X-Ray Classifier
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Background

This dataset was obtained from the Stanford ML group, which worked with a group of board certified radiologists to prepare and label the data.

Creating a ML model that could assist in the identification of x-ray studies would be a major contribution to the healthcare industry.

Objectives

- Test models to make a diagnosis of normal vs abnormal on X-Rays of the arm
  - Simple C – basic CNN
  - CP – convolution-pool
  - CCP - convolution-convolution-pool
- Test best performing model on each set of X-Rays (finger, hand, wrist, forearm, elbow, humerus, shoulder)
- Compare best model performance vs pre-trained model: Xception

Data

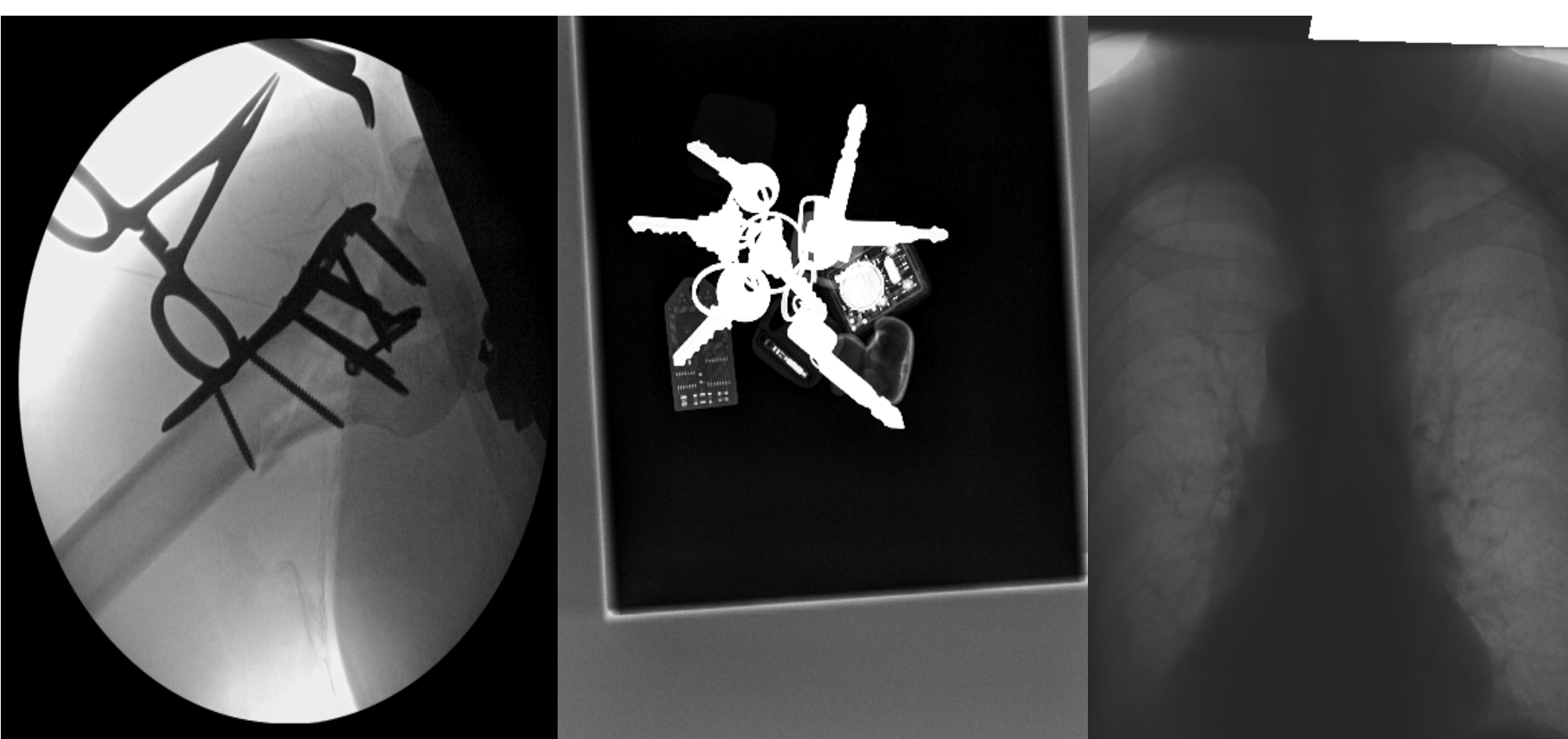- 40k images: 36.5k training images, 3.2k testing images.
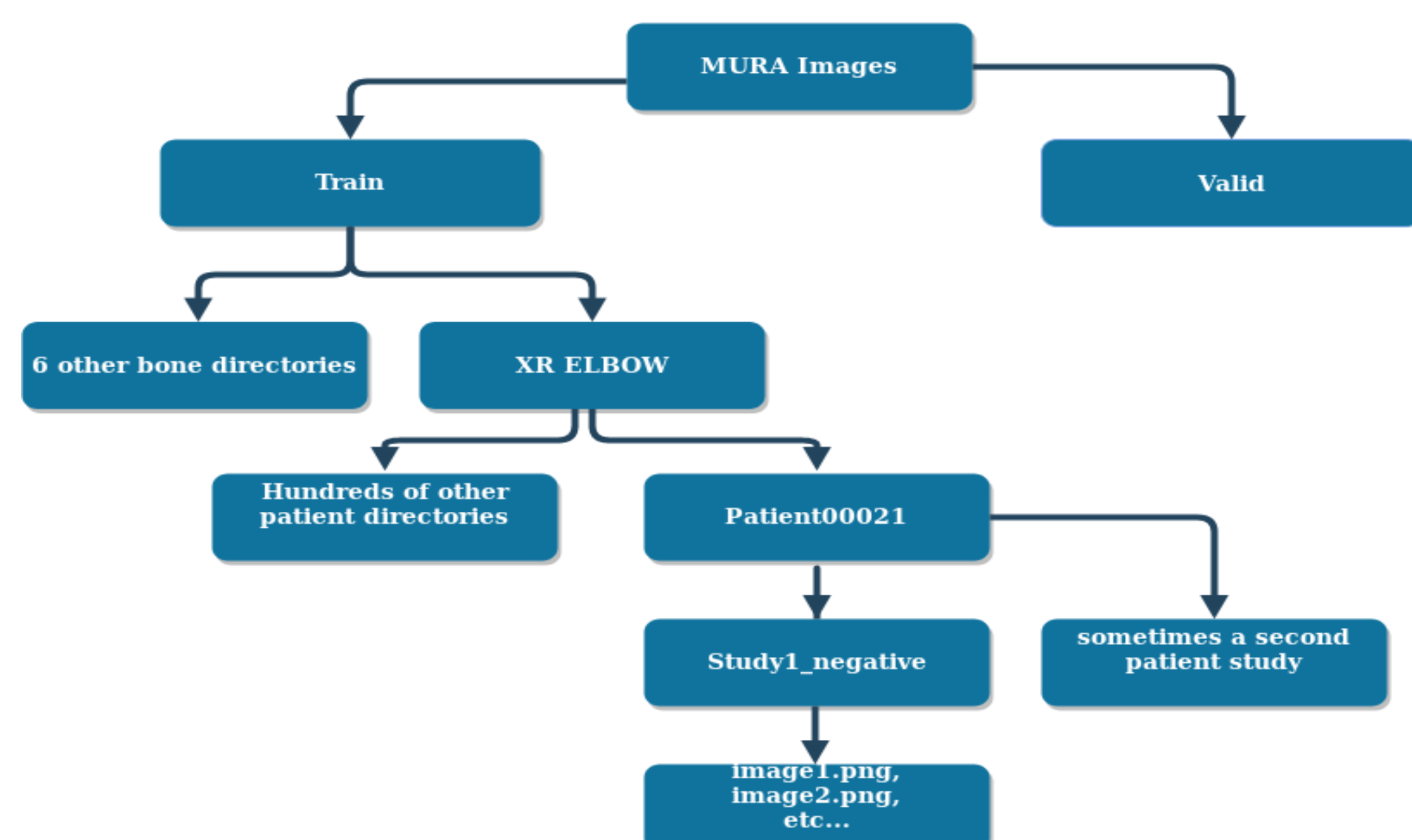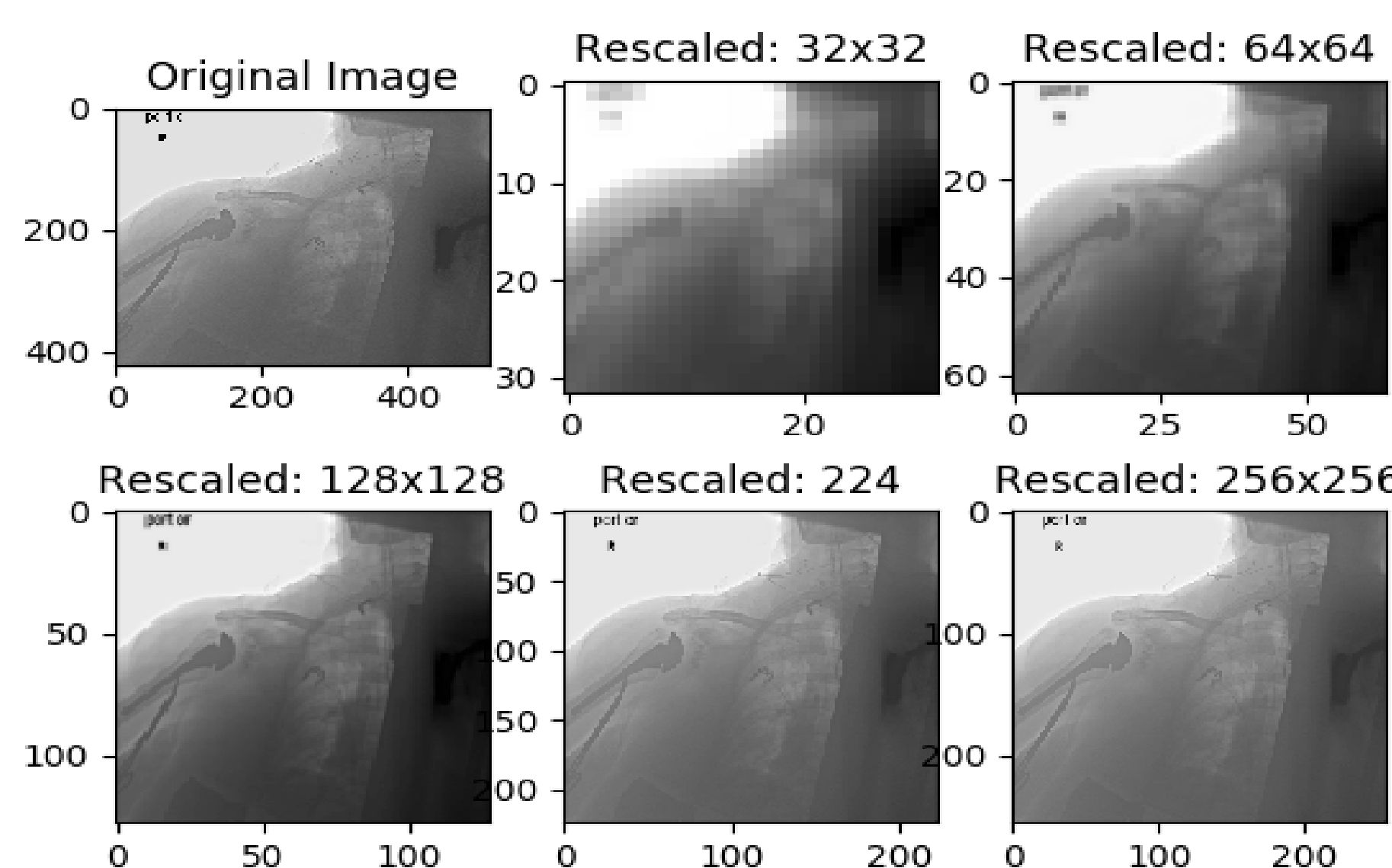

