Dynamic Closest Color Warping to Sort and Compare Palettes

SIGGRAPH 2021
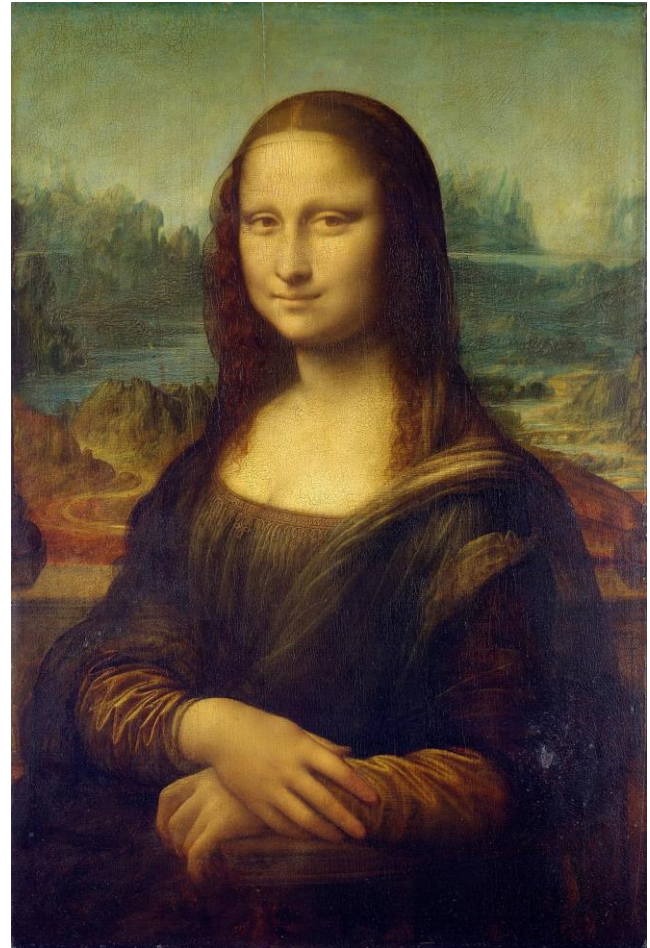
SUZI KIM and SUNGHEE CHOI, KAIST, Republic of Korea
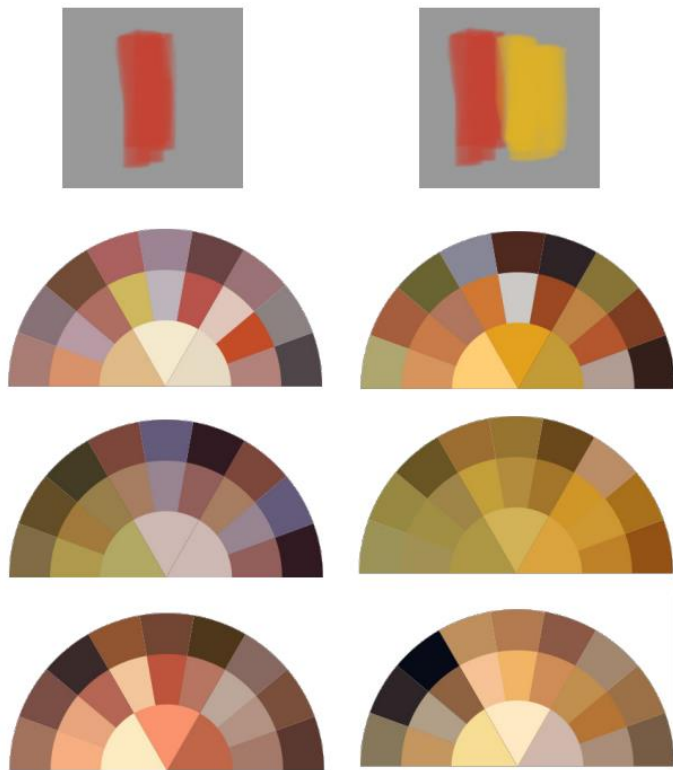
Why do we need a palette?
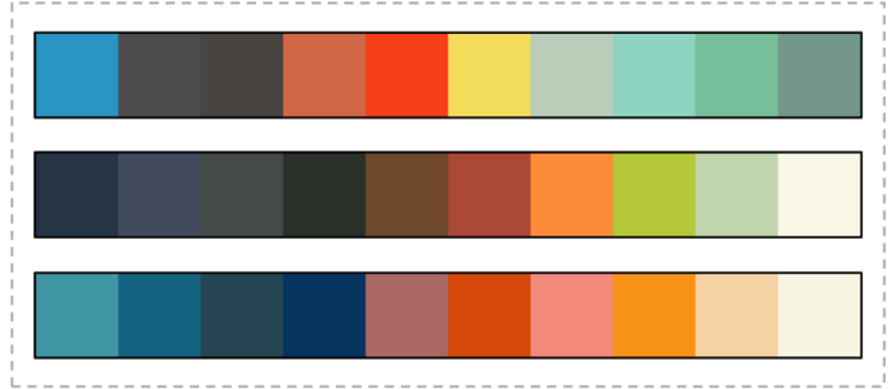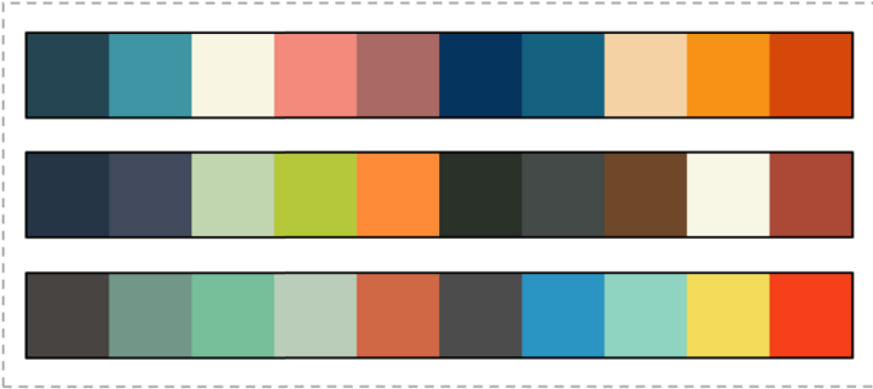
Why do we need a palette?

