iDECOR

Your Furniture Recommender

Here is where you furnish your home with a Click, just from your couch.

01

Project Aim

02

Data Acquisition

03

Modelling

04

Challenges

05

Future Extensions

06

References

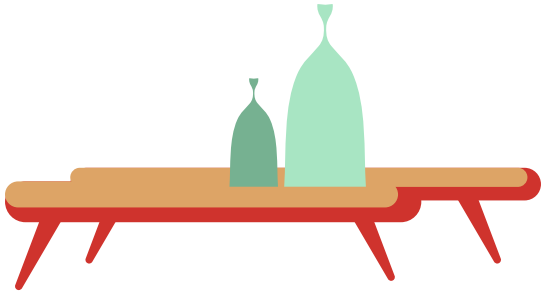
What iDECOR does

iDECOR is a Furniture Recommender that allows users who have recently moved to explore furnitures on IKEA at ease.

After uploading a room scene image, iDECOR returns users with similar-styled furnitures in favour from IKEA dataset.

60%

Amazon's Conversion to Sales could be contributed from On-site Recommendations^

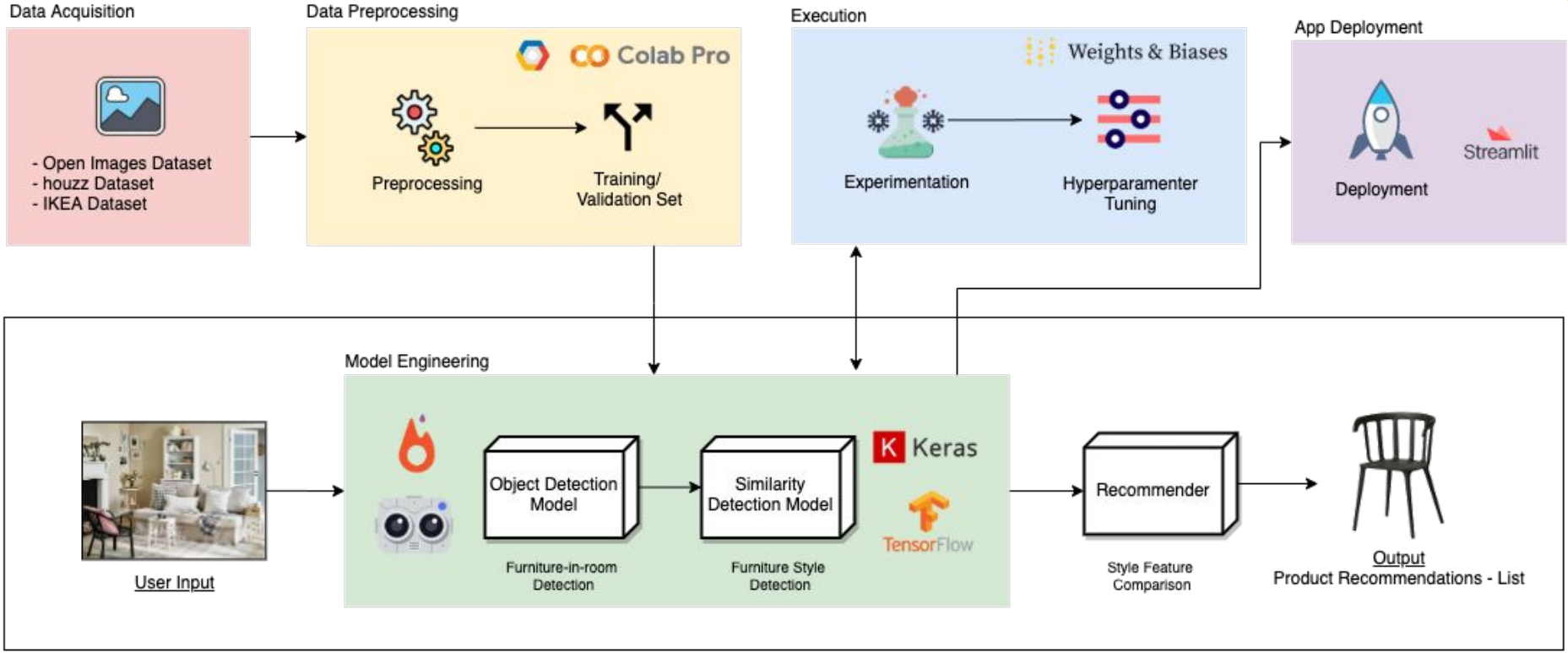


^The Amazon Recommendations Secret to Selling More Online
https://rejoiner.com/resources/amazon-recommendations-secret-selling-online/

Why create iDECOR

To drive IKEA's sales by improving its Onsite Recommendations

System Architecture

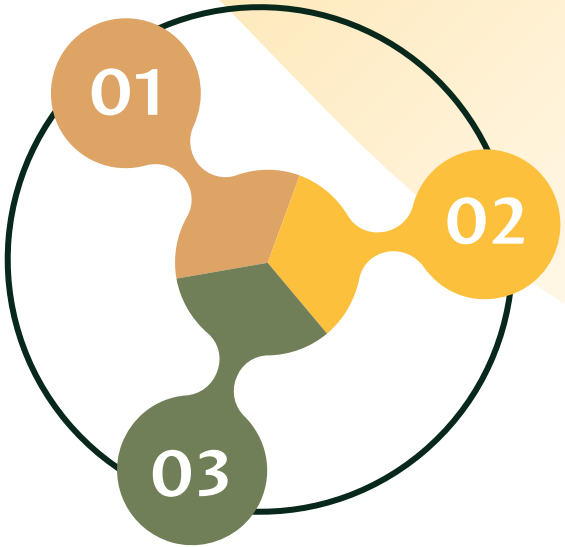


Data Acquisition

01

Annotated Furniture Images

~10k images across 6 categories* annotated with image-level labels, object bounding boxes obtained via "Open Images Dataset V6" API



02

Style-labelled Furniture Images

~13k images on 15 styles obtained from Bonn Furniture Styles Dataset available online^

^https://cvml.comp.nus.edu.sg/furniture/index.html

03

IKEA Product Images

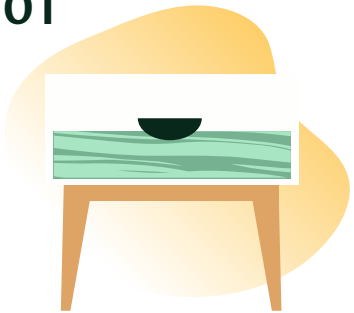
~1400 images web-scraped from IKEA Hong Kong's official website

