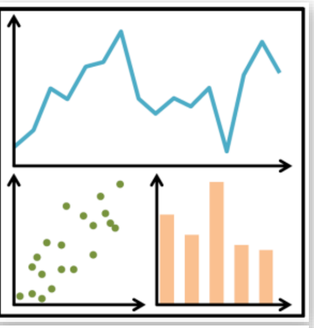
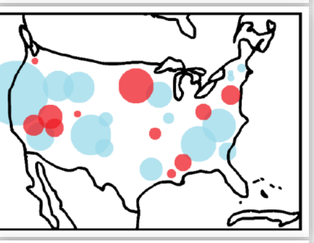
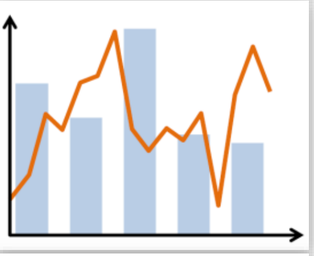
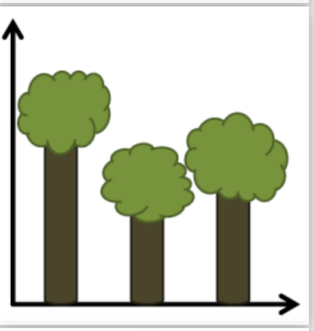
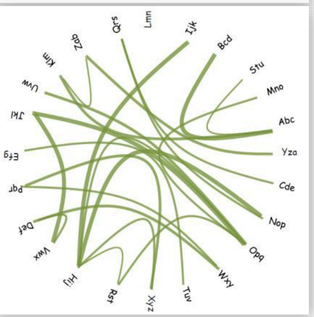






Marks and Channels, Data Types

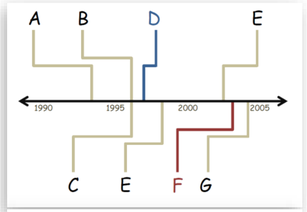
CS 7250

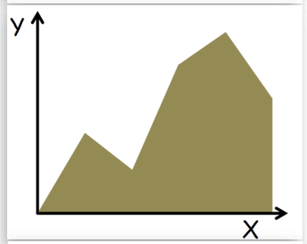
SPRING 2020

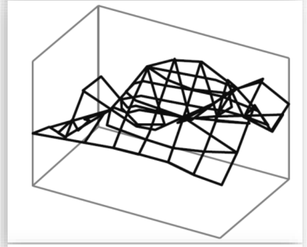
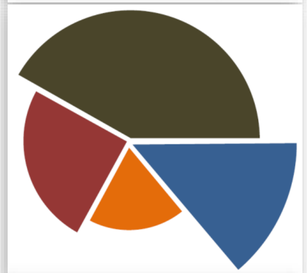
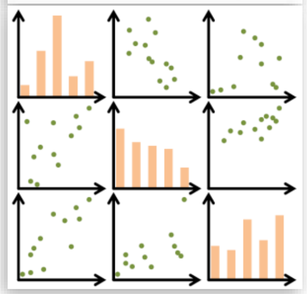
Prof. Cody Dunne

NORTHEASTERN UNIVERSITY

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





In-Class Programming — South End Altair

~25 min total

Previously, on CS 7250…

“Graphical Integrity”

To achieve graphical “excellence” according to Tufte:

1. Above all else show the data.
2. Maximize the data-ink ratio.
3. Erase non-data ink.
4. Erase redundant data ink.
5. Revise and edit.

Tufte, “Visual Display of Quantitative Information” (1983)

“Chart Junk”

Chart junk can... persuade, help with memorability, engage

... bias, limit data-ink ratio, clutter, lower trust

<u>Take-away</u>: it depends on your audience, task, and context...

Now, on CS 7250…

MARKS AND CHANNELS

Goals for Today

- Learn the basic visual primitives of visualizations (marks and channels)
- Understand how marks and channels are assembled to make visualizations
- Learn which marks and channels are most effective for a given task (“perceptual ordering”)

Visualization Building Blocks

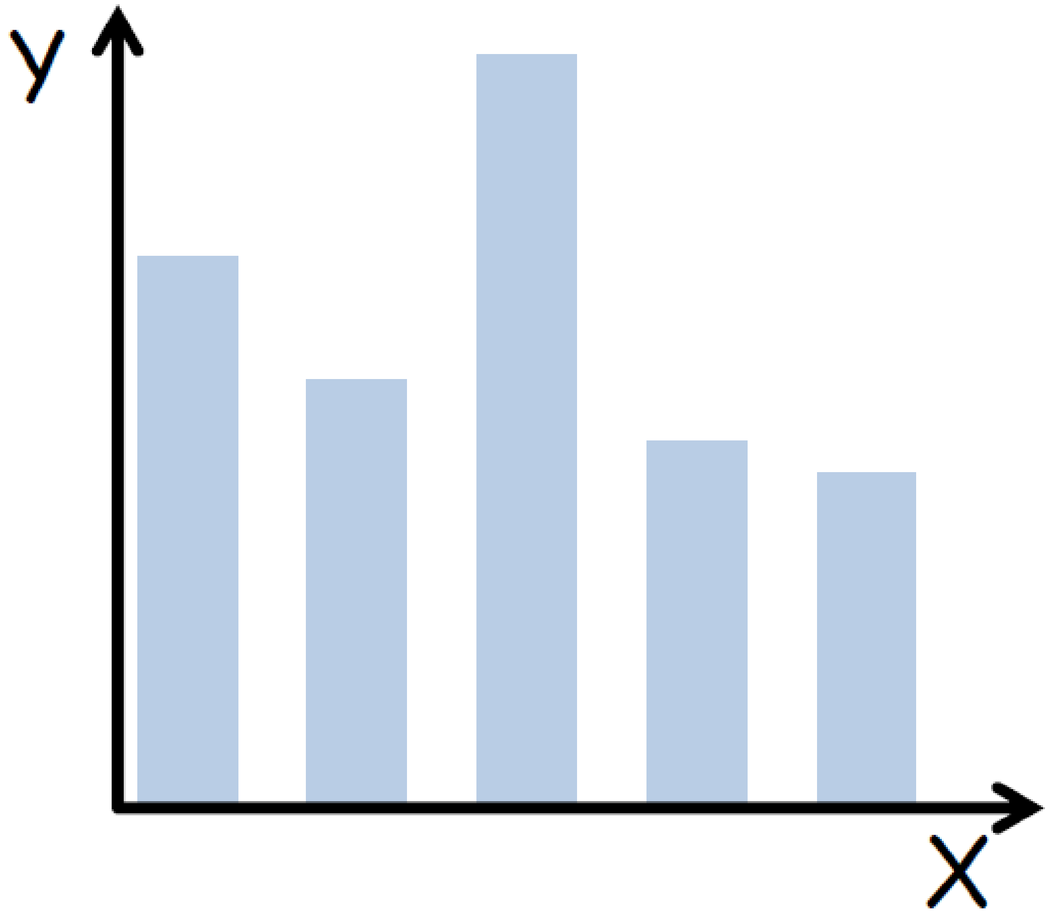
MARK = basic graphical element in an image

Visualization Building Blocks

CHANNEL = way to control the appearance of marks, independent of the dimensionality of the geometric primitive

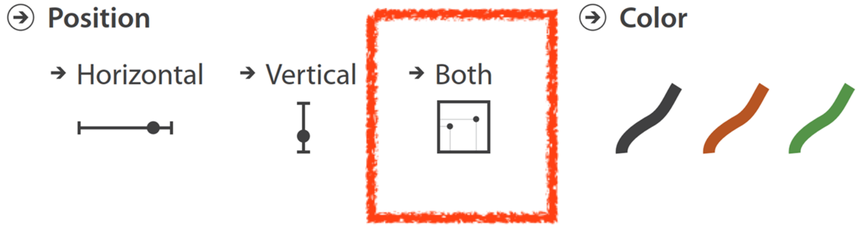
Visualization Building Blocks

of attributes encoded: 2



MARK:

CHANNEL :



Visualization Building Blocks

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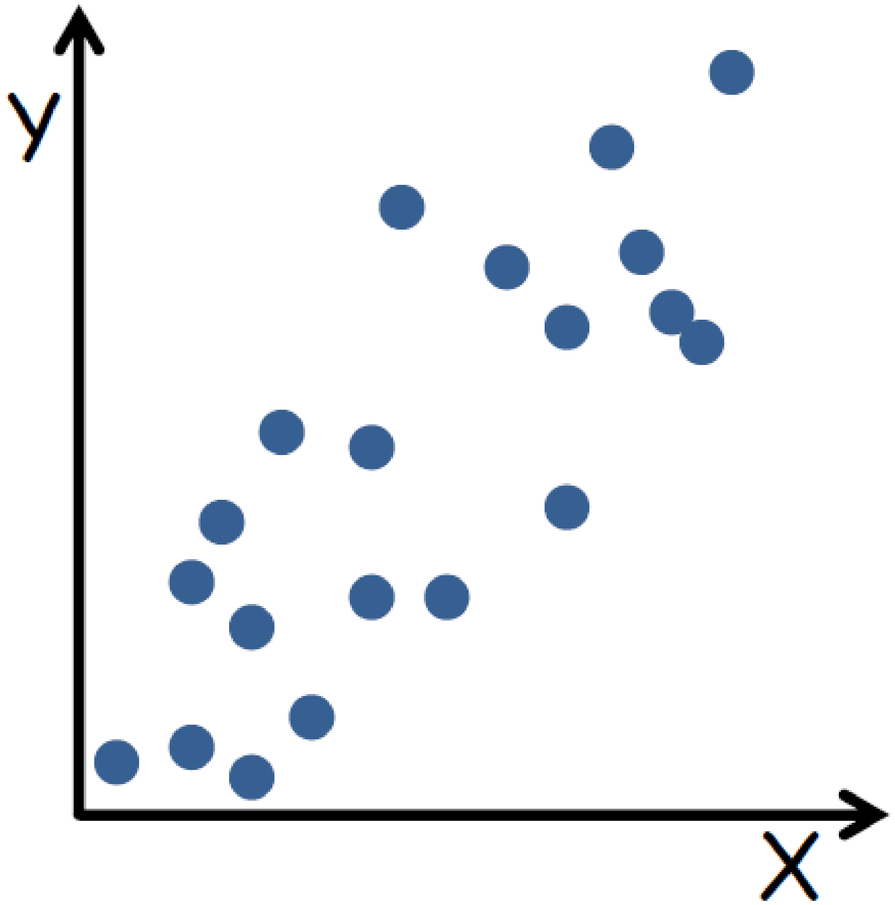

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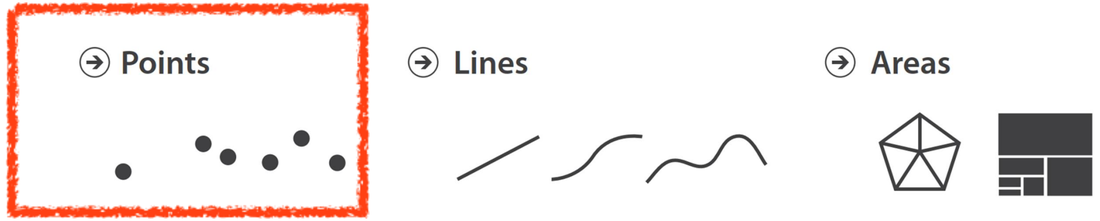

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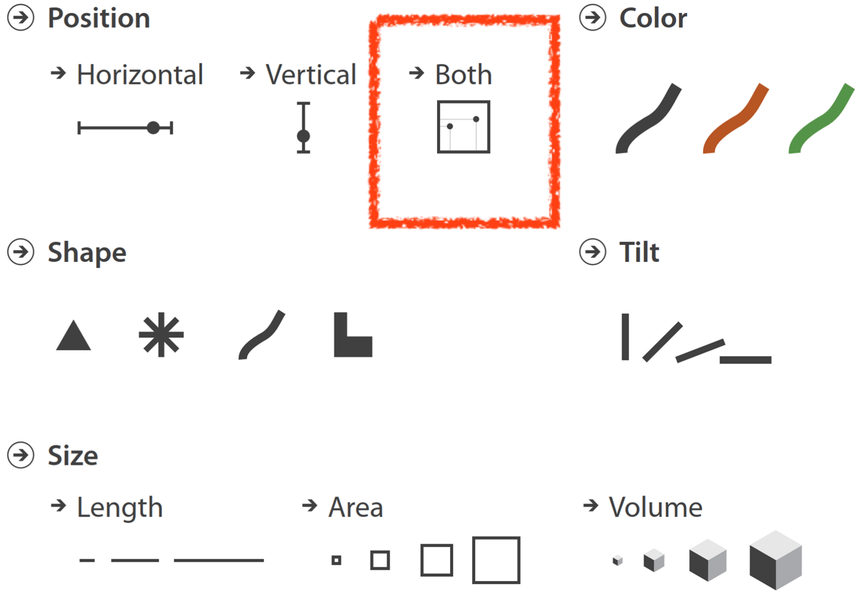

Visualization Building Blocks

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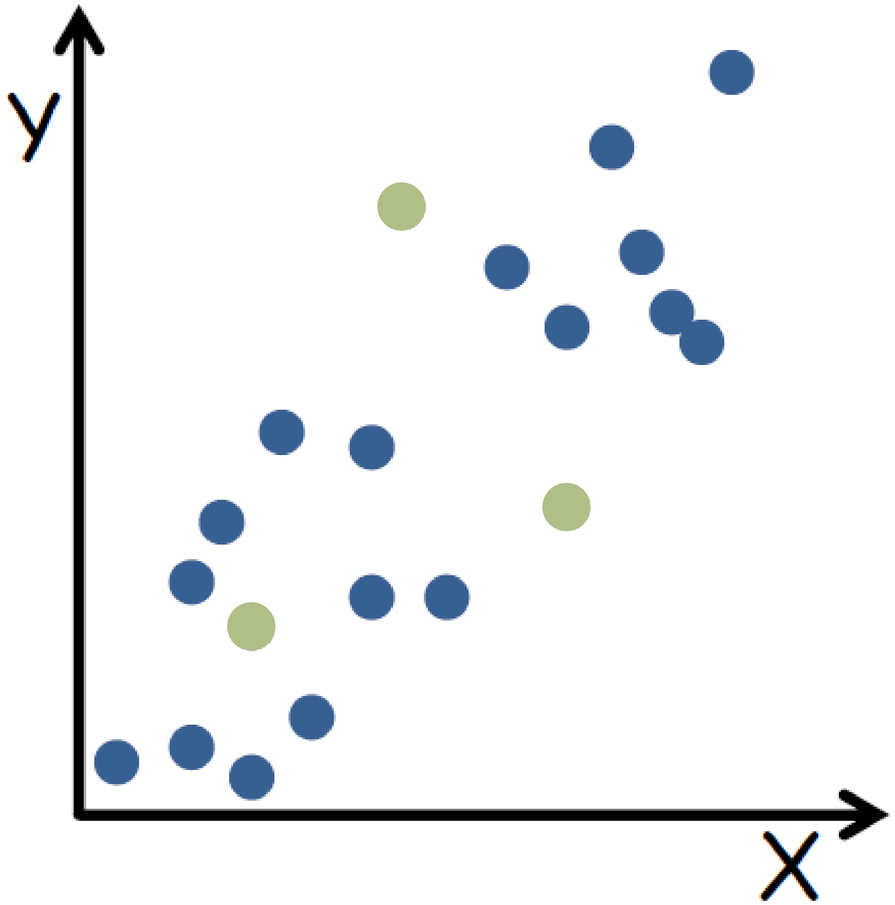

