

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

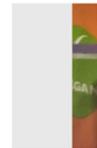
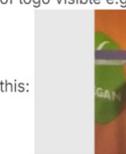
■ Tool: *LabelImg*

Using Labeling Guidelines To Ensure Consistency

1 Labeling Wiki

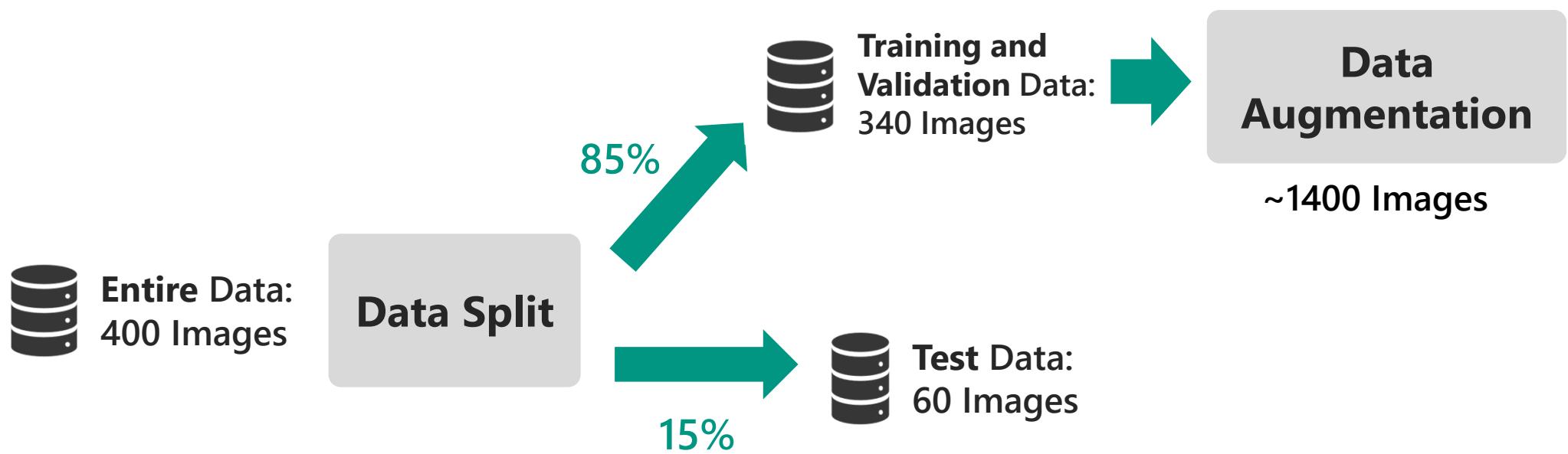
Example Image of Label with Bounding Box	Class Name	Position in classes.txt
	bio_hexagon	0
	eco_stars	1

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:  <td>[felix 2]</td>	[felix 2]

