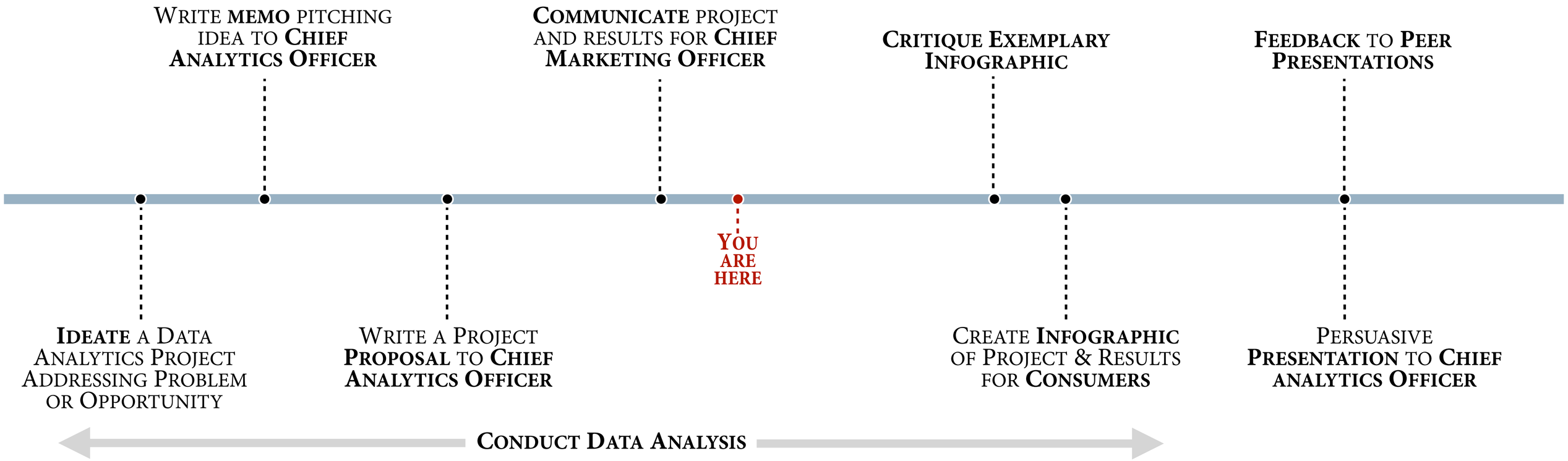
Storytelling With Data

# Effective visuals — encoding data graphically: grammar, layers, color

Scott Spencer | Columbia University

# Conceptual project timeline



# the grammar of graphics

**DATA :** a set of data operations that create variables from datasets

**TRANSFORMATIONS :** variable transformations (*e.g., rank*)

**SCALES :** scale transformations (*e.g., log*)

**COORDINATES :** a coordinate system (*e.g., cartesian, polar*)

**ELEMENTS :** graphs (*e.g., points, lines*) and their aesthetic attributes (*e.g., color, opacity, shape, size, orientation*)

**GUIDES :** one or more guides (*axes, legends, etc.*)

Wilkinson, Leland

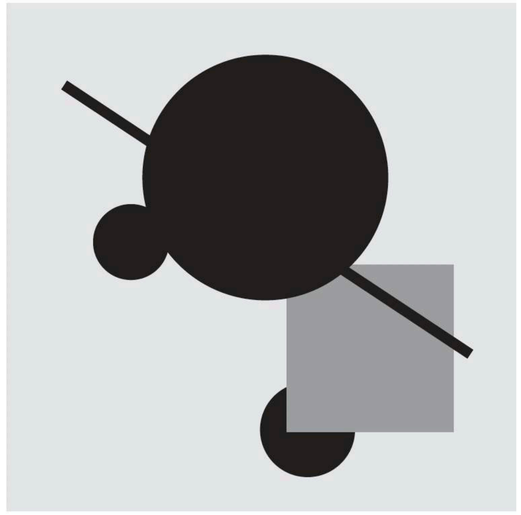
```
# load grammar of graphics
library(ggplot2)

p <-

  # functions for data ink

ggplot(data = <data>,
       mapping = aes(<aesthetic> = <variable>,
                     <aesthetic> = <variable>,
                     <...> = <...>) +
geom_<type>(<...>) +
scale_<mapping>_<type>(<...>) +
coord_<type>(<...>) +
facet_<type>(<...>) +
<...> +

  # functions for non-data ink

labs(<...>) +
theme(<...> = <...>) +
annotate(<...>) +
<...>
```

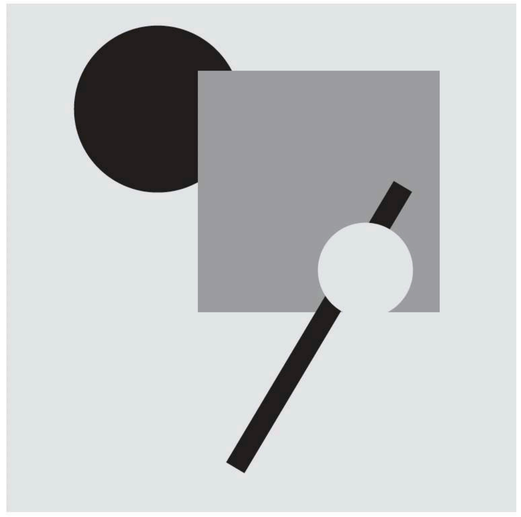
DATA
TRANSFORMATIONS
ELEMENTS
SCALES & GUIDES
COORDINATES
GUIDES

```
element_blank()
element_line(<...> = <...>)
element_rect(<...> = <...>)
element_text(<...> = <...>)
```

Wickham, Hadley

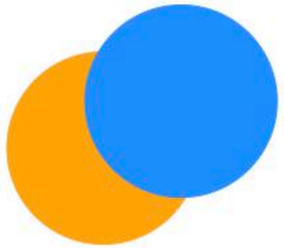
# thinking about graphics as layers



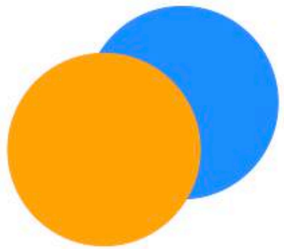


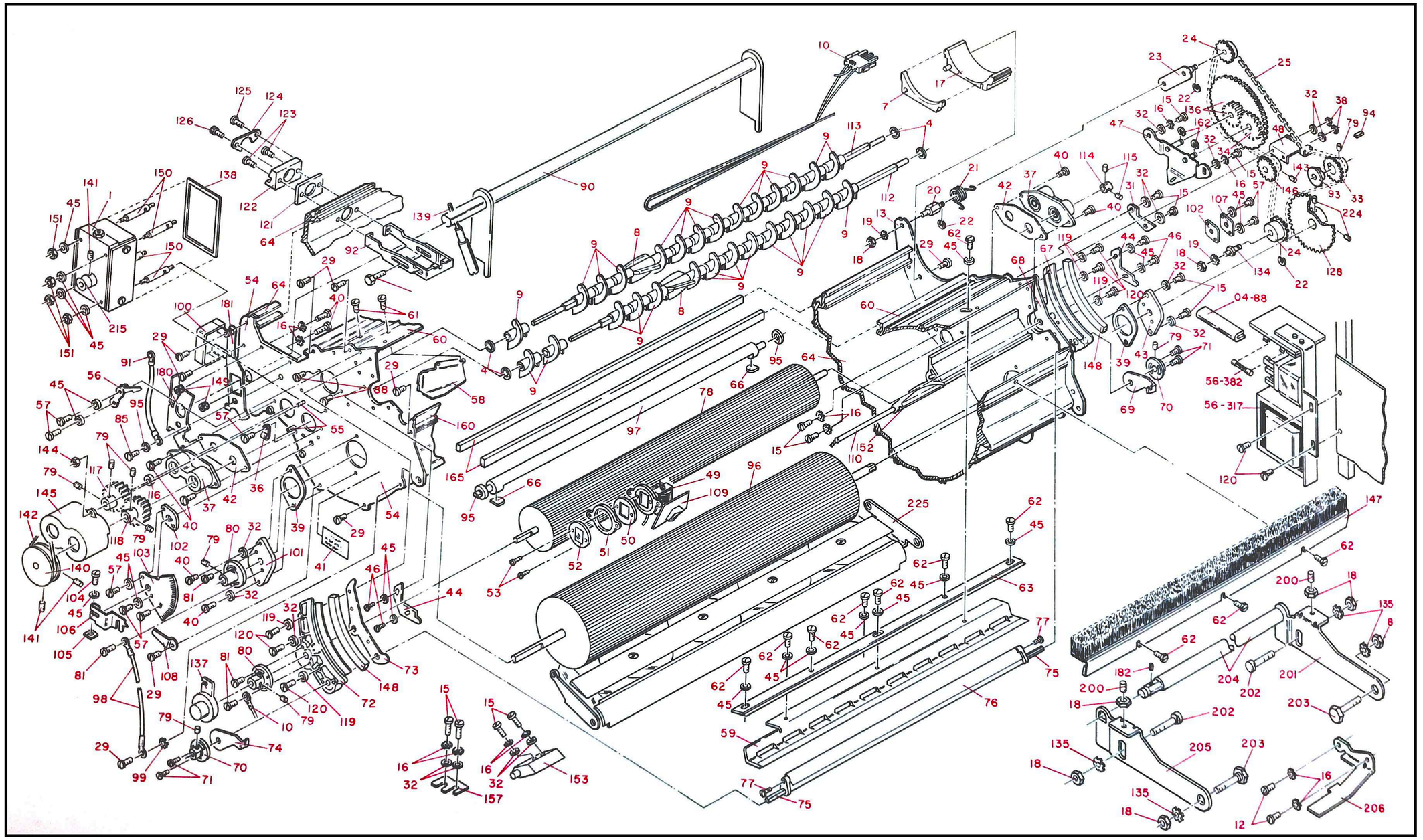
Samara, Timothy

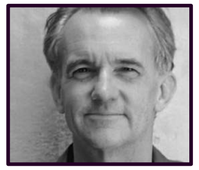
```
ggplot() +
  theme_void() +
  scale_x_continuous(limits = c(-5, 5)) +
  scale_y_continuous(limits = c(-5, 5)) +
  geom_point(aes(x = 0, y = 0),
             size = 50, color = "orange") +
  geom_point(aes(x = 1, y = 1),
             size = 50, color = "dodgerblue")
```



