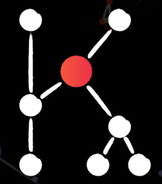

MARK AND CHANNELS

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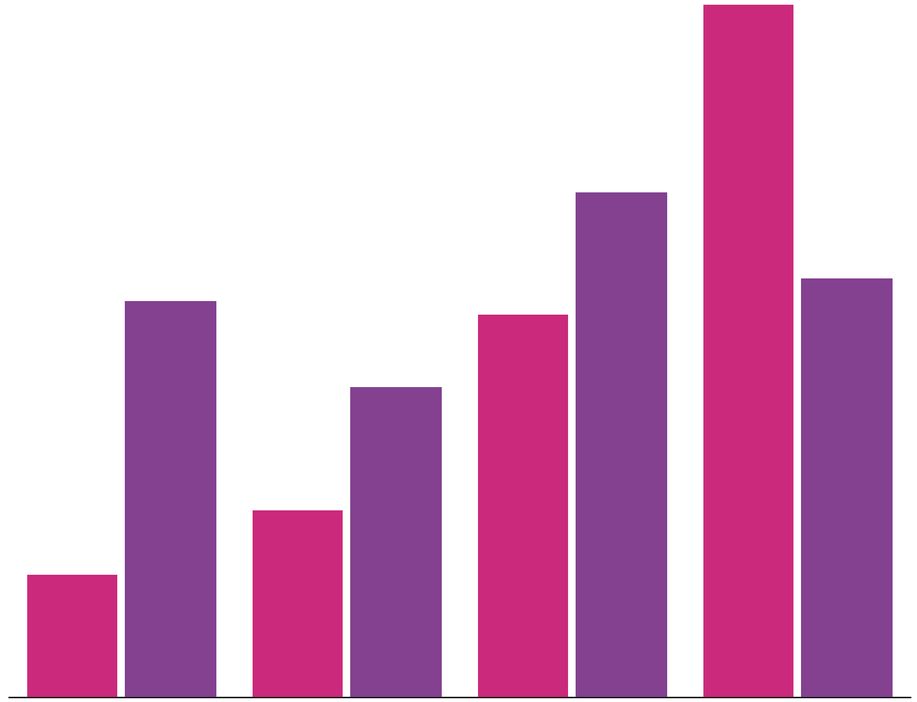
Definitions

Marks: basic geometric elements to represent items or links

Channels: visual variable, change the appearance of marks based on attributes



Marks for items/nodes

Points

0D

sense of place

Lines

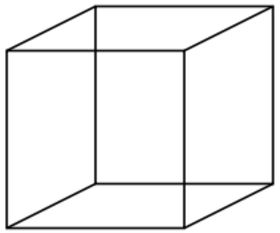
1D

sense of length and direction

Areas

2D

sense of space and scale



3D

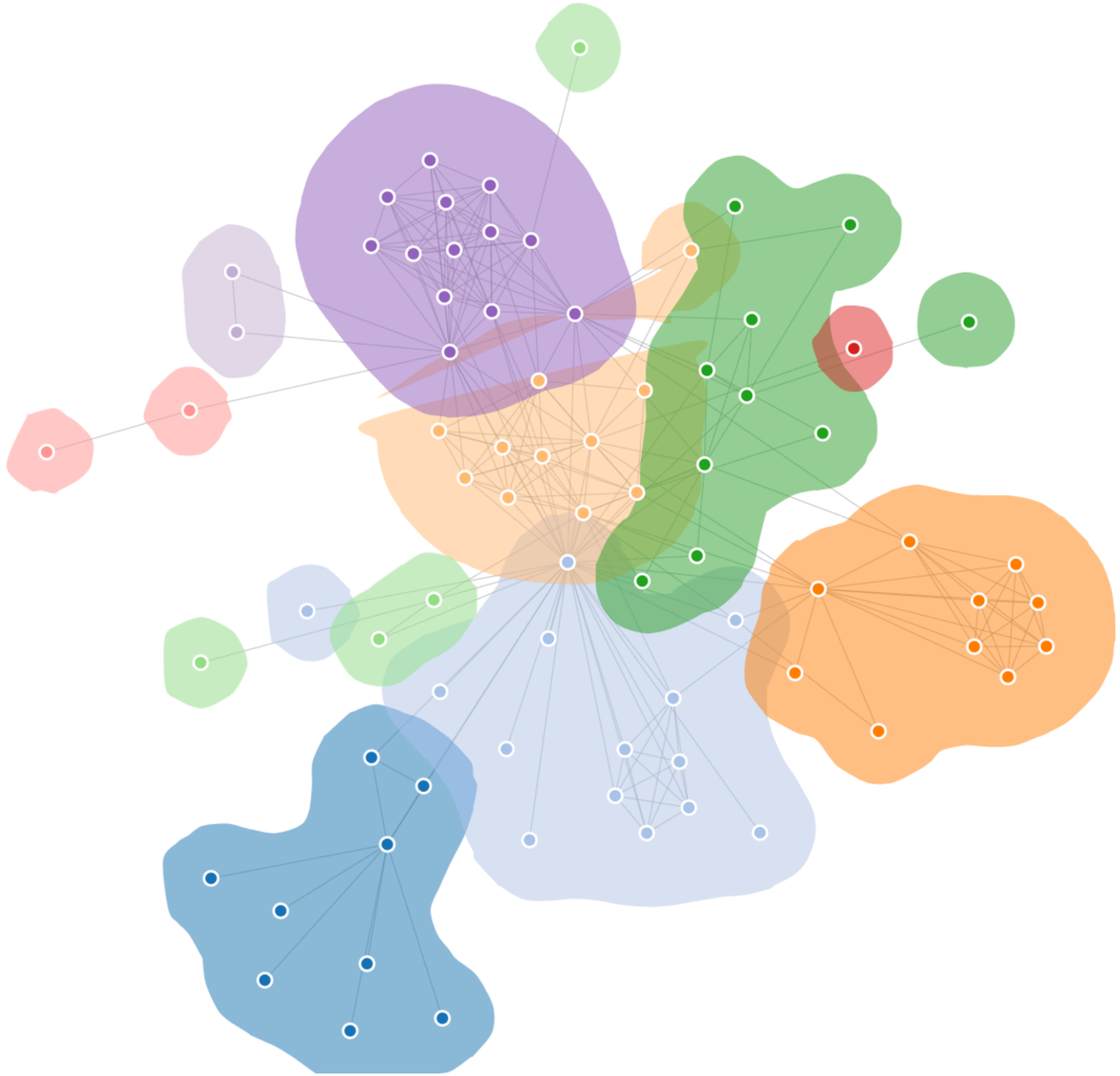
sense of volume

Marks for links

(Enclosure)

Containment

Connection



Channels (visual attributes)

