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INDUSTRIAL DATA SCIENCE 2

CASE STUDY- GROUP III

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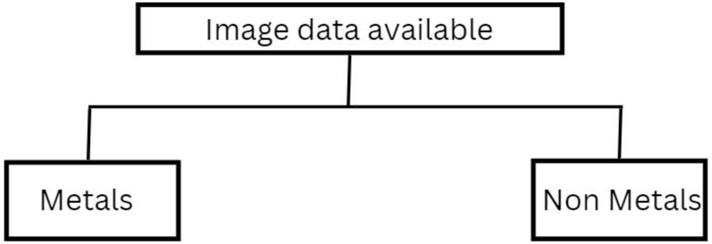
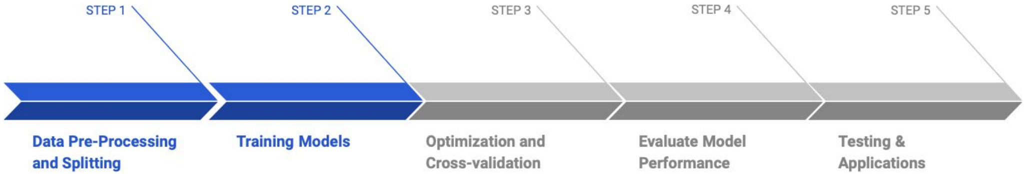
An Overview of the First Presentation

Problem Statement – In industries where precision and reliability are crucial, the presence of contaminants such as metal and non-metal particles can lead to significant quality issues.

Solution– To address the challenge of particle analysis, we use YOLO and CNN models, and compare their results.





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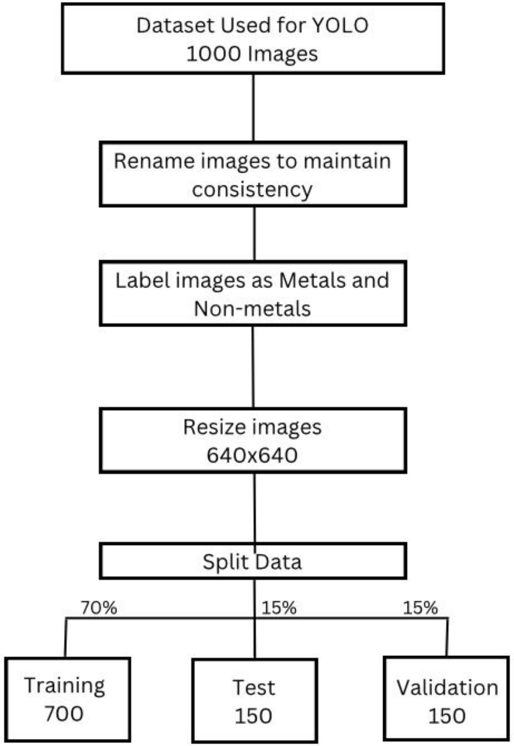
YOLO v8n Model- Methodology



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Validation Results- Batch One

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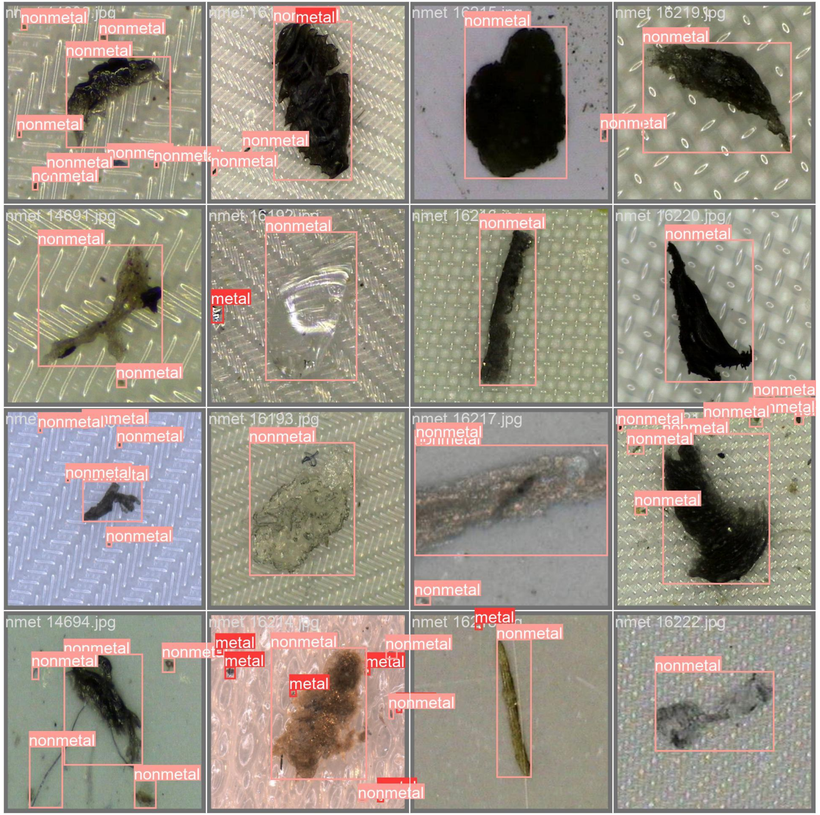
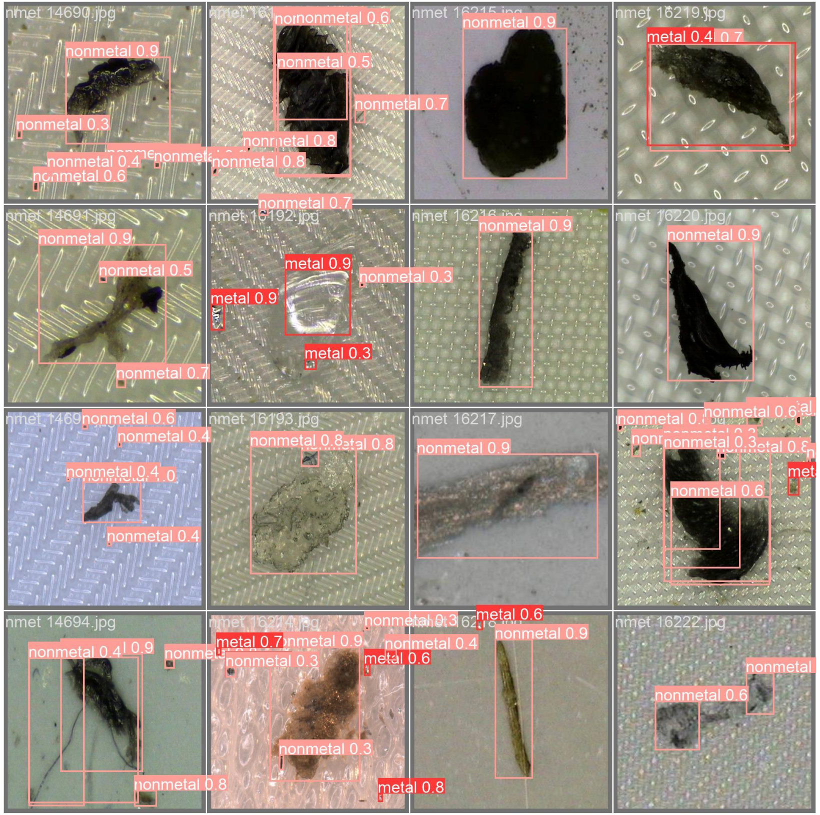
***Along each label, the confidence score of prediction is shown.**





