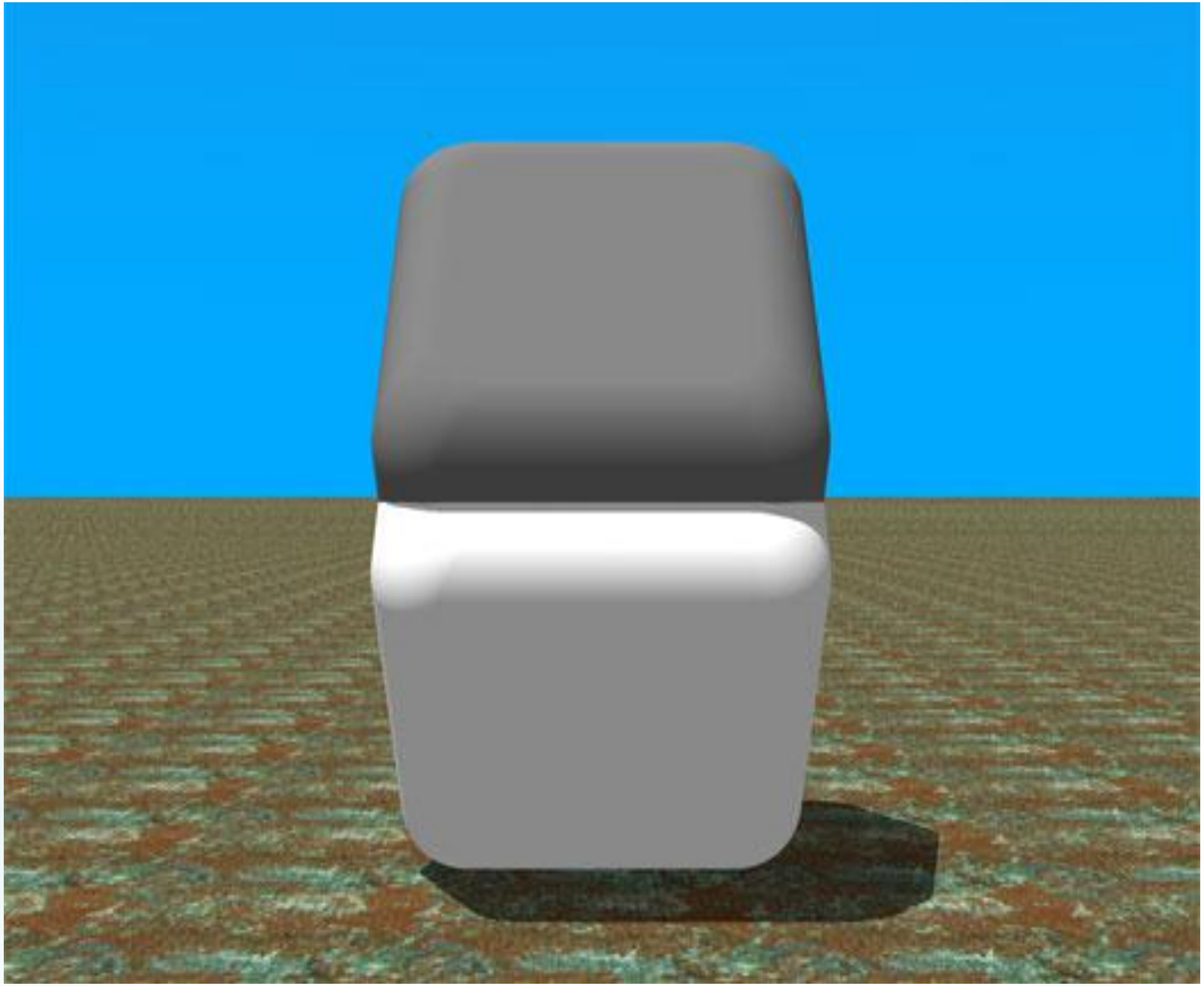
CDS 6324 DATA VISUALIZATION

LECTURE 3: VISUAL PERCEPTION



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DATA

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Visual principles

Content adapted from Data Visualization 101 modules

Gestalt Laws of Perceptual Organization

- Our brains prefer order and simplicity
  - When we see many shapes or points, we do not perceive them as random. Instead, we automatically group elements into patterns and objects
- This behavior is explained by Prägnanz:
  - We tend to interpret visual information in the simplest, most organized way possible
- In data visualization:
  - Viewers naturally look for structure and patterns before reading values

Gestalt Laws of Perceptual Organization

- Gestalt principles explain how humans:
  - Perceive visual elements and organize them into unified wholes
- Key idea:
  - "The whole is greater than the sum of its parts"
- In a chart, viewers do not just see individual elements:
  - Bars → trends / Points → clusters / Lines → shapes or relations
- Why this matters for designers:
  - Charts should align with how people naturally group and interpret visuals

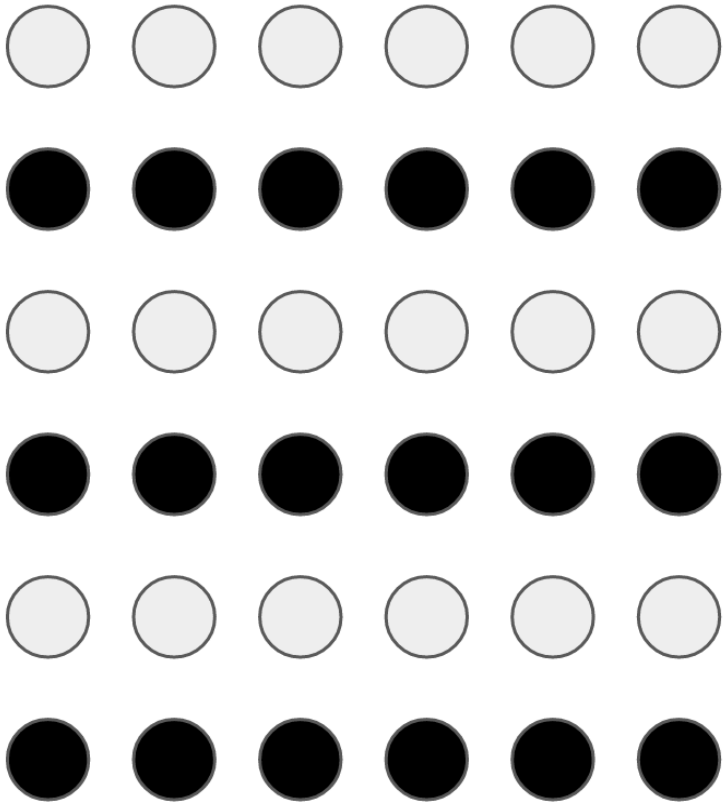
Gestalt Laws of Perceptual Organization

- Key principles

Similarity	**Continuity**
Proximity	**Connectedness**
Enclosure	**Figure-Ground**
Closure	**Prägnanz (Simplicity)**

Law of Similarity

Our brains tend to make connections between elements with a similar design.



