Change Log

Overview

- This model aims to be able to predict the quality of wine based off of different factors about the wine.
- I obtained my dataset from the University of California Irvine's website (https://archive.ics.uci.edu/dataset/186/wine+quality)
- There are 11 columns about the wine and it's makeup and then a quality rating at the end for my target value.
- The red wine dataset has 1600 entries and the white wine dataset has 4900 entries.
- This is a relatively small dataset but I wanted to use a simple enough dataset and prediction whilst I get used to using Neural Networks and figuring out how they work.
- I am planning to use a Feedforward Neural Network for this as it is a simple regression task and it should be a good fit for the data that I have.

Learnings & Findings

- I was reading the tensorflow docs here (https://www.tensorflow.org/tutorials/quickstart/beginner) and a GeeksForGeeks artice here (https://www.geeksforgeeks.org/feedforward-neural-network/) to get an idea of how to structure the code for this model.
- I have always used Sci-Kit learn for all of my models previously, however I was doing some research and found that Tensorflow seems to be a better fit for Neural Networks as it gives you a lot more control over the model in comparison to Sci-Kit Learns version.
- I would like to see if there is a difference in what makes a white wine good quality in comparison to red wine, this is something I'd like to investigate further on in the notebook, I want to run this model on Red, White and a combination of the two to see the results.
- Learned about adam optimiser from here (https://www.geeksforgeeks.org/adam-optimizer-in-tensorflow/)
- I have a MAE rating of 0.57 now so I want to see if I can improve this by using Standard Scaling
- I then moved on to replicating the same process with the red wine dataset, with even better success at a 0.51 MAE score.
- I then wanted to see what the score would be like for the combination of both and this was also a success.

Results

- I now have a good and much clearer understanding of how even a simple enough Neural Network works and how it is structured.
- These datasets worked well in making predictions in the end with them all only being about .5 off in mst scenarios on the quality score.
- I can now take these learnings and take on a more complex model with more obscure data to challenge myself in using Neural Networks.
- Red wine and Combined ended up being a little bit better on the predictions but not by a massive amount.

```python
import tensorflow as tf
from tensorflow import keras
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
import pandas as pd

white_df = pd.read_csv('winequality-white.csv', sep=';')
red_df = pd.read_csv('winequality-red.csv', sep=';')

print(white_df.head())
print(red_df.head())
```

```
   fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
0            7.0              0.27         0.36            20.7
0.045
1            6.3              0.30         0.34             1.6
0.049
2            8.1              0.28         0.40             6.9
0.050
3            7.2              0.23         0.32             8.5
0.058
4            7.2              0.23         0.32             8.5
0.058

   free sulfur dioxide  total sulfur dioxide  density    pH  sulphates
\
0                 45.0                 170.0   1.0010  3.00       0.45

1                 14.0                 132.0   0.9940  3.30       0.49

2                 30.0                  97.0   0.9951  3.26       0.44

3                 47.0                 186.0   0.9956  3.19       0.40

4                 47.0                 186.0   0.9956  3.19       0.40


   alcohol  quality
0      8.8        6
1      9.5        6
2     10.1        6
3      9.9        6
4      9.9        6
   fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
0            7.4              0.70         0.00             1.9
0.076
1            7.8              0.88         0.00             2.6
0.098
```

```
2           7.8              0.76         0.04             2.3
0.092
3          11.2              0.28         0.56             1.9
0.075
4           7.4              0.70         0.00             1.9
0.076

   free sulfur dioxide  total sulfur dioxide  density    pH  sulphates
\
0                 11.0                  34.0   0.9978  3.51       0.56

1                 25.0                  67.0   0.9968  3.20       0.68

2                 15.0                  54.0   0.9970  3.26       0.65

3                 17.0                  60.0   0.9980  3.16       0.58

4                 11.0                  34.0   0.9978  3.51       0.56


   alcohol  quality
0      9.4        5
1      9.8        5
2      9.8        5
3      9.8        6
4      9.4        5
```

I am just importing my two datasets here using pandas and importing the necessary libraries for later on.

```
X = white_df.drop('quality', axis=1)
y = white_df['quality']

X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
```

I'm just starting off with white at random to see how it goes, I will eventually be doing this model on all of the datasets

```
model = keras.Sequential([
    keras.layers.Input(shape=(X_train.shape[1],)),
    keras.layers.Dense(64, activation='relu'),
    keras.layers.Dense(32, activation='relu'),
    keras.layers.Dense(1, activation='linear')
])
```

Here I am defining the model using Keras and Tensorflow.

Using Sequential here tells it that we are using a Feed Forward Neural Network. Firstly I added my input layer which just contains my training X data. Then I am creating 2 hidden layers on top of Tensorflows already built model with 64 neurons and then the next one is the same but with 32 neurons. The relu activation function keeps the positive values but turns the negative ones into 0. The final layer I added then is the output layer which just has one neuron and I used linear becasue this is a regression model rather than classification.

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

In this code block I am compiling the model. An optimiser controls how the model updates the weights for the Neural Network. The adam optimiser is usually used becuase it adjusts the learning rates automatically.

