

C1W1_Assignment

January 3, 2021

1 Week 1: Multiple Output Models using the Keras Functional API

Welcome to the first programming assignment of the course! Your task will be to use the Keras functional API to train a model to predict two outputs. For this lab, you will use the [Wine Quality Dataset](#) from the [UCI machine learning repository](#). It has separate datasets for red wine and white wine.

Normally, the wines are classified into one of the quality ratings specified in the attributes. In this exercise, you will combine the two datasets to predict the wine quality and whether the wine is red or white solely from the attributes.

You will model wine quality estimations as a regression problem and wine type detection as a binary classification problem.

Please complete sections that are marked (TODO)

1.1 Imports

```
[1]: import tensorflow as tf
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, Input

import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix
import itertools

import utils
```

1.2 Load Dataset

You will now download the dataset from the [UCI Machine Learning Repository](#).

1.2.1 Pre-process the white wine dataset (TODO)

You will add a new column named `is_red` in your dataframe to indicate if the wine is white or red. - In the white wine dataset, you will fill the column `is_red` with zeros (0).

```
[5]: # Please uncomment all lines in this cell and replace those marked with `# YOUR_
      ↪CODE HERE`.
      # You can select all lines in this code cell with Ctrl+A (Windows/Linux) or_
      ↪Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.

      # URL of the white wine dataset
      URL = 'http://archive.ics.uci.edu/ml/machine-learning-databases/wine-quality/
      ↪winequality-white.csv'

      # load the dataset from the URL
      white_df = pd.read_csv(URL, sep=";")

      # fill the `is_red` column with zeros.
      white_df["is_red"] = 0# YOUR CODE HERE

      # keep only the first of duplicate items
      white_df = white_df.drop_duplicates(keep='first')
```

```
[6]: # You can click `File -> Open` in the menu above and open the `utils.py` file
      # in case you want to inspect the unit tests being used for each graded_
      ↪function.

      utils.test_white_df(white_df)
```

All public tests passed

```
[7]: print(white_df.alcohol[0])
      print(white_df.alcohol[100])

      # EXPECTED OUTPUT
      # 8.8
      # 9.1
```

8.8

9.1

1.2.2 Pre-process the red wine dataset (TODO)

- In the red wine dataset, you will fill in the column `is_red` with ones (1).

```
[8]: # Please uncomment all lines in this cell and replace those marked with `# YOUR_
      ↪CODE HERE`.
      # You can select all lines in this code cell with Ctrl+A (Windows/Linux) or
      ↪Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.

      # URL of the red wine dataset
      URL = 'http://archive.ics.uci.edu/ml/machine-learning-databases/wine-quality/
      ↪winequality-red.csv'

      # load the dataset from the URL
      red_df = pd.read_csv(URL, sep=";")

      # fill the `is_red` column with ones.
      red_df["is_red"] = 1# YOUR CODE HERE

      # keep only the first of duplicate items
      red_df = red_df.drop_duplicates(keep='first')
```

```
[9]: utils.test_red_df(red_df)
```

All public tests passed

```
[10]: print(red_df.alcohol[0])
      print(red_df.alcohol[100])

      # EXPECTED OUTPUT
      # 9.4
      # 10.2
```

9.4
10.2

1.2.3 Concatenate the datasets

Next, concatenate the red and white wine dataframes.

```
[11]: df = pd.concat([red_df, white_df], ignore_index=True)
```

```
[12]: print(df.alcohol[0])
      print(df.alcohol[100])

      # EXPECTED OUTPUT
      # 9.4
      # 9.5
```

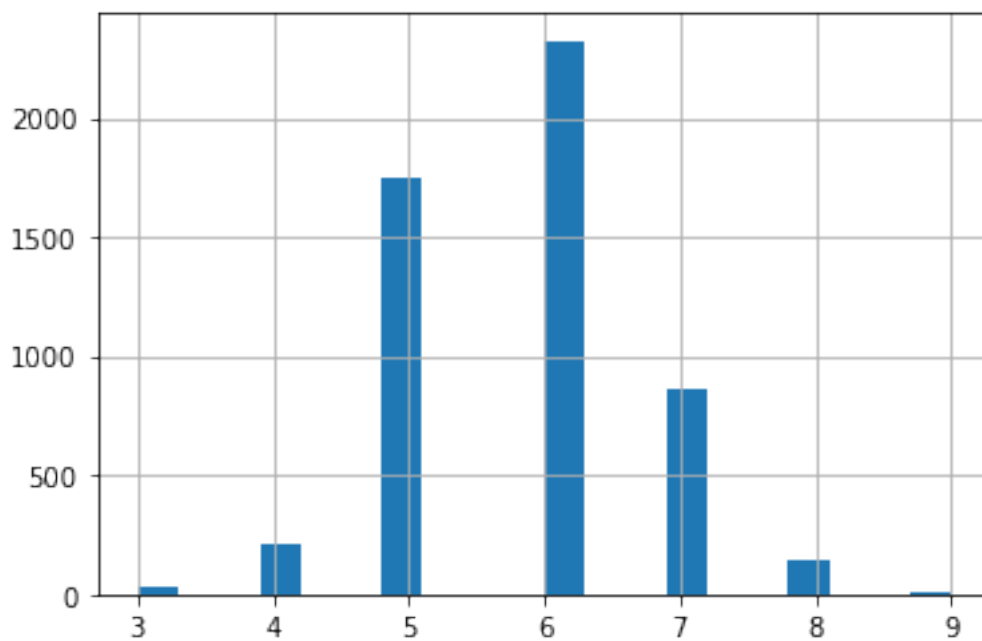
9.4

9.5

```
[ ]: # NOTE: In a real-world scenario, you should shuffle the data.  
# YOU ARE NOT going to do that here because we want to test  
# with deterministic data. But if you want the code to do it,  
# it's in the commented line below:  
  
#df = df.iloc[np.random.permutation(len(df))]
```

This will chart the quality of the wines.

```
[13]: df['quality'].hist(bins=20);
```



1.2.4 Imbalanced data (TODO)

You can see from the plot above that the wine quality dataset is imbalanced. - Since there are very few observations with quality equal to 3, 4, 8 and 9, you can drop these observations from your dataset. - You can do this by removing data belonging to all classes except those > 4 and < 8 .

```
[14]: # Please uncomment all lines in this cell and replace those marked with `# YOUR_␣  
# CODE HERE`.  
# You can select all lines in this code cell with Ctrl+A (Windows/Linux) or ␣  
# Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.
```

```
# get data with wine quality greater than 4 and less than 8
df = df[(df['quality'] > 4) & (df['quality'] < 8)]

# reset index and drop the old one
df = df.reset_index(drop=True)
```

```
[15]: utils.test_df_drop(df)
```

All public tests passed

```
[16]: print(df.alcohol[0])
print(df.alcohol[100])

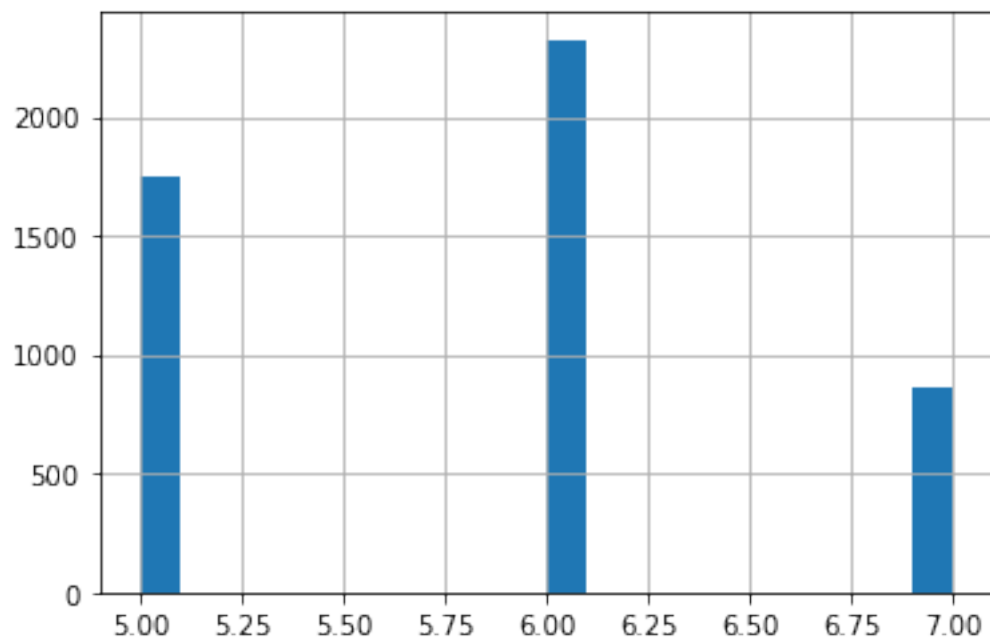
# EXPECTED OUTPUT
# 9.4
# 10.9
```

9.4

10.9

You can plot again to see the new range of data and quality

```
[17]: df['quality'].hist(bins=20);
```



1.2.5 Train Test Split (TODO)

Next, you can split the datasets into training, test and validation datasets. - The data frame should be split 80:20 into `train` and `test` sets. - The resulting `train` should then be split 80:20 into `train` and `val` sets. - The `train_test_split` parameter `test_size` takes a float value that ranges between 0. and 1, and represents the proportion of the dataset that is allocated to the test set. The rest of the data is allocated to the training set.

