AI Based Bone Age Prediction

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Presentation Outline

- Motivation
- Introduction
- Problem Statement & Objectives
- Scopes
- Applications
- Methodology
- Results
- Analysis/Discussion of Results
- Future Enhancements
- References

Motivation

- Costly Pre-existing software
- Variability in Interpretation
- Time-Consuming Process
- Limited Accessibility of specialized radiologists
- Risk of Human Error
- Lack of Standardization

Objectives

- To implement an AI-based Bone age prediction model based on Left hand Xray Images.

Why Left-Hand Radiographs only?

- Standardization
- Availability of reference data
- Convenience
- Contains Key Ossification centers

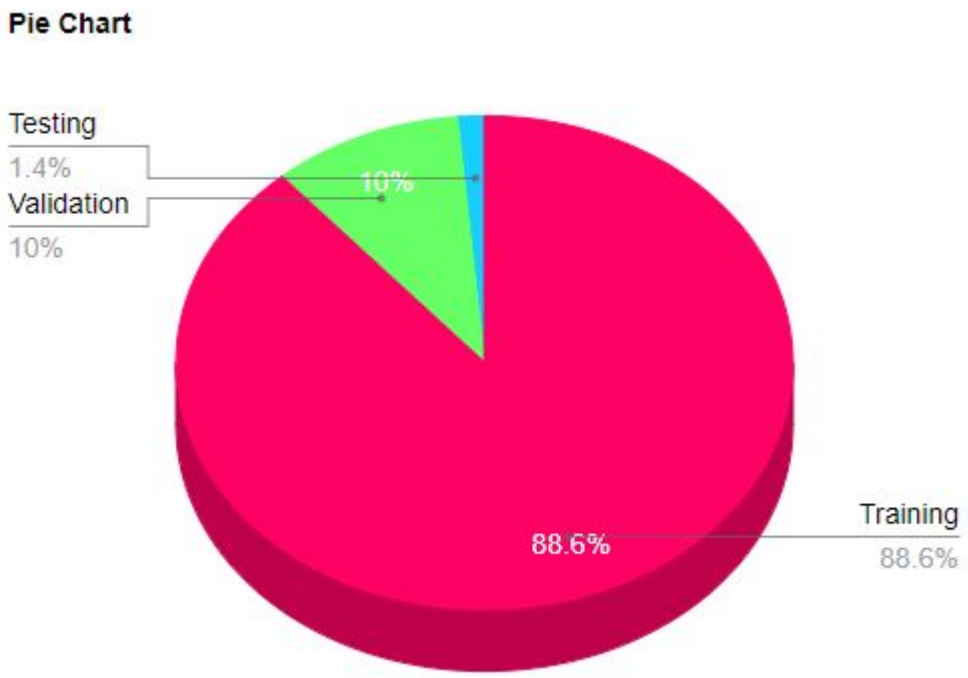
Scopes

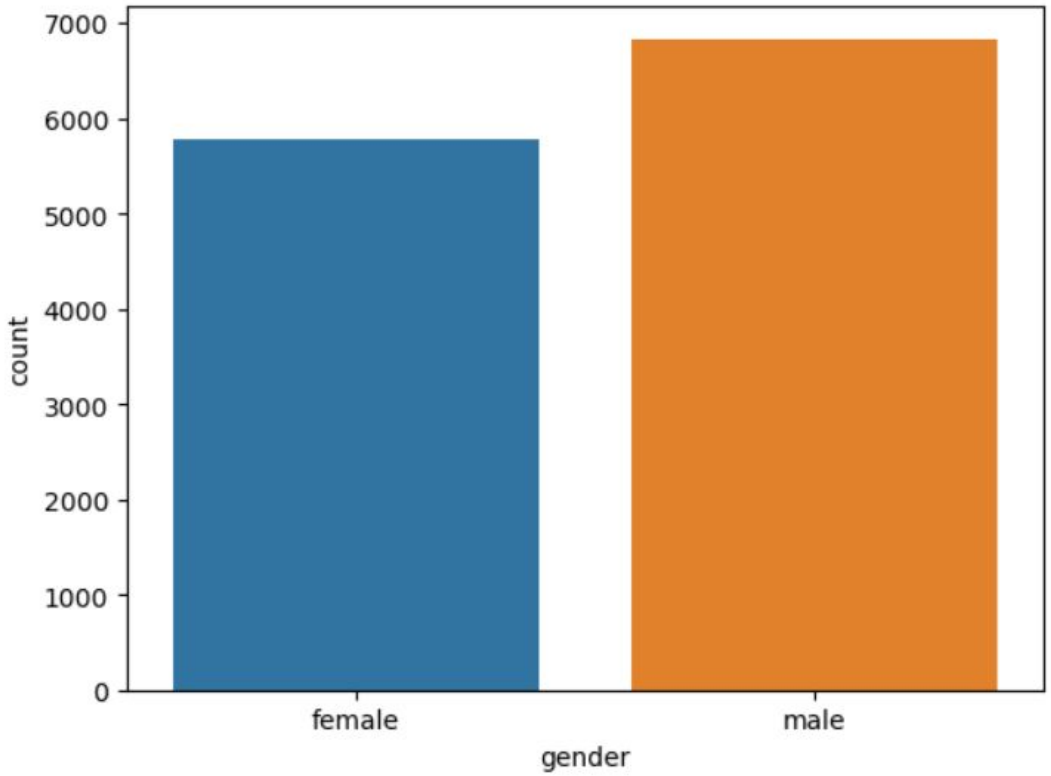
- Pediatric Growth Monitoring
- Orthopedics and Bone Health
- Puberty and Adolescence Assessment
- Skeletal Maturity test