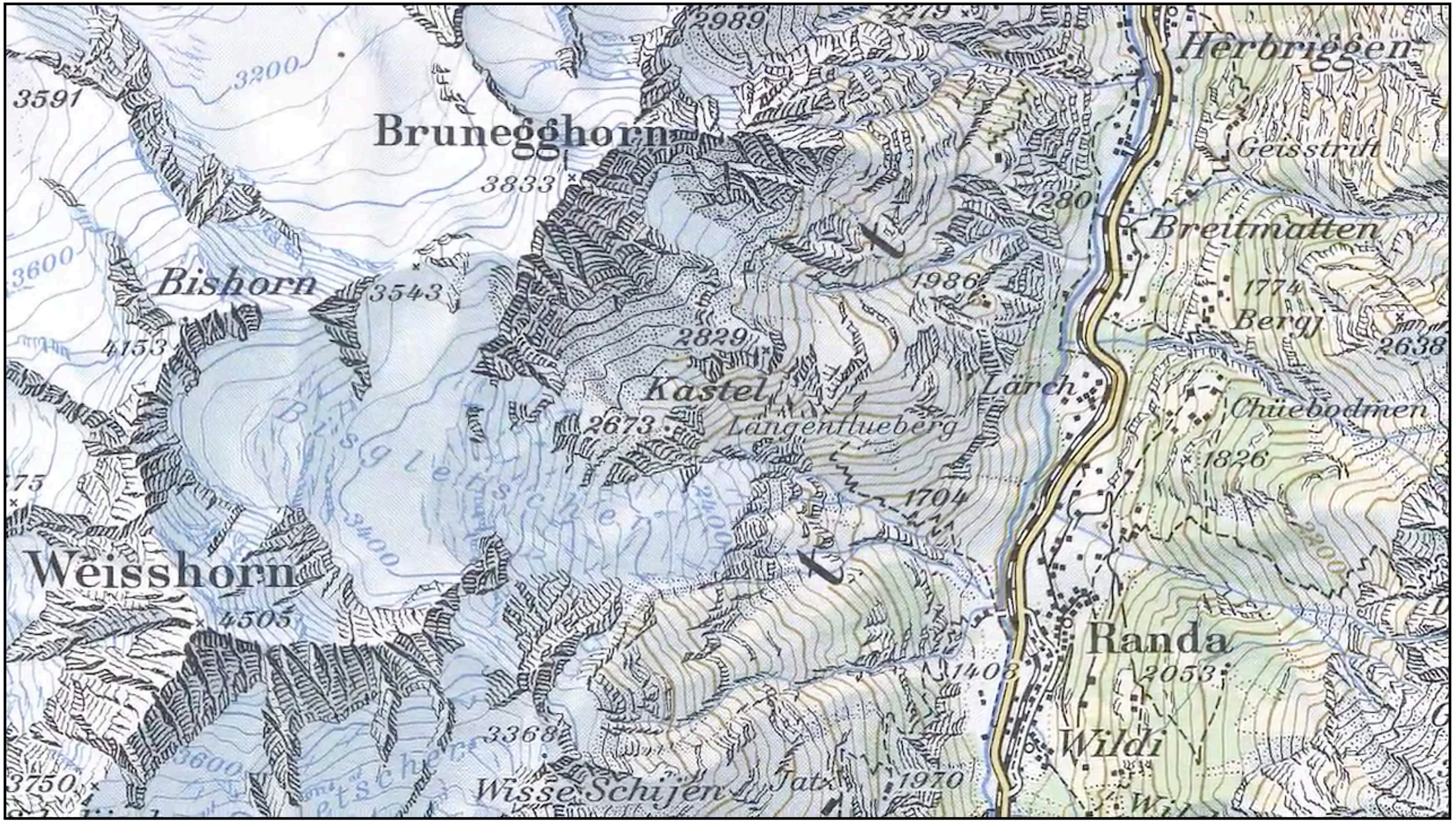
```
ggplot() +
  theme_void() +
  scale_x_continuous(limits = c(-5, 5)) +
  scale_y_continuous(limits = c(-5, 5)) +
  geom_point(aes(x = 1, y = 1),
             size = 50, color = "dodgerblue") +
  geom_point(aes(x = 0, y = 0),
             size = 50, color = "orange")
```

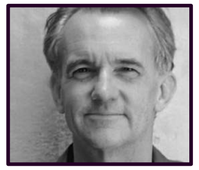






Tufte, Edward



Tufte, Edward

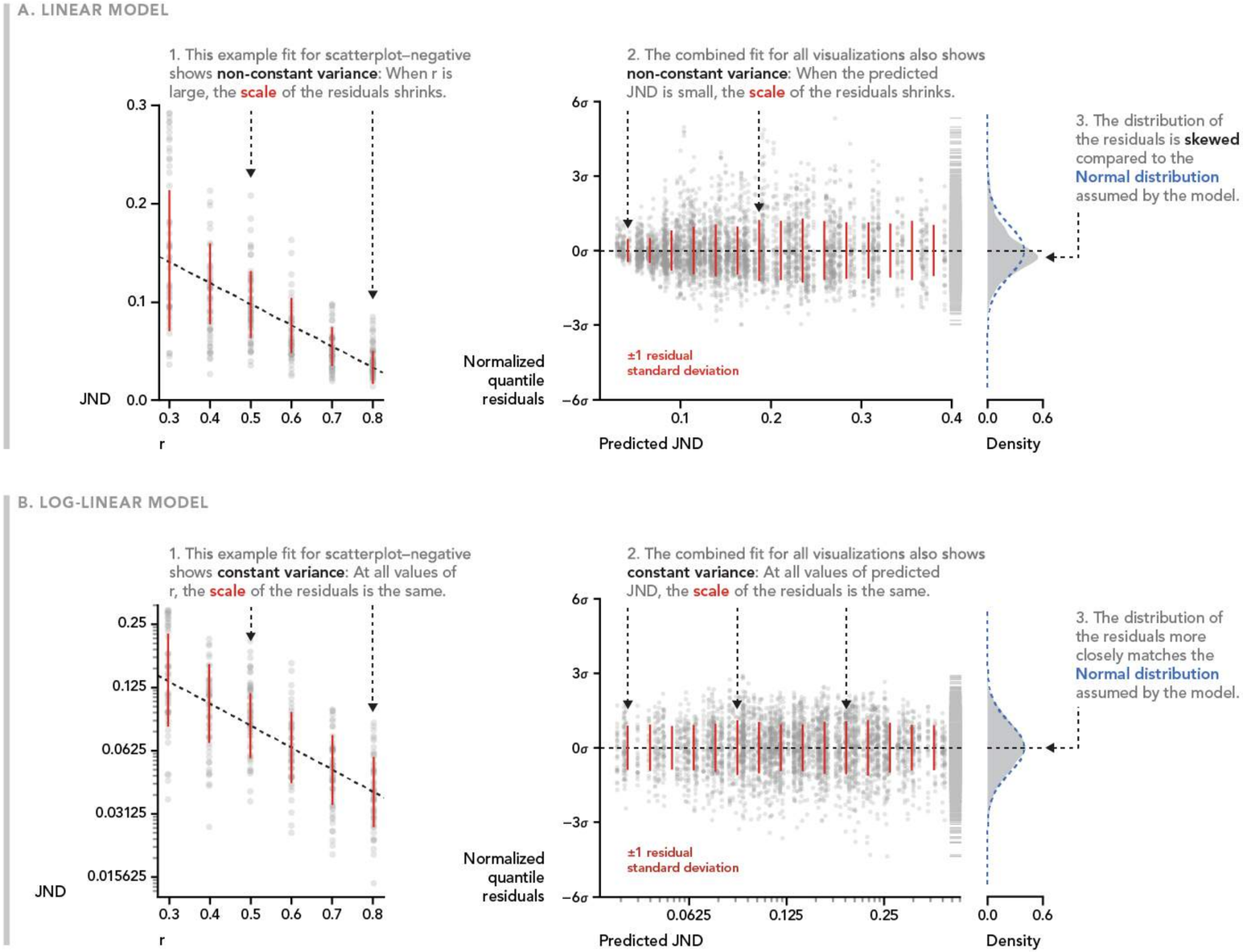
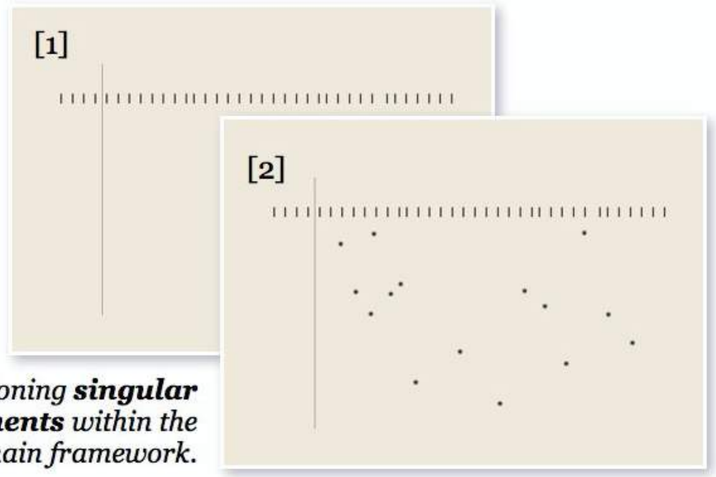



Fig. 3 Comparison of fits of the linear model (Section 3) and the log-linear model (Section 4). Example fits of each model to scatterplot–negative are shown in A.1 and B.1. Plots of normalized residuals for all visualization × direction pairs are shown in A.2 and B.2. Density plots of normalized residuals with comparison to the standard normal distribution are shown in A.3 and B.3.

