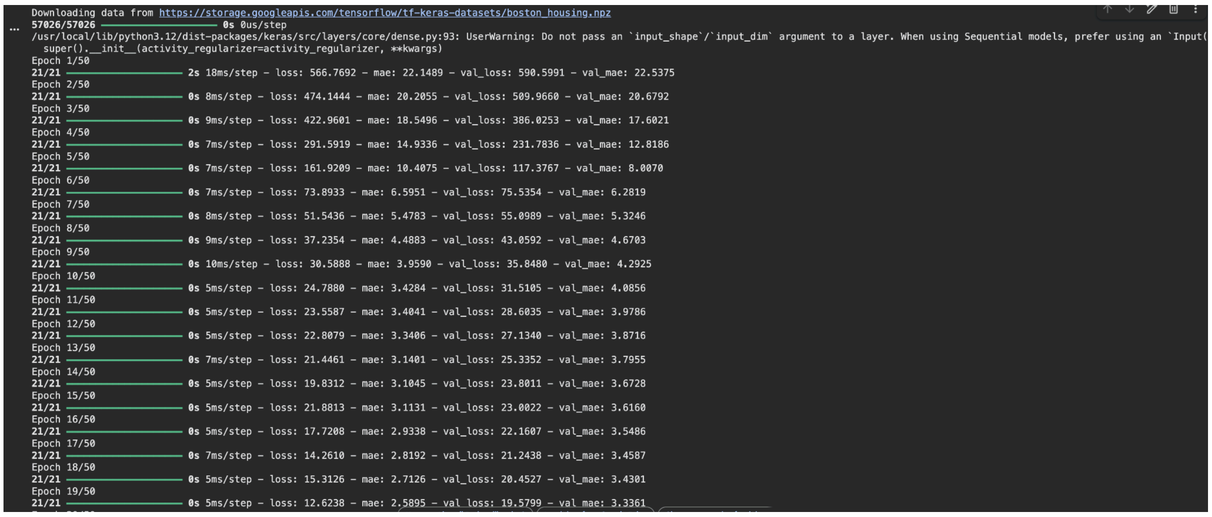
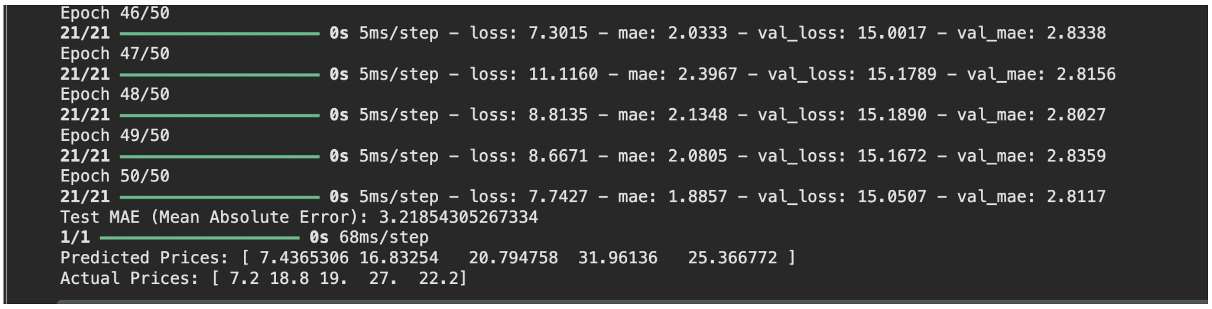
Q1. Implement a deep-neural feed-forward network for estimating the price of house, given real-estate data (Boston Housing Price)

```
import tensorflow as tf

from tensorflow.keras.models import Sequential

from tensorflow.keras.layers import Dense

from tensorflow.keras.datasets import boston_housing

from sklearn.preprocessing import StandardScaler

(x_train, y_train), (x_test, y_test) = boston_housing.load_data()

scaler = StandardScaler()

x_train = scaler.fit_transform(x_train)

x_test = scaler.transform(x_test)

model = Sequential([

Dense(64, activation='relu', input_shape=(x_train.shape[1],)),

Dense(32, activation='relu'),

Dense(1)

])

model.compile(

optimizer='adam',

loss='mse',

metrics=['mae']

)

history = model.fit(

x_train, y_train,

epochs=50,

batch_size=16,
validation_split=0.2,

verbose=1

)

loss, mae = model.evaluate(x_test, y_test, verbose=0)

print("Test MAE (Mean Absolute Error):", mae)

predicted = model.predict(x_test[:5])

print("Predicted Prices:", predicted.flatten())

print("Actual Prices:", y_test[:5])
```



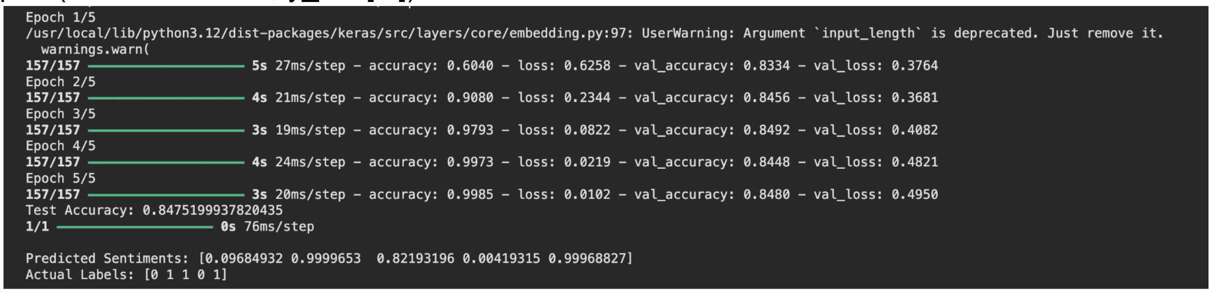
```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/boston_housing.npz
57026/57026 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
/usr/local/lib/python3.12/dist-packages/keras/src/layers/core/dense.py:93: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Epoch 1/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 2s 18ms/step - loss: 566.7692 - mae: 22.1489 - val_loss: 590.5991 - val_mae: 22.5375
Epoch 2/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 474.1444 - mae: 20.2055 - val_loss: 509.9660 - val_mae: 20.6792
Epoch 3/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 422.9601 - mae: 18.5496 - val_loss: 386.0253 - val_mae: 17.6021
Epoch 4/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 291.5919 - mae: 14.9336 - val_loss: 231.7836 - val_mae: 12.8186
