Interactive Visualization

Data Visualization: Basic Techniques

Bachelor of Arts in Interaction Design
Zürich University of the Arts
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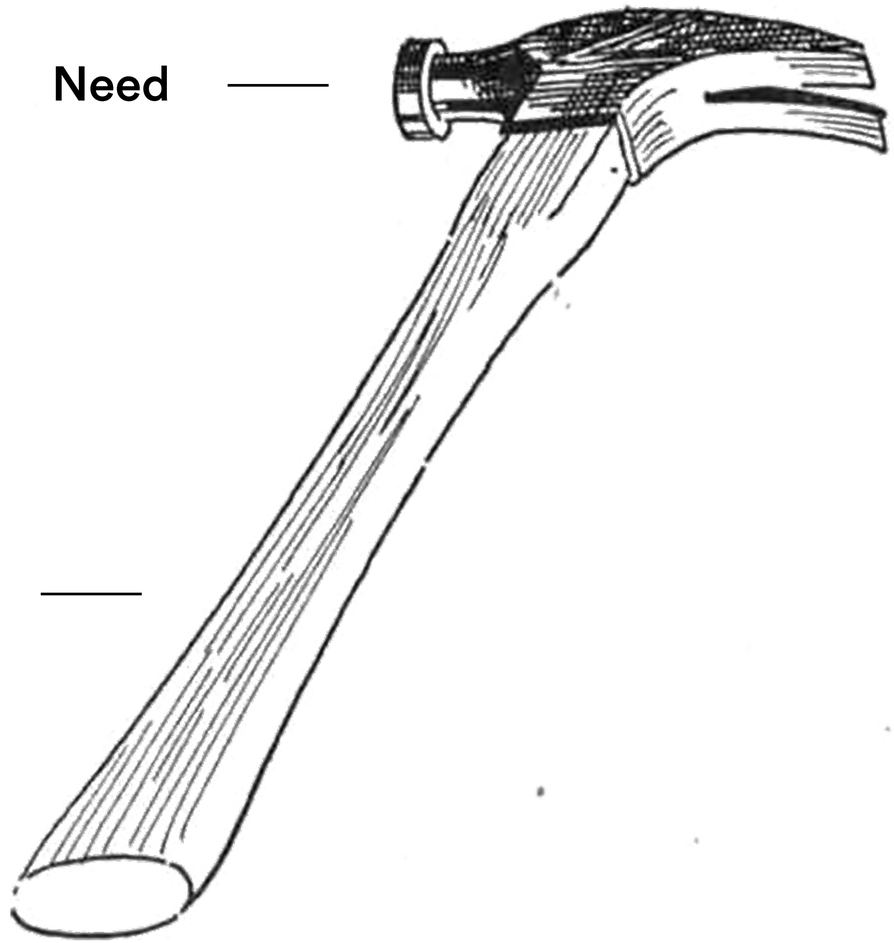
Module 2

Basic Techniques

Tool

Need

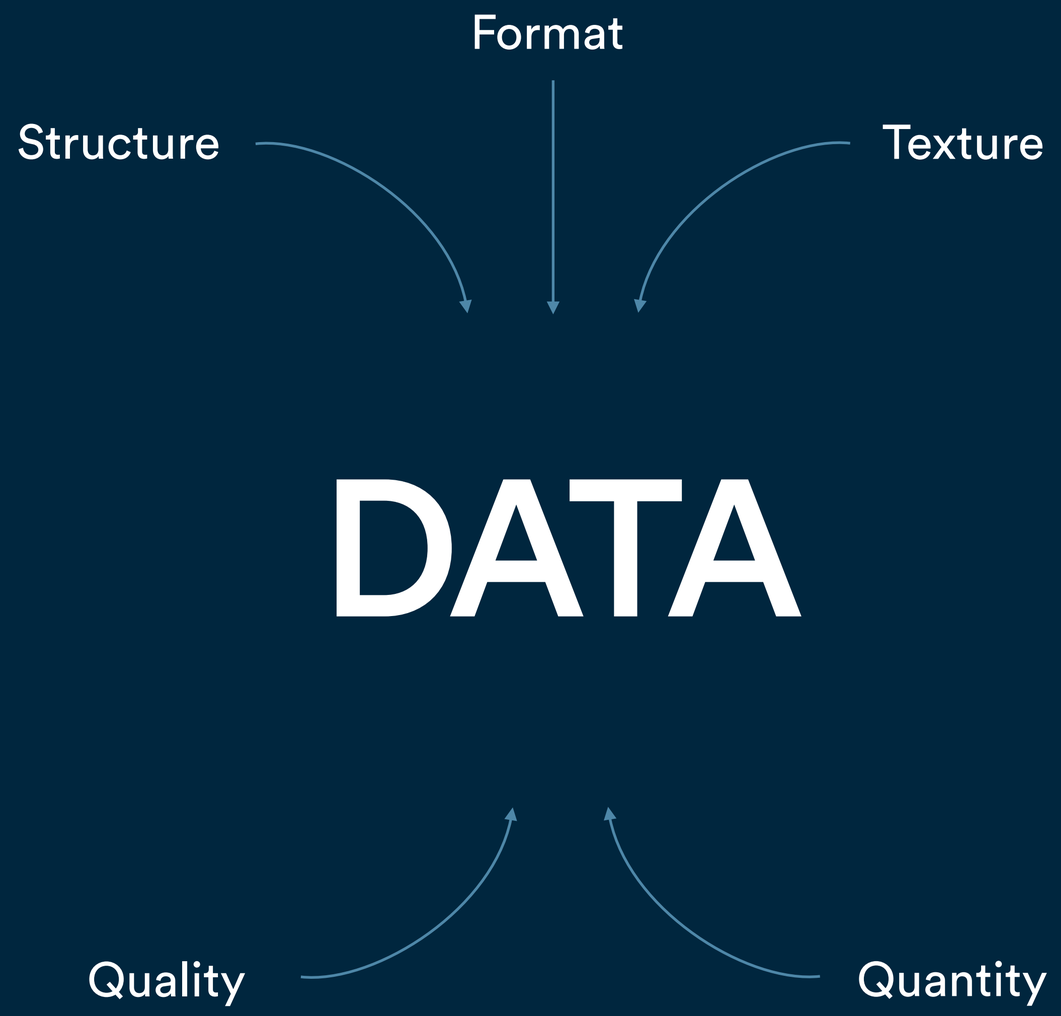
Capability

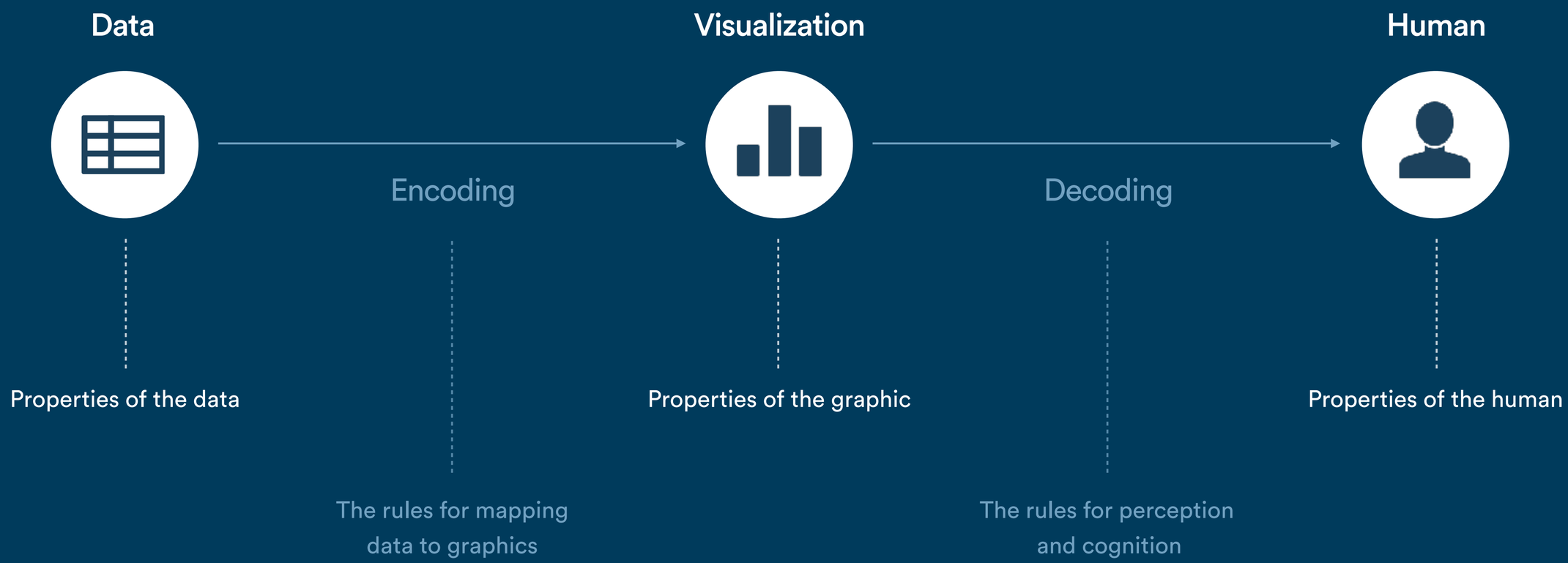


Optimized for the problem

Optimized for the human


Motivation
Activities
Skills
HUMAN
Abtitudes
Attitudes


Format
Structure
Texture
DATA
Quality
Quantity


Data
Visualization
Human
Encoding
Decoding
Properties of the data
The rules for mapping data to graphics
Properties of the graphic
The rules for perception and cognition
Properties of the human

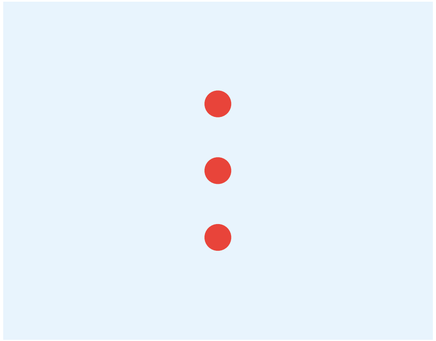
2.1

Data Properties

What can be visualized?

Data Types

Items

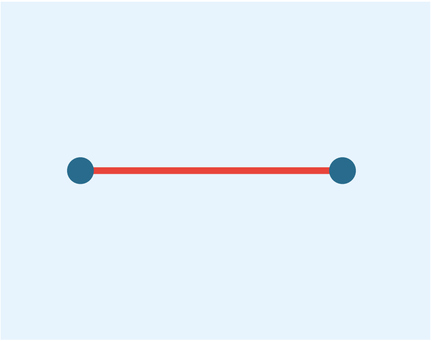


Individual and discrete entity, such as a row in a simple table.

Attributes

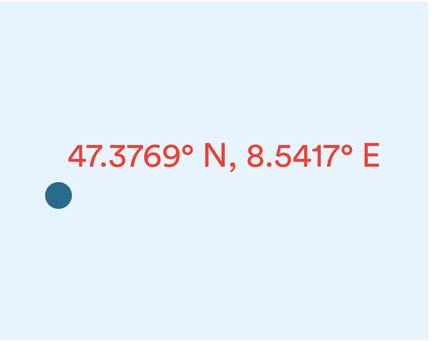
Specific property that can be measured, observed, or logged.

Links



Relationship between items, typically within a network.