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Why do we need a palette?

Why do we need to sort a palette?

- Easily create good palettes without professional art skills

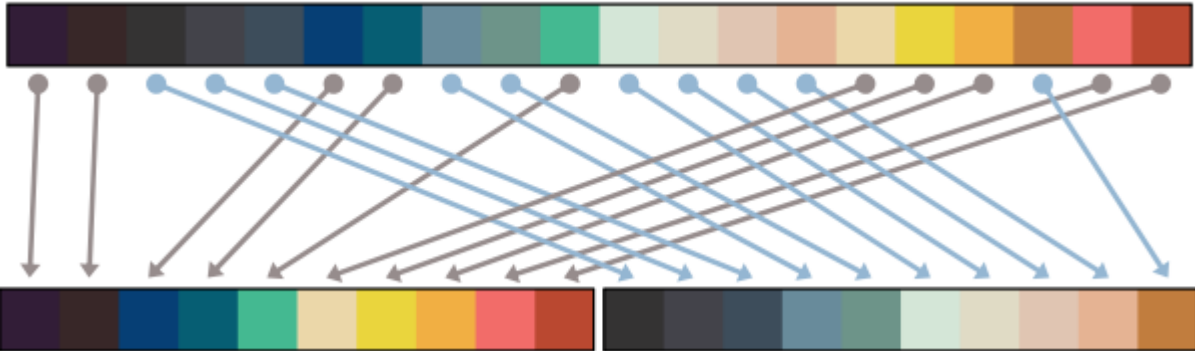- Find color trendings in random combination of colors

What's the problem to sort a palette?

- How do you define a *good color trending*?

- What's the *distance* between 2 colors?

- Can we separate several palettes from a bunch of colors?

What we want:

Visual Plausibility

Palette Creation

Palette Sorting

Palette Separation

Inner Structure of Colors

Fun Application

What we don't want:

Image Compression

Neural Network

Boring Evaluation

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Single Palettes Sorting

Single Palette Sorting

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"Nature Order of Colors":

