YOLOv11n-Segmentation Model

It focuses on detecting **blue color changes (dots)** within a **pink patch** using **YOLOv11n-seg** for instance segmentation. The objective is to localize blue dot-like irregularities inside circular pink regions, useful for real-time monitoring of chemical changes or reactions on paper.

Dataset Details

Manual Dataset Preparation

- **Pink Paper**: Circular patches were manually cut from pink-coloured paper.
- **Dot Creation**: Blue watercolour droplets were placed within the pink circles, resulting in **irregular-shaped blue marks**.
- **Photography Setup**: Images were captured on a **plain background under varying lighting conditions** to ensure **diversity and robustness** in the dataset. This helps the model generalize better across different real-world scenarios.

Annotation

- **Tool Used**: Roboflow
- **Project Type**: Instance Segmentation
- **Annotation Method**: Smart Polygon Tool (per-pixel blue dot region inside pink patch)
- **Dataset Split**

Set	Count	Percentage
Train Set	159	88%
Valid Set	15	8%
Test Set	7	4%

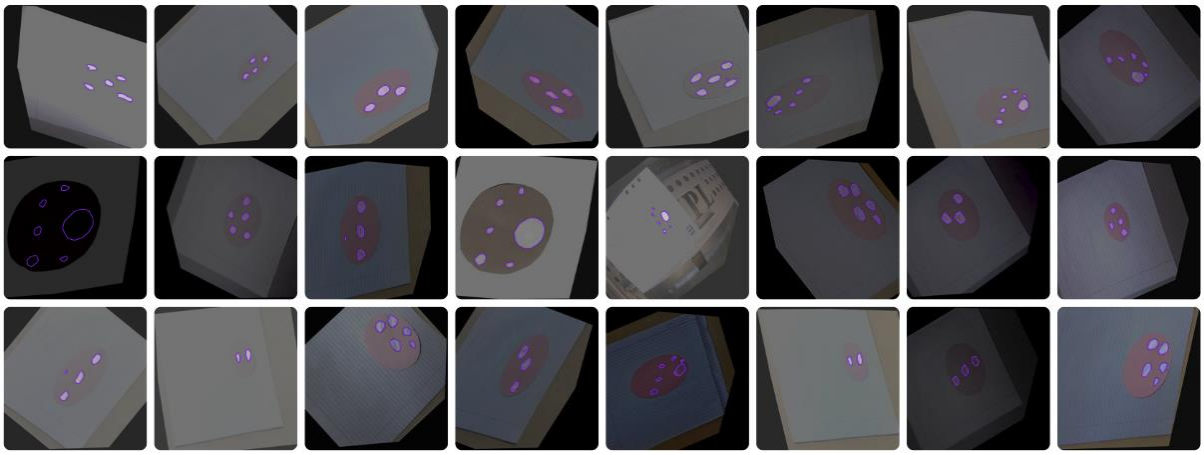
Preprocessing: The preprocessing steps included Auto-Orient, which was successfully applied, and Resize, where all images were stretched to 640×640 pixels, preserving non-uniform aspect ratios.

Augmentations

Each training image generates **3 outputs** via augmentation:

Augmentation Type	Range
Rotation	±45°
Shear	±13° Horizontal, ±14° Vertical
Saturation	-55% to +55%
Brightness	-36% to +36%
Exposure	-27% to +27%

These augmentations ensure the model learns to generalize across various lighting, orientation, and color shift conditions.



Model & Training Setup

Command Used: *yolo segment train data=data.yaml model=yolo11n-seg.yaml pretrained=yolo11n-seg.pt epochs=100 imgsz=1024 batch=32*

Configuration

Setting	Value
Model	yolo11n-seg.yaml (2.84M params)
Pretrained	yolo11n-seg.pt
Epochs	100
Image Size	1024
Batch Size	32
Device	GPU (CUDA)
Augmentations	Enabled

Training Results Summary

Metric	Value
Box mAP@0.5	0.985
Segmentation mAP@0.5	0.971
Segmentation mAP@0.5:0.95	0.712

- Loss steadily decreased.
- Accuracy peaked in last 10 epochs.
- Best model saved as runs/segment/train/weights/best.pt.

Final Outputs

Output File / Folder	Description
train_batch*.jpg	Sample predictions during training
results.csv	Epoch-wise logs
confusion_matrix.png, F1_curve.png, PR_curve.png	Evaluation metrics
best.pt / last.pt	Trained weights

MODEL INFERENCE

The **MAIN.py** Python script utilizes a **YOLOv11 segmentation model** to detect **blue dots** inside pink paper regions in both **images and videos**. It supports dynamic annotation visualization and saves the output with detected masks.

Features

- Accepts both **image** and **video** file inputs.
- Supports **YOLOv11 segmentation** format with `retina_masks=True` for fine-grained instance masks.
- Automatically saves **annotated output** images or videos.
- Displays real-time detection results during video processing.

Dependencies

- `ultralytics` (YOLOv11)
- OpenCV (`cv2`)
- `os` for path and file checks

Working Mechanism

1. **Model Loading**:
   Loads the pretrained YOLOv11n segmentation model from: **train/weights/best.pt**
2. **Image Processing**:

   - Performs inference.
   - Applies **segmentation masks** (without bounding boxes).
   - Saves and displays the annotated output image.

   3. Video Processing:

   - Reads video frame-by-frame.
   - Runs YOLOv11 segmentation on each frame.
   - Applies mask overlays and writes annotated frames to an output `.avi` file.
   - Allows early exit with the `'q'` key.

   Example Output

   - `output_detected.jpg` — for image input
   - `output_detected.avi` — for video input