Position

- Horizontal
- Vertical
- Both

Color

Shape

Tilt

Size

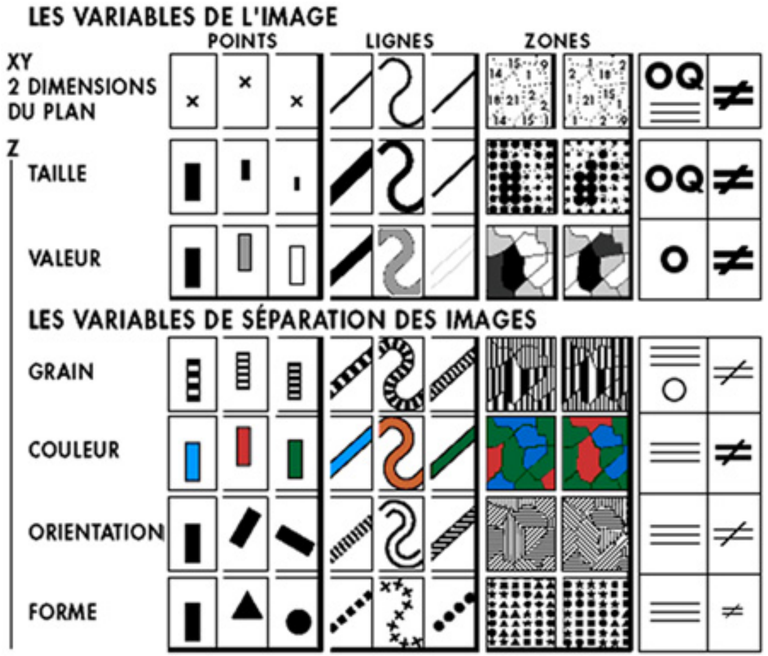
- Length
- Area
- Volume

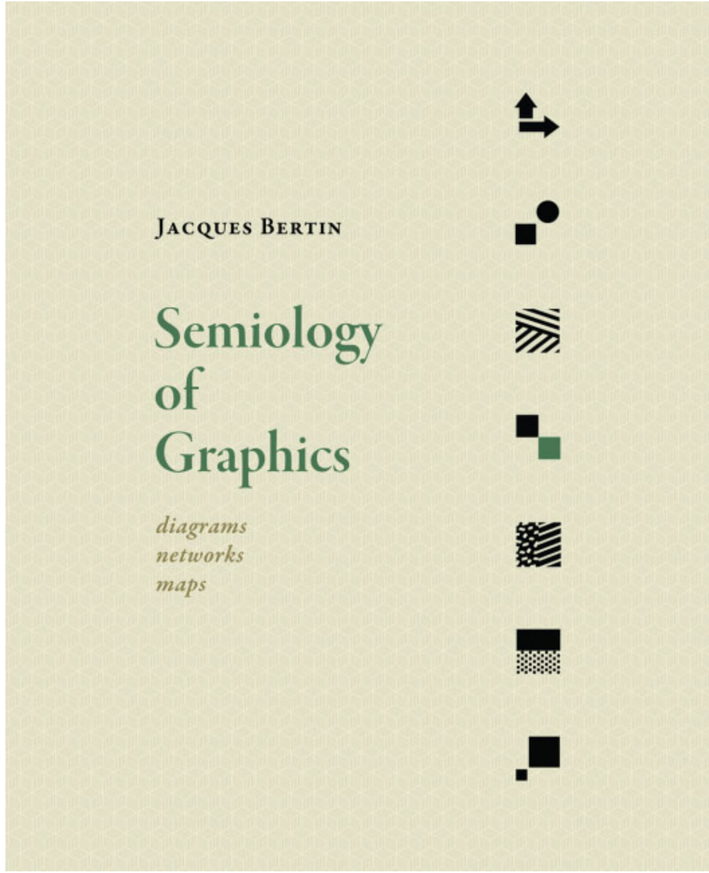
Control appearence of marks

[T. Munzner, Visualization Analysis and Design, 2014]

A bit of history

First introduced by Jacques Bertin [1918-2010], a french cartographer in “Sémiologie graphiques” [1967]





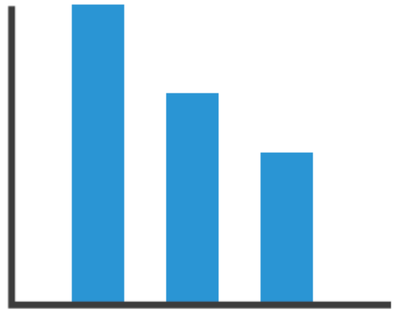
Two core principles

Expressiveness: the visual encoding should only express the information contained in the dataset attributes.

Effectiveness: the importance of the attribute should match the noticeability of the channel.

Combining marks and channels

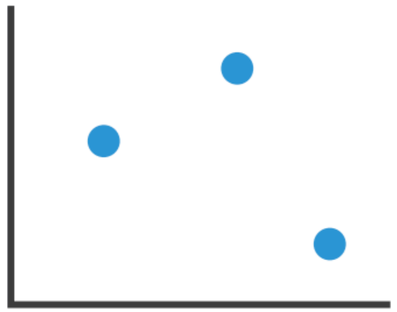
Line



Length
Position

1 quantitative attr.
1 categorical attr.

Point



Position

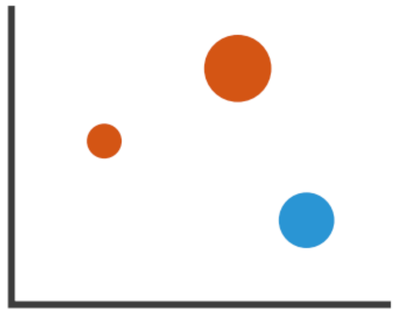
2 quantitative attr.

Point

Position
Hue

2 quantitative attr.
1 categorical attr.

Point

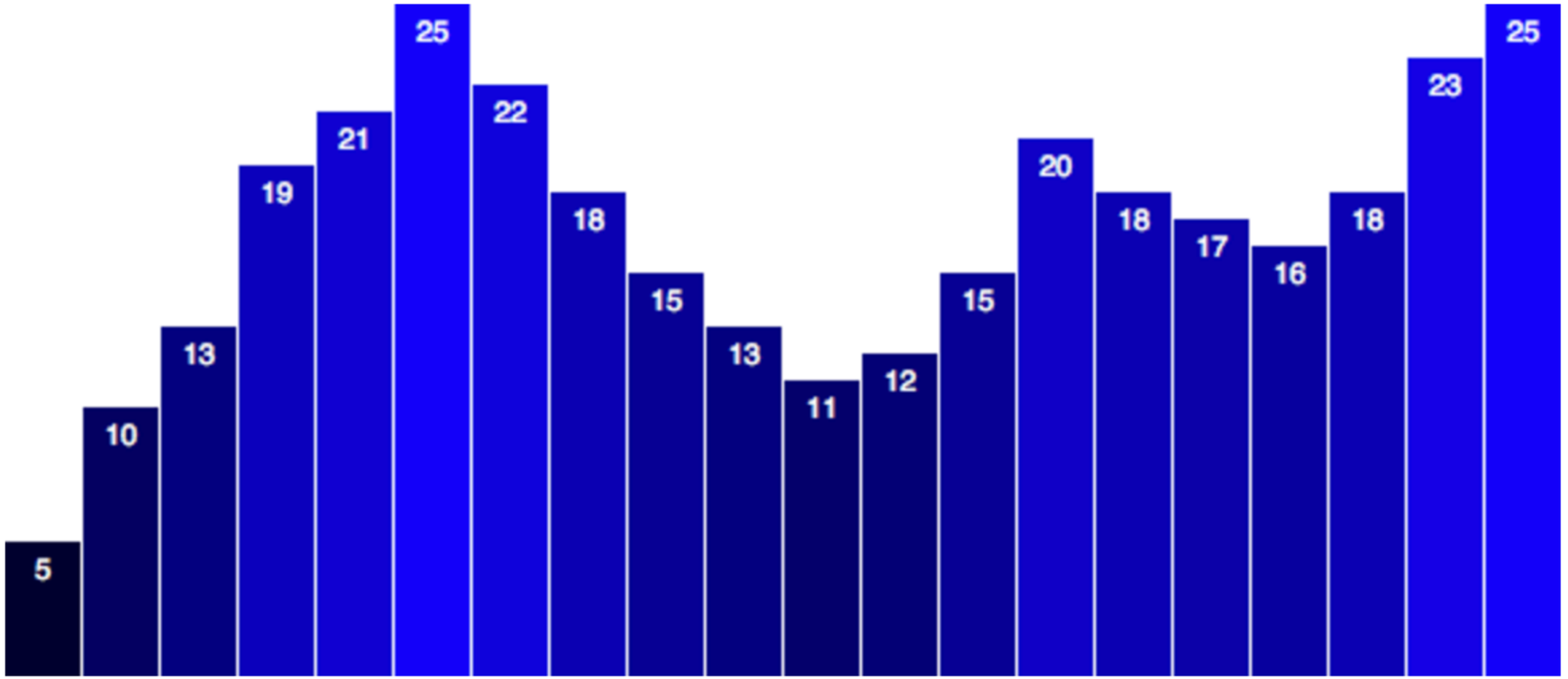


Position
Hue
Size

3 quantitative attr.
1 categorical attr.

