```
In [ ]: # 1. Write a Python program to compute the output of a single neuron for input

# Given values
x = 3      # input
w = 2      # weight
b = 1      # bias

# Compute neuron output (simple linear neuron)
output = x * w + b

# Display result
print("Output of the neuron:", output)
```

```
Output of the neuron: 7
```

```
In [ ]: # 2. Implement a CNN model to classify CIFAR-10 dataset images.

import tensorflow as tf
from tensorflow.keras import layers, models
(x_train,y_train),(x_test,y_test) = tf.keras.datasets.cifar10.load_data()
x_train, x_test = x_train/255.0, x_test/255.0

def make_cnn():
    m = models.Sequential([
        layers.Conv2D(32,(3,3), activation='relu', input_shape=(32,32,3)),
        layers.MaxPooling2D(2,2),
        layers.Conv2D(64,(3,3), activation='relu'),
        layers.MaxPooling2D(2,2),
        layers.Flatten(),
        layers.Dense(128, activation='relu'),
        layers.Dense(10, activation='softmax')
    ])
    m.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metric
    return m

model = make_cnn()
model.fit(x_train, y_train, epochs=5, batch_size=64, validation_split=0.1)
print("Test accuracy:", model.evaluate(x_test,y_test, verbose=0)[1])
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170498071/170498071 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
/usr/local/lib/python3.12/dist-packages/keras/src/layers/convolutional/base_con
v.py:113: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a l
ayer. When using Sequential models, prefer using an `Input(shape)` object as th
e first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

```
Epoch 1/5
704/704 ━━━━━━━━━━━━━━━━━━━━ 61s 84ms/step - accuracy: 0.3763 - loss: 1.7366 -
val_accuracy: 0.5468 - val_loss: 1.2653
Epoch 2/5
704/704 ━━━━━━━━━━━━━━━━━━━━ 85s 88ms/step - accuracy: 0.5790 - loss: 1.1926 -
val_accuracy: 0.6296 - val_loss: 1.0854
Epoch 3/5
704/704 ━━━━━━━━━━━━━━━━━━━━ 62s 87ms/step - accuracy: 0.6398 - loss: 1.0366 -
val_accuracy: 0.6430 - val_loss: 1.0163
Epoch 4/5
704/704 ━━━━━━━━━━━━━━━━━━━━ 79s 84ms/step - accuracy: 0.6768 - loss: 0.9272 -
val_accuracy: 0.6792 - val_loss: 0.9260
Epoch 5/5
704/704 ━━━━━━━━━━━━━━━━━━━━ 87s 92ms/step - accuracy: 0.7067 - loss: 0.8482 -
val_accuracy: 0.6866 - val_loss: 0.9108
Test accuracy: 0.6746000051498413
```

In [ ]:

```python
# 3. Write a Python program to compute the sigmoid activation for input x = 0.

import math

# Given input
x = 0.5
sigmoid = 1 / (1 + math.exp(-x))

# Display result
print("Sigmoid activation for input", x, "is:", sigmoid)
```

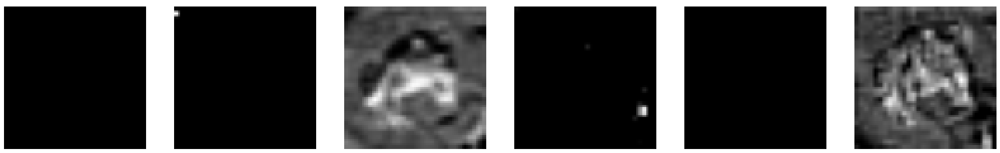
```
Sigmoid activation for input 0.5 is: 0.6224593312018546
```

In [ ]:

```python
# 4. Write a Python program to visualize feature maps from the first convoluti

import tensorflow as tf
import matplotlib.pyplot as plt
from tensorflow.keras import Model

# Load data
(x_train, _), _ = tf.keras.datasets.cifar10.load_data()
x_train = x_train / 255.0
img = x_train[:1]

# Simple CNN (input_shape ensures model is built)
model = tf.keras.Sequential([
    tf.keras.layers.Conv2D(32, 3, activation='relu', input_shape=(32,32,3)),
    tf.keras.layers.MaxPool2D(2),
    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(10, activation='softmax')
])

# Take first Conv layer output
first_layer = model.layers[0]
extractor = Model(inputs=first_layer.input, outputs=first_layer.output)

# Get feature maps
```

```python
maps = extractor.predict(img)[0]

# Plot first 6 feature maps
for i in range(6):
    plt.subplot(1,6,i+1)
    plt.imshow(maps[..., i], cmap='gray')
    plt.axis('off')
plt.show()
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 77ms/step
/usr/local/lib/python3.12/dist-packages/keras/src/layers/convolutional/base_conv.py:113: 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)
```



In [ ]:

```python
# 5. Write a Python program to compute the tanh activation function for input

import math

# Given input
x = 0.5
tanh_value = math.tanh(x)

# Display result
print("Tanh activation for input", x, "is:", tanh_value)
```

```
Tanh activation for input 0.5 is: 0.46211715726000974
```

In [ ]:

```python
# 6. Write a Python function to compute forward propagation in a single-layer

import numpy as np
def forward(x,W,b):
    return 1/(1+np.exp(-(x@W+b)))   # sigmoid
x=np.array([[1,2]])
W=np.array([[.5],[-.2]])
b=np.array([0.1])
print(forward(x,W,b))
```

```
[[0.549834]]
```

In [ ]:

```python
# 7. Write a Python program to compute the output of a single neuron with two

# Given values
x = [1, 2]        # inputs
w = [0.5, 0.5]    # weights
b = 0             # bias

# Compute neuron output: (x1*w1 + x2*w2) + b
```

```
output = (x[0] * w[0]) + (x[1] * w[1]) + b

# Display result
print("Output of the neuron:", output)
```

```
Output of the neuron: 1.5
```

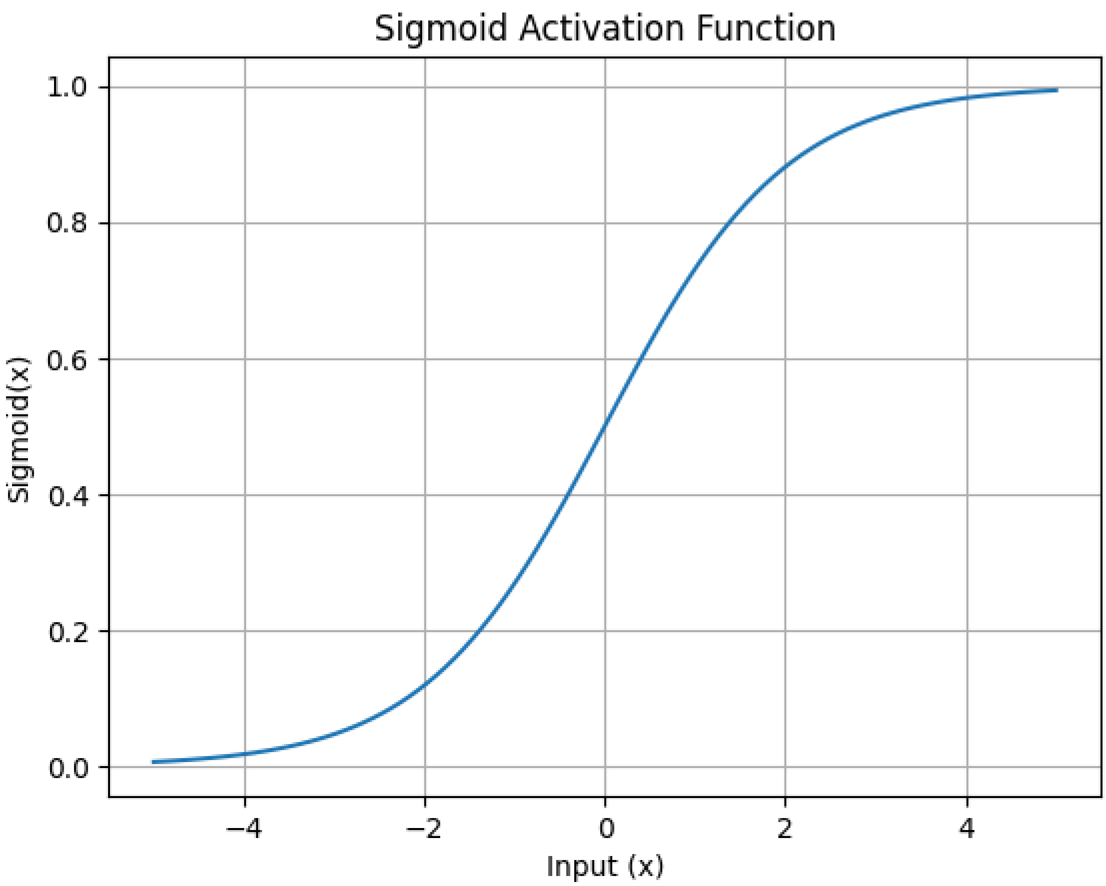
In [ ]:

```
# 8. Create a Python function to compare the outputs of sigmoid and tanh activ

import numpy as np
x=np.linspace(-3,3,7)
sig=1/(1+np.exp(-x))
tanh=np.tanh(x)
print("x:",x)
print("sigmoid:",np.round(sig,2))
print("tanh:",np.round(tanh,2))
```

```
x: [-3. -2. -1.  0.  1.  2.  3.]
sigmoid: [0.05 0.12 0.27 0.5  0.73 0.88 0.95]
tanh: [-1.   -0.96 -0.76  0.    0.76  0.96  1.  ]
```

In [ ]:

```
# 9. Write a Python program to plot the sigmoid activation function for values

import numpy as np
import matplotlib.pyplot as plt

# Create an array of values from -5 to +5
x = np.linspace(-5, 5, 100)

# Compute sigmoid activation for each x
sigmoid = 1 / (1 + np.exp(-x))

# Plot the sigmoid function
plt.plot(x, sigmoid)
plt.title("Sigmoid Activation Function")
plt.xlabel("Input (x)")
plt.ylabel("Sigmoid(x)")
plt.grid(True)
plt.show()
```



In [ ]:

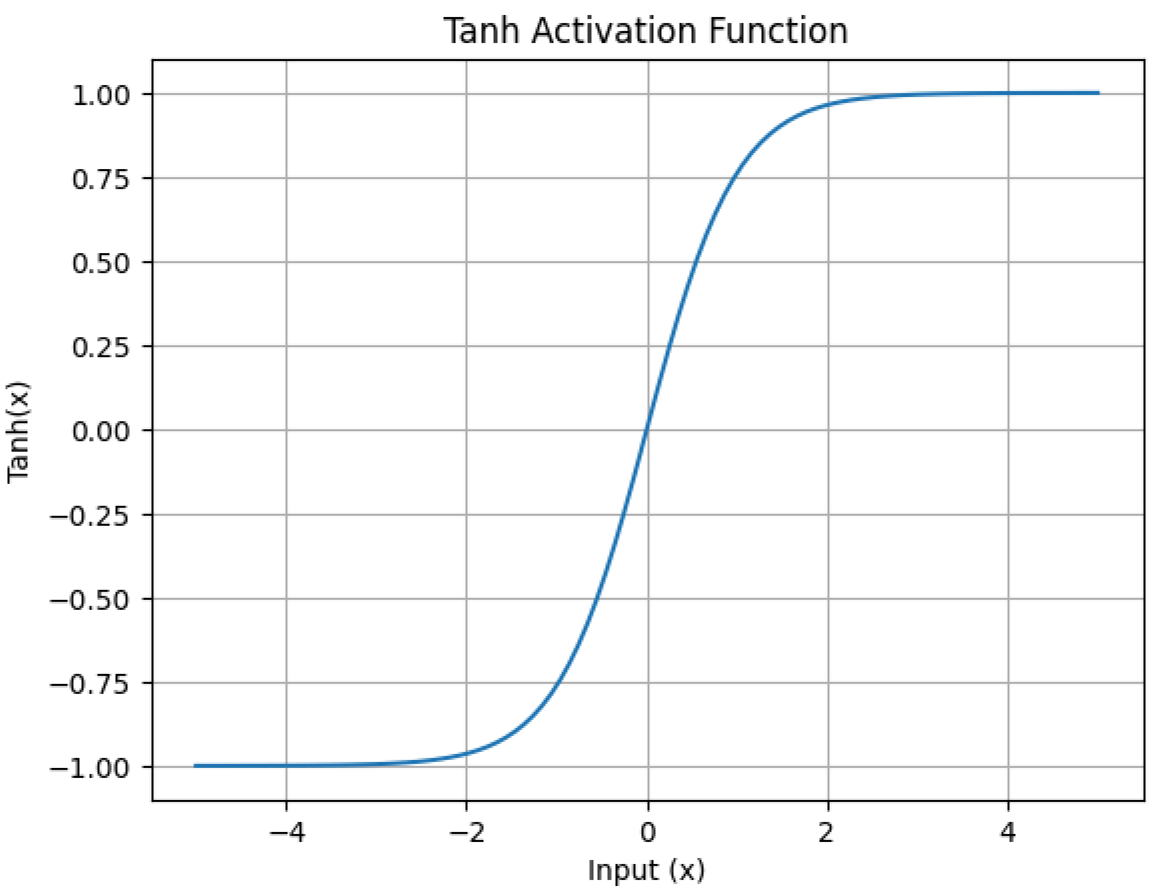
```
# 10. Write a program to compare training accuracy of CNNs with different kern

import tensorflow as tf

# Load data
(x, y), (xt, yt) = tf.keras.datasets.cifar10.load_data()
x, xt = x[:2000]/255.0, xt[:500]/255.0
y, yt = y[:2000].flatten(), yt[:500].flatten()

# Compare CNNs with kernel sizes 3 and 5
for k in [3, 5]:
    m = tf.keras.Sequential([
        tf.keras.layers.Conv2D(32, k, activation='relu', input_shape=(32,32,3)
        tf.keras.layers.Flatten(),
        tf.keras.layers.Dense(10, activation='softmax')
    ])
    m.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metric
    m.fit(x, y, epochs=1, verbose=0)
    acc = m.evaluate(xt, yt, verbose=0)[1]
    print("Kernel", k, "Accuracy:", round(acc, 3))
```

```
Kernel 3 Accuracy: 0.356
Kernel 5 Accuracy: 0.332
```

In [ ]:

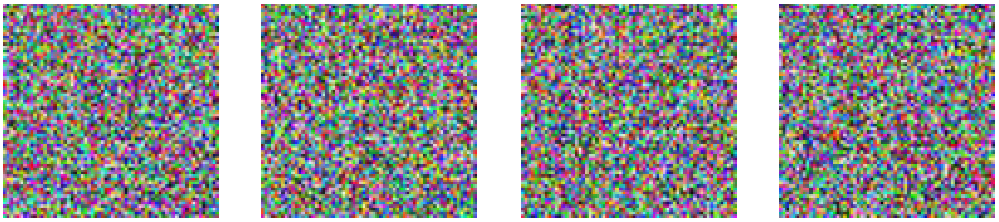
```
# 11. Write a Python program to plot the tanh activation function for values f
```

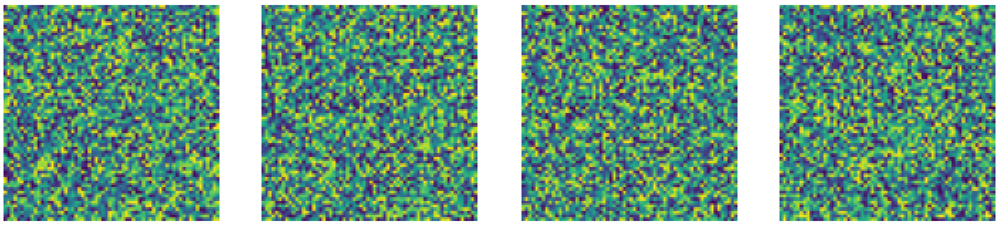
```python
import numpy as np
import matplotlib.pyplot as plt