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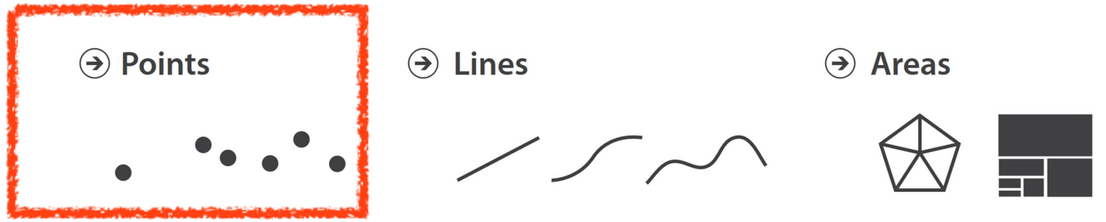

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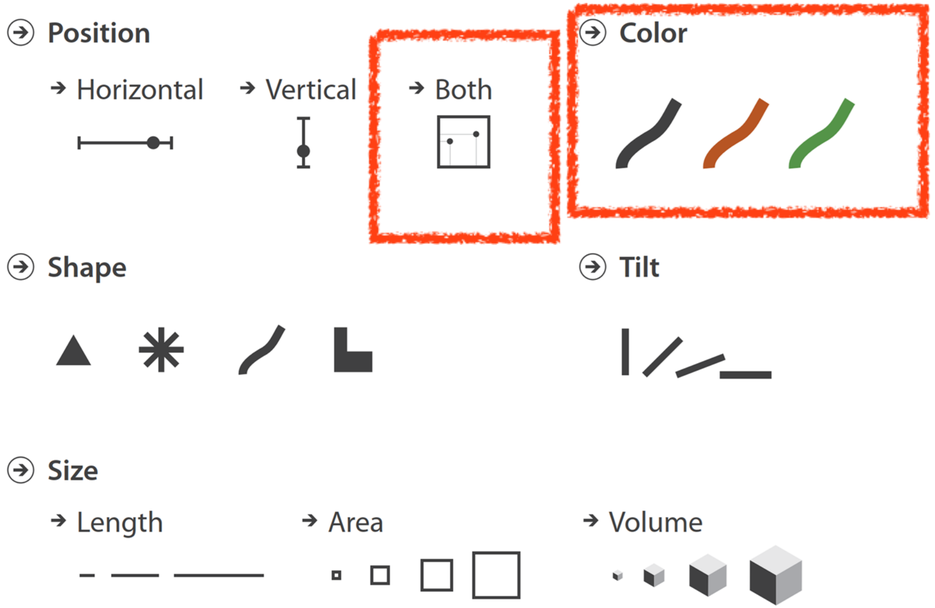

Visualization Building Blocks

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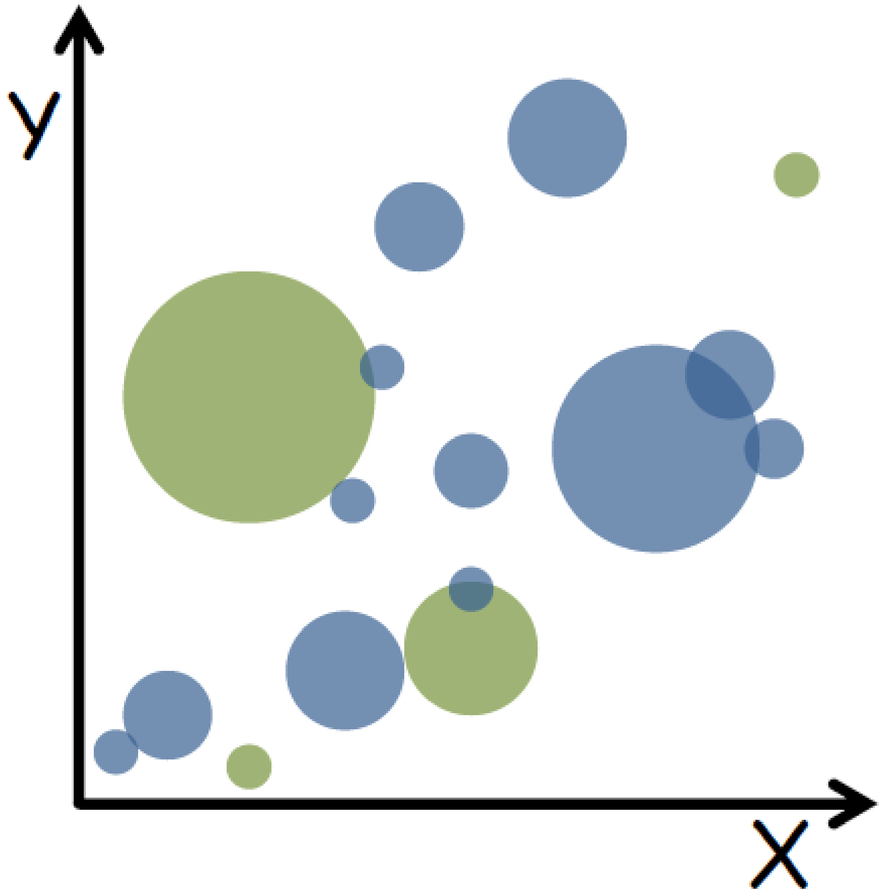

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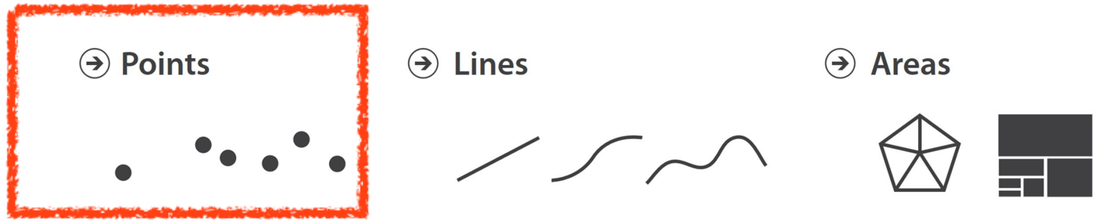

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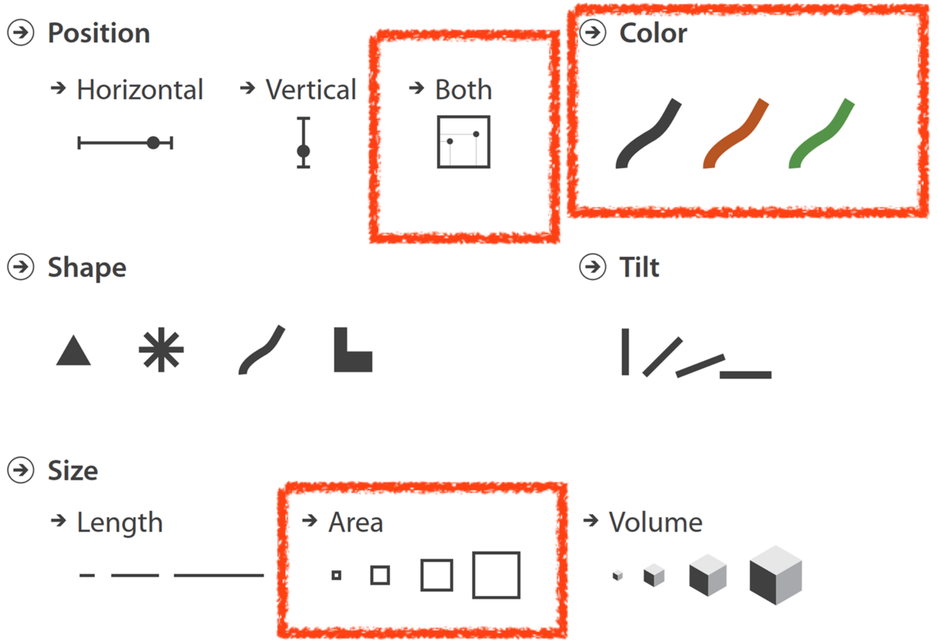
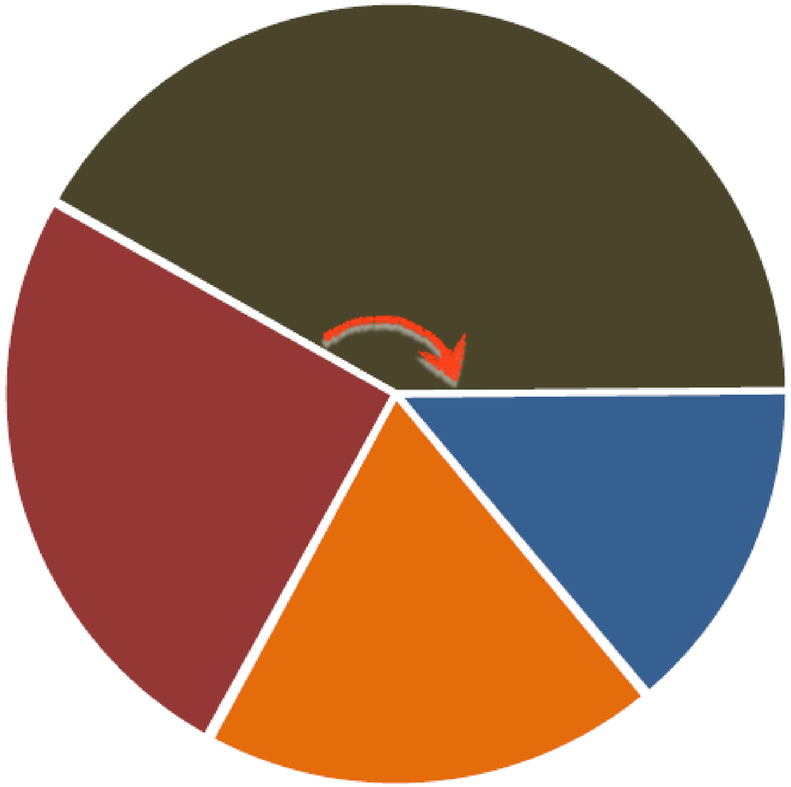


Visualization Building Blocks

of attributes encoded: 2



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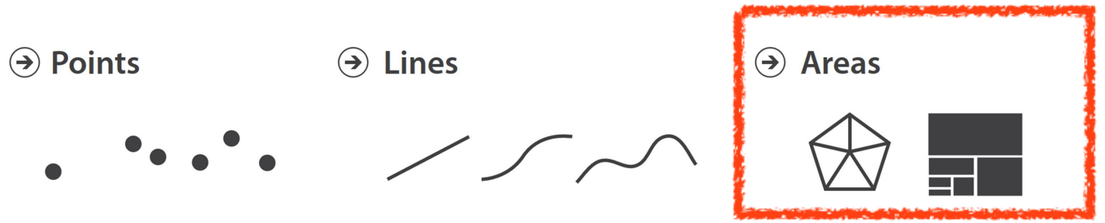

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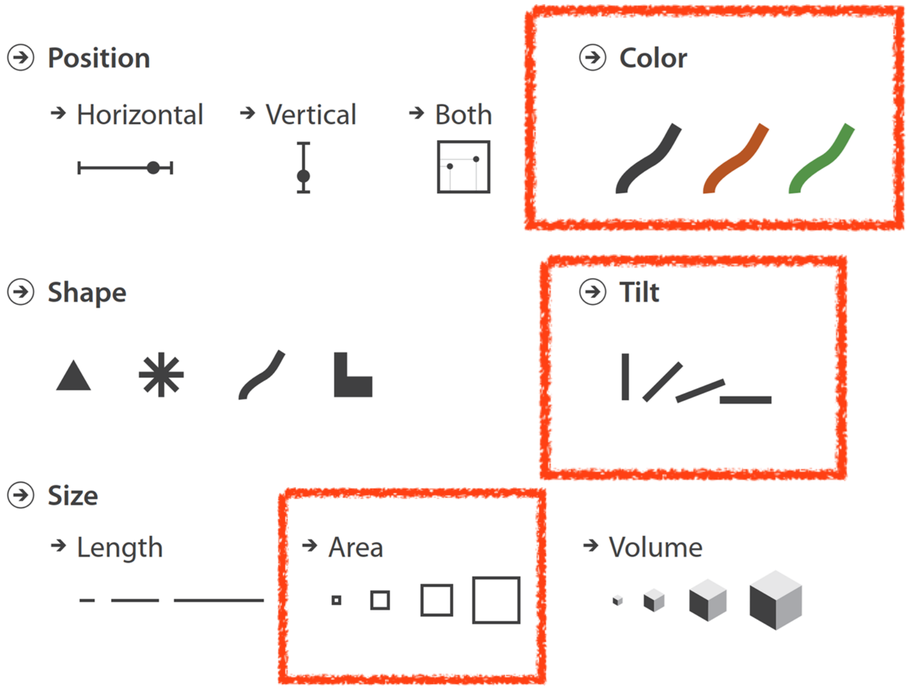

Visualization Building Blocks

of attributes encoded: 2

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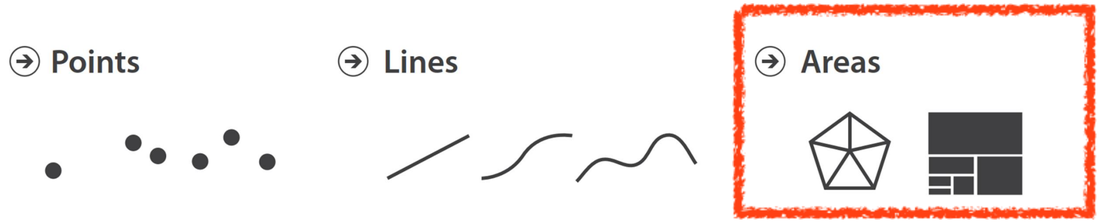

