Experiment 2

Problem Statement:

To build an ANN Model to convert temperature in degree Celsius to Fahrenheit.

GitHub & Google Collab Links:

GitHub Link: https://github.com/piyush-gambhir/ncu-lab-manual-and-end-semester-projects/blob/main/NCU-CSL312%20-%20DL%20-%20Lab%20Manual/Experiment%202/Experiment%202.ipynb

Google Collab Link:

Open in Colab

Installing Dependencies:

! pip install tensorflow numpy matplotlib scikit-learn pandas seaborn

Code

In [ ]:
```
# importing required libraries
import tensorflow as tf
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [ ]:
```
# loading the dataset
dataset = pd.read_csv('celcius_to_fahrenheit_dataset.csv')

# printing the first 5 rows of the dataset
print("First 5 rows of the dataset:")
print(dataset.head())

# printing the last 5 rows of the dataset
print("\nLast 5 rows of the dataset:")
print(dataset.tail())
```

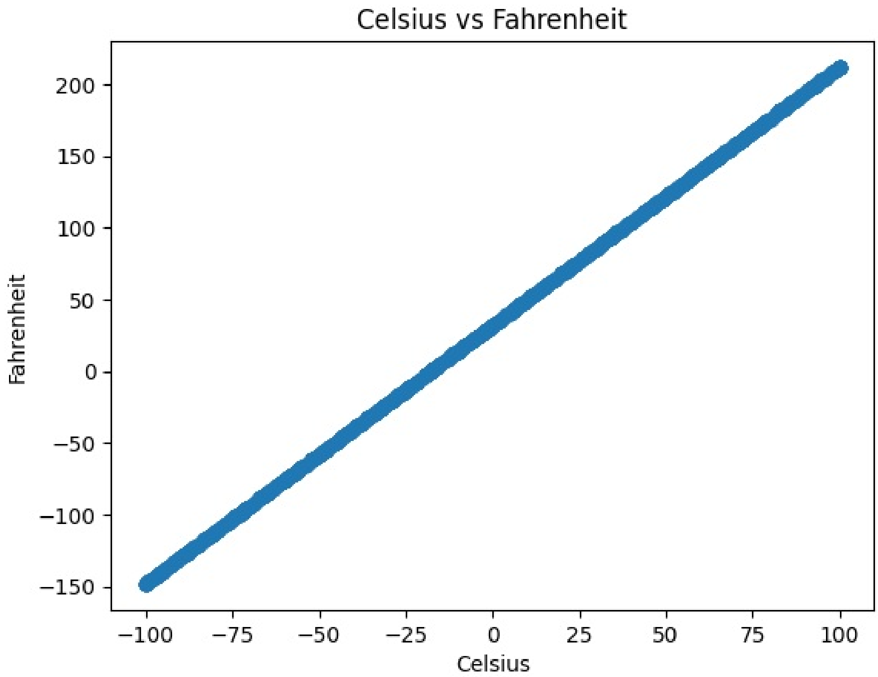
```
First 5 rows of the dataset:
   Celsius  Fahrenheit
0      -67       -88.6
1       40       104.0
2      -97      -142.6
3       57       134.6
4      -50       -58.0

Last 5 rows of the dataset:
     Celsius  Fahrenheit
995      -80      -112.0
996       50       122.0
997       18        64.4
998       47       116.6
999      -67       -88.6
```

In [ ]:
```
# describing the dataset
print("\nDescription of the dataset:")
print(dataset.describe())

# checking information about the dataset
print("\nInformation about the dataset:")
print(dataset.info())
```

```
Description of the dataset:
           Celsius   Fahrenheit
count  1000.000000  1000.000000
mean     -0.029000    31.947800
std      57.334173   103.201511
min    -100.000000  -148.000000
25%     -50.000000   -58.000000
50%      -2.000000    28.400000
75%      50.000000   122.000000
max     100.000000   212.000000

