

# AISS CV – Group 6 – Food Label Recognition

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## Our Solution

Our CV application detects labels on supermarket items to

- Help users differentiate between legitimate & marketing labels
- Provide additional information on legitimate labels



 EU-Bio-Logo

Bio-Hexagon (EU-Bio-Logo): Das EU-Bio-Logo kennzeichnet Lebensmittel, die den EU-Vorschriften für ökologischen Landbau entsprechen. Es garantiert, dass mindestens 95% der Inhaltsstoffe aus ökologischem Anbau stammen.

 EU-Bio-Siegel

Das EU-Bio-Siegel (mit Sternen) kennzeichnet Lebensmittel, die gemäß den strengen Vorgaben der EU-Öko-Verordnung hergestellt wurden. Es garantiert, dass mindestens 95% der Zutaten aus ökologischem Landbau stammen und die Produktion umweltfreundlich sowie tiergerecht erfolgt.



Quickly assess properties  
and quality of different  
products while directly  
engaging with  
them in the supermarket

# Developing Our Solution

- Collecting & Preparing Data
- Choosing & Training The Model
- Evaluating our Model
- Putting It All Together

# Creating Our Data Set



No suitable data sets publicly available for our use case



## Collect Photos



With label: 160  
No label: 160



With label: 37  
No label: 37

~400 photos



## Label Photos

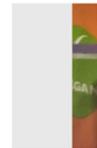
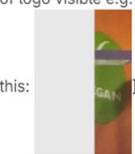
■ Tool: *LabelImg*

# Using Labeling Guidelines To Ensure Consistency

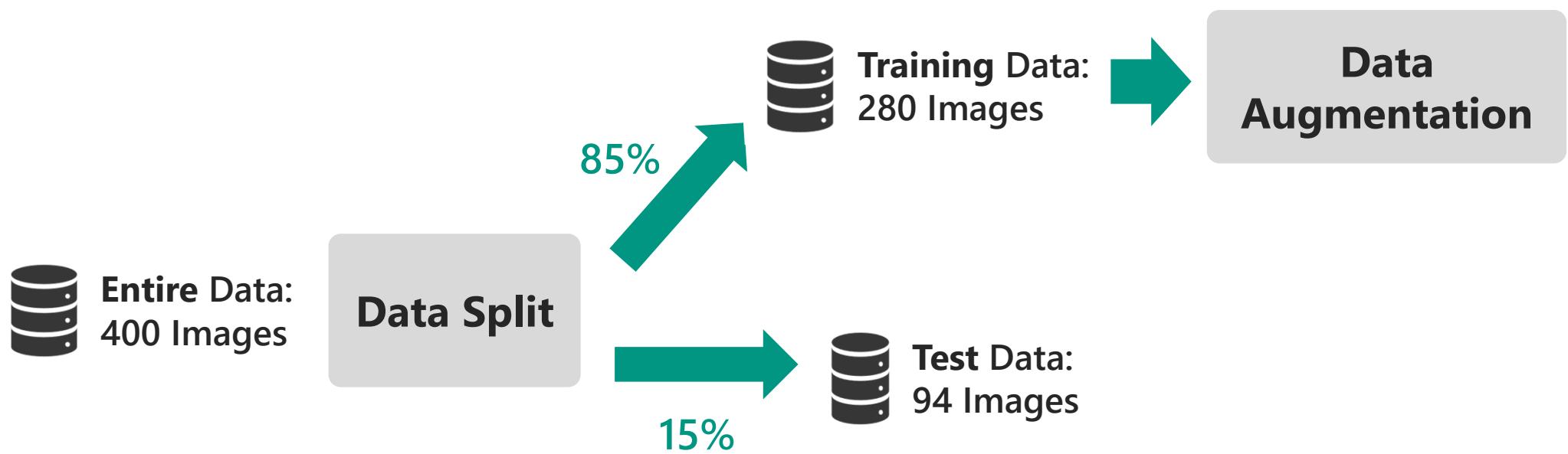
## 1 Labeling Wiki

Example Image of Label with Bounding Box	Class Name	Position in classes.txt
	bio_hexagon	0
	eco_stars	1

## 2 Edge Case Wiki

Image of Edge Case	Problem Description	Solution Description	Note to find affected images
	label not completely within the picture	[proposal] still label the visible part if at least 50% of logo visible e.g. [label this:  ] [don't label this:  <p>+ Best Practice Labeling Rules</p>	

# Data Split and Augmentation



# Data Augmentation Operations

Original



Safe Rotate  
&  
Color Jitter



Contrast  
&  
Cropping



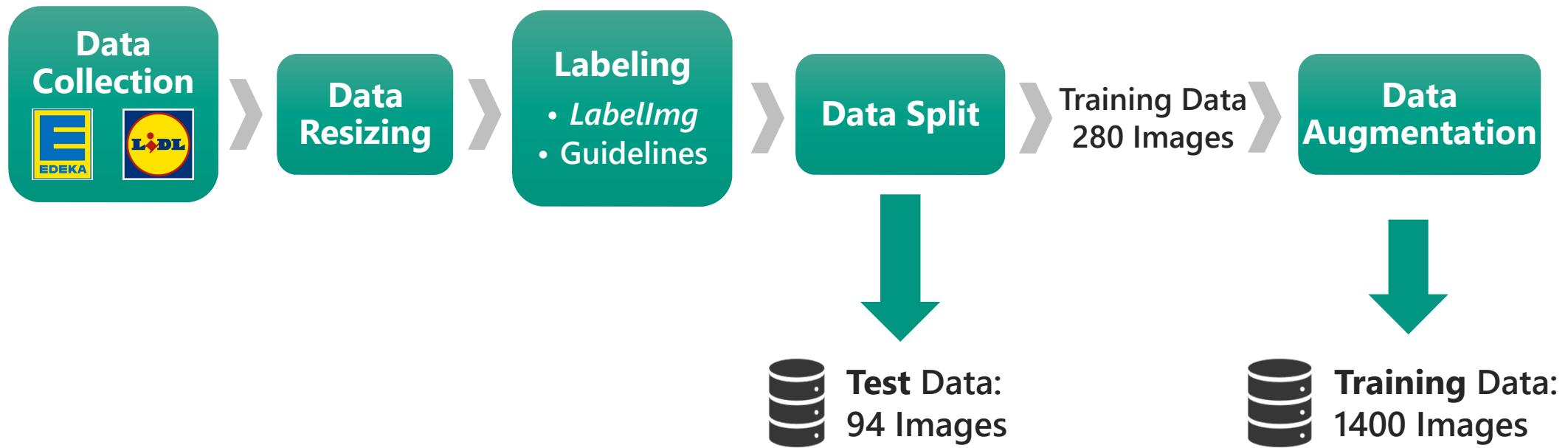
Horizontal  
Flip  
&  
Blurring



Vertical  
Flip  
&  
Elastic  
Transform



# Our Data Processing Pipeline



# Choosing The Right Model For The Task

- ✓ Pretrained & SOTA object detection model
- ✓ Small model for fast inference on Jetson Nano (Accuracy-Speed Tradeoff)
- ✓ Simple training and inference API using „Darknet” Framework

→ Tiny YOLO v4  + Darknet



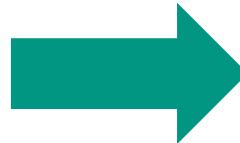
# Training & Using Darknet

**Train** on separate GPU for acceleration



1771 train images

NVIDIA RTX 4090 GPU



**Deploy and Use** on Jetson Nano



 To run Darknet, it's necessary to recompile OpenCV in order to support CUDA and GStreamer

