Erythroblast Cells: ML Models for Multiclass Classification in Single Image and Mixed Magnification.

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DH 307: R & D Project

Week 4

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Overview

1. Task Overview
2. Paper Review
3. Findings and Results
4. Conclusion
5. Plan for This Week

Task Overview

- Overview of the YOLO architecture
- Loss functions and optimization during training
- Model validation and performance evaluation
- Predictions on augmented images

YOLOv11 Architecture for Object Detection

- **No Official Paper**: YOLOv11 lacks a publicly available official paper or architectural diagram.
- **Backbone**: Uses the C3k2 block for feature extraction, an improvement over C2f in YOLOv8.
- **Neck**: Includes Spatial Pyramid Pooling Fast (SPPF) for multi-scale feature representation and C2PSA (Parallel Spatial Attention) for better feature extraction.
- **Head**: Similar to YOLOv10, optimized for detecting objects at different scales.
- **Enhancements**: Improved attention mechanisms and efficiency optimizations for real-time detection.

YOLOv11 Architecture

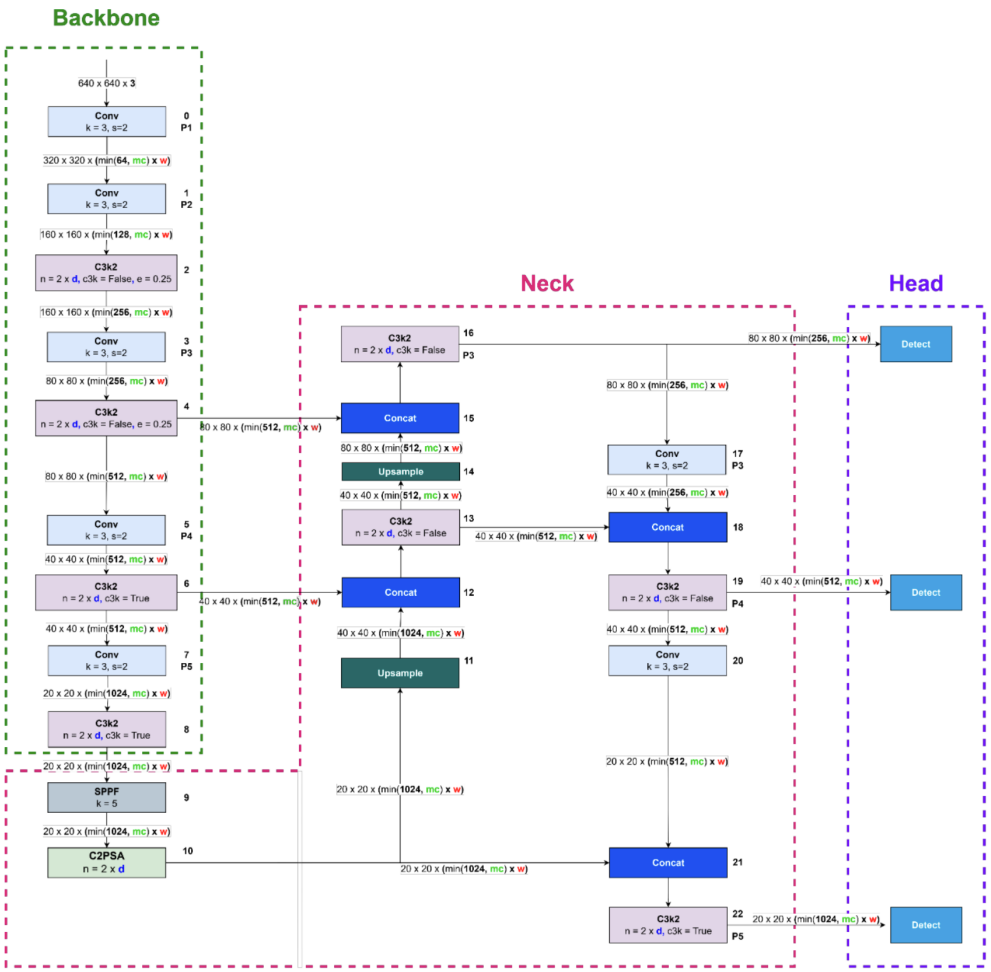

Figure: YOLOv11 Architecture

YOLOv11 Loss Functions

- **Class Probability Loss (L_{cls})**
  - Measures classification accuracy.
  - Uses Binary Cross-Entropy (BCE) loss.
- **Bounding Box Regression Loss (L_{box})**
  - Ensures predicted bounding boxes align with ground truth.
  - Uses IoU-based losses for better localization.
- **Distribution Focal Loss (DFL) (L_{dfl})**
  - Refines bounding box predictions by treating coordinates as probability distributions.
  - Improves precision, especially for small objects.

Total Loss Function:

$$L = L_{cls} + L_{box} + L_{dfl}$$

Findings and Results for Individual Images

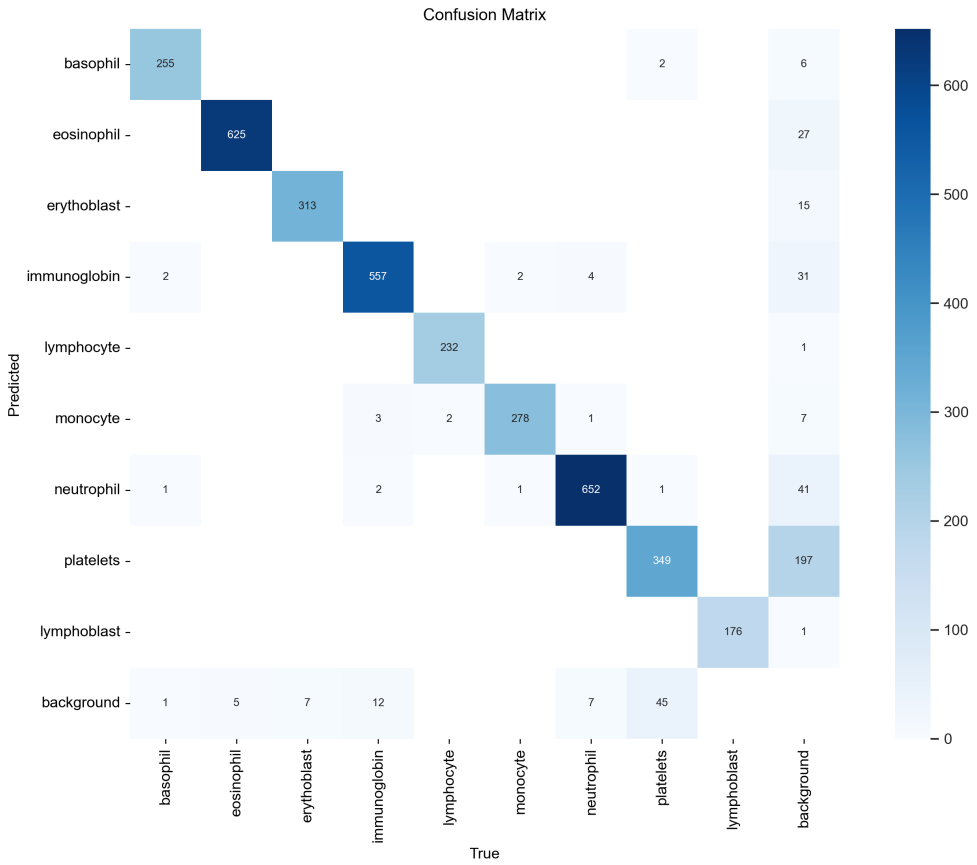

Figure: Confusion Matrix for Individual Images

We observe that the false positives for Platelets is relatively high.

