**Assignment No. 1**

**Code:**

import numpy as np

import matplotlib.pyplot as plt

def sigmoid(x):

return 1 / (1 + np.exp(-x))

def relu(x):

return np.maximum(0, x)

def tanh(x):

return np.tanh(x)

def softmax(x):

return np.exp(x) / np.sum(np.exp(x))

# Create x values

x = np.linspace(-10, 10, 100)

# Create plots for each activation function fig, axs = plt.subplots(2, 2, figsize=(8, 8)) axs[0, 0].plot(x, sigmoid(x))

axs[0, 0].set\_title('Sigmoid') axs[0, 1].plot(x, relu(x))

axs[0, 1].set\_title('ReLU')

axs[1, 0].plot(x, tanh(x))

axs[1, 0].set\_title('Tanh')

axs[1, 1].plot(x, softmax(x)) axs[1, 1].set\_title('Softmax')

# Add common axis labels and titles fig.suptitle('Common Activation Functions') for ax in axs.flat:

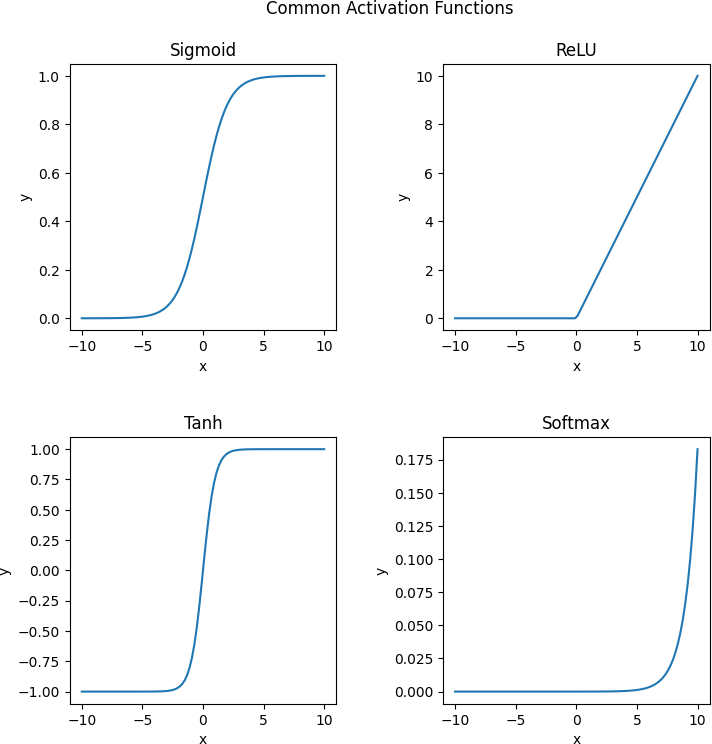
ax.set(xlabel='x', ylabel='y')

# Adjust spacing between subplots

plt.subplots\_adjust(left=0.1, bottom=0.1, right=0.9, top=0.9, wspace=0.4, hspace=0.4)

# Show the plot plt.show()

# Output:



**Assignment No. 2**

# Code:

# importing libraries import numpy as np

# function of checking thresold value def linear\_threshold\_gate(dot, T):

'''Returns the binary threshold output''' if dot >= T:

return 1 else:

return 0

# matrix of inputs input\_table = np.array([

[0,0], # both no

[0,1], # one no, one yes [1,0], # one yes, one no [1,1] # bot yes

])

print (f'input table:\n{input\_table}') weights = np.array([1,-1]) dot\_products = input\_table @ weights

T = 1

for i in range (0,4):

activation = linear\_threshold\_gate(dot\_products[i], T) print(f'Activation: {activation}')

**Output:** input table: [[0 0]

[0 1]

[1 0]

[1 1]]