Law of Similarity Example

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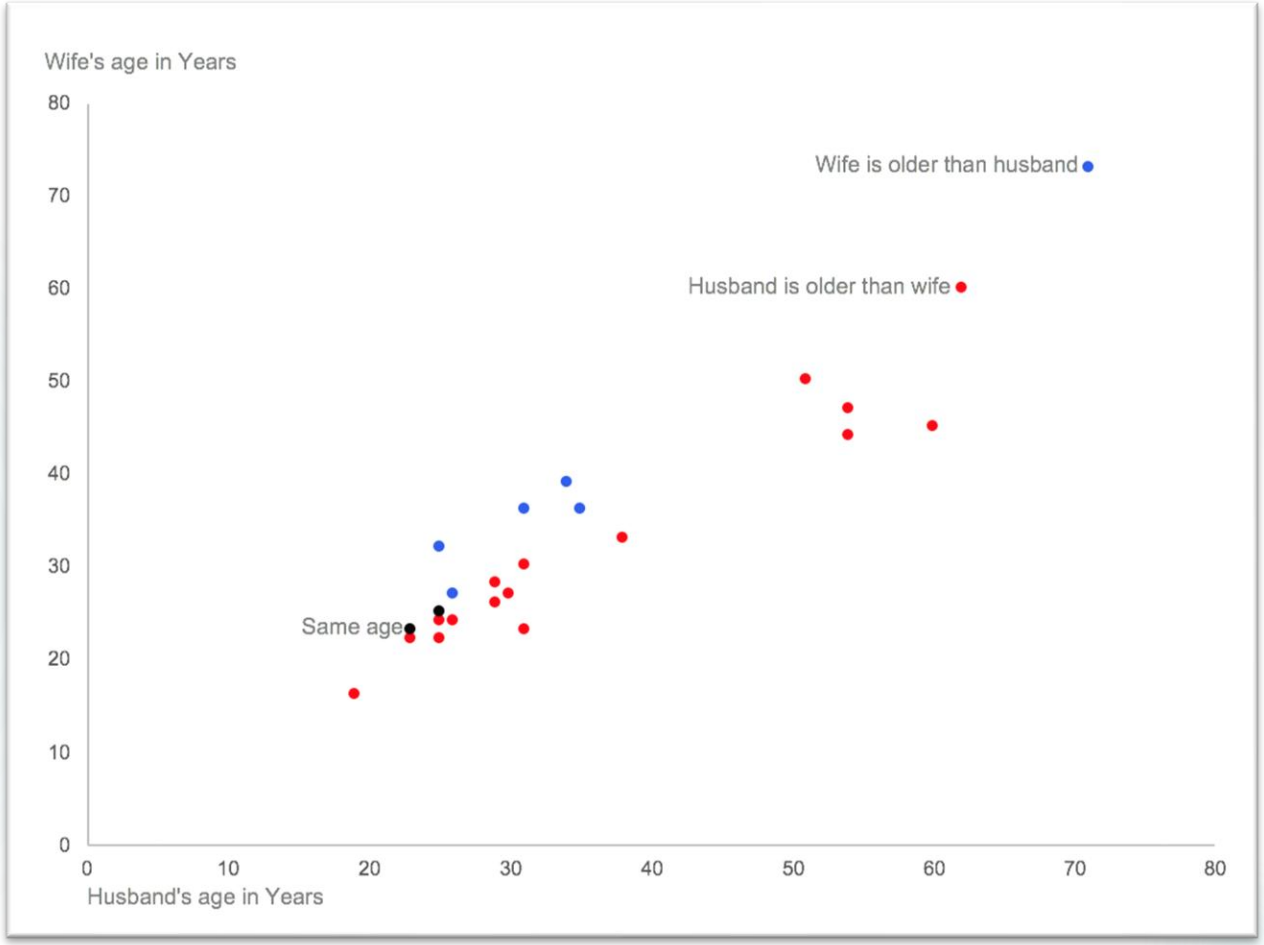
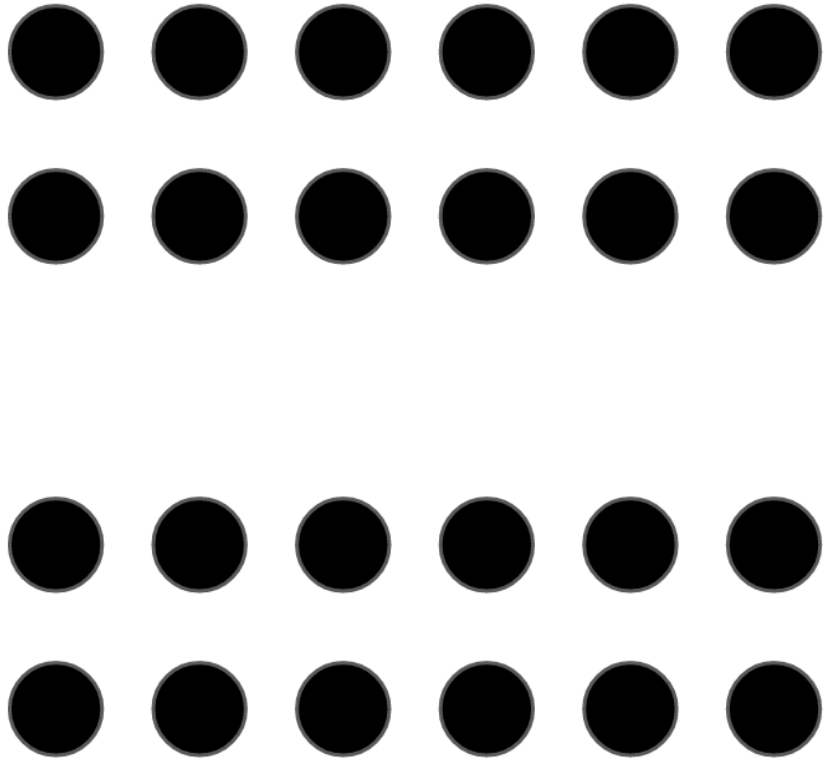


How many groups do you see?

Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

Law of Proximity

Elements that are closer together in a design are often linked in our minds



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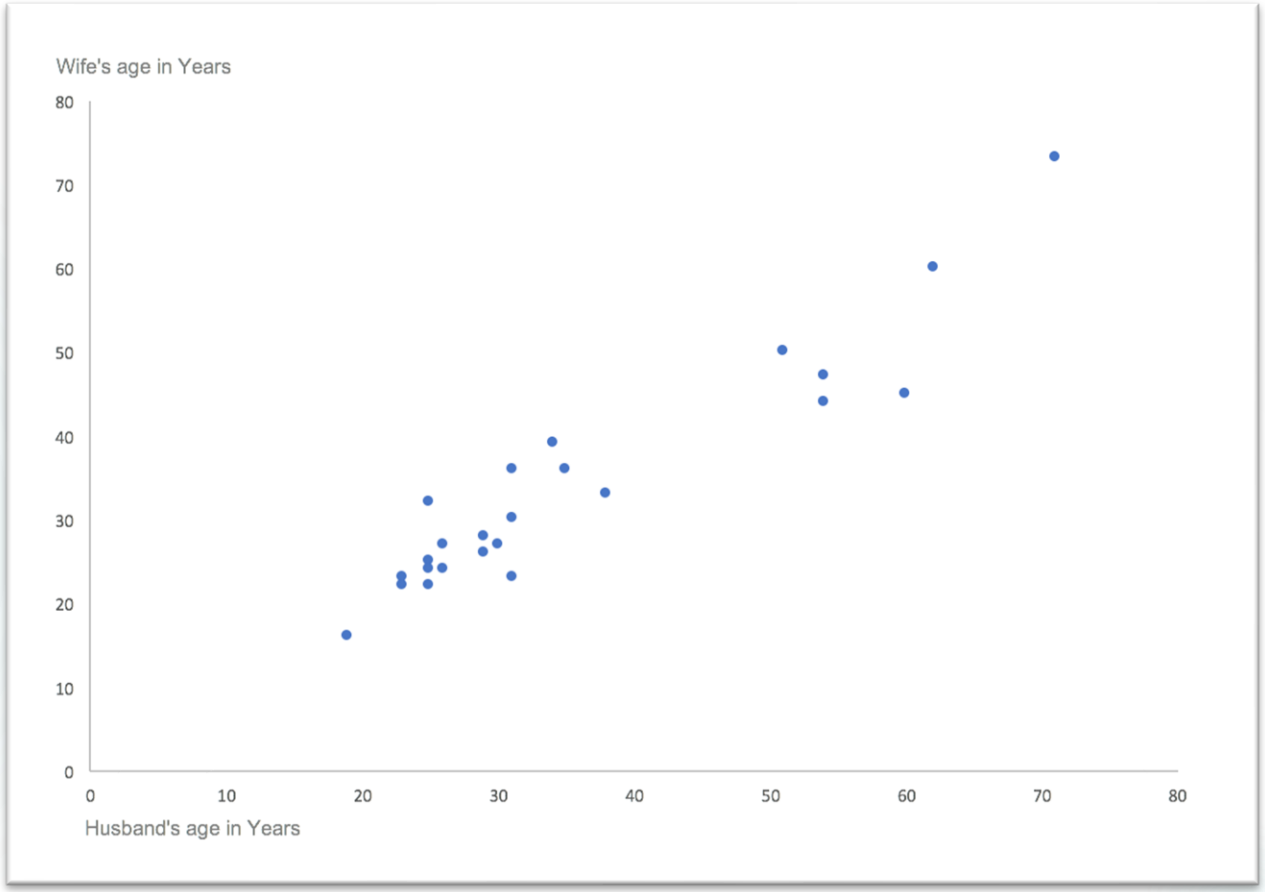
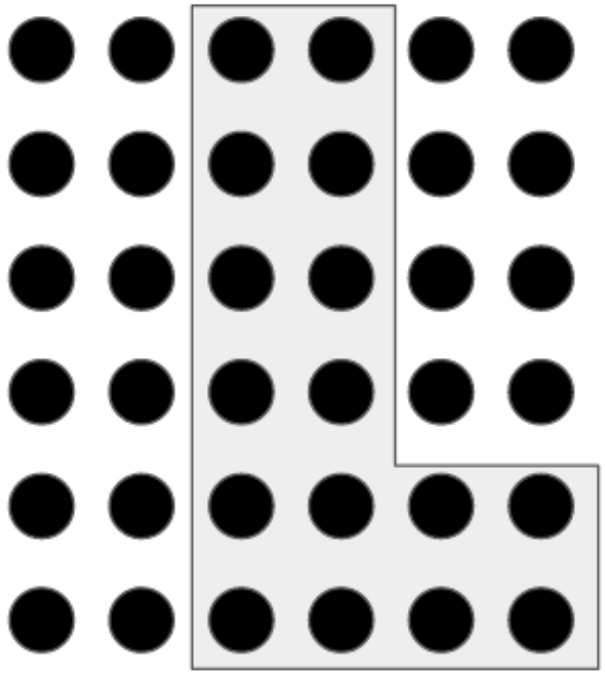


How many groups do you see?

Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

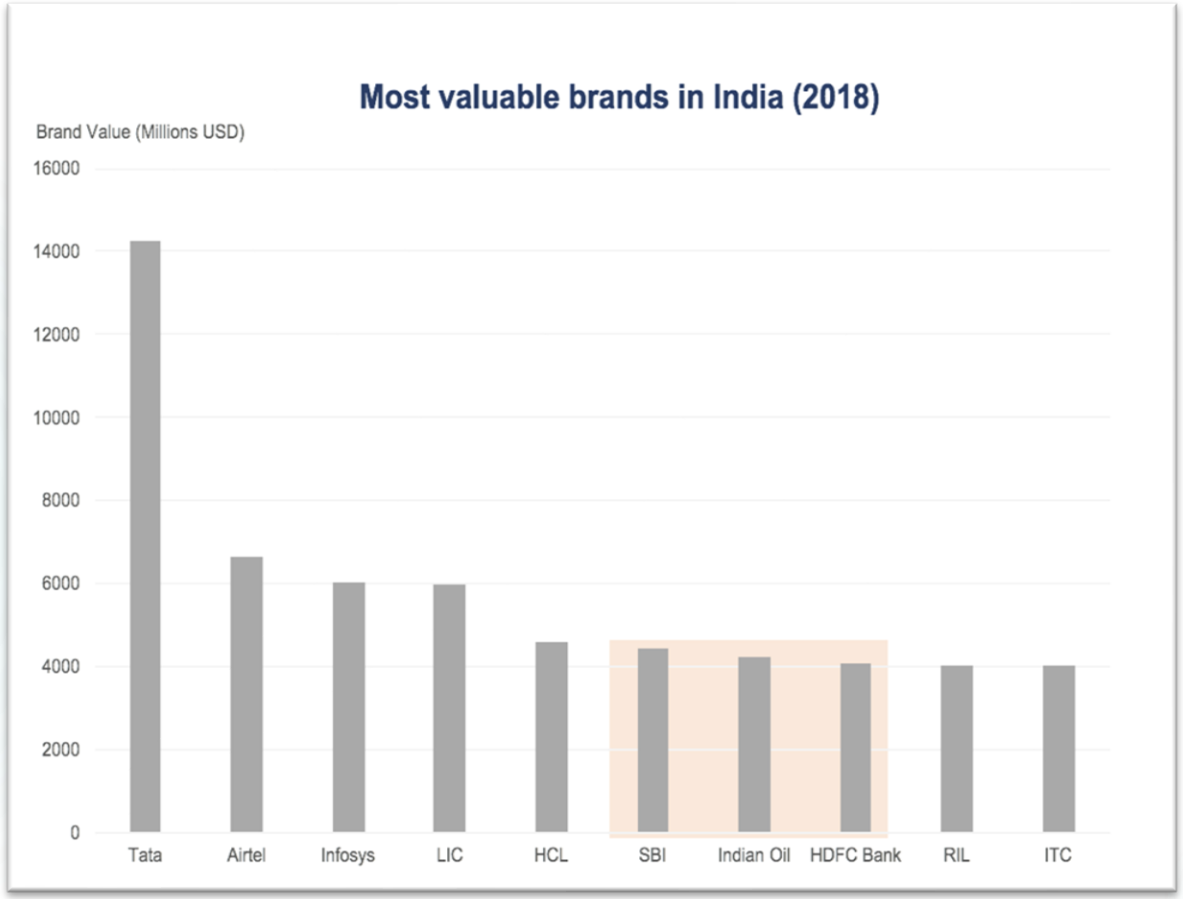
Law of Enclosure

Objects that appear to have a boundary around them are perceived as a group.



Law of Enclosure Example

Objects that appear to have a boundary around them are perceived as a group.



Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

Law of Closure

Open structures are perceived as closed, complete, and regular whenever there is a way that they can be reasonably interpreted as such.

Law of Closure Example

Open structures are perceived as closed, complete, and regular whenever there is a way that they can be reasonably interpreted as such.

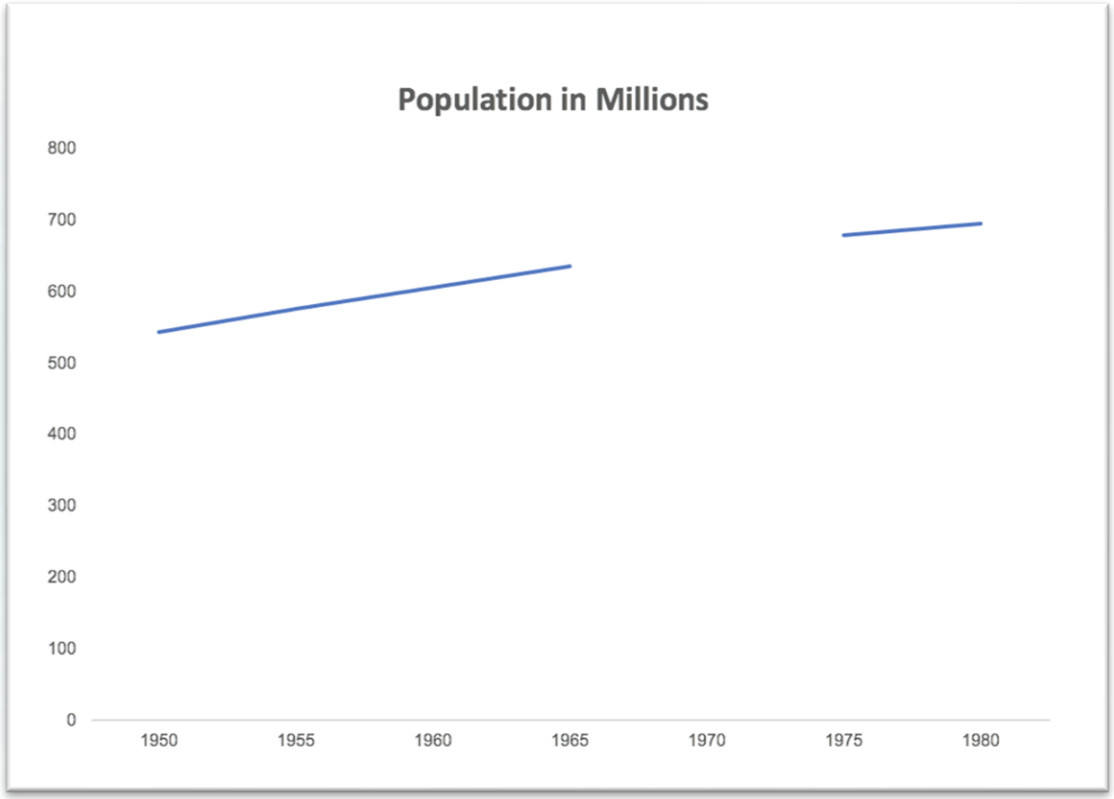
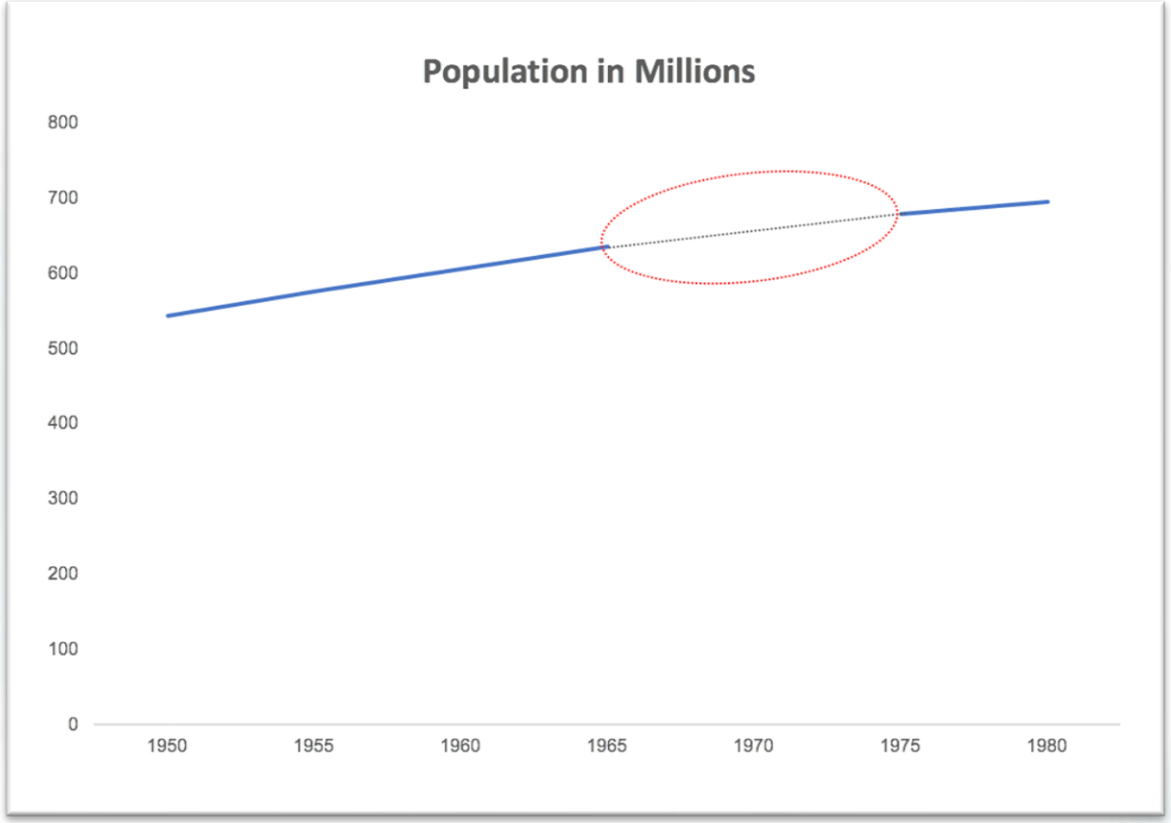


