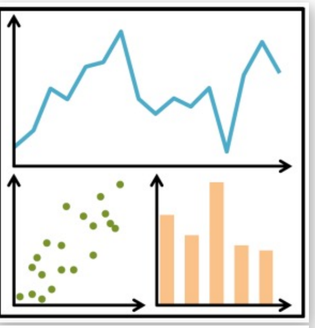
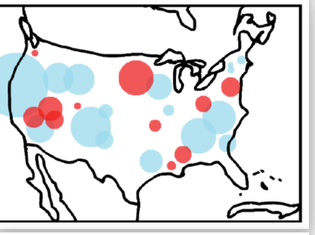
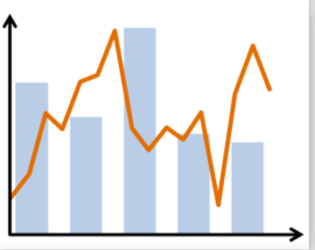
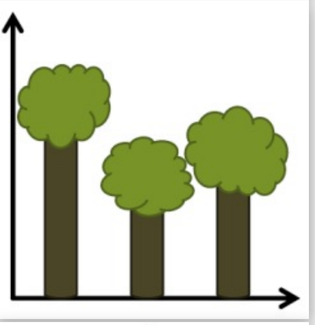
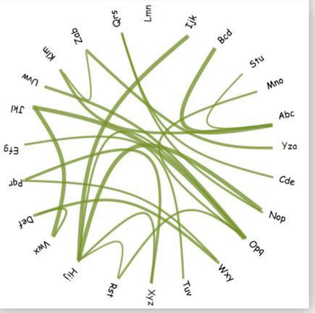






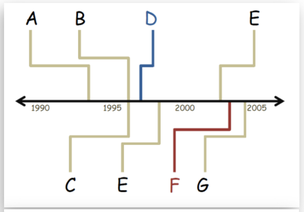
Lecture 5: Marks and Channels

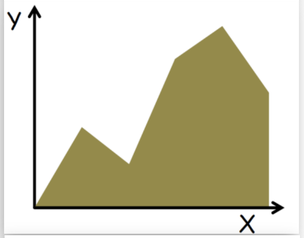
DS 4200

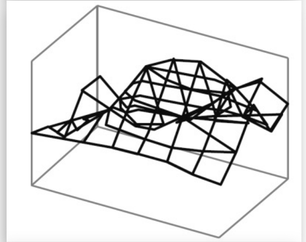
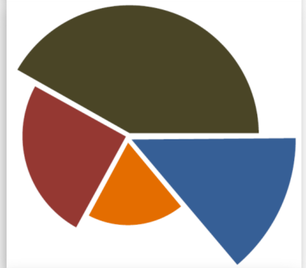
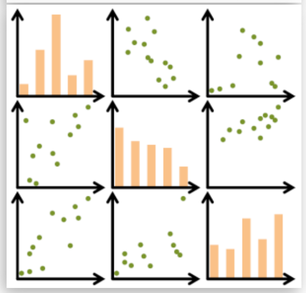
SPRING 2023

Prof. Ab Mosca (they/them)

NORTHEASTERN UNIVERSITY





Slides and inspiration from Cody Dunne, Michelle Borkin, Dylan Cashman, Krzysztof Gajos, Hanspeter Pfister, Miriah Meyer, Jonathan Schwabish, and David Sprague

Last Class

We:

- Reviewed task abstraction
- Practiced interviewing domain experts

Any Questions?

Today

- Marks and Channels

Visualization Design Process

From Munzner's book

Visualization Building Blocks

What?

Why?

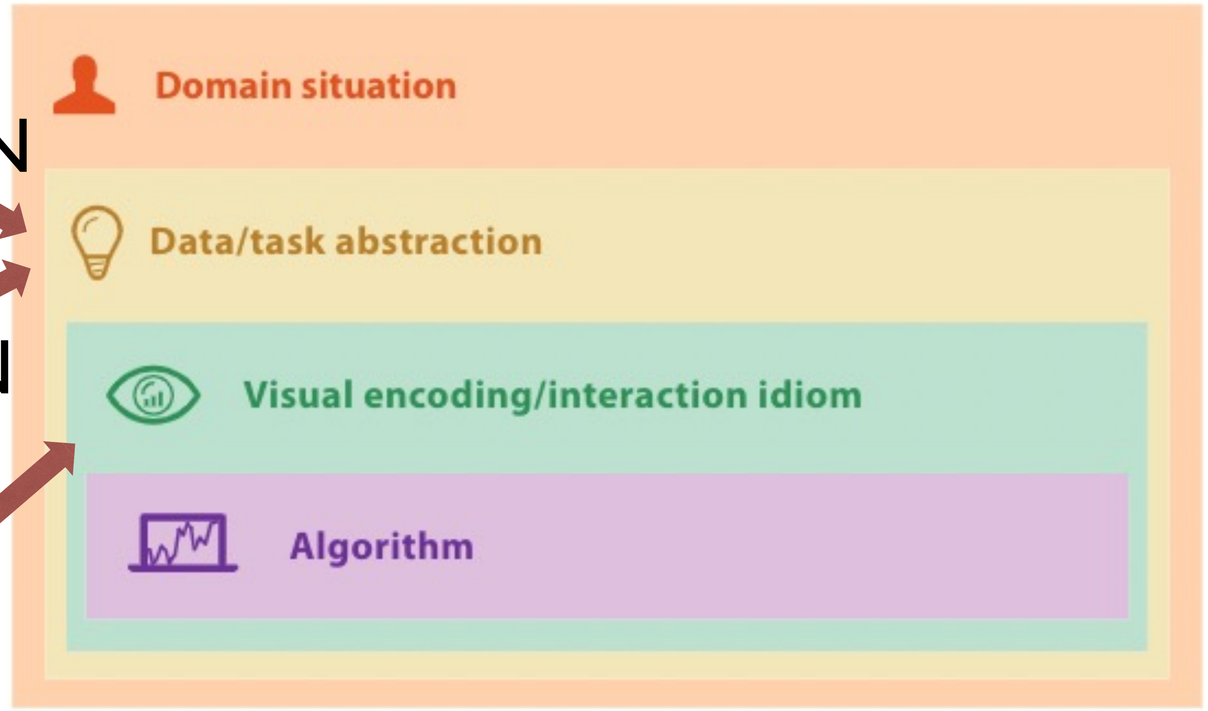
How?

DATA ABSTRACTION

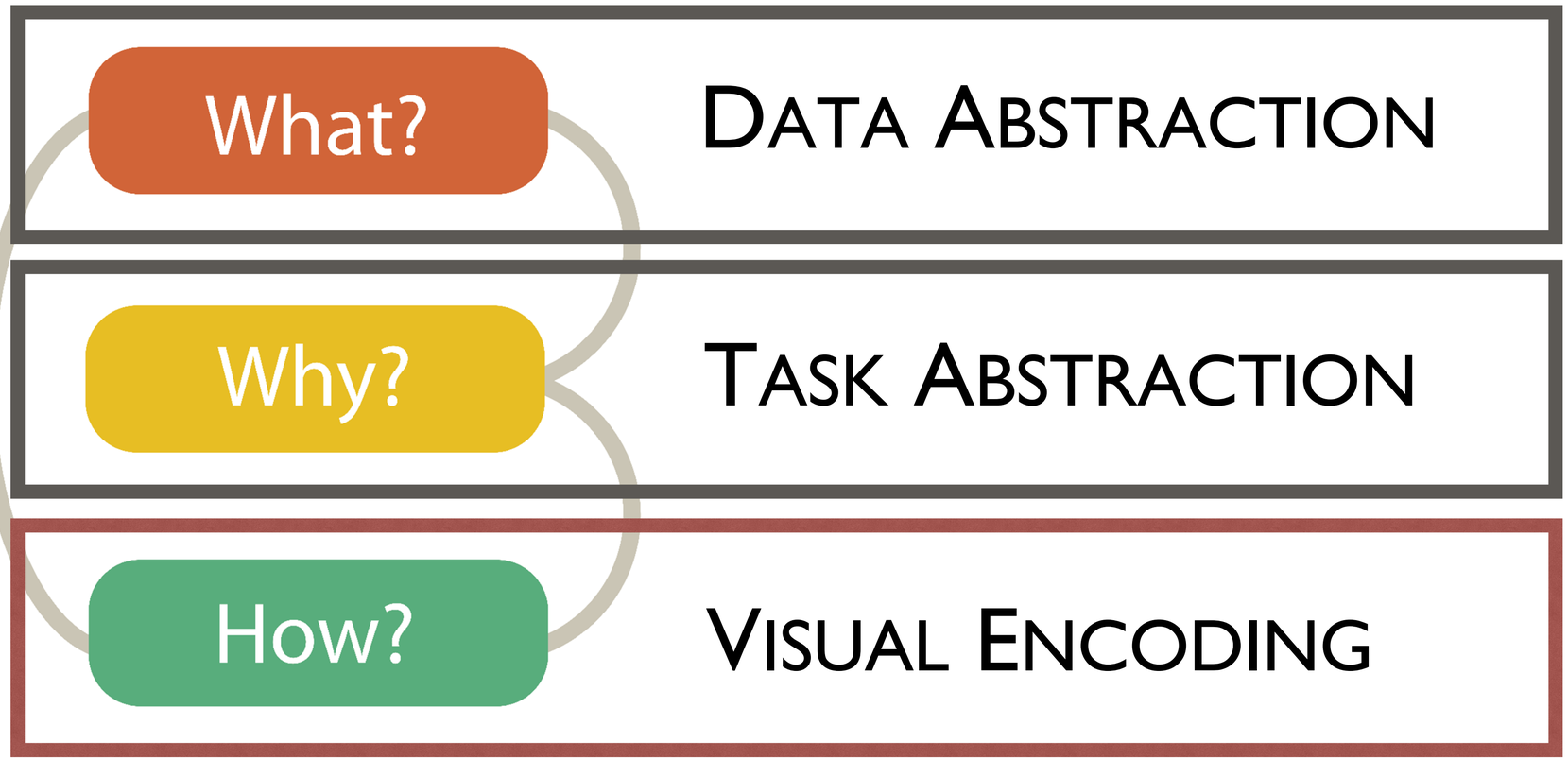
TASK ABSTRACTION

VISUAL ENCODING

Munzner's Nested Model



Visualization Building Blocks



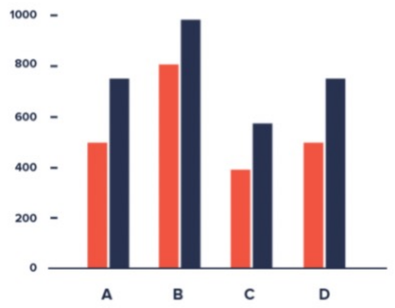
Visual Encoding

From Munzner's book

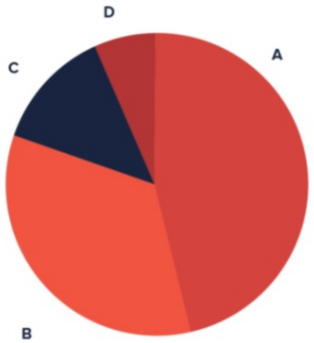
Visual Encoding

What is it? The literal representation of data in a visualization.

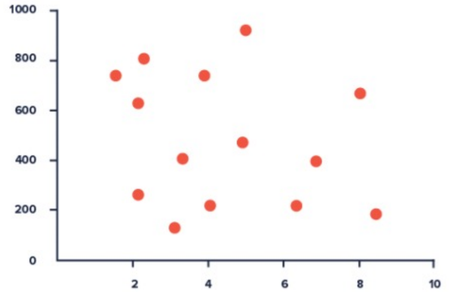
Grouped Bar Chart



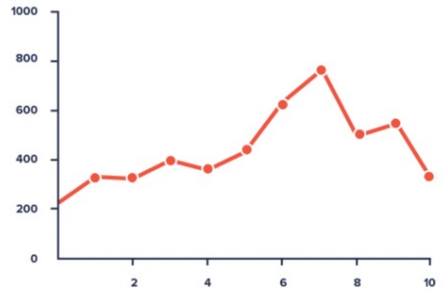
Pie Chart



Scatter Plot



Line Graph

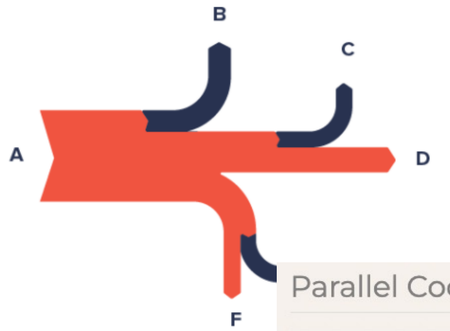


https://datavizproject.com/

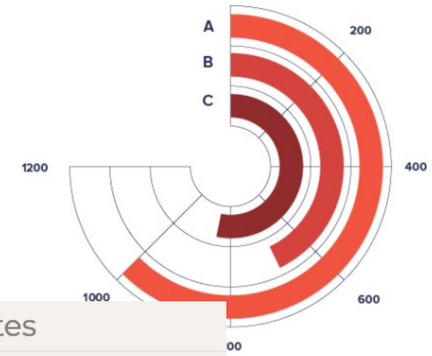
Visual Encoding

What is it? The literal representation of data in a visualization.

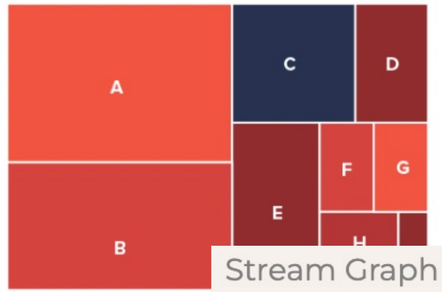
Sankey Diagram



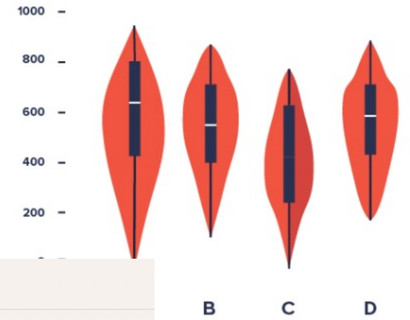
Radial Bar Chart



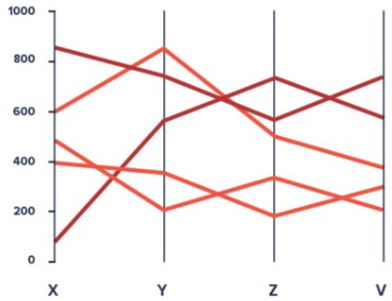
Treemap



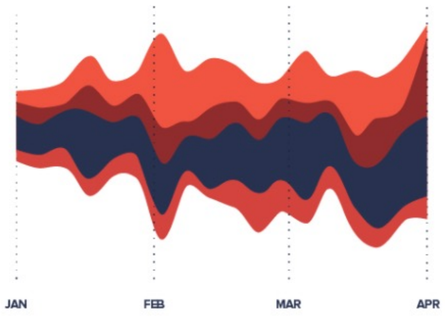
Violin Plot



Parallel Coordinates



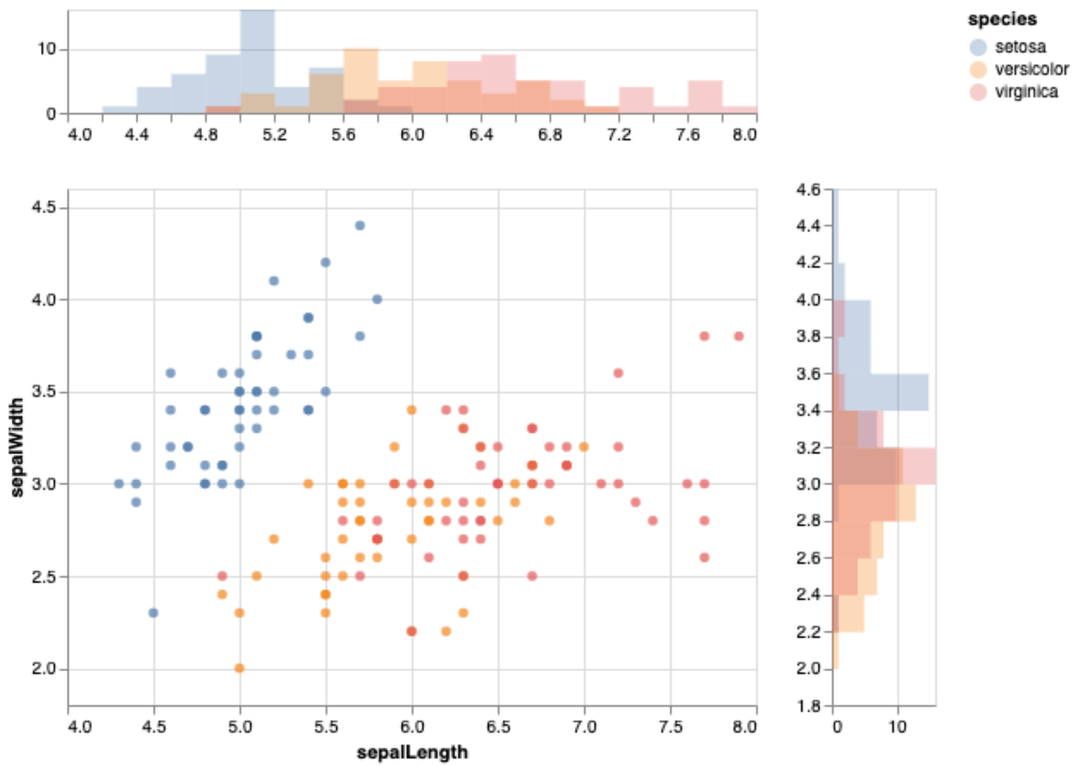
Stream Graph

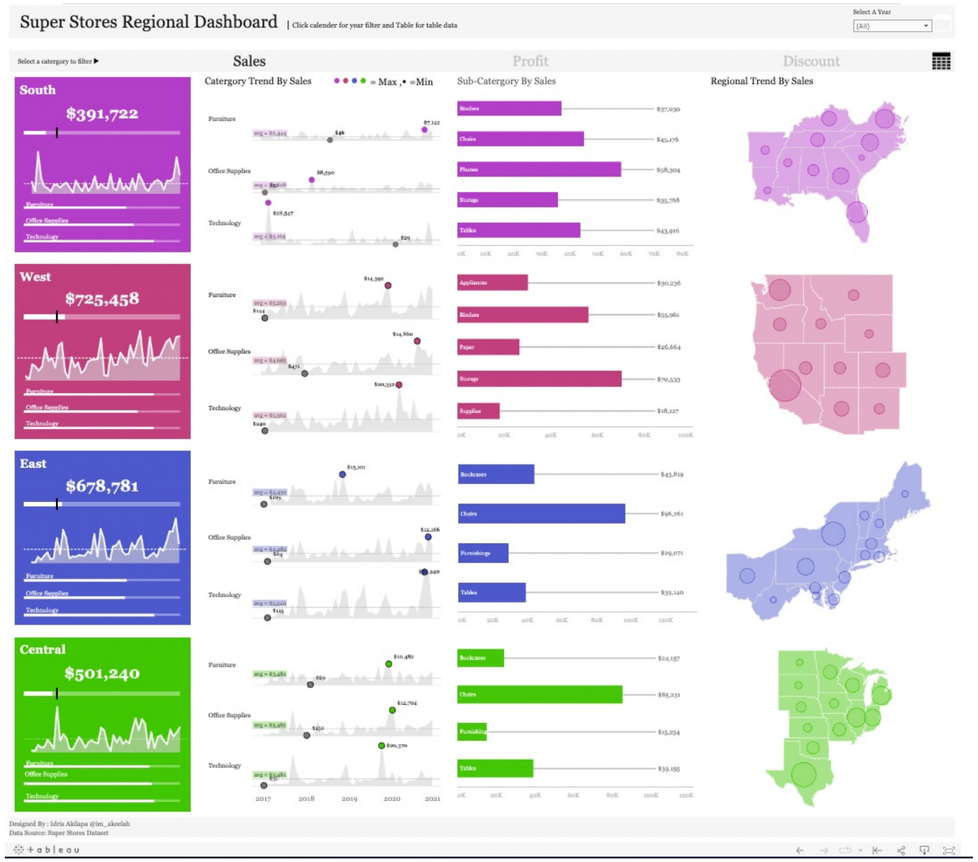


https://datavizproject.com/

Visual Encoding

What is it? The literal representation of data in a visualization.