+ Best Practice Labeling Rules

Data Split and Augmentation



Data Augmentation Operations

Original



Safe Rotate
&
Color Jitter



Contrast
&
Cropping



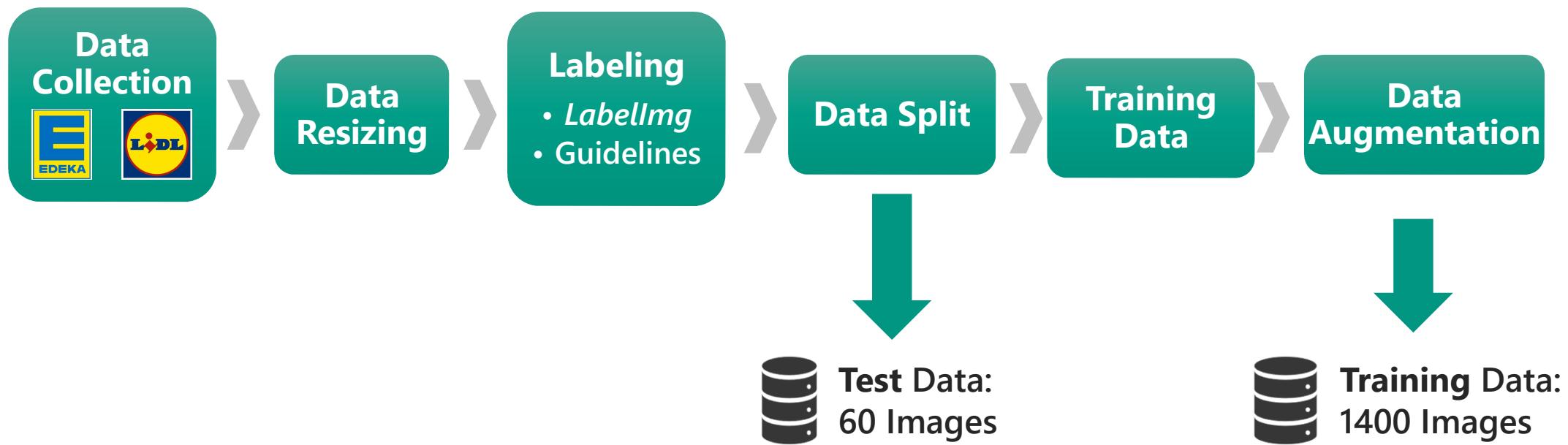
Horizontal
Flip
&
Blurring



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



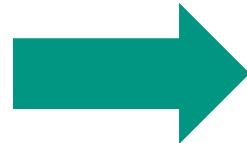