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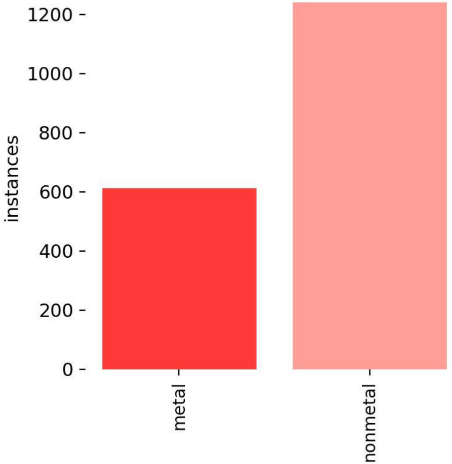

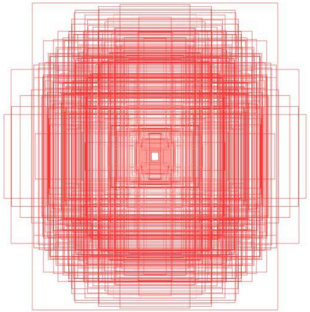

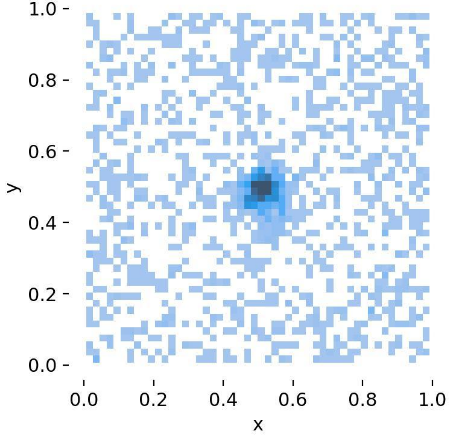

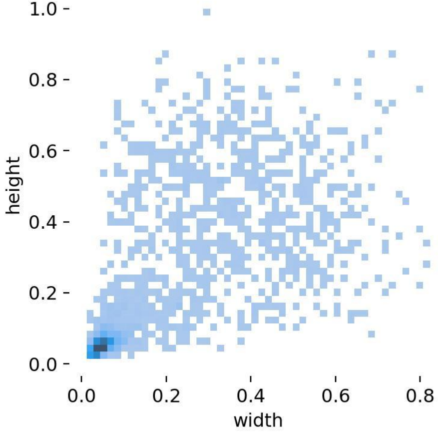

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Bar Graph:

- Displays the number of instances detected for metals and non-metals.

Scatter Plot (Bounding Boxes Distribution):

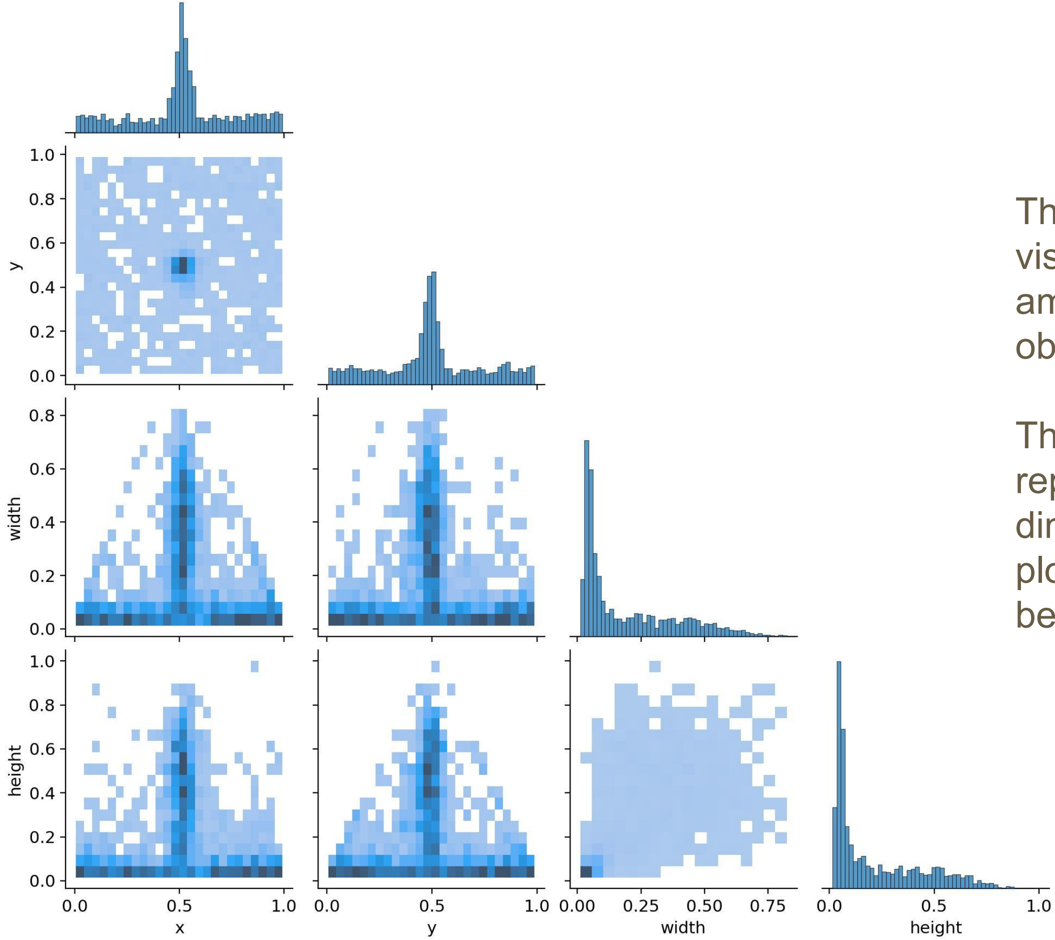
- Red boxes represent bounding boxes around detected objects.
- Illustrates the concentration and spread of object locations within the center of the images.

Scatter Plot (X and Y Coordinates):

- Shows the X and Y coordinates of detected objects.
- Highlights the positions of objects within the center of the images.

