bostonhousednn

March 25, 2025

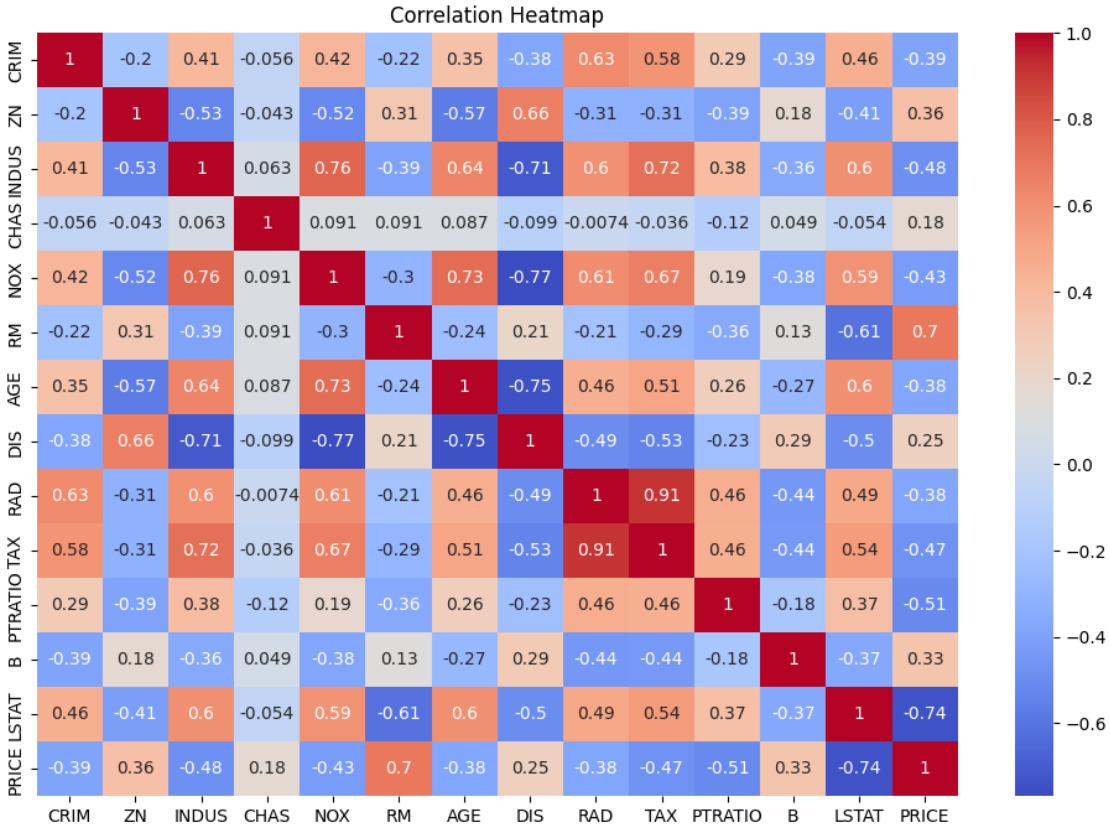
[ ]:
```
# This Python 3 environment comes with many helpful analytics libraries␣
 ↪installed
# It is defined by the kaggle/python Docker image: https://github.com/kaggle/
 ↪docker-python
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list␣
 ↪all files under the input directory

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that␣
 ↪gets preserved as output when you create a version using "Save & Run All"
# You can also write temporary files to /kaggle/temp/, but they won't be saved␣
 ↪outside of the current session
```

[2]:
```
# Import required libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# For data splitting and metrics
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score

# Linear Regression Model
from sklearn.linear_model import LinearRegression
```

