Lab4: Object detection (YOLO)

3099704 AI for Digital Health (2025/2)

Outline

- **Objective**
- **Material:** Google Colab, Ultralytics HUB, Ultralytics Libraries

- **Lab4.1: YOLOv8n (Ultralytics Hub)**
- Dataset: kvasir dataset (2017)
- Model: YOLOv8 (Ultralytics ,2023)
- Lab4.1: YOLOv8n (Ultralytics Hub) - 5 steps
- Results: Mean IoU = 0.8022

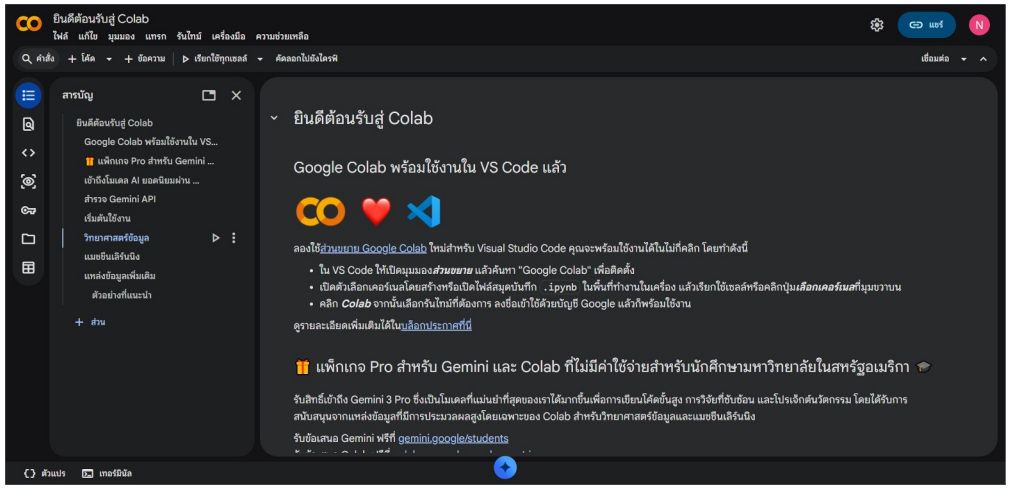
- **Lab4.2: YOLOv8s (Ultralytics)**
- Lab4.2: YOLOv8s (Ultralytics) - 4 steps
- Folder structure
- Results: Mean IoU = 0.8444
- Make it into a video!

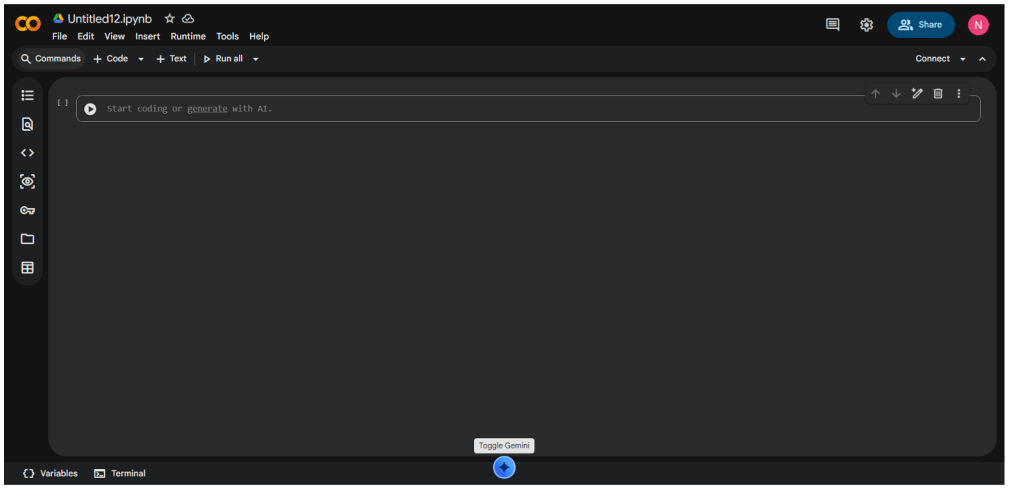
Objective

- **Create & train** object detection model from ultralytics hub and ultralytics library
- **Inference & evaluate** performent each model

Material

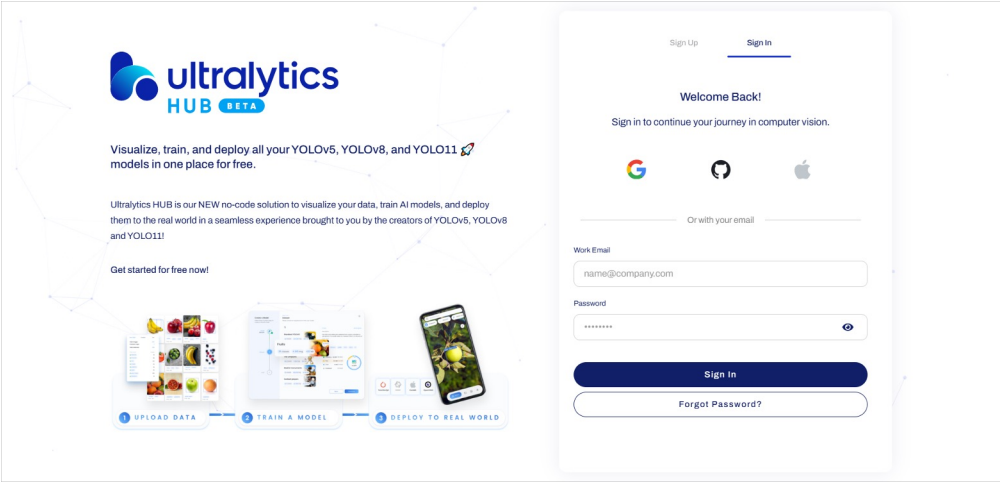
- With **Google Colab**, you don't need to install any software. All you need is a Google account, and you can start using it right away. Simply visit: https://colab.research.google.com/ or select NEW NOTEBOOK to start a new file.

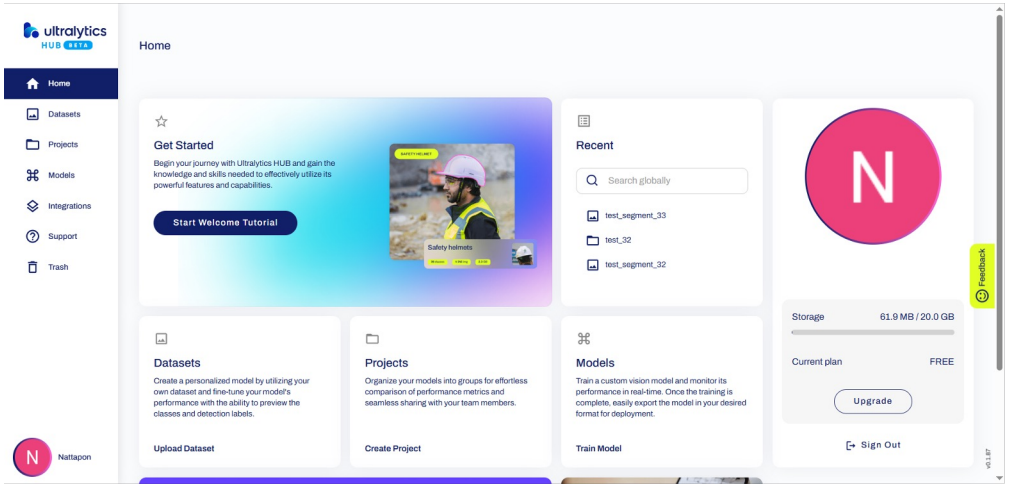




Material

- **Ultralytics HUB** is a web-based platform that can be accessed via a browser at https://hub.ultralytics.com/, enabling users to upload datasets, train YOLO models, and monitor performance without any local software installation.





