

# EC9630: Machine Learning

## Assignment 3

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2019/E/136

```
In [ ]: # DownLoad required Library  
pip install tensorflow
```

Requirement already satisfied: tensorflow in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (2.12.0)

Requirement already satisfied: tensorflow-intel==2.12.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow) (2.12.0)

Requirement already satisfied: absl-py>=1.0.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (1.4.0)

Requirement already satisfied: astunparse>=1.6.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (1.6.3)

Requirement already satisfied: flatbuffers>=2.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (23.5.26)

Requirement already satisfied: gast<=0.4.0,>=0.2.1 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (0.4.0)

Requirement already satisfied: google-pasta>=0.1.1 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (0.2.0)

Requirement already satisfied: h5py>=2.9.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (3.8.0)

Requirement already satisfied: jax>=0.3.15 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (0.4.10)

Requirement already satisfied: libclang>=13.0.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (16.0.0)

Requirement already satisfied: numpy<1.24,>=1.22 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (1.23.5)

Requirement already satisfied: opt-einsum>=2.3.2 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (3.3.0)

Requirement already satisfied: packaging in c:\users\banuka\appdata\roaming\python\python311\site-packages (from tensorflow-intel==2.12.0->tensorflow) (23.0)

Requirement already satisfied: protobuf!=4.21.0,!>4.21.1,!>4.21.2,!>4.21.3,!>4.21.4,!>4.21.5,<5.0.0dev,=>3.20.3 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (3.20.3)

Requirement already satisfied: setuptools in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (65.5.0)

Requirement already satisfied: six>=1.12.0 in c:\users\banuka\appdata\roaming\python\python311\site-packages (from tensorflow-intel==2.12.0->tensorflow) (1.16.0)

Requirement already satisfied: termcolor>=1.1.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (2.3.0)

Requirement already satisfied: typing-extentions>=3.6.6 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (4.6.2)

Requirement already satisfied: wrapt<1.15,>=1.11.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (1.14.1)

Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (1.54.2)

Requirement already satisfied: tensorflow<2.13,>=2.12 in c:\users\banuka\appdata\local\programs\python\python311\lib