Kay, Matthew

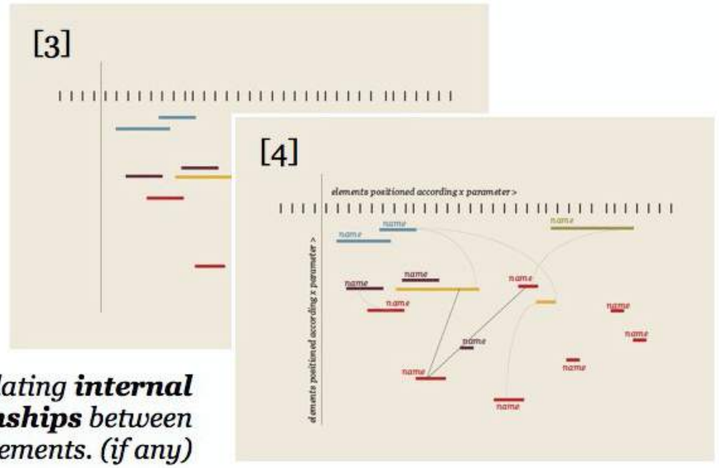
Lupi, Giorgia

*Composing the main **architecture** of the visualization*

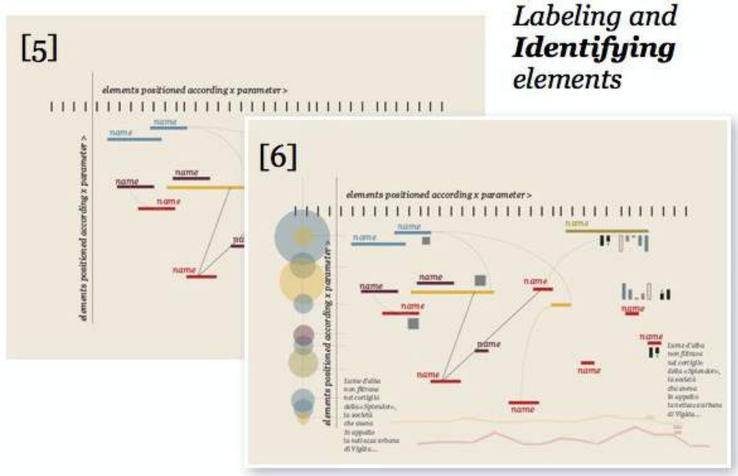



*Positioning **singular elements** within the main framework.*

*Constructing shaped elements of **dimensionality and form***

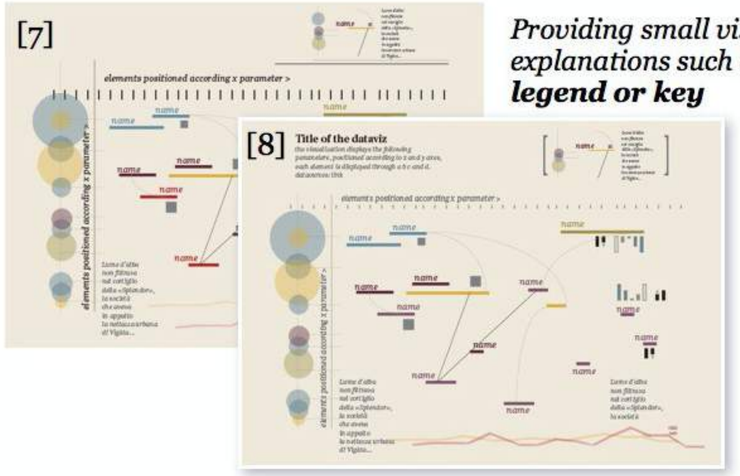



*Elucidating **internal relationships** between elements. (if any)*




*Labeling and **Identifying** elements*

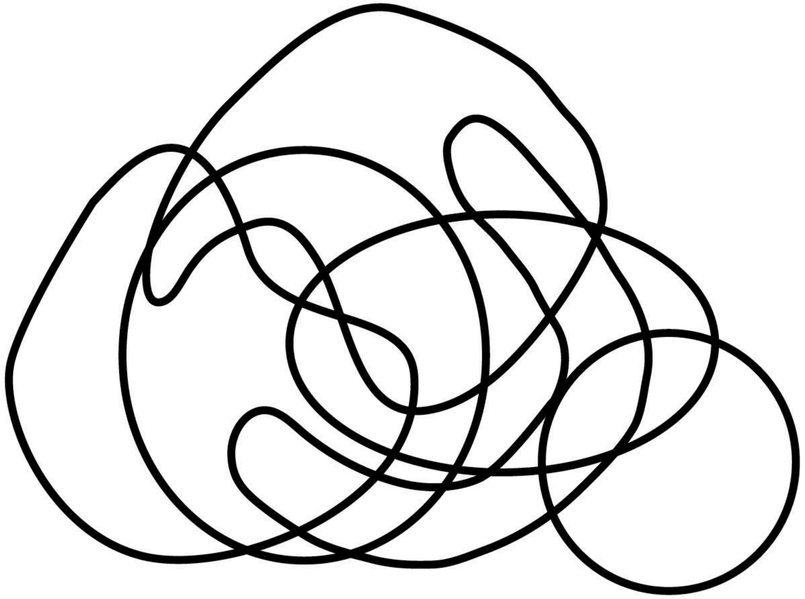
*Supplementing the greater story through the addition of "**minor or tangental tales**" elements*

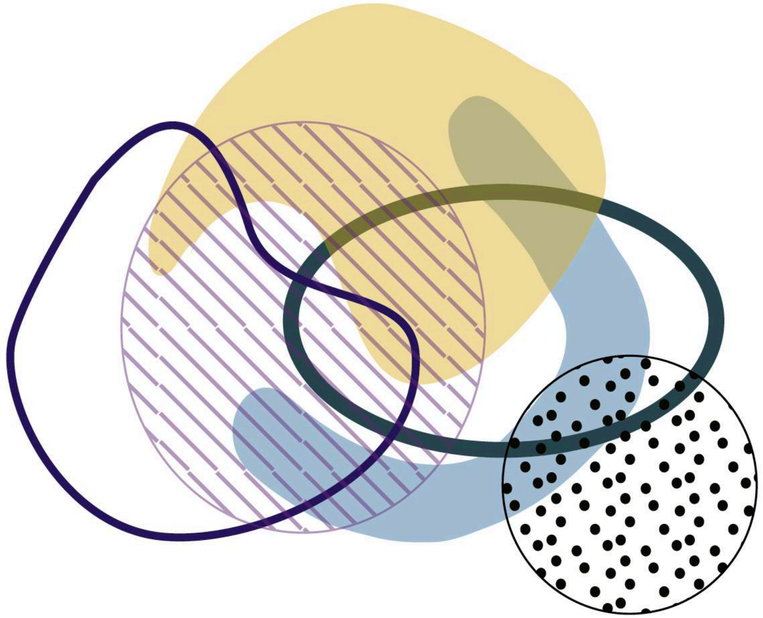


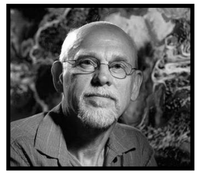

*Providing small visual explanations such as a **legend or key***

***Fine-tuning** and stylizing of elements shapes, colors, and weights to make hierarchies pop out.*

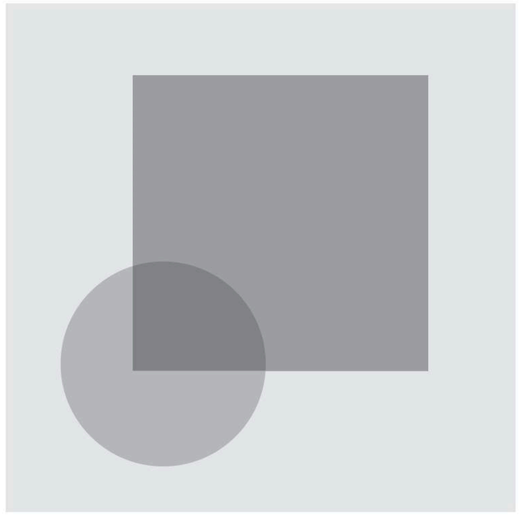
 ***in this Euler diagram, color and texture help to distinguish layers of information***





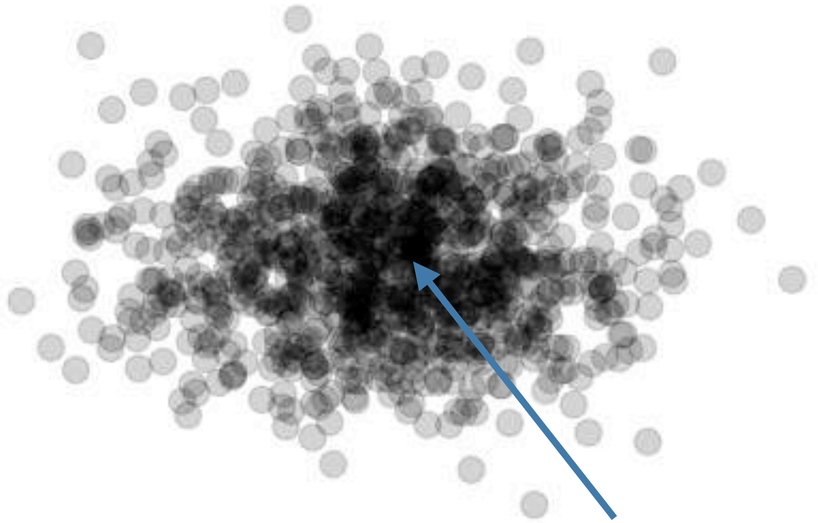


Ware, Colin



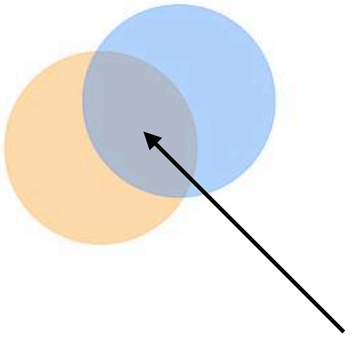
Samara, Timothy

```
x <- rnorm(1000)
y <- rnorm(1000)

ggplot() +
  theme_void() +
  scale_x_continuous(limits = c(-5, 5)) +
  scale_y_continuous(limits = c(-5, 5)) +
  geom_point(aes(x = x, y = y),
             size = 4, color = "black",
             alpha = 0.2)
```



