MICHIGAN STATE UNIVERSITY

Project Plan

Material Normalization Using Computer Vision

The Capstone Experience

Team Herman Miller

Josh Bhattarai
Ritwik Biswas
Joseph Smith
Ted Stacy
David Xuan

Department of Computer Science and Engineering
Michigan State University

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From Students…
…to Professionals

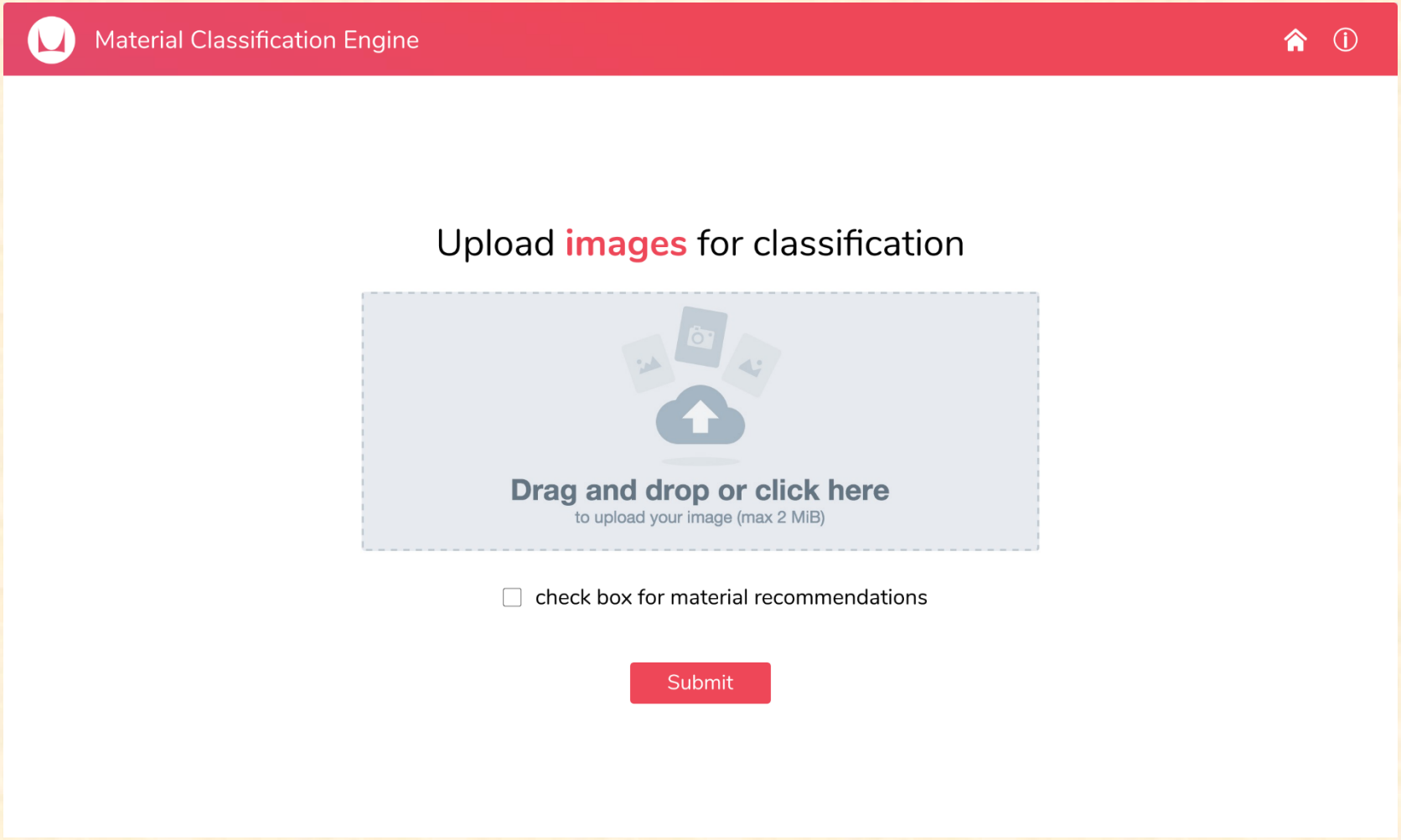
Functional Specifications

- Herman Miller needs an efficient way to normalize their fabric dataset
- Currently, there is no process in place for sorting aesthetic/subjective categories
- When Herman Miller receives a custom order with a proposed fabric, a manual search is done to find a Herman Miller fabric similar to the customers proposed fabric
- Our system will create a predictive model to categorize newly acquired Herman Miller fabrics
- Our predictive model will also be leveraged for categorizing a non-Herman Miller fabric, and suggesting Herman Miller fabrics that are similar