Activation: 0

Activation: 0

Activation: 1

Activation: 0

# Assignment No.3

**Code:**

import numpy as np

# Define the perceptron class class Perceptron:

def init (self, input\_size, lr=0.1): self.W = np.zeros(input\_size + 1) self.lr = lr

def activation\_fn(self, x): return 1 if x >= 0 else 0

def predict (self, x):

x = np.insert(x, 0, 1) z = self.W.T.dot(x)

a = self.activation\_fn(z) return a

def train (self, X, Y, epochs): for \_ in range(epochs):

for i in range(Y.shape[0]): x = X[i]

y = self.predict(x) e = Y[i] - y

self.W = self.W + self.lr \* e \* np.insert(x, 0, 1)

# Define the input data and labels X = np.array([

[0,0,0,0,0,0,1,0,0,0], # 0

[0,0,0,0,0,0,0,1,0,0], # 1

[0,0,0,0,0,0,0,0,1,0], # 2

[0,0,0,0,0,0,0,0,0,1], # 3

[0,0,0,0,0,0,1,1,0,0], # 4

[0,0,0,0,0,0,1,0,1,0], # 5

[0,0,0,0,0,0,1,1,1,0], # 6

[0,0,0,0,0,0,1,1,1,1], # 7

[0,0,0,0,0,0,1,0,1,1], # 8

[0,0,0,0,0,0,0,1,1,1], # 9

])

Y = np.array([0, 1, 0, 1, 0, 1, 0, 1, 0, 1])

# Create the perceptron and train it perceptron = Perceptron(input\_size=10) perceptron.train(X, Y, epochs=100)

# Test the perceptron on some input data test\_X = np.array([

[0,0,0,0,0,0,1,0,0,0], # 0

[0,0,0,0,0,0,0,1,0,0], # 1

[0,0,0,0,0,0,0,0,1,0], # 2

[0,0,0,0,0,0,0,0,0,1], # 3

[0,0,0,0,0,0,1,1,0,0], # 4

[0,0,0,0,0,0,1,0,1,0], # 5

[0,0,0,0,0,0,1,1,1,0], # 6

[0,0,0,0,0,0,1,1,1,1], # 7

[0,0,0,0,0,0,1,0,1,1], # 8

[0,0,0,0,0,0,0,1,1,1], # 9

])

for i in range(test\_X.shape[0]):

x = test\_X[i]

y = perceptron.predict(x)

print(f'{x} is {"even" if y == 0 else "odd"}')

# Output:

[0 0 0 0 0 0 1 0 0 0] is even

[0 0 0 0 0 0 0 1 0 0] is odd

[0 0 0 0 0 0 0 0 1 0] is even

[0 0 0 0 0 0 0 0 0 1] is odd

[0 0 0 0 0 0 1 1 0 0] is even

[0 0 0 0 0 0 1 0 1 0] is even

[0 0 0 0 0 0 1 1 1 0] is even

[0 0 0 0 0 0 1 1 1 1] is even

[0 0 0 0 0 0 1 0 1 1] is even

[0 0 0 0 0 0 0 1 1 1] is odd

# Assignment No. 4

**Code**:

import numpy as np

import matplotlib.pyplot as plt

from sklearn.datasets import load\_iris

# load iris dataset iris = load\_iris()

# extract sepal length and petal length features X = iris.data[:, [0, 2]]

y = iris.target

# setosa is class 0, versicolor is class 1 y = np.where(y = = 0, 0, 1)

# initialize weights and bias w = np.zeros(2)

b = 0

# set learning rate and number of epochs lr = 0.1

epochs = 50

# define perceptron function def perceptron(x, w, b):

# calculate weighted sum of inputs z = (x@w) + b

# apply step function

return np.where(z >= 0, 1, 0)

# train the perceptron

for epoch in range(epochs): for i in range(len(X)):

x = X[i] target = y[i]

output = perceptron(x, w, b) error = target - output

w += lr \* error \* x

b += lr \* error

# plot decision boundary

x\_min, x\_max = X[:, 0].min() - 0.5, X[:, 0].max() + 0.5

y\_min, y\_max = X[:, 1].min() - 0.5, X[:, 1].max() + 0.5 xx, yy = np.meshgrid(np.arange(x\_min, x\_max, 0.02),

np.arange(y\_min, y\_max, 0.02))

