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Northeastern University

TASKS, ENCODINGS

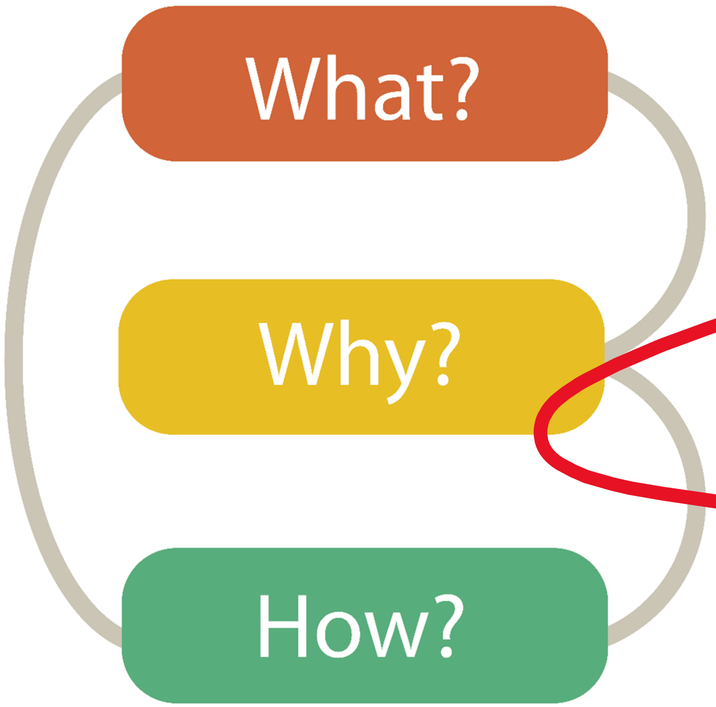
Checking In

Task Abstraction

Goals for Today

- Learn what task abstraction is
- Practice performing task abstraction

Analysis



What data is shown?

DATA ABSTRACTION

Why is the user analyzing / viewing it?

TASK ABSTRACTION

How is the data presented?

VISUAL ENCODING

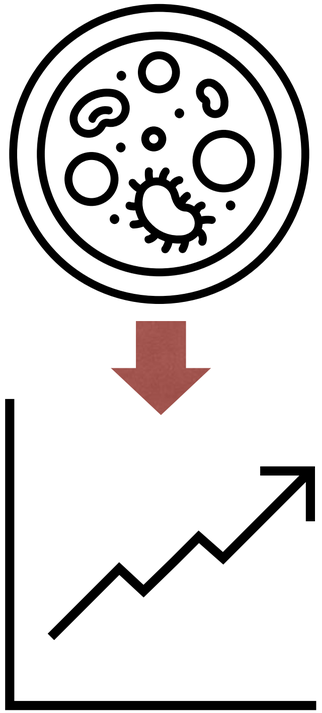
Task Abstraction

What:

The process of taking specific **domain tasks** and thinking about them as **abstract** (modular!) pieces

I need to perform **cellular analysis**.

I need to **compare** measure A to B over time.

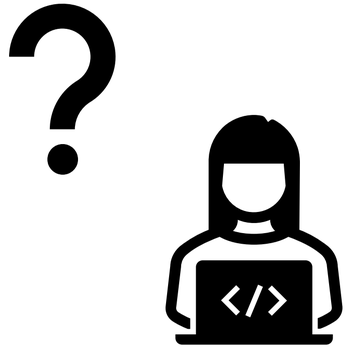


Task Abstraction

Why:

To translate domain specific terms into well-known and transferable visualization tasks.

I need a visualization for performing **cellular analysis**!



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I need a visualization for performing **cellular analysis**!

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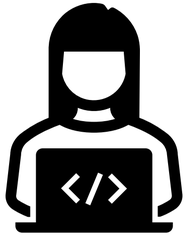
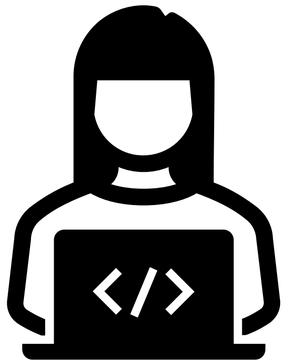




Visualization Tools

Specific *General*

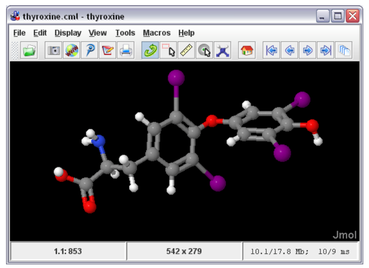
Gephi

Altair

D3

ArcGIS ESRI

tableau



Task Abstraction

High-level

Medium-level

Low-level

Why?

Actions

Analyze

- Consume
  - *Discover*
  - *Present*
  - *Enjoy*
- Produce
  - *Annotate*
  - *Record*
  - *Derive*

Search

	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

Query

- Identify
- Compare
- Summarize

Targets

All Data

- Trends
- Outliers
- Features

Attributes

- One
- Many
  - *Distribution*
  - *Dependency*
  - *Correlation*
  - *Similarity*
  - *Extremes*

Network Data

- Topology
- *Paths*

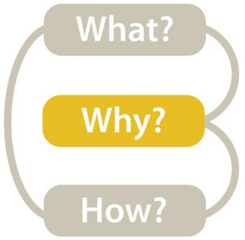
Spatial Data

- Shape

What?

Why?

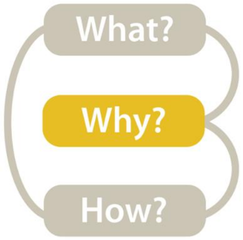
How?



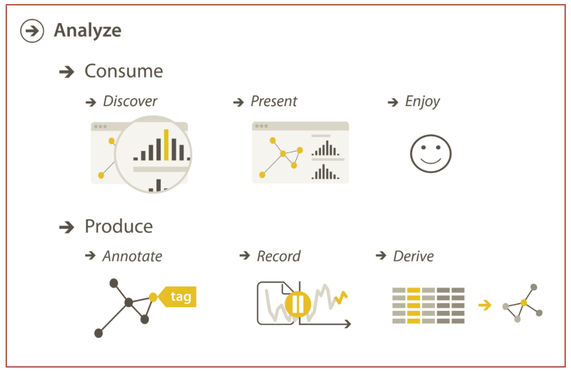
High-level → How is the vis being used to analyze?

- **Analyze**
  - Consume
    - *Discover*
    - *Present*
    - *Enjoy*

  - Produce
    - *Annotate*
    - *Record*
    - *Derive*



High-level → Consume → Discover



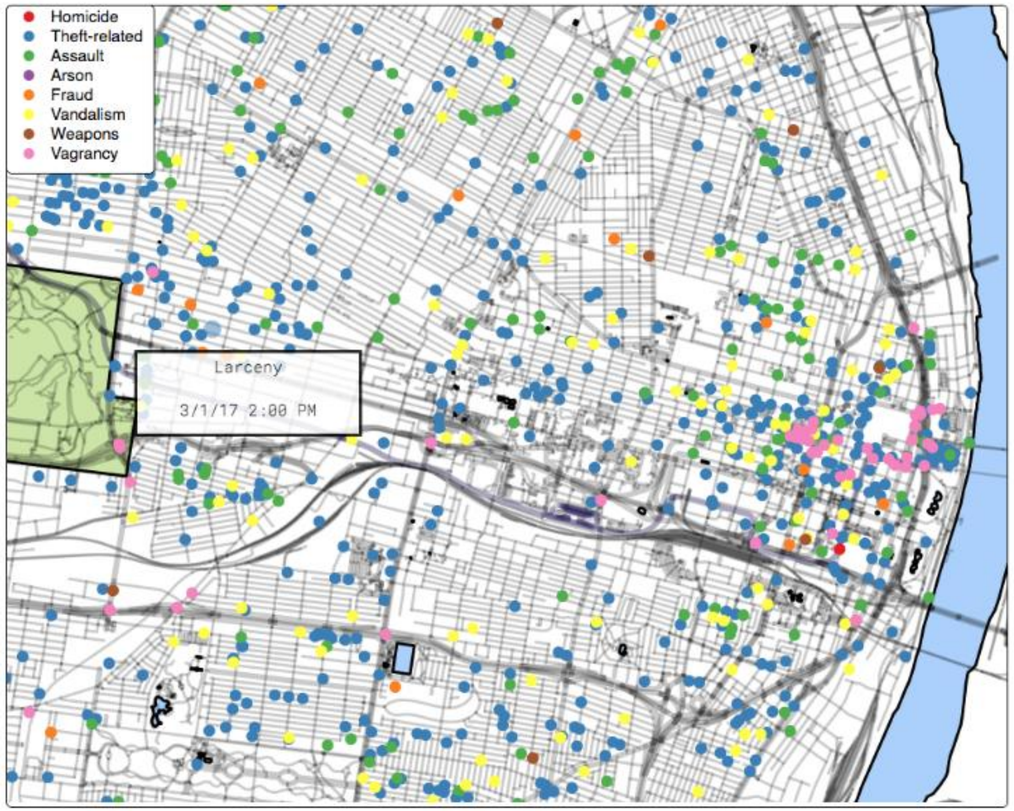


Figure 4: The interface used in our experiment. Participants used their mouse to pan and zoom the map. A tooltip displayed information about the crimes on click.

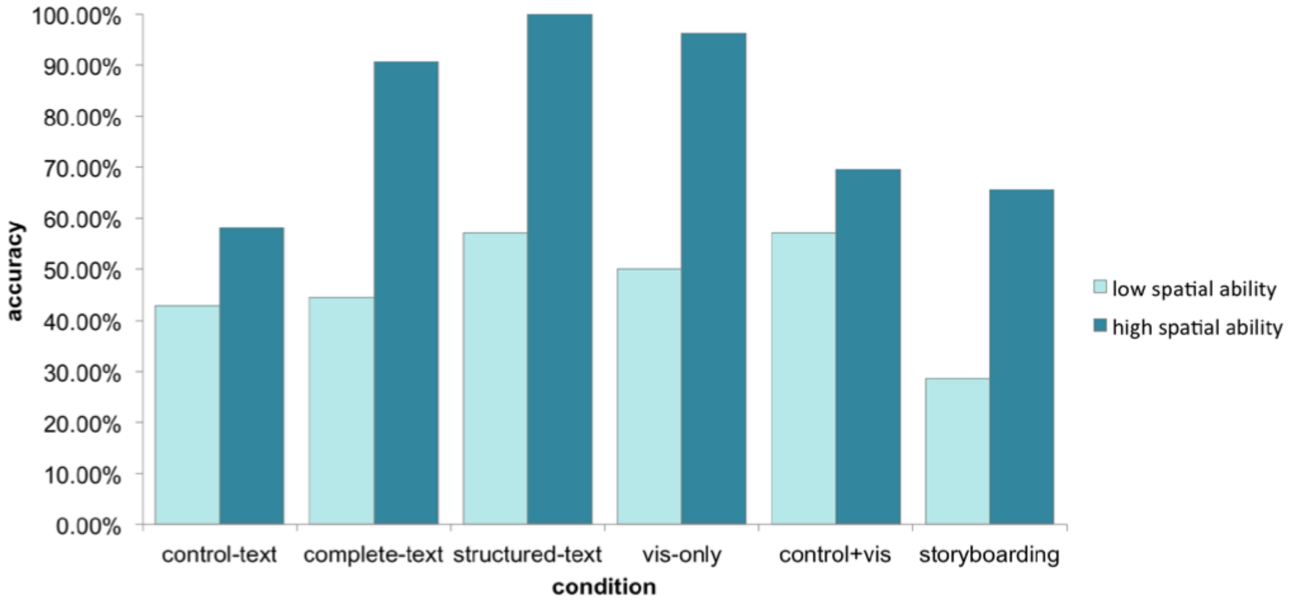
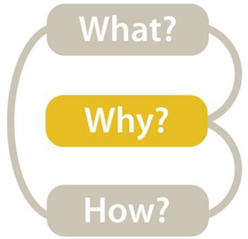
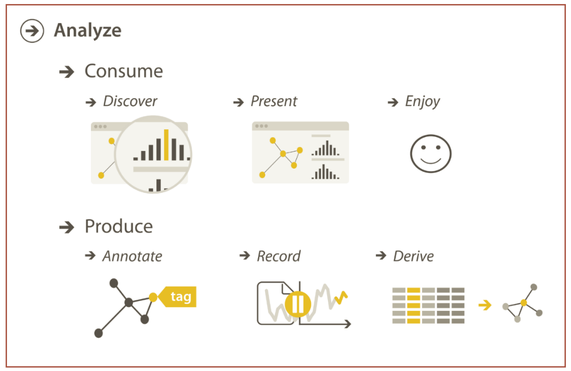


Fig. 3. Average accuracy for the low and high spatial ability groups for each design. Overall, we found that high spatial users were much more likely to correctly answer the question prompts.

Ottley et al. 2016, Ottley et al. 2019



High-level → Consume → Present

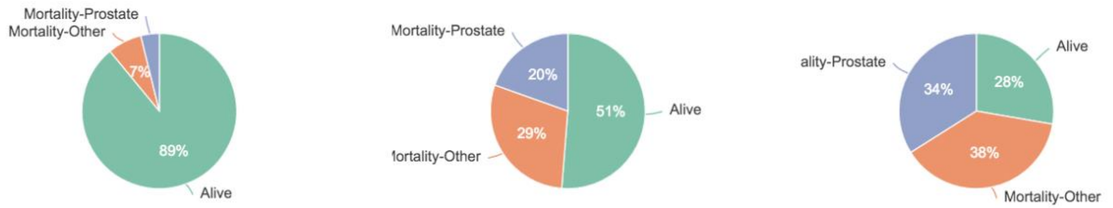


How big of a threat is my prostate cancer?

Before thinking about the benefits of specific treatments, it's helpful to first think about how big of threat your prostate cancer is to your future survival. The pie chart below shows the following:

- Your chances of being **alive** (in GREEN)
- Your chances of dying from your **prostate cancer** (in PURPLE)
- Your chances of dying from **other causes** (in ORANGE)

1 Year (70 years old) | 5 years (74 years old) | 10 Years (79 years old)

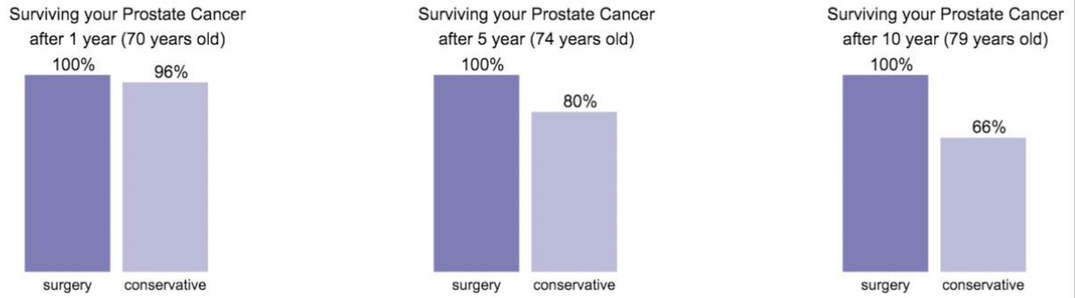


How effective are different treatments for my prostate cancer?

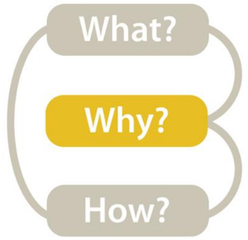
The expected benefits from **surgery** and **conservative management** are listed below.

These results show your estimated chances of either surviving or dying **from your prostate cancer** at 1, 5, and 10 years, depending on whether you choose either surgery (DARK PURPLE BAR) or conservative treatment (LIGHT PURPLE BAR) .

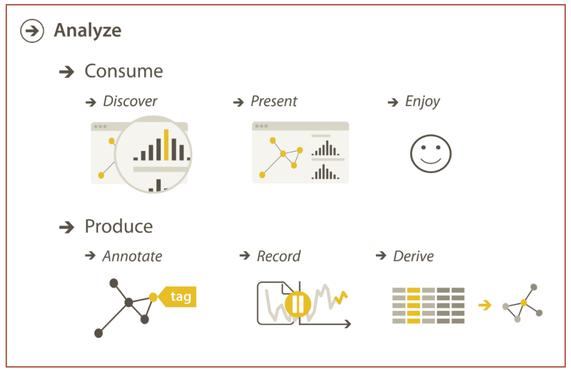
You can view these risks in terms of either survival or mortality.



Hakone et al. 2017



High-level → Consume → Enjoy



NameVoyager: Explore baby names and name trends letter by letter

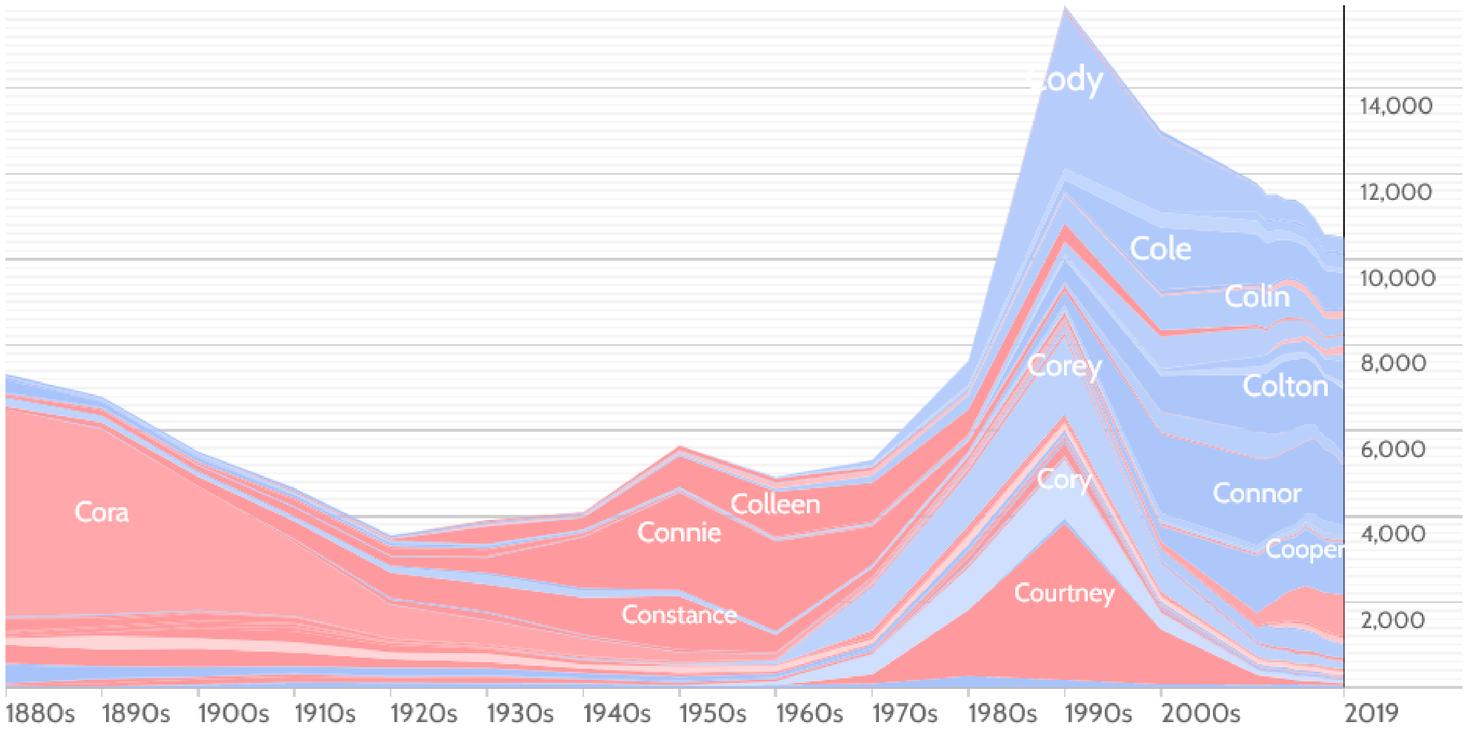
Baby Name > Co Both Boys Girls

boys 1000 500 100 25 1
girls 1000 500 100 25 1

Current rank:

Names starting with 'CO' per million babies

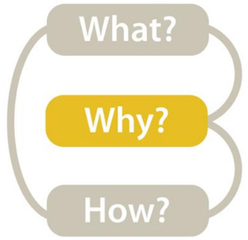
per million births



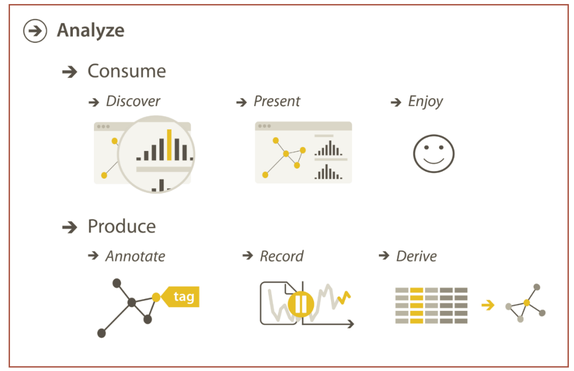
Click a name graph to view that name. Double-click to read more about it.

