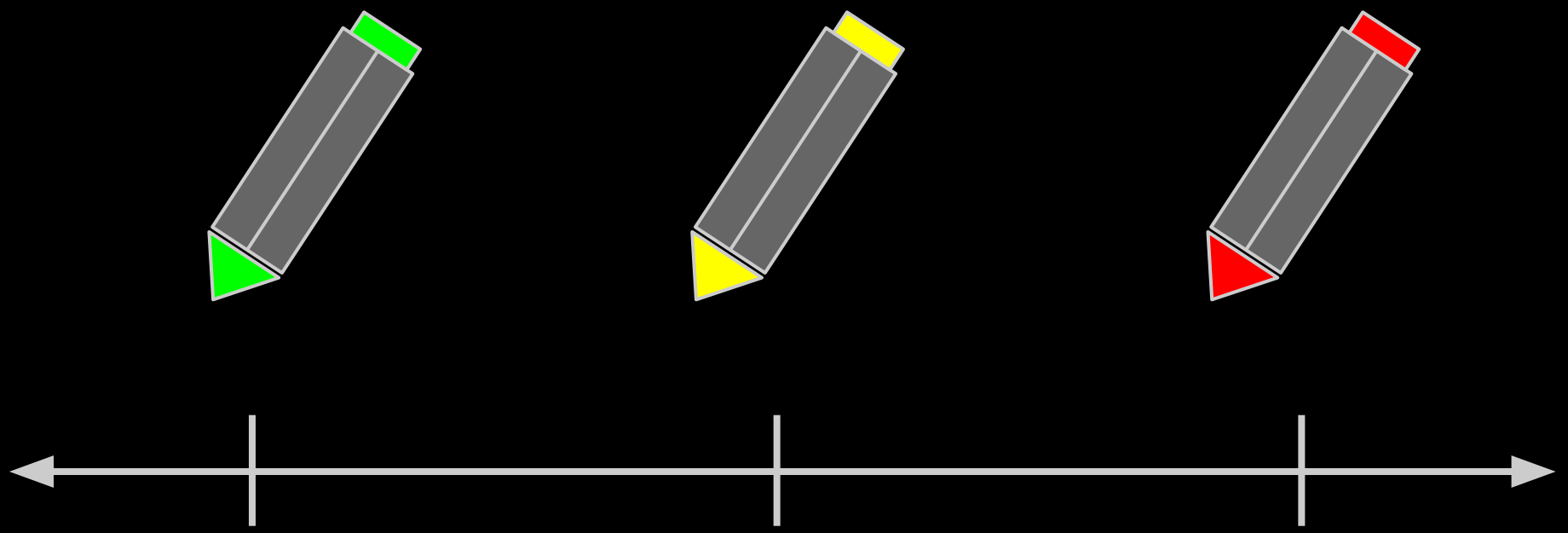


Source: [Explorable Explanation - Bret Victor]

“ To develop a complete mind, study the science of art, the art of science. Learn how to see. Realize that everything connects to everything else. “

– Leonardo da Vinci

Visual Thinking Spectrum



Hand me the Pen

I can draw but...

I'm not visual

Gesture with Pen

Pointing, Waving, Grabbing, Holding,
Reaching out, Dancing

Smiling, Frowning, Disinterest, Concern,
Full Attention, Surprise

“Put this there”

Visual Wired Brain

50%
of the brain used for visual processing

70%
of the sensory receptors are in the eyes

100ms
to get a sense of the visual scene

Visual Language

While you are travelling down this road there is a chance that one or more rocks of varying size may fall from the slopes.

You should be aware of this before you travel this way so that you are cautious of this particular type of hazard.

Visualization

ˌvɪʒʊəlaɪˈzeɪʃən (noun)

Derived from the Latin verb **videre**, "to look, to see"

The act or instance to form a mental image or picture (without an object)

The act or instance to make visible or visual (with an object)

Pattern Seekers

“Why should we be interested in visualization? Because the human visual system is a pattern seeker of enormous power and subtlety.

The eye and the visual cortex of the brain form a massively parallel processor that provides the highest-bandwidth channel into human cognitive centers.

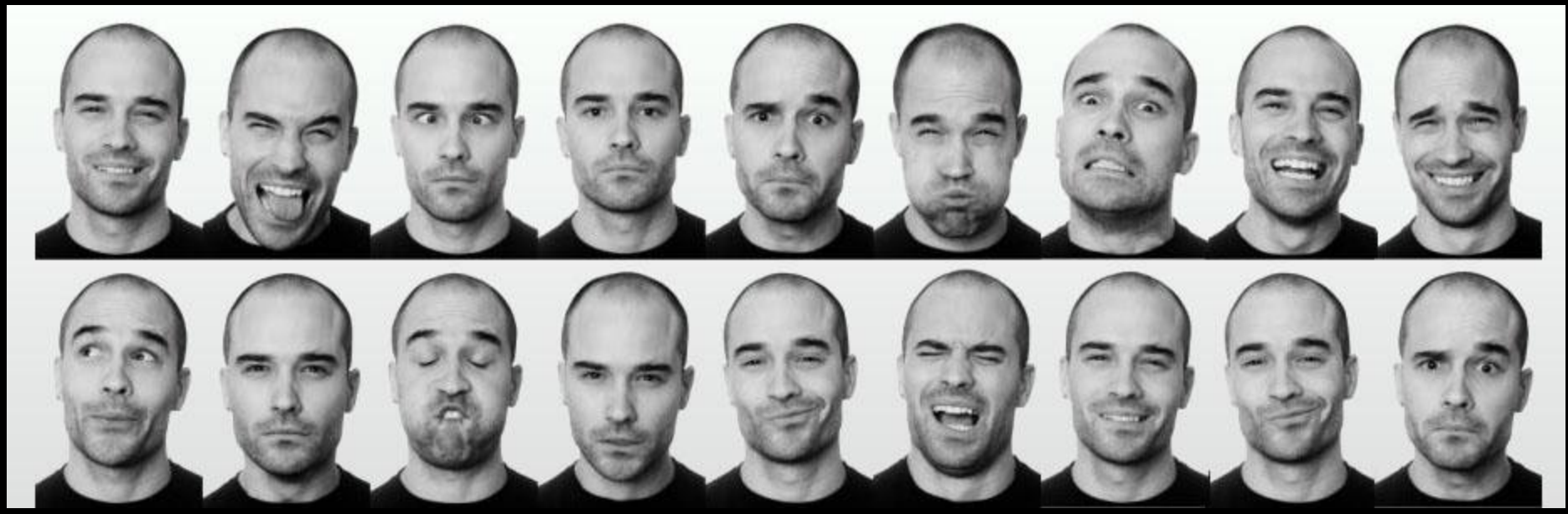
At higher levels of processing, perception and cognition are closely interrelated, which is the reason why the words ’understanding’ and ‘seeing’ are synonymous. ”

– Colin Ware

Pattern Recognition

Driving a Car

Pattern Recognition



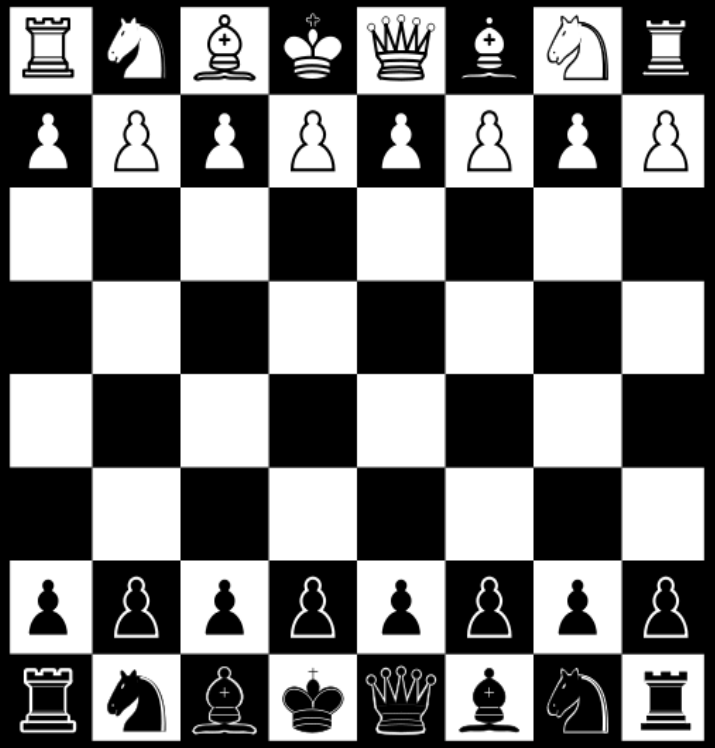
Facial & Emotion Recognition

Pattern Recognition

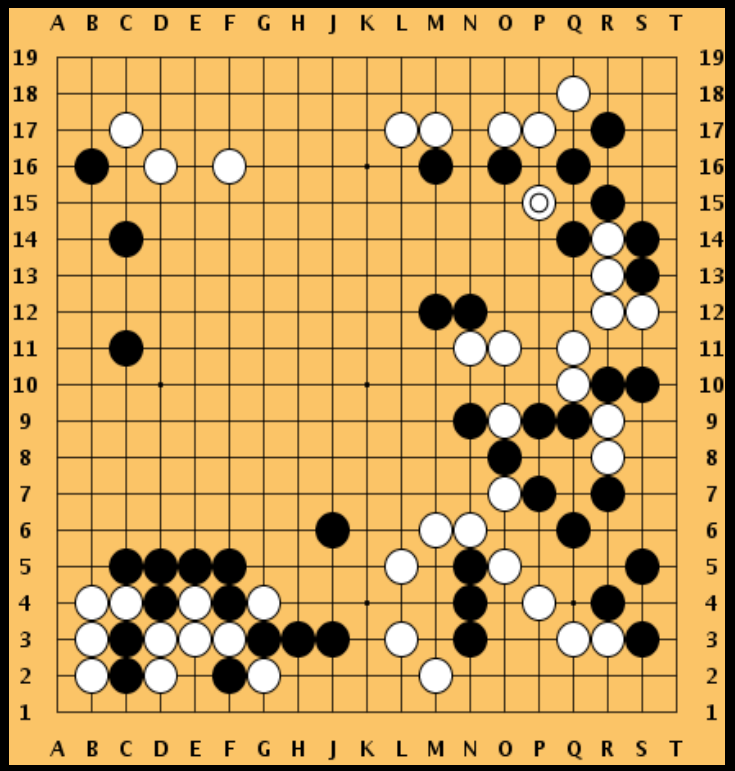
CAPTCHA

Completely Automated Public Turing test to tell Computers and Humans Apart

Pattern Recognition

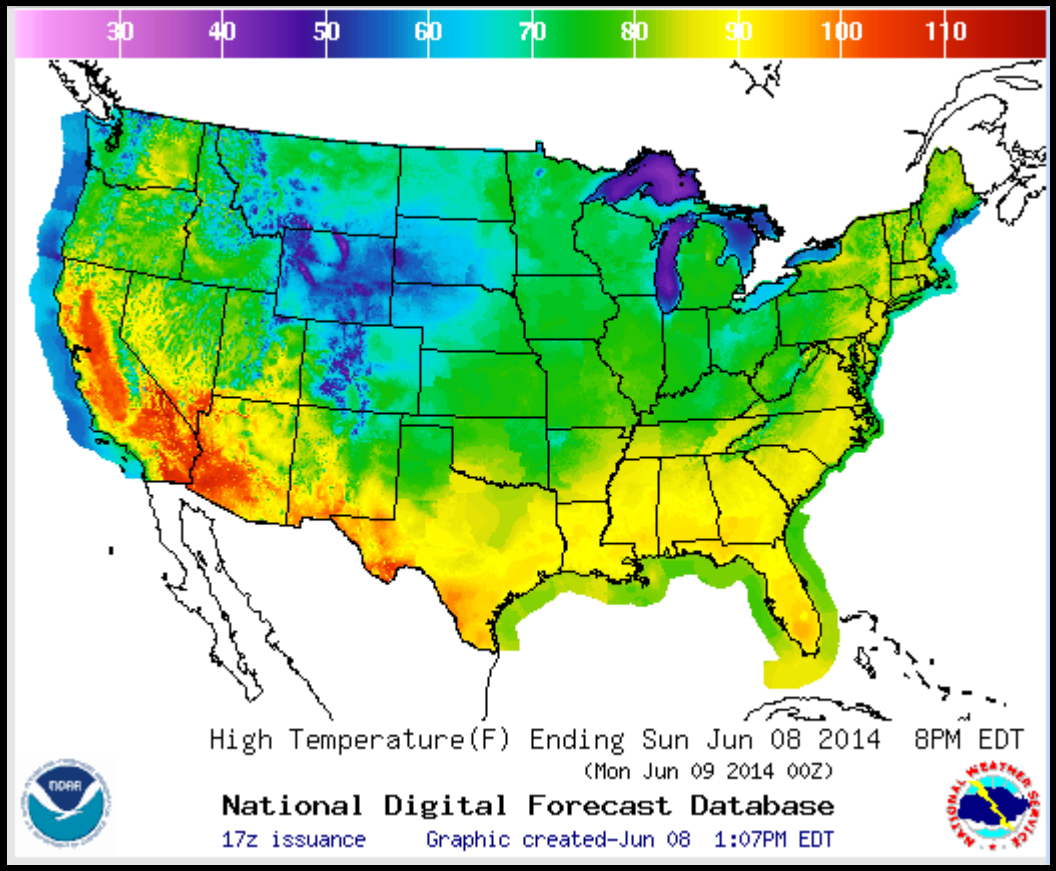


Chess



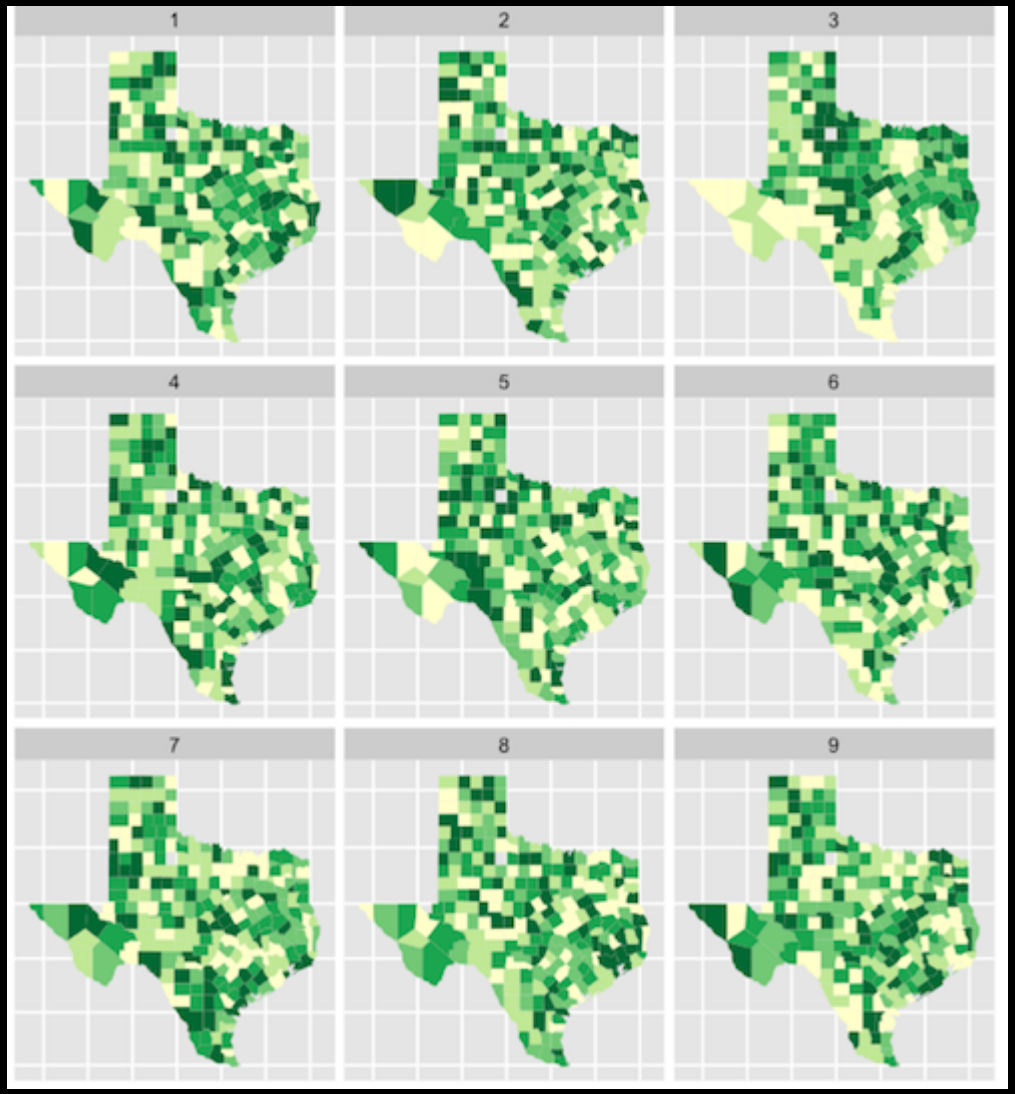
Go

Pattern Recognition



Weather Forecasts

Patterns in Random Noise



Choropleth maps of cancer deaths in Texas, where darker colors = more deaths.

Can you spot which of the nine plots is made from a real dataset and not from under the null hypothesis of spatial independence?

Source: Graphical Inference for Infovis

Visualization

“Transformation of the symbolic into the geometric”

- McCormick et al. 1987

“The use of computer-generated, interactive, visual representations of abstract data to amplify cognition.”

- Card, Mackinlay, & Shneiderman 1999

Value of Visualization

Expand memory
Answer questions
Find patterns
See data in context

Make decisions
Persuade | Tell a story
Share | Collaborate

Inspire

Value of Visualization

Exploration

Explanation

Expression

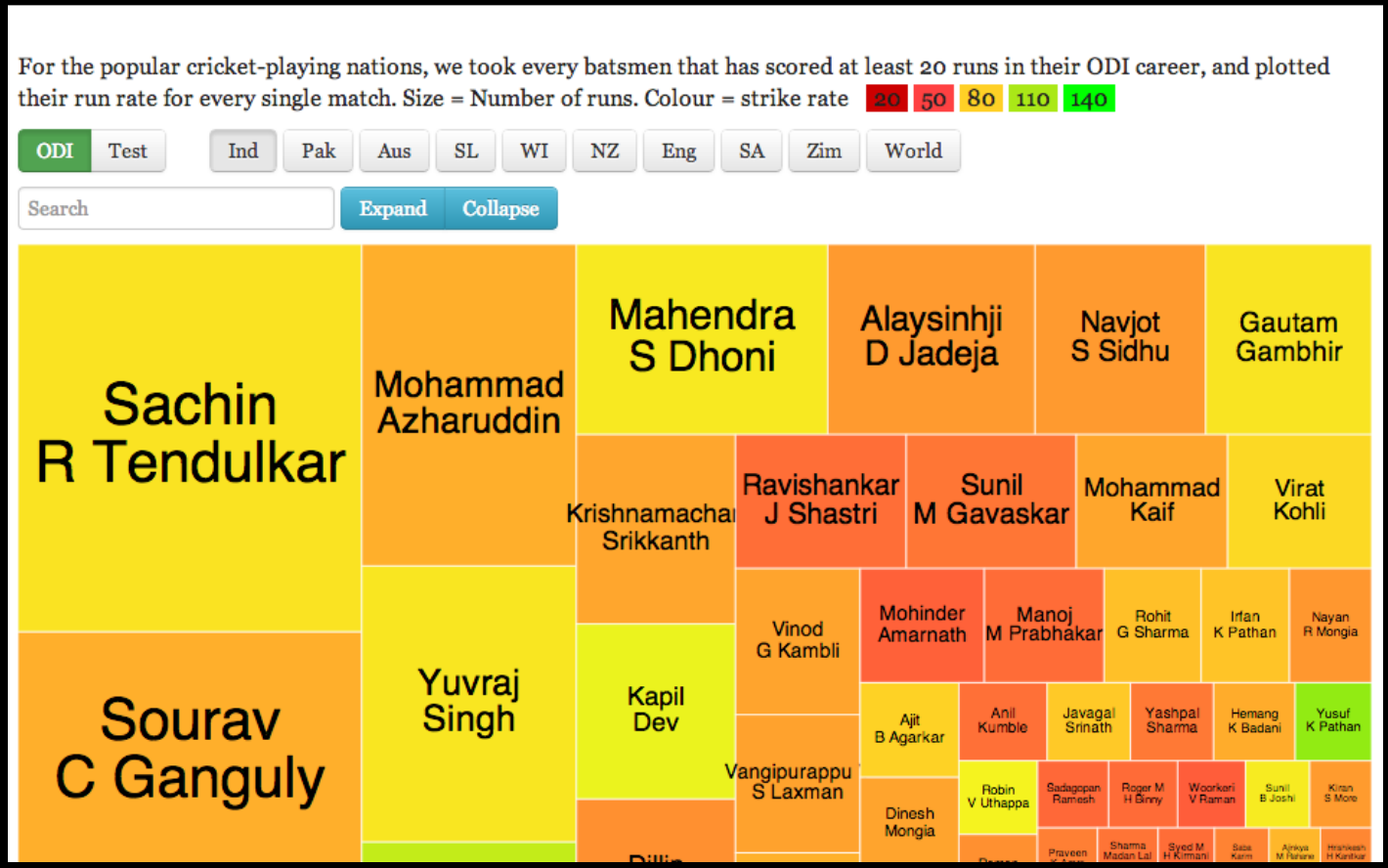
Exploration | Interactive

Data Tool for engagement,
exploration and discovery

Cricket Stats

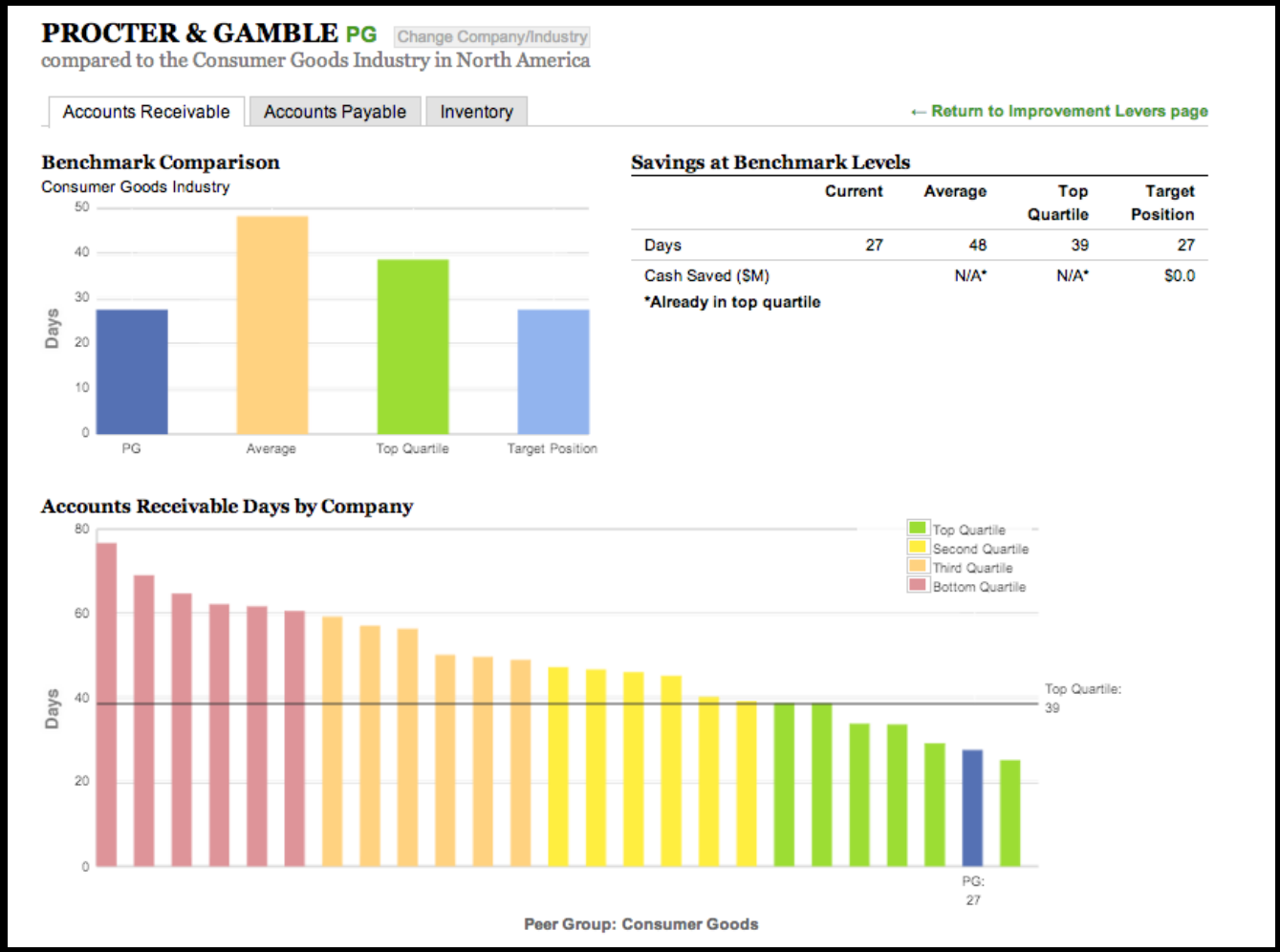
ODI: IND BATTING

Gramener



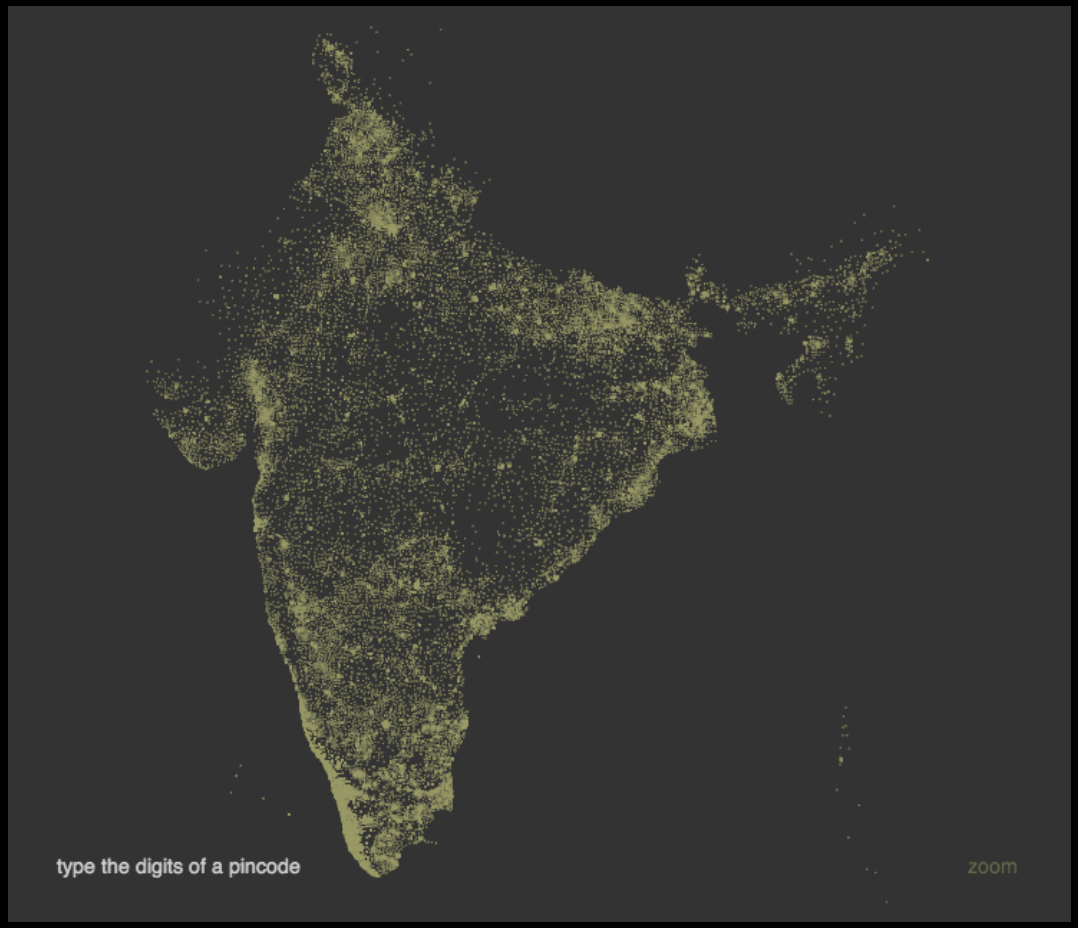
Source: [Gramener]

Working Capital Profiler



Source: [Strategy&]

Pincode decoder

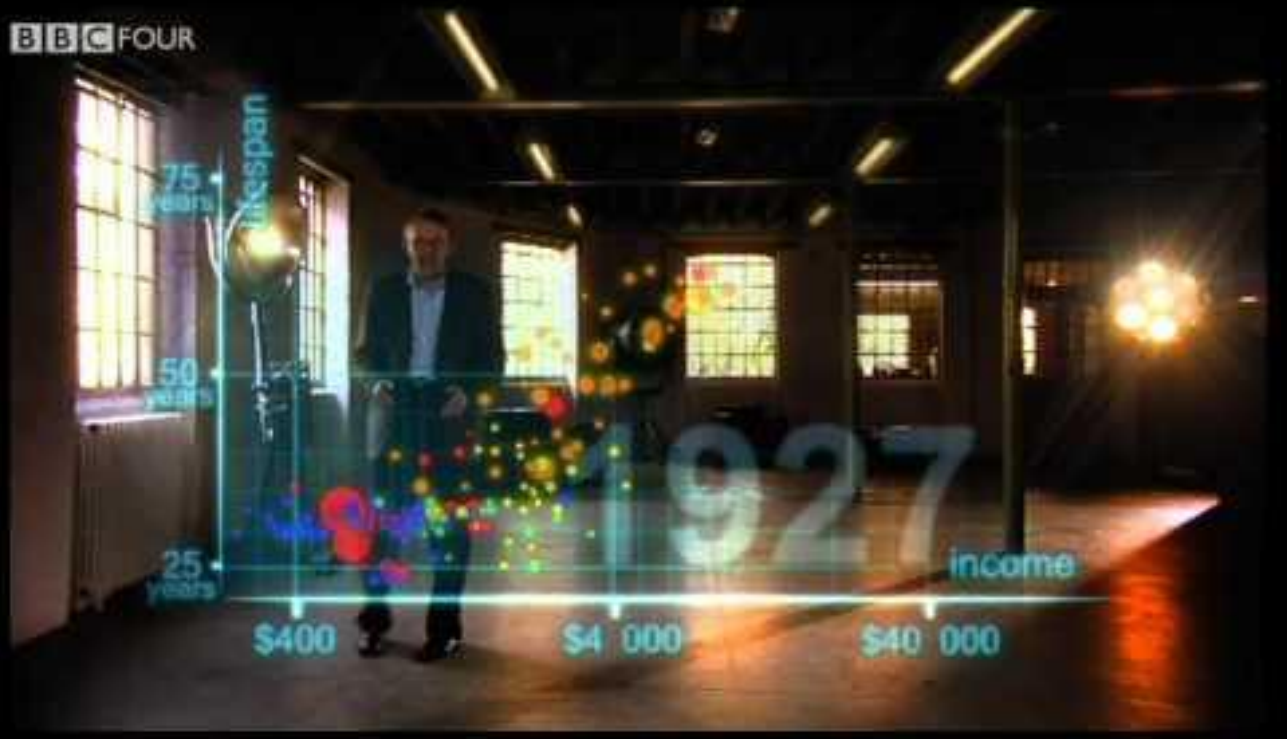


Source: Pindecode

Explanatory | Narrative

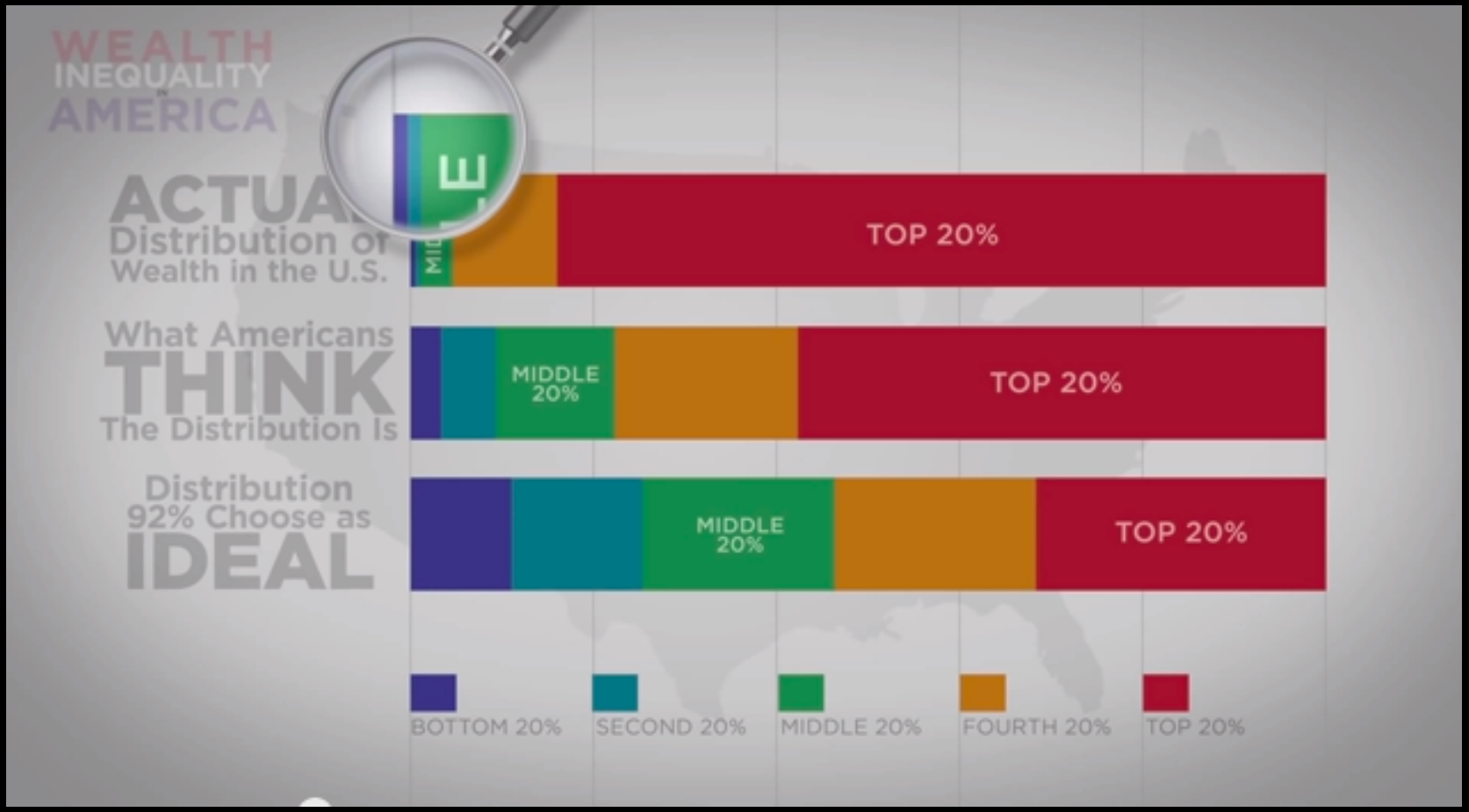
Data Stories for telling a specific and (linear) visual narrative