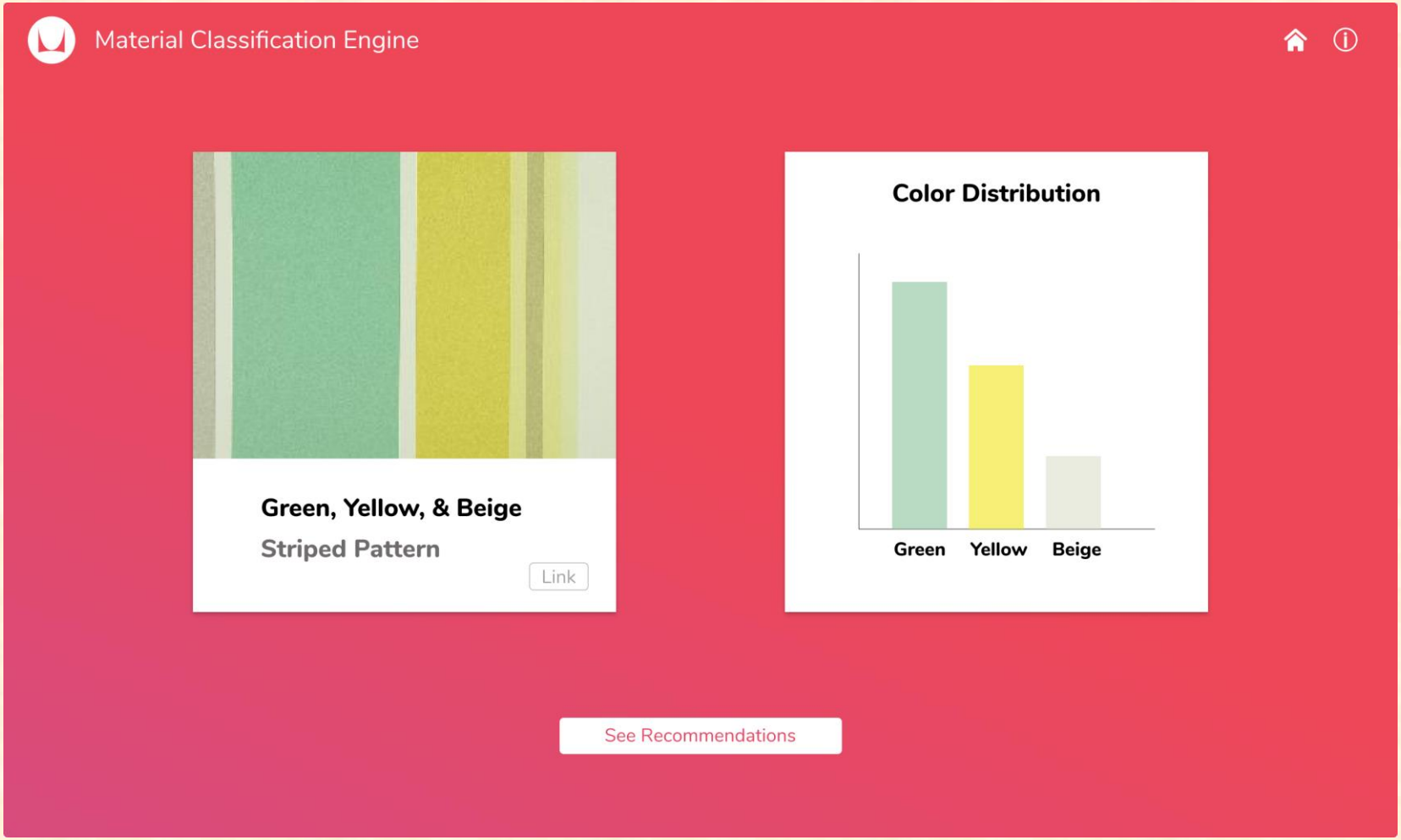
Design Specifications

- Our material normalization system contains three primary components:
  - A predictive model to perform fabric categorization
  - A web component to serve our predictive model as an API
  - A user interface with the ability to upload fabric images, return the images categorization tags, and if applicable, return similar Herman Miller owned images