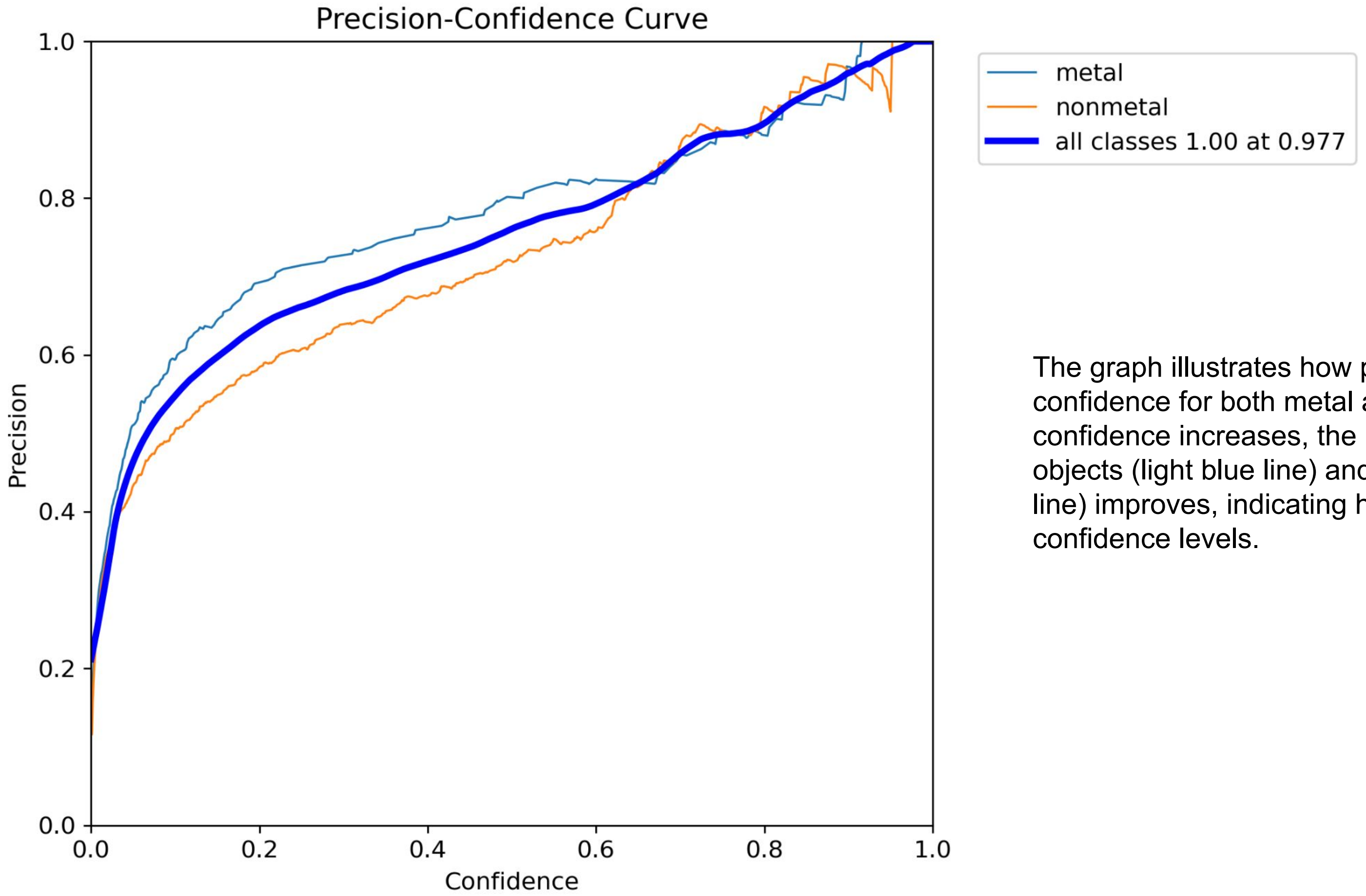
Scatter Plot (Width and Height Distribution):

- Displays the width and height distribution of detected objects.
- Indicates variations in object sizes.

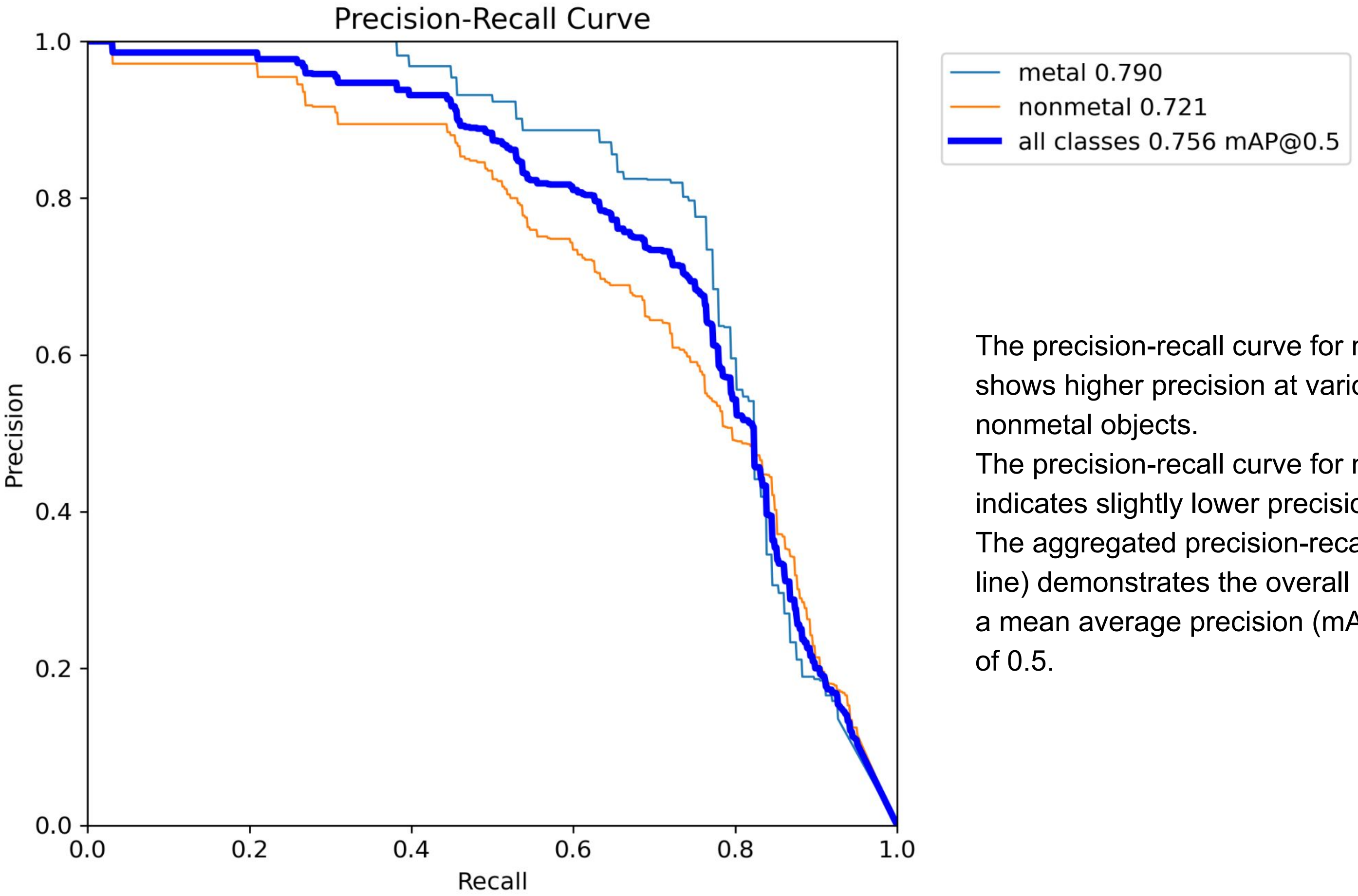


The pair plot provides a comprehensive visualization of the pairwise relationships among different dimensions of the detected objects (X, Y, Width and Height).

