Automated Scoliosis Detection and Measurement

Automated Algorithm Design - VIP

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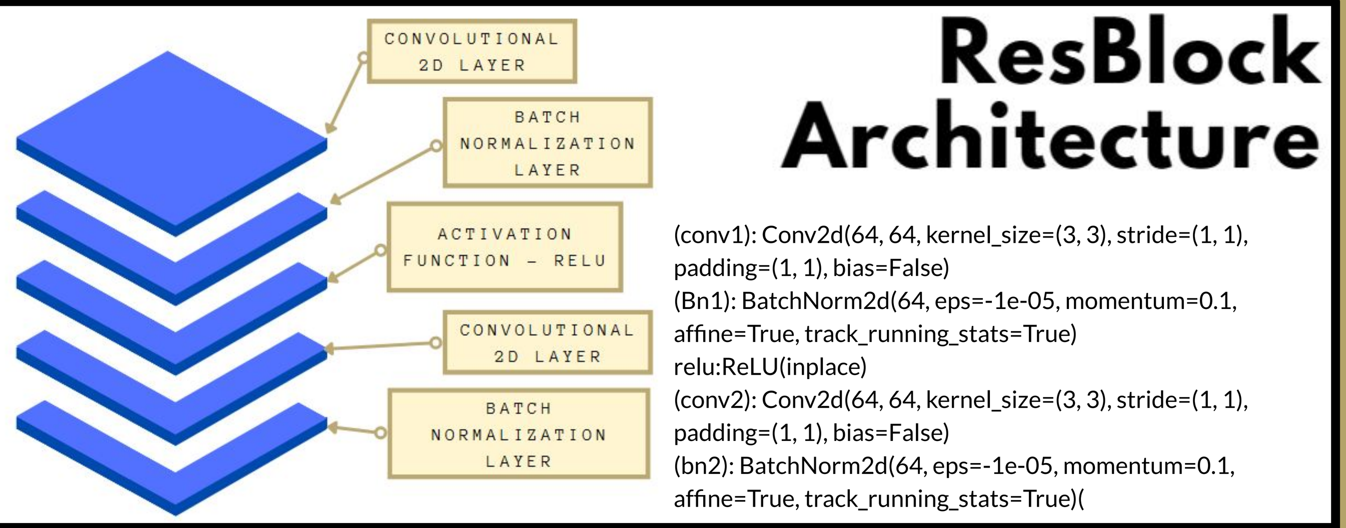
Abstract

Adolescent Idiopathic Scoliosis (AIS) is a common form of scoliosis affecting children ages 10-18, which can lead to pain and further medical complications. The standard measure of scoliosis cobb angle, the angle created by the most tilted pair of vertebra.

We propose the use of a neural-net model to predict vertebra landmarks from x-ray images to calculate cobb angle. We use this model as a foundation to build individuals using an evolutionary algorithm engine. By introducing novel neural net components from various models across literature, we can increase the accuracy of cobb angle detections.



Tools

Our data and code is held in Microsoft Azure, a cloud computing service. Azure's cloud technology allows us to use a powerful computing environment and a secure location to store related data.

Within Azure, we are using the Evolutionary Multi-Objective Algorithm Design Engine (EMADE), which utilizes genetic programming to develop models that are optimized for our defined goals.

We are also making use of machine learning libraries, such as Keras. Keras is a deep learning API allowing us to build neural networks in Python.

Methods

Using EMADE, we will develop novel neural network structures for Cobb Angle measurements.

EMADE will produce various models, which we can score based on evaluation functions. It then uses these evaluations to develop more models that optimize for them.

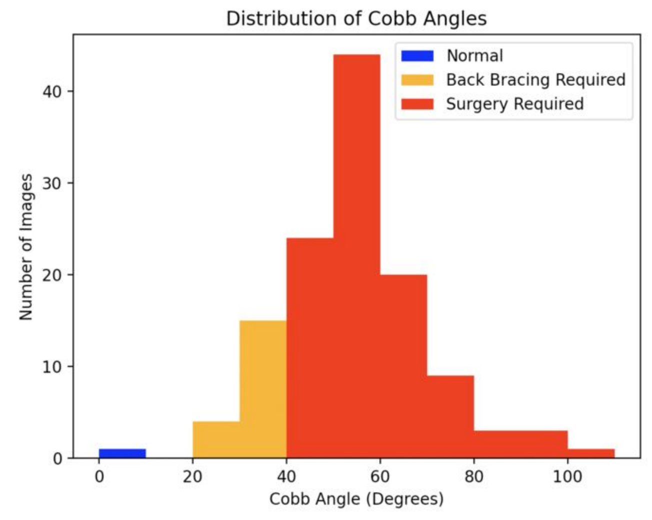
SMAPE: Symmetric Mean Absolute Percentage Error is our primary evaluation function.

$$SMAPE = \frac{100}{n} \times \sum_{i=1}^{n} \frac{\left|Y_i - \widehat{Y_i}\right|}{\left(|Y_i| + |\widehat{Y_i}|\right)/2}$$

