



CanOrNot?

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PROBLEM

The average global recycling rate is at a low of less than 20% [1].

Why?



- 1. Lack of public awareness** of what can be recycled
 - a. Contamination of items in blue bins of SG
 - b. Different countries, different recycling rules
- 2. Landscape of recycling**
 - a. Majority are disposed of as general waste rather than recycled through a circular value chain.
- 3. Increased Consumerism**
 - a. Sophisticated packaging makes it harder for people to recycle

[1]: <https://www.developmentaid.org/news-stream/post/158158/world-waste-statistics-by-country>

EXISTING WORKS

1. Classification of recycling logos on tetra packs

- Only 2 classes - CPAP81, CPAP84
- Limited to only paper carton



2. Waste detection in natural and urban environments

- Post-consumer solution
- Classifies: bio, glass, metal and plastic, non-recyclable, other, paper, and unknown

OUR SOLUTION

RECYCLING WEB APP

Take a photo of the object you want to recycle and it will be classified into 6 categories:

Cardboard

Paper

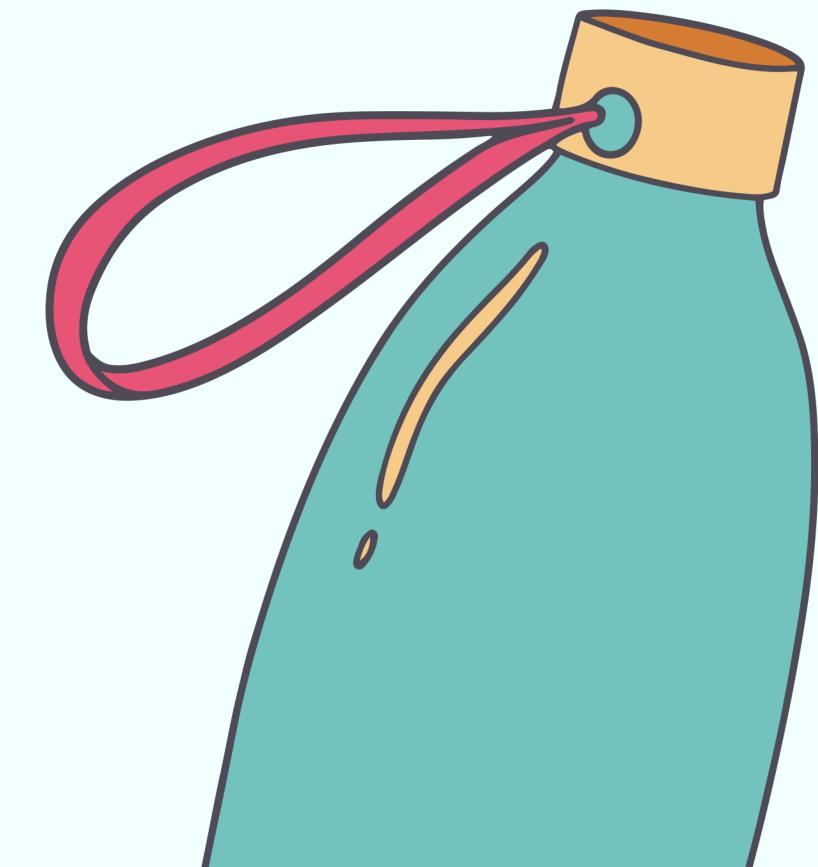
Metal

Plastic

Glass

Trash

More information can be given on what material and how it can be recycled!



WHO WILL THIS AFFECT?



We will be targeting citizens in countries who have difficulty trying to segregate waste.

Nonetheless, anyone can still use this for their benefit!



OBJECTIVE:

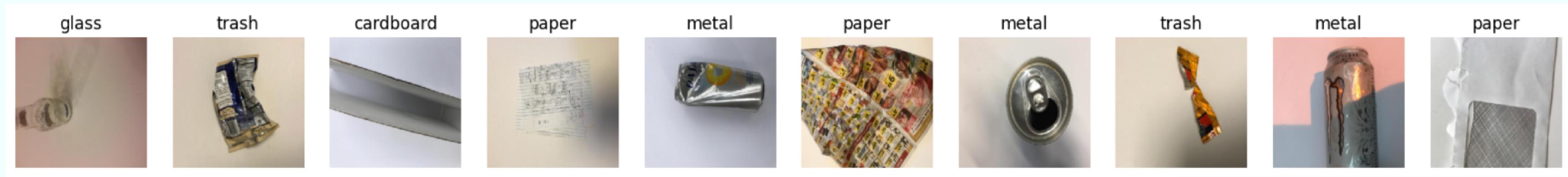
- Develop a highly accurate ML model that can classify waste materials into their respective recycling categories.
- Promote recycling and environmental sustainability by leveraging technology to enhance waste management practices.

DATASETS

Garbage Classification

- Images with **6 classes** labelled: cardboard, glass, metal , paper, plastic and trash.
- 2,527 images

