Karlsruhe Institute of Technology

AISS CV – Group 6 – Food Label Recognition

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IISM

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FAIRTRADE
V-LABEL INTERNATIONAL
VEGETARIAN
Regional
Wo kommt es her?
Wo wurde es verarbeitet?
Wie hoch ist der regionale Anteil?
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Gesamturteil
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GARANTIERT TRADITIONELLE SPEZIALITÄT
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BLAUER ENGEL
DAS UMWELTZEICHEN
INDICACIÓN GEOGRÁFICA PROTEGIDA
Ohne Gentechnik
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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

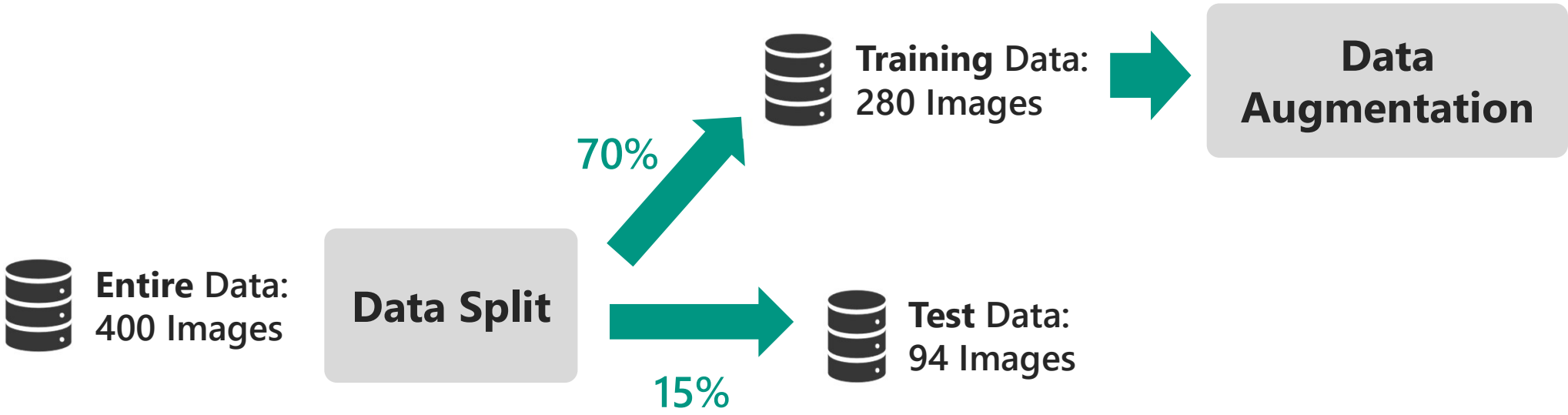
Example Image of Label with Bounding Box	Class Name		Position in classes.txt
	bio_hexagon		0
	eco_stars		1

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: ]	[felix 2]

