```
# Data analysis and visualization
import tensorflow as tf
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline

# Preprocessing and evaluation
from sklearn.model_selection import train_test_split
from sklearn.compose import make_column_transformer
from sklearn.preprocessing import MinMaxScaler
```

```
(X_train , y_train), (X_test , y_test) = tf.keras.datasets.boston_housing.load_data(
                                            path = 'boston_housing_npz',
                                            test_split = 0.2,
                                            seed = 42
                                        )
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/boston_housing.npz
57026/57026 [==============================] - 0s 0us/step
```

```
# Checking the data shape and type
(X_train.shape, type(X_train)), (X_test.shape, type(X_test)), (y_train.shape, type(y_train)), (y_test.shape, type(y_test
```

```
(((404, 13), numpy.ndarray),
 ((102, 13), numpy.ndarray),
 ((404,), numpy.ndarray),
 ((102,), numpy.ndarray))
```

```
# Converting Data to DataFrame
X_train_df = pd.DataFrame(X_train)
y_train_df = pd.DataFrame(y_train)

# Preview the training data
X_train_df.head(10)
```

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 0.09178 | 0.0 | 4.05 | 0.0 | 0.510 | 6.416 | 84.1 | 2.6463 | 5.0 | 296.0 | 16.6 | 395.50 | 9.04 |
| **1** | 0.05644 | 40.0 | 6.41 | 1.0 | 0.447 | 6.758 | 32.9 | 4.0776 | 4.0 | 254.0 | 17.6 | 396.90 | 3.53 |
| **2** | 0.10574 | 0.0 | 27.74 | 0.0 | 0.609 | 5.983 | 98.8 | 1.8681 | 4.0 | 711.0 | 20.1 | 390.11 | 18.07 |
| **3** | 0.09164 | 0.0 | 10.81 | 0.0 | 0.413 | 6.065 | 7.8 | 5.2873 | 4.0 | 305.0 | 19.2 | 390.91 | 5.52 |
| **4** | 5.09017 | 0.0 | 18.10 | 0.0 | 0.713 | 6.297 | 91.8 | 2.3682 | 24.0 | 666.0 | 20.2 | 385.09 | 17.27 |
| **5** | 0.10153 | 0.0 | 12.83 | 0.0 | 0.437 | 6.279 | 74.5 | 4.0522 | 5.0 | 398.0 | 18.7 | 373.66 | 11.97 |
| **6** | 0.31827 | 0.0 | 9.90 | 0.0 | 0.544 | 5.914 | 83.2 | 3.9986 | 4.0 | 304.0 | 18.4 | 390.70 | 18.33 |
| **7** | 0.29090 | 0.0 | 21.89 | 0.0 | 0.624 | 6.174 | 93.6 | 1.6119 | 4.0 | 437.0 | 21.2 | 388.08 | 24.16 |
| **8** | 4.03841 | 0.0 | 18.10 | 0.0 | 0.532 | 6.229 | 90.7 | 3.0993 | 24.0 | 666.0 | 20.2 | 395.33 | 12.87 |
| **9** | 0.22438 | 0.0 | 9.69 | 0.0 | 0.585 | 6.027 | 79.7 | 2.4982 | 6.0 | 391.0 | 19.2 | 396.90 | 14.33 |

```
# View summary of datasets
X_train_df.info()
print('_'*40)
y_train_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 404 entries, 0 to 403
Data columns (total 13 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   0       404 non-null    float64
 1   1       404 non-null    float64
 2   2       404 non-null    float64
 3   3       404 non-null    float64
 4   4       404 non-null    float64
 5   5       404 non-null    float64
 6   6       404 non-null    float64
 7   7       404 non-null    float64
 8   8       404 non-null    float64
 9   9       404 non-null    float64