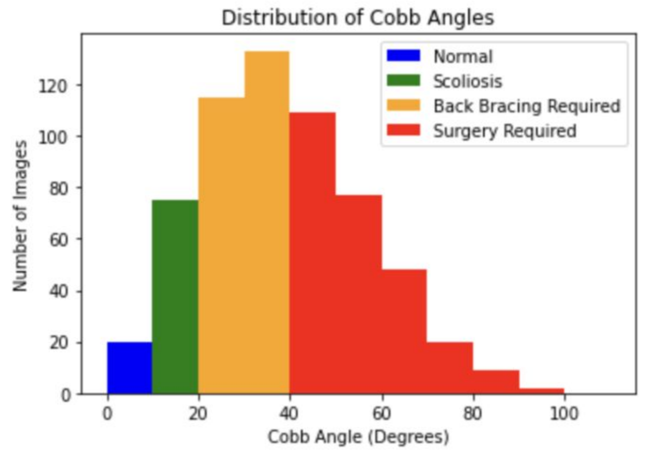
Note that it can quantify both under and overestimates with percentage error; however, it does not necessarily treat them equally. (It weights underestimates more heavily)

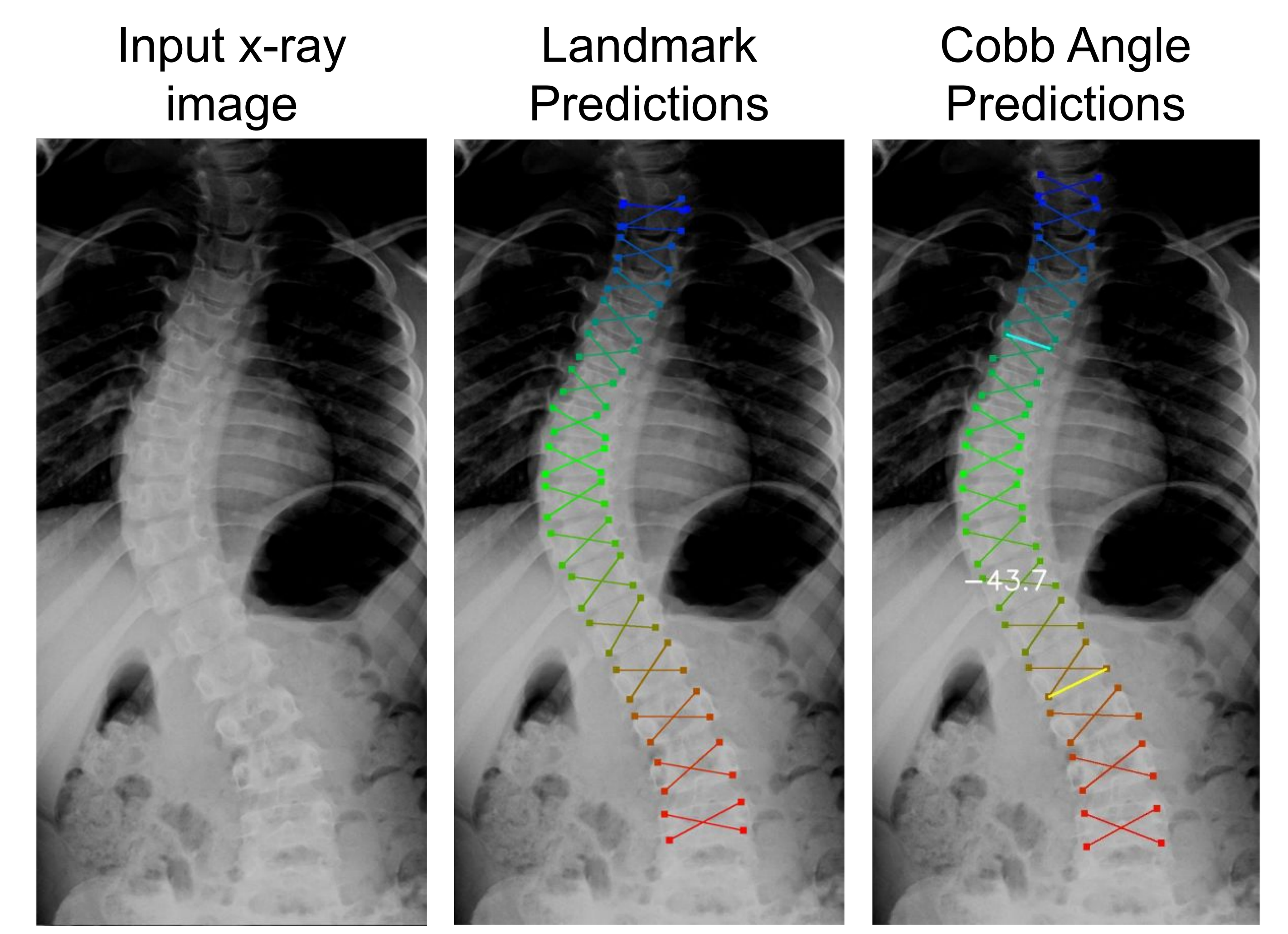
Dataset

AASCE Dataset:
Collection of x-ray image labelled with Cobb Angle Calculations from human radiologists. Part of the 2019 AASCE MICCAI Challenge to encourage development of automated estimators of spinal curvature.



Shriners Dataset:
Collection of x-rays provided by the Shriners Hospitals for Children. Images will be used for evaluation of individual algorithms produced.





Results

We were able to replicate the results of the VFL model on the AASCE dataset and make predictions on Shriners images. Runs of the model on Azure yielded a SMAPE of 9.06 on the AASCE dataset and 16.5 on the Shriners image set.

Future Work

Our current goal is to reconstruct the model architecture with neural net lays in keras to use EMADE to evolve over the architecture to improve the landmark identification accuracy of the models. Since the 2020 paper which provided the foundational model for our work, there have been other similar models, some directly inspired by the same paper, which have incorporated many of the same core architecture elements as the VFL model. We would likely study these models further and incorporate their changes to expand the search space for the algorithm evolution.