Z = perceptron(np.c\_[xx.ravel(), yy.ravel()], w, b) Z = Z.reshape(xx.shape)

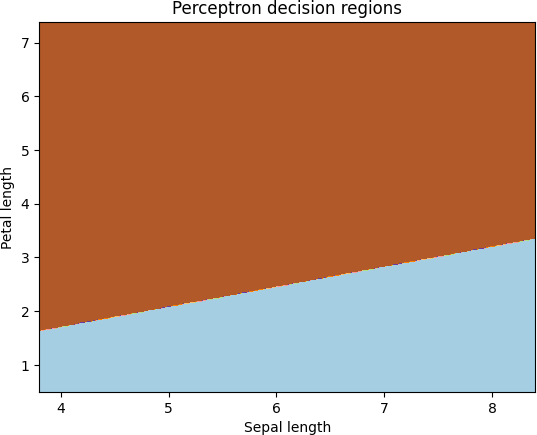
plt.contourf(xx, yy, Z, cmap=plt.cm.Paired)

# plot data points

plt.scatter(X[:, 0], X[:, 1], c=y, cmap=plt.cm.Paired) plt.xlabel('Sepal length')

plt.ylabel('Petal length') plt.title('Perceptron decision regions') plt.show()

# Output:



**Assignment No. 5**

# Code:

import numpy as np

# define two pairs of vectors x1 = np.array([1, 1, 1, -1])

y1 = np.array([1, -1])

x2 = np.array([-1, -1, 1, 1]) y2 = np.array([-1, 1])

# compute weight matrix W

W = np.outer(y1, x1) + np.outer(y2, x2)

# define BAM function def bam(x):

y = np.dot (W, x)

y = np.where(y >= 0, 1, -1) return y

# test BAM with inputs

x\_test = np.array([1, -1, -1, -1]) y\_test = bam(x\_test)

# print output print("Input x: ", x\_test) print("Output y: ", y\_test)

# Output:

Input x: [ 1 -1 -1 -1]

Output y: [ 1 -1]

# Assignment No.6

**Code:**

import numpy as np class NeuralNetwork:

def init (self, input\_size, hidden\_size, output\_size): self.W1 = np.random.randn(input\_size, hidden\_size) self.b1 = np.zeros((1, hidden\_size))

self.W2 = np.random.randn(hidden\_size, output\_size) self.b2 = np.zeros((1, output\_size))

def sigmoid(self, x):

return 1 / (1 + np.exp(-x))

def sigmoid\_derivative(self, x): return x \* (1 - x)

def forward\_propagation(self, X): self.z1 = np.dot(X, self.W1) + self.b1 self.a1 = self.sigmoid(self.z1)

self.z2 = np.dot(self.a1, self.W2) + self.b2 self.y\_hat = self.sigmoid(self.z2)

return self.y\_hat

def backward\_propagation(self, X, y, y\_hat): self.error = y - y\_hat

self.delta2 = self.error \* self.sigmoid\_derivative(y\_hat) self.a1\_error = self.delta2.dot(self.W2.T)

self.delta1 = self.a1\_error \* self.sigmoid\_derivative(self.a1) self.W2 += self.a1.T.dot(self.delta2)

self.b2 += np.sum(self.delta2, axis=0, keepdims=True) self.W1 += X.T.dot(self.delta1)

self.b1 += np.sum(self.delta1, axis=0)

def train(self, X, y, epochs, learning\_rate): for i in range(epochs):

y\_hat = self.forward\_propagation(X)

self.backward\_propagation(X, y, y\_hat) if i % 100 == 0:

print("Error at epoch", i, ":", np.mean(np.abs(self.error)))

# Define the input and output datasets

X = np.array([[0, 0], [0, 1], [1, 0], [1, 1]])

y = np.array([[0], [1], [1], [0]])