Ultralytics HUB (limitation)

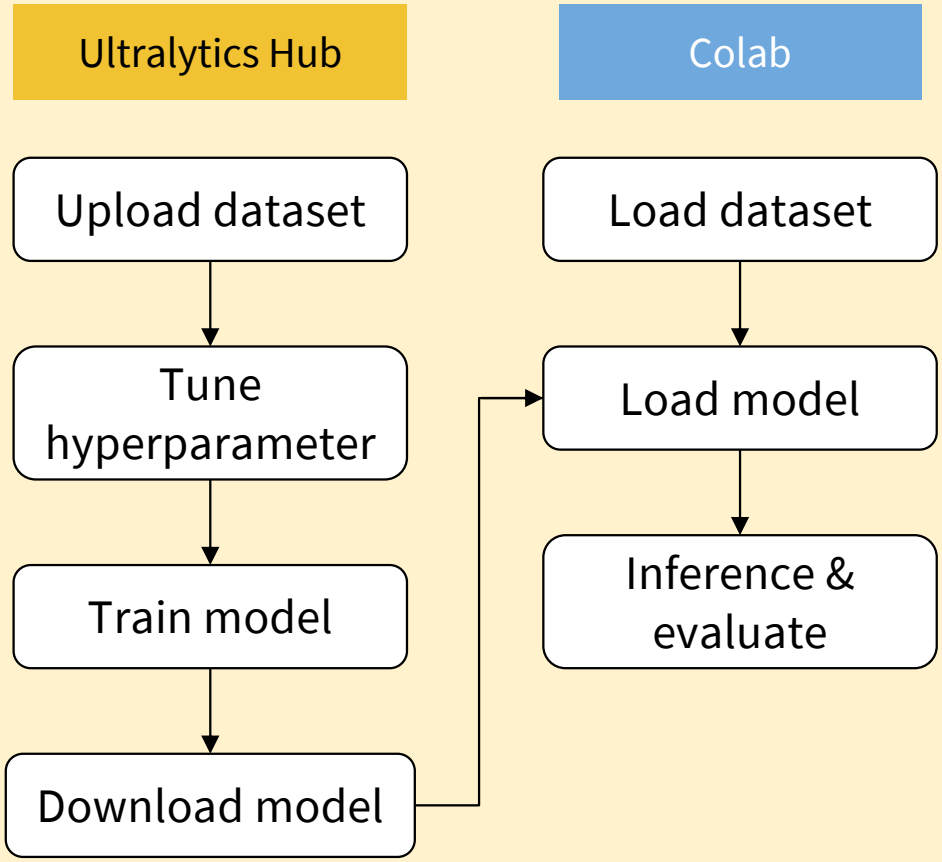
In this lab, we use the Ultralytics HUB free plan, which comes with the following limitations:
(1) **Inference API** allows up to **100 calls per hour and 1,000 calls per month**
(2) total dataset **storage** on Ultralytics HUB is limited to **20.0 GB.**

Material

- **Ultralytics is a Python library for computer vision tasks**, best known for developing and training **YOLO (You Only Look Once)** models.
- It supports common tasks such as **image classification, object detection, and image segmentation**.
- Ultralytics models can be trained and used **on a local computer or on Google Colab**.
- Install the library using **pip**

Lab4.1: YOLOv8n (Ultralytics Hub)

In this lab, you will create polyp detection model **(YOLOv8n)** using **Ultralytics HUB** and then evaluate its performance using a **Google Colab notebook.**



Dataset: kvasir dataset (2017)

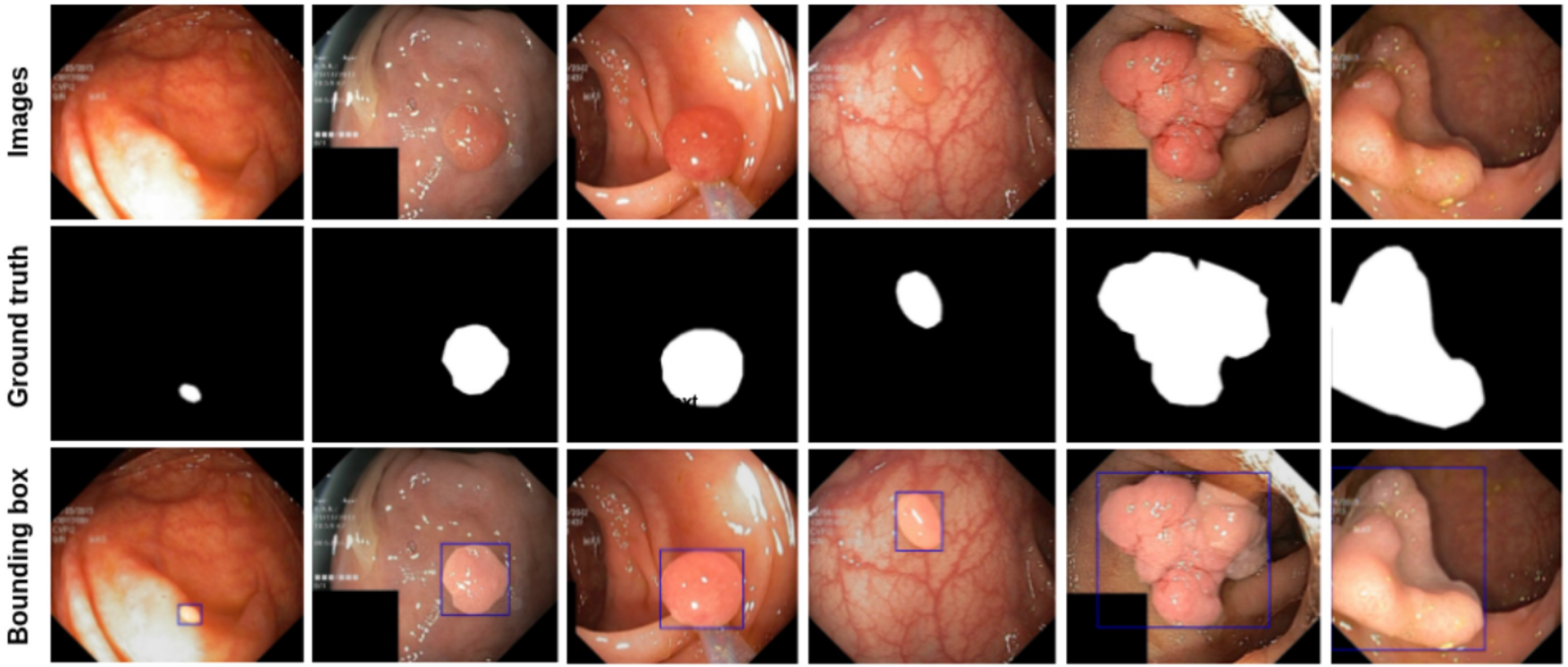
- **Kvasir dataset** consists of 4,000 images, annotated, including 8 classes showing anatomical landmarks, phatological findings or endoscopic procedures in the GI tract.

- The dataset consist of the images with different resolution from 720x576 up to 1920x1072 pixels in JPG format and documents in JSON format

- The dataset was released in 2017 by the **Simula Research Laboratory, Norway.**

- To simplify the experiment, we selected only **500 images** containing polyps and prepared the dataset in a format compatible with YOLO training.

Dataset: kvasir dataset (2017)



The figure shows the example images, bounding box, and mask from Kvasir-SEG. The white mask shows the area covered by the polyp region, and the background regions contain non-polyp tissue pixels.

Model: YOLOv8 (Ultralytics ,2023)

- YOLOv8 was released by Ultralytics on January 10, 2023, offering cutting-edge performance in terms of accuracy and speed.