Information about the dataset:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 2 columns):
 #   Column      Non-Null Count  Dtype  
---  ------      --------------  -----  
 0   Celsius     1000 non-null   int64  
 1   Fahrenheit  1000 non-null   float64
dtypes: float64(1), int64(1)
memory usage: 15.8 KB
None
```

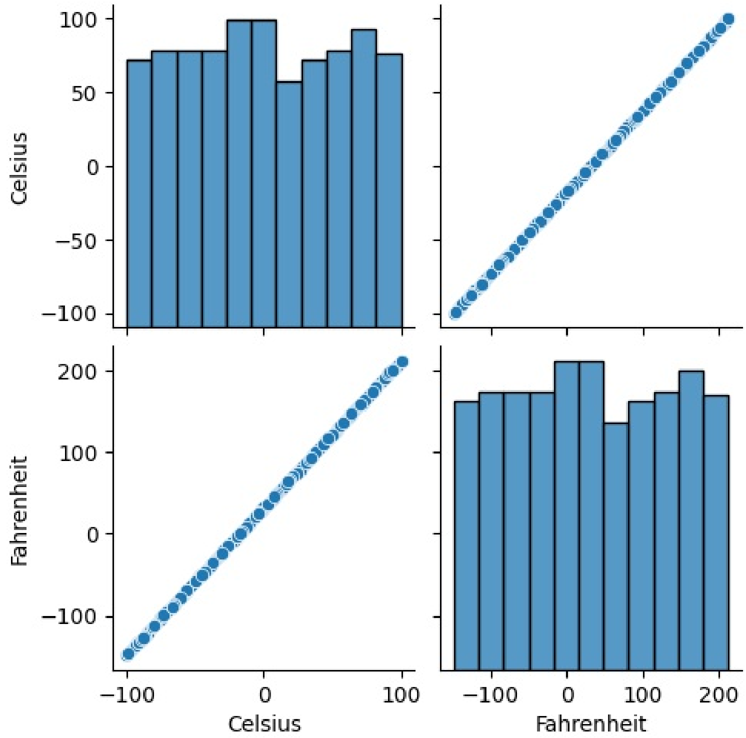
In [ ]:

```
# plotting scatter plot between Celsius and Fahrenheit
plt.scatter(dataset['Celsius'], dataset['Fahrenheit'])
plt.title('Celsius vs Fahrenheit')
plt.xlabel('Celsius')
plt.ylabel('Fahrenheit')
plt.show()
```



In [ ]:

```
# plotting the pair plot of the dataset
sns.pairplot(dataset)
plt.show()
```



In [ ]:
```
# creating training and testing dataset
X_train = dataset['Celsius']
y_train = dataset['Fahrenheit']

print("Shape of X_train:", X_train.shape)
print("Shape of y_train:", y_train.shape)
```

```
Shape of X_train: (1000,)
Shape of y_train: (1000,)
```

In [ ]:
```
# training the model
model = tf.keras.Sequential()
model.add(tf.keras.layers.Dense(units= 32 , input_shape = (1,)))
#Dense when we have fully connected atificial neural network
# now we are adding one more layer to the network
model.add(tf.keras.layers.Dense(units = 32))
# now adding the output layer
model.add(tf.keras.layers.Dense(units = 1))
```

```
c:\Users\mainp\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\layers\core\dense.py:86: User
Warning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer usin
g an `Input(shape)` object as the first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

In [ ]:
```
# model summary
model.summary()
```

Model: "sequential"

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 32)	64
dense_1 (Dense)	(None, 32)	1,056
dense_2 (Dense)	(None, 1)	33

Total params: 1,153 (4.50 KB)

Trainable params: 1,153 (4.50 KB)

Non-trainable params: 0 (0.00 B)

In [ ]:
```
# Compiling the model with a correct learning rate format
model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=1.0),  # Use a float for learning rate
              loss='mean_squared_error')

# Training the model
epochs_hist = model.fit(X_train, y_train, epochs=30, validation_split=0.2)
```