Findings and Results for Individual Images

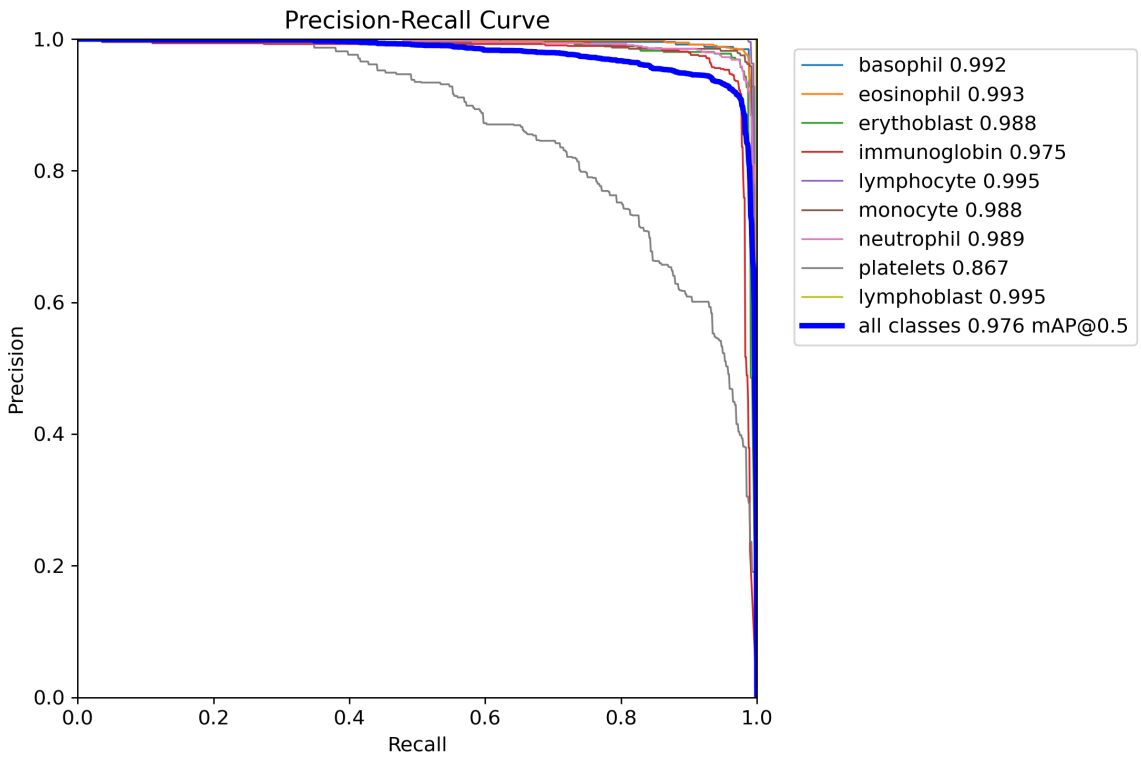

Figure: Precision-Recall Curve for Individual Images

We observe that the Platelet performance is relatively poor.

Findings and Results for Individual Images

Poor detection is due to an increased number of missing and incorrect labels for platelets.