The diagonal displays histograms that represent the distribution of each dimension, while the off-diagonal scatter plots illustrate the interrelationships between these dimensions.



The graph illustrates how precision varies with confidence for both metal and nonmetal objects. As confidence increases, the precision for detecting metal objects (light blue line) and nonmetal objects (orange line) improves, indicating higher accuracy at higher confidence levels.



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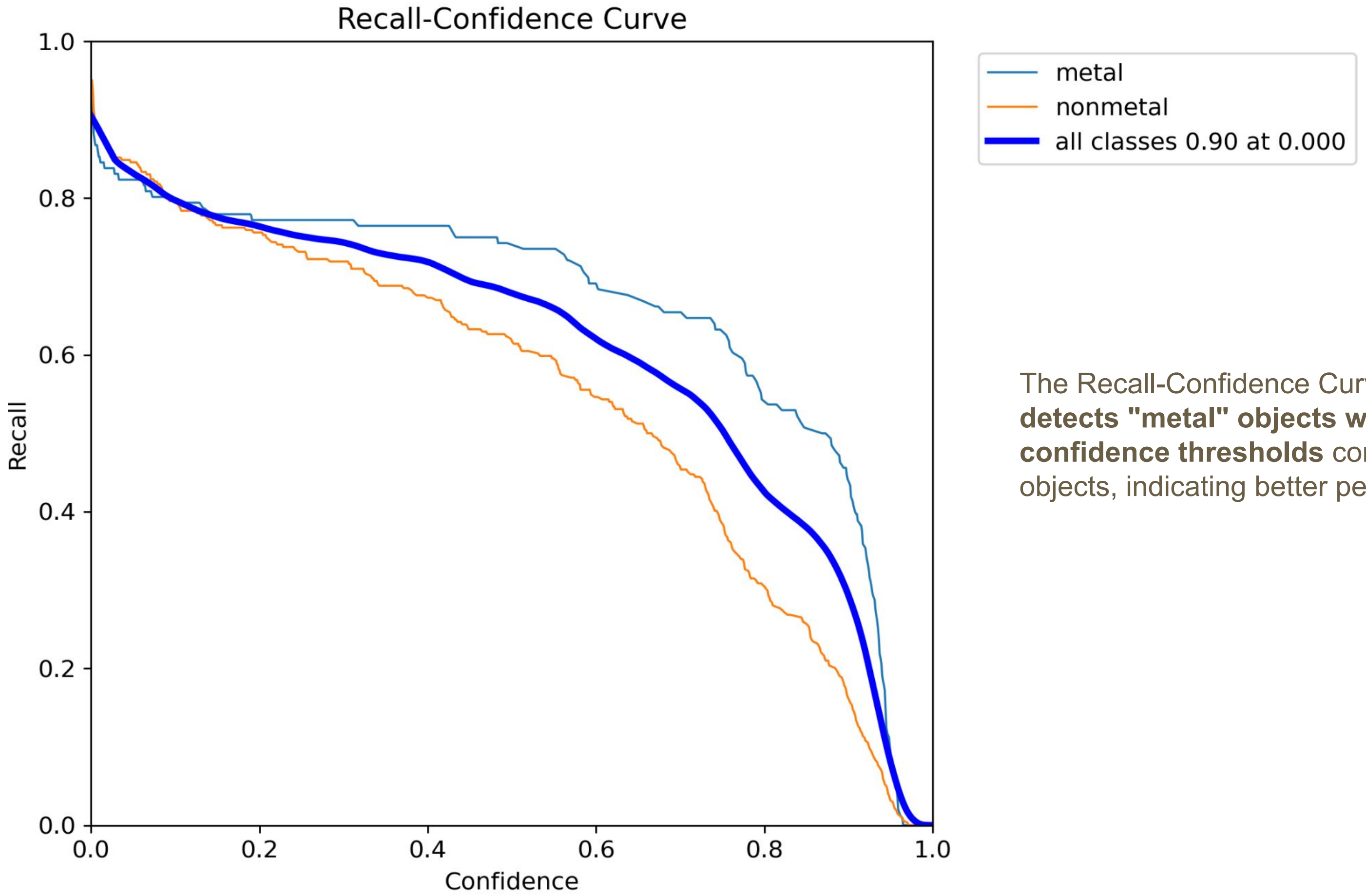
The precision-recall curve for metal objects (light blue line) shows higher precision at various recall levels compared to nonmetal objects.

The precision-recall curve for non metal objects (orange line) indicates slightly lower precision compared to metal objects.

The aggregated precision-recall curve for all classes (dark blue line) demonstrates the overall performance of the model, with a mean average precision (mAP) of 0.756 at a recall threshold of 0.5.