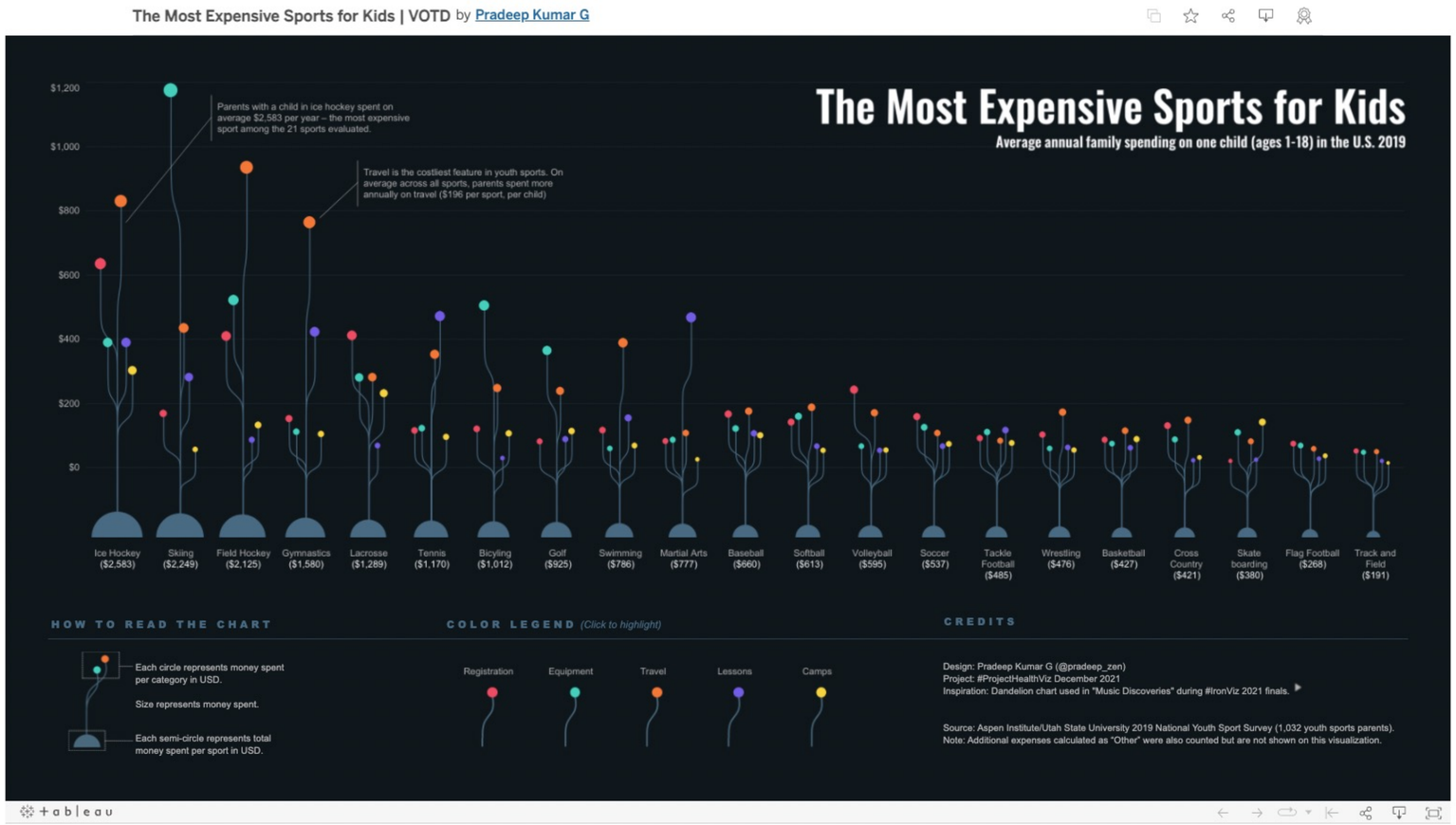


https://altair-viz.github.io/gallery/index.html

https://public.tableau.com/app/profile/akilapa.idris5302/viz/SuperStoresRegionalDashboard/SuperStoreRegionalDashboard

Visual Encoding

What is it? The literal representation of data in a visualization.



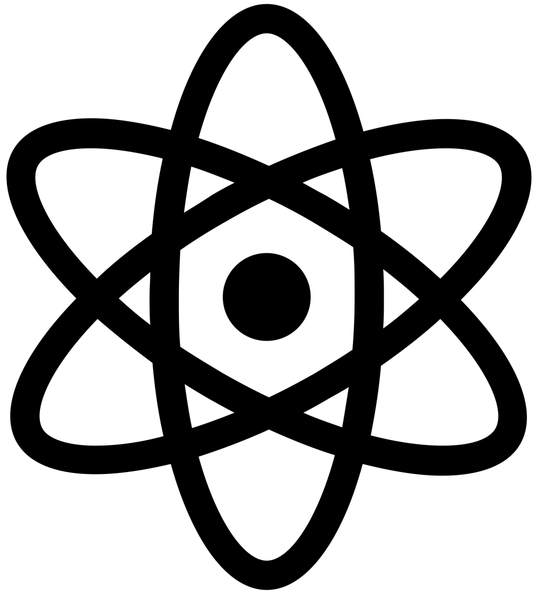
https://public.tableau.com/app/profile/pradeepkumar.g/viz/TheMostExpensiveSportsforKids/ProjectHealthViz

Marks and Channels

From Munzner's book

Marks and Channels

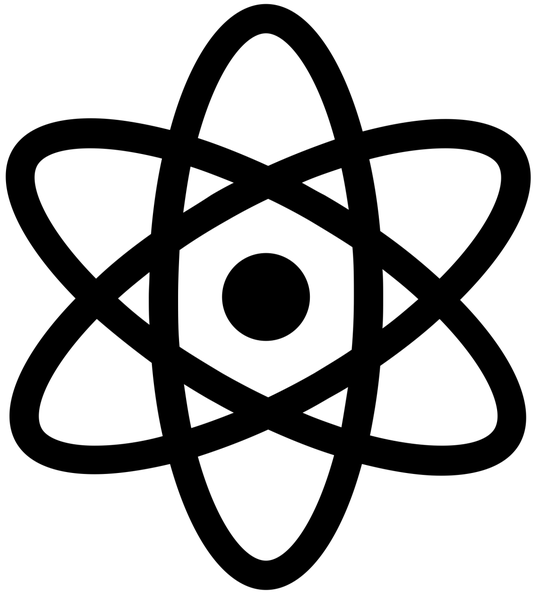
MARKS AND CHANNELS = basic visual primitives that make up visualizations



Marks and Channels

MARKS AND CHANNELS = basic visual primitives that make up visualizations

MARK = basic graphical element in an image



CHANNELS = ways to control the appearance of marks

Marks

MARK = basic graphical element in an image

Points

→ 0D

Lines

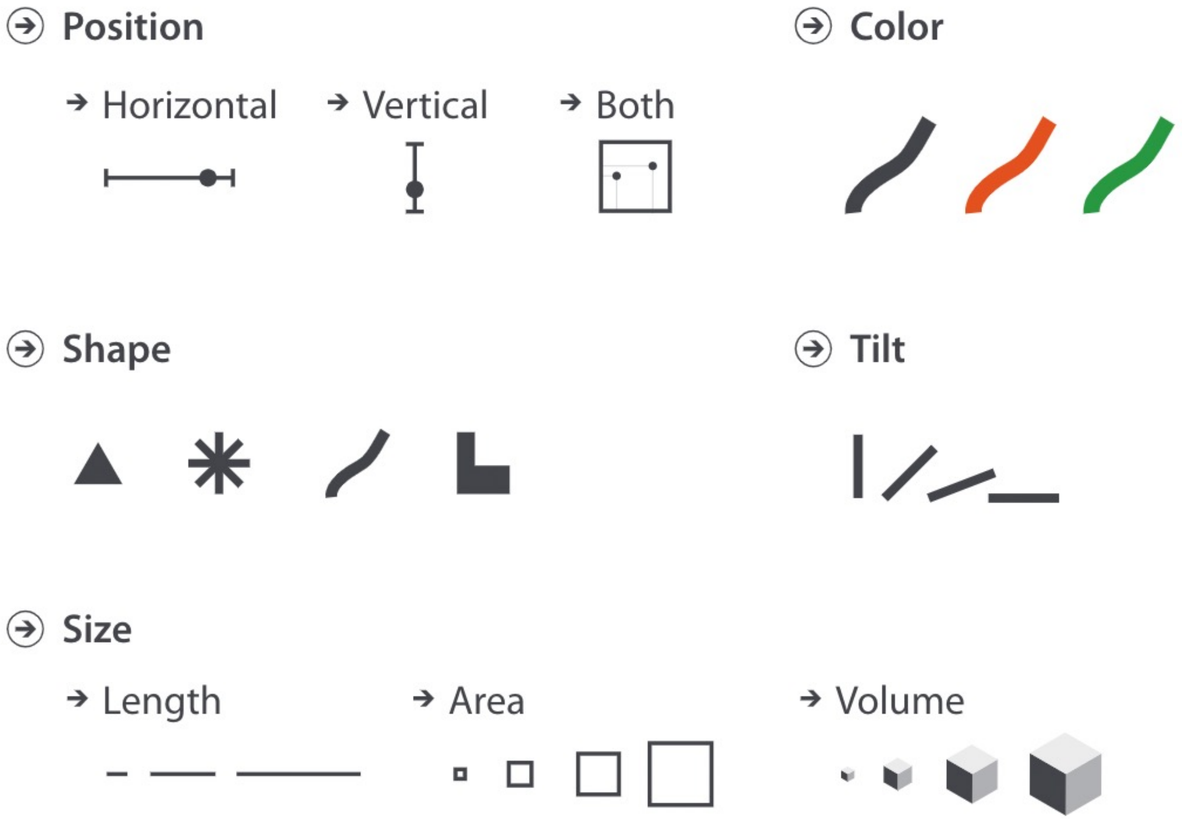
→ 1D (length)

Areas

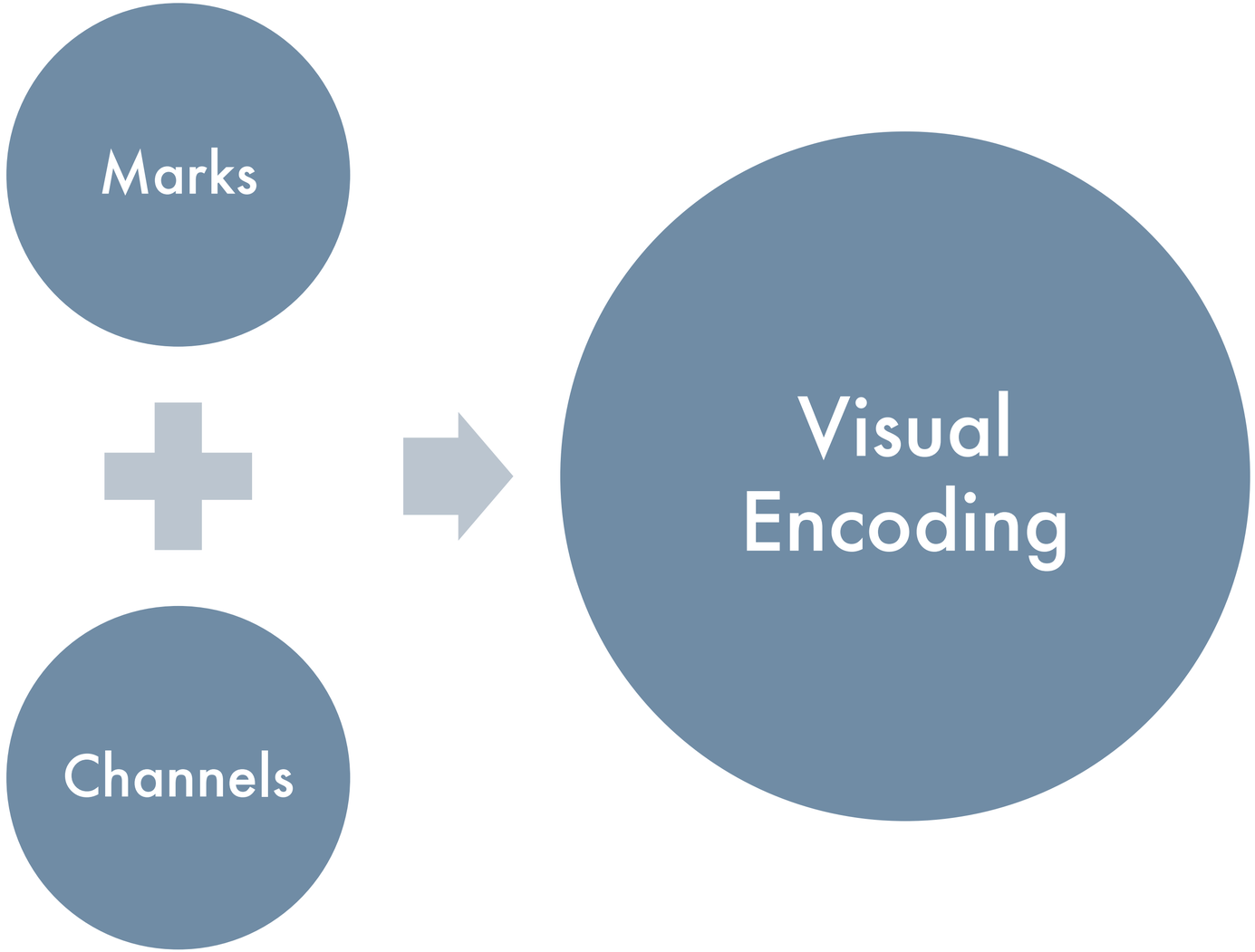
→ 2D (height, width)

Channels

CHANNEL = way to control the appearance of marks (independent of dimensions)

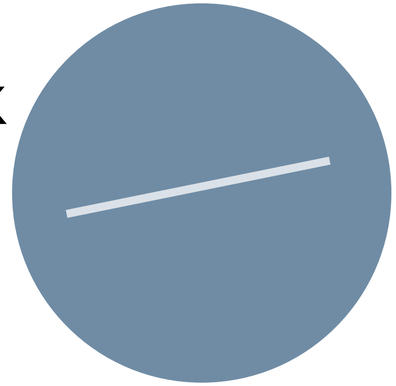


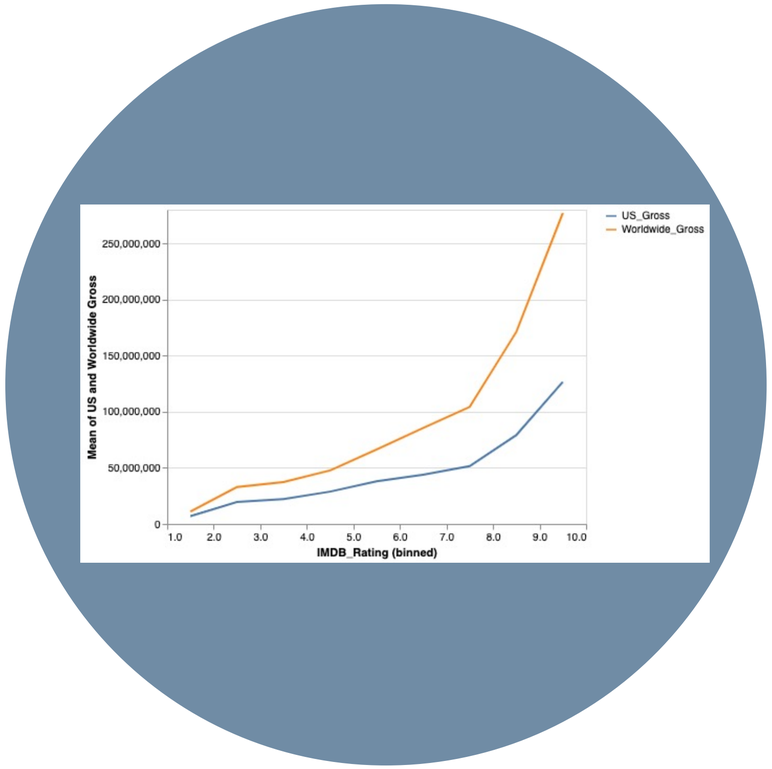
Visual Encoding



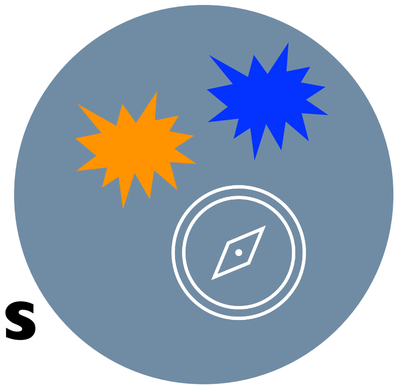
Visual Encoding

Mark





Visual Encoding (Line chart)