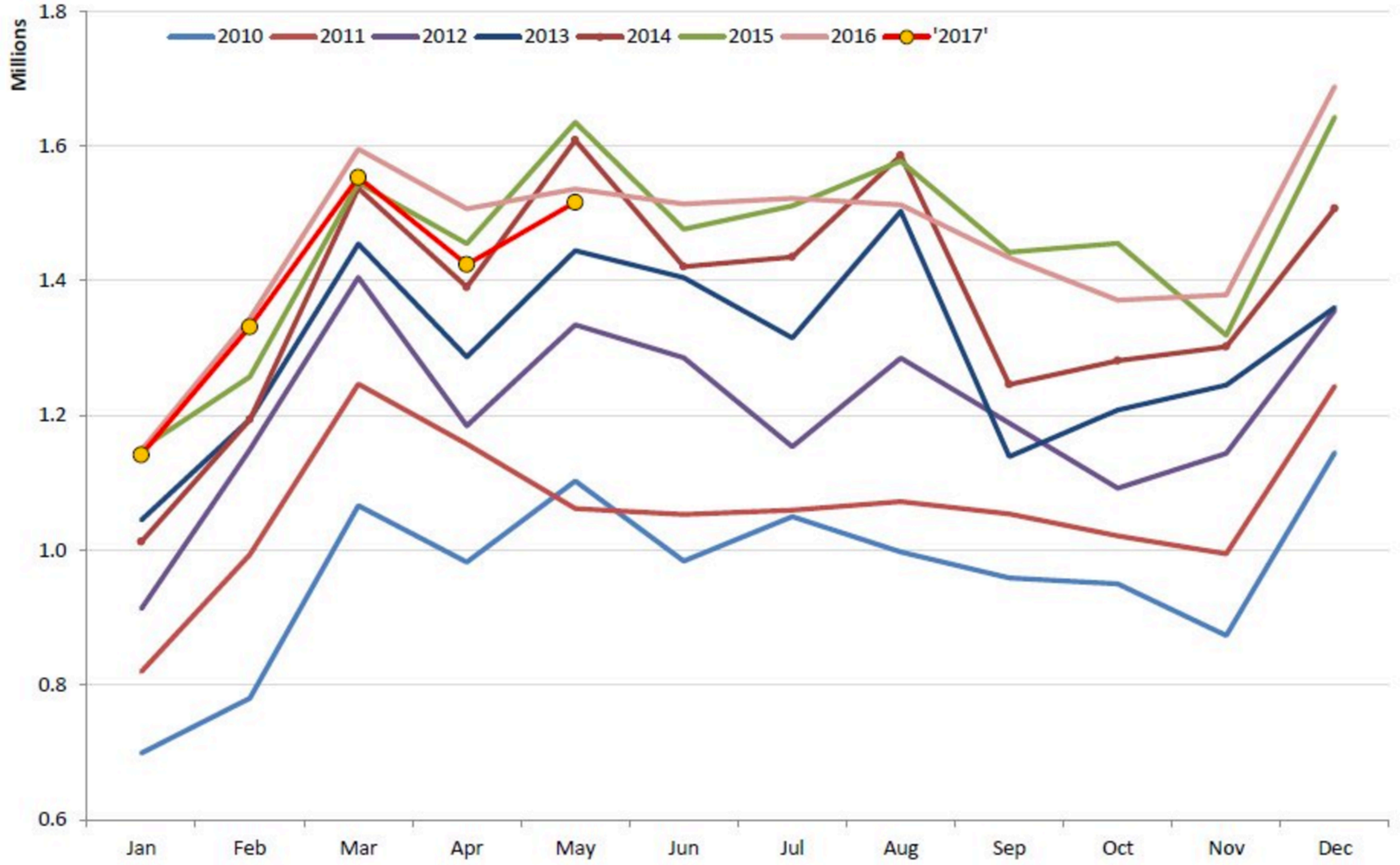
T. Munzner, Visualization Analysis and Design, 2014

Redundant encoding



Length + hue

Cluttered space



Channels types

➔ Categorical

➔ Ordered

➔ *Ordinal*

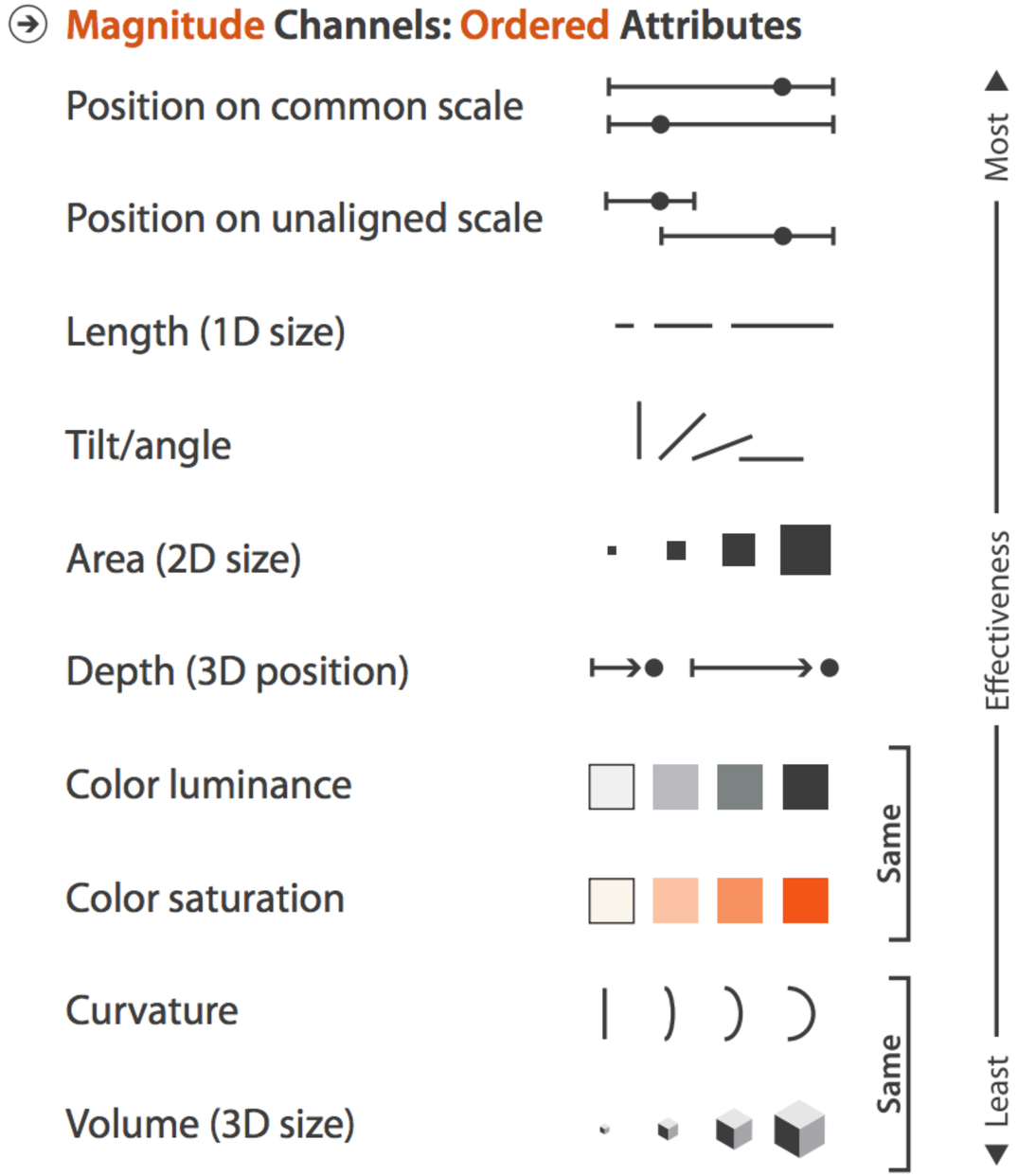
➔ *Quantitative*

Identity channels

What?

Magnitude channels

How much?