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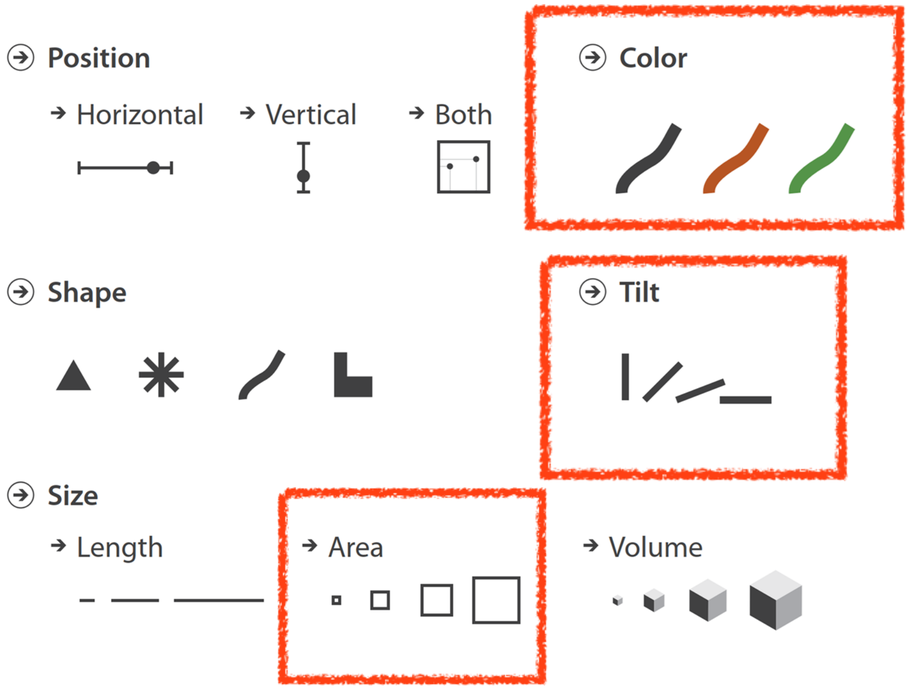
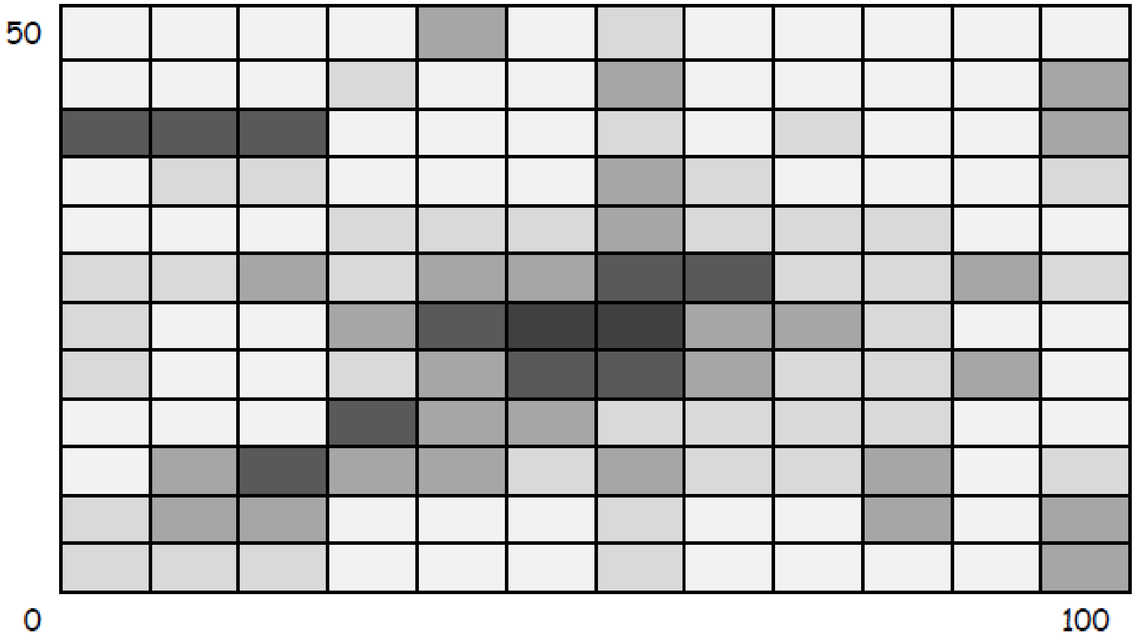


Visualization Building Blocks

of attributes encoded:



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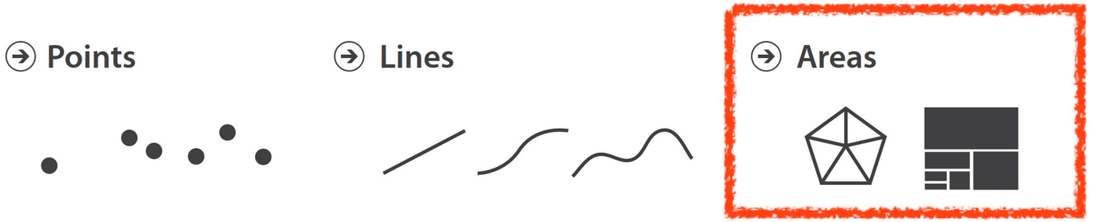

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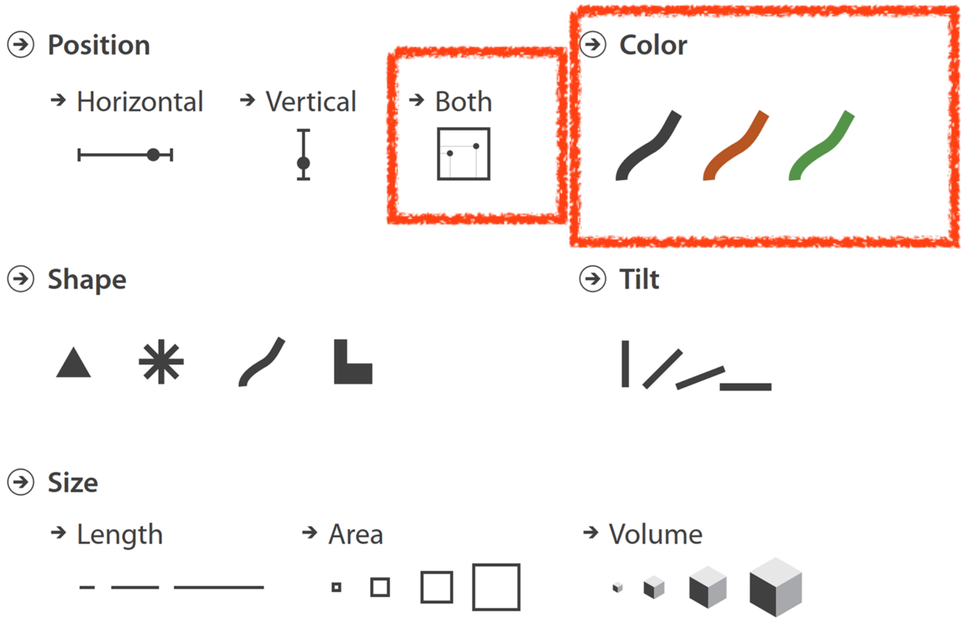


Visualization Building Blocks

of attributes encoded: ?

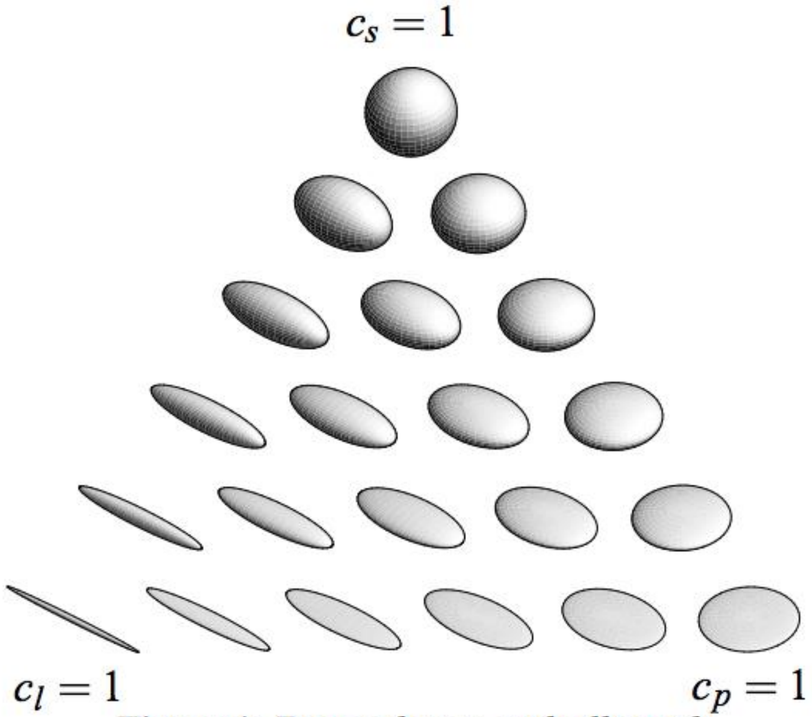
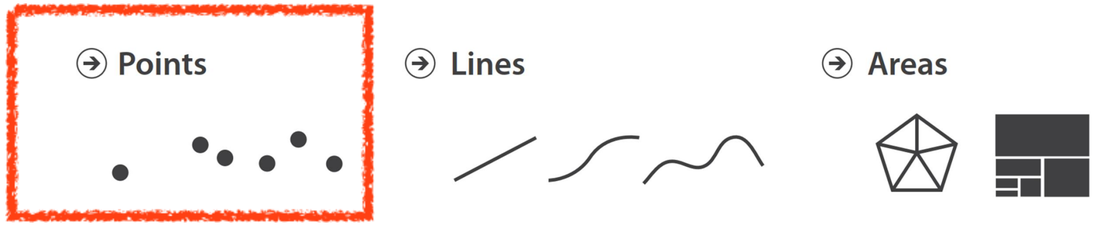


Figure 4: *Tensor shapes, with ellipsoids.*

+ position in 3D space

MARK:



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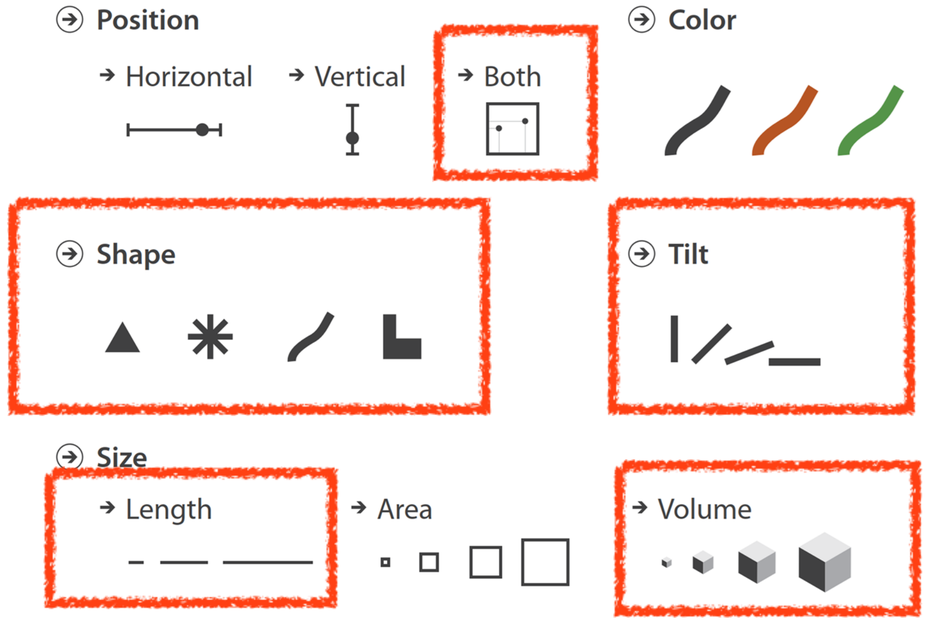