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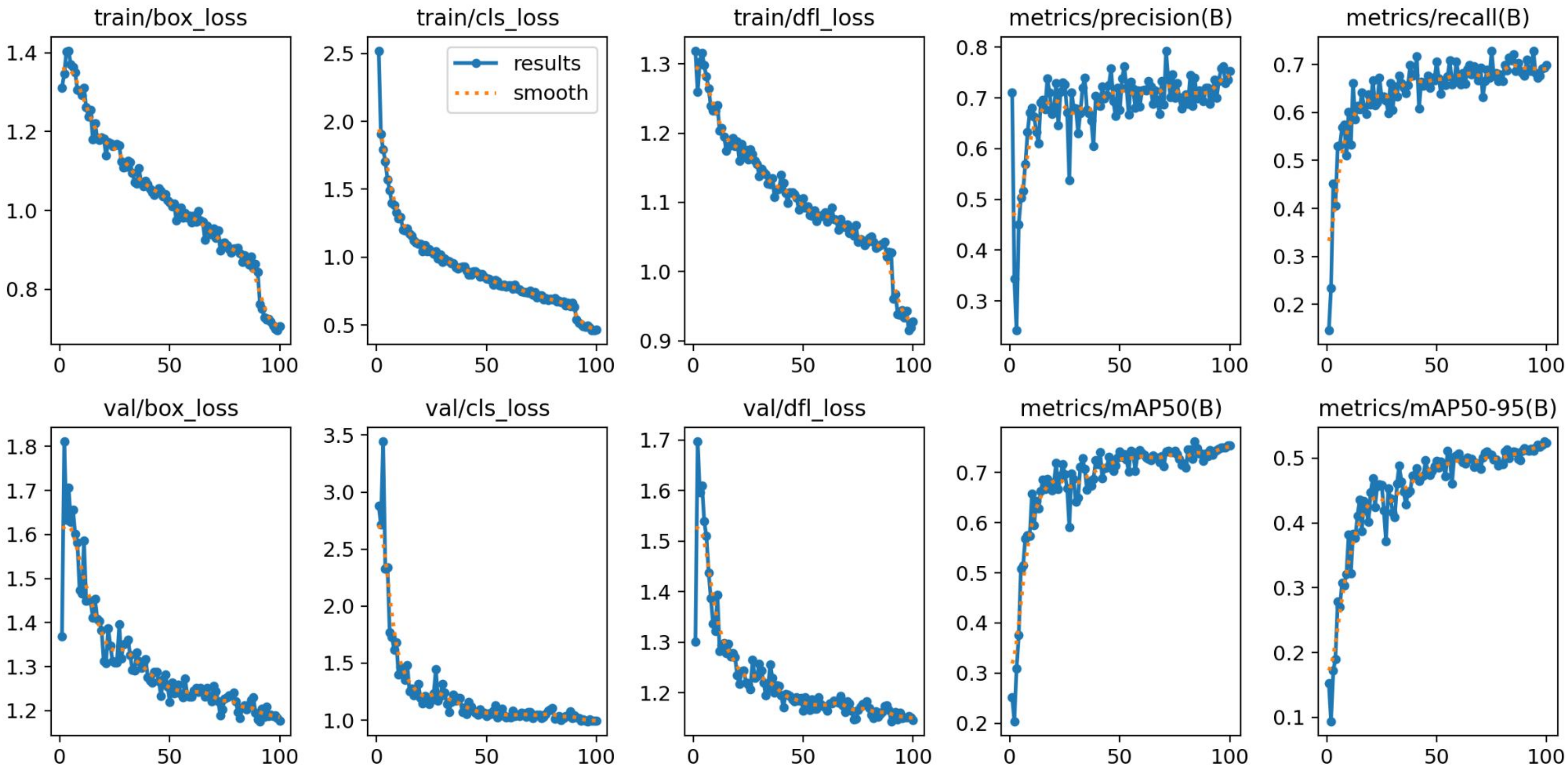
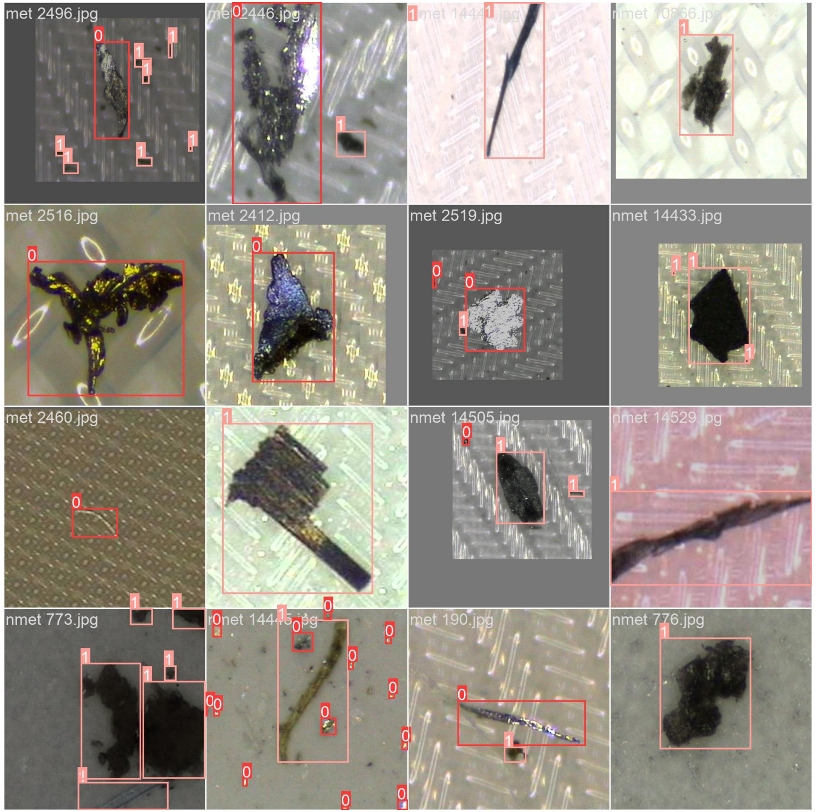
The Recall-Confidence Curve shows that the model **detects "metal" objects with higher recall at higher confidence thresholds** compared to "nonmetal" objects, indicating better performance for metals.


train/box_loss
train/cls_loss
results
smooth
train/dfl_loss
metrics/precision(B)
metrics/recall(B)
val/box_loss
val/cls_loss
val/dfl_loss
metrics/mAP50(B)
metrics/mAP50-95(B)

Train Batch Results



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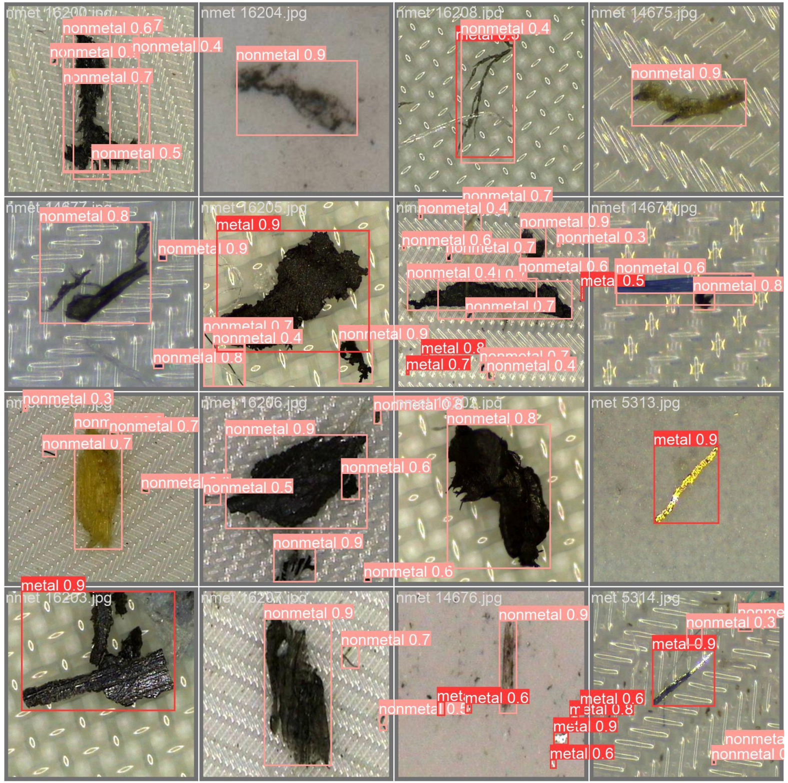
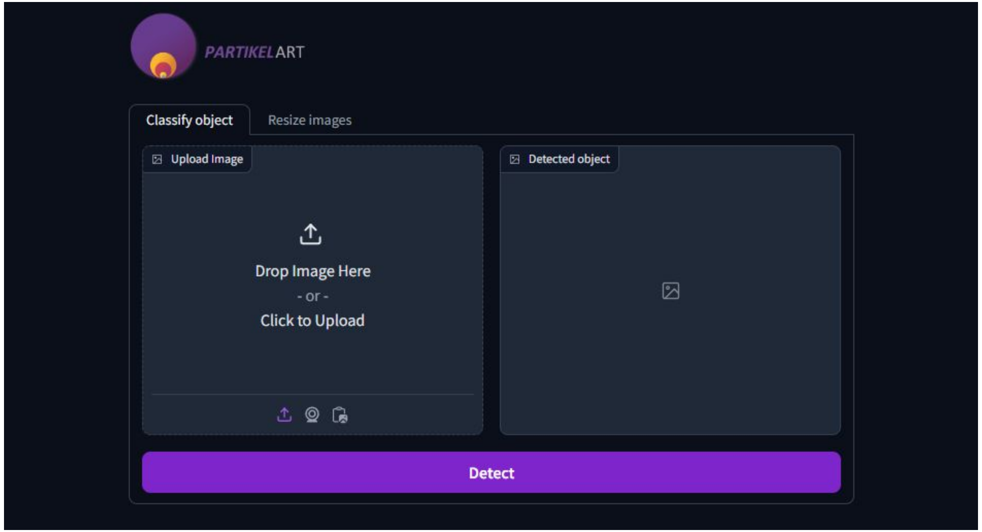
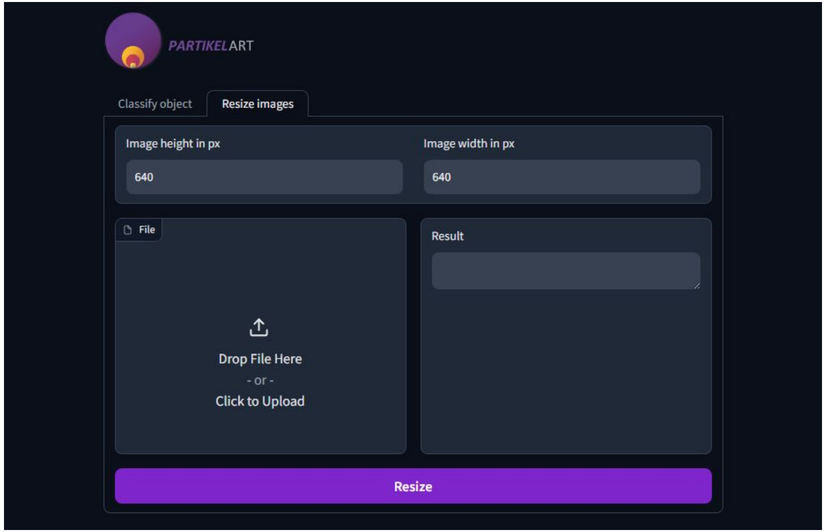
Validation Batch- Prediction Results