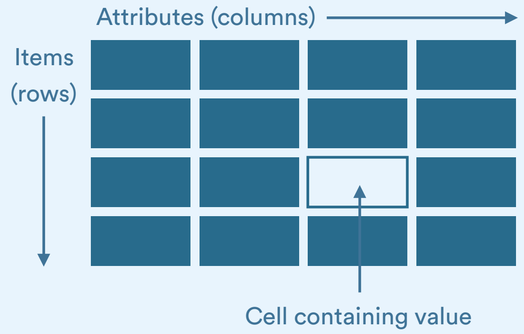
Positions



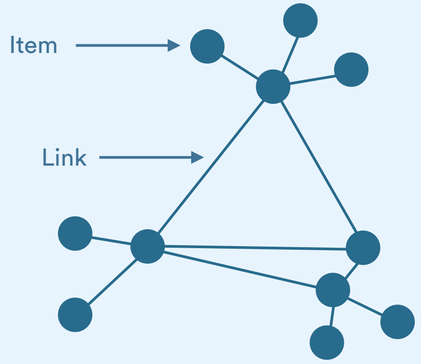
Spatial data providing a location in two- or three-dimensional space.

Data Set Types

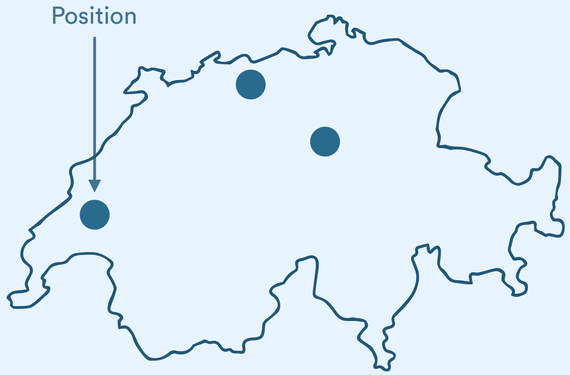
Tables



Networks

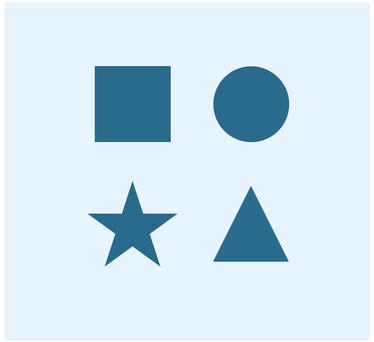


Geometry



Data Attribute Types

Nominal

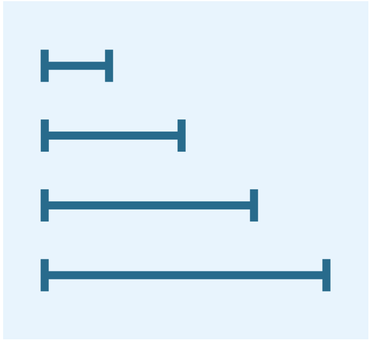


Data with categories of things that have no implicit ordering like song genres or animal families.

Ordinal

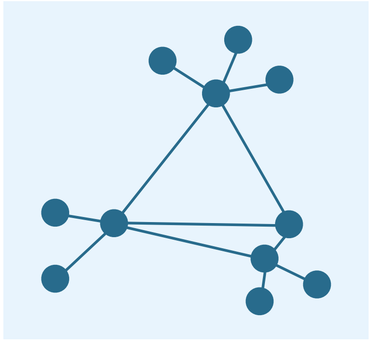
Data with an implicit order and discrete steps like shirt sizes or sport medals.

Quantitative



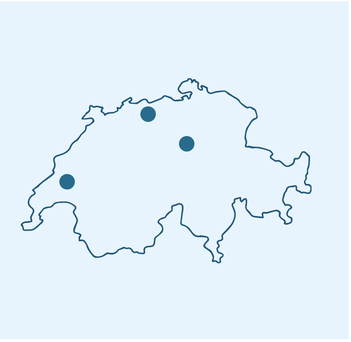
Data with a measure of magnitude like height, weight, temperature or price.

Relational



Data with groups of interconnected items like a social network or gene interaction.

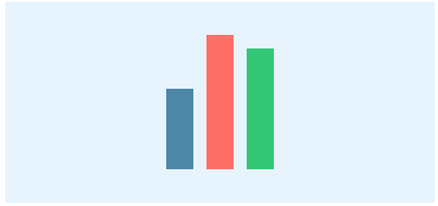
Spatial



Data with specification about the shape of items like a geographical map or a body of mass.

Data Relationships

Nominal Comparison

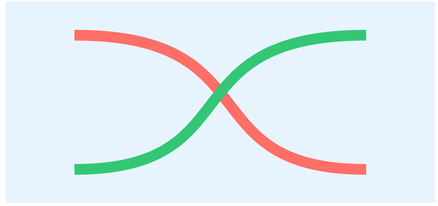


Number of website visitors to various websites.

Time Series

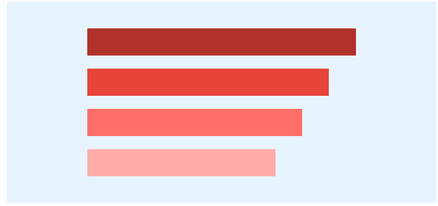
Changes in the national uneployment rate over time.

Correlation



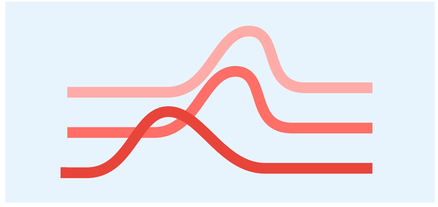
National salaries according to education level.

Ranking



Highest earning football players ranked by salary.

Deviation

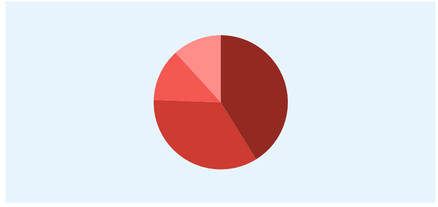


Movie tickets sold on a rainy day vs. a sunny day.

Distributions

Heights of players on a basketball team.

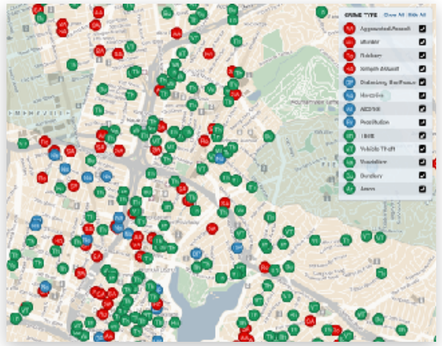
Part-of-Whole



Percentage of browsers accessing a website.

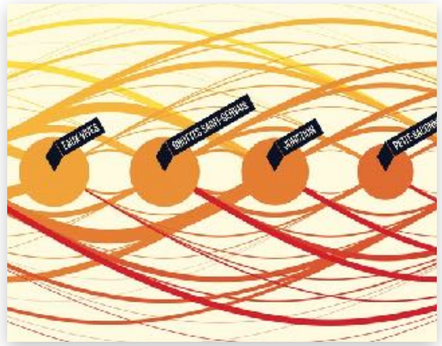
Data Order Types

Location



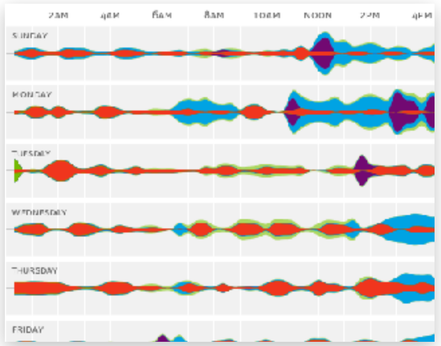
Stamen. Crimespotting

Alphabet



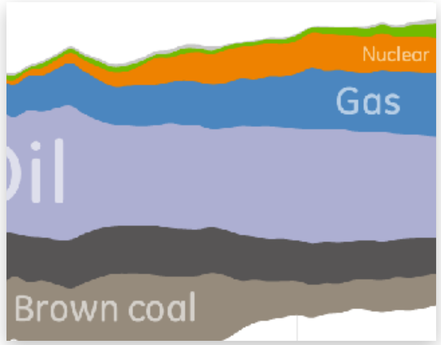
Interactive Things. Ville Vivante

Time



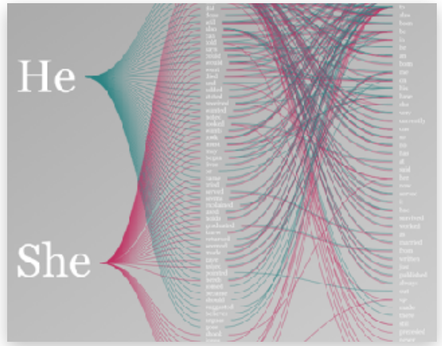
Fathom. Powering the Kitchen

Category



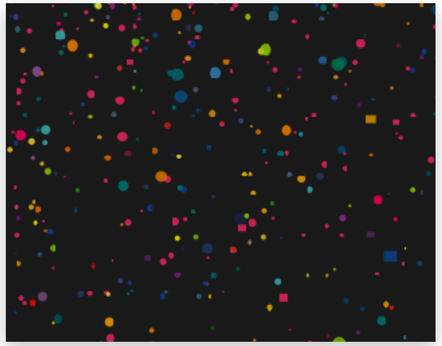
Gregor Aisch. German Energy Landscape

Hierarchy



Chris Harrison. He and She Google Ngram

Random



Jonathan Harris. We Feel Fine

http://www.interaction-design.org/encyclopedia/data_visualization_for_human_perception.html

2.2

Human Properties

How are graphics perceived?

How many times do you see the digit 5?

98734979056479028947286240024060370705702790728032080290073025012702370083740820787202720070247802602703793775709707377970667462097094702792797970972309723097592750927279798734972608020

Stephen Few (2004), Tapping the Power of Visual Perception

Preattentive Processing: What is it?

- Preattentive Processing is like a small super power.
  The ability of the low-level human visual system to rapidly identify certain basic visual properties.

