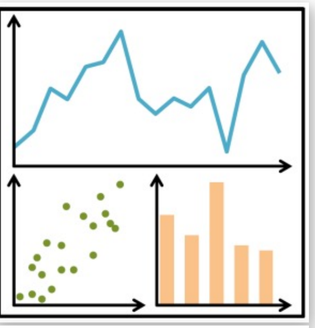
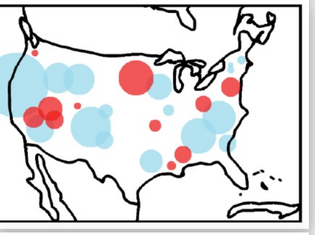
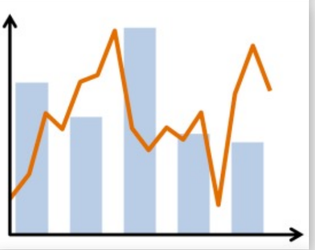
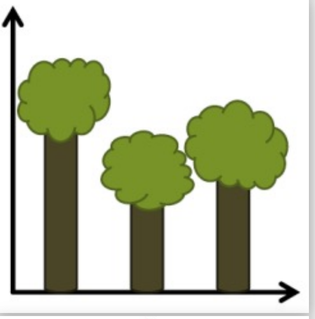
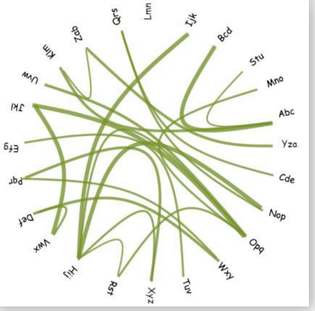






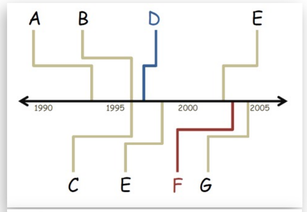
# Lecture 5: Marks and Channels

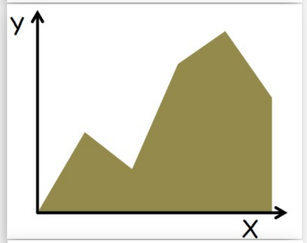
DS 4200

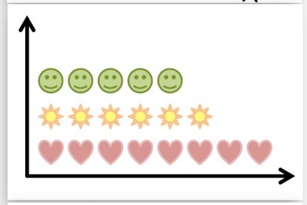
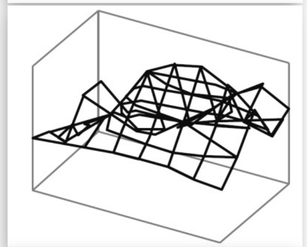
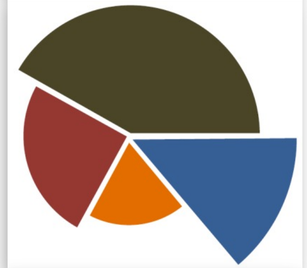
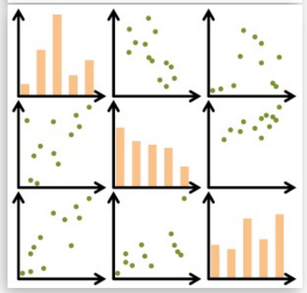
FALL 2022

*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?

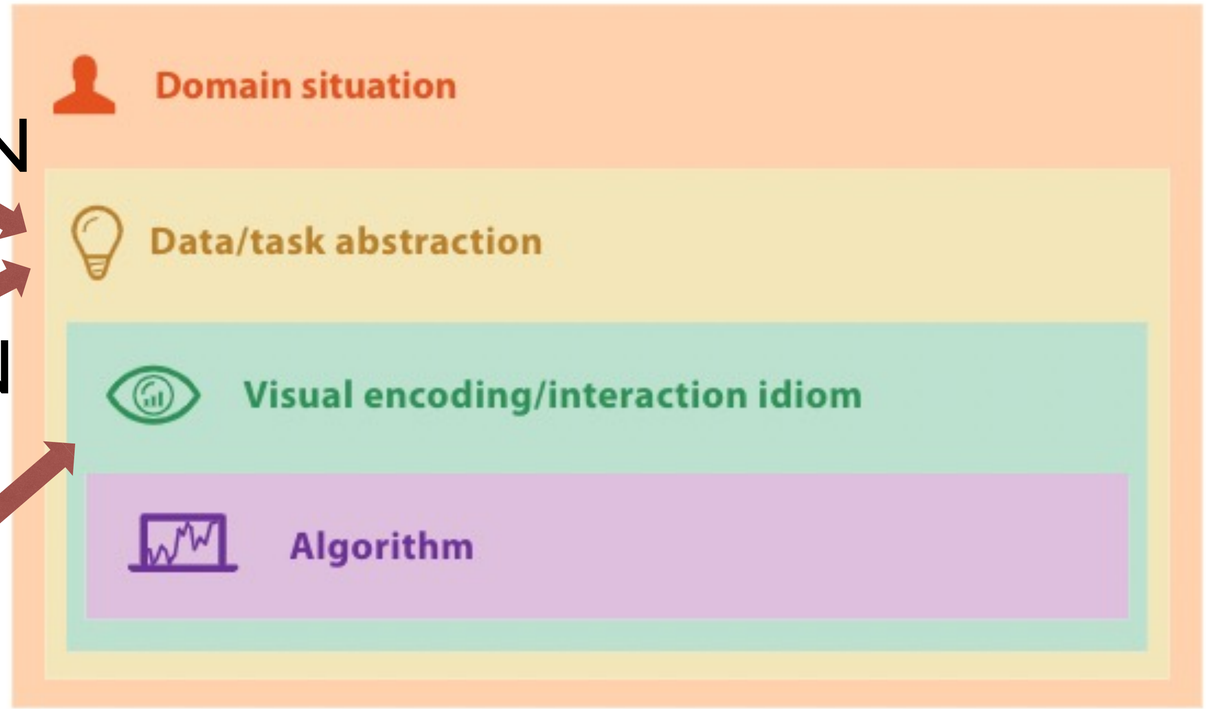
How?