Channels

Visual Encoding

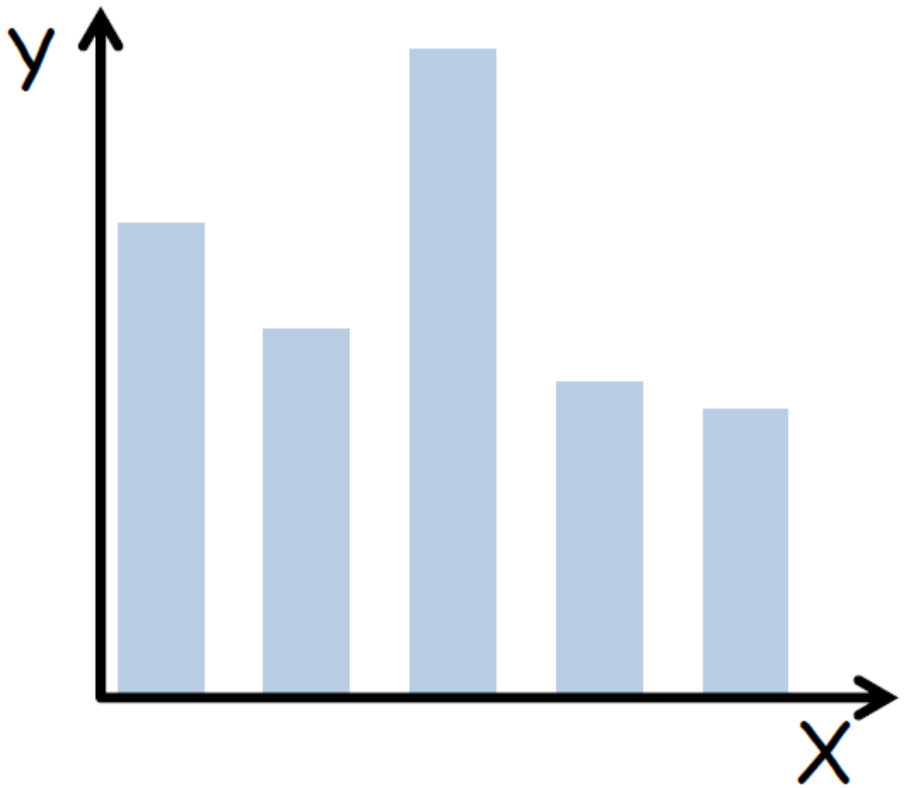
Mark

oding
art)