Final Training & Using Darknet

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



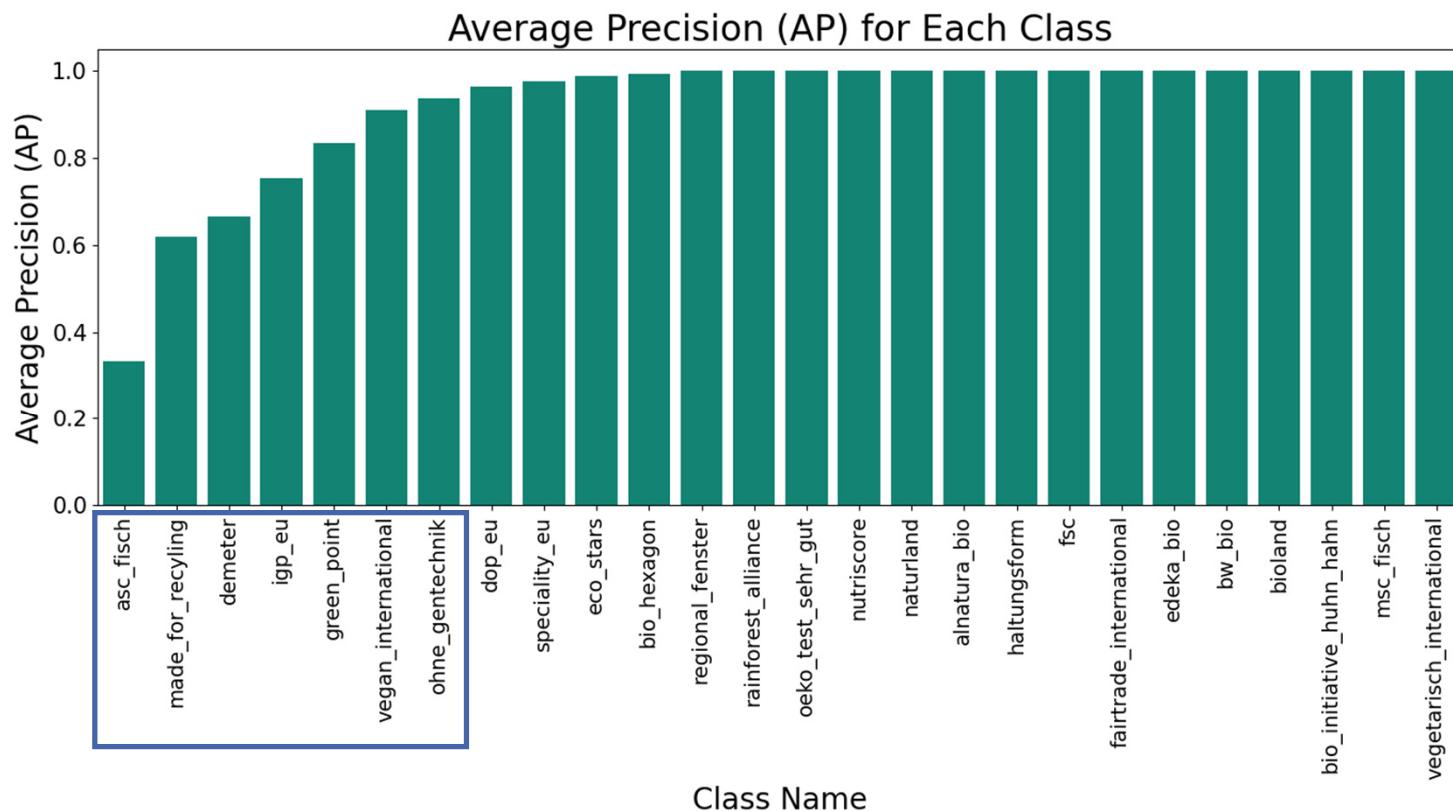
Missed: 26

+

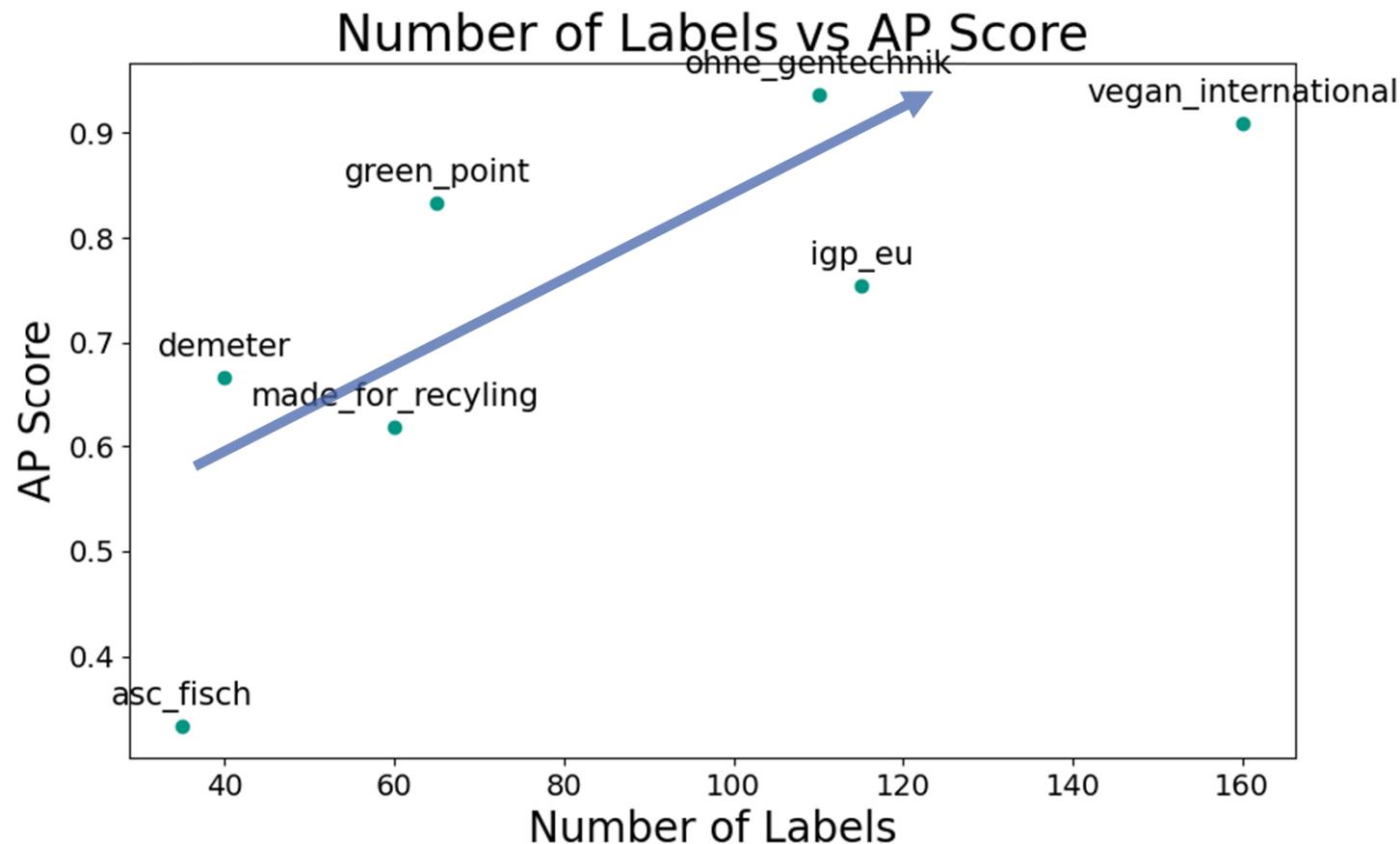
no label

Incorrect: 15

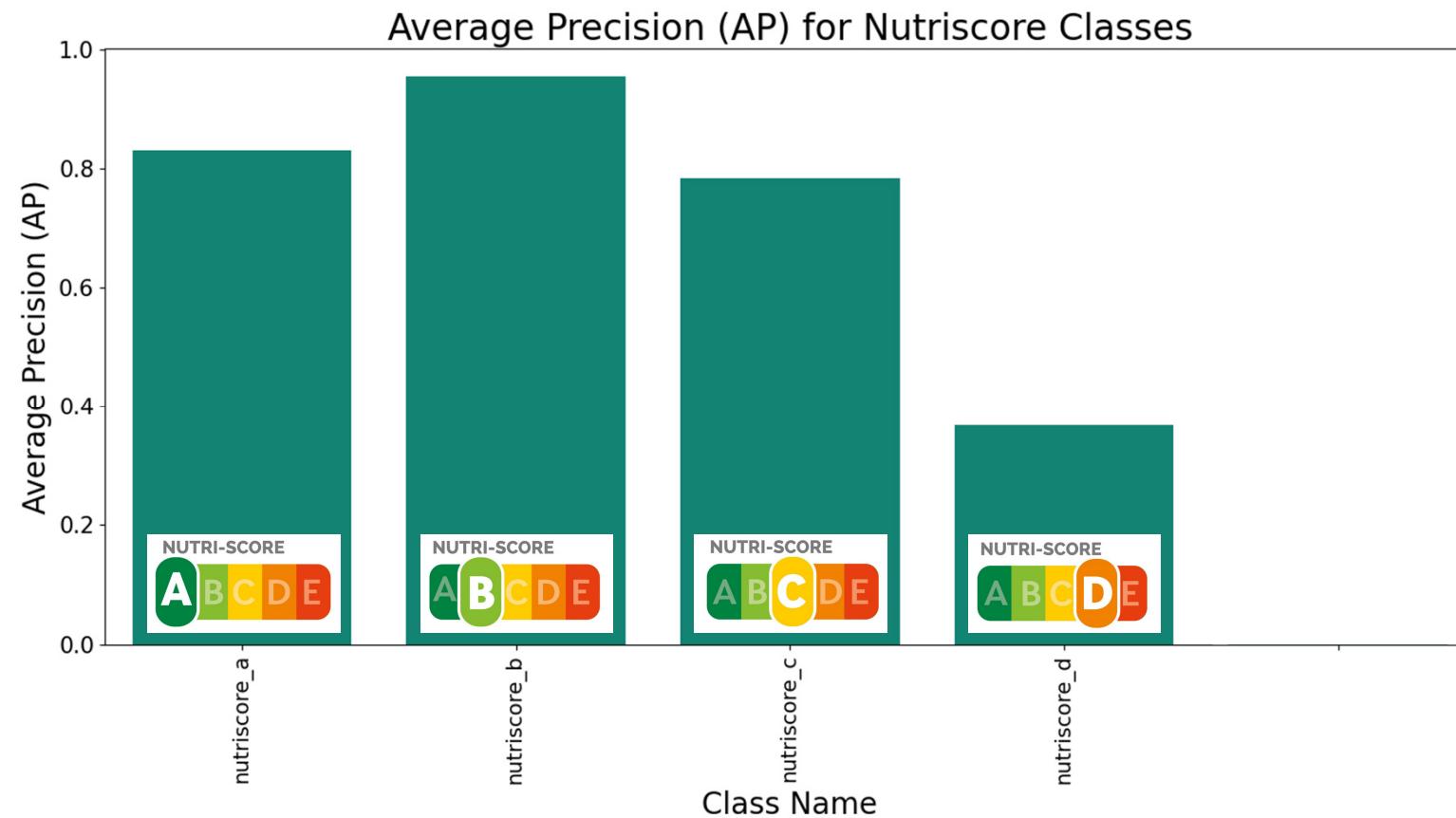
Our Model Achieves A High Average Precision