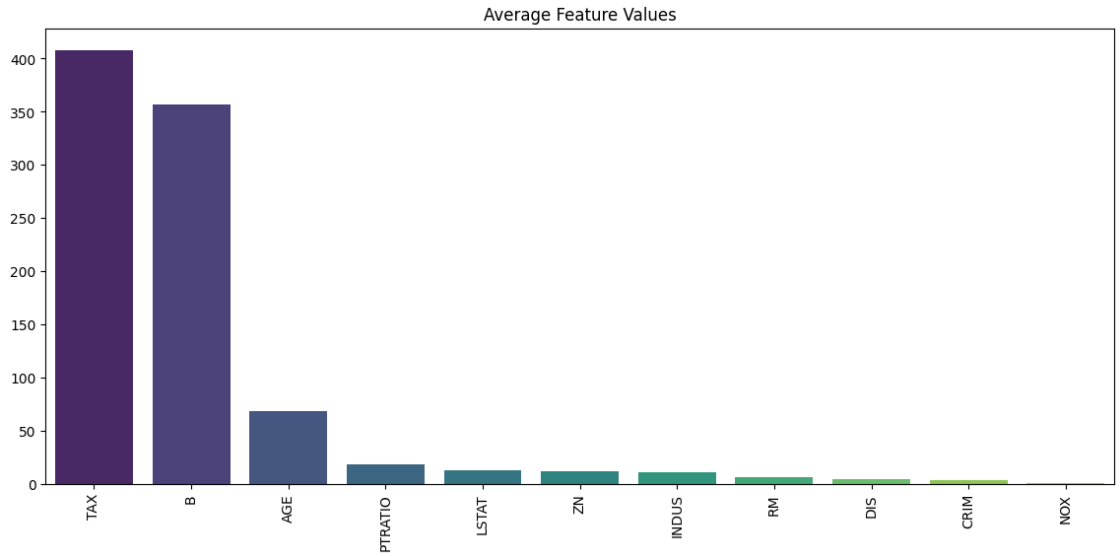
```
# Deep Neural Network (using Keras)
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras.callbacks import EarlyStopping

# Suppress warnings for cleaner output
import warnings
warnings.filterwarnings("ignore")
```

[4]:
```
from sklearn.datasets import fetch_openml
boston = fetch_openml(name='boston', version=1, as_frame=True)
data = boston.frame
data.rename(columns={'MEDV': 'PRICE'}, inplace=True)
```

[8]:
```
plt.figure(figsize=(12, 8))
corr_matrix = data.corr()
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm')
plt.title("Correlation Heatmap")
plt.show()
```



[10]:
```
plt.figure(figsize=(14, 6))
# Calculate mean only for numeric columns
avg_values = data.drop('PRICE', axis=1).mean(numeric_only=True).
 ↪sort_values(ascending=False)
sns.barplot(x=avg_values.index, y=avg_values.values, palette="viridis")
plt.xticks(rotation=90)
plt.title("Average Feature Values")
plt.show()
```



[11]:
```
print("\nNull values in each column:")
print(data.isnull().sum())
```

```
Null values in each column:
CRIM       0
ZN         0
INDUS      0
CHAS       0
NOX        0
RM         0
AGE        0
DIS        0
RAD        0
TAX        0
PTRATIO    0
B          0
LSTAT      0
PRICE      0
dtype: int64
```

[12]:
```
X = data.drop('PRICE', axis=1)
y = data['PRICE']
```

[13]:
```
# Train-test split (80-20 split)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
↪random_state=42)
```

[15]:
```
# Standardize the features (mean=0, std=1)
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
```

[16]:
```
# Train the Linear Regression Model
lin_reg = LinearRegression()
lin_reg.fit(X_train_scaled, y_train)
```

[16]:
```
LinearRegression()
```

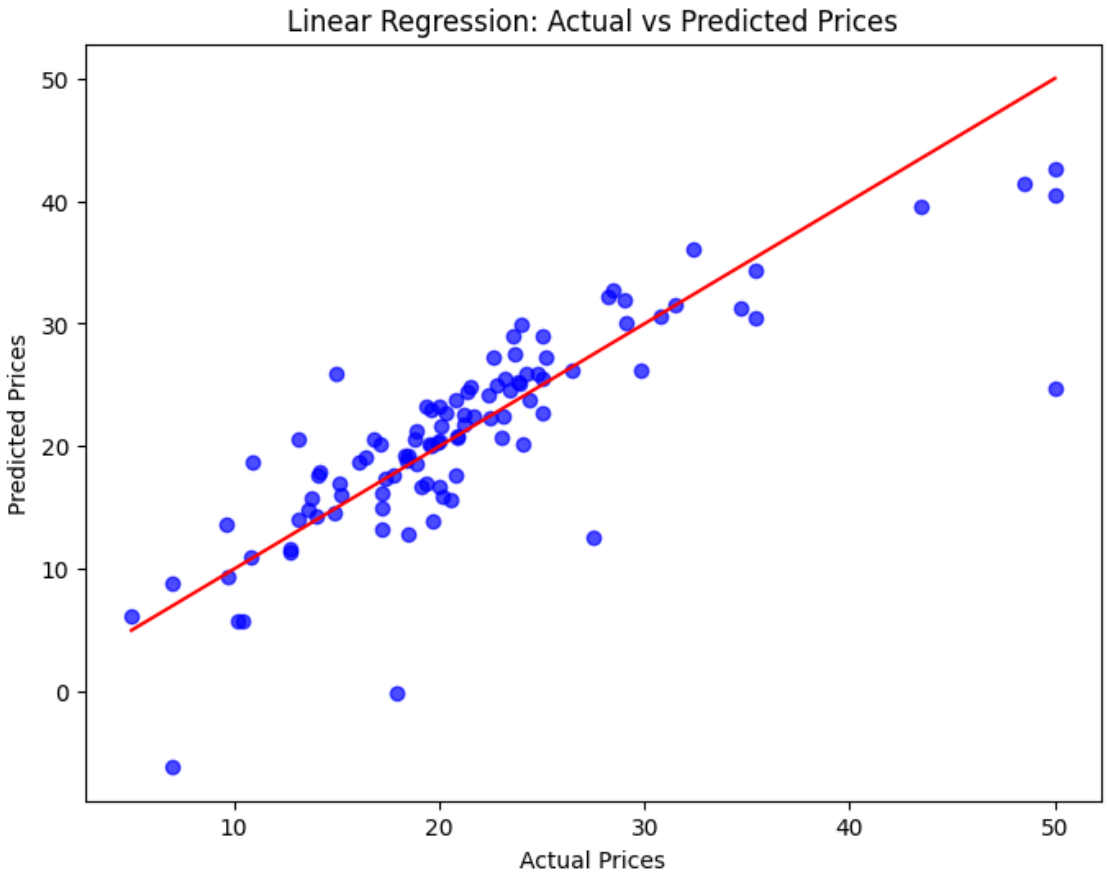
[17]:
```
# Predictions
y_pred_lin = lin_reg.predict(X_test_scaled)
```