The Joy of Stats



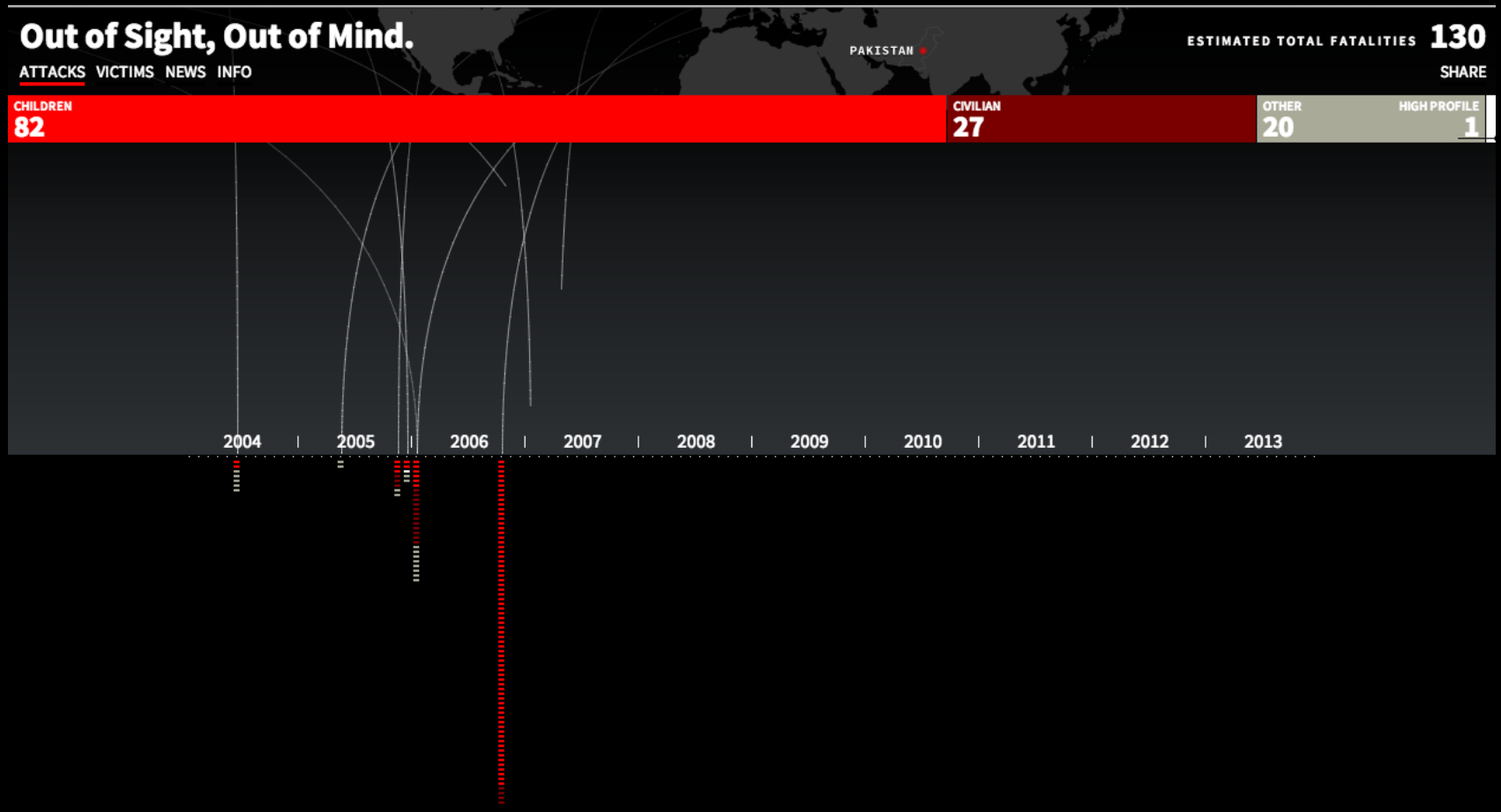
Source: Hans Rosling

Wealth Inequality



Source: Politizane

Drone Attacks

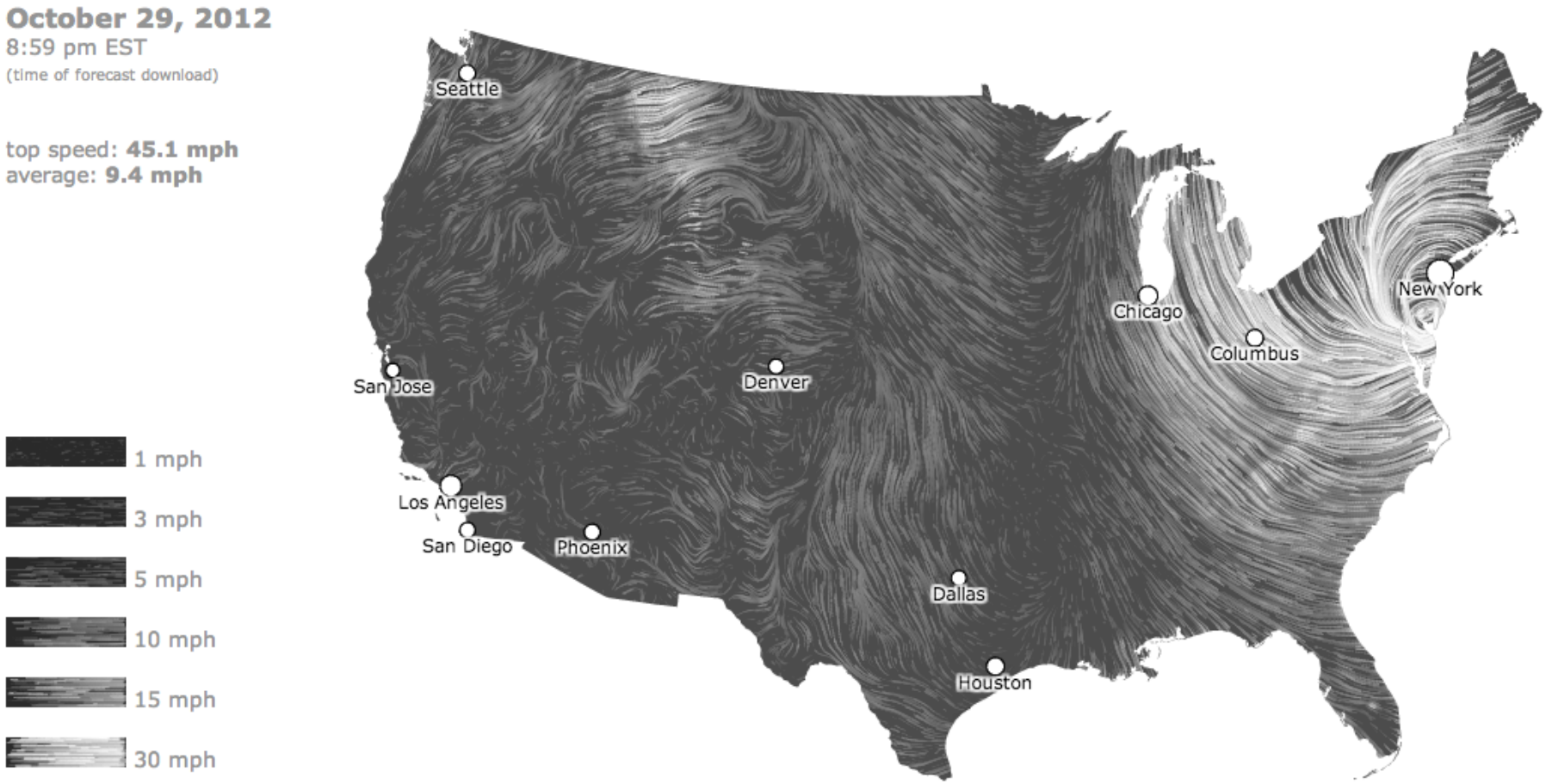


Source: Pitch Interactive

Exhibition | Expression

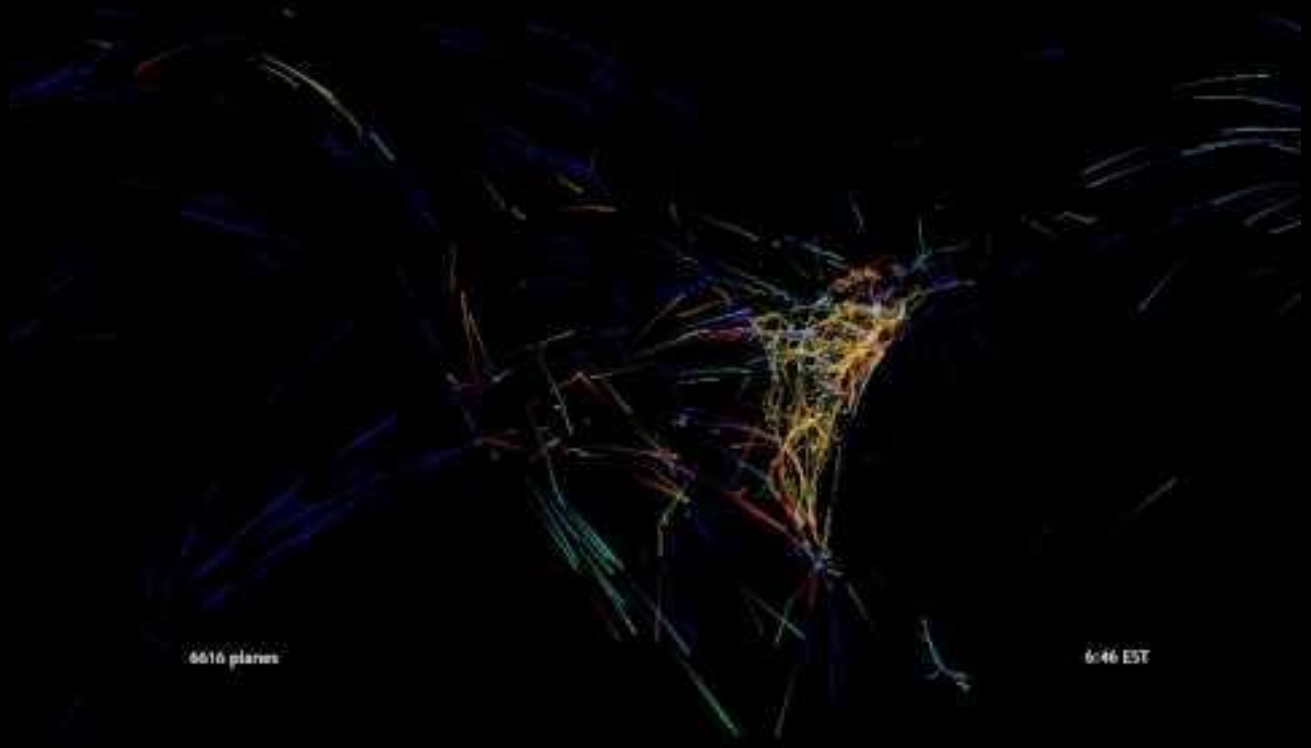
Data Art for visual expression, delight (and impact, insight)

Wind Map



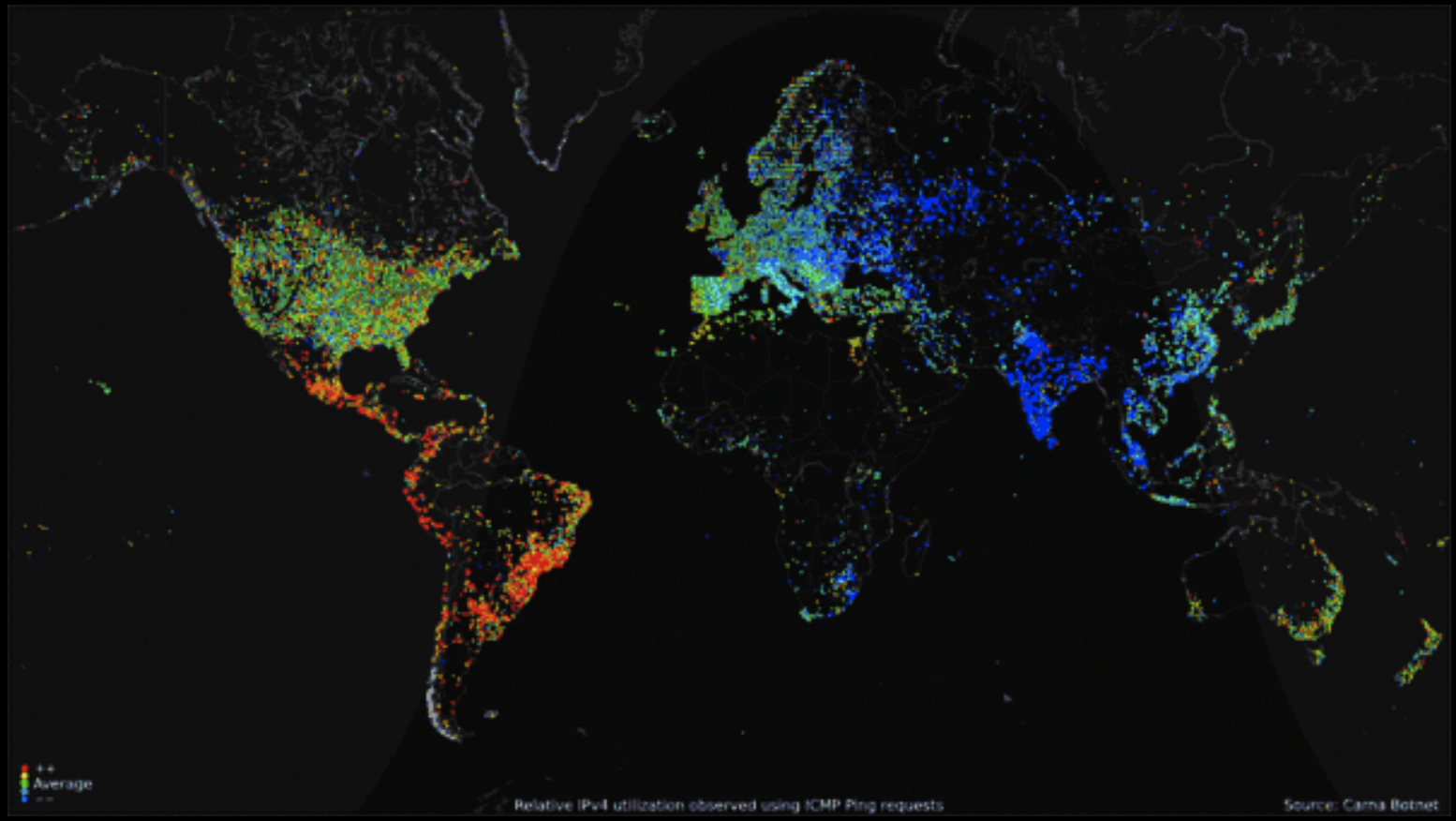
Source: hint.fm/wind

Flight Patterns



Source: Aaron Koblin

Internet Census



Source: Internet Census

Making Sense of Data

"The ability to take data—to be able to understand it, to process it, to extract value from it, to visualize it, to communicate it—that's going to be a hugely important skill in the next decades, … because now we really do have essentially free and ubiquitous data. So the complimentary scarce factor is the ability to understand that data and extract value from it."

– Hal Varian, Google's Chief Economist

Design Framework

Approach for Creating Data-Visual-Stories

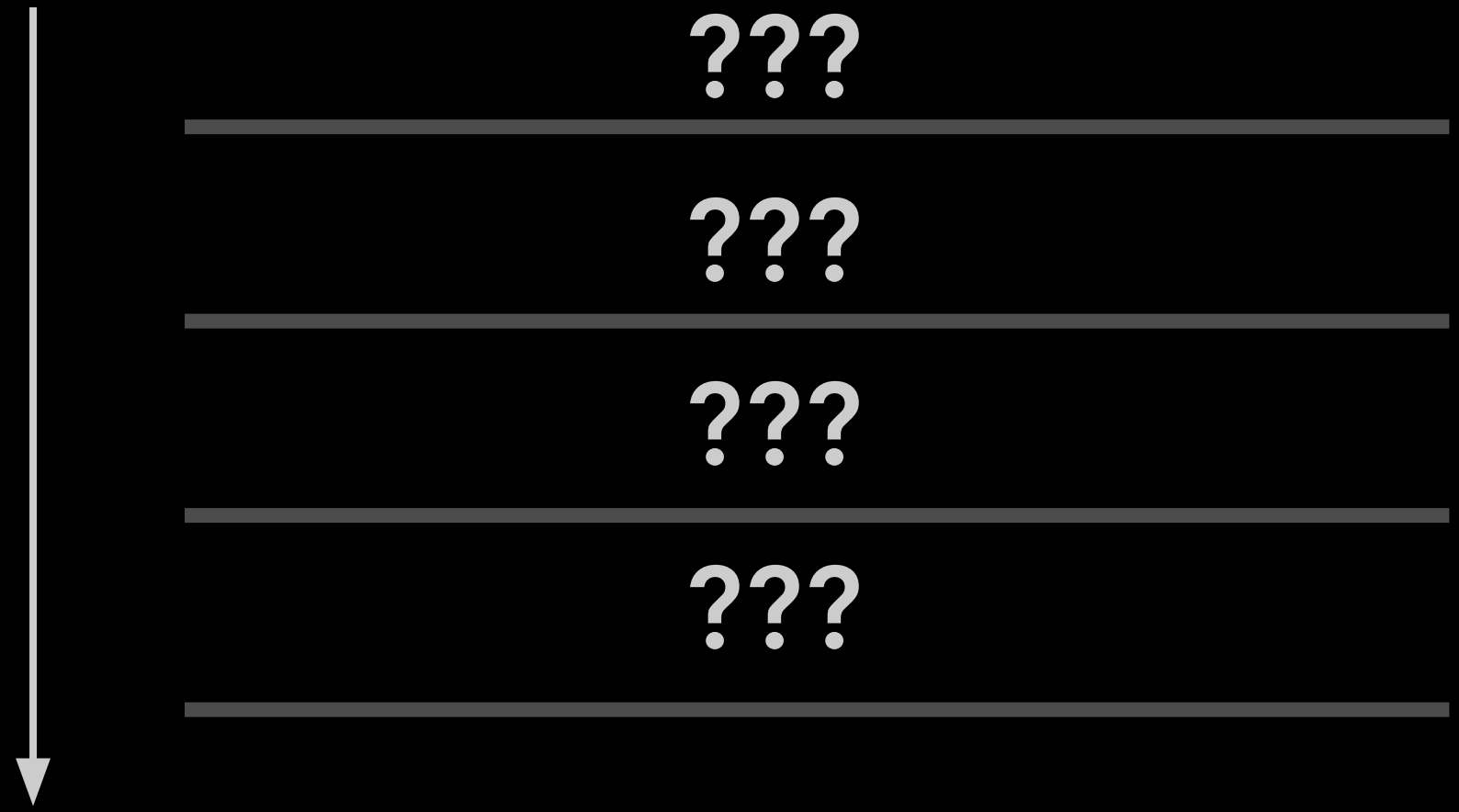
Word | **Writer**

Note | **Musician**

Frame | **Film Maker**

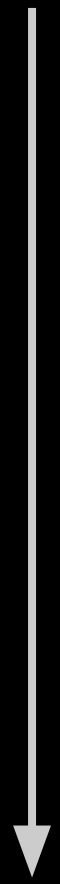
Datum | **Data Artist**

Datum



Data-Visual-Story

Datum



See the Data

Show the Visual

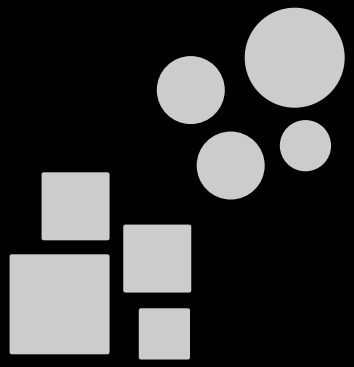
Tell the Story

Engage the Audience

Data-Stories

See the Data

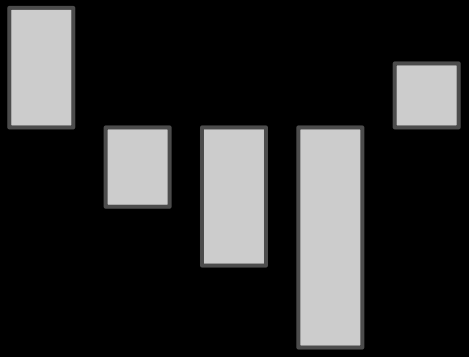
Pattern



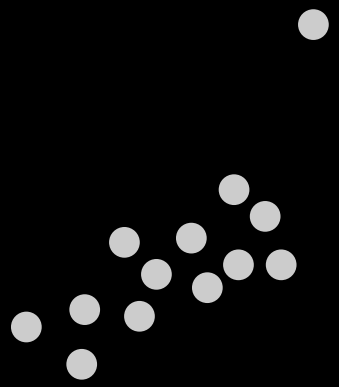
Trend

Data
Abstraction

Deviation



Outlier



Anscombe's Quartet

x1	y1	x2	y2	x3	y3	x4	y4
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Anscombe's Quartet

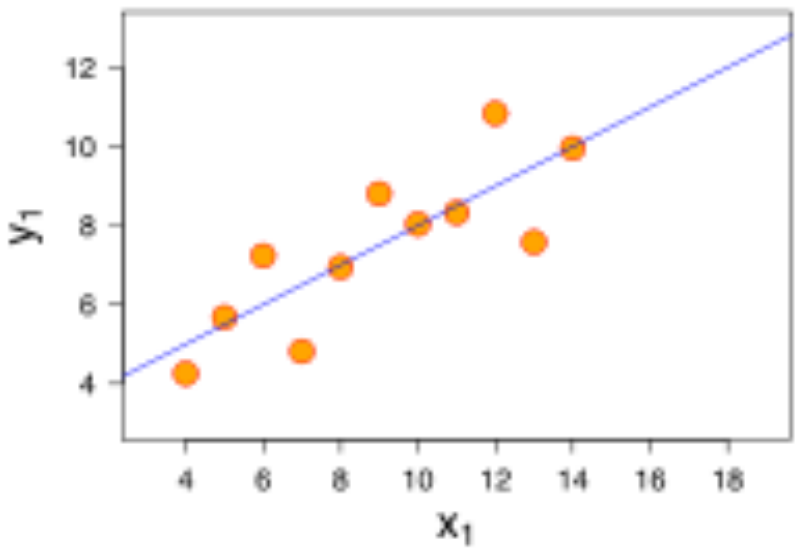
x(mean) = 9

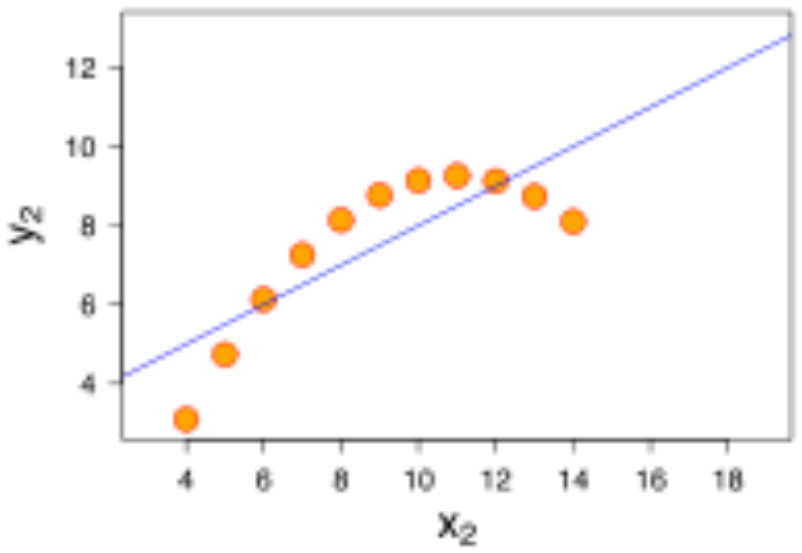
y(mean) = 7.5

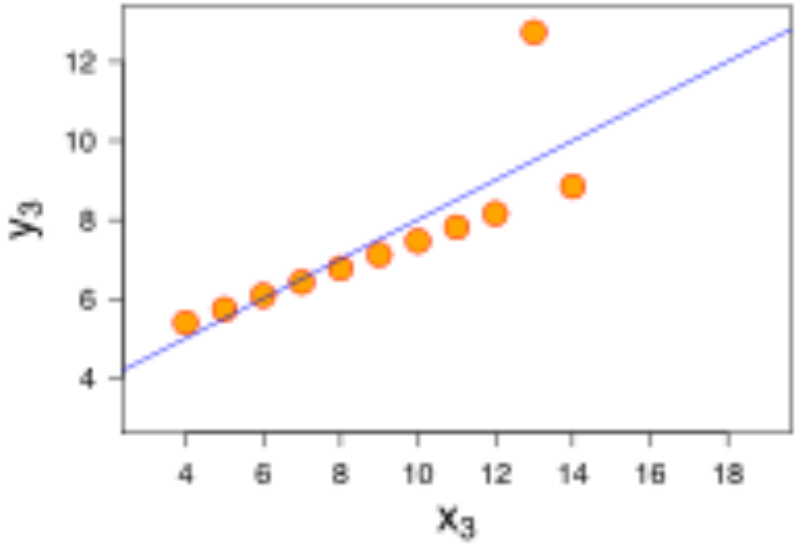
x(var) = 11

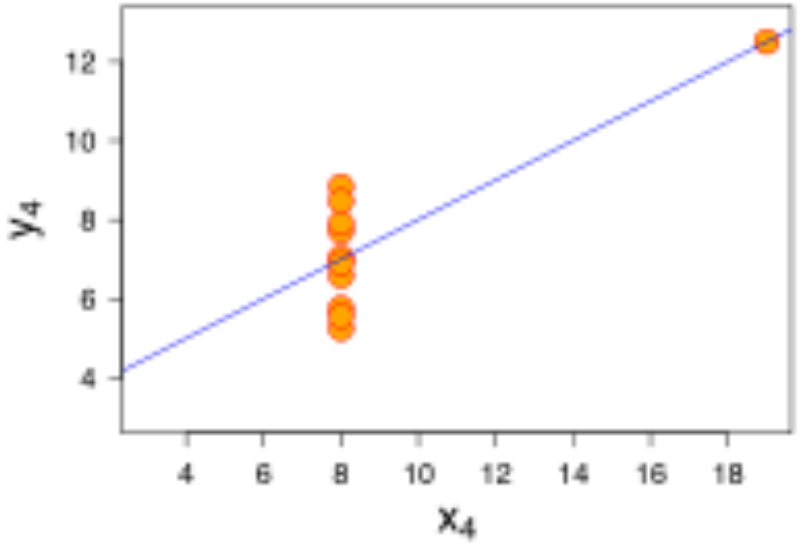
y(var) = 4.12

y = 3.00 + 0.500 x


12
10
8
6
4
y1
4
6
8
10
12
14
16
18
x1


12
10
8
6
4
y2
4
6
8
10
12
14
16
18
x2


12
10
8
6
4
y3
4
6
8
10
12
14
16
18
x3


12
10
8
6
4
y4
4
6
8
10
12
14
16
18
x4

This is hard work

"80% perspiration,
10% great idea,
10% output."

- Simon Rogers

See the Data

1. Acquire
2. Prepare
3. Refine
4. Explore

See the Data

1. Acquire
2. Prepare
3. Refine

Data Wrangling

4. Explore

Exploratory Data Analysis

Explore

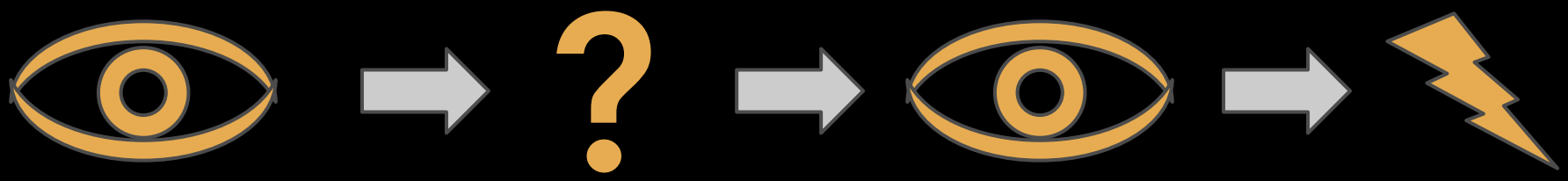
"Visualization gives you answers to questions you didn't know you had."

- Ben Schneiderman

Directed Approach

Question Explore Insight

Exploratory Approach



Explore Question Explore Insight

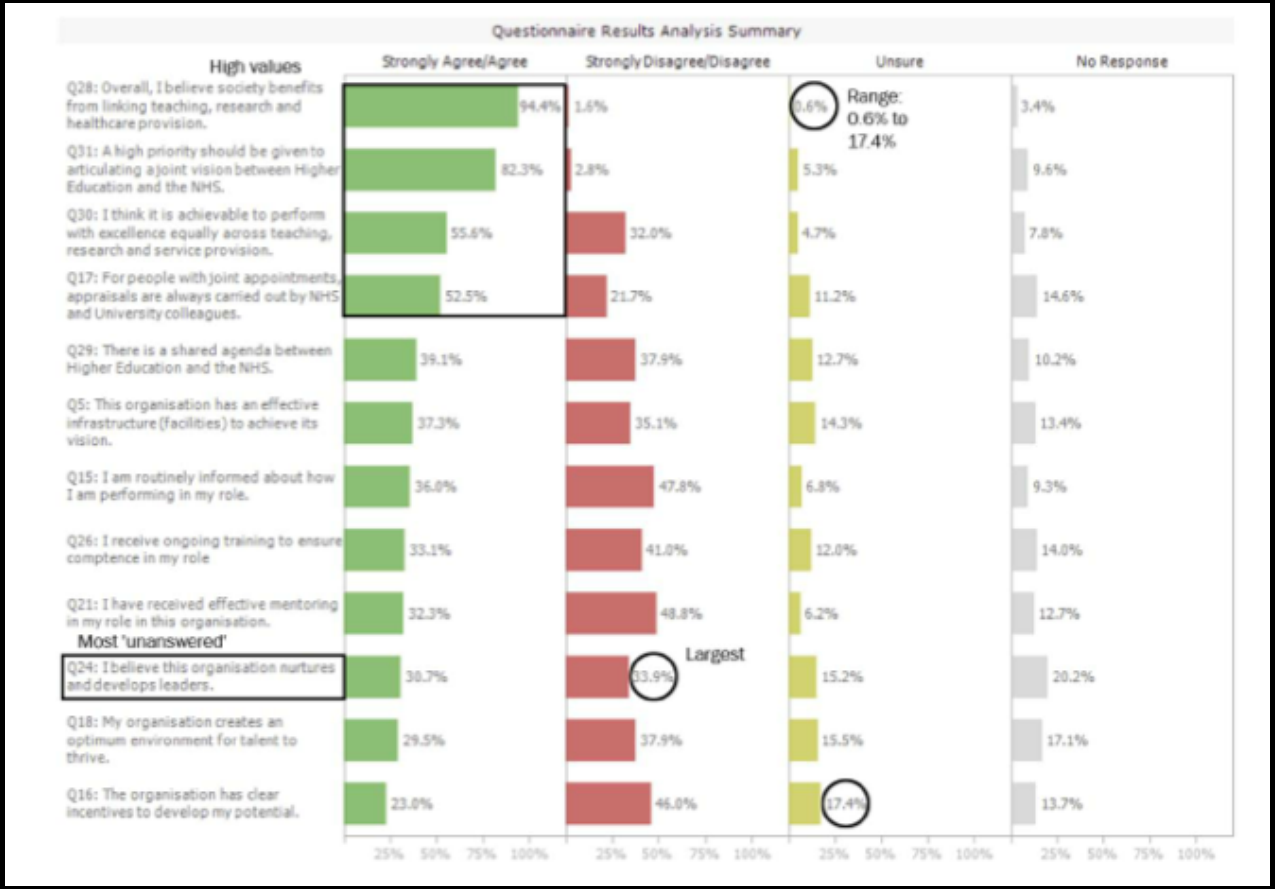
Visually Exploring

Active Seeing

Skill Building over Time

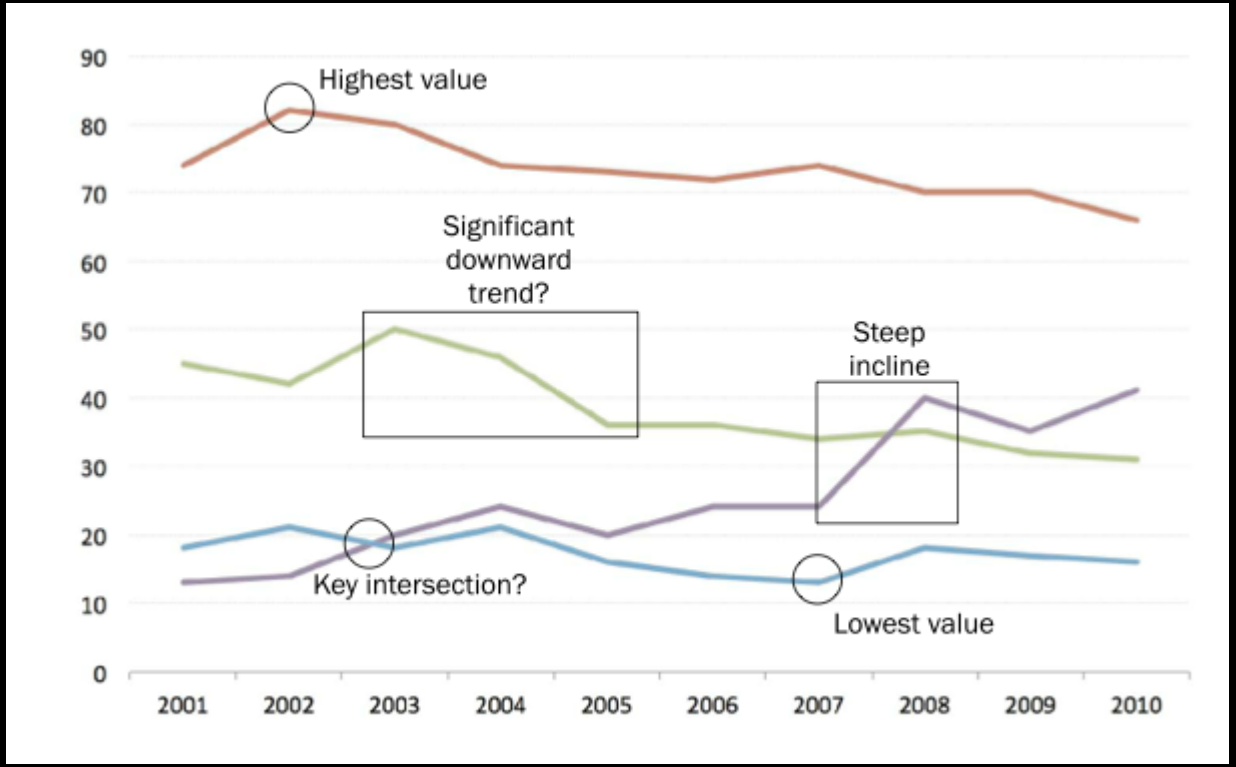
Comparison, Deviations

- Range, Distribution: high, low, shape
- Ranking: big, medium, small
- Categorical Comparison: proportion
- Measurement: absolutes
- Context: target, average, forecast
- Hierarchical: category, subcategories



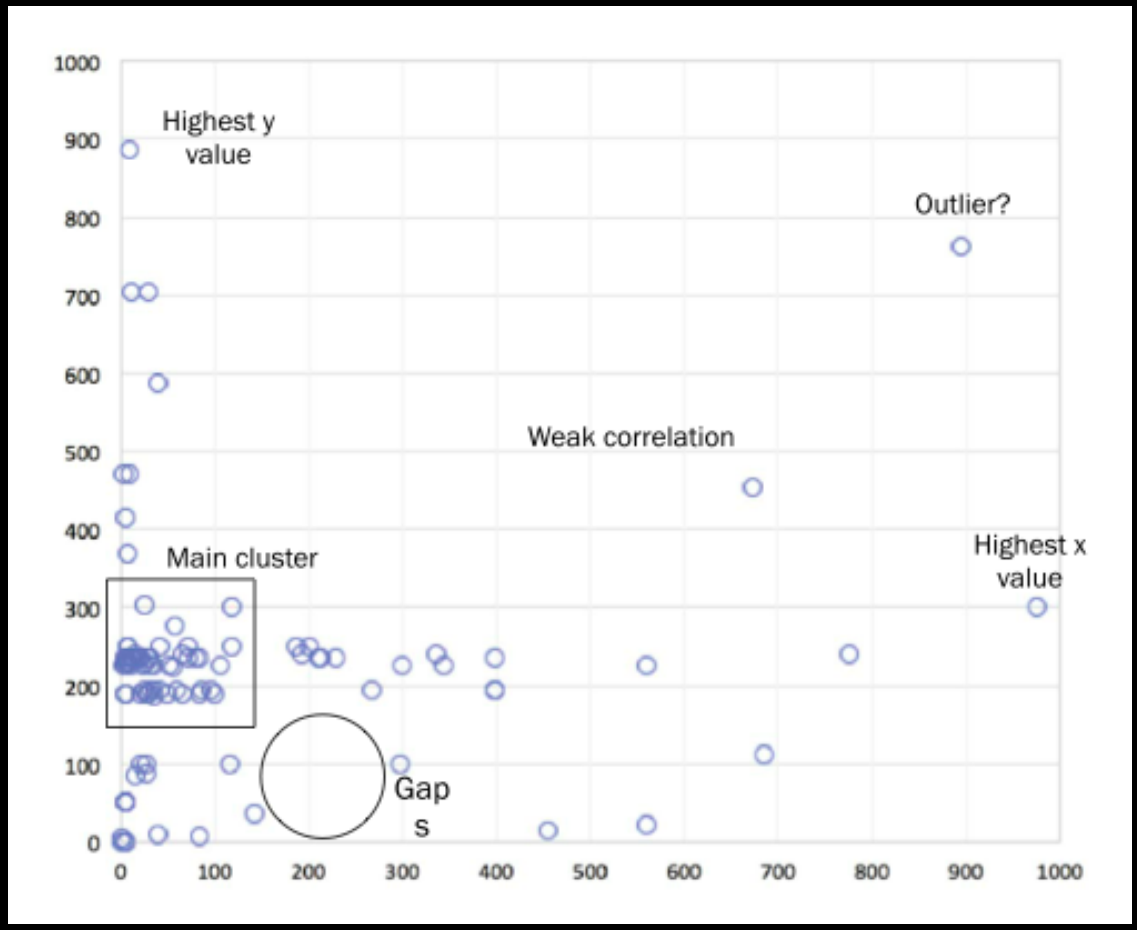
Trends

- Direction: up, down or flat
- Optima: highs. lows
- Rate of Change: linear, exponential
- Fluctuation: seasonal, rhythm
- Significance: signal vs. noise
- Intersection: overlap, crossover