[]:

```
[18]: # Please uncomment all lines in this cell and replace those marked with `# YOUR
      ↪CODE HERE`.
      # You can select all lines in this code cell with Ctrl+A (Windows/Linux) or
      ↪Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.

      # Please do not change the random_state parameter. This is needed for grading.

      # split df into 80:20 train and test sets
      train, test = train_test_split(df, test_size=0.2, random_state = 1)

      # split train into 80:20 train and val sets
      train, val = train_test_split(train, test_size=0.2, random_state = 1)

[19]: utils.test_data_sizes(train.size, test.size, val.size)
```

All public tests passed

Here's where you can explore the training stats. You can pop the labels 'is_red' and 'quality' from the data as these will be used as the labels

```
[20]: train_stats = train.describe()
      train_stats.pop('is_red')
      train_stats.pop('quality')
      train_stats = train_stats.transpose()
```

Explore the training stats!

```
[21]: train_stats
```

```
[21]:
```

	count	mean	std	min	25%	\
fixed acidity	3155.0	7.221616	1.325297	3.80000	6.40000	
volatile acidity	3155.0	0.338929	0.162476	0.08000	0.23000	
citric acid	3155.0	0.321569	0.147970	0.00000	0.25000	
residual sugar	3155.0	5.155911	4.639632	0.60000	1.80000	
chlorides	3155.0	0.056976	0.036802	0.01200	0.03800	
free sulfur dioxide	3155.0	30.388590	17.236784	1.00000	17.00000	
total sulfur dioxide	3155.0	115.062282	56.706617	6.00000	75.00000	

density	3155.0	0.994633	0.003005	0.98711	0.99232
pH	3155.0	3.223201	0.161272	2.72000	3.11000
sulphates	3155.0	0.534051	0.149149	0.22000	0.43000
alcohol	3155.0	10.504466	1.154654	8.50000	9.50000

	50%	75%	max
fixed acidity	7.00000	7.7000	15.60000
volatile acidity	0.29000	0.4000	1.24000
citric acid	0.31000	0.4000	1.66000
residual sugar	2.80000	7.6500	65.80000
chlorides	0.04700	0.0660	0.61100
free sulfur dioxide	28.00000	41.0000	131.00000
total sulfur dioxide	117.00000	156.0000	344.00000
density	0.99481	0.9968	1.03898
pH	3.21000	3.3300	4.01000
sulphates	0.51000	0.6000	1.95000
alcohol	10.30000	11.3000	14.00000

1.2.6 Get the labels (TODO)

The features and labels are currently in the same dataframe. - You will want to store the label columns `is_red` and `quality` separately from the feature columns.

- The following function, `format_output`, gets these two columns from the dataframe (it's given to you). - `format_output` also formats the data into numpy arrays. - Please use the `format_output` and apply it to the `train`, `val` and `test` sets to get dataframes for the labels.

```
[22]: def format_output(data):
        is_red = data.pop('is_red')
        is_red = np.array(is_red)
        quality = data.pop('quality')
        quality = np.array(quality)
        return (quality, is_red)
```

```
[23]: # Please uncomment all lines in this cell and replace those marked with `# YOUR
        ↳ CODE HERE`.
        # You can select all lines in this code cell with Ctrl+A (Windows/Linux) or
        ↳ Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.

        # format the output of the train set
        train_Y = format_output(train)

        # format the output of the val set
        val_Y = format_output(val)
```

```
# format the output of the test set
test_Y = format_output(test)
```

```
[24]: utils.test_format_output(df, train_Y, val_Y, test_Y)
```

All public tests passed

Notice that after you get the labels, the `train`, `val` and `test` dataframes no longer contain the label columns, and contain just the feature columns. - This is because you used `.pop` in the `format_output` function.

```
[25]: train.head()
```

```
[25]:
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	\
225	7.5	0.65	0.18	7.0	0.088	
3557	6.3	0.27	0.29	12.2	0.044	
3825	8.8	0.27	0.25	5.0	0.024	
1740	6.4	0.45	0.07	1.1	0.030	
1221	7.2	0.53	0.13	2.0	0.058	

	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	\
225	27.0	94.0	0.99915	3.38	0.77	
3557	59.0	196.0	0.99782	3.14	0.40	
3825	52.0	99.0	0.99250	2.87	0.49	
1740	10.0	131.0	0.99050	2.97	0.28	
1221	18.0	22.0	0.99573	3.21	0.68	

	alcohol
225	9.4
3557	8.8
3825	11.4
1740	10.8
1221	9.9

1.2.7 Normalize the data (TODO)

Next, you can normalize the data, `x`, using the formula:

$$x_{norm} = \frac{x - \mu}{\sigma}$$

- The `norm` function is defined for you. - Please apply the `norm` function to normalize the dataframes that contains the feature columns of `train`, `val` and `test` sets.

```
[26]: def norm(x):
      return (x - train_stats['mean']) / train_stats['std']
```

```
[27]:
```



```

# Please uncomment all lines in this cell and replace those marked with `# YOUR_
↪CODE HERE`.
# You can select all lines in this code cell with Ctrl+A (Windows/Linux) or_
↪Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.

# normalize the train set
norm_train_X = norm(train)

# normalize the val set
norm_val_X = norm(val)

# normalize the test set
norm_test_X = norm(test)

```

```
[28]: utils.test_norm(norm_train_X, norm_val_X, norm_test_X, train, val, test)
```

All public tests passed

1.3 Define the Model (TODO)

Define the model using the functional API. The base model will be 2 Dense layers of 128 neurons each, and have the 'relu' activation. - Check out the documentation for [tf.keras.layers.Dense](#)

```

[31]: # Please uncomment all lines in this cell and replace those marked with `# YOUR_
↪CODE HERE`.
# You can select all lines in this code cell with Ctrl+A (Windows/Linux) or_
↪Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.

def base_model(inputs):

    # connect a Dense layer with 128 neurons and a relu activation
    x = Dense(128, activation='relu', name="first_base_dense")(inputs)

    # connect another Dense layer with 128 neurons and a relu activation
    x = Dense(128, activation='relu', name="second_base_dense")(x) # YOUR CODE_
↪HERE
    return x

```

```
[32]: utils.test_base_model(base_model)
```

All public tests passed

2 Define output layers of the model (TODO)

You will add output layers to the base model. - The model will need two outputs.

One output layer will predict wine quality, which is a numeric value. - Define a **Dense** layer with 1 neuron. - Since this is a regression output, the activation can be left as its default value **None**.

The other output layer will predict the wine type, which is either red 1 or not red 0 (white). - Define a **Dense** layer with 1 neuron. - Since there are two possible categories, you can use a sigmoid activation for binary classification.

Define the **Model** - Define the **Model** object, and set the following parameters: - **inputs**: pass in the inputs to the model as a list. - **outputs**: pass in a list of the outputs that you just defined: wine quality, then wine type. - **Note**: please list the wine quality before wine type in the outputs, as this will affect the calculated loss if you choose the other order.