# Create input values from -5 to +5
x = np.linspace(-5, 5, 100)

# Compute tanh activation for each x
tanh_values = np.tanh(x)

# Plot tanh function
plt.plot(x, tanh_values)
plt.title("Tanh Activation Function")
plt.xlabel("Input (x)")
plt.ylabel("Tanh(x)")
plt.grid(True)
plt.show()
```



In [ ]:

```python
# 12. Write a Python program to visualize segmentation results for multiple im

import matplotlib.pyplot as plt, numpy as np
imgs=[np.random.rand(64,64,3) for _ in range(4)]
masks=[np.random.rand(64,64) for _ in range(4)]
for i in range(4):
    plt.subplot(2,4,i+1);plt.imshow(imgs[i]);plt.axis('off')
    plt.subplot(2,4,4+i+1);plt.imshow(masks[i]);plt.axis('off')
plt.show()
```





```
In [ ]: # 13. Write a Python program to compute the output of the ReLU activation func
# for the inputs [-2, -1, 0, 1, 2].

import numpy as np

# Given inputs
inputs = np.array([-2, -1, 0, 1, 2])

# Compute ReLU activation: ReLU(x) = max(0, x)
relu_output = np.maximum(0, inputs)

# Display result
print("Input values:", inputs)
print("ReLU outputs:", relu_output)
```

```
Input values: [-2 -1  0  1  2]
ReLU outputs: [0 0 0 1 2]
```

```
In [ ]: # 14. Build a bidirectional LSTM for IMDB sentiment classification.

from tensorflow.keras.datasets import imdb
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, Bidirectional, LSTM, Dense

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

# Pad sequences to ensure equal length
x_train = pad_sequences(x_train, maxlen=200)
x_test = pad_sequences(x_test, maxlen=200)

# Build model
```

```python
model = Sequential()
model.add(Embedding(input_dim=5000, output_dim=64, input_length=200))
model.add(Bidirectional(LSTM(64)))
model.add(Dense(1, activation='sigmoid'))

# Compile model
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy

# Display model summary
model.summary()

# Train model
# (You can uncomment below line to actually train)
# model.fit(x_train, y_train, epochs=3, batch_size=64, validation_split=0.2)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datase
ts/imdb.npz
17464789/17464789 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
/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(
```

Model: "sequential"

Layer (type)	Output Shape	Param #
embedding (Embedding)	?	0 (unbuilt)
bidirectional (Bidirectional)	?	0 (unbuilt)
dense (Dense)	?	0 (unbuilt)

Total params: 0 (0.00 B)

Trainable params: 0 (0.00 B)

Non-trainable params: 0 (0.00 B)

In [ ]:

```python
# 15. Write a Python program to implement a step activation function for any i

# Step activation function
def step_function(x):
    if x >= 0:
        return 1
    else:
        return 0

# Test values
inputs = [-2, -1, 0, 1, 2]

# Compute outputs
outputs = [step_function(i) for i in inputs]

# Display result
print("Input values:", inputs)
```

```python
print("Step function outputs:", outputs)
```

```
Input values: [-2, -1, 0, 1, 2]
Step function outputs: [0, 0, 1, 1, 1]
```

In [ ]:
```python
# 16. Create a Python program to tokenize custom movie reviews and predict sen

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.linear_model import LogisticRegression

texts = ["good movie", "bad movie", "awesome film", "boring story"]
y = [1, 0, 1, 0]

v = CountVectorizer()
X = v.fit_transform(texts)
m = LogisticRegression().fit(X, y)

review = "not a good film"
pred = m.predict(v.transform([review]))[0]
print(f"Review: '{review}' → Predicted Sentiment:", "Positive" if pred==1 else
```

```
Review: 'not a good film' → Predicted Sentiment: Positive
```

In [ ]:
```python
# 17. Write a Python program to compute the output of the Leaky ReLU activatio

# Given input
x = -3

# Define Leaky ReLU function
def leaky_relu(x, alpha=0.01):
    return x if x > 0 else alpha * x

# Compute output
output = leaky_relu(x)

# Display result
print("Leaky ReLU output for input", x, "is:", output)
```

```
Leaky ReLU output for input -3 is: -0.03
```

In [ ]:
```python
# 18. Compare model performance between SimpleRNN, LSTM, and GRU on the same d

import tensorflow as tf
from tensorflow.keras import layers, models

(x, y), (xt, yt) = tf.keras.datasets.imdb.load_data(num_words=5000)
x = tf.keras.preprocessing.sequence.pad_sequences(x, maxlen=100)
y, yt = y.astype('int32'), yt.astype('int32')

# Compare SimpleRNN, LSTM, GRU
for cell in [layers.SimpleRNN, layers.LSTM, layers.GRU]:
    m = models.Sequential([
        layers.Embedding(5000, 32),
        cell(32),
        layers.Dense(1, activation='sigmoid')
```

```
    ])
    m.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy
    m.fit(x[:2000], y[:2000], epochs=1, batch_size=128, verbose=0)
    acc = m.evaluate(x[:500], y[:500], verbose=0)[1]
    print(f"{cell.__name__} Accuracy: {acc:.3f}")
```

```
SimpleRNN Accuracy: 0.666
LSTM Accuracy: 0.610
GRU Accuracy: 0.544
```

In [ ]:

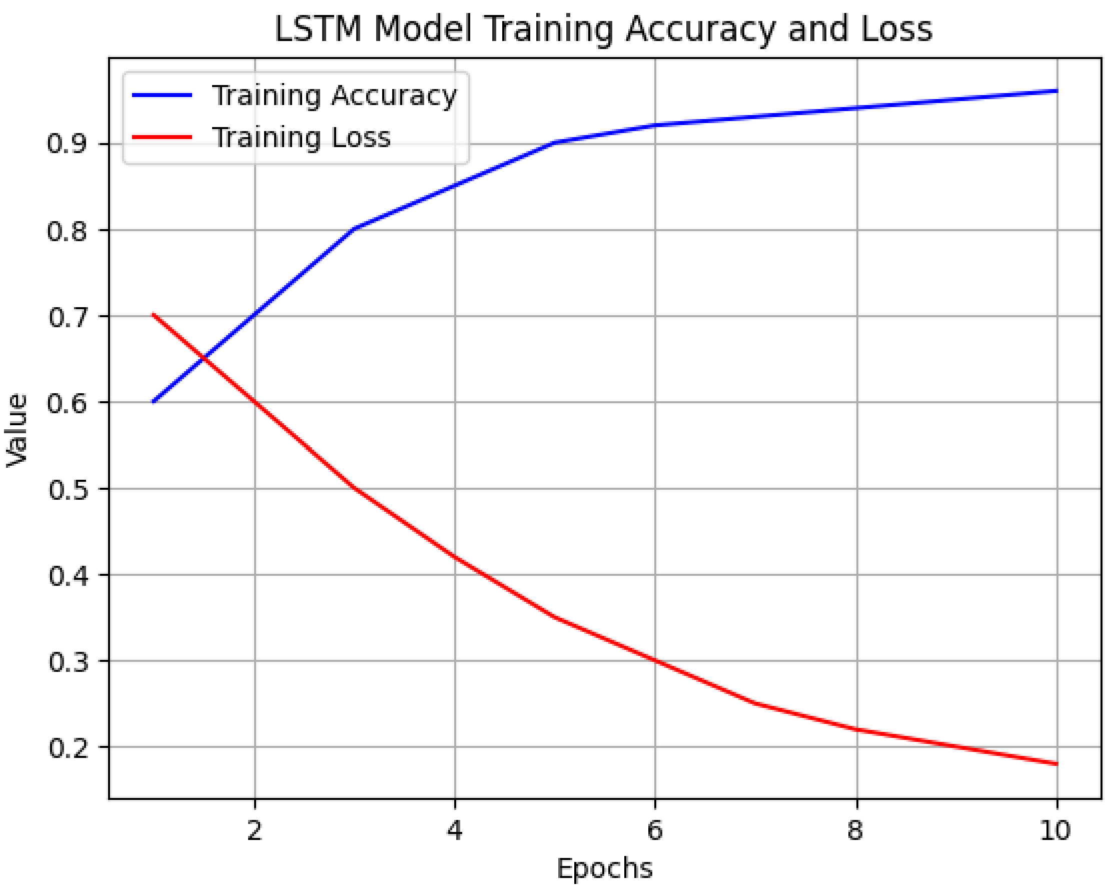
```
# 19. Write a Python program to build a simple neural network in Keras to solv

import numpy as np
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense

# Define input and output for XOR problem
x = np.array([[0, 0], [0, 1], [1, 0], [1, 1]])
y = np.array([[0], [1], [1], [0]])