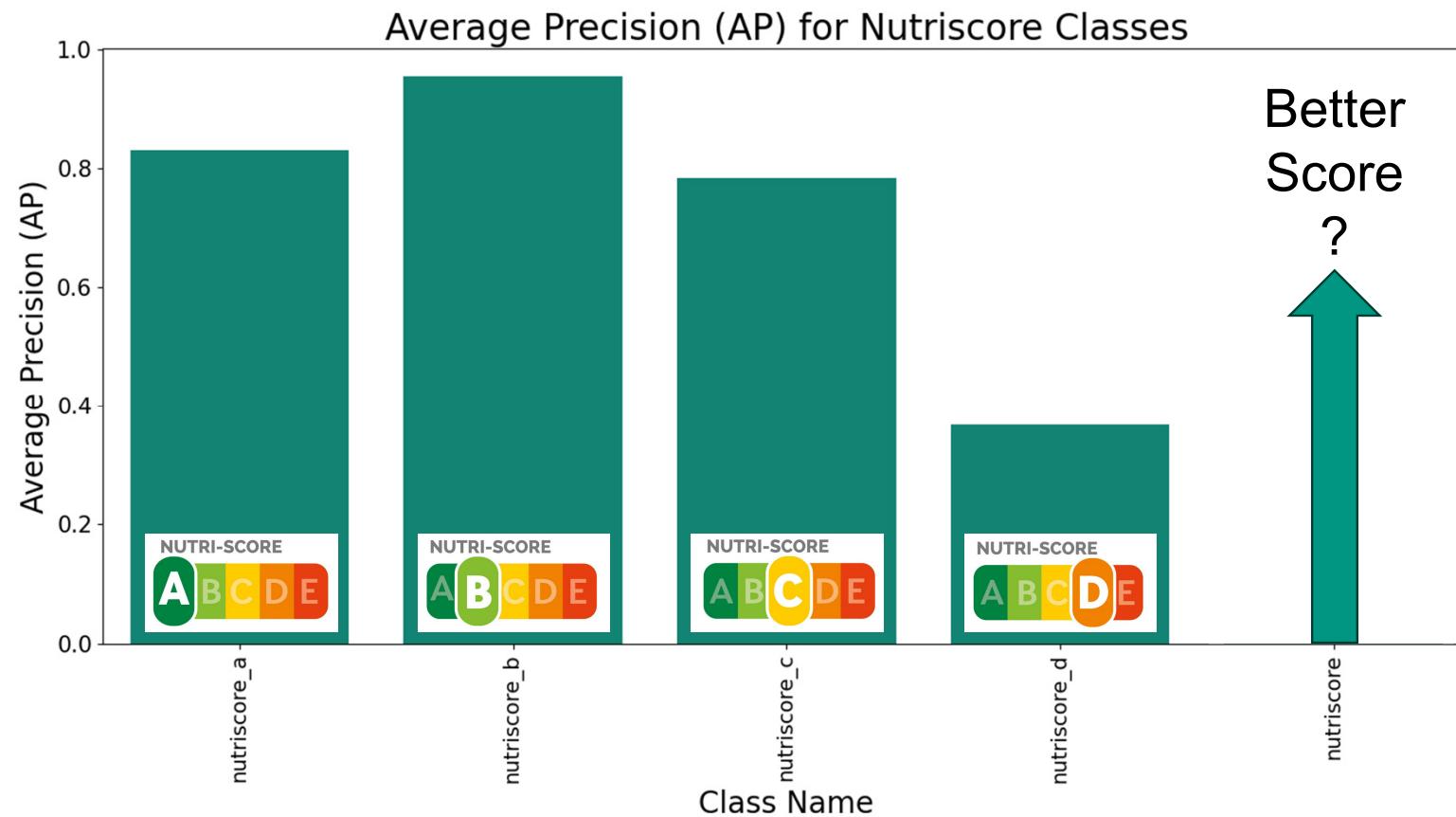
Relationship: Number of Labels & AP Score