[18]:
```
# Evaluation Metrics for Linear Regression
mse_lin = mean_squared_error(y_test, y_pred_lin)
mae_lin = mean_absolute_error(y_test, y_pred_lin)
r2_lin  = r2_score(y_test, y_pred_lin)
```

[19]:
```
print("\nLinear Regression Performance:")
print(f"Mean Squared Error (MSE): {mse_lin:.3f}")
print(f"Mean Absolute Error (MAE): {mae_lin:.3f}")
print(f"R2 Score: {r2_lin:.3f}")
```

```
Linear Regression Performance:
Mean Squared Error (MSE): 24.291
Mean Absolute Error (MAE): 3.189
R2 Score: 0.669
```

[20]:
```
plt.figure(figsize=(8, 6))
plt.scatter(y_test, y_pred_lin, alpha=0.7, color='blue')
plt.xlabel("Actual Prices")
plt.ylabel("Predicted Prices")
plt.title("Linear Regression: Actual vs Predicted Prices")
plt.plot([min(y_test), max(y_test)], [min(y_test), max(y_test)], color='red') ␣
↪# Diagonal line
plt.show()
```



[21]:
```
# Build the DNN model
model = Sequential([
    Dense(64, input_dim=X_train_scaled.shape[1], activation='relu'),
    Dense(32, activation='relu'),
    Dense(16, activation='relu'),
    Dense(1)  # Output layer for regression
])
```