- CIELAB* color space
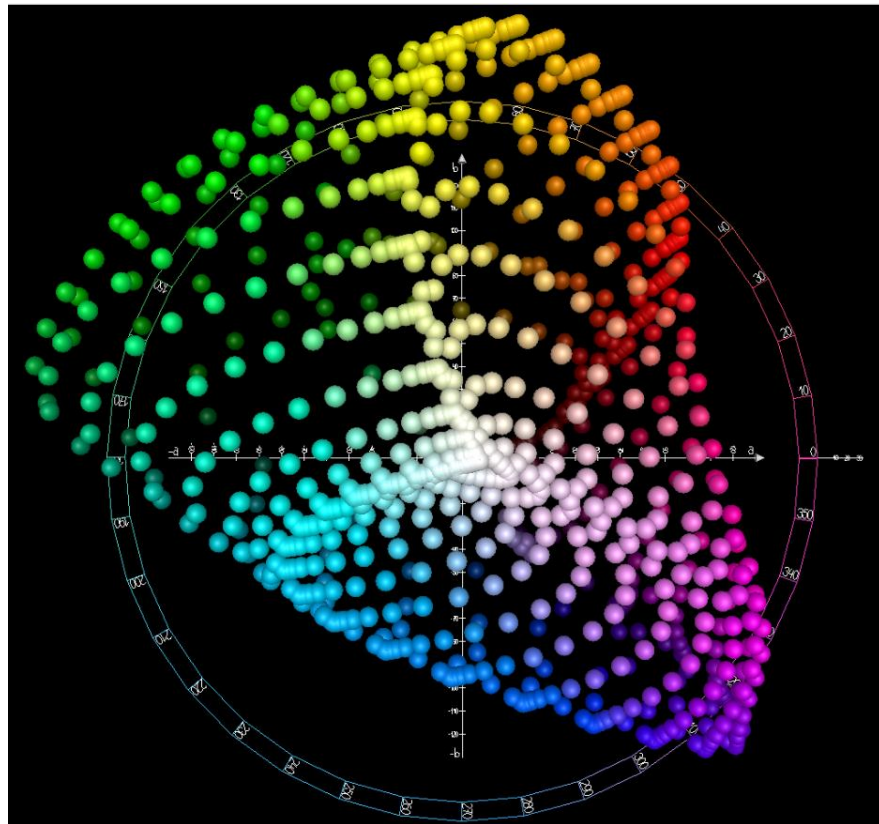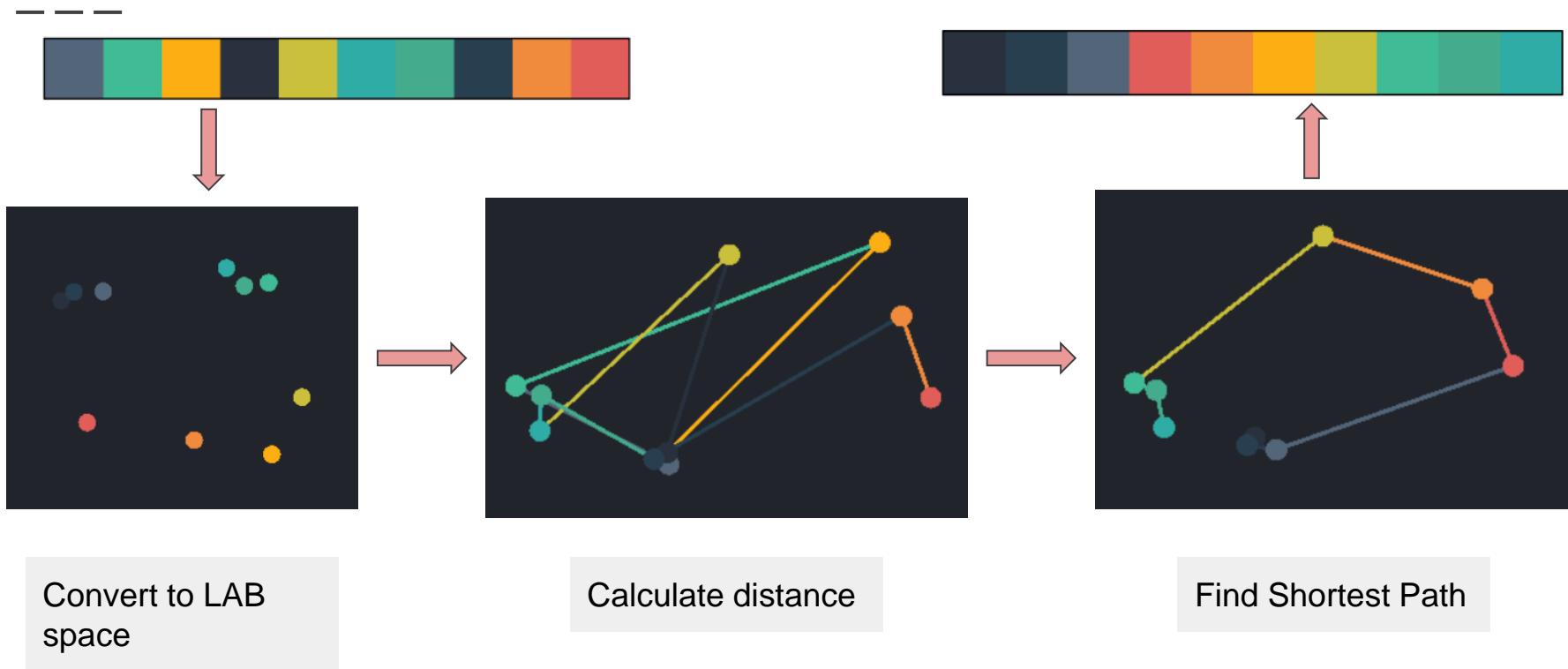
L*: Luminance