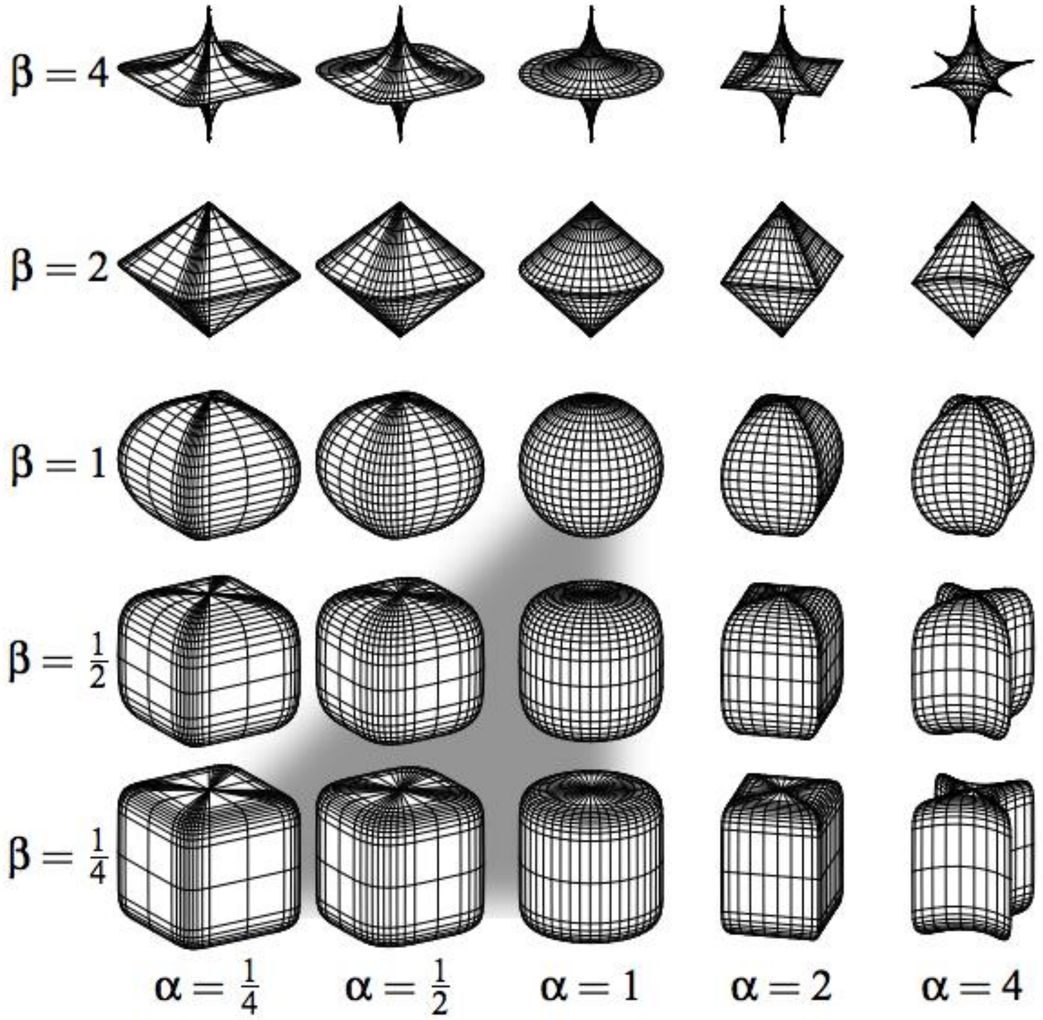
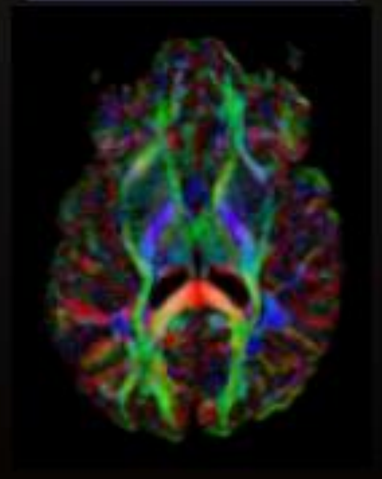
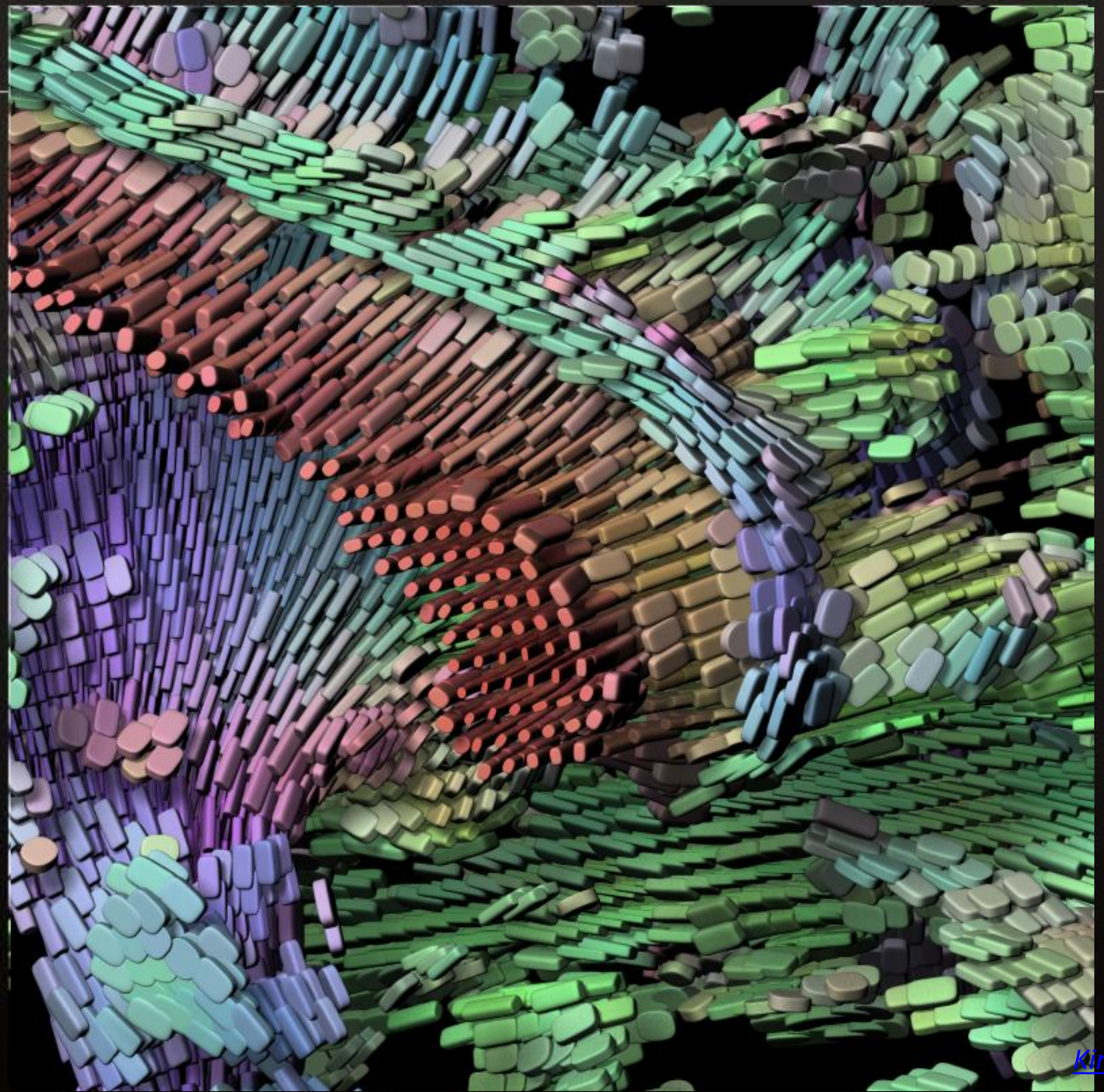


Figure 6: *Superquadrics defined by Equation 3. The gray triangle indicates the subset of the shape space employed by superquadric tensor glyphs. Edges indicate the tessellation resulting from uniform steps in* ϕ *and* θ.

Kindlmann (2004)

Results





Kindlmann (2004)

Visualization Building Blocks

Marks as Items/Nodes

- Points

- Lines

- Areas

Marks as Links

- Containment

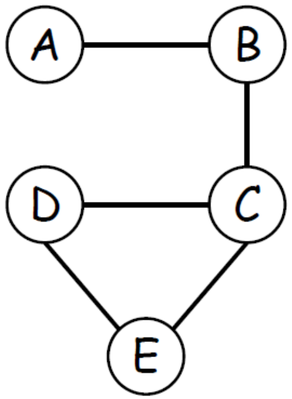
- Connection

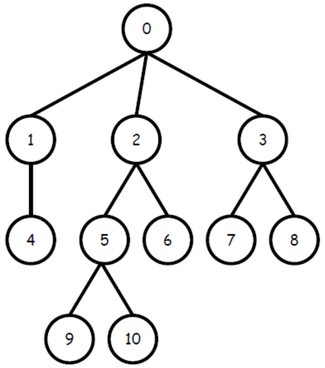
Visualization Building Blocks

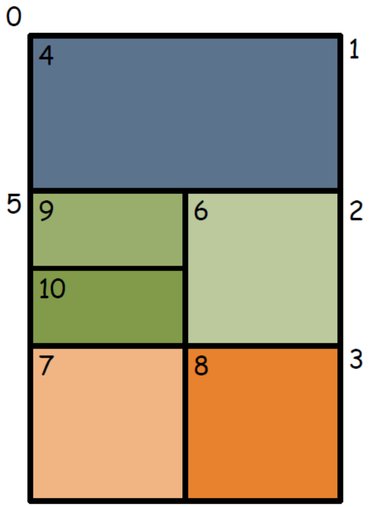
Marks as Links

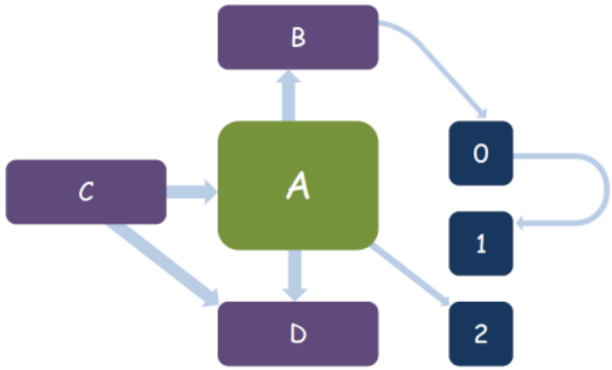
- Containment

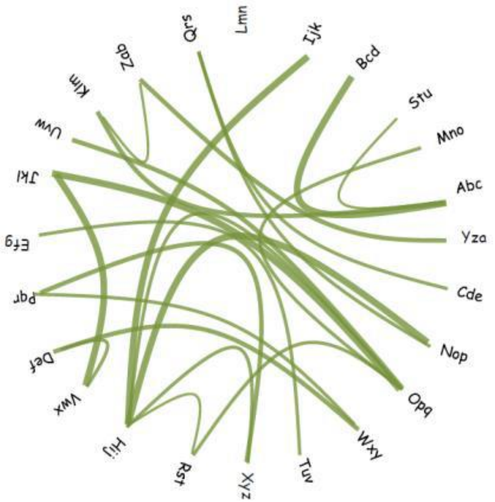
- Connection











Visualization Building Blocks

Marks as Items/Nodes

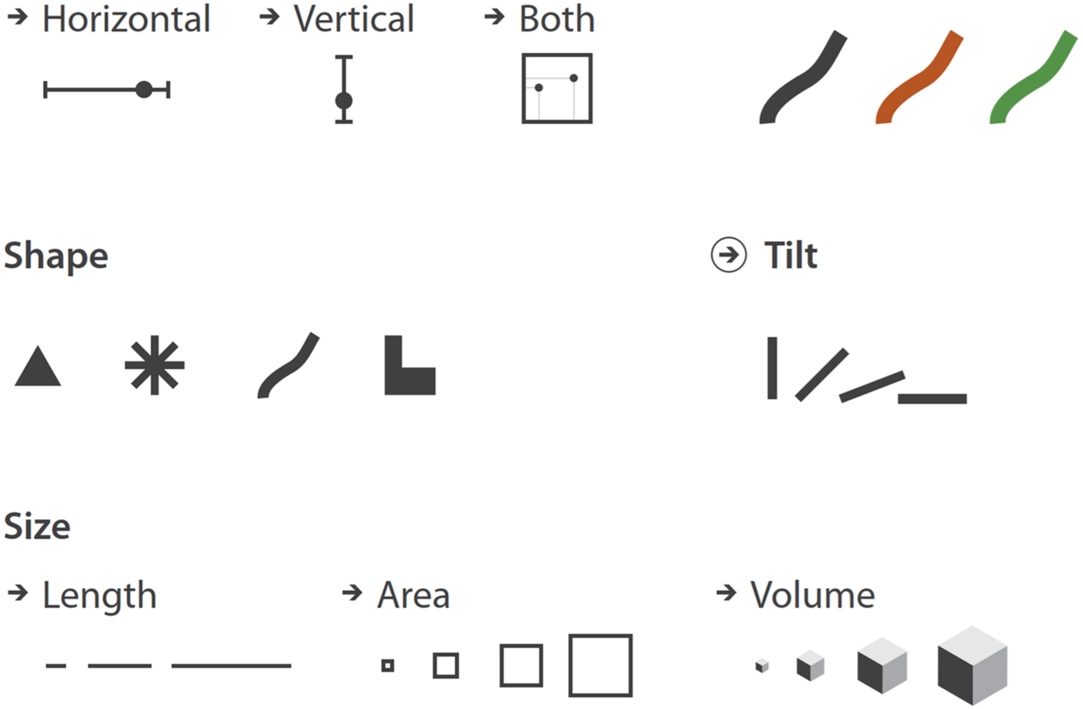
- Points
- Lines
- Areas

Marks as Links

- Containment
- Connection

Channels :

- Position
  - Horizontal
  - Vertical
  - Both
- Color
- Shape
- Tilt
- Size
  - Length
  - Area
  - Volume



Note: these are all really important concepts when it comes time to coding your visualizations...!

How do I pick *which* marks or channels to use?

“Ordering of Elemental Perceptual Tasks”

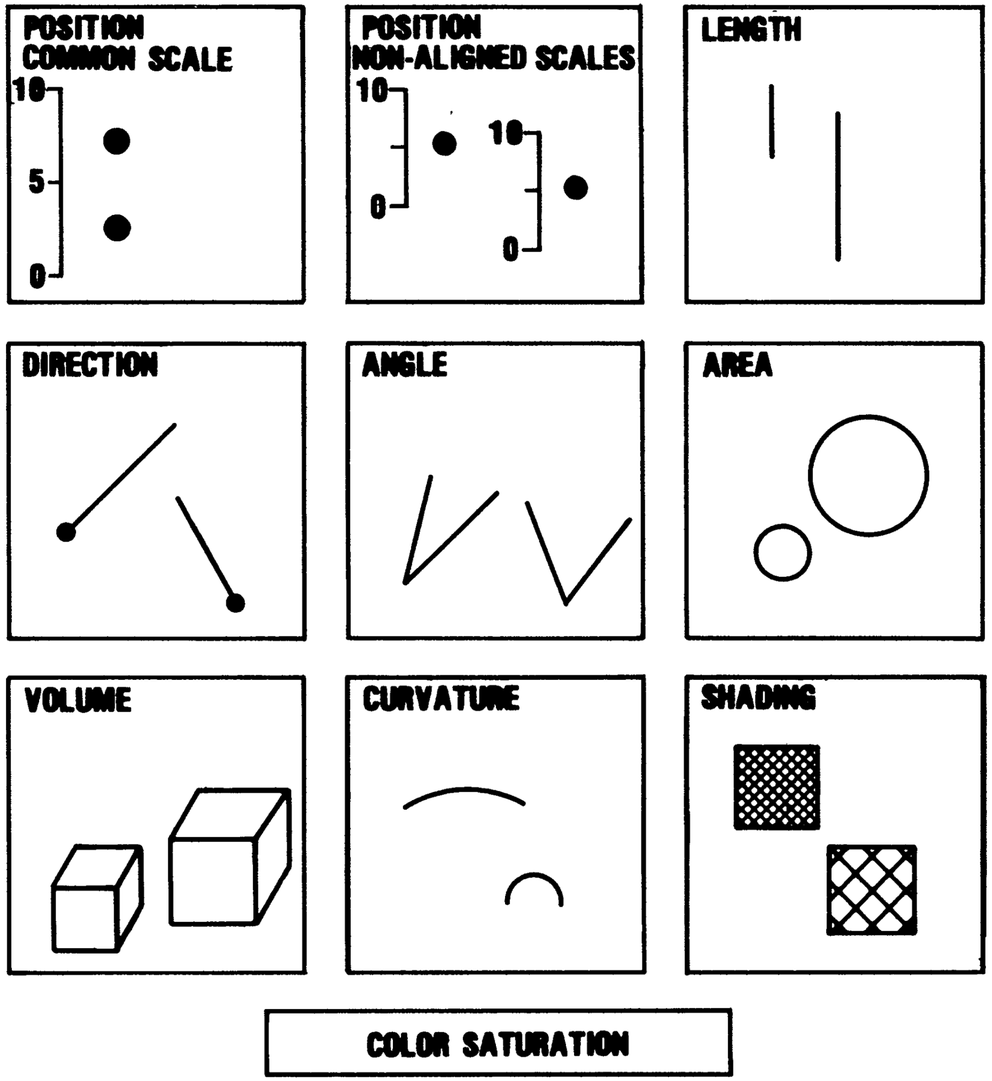


Figure 1. Elementary perceptual tasks.