Applications

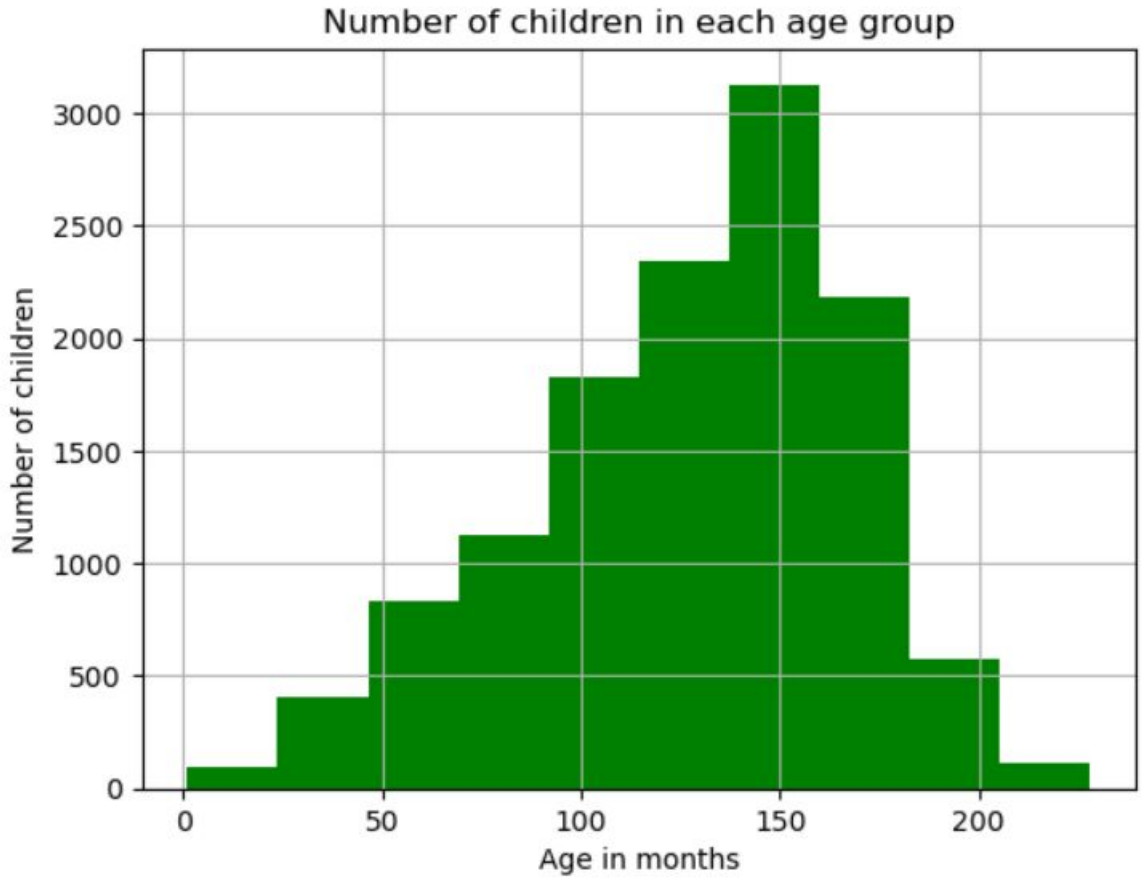
- Educational tool enhancing understanding of skeletal development.
- Orthopedic surgery planning based on skeletal maturity.
- Clinical Decision support system.
- Determining the skeletal maturity of young athletes.
- Research and population health studies.

Dataset

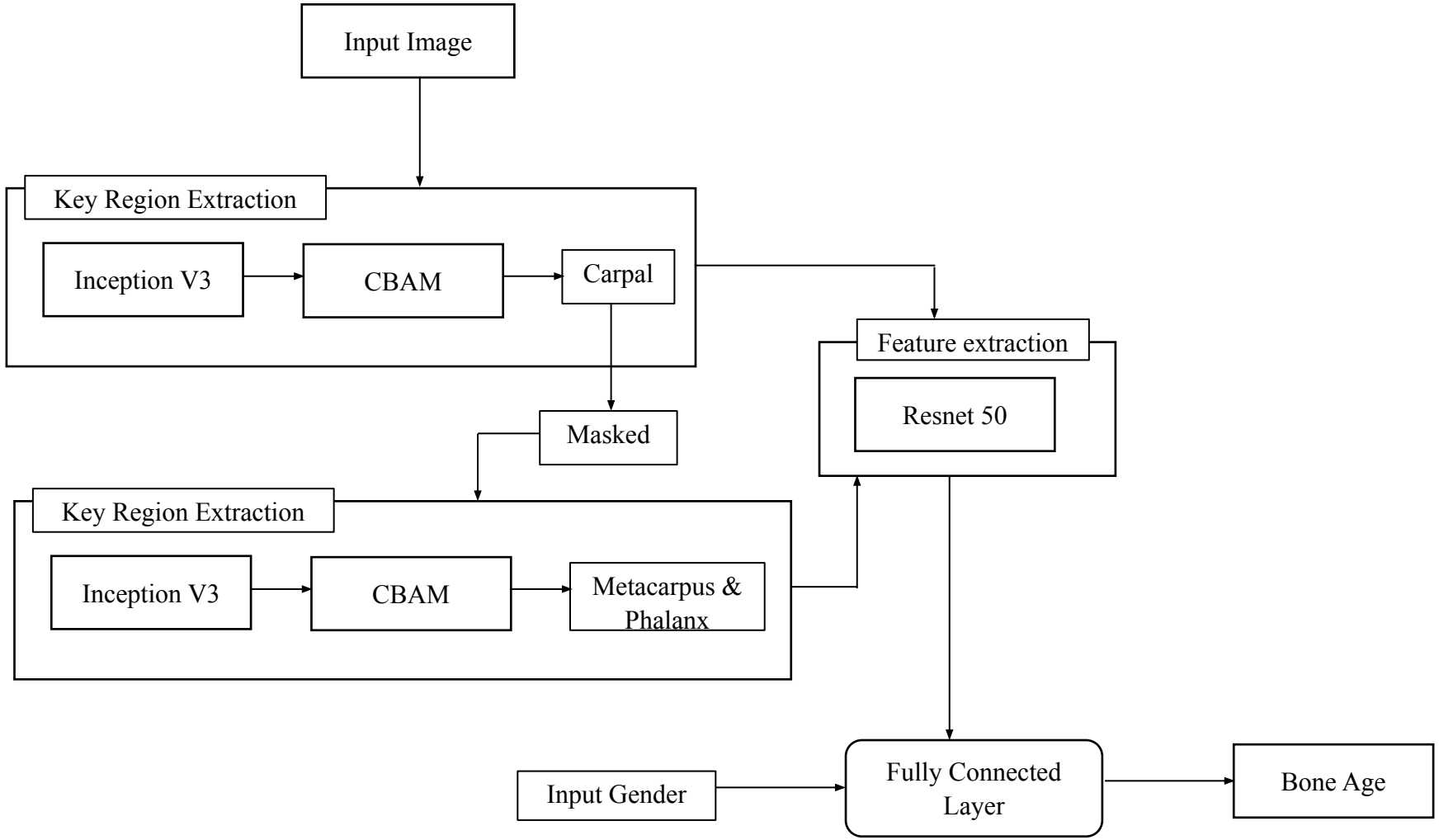

Pie Chart
Testing
1.4%
Validation
10%
10%
88.6%
Training
88.6%


7000
6000
5000
4000
3000
2000
1000
0
count
female
male
gender

Dataset


Number of children in each age group
Number of children
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
Age in months

Methodology-[1]
(System Block Diagram)