- Object Detection Model
- Similarity Detection Model
- Recommendation Source

6 Categories | Bed, Cabinetry, Chair, Couch, Lamp, Table

Data Preprocessing

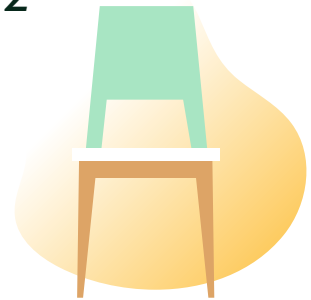
01



Balancing Dataset

200 pcs x 15 furniture styles from houzz furniture dataset chosen equally

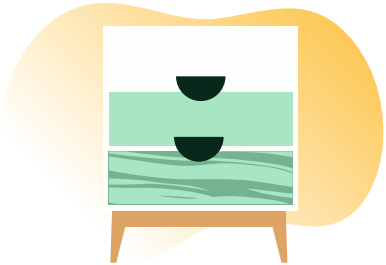
02



Multi-Label Binarizer

Encoding multiple labels per instance for houzz furniture dataset

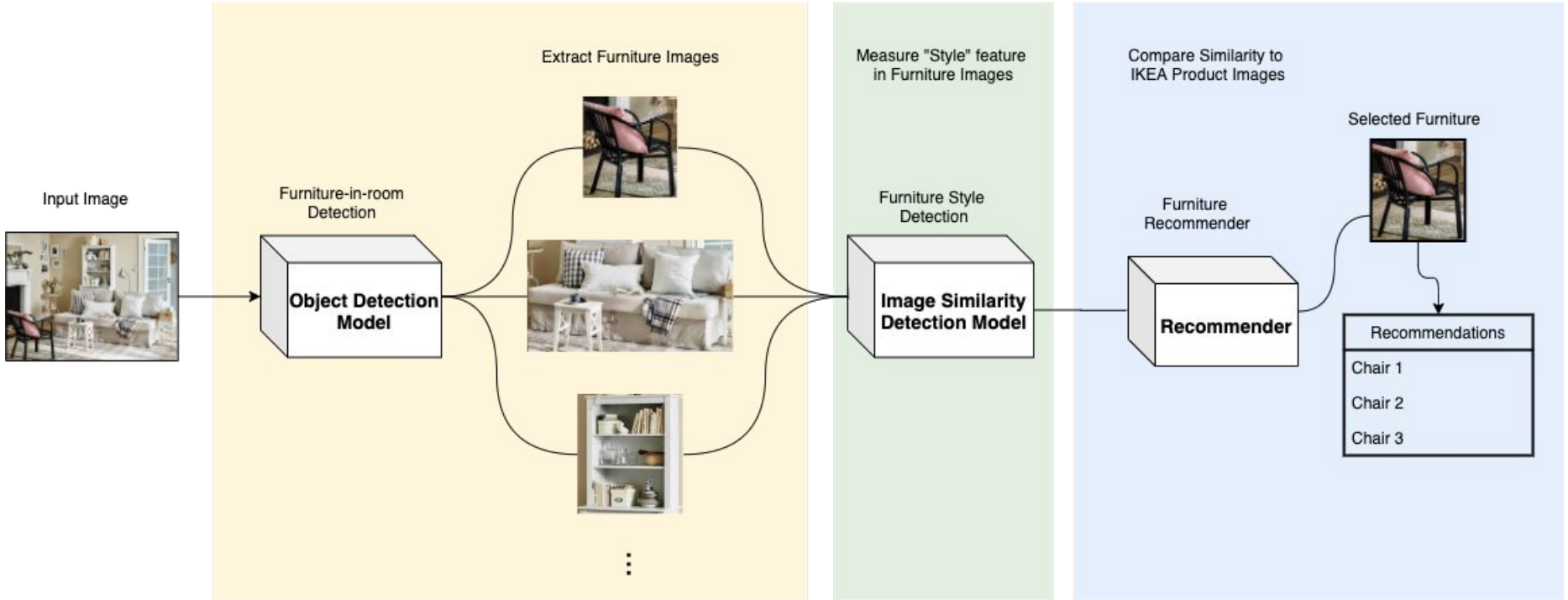
03



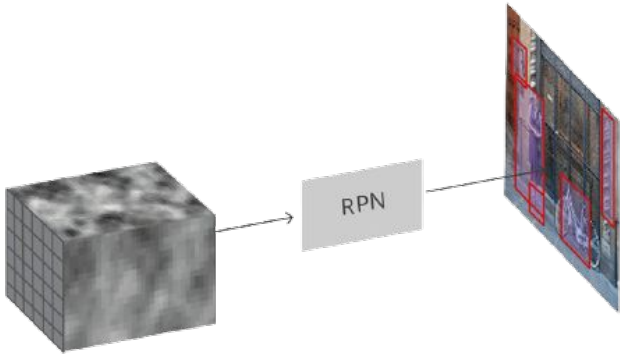
Detectron 2 Formatting

Preprocessing image information into acceptable format and registered as Detectron2 custom datasets

Modelling Overview



WHY Detectron2 & Faster R-CNN?



Detectron2

Object Detection Library launched by Facebook AI Research (FAIR)

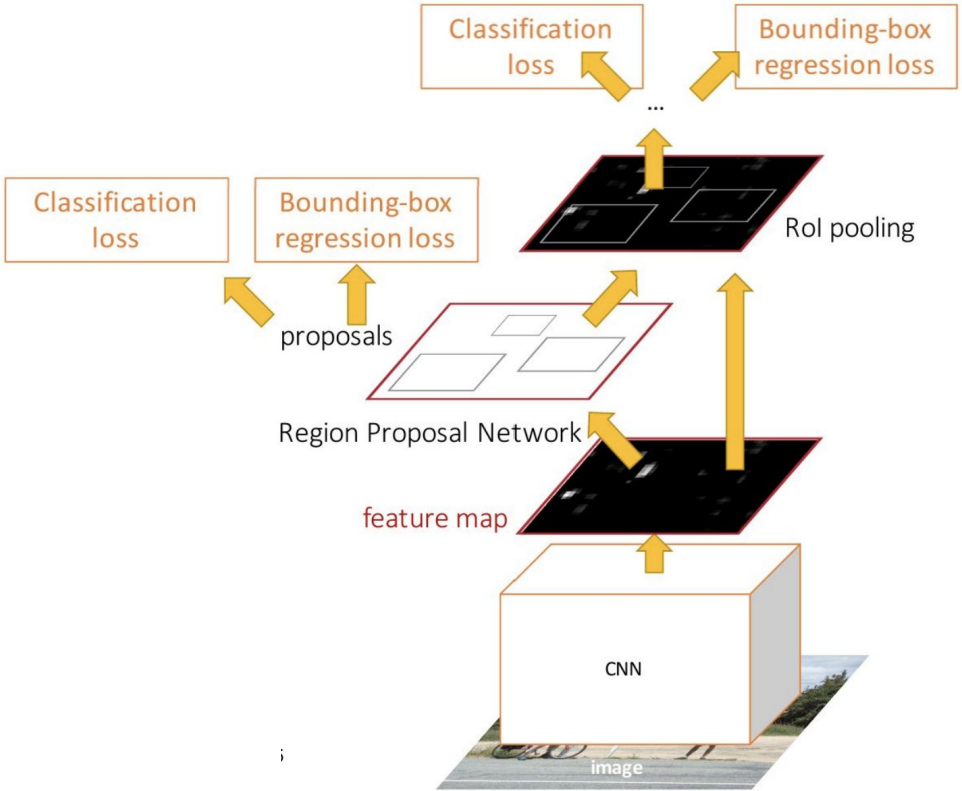
- Modular design with pre-trained models to test on and allow flexible adaptation in model training