+ Best Practice Labeling Rules

Data Split and Augmentation



Data Augmentation Operations

Original

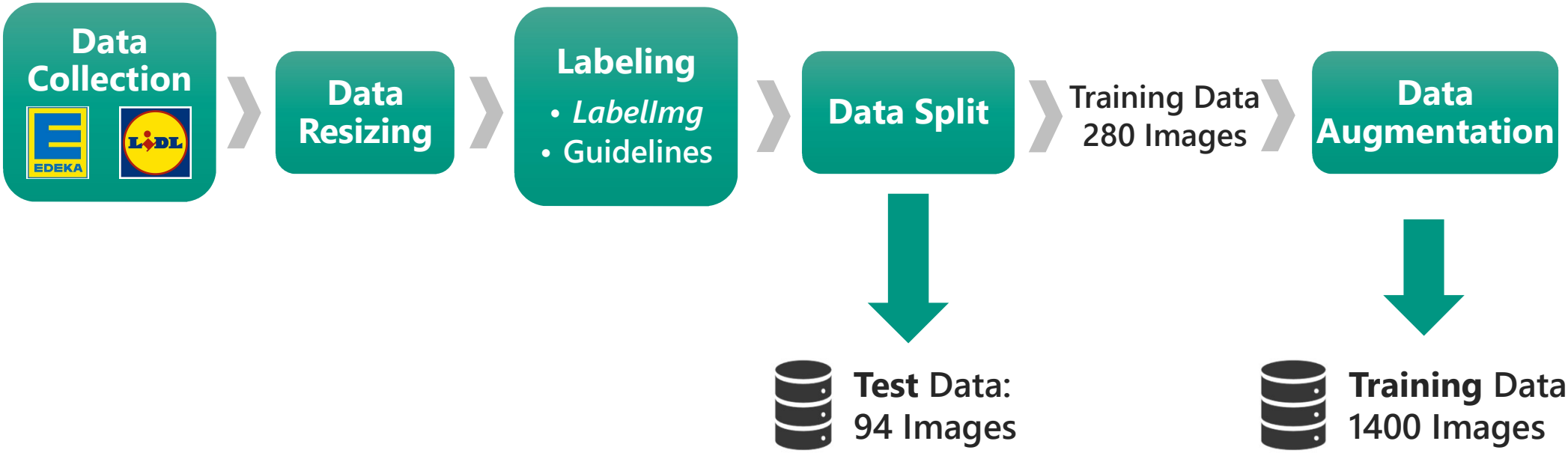
Safe Rotate & Color Jitter

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

Training & Using Darknet