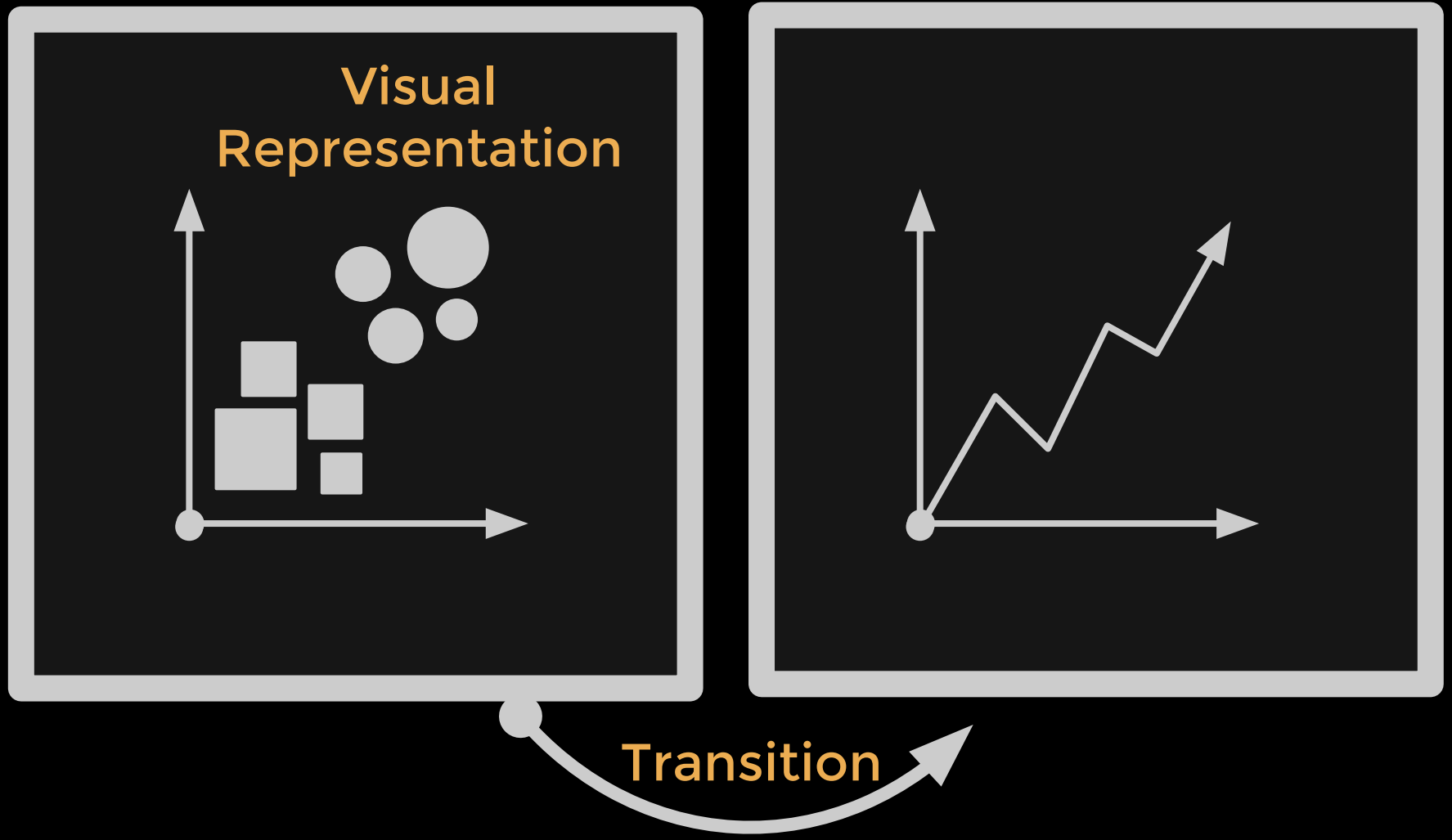
Patterns, Relationships

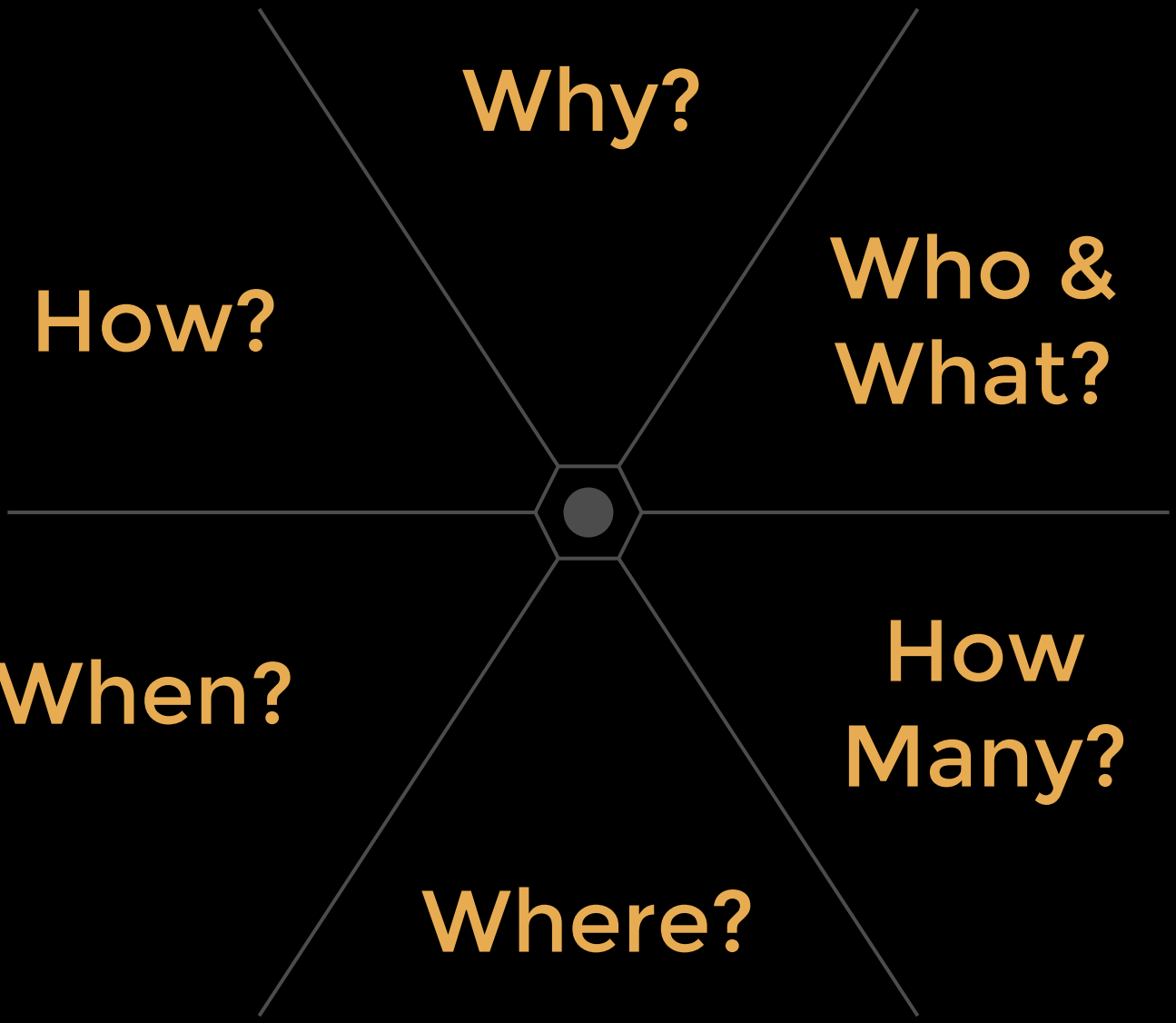
- Exceptions: outliers
- Boundaries: highs. lows
- Correlation: weak, strong
- Association: variables, values
- Clusters: bunching, gaps
- Intersection: overlap, crossover

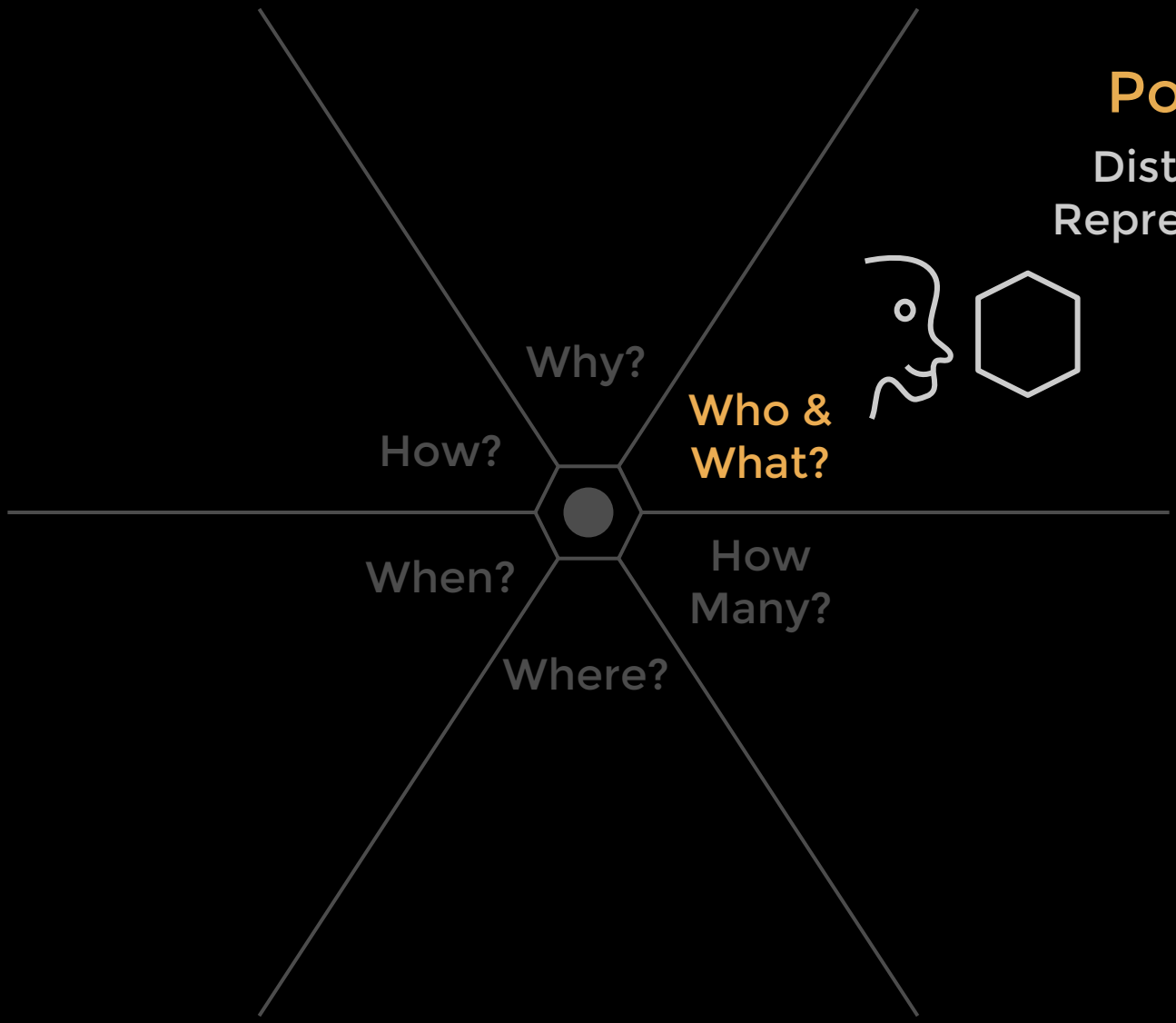


Show the Visual

Framing



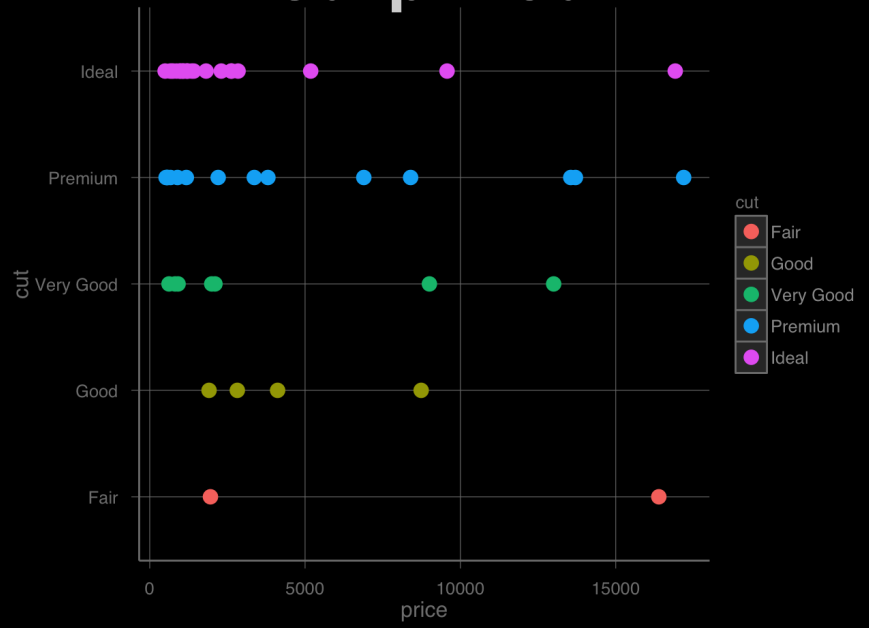

Why?
Who &
What?
How
Many?
Where?
When?
How?



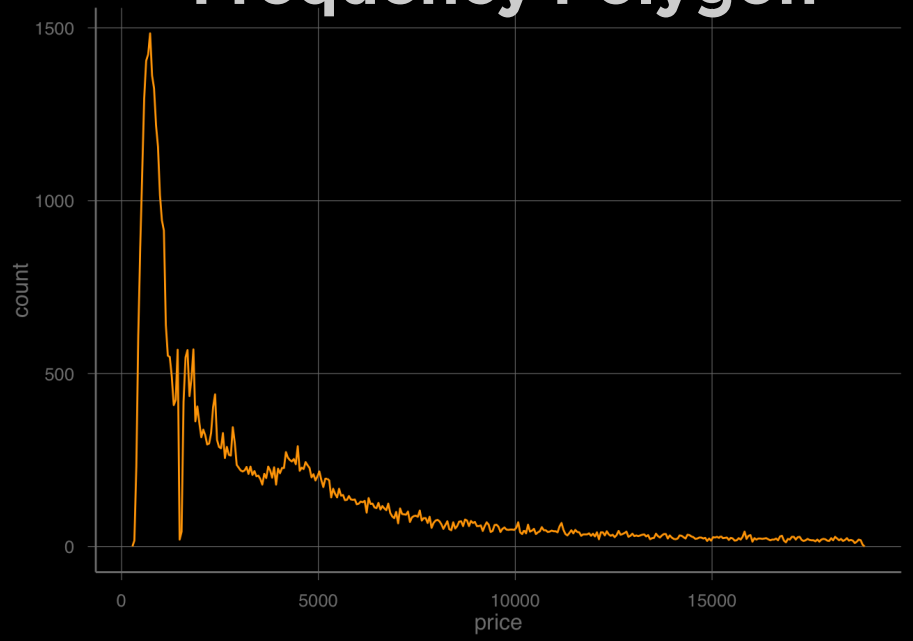
Portrait

Distribution
Representation

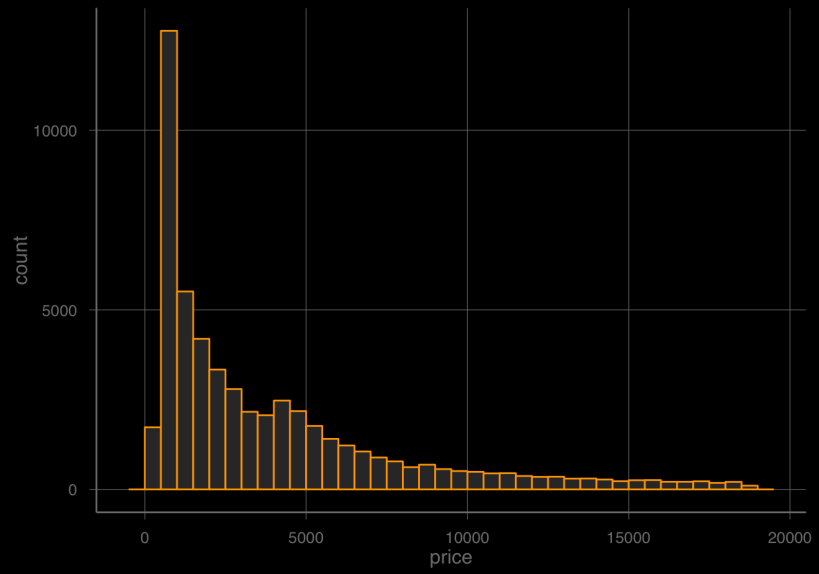
Strip Plot



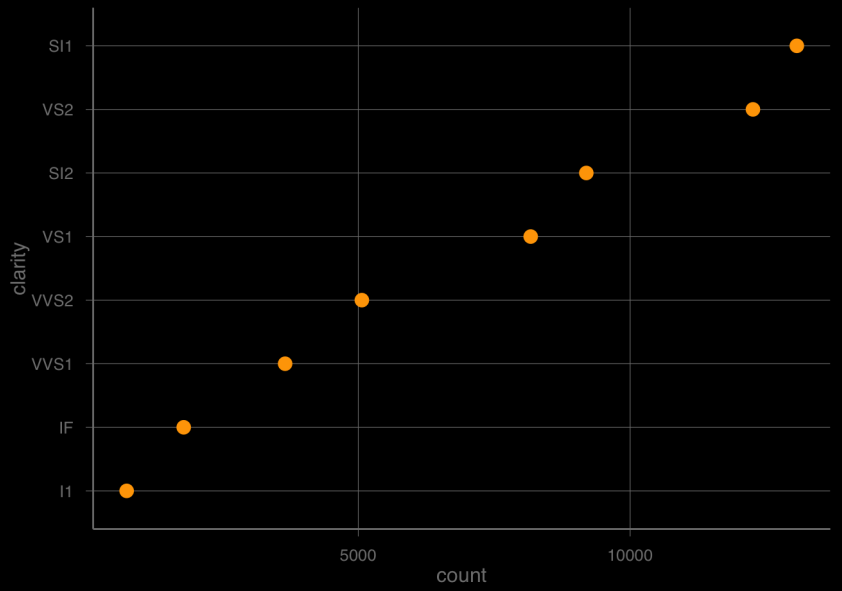
Frequency Polygon



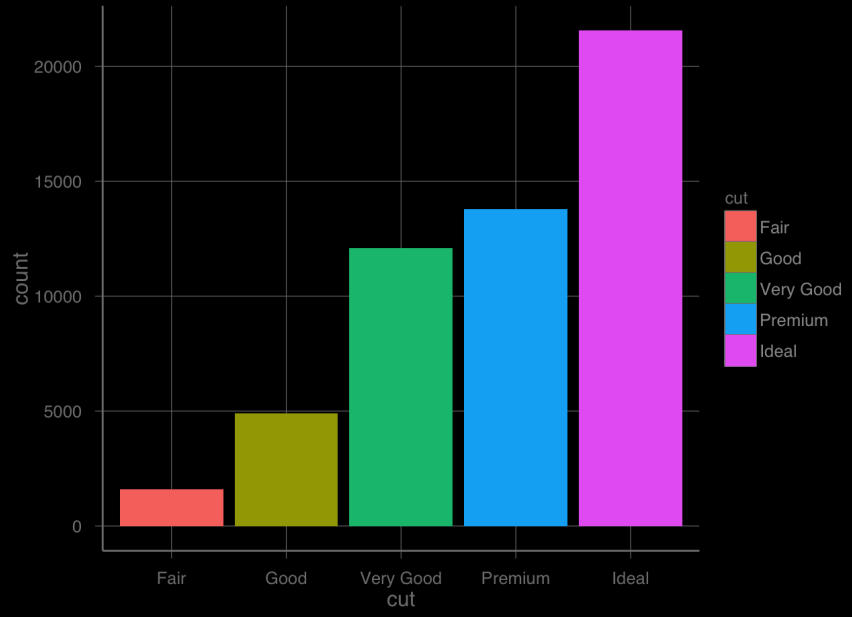
Histogram



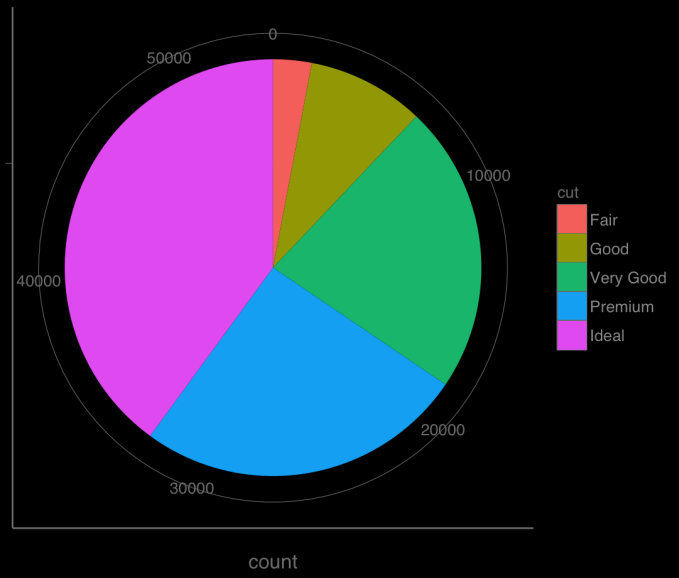
Dot Plot



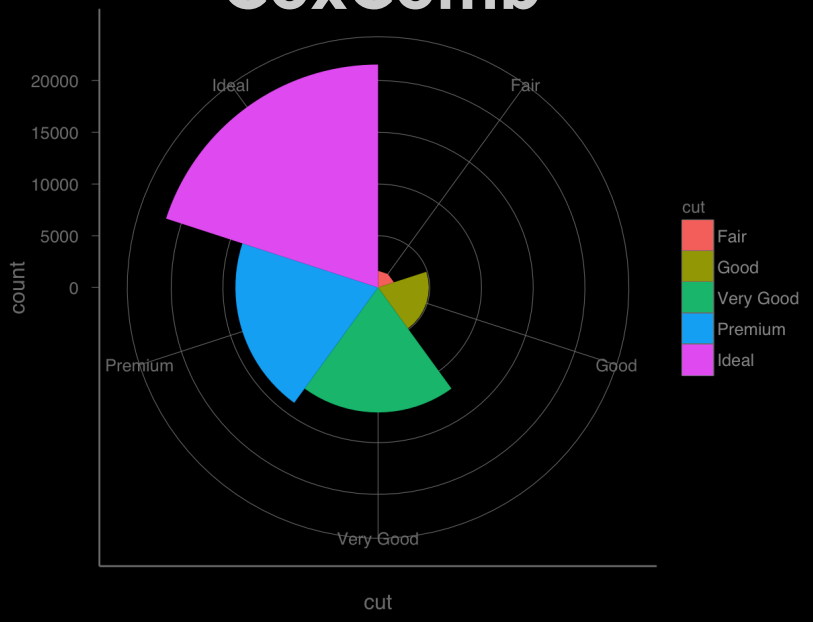
Column (Bar) Chart



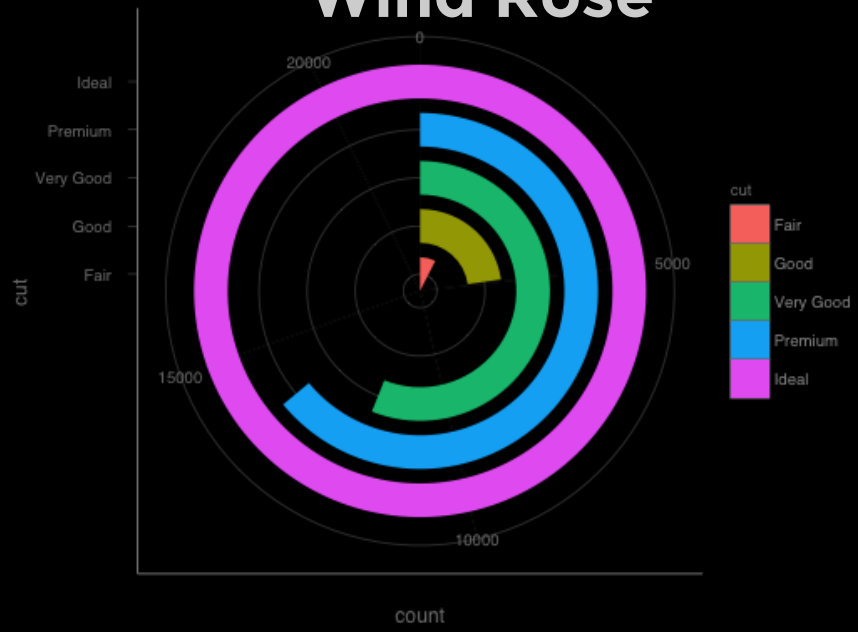
Pie Chart



CoxComb



Wind Rose



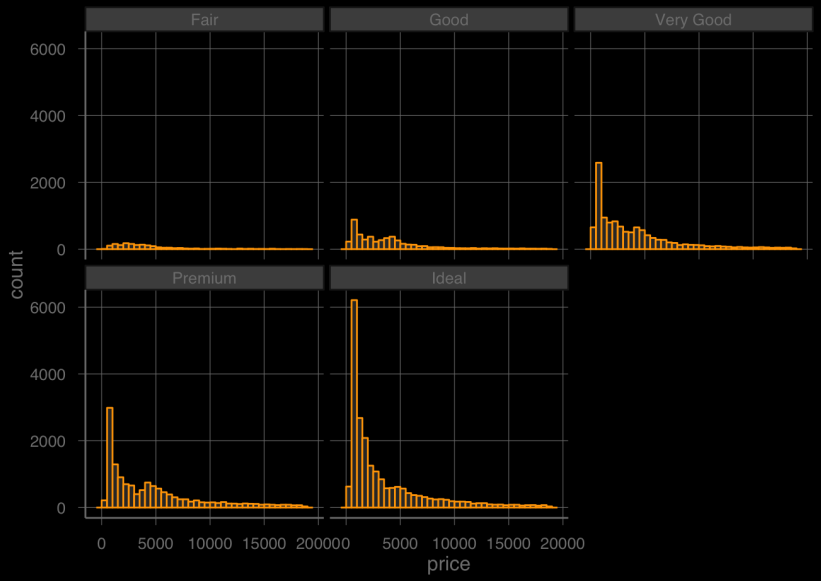
Portrait

Distribution
Representation

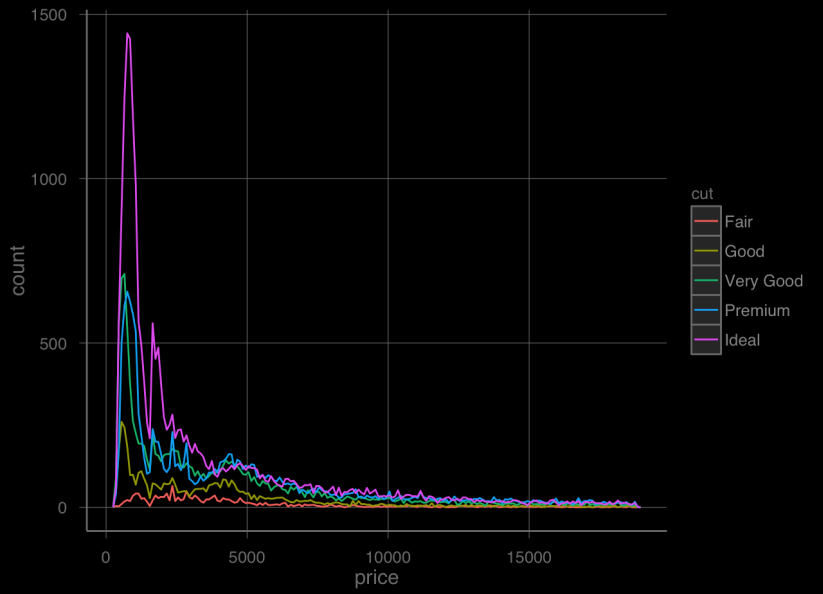
Comparison

Comparative
Representation

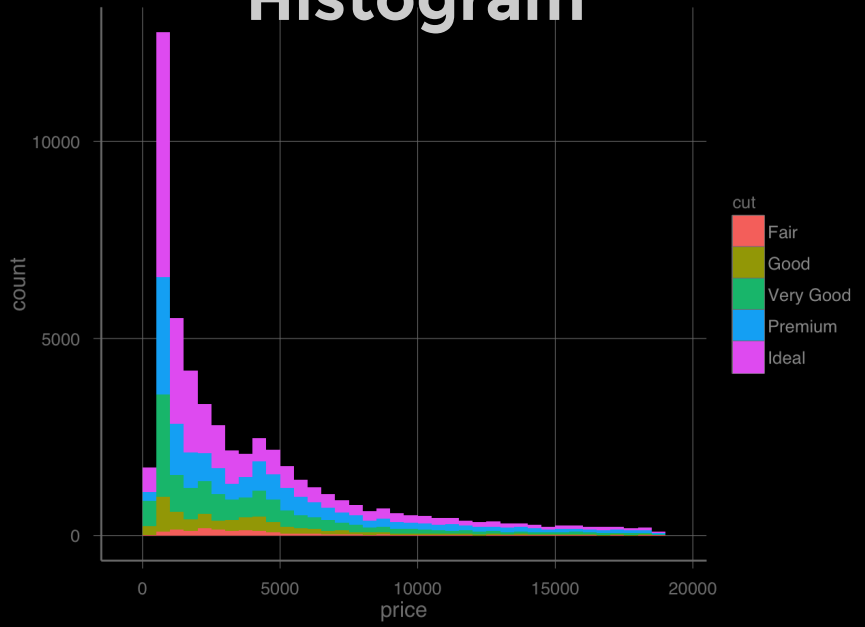
Small Multiple



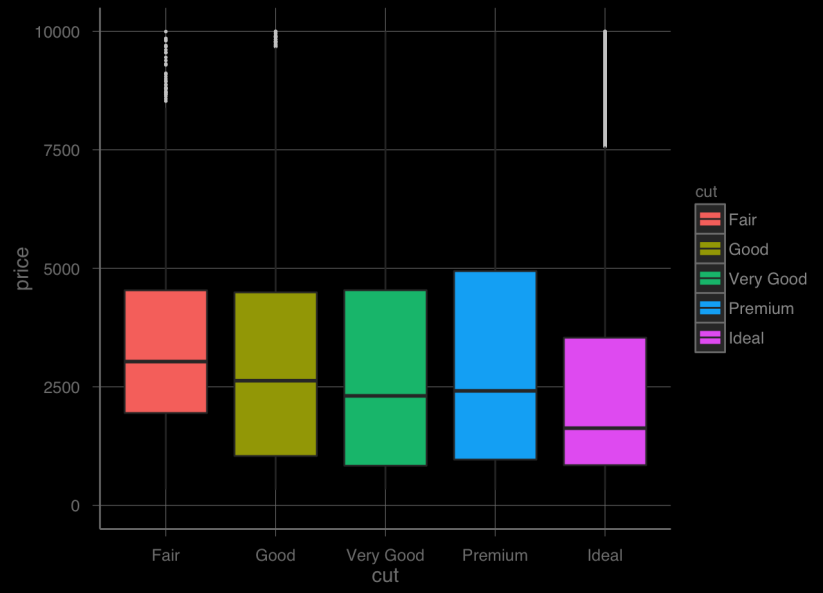
Frequency Polygon



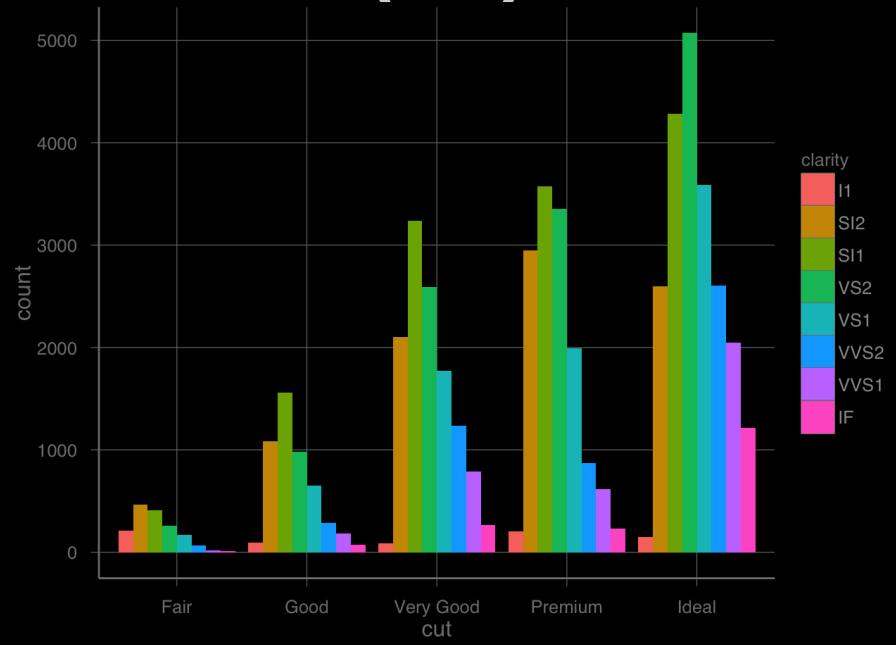
Histogram



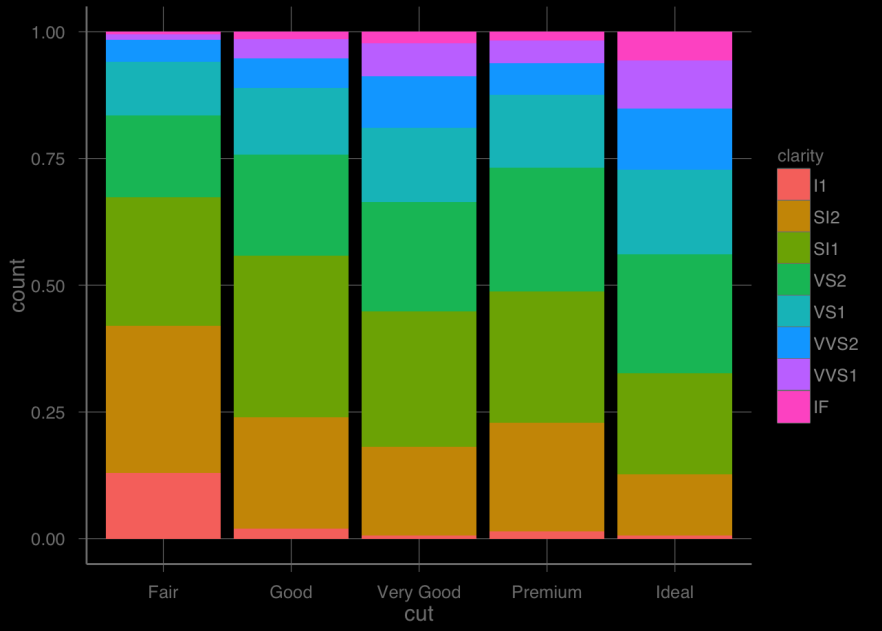
Box Plot



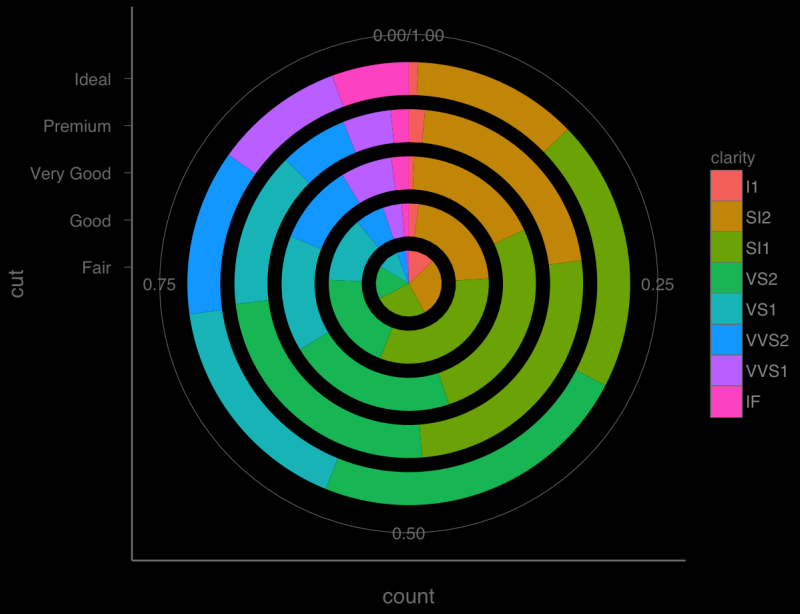
Column (Bar) Chart



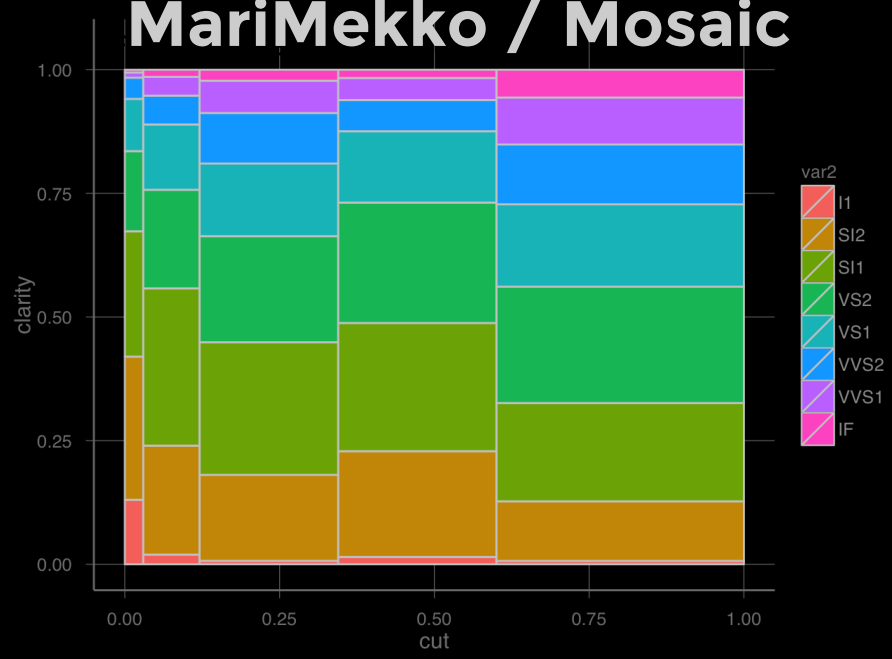
Stacked Chart



CoxComb

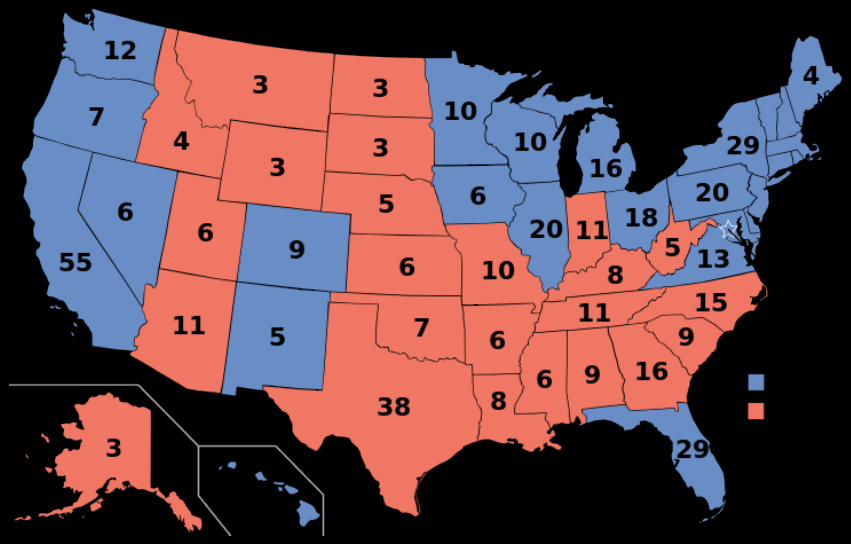


MariMekko / Mosaic

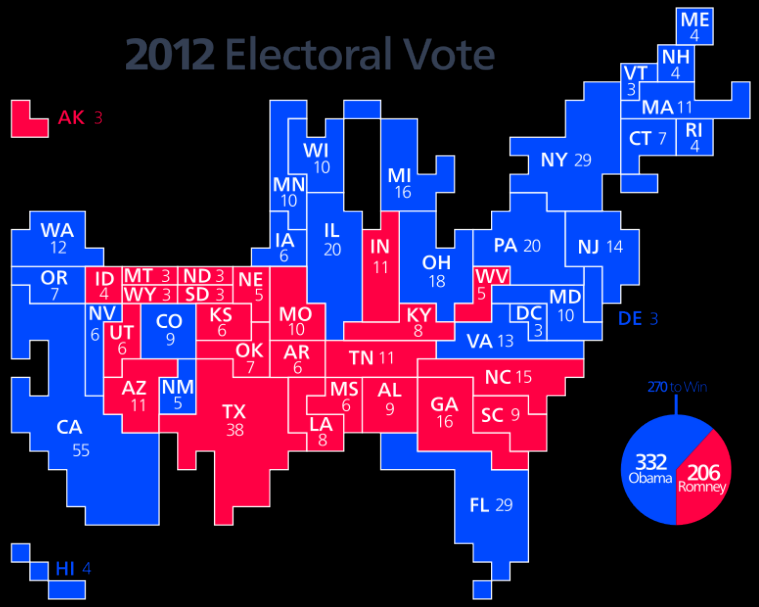



Why?
Who &
What?
How?
How
Many?
When?
Where?
?
Portrait
Distribution
Representation
Comparison
Comparative
Representation
Map
Position in Space

