Investigating Human and Computer Performance in Color Comparison for Coral Bleaching Monitoring

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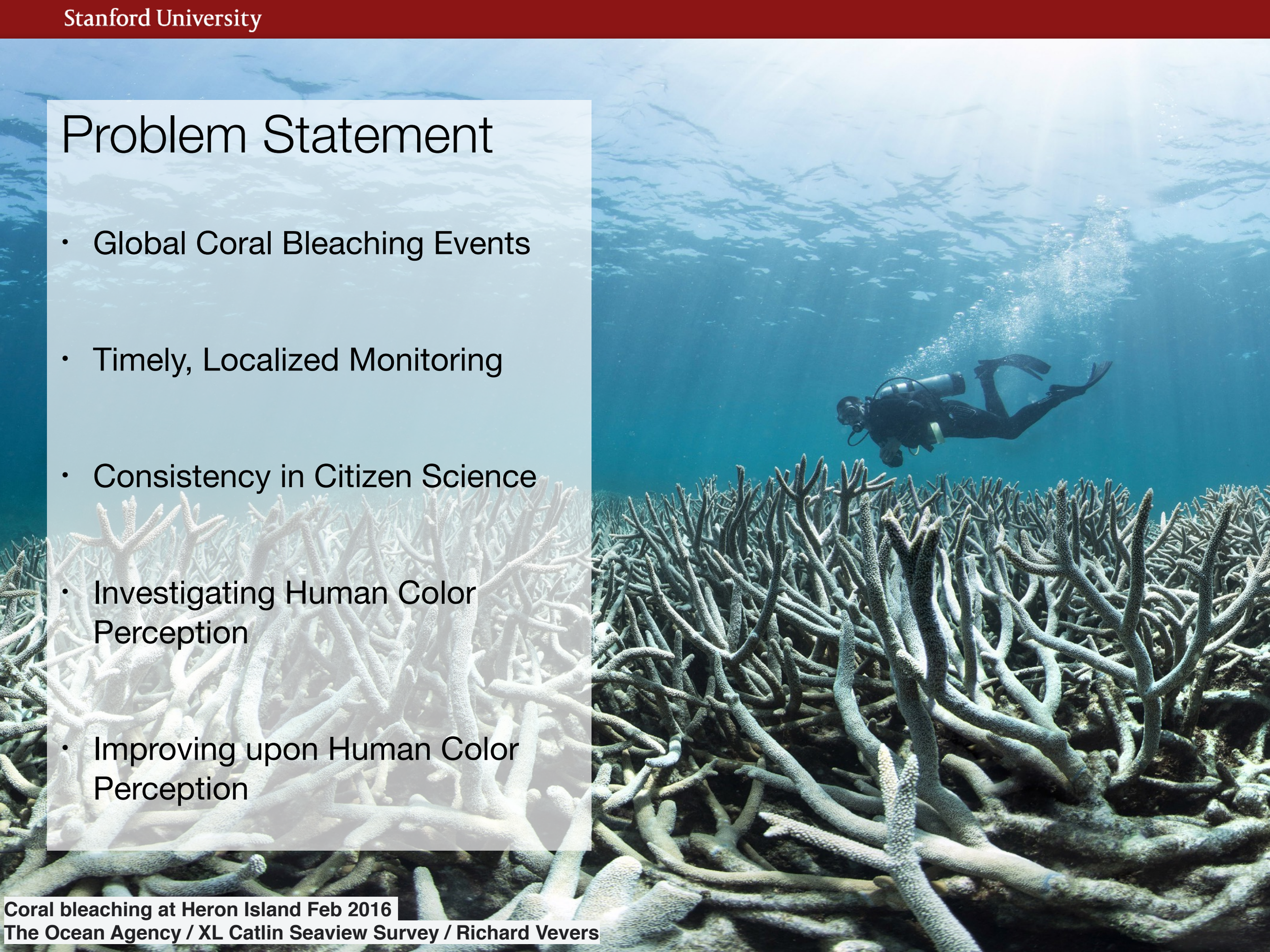
Final Project Presentation
Wrigley Field Program in Hawaii | 2018
Dec. 14, 2018

Presentation Outline

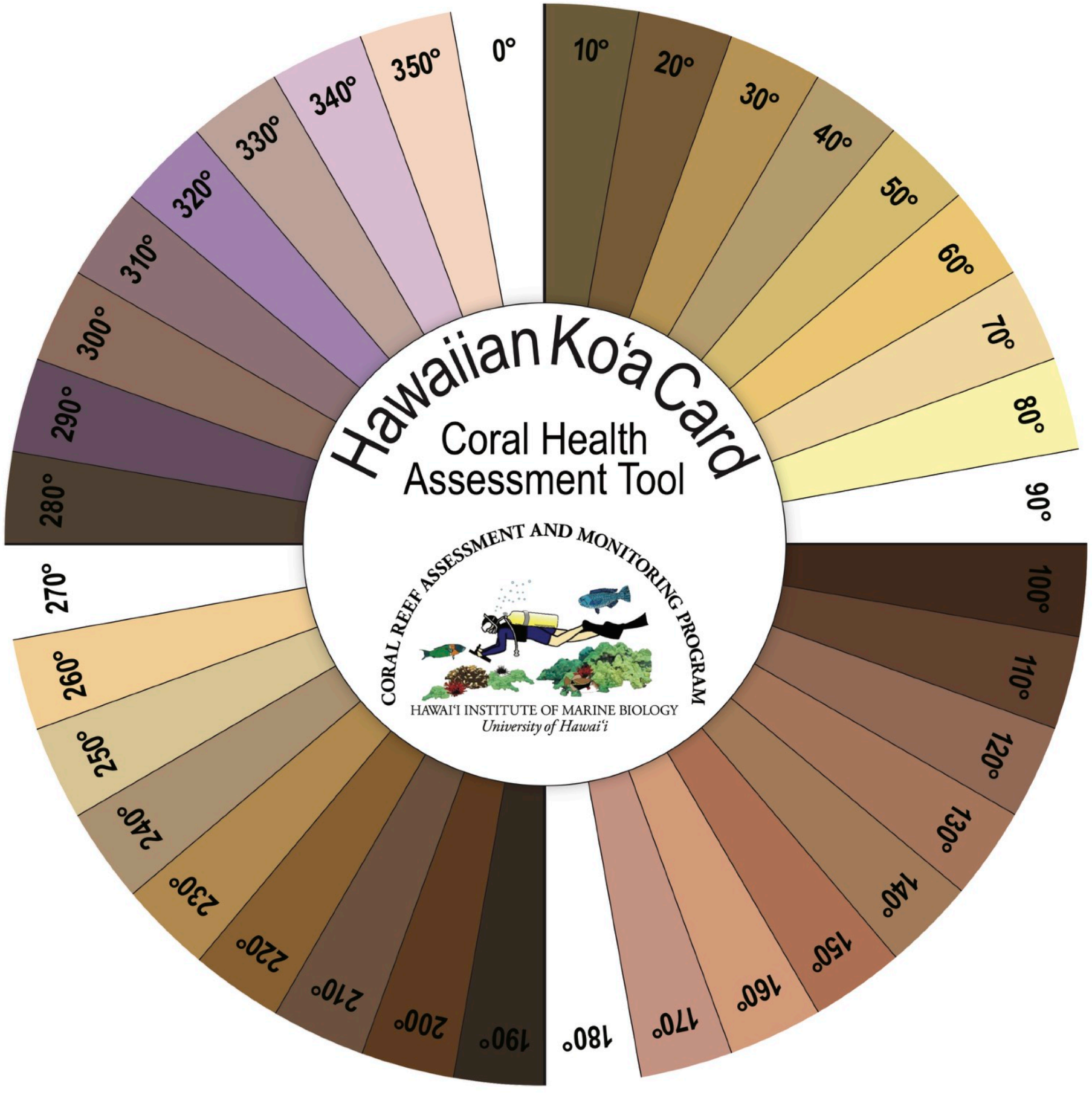
- **[Research Motivation: Coral Bleaching Monitoring]**
- Qualifying Human Color Perception
- Emulating Human Efforts with Computers
- Comparing Computers & Humans - What We Learn

Problem Statement

- Global Coral Bleaching Events
- Timely, Localized Monitoring
- Consistency in Citizen Science
- Investigating Human Color Perception
- Improving upon Human Color Perception



Coral bleaching at Heron Island Feb 2016
The Ocean Agency / XL Catlin Seaview Survey / Richard Vevers



Bahr et al., in prep (expected 2019)

Ko’a Card - Human Observers

Research Goals & Hypothesis

- Investigate human performance in color perception tasks
    - Large variation motivates more consistent method
- Develop application to analyze coral colors and compare to humans
    - Computer processing is more consistent and accurate
- Improve citizen science efforts

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Human Performance Analysis

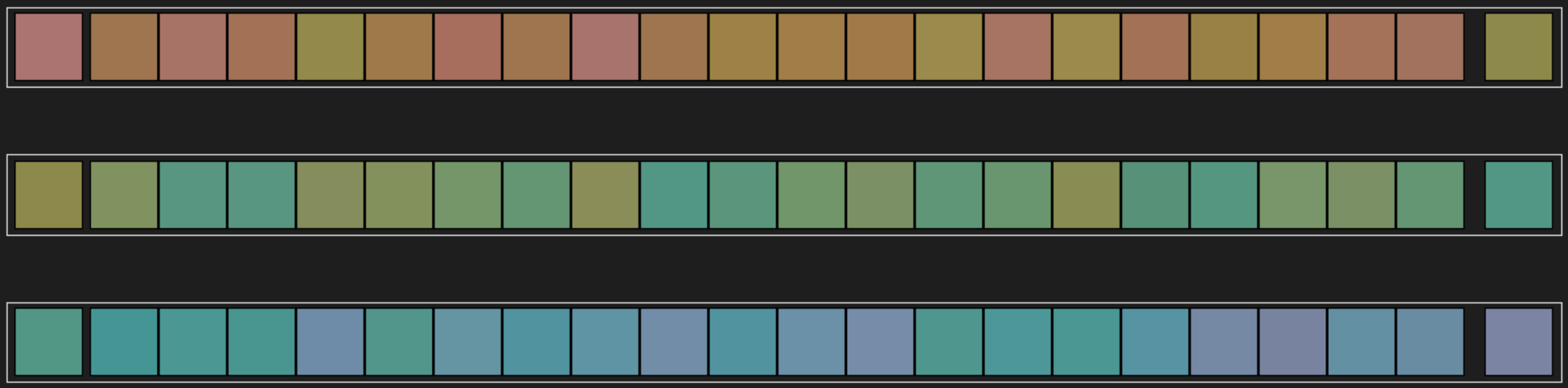
- Farnsworth-Munsell 100 Hue Test[1]

- Human Observations of Coral

[1] Courtesy of https://xritephoto.com/cool-tools

Drag and drop the colors in each row to arrange them by hue order.

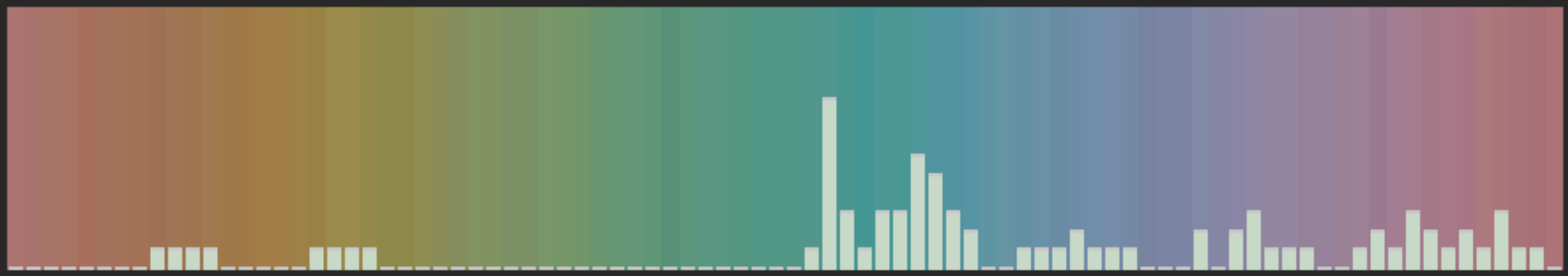
The first and last color chips are fixed. Click on "Score Test" when done.