DATA ABSTRACTION

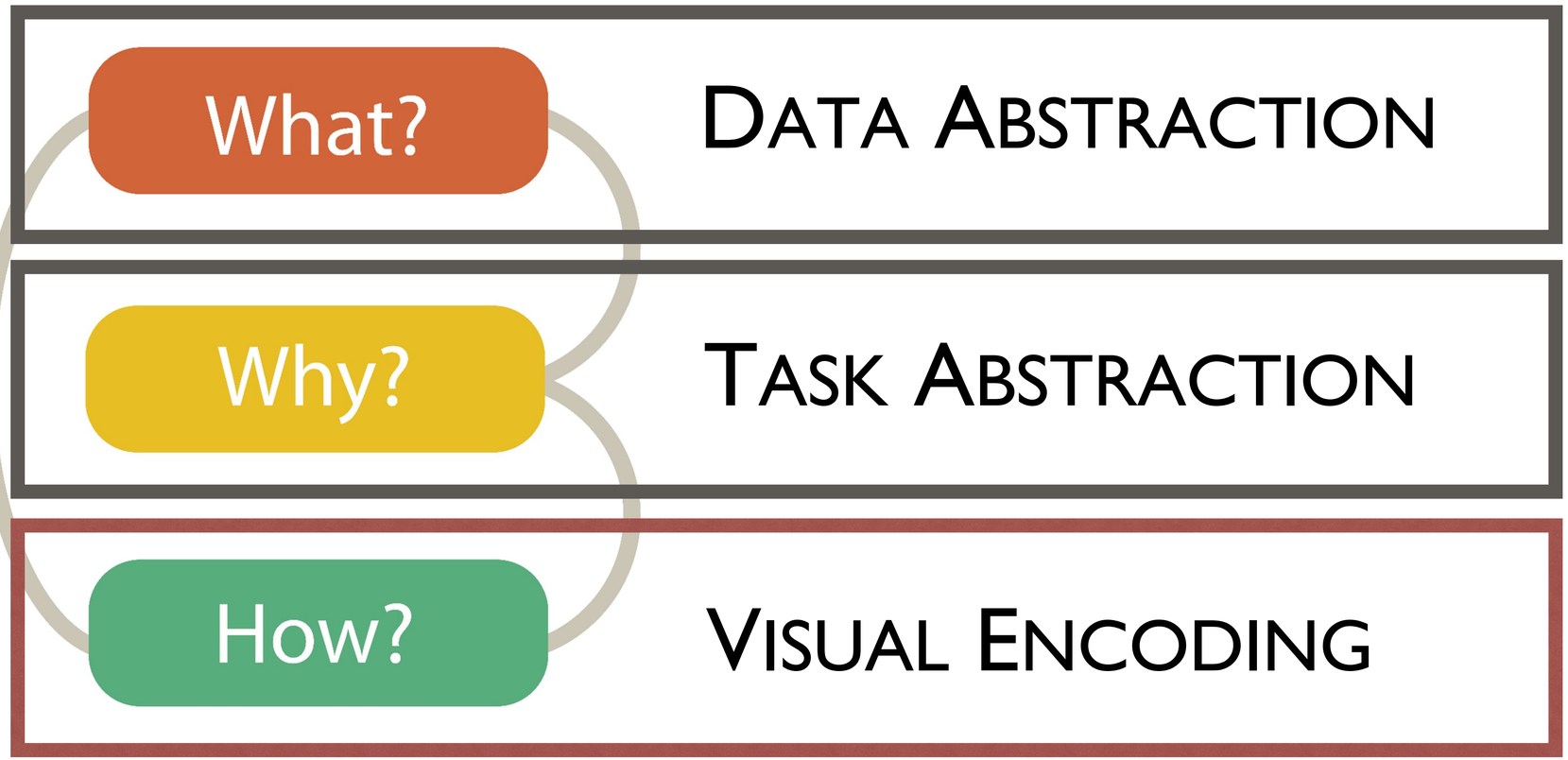
TASK ABSTRACTION

VISUAL ENCODING

**Munzner's Nested Model**



# Visualization Building Blocks



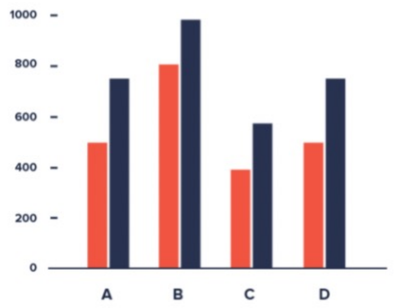
# Visual Encoding

From Munzner's book

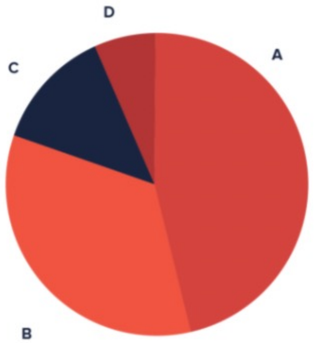
# Visual Encoding

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

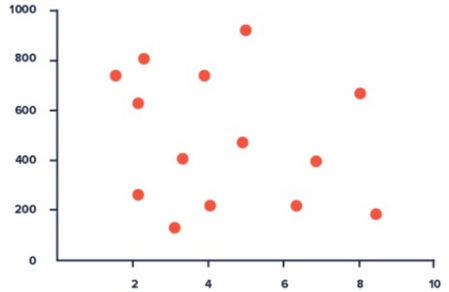
Grouped Bar Chart



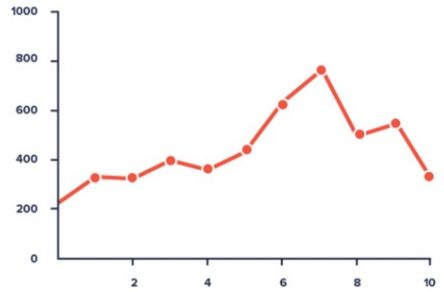

Pie Chart




Scatter Plot




Line Graph

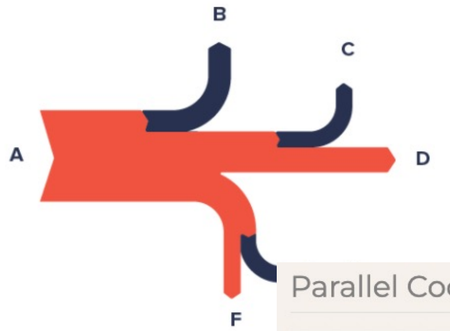



https://datavizproject.com/

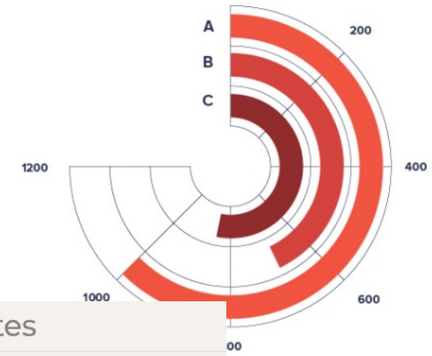
# Visual Encoding

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

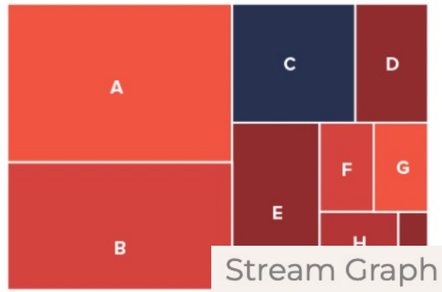
Sankey Diagram



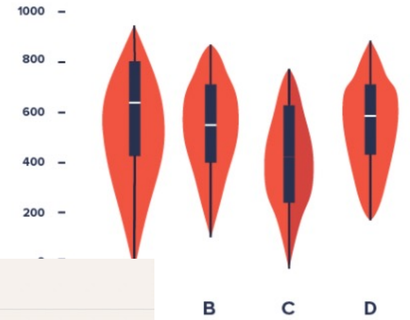

Radial Bar Chart



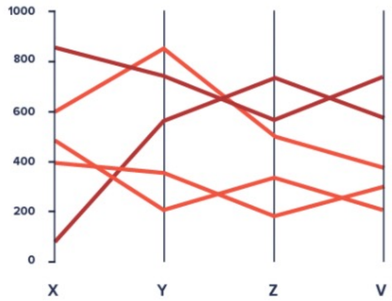

Treemap



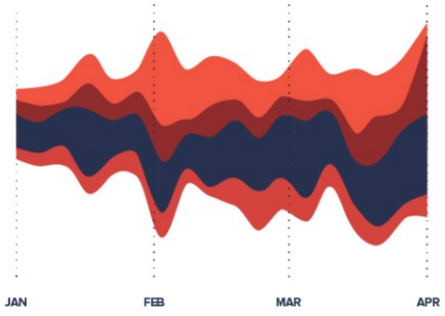

Violin Plot




Parallel Coordinates



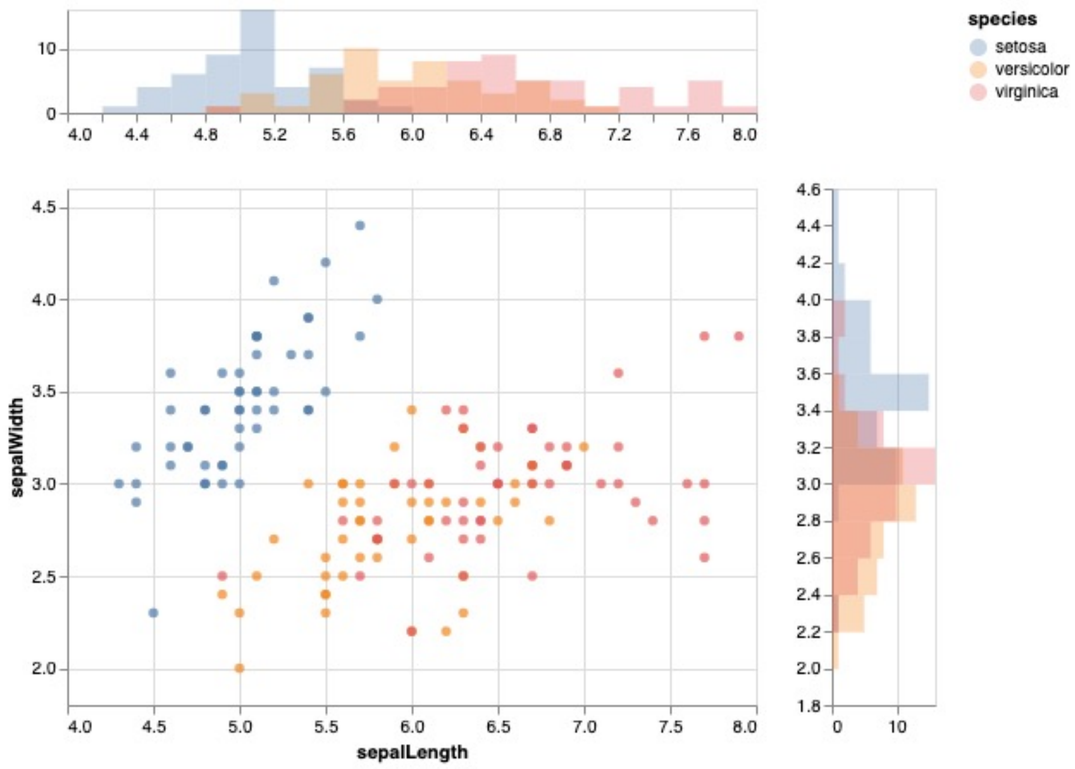

Stream Graph

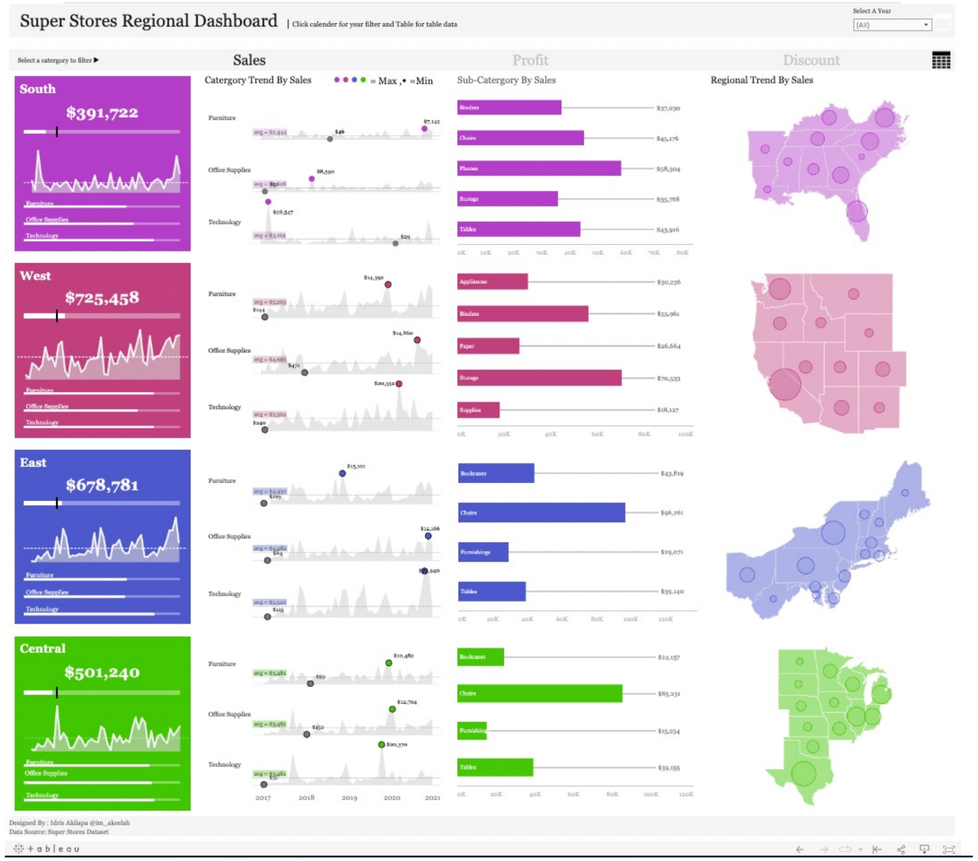



https://datavizproject.com/

# Visual Encoding

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



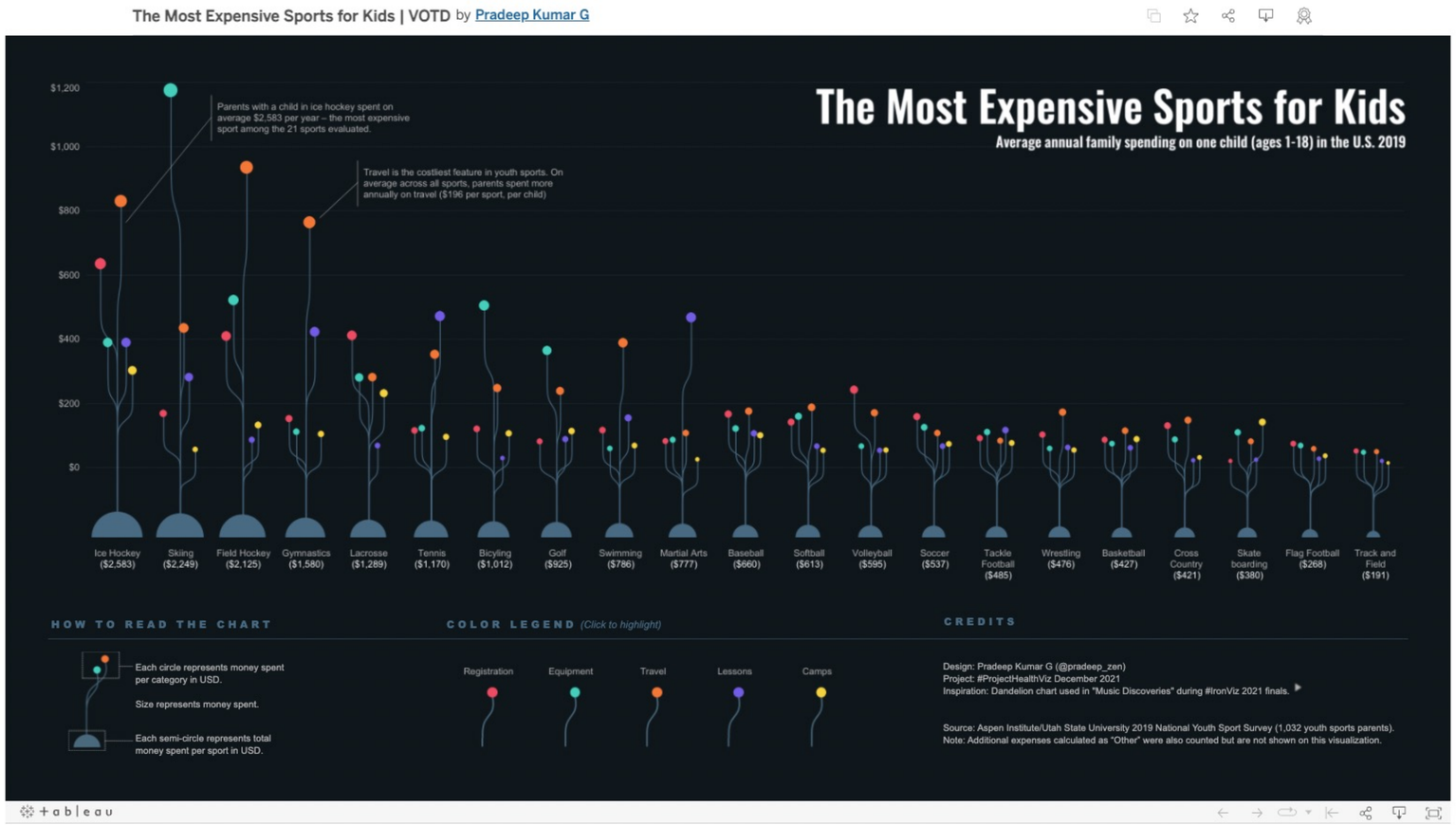




https://altair-viz.github.io/gallery/index.html

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

# Visual Encoding

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



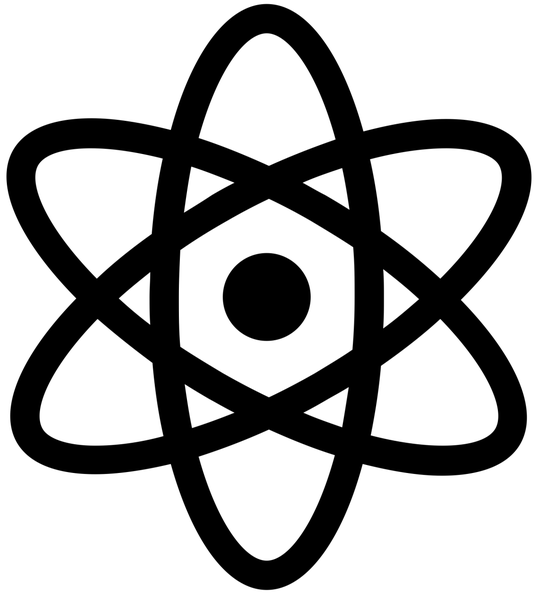

https://public.tableau.com/app/profile/pradeepkumar.g/viz/TheMostExpensiveSportsforKids/ProjectHealthViz

# Marks and Channels

From Munzner's book

# Marks and Channels

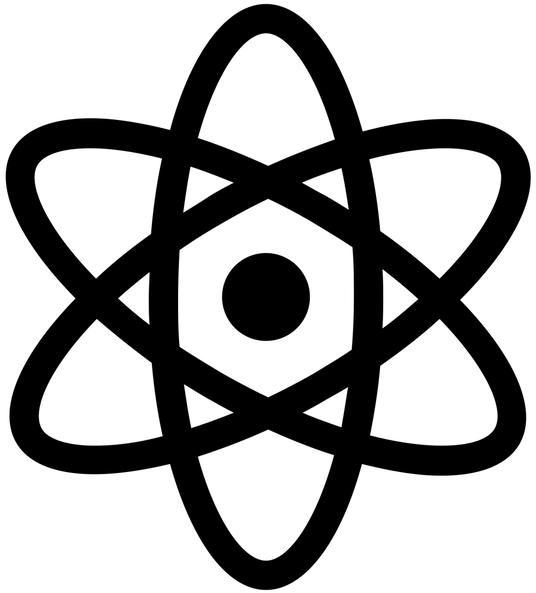
MARKS AND CHANNELS = basic visual primitives that make up visualizations



# 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

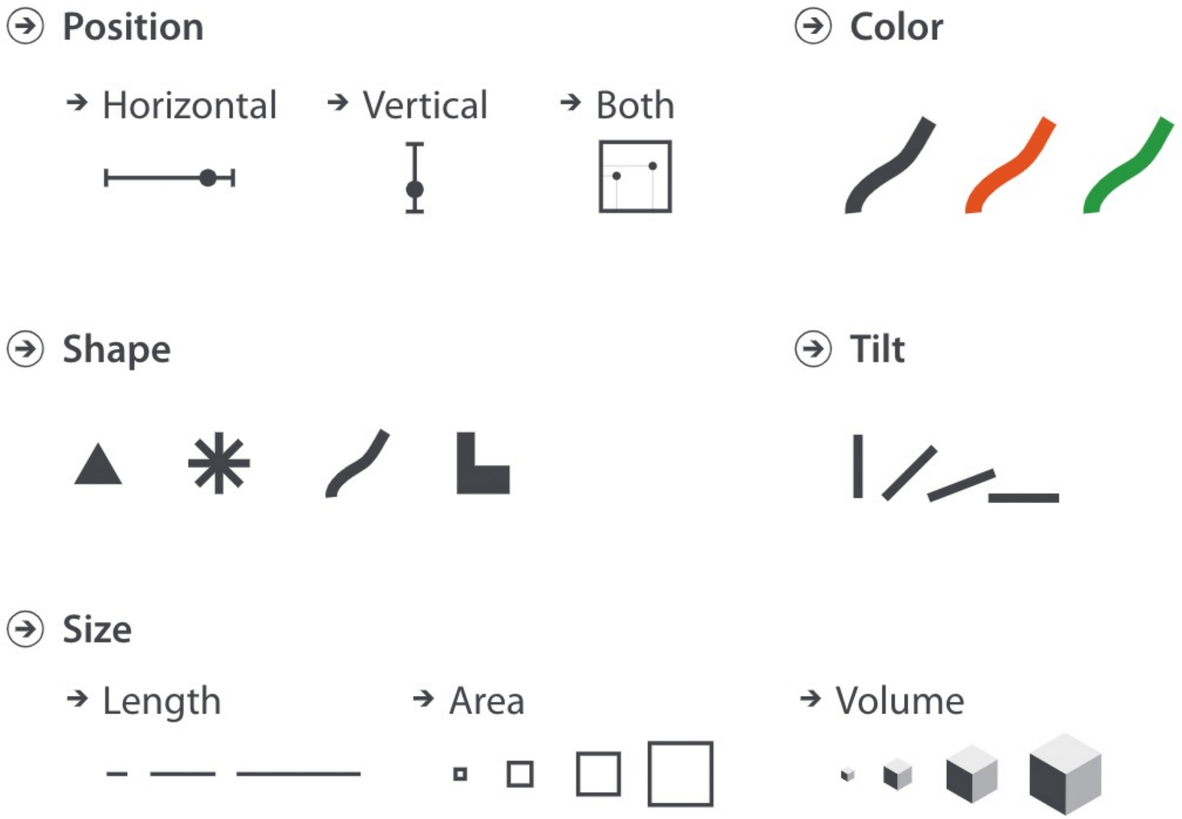
→ 1D (length)

Areas

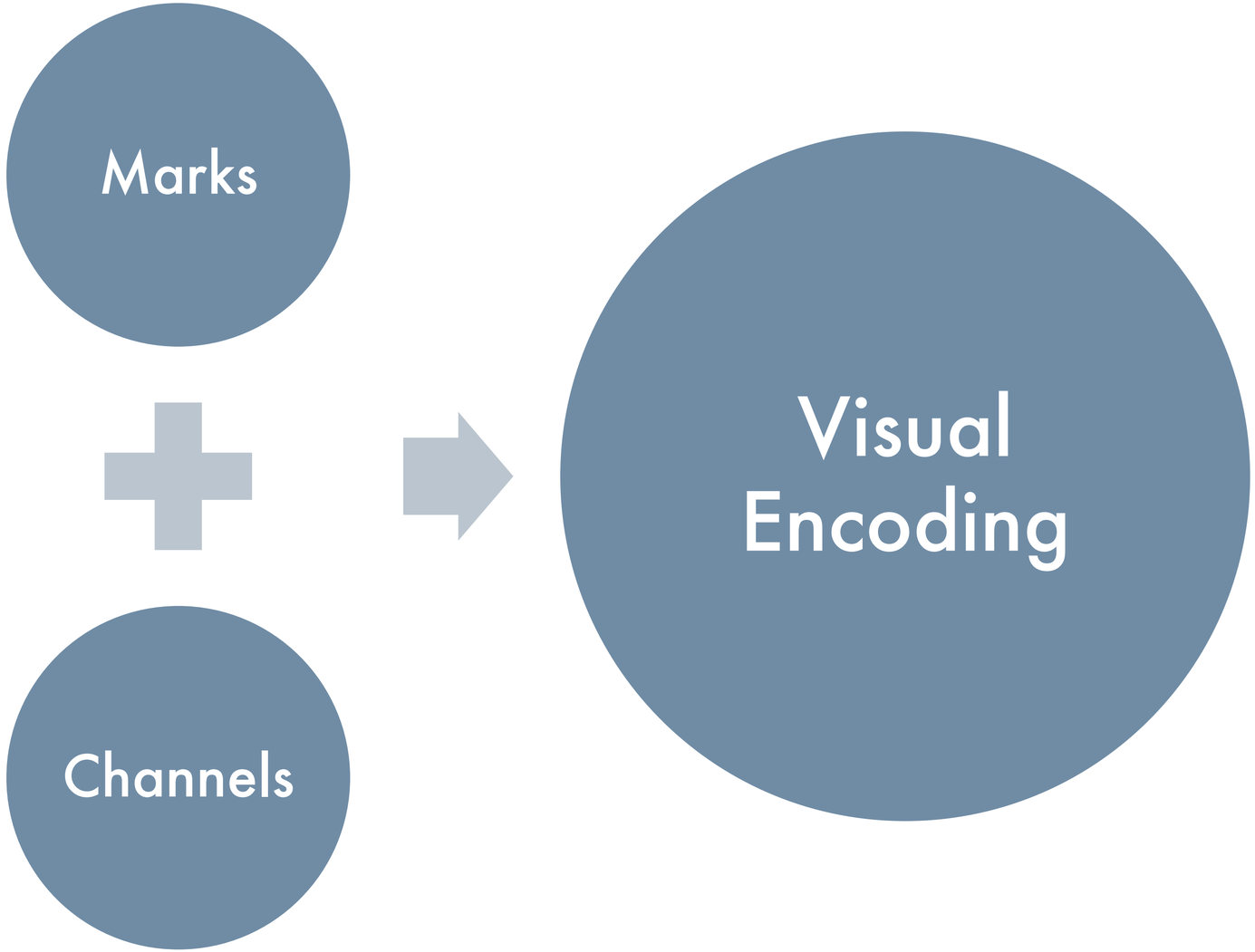
→ 2D (height, width)

