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BONE FRACTURE DETECTION USING CONVOLUTIONAL NEURAL NETWORKS

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Abstract: Bone fractures are the major and common issues faced by many people. These fractures often occur during accidents. To predict these fractures doctors are using x-rays. Sometimes it is difficult to predict whether it is fractured or not through the x-rays manually. These x-rays show a clear picture of the damage but the main issue is that some physicians are overlooking the small fractures which may cause a lot of damage in the future to that particular person. Model which analyses and classifies the images of hand, leg, chest, fingers and wrist fractures in a clear way. There are many other techniques to detect these fractures and this project is molded by using some artificial intelligence applications using machine learning and deep learning techniques. This project investigates specifically various models dependent on Convolutional Neural Networks which helps us to provide a better solution as it is a step-by-step process of image analyzing algorithm to predict whether the bone is fractured or normal. By comparing 3 types of CNN models which are ConvNet/CNN, VGG16 & R-CNN with the same image dataset, R-CNN gave the best accuracy.

Index Terms **- Convolutional Neural Networks, Machine Learning, algorithm, Fractures, Bones, Accidents, Doctors, X-Rays.**

I. INTRODUCTION

Fractures are one of the most common issues that each living body faces. Even doctors are overlooking minor fractures that might lead to more serious injury in the future. Through x-rays are there but it might be difficult to tell if it is broken or not. If you break a bone, you must treat it as a medical emergency and get care as soon as possible. Fractures come in a various shapes and sizes. When there is a break in the bone, it is called a fracture. Traumatic fractures are more prevalent and are caused by a rapid fall, high pressure, unnecessary fighting, accidents, or any other reason, whereas a pathological fracture is caused by a medical condition of the bone. So, this project is to find the best accurate Convolutional Neural Network model which is a step-bystep picture analyzing algorithm that aids us in providing better results to detect bone fractures. Bone fractures and normal 221 X-Rays are taken to analyse and classify the images of hand, leg, chest, fingers and wrist fractures clearly.

II. PROBLEM STATEMENT

Machine learning and deep learning approaches are the major themes of this model and gathered some information including x-rays. Few libraries are used to enable the model.

The model analyses bone fracture of the hand, leg, chest, fingers and wrist bones. Suggest scanning the CT or X-ray to execute the Convolutional Neural Network algorithm function, which analyses the entire x-ray and provides us with clear information about the scanned picture.

III. OBJECTIVES

- To comprehend the extremes & limitations of CNN.
- To completely & thoroughly understand the medical jargon behind Human Bone Architecture to devise a better system.
- To study X- Rays, extract features, and choose the right parameters for the algorithm.
- To compare the following algorithms and get the best results.

IV. AIM

This paper is to reproduce a systematic approach for Bone Fracture Detection using Convolutional Neural Networks from X-Ray images.

1. Approach – Role of R-CNN

Python served as the foundation for our model's preparation and processing. We utilized few distinct Python libraries to interact with our model about the outcome of each X-ray Images. tensorflow, sklearn, seaborn, Matplotlib, pandas and Numpy were imported. These libraries are critical in any python application when it comes to Convolutional Neural Network. Python was not created to do just numerical computations.

However, because of its short and simple syntax, it didn't take long for the scientific and technical community to notice it. These libraries were built not long after to aid scientists and mathematicians in performing sophisticated numerical computations. Tensorflow and sklearn is a library for machine and deep learning applications. This is a big plus for us since we'll be able create CNN model, seaborn and matplotlib is used to plotting arrays in two dimensions, which will help us figure out how well our model worked. Our model's most significant layer is the Convolution layer. Its primary task is to fully comprehend the image by converting it to an input image composed of 1s and 0s.