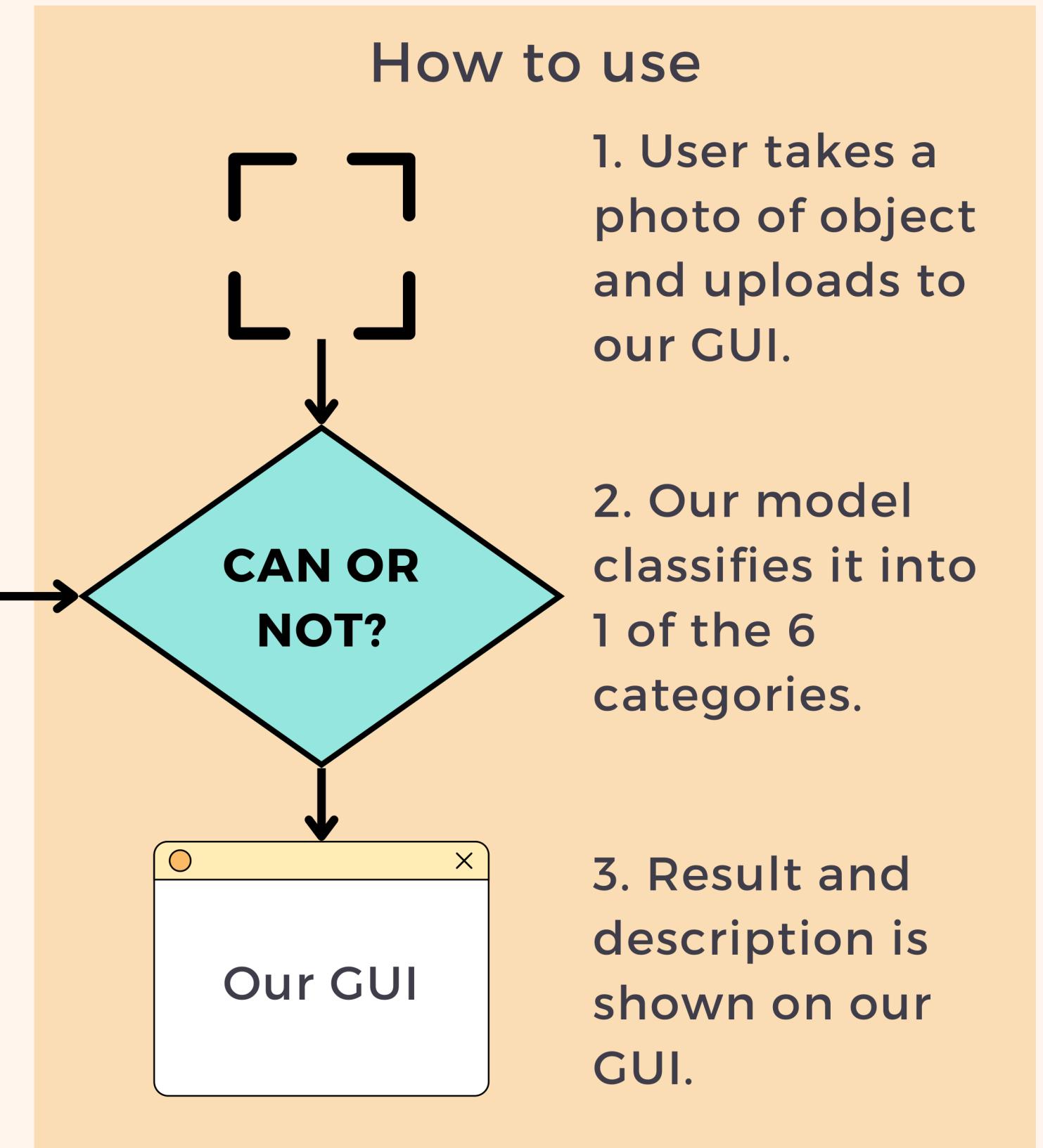
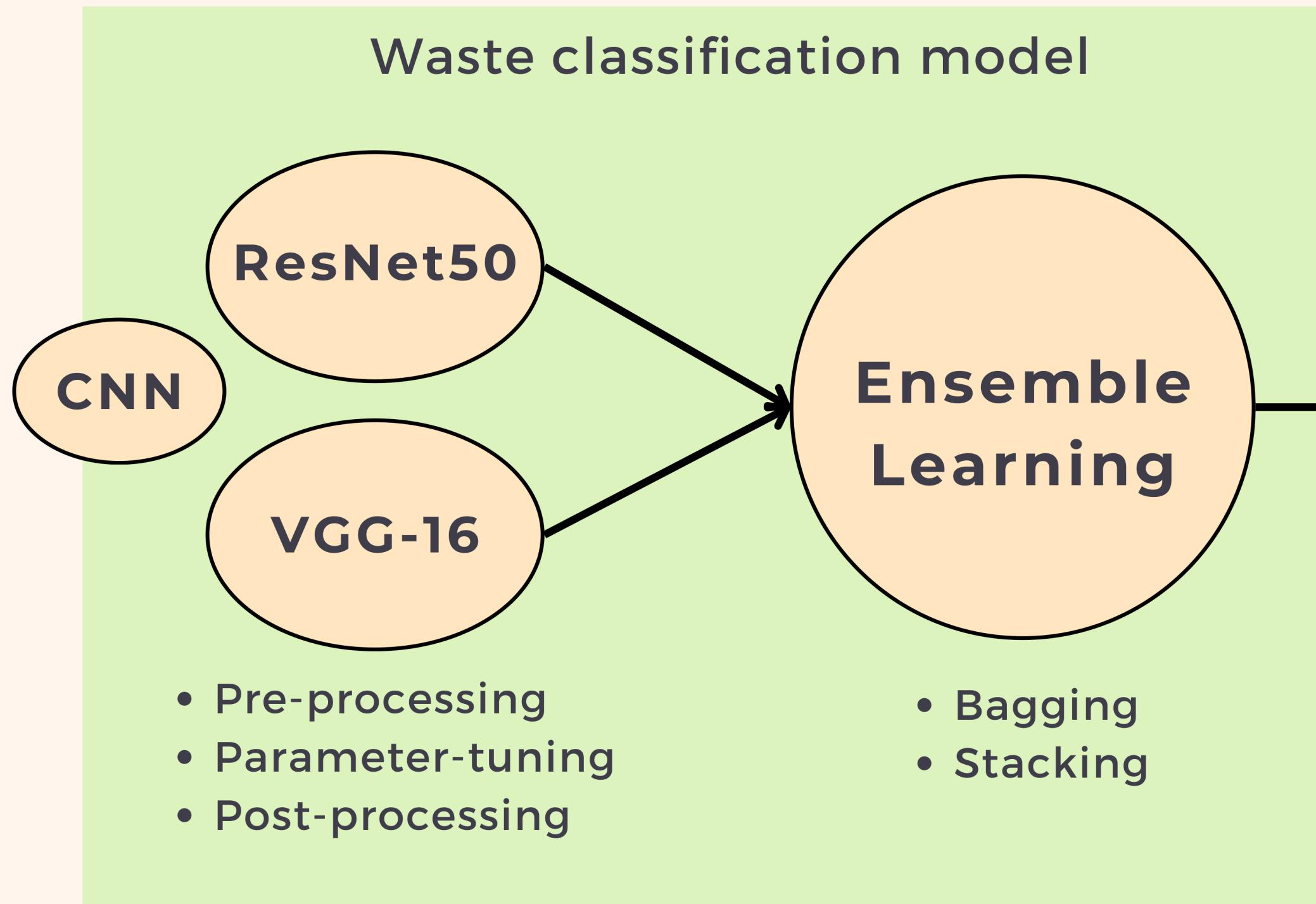
<https://www.kaggle.com/datasets/asdasdasdas/garbage-classification>



With data augmentation !

- increase the diversity of the data available without actually having to collect new data.