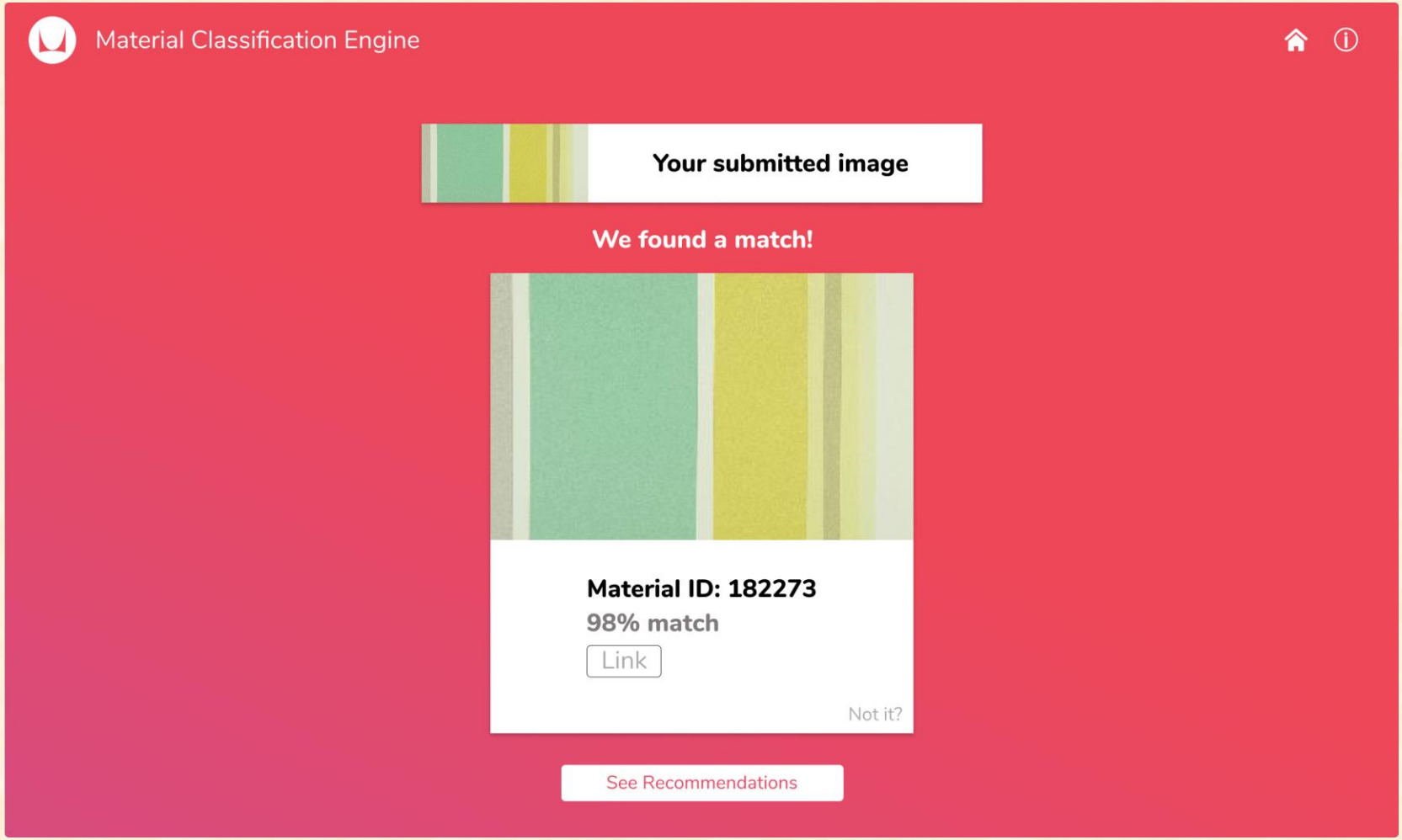
Screen Mockup: Image Upload



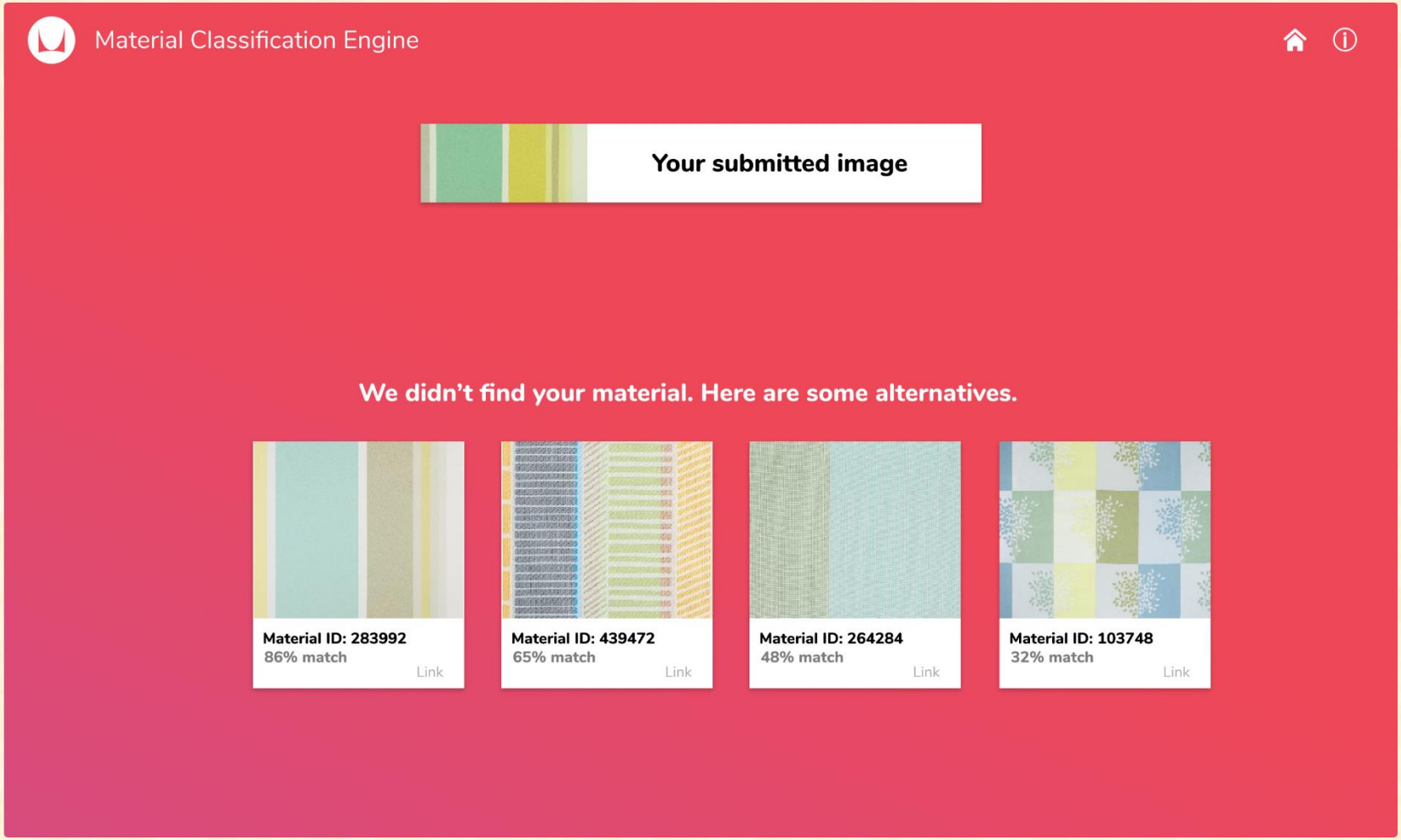
Screen Mockup: Classification



Screen Mockup: Image Match



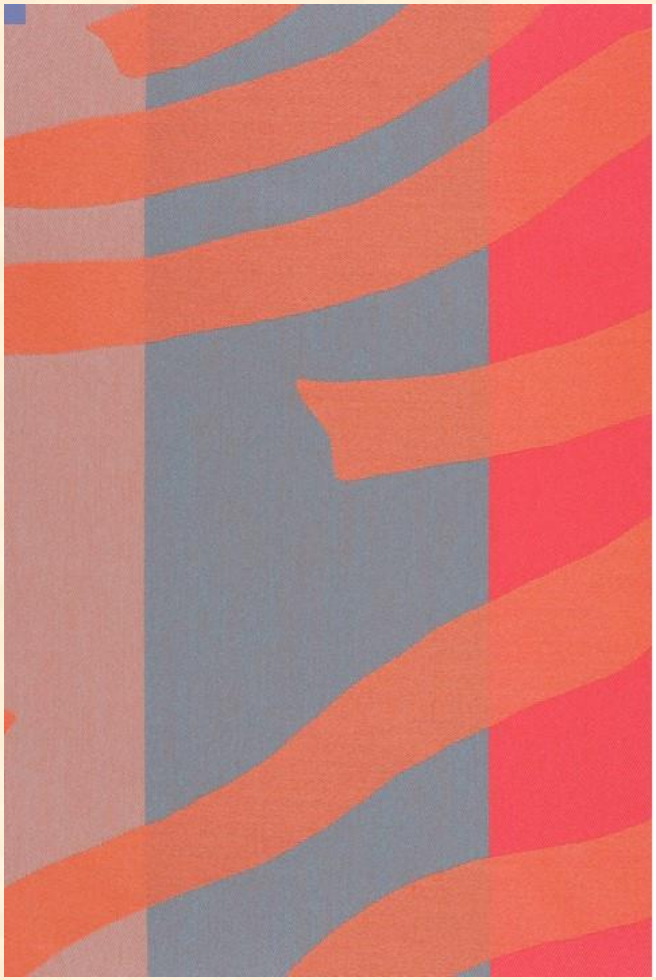
Screen Mockup: Recommendations



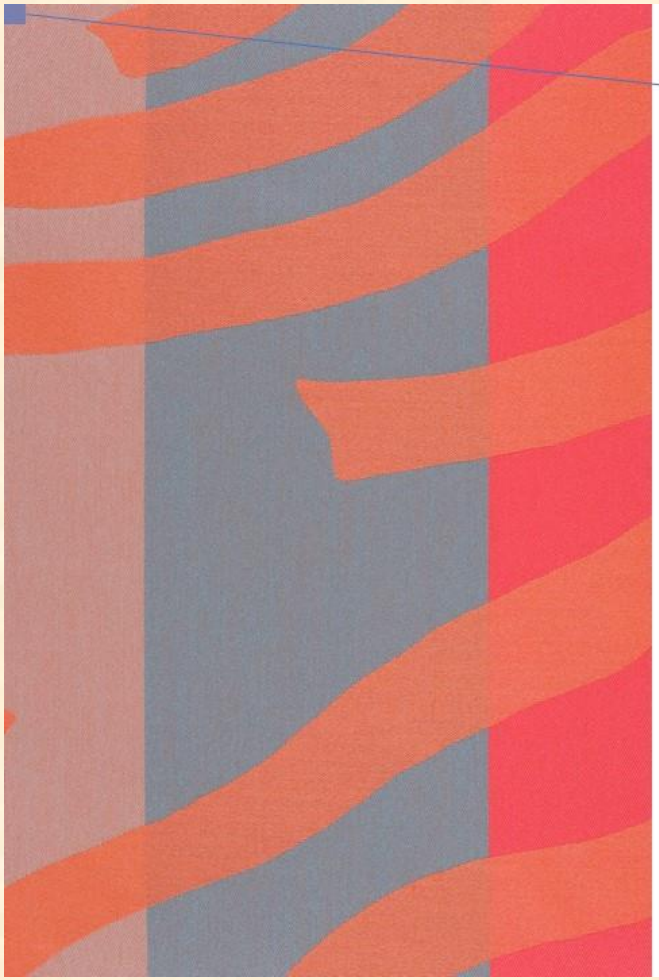
Technical Specifications

- Color Classifier (79.0% accuracy)
  - Color Adaboost Classifier (Decision tree base model) Trained it on 11,000 test images from Herman Miller
  - We scan an input image by 3x3 pixel blocks and create a color distribution pattern