```
[37]: # Please uncomment all lines in this cell and replace those marked with `# YOUR`  
      ↪CODE HERE`.  
# You can select all lines in this code cell with Ctrl+A (Windows/Linux) or`  
      ↪Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.  
  
def final_model(inputs):  
  
    # get the base model  
    x = base_model(inputs)  
  
    # connect the output Dense layer for regression  
    wine_quality = Dense(units='1', name='wine_quality')(x)  
  
    # connect the output Dense layer for classification. this will use a`  
    ↪sigmoid activation.  
    wine_type = Dense(units='1', activation='sigmoid', name='wine_type')(x)  
  
    # define the model using the input and output layers  
    model = Model(inputs=inputs, outputs=[wine_quality, wine_type])  
  
    return model
```

```
[38]: utils.test_final_model(final_model)
```

All public tests passed

2.1 Compiling the Model

Next, compile the model. When setting the loss parameter of `model.compile`, you're setting the loss for each of the two outputs (wine quality and wine type).

To set more than one loss, use a dictionary of key-value pairs. - You can look at the docs for the losses [here](#). - **Note:** For the desired spelling, please look at the “Functions” section of the documentation and not the “classes” section on that same page. - `wine_type`: Since you will be performing binary classification on wine type, you should use the binary crossentropy loss function for it. Please pass this in as a string.

- **Hint**, this should be all lowercase. In the documentation, you’ll see this under the “Functions” section, not the “Classes” section. - `wine_quality`: since this is a regression output, use the mean squared error. Please pass it in as a string, all lowercase. - **Hint:** You may notice that there are two aliases for mean squared error. Please use the shorter name.

You will also set the metric for each of the two outputs. Again, to set metrics for two or more outputs, use a dictionary with key value pairs. - The metrics documentation is linked [here](#). - For the wine type, please set it to accuracy as a string, all lowercase. - For wine quality, please use the root mean squared error. Instead of a string, you’ll set it to an instance of the class `RootMeanSquaredError`, which belongs to the `tf.keras.metrics` module.

Note: If you see the error message `>Exception: wine quality loss function is incorrect`.

- Please also check your other losses and metrics, as the error may be caused by the other three key-value pairs and not the wine quality loss.

```
[44]: # Please uncomment all lines in this cell and replace those marked with `# YOUR_  
→CODE HERE`.  
# You can select all lines in this code cell with Ctrl+A (Windows/Linux) or  
→Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.  
  
inputs = tf.keras.layers.Input(shape=(11,))  
rms = tf.keras.optimizers.RMSprop(lr=0.0001)  
model = final_model(inputs)  
  
model.compile(optimizer=rms,  
              loss = {'wine_type' : 'binary_crossentropy',  
                     'wine_quality' : 'mse'  
                    },  
              metrics = {'wine_type' : 'accuracy',  
                        'wine_quality': tf.keras.metrics.RootMeanSquaredError()  
                       }  
            )
```

```
[45]: utils.test_model_compile(model)
```

All public tests passed

2.2 Training the Model

Fit the model to the training inputs and outputs. - Check the documentation for `model.fit`. - Remember to use the normalized training set as inputs. - For the validation data, please use the

normalized validation set.

```
[46]: # Please uncomment all lines in this cell and replace those marked with `# YOUR_
      ↪CODE HERE`.
      # You can select all lines in this code cell with Ctrl+A (Windows/Linux) or_
      ↪Cmd+A (Mac), then press Ctrl+/ (Windows/Linux) or Cmd+/ (Mac) to uncomment.

      history = model.fit(norm_train_X, train_Y,
                          epochs = 180, validation_data=(norm_val_X, val_Y))
```

Train on 3155 samples, validate on 789 samples

Epoch 1/180

```
3155/3155 [=====] - 1s 350us/sample - loss: 27.1330 -
wine_quality_loss: 26.3534 - wine_type_loss: 0.7462 -
wine_quality_root_mean_squared_error: 5.1368 - wine_type_accuracy: 0.2650 -
val_loss: 19.0685 - val_wine_quality_loss: 18.3428 - val_wine_type_loss: 0.7377
- val_wine_quality_root_mean_squared_error: 4.2815 - val_wine_type_accuracy:
0.2801
```

Epoch 2/180

```
3155/3155 [=====] - 0s 115us/sample - loss: 12.5343 -
wine_quality_loss: 11.7957 - wine_type_loss: 0.7138 -
wine_quality_root_mean_squared_error: 3.4381 - wine_type_accuracy: 0.3937 -
val_loss: 7.2824 - val_wine_quality_loss: 6.6432 - val_wine_type_loss: 0.6813 -
val_wine_quality_root_mean_squared_error: 2.5693 - val_wine_type_accuracy:
0.5640
```

Epoch 3/180

```
3155/3155 [=====] - 0s 96us/sample - loss: 4.9041 -
wine_quality_loss: 4.2692 - wine_type_loss: 0.6263 -
wine_quality_root_mean_squared_error: 2.0682 - wine_type_accuracy: 0.7604 -
val_loss: 3.2131 - val_wine_quality_loss: 2.6869 - val_wine_type_loss: 0.5677 -
val_wine_quality_root_mean_squared_error: 1.6264 - val_wine_type_accuracy:
0.8302
```

Epoch 4/180

```
3155/3155 [=====] - 0s 97us/sample - loss: 2.8598 -
wine_quality_loss: 2.3518 - wine_type_loss: 0.5048 -
wine_quality_root_mean_squared_error: 1.5346 - wine_type_accuracy: 0.8235 -
val_loss: 2.5059 - val_wine_quality_loss: 2.0765 - val_wine_type_loss: 0.4570 -
val_wine_quality_root_mean_squared_error: 1.4313 - val_wine_type_accuracy:
0.8162
```

Epoch 5/180

