

Objectives

Goal: Detect dental pathologies in panoramic X-rays using CNNs

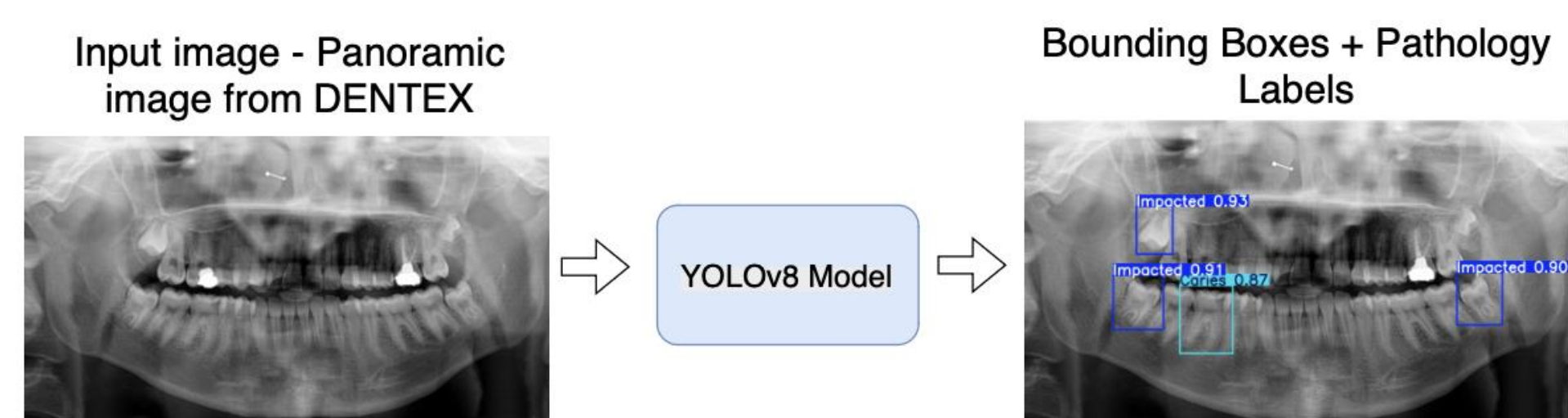
Motivation: Manual analysis is time-consuming and subjective → automation improves accuracy and efficiency

Approach: Train YOLOv8 and ResNet18 on DENTEX dataset with bounding boxes and classification labels

Problem

- Panoramic dental X-rays are **complex and dense** medical images used in routine diagnostics
- Manual analysis is **slow, subjective**, and **requires expert training**
- Automatic detection could **reduce workload** and **increase diagnostic consistency**

