

CNN-based Detection of Osteoporosis from Knee X-ray Images

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Background

Osteoporosis is a significant global issue characterized by **decreased bone density** and **increased fracture risk**, particularly among postmenopausal women and older adults. By leveraging advanced technologies like **CNNs**, we aim to enhance the accuracy and efficiency of osteoporosis diagnosis. Our research project goal is to provide doctors with a valuable tool that can aid in early detection and intervention, ultimately improving **patient care** and **outcomes**.

EfficientNet

EfficientNet is an advanced deep learning architecture known for its superior **performance** and **efficiency**. It incorporates a scaling method and **compound coefficient technique** to enable precise adjustments of **depth, width, and resolution**, making it a highly effective model for various tasks in **image classification**.

YOLOv5

YOLOv5 is an **object classification** model that belongs to the **YOLO** (You Only Look Once) family of algorithms.

Grad-CAM

Grad-CAM (**Gradient-weighted Class Activation Mapping**) is a technique used for visualizing and **understanding the decisions** made by convolutional neural networks (CNNs) in the context of image classification tasks.

App Development



Initial prototyping of the app for end users was done via **Django**. The interface was very basic and linked to our **PyTorch** backend detection pipeline.

This was then further developed into an App using **Swift**. Features such as variable transparency and upload history were implemented.