Epoch 5/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 161.9209 - mae: 10.4075 - val_loss: 117.3767 - val_mae: 8.0070
Epoch 6/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 73.8933 - mae: 6.5951 - val_loss: 75.5354 - val_mae: 6.2819
Epoch 7/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 51.5436 - mae: 5.4783 - val_loss: 55.0989 - val_mae: 5.3246
Epoch 8/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 37.2354 - mae: 4.4883 - val_loss: 43.0592 - val_mae: 4.6703
Epoch 9/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 30.5888 - mae: 3.9590 - val_loss: 35.8480 - val_mae: 4.2925
Epoch 10/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 24.7880 - mae: 3.4284 - val_loss: 31.5105 - val_mae: 4.0856
Epoch 11/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 23.5587 - mae: 3.4041 - val_loss: 28.6035 - val_mae: 3.9786
Epoch 12/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 22.8079 - mae: 3.3406 - val_loss: 27.1340 - val_mae: 3.8716
Epoch 13/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 21.4461 - mae: 3.1401 - val_loss: 25.3352 - val_mae: 3.7955
Epoch 14/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 19.8312 - mae: 3.1045 - val_loss: 23.8011 - val_mae: 3.6728
Epoch 15/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 21.8813 - mae: 3.1131 - val_loss: 23.0022 - val_mae: 3.6160
Epoch 16/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 17.7208 - mae: 2.9338 - val_loss: 22.1607 - val_mae: 3.5486
Epoch 17/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 14.2610 - mae: 2.8192 - val_loss: 21.2438 - val_mae: 3.4587
Epoch 18/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 15.3126 - mae: 2.7126 - val_loss: 20.4527 - val_mae: 3.4301
Epoch 19/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 12.6238 - mae: 2.5895 - val_loss: 19.5799 - val_mae: 3.3361
```



```
Epoch 46/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 7.3015 - mae: 2.0333 - val_loss: 15.0017 - val_mae: 2.8338
Epoch 47/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 11.1160 - mae: 2.3967 - val_loss: 15.1789 - val_mae: 2.8156