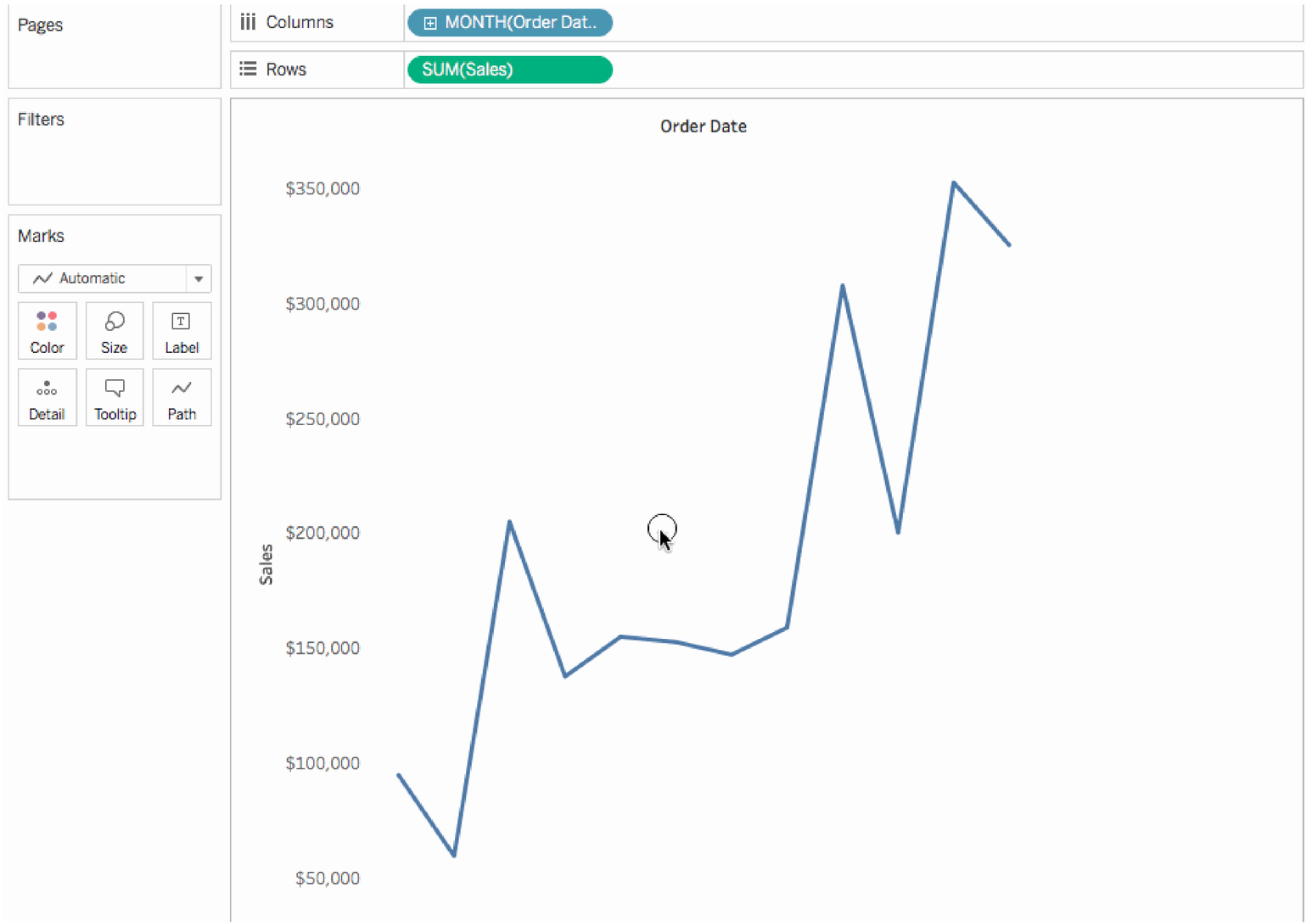
enlarge

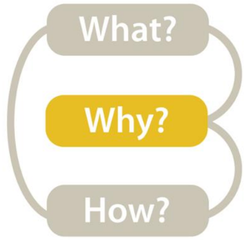
[Baby Name Voyager](#) (interactive Way Back Machine)



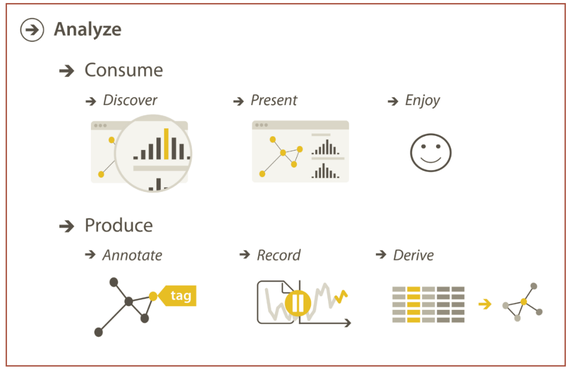
High-level → Produce → Annotate

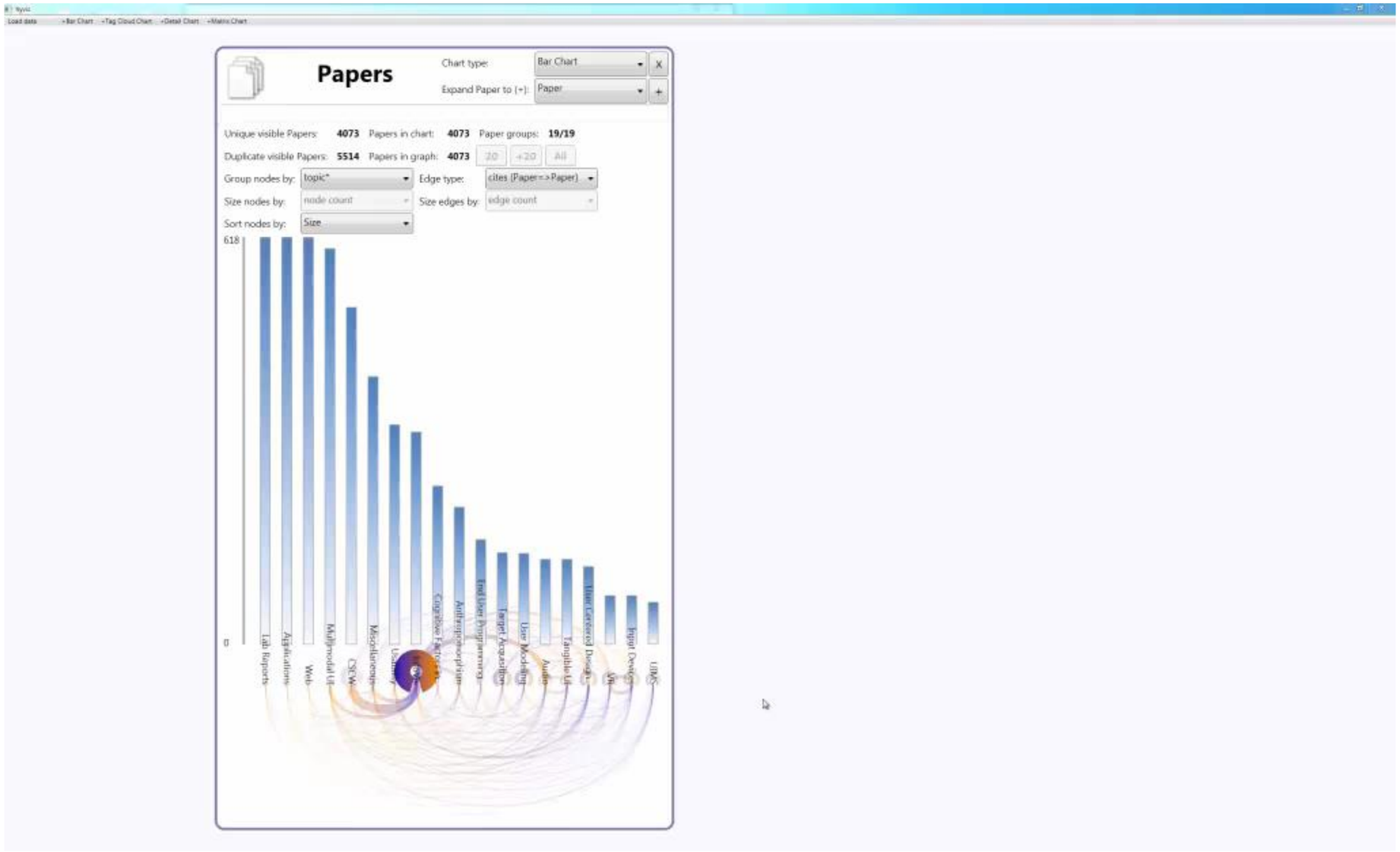


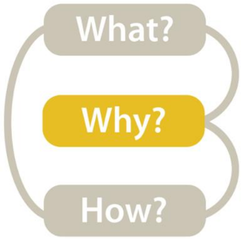




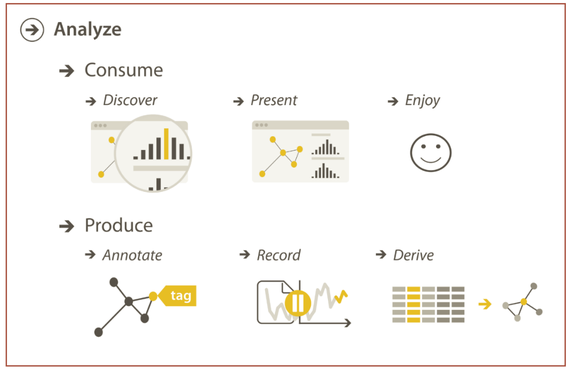
High-level → Produce → Record

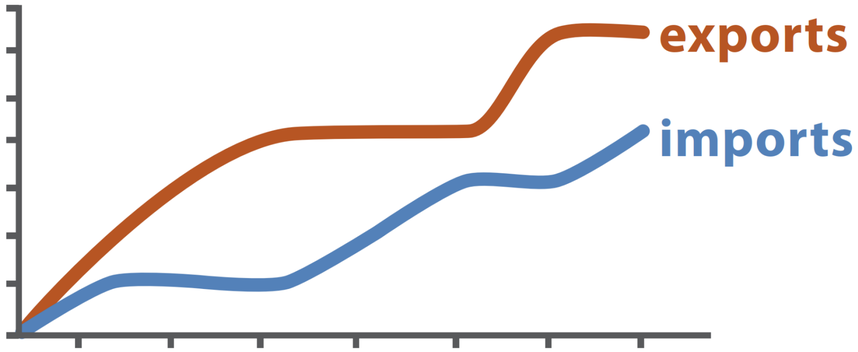




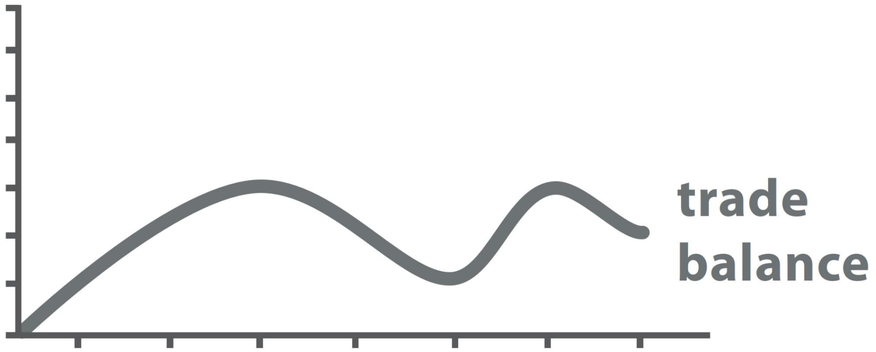


High-level → Produce → Derive



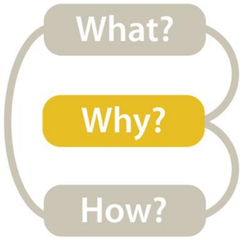


Original Data



trade balance = exports – imports

Derived Data



High-level → How is the vis being used to analyze?

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→ *Record*

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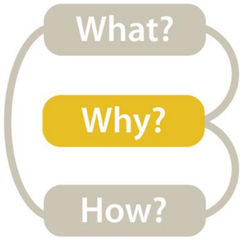

Mid-level → What type of search is required for the high-level action?

Analyze

- Consume
  - *Discover*
  - *Present*
  - *Enjoy*
- Produce
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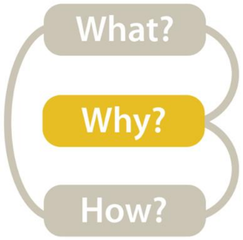
  - *Derive*

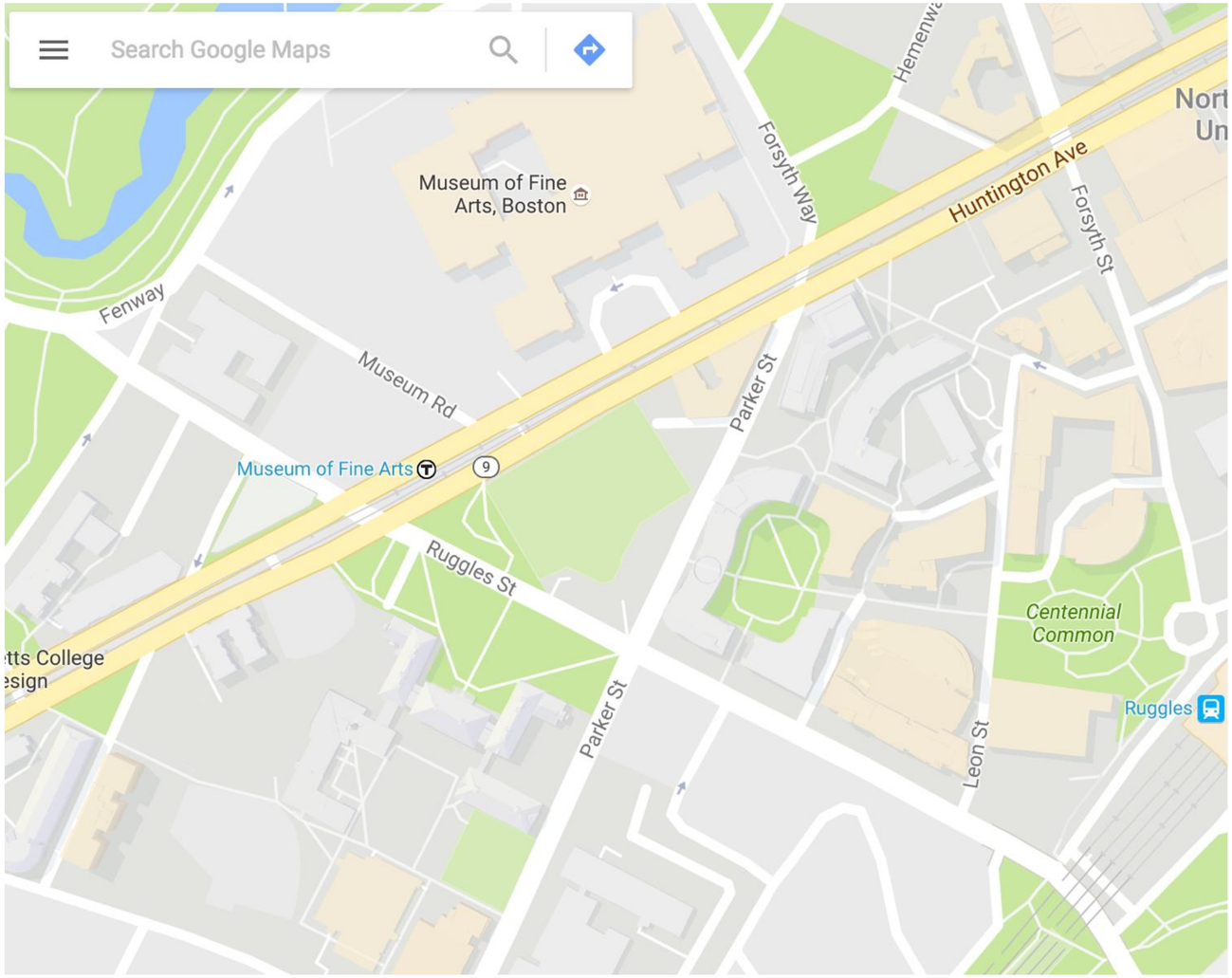
Search

	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*



Mid-level/Search

Search



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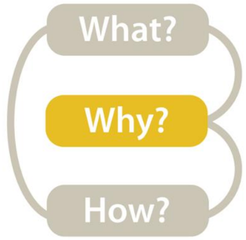
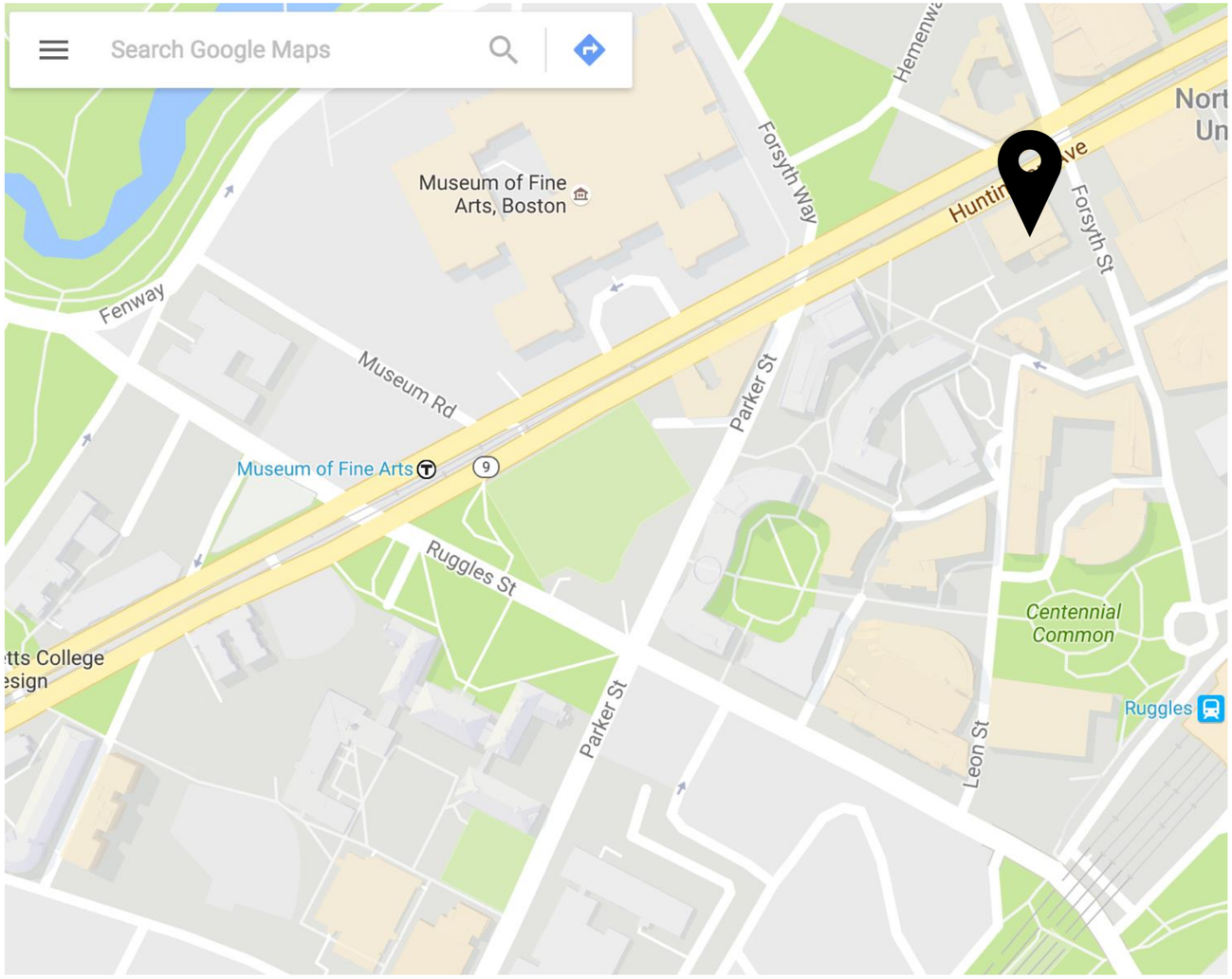
Location unknown	*Locate*	*Explore*



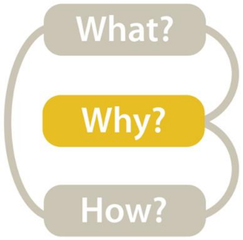
Mid-level/Search → Lookup

Search



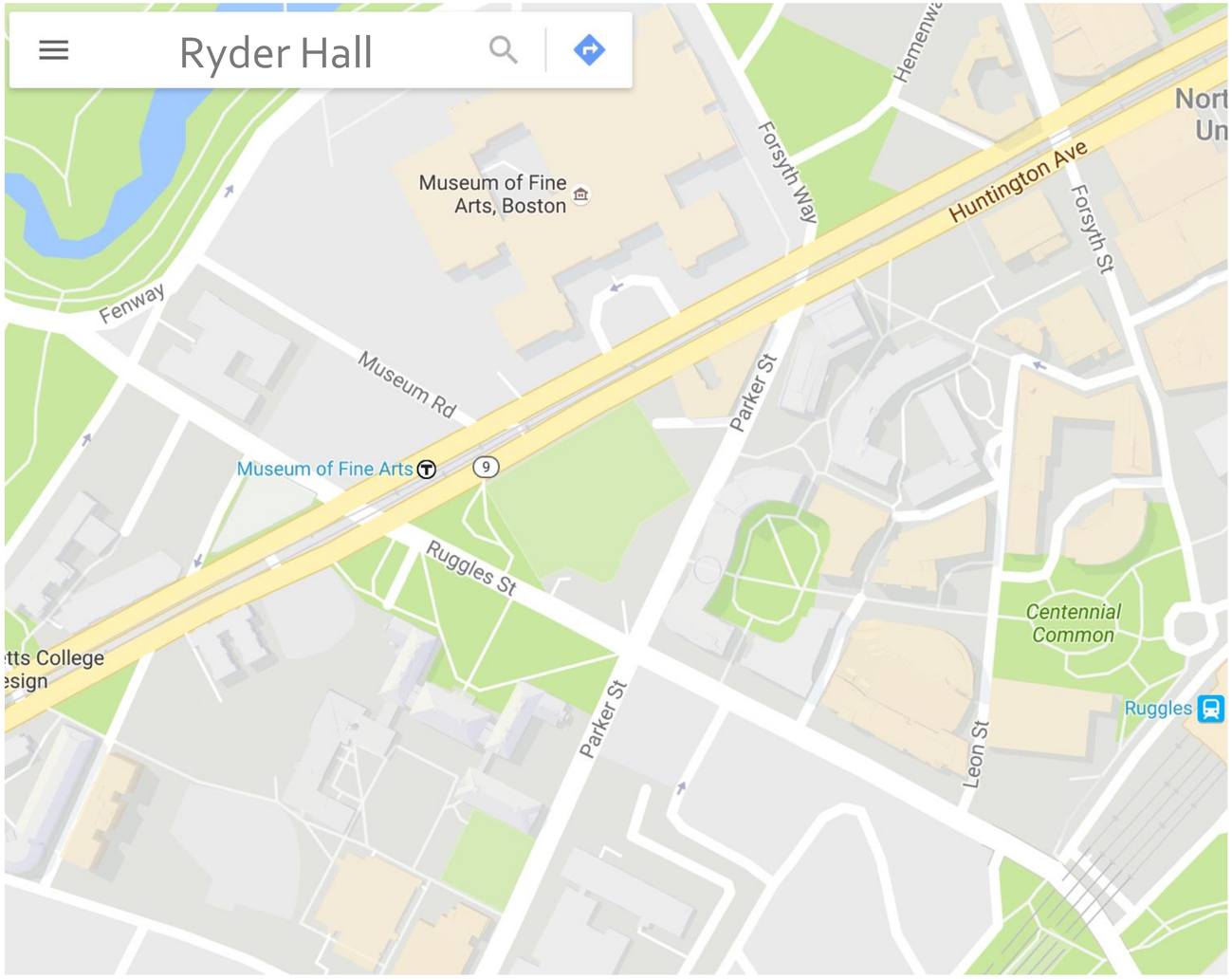
	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

What is the address of Knowles?