Chart with some missing data for the year 1970.
Do you 'see' the connecting line?

Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

Law of Closure Example: Closed

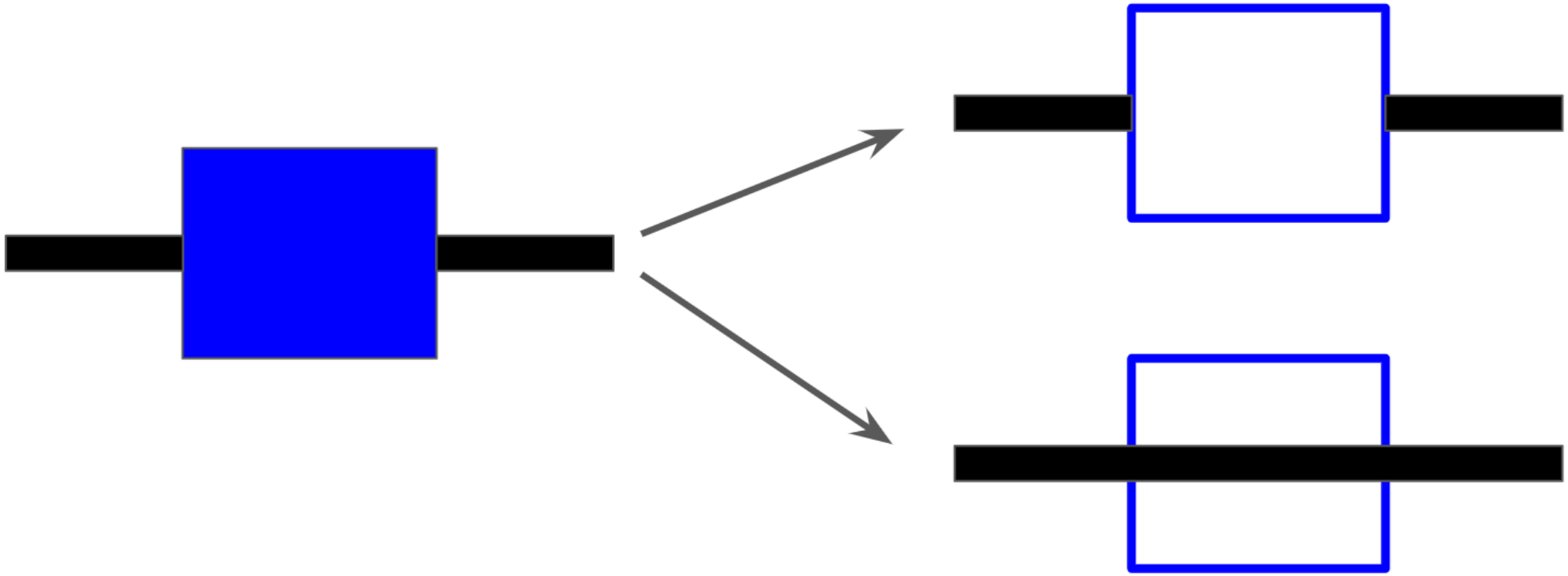
Open structures are perceived as closed, complete, and regular whenever there is a way that they can be reasonably interpreted as such.



Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

Law of Continuity

Objects that are aligned together or appear to be a continuation of one another are perceived as a group.



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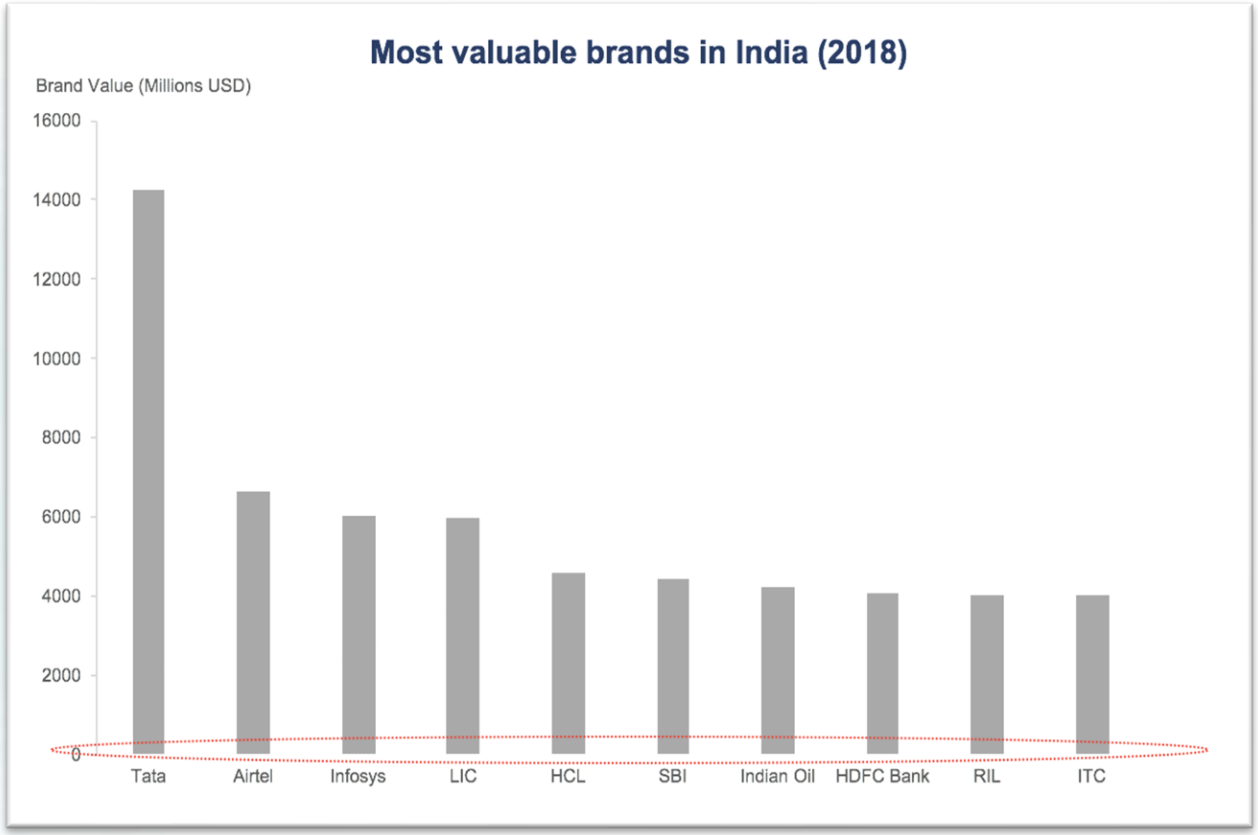
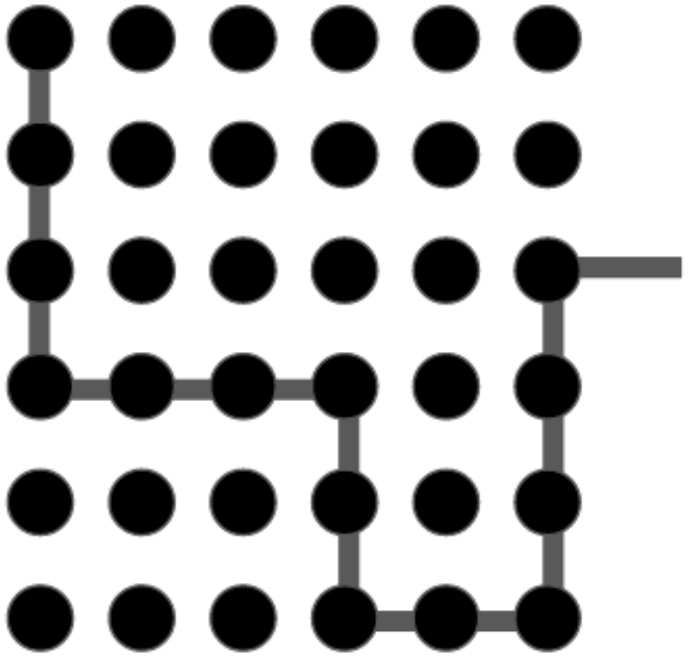


Do you see a common horizontal baseline? Actually, there is no x-axis line in

Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

Law of Connectedness

Objects that are connected, usually by a line, are perceived as a group.