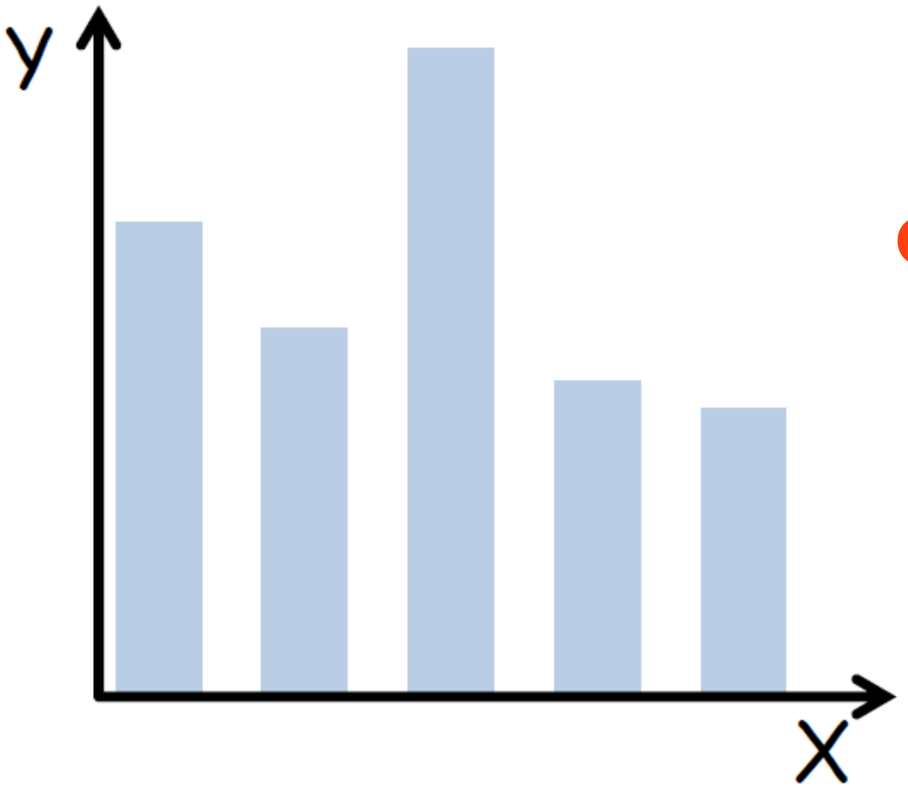
Channels

We can decompose any visualization into marks and channels

Visual Encoding

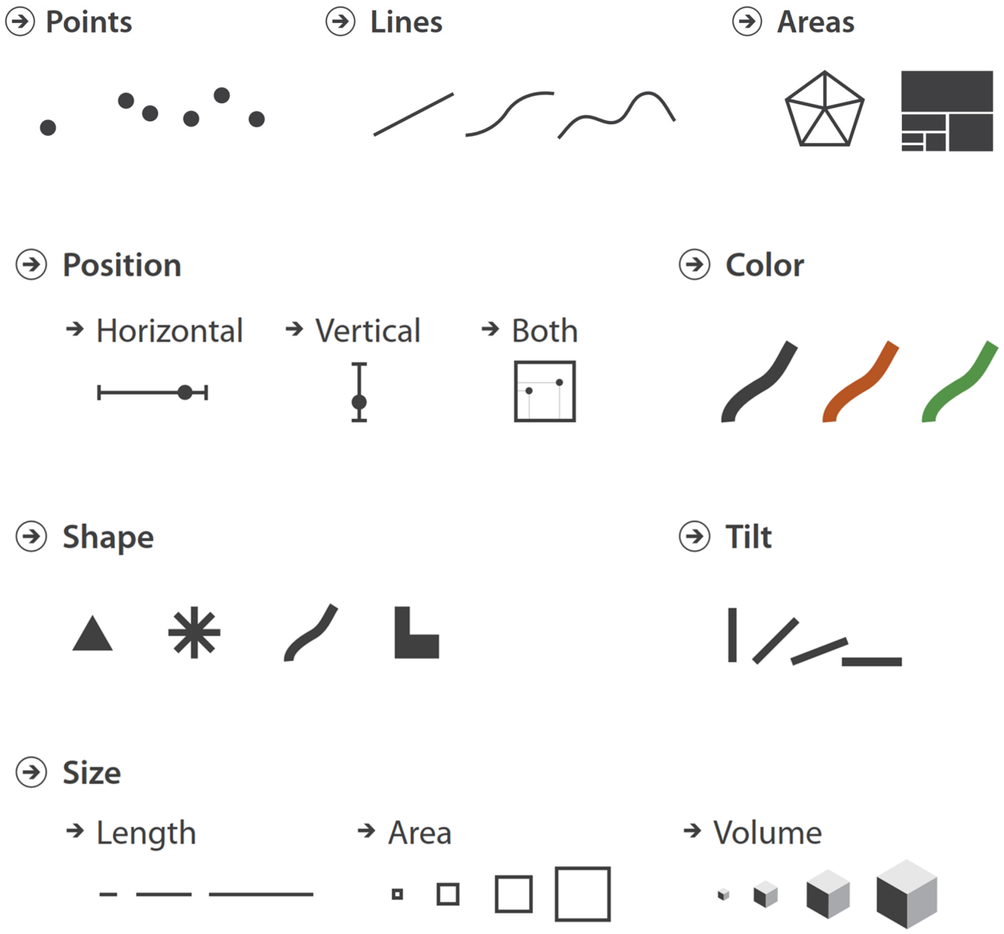


Visual Encoding

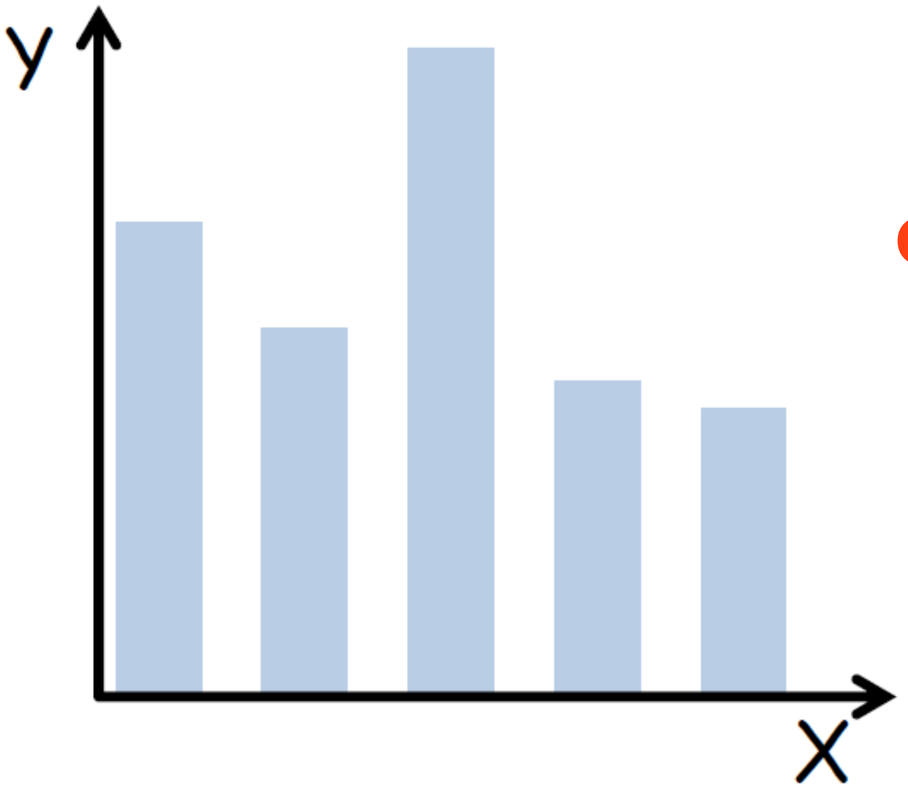


Marks

Channels

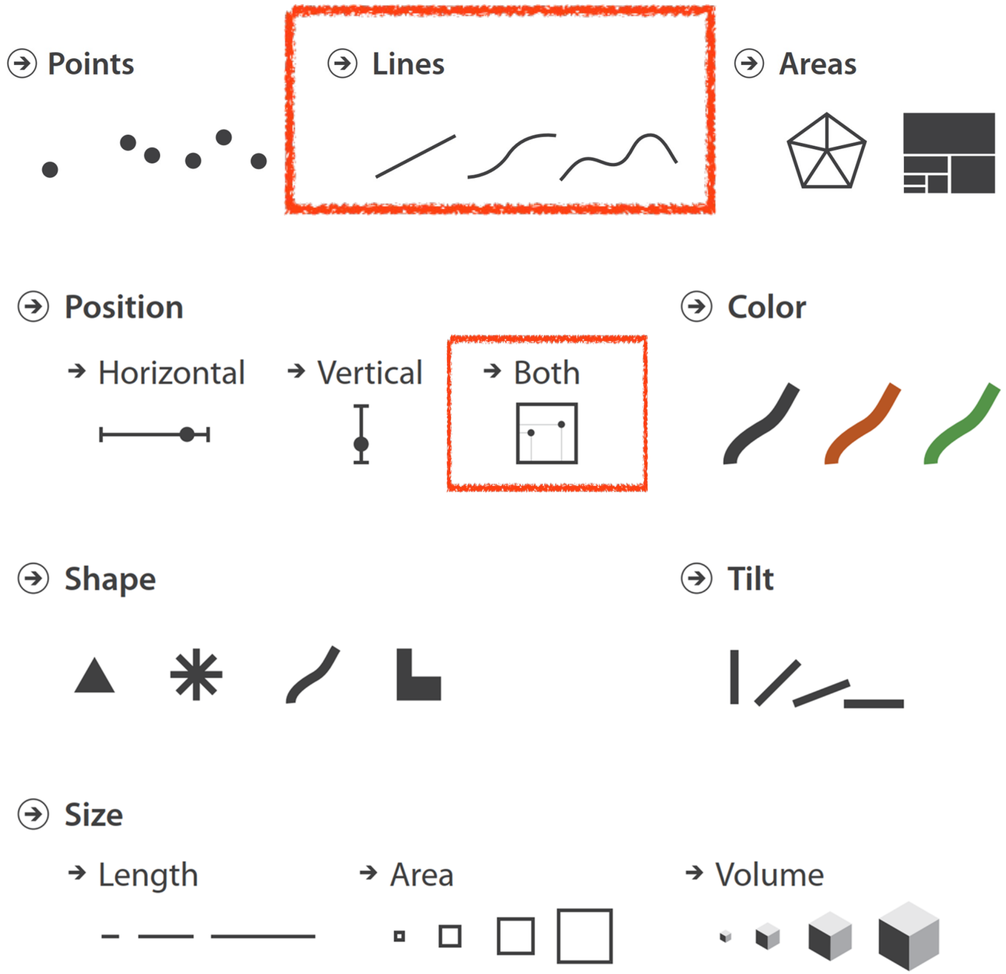


Visual Encoding



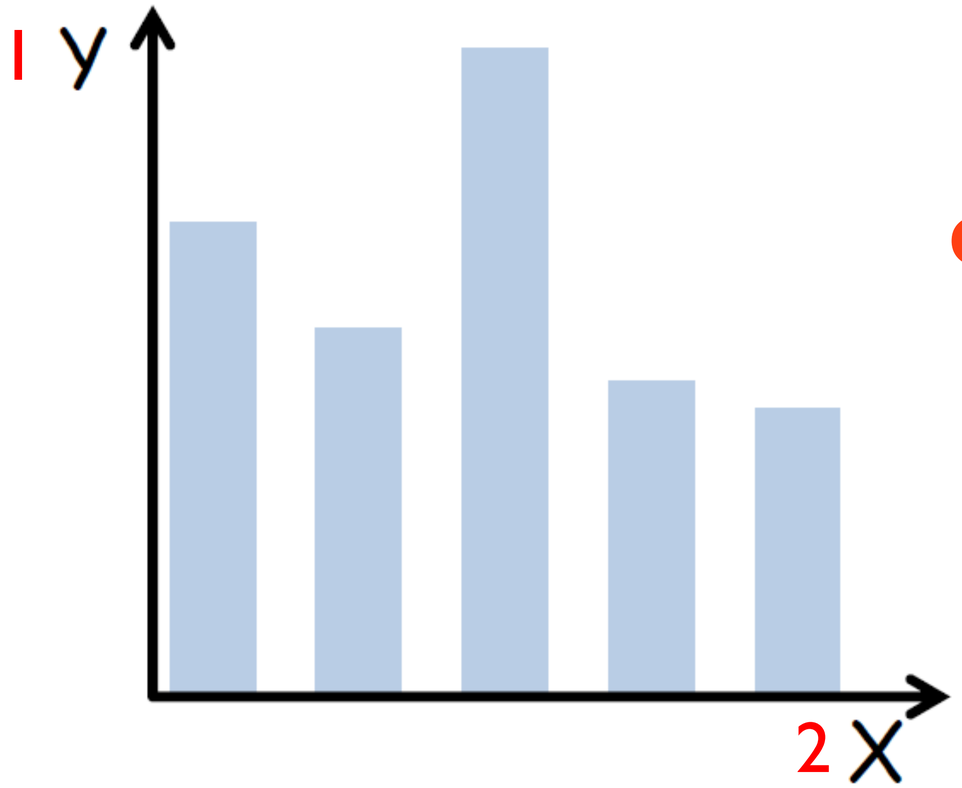
Marks

Channels



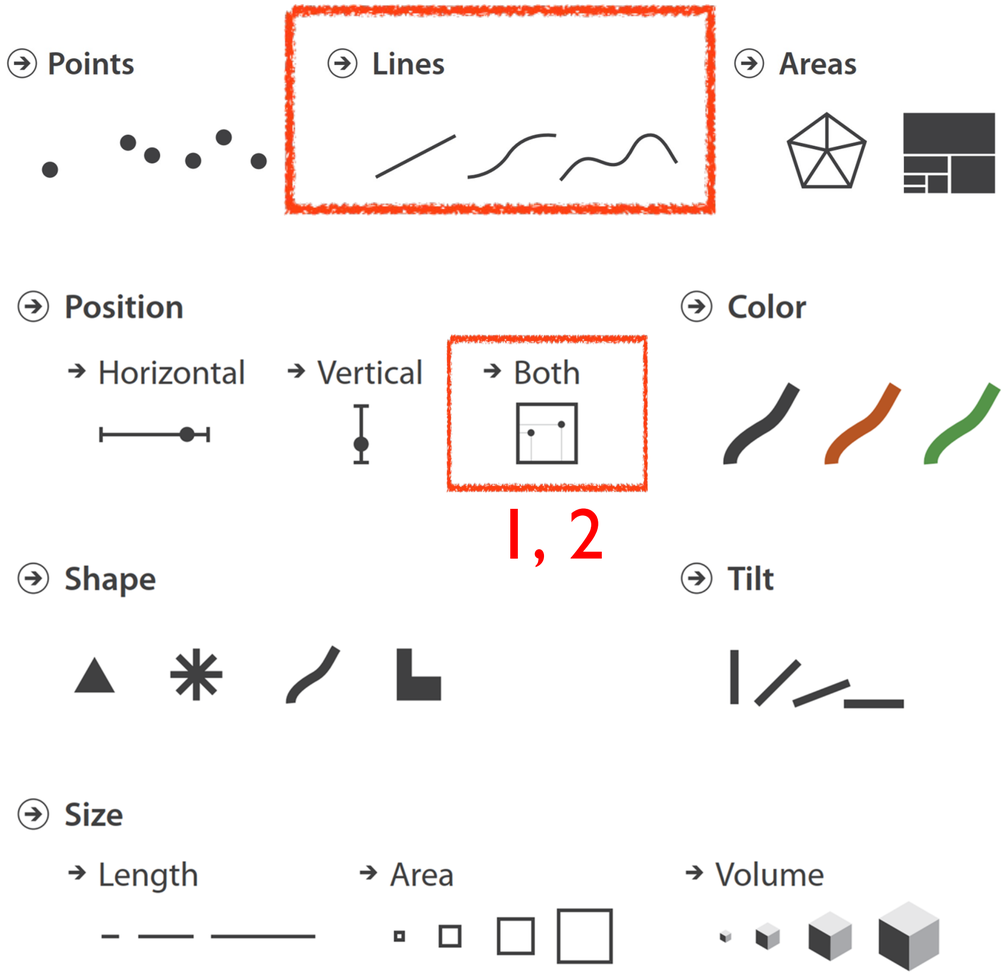
Visual Encoding

2 Attributes → 2 Channels

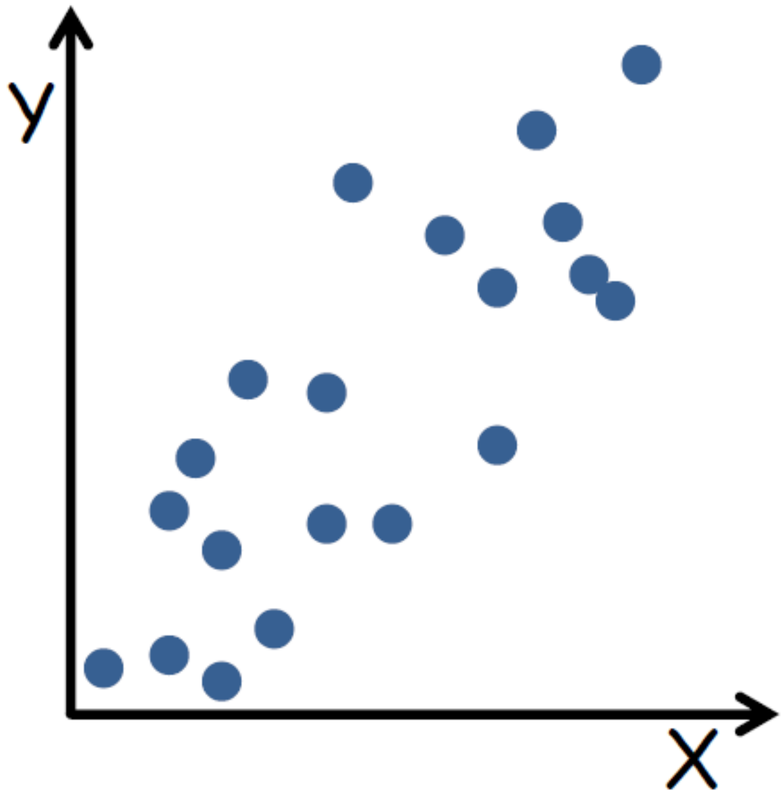


Marks

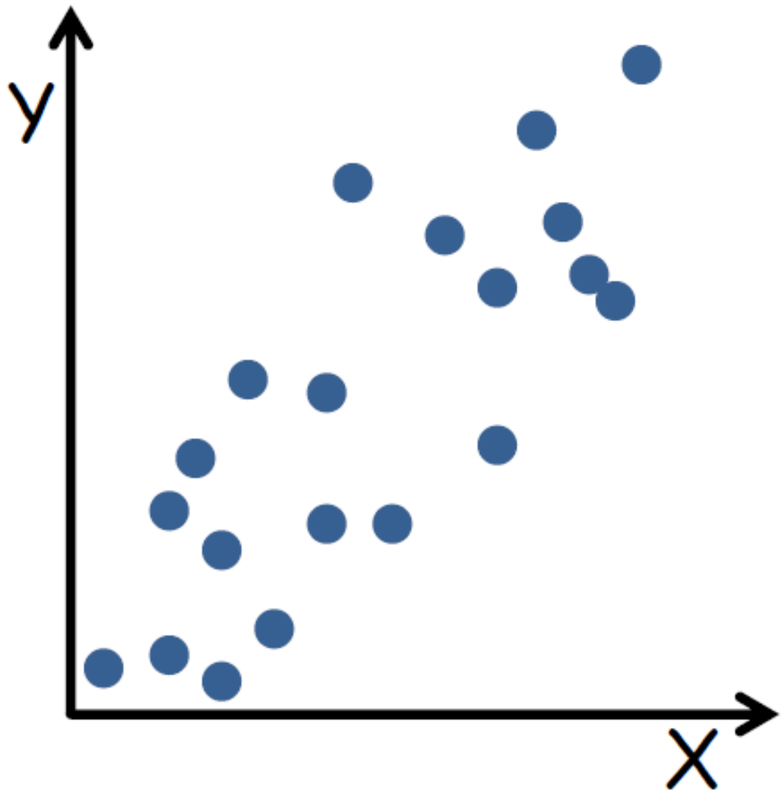
Channels



Visual Encoding

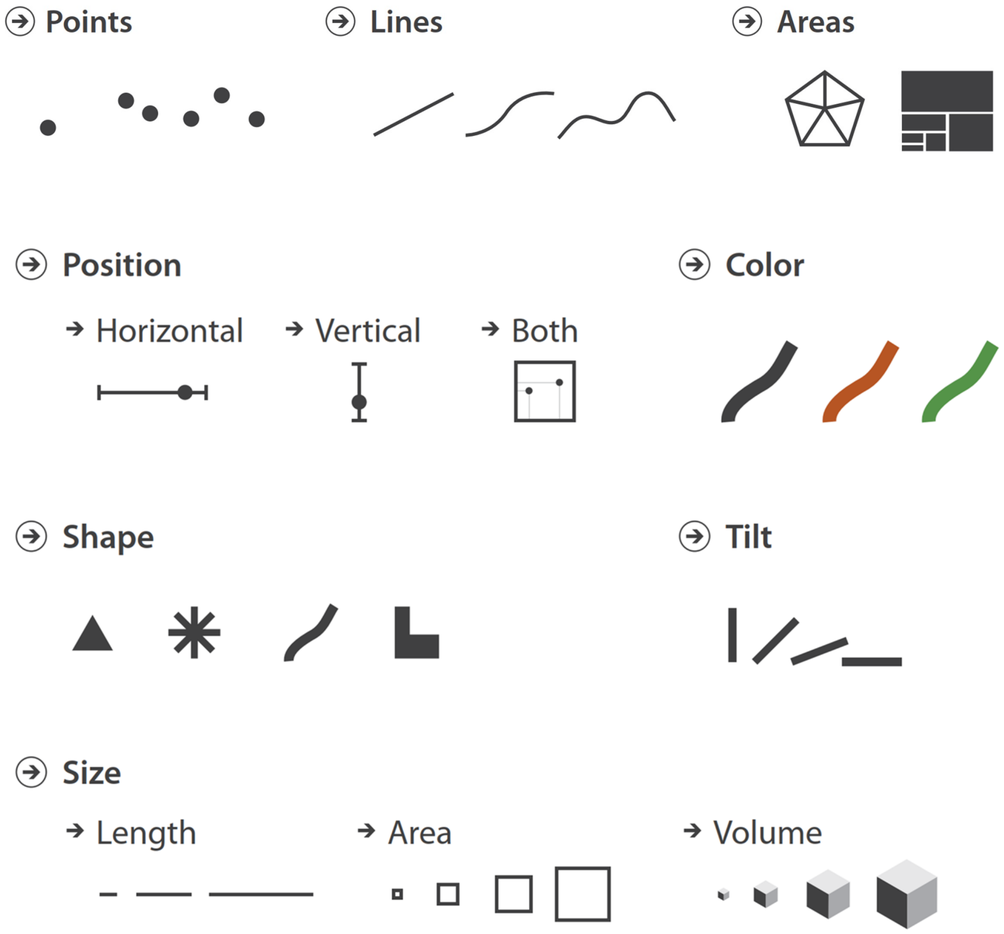


Visual Encoding

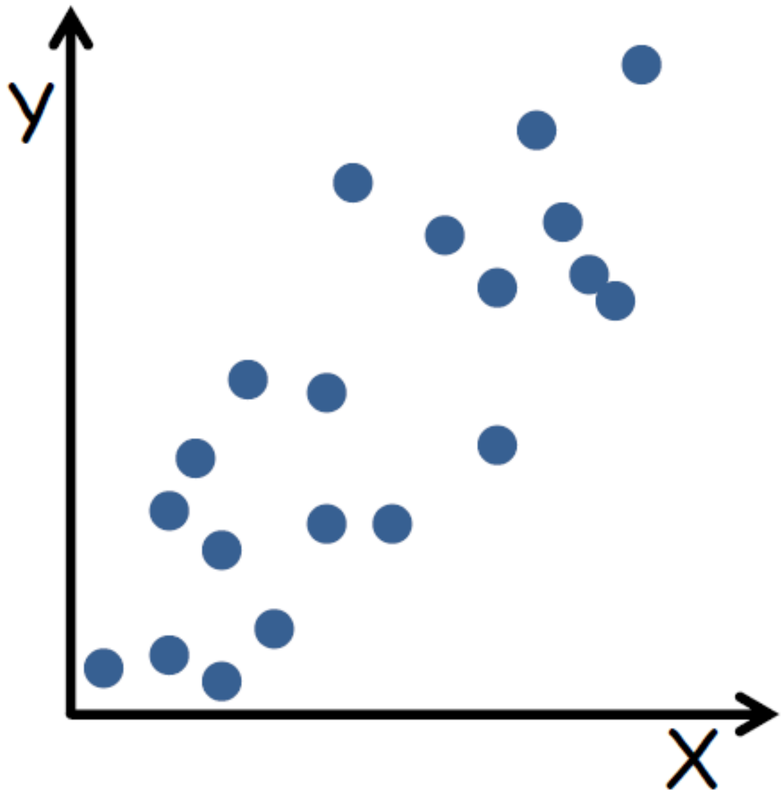


Marks

Channels

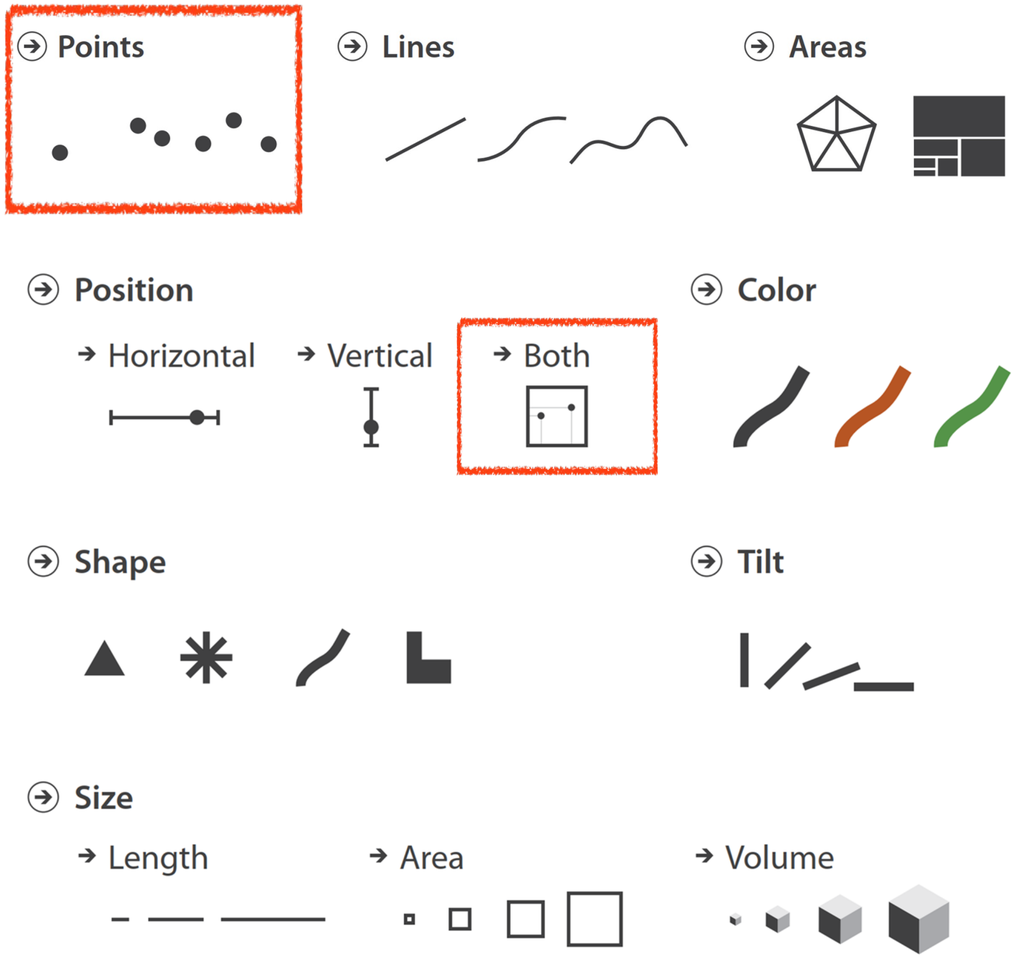