# Channels

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

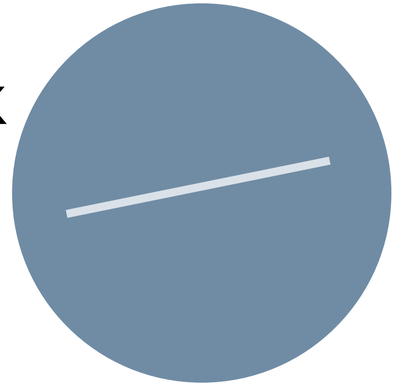


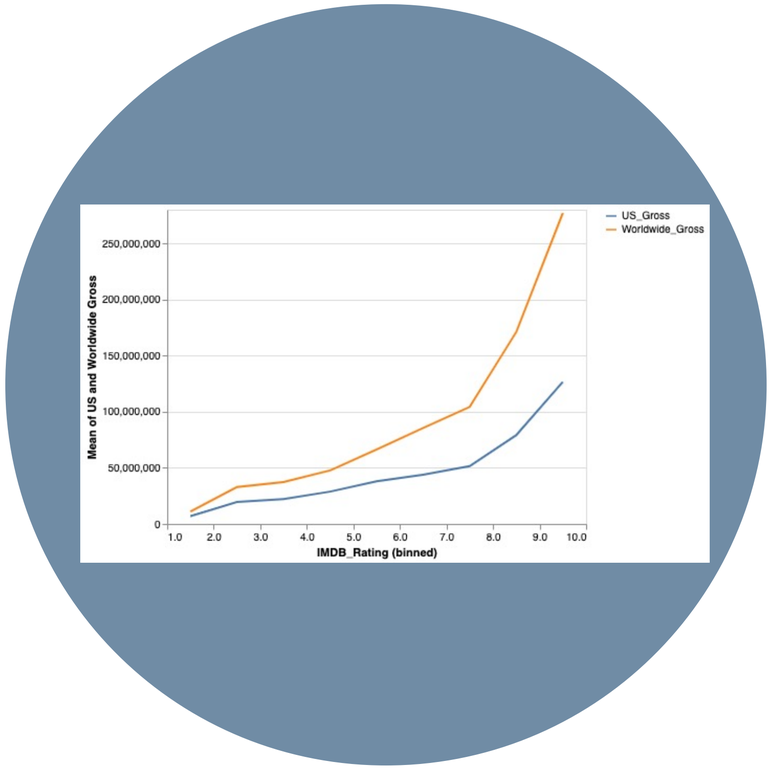
# Visual Encoding



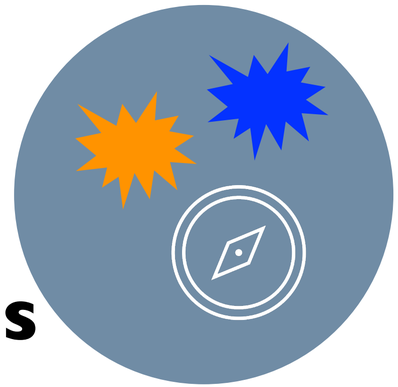
# Visual Encoding

**Mark**






**Visual Encoding (Line chart)**



**Channels**

# Visual Encoding

Mark

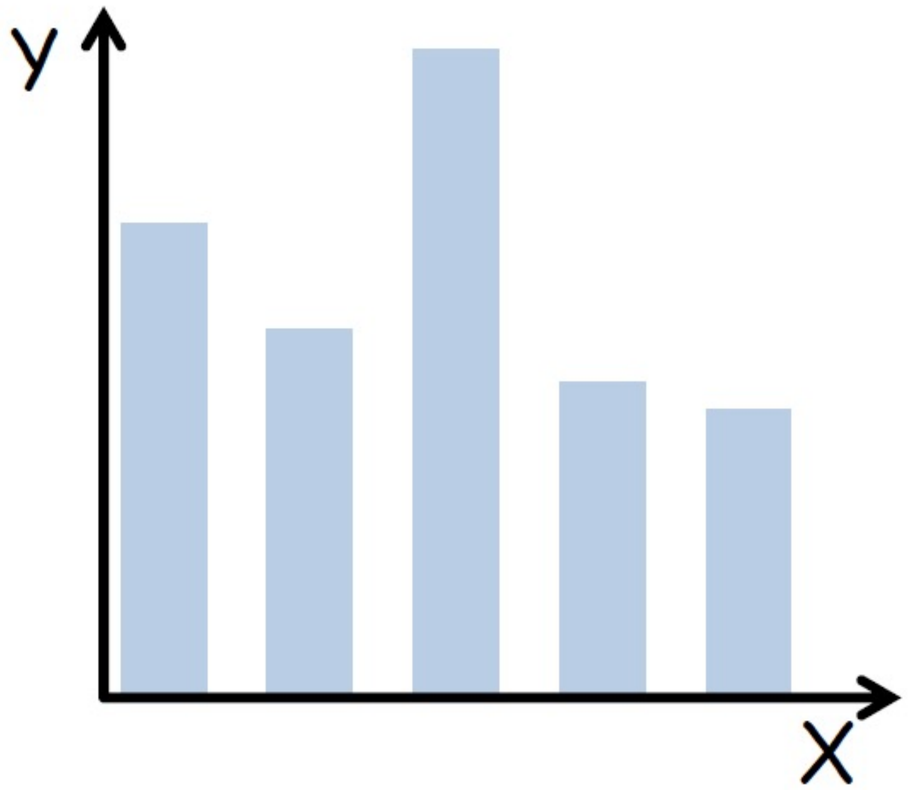



oding
art)