I am then using Mean Square Error and Mean Absolute error as these are very good for regression as they track how much error is occuring in the predictions that the model is making.

```
model.fit(X_train, y_train, epochs=100, batch_size=16,
validation_split=0.2)
```

```
Epoch 1/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 1s 951us/step - loss: 18.0223 - mae:
2.8530 - val_loss: 1.0642 - val_mae: 0.8004
Epoch 2/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 671us/step - loss: 0.7668 - mae:
0.6834 - val_loss: 0.6459 - val_mae: 0.6253
Epoch 3/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.7435 - mae:
0.6764 - val_loss: 0.6571 - val_mae: 0.6319
Epoch 4/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.6736 - mae:
0.6427 - val_loss: 0.6431 - val_mae: 0.6277
Epoch 5/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 667us/step - loss: 0.6657 - mae:
0.6253 - val_loss: 0.6236 - val_mae: 0.6170
Epoch 6/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 670us/step - loss: 0.7041 - mae:
0.6524 - val_loss: 0.6539 - val_mae: 0.6369
Epoch 7/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.6596 - mae:
0.6354 - val_loss: 0.8880 - val_mae: 0.7370
Epoch 8/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 671us/step - loss: 0.7306 - mae:
0.6730 - val_loss: 0.7512 - val_mae: 0.6706
Epoch 9/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 675us/step - loss: 0.8951 - mae:
0.7438 - val_loss: 0.8290 - val_mae: 0.7329
Epoch 10/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 662us/step - loss: 0.7282 - mae:
0.6680 - val_loss: 0.8485 - val_mae: 0.7414
Epoch 11/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 652us/step - loss: 0.8454 - mae:
0.7257 - val_loss: 0.6002 - val_mae: 0.6045
```

```
Epoch 12/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 672us/step - loss: 0.6253 - mae: 0.6161 - val_loss: 1.1739 - val_mae: 0.8697
Epoch 13/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 678us/step - loss: 0.7739 - mae: 0.6910 - val_loss: 0.6033 - val_mae: 0.6055
Epoch 14/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.6306 - mae: 0.6242 - val_loss: 0.5875 - val_mae: 0.5991
Epoch 15/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.6528 - mae: 0.6401 - val_loss: 1.0507 - val_mae: 0.8101
Epoch 16/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 687us/step - loss: 0.8030 - mae: 0.7125 - val_loss: 0.6653 - val_mae: 0.6288
Epoch 17/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 675us/step - loss: 0.7328 - mae: 0.6614 - val_loss: 1.0034 - val_mae: 0.8203
Epoch 18/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 649us/step - loss: 0.7551 - mae: 0.6815 - val_loss: 0.5862 - val_mae: 0.6046
Epoch 19/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 670us/step - loss: 0.6716 - mae: 0.6457 - val_loss: 0.6041 - val_mae: 0.6121
Epoch 20/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 667us/step - loss: 0.6108 - mae: 0.6149 - val_loss: 0.6138 - val_mae: 0.6125
Epoch 21/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.6788 - mae: 0.6458 - val_loss: 0.8042 - val_mae: 0.6926
Epoch 22/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 660us/step - loss: 0.6961 - mae: 0.6573 - val_loss: 0.7104 - val_mae: 0.6691
Epoch 23/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 662us/step - loss: 0.6294 - mae: 0.6218 - val_loss: 0.6867 - val_mae: 0.6579
Epoch 24/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.6541 - mae: 0.6289 - val_loss: 0.8090 - val_mae: 0.6959
Epoch 25/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 670us/step - loss: 0.6615 - mae: 0.6309 - val_loss: 0.5892 - val_mae: 0.5958
Epoch 26/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 666us/step - loss: 0.6461 - mae: 0.6353 - val_loss: 0.7365 - val_mae: 0.6627
Epoch 27/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 650us/step - loss: 0.7638 - mae: 0.6865 - val_loss: 0.6348 - val_mae: 0.6117
Epoch 28/100
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196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.6033 - mae:
0.6071 - val_loss: 0.6371 - val_mae: 0.6169
Epoch 29/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 663us/step - loss: 0.5712 - mae:
0.5904 - val_loss: 0.5971 - val_mae: 0.5989
Epoch 30/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 649us/step - loss: 0.5954 - mae:
0.6052 - val_loss: 0.7430 - val_mae: 0.6630
Epoch 31/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.6271 - mae:
0.6157 - val_loss: 0.9087 - val_mae: 0.7482
Epoch 32/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 655us/step - loss: 0.5961 - mae:
0.5978 - val_loss: 0.5844 - val_mae: 0.5948
Epoch 33/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 669us/step - loss: 0.6520 - mae:
0.6419 - val_loss: 0.5891 - val_mae: 0.6010
Epoch 34/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 706us/step - loss: 0.6027 - mae:
0.6088 - val_loss: 0.6887 - val_mae: 0.6375
Epoch 35/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 645us/step - loss: 0.6369 - mae:
0.6268 - val_loss: 0.7299 - val_mae: 0.6623
Epoch 36/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 634us/step - loss: 0.6361 - mae:
0.6236 - val_loss: 0.7137 - val_mae: 0.6476
Epoch 37/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 643us/step - loss: 0.6561 - mae:
0.6301 - val_loss: 0.6781 - val_mae: 0.6354
Epoch 38/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 677us/step - loss: 0.5829 - mae:
0.5903 - val_loss: 0.6223 - val_mae: 0.6168
Epoch 39/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 637us/step - loss: 0.6167 - mae:
0.6077 - val_loss: 0.7516 - val_mae: 0.6870
Epoch 40/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 895us/step - loss: 0.5916 - mae:
0.6002 - val_loss: 0.6376 - val_mae: 0.6164
Epoch 41/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.6046 - mae:
0.6089 - val_loss: 0.6201 - val_mae: 0.6145
Epoch 42/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 662us/step - loss: 0.6359 - mae:
0.6207 - val_loss: 0.5978 - val_mae: 0.6032
Epoch 43/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 679us/step - loss: 0.5849 - mae:
0.6003 - val_loss: 0.5875 - val_mae: 0.5940
Epoch 44/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 663us/step - loss: 0.5799 - mae:
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```
0.5984 - val_loss: 0.6294 - val_mae: 0.6113
Epoch 45/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.5856 - mae:
0.5960 - val_loss: 0.6630 - val_mae: 0.6229
Epoch 46/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 662us/step - loss: 0.6639 - mae:
0.6383 - val_loss: 0.5816 - val_mae: 0.5912
Epoch 47/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.5771 - mae:
0.5916 - val_loss: 0.6882 - val_mae: 0.6321
Epoch 48/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 643us/step - loss: 0.6298 - mae:
0.6201 - val_loss: 0.5840 - val_mae: 0.5935
Epoch 49/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 662us/step - loss: 0.6003 - mae:
0.6070 - val_loss: 0.6098 - val_mae: 0.6040
Epoch 50/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 667us/step - loss: 0.5900 - mae:
0.5922 - val_loss: 0.5984 - val_mae: 0.5930
Epoch 51/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 672us/step - loss: 0.6271 - mae:
0.6235 - val_loss: 0.5870 - val_mae: 0.5934
Epoch 52/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 691us/step - loss: 0.5669 - mae:
0.5910 - val_loss: 0.7179 - val_mae: 0.6525
Epoch 53/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.6035 - mae:
0.6099 - val_loss: 0.7189 - val_mae: 0.6561
Epoch 54/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 669us/step - loss: 0.6292 - mae:
0.6223 - val_loss: 0.6151 - val_mae: 0.6127
Epoch 55/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 671us/step - loss: 0.5426 - mae:
0.5797 - val_loss: 0.5993 - val_mae: 0.5976
Epoch 56/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 662us/step - loss: 0.5953 - mae:
0.5956 - val_loss: 0.5869 - val_mae: 0.5959
Epoch 57/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 651us/step - loss: 0.5927 - mae:
0.6039 - val_loss: 0.6083 - val_mae: 0.6086
Epoch 58/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 674us/step - loss: 0.6074 - mae:
0.6108 - val_loss: 0.5972 - val_mae: 0.5995
Epoch 59/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 652us/step - loss: 0.6185 - mae:
0.6087 - val_loss: 0.5945 - val_mae: 0.5934
Epoch 60/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.5833 - mae:
0.5953 - val_loss: 0.5757 - val_mae: 0.5881
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Epoch 61/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 671us/step - loss: 0.5785 - mae:
0.5933 - val_loss: 0.9049 - val_mae: 0.7395
Epoch 62/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.5796 - mae:
0.5967 - val_loss: 0.6315 - val_mae: 0.6090
Epoch 63/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 664us/step - loss: 0.5593 - mae:
0.5868 - val_loss: 0.5977 - val_mae: 0.5965
Epoch 64/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 670us/step - loss: 0.5358 - mae:
0.5749 - val_loss: 0.6351 - val_mae: 0.6235
Epoch 65/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 660us/step - loss: 0.5897 - mae:
0.5936 - val_loss: 0.5864 - val_mae: 0.5918
Epoch 66/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 667us/step - loss: 0.5636 - mae:
0.5899 - val_loss: 0.6123 - val_mae: 0.6106
Epoch 67/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 669us/step - loss: 0.5885 - mae:
0.6012 - val_loss: 0.5818 - val_mae: 0.5899
Epoch 68/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 666us/step - loss: 0.6060 - mae:
0.6054 - val_loss: 0.5815 - val_mae: 0.5908
Epoch 69/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.5880 - mae:
0.6033 - val_loss: 0.5862 - val_mae: 0.5938
Epoch 70/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 679us/step - loss: 0.6027 - mae:
0.6055 - val_loss: 0.5908 - val_mae: 0.5981
Epoch 71/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 663us/step - loss: 0.5504 - mae:
0.5765 - val_loss: 0.6048 - val_mae: 0.6012
Epoch 72/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 832us/step - loss: 0.5286 - mae:
0.5732 - val_loss: 0.7828 - val_mae: 0.7077
Epoch 73/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 673us/step - loss: 0.5633 - mae:
0.5917 - val_loss: 0.6731 - val_mae: 0.6319
Epoch 74/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 671us/step - loss: 0.5439 - mae:
0.5773 - val_loss: 0.5843 - val_mae: 0.5912
Epoch 75/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 642us/step - loss: 0.5659 - mae:
0.5875 - val_loss: 0.6061 - val_mae: 0.6009
Epoch 76/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 653us/step - loss: 0.6054 - mae:
0.6104 - val_loss: 0.6117 - val_mae: 0.6029
Epoch 77/100
```

```
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 664us/step - loss: 0.5693 - mae:
0.5867 - val_loss: 0.5856 - val_mae: 0.5967
Epoch 78/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 662us/step - loss: 0.5594 - mae:
0.5917 - val_loss: 0.5865 - val_mae: 0.5914
Epoch 79/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 700us/step - loss: 0.5524 - mae:
0.5787 - val_loss: 0.5905 - val_mae: 0.5986
Epoch 80/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.5419 - mae:
0.5821 - val_loss: 0.7119 - val_mae: 0.6654
Epoch 81/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 888us/step - loss: 0.5820 - mae:
0.5967 - val_loss: 0.5837 - val_mae: 0.5951
Epoch 82/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.5530 - mae:
0.5826 - val_loss: 0.6018 - val_mae: 0.5985
Epoch 83/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 674us/step - loss: 0.6151 - mae:
0.6158 - val_loss: 0.5956 - val_mae: 0.5960
Epoch 84/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 662us/step - loss: 0.5662 - mae:
0.5928 - val_loss: 0.5814 - val_mae: 0.5911
Epoch 85/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 670us/step - loss: 0.5676 - mae:
0.5880 - val_loss: 0.6348 - val_mae: 0.6209
Epoch 86/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 667us/step - loss: 0.5683 - mae:
0.5878 - val_loss: 0.6955 - val_mae: 0.6577
Epoch 87/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 716us/step - loss: 0.6165 - mae:
0.6040 - val_loss: 0.5708 - val_mae: 0.5850
Epoch 88/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 690us/step - loss: 0.5594 - mae:
0.5853 - val_loss: 0.5786 - val_mae: 0.5869
Epoch 89/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 646us/step - loss: 0.5384 - mae:
0.5751 - val_loss: 0.6137 - val_mae: 0.6087
Epoch 90/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 690us/step - loss: 0.5697 - mae:
0.5893 - val_loss: 0.5829 - val_mae: 0.5922
Epoch 91/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 683us/step - loss: 0.5412 - mae:
0.5788 - val_loss: 0.5707 - val_mae: 0.5865
Epoch 92/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 674us/step - loss: 0.5400 - mae:
0.5806 - val_loss: 0.5989 - val_mae: 0.5963
Epoch 93/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 737us/step - loss: 0.5370 - mae:
```

```
0.5780 - val_loss: 0.6160 - val_mae: 0.6126
Epoch 94/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 735us/step - loss: 0.5619 - mae:
0.5846 - val_loss: 0.7307 - val_mae: 0.6813
Epoch 95/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 638us/step - loss: 0.5521 - mae:
0.5831 - val_loss: 0.5754 - val_mae: 0.5878
Epoch 96/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 706us/step - loss: 0.5304 - mae:
0.5721 - val_loss: 0.5689 - val_mae: 0.5833
Epoch 97/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 744us/step - loss: 0.5194 - mae:
0.5633 - val_loss: 0.6094 - val_mae: 0.6085
Epoch 98/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 882us/step - loss: 0.5718 - mae:
0.5905 - val_loss: 0.5821 - val_mae: 0.5892
Epoch 99/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 701us/step - loss: 0.5580 - mae:
0.5868 - val_loss: 0.5836 - val_mae: 0.5902
Epoch 100/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 776us/step - loss: 0.5423 - mae:
0.5796 - val_loss: 0.5721 - val_mae: 0.5859

<keras.src.callbacks.history.History at 0x178deff90>
```