 10  10      404 non-null    float64
 11  11      404 non-null    float64
 12  12      404 non-null    float64
dtypes: float64(13)
memory usage: 41.2 KB
________________________________________
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 404 entries, 0 to 403
Data columns (total 1 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   0       404 non-null    float64
dtypes: float64(1)
memory usage: 3.3 KB
```

```
# distribution of numerical feature values across the samples
X_train_df.describe()
```

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **count** | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 |
| **mean** | 3.789989 | 11.568069 | 11.214059 | 0.069307 | 0.554524 | 6.284824 | 69.119307 | 3.792258 | 9.660891 | 408.960396 | 18.481931 |
| **std** | 9.132761 | 24.269648 | 6.925462 | 0.254290 | 0.116408 | 0.723759 | 28.034606 | 2.142651 | 8.736073 | 169.685166 | 2.157322 |
| **min** | 0.006320 | 0.000000 | 0.460000 | 0.000000 | 0.385000 | 3.561000 | 2.900000 | 1.137000 | 1.000000 | 187.000000 | 12.600000 |
| **25%** | 0.081960 | 0.000000 | 5.190000 | 0.000000 | 0.452000 | 5.878750 | 45.475000 | 2.097050 | 4.000000 | 281.000000 | 17.400000 |
| **50%** | 0.262660 | 0.000000 | 9.690000 | 0.000000 | 0.538000 | 6.210000 | 77.500000 | 3.167500 | 5.000000 | 330.000000 | 19.100000 |
| **75%** | 3.717875 | 12.500000 | 18.100000 | 0.000000 | 0.624000 | 6.620500 | 94.425000 | 5.118000 | 24.000000 | 666.000000 | 20.200000 |
| **max** | 88.976200 | 100.000000 | 27.740000 | 1.000000 | 0.871000 | 8.780000 | 100.000000 | 12.126500 | 24.000000 | 711.000000 | 22.000000 |

```
# Create column transformer
ct = make_column_transformer(
    (MinMaxScaler(), [0, 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12])
)

# Normalization and data type change
X_train = ct.fit_transform(X_train).astype('float32')
X_test = ct.transform(X_test).astype('float32')
y_train = y_train.astype('float32')
y_test = y_test.astype('float32')

# Distribution of X_train feature values after normalization
pd.DataFrame(X_train).describe()
```

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **count** | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 | 404.000000 |
| **mean** | 0.042528 | 0.115681 | 0.394210 | 0.348815 | 0.521905 | 0.681970 | 0.241618 | 0.376560 | 0.423589 | 0.625737 | 0.897607 |
| **std** | 0.102650 | 0.242696 | 0.253866 | 0.239522 | 0.138678 | 0.288719 | 0.194973 | 0.379829 | 0.323827 | 0.229502 | 0.232131 |
| **min** | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| **25%** | 0.000850 | 0.000000 | 0.173387 | 0.137860 | 0.444098 | 0.438466 | 0.087361 | 0.130435 | 0.179389 | 0.510638 | 0.944992 |
| **50%** | 0.002881 | 0.000000 | 0.338343 | 0.314815 | 0.507569 | 0.768280 | 0.184767 | 0.173913 | 0.272901 | 0.691489 | 0.985892 |
| **75%** | 0.041717 | 0.125000 | 0.646628 | 0.491770 | 0.586223 | 0.942585 | 0.362255 | 1.000000 | 0.914122 | 0.808511 | 0.997252 |