\site-packages (from tensorflow-intel==2.12.0->tensorflow) (2.12.3)  
Requirement already satisfied: tensorflow-estimator<2.13,>=2.12.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (2.12.0)  
Requirement already satisfied: keras<2.13,>=2.12.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (2.12.0)  
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.0->tensorflow) (0.31.0)  
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from astunparse>=1.6.0->tensorflow-intel==2.12.0->tensorflow) (0.40.0)  
Requirement already satisfied: ml-dtypes>=0.1.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from jax>=0.3.15->tensorflow-intel==2.12.0->tensorflow) (0.1.0)  
Requirement already satisfied: scipy>=1.7 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from jax>=0.3.15->tensorflow-intel==2.12.0->tensorflow) (1.10.1)  
Requirement already satisfied: google-auth<3,>=1.6.3 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.->tensorflow) (2.19.0)  
Requirement already satisfied: google-auth-oauthlib<1.1,>=0.5 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (1.0.0)  
Requirement already satisfied: markdown>=2.6.8 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (3.4.3)  
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12->tensorflow-intel==2.12.0->tensorflow) (2.28.2)  
Requirement already satisfied: tensorflow-data-server<0.8.0,>=0.7.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.12.->tensorflow-intel==2.12.0->tensorflow) (0.7.0)  
Requirement already satisfied: werkzeug>=1.0.1 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (2.3.4)  
Requirement already satisfied: cachetools<6.0,>=2.0.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from google-auth<3,>=1.6.3->tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (5.3.1)  
Requirement already satisfied: pyasn1-modules>=0.2.1 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from google-auth<3,>=1.6.3->tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (0.3.0)  
Requirement already satisfied: rsa<5,>=3.1.4 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from google-auth<3,>=1.6.3->tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (4.9)  
Requirement already satisfied: urllib3<2.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from google-auth<3,>=1.6.3->tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (1.26.15)  
Requirement already satisfied: requests-oauthlib>=0.7.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from google-auth-oauthlib<1.1,>=0.5->tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (1.3.1)  
Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from requests<3,>=2.21.0->tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (3.1.0)  
Requirement already satisfied: idna<4,>=2.5 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from requests<3,>=2.21.0->tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (3.4)  
Requirement already satisfied: certifi>=2017.4.17 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from requests<3,>=2.21.0->tensorflow<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (2022.12.7)

```
Requirement already satisfied: MarkupSafe>=2.1.1 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from werkzeug>=1.0.1->tensorboard<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (2.1.2)
Requirement already satisfied: pyasn1<0.6.0,>=0.4.6 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->tensorboard<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (0.5.0)
Requirement already satisfied: oauthlib>=3.0.0 in c:\users\banuka\appdata\local\programs\python\python311\lib\site-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<1.1,>=0.5->tensorboard<2.13,>=2.12->tensorflow-intel==2.12.0->tensorflow) (3.2.2)
Note: you may need to restart the kernel to use updated packages.
```

```
In [ ]: # Q01
from tensorflow.keras.datasets import boston_housing

# Q02
# Load the Boston Housing dataset
(x_train, y_train), (x_test, y_test) = boston_housing.load_data()

print("X_train, y_train :",(x_train, y_train))
print("X_test, y_test :",(x_test, y_test))
```



```

23.9, 20.6, 31.5, 23.3, 16.8, 14. , 33.8, 36.1, 12.8, 18.3, 18.7,
19.1, 29. , 30.1, 50. , 50. , 22. , 11.9, 37.6, 50. , 22.7, 20.8,
23.5, 27.9, 50. , 19.3, 23.9, 22.6, 15.2, 21.7, 19.2, 43.8, 20.3,
33.2, 19.9, 22.5, 32.7, 22. , 17.1, 19. , 15. , 16.1, 25.1, 23.7,
28.7, 37.2, 22.6, 16.4, 25. , 29.8, 22.1, 17.4, 18.1, 30.3, 17.5,
24.7, 12.6, 26.5, 28.7, 13.3, 10.4, 24.4, 23. , 20. , 17.8, 7. ,
11.8, 24.4, 13.8, 19.4, 25.2, 19.4, 19.4, 29.1]))
X_test, y_test : (array([[1.80846e+01, 0.00000e+00, 1.81000e+01, ..., 2.02000e+01,
   2.72500e+01, 2.90500e+01],
  [1.23290e-01, 0.00000e+00, 1.00100e+01, ..., 1.78000e+01,
   3.94950e+02, 1.62100e+01],
  [5.49700e-02, 0.00000e+00, 5.19000e+00, ..., 2.02000e+01,
   3.96900e+02, 9.74000e+00],
  ...,
  [1.83377e+00, 0.00000e+00, 1.95800e+01, ..., 1.47000e+01,
   3.89610e+02, 1.92000e+00],
  [3.58090e-01, 0.00000e+00, 6.20000e+00, ..., 1.74000e+01,
   3.91700e+02, 9.71000e+00],
  [2.92400e+00, 0.00000e+00, 1.95800e+01, ..., 1.47000e+01,
   2.40160e+02, 9.81000e+00]]), array([ 7.2, 18.8, 19. , 27. , 22.2, 24.5, 31.2, 22.9, 20.5, 23.2, 18.6,
  14.5, 17.8, 50. , 20.8, 24.3, 24.2, 19.8, 19.1, 22.7, 12. , 10.2,
  20. , 18.5, 20.9, 23. , 27.5, 30.1, 9.5, 22. , 21.2, 14.1, 33.1,
  23.4, 20.1, 7.4, 15.4, 23.8, 20.1, 24.5, 33. , 28.4, 14.1, 46.7,
  32.5, 29.6, 28.4, 19.8, 20.2, 25. , 35.4, 20.3, 9.7, 14.5, 34.9,
  26.6, 7.2, 50. , 32.4, 21.6, 29.8, 13.1, 27.5, 21.2, 23.1, 21.9,
  13. , 23.2, 8.1, 5.6, 21.7, 29.6, 19.6, 7. , 26.4, 18.9, 20.9,
  28.1, 35.4, 10.2, 24.3, 43.1, 17.6, 15.4, 16.2, 27.1, 21.4, 21.5,
  22.4, 25. , 16.6, 18.6, 22. , 42.8, 35.1, 21.5, 36. , 21.9, 24.1,
  50. , 26.7, 25. ]))

```

In [ ]:

```

# Q03
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras.optimizers import Adam

# Define the model
ANN_model = Sequential()
ANN_model.add(Dense(64, activation='relu', input_shape=(13,))) # Hidden Layer 1
ANN_model.add(Dense(64, activation='relu')) # Hidden Layer 2
ANN_model.add(Dense(1)) # Output Layer