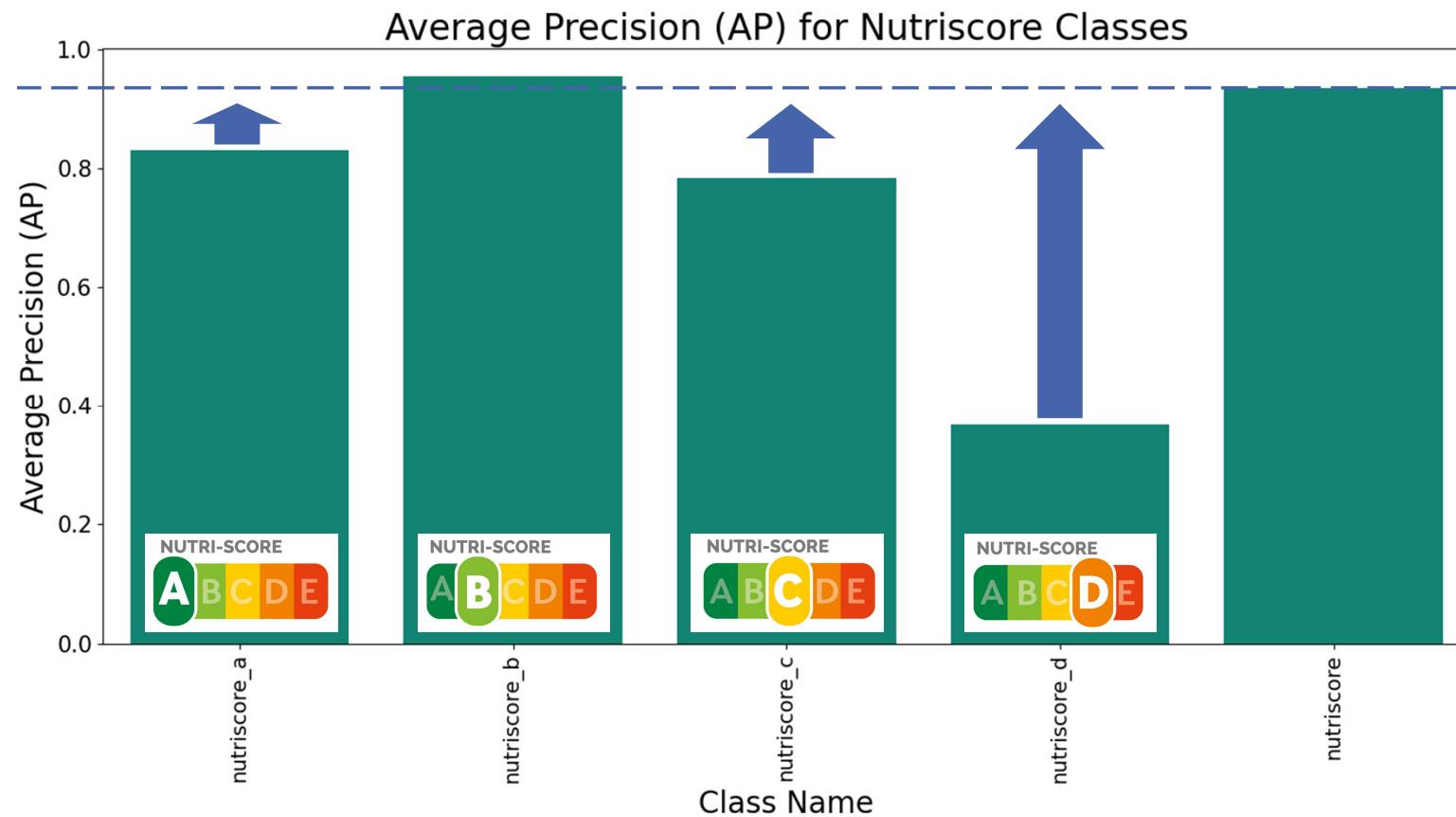
Improving Poor Performing Classes



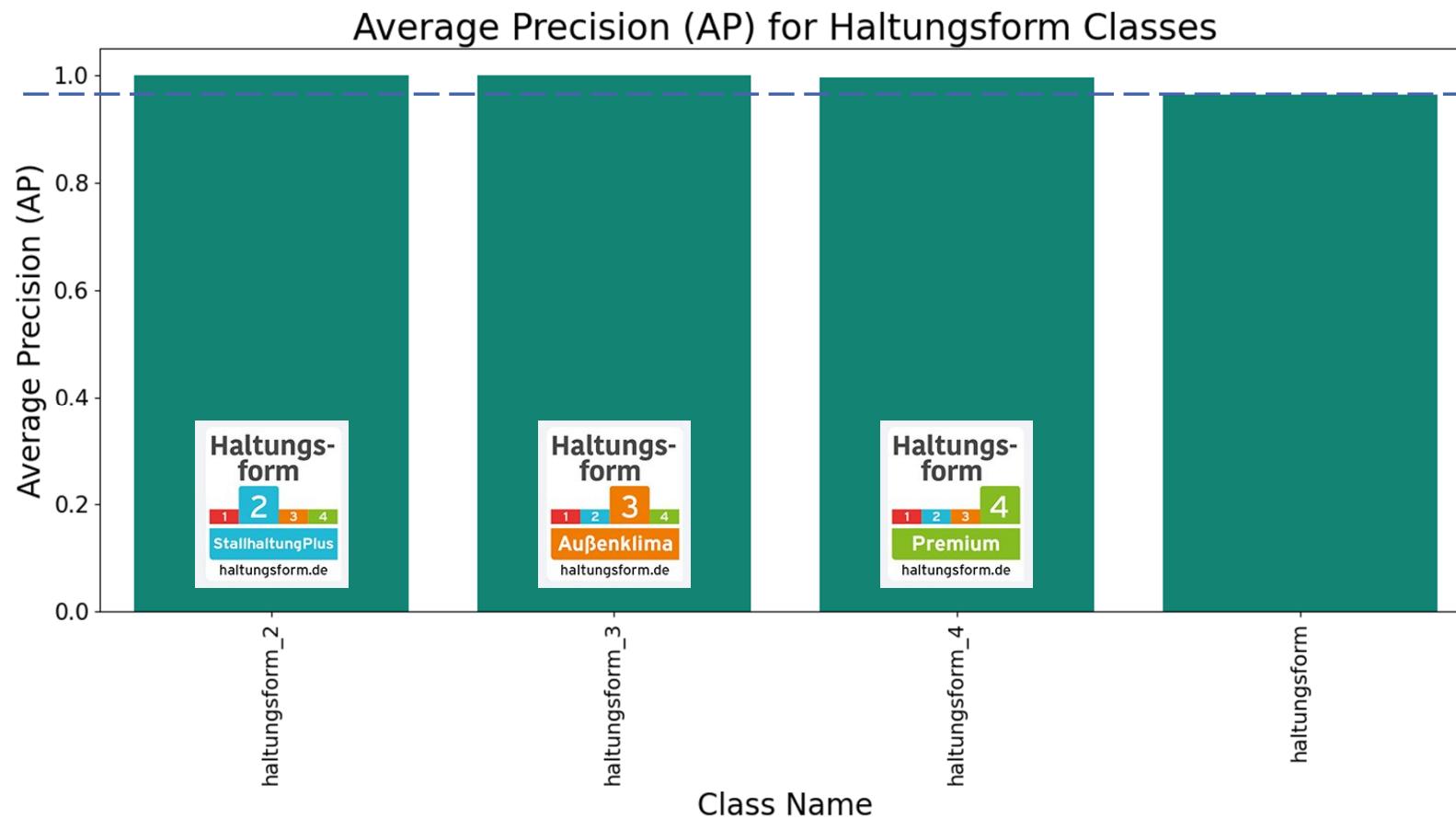
Improving Poor Performing Classes



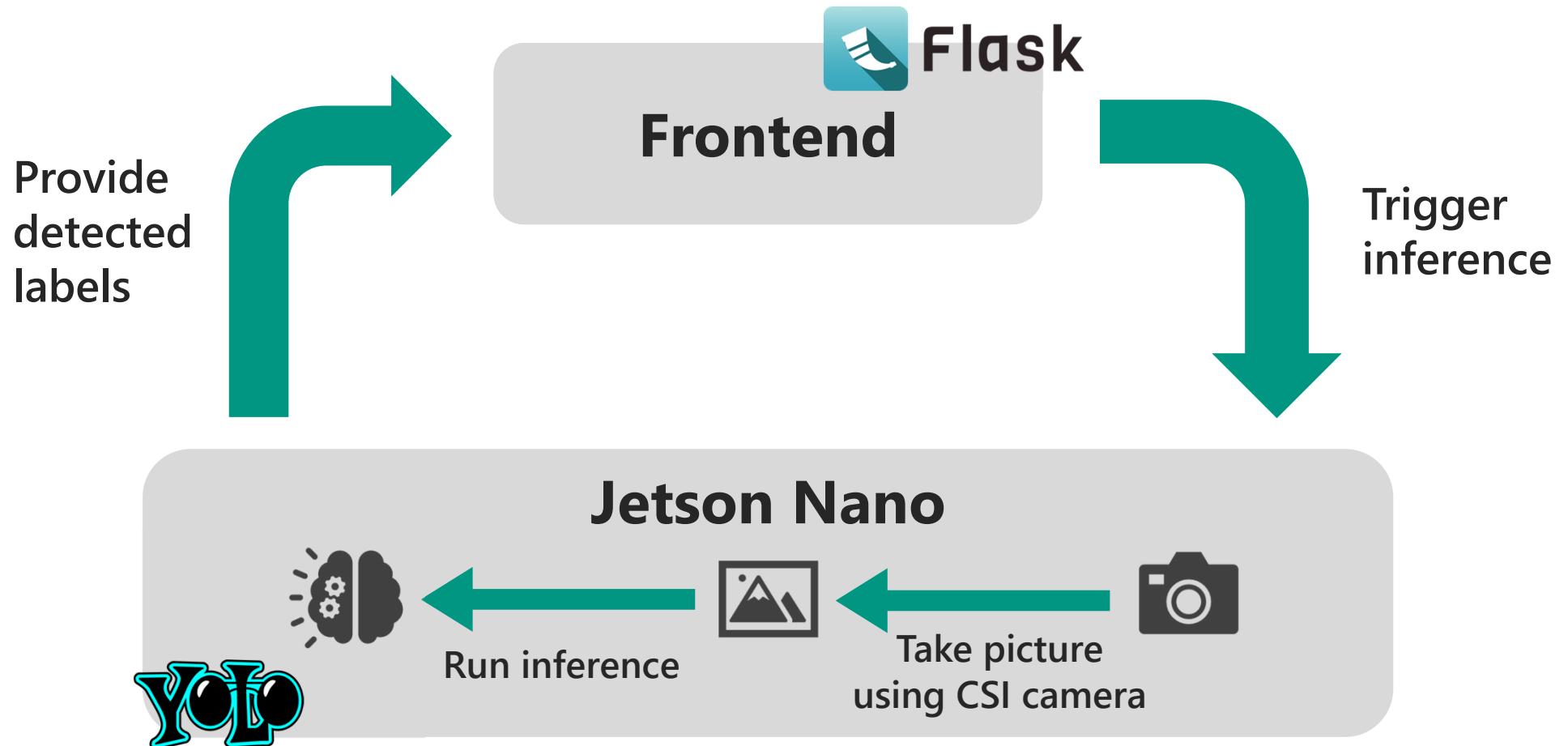
Improving Poor Performing Classes