Law of Connection Example

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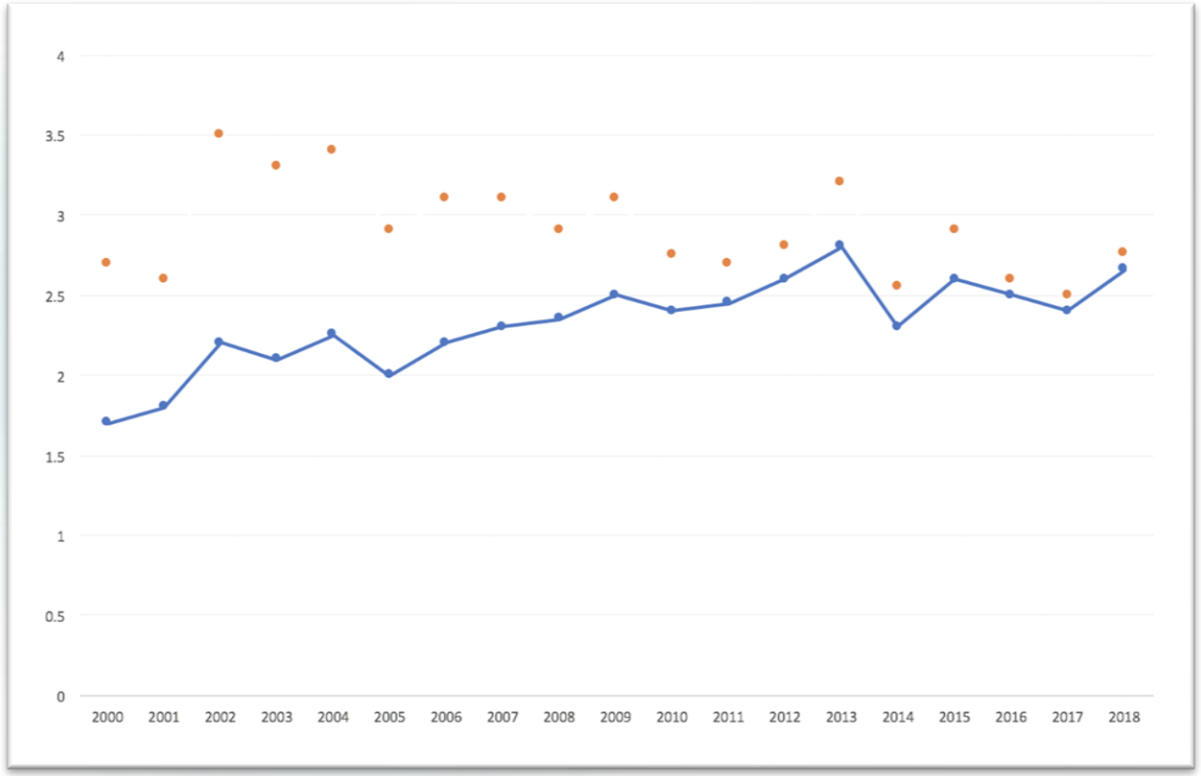

Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

Law of Connection Example

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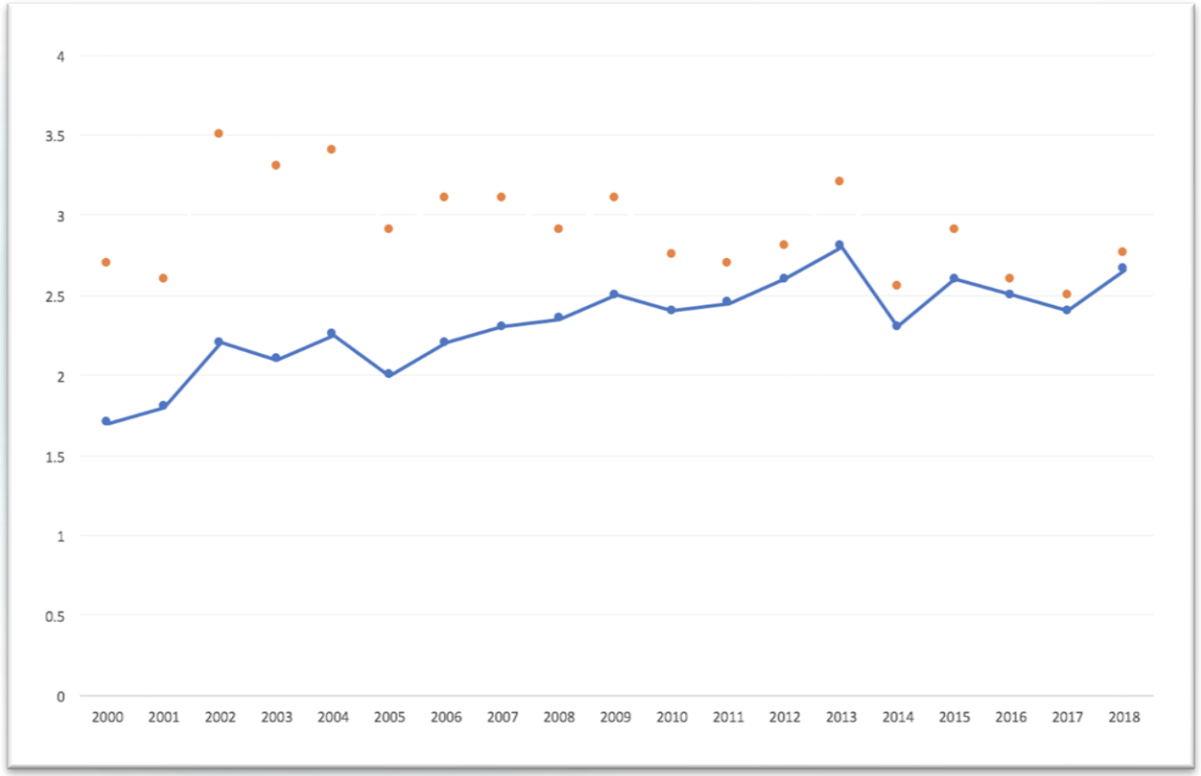
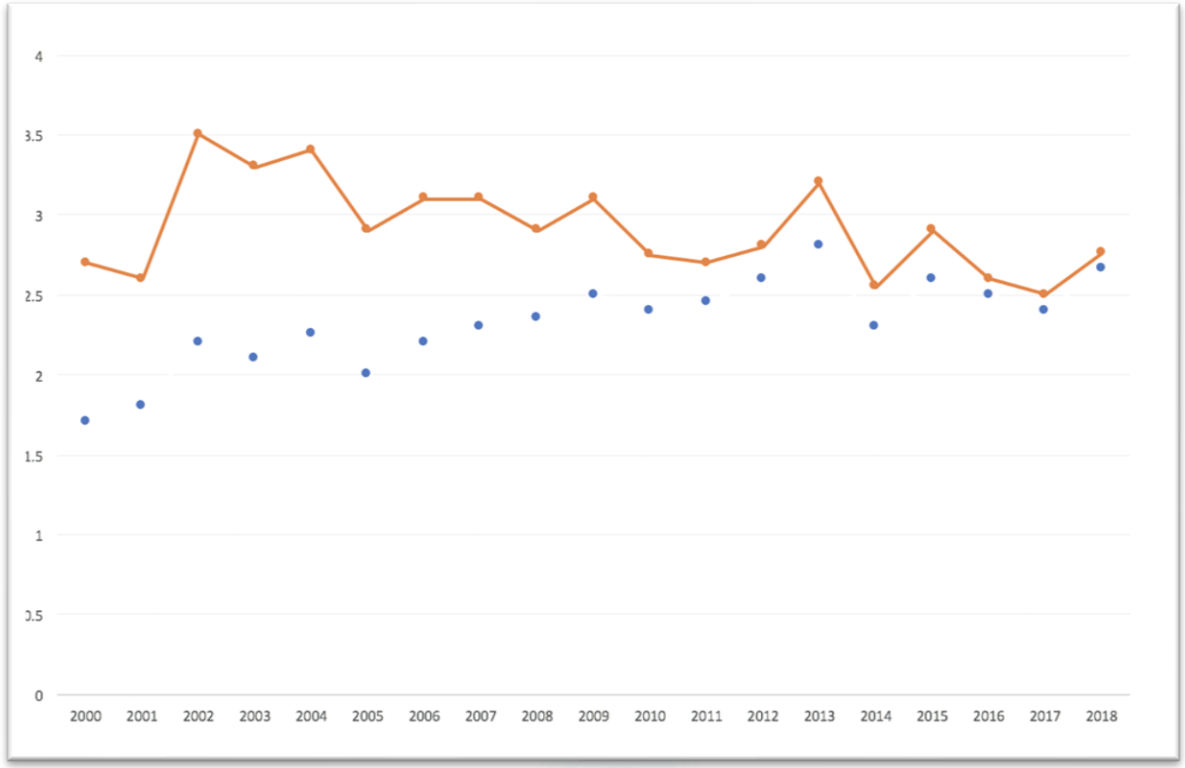
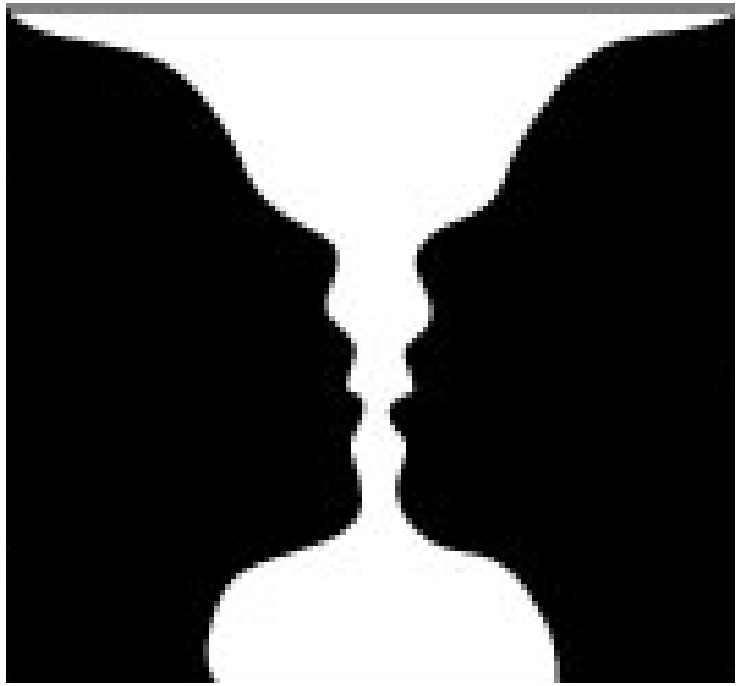