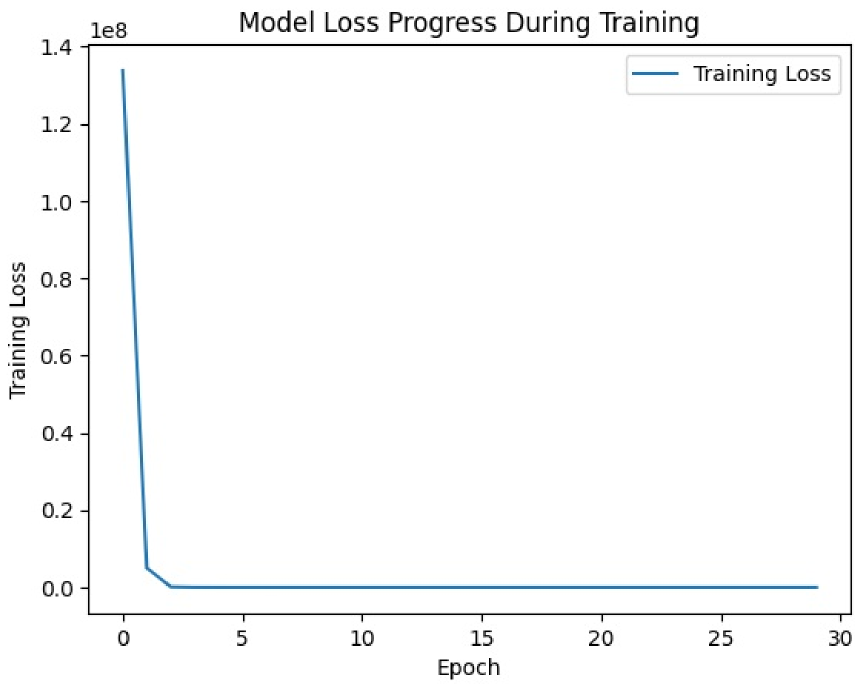
```
Epoch 1/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 184185392.0000 - val_loss: 19116780.0000
Epoch 2/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 8236354.5000 - val_loss: 225760.6562
Epoch 3/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 179850.9219 - val_loss: 13941.5430
Epoch 4/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 12388.3965 - val_loss: 1299.8925
Epoch 5/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1352.4651 - val_loss: 669.6835
Epoch 6/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 537.3693 - val_loss: 290.2394
Epoch 7/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 242.8764 - val_loss: 124.3791
Epoch 8/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 101.0022 - val_loss: 47.9577
Epoch 9/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 38.3891 - val_loss: 16.8620
Epoch 10/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 13.1718 - val_loss: 5.3163
Epoch 11/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 4.1010 - val_loss: 1.5207
Epoch 12/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1.1502 - val_loss: 0.3860
Epoch 13/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 0.2851 - val_loss: 0.0883
Epoch 14/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 0.0644 - val_loss: 0.0180
Epoch 15/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 0.0129 - val_loss: 0.0033
Epoch 16/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0022 - val_loss: 5.1203e-04
Epoch 17/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 3.4311e-04 - val_loss: 7.0061e-05
Epoch 18/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 4.5889e-05 - val_loss: 8.2502e-06
Epoch 19/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 5.3816e-06 - val_loss: 8.4195e-07
Epoch 20/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 5.2030e-07 - val_loss: 9.0222e-08
Epoch 21/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 6.0556e-08 - val_loss: 1.1120e-08
Epoch 22/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 9.3749e-09 - val_loss: 6.0435e-09
Epoch 23/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 5.2943e-09 - val_loss: 4.5255e-09
Epoch 24/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 4.3170e-09 - val_loss: 3.9230e-09
Epoch 25/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 3.5315e-09 - val_loss: 2.9899e-09
Epoch 26/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 2.8870e-09 - val_loss: 2.6312e-09
Epoch 27/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 2.5734e-09 - val_loss: 2.1170e-09
Epoch 28/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1.9519e-09 - val_loss: 1.8936e-09
Epoch 29/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1.7950e-09 - val_loss: 1.6838e-09
Epoch 30/30
25/25 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1.5256e-09 - val_loss: 1.4503e-09
```

