2D Scalar Visualization

Thanks to Drs. Rheingans and Hansen for material for these slides
Color Mapping

- Display scalar value through a color map or a color scale
- Map interval on the real line to a path through color space $f : \mathbb{R} \to \{\text{RGB, HSV}\}$
- (demo: ozone.vt, mpl jet)
Basic Strategies

• Vary a single color model component
• Remember color science: relative brightness vs absolute brightness
• Use brightness for qualitative assessments
• (demo: ozone.vt, Red-White, making it grey)
Basic Strategies

• Vary a single color model component
  • Remember color science
    • Use **hue** for **quantitative assessments**
  • (demo: ozone.py, Hue wrap, hue no wrap)
Basic Strategies

- Redundant Cues
  - Fault tolerance: provide same info in multiple ways
- Easy with color scales
- (demo: ozone.vt, Redundant *)
Basic Strategies

• If there is a neutral, zero-like scalar in the field, use a double-ended scale

• Alternatively, if you want to emphasize both extremes.

• (demo: ozone.py, Double-Ended)
Some Standard Color Scales

- Gray
- Linearized Gray
- Rainbow
- Magenta
- Heated
- Optimal
- Linearized Optimal
- Blue-Cyan
- Blue-Yellow
Gray, Linearized Gray

- Gray
- Linearized Gray

- Are these really different?
Gray vs. Linear Gray

Gray

Linearized Gray
More color scales..

Magenta

Rainbow

Blue-Cyan

Heated

Blue-Yellow

Optimal
Remember Cultural Issues

- Sometimes colors have connotations
- A colorbar might not be enough help, people love to jump to conclusions
  - Red “bad”, green “good” not universal, so it’s even worse!
- If you can’t help it, at least be aware
Bivariate color scales

• We intuitively perceive colors along three axes
• use that to display more information in a single picture
• Good: less waste
• Bad: less redundancy, interference
Hue vs Brightness

- Changes of hue imply change in brightness
Hue vs Brightness

- **Isoluminant** colormaps
- *(watch out for gamma!)*
How to design colorscales

- **Trumbo’s principles:**
  - Ordered values should be represented by ordered colors
  - Significantly different levels should be given significantly different colors
  - Bivariate colormaps should preserve univariate information
  - To show correlation, use “above diagonal”, “on diagonal”, “below diagonal”
Trumbo’s Principle #1

Bad

Better
Trumbo’s Principle #2

Bad

Better
Trumbo’s Principles #3, 4

Tufte ‘83, pg. 153
Heightfields

- We use height in 1D plots, let’s use it in 2D plots
- Direct intuition with topography
- (demo: elevation.vt)
Contour Lines

• Draw lines of constant value
• They bound regions of contiguous values
  • Loops or lines through end of dataset
• Multiple contours
  • Why?
• (demo: elevation.vt, Contours)
Computing Contours

- Simplest case: triangles
  - Let’s use Rolle’s theorem: if along a line $[a, b]$, $\text{sgn}(f(a)) \neq \text{sgn}(f(b))$ there exists a root of $f$ in $[a, b]$
  - It’s enough to know it roughly, since we’re sampling the scalar field anyway
Contouring triangles

Only these two cases. Why?
Contouring squares

• (demo, elevation.vt, contours)
Contouring squares

- More cases
Resolving the ambiguity

- Goes back to interpolation...
- (demo: asymptotic_decider.vt)
Resolving the ambiguity

• Simple! Compare value with asymptote scalar, and use that