In this code block I am now fitting my model to the data and it gives me back the results for each of the specified metrics that I gave it beforehand.

```
loss, mae = model.evaluate(X_test, y_test)
print(f"Model MAE: {mae:.4f}")

31/31 ━━━━━━━━━━━━━━━━━━━━ 0s 748us/step - loss: 0.5459 - mae: 0.5856
Model MAE: 0.5759
```

ChatGPT gave me this block just to check the overall MAE for the model which is at 0.57, this means that on average it is 0.57 away from the actual rating which on a scale of 1 to 10 is quite a good rating but I'd like to see if I can improve it.

My first step that I'm going to take to see if it improves it is using Standard Scaling, this is because features in this dataset are scaled differently and the mdel might be able to predict better if they are all scaled similarly.

```
scaler = StandardScaler()
X = white_df.drop('quality', axis=1)
y = white_df['quality']

X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
```

```
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
```

Here I am scaling the x training and test values to see if this will help with the accuracy rating of my model.

```
model = keras.Sequential([
    keras.layers.Input(shape=(X_train.shape[1],)),
    keras.layers.Dense(64, activation='relu'),
    keras.layers.Dense(32, activation='relu'),
    keras.layers.Dense(1, activation='linear')
])

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

model.fit(X_train, y_train, epochs=100, batch_size=16,
validation_split=0.2)
```

```
Epoch 1/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 1s 949us/step - loss: 15.4253 - mae:
3.3969 - val_loss: 2.2578 - val_mae: 1.1803
Epoch 2/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 675us/step - loss: 2.1597 - mae:
1.1228 - val_loss: 1.4029 - val_mae: 0.9099
Epoch 3/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 706us/step - loss: 1.2295 - mae:
0.8644 - val_loss: 0.9535 - val_mae: 0.7487
Epoch 4/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 643us/step - loss: 0.8830 - mae:
0.7260 - val_loss: 0.7221 - val_mae: 0.6483
Epoch 5/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 653us/step - loss: 0.6984 - mae:
0.6483 - val_loss: 0.6225 - val_mae: 0.6028
Epoch 6/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 634us/step - loss: 0.5895 - mae:
0.5950 - val_loss: 0.5848 - val_mae: 0.5956
Epoch 7/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 638us/step - loss: 0.5323 - mae:
0.5649 - val_loss: 0.5554 - val_mae: 0.5763
Epoch 8/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 631us/step - loss: 0.5006 - mae:
0.5538 - val_loss: 0.5651 - val_mae: 0.5759
Epoch 9/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 627us/step - loss: 0.4876 - mae:
0.5511 - val_loss: 0.5439 - val_mae: 0.5647
Epoch 10/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 631us/step - loss: 0.5072 - mae:
0.5593 - val_loss: 0.5762 - val_mae: 0.5821
Epoch 11/100
```

```
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 634us/step - loss: 0.4770 - mae:
0.5397 - val_loss: 0.5264 - val_mae: 0.5555
Epoch 12/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 627us/step - loss: 0.4430 - mae:
0.5260 - val_loss: 0.5328 - val_mae: 0.5600
Epoch 13/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 633us/step - loss: 0.4723 - mae:
0.5413 - val_loss: 0.5711 - val_mae: 0.5826
Epoch 14/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 638us/step - loss: 0.4593 - mae:
0.5375 - val_loss: 0.5640 - val_mae: 0.5782
Epoch 15/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 632us/step - loss: 0.4902 - mae:
0.5480 - val_loss: 0.5203 - val_mae: 0.5482
Epoch 16/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 656us/step - loss: 0.4455 - mae:
0.5237 - val_loss: 0.5052 - val_mae: 0.5413
Epoch 17/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 690us/step - loss: 0.4701 - mae:
0.5283 - val_loss: 0.5172 - val_mae: 0.5495
Epoch 18/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 700us/step - loss: 0.4741 - mae:
0.5426 - val_loss: 0.5259 - val_mae: 0.5554
Epoch 19/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 635us/step - loss: 0.4350 - mae:
0.5151 - val_loss: 0.5242 - val_mae: 0.5547
Epoch 20/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 645us/step - loss: 0.4494 - mae:
0.5274 - val_loss: 0.5155 - val_mae: 0.5490
Epoch 21/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 656us/step - loss: 0.4658 - mae:
0.5281 - val_loss: 0.5110 - val_mae: 0.5439
Epoch 22/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 645us/step - loss: 0.4141 - mae:
0.5037 - val_loss: 0.5384 - val_mae: 0.5626
Epoch 23/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 676us/step - loss: 0.4257 - mae:
0.5068 - val_loss: 0.5176 - val_mae: 0.5458
Epoch 24/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 686us/step - loss: 0.4353 - mae:
0.5165 - val_loss: 0.5113 - val_mae: 0.5455
Epoch 25/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 683us/step - loss: 0.4385 - mae:
0.5054 - val_loss: 0.5148 - val_mae: 0.5460
Epoch 26/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 650us/step - loss: 0.4045 - mae:
0.4945 - val_loss: 0.5218 - val_mae: 0.5575
Epoch 27/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 635us/step - loss: 0.4109 - mae:
```

```
0.5014 - val_loss: 0.5377 - val_mae: 0.5637
Epoch 28/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 695us/step - loss: 0.4391 - mae:
0.5237 - val_loss: 0.5364 - val_mae: 0.5598
Epoch 29/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 707us/step - loss: 0.4077 - mae:
0.5009 - val_loss: 0.5200 - val_mae: 0.5492
Epoch 30/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 675us/step - loss: 0.4062 - mae:
0.5031 - val_loss: 0.5272 - val_mae: 0.5526
Epoch 31/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 697us/step - loss: 0.3993 - mae:
0.4962 - val_loss: 0.5191 - val_mae: 0.5505
Epoch 32/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 977us/step - loss: 0.4147 - mae:
0.5020 - val_loss: 0.5086 - val_mae: 0.5482
Epoch 33/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 660us/step - loss: 0.4094 - mae:
0.4985 - val_loss: 0.5523 - val_mae: 0.5745
Epoch 34/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 643us/step - loss: 0.4301 - mae:
0.5093 - val_loss: 0.5192 - val_mae: 0.5523
Epoch 35/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 647us/step - loss: 0.3858 - mae:
0.4850 - val_loss: 0.5295 - val_mae: 0.5577
Epoch 36/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 666us/step - loss: 0.4195 - mae:
0.5085 - val_loss: 0.5099 - val_mae: 0.5415
Epoch 37/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 674us/step - loss: 0.4127 - mae:
0.4962 - val_loss: 0.5366 - val_mae: 0.5618
Epoch 38/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 652us/step - loss: 0.3817 - mae:
0.4829 - val_loss: 0.5338 - val_mae: 0.5634
Epoch 39/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 673us/step - loss: 0.4083 - mae:
0.4968 - val_loss: 0.5207 - val_mae: 0.5527
Epoch 40/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 669us/step - loss: 0.3867 - mae:
0.4861 - val_loss: 0.5305 - val_mae: 0.5510
Epoch 41/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 648us/step - loss: 0.3704 - mae:
0.4727 - val_loss: 0.5259 - val_mae: 0.5574
Epoch 42/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 640us/step - loss: 0.3756 - mae:
0.4839 - val_loss: 0.5421 - val_mae: 0.5661
Epoch 43/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 631us/step - loss: 0.3805 - mae:
0.4810 - val_loss: 0.5173 - val_mae: 0.5459
```

```
Epoch 44/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 632us/step - loss: 0.3858 - mae:
0.4864 - val_loss: 0.5325 - val_mae: 0.5591
Epoch 45/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 626us/step - loss: 0.3700 - mae:
0.4716 - val_loss: 0.5397 - val_mae: 0.5644
Epoch 46/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 632us/step - loss: 0.3547 - mae:
0.4715 - val_loss: 0.5236 - val_mae: 0.5567
Epoch 47/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 628us/step - loss: 0.3856 - mae:
0.4886 - val_loss: 0.5135 - val_mae: 0.5472
Epoch 48/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 707us/step - loss: 0.3551 - mae:
0.4678 - val_loss: 0.5162 - val_mae: 0.5507
Epoch 49/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 639us/step - loss: 0.3572 - mae:
0.4684 - val_loss: 0.5663 - val_mae: 0.5756
Epoch 50/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 660us/step - loss: 0.3697 - mae:
0.4746 - val_loss: 0.5322 - val_mae: 0.5601
Epoch 51/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 663us/step - loss: 0.3470 - mae:
0.4617 - val_loss: 0.5285 - val_mae: 0.5563
Epoch 52/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 663us/step - loss: 0.3656 - mae:
0.4665 - val_loss: 0.5564 - val_mae: 0.5703
Epoch 53/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 647us/step - loss: 0.3484 - mae:
0.4640 - val_loss: 0.5329 - val_mae: 0.5603
Epoch 54/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 640us/step - loss: 0.3756 - mae:
0.4845 - val_loss: 0.5344 - val_mae: 0.5579
Epoch 55/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 648us/step - loss: 0.3490 - mae:
0.4643 - val_loss: 0.5347 - val_mae: 0.5614
Epoch 56/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 636us/step - loss: 0.3350 - mae:
0.4558 - val_loss: 0.5474 - val_mae: 0.5687
Epoch 57/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 632us/step - loss: 0.3555 - mae:
0.4668 - val_loss: 0.5274 - val_mae: 0.5547
Epoch 58/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 651us/step - loss: 0.3423 - mae:
0.4521 - val_loss: 0.5476 - val_mae: 0.5691
Epoch 59/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 635us/step - loss: 0.3529 - mae:
0.4602 - val_loss: 0.5289 - val_mae: 0.5573
Epoch 60/100
```

```
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 640us/step - loss: 0.3440 - mae:
0.4554 - val_loss: 0.5252 - val_mae: 0.5546
Epoch 61/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 632us/step - loss: 0.3234 - mae:
0.4496 - val_loss: 0.5553 - val_mae: 0.5679
Epoch 62/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 629us/step - loss: 0.3522 - mae:
0.4654 - val_loss: 0.5509 - val_mae: 0.5771
Epoch 63/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 667us/step - loss: 0.3489 - mae:
0.4581 - val_loss: 0.5363 - val_mae: 0.5637
Epoch 64/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 699us/step - loss: 0.3324 - mae:
0.4485 - val_loss: 0.5455 - val_mae: 0.5669
Epoch 65/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 751us/step - loss: 0.3466 - mae:
0.4638 - val_loss: 0.5372 - val_mae: 0.5615
Epoch 66/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 792us/step - loss: 0.3566 - mae:
0.4652 - val_loss: 0.5352 - val_mae: 0.5619
Epoch 67/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 650us/step - loss: 0.3255 - mae:
0.4472 - val_loss: 0.5551 - val_mae: 0.5632
Epoch 68/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 696us/step - loss: 0.3512 - mae:
0.4611 - val_loss: 0.5603 - val_mae: 0.5728
Epoch 69/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 718us/step - loss: 0.3486 - mae:
0.4641 - val_loss: 0.5215 - val_mae: 0.5501
Epoch 70/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 709us/step - loss: 0.3180 - mae:
0.4429 - val_loss: 0.5297 - val_mae: 0.5580
Epoch 71/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 934us/step - loss: 0.3393 - mae:
0.4561 - val_loss: 0.5421 - val_mae: 0.5633
Epoch 72/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 687us/step - loss: 0.3255 - mae:
0.4457 - val_loss: 0.5216 - val_mae: 0.5494
Epoch 73/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 682us/step - loss: 0.3216 - mae:
0.4438 - val_loss: 0.5433 - val_mae: 0.5655
Epoch 74/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 686us/step - loss: 0.3295 - mae:
0.4476 - val_loss: 0.5428 - val_mae: 0.5609
Epoch 75/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 864us/step - loss: 0.3455 - mae:
0.4585 - val_loss: 0.5801 - val_mae: 0.5847
Epoch 76/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 721us/step - loss: 0.3342 - mae:
```

```
0.4492 - val_loss: 0.5294 - val_mae: 0.5550
Epoch 77/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 666us/step - loss: 0.3209 - mae:
0.4452 - val_loss: 0.5825 - val_mae: 0.5854
Epoch 78/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 671us/step - loss: 0.3223 - mae:
0.4445 - val_loss: 0.5524 - val_mae: 0.5686
Epoch 79/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 665us/step - loss: 0.3112 - mae:
0.4350 - val_loss: 0.5344 - val_mae: 0.5578
Epoch 80/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 688us/step - loss: 0.3159 - mae:
0.4373 - val_loss: 0.5326 - val_mae: 0.5560
Epoch 81/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 716us/step - loss: 0.3185 - mae:
0.4432 - val_loss: 0.5481 - val_mae: 0.5672
Epoch 82/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 694us/step - loss: 0.3251 - mae:
0.4458 - val_loss: 0.5719 - val_mae: 0.5815
Epoch 83/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 692us/step - loss: 0.3169 - mae:
0.4395 - val_loss: 0.5431 - val_mae: 0.5644
Epoch 84/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 669us/step - loss: 0.3116 - mae:
0.4345 - val_loss: 0.5460 - val_mae: 0.5674
Epoch 85/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 686us/step - loss: 0.3031 - mae:
0.4335 - val_loss: 0.5384 - val_mae: 0.5609
Epoch 86/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 698us/step - loss: 0.2955 - mae:
0.4227 - val_loss: 0.5375 - val_mae: 0.5588
Epoch 87/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 956us/step - loss: 0.2949 - mae:
0.4237 - val_loss: 0.6170 - val_mae: 0.5972
Epoch 88/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 673us/step - loss: 0.3008 - mae:
0.4332 - val_loss: 0.5399 - val_mae: 0.5617
Epoch 89/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 669us/step - loss: 0.2937 - mae:
0.4270 - val_loss: 0.5457 - val_mae: 0.5653
Epoch 90/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.2929 - mae:
0.4208 - val_loss: 0.5360 - val_mae: 0.5580
Epoch 91/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 664us/step - loss: 0.2792 - mae:
0.4151 - val_loss: 0.5745 - val_mae: 0.5739
Epoch 92/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 731us/step - loss: 0.3052 - mae:
0.4322 - val_loss: 0.5424 - val_mae: 0.5597
```

```
Epoch 93/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 858us/step - loss: 0.2905 - mae: 
0.4177 - val_loss: 0.5322 - val_mae: 0.5577
Epoch 94/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 759us/step - loss: 0.2951 - mae: 
0.4256 - val_loss: 0.5569 - val_mae: 0.5736
Epoch 95/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 664us/step - loss: 0.2826 - mae: 
0.4111 - val_loss: 0.5893 - val_mae: 0.5937
Epoch 96/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 762us/step - loss: 0.3061 - mae: 
0.4330 - val_loss: 0.5457 - val_mae: 0.5606
Epoch 97/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 869us/step - loss: 0.2853 - mae: 
0.4173 - val_loss: 0.5523 - val_mae: 0.5683
Epoch 98/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 690us/step - loss: 0.2772 - mae: 
0.4109 - val_loss: 0.5519 - val_mae: 0.5701
Epoch 99/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 694us/step - loss: 0.2976 - mae: 
0.4267 - val_loss: 0.5499 - val_mae: 0.5616
Epoch 100/100
196/196 ━━━━━━━━━━━━━━━━━━━━ 0s 644us/step - loss: 0.2686 - mae: 
0.4084 - val_loss: 0.5489 - val_mae: 0.5643

<keras.src.callbacks.history.History at 0x178de6410>

loss, mae = model.evaluate(X_test, y_test)
print(f"Model MAE: {mae:.4f}")

31/31 ━━━━━━━━━━━━━━━━━━━━ 0s 722us/step - loss: 0.5539 - mae: 0.5711
Model MAE: 0.5584
```