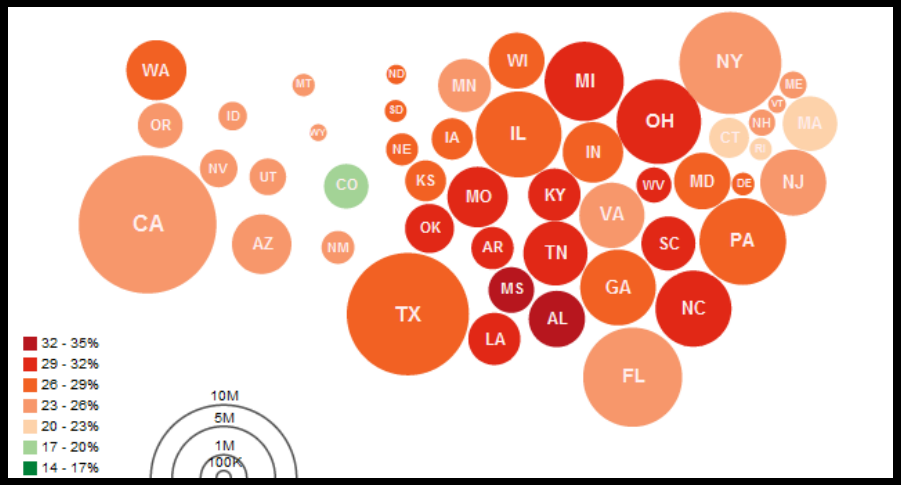
Chloropleth



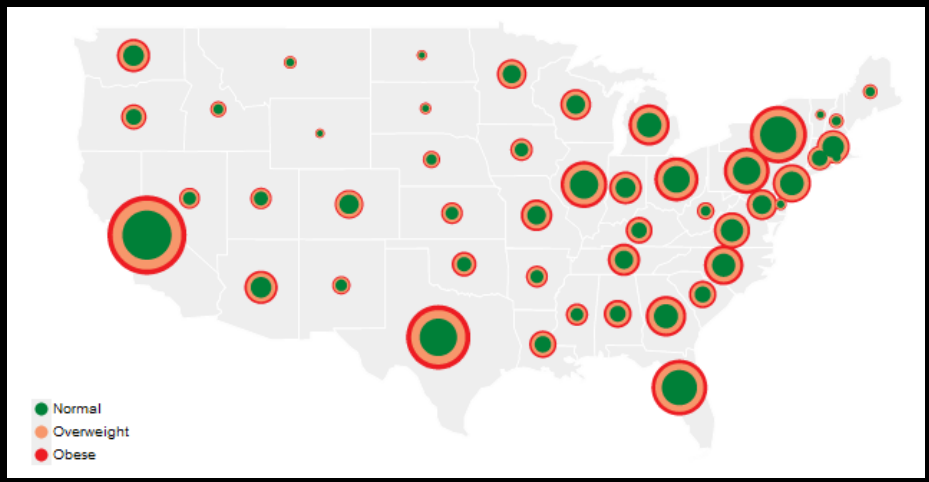
Cartogram



Dorling Cartogram

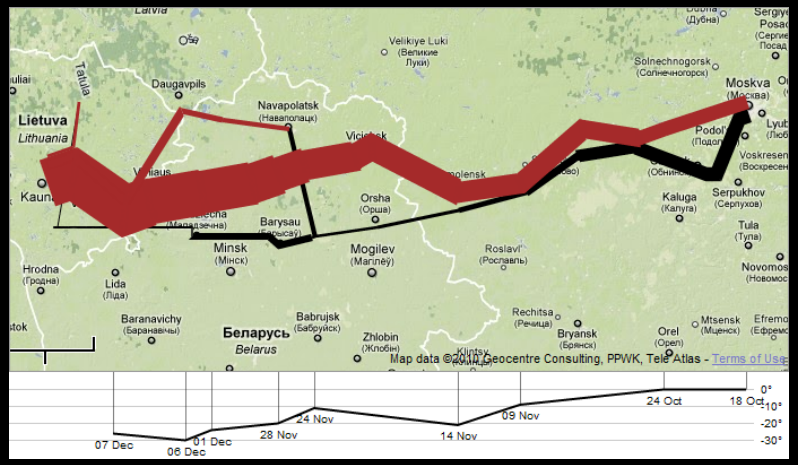


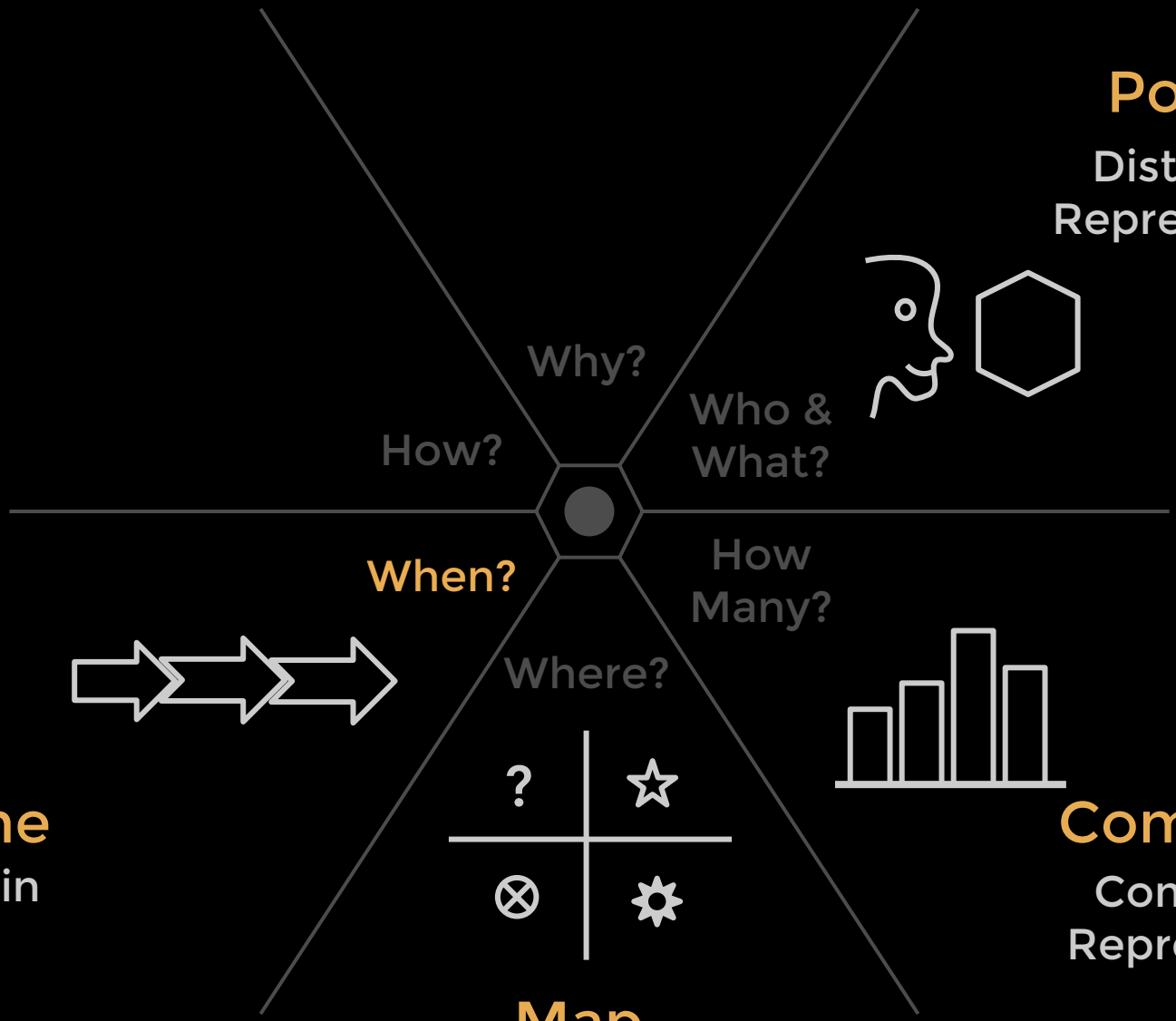
Graduated Symbol



Map Connection

Flow Map





Portrait

Distribution
Representation

Timeline

Position in
Time

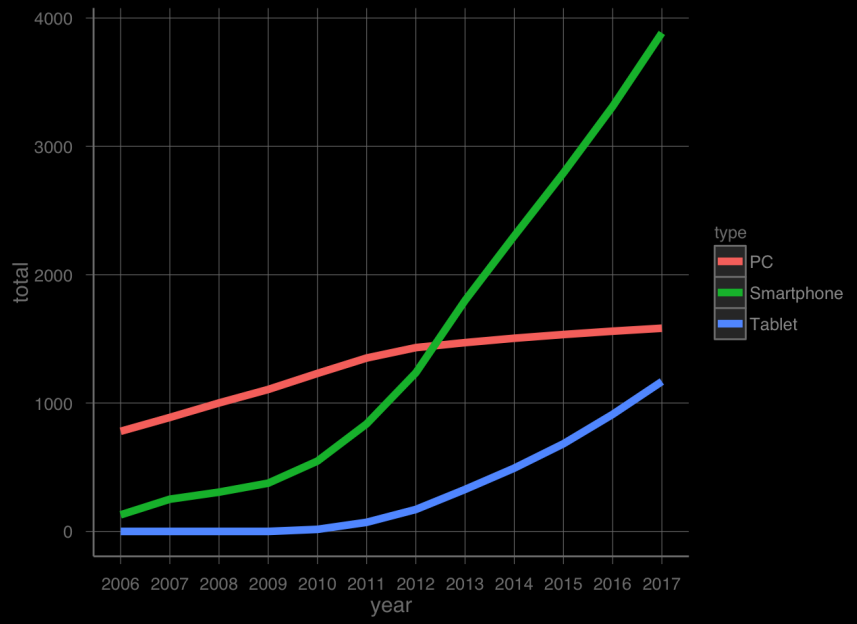
Comparison

Comparative
Representation

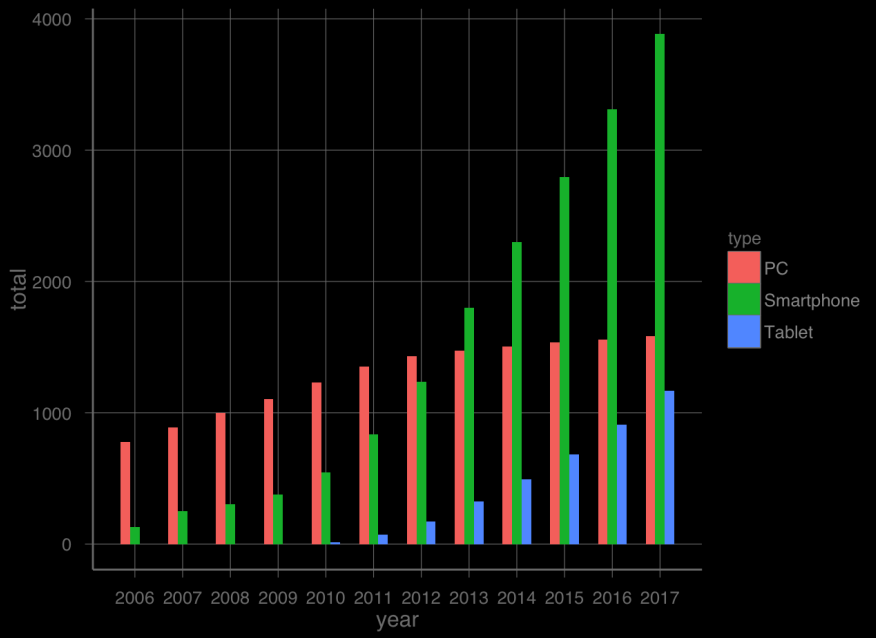
Map

Position in Space

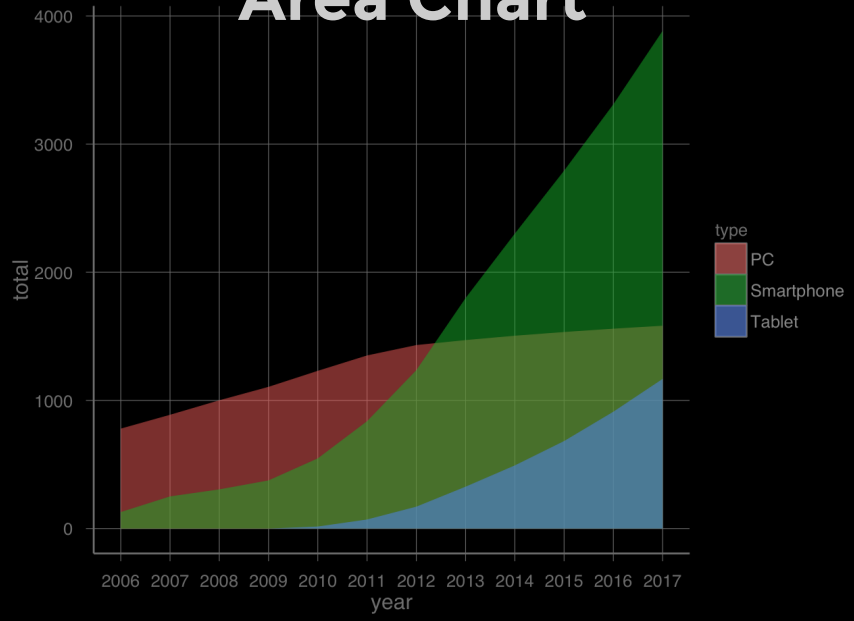
Line Chart



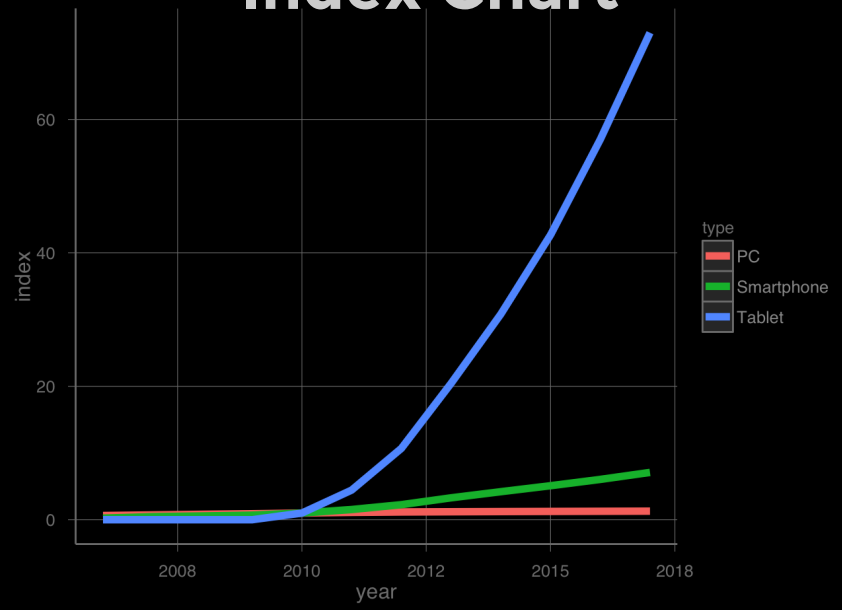
Bar Chart



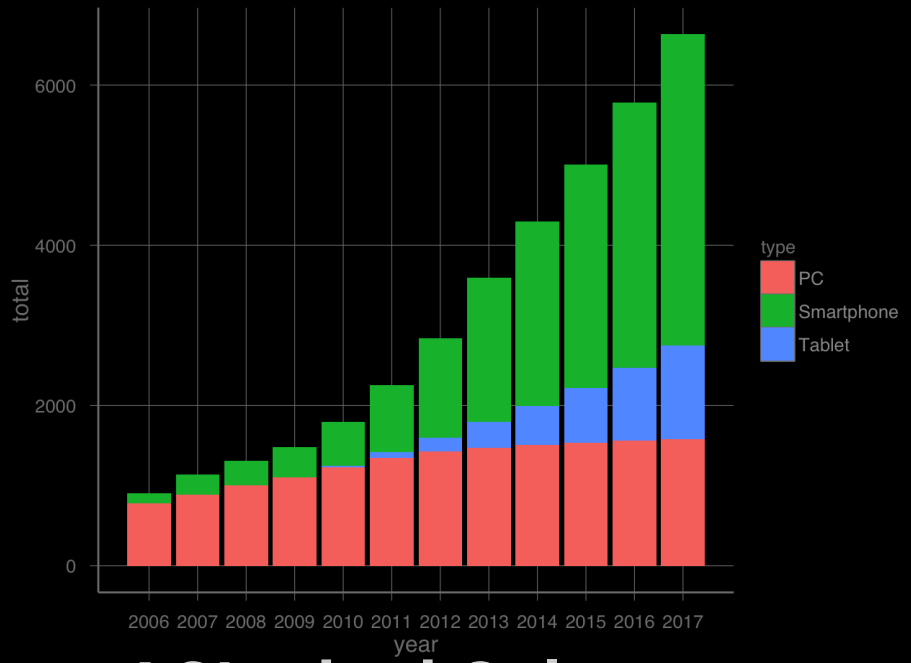
Area Chart



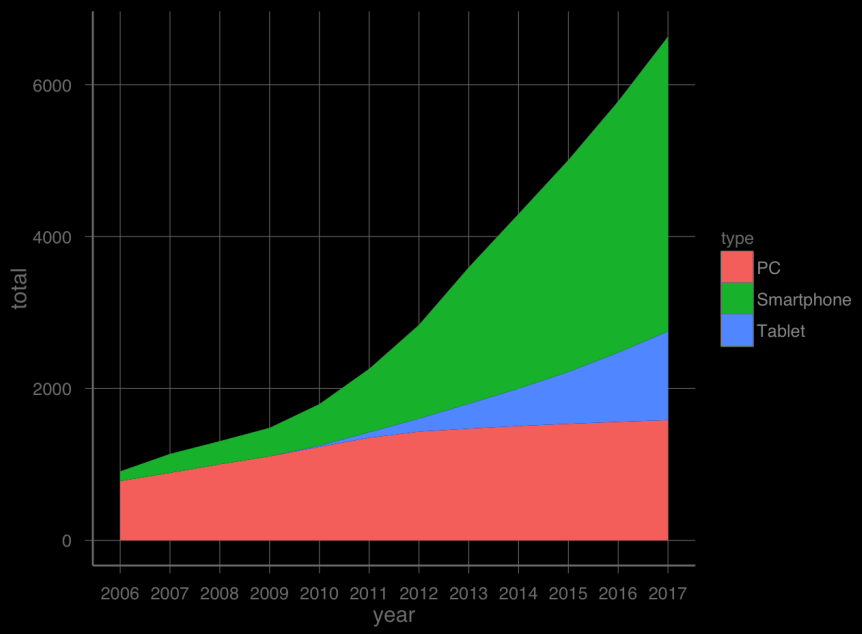
Index Chart



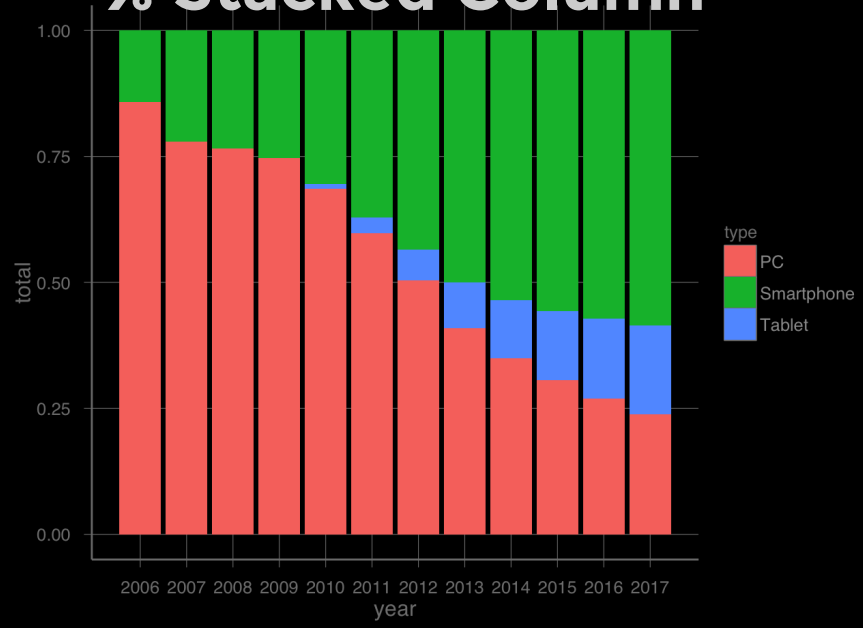
Stacked Column



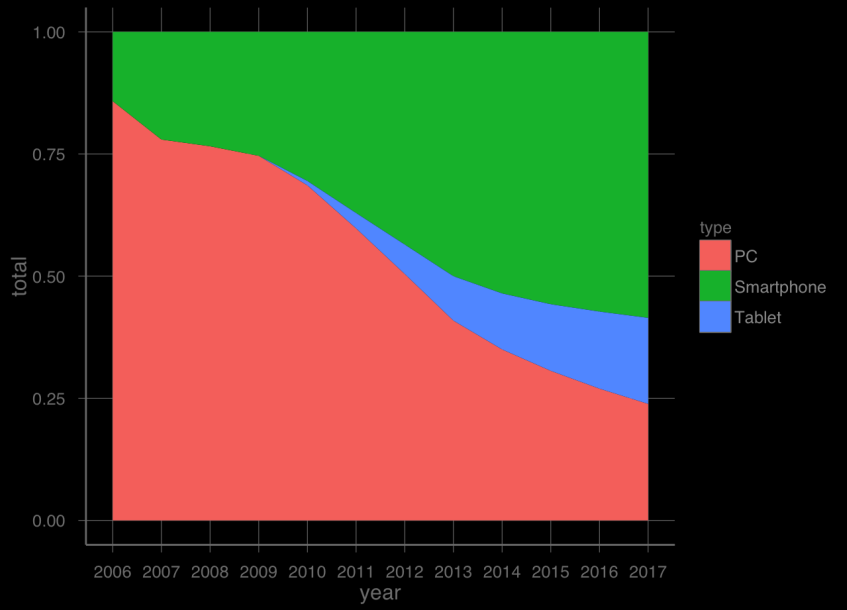
Stacked Area



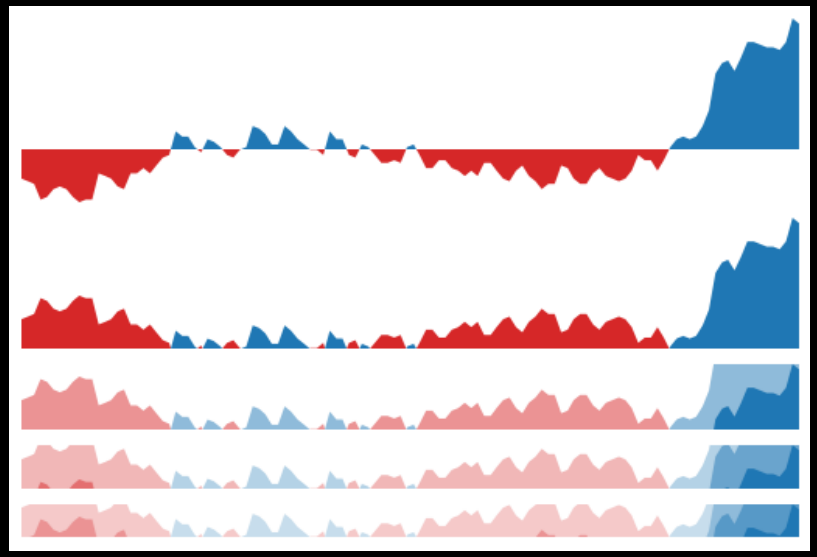
% Stacked Column



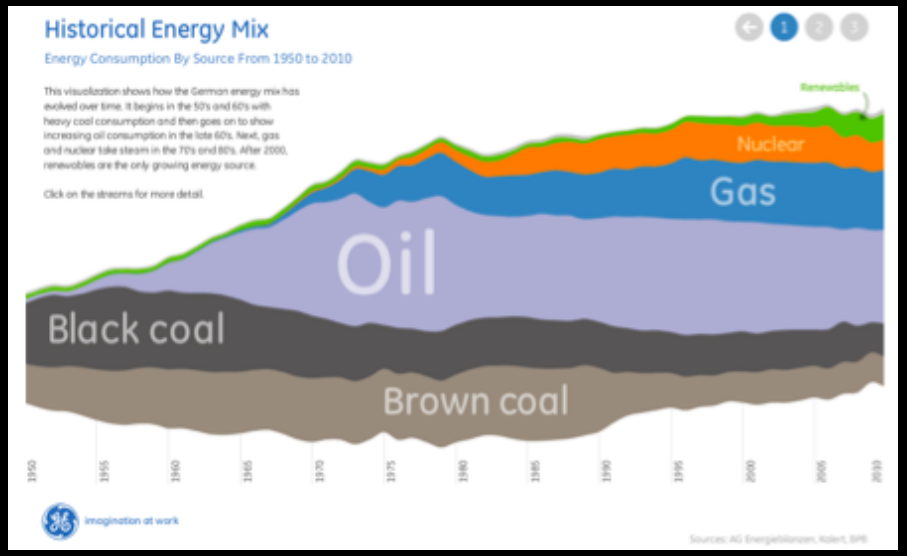
% Stacked Area



Horizon Chart

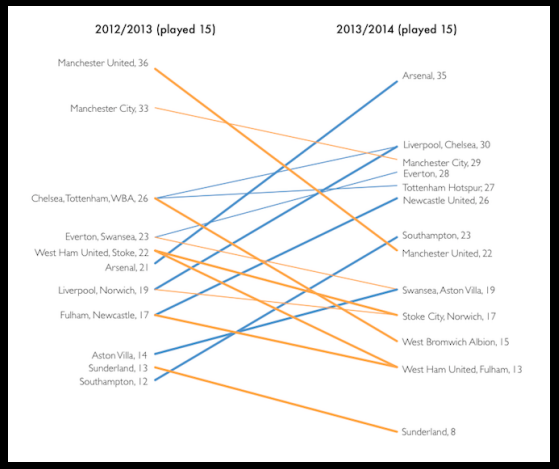


Stream Graph

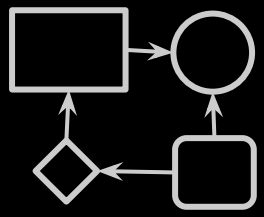


Sparklines

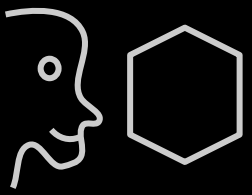
Slopegraph



Flowchart
Relationship, Hierarchy



Portrait
Distribution Representation



Why?

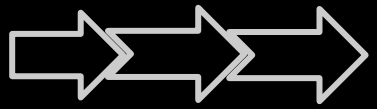
Who & What?

How?

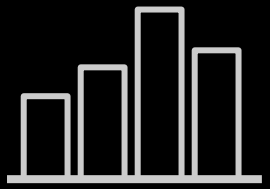
How Many?

When?

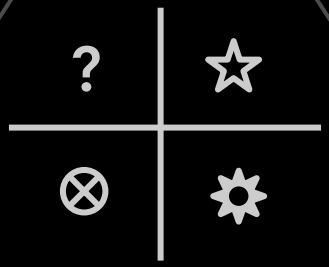
Where?



Timeline
Position in Time

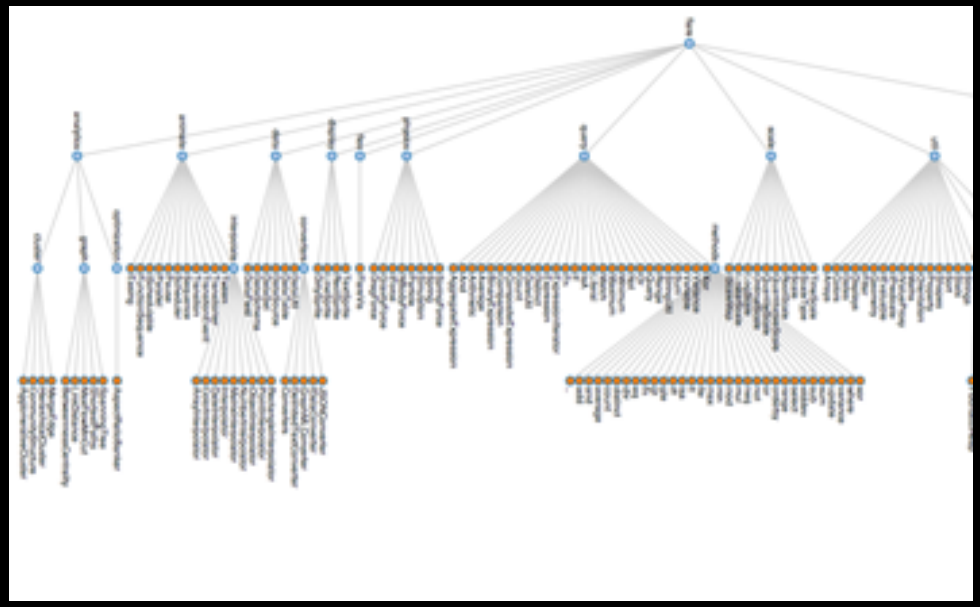


Comparison
Comparative Representation

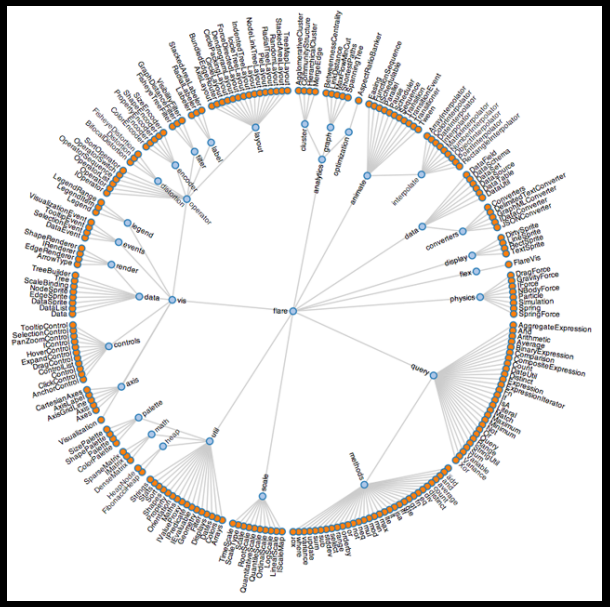


Map
Position in Space

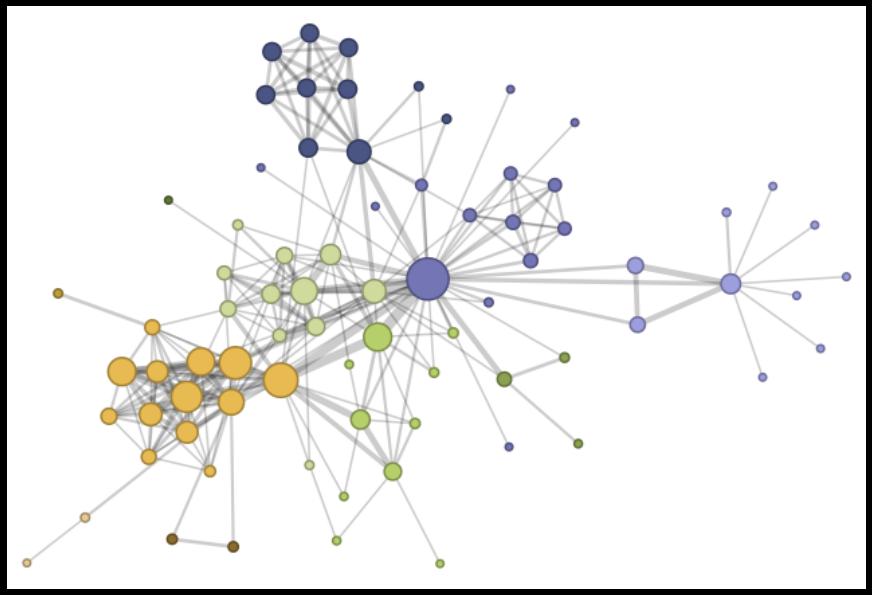
Tree – Node Linkage



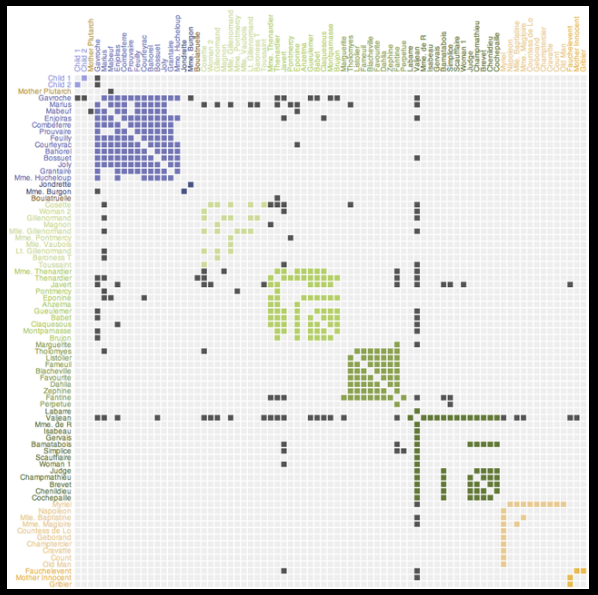
Tree Radial



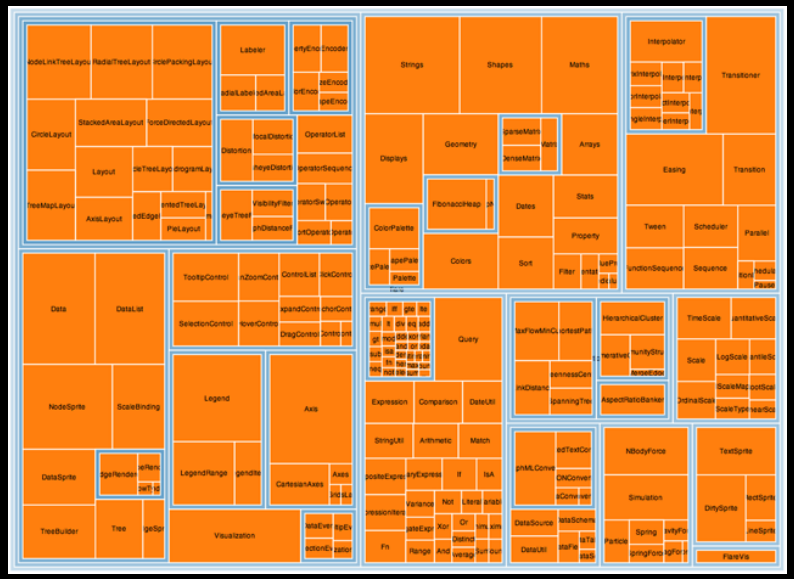
Force Directed



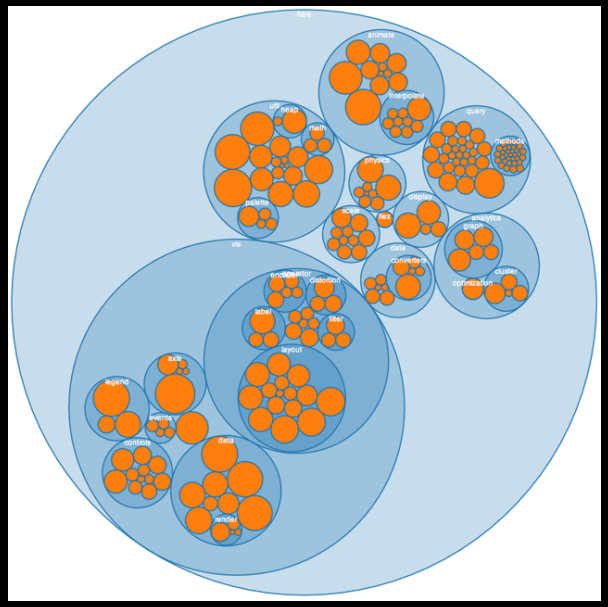
Matrix View



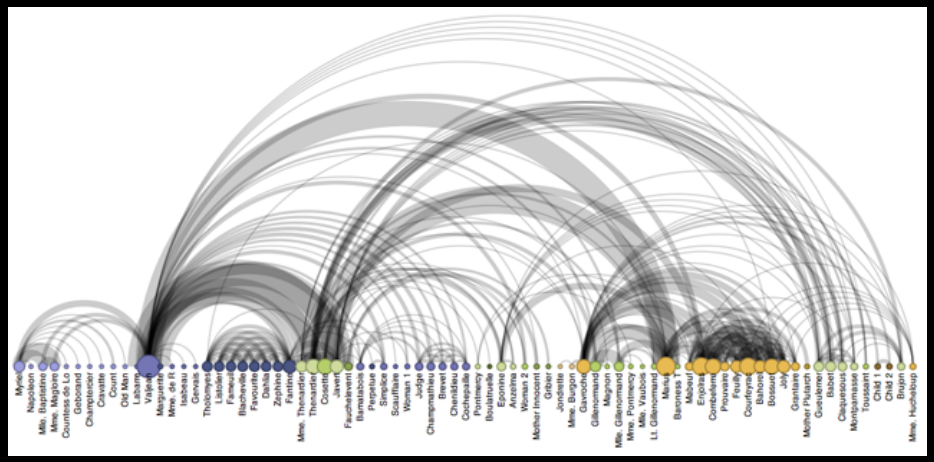
Enclosure



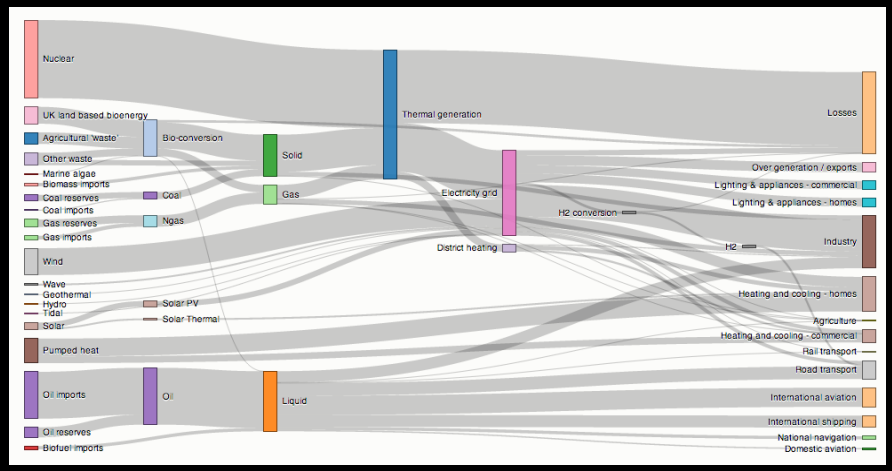
Radial Enclosure



Arc Diagram

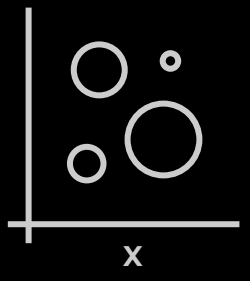


Sankey Diagram



Multi-Variable Plot

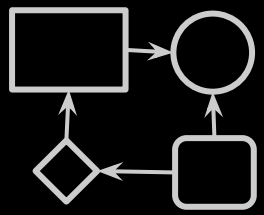
Deduction & Prediction



Why?