# Good Quality of Model Predictions

214 Bounding Boxes



Correct: 188



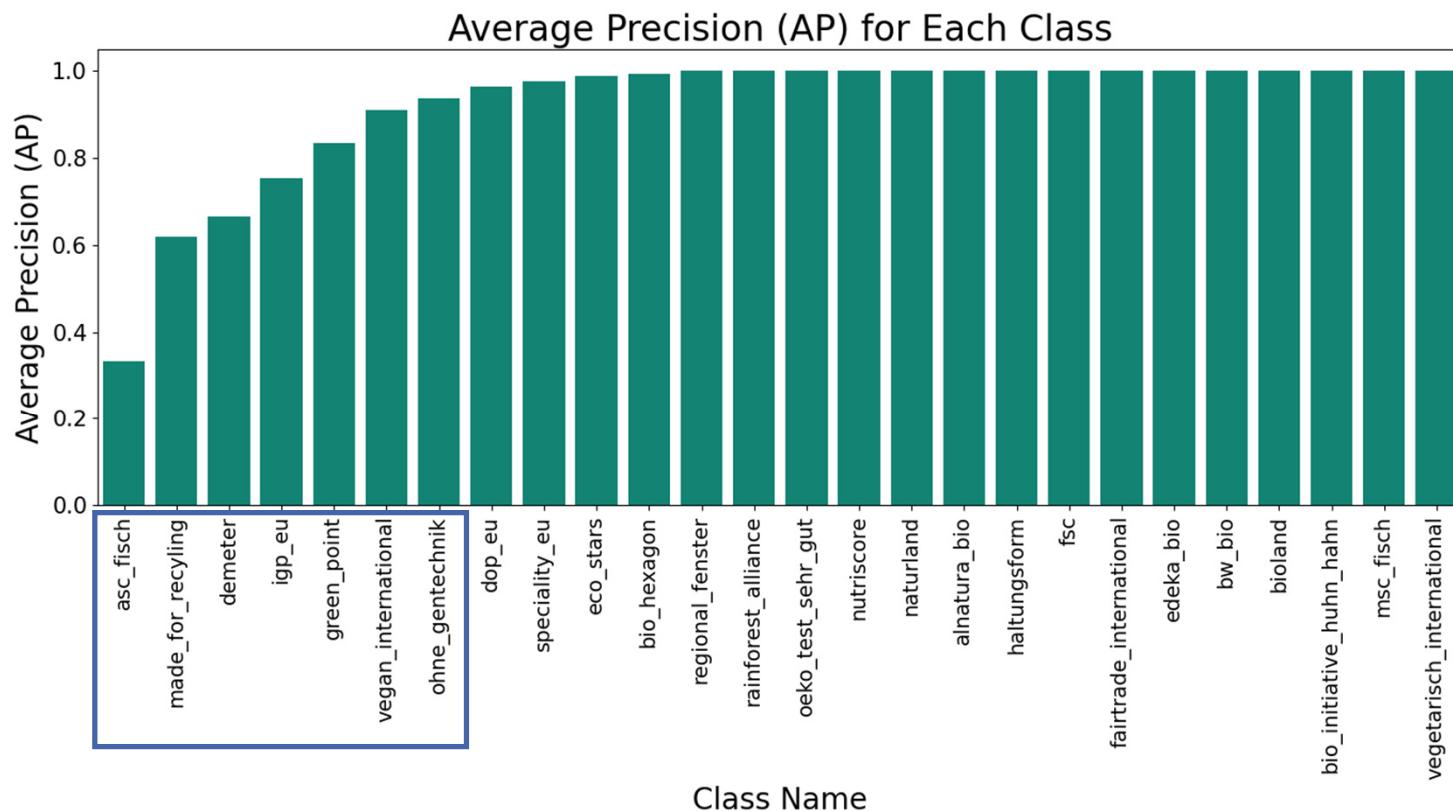
Missed: 26



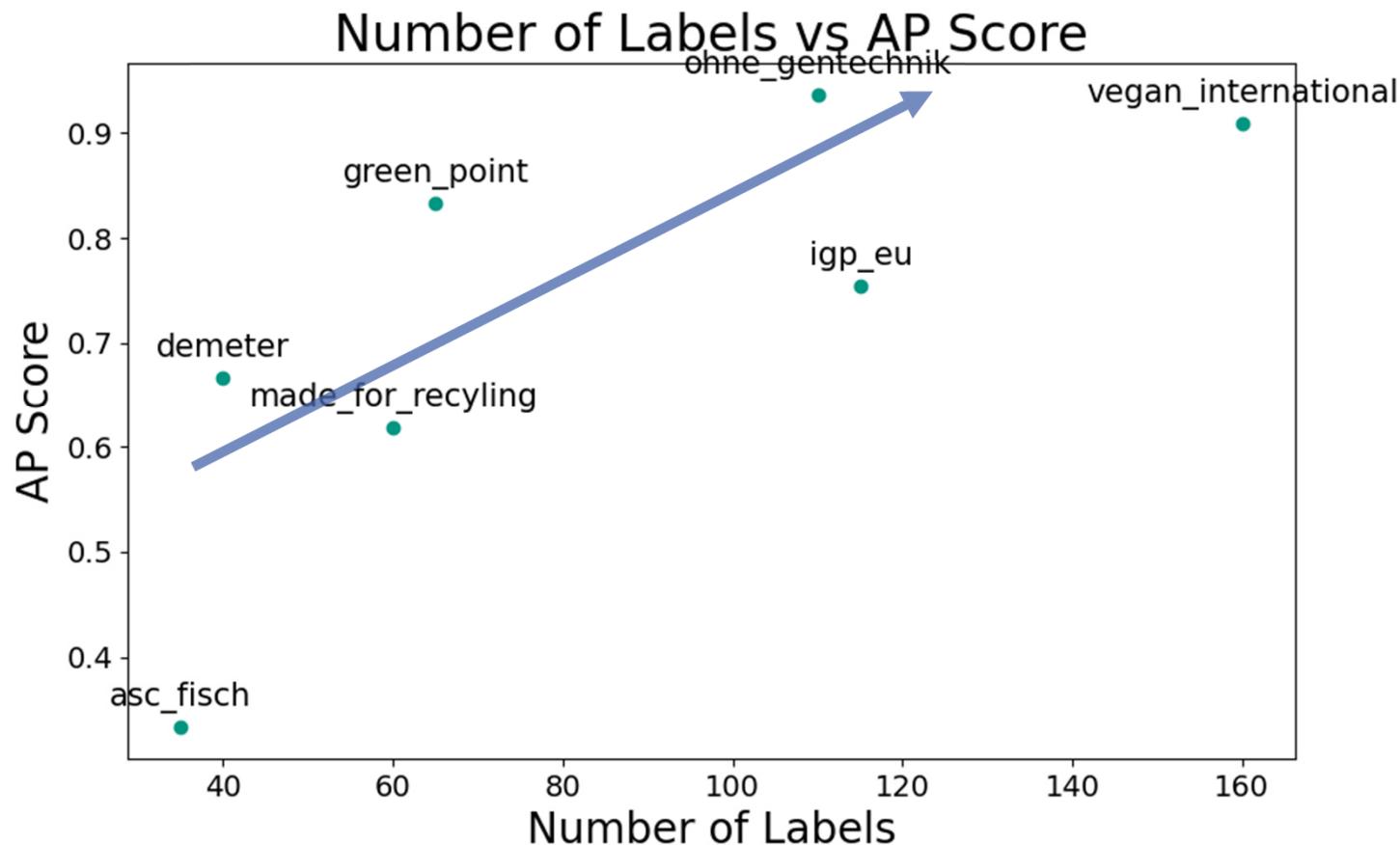
no label