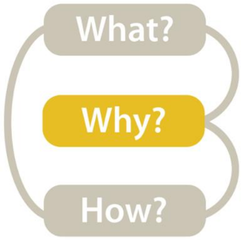
Mid-level/Search → Locate

Search



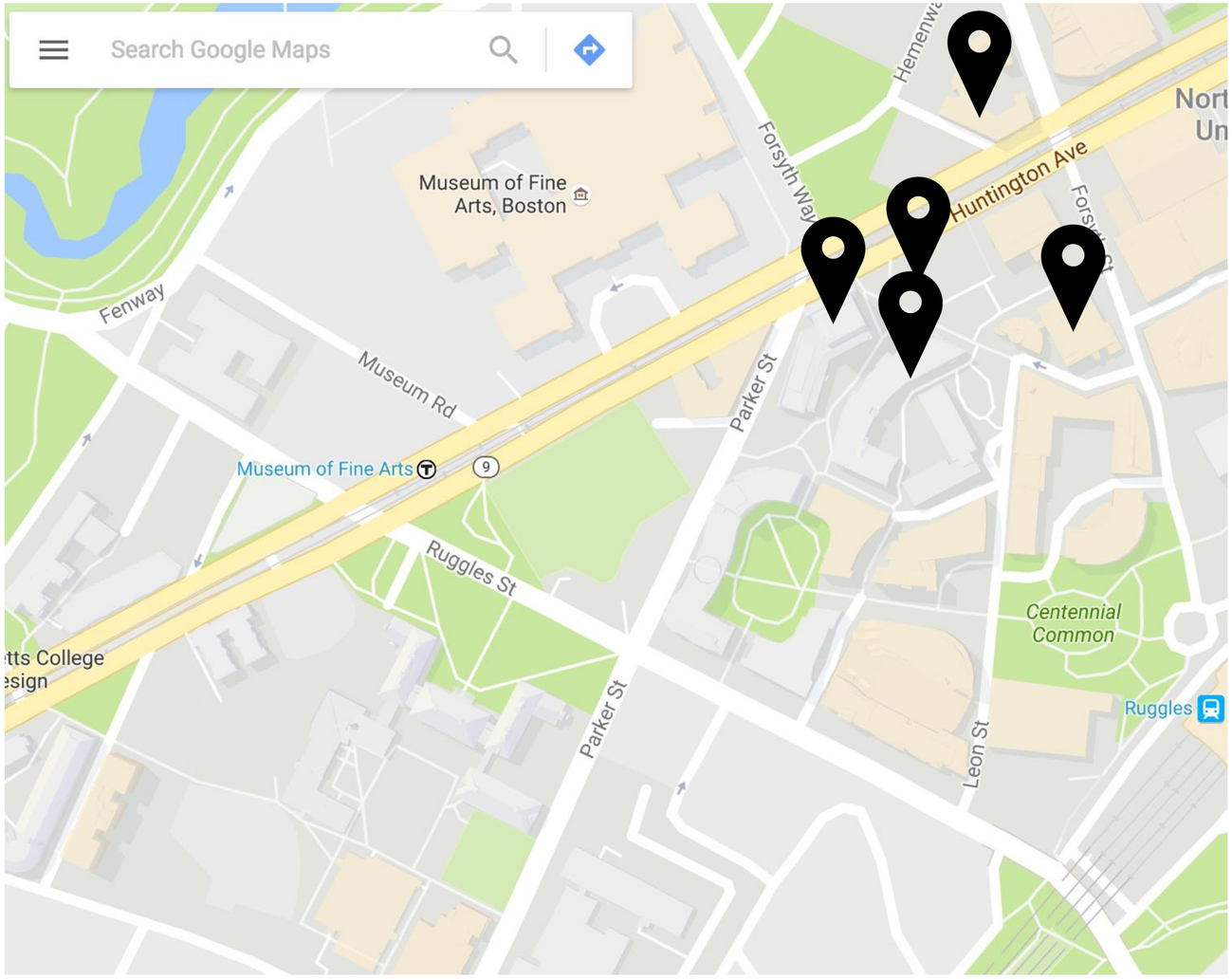
	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

Where is Knowles?



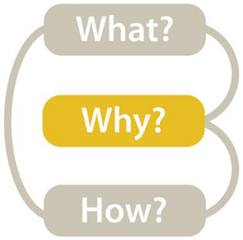
Mid-level/Search → Browse

Search



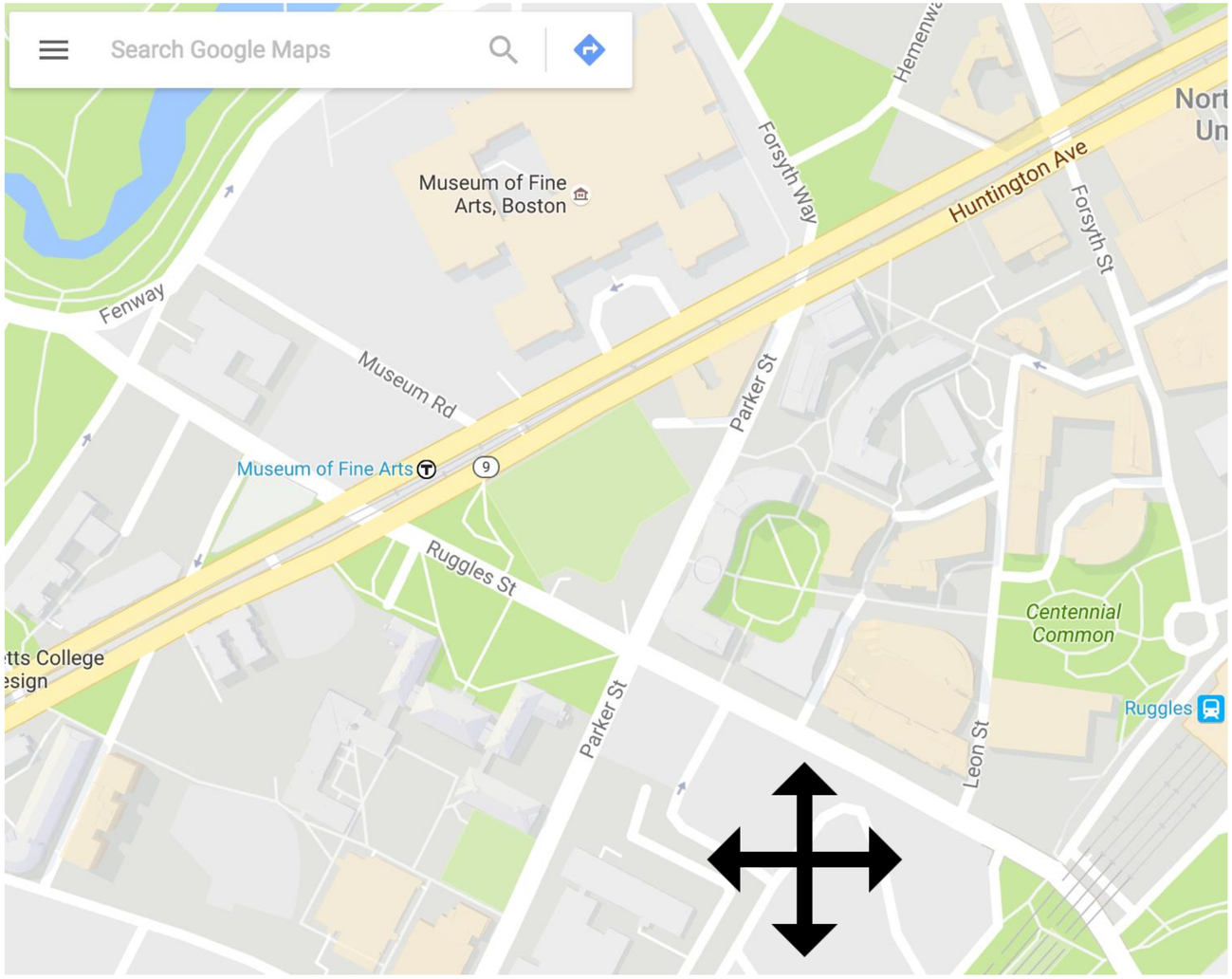
	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

What buildings are near Knowles?



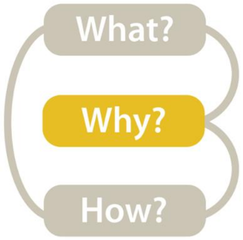
Mid-level/Search → Explore

Search



	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

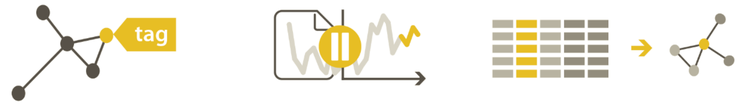
Where can I study?

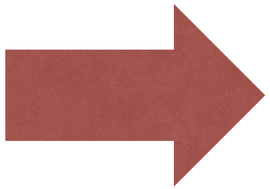


Mid-level → What type of search is required for the high-level action?

- **Analyze**
  - Consume
    - *Discover*
    - *Present*
    - *Enjoy*

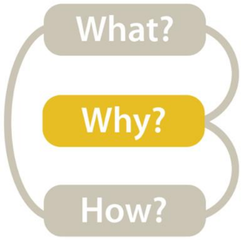
  - Produce
    - *Annotate*
    - *Record*
    - *Derive*





- **Search**

	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

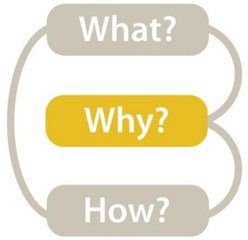


Low-level/Query→What is the query the vis. needs to support?

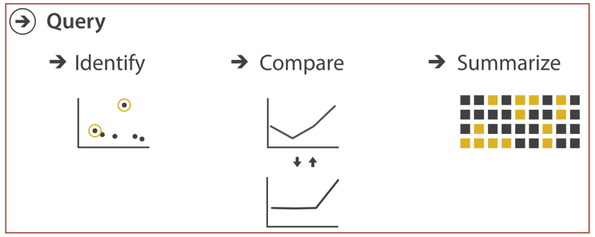
- **Analyze**
  - Consume
    - *Discover*
    - *Present*
    - *Enjoy*
  - Produce
    - *Annotate*
    - *Record*
    - *Derive*
- **Search**

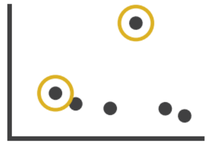
	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

- **Query**
  - Identify
  - Compare
  - Summarize

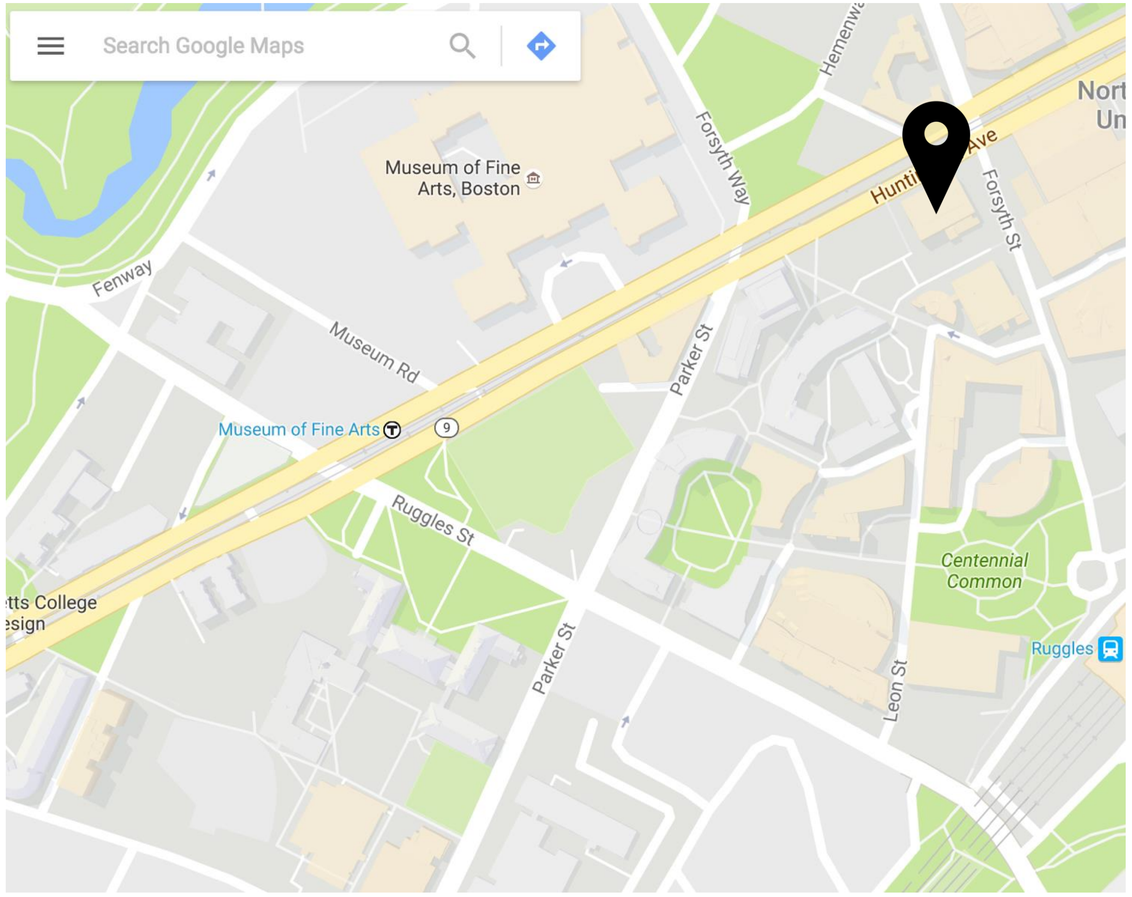


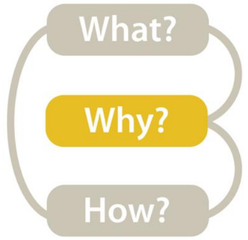
Low-level→Identify



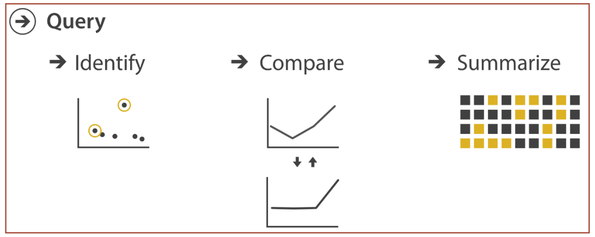


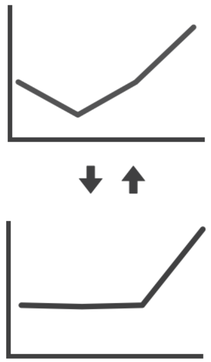
single target





Low-level→Compare





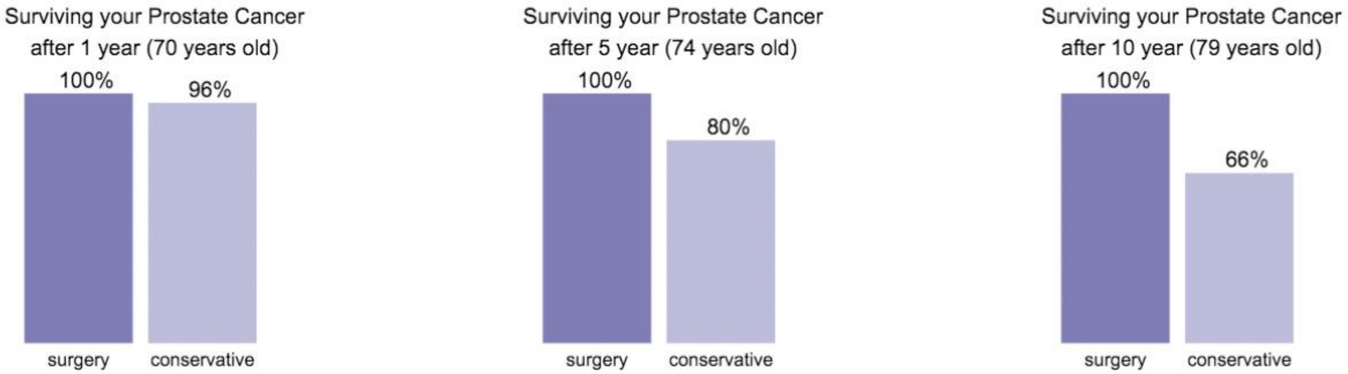
multiple targets

How effective are different treatments for my prostate cancer?

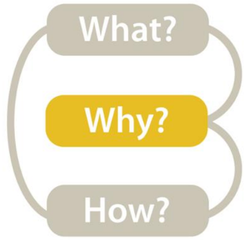
The expected benefits from **surgery** and **conservative management** are listed below.

These results show your estimated chances of either surviving or dying **from your prostate cancer** at 1, 5, and 10 years, depending on whether you choose either surgery **(DARK PURPLE BAR)** or conservative treatment **(LIGHT PURPLE BAR)** .

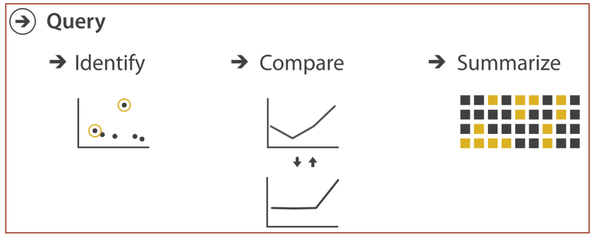
You can view these risks in terms of either survival or mortality.



Hakone et al. 2017



Low-level→Summarize



all targets

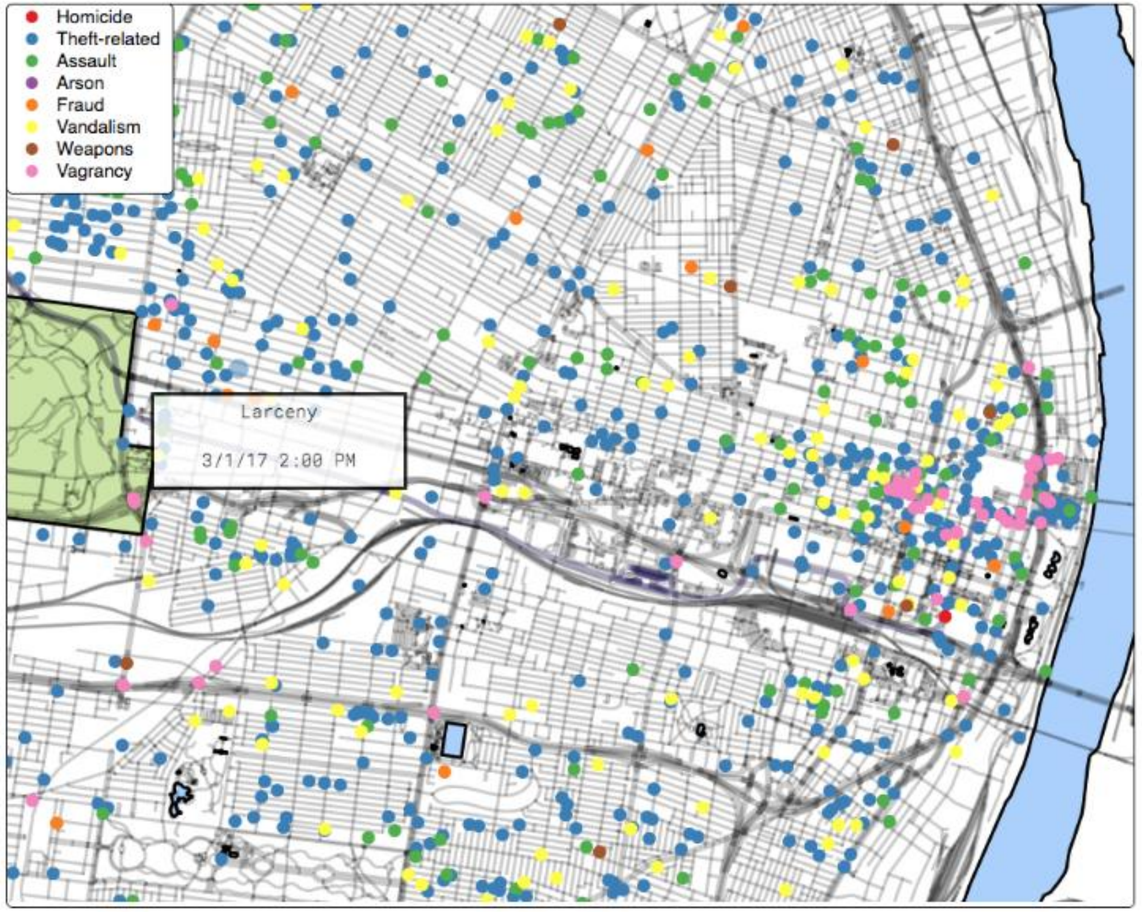


Figure 4: The interface used in our experiment. Participants used their mouse to pan and zoom the map. A tooltip displayed information about the crimes on click.

Ottley et al. 2016

TASK ABSTRACTION

TARGETS are aspects of the data interest that are interest to the user.

Why?

Actions

Analyze

- Consume
  - *Discover*
  - *Present*
  - *Enjoy*
- Produce
  - *Annotate*
  - *Record*
  - *Derive*

Search

	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

Query

- Identify
- Compare
- Summarize

Targets

All Data

- Trends
- Outliers
- Features

Attributes

- One
- Many
  - *Distribution*
  - *Dependency*
  - *Correlation*
  - *Similarity*
  - *Extremes*

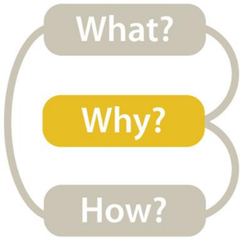
Network Data

- Topology
- *Paths*

Spatial Data

- Shape

What?
Why?
How?