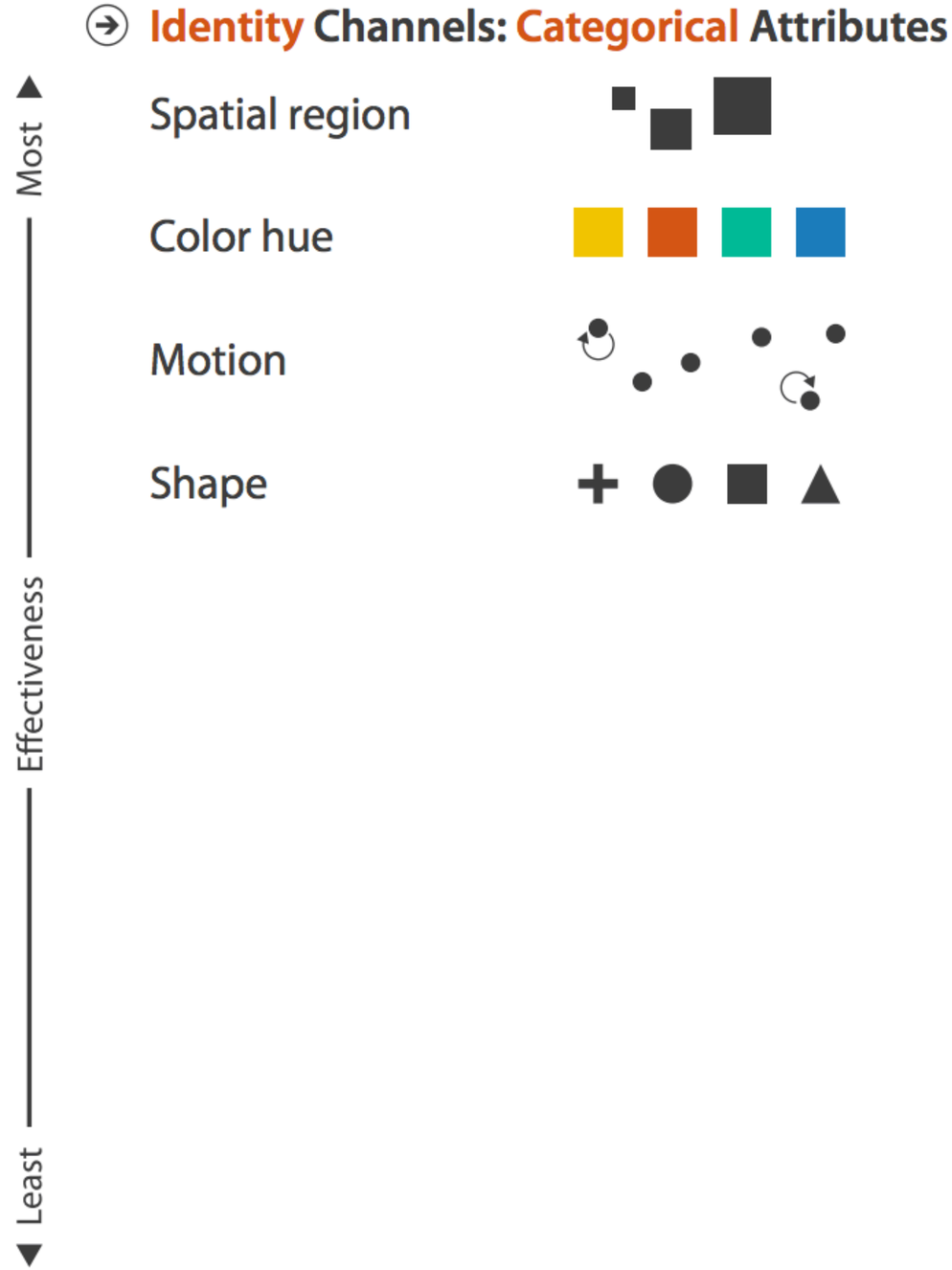


Magnitude channels ranking for quantitative and ordered data

T. Munzner, Visualization Analysis and Design, 2014

Identity channels ranking for categorical (nominal) data

can only support a limited number of discriminable levels.

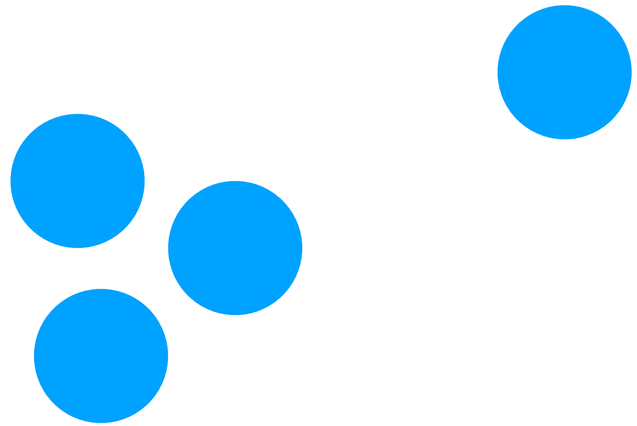


T. Munzner, Visualization Analysis and Design, 2014

Channel properties

Property	Description
Selectivity	Can we spot the difference between marks?
Associativity	Can we group marks together?
Quantitativity	Can we measure the difference between two marks?
Ordering	Can we order marks?
Drawability count	How many unique marks can we make?

Position



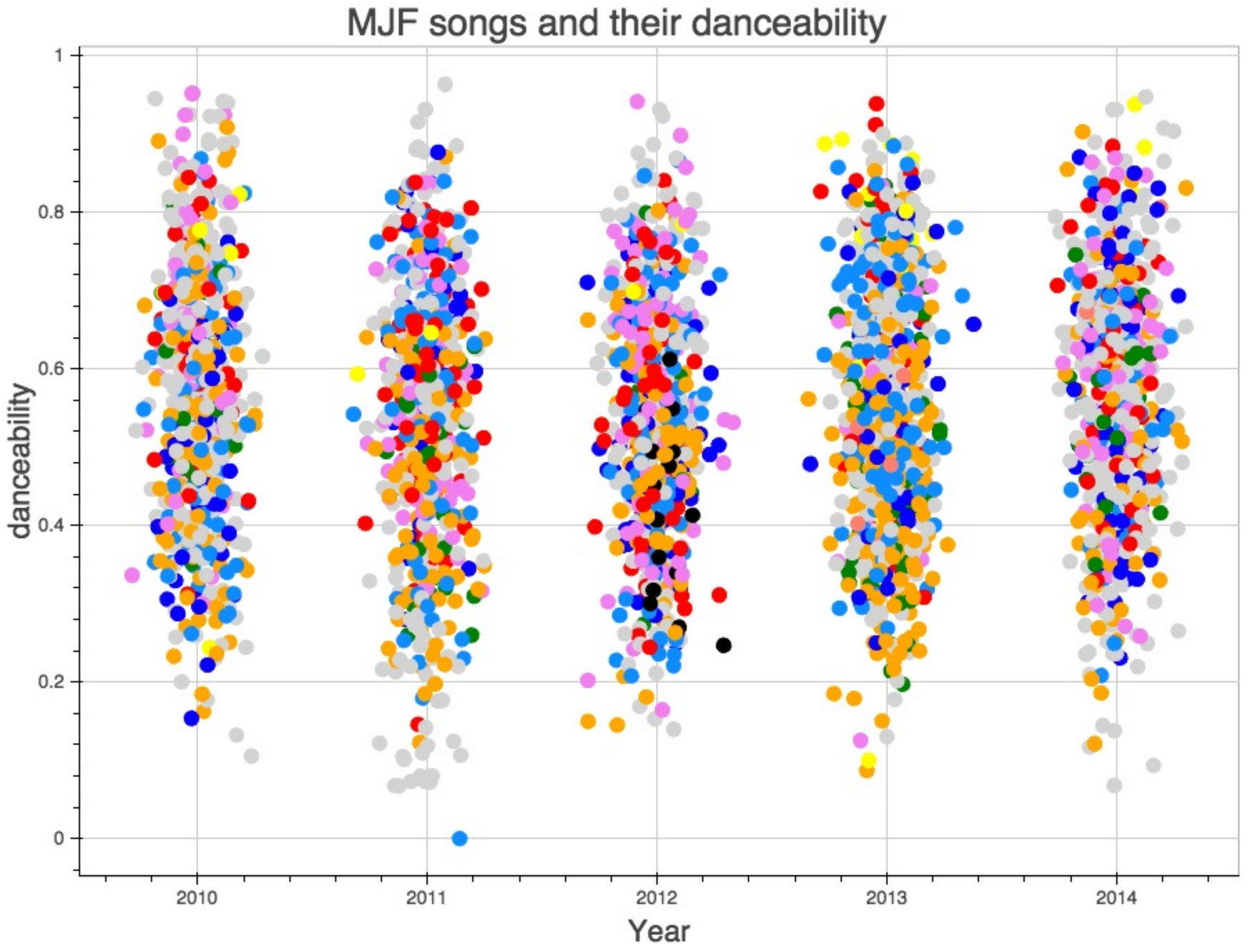
Strongest channel

Works for all data types

Selectivity	yes
Associativity	yes
Quantitativity	yes
Ordering	yes
Drawability count	huge

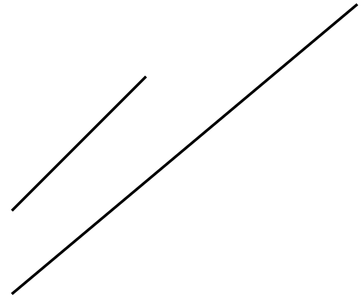
Issues

Cluttering
Not always available (spatial dataset)


MJF songs and their danceability
danceability
1
0.8
0.6
0.4
0.2
0
2010
2011
2012
2013
2014
Year

Length, area, volume

Easy to spot the longest line



OK to find the largest area

Issues

Hard to find the biggest volume

1D length

Selectivity	yes
Associativity	yes
Quantitativity	yes
Ordering	yes
Drawability count	high