Score Test

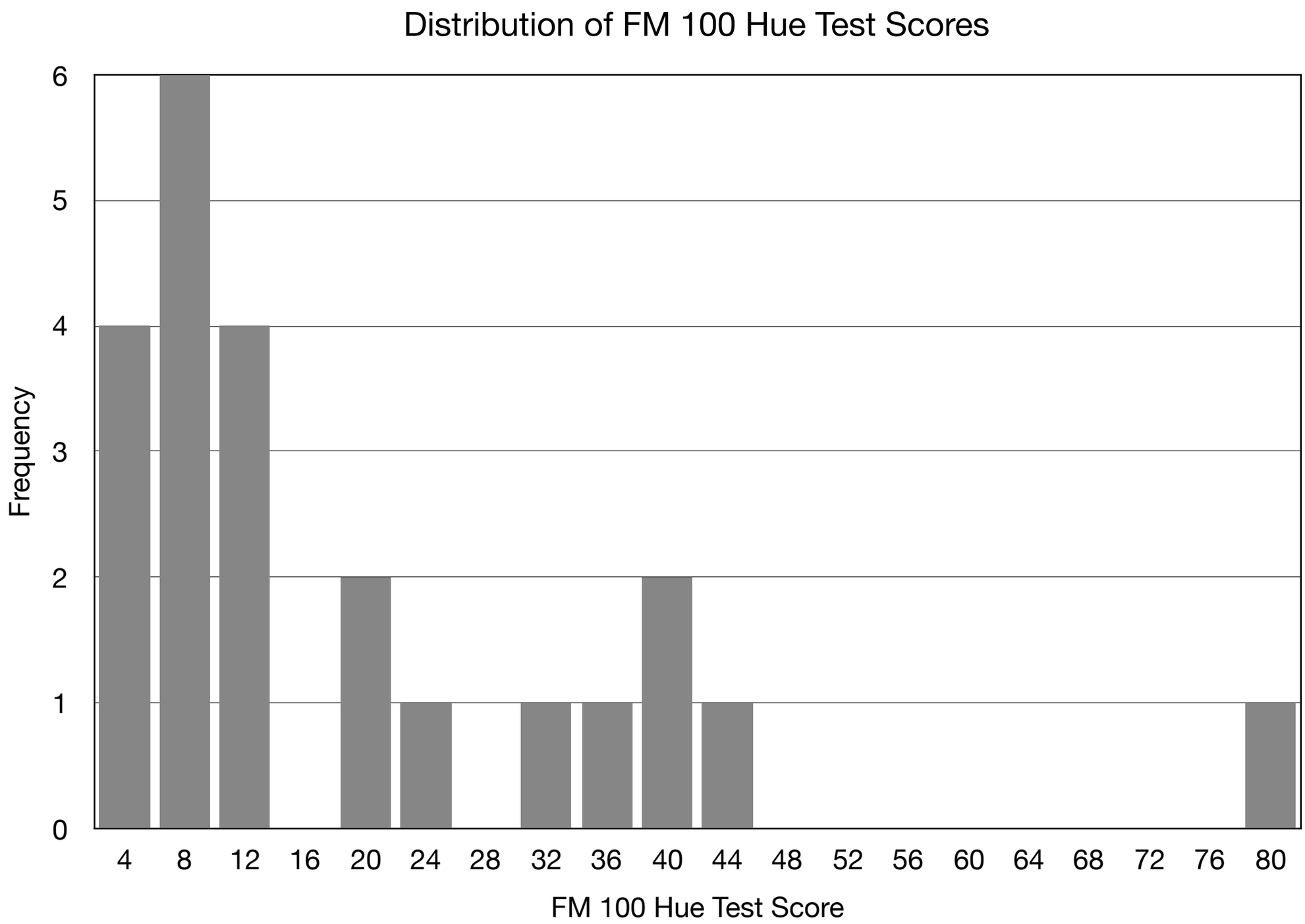
Your score: 80

FM Hue Test Results

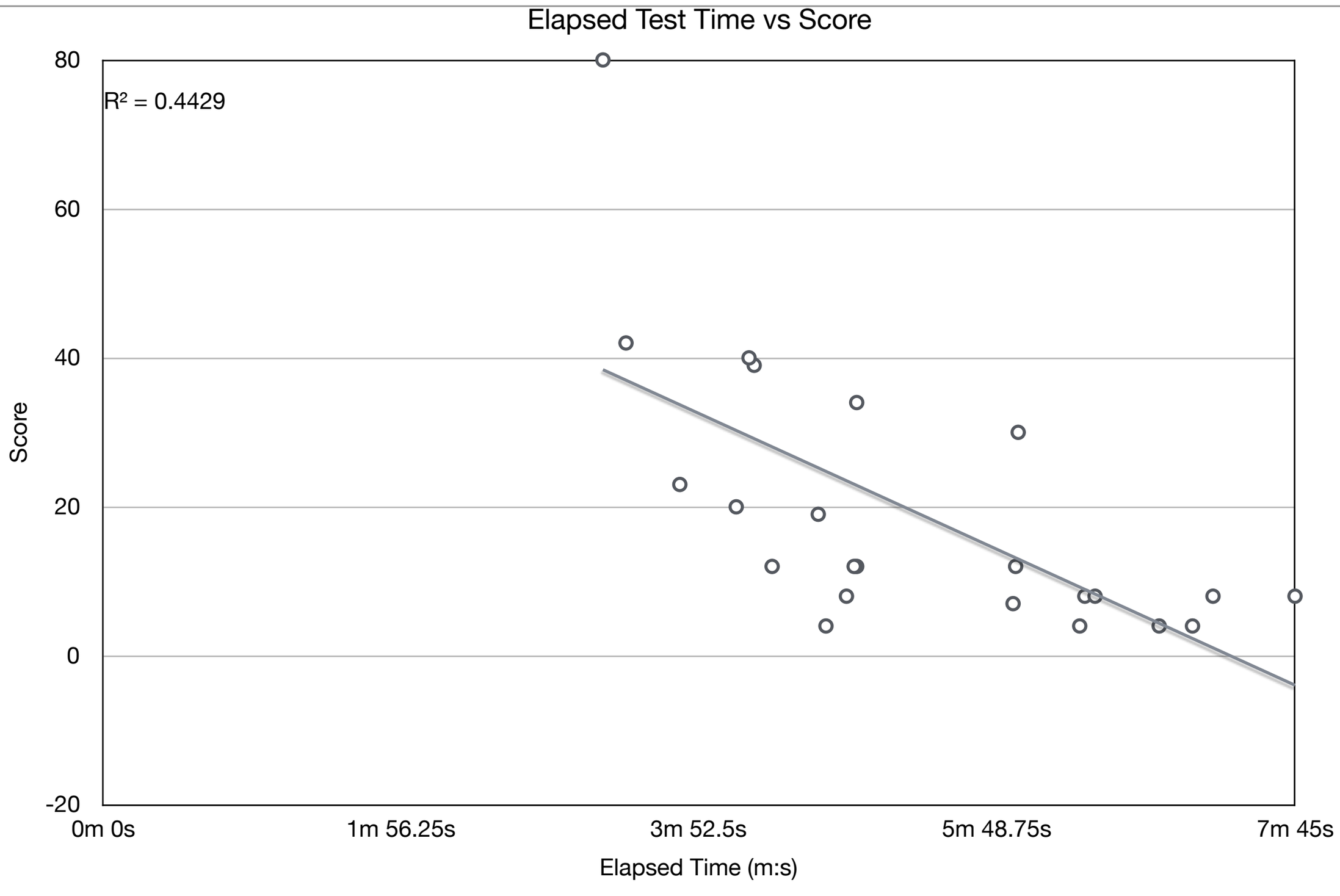


A lower score is better, with ZERO being the perfect score. The bars above show the regions of the color spectrum where hue discrimination is low.

Human Performance Analysis - Results

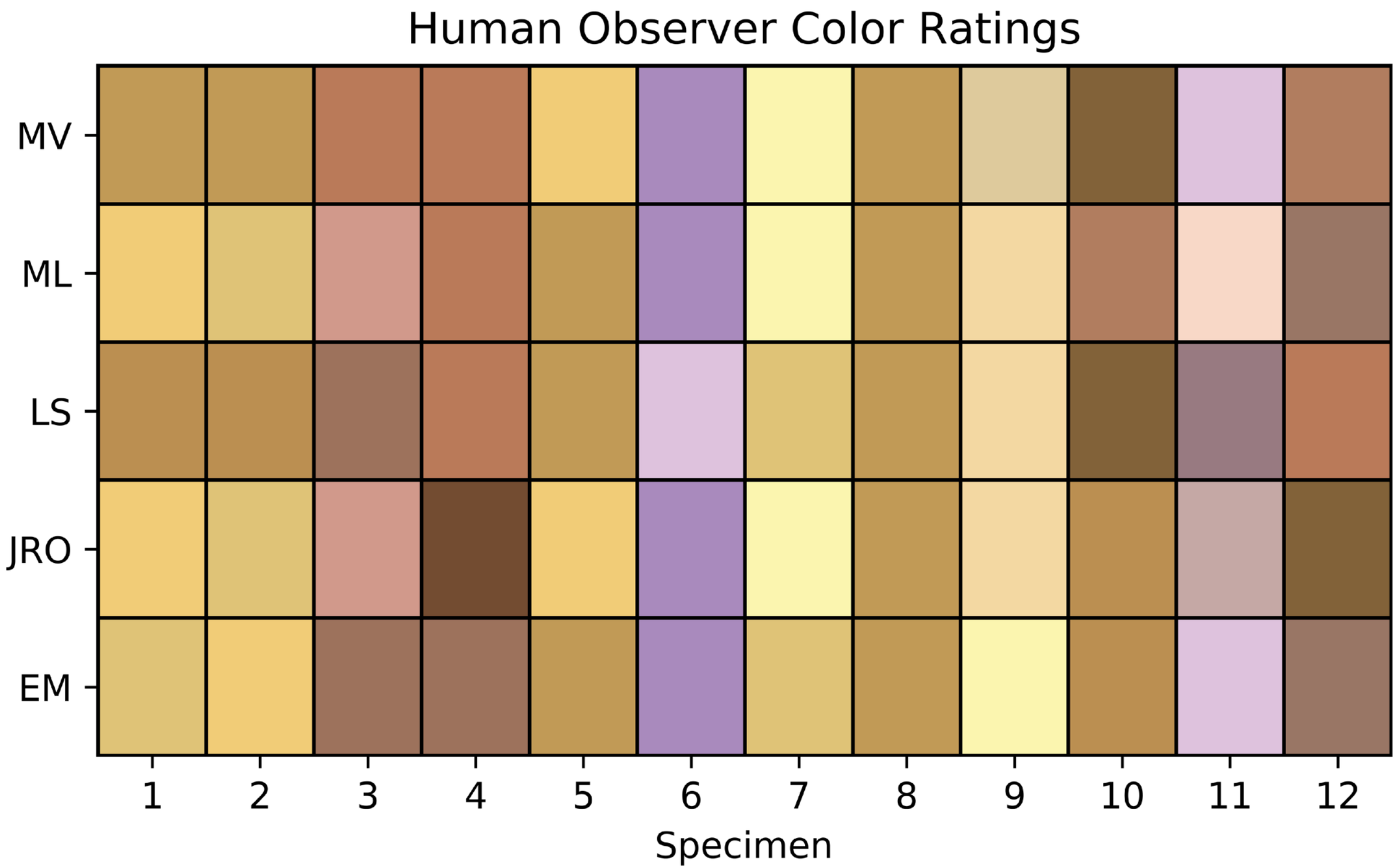


Human Performance Analysis - Results



Ko’a Card - Human Observers

Human Performance Analysis - Results



Human Performance Analysis - Results

- Surprisingly Robust

- More time deciding = better performance

- Can we do better?

