universität
innsbruck
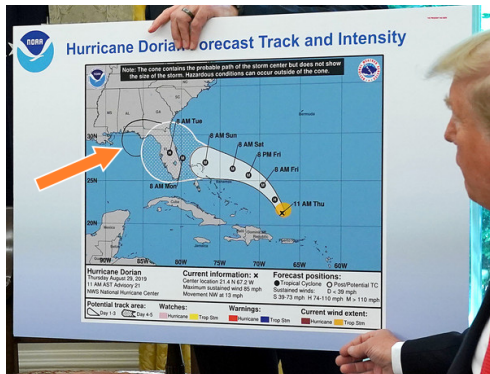
colorspace

Robust Color Maps That Work for Most Audiences
(Including the U.S. President)
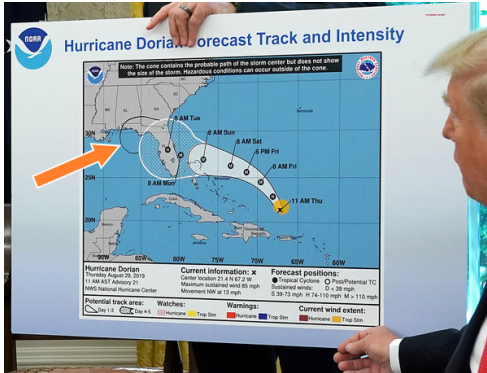
Reto Stauffer, Achim Zeileis

http://colorspace.R-Forge.R-project.org/
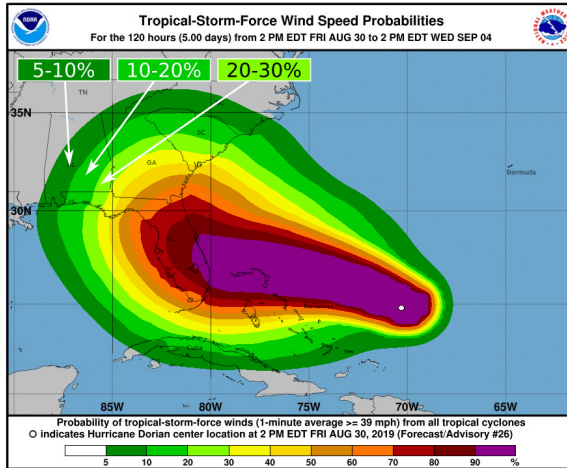
Motivation

Motivation

Projected track and wind speed forecast of hurricane Dorian. Screenshot of a video released by the White House (Sep. 4, 2019), tweet by the U.S. president (Sep. 5, 2019).
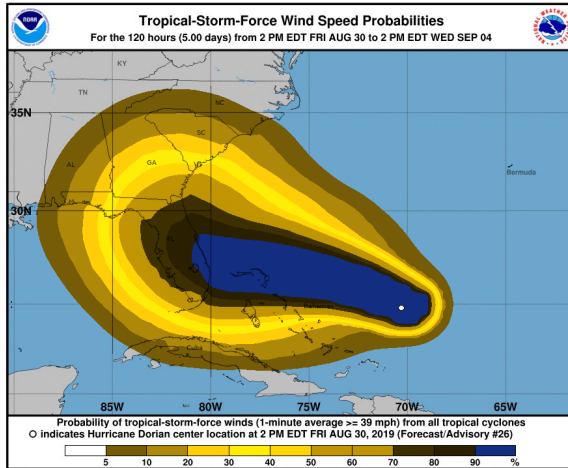
Motivation

Probability of exceeding wind speeds of 39 mph ($63\,\mathrm{km\,h^{-1}}$), Aug 30 – Sep 04, 2019 (noaa.gov).