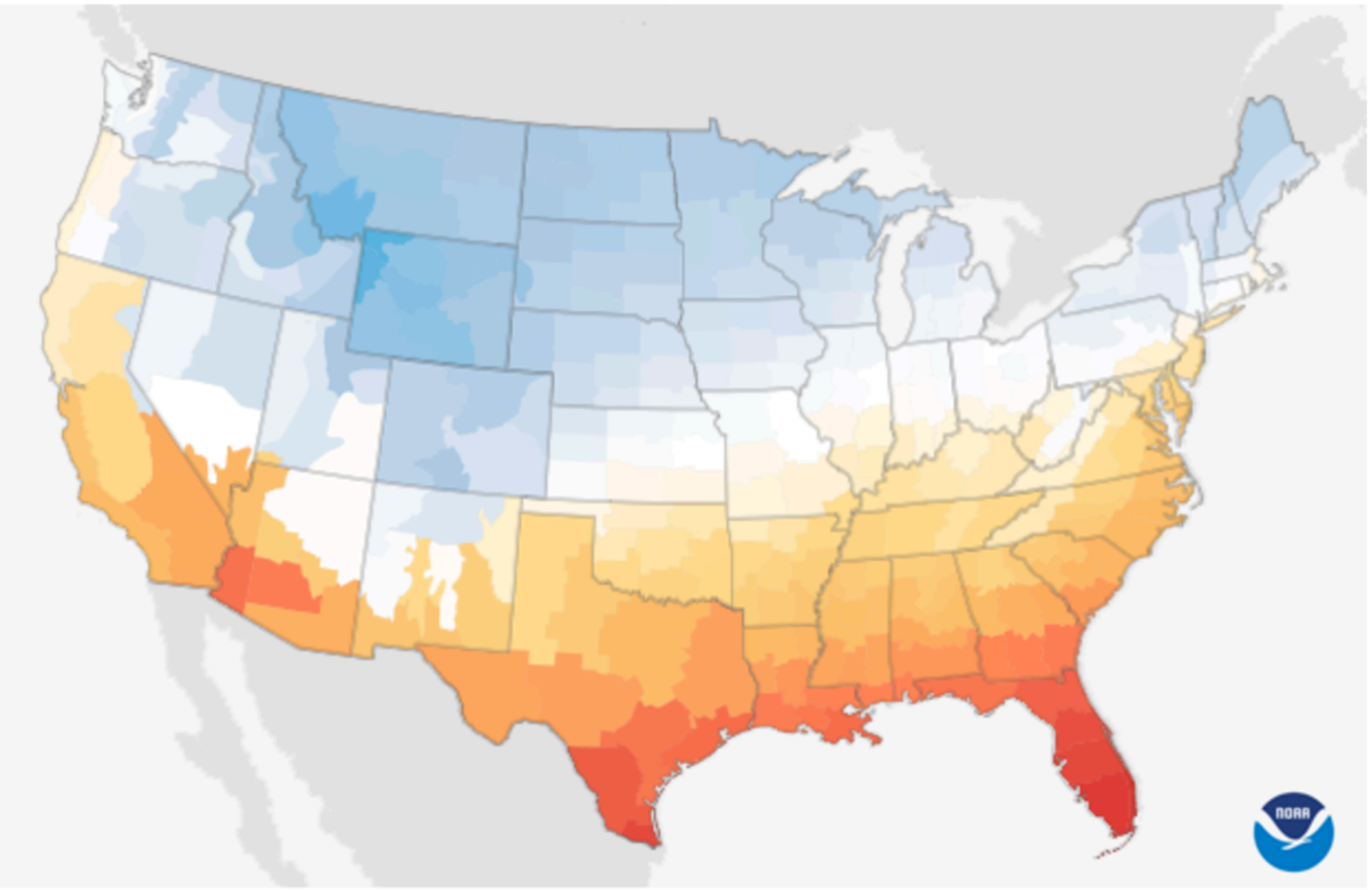
Luminance, saturation

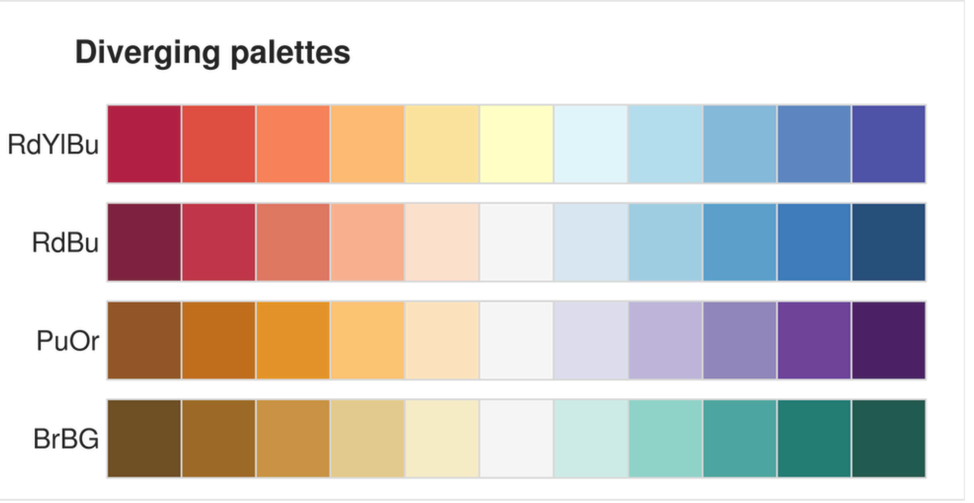
OK in addition of position, length and size

Issues

Many shades
are not easily distinguishable

Selectivity	yes
Associativity	yes
Quantitativity	OK-ish
Ordering	yes
Drawability count	low





me diverging palettes from Color Brewer

Hue

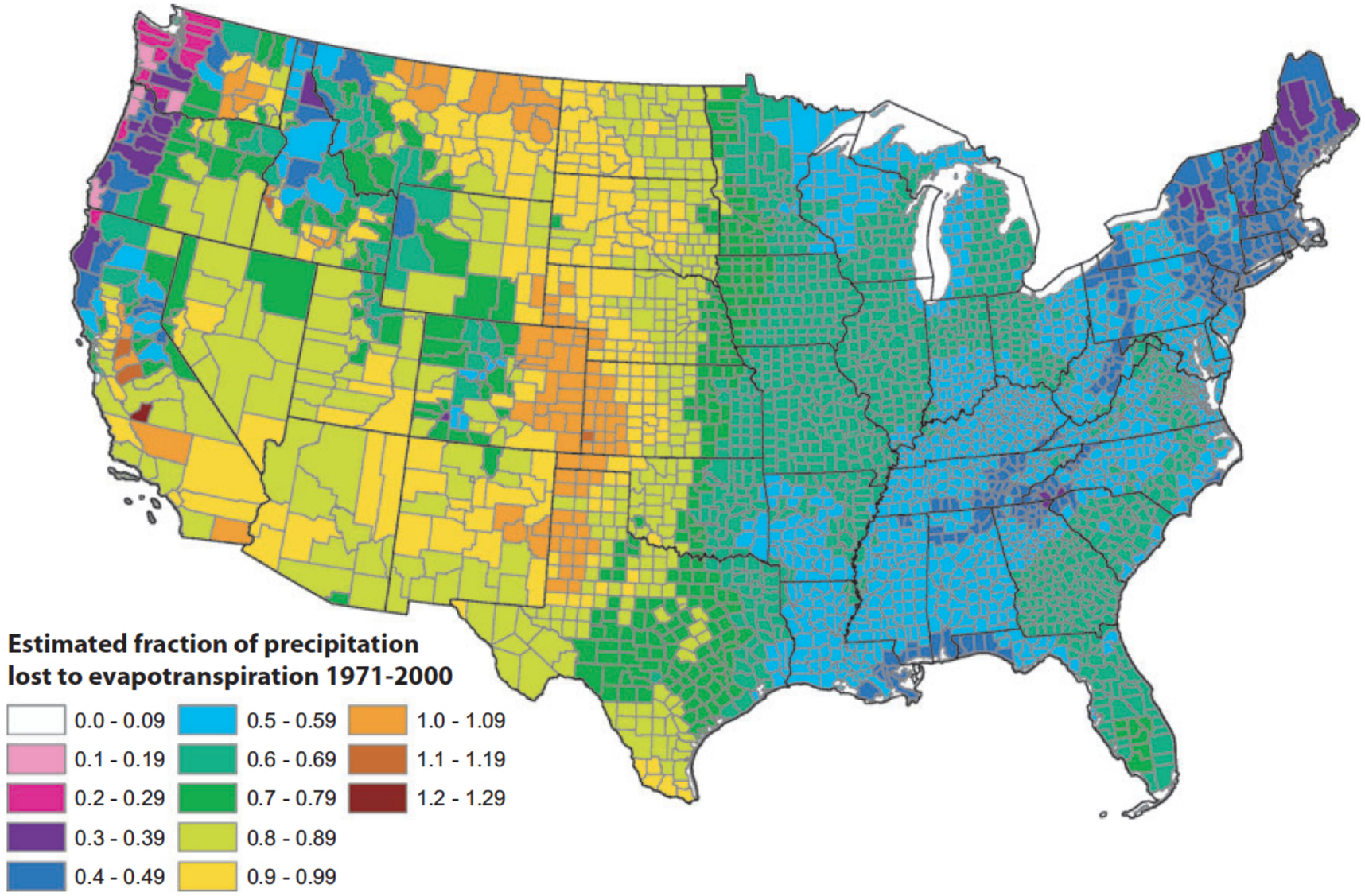
Good for of qualitative data (identity channel)

