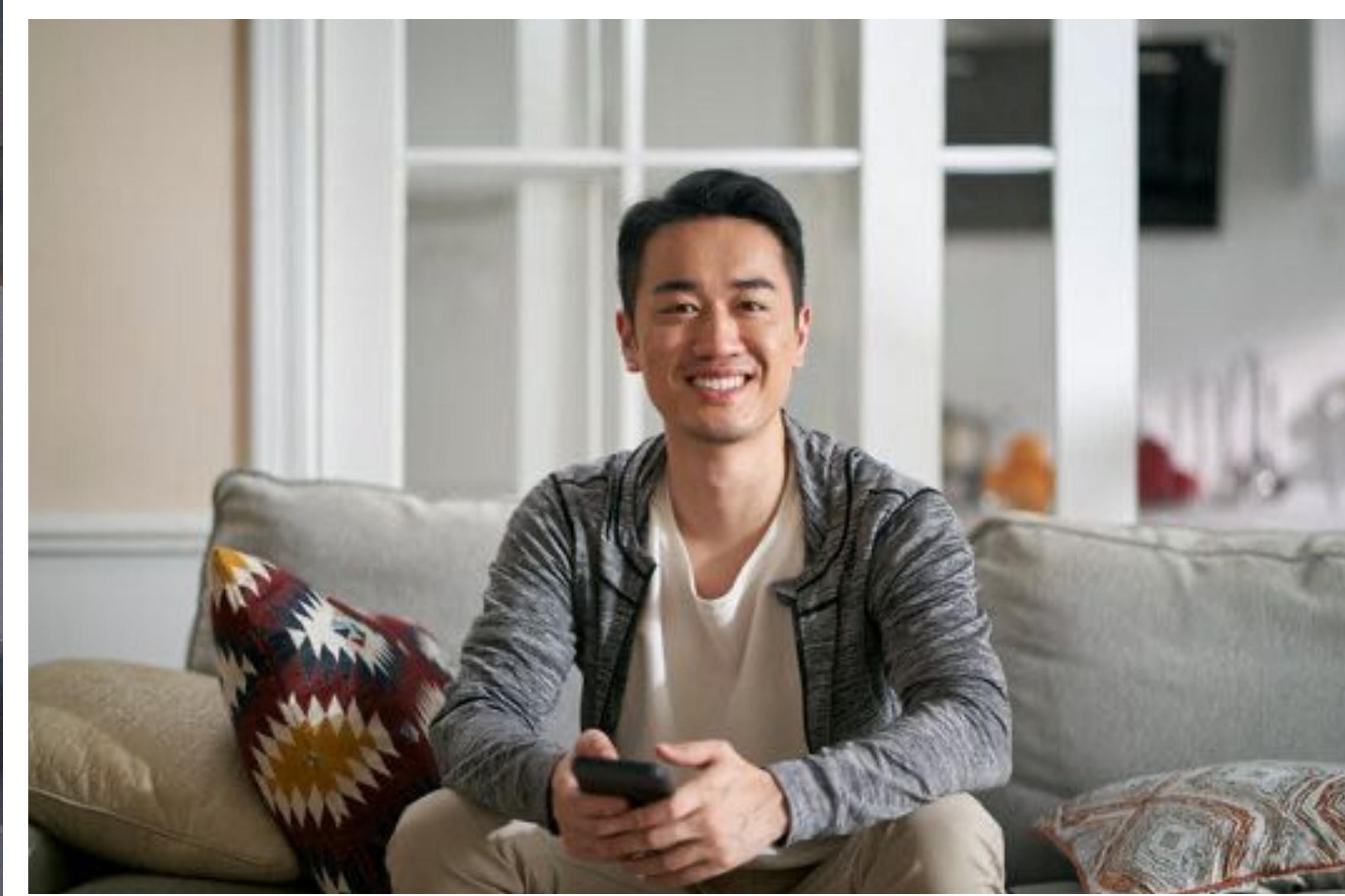


INTERIOR DESIGN

CAPSTONE PROJECT
EUGENE MATTHEW CHEONG
DSI-SG-42



GEORGE LEE, 42

INTERIOR DESIGNER

George has spent eight years designing beautiful homes, adjusting to different client preferences.

Despite his experience, he often finds it difficult to start new projects because of the vast array of products and colours available.

He also struggles to understand what clients want from their text messages alone. George needs a way to simplify the beginning of his design projects and better grasp client needs.



HOW CAN WE HELP INTERIOR DESIGNERS RECOMMEND DESIGNS MORE EFFICIENTLY?



Interior Designers' Initial Difficulties

1. Difficult to find products available in the market that matches the colours.
2. Difficult to find colours that complements each other
3. Difficulty interpreting client requirements from text descriptions

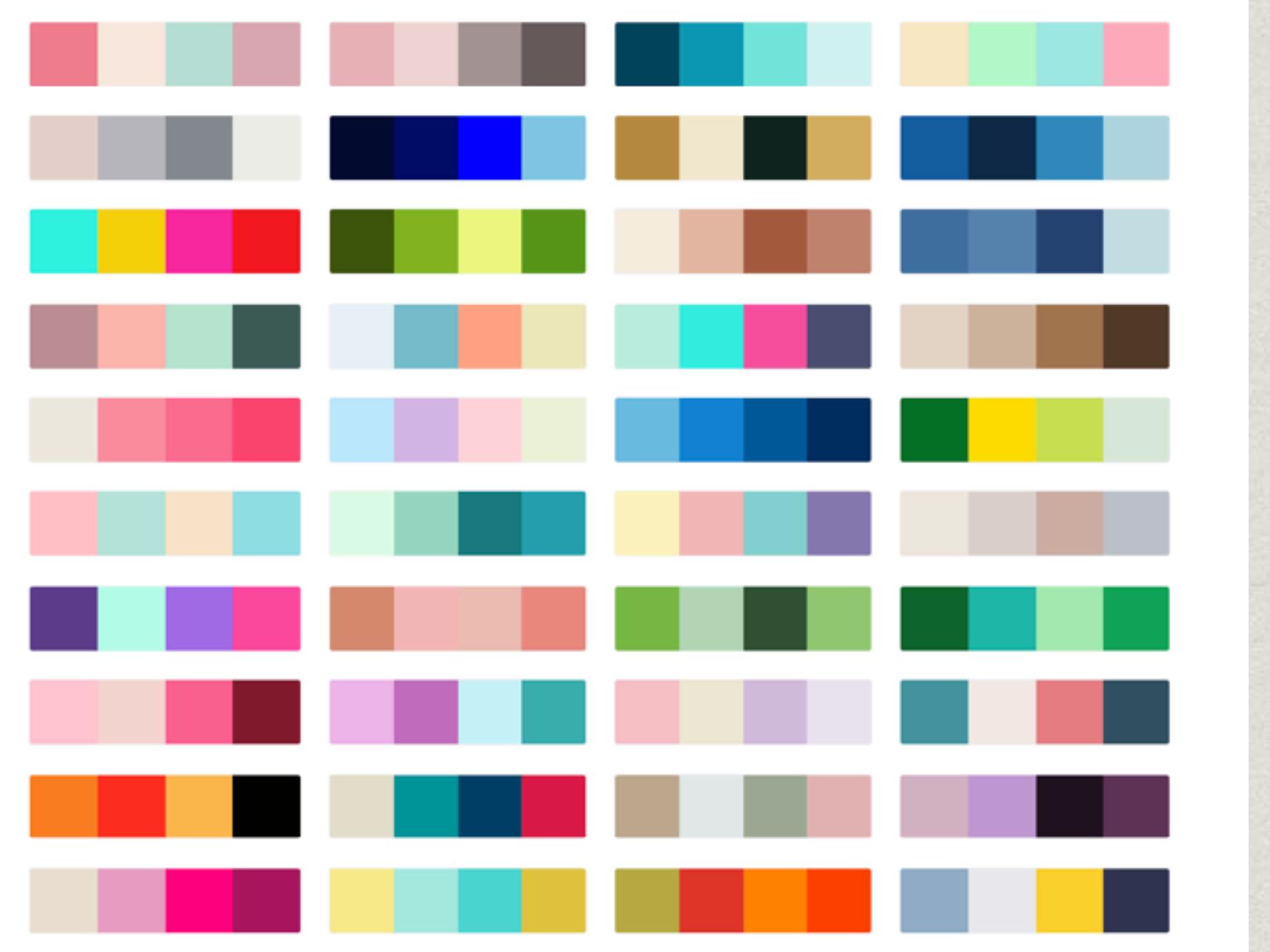
Interior Designers' Initial Difficulties

1. Difficult to find products available in the market that matches the colours.
2. Difficult to find colours that complements each other
3. Difficulty interpreting client requirements from text descriptions

The screenshot shows a website for Lian Seng Hin Tiles Stone Mosaic. At the top right is a navigation bar with links: HOME, ABOUT US, FEATURED, PRODUCTS, and CONTACT US. Below the navigation is a search bar with placeholder text "What are you looking for ...". To the right of the search bar is a magnifying glass icon. On the left side, there's a sidebar with a logo for "CENTRE HAFARY" and a "FILTER BY" section containing various product categories like Material, Effects, Colour, Size, Finish, Slip Rating, Origin, Technology, and several numerical codes such as 01-201, 01-TGS, 01-NB3, 01-ROW, 01-GT6, 01-POL, 05-INN, 01-1861, 01-330, and 01-36U. Below this is a "COLORS" section with a vertical scroll bar. The main content area features a large image of a textured surface, likely wood or stone. Below the image are buttons for WOODS, SOLIDS, PATTERNS, SPECIALITIES, and NEW. A "FILTER" section includes dropdown menus for PRODUCT LABEL, THEMES, GRAINS, TYPES, FINISH, SIZE, and SHADES. A search bar at the bottom allows users to search by colour code or name, with an example "E.g. NP OW 1001 P or Sun Glint". The page also displays a "SAVA" section with a dark wood sample, a "RYE SAWA WOOD" sample, and a "VIEW DETAIL" button. It includes a "Colour Family: WHITE" section with a row of colored circles and three detailed product cards for "ANGEL PINK" (1162), "APPLE WHITE" (1140), and "APPLE WHITE" (9070).