Incorrect: 15

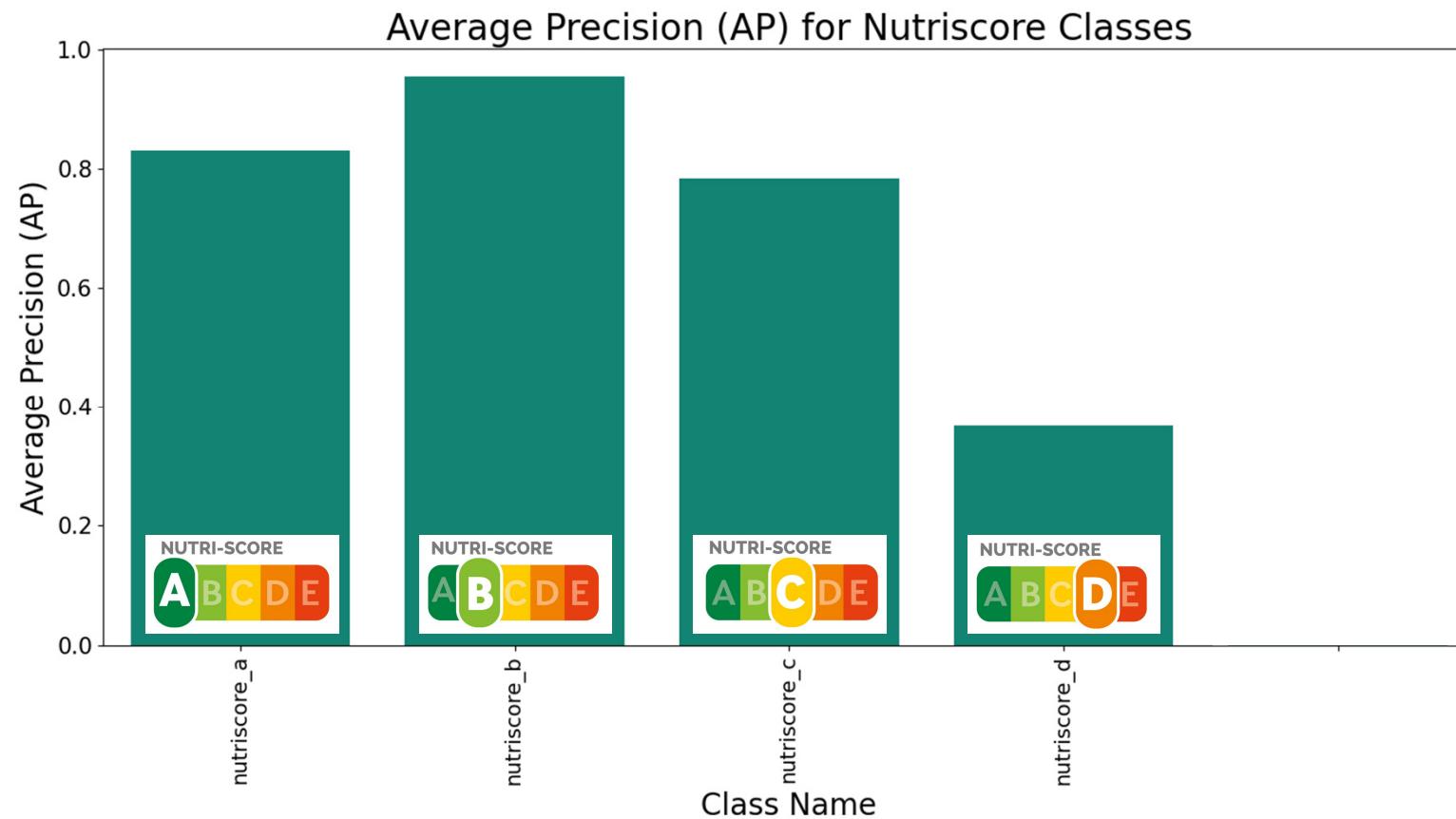
# Our Model Achieves A High Average Precision



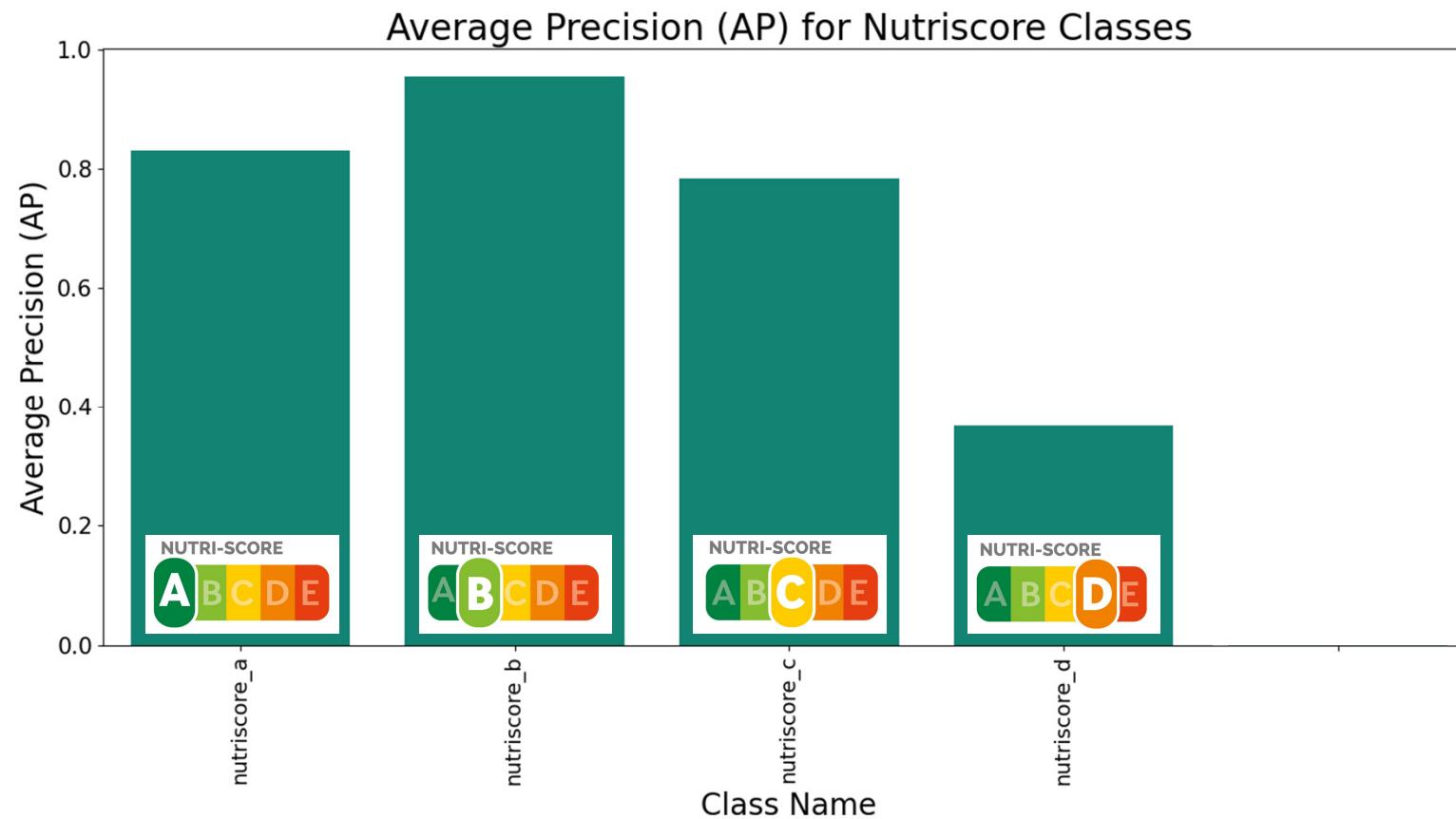
## Relationship: Number of Labels & AP Score