| **max** | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 |

```
# Reserve data for validation
X_train, X_val, y_train, y_val = train_test_split(X_train, y_train, test_size=0.1, random_state=42)
X_train.shape, X_val.shape, y_train.shape, y_val.shape
```

```
((363, 12), (41, 12), (363,), (41,))
```

```
# Set random seed
tf.random.set_seed(42)

# Building the model
model = tf.keras.Sequential([
  tf.keras.layers.Dense(units=10, activation='relu', input_shape=(X_train.shape[1],), name='Dense_1'),
  tf.keras.layers.Dense(units=100, activation='relu', name='Dense_2'),
  tf.keras.layers.Dense(units=1, name='Prediction')
])

# Compiling the model
model.compile(
    loss = tf.keras.losses.mean_squared_error,
    optimizer = tf.keras.optimizers.RMSprop(learning_rate=0.01),
    metrics = ['mse']
)

# Training the model
history = model.fit(
    X_train,
    y_train,
    batch_size=32,
    epochs=50,
    validation_data=(X_val, y_val)
)
```

```
Epoch 1/50
12/12 [==============================] - 1s 33ms/step - loss: 308.4484 - mse: 308.4484 - val_loss: 146.9222 - val_mse: 146.9222
Epoch 2/50
12/12 [==============================] - 0s 9ms/step - loss: 95.1682 - mse: 95.1682 - val_loss: 92.9939 - val_mse: 92.9939
Epoch 3/50
12/12 [==============================] - 0s 7ms/step - loss: 62.2104 - mse: 62.2104 - val_loss: 68.8015 - val_mse: 68.8015
Epoch 4/50
12/12 [==============================] - 0s 8ms/step - loss: 49.0687 - mse: 49.0687 - val_loss: 56.8894 - val_mse: 56.8894
Epoch 5/50
12/12 [==============================] - 0s 8ms/step - loss: 45.6809 - mse: 45.6809 - val_loss: 68.7085 - val_mse: 68.7085
Epoch 6/50
12/12 [==============================] - 0s 7ms/step - loss: 38.9542 - mse: 38.9542 - val_loss: 61.3664 - val_mse: 61.3664
Epoch 7/50
12/12 [==============================] - 0s 9ms/step - loss: 32.9990 - mse: 32.9990 - val_loss: 35.6852 - val_mse: 35.6852
Epoch 8/50
12/12 [==============================] - 0s 10ms/step - loss: 29.6053 - mse: 29.6053 - val_loss: 47.0410 - val_mse: 47.0410
Epoch 9/50
12/12 [==============================] - 0s 8ms/step - loss: 28.8039 - mse: 28.8039 - val_loss: 30.4692 - val_mse: 30.4692
Epoch 10/50
12/12 [==============================] - 0s 8ms/step - loss: 28.7124 - mse: 28.7124 - val_loss: 38.0187 - val_mse: 38.0187
Epoch 11/50
12/12 [==============================] - 0s 5ms/step - loss: 23.2083 - mse: 23.2083 - val_loss: 45.0314 - val_mse: 45.0314
Epoch 12/50
12/12 [==============================] - 0s 5ms/step - loss: 26.8295 - mse: 26.8295 - val_loss: 25.9321 - val_mse: 25.9321
Epoch 13/50
12/12 [==============================] - 0s 5ms/step - loss: 22.4063 - mse: 22.4063 - val_loss: 33.7716 - val_mse: 33.7716
Epoch 14/50
12/12 [==============================] - 0s 5ms/step - loss: 23.0061 - mse: 23.0061 - val_loss: 19.8987 - val_mse: 19.8987
Epoch 15/50
12/12 [==============================] - 0s 6ms/step - loss: 22.7476 - mse: 22.7476 - val_loss: 19.6241 - val_mse: 19.6241