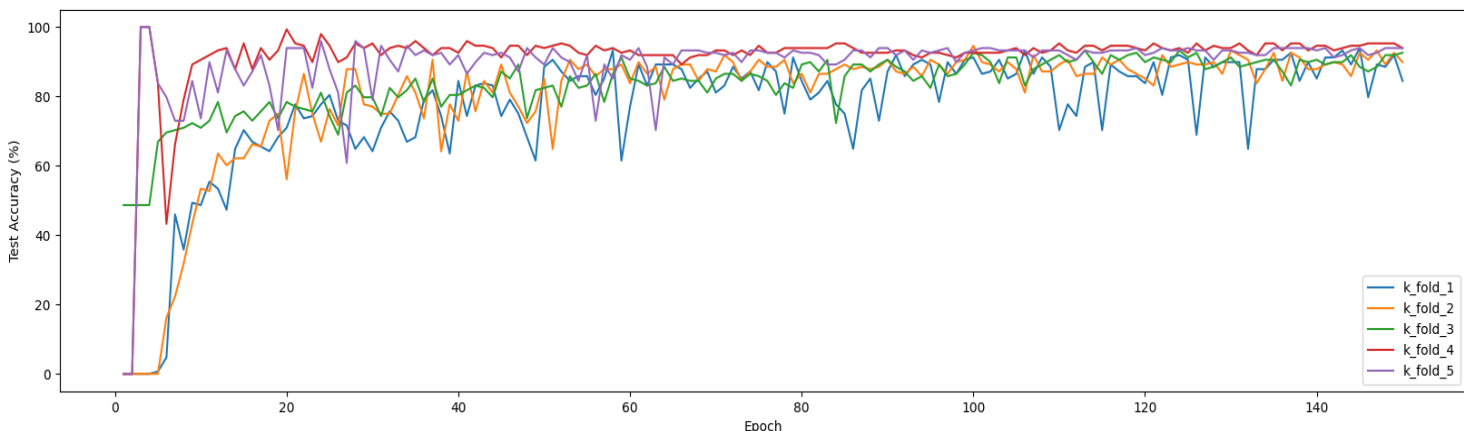
EfficientNet Model Accuracy

YoloV5 Model Accuracy

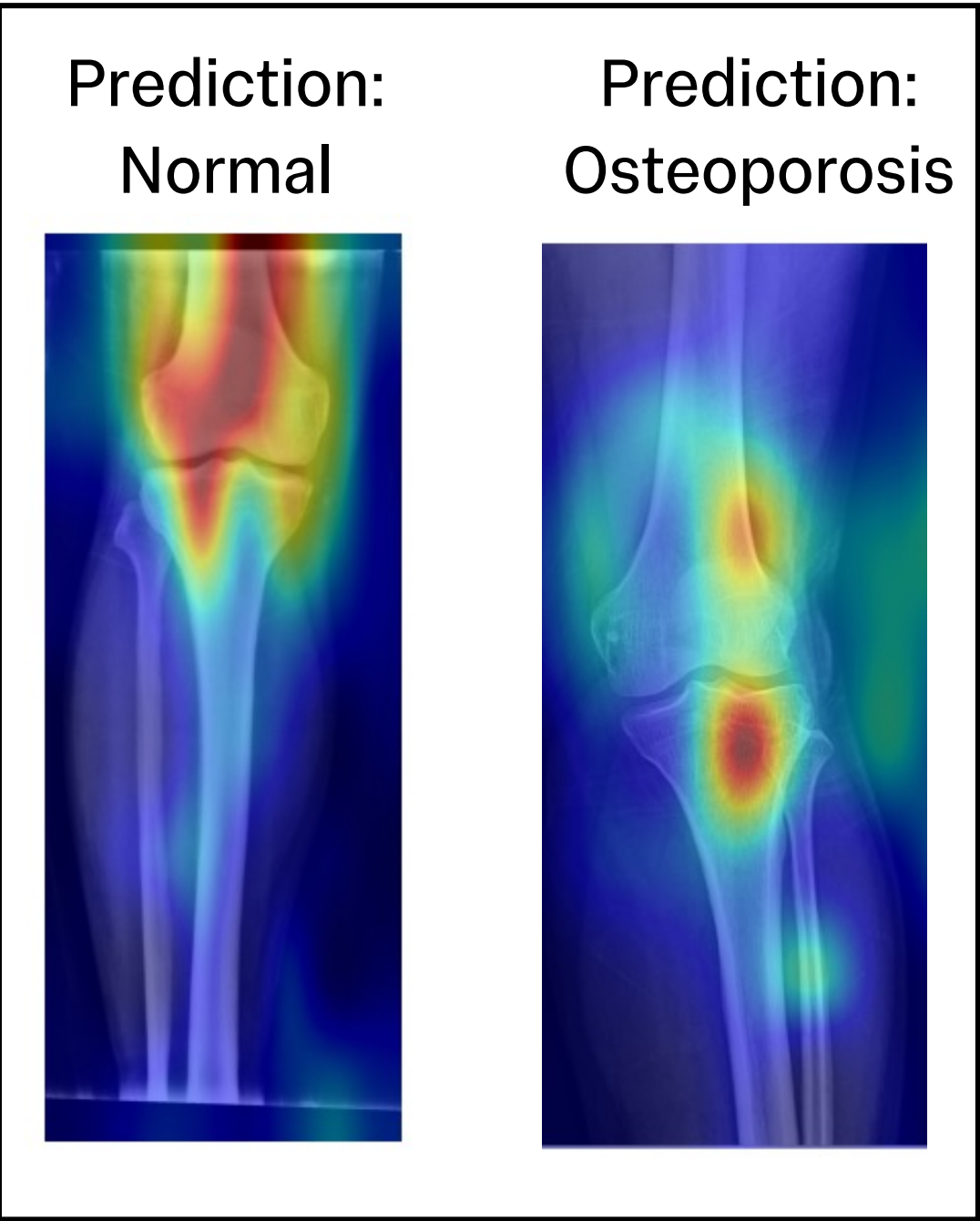
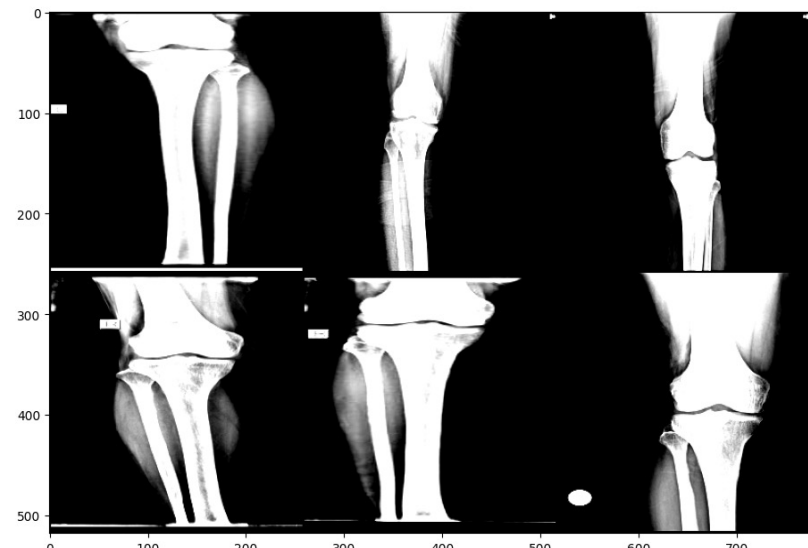
Images in Dataset