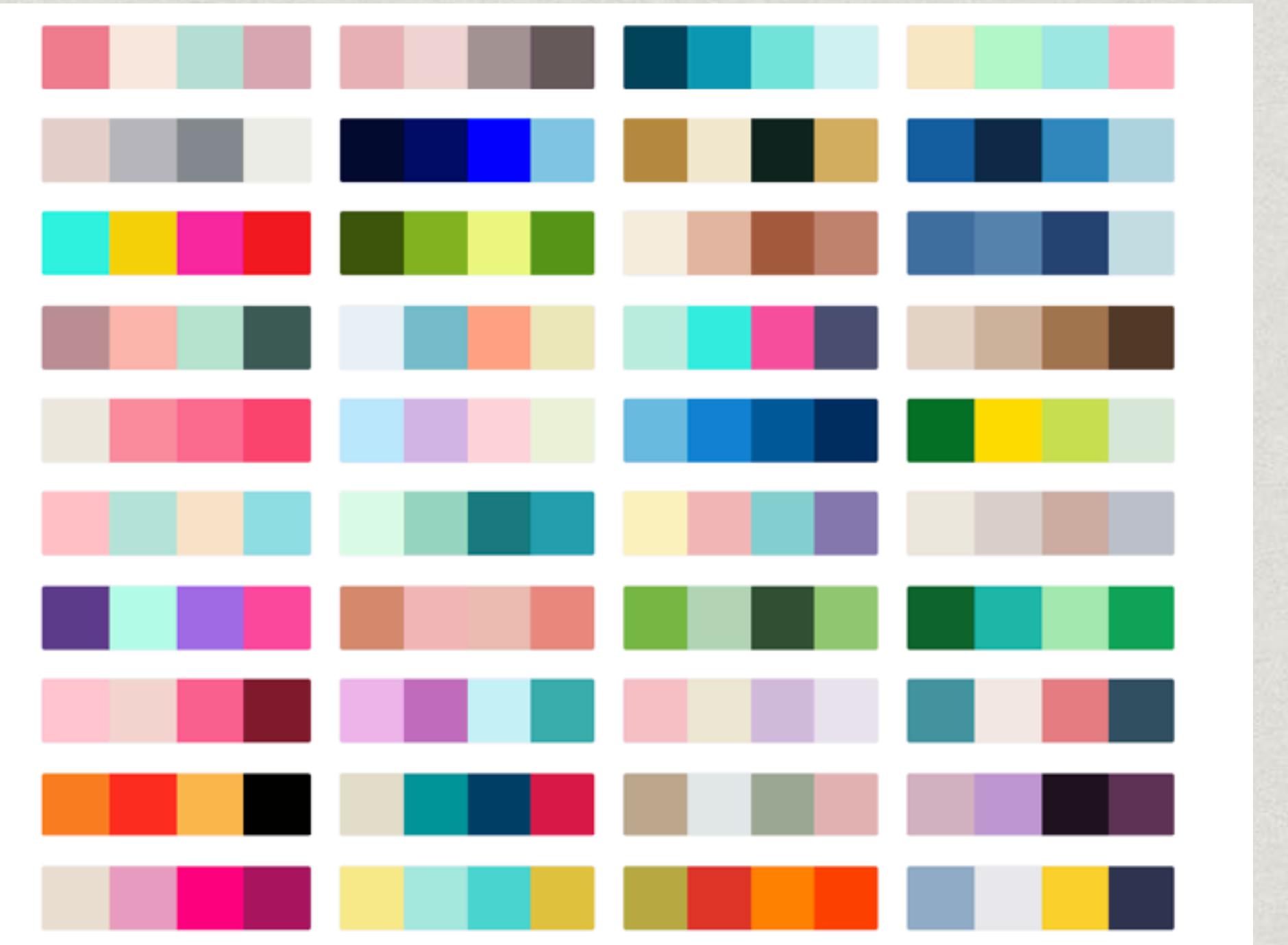
Canva

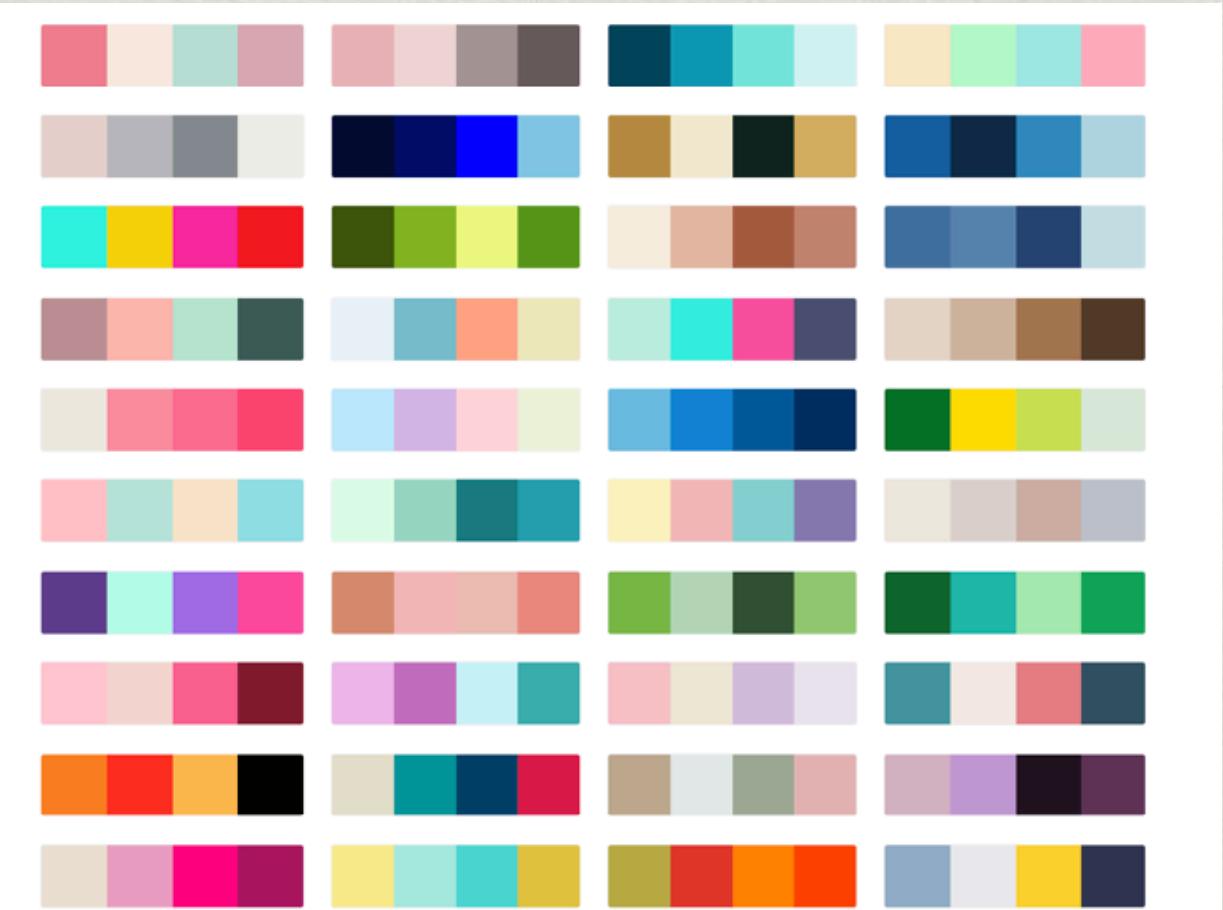
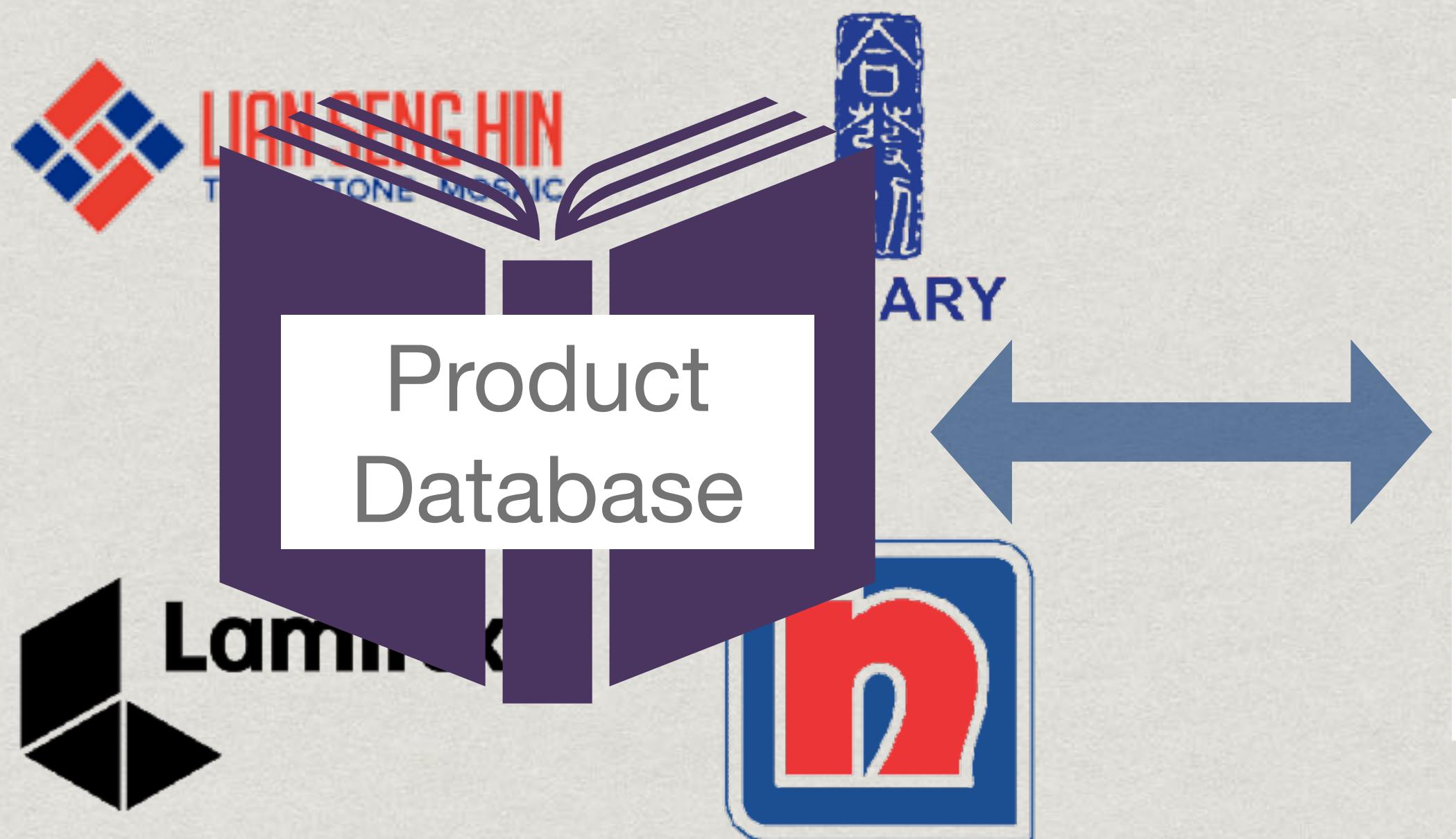




Canva

- Thousands of colour palettes
- Many combinations with 16 million colours





App Features

- Product Catalogue Recommender with Image
- Product to Colour Palette Recommender
- Colour Palette to Product Recommender
- Colour Palette AI Assistant

Website Scraping

- 14,000+ products and images
- 500+ Canva colour palettes

Models

1. Colour Recommendation System
2. VGG16 Convolutional Neural Network Model
3. LLama3 (Large Language Model)

Catalogue Datasets



Colour Palette Datasets

Canva

Catalogue Datasets



- Catalogue dataset is not clean. When scraping, there are images that are not images of the product.





Interior Designers' Initial Difficulties

1. Difficult to find products available in the market that matches the colours.
2. Difficult to find colours that complements each other
3. Difficulty interpreting client requirements from text descriptions

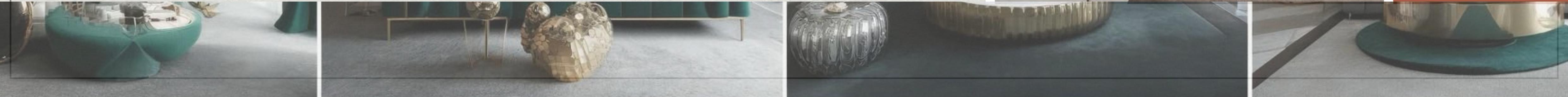
App Features

- Product Catalogue Recommender with Image
- Product to Colour Palette Recommender
- Colour Palette to Product Recommender
- Colour Palette AI Assistant

Product Catalogue Recommender with Image

Problems Faced

- **Classification**
 - Lack of time to gather enough dataset per the product
 - Over 14,000 products
 - Catalogues are always updating





Colour Recommendation System

Recommendation
System



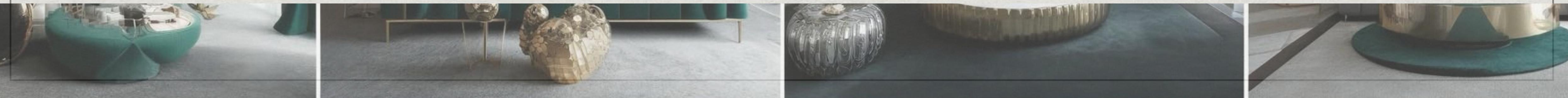
Recommendation System

How does it work?