# Create a neural network with 2 input neurons, 4 neurons in the hidden layer, and 1 output neuron

nn = NeuralNetwork ([2, 4, 1], activation='relu')

# Train the neural network on the input and output datasets for 10000 epochs with a learning rate of 0.1

nn.train(X, y, lr=0.1, epochs=10000)

# Use the trained neural network to make predictions on the same input dataset predictions = nn.predict(X)

# Print the predictions print(predictions)

# Output:

[[5.55111512e-16] [6.66666667e-01] [6.66666667e-01] [6.66666667e-01]]

# Assignment No. 7

**Code:**

import numpy as np

class XORNetwork: def init (self):

# Initialize the weights and biases randomly self.W1 = np.random.randn(2, 2)

self.b1 = np.random.randn(2) self.W2 = np.random.randn(2, 1) self.b2 = np.random.randn(1)

def sigmoid(self, x):

return 1 / (1 + np.exp(-x))

def sigmoid\_derivative(self, x): return x \* (1 - x)

def forward(self, X):

# Perform the forward pass

self.z1 = np.dot(X, self.W1) + self.b1 self.a1 = self.sigmoid(self.z1)

self.z2 = np.dot(self.a1, self.W2) + self.b2 self.a2 = self.sigmoid(self.z2)

return self.a2

def backward(self, X, y, output): # Perform the backward pass self.output\_error = y - output

self.output\_delta = self.output\_error \* self.sigmoid\_derivative(output)

self.z1\_error = self.output\_delta.dot(self.W2.T)

self.z1\_delta = self.z1\_error \* self.sigmoid\_derivative(self.a1)

self.W1 += X.T.dot(self.z1\_delta) self.b1 += np.sum(self.z1\_delta, axis=0)

self.W2 += self.a1.T.dot(self.output\_delta) self.b2 += np.sum(self.output\_delta, axis=0)

def train(self, X, y, epochs):

# Train the network for a given number of epochs for i in range(epochs):

output = self.forward(X) self.backward(X, y, output)

def predict(self, X):

# Make predictions for a given set of inputs return self.forward(X)

# Create a new XORNetwork instance xor\_nn = XORNetwork()

# Define the input and output datasets for XOR X = np.array([[0, 0], [0, 1], [1, 0], [1, 1]])

y = np.array([[0], [1], [1], [0]])

# Train the network for 10000 epochs xor\_nn.train(X, y, epochs=10000)

# Make predictions on the input dataset predictions = xor\_nn.predict(X)

# Print the predictions print(predictions)

# Output:

[[0.01063456]

[0.98893162]

[0.98893279]

[0.01358006]]

# Assignment No. 8

**Code:**

import numpy as np

# Define sigmoid activation function def sigmoid(x):

return 1 / (1 + np.exp(-x))

# Define derivative of sigmoid function def sigmoid\_derivative(x):

return x \* (1 - x)

# Define input dataset

X = np.array([[0,0], [0,1], [1,0], [1,1]])

# Define output dataset

y = np.array([[0], [1], [1], [0]])

# Define hyperparameters learning\_rate = 0.1

num\_epochs = 100000

# Initialize weights randomly with mean 0 hidden\_weights = 2\*np.random.random((2,2)) - 1 output\_weights = 2\*np.random.random((2,1)) - 1

# Train the neural network for i in range(num\_epochs):

# Forward propagation

hidden\_layer = sigmoid(np.dot(X, hidden\_weights)) output\_layer = sigmoid(np.dot(hidden\_layer, output\_weights))

# Backpropagation output\_error = y - output\_layer

output\_delta = output\_error \* sigmoid\_derivative(output\_layer) hidden\_error = output\_delta.dot(output\_weights.T)

hidden\_delta = hidden\_error \* sigmoid\_derivative(hidden\_layer)

output\_weights += hidden\_layer.T.dot(output\_delta) \* learning\_rate hidden\_weights += X.T.dot(hidden\_delta) \* learning\_rate

# Display input and output print("Input:")

print(X) print("Output:") print(output\_layer)