95% 83% 742

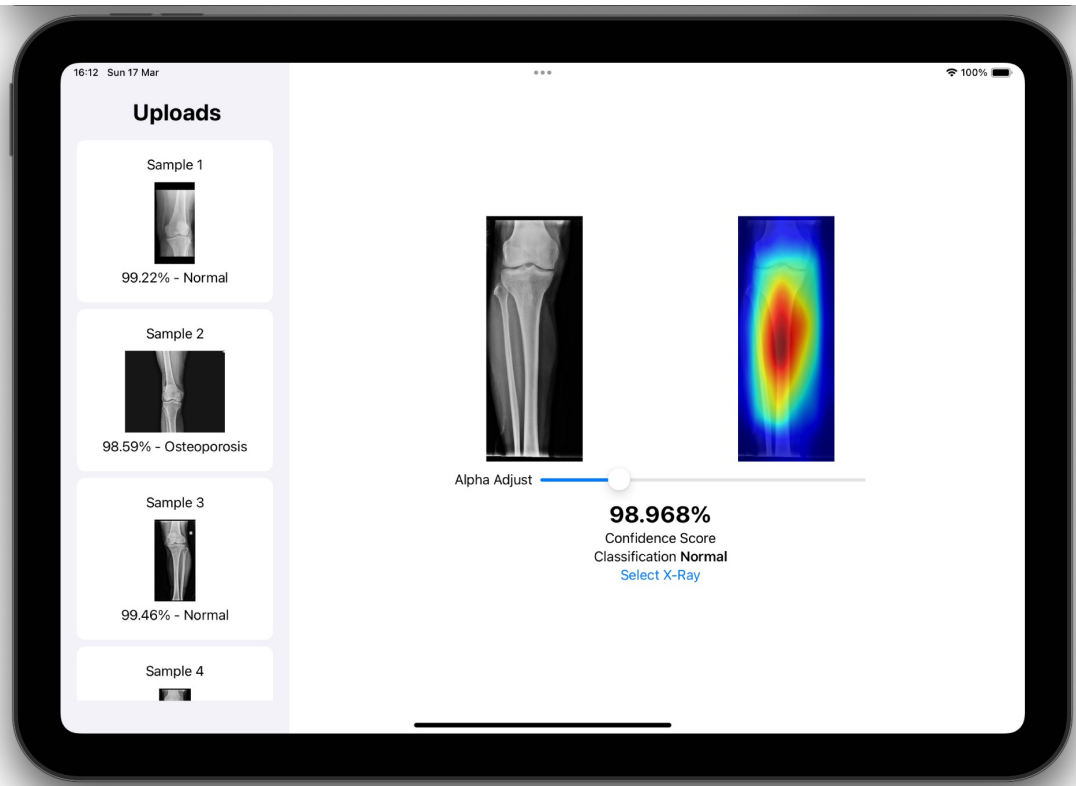
Detection Pipeline



Cross-validated
EfficientNet / YOLOv5
Model (using Augmented Data) + Grad-CAM
Implementation



GRAD-Cam analysis of two images. Highlighted areas show what is causing the biggest influence on the score. Overall, the models were able to correctly identify unique features within and on the border of bone structures



Conclusion

Through investigation of the CNN image classifiers in **PyTorch**. We have found a fairly accurate model for our dataset allowing us to detect whether osteoporosis is present in an image.

An **improvement to this research study** would be more extensive data from different reliable sources. Expert opinion on the image's **Grad-CAM** output would also be valuable.