a*: Red and Green

b*: Blue and Yellow

CIELAB colorspace is a device independent,
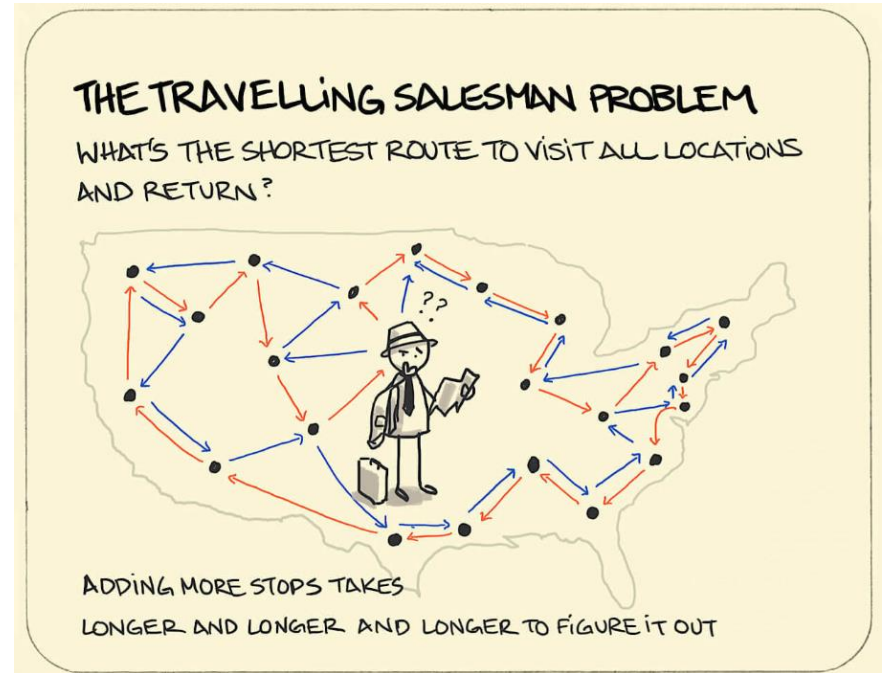
"standard observer" model

Reference: [Math | EasyRGB](#)

Single Palette Sorting

Convert to LAB space

Calculate distance

Find Shortest Path

Solving Traveling Salesman Problem

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Old classic problem from 1930, but still under intensive studying…

- Iterate through all solution? O(n!)
- Held-Karp Algorithm(Dynamic Programming)
- Genetic Algorithm
- Annealing
- Lin–Kernighan heuristic 👍

THE TRAVELLING SALESMAN PROBLEM
WHAT'S THE SHORTEST ROUTE TO VISIT ALL LOCATIONS AND RETURN?

ADDING MORE STOPS TAKES
LONGER AND LONGER AND LONGER TO FIGURE IT OUT

Single Palette Sorting

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1. Locate color point in CIELAB space

2. Calculate distance between colors

3. Symmetric Traveling Salesman Problem

4. Cut the longest edge to flatten the loop into a palette

Single Palette Sorting is Good Enough?

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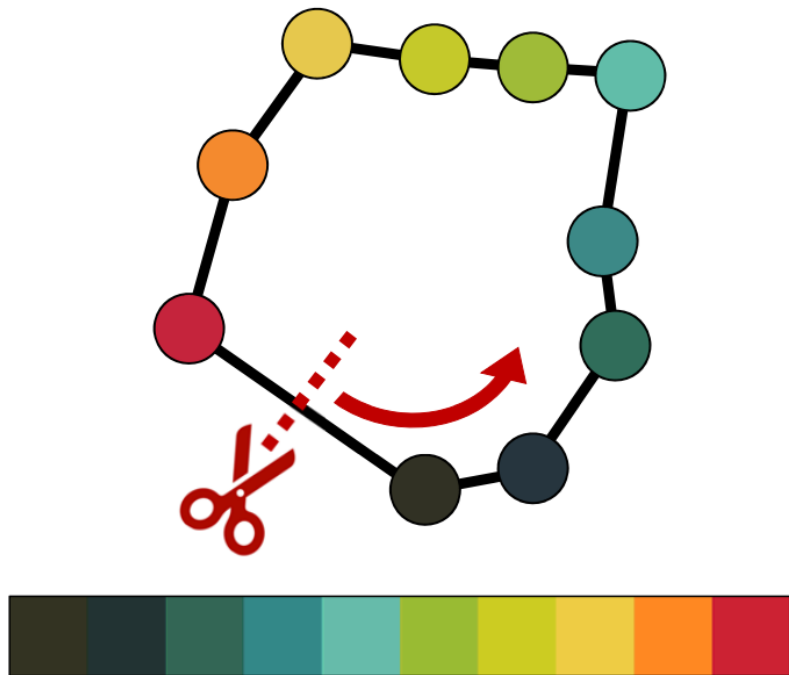
Our result:

Looks good, but…

Single Palette Sorting is Good Enough?