Epoch 48/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 8.8135 - mae: 2.1348 - val_loss: 15.1890 - val_mae: 2.8027
Epoch 49/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 8.6671 - mae: 2.0805 - val_loss: 15.1672 - val_mae: 2.8359
Epoch 50/50
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 7.7427 - mae: 1.8857 - val_loss: 15.0507 - val_mae: 2.8117
Test MAE (Mean Absolute Error): 3.21854305267334
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 68ms/step
Predicted Prices: [ 7.4365306 16.83254   20.794758  31.96136   25.366772 ]
Actual Prices: [ 7.2 18.8 19.  27.  22.2]
```

Q2. Implement a feed-forward neural networks for classifying movie reviews as positive or negative (using IMDB dataset)

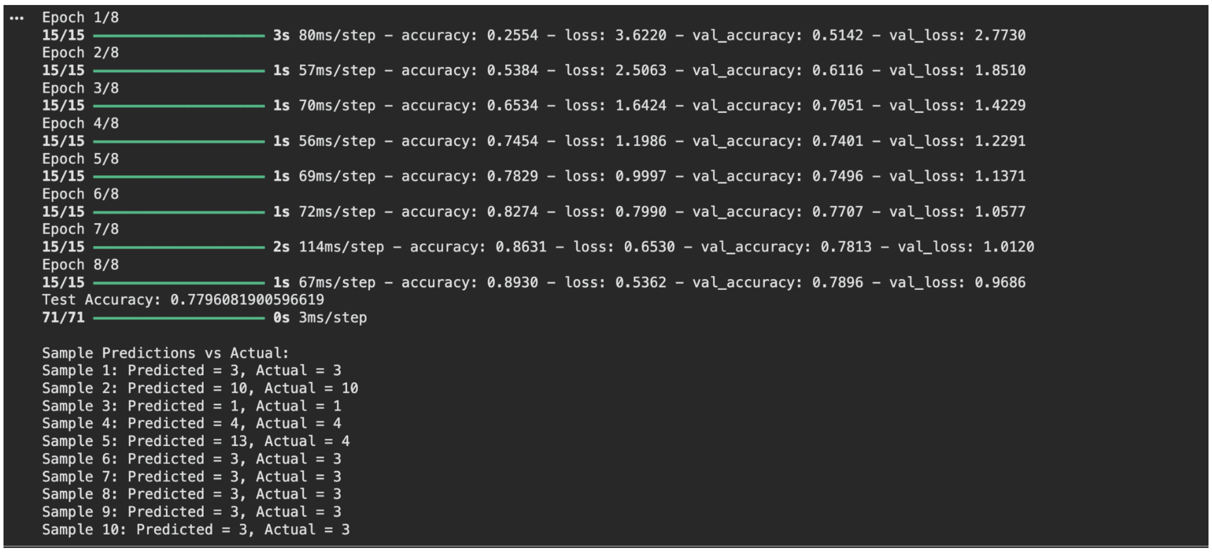
```
import tensorflow as tf
from tensorflow.keras.datasets import imdb
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Embedding, Flatten
from tensorflow.keras.preprocessing.sequence import pad_sequences

vocab_size = 5000  # keep top 5000 words
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=vocab_size)


max_length = 200
x_train = pad_sequences(x_train, maxlen=max_length)
x_test = pad_sequences(x_test, maxlen=max_length)


model = Sequential([
    Embedding(vocab_size, 32, input_length=max_length),  # Word embeddings
    Flatten(),
    Dense(64, activation='relu'),
    Dense(1, activation='sigmoid')  # Binary classification
])


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


history = model.fit(
    x_train, y_train,
    epochs=5,
    batch_size=128,
    validation_split=0.2
)


loss, acc = model.evaluate(x_test, y_test, verbose=0)
print("Test Accuracy:", acc)


predictions = model.predict(x_test[:5])
print("\nPredicted Sentiments:", predictions.flatten())
print("Actual Labels:", y_test[:5])
```



```
Epoch 1/5
/usr/local/lib/python3.12/dist-packages/keras/src/layers/core/embedding.py:97: UserWarning: Argument `input_length` is deprecated. Just remove it.