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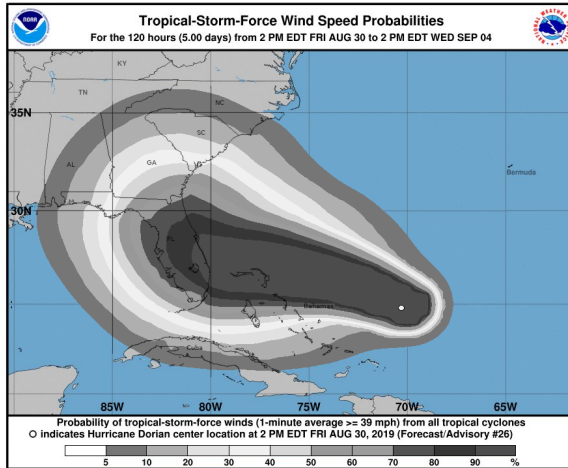

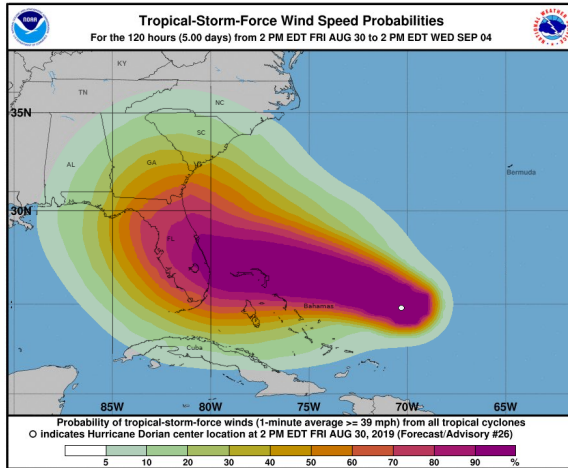Probability of exceeding wind speeds of 39 mph (63 km h^{-1}), Aug 30 – Sep 04, 2019 (noaa.gov).

Motivation

Probability of exceeding wind speeds of 39 mph (63 km h^{-1}), Aug 30 – Sep 04, 2019 (noaa.gov).

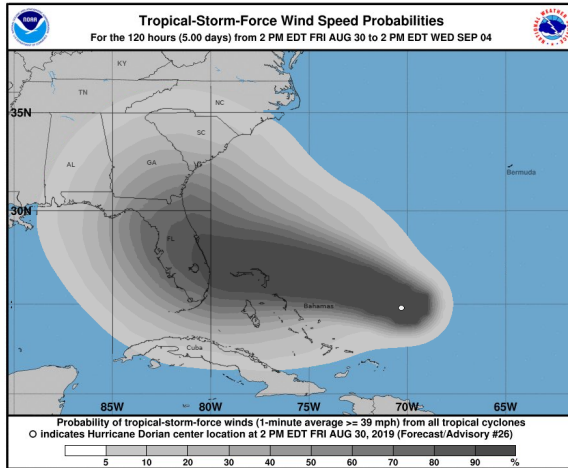# HCL vs. RGB

HCL: Polar coordinates in CIELUV. Captures perceptual dimensions of the human visual system very well.

Hue
(Type of color)

Chroma
(Colorfulness)

Luminance
(Brightness)

HCL vs. RGB

HCL: Polar coordinates in CIELUV. Captures perceptual dimensions of the human visual system very well.
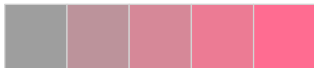
RGB: Motivated by how computers/TVs used to generate and still represent color.

HCL vs. RGB
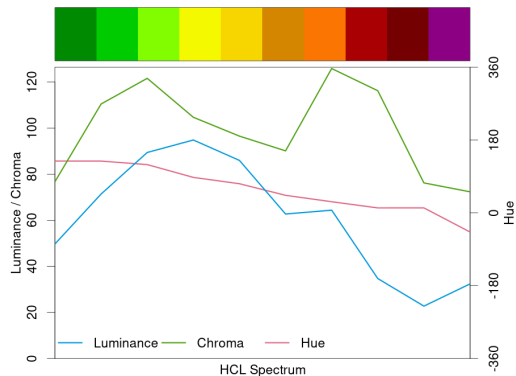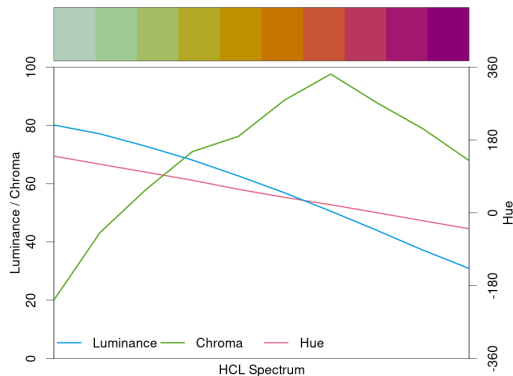
Spectrum of the HCL (l.) and RGB (r.) color maps used for the motivational figure.
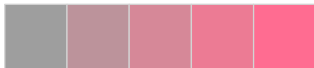
Color palettes: Somewhere over the Rainbow

Qualitative (Set 2)	**Sequential (Blues 3)**	**Diverging (Green–Brown)**
Color	Color	Color
Desaturated	Desaturated	Desaturated

Qualitative: For categorical information.
Constant chroma and luminance.