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All Data

- Trends
- Outliers
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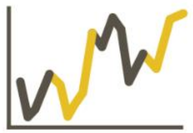
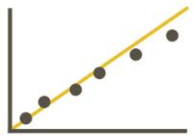
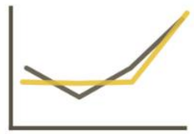


Attributes

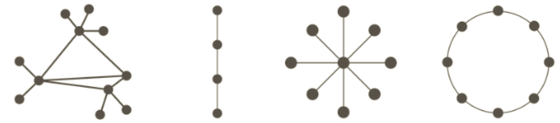
- One
  - *Distribution*
  - *Extremes*
- Many
  - *Dependency*
  - *Correlation*
  - *Similarity*



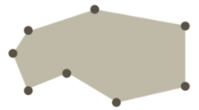
Network Data

- Topology
- *Paths*




Spatial Data

- Shape



Task Abstraction

Why?

Actions

Analyze

- Consume
  - *Discover*
  - *Present*
  - *Enjoy*
- Produce
  - *Annotate*
  - *Record*
  - *Derive*

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Targets

All Data

- Trends
- Outliers
- Features

Attributes

- One
- Many
  - *Distribution*
  - *Dependency*
  - *Correlation*
  - *Similarity*
  - *Extremes*

Network Data

- Topology
- *Paths*

Spatial Data

- Shape

Lots of other task taxonomies, esp. low-level...!

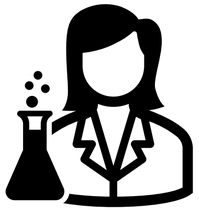
What?
Why?
How?

Analytic Task Taxonomy *Low-level*

Retrieve Value	*How long is the movie Gone with the Wind?*
Filter	*What comedies have won awards?*
Compute Derived Value	*How many awards have MGM studio won in total?*
Find Extremum	*What director/film has won the most awards?*
Sort	*Rank movies by most number of awards.*
Determine Range	*What is the range of film lengths?*
Characterize Distribution	*What is the age distribution of actors?*
Find Anomalies	*Are there exceptions to the relationship between number of awards won and total movies made by an actor?*
Cluster	*Is there a cluster of typical film lengths?*
Correlate	*Is there a trend of increasing film length over the years?*

[Amar et al., 2005]

An example task analysis



I need a visualization for performing **cellular analysis**!

High-level →
Derive

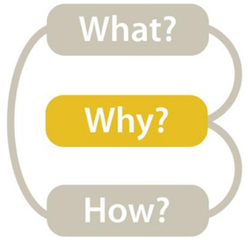
Medium-level/Search →
Lookup or Locate

I need to **compare** measure A to B over time.

Low-level/Query →
Compare

Target(s) → All data → trends; Attributes → similarity

In-class exercise:
Mock Interview, Task Analysis



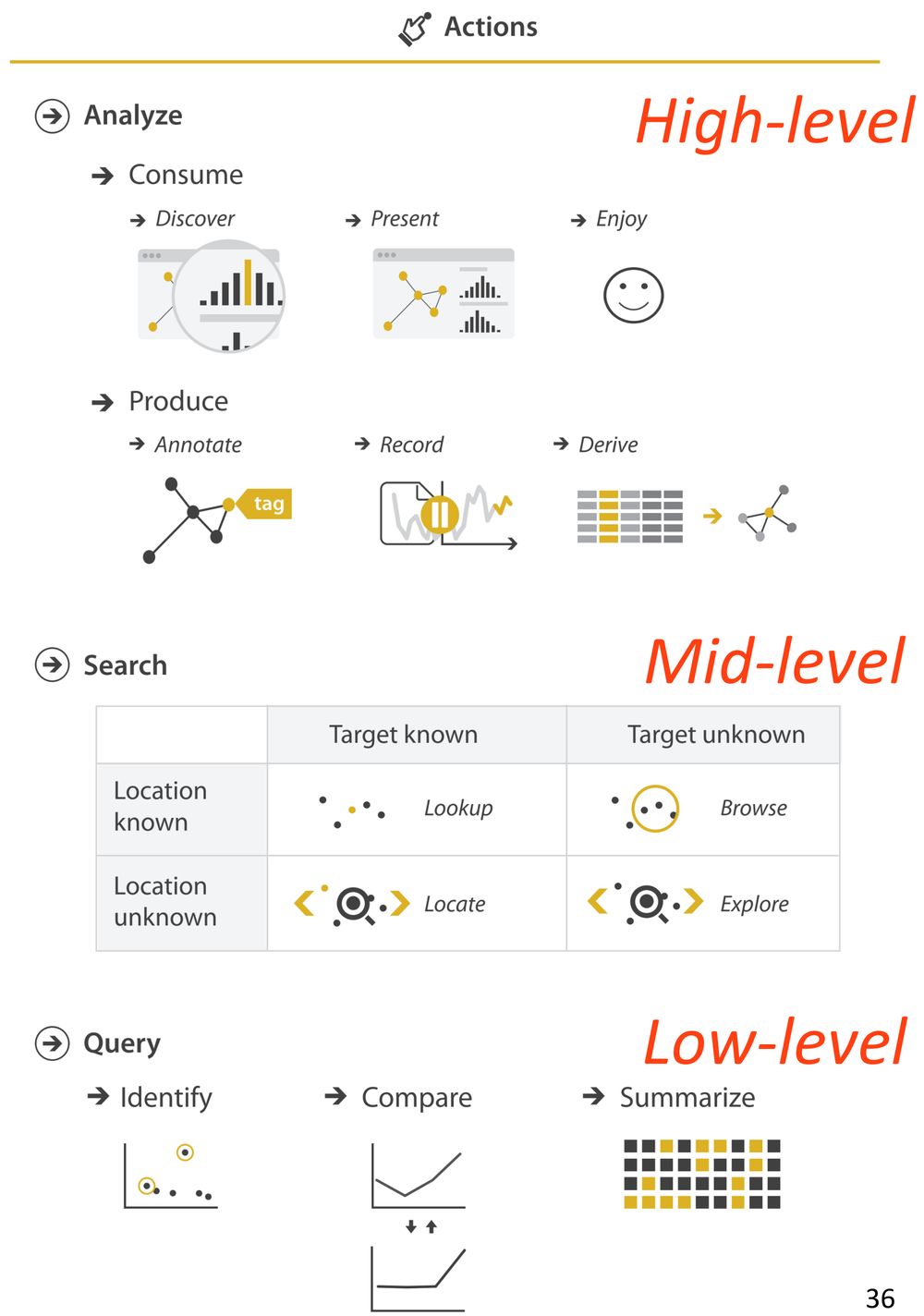
Task Analysis

Visualization for Public Transit Development

20m

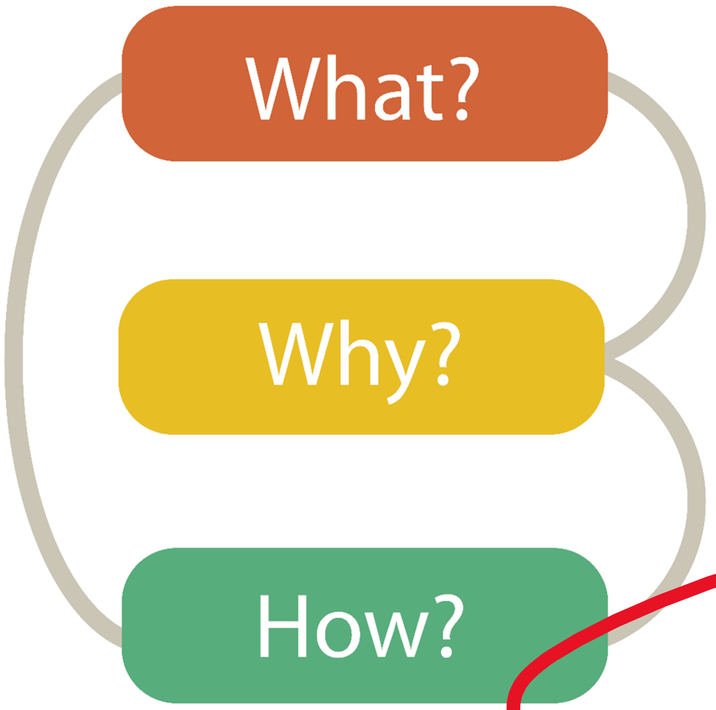
INSTRUCTIONS:

- Separate into groups of ~3.
- Pretend you are transportation engineers, e.g., for the MBTA, City of Boston.
- Discuss the user tasks and goals and abstract them using the taxonomy from VAD (right, Fig. 3.2).
- Save your **notes & group members** for a later exercise!!!



ARRANGE TABLES

Analysis



What data is shown?

DATA ABSTRACTION

Why is the user analyzing / viewing it?

TASK ABSTRACTION

How is the data presented?

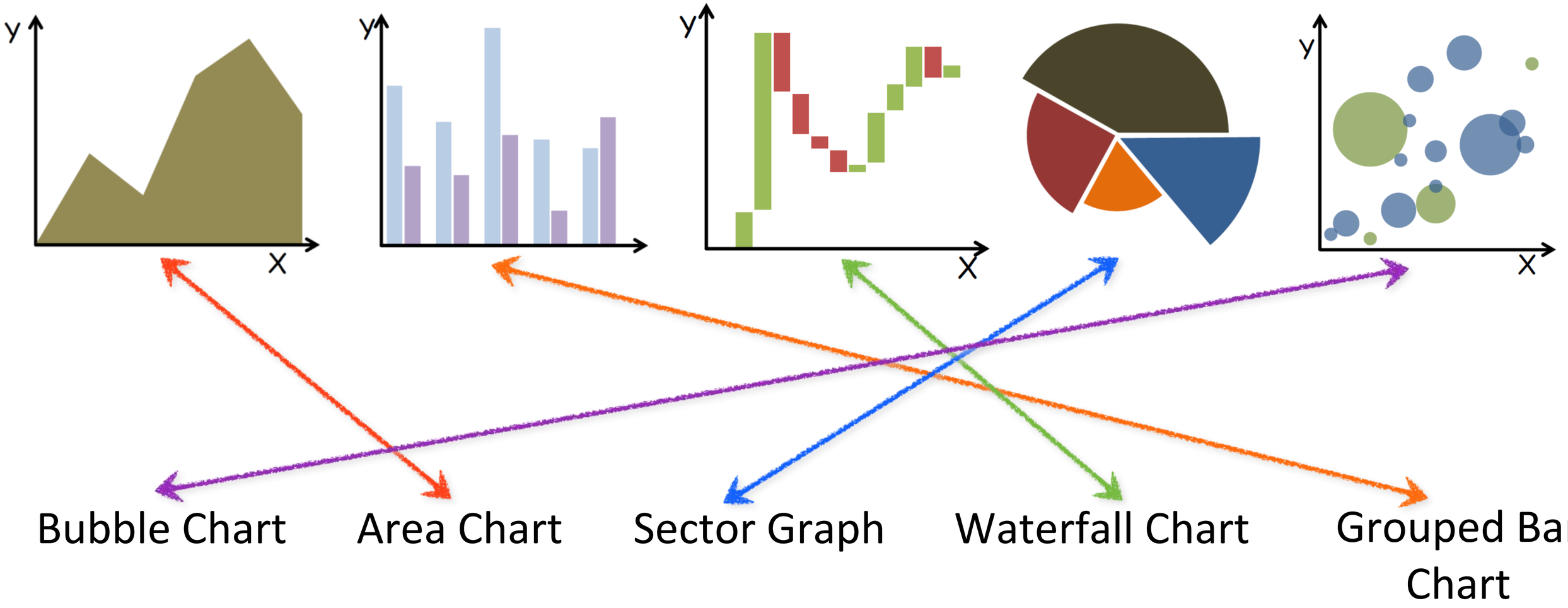
VISUAL ENCODING

Goals for Today

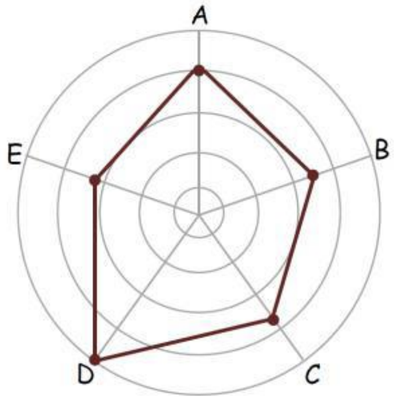
- Learn about many visual encoding options available
- Practice performing task abstraction

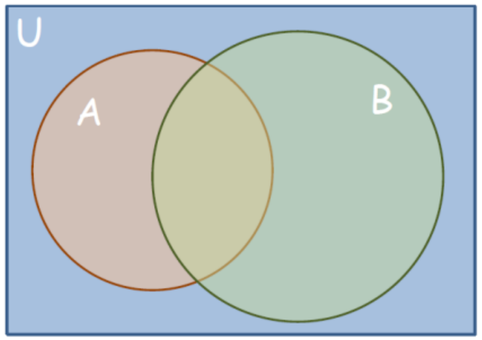
In-class exercise: Encodings Worksheet

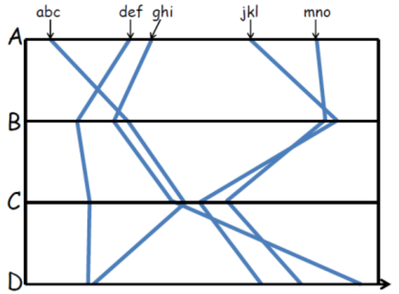
Encoding Match-up

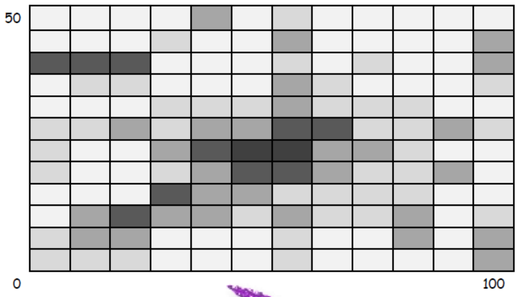


Encoding Match-up









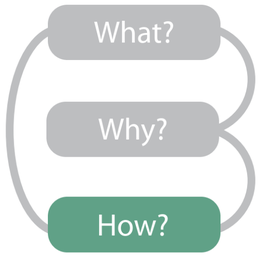
Venn Diagram

Heat Map

Star Plot

Box & Whisker Plot

Parallel Coordinates



Now…

How?

Encode

- **Arrange**
  - Express
  - Separate
  - Order
  - Align
  - Use
- **Map**
  from categorical and ordered attributes
  - Color
    - *Hue*
    - *Saturation*
    - *Luminance*
  - Size, Angle, Curvature, …
  - Shape
  - Motion
    Direction, Rate, Frequency, …

Manipulate

- **Change**
- **Select**
- **Navigate**

Facet

- **Juxtapose**
- **Partition**
- **Superimpose**

Reduce

- **Filter**
- **Aggregate**
- **Embed**

Later this semester…

Arrange Tables

- **Separate, Order, Align Regions**
  - Separate
  - Order
  - Align

  - *1 Key*
    List
  - *2 Keys*
    Matrix
  - *3 Keys*
    Volume
  - *Many Keys*
    Recursive Subdivision

Key: an independent attribute that can be used as a unique index (Tableau Dimension)

Value: a dependent attribute (i.e., cell in a table) (Tableau Measures)

Categorical or Ordinal

Categorical Ordinal, or Quantitative

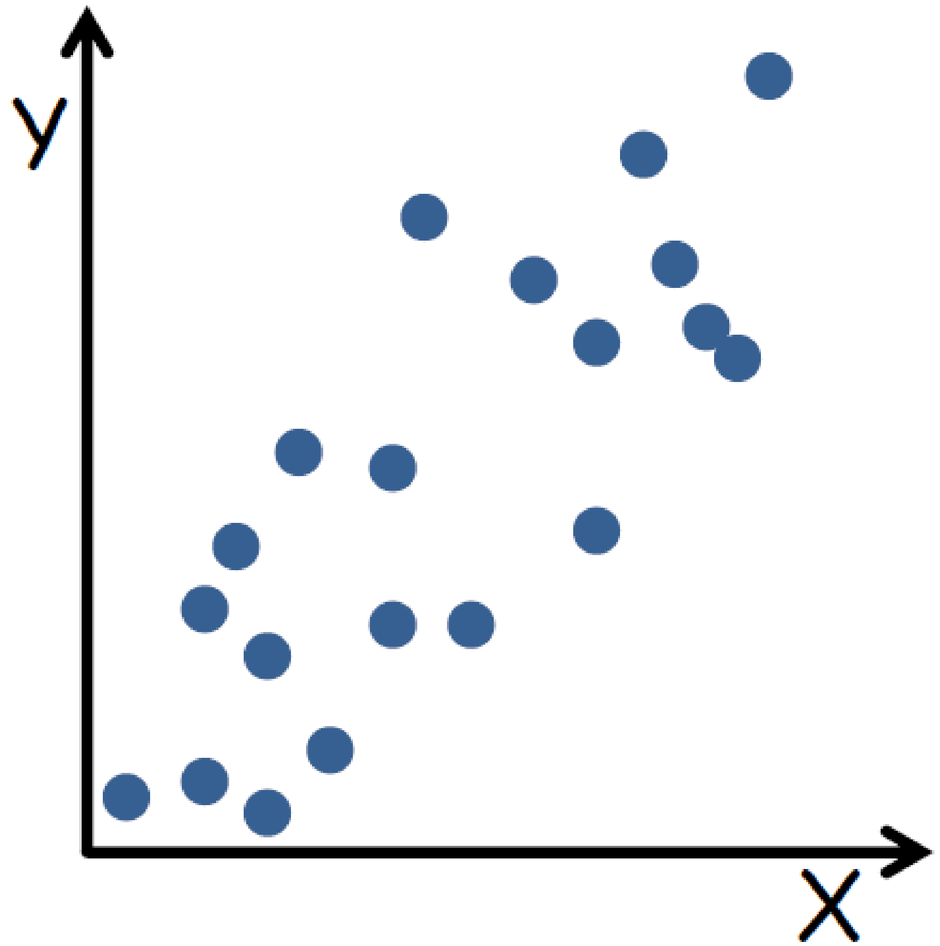
Example Keys

Key

Date	Precipitation	High Temperature
May 1, 2016	0”	60
May 2, 2016	0.3”	62
May 3, 2016	1”	55
May 4, 2016	0”	67

Student	College	HW1 grade (out of 10)
John	COS	9
Jane	Khoury	10
June	Khoury	8
Joe	Khoury	8