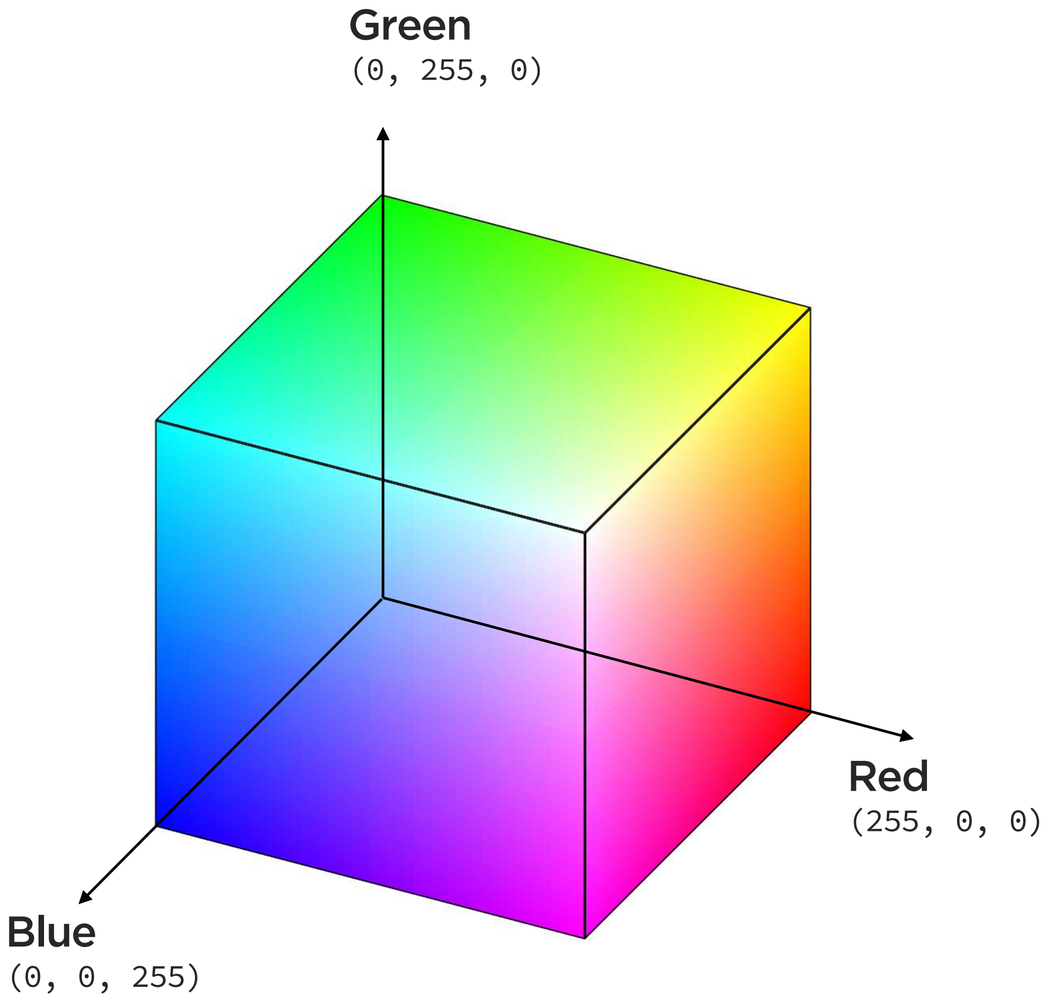
dense areas of data are darker

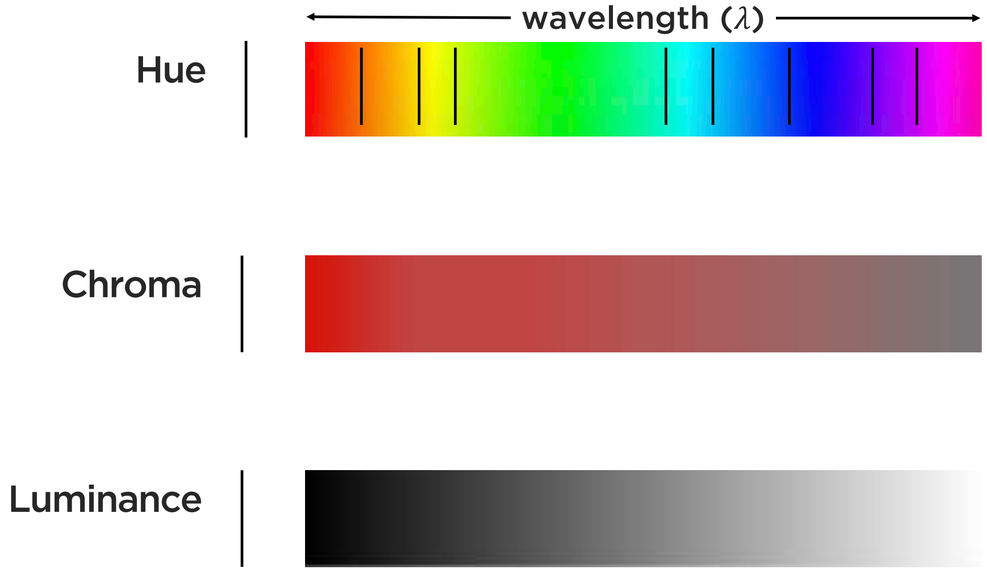
```
ggplot() +
  theme_void() +
  scale_x_continuous(limits = c(-5, 5)) +
  scale_y_continuous(limits = c(-5, 5)) +
  geom_point(aes(x = 0, y = 0),
             size = 50, color = "orange",
             alpha = 0.4) +
  geom_point(aes(x = 1, y = 1),
             size = 50, color = "dodgerblue",
             alpha = 0.4)
```



**I didn't encode data with *this* color!?**

# encoding data as color

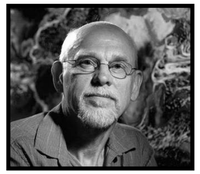

Green
(0, 255, 0)
Red
(255, 0, 0)
Blue
(0, 0, 255)


wavelength (λ)
Hue
Chroma
Luminance

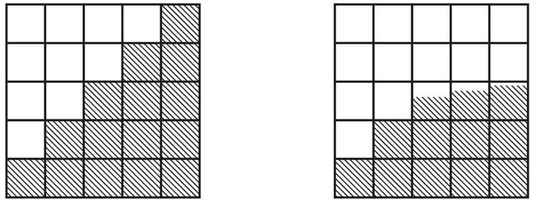

$f(x)$
75
50
25
66
50
51
94
29
12
33
56
40
66
12
64
52
17
32
35
84
60
32
64

**LUMINANCE :** the *measured* amount of light coming from some region of space.

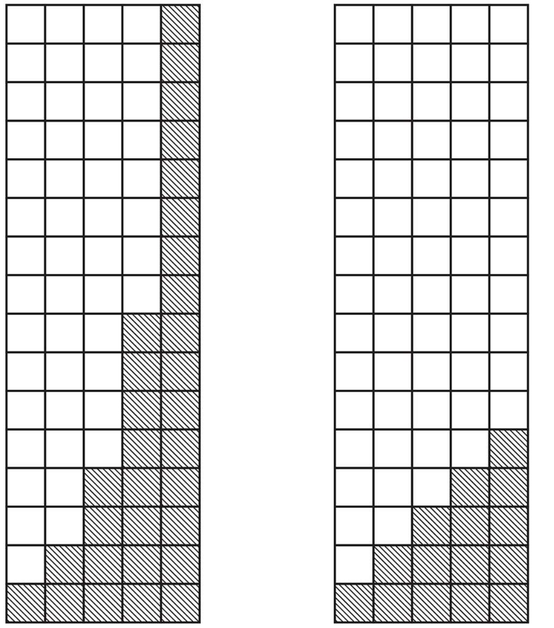
**BRIGHTNESS :** the *perceived* amount of light coming from that region of space.