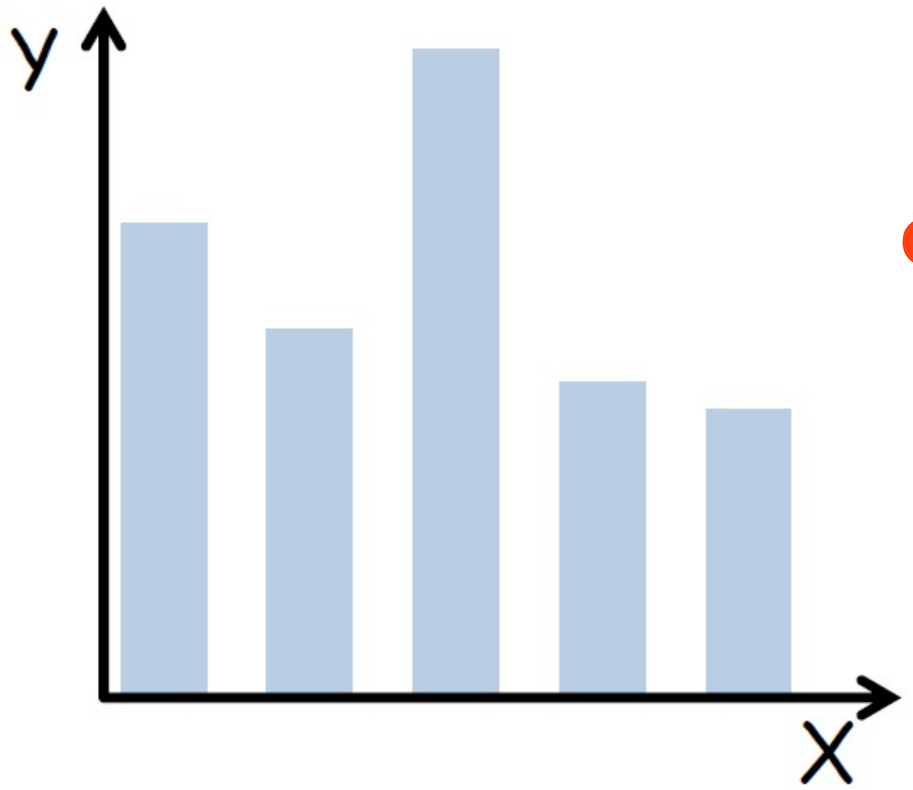
Channels

We can decompose any visualization into marks and channels

# Visual Encoding

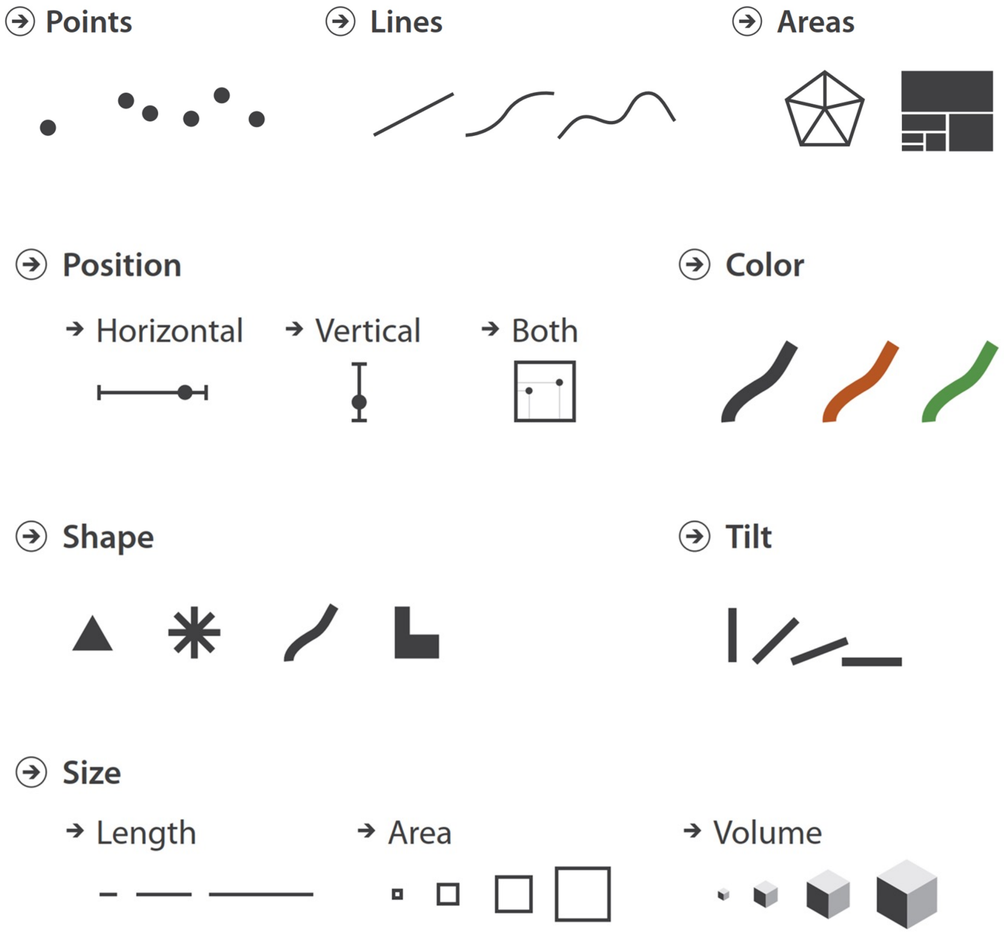


# Visual Encoding

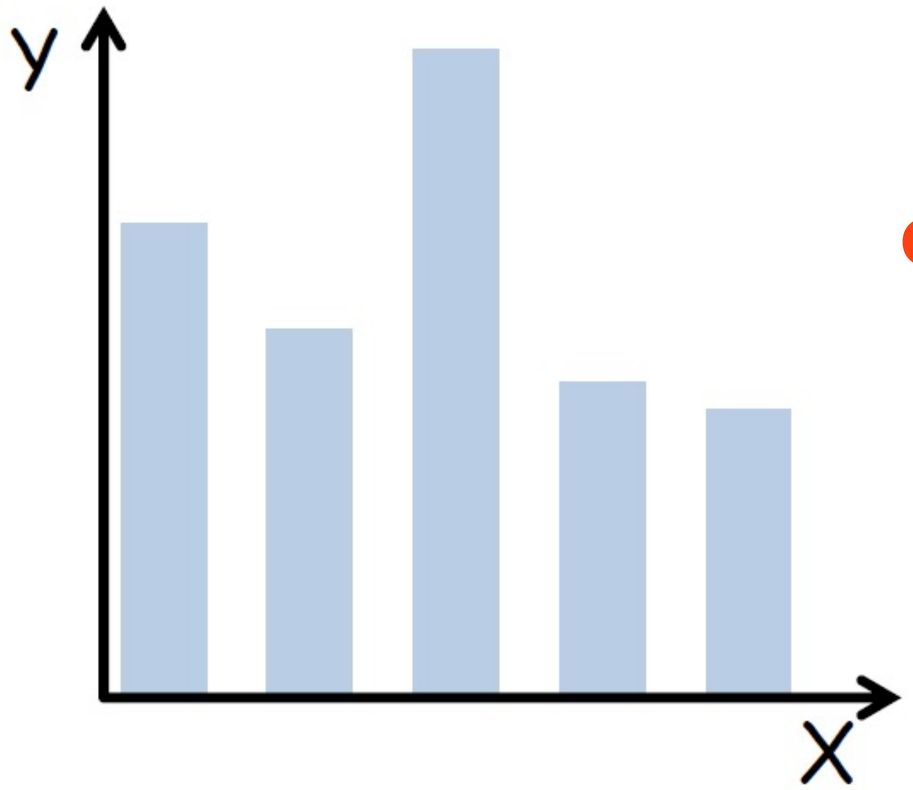



**Marks**

**Channels**

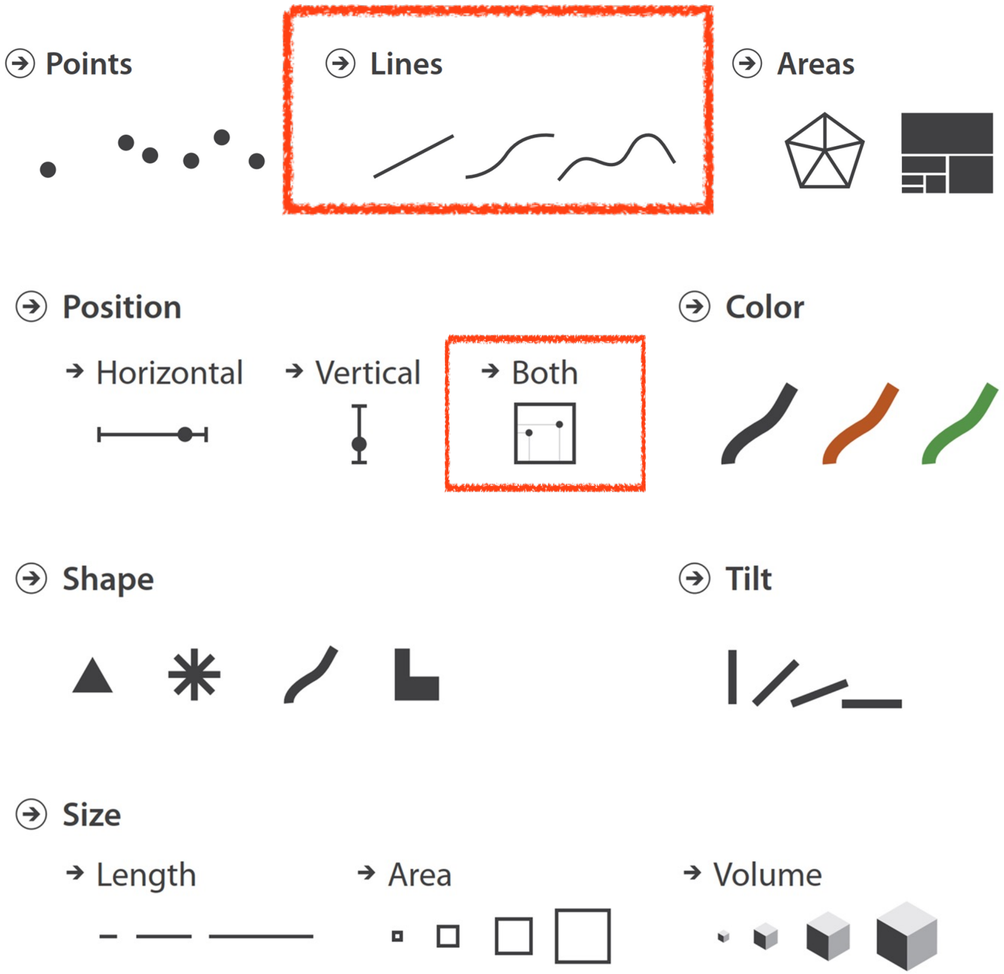


# Visual Encoding



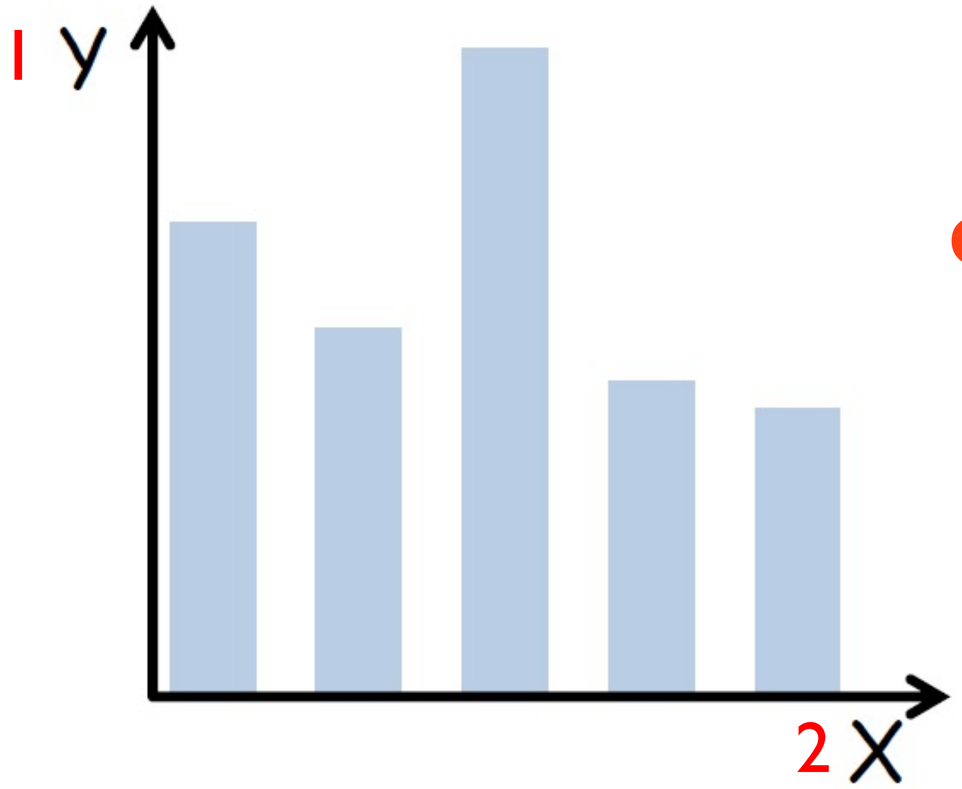

**Marks**

**Channels**



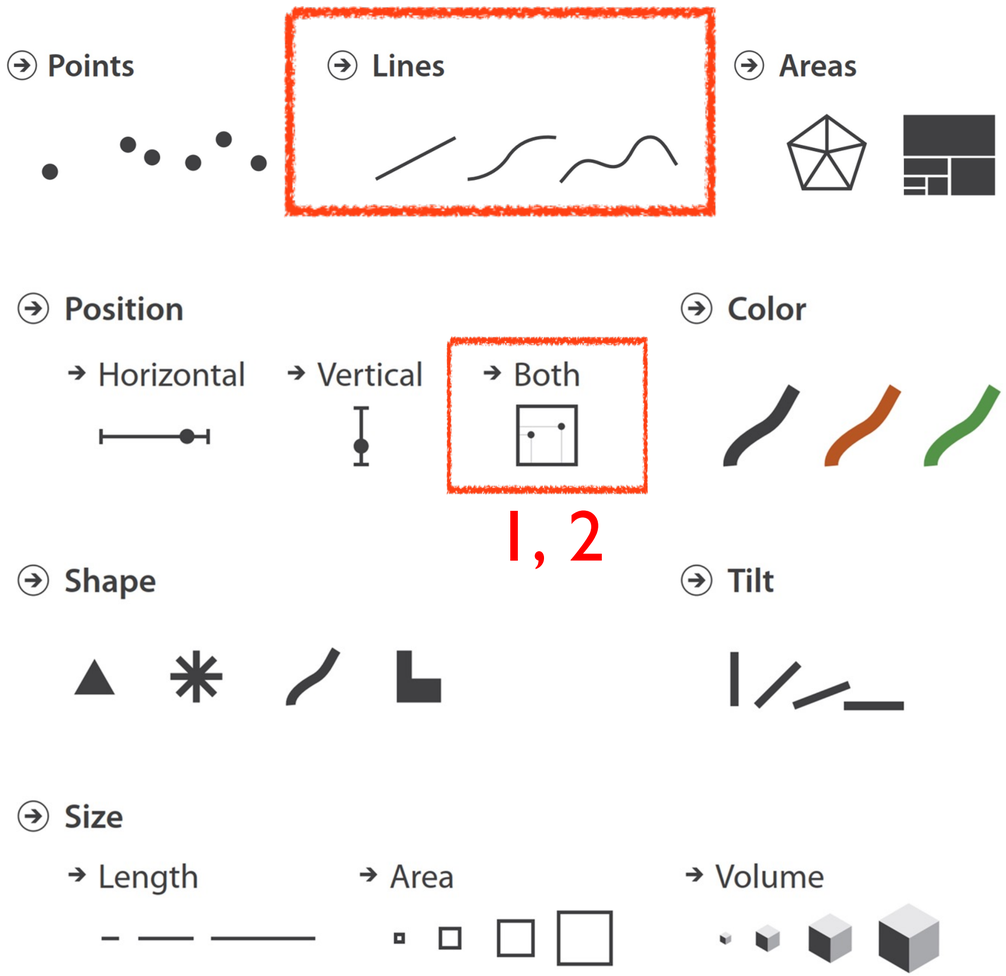
# Visual Encoding

**2 Attributes → 2 Channels**

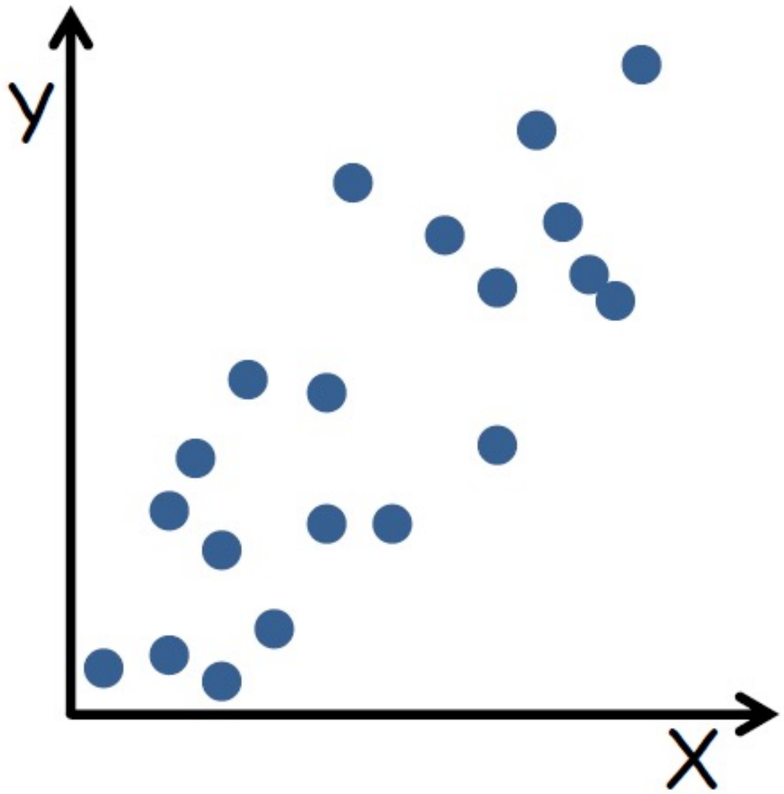



**Marks**

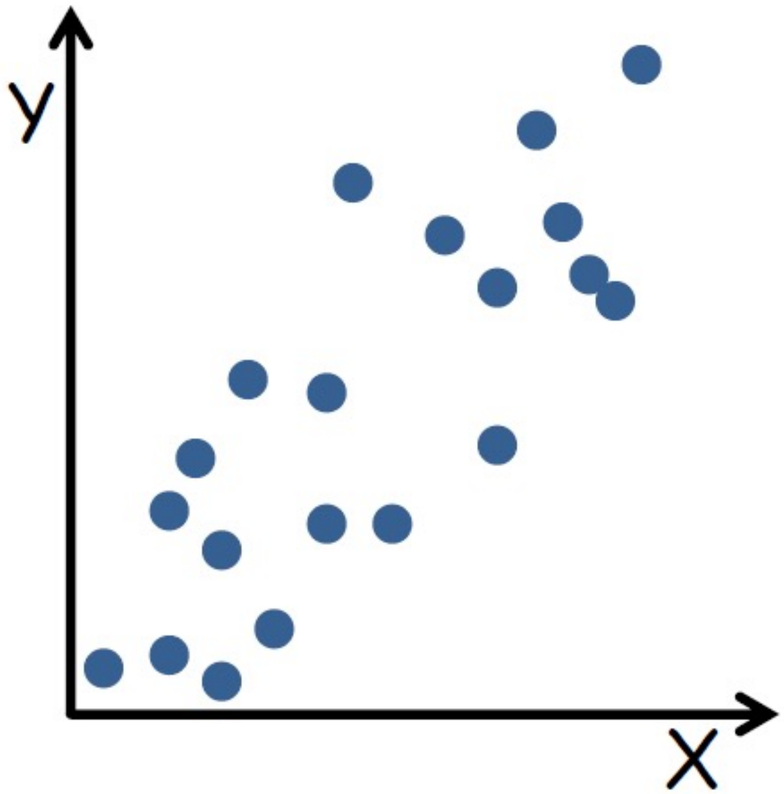
**Channels**



# Visual Encoding

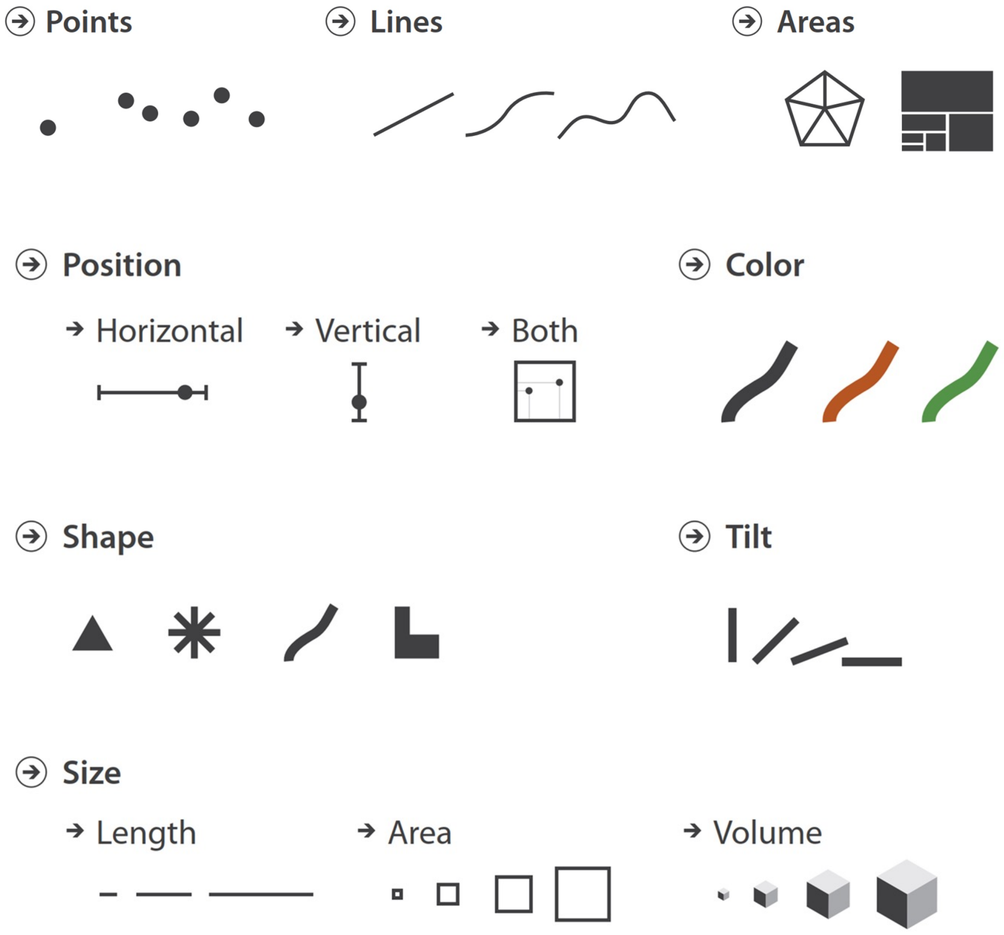


# Visual Encoding

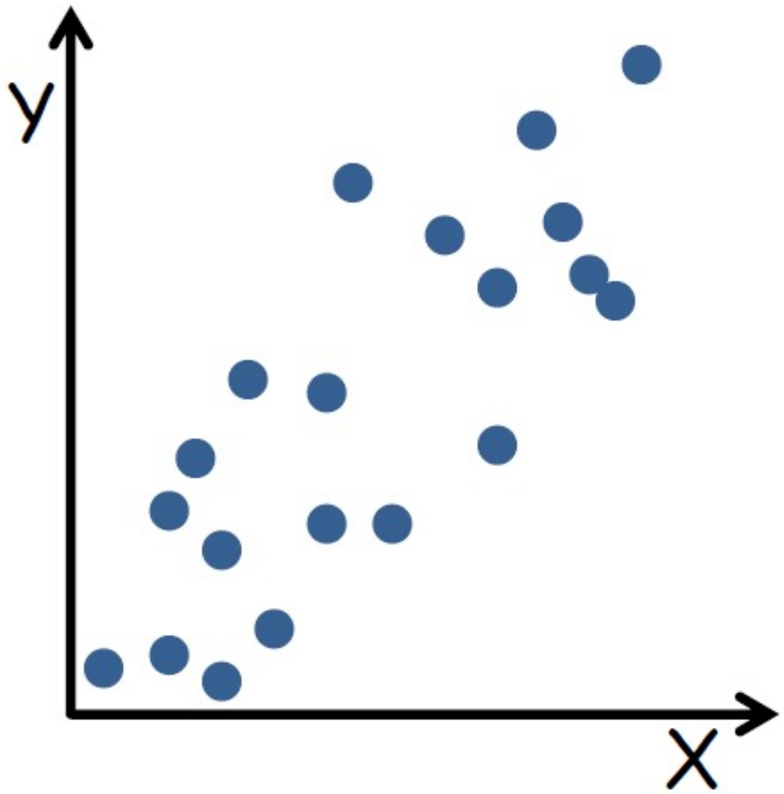



**Marks**

**Channels**



# Visual Encoding




**Marks**

Points

