Pediatric bone age prediction using hand radiography-a deep learning approach

Application of machine learning in healthcare is ever increasing. The use of the machine learning to detect lesions from radiographic images, such as MRI, CT scan, and X-ray, is growing. Bone age is an indicator of child's skeletal maturity. A child's bone age may or may not exactly match with the child's age according to his or her birth date. Many factors, such as, nutrition, genetics, hormones, and disease states, influence the development of the skeletal [1]. The bone age study can tell how fast or slowly a child's skeleton is maturing [2] and it can also provide useful information on many other clinical concerns. Current solutions available to predict bone age are either manual and time consuming or performance highly depends on the quality of the images. Researchers have started predicting the bone age using the deep learning model.

Data

A deep leaning model was trained using the data set provided in the Pediatric Bone Age Challenge (2017) organized by the Radiological Society of North America (RSNA). The data set can be downloaded from.

The data set includes 12,611 hand radiographs (X-ray) for training; 1,425 hand radiographs for validation; and 200 hand radiographs for testing. The data set also includes three CSV files, one for each training, validation, and test data, and contain image number along with skeletal age and sex. The skeletal age was obtained from the accompanying clinical radiology report provided at the time of imaging.

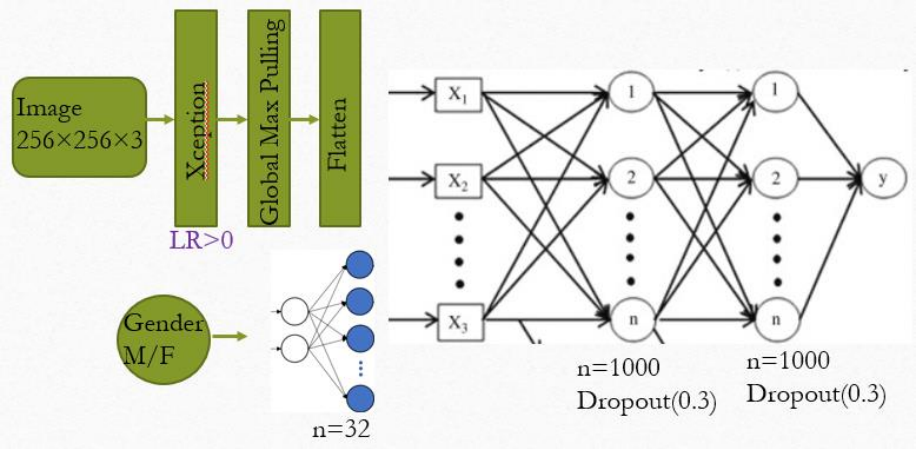
The images come with variety of backgrounds, with different intensities, borders, angles, shapes, multiple backgrounds. The size of image is ranging from few hundred pixels to a few thousand pixels. Therefore, images were preprocessed to clean up the background and to make all images square and same size.

Model Inputs

- Child's hand radiography
- Child's gender information

Model Architecture

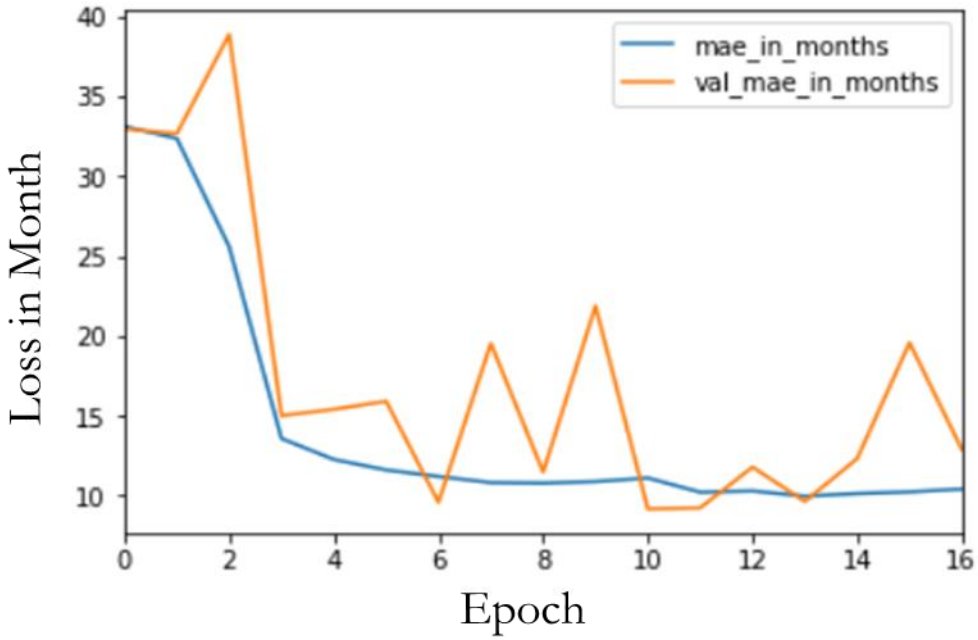
A deep learning model is constructed using a pretrained Xception and fully connected layers as shown below.