Recommendation
System

What is Cosine Similarity?

- Measures the cosine of the angle between two vectors, making it sensitive only to the **direction** of the vectors, not their **magnitude**.
- This characteristic is particularly useful in **colour comparison** because it focuses on the **proportion of colours** (i.e., their **hue** and **saturation**) rather than the **intensity**.
For example, a very light pink and a very dark red might be very different in RGB space due to their different luminance levels, but their **underlying hue** is **similar**, which **cosine similarity** can **capture more effectively**.



CIELAB colour space

Recommendation
System

Why CIELAB?

- CIELAB is a colour space that is designed to approximate human vision.
- It expresses colour as three values:
L* for perceptual lightness
a* and **b*** for the **4** unique colours of human vision:
red, green, blue and yellow.



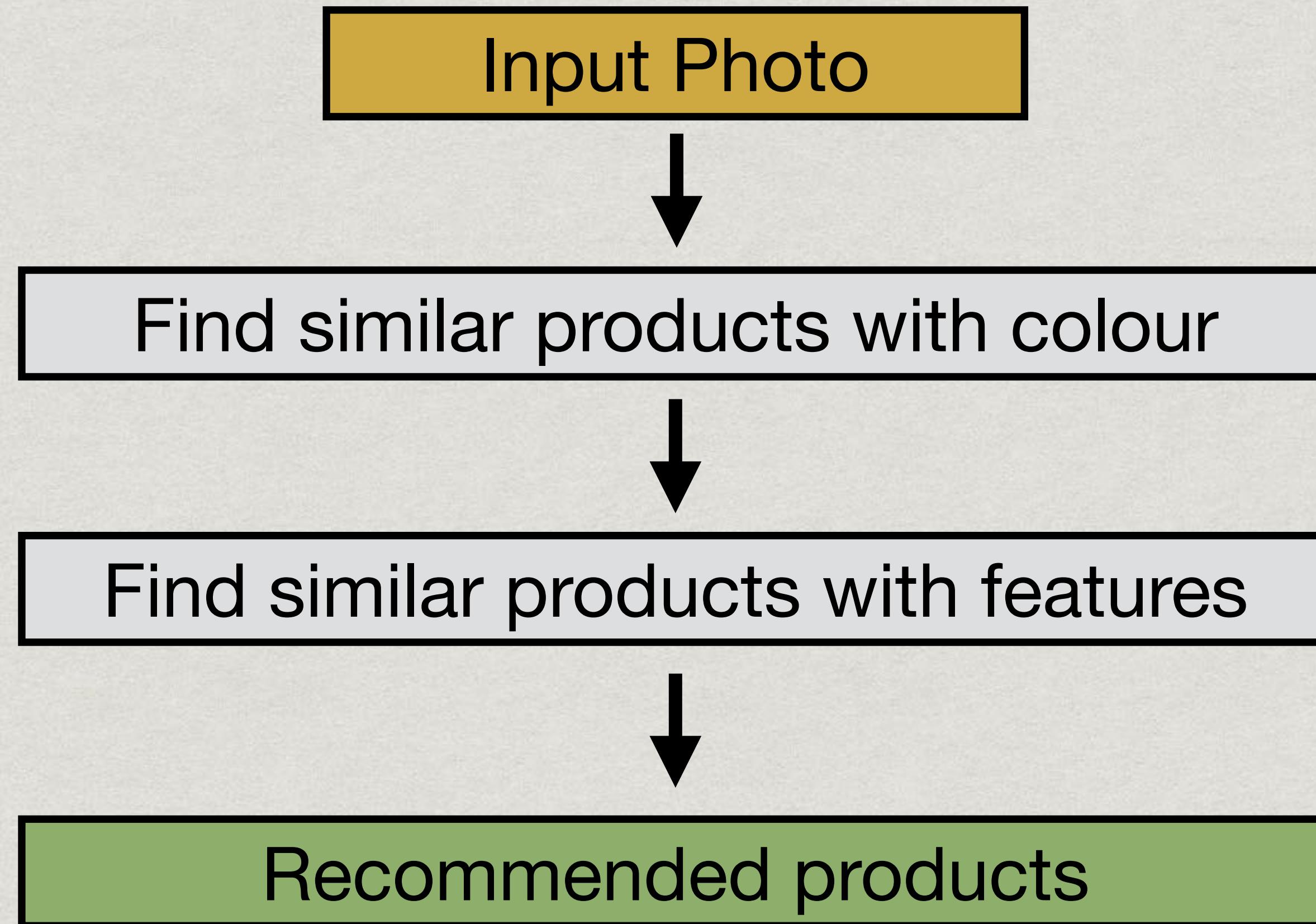
Product Catalogue Recommender with Image Approach



- Colour
- Features/Texture/Detail



Product Catalogue Recommender with Image Approach



Finding Similar Colour

How does it work?

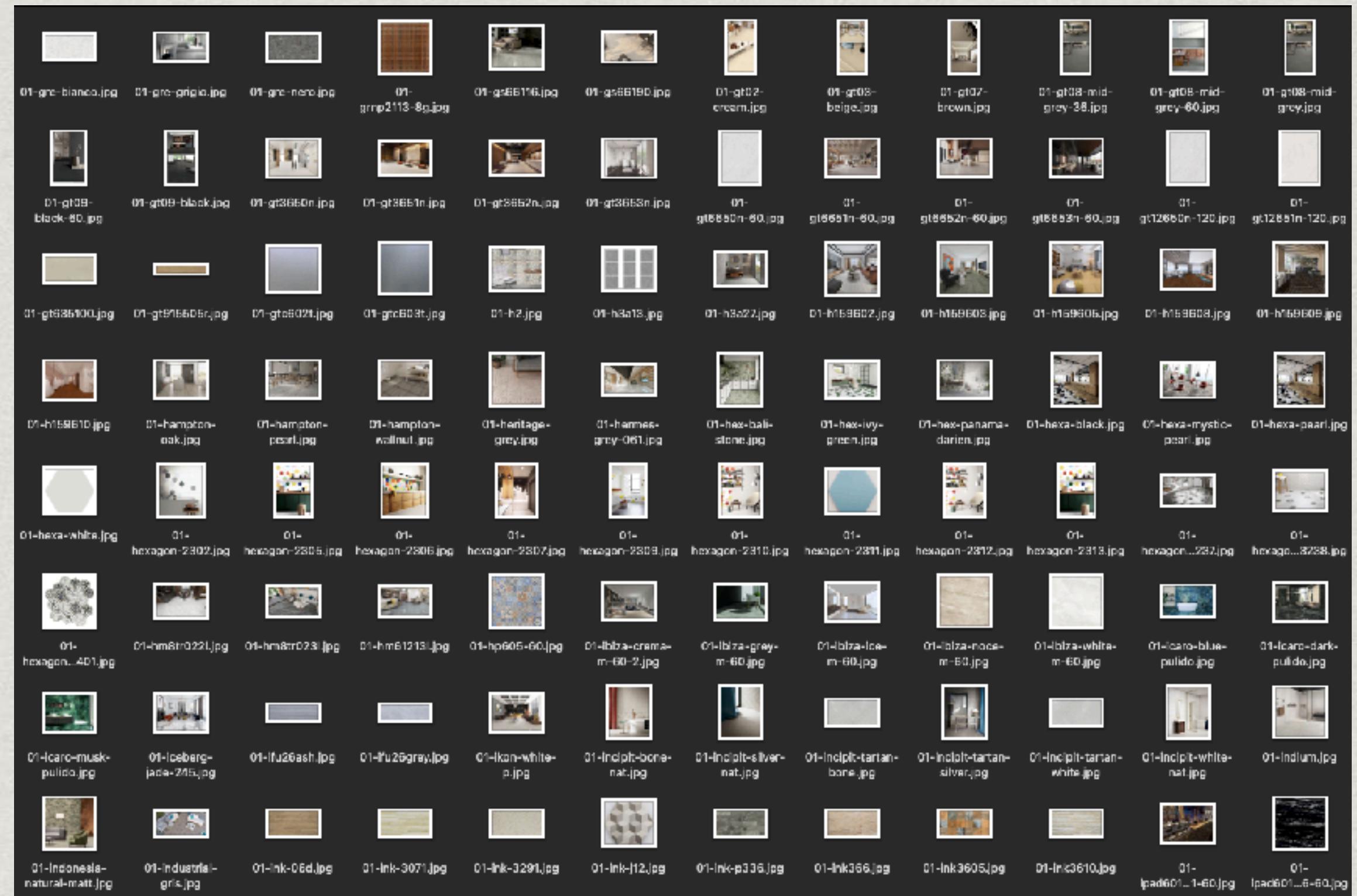
Input Image



Preprocessing



Converting Products Images into Vectors



14,000+ product images

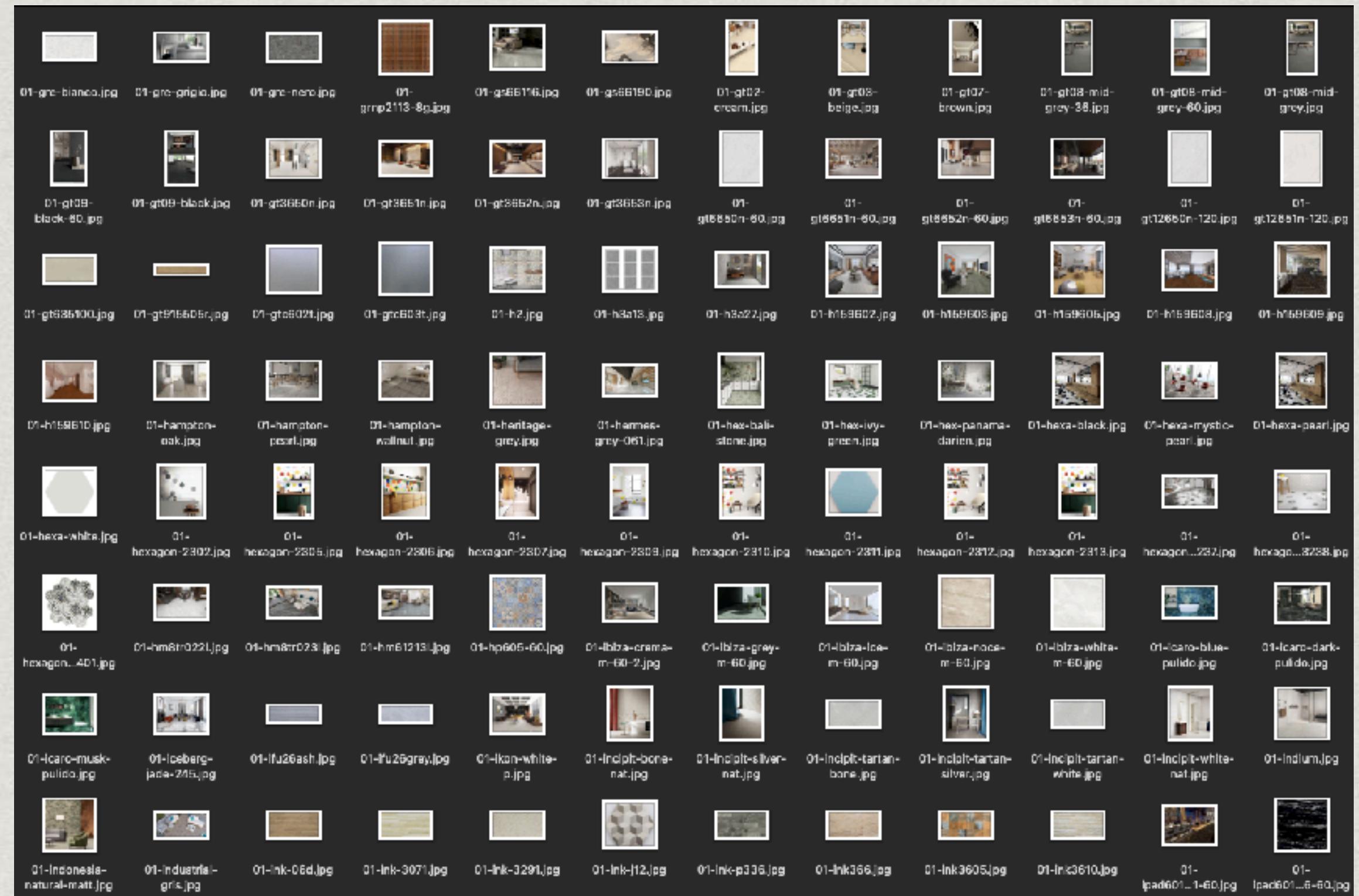


Preprocessing

- Resize to a consistent size
- Converting to the correct colour space
- Normalize