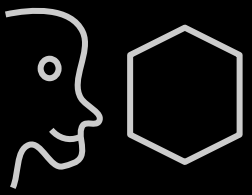
Flowchart

Relationship, Hierarchy



Portrait

Distribution Representation



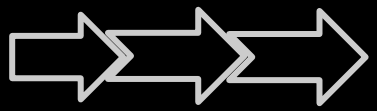
How?

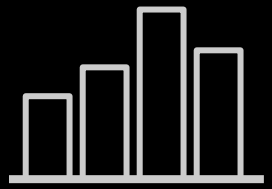
Who & What?

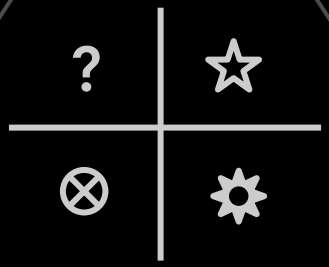
When?

How Many?

Where?







Timeline

Position in Time

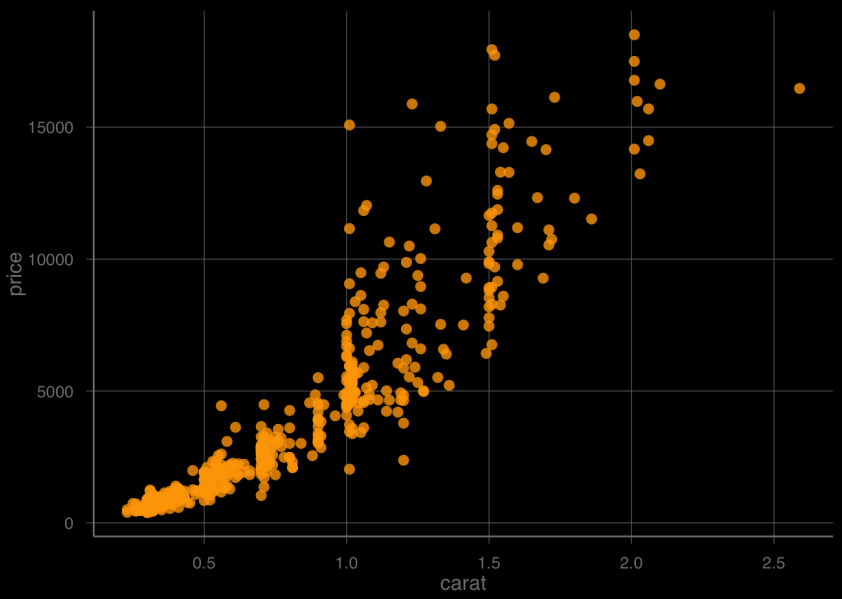
Comparison

Comparative Representation

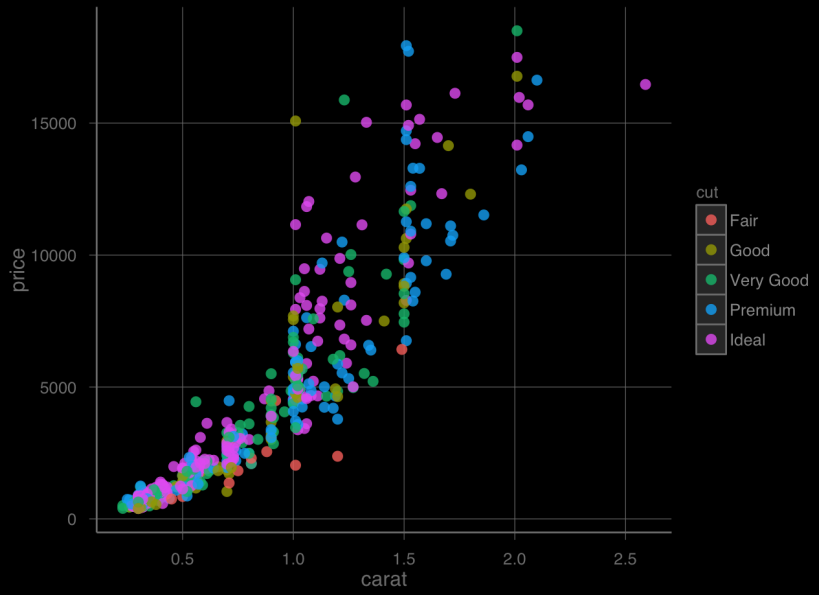
Map

Position in Space

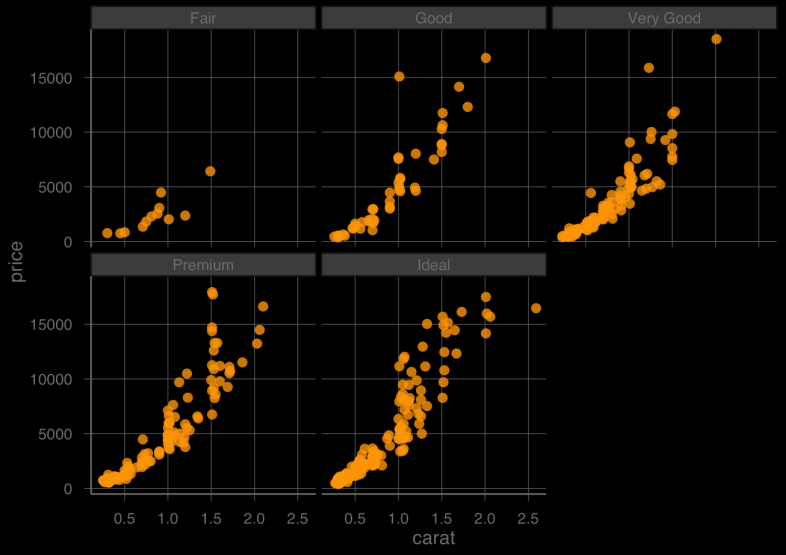
Scatter Plot



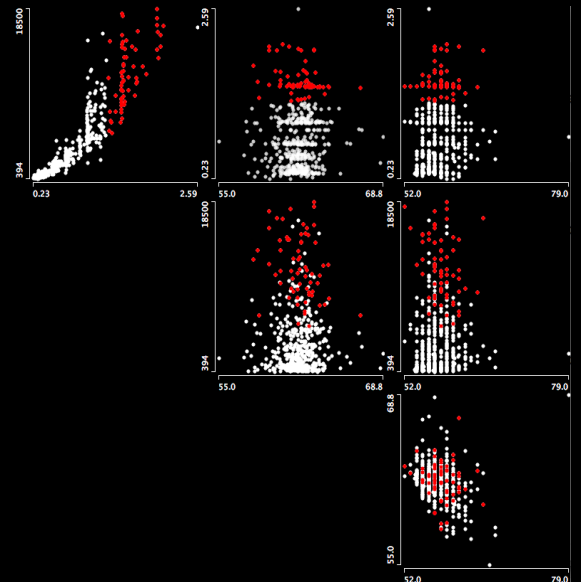
Scatter Plot - Color



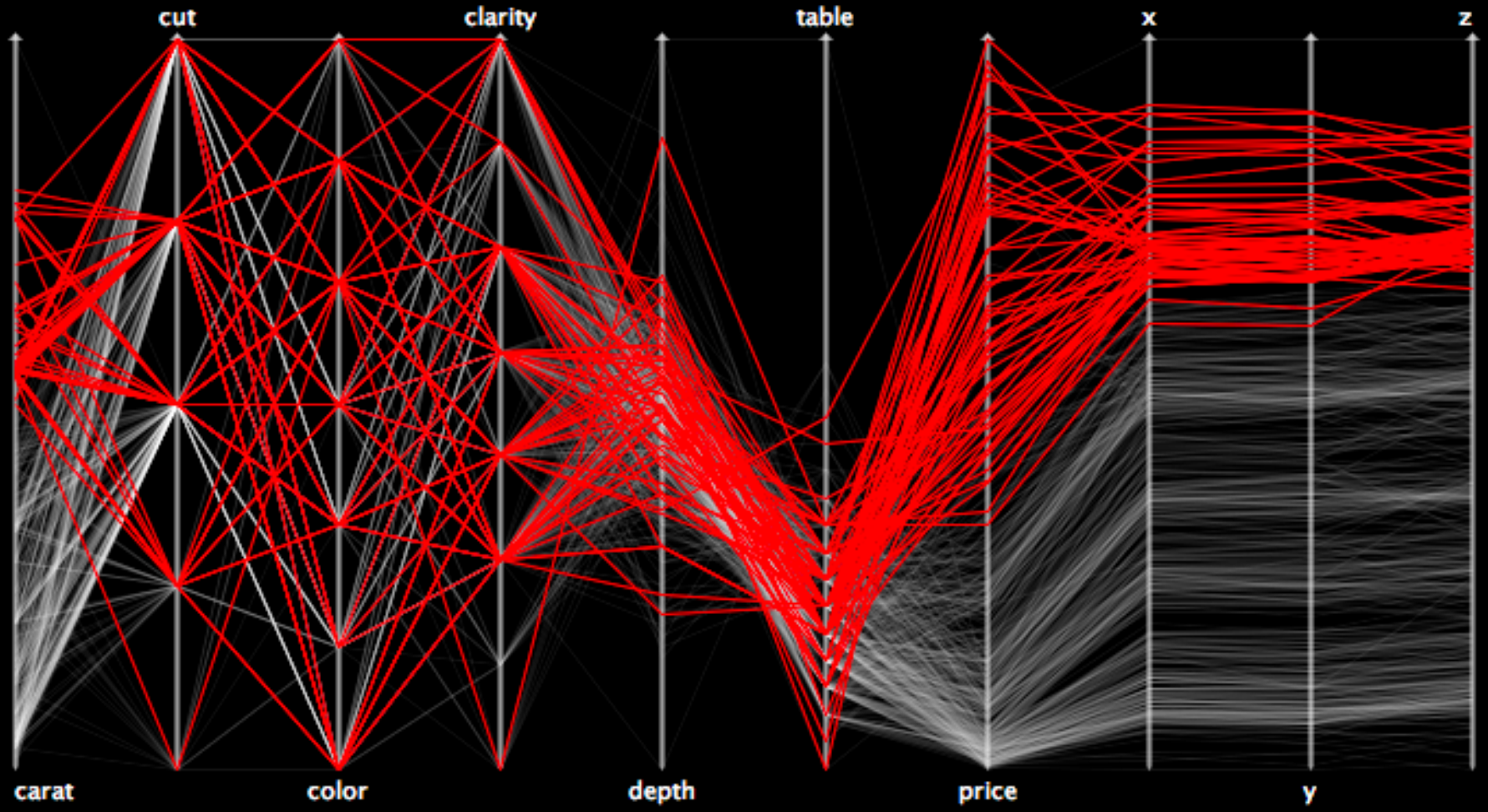
Scatter Plot - Multiple



Scatter Plot Matrix



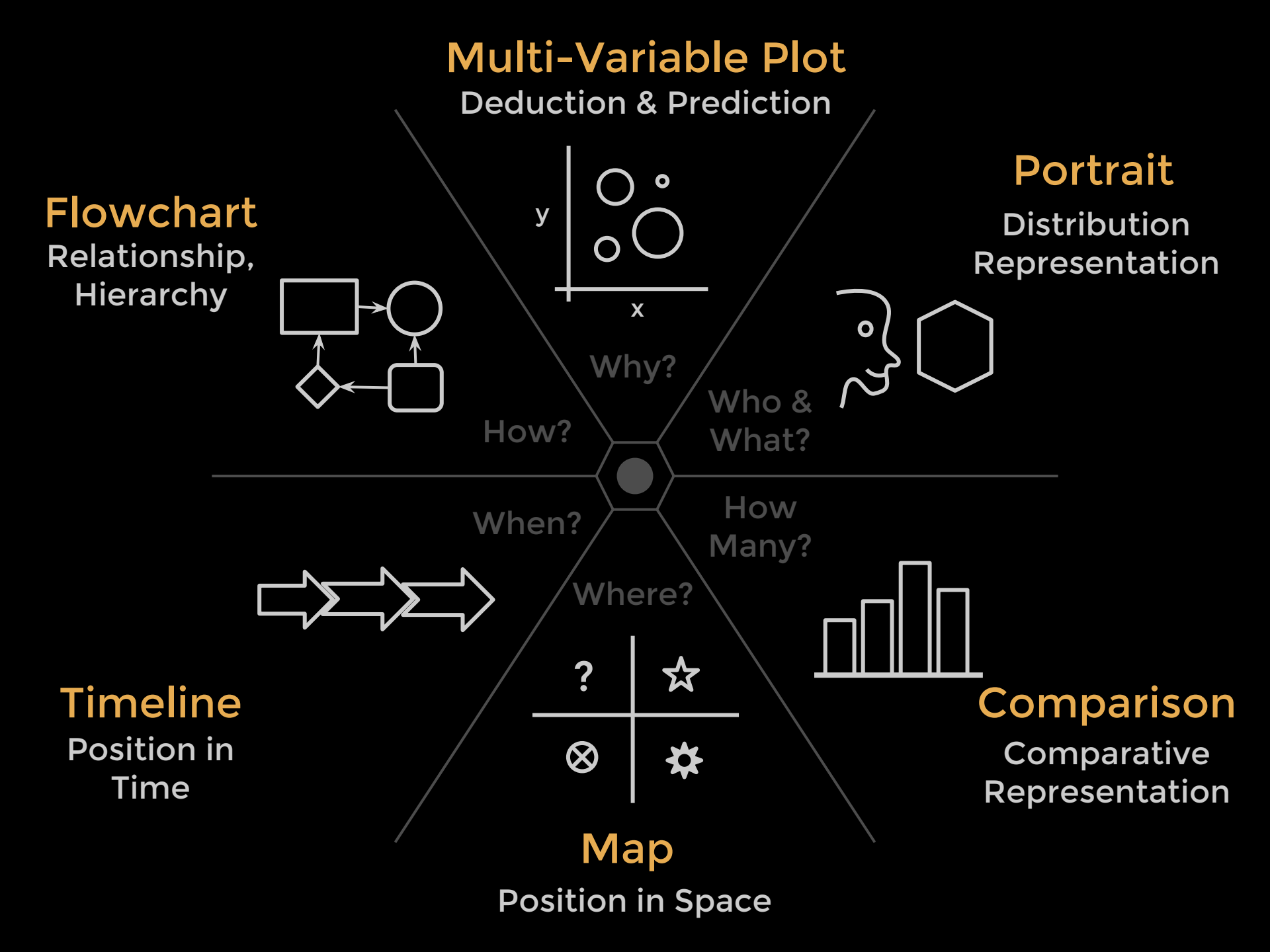
Parallel Coordinates



Data : n x quantitative, n x categorical
Encoding : position, connection, color

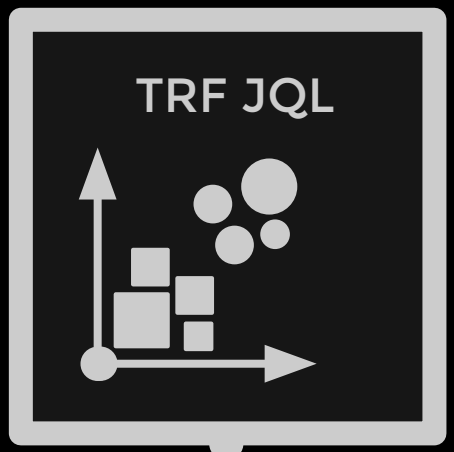
Bubble Chart

Data : 4 x quantitative, 1 x categorical
Encoding : position, size, color, motion

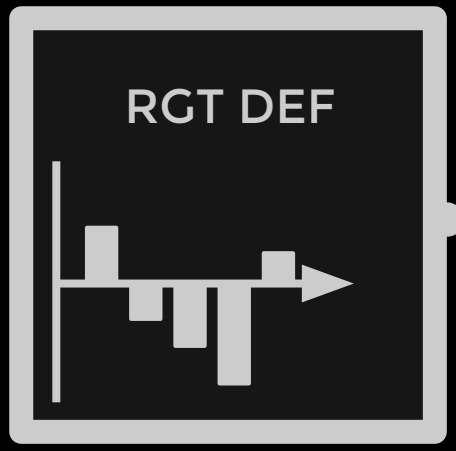

Multi-Variable Plot
Deduction & Prediction
y
x
Why?
Portrait
Distribution
Representation
Who &
What?
Flowchart
Relationship,
Hierarchy
How?
How
Many?
When?
Where?
?
Timeline
Position in
Time
Comparison
Comparative
Representation
Map
Position in Space

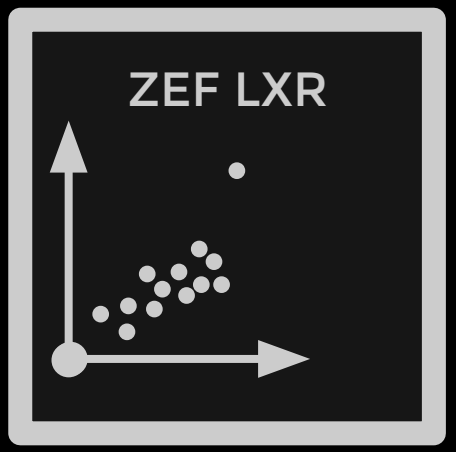
Tell the Story

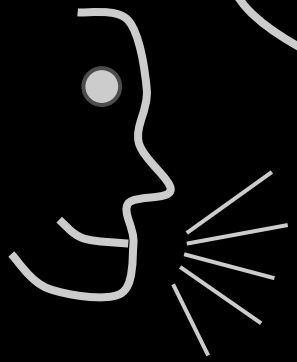
Ordering &
Structure



Messaging
(Verbal & Text)



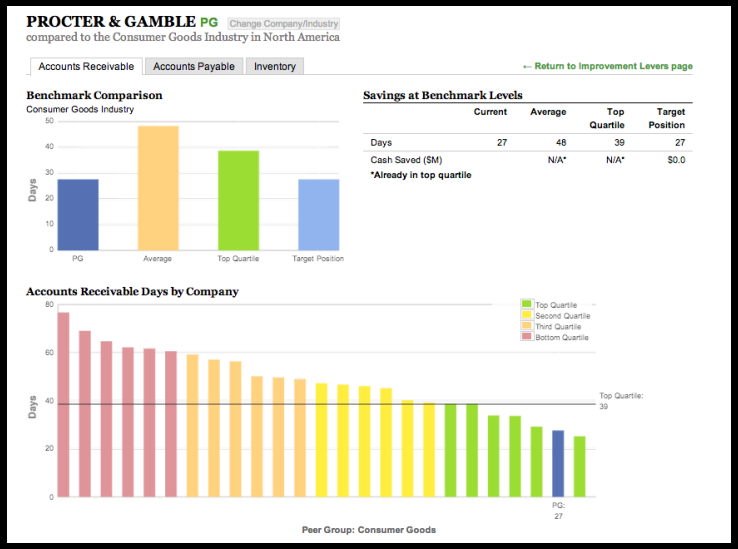




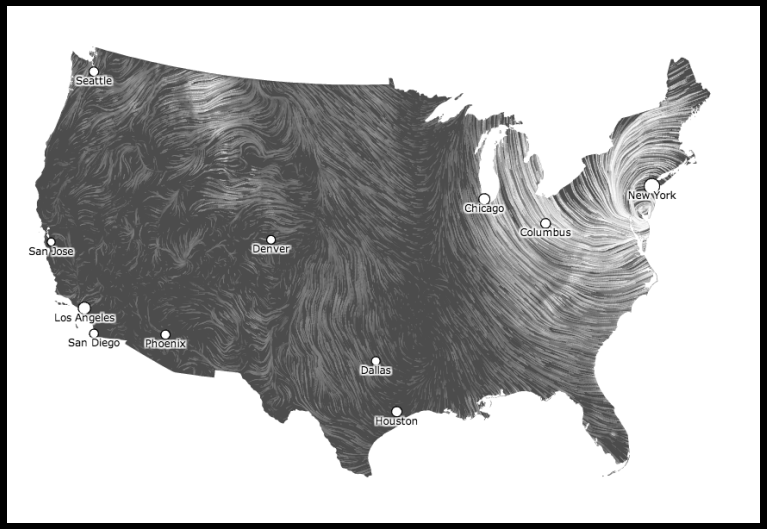
Point of View
Relatability

Tone of Visualization

Analytical & Pragmatic



Emotive & Abstract



I think people have begun to forget how powerful human stories are, exchanging their sense of empathy for a fetishistic fascination with data, networks, patterns, and total information... Really, the data is just part of the story. The human stuff is the main stuff, and the data should enrich it.

- Jonathan Harris

People | tell stories

Words | tell stories

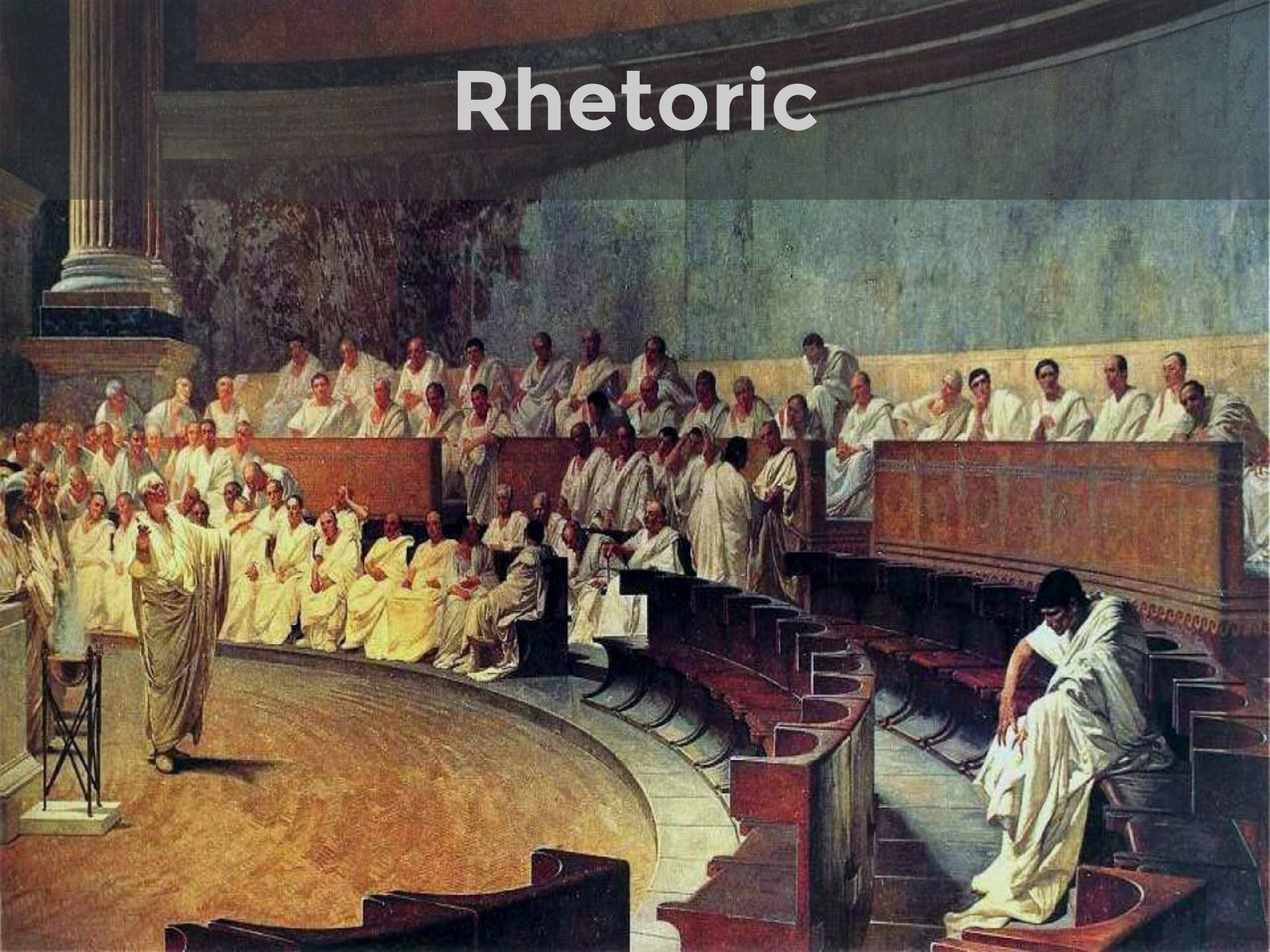
Pictures | tell stories

Comics | tell stories

Movies | tell stories


Speakers' Corner

Rhetoric



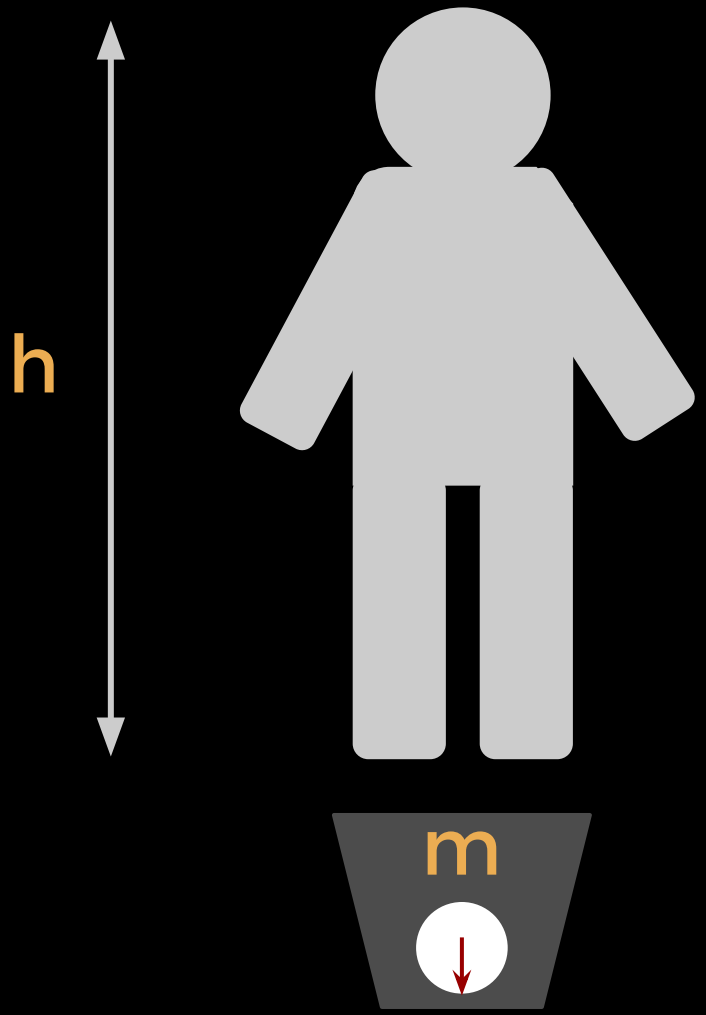
Persuasion

logos | **reason**

ethos | **credible**

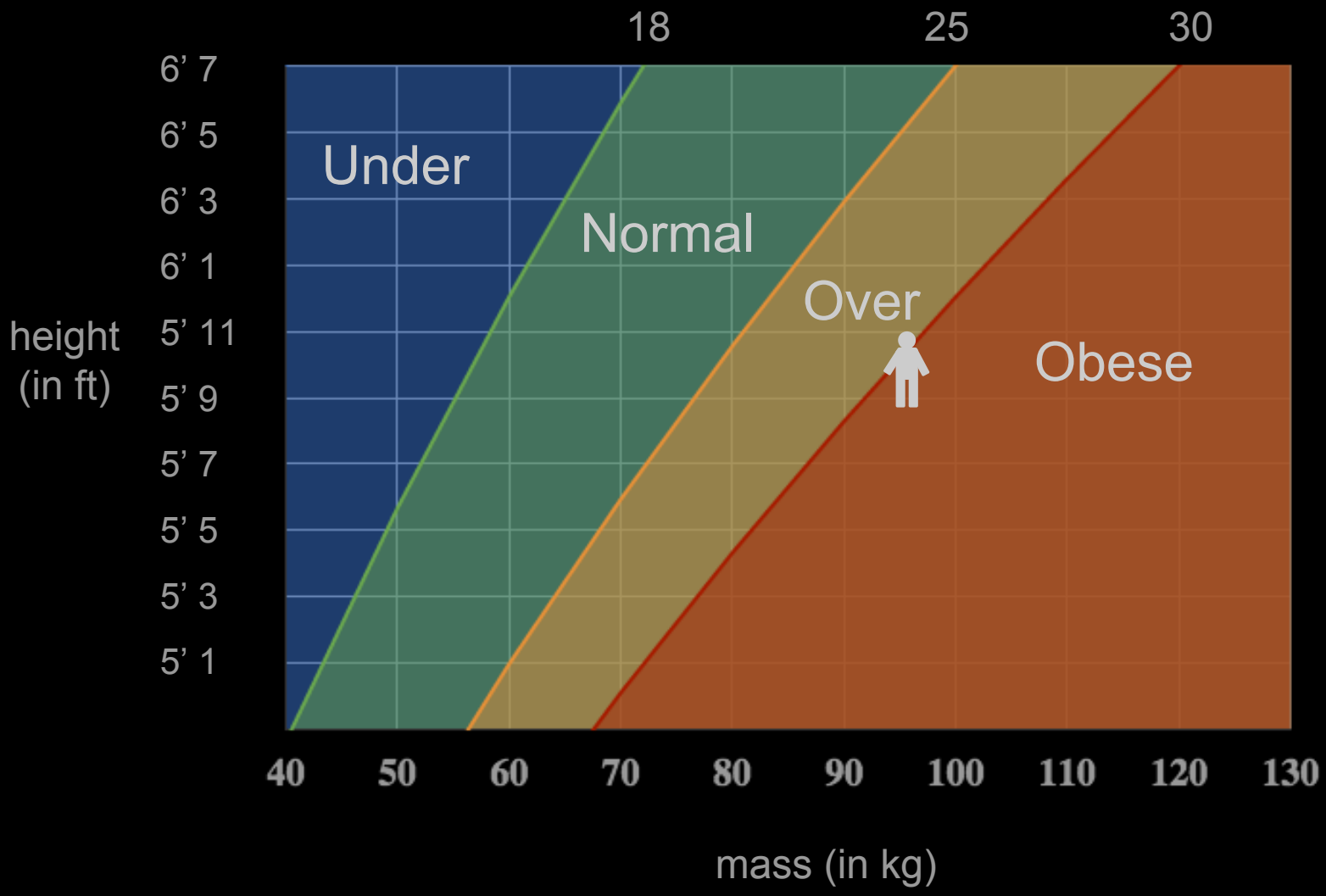
pathos | **emotional**

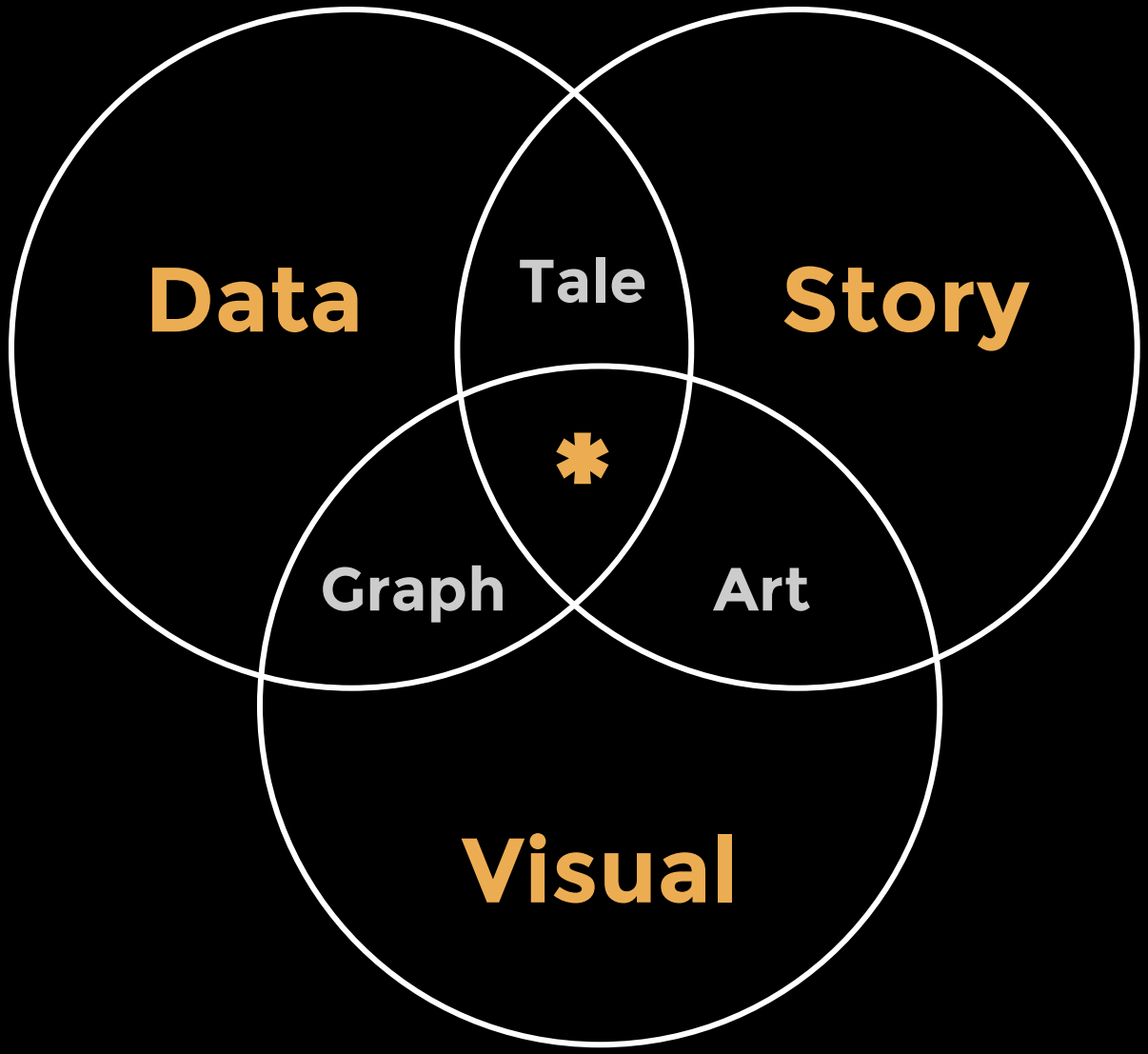
Body Mass Index (BMI)



$$BMI = \frac{\text{mass (kg)}}{[\ \text{height (m)}\ ]^2}$$

Living on the edge




Data
Tale
Story
*
Graph
Art
Visual

analysis | **SYNTHESIS**

numbers | **VISUALISE**

argument | **STORY**

logic | EMPATHY

Data & Stories

The focus of stories is on
individual people rather than averages,
on motives rather than movements,
on point of view rather than the view
from nowhere,
context rather than raw data.

Moreover, stories are open-ended and
metaphorical rather than determinate
and literal.

The Story Mindset

In listening to stories we tend to suspend disbelief in order to be entertained, whereas in evaluating statistics we generally have an opposite inclination to suspend belief in order not to be beguiled.

– John Allen Paulos

Why Stories?

Stories are | **emotional**

Stories are | **memorable**

Stories are | **impactful**

Dual Coding

Aural

Visual

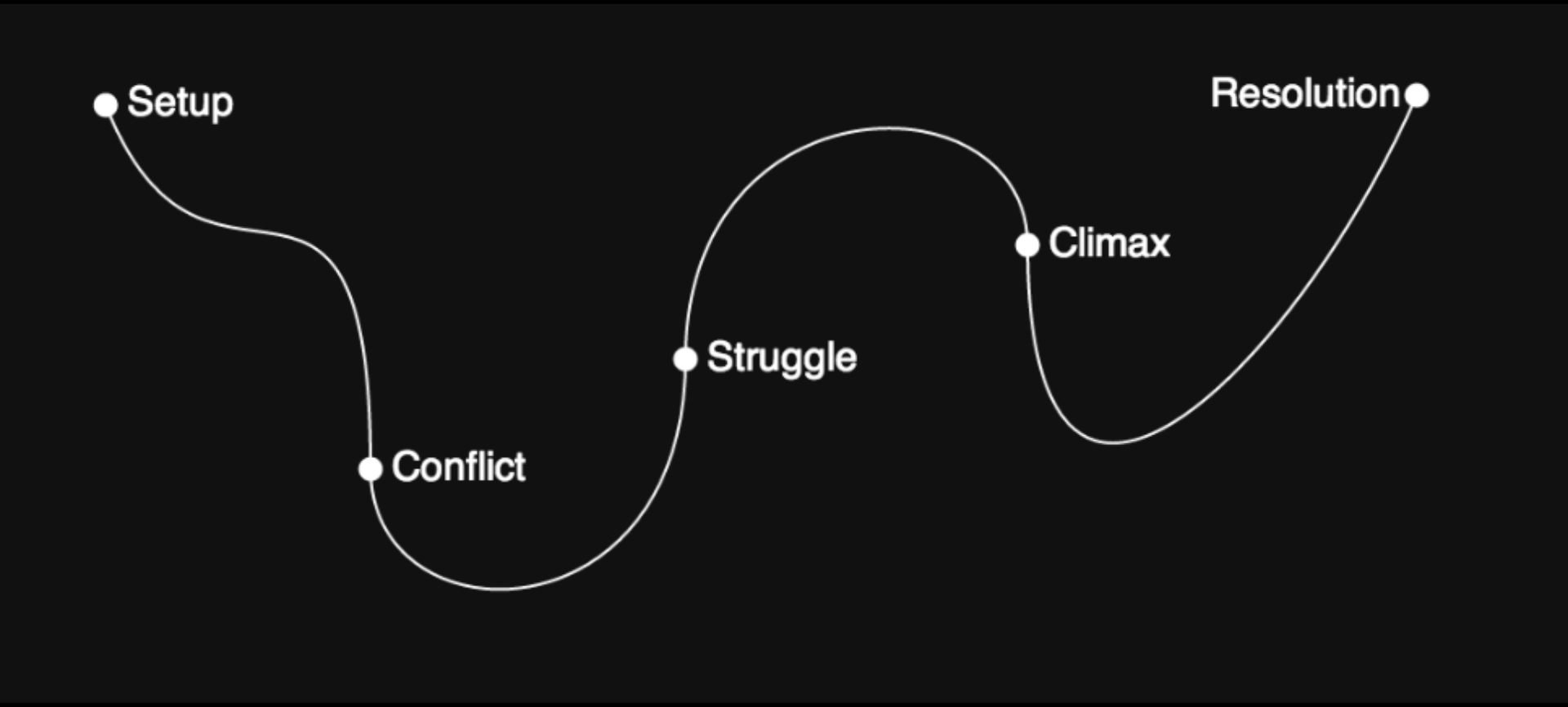
Narrative

/ˈnærətiv / (noun)

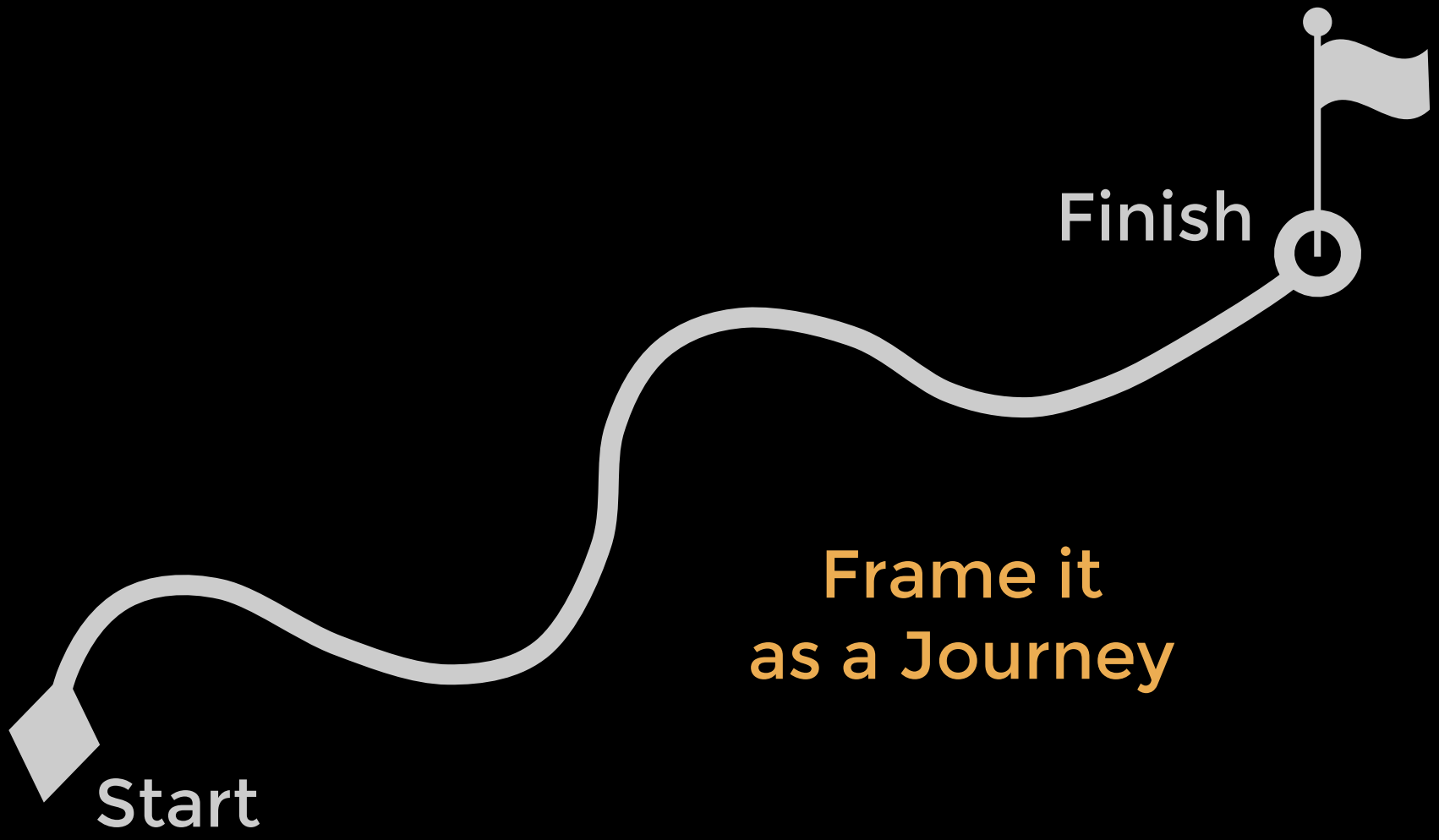
A narrative (or story) is any account of connected events, presented to a reader or listener in a sequence of written or spoken words, or in a sequence of (moving) pictures.