Graphical User Interface





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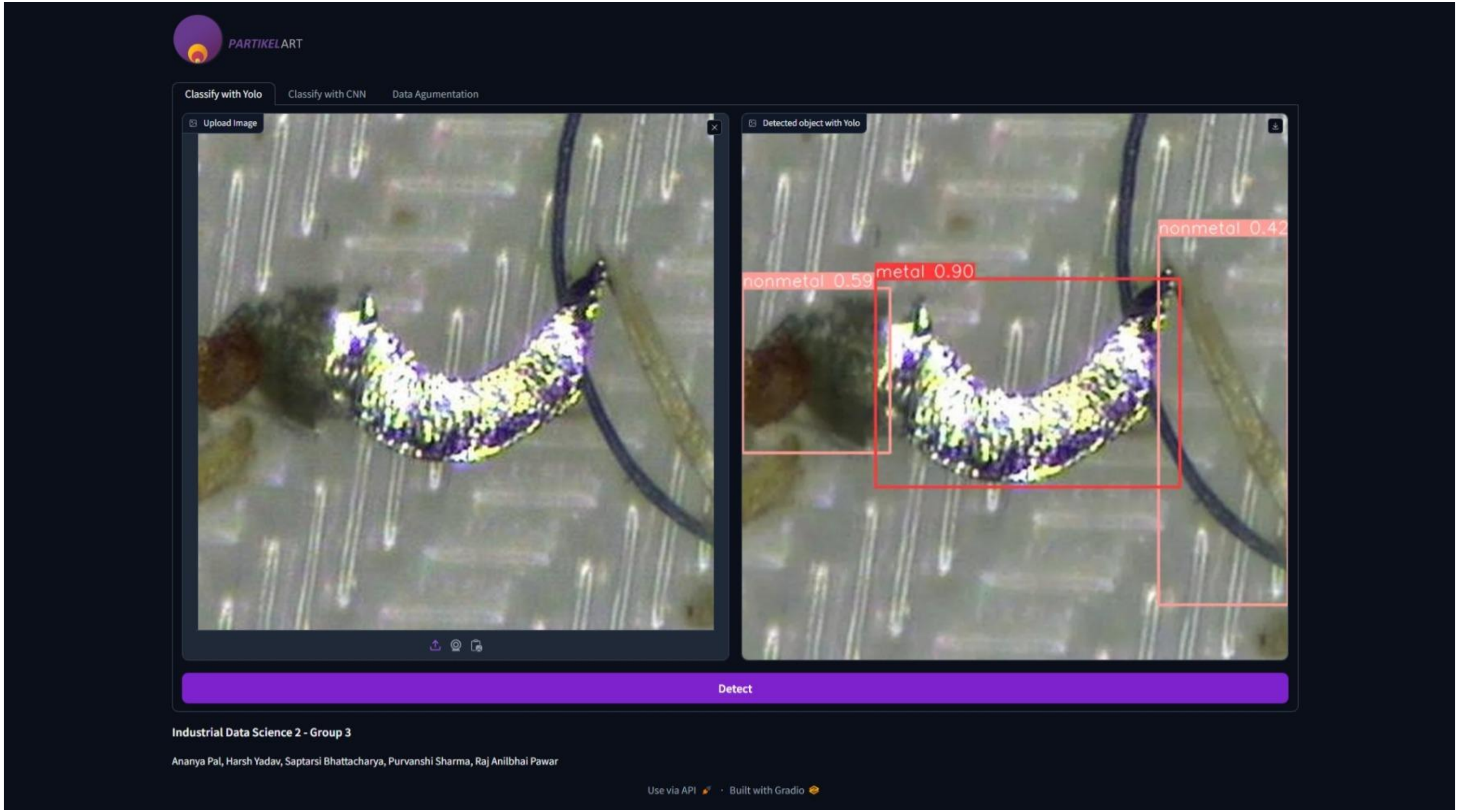
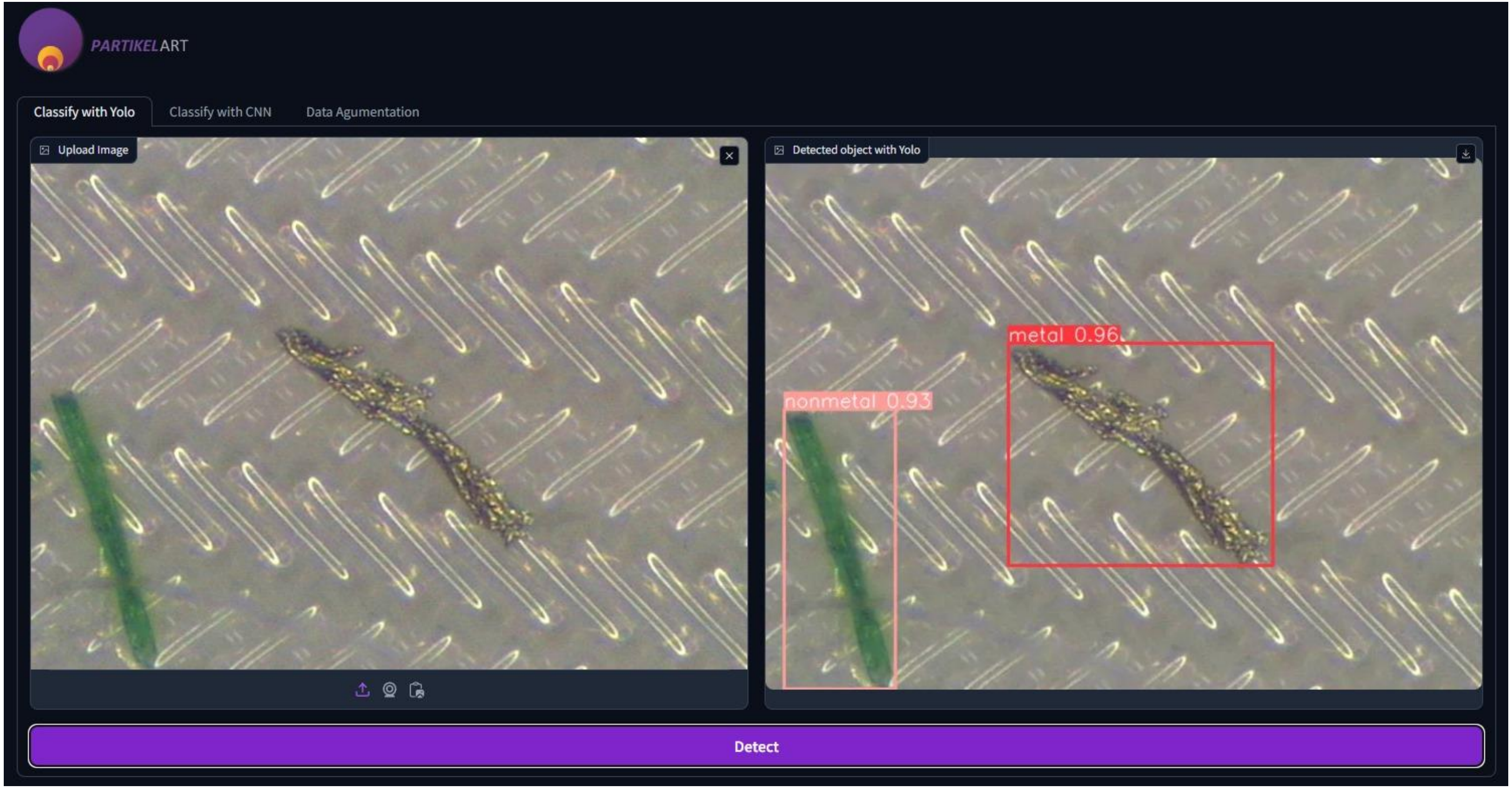