MODELS & PIPELINE



HOW WE EVALUATE

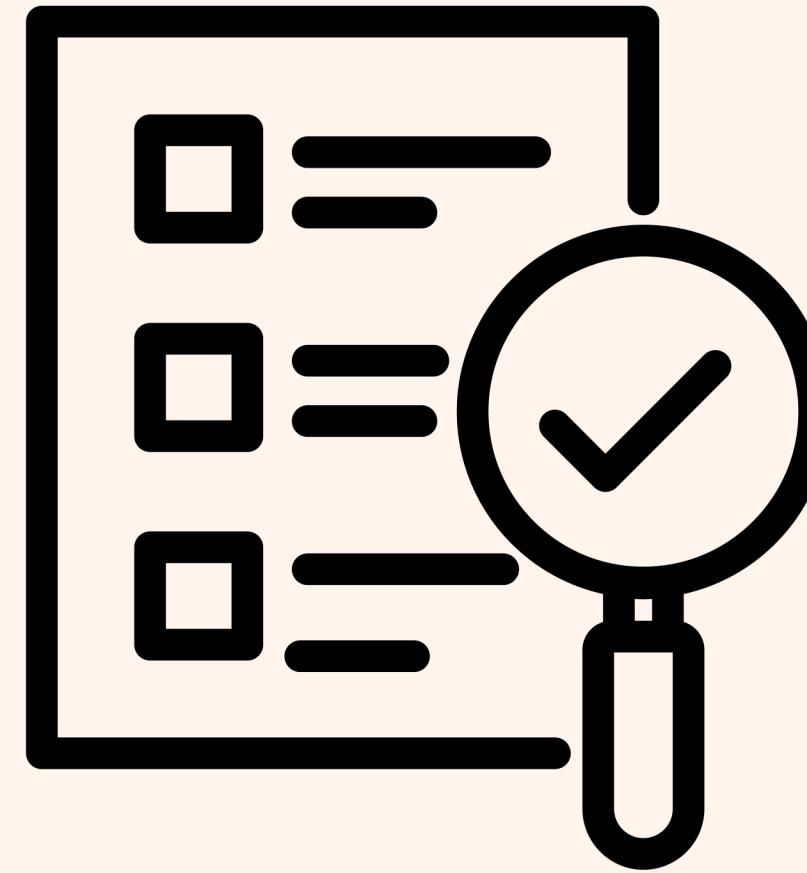
Training vs Validation Accuracy

ROC

Prediction Shown

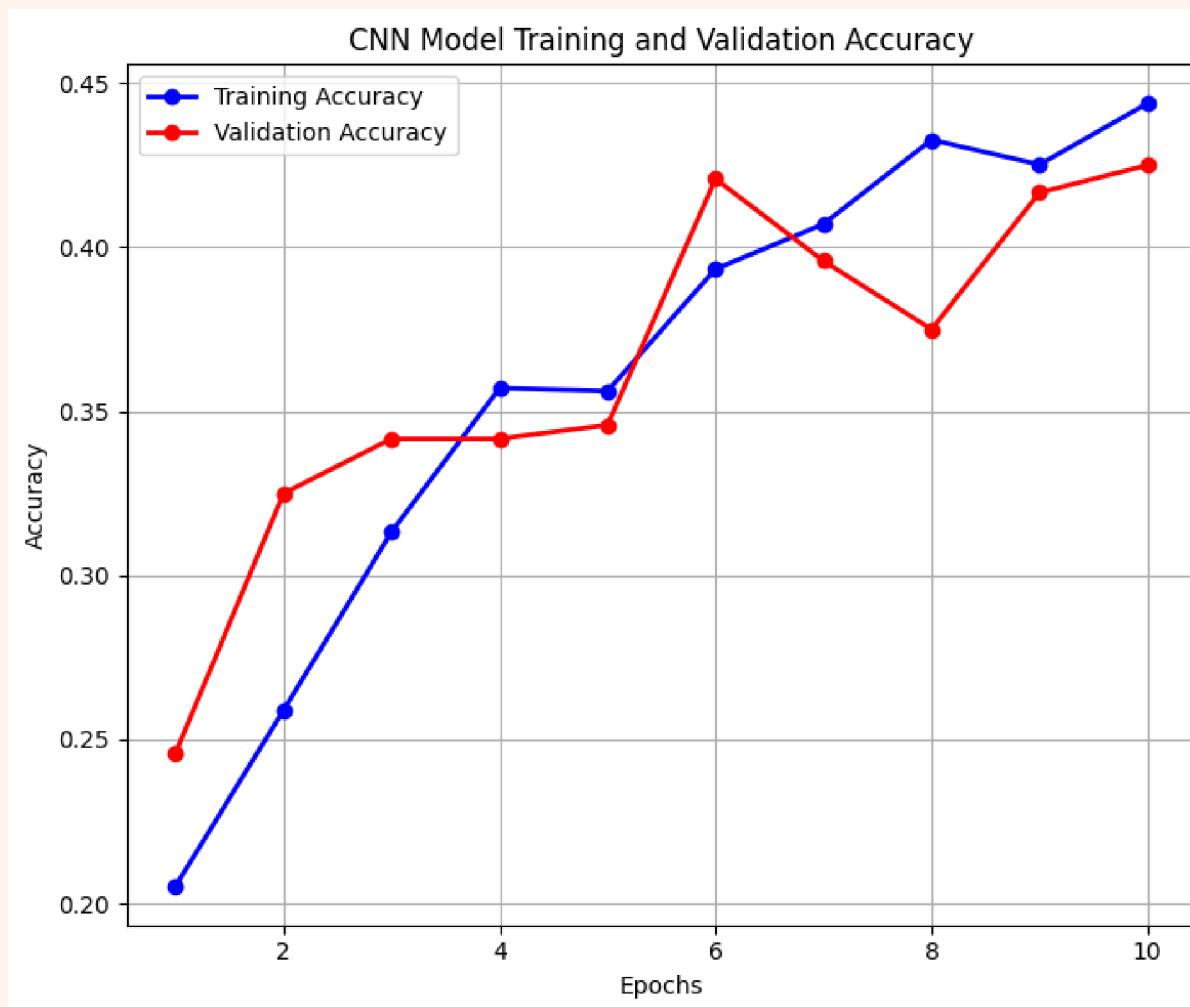
F1 Score

Confusion Matrix

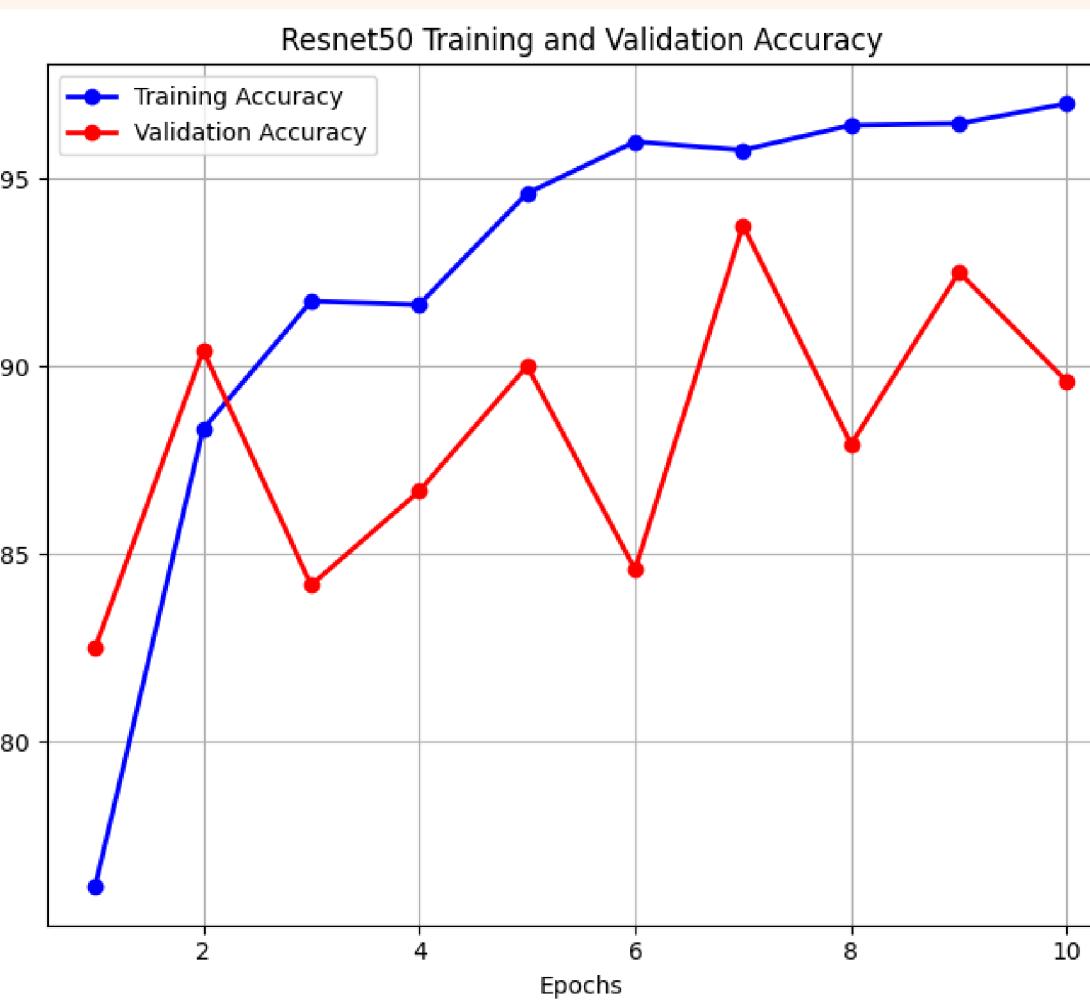


EVALUATION ACCURACY

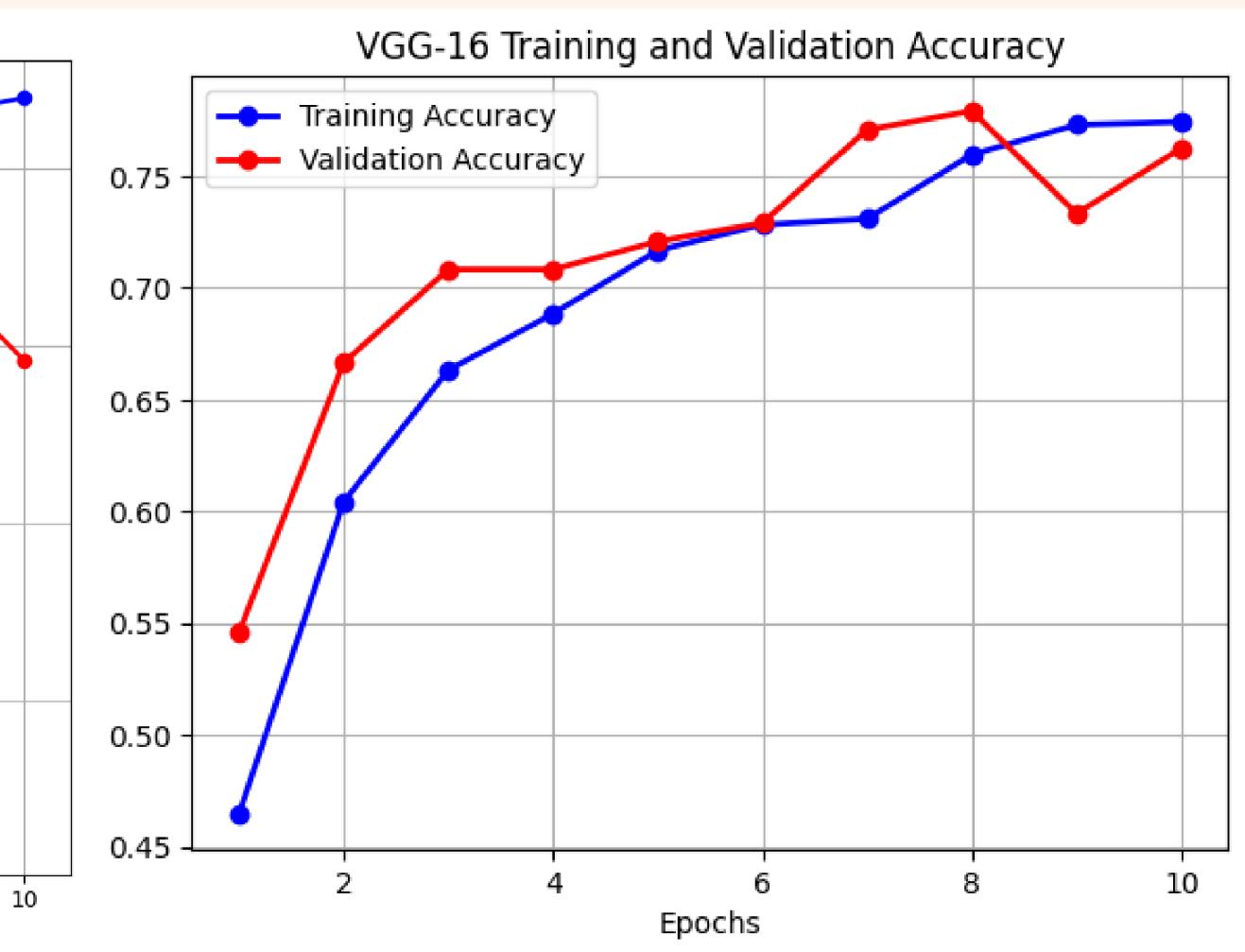
Simple CNN



ResNet50



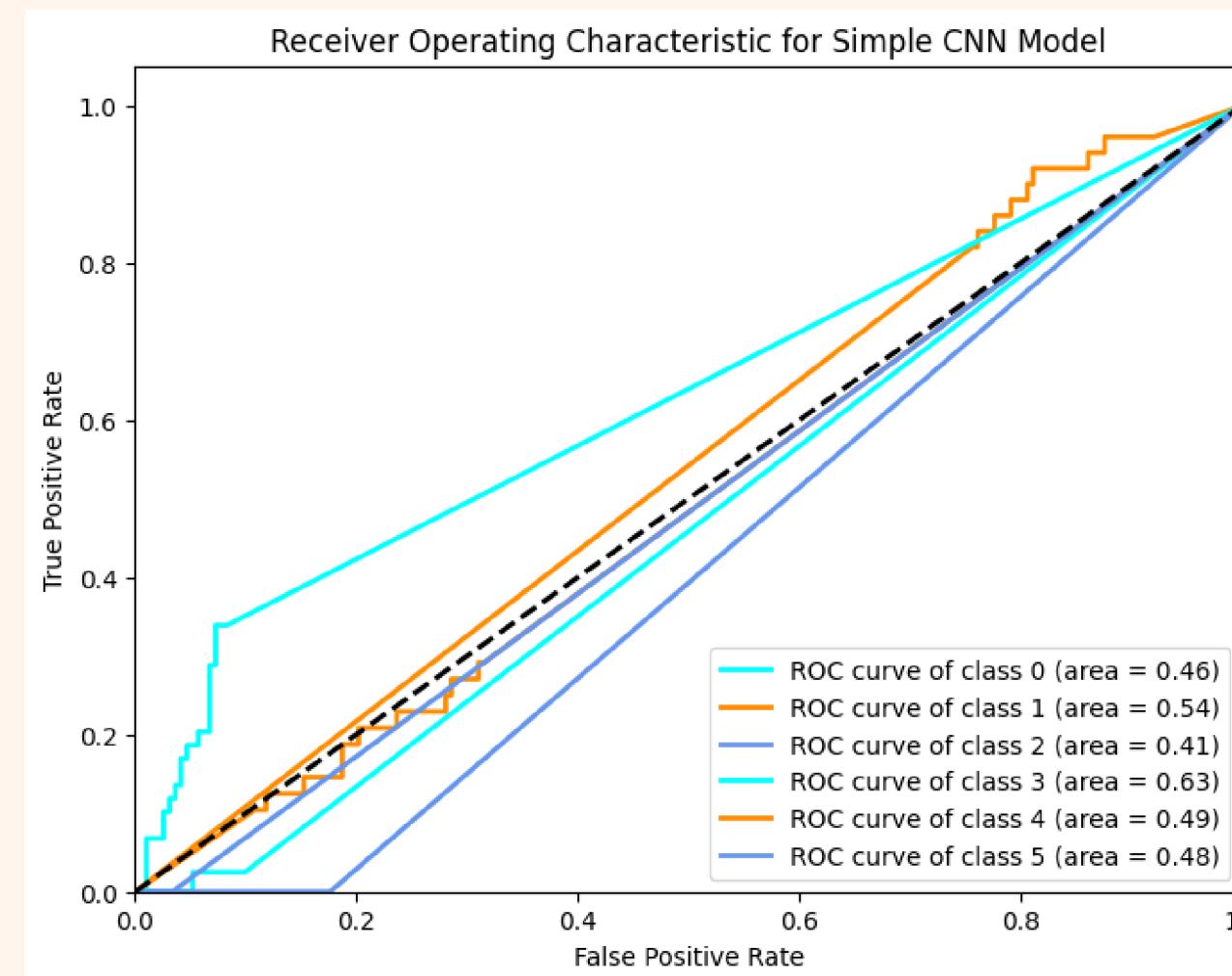
VGG16



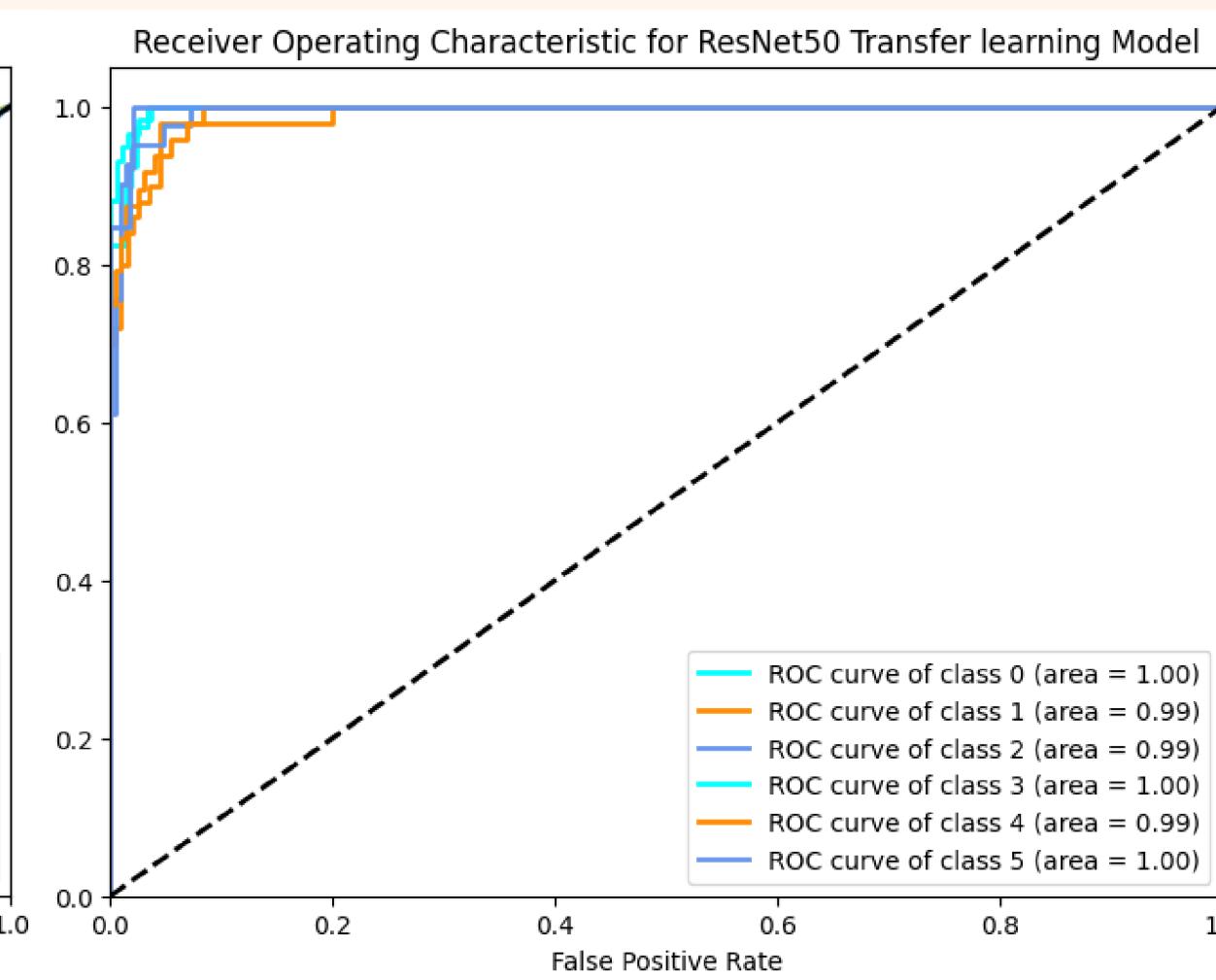