Issues

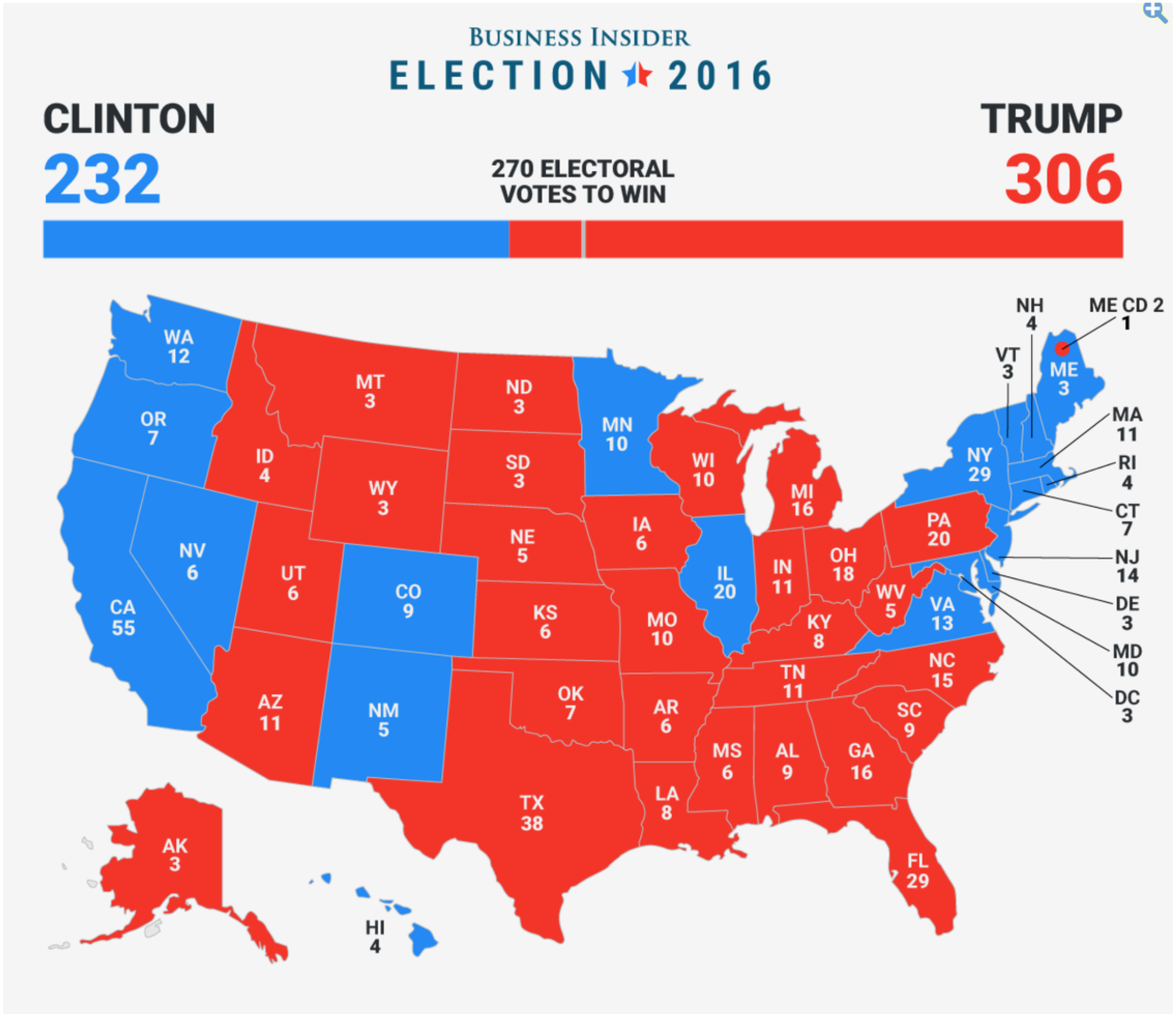
Limited number of classes (7-10)
Doesn’t work for quantitative data
Colormaps are hard to design

Selectivity	yes
Associativity	yes
Quantitativity	no
Ordering	no
Drawability count	low

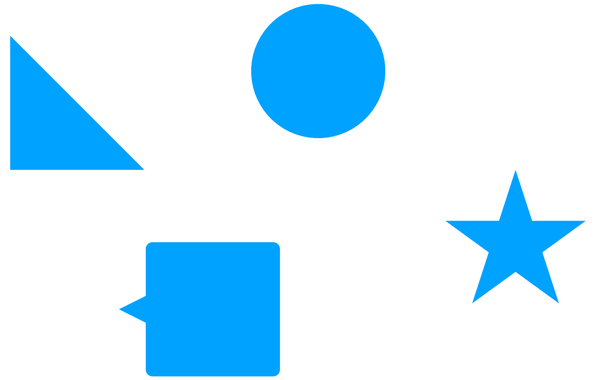
Bad example


Estimated fraction of precipitation
lost to evapotranspiration 1971-2000
0.0 - 0.09
0.1 - 0.19
0.2 - 0.29
0.3 - 0.39
0.4 - 0.49
0.5 - 0.59
0.6 - 0.69
0.7 - 0.79
0.8 - 0.89
0.9 - 0.99
1.0 - 1.09
1.1 - 1.19
1.2 - 1.29