Methodology

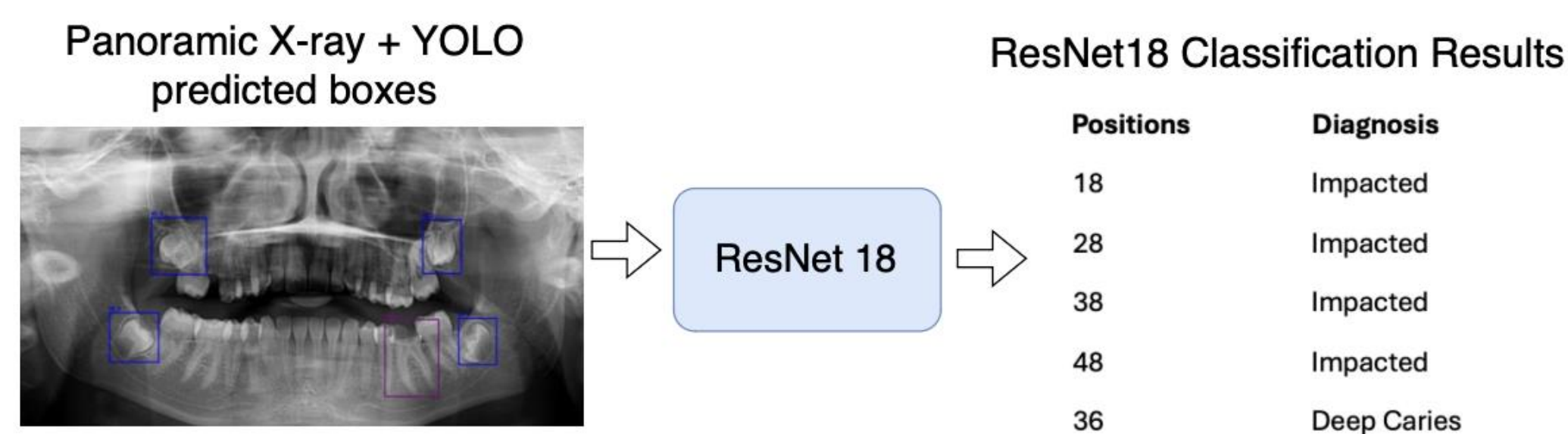


Methodology 1: Object Detection using YOLOv8n

Input: Full panoramic X-ray

Model: YOLOv8n object detector (Ultralytics)

Output: Bounding boxes + pathology class



Methodology 2: Classification using ResNet18

Input: Full panoramic X-ray

Bounding box (from YOLOv8) is used as **region label**

Model: ResNet18 pretrained on ImageNet, fine-tuned for pathology classification

YOLOv8 Detection: evaluate detection performance (mAP, precision, recall)

• **ResNet18 Classification:** compare classification accuracy using YOLO-guided labels

• **FP/image analysis:** assess false positive rate under confidence threshold

References

- [1] Hamamci, A., Kadioglu, S., Yildirim, A., Yildirim, M., & Toprak, A. (2023). DENTEX: An Abnormal Tooth Detection with Dental Enumeration and Diagnosis Benchmark for Panoramic X-rays. *arXiv preprint*, arXiv:2308.14545.
- [2] ForouzeshFar, M., Yao, Y., Karami, A., & MacIntyre, C. R. (2024). Dental Caries Diagnosis from Bitewing Images Using Convolutional Neural Networks. *Scientific Reports*, 14(1), 3025.
- [3] Faure, P., & Engelbrecht, H. (2021). Deep learning classification of panoramic dental X-ray image quality. *Computer Methods and Programs in Biomedicine*, 198, 105771.
- [4] Beser, F. A., Kocasarac, H. D., Cakur, B., & Ari, M. (2024). Pediatric Tooth Detection and Segmentation in Panoramic X-rays Using YOLOv5. *Journal of Digital Imaging*, 37(1), 152–160.

Datasets

We used the **DENTEX Challenge dataset**, which contains over 1,000 annotated panoramic dental X-rays.

Each image labeled with:

- Tooth quadrant
- Tooth number (FDI system)
- Diagnosis: Caries, Deep Caries, Periapical Lesion, Impacted Tooth

Format: Converted to YOLO object detection format

Split: 90% training, 10% validation (patient-wise)

Results

We trained a YOLOv8n model with 1024×1024 input resolution, and a two-phase schedule (frozen → unfrozen). The training stabilized after 100 epochs.