[Cleveland & McGill (1984)]

“Ordering of Elemental Perceptual Tasks”

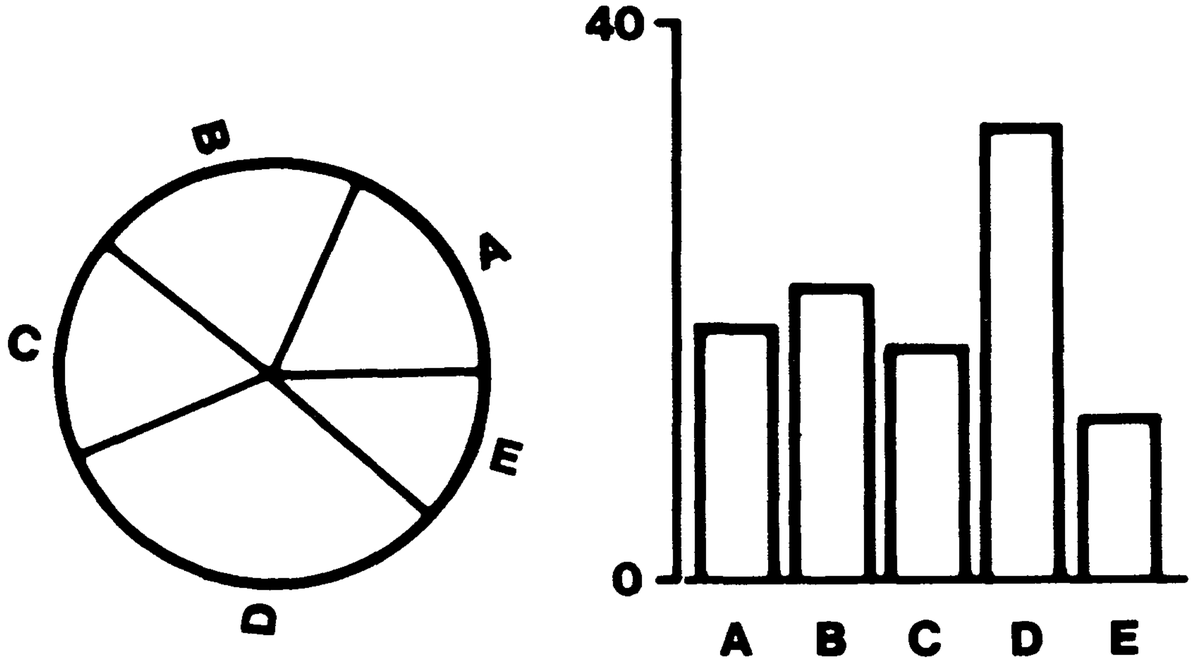


Figure 3. Graphs from position–angle experiment.

TASK: Which segment/bar is the maximum, and what is its percentage/value?

Cleveland & McGill (1984)

“Ordering of Elemental Perceptual Tasks”

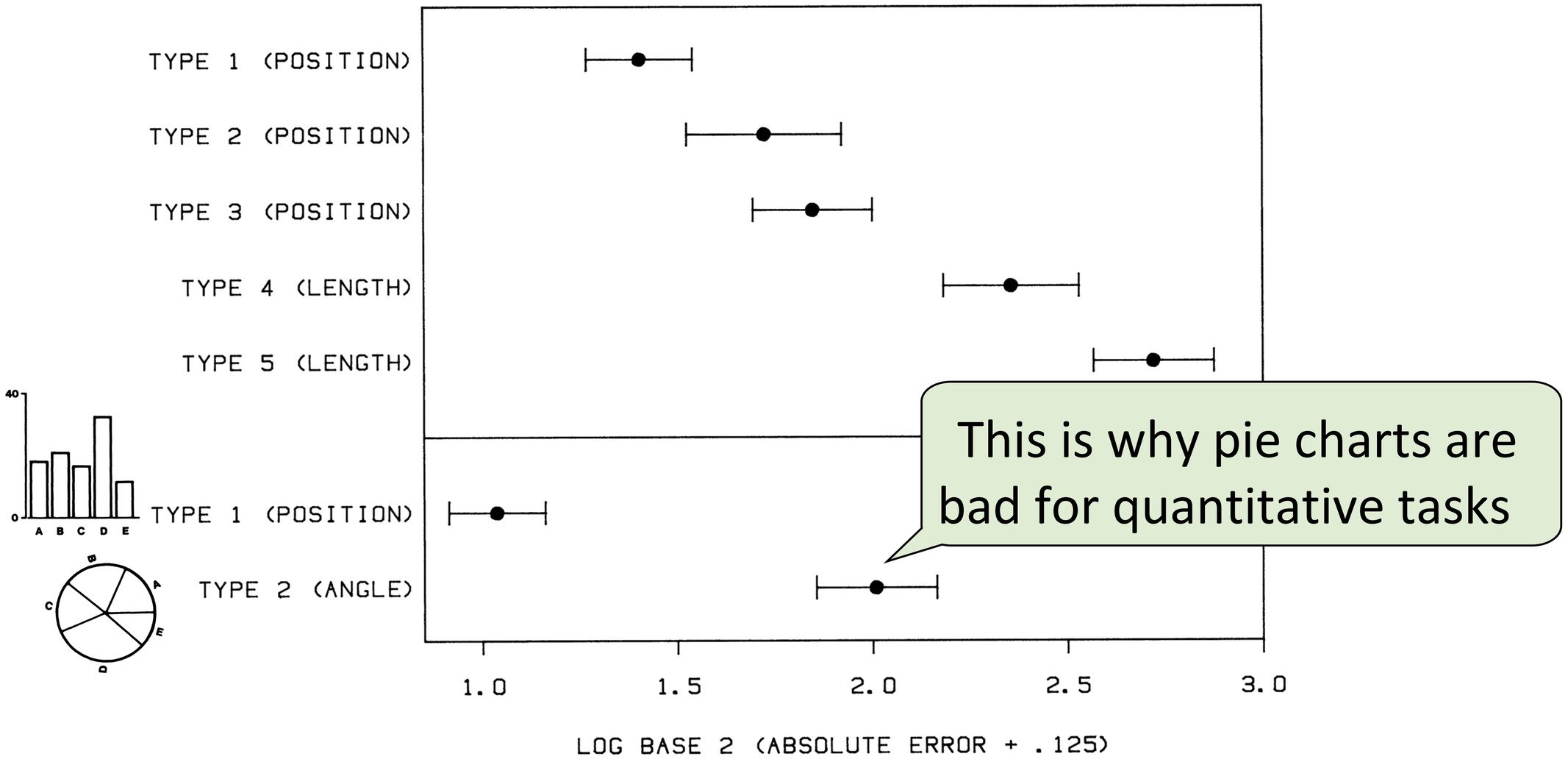
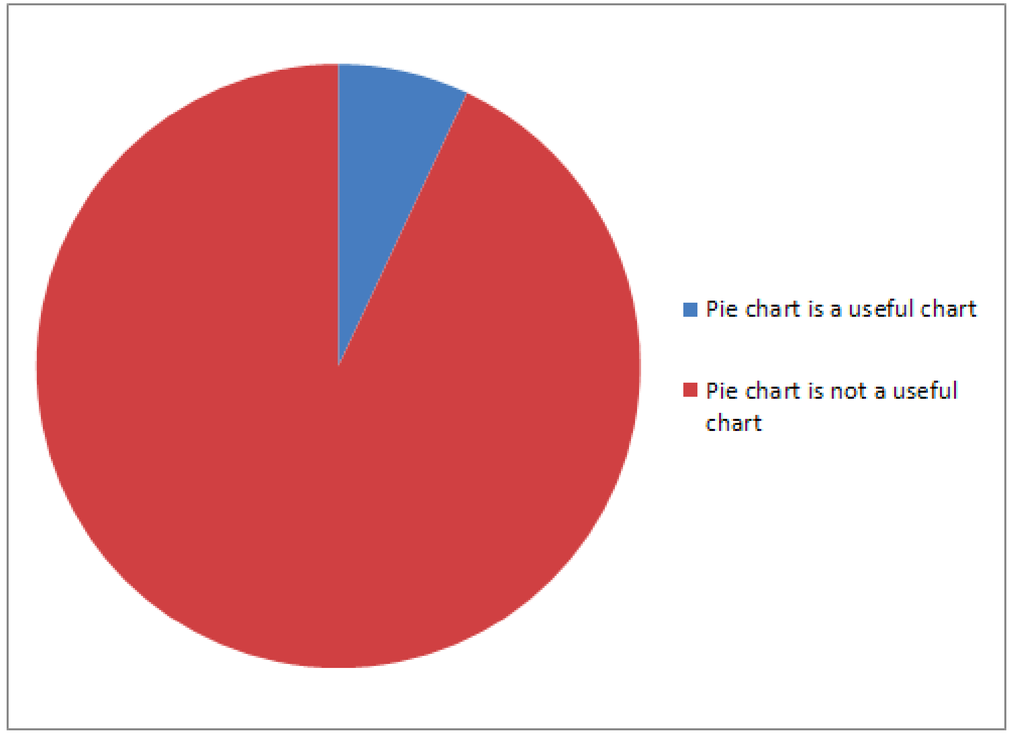
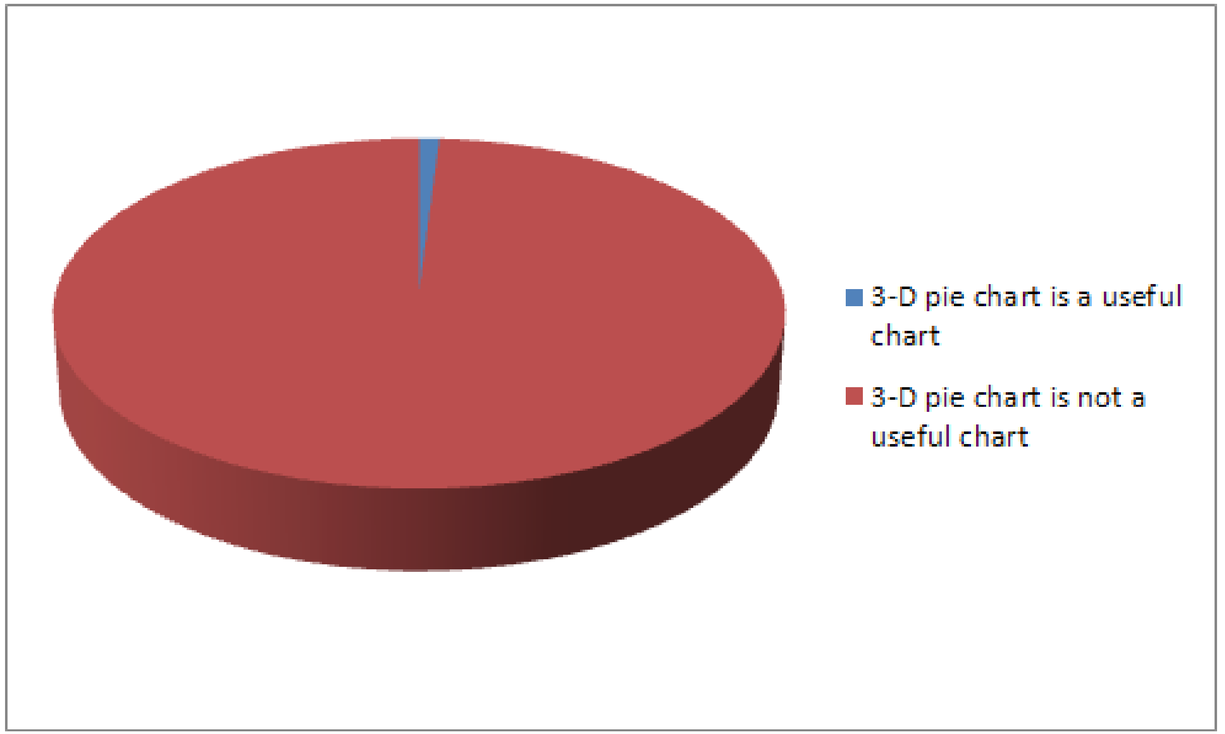


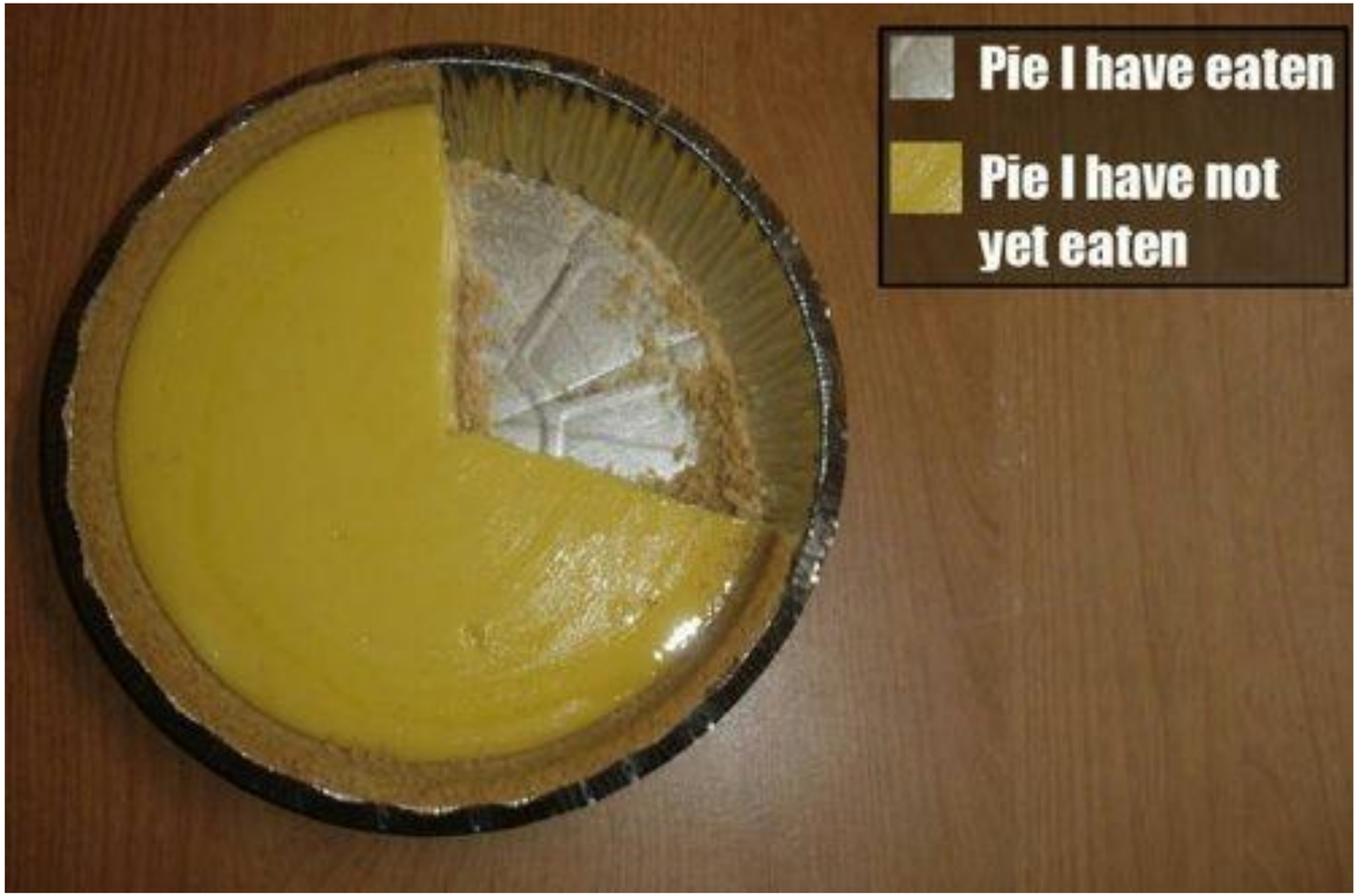
Figure 16. Log absolute error means and 95% confidence intervals for judgment types in position–length experiment (top) and position–angle experiment (bottom).