Epoch 16/50
12/12 [==============================] - 0s 5ms/step - loss: 21.5558 - mse: 21.5558 - val_loss: 22.3366 - val_mse: 22.3366
Epoch 17/50
12/12 [==============================] - 0s 6ms/step - loss: 22.3931 - mse: 22.3931 - val_loss: 46.4523 - val_mse: 46.4523
Epoch 18/50
12/12 [==============================] - 0s 7ms/step - loss: 23.5593 - mse: 23.5593 - val_loss: 18.2555 - val_mse: 18.2555
Epoch 19/50
12/12 [==============================] - 0s 7ms/step - loss: 19.2828 - mse: 19.2828 - val_loss: 17.9827 - val_mse: 17.9827
Epoch 20/50
12/12 [==============================] - 0s 5ms/step - loss: 22.7105 - mse: 22.7105 - val_loss: 20.5292 - val_mse: 20.5292
Epoch 21/50
12/12 [==============================] - 0s 7ms/step - loss: 22.5749 - mse: 22.5749 - val_loss: 18.6884 - val_mse: 18.6884
Epoch 22/50
12/12 [==============================] - 0s 5ms/step - loss: 19.0899 - mse: 19.0899 - val_loss: 58.9656 - val_mse: 58.9656
Epoch 23/50
12/12 [==============================] - 0s 6ms/step - loss: 22.1505 - mse: 22.1505 - val_loss: 17.7170 - val_mse: 17.7170
Epoch 24/50
12/12 [==============================] - 0s 5ms/step - loss: 21.5239 - mse: 21.5239 - val_loss: 17.5552 - val_mse: 17.5552
Epoch 25/50
12/12 [==============================] - 0s 5ms/step - loss: 18.7696 - mse: 18.7696 - val_loss: 33.4806 - val_mse: 33.4806
Epoch 26/50
12/12 [==============================] - 0s 5ms/step - loss: 21.0288 - mse: 21.0288 - val_loss: 37.7337 - val_mse: 37.7337
Epoch 27/50
12/12 [==============================] - 0s 5ms/step - loss: 19.4240 - mse: 19.4240 - val_loss: 27.9656 - val_mse: 27.9656
Epoch 28/50
12/12 [==============================] - 0s 7ms/step - loss: 18.7796 - mse: 18.7796 - val_loss: 16.4296 - val_mse: 16.4296
Epoch 29/50
12/12 [==============================] - 0s 6ms/step - loss: 19.5165 - mse: 19.5165 - val_loss: 36.3188 - val_mse: 36.3188
```

```
# Preview the mean value of training and validation data
y_train.mean(), y_val.mean()
```

```
(22.235537, 24.89756)
```

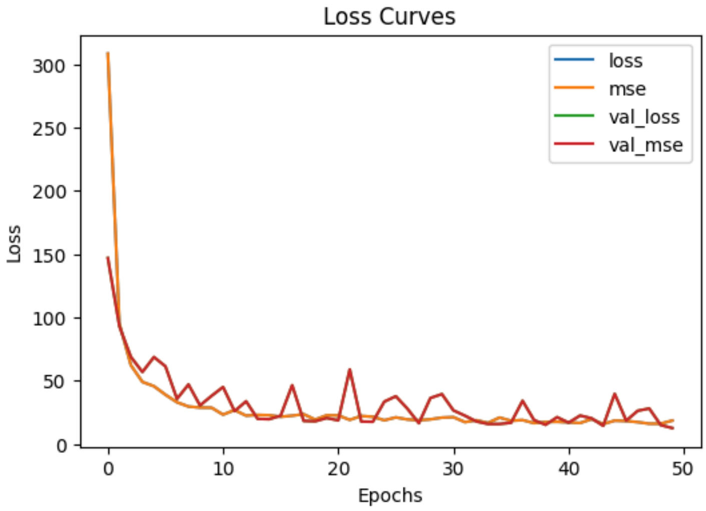
```
# Evaluate the model on the test data
print("Evaluation on Test data \n")
loss, mse = model.evaluate(X_test, y_test, batch_size=32)
print(f"\nModel loss on test set: {loss}")
print(f"Model mean squared error on test set: {(mse):.2f}")
```

```
Evaluation on Test data

4/4 [==============================] - 0s 4ms/step - loss: 18.0088 - mse: 18.0088

Model loss on test set: 18.00882339477539
Model mean squared error on test set: 18.01
```

```
# Plot the loss curves
pd.DataFrame(history.history).plot(figsize=(6, 4), xlabel="Epochs", ylabel="Loss", title='Loss Curves')
plt.show()
```



```
# Make predictions
y_pred = model.predict(X_test)

# View the first prediction
y_pred[0]
```

```
4/4 [==============================] - 0s 4ms/step
array([19.403996], dtype=float32)
```

```
Start coding or generate with AI.
```

```
Start coding or generate with AI.
```