2. SIGNIFICANCE OF THE PROJECT

Below are the reasons how intense Bone fractures are and how important it is to detect bone fractures:

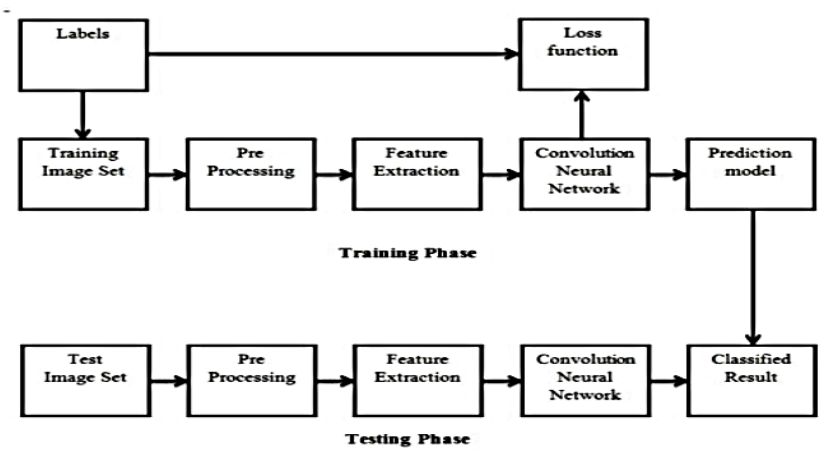
- If you break or fracture a bone, you must treat it as a medical emergency and get care as soon as possible.
- Fractures come in a various shapes and sizes. When there is a break in the bone, it is called a fracture.
- Traumatic fractures are more prevalent and are caused by a rapid fall, high pressure, unnecessary fighting, accidents, or any other reason, whereas a pathological fracture is caused by a medical condition of the bone.

3. EXISTENT WORK

The focus of this study "Image Segmentation Technique Using SVM Classifier for Detection of Medical Purpose" is on using an SVM classifier to develop a pharmaceutical choice framework based on edge detection and lattice relationships. The suggested technique produces extremely favorable results when it comes to categorizing the solid and pathogen-affected bones. The framework is useful in assisting the doctor in reaching a final determination. This is useful for determining if a human bone is normal or atypical, with a high rate of affectability and precision. The system is exact, robust, easy to use, non-obtrusive, and modest, all of which are positive attributes. The edges of a photograph are constantly made up of various inalienable data, such as step single, course, structure, and so on, all of which are significant attributes for extracting highlights in image recognition.
In many situations, pixels close and on the edge shift continuously, but pixels on the other side of the margin undergo abrupt alterations. This approach combines prior knowledge of framework division and visual recordings of location and aspect. Significant components are included in the computerized personality fracture division approach that has been developed: division and pre-planning Ce-t1w and bent are two explicit MRI modalities that we believe are appropriate for brain tumour division and maybe contribute to this framework.

I. RESEARCH METHODOLOGY

The dataset was collected from the bone fracture imaging repository in this case. It includes a big database of public datasets on all types of bone fractures. It can be downloaded from several resources. The technique utilized was a Convolution neural network, which is a supervised learning approach that adjusts the weights of the model using labeled training data. All of the hidden layers in a convolution neural network are linked. Because some banks utilize convolution neural networks to determine the amount on a check, they were chosen. Keras with the TensorFlow backend was utilized in this example. Keras is a strong neural network API that can operate on top of the TensorFlow API.



1. LAYER BUILD

In our project as mentioned earlier, we have utilized convolutional neural layers to obtain the greatest accuracy and the process is described below.

2. MAX POOLING

The goal of this max-pooling approach is to down sample the image. Here, we'll choose a 2X2 stride and move it across the image to acquire the greatest value from that stride. This was done to minimize the model's overall computational complexity.

3. OVERFITTING

Over fitting is a model that indicates that it learns too much from the input and noise, which has a detrimental influence on the outcome. Dropouts can be used to solve this problem.

4. OPTIMIZER

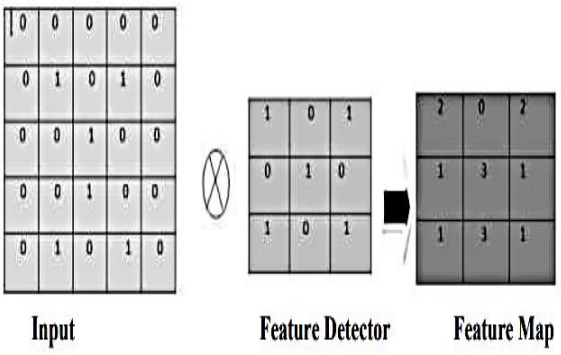
To provide an accurate output, the optimizer is utilized in the neural network to change the network's weights. Many optimizers are accessible in the Keras API, including Adam, RMS prop, and SGD, all of which update via stochastic gradient descent. When using the Adam optimizer to train the model, it yields 100% accuracy but does not produce the correct output. This was also true of the SGD optimizer. However, when used with the terms prop, it performed properly with accurate output and had 86.32% accuracy.