Lines

Areas

**Channels**

Position

Horizontal

Vertical

Both

Color

Shape

Tilt

Size

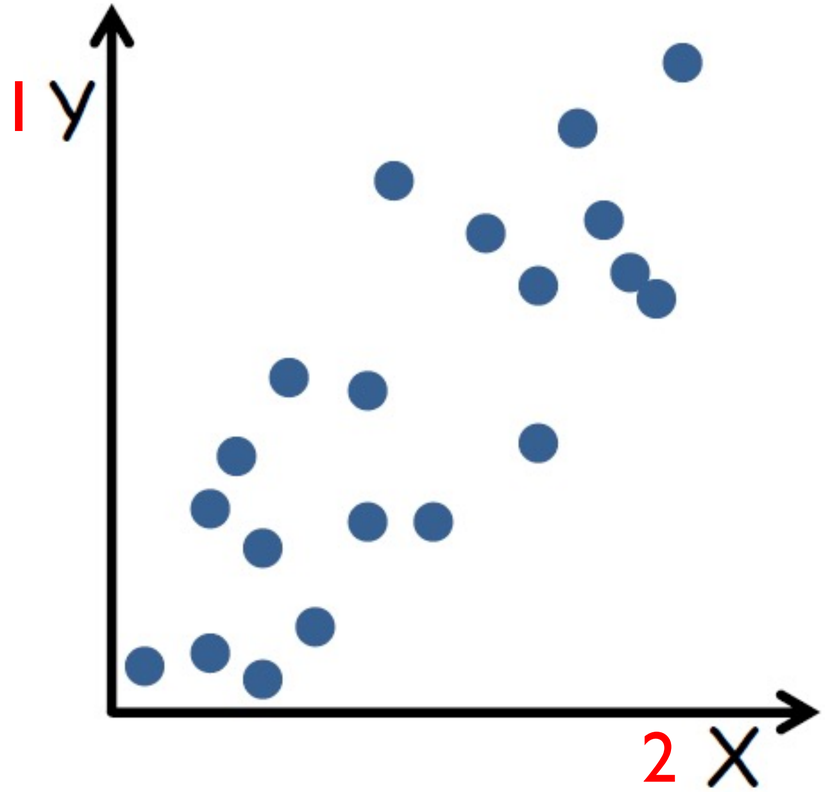
Length

Area

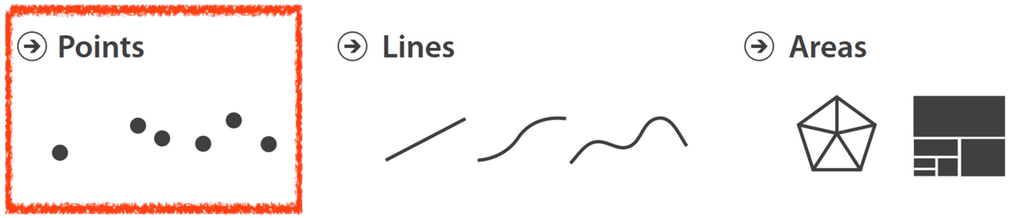
Volume

# Visual Encoding

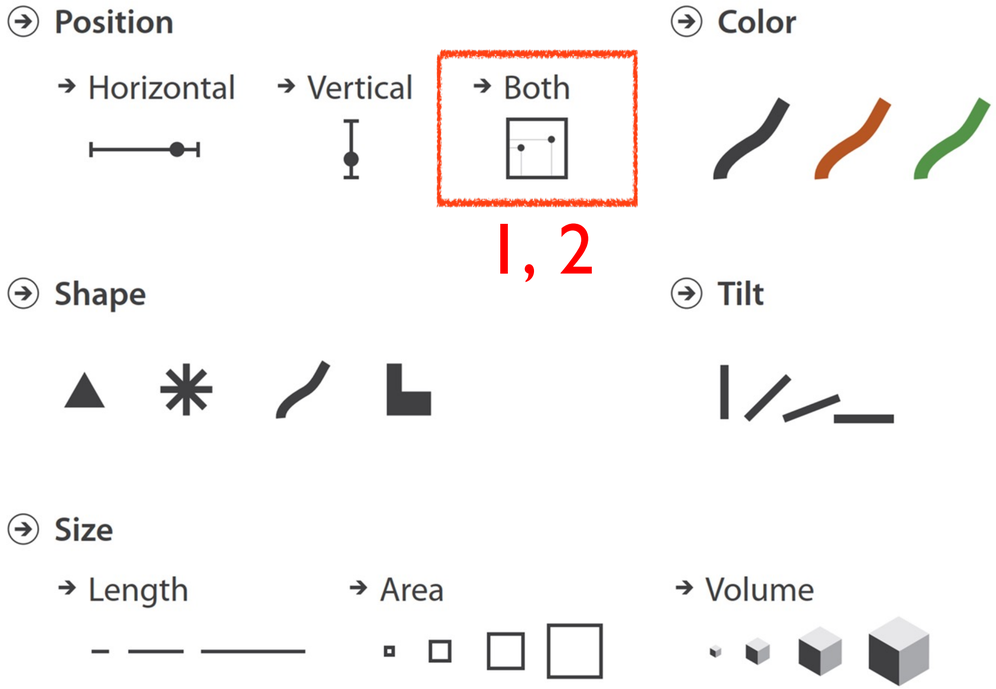
**2 Attributes → 2 Channels**



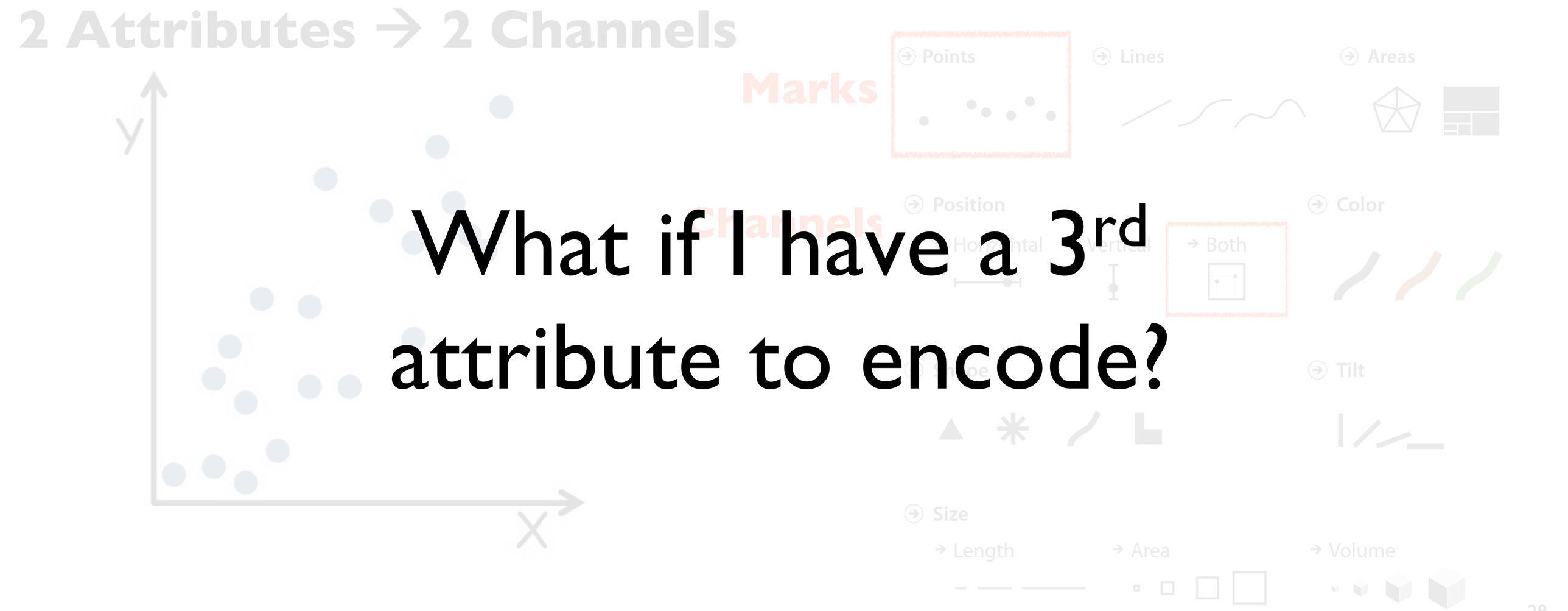

**Marks**




**Channels**



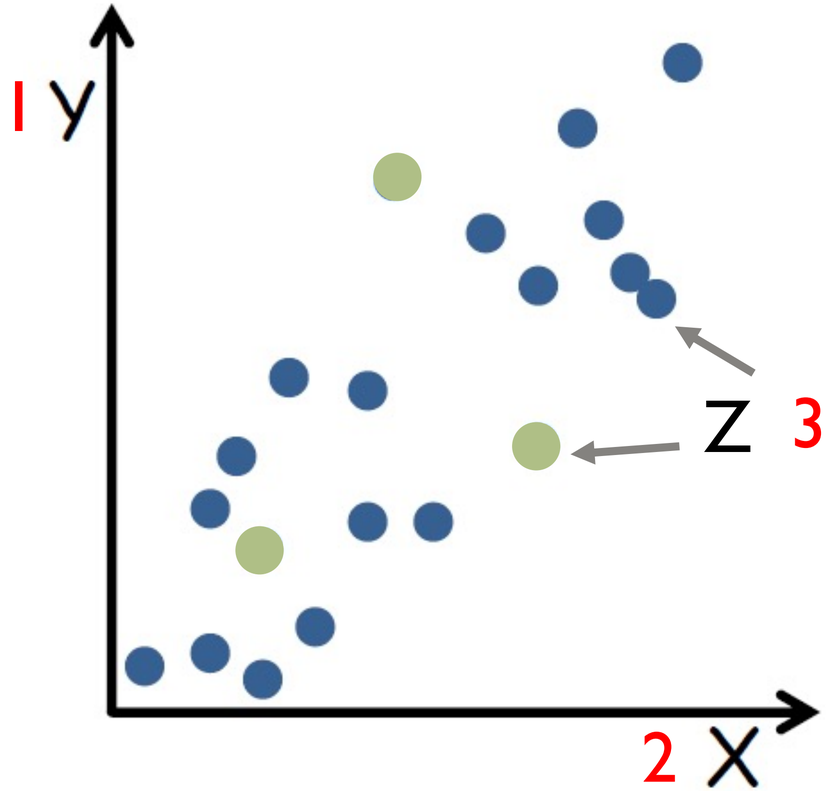
# Visual Encoding



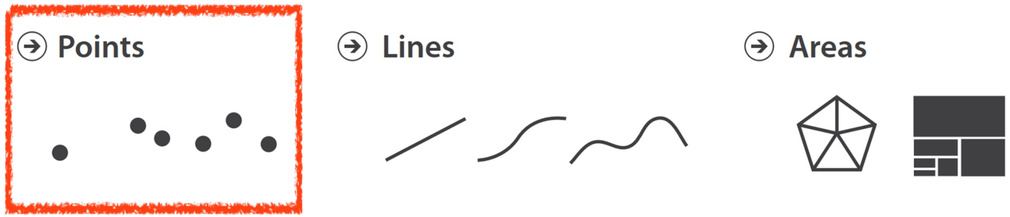

What if I have a 3rd attribute to encode?

# Visual Encoding

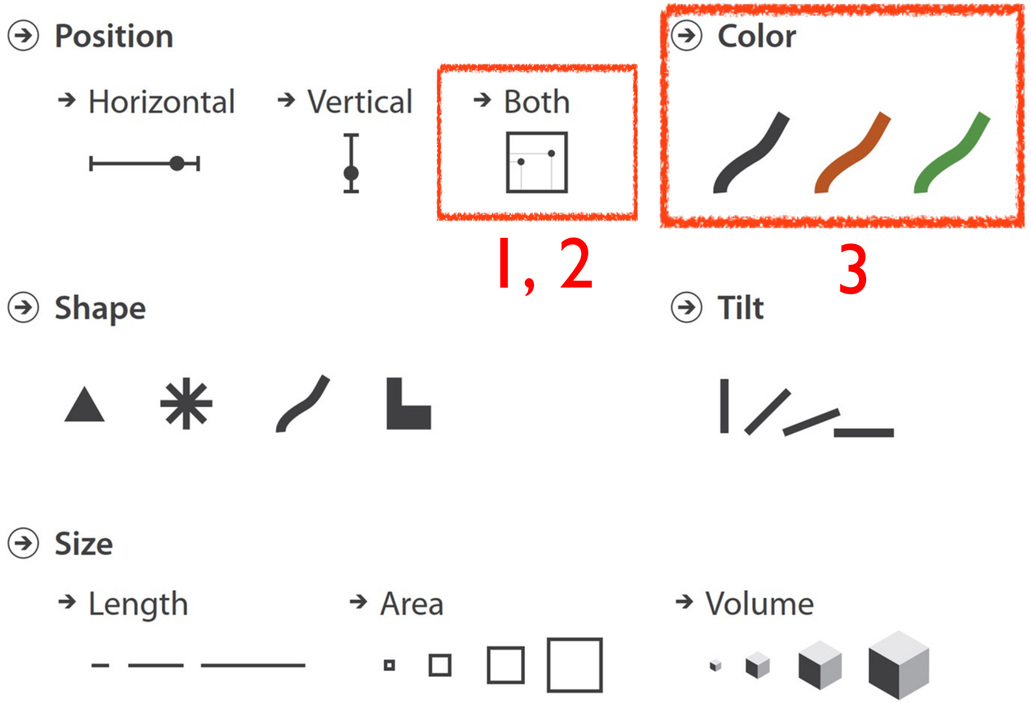
**3 Attributes → 3 Channels**



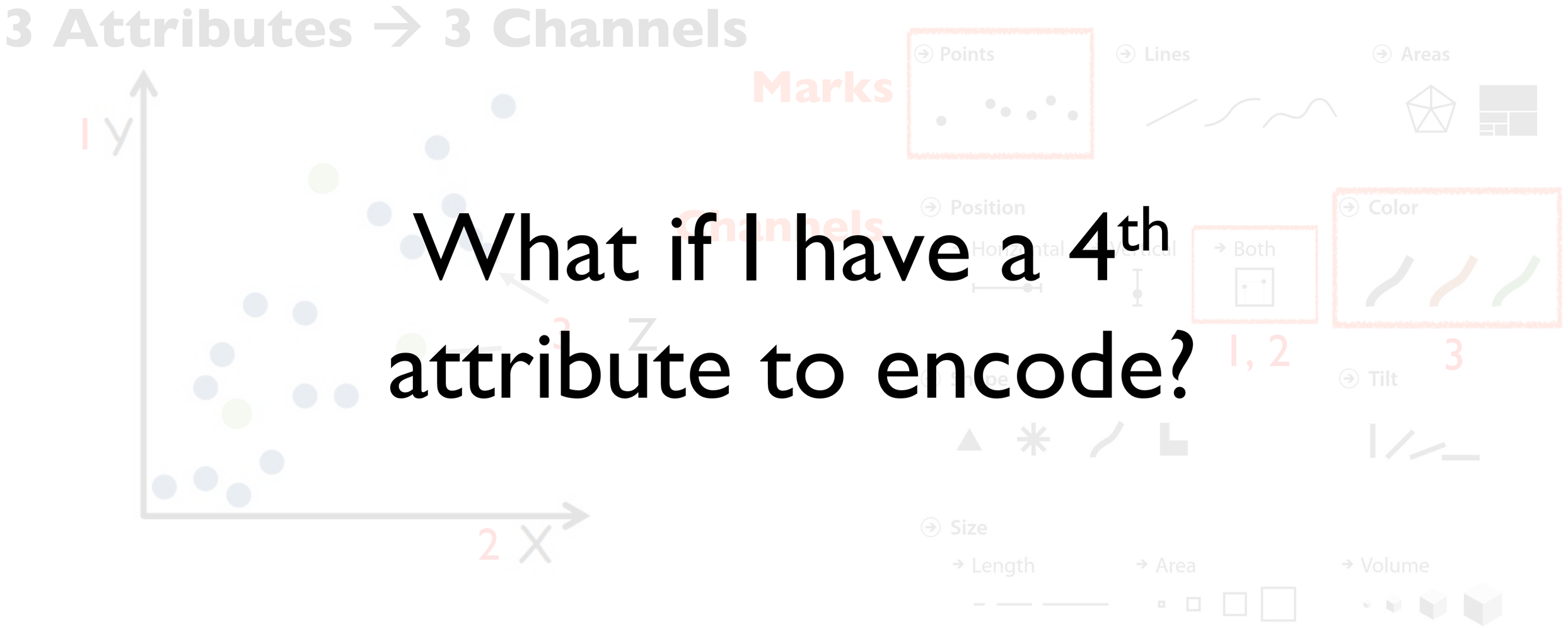

**Marks**




**Channels**



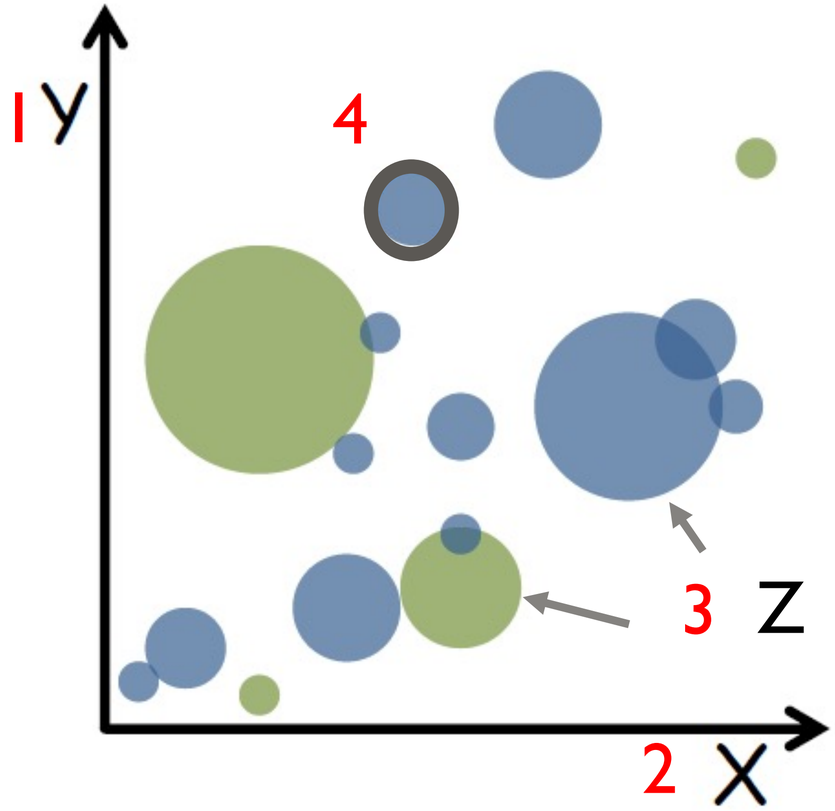
# Visual Encoding




What if I have a 4th attribute to encode?