Train on separate GPU for acceleration

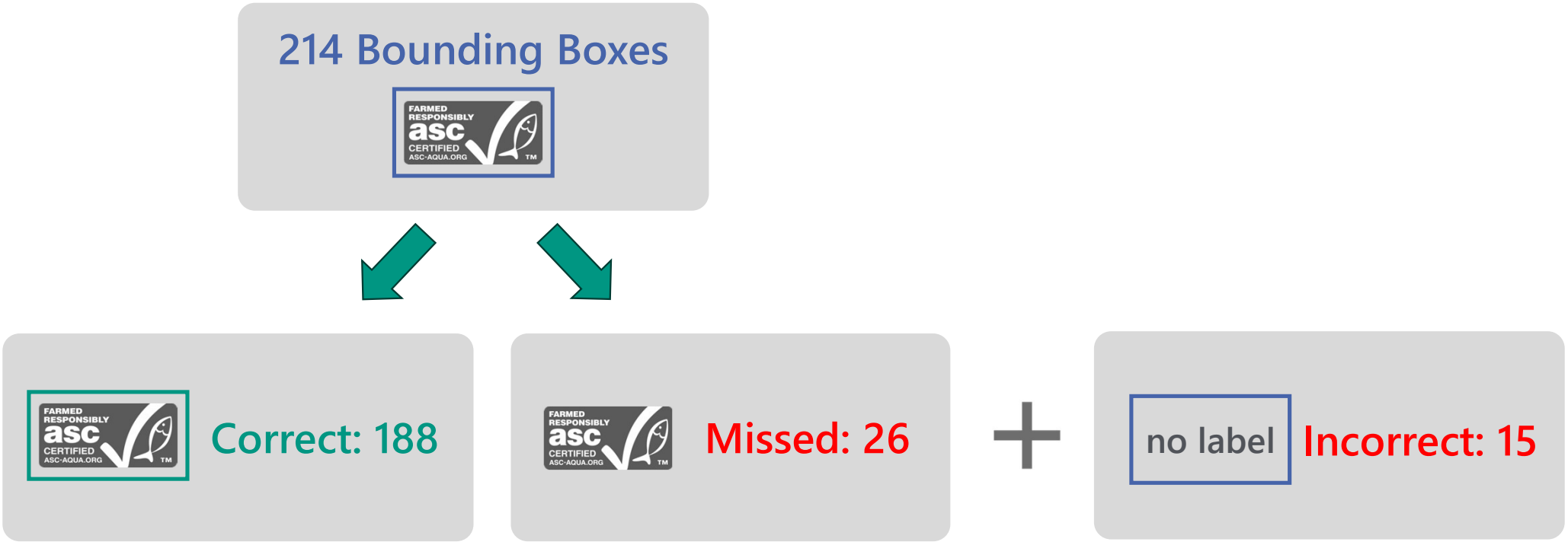
1771 train images

NVIDIA RTX 4090 GPU

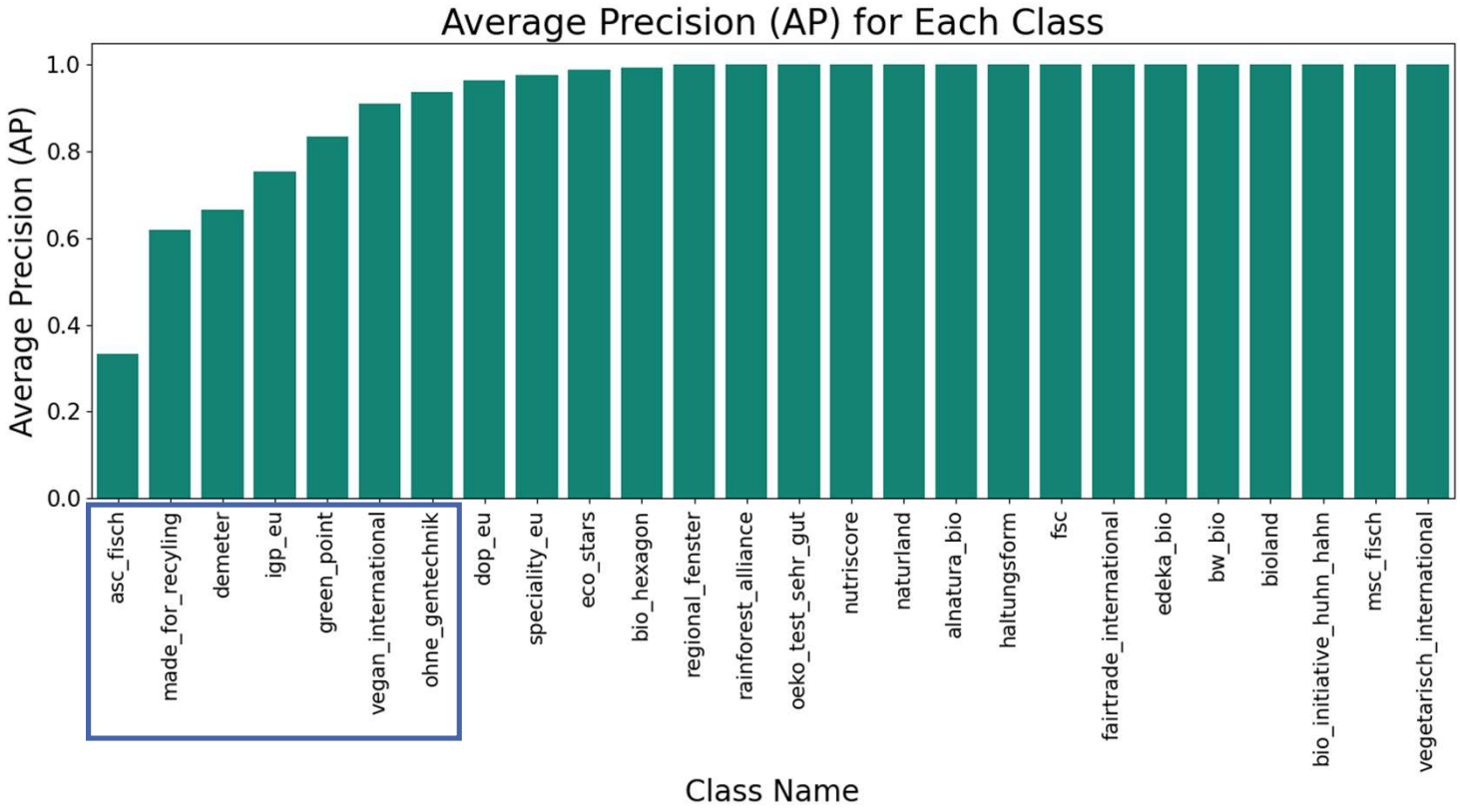
Deploy and Use on Jetson Nano

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