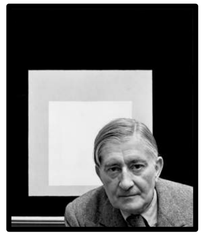
Ware, Colin



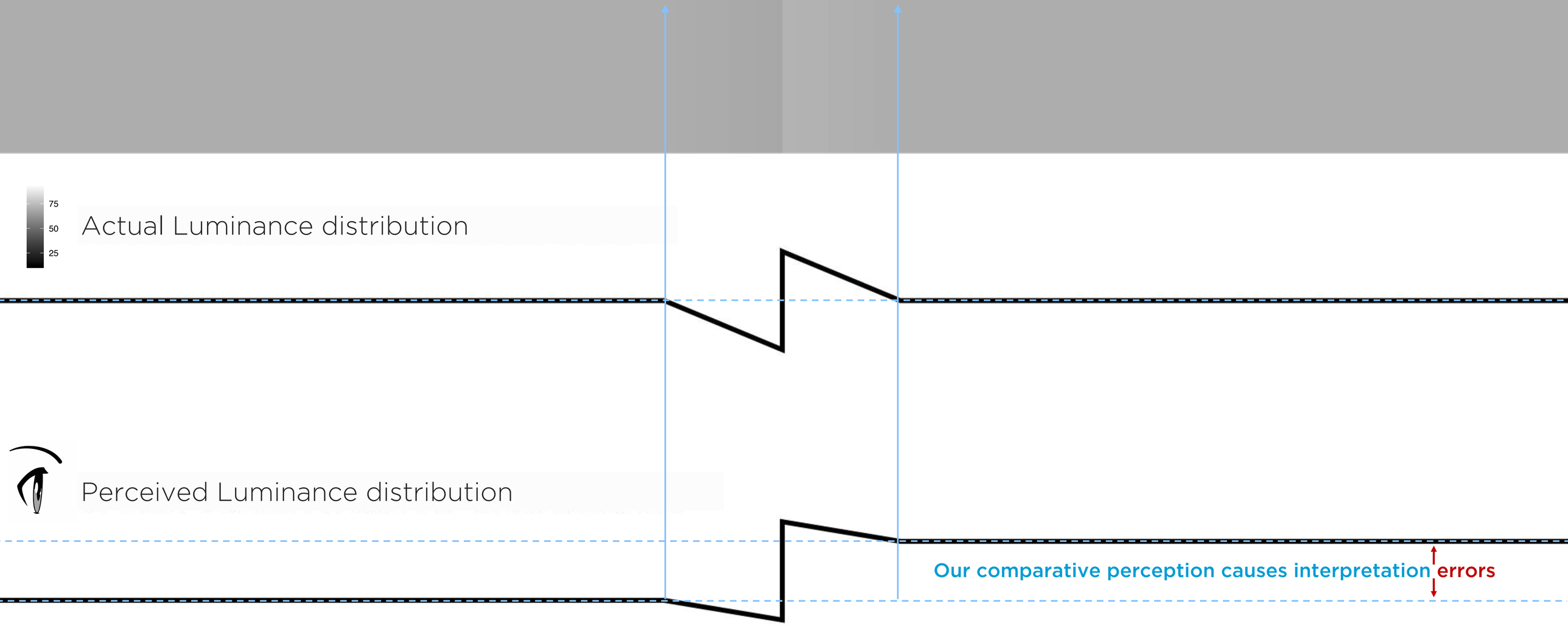
THIS PHYSICAL FACT REDUCES TO THIS PSYCHOLOGICAL EFFECT

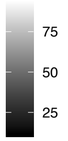


THIS PHYSICAL FACT PRODUCES THIS PSYCHOLOGICAL EFFECT



Albers, Josef


75
50
25
Actual Luminance distribution
Perceived Luminance distribution
Our comparative perception causes interpretation errors



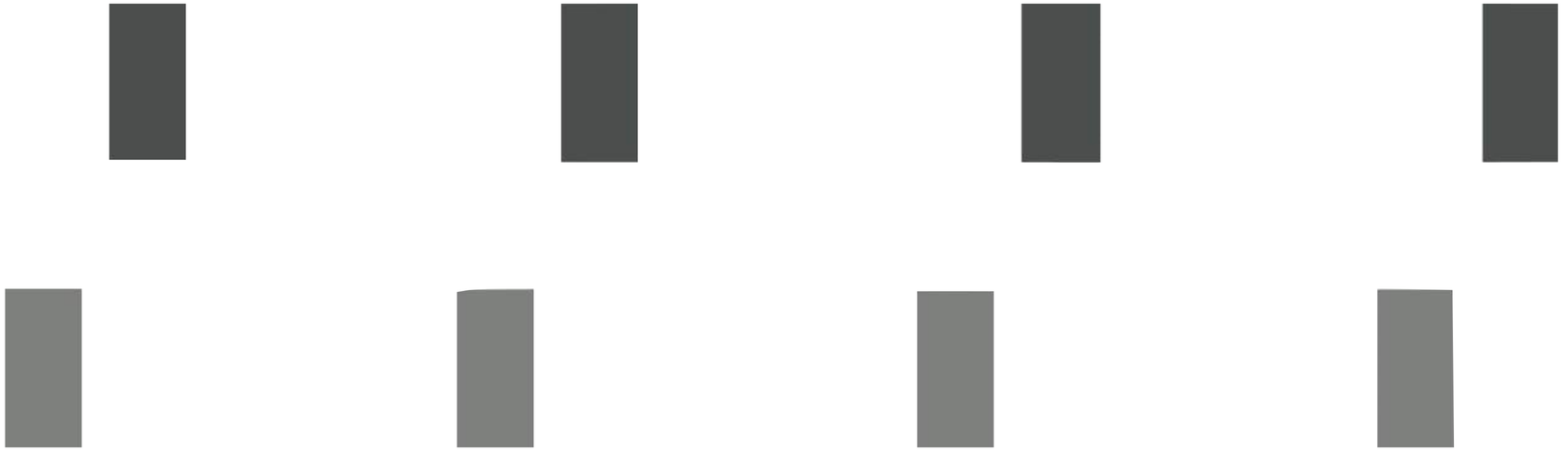

Actual Luminance distribution

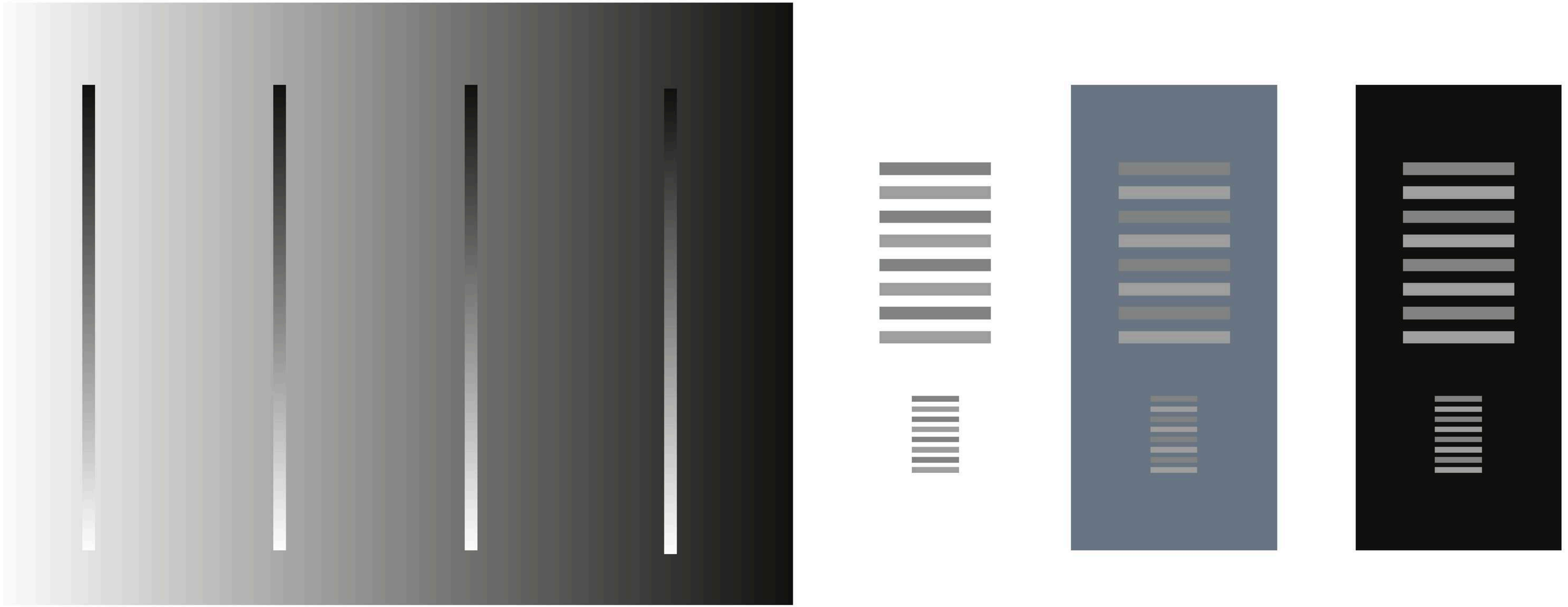
Perceived Luminance distribution

Our comparative perception causes interpretation errors

 ***background and adjacent luminance can interfere with our perception***

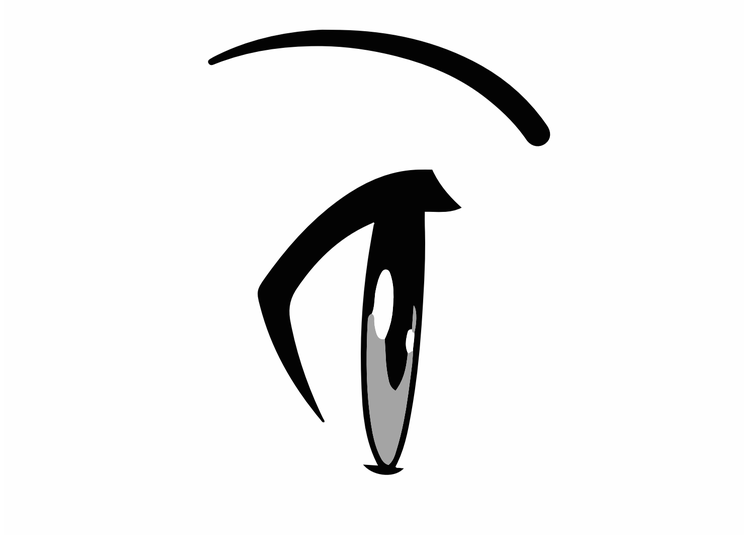
Ware, Colin

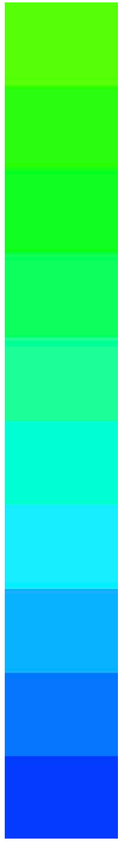




Ware, Colin

 ***as with luminance, hue values in the RGB color space fail to uniformly scale across values.***





**Same luminance or lightness?**

HSL(250, 100%, 50%)
HSL(250, 100%, 50%)

HSL(60, 100%, 50%)
HSL(60, 100%, 50%)

Boronine, Alexei

**Same saturation?**

HSL(0, 90%, 40%)
HSL(0, 90%, 40%)

HSL(0, 90%, 80%)
HSL(0, 90%, 80%)

Boronine, Alexei

## Equal difference between hues?

HSL(30, 100%, 50%)
HSL(30, 100%, 50%)