Count of Negatives/Positives per Bone

- Negatives
- Positives
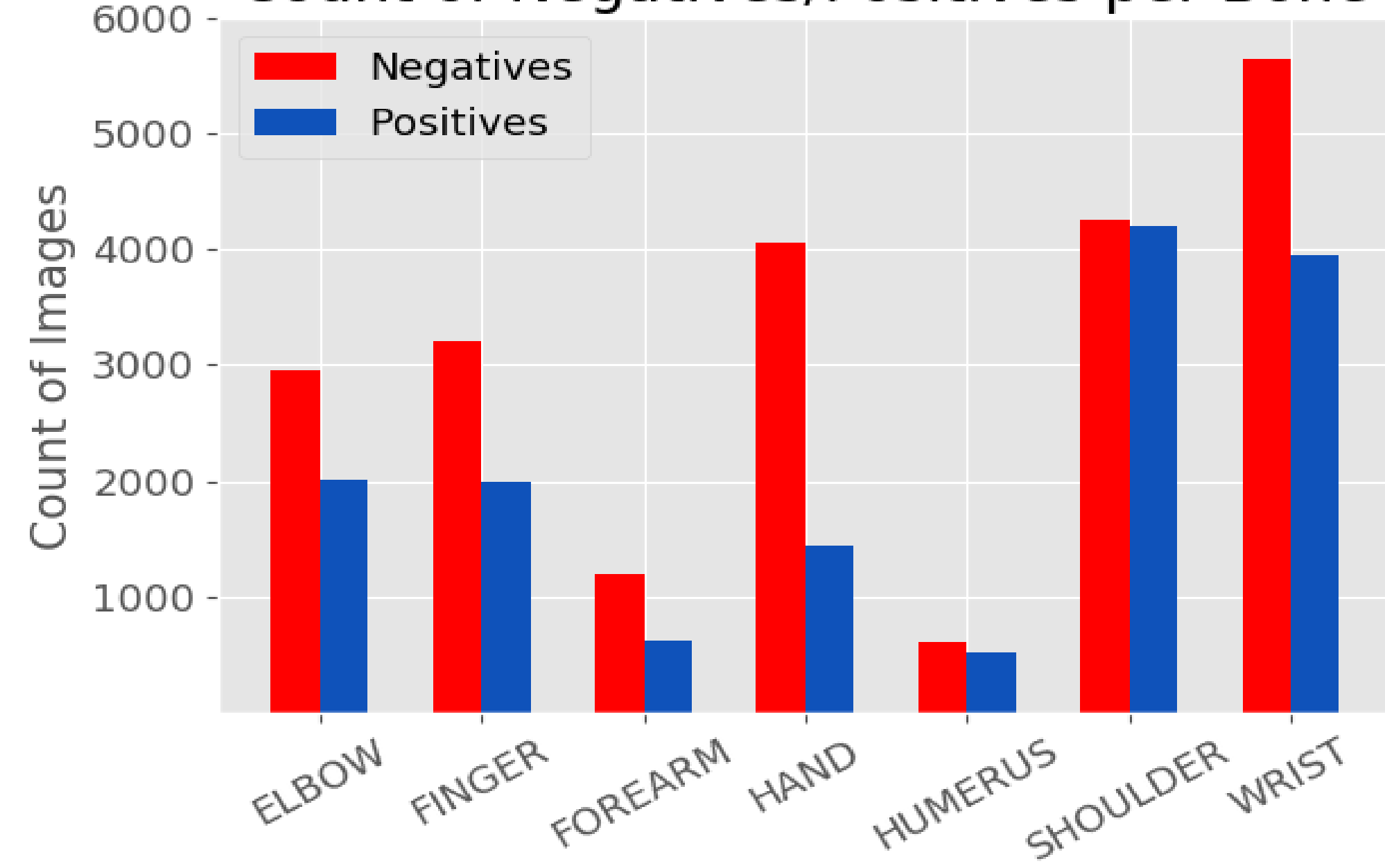
- **Difficult data:**