Faster R-CNN

Region Proposal Network (RPN) introduced in object detection network to hypothesize object locations

- Shorter inference time and fewer training memory compare to Mask R-CNN
- Higher accuracy compared to Fast R-CNN

Faster R-CNN Structure

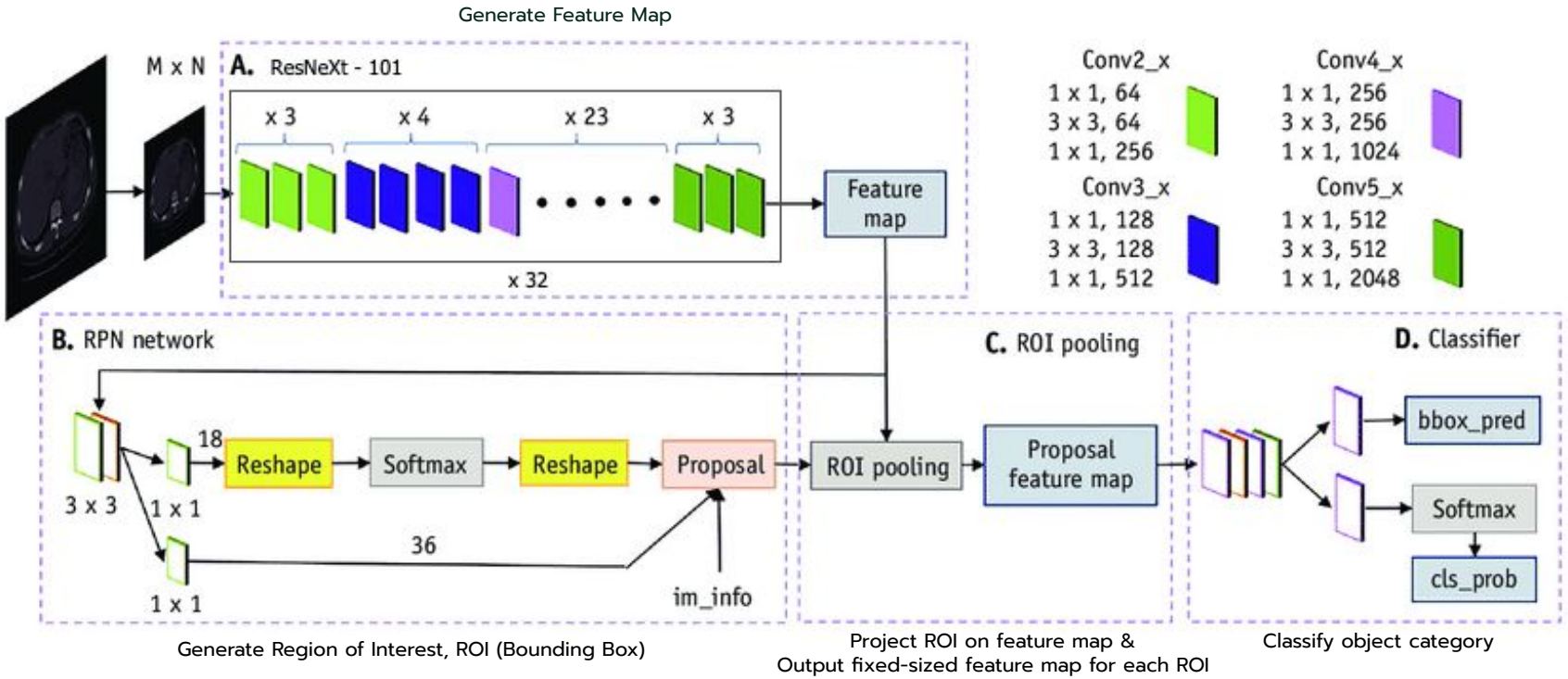


4 Major Parts

- Convolution Neural Network
- Region Proposal Network
- ROI Pooling
- Classification

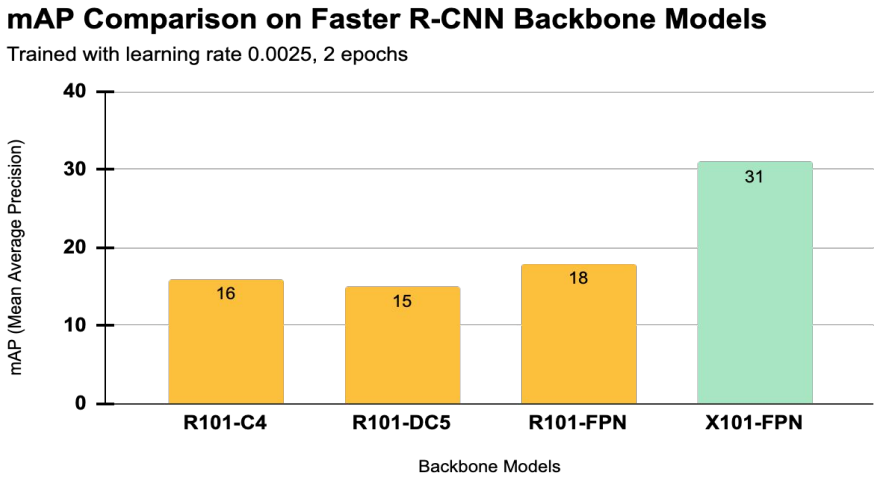
^ Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks
https://arxiv.org/pdf/1506.01497.pdf

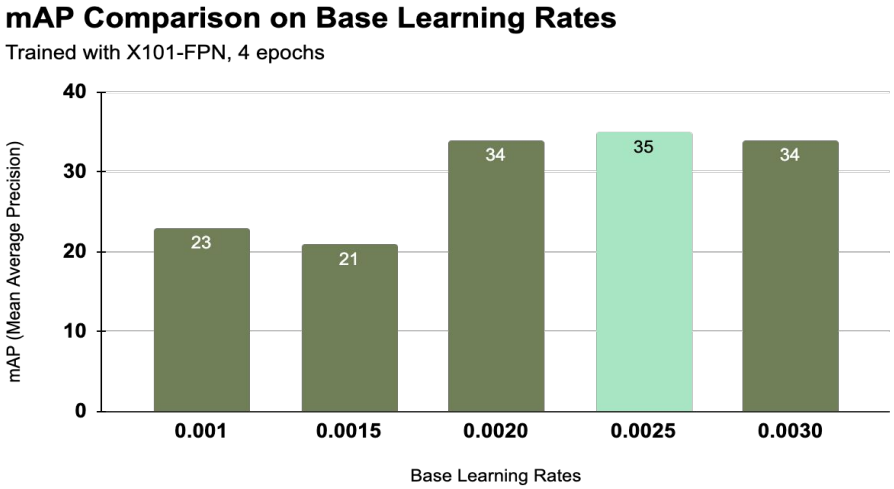
Faster R-CNN Structure (Cont'd)



Model Evaluation

Object Detection Model





Highest mAP (Average Precision) with Faster R-CNN X101 model at 0.0025lr on 4 epochs.

VGG16/ InceptionV3

Transfer Learning on multi-label classification

WHY Transfer Learning?