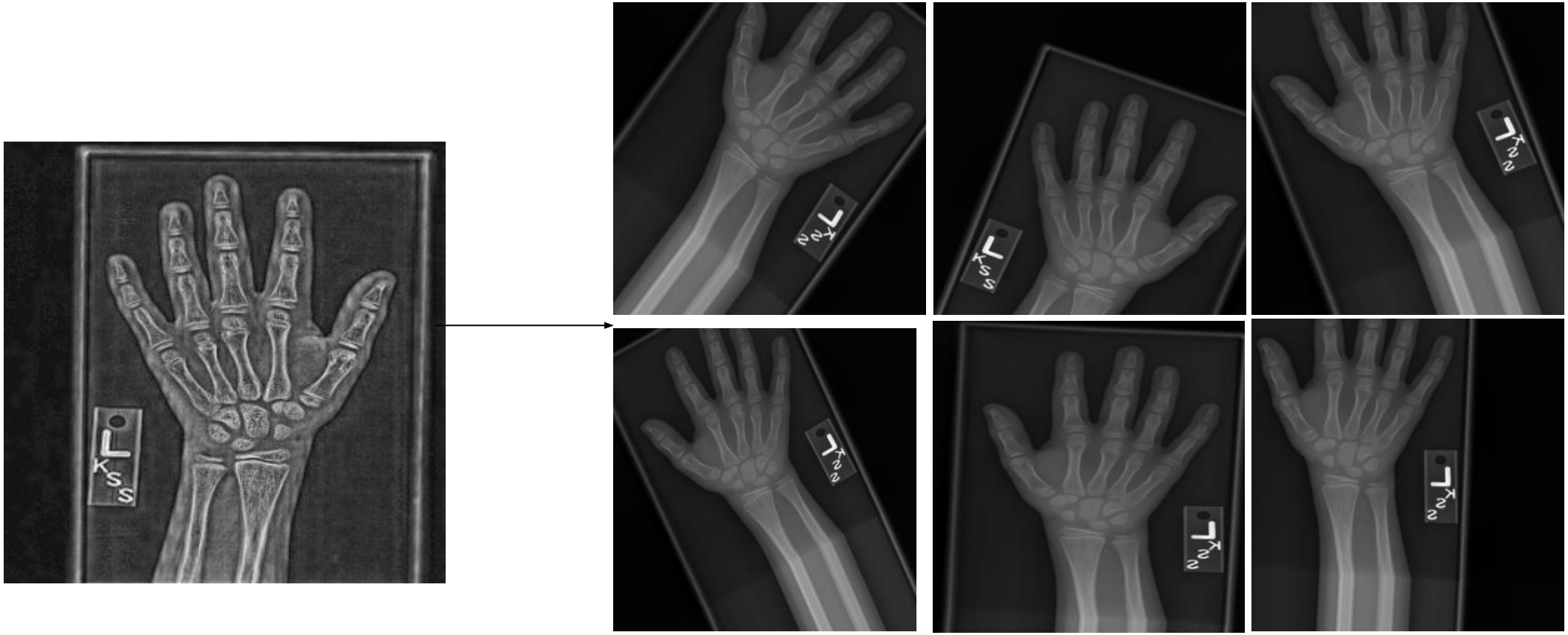
Methodology-[2] Preprocessing

- Resize the image (Bicubic Interpolation)
- Enhance the image (CLAHE)
- Normalization

Methodology-[3] Augmentation

- Rotation Range - 40
- Width and Height Shift Range – 0.2
- Zoom – 0.2
- Horizontal Flip - True
- Fill mode - Nearest

Methodology-[4] Augmentation



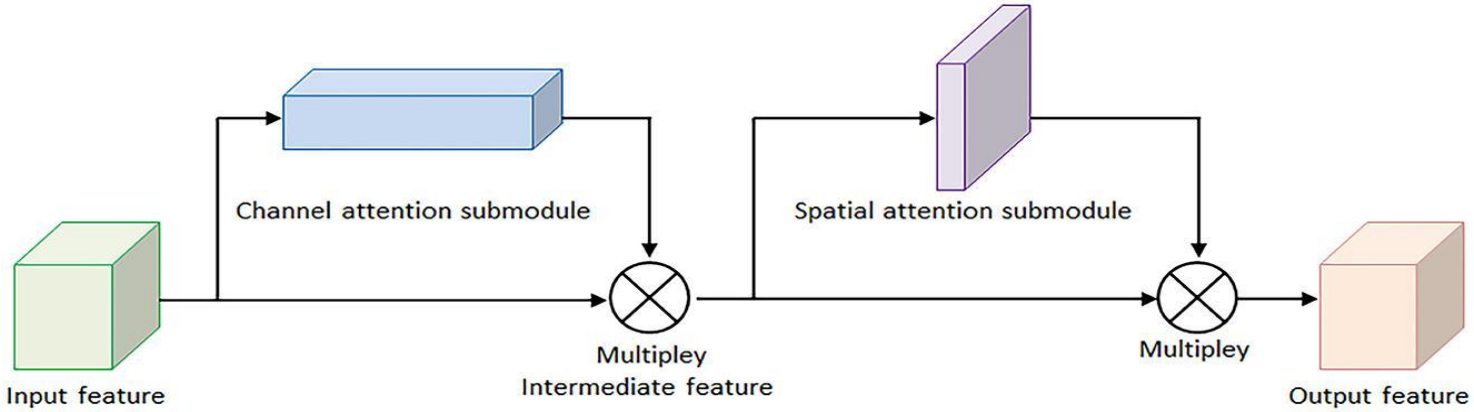
Original

Augmented

Methodology-[5]
Inception V3

- Capture features at multiple scales in its inception modules.
- Use multiple filter sizes (1 X 1, 3 X 3, 5 X 5) and pooling operations in parallel.
- Introduces the factorized convolution.
- Incorporates auxiliary classifiers at intermediate layers.

Methodology-[6]
Convolutional Block Attention Module



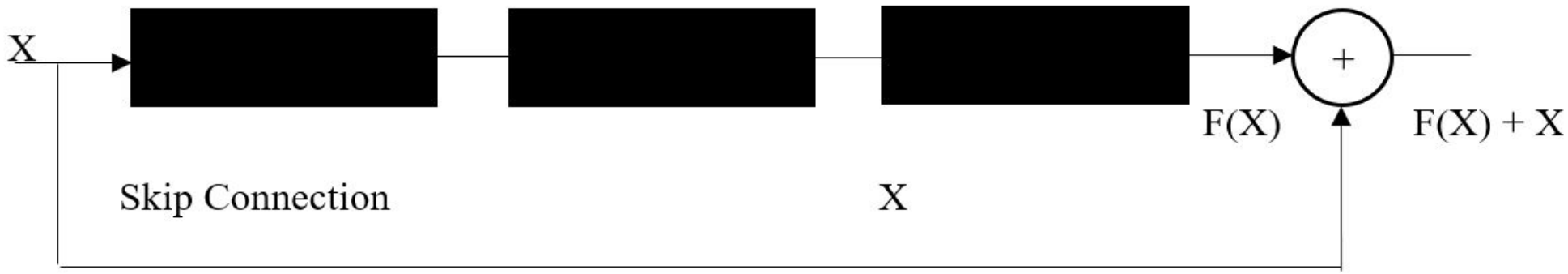
- CBAM with InceptionV3 adds an attention mechanism
- CAM improves feature representation by emphasizing important channels in feature map
- SAM enhances feature representation by assigning varying importance to different spatial regions within an image

Methodology-[7]
Masking

- Set threshold value (0.7)
- Identify Regions of interest
- Crops & Preserves regions