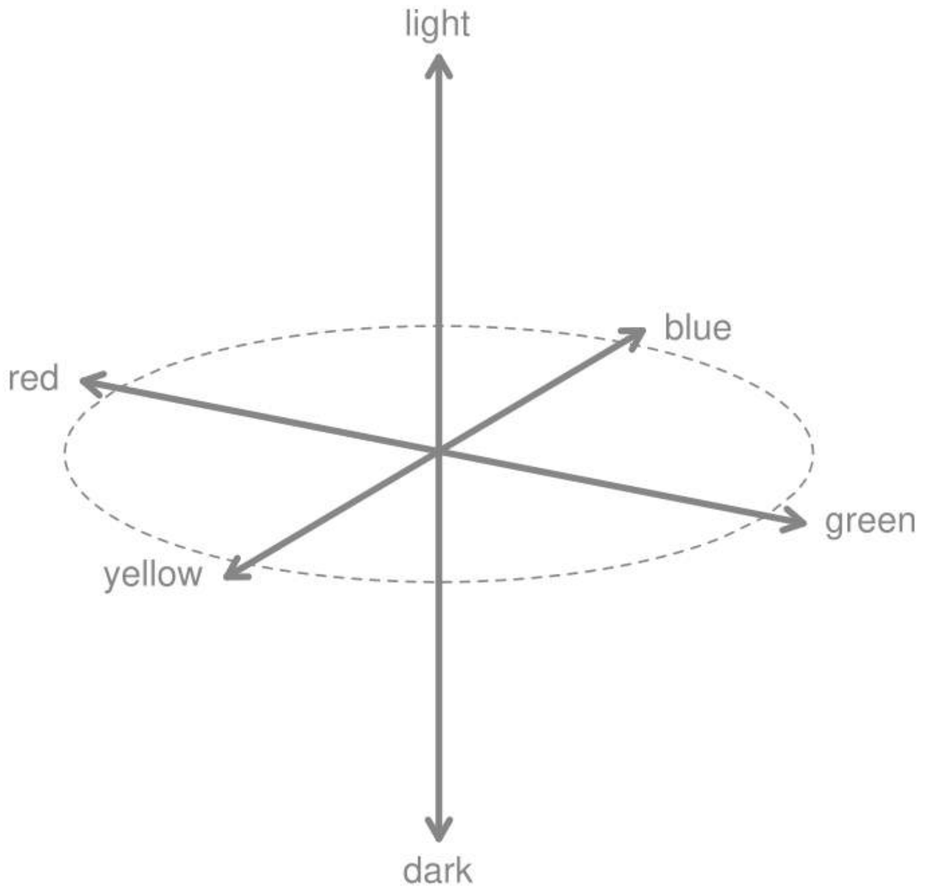
HSL(50, 100%, 50%)
HSL(50, 100%, 50%)

HSL(230, 100%, 50%)
HSL(230, 100%, 50%)

HSL(250, 100%, 50%)
HSL(250, 100%, 50%)

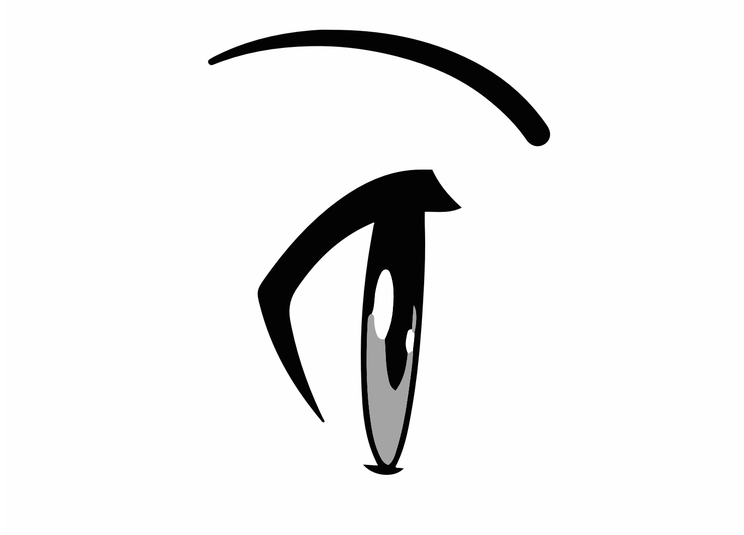
---

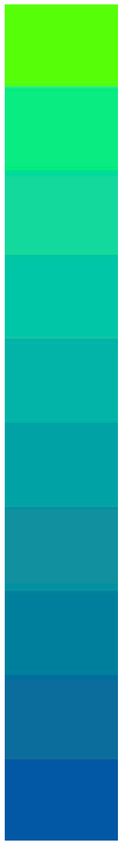
Boronine, Alexei




The International Commission on Illumination (CIE) studied human perception and re-mapped color into a space where we perceive color changes uniformly.

Their **CIELuv** color model has two dimensions — u and v — that represent color scales from red to green and yellow to blue.





Load functions for mapping data to perceptually-uniform color
https://github.com/ssp3nc3r/hsluv-rcpp

```
library(HSLuv)
```

Create sample data encoded as hue, saturation, luminance

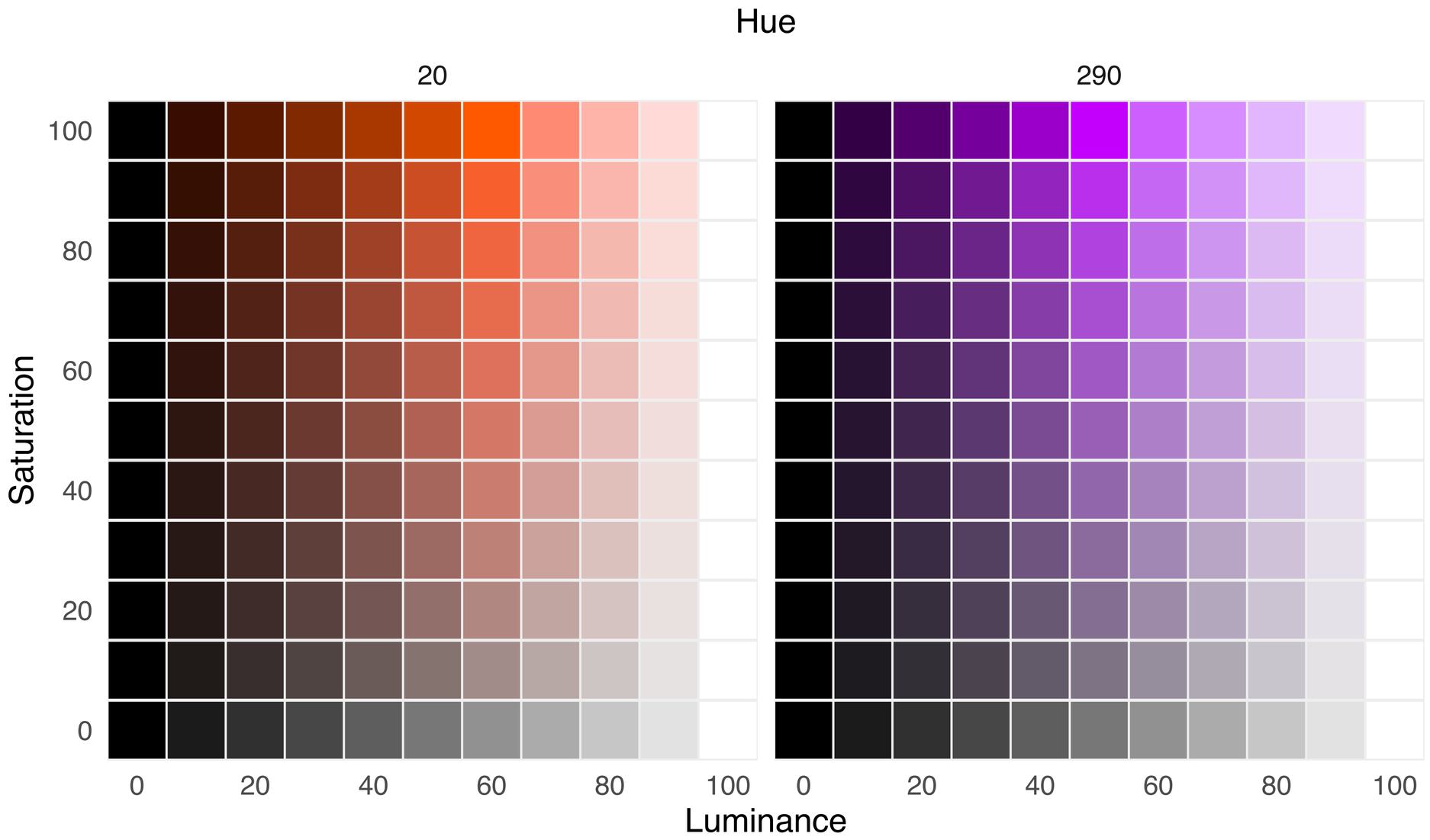
```
df <- expand.grid(H = c(20, 290),
                  S = seq(0, 100, by = 10),
                  L = seq(0, 100, by = 10))
```

Convert HSLuv scaled values to RGB
color space as hex code #RRGGBB

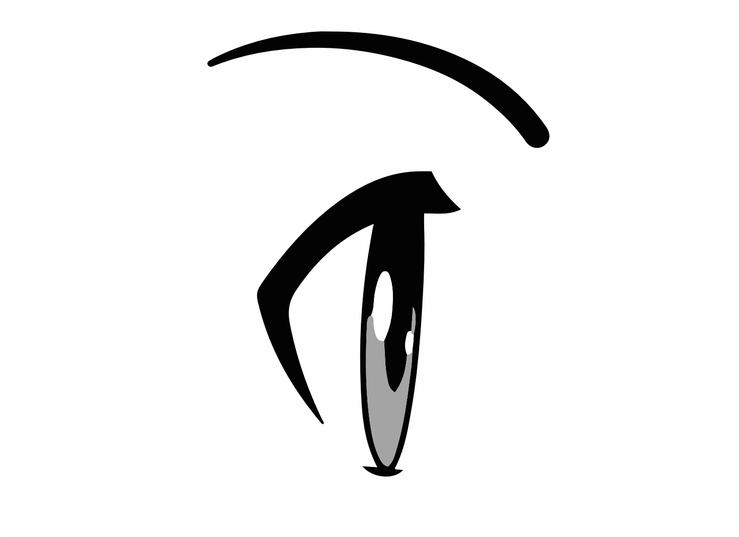
```
df$colors <- with(df, hsluv_hex(H, S, L) )
```