- Pattern Classifier (84.4% accuracy)
  - Used transfer learning to retrain the bottleneck layer of ImageNet Inception v3 (State of the art CNN image classifier)
- Recommendation Engine
  - Our engine will be able to compare user submitted images to fabrics in the database based on classification metadata

Color Classification



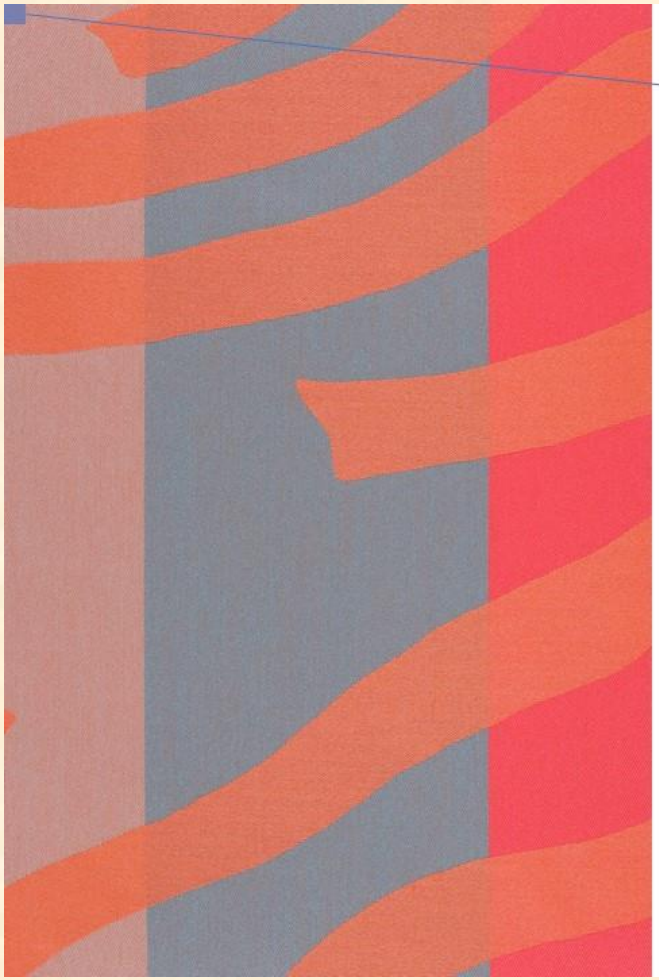
Color Classification



RGB values of 3x3 block

210 159 155	191 140 136	228 177 173
255 222 218	221 170 166	204 153 149
207 156 152	241 190 186	169 118 114