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

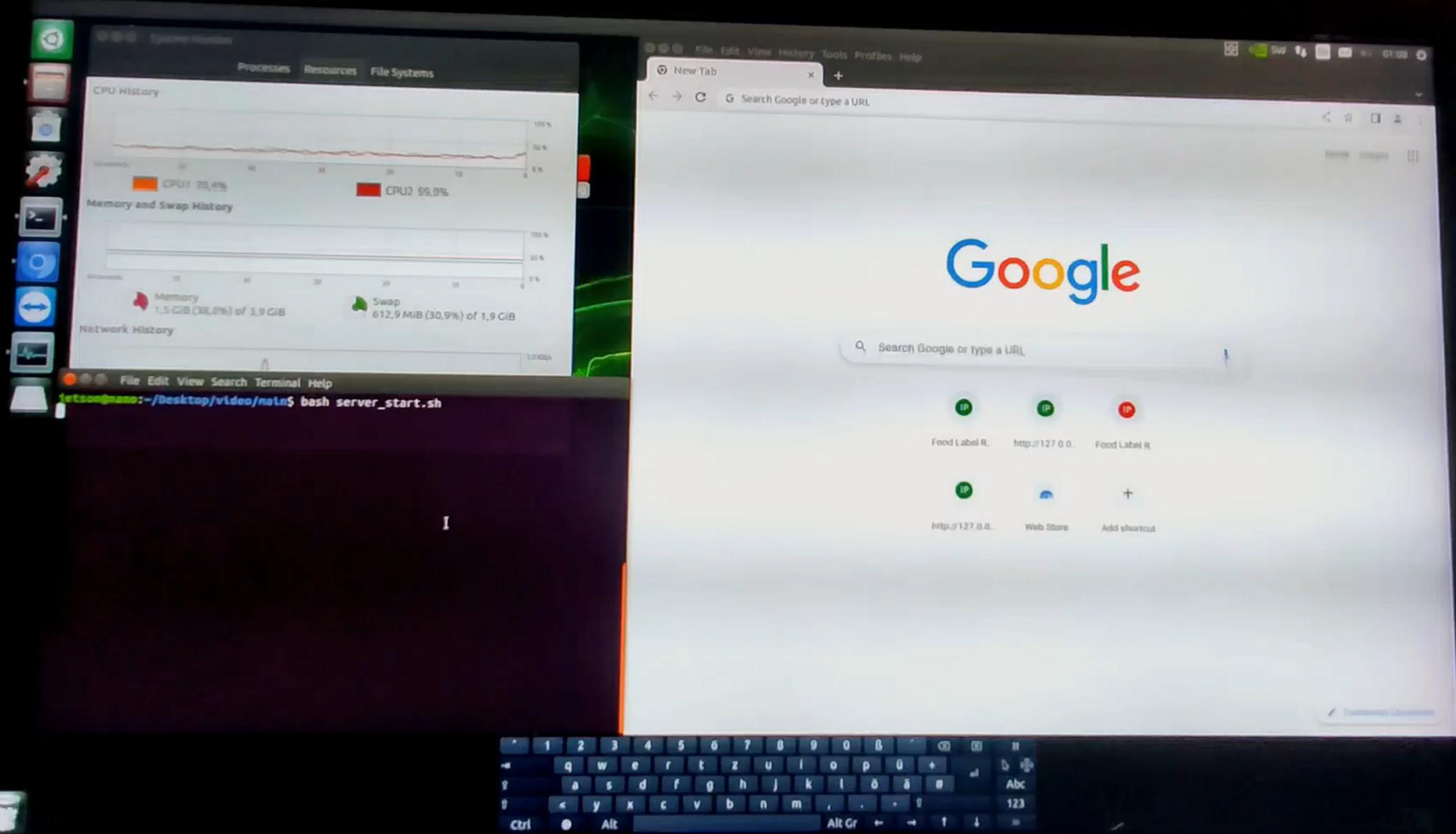
- Train Darknet on GPU, run inference on Jetson Nano



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.