- Preattentive Detection precedes focused attention.
  Requires only 200 to 250 ms on large multi-element displays

Preattentive Features

Scale

Position

Direction

Shape

Texture

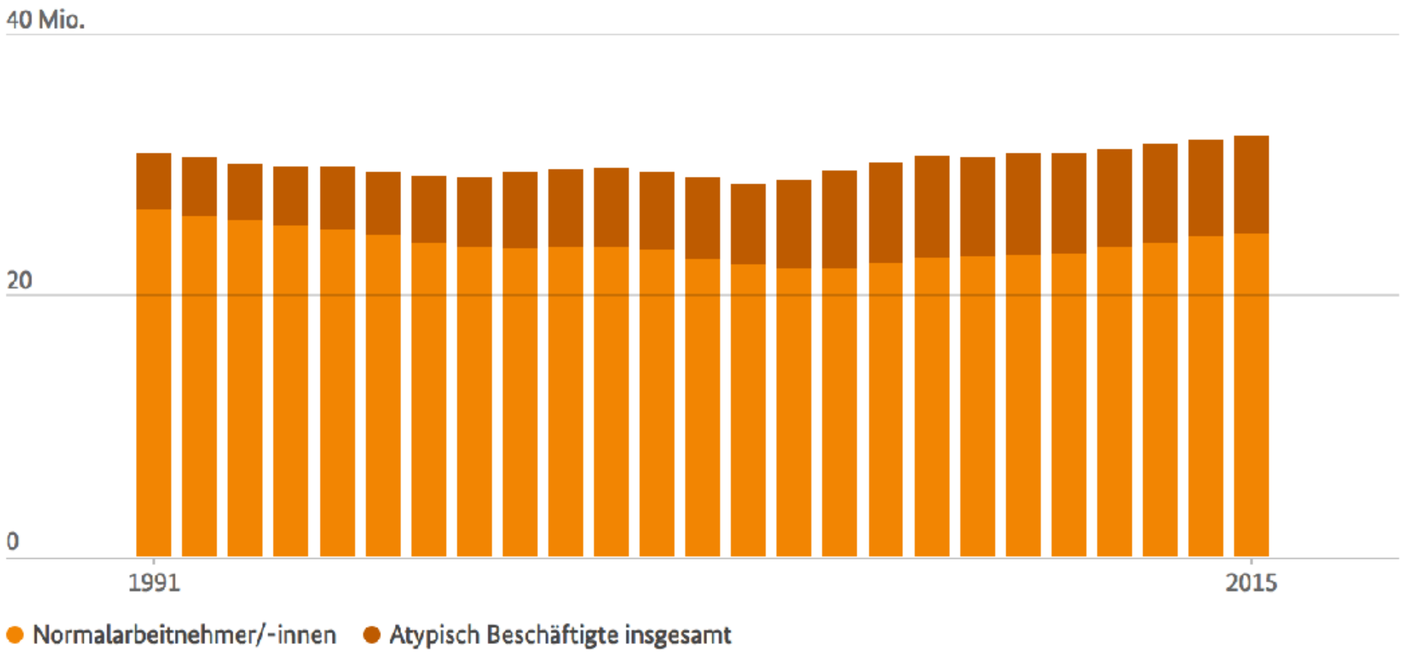
Color (HSB)

Opacity

Sharpness

http://www.infovis-wiki.net/index.php?title=Visual_Variables

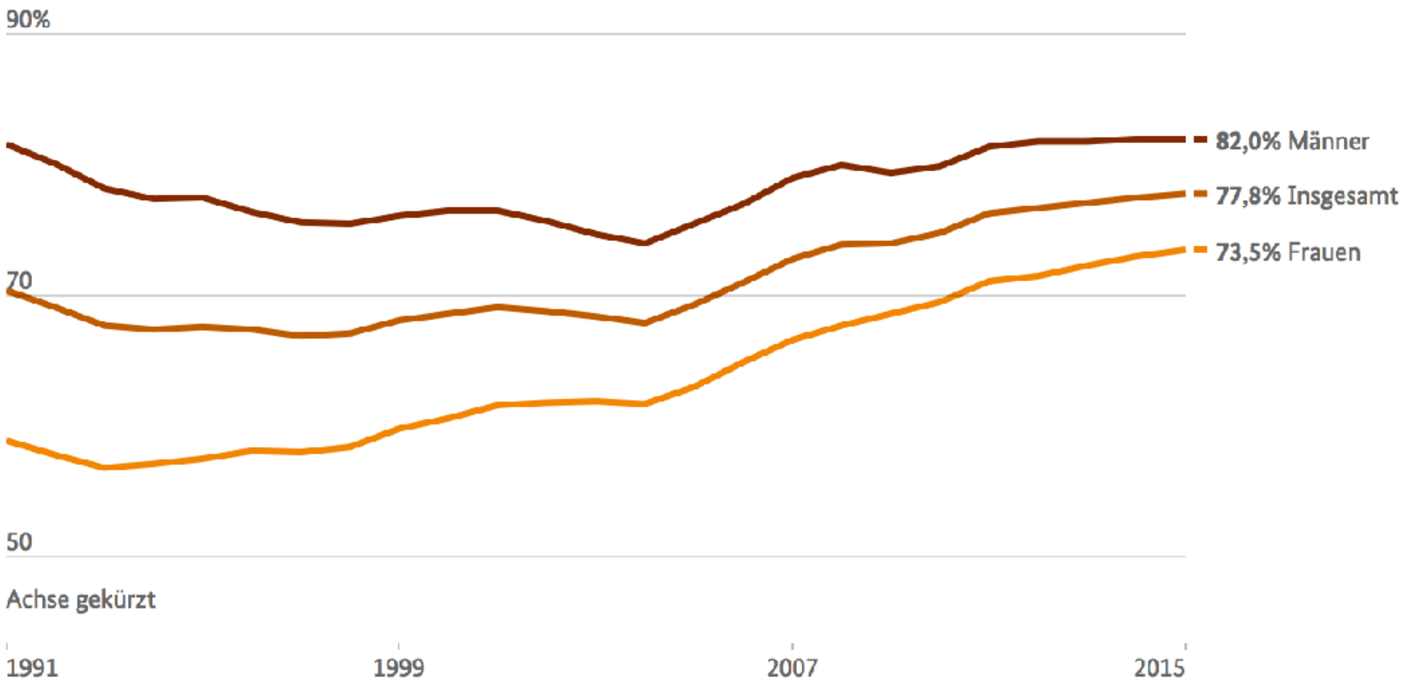
Anzahl atypisch und normal Beschäftigter 1991 bis 2015



Quelle: Statistisches Bundesamt, Ergebnisse des Mikrozensus 2015.

Aktualisierte Daten

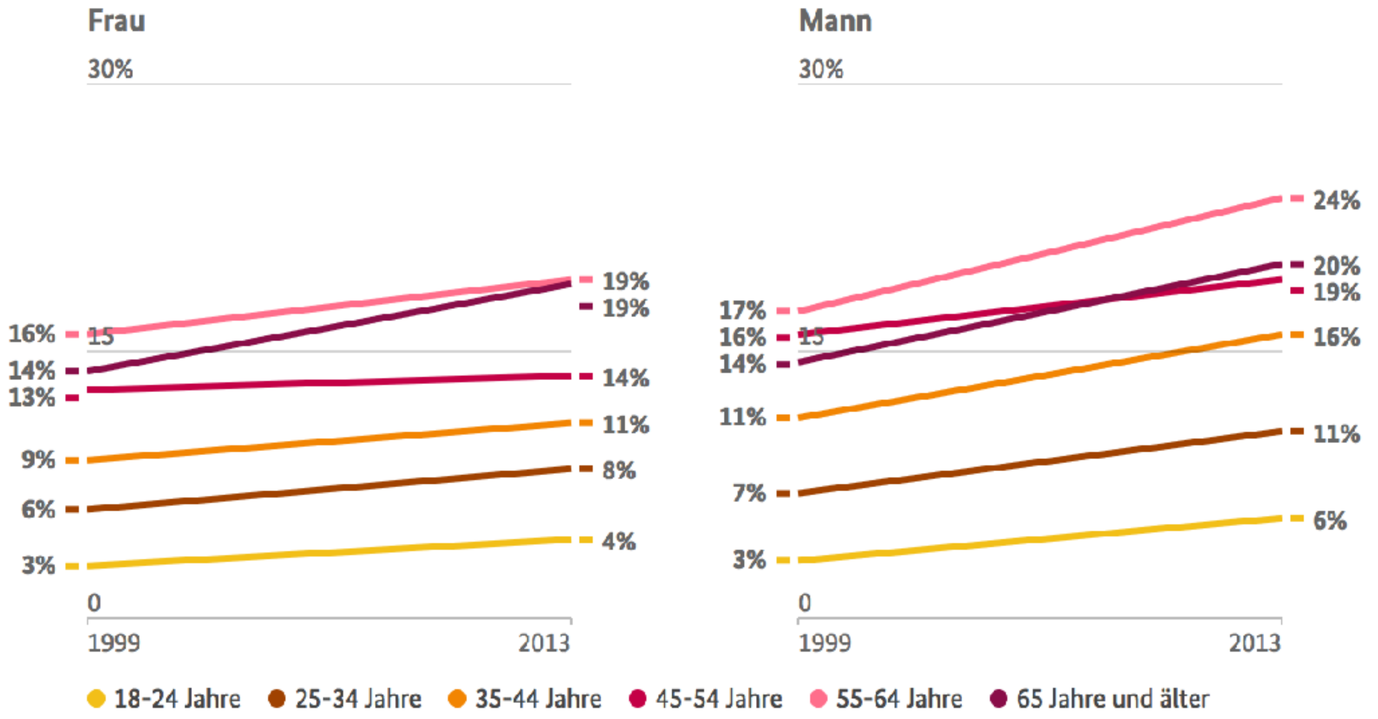
Entwicklung der Erwerbstätigenquote der 20-64-Jährigen nach Geschlecht



Quelle: Statistisches Bundesamt, Ergebnisse des Mikrozensus 2015.