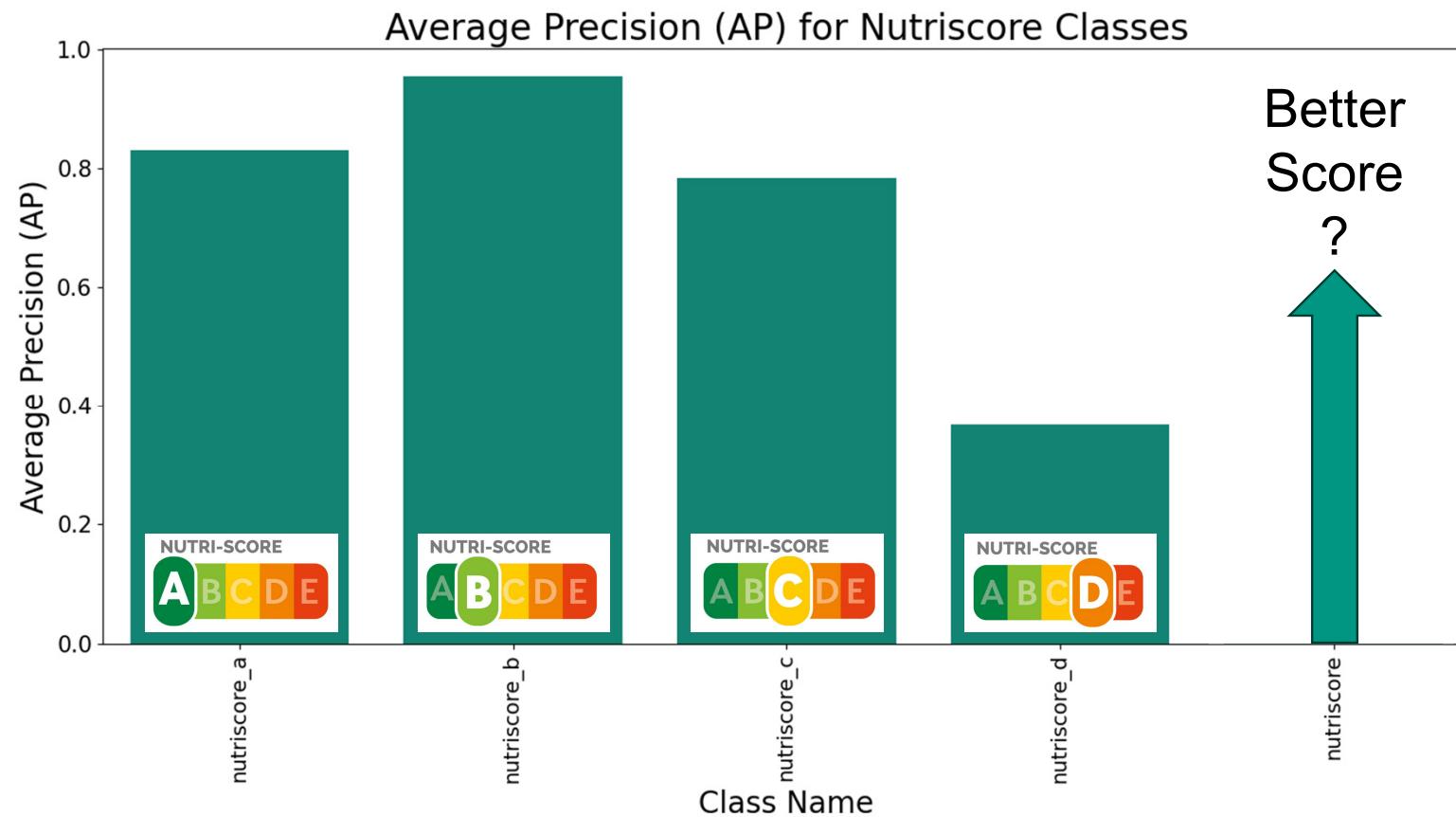
# Improving Poor Performing Classes



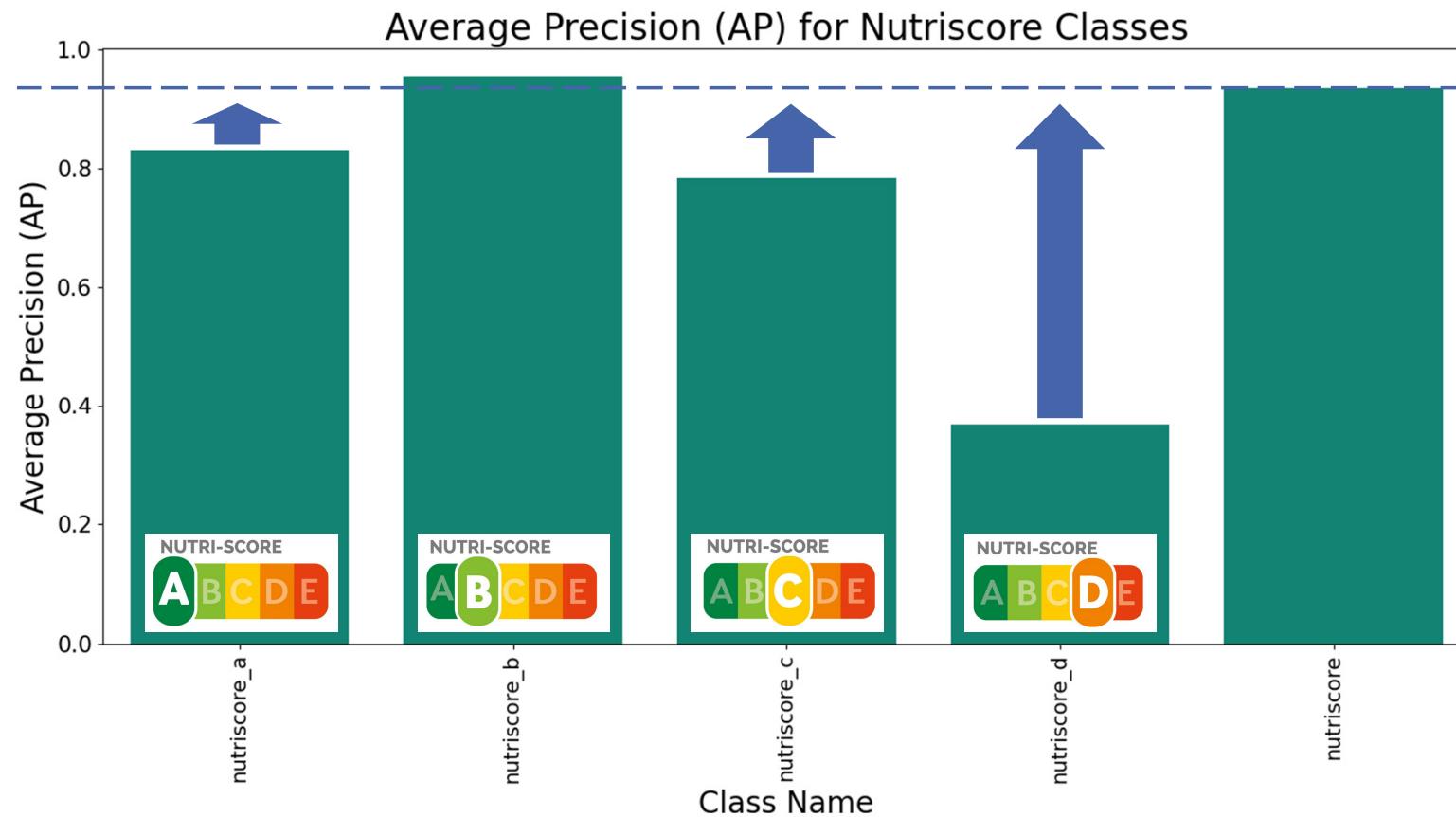
# Improving Poor Performing Classes



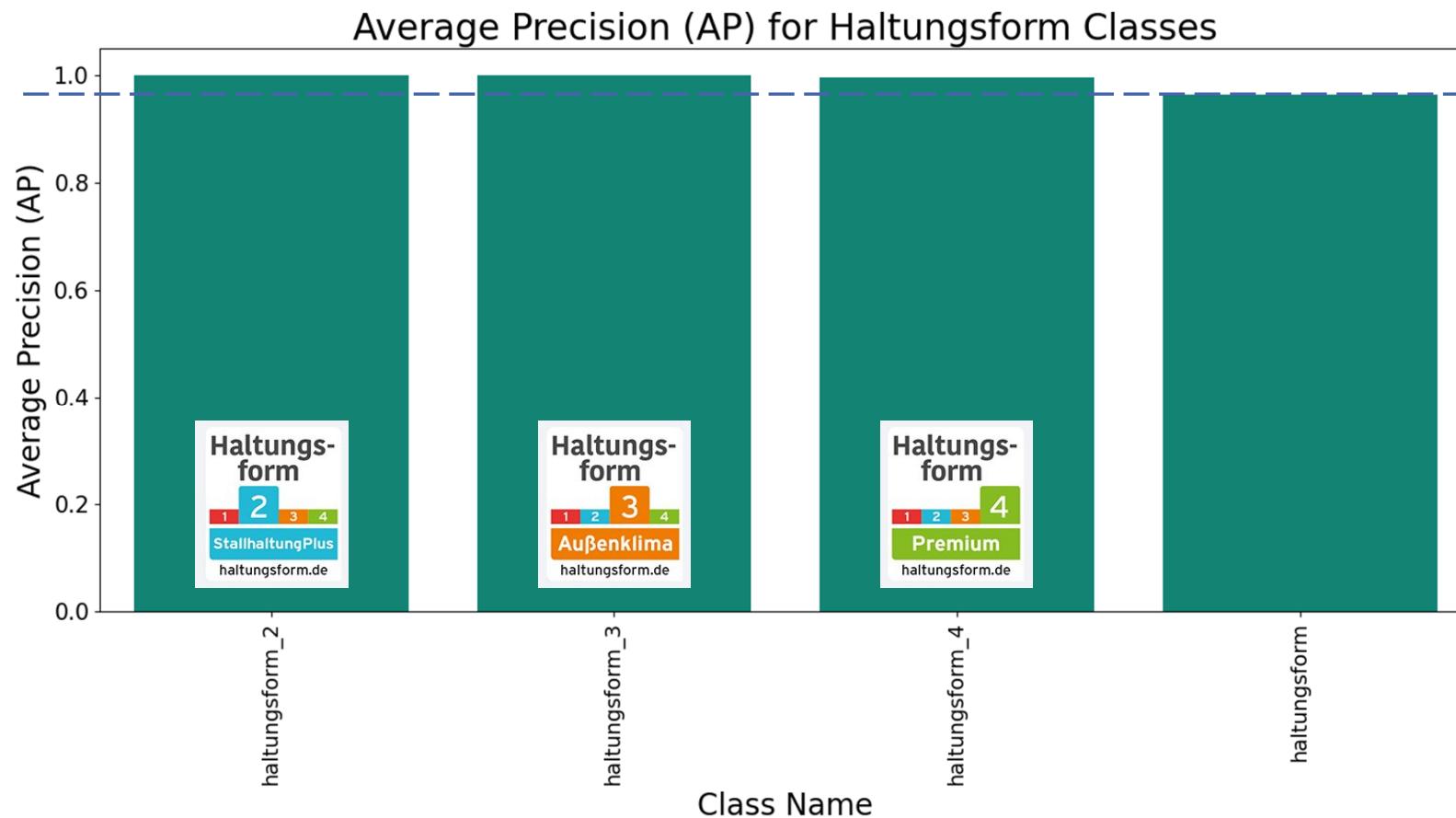
# Improving Poor Performing Classes



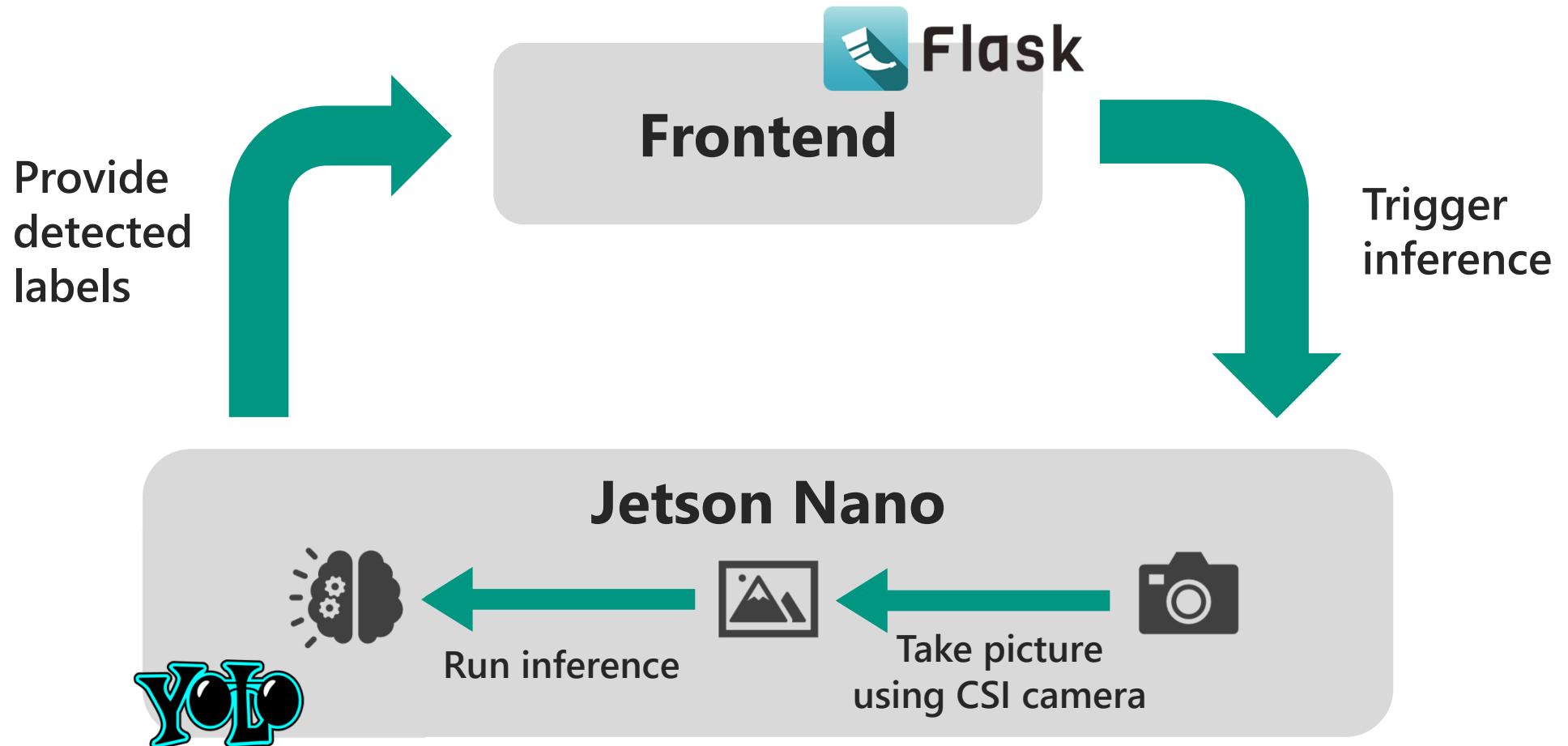
# Improving Poor Performing Classes



# No Benefit For Already Well Performing Classes



## Putting It All Together



# Let's Run Our Model!

# Thank You For Your Attention 😊



## Business Case

- CV Application to detect labels on supermarket items and provide information to users