[Cleveland & McGill (1984)](#)

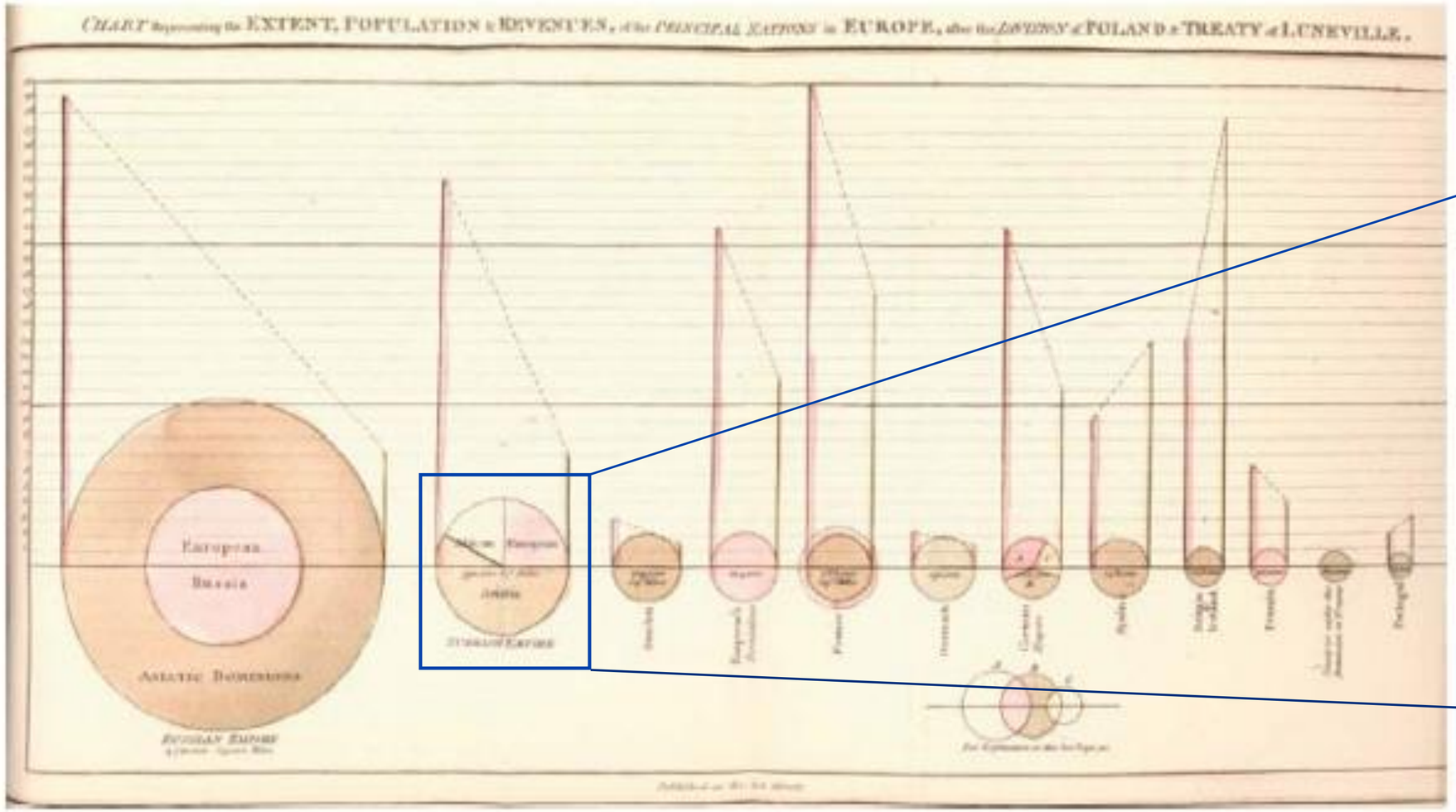


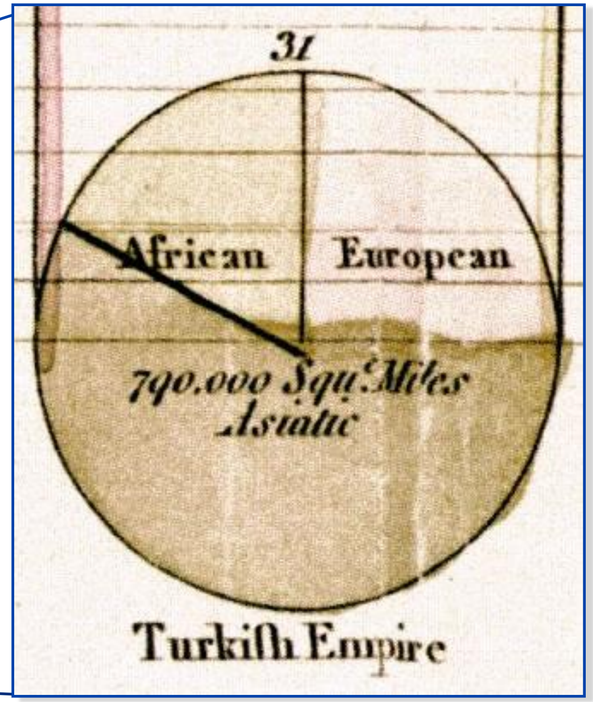


https://www.washingtonpost.com/news/wonk/wp/2013/06/17/the-usefulness-of-pie-charts-in-two-pie-charts/



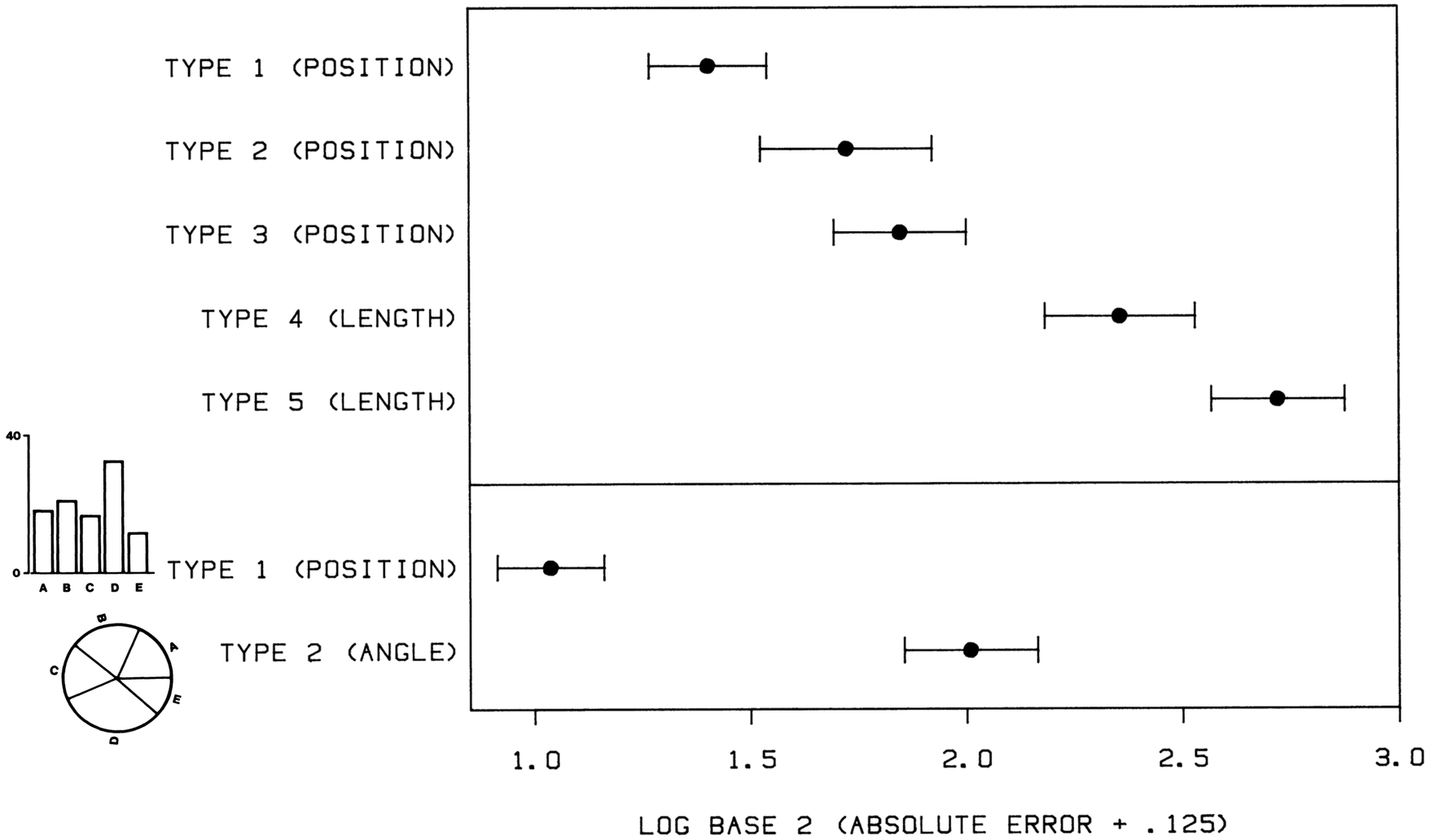
http://www.datasciencecentral.com/profiles/blogs/10-resources-to-help-you-stop-doing-pie-charts





William Playfair (1801)

“Ordering of Elemental Perceptual Tasks”



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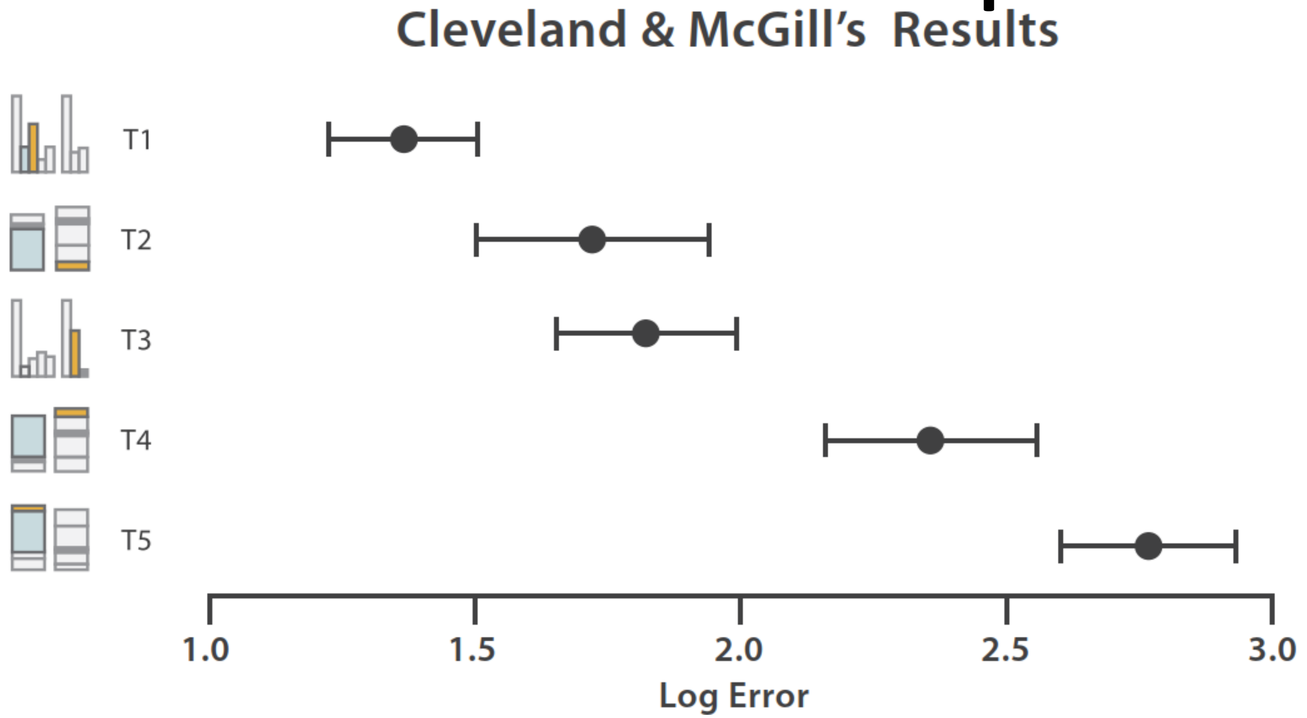
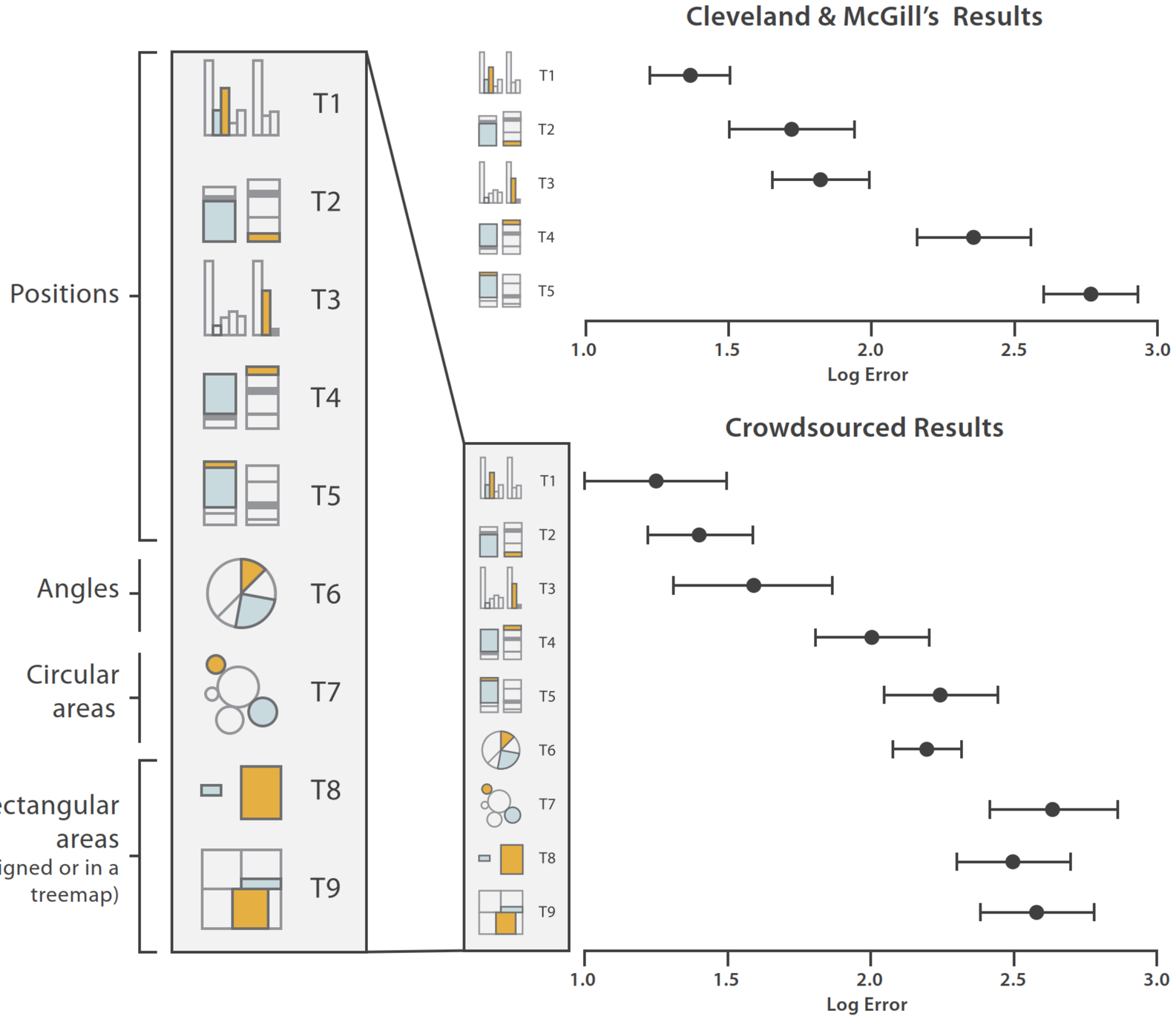
[Cleveland & McGill (1984)](#)