- **Misclassified data:**

- **Total dataset** after cleaning and balancing: 44k train, 3.2k test
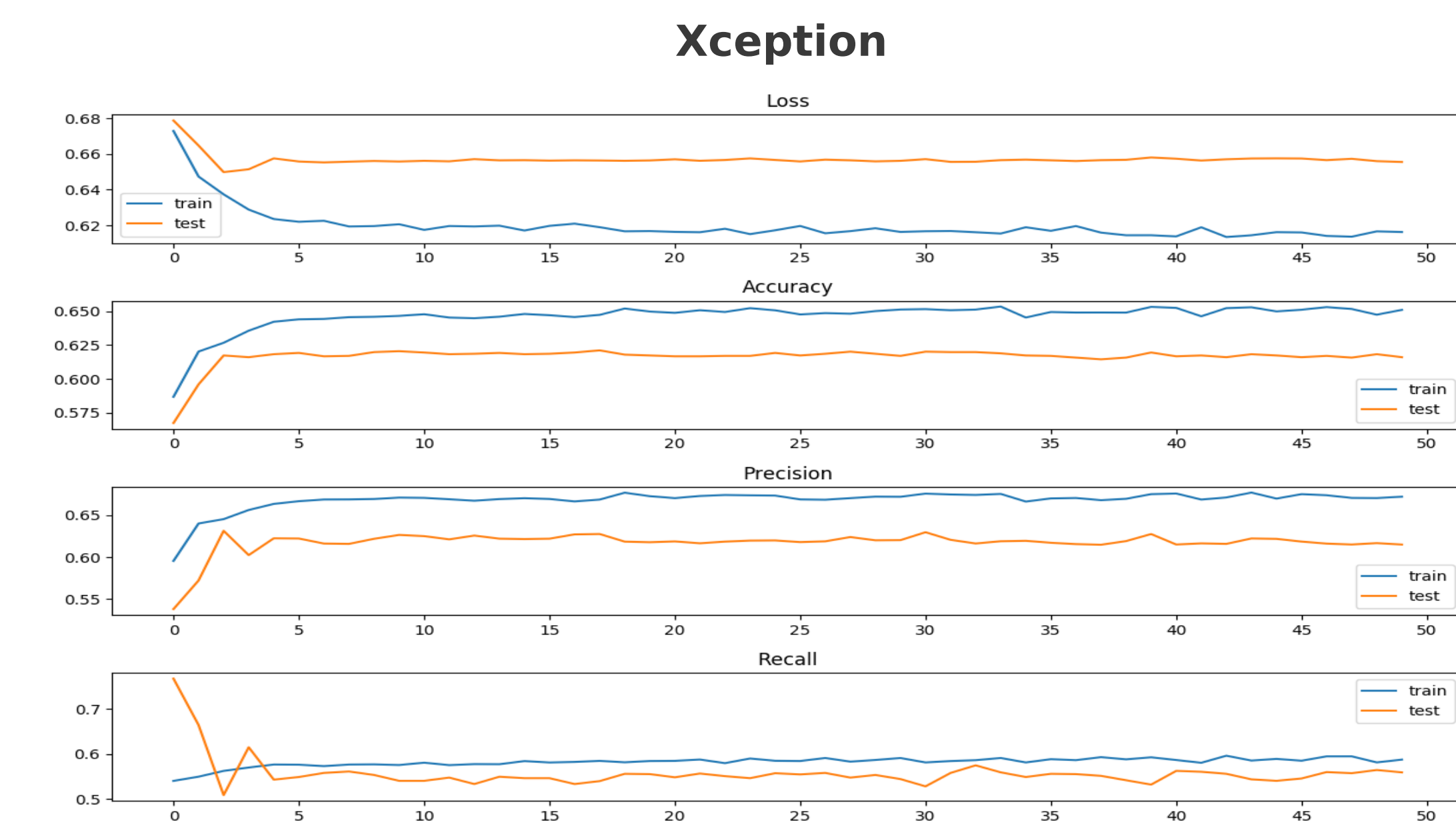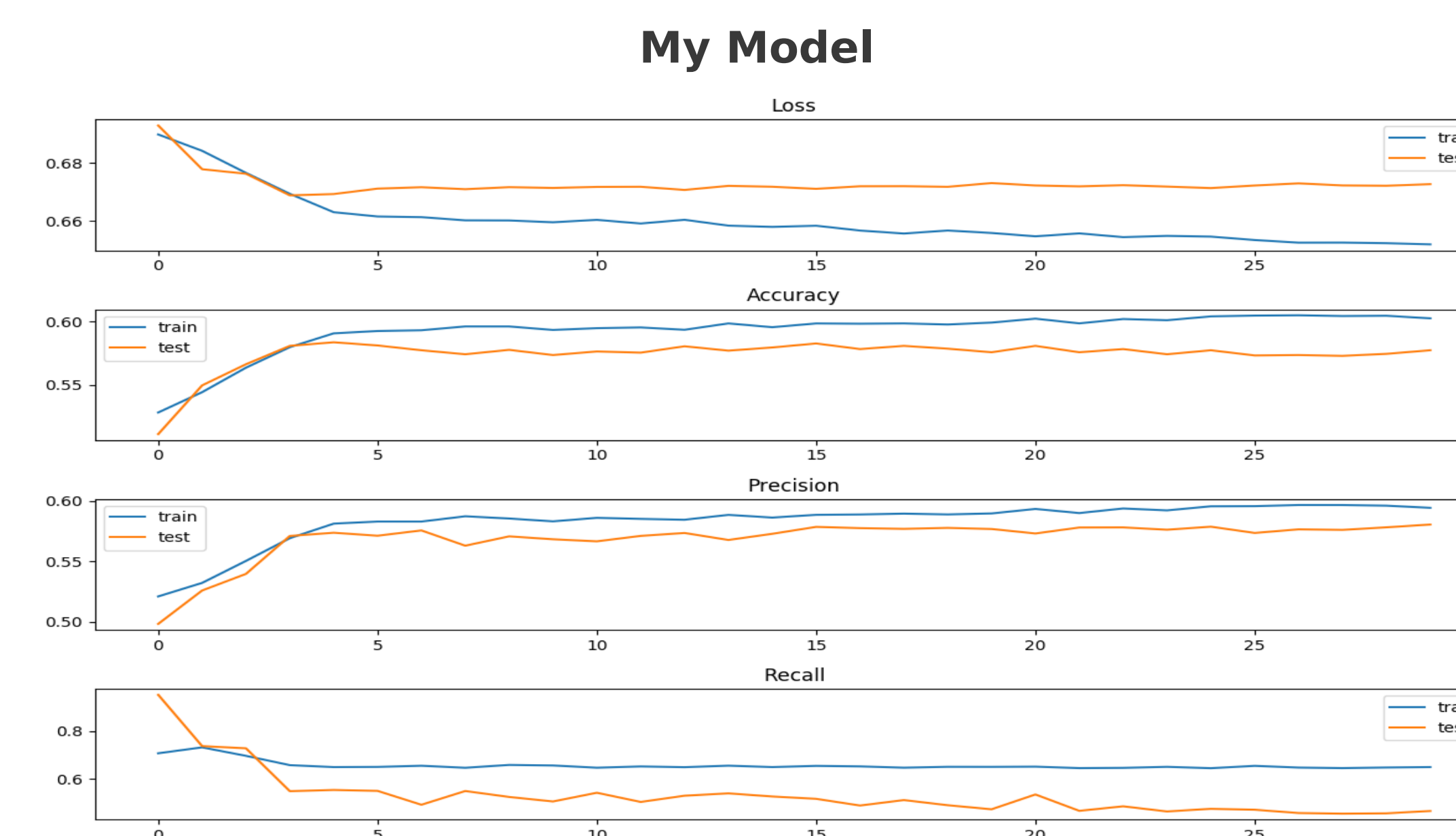
Image Size/Augmentation