- high of 0.9

EVALUATION ROC

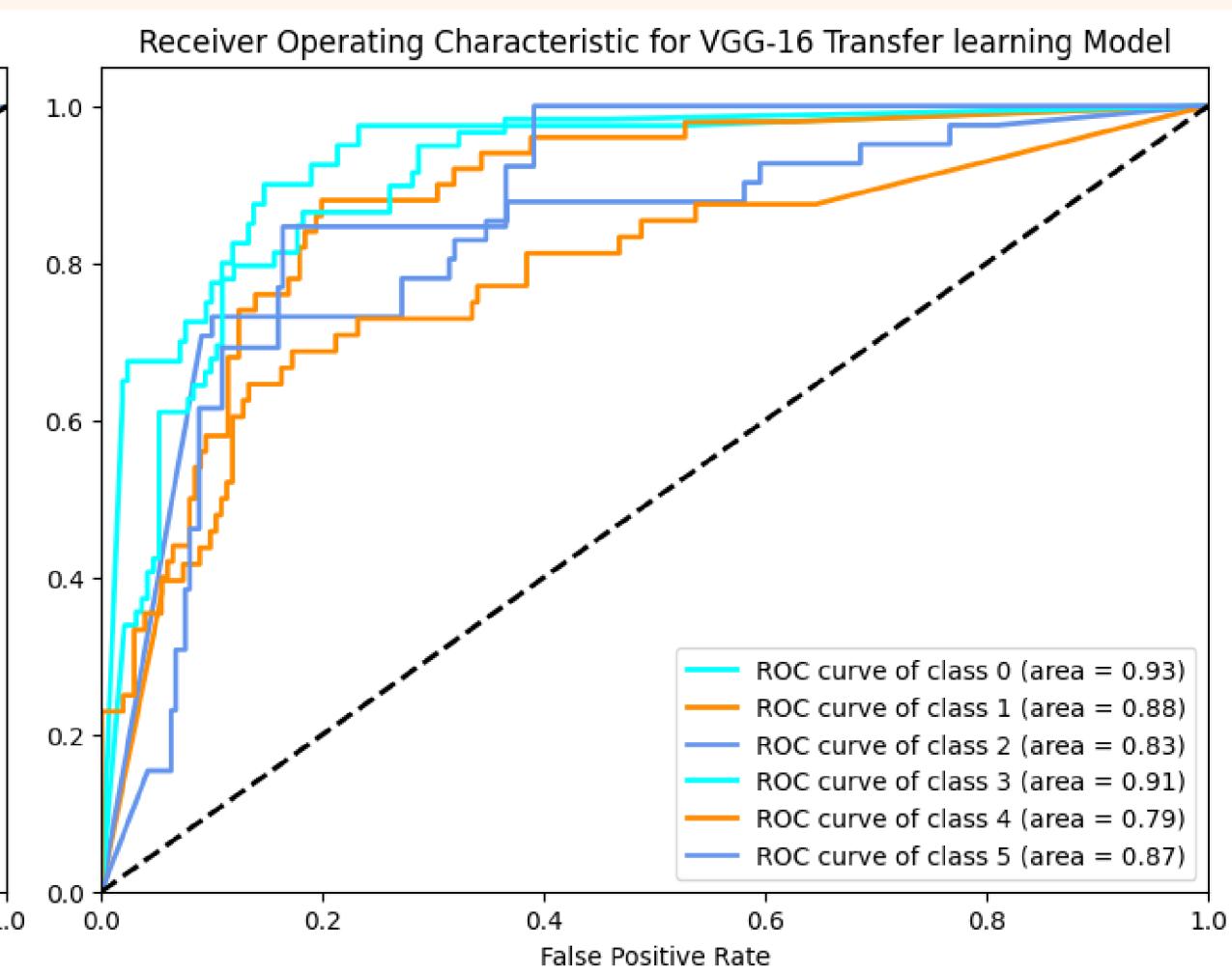
Simple CNN



ResNet50



VGG16



- AUC value close or equal to 1.00

EVALUATION PREDICTIONS

Actual: plastic
Simple CNN Predicted: metal
ResNet Predicted: plastic
VGG-16 Predicted: glass



Actual: plastic
Simple CNN Predicted: paper
ResNet Predicted: plastic
VGG-16 Predicted: trash



Actual: plastic
Simple CNN Predicted: metal
ResNet Predicted: plastic
VGG-16 Predicted: metal



Actual: cardboard
Simple CNN Predicted: glass
ResNet Predicted: cardboard
VGG-16 Predicted: cardboard



Actual: cardboard
Simple CNN Predicted: glass
ResNet Predicted: cardboard
VGG-16 Predicted: paper



- Simple CNN misclassified all of them
- VGG-16 misclassified plastic as glass, trash, and metal, and misclassified cardboard as paper.
- ResNet50 accurately predicts, matches with the ground truth.