Converting Products Images into Vectors



14,000+ product images

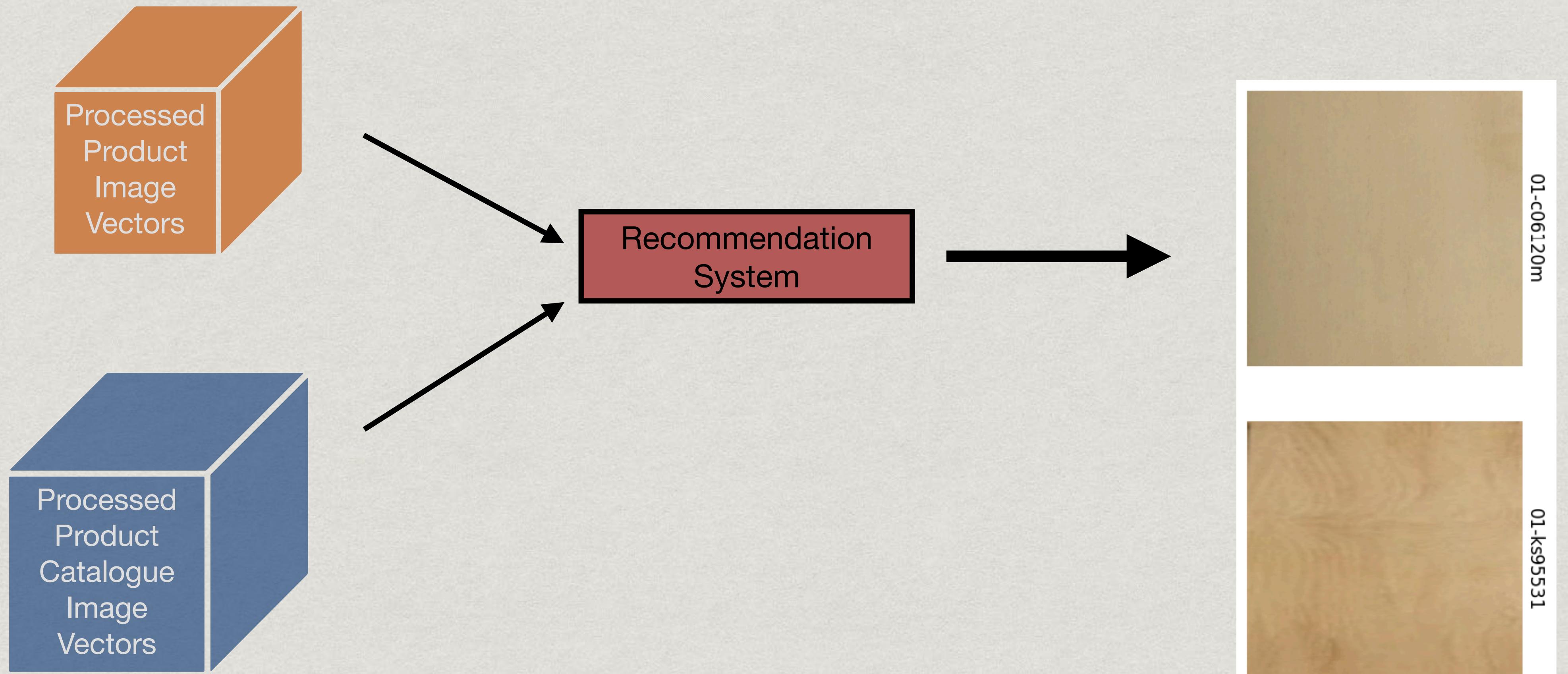


Preprocessing

- Resize to a consistent size
- Converting to the correct colour space
- Normalize



Finding Similarities by Colour



Finding Similarities by Colour



Not that similar in feature, texture or detail. Only colour.

01-c06120m



01-ks95531



01-zz6873m-60



01-zz6873m-b4



01-senlin-beige



01-qpm80833a-p



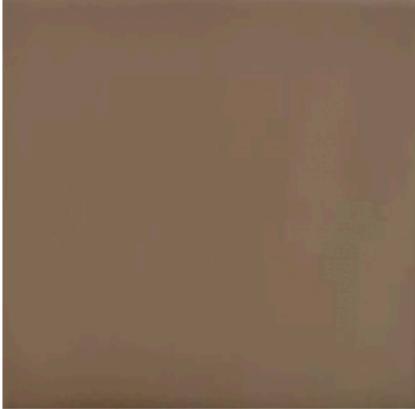
01-chocolate



WY 1281D



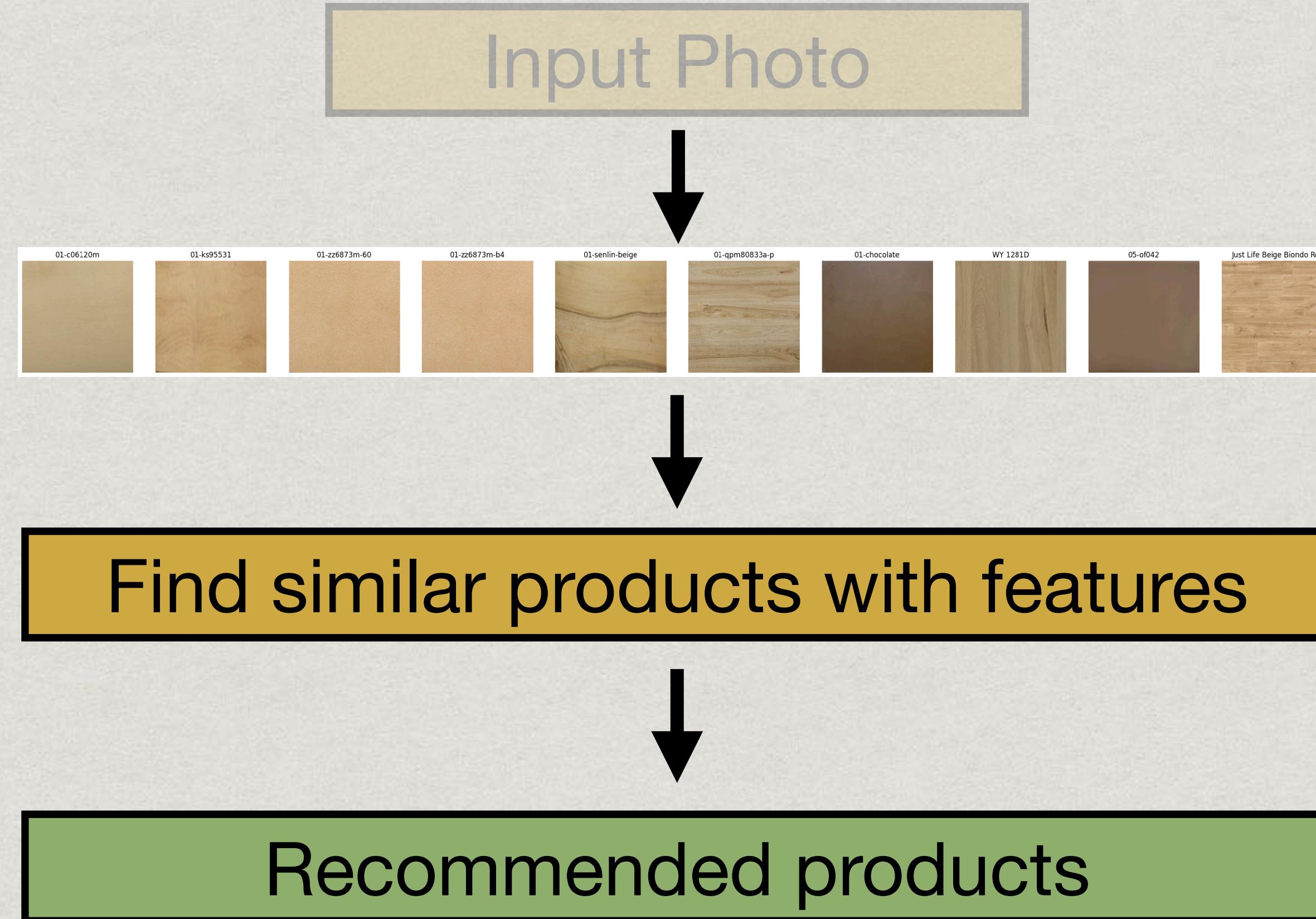
05-of042



Just Life Beige Biondo Ret



Approach



Finding Similar Pattern

What is VGG16?

Pre-trained model



Finding Similar Pattern

What is VGG16?

- Pre-trained Model
- Convolutional Neural Network
- Used for Object detection and classification
- Able to classify 1000 categories
 - ImageNet Database
- Able to identify features

Pre-trained model



Finding Similar Pattern

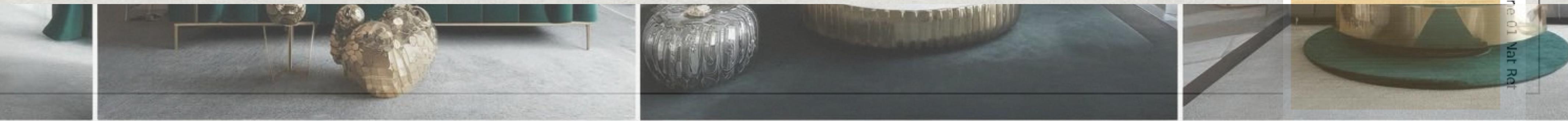
How does it work?