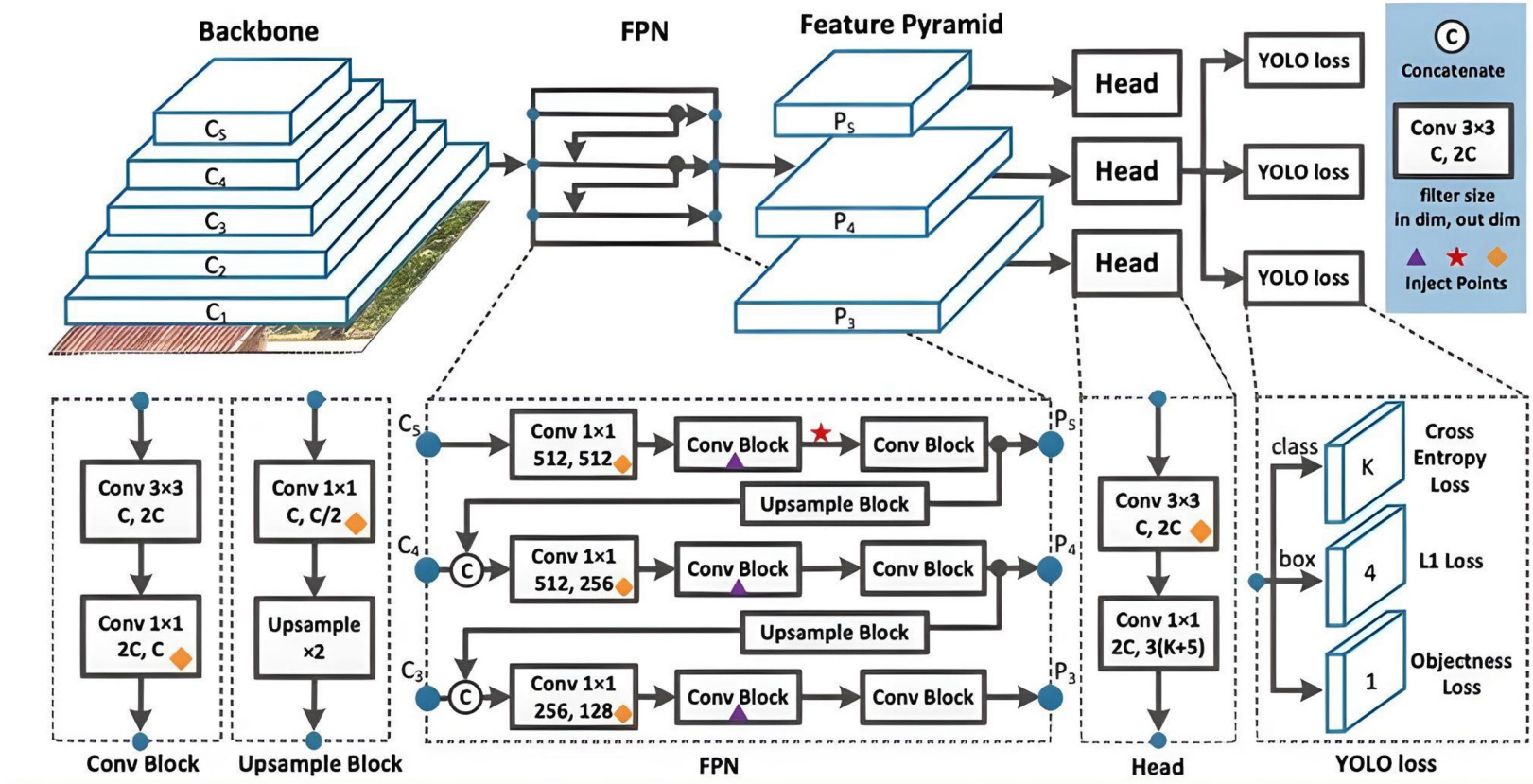
- These models are desiged for various tasks like instance segmentation, pose/keypoints detection, oriented object detection, and classification.

Model: YOLOv8 (Ultralytics ,2023)

In this lab, we chose to use YOLOv8, which has the following key architectural innovations:

- **Backbone**: Uses CSPNet with improved **C2f modules** for efficient feature extraction and richer representations.
- **Neck**: Combines **FPN + PAN** to fuse multi-scale features, enabling detection of both small and large objects.
- **Head**: Anchor-free and **decoupled** design, separating classification and localization for higher accuracy.
- **Loss Functions**: Employs task-specific losses (e.g., BCE for classification, DFL for bounding box regression).

Model: YOLOv8 (Ultralytics ,2023)



Model: YOLOv8 (Ultralytics ,2023)

YOLOv8 is available in multiple model sizes: n (nano), s (small), m (medium), l (large), and x (extra-large). These models share the same overall architecture but differ in the number of channels (width) and repeated blocks (depth). Due to limitations, we use the **nano, small** version, which has the lowest computational cost.

Model	size (pixels)	mAP^{val} 50-95	Speed CPU ONNX (ms)	Speed A100 TensorRT (ms)	params (M)	FLOPs (B)
YOLOv8n	640	37.3	80.4	0.99	3.2	8.7
YOLOv8s	640	44.9	128.4	1.20	11.2	28.6
YOLOv8m	640	50.2	234.7	1.83	25.9	78.9
YOLOv8l	640	52.9	375.2	2.39	43.7	165.2
YOLOv8x	640	53.9	479.1	3.53	68.2	257.8

Lab4.1: YOLOv8n (Ultralytics Hub) - Steps

1) Sign in Ultralytic hub

2) Download the dataset from GitHub, then upload in Ultralytic hub.

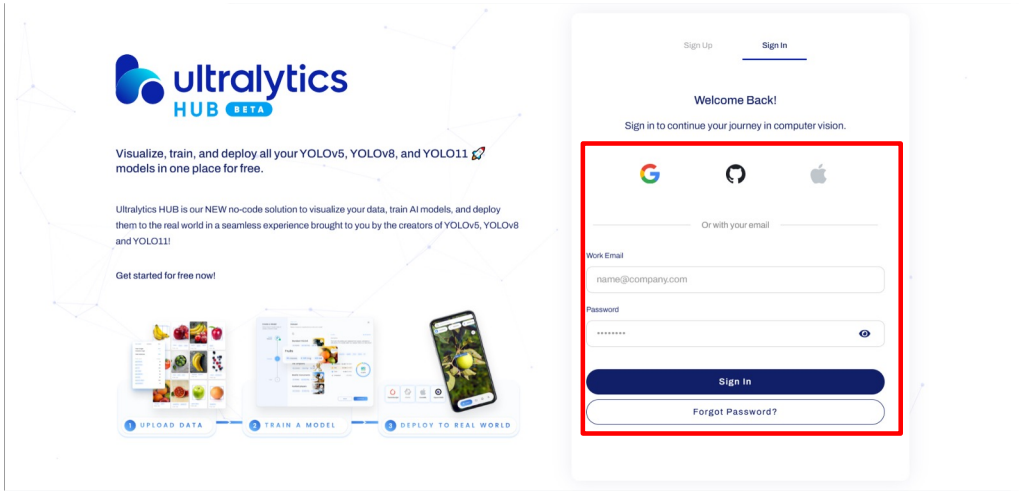
3) Create new project

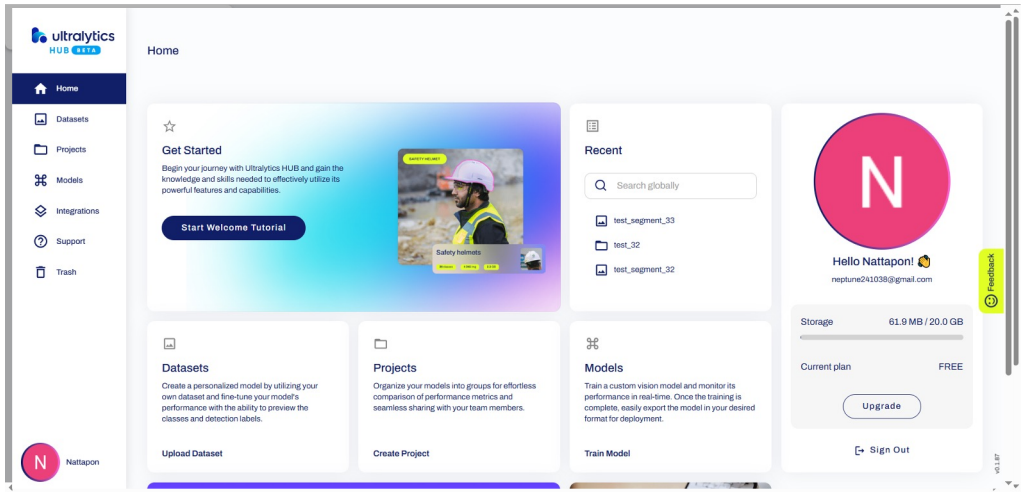
4) Train Model (choose dataset)

5) Export model (Pytorch version)

Lab4.1: YOLOv8n (Ultralytics Hub)