# Output:

Input:

[[0 0]

[0 1]

[1 0]

[1 1]]

Output: [[0.61385986]

[0.63944088]

[0.8569871 ]

[0.11295854]]

# Assignment No. 9

**Code:**

import numpy as np class HopfieldNetwork:

def init (self, n\_neurons): self.n\_neurons = n\_neurons

self.weights = np.zeros((n\_neurons, n\_neurons))

def train(self, patterns): for pattern in patterns:

self.weights += np.outer(pattern, pattern) np.fill\_diagonal(self.weights, 0)

def predict(self, pattern):

energy = -0.5 \* np.dot(np.dot(pattern, self.weights), pattern) return np.sign(np.dot(pattern, self.weights) + energy)

if name == ' main ': patterns = np.array([

[1, 1, -1, -1],

[-1, -1, 1, 1],

[1, -1, 1, -1],

[-1, 1, -1, 1]

])

n\_neurons = patterns.shape[1]

network = HopfieldNetwork(n\_neurons) network.train(patterns)

for pattern in patterns:

prediction = network.predict(pattern) print('Input pattern:', pattern) print('Predicted pattern:', prediction)

# Output:

Input pattern: [ 1 1 -1 -1]

Predicted pattern: [-1. -1. -1. -1.]

Input pattern: [-1 -1 1 1]

Predicted pattern: [-1. -1. -1. -1.]

Input pattern: [ 1 -1 1 -1]

Predicted pattern: [-1. -1. -1. -1.]

Input pattern: [-1 1 -1 1]

Predicted pattern: [-1. -1. -1. -1.]

# Assignment No. 10

**Code:**

import keras

from keras.datasets import cifar10 from keras.models import Sequential

from keras.layers import Dense, Dropout, Flatten from keras.layers import Conv2D, MaxPooling2D from keras.optimizers import SGD

from keras.preprocessing.image import ImageDataGenerator

# Load CIFAR-10 dataset

(X\_train, y\_train), (X\_test, y\_test) = cifar10.load\_data()

# Define the model model = Sequential()

model.add(Conv2D(32, (3, 3), activation='relu', input\_shape=(32, 32, 3)))

model.add(Conv2D(32, (3, 3), activation='relu'))

model.add(MaxPooling2D(pool\_size=(2, 2))) model.add(Dropout(0.25)) model.add(Conv2D(64, (3, 3), activation='relu'))

model.add(Conv2D(64, (3, 3), activation='relu'))

model.add(MaxPooling2D(pool\_size=(2, 2))) model.add(Dropout(0.25)) model.add(Flatten())

model.add(Dense(512, activation='relu')) model.add(Dropout(0.5)) model.add(Dense(10, activation='softmax'))

# Define data generators

train\_datagen = ImageDataGenerator(rescale=1./255, shear\_range=0.2, zoom\_range=0.2, horizontal\_flip=True)

test\_datagen = ImageDataGenerator(rescale=1./255)

# Prepare the data

train\_set = train\_datagen.flow(X\_train, y\_train, batch\_size=32) test\_set = test\_datagen.flow(X\_test, y\_test, batch\_size=32)

# Compile the model

sgd = SGD(lr=0.01, decay=1e-6, momentum=0.9, nesterov=True) model.compile(loss='categorical\_crossentropy', optimizer=sgd, metrics=['accuracy'])

# Train the model

model.fit\_generator(train\_set, steps\_per\_epoch=len(X\_train)//32, epochs=100, validation\_data=test\_set, validation\_steps=len(X\_test)//32)

# Evaluate the model

score = model.evaluate(test\_set, verbose=0) print('Test loss:', score[0])

print('Test accuracy:', score[1])

# Output:

Downloading data from https:/[/www.cs.toronto.edu/~kriz/cifa](http://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz)r[-10-python.tar.gz](http://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz) 170498071/170498071 [==============================] - 3s 0us/step