Plot data encoded as colors

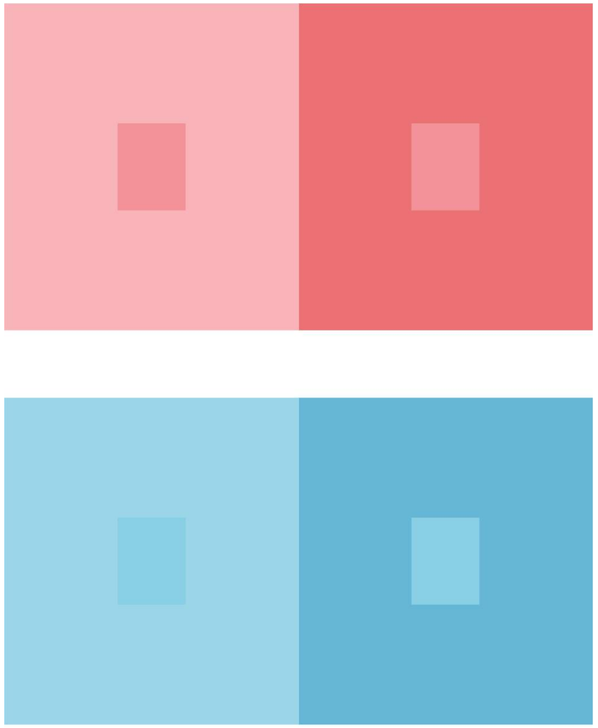
```
library(ggplot2)

ggplot(df) +

  theme_minimal() +

  theme(panel.grid = element_blank(),
        axis.text.x.top = element_blank()) +

  geom_point(aes(L, S),
             color = '#eeeeee',
             fill = df$colors,
             size = 10,
             shape = 22) +

  scale_x_continuous(breaks = seq(0, 100, by = 20),
                     sec.axis = sec_axis(~., name = 'Hue')) +

  scale_y_continuous(breaks = seq(0, 100, by = 20)) +

  facet_wrap(~H) +

  labs(x = 'Luminance',
       y = 'Saturation')
```