Law of Figure-Ground

We instinctively perceive objects as either being in the foreground (figure) or the background (ground).



Law of Figure Ground Example 1

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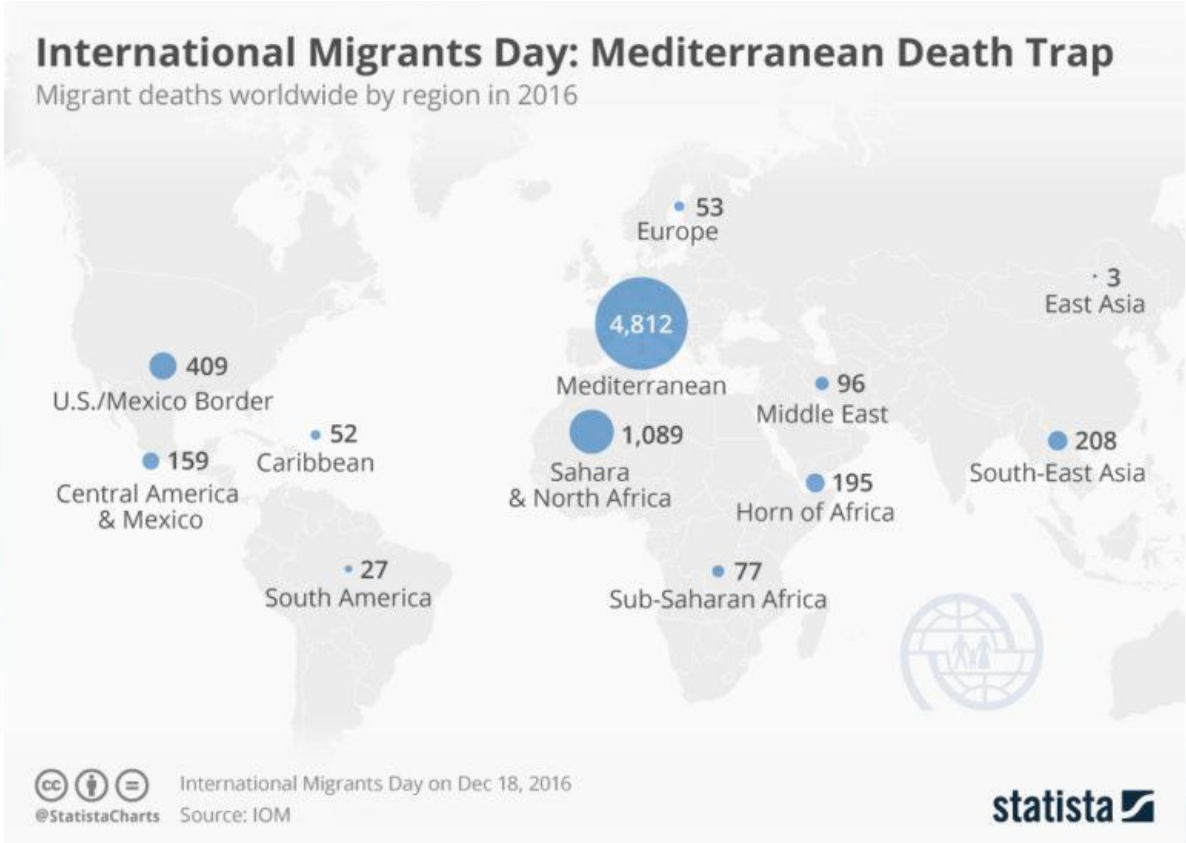
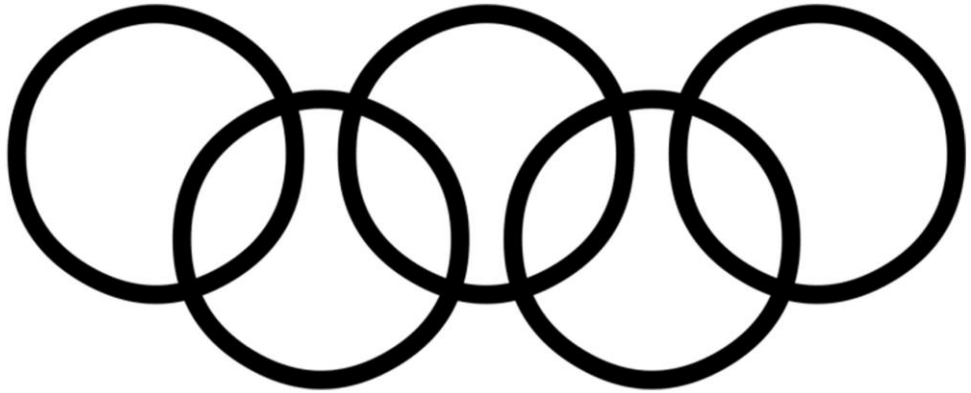


Chart source: Statista

Law of Prägnanz (Simplicity)

Particular objects in the environment are perceived in a way that makes them appear as simple as possible