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Our result:

Looks good, but…

Useful palette in real world is not

a single flatten row, but an array
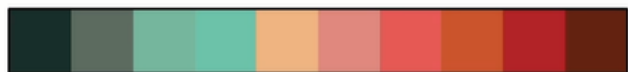
Single Palette Sorting is Good Enough?

1. Plenty of colors categorized into multiple columns

2. Colors in Every column is well sorted

3. Color trendings in each column is similar

Two Palettes Sorting

Two Palettes Sorting

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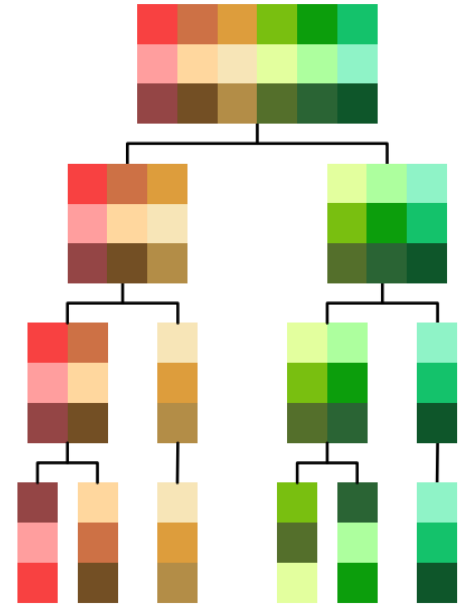# Two Palettes Sorting
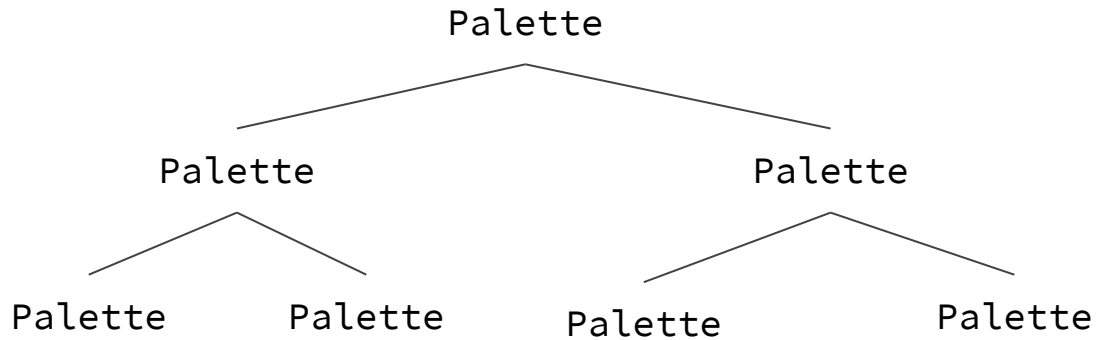