Visual Encoding



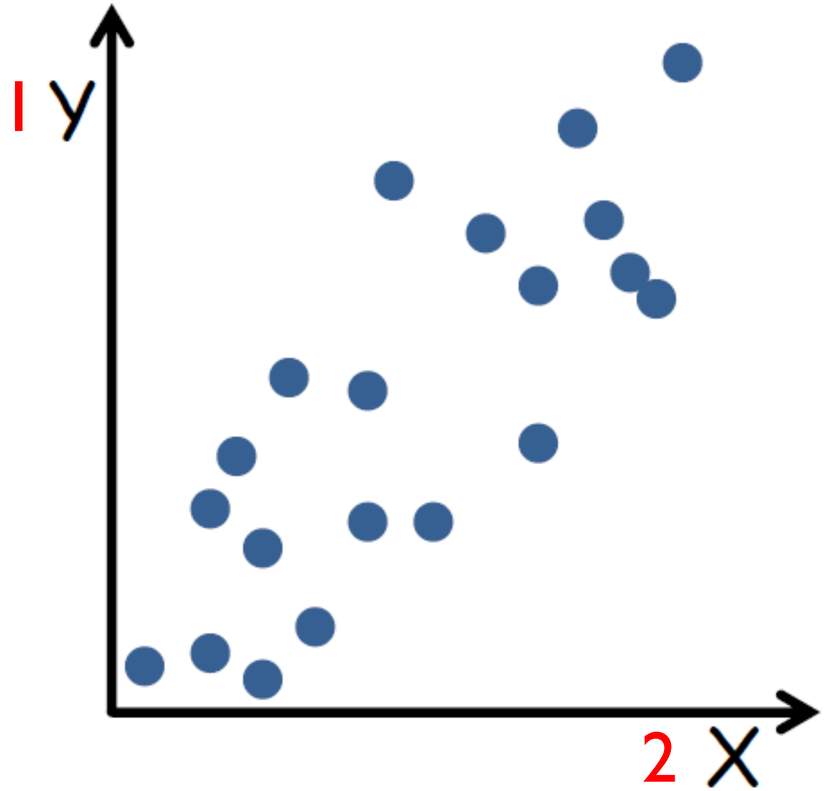
Marks

Channels

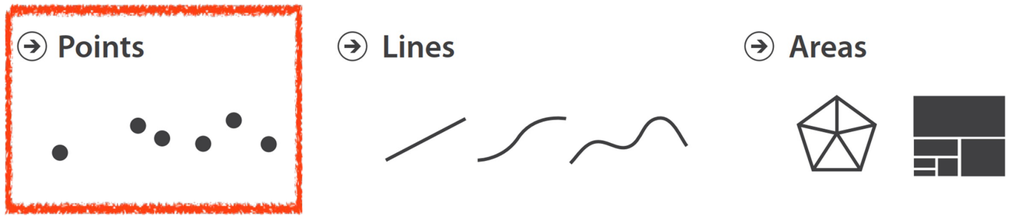


Visual Encoding

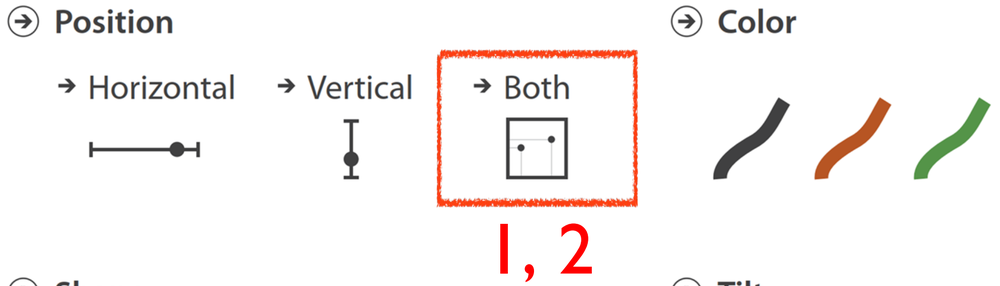
2 Attributes → 2 Channels



Marks

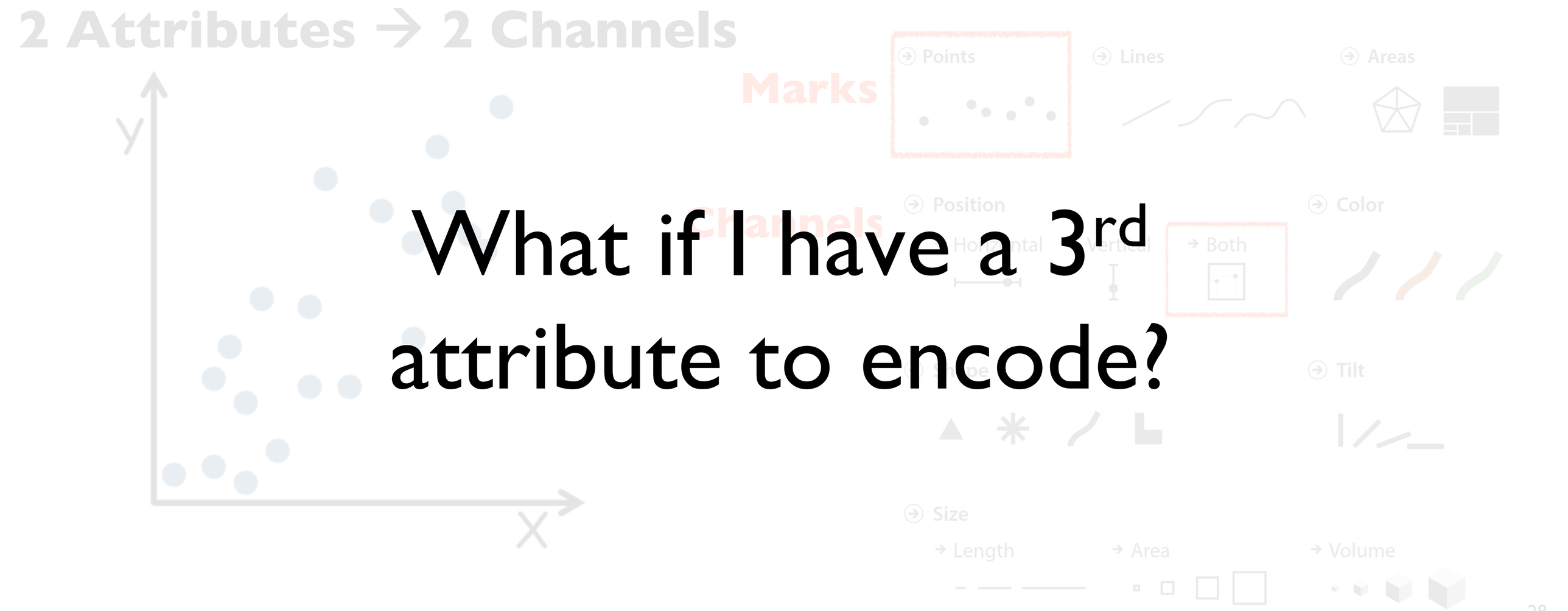


Channels



1, 2

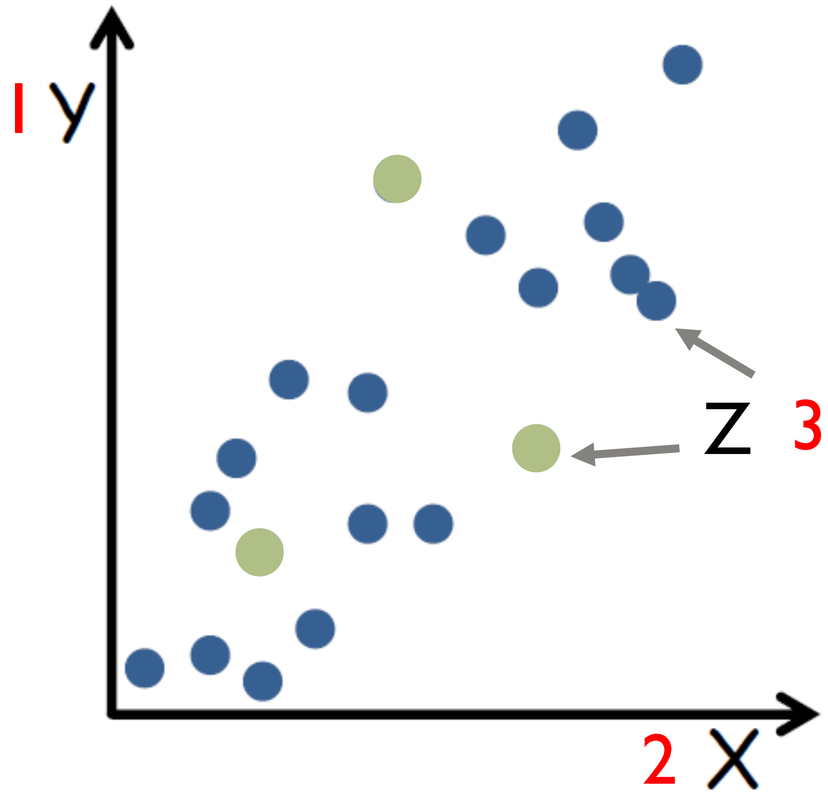
Visual Encoding



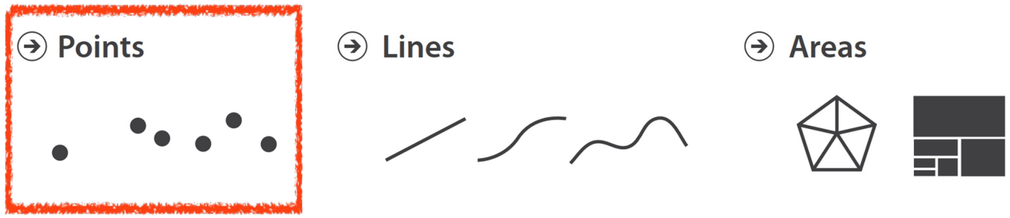
What if I have a 3rd attribute to encode?

Visual Encoding

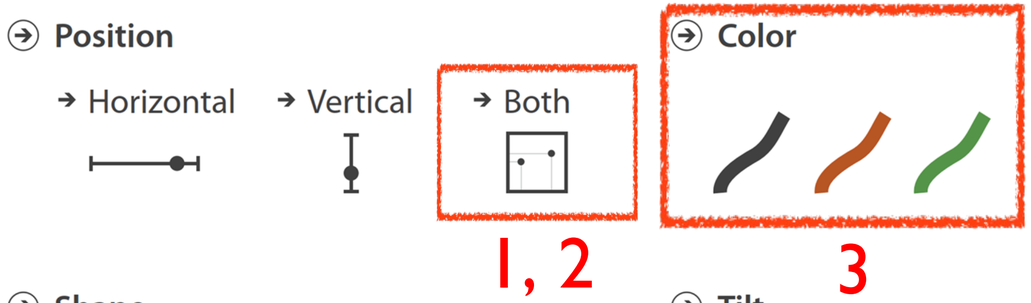
3 Attributes → 3 Channels



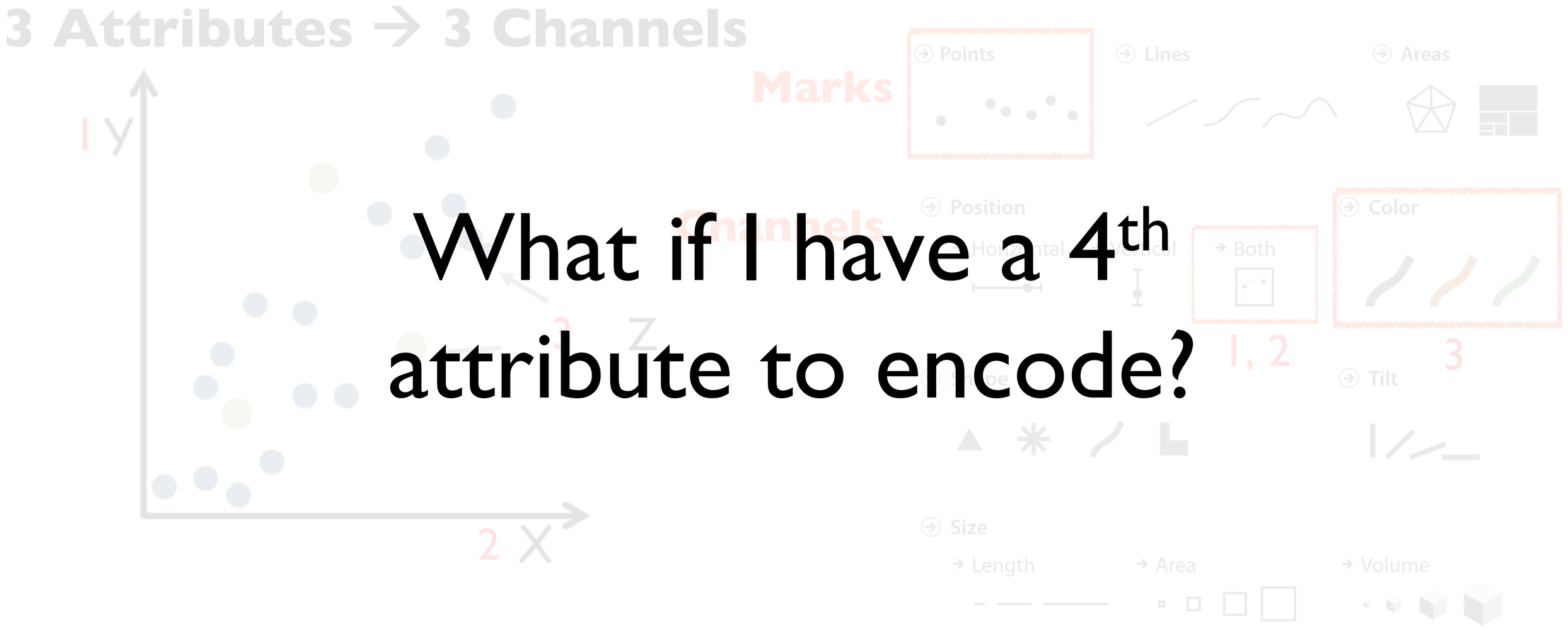
Marks



Channels



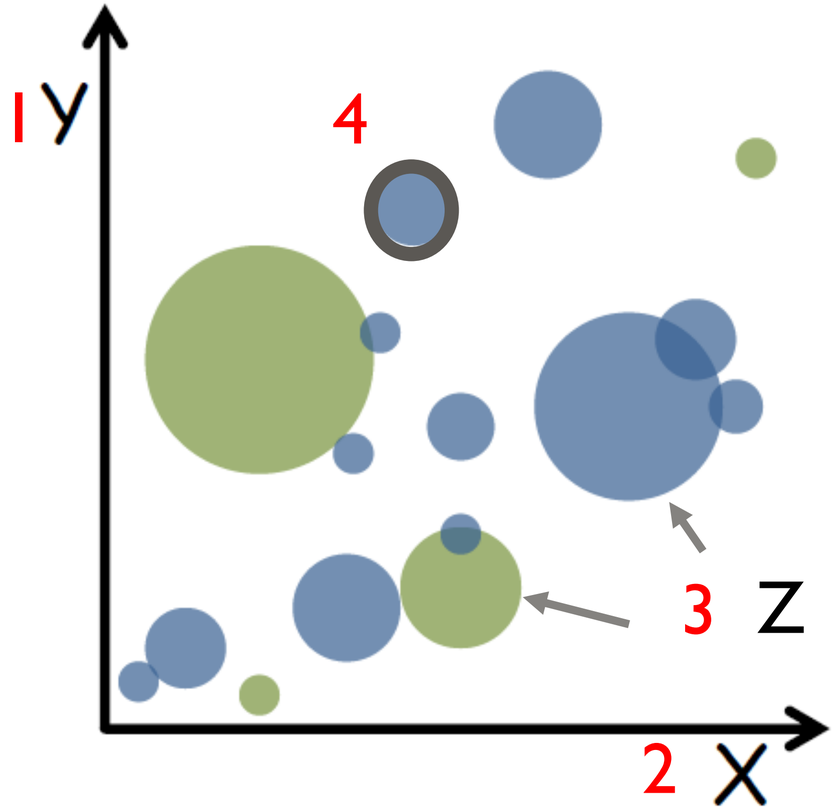
Visual Encoding



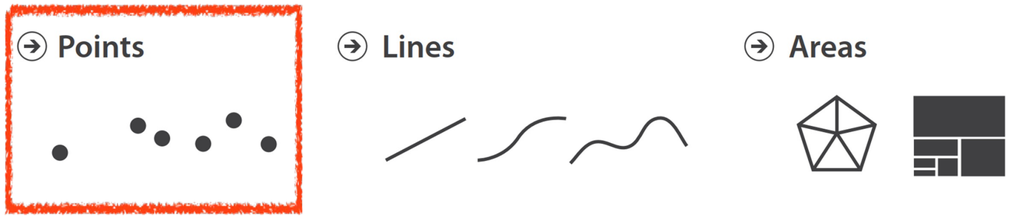
What if I have a 4th attribute to encode?