Epoch 1/100

/usr/local/lib/python3.10/dist-packages/keras/optimizers/legacy/gradient\_descent.py:114: UserWarning: The `lr` argument is deprecated, use `learning\_rate` instead.

super(). init (name, \*\*kwargs)

<ipython-input-15-75bb0166727e>:40: UserWarning: `Model.fit\_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators. model.fit\_generator(train\_set, steps\_per\_epoch=len(X\_train)//32, epochs=100, validation\_data=test\_set, validation\_steps=len(X\_test)//32)

1562/1562 [==============================] - 270s 172ms/step - loss: nan - accuracy: 0.9977 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 2/100

1562/1562 [==============================] - 264s 169ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 3/100

1562/1562 [==============================] - 255s 163ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 4/100

1562/1562 [==============================] - 242s 155ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 5/100

1562/1562 [==============================] - 247s 158ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 6/100

1562/1562 [==============================] - 244s 156ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 7/100

1562/1562 [==============================] - 244s 156ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 8/100

1562/1562 [==============================] - 245s 157ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 9/100

1562/1562 [==============================] - 240s 153ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 10/100

1562/1562 [==============================] - 251s 161ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 11/100

1562/1562 [==============================] - 249s 159ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 12/100

1562/1562 [==============================] - 248s 159ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 13/100

1562/1562 [==============================] - 243s 156ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 14/100

1562/1562 [==============================] - 244s 156ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 15/100

1562/1562 [==============================] - 242s 155ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

Epoch 16/100

1562/1562 [==============================] - 241s 154ms/step - loss: nan - accuracy: 1.0000 - val\_loss: nan - val\_accuracy: 1.0000

# Assignment No. 11

**Code:**

import tensorflow as tf import numpy as np

from sklearn.model\_selection import train\_test\_split from sklearn.preprocessing import StandardScaler from sklearn.datasets import load\_breast\_cancer df=load\_breast\_cancer()

X\_train,X\_test,y\_train,y\_test=train\_test\_split(df.data,df.target,test\_size=0.20,random\_state=42) sc=StandardScaler()

X\_train=sc.fit\_transform(X\_train)

X\_test=sc.transform(X\_test)

model=tf.keras.models.Sequential([tf.keras.layers.Dense(1,activation='sigmoid',input\_shape=(X

\_train.shape[1],))]) model.compile(optimizer='adam',loss='binary\_crossentropy',metrics=['accuracy'])

model.fit(X\_train,y\_train,epochs=5) y\_pred=model.predict(X\_test) test\_loss,test\_accuracy=model.evaluate(X\_test,y\_test) print("accuracy is",test\_accuracy)

# Output:

Epoch 1/5

15/15 [==============================] - 1s 2ms/step - loss: 0.5449 - accuracy: 0.7385

Epoch 2/5

15/15 [==============================] - 0s 2ms/step - loss: 0.4896 - accuracy: 0.7802

Epoch 3/5

15/15 [==============================] - 0s 2ms/step - loss: 0.4439 - accuracy: 0.8286

Epoch 4/5

15/15 [==============================] - 0s 2ms/step - loss: 0.4074 - accuracy: 0.8462

Epoch 5/5

15/15 [==============================] - 0s 3ms/step - loss: 0.3776 - accuracy: 0.8593

4/4 [==============================] - 0s 5ms/step

4/4 [==============================] - 0s 4ms/step - loss: 0.3090 - accuracy: 0.9298

accuracy is 0.9298245906829834

# Assignment No. 12

**Code:**

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)

y\_test = to\_categorical(y\_test)

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)),

Conv2D(64, (3, 3), activation='relu'), Flatten(),

Dense(64, activation='relu'), Dense(10, activation='softmax')

])

model.compile(optimizer='adam', loss='categorical\_crossentropy', metrics=['accuracy']) model.fit(X\_train, y\_train, batch\_size=64, epochs=10, verbose=1)

loss, accuracy = model.evaluate(X\_test, y\_test) print(f"Test Loss: {loss}")

print(f"Test Accuracy: {accuracy}")

# Output:

Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz 11490434/11490434 [==============================] - 0s 0us/step