[22]:
```
model.compile(optimizer='adam', loss='mse', metrics=['mae'])
```

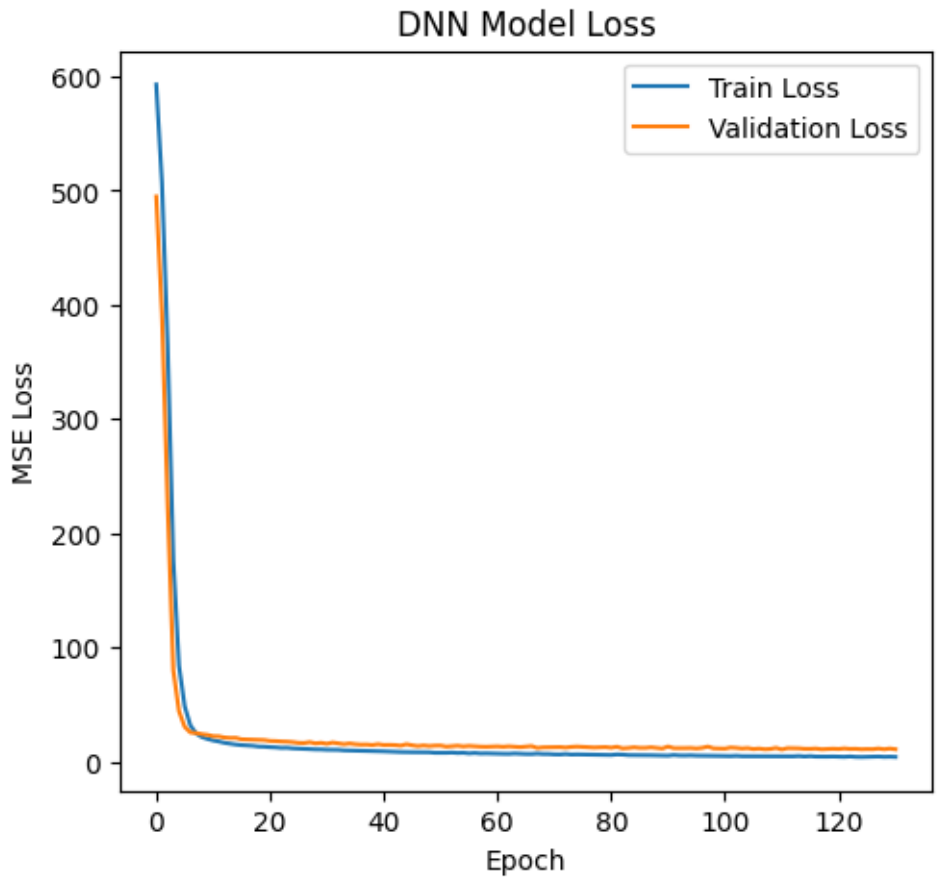
[23]:
```
# Callback to stop early if validation loss doesn't improve
early_stop = EarlyStopping(monitor='val_loss', patience=20,␣
 ↪restore_best_weights=True)
```

[24]:
```
# Train the model
history = model.fit(X_train_scaled, y_train,
                    validation_split=0.2,
                    epochs=200,
                    batch_size=16,
```

```
                    callbacks=[early_stop],
                    verbose=0)
```

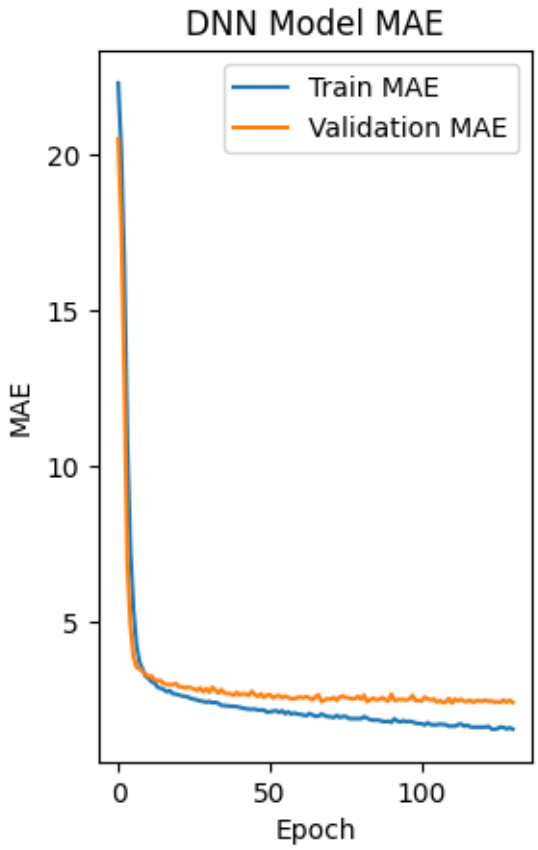
[25]:
```
# Plot training history
plt.figure(figsize=(12, 5))
plt.subplot(1, 2, 1)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title("DNN Model Loss")
plt.xlabel("Epoch")
plt.ylabel("MSE Loss")
plt.legend()
```

[25]:
```
<matplotlib.legend.Legend at 0x7c319063b460>
```



[26]:
```
plt.subplot(1, 2, 2)
plt.plot(history.history['mae'], label='Train MAE')
plt.plot(history.history['val_mae'], label='Validation MAE')
plt.title("DNN Model MAE")
```

```
plt.xlabel("Epoch")
plt.ylabel("MAE")
plt.legend()
plt.show()
```