Methodology-[8] ResNet50

- Convolutional operation
- Batch Normalization
- Relu Activation
- Residual Activation
- Pooling operation



Result-[1]

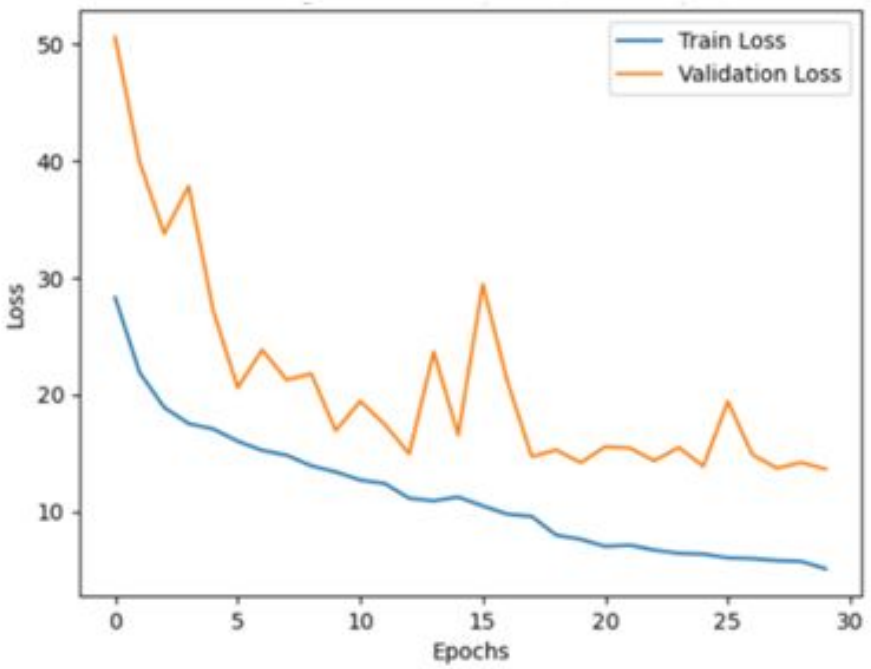


Fig: Training Loss For Metacarpal

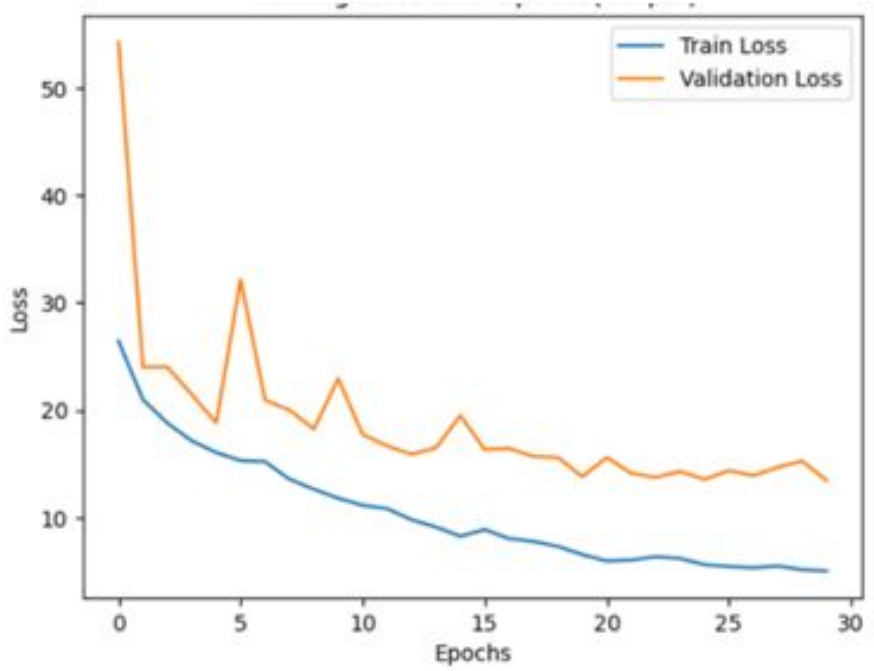


Fig: Training Loss For carpal

Result-[2]

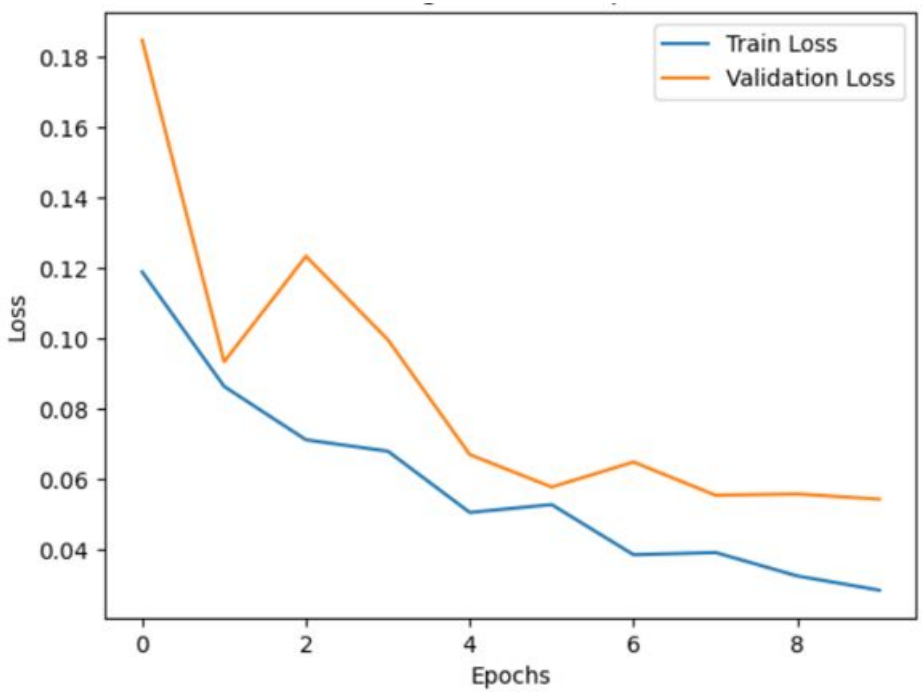


Fig: MAE vs Epochs (Combined Model)

Result-[3]