Sequential: For ordered/numeric information (i.e., high to low).
Monotonic increase/decrease of chroma and luminance.

Diverging: For ordered/numeric information around a central neutral value.
Symmetric change in chroma and luminance.

Color palettes: Somewhere over the Rainbow

Qualitative
- Pastel 1
- Dark 2
- Dark 3
- Set 2
- Set 3
- Warm
- Cold
- Harmonic
- Dynamic

Sequential (single–hue)
- Grays
- Light Grays
- Blues 2
- Blues 3
- Purples 2
- Purples 3
- Reds 2
- Reds 3
- Greens 2

- Greens 3
- Oslo

Sequential (multi–hue)
- Purple–Blue
- Red–Purple
- Red–Blue
- Purple–Orar
- Purple–Yello
- Blue–Yellow
- Green–Yello
- Red–Yellow
- Heat
- Heat 2
- Terrain
- Terrain 2
- Viridis
- Plasma
- Inferno
- Dark Mint
- Mint

- BluGrn
- Teal
- TealGrn
- Emrld
- BluYl
- ag_GrnYl
- Peach
- PinkYl
- Burg
- BurgYl
- RedOr
- OrYel
- Purp
- PurpOr
- Sunset
- Magenta
- SunsetDark
- ag_Sunset
- BrwnYl
- YlOrRd

- YlOrBr
- OrRd
- Oranges
- YlGn
- YlGnBu
- Reds
- RdPu
- PuRd
- Purples
- PuBuGn
- PuBu
- Greens
- BuGn
- GnBu
- BuPu
- Blues
- Lajolla
- Turku

Diverging
- Blue–Red

- Blue–Red 2
- Blue–Red 3
- Red–Green
- Purple–Gre
- Purple–Brov
- Green–Brov
- Blue–Yellow
- Blue–Yellow
- Green–Orar
- Cyan–Mage
- Tropic
- Broc
- Cork
- Vik
- Berlin
- Lisbon
- Tofino

Summary

Our goal:

- Raise the awareness to avoid using inefficient color maps.
- Provide tools to chose and modify efficient color maps.
- Offer tools to assess color palettes to identify possible problems.

Guidelines:

- Avoid large areas of vivid colors.
- Areas of interest should stand out from background.
- Choose type of palette based on the data to be visualized.
- Check color maps used: visual constraints, effectiveness.

Software, Tools and Information

R package:

- *colorspace* facilitates exploration, manipulation, and assessment.
- http://colorspace.r-forge.r-project.org/

Python package:

- *colorspace*; package still in β-state.
- https://github.com/retostauffer/python-colorspace

Web interface:

- http://hclwizard.org/; interactive tools and more information.

References

Zeileis A, Fisher JC, Hornik K, Ihaka R, McWhite CD, Murrell P, Stauffer R, Wilke CO (2019). "colorspace: A Toolbox for Manipulating and Assessing Colors and Palettes." arXiv:1903.06490, arXiv.org E-Print Archive. `http://arxiv.org/abs/1903.06490`

Zeileis A, Hornik K, Murrell P (2009). "Escaping RGBland: Selecting Colors for Statistical Graphics." *Computational Statistics & Data Analysis*, **53**, 3259–3270. `doi:10.1016/j.csda.2008.11.033`.

Stauffer R, Mayr GJ, Dabernig M, Zeileis A (2015). "Somewhere over the Rainbow: How to Make Effective Use of Colors in Meteorological Visualizations." *Bulletin of the American Meteorological Society*, **96**(2), 203–216. `doi:10.1175/BAMS-D-13-00155.1`