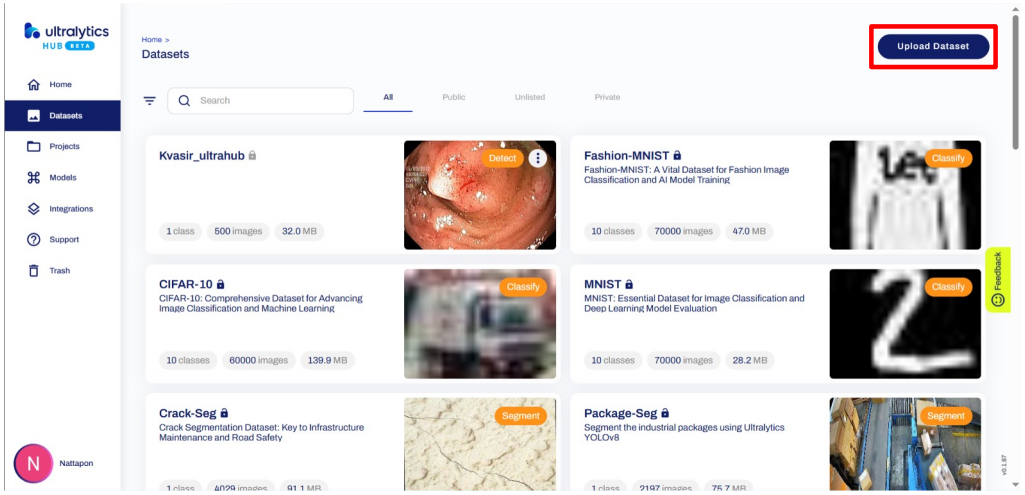
1) Sign in [Ultralytic hub]

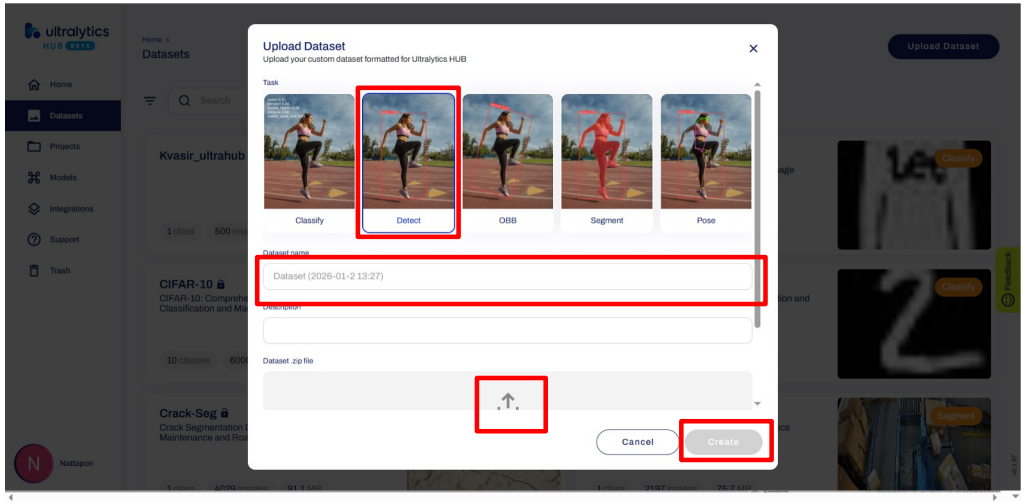




Lab4.1: YOLOv8n (Ultralytics Hub)

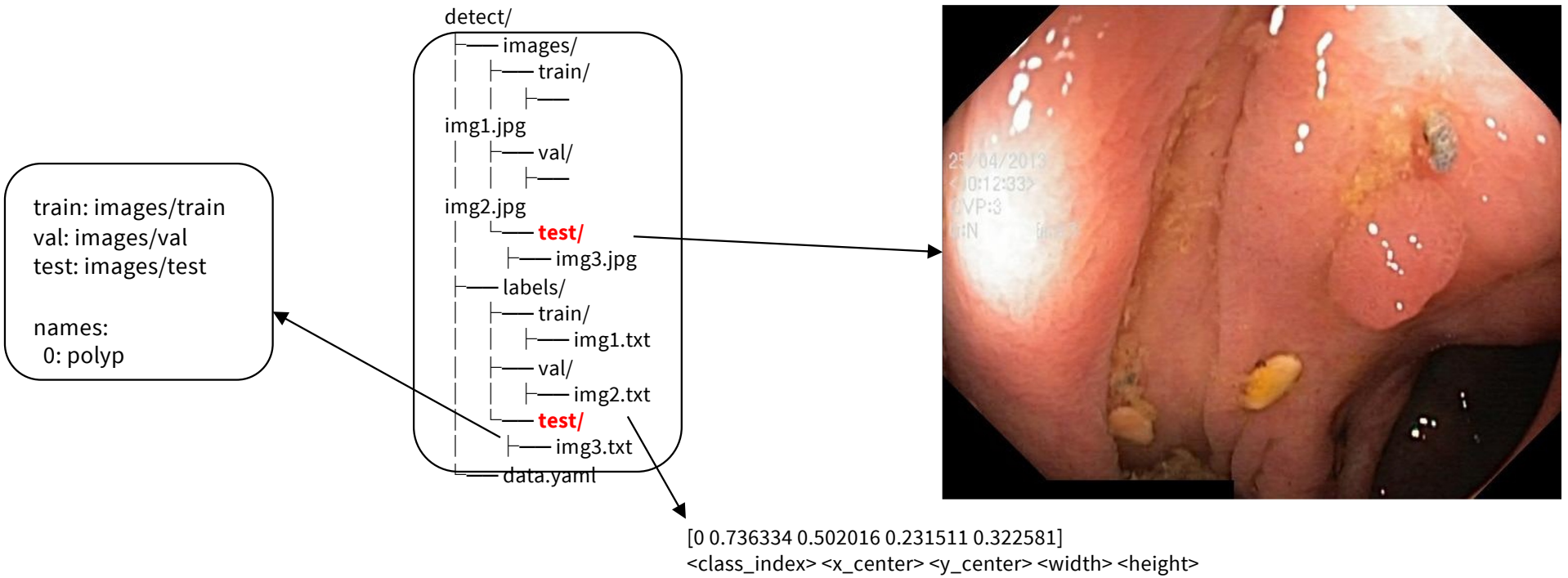
2) Download the dataset from GitHub, then upload in **Ultralytic hub**.





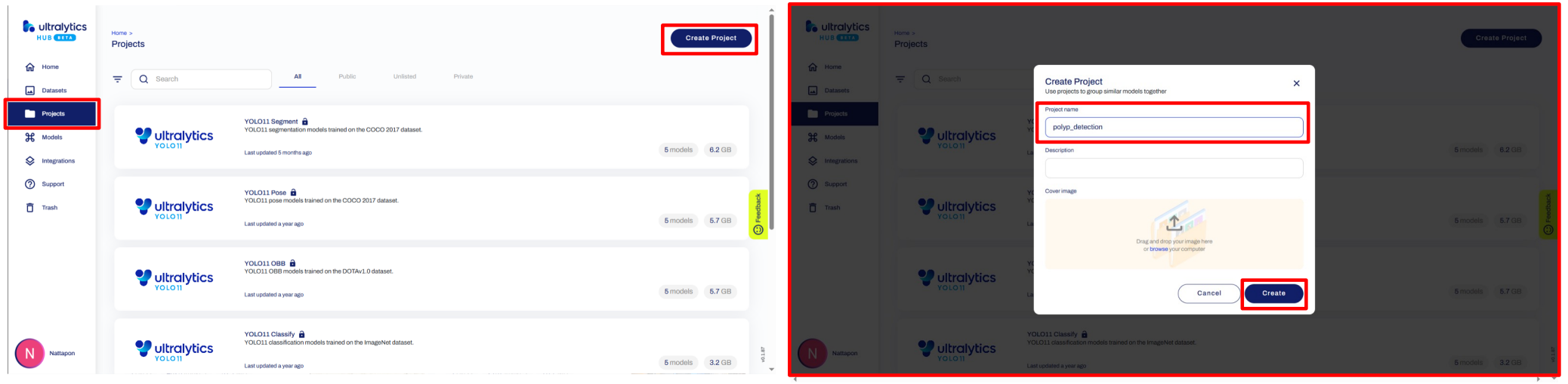
Lab4.1: YOLOv8n (Ultralytics Hub)

2) Download the dataset from GitHub, then upload in **Ultralytic hub**.