Color Classification



RGB values of 3x3 block

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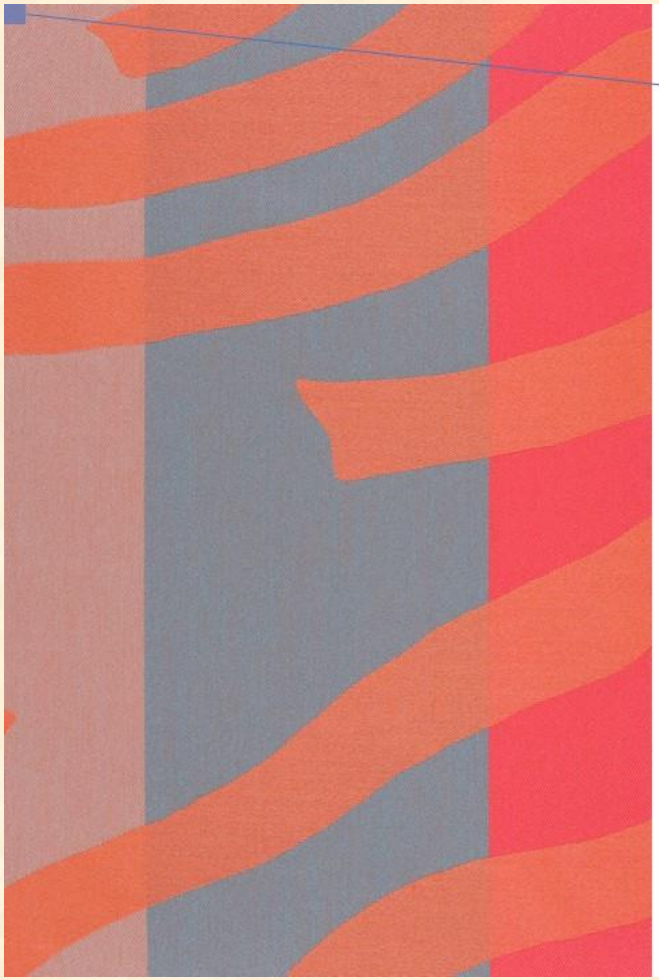
RGB mean

