Detecting Deepfake Images using Convolutional Neural Networks

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Project Objective

- Develop a deep learning model to classify images as real or fake.
- Use CNNs for their ability to capture spatial hierarchies in images.

Dataset Description

- Source: Kaggle, “Deepfake and Real Images” dataset.
- Structure:Train: Images for training the model.
- Test: Images for evaluating model performance.
- Validation: Images for tuning the model.
- Subfolders: Real and Fake images in each directory.

Data Preparation

Organized images into respective directories.

Preprocessed images by resizing to 32x32 pixels.

Normalized pixel values to [0, 1] range.

Data Augmentation

- Techniques: Rescaling, Shear Transformation, Zoom, Horizontal Flip.
- Helps to generalize the model and prevent overfitting.

In [2]:

```
image_size = (32, 32)

train_datagen = ImageDataGenerator(rescale=1./255, rotation_range=15, width_shift_range=0.1,
                                   height_shift_range=0.1, zoom_range=0.1, horizontal_flip=True)

validation_datagen = ImageDataGenerator(rescale=1./255)

test_datagen = ImageDataGenerator(rescale=1./255)

batch_size = 32

train_generator = train_datagen.flow_from_directory('/Users/harsh/Downloads/Dataset/Train', target_size=image_si
                                                    batch_size=batch_size, class_mode='binary')

validation_generator = validation_datagen.flow_from_directory('/Users/harsh/Downloads/Dataset/Validation',
                                                              target_size=image_size,
                                                              batch_size=batch_size, class_mode='binary')

test_generator = test_datagen.flow_from_directory('/Users/harsh/Downloads/Dataset/Test', target_size=image_size,
                                                  batch_size=batch_size, class_mode='binary')

```

```
Found 140002 images belonging to 2 classes.
Found 39428 images belonging to 2 classes.
Found 10905 images belonging to 2 classes.
```

CNN Architecture

- Layers: Convolutional: Extract features using filters.
- MaxPooling: Reduce spatial dimensions.
- Flatten: Convert 2D matrices to 1D.
- Dense: Fully connected layers for classification.
- Dropout: Prevent overfitting by randomly dropping neurons.

In [3]:

```
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(32, 32, 3)),
    MaxPooling2D((2, 2)),
    Conv2D(64, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),
    Flatten(),
    Dense(128, activation='relu'),
    Dropout(0.5),
    Dense(1, activation='sigmoid')
])

```

In [4]:

```
model.compile(loss='binary_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])

```

Training the Model

- Trained for 50 epochs.
- Batch size of 32 for efficient processing.

In [5]:

```
early_stopping = EarlyStopping(monitor='val_loss', patience=10, restore_best_weights=True)
model_checkpoint = ModelCheckpoint('best_model.h5', save_best_only=True)

history = model.fit(train_generator, epochs=50, validation_data=validation_generator,
                    callbacks=[early_stopping, model_checkpoint])

```

```
Epoch 1/50
4376/4376 [==============================] - 139s 32ms/step - loss: 0.5646 - accuracy: 0.6993 - val_loss: 0.5039 -
val_accuracy: 0.7504
Epoch 2/50
   5/4376 [..............................] - ETA: 2:20 - loss: 0.5326 - accuracy: 0.7125
/Users/harsh/Apps/anaconda3/lib/python3.10/site-packages/keras/src/engine/training.py:3079: UserWarning: You are sa
ving your model as an HDF5 file via `model.save()`. This file format is considered legacy. We recommend using inste
ad the native Keras format, e.g. `model.save('my_model.keras')`.
  saving_api.save_model(
4376/4376 [==============================] - 139s 32ms/step - loss: 0.5032 - accuracy: 0.7480 - val_loss: 0.4742 -
val_accuracy: 0.7670
Epoch 3/50
4376/4376 [==============================] - 137s 31ms/step - loss: 0.4764 - accuracy: 0.7677 - val_loss: 0.4481 -
val_accuracy: 0.7858
Epoch 4/50
4376/4376 [==============================] - 139s 32ms/step - loss: 0.4602 - accuracy: 0.7789 - val_loss: 0.4386 -
val_accuracy: 0.7916
```

Model Performance

- Training and validation accuracy/loss graphs.
- Demonstrated the model's learning curve.