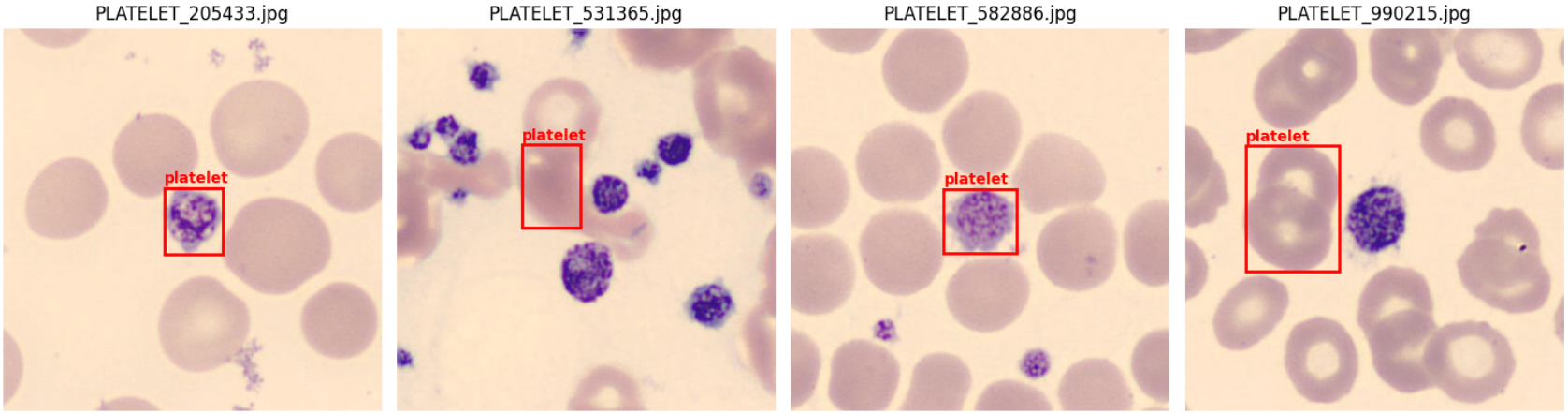

Figure: Ground Truth Labels for Platelets

Findings and Results for Combined Images

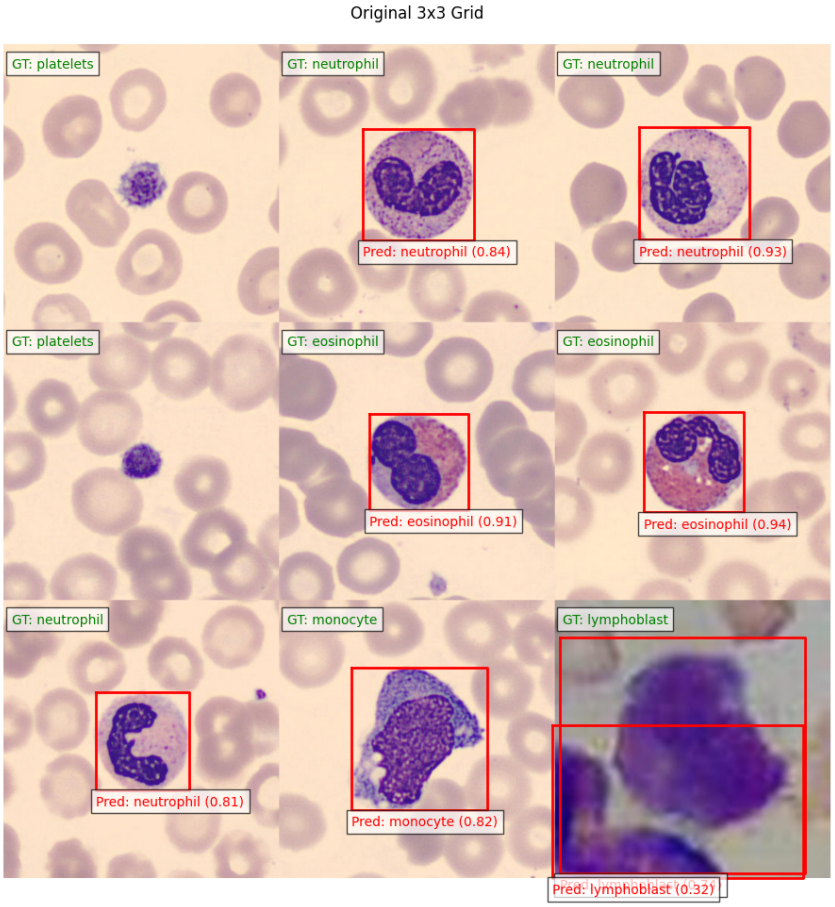

Figure: Detection on a 3×3 Combined Image

Findings and Results for Combined Images

