Ex1: Train Simple Perceptron with Gradient Descent for regression

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Consider the following dataset

X1	X2	Target (Y)
1.0	2.0	3.0
2.0	1.0	4.0
3.0	3.0	6.0
4.0	5.0	9.0
5.0	4.0	10.0
6.0	6.0	12.0

Test Data:

X1	X2	Target (Y)
6.5	5.5	12.5
7.0	7.0	14.0

Create a simple perceptron for regression with the provided dataset, the structure is as follows:

Perceptron Structure

Input Layer:

Nodes: 2 input nodes (one for each feature, X1 and X2).

Output Layer:

Node: 1 output node, which provides the predicted value (regression output).

Perform the following steps:

Import Libraries: Set up the environment with necessary imports.

Prepare Dataset: Define the input features and target values.

Build Model: Use Kera's Sequential model to create a single-layer perceptron.

Compile Model: Choose an optimizer and loss function.

Train Model: Fit the model on the dataset.

Evaluate Model: Check the loss to see how well the model is trained.

Make Predictions: Use the model to predict outputs.

Code:

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

# Training Data
X_train = np.array([
    [1.0, 2.0],
    [2.0, 1.0],
    [3.0, 3.0],
    [4.0, 5.0],
    [5.0, 4.0],
    [6.0, 6.0]
])

Y_train = np.array([3.0, 4.0, 6.0, 9.0, 10.0, 12.0])

# Test Data
X_test = np.array([
    [6.5, 5.5],
```

```
    [7.0, 7.0]
])

Y_test = np.array([12.5, 14.0])

# Build the model
model = Sequential()
model.add(Dense(1, input_dim=2, activation='linear'))

# Compile the model
model.compile(optimizer=SGD(learning_rate=0.01), loss='mse')

# Train the model
model.fit(X_train, Y_train, epochs=100, verbose=1)

# Evaluate the model
loss = model.evaluate(X_train, Y_train)
print(f"Training Loss: {loss}")

# Make predictions
predictions = model.predict(X_test)
print("Predictions:")
for i, pred in enumerate(predictions):
    print(f"Input: {X_test[i]} => Predicted: {pred[0]}, Actual: {Y_test[i]}")
```

output:

```
Epoch 1/100
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: 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)
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 366ms/step - loss: 213.9558
```

Epoch 2/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 39ms/step - loss: 31.5885

Epoch 3/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 4.7568

Epoch 4/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 57ms/step - loss: 0.8082

Epoch 5/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 57ms/step - loss: 0.2264

Epoch 6/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 38ms/step - loss: 0.1399

Epoch 7/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 37ms/step - loss: 0.1262

Epoch 8/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 55ms/step - loss: 0.1234

Epoch 9/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 37ms/step - loss: 0.1221

Epoch 10/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 37ms/step - loss: 0.1210

Epoch 11/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 55ms/step - loss: 0.1200

Epoch 12/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.1191

Epoch 13/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 60ms/step - loss: 0.1181

Epoch 14/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 45ms/step - loss: 0.1171

Epoch 15/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 54ms/step - loss: 0.1162

Epoch 16/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 57ms/step - loss: 0.1153

Epoch 17/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 32ms/step - loss: 0.1144

Epoch 18/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 39ms/step - loss: 0.1135

Epoch 19/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 43ms/step - loss: 0.1126

Epoch 20/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 43ms/step - loss: 0.1117

Epoch 21/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 58ms/step - loss: 0.1108

Epoch 22/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 41ms/step - loss: 0.1100

Epoch 23/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 60ms/step - loss: 0.1091

Epoch 24/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 57ms/step - loss: 0.1083

Epoch 25/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 58ms/step - loss: 0.1075

Epoch 26/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 34ms/step - loss: 0.1067

Epoch 27/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.1059

Epoch 28/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 61ms/step - loss: 0.1051

Epoch 29/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 58ms/step - loss: 0.1043

Epoch 30/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 62ms/step - loss: 0.1035

Epoch 31/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 56ms/step - loss: 0.1028

Epoch 32/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 36ms/step - loss: 0.1020

Epoch 33/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 43ms/step - loss: 0.1013

Epoch 34/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 37ms/step - loss: 0.1005

Epoch 35/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 41ms/step - loss: 0.0998

Epoch 36/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 46ms/step - loss: 0.0991

Epoch 37/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 35ms/step - loss: 0.0984

Epoch 38/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 46ms/step - loss: 0.0977

Epoch 39/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 36ms/step - loss: 0.0970

Epoch 40/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 55ms/step - loss: 0.0964

Epoch 41/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.0957

Epoch 42/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.0950

Epoch 43/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 54ms/step - loss: 0.0944

Epoch 44/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 34ms/step - loss: 0.0937

Epoch 45/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 68ms/step - loss: 0.0931

Epoch 46/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 49ms/step - loss: 0.0925

Epoch 47/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 31ms/step - loss: 0.0919

Epoch 48/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 63ms/step - loss: 0.0913

Epoch 49/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 36ms/step - loss: 0.0907

Epoch 50/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 35ms/step - loss: 0.0901

Epoch 51/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.0895

Epoch 52/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.0889

Epoch 53/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 41ms/step - loss: 0.0884

Epoch 54/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.0878

Epoch 55/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 39ms/step - loss: 0.0872

Epoch 56/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 55ms/step - loss: 0.0867

Epoch 57/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.0862

Epoch 58/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 64ms/step - loss: 0.0856

Epoch 59/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 40ms/step - loss: 0.0851

Epoch 60/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 60ms/step - loss: 0.0846

Epoch 61/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 40ms/step - loss: 0.0841

Epoch 62/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 60ms/step - loss: 0.0836

Epoch 63/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 36ms/step - loss: 0.0831

Epoch 64/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 34ms/step - loss: 0.0826

Epoch 65/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 34ms/step - loss: 0.0821

Epoch 66/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 35ms/step - loss: 0.0816

Epoch 67/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 41ms/step - loss: 0.0812

Epoch 68/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 44ms/step - loss: 0.0807

Epoch 69/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 47ms/step - loss: 0.0802

Epoch 70/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 46ms/step - loss: 0.0798

Epoch 71/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 55ms/step - loss: 0.0793

Epoch 72/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0789

Epoch 73/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 57ms/step - loss: 0.0785

Epoch 74/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0780

Epoch 75/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0776

Epoch 76/100

1/1 ━━━━━━━━━━━━━━━━━━━━ **0s** 56ms/step - loss: 0.0772

Epoch 77/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 31ms/step - loss: 0.0768

Epoch 78/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 56ms/step - loss: 0.0764

Epoch 79/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0760

Epoch 80/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 27ms/step - loss: 0.0756

Epoch 81/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0752

Epoch 82/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0748

Epoch 83/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 59ms/step - loss: 0.0744

Epoch 84/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 53ms/step - loss: 0.0740

Epoch 85/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 26ms/step - loss: 0.0737

Epoch 86/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 27ms/step - loss: 0.0733

Epoch 87/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0729

Epoch 88/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 58ms/step - loss: 0.0726

Epoch 89/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0722

Epoch 90/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 30ms/step - loss: 0.0719

Epoch 91/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 30ms/step - loss: 0.0715

Epoch 92/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 27ms/step - loss: 0.0712

Epoch 93/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 28ms/step - loss: 0.0709

Epoch 94/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 58ms/step - loss: 0.0705

Epoch 95/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 58ms/step - loss: 0.0702

Epoch 96/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 27ms/step - loss: 0.0699

Epoch 97/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 31ms/step - loss: 0.0696

Epoch 98/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 29ms/step - loss: 0.0692

Epoch 99/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 29ms/step - loss: 0.0689

Epoch 100/100

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 58ms/step - loss: 0.0686

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 97ms/step - loss: 0.0683

Training Loss: 0.06832978874444962

1/1 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **0s** 40ms/step

Predictions:

Input: [6.5 5.5] => Predicted: 12.533988952636719, Actual: 12.5

Input: [7. 7.] => Predicted: 14.172568321228027, Actual: 14.0