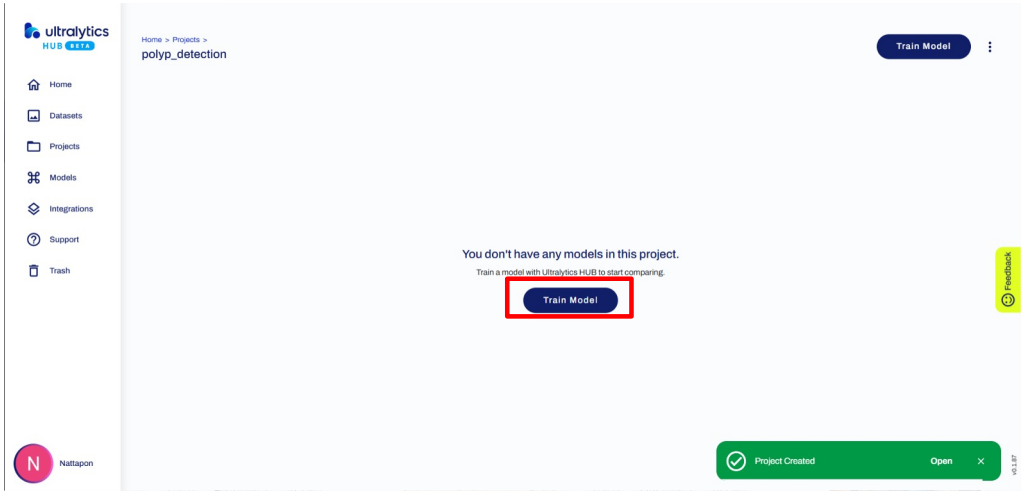
Lab4.1: YOLOv8n (Ultralytics Hub)

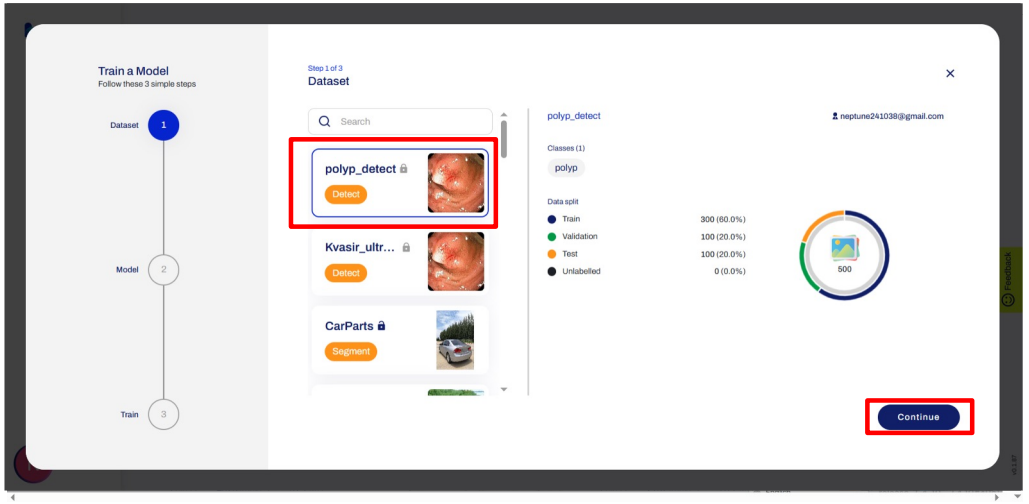
3) Create new project



Lab4.1: YOLOv8n (Ultralytics Hub)

4) Train Model (choose dataset)

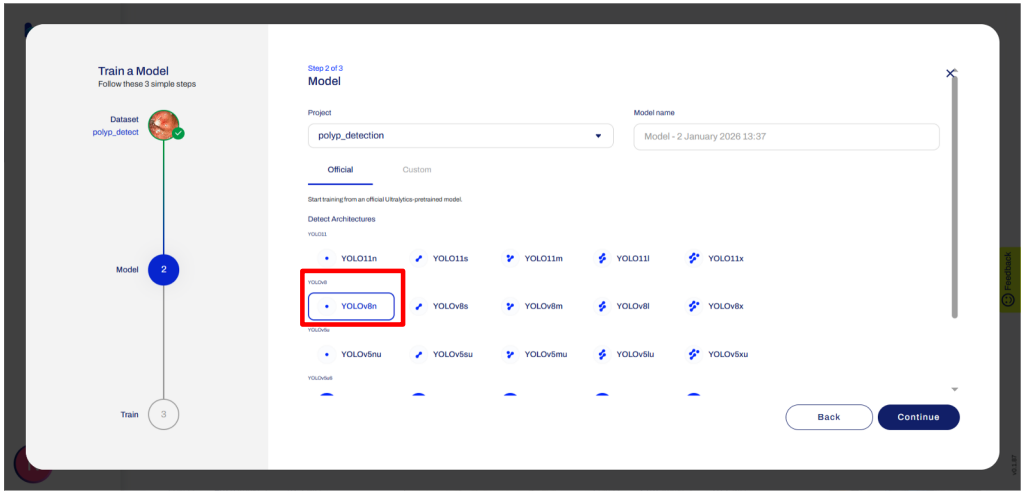


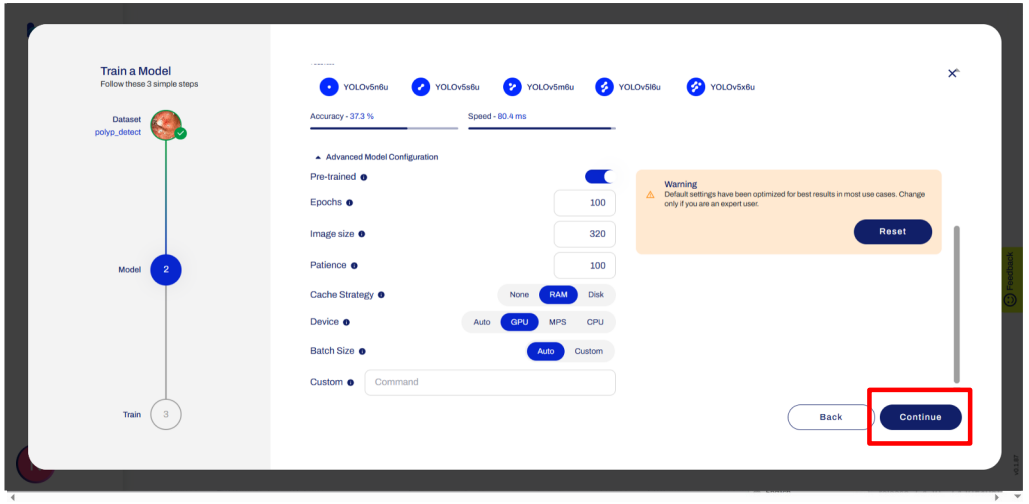


Lab4.1: YOLOv8n (Ultralytics Hub)

4) Train Model (set configuration)