214 165 161

Color Classification



RGB values of 3x3 block

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RGB mean

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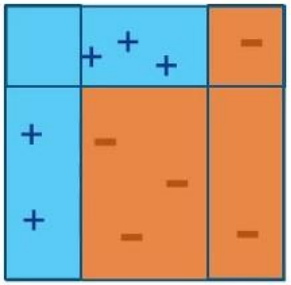
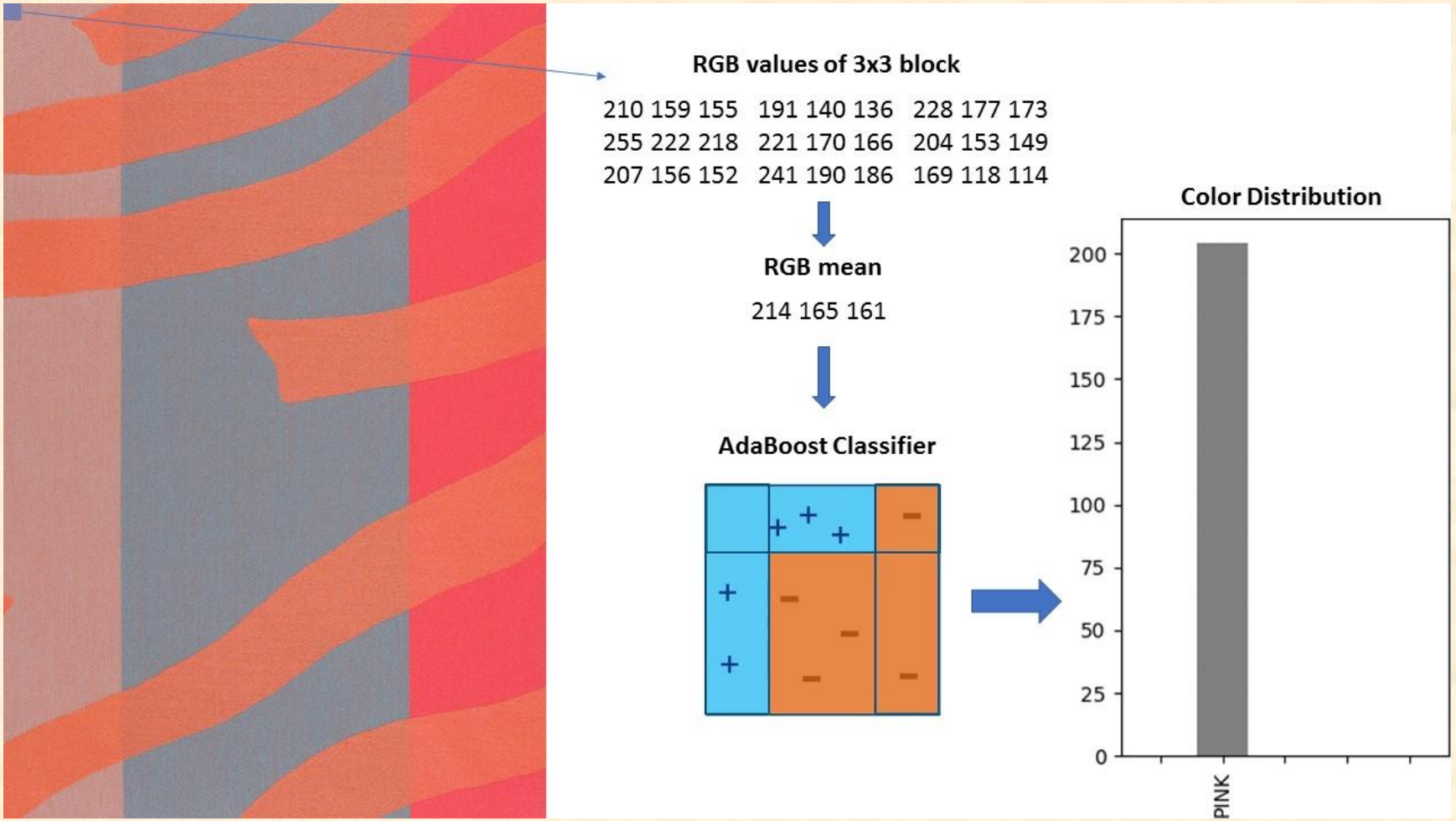
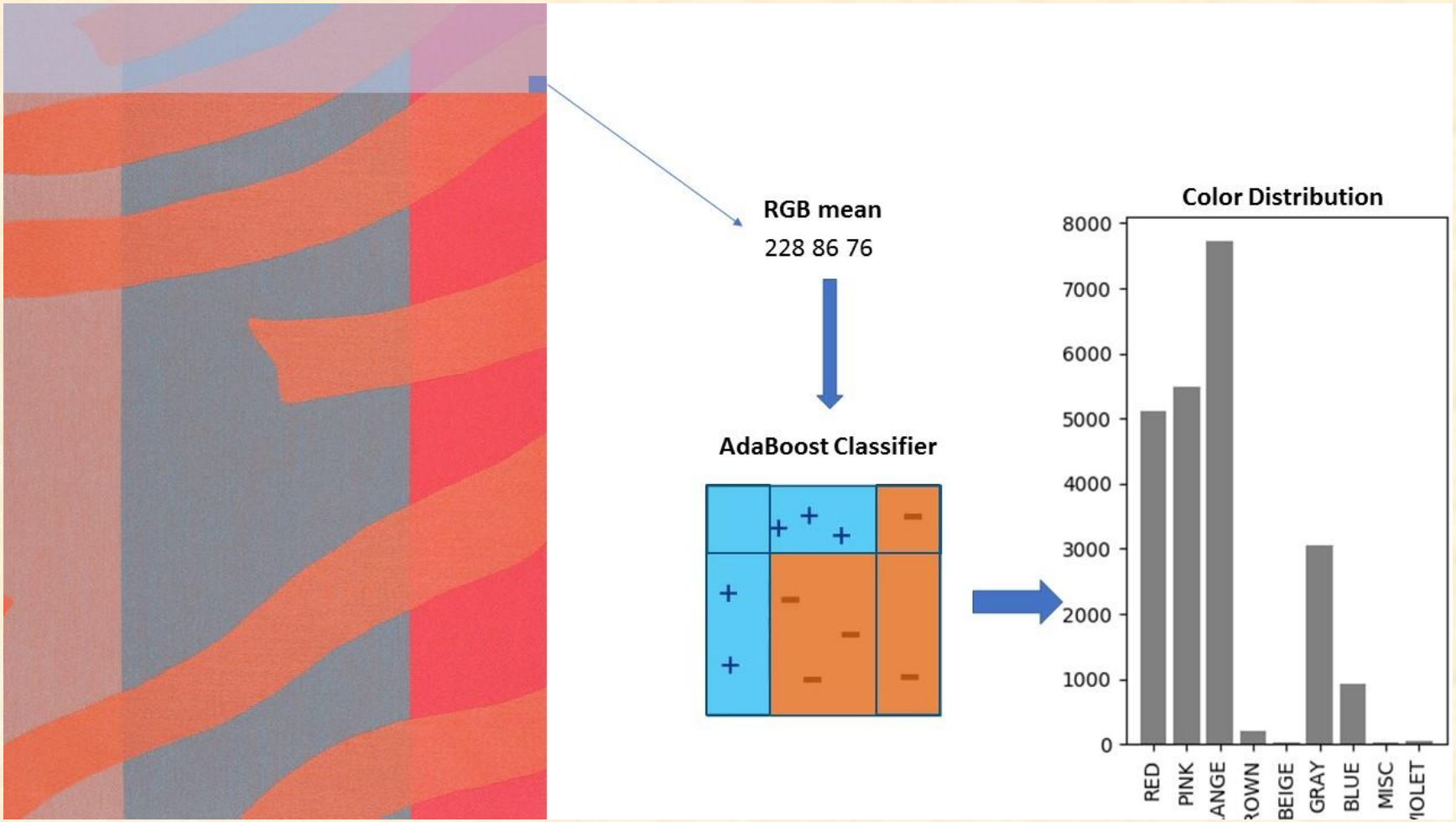
AdaBoost Classifier