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Computer Performance Analysis

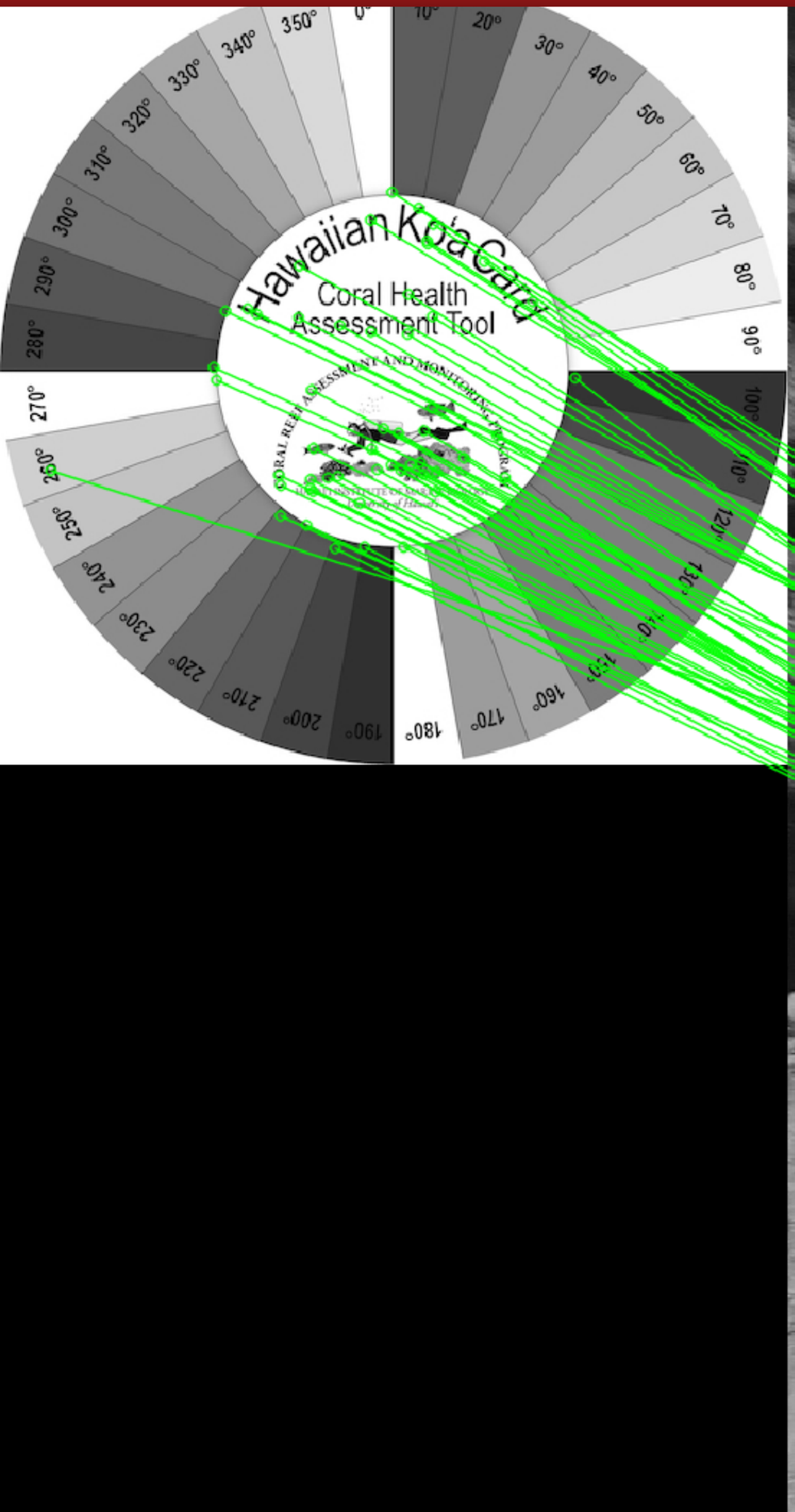
- Applying modern computer vision techniques to process coral images

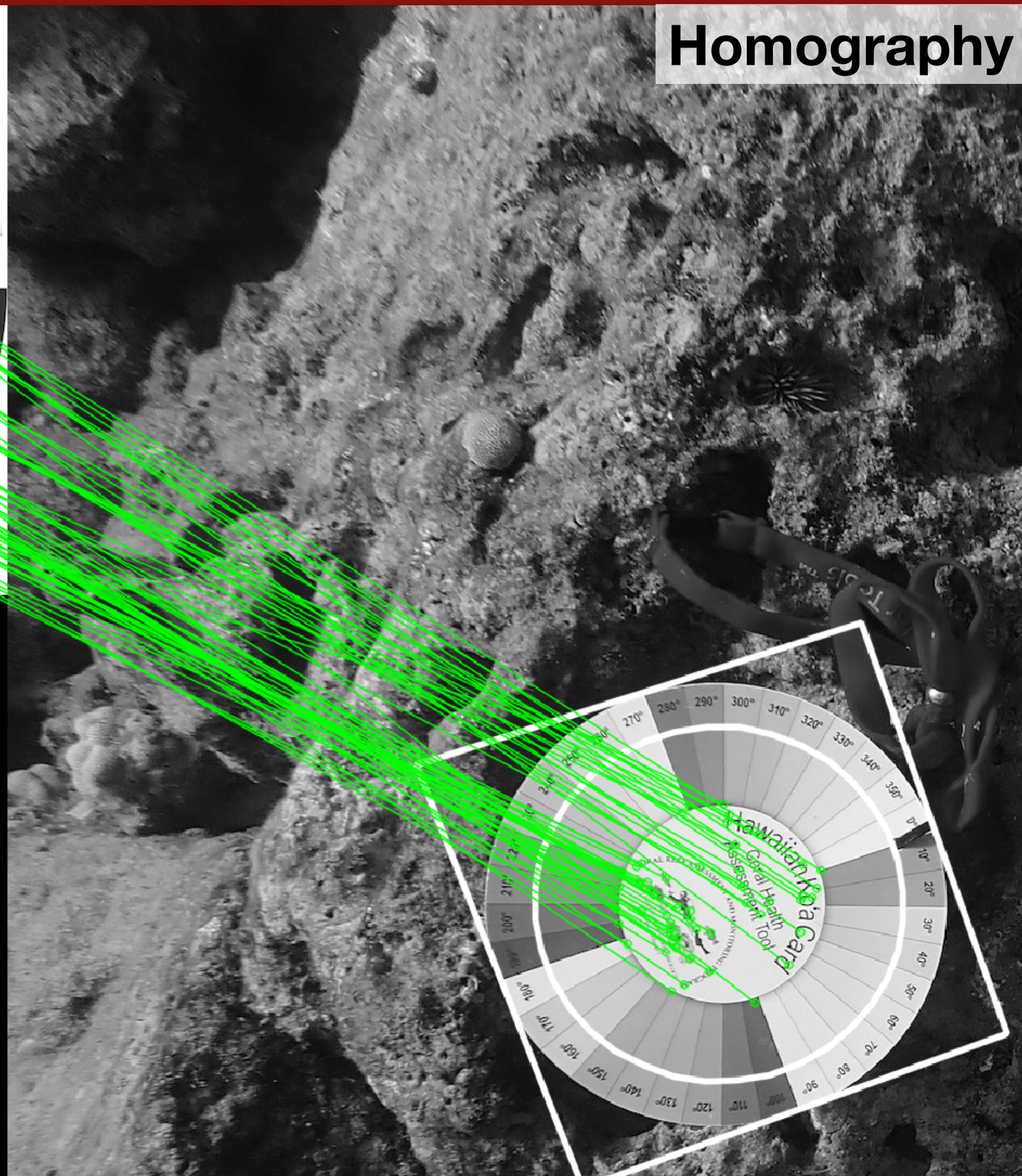
- Images taken after volunteers rate coral

