

```
import tensorflow as tf
from tensorflow.keras import layers, models, Sequential
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt

# Set dataset path
dataset_path = '/kaggle/input/brain-tumor-mri-dataset'

# Preprocess images
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

train_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='training'
)

val_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='validation'
)

# ----- CNN Model -----
def build_cnn_model():
    return Sequential([
        layers.Conv2D(16, (3,3), activation='relu',
padding='same', input_shape=(56, 56, 3)),
        layers.MaxPooling2D((2,2)),
        layers.Conv2D(32, (3,3), activation='relu',
padding='same'),
        layers.MaxPooling2D((2,2)),
        layers.Conv2D(64, (3,3), activation='relu',
padding='same'),
        layers.MaxPooling2D((2,2)),
        layers.Flatten(),
        layers.Dense(64, activation='relu'),
        layers.Dropout(0.5),
        layers.Dense(len(train_data.class_indices)),
activation='softmax')
    ]
)
```

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cnn_model = build_cnn_model()
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

cnn_history = cnn_model.fit(train_data, validation_data=val_data,
epochs=2)

# Evaluate CNN Model
loss, accuracy = cnn_model.evaluate(val_data)
print(f"CNN Validation Accuracy: {accuracy * 100:.2f}%")

# ----- RNN Model
-----

def build_rnn_model():
    return Sequential(
        [
            layers.TimeDistributed(layers.Conv2D(32, (3,3),
activation='relu', padding='same'), input_shape=(10, 56, 56, 3)),
            layers.TimeDistributed(layers.MaxPooling2D((2,2))),
            layers.TimeDistributed(layers.Flatten()),
            layers.LSTM(64, return_sequences=True),
            layers.LSTM(64),
            layers.Dense(64, activation='relu'),
            layers.Dense(len(train_data.class_indices),
activation='softmax')
        ]
    )
rnn_model = build_rnn_model()
rnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

# ----- GAN Model
-----

def build_generator():
    return Sequential(
        [
            layers.Dense(128, activation='relu', input_dim=100),
            layers.Dense(7 * 7 * 256),
            layers.BatchNormalization(),
            layers.Reshape((7, 7, 256)),
            layers.Conv2DTranspose(128, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(64, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(3, kernel_size=4, strides=2,
padding='same', activation='sigmoid')
        ]
    )

def build_discriminator():

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    return Sequential(
        [
            layers.Conv2D(64, (3,3), padding='same', input_shape=(56,
56, 3)),
            layers.LeakyReLU(alpha=0.2),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),
            layers.Dense(1, activation='sigmoid')
        ]
    )

generator = build_generator()
discriminator = build_discriminator()
discriminator.compile(loss='binary_crossentropy', optimizer='adam',
metrics=['accuracy'])

z = layers.Input(shape=(100,))
generated_image = generator(z)
discriminator.trainable = False
validity = discriminator(generated_image)
gan_model = models.Model(z, validity)
gan_model.compile(loss='binary_crossentropy', optimizer='adam')

print("Models built for CNN, RNN, and GANs")

Found 5619 images belonging to 2 classes.
Found 1404 images belonging to 2 classes.
Epoch 1/2
176/176 ━━━━━━━━━━ 18s 85ms/step - accuracy: 0.8064 - loss:
0.5095 - val_accuracy: 0.8134 - val_loss: 0.4883
Epoch 2/2
176/176 ━━━━━━━━━━ 13s 72ms/step - accuracy: 0.8039 - loss:
0.4938 - val_accuracy: 0.8134 - val_loss: 0.4965
44/44 ━━━━━━━━━━ 3s 62ms/step - accuracy: 0.8035 - loss:
0.5108
CNN Validation Accuracy: 81.34%
Models built for CNN, RNN, and GANs

import tensorflow as tf
from tensorflow.keras import layers, models, Sequential
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt

# Set dataset path
dataset_path = '/kaggle/input/brain-tumor-mri-dataset'

# Preprocess images
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

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train_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='training'
)

val_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='validation'
)

# ----- CNN Model
-----
def build_cnn_model():
    return Sequential([
        layers.Conv2D(16, (3,3), activation='relu', padding='same',
input_shape=(56, 56, 3)),
        layers.MaxPooling2D((2,2)),
        layers.Conv2D(32, (3,3), activation='relu', padding='same'),
        layers.MaxPooling2D((2,2)),
        layers.Conv2D(64, (3,3), activation='relu', padding='same'),
        layers.MaxPooling2D((2,2)),
        layers.Flatten(),
        layers.Dense(64, activation='relu'),
        layers.Dropout(0.5),
        layers.Dense(len(train_data.class_indices),
activation='softmax')
    ])

cnn_model = build_cnn_model()
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

cnn_history = cnn_model.fit(train_data, validation_data=val_data,
epochs=2)

# Evaluate CNN Model
loss, accuracy = cnn_model.evaluate(val_data)
print(f"CNN Validation Accuracy: {accuracy * 100:.2f}%")

# ----- Visualizations
-----
def plot_history(history, title):
    plt.figure(figsize=(12, 5))

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# Plot Accuracy
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()
plt.title(f'{title} - Accuracy')

# Plot Loss
plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.title(f'{title} - Loss')
plt.show()

# Plot CNN Results
plot_history(cnn_history, 'CNN')

# ----- Display Predictions
-----
def display_predictions(model, data):
    images, labels = next(data)
    predictions = model.predict(images)

    plt.figure(figsize=(12, 12))
    for i in range(9):
        plt.subplot(3, 3, i + 1)
        plt.imshow(images[i])
        actual_label = np.argmax(labels[i])
        predicted_label = np.argmax(predictions[i])
        plt.title(f"Actual: {data.class_indices[actual_label]}\nPredicted: {data.class_indices[predicted_label]}")
    plt.axis('off')
    plt.show()

print("Displaying Actual vs Predicted Images")
display_predictions(cnn_model, val_data)

# You can follow a similar structure to add visualizations for RNN and GANs if needed.

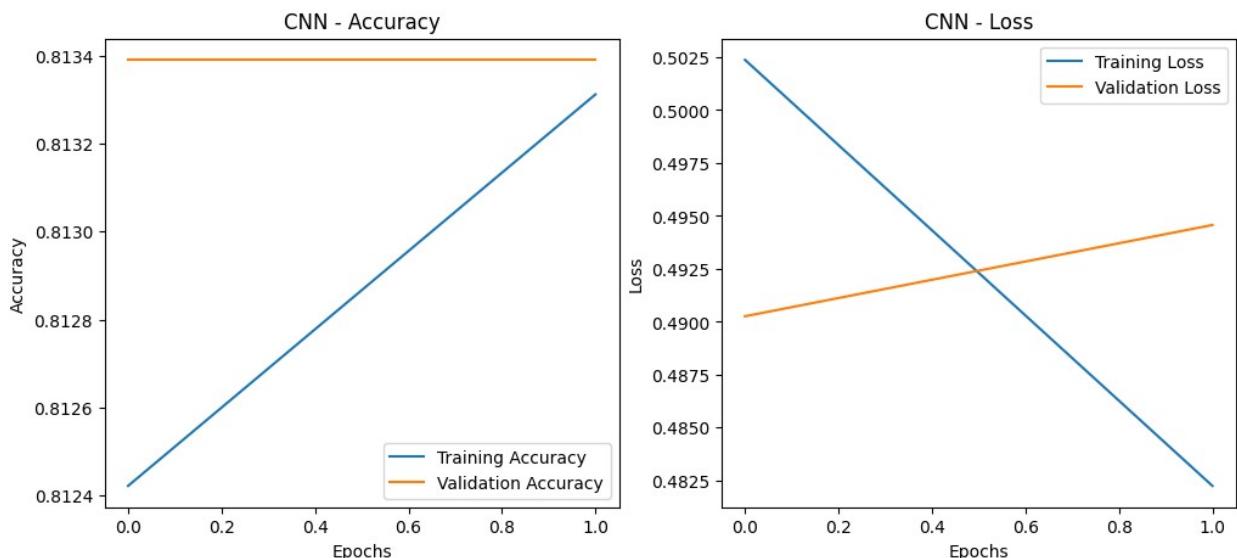
Found 5619 images belonging to 2 classes.
Found 1404 images belonging to 2 classes.
Epoch 1/2
176/176 ━━━━━━━━━━━━ 17s 83ms/step - accuracy: 0.8113 - loss:

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0.5150 - val_accuracy: 0.8134 - val_loss: 0.4903
Epoch 2/2
176/176 ━━━━━━━━━━ 13s 72ms/step - accuracy: 0.8111 - loss:
0.4887 - val_accuracy: 0.8134 - val_loss: 0.4946
44/44 ━━━━━━━ 3s 66ms/step - accuracy: 0.8077 - loss:
0.5024
CNN Validation Accuracy: 81.34%

```



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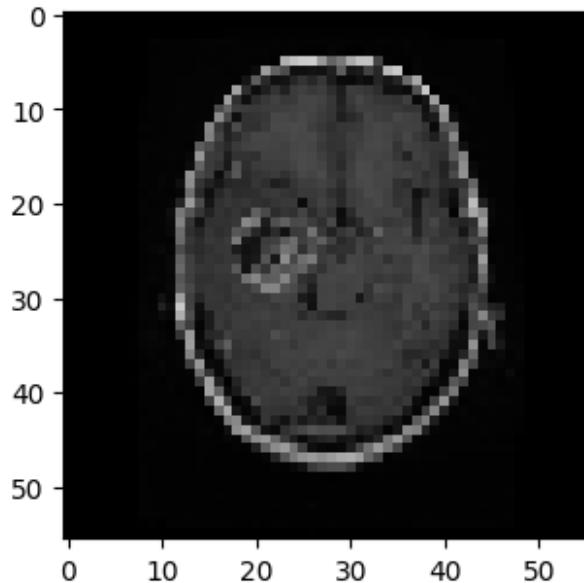
Displaying Actual vs Predicted Images
1/1 ━━━━━━━ 0s 264ms/step
-----
```

```

KeyError Traceback (most recent call
last)
<ipython-input-10-0c68437f4821> in <cell line: 95>()
      93
      94     print("Displaying Actual vs Predicted Images")
---> 95     display_predictions(cnn_model, val_data)
      96
      97 # You can follow a similar structure to add visualizations for
RNN and GANs if needed.

<ipython-input-10-0c68437f4821> in display_predictions(model, data)
      88         actual_label = np.argmax(labels[i])
      89         predicted_label = np.argmax(predictions[i])
---> 90         plt.title(f"Actual:
{data.class_indices[actual_label]}\nPredicted:
{data.class_indices[predicted_label]}")
      91         plt.axis('off')
      92     plt.show()
```

```
KeyError: 1
```



```
import tensorflow as tf
from tensorflow.keras import layers, models, Sequential
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt

# Set dataset path
dataset_path = '/kaggle/input/brain-tumor-mri-dataset'

# Preprocess images
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

train_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='training'
)

val_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='validation'
)
```

```

# ----- CNN Model -----
def build_cnn_model():
    return Sequential(
        [
            layers.Conv2D(16, (3,3), activation='relu',
padding='same', input_shape=(56, 56, 3)),
            layers.MaxPooling2D((2,2)),
            layers.Conv2D(32, (3,3), activation='relu',
padding='same'),
            layers.MaxPooling2D((2,2)),
            layers.Conv2D(64, (3,3), activation='relu',
padding='same'),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),
            layers.Dense(64, activation='relu'),
            layers.Dropout(0.5),
            layers.Dense(len(train_data.class_indices),
activation='softmax')
        ]
    )

cnn_model = build_cnn_model()
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

cnn_history = cnn_model.fit(train_data, validation_data=val_data,
epochs=2)

# Evaluate CNN Model
loss, accuracy = cnn_model.evaluate(val_data)
print(f"CNN Validation Accuracy: {accuracy * 100:.2f}%")

# Visualize results for CNN
plt.figure()
plt.plot(cnn_history.history['accuracy'], label='Train Accuracy')
plt.plot(cnn_history.history['val_accuracy'], label='Validation
Accuracy')
plt.title('CNN Model Accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

plt.figure()
plt.plot(cnn_history.history['loss'], label='Train Loss')
plt.plot(cnn_history.history['val_loss'], label='Validation Loss')
plt.title('CNN Model Loss')
plt.xlabel('Epochs')

```

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plt.ylabel('Loss')
plt.legend()
plt.show()

# ----- RNN Model
-----

def build_rnn_model():
    return Sequential(
        [
            layers.TimeDistributed(layers.Conv2D(32, (3,3),
activation='relu', padding='same'), input_shape=(10, 56, 56, 3)),
            layers.TimeDistributed(layers.MaxPooling2D((2,2))),
            layers.TimeDistributed(layers.Flatten()),
            layers.LSTM(64, return_sequences=True),
            layers.LSTM(64),
            layers.Dense(64, activation='relu'),
            layers.Dense(len(train_data.class_indices),
activation='softmax')
        ]
    )
rnn_model = build_rnn_model()
rnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

# ----- GAN Model
-----

def build_generator():
    return Sequential(
        [
            layers.Dense(128, activation='relu', input_dim=100),
            layers.Dense(7 * 7 * 256),
            layers.BatchNormalization(),
            layers.Reshape((7, 7, 256)),
            layers.Conv2DTranspose(128, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(64, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(3, kernel_size=4, strides=2,
padding='same', activation='sigmoid')
        ]
    )

def build_discriminator():
    return Sequential(
        [
            layers.Conv2D(64, (3,3), padding='same', input_shape=(56,
56, 3)),
            layers.LeakyReLU(alpha=0.2),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),

```

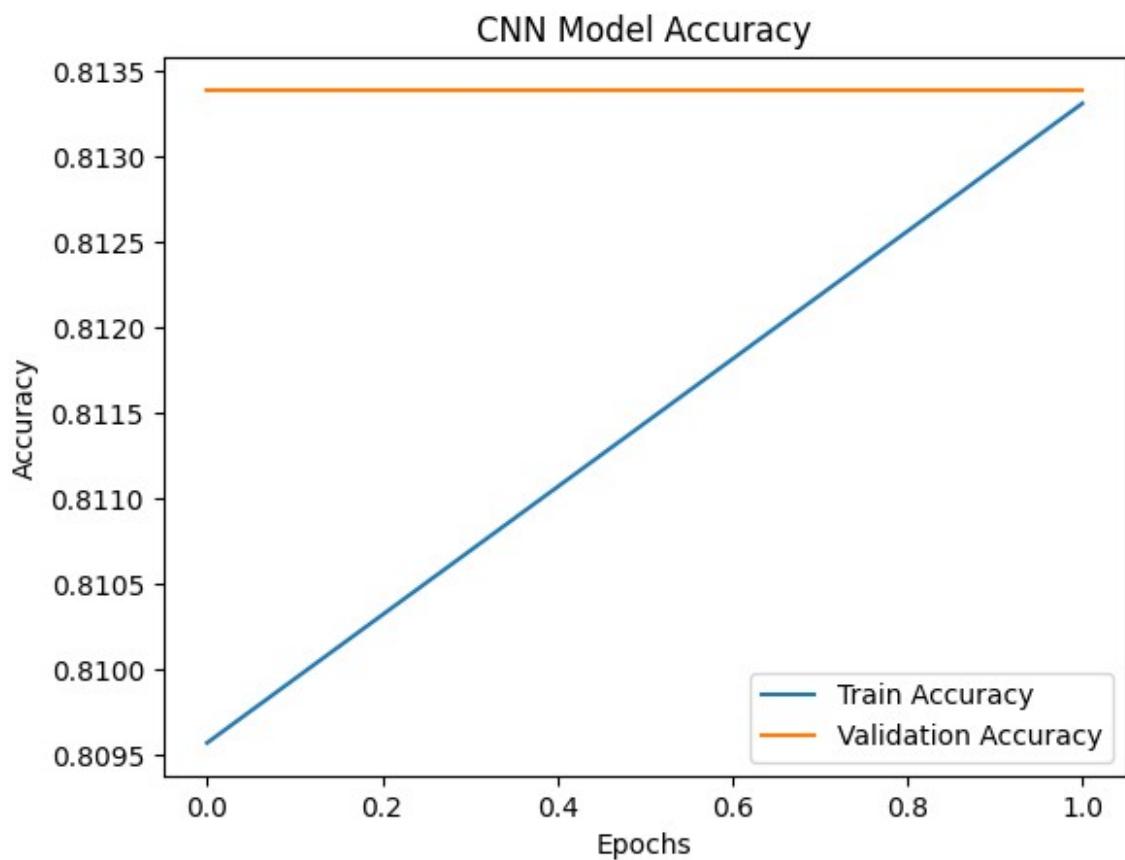
```
        layers.Dense(1, activation='sigmoid')
    ]
)