Law of Prägnanz (Simplicity) Example

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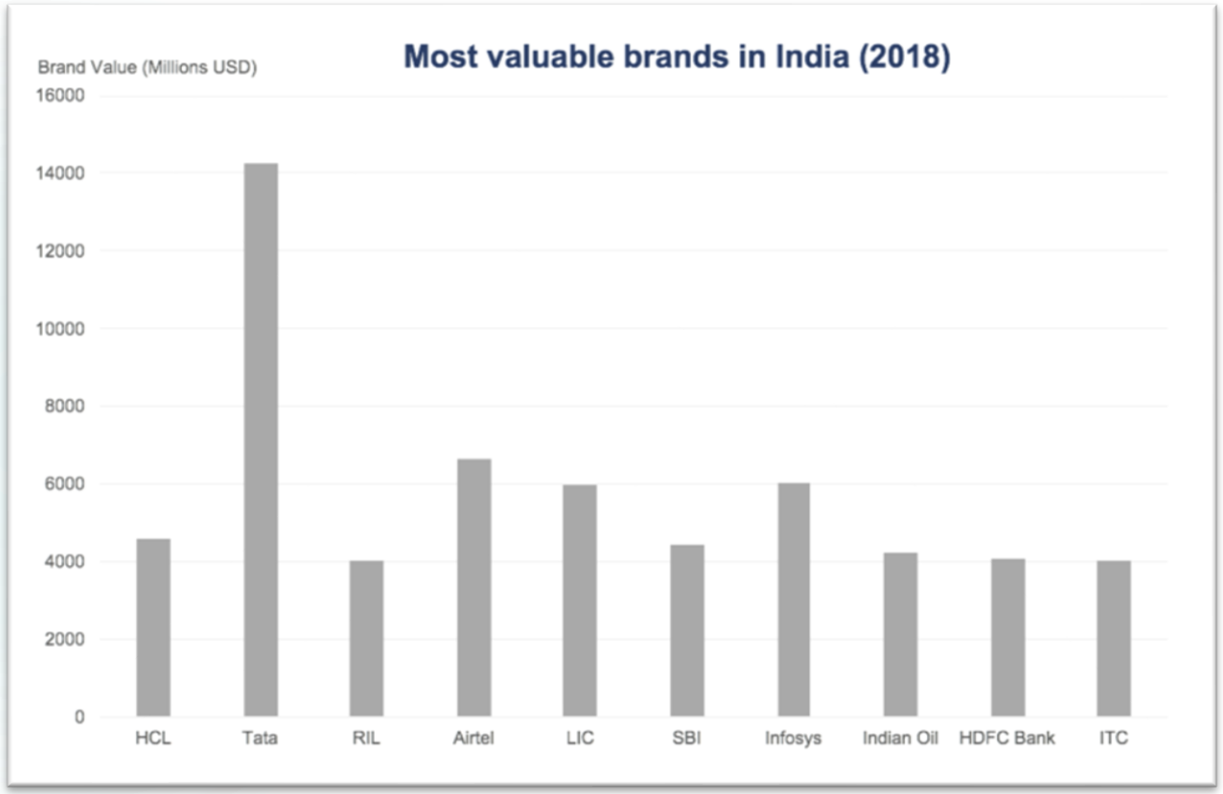

We tend to search for a pattern to make sense of a chart.

Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

Law of Prägnanz (Simplicity) Example

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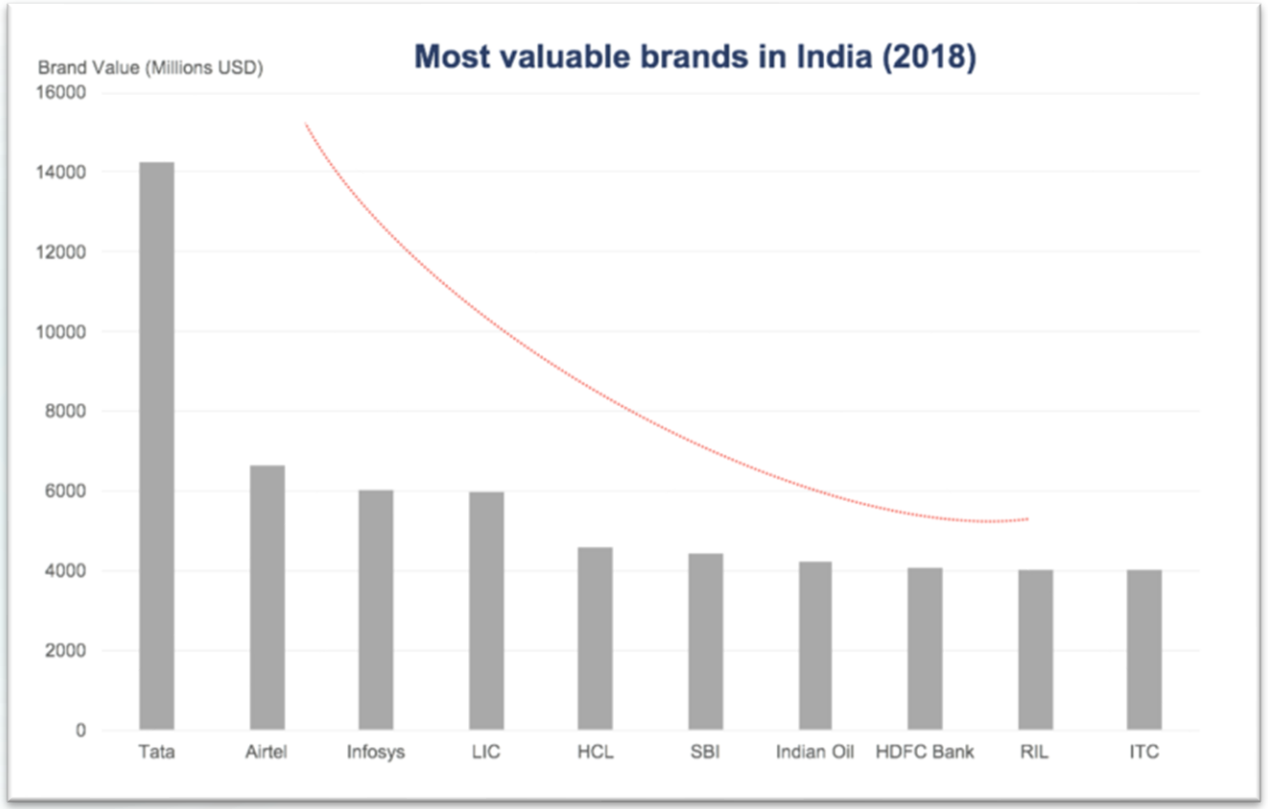


Sorting the chart makes patterns easier to see and improves overall clarity.

Daydreaming Numbers, "Gestalt Laws Applied to Data Visualization"

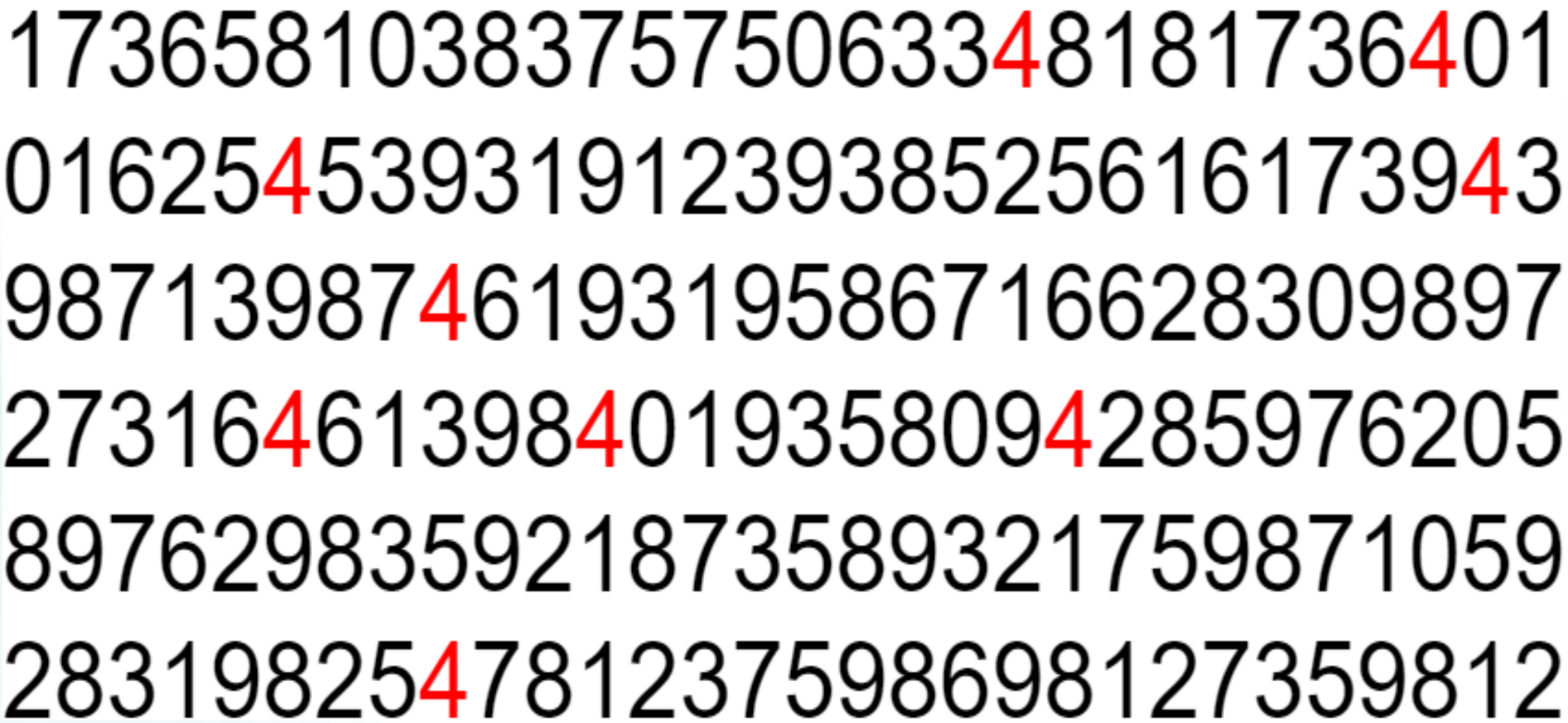
Preattentive Processing

Content adapted from Data Visualization 101 module

Count the 4s

1736581038375750633481817364 01
0162545393191239385256161739 43
9871398746193195867166283098 97
2731646139840193580942859762 05
8976298359218735893217598710 59
2831982547812375986981273598 12