PARTIKELART
Classify with Yolo
Classify with CNN
Data Agumentation
Upload Image
Detected object with Yolo
nonmetal 0.42
metal 0.90
nonmetal 0.59
Detect
Industrial Data Science 2 - Group 3
Ananya Pal, Harsh Yadav, Saptarsi Bhattacharya, Purvanshi Sharma, Raj Anilbhai Pawar
Use via API · Built with Gradio


PARTIKELART
Classify with Yolo
Classify with CNN
Data Agumentation
Upload Image
Detected object with Yolo
metal 0.96
nonmetal 0.93
Detect

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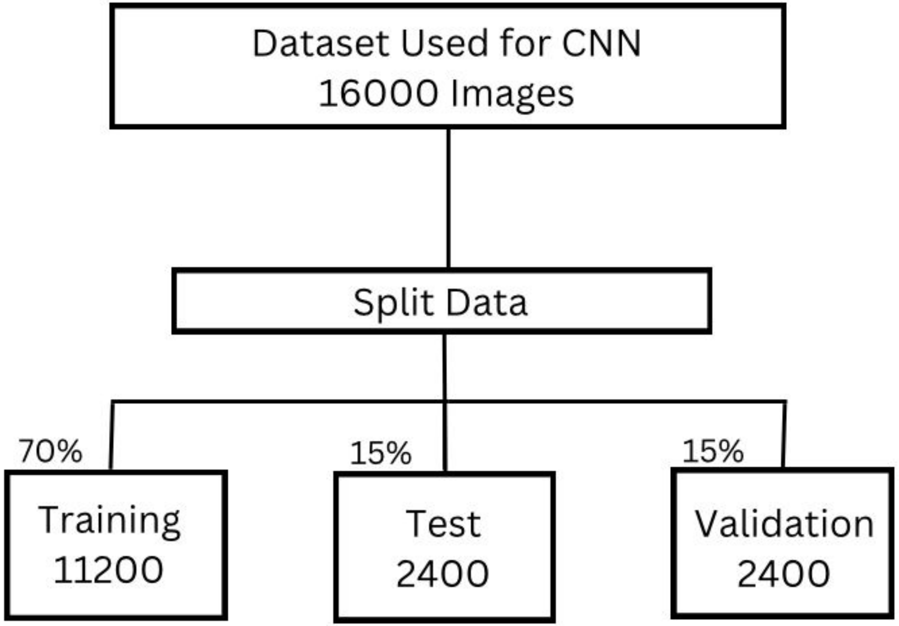
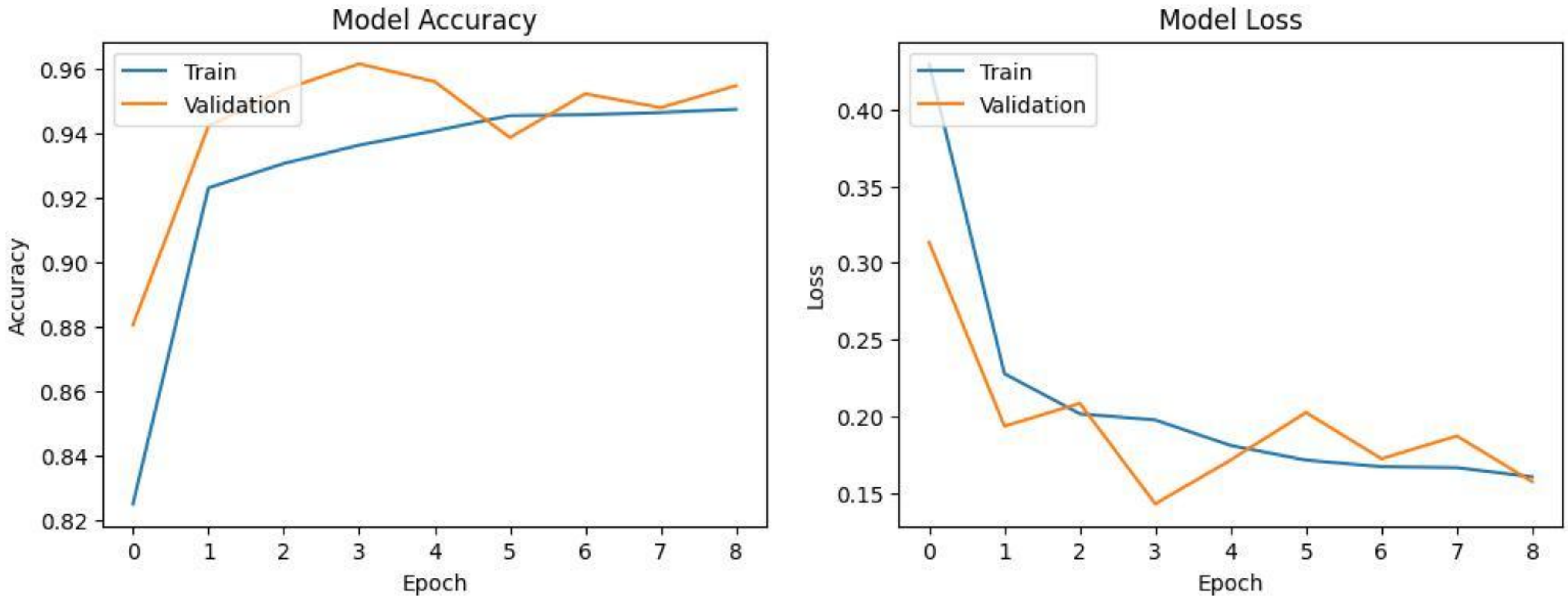
CNN Methodology