- model: YOLOv8n, Epochs: 100, Image size: 320, Cache: RAM, Device: GPU

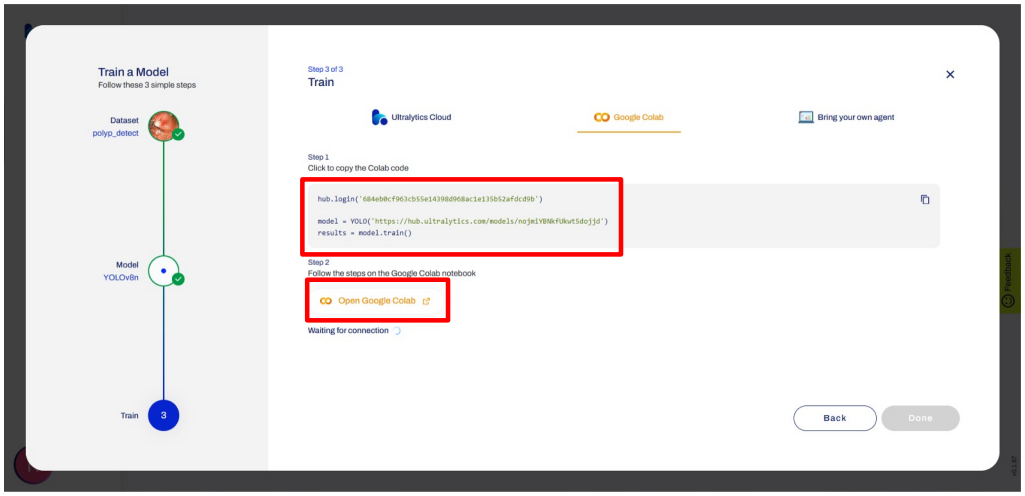


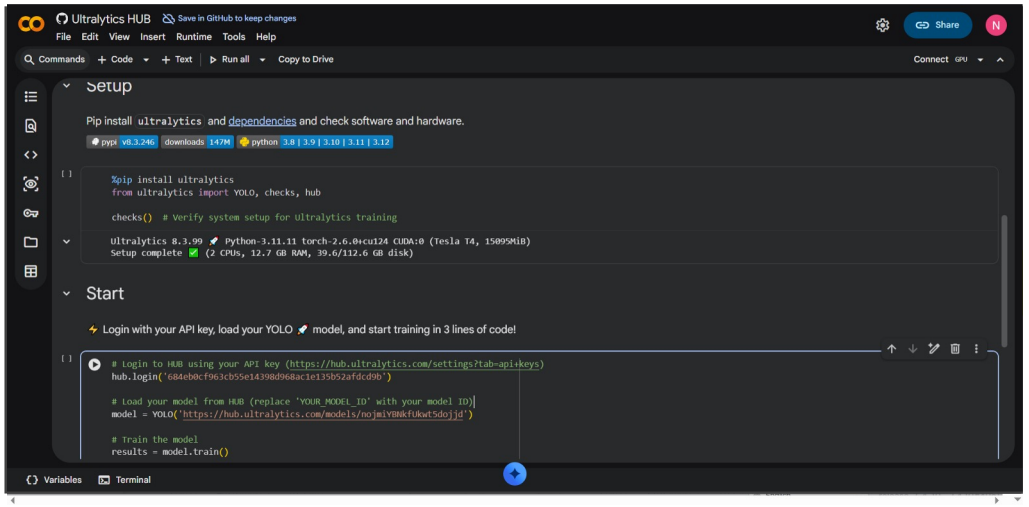


Lab4.1: YOLOv8n (Ultralytics Hub)

4) Train Model (training)

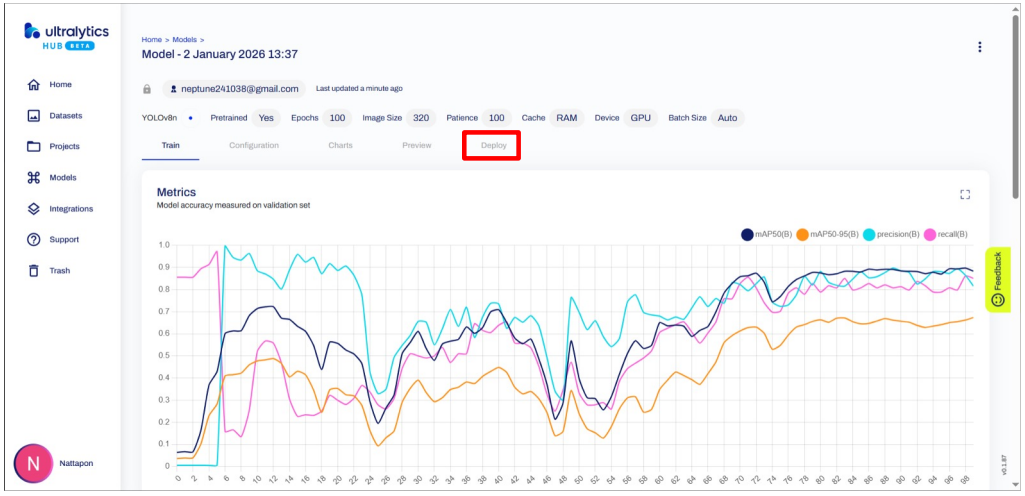
- Copy code and run in colab

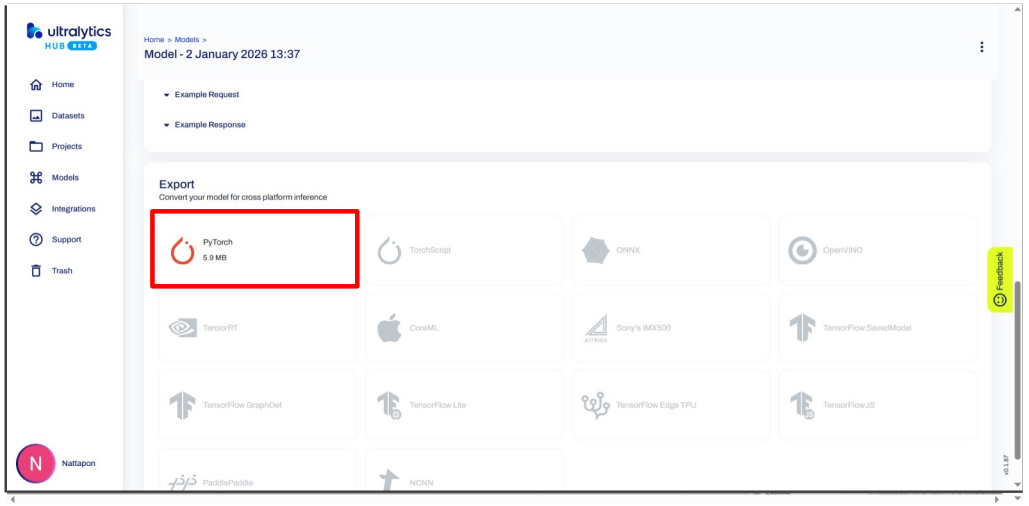




Lab4.1: YOLOv8n (Ultralytics Hub)

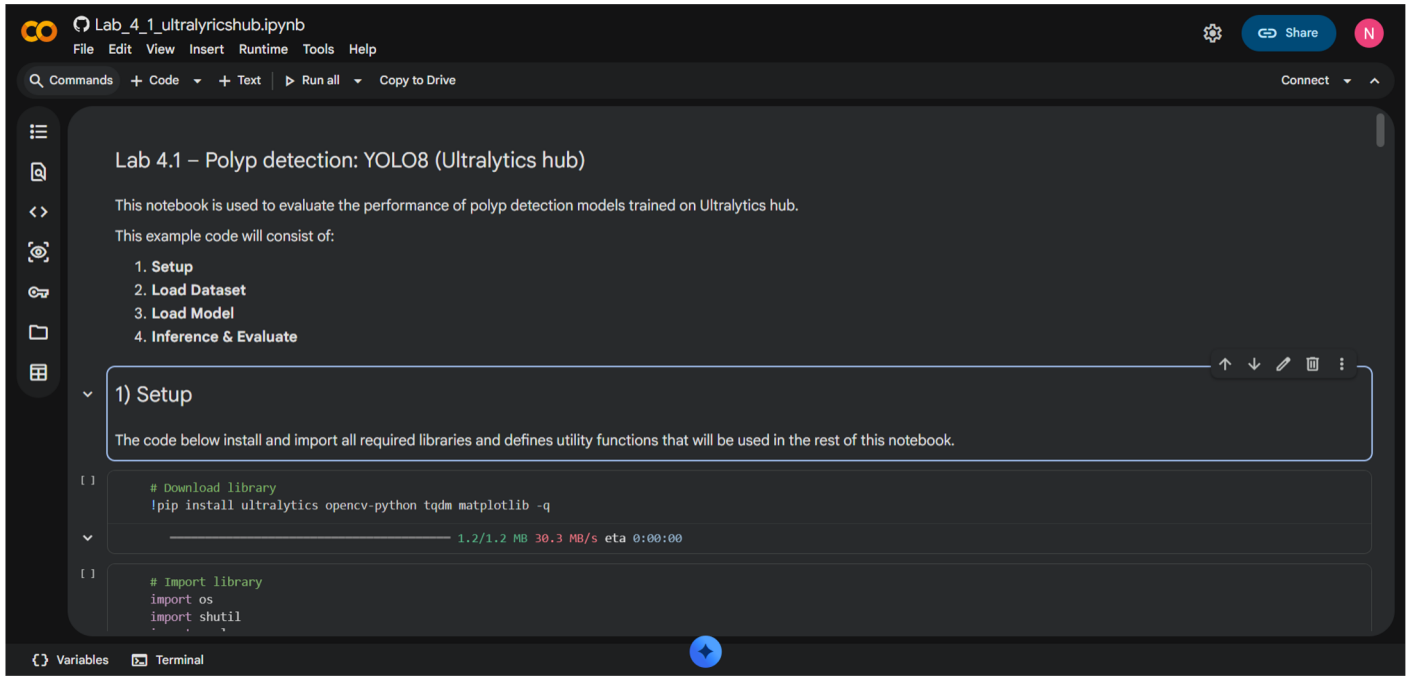
5) Export model (Pytorch version)





Lab4.1: YOLOv8n (Ultralytics Hub)

5) Open Lab_4_1_ultralyricshub in Colab, upload the pt. file exported from Ultralytics Hub, and then run the code in the notebook to evaluate the model's performance.