I also ended up trying a few different epoch amounts and I seemed to have the best results whilst using 100 epochs.

As can be seen here this dropped the MAE score from .57 to .55 which is encouraging to see as it was still fitting well beforehand.

I am now going to try this on the red wine dataset.

```
scaler = StandardScaler()
X = red_df.drop('quality', axis=1)
y = red_df['quality']

X_train, X_test, y_train, y_test = train_test_split(X, y, 
test_size=0.2, random_state=42)
```

```
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

model = keras.Sequential([
    keras.layers.Input(shape=(X_train.shape[1],)),
    keras.layers.Dense(64, activation='relu'),
    keras.layers.Dense(32, activation='relu'),
    keras.layers.Dense(1, activation='linear')
])

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

model.fit(X_train, y_train, epochs=100, batch_size=16,
validation_split=0.2)
```

```
Epoch 1/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 27.6665 - mae: 5.0815 -
val_loss: 4.7705 - val_mae: 1.9128
Epoch 2/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 3.0794 - mae: 1.4374 -
val_loss: 2.0831 - val_mae: 1.1222
Epoch 3/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 2.1349 - mae: 1.1196 -
val_loss: 1.7931 - val_mae: 1.0498
Epoch 4/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 969us/step - loss: 1.7248 - mae: 1.0241
- val_loss: 1.6002 - val_mae: 0.9924
Epoch 5/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 1.4155 - mae: 0.9429 -
val_loss: 1.4399 - val_mae: 0.9326
Epoch 6/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 1.2647 - mae: 0.8827 -
val_loss: 1.2695 - val_mae: 0.8813
Epoch 7/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 984us/step - loss: 1.0398 - mae: 0.8043
- val_loss: 1.1428 - val_mae: 0.8269
Epoch 8/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 994us/step - loss: 1.0090 - mae: 0.7943
- val_loss: 1.0298 - val_mae: 0.7878
Epoch 9/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.8240 - mae: 0.7210 -
val_loss: 0.9358 - val_mae: 0.7460
Epoch 10/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 993us/step - loss: 0.8480 - mae: 0.7299
- val_loss: 0.8707 - val_mae: 0.7347
Epoch 11/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 972us/step - loss: 0.7314 - mae: 0.6666
- val_loss: 0.7584 - val_mae: 0.6693
Epoch 12/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 991us/step - loss: 0.6894 - mae: 0.6501
```

```
- val_loss: 0.7365 - val_mae: 0.6685
Epoch 13/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 979us/step - loss: 0.6197 - mae: 0.6132
- val_loss: 0.6522 - val_mae: 0.6162
Epoch 14/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 987us/step - loss: 0.5580 - mae: 0.5820
- val_loss: 0.6195 - val_mae: 0.6041
Epoch 15/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 997us/step - loss: 0.5284 - mae: 0.5706
- val_loss: 0.5843 - val_mae: 0.5929
Epoch 16/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 988us/step - loss: 0.4944 - mae: 0.5510
- val_loss: 0.5541 - val_mae: 0.5831
Epoch 17/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 989us/step - loss: 0.5229 - mae: 0.5744
- val_loss: 0.5146 - val_mae: 0.5398
Epoch 18/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 991us/step - loss: 0.4684 - mae: 0.5335
- val_loss: 0.4888 - val_mae: 0.5288
Epoch 19/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.4780 - mae: 0.5398 -
val_loss: 0.4682 - val_mae: 0.5326
Epoch 20/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 934us/step - loss: 0.4329 - mae: 0.5156
- val_loss: 0.4541 - val_mae: 0.5171
Epoch 21/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 996us/step - loss: 0.4067 - mae: 0.4997
- val_loss: 0.4530 - val_mae: 0.5150
Epoch 22/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 931us/step - loss: 0.3962 - mae: 0.4862
- val_loss: 0.4519 - val_mae: 0.5211
Epoch 23/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 922us/step - loss: 0.4010 - mae: 0.5022
- val_loss: 0.4436 - val_mae: 0.5155
Epoch 24/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.4566 - mae: 0.5309 -
val_loss: 0.4224 - val_mae: 0.5024
Epoch 25/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 987us/step - loss: 0.3867 - mae: 0.4874
- val_loss: 0.4424 - val_mae: 0.5237
Epoch 26/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.3965 - mae: 0.5013 -
val_loss: 0.4291 - val_mae: 0.5069
Epoch 27/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 996us/step - loss: 0.3855 - mae: 0.4858
- val_loss: 0.4081 - val_mae: 0.5011
Epoch 28/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 991us/step - loss: 0.3651 - mae: 0.4771
- val_loss: 0.4062 - val_mae: 0.4908
```

```
Epoch 29/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 983us/step - loss: 0.3844 - mae: 0.4867
- val_loss: 0.3971 - val_mae: 0.4940
Epoch 30/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 935us/step - loss: 0.3473 - mae: 0.4588
- val_loss: 0.4176 - val_mae: 0.4975
Epoch 31/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.3816 - mae: 0.4913 -
val_loss: 0.3924 - val_mae: 0.4851
Epoch 32/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 986us/step - loss: 0.3716 - mae: 0.4751
- val_loss: 0.3816 - val_mae: 0.4755
Epoch 33/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 914us/step - loss: 0.3529 - mae: 0.4530
- val_loss: 0.4030 - val_mae: 0.4845
Epoch 34/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 932us/step - loss: 0.3979 - mae: 0.4901
- val_loss: 0.3849 - val_mae: 0.4746
Epoch 35/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 919us/step - loss: 0.3412 - mae: 0.4570
- val_loss: 0.3791 - val_mae: 0.4746
Epoch 36/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 984us/step - loss: 0.3489 - mae: 0.4552
- val_loss: 0.3650 - val_mae: 0.4674
Epoch 37/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 980us/step - loss: 0.3221 - mae: 0.4388
- val_loss: 0.3874 - val_mae: 0.4806
Epoch 38/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 927us/step - loss: 0.3445 - mae: 0.4512
- val_loss: 0.3631 - val_mae: 0.4606
Epoch 39/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 989us/step - loss: 0.3705 - mae: 0.4682
- val_loss: 0.3924 - val_mae: 0.4771
Epoch 40/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 979us/step - loss: 0.3148 - mae: 0.4354
- val_loss: 0.3791 - val_mae: 0.4752
Epoch 41/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.3369 - mae: 0.4465 -
val_loss: 0.3909 - val_mae: 0.4853
Epoch 42/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.3248 - mae: 0.4501 -
val_loss: 0.3972 - val_mae: 0.4908
Epoch 43/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 992us/step - loss: 0.3379 - mae: 0.4516
- val_loss: 0.3739 - val_mae: 0.4636
Epoch 44/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 983us/step - loss: 0.3036 - mae: 0.4233
- val_loss: 0.3734 - val_mae: 0.4687
Epoch 45/100
```

```
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 995us/step - loss: 0.3117 - mae: 0.4375
- val_loss: 0.3928 - val_mae: 0.4876
Epoch 46/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 918us/step - loss: 0.3277 - mae: 0.4468
- val_loss: 0.3882 - val_mae: 0.4758
Epoch 47/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 0.3147 - mae: 0.4366 -
val_loss: 0.3898 - val_mae: 0.4759