EVALUATION (ENSEMBLE)

Accuracy

```
Accuracy of Bagging (ResNet50 + VGG16): 0.9123505976095617
Accuracy of Stacking (ResNet50 + VGG16): 0.9322709163346613
Accuracy of ResNet50: 0.9243027888446215
Accuracy of VGG16: 0.7689243027888446
```

ResNet50

VGG-16

Bagging

Stacking



EVALUATION (ENSEMBLE)

Accuracy

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F1 Score

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F1 Score of Stacking (ResNet50 + VGG16): 0.9334300378957021
F1 Score of ResNet50: 0.9240417711039396
F1 Score of VGG16: 0.7716666776382977
```

ResNet50

VGG-16

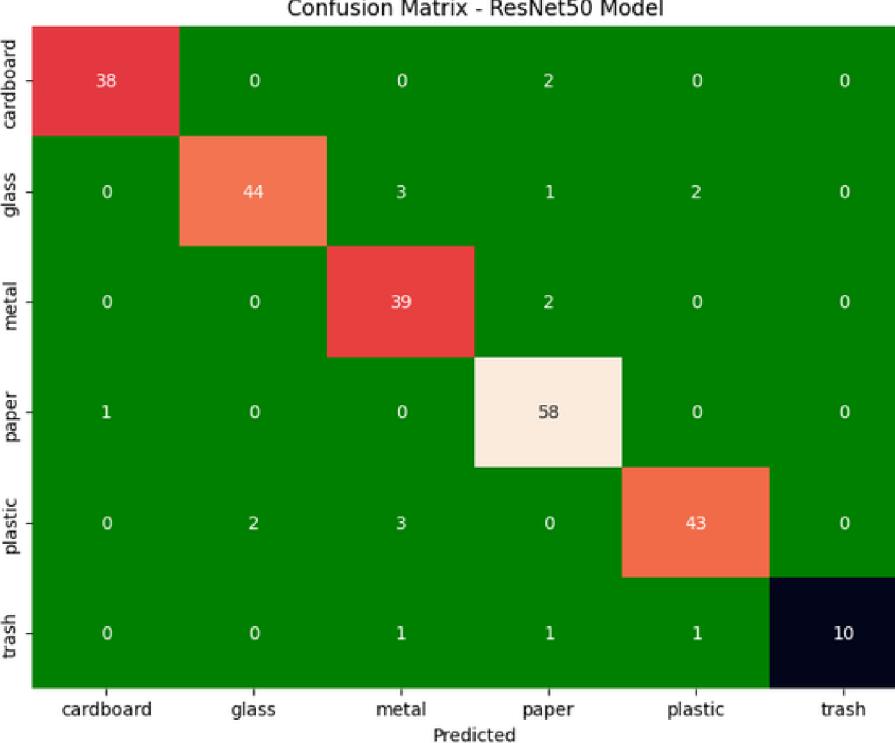
Bagging

Stacking



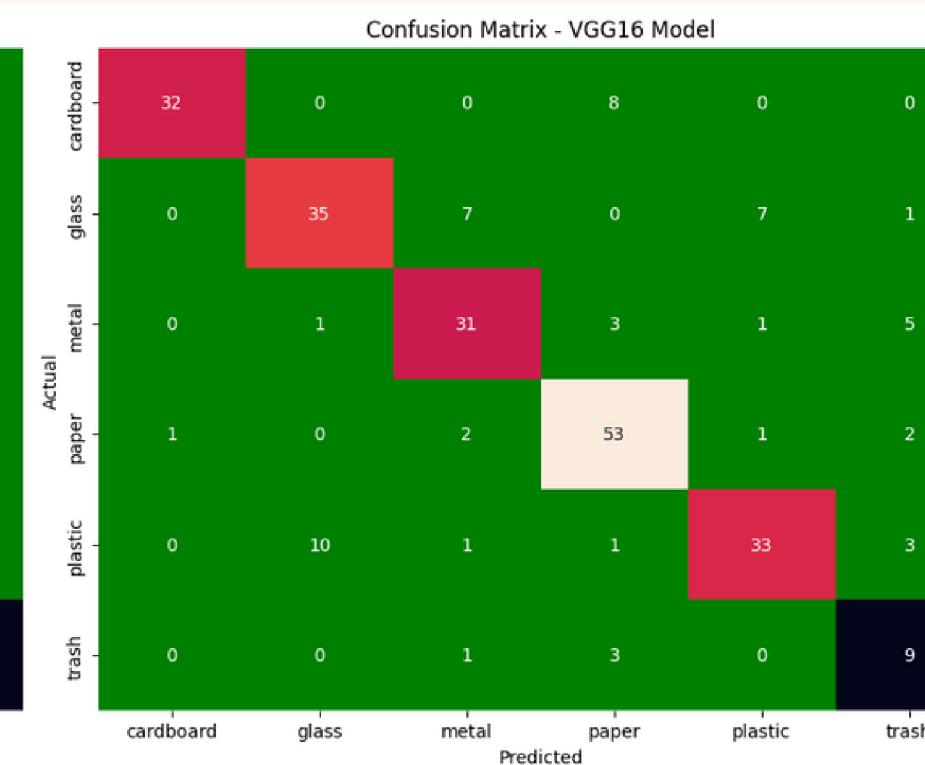
EVALUATION (ENSEMBLE)

Cardboard



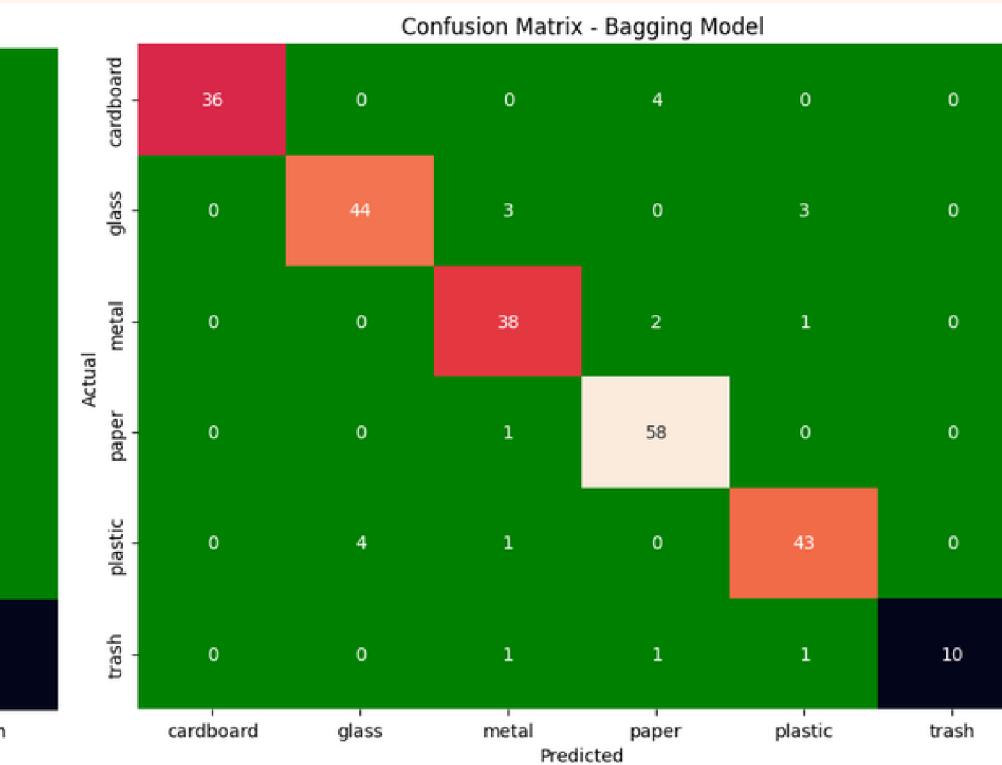
Glass

Stacking