# Build neural network model
model = Sequential()
model.add(Dense(4, input_dim=2, activation='relu'))
model.add(Dense(1, activation='sigmoid'))

# Compile the model
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy

# Train the model
model.fit(x, y, epochs=500, verbose=0)

# Test the model
output = model.predict(x)
print("Predicted Output for XOR Problem:")
print(output)
```

```
/usr/local/lib/python3.12/dist-packages/keras/src/layers/core/dense.py:93: User
Warning: Do not pass an `input_shape`/`input_dim` argument to a layer. When usi
ng Sequential models, prefer using an `Input(shape)` object as the first layer
in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 67ms/step
Predicted Output for XOR Problem:
[[0.41239437]
 [0.7777667 ]
 [0.44113186]
 [0.4602341 ]]
```

In [ ]:

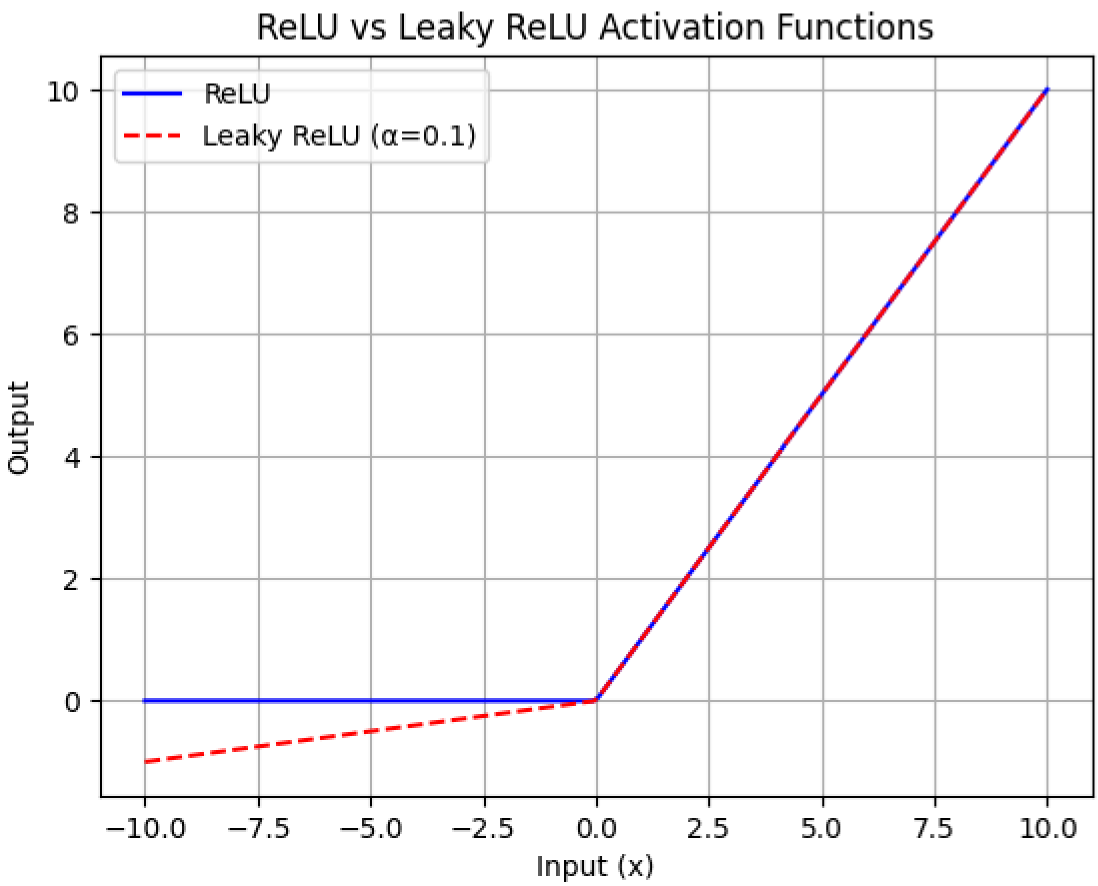
```
# 20. Write a Python program to visualize training accuracy and loss for LSTM

import matplotlib.pyplot as plt

# Sample data (for 10 epochs)
epochs = range(1, 11)
```

```python
train_acc = [0.6, 0.7, 0.8, 0.85, 0.9, 0.92, 0.93, 0.94, 0.95, 0.96]
train_loss = [0.7, 0.6, 0.5, 0.42, 0.35, 0.3, 0.25, 0.22, 0.20, 0.18]

# Plot accuracy
plt.plot(epochs, train_acc, label='Training Accuracy', color='blue')
plt.plot(epochs, train_loss, label='Training Loss', color='red')
plt.title("LSTM Model Training Accuracy and Loss")
plt.xlabel("Epochs")
plt.ylabel("Value")
plt.legend()
plt.grid(True)
plt.show()
```



In [ ]:
```python
# 21. Write a Python program to plot the ReLU and Leaky ReLU activation functi

import numpy as np
import matplotlib.pyplot as plt

# Create input range
x = np.linspace(-10, 10, 200)

# Define ReLU and Leaky ReLU functions
relu = np.maximum(0, x)
leaky_relu = np.where(x > 0, x, 0.1 * x)

# Plot both functions
```

```
plt.plot(x, relu, label='ReLU', color='blue')
plt.plot(x, leaky_relu, label='Leaky ReLU (α=0.1)', color='red', linestyle='--
plt.title("ReLU vs Leaky ReLU Activation Functions")
plt.xlabel("Input (x)")
plt.ylabel("Output")
plt.legend()
plt.grid(True)
plt.show()
```



In [ ]:

```
# 22. Compare training time between LSTM-based and GRU-based Seq2Seq models.

import numpy as np
import time
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, GRU, Dense

# Create dummy sequential data
x_train = np.random.random((1000, 10, 8))
y_train = np.random.random((1000, 1))

# ------------------------------
# LSTM-based Model
# ------------------------------
lstm_model = Sequential([
    LSTM(32, input_shape=(10, 8)),
    Dense(1, activation='linear')
```

```python
])

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

start_time = time.time()
lstm_model.fit(x_train, y_train, epochs=3, batch_size=32, verbose=0)
lstm_time = time.time() - start_time

print("LSTM model training time: {:.2f} seconds".format(lstm_time))

# ------------------------------
# GRU-based Model
# ------------------------------
gru_model = Sequential([
    GRU(32, input_shape=(10, 8)),
    Dense(1, activation='linear')
])

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

start_time = time.time()
gru_model.fit(x_train, y_train, epochs=3, batch_size=32, verbose=0)
gru_time = time.time() - start_time

print("GRU model training time: {:.2f} seconds".format(gru_time))

# ------------------------------
# Comparison
# ------------------------------
if lstm_time > gru_time:
    print("\nGRU trained faster than LSTM.")
else:
    print("\nLSTM trained faster than GRU.")
```

```
/usr/local/lib/python3.12/dist-packages/keras/src/layers/rnn/rnn.py:199: 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__(**kwargs)
LSTM model training time: 2.31 seconds
GRU model training time: 2.68 seconds

LSTM trained faster than GRU.
```

In [ ]:

```python
# 24. Create a function to display word-level alignment between source and pre

def show_alignment(source, target):
    src_words = source.split()
    tgt_words = target.split()
    print("Word Alignment:\n")
    for i, (s, t) in enumerate(zip(src_words, tgt_words)):
        print(f"{i+1}. {s:<10} → {t}")

# Example
```

```
source = "I love natural language processing"
predicted = "Yo amo procesamiento de lenguaje"
show_alignment(source, predicted)
```

```
Word Alignment:

1. I          → Yo
2. love       → amo
3. natural    → procesamiento
4. language   → de
5. processing → lenguaje
```

In [ ]:

```
# 25. Write a Python program to create a two-layer perceptron using Keras with

from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense

# Create a Sequential model
model = Sequential()

# Input layer + First hidden layer with 4 neurons (you can choose any number)
model.add(Dense(4, input_dim=2, activation='relu'))

# Output layer with 1 neuron
model.add(Dense(1, activation='sigmoid'))

# Compile the model
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy

# Display model summary
model.summary()
```

Model: "sequential_4"

Layer (type)	**Output Shape**	**Param #**
dense_5 (Dense)	(None, 4)	12
dense_6 (Dense)	(None, 1)	5

Total params: 17 (68.00 B)

Trainable params: 17 (68.00 B)

Non-trainable params: 0 (0.00 B)

In [ ]:

```
# 26. Write a Python function to test your trained model on unseen text sample

def test_model(model, x):
    model.eval()
    with torch.no_grad():
        pred = model(x)
    print("Predicted:", pred)

# Example
```

```python
import torch, torch.nn as nn
model = nn.Linear(5, 3)
x = torch.randn(1, 5)
test_model(model, x)
```

```
Predicted: tensor([[-0.1316,  1.0132,  0.3211]])
```

In [ ]:

```python
# 27. Write a Python program to implement Depth-Limited Search (DLS) algorithm

def dls(graph, start, goal, limit):
    print(f"Visiting {start}, Limit={limit}")
    if start == goal:
        print(f"Reached goal {goal}!")
        return True
    if limit <= 0:
        return False
    for neighbor in graph.get(start, []):
        if dls(graph, neighbor, goal, limit - 1):
            return True
    return False

# Example
graph = {
    'A': ['B', 'C'],
    'B': ['D', 'E'],
    'C': ['F'],
    'E': ['G']
  }

print("Searching with depth limit 3:", dls(graph, 'A', 'G', 3))
print("Searching with depth limit 2:", dls(graph, 'A', 'G', 2))
```

```
Visiting A, Limit=3
Visiting B, Limit=2
Visiting D, Limit=1
Visiting E, Limit=1
Visiting G, Limit=0
Reached goal G!
Searching with depth limit 3: True
Visiting A, Limit=2
Visiting B, Limit=1
Visiting D, Limit=0
Visiting E, Limit=0
Visiting C, Limit=1
Visiting F, Limit=0
Searching with depth limit 2: False
```

In [ ]:

```python
# 28. Write a Python program to perform gradient descent to minimize the funct

x = 10.0
lr = 0.1

for i in range(20):
    grad = 2 * x
```

```python
    x -= lr * grad
    print(f"Step {i+1}: x = {x:.4f}, f(x) = {x**2:.4f}")
```

```
Step 1: x = 8.0000, f(x) = 64.0000
Step 2: x = 6.4000, f(x) = 40.9600
Step 3: x = 5.1200, f(x) = 26.2144
Step 4: x = 4.0960, f(x) = 16.7772
Step 5: x = 3.2768, f(x) = 10.7374
Step 6: x = 2.6214, f(x) = 6.8719
Step 7: x = 2.0972, f(x) = 4.3980
Step 8: x = 1.6777, f(x) = 2.8147
Step 9: x = 1.3422, f(x) = 1.8014
Step 10: x = 1.0737, f(x) = 1.1529
Step 11: x = 0.8590, f(x) = 0.7379
Step 12: x = 0.6872, f(x) = 0.4722
Step 13: x = 0.5498, f(x) = 0.3022
Step 14: x = 0.4398, f(x) = 0.1934
Step 15: x = 0.3518, f(x) = 0.1238
Step 16: x = 0.2815, f(x) = 0.0792
Step 17: x = 0.2252, f(x) = 0.0507
Step 18: x = 0.1801, f(x) = 0.0325
Step 19: x = 0.1441, f(x) = 0.0208
Step 20: x = 0.1153, f(x) = 0.0133
```

In [ ]:

```python
# 29. Write a Python program for a single neuron with 2 inputs and a bias.
# Use a sigmoid activation function. Calculate output for given inputs.

import math

# Given inputs and weights
x1, x2 = 1.0, 2.0
w1, w2 = 0.5, 0.3
b = 0.1  # bias

# Compute weighted sum
z = (x1 * w1) + (x2 * w2) + b

# Sigmoid activation function
output = 1 / (1 + math.exp(-z))

# Display result
print("Weighted sum (z):", z)
print("Output after sigmoid activation:", output)
```

```
Weighted sum (z): 1.2000000000000002
Output after sigmoid activation: 0.7685247834990178
```

In [ ]:

```python
# 30. Create a Python function that trains a multilayer perceptron on a small

import torch
import torch.nn as nn

def train_mlp():
    X = torch.randn(20, 5)
```

```python
    y = torch.randn(20, 1)

    model = nn.Sequential(nn.Linear(5, 10), nn.ReLU(), nn.Linear(10, 1))
    loss_fn = nn.MSELoss()
    opt = torch.optim.SGD(model.parameters(), lr=0.01)

    for epoch in range(10):
        opt.zero_grad()
        out = model(X)
        loss = loss_fn(out, y)
        loss.backward()
        opt.step()
        print(f"Epoch {epoch+1}: Loss = {loss.item():.4f}")

train_mlp()
```

```
Epoch 1: Loss = 0.9021
Epoch 2: Loss = 0.8618
Epoch 3: Loss = 0.8258
Epoch 4: Loss = 0.7936
Epoch 5: Loss = 0.7647
Epoch 6: Loss = 0.7388
Epoch 7: Loss = 0.7154
Epoch 8: Loss = 0.6943
Epoch 9: Loss = 0.6751
Epoch 10: Loss = 0.6577
```

In [ ]:

```python
# 31. Implement a multilayer perceptron with one hidden layer (2 neurons) and
# Use sigmoid activation. Use fixed weights and biases and calculate output fo

import math

# Sigmoid activation
def sigmoid(x):
    return 1 / (1 + math.exp(-x))

# Given sample input
x1, x2 = 0.5, 0.9

# Hidden layer weights and biases
w1 = [[0.2, 0.4],   # weights for hidden neuron 1
      [0.3, 0.7]]   # weights for hidden neuron 2
b1 = [0.1, 0.2]     # biases for hidden layer neurons

# Output layer weights and bias
w2 = [0.6, 0.9]
b2 = 0.3

# Hidden layer outputs
h1 = sigmoid(x1 * w1[0][0] + x2 * w1[1][0] + b1[0])
h2 = sigmoid(x1 * w1[0][1] + x2 * w1[1][1] + b1[1])

# Output neuron
output = sigmoid(h1 * w2[0] + h2 * w2[1] + b2)
```

```python
print("Hidden neuron outputs:", round(h1, 4), round(h2, 4))
print("Final output:", round(output, 4))
```

```
Hidden neuron outputs: 0.6154 0.7369
Final output: 0.7912
```

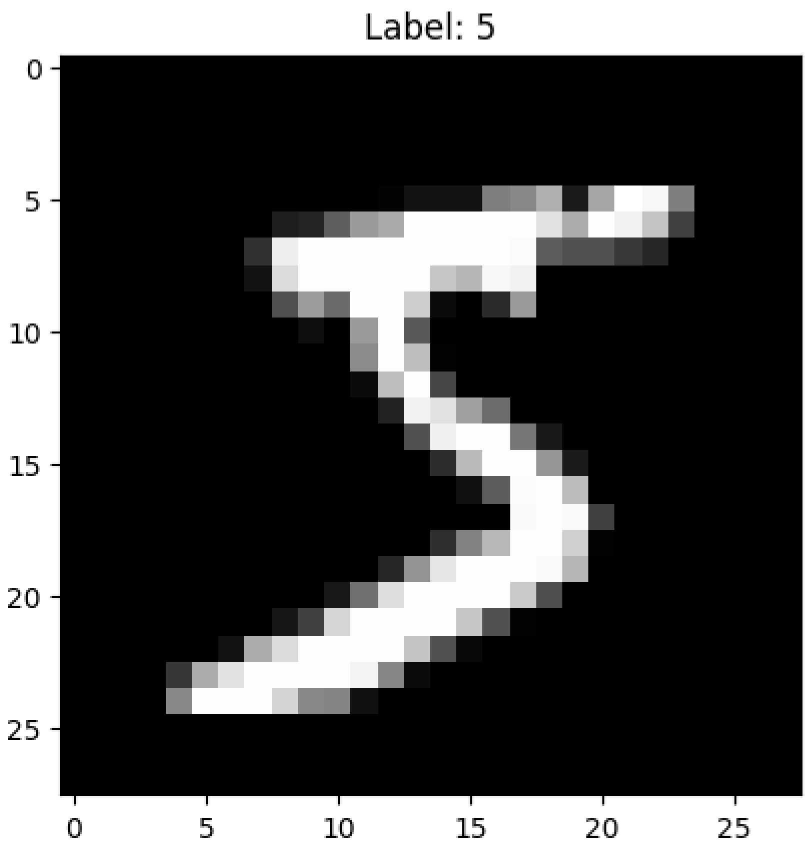
In [ ]:

```python
# 32. Implement a single layer perceptron to learn the AND logic gate.
# Use a step activation function. Train the perceptron using the perceptron le

import numpy as np

# Step activation function
def step(x):
    return 1 if x >= 0 else 0

# Input and expected output for AND gate
X = np.array([[0,0], [0,1], [1,0], [1,1]])
y = np.array([0, 0, 0, 1])

# Initialize weights and bias
w = np.zeros(2)
b = 0
lr = 0.1  # learning rate

# Training the perceptron
for epoch in range(10):
    for i in range(len(X)):
        z = np.dot(X[i], w) + b
        y_pred = step(z)
        error = y[i] - y_pred
        w += lr * error * X[i]
        b += lr * error
    print(f"Epoch {epoch+1}: weights={w}, bias={b}")

# Test perceptron
for i in range(len(X)):
    z = np.dot(X[i], w) + b
    print(f"Input: {X[i]}, Output: {step(z)}")
```

```
Epoch 1: weights=[0.1 0.1], bias=0.0
Epoch 2: weights=[0.2 0.1], bias=-0.1
Epoch 3: weights=[0.2 0.1], bias=-0.20000000000000004
Epoch 4: weights=[0.2 0.1], bias=-0.20000000000000004
Epoch 5: weights=[0.2 0.1], bias=-0.20000000000000004
Epoch 6: weights=[0.2 0.1], bias=-0.20000000000000004
Epoch 7: weights=[0.2 0.1], bias=-0.20000000000000004
Epoch 8: weights=[0.2 0.1], bias=-0.20000000000000004
Epoch 9: weights=[0.2 0.1], bias=-0.20000000000000004
Epoch 10: weights=[0.2 0.1], bias=-0.20000000000000004
Input: [0 0], Output: 0
Input: [0 1], Output: 0
Input: [1 0], Output: 0
Input: [1 1], Output: 1
```

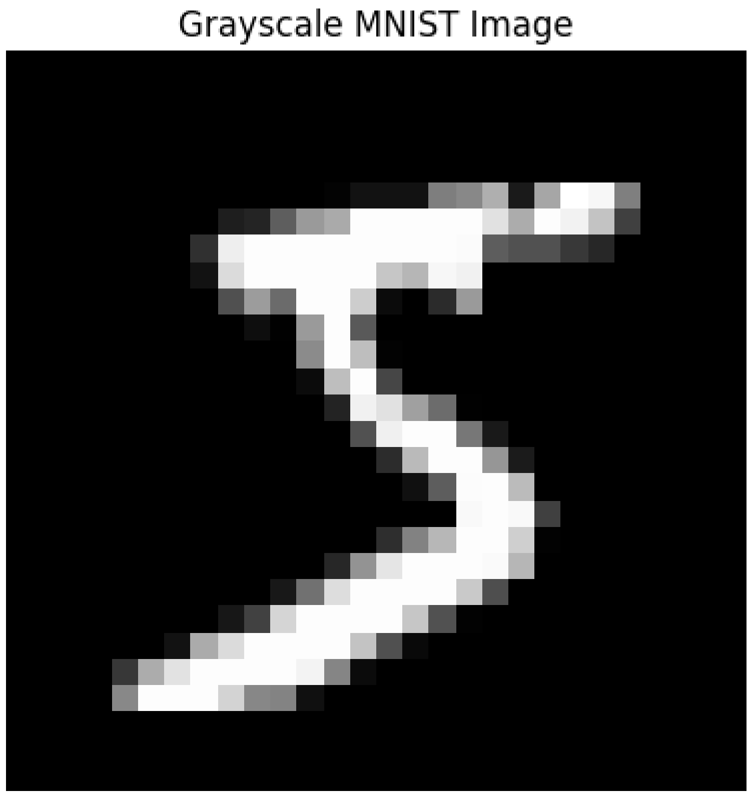
In [ ]:
```python
# 33. Write a Python program to load the MNIST dataset and display the first i

from tensorflow.keras.datasets import mnist
import matplotlib.pyplot as plt

# Load dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()

# Display first image
plt.imshow(x_train[0], cmap='gray')
plt.title(f"Label: {y_train[0]}")
plt.show()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datase
ts/mnist.npz
11490434/11490434 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
```



In [ ]:
```python
# 34. Write a Python program to plot a grayscale image using matplotlib from t

from tensorflow.keras.datasets import mnist
import matplotlib.pyplot as plt

# Load MNIST data
(x_train, y_train), _ = mnist.load_data()

# Plot first image in grayscale
plt.imshow(x_train[0], cmap='gray')
plt.title("Grayscale MNIST Image")
```

```
plt.axis('off')
plt.show()
```



In [ ]:

```
# 35. Write a Python program to train the CNN model for one epoch using the MN

from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense

# Load dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()

# Reshape and normalize
x_train = x_train.reshape(-1, 28, 28, 1) / 255.0
x_test = x_test.reshape(-1, 28, 28, 1) / 255.0

# One-hot encode labels
y_train = to_categorical(y_train)
y_test = to_categorical(y_test)

# Build simple CNN
model = Sequential([
    Conv2D(8, (3,3), activation='relu', input_shape=(28,28,1)),
    MaxPooling2D(2,2),
    Flatten(),
    Dense(10, activation='softmax')
])
```

```python
# Compile model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['acc

# Train for 1 epoch
model.fit(x_train, y_train, epochs=1, batch_size=64)
```

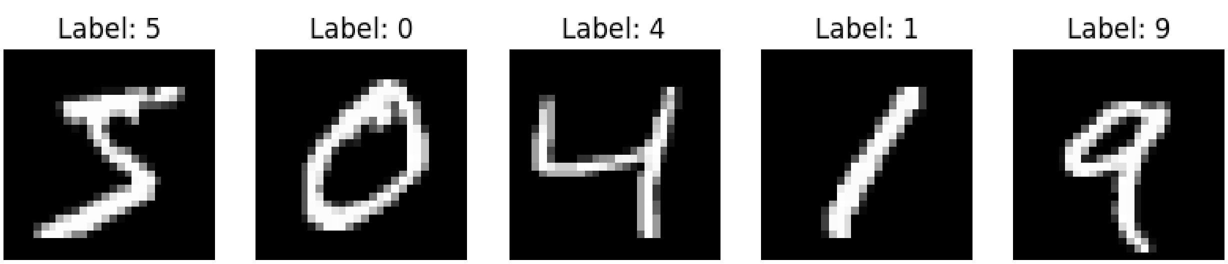
```
/usr/local/lib/python3.12/dist-packages/keras/src/layers/convolutional/base_con
v.py:113: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a l
ayer. When using Sequential models, prefer using an `Input(shape)` object as th
e first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
938/938 ━━━━━━━━━━━━━━━━━━━━ 16s 16ms/step - accuracy: 0.8191 - loss: 0.7157
```

Out[ ]: `<keras.src.callbacks.history.History at 0x7dc8ea2a8860>`

In [ ]:

```python
# 36. Write a Python program to
# a. Print the shape of the MNIST dataset.
# b. Display the first 5 images in a single row with their labels.