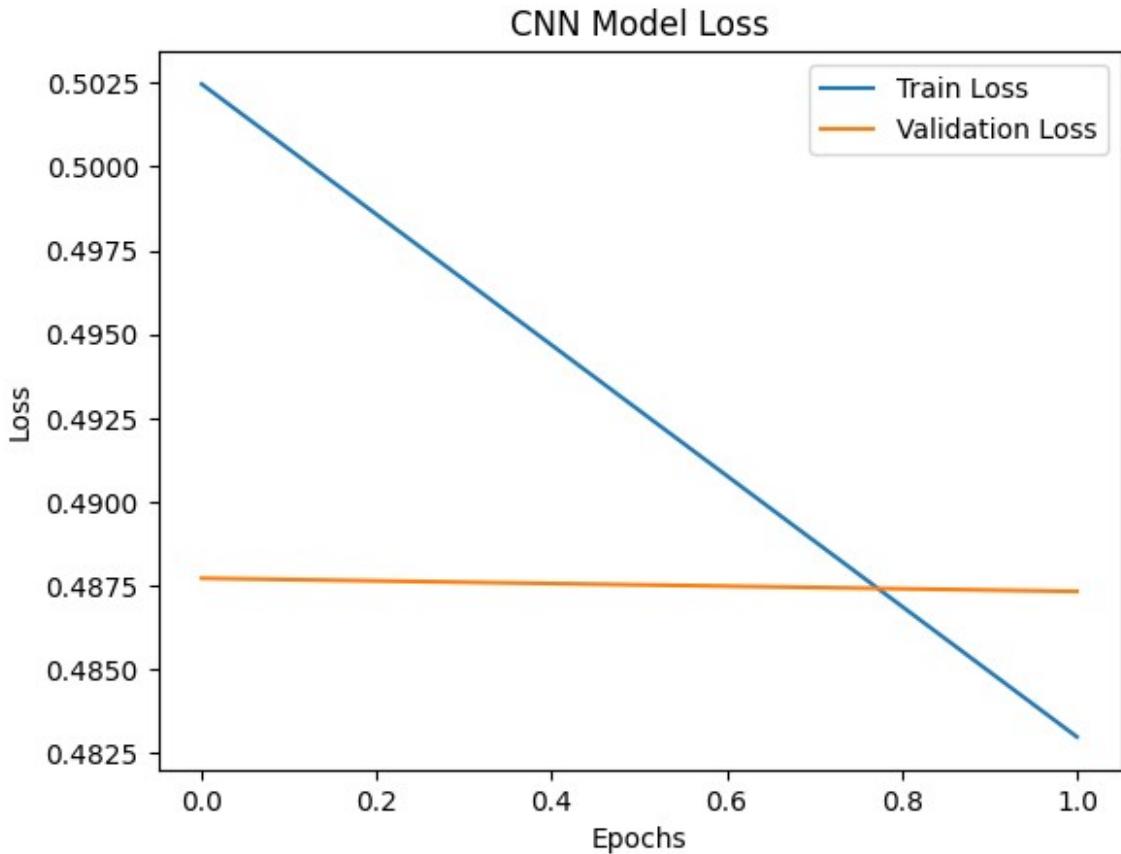
generator = build_generator()
discriminator = build_discriminator()
discriminator.compile(loss='binary_crossentropy', optimizer='adam',
metrics=['accuracy'])

z = layers.Input(shape=(100,))
generated_image = generator(z)
discriminator.trainable = False
validity = discriminator(generated_image)
gan_model = models.Model(z, validity)
gan_model.compile(loss='binary_crossentropy', optimizer='adam')

print("Models built for CNN, RNN, and GANs")

Found 5619 images belonging to 2 classes.
Found 1404 images belonging to 2 classes.
Epoch 1/2
176/176 ━━━━━━━━━━ 17s 83ms/step - accuracy: 0.7904 - loss:
0.5254 - val_accuracy: 0.8134 - val_loss: 0.4877
Epoch 2/2
176/176 ━━━━━━━━━━ 13s 71ms/step - accuracy: 0.8115 - loss:
0.4868 - val_accuracy: 0.8134 - val_loss: 0.4873
44/44 ━━━━━━━━━━ 3s 61ms/step - accuracy: 0.8237 - loss:
0.4742
CNN Validation Accuracy: 81.34%
```





Models built for CNN, RNN, and GANs

```
import tensorflow as tf
from tensorflow.keras import layers, models, Sequential
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt

# Set dataset path
dataset_path = '/kaggle/input/brain-tumor-mri-dataset'

# Preprocess images
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

train_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='training'
)

val_data = datagen.flow_from_directory(
```

```

        dataset_path,
        target_size=(56, 56),
        batch_size=32,
        class_mode='categorical',
        subset='validation'
    )

# ----- CNN Model -----
def build_cnn_model():
    return Sequential(
        [
            layers.Conv2D(16, (3,3), activation='relu',
padding='same', input_shape=(56, 56, 3)),
            layers.MaxPooling2D((2,2)),
            layers.Conv2D(32, (3,3), activation='relu',
padding='same'),
            layers.MaxPooling2D((2,2)),
            layers.Conv2D(64, (3,3), activation='relu',
padding='same'),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),
            layers.Dense(64, activation='relu'),
            layers.Dropout(0.5),
            layers.Dense(len(train_data.class_indices),
activation='softmax')
        ]
    )

cnn_model = build_cnn_model()
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

cnn_history = cnn_model.fit(train_data, validation_data=val_data,
epochs=50)

# Evaluate CNN Model
loss, accuracy = cnn_model.evaluate(val_data)
print(f"CNN Validation Accuracy: {accuracy * 100:.2f}%")

# Visualize results for CNN
plt.figure()
plt.plot(cnn_history.history['accuracy'], label='Train Accuracy')
plt.plot(cnn_history.history['val_accuracy'], label='Validation
Accuracy')
plt.title('CNN Model Accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

```

```

plt.figure()
plt.plot(cnn_history.history['loss'], label='Train Loss')
plt.plot(cnn_history.history['val_loss'], label='Validation Loss')
plt.title('CNN Model Loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()

# Display actual vs predicted images for CNN
import random

x_val, y_val = next(val_data)
predictions = cnn_model.predict(x_val)

plt.figure(figsize=(12, 12))
for i in range(9):
    plt.subplot(3, 3, i+1)
    plt.imshow(x_val[i])
    true_label = np.argmax(y_val[i])
    pred_label = np.argmax(predictions[i])
    plt.title(f"True: {list(train_data.class_indices.keys())} [true_label]\nPred: {list(train_data.class_indices.keys())} [pred_label]")
    plt.axis('off')
plt.tight_layout()
plt.show()

# ----- RNN Model
-----
def build_rnn_model():
    return Sequential(
        [
            layers.TimeDistributed(layers.Conv2D(32, (3,3),
activation='relu', padding='same'), input_shape=(10, 56, 56, 3)),
            layers.TimeDistributed(layers.MaxPooling2D((2,2))),
            layers.TimeDistributed(layers.Flatten()),
            layers.LSTM(64, return_sequences=True),
            layers.LSTM(64),
            layers.Dense(64, activation='relu'),
            layers.Dense(len(train_data.class_indices),
activation='softmax')
        ]
    )
rnn_model = build_rnn_model()
rnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

# ----- GAN Model

```

```

-----
def build_generator():
    return Sequential(
        [
            layers.Dense(128, activation='relu', input_dim=100),
            layers.Dense(7 * 7 * 256),
            layers.BatchNormalization(),
            layers.Reshape((7, 7, 256)),
            layers.Conv2DTranspose(128, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(64, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(3, kernel_size=4, strides=2,
padding='same', activation='sigmoid')
        ]
    )

def build_discriminator():
    return Sequential(
        [
            layers.Conv2D(64, (3,3), padding='same', input_shape=(56,
56, 3)),
            layers.LeakyReLU(alpha=0.2),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),
            layers.Dense(1, activation='sigmoid')
        ]
    )

generator = build_generator()
discriminator = build_discriminator()
discriminator.compile(loss='binary_crossentropy', optimizer='adam',
metrics=['accuracy'])

z = layers.Input(shape=(100,))
generated_image = generator(z)
discriminator.trainable = False
validity = discriminator(generated_image)
gan_model = models.Model(z, validity)
gan_model.compile(loss='binary_crossentropy', optimizer='adam')

print("Models built for CNN, RNN, and GANs")