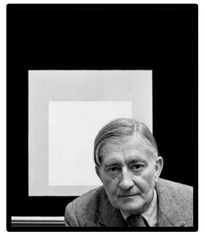

Hue
20
290
Saturation
100
80
60
40
20
0
0
20
40
60
80
100
Luminance

 ***perceptually uniform color spaces also help in distinguishing categorical data.***

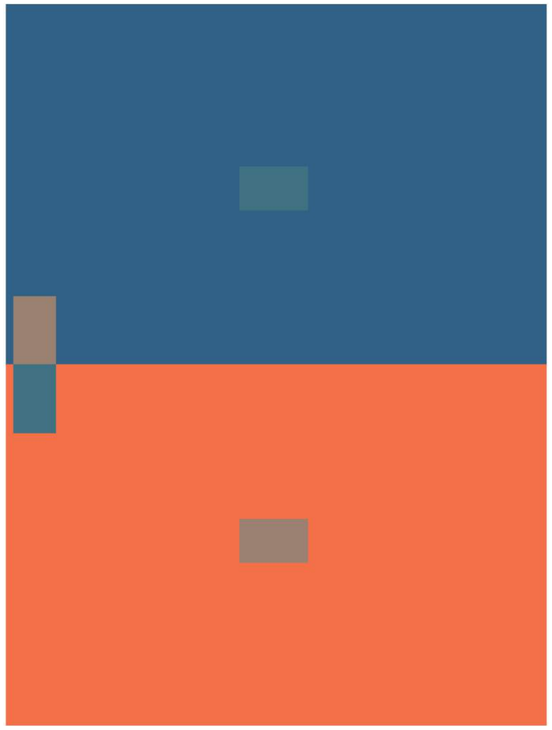


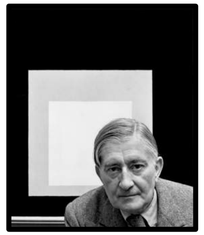
# interaction of color



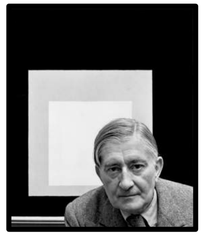


Albers, Josef



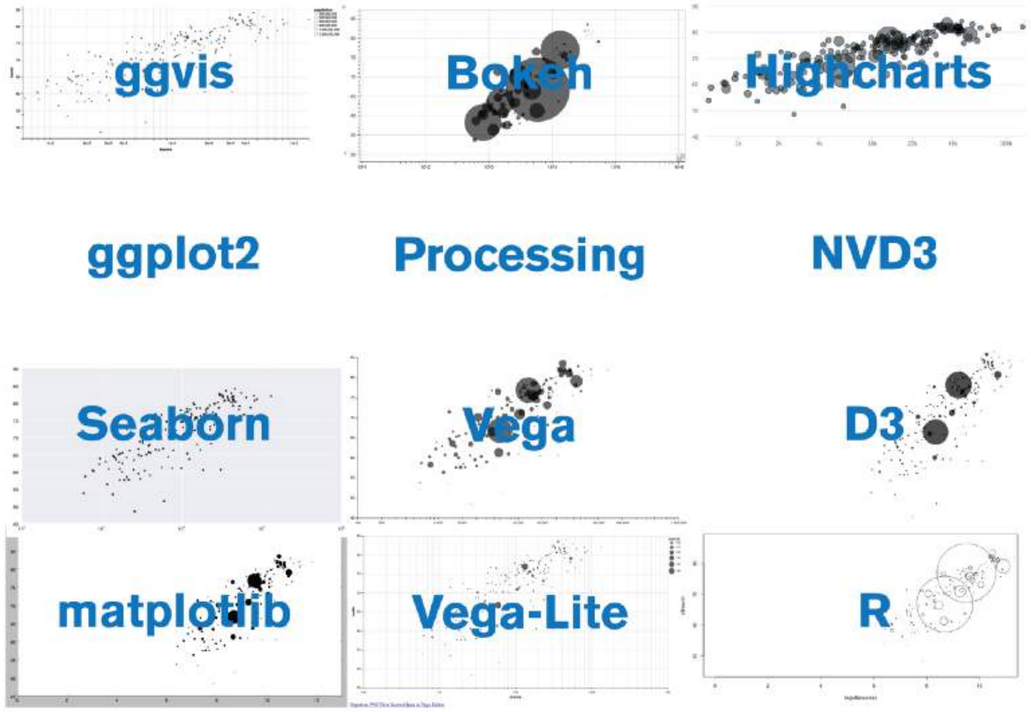


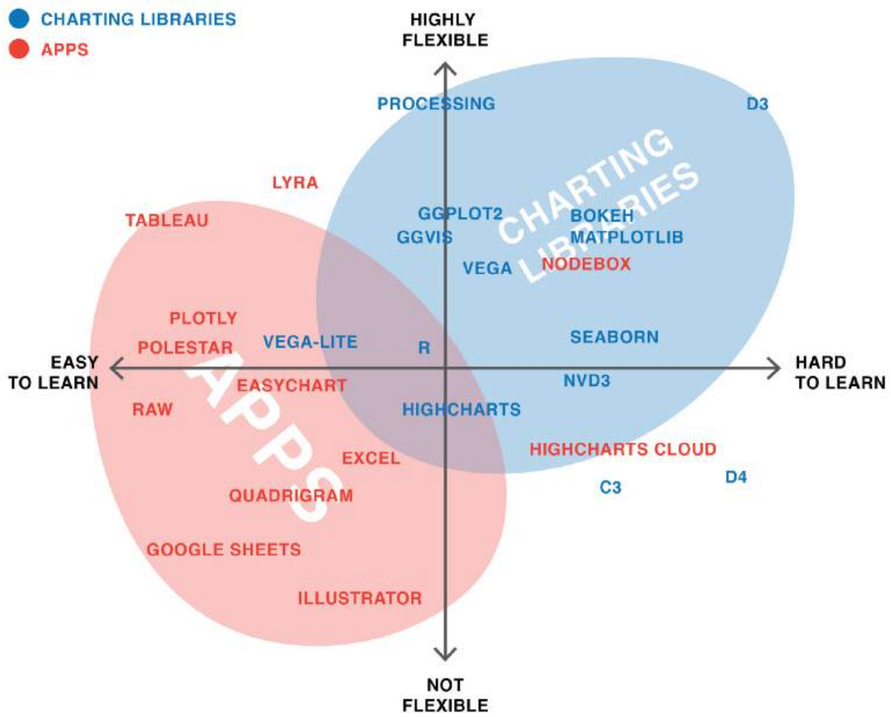
Albers, Josef



Albers, Josef

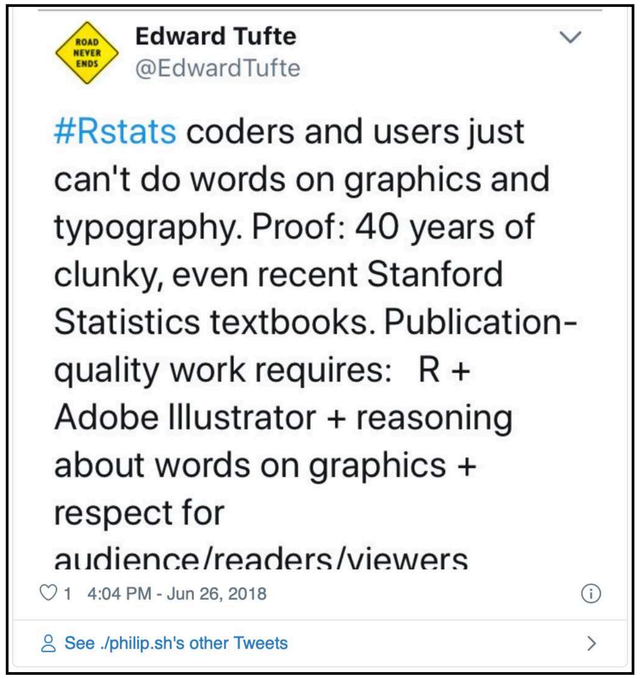
# perspectives on tools

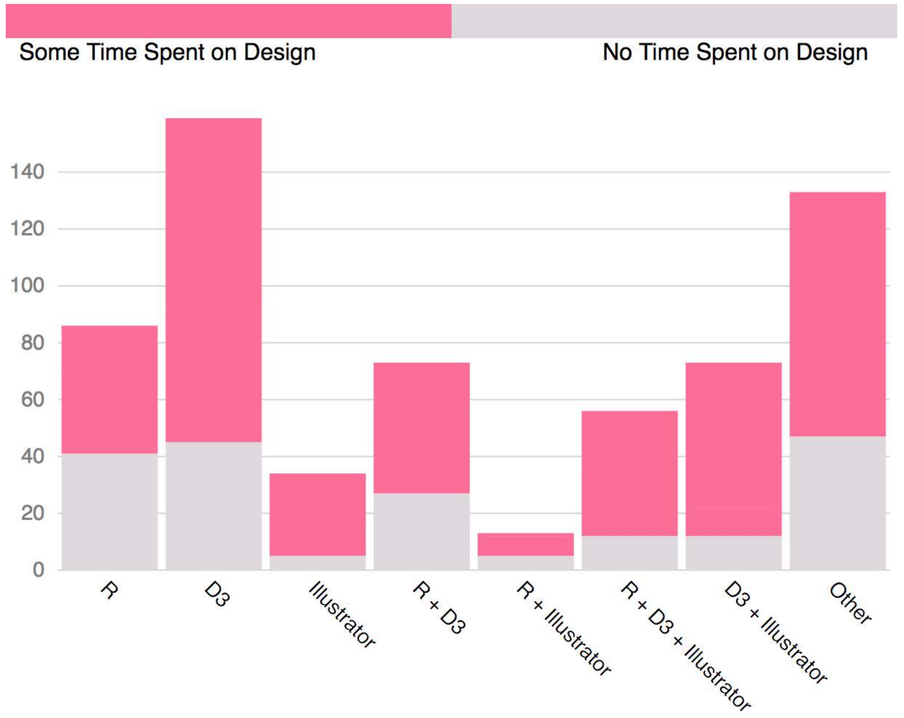



Rost, Lisa Charlotte

"There are no perfect tools, just good tools for people with certain goals."



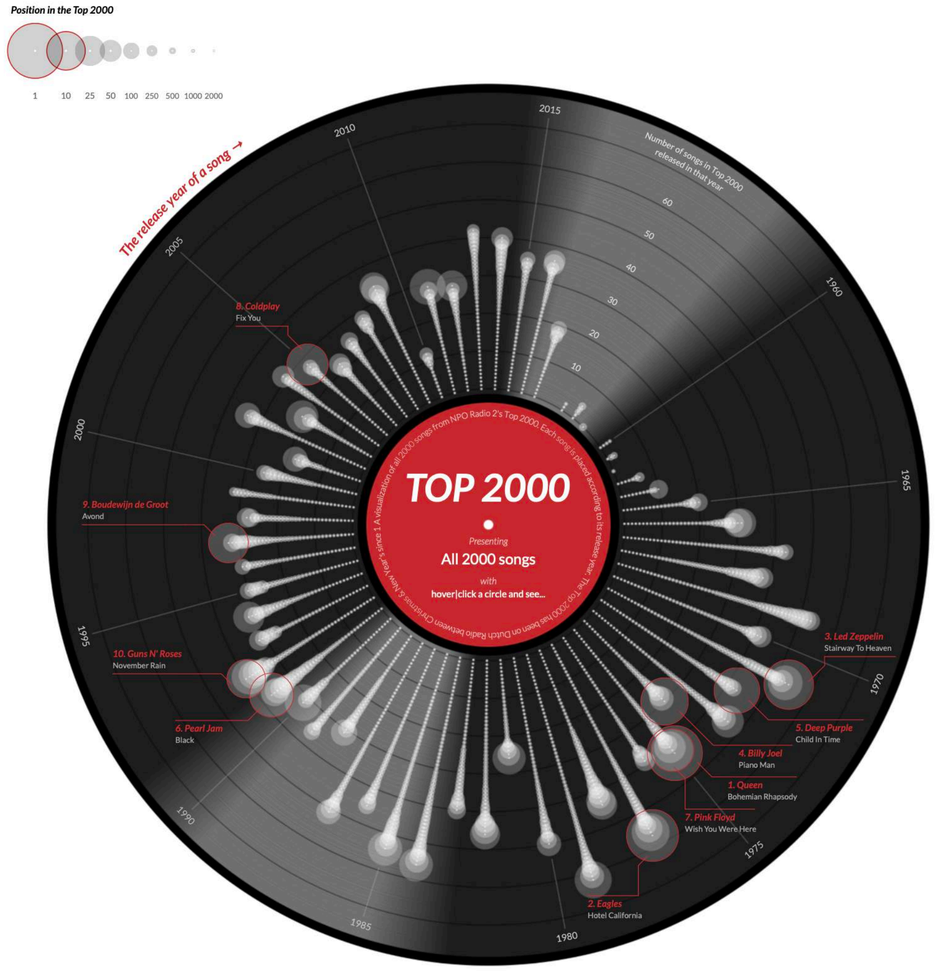




Meeks, Elijah

# practice in the studio

# Let The Music Play

All songs from the TOP 2000 of 2017 according to their release years



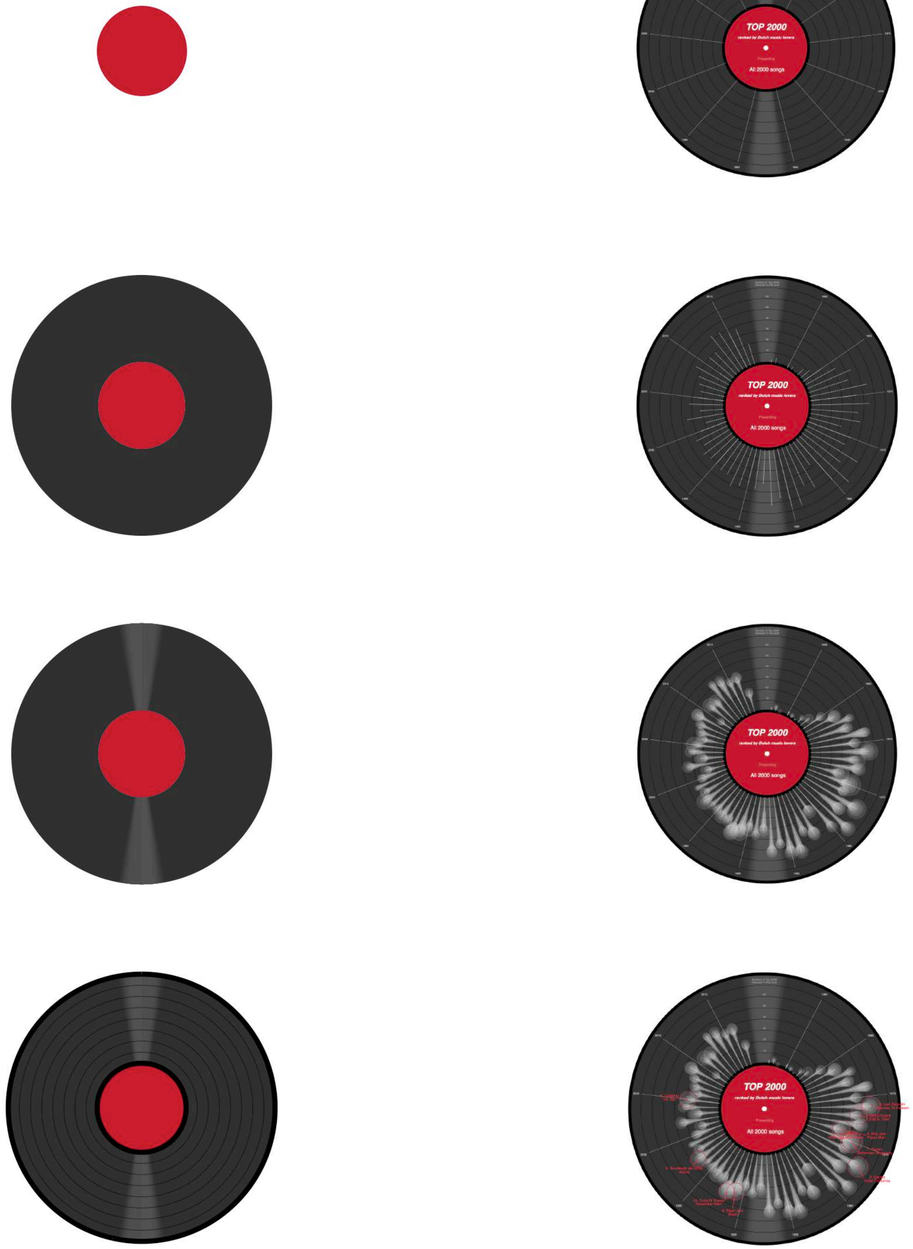

When hovering (or clicking on mobile) a circle all the songs of that artist are highlighted and connected by a line. When the song happens to be a collaboration between two artists, you'll see multiple lines, one for each artist.

Created by Nadieh Bremer | Visual Cinnamon

Data from NPO Radio 2

Ga naar de Nederlandse versie

Check out my Top 2000 visuals from 2015 & 2016



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