from tensorflow.keras.datasets import mnist
import matplotlib.pyplot as plt

# Load MNIST dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()

# (a) Print dataset shape
print("Training data shape:", x_train.shape)
print("Test data shape:", x_test.shape)

# (b) Display first 5 images with labels
plt.figure(figsize=(10, 2))
for i in range(5):
    plt.subplot(1, 5, i+1)
    plt.imshow(x_train[i], cmap='gray')
    plt.title(f"Label: {y_train[i]}")
    plt.axis('off')
plt.show()
```

```
Training data shape: (60000, 28, 28)
Test data shape: (10000, 28, 28)
```



In [ ]:

```python
# 37. Write a Python program to build a simple Convolutional Neural Network (C
# using Keras for MNIST images.

from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical
```

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense

# Load and preprocess data
(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)
y_test = to_categorical(y_test)

# Build CNN model
model = Sequential([
    Conv2D(32, (3,3), activation='relu', input_shape=(28,28,1)),
    MaxPooling2D(2,2),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(10, activation='softmax')
])

# Compile model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['acc

# Summary of the model
model.summary()
```

Model: "sequential_6"

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 26, 26, 32)	320
max_pooling2d_1 (MaxPooling2D)	(None, 13, 13, 32)	0
flatten_1 (Flatten)	(None, 5408)	0
dense_8 (Dense)	(None, 64)	346,176
dense_9 (Dense)	(None, 10)	650

Total params: 347,146 (1.32 MB)

Trainable params: 347,146 (1.32 MB)

Non-trainable params: 0 (0.00 B)

In [ ]:

```
# 38. Write a Python program to plot a diagram of the CNN model architecture.

from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Input, Conv2D, MaxPooling2D, Flatten, Dens
from tensorflow.keras.utils import plot_model

model = Sequential([
    Input(shape=(28,28,1)),
    Conv2D(32, (3,3), activation='relu'),
```

```
    MaxPooling2D(2,2),
    Conv2D(64, (3,3), activation='relu'),
    MaxPooling2D(2,2),
    Flatten(),
    Dense(128, activation='relu'),
    Dense(10, activation='softmax')
])

plot_model(model, to_file='cnn_model.png', show_shapes=True)
print("CNN model diagram saved as cnn_model.png")
```

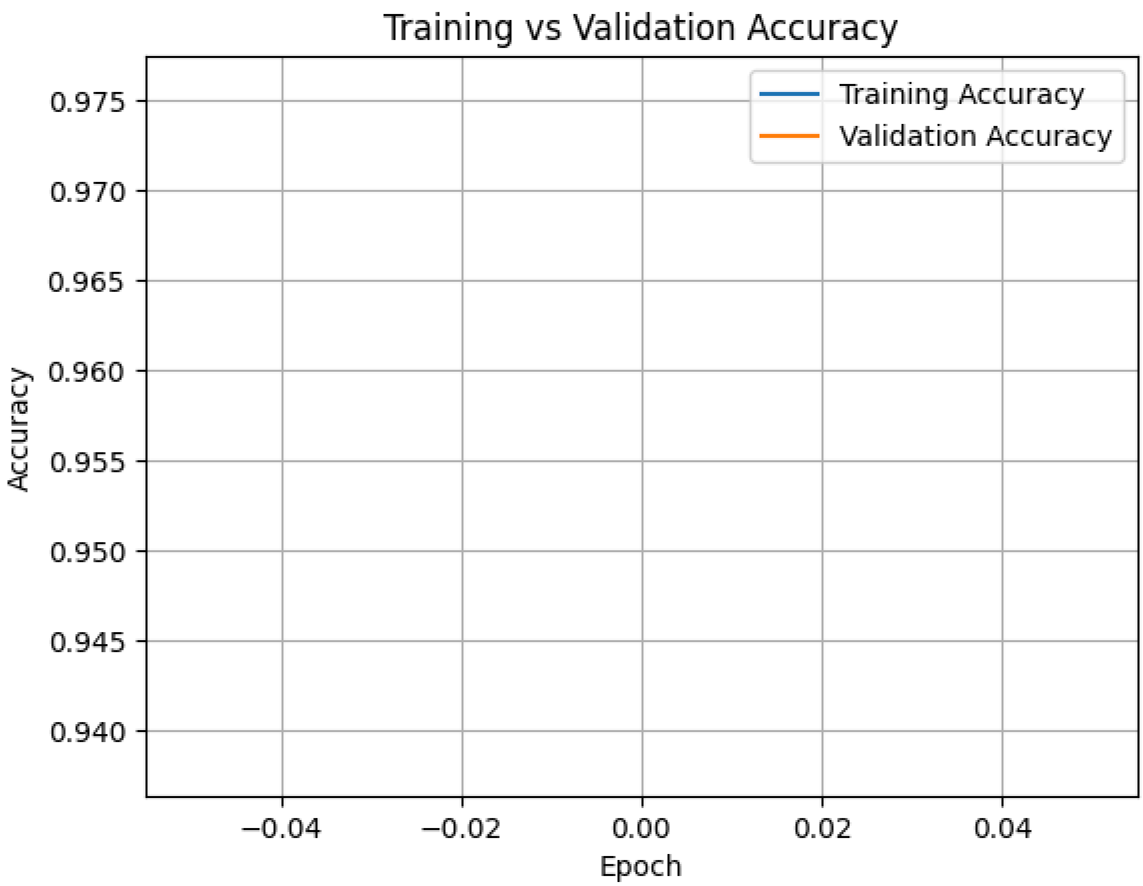
```
CNN model diagram saved as cnn_model.png
```

In [ ]:

```
# 39. Write a Python program to train the CNN model for one epoch using the MN
# and save the training accuracy plot as an image (PNG/JPEG).

import matplotlib.pyplot as plt
from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense

# Load MNIST dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()

# Reshape and normalize input data
x_train = x_train.reshape(-1, 28, 28, 1) / 255.0
x_test = x_test.reshape(-1, 28, 28, 1) / 255.0

# One-hot encode labels
y_train = to_categorical(y_train)
y_test = to_categorical(y_test)

# Build a simple CNN model
model = Sequential([
    Conv2D(32, (3,3), activation='relu', input_shape=(28,28,1)),
    MaxPooling2D(2,2),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(10, activation='softmax')
])

# Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['acc

# Train the CNN model for 1 epoch
history = model.fit(x_train, y_train, epochs=1, batch_size=64, validation_data

# Plot accuracy
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Training vs Validation Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
```

```
plt.legend()
plt.grid(True)

# Save the plot as an image (PNG format)
plt.savefig("cnn_training_accuracy.png")
plt.show()

print("CNN model trained for one epoch and accuracy plot saved as 'cnn_trainin
```

```
938/938 ━━━━━━━━━━━━━━━━━━━━ 30s 30ms/step - accuracy: 0.8826 - loss: 0.4214 -
val_accuracy: 0.9756 - val_loss: 0.0783
```




```
CNN model trained for one epoch and accuracy plot saved as 'cnn_training_accura
cy.png'
```

In [ ]:

```
# 40. Write a Python program to evaluate the trained CNN model again on the tr

from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense

# Load MNIST dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()

# Reshape and normalize input data
x_train = x_train.reshape(-1, 28, 28, 1) / 255.0
x_test = x_test.reshape(-1, 28, 28, 1) / 255.0
```

```python
# One-hot encode labels
y_train = to_categorical(y_train)
y_test = to_categorical(y_test)

# Build the same CNN model
model = Sequential([
    Conv2D(32, (3,3), activation='relu', input_shape=(28,28,1)),
    MaxPooling2D(2,2),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(10, activation='softmax')
])

# Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['acc

# Train for 1 epoch
model.fit(x_train, y_train, epochs=1, batch_size=64, verbose=1)

# Evaluate the model on training data
loss, accuracy = model.evaluate(x_train, y_train, verbose=0)

print("CNN Model Evaluation on Training Data:")
print("Training Loss:", round(loss, 4))
print("Training Accuracy:", round(accuracy * 100, 2), "%")
```

```
938/938 ━━━━━━━━━━━━━━━━━━━━ 28s 29ms/step - accuracy: 0.8806 - loss: 0.4192
CNN Model Evaluation on Training Data:
Training Loss: 0.0765
Training Accuracy: 97.8 %
```