  warnings.warn(
157/157 ━━━━━━━━━━━━━━━━━━━━ 5s 27ms/step - accuracy: 0.6040 - loss: 0.6258 - val_accuracy: 0.8334 - val_loss: 0.3764
Epoch 2/5
157/157 ━━━━━━━━━━━━━━━━━━━━ 4s 21ms/step - accuracy: 0.9080 - loss: 0.2344 - val_accuracy: 0.8456 - val_loss: 0.3681
Epoch 3/5
157/157 ━━━━━━━━━━━━━━━━━━━━ 3s 19ms/step - accuracy: 0.9793 - loss: 0.0822 - val_accuracy: 0.8492 - val_loss: 0.4082
Epoch 4/5
157/157 ━━━━━━━━━━━━━━━━━━━━ 4s 24ms/step - accuracy: 0.9973 - loss: 0.0219 - val_accuracy: 0.8448 - val_loss: 0.4821
Epoch 5/5
157/157 ━━━━━━━━━━━━━━━━━━━━ 3s 20ms/step - accuracy: 0.9985 - loss: 0.0102 - val_accuracy: 0.8480 - val_loss: 0.4950
Test Accuracy: 0.8475199937820435
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 76ms/step

Predicted Sentiments: [0.09684932 0.9999653  0.82193196 0.00419315 0.99968827]
Actual Labels: [0 1 1 0 1]
```

Q3.Implement a deep-neural network for classifying news wires by topic (Reuters dataset).

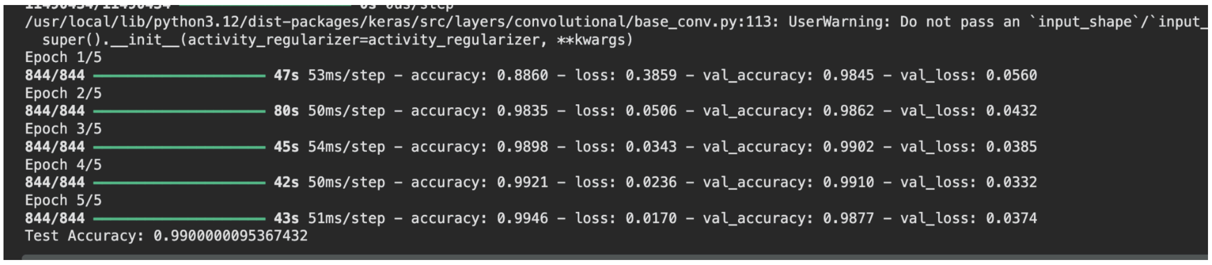
```
import numpy as np
from tensorflow.keras.datasets import reuters
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras.utils import to_categorical

num_words = 10000
(x_train, y_train), (x_test, y_test) = reuters.load_data(num_words=num_words)


def vectorize_sequences(sequences, dimension=num_words):
    results = np.zeros((len(sequences), dimension))
    for i, seq in enumerate(sequences):
        results[i, seq] = 1.0
    return results

x_train = vectorize_sequences(x_train)
x_test = vectorize_sequences(x_test)


y_train_cat = to_categorical(y_train)
y_test_cat = to_categorical(y_test)


model = Sequential([
    Dense(64, activation='relu', input_shape=(num_words,)),
    Dense(64, activation='relu'),
    Dense(46, activation='softmax')
])


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

history = model.fit(x_train, y_train_cat, epochs=8, batch_size=512, validation_split=0.2)

loss, acc = model.evaluate(x_test, y_test_cat, verbose=0)
print("Test Accuracy:", acc)

predictions = model.predict(x_test)
predicted_classes = np.argmax(predictions, axis=1)  # Convert to class index
actual_classes = y_test


print("\nSample Predictions vs Actual:")
for i in range(10):
    print(f"Sample {i+1}: Predicted = {predicted_classes[i]}, Actual = {actual_classes[i]}")
```



```
… Epoch 1/8
  15/15 ━━━━━━━━━━━━━━━━━━━━ 3s 80ms/step - accuracy: 0.2554 - loss: 3.6220 - val_accuracy: 0.5142 - val_loss: 2.7730
  Epoch 2/8
  15/15 ━━━━━━━━━━━━━━━━━━━━ 1s 57ms/step - accuracy: 0.5384 - loss: 2.5063 - val_accuracy: 0.6116 - val_loss: 1.8510
  Epoch 3/8
  15/15 ━━━━━━━━━━━━━━━━━━━━ 1s 70ms/step - accuracy: 0.6534 - loss: 1.6424 - val_accuracy: 0.7051 - val_loss: 1.4229
  Epoch 4/8
  15/15 ━━━━━━━━━━━━━━━━━━━━ 1s 56ms/step - accuracy: 0.7454 - loss: 1.1986 - val_accuracy: 0.7401 - val_loss: 1.2291