Found 5619 images belonging to 2 classes.
Found 1404 images belonging to 2 classes.
Epoch 1/50
176/176 ━━━━━━━━━━━━ 18s 84ms/step - accuracy: 0.7946 - loss:
0.5331 - val_accuracy: 0.8134 - val_loss: 0.4862
Epoch 2/50
176/176 ━━━━━━━━━━━━ 13s 71ms/step - accuracy: 0.8084 - loss:

```

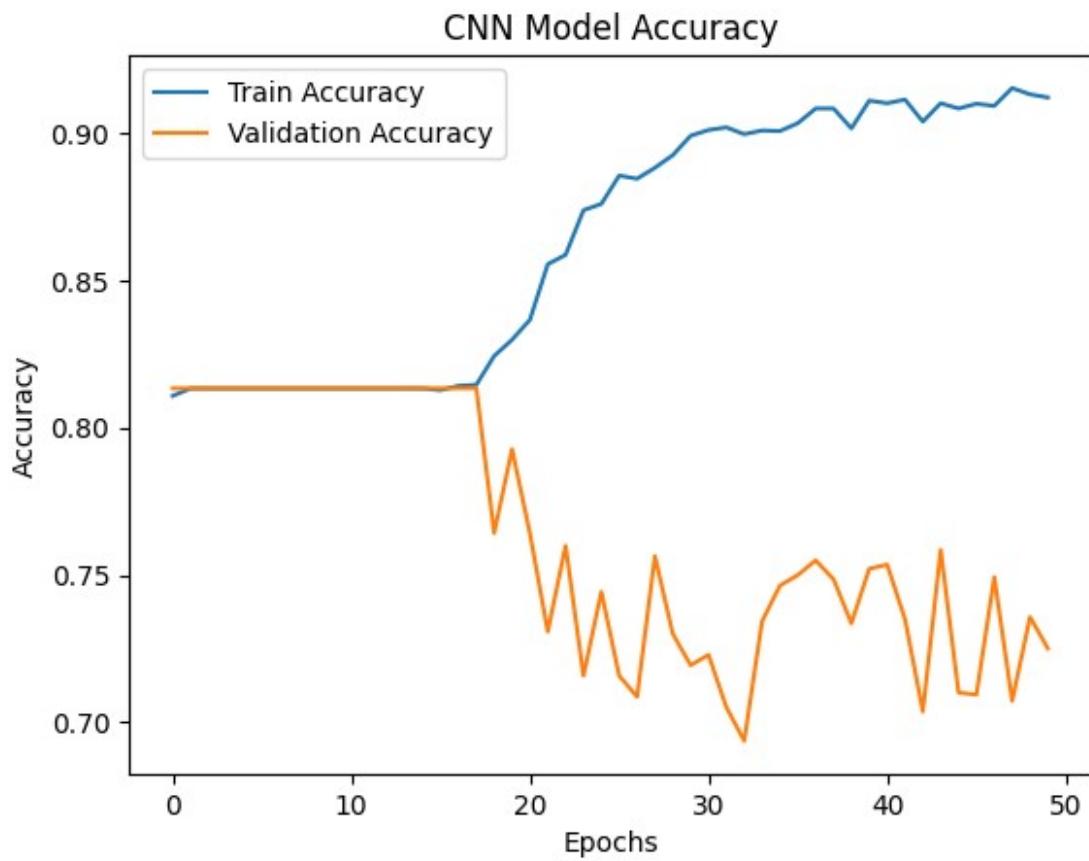
```
0.4918 - val_accuracy: 0.8134 - val_loss: 0.4871
Epoch 3/50
176/176 ----- 13s 70ms/step - accuracy: 0.8158 - loss:
0.4754 - val_accuracy: 0.8134 - val_loss: 0.4865
Epoch 4/50
176/176 ----- 13s 69ms/step - accuracy: 0.8021 - loss:
0.4890 - val_accuracy: 0.8134 - val_loss: 0.4911
Epoch 5/50
176/176 ----- 13s 70ms/step - accuracy: 0.8118 - loss:
0.4685 - val_accuracy: 0.8134 - val_loss: 0.4887
Epoch 6/50
176/176 ----- 14s 76ms/step - accuracy: 0.8193 - loss:
0.4535 - val_accuracy: 0.8134 - val_loss: 0.5046
Epoch 7/50
176/176 ----- 13s 72ms/step - accuracy: 0.8117 - loss:
0.4683 - val_accuracy: 0.8134 - val_loss: 0.4931
Epoch 8/50
176/176 ----- 13s 73ms/step - accuracy: 0.8069 - loss:
0.4561 - val_accuracy: 0.8134 - val_loss: 0.5284
Epoch 9/50
176/176 ----- 13s 69ms/step - accuracy: 0.8072 - loss:
0.4549 - val_accuracy: 0.8134 - val_loss: 0.4993
Epoch 10/50
176/176 ----- 13s 71ms/step - accuracy: 0.8234 - loss:
0.4177 - val_accuracy: 0.8134 - val_loss: 0.4998
Epoch 11/50
176/176 ----- 13s 73ms/step - accuracy: 0.8106 - loss:
0.4272 - val_accuracy: 0.8134 - val_loss: 0.5063
Epoch 12/50
176/176 ----- 13s 72ms/step - accuracy: 0.8172 - loss:
0.4149 - val_accuracy: 0.8134 - val_loss: 0.5089
Epoch 13/50
176/176 ----- 13s 72ms/step - accuracy: 0.8112 - loss:
0.4162 - val_accuracy: 0.8134 - val_loss: 0.5138
Epoch 14/50
176/176 ----- 13s 70ms/step - accuracy: 0.8164 - loss:
0.4009 - val_accuracy: 0.8134 - val_loss: 0.5329
Epoch 15/50
176/176 ----- 13s 72ms/step - accuracy: 0.8111 - loss:
0.3862 - val_accuracy: 0.8134 - val_loss: 0.5227
Epoch 16/50
176/176 ----- 13s 73ms/step - accuracy: 0.8105 - loss:
0.3711 - val_accuracy: 0.8134 - val_loss: 0.5550
Epoch 17/50
176/176 ----- 13s 72ms/step - accuracy: 0.8171 - loss:
0.3323 - val_accuracy: 0.8134 - val_loss: 0.5651
Epoch 18/50
176/176 ----- 13s 70ms/step - accuracy: 0.8047 - loss:
0.3332 - val_accuracy: 0.8134 - val_loss: 0.6212
```

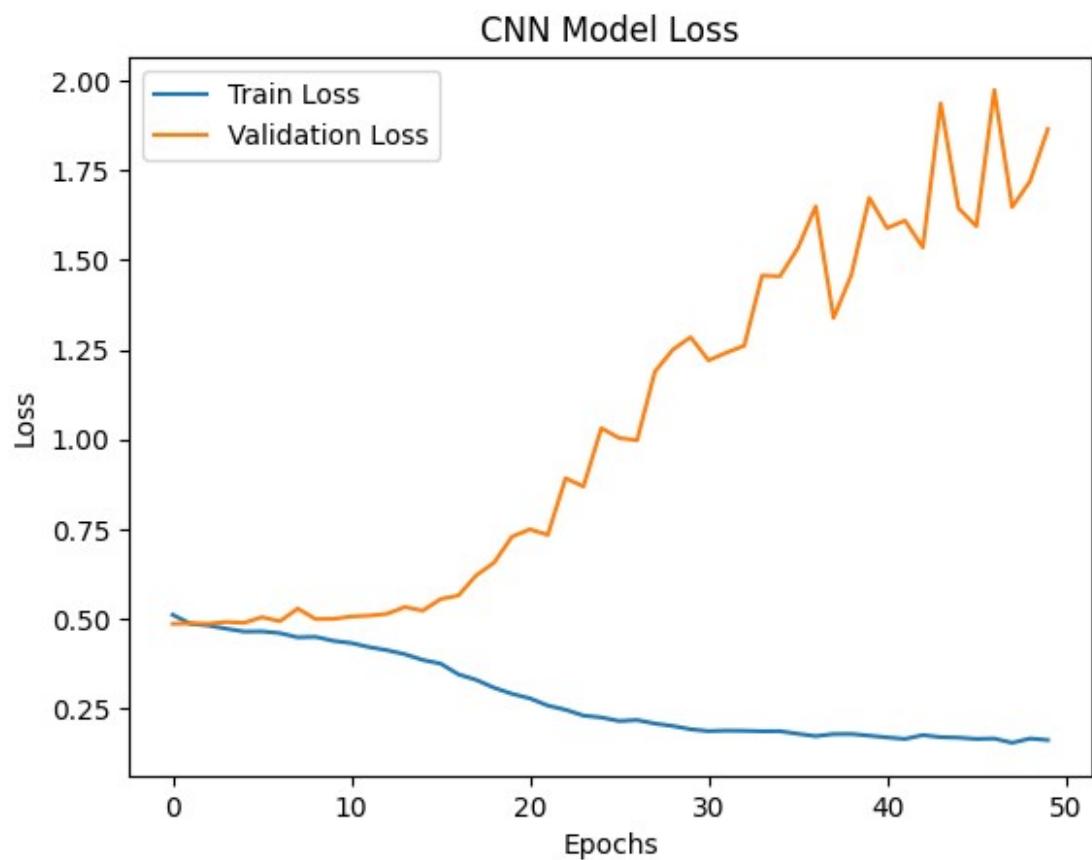
```
Epoch 19/50
176/176 12s 69ms/step - accuracy: 0.8273 - loss: 0.2950 - val_accuracy: 0.7642 - val_loss: 0.6568
Epoch 20/50
176/176 14s 76ms/step - accuracy: 0.8354 - loss: 0.2771 - val_accuracy: 0.7927 - val_loss: 0.7290
Epoch 21/50
176/176 14s 76ms/step - accuracy: 0.8356 - loss: 0.2711 - val_accuracy: 0.7642 - val_loss: 0.7492
Epoch 22/50
176/176 13s 74ms/step - accuracy: 0.8632 - loss: 0.2476 - val_accuracy: 0.7308 - val_loss: 0.7338
Epoch 23/50
176/176 13s 69ms/step - accuracy: 0.8676 - loss: 0.2434 - val_accuracy: 0.7600 - val_loss: 0.8918
Epoch 24/50
176/176 13s 71ms/step - accuracy: 0.8820 - loss: 0.2253 - val_accuracy: 0.7158 - val_loss: 0.8684
Epoch 25/50
176/176 13s 72ms/step - accuracy: 0.8848 - loss: 0.2147 - val_accuracy: 0.7443 - val_loss: 1.0310
Epoch 26/50
176/176 13s 72ms/step - accuracy: 0.8886 - loss: 0.2097 - val_accuracy: 0.7158 - val_loss: 1.0037
Epoch 27/50
176/176 13s 72ms/step - accuracy: 0.8908 - loss: 0.2068 - val_accuracy: 0.7087 - val_loss: 0.9975
Epoch 28/50
176/176 13s 69ms/step - accuracy: 0.8975 - loss: 0.2001 - val_accuracy: 0.7564 - val_loss: 1.1886
Epoch 29/50
176/176 13s 72ms/step - accuracy: 0.8970 - loss: 0.1911 - val_accuracy: 0.7301 - val_loss: 1.2497
Epoch 30/50
176/176 13s 72ms/step - accuracy: 0.8998 - loss: 0.1855 - val_accuracy: 0.7194 - val_loss: 1.2846
Epoch 31/50
176/176 13s 71ms/step - accuracy: 0.9102 - loss: 0.1759 - val_accuracy: 0.7229 - val_loss: 1.2200
Epoch 32/50
176/176 13s 70ms/step - accuracy: 0.9092 - loss: 0.1802 - val_accuracy: 0.7051 - val_loss: 1.2415
Epoch 33/50
176/176 13s 70ms/step - accuracy: 0.9045 - loss: 0.1801 - val_accuracy: 0.6937 - val_loss: 1.2608
Epoch 34/50
176/176 13s 73ms/step - accuracy: 0.9072 - loss: 0.1826 - val_accuracy: 0.7343 - val_loss: 1.4565
Epoch 35/50
```

```
176/176 ━━━━━━━━━━ 13s 74ms/step - accuracy: 0.9090 - loss:  
0.1797 - val_accuracy: 0.7464 - val_loss: 1.4542  
Epoch 36/50  
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.9055 - loss:  
0.1769 - val_accuracy: 0.7500 - val_loss: 1.5326  
Epoch 37/50  
176/176 ━━━━━━━━━━ 13s 71ms/step - accuracy: 0.9088 - loss:  
0.1748 - val_accuracy: 0.7550 - val_loss: 1.6491  
Epoch 38/50  
176/176 ━━━━━━━━━━ 13s 72ms/step - accuracy: 0.9115 - loss:  
0.1753 - val_accuracy: 0.7486 - val_loss: 1.3383  
Epoch 39/50  
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.9005 - loss:  
0.1845 - val_accuracy: 0.7336 - val_loss: 1.4584  
Epoch 40/50  
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.9134 - loss:  
0.1741 - val_accuracy: 0.7521 - val_loss: 1.6729  
Epoch 41/50  
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.9185 - loss:  
0.1598 - val_accuracy: 0.7536 - val_loss: 1.5887  
Epoch 42/50  
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.9180 - loss:  
0.1637 - val_accuracy: 0.7350 - val_loss: 1.6095  
Epoch 43/50  
176/176 ━━━━━━━━━━ 14s 75ms/step - accuracy: 0.9133 - loss:  
0.1694 - val_accuracy: 0.7037 - val_loss: 1.5347  
Epoch 44/50  
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.9176 - loss:  
0.1570 - val_accuracy: 0.7585 - val_loss: 1.9362  
Epoch 45/50  
176/176 ━━━━━━━━━━ 13s 74ms/step - accuracy: 0.9172 - loss:  
0.1534 - val_accuracy: 0.7101 - val_loss: 1.6435  
Epoch 46/50  
176/176 ━━━━━━━━━━ 13s 74ms/step - accuracy: 0.9076 - loss:  
0.1663 - val_accuracy: 0.7094 - val_loss: 1.5936  
Epoch 47/50  
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.9058 - loss:  
0.1667 - val_accuracy: 0.7493 - val_loss: 1.9732  
Epoch 48/50  
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.9187 - loss:  
0.1488 - val_accuracy: 0.7073 - val_loss: 1.6471  
Epoch 49/50  
176/176 ━━━━━━━━━━ 14s 76ms/step - accuracy: 0.9166 - loss:  
0.1583 - val_accuracy: 0.7358 - val_loss: 1.7191  
Epoch 50/50  
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.9145 - loss:  
0.1595 - val_accuracy: 0.7251 - val_loss: 1.8644  
44/44 ━━━━━━━━━━ 3s 59ms/step - accuracy: 0.7311 - loss:
```

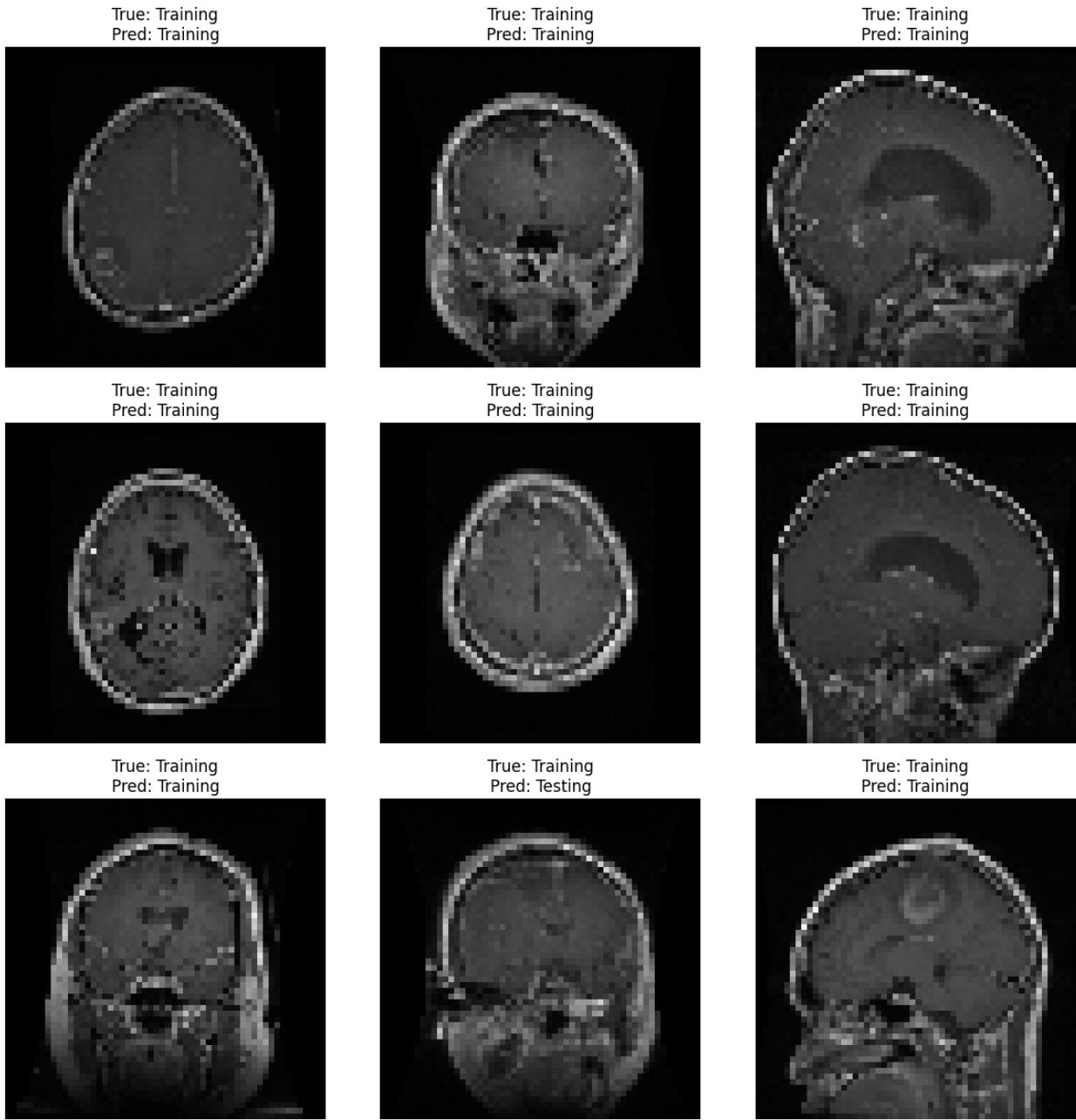
1.6851

CNN Validation Accuracy: 72.51%





1/1 ————— 0s 188ms/step



Models built for CNN, RNN, and GANs

```
import tensorflow as tf
from tensorflow.keras import layers, models, Sequential
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt

# Set dataset path
dataset_path = '/kaggle/input/brain-tumor-mri-dataset'
```

```

# Preprocess images
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

train_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='training'
)

val_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='validation'
)

# ----- CNN Model -----
def build_cnn_model():
    return Sequential(
        [
            layers.Conv2D(16, (3,3), activation='relu',
padding='same', input_shape=(56, 56, 3)),
            layers.MaxPooling2D((2,2)),
            layers.Conv2D(32, (3,3), activation='relu',
padding='same'),
            layers.MaxPooling2D((2,2)),
            layers.Conv2D(64, (3,3), activation='relu',
padding='same'),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),
            layers.Dense(64, activation='relu'),
            layers.Dropout(0.5),
            layers.Dense(len(train_data.class_indices),
activation='softmax')
        ]
    )

cnn_model = build_cnn_model()
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

cnn_history = cnn_model.fit(train_data, validation_data=val_data,
epochs=20)

# Evaluate CNN Model
loss, accuracy = cnn_model.evaluate(val_data)

```

```

print(f"CNN Validation Accuracy: {accuracy * 100:.2f}%")

# Visualize results for CNN
plt.figure()
plt.plot(cnn_history.history['accuracy'], label='Train Accuracy')
plt.plot(cnn_history.history['val_accuracy'], label='Validation Accuracy')
plt.title('CNN Model Accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

plt.figure()
plt.plot(cnn_history.history['loss'], label='Train Loss')
plt.plot(cnn_history.history['val_loss'], label='Validation Loss')
plt.title('CNN Model Loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()

# Display actual vs predicted images for CNN
import random

x_val, y_val = next(val_data)
predictions = cnn_model.predict(x_val)

plt.figure(figsize=(12, 12))
for i in range(9):
    plt.subplot(3, 3, i+1)
    plt.imshow(x_val[i])
    true_label = np.argmax(y_val[i])
    pred_label = np.argmax(predictions[i])
    plt.title(f"True: {list(train_data.class_indices.keys())}[{true_label}]\nPred: {list(train_data.class_indices.keys())}[{pred_label}]")
    plt.axis('off')
plt.tight_layout()
plt.show()