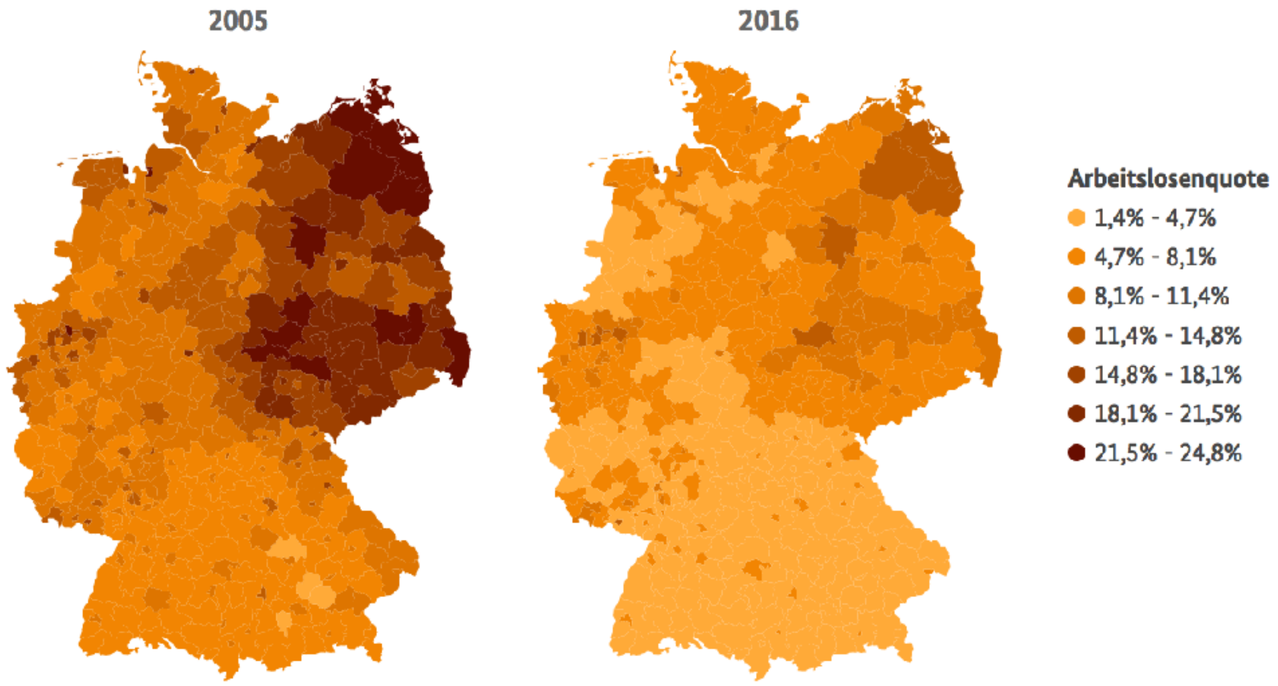
Aktualisierte Daten

Entwicklung des Anteils an Fettleibigen nach Altersgruppen 1999 und 2013

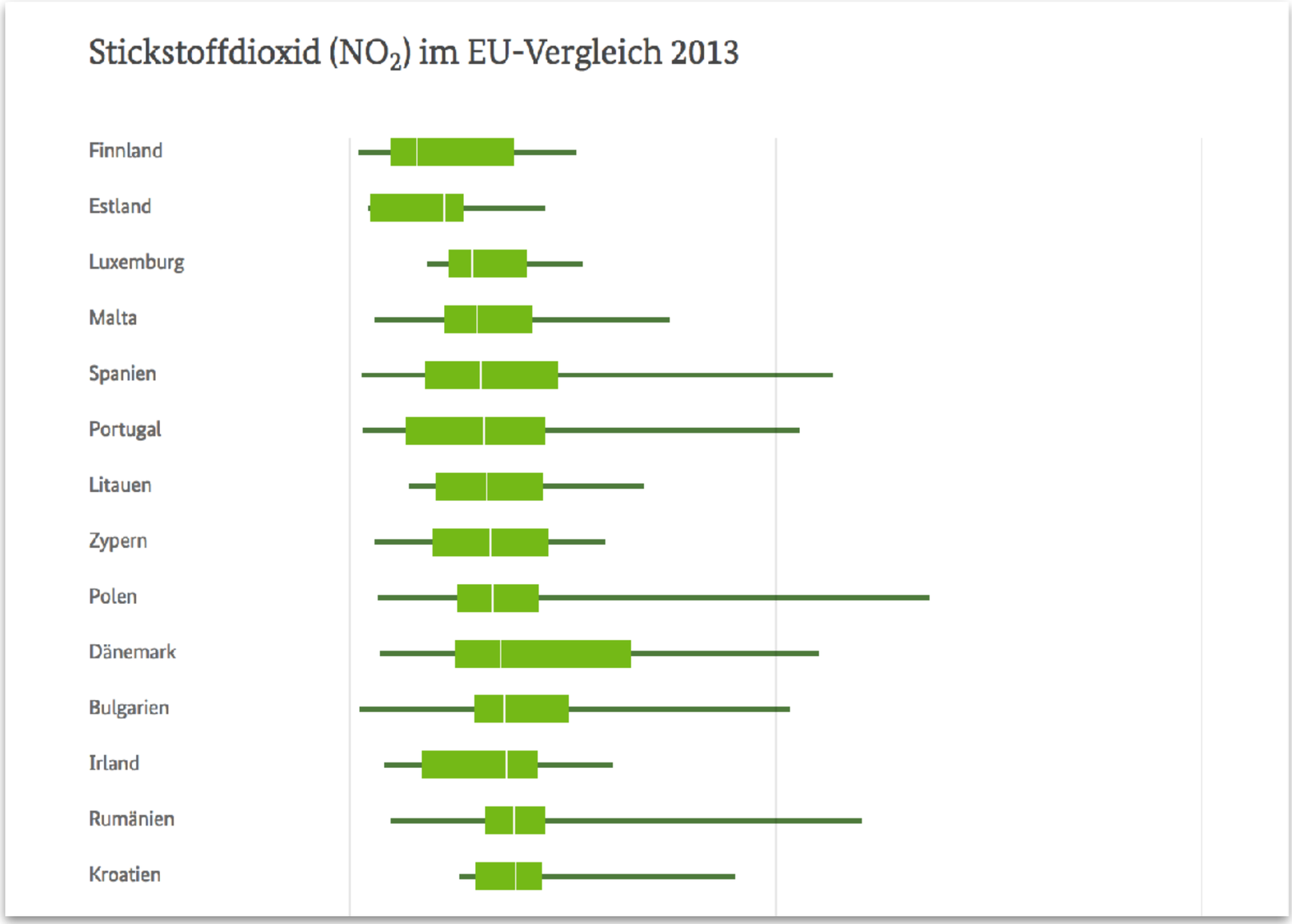


Quelle: Statistisches Bundesamt, Mikrozensus, eigene Berechnungen.

Regionale Verteilung der Arbeitslosigkeit in Deutschland auf Kreisebene 2005 und 2016



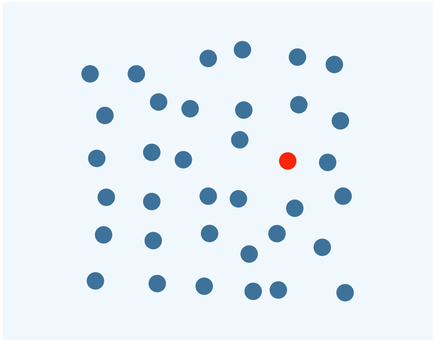
Quelle: Laufende Raumbeobachtung des BBSR, Bundesagentur für Arbeit.
Geometrische Grundlage: © GeoBasis-DE / BKG 2016.
Aktualisierte Daten



Wellbeing in Germany by Interactive Things

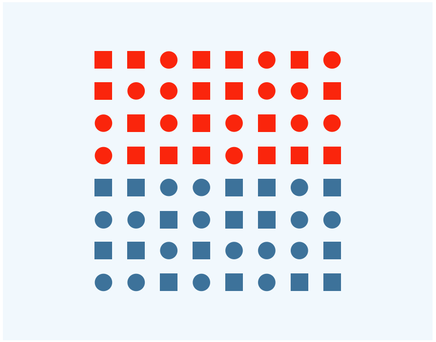
Preattentive Tasks

Target Detection



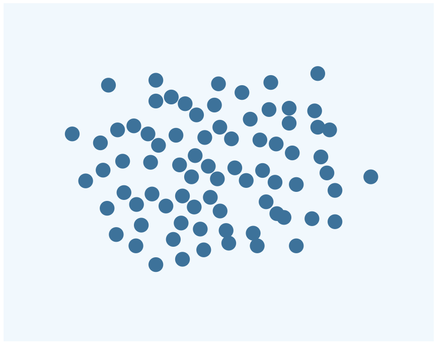
Users rapidly and accurately detect the presence or absence of a "target" element with a unique visual feature within a field of distractor elements.

Boundary Detection



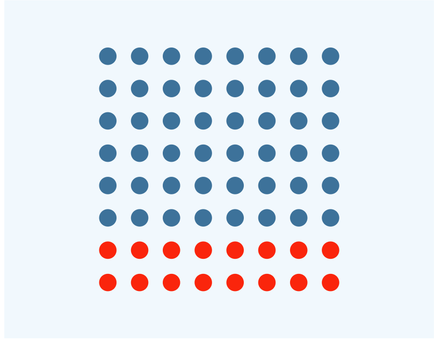
Users rapidly and accurately detect a texture boundary between two groups of elements, where all of the elements in each group have a common visual property.

Region Tracking



Users track one or more elements with a unique visual feature as they move in time and space.

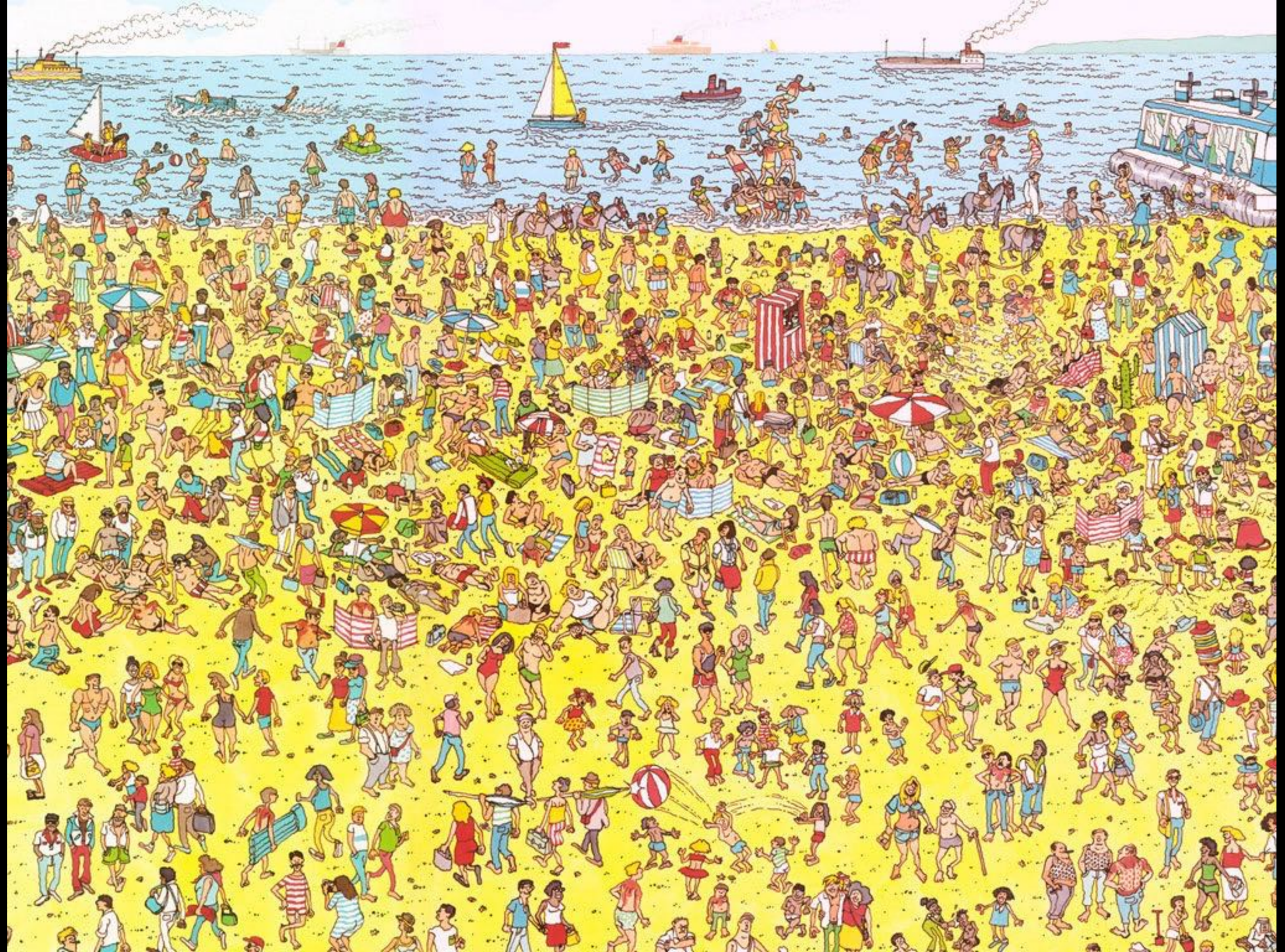
Counting & Estimation



Users count or estimate the number of elements with a unique visual feature.

Where are the highest values located?

Jacques Bertin (1983), Semiology of Graphics



Preattentive Processing: What is it good for?

1. Certain tasks that depend on preattentive features can sometimes be done for free by our brains.

2. The low-level visual system can be harnessed during visualization to draw attention to areas of potential interest in a display.

3. The more of our visualization we can tell using preattentive features, the faster and better our viewer will get it.

Gestalt Principles: What is it?

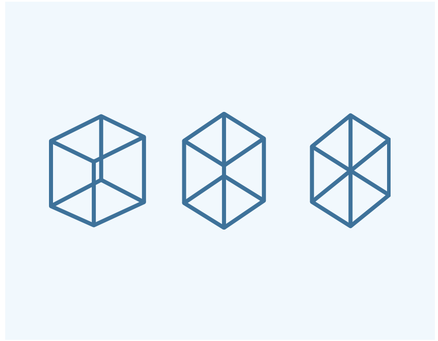
- Our brain is optimized for higher-level constructs.
  Our perception operates less on individual visual features like points, lines, and areas.