5. FLATTEN LAYER

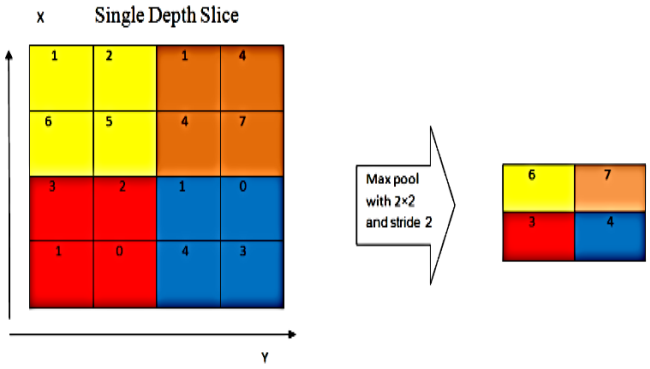
It flattens all of the structures into a single vector, i.e., it adds all of the numerous 2d kernels that may be used by the dense layers for the final classification.

6. ACTIVATION FUNCTION

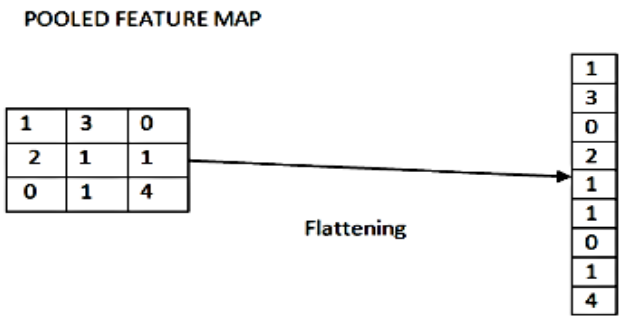
It specifies the node's output based on the input it receives. There are many different forms of activation functions, including Rectifier, sigmoid, and others. The rectifier activation function is used in the model's hidden layers, while the sigmoid function is used in the output since it returns the probability value. The value of the Rectifier function is always larger than 0. When the probability is to be utilized as an output, the sigmoid function is employed. Suffering the mistake made for the training set on the given epoch is the loss in the model. Because the loss was only computed on a binary output, i.e. fracture or non-fracture, binary entropy was employed.