Epoch 48/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 984us/step - loss: 0.2997 - mae: 0.4225
- val_loss: 0.4157 - val_mae: 0.4970
Epoch 49/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 925us/step - loss: 0.3050 - mae: 0.4350
- val_loss: 0.3627 - val_mae: 0.4622
Epoch 50/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 939us/step - loss: 0.3240 - mae: 0.4380
- val_loss: 0.4057 - val_mae: 0.4843
Epoch 51/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 989us/step - loss: 0.3008 - mae: 0.4193
- val_loss: 0.3632 - val_mae: 0.4712
Epoch 52/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 995us/step - loss: 0.2943 - mae: 0.4220
- val_loss: 0.4489 - val_mae: 0.5154
Epoch 53/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 985us/step - loss: 0.3250 - mae: 0.4395
- val_loss: 0.3870 - val_mae: 0.4801
Epoch 54/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 988us/step - loss: 0.2833 - mae: 0.4170
- val_loss: 0.3836 - val_mae: 0.4768
Epoch 55/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 960us/step - loss: 0.3187 - mae: 0.4368
- val_loss: 0.3902 - val_mae: 0.4883
Epoch 56/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 992us/step - loss: 0.3238 - mae: 0.4399
- val_loss: 0.3731 - val_mae: 0.4641
Epoch 57/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2694 - mae: 0.4043 -
val_loss: 0.3605 - val_mae: 0.4500
Epoch 58/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2582 - mae: 0.3923 -
val_loss: 0.3610 - val_mae: 0.4571
Epoch 59/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2672 - mae: 0.4035 -
val_loss: 0.3858 - val_mae: 0.4755
Epoch 60/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2943 - mae: 0.4196 -
val_loss: 0.3663 - val_mae: 0.4546
Epoch 61/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.3024 - mae: 0.4222 -
```

```
val_loss: 0.3650 - val_mae: 0.4599
Epoch 62/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2474 - mae: 0.3899 -
val_loss: 0.3659 - val_mae: 0.4544
Epoch 63/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 997us/step - loss: 0.2745 - mae: 0.4076
- val_loss: 0.3543 - val_mae: 0.4515
Epoch 64/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2952 - mae: 0.4198 -
val_loss: 0.3775 - val_mae: 0.4714
Epoch 65/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2786 - mae: 0.4060 -
val_loss: 0.3914 - val_mae: 0.4862
Epoch 66/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2663 - mae: 0.3966 -
val_loss: 0.3668 - val_mae: 0.4578
Epoch 67/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2717 - mae: 0.3911 -
val_loss: 0.3771 - val_mae: 0.4643
Epoch 68/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2548 - mae: 0.3878 -
val_loss: 0.3711 - val_mae: 0.4611
Epoch 69/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2663 - mae: 0.3947 -
val_loss: 0.3612 - val_mae: 0.4578
Epoch 70/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2810 - mae: 0.4078 -
val_loss: 0.4048 - val_mae: 0.4826
Epoch 71/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 950us/step - loss: 0.2899 - mae: 0.4181
- val_loss: 0.4525 - val_mae: 0.5155
Epoch 72/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2780 - mae: 0.3990 -
val_loss: 0.4233 - val_mae: 0.4987
Epoch 73/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 948us/step - loss: 0.2621 - mae: 0.3937
- val_loss: 0.3689 - val_mae: 0.4687
Epoch 74/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 932us/step - loss: 0.2464 - mae: 0.3856
- val_loss: 0.4029 - val_mae: 0.4841
Epoch 75/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 990us/step - loss: 0.2763 - mae: 0.4112
- val_loss: 0.3995 - val_mae: 0.4738
Epoch 76/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 931us/step - loss: 0.2574 - mae: 0.3902
- val_loss: 0.3838 - val_mae: 0.4719
Epoch 77/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 979us/step - loss: 0.2652 - mae: 0.3917
- val_loss: 0.4049 - val_mae: 0.4869
```

```
Epoch 78/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 982us/step - loss: 0.2340 - mae: 0.3729
- val_loss: 0.3734 - val_mae: 0.4606
Epoch 79/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 919us/step - loss: 0.2408 - mae: 0.3796
- val_loss: 0.3895 - val_mae: 0.4698
Epoch 80/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 991us/step - loss: 0.2319 - mae: 0.3609
- val_loss: 0.3825 - val_mae: 0.4672
Epoch 81/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 990us/step - loss: 0.2441 - mae: 0.3786
- val_loss: 0.3945 - val_mae: 0.4764
Epoch 82/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 994us/step - loss: 0.2503 - mae: 0.3794
- val_loss: 0.4267 - val_mae: 0.5026
Epoch 83/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 988us/step - loss: 0.2414 - mae: 0.3818
- val_loss: 0.4494 - val_mae: 0.5066
Epoch 84/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 963us/step - loss: 0.2613 - mae: 0.3986
- val_loss: 0.3870 - val_mae: 0.4607
Epoch 85/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 977us/step - loss: 0.2229 - mae: 0.3582
- val_loss: 0.4057 - val_mae: 0.4864
Epoch 86/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2322 - mae: 0.3709 -
val_loss: 0.3940 - val_mae: 0.4708
Epoch 87/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2221 - mae: 0.3614 -
val_loss: 0.3933 - val_mae: 0.4657
Epoch 88/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.2296 - mae: 0.3586 -
val_loss: 0.3871 - val_mae: 0.4696
Epoch 89/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 996us/step - loss: 0.2172 - mae: 0.3607
- val_loss: 0.4095 - val_mae: 0.4847
Epoch 90/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 935us/step - loss: 0.2189 - mae: 0.3585
- val_loss: 0.4341 - val_mae: 0.4872
Epoch 91/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 988us/step - loss: 0.2091 - mae: 0.3510
- val_loss: 0.3861 - val_mae: 0.4631
Epoch 92/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 995us/step - loss: 0.2273 - mae: 0.3653
- val_loss: 0.4007 - val_mae: 0.4823
Epoch 93/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 963us/step - loss: 0.2156 - mae: 0.3646
- val_loss: 0.4272 - val_mae: 0.4979
Epoch 94/100
```

```
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 980us/step - loss: 0.2044 - mae: 0.3464
- val_loss: 0.4197 - val_mae: 0.4910
Epoch 95/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 998us/step - loss: 0.2180 - mae: 0.3585
- val_loss: 0.4065 - val_mae: 0.4744
Epoch 96/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 1000us/step - loss: 0.2059 - mae: 0.3484
- val_loss: 0.4263 - val_mae: 0.4861
Epoch 97/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 977us/step - loss: 0.2012 - mae: 0.3508
- val_loss: 0.4398 - val_mae: 0.5188
Epoch 98/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 932us/step - loss: 0.2423 - mae: 0.3793
- val_loss: 0.4421 - val_mae: 0.4939
Epoch 99/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 978us/step - loss: 0.2166 - mae: 0.3596
- val_loss: 0.4107 - val_mae: 0.4681
Epoch 100/100
64/64 ━━━━━━━━━━━━━━━━━━━━ 0s 929us/step - loss: 0.2160 - mae: 0.3512
- val_loss: 0.4443 - val_mae: 0.5055

<keras.src.callbacks.history.History at 0x17b166210>
```

```
loss, mae = model.evaluate(X_test, y_test)
print(f"Model MAE: {mae:.4f}")
```

```
10/10 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 0.4428 - mae: 0.5176
Model MAE: 0.5184
```