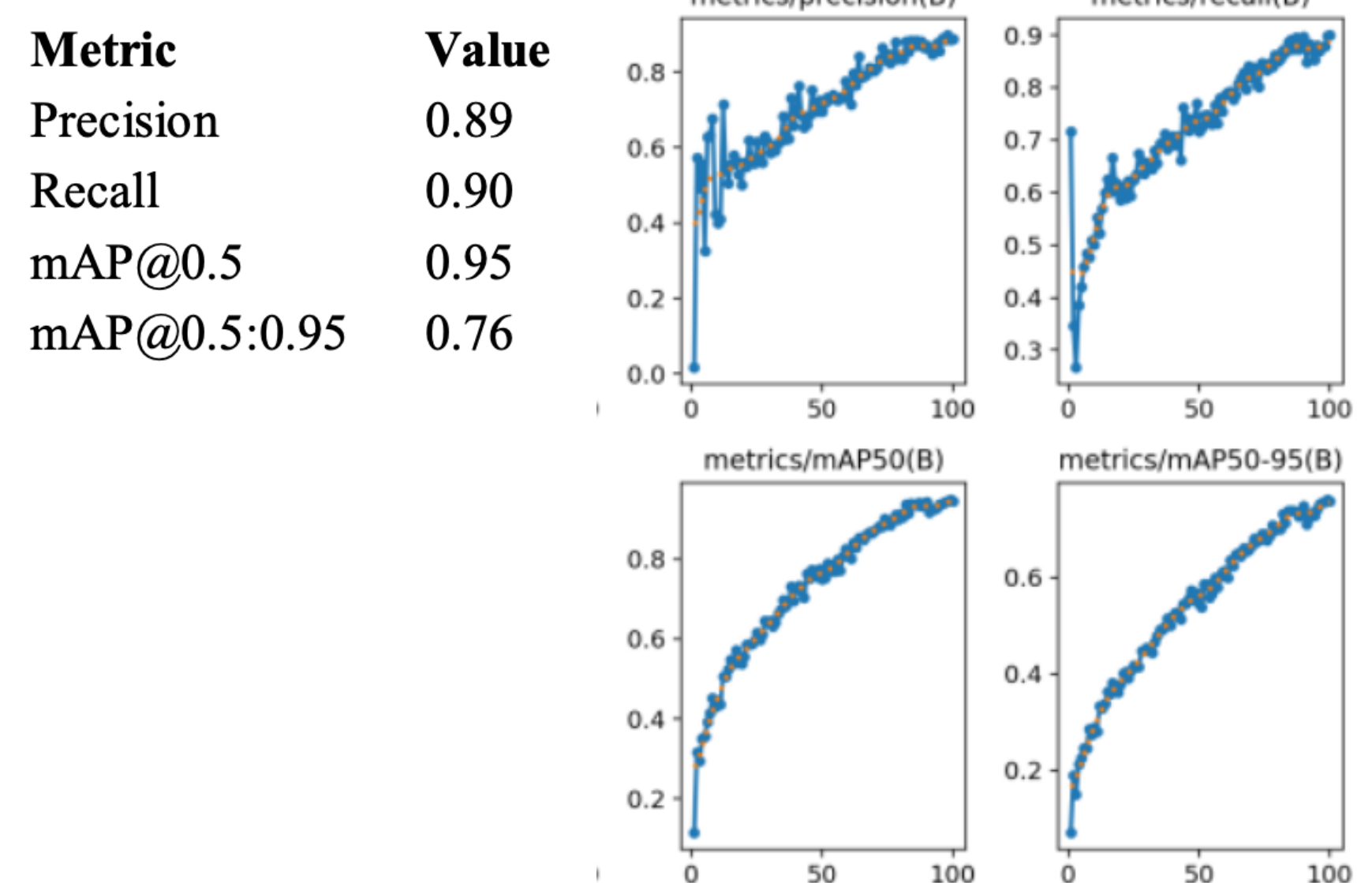


Figure: YOLOv8n validation metrics and learning curves

We trained a ResNet18 model using YOLOv8-predicted bounding boxes as weak supervision on full panoramic images.