# ----- RNN Model
-----
def build_rnn_model():
    return Sequential(
        [
            layers.TimeDistributed(layers.Conv2D(32, (3,3),
activation='relu', padding='same'), input_shape=(10, 56, 56, 3)),
            layers.TimeDistributed(layers.MaxPooling2D((2,2))),
            layers.TimeDistributed(layers.Flatten()),

```

```

        layers.LSTM(64, return_sequences=True),
        layers.LSTM(64),
        layers.Dense(64, activation='relu'),
        layers.Dense(len(train_data.class_indices),
activation='softmax')
    ]
)
rnn_model = build_rnn_model()
rnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

# ----- GAN Model
-----

def build_generator():
    return Sequential(
        [
            layers.Dense(128, activation='relu', input_dim=100),
            layers.Dense(7 * 7 * 256),
            layers.BatchNormalization(),
            layers.Reshape((7, 7, 256)),
            layers.Conv2DTranspose(128, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(64, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(3, kernel_size=4, strides=2,
padding='same', activation='sigmoid')
        ]
    )

def build_discriminator():
    return Sequential(
        [
            layers.Conv2D(64, (3,3), padding='same', input_shape=(56,
56, 3)),
            layers.LeakyReLU(alpha=0.2),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),
            layers.Dense(1, activation='sigmoid')
        ]
    )

generator = build_generator()
discriminator = build_discriminator()
discriminator.compile(loss='binary_crossentropy', optimizer='adam',
metrics=['accuracy'])

z = layers.Input(shape=(100,))
generated_image = generator(z)
discriminator.trainable = False
validity = discriminator(generated_image)

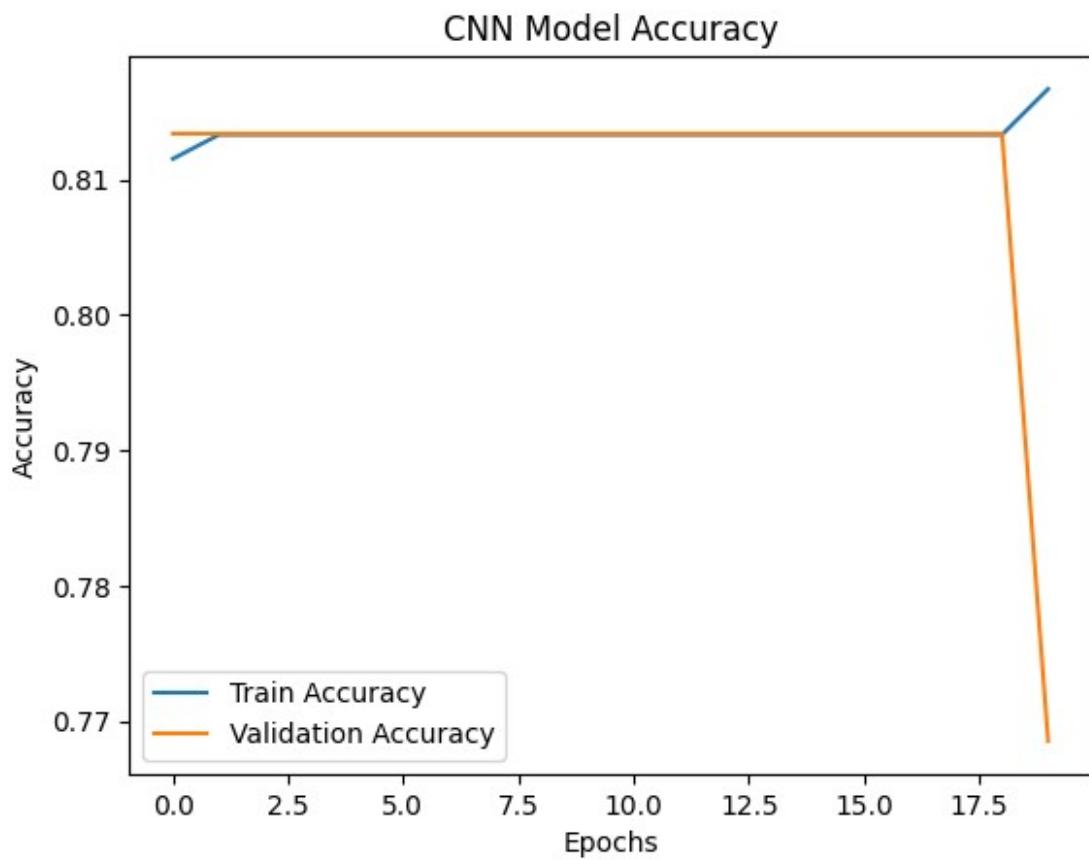
```

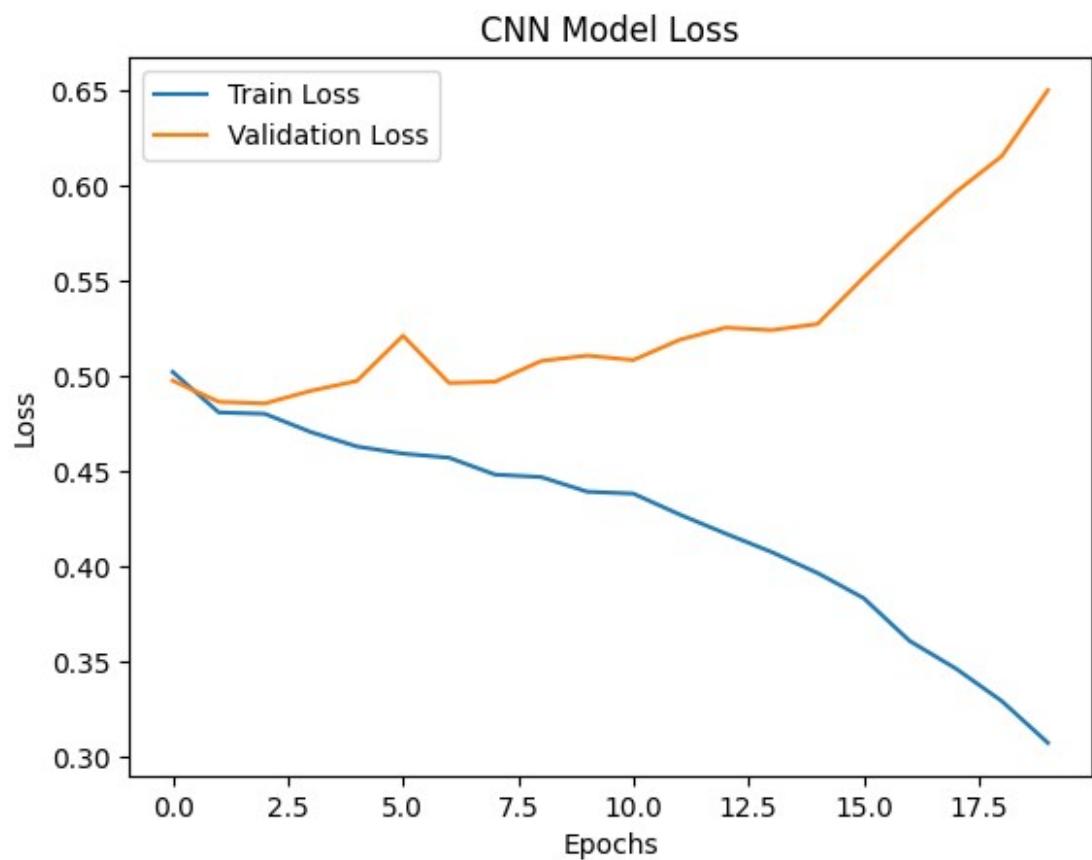
```
gan_model = models.Model(z, validity)
gan_model.compile(loss='binary_crossentropy', optimizer='adam')

print("Models built for CNN, RNN, and GANs")

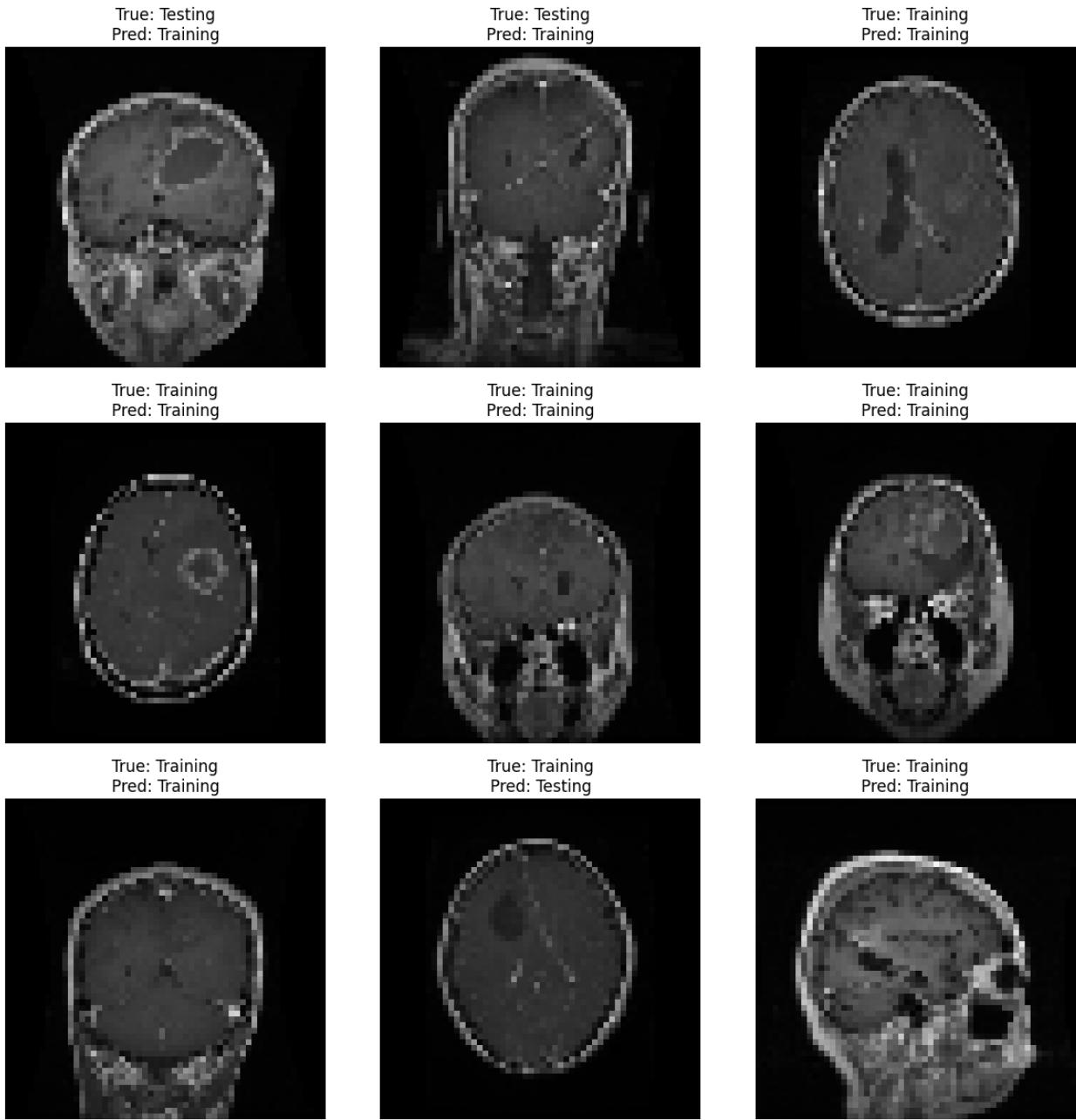
Found 5619 images belonging to 2 classes.
Found 1404 images belonging to 2 classes.
Epoch 1/20
176/176 ━━━━━━━━━━ 18s 88ms/step - accuracy: 0.8015 - loss: 0.5173 - val_accuracy: 0.8134 - val_loss: 0.4976
Epoch 2/20
176/176 ━━━━━━━━━━ 14s 74ms/step - accuracy: 0.8084 - loss: 0.4879 - val_accuracy: 0.8134 - val_loss: 0.4865
Epoch 3/20
176/176 ━━━━━━━━━━ 13s 72ms/step - accuracy: 0.8163 - loss: 0.4747 - val_accuracy: 0.8134 - val_loss: 0.4857
Epoch 4/20
176/176 ━━━━━━━━━━ 13s 72ms/step - accuracy: 0.8162 - loss: 0.4673 - val_accuracy: 0.8134 - val_loss: 0.4923
Epoch 5/20
176/176 ━━━━━━━━━━ 14s 74ms/step - accuracy: 0.8122 - loss: 0.4646 - val_accuracy: 0.8134 - val_loss: 0.4975
Epoch 6/20
176/176 ━━━━━━━━━━ 14s 79ms/step - accuracy: 0.8085 - loss: 0.4692 - val_accuracy: 0.8134 - val_loss: 0.5212
Epoch 7/20
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.8106 - loss: 0.4662 - val_accuracy: 0.8134 - val_loss: 0.4964
Epoch 8/20
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.8137 - loss: 0.4508 - val_accuracy: 0.8134 - val_loss: 0.4970
Epoch 9/20
176/176 ━━━━━━━━━━ 14s 76ms/step - accuracy: 0.8161 - loss: 0.4414 - val_accuracy: 0.8134 - val_loss: 0.5080
Epoch 10/20
176/176 ━━━━━━━━━━ 14s 80ms/step - accuracy: 0.8047 - loss: 0.4512 - val_accuracy: 0.8134 - val_loss: 0.5108
Epoch 11/20
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.8038 - loss: 0.4504 - val_accuracy: 0.8134 - val_loss: 0.5084
Epoch 12/20
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.8108 - loss: 0.4368 - val_accuracy: 0.8134 - val_loss: 0.5190
176/176 ━━━━━━━━━━ 14s 76ms/step - accuracy: 0.8138 - loss: 0.4177 - val_accuracy: 0.8134 - val_loss: 0.5255
Epoch 14/20
176/176 ━━━━━━━━━━ 14s 76ms/step - accuracy: 0.8190 - loss: 0.3989 - val_accuracy: 0.8134 - val_loss: 0.5241
Epoch 15/20
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.8186 - loss:
```

```
0.3855 - val_accuracy: 0.8134 - val_loss: 0.5274
Epoch 16/20
176/176 ━━━━━━━━━━ 13s 74ms/step - accuracy: 0.8216 - loss:
0.3681 - val_accuracy: 0.8134 - val_loss: 0.5518
Epoch 17/20
176/176 ━━━━━━━━━━ 13s 74ms/step - accuracy: 0.8194 - loss:
0.3542 - val_accuracy: 0.8134 - val_loss: 0.5750
Epoch 18/20
176/176 ━━━━━━━━━━ 14s 76ms/step - accuracy: 0.8209 - loss:
0.3366 - val_accuracy: 0.8134 - val_loss: 0.5966
Epoch 19/20
176/176 ━━━━━━━━━━ 14s 75ms/step - accuracy: 0.8115 - loss:
0.3220 - val_accuracy: 0.8134 - val_loss: 0.6155
Epoch 20/20
176/176 ━━━━━━━━━━ 13s 74ms/step - accuracy: 0.8135 - loss:
0.3006 - val_accuracy: 0.7685 - val_loss: 0.6502
44/44 ━━━━━━━━━━ 3s 62ms/step - accuracy: 0.7732 - loss:
0.6258
CNN Validation Accuracy: 76.85%
```





1/1 ————— 0s 190ms/step



Models built for CNN, RNN, and GANs