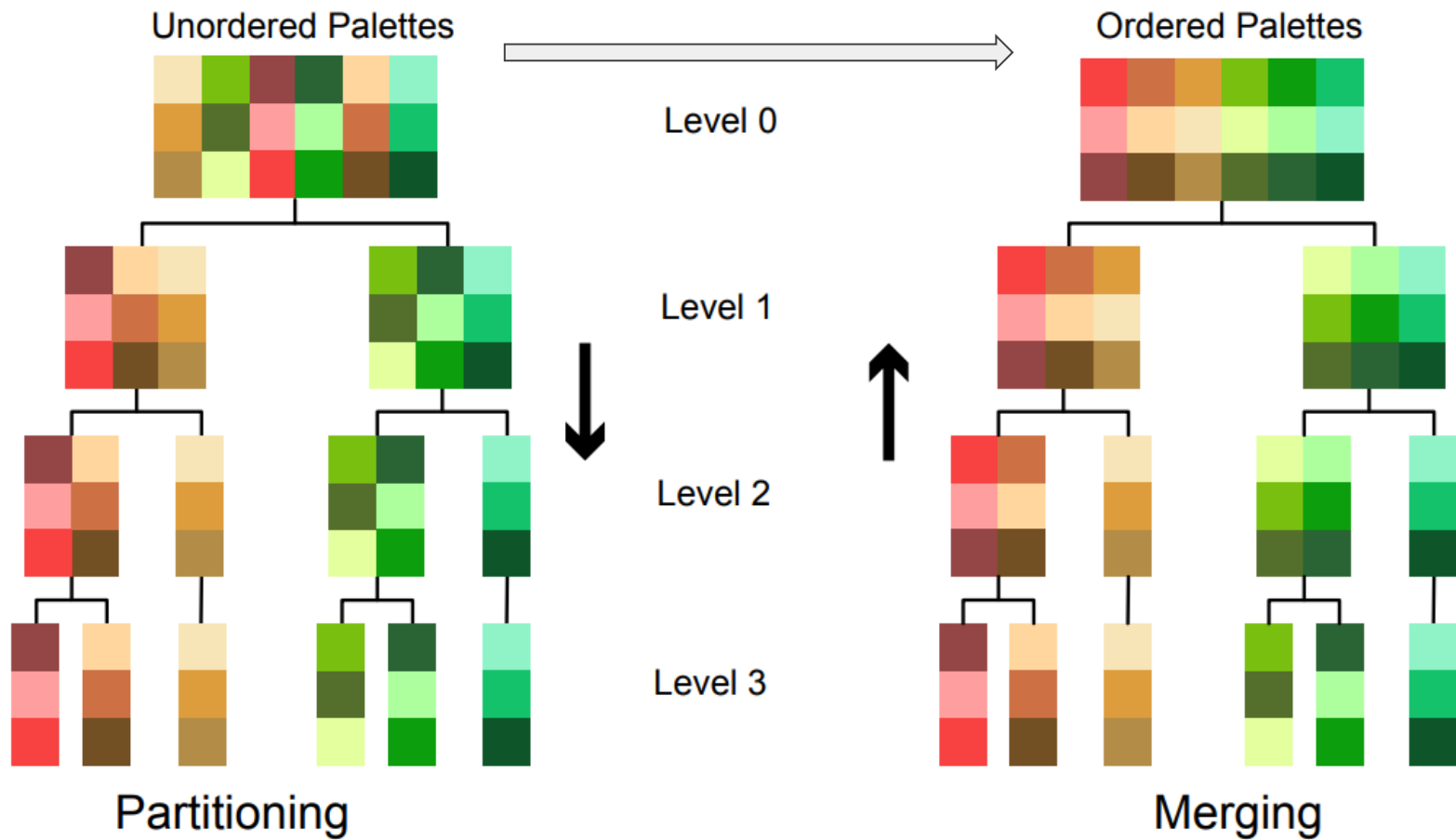

a. Both well sorted   b. Similar color trending

Two Palettes Sorting

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Why do we need to sort two palettes?

Two Palettes Sorting

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Why do we need to sort two palettes?
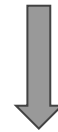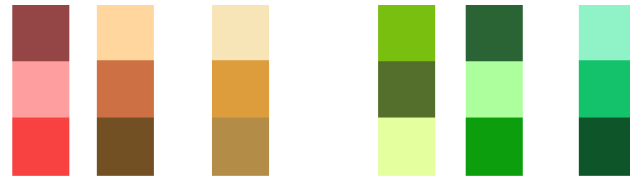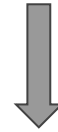
Merge 2 palettes = Merge infinite palettes

Palette

Palette   Palette

Palette   Palette   Palette   Palette

Unordered Palettes

Ordered Palettes

Level 0

Level 1

Level 2

Level 3

Partitioning

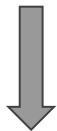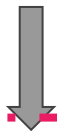Merging

Unordered Messy Colors

Lots of little Palettes
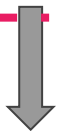
Ordering little Palettes

Beautiful Big Palettes
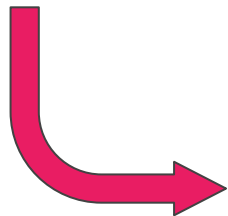
Unordered Messy Colors

Lots of little Palettes

Two Palettes Sorting

Ordering little Palettes

Beautiful Big Palettes

Two Palettes Sorting

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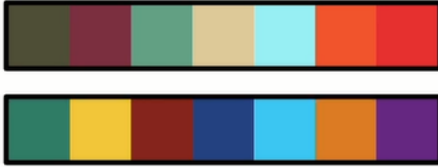
Two Palettes

Two Palettes Sorting

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1
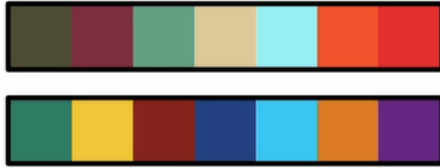
Two Palettes

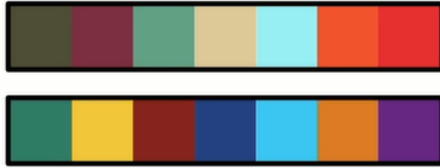**2**

Merged Palettes

Two Palettes Sorting
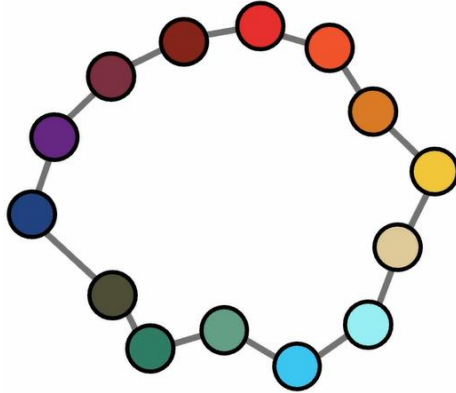
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1