Lab4.1: YOLOv8n (Ultralytics Hub)

5) Overview of [Lab_4_1_ultralyricshub]

upload from Ultralytics hub

YOLOv8_polyp.pt

load model

model = YOLO("YOLOv8_polyp.pt")

inference

download from github

```
detect/
├── images/
│   ├── train/
│   │   ├── img1.jpg
│   │   └── img2.jpg
│   └── val/
│       └── test/
│           └── img3.jpg
├── labels/
│   ├── train/
│   │   └── img1.txt
│   ├── val/
│   │   └── img2.txt
│   └── test/
│       └── img3.txt
└── data.yaml
```

results = model.predict(test_imgs)

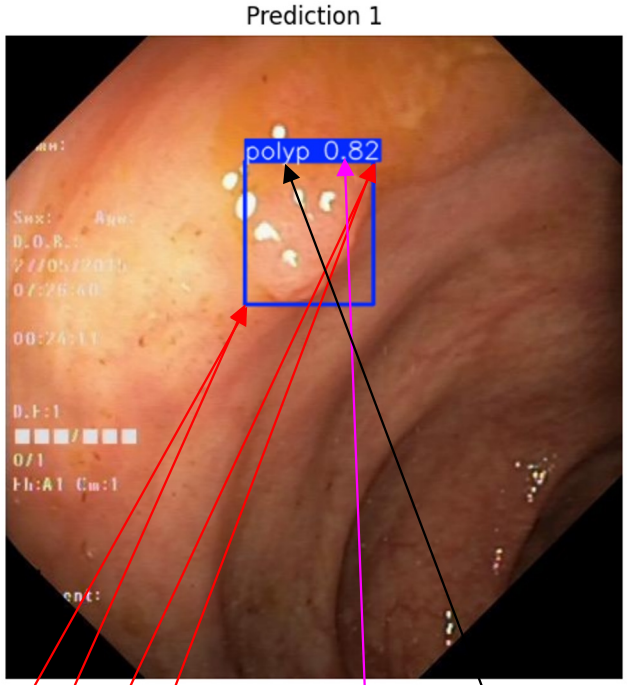
sample

results[0].boxes.data = [x1,y1,x2,y2, confidence score,class]

bbox_iou(pred_box, gt_box)

evaluate

```
YOLOv8 Detection Performance:
• Mean IoU: 0.8022
• Avg inference time: 64.15 ms/img
```



Lab4.1: YOLOv8n (Ultralytics Hub)

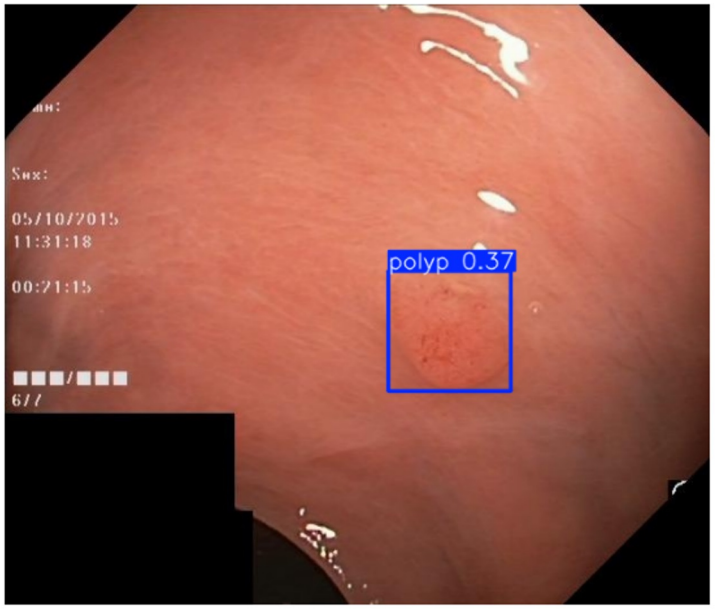
Results may vary between runs due to random seed initialization and hyperparameter tuning; however, the overall performance should be similar to the results shown on this page.

```
Testing 100 test images...
Evaluating YOLOv8 Detection: 100%|██████████| 100/100 [00:06<00:00, 14.81it/s]
 YOLOv8 Detection Performance:
• Mean IoU: 0.8022
• Avg inference time: 64.15 ms/img
```

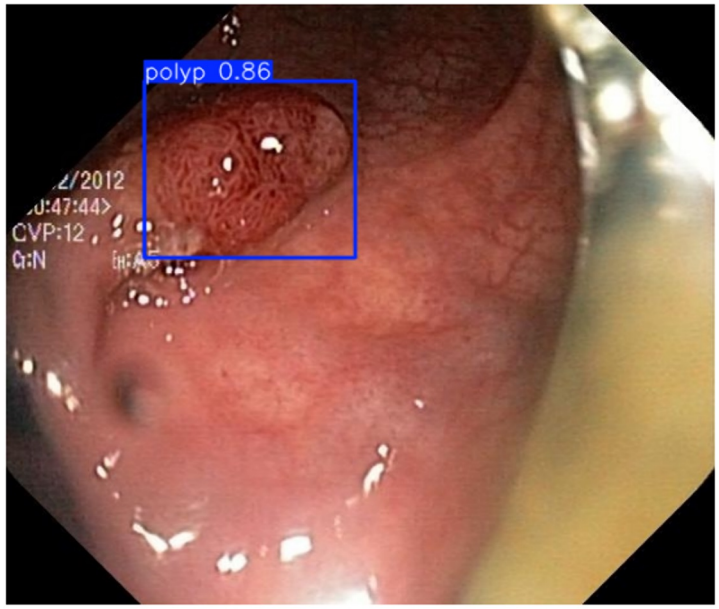
Lab4.1: YOLOv8n (Ultralytics Hub)

Results may vary between runs due to random seed initialization and hyperparameter tuning; however, the overall performance should be similar to the results shown on this page.

Prediction 1

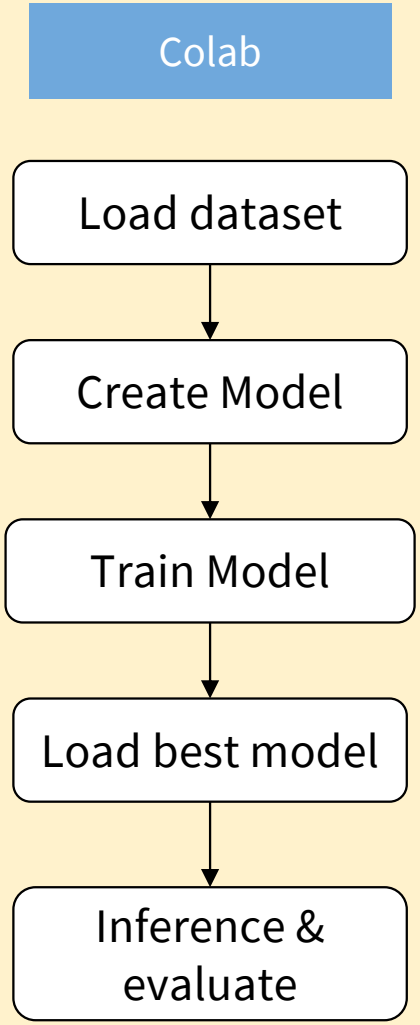


Prediction 2



Lab4.2: YOLOv8s (Ultralytics)