Recommended Products

Recommended Products
by Colour Similarity



Input Photo



Features

Features

Recommendation System



Evo Coal Rec

Evo Tatami Grey Lap

Star 4.0 Storage 01 Nat Rat

Finding Similarities by Colour



Much better results

Evo Coal Rec



Evo Tatami Grey Lap



Ston 4.0 Stone 01 Nat Ret



MA26672P(M)



Evo Tatami Coal Lap



Nature Mood Glacier Glossy R



Ston 4.0 Stone 01 HGlo Rt



Nature Mood Mount Peak Glos R



Evo Grey Rec



Nature Mood Tundra Glossy R



Product Catalogue Recommender

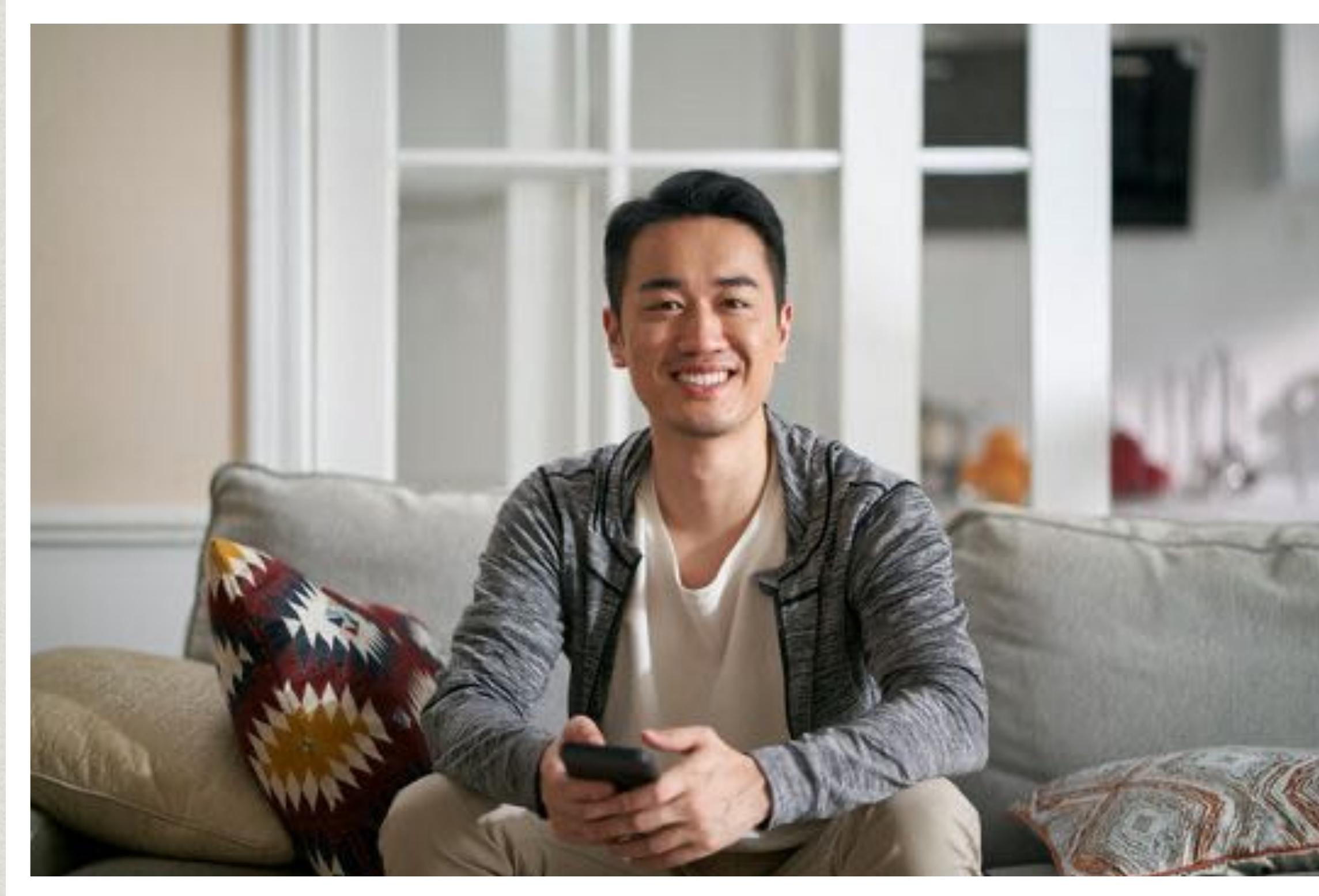
Limitations

- Unable to detect complex patterned tiles
- Unable to classify or recommend materials, only colours and small details like texture.
- Recommendation System is computationally expensive because of the amount of data is in the image per product.
- Catalogue dataset is not clean so it might not recommend the product because it cannot find





Interior Designers' Initial Difficulties



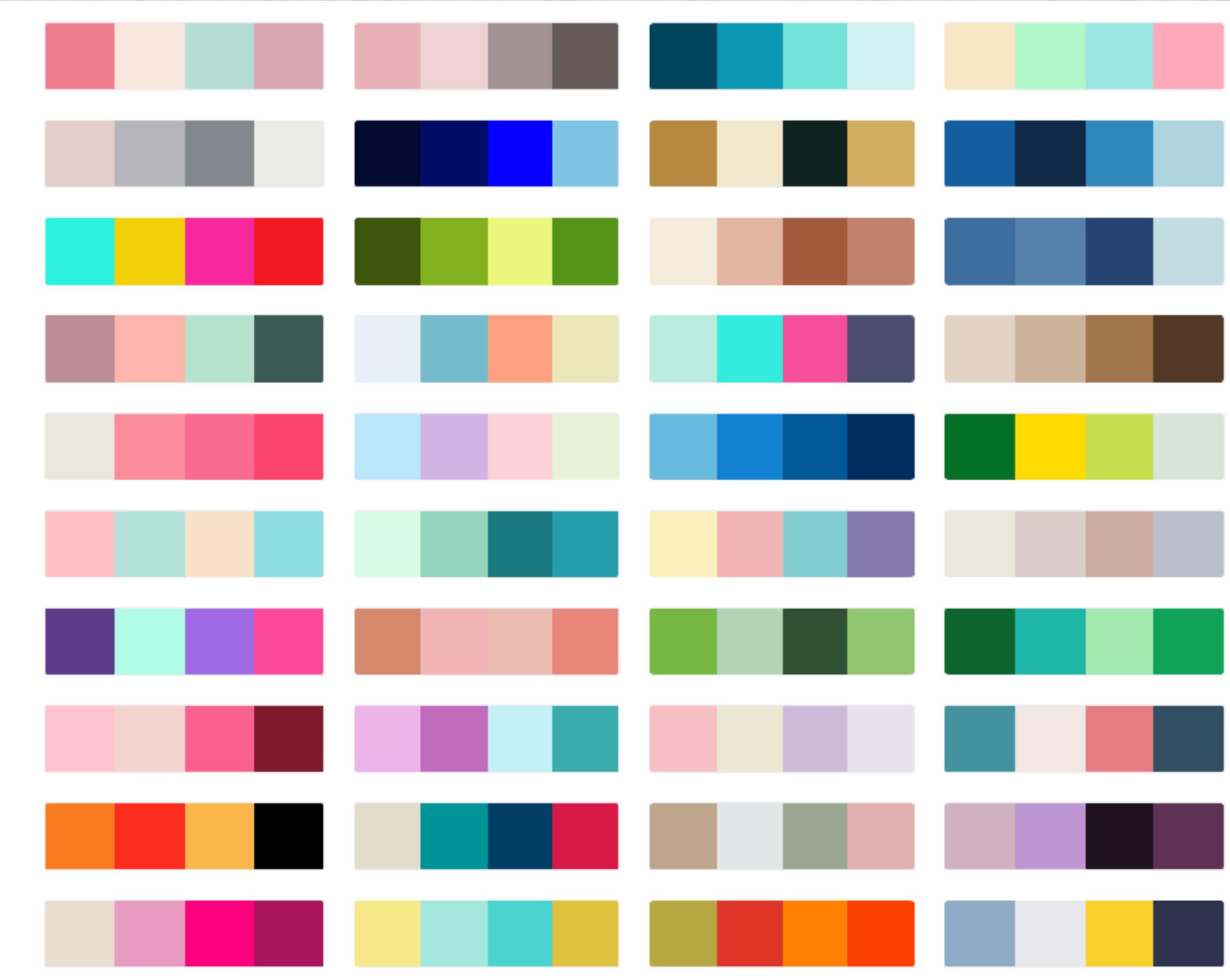
- ✓ 1. Difficult to find products available in the market that matches the colours.
 - 2. Difficult to find colours that complements each other
 - 3. Difficulty interpreting client requirements from text descriptions
- 

App Features

- Product Catalogue Recommender with Image
- Product to Colour Palette Recommender
- Colour Palette to Product Recommender
- Colour Palette AI Assistant

Recommendation System (Colours)