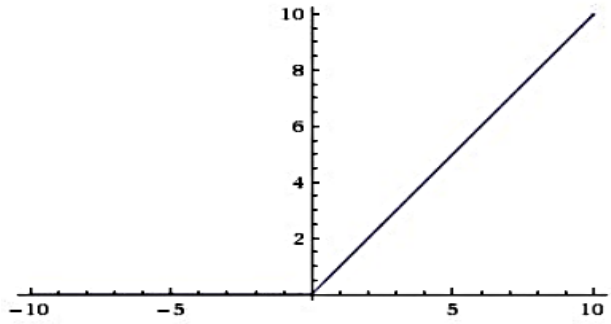
Feature Mapping of our R-CNN



Single Depth Slice with Max pool



Flattening layer in R-CNN

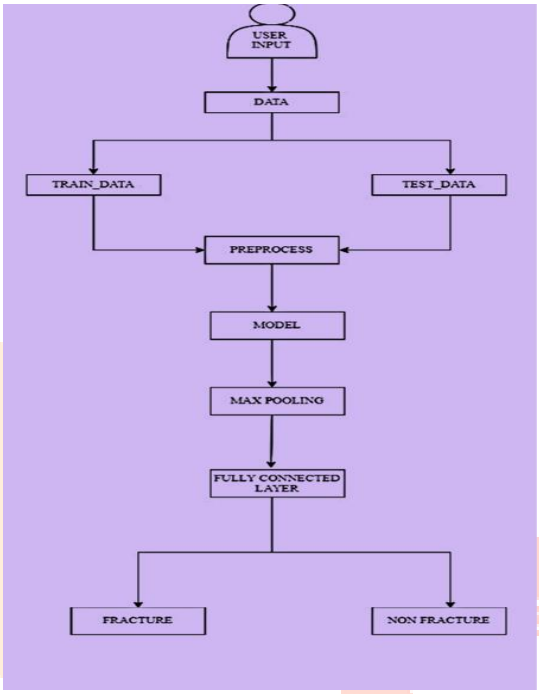


ReLU function graph

The Rectified Linear Unit is a particular unit found in each layer that plays an important function in Convolutional Neural Networks. In deep learning models, it's also known as the Activation function. If you provide the Relu function with a negative number, it will return 0; otherwise, it will return x. For example, consider the following diagram.
Now that we've gone over each layer in detail, let's look at how we'll put them all together to create the model we need.

II. SYSTEM ARCHITECTURE

Dataset that was used was taken from the bone fracture imaging archive. It has a very large collection of public datasets of every kind of bone fracture and normal X-ray images. The algorithm used was a Convolution neural networks which was a supervised learning algorithm which takes a labeled training data to adjust the weights if the models. In convolution neural network all the hidden layers are interconnected. The convolution neural networks were selected because that some banks use them to identify the amount on the cheque also. The library used here was keras with the TensorFlow backend. Keras is a powerful neural network API which has the capability of running over TensorFlow API. Finally the model is going to predict the accurate results weather the bone is fractured or not.



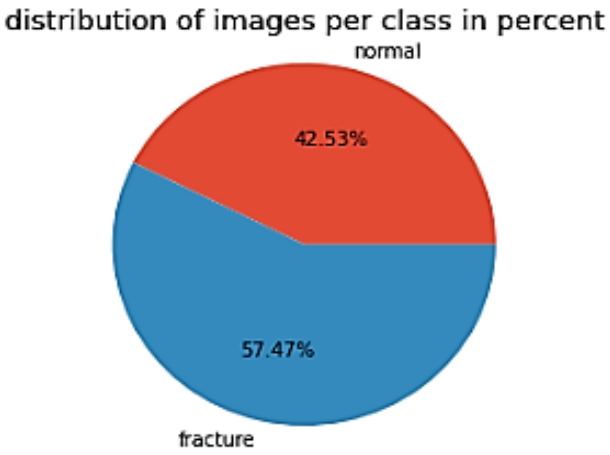
Flowchart of the project

1. SOFTWARE & HARDWARE REQUIREMENTS TABLE

Sl.No	Type of Requirement	Description
1.	Software – Code Console	Python 3.8.6
2.	Software -Lap OS	Windows/Mac
3.	Hardware- RAM & ROM	8 GB | 256 GB
4.	Software – MS Office	For Proj Doc
5.	Internet/Wifi /LAN	Min- 50 MBPS

2. DATASET DESCRIPTION

In this paper some information that includes photographs of both fractured and non-fractured objects. It has been separated into two sections: testing data and training data. We have both fractured and non-fractured photos in the testing data, and we have over 221 images in both the training and testing sets. Each picture has its own set of attributes, such as image height and width. We used Kaggle, Github, google photos to obtain both fractured and non-fractured data.