Two Palettes

2

Sorted Palettes

Two Palettes Sorting

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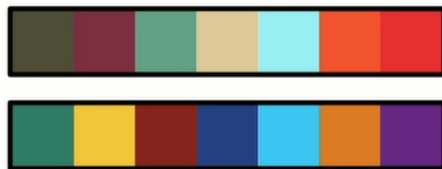
1

Two Palettes

2

Sorted Palettes

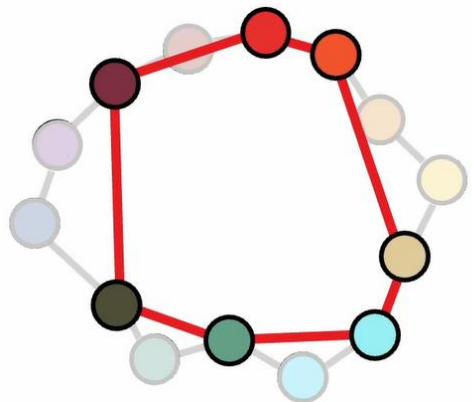# Two Palettes Sorting

— — —
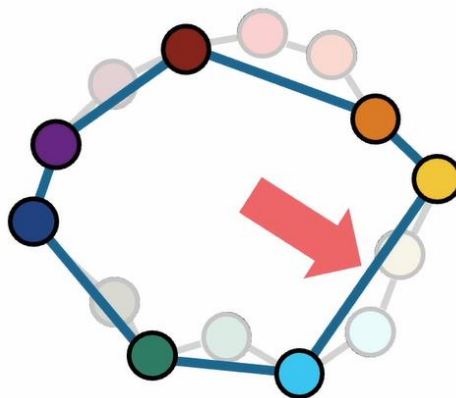
1
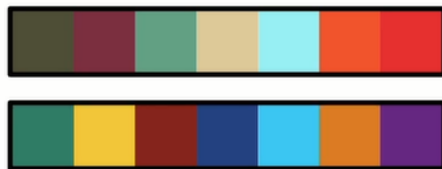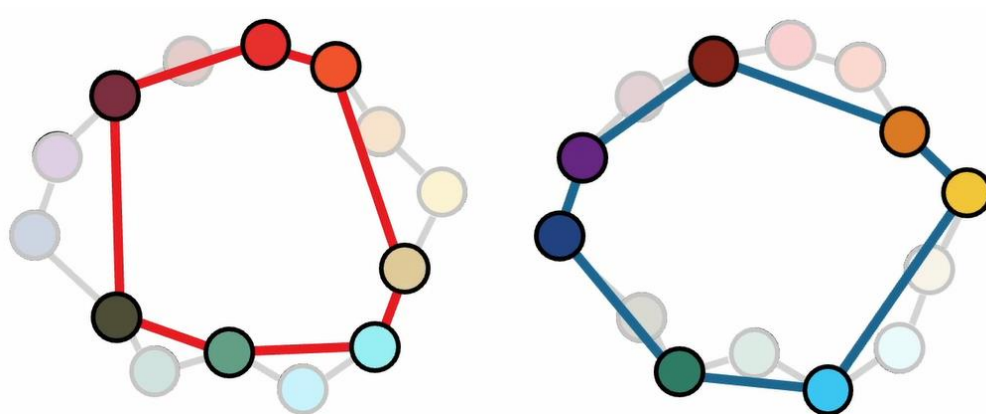
Two Palettes

2

Sorted Palettes

3

Find the longest edge connecting the same palette colors
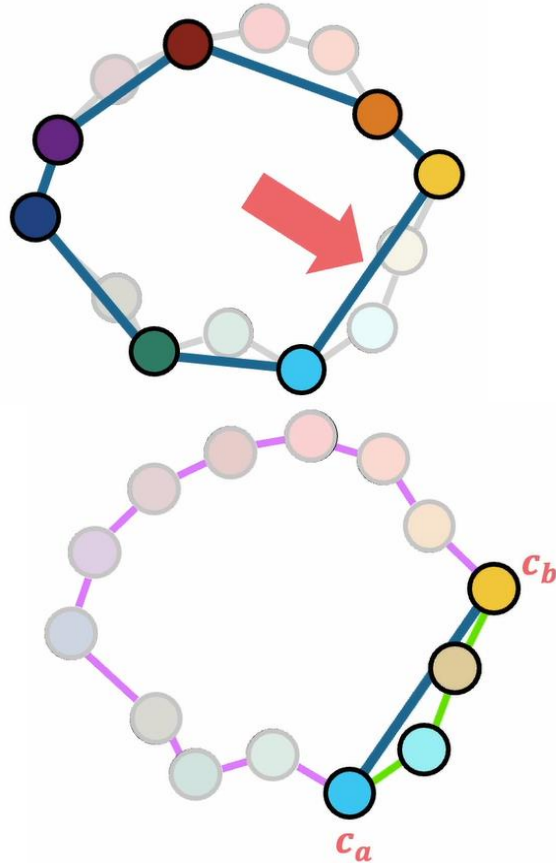
Two Palettes Sorting

