Color in Statistical Charts

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https://observablehq.com/collection/@ijlyttle/color

(Incomplete) Thanks

- Haley Jeppson
- Scheider Electric, Catherine Stolarski
- R colorspace package, Achim Zeileis
- Lisa Charlotte Muth
- Jacob Rus
- Observable

Foundations

Deliver:

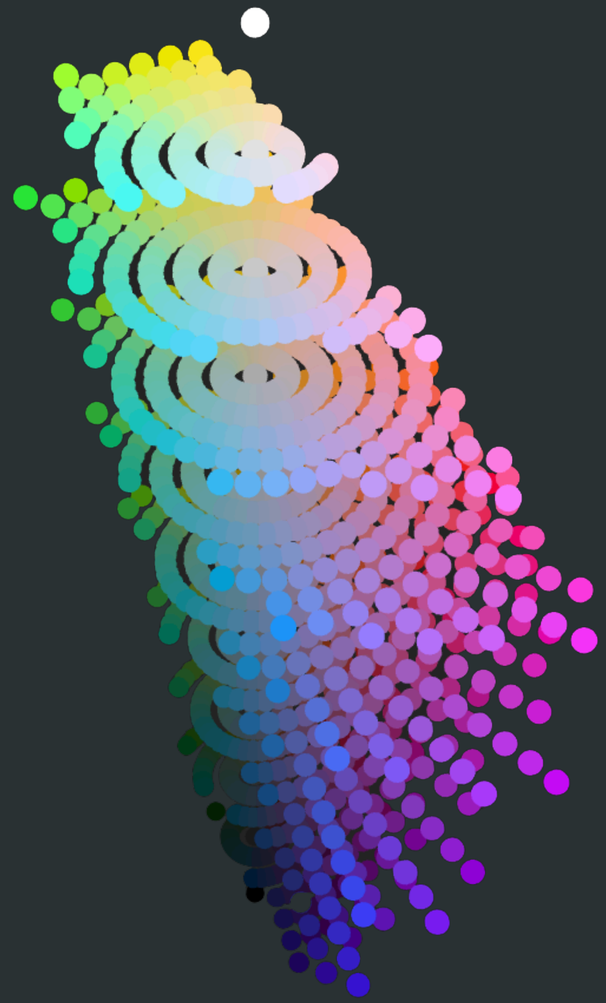
- Categorical scale: is one value different from another?
- Quantitative scales: is one value larger than another?

Requirements:

- Design also for dark mode
- Effective for folks with color-vision deficiency (CVD)
- Abide by organizational directives
- Look good

Color Spaces

- Humans perceive: luminance, chroma, hue
- Computers emit: red, green, blue
- Color spaces:
  - map between LCH and RGB
  - allow us to estimate the perceptual distance between any two colors
- RGB gamut:
  - Extent of what a display can show
  - colors with `#00` or `#FF` are saturated



Color-Vision Deficiency

Three major types:

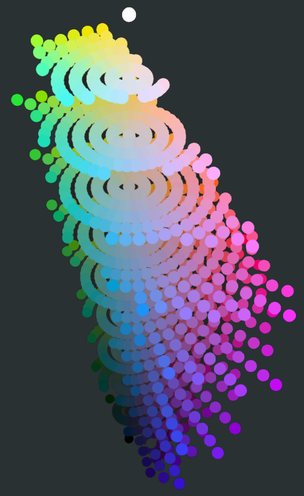
- Protan: red
- Deuteran: green
- Tritan: blue

Severity can vary

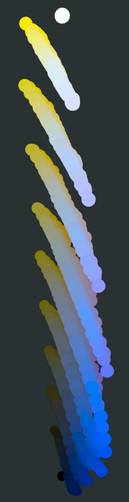
Deuteran is the most common

We can simulate CVD using models by Machado et al. (2009), following the R colorspace package by Zeileis at al. (2020)

None

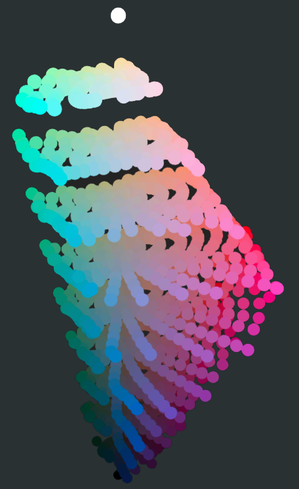


Protan



Deuteran

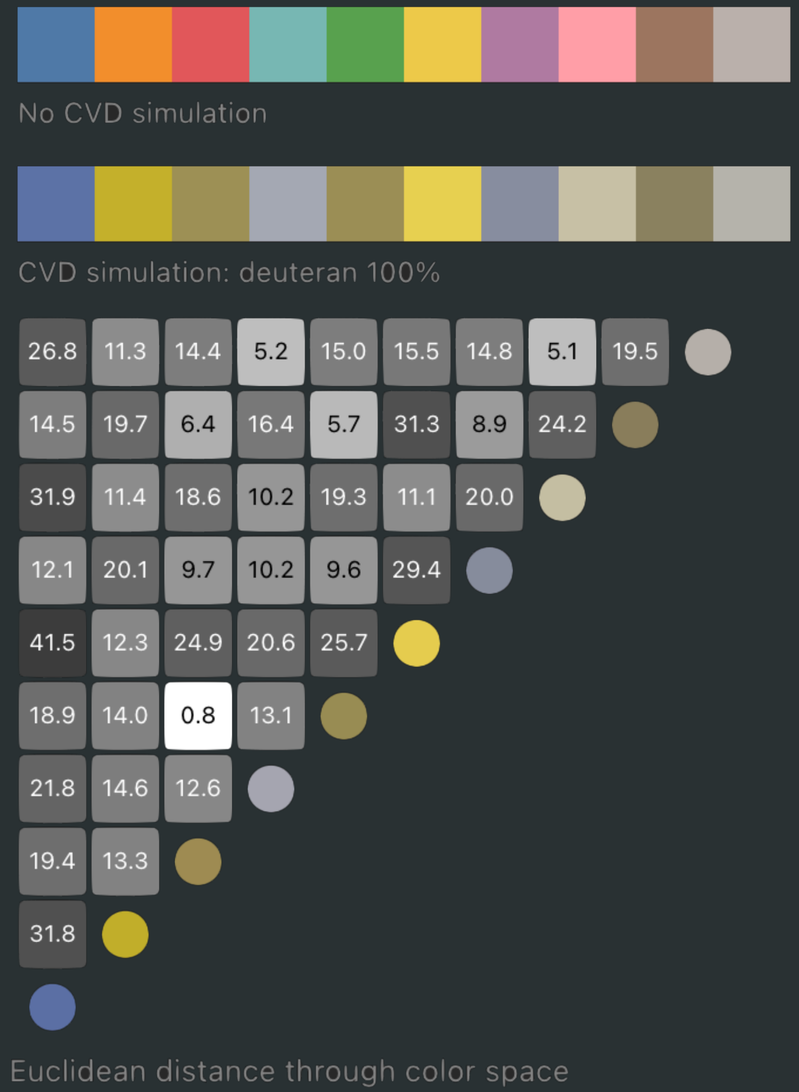
Tritan



Categorical Scale

Tableau10 is the go-to scale:

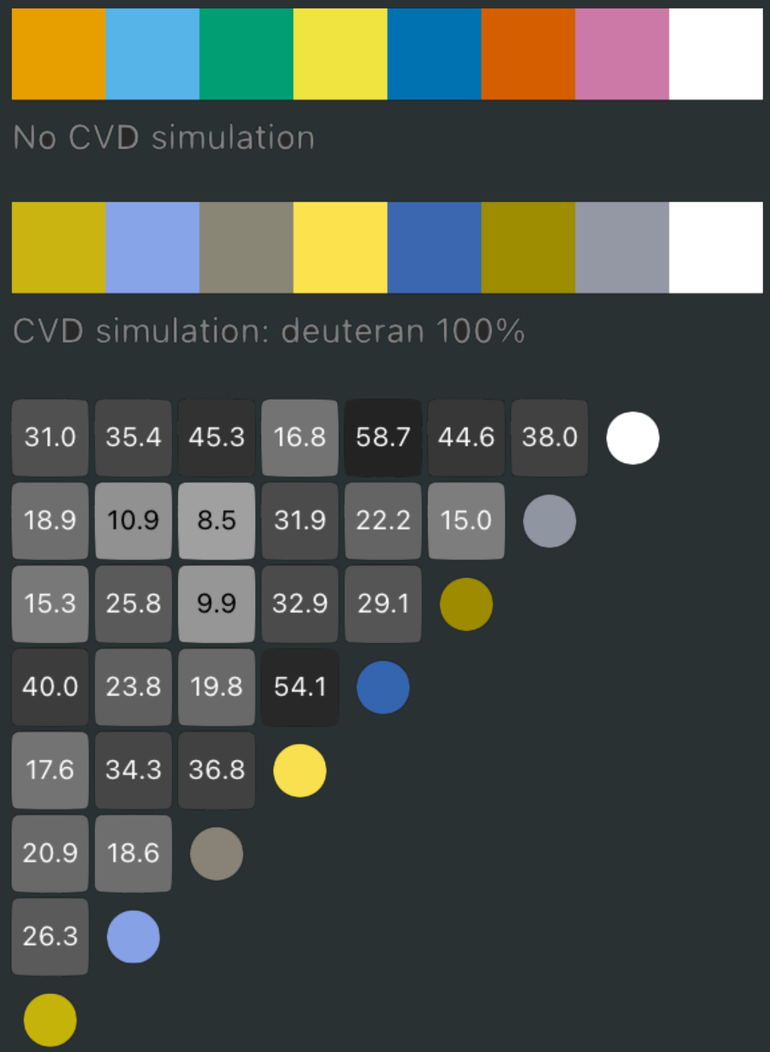
- very aesthetically pleasing, not "shouty"
- works in light mode and dark mode
- runs into issues with CVD
- red often reserved for alerts



Categorical Scale

Okabe-Ito is designed for CVD performance:

- red often reserved for alerts
- I think neutrals should be reserved



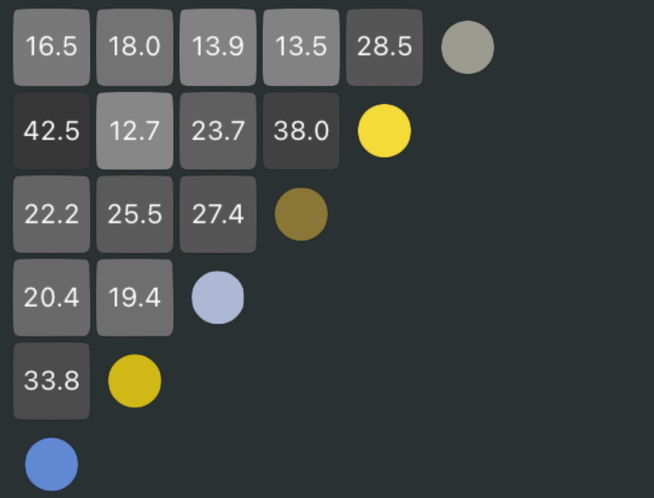
Categorical Scale

Remix of Tableau10 with Okabe-Ito:

- drops red and neutral from Okabe-Ito
- resequences to follow Tableau10
- aims for "less shouty", like Tableau10
- shuffle colors around to improve CVD performance

No CVD simulation

CVD simulation: deuteran 100%



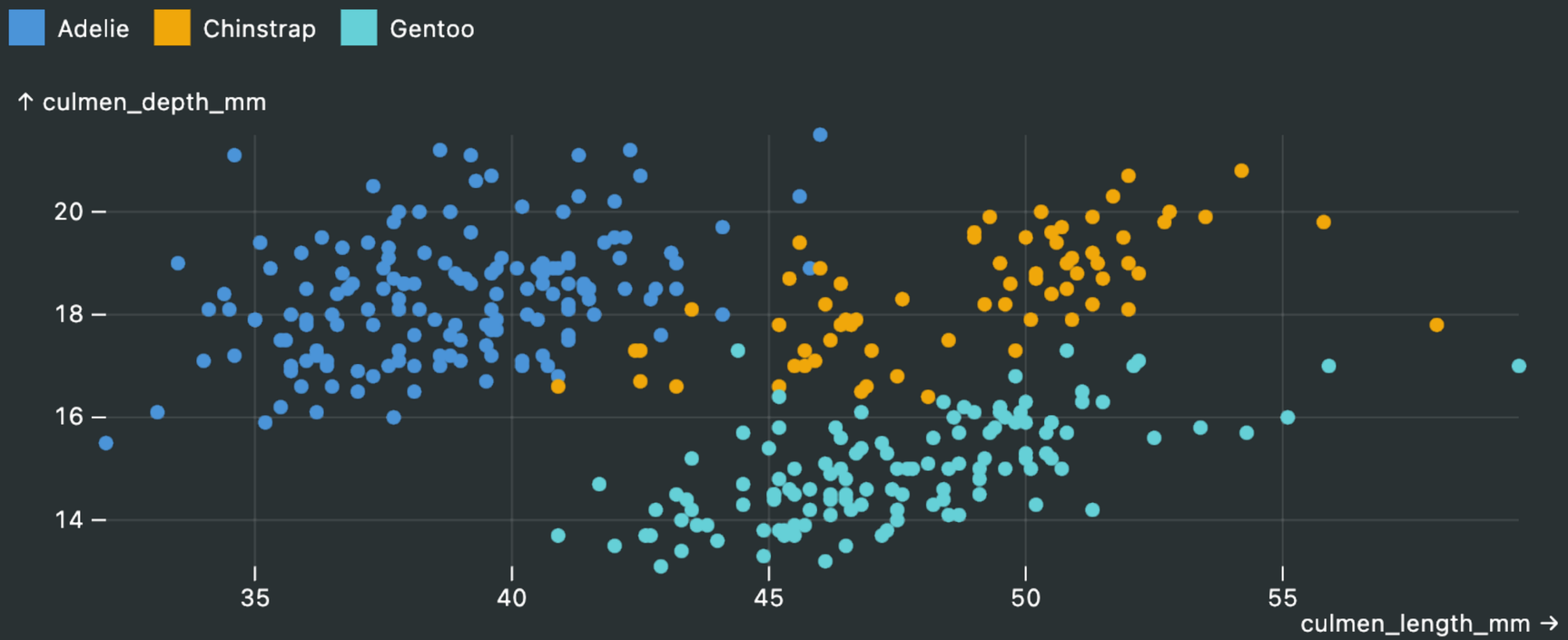
Euclidean distance through color space

Brand Colors

- Often saturated, to attract attention:

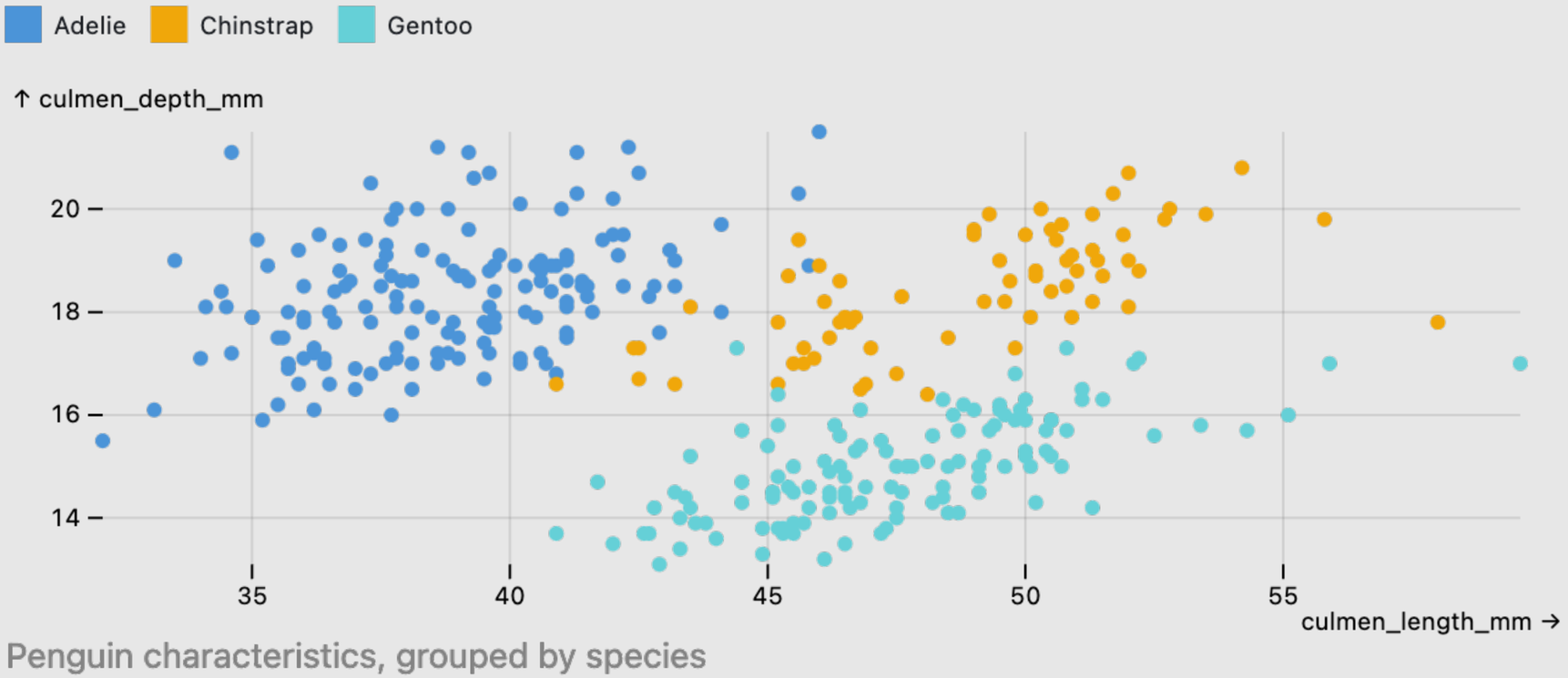
- Data-visualization colors tend to be less "shouty":

Categorical Scale Tryout



Penguin characteristics, grouped by species

Categorical Scale Tryout



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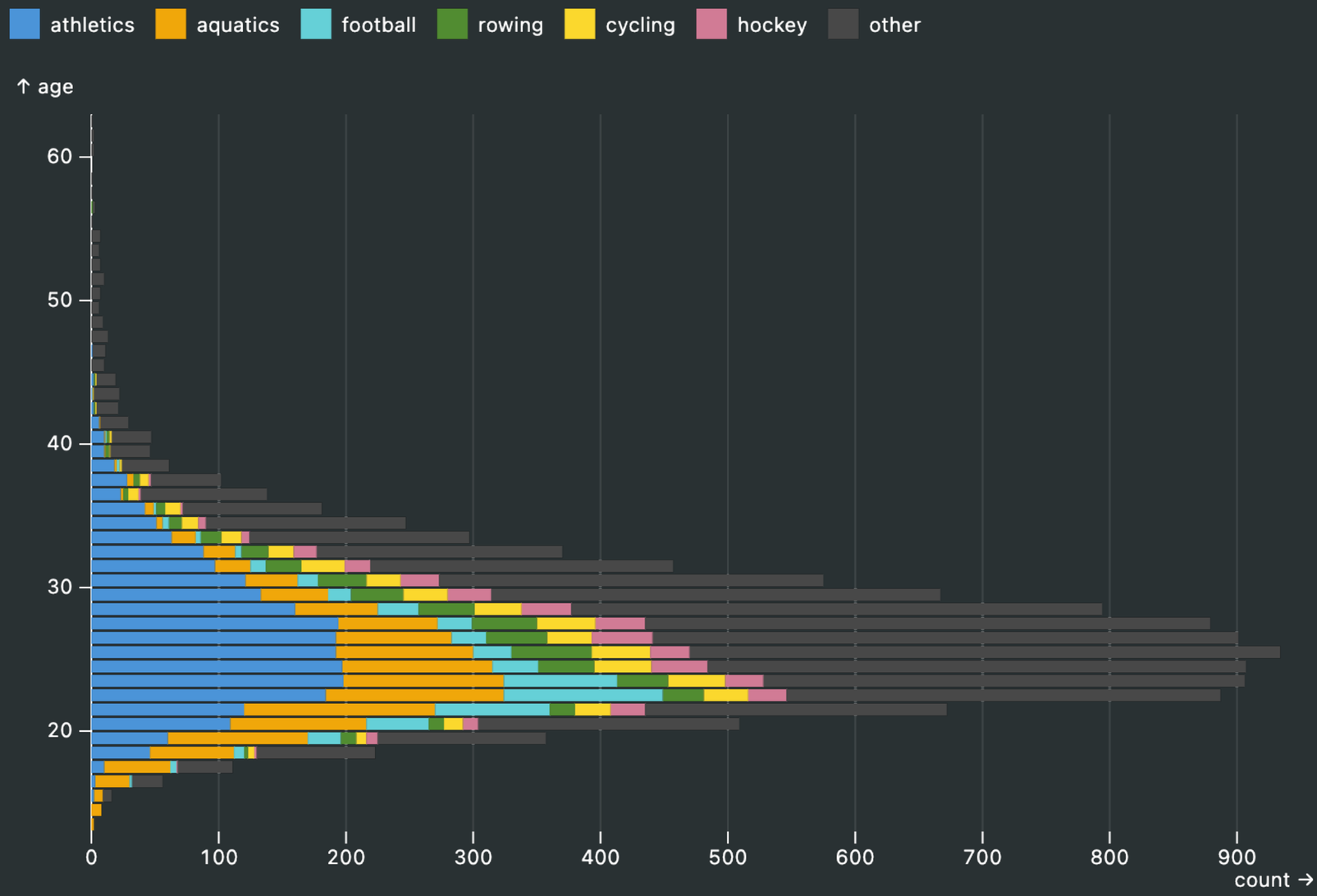
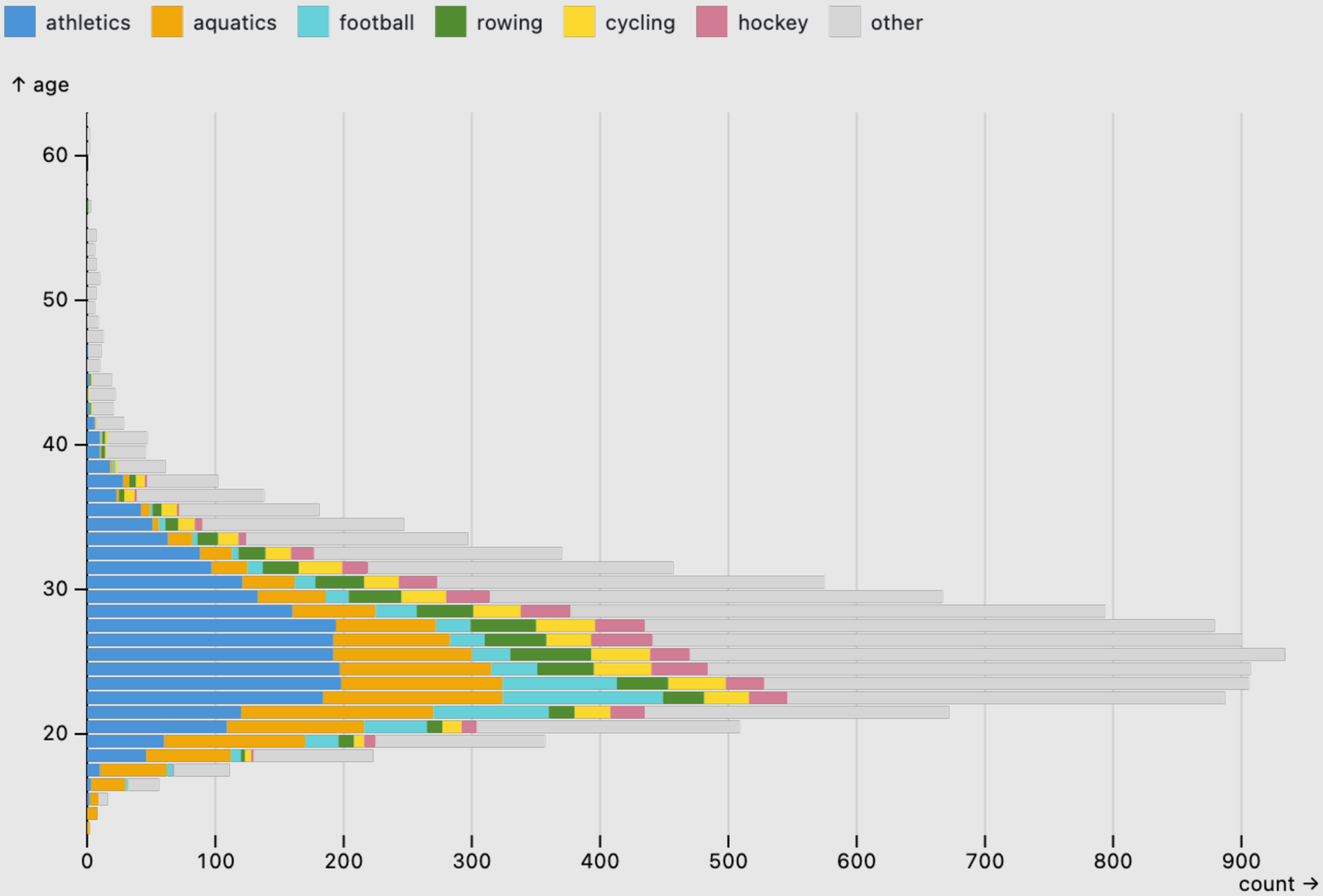


Participants at 2016 Olympics, grouped by age and sport

Categorical Scale Tryout

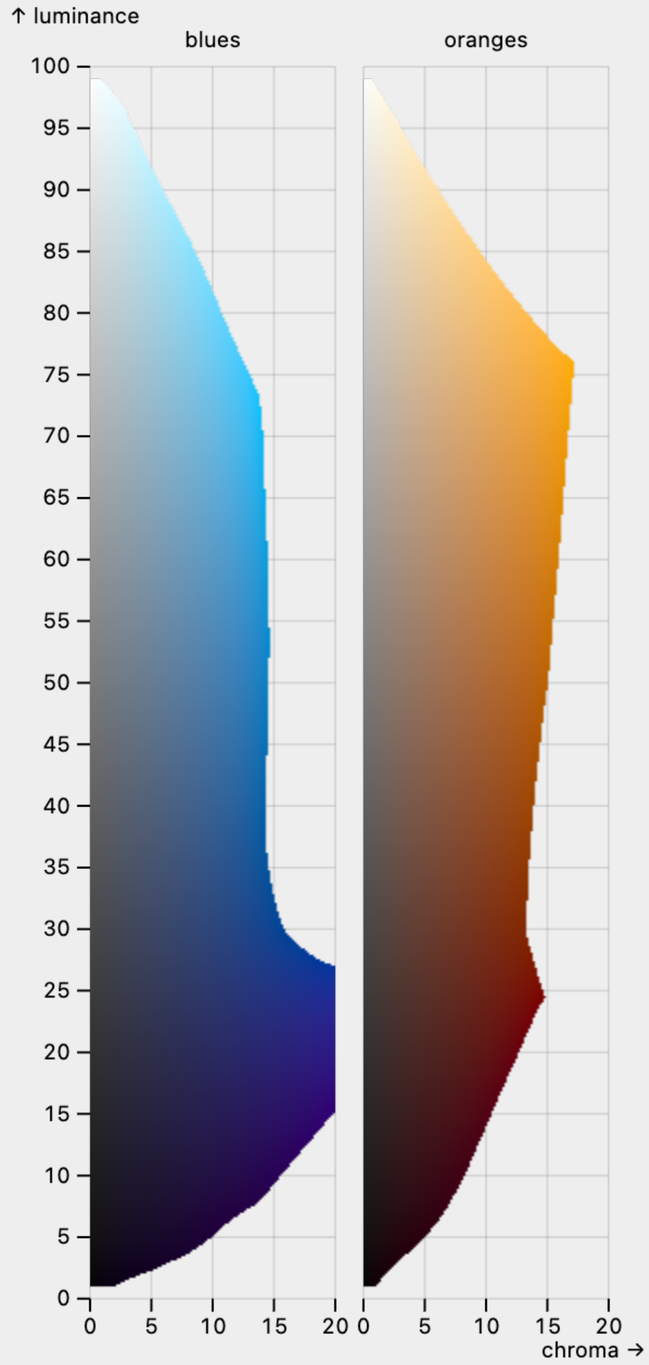


Participants at 2016 Olympics, grouped by age and sport

Quantitative Scales

Color surface:

- hue is a (linear) function of luminance

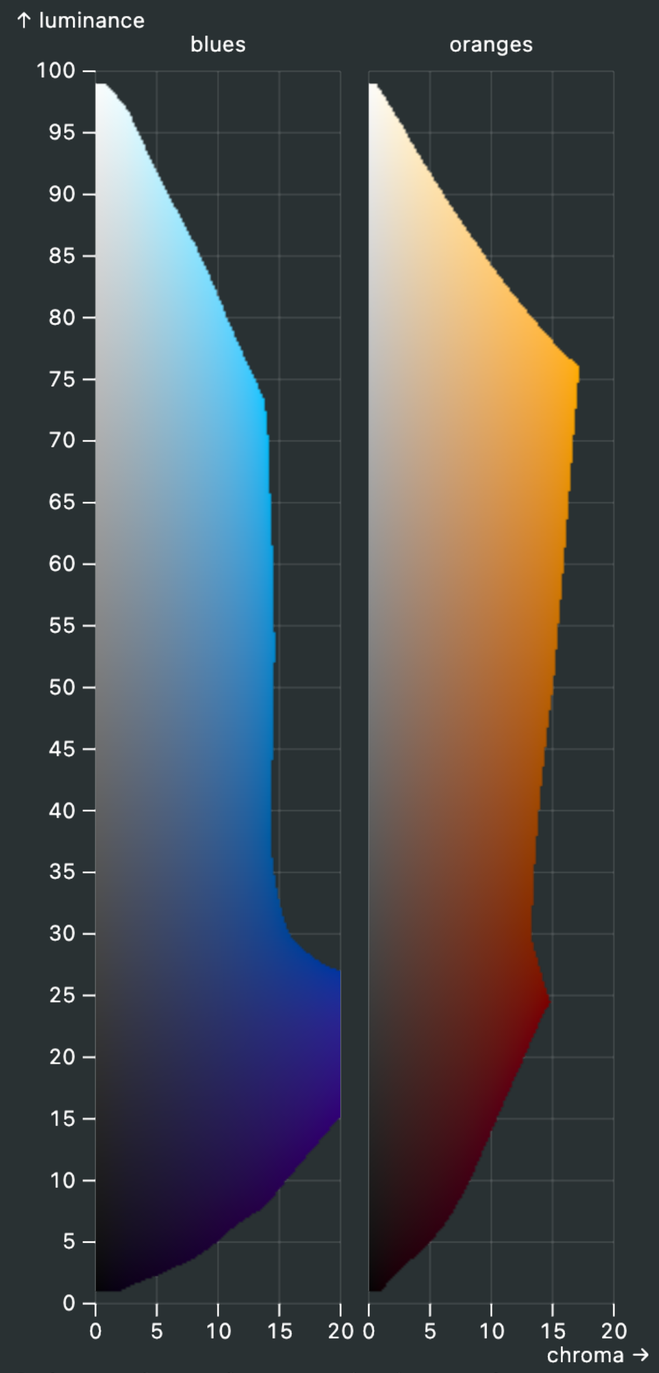


Color surfaces for quantitative scales

Quantitative Scales

Color surface:

- hue is a (linear) function of luminance

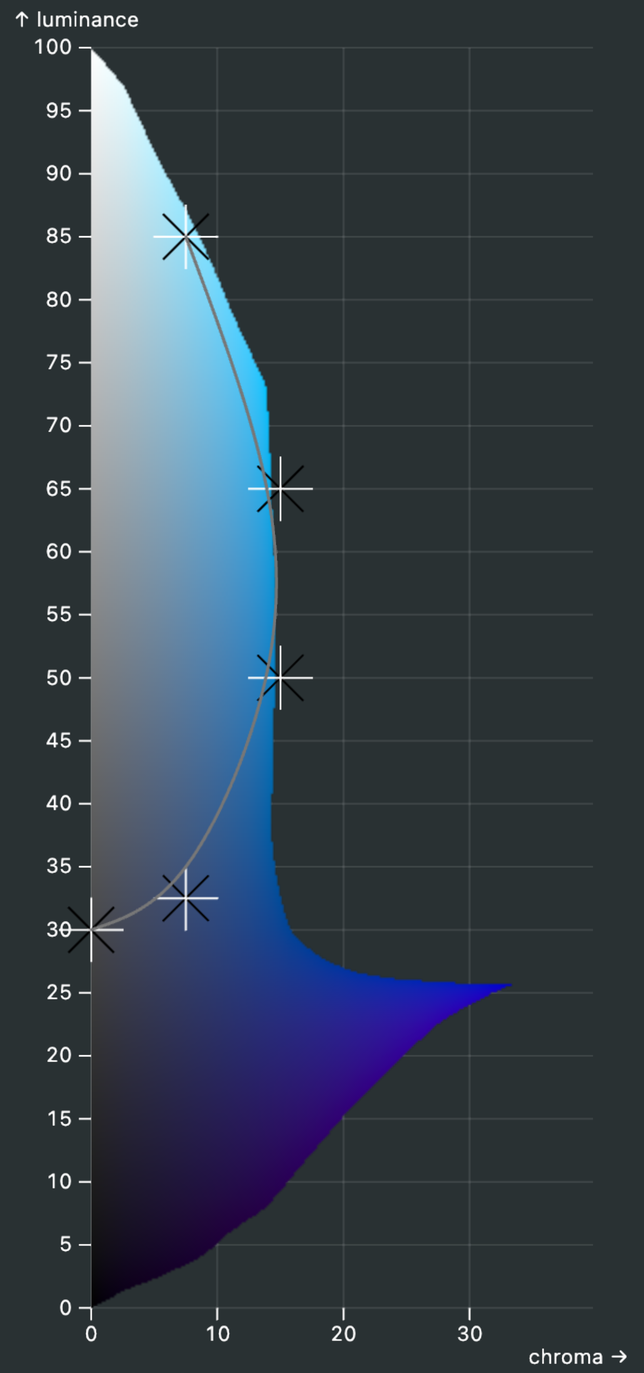


Color surfaces for quantitative scales

Quantitative Scales

Color trajectory:

- spline in chroma, luminance
- defined by control points

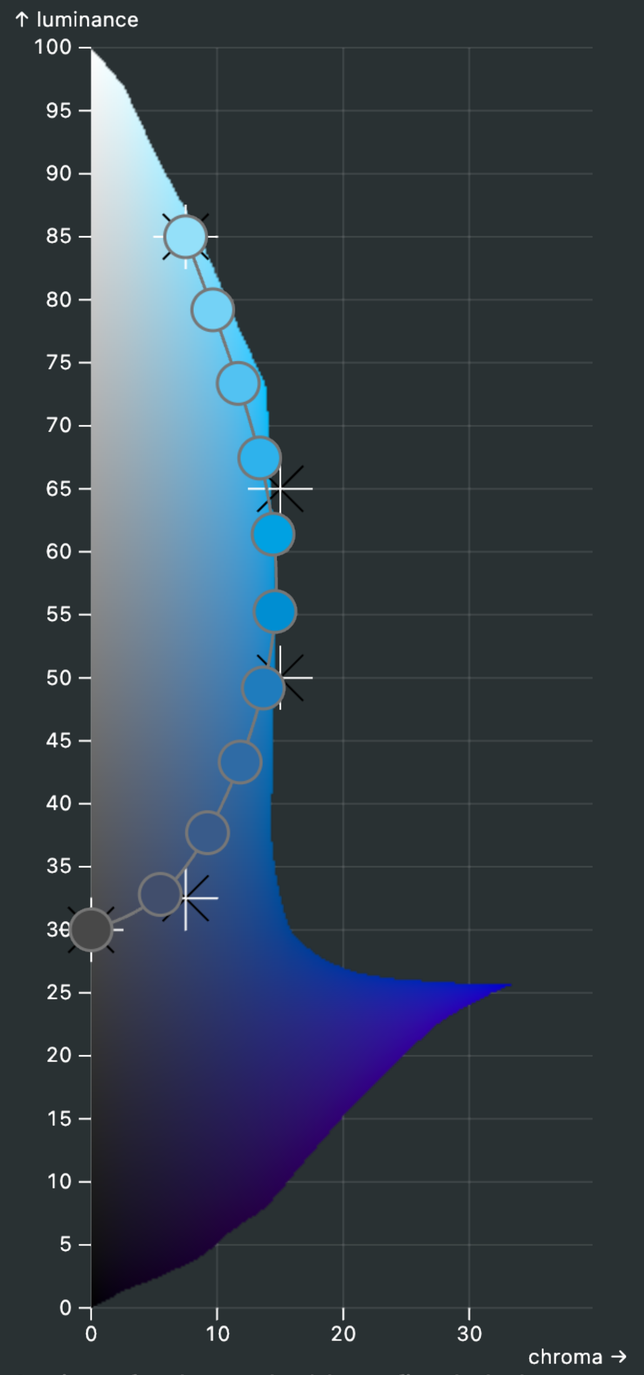


Design of color scale: blues-fixed-dark

Quantitative Scales

Color scale:

- color trajectory on a color surface
- rescaled to Euclidean distance through color space

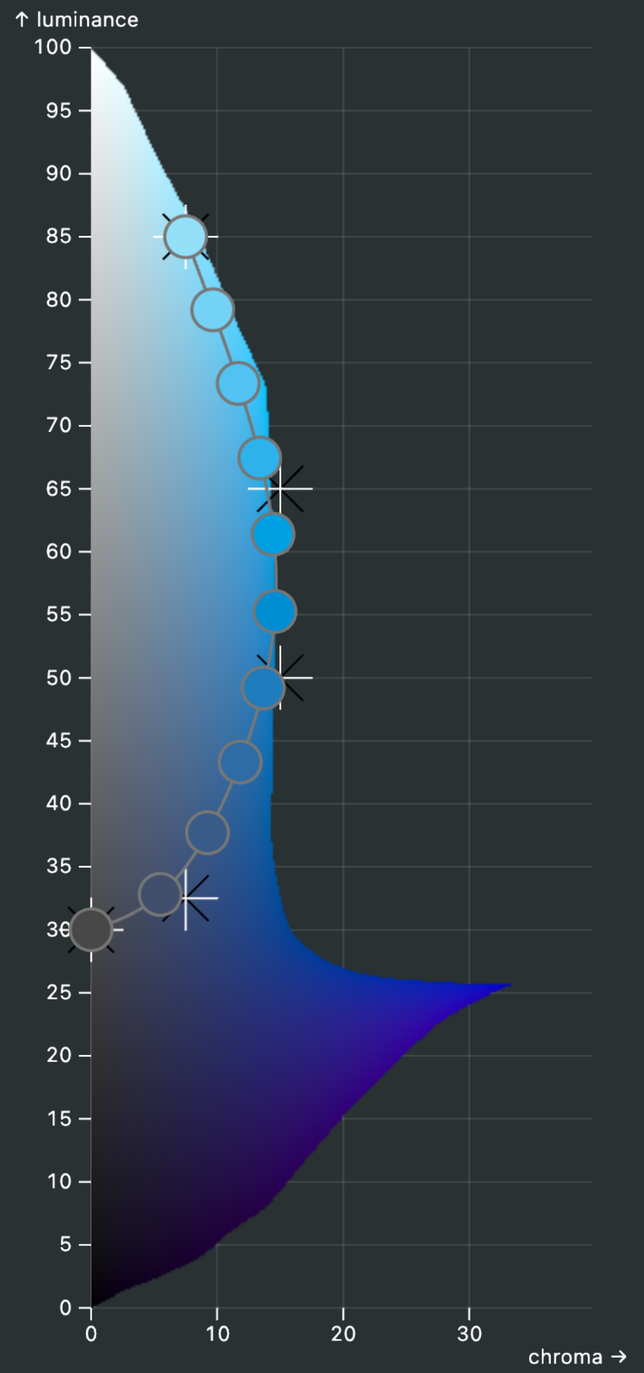


Design of color scale: blues-fixed-dark

Quantitative Scales

Fixed scale:

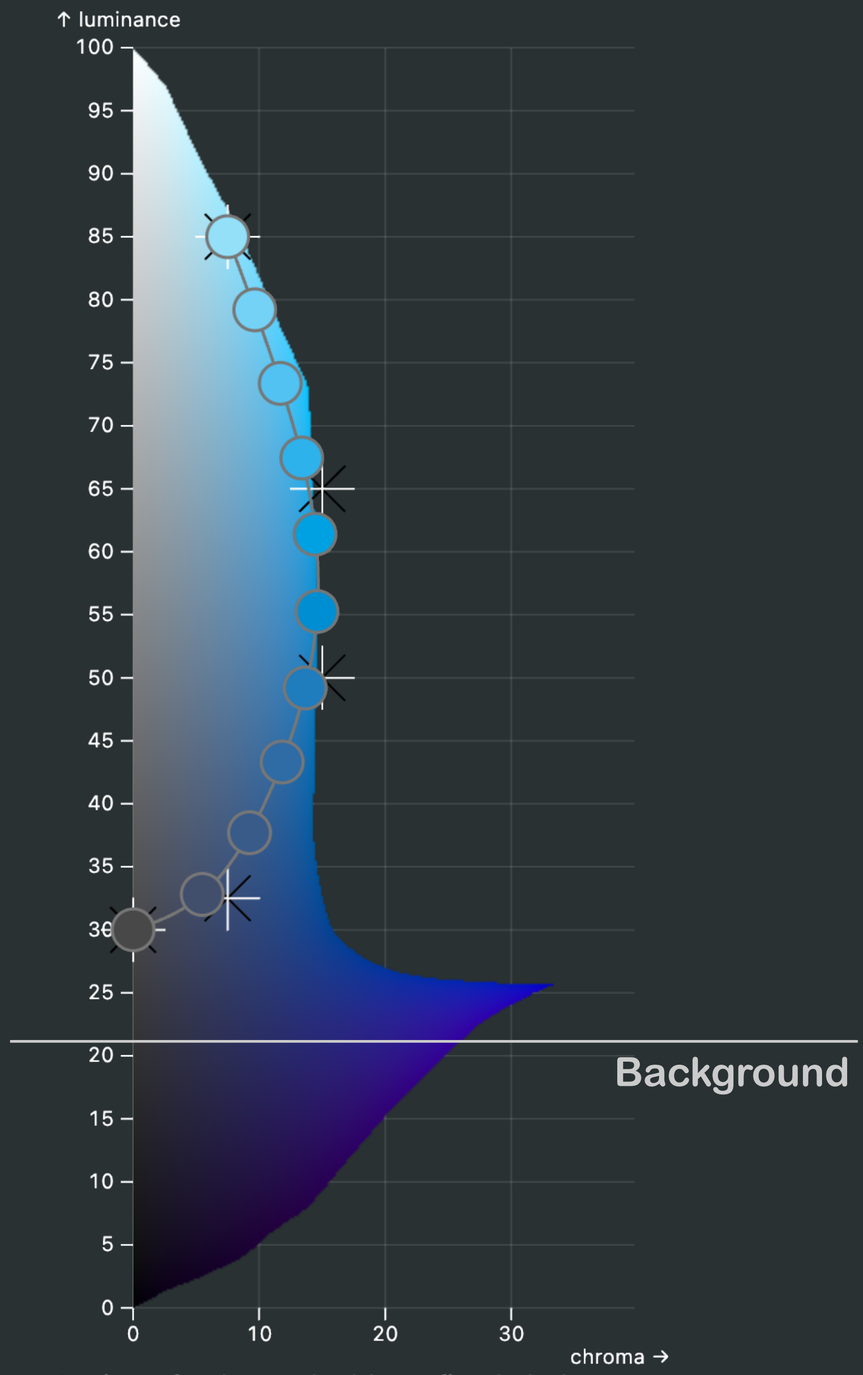
- neutral color to map to a reference value



Design of color scale: blues-fixed-dark

Quantitative Scales

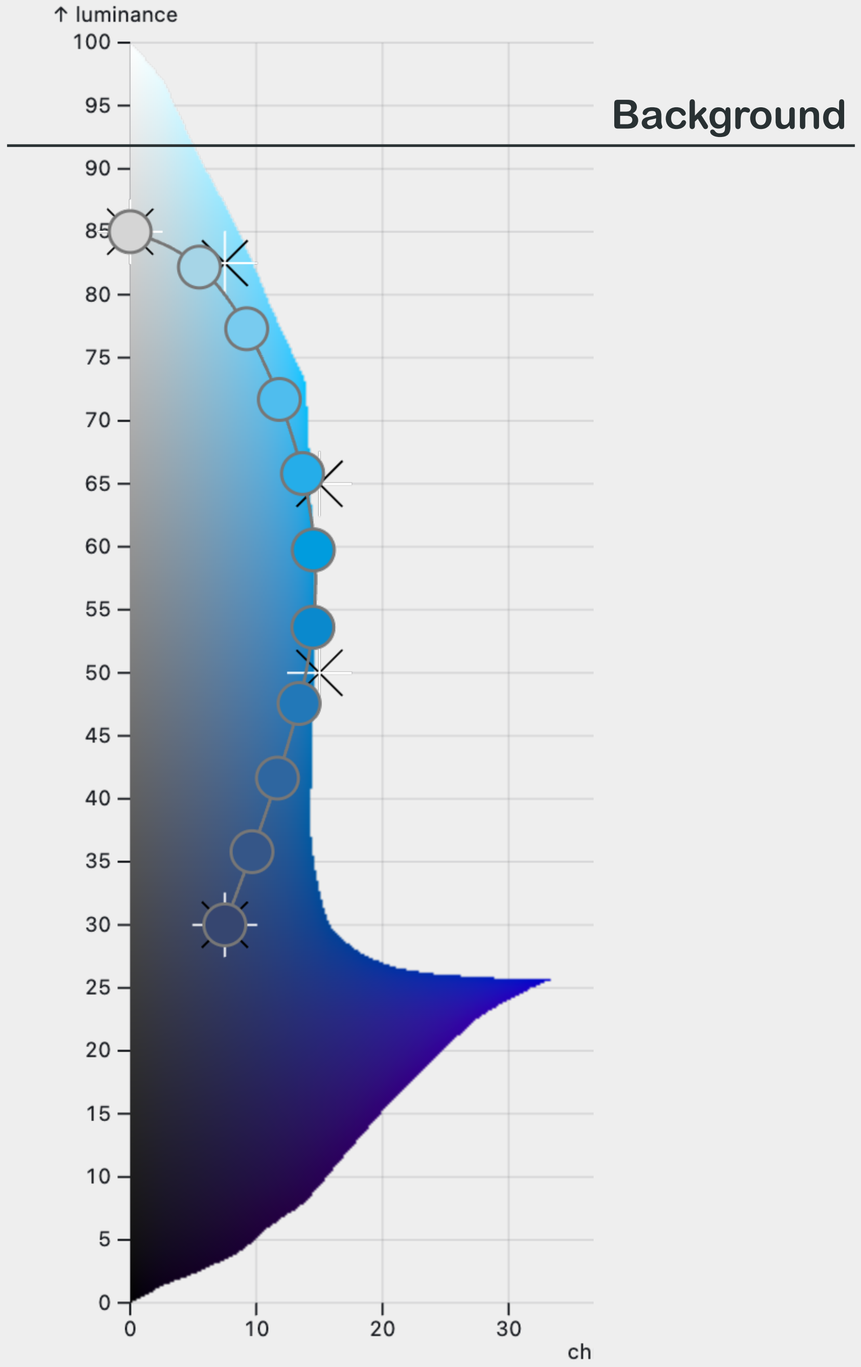
Keep all colors away from background luminance



Design of color scale: blues-fixed-dark

Quantitative Scales

Keep all colors away from background luminance

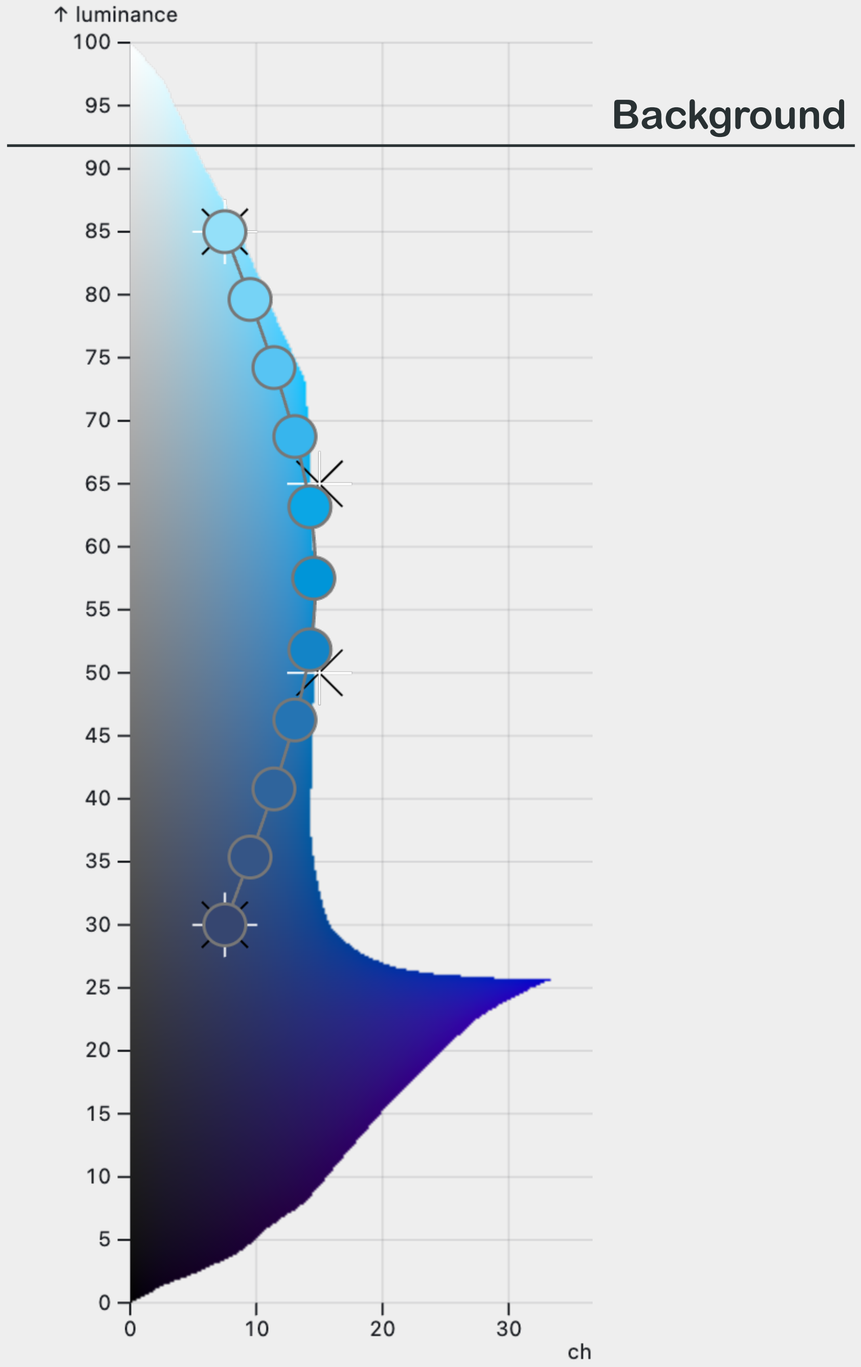


Design of color scale: blues-fixed-light

Quantitative Scales

Floating scale:

- no reference value

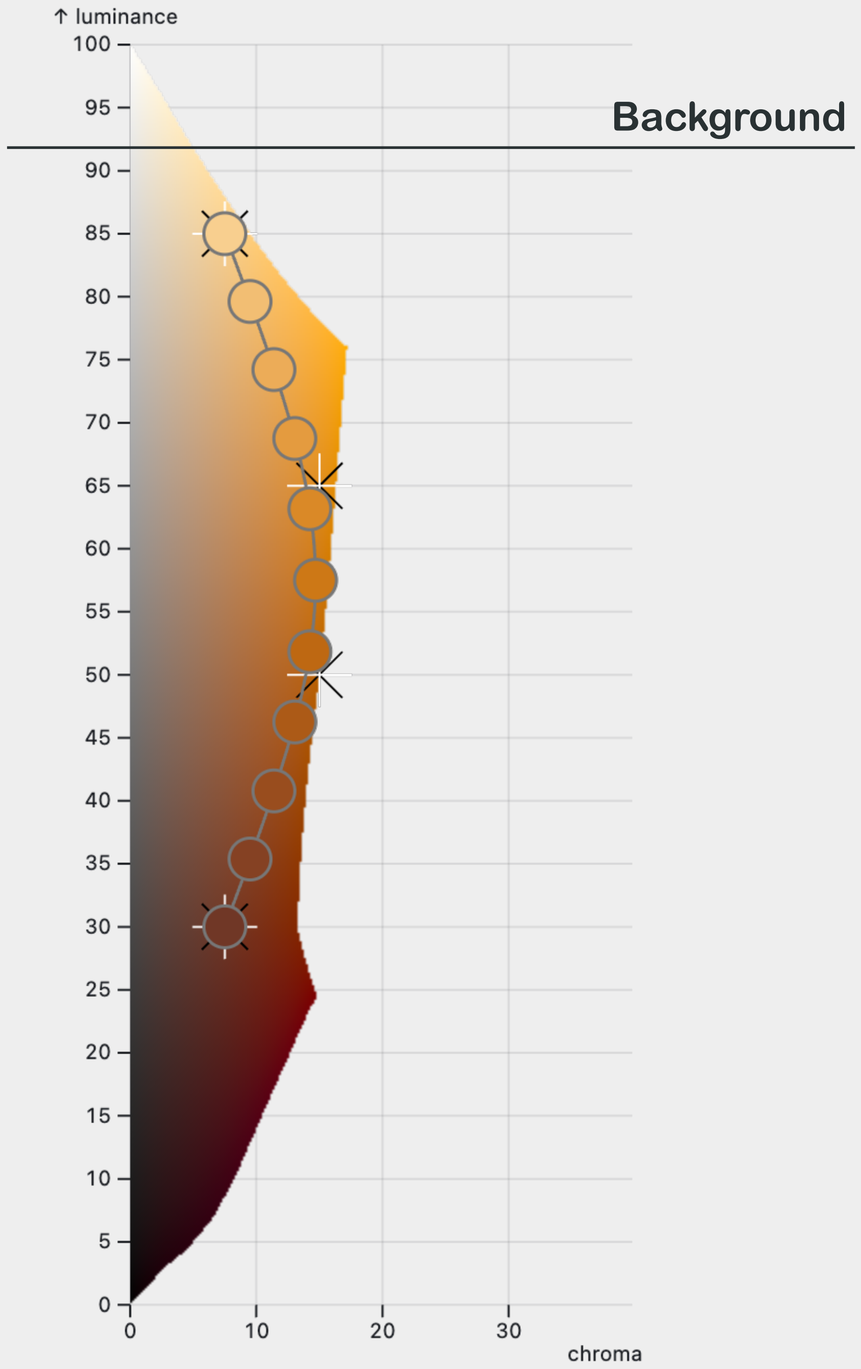


Design of color scale: blues-float-light

Quantitative Scales

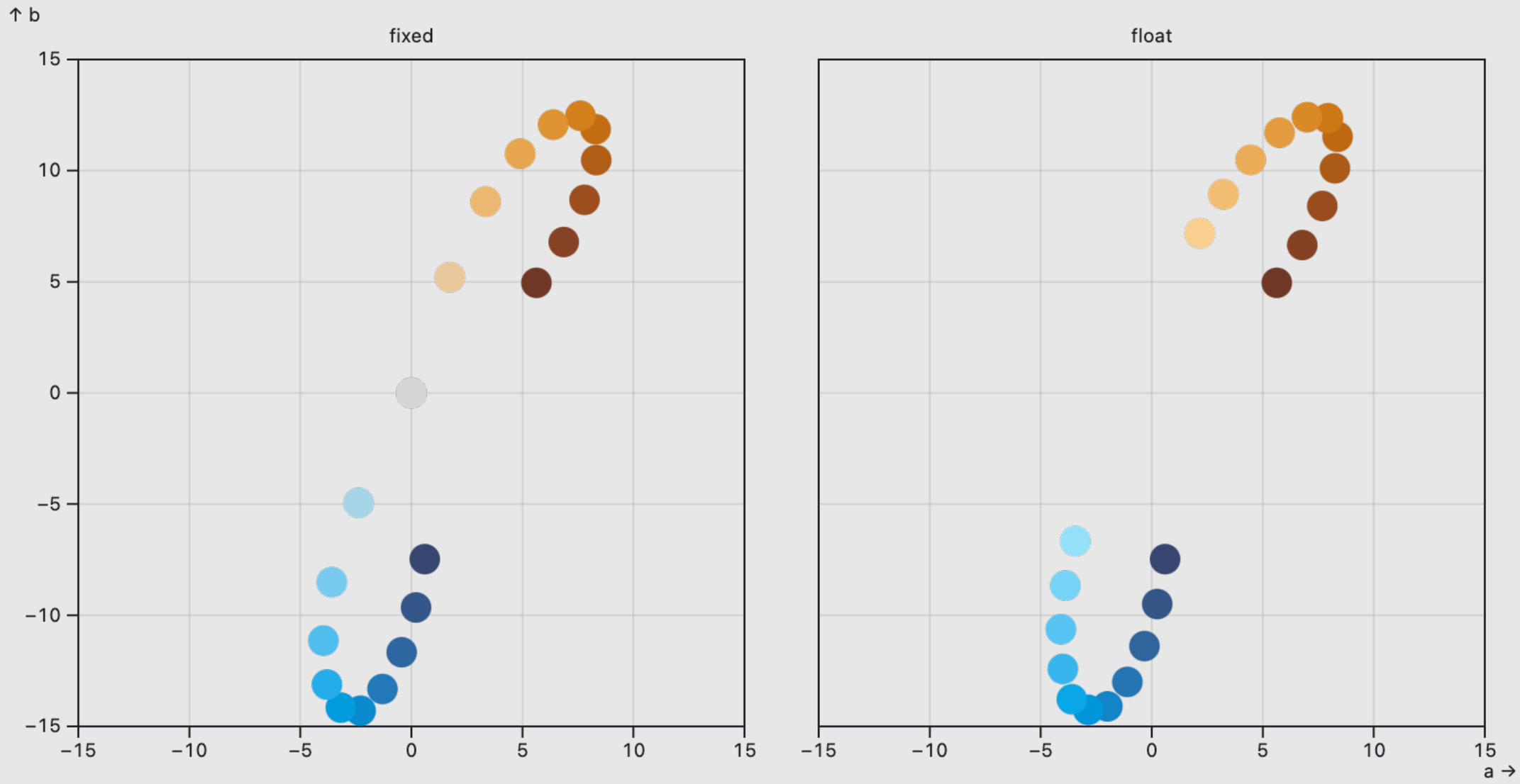
Floating scale:

- no reference value



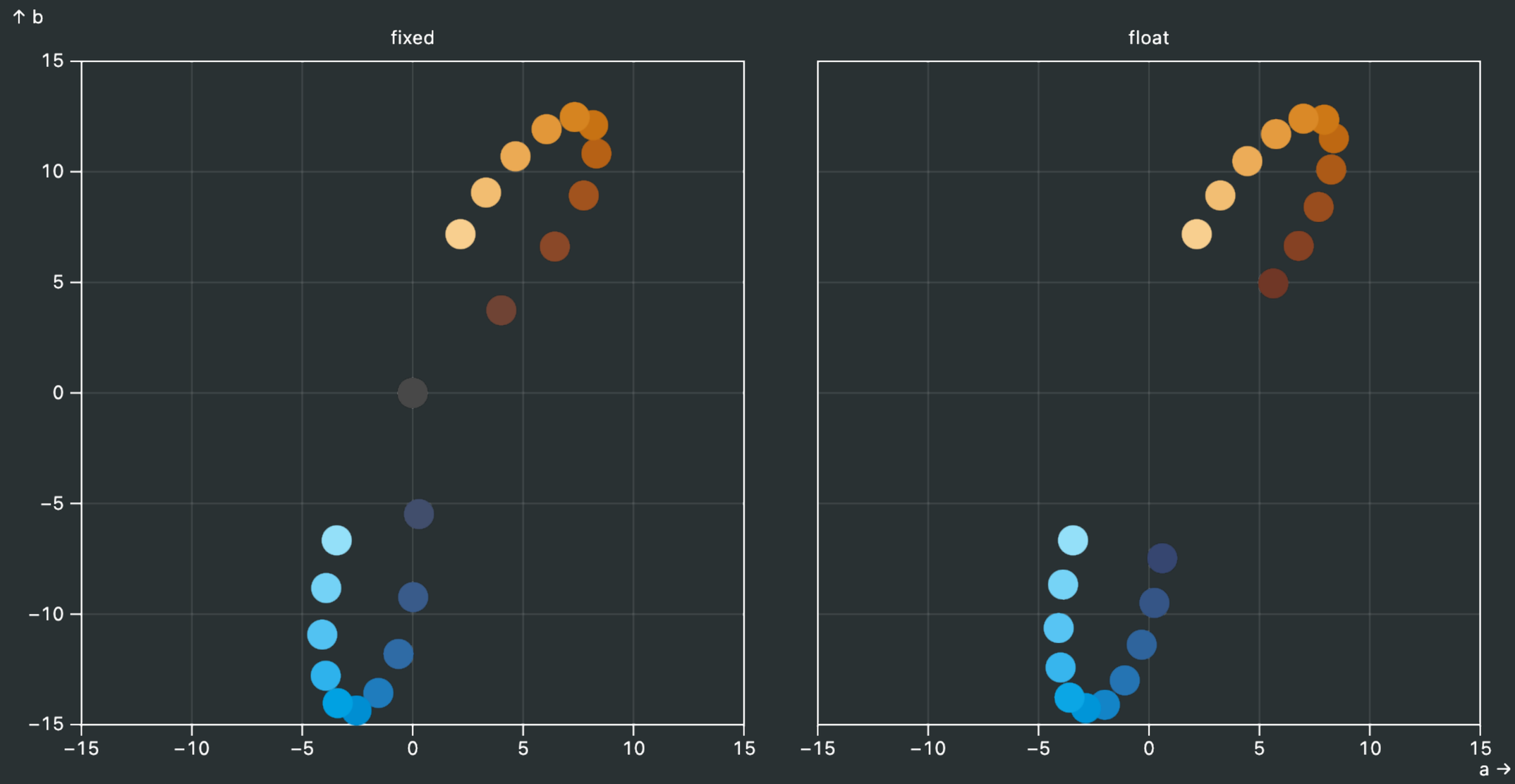
Design of color scale: oranges-float-light

Quantitative Scales



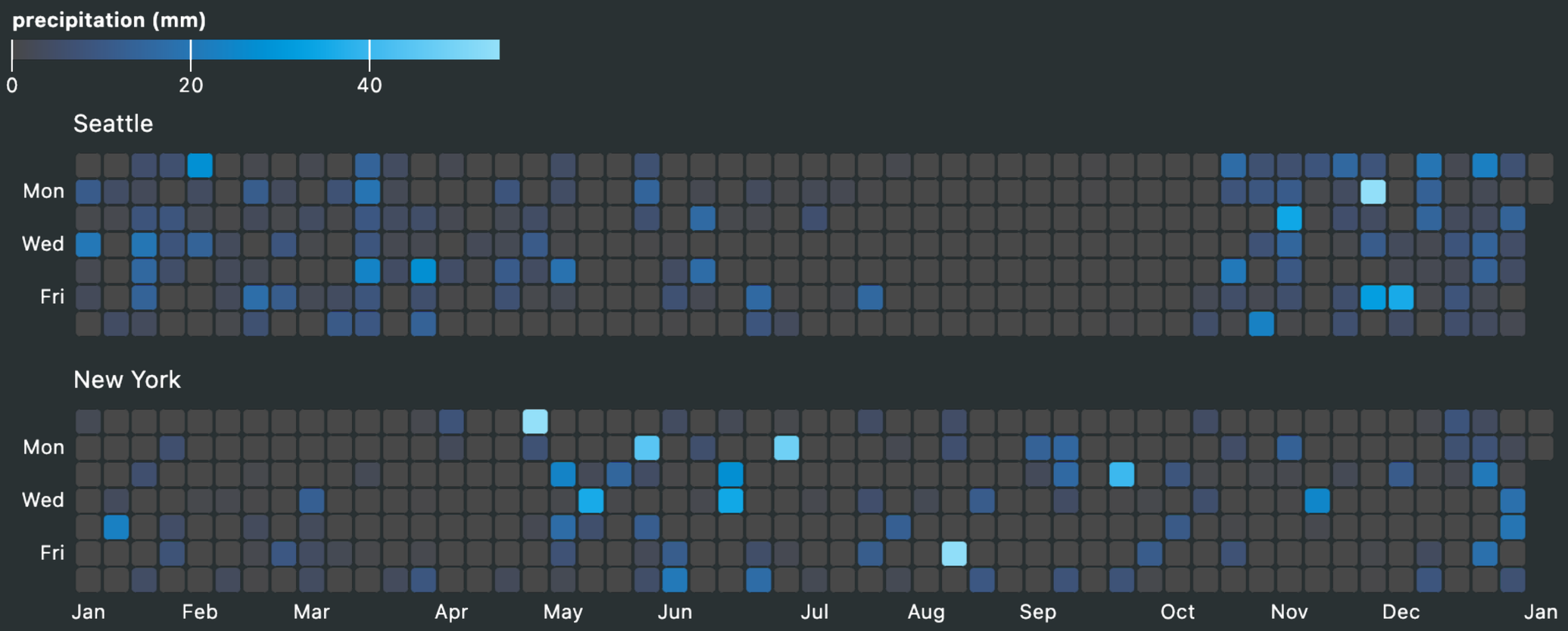
Chroma and hue of quantitative color-scales for light mode

Quantitative Scales



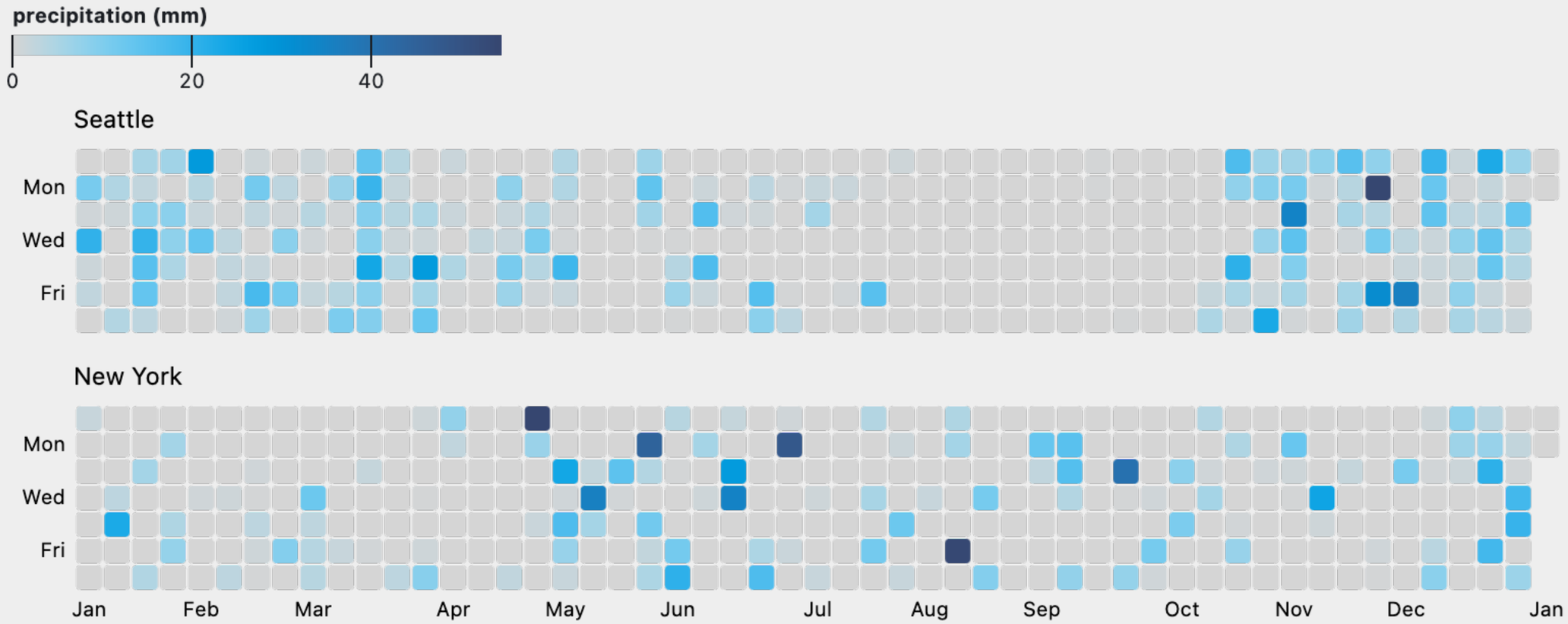
Chroma and hue of quantitative color-scales for dark mode

Quantitative Scale Tryout



Daily precipitation observations in 2012, grouped by city

Quantitative Scale Tryout



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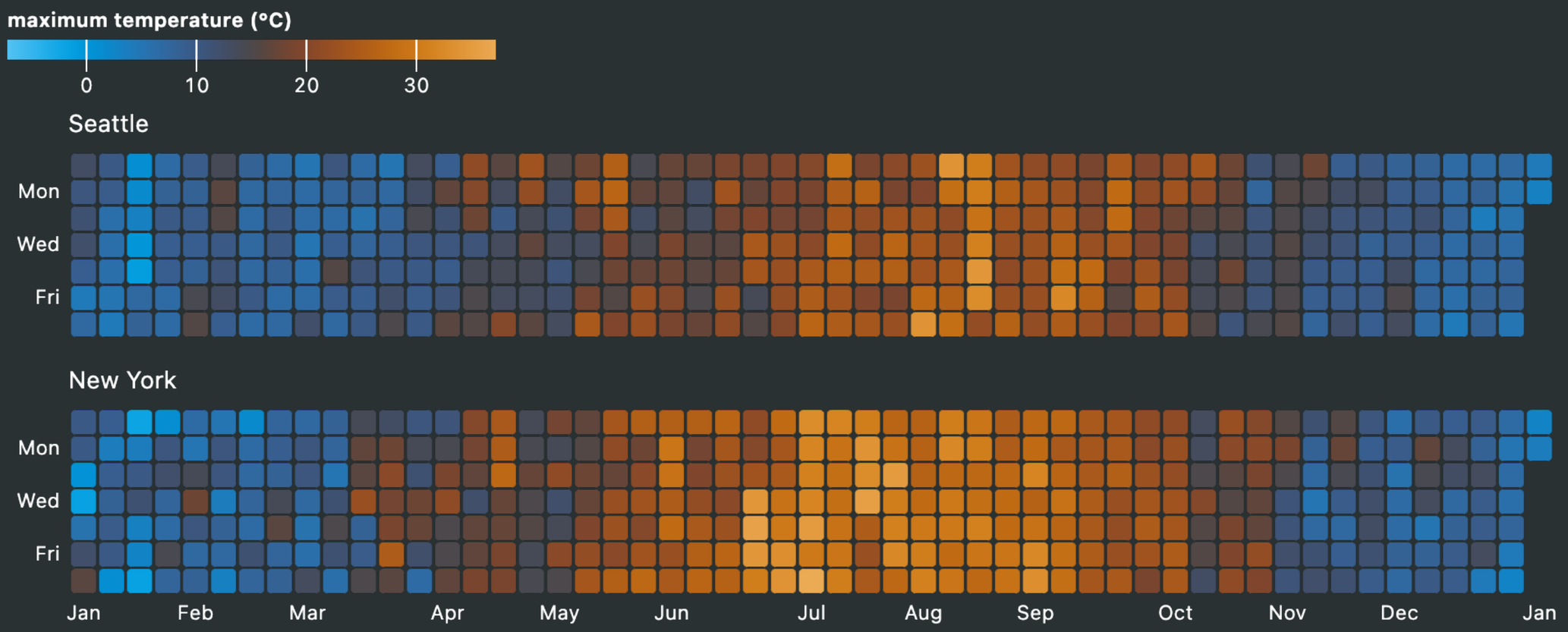

Daily temperature observations in 2012, grouped by city

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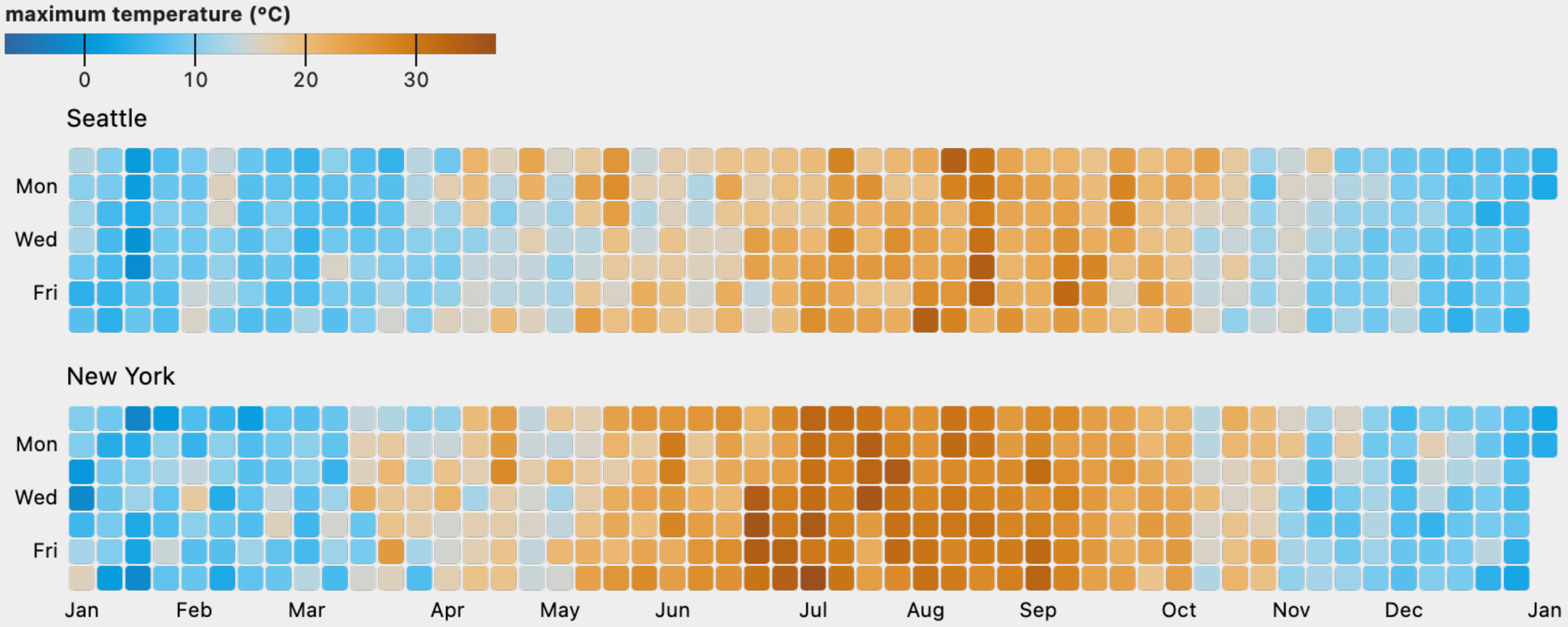

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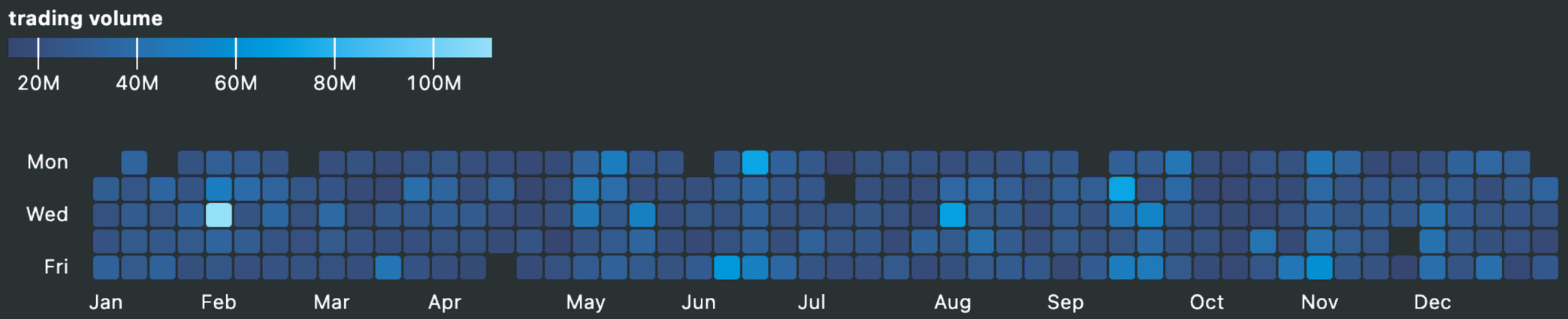
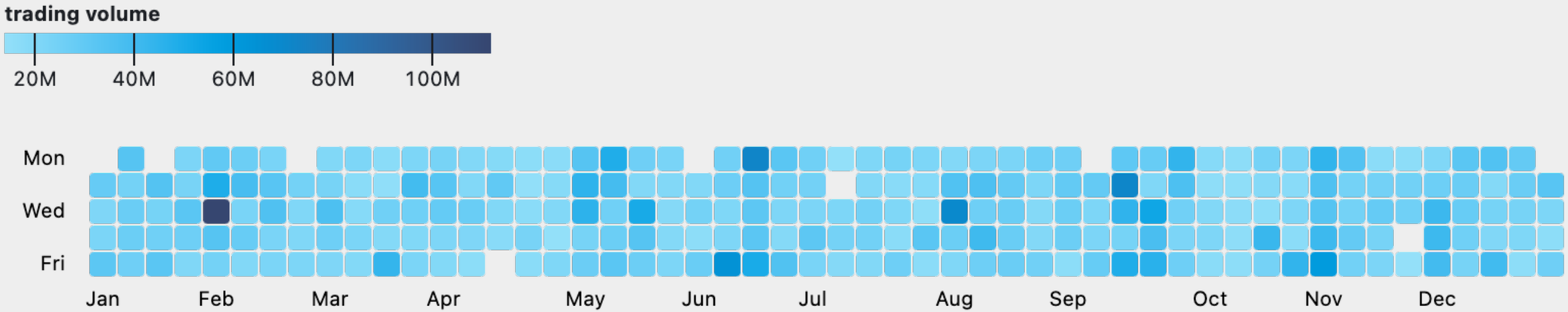


Trading volume of AAPL stock in 2017

Quantitative Scale Tryout



Trading volume of AAPL stock in 2017

Concluding Thoughts

- Mind your hues for color-vision deficiency (CVD)
- Luminance drives color scales:
  - quantitative scales - interesting values prominent from background
  - categorical scales - luminance differences to (help) avoid CVD problems