- Hard Task
  - Underwater Lighting
  - Image Structure

Original

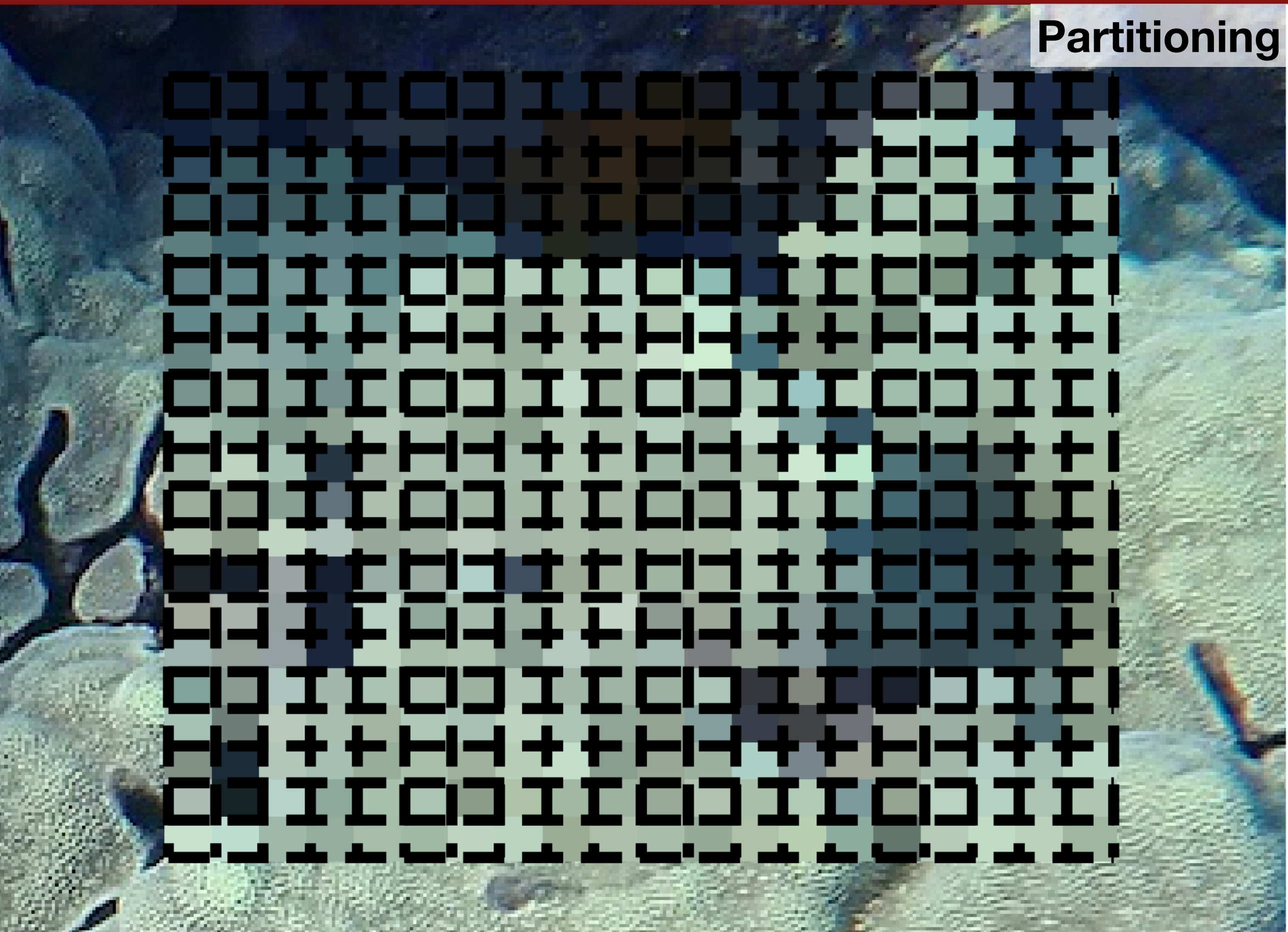
Homography


Hawaiian Koa Carg
Coral Health
Assessment Tool


Hawaiian Koa Carg
Coral Health
Assessment Tool


Segmentation

Partitioning



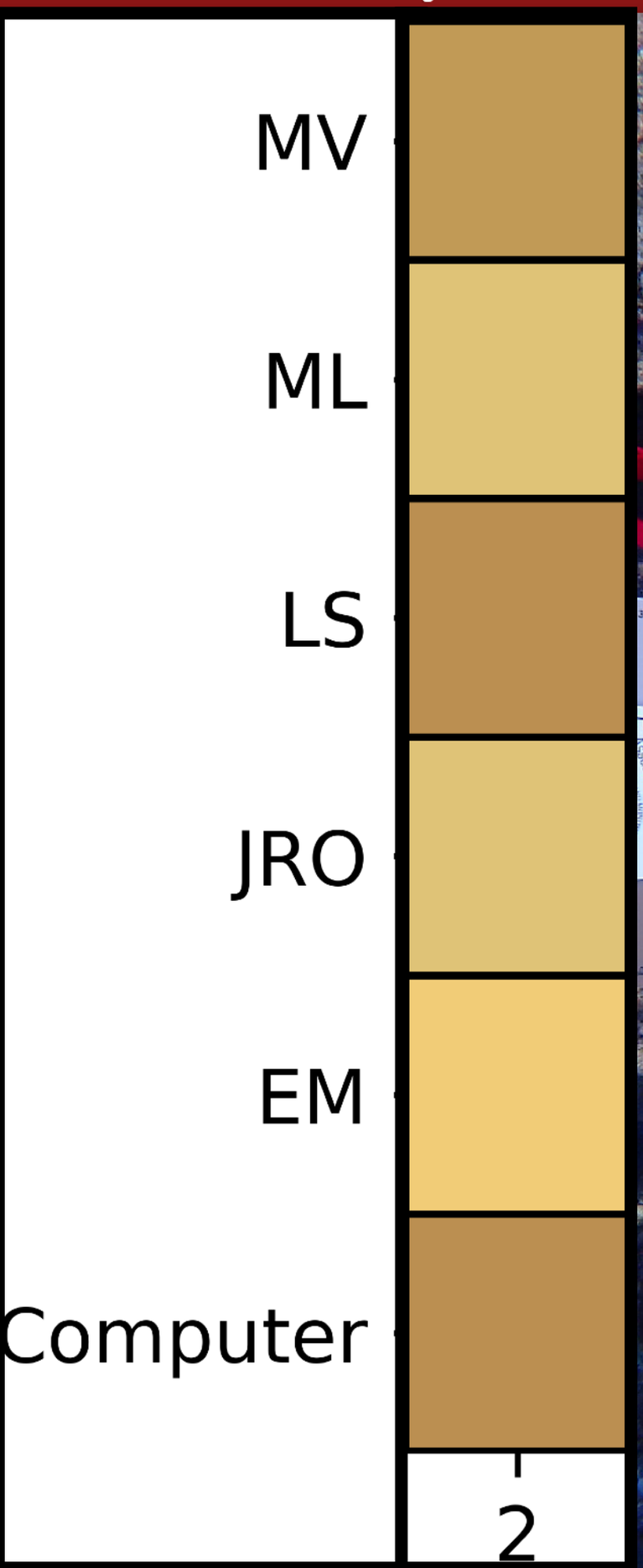
Color Matching

Candidates

Modal Value

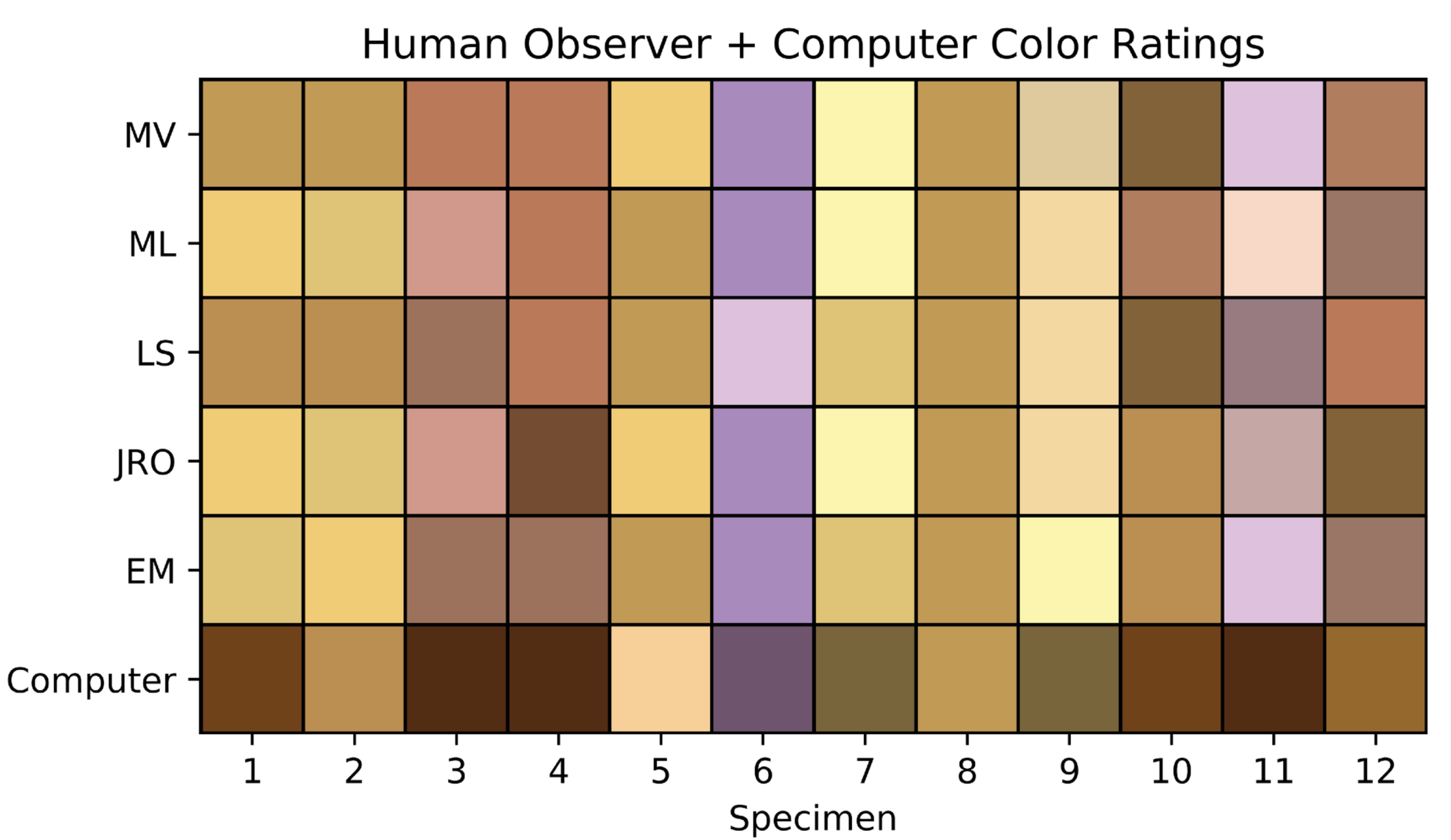
In-Scene Match

Reference Value
230°


MV
ML
LS
JRO
EM
Computer
2