- To train on a smaller dataset
- Taking features learnt from ImageNet Dataset of over 14 million images across 1000 classes

Multi-label Classification

Predictive modeling involves predicting zero or more mutually non-exclusive class labels

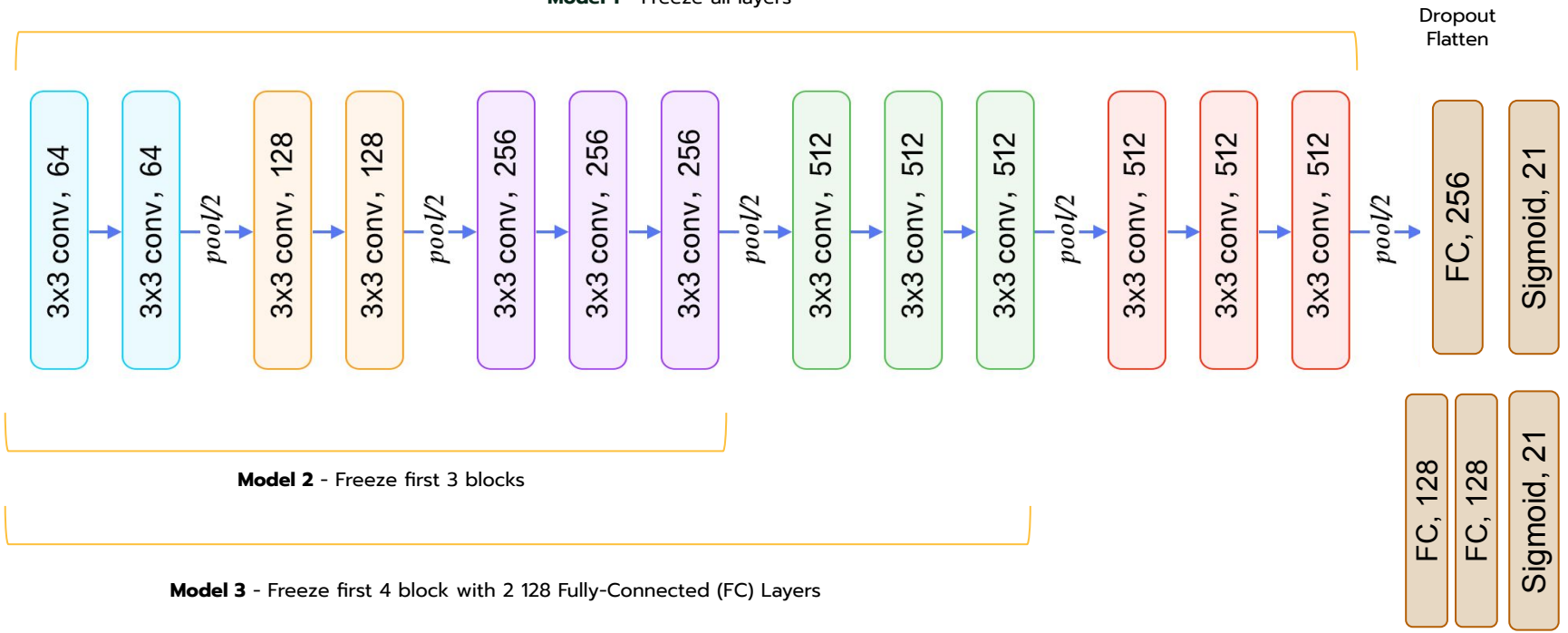
VGG16 InceptionV3

Widely-used Image Recognition Model that has shown to attain over 90% top-5 test accuracy on ImageNet Dataset

VGG16

Model Architecture

Model 1 - Freeze all layers



Model 2 - Freeze first 3 blocks

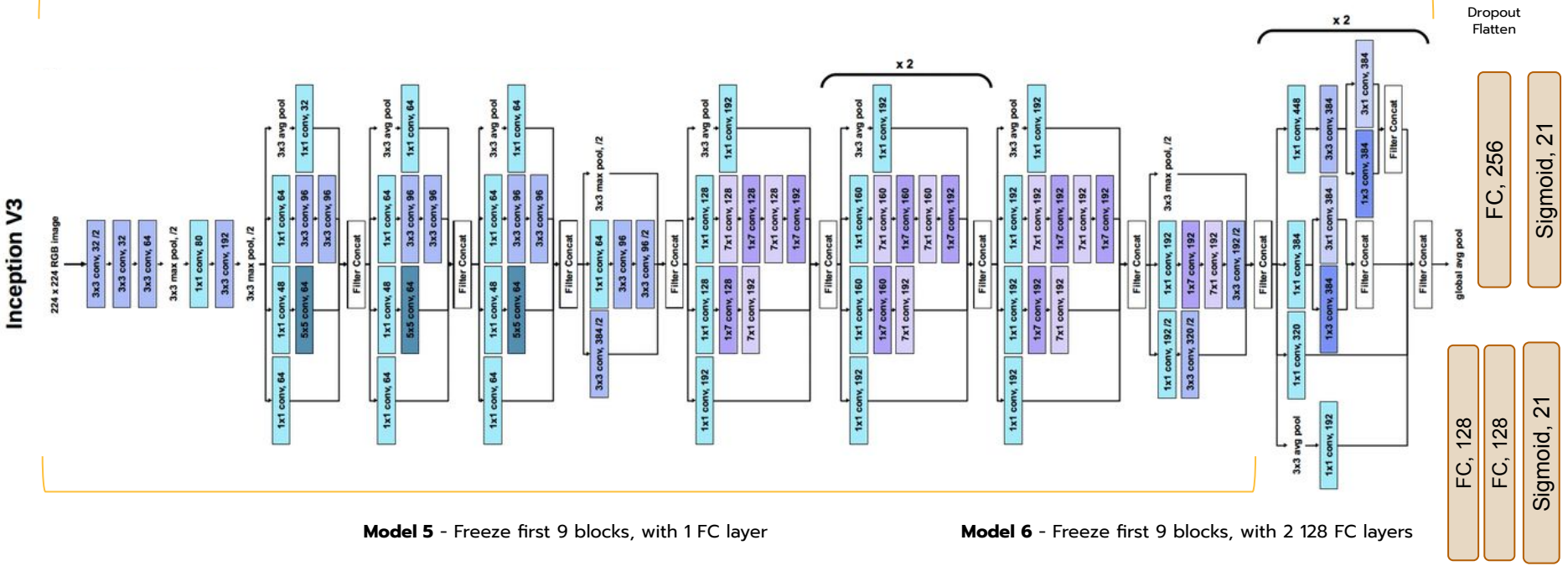
Model 3 - Freeze first 4 block with 2 128 Fully-Connected (FC) Layers