Count the 4s: Color

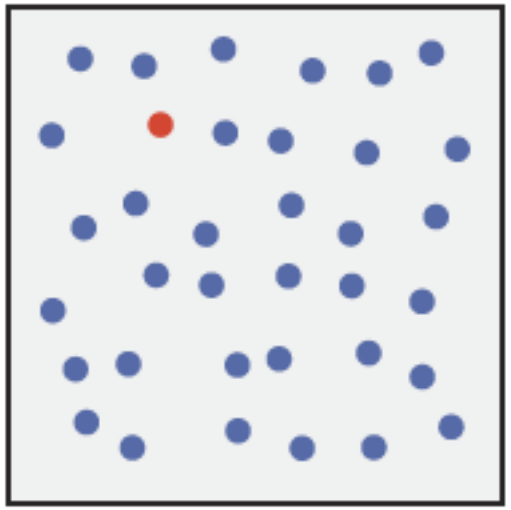


Count the 4s: Color

By highlighting the fours, counting becomes almost instantaneous.

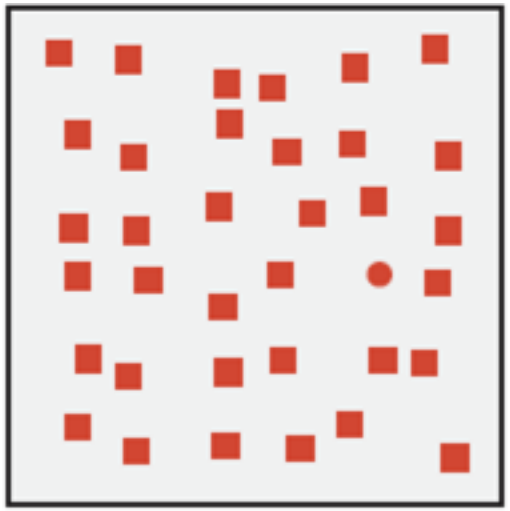
This illustrates **preattentive processing**, where visual features such as color or shape are detected in milliseconds—before deliberate analysis—making patterns in charts immediately visible.

Pre-attentive Processing: Color



Healey, C. G., & Enns, J. T. (2012). Attention and visual memory in visualization and computer graphics. *IEEE Transactions on Visualization and Computer Graphics, 18*(7), 1170-1188.
http://dx.doi.org.proxy.lib.duke.edu/10.1109/TVCG.2011.127

Pre-attentive Processing: Color



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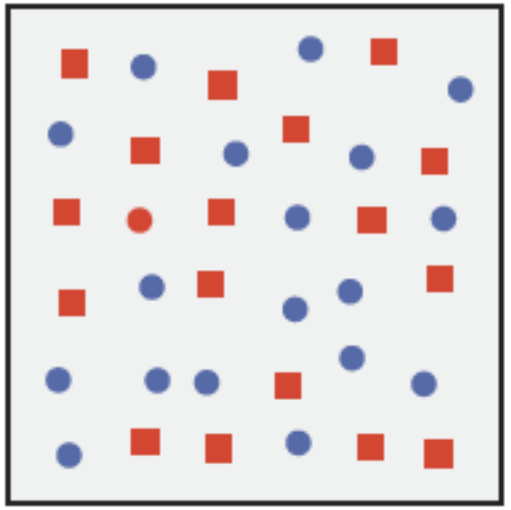

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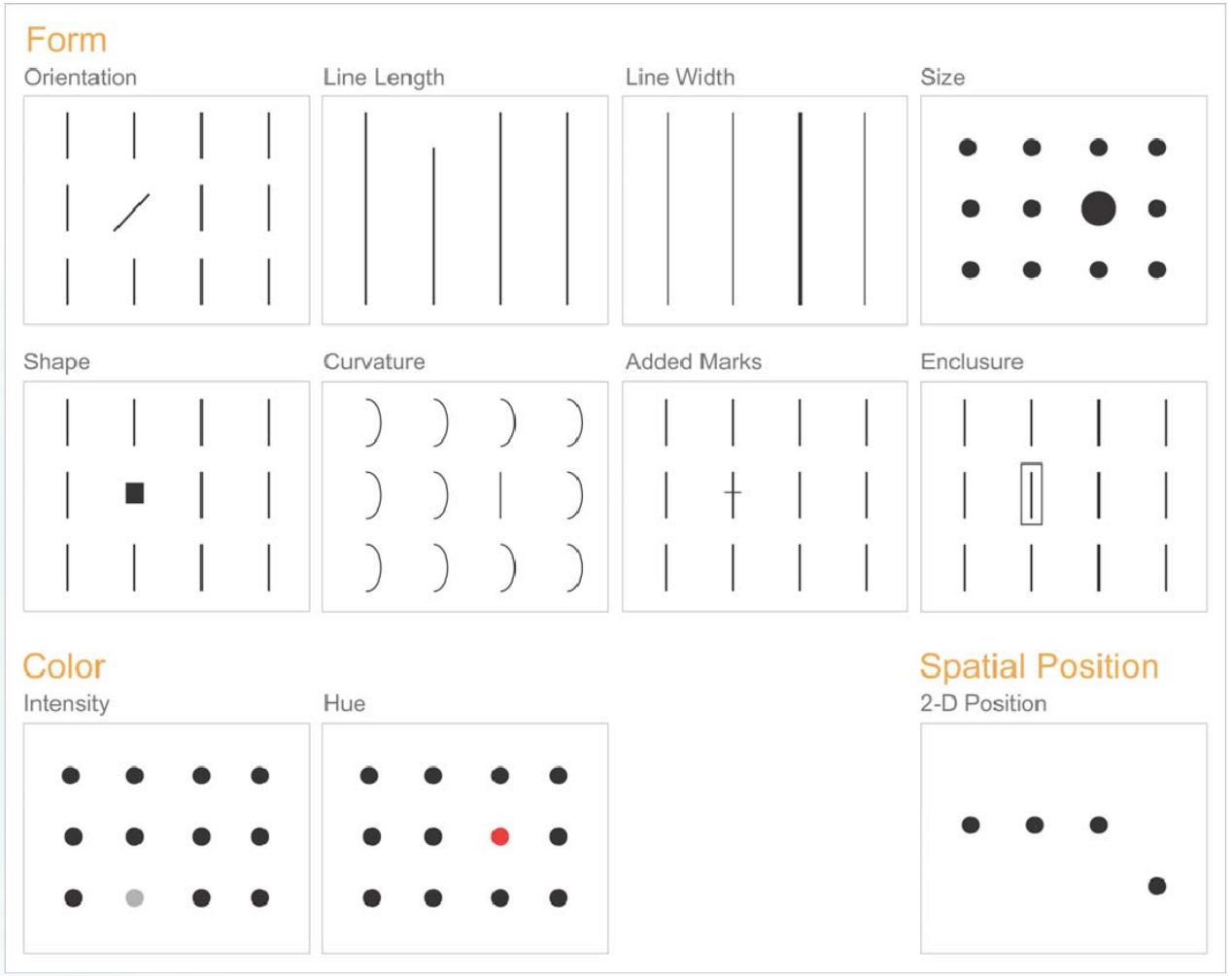
Pre-attentive attributes for visualization



Also see work of Colin Ware and Christopher Healey

Stephen Few, "Tapping the Power of Visual Perception"

Key Takeaways

- The understanding and interpretation of data is an activity of human cognition
- Learning more about the way our brains work, how we perceive and process data, and improving how we practice visualization is essential to achieving these goals.

Learning Activities

Video Brain Game

National Geographic: Test Your Brain Episode 2 – Perception

https://www.dailymotion.com/video/xq1rfl

Learning Task

- Complete the L03 Learning Activity Worksheet
- Submission: eBwise (count as attendance)
- Due date: 19th April 2025