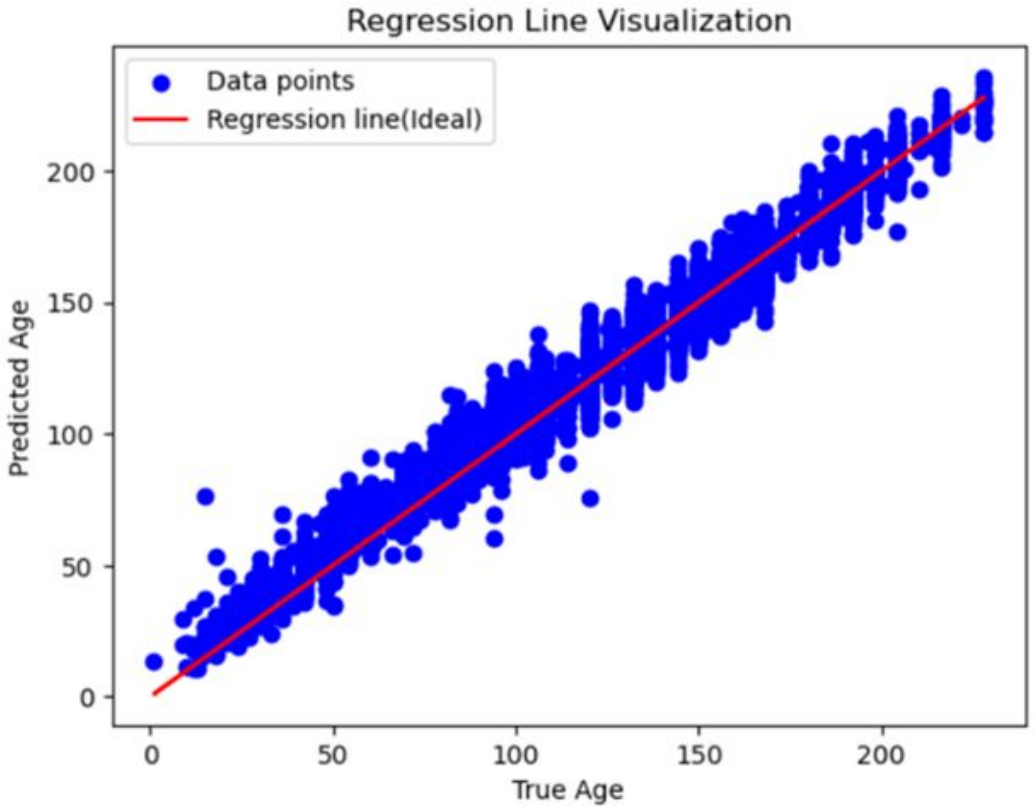


Fig: Predicted vs Actual bone age for Metacarpal(Training)

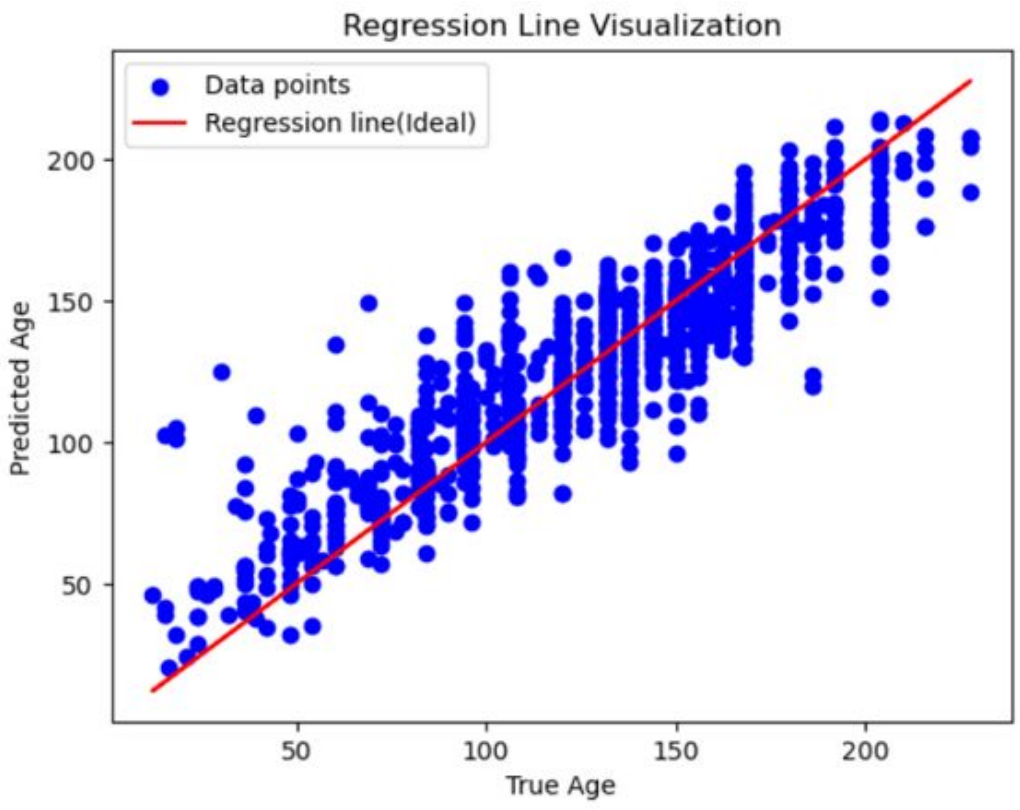


Fig: Predicted vs Actual bone age for Metacarpal(Validation)

Result-[4]

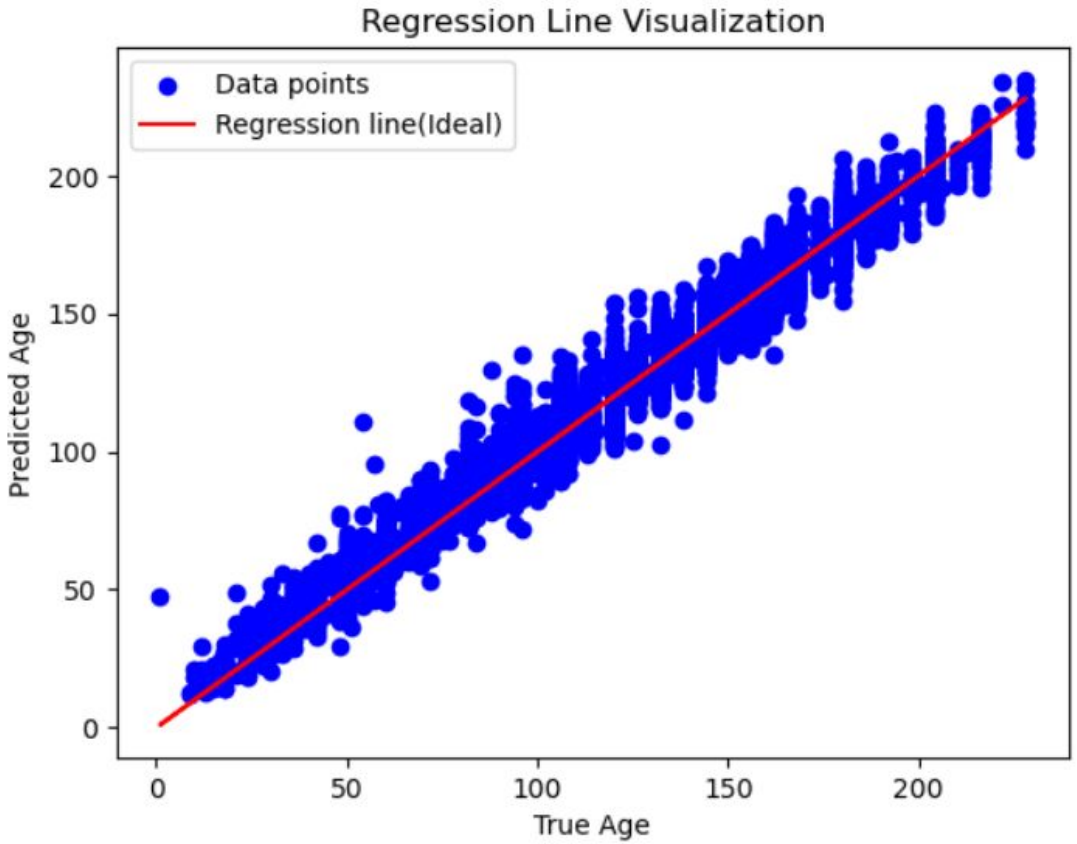


Fig: Predicted vs Actual bone age for carpal(Training)