Epoch 1/10

938/938 [==============================] - 59s 60ms/step - loss: 0.1783 - accuracy:

0.9448

Epoch 2/10

938/938 [==============================] - 56s 60ms/step - loss: 0.0541 - accuracy:

0.9835

Epoch 3/10

938/938 [==============================] - 55s 59ms/step - loss: 0.0378 - accuracy:

0.9878

Epoch 4/10

938/938 [==============================] - 58s 61ms/step - loss: 0.0295 - accuracy:

0.9908

Epoch 5/10

938/938 [==============================] - 55s 59ms/step - loss: 0.0234 - accuracy:

0.9926

Epoch 6/10

938/938 [==============================] - 55s 59ms/step - loss: 0.0202 - accuracy:

0.9936

Epoch 7/10

938/938 [==============================] - 55s 59ms/step - loss: 0.0153 - accuracy:

0.9950

Epoch 8/10

938/938 [==============================] - 55s 58ms/step - loss: 0.0139 - accuracy:

0.9957

Epoch 9/10

938/938 [==============================] - 56s 59ms/step - loss: 0.0117 - accuracy:

0.9961

Epoch 10/10

938/938 [==============================] - 54s 58ms/step - loss: 0.0091 - accuracy:

0.9971

313/313 [==============================] - 3s 9ms/step - loss: 0.0285 - accuracy:

0.9921

Test Loss: 0.028454650193452835

Test Accuracy: 0.9921000003814697

# Assignment No. 13

**Code:**

import tensorflow as tf

from tensorflow.keras.datasets import mnist from tensorflow.keras.models import Sequential

from tensorflow.keras.layers import Dense, Flatten from tensorflow.keras.optimizers import Adam

# Load and preprocess the MNIST dataset

(X\_train, y\_train), (X\_test, y\_test) = mnist.load\_data() X\_train = X\_train / 255.0

X\_test = X\_test / 255.0

# Define the model architecture model = Sequential([

Flatten(input\_shape=(28, 28)), Dense(128, activation='relu'), Dense(10, activation='softmax')

])

# Compile the model model.compile(optimizer=Adam(learning\_rate=0.001),

loss='sparse\_categorical\_crossentropy', metrics=['accuracy'])

# Train the model

model.fit(X\_train, y\_train, batch\_size=64, epochs=10, verbose=1)

# Evaluate the model

loss, accuracy = model.evaluate(X\_test, y\_test) print(f"Test Loss: {loss}")

print(f"Test Accuracy: {accuracy}")

# Output:

Epoch 1/10

938/938 [==============================] - 5s 4ms/step - loss: 0.2984 - accuracy:

0.9153

Epoch 2/10

938/938 [==============================] - 7s 7ms/step - loss: 0.1353 - accuracy:

0.9612

Epoch 3/10

938/938 [==============================] - 4s 4ms/step - loss: 0.0944 - accuracy:

0.9723

Epoch 4/10

938/938 [==============================] - 4s 5ms/step - loss: 0.0708 - accuracy:

0.9783

Epoch 5/10

938/938 [==============================] - 4s 4ms/step - loss: 0.0558 - accuracy:

0.9833

Epoch 6/10

938/938 [==============================] - 4s 4ms/step - loss: 0.0447 - accuracy:

0.9864

Epoch 7/10

938/938 [==============================] - 4s 4ms/step - loss: 0.0363 - accuracy:

0.9892

Epoch 8/10

938/938 [==============================] - 4s 5ms/step - loss: 0.0293 - accuracy:

0.9913

Epoch 9/10

938/938 [==============================] - 4s 4ms/step - loss: 0.0255 - accuracy:

0.9927

Epoch 10/10

938/938 [==============================] - 4s 4ms/step - loss: 0.0202 - accuracy:

0.9944

313/313 [==============================] - 1s 2ms/step - loss: 0.0679 - accuracy:

0.9804

Test Loss: 0.06786014884710312

Test Accuracy: 0.980400025844574