Arrange Tables — No Key

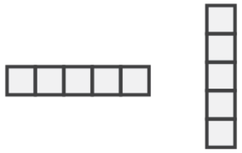


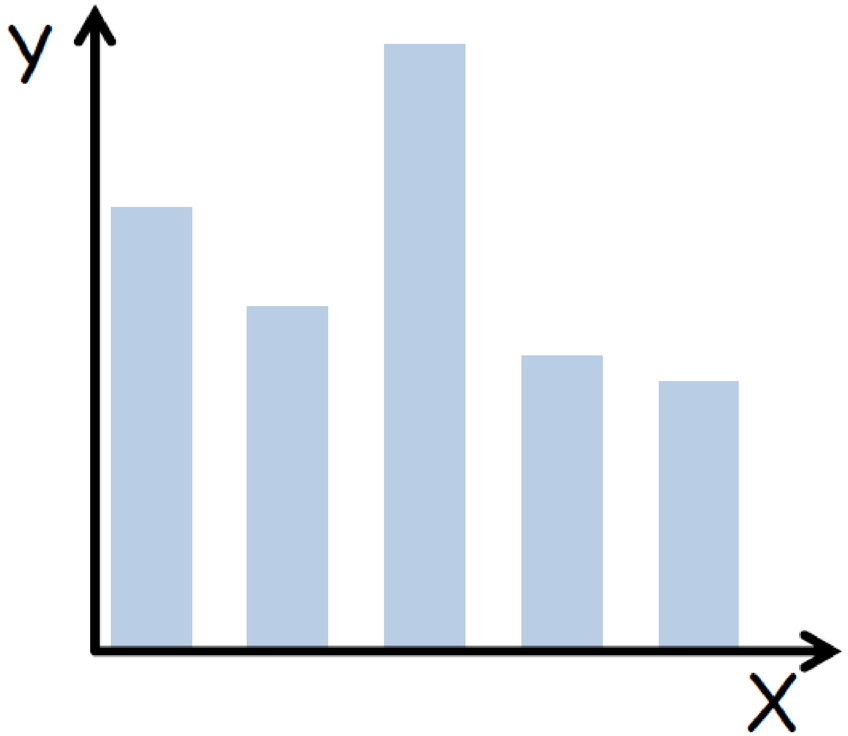
SCATTER PLOT

Arrange Tables — One Key

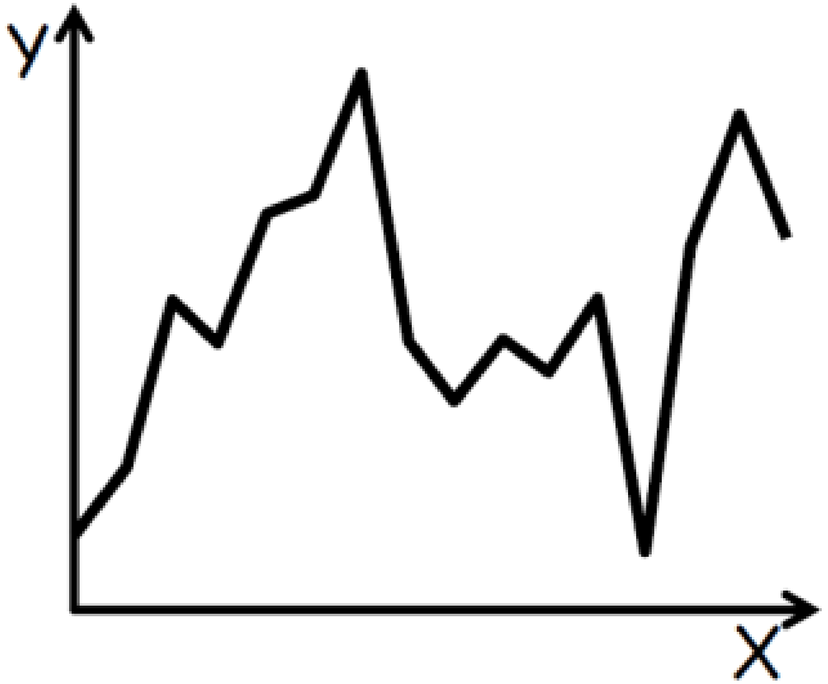
➔ *1 Key*

List





BAR CHART

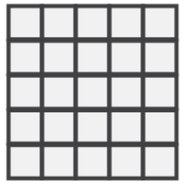


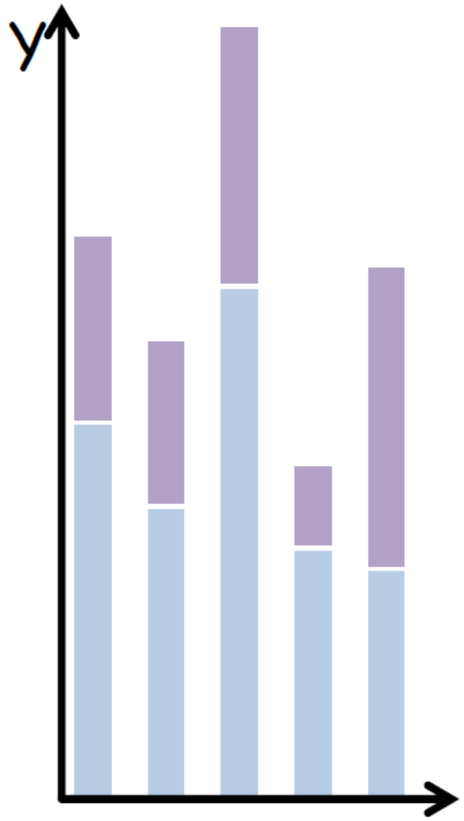
LINE GRAPH

Arrange Tables — Two Keys

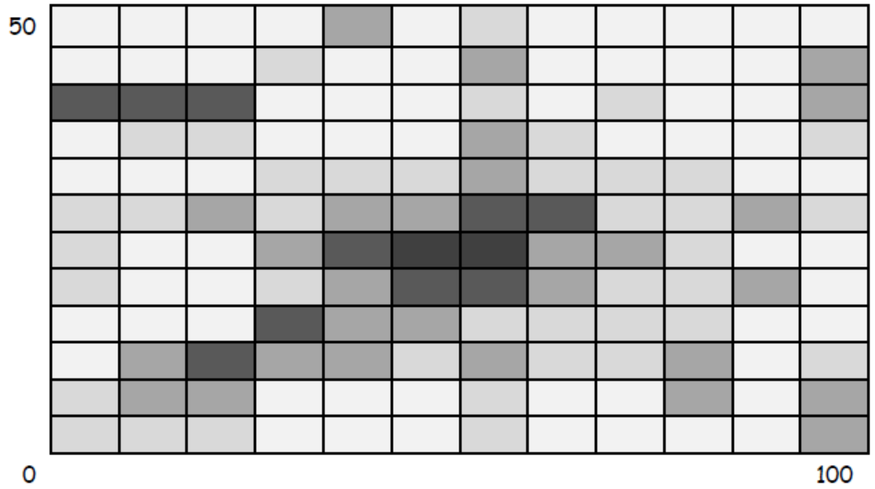
➔ *2 Keys*

Matrix





STACKED BAR CHART

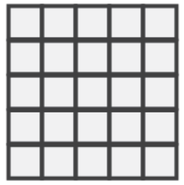


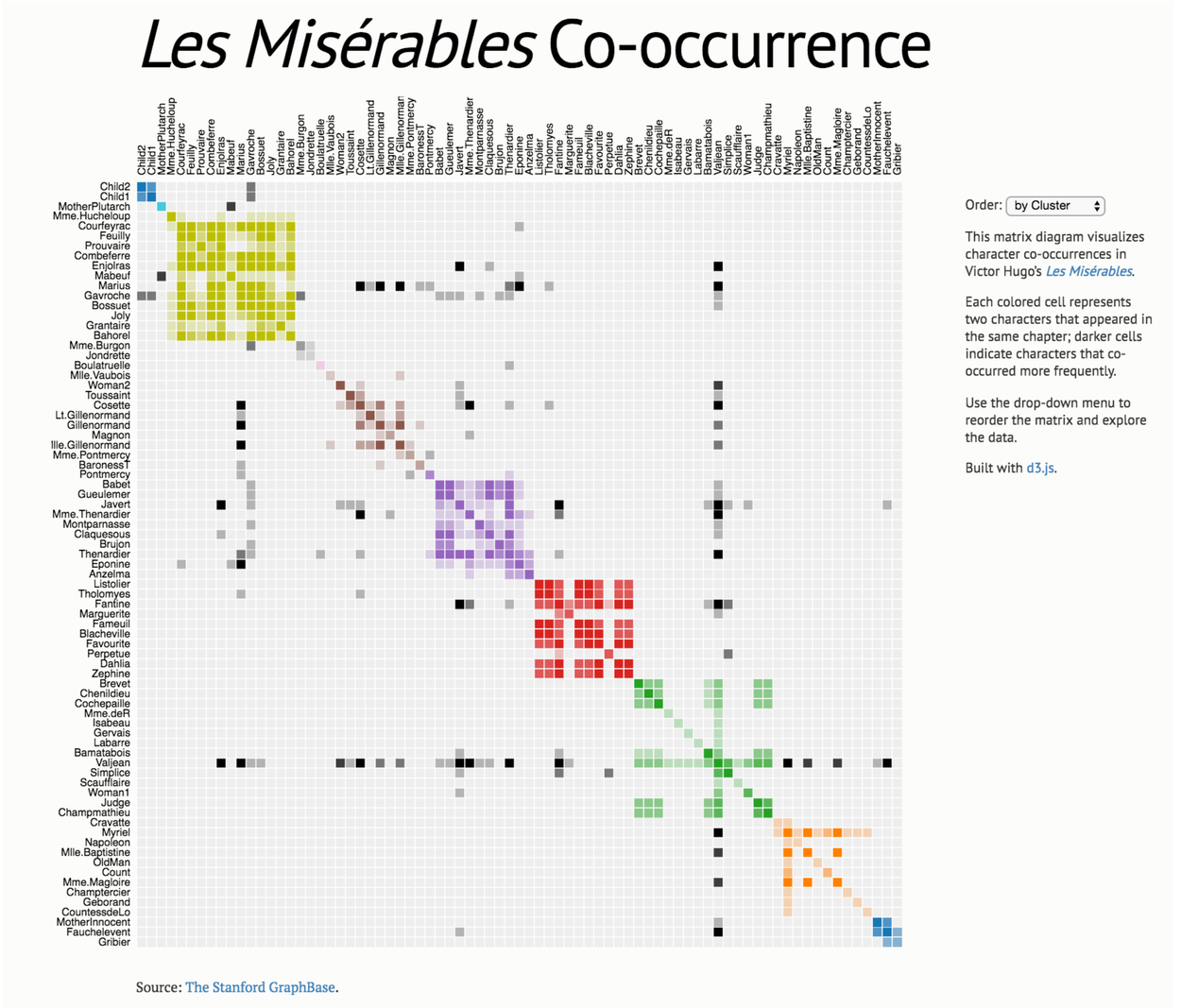
HEATMAP

Arrange Tables — Two Keys (Network)

➔ *2 Keys*

Matrix



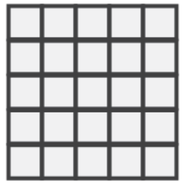


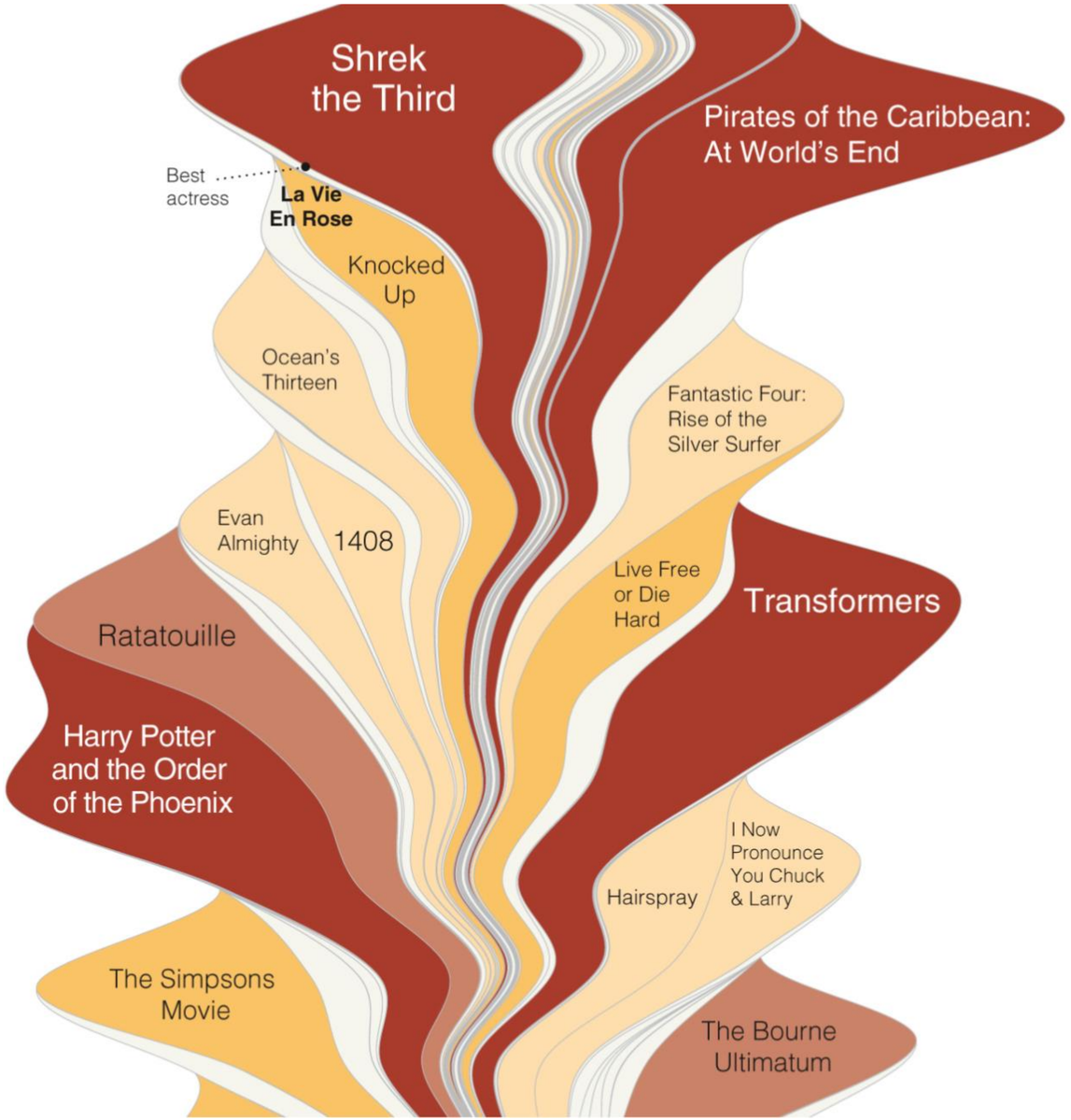
Bostock, 2012

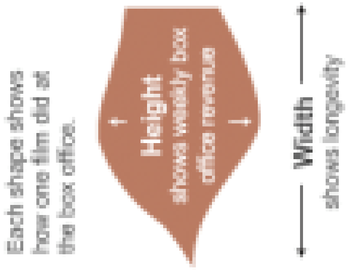
Arrange Tables — Two Keys

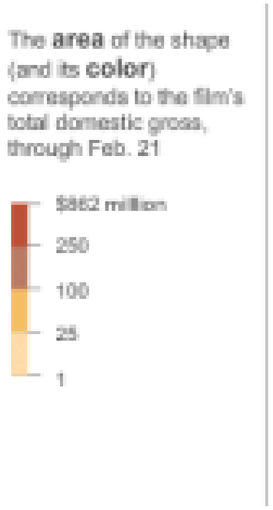
➔ *2 Keys*

Matrix







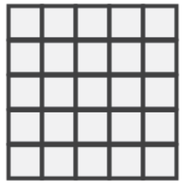


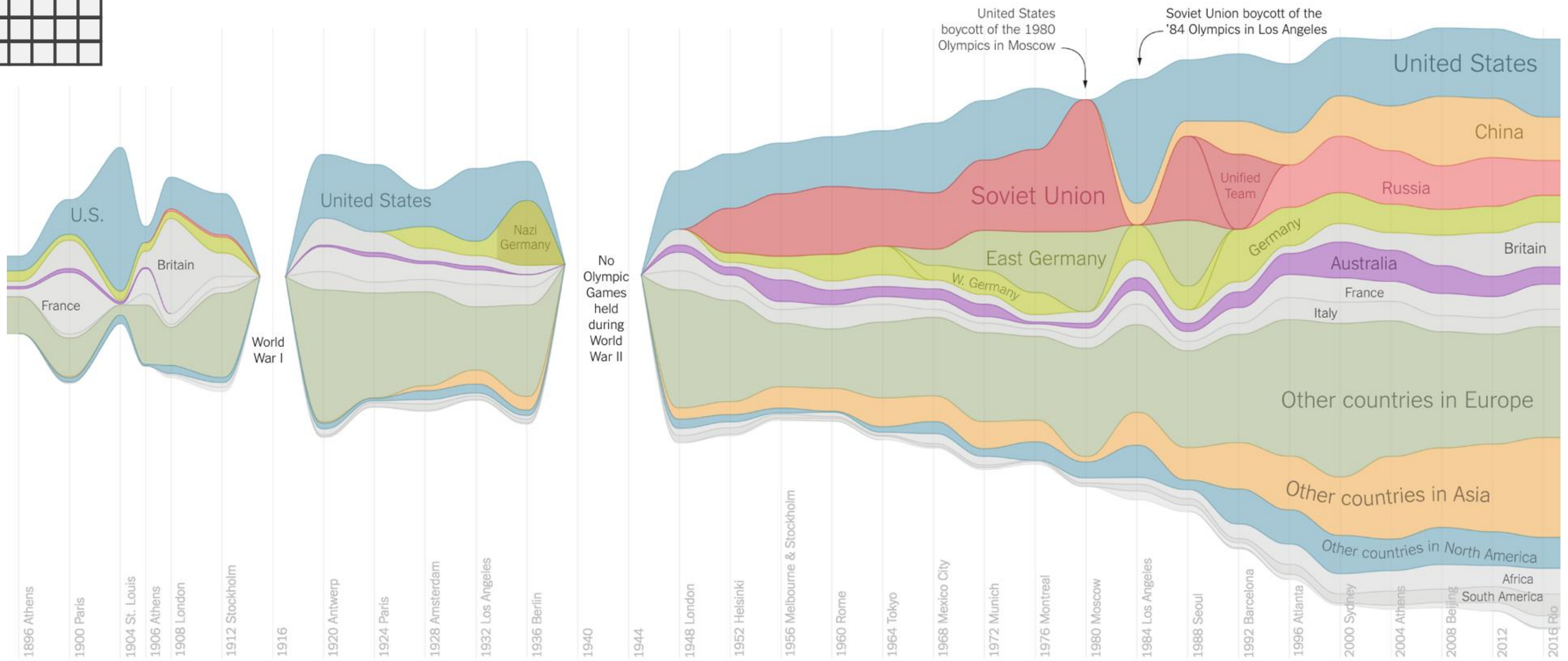
Byron & Wattenberg, 2008

Arrange Tables — Two Keys

➔ *2 Keys*

Matrix



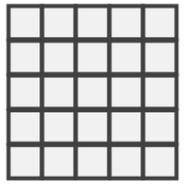


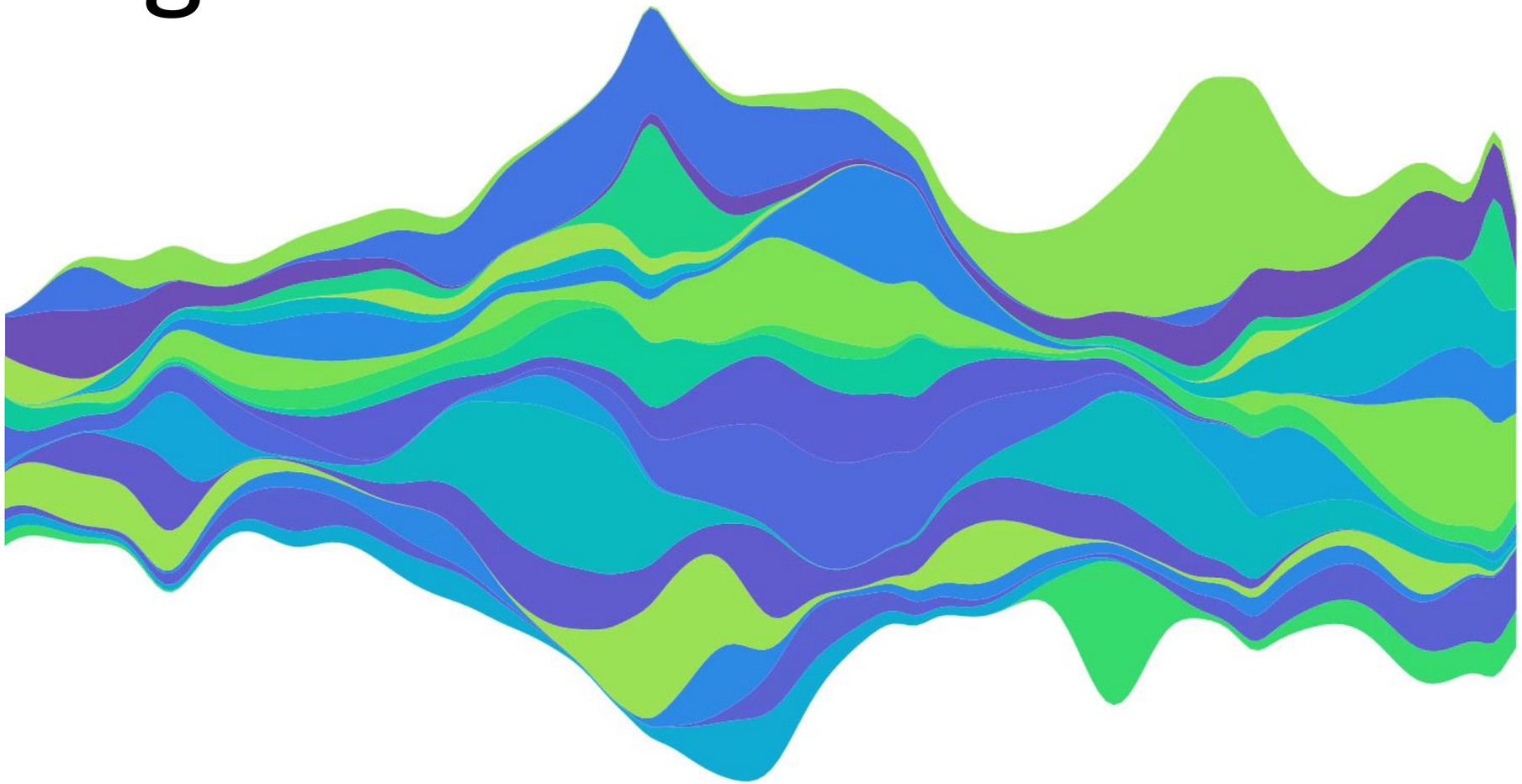
NY Times, 2016

Arrange Tables — ~~Two~~ Three Keys

➔ *2 Keys*

Matrix





STREAMGRAPH

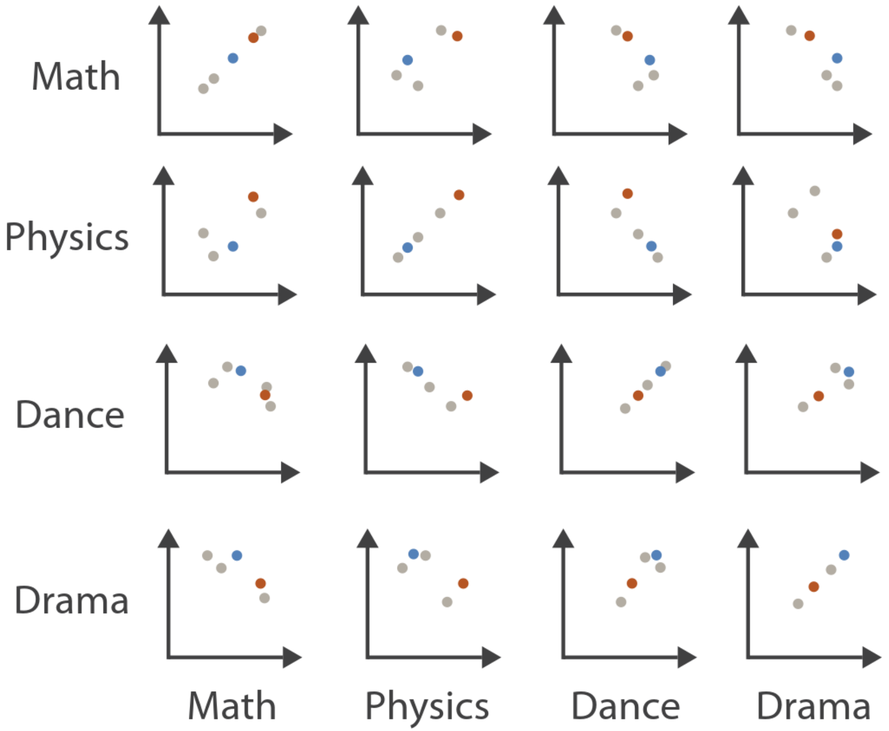
[Bostock, 2018]