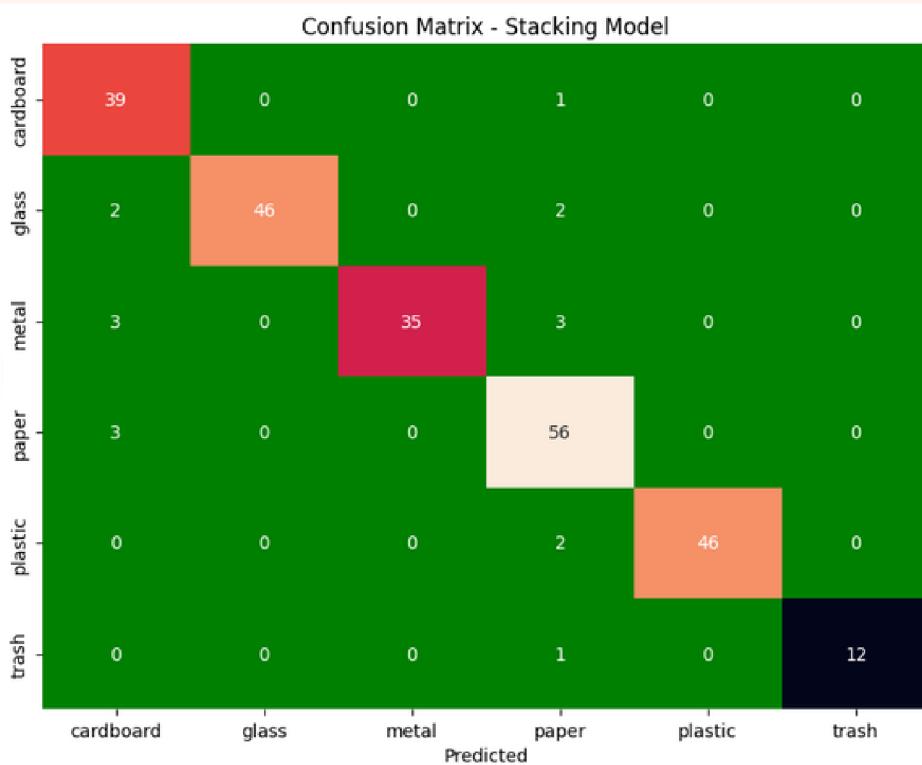
Metal

ResNet50



Plastic

Stacking



ResNet50

VGG-16

Bagging

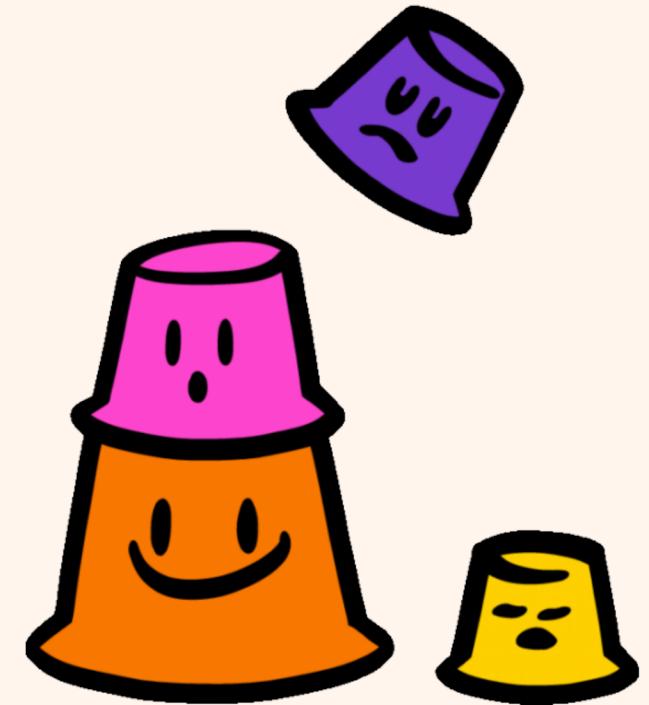
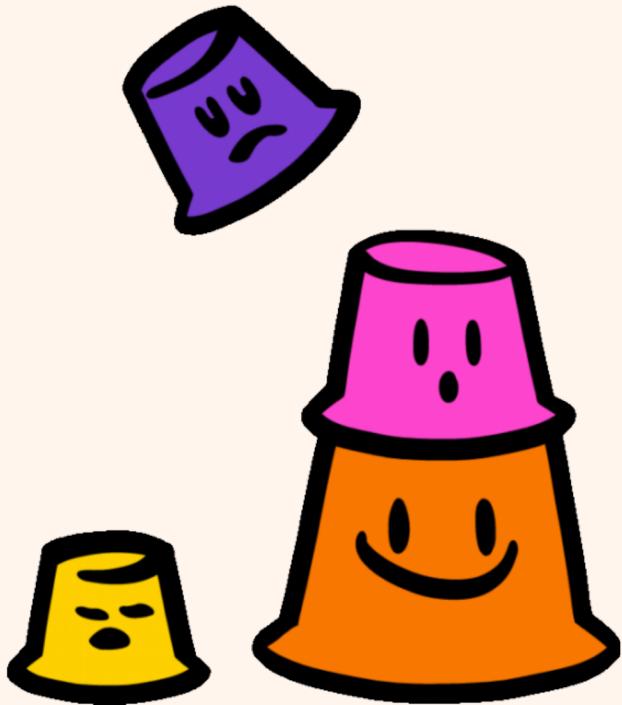
Stacking



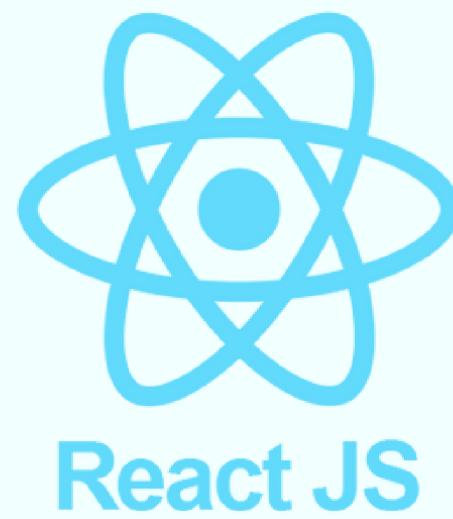
Chosen Model



Stacking



APPLICATION PIPELINE



Frontend

Sends uploaded
image through a
formData object



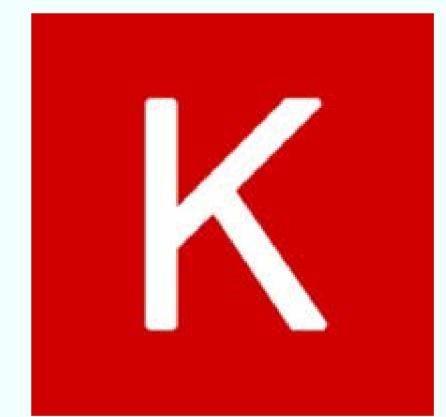
Return predicted
results



Preprocess image
+ load model
weights



Run inference using
stacked models +
meta model

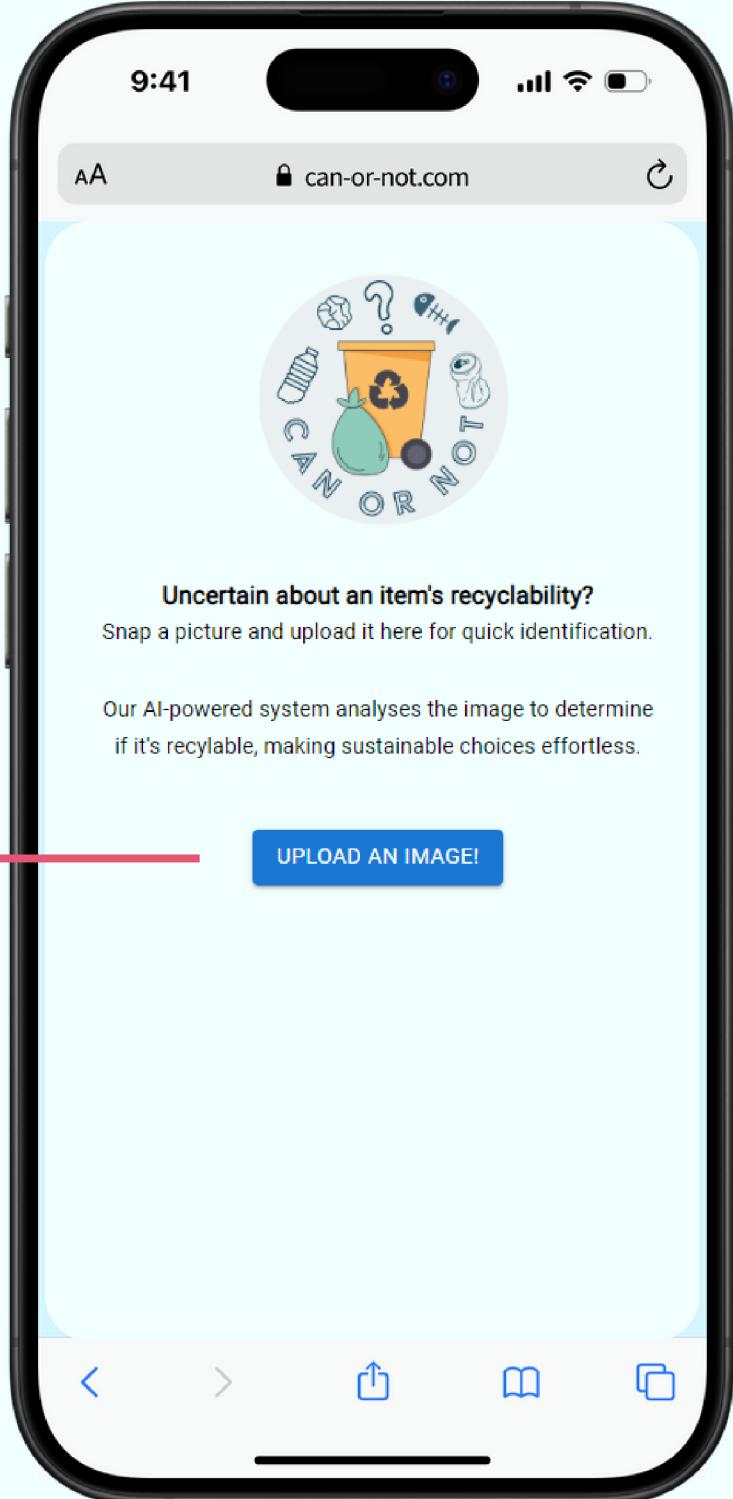


Backend

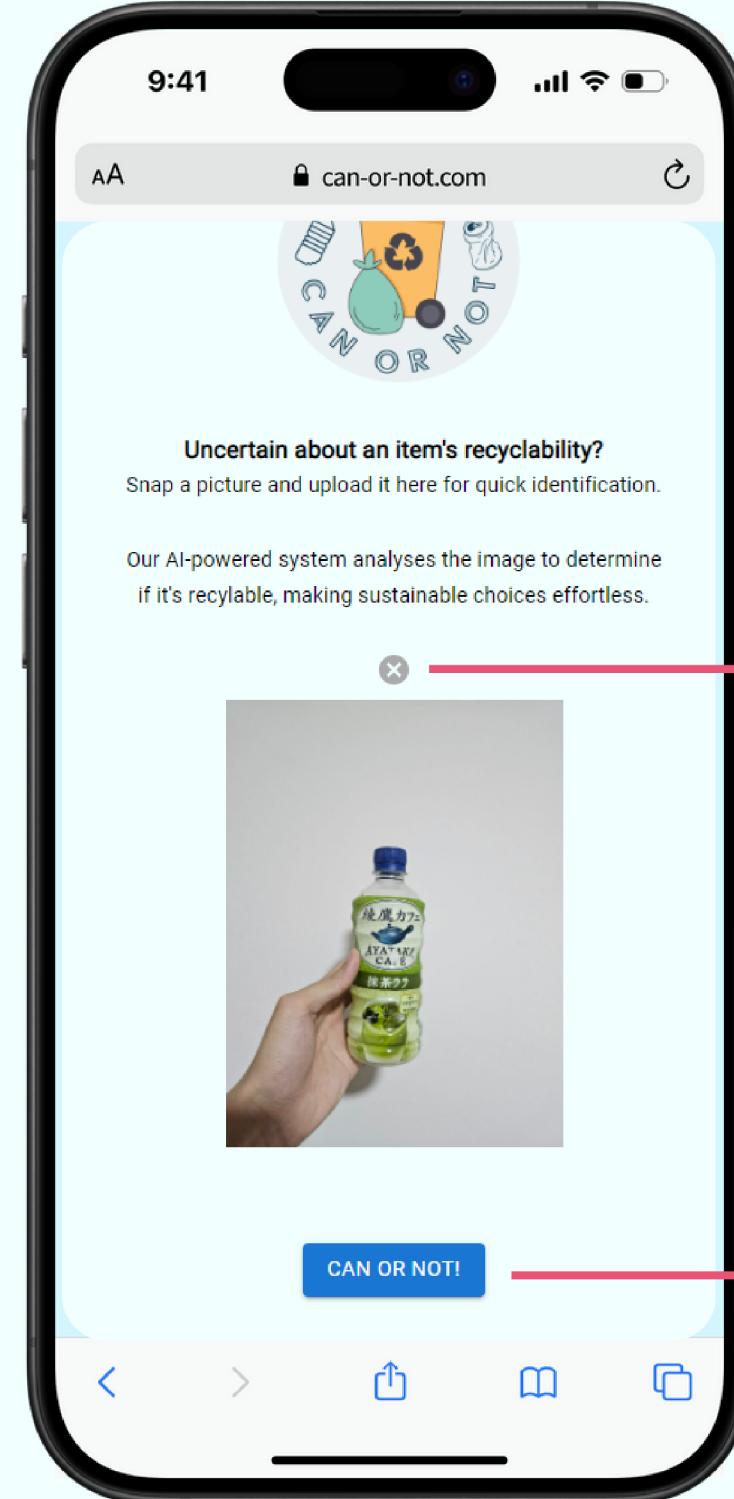
GRAPHICAL USER INTERFACE

HOME PAGE

1. Choose image from gallery



2. Image is removable



3. Run model inference

GRAPHICAL USER INTERFACE

RESULTS PAGE

Glass



Uncertain about an item's recyclability?
Snap a picture and upload it here for quick identification

Cardboard



Uncertain about an item's recyclability?
Snap a picture and upload it here for quick identification



Uncertain about an item's recyclability?
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Paper



Metal

Plastic

Trash

FUTURE IMPROVEMENTS

CURRENT MODEL LIMITATIONS

1. Training size insufficient (~2500 images)
2. Background images mostly beige -> model cannot generalize well on other backgrounds

IMPROVEMENTS TO MAKE

1. Increase training size
2. Applying bounding boxes to localize item to be classified to increase accuracy





UNSDG

Goal 12:
Ensure sustainable production and
consumption patterns





Thank you!

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