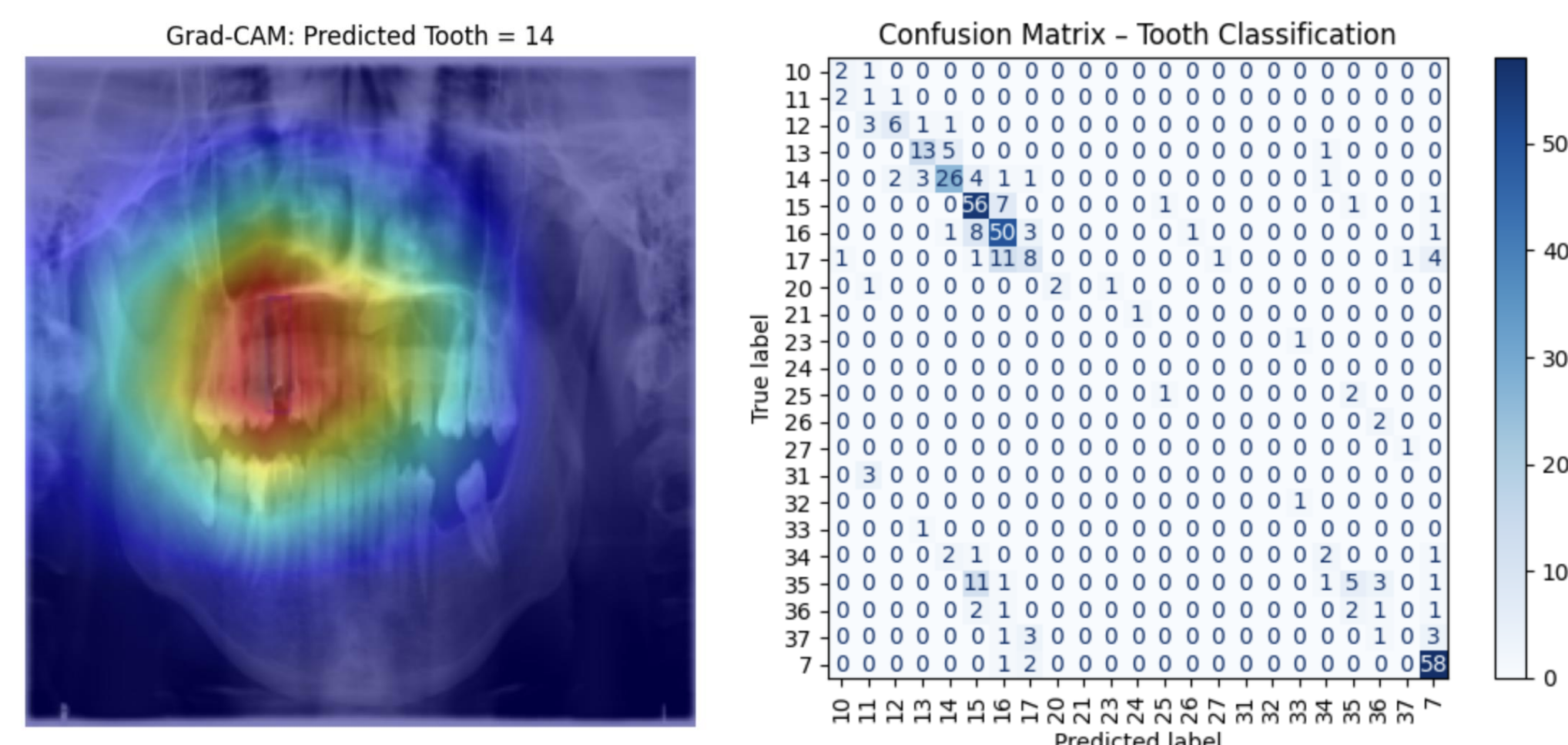


Figure: Grad-CAM visualization for ResNet18

Figure : Confusion matrix for tooth classification.

The updated ResNet18 model achieved 88.5% classification accuracy on YOLO-guided inputs.

Conclusions

Both models performed well given their designs and supervision. YOLOv8n achieved accurate localization of four dental pathologies, while ResNet18, trained on full panoramic images with YOLO-based labels, reached 88.5% accuracy. Future work includes fusing detection with classification and testing generalization on external datasets.