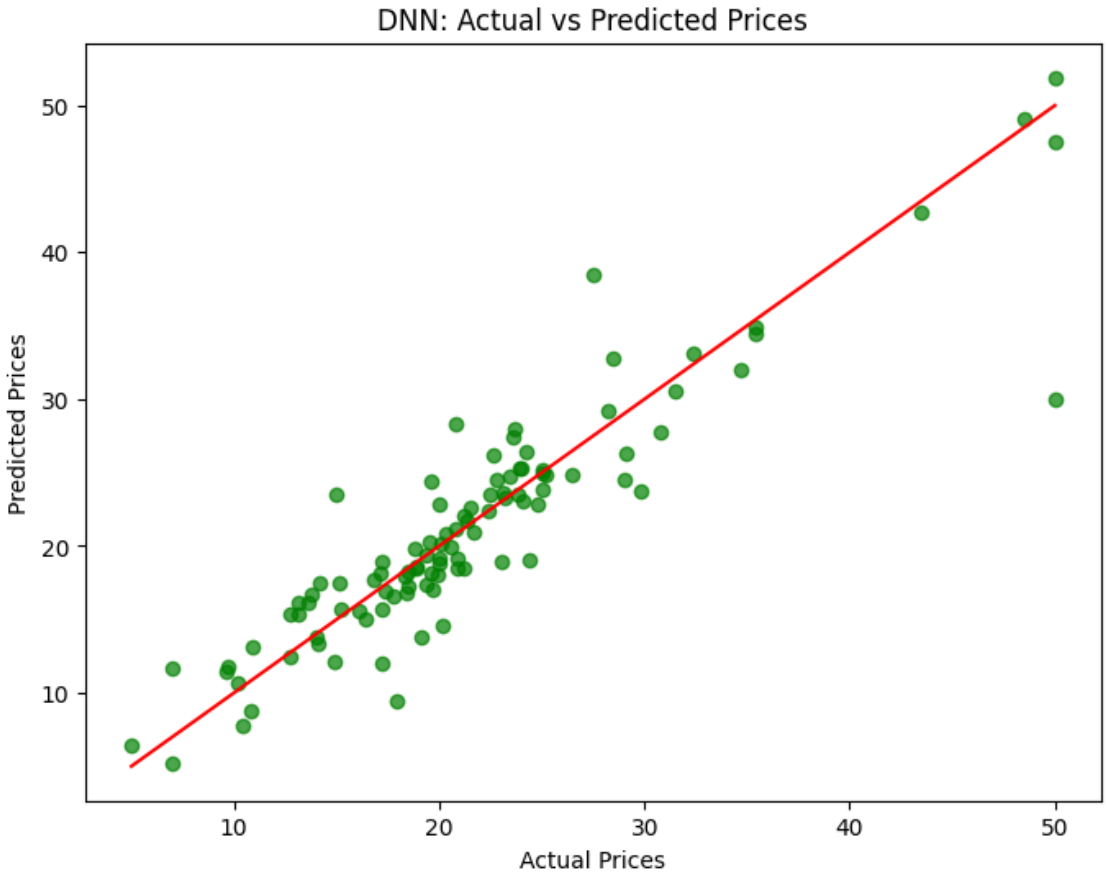
[27]:
```
# Predictions with DNN
y_pred_dnn = model.predict(X_test_scaled).flatten()
```

```
4/4             0s 13ms/step
```

[29]:
```
# Evaluation Metrics for DNN
mse_dnn = mean_squared_error(y_test, y_pred_dnn)
mae_dnn = mean_absolute_error(y_test, y_pred_dnn)
r2_dnn  = r2_score(y_test, y_pred_dnn)
print("\nDeep Neural Network Performance:")
print(f"Mean Squared Error (MSE): {mse_dnn:.3f}")
print(f"Mean Absolute Error (MAE): {mae_dnn:.3f}")
print(f"R2 Score: {r2_dnn:.3f}")
```

```
Deep Neural Network Performance:
Mean Squared Error (MSE): 12.120
Mean Absolute Error (MAE): 2.246
R2 Score: 0.835
```

[30]:
```
# Visualize Actual vs Predicted for DNN
plt.figure(figsize=(8, 6))
plt.scatter(y_test, y_pred_dnn, alpha=0.7, color='green')
plt.xlabel("Actual Prices")
plt.ylabel("Predicted Prices")
plt.title("DNN: Actual vs Predicted Prices")
plt.plot([min(y_test), max(y_test)], [min(y_test), max(y_test)], color='red') ␣
↪# Diagonal line
plt.show()
```



[31]:
```
print("\n=== Comparison Summary ===")
print(f"Linear Regression -> MSE: {mse_lin:.3f}, MAE: {mae_lin:.3f}, R2:␣
↪{r2_lin:.3f}")
```

```
print(f"Deep Neural Network -> MSE: {mse_dnn:.3f}, MAE: {mae_dnn:.3f}, R2:␣
  ↪{r2_dnn:.3f}")
```

```
=== Comparison Summary ===
Linear Regression -> MSE: 24.291, MAE: 3.189, R2: 0.669
Deep Neural Network -> MSE: 12.120, MAE: 2.246, R2: 0.835
```