BRAUDE
College of Engineering, karmiel

# BAYU-NET

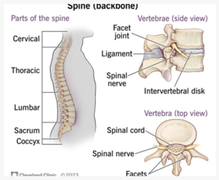
**Scoliosis analysis through Computer Vision Models**

**Students: Rafael Abbassov & Dvir Hayat**
**Advisor: Cohen Weiss Miri**

"הגב שלי עקום, אבל אני עומד זקוף בשביל אלה שכבר לא יכולים."

## Background

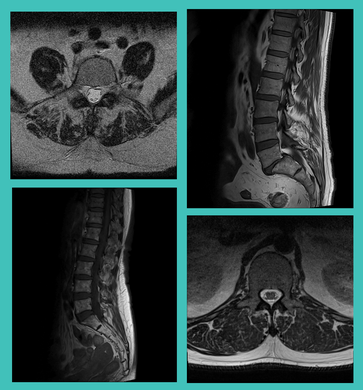
Scoliosis is a spine condition causing abnormal curvature, diagnosed by measuring the Cobb angle on spinal scans.


Manual analysis is time-consuming and inconsistent, while current automated methods often fail to handle complex spine structures reliably.

## Dataset

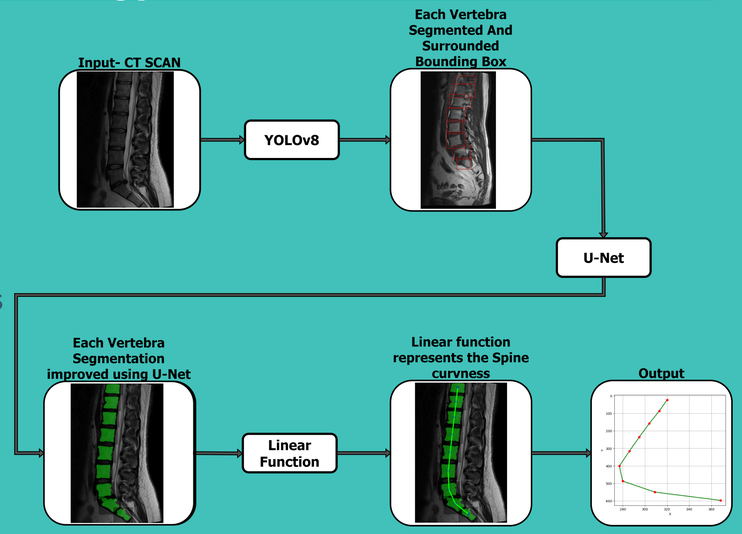
We used the **Kaggle Lumbar Spine 2024** dataset (~147,000 CT images) as our base. **Since it lacked vertebra-level annotations**, we **manually** labeled individual vertebrae using **Roboflow**, creating a **custom dataset** for detection (YOLOv8) and segmentation (Attention U-Net).

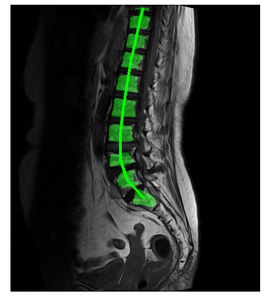


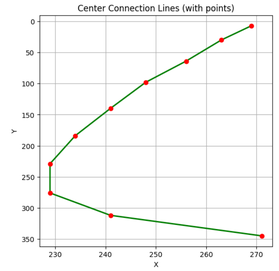
## Methodology

**Stage approach using CT scans:**

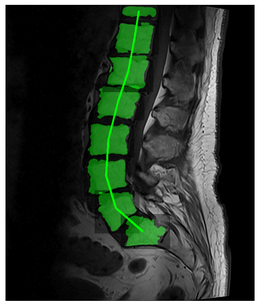
1. **Vertebrae detection** using **YOLOv8**
2. **Vertebrae segmentation** using **Attention U-Net**.
3. **Linear interpolation** using the **Vertebrae's centers** to model spinal **curvature**.
4. **Measurement** for scoliosis assessment.