* Multi-label Classification on 6 Product Categories across 15 Styles

InceptionV3

Model Architecture

Model 4 - Freeze all layers

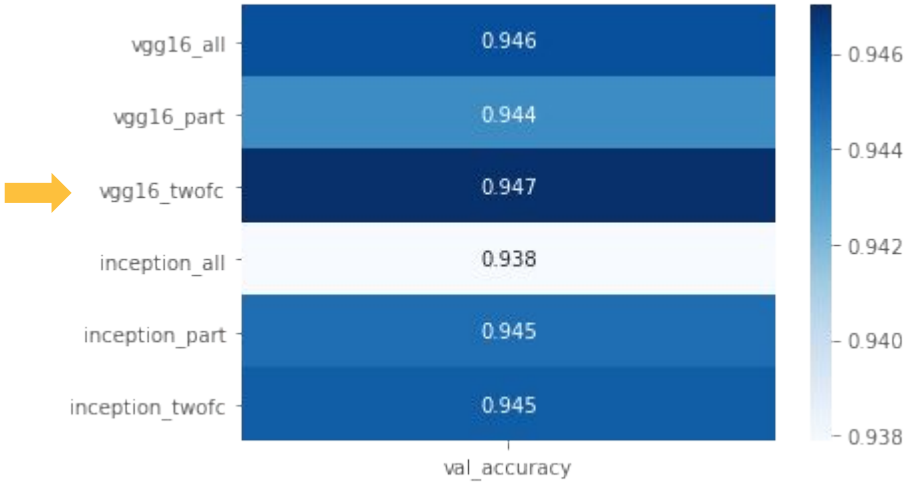


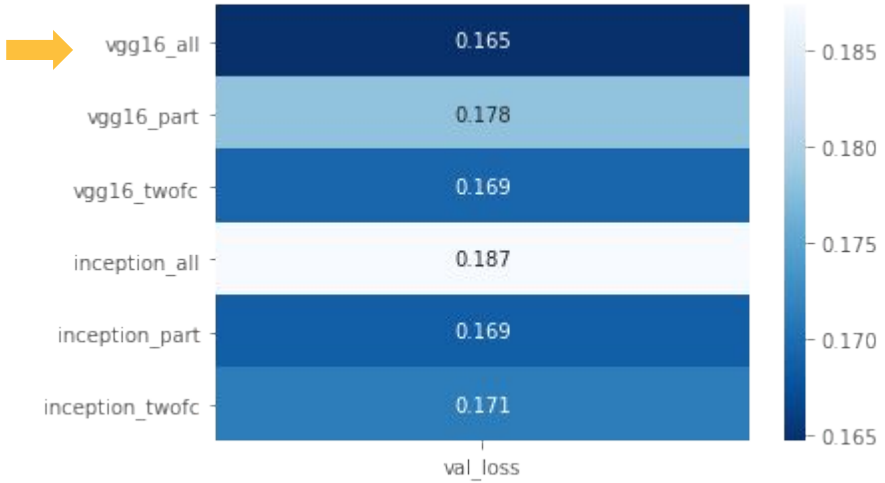
Model 5 - Freeze first 9 blocks, with 1 FC layer

Model 6 - Freeze first 9 blocks, with 2 128 FC layers

Model Evaluation

Similarity Detection Model





Highest Validation Accuracy scored with Model 3 and Lowest Loss with Model 1, these 2 models will be further evaluated.

* Sample Distribution: Training: 70% Testing: 15% Validation: 15%
* Trained with Image Augmentation

Furniture Recommender

01 Pre-process images to fit in the model

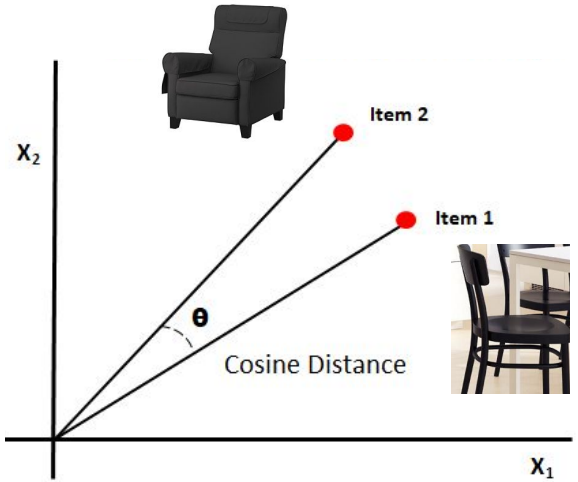
Remove the top layer of the trained model for prediction