In [ ]:

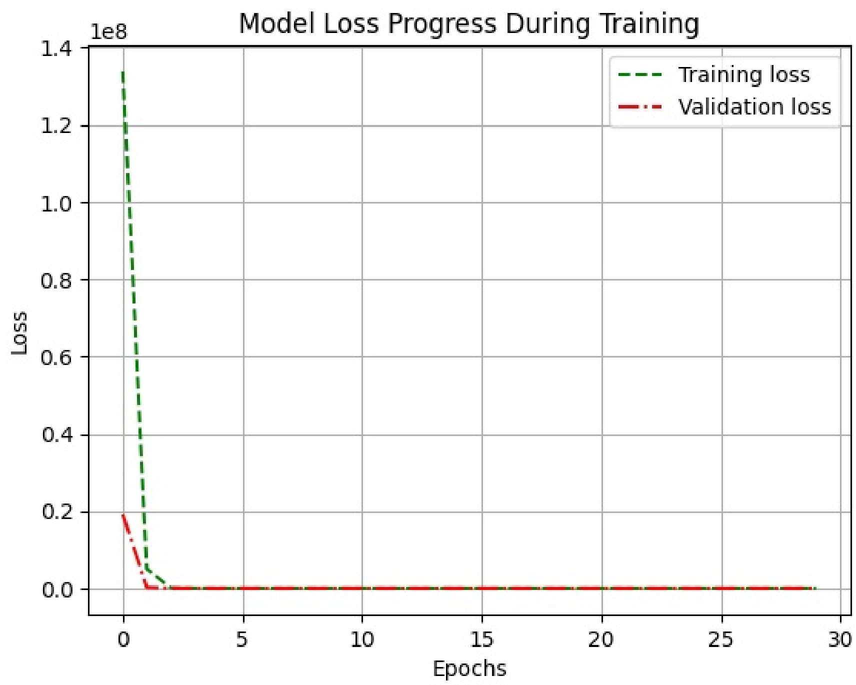
```python
# evaluating the model
print("Loss of the model:", epochs_hist.history['loss'][-1])
print("Validation Loss of the model:", epochs_hist.history['val_loss'][-1])

# plotting the loss
plt.plot(epochs_hist.history['loss'])
plt.title('Model Loss Progress During Training')
plt.xlabel('Epoch')
plt.ylabel('Training Loss')
plt.legend(['Training Loss'])
```

```
Loss of the model: 1.499840363017313e-09
Validation Loss of the model: 1.4503127587772724e-09
```

Out[ ]: <matplotlib.legend.Legend at 0x1ef20de7250>



In [ ]:
```
# plotting the loss and validation loss together
plt.plot(epochs_hist.history['loss'], color='green', label='Training loss', linestyle='--')
plt.plot(epochs_hist.history['val_loss'], color='red', label='Validation loss', linestyle='-.')
plt.title('Model Loss Progress During Training')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.grid(True)
plt.show()
```