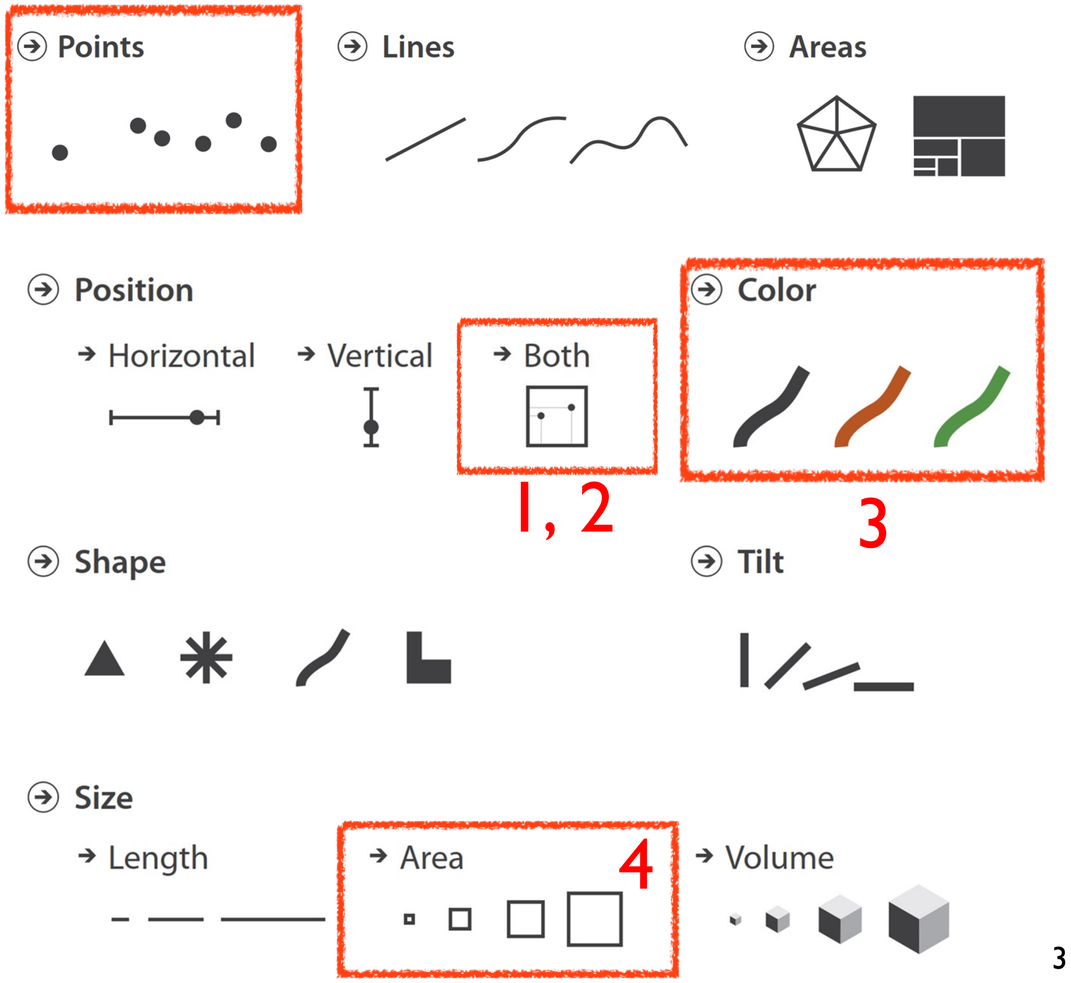
# Visual Encoding

**4 Attributes → 4 Channels**

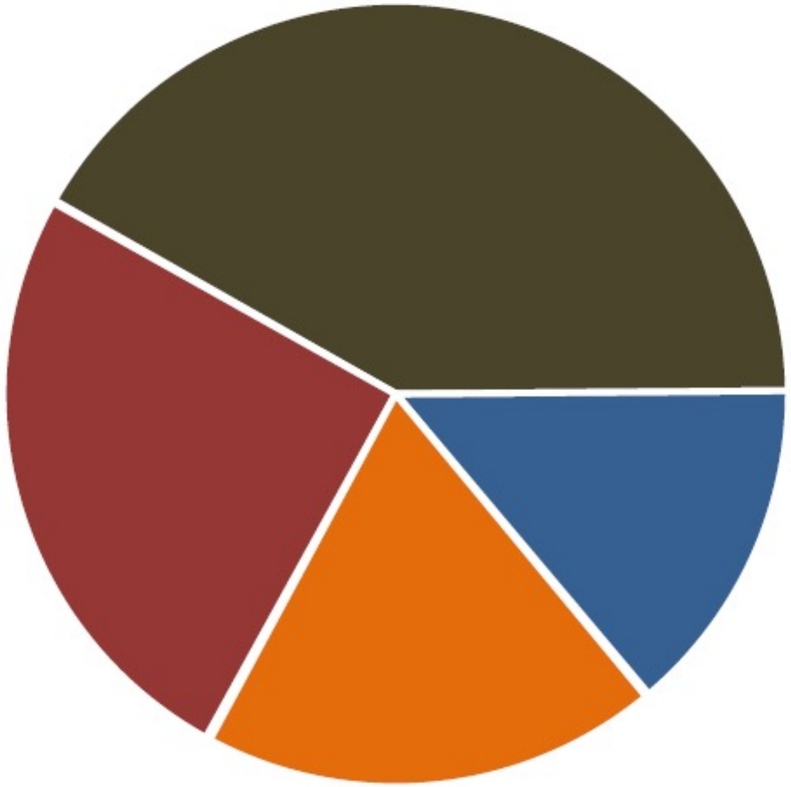



**Marks**

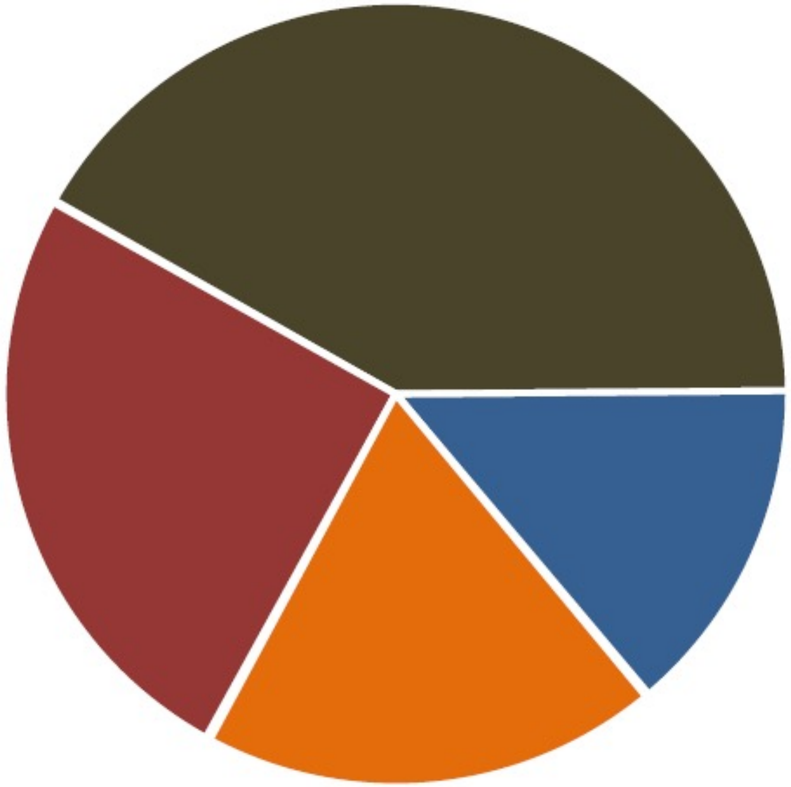
**Channels**



# Visual Encoding



# Visual Encoding

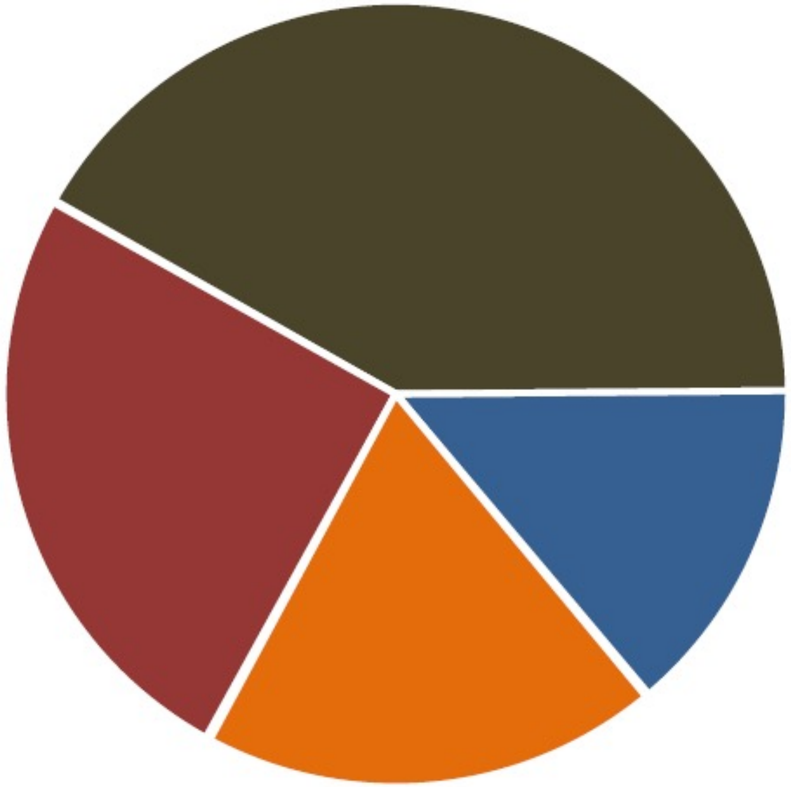


**Marks**


**Channels**

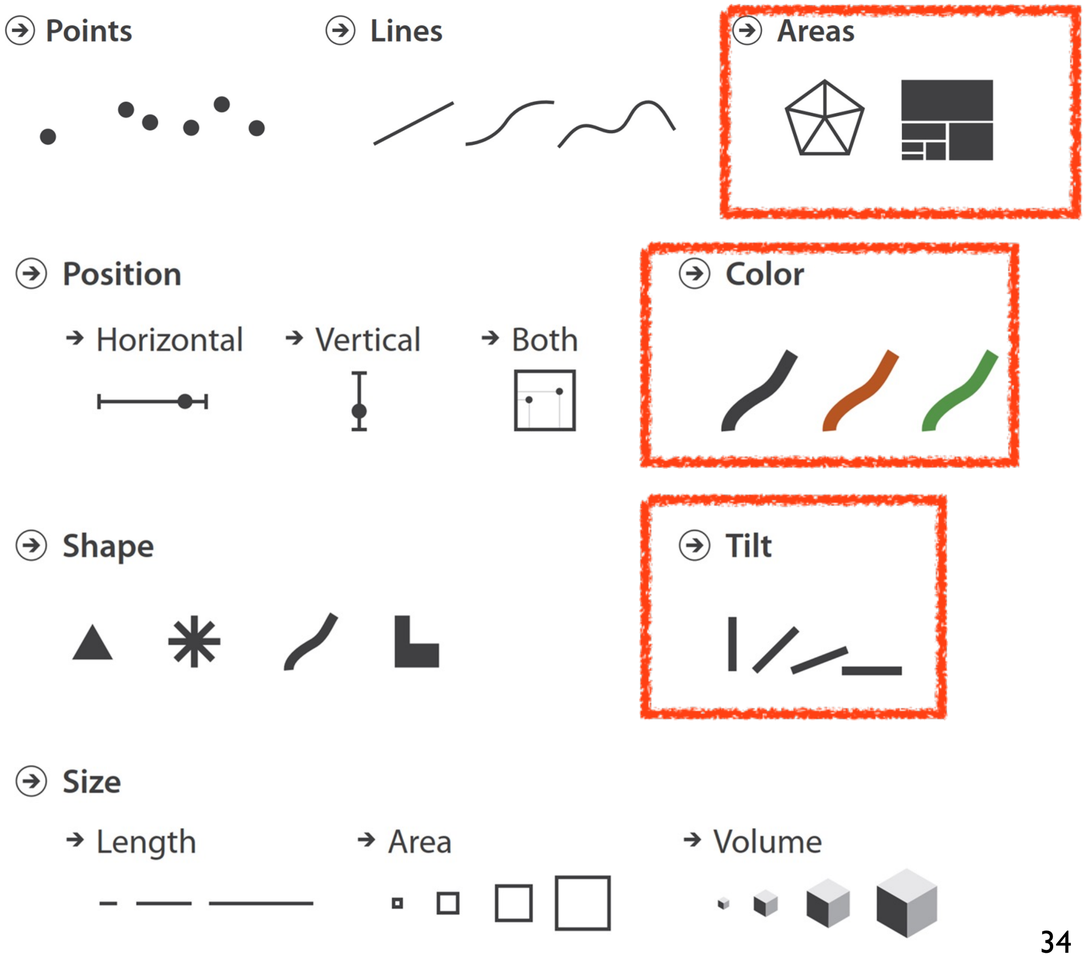


# Visual Encoding



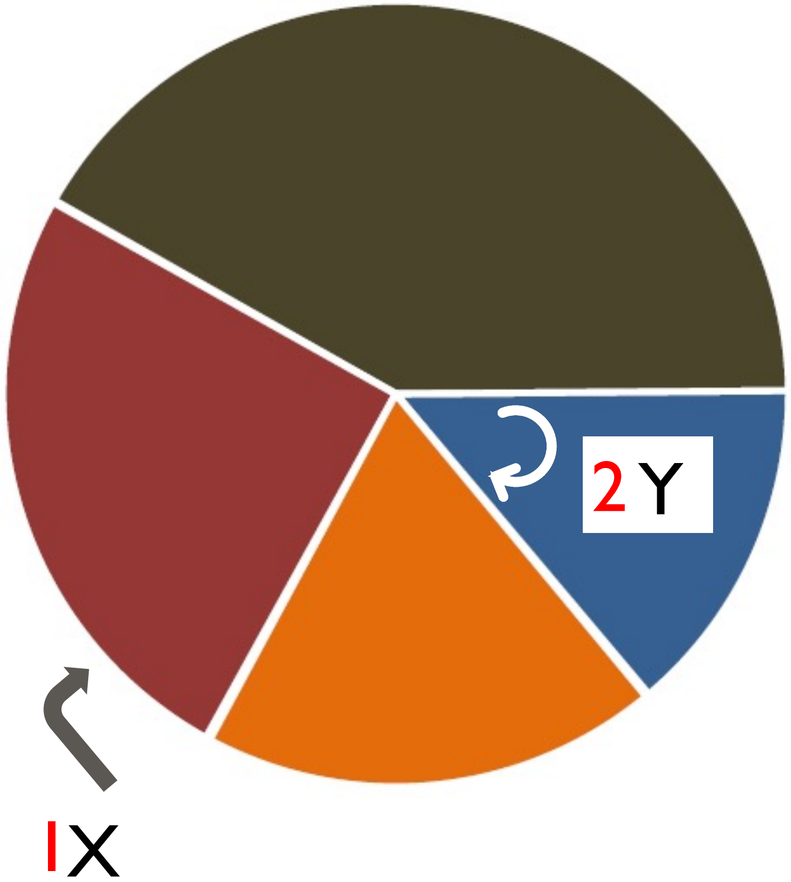
**Marks**

**Channels**



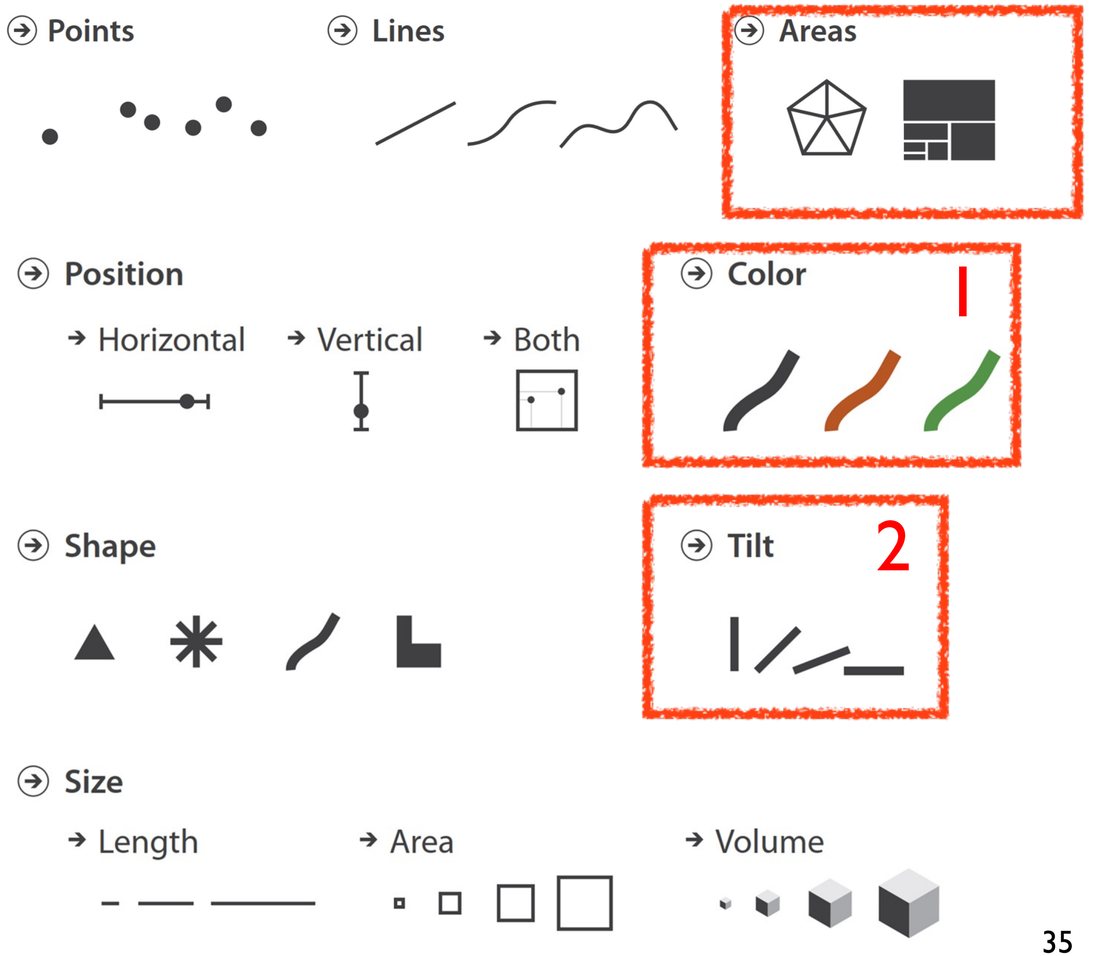
# Visual Encoding

**2 Attributes → 2 Channels**




**Marks**

**Channels**



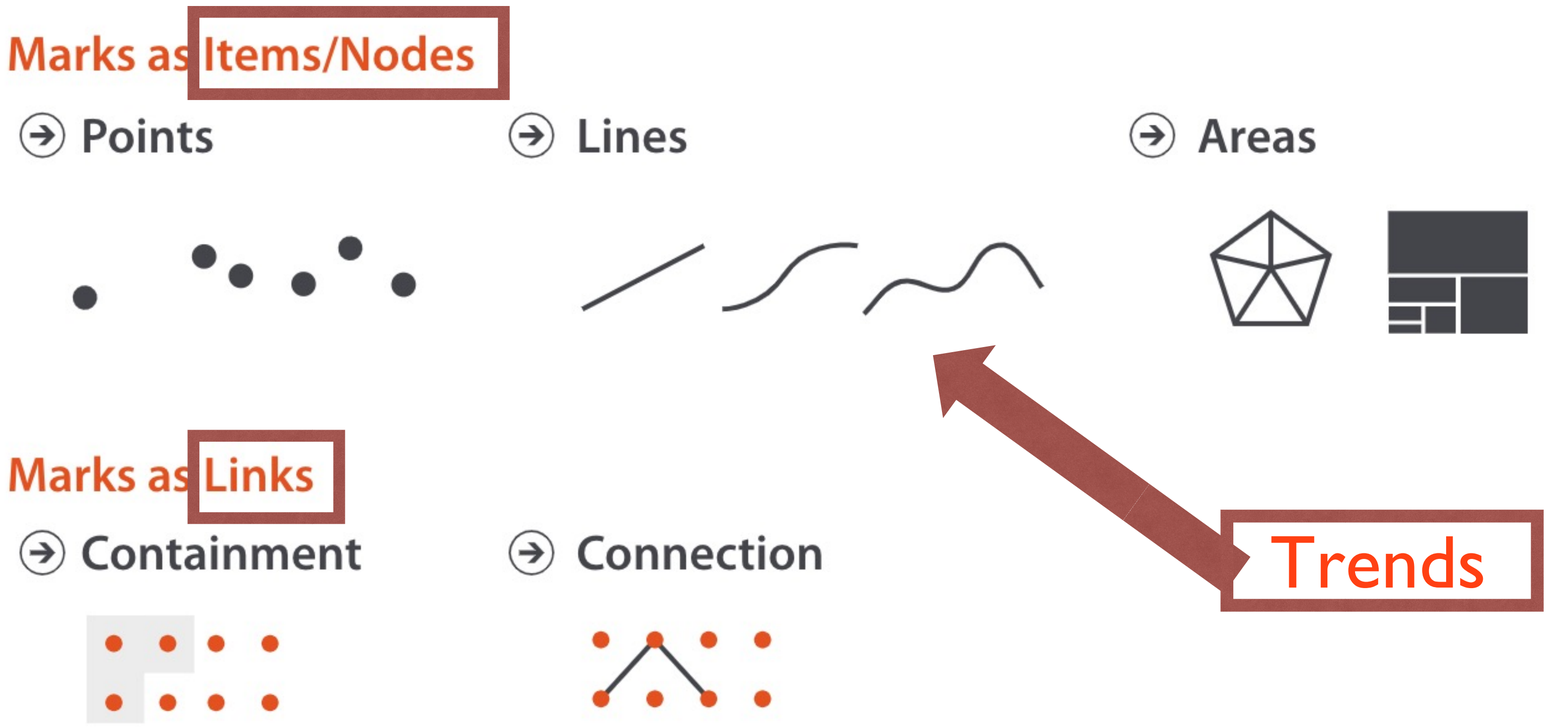
# Choosing Marks and Channels

From Munzner's book

# Marks


- Work in 3 groups (one for each mark type)
- 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**