The input images were augmented before feeding to the model. The model architecture has a single out, which is the predicted bone age.

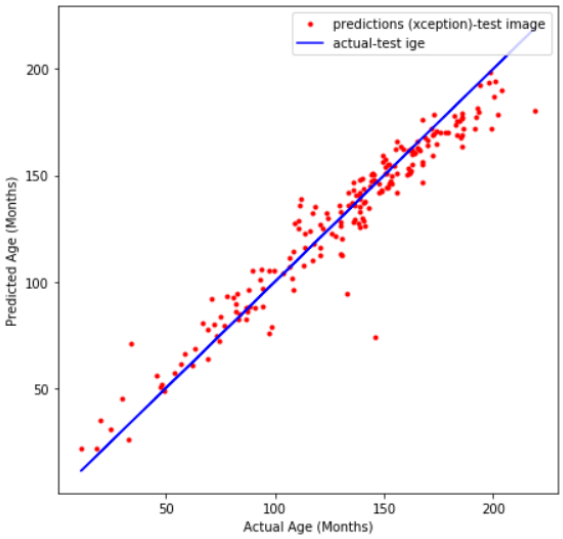
Model Training

Model was trained with 'mse' loss and 'EarlyStopping', 'ModelCheckpoint', 'ReducedLROnPlateau' callback function for 20 epoch. The training and validation loss with epoch number is presented below



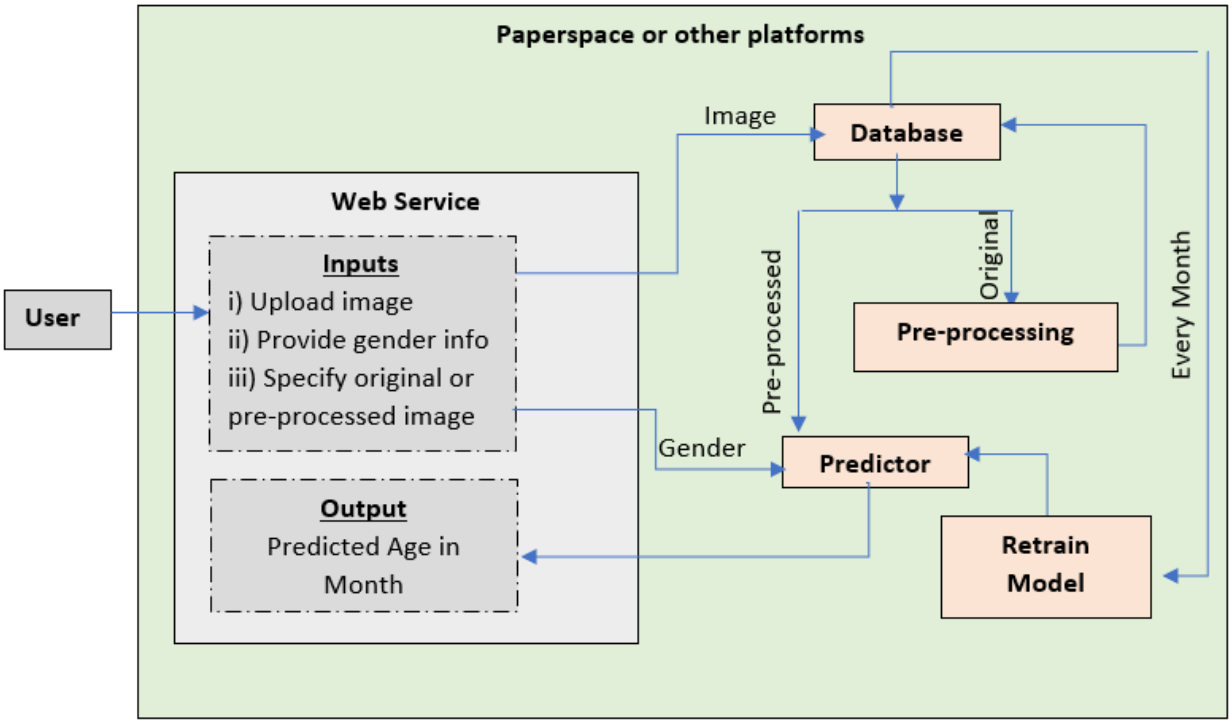
Model Evaluation on Test Data

Mean absolute distance (MAE) of the test images is 8.2 months.



Deployment Architecture

Model is deployed in the Paperspace platform using Flask API. Deployment architecture is as shown below.



Conclusion

Preliminary results of the application of deep learning model for the bone age prediction is promising. Deep learning model can be used for pediatric bone age prediction. As deep learning model is being successful in many sectors, it will be very successful in the health care application and will become a physician aide for early detection of the disease and monitoring the treatment plan.