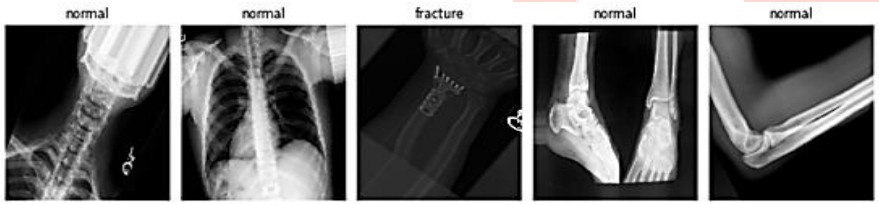


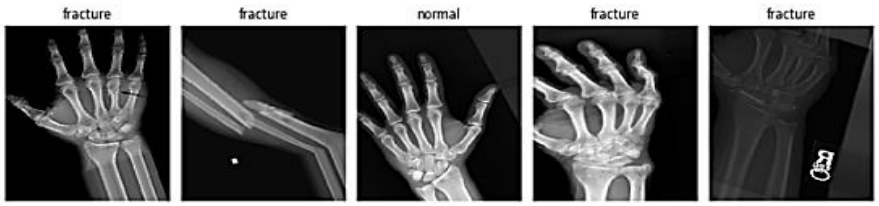
3. TRAINING OUR IMAGE SET

To ensure that the model we've created works properly, we'll need to import two essential crucial components first. We must import all of the essential packages, as well as our datasets, which we will implement later. This procedure can be further degraded to the step below. The initial step is to import all of our necessary programs, as well as our datasets. It's not difficult at all to import all of our programs. It follows the same steps as any other model on the market. The process of importing our data sets is when things become interesting. To develop our model, we used the TensorFlow program.

4. PREPROCESSING

Our Model was built in such a way that it can pierce through numerical data and analyze it further. If our Entries aren't properly transformed to a format that our model can appreciate, they'll be discarded. The first step in resolving this is to scale all of our photographs to argentine proportions. To test, we used both grayscale and colour photos. These photos were then transformed to Matrix Format as a result of this phase. Our model now understands that a matrix is nothing more than numerical data stored in a two-dimensional array.





5. FEATURE EXTRACTION

It's used to reduce the supplied image's size. To tackle computer vision problems like object identification, detection, and recognition, extraction, and detection are coupled. In terms of dimensionality reduction, extraction is indicated. We decrease the information when it becomes too massive to manage at a later stage. We use a technique called include selection to identify underlying highlights. To distinguish between the photos, features are extracted. In machine vision algorithms, features extraction is employed. We may also use the characteristics gathered from the image to train various algorithms. This is a common strategy in machine learning.

