**Bone Fracture Detection using Deep Learning: A Detailed Report**

1. **Introduction**  
   The goal of this project is to develop a deep learning model capable of accurately classifying X-ray images as either "Fractured" or "Not Fractured." This model can assist medical professionals in quickly identifying bone fractures, leading to faster diagnosis and treatment.
2. **Dataset**  
   The dataset used in this project is the "Bone Fracture Binary Classification" dataset, which contains X-ray images of fractured and non-fractured bones. The dataset is divided into three subsets: train, validation, and test.

3**. Exploratory Data Analysis (EDA)**  
The EDA process involved visualizing sample images from the "Fractured" and "Not Fractured" classes to gain an understanding of the data. The distribution of the classes was analysed to ensure a balanced dataset.

**EDA Findings:**

* The X-ray images in the dataset are grayscale and vary in size.
* The "Fractured" class images clearly show fractures or breaks in the bones, while the "Not Fractured" class images appear normal.
* The dataset seems to be well-balanced, with a similar number of images in each class.

**4. Data Preprocessing**  
The data preprocessing steps included:

Rescaling the images to a range of 0-1 for efficient processing.

Applying data augmentation techniques, such as rotation, shifting, shearing, zooming, and flipping, to the training data to increase diversity and prevent overfitting.

Resizing the images to a fixed size of 150x150 pixels for consistency.

**5. Model Architecture**  
The model architecture employed transfer learning using the VGG16 pre-trained model as the base model. The top layers of the VGG16 model were replaced with custom layers:

A Flatten layer

A Dense layer with 512 units and ReLU activation

A final Dense layer with a single unit and sigmoid activation for binary classification

The base model layers were frozen to leverage the pre-trained weights as feature extractors.

**6. Model Training**  
The model was compiled with the Adam optimizer and binary cross-entropy loss function. The accuracy metric was used to evaluate the model's performance during training. The model was trained for 10 epochs using the training and validation data generators.

**7. Model Evaluation**  
The model's performance was evaluated on the test set, and the following metrics were calculated:

Test Accuracy: 0.8660

Precision: 0.5104

Recall: 0.4695

F1-score: 0.4891

Predictions on the Test Set:

python

predictions = model.predict(test\_generator)

y\_true = test\_generator.classes

y\_pred = predictions > 0.5

The predictions variable contains the model's predicted probabilities for each image in the test set. The y\_true variable contains the true labels (0 for "Not Fractured" and 1 for "Fractured"), and y\_pred contains the binary predictions based on a threshold of 0.5.

**8. Deployment with Flask**  
The trained model was deployed as a web application using Flask. Users can upload X-ray images, and the application will classify them as "Fractured" or "Not Fractured." The prediction result is displayed on a separate page.

**9. Conclusion**  
The developed deep learning model leverages transfer learning and the VGG16 architecture to classify X-ray images as "Fractured" or "Not Fractured." The model's performance was evaluated using various metrics, and the results are promising, with a test accuracy of 0.8660. However, the precision, recall, and F1-score values indicate room for improvement.

The Flask deployment allows for easy integration and use of the model in real-world scenarios, potentially assisting medical professionals in faster diagnosis and treatment of bone fractures.