```

```
# Compile
ANN_model.compile(optimizer = Adam(learning_rate=0.001), loss='mse')

history = ANN_model.fit(x_train, y_train, batch_size=32, epochs=100, validation_data=(x_test, y_test)) # Train the model
```

```
Epoch 1/100
13/13 [=====] - 2s 25ms/step - loss: 309.0654 - val_loss: 143.7905
Epoch 2/100
13/13 [=====] - 0s 5ms/step - loss: 104.2449 - val_loss: 89.3069
Epoch 3/100
13/13 [=====] - 0s 5ms/step - loss: 79.0955 - val_loss: 70.0759
Epoch 4/100
13/13 [=====] - 0s 5ms/step - loss: 71.3400 - val_loss: 67.4402
Epoch 5/100
13/13 [=====] - 0s 5ms/step - loss: 66.7398 - val_loss: 71.5143
Epoch 6/100
13/13 [=====] - 0s 6ms/step - loss: 60.4791 - val_loss: 64.0537
Epoch 7/100
13/13 [=====] - 0s 6ms/step - loss: 57.2872 - val_loss: 61.8508
Epoch 8/100
13/13 [=====] - 0s 5ms/step - loss: 52.5043 - val_loss: 54.2201
Epoch 9/100
13/13 [=====] - 0s 5ms/step - loss: 50.7517 - val_loss: 54.3527
Epoch 10/100
13/13 [=====] - 0s 5ms/step - loss: 55.2127 - val_loss: 55.5755
Epoch 11/100
13/13 [=====] - 0s 5ms/step - loss: 50.7127 - val_loss: 51.6085
Epoch 12/100
13/13 [=====] - 0s 6ms/step - loss: 49.5509 - val_loss: 60.1382
Epoch 13/100
13/13 [=====] - 0s 6ms/step - loss: 48.3289 - val_loss: 62.3087
Epoch 14/100
13/13 [=====] - 0s 6ms/step - loss: 54.2114 - val_loss: 78.3039
Epoch 15/100
13/13 [=====] - 0s 6ms/step - loss: 52.0462 - val_loss: 50.7714
Epoch 16/100
13/13 [=====] - 0s 5ms/step - loss: 43.4968 - val_loss: 48.4325
Epoch 17/100
13/13 [=====] - 0s 5ms/step - loss: 43.2236 - val_loss: 57.3602
Epoch 18/100
13/13 [=====] - 0s 5ms/step - loss: 44.1890 - val_loss: 48.5935
Epoch 19/100
13/13 [=====] - 0s 5ms/step - loss: 45.5447 - val_loss: 55.7584
Epoch 20/100
13/13 [=====] - 0s 5ms/step - loss: 47.0321 - val_loss: 57.5252
Epoch 21/100
13/13 [=====] - 0s 5ms/step - loss: 51.7601 - val_loss: 52.5451
```

Epoch 22/100  
13/13 [=====] - 0s 9ms/step - loss: 49.7804 - val\_loss: 48.1953  
Epoch 23/100  
13/13 [=====] - 0s 6ms/step - loss: 41.7875 - val\_loss: 43.2392  
Epoch 24/100  
13/13 [=====] - 0s 6ms/step - loss: 37.8373 - val\_loss: 47.1011  
Epoch 25/100  
13/13 [=====] - 0s 7ms/step - loss: 38.3671 - val\_loss: 41.8926  
Epoch 26/100  
13/13 [=====] - 0s 7ms/step - loss: 38.2473 - val\_loss: 45.3663  
Epoch 27/100  
13/13 [=====] - 0s 8ms/step - loss: 35.4339 - val\_loss: 41.3415  
Epoch 28/100  
13/13 [=====] - 0s 10ms/step - loss: 35.0152 - val\_loss: 58.9585  
Epoch 29/100  
13/13 [=====] - 0s 7ms/step - loss: 41.2214 - val\_loss: 39.6321  
Epoch 30/100  
13/13 [=====] - 0s 8ms/step - loss: 35.3454 - val\_loss: 40.5455  
Epoch 31/100  
13/13 [=====] - 0s 8ms/step - loss: 33.5624 - val\_loss: 40.5606  
Epoch 32/100  
13/13 [=====] - 0s 7ms/step - loss: 34.1326 - val\_loss: 38.8932  
Epoch 33/100  
13/13 [=====] - 0s 8ms/step - loss: 33.8791 - val\_loss: 41.7300  
Epoch 34/100  
13/13 [=====] - 0s 8ms/step - loss: 32.9700 - val\_loss: 38.4363  
Epoch 35/100  
13/13 [=====] - 0s 8ms/step - loss: 33.6410 - val\_loss: 39.1053  
Epoch 36/100  
13/13 [=====] - 0s 7ms/step - loss: 33.0256 - val\_loss: 35.7117  
Epoch 38/100  
13/13 [=====] - 0s 8ms/step - loss: 31.8134 - val\_loss: 35.3685  
Epoch 39/100  
13/13 [=====] - 0s 7ms/step - loss: 31.8449 - val\_loss: 34.5388  
Epoch 40/100  
13/13 [=====] - 0s 7ms/step - loss: 32.0370 - val\_loss: 34.4483  
Epoch 41/100  
13/13 [=====] - 0s 6ms/step - loss: 30.9359 - val\_loss: 32.9097  
Epoch 42/100  
13/13 [=====] - 0s 6ms/step - loss: 31.6382 - val\_loss: 33.3079

Epoch 43/100  
13/13 [=====] - 0s 6ms/step - loss: 29.3463 - val\_loss: 34.8039  
Epoch 44/100  
13/13 [=====] - 0s 8ms/step - loss: 32.5667 - val\_loss: 36.2216  
Epoch 45/100  
13/13 [=====] - 0s 7ms/step - loss: 31.0874 - val\_loss: 33.8952  
Epoch 46/100  
13/13 [=====] - 0s 13ms/step - loss: 31.0670 - val\_loss: 35.4586  
Epoch 47/100  
13/13 [=====] - 0s 7ms/step - loss: 31.3214 - val\_loss: 43.6733  
Epoch 48/100  
13/13 [=====] - 0s 7ms/step - loss: 31.9743 - val\_loss: 33.4861  
Epoch 49/100  
13/13 [=====] - 0s 7ms/step - loss: 32.1482 - val\_loss: 40.1469  
Epoch 50/100  
13/13 [=====] - 0s 7ms/step - loss: 40.5827 - val\_loss: 32.0707  
Epoch 51/100  
13/13 [=====] - 0s 7ms/step - loss: 35.3167 - val\_loss: 35.4384  
Epoch 52/100  
13/13 [=====] - 0s 7ms/step - loss: 32.9082 - val\_loss: 32.7121  
Epoch 53/100  
13/13 [=====] - 0s 7ms/step - loss: 30.2891 - val\_loss: 31.2665  
Epoch 54/100  
13/13 [=====] - 0s 7ms/step - loss: 27.8672 - val\_loss: 37.1573  
Epoch 55/100  
13/13 [=====] - 0s 8ms/step - loss: 28.9238 - val\_loss: 31.8297  
Epoch 56/100  
13/13 [=====] - 0s 7ms/step - loss: 29.3592 - val\_loss: 31.2713  
Epoch 57/100  
13/13 [=====] - 0s 8ms/step - loss: 27.3336 - val\_loss: 29.2203  
Epoch 58/100  
13/13 [=====] - 0s 8ms/step - loss: 26.7384 - val\_loss: 35.8091  
Epoch 59/100  
13/13 [=====] - 0s 7ms/step - loss: 28.2591 - val\_loss: 28.9293  
Epoch 60/100  
13/13 [=====] - 0s 8ms/step - loss: 28.0851 - val\_loss: 33.1534  
Epoch 61/100  
13/13 [=====] - 0s 9ms/step - loss: 28.3389 - val\_loss: 29.9712  
Epoch 62/100  
13/13 [=====] - 0s 9ms/step - loss: 27.8051 - val\_loss: 28.6961  
Epoch 63/100  
13/13 [=====] - 0s 10ms/step - loss: 25.6668 - val\_loss: 29.4317

Epoch 64/100  
13/13 [=====] - 0s 8ms/step - loss: 25.9854 - val\_loss: 31.9511  
Epoch 65/100  
13/13 [=====] - 0s 7ms/step - loss: 26.3376 - val\_loss: 37.3088  
Epoch 66/100  
13/13 [=====] - 0s 7ms/step - loss: 28.1524 - val\_loss: 31.1769  
Epoch 67/100  
13/13 [=====] - 0s 6ms/step - loss: 25.2614 - val\_loss: 29.4477  
Epoch 68/100  
13/13 [=====] - 0s 6ms/step - loss: 26.2530 - val\_loss: 31.5330  
Epoch 69/100  
13/13 [=====] - 0s 9ms/step - loss: 23.6940 - val\_loss: 28.4158  
Epoch 70/100  
13/13 [=====] - 0s 6ms/step - loss: 25.4068 - val\_loss: 27.3727  
Epoch 71/100  
13/13 [=====] - 0s 6ms/step - loss: 25.9211 - val\_loss: 26.9832  
Epoch 72/100  
13/13 [=====] - 0s 6ms/step - loss: 23.7279 - val\_loss: 26.9700  
Epoch 73/100  
13/13 [=====] - 0s 5ms/step - loss: 25.8228 - val\_loss: 29.7686  
Epoch 74/100  
13/13 [=====] - 0s 6ms/step - loss: 25.9188 - val\_loss: 26.5868  
Epoch 75/100  
13/13 [=====] - 0s 6ms/step - loss: 25.5355 - val\_loss: 26.9516  
Epoch 76/100  
13/13 [=====] - 0s 8ms/step - loss: 25.0495 - val\_loss: 27.9197  
Epoch 77/100  
13/13 [=====] - 0s 8ms/step - loss: 30.1870 - val\_loss: 40.2423  
Epoch 78/100  
13/13 [=====] - 0s 6ms/step - loss: 29.5737 - val\_loss: 37.4093  
Epoch 79/100  
13/13 [=====] - 0s 5ms/step - loss: 29.9065 - val\_loss: 25.3238  
Epoch 80/100  
13/13 [=====] - 0s 6ms/step - loss: 23.9264 - val\_loss: 30.1465  
Epoch 81/100  
13/13 [=====] - 0s 6ms/step - loss: 25.8313 - val\_loss: 30.4813  
Epoch 82/100  
13/13 [=====] - 0s 5ms/step - loss: 26.6398 - val\_loss: 34.9218  
Epoch 83/100  
13/13 [=====] - 0s 5ms/step - loss: 23.8659 - val\_loss: 26.6256  
Epoch 84/100  
13/13 [=====] - 0s 6ms/step - loss: 22.7631 - val\_loss: 43.2300

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Epoch 85/100
13/13 [=====] - 0s 5ms/step - loss: 25.3495 - val_loss: 28.5751
Epoch 86/100
13/13 [=====] - 0s 5ms/step - loss: 22.1271 - val_loss: 28.1610
Epoch 87/100
13/13 [=====] - 0s 6ms/step - loss: 22.8388 - val_loss: 31.6843
Epoch 88/100
13/13 [=====] - 0s 6ms/step - loss: 22.6768 - val_loss: 25.4358
Epoch 89/100
13/13 [=====] - 0s 6ms/step - loss: 21.9057 - val_loss: 26.2204
Epoch 90/100
13/13 [=====] - 0s 5ms/step - loss: 20.7815 - val_loss: 25.6339
Epoch 91/100
13/13 [=====] - 0s 5ms/step - loss: 23.6279 - val_loss: 28.0513
Epoch 92/100
13/13 [=====] - 0s 11ms/step - loss: 21.9478 - val_loss: 28.5496
Epoch 93/100
13/13 [=====] - 0s 6ms/step - loss: 22.3840 - val_loss: 27.8451
Epoch 94/100
13/13 [=====] - 0s 7ms/step - loss: 21.9554 - val_loss: 25.9550
Epoch 95/100
13/13 [=====] - 0s 5ms/step - loss: 21.6777 - val_loss: 24.9790
Epoch 96/100
13/13 [=====] - 0s 6ms/step - loss: 21.7521 - val_loss: 34.5640
Epoch 97/100
13/13 [=====] - 0s 5ms/step - loss: 25.9316 - val_loss: 25.5762
Epoch 98/100
13/13 [=====] - 0s 6ms/step - loss: 24.4340 - val_loss: 32.7271
Epoch 99/100
13/13 [=====] - 0s 5ms/step - loss: 31.8837 - val_loss: 47.4055
Epoch 100/100
13/13 [=====] - 0s 6ms/step - loss: 26.6313 - val_loss: 36.7656
```

```
In [ ]: # Q04
# Use the model to evaluate the model on the test data
Eval_loss = ANN_model.evaluate(x_test, y_test)

# Print the Loss
print("Test data Loss:", Eval_loss)
```

```
4/4 [=====] - 0s 3ms/step - loss: 36.7656
4/4 [=====] - 0s 3ms/step - loss: 36.7656
Test data Loss: 36.76555633544922
```

```
In [ ]: # Q05
import matplotlib.pyplot as plt

# Create predictions on the test data
predictions = ANN_model.predict(x_test)

# Plot the actual target against the predicted target value
plt.scatter(y_test, predictions)
plt.xlabel('Actual Target values')
plt.ylabel('Predicted Target values')
plt.title('Actual vs Predicted Target Values')
plt.show() #plot
```

```
4/4 [=====] - 0s 2ms/step
```