Original Image | Rescaled: 32x32 | Rescaled: 64x64
Rescaled: 128x128 | Rescaled: 224 | Rescaled: 256x256

Model Arch.

Block 1 x 2	
2D Convolutional 3x3 (64 filters)	Activation: Relu/LeakyReLU
2D Max Pooling 2x2	Dropout: 20%

Block 2 x 2	
2D Convolutional 3x3 (128 filters)	Activation: Relu/LeakyReLU
2D Max Pooling 2x2	Dropout: 20%

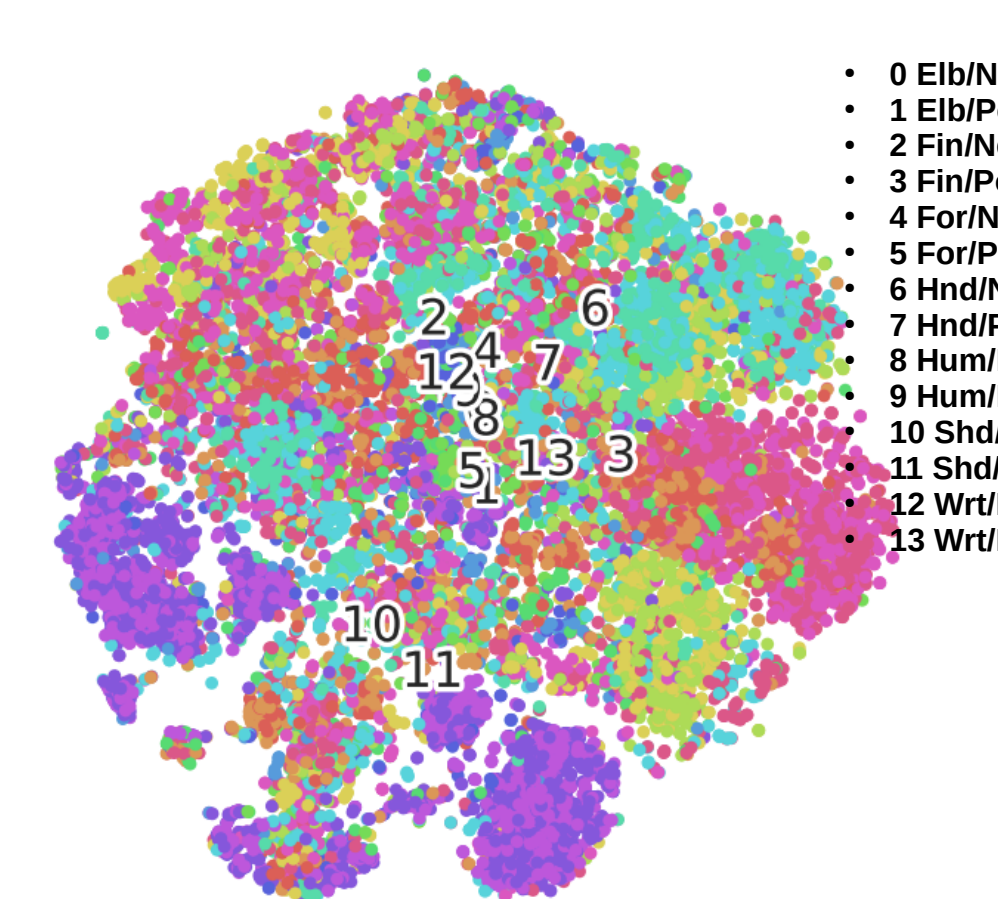| Block 3 x 2	
2D Convolutional 3x3 (256 filters)	Activation: Relu/LeakyReLU
2D Max Pooling 2x2	Dropout: 20%

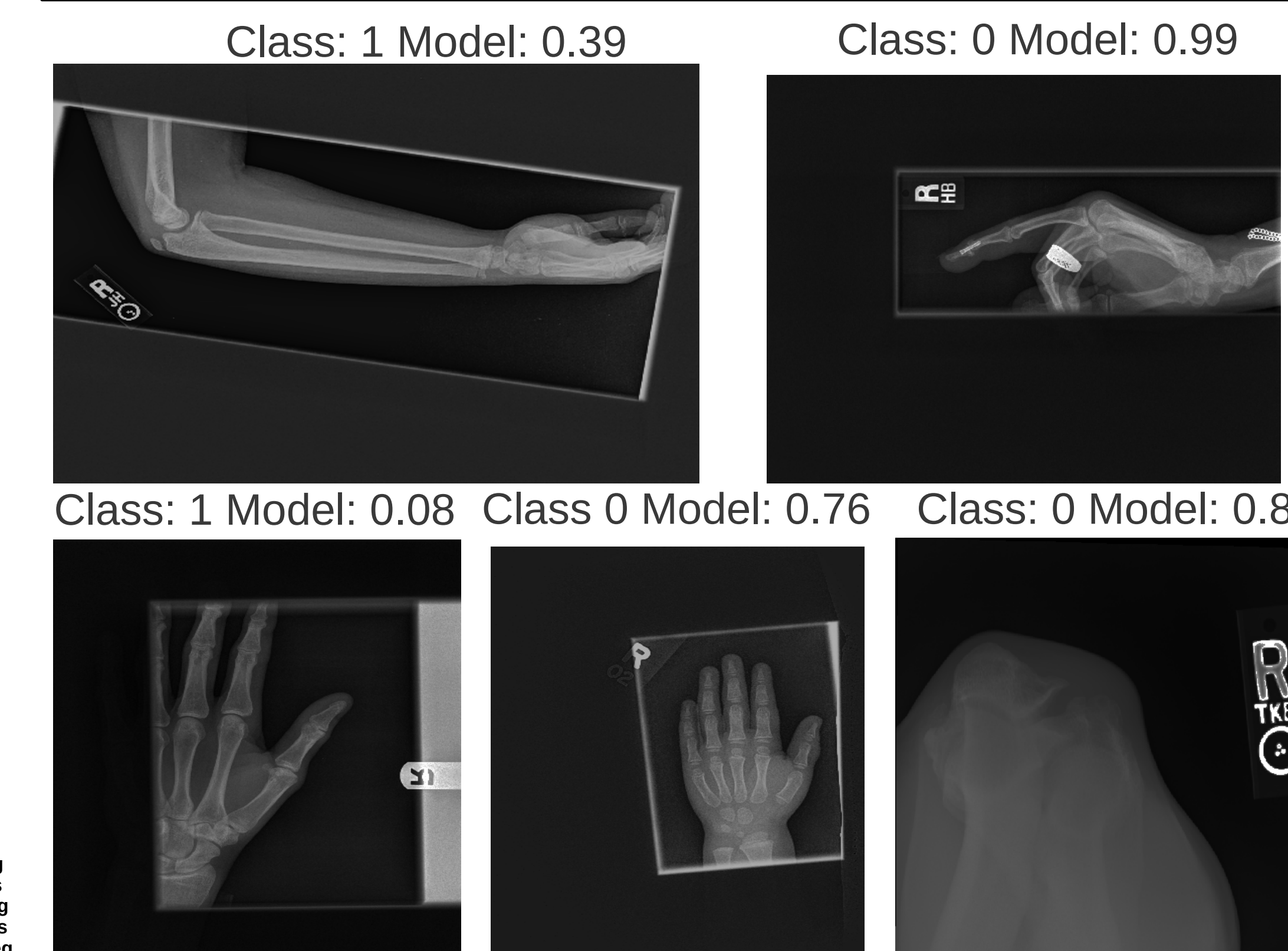| Block 4 x 2	
Flatten for Dense Layers	
Dense: 64 Neurons	Activation: LeakyReLU
Dense: 32 Neurons	Activation: LeakyReLU
Dense: 1 Neuron	Activation: Sigmoid
Loss: Binary Crossentropy	
Optimizer: Adam	