In [ ]:
```
# model weights
print("Model Weights:", model.get_weights())
```

```
Model Weights: [array([[ 0.25968587,  0.22125825,  0.28224224, -0.17559958,  0.23964815,
        -0.22765678,  0.21759656,  0.35055447,  0.14478815, -0.26485002,
         0.19265151, -0.13548216, -0.2397434 , -0.19253737,  0.16309   ,
         0.30045104, -0.20057109,  0.20200449,  0.31095803,  0.13719064,
         0.22023755,  0.23763582, -0.23571041,  0.21217768, -0.19351862,
         0.17558281, -0.22309747,  0.16892143, -0.34211284,  0.06600088,
         0.316667  , -0.17547919]], dtype=float32), array([-2.8962476 ,  1.1375874 ,  1.0828029 , -4.1755123 , -
3.1734562 ,
        0.40072462,  1.2057605 , -0.25412676,  5.3564715 ,  3.0925992 ,
        3.9584725 , -1.82679   , -0.6908085 , -3.962711  ,  5.1209865 ,
       -3.2419553 , -0.99446344,  2.322351  , -0.59030426,  5.5396786 ,
       -1.2115853 ,  0.74181646, -1.8299431 ,  4.683813  ,  2.735801  ,
        5.0844874 , -0.9813589 ,  5.412247  ,  0.56680304, -2.441406  ,
       -0.47981733, -4.6937227 ], dtype=float32), array([[-1.739051  ,  2.485136  ,  2.1538115 , ..., -2.3576014
,
        -1.8810381 ,  2.283118  ],
       [-1.3970966 ,  1.282545  ,  1.1863807 , ..., -1.3349036 ,
        -1.2531143 ,  0.9784058 ],
       [ 1.0310407 , -1.3818057 , -1.2115515 , ...,  0.7019355 ,
         0.7162694 , -1.5180666 ],
       ...,
       [-1.8380595 ,  1.8653036 ,  1.6288487 , ..., -1.6006715 ,
        -1.5952858 ,  2.1657426 ],
       [ 0.9168684 , -1.1619155 , -0.6694877 , ...,  0.3581251 ,
         0.07749831, -1.3688766 ],
       [ 0.5317285 , -0.09177828, -0.7525865 , ...,  0.36294675,
         0.545534  , -0.34297764]], dtype=float32), array([ -2.4932847 ,  -9.675127  ,   0.42501694,  10.065001
,
        -0.20992652,   3.964413  ,   9.729676  ,   9.914365  ,
        -4.3035593 ,  -9.414612  ,  -2.7395303 ,   9.503131  ,
        10.006139  ,  -9.70948   ,  -3.6765878 ,   2.4854155 ,
         0.9277671 , -10.061466  ,   3.09827   ,   4.140408  ,
        -3.8939774 ,  -5.2399974 ,  -9.273331  ,  -2.40441   ,
        -9.771945  ,  -9.158293  ,  -1.0062532 ,  -3.8165867 ,
        -9.294314  ,   9.602301  ,   9.229294  ,  -9.535021  ],
      dtype=float32), array([[-0.01261254],
       [-0.16410564],
       [-0.18116668],
       [ 0.17280662],
       [-0.18493941],
       [ 0.07949521],
       [ 0.17311478],
       [ 0.07412434],
       [-0.09236651],
       [ 0.03712983],
       [ 0.07558435],
       [ 0.04765628],
       [ 0.14957748],
       [-0.16422854],
       [-0.00980624],
       [-0.09619454],
       [-0.04052752],
       [-0.06529744],
       [ 0.0081004 ],
       [ 0.12431894],
       [-0.11465567],
       [-0.18500377],
       [ 0.02729801],
       [ 0.03722989],
       [-0.27393368],
       [ 0.09166551],
       [ 0.10329478],
       [-0.04095844],
       [-0.22640787],
       [-0.03853676],
       [-0.01387837],
       [-0.23503576]], dtype=float32), array([8.492162], dtype=float32)]
```

In [ ]:

```
# Making predictions
# Convert to a numpy array and keep it as a batch of one element
Celsius_value = np.array([100])
Fahrenheit_value = model.predict(Celsius_value)
print("Fahrenheit value for Celsius value 100:", Fahrenheit_value[0])

# Calculating with formula
Fahrenheit_value_formula = 9/5 * Celsius_value[0] + 32
print("Fahrenheit value for Celsius value 100 using formula:",
      Fahrenheit_value_formula)
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 52ms/step
Fahrenheit value for Celsius value 100: [212.00005]
Fahrenheit value for Celsius value 100 using formula: 212.0
```

In [ ]:

```
# saving the model
```

```
model.save('celcius_to_fahrenheit_model.h5')
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. T
his file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_m
odel.keras')` or `keras.saving.save_model(model, 'my_model.keras')`.
```