“Ordering of Elemental Perceptual Tasks”



Heer & Bostock (2010)



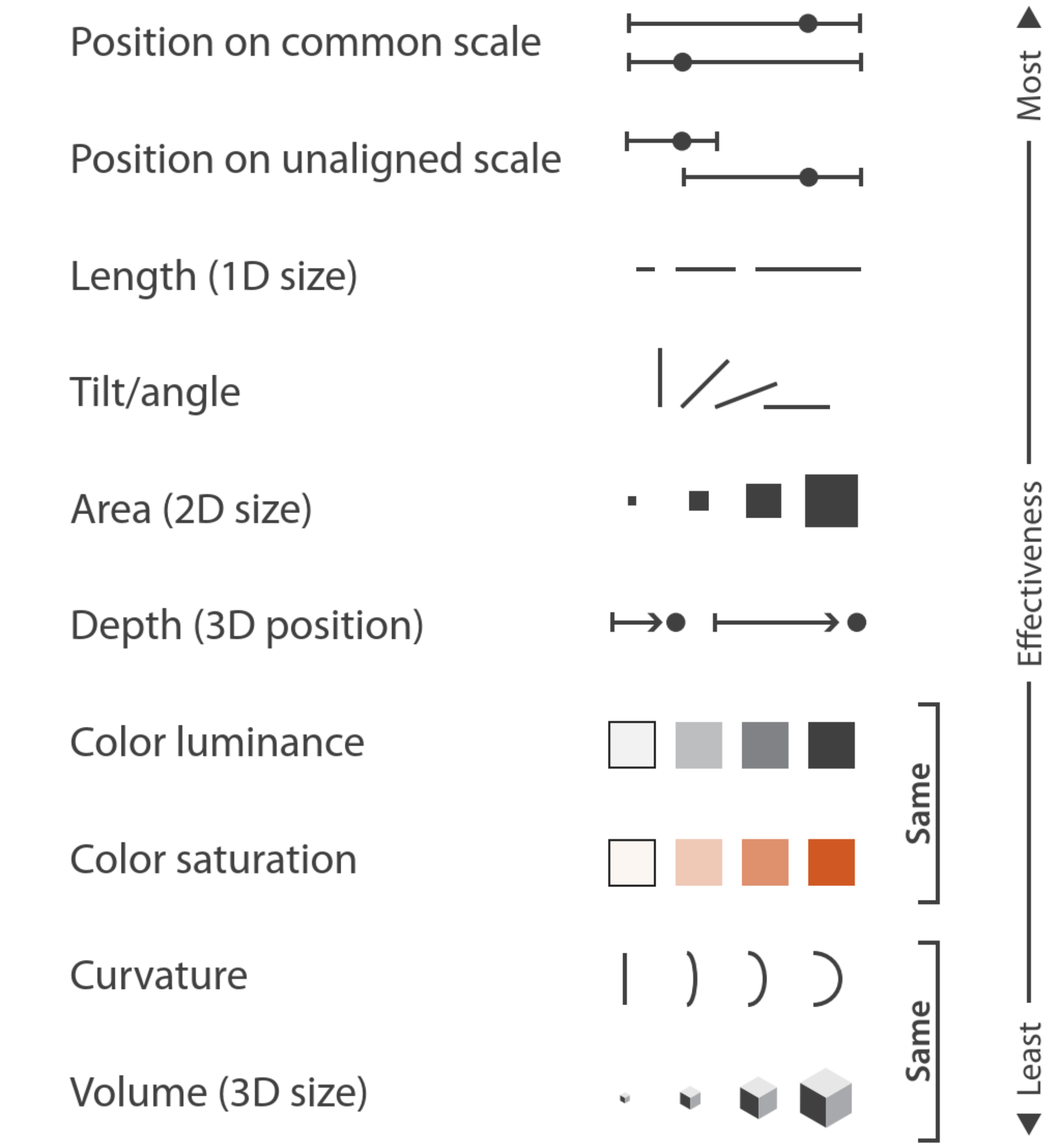
[Heer & Bostock (2010)](#)

Channels: Expressiveness Types and Effectiveness Ranks

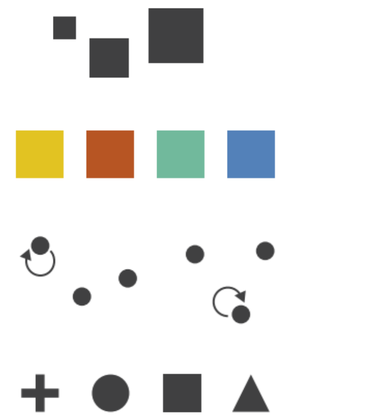
- **Magnitude Channels: Ordered Attributes**

Channels: Expressiveness Types and Effectiveness Ranks

Magnitude Channels: Ordered Attributes



Identity Channels: Categorical Attributes



Expressiveness and Effectiveness

Effectiveness principle: the importance of the attribute should match the salience of the channel; that is, its noticeability.
(i.e., encode most important attributes with highest ranked channels)

Expressiveness principle: the visual encoding should express all of, and only, the information in the dataset attributes.
(i.e., data characteristics should match the channel)

Mackinlay (1986)

My Summary: Prioritize choosing the most appropriate channel for each attribute

Expressiveness and Effectiveness

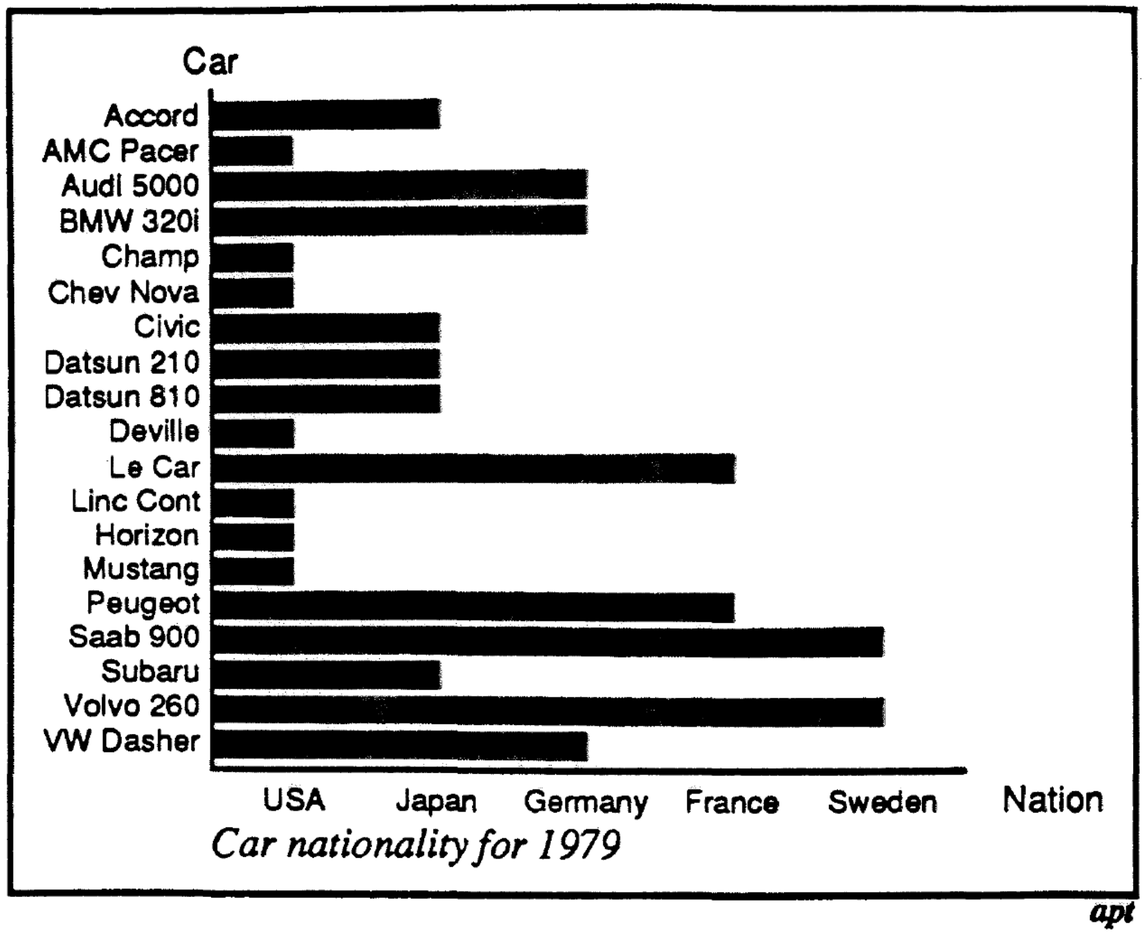


Figure 11: Incorrect Use of a Bar Chart for the Nation Relation. *The lengths of the bars suggest an ordering on the vertical axis, as if the* USA *cars were longer or better than the other cars, which is not true for the Nation relation.*

Mackinlay (1986)

Expressiveness and Effectiveness

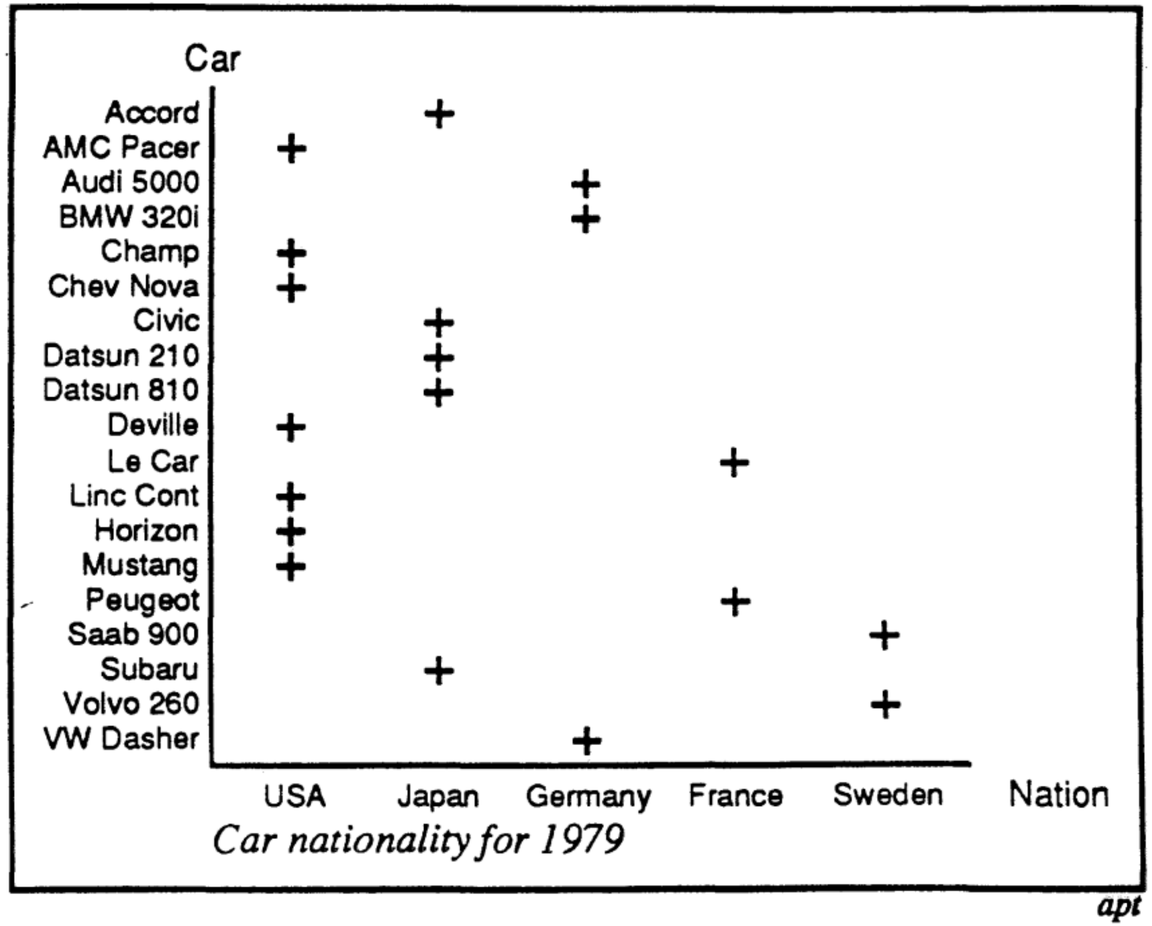
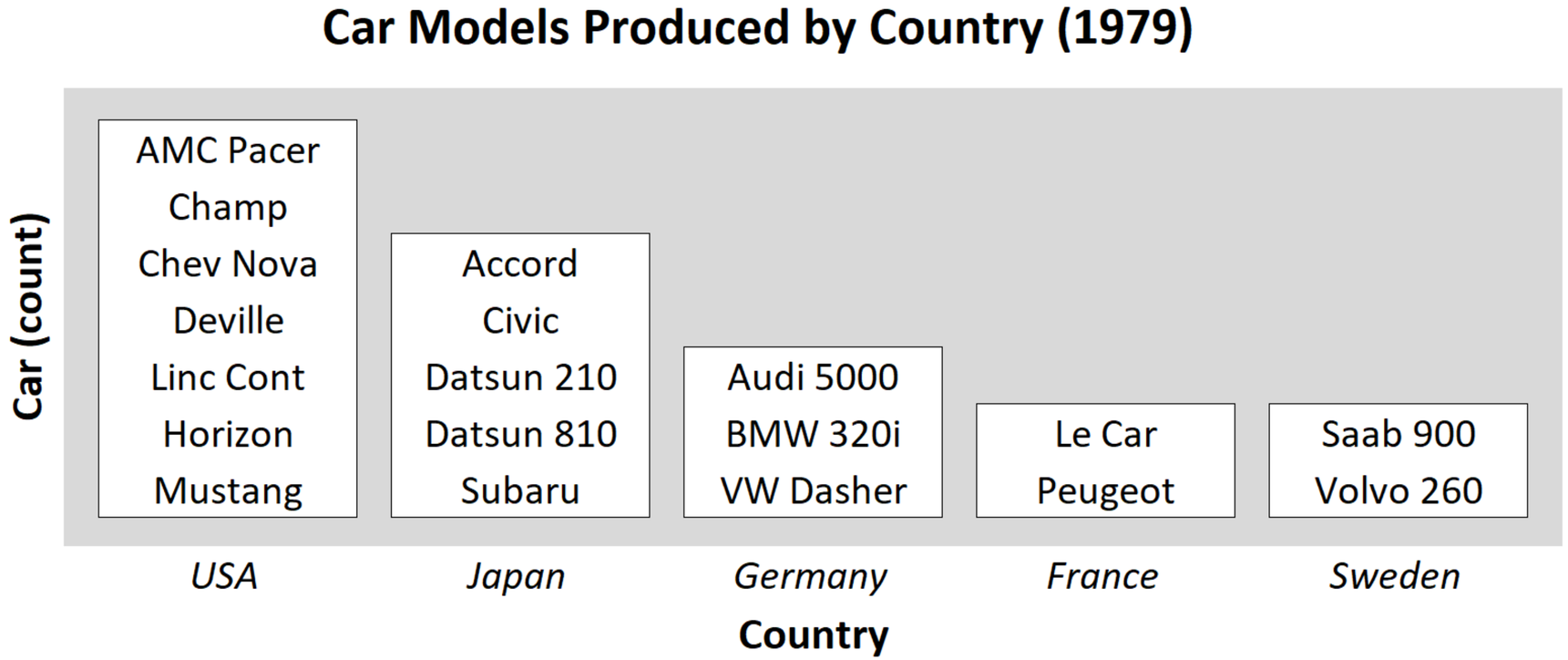