- Gestalt is the interplay between the parts and the whole.
  The whole is “other” than the sum of its parts.
  —Kurt Koffka

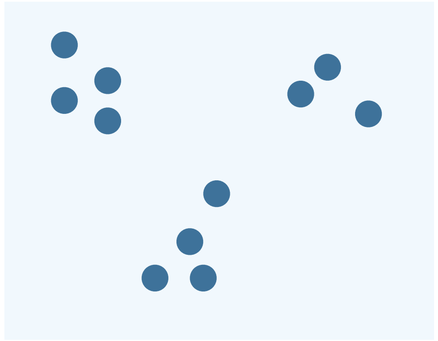
- Gestalt Principles are heuristics.
  Our brain uses them to make sense of the world around us.

Gestalt Principles

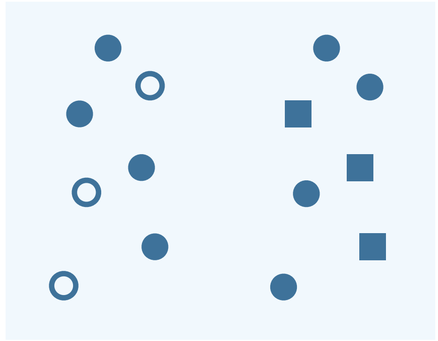
Simplicity



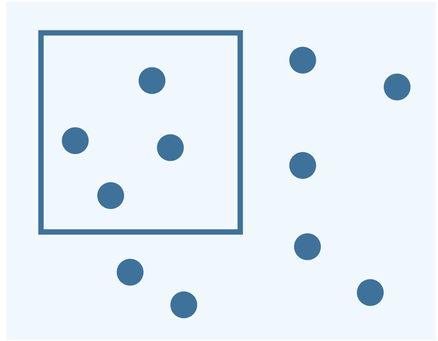
Proximity



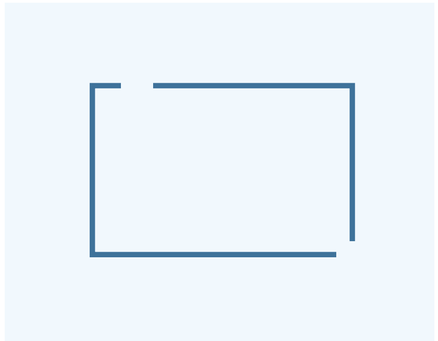
Similarity



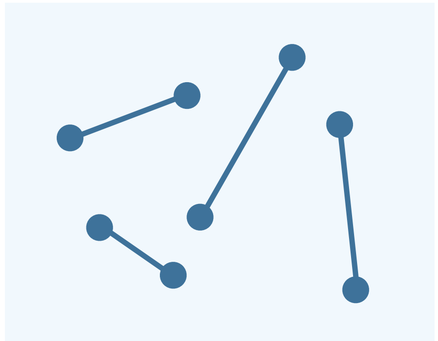
Enclosure



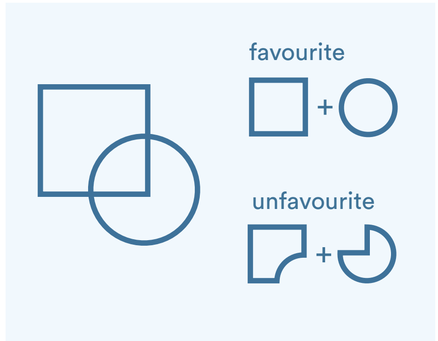
Closure



Connection



Continuity



Familiarity

http://www.interaction-design.org/encyclopedia/data_visualization_for_human_perception.html

Gestalt Principles: What is it good for?

1. Our brains has the incredible ability to take lots of perceptual shortcuts when confronted with a stimuli.

2. We need to consider these potentially taken shortcuts as they can either help or harm our visualizations.

User Empathy

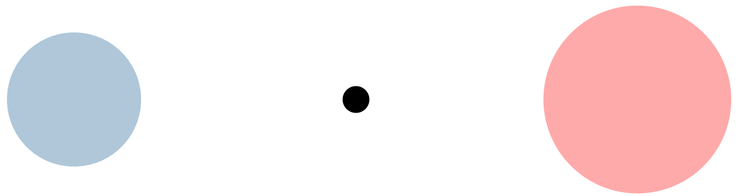
Audience Questionnaire

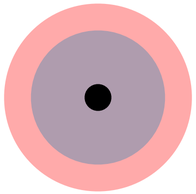
- Who is the target audience and what is their relationship to my data?
- In which context will the audience receive the information I present?
- What information does the audience need to be successful?
- How much detail does the audience need to see or has time for?
- What learned or cultural assumptions might the audience have?
- What key message or insights should the audience take away?
- ...

2.3

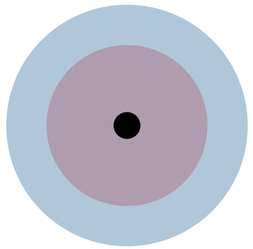
Graphical Encoding

How can we turn data into graphics?