Visual Encoding

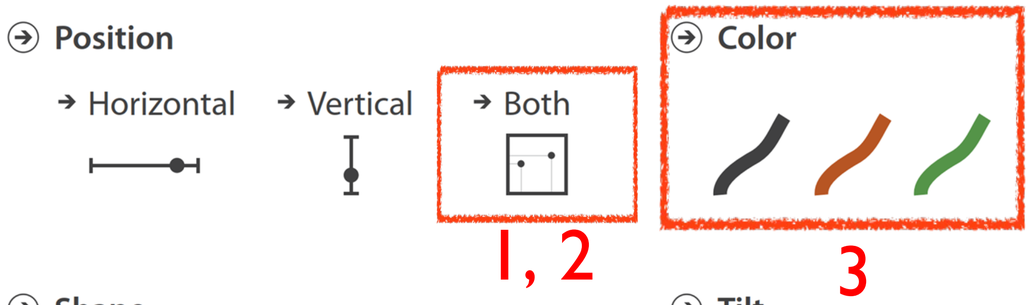
4 Attributes → 4 Channels



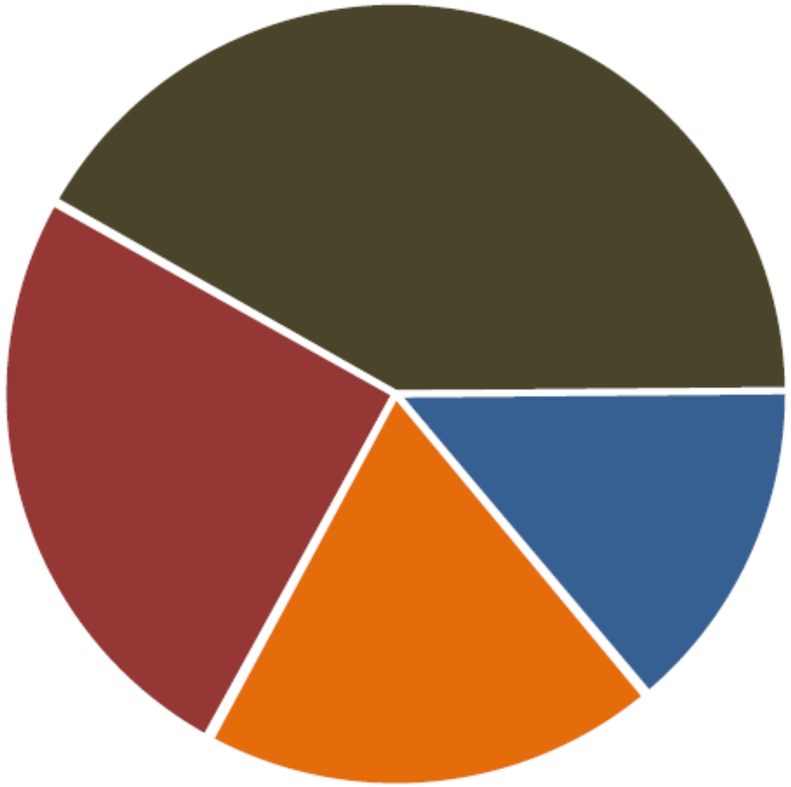
Marks



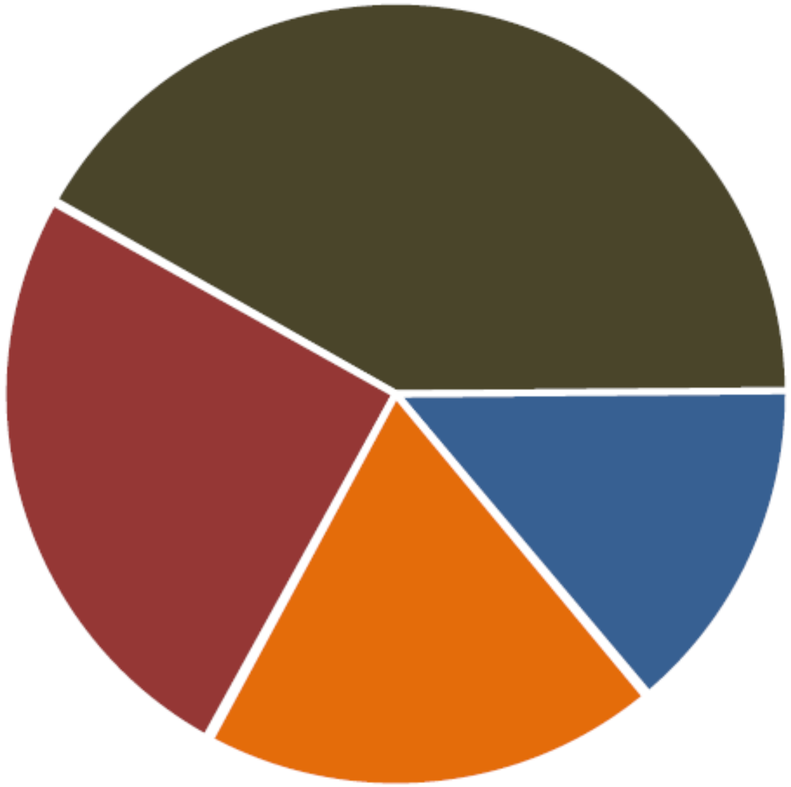
Channels



Visual Encoding

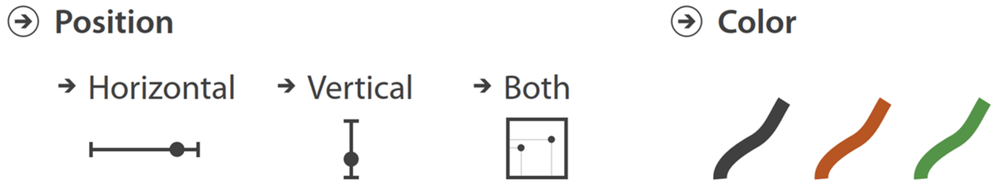


Visual Encoding

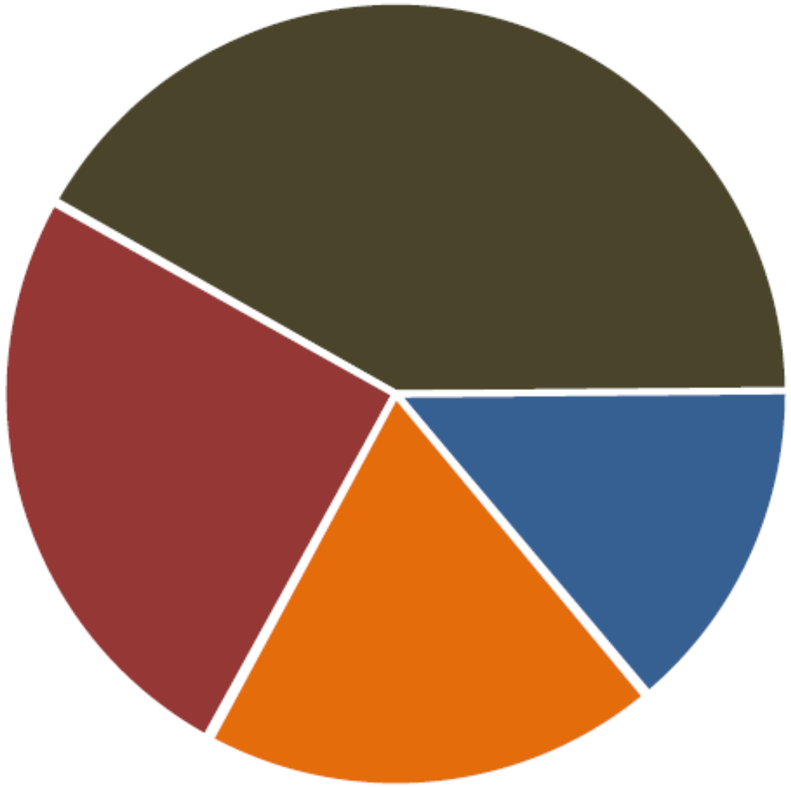


Marks

Channels

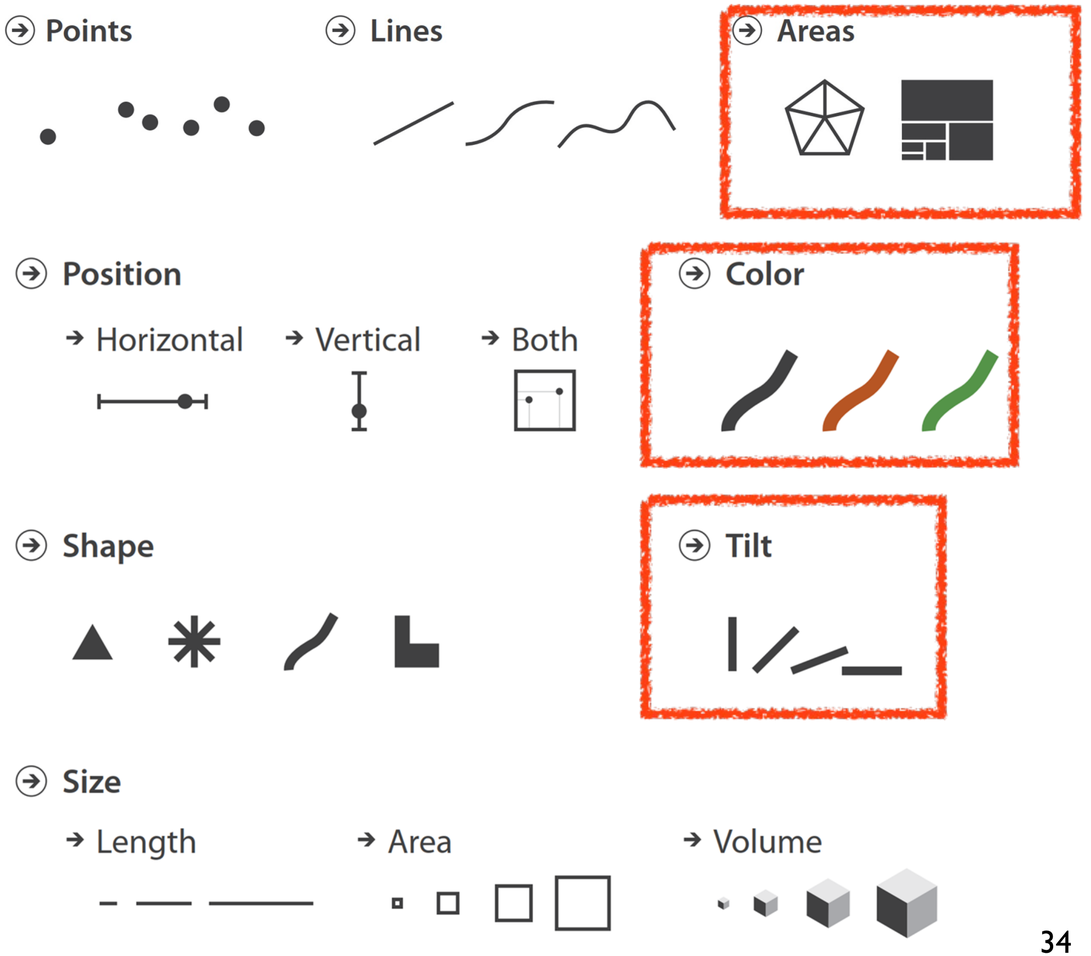


Visual Encoding



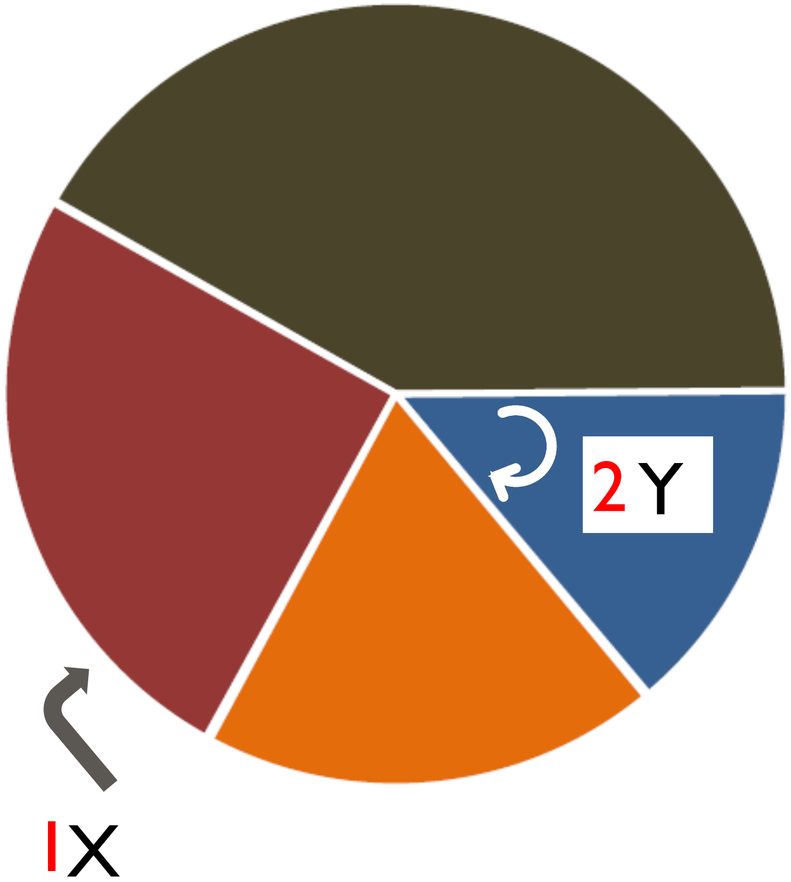
Marks

Channels



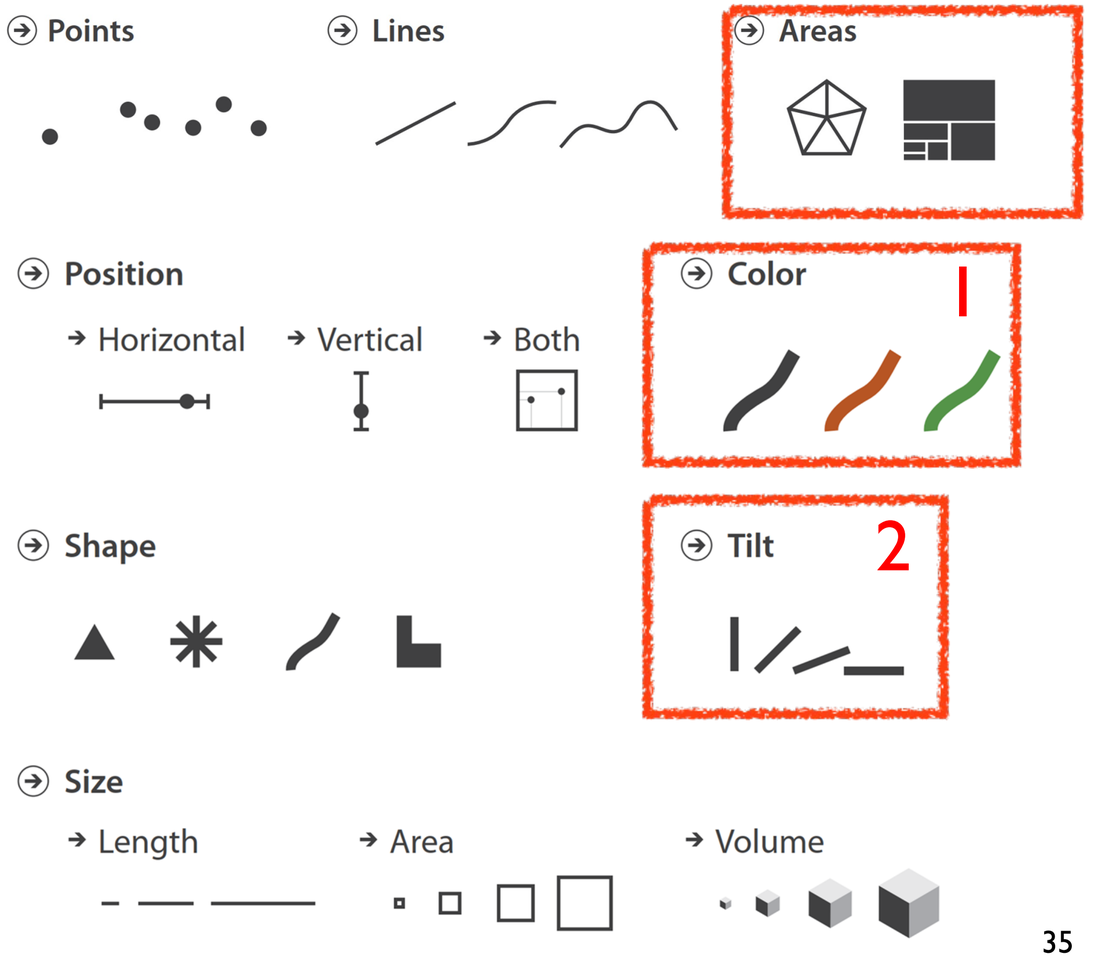
Visual Encoding

2 Attributes → 2 Channels



Marks

Channels



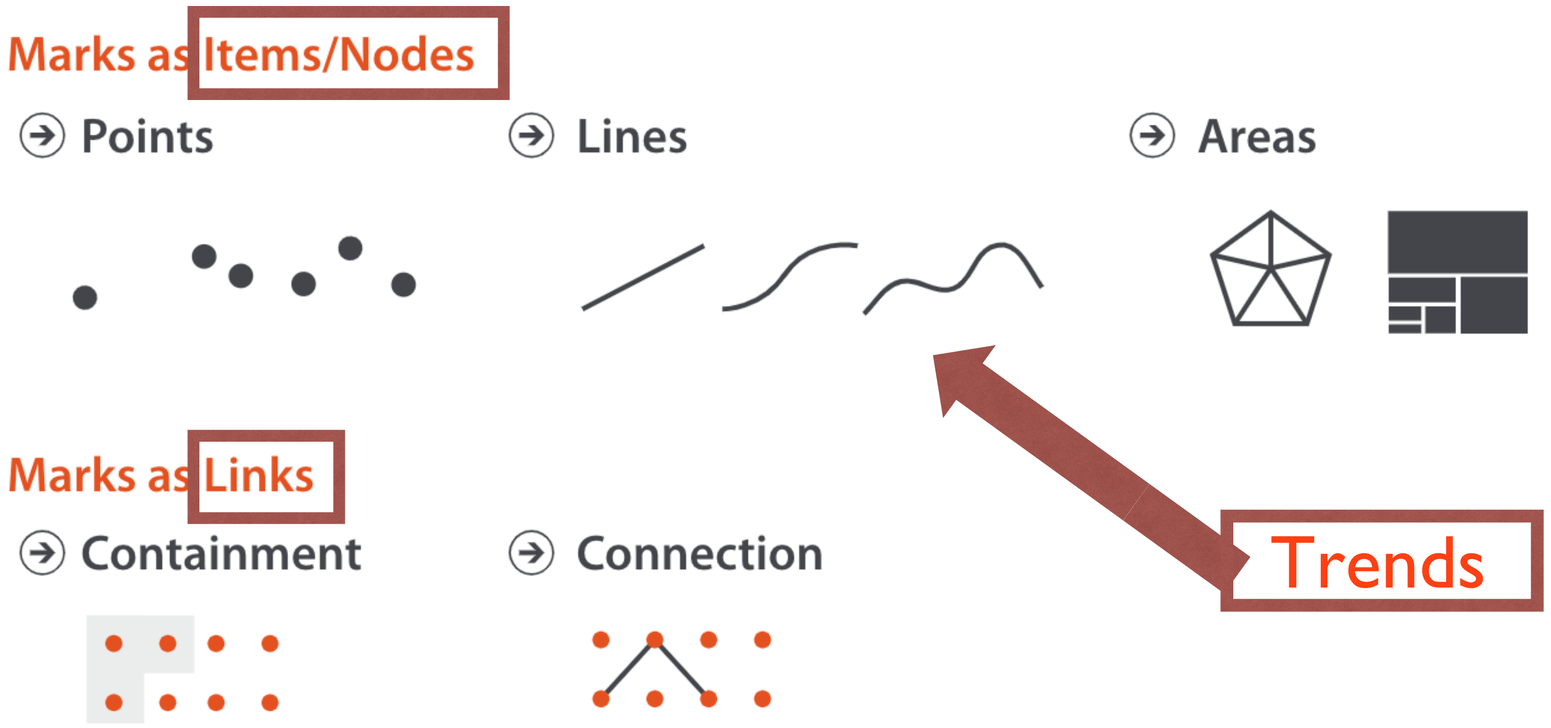
Choosing Marks and Channels

From Munzner's book

Marks

- Work in groups
- What types of data or things can you represent with each of these mark types?
- Be prepared to share your answers

Marks


Marks as Items/Nodes
Points
Lines
Areas
Marks as Links
Containment
Connection
Trends