  Epoch 5/8
  15/15 ━━━━━━━━━━━━━━━━━━━━ 1s 69ms/step - accuracy: 0.7829 - loss: 0.9997 - val_accuracy: 0.7496 - val_loss: 1.1371
  Epoch 6/8
  15/15 ━━━━━━━━━━━━━━━━━━━━ 1s 72ms/step - accuracy: 0.8274 - loss: 0.7990 - val_accuracy: 0.7707 - val_loss: 1.0577
  Epoch 7/8
  15/15 ━━━━━━━━━━━━━━━━━━━━ 2s 114ms/step - accuracy: 0.8631 - loss: 0.6530 - val_accuracy: 0.7813 - val_loss: 1.0120
  Epoch 8/8
  15/15 ━━━━━━━━━━━━━━━━━━━━ 1s 67ms/step - accuracy: 0.8930 - loss: 0.5362 - val_accuracy: 0.7896 - val_loss: 0.9686
  Test Accuracy: 0.7796081900596619
  71/71 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step

  Sample Predictions vs Actual:
  Sample 1: Predicted = 3, Actual = 3
  Sample 2: Predicted = 10, Actual = 10
  Sample 3: Predicted = 1, Actual = 1
  Sample 4: Predicted = 4, Actual = 4
  Sample 5: Predicted = 13, Actual = 4
  Sample 6: Predicted = 3, Actual = 3
  Sample 7: Predicted = 3, Actual = 3
  Sample 8: Predicted = 3, Actual = 3
  Sample 9: Predicted = 3, Actual = 3
  Sample 10: Predicted = 3, Actual = 3
```

Q4. Implement CNN for classifying MNIST dataset

```
# Import Libraries
import tensorflow as tf
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense
from tensorflow.keras.utils import to_categorical


(x_train, y_train), (x_test, y_test) = mnist.load_data()


x_train = x_train.reshape(-1, 28, 28, 1) / 255.0
x_test = x_test.reshape(-1, 28, 28, 1) / 255.0


y_train = to_categorical(y_train, 10)
y_test = to_categorical(y_test, 10)


model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 1)),
    MaxPooling2D((2, 2)),

    Conv2D(64, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),

    Flatten(),
    Dense(128, activation='relu'),
    Dense(10, activation='softmax')  # 10 classes
])


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


history = model.fit(
    x_train, y_train,
    epochs=5,
    batch_size=64,
    validation_split=0.1
)


loss, acc = model.evaluate(x_test, y_test, verbose=0)
print("Test Accuracy:", acc)
```

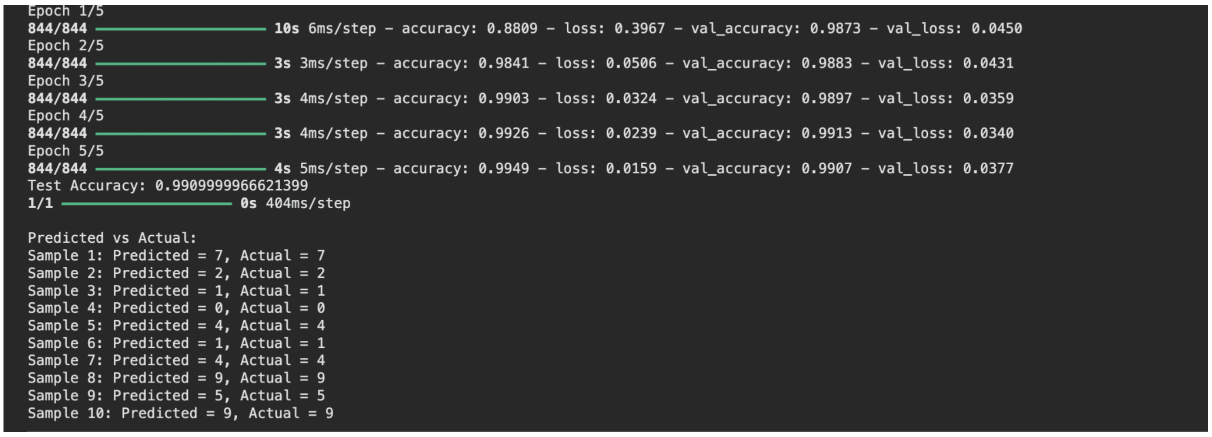


```
/usr/local/lib/python3.12/dist-packages/keras/src/layers/convolutional/base_conv.py:113: UserWarning: Do not pass an `input_shape`/`input_
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Epoch 1/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 47s 53ms/step - accuracy: 0.8860 - loss: 0.3859 - val_accuracy: 0.9845 - val_loss: 0.0560
Epoch 2/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 80s 50ms/step - accuracy: 0.9835 - loss: 0.0506 - val_accuracy: 0.9862 - val_loss: 0.0432
Epoch 3/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 45s 54ms/step - accuracy: 0.9898 - loss: 0.0343 - val_accuracy: 0.9902 - val_loss: 0.0385
Epoch 4/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 42s 50ms/step - accuracy: 0.9921 - loss: 0.0236 - val_accuracy: 0.9910 - val_loss: 0.0332