```
3155/3155 [=====] - 0s 93us/sample - loss: 2.3564 -
wine_quality_loss: 1.9485 - wine_type_loss: 0.4065 -
wine_quality_root_mean_squared_error: 1.3963 - wine_type_accuracy: 0.8529 -
val_loss: 2.1427 - val_wine_quality_loss: 1.7891 - val_wine_type_loss: 0.3691 -
val_wine_quality_root_mean_squared_error: 1.3316 - val_wine_type_accuracy:
0.8809
```

Epoch 6/180
 3155/3155 [=====] - 0s 93us/sample - loss: 2.0299 -
 wine_quality_loss: 1.7003 - wine_type_loss: 0.3269 -
 wine_quality_root_mean_squared_error: 1.3049 - wine_type_accuracy: 0.9128 -
 val_loss: 1.8784 - val_wine_quality_loss: 1.5911 - val_wine_type_loss: 0.2975 -
 val_wine_quality_root_mean_squared_error: 1.2572 - val_wine_type_accuracy:
 0.9341

Epoch 7/180
 3155/3155 [=====] - 0s 78us/sample - loss: 1.7794 -
 wine_quality_loss: 1.5167 - wine_type_loss: 0.2599 -
 wine_quality_root_mean_squared_error: 1.2326 - wine_type_accuracy: 0.9531 -
 val_loss: 1.6699 - val_wine_quality_loss: 1.4404 - val_wine_type_loss: 0.2357 -
 val_wine_quality_root_mean_squared_error: 1.1974 - val_wine_type_accuracy:
 0.9582

Epoch 8/180
 3155/3155 [=====] - 0s 93us/sample - loss: 1.5942 -
 wine_quality_loss: 1.3883 - wine_type_loss: 0.2084 -
 wine_quality_root_mean_squared_error: 1.1771 - wine_type_accuracy: 0.9702 -
 val_loss: 1.5039 - val_wine_quality_loss: 1.3187 - val_wine_type_loss: 0.1898 -
 val_wine_quality_root_mean_squared_error: 1.1462 - val_wine_type_accuracy:
 0.9823

Epoch 9/180
 3155/3155 [=====] - 0s 91us/sample - loss: 1.4426 -
 wine_quality_loss: 1.2739 - wine_type_loss: 0.1688 -
 wine_quality_root_mean_squared_error: 1.1288 - wine_type_accuracy: 0.9759 -
 val_loss: 1.3596 - val_wine_quality_loss: 1.2100 - val_wine_type_loss: 0.1523 -
 val_wine_quality_root_mean_squared_error: 1.0986 - val_wine_type_accuracy:
 0.9886

Epoch 10/180
 3155/3155 [=====] - 0s 94us/sample - loss: 1.3127 -
 wine_quality_loss: 1.1773 - wine_type_loss: 0.1369 -
 wine_quality_root_mean_squared_error: 1.0843 - wine_type_accuracy: 0.9857 -
 val_loss: 1.2464 - val_wine_quality_loss: 1.1240 - val_wine_type_loss: 0.1248 -
 val_wine_quality_root_mean_squared_error: 1.0589 - val_wine_type_accuracy:
 0.9886

Epoch 11/180
 3155/3155 [=====] - 0s 93us/sample - loss: 1.2099 -
 wine_quality_loss: 1.0977 - wine_type_loss: 0.1142 -
 wine_quality_root_mean_squared_error: 1.0467 - wine_type_accuracy: 0.9876 -
 val_loss: 1.1632 - val_wine_quality_loss: 1.0586 - val_wine_type_loss: 0.1044 -
 val_wine_quality_root_mean_squared_error: 1.0289 - val_wine_type_accuracy:
 0.9899

Epoch 12/180
 3155/3155 [=====] - 0s 92us/sample - loss: 1.1192 -
 wine_quality_loss: 1.0229 - wine_type_loss: 0.0970 -
 wine_quality_root_mean_squared_error: 1.0109 - wine_type_accuracy: 0.9895 -
 val_loss: 1.0659 - val_wine_quality_loss: 0.9771 - val_wine_type_loss: 0.0887 -
 val_wine_quality_root_mean_squared_error: 0.9884 - val_wine_type_accuracy:

0.9899

Epoch 13/180

3155/3155 [=====] - 0s 94us/sample - loss: 1.0400 -
 wine_quality_loss: 0.9563 - wine_type_loss: 0.0838 -
 wine_quality_root_mean_squared_error: 0.9778 - wine_type_accuracy: 0.9895 -
 val_loss: 0.9974 - val_wine_quality_loss: 0.9197 - val_wine_type_loss: 0.0768 -
 val_wine_quality_root_mean_squared_error: 0.9594 - val_wine_type_accuracy:
 0.9899

Epoch 14/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.9757 -
 wine_quality_loss: 0.9010 - wine_type_loss: 0.0735 -
 wine_quality_root_mean_squared_error: 0.9498 - wine_type_accuracy: 0.9895 -
 val_loss: 0.9228 - val_wine_quality_loss: 0.8546 - val_wine_type_loss: 0.0672 -
 val_wine_quality_root_mean_squared_error: 0.9249 - val_wine_type_accuracy:
 0.9899

Epoch 15/180

3155/3155 [=====] - 0s 78us/sample - loss: 0.9126 -
 wine_quality_loss: 0.8640 - wine_type_loss: 0.0655 -
 wine_quality_root_mean_squared_error: 0.9203 - wine_type_accuracy: 0.9895 -
 val_loss: 0.8802 - val_wine_quality_loss: 0.8187 - val_wine_type_loss: 0.0600 -
 val_wine_quality_root_mean_squared_error: 0.9055 - val_wine_type_accuracy:
 0.9899

Epoch 16/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.8612 -
 wine_quality_loss: 0.8018 - wine_type_loss: 0.0599 -
 wine_quality_root_mean_squared_error: 0.8952 - wine_type_accuracy: 0.9902 -
 val_loss: 0.8163 - val_wine_quality_loss: 0.7602 - val_wine_type_loss: 0.0549 -
 val_wine_quality_root_mean_squared_error: 0.8724 - val_wine_type_accuracy:
 0.9924

Epoch 17/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.8131 -
 wine_quality_loss: 0.7587 - wine_type_loss: 0.0551 -
 wine_quality_root_mean_squared_error: 0.8706 - wine_type_accuracy: 0.9908 -
 val_loss: 0.7633 - val_wine_quality_loss: 0.7114 - val_wine_type_loss: 0.0506 -
 val_wine_quality_root_mean_squared_error: 0.8440 - val_wine_type_accuracy:
 0.9924

Epoch 18/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.7695 -
 wine_quality_loss: 0.7195 - wine_type_loss: 0.0514 -
 wine_quality_root_mean_squared_error: 0.8474 - wine_type_accuracy: 0.9914 -
 val_loss: 0.7337 - val_wine_quality_loss: 0.6851 - val_wine_type_loss: 0.0472 -
 val_wine_quality_root_mean_squared_error: 0.8284 - val_wine_type_accuracy:
 0.9937

Epoch 19/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.7284 -
 wine_quality_loss: 0.6803 - wine_type_loss: 0.0483 -
 wine_quality_root_mean_squared_error: 0.8247 - wine_type_accuracy: 0.9924 -
 val_loss: 0.6859 - val_wine_quality_loss: 0.6398 - val_wine_type_loss: 0.0445 -

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val_wine_quality_root_mean_squared_error: 0.8006 - val_wine_type_accuracy:
0.9937
Epoch 20/180
3155/3155 [=====] - 0s 90us/sample - loss: 0.6922 -
wine_quality_loss: 0.6457 - wine_type_loss: 0.0458 -
wine_quality_root_mean_squared_error: 0.8040 - wine_type_accuracy: 0.9921 -
val_loss: 0.6535 - val_wine_quality_loss: 0.6097 - val_wine_type_loss: 0.0422 -
val_wine_quality_root_mean_squared_error: 0.7817 - val_wine_type_accuracy:
0.9937
Epoch 21/180
3155/3155 [=====] - 0s 75us/sample - loss: 0.6585 -
wine_quality_loss: 0.6141 - wine_type_loss: 0.0437 -
wine_quality_root_mean_squared_error: 0.7840 - wine_type_accuracy: 0.9921 -
val_loss: 0.6247 - val_wine_quality_loss: 0.5828 - val_wine_type_loss: 0.0404 -
val_wine_quality_root_mean_squared_error: 0.7642 - val_wine_type_accuracy:
0.9937
Epoch 22/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.6265 -
wine_quality_loss: 0.5838 - wine_type_loss: 0.0419 -
wine_quality_root_mean_squared_error: 0.7645 - wine_type_accuracy: 0.9921 -
val_loss: 0.5974 - val_wine_quality_loss: 0.5572 - val_wine_type_loss: 0.0388 -
val_wine_quality_root_mean_squared_error: 0.7472 - val_wine_type_accuracy:
0.9937
Epoch 23/180
3155/3155 [=====] - 0s 93us/sample - loss: 0.5968 -
wine_quality_loss: 0.5564 - wine_type_loss: 0.0405 -
wine_quality_root_mean_squared_error: 0.7458 - wine_type_accuracy: 0.9921 -
val_loss: 0.5751 - val_wine_quality_loss: 0.5364 - val_wine_type_loss: 0.0376 -
val_wine_quality_root_mean_squared_error: 0.7329 - val_wine_type_accuracy:
0.9949
Epoch 24/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.5702 -
wine_quality_loss: 0.5308 - wine_type_loss: 0.0392 -
wine_quality_root_mean_squared_error: 0.7286 - wine_type_accuracy: 0.9927 -
val_loss: 0.5392 - val_wine_quality_loss: 0.5016 - val_wine_type_loss: 0.0365 -
val_wine_quality_root_mean_squared_error: 0.7088 - val_wine_type_accuracy:
0.9949
Epoch 25/180
3155/3155 [=====] - 0s 90us/sample - loss: 0.5436 -
wine_quality_loss: 0.5050 - wine_type_loss: 0.0381 -
wine_quality_root_mean_squared_error: 0.7109 - wine_type_accuracy: 0.9927 -
val_loss: 0.5183 - val_wine_quality_loss: 0.4815 - val_wine_type_loss: 0.0354 -
val_wine_quality_root_mean_squared_error: 0.6946 - val_wine_type_accuracy:
0.9949
Epoch 26/180
3155/3155 [=====] - 0s 74us/sample - loss: 0.5220 -
wine_quality_loss: 0.4842 - wine_type_loss: 0.0372 -
wine_quality_root_mean_squared_error: 0.6962 - wine_type_accuracy: 0.9927 -

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val_loss: 0.4998 - val_wine_quality_loss: 0.4636 - val_wine_type_loss: 0.0347 -
val_wine_quality_root_mean_squared_error: 0.6817 - val_wine_type_accuracy:
0.9949

Epoch 27/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.5020 -
wine_quality_loss: 0.4650 - wine_type_loss: 0.0364 -
wine_quality_root_mean_squared_error: 0.6823 - wine_type_accuracy: 0.9930 -
val_loss: 0.4767 - val_wine_quality_loss: 0.4415 - val_wine_type_loss: 0.0340 -
val_wine_quality_root_mean_squared_error: 0.6651 - val_wine_type_accuracy:
0.9962

Epoch 28/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.4829 -
wine_quality_loss: 0.4471 - wine_type_loss: 0.0355 -
wine_quality_root_mean_squared_error: 0.6688 - wine_type_accuracy: 0.9930 -
val_loss: 0.4643 - val_wine_quality_loss: 0.4294 - val_wine_type_loss: 0.0333 -
val_wine_quality_root_mean_squared_error: 0.6563 - val_wine_type_accuracy:
0.9962

Epoch 29/180

3155/3155 [=====] - 0s 73us/sample - loss: 0.4677 -
wine_quality_loss: 0.4322 - wine_type_loss: 0.0349 -
wine_quality_root_mean_squared_error: 0.6578 - wine_type_accuracy: 0.9937 -
val_loss: 0.4459 - val_wine_quality_loss: 0.4120 - val_wine_type_loss: 0.0328 -
val_wine_quality_root_mean_squared_error: 0.6424 - val_wine_type_accuracy:
0.9949

Epoch 30/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.4532 -
wine_quality_loss: 0.4187 - wine_type_loss: 0.0346 -
wine_quality_root_mean_squared_error: 0.6472 - wine_type_accuracy: 0.9937 -
val_loss: 0.4300 - val_wine_quality_loss: 0.3961 - val_wine_type_loss: 0.0326 -
val_wine_quality_root_mean_squared_error: 0.6301 - val_wine_type_accuracy:
0.9949

Epoch 31/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.4393 -
wine_quality_loss: 0.4060 - wine_type_loss: 0.0337 -
wine_quality_root_mean_squared_error: 0.6367 - wine_type_accuracy: 0.9937 -
val_loss: 0.4179 - val_wine_quality_loss: 0.3847 - val_wine_type_loss: 0.0320 -
val_wine_quality_root_mean_squared_error: 0.6210 - val_wine_type_accuracy:
0.9949

Epoch 32/180

3155/3155 [=====] - 0s 96us/sample - loss: 0.4276 -
wine_quality_loss: 0.3943 - wine_type_loss: 0.0332 -
wine_quality_root_mean_squared_error: 0.6279 - wine_type_accuracy: 0.9940 -
val_loss: 0.4240 - val_wine_quality_loss: 0.3910 - val_wine_type_loss: 0.0317 -
val_wine_quality_root_mean_squared_error: 0.6261 - val_wine_type_accuracy:
0.9949

Epoch 33/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.4165 -
wine_quality_loss: 0.3840 - wine_type_loss: 0.0327 -

wine_quality_root_mean_squared_error: 0.6194 - wine_type_accuracy: 0.9940 -
val_loss: 0.3978 - val_wine_quality_loss: 0.3656 - val_wine_type_loss: 0.0314 -
val_wine_quality_root_mean_squared_error: 0.6050 - val_wine_type_accuracy:
0.9949

Epoch 34/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.4093 -
wine_quality_loss: 0.3774 - wine_type_loss: 0.0323 -
wine_quality_root_mean_squared_error: 0.6140 - wine_type_accuracy: 0.9943 -
val_loss: 0.4058 - val_wine_quality_loss: 0.3736 - val_wine_type_loss: 0.0309 -
val_wine_quality_root_mean_squared_error: 0.6120 - val_wine_type_accuracy:
0.9949

Epoch 35/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.3997 -
wine_quality_loss: 0.3677 - wine_type_loss: 0.0320 -
wine_quality_root_mean_squared_error: 0.6064 - wine_type_accuracy: 0.9943 -
val_loss: 0.3869 - val_wine_quality_loss: 0.3552 - val_wine_type_loss: 0.0307 -
val_wine_quality_root_mean_squared_error: 0.5965 - val_wine_type_accuracy:
0.9949

Epoch 36/180

3155/3155 [=====] - 0s 77us/sample - loss: 0.3930 -
wine_quality_loss: 0.3620 - wine_type_loss: 0.0315 -
wine_quality_root_mean_squared_error: 0.6012 - wine_type_accuracy: 0.9946 -
val_loss: 0.3883 - val_wine_quality_loss: 0.3568 - val_wine_type_loss: 0.0304 -
val_wine_quality_root_mean_squared_error: 0.5979 - val_wine_type_accuracy:
0.9949

Epoch 37/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.3868 -
wine_quality_loss: 0.3552 - wine_type_loss: 0.0314 -
wine_quality_root_mean_squared_error: 0.5963 - wine_type_accuracy: 0.9946 -
val_loss: 0.3750 - val_wine_quality_loss: 0.3440 - val_wine_type_loss: 0.0302 -
val_wine_quality_root_mean_squared_error: 0.5870 - val_wine_type_accuracy:
0.9949

Epoch 38/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.3801 -
wine_quality_loss: 0.3490 - wine_type_loss: 0.0308 -
wine_quality_root_mean_squared_error: 0.5909 - wine_type_accuracy: 0.9943 -
val_loss: 0.3690 - val_wine_quality_loss: 0.3381 - val_wine_type_loss: 0.0300 -
val_wine_quality_root_mean_squared_error: 0.5819 - val_wine_type_accuracy:
0.9949

Epoch 39/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.3770 -
wine_quality_loss: 0.3460 - wine_type_loss: 0.0306 -
wine_quality_root_mean_squared_error: 0.5885 - wine_type_accuracy: 0.9949 -
val_loss: 0.3722 - val_wine_quality_loss: 0.3411 - val_wine_type_loss: 0.0301 -
val_wine_quality_root_mean_squared_error: 0.5846 - val_wine_type_accuracy:
0.9949

Epoch 40/180

3155/3155 [=====] - 0s 88us/sample - loss: 0.3700 -

wine_quality_loss: 0.3395 - wine_type_loss: 0.0304 -
 wine_quality_root_mean_squared_error: 0.5828 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3725 - val_wine_quality_loss: 0.3415 - val_wine_type_loss: 0.0298 -
 val_wine_quality_root_mean_squared_error: 0.5851 - val_wine_type_accuracy:
 0.9949
 Epoch 41/180
 3155/3155 [=====] - 0s 77us/sample - loss: 0.3673 -
 wine_quality_loss: 0.3370 - wine_type_loss: 0.0300 -
 wine_quality_root_mean_squared_error: 0.5807 - wine_type_accuracy: 0.9946 -
 val_loss: 0.3738 - val_wine_quality_loss: 0.3433 - val_wine_type_loss: 0.0297 -
 val_wine_quality_root_mean_squared_error: 0.5863 - val_wine_type_accuracy:
 0.9949
 Epoch 42/180
 3155/3155 [=====] - 0s 91us/sample - loss: 0.3641 -
 wine_quality_loss: 0.3345 - wine_type_loss: 0.0297 -
 wine_quality_root_mean_squared_error: 0.5782 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3600 - val_wine_quality_loss: 0.3295 - val_wine_type_loss: 0.0296 -
 val_wine_quality_root_mean_squared_error: 0.5745 - val_wine_type_accuracy:
 0.9949
 Epoch 43/180
 3155/3155 [=====] - 0s 92us/sample - loss: 0.3591 -
 wine_quality_loss: 0.3293 - wine_type_loss: 0.0295 -
 wine_quality_root_mean_squared_error: 0.5741 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3594 - val_wine_quality_loss: 0.3290 - val_wine_type_loss: 0.0296 -
 val_wine_quality_root_mean_squared_error: 0.5740 - val_wine_type_accuracy:
 0.9949
 Epoch 44/180
 3155/3155 [=====] - 0s 93us/sample - loss: 0.3570 -
 wine_quality_loss: 0.3276 - wine_type_loss: 0.0292 -
 wine_quality_root_mean_squared_error: 0.5725 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3538 - val_wine_quality_loss: 0.3237 - val_wine_type_loss: 0.0295 -
 val_wine_quality_root_mean_squared_error: 0.5692 - val_wine_type_accuracy:
 0.9949
 Epoch 45/180
 3155/3155 [=====] - 0s 75us/sample - loss: 0.3541 -
 wine_quality_loss: 0.3253 - wine_type_loss: 0.0290 -
 wine_quality_root_mean_squared_error: 0.5701 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3573 - val_wine_quality_loss: 0.3271 - val_wine_type_loss: 0.0292 -
 val_wine_quality_root_mean_squared_error: 0.5724 - val_wine_type_accuracy:
 0.9949
 Epoch 46/180
 3155/3155 [=====] - 0s 78us/sample - loss: 0.3519 -
 wine_quality_loss: 0.3232 - wine_type_loss: 0.0292 -
 wine_quality_root_mean_squared_error: 0.5684 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3622 - val_wine_quality_loss: 0.3320 - val_wine_type_loss: 0.0293 -