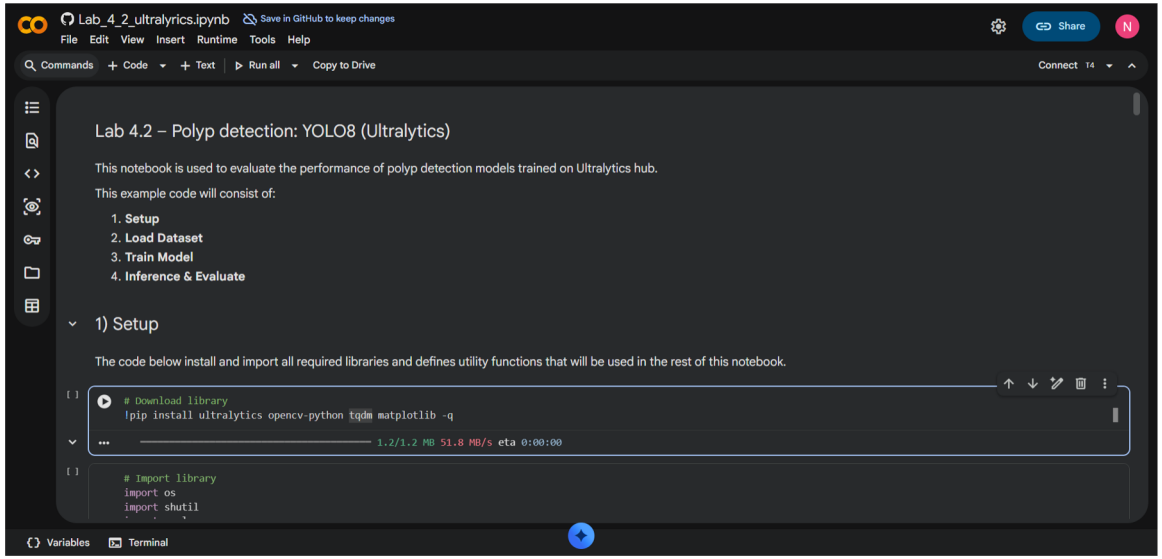
In this lab, you will create an polyp detection model **(YOLOv8s)** and evaluate its performance using **Ultralytics library** in colab



Lab4.2: YOLOv8s (Ultralytics) - 4 steps

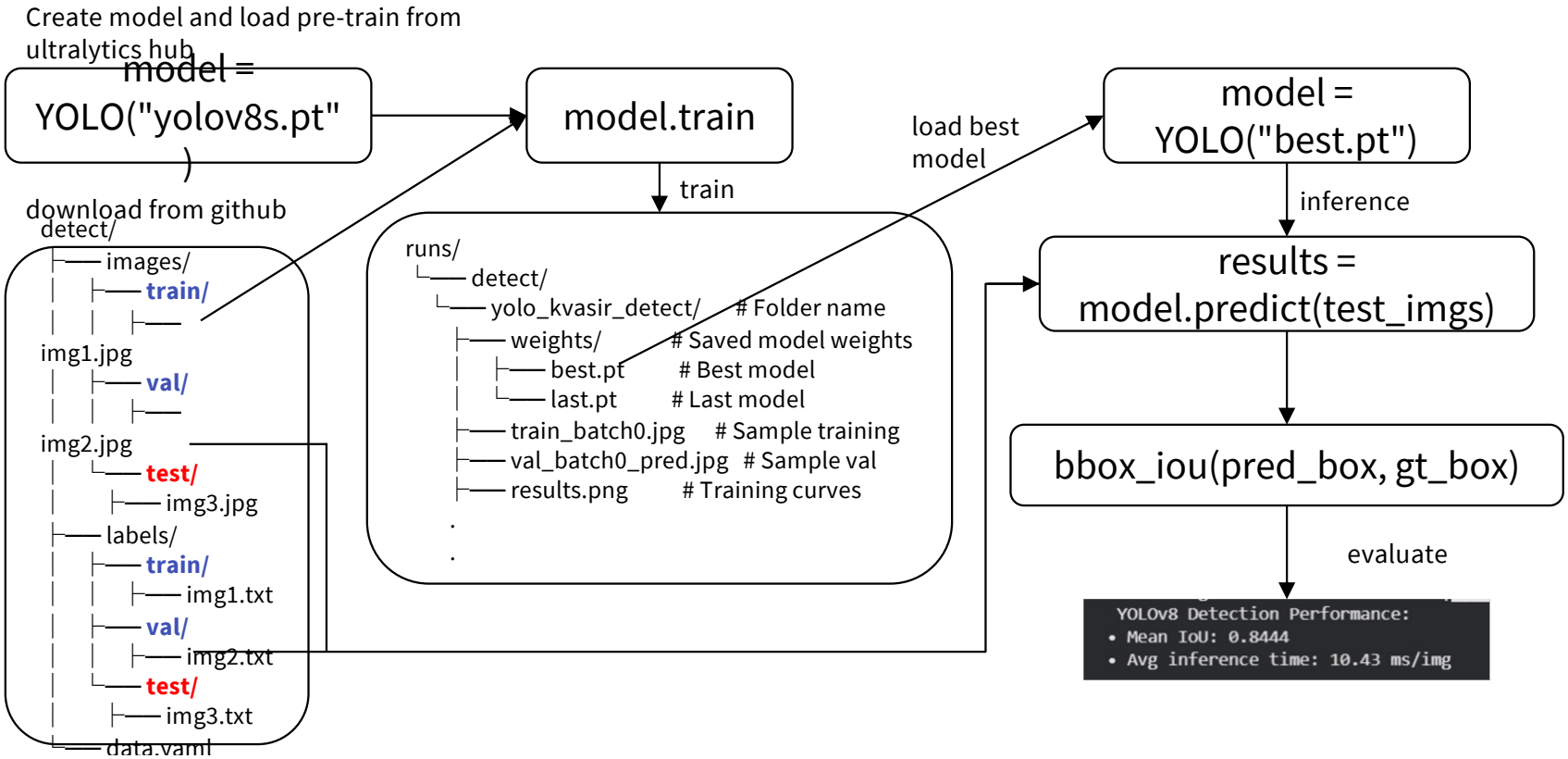
Run Lab_4_2_ultralyrics.ipynb (in colab)

1) Setup
2) Load Data
3) Train model
4) Inference & Evaluate



Lab4.2: YOLOv8s (Ultralytics)

Overview of [Lab_4_2_ultralyrics.ipynb]



Lab4.2: YOLOv8s (Ultralytics)

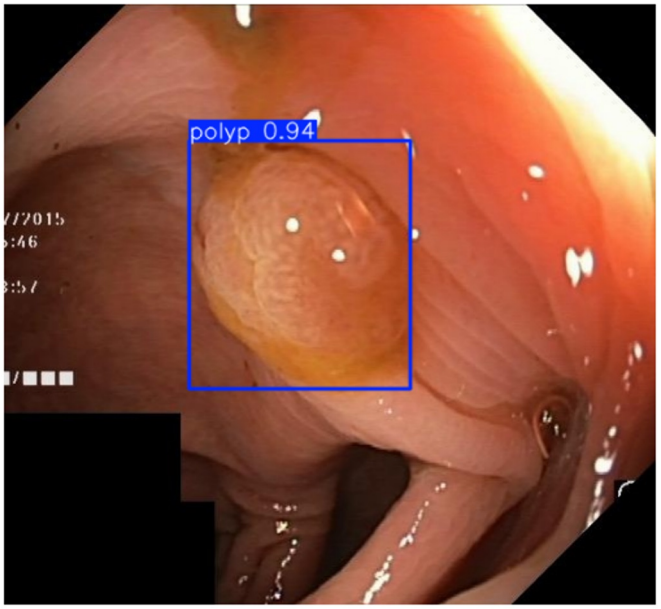
Results may vary between runs due to random seed initialization and hyperparameter tuning; however, the overall performance should be similar to the results shown on this page.

```
Testing 100 test images...
Evaluating YOLOv8 Detection: 100%|██████████| 100/100 [00:01<00:00, 80.09it/s]
 YOLOv8 Detection Performance:
• Mean IoU: 0.8444
• Avg inference time: 10.43 ms/img
```

Lab4.2: YOLOv8s (Ultralytics)

Results may vary between runs due to random seed initialization and hyperparameter tuning; however, the overall performance should be similar to the results shown on this page.

Prediction 1



Prediction 2