Unsupervised

- PCA-TSNE: All Neg. vs Pos.

- Negative
- Positive

- PCA-TSNE: All Classes

0 Elb/Neg
1 Elb/Pos
2 Fin/Neg
3 Fin/Pos
4 For/Neg
5 For/Pos
6 Hnd/Neg
7 Hnd/Pos
8 Hum/Neg
9 Hum/Pos
10 Shd/Neg
11 Shd/Pos
12 Wrt/Neg
13 Wrt/Pos

Results

My Model

Xception

Image Size	64x64		96x96		128x128	
Model	My Model	Xception	My Model	Xception	My Model	Xception
Accuracy	62%	-	63%	62%	61%	63%
Precision	63%	-	65%	62%	61%	67%
Recall	49%	-	58%	56%	56%	45%
F1	55%	-	61%	59%	58%	54%
AUROC	61%	-	63%	61%	61%	62%

F1 Score		
Bone	My Model	Xception
Elbow	73%*	63%
Finger	69%*	64%
Forearm	67%*	65%
Hand	21%	56%*
Humerus	63%	72%*
Shoulder	70%*	12%
Wrist	66%*	55%

Accuracy		
Bone	My Model	Xception
Elbow	75%*	55%
Finger	68%*	58%
Forearm	64%*	57%
Hand	59%*	54%
Humerus	63%	69%
Shoulder	73%*	52%
Wrist	70%*	66%

* - indicates better performing model

Misclassified Results

Class: 1 Model: 0.39   Class: 0 Model: 0.99

Class: 1 Model: 0.08   Class 0 Model: 0.76   Class: 0 Model: 0.82

Future Steps

- Separate images
- Visualize layers of CNN
- Class activation map
- Prediction per study
- Adult/youth study
- Transfer Learning
- Unsupervised Learning
- VGG19

Tech Stack

python | learn machine learning in Python | TensorFlow | Keras
NumPy | matplotlib | pandas

References

- Rajpurkar P, Irvin J, Bagu Al, Ding D, Duan T, Mehta H, Yang B, Zhu K, Laird D, Ball RL, et al. 2017. MURA: Large Dataset for Abnormality Detection in Musculoskeletal Radiographs. 1st Conference on Medical Imaging with Deep Learning.