Channels

Position

- Horizontal
- Vertical
- Both

Color

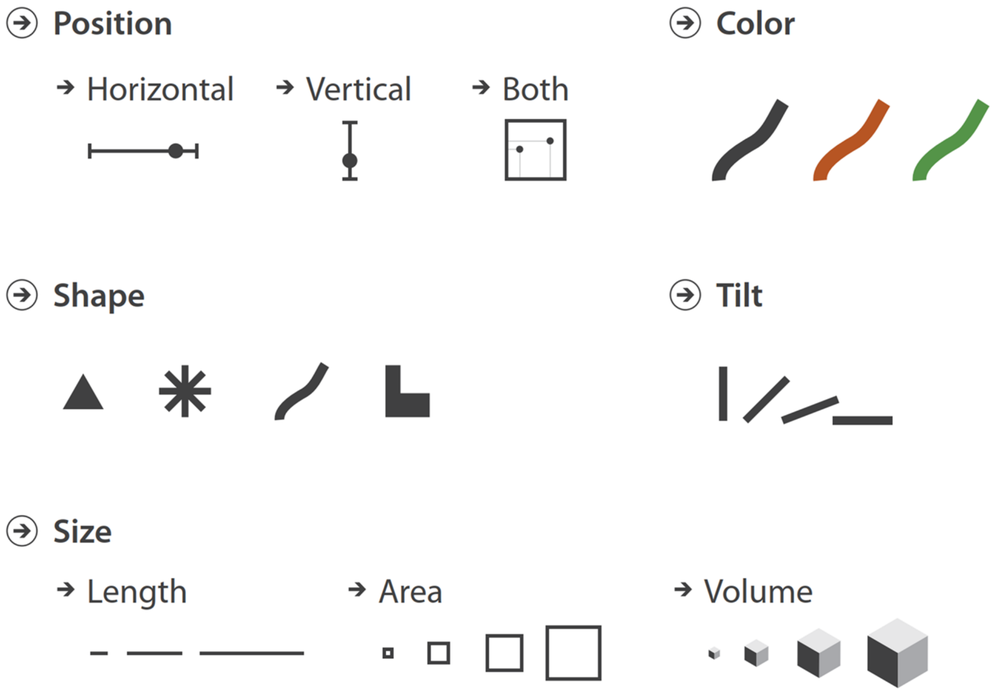
Shape

Tilt

Size

- Length
- Area
- Volume

Channels

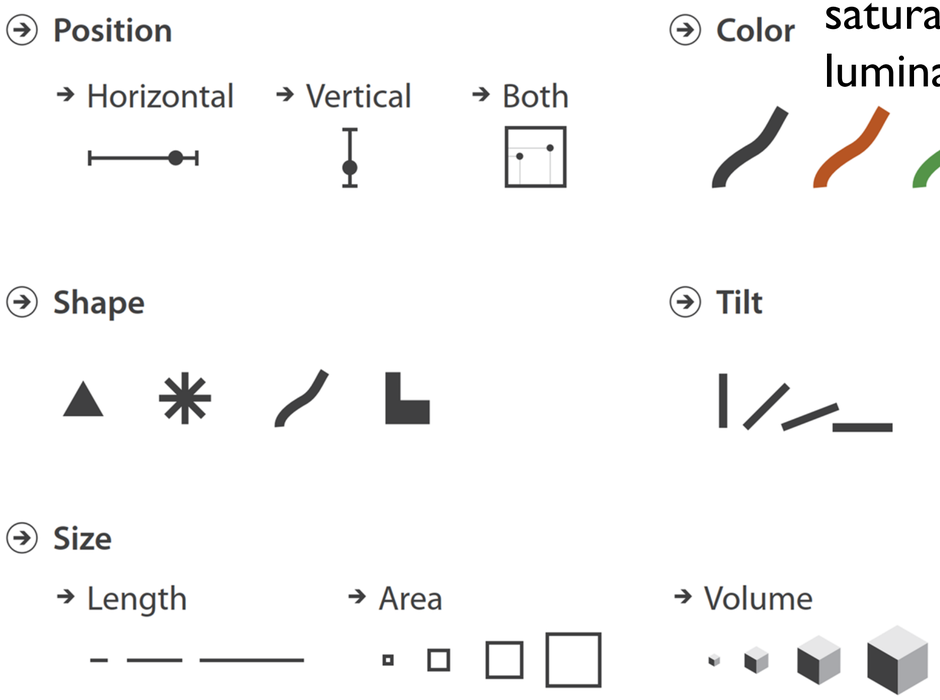


A note on color:

- We consider 3 aspects of color: hue, luminance, and saturation

https://rockcontent.com/blog/building-effective-color-scales/

Channels



- Work in groups. Each will be assigned a channel
- Use your assigned channel (and only that channel) to encode the following data

Dataset 1	Dataset 2	Dataset 3
Pear	Sophomore	1.5
Apple	Junior	7.25
Grape	Senior	- 3.4

Channels

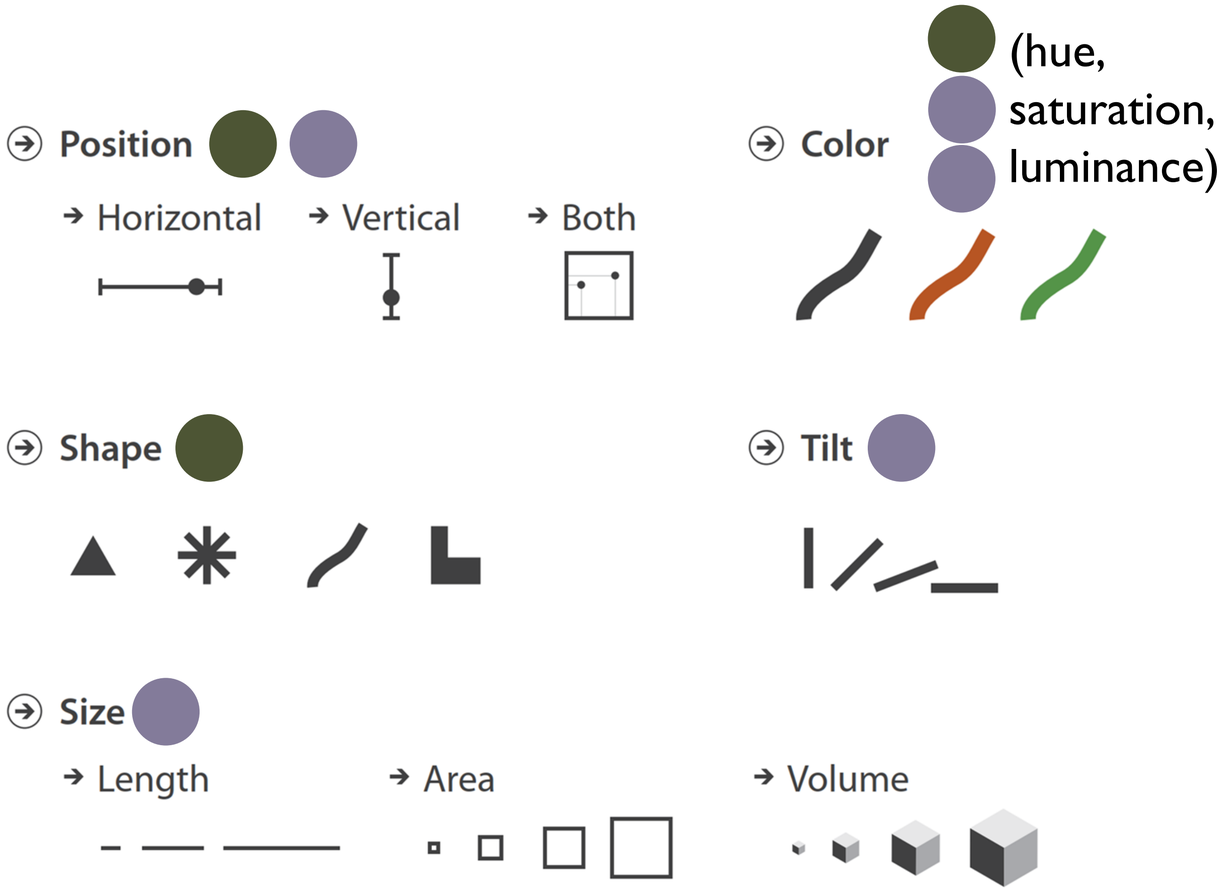
Based on human perception

Identity

→ **What**: position, shape, hue (color)

Magnitude

→ **How much**: position, size, luminance (color), saturation (color), tilt



Choosing Marks and Channels

Expressiveness + Effectiveness

Choosing Marks and Channels

Expressiveness Principle = The visual encoding should express all of, and only, the information in the dataset attributes.

- i.e. The perceptual interpretation of channels (identity vs. magnitude) should match the interpretation of data.

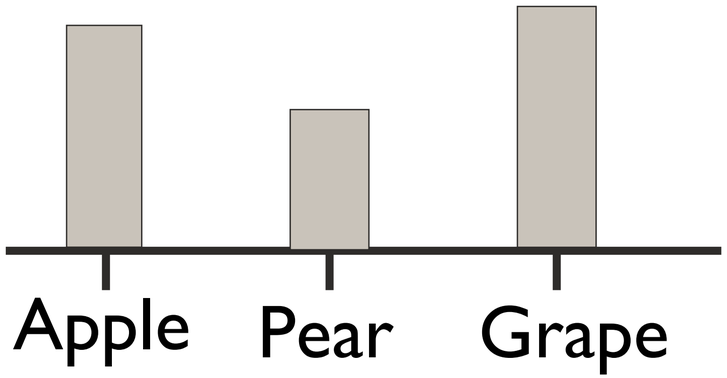
Choosing Marks and Channels

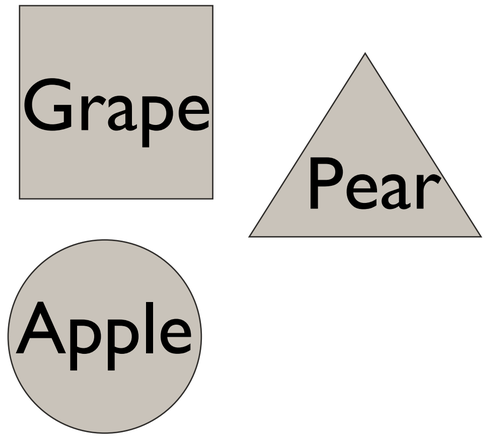
Expressiveness Principle = The visual encoding should express all of, and only, the information in the dataset attributes.

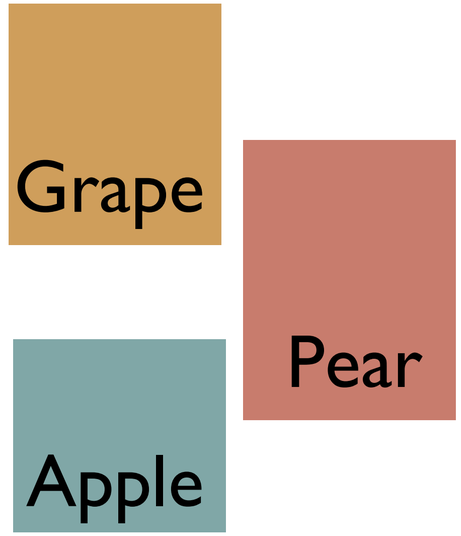
- i.e. The perceptual interpretation of channels (identity vs. magnitude) should match the interpretation of data.

Dataset 1
Pear
Apple
Grape

Categorical – Identity







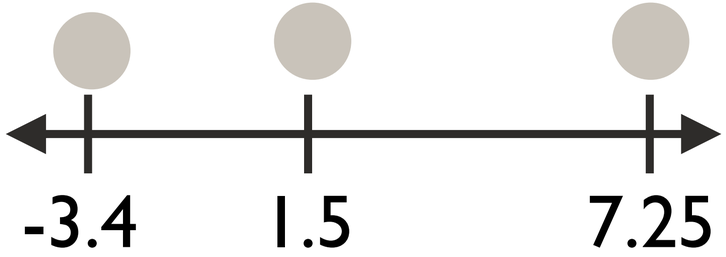
Choosing Marks and Channels

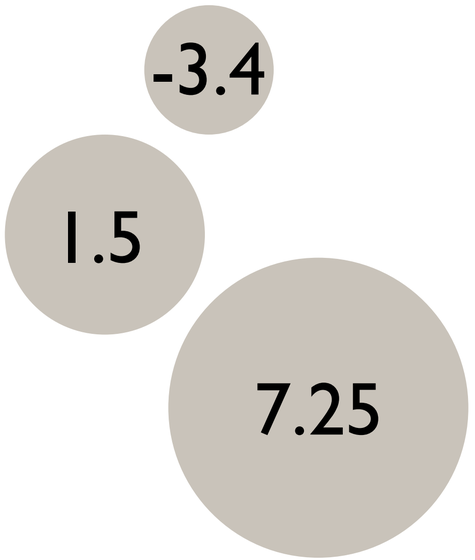
Expressiveness Principle = The visual encoding should express all of, and only, the information in the dataset attributes.

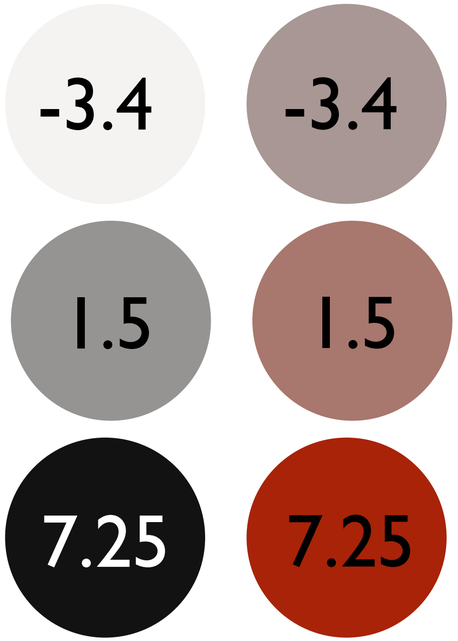
- i.e. The perceptual interpretation of channels (identity vs. magnitude) should match the interpretation of data.

Dataset 3
1.5
7.25
- 3.4

Quantitative – Magnitude







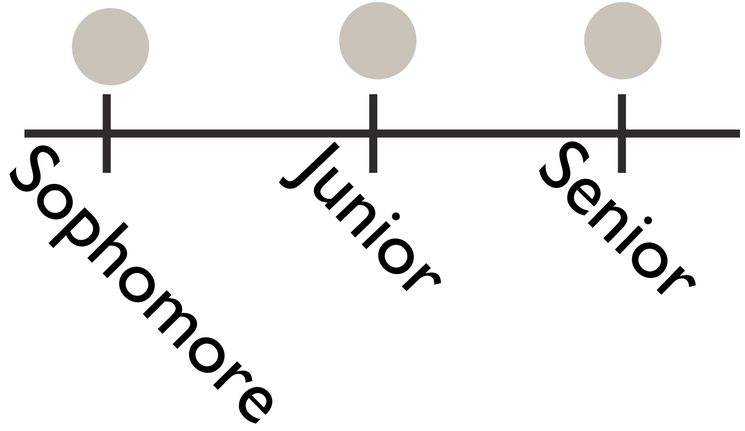
Choosing Marks and Channels

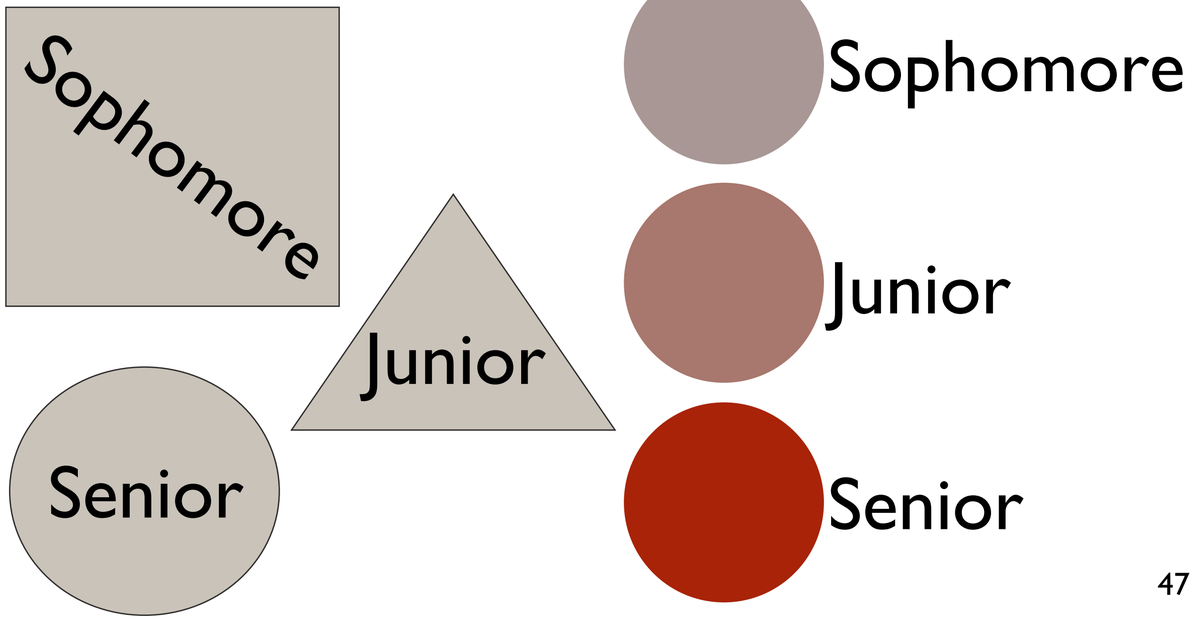
Expressiveness Principle = The visual encoding should express all of, and only, the information in the dataset attributes.

- i.e. The perceptual interpretation of channels (identity vs. magnitude) should match the interpretation of data.

Dataset 2
Sophomore
Junior
Senior

Ordinal – Identity / Magnitude





Choosing Marks and Channels

Effectiveness Principle = The salience (noticeability) of channels used in the visual encoding should match the importance of attributes.
- i.e. More important attributes should be encoded with more effective channels.

Choosing Marks and Channels

Effectiveness Principle = The salience (noticeability) of channels used in the visual encoding should match the importance of attributes.
- i.e. More important attributes should be encoded with more **effective** channels.

Effectiveness

Effectiveness = Based on a compilation of research, how well a channel supports:

- Accuracy
- Discriminability
- Separability
- Visual popout
- Grouping

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much longer is the second bar?

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much longer is the second bar?

2X

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second square?

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second square?

4X

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second box?