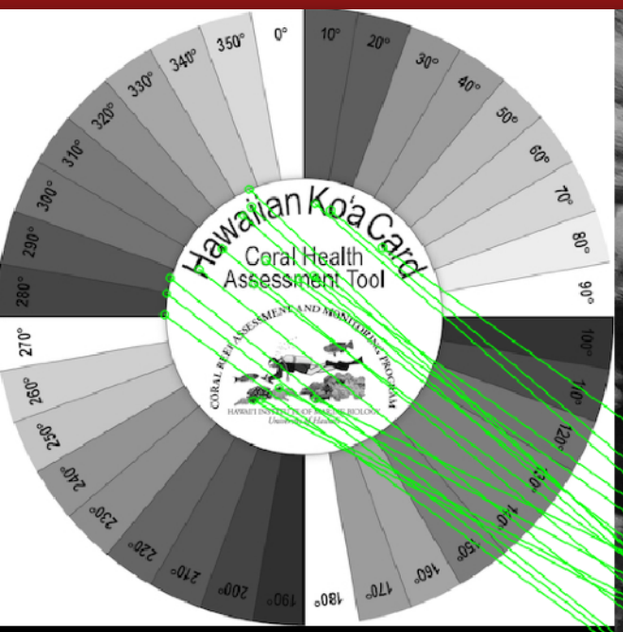

Color Matching

Computer Performance Analysis - Results

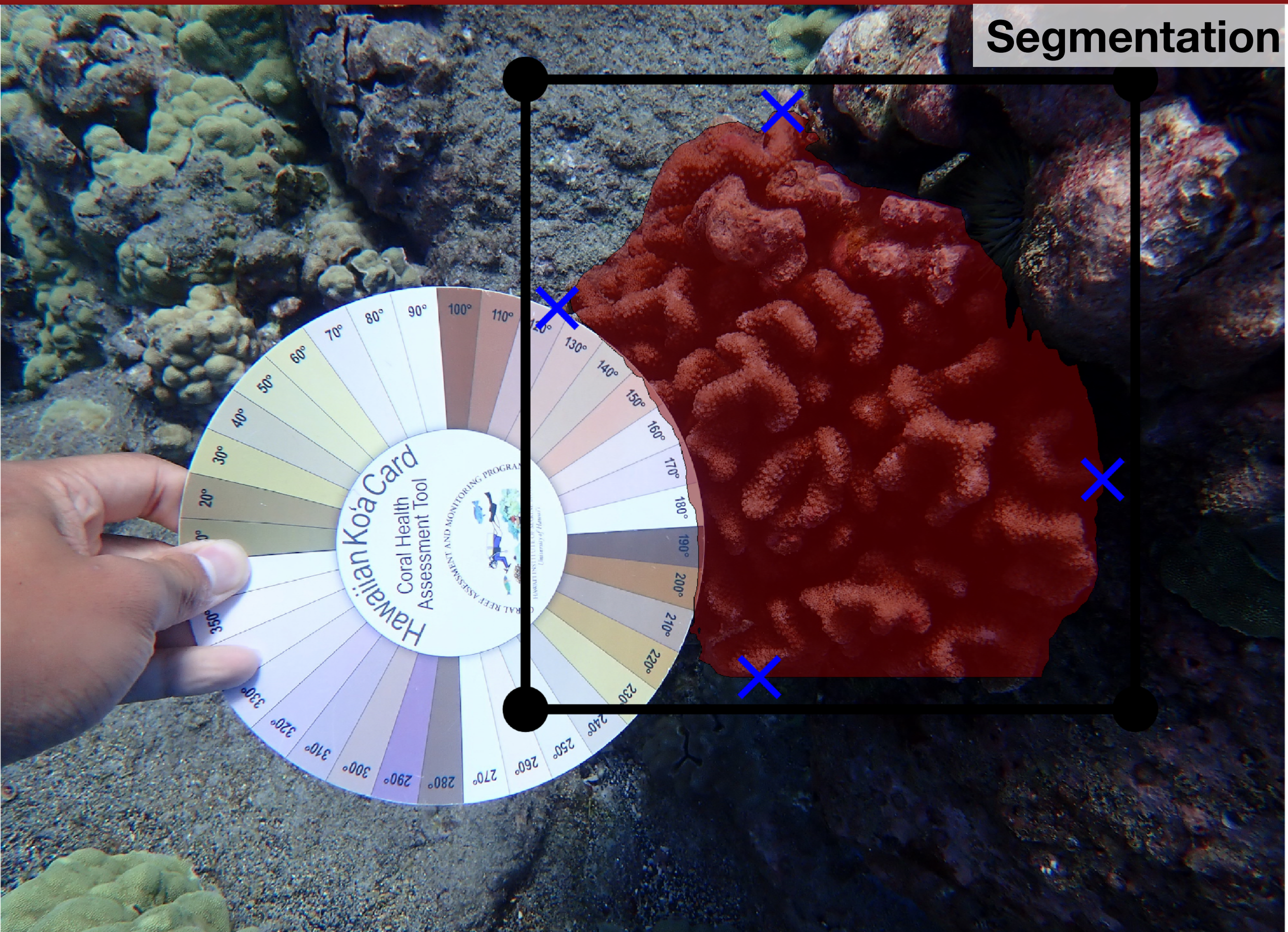


Original

Homography



Segmentation



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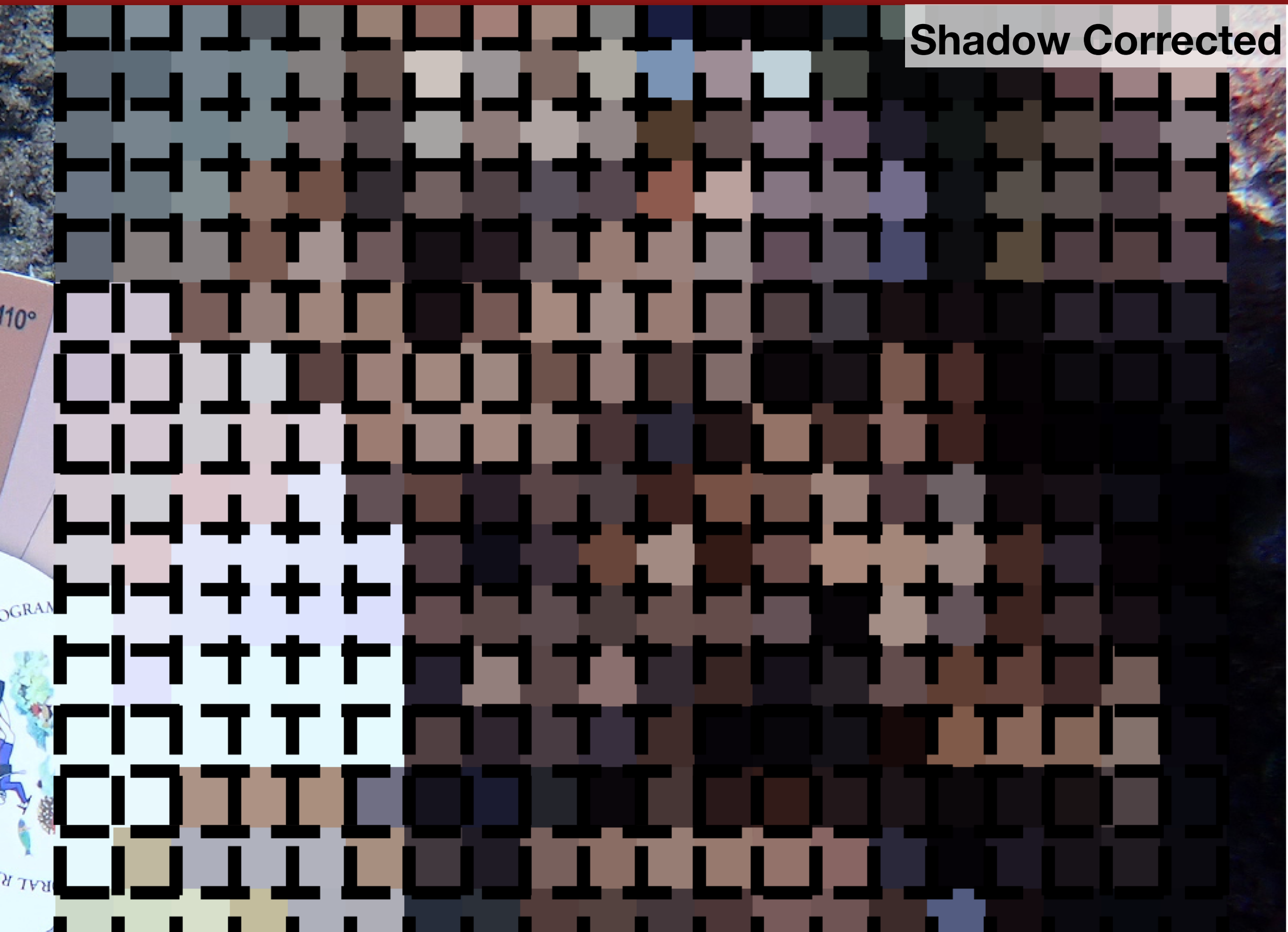
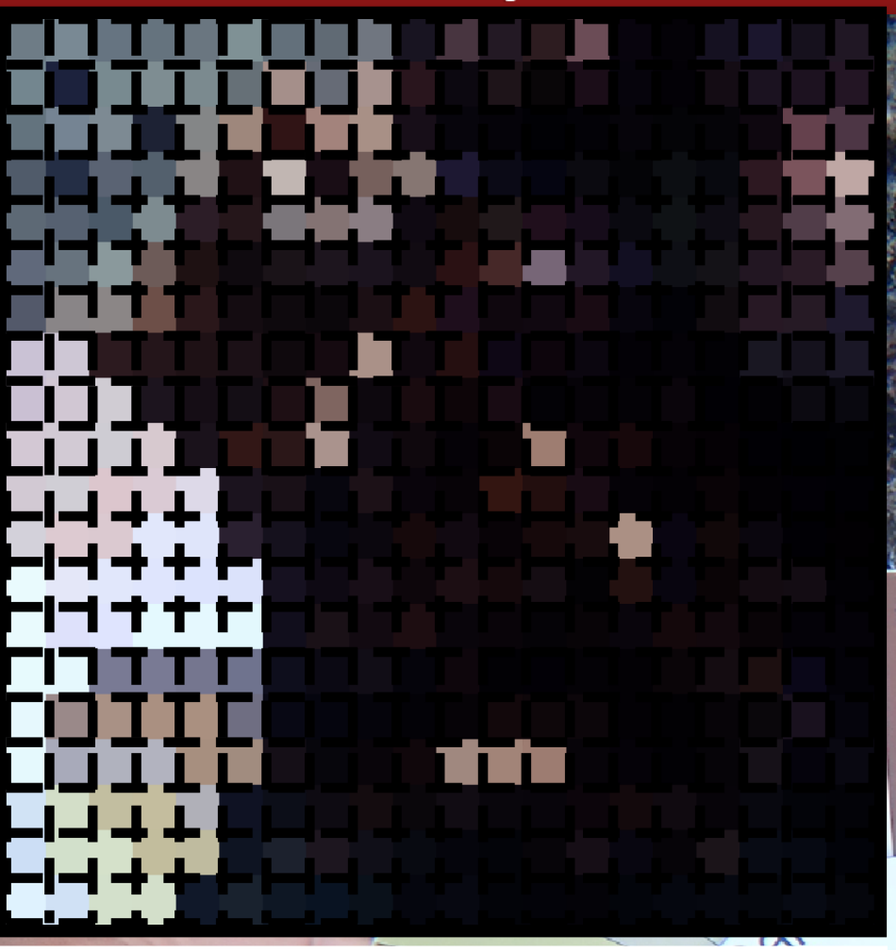
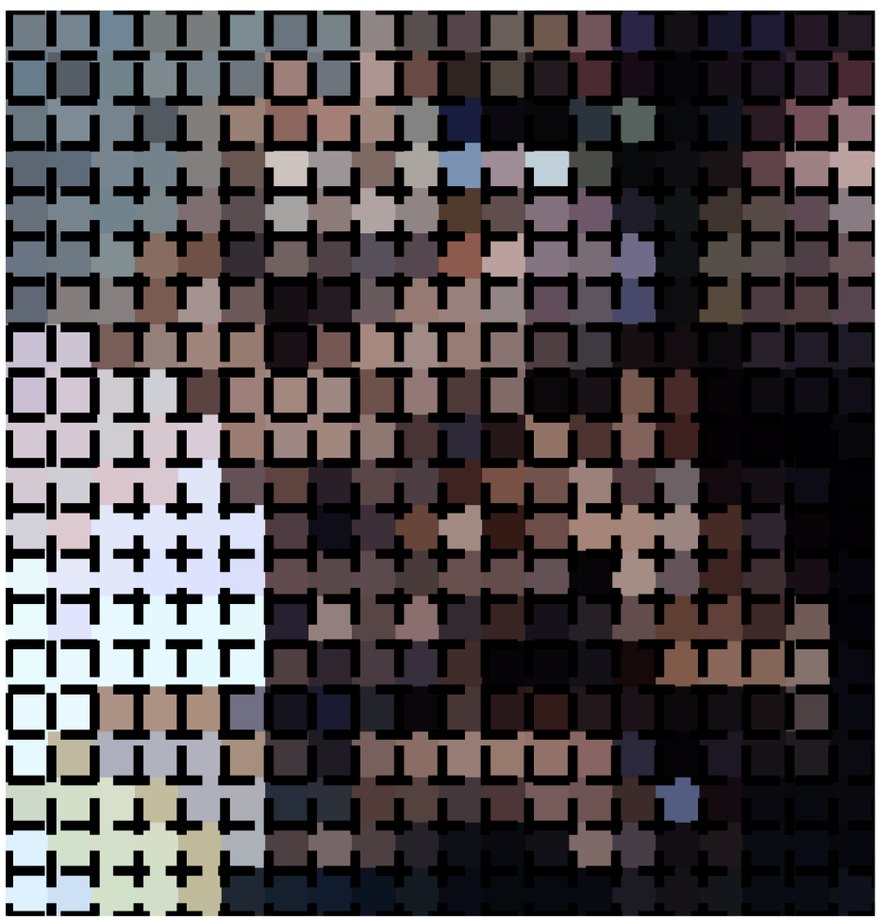
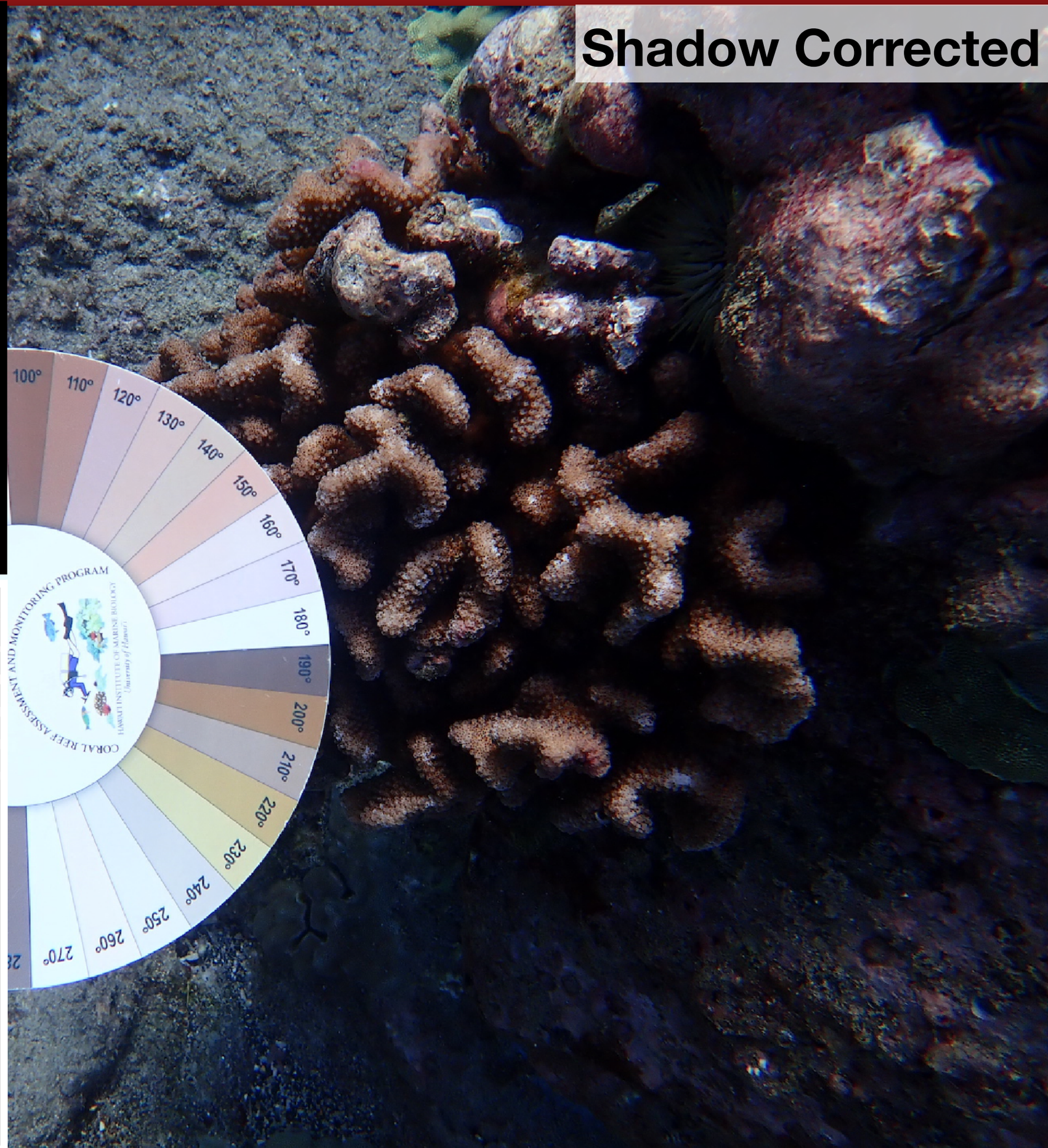
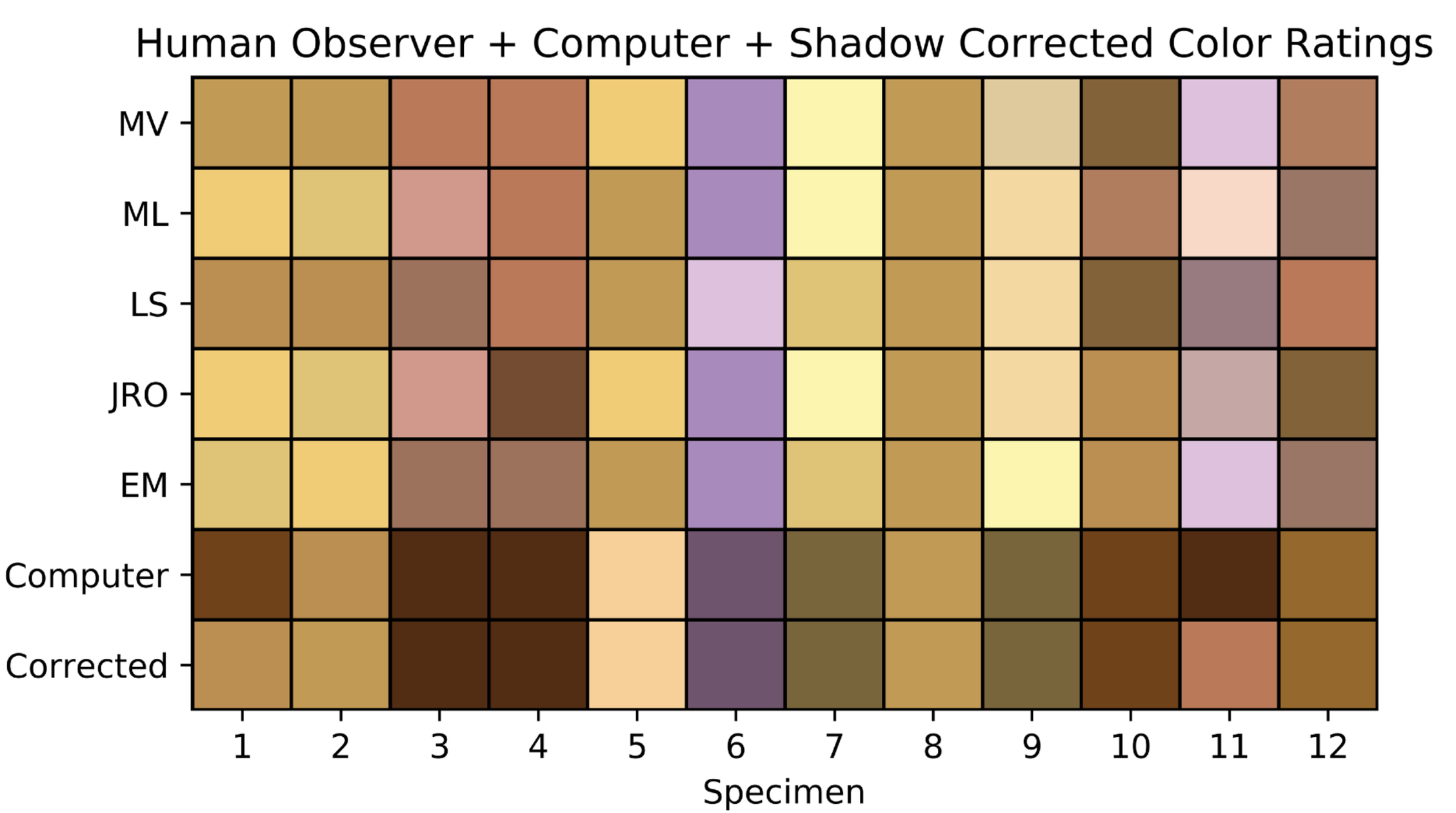