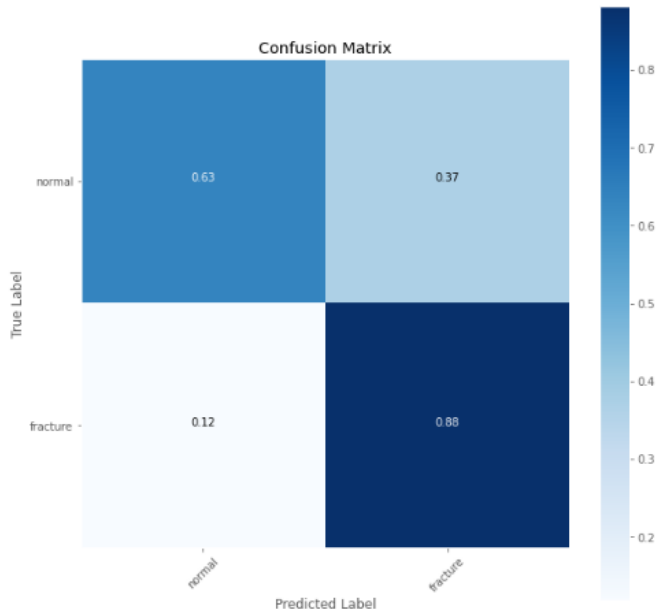
III. RESULTS AND ANALYSIS

By comparing 3 algorithms of CNN –

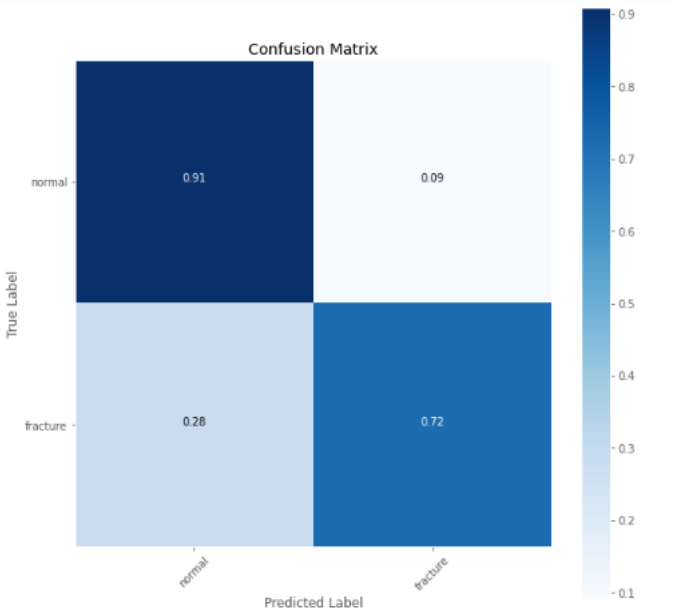
- ConvNet/CNN show an accuracy of 55.69%
- Visual Geometry Group - (VGG16) shows an accuracy of 65.8%
- Region-Based Convolutional Neural Network - (R-CNN) shows an accuracy of 86.32%

1. RESULT OF R-CNN MODEL WITH LOSS AND ACCURACY

2. CONFUSION MATRIX OF R-CNN



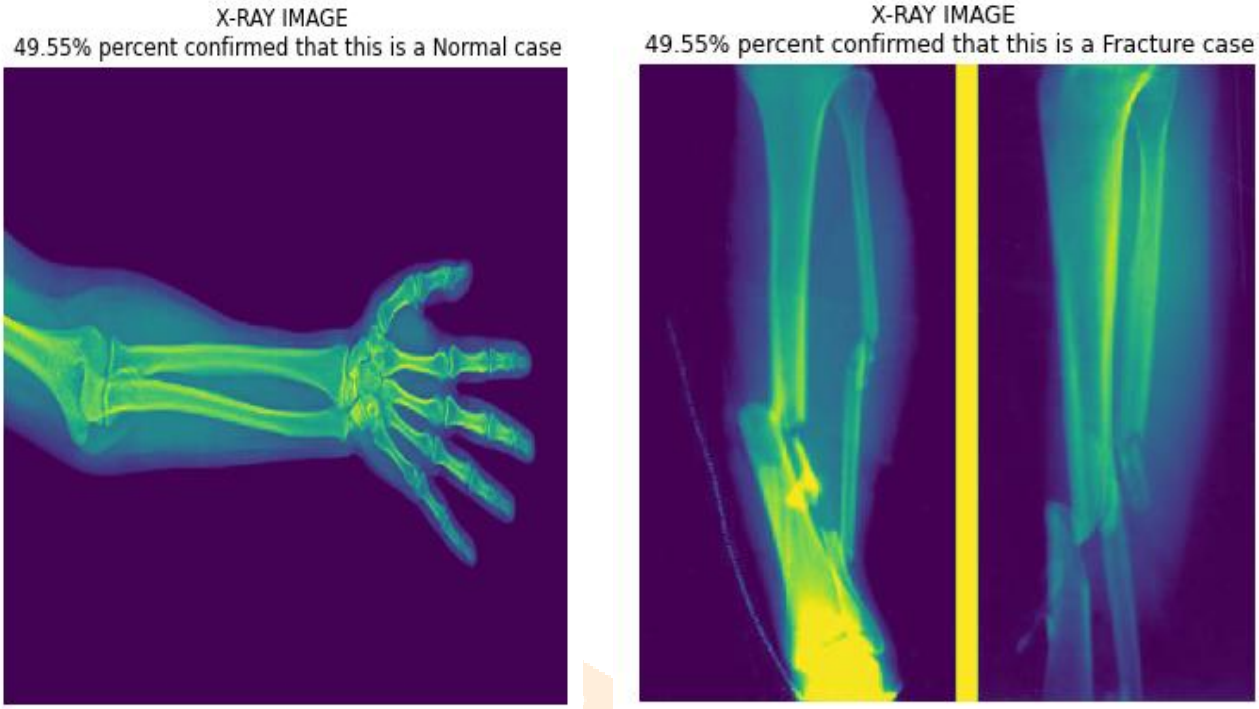
R-CNN Confusion Matrix for validation dataset results
Predicted accuracy fracture: 88% and normal: 63%