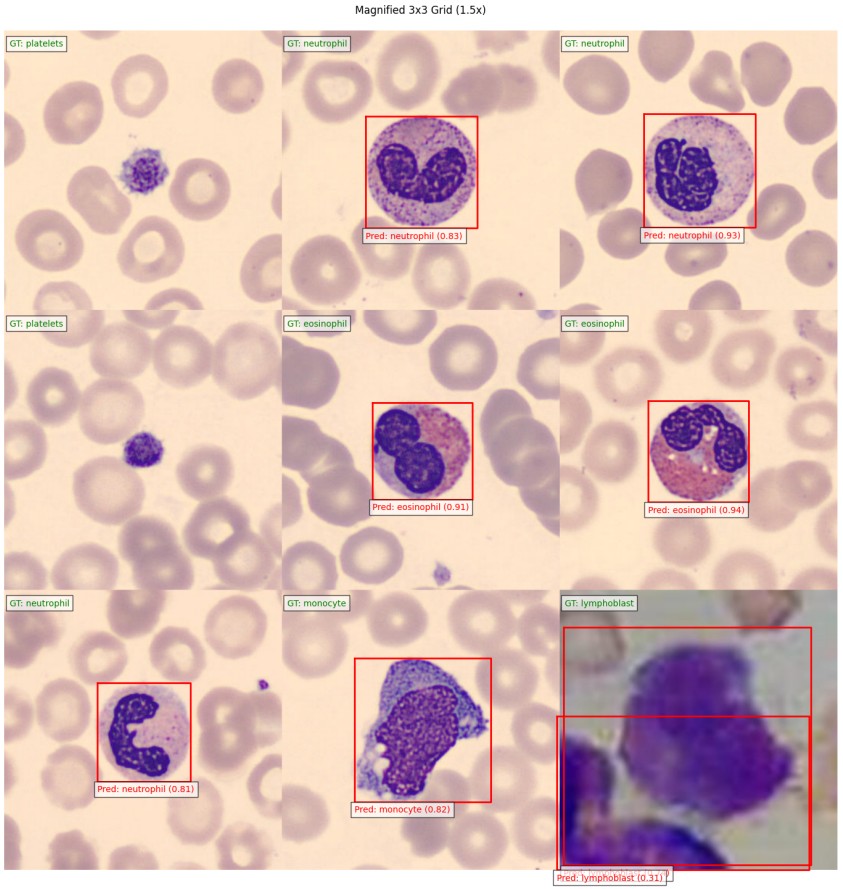

Figure: Detection on a Magnified 3×3 Combined Image

Findings and Results for Combined Images

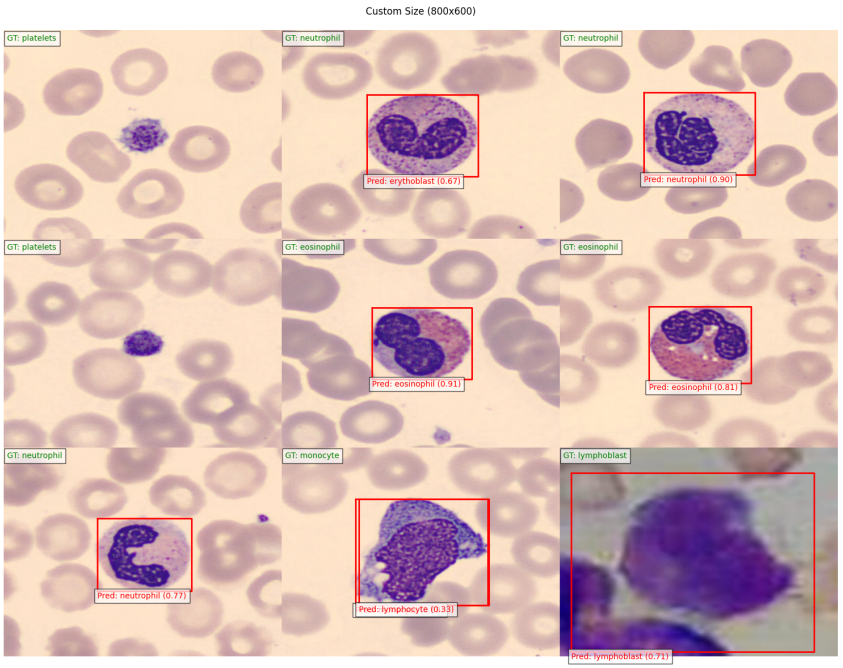

Figure: Detection on a Custom 800×600 Combined Image

The prediction accuracy decreased after resizing the image.