Shadow Corrected






Shadow Corrected
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
CORAL REEF ASSESSMENT AND MONITORING PROGRAM
HAWAII INSTITUTE OF MARINE BIOLOGY
University of Hawai'i

Computer Performance Analysis - Results



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- Research Motivation: Coral Bleaching Monitoring
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- **[Comparing Computers & Humans - What We Learn]**

Comparing Human and Computer Analysis

- Humans are quite good.

- Current computer method had a hard time with shadows.

- Computers have potential in consistency and more complex analysis of images

Implications on Citizen Science Efforts

- Citizen science works at scale for bleaching monitoring with colors.

- Developed datasheet

- Developed algorithmic toolbox

- Ko'a Card Improvements

Citizen Scientists?

Future Work & Limitations

- More datapoint in different conditions

- More robust shadow elimination and color matching

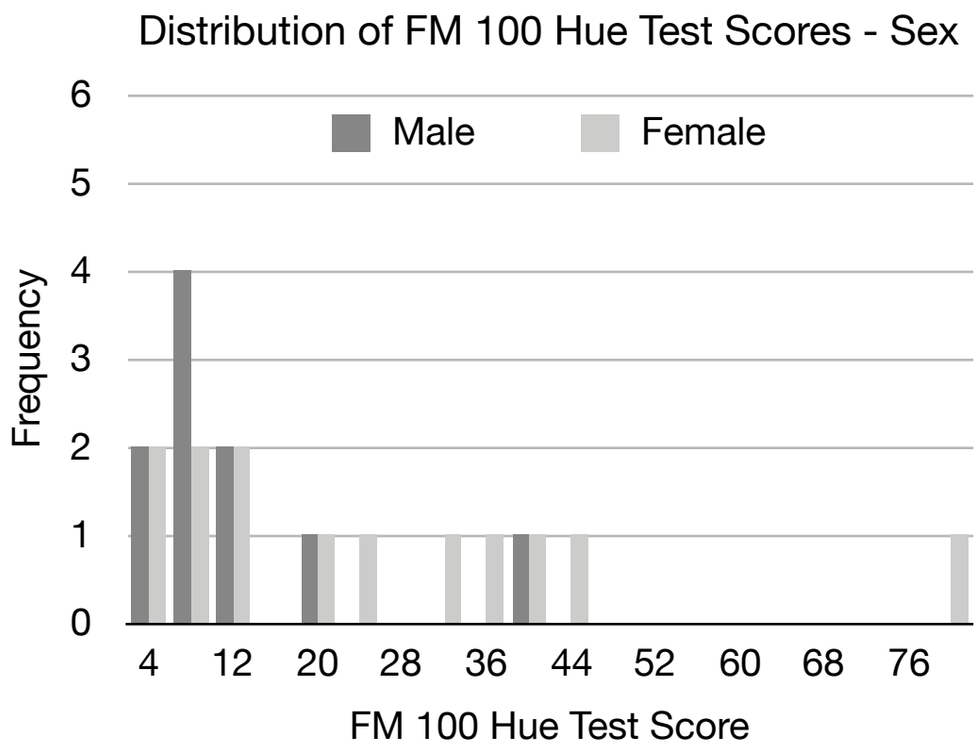
- Correlating shades with zooxanthellae & chlorophyll

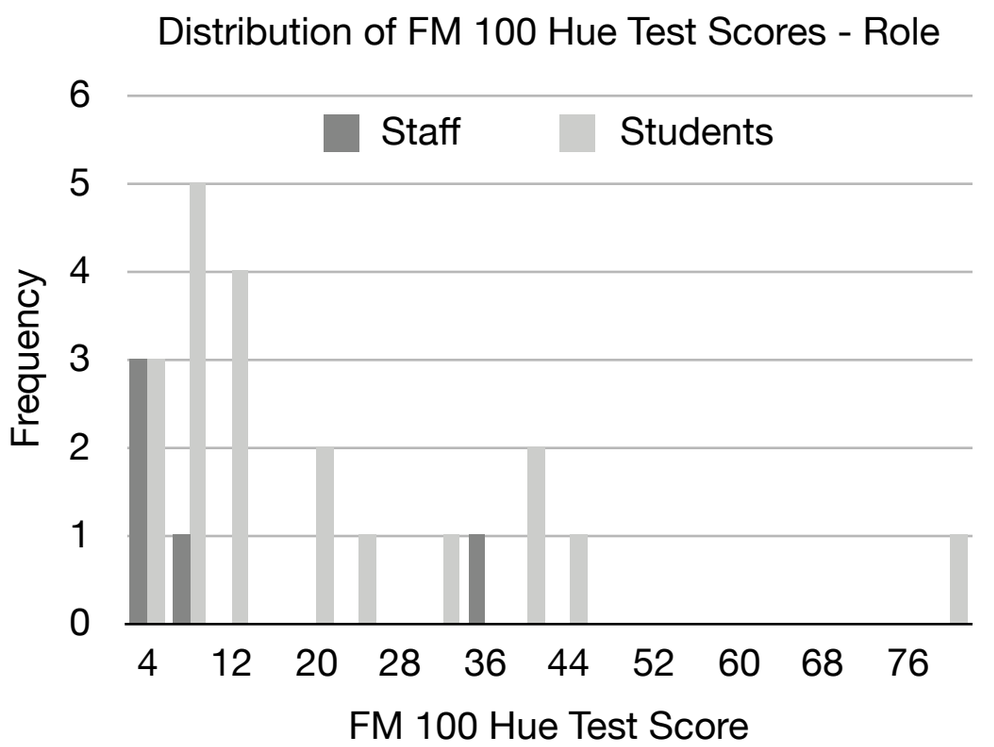
- Integrating with Eyes of the Reef Network https://eorhawaii.org

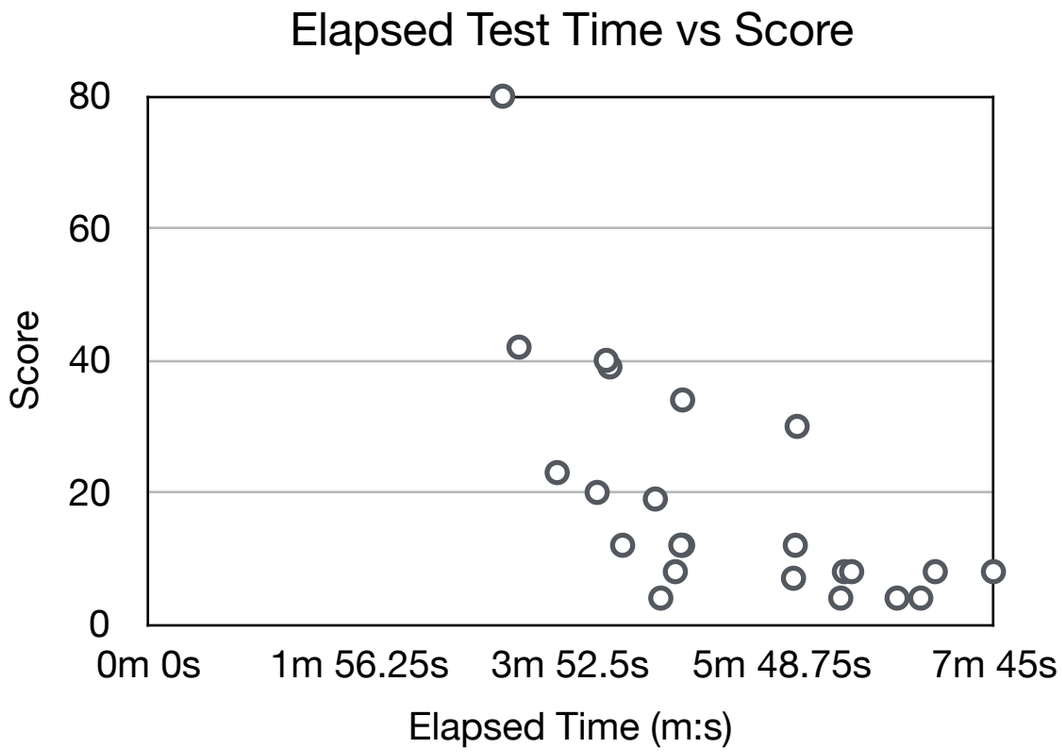
Questions?

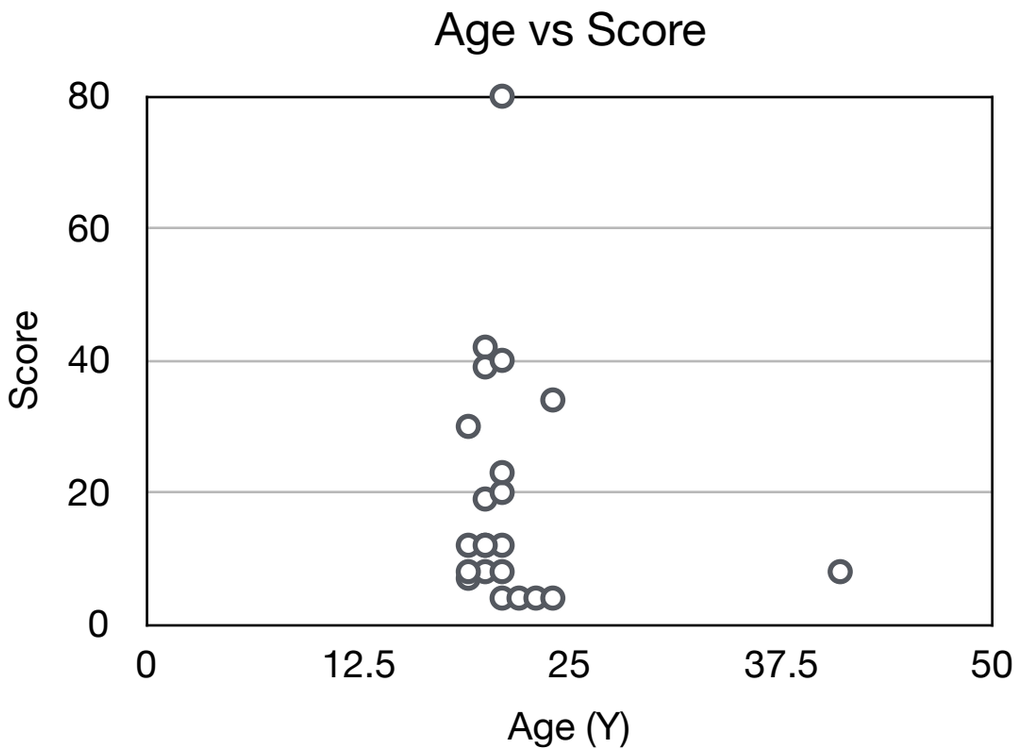
Mahalo!