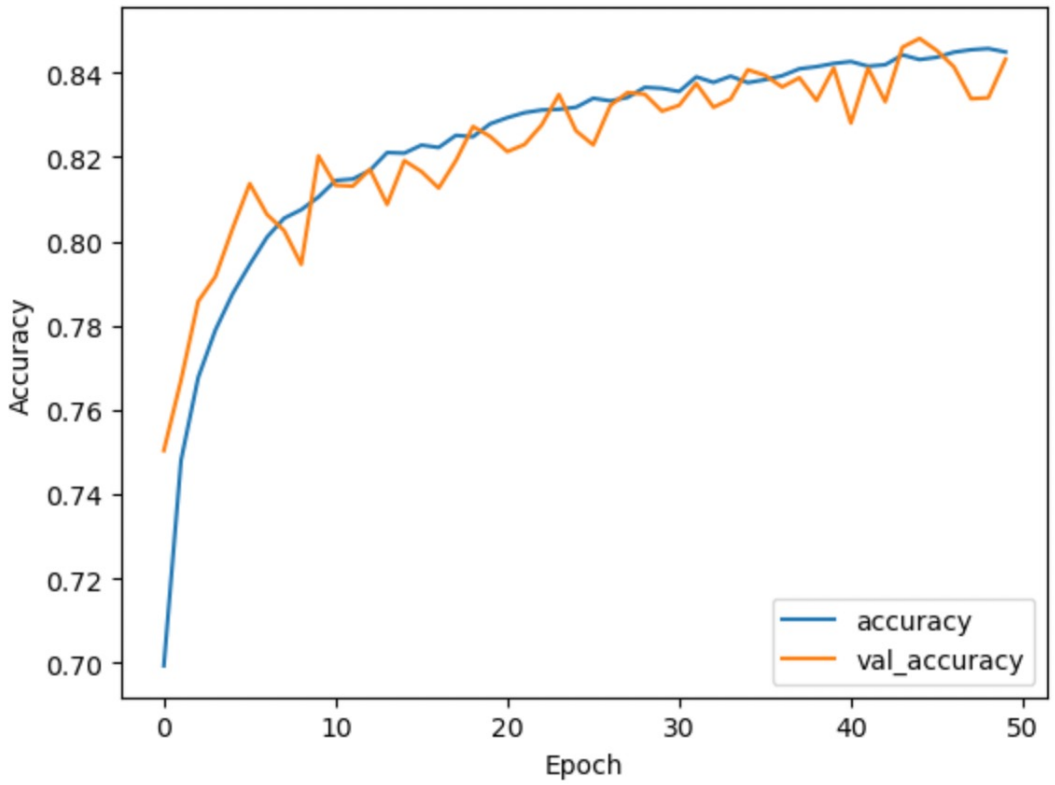
In [36]:

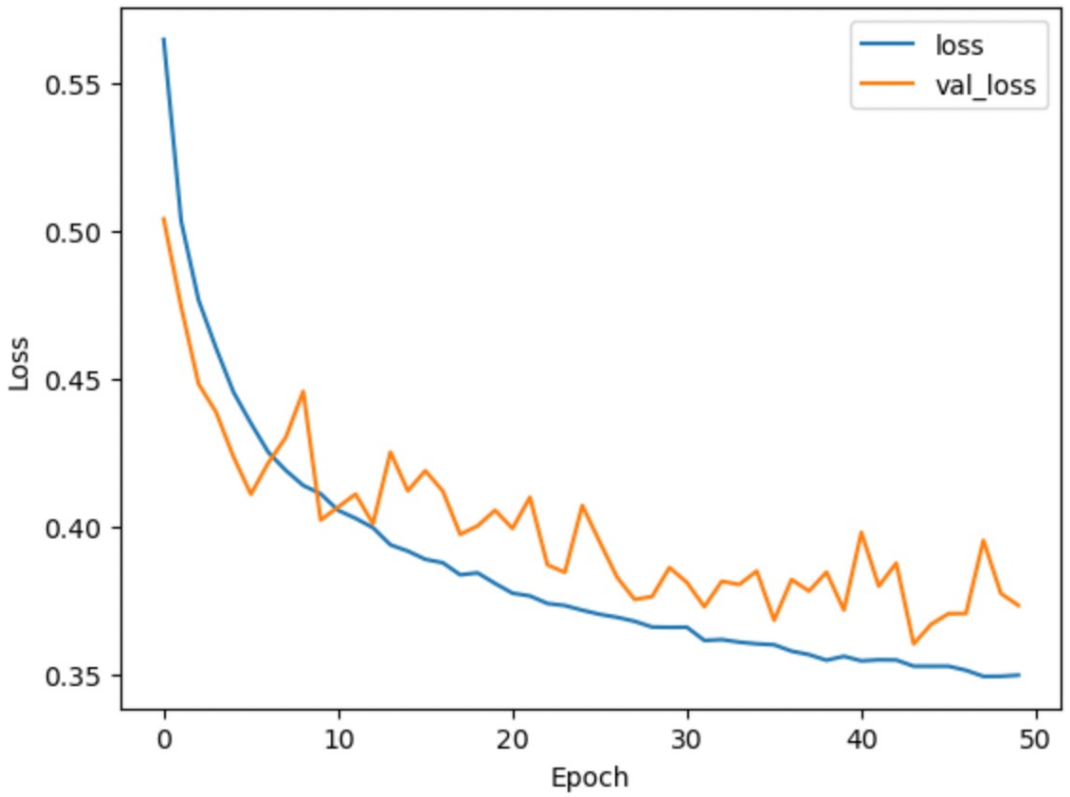
```
model.load_weights('best_model.h5')

# Evaluate on test set
test_loss, test_acc = model.evaluate(test_generator)
print(f'Test accuracy: {test_acc * 100:.2f}%')
```

```
341/341 [==============================] - 7s 20ms/step - loss: 0.4240 - accuracy: 0.8074
Test accuracy: 80.74%
```

Plotting training & validation accuracy and loss





Predict Image Function

In [21]:

```
def predict_image(img_path):
    img = image.load_img(img_path, target_size=image_size)
    img_array = image.img_to_array(img)
    img_array = np.expand_dims(img_array, axis=0)
    img_array /= 255.

    prediction = model.predict(img_array)
    if prediction[0] > 0.5:
        print("Real")
    else:
        print("Fake")


```

In [32]:
```
predict_image('/Users/harsh/Downloads/Dataset/Validation/Real/real_0.jpg')
predict_image('/Users/harsh/Downloads/Dataset/Validation/Fake/fake_0.jpg')
```

```
1/1 [==============================] - 0s 10ms/step
Real
1/1 [==============================] - 0s 8ms/step
Fake
```

In [33]:
```
predict_image('/Users/harsh/Downloads/Dataset/Test/Real/real_3.jpg')
predict_image('/Users/harsh/Downloads/Dataset/Test/Fake/fake_3.jpg')
```

```
1/1 [==============================] - 0s 12ms/step
Real
1/1 [==============================] - 0s 10ms/step
Fake
```

In [34]:
```
predict_image('/Users/harsh/Downloads/Dataset/Test/Real/real_2.jpg')
predict_image('/Users/harsh/Downloads/Dataset/Test/Fake/fake_2.jpg')
```

```
1/1 [==============================] - 0s 14ms/step
Fake
1/1 [==============================] - 0s 8ms/step
Fake
```

Future Work

- Improvements:
  - Use a larger, more diverse dataset.
  - Experiment with more complex CNN architectures.
  - Apply transfer learning with pretrained models like VGG16, ResNet.
- Applications:
  - Extend to video deepfake detection.
  - Develop real-time deepfake detection systems.

Thank You