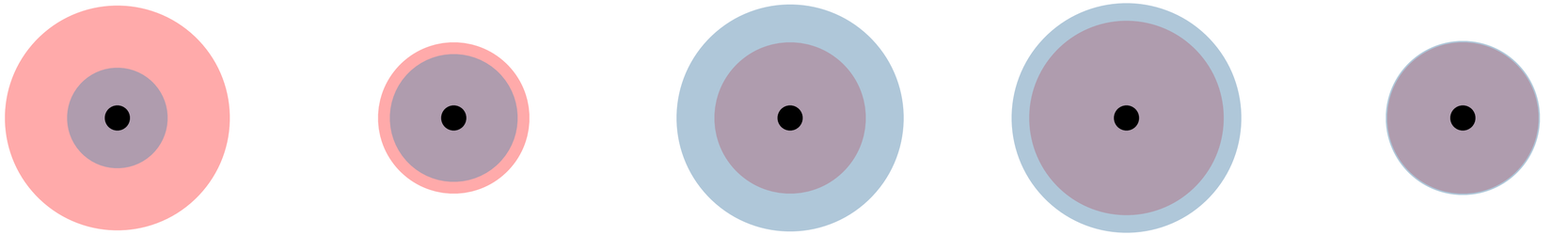

Billable
Unbillable

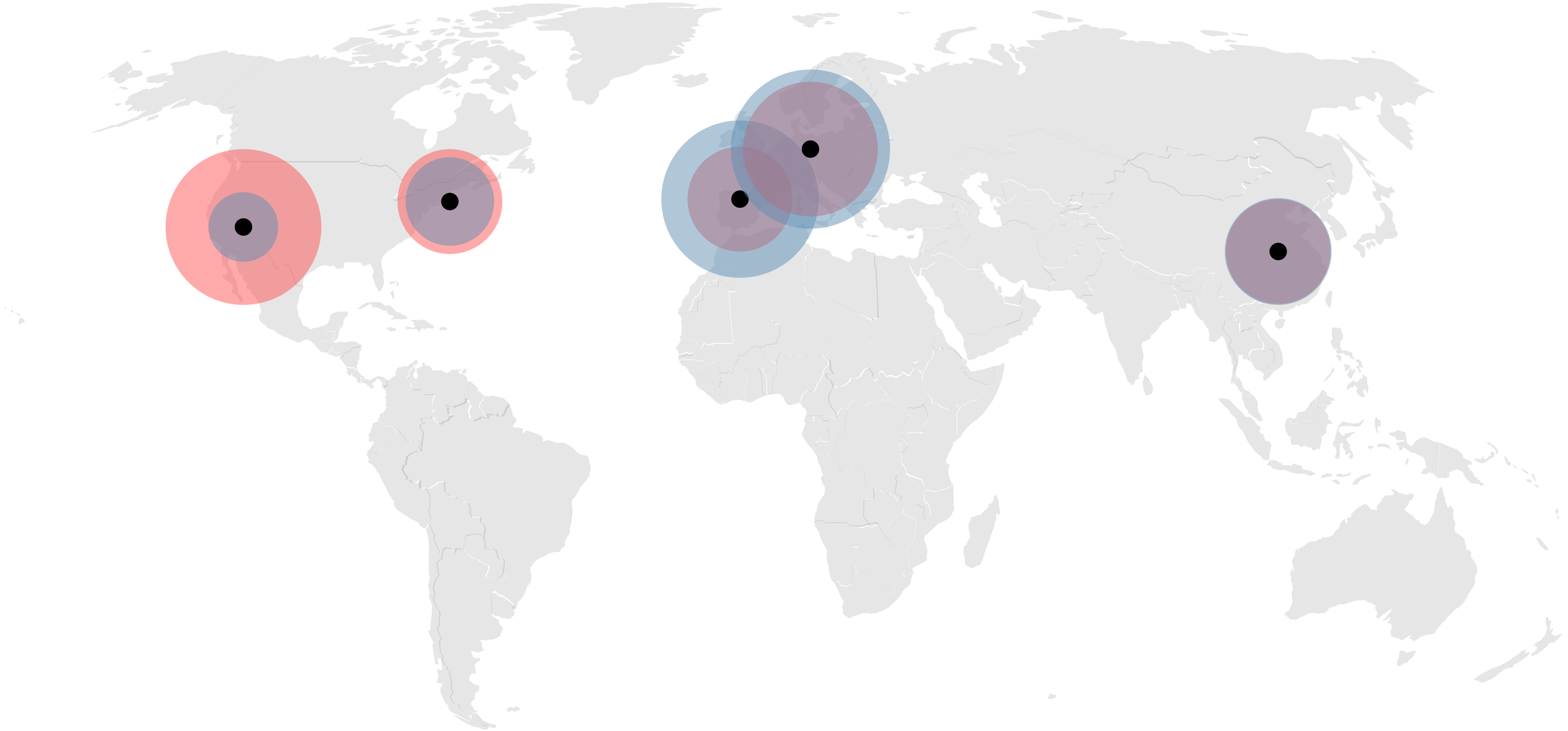


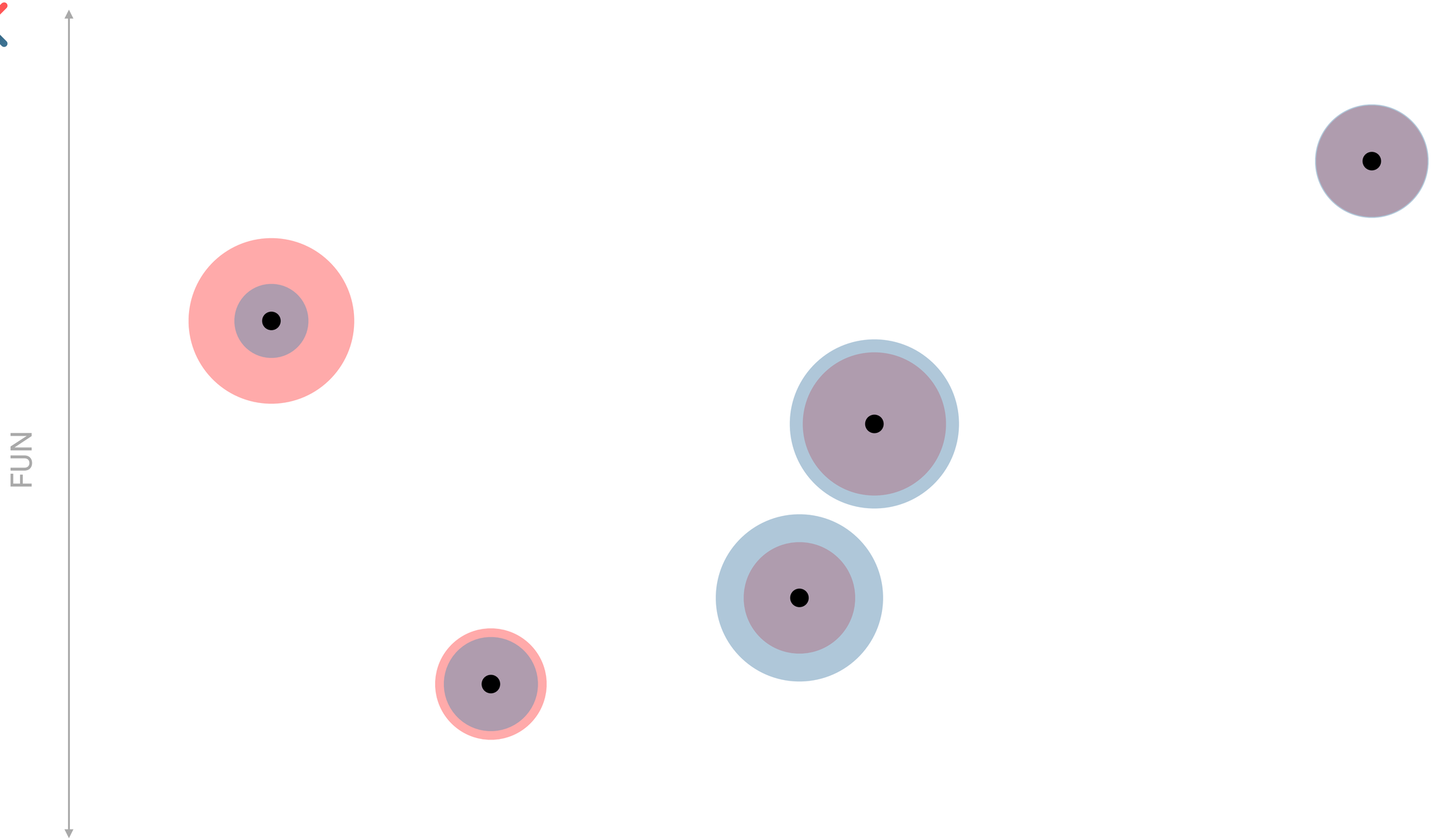
Loss

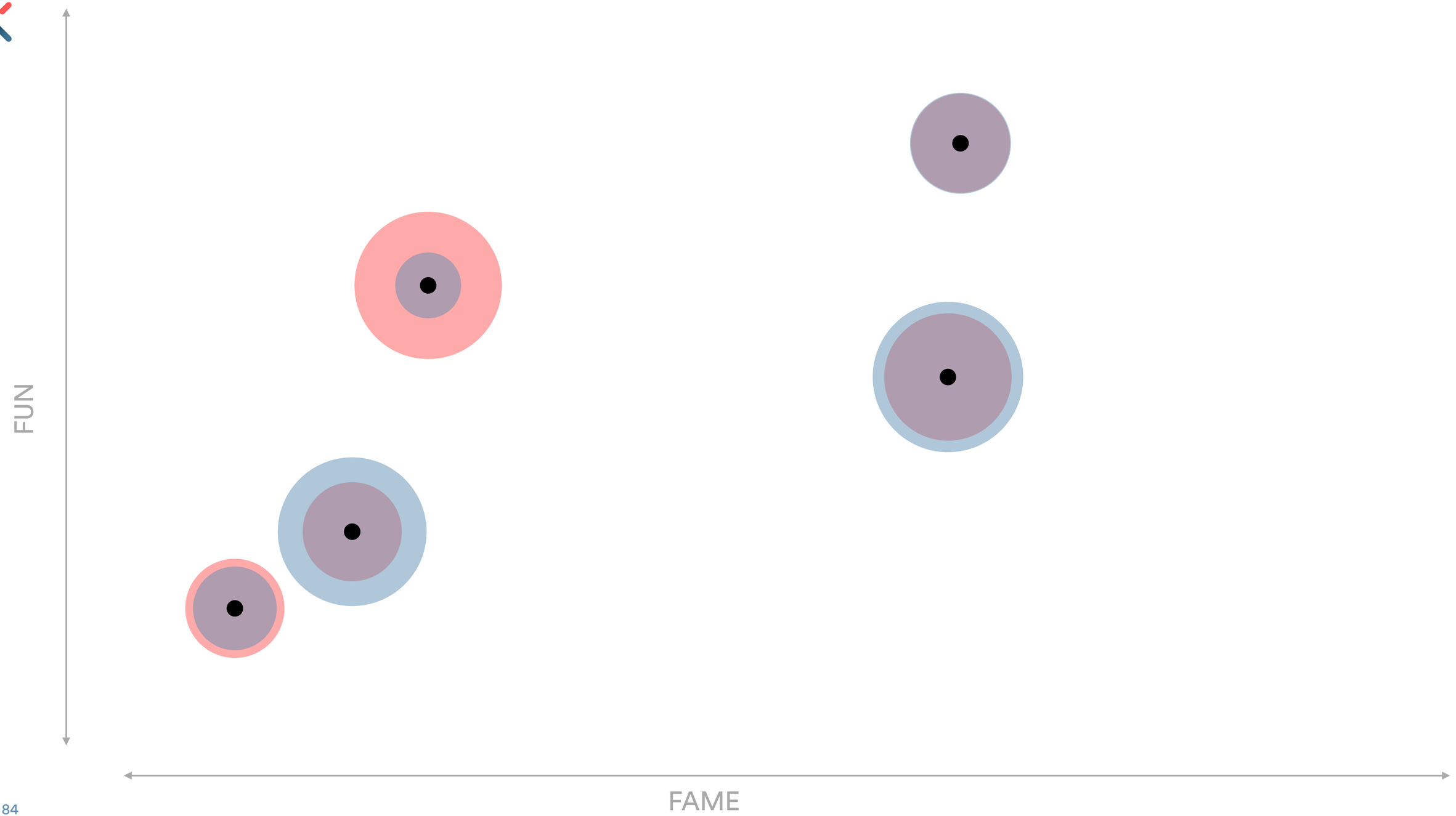


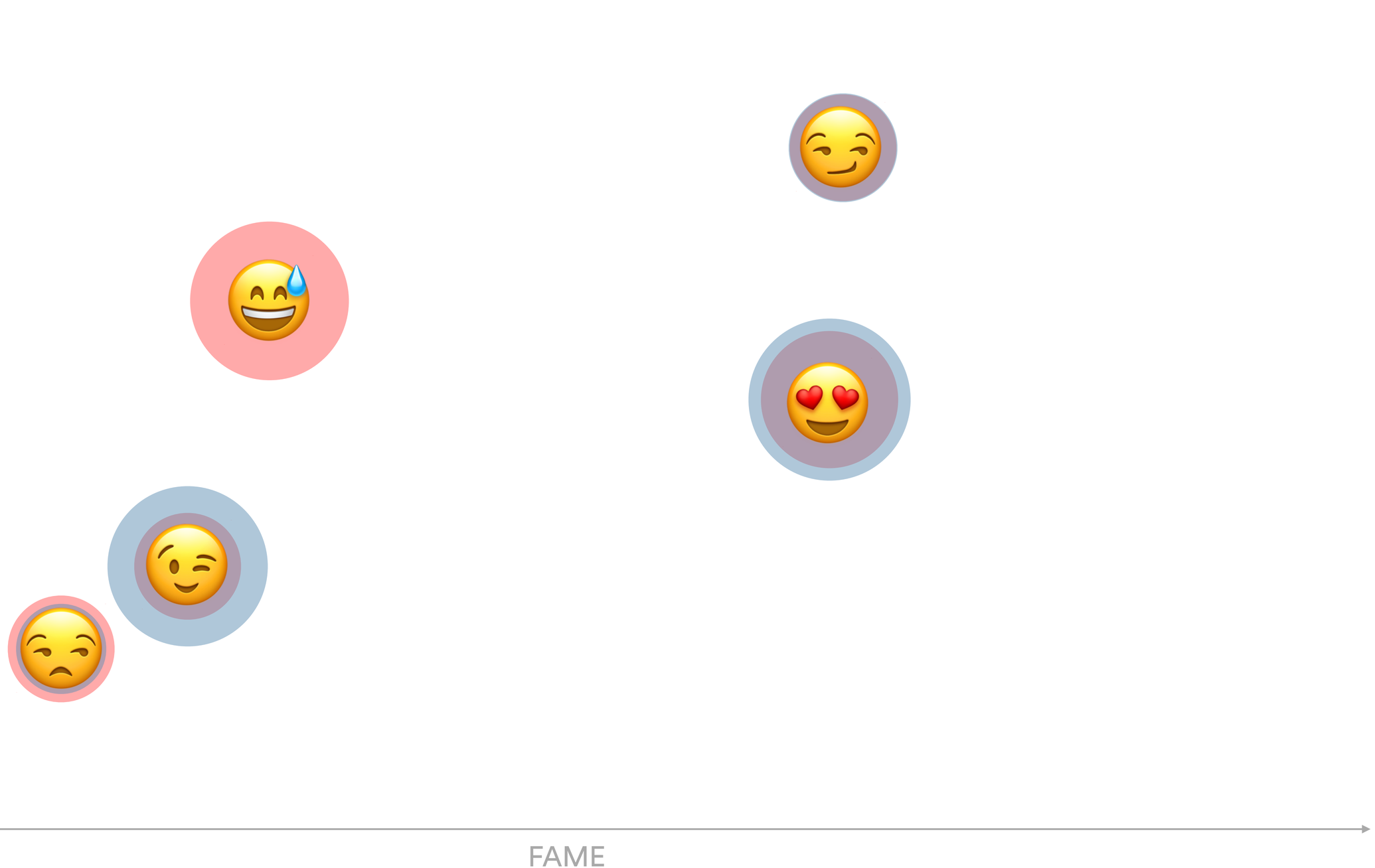
Profit

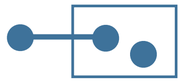

Project–1
Project–2
Project–3
Project–4
Project–5




FUN

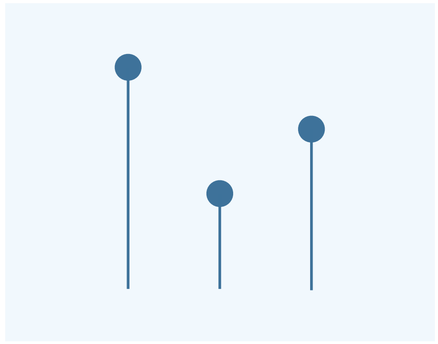

FUN
FAME


FUN
FAME

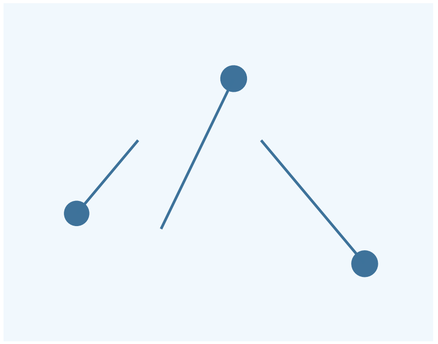
Example	Visual Variable	Ordered	Useful Values	Quantitative	Ordinal	Categorical	Relational
	Position, Placement	✓	Infinite	✓	✓	✓	✓
1, 3, 4; A, B, C	Text Labels	Alphabetical or Numerical	Infinite	✓	✓	✓	✓
	Length	✓	Many	✓	✓	✗	✗
	Size, Area	✓	Many	✓	✓	✗	✗
	Angle	✓	Medium	✓	✓	✗	✗
	Pattern Density	✓	Few	✓	✓	✗	✗
	Weight, Boldness	✓	Few	✗	✓	✗	✗
	Saturation, Brightness	✓	Few	✗	✓	✗	✗
	Color Hue	✓	Few	✗	✗	✓	✗
	Shape, Icon		Medium	✗	✗	✓	✗
	Pattern Texture		Medium	✗	✗	✓	✗
	Enclosure, Connection		Infinite	✗	✗	✓	✓
	Line Pattern		Few	✗	✗	✗	✓
	Line Ending		Few	✗	✗	✗	✓