Epoch 5/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 43s 51ms/step - accuracy: 0.9946 - loss: 0.0170 - val_accuracy: 0.9877 - val_loss: 0.0374
Test Accuracy: 0.9900000095367432
```

Q5.Classify MNIST dataset using any pertained model

```
import tensorflow as tf
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, GlobalAveragePooling2D, Conv2D
from tensorflow.keras.applications import MobileNetV2
from tensorflow.keras.utils import to_categorical


(x_train, y_train), (x_test, y_test) = mnist.load_data()

x_train = x_train.astype("float32") / 255.0
x_test = x_test.astype("float32") / 255.0


x_train = tf.expand_dims(x_train, axis=-1)
x_test = tf.expand_dims(x_test, axis=-1)


x_train = tf.image.grayscale_to_rgb(x_train)
x_test = tf.image.grayscale_to_rgb(x_test)


x_train = tf.image.resize(x_train, (224, 224))
x_test = tf.image.resize(x_test, (224, 224))
```

```
y_train = to_categorical(y_train, 10)
y_test = to_categorical(y_test, 10)

base_model = MobileNetV2(
    weights="imagenet",
    include_top=False,
    input_shape=(224, 224, 3)
)

base_model.trainable = False

model = Sequential([
    base_model,
    GlobalAveragePooling2D(),
    Dense(128, activation="relu"),
    Dense(10, activation="softmax")  # 10 MNIST digits
])


model.compile(
    optimizer="adam",
    loss="categorical_crossentropy",
    metrics=["accuracy"]
)


history = model.fit(
    x_train, y_train,
    epochs=5,
    batch_size=32,
    validation_split=0.1
)
predictions = model.predict(x_test[:10])
predicted_classes = tf.argmax(predictions, axis=1)
actual_classes = tf.argmax(y_test[:10], axis=1)


loss, acc = model.evaluate(x_test, y_test, verbose=0)
print("Test Accuracy:", acc)
```



```
Epoch 1/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 10s 6ms/step - accuracy: 0.8809 - loss: 0.3967 - val_accuracy: 0.9873 - val_loss: 0.0450
Epoch 2/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 3s 3ms/step - accuracy: 0.9841 - loss: 0.0506 - val_accuracy: 0.9883 - val_loss: 0.0431
Epoch 3/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.9903 - loss: 0.0324 - val_accuracy: 0.9897 - val_loss: 0.0359
Epoch 4/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.9926 - loss: 0.0239 - val_accuracy: 0.9913 - val_loss: 0.0340
Epoch 5/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 4s 5ms/step - accuracy: 0.9949 - loss: 0.0159 - val_accuracy: 0.9907 - val_loss: 0.0377
Test Accuracy: 0.9909999966621399
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 404ms/step

Predicted vs Actual:
Sample 1: Predicted = 7, Actual = 7
Sample 2: Predicted = 2, Actual = 2
Sample 3: Predicted = 1, Actual = 1
Sample 4: Predicted = 0, Actual = 0
Sample 5: Predicted = 4, Actual = 4
Sample 6: Predicted = 1, Actual = 1
Sample 7: Predicted = 4, Actual = 4