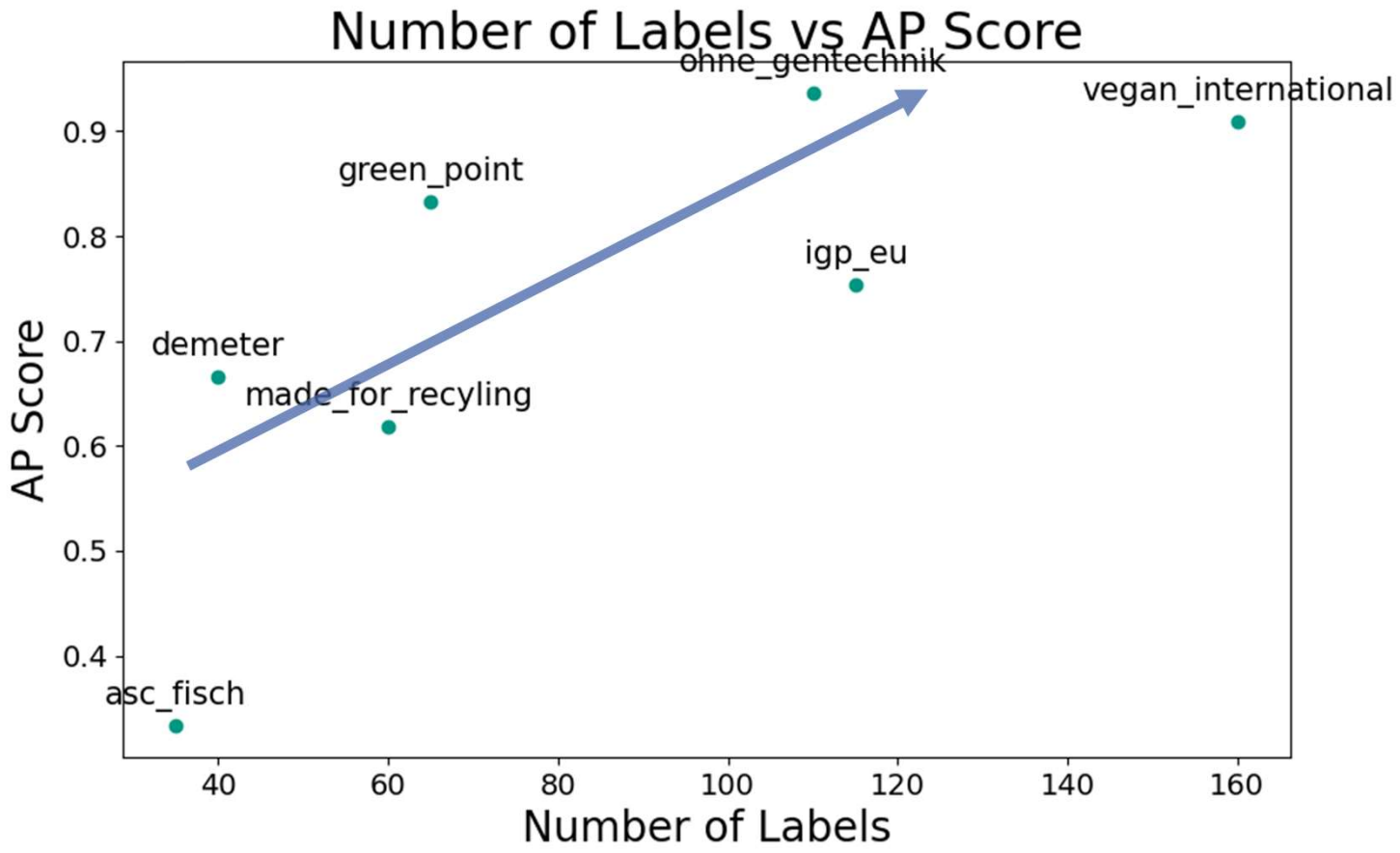
Good Quality of Model Predictions



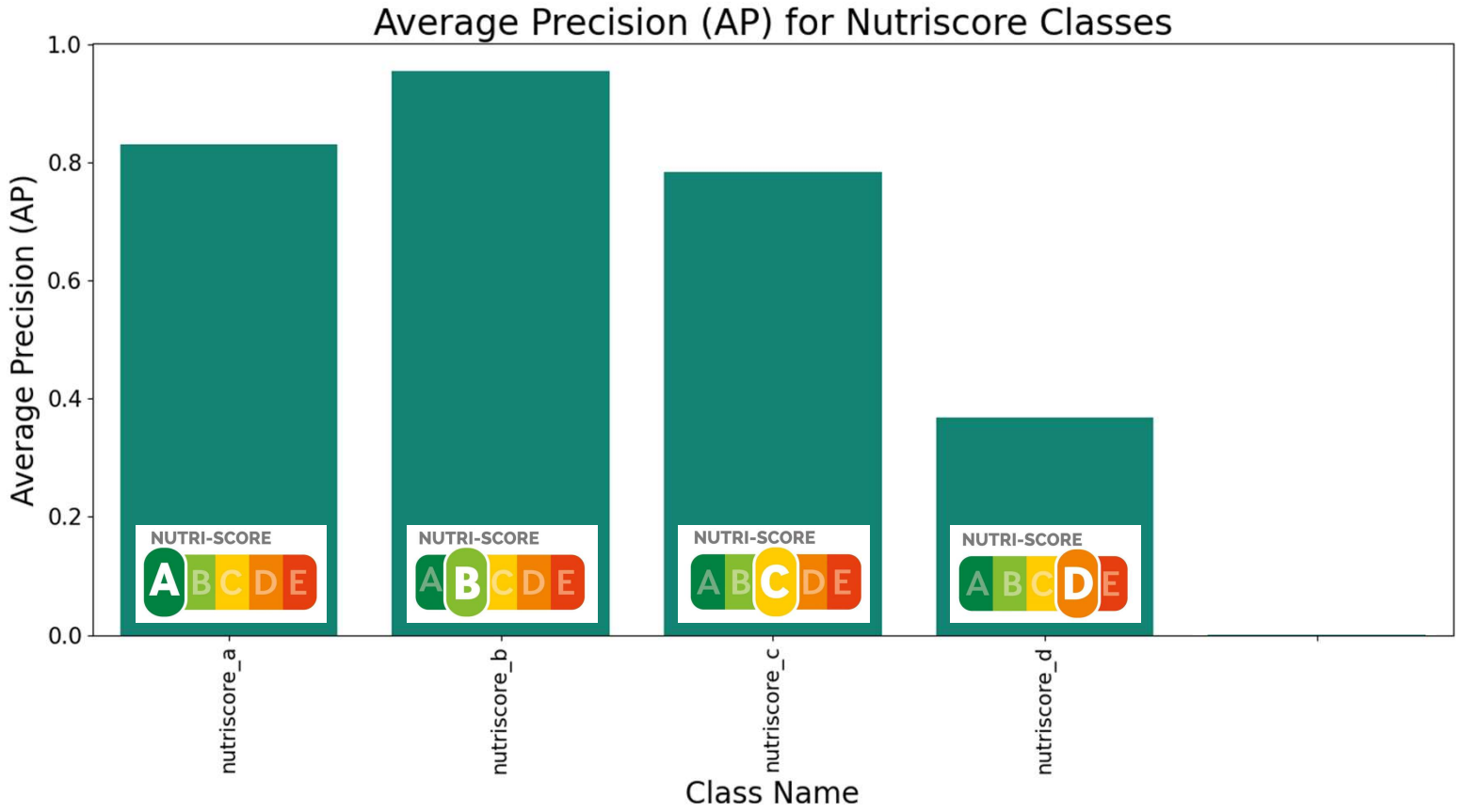
Our Model Achieves A High Average Precision



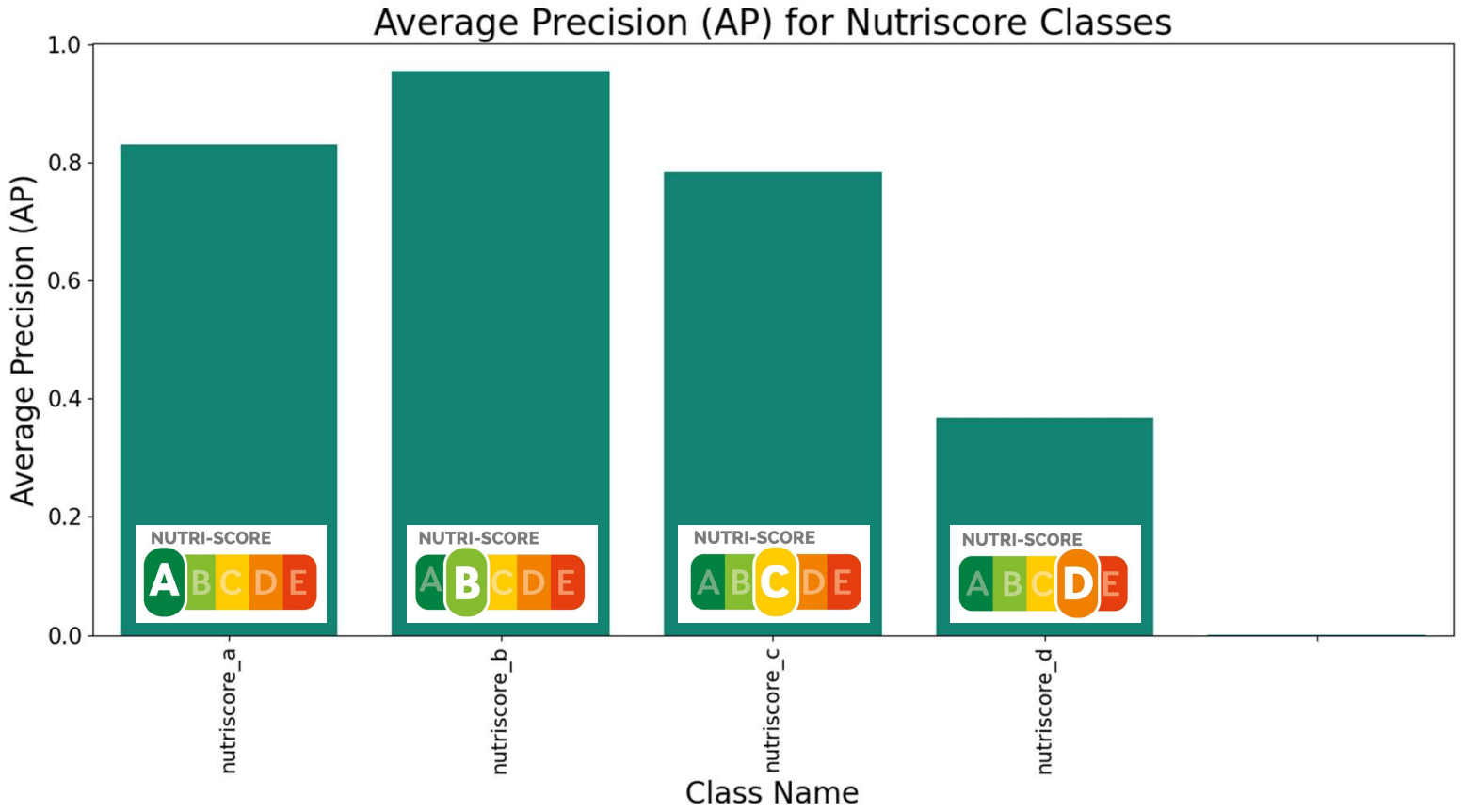
Relationship: Number of Labels & AP Score