 val_wine_quality_root_mean_squared_error: 0.5767 - val_wine_type_accuracy:
 0.9949
 Epoch 47/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.3493 -
 wine_quality_loss: 0.3212 - wine_type_loss: 0.0287 -
 wine_quality_root_mean_squared_error: 0.5663 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3506 - val_wine_quality_loss: 0.3210 - val_wine_type_loss: 0.0291 -
 val_wine_quality_root_mean_squared_error: 0.5667 - val_wine_type_accuracy:
 0.9949

Epoch 48/180

3155/3155 [=====] - 0s 88us/sample - loss: 0.3473 -
 wine_quality_loss: 0.3189 - wine_type_loss: 0.0283 -
 wine_quality_root_mean_squared_error: 0.5647 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3538 - val_wine_quality_loss: 0.3240 - val_wine_type_loss: 0.0290 -
 val_wine_quality_root_mean_squared_error: 0.5696 - val_wine_type_accuracy:
 0.9949

Epoch 49/180

3155/3155 [=====] - 0s 76us/sample - loss: 0.3454 -
 wine_quality_loss: 0.3171 - wine_type_loss: 0.0281 -
 wine_quality_root_mean_squared_error: 0.5632 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3461 - val_wine_quality_loss: 0.3165 - val_wine_type_loss: 0.0289 -
 val_wine_quality_root_mean_squared_error: 0.5629 - val_wine_type_accuracy:
 0.9949

Epoch 50/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.3426 -
 wine_quality_loss: 0.3149 - wine_type_loss: 0.0278 -
 wine_quality_root_mean_squared_error: 0.5610 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3477 - val_wine_quality_loss: 0.3181 - val_wine_type_loss: 0.0287 -
 val_wine_quality_root_mean_squared_error: 0.5645 - val_wine_type_accuracy:
 0.9949

Epoch 51/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.3402 -
 wine_quality_loss: 0.3124 - wine_type_loss: 0.0290 -
 wine_quality_root_mean_squared_error: 0.5590 - wine_type_accuracy: 0.9949 -
 val_loss: 0.3490 - val_wine_quality_loss: 0.3195 - val_wine_type_loss: 0.0287 -
 val_wine_quality_root_mean_squared_error: 0.5656 - val_wine_type_accuracy:
 0.9949

Epoch 52/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.3399 -
 wine_quality_loss: 0.3121 - wine_type_loss: 0.0275 -
 wine_quality_root_mean_squared_error: 0.5589 - wine_type_accuracy: 0.9952 -
 val_loss: 0.3478 - val_wine_quality_loss: 0.3186 - val_wine_type_loss: 0.0286 -
 val_wine_quality_root_mean_squared_error: 0.5647 - val_wine_type_accuracy:
 0.9949

Epoch 53/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.3376 -
 wine_quality_loss: 0.3100 - wine_type_loss: 0.0273 -
 wine_quality_root_mean_squared_error: 0.5570 - wine_type_accuracy: 0.9952 -
 val_loss: 0.3437 - val_wine_quality_loss: 0.3146 - val_wine_type_loss: 0.0285 -
 val_wine_quality_root_mean_squared_error: 0.5611 - val_wine_type_accuracy:
 0.9949

Epoch 54/180
3155/3155 [=====] - 0s 89us/sample - loss: 0.3366 -
wine_quality_loss: 0.3095 - wine_type_loss: 0.0271 -
wine_quality_root_mean_squared_error: 0.5563 - wine_type_accuracy: 0.9952 -
val_loss: 0.3497 - val_wine_quality_loss: 0.3203 - val_wine_type_loss: 0.0284 -
val_wine_quality_root_mean_squared_error: 0.5665 - val_wine_type_accuracy:
0.9949

Epoch 55/180
3155/3155 [=====] - 0s 76us/sample - loss: 0.3353 -
wine_quality_loss: 0.3088 - wine_type_loss: 0.0284 -
wine_quality_root_mean_squared_error: 0.5552 - wine_type_accuracy: 0.9952 -
val_loss: 0.3421 - val_wine_quality_loss: 0.3130 - val_wine_type_loss: 0.0284 -
val_wine_quality_root_mean_squared_error: 0.5598 - val_wine_type_accuracy:
0.9949

Epoch 56/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.3337 -
wine_quality_loss: 0.3068 - wine_type_loss: 0.0267 -
wine_quality_root_mean_squared_error: 0.5540 - wine_type_accuracy: 0.9952 -
val_loss: 0.3415 - val_wine_quality_loss: 0.3123 - val_wine_type_loss: 0.0283 -
val_wine_quality_root_mean_squared_error: 0.5593 - val_wine_type_accuracy:
0.9949

Epoch 57/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.3324 -
wine_quality_loss: 0.3058 - wine_type_loss: 0.0266 -
wine_quality_root_mean_squared_error: 0.5529 - wine_type_accuracy: 0.9952 -
val_loss: 0.3395 - val_wine_quality_loss: 0.3106 - val_wine_type_loss: 0.0283 -
val_wine_quality_root_mean_squared_error: 0.5575 - val_wine_type_accuracy:
0.9949

Epoch 58/180
3155/3155 [=====] - 0s 73us/sample - loss: 0.3301 -
wine_quality_loss: 0.3036 - wine_type_loss: 0.0266 -
wine_quality_root_mean_squared_error: 0.5510 - wine_type_accuracy: 0.9952 -
val_loss: 0.3451 - val_wine_quality_loss: 0.3159 - val_wine_type_loss: 0.0283 -
val_wine_quality_root_mean_squared_error: 0.5626 - val_wine_type_accuracy:
0.9949

Epoch 59/180
3155/3155 [=====] - 0s 93us/sample - loss: 0.3300 -
wine_quality_loss: 0.3038 - wine_type_loss: 0.0263 -
wine_quality_root_mean_squared_error: 0.5511 - wine_type_accuracy: 0.9952 -
val_loss: 0.3412 - val_wine_quality_loss: 0.3122 - val_wine_type_loss: 0.0283 -
val_wine_quality_root_mean_squared_error: 0.5590 - val_wine_type_accuracy:
0.9949

Epoch 60/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.3288 -
wine_quality_loss: 0.3025 - wine_type_loss: 0.0261 -
wine_quality_root_mean_squared_error: 0.5501 - wine_type_accuracy: 0.9956 -
val_loss: 0.3456 - val_wine_quality_loss: 0.3165 - val_wine_type_loss: 0.0284 -
val_wine_quality_root_mean_squared_error: 0.5629 - val_wine_type_accuracy:

0.9949
Epoch 61/180
3155/3155 [=====] - 0s 90us/sample - loss: 0.3271 -
wine_quality_loss: 0.3009 - wine_type_loss: 0.0259 -
wine_quality_root_mean_squared_error: 0.5487 - wine_type_accuracy: 0.9952 -
val_loss: 0.3449 - val_wine_quality_loss: 0.3160 - val_wine_type_loss: 0.0284 -
val_wine_quality_root_mean_squared_error: 0.5622 - val_wine_type_accuracy:
0.9949
Epoch 62/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.3260 -
wine_quality_loss: 0.3004 - wine_type_loss: 0.0258 -
wine_quality_root_mean_squared_error: 0.5478 - wine_type_accuracy: 0.9952 -
val_loss: 0.3407 - val_wine_quality_loss: 0.3117 - val_wine_type_loss: 0.0282 -
val_wine_quality_root_mean_squared_error: 0.5587 - val_wine_type_accuracy:
0.9949
Epoch 63/180
3155/3155 [=====] - 0s 78us/sample - loss: 0.3240 -
wine_quality_loss: 0.2980 - wine_type_loss: 0.0256 -
wine_quality_root_mean_squared_error: 0.5461 - wine_type_accuracy: 0.9952 -
val_loss: 0.3440 - val_wine_quality_loss: 0.3152 - val_wine_type_loss: 0.0283 -
val_wine_quality_root_mean_squared_error: 0.5615 - val_wine_type_accuracy:
0.9949
Epoch 64/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.3246 -
wine_quality_loss: 0.2984 - wine_type_loss: 0.0255 -
wine_quality_root_mean_squared_error: 0.5468 - wine_type_accuracy: 0.9952 -
val_loss: 0.3381 - val_wine_quality_loss: 0.3092 - val_wine_type_loss: 0.0282 -
val_wine_quality_root_mean_squared_error: 0.5564 - val_wine_type_accuracy:
0.9949
Epoch 65/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.3228 -
wine_quality_loss: 0.2974 - wine_type_loss: 0.0254 -
wine_quality_root_mean_squared_error: 0.5453 - wine_type_accuracy: 0.9952 -
val_loss: 0.3395 - val_wine_quality_loss: 0.3109 - val_wine_type_loss: 0.0282 -
val_wine_quality_root_mean_squared_error: 0.5576 - val_wine_type_accuracy:
0.9949
Epoch 66/180
3155/3155 [=====] - 0s 93us/sample - loss: 0.3220 -
wine_quality_loss: 0.2972 - wine_type_loss: 0.0252 -
wine_quality_root_mean_squared_error: 0.5448 - wine_type_accuracy: 0.9956 -
val_loss: 0.3416 - val_wine_quality_loss: 0.3127 - val_wine_type_loss: 0.0282 -
val_wine_quality_root_mean_squared_error: 0.5595 - val_wine_type_accuracy:
0.9949
Epoch 67/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.3225 -
wine_quality_loss: 0.2976 - wine_type_loss: 0.0251 -
wine_quality_root_mean_squared_error: 0.5453 - wine_type_accuracy: 0.9952 -
val_loss: 0.3410 - val_wine_quality_loss: 0.3124 - val_wine_type_loss: 0.0281 -