Sample 8: Predicted = 9, Actual = 9
Sample 9: Predicted = 5, Actual = 5
Sample 10: Predicted = 9, Actual = 9
```

Create a model for time-series forecasting using RNN/LSTM

```
import numpy as np
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense

# 1. Create simple time-series data
data = np.sin(np.linspace(0, 50, 500))

# 2. Prepare sequences
def create_data(series, step=10):
    X, y = [], []
    for i in range(len(series)-step):
        X.append(series[i:i+step])
        y.append(series[i+step])
    return np.array(X), np.array(y)

X, y = create_data(data)
X = X.reshape((X.shape[0], X.shape[1], 1))

# 3. Train-test split
split = int(0.8 * len(X))
X_train, X_test = X[:split], X[split:]
y_train, y_test = y[:split], y[split:]

# 4. Build LSTM model
model = Sequential([
    LSTM(50, input_shape=(X.shape[1], 1)),
    Dense(1)
])

# 5. Compile
model.compile(optimizer='adam', loss='mse')

# 6. Train
model.fit(X_train, y_train, epochs=10, batch_size=32, validation_split=0.2)

# 7. Predict
pred = model.predict(X_test[:5])

print("Predicted:", pred.flatten())
print("Actual:", y_test[:5])
```

Implement an auto-encoder.

```
import numpy as np

from keras.models import Model

from keras.layers import Input, Dense

from keras.datasets.mnist import load_data

(x_train, _),(_,_) = load_data()

x_train = x_train/255

x_train.shape

x_train = x_train.reshape((len(x_train), np.prod(x_train.shape[1:])))

x_train.shape

x_train = x_train[:1000]

inputs = Input(shape=(784,))

x = Dense(512, activation='relu')(inputs) # Encoder Layer 1

x = Dense(256, activation='relu')(x) # Encoder Layer 2

x = Dense(128, activation='relu')(x) #bottleneck

x = Dense(512, activation='relu')(x) # Decoder Layer 1

outputs = Dense(784, activation='sigmoid')(x) # Decoder Layer 2

model = Model(inputs=inputs, outputs=outputs)

model.summary()

model.compile(optimizer='adam',loss='mse')

model.fit(x_train, x_train, epochs=20, batch_size=32, verbose=2)

test_sample = x_train[0:1]

reconstructed_sample = model.predict(test_sample)

print("\n--- Reconstruction Example ---")
print("Original Sample (first 10 values):")

print(test_sample[0, :10])

print("\nReconstructed Sample (first 10 values):")

print(reconstructed_sample[0, :10])

import matplotlib.pyplot as plt

# Take one sample

test_sample = x_train[0:1]

reconstructed_sample = model.predict(test_sample)

# Reshape for plotting (784 → 28x28)

original_img = test_sample.reshape(28, 28)

reconstructed_img = reconstructed_sample.reshape(28, 28)

# Plot images

plt.figure(figsize=(6,3))

plt.subplot(1, 2, 1)

plt.imshow(original_img, cmap='gray')

plt.title("Original Image")

plt.axis('off')

plt.subplot(1, 2, 2)

plt.imshow(reconstructed_img, cmap='gray')

plt.title("Reconstructed Image")

plt.axis('off')

plt.show()
```