Accuracy of Quantitative Perceptual Tasks

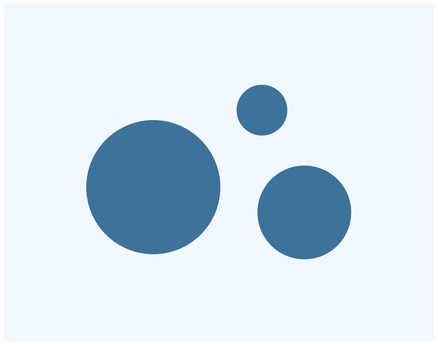
Position



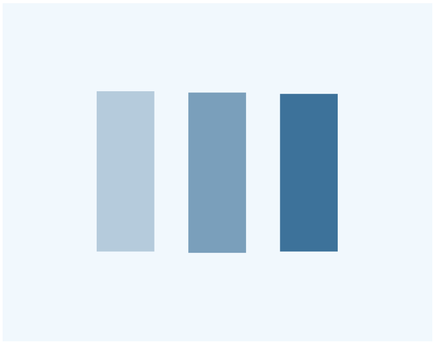
Direction



Area



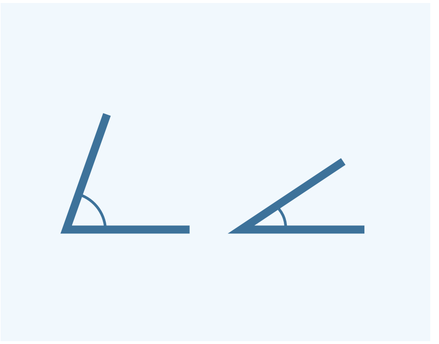
Shading



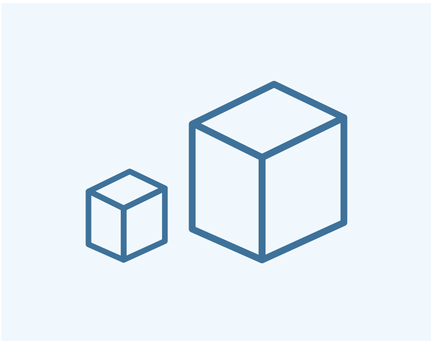
More accurate ← → Less accurate

Length

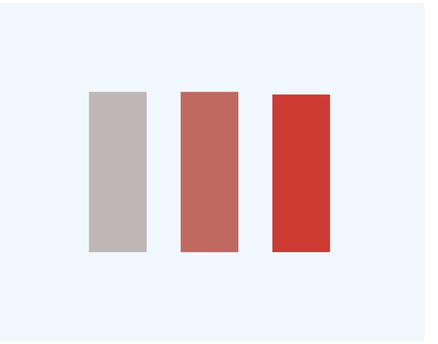
Angle



Volume



Saturation



Alberto Cairo (2013), The Functional Art

Best Practices for Encoding

1. Importance

Encode the most important property of the data in the most effective way.

2. Consistency

Encode the property of the data accurately with the property of the representation.

3. Redundancy

Avoid using more than one encoding to communicate the same information.

4. Independence

Avoid using visually similar encodings for independent variables.

Exercise

Encoding Two (yes, two) Values

Tools: Pen & Paper

Duration: 10 Minutes

Encoding Two Values

- Find different ways to visualize 75 and 37.
- The visualization will depend directly on the unit, meaning, and context of the values.
- You have 10 minutes to come up with 5 ideas.
- Let’s go!

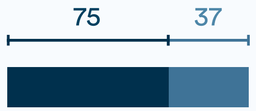
Number Notation

75, 37

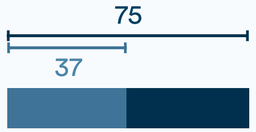
Bars

Percentages Bars

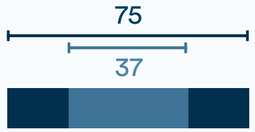
Spliced Bar



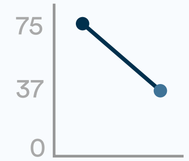
Proportion



Interval



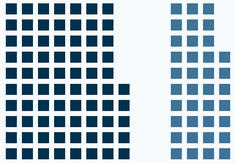
Line Graph



Tens and Units

Squares Merged

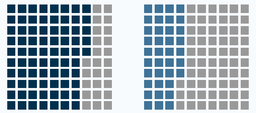
Squares



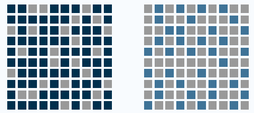
Icon Surfaces

Icon Height

Number Notation



Percentages / Density



Horizontal/Vertical Proportions

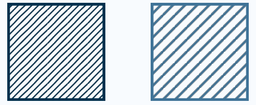
Geometric Proportions

Color Scale

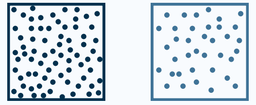
Nodes and Connections

Gray Tones

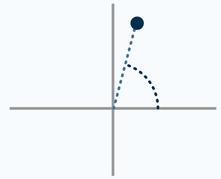
Dashed



Density



Coordinates



Angles

Semi-circle Areas

Pie Chart

Donut Chart

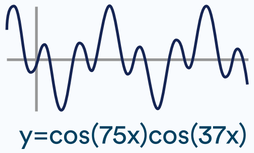
Circle and External Ring

Co-centered Circles

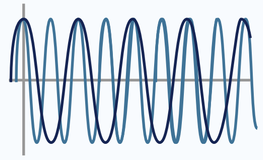
Shape Surfaces

Different Shape Surfaces

Parameters of a Mathematical Function



Harmonic Frequencies

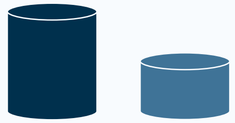


Special Metaphors

Shape Divided

Square Divided

Volumes



Values Associated to Countries

Geographic Coordinates

Square Surfaces

Circle Areas

Santiago Ortiz (2012), 45 Ways to Communicate Two Quantities, http://ixt.gs/19mK3aT

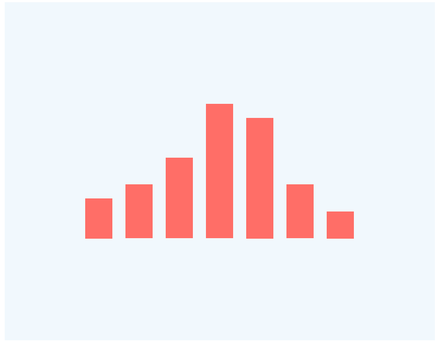
2.4

Graphical Methods

How to pick the right chart, graph, or diagram.

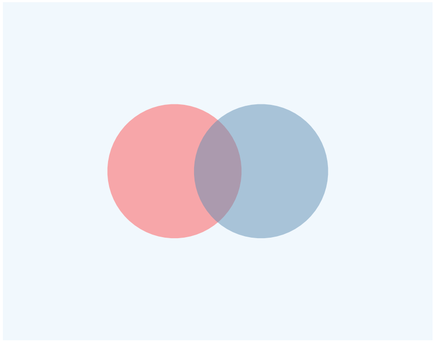
Taxonomy

Chart



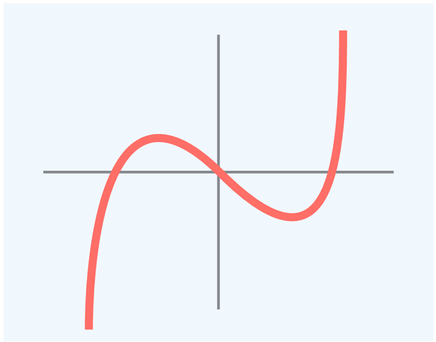
A chart represents tabular numeric data with marks like bar charts, line charts, pie charts or histograms.

Diagram



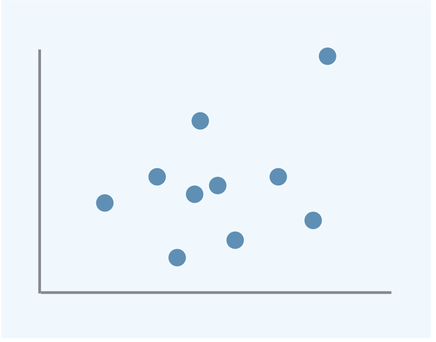
A diagram is a symbolic representation of data like a venn diagram, flow diagram, or organigram.

Graph



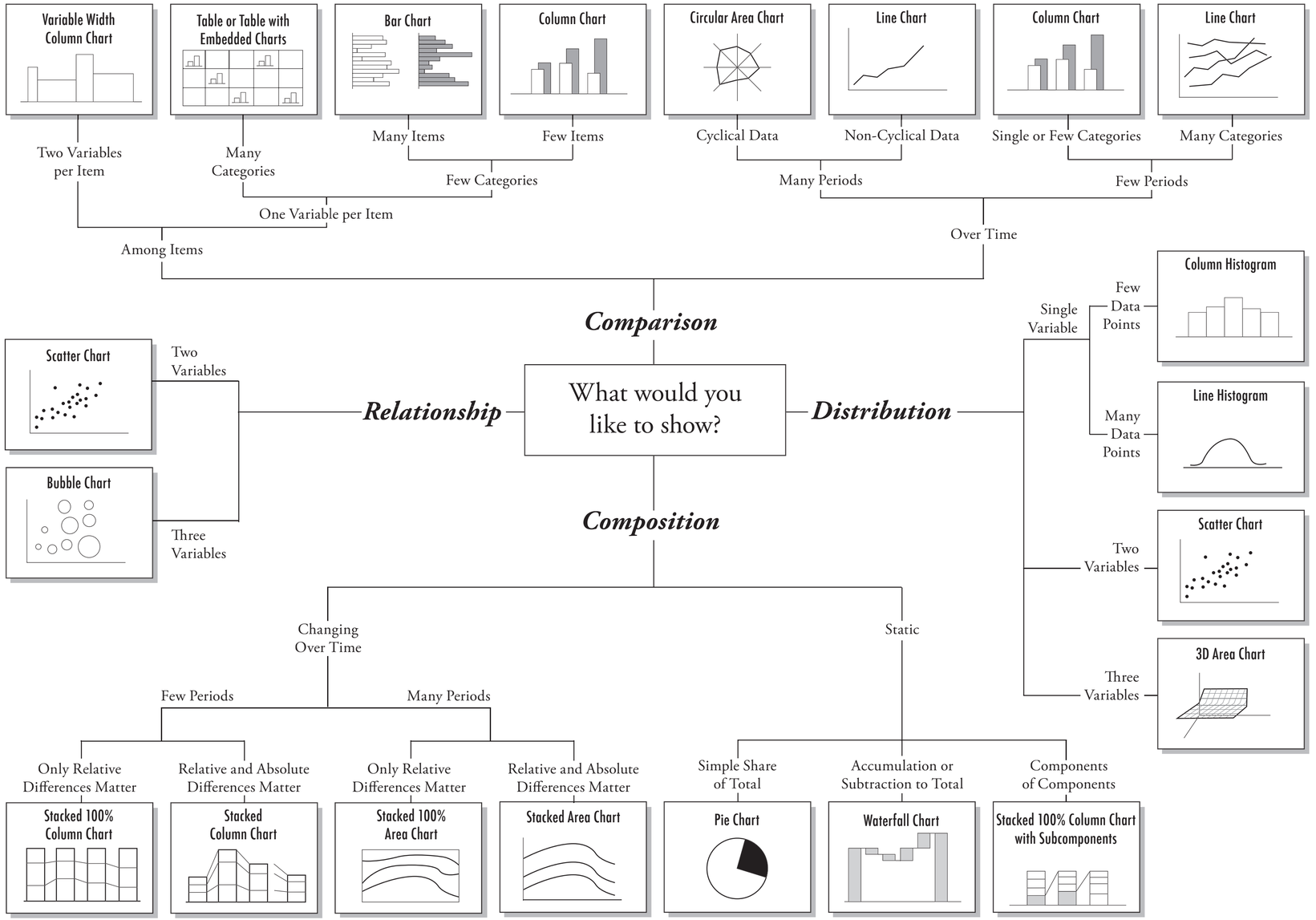
A graph is a visual representation of a mathematical function in 2d or 3d.