Derived from the Latin verb **narrare**, "to tell"

Narrative Structure



Cognitive Flow




CHOICE OF MOMENT
DECIDING WHICH MOMENTS TO INCLUDE IN A COMICS STORY AND WHICH TO LEAVE OUT.
1
2
3
CHOICE OF FRAME
CHOOSING THE RIGHT DISTANCE AND ANGLE TO VIEW THOSE MOMENTS --
-- AND WHERE TO TRIM THEM.
CHOICE OF IMAGE
RENDERING THE CHARACTERS, OBJECTS AND ENVIRONMENTS IN THOSE FRAMES CLEARLY.
CHOICE OF WORD
HEY!
PICKING WORDS THAT ADD VALUABLE INFORMATION AND WORK WELL WITH THE IMAGES AROUND THEM.
CHOICE OF FLOW
GUIDING READERS THROUGH AND BETWEEN PANELS ON A PAGE OR SCREEN.
THESE ARE THE FIVE ARENAS WHERE YOUR CHOICES CAN MAKE THE DIFFERENCE BETWEEN CLEAR, CONVINCING STORYTELLING AND A CONFUSING MESS.
CHOICE OF MOMENT
CHOICE OF FRAME
CHOICE OF IMAGE
CHOICE OF WORD
CHOICE OF FLOW

Don’t just add a chart…

The Economist | World politics | Business & finance | Economics | Science & technology | Culture

Japanese luxury cars

The limits to Infiniti

Japan’s premium motor brands are still far behind their German rivals. The giant carmakers that own them are missing out on pots of potential profit

Jun 7th 2014 | From the print edition

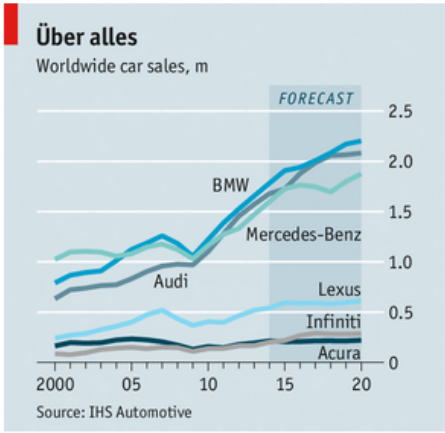
Timekeeper | Like 544 | Tweet 360

A MONTH before launching Lexus in America in 1989, Toyota considered running a television advertisement showing German aristocrats at a wild party in a hilltop castle. The voice-over intoned that the Teutons had dominated upmarket, high-performance cars for nearly 60 years but they had only “30 days left to enjoy it”.

Palmer, a Nissan executive, puts it, premium models account for “12% of the volume and 50% of the profits” of the entire car industry.

Consumer Cyclicals
Carmaking
Manufacturing
Motor vehicle manufacturing

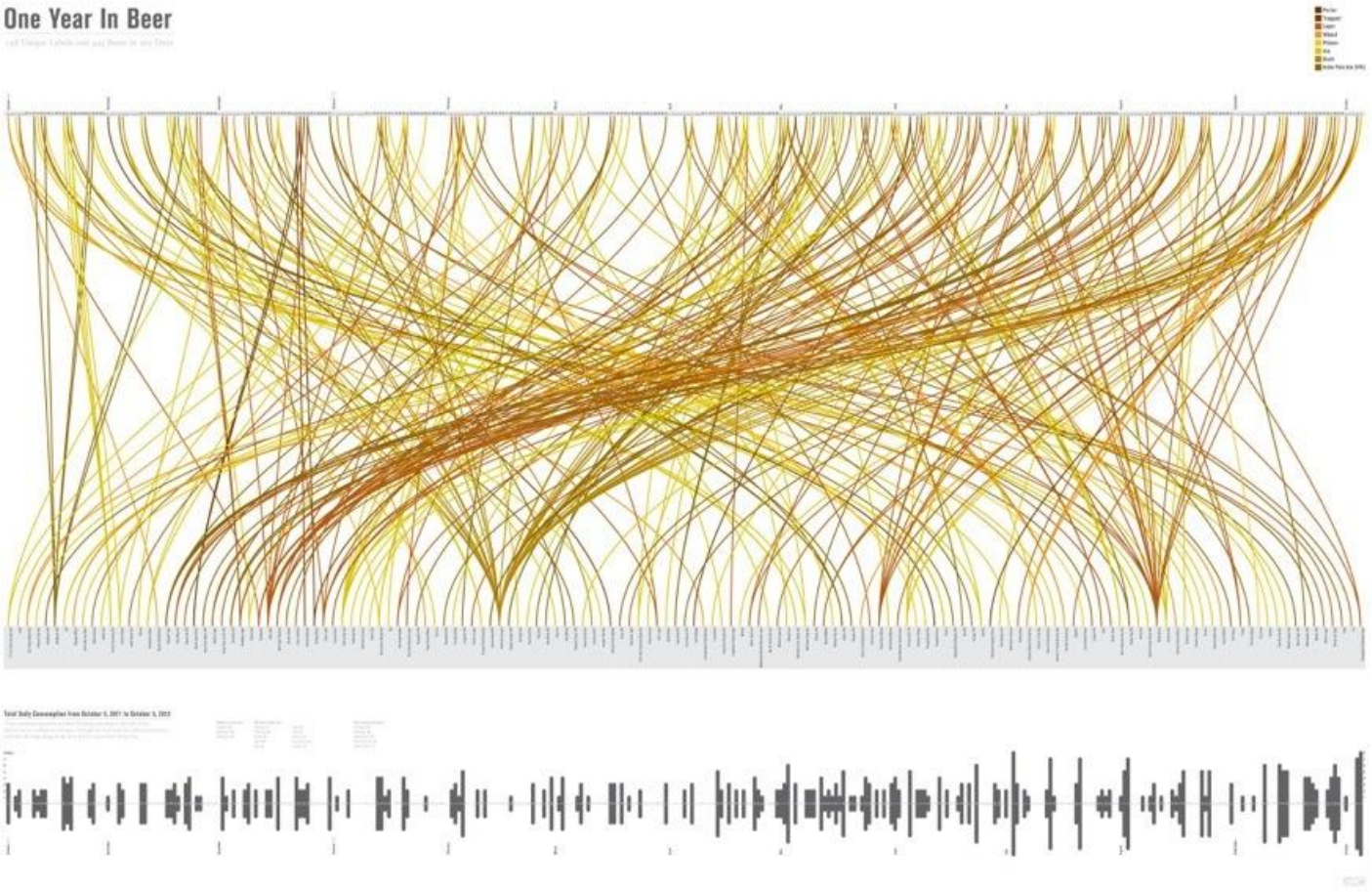
At first the Japanese carmakers’ premium marques were aimed mainly at the American market, and got off to a good start. Their mass-market brands had given anything Japanese-made a reputation for reliability. The new, premium models were technically advanced compared with Lincolns and Cadillacs, Detroit’s upmarket offerings, and cheaper than their German rivals. By 2000 Lexus was the best-selling luxury-car brand in America, a position it held for more than a decade.



However, tarting up mainstream models with a bit of wood and leather may have impressed American motorists, who care more about value than styling, but it did not impress image-conscious European buyers. Acura, perhaps sensing the futility of the task, avoided Europe altogether. Since their premium brands had failed to go global, the Japanese carmakers were reluctant to give them the resources to keep up with the competition.

Source: Economist

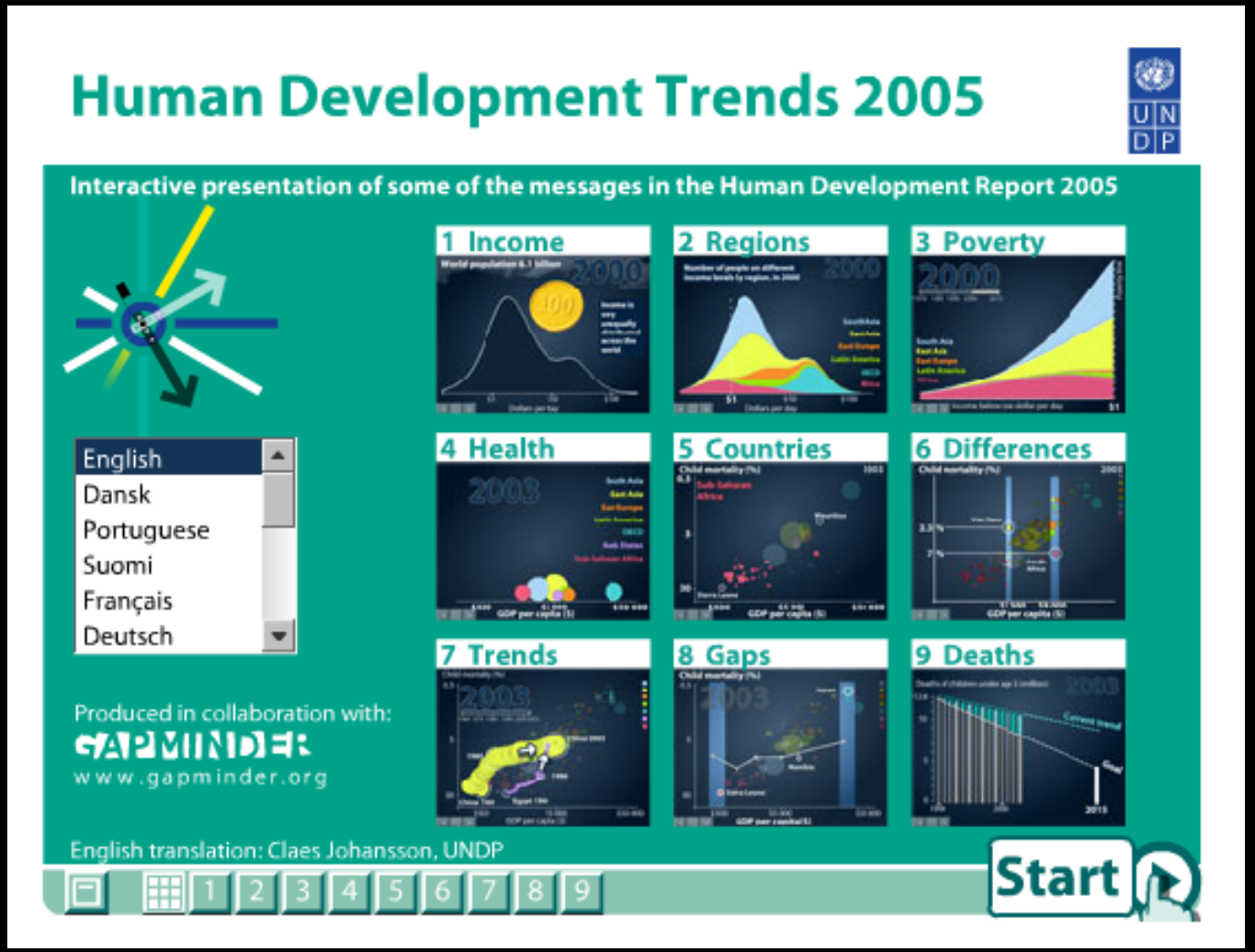
...or complex visualization



Source: Joshua Gallagher

Think Stories, not Charts

Telling Compelling Stories



Source: [Gapminder]

Explanatory
(Narrative)

Strong Order

Heavy Messaging

Limited Interactivity

Author Driven

Exploration
(Interactive)

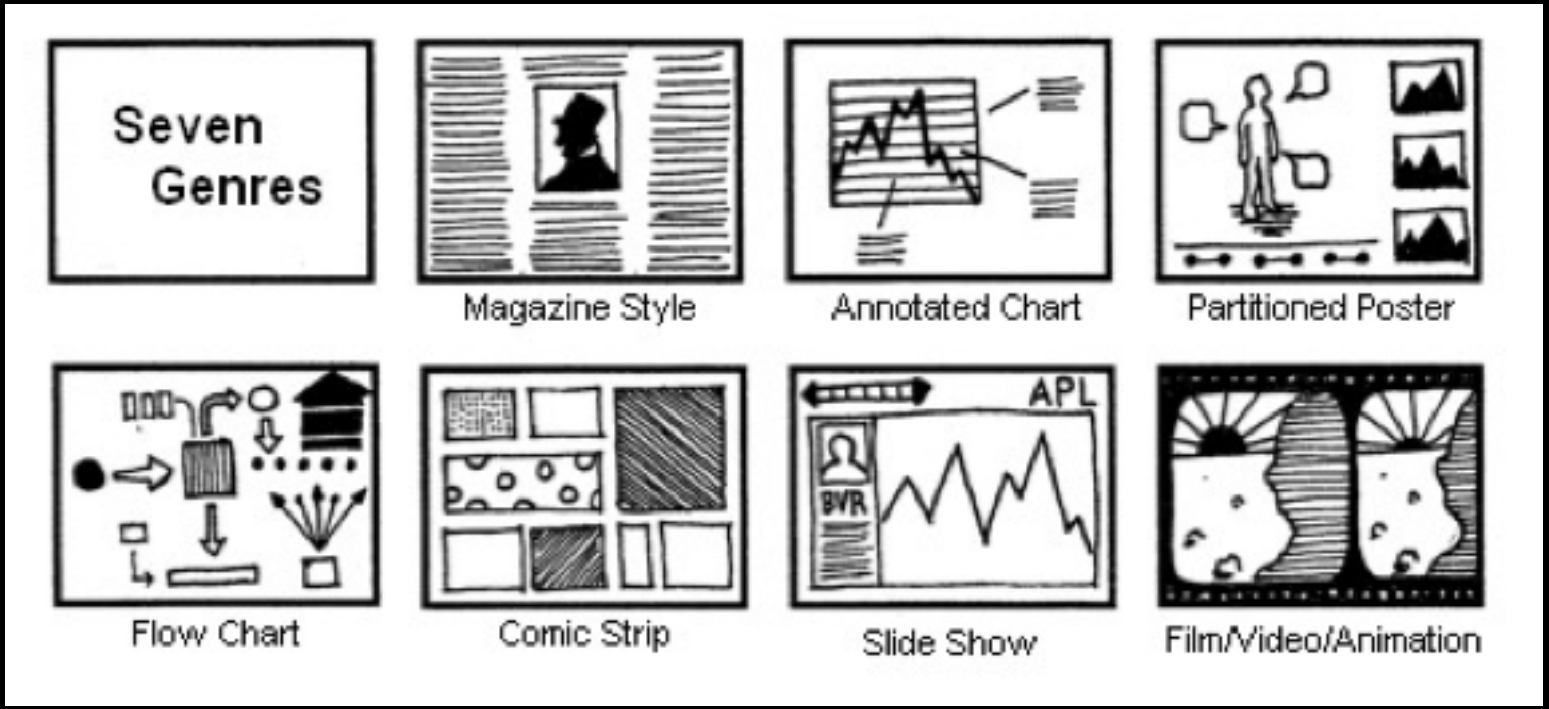
Weak Order

Light Messaging

Free Interactivity

Reader Driven

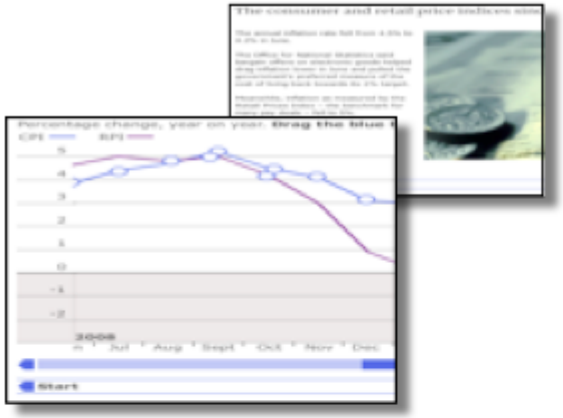
Genres of Story



Source: Narrative Visualization

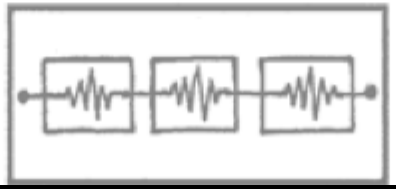
Think about the structure

Explanatory (Narrative) ⟷ **Exploration (Interactive)**

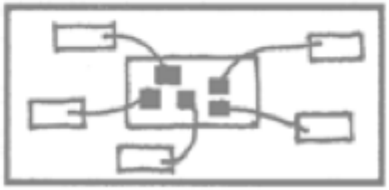


martini glass

interactive slideshow



drill-down story

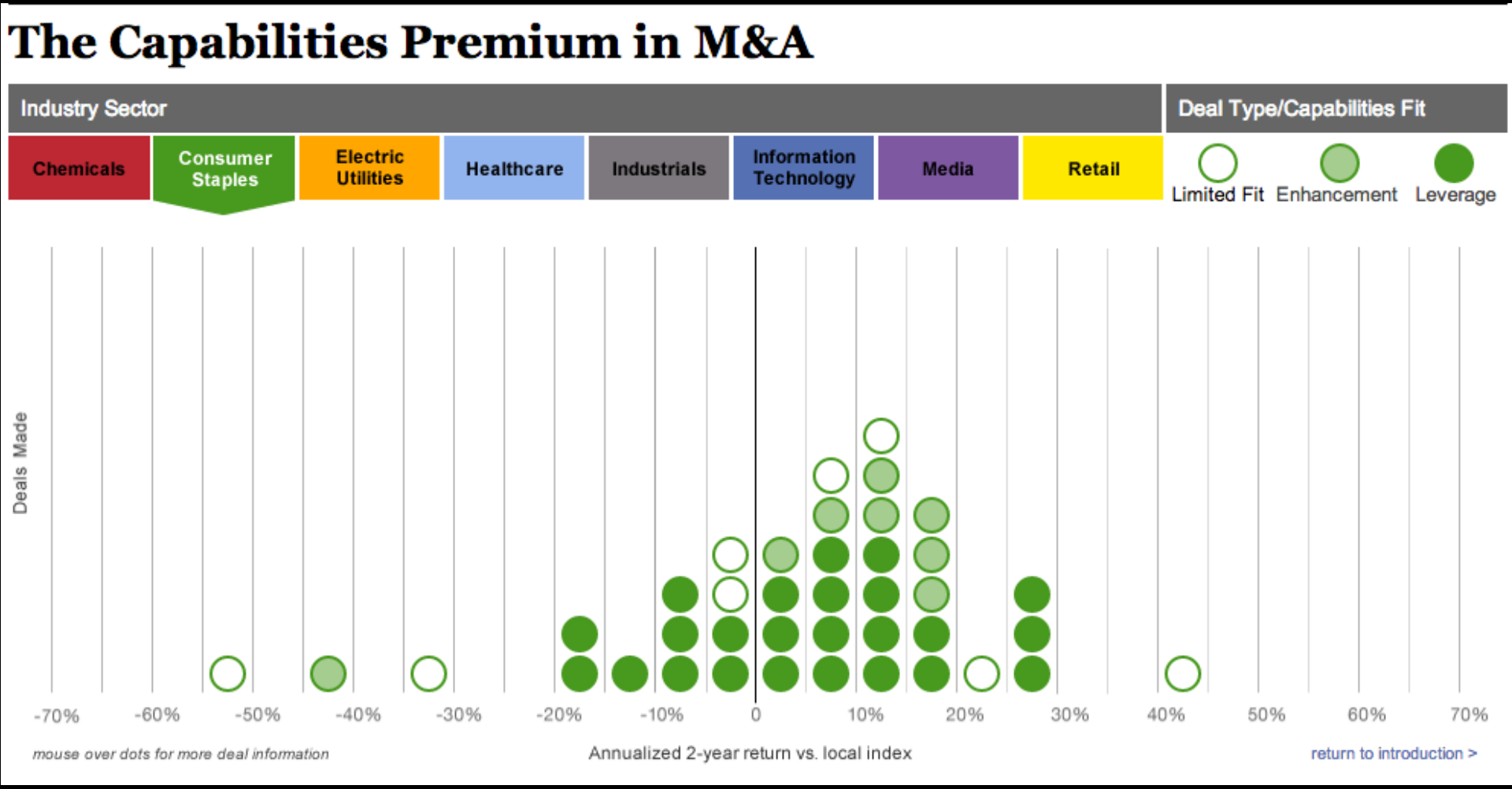


Source: Narrative Visualization

Choose the Visualization

Source: [Bloomberg]

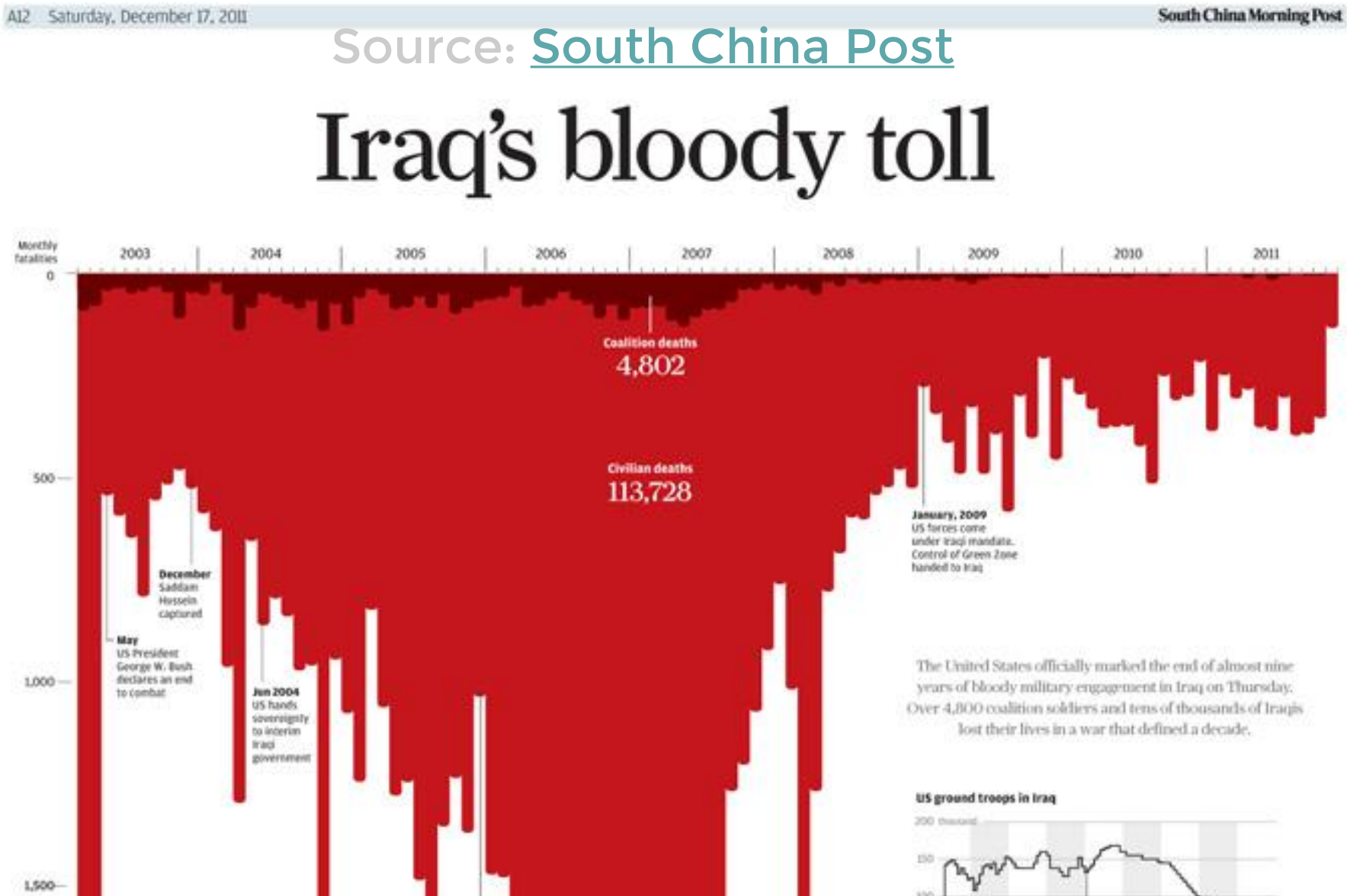
Make it Simple

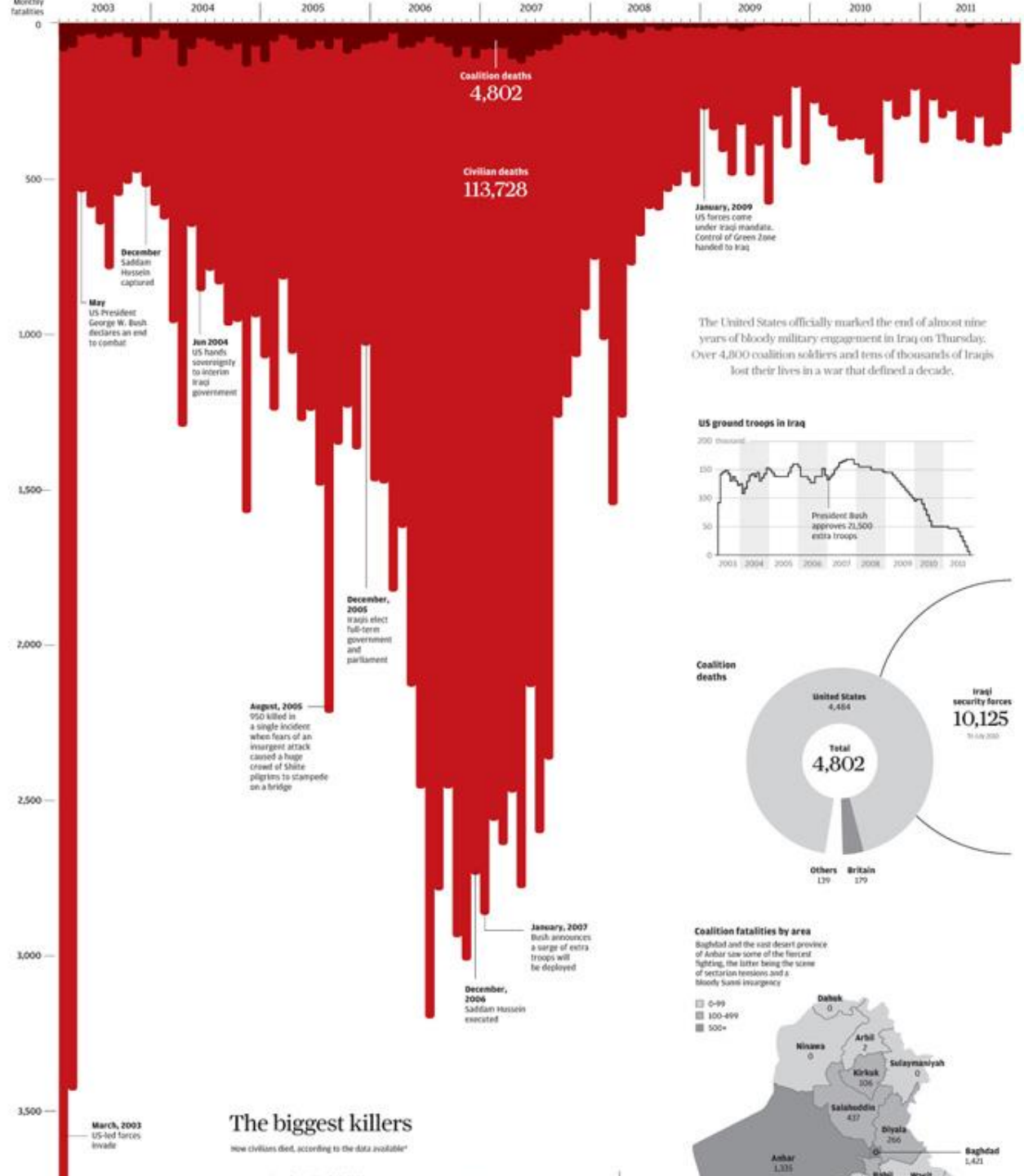


Source: [Capabilities Premium]

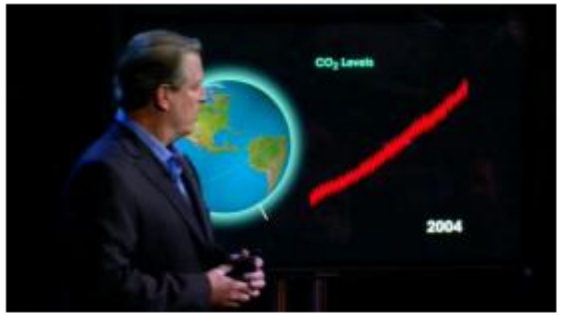
Representation Matters

Source: South China Post



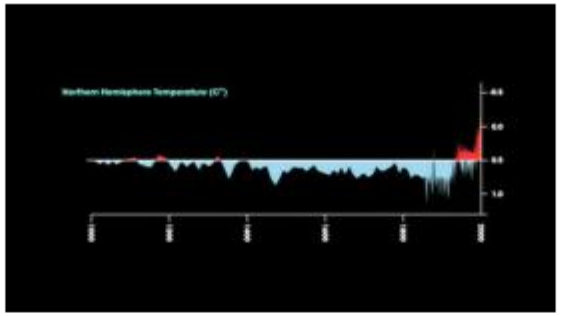

Monthly fatalities
2003
2004
2005
2006
2007
2008
2009
2010
2011
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Coalition deaths
4,802
Civilian deaths
113,728
January, 2009
US forces come under Iraqi mandate. Control of Green Zone handed to Iraq
December
Saddam Hussein captured
May
US President George W. Bush declares an end to combat
Jun 2004
US hands sovereignty to interim Iraqi government
December, 2005
Iraqis elect full-term government and parliament
August, 2005
950 killed in a single incident when fears of an insurgent attack caused a huge crowd of Shiite pilgrims to stampede on a bridge
January, 2007
Bush announces a surge of extra troops will be deployed
December, 2006
Saddam Hussein executed
March, 2003
US-led forces invade
The United States officially marked the end of almost nine years of bloody military engagement in Iraq on Thursday. Over 4,800 coalition soldiers and tens of thousands of Iraqis lost their lives in a war that defined a decade.
US ground troops in Iraq
200 thousand
150
100
50
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
President Bush approves 21,500 extra troops
Coalition deaths
United States
4,484
Total
4,802
Iraqi security forces
10,125
Others
139
Britain
179
Coalition fatalities by area
Baghdad and the vast desert province of Anbar saw some of the fiercest fighting, the latter being the scene of sectarian tensions and a bloody Sunni insurgency
0-99
100-499
500+
Dahuk
0
Arbil
7
Nineva
0
Sulaymaniyah
0
Kirkuk
306
Salahuddin
417
Diyala
266
Baghdad
1,421
Anbar
1,335
The biggest killers
How civilians died, according to the data available*

More Linear, More Story Like



00:16:08

Measured since 1958, atmospheric carbon dioxide (CO2) has been increasing steadily.

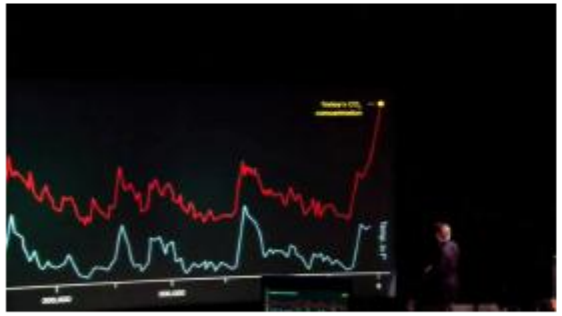


00:20:19

One thousand years of temperature history obtained from isotope analysis of ice cores.

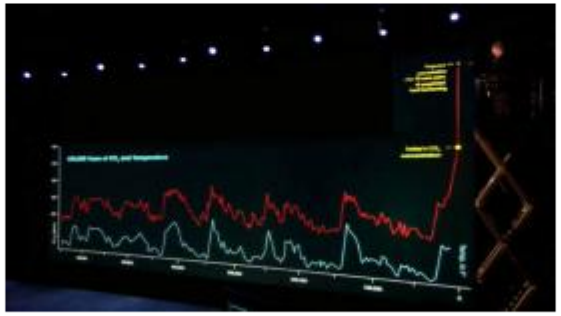
00:20:53

One thousand years of CO2 and temperature data -- the curves have similar shape.



00:22:49

650,000 years of CO2 and temperature history, from Antarctic ice cores. Dips record ice ages. CO2 concentration and temperature are related. CO2 has spiked upward in recent years.