Human Performance Analysis - Results

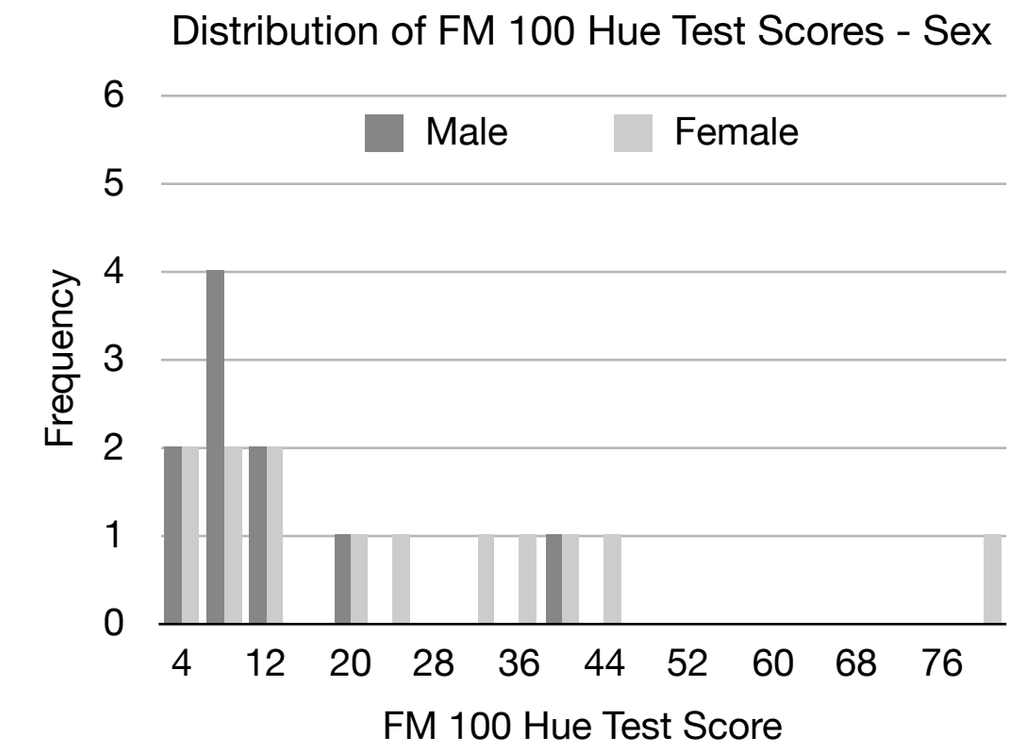


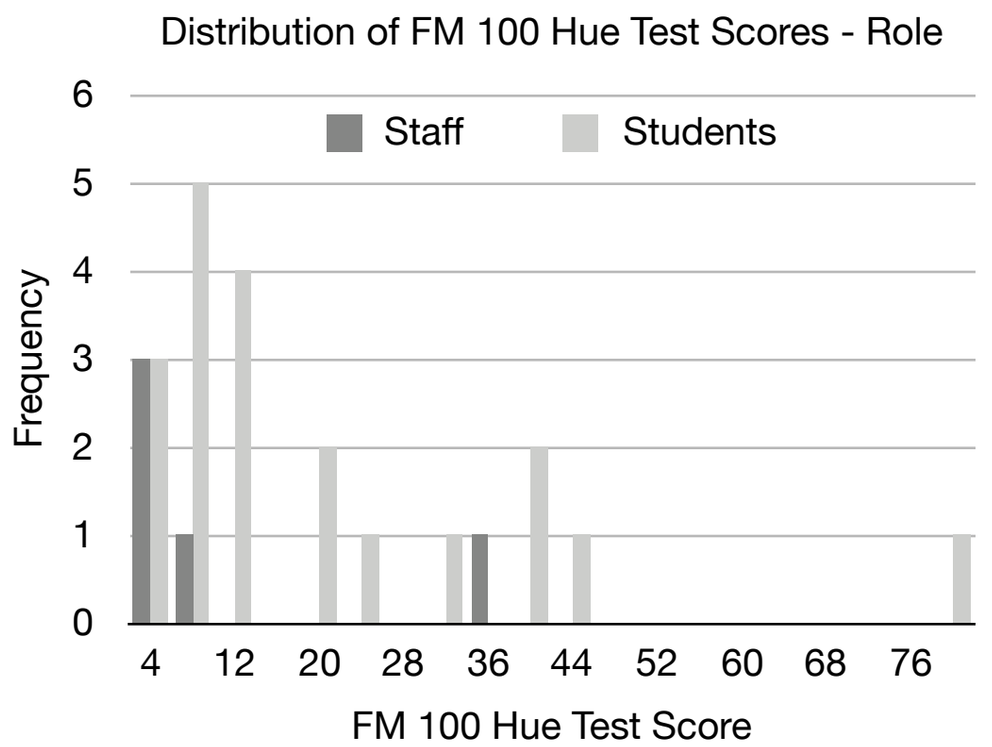


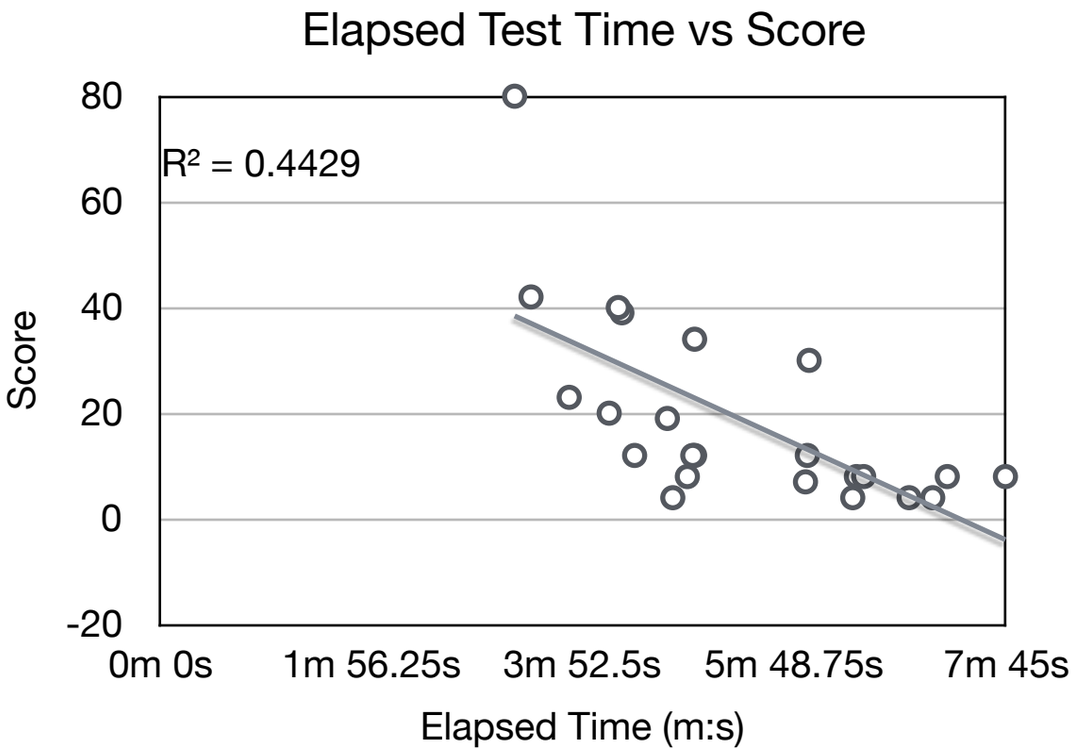


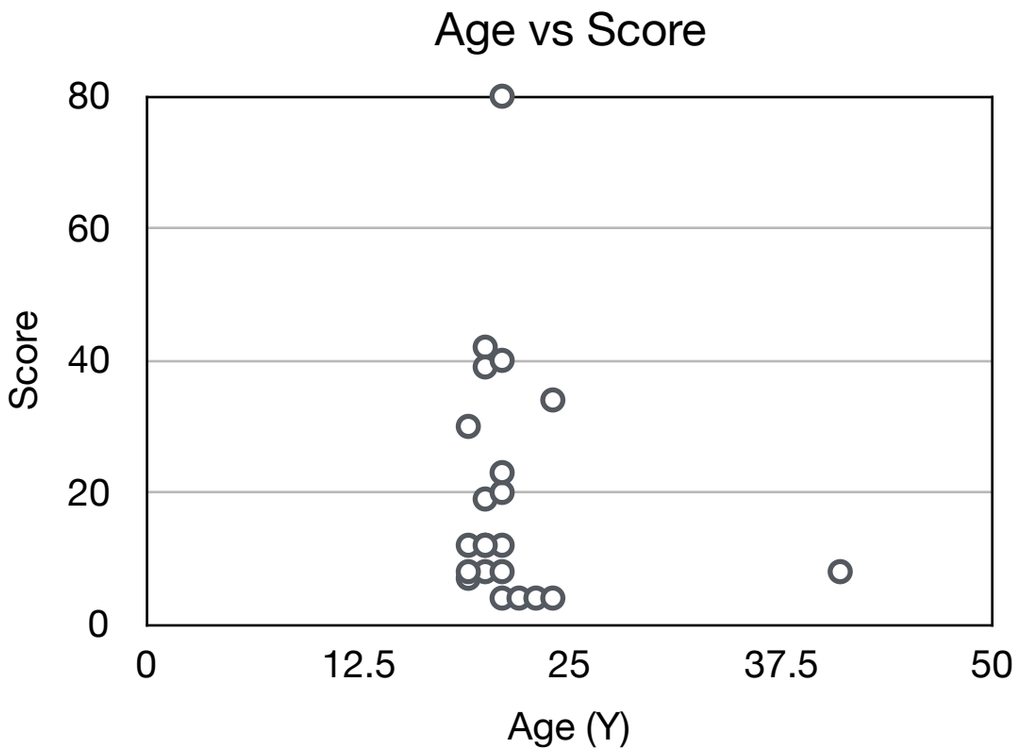


Human Performance Analysis - Results

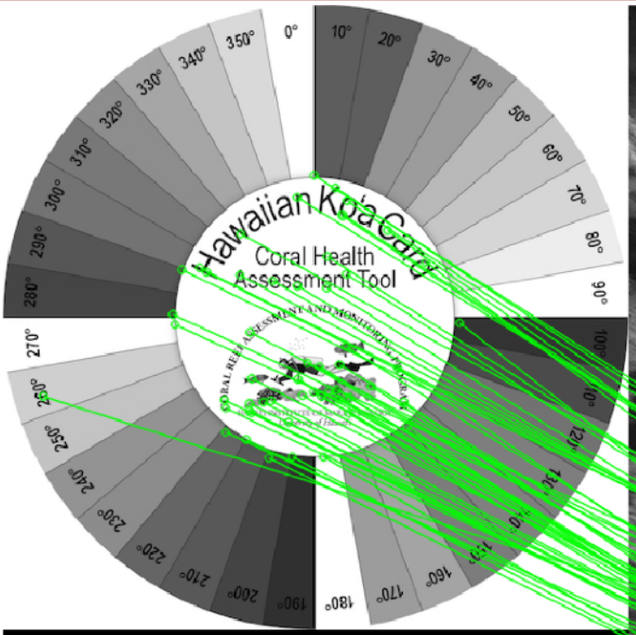








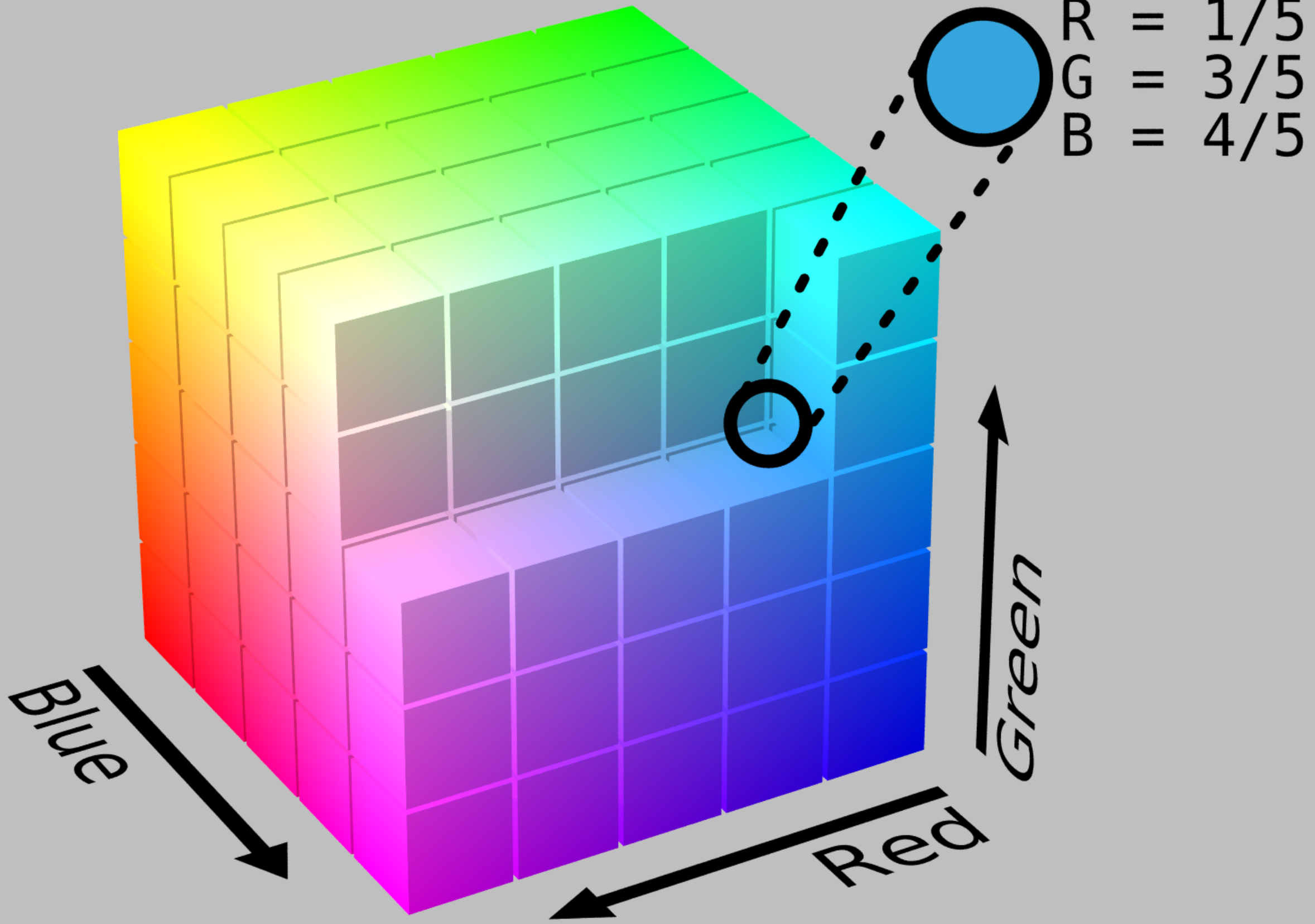
Homography



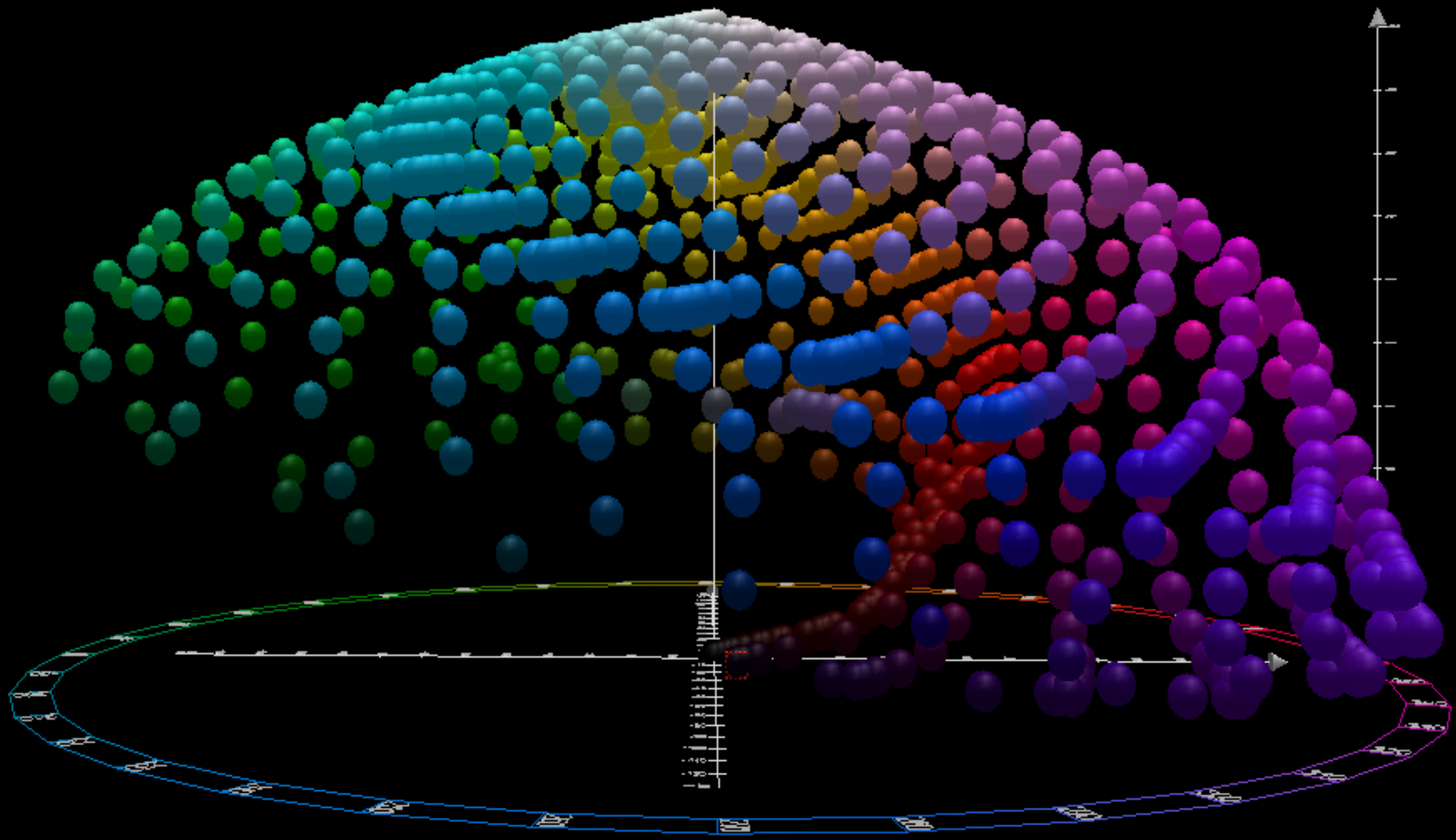
Hypotheses

- Variation in human perception motivates a need for consistency and reproducibility

- Modern computer vision technology can deliver both and improve upon or replace human efforts



RGB Color Space
By SharkD - Own work. Download source code., CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=9803283



CIELAB Space

Computer Performance Analysis