In [ ]:

```python
# 41. Write a Python program to tokenize the text “Deep Learning is amazing” u

from tensorflow.keras.preprocessing.text import Tokenizer

text = ["Deep Learning is amazing"]
tok = Tokenizer()
tok.fit_on_texts(text)
print(tok.word_index)
print(tok.texts_to_sequences(text))
```

```
{'deep': 1, 'learning': 2, 'is': 3, 'amazing': 4}
[[1, 2, 3, 4]]
```

In [ ]:

```python
# 42. Write a Python program to convert the given text into a sequence of inte

from tensorflow.keras.preprocessing.text import Tokenizer

# Sample text data
texts = ["I love deep learning", "Deep learning loves me"]

# Create a Tokenizer object
tokenizer = Tokenizer()
```

```python
# Fit the tokenizer on the text
tokenizer.fit_on_texts(texts)

# Convert the text to sequences of integers
sequences = tokenizer.texts_to_sequences(texts)

print("Word Index:", tokenizer.word_index)
print("Text to Integer Sequences:", sequences)
```

```
Word Index: {'deep': 1, 'learning': 2, 'i': 3, 'love': 4, 'loves': 5, 'me': 6}
Text to Integer Sequences: [[3, 4, 1, 2], [1, 2, 5, 6]]
```

In [ ]:

```python
# 43. Train a simple RNN-based model to classify IMDB movie reviews as positiv
# a. Load IMDB dataset
# b. Tokenize and pad sequences
# c. Train a model with SimpleRNN layer and evaluate accuracy

from tensorflow.keras.datasets import imdb
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, SimpleRNN, Dense

# Load the IMDB dataset (keeping top 10,000 words)
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=10000)

# Pad sequences to make equal length
x_train = pad_sequences(x_train, maxlen=200)
x_test = pad_sequences(x_test, maxlen=200)

# Build the RNN model
model = Sequential([
    Embedding(input_dim=10000, output_dim=32, input_length=200),
    SimpleRNN(32),
    Dense(1, activation='sigmoid')
])

# Compile the model
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy

# Train for 1 epoch (for demo)
model.fit(x_train, y_train, epochs=1, batch_size=64, validation_split=0.2)

# Evaluate the model
loss, acc = model.evaluate(x_test, y_test, verbose=0)
print("Test Accuracy:", round(acc * 100, 2), "%")
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 20s 55ms/step - accuracy: 0.6435 - loss: 0.6303 -
val_accuracy: 0.7074 - val_loss: 0.6104
Test Accuracy: 70.04 %
```

In [ ]:

```python
# 44. Write a Python program to create a simple RNN model in Keras for text da
# a. Print the summary of the RNN model.
# b. Save the created RNN model to a file.
```

```python
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, SimpleRNN, Dense

# Create a simple RNN model
model = Sequential([
    Embedding(input_dim=5000, output_dim=32, input_length=100),
    SimpleRNN(16),
    Dense(1, activation='sigmoid')
])

# Print model summary
print("RNN Model Summary:")
model.summary()

# Save the model to a file
model.save("simple_rnn_model.keras")
print("RNN model saved successfully as 'simple_rnn_model.keras'")
```

RNN Model Summary:

Model: "sequential_11"

Layer (type)	Output Shape	Param #
embedding_2 (Embedding)	?	0 (unbuilt)
simple_rnn_1 (SimpleRNN)	?	0 (unbuilt)
dense_17 (Dense)	?	0 (unbuilt)

Total params: 0 (0.00 B)

Trainable params: 0 (0.00 B)

Non-trainable params: 0 (0.00 B)

RNN model saved successfully as 'simple_rnn_model.keras'

```
/usr/local/lib/python3.12/dist-packages/keras/src/saving/saving_api.py:107: UserWarning: You are saving a model that has not yet been built. It might not contain any weights yet. Consider building the model first by calling it on some data.
  return saving_lib.save_model(model, filepath)
```

In [ ]:

```python
# 45. Write a Python program to create an LSTM layer with 10 units using Keras

from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM

# Create a simple model with one LSTM layer (10 units)
model = Sequential([
    LSTM(10, input_shape=(5, 1))
])

# Display model summary
print("LSTM Model Summary:")
```

```
model.summary()
```

LSTM Model Summary:
Model: "sequential_12"

Layer (type)	Output Shape	Param #
lstm_2 (LSTM)	(None, 10)	480

Total params: 480 (1.88 KB)

Trainable params: 480 (1.88 KB)

Non-trainable params: 0 (0.00 B)

In [ ]:
```
# 46. Add dropout to your LSTM layers to prevent overfitting and analyze its e

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

# Dummy data
X = np.random.randn(100, 10, 8)
y = np.random.randn(100, 1)

# LSTM model with dropout
model = Sequential([
    LSTM(64, dropout=0.3, recurrent_dropout=0.3, input_shape=(10, 8)),
    Dense(1)
])

model.compile(optimizer='adam', loss='mse')
history = model.fit(X, y, epochs=10, batch_size=16, verbose=1)
```

```
Epoch 1/10
/usr/local/lib/python3.12/dist-packages/keras/src/layers/rnn/rnn.py:199: UserWa
rning: 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__(**kwargs)
```

```
7/7 ━━━━━━━━━━━━━━━━━━━━ 5s 14ms/step - loss: 0.8126
Epoch 2/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 0.6292
Epoch 3/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.7441
Epoch 4/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.8728
Epoch 5/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.8178
Epoch 6/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.8539
Epoch 7/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 0.6048
Epoch 8/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 0.6401
Epoch 9/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 0.6793
Epoch 10/10
7/7 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 0.6682
```

In [ ]:

```python
# 47. Write a Python program to pad text sequences using pad_sequences from Ke

from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences

# Some short text sentences
texts = ["I love AI", "AI is future", "Deep learning"]

# Create a tokenizer and convert text to numbers
tokenizer = Tokenizer()
tokenizer.fit_on_texts(texts)
seq = tokenizer.texts_to_sequences(texts)

print("Original sequences:", seq)

# Pad all sequences to the same length
padded = pad_sequences(seq)

print("Padded sequences:\n", padded)
```

```
Original sequences: [[2, 3, 1], [1, 4, 5], [6, 7]]
Padded sequences:
 [[2 3 1]
 [1 4 5]
 [0 6 7]]
```

In [ ]:

```python
# 48. Write a Python program to compute the vocabulary size of the tokenizer.

from tensorflow.keras.preprocessing.text import Tokenizer

texts = ["Deep Learning is amazing", "I love AI and Deep Learning"]
tokenizer = Tokenizer()
tokenizer.fit_on_texts(texts)
```

```
vocab_size = len(tokenizer.word_index) + 1  # +1 for padding token
print("Vocabulary size:", vocab_size)
```

```
Vocabulary size: 9
```

In [ ]:
```
# 49. Write a Python program to print a sequence of numbers from 1 to 10
# and also print its reversed version.

# Create a list of numbers from 1 to 10
numbers = list(range(1, 11))

print("Original sequence:", numbers)

# Print the reversed version
reversed_numbers = list(reversed(numbers))

print("Reversed sequence:", reversed_numbers)
```

```
Original sequence: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
Reversed sequence: [10, 9, 8, 7, 6, 5, 4, 3, 2, 1]
```

In [ ]:
```
# 50. Write a short explanation of the encoder-decoder concept used in sequenc

Encoder-Decoder Concept in Seq2Seq Models:

Encoder: Processes the input sequence and compresses it into a fixed-size cont

Decoder: Uses this context vector to generate the output sequence step by step

This architecture is widely used in tasks like machine translation, text summa

Key Idea: The encoder “understands” the input, and the decoder “produces” the




# import torch, torch.nn as nn

# # Encoder
# encoder = nn.LSTM(input_size=10, hidden_size=20)
# # Decoder
# decoder = nn.LSTM(input_size=10, hidden_size=20)
# fc = nn.Linear(20, 10)

# # Forward pass
# x = torch.randn(5, 1, 10)
# _, (h, c) = encoder(x)
# y = torch.randn(5, 1, 10)
# out, _ = decoder(y, (h, c))
# out = fc(out)
# print(out.shape)
```

```
torch.Size([5, 1, 10])
```