## Data Preparation

- Collect images from supermarket
- Augment images to increase model performance → avoid data leakage



## Training & Inference

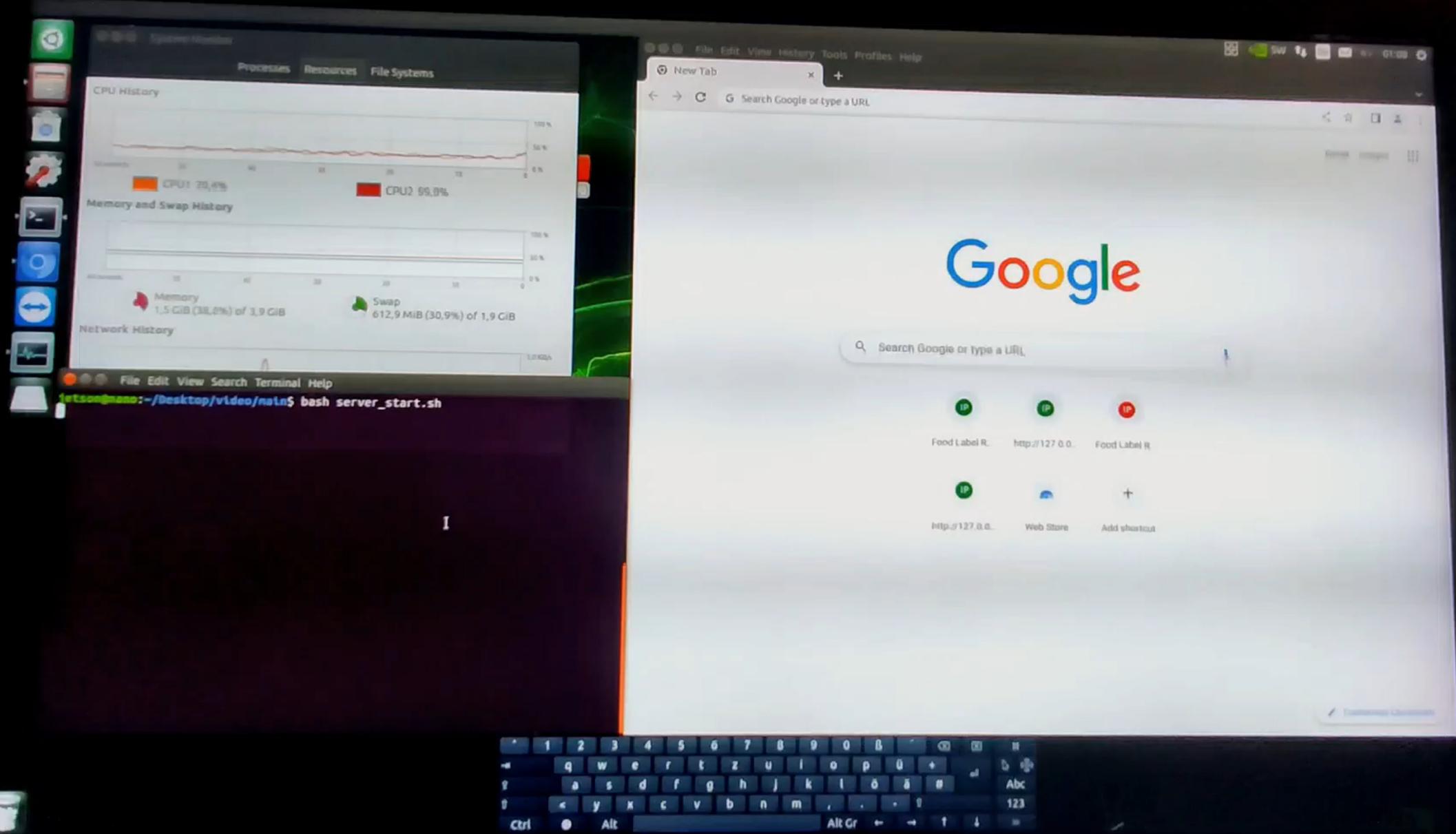
- Train Darknet on GPU, run inference on Jetson Nano



## Frontend Integration

- Flask webapp allows users to run inference on Jetson Nano using video/ image stream from CSI camera

# Backup Slides



# Web Frontend – Video Stream & Label Information

## Food Label Recognition

Take a picture of food products and get information on the labels their packaging might have.



 **EU-Organic Label** ^

The EU organic seal identifies foods produced according to the strict requirements of the EU organic regulation. It guarantees that at least 95% of the ingredients come from organic farming and that production is environmentally friendly and animal-friendly.

 **Haltungsform Label** ^

This label categorizes animal products based on the farming conditions, ranging from basic to premium standards of animal welfare.