Findings and Results for Combined Images

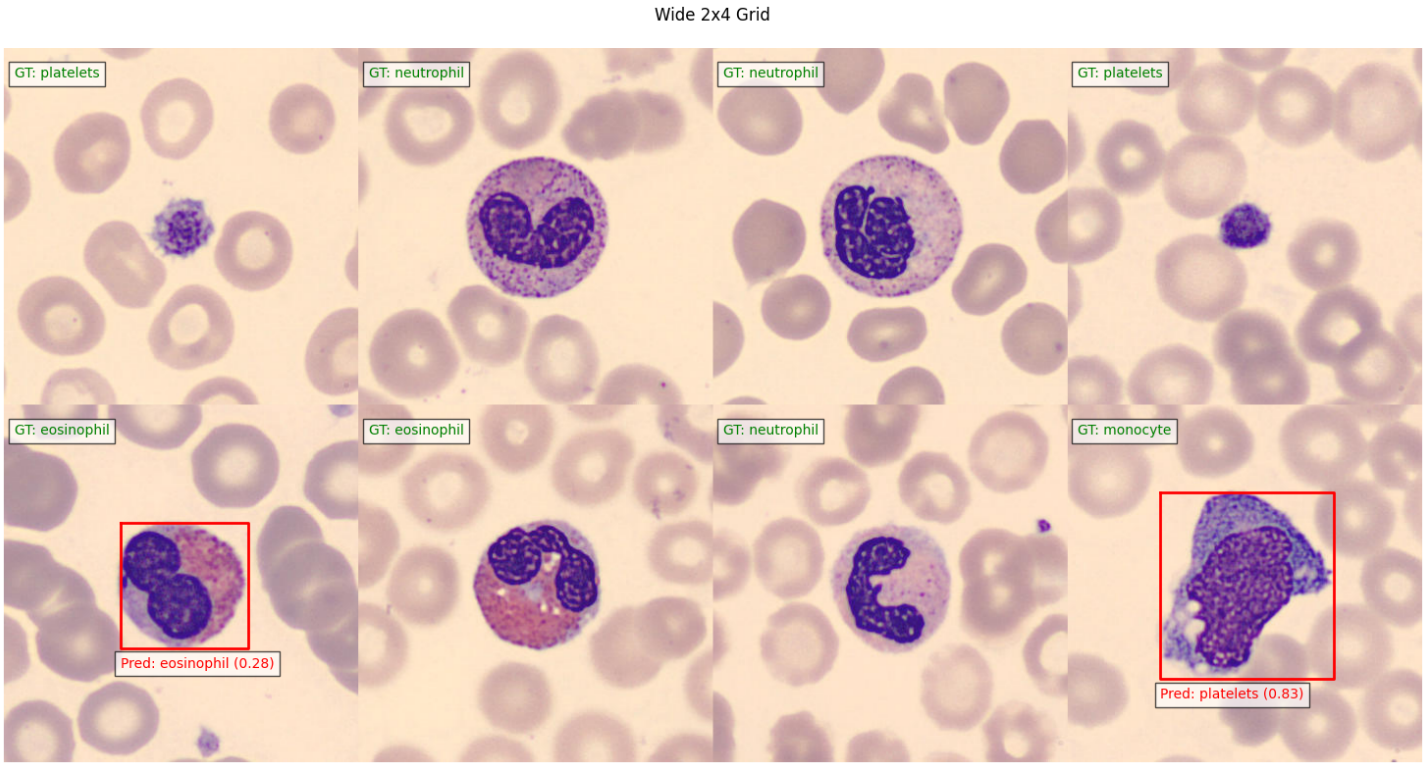

Figure: Detection on a 2×4 Combined Image

Findings and Results for Combined Images

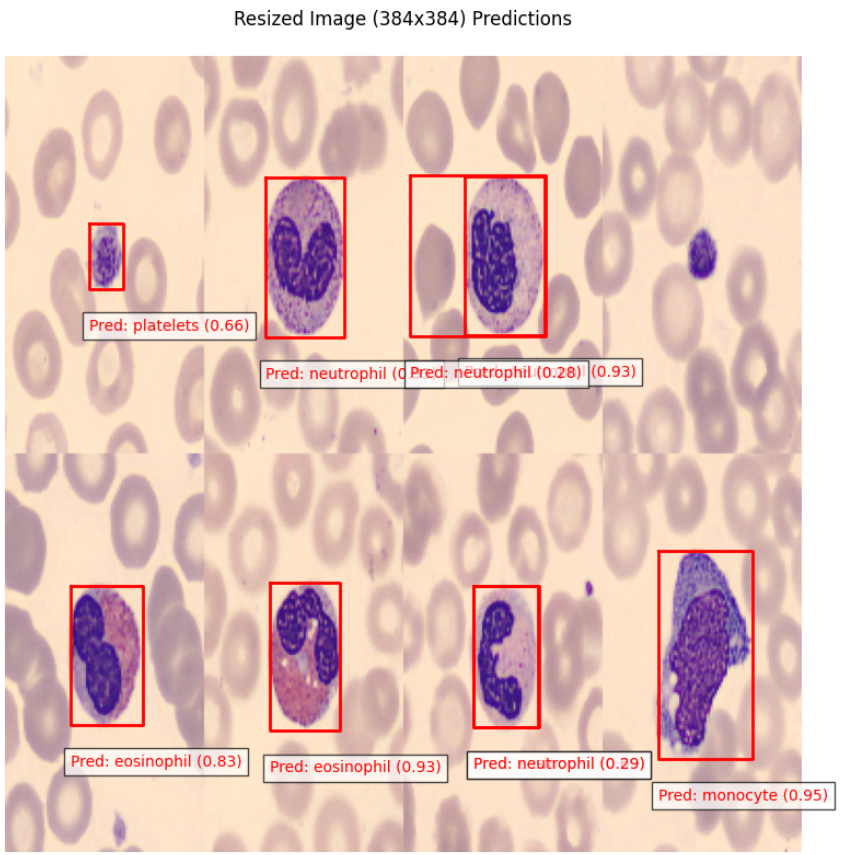

Figure: Detection on resized 2×4 Combined Image

The prediction improved after resizing to 384×384.

Conclusion

- The model was trained for 100 epochs.
- It performed well on both individual and combined images.
- The ground truth (especially for platelets) needs correction for improvement.
- The prediction on magnified images did not show significant deterioration.
- The model exhibits some bias when predicting on different image sizes (e.g., poor performance on 2×4). This can be improved by applying various augmentations provided by Ultralytics, such as mosaic, mixup, and copy-paste.

Plan for This Week

- **Data Curation:**
  - Identify and remove incorrectly labeled data.
  - Augment the dataset if necessary to improve model generalization.
- **Model Fine-Tuning:**
  - Train the model on combined images to assess improvements in multi-class detection performance.
  - Fine-tune the YOLO model using the curated dataset.

References

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