— — —

3

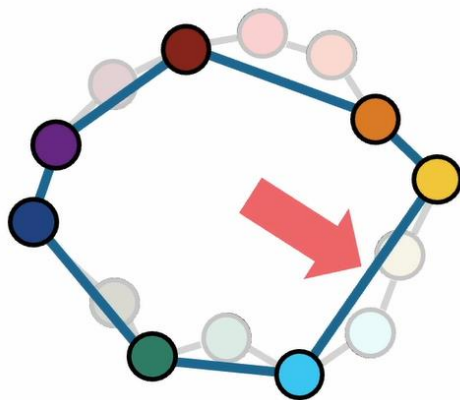Find the longest edge connecting the same palette colors

4

Choose the subpath with fewer vertices

Two Palettes Sorting

– – –

3

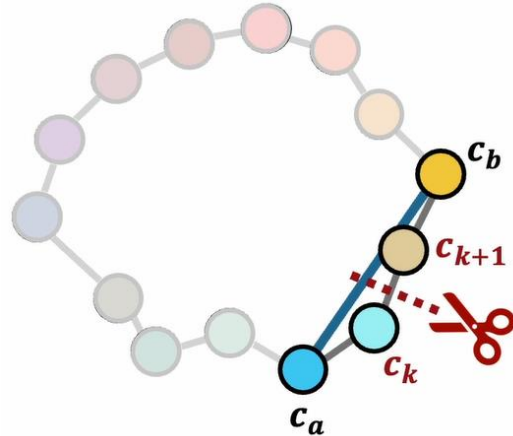Find the longest edge connecting the same palette colors

4

Choose the subpath with fewer vertices, and find a cut point

$$\min_{i \in (a,b)} \{ \sum_{i=a+1}^{k} d(c_a, c_i) + \sum_{i=k+1}^{b-1} d(c_b, c_i) \}$$

Two Palettes Sorting

— — —

4

Choose the subpath with fewer
vertices, and find a cut point

$$\min_{i \in (a,b)} \left\{ \sum_{i=a+1}^{k} d(c_a, c_i) + \sum_{i=k+1}^{b-1} d(c_b, c_i) \right\}$$
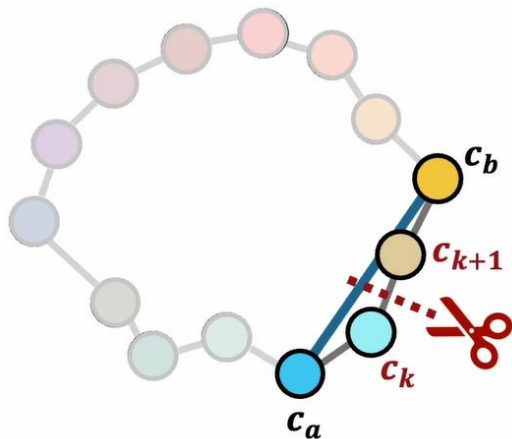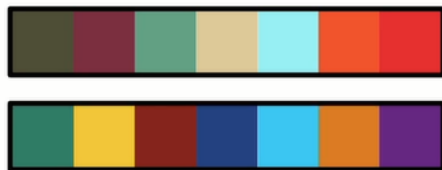
5

Flatten into sorted palette

Two Palettes Sorting

— — —

1

Two Palettes

5

Flatten into sorted palette

Two Palettes Sorting

— — —

1

Two Palettes

Different size

5

Flatten into sorted palette

Two Palettes Sorting

— — —

1

Two Palettes

Different size

More than 2 palettes

5

Flatten into sorted palette

Application

Palette Interpolation

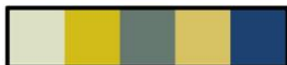Random Colors

Sorted Colors

Interpolation

A Good Palette

Palette Extraction

Palette Transfer

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Palette Transfer

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Source

Target

Sorted Target

Adjusted Target

Palette Transfer

My Implementation

Fun Palettes

An application to:

1. Visualize color space

2. Edit and adjust color palette

3. Color palette sorting

4. Save and load palette

5. Create palette from several color

What I expect further:

1. Better methods on solving TSP

2. Palette extraction and transfer from image

Thank You!