Good example



Shape

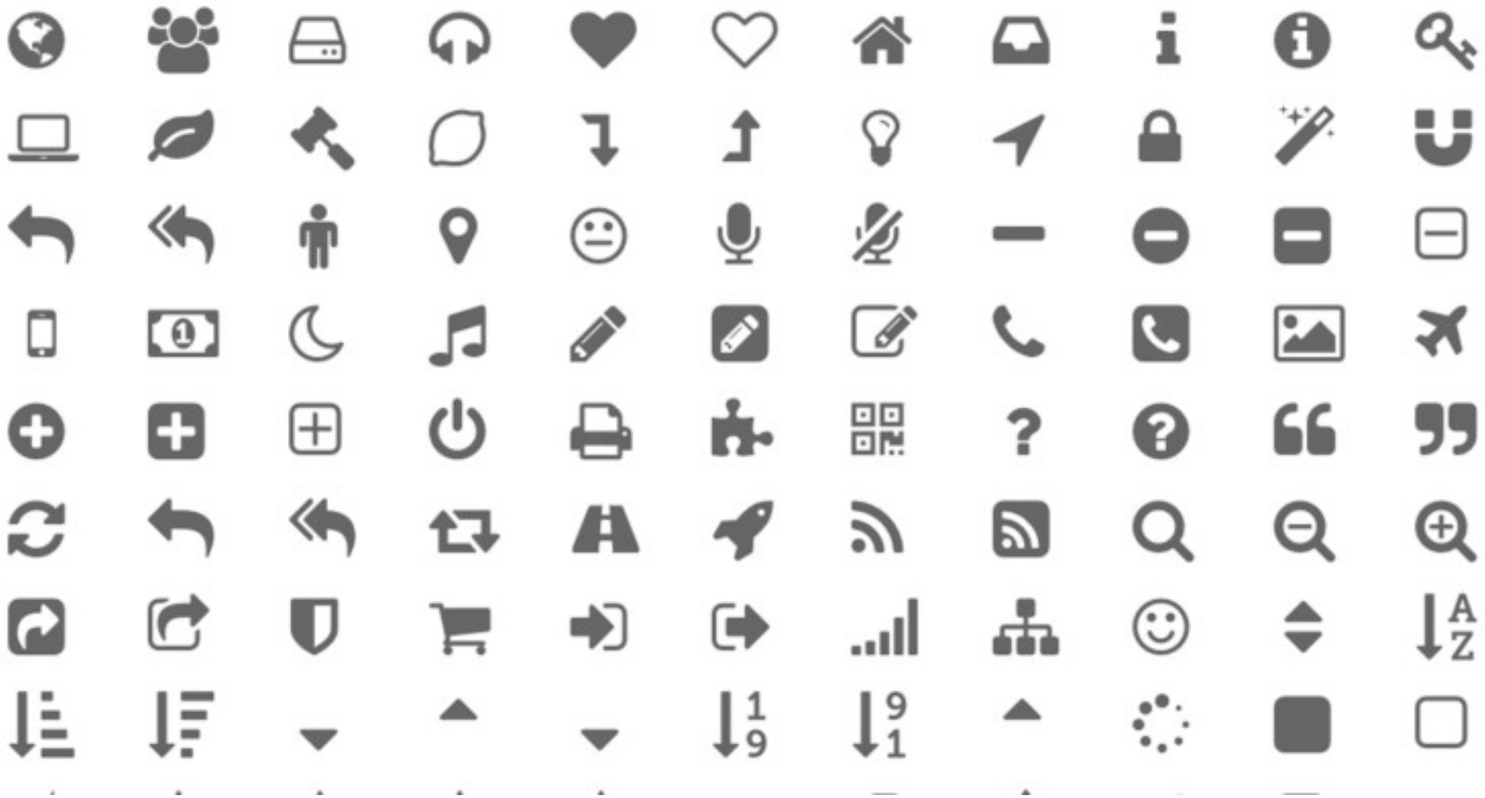


Excellent to recognize many classes

Selectivity	yes
Associativity	low
Quantitativity	no
Ordering	no
Drawability count	high

Issues

No grouping
No ordering



Channel effectiveness

Accuracy: How well can a user read the information in the channel?

Discriminability: How easily can we perceive differences between attribute levels?

Separability: Can we use one channel independently of another? Do they interfere?

Popout: How can a channel trigger a visual popout when processing data?

Grouping: How can a channel trigger some of the Gestalt principles?

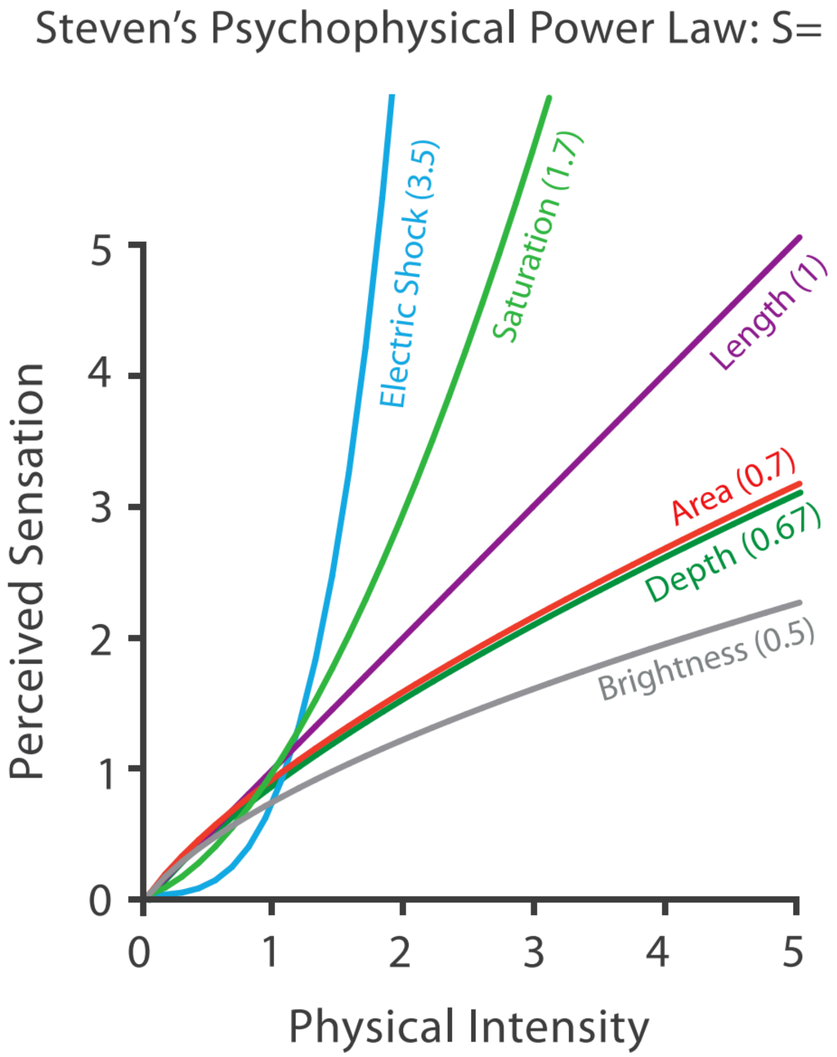
Channel accuracy

How close is our perception of a stimulus compared to some objective measurement of it?

Some answers from psychophysics: systematic measurement of general human perception

Psychophysical power law of Stevens

S



I

T. Munzner, Visualization Analysis and Design, 2014

Length perception test

x3

How much smaller?

Area perception test

How much larger?

x9

Area proportiomal to diameter squared!

Brightness perception test

How much darker?

x2

Brightness perception test

How much darker?