```
import tensorflow as tf
from tensorflow.keras import layers, models, Sequential
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt

# Set dataset path
dataset_path = '/kaggle/input/brain-tumor-mri-dataset'
```

```

# Preprocess images
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

train_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='training'
)

val_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='validation'
)

# ----- CNN Model -----
def build_cnn_model():
    return Sequential(
        [
            layers.Conv2D(16, (3,3), activation='relu',
padding='same', input_shape=(56, 56, 3)),
            layers.MaxPooling2D((2,2)),
            layers.Conv2D(32, (3,3), activation='relu',
padding='same'),
            layers.MaxPooling2D((2,2)),
            layers.Conv2D(64, (3,3), activation='relu',
padding='same'),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),
            layers.Dense(64, activation='relu'),
            layers.Dropout(0.5),
            layers.Dense(len(train_data.class_indices),
activation='softmax')
        ]
    )

cnn_model = build_cnn_model()
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

cnn_history = cnn_model.fit(train_data, validation_data=val_data,
epochs=10)

# Evaluate CNN Model
loss, accuracy = cnn_model.evaluate(val_data)

```

```

print(f"CNN Validation Accuracy: {accuracy * 100:.2f}%")

# Visualize results for CNN
plt.figure()
plt.plot(cnn_history.history['accuracy'], label='Train Accuracy')
plt.plot(cnn_history.history['val_accuracy'], label='Validation Accuracy')
plt.title('CNN Model Accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

plt.figure()
plt.plot(cnn_history.history['loss'], label='Train Loss')
plt.plot(cnn_history.history['val_loss'], label='Validation Loss')
plt.title('CNN Model Loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()

# Display actual vs predicted images for CNN
import random

x_val, y_val = next(val_data)
predictions = cnn_model.predict(x_val)

plt.figure(figsize=(12, 12))
for i in range(9):
    plt.subplot(3, 3, i+1)
    plt.imshow(x_val[i])
    true_label = np.argmax(y_val[i])
    pred_label = np.argmax(predictions[i])
    plt.title(f"True: {list(train_data.class_indices.keys())}[{true_label}]\nPred: {list(train_data.class_indices.keys())}[{pred_label}]")
    plt.axis('off')
plt.tight_layout()
plt.show()

# ----- RNN Model
-----
def build_rnn_model():
    return Sequential(
        [
            layers.TimeDistributed(layers.Conv2D(32, (3,3),
activation='relu', padding='same'), input_shape=(10, 56, 56, 3)),
            layers.TimeDistributed(layers.MaxPooling2D((2,2))),
            layers.TimeDistributed(layers.Flatten()),

```

```

        layers.LSTM(64, return_sequences=True),
        layers.LSTM(64),
        layers.Dense(64, activation='relu'),
        layers.Dense(len(train_data.class_indices),
activation='softmax')
    ]
)
rnn_model = build_rnn_model()
rnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

# ----- GAN Model
-----

def build_generator():
    return Sequential(
        [
            layers.Dense(128, activation='relu', input_dim=100),
            layers.Dense(7 * 7 * 256),
            layers.BatchNormalization(),
            layers.Reshape((7, 7, 256)),
            layers.Conv2DTranspose(128, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(64, kernel_size=4, strides=2,
padding='same', activation='relu'),
            layers.Conv2DTranspose(3, kernel_size=4, strides=2,
padding='same', activation='sigmoid')
        ]
    )

def build_discriminator():
    return Sequential(
        [
            layers.Conv2D(64, (3,3), padding='same', input_shape=(56,
56, 3)),
            layers.LeakyReLU(alpha=0.2),
            layers.MaxPooling2D((2,2)),
            layers.Flatten(),
            layers.Dense(1, activation='sigmoid')
        ]
    )

generator = build_generator()
discriminator = build_discriminator()
discriminator.compile(loss='binary_crossentropy', optimizer='adam',
metrics=['accuracy'])

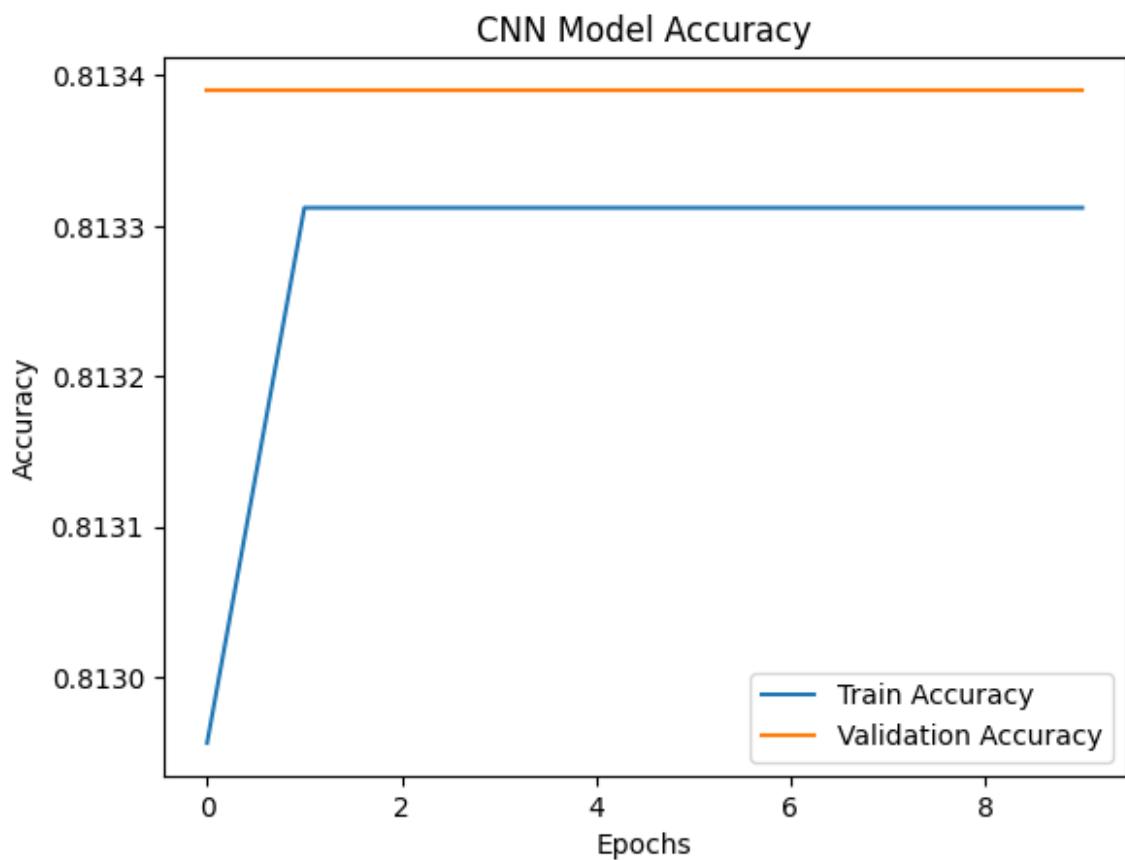
z = layers.Input(shape=(100,))
generated_image = generator(z)
discriminator.trainable = False
validity = discriminator(generated_image)

```

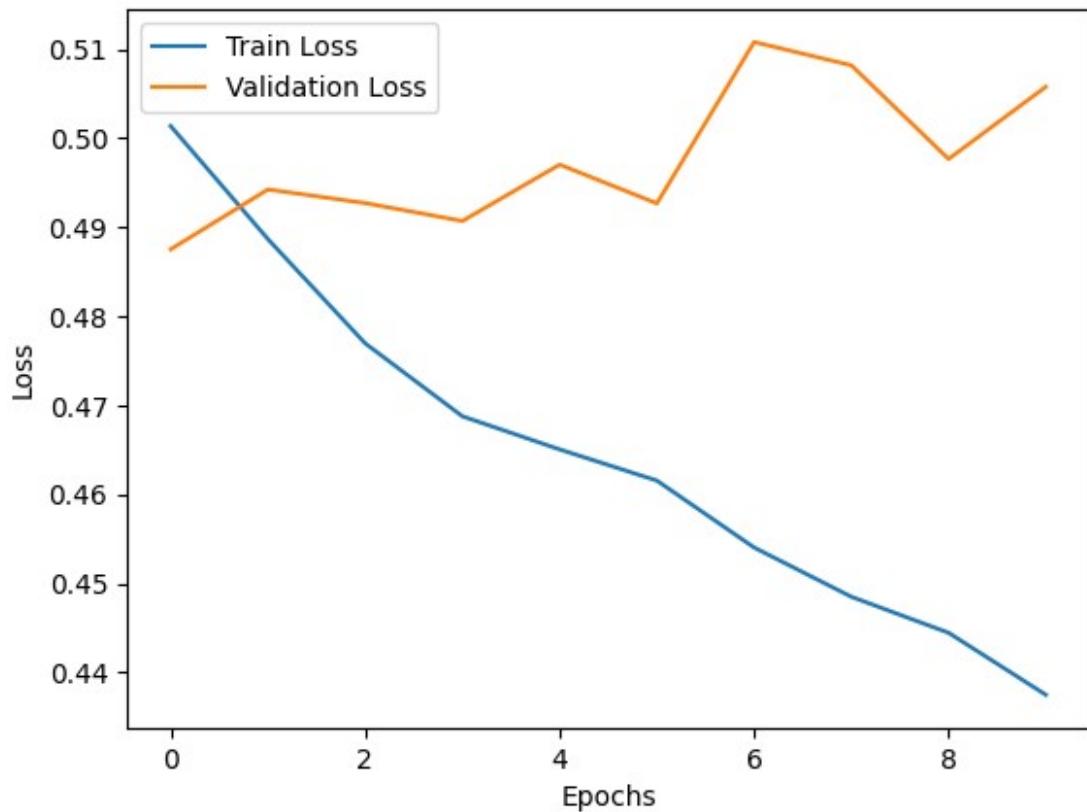
```
gan_model = models.Model(z, validity)
gan_model.compile(loss='binary_crossentropy', optimizer='adam')

print("Models built for CNN, RNN, and GANs")

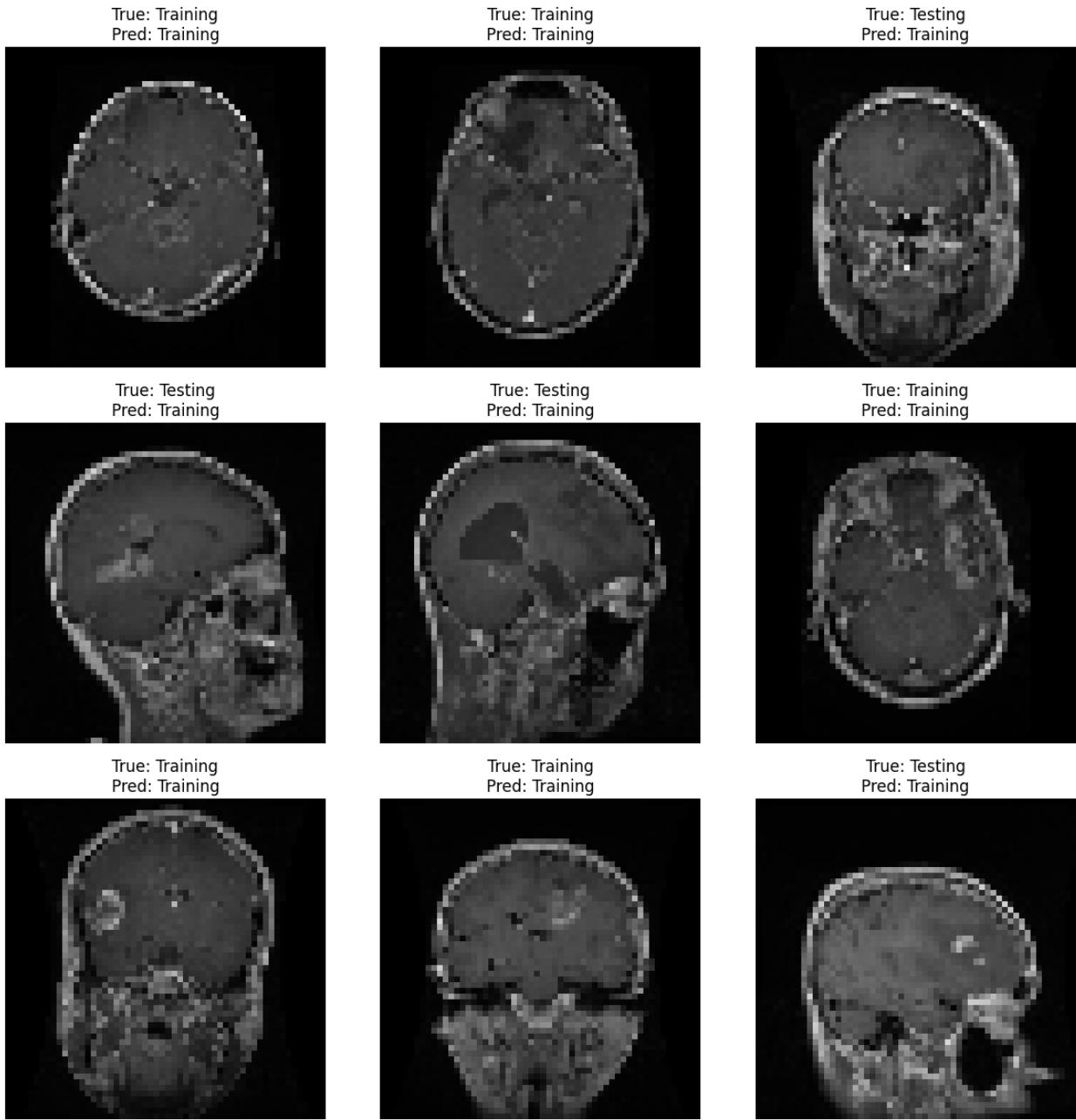
Found 5619 images belonging to 2 classes.
Found 1404 images belonging to 2 classes.
Epoch 1/10
176/176 ━━━━━━━━━━ 18s 85ms/step - accuracy: 0.8058 - loss: 0.5274 - val_accuracy: 0.8134 - val_loss: 0.4875
Epoch 2/10
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.8169 - loss: 0.4841 - val_accuracy: 0.8134 - val_loss: 0.4943
Epoch 3/10
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.8112 - loss: 0.4817 - val_accuracy: 0.8134 - val_loss: 0.4927
Epoch 4/10
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.8161 - loss: 0.4636 - val_accuracy: 0.8134 - val_loss: 0.4907
Epoch 5/10
176/176 ━━━━━━━━━━ 13s 71ms/step - accuracy: 0.8070 - loss: 0.4737 - val_accuracy: 0.8134 - val_loss: 0.4970
Epoch 6/10
176/176 ━━━━━━━━━━ 13s 70ms/step - accuracy: 0.8099 - loss: 0.4618 - val_accuracy: 0.8134 - val_loss: 0.4927
Epoch 7/10
176/176 ━━━━━━━━━━ 13s 74ms/step - accuracy: 0.8109 - loss: 0.4573 - val_accuracy: 0.8134 - val_loss: 0.5108
Epoch 8/10
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.8103 - loss: 0.4539 - val_accuracy: 0.8134 - val_loss: 0.5082
Epoch 9/10
176/176 ━━━━━━━━━━ 13s 72ms/step - accuracy: 0.8174 - loss: 0.4364 - val_accuracy: 0.8134 - val_loss: 0.4977
Epoch 10/10
176/176 ━━━━━━━━━━ 13s 73ms/step - accuracy: 0.8116 - loss: 0.4347 - val_accuracy: 0.8134 - val_loss: 0.5058
44/44 ━━━━━━━━━━ 3s 64ms/step - accuracy: 0.8082 - loss: 0.5135
CNN Validation Accuracy: 81.34%
```



CNN Model Loss



1/1 ————— 0s 190ms/step



Models built for CNN, RNN, and GANs