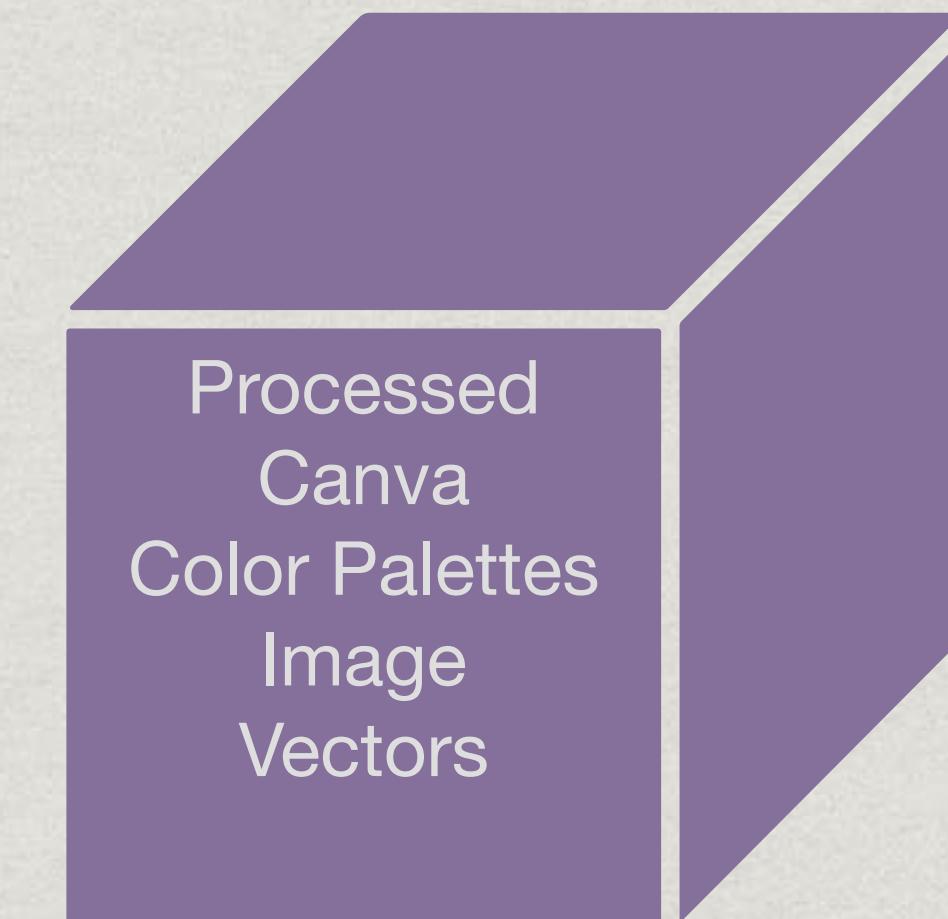
Products to Colour Palettes



2000+ Colours

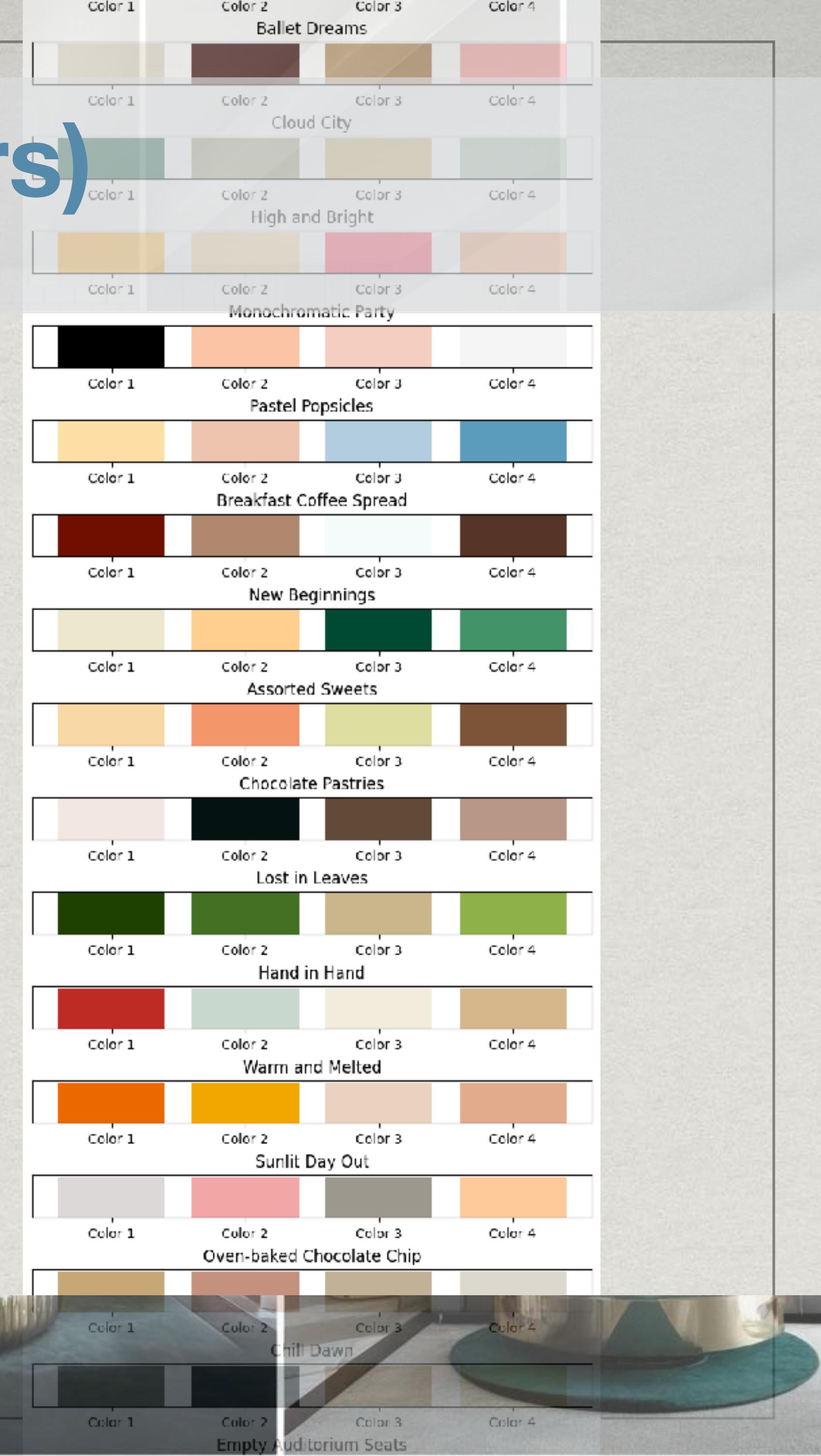
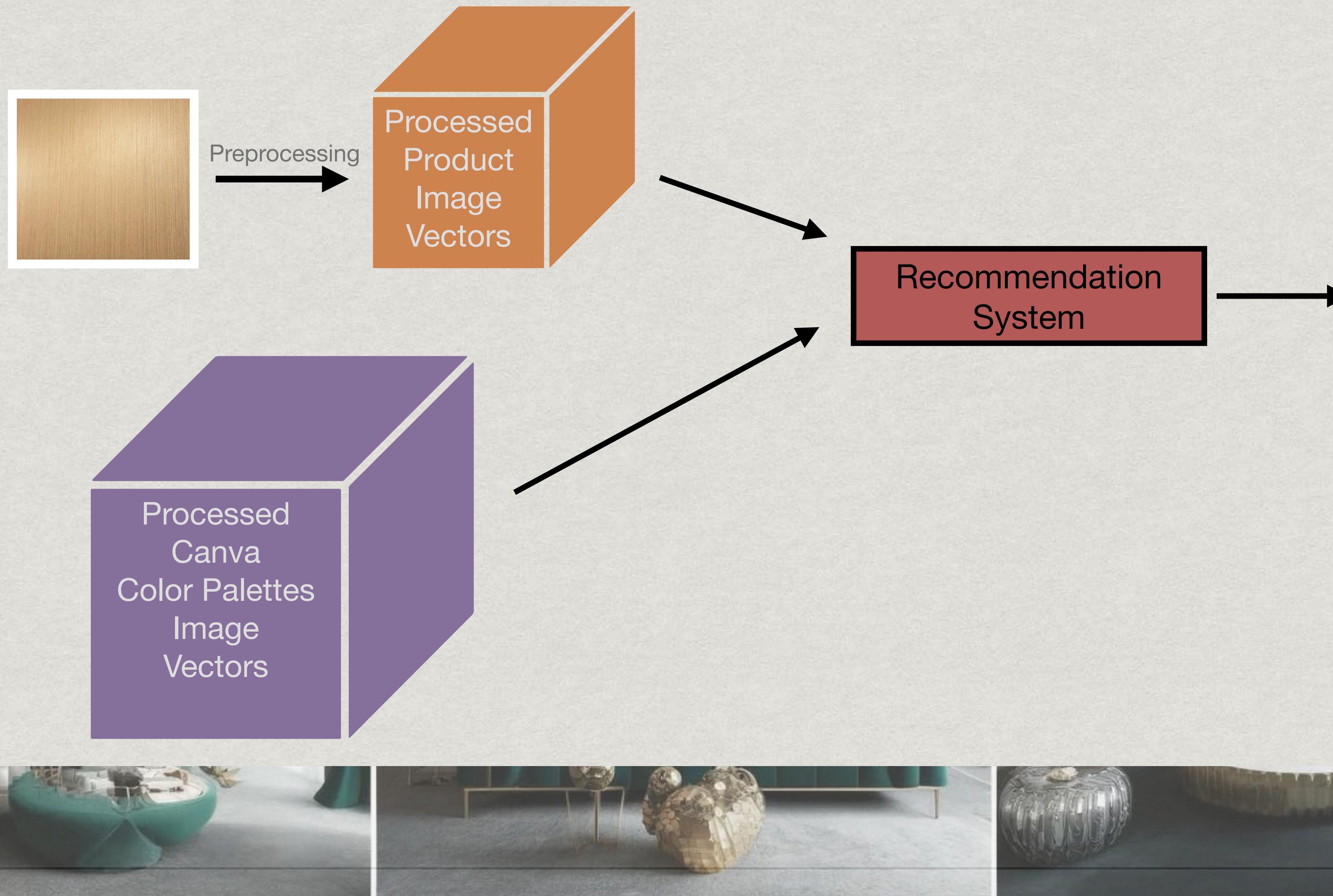
Preprocessing

- Resize to a consistent size
- Converting to the correct colour space
- Normalize



Recommendation System (Colours)

Products to Colour Palettes



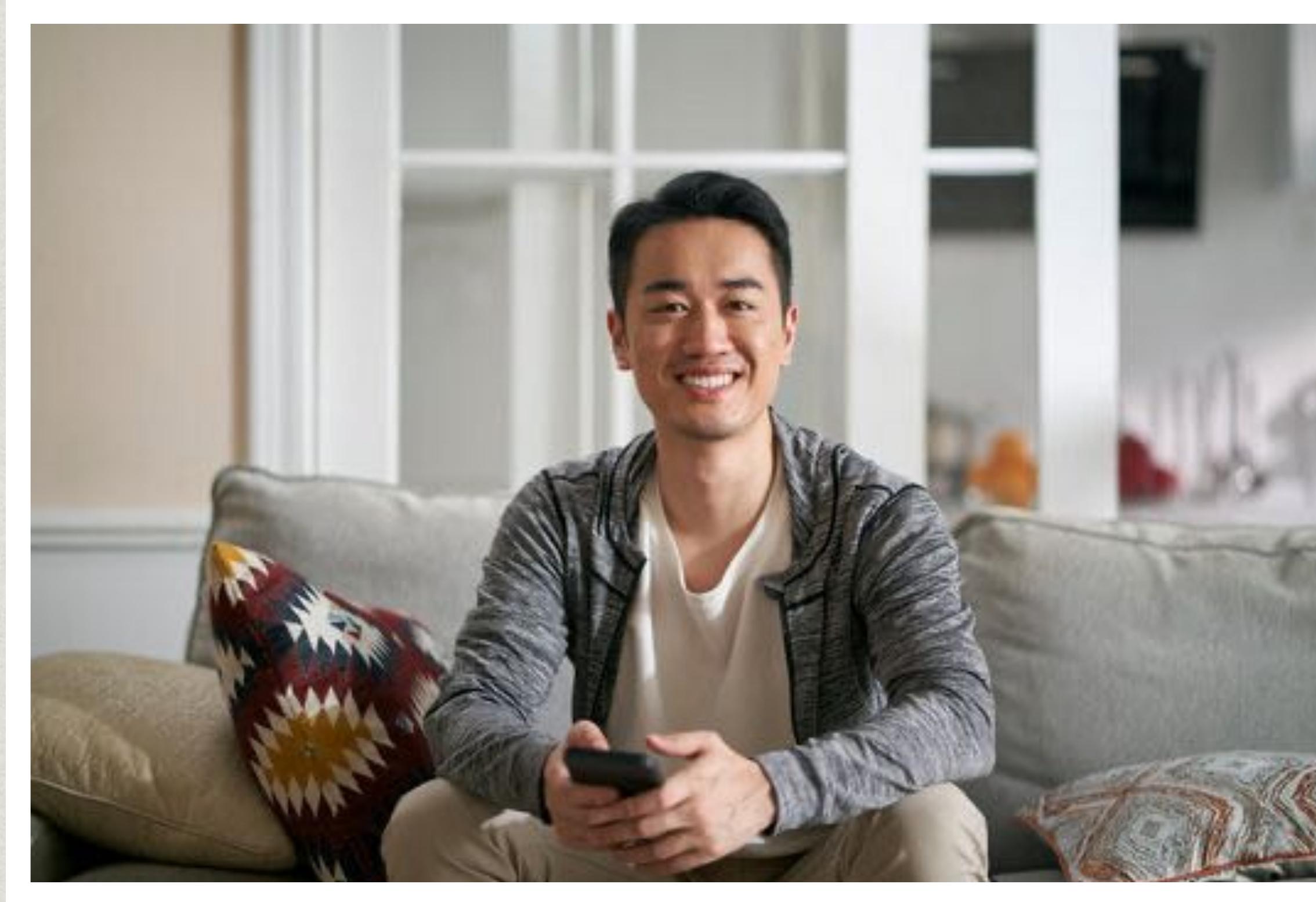
Recommendation System (Colours)

Colour Palette to Product





Interior Designers' Initial Difficulties



- ✓ 1. Difficult to find products available in the market that matches the colours.
 - ✓ 2. Difficult to find colours that complements each other
 - 3. Difficulty interpreting client requirements from text descriptions
- 

App Features

- Product Catalogue Recommender with Image
- Product to Colour Palette Recommender
- Colour Palette to Product Recommender
- Colour Palette AI Assistant

Chatbot to recommend colour & colour palettes

How does it work?

Llama3

- Large Language Model developed by Meta
- Its efficiency in handling different types of language tasks, and its scalability, which allows it to be used in various settings from small-scale to large-scale deployments.
- It is able to recommend colour palettes and colours that complements to the user needs.