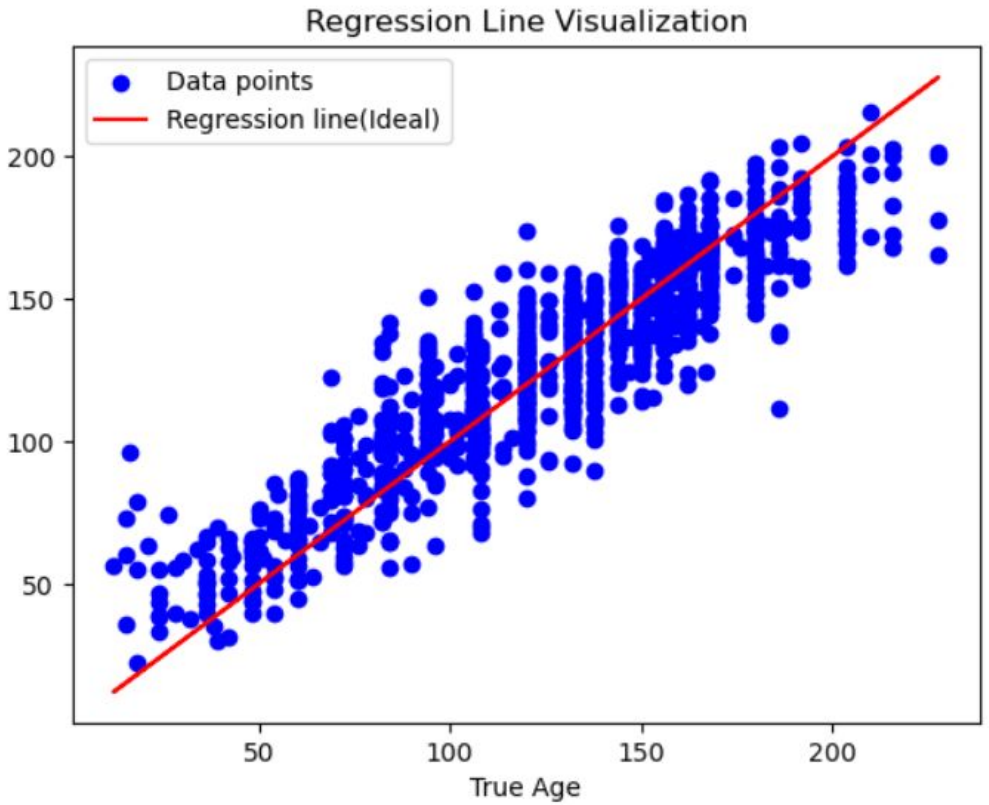
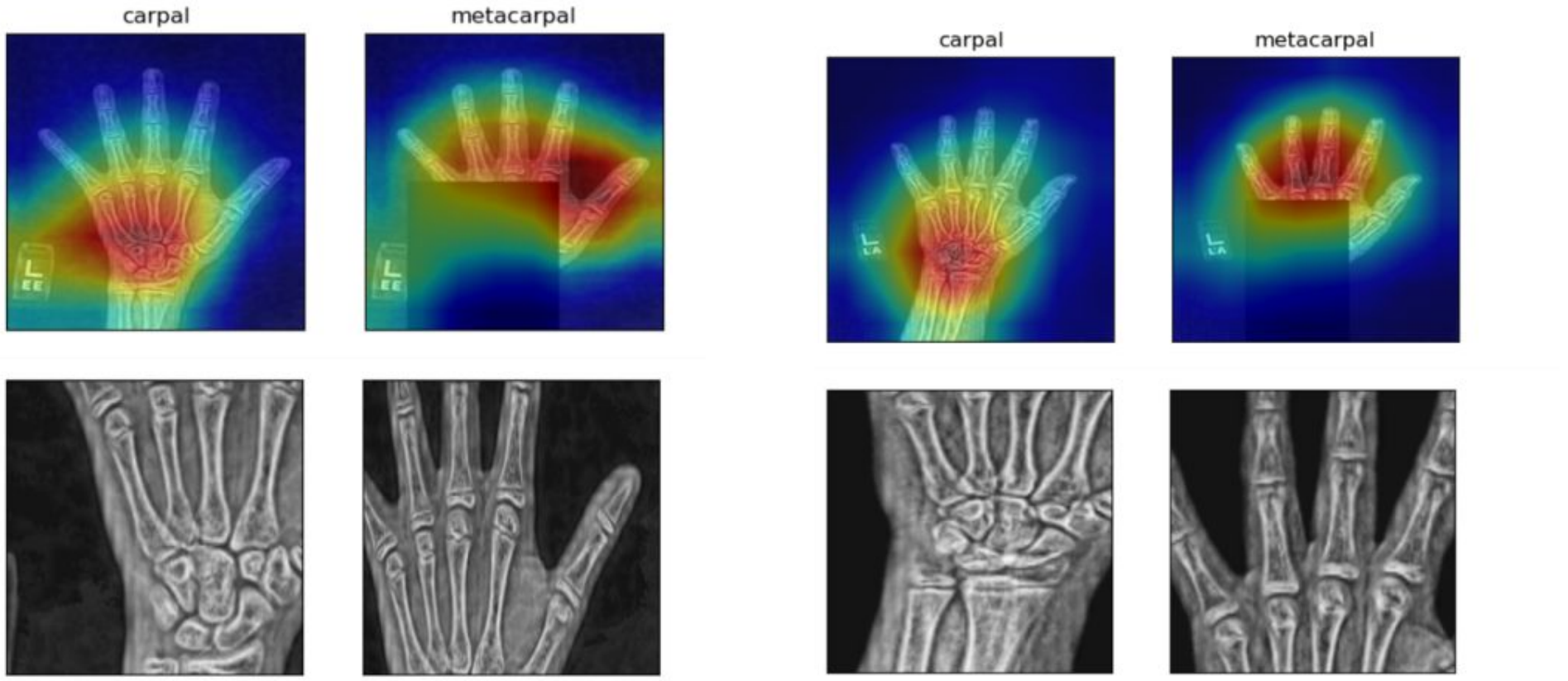
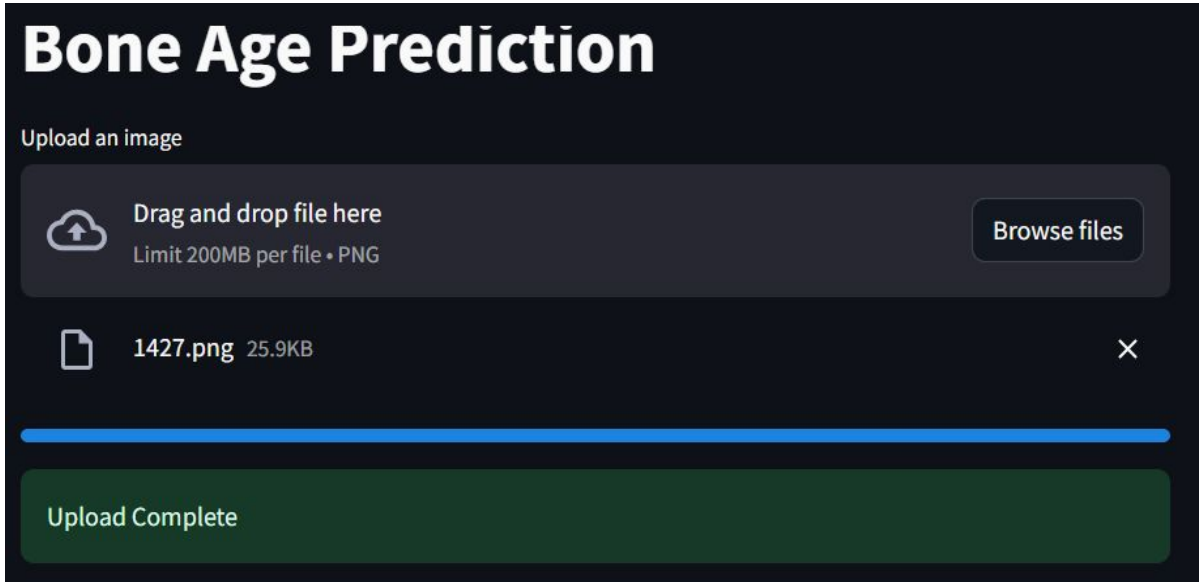