```

val_wine_quality_root_mean_squared_error: 0.5590 - val_wine_type_accuracy:
0.9949
Epoch 68/180
3155/3155 [=====] - 0s 89us/sample - loss: 0.3212 -
wine_quality_loss: 0.2967 - wine_type_loss: 0.0250 -
wine_quality_root_mean_squared_error: 0.5442 - wine_type_accuracy: 0.9952 -
val_loss: 0.3385 - val_wine_quality_loss: 0.3099 - val_wine_type_loss: 0.0280 -
val_wine_quality_root_mean_squared_error: 0.5569 - val_wine_type_accuracy:
0.9949
Epoch 69/180
3155/3155 [=====] - 0s 78us/sample - loss: 0.3198 -
wine_quality_loss: 0.2949 - wine_type_loss: 0.0248 -
wine_quality_root_mean_squared_error: 0.5431 - wine_type_accuracy: 0.9952 -
val_loss: 0.3452 - val_wine_quality_loss: 0.3164 - val_wine_type_loss: 0.0281 -
val_wine_quality_root_mean_squared_error: 0.5628 - val_wine_type_accuracy:
0.9949
Epoch 70/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.3194 -
wine_quality_loss: 0.2944 - wine_type_loss: 0.0247 -
wine_quality_root_mean_squared_error: 0.5428 - wine_type_accuracy: 0.9952 -
val_loss: 0.3348 - val_wine_quality_loss: 0.3065 - val_wine_type_loss: 0.0280 -
val_wine_quality_root_mean_squared_error: 0.5536 - val_wine_type_accuracy:
0.9949
Epoch 71/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.3181 -
wine_quality_loss: 0.2934 - wine_type_loss: 0.0246 -
wine_quality_root_mean_squared_error: 0.5417 - wine_type_accuracy: 0.9956 -
val_loss: 0.3373 - val_wine_quality_loss: 0.3090 - val_wine_type_loss: 0.0280 -
val_wine_quality_root_mean_squared_error: 0.5559 - val_wine_type_accuracy:
0.9949
Epoch 72/180
3155/3155 [=====] - 0s 71us/sample - loss: 0.3170 -
wine_quality_loss: 0.2922 - wine_type_loss: 0.0244 -
wine_quality_root_mean_squared_error: 0.5408 - wine_type_accuracy: 0.9952 -
val_loss: 0.3418 - val_wine_quality_loss: 0.3132 - val_wine_type_loss: 0.0280 -
val_wine_quality_root_mean_squared_error: 0.5599 - val_wine_type_accuracy:
0.9949
Epoch 73/180
3155/3155 [=====] - 0s 90us/sample - loss: 0.3174 -
wine_quality_loss: 0.2934 - wine_type_loss: 0.0244 -
wine_quality_root_mean_squared_error: 0.5413 - wine_type_accuracy: 0.9952 -
val_loss: 0.3470 - val_wine_quality_loss: 0.3184 - val_wine_type_loss: 0.0279 -
val_wine_quality_root_mean_squared_error: 0.5646 - val_wine_type_accuracy:
0.9949
Epoch 74/180
3155/3155 [=====] - 0s 90us/sample - loss: 0.3148 -
wine_quality_loss: 0.2906 - wine_type_loss: 0.0242 -
wine_quality_root_mean_squared_error: 0.5390 - wine_type_accuracy: 0.9956 -

```

val_loss: 0.3361 - val_wine_quality_loss: 0.3078 - val_wine_type_loss: 0.0279 -
val_wine_quality_root_mean_squared_error: 0.5549 - val_wine_type_accuracy:
0.9949

Epoch 75/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.3156 -
wine_quality_loss: 0.2909 - wine_type_loss: 0.0241 -
wine_quality_root_mean_squared_error: 0.5397 - wine_type_accuracy: 0.9956 -
val_loss: 0.3358 - val_wine_quality_loss: 0.3073 - val_wine_type_loss: 0.0279 -
val_wine_quality_root_mean_squared_error: 0.5546 - val_wine_type_accuracy:
0.9949

Epoch 76/180

3155/3155 [=====] - 0s 76us/sample - loss: 0.3141 -
wine_quality_loss: 0.2903 - wine_type_loss: 0.0240 -
wine_quality_root_mean_squared_error: 0.5385 - wine_type_accuracy: 0.9956 -
val_loss: 0.3374 - val_wine_quality_loss: 0.3088 - val_wine_type_loss: 0.0278 -
val_wine_quality_root_mean_squared_error: 0.5561 - val_wine_type_accuracy:
0.9949

Epoch 77/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.3140 -
wine_quality_loss: 0.2901 - wine_type_loss: 0.0239 -
wine_quality_root_mean_squared_error: 0.5385 - wine_type_accuracy: 0.9959 -
val_loss: 0.3366 - val_wine_quality_loss: 0.3083 - val_wine_type_loss: 0.0279 -
val_wine_quality_root_mean_squared_error: 0.5553 - val_wine_type_accuracy:
0.9949

Epoch 78/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.3138 -
wine_quality_loss: 0.2905 - wine_type_loss: 0.0238 -
wine_quality_root_mean_squared_error: 0.5385 - wine_type_accuracy: 0.9959 -
val_loss: 0.3346 - val_wine_quality_loss: 0.3062 - val_wine_type_loss: 0.0278 -
val_wine_quality_root_mean_squared_error: 0.5535 - val_wine_type_accuracy:
0.9949

Epoch 79/180

3155/3155 [=====] - 0s 75us/sample - loss: 0.3128 -
wine_quality_loss: 0.2890 - wine_type_loss: 0.0237 -
wine_quality_root_mean_squared_error: 0.5377 - wine_type_accuracy: 0.9959 -
val_loss: 0.3335 - val_wine_quality_loss: 0.3050 - val_wine_type_loss: 0.0279 -
val_wine_quality_root_mean_squared_error: 0.5525 - val_wine_type_accuracy:
0.9949

Epoch 80/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.3111 -
wine_quality_loss: 0.2875 - wine_type_loss: 0.0236 -
wine_quality_root_mean_squared_error: 0.5361 - wine_type_accuracy: 0.9956 -
val_loss: 0.3506 - val_wine_quality_loss: 0.3218 - val_wine_type_loss: 0.0279 -
val_wine_quality_root_mean_squared_error: 0.5678 - val_wine_type_accuracy:
0.9949

Epoch 81/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.3112 -
wine_quality_loss: 0.2875 - wine_type_loss: 0.0235 -

wine_quality_root_mean_squared_error: 0.5364 - wine_type_accuracy: 0.9959 -
val_loss: 0.3363 - val_wine_quality_loss: 0.3078 - val_wine_type_loss: 0.0278 -
val_wine_quality_root_mean_squared_error: 0.5551 - val_wine_type_accuracy:
0.9949

Epoch 82/180

3155/3155 [=====] - 0s 72us/sample - loss: 0.3102 -
wine_quality_loss: 0.2868 - wine_type_loss: 0.0234 -
wine_quality_root_mean_squared_error: 0.5355 - wine_type_accuracy: 0.9959 -
val_loss: 0.3352 - val_wine_quality_loss: 0.3068 - val_wine_type_loss: 0.0278 -
val_wine_quality_root_mean_squared_error: 0.5542 - val_wine_type_accuracy:
0.9949

Epoch 83/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.3090 -
wine_quality_loss: 0.2856 - wine_type_loss: 0.0232 -
wine_quality_root_mean_squared_error: 0.5345 - wine_type_accuracy: 0.9959 -
val_loss: 0.3685 - val_wine_quality_loss: 0.3401 - val_wine_type_loss: 0.0277 -
val_wine_quality_root_mean_squared_error: 0.5834 - val_wine_type_accuracy:
0.9949

Epoch 84/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.3088 -
wine_quality_loss: 0.2852 - wine_type_loss: 0.0231 -
wine_quality_root_mean_squared_error: 0.5344 - wine_type_accuracy: 0.9959 -
val_loss: 0.3371 - val_wine_quality_loss: 0.3087 - val_wine_type_loss: 0.0276 -
val_wine_quality_root_mean_squared_error: 0.5560 - val_wine_type_accuracy:
0.9949

Epoch 85/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.3083 -
wine_quality_loss: 0.2848 - wine_type_loss: 0.0231 -
wine_quality_root_mean_squared_error: 0.5340 - wine_type_accuracy: 0.9959 -
val_loss: 0.3361 - val_wine_quality_loss: 0.3081 - val_wine_type_loss: 0.0275 -
val_wine_quality_root_mean_squared_error: 0.5551 - val_wine_type_accuracy:
0.9949

Epoch 86/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.3070 -