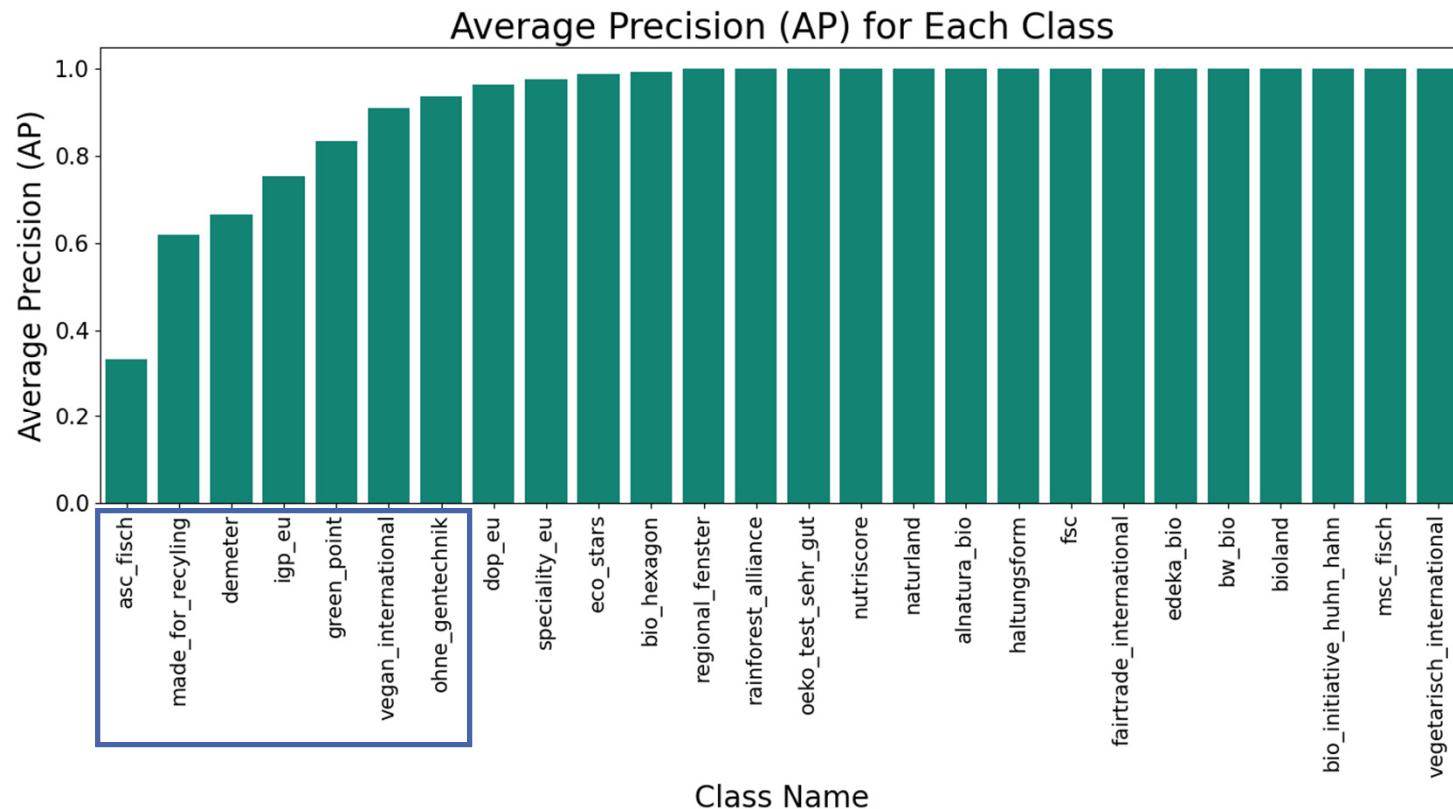
 **Nutri-Score** ^

The Nutri-Score is a nutrition labeling system that evaluates foods based on their nutritional quality. It is intended to help consumers make healthier food choices.

## Results in Detail

- Mean Average Precision Score: 92%
- Intersection over Union: 74.06 %
- Test BBoxes: 214
  - TP: 188
  - FP: 26
  - FN: 15

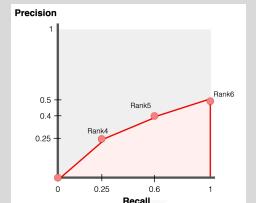
# Our Model Achieves A High Average Precision



AP per class:

Calculate Precision and Recall based on IoU for different confidence thresholds

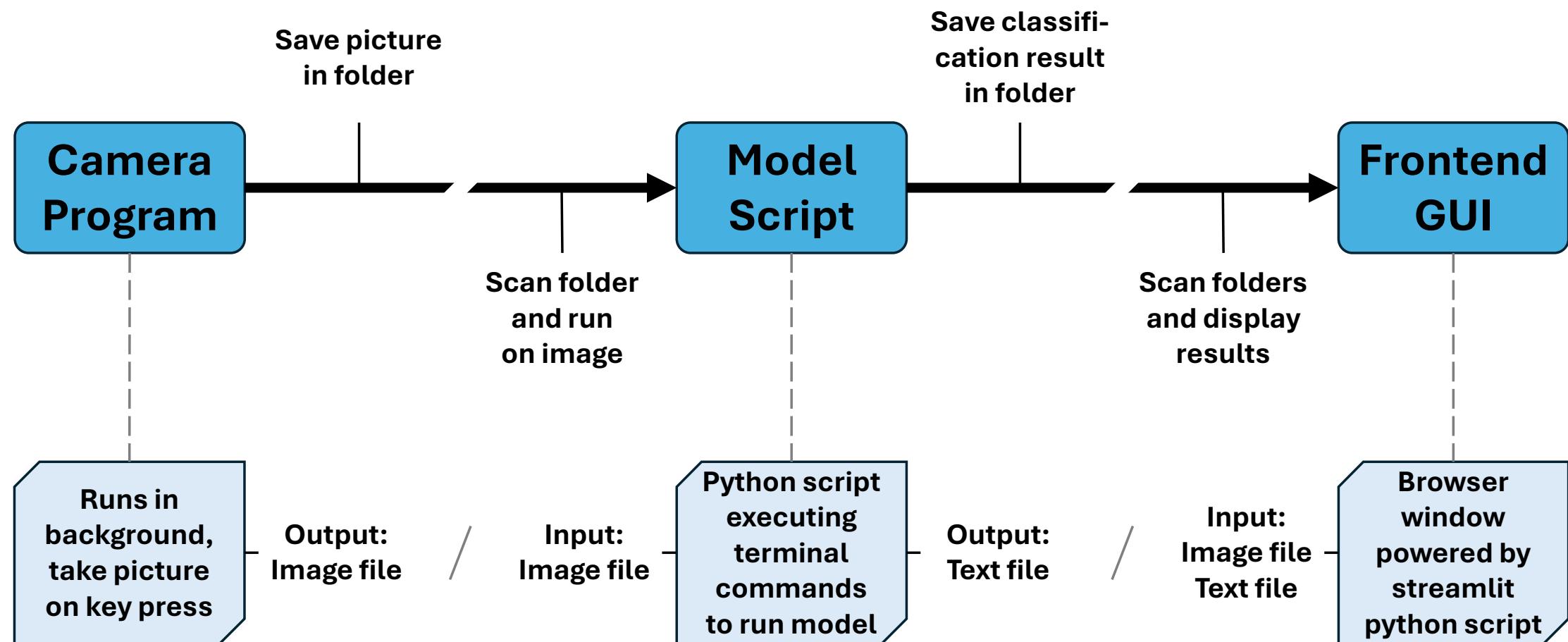
Plot Precision-Recall Curve:



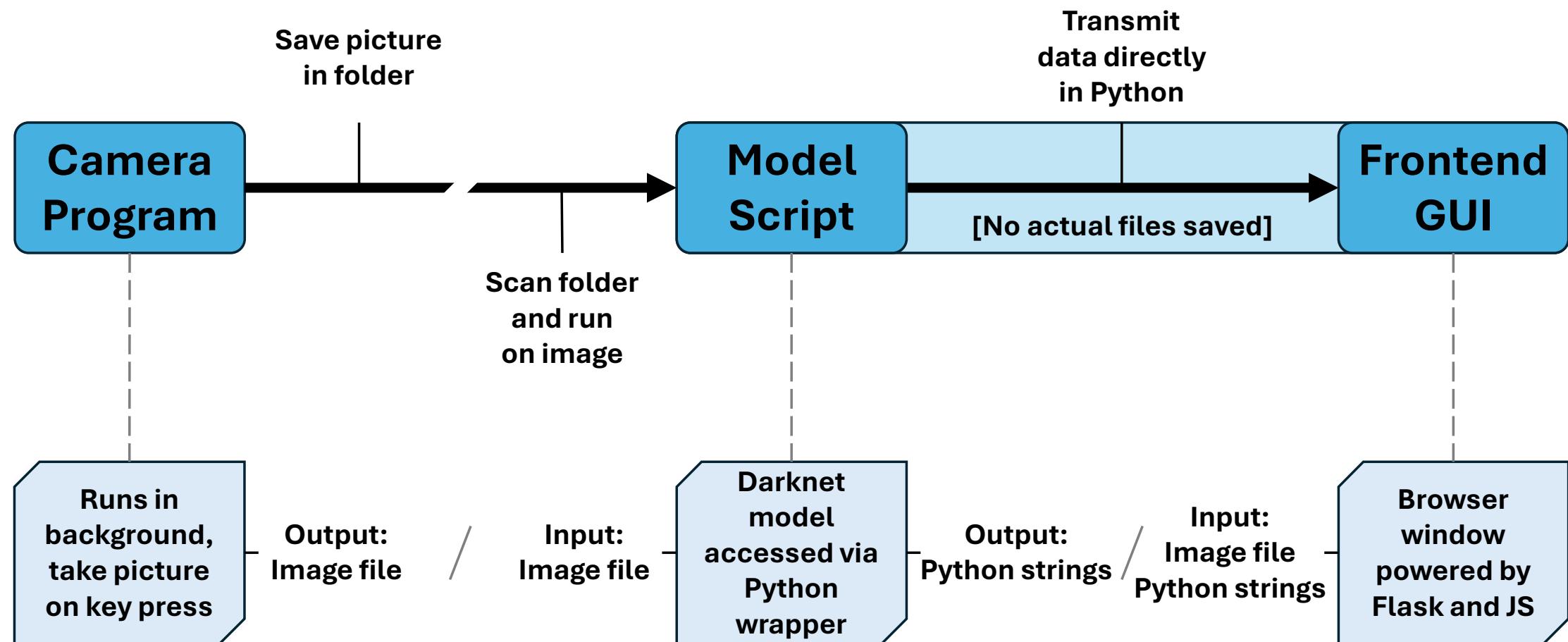
AP=Area under Curve

AP considers the precision-recall trade-off

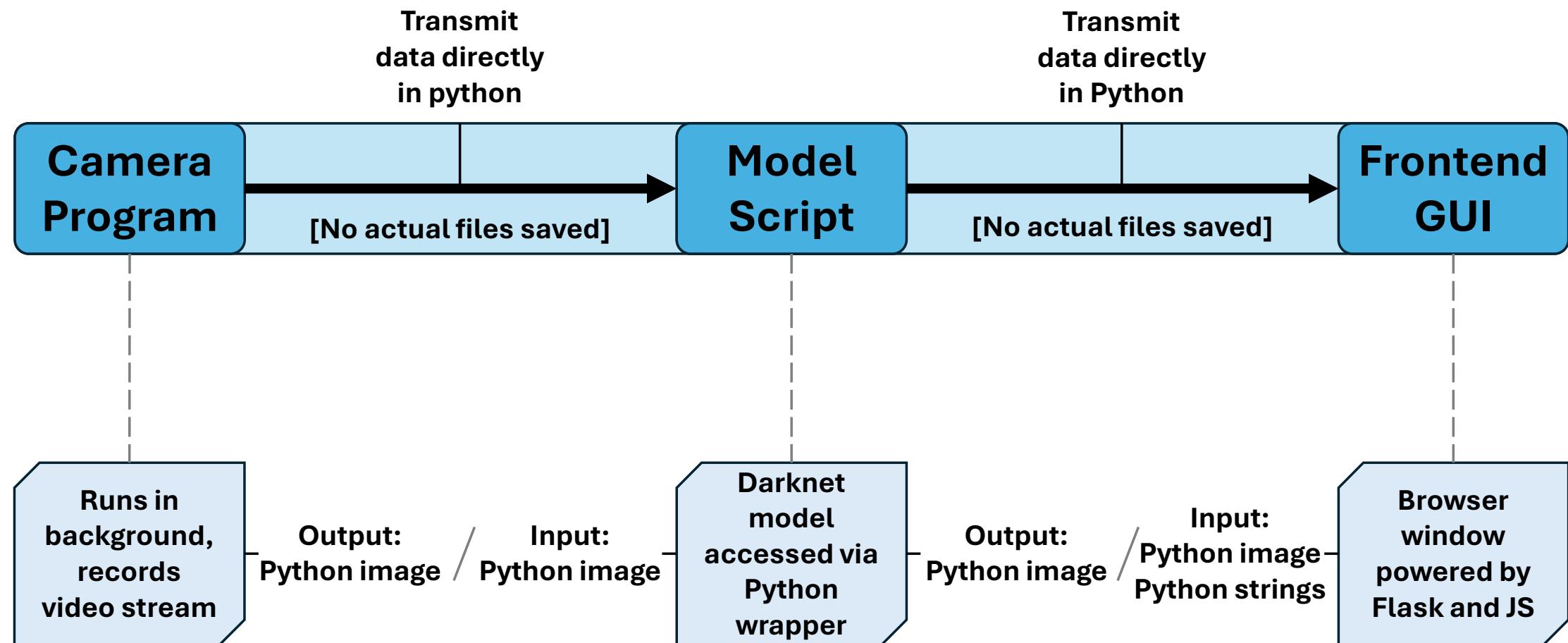
# Program Flow – 1<sup>st</sup> Version with Streamlit



## Program Flow – 2<sup>nd</sup> Version: Flask Images



# Program Flow – 3<sup>rd</sup> Version: Flask Video



# References

- [https://www.freepik.com/free-vector/hand-drawn-woman-supermarket\\_4104602.htm#fromView=search&page=2&position=0&uuid=215175ba-a29a-4a77-aeb5-fb61ce7917c2](https://www.freepik.com/free-vector/hand-drawn-woman-supermarket_4104602.htm#fromView=search&page=2&position=0&uuid=215175ba-a29a-4a77-aeb5-fb61ce7917c2)
- <https://www.evidentlyai.com/ranking-metrics/mean-average-precision-map>
- <https://www.verbraucherzentrale.de/wissen/lebensmittel/kennzeichnung-und-inhaltsstoffe/nutriscore-was bedeutet-die-kennzeichnung-76209>

## Team Organization – Tools

- Discord server – chat & weekly meetings
- Miro board – brainstorming & planning
- GitLab repo – code & wiki
- Shared cloud – dataset (images)



# Model Overview – ML Task

Multiple objects per image

Multiple bounding boxes