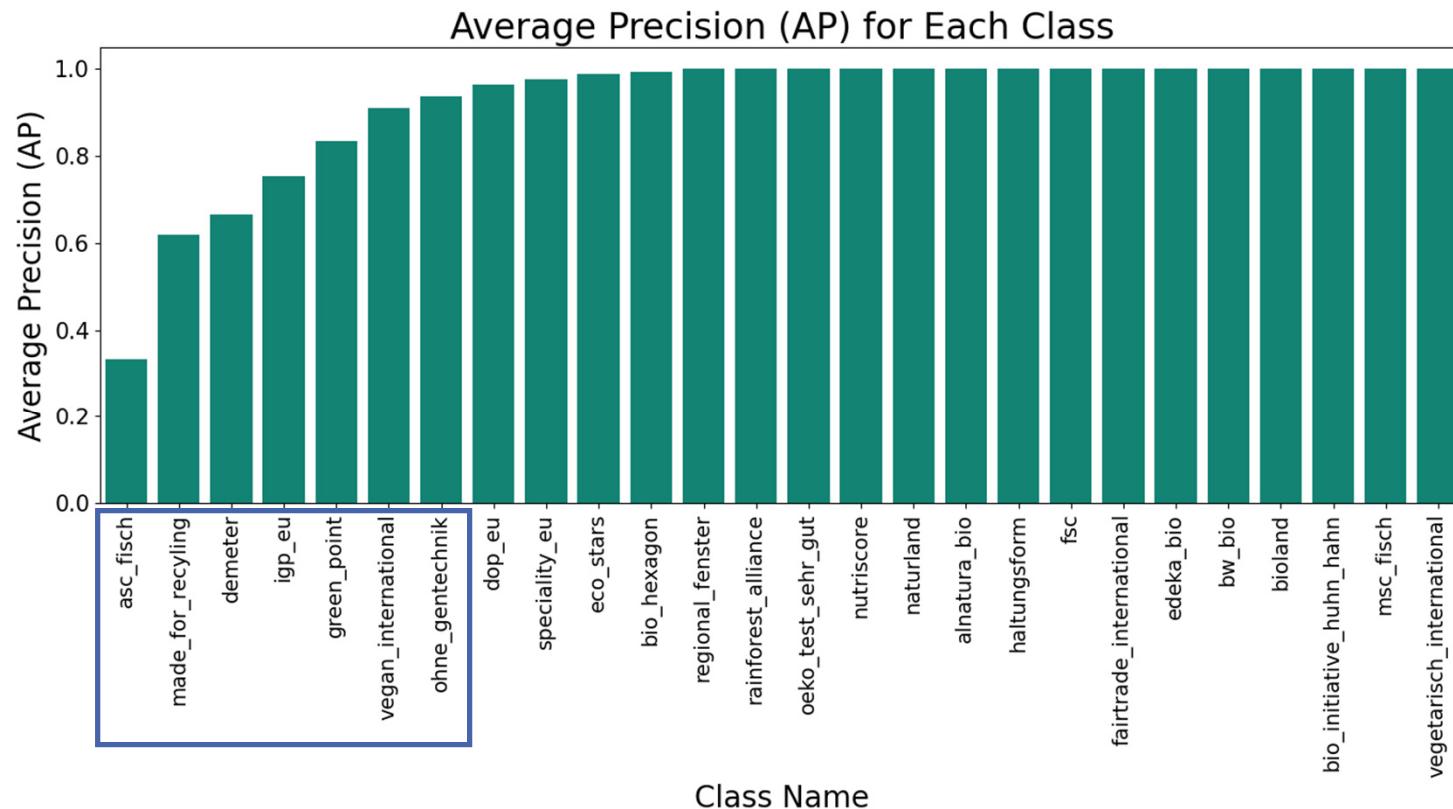
 **Nutri-Score**

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

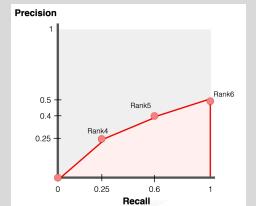
Our Model Achieves A High Average Precision



AP per class:

Calculate Precision and Recall based on IoU for different confidence thresholds

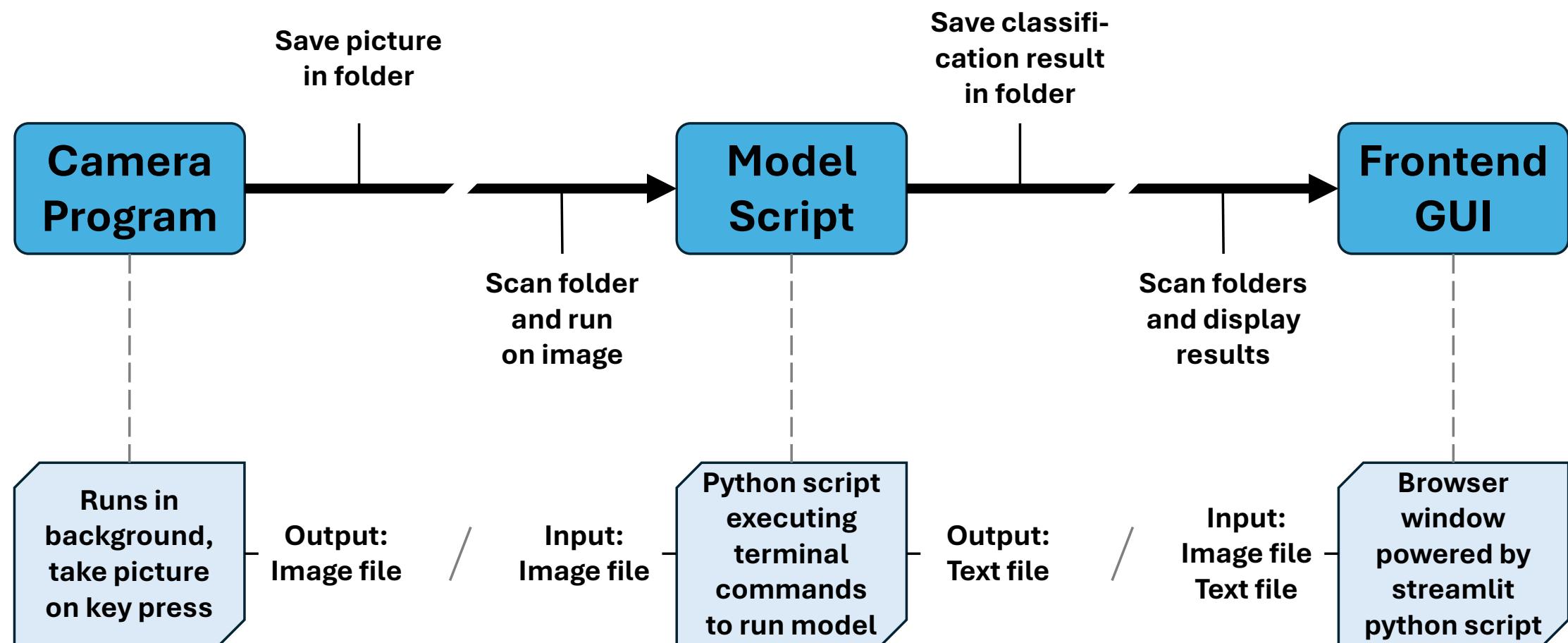
Plot Precision-Recall Curve:



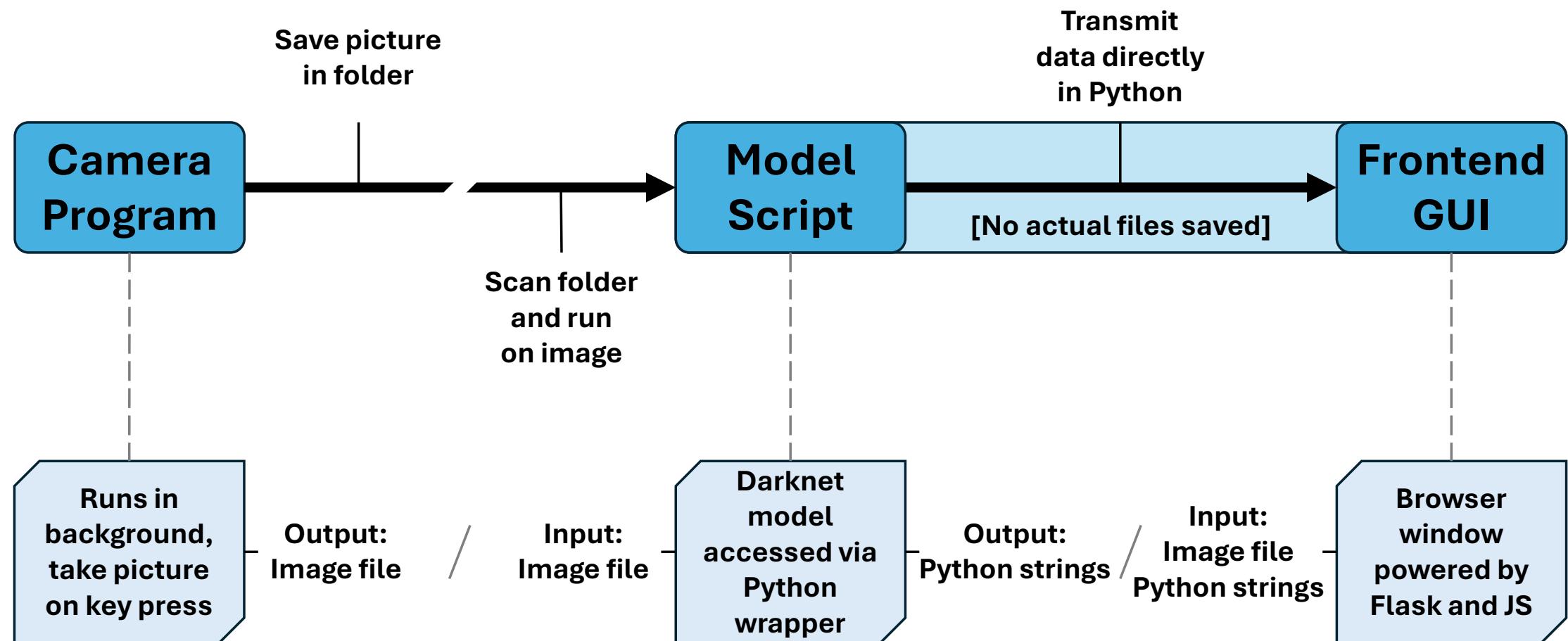
AP=Area under Curve

AP considers the precision-recall trade-off

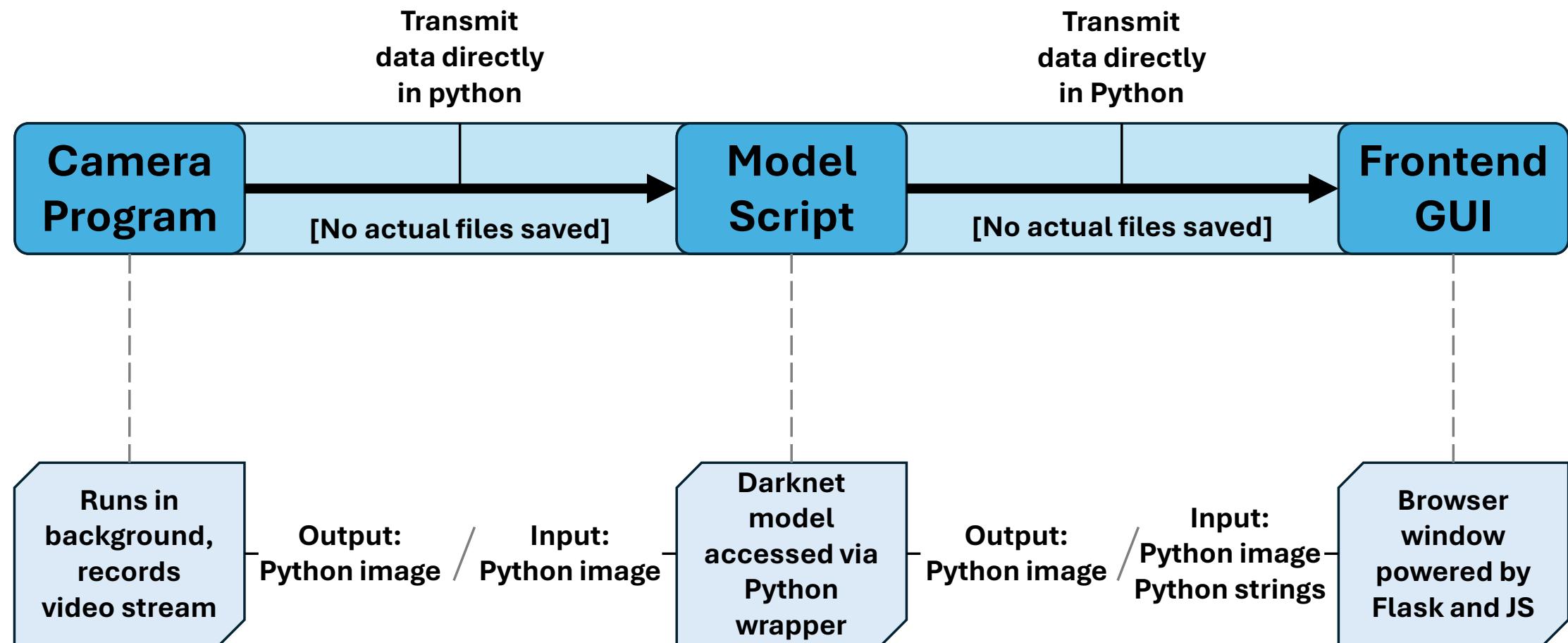
Program Flow – 1st Version with Streamlit



Program Flow – 2nd Version: Flask Images



Program Flow – 3rd 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.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)



miro



bw Sync & Share

Model Overview – ML Task

Multiple objects per image

Multiple bounding boxes