x3

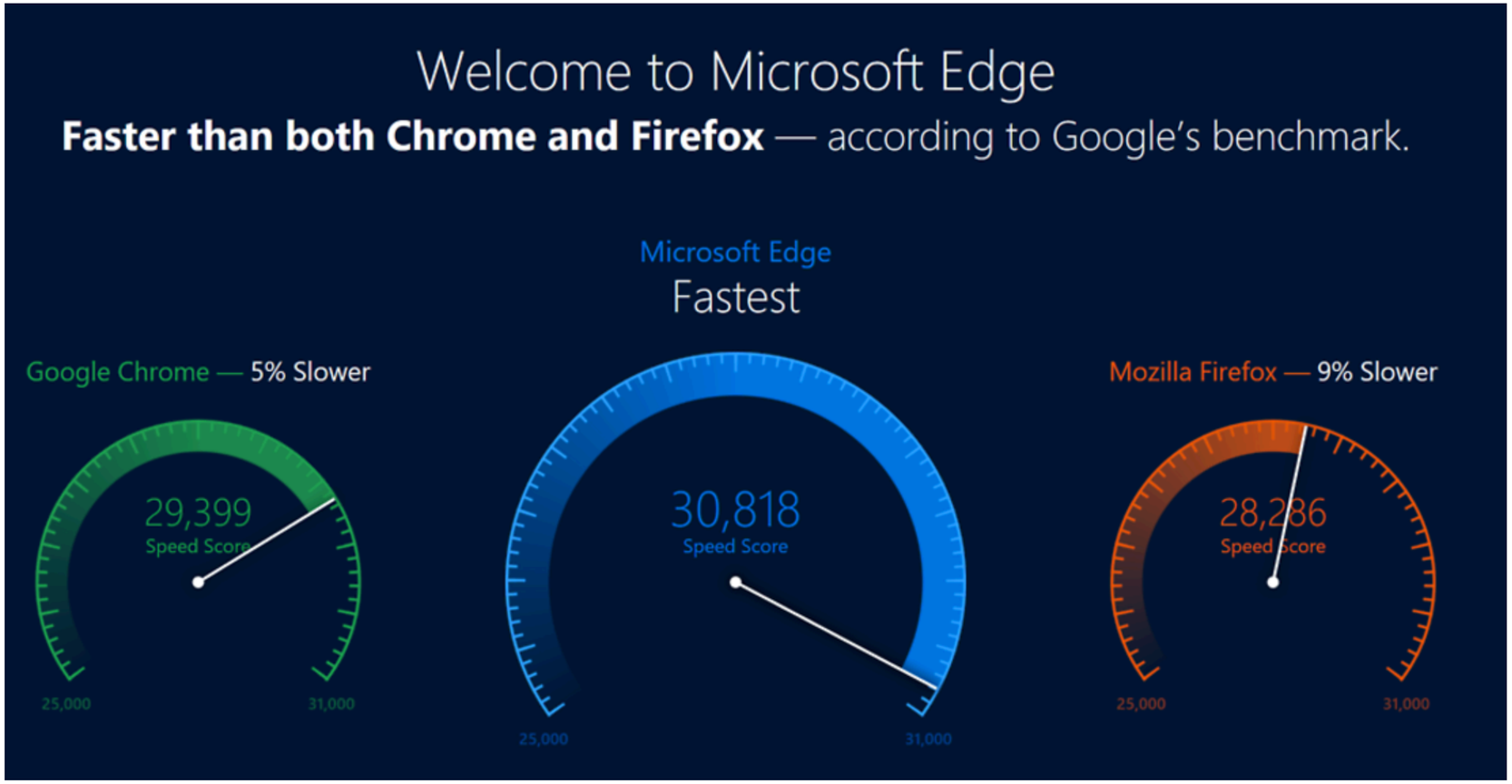
Other factors degrading accuracy

Alignment

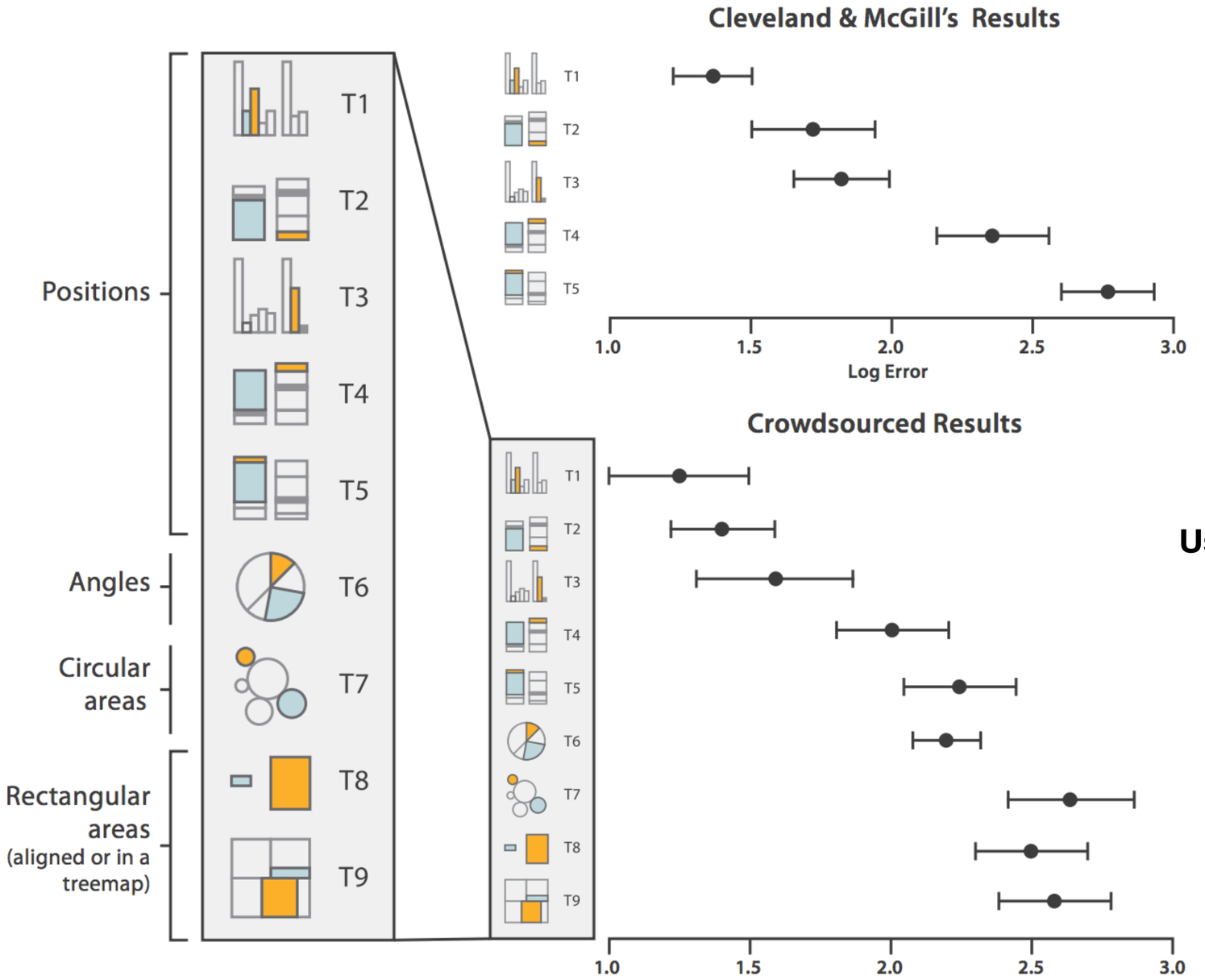
Distractors

Distance

Common scale



Error rates across visual channels



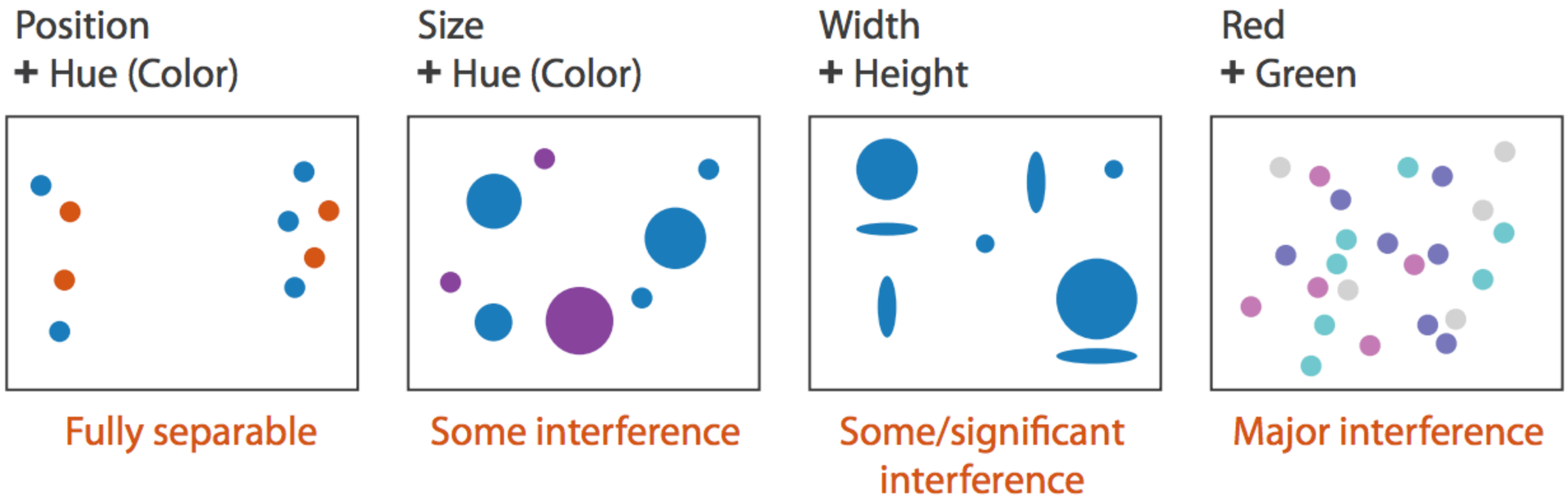
Crowdsourcing Graphical Perception:
Using Mechanical Turk to Assess Visualization Design
[Heer and Bostock 2010]

Log Error = log2(judged percent - true percent + 1/8)

Separability of attributes

Low-level preattentive processing features

Gestalt principles



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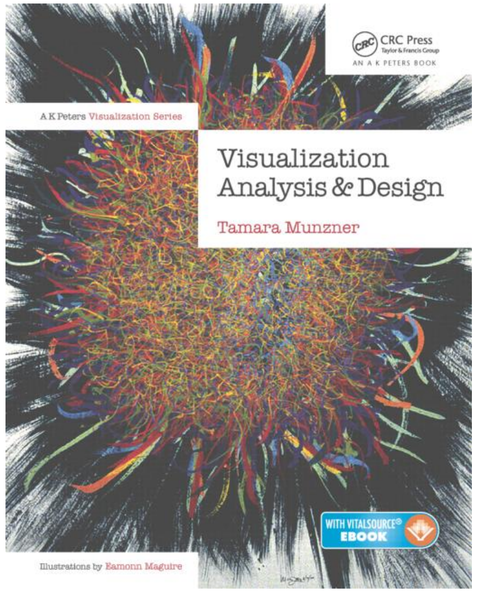
Homework

Read Visualization Analysis and Design
Chapter 5, 10



Watch: https://youtu.be/xAoljeRJ3lU