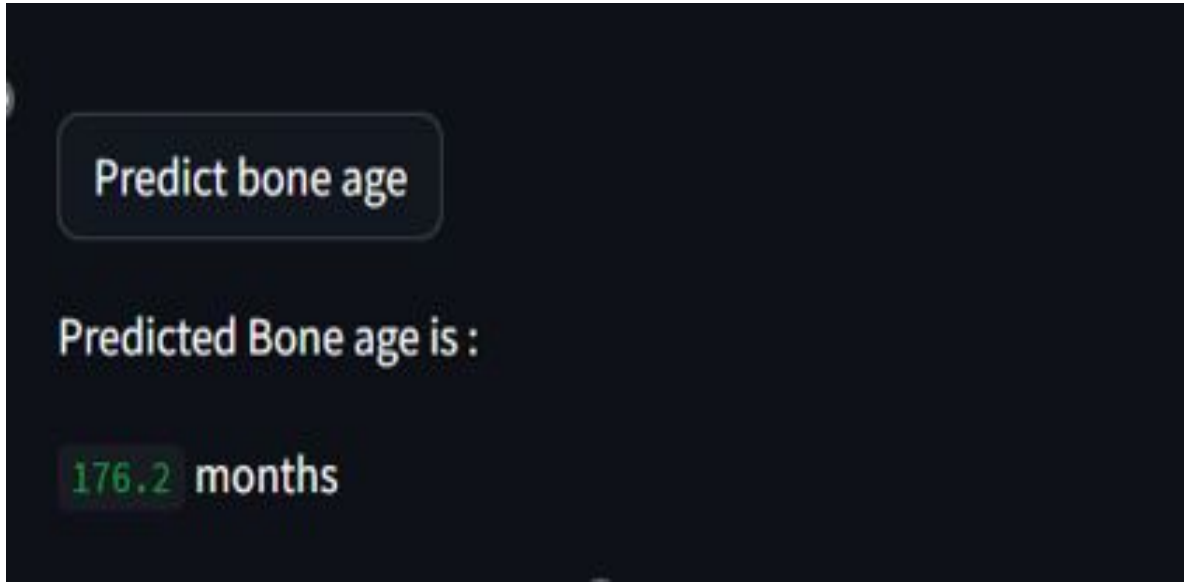
Fig: Predicted vs Actual bone age for carpal(Validation)

Results-[5]



Results-[6]


Bone Age Prediction
Upload an image
Drag and drop file here
Limit 200MB per file • PNG
Browse files
1427.png 25.9KB
Upload Complete


Predict bone age
Predicted Bone age is :
176.2 months

Results-[7]

- On the same testing dataset:

Our Model	Dr. Albert Model
R squared: 0.901167	R squared: 0.897288

Analysis-[1]