Arrange Tables — Axes

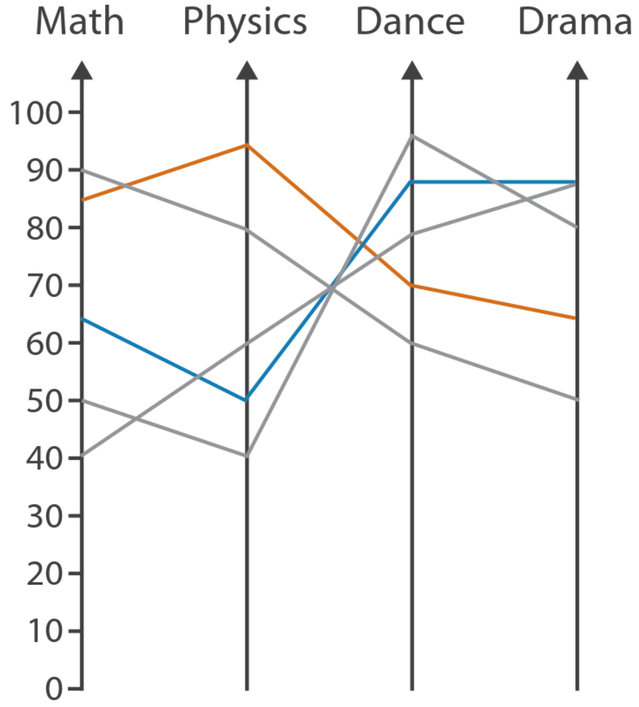
Table

Math	Physics	Dance	Drama
85	95	70	65
90	80	60	50
65	50	90	90
50	40	95	80
40	60	80	90

Scatterplot Matrix

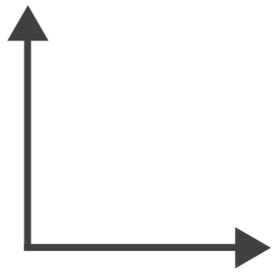


Parallel Coordinates

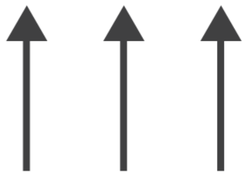


Arrange Tables — Axes

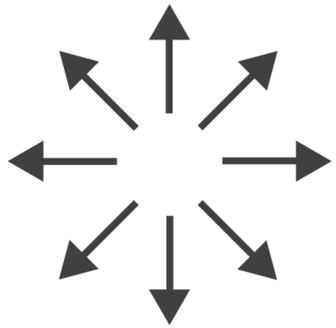
- **Axis Orientation**
  - Rectilinear



  - Parallel

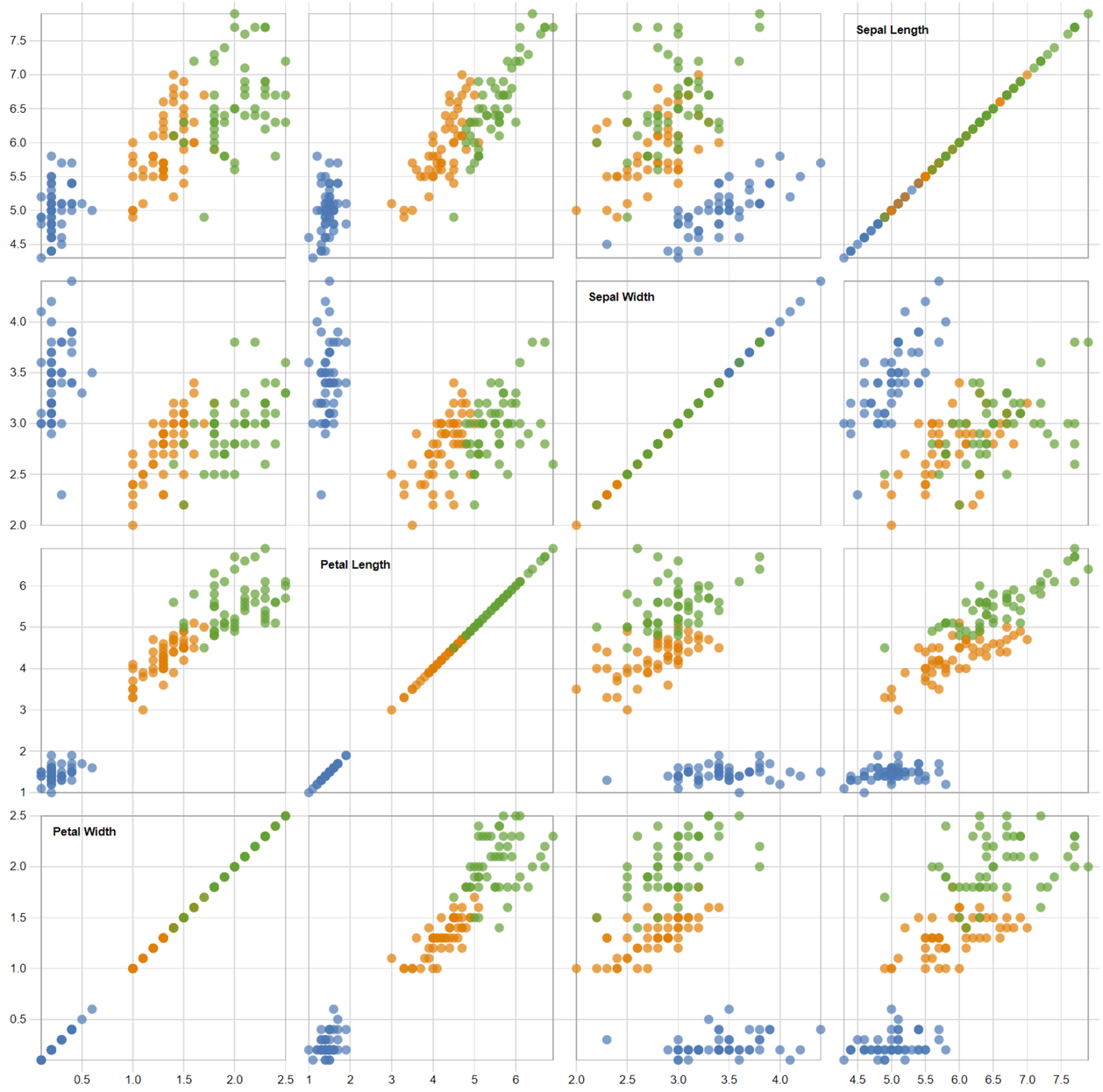


  - Radial



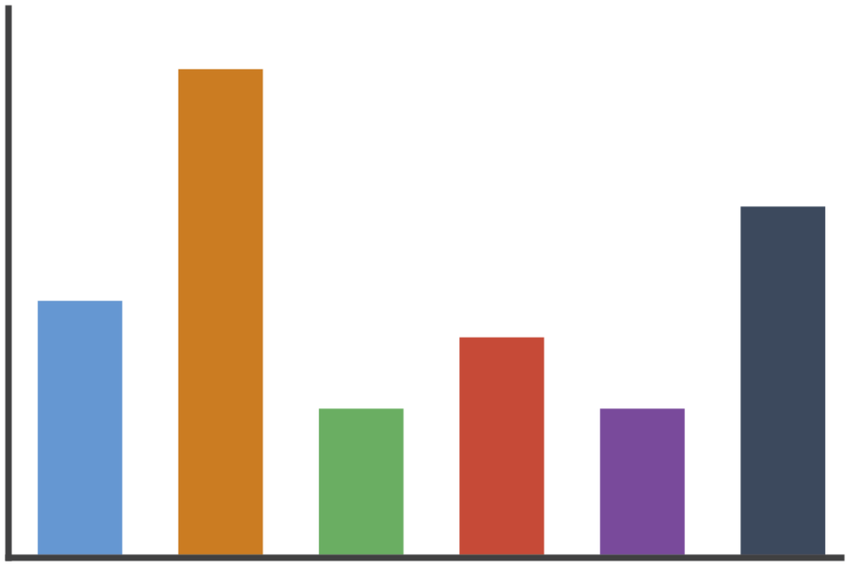
Scatterplot Matrix Brushing

- Rectilinear



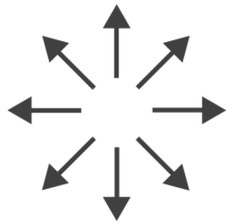
Bostock, Rivière' 2019

Arrange Tables

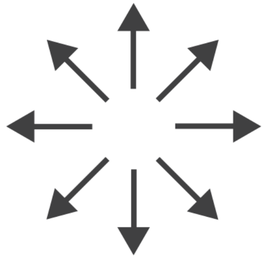


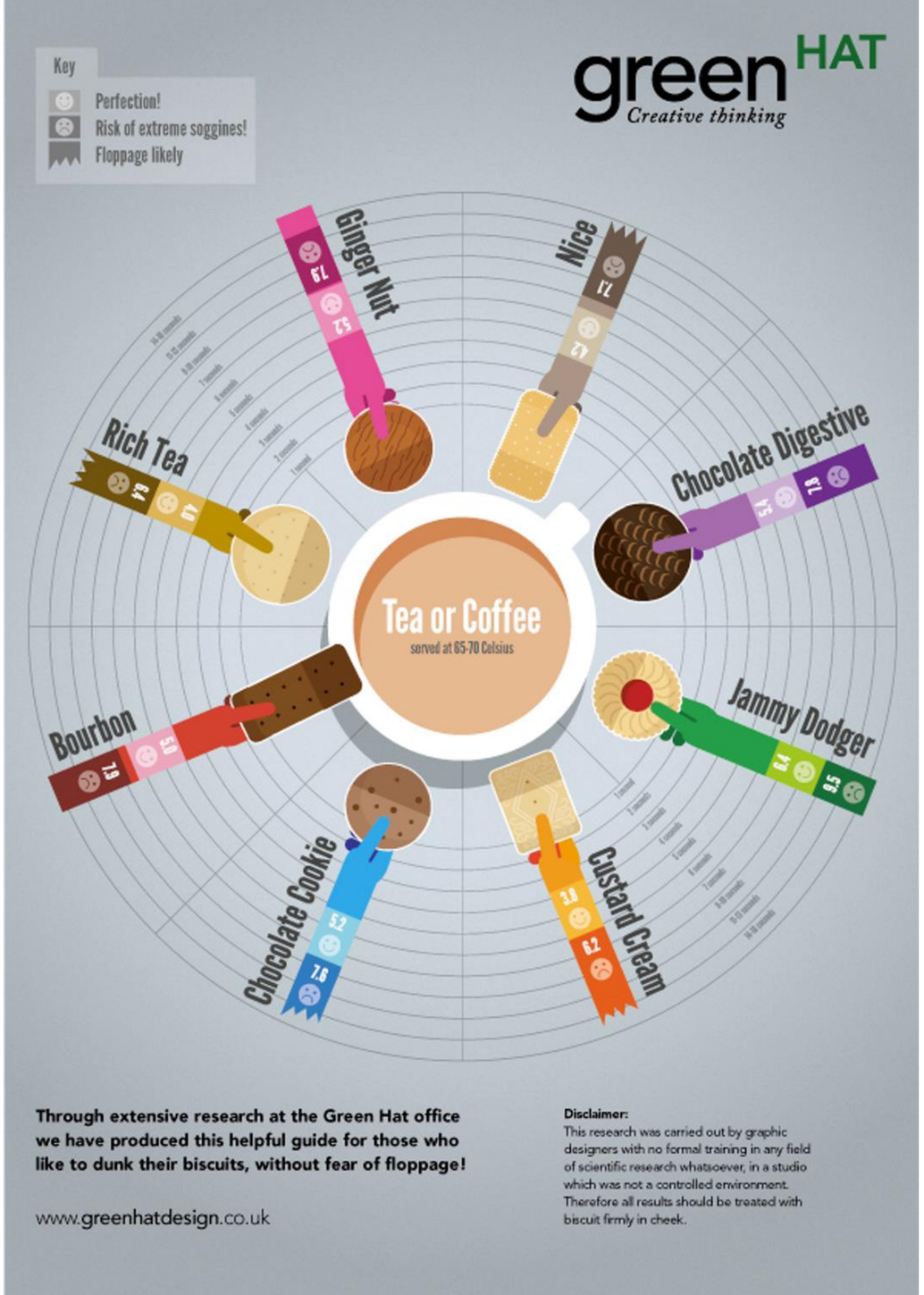
→ Rectilinear

→ Radial

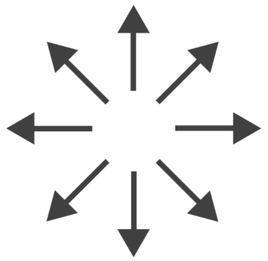


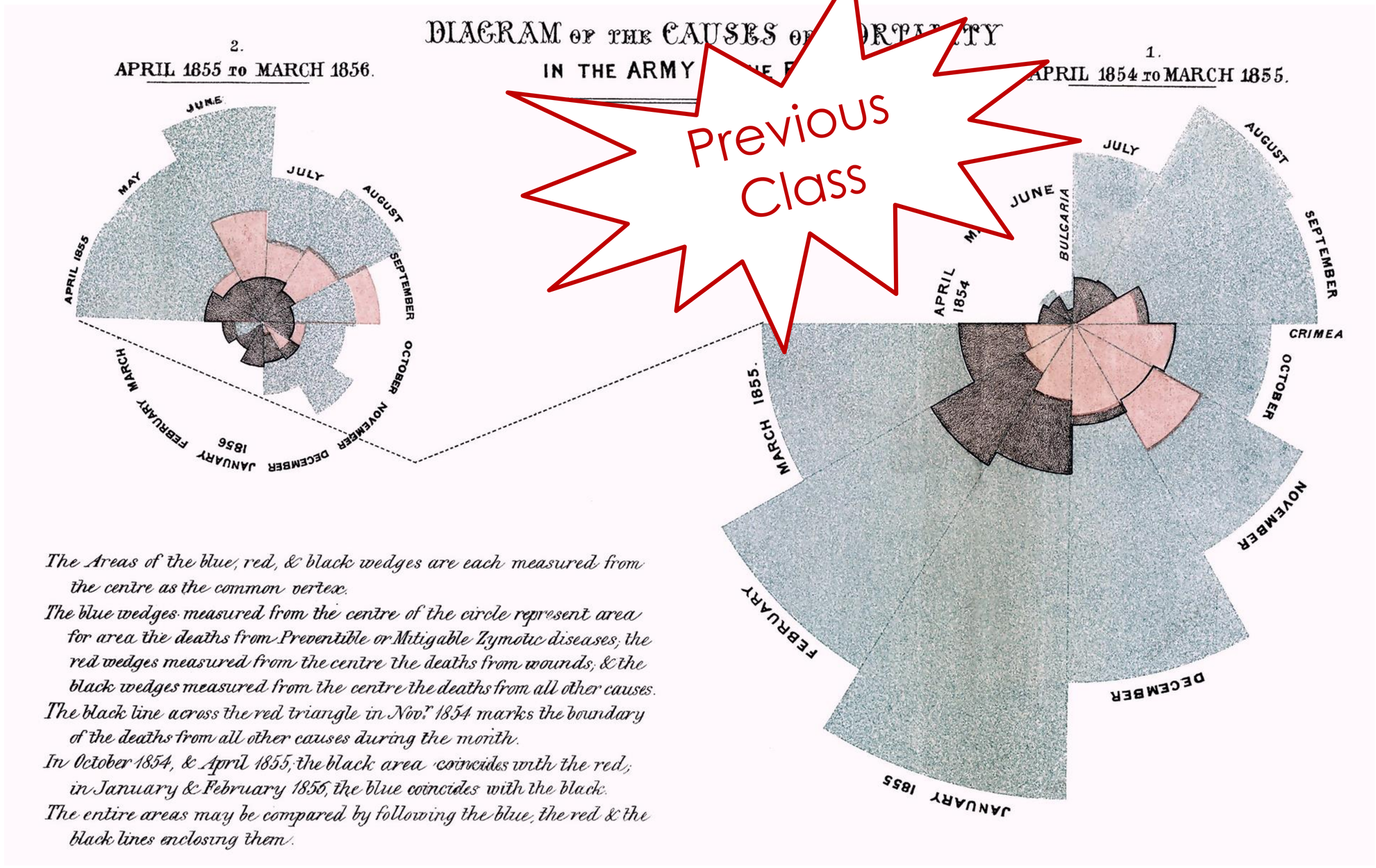
➔ Radial



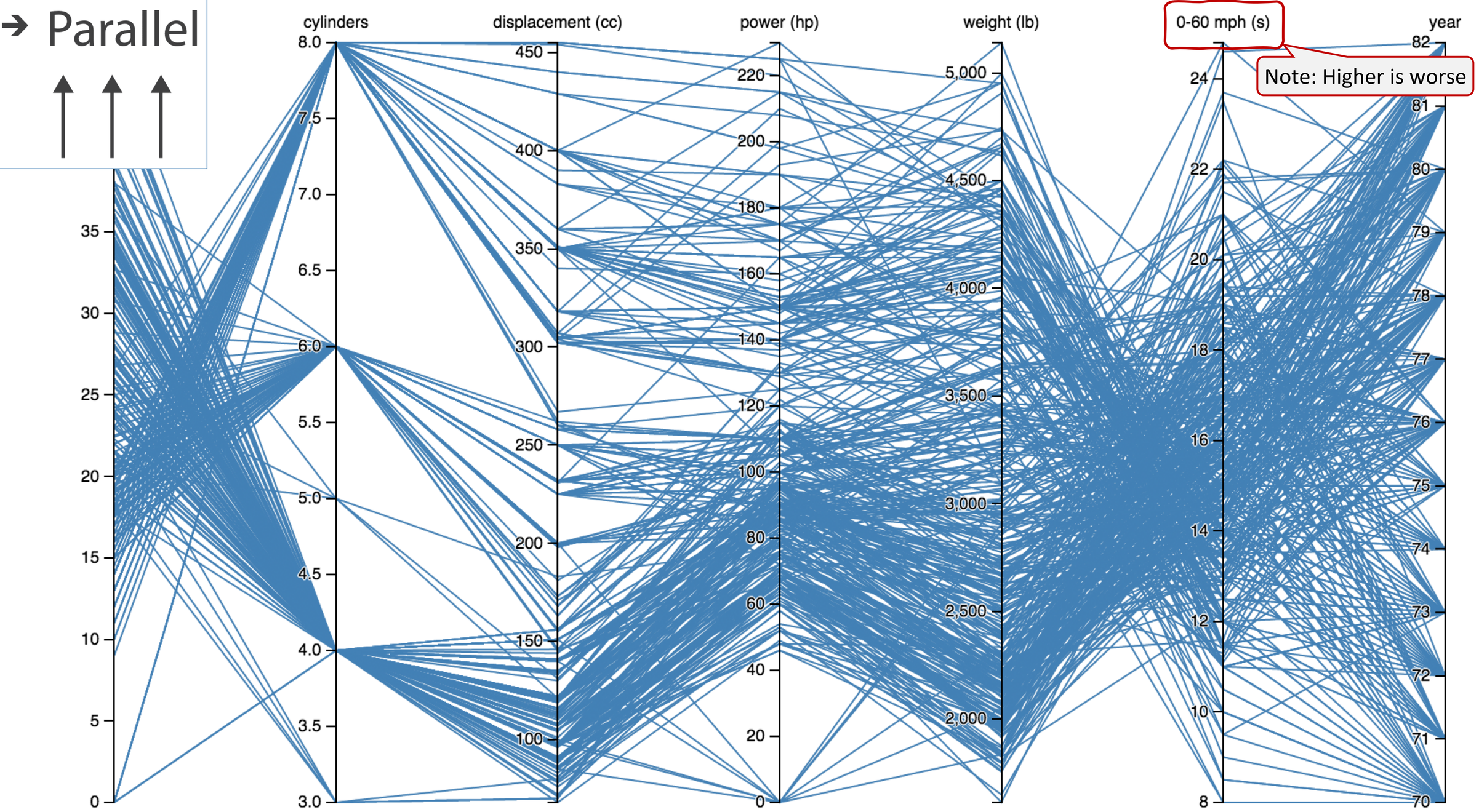

Key
Perfection!
Risk of extreme soggines!
Floppage likely
green HAT
Creative thinking
Ginger Nut
7.3
5.2
Nice
7.3
4.2
Chocolate Digestive
7.5
7.9
Rich Tea
7.4
7.1
Tea or Coffee
served at 65-70 Celsius
Bourbon
7.1
6.5
Jammy Dodger
7.7
8.5
Chocolate Cookie
5.2
7.6
Custard Cream
3.5
8.2
Through extensive research at the Green Hat office we have produced this helpful guide for those who like to dunk their biscuits, without fear of floppage!
www.greenhatdesign.co.uk
Disclaimer:
This research was carried out by graphic designers with no formal training in any field of scientific research whatsoever, in a studio which was not a controlled environment. Therefore all results should be treated with biscuit firmly in cheek.