- Applying modern computer vision techniques to process coral images

- Image Capture
  - Olympus Tough TG-5 4K
  - 4x Wide Optical Zoom 4.5-18.0 mm 1:2.0-4.9 F2.0
  - Underwater Snapshot Setting

Computer Performance Analysis

- November & December

- Mornings, Sunny.

- Same procedure as human observers

Computer Performance Analysis - Challenges

- Underwater lighting is hard
- Image structure is hard
- Color is surprisingly hard!

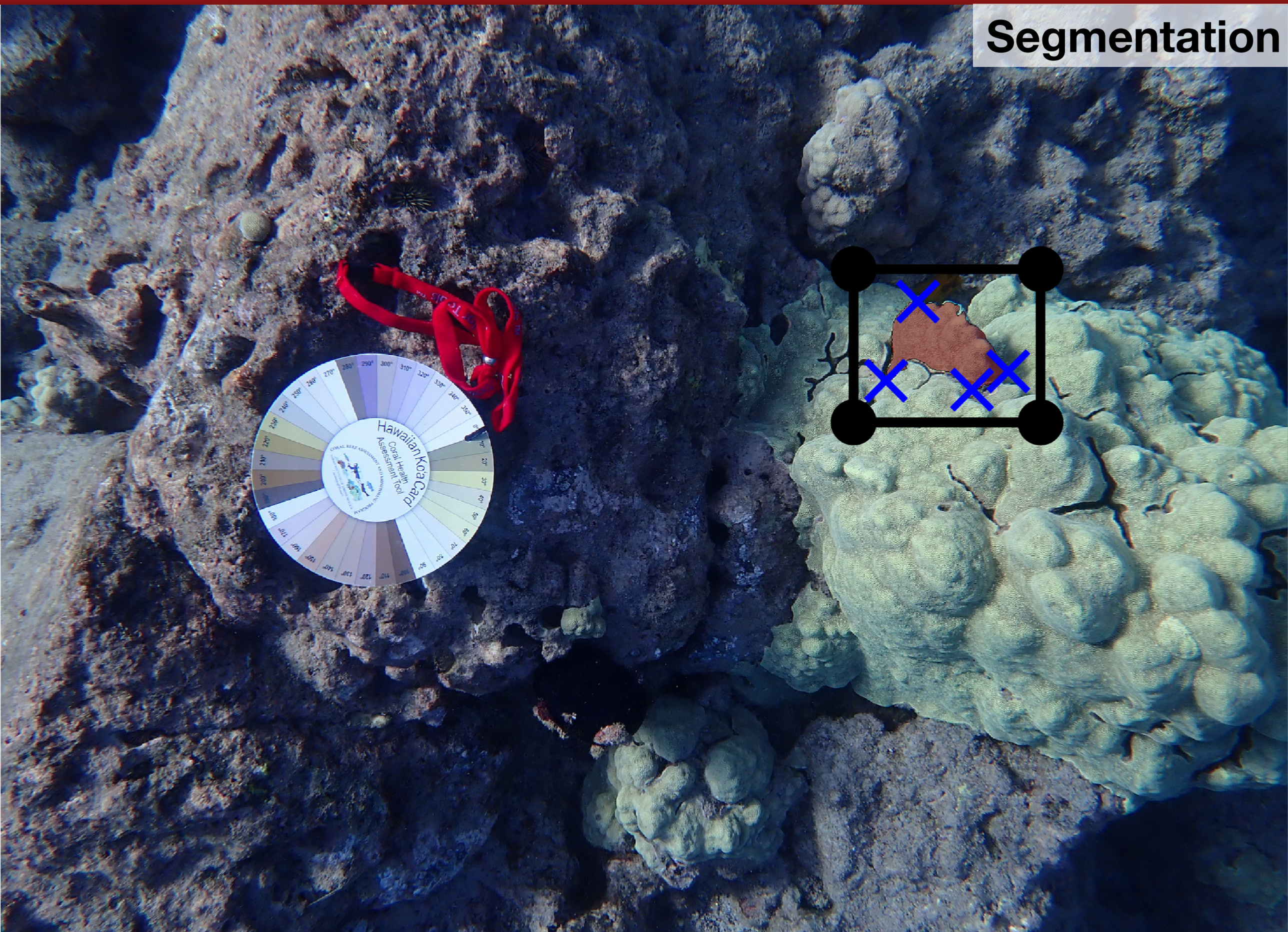
Computer Performance Analysis - Structure

- Homography: Finding the Color Card
- Segmentation: Finding the Coral
- Partitioning: Extracting Coral Colors
- Color Comparison: Comparing Coral Color to Card Color

Color Matching

Candidates	Modal Value	In-Scene Match	Reference Value
			230° Delta-E: 6.09

Segmentation



Partitioning