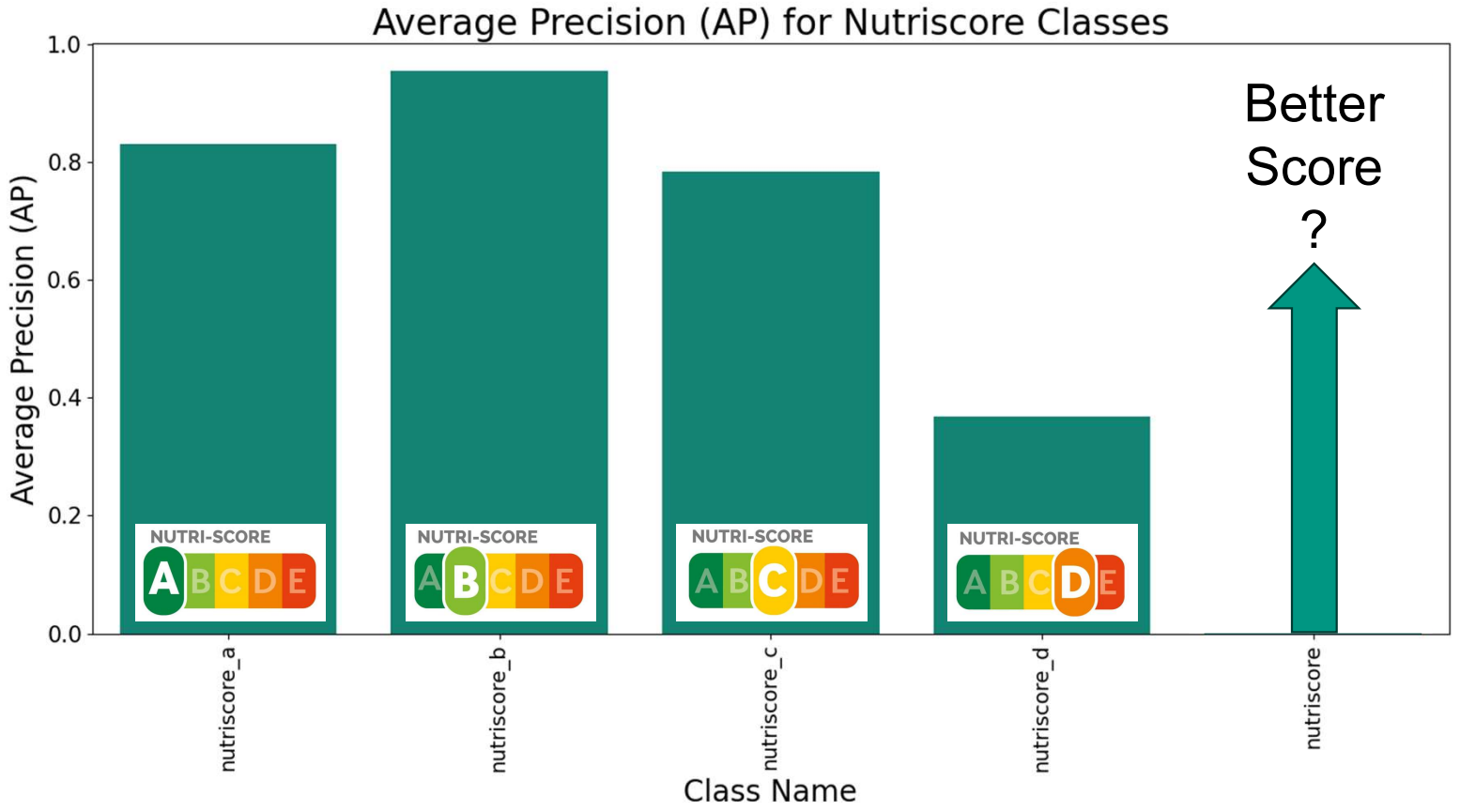
Improving Poor Performing Classes



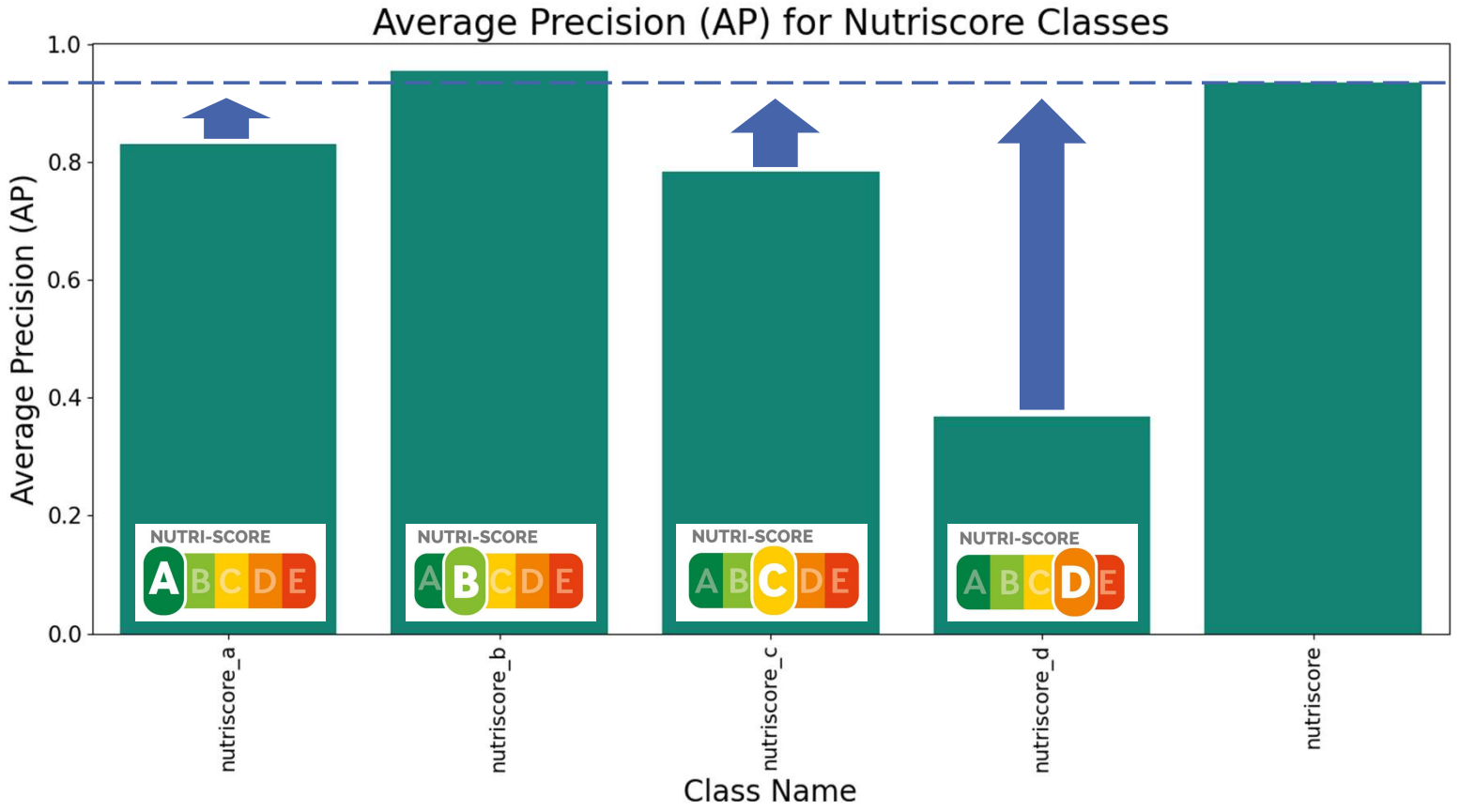
Improving Poor Performing Classes



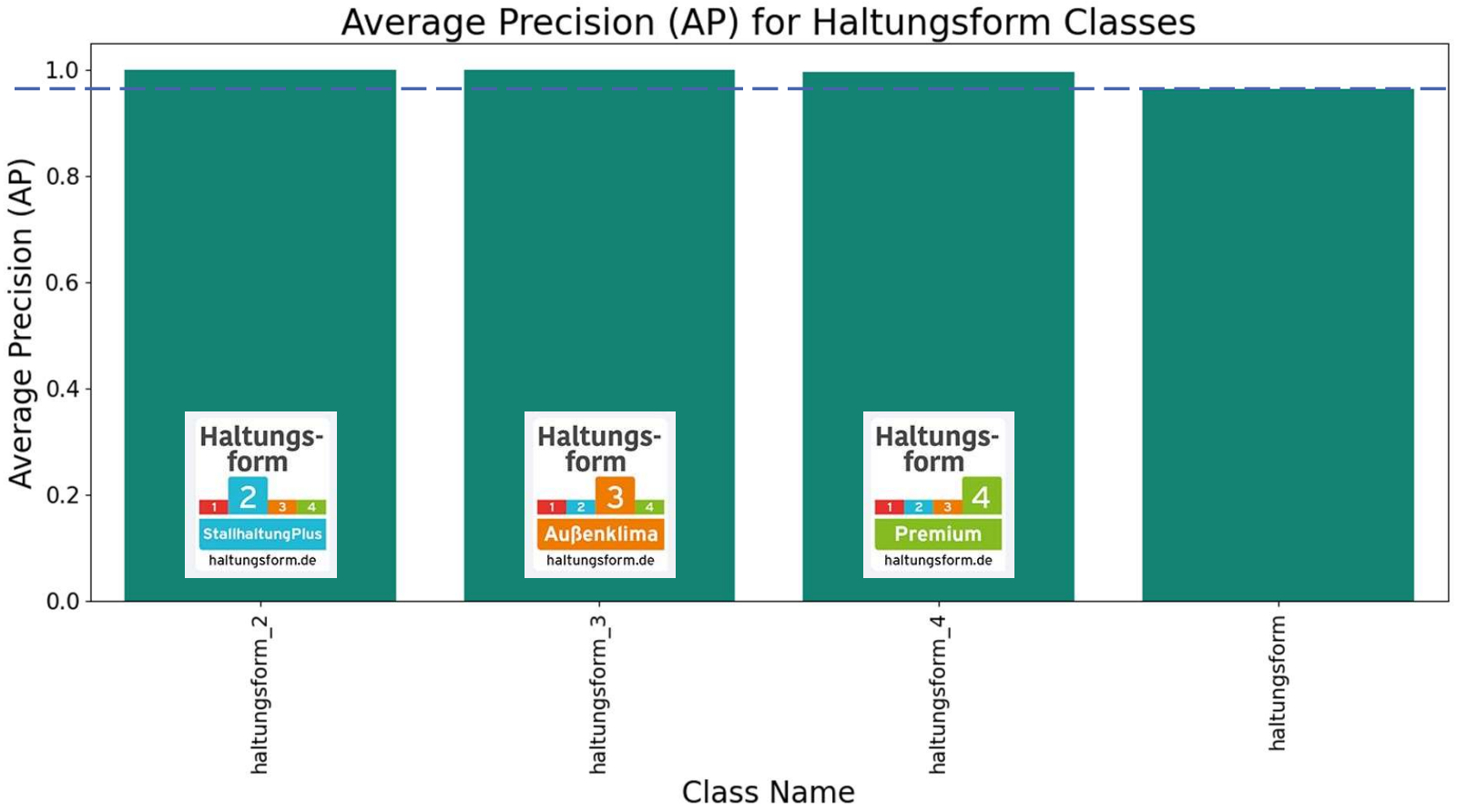
Improving Poor Performing Classes



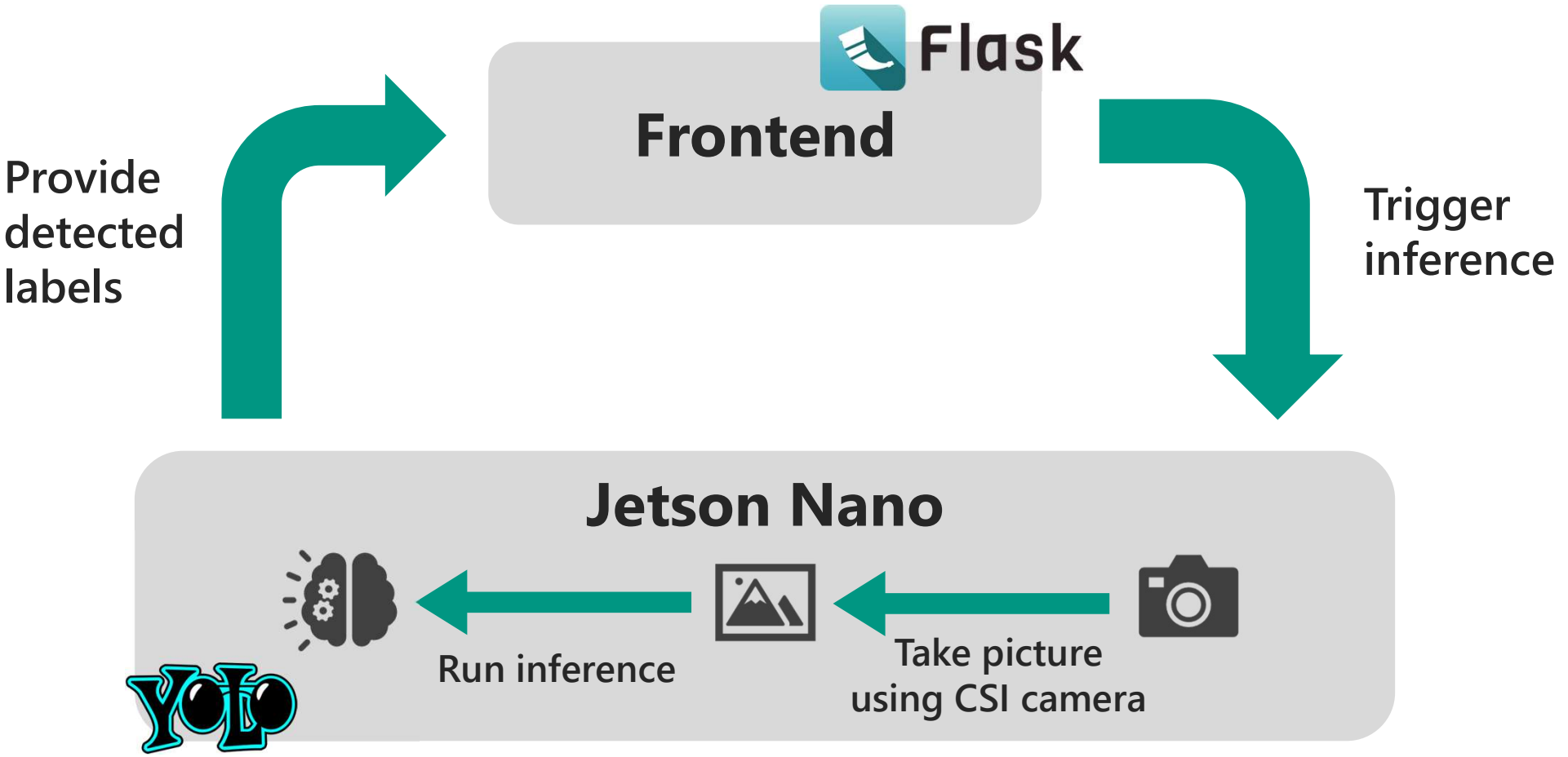
Improving Poor Performing Classes



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

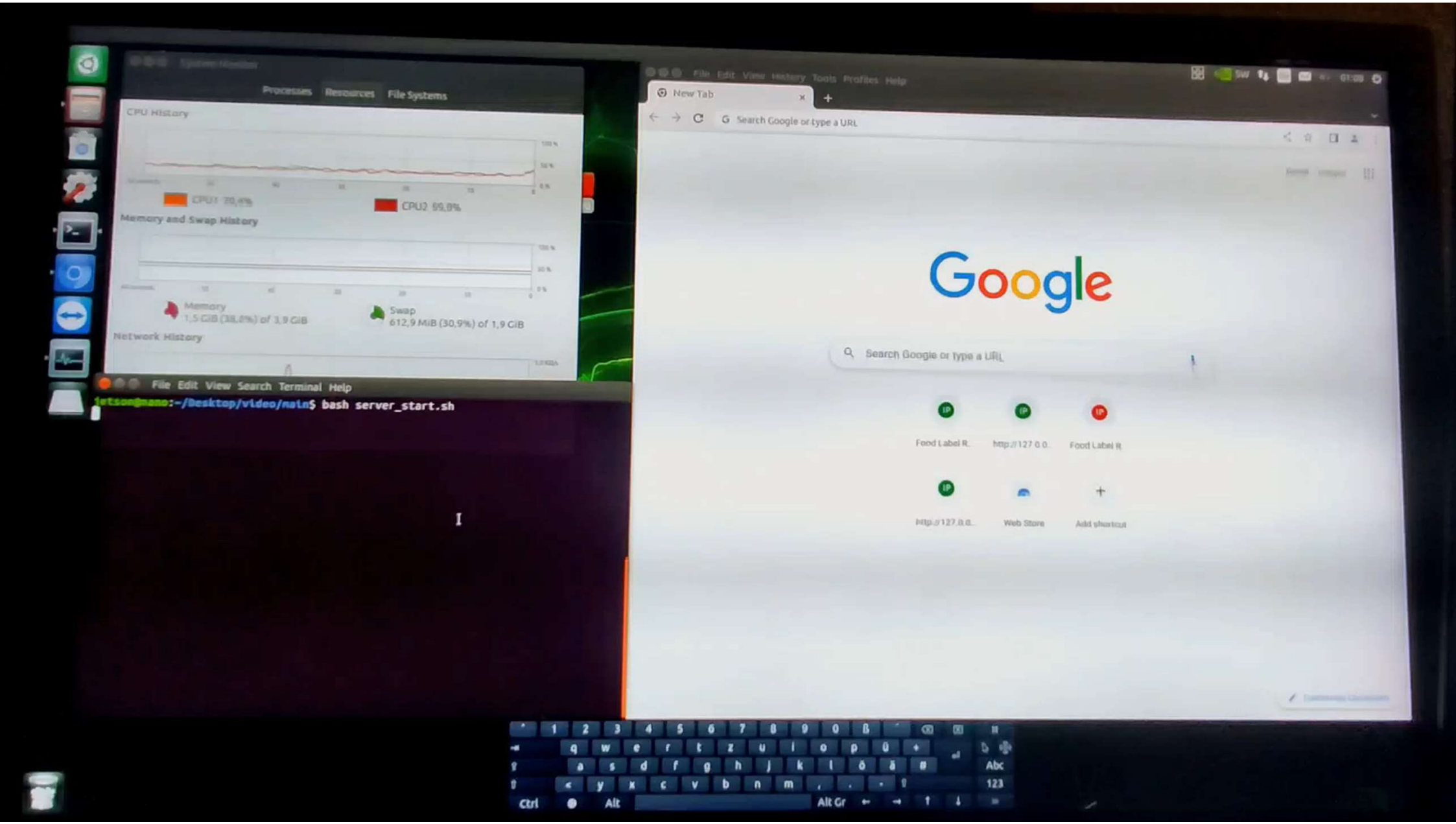
Training & Inference

- 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


Processes
Resources
File Systems
CPU History
CPU1 20,4%
CPU2 99,8%
Memory and Swap History
Memory
1,5 GiB (38,8%) of 3,9 GiB
Swap
612,9 MiB (30,9%) of 1,9 GiB
Network History
File Edit View Search Terminal Help
jetson@nano:~/Desktop/video/main$ bash server_start.sh
New Tab
Search Google or type a URL
Google
Search Google or type a URL
Food Label R...
http://127.0.0...
Food Label R
http://127.0.0...
Web Store
Add shortcut
Ctrl
Alt
Alt Gr
Abc
123

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.