As can be seen by the code block above the red wine is predicting better as it has a MAE rating of 0.51 which is better than the white wine rating, I now want to combine the 2 datasets and see the results of this.

```
combined_df = pd.concat([white_df, red_df])

combined_df.to_csv('winequality-combined.csv', index=False)
```

Here I'm just combining both of the datasets and then saving them to a new csv file.

```
scaler = StandardScaler()
X = combined_df.drop('quality', axis=1)
y = combined_df['quality']

X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)


X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
```

```
model = keras.Sequential([
    keras.layers.Input(shape=(X_train.shape[1],)),
    keras.layers.Dense(64, activation='relu'),
    keras.layers.Dense(32, activation='relu'),
    keras.layers.Dense(1, activation='linear')
])

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

model.fit(X_train, y_train, epochs=100, batch_size=16,
validation_split=0.2)
```

```
Epoch 1/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 1s 864us/step - loss: 13.7221 - mae:
3.0679 - val_loss: 1.5738 - val_mae: 0.9810
Epoch 2/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 661us/step - loss: 1.5737 - mae:
0.9689 - val_loss: 1.1133 - val_mae: 0.8191
Epoch 3/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 653us/step - loss: 1.0925 - mae:
0.7970 - val_loss: 0.8281 - val_mae: 0.7094
Epoch 4/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 634us/step - loss: 0.7683 - mae:
0.6830 - val_loss: 0.6570 - val_mae: 0.6211
Epoch 5/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 631us/step - loss: 0.6175 - mae:
0.6167 - val_loss: 0.5960 - val_mae: 0.5962
Epoch 6/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 630us/step - loss: 0.5330 - mae:
0.5702 - val_loss: 0.5485 - val_mae: 0.5697
Epoch 7/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 626us/step - loss: 0.5323 - mae:
0.5689 - val_loss: 0.5450 - val_mae: 0.5669
Epoch 8/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 630us/step - loss: 0.5275 - mae:
0.5646 - val_loss: 0.5397 - val_mae: 0.5626
Epoch 9/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 634us/step - loss: 0.4803 - mae:
0.5443 - val_loss: 0.7002 - val_mae: 0.6488
Epoch 10/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 637us/step - loss: 0.4754 - mae:
0.5400 - val_loss: 0.5377 - val_mae: 0.5632
Epoch 11/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 627us/step - loss: 0.4853 - mae:
0.5422 - val_loss: 0.5041 - val_mae: 0.5416
Epoch 12/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 651us/step - loss: 0.4745 - mae:
0.5337 - val_loss: 0.5102 - val_mae: 0.5460
Epoch 13/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 622us/step - loss: 0.4549 - mae:
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0.5251 - val_loss: 0.5061 - val_mae: 0.5408
Epoch 14/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 625us/step - loss: 0.4793 - mae:
0.5405 - val_loss: 0.5054 - val_mae: 0.5442
Epoch 15/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 624us/step - loss: 0.4649 - mae:
0.5368 - val_loss: 0.5266 - val_mae: 0.5587
Epoch 16/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 630us/step - loss: 0.4617 - mae:
0.5280 - val_loss: 0.5204 - val_mae: 0.5510
Epoch 17/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 622us/step - loss: 0.4609 - mae:
0.5339 - val_loss: 0.5055 - val_mae: 0.5430
Epoch 18/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 634us/step - loss: 0.4392 - mae:
0.5189 - val_loss: 0.5387 - val_mae: 0.5642
Epoch 19/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 629us/step - loss: 0.4514 - mae:
0.5217 - val_loss: 0.5108 - val_mae: 0.5396
Epoch 20/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 650us/step - loss: 0.4299 - mae:
0.5152 - val_loss: 0.5423 - val_mae: 0.5680
Epoch 21/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 627us/step - loss: 0.4300 - mae:
0.5160 - val_loss: 0.5388 - val_mae: 0.5643
Epoch 22/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 648us/step - loss: 0.4287 - mae:
0.5193 - val_loss: 0.5101 - val_mae: 0.5461
Epoch 23/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 637us/step - loss: 0.4297 - mae:
0.5169 - val_loss: 0.5177 - val_mae: 0.5539
Epoch 24/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 736us/step - loss: 0.4248 - mae:
0.5073 - val_loss: 0.5252 - val_mae: 0.5584
Epoch 25/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 986us/step - loss: 0.4176 - mae:
0.5069 - val_loss: 0.5048 - val_mae: 0.5448
Epoch 26/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 619us/step - loss: 0.4184 - mae:
0.5051 - val_loss: 0.5340 - val_mae: 0.5609
Epoch 27/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 644us/step - loss: 0.4288 - mae:
0.5138 - val_loss: 0.5207 - val_mae: 0.5517
Epoch 28/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 608us/step - loss: 0.4246 - mae:
0.5097 - val_loss: 0.5009 - val_mae: 0.5396
Epoch 29/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 602us/step - loss: 0.4110 - mae:
0.5008 - val_loss: 0.5754 - val_mae: 0.5841
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Epoch 30/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 605us/step - loss: 0.4298 - mae:
0.5133 - val_loss: 0.5297 - val_mae: 0.5543
Epoch 31/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 605us/step - loss: 0.4309 - mae:
0.5107 - val_loss: 0.5119 - val_mae: 0.5486
Epoch 32/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 614us/step - loss: 0.4171 - mae:
0.5055 - val_loss: 0.4930 - val_mae: 0.5359
Epoch 33/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 630us/step - loss: 0.4186 - mae:
0.5088 - val_loss: 0.5006 - val_mae: 0.5421
Epoch 34/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 624us/step - loss: 0.4021 - mae:
0.4970 - val_loss: 0.5262 - val_mae: 0.5606
Epoch 35/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 619us/step - loss: 0.4068 - mae:
0.4983 - val_loss: 0.4976 - val_mae: 0.5362
Epoch 36/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 606us/step - loss: 0.4018 - mae:
0.4966 - val_loss: 0.5246 - val_mae: 0.5578
Epoch 37/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 610us/step - loss: 0.4117 - mae:
0.5009 - val_loss: 0.4906 - val_mae: 0.5286
Epoch 38/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 599us/step - loss: 0.3941 - mae:
0.4914 - val_loss: 0.5229 - val_mae: 0.5497
Epoch 39/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 598us/step - loss: 0.3905 - mae:
0.4899 - val_loss: 0.5045 - val_mae: 0.5463
Epoch 40/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 592us/step - loss: 0.3937 - mae:
0.4965 - val_loss: 0.5133 - val_mae: 0.5468
Epoch 41/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 600us/step - loss: 0.4088 - mae:
0.5011 - val_loss: 0.5242 - val_mae: 0.5585
Epoch 42/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 614us/step - loss: 0.3815 - mae:
0.4804 - val_loss: 0.5354 - val_mae: 0.5613
Epoch 43/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 597us/step - loss: 0.3991 - mae:
0.4947 - val_loss: 0.5380 - val_mae: 0.5678
Epoch 44/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 621us/step - loss: 0.3905 - mae:
0.4908 - val_loss: 0.5334 - val_mae: 0.5599
Epoch 45/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 630us/step - loss: 0.3969 - mae:
0.4878 - val_loss: 0.5068 - val_mae: 0.5404
Epoch 46/100
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260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 610us/step - loss: 0.3908 - mae:
0.4899 - val_loss: 0.5315 - val_mae: 0.5604
Epoch 47/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 813us/step - loss: 0.3969 - mae:
0.4929 - val_loss: 0.5003 - val_mae: 0.5399
Epoch 48/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 603us/step - loss: 0.3825 - mae:
0.4859 - val_loss: 0.5013 - val_mae: 0.5404
Epoch 49/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 600us/step - loss: 0.3820 - mae:
0.4825 - val_loss: 0.5157 - val_mae: 0.5493
Epoch 50/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 593us/step - loss: 0.3805 - mae:
0.4821 - val_loss: 0.4987 - val_mae: 0.5438
Epoch 51/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 600us/step - loss: 0.3843 - mae:
0.4800 - val_loss: 0.4859 - val_mae: 0.5335
Epoch 52/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 595us/step - loss: 0.3773 - mae:
0.4754 - val_loss: 0.5411 - val_mae: 0.5600
Epoch 53/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 642us/step - loss: 0.3710 - mae:
0.4725 - val_loss: 0.5063 - val_mae: 0.5420
Epoch 54/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 607us/step - loss: 0.3743 - mae:
0.4801 - val_loss: 0.5546 - val_mae: 0.5650
Epoch 55/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 612us/step - loss: 0.3757 - mae:
0.4834 - val_loss: 0.4967 - val_mae: 0.5369
Epoch 56/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 622us/step - loss: 0.3763 - mae:
0.4836 - val_loss: 0.4981 - val_mae: 0.5403
Epoch 57/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 626us/step - loss: 0.3575 - mae:
0.4670 - val_loss: 0.5047 - val_mae: 0.5394
Epoch 58/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 681us/step - loss: 0.3569 - mae:
0.4689 - val_loss: 0.5015 - val_mae: 0.5445
Epoch 59/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 594us/step - loss: 0.3661 - mae:
0.4770 - val_loss: 0.5591 - val_mae: 0.5761
Epoch 60/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 597us/step - loss: 0.3778 - mae:
0.4823 - val_loss: 0.5104 - val_mae: 0.5495
Epoch 61/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 599us/step - loss: 0.3644 - mae:
0.4675 - val_loss: 0.5217 - val_mae: 0.5444
Epoch 62/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 593us/step - loss: 0.3778 - mae:
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0.4814 - val_loss: 0.5155 - val_mae: 0.5554
Epoch 63/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 631us/step - loss: 0.3671 - mae:
0.4772 - val_loss: 0.5037 - val_mae: 0.5425
Epoch 64/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 777us/step - loss: 0.3606 - mae:
0.4647 - val_loss: 0.5074 - val_mae: 0.5442
Epoch 65/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 620us/step - loss: 0.3625 - mae:
0.4713 - val_loss: 0.5002 - val_mae: 0.5409
Epoch 66/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 625us/step - loss: 0.3554 - mae:
0.4658 - val_loss: 0.5255 - val_mae: 0.5476
Epoch 67/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 595us/step - loss: 0.3628 - mae:
0.4741 - val_loss: 0.5034 - val_mae: 0.5456
Epoch 68/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 602us/step - loss: 0.3612 - mae:
0.4715 - val_loss: 0.5156 - val_mae: 0.5452
Epoch 69/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 594us/step - loss: 0.3597 - mae:
0.4652 - val_loss: 0.5291 - val_mae: 0.5615
Epoch 70/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 590us/step - loss: 0.3557 - mae:
0.4679 - val_loss: 0.5478 - val_mae: 0.5622
Epoch 71/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 593us/step - loss: 0.3383 - mae:
0.4550 - val_loss: 0.5194 - val_mae: 0.5577
Epoch 72/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 636us/step - loss: 0.3545 - mae:
0.4681 - val_loss: 0.5354 - val_mae: 0.5644
Epoch 73/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 623us/step - loss: 0.3648 - mae:
0.4687 - val_loss: 0.5034 - val_mae: 0.5394
Epoch 74/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 600us/step - loss: 0.3357 - mae:
0.4538 - val_loss: 0.5178 - val_mae: 0.5507
Epoch 75/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 832us/step - loss: 0.3535 - mae:
0.4593 - val_loss: 0.5240 - val_mae: 0.5591
Epoch 76/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 608us/step - loss: 0.3488 - mae:
0.4567 - val_loss: 0.5172 - val_mae: 0.5535
Epoch 77/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 601us/step - loss: 0.3399 - mae:
0.4538 - val_loss: 0.5095 - val_mae: 0.5494
Epoch 78/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 605us/step - loss: 0.3389 - mae:
0.4548 - val_loss: 0.4944 - val_mae: 0.5302
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Epoch 79/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 668us/step - loss: 0.3497 - mae:
0.4614 - val_loss: 0.5429 - val_mae: 0.5617
Epoch 80/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 689us/step - loss: 0.3632 - mae:
0.4733 - val_loss: 0.5116 - val_mae: 0.5439
Epoch 81/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 747us/step - loss: 0.3463 - mae:
0.4527 - val_loss: 0.5056 - val_mae: 0.5429
Epoch 82/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 655us/step - loss: 0.3698 - mae:
0.4660 - val_loss: 0.5280 - val_mae: 0.5564
Epoch 83/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 691us/step - loss: 0.3431 - mae:
0.4557 - val_loss: 0.5490 - val_mae: 0.5741
Epoch 84/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 610us/step - loss: 0.3544 - mae:
0.4658 - val_loss: 0.5376 - val_mae: 0.5618
Epoch 85/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 606us/step - loss: 0.3508 - mae:
0.4614 - val_loss: 0.5127 - val_mae: 0.5430
Epoch 86/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 890us/step - loss: 0.3335 - mae:
0.4477 - val_loss: 0.5315 - val_mae: 0.5642
Epoch 87/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 629us/step - loss: 0.3301 - mae:
0.4475 - val_loss: 0.5080 - val_mae: 0.5460
Epoch 88/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 610us/step - loss: 0.3166 - mae:
0.4425 - val_loss: 0.5078 - val_mae: 0.5460
Epoch 89/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 672us/step - loss: 0.3383 - mae:
0.4533 - val_loss: 0.5136 - val_mae: 0.5488
Epoch 90/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 670us/step - loss: 0.3456 - mae:
0.4606 - val_loss: 0.5277 - val_mae: 0.5511
Epoch 91/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 611us/step - loss: 0.3388 - mae:
0.4516 - val_loss: 0.5104 - val_mae: 0.5459
Epoch 92/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 595us/step - loss: 0.3272 - mae:
0.4508 - val_loss: 0.5050 - val_mae: 0.5447
Epoch 93/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 603us/step - loss: 0.3357 - mae:
0.4495 - val_loss: 0.5482 - val_mae: 0.5715
Epoch 94/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 659us/step - loss: 0.3320 - mae:
0.4474 - val_loss: 0.5197 - val_mae: 0.5484
Epoch 95/100
```

```
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 618us/step - loss: 0.3286 - mae:
0.4469 - val_loss: 0.5118 - val_mae: 0.5449
Epoch 96/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 641us/step - loss: 0.3313 - mae:
0.4506 - val_loss: 0.5401 - val_mae: 0.5663
Epoch 97/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 679us/step - loss: 0.3378 - mae:
0.4542 - val_loss: 0.5109 - val_mae: 0.5477
Epoch 98/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 855us/step - loss: 0.3320 - mae:
0.4455 - val_loss: 0.5107 - val_mae: 0.5420
Epoch 99/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 654us/step - loss: 0.3457 - mae:
0.4564 - val_loss: 0.5051 - val_mae: 0.5413
Epoch 100/100
260/260 ━━━━━━━━━━━━━━━━━━━━ 0s 652us/step - loss: 0.3355 - mae:
0.4512 - val_loss: 0.5129 - val_mae: 0.5445

<keras.src.callbacks.history.History at 0x178dd63d0>
```

```python
loss, mae = model.evaluate(X_test, y_test)
print(f"Model MAE: {mae:.4f}")
```

```
41/41 ━━━━━━━━━━━━━━━━━━━━ 0s 731us/step - loss: 0.4374 - mae: 0.5128
Model MAE: 0.5122
```

The combined dataset is also performing well similarly to the red wine as it is sitting at 0.51 on the MAE score.