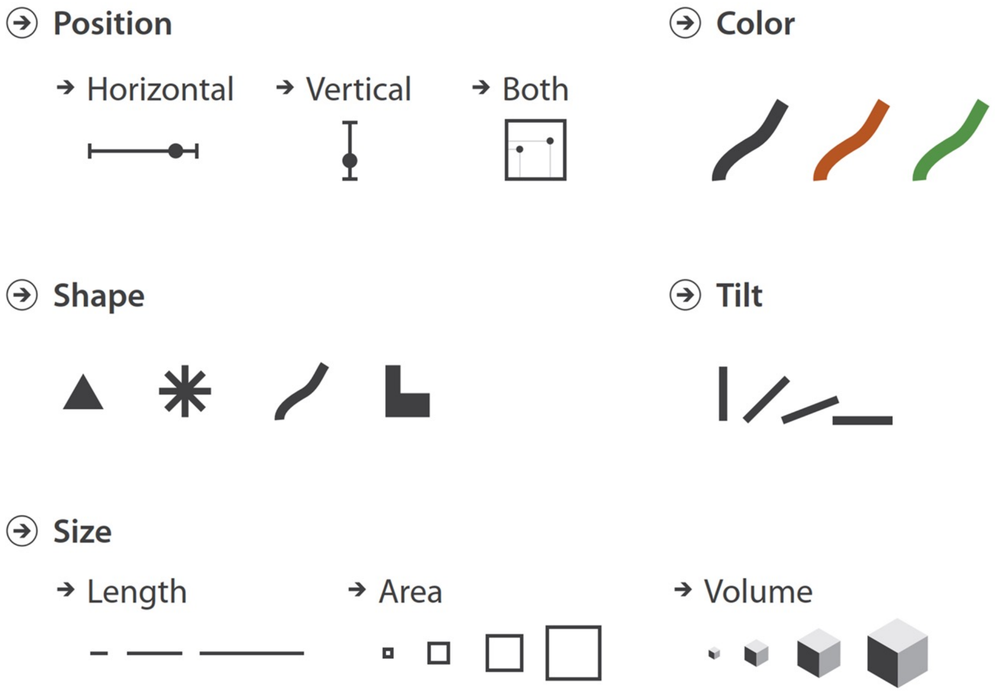
**Shape**

**Tilt**

**Size**

- Length
- Area
- Volume

# Channels

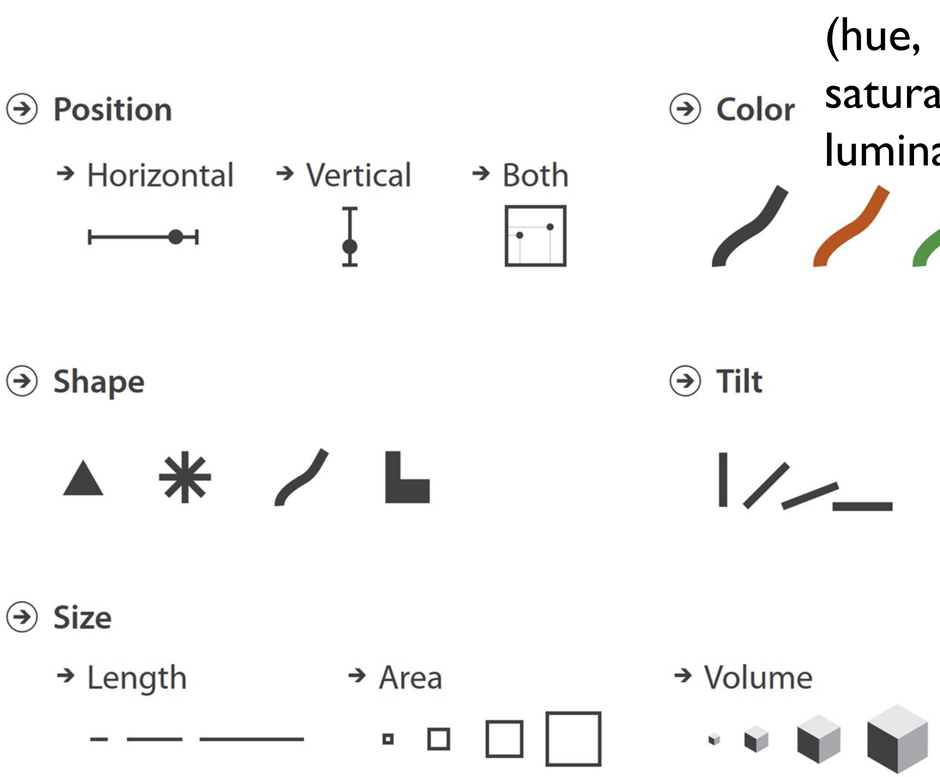



A note on color:

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


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

# Channels




- Work in 5 groups (one for each channel)
- Use your assigned channel to create a visual encoding for the following data:

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

# Channels

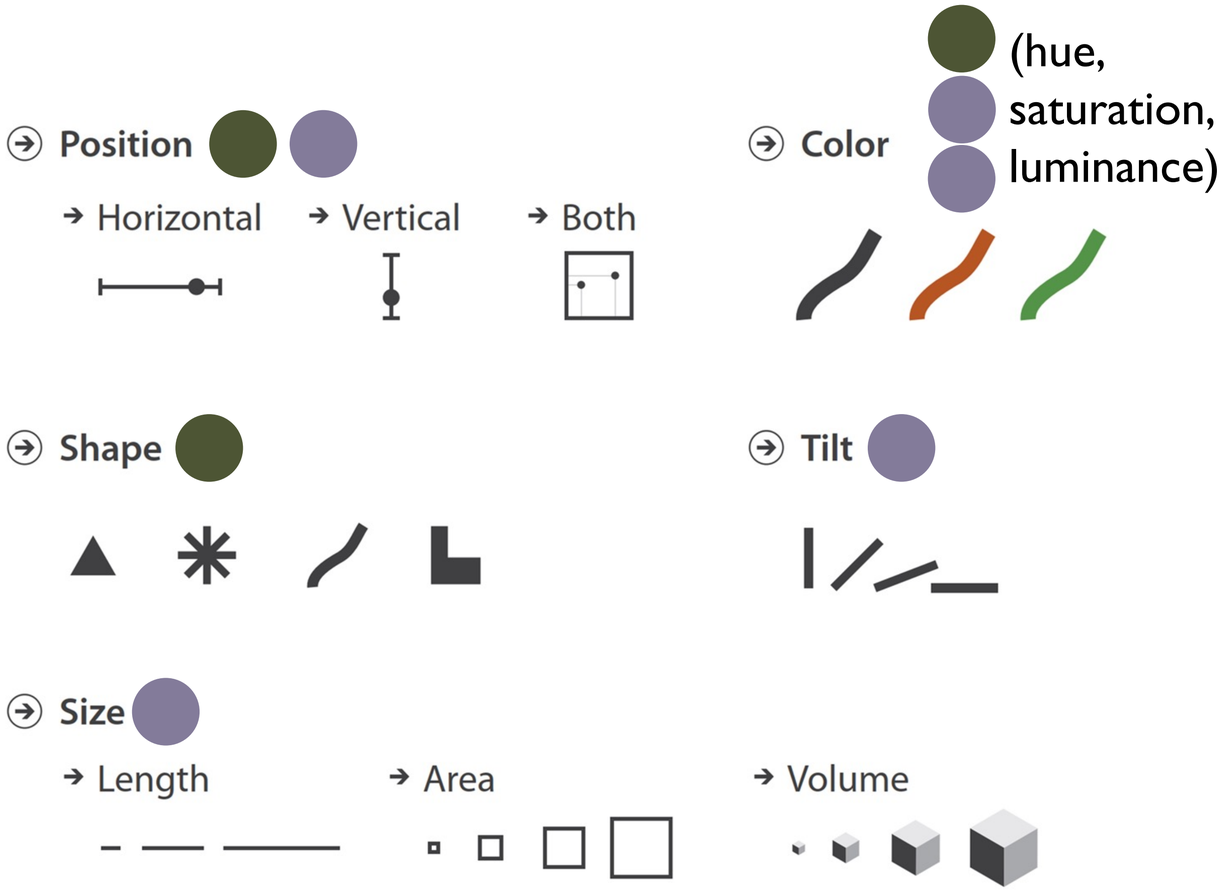
**Based on human perception**

**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.

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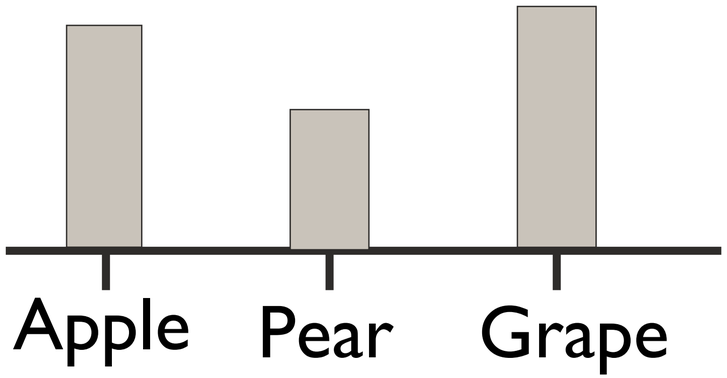
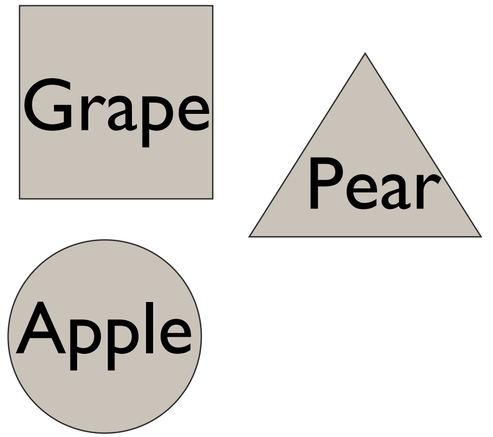
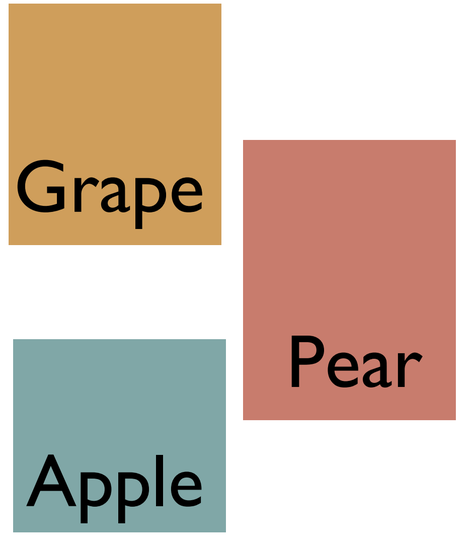
| Dataset 1 |
| --- |
| Pear |
| Apple |
| Grape |

Categorical – Identity



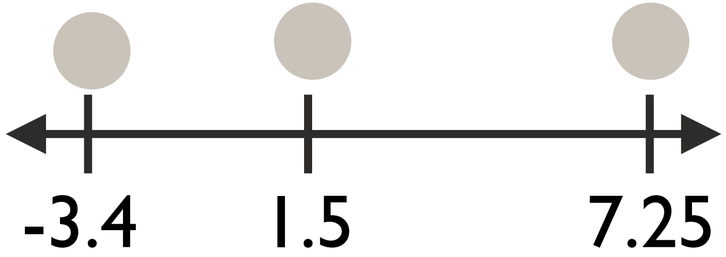
# Choosing Marks and Channels

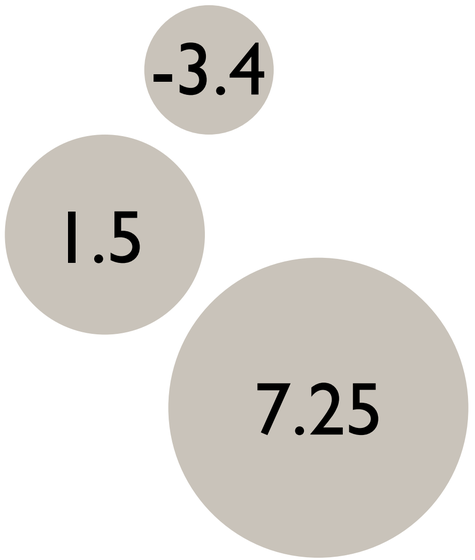
**Expressiveness Principle** = The visual encoding should express all of, and only, the information in the dataset attributes.

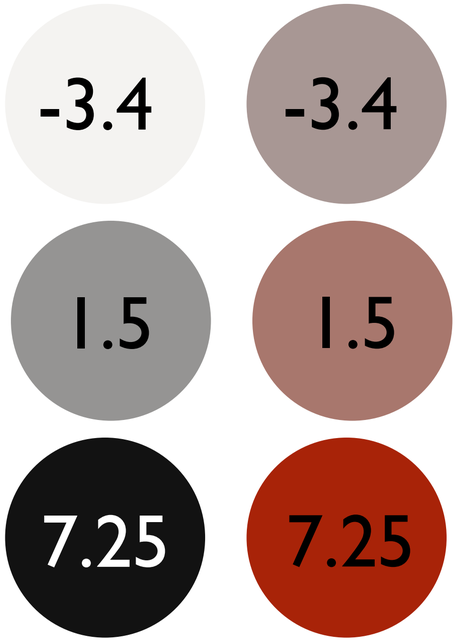
- i.e. The perceptual interpretation of channels (identity vs. magnitude) should match the interpretation of data.

| Dataset 3 |
| --- |
| 1.5 |
| 7.25 |
| - 3.4 |

Quantitative – Magnitude



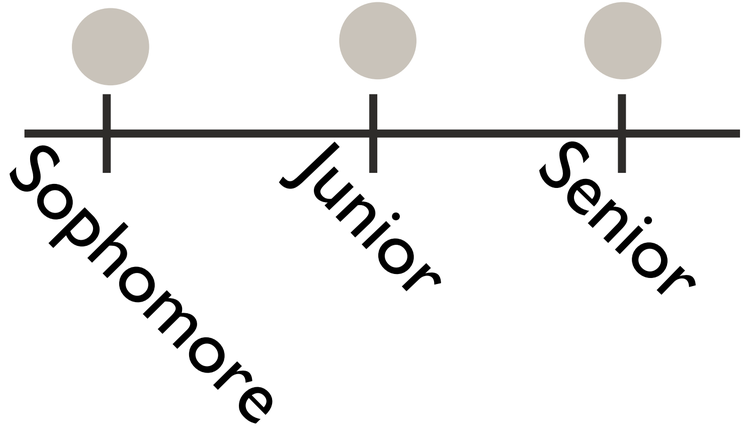
# Choosing Marks and Channels

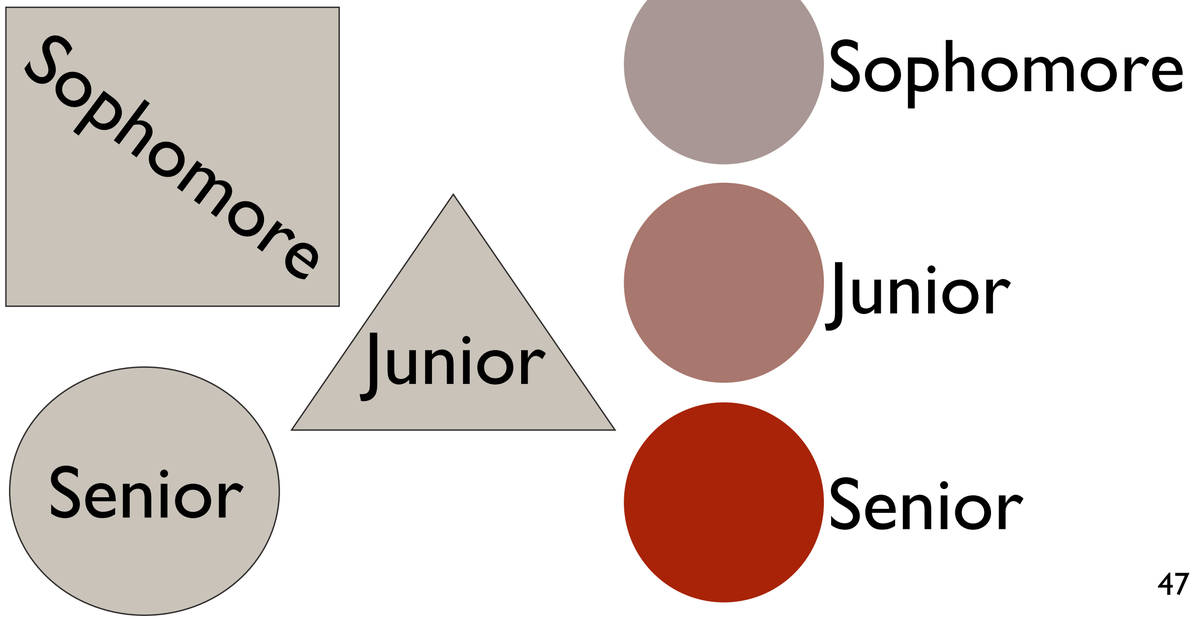
**Expressiveness Principle** = The visual encoding should express all of, and only, the information in the dataset attributes.