Figure 12: Correct Use of a Plot Chart for the Nation Relation. *Since bar charts encode ordered domain sets, plot charts are conventionally used to encode nominal domain sets. The ordering of the labels on the axes is ignored.*

Mackinlay (1986)

Expressiveness and Effectiveness



IN-CLASS EXERCISE

3, 12, 42

3, 12, 42

In-class Sketching: “Three numbers”

20m

1. Break-out into groups of ~3 students.
2. **Together** *(15m) u*se pens & post-it notes to sketch as many possible visualizations as you can of these three numbers.
3. No upload required
4. **As a class** *(5m)* we will discuss some of the designs and themes.

Jonathan Schwabish

Data Types

Goals for Today

- Learn what are data types and dataset types
- Learn what are attribute types
- Learn how to pick appropriate visual representations based on attribute type and perceptual properties

Data Types

TYPE = structural or mathematical interpretation of the data

Data Types

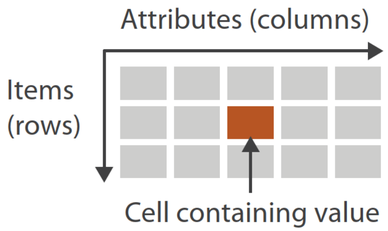
- Items *(row, node)*
- Attributes *(variable, data dimension)*
- Links *(relationship)*
- Positions *(spatial location)*
- Grids *(sampling)*

Data Types

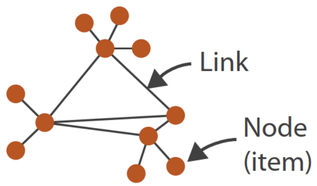
DATASET = collection of information that is the target of analysis

Dataset Types

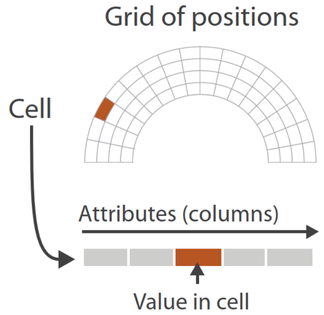
- Tables



- Networks

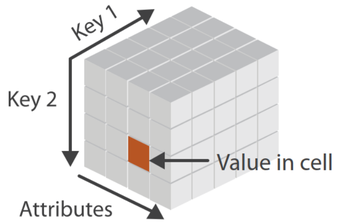


- Fields (Continuous)



- Geometry (Spatial)

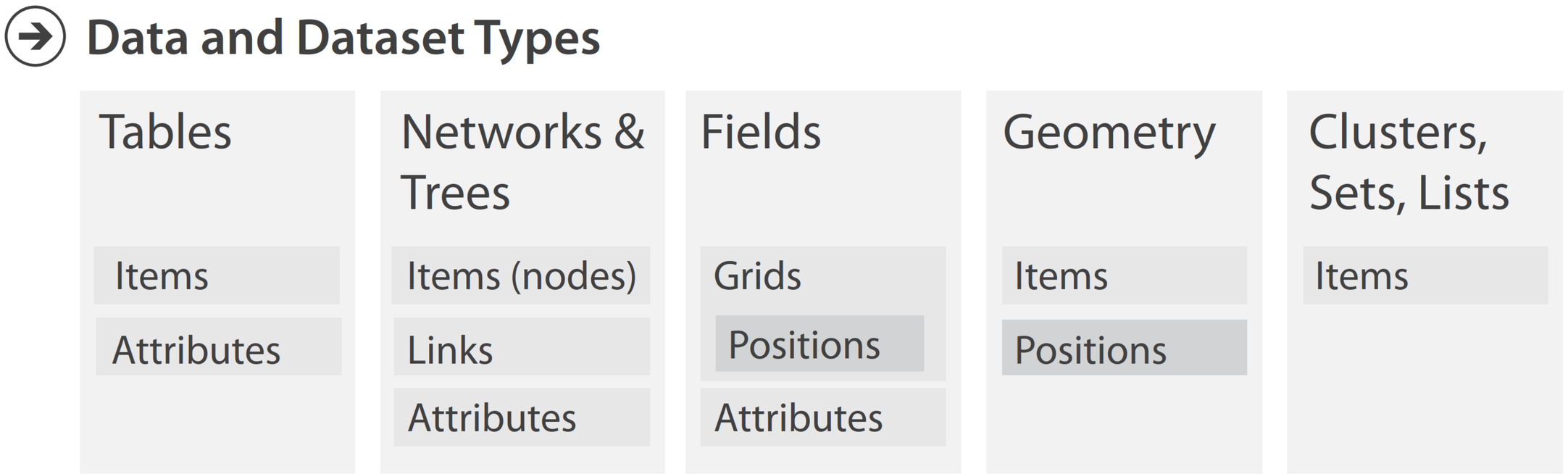
- *Multidimensional Table*



- *Trees*

Data Types

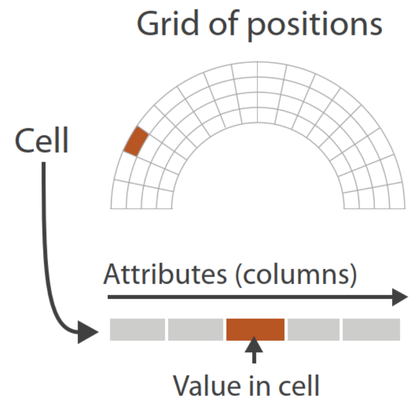
DATASET = collection of information that is the target of analysis



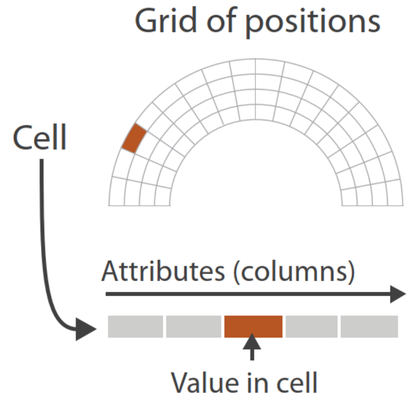
grid types

Relevant to anyone in the sciences!

➔ Fields (Continuous)



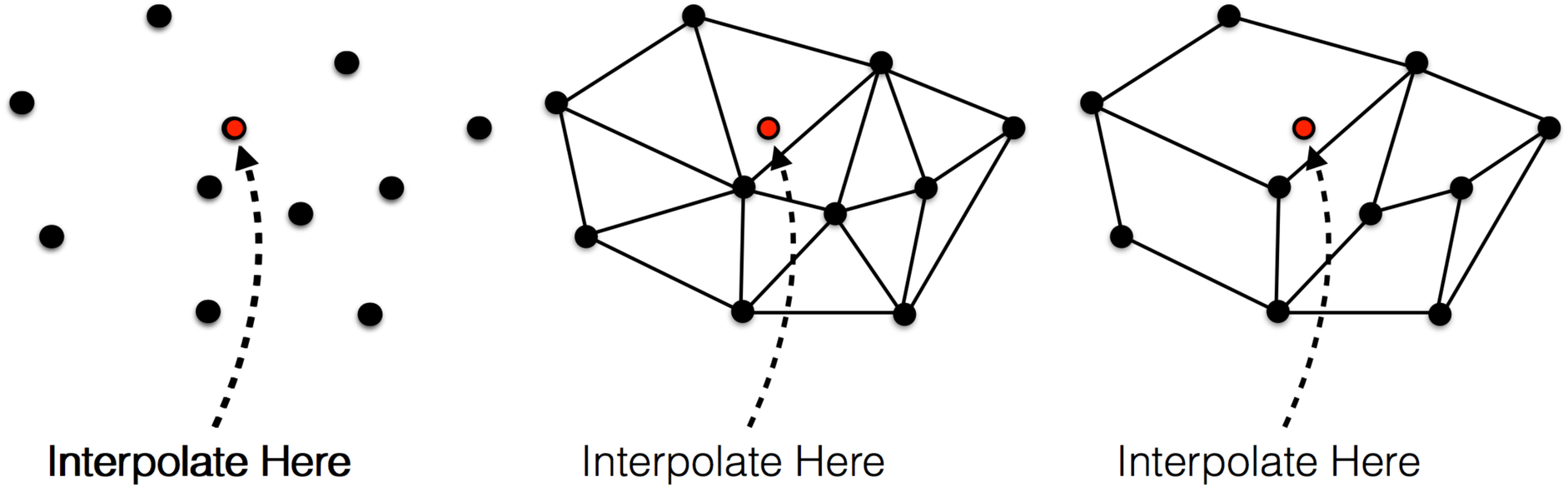
grid choices impact how continuous data is interpreted



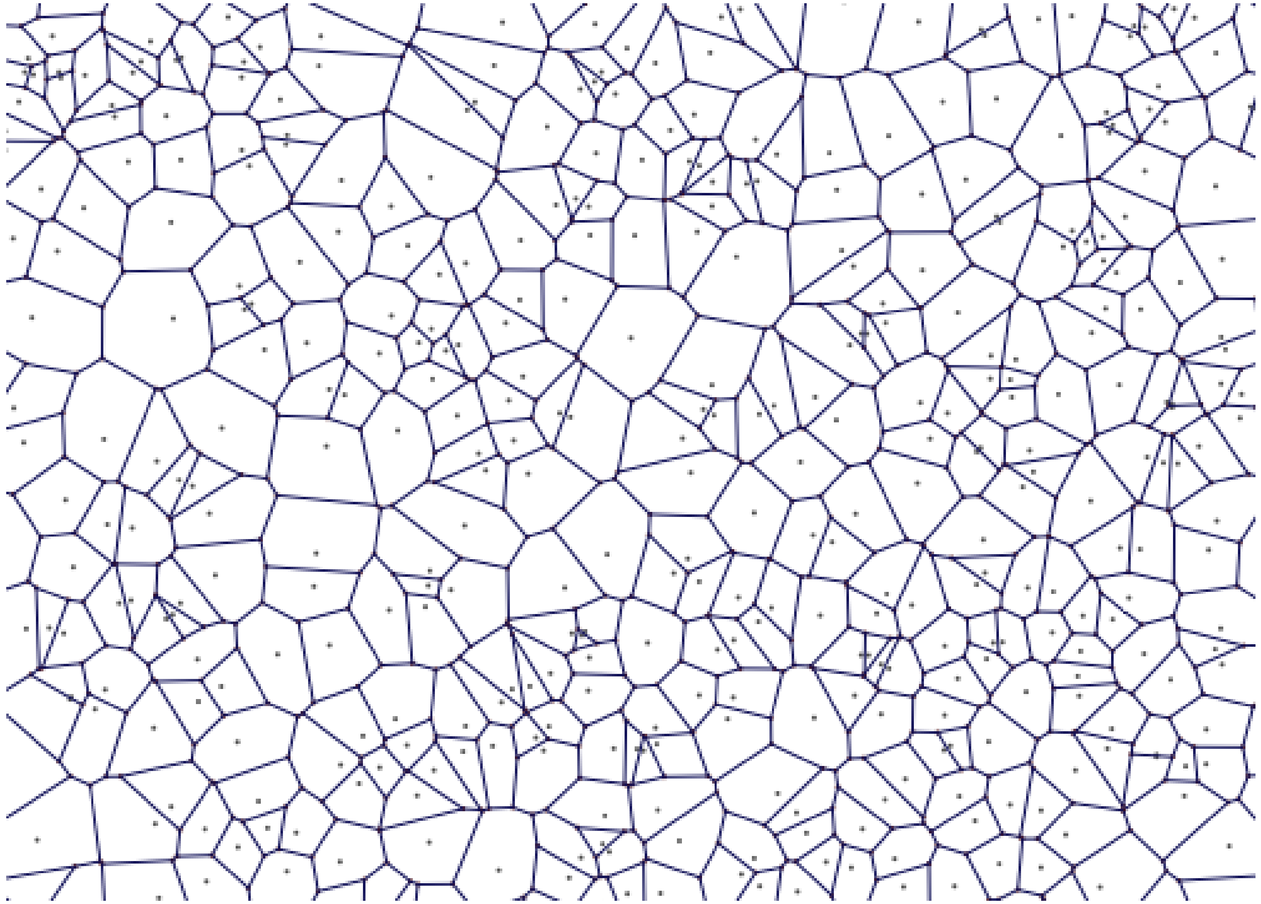
two key considerations:

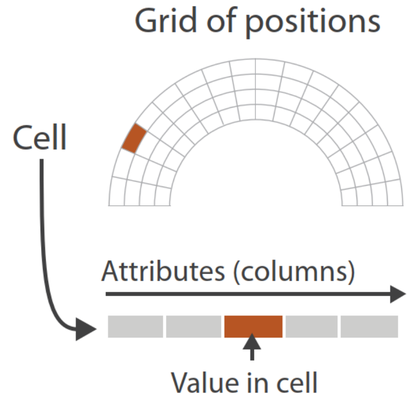
sampling, or the choice of where attributes are measured

interpolation, or how to model the attributes in the rest of space



“Voronoi Tessellation”





https://en.wikipedia.org/wiki/Voronoi_diagram