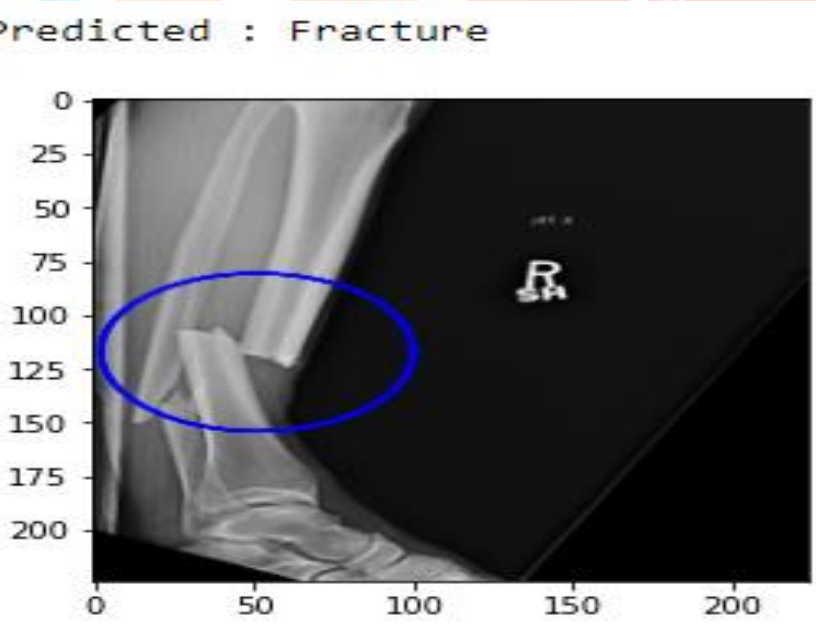
R-CNN Confusion Matrix for testing dataset results
Predicted accuracy Fracture: 72% and Normal: 91%

3. OUTCOMS OF THREE ALGORITHMS

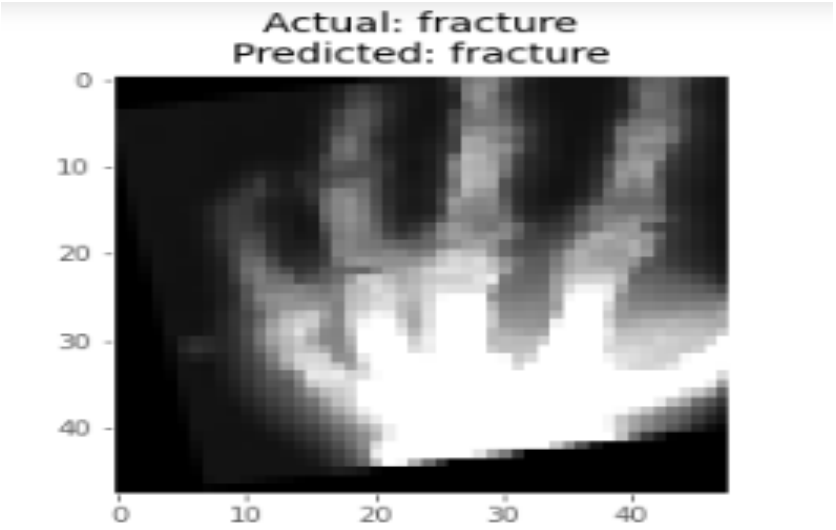
- **Outcomes of ConvNet/CNN**



- **Outcomes of VGG-16**



- **Outcomes of R-CNN**

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Clipping input data to the valid rang
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IV. CONCLUSION

With the use of data that this project acquired, to investigated bone fractures using the Convolutional Neural Network technique in this research. Algorithm successfully determines which scans are fragmented and which are not. Model is accurate to the tune of 70 to 87 per cent. In this project model has examined around 221 photos from both the testing and training data sets. Because there were utilizing the Region-Based Convolutional Neural Network technique, the model worked perfectly with accuracy of 87.32%.

By comparing 3 algorithms of CNN:

- ConvNet/CNN show an accuracy of 55.69%
- Visual Geometry Group - (VGG16) shows an accuracy of 65.8%
- Region-Based Convolutional Neural Network - (R-CNN) shows an accuracy of 86.32%

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