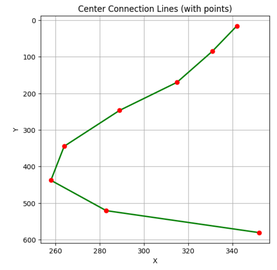




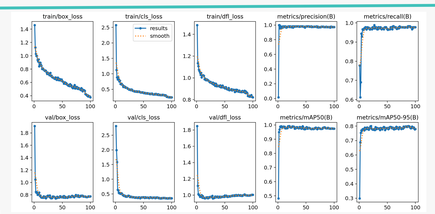

Comparison of two **different CT scans** used for scoliosis analysis – The **lower** spine shows **greater curvature**, as **reflected** in the corresponding **output graph**.





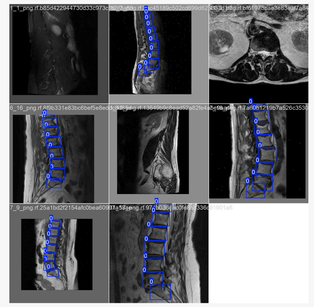

## Results

The **YOLOv8** model was trained for **100 epochs**. During training, both **precision** and **recall** quickly converged toward **1.0**, while the validation **mAP@0.5** reached **0.99** and **mAP@0.5:0.95** stabilized around **0.79**, indicating strong and consistent detection performance.




| Parameter / Result | Run 1 (50 epochs) | Run 2 (100 epochs) | Run 3 (200 epochs) |
|---|---|---|---|
| Epochs | 50 | 100 | 200 |
| Batch Size | 8 | 8 | 8 |
| Initial Learning Rate (pg0) | $1.670 \times 10^{-3}$ | $2.0 \times 10^{-5}$ | $3.0 \times 10^{-5}$ |
| Drop Rate (1 − mAP) (↓) | 0.20087 | 0.22034 | 0.42038 |
| mAP@0.5:0.95 (↑) | 0.77966 | **0.79913** | 0.57962 |

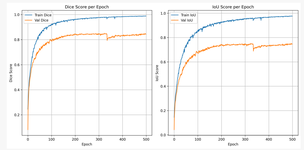
Table 1: Comparison of YOLOv8 training configurations and performance results.

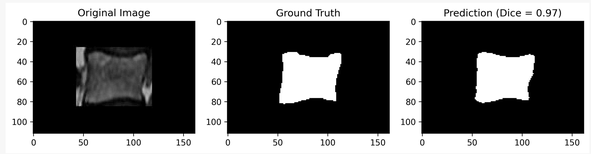


The **Attention U-Net** model was trained for **500 epochs**, achieving a **Dice Score** of **0.97** and an **IoU** of **0.94** on the best run. Performance was evaluated on both training and validation sets, showing a **stable learning trajectory** with **no overfitting**. The training and validation loss curves decreased steadily, confirming strong model convergence and segmentation accuracy.

| Parameter / Metric | Run 1 | Run 2 | Run 3 | Run 4 |
|---|---|---|---|---|
| Epochs | 500 | 200 | 100 | 100 |
| Batch Size | 8 | 8 | 16 | 8 |
| Learning Rate | $5 \times 10^{-6}$ | $1 \times 10^{-5}$ | $1 \times 10^{-4}$ | $1 \times 10^{-5}$ |
| Dice Score | **0.97** | 0.97 | 0.91 | 0.95 |
| IoU Score | **0.94** | 0.80 | 0.95 | 0.80 |

Table 2: U-Net training configuration and performance comparison.




## Full Project Pipeline:


## Conclusions

Although trained on a relatively **small, manually labeled dataset**, our framework achieved **high accuracy** in both **vertebra detection** and **segmentation**.

The results highlight the effectiveness of our staged **architecture** and **preprocessing** strategy.

Expanding the dataset with **more diverse scans** would likely improve the model's **generalization and robustness**.

In the future, access to **larger datasets** with **annotation** could enable the development of a fully **generalized spine analysis** pipeline, including **automated scoliosis detection** and **severity assessment**.