➔ Radial





FLORENCE NIGHTINGALE (C. 1858)


Parallel
cylinders
displacement (cc)
power (hp)
weight (lb)
0-60 mph (s)
year
Note: Higher is worse

Davies, 2019

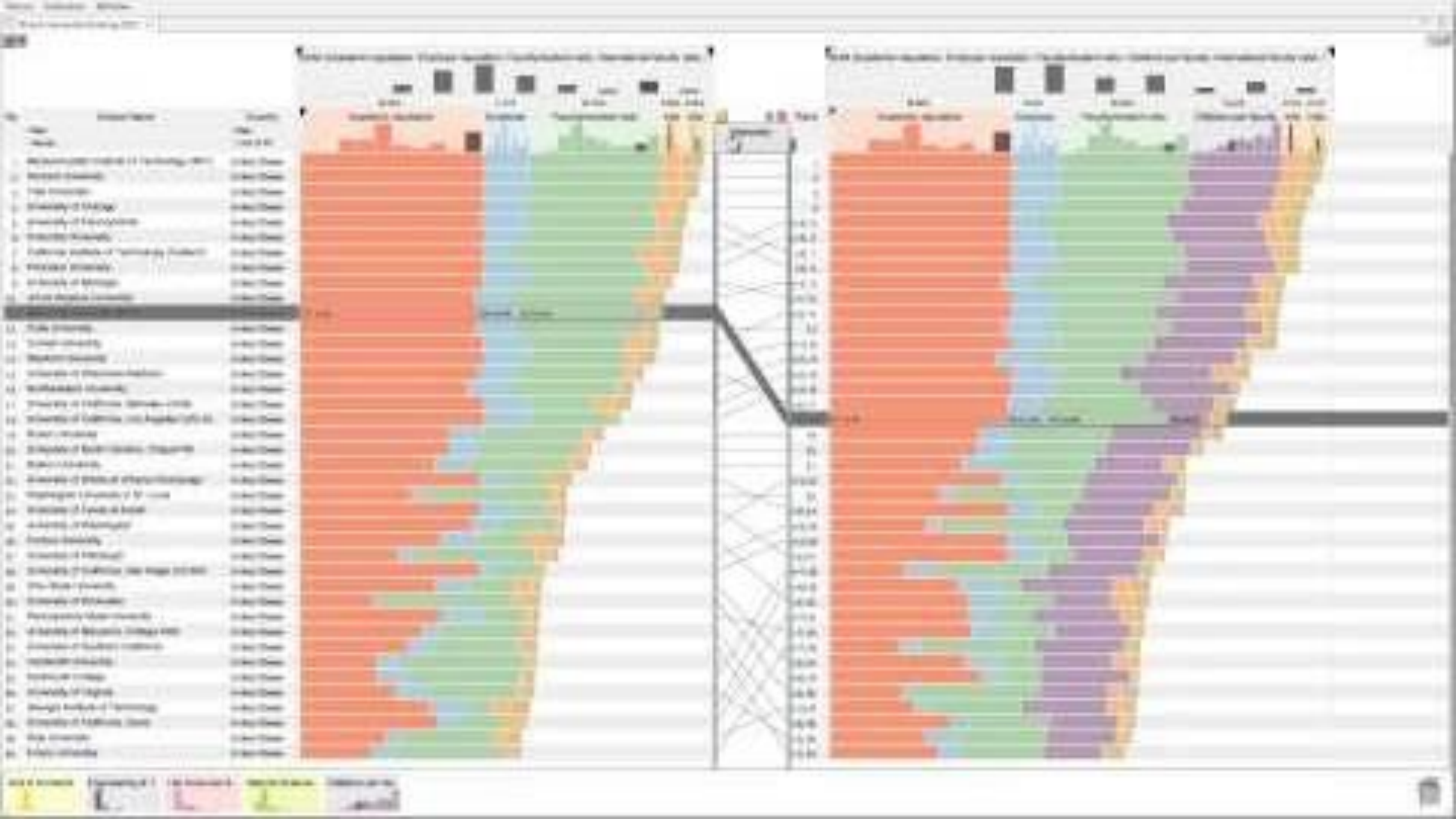
Arrange Tables — Many Keys (Tree)

- *Many Keys*
  Recursive Subdivision

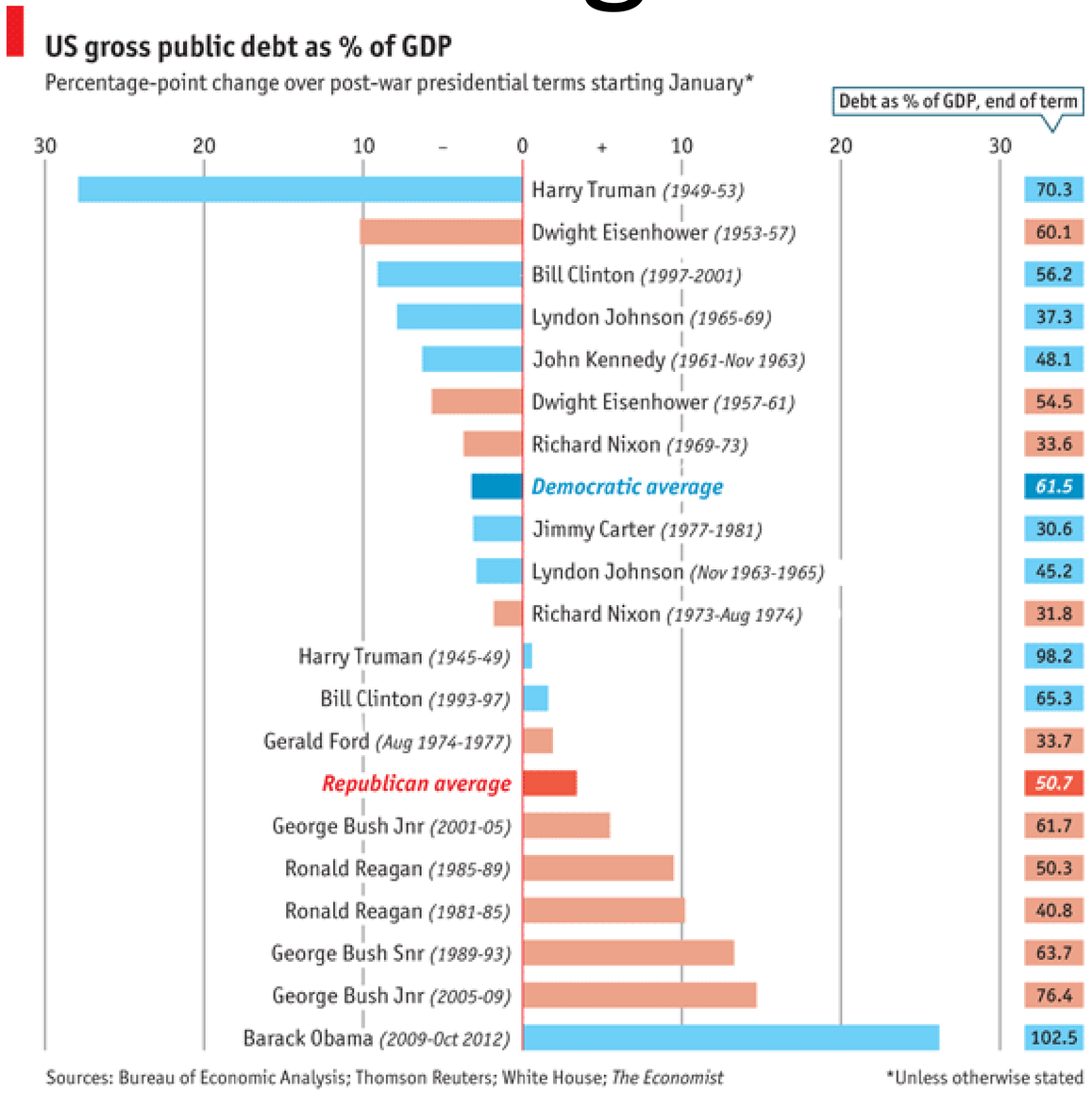
finviz, 2020

How to handle multiple keys...?


Rankings are omnipresent

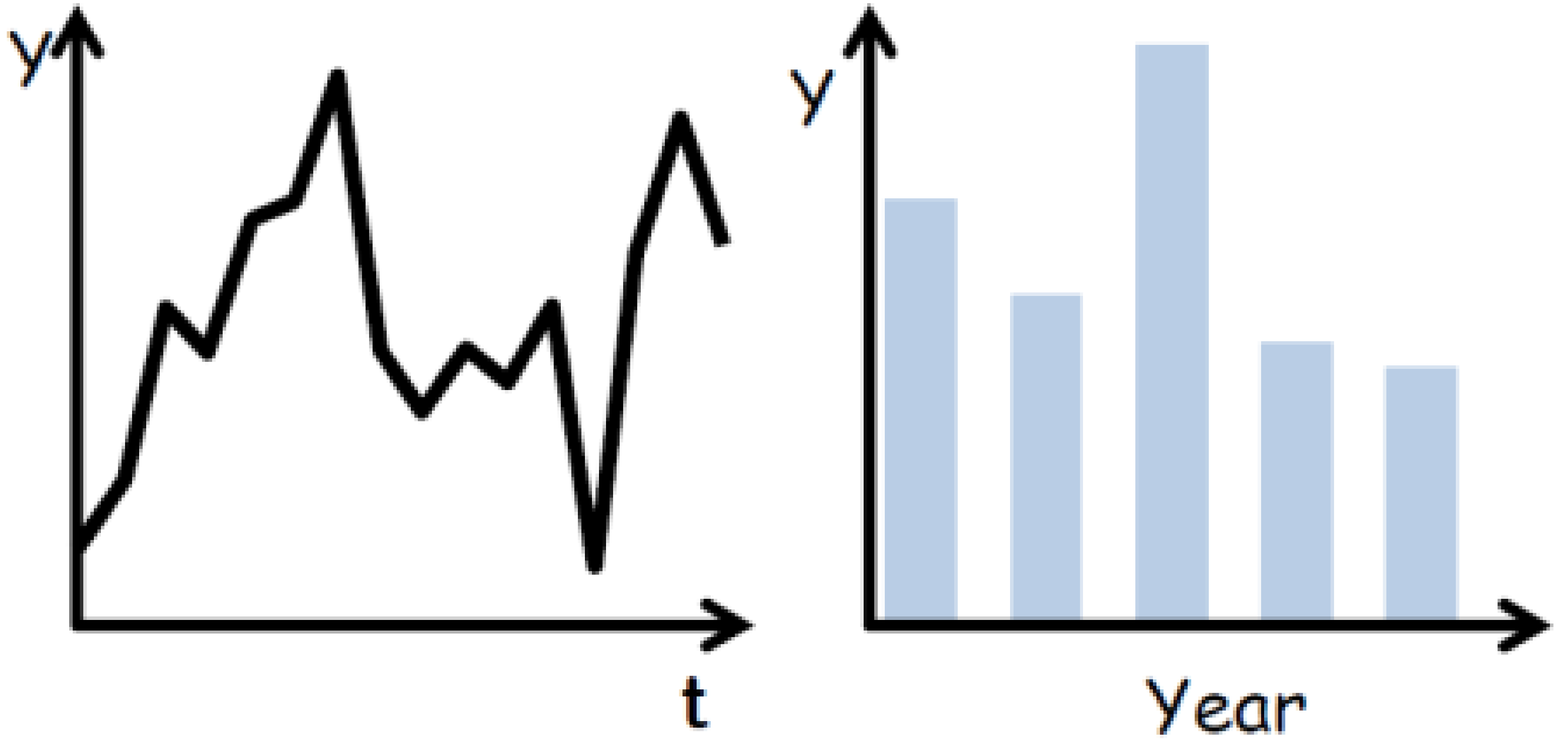


Divergent



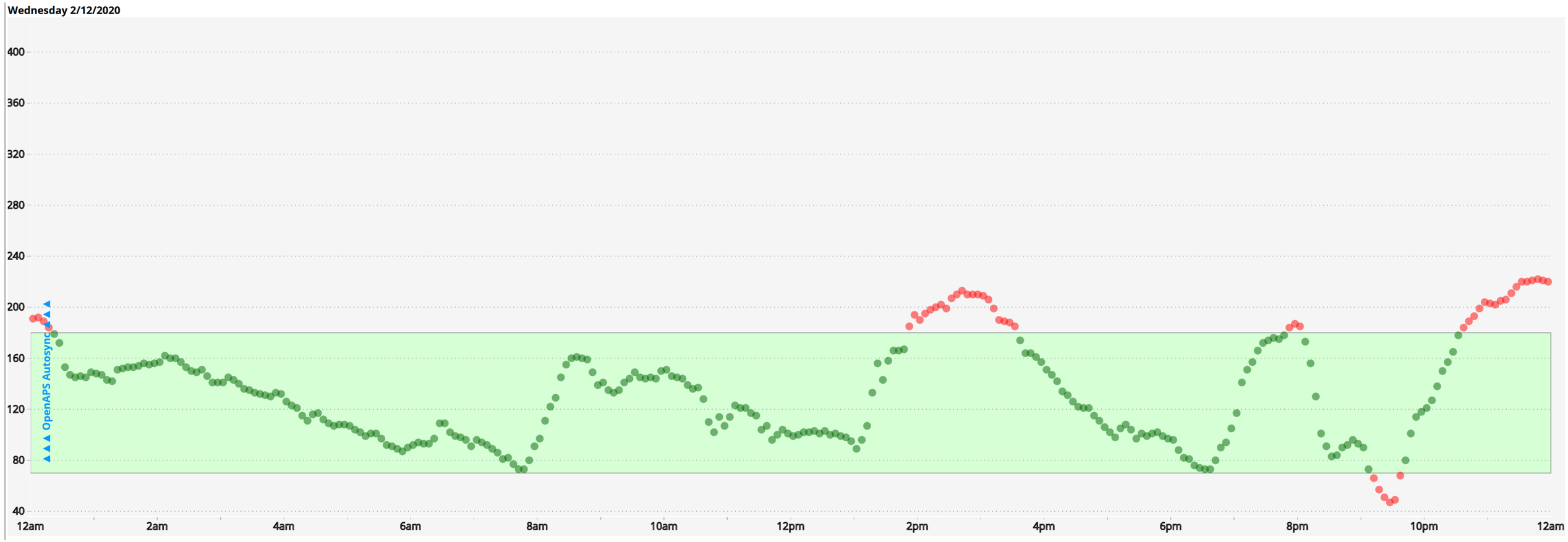
The Economist, 2012

Time Series



(Quantitative data over time)

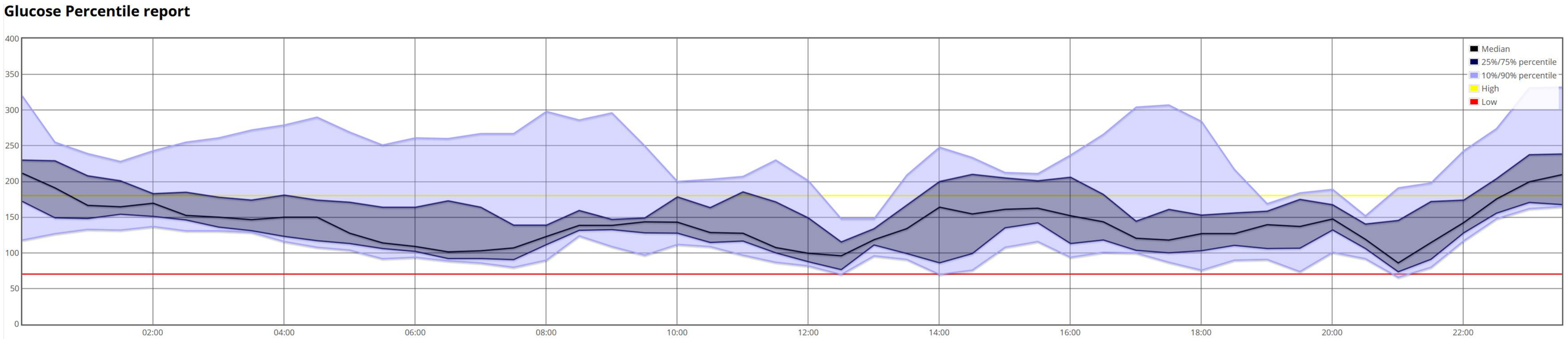
Time Series



(Quantitative data over time)

Cody Dunne, Nightscout Foundation, 2020

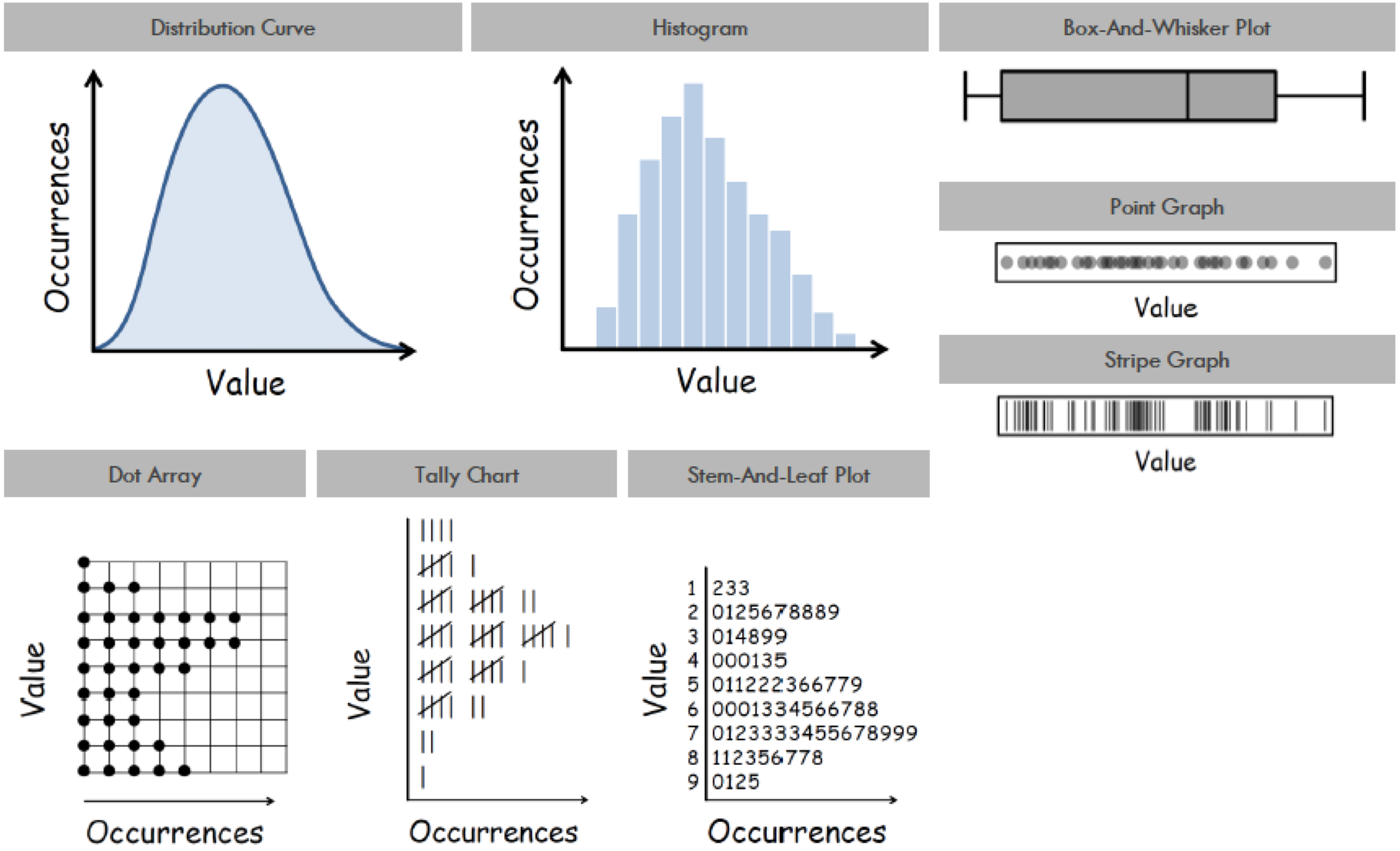
Time Series Distributions



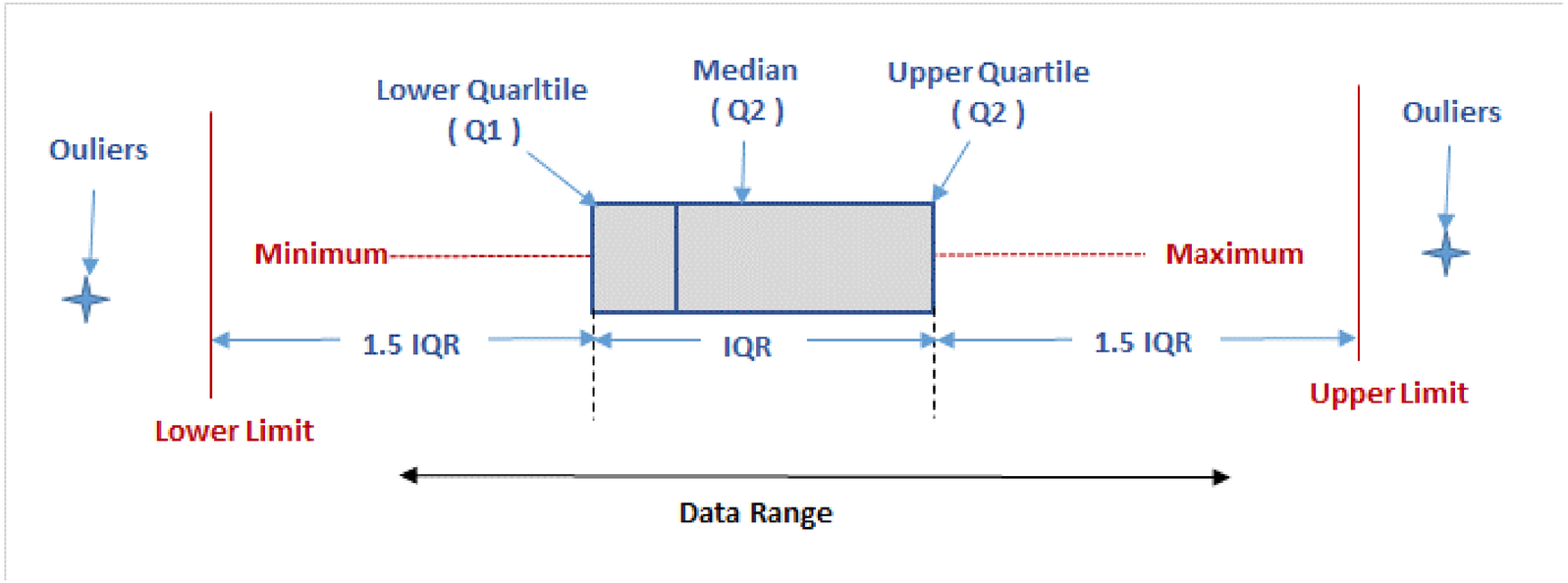
(Quantitative data over time)