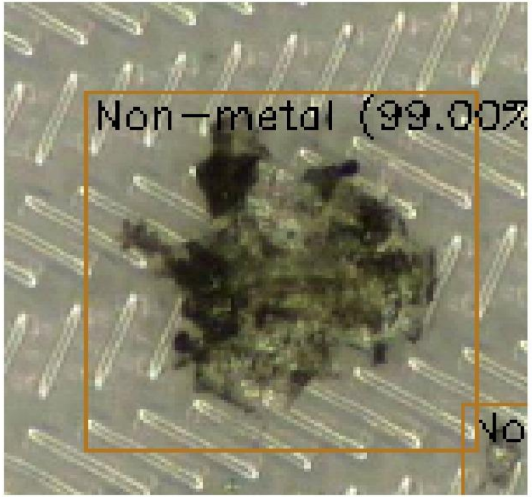


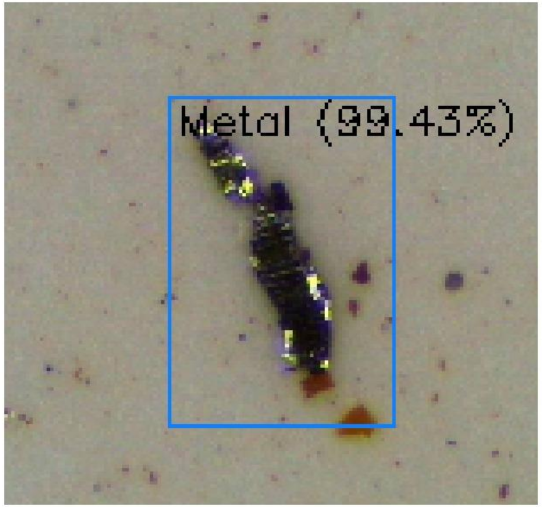
- 100 epochs
- **Batch size** - 32

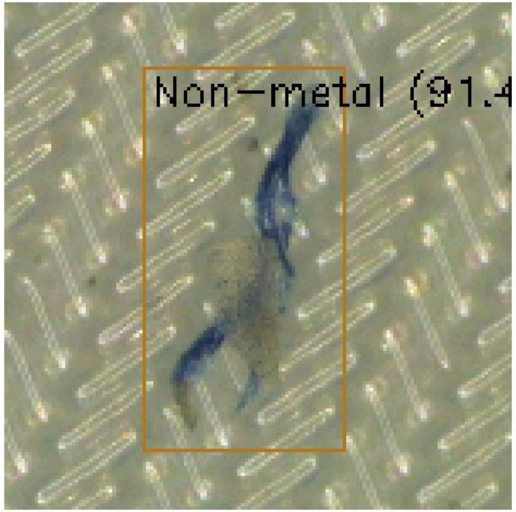
CNN Result


Model Accuracy
Train
Validation
Accuracy
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0
1
2
3
4
5
6
7
8
Epoch
Model Loss
Train
Validation
Loss
0.40
0.35
0.30
0.25
0.20
0.15
0
1
2
3
4
5
6
7
8
Epoch

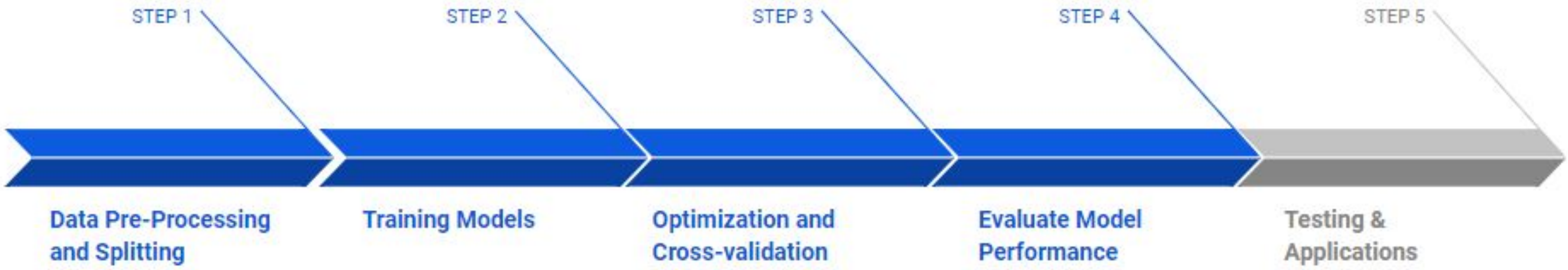
CNN Result







Project Flow Timeline Achieved



Conclusion

- We addressed the significant quality issues in industries caused by contaminants, particularly metals.
- To tackle this challenge, we employed YOLO and CNN models for particle analysis and compared their results.
- Custom trained YOLO v8n model (n = nano) (base model) trained over 3.2 M parameters, demonstrated its ability to accurately identify and classify particles, as shown by the validation and training results. The model shows an accuracy of 75%.
- The CNN model, trained over 100 epochs with a batch size of 32, also showed promising results, showing an accuracy of 95% which is better than YOLO v8n.
- The graphical user interface we developed further supports practical application and user-friendly interaction with the models.

Future Work

- In our future work, we plan to test our models on phone images, which are lower resolution compared to the high-resolution microscopic images. Now, we will use **Transfer Learning.**

  This will involve:

  - Adapting our models to handle lower resolution images while maintaining accuracy.
  - Implementing techniques to enhance the quality of predictions on phone images.
  - Achieving a high accuracy for particle analysis on these lower resolution images, similar to the results obtained with microscopic images.

- By extending our model's capabilities to more commonly available imaging devices, we aim to make particle analysis more accessible so that anybody with PartikelART mobile app will able to identify the particles easily.

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References

1. YOLOv8 Model *https://github.com/ultralytics*, author = {Glenn Jocher, Et al.}, year = 2023, url = {https://github.com/ultralytics/ultralytics}

2. Scikit-learn, author = {Pedregosa, Et al.}, year = 2011

3. Matplotlib, author = {Hunter, Et.al.}, year = 2007

4. Tensorflow, author = {Paul and Chen, Et. al.}, year = 2016

5. NumPy, author = {Charles R. Harris, Et al.}, year = 2020

6. OpenCV, author = {Bradski, G., Et.al.}, year = 2000

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Q&A!