Color Crafting: Automating the Construction of Designer Quality Color Ramps

CPSC 547
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Existing Approaches
• Use (limited) intuition
• Choose from predefined set
• Select colors (control points) and interpolate

How can designers of all levels craft high-quality color ramps?

Hand designed
Interpolating endpoints

Hand designed ramps can be modelled as curves
• Curves have salient structural properties
• Common structural patterns occur across subsets of ramps

Color ramps can be modelled as curves

• Curves have salient structural properties
• Common structural patterns occur across subsets of ramps

Method Overview
1. Transform designer ramps into curves
2. Cluster the curves
3. Model the curves
4. Seed the curves

[Step 1] Transform Ramps Into Curves
• Raw data: 222 designer-quality color ramps
• Fit interpolating curve through colors of each ramp
• Normalize curves to nine points

[Step 2] Curve Clustering
• Use two unsupervised clustering techniques to capture patterns in expert-crafted ramps
1. Bayesian
2. K-means
• Clustering is based on curve structure (not color)

[Step 2] Curve Clustering
• Method 1: Bayesian Clustering
• Group curves based on overall shape
• Elastic shape metric = invariant to affine transformations

[Step 2] Curve Clustering
• Method 2: K-means Clustering
• Group curves based on color ramp structure
• Compute 255-dimension feature vector for each curve
• Explicitly consider features related to structure of ramp
• E.g. Rate of change between adjacent colors

[Step 3] Model Construction
• Within each cluster...
• Align each curve to common starting point
• Orient each curve to same direction
• Construct a representative curve

Modeling Designer Practice
• Goal: construct high-quality color ramps that reflect experts’ design practices
• Method: utilize clustering algorithms to learn patterns from designer color ramps

Background

Color Ramps
• Used to encode ordered data
• Can be sequential or diverging
• Properties of effective ramps:
  • Discriminable colors
  • Well-aligned with the data
  • Aesthetically pleasing

Evaluation

Critique
[Step 4] Seeding
- User specifies seed color
- Compute $\Delta L^*$ between seed and control points
- Translate curve
- Compute other colors based on relative positions of control points

$L^* = 27$

Critique: Strengths
- Robust evaluation methods
- Great example how algorithm/techniques from different studies can be combined
- E.g. Bayesian clustering approach was from a different paper
- Algorithm has very high utility
- Color ramps are used all the time!

Discussion

Lab Study/Expert Review
- Goal: Compare accuracy and subjective preference between ramps generated from different techniques
  - Bayesian clustering
  - K-means clustering
  - Linear interpolation
  - Hand-crafted by designer

Critique: Weaknesses
- Restrictive input/output
- E.g. Can only specify one seed color, generated ramp has nine colors
- Clustering techniques difficult to understand without prior ML knowledge

Thank you!

https://cmci.colorado.edu/visualab/ColorCrafting/