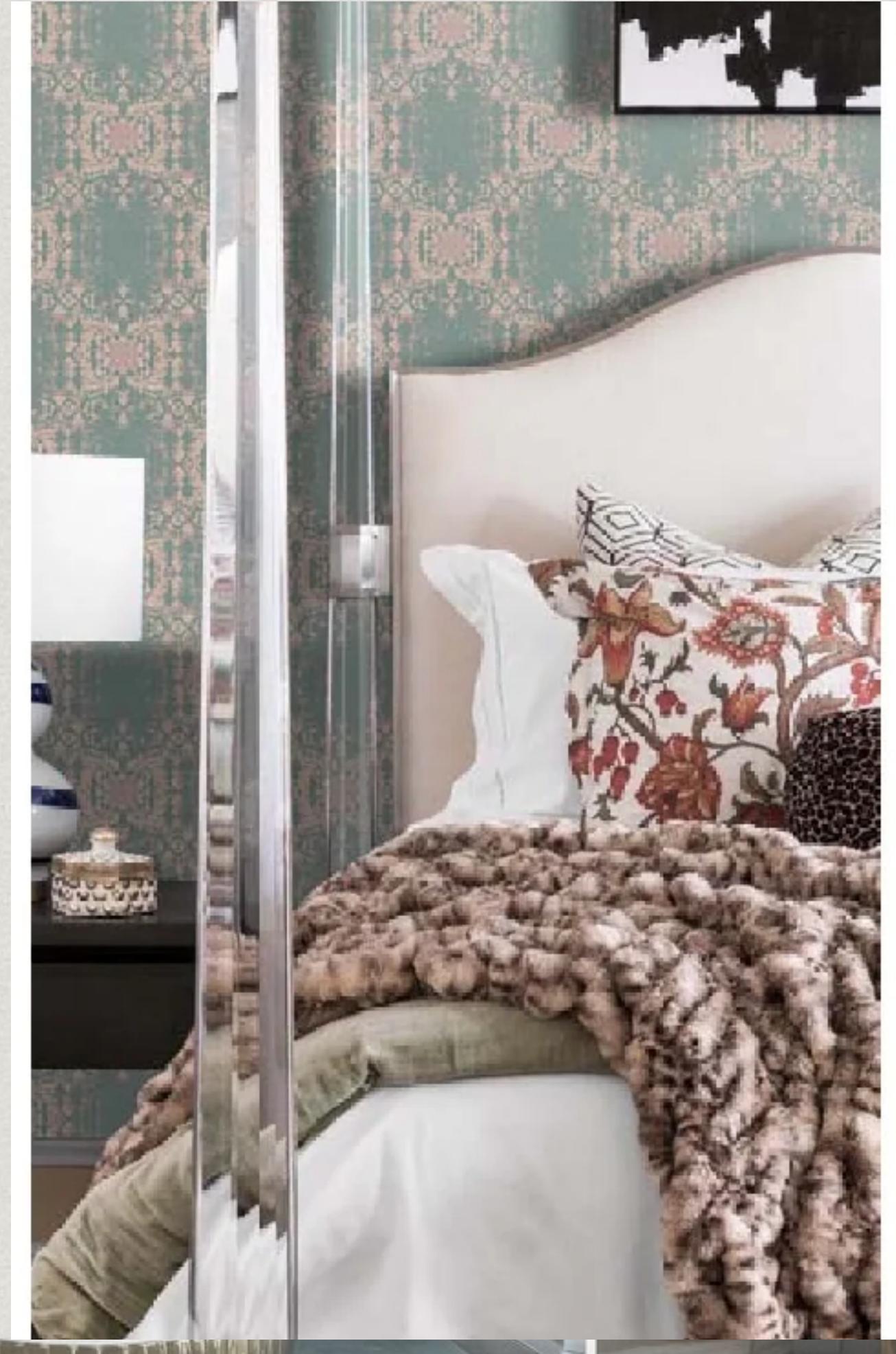


Chatbot to recommend colour & colour palettes

Integration

Initial Prompt

- "You are an interior designer in this app and are tasked to suggest colour palettes to suit their preferences based on their description. Set a professional tone when responding."
- "When suggesting colours, do include hex codes in all of the response and have it as a separate list. Do not suggest any products or furnitures. Only colours and colour palettes."

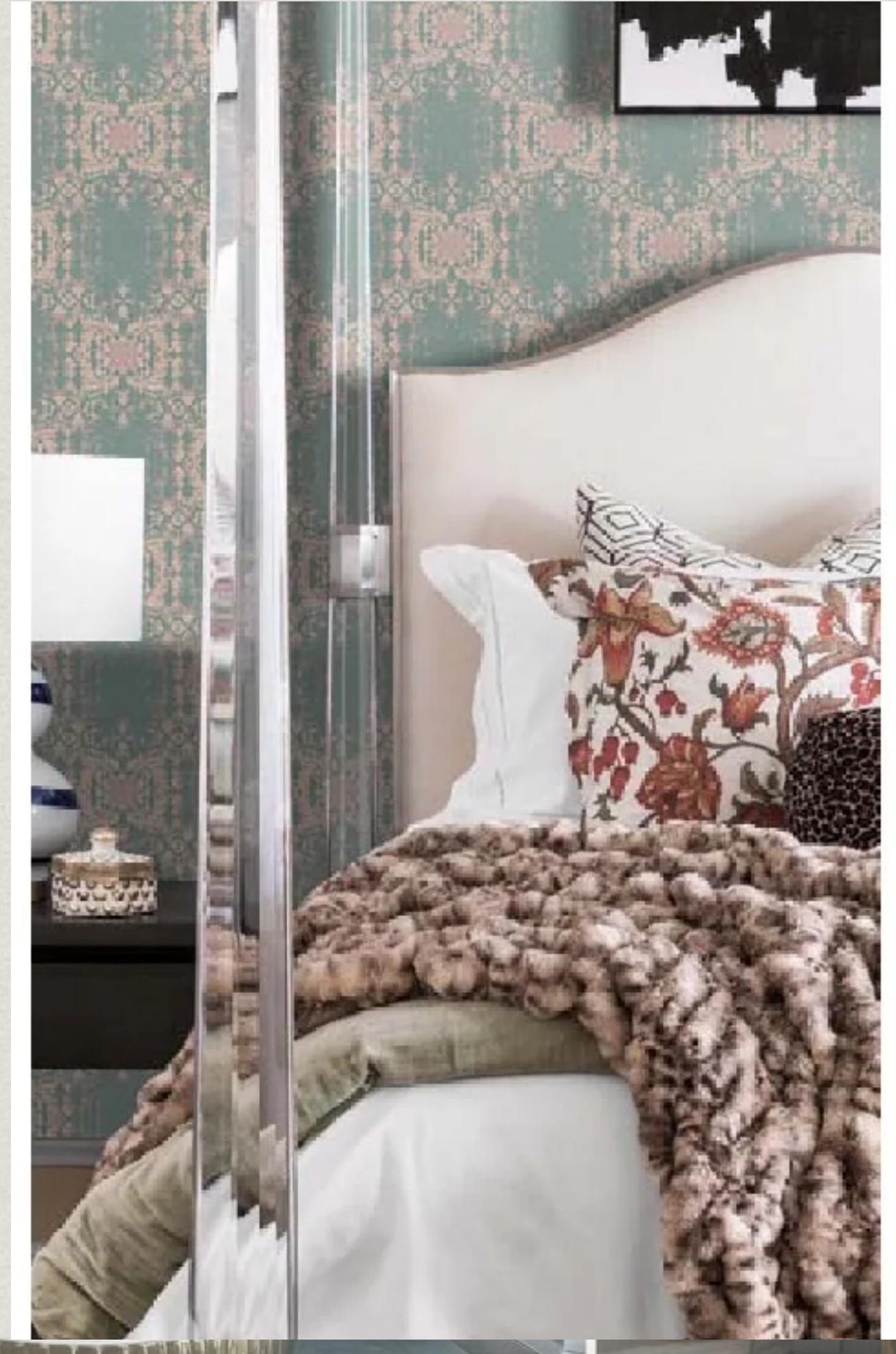


Chatbot to recommend colour & colour palettes

How does it work?

Extract hex codes

- Take the reply from the chatbot and extract the hex codes with regular expression.
- Regular expressions (Regex) are patterns used to match character combinations in strings



Chatbot to recommend colour & colour palettes

How does it work?

Example reply from chatbot

What a sweetie! I'd be happy to help you find some lovely color palettes for your little princess!

Based on your request, I'll recommend some pink-inspired palettes from my list:

1. **Lilac Shimmer**: A soft and romantic palette featuring #3E004A (a light lilac), #ADE292 (a gentle yellow-green), #4120A9 (a deep berry pink), and #7800A2 (a rich plum). Perfect for a sweet 4-year-old!
2. **Candy Style**: A playful and whimsical palette with #5558D8 (a pastel blue-pink), #D4BBDD (a soft peach), #FBD3DA (a warm beige), and #8ADFE3 (a pale aqua). Your little one might enjoy these colors!
3. **Fresh Succulent**: A bright and cheerful palette featuring #13292A (a deep green), #91CABE (a vibrant pink), #499FA4 (a soft peach), and #B5DFD6 (a creamy white). This palette is perfect for a lively and energetic 4-year-old!
4. **Blush of Trees**: A gentle and soothing palette with #E5A298 (a light coral), #C1D9B7 (a pale green), #2C7721 (a deep brown), and #00E091 (a soft mint). This palette is ideal for a sweet and nature-loving little one!

Feel free to pick the one that resonates with your daughter's personality, or mix-and-match colors from these palettes to create a unique combination that she'll love!

- Gather into a list for both colour palettes and colours.