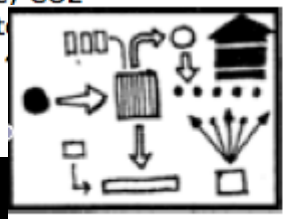


00:23:53

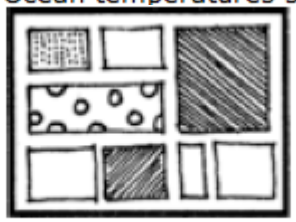
If no changes are made, CO2 concentration is predict
higher (to 600 ppm) in

00:29:54

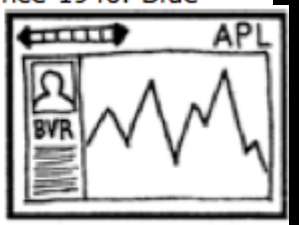
Ocean temperatures since 1940. Blue



FLOWCHART



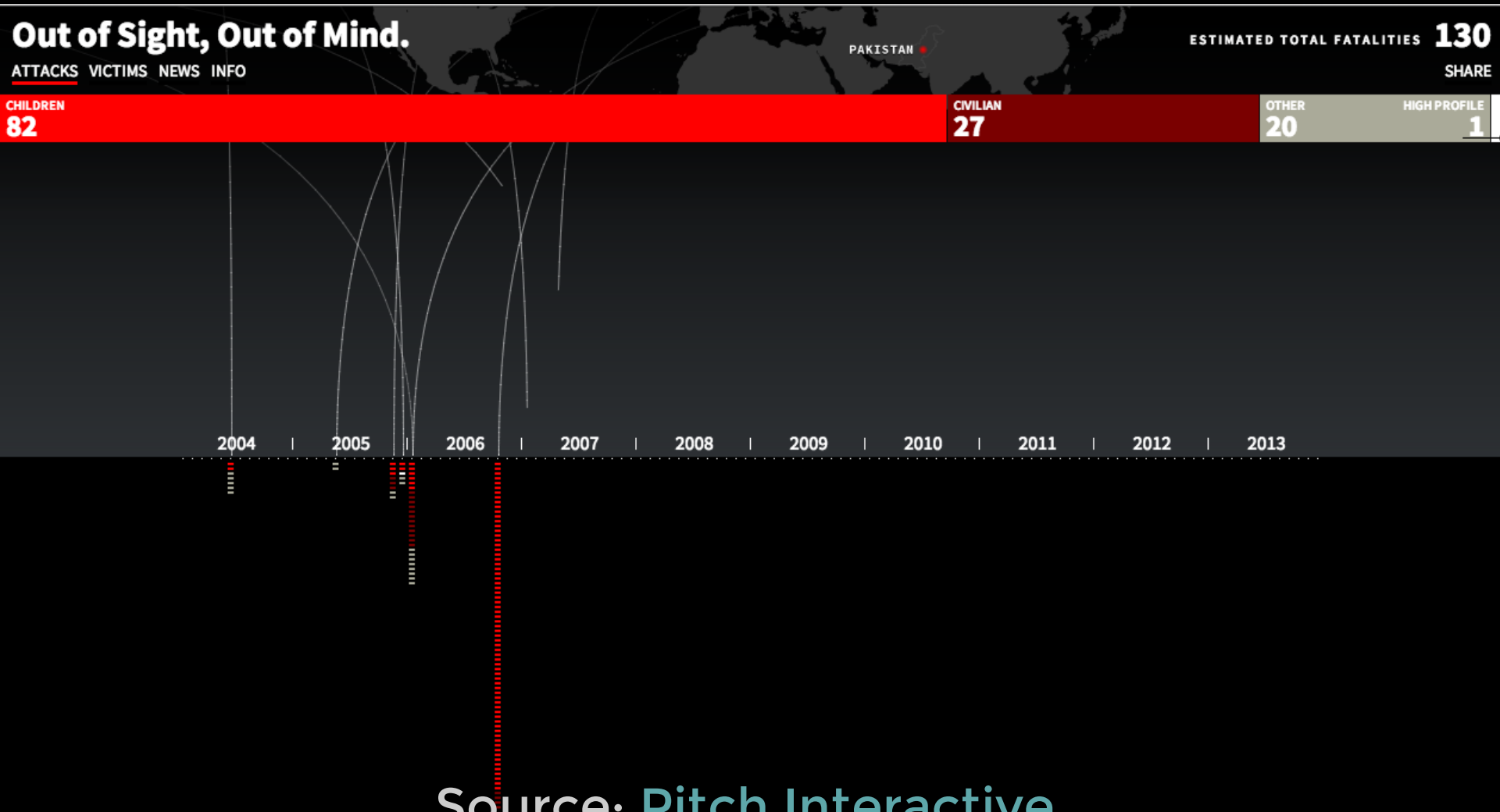
COMICSTRIP



SLIDESHOW

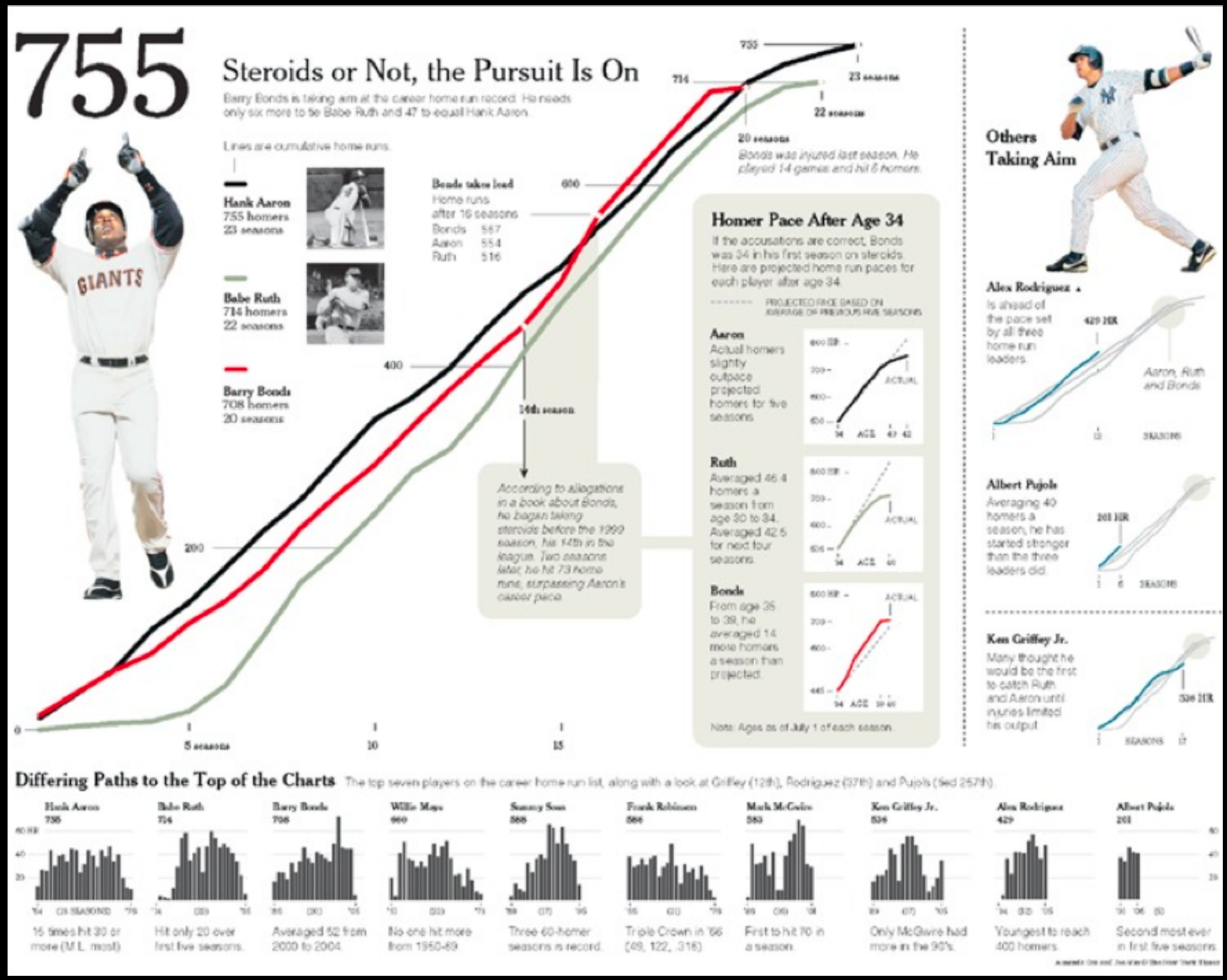
Source: Inconvenient Truth

Linear Narrative



Source: [Pitch Interactive]

Story Structure

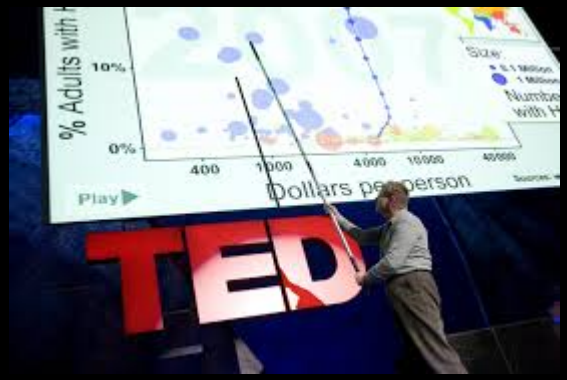


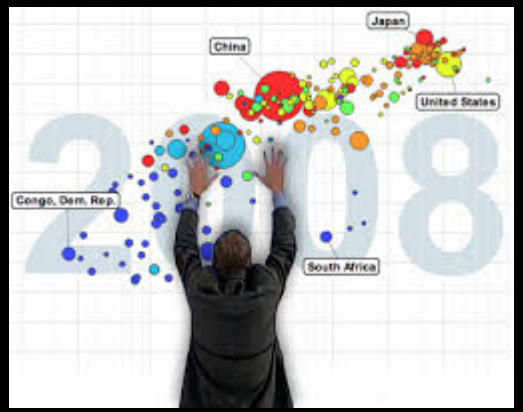
Story Structure

Focus Attention

Choose a Canvas	Put Visuals	Focus Attention
Rocks	Hieroglyph Carving	(Hand) Pointing
Paper	Pen Drawing	Pen Movement
Transparency	Marker Pens	Stick
Whiteboard	Marker Drawings	Pen Movement
Presentation	Slides	Next Slide Please??

Focus Attention

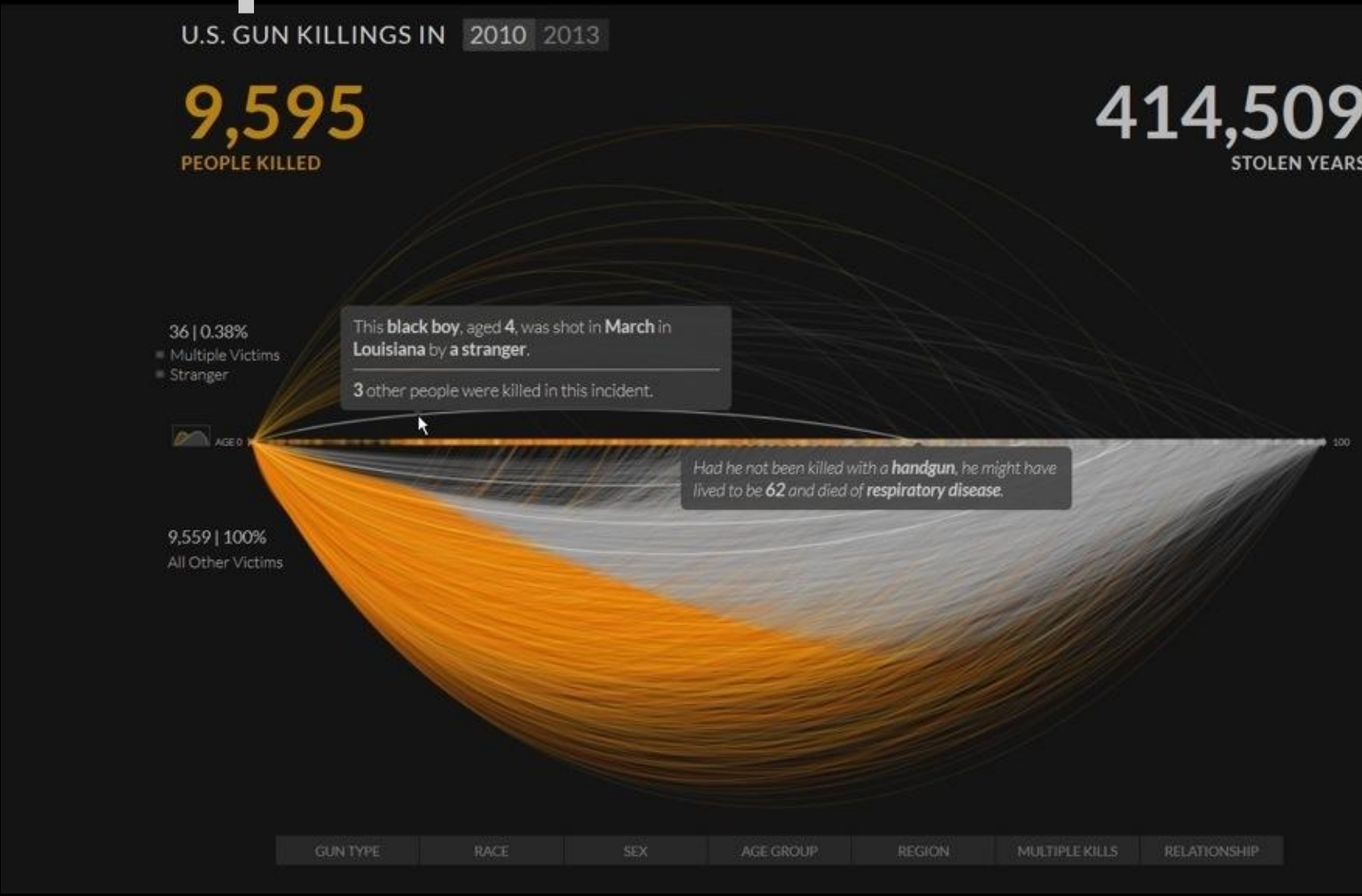




Focus Attention

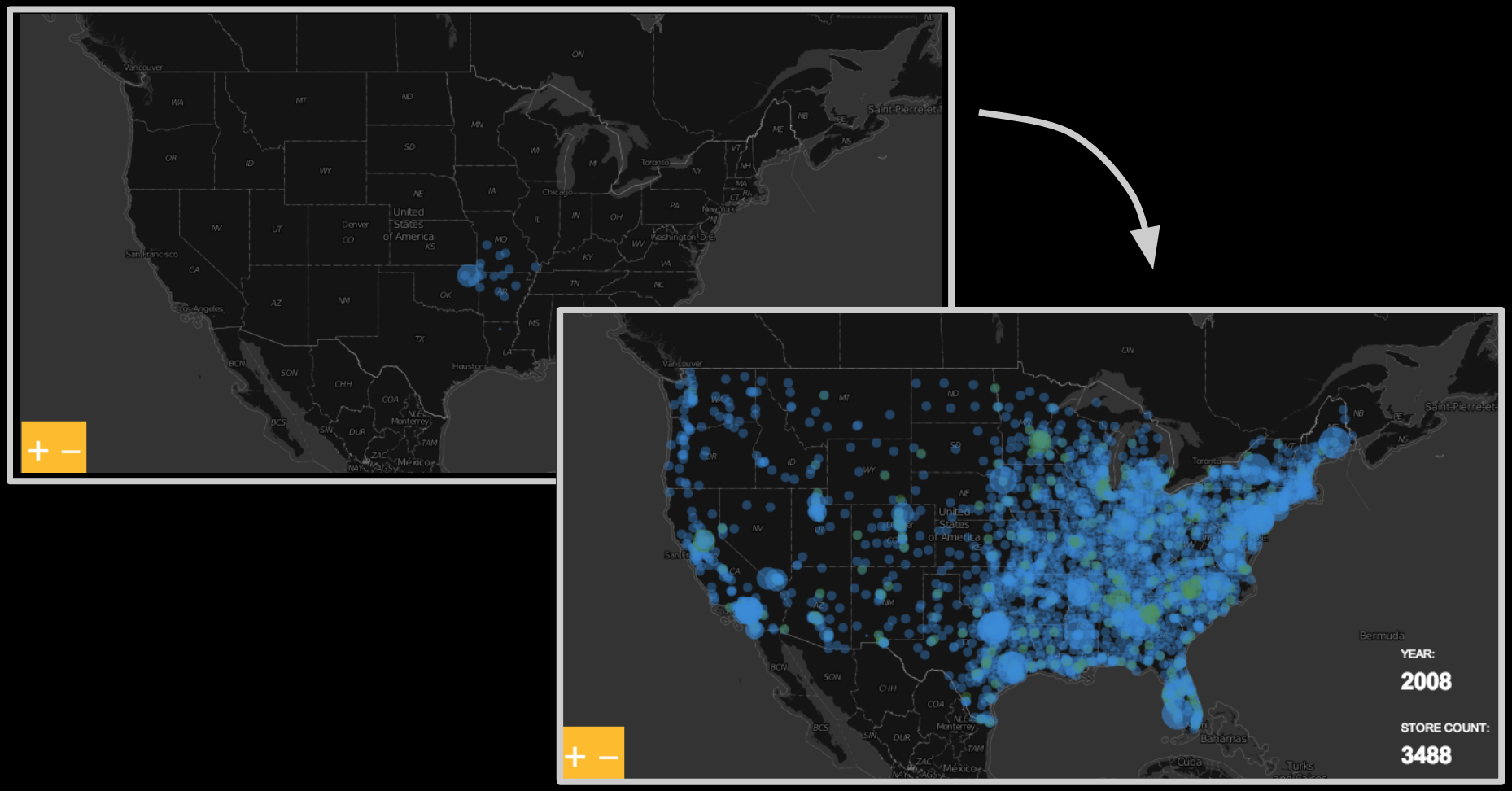
Choose a Canvas	Put Visuals	Focus Attention
Rocks	Hieroglyph Carving	(Hand) Pointing
Paper	Pen Drawing	Pen Movement
Transparency	Marker Pens	Stick
Whiteboard	Marker Drawings	Pen Movement
Presentation	Slides	Next Slide Please??
Genre	Data Viz	Highlight, CloseUp, Zoom, Framing Feature Distinct Motion, Audio

Explain and Guide Reader



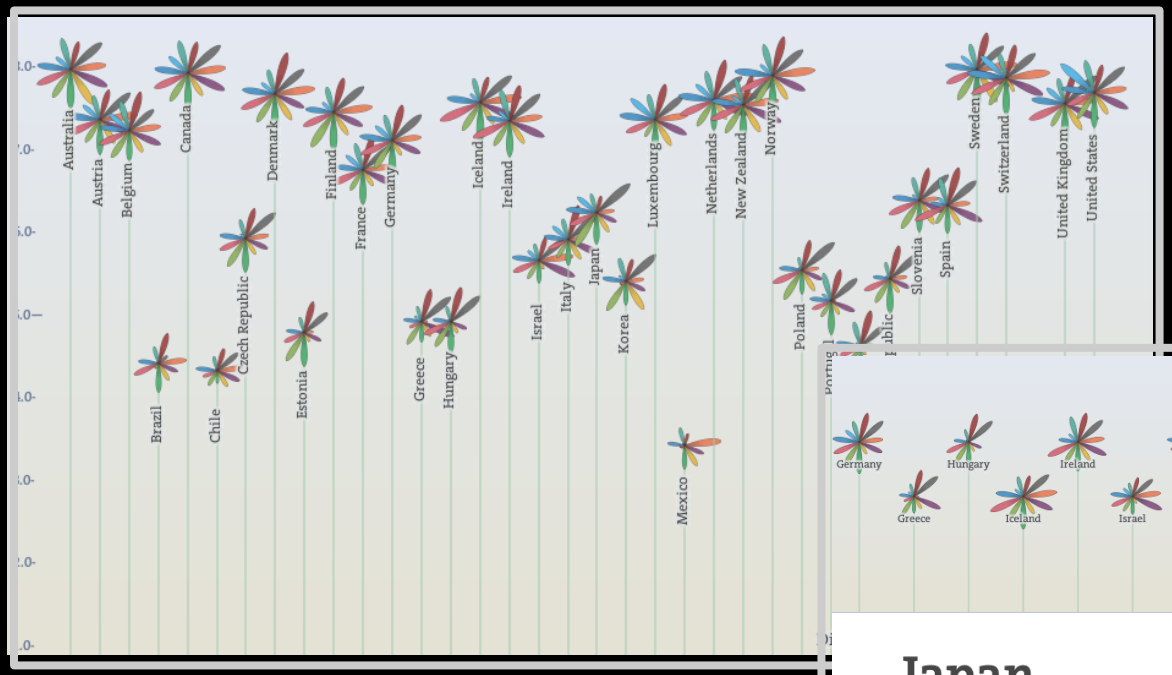
Source: [Guns - Periscopic]

Single Frame Dominates

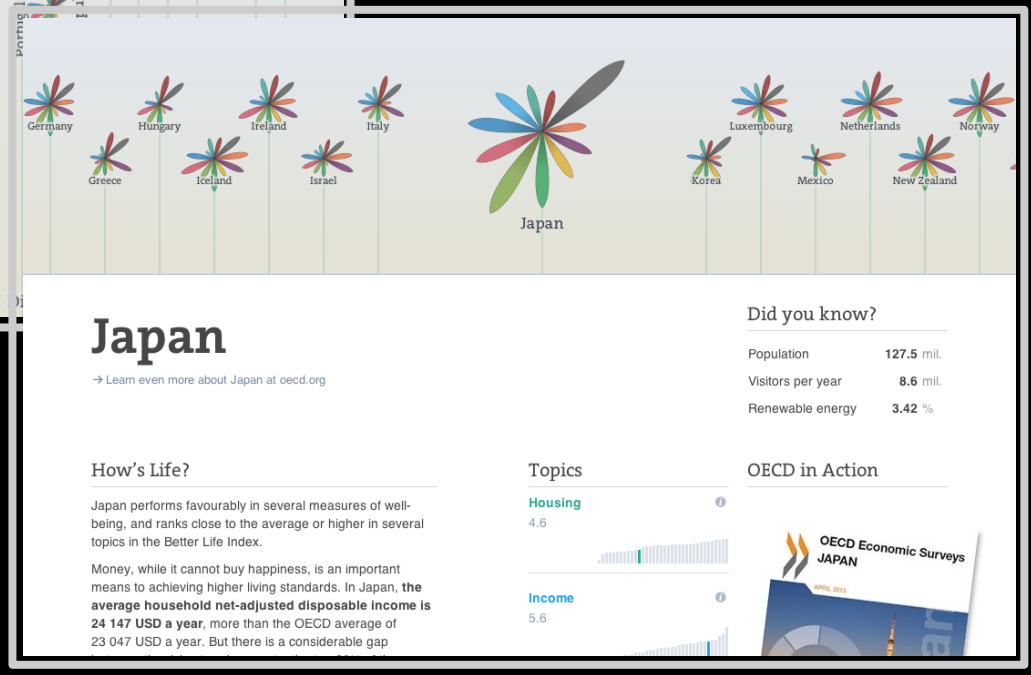


Source: Walmart & Target Store Expansion

Establish & Focus

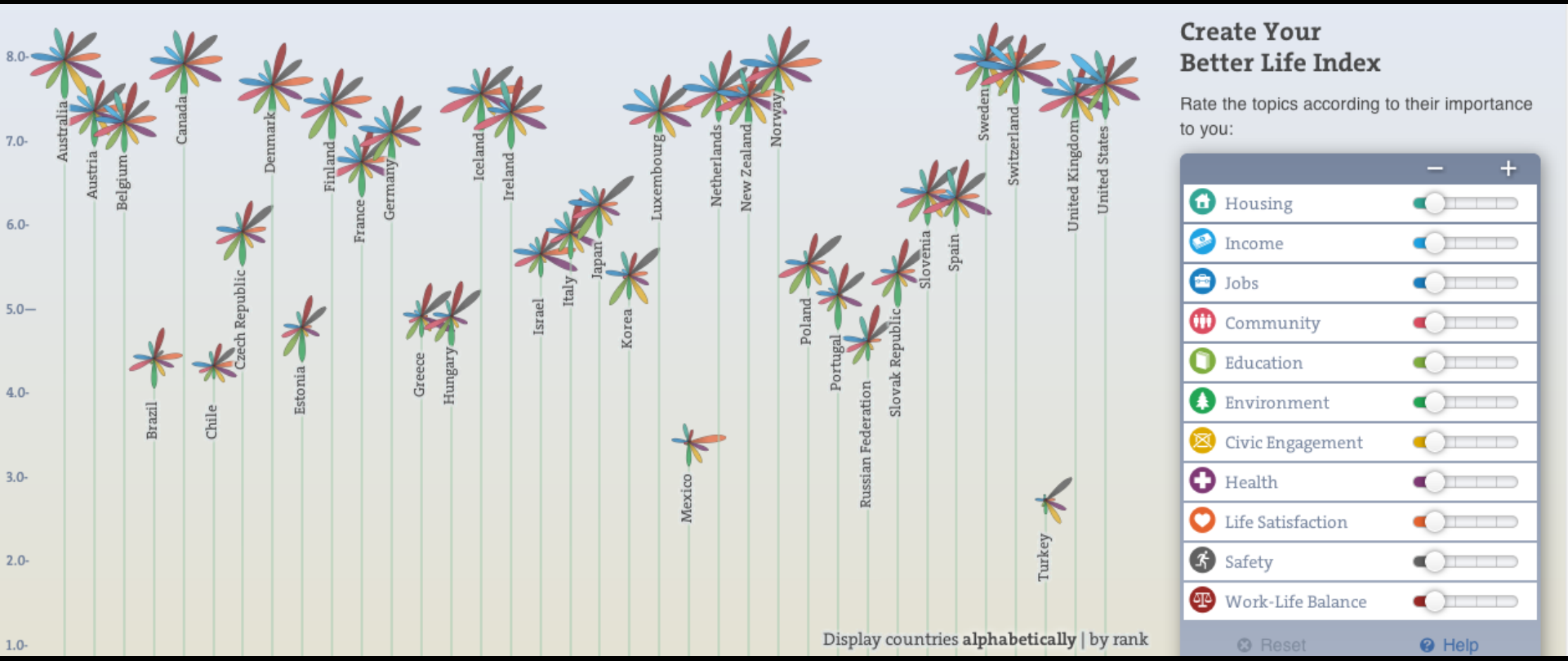


Consistent Visual Framework



Source: [OECD Better Life]

Establish & Focus



Source: [OECD Better Life]

Use Staging & Animation

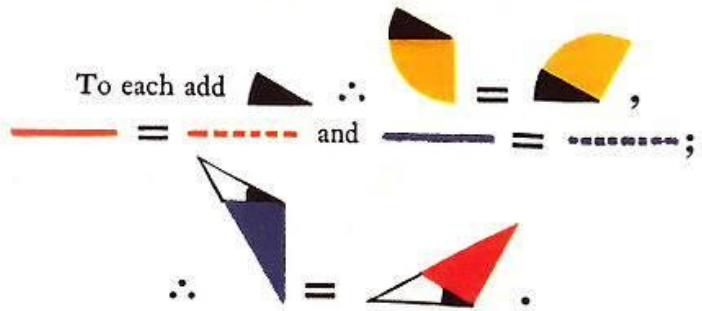
Source: [Gapminder]

Say it with Text

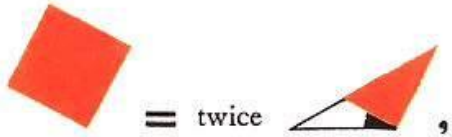
IN *a right angled triangle*  *the ſquare on the hypotenuſe* ——— *is equal to the ſum of the ſquares of the ſides,* (——— *and* ———).

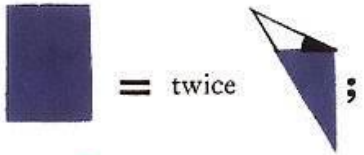
On ———, ——— and ——— deſcribe ſquares, (pr. 46.)

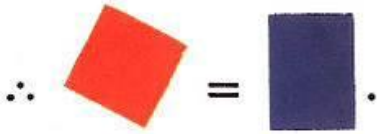
Draw ····· ‖ – – – – (pr. 31.)
alſo draw ——— and ———.

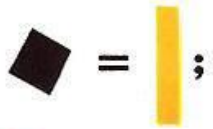


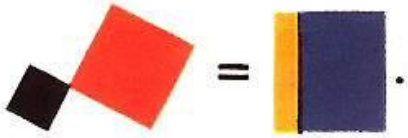
Again, becauſe ——— ‖ ·····



and  ;

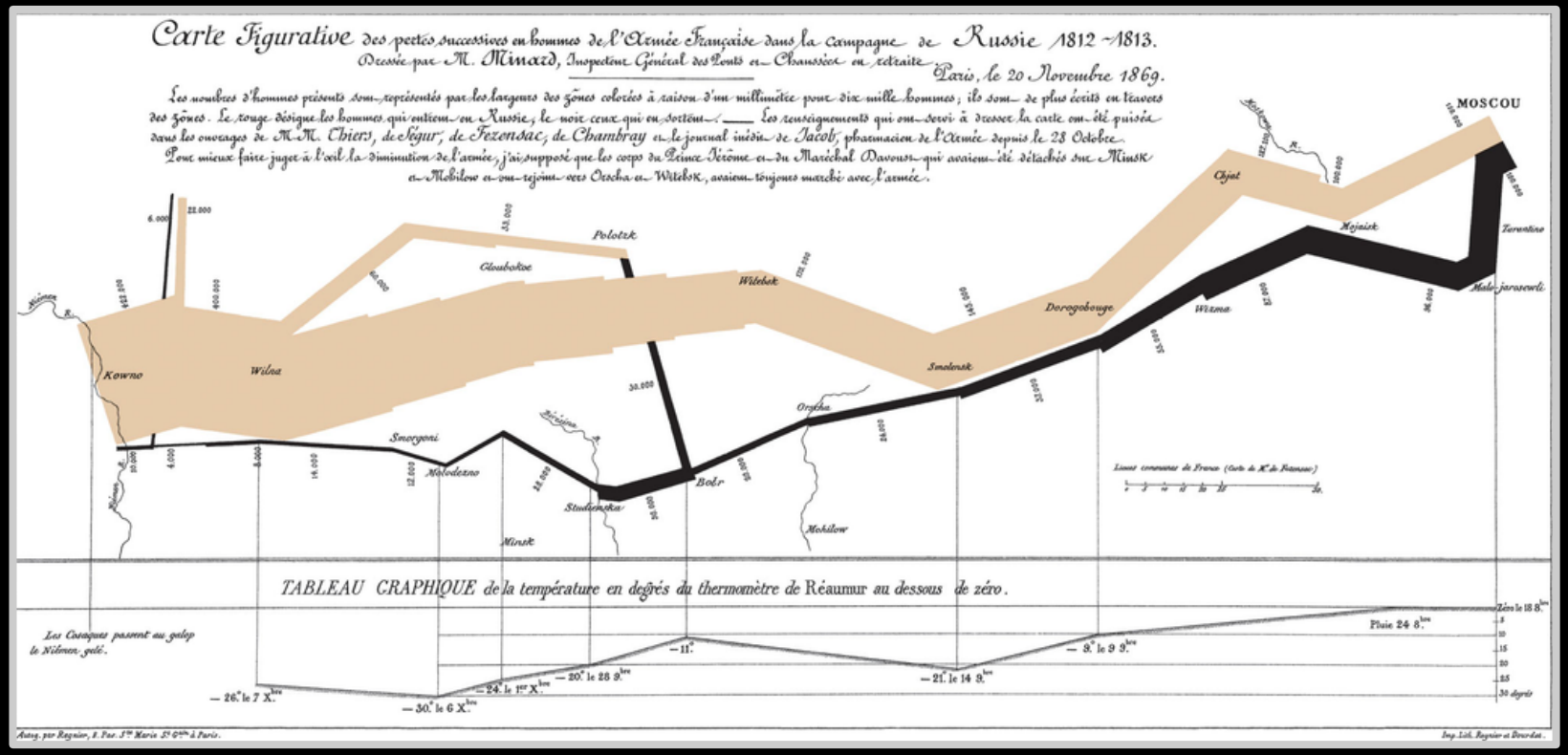


In the ſame manner it may be ſhown that  ;

hence 

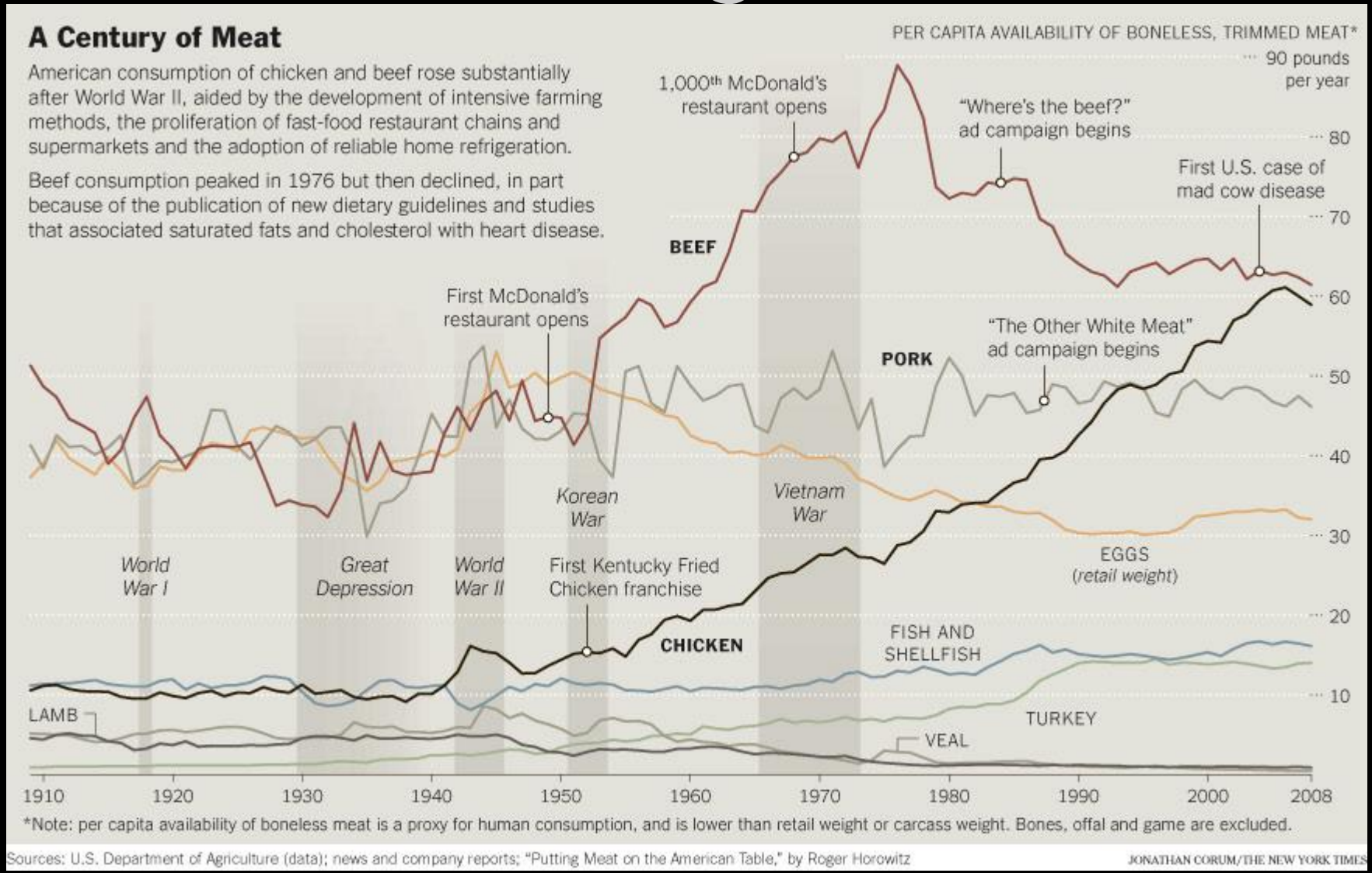
Q. E. D.

Weave Text into Graphics



Source: [Napolean's Campaign]

Provide Meaningful Annotation

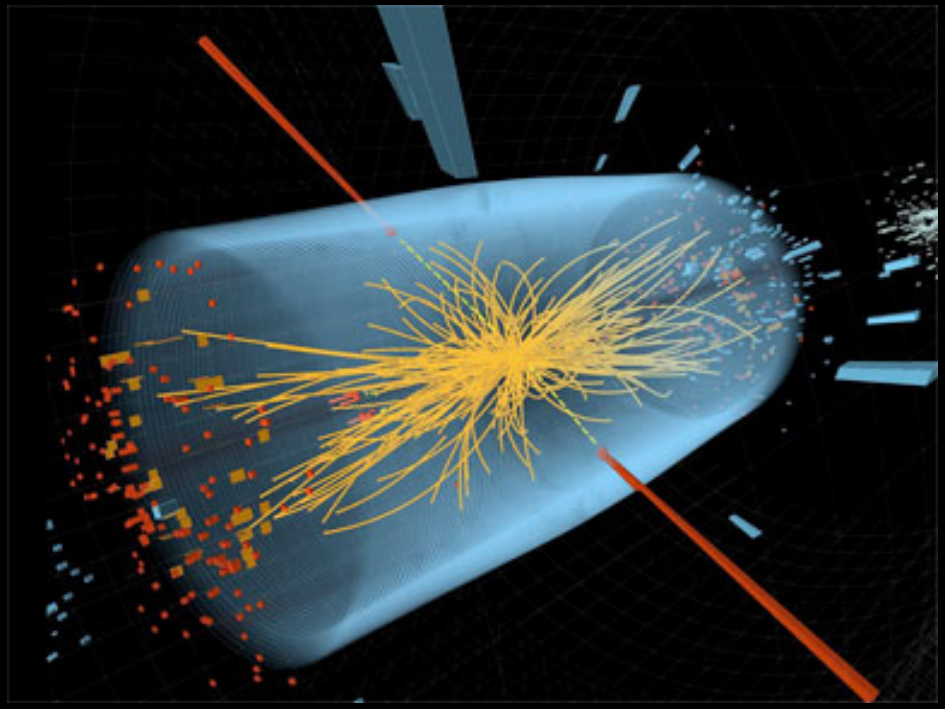


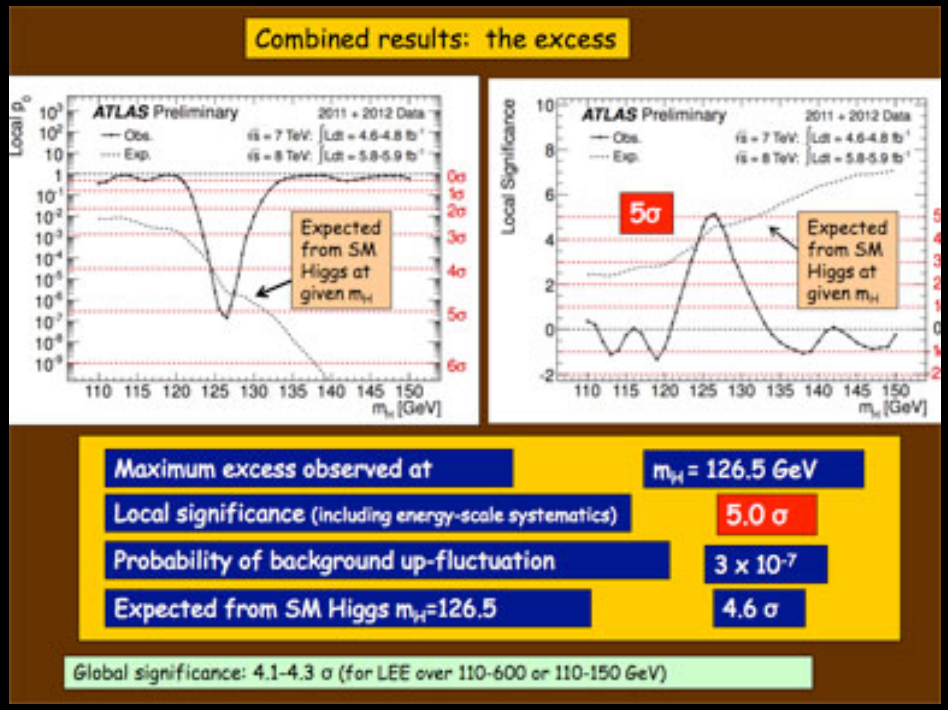
Source: New York Times

Power of Verbal Messaging

Source: [Hans Rosling | Joy of Stats]

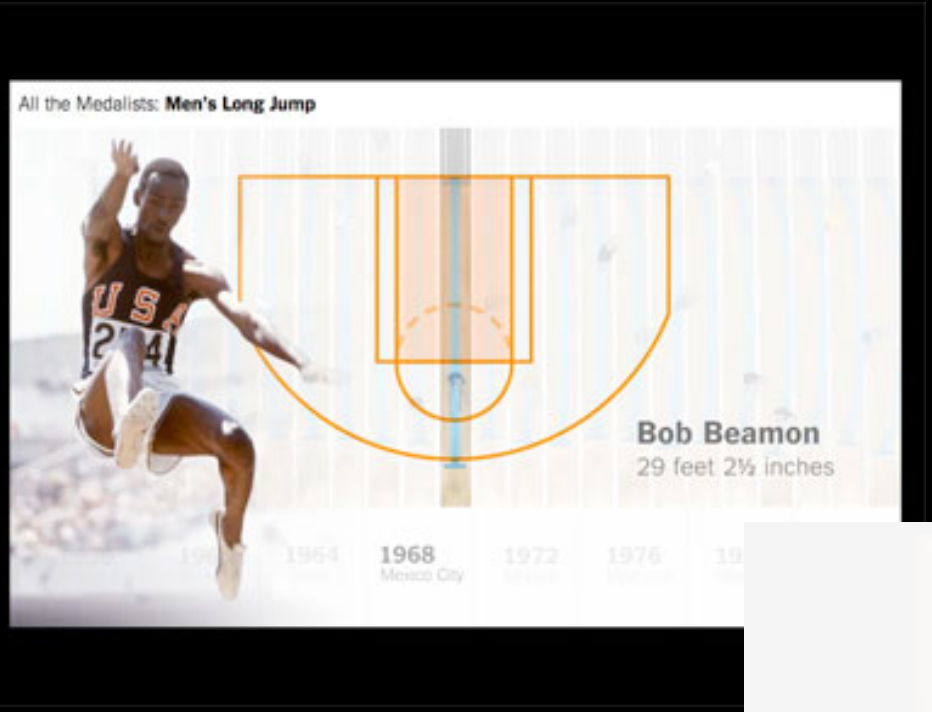
Answer the why?