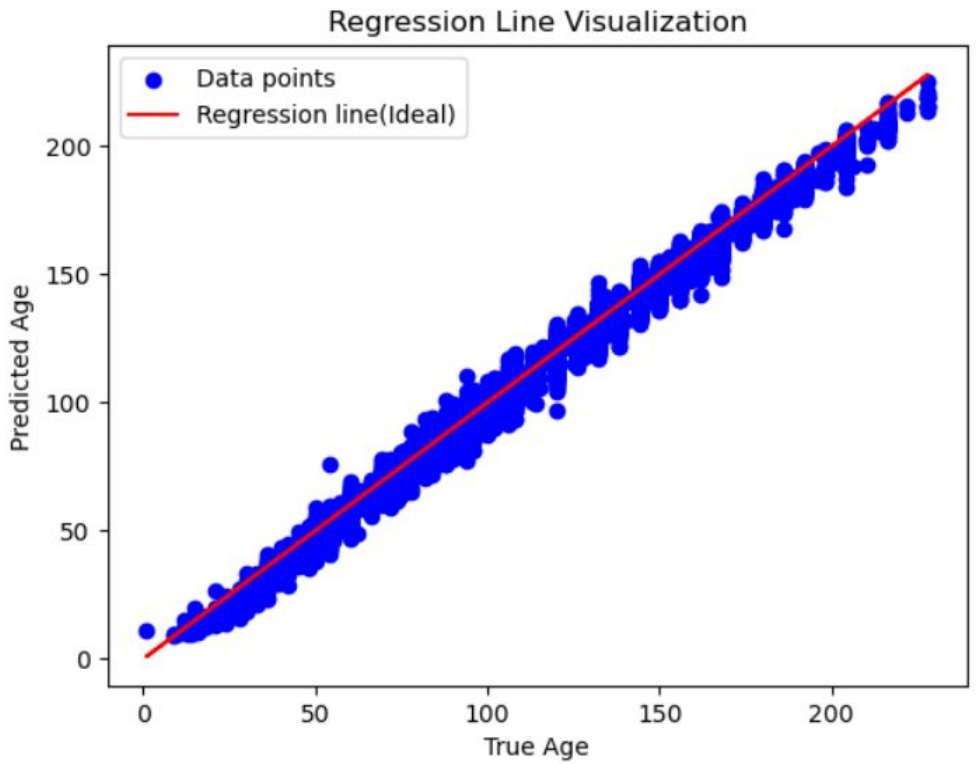


Fig: Regression Graph for Combined Training

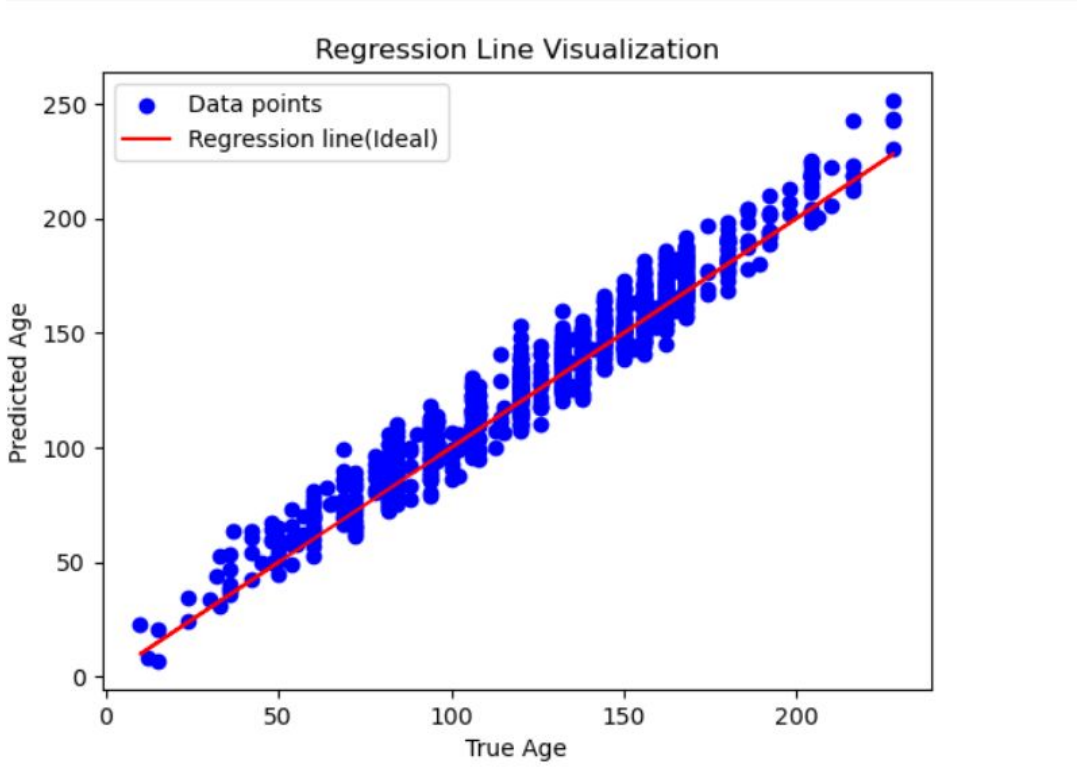


Fig: Regression Graph for Combined Validation

Analysis-[2]

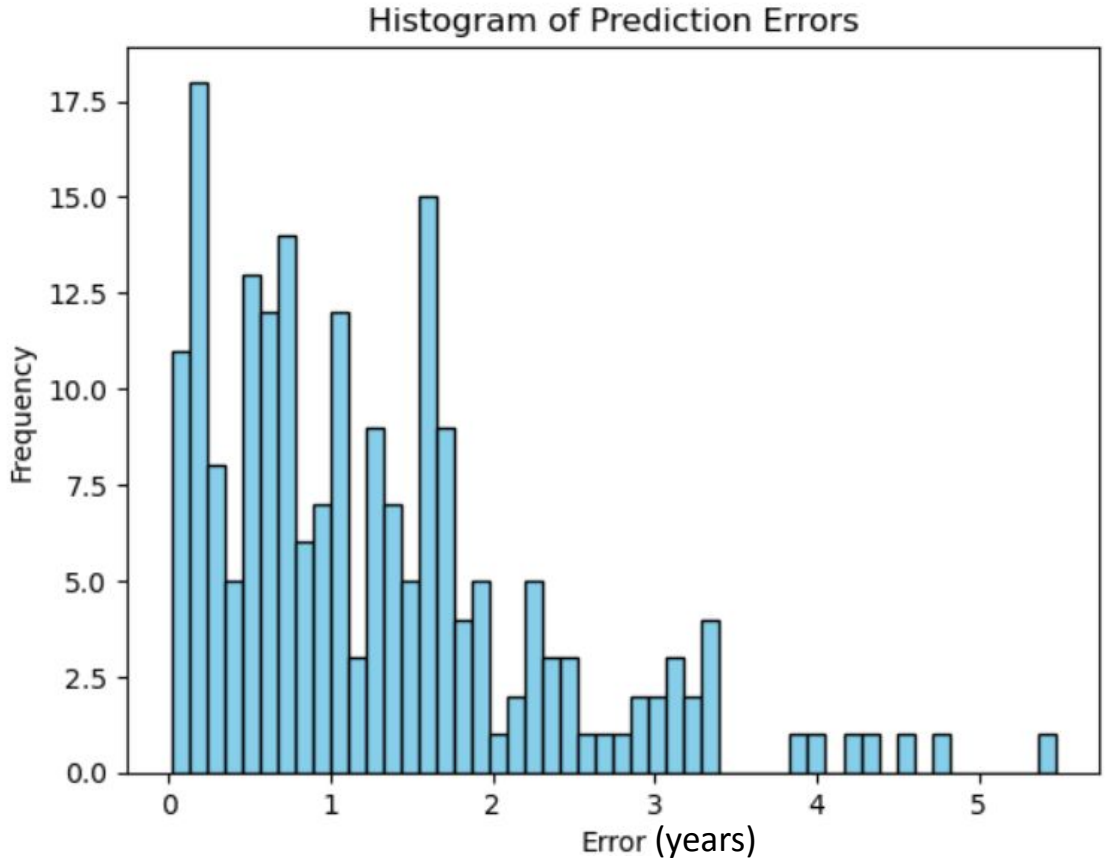


Fig: Histogram of Prediction Errors (Testing Dataset)

Future Enhancements

- Collection of Regional specific dataset for training .
- Newer Models like Vision Transformers can be implemented to further improve the model.
- Can be integrated in hospital service applications.

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[6] S. Ibrahim and H. A.Ben, "Ridge Regression Neural Network for Pediatric Bone Age Assessment," *Concordia Institure for Information Systems Engineering,* pp. 4-5, 2021.

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[10] M. Satoh and K. Xin, "J-stage," 2015. [Online]. Available: https://www.jstage.jst.go.jp/article/cpe/24/4/24_2015-0011/_article#:~:text=The%20main%20bone%20age%20assessment,resonance%20(MR)%20imaging%20methods..

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