```
import tensorflow as tf
from tensorflow.keras import layers, models, Sequential
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt
import os

# Set dataset path
dataset_path = '/kaggle/input/brain-tumor-mri-dataset' # Update this
```

```

path as needed

# ----- Data Preprocessing
-----
# Create image data generators for training and validation
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

# Load training data
train_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='training',
    shuffle=True
)

# Load validation data
val_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(56, 56),
    batch_size=32,
    class_mode='categorical',
    subset='validation',
    shuffle=False
)

# ----- Build CNN Model
-----
def build_cnn_model(input_shape=(56, 56, 3), num_classes=2):
    model = Sequential([
        layers.Conv2D(32, (3, 3), activation='relu', padding='same',
input_shape=input_shape),
        layers.MaxPooling2D((2, 2)),
        layers.Conv2D(64, (3, 3), activation='relu', padding='same'),
        layers.MaxPooling2D((2, 2)),
        layers.Conv2D(128, (3, 3), activation='relu', padding='same'),
        layers.MaxPooling2D((2, 2)),
        layers.Flatten(),
        layers.Dense(128, activation='relu'),
        layers.Dropout(0.5),
        layers.Dense(num_classes, activation='softmax')
    ])
    return model

cnn_model = build_cnn_model(num_classes=len(train_data.class_indices))
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

# ----- Train CNN Model
-----
```

```

-----  

cnn_history = cnn_model.fit(train_data, validation_data=val_data,  

epoches=50)  

# ----- Evaluate Model  

-----  

loss, accuracy = cnn_model.evaluate(val_data)  

print(f"CNN Validation Accuracy: {accuracy * 100:.2f}%")  

# ----- Plot Accuracy & Loss  

-----  

plt.figure(figsize=(10, 4))  

plt.subplot(1, 2, 1)  

plt.plot(cnn_history.history['accuracy'], label='Train')  

plt.plot(cnn_history.history['val_accuracy'], label='Val')  

plt.title('Model Accuracy')  

plt.xlabel('Epochs')  

plt.ylabel('Accuracy')  

plt.legend()  

plt.subplot(1, 2, 2)  

plt.plot(cnn_history.history['loss'], label='Train')  

plt.plot(cnn_history.history['val_loss'], label='Val')  

plt.title('Model Loss')  

plt.xlabel('Epochs')  

plt.ylabel('Loss')  

plt.legend()  

plt.tight_layout()  

plt.show()  

# ----- Visualize Predictions  

-----  

x_val, y_val = next(val_data)  

predictions = cnn_model.predict(x_val)  

plt.figure(figsize=(12, 12))  

for i in range(9):  

    plt.subplot(3, 3, i + 1)  

    plt.imshow(x_val[i])  

    true_label = np.argmax(y_val[i])  

    pred_label = np.argmax(predictions[i])  

    plt.title(f"True: {list(train_data.class_indices.keys())}  

[true_label]}\nPred: {list(train_data.class_indices.keys())}  

[pred_label]}")  

    plt.axis('off')  

plt.tight_layout()  

plt.show()

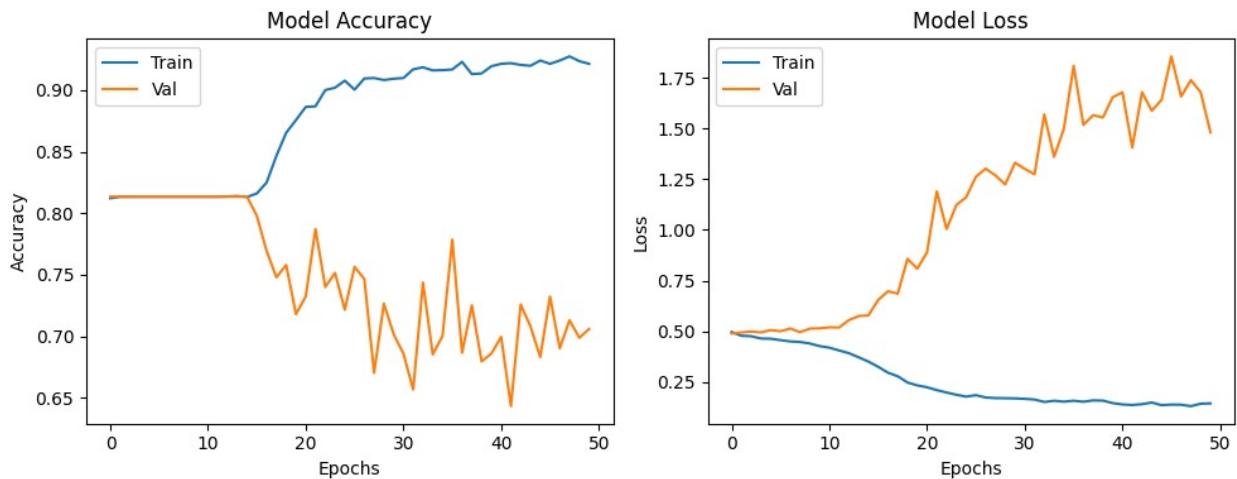
```

```
Found 5619 images belonging to 2 classes.  
Found 1404 images belonging to 2 classes.  
Epoch 1/50  
  
/usr/local/lib/python3.11/dist-packages/keras/src/layers/  
convolutional/base_conv.py:107: UserWarning: Do not pass an  
'input_shape'/'input_dim` argument to a layer. When using Sequential  
models, prefer using an `Input(shape)` object as the first layer in  
the model instead.  
    super().__init__(activity_regularizer=activity_regularizer,  
**kwargs)  
  
176/176 ━━━━━━━━━━ 21s 94ms/step - accuracy: 0.8054 - loss:  
0.5106 - val_accuracy: 0.8134 - val_loss: 0.4885  
Epoch 2/50  
176/176 ━━━━━━━━━━ 15s 80ms/step - accuracy: 0.8100 - loss:  
0.4853 - val_accuracy: 0.8134 - val_loss: 0.4938  
Epoch 3/50  
176/176 ━━━━━━━━━━ 14s 79ms/step - accuracy: 0.8131 - loss:  
0.4781 - val_accuracy: 0.8134 - val_loss: 0.4983  
Epoch 4/50  
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.8112 - loss:  
0.4633 - val_accuracy: 0.8134 - val_loss: 0.4940  
Epoch 5/50  
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.8075 - loss:  
0.4700 - val_accuracy: 0.8134 - val_loss: 0.5057  
Epoch 6/50  
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.8098 - loss:  
0.4627 - val_accuracy: 0.8134 - val_loss: 0.5000  
Epoch 7/50  
176/176 ━━━━━━━━━━ 14s 75ms/step - accuracy: 0.8182 - loss:  
0.4419 - val_accuracy: 0.8134 - val_loss: 0.5132  
Epoch 8/50  
176/176 ━━━━━━━━━━ 13s 74ms/step - accuracy: 0.8136 - loss:  
0.4503 - val_accuracy: 0.8134 - val_loss: 0.4951  
Epoch 9/50  
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.8087 - loss:  
0.4441 - val_accuracy: 0.8134 - val_loss: 0.5128  
Epoch 10/50  
176/176 ━━━━━━━━━━ 14s 79ms/step - accuracy: 0.8146 - loss:  
0.4243 - val_accuracy: 0.8134 - val_loss: 0.5144  
Epoch 11/50  
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.8180 - loss:  
0.4107 - val_accuracy: 0.8134 - val_loss: 0.5192  
Epoch 12/50  
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.8137 - loss:  
0.4008 - val_accuracy: 0.8134 - val_loss: 0.5182  
Epoch 13/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.8115 - loss:  
0.3891 - val_accuracy: 0.8134 - val_loss: 0.5548
```

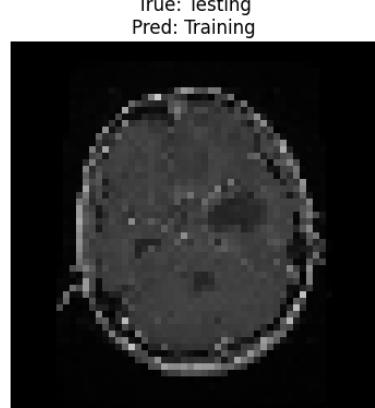
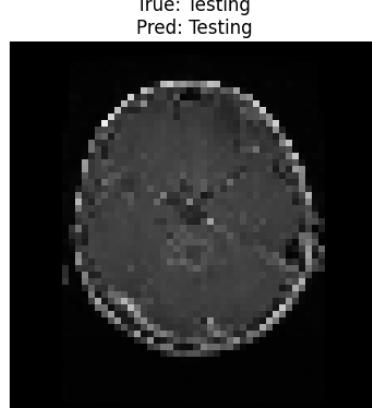
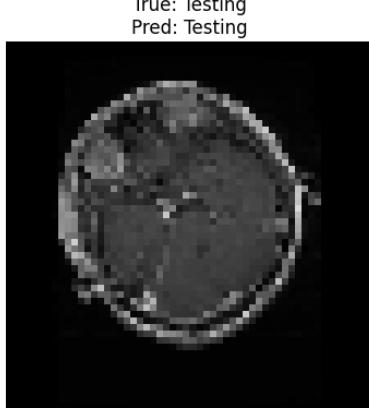
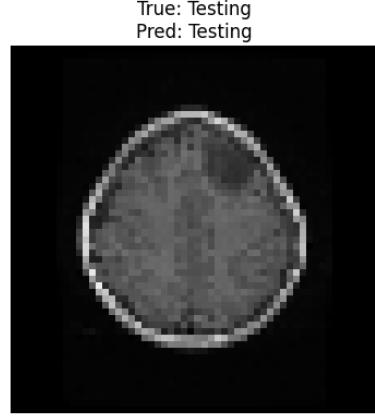
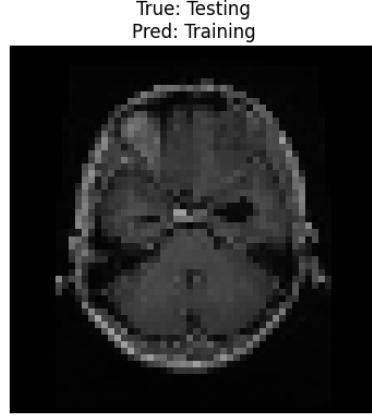
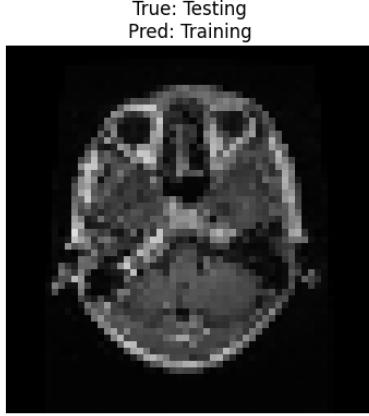
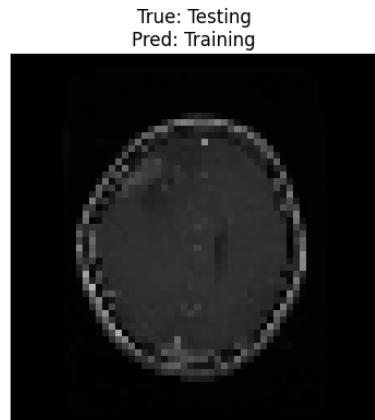
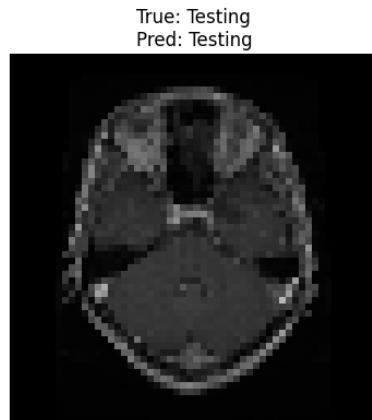
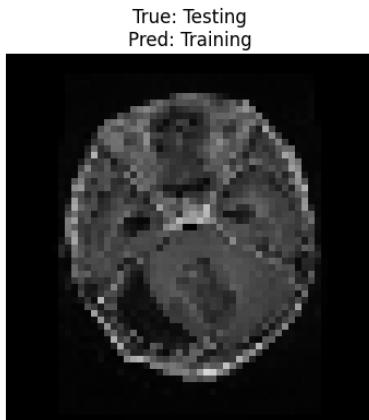
```
Epoch 14/50
176/176 16s 88ms/step - accuracy: 0.8149 - loss: 0.3682 - val_accuracy: 0.8134 - val_loss: 0.5747
Epoch 15/50
176/176 16s 87ms/step - accuracy: 0.8177 - loss: 0.3348 - val_accuracy: 0.8134 - val_loss: 0.5782
Epoch 16/50
176/176 15s 81ms/step - accuracy: 0.8243 - loss: 0.3142 - val_accuracy: 0.7977 - val_loss: 0.6546
Epoch 17/50
176/176 16s 86ms/step - accuracy: 0.8182 - loss: 0.2962 - val_accuracy: 0.7692 - val_loss: 0.6972
Epoch 18/50
176/176 16s 87ms/step - accuracy: 0.8529 - loss: 0.2673 - val_accuracy: 0.7479 - val_loss: 0.6855
Epoch 19/50
176/176 15s 85ms/step - accuracy: 0.8733 - loss: 0.2401 - val_accuracy: 0.7578 - val_loss: 0.8575
Epoch 20/50
176/176 15s 84ms/step - accuracy: 0.8811 - loss: 0.2320 - val_accuracy: 0.7179 - val_loss: 0.8087
Epoch 21/50
176/176 15s 84ms/step - accuracy: 0.8911 - loss: 0.2097 - val_accuracy: 0.7322 - val_loss: 0.8900
Epoch 22/50
176/176 15s 82ms/step - accuracy: 0.8925 - loss: 0.1998 - val_accuracy: 0.7870 - val_loss: 1.1906
Epoch 23/50
176/176 15s 83ms/step - accuracy: 0.9149 - loss: 0.1875 - val_accuracy: 0.7400 - val_loss: 1.0042
Epoch 24/50
176/176 15s 80ms/step - accuracy: 0.9033 - loss: 0.1877 - val_accuracy: 0.7514 - val_loss: 1.1234
Epoch 25/50
176/176 15s 81ms/step - accuracy: 0.9129 - loss: 0.1687 - val_accuracy: 0.7215 - val_loss: 1.1613
Epoch 26/50
176/176 16s 86ms/step - accuracy: 0.9038 - loss: 0.1765 - val_accuracy: 0.7564 - val_loss: 1.2629
Epoch 27/50
176/176 16s 86ms/step - accuracy: 0.9191 - loss: 0.1619 - val_accuracy: 0.7464 - val_loss: 1.3025
Epoch 28/50
176/176 15s 82ms/step - accuracy: 0.9117 - loss: 0.1679 - val_accuracy: 0.6702 - val_loss: 1.2695
Epoch 29/50
176/176 15s 83ms/step - accuracy: 0.9169 - loss: 0.1558 - val_accuracy: 0.7265 - val_loss: 1.2248
Epoch 30/50
```