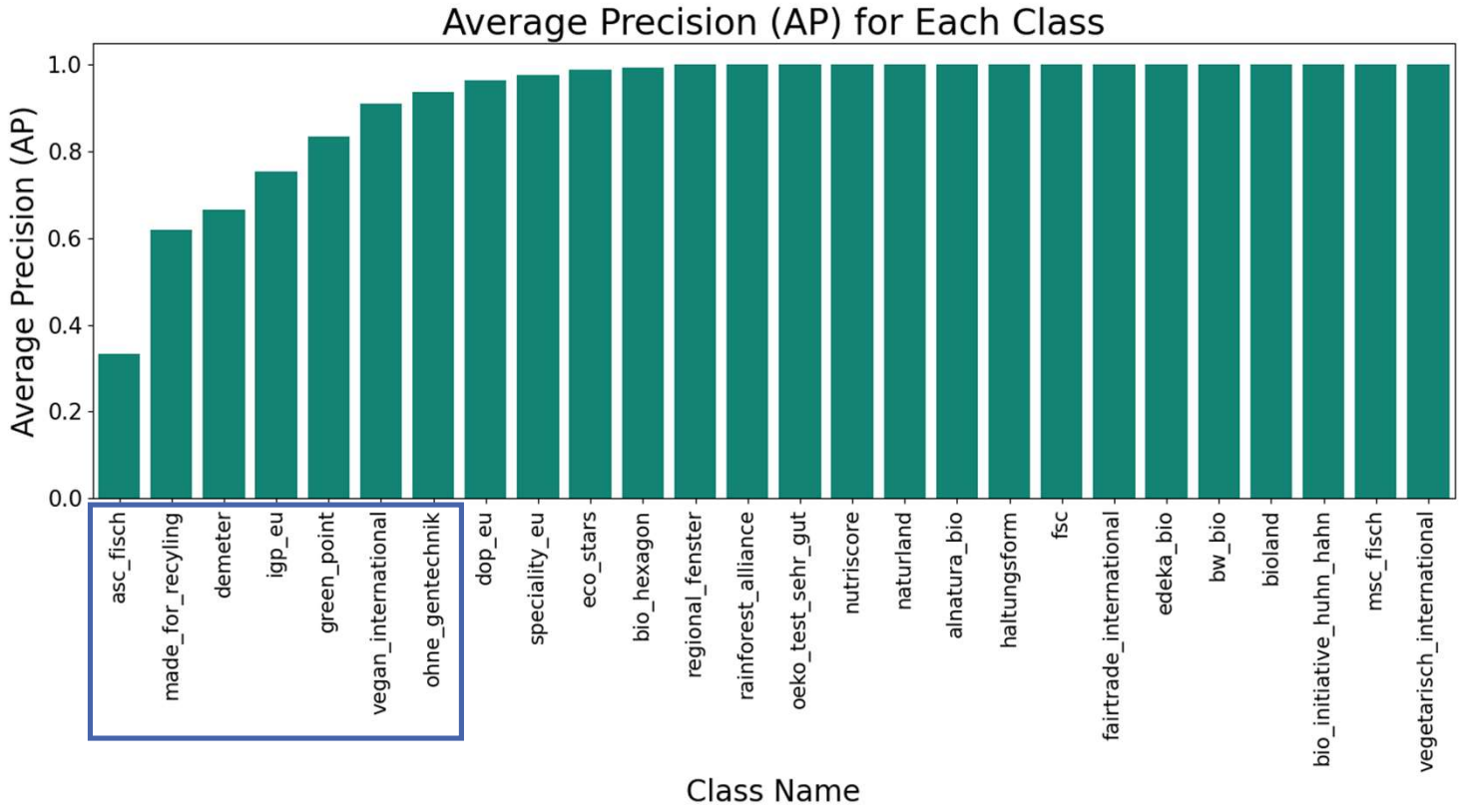
Nutri-Score

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

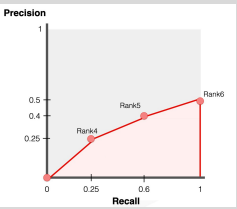
Our Model Achieves A High Average Precision



AP per class:

Calculate Precision and Recall based on IoU for different confidence thresholds

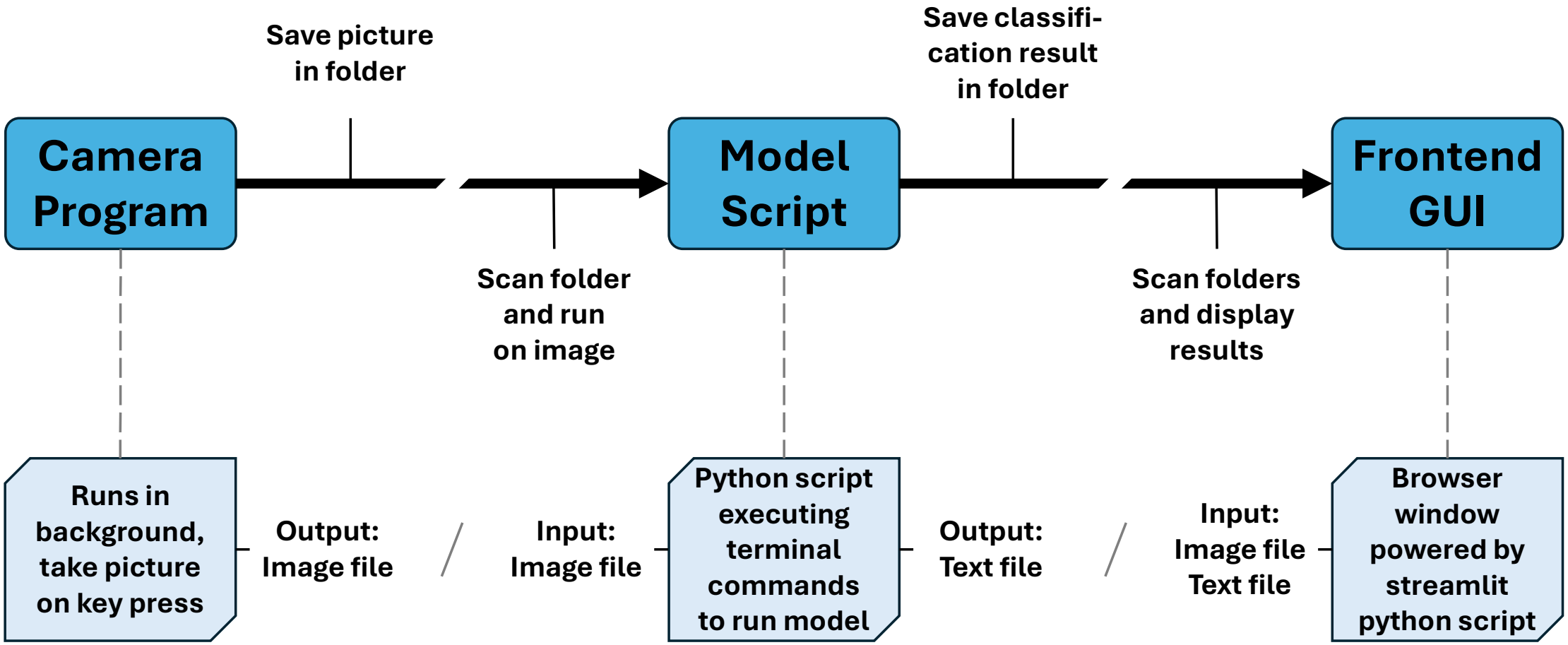
Plot Precision-Recall Curve:



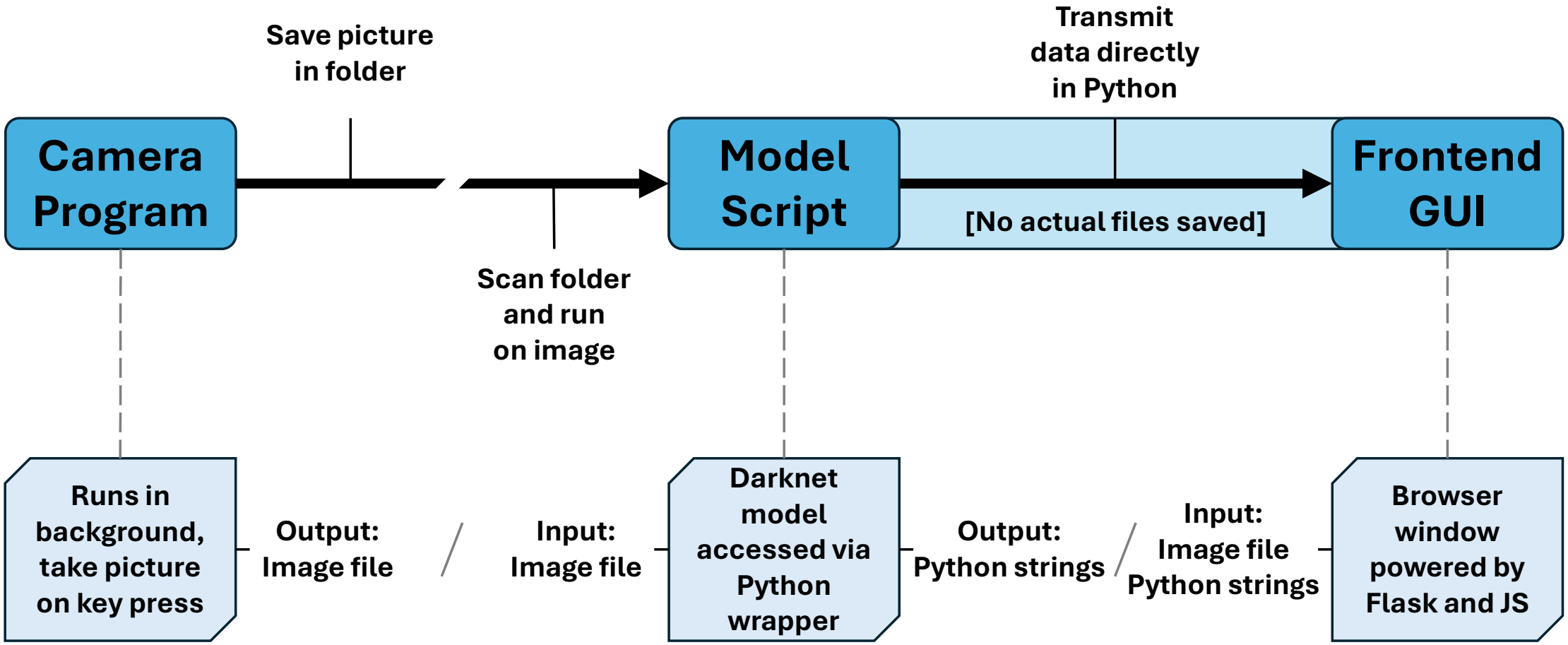
AP=Area under Curve

AP considers the precision-recall trade-off

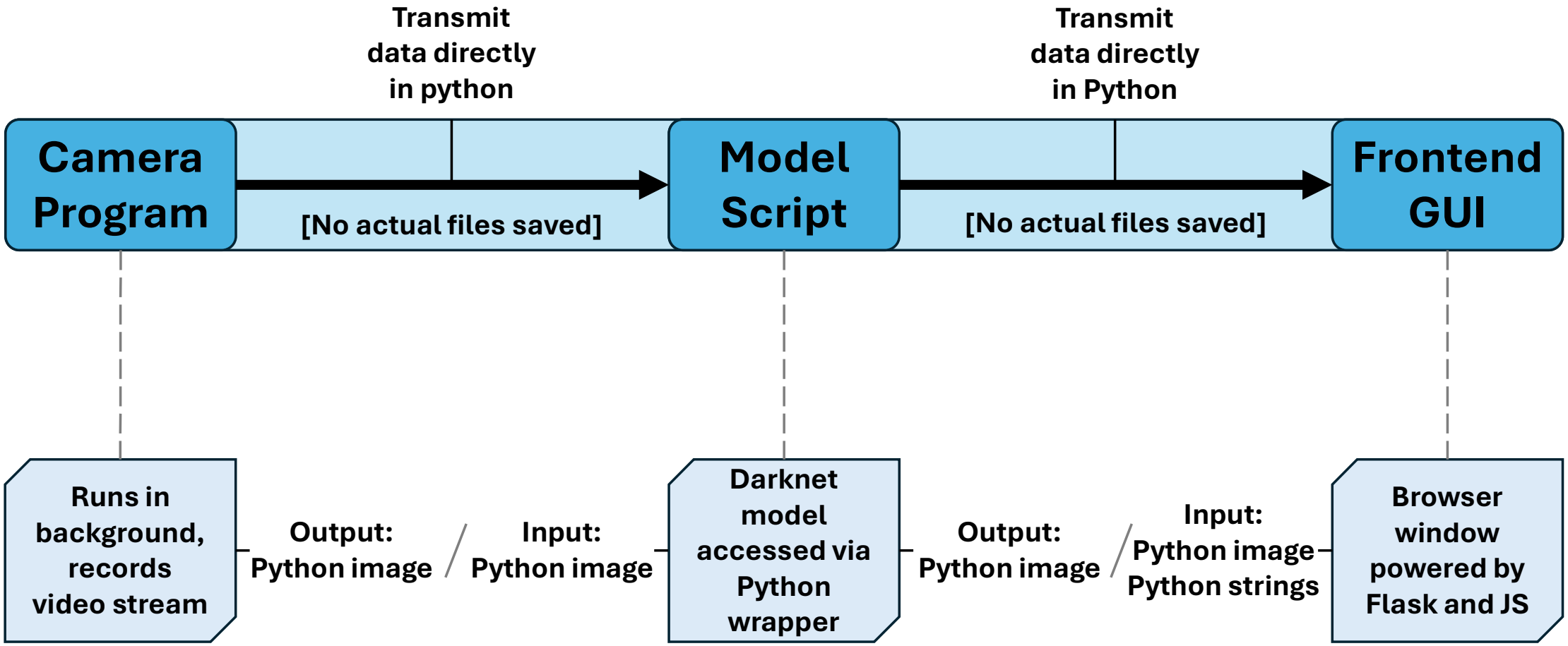
Program Flow – 1st Version with Streamlit



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)

Model Overview – ML Task

Multiple objects per image

Multiple bounding boxes