Accuracy

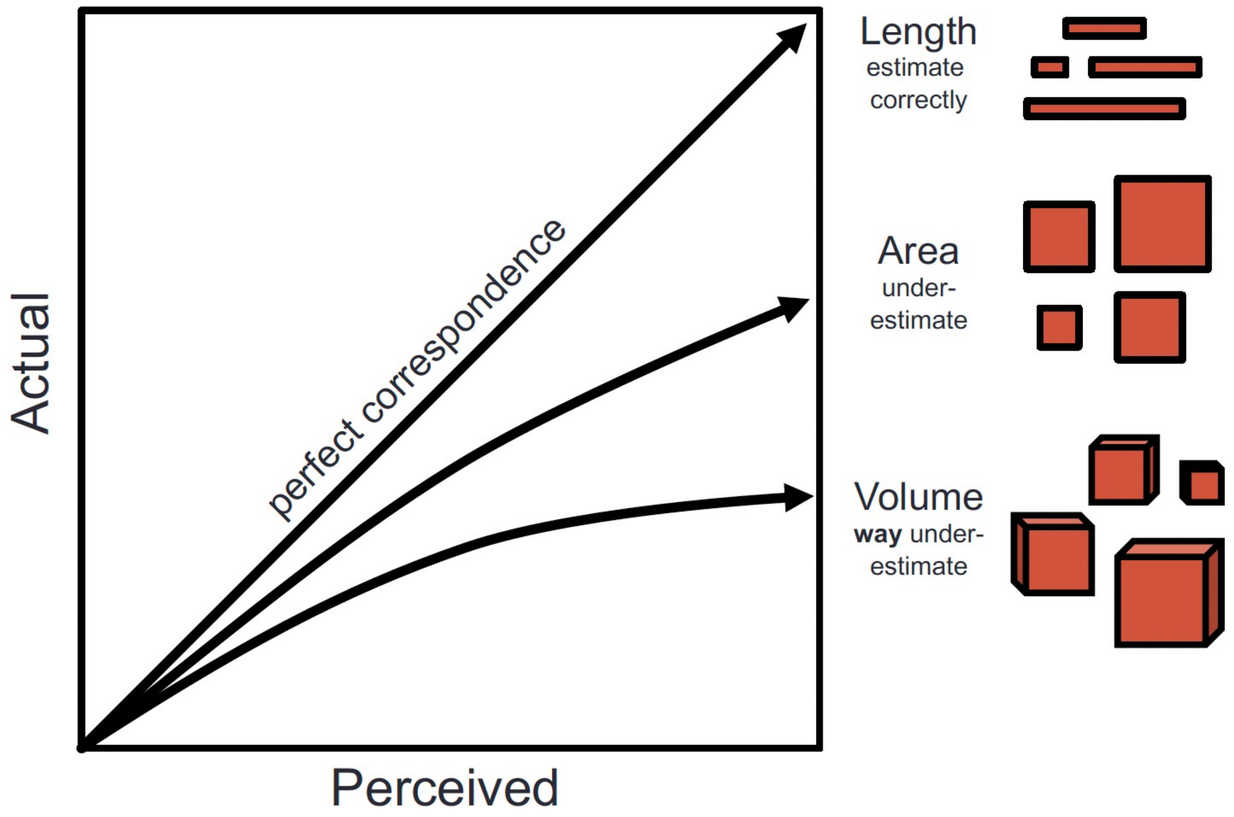
Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second box?

27X

Accuracy

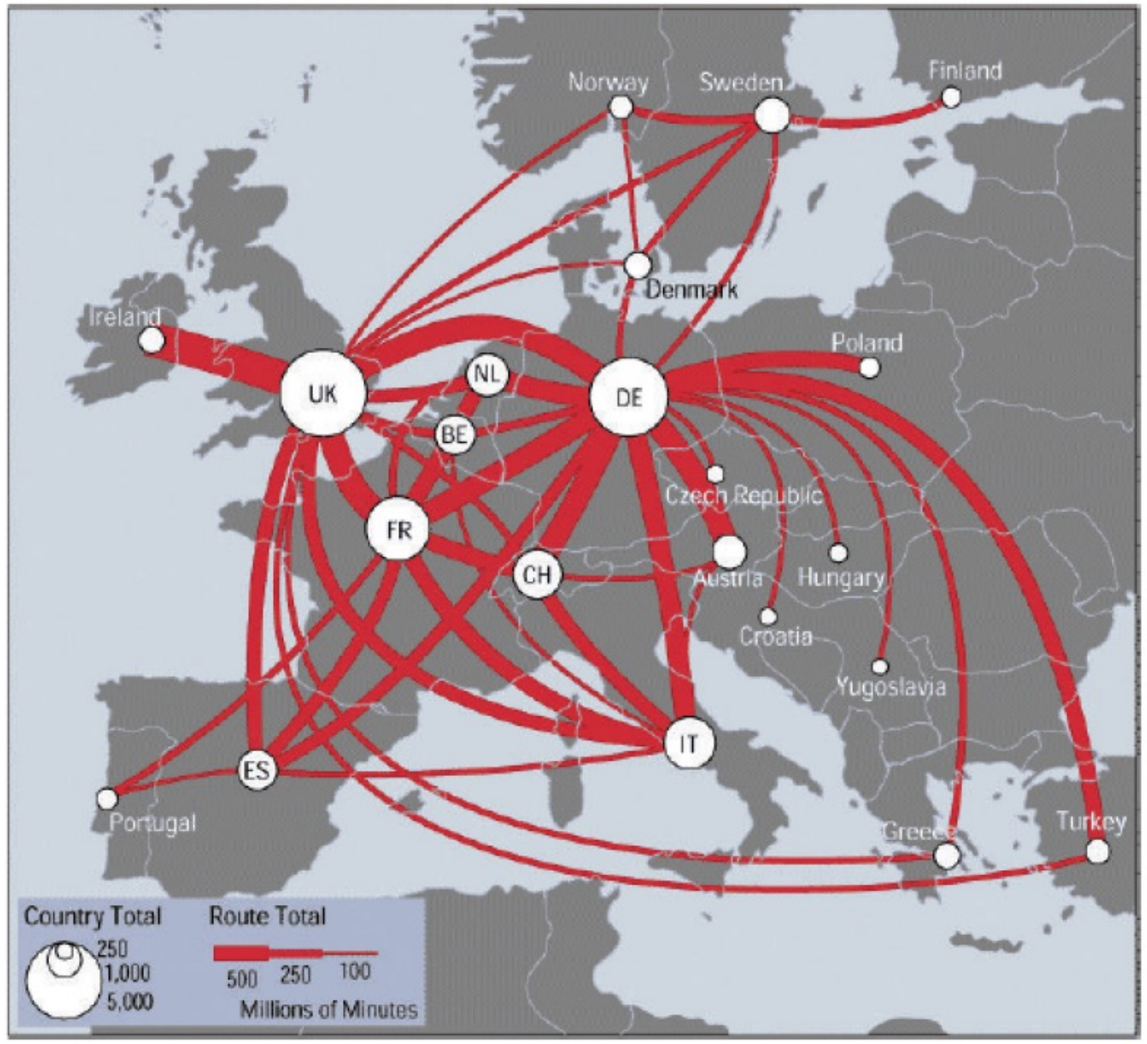
Definition: how close human perceptual judgement is to an objective measurement of the stimulus



http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Discriminability

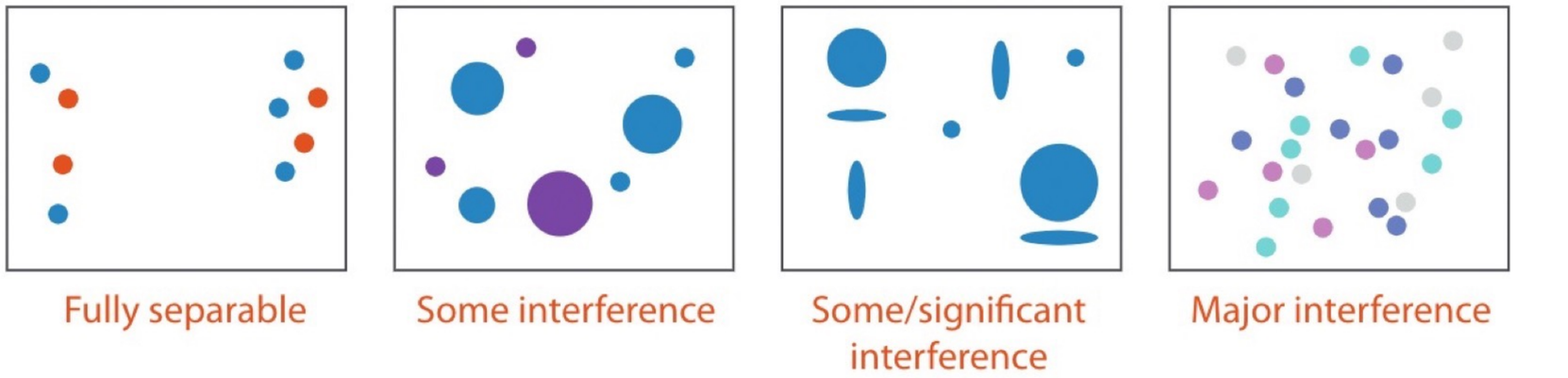
Definition: how differentiable levels of the channel are



https://web.cse.ohio-state.edu/~shen.94/Melbourne/Slides/TamaraChp5.pdf

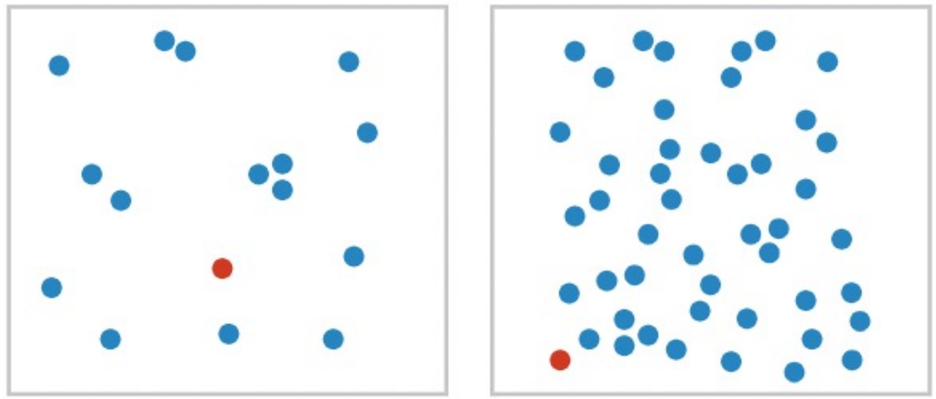
Separability

Definition: whether channels exist independently or integrally with others



Visual Popout

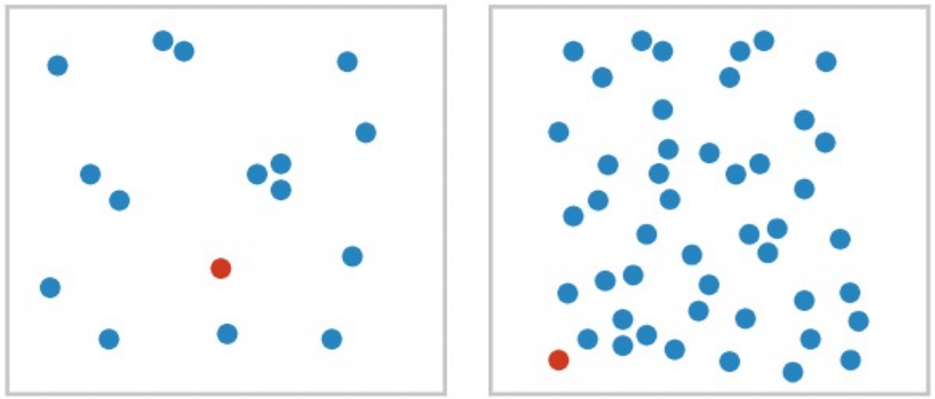
Definition: how well a distinct item stands out from others



(a) (b)

Visual Popout

Definition: how well a distinct item stands out from others

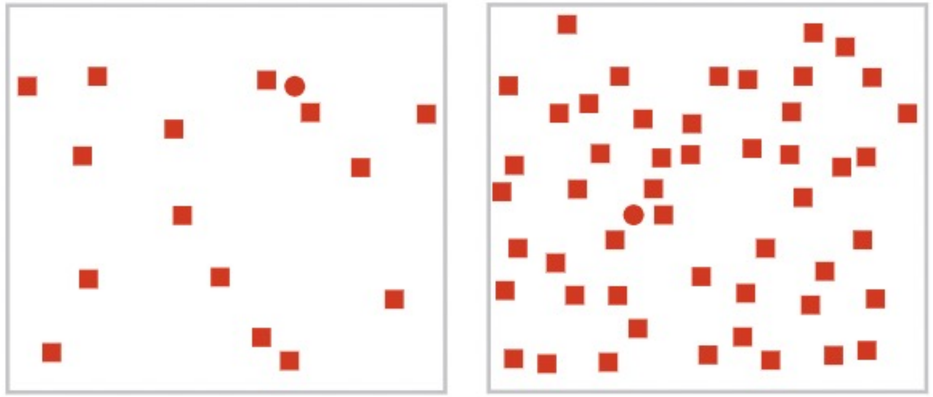


(a) (b)

Color is a good channel for this

Visual Popout

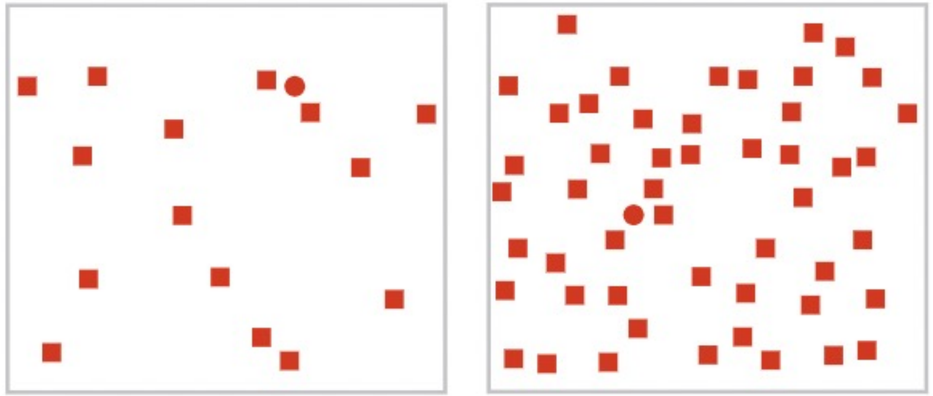
Definition: how well a distinct item stands out from others



(c) (d)

Visual Popout

Definition: how well a distinct item stands out from others

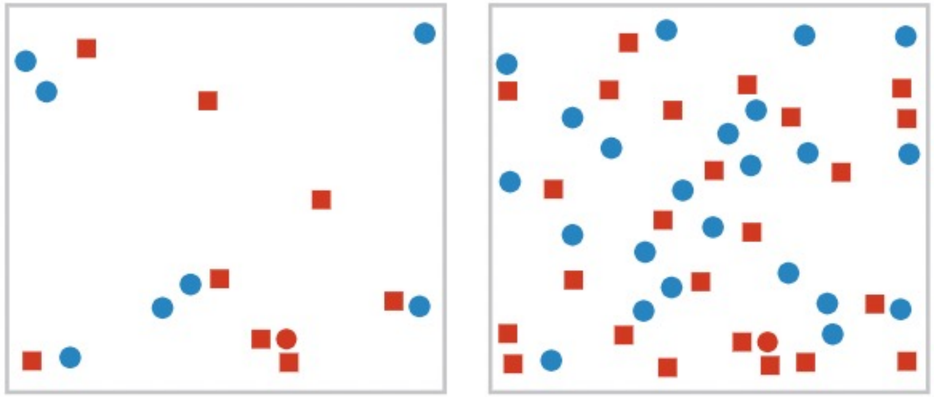


(c) (d)

Shape is not as helpful

Visual Popout

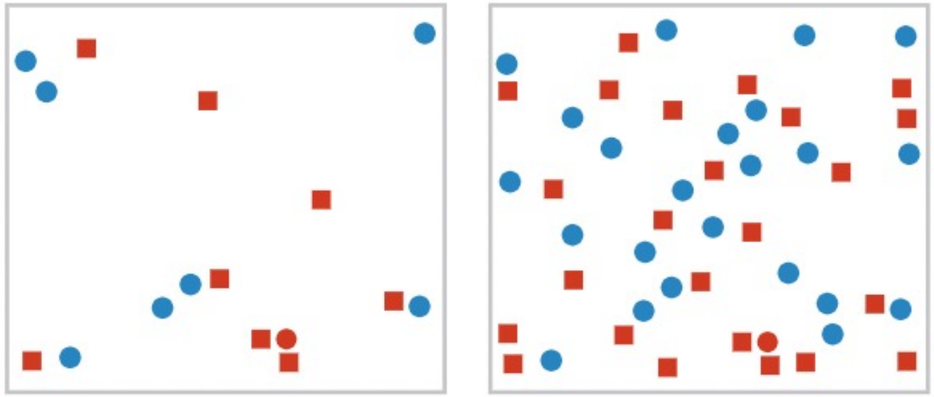
Definition: how well a distinct item stands out from others



(e) (f)

Visual Popout

Definition: how well a distinct item stands out from others

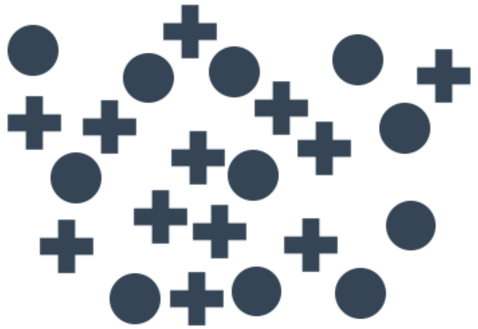


(e) (f)

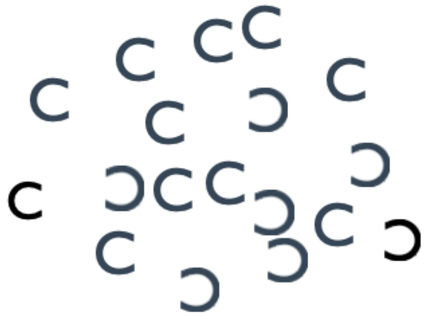
Combining color and shape causes “competition” – color is processed first

Grouping

Definition: how likely people are to infer differences as representing distinct groups



Circles and +’s



C’s and Ↄ’s

Expressiveness + Effectiveness

Channels: Expressiveness Types and Effectiveness Ranks

Magnitude Channels: Ordered Attributes

- Position on common scale
- Position on unaligned scale
- Length (1D size)
- Tilt/angle
- Area (2D size)
- Depth (3D position)
- Color luminance
- Color saturation
- Curvature
- Volume (3D size)

Same

Same

Effectiveness: Most → Least

Identity Channels: Categorical Attributes

- Spatial region
- Color hue
- Motion
- Shape

Let’s take a break! Stretch, go for a walk, be social ☺
Be back here in 10 mins.

Decomposing Graphics

Summary

Today we:

- Reviewed Marks and Channels
- Reviewed Expressiveness and Effectiveness
- Worked on ic-04 (Decomposing Graphics)

ic-04 is DUE today.
hw-03 and pm-01 are OUT today.