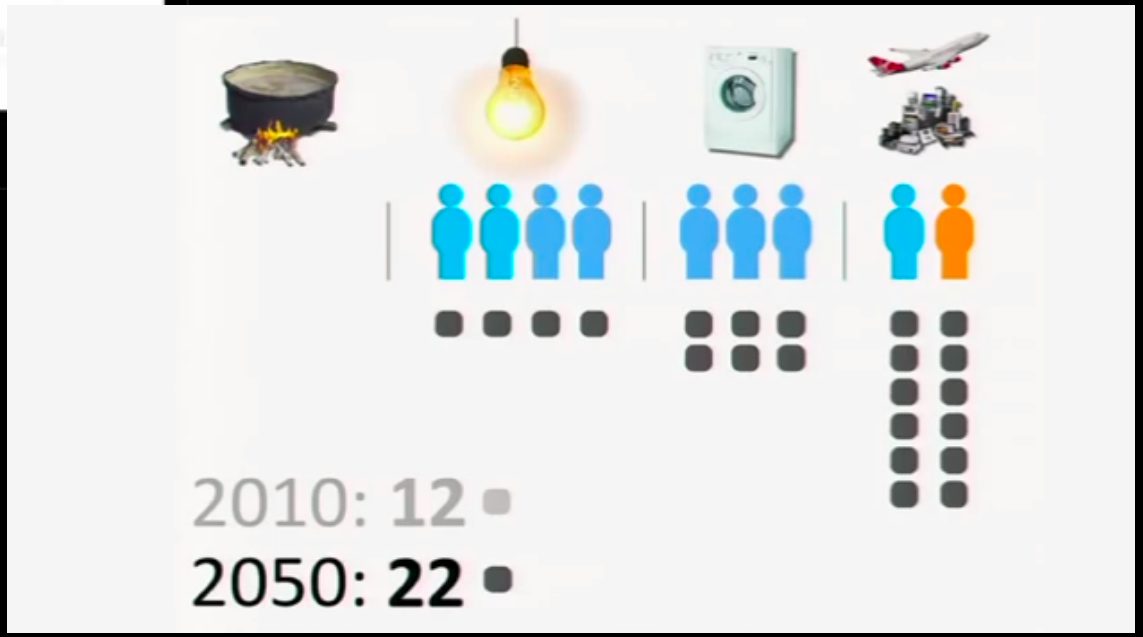




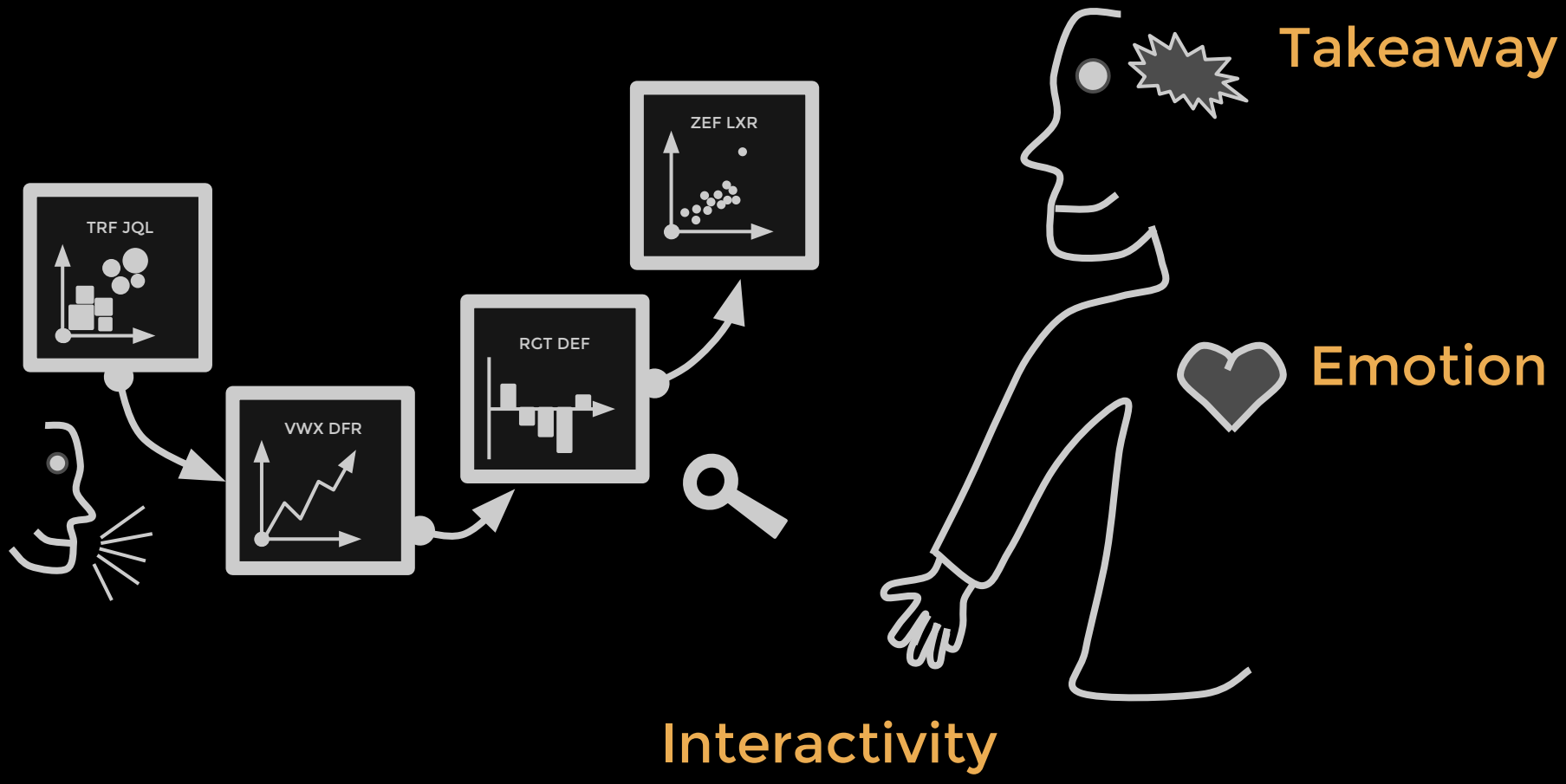
We are good at who, what, where, when. Not why?

Provide Relatability

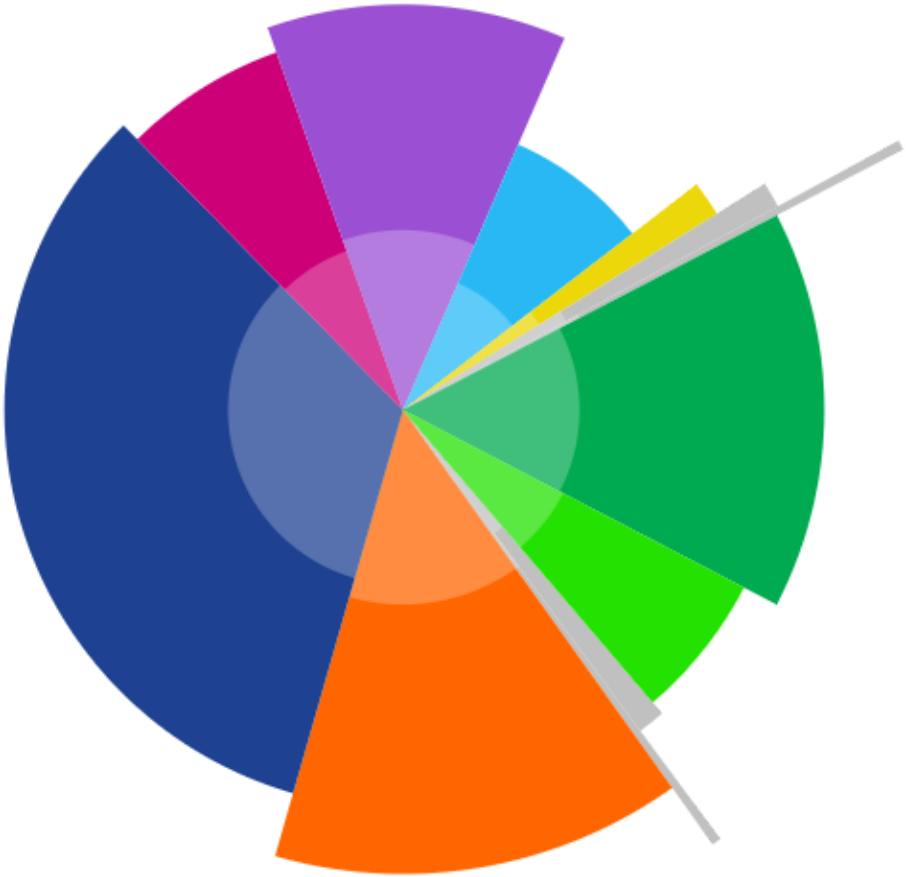




Engage the Audience



Attention & Engagment



Acid Reflux

Average yearly health care cost of a 50-year-old with Acid Reflux: **$5,456**

Personal Cost: **$958**

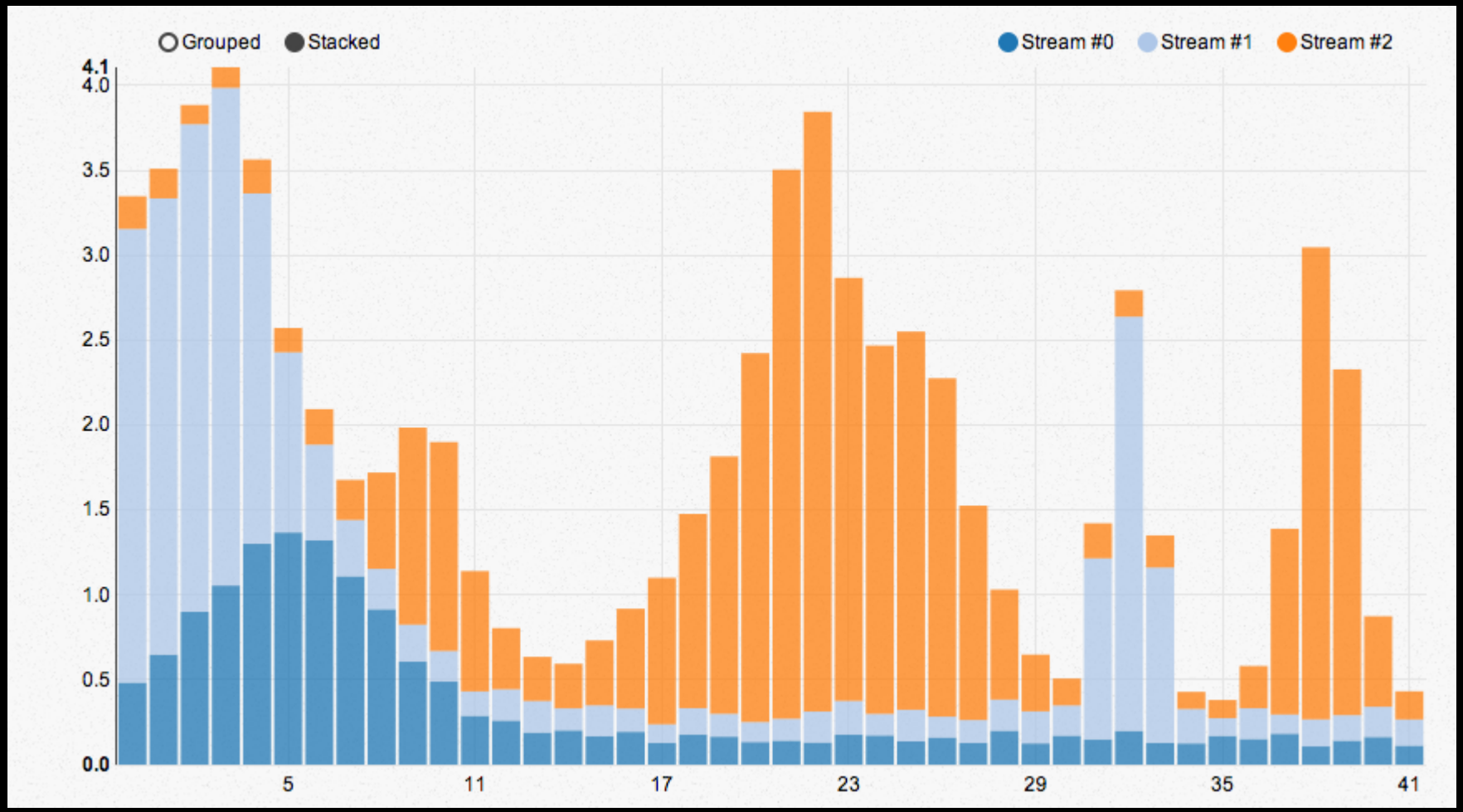
Insurer Cost: **$4,497**

Total yearly health care cost for the 987 patients with Acid Reflux: **$5,384,667**

Age 50

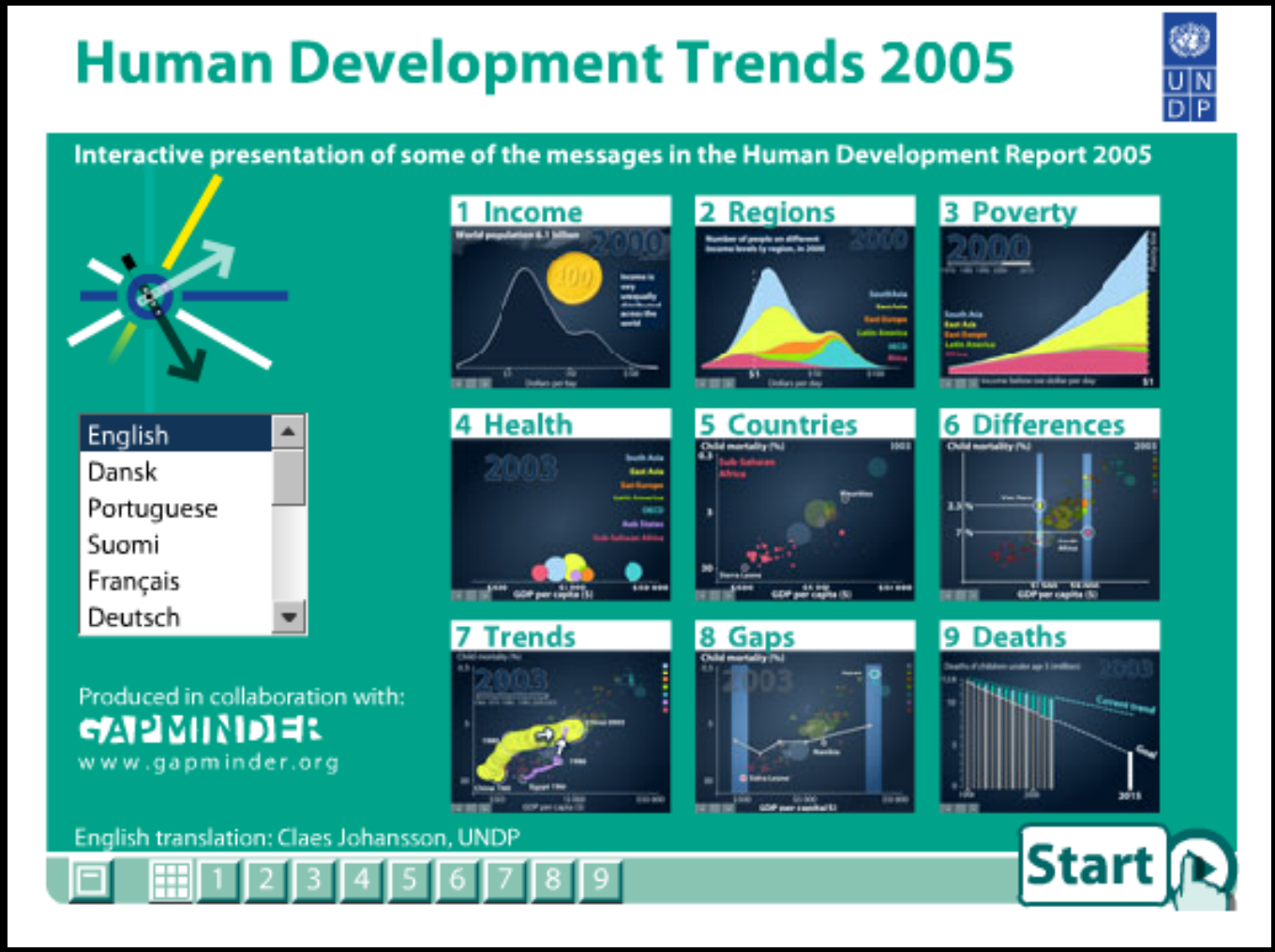
Source: Cost of Sick

Animation Helps



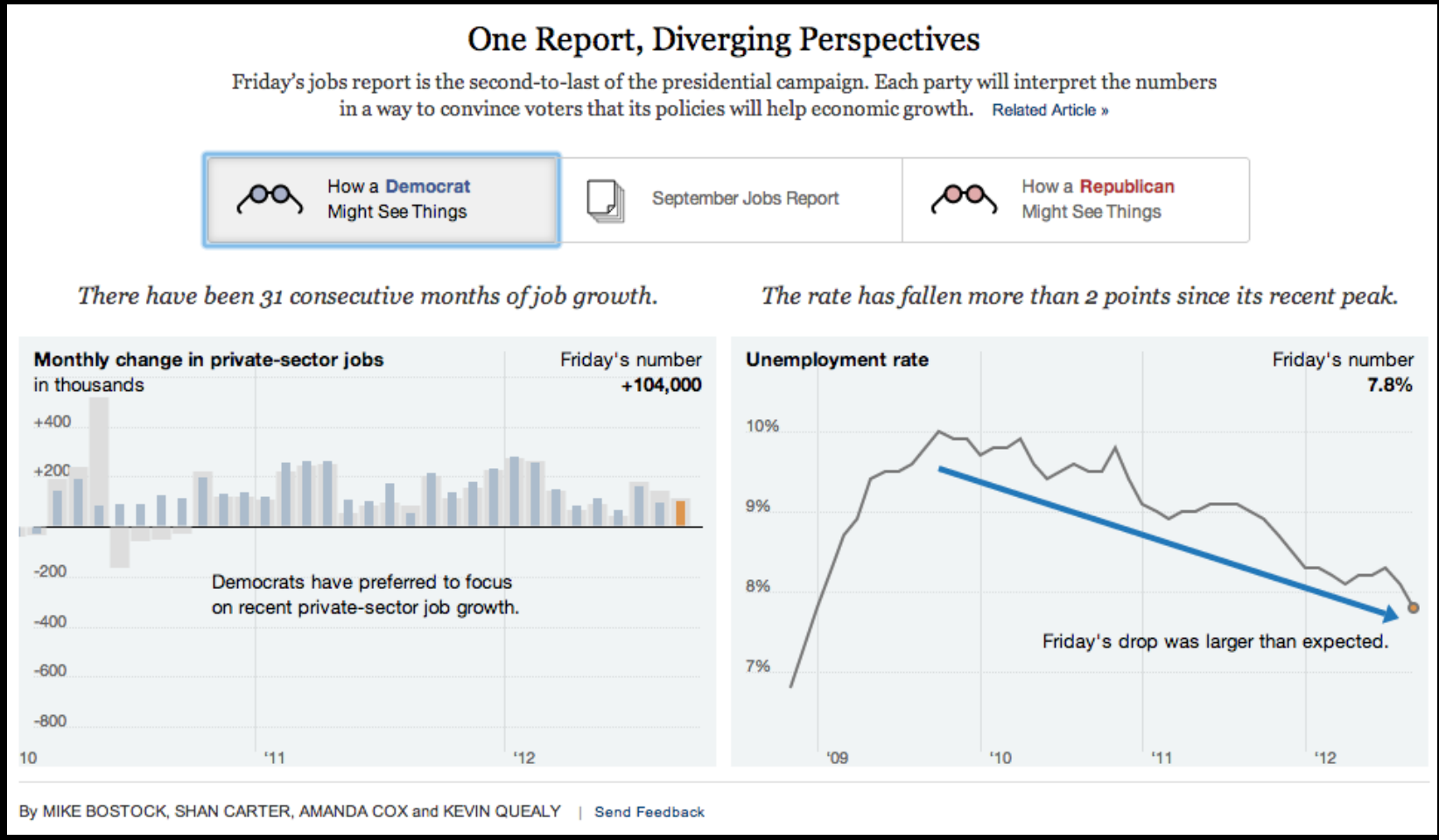
Source: [Multibar Transition]

Be Explicit about Actions



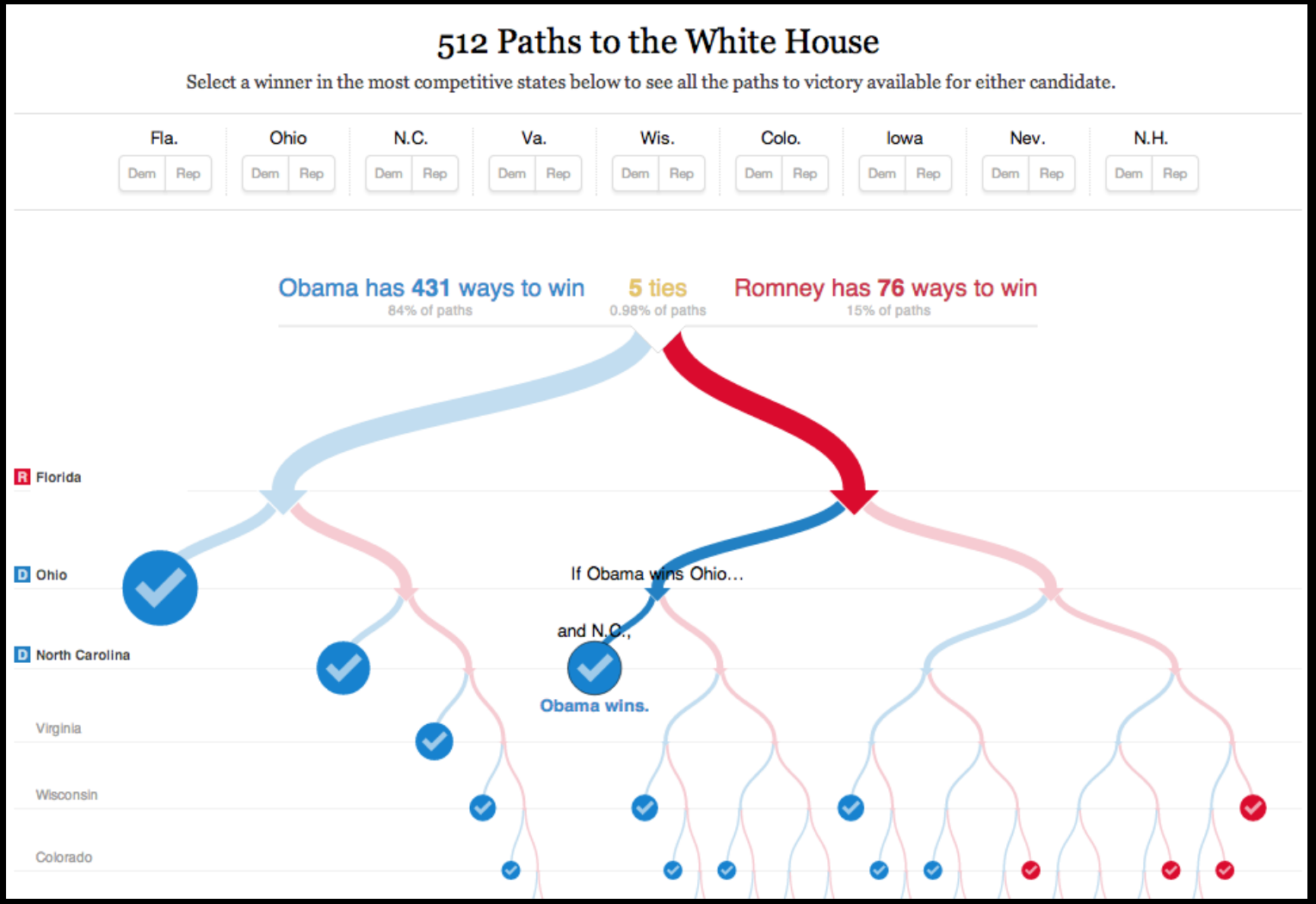
Source: [Gapminder]

Restrict Interactivity



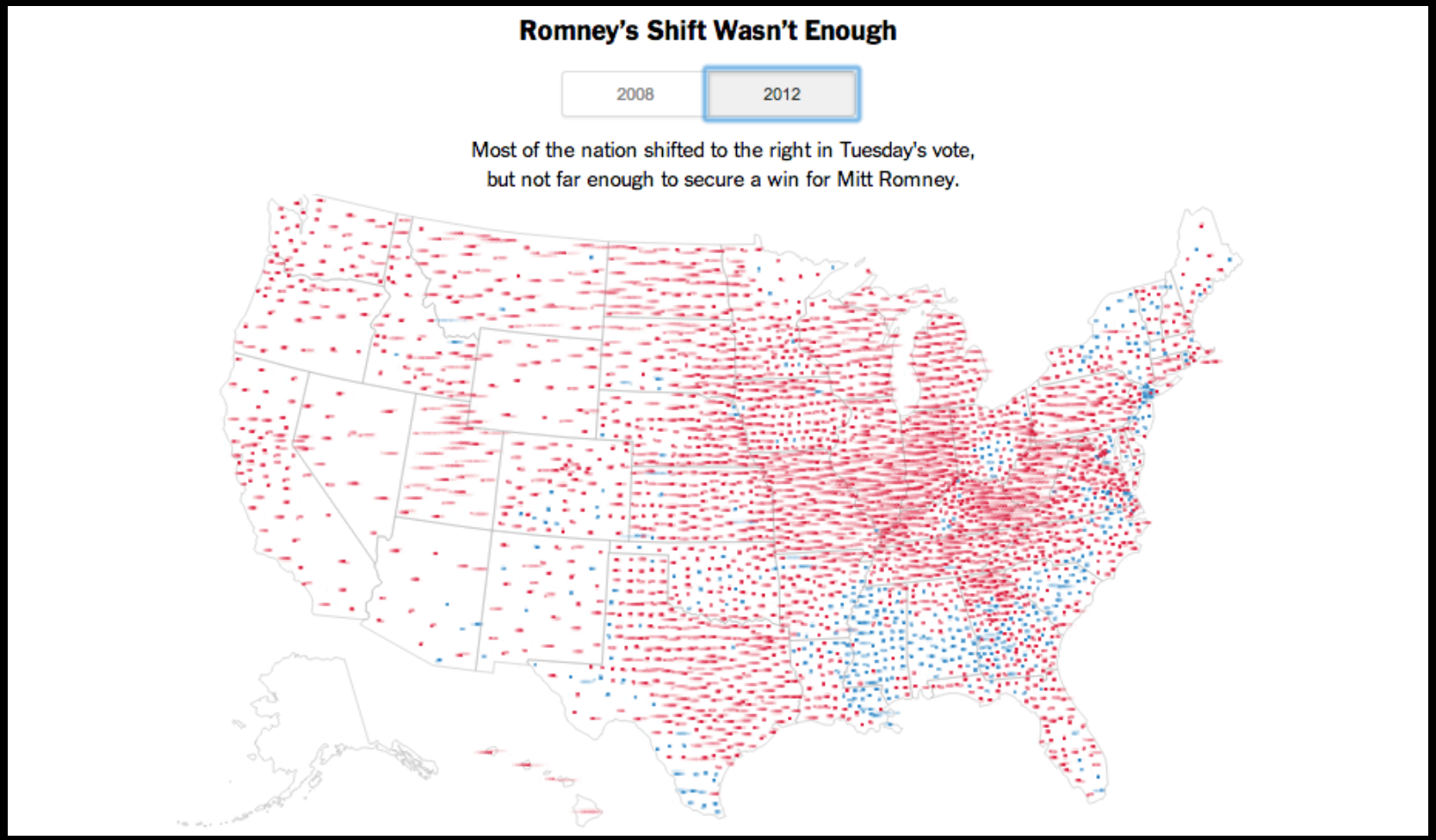
Source: [One Report, Many Perspective]

Make it look live



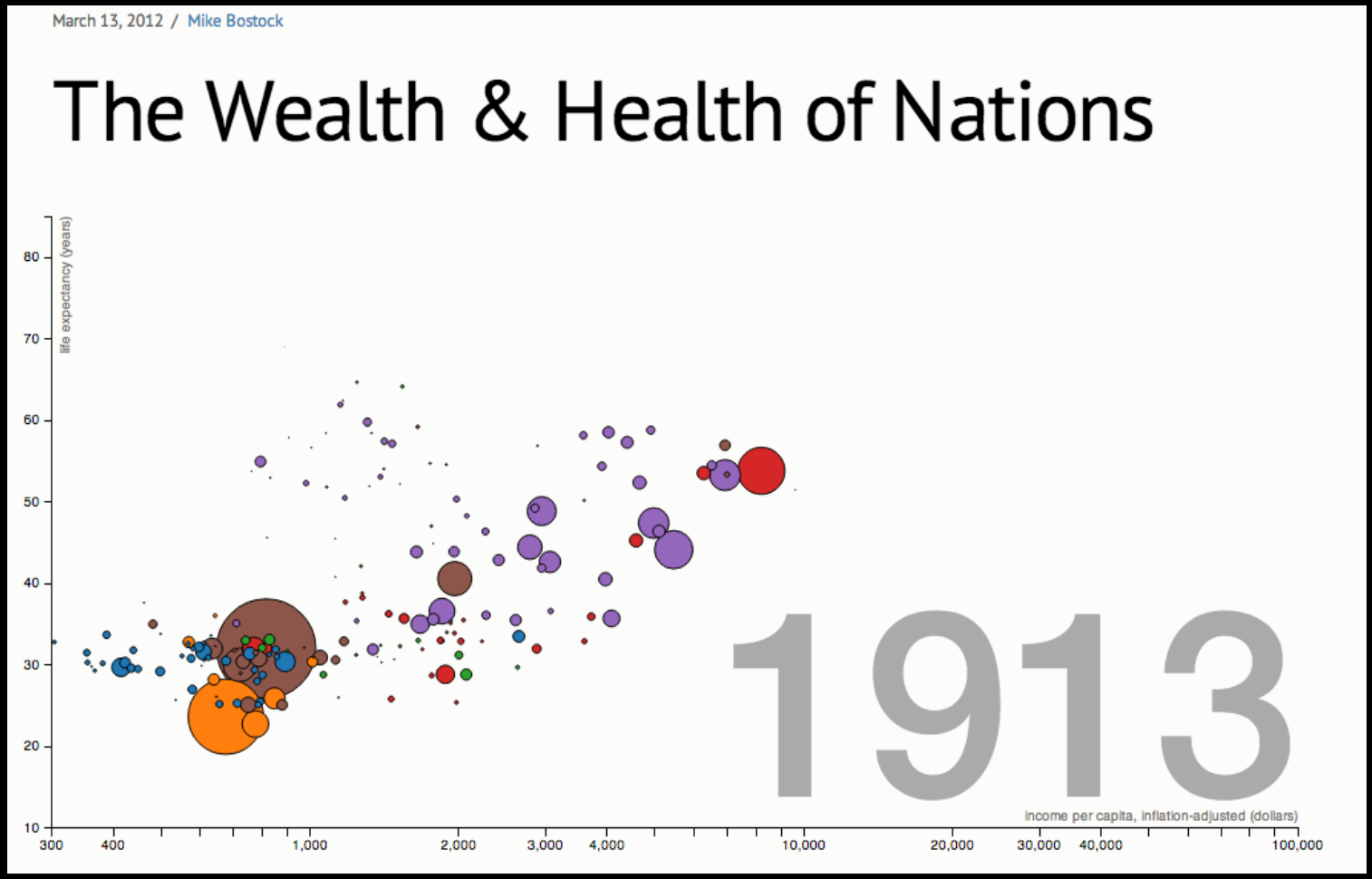
Source: [512 Paths to White House]

Make it look live



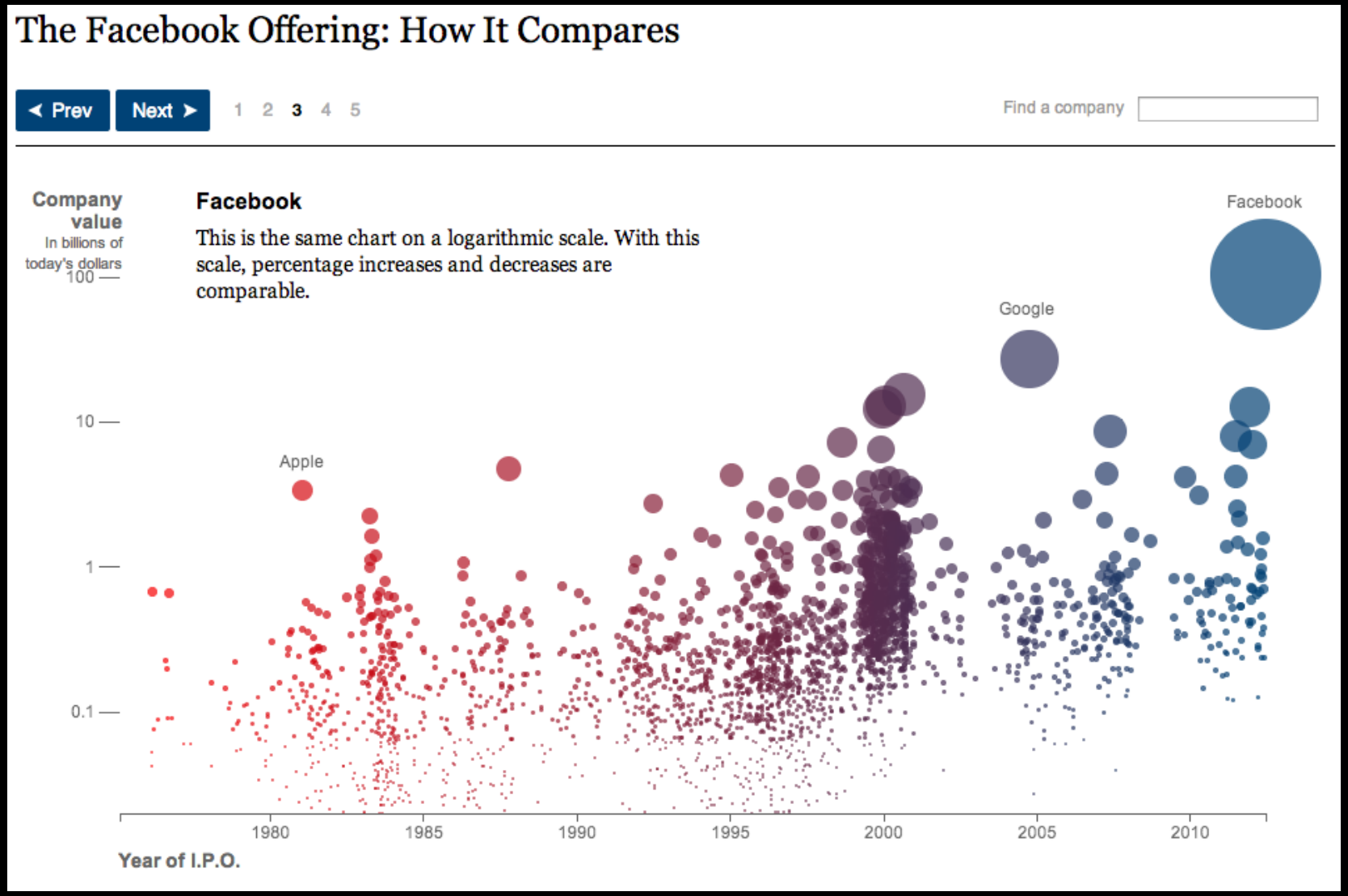
Source: Obama's Path

Make Interaction Easy



Source: [Health and Wealth of Nation]

Linear Navigation: Story Like



Source: NY Times

Science or Art?

Science

Perceptual Psychology

Cognitive Science

Graphic Design

Data Analysis

Art

Emotional

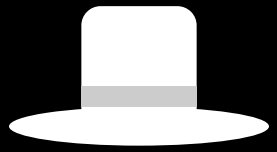
Aesthetic sense

Craft and Skill

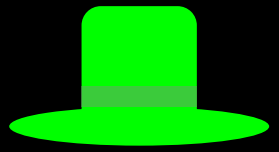
Creativity

Six Thinking Hats

Benefits



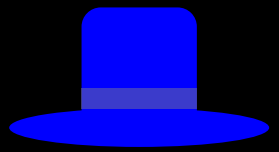
Facts



Creativity

Feelings

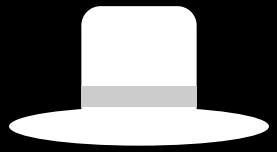
Caution



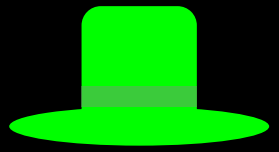
Process

Visualization Skill Hats

Explorer



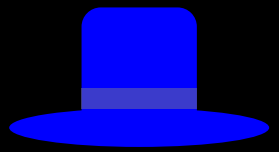
Data Scientist



Visual Designer

Storyteller

Programmer



Manager

Visualization Tools

Tools Landscape

Abstract	Blackbox
Flexible	Limited
Difficult	Simple
Slow	Quick
Code	GUI
Expressive	Efficient

Tools Landscape

Abstract, Flexible, Difficult
Slow, Code, Expressive

Blackbox, Limited, Simple
Quick, GUI, Efficient

Tools Landscape

Abstract, Flexible, Difficult
Slow, Code, Expressive

Blackbox, Limited, Simple
Quick, GUI, Efficient

Canvas

Paint directly on a pixel grid. Design & manage every element of chart

Processing
Nodebox

sketchpad

Raphael.js
Paper.js
Processing.js

Grammar

Collection of graphical primitives for composing data driven graphics

R-ggplot2
SPSS

raw

d3.js
Vega
Bokeh

Visual

Visual analysis languages allowing flexibility to design many variants

Tableau
Gephi

plot.ly

...

Charting

Collection of fixed charts that require data to be shaped in a particular way

Excel
Mondrian

Many Eyes

Google Charts
HighCharts
Fusion Charts

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