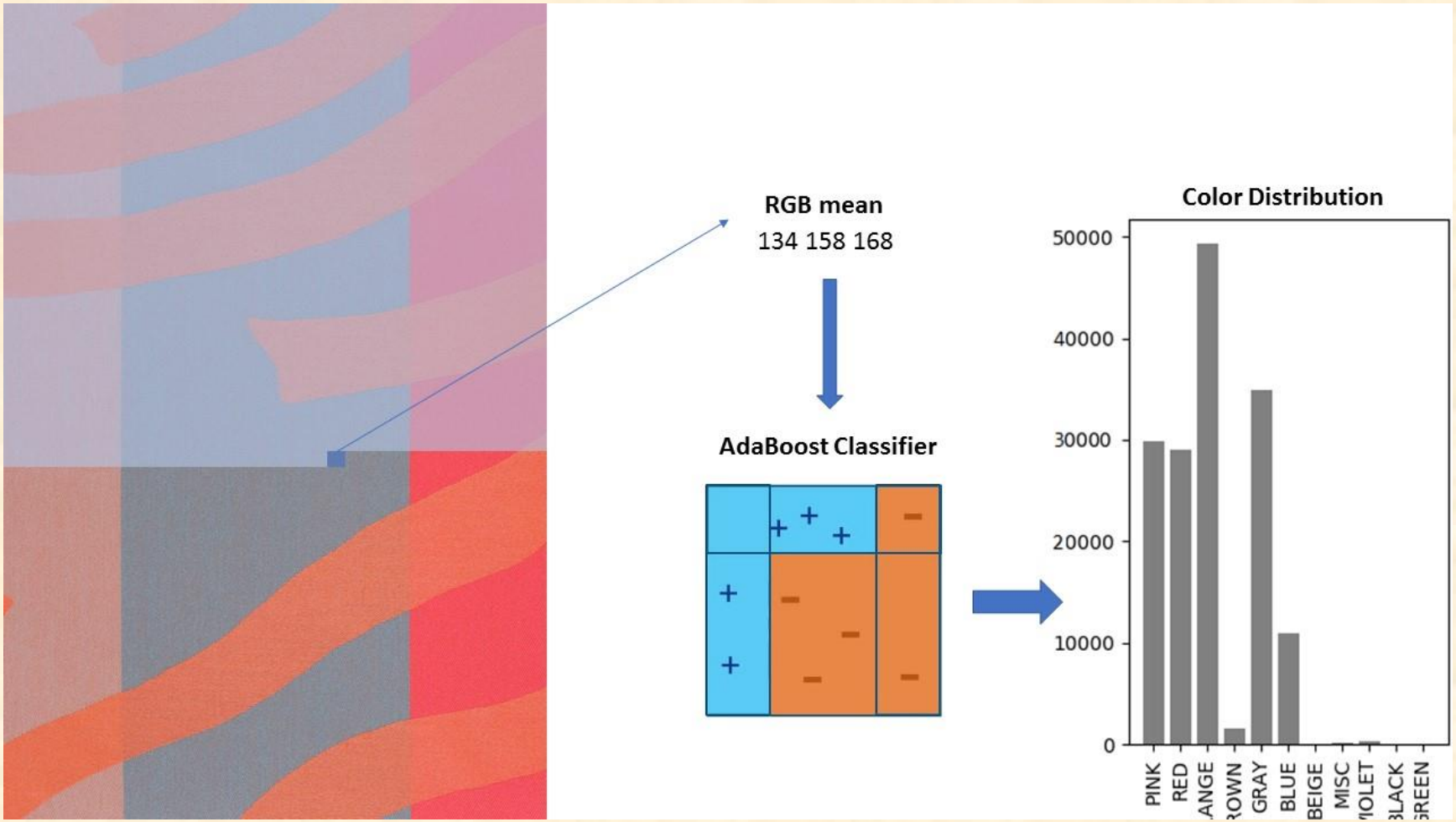
Color Classification



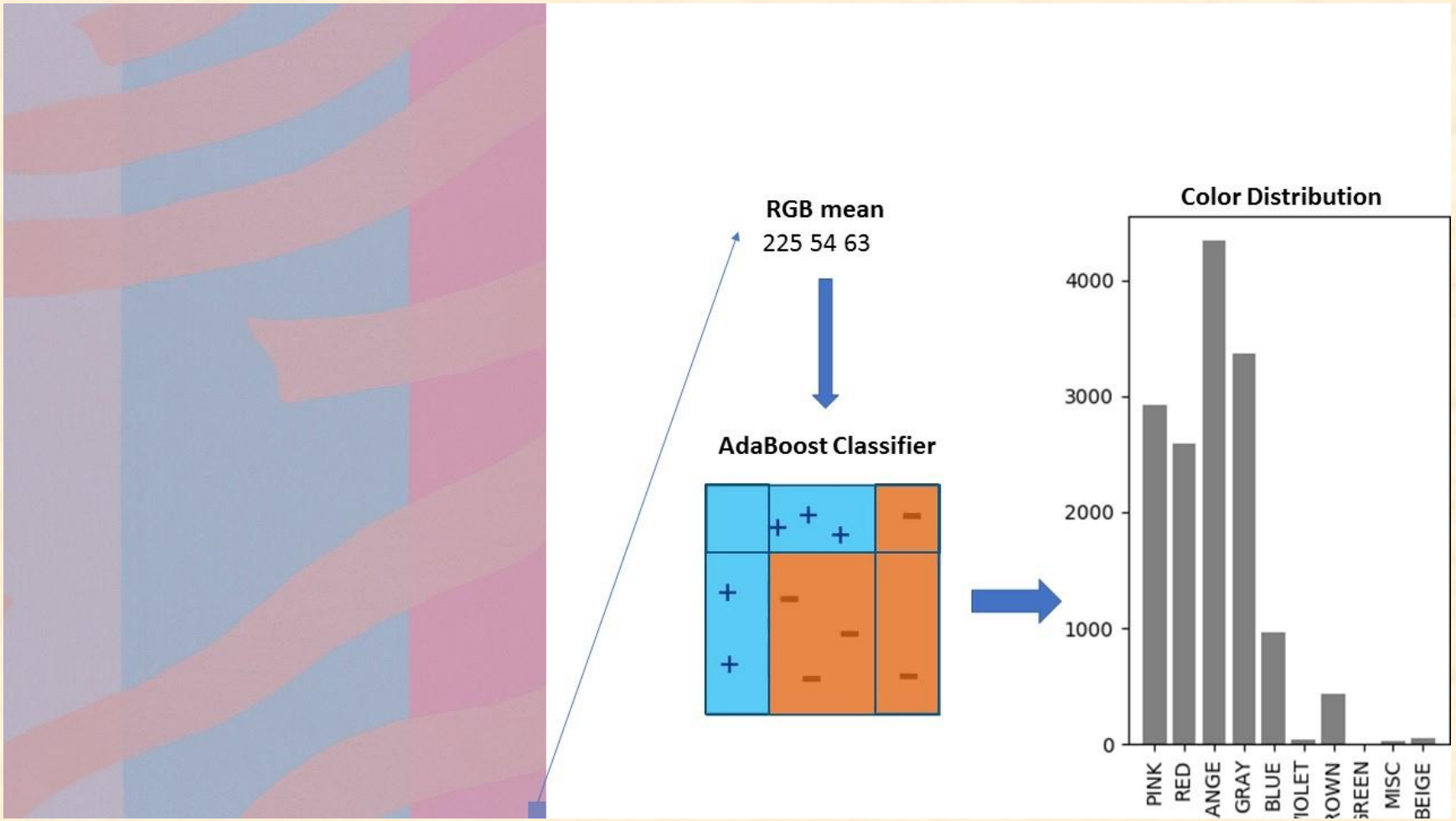
Color Classification



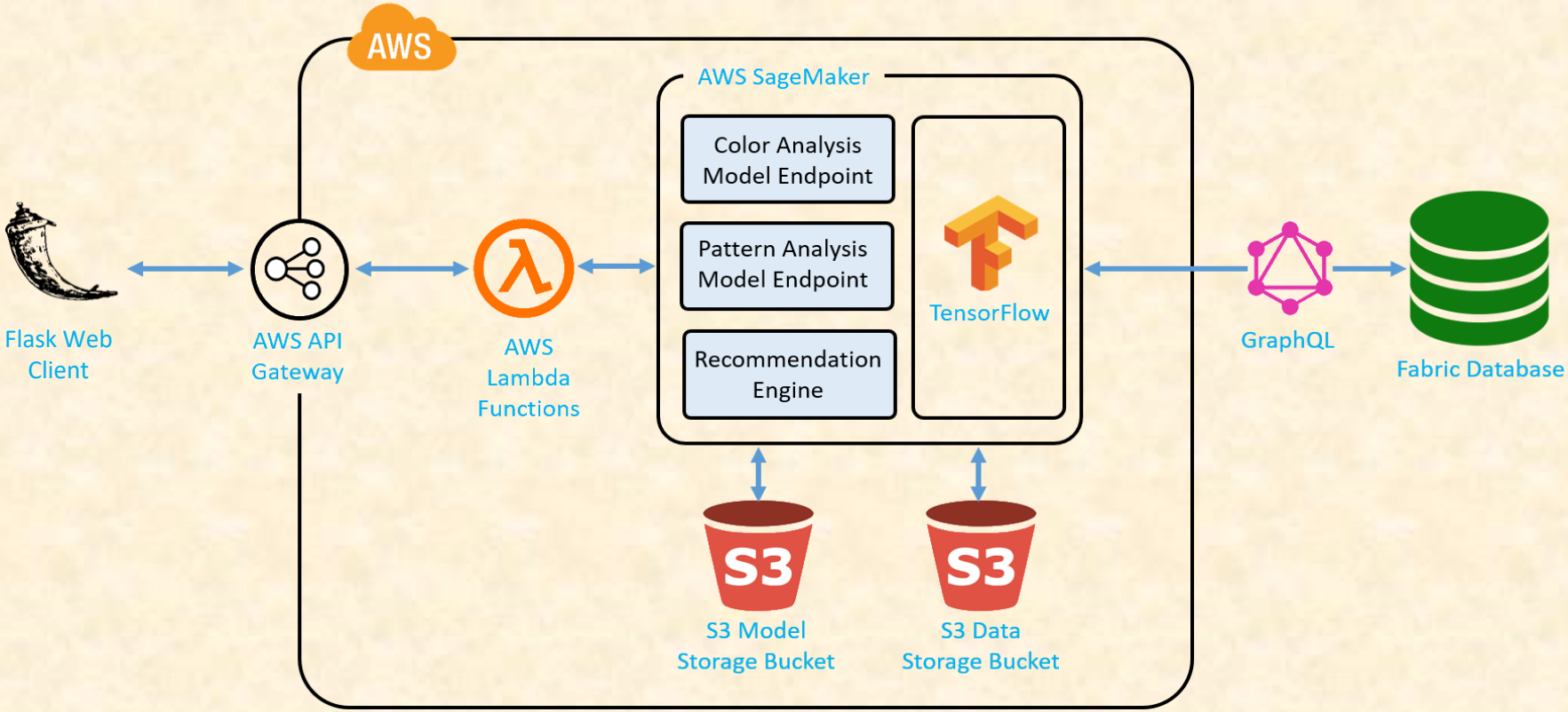
Color Classification



Color Classification



System Architecture



System Components

- Software Platforms / Technologies
  - Amazon Web Services
    - S3 – Storage for training dataset
    - SageMaker – Makes use of Jupyter Notebooks instances running TensorFlow transfer learning network to train and deploy machine learning models
    - Lambda – Interfaces model endpoints
    - API Gateway – Endpoint for client requests
  - Machine Learning
    - TensorFlow – Used for training neural network for pattern classification
    - Scikit-learn – Used for training RGB based color classification
  - Flask
    - Client side framework used to interface with AWS
  - GraphQL
    - A schema definition language used for querying their fabric database

Risks

- Inconsistent Tags
  - The dataset that we are using to train our machine learning models have incorrect tags that will negatively affect models
  - **Solution:** Create a script that will assist in manually retagging images in the dataset
- API Efficiency
  - Our API and classification models take a significant amount of time and the process needs to scale for batch classification
  - **Solution:** Utilize asynchronous calls so the calls execute faster

- Pattern Scale Feasibility (**Stretch Goal**)
  - Herman Miller wants a categorization called pattern scale which is the size of the pattern on a fabric, which is near impossible to determine with the given constraints
  - **Solution:** Look into EXIF or other image metadata that will determine scale or request scale in API, there are also other computer vision theories

Questions?