wine_quality_loss: 0.2843 - wine_type_loss: 0.0229 -
wine_quality_root_mean_squared_error: 0.5330 - wine_type_accuracy: 0.9959 -
val_loss: 0.3386 - val_wine_quality_loss: 0.3103 - val_wine_type_loss: 0.0277 -
val_wine_quality_root_mean_squared_error: 0.5572 - val_wine_type_accuracy:
0.9949

Epoch 87/180

3155/3155 [=====] - 0s 75us/sample - loss: 0.3068 -
wine_quality_loss: 0.2842 - wine_type_loss: 0.0229 -
wine_quality_root_mean_squared_error: 0.5328 - wine_type_accuracy: 0.9959 -
val_loss: 0.3357 - val_wine_quality_loss: 0.3075 - val_wine_type_loss: 0.0277 -
val_wine_quality_root_mean_squared_error: 0.5547 - val_wine_type_accuracy:
0.9949

Epoch 88/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.3066 -

wine_quality_loss: 0.2837 - wine_type_loss: 0.0228 -
 wine_quality_root_mean_squared_error: 0.5327 - wine_type_accuracy: 0.9959 -
 val_loss: 0.3331 - val_wine_quality_loss: 0.3049 - val_wine_type_loss: 0.0275 -
 val_wine_quality_root_mean_squared_error: 0.5525 - val_wine_type_accuracy:
 0.9949
 Epoch 89/180
 3155/3155 [=====] - 0s 92us/sample - loss: 0.3056 -
 wine_quality_loss: 0.2828 - wine_type_loss: 0.0226 -
 wine_quality_root_mean_squared_error: 0.5318 - wine_type_accuracy: 0.9959 -
 val_loss: 0.3359 - val_wine_quality_loss: 0.3078 - val_wine_type_loss: 0.0275 -
 val_wine_quality_root_mean_squared_error: 0.5550 - val_wine_type_accuracy:
 0.9949
 Epoch 90/180
 3155/3155 [=====] - 0s 90us/sample - loss: 0.3051 -
 wine_quality_loss: 0.2830 - wine_type_loss: 0.0225 -
 wine_quality_root_mean_squared_error: 0.5315 - wine_type_accuracy: 0.9959 -
 val_loss: 0.3322 - val_wine_quality_loss: 0.3042 - val_wine_type_loss: 0.0275 -
 val_wine_quality_root_mean_squared_error: 0.5517 - val_wine_type_accuracy:
 0.9949
 Epoch 91/180
 3155/3155 [=====] - 0s 77us/sample - loss: 0.3049 -
 wine_quality_loss: 0.2826 - wine_type_loss: 0.0224 -
 wine_quality_root_mean_squared_error: 0.5314 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3299 - val_wine_quality_loss: 0.3019 - val_wine_type_loss: 0.0275 -
 val_wine_quality_root_mean_squared_error: 0.5496 - val_wine_type_accuracy:
 0.9949
 Epoch 92/180
 3155/3155 [=====] - 0s 92us/sample - loss: 0.3029 -
 wine_quality_loss: 0.2804 - wine_type_loss: 0.0226 -
 wine_quality_root_mean_squared_error: 0.5295 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3367 - val_wine_quality_loss: 0.3085 - val_wine_type_loss: 0.0275 -
 val_wine_quality_root_mean_squared_error: 0.5557 - val_wine_type_accuracy:
 0.9949
 Epoch 93/180
 3155/3155 [=====] - 0s 91us/sample - loss: 0.3018 -
 wine_quality_loss: 0.2798 - wine_type_loss: 0.0223 -
 wine_quality_root_mean_squared_error: 0.5286 - wine_type_accuracy: 0.9959 -
 val_loss: 0.3338 - val_wine_quality_loss: 0.3056 - val_wine_type_loss: 0.0274 -
 val_wine_quality_root_mean_squared_error: 0.5532 - val_wine_type_accuracy:
 0.9949
 Epoch 94/180
 3155/3155 [=====] - 0s 89us/sample - loss: 0.3026 -
 wine_quality_loss: 0.2800 - wine_type_loss: 0.0221 -
 wine_quality_root_mean_squared_error: 0.5295 - wine_type_accuracy: 0.9959 -
 val_loss: 0.3298 - val_wine_quality_loss: 0.3018 - val_wine_type_loss: 0.0273 -
 val_wine_quality_root_mean_squared_error: 0.5497 - val_wine_type_accuracy:
 0.9949
 Epoch 95/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.3033 -
 wine_quality_loss: 0.2812 - wine_type_loss: 0.0220 -
 wine_quality_root_mean_squared_error: 0.5303 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3327 - val_wine_quality_loss: 0.3047 - val_wine_type_loss: 0.0274 -
 val_wine_quality_root_mean_squared_error: 0.5522 - val_wine_type_accuracy:
 0.9949

Epoch 96/180

3155/3155 [=====] - 0s 77us/sample - loss: 0.3012 -
 wine_quality_loss: 0.2801 - wine_type_loss: 0.0220 -
 wine_quality_root_mean_squared_error: 0.5283 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3418 - val_wine_quality_loss: 0.3136 - val_wine_type_loss: 0.0274 -
 val_wine_quality_root_mean_squared_error: 0.5604 - val_wine_type_accuracy:
 0.9949

Epoch 97/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.3007 -
 wine_quality_loss: 0.2791 - wine_type_loss: 0.0219 -
 wine_quality_root_mean_squared_error: 0.5279 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3382 - val_wine_quality_loss: 0.3101 - val_wine_type_loss: 0.0274 -
 val_wine_quality_root_mean_squared_error: 0.5572 - val_wine_type_accuracy:
 0.9949

Epoch 98/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.3003 -
 wine_quality_loss: 0.2787 - wine_type_loss: 0.0218 -
 wine_quality_root_mean_squared_error: 0.5277 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3402 - val_wine_quality_loss: 0.3122 - val_wine_type_loss: 0.0274 -
 val_wine_quality_root_mean_squared_error: 0.5590 - val_wine_type_accuracy:
 0.9949

Epoch 99/180

3155/3155 [=====] - 0s 75us/sample - loss: 0.3000 -
 wine_quality_loss: 0.2778 - wine_type_loss: 0.0217 -
 wine_quality_root_mean_squared_error: 0.5275 - wine_type_accuracy: 0.9959 -
 val_loss: 0.3345 - val_wine_quality_loss: 0.3066 - val_wine_type_loss: 0.0273 -
 val_wine_quality_root_mean_squared_error: 0.5539 - val_wine_type_accuracy:
 0.9949

Epoch 100/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2994 -
 wine_quality_loss: 0.2776 - wine_type_loss: 0.0216 -
 wine_quality_root_mean_squared_error: 0.5270 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3334 - val_wine_quality_loss: 0.3058 - val_wine_type_loss: 0.0273 -
 val_wine_quality_root_mean_squared_error: 0.5530 - val_wine_type_accuracy:
 0.9949

Epoch 101/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.2983 -
 wine_quality_loss: 0.2772 - wine_type_loss: 0.0215 -
 wine_quality_root_mean_squared_error: 0.5261 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3359 - val_wine_quality_loss: 0.3080 - val_wine_type_loss: 0.0273 -
 val_wine_quality_root_mean_squared_error: 0.5552 - val_wine_type_accuracy:
 0.9949

Epoch 102/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.2980 -
wine_quality_loss: 0.2760 - wine_type_loss: 0.0225 -
wine_quality_root_mean_squared_error: 0.5258 - wine_type_accuracy: 0.9962 -
val_loss: 0.3356 - val_wine_quality_loss: 0.3078 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5550 - val_wine_type_accuracy:
0.9949

Epoch 103/180

3155/3155 [=====] - 0s 74us/sample - loss: 0.2982 -
wine_quality_loss: 0.2768 - wine_type_loss: 0.0213 -
wine_quality_root_mean_squared_error: 0.5261 - wine_type_accuracy: 0.9962 -
val_loss: 0.3347 - val_wine_quality_loss: 0.3069 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5541 - val_wine_type_accuracy:
0.9949

Epoch 104/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2971 -
wine_quality_loss: 0.2753 - wine_type_loss: 0.0