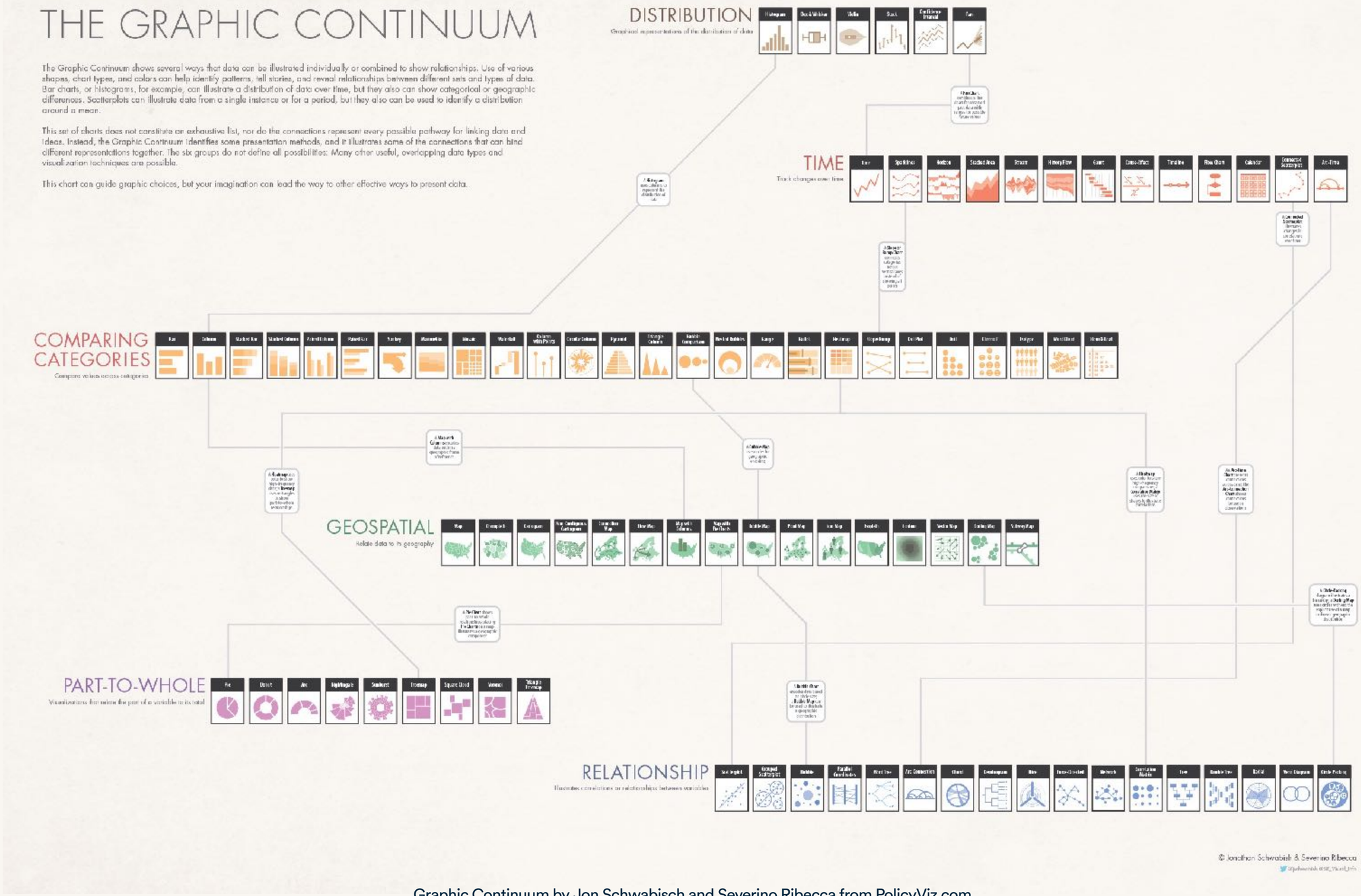
Plot



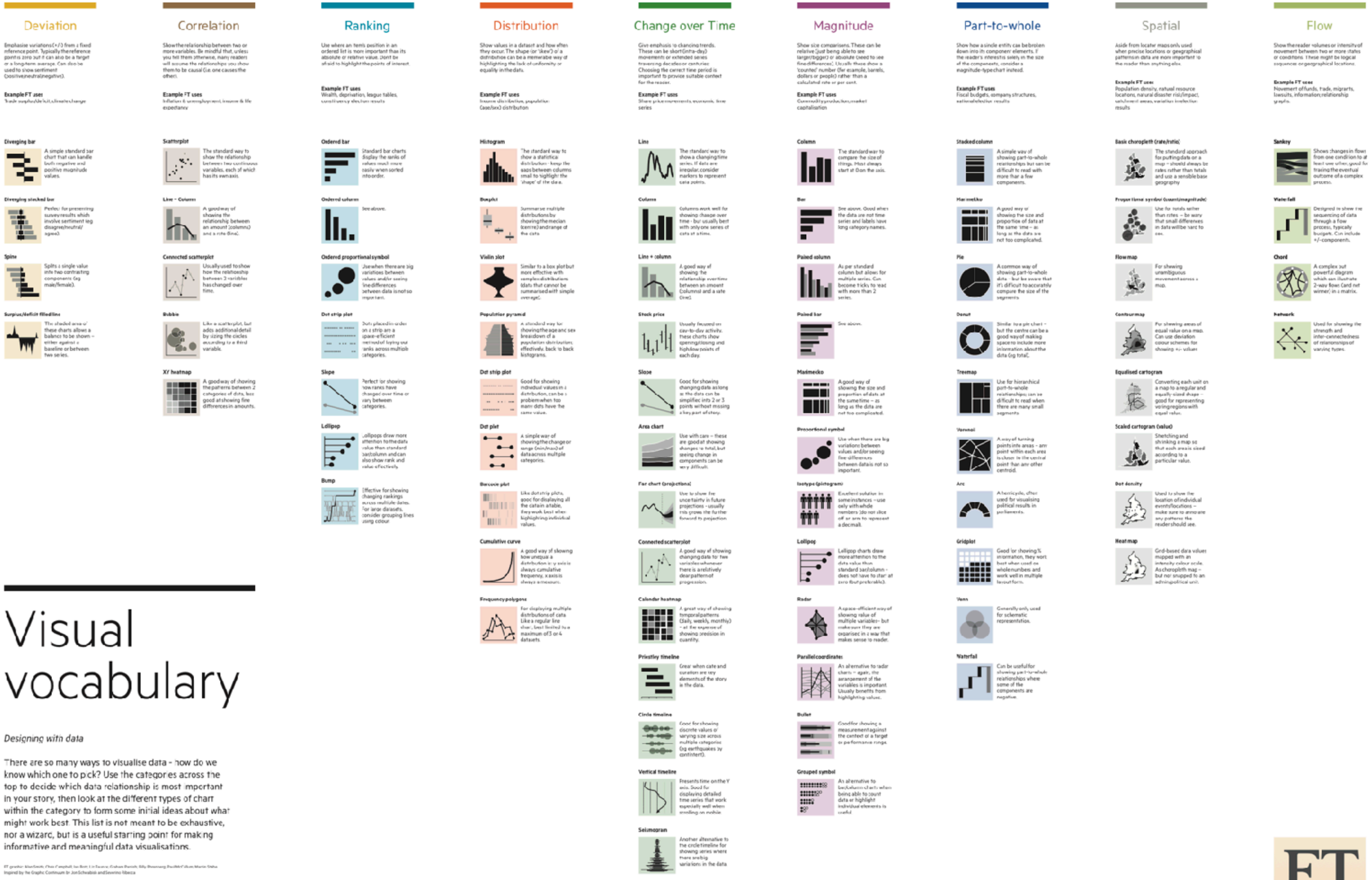
A plot represents the relationship between two or more variables like a scatter plot, box plot, or carpet plot.

Chart Suggestions—A Thought-Starter





Graphic Continuum by Jon Schwabisch and Severino Ribecca from PolicyViz.com



Visual vocabulary

Designing with data

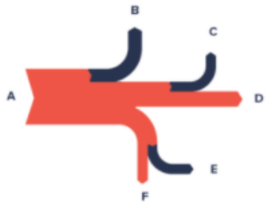
There are so many ways to visualise data - how do we know which one to pick? Use the categories across the top to decide which data relationship is most important in your story, then look at the different types of chart within the category to form some initial ideas about what might work best. This list is not meant to be exhaustive, nor a wizard, but is a useful starting point for making informative and meaningful data visualisations.

FT graphic: Alan Smith, Chris Campbell, Ian Bott, Liz Faunce, Graham Parrish, Billy Ehrenberg, Paul McCallum, Martin Stabe
Inspired by the Graphic Continuum by Jon Schwabish and Severino Ribecca

ft.com/vocabulary

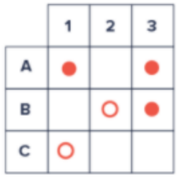
Visual Vocabulary by Alan Smith from Financial Times

Sankey Diagram

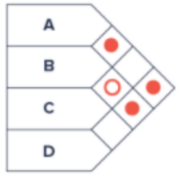


Alluvial Diagram

Matrix Diagram

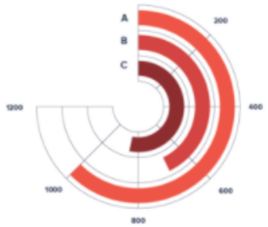


Matrix Diagram (Roof Shaped)



Donut Chart

Radial Bar Chart



Radial Histogram

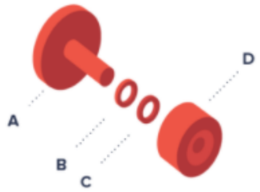
Sorted Stream Graph

Fishbone Diagram

Isoline Map

Pictorial fraction chart

Exploded View Drawing



Arc Diagram

Flow Map

Hive Plot

Word Cloud

Violin Plot

Hexagonal Binning

Pictorial Stacked Chart

Sunburst Diagram

Many Thanks!

Don’t hesitate to get in touch.

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