02

03 Collect vector output for all IKEA products and user image

Compare vectors using **Cosine Similarity**

04

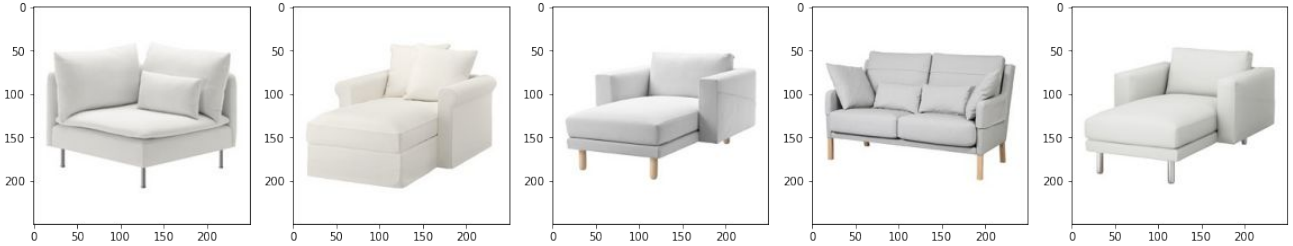


$$sim(A,B) = \cos(\theta) = \frac{A \cdot B}{\|A\|\|B\|}$$

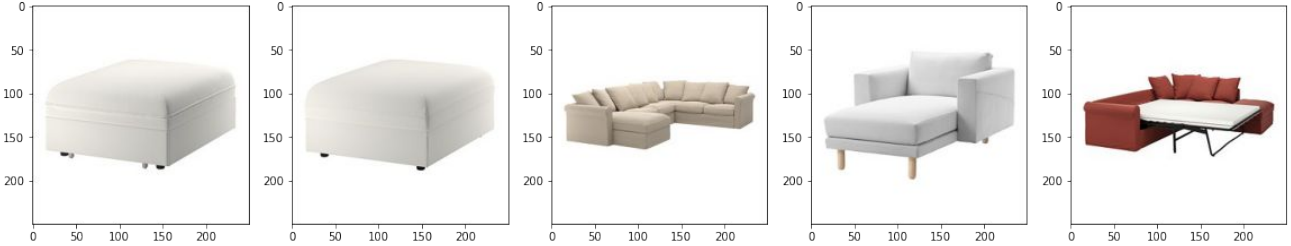
Model Evaluation

Similarity Detection Model

Model 1 🙂



Model 3

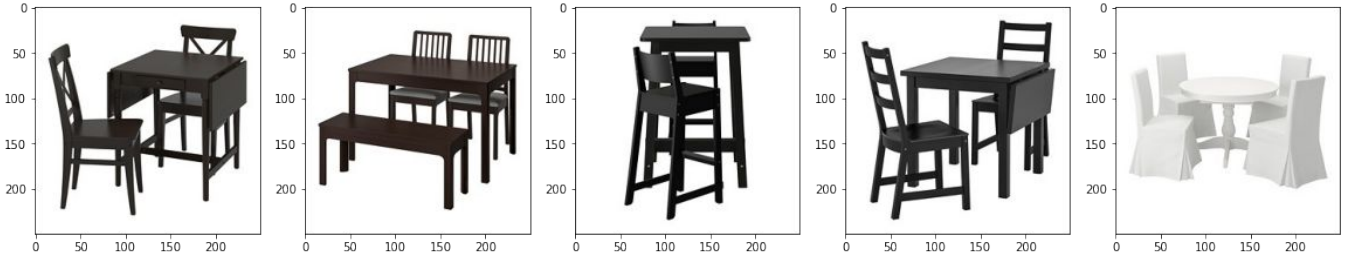


* Filtered items specific to SOFA category

Model Evaluation

Similarity Detection Model

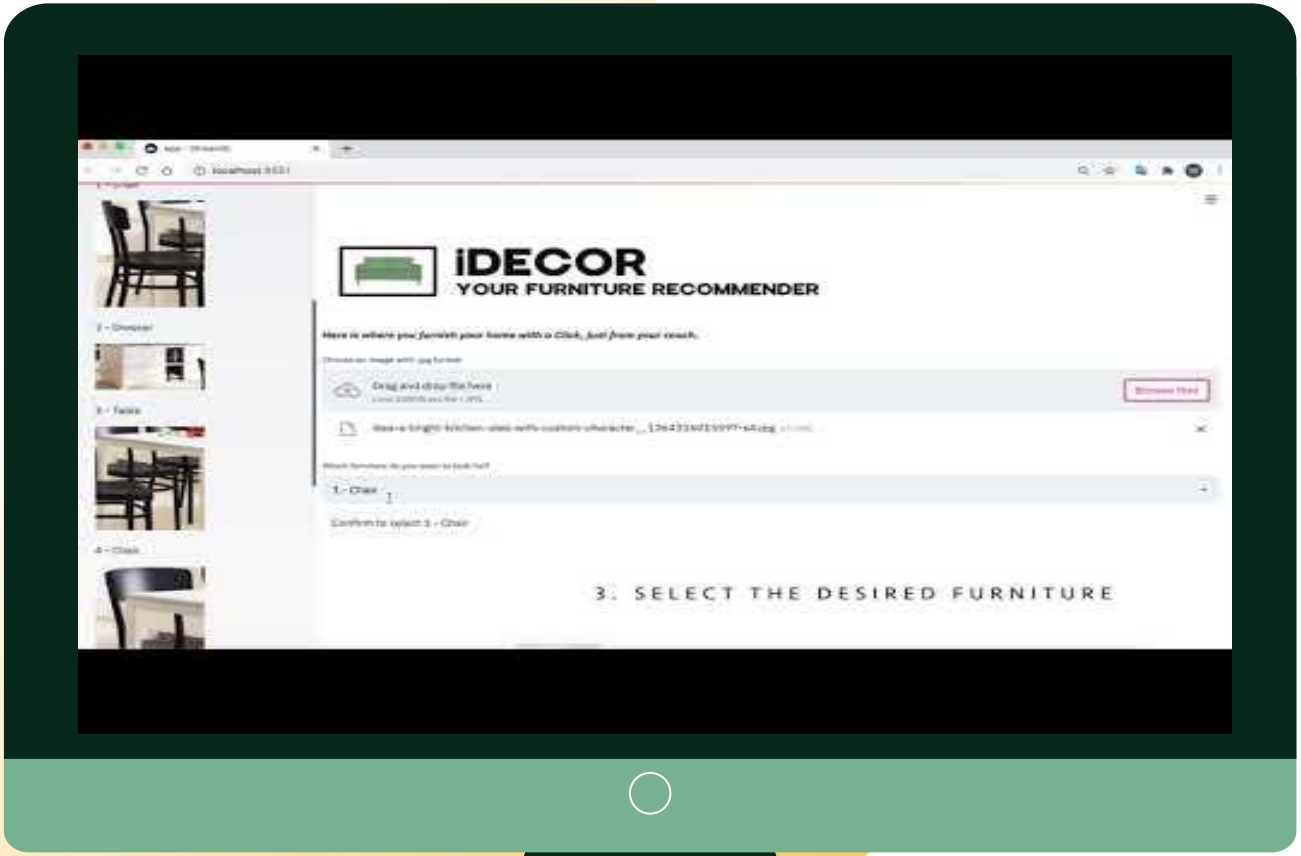
Model 1



Model 3

SNEAK PEEK

Deployment with Streamlit



^https://www.youtube.com/watch?v=5ADEoz7ZIYw&feature=emb_logo

Challenges

Limited Training Images

- ~10k annotated images on interested categories available on Open Images Dataset V6 for Detectron2 model training

Limited Diversity in Recommending Products

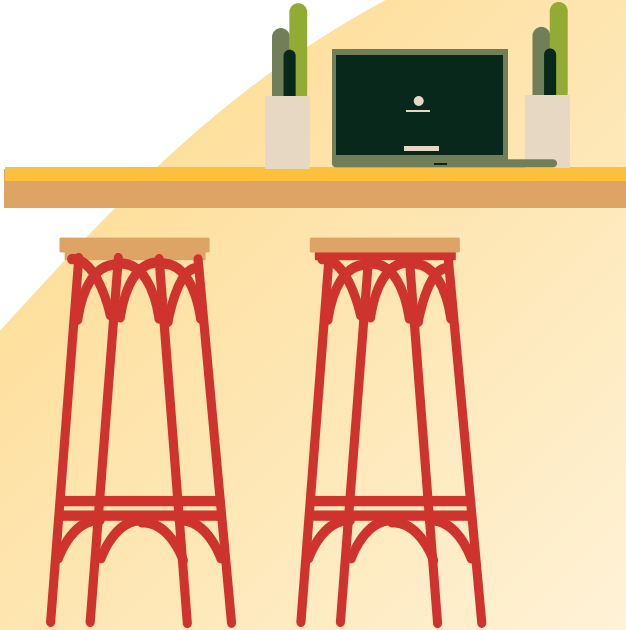
- IKEA products are mostly in minimalist style, difficult to recommend high-precision furniture items

Limited Labelled Attributes

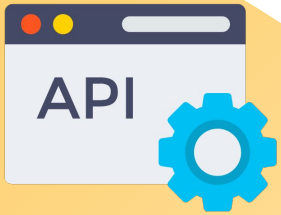
- Other product features such as colours and materials are missing or/and not highly aligned

Subjectivity in Style Measurement

- Measurement of style by interior designers' classifications could be further replaced by user ratings / click-through actions



Further Extensions



API

Allows integrations with other systems/platforms, enhancing product innovation and usability

Real-time

Calling product catalogues in real-time to keep the stock options updated

Scalable

Catalogue expansion to include more brands and furniture categories

Conclusion

Data Sourcing

- Expand the scope to more brands
- Real-time pull of product catalogue via API

Object Detection

- Video support
- More furniture classes
- More training images with annotations

Similarity Detection

- Refine methodology for similarity comparison by assigning weightings to tensors of early layers
- Explore CTR/ Response Rate/ User Rating as objective measurement