Cody Dunne, Nightscout Foundation, 2020

Distributions & Correlations

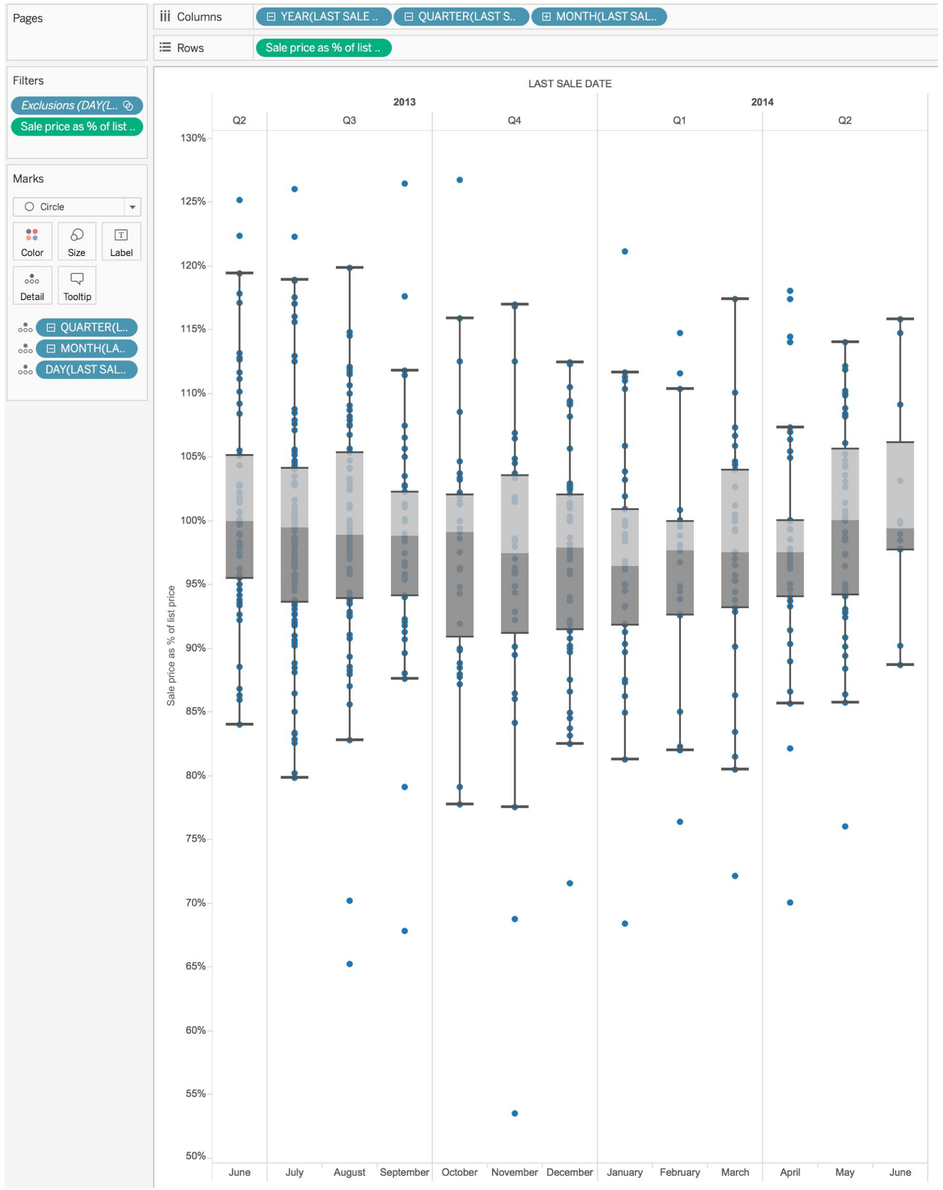


Distributions & Correlations

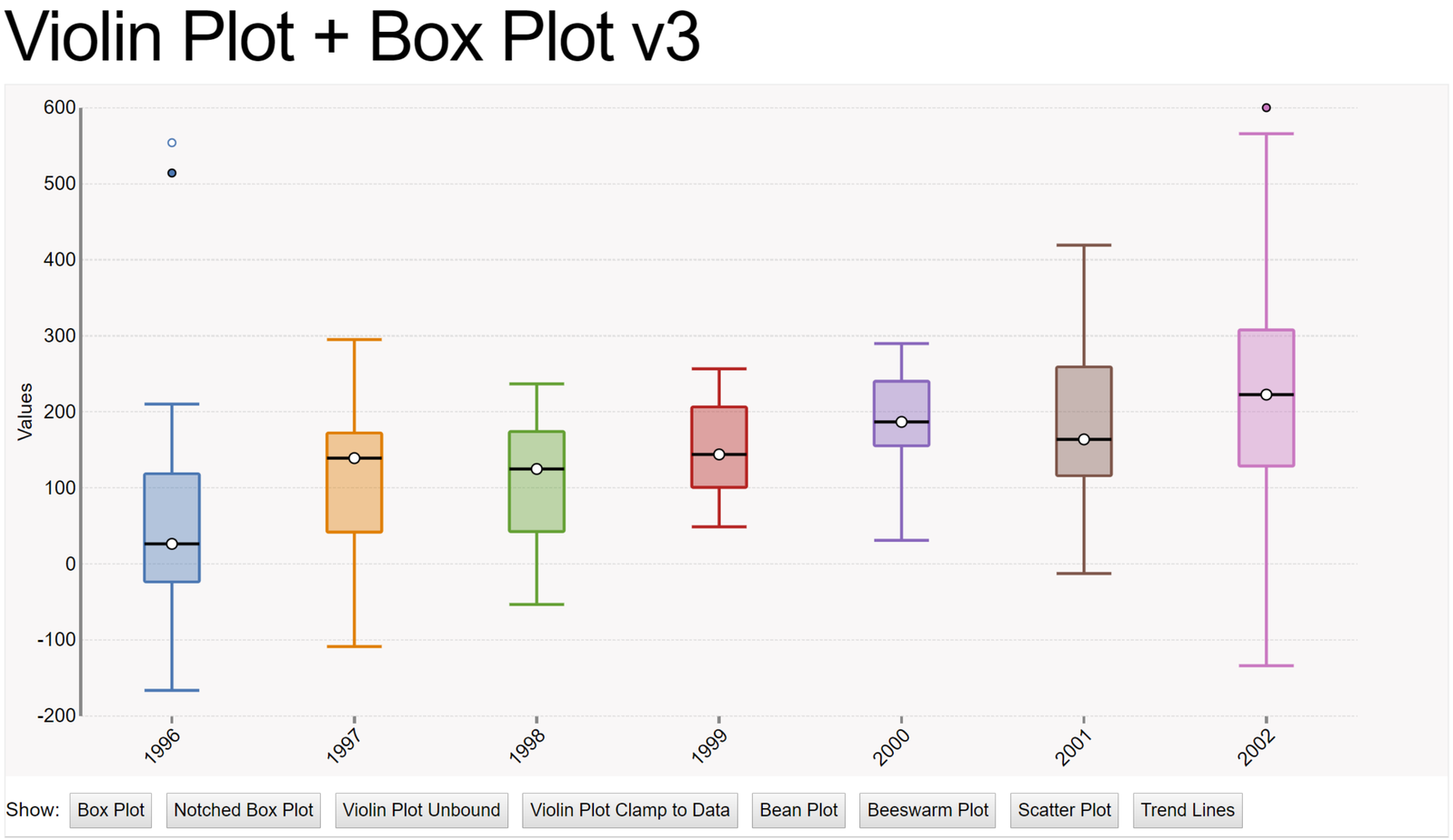


BOX AND WHISKER PLOT

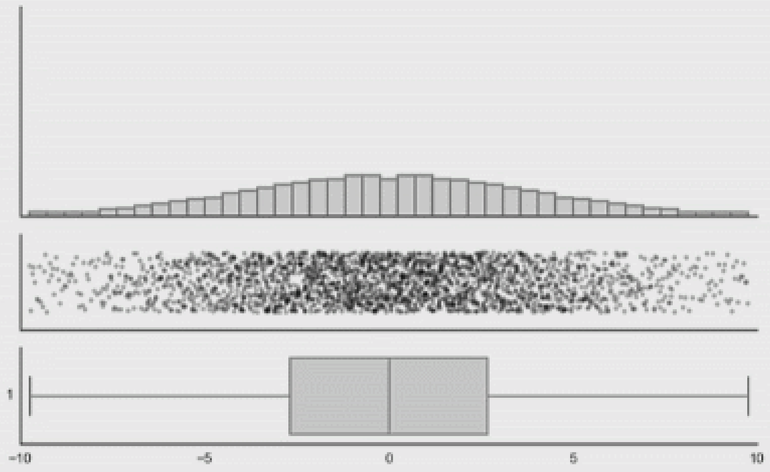
Distributions & Correlations

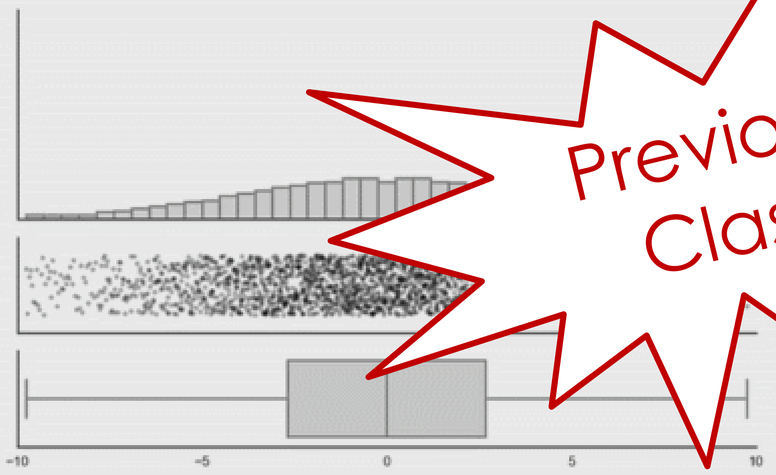


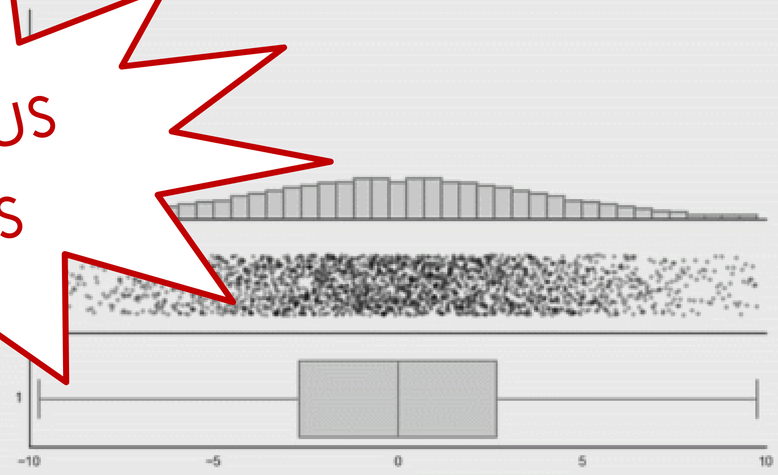
Distributions & Correlations



Interactive, : Sielen, 2018

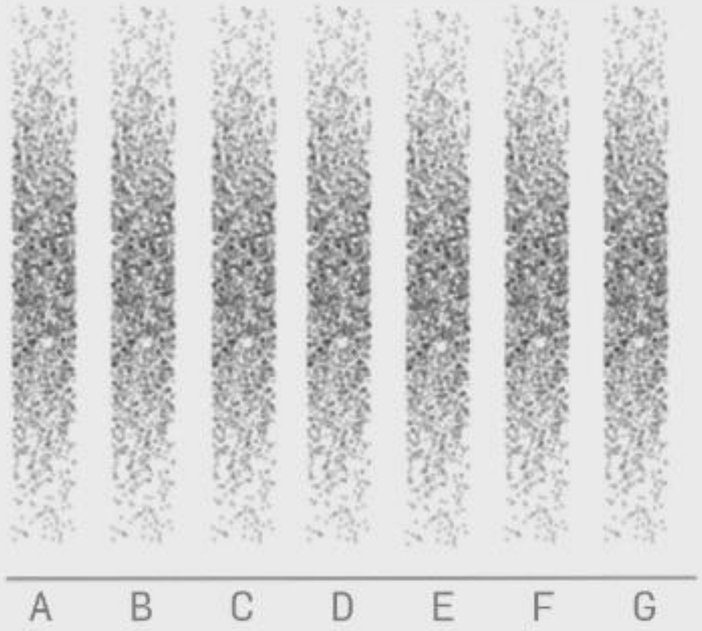




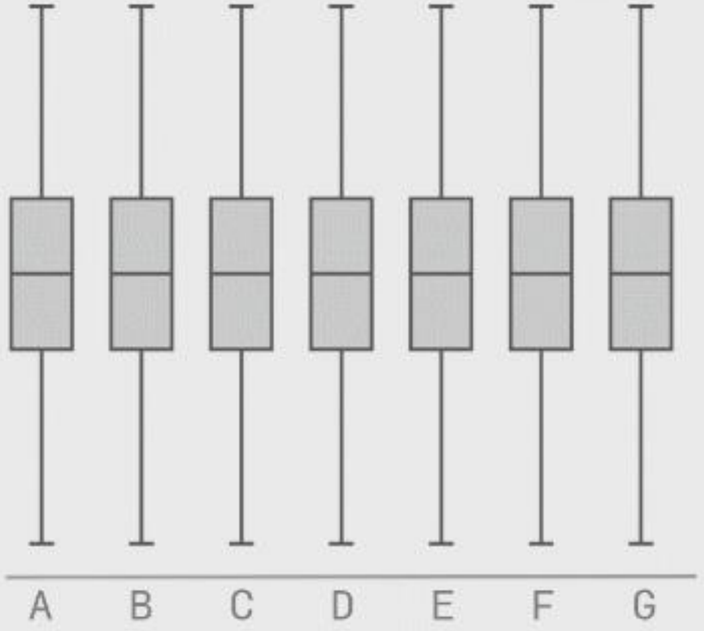


Previous Class

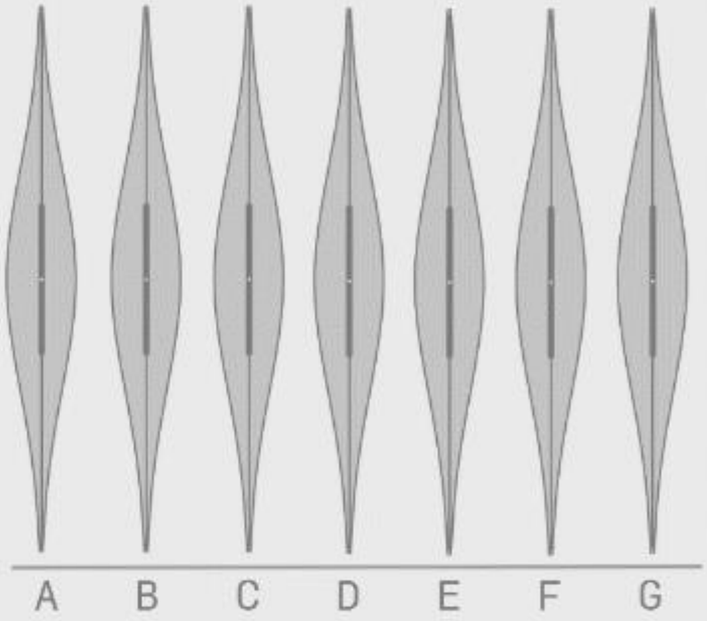
Raw Data



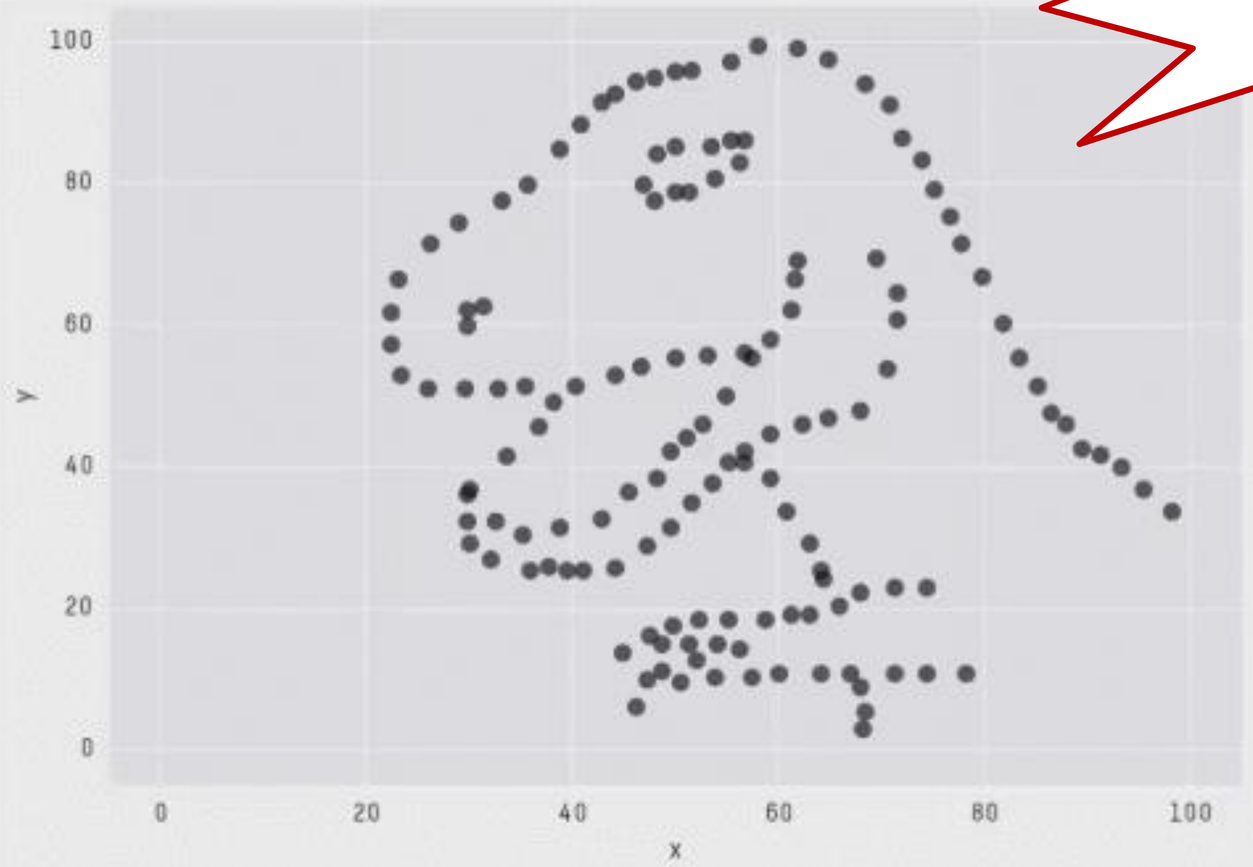
Box-plot of the Data



Violin-plot of the Data



Matejka &Fitzmaurice, 2017



Previous Class

X Mean: 54.2659224
Y Mean: 47.8313999
X SD : 16.7649829
Y SD : 26.9342120
Corr. : -0.0642526

Matejka &Fitzmaurice, 2017

For Next Time

neu-ds-4200-f23.github.io/schedule/

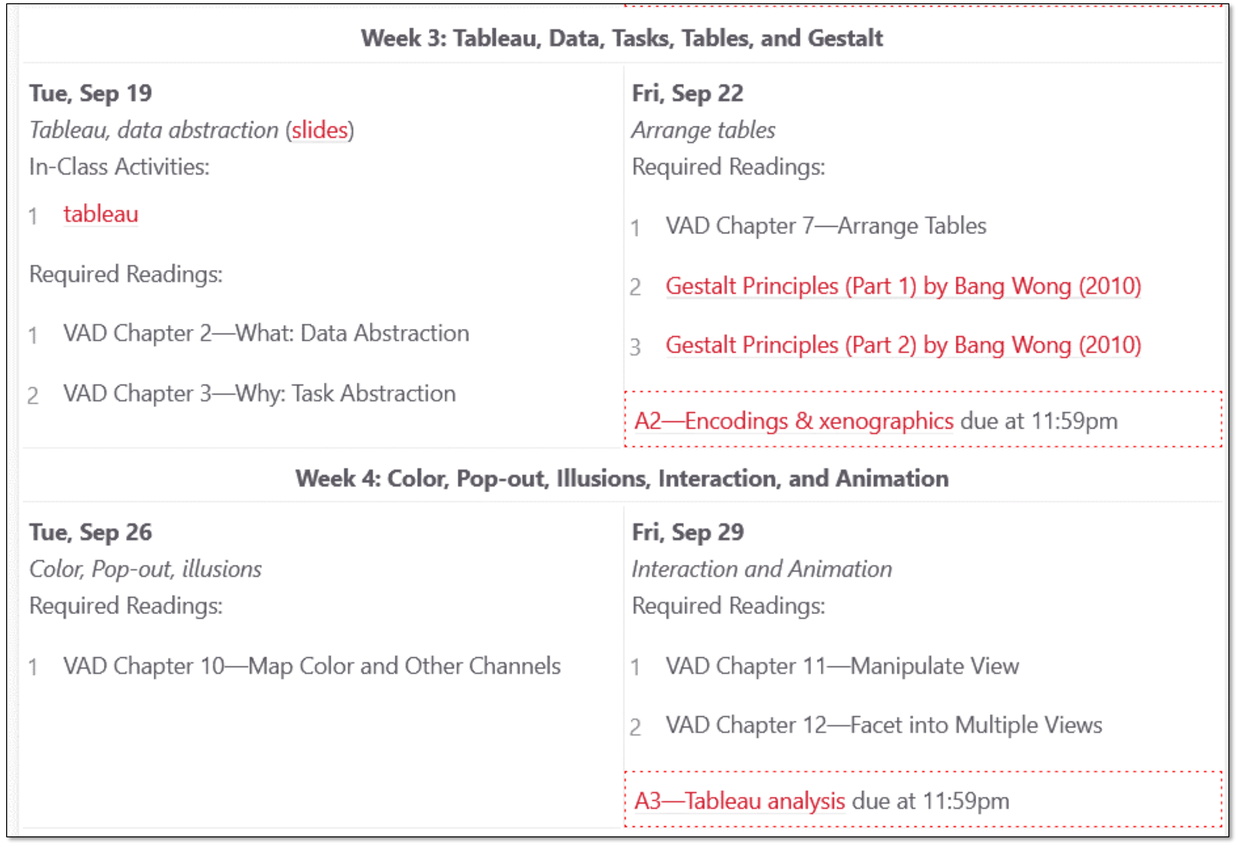
Look at the upcoming assignments and deadlines

- Textbook, Readings, & Reading Quizzes—Variable days
- In-Class Activities—If due, they are due 11:59pm the same day as class

Everyday Required Supplies:

- 5+ colors of pen or marker
- White paper
- Laptop and charger

Use Slack for general questions, email codydunne-and-tas@ccs.neu.edu for questions specific to you.



Week 3: Tableau, Data, Tasks, Tables, and Gestalt

Tue, Sep 19
Tableau, data abstraction (slides)
In-Class Activities:
1 tableau
Required Readings:
1 VAD Chapter 2—What: Data Abstraction
2 VAD Chapter 3—Why: Task Abstraction

Fri, Sep 22
Arrange tables
Required Readings:
1 VAD Chapter 7—Arrange Tables
2 Gestalt Principles (Part 1) by Bang Wong (2010)
3 Gestalt Principles (Part 2) by Bang Wong (2010)
A2—Encodings & xenographics due at 11:59pm

Week 4: Color, Pop-out, Illusions, Interaction, and Animation

Tue, Sep 26
Color, Pop-out, illusions
Required Readings:
1 VAD Chapter 10—Map Color and Other Channels

Fri, Sep 29
Interaction and Animation
Required Readings:
1 VAD Chapter 11—Manipulate View
2 VAD Chapter 12—Facet into Multiple Views
A3—Tableau analysis due at 11:59pm