Colour Palettes

Colour Hex Codes



Chatbot to recommend colour & colour palettes

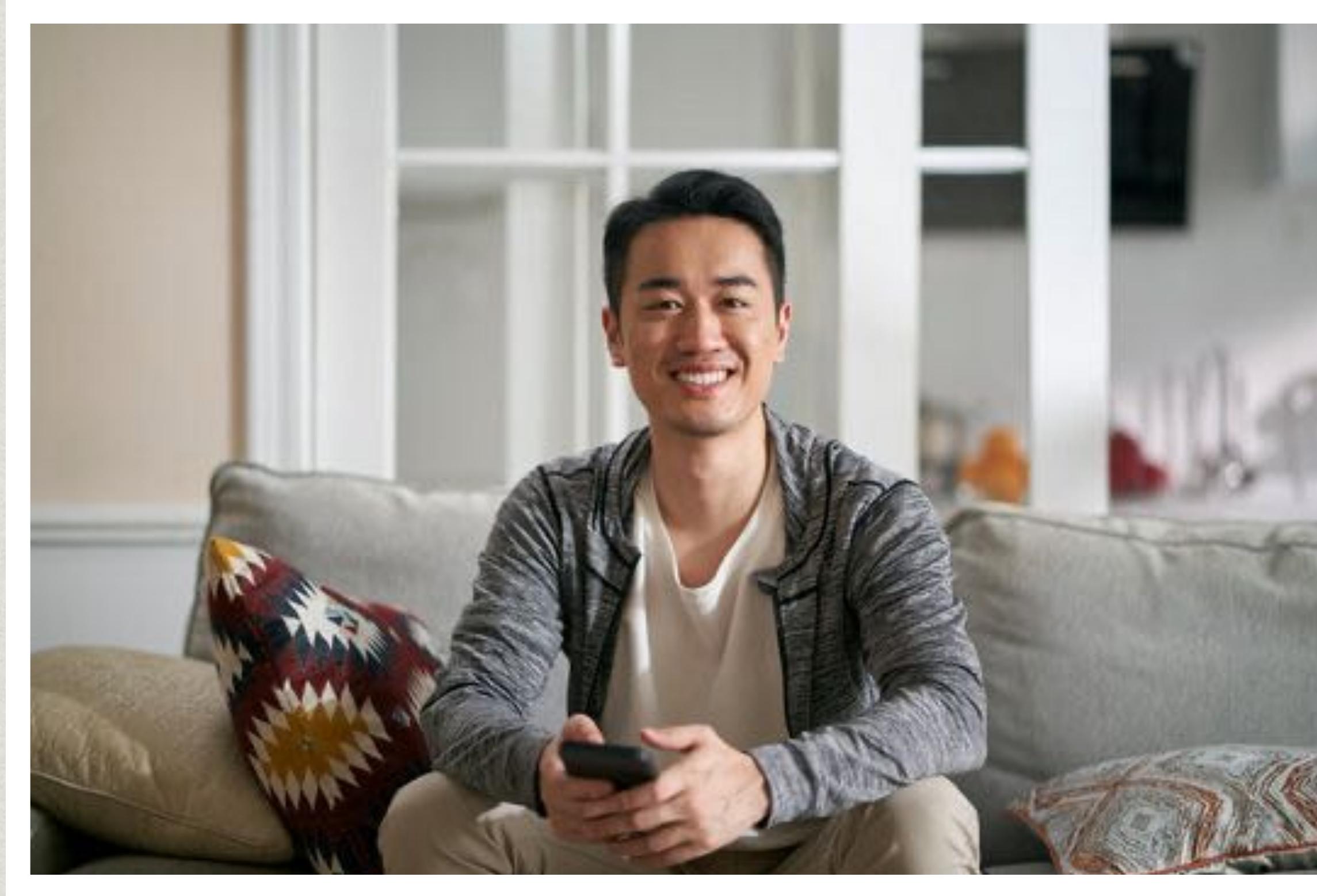
Limitations

- There are limited controls to set the **tone/temperature** for the chatbot.
- Limitations exist in defining the **context's scope** and **boundaries**. Occasionally, the **LLM** might **supplement its responses** with **additional information**.





Interior Designers' Initial Difficulties



- ✓ Difficult to find products available in the market that matches the colours.
 - ✓ Difficult to find colours that complements each other
 - ✓ Difficulty interpreting client requirements from text descriptions
- 

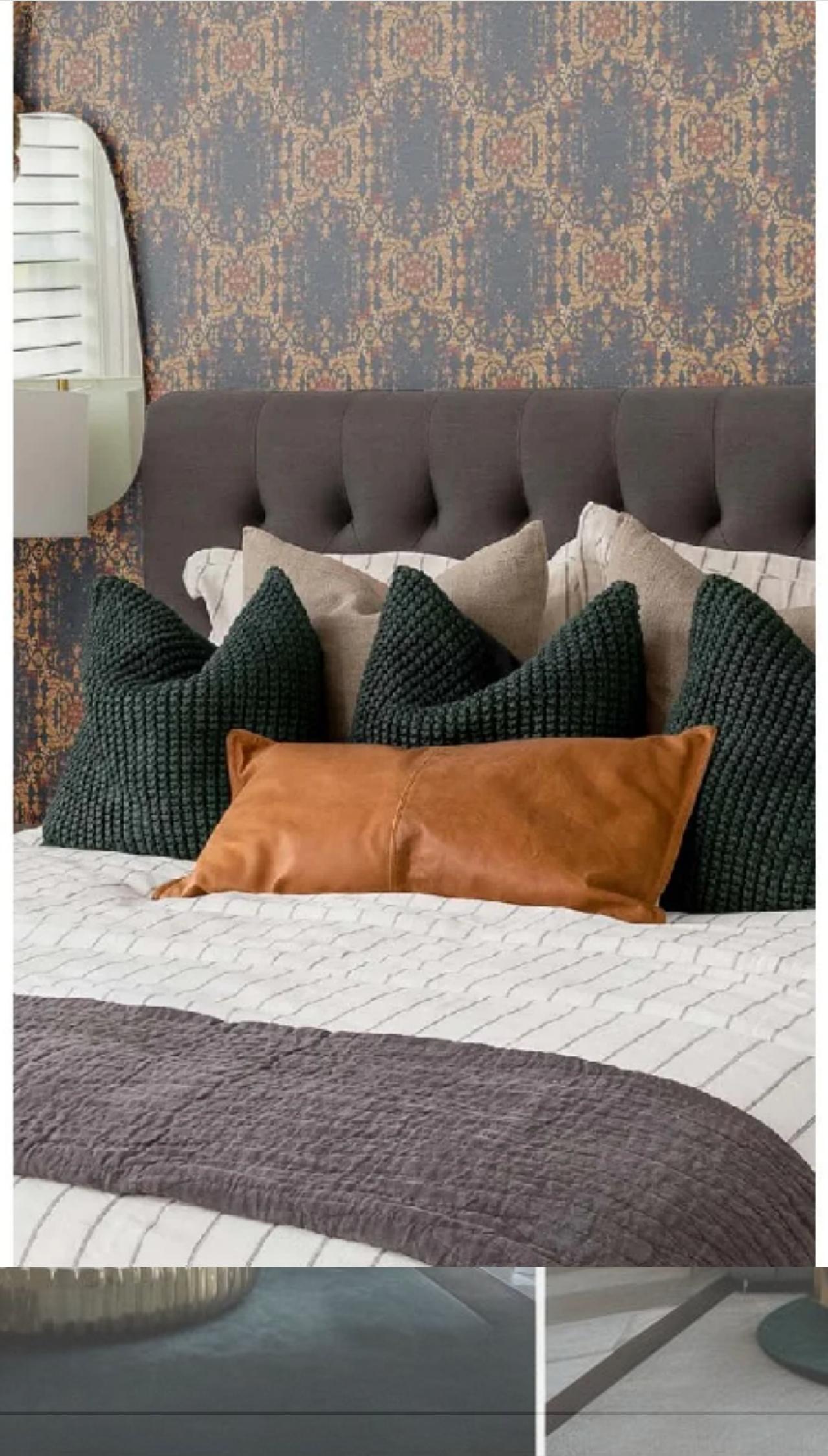
Limitations

- Inability to accurately **detect complex patterns** or identify products with **multiple colours**.
- Recommendation System is computationally expensive because of the amount of data in the image per product.
- There are limited controls to set the **tone/temperature** for the chatbot.
- Limitations exist in defining the **context's scope** and **boundaries**. Occasionally, the **LLM** might **supplement** its **responses** with **additional information**.



Recommendations

- **More Resources for Data Collection and Cleaning:**
 - Expand the dataset by collecting more diverse examples of materials and products. Gathering images that showcase a variety of material types and products with complex patterns and multi-coloured designs to improve the system's recognition and classification capabilities.
 - Replace the incorrect images of the products to the proper images of the product to allow the recommendation system to recommend.
- **Implement Advanced Image Recognition Models:**
 - Integrate more sophisticated image processing algorithms that can handle complex patterns and multi-colour detection more effectively.
- **Explore Retrieval-Augmented Generation (RAG) for LLM:**
 - Investigate the potential of RAG to enhance the LLM's performance. By integrating a retrieval mechanism, the LLM can access a broader knowledge base during generation, allowing for more contextually relevant and updated responses.

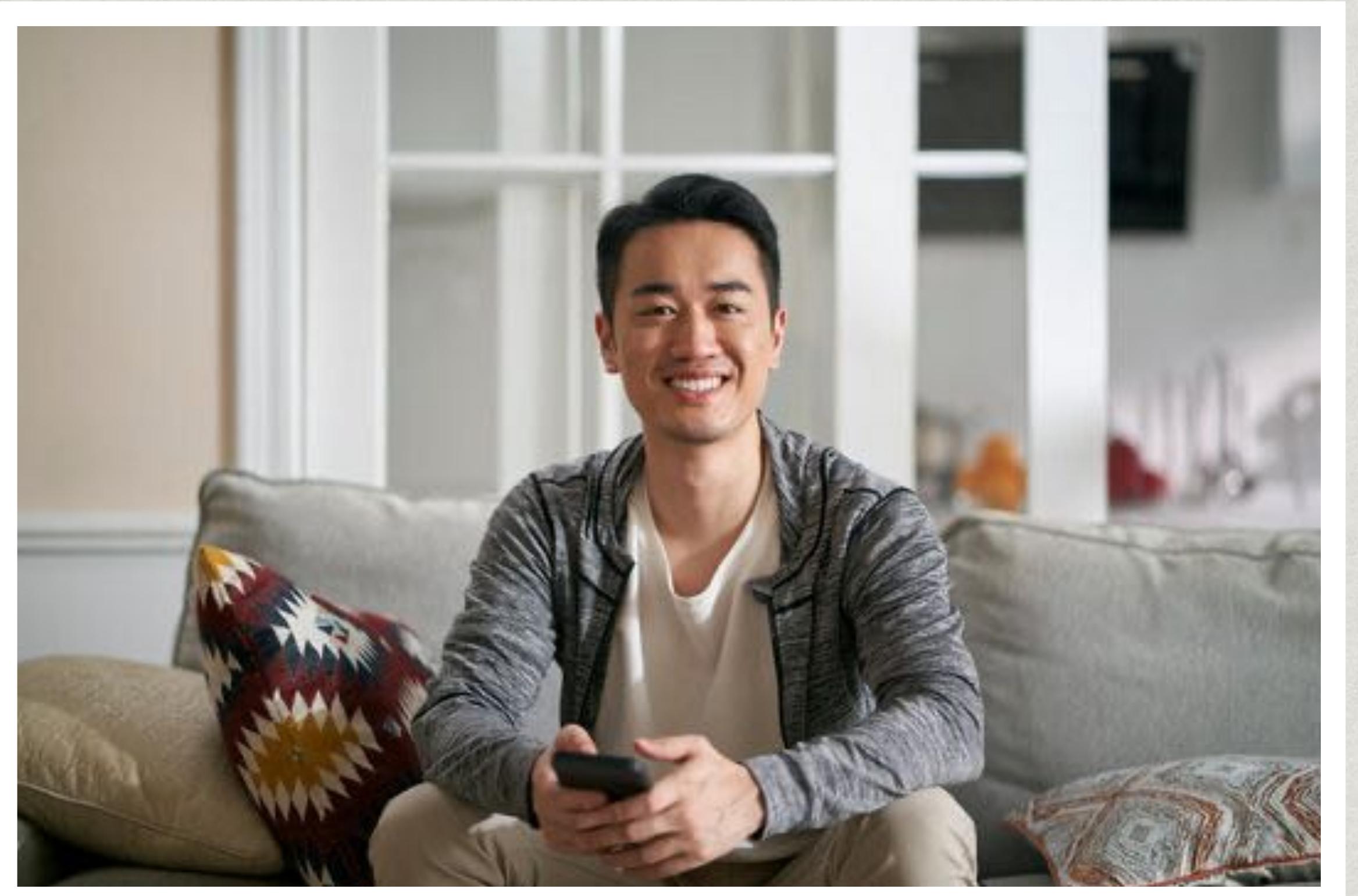


Conclusions

By automating the process of selecting and suggesting interior design products, our system not only **saves time** but also enhances the **alignment with clients' preferences**, something that is challenging to achieve manually.

However, due to **limitations** in accurately recognizing patterns and classifying materials, **ongoing enhancements** and **regular updates** are **crucial**. These improvements will help us keep pace with **evolving design trends**, thereby delivering sustained value to interior designers and their clients.

With these advancements, we aim to assist interior designers like George in overcoming initial project hurdles and effectively interpreting client preferences. This support will lead to more **inspired** and **harmonious design solutions**.



App Demo



THANK YOU