Deployment

- Save user uploads to Cloud for further storage for BI

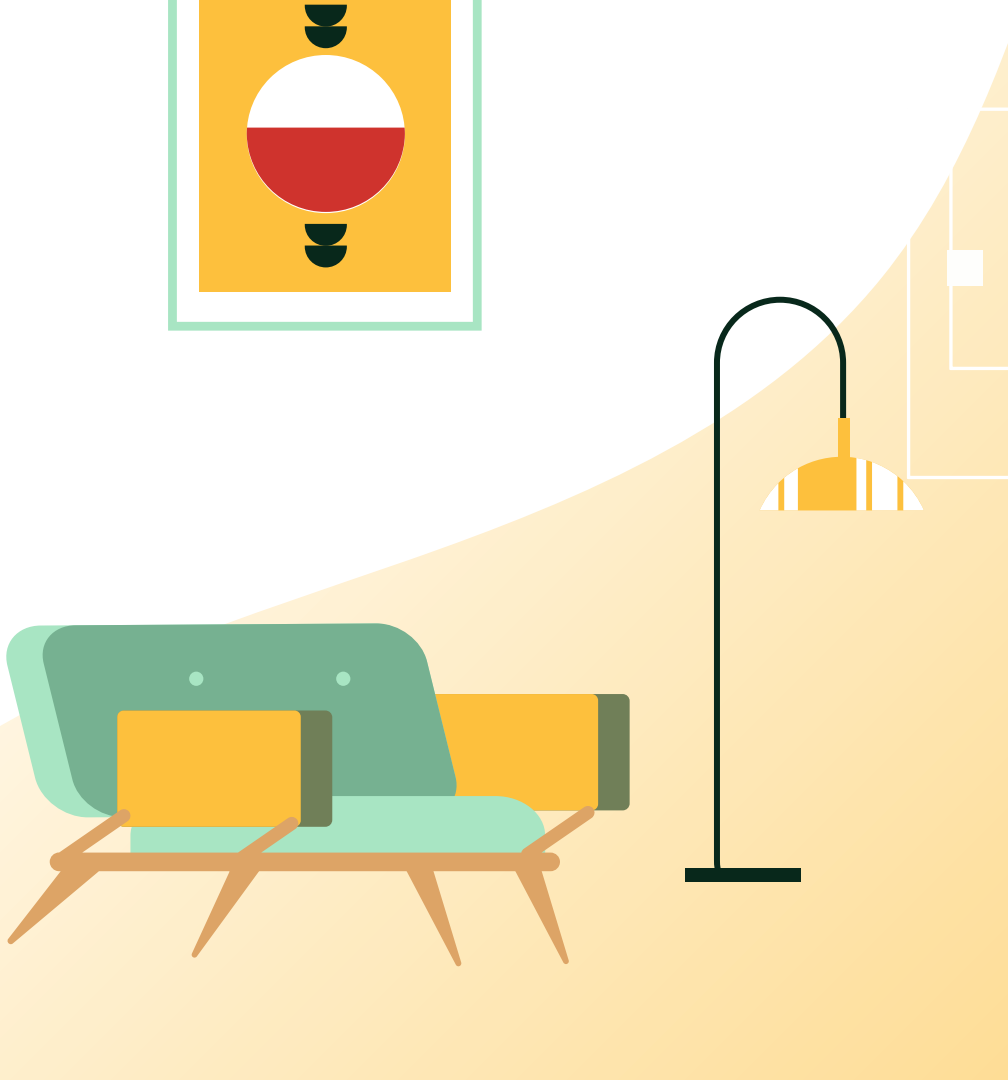
API Launch

- Explore the possibility to scale up the system by connecting to wider eCommerce site

References

- Replicating Airbnb's Amenity Detection with Detectron2
  https://towardsdatascience.com/replicating-airbnbs-amenity-detection-with-detectron2-28f33704d6ff
- Build a scalable, online recommender with Keras, Docker, GCP, and GKE
  https://blog.insightdatascience.com/building-a-scalable-online-product-recommender-with-keras-docker-gcp-and-gke-52a5ab2c7688
- Github - Facebook Research - Detectron2
  https://github.com/facebookresearch/detectron2
- Digging into Detectron 2 — part 1 to 5
  https://medium.com/@hirotoschwert/digging-into-detectron-2-47b2e794fabd
- Understanding Region of Interest — (RoI Pooling)
  https://towardsdatascience.com/understanding-region-of-interest-part-1-roi-pooling-e4f5dd65bb44
- Step by step VGG16 implementation in Keras for beginners
  https://towardsdatascience.com/step-by-step-vgg16-implementation-in-keras-for-beginners-a833c686ae6c
- A personalized 'shop-by-style' experience using PyTorch on Amazon SageMaker and Amazon Neptune
  https://aws.amazon.com/tw/blogs/machine-learning/a-personalized-shop-by-style-experience-using-pytorch-on-amazon-sagemaker-and-amazon-neptune/
- Image Similarity Using VGG16 Transfer Learning and Cosine Similarity
  https://medium.com/@jeff.lee.1990710/image-similarity-using-vgg16-transfer-learning-and-cosine-similarity-98571d8055e3
- Detectron2: A PyTorch-based modular object detection library
  https://ai.facebook.com/blog/-detectron2-a-pytorch-based-modular-object-detection-library-/

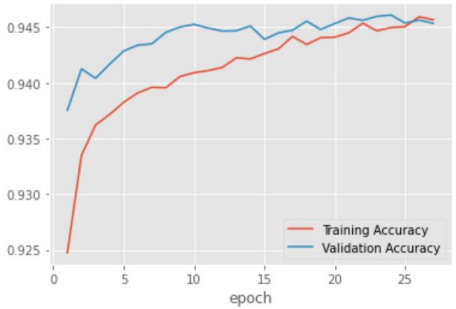
Appendix

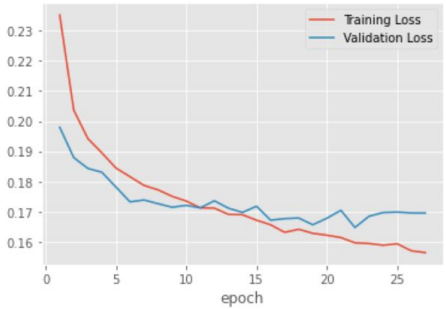


Model Evaluation

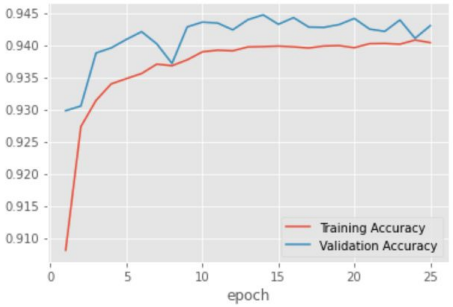
Similarity Detection Model - VGG16

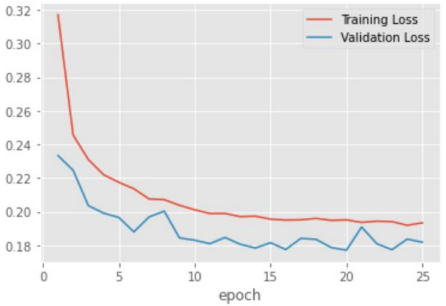
All Blocks Freezed + 1 FC Layer



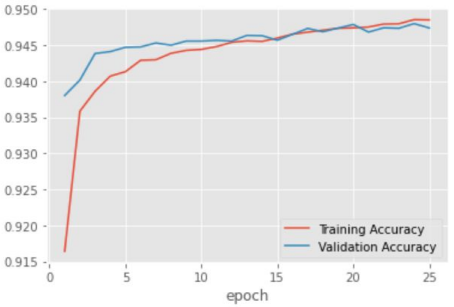


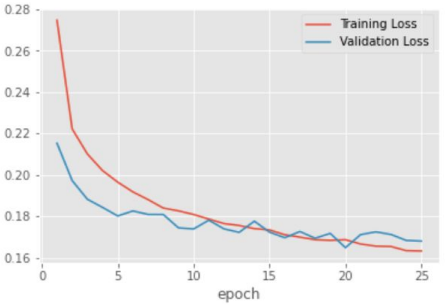
3 Blocks Freezed + 1 FC Layer





4 Blocks Freezed + 2 FC Layers

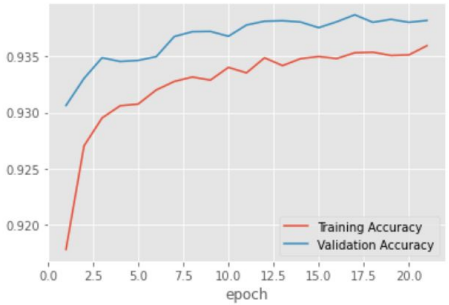


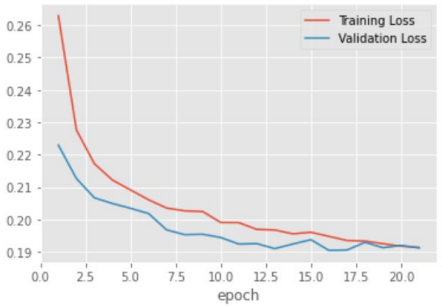


Model Evaluation

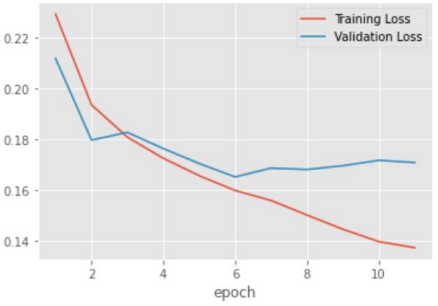
Similarity Detection Model - Inception V3

All Blocks Freezed + 1 FC Layer

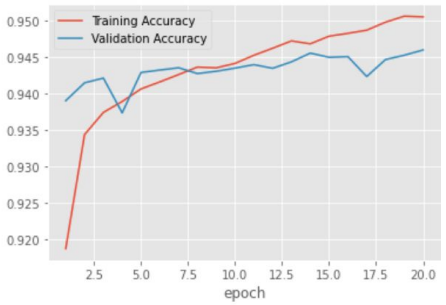


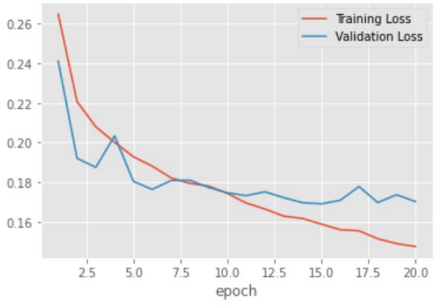


3 Blocks Freezed + 1 FC Layer



4 Blocks Freezed + 2 FC Layers





iDECOR

YOUR FURNITURE RECOMMENDER

AI-powered Furniture Detector & Recommender to provide a seamless & effortless online shopping experience for furniture items with best matching style

BUSINESS VALUES

iDECOR leverages AI to help narrow down most similar items in terms of visual cues from furniture product catalogue, in order to drive conversions to sales of furniture retailers by improving onsite recommendations.

50% **Shoppers have purchased from recommendations**

60% **Revenue could be contributed by recommendations**

DATASETS

Six major furniture items including **Bed, Cabinet, Chair, Couch, Lamp** and **Table** were selected as our first step in the launch of our redirect system.

Houzz Dataset
~13K furniture images with 15 predefined styles

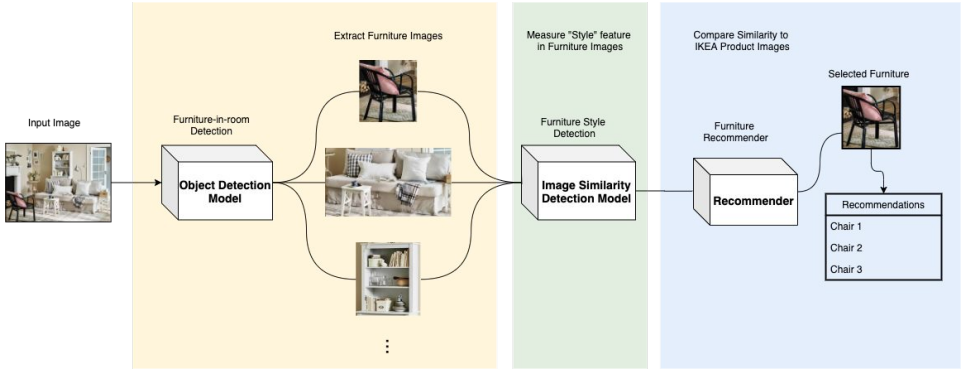
Open Images V6
~10K furniture images with annotations info

IKEA Stock Set
Scraped 1000+ furniture items with link and price

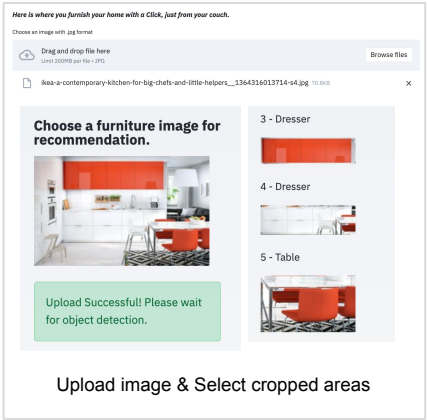
TECHNOLOGY

Python, Tensorflow, Pytorch, Google Colab, Weights & Biases, Google Cloud Platform, Detectron2, Selenium, Streamlit

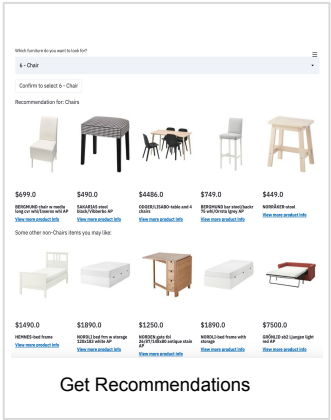
MODEL OVERVIEW



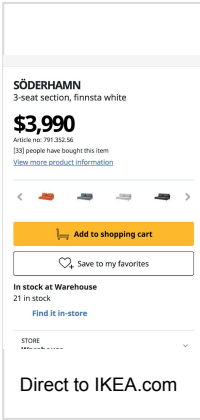
DEPLOYMENT



Upload image & Select cropped areas



Get Recommendations



Direct to IKEA.com

Developed by Mandy Kan, Rainfield Mak, Sophia Chan & Desmond Chiu