- 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

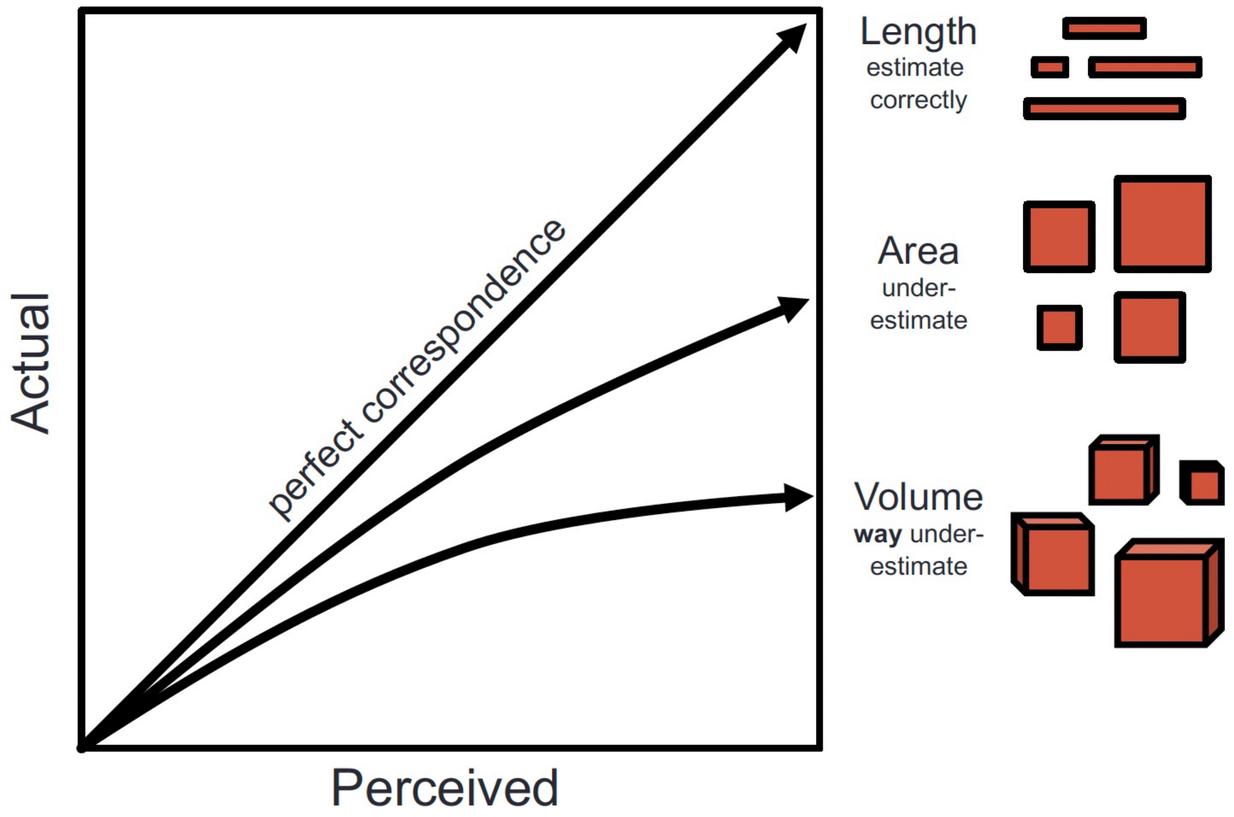
**Definition:** how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second box?

27X

# Accuracy

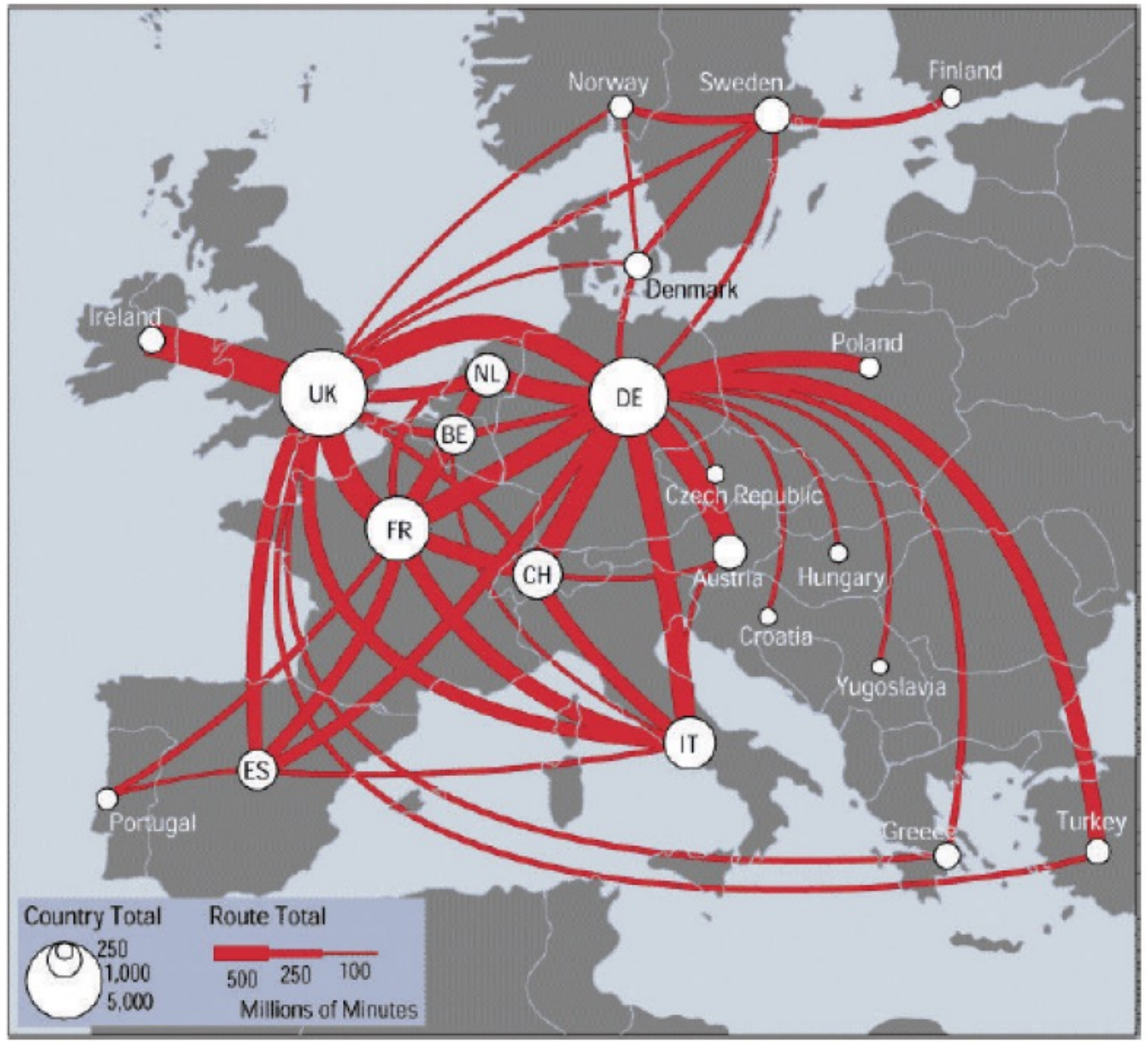
**Definition:** how close human perceptual judgement is to an objective measurement of the stimulus




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

# Discriminability

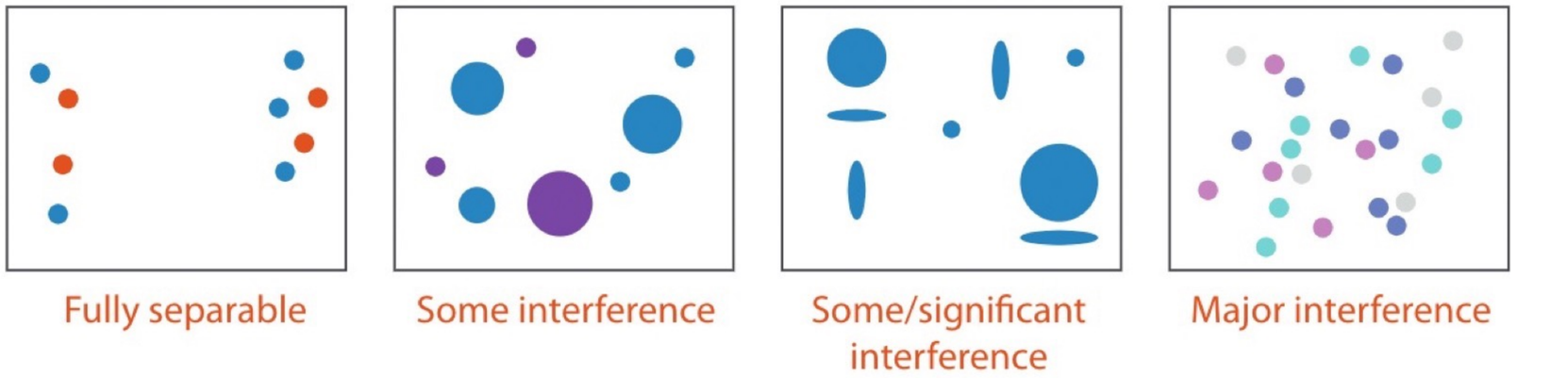
**Definition:** how differentiable levels of the channel are




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

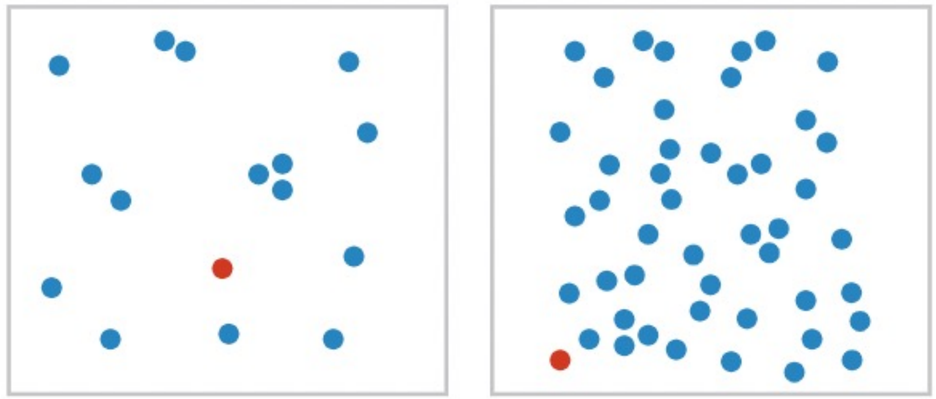
# Separability

**Definition:** whether channels exist independently or integrally with others



# Visual Popout

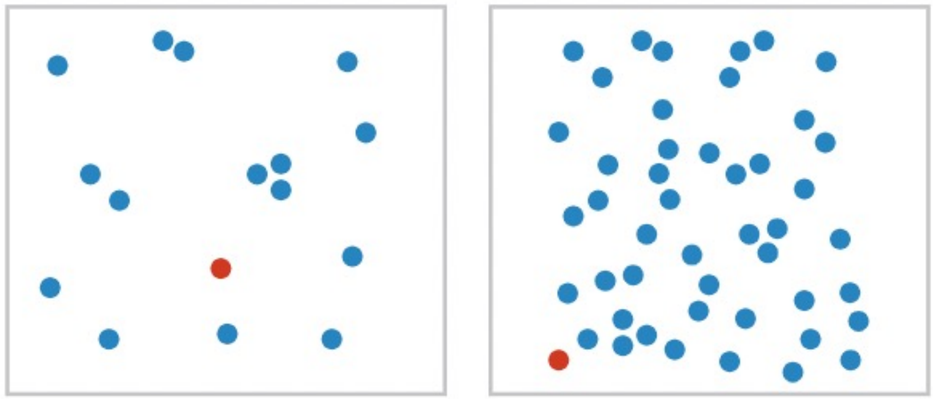
**Definition:** how well a distinct item stands out from others



(a) (b)

# Visual Popout

**Definition:** how well a distinct item stands out from others

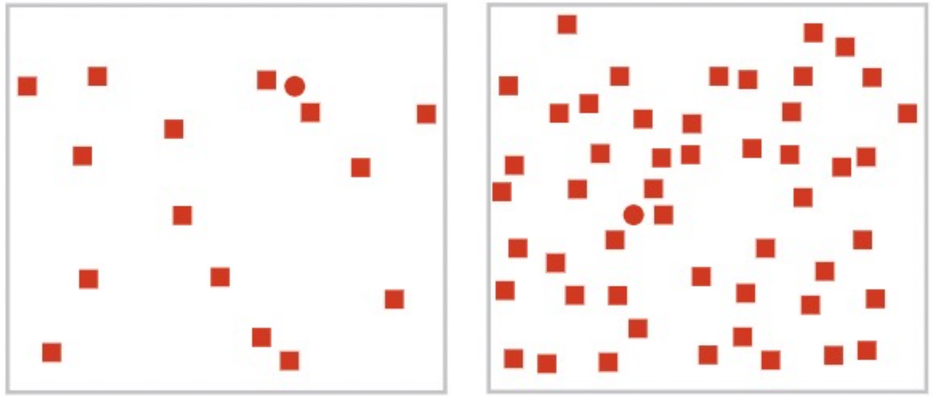


(a) (b)

Color is a good channel for this

# Visual Popout

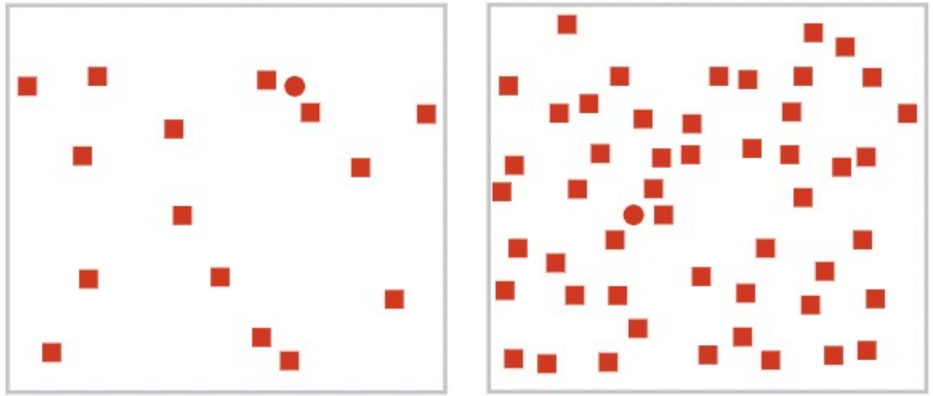
**Definition:** how well a distinct item stands out from others



(c) (d)

# Visual Popout

**Definition:** how well a distinct item stands out from others

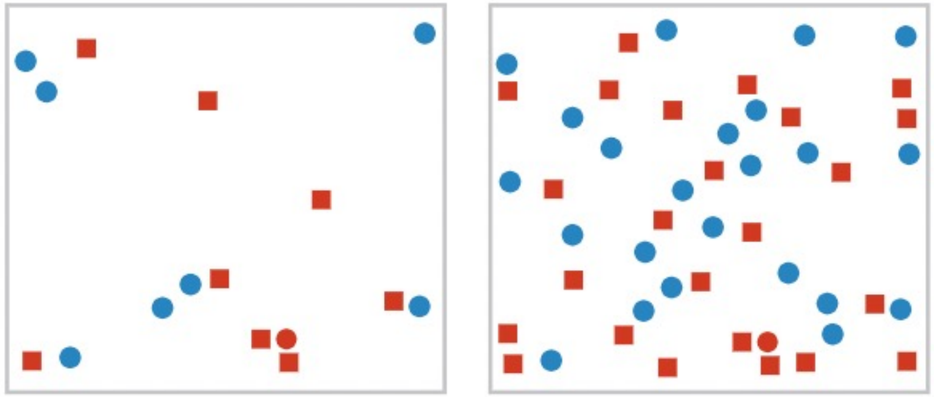


(c) (d)

Shape is not as helpful

# Visual Popout

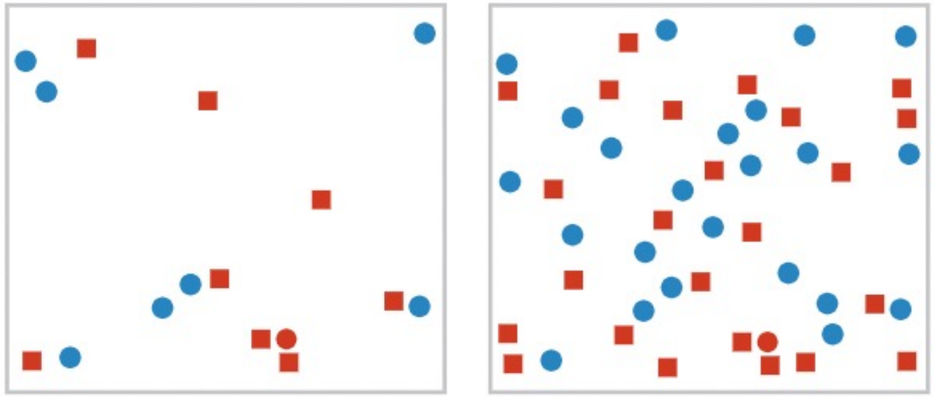
**Definition:** how well a distinct item stands out from others



(e) (f)

# Visual Popout

**Definition:** how well a distinct item stands out from others

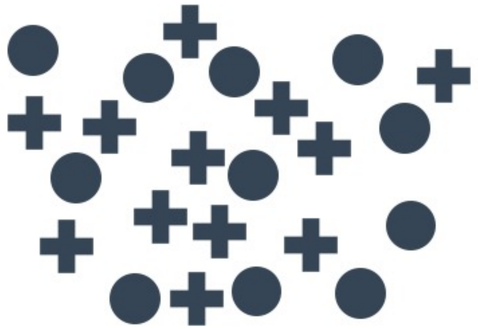


(e) (f)

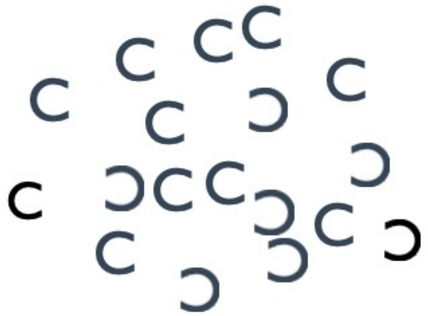
Combining color and shape causes “competition” – color is processed first

# 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-02 is DUE before next class.**