```
176/176 ━━━━━━━━━━ 15s 82ms/step - accuracy: 0.9167 - loss:  
0.1621 - val_accuracy: 0.7016 - val_loss: 1.3319  
Epoch 31/50  
176/176 ━━━━━━━━━━ 15s 81ms/step - accuracy: 0.9106 - loss:  
0.1651 - val_accuracy: 0.6859 - val_loss: 1.3016  
Epoch 32/50  
176/176 ━━━━━━━━━━ 15s 81ms/step - accuracy: 0.9201 - loss:  
0.1544 - val_accuracy: 0.6567 - val_loss: 1.2749  
Epoch 33/50  
176/176 ━━━━━━━━━━ 15s 82ms/step - accuracy: 0.9208 - loss:  
0.1470 - val_accuracy: 0.7436 - val_loss: 1.5702  
Epoch 34/50  
176/176 ━━━━━━━━━━ 15s 85ms/step - accuracy: 0.9179 - loss:  
0.1525 - val_accuracy: 0.6852 - val_loss: 1.3612  
Epoch 35/50  
176/176 ━━━━━━━━━━ 15s 81ms/step - accuracy: 0.9301 - loss:  
0.1338 - val_accuracy: 0.7001 - val_loss: 1.4996  
Epoch 36/50  
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.9253 - loss:  
0.1423 - val_accuracy: 0.7785 - val_loss: 1.8106  
Epoch 37/50  
176/176 ━━━━━━━━━━ 15s 81ms/step - accuracy: 0.9226 - loss:  
0.1544 - val_accuracy: 0.6866 - val_loss: 1.5190  
Epoch 38/50  
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.9140 - loss:  
0.1514 - val_accuracy: 0.7251 - val_loss: 1.5667  
Epoch 39/50  
176/176 ━━━━━━━━━━ 14s 79ms/step - accuracy: 0.9169 - loss:  
0.1534 - val_accuracy: 0.6795 - val_loss: 1.5557  
Epoch 40/50  
176/176 ━━━━━━━━━━ 14s 77ms/step - accuracy: 0.9111 - loss:  
0.1564 - val_accuracy: 0.6859 - val_loss: 1.6554  
Epoch 41/50  
176/176 ━━━━━━━━━━ 14s 79ms/step - accuracy: 0.9302 - loss:  
0.1316 - val_accuracy: 0.6994 - val_loss: 1.6796  
Epoch 42/50  
176/176 ━━━━━━━━━━ 14s 79ms/step - accuracy: 0.9298 - loss:  
0.1251 - val_accuracy: 0.6432 - val_loss: 1.4067  
Epoch 43/50  
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.9237 - loss:  
0.1346 - val_accuracy: 0.7258 - val_loss: 1.6801  
Epoch 44/50  
176/176 ━━━━━━━━━━ 14s 75ms/step - accuracy: 0.9263 - loss:  
0.1368 - val_accuracy: 0.7080 - val_loss: 1.5885  
Epoch 45/50  
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.9284 - loss:  
0.1284 - val_accuracy: 0.6830 - val_loss: 1.6427  
Epoch 46/50  
176/176 ━━━━━━━━━━ 14s 80ms/step - accuracy: 0.9218 - loss:
```

```
0.1371 - val_accuracy: 0.7322 - val_loss: 1.8573
Epoch 47/50
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.9307 - loss:
0.1286 - val_accuracy: 0.6902 - val_loss: 1.6589
Epoch 48/50
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.9302 - loss:
0.1242 - val_accuracy: 0.7130 - val_loss: 1.7400
Epoch 49/50
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.9268 - loss:
0.1376 - val_accuracy: 0.6987 - val_loss: 1.6801
Epoch 50/50
176/176 ━━━━━━━━━━ 14s 78ms/step - accuracy: 0.9258 - loss:
0.1366 - val_accuracy: 0.7058 - val_loss: 1.4823
44/44 ━━━━━━━━━━ 3s 67ms/step - accuracy: 0.5106 - loss:
3.1887
CNN Validation Accuracy: 70.58%
```



```
1/1 ━━━━━━━━━━ 0s 337ms/step
```



```
# Install OpenCV (if you're on Colab or Kaggle)
!pip install opencv-python

# ----- Imports -----
import tensorflow as tf
from tensorflow.keras import layers, models
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt
import cv2
```

```

# ----- Data Preparation -----
dataset_path = '/kaggle/input/brain-tumor-mri-dataset'

datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

train_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(128, 128),
    batch_size=32,
    class_mode='categorical',
    subset='training'
)

val_data = datagen.flow_from_directory(
    dataset_path,
    target_size=(128, 128),
    batch_size=1,
    class_mode='categorical',
    subset='validation',
    shuffle=False
)

# ----- CNN Model (Functional API) -----
def build_cnn_model(input_shape=(128, 128, 3), num_classes=2):
    inputs = layers.Input(shape=input_shape)
    x = layers.Conv2D(32, (3, 3), activation='relu', padding='same')(inputs)
    x = layers.MaxPooling2D((2, 2))(x)
    x = layers.Conv2D(64, (3, 3), activation='relu', padding='same')(x)
    x = layers.MaxPooling2D((2, 2))(x)
    x = layers.Conv2D(128, (3, 3), activation='relu', padding='same', name='last_conv')(x)
    x = layers.MaxPooling2D((2, 2))(x)
    x = layers.Flatten()(x)
    x = layers.Dense(128, activation='relu')(x)
    x = layers.Dropout(0.5)(x)
    outputs = layers.Dense(num_classes, activation='softmax')(x)

    model = models.Model(inputs=inputs, outputs=outputs)
    return model

cnn_model = build_cnn_model(num_classes=len(train_data.class_indices))
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

# ----- Training -----
cnn_model.fit(train_data, validation_data=val_data, epochs=50)

```

```

# ----- Grad-CAM Helper
-----
def get_grad_cam(model, img_tensor, class_index):
    grad_model = models.Model([model.inputs],
    [model.get_layer("last_conv").output, model.output])
    with tf.GradientTape() as tape:
        conv_outputs, predictions = grad_model(img_tensor)
        loss = predictions[:, class_index]
    grads = tape.gradient(loss, conv_outputs)
    pooled_grads = tf.reduce_mean(grads, axis=(0, 1, 2))
    conv_outputs = conv_outputs[0]
    heatmap = tf.reduce_sum(tf.multiply(pooled_grads, conv_outputs),
axis=-1)
    heatmap = np.maximum(heatmap, 0)
    heatmap /= tf.math.reduce_max(heatmap) +
tf.keras.backend.epsilon()
    return heatmap.numpy()

# ----- Bounding Box Drawing
-----
def show_bounding_box(img, heatmap):
    heatmap_resized = cv2.resize(heatmap, (img.shape[1],
img.shape[0]))
    thresh = np.uint8(255 * heatmap_resized)
    contours, _ = cv2.findContours(thresh, cv2.RETR_EXTERNAL,
cv2.CHAIN_APPROX_SIMPLE)
    img_bgr = np.uint8(img * 255)

    for cnt in contours:
        x, y, w, h = cv2.boundingRect(cnt)
        if w * h > 100: # filter small areas
            cv2.rectangle(img_bgr, (x, y), (x + w, y + h), (0, 255,
0), 2)

    plt.imshow(cv2.cvtColor(img_bgr, cv2.COLOR_BGR2RGB))
    plt.axis('off')
    plt.title("Tumor Detection with Bounding Box")
    plt.show()

# ----- Visualize on Validation Samples
-----
for i in range(3): # Display 3 validation examples
    x, y = val_data[i]

    pred = cnn_model.predict(x)
    class_idx = np.argmax(pred[0])

    heatmap = get_grad_cam(cnn_model, x, class_idx)
    show_bounding_box(x[0], heatmap)

```

```
Requirement already satisfied: opencv-python in
/usr/local/lib/python3.11/dist-packages (4.11.0.86)
Requirement already satisfied: numpy>=1.21.2 in
/usr/local/lib/python3.11/dist-packages (from opencv-python) (1.26.4)
Requirement already satisfied: mkl_fft in
/usr/local/lib/python3.11/dist-packages (from numpy>=1.21.2->opencv-
python) (1.3.8)
Requirement already satisfied: mkl_random in
/usr/local/lib/python3.11/dist-packages (from numpy>=1.21.2->opencv-
python) (1.2.4)
Requirement already satisfied: mkl_umat in
/usr/local/lib/python3.11/dist-packages (from numpy>=1.21.2->opencv-
python) (0.1.1)
Requirement already satisfied: mkl in /usr/local/lib/python3.11/dist-
packages (from numpy>=1.21.2->opencv-python) (2025.1.0)
Requirement already satisfied: tbb4py in
/usr/local/lib/python3.11/dist-packages (from numpy>=1.21.2->opencv-
python) (2022.1.0)
Requirement already satisfied: mkl-service in
/usr/local/lib/python3.11/dist-packages (from numpy>=1.21.2->opencv-
python) (2.4.1)
Requirement already satisfied: intel-openmp<2026,>=2024 in
/usr/local/lib/python3.11/dist-packages (from mkl->numpy>=1.21.2-
>opencv-python) (2024.2.0)
Requirement already satisfied: tbb==2022.* in
/usr/local/lib/python3.11/dist-packages (from mkl->numpy>=1.21.2-
>opencv-python) (2022.1.0)
Requirement already satisfied: tcmlib==1.* in
/usr/local/lib/python3.11/dist-packages (from tbb==2022.*->mkl-
>numpy>=1.21.2->opencv-python) (1.2.0)
Requirement already satisfied: intel-cmplr-lib-rt in
/usr/local/lib/python3.11/dist-packages (from mkl_umat-
>numpy>=1.21.2->opencv-python) (2024.2.0)
Requirement already satisfied: intel-cmplr-lib-ur==2024.2.0 in
/usr/local/lib/python3.11/dist-packages (from intel-
openmp<2026,>=2024->mkl->numpy>=1.21.2->opencv-python) (2024.2.0)
```

```
2025-04-22 16:58:04.990898: E
external/local_xla/xla/stream_executor/cuda/cuda_fft.cc:477] Unable to
register cuFFT factory: Attempting to register factory for plugin
cuFFT when one has already been registered
WARNING: All log messages before absl::InitializeLog() is called are
written to STDERR
E0000 00:00:1745341085.248072      31 cuda_dnn.cc:8310] Unable to
register cuDNN factory: Attempting to register factory for plugin
cuDNN when one has already been registered
E0000 00:00:1745341085.318054      31 cuda_blas.cc:1418] Unable to
register cuBLAS factory: Attempting to register factory for plugin
cuBLAS when one has already been registered
```

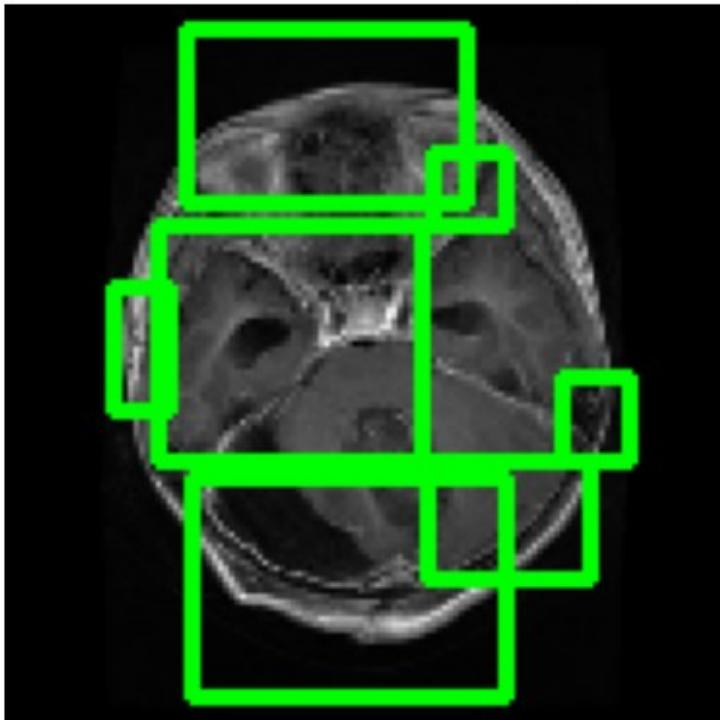
```
Found 5619 images belonging to 2 classes.  
Found 1404 images belonging to 2 classes.  
  
I0000 00:00:1745341105.351483      31 gpu_device.cc:2022] Created  
device /job:localhost/replica:0/task:0/device:GPU:0 with 15513 MB  
memory: -> device: 0, name: Tesla P100-PCIE-16GB, pci bus id:  
0000:00:04.0, compute capability: 6.0  
  
Epoch 1/50  
  
/usr/local/lib/python3.11/dist-packages/keras/src/trainers/  
data_adapters/py_dataset_adapter.py:122: UserWarning: Your `PyDataset`  
class should call `super().__init__(**kwargs)` in its constructor.  
`**kwargs` can include `workers`, `use_multiprocessing`,  
`max_queue_size`. Do not pass these arguments to `fit()`, as they will  
be ignored.  
    self._warn_if_super_not_called()  
WARNING: All log messages before absl::InitializeLog() is called are  
written to STDERR  
I0000 00:00:1745341111.082461      109 service.cc:148] XLA service  
0x7e46bc006c40 initialized for platform CUDA (this does not guarantee  
that XLA will be used). Devices:  
I0000 00:00:1745341111.083371      109 service.cc:156] StreamExecutor  
device (0): Tesla P100-PCIE-16GB, Compute Capability 6.0  
I0000 00:00:1745341111.430122      109 cuda_dnn.cc:529] Loaded cuDNN  
version 90300  
  
1/176 ━━━━━━━━━━ 21:41 7s/step - accuracy: 0.4375 - loss:  
0.7083  
  
I0000 00:00:1745341114.597002      109 device_compiler.h:188] Compiled  
cluster using XLA! This line is logged at most once for the lifetime  
of the process.  
  
176/176 ━━━━━━━━━━ 45s 215ms/step - accuracy: 0.8007 - loss:  
0.5539 - val_accuracy: 0.8134 - val_loss: 0.4859  
Epoch 2/50  
176/176 ━━━━━━━━━━ 17s 91ms/step - accuracy: 0.8150 - loss:  
0.4792 - val_accuracy: 0.8134 - val_loss: 0.4901  
Epoch 3/50  
176/176 ━━━━━━━━━━ 16s 90ms/step - accuracy: 0.8204 - loss:  
0.4647 - val_accuracy: 0.8134 - val_loss: 0.4847  
Epoch 4/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.8092 - loss:  
0.4659 - val_accuracy: 0.8134 - val_loss: 0.4901  
Epoch 5/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.8133 - loss:  
0.4573 - val_accuracy: 0.8134 - val_loss: 0.4955  
Epoch 6/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.8173 - loss:  
0.4506 - val_accuracy: 0.8134 - val_loss: 0.4911
```

```
Epoch 7/50
176/176 ————— 15s 85ms/step - accuracy: 0.8167 - loss: 0.4458 - val_accuracy: 0.8134 - val_loss: 0.4938
Epoch 8/50
176/176 ————— 17s 92ms/step - accuracy: 0.8157 - loss: 0.4403 - val_accuracy: 0.8134 - val_loss: 0.4962
Epoch 9/50
176/176 ————— 15s 85ms/step - accuracy: 0.8114 - loss: 0.4332 - val_accuracy: 0.8134 - val_loss: 0.4977
Epoch 10/50
176/176 ————— 16s 87ms/step - accuracy: 0.8168 - loss: 0.4177 - val_accuracy: 0.8134 - val_loss: 0.5084
Epoch 11/50
176/176 ————— 16s 87ms/step - accuracy: 0.8158 - loss: 0.4101 - val_accuracy: 0.8134 - val_loss: 0.5121
Epoch 12/50
176/176 ————— 16s 88ms/step - accuracy: 0.8160 - loss: 0.3955 - val_accuracy: 0.8134 - val_loss: 0.5219
Epoch 13/50
176/176 ————— 16s 86ms/step - accuracy: 0.8165 - loss: 0.4078 - val_accuracy: 0.8134 - val_loss: 0.5343
Epoch 14/50
176/176 ————— 16s 88ms/step - accuracy: 0.8204 - loss: 0.3638 - val_accuracy: 0.8134 - val_loss: 0.5484
Epoch 15/50
176/176 ————— 16s 87ms/step - accuracy: 0.8200 - loss: 0.3647 - val_accuracy: 0.8105 - val_loss: 0.6266
Epoch 16/50
176/176 ————— 16s 89ms/step - accuracy: 0.8236 - loss: 0.3399 - val_accuracy: 0.8063 - val_loss: 0.6111
Epoch 17/50
176/176 ————— 16s 86ms/step - accuracy: 0.8376 - loss: 0.3141 - val_accuracy: 0.7999 - val_loss: 0.6910
Epoch 18/50
176/176 ————— 15s 85ms/step - accuracy: 0.8362 - loss: 0.2880 - val_accuracy: 0.7272 - val_loss: 0.7261
Epoch 19/50
176/176 ————— 16s 86ms/step - accuracy: 0.8747 - loss: 0.2589 - val_accuracy: 0.7650 - val_loss: 0.9255
Epoch 20/50
176/176 ————— 16s 89ms/step - accuracy: 0.8736 - loss: 0.2399 - val_accuracy: 0.7436 - val_loss: 0.9252
Epoch 21/50
176/176 ————— 15s 85ms/step - accuracy: 0.8801 - loss: 0.2330 - val_accuracy: 0.7507 - val_loss: 0.9615
Epoch 22/50
176/176 ————— 16s 86ms/step - accuracy: 0.8856 - loss: 0.2143 - val_accuracy: 0.7308 - val_loss: 1.0972
Epoch 23/50
```

```
176/176 ━━━━━━━━━━ 16s 87ms/step - accuracy: 0.8886 - loss:  
0.2114 - val_accuracy: 0.7429 - val_loss: 1.0507  
Epoch 24/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.9054 - loss:  
0.1836 - val_accuracy: 0.7365 - val_loss: 1.1089  
Epoch 25/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.8996 - loss:  
0.1981 - val_accuracy: 0.7272 - val_loss: 1.2598  
Epoch 26/50  
176/176 ━━━━━━━━━━ 15s 85ms/step - accuracy: 0.9101 - loss:  
0.1754 - val_accuracy: 0.7350 - val_loss: 1.2202  
Epoch 27/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.9060 - loss:  
0.1769 - val_accuracy: 0.7172 - val_loss: 1.2538  
Epoch 28/50  
176/176 ━━━━━━━━━━ 16s 87ms/step - accuracy: 0.9103 - loss:  
0.1653 - val_accuracy: 0.7123 - val_loss: 1.4029  
Epoch 29/50  
176/176 ━━━━━━━━━━ 16s 85ms/step - accuracy: 0.9117 - loss:  
0.1610 - val_accuracy: 0.7301 - val_loss: 1.2940  
Epoch 30/50  
176/176 ━━━━━━━━━━ 15s 85ms/step - accuracy: 0.9128 - loss:  
0.1588 - val_accuracy: 0.7293 - val_loss: 1.4422  
Epoch 31/50  
176/176 ━━━━━━━━━━ 16s 87ms/step - accuracy: 0.9173 - loss:  
0.1519 - val_accuracy: 0.7244 - val_loss: 1.3590  
Epoch 32/50  
176/176 ━━━━━━━━━━ 16s 87ms/step - accuracy: 0.9114 - loss:  
0.1581 - val_accuracy: 0.7194 - val_loss: 1.3972  
Epoch 33/50  
176/176 ━━━━━━━━━━ 15s 85ms/step - accuracy: 0.9187 - loss:  
0.1432 - val_accuracy: 0.7208 - val_loss: 1.4026  
Epoch 34/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.9167 - loss:  
0.1488 - val_accuracy: 0.7208 - val_loss: 1.5714  
Epoch 35/50  
176/176 ━━━━━━━━━━ 16s 87ms/step - accuracy: 0.9175 - loss:  
0.1509 - val_accuracy: 0.7358 - val_loss: 1.4092  
Epoch 36/50  
176/176 ━━━━━━━━━━ 16s 86ms/step - accuracy: 0.9200 - loss:  
0.1483 - val_accuracy: 0.6859 - val_loss: 1.4119  
Epoch 37/50  
176/176 ━━━━━━━━━━ 15s 84ms/step - accuracy: 0.9216 - loss:  
0.1405 - val_accuracy: 0.7279 - val_loss: 1.6451  
Epoch 38/50  
176/176 ━━━━━━━━━━ 16s 88ms/step - accuracy: 0.9201 - loss:  
0.1415 - val_accuracy: 0.7009 - val_loss: 1.6138  
Epoch 39/50  
176/176 ━━━━━━━━━━ 16s 91ms/step - accuracy: 0.9147 - loss:
```

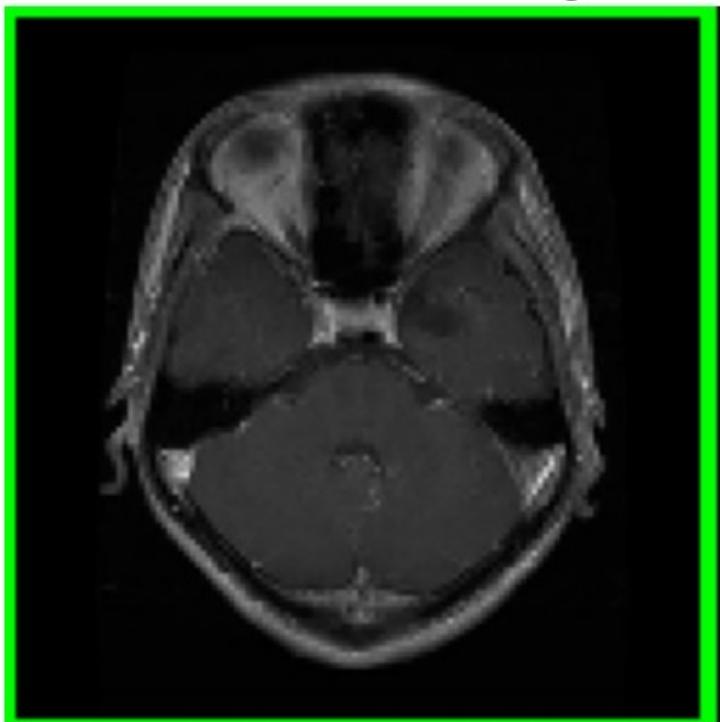
```
0.1528 - val_accuracy: 0.7528 - val_loss: 1.8111
Epoch 40/50
176/176 ————— 16s 87ms/step - accuracy: 0.9196 - loss:
0.1463 - val_accuracy: 0.7080 - val_loss: 1.6034
Epoch 41/50
176/176 ————— 15s 85ms/step - accuracy: 0.9199 - loss:
0.1450 - val_accuracy: 0.7144 - val_loss: 1.5563
Epoch 42/50
176/176 ————— 16s 88ms/step - accuracy: 0.9271 - loss:
0.1338 - val_accuracy: 0.7044 - val_loss: 1.6037
Epoch 43/50
176/176 ————— 16s 87ms/step - accuracy: 0.9275 - loss:
0.1374 - val_accuracy: 0.7429 - val_loss: 1.5726
Epoch 44/50
176/176 ————— 15s 85ms/step - accuracy: 0.9244 - loss:
0.1349 - val_accuracy: 0.7037 - val_loss: 1.3271
Epoch 45/50
176/176 ————— 15s 84ms/step - accuracy: 0.9154 - loss:
0.1430 - val_accuracy: 0.7322 - val_loss: 1.8052
Epoch 46/50
176/176 ————— 16s 86ms/step - accuracy: 0.9162 - loss:
0.1422 - val_accuracy: 0.7386 - val_loss: 1.6521
Epoch 47/50
176/176 ————— 16s 87ms/step - accuracy: 0.9235 - loss:
0.1373 - val_accuracy: 0.7265 - val_loss: 1.6024
Epoch 48/50
176/176 ————— 17s 92ms/step - accuracy: 0.9273 - loss:
0.1319 - val_accuracy: 0.7365 - val_loss: 1.6736
Epoch 49/50
176/176 ————— 16s 90ms/step - accuracy: 0.9227 - loss:
0.1356 - val_accuracy: 0.7279 - val_loss: 1.6848
Epoch 50/50
176/176 ————— 18s 98ms/step - accuracy: 0.9314 - loss:
0.1241 - val_accuracy: 0.7094 - val_loss: 1.7823
1/1 ————— 0s 409ms/step
```

Tumor Detection with Bounding Box



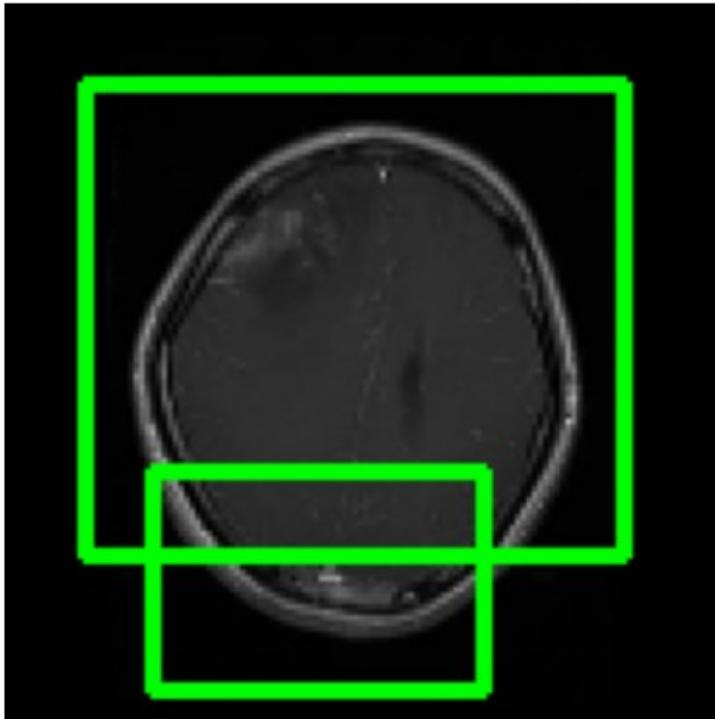
1/1 ————— 0s 17ms/step

Tumor Detection with Bounding Box



1/1 ————— 0s 17ms/step

Tumor Detection with Bounding Box



```
import numpy as np
import matplotlib.pyplot as plt
import tensorflow as tf
import cv2
from tensorflow.keras import layers, models, Input
from tensorflow.keras.utils import to_categorical
from sklearn.model_selection import train_test_split

# ----- Data Loader -----
def load_fake_brain_tumor_data(samples=1000, img_size=(56, 56)):
    X = np.random.rand(samples, img_size[0], img_size[1],
3).astype(np.float32)
    y = np.random.randint(0, 2, size=(samples,))
    y = to_categorical(y, 2)
    return X, y

# ----- CNN Model -----
def build_cnn_model(input_shape, num_classes):
    inputs = Input(shape=input_shape)
    x = layers.Conv2D(32, (3, 3), activation='relu', name='last_conv')(inputs)
    x = layers.MaxPooling2D((2, 2))(x)
    x = layers.Conv2D(64, (3, 3), activation='relu')(x)
```

```

x = layers.MaxPooling2D((2, 2))(x)
x = layers.Flatten()(x)
x = layers.Dense(64, activation='relu')(x)
outputs = layers.Dense(num_classes, activation='softmax')(x)
return models.Model(inputs, outputs)

# ----- Grad-CAM -----
def get_grad_cam(model, img_tensor, class_index):
    grad_model = tf.keras.models.Model(
        [model.inputs],
        [model.get_layer("last_conv").output, model.output]
    )

    with tf.GradientTape() as tape:
        conv_outputs, predictions = grad_model(img_tensor)
        loss = predictions[:, class_index]

    grads = tape.gradient(loss, conv_outputs)
    pooled_grads = tf.reduce_mean(grads, axis=(0, 1, 2))
    conv_outputs = conv_outputs[0]
    heatmap = tf.reduce_sum(tf.multiply(pooled_grads, conv_outputs),
                           axis=-1)

    heatmap = np.maximum(heatmap, 0)
    heatmap /= tf.math.reduce_max(heatmap) +
    tf.keras.backend.epsilon()
    return heatmap.numpy()

# ----- Draw Box -----
def draw_box(img, heatmap, threshold=0.5):
    heatmap_resized = cv2.resize(heatmap, (img.shape[1],
    img.shape[0]))
    mask = heatmap_resized > threshold
    contours, _ = cv2.findContours(mask.astype(np.uint8),
    cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)
    img_disp = (img * 255).astype(np.uint8)
    if contours:
        x, y, w, h = cv2.boundingRect(contours[0])
        cv2.rectangle(img_disp, (x, y), (x + w, y + h), (255, 255,
255), 1)
    return img_disp

# ----- Display Grid -----
def display_image_grid(model, X_samples, grid_shape=(3, 5)):
    fig, axes = plt.subplots(*grid_shape, figsize=(15, 9))
    axes = axes.flatten()

    for i, ax in enumerate(axes):
        x = X_samples[i:i+1]
        pred = model.predict(x, verbose=0)

```

```
class_idx = np.argmax(pred[0])
heatmap = get_grad_cam(model, x, class_idx)
boxed_img = draw_box(x[0], heatmap)

ax.imshow(boxed_img)
ax.axis('off')

plt.tight_layout()
plt.show()

# ----- Main -----
X, y = load_fake_brain_tumor_data()
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2)

model = build_cnn_model(input_shape=X.shape[1:], num_classes=2)
model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])
model.fit(X_train, y_train, epochs=2, batch_size=32,
validation_split=0.1)

display_image_grid(model, X_test, grid_shape=(3, 5)) # 15 samples

Epoch 1/2
23/23 ━━━━━━━━━━ 4s 88ms/step - accuracy: 0.5416 - loss:
0.8566 - val_accuracy: 0.4750 - val_loss: 0.6928
Epoch 2/2
23/23 ━━━━━━━━━━ 0s 4ms/step - accuracy: 0.5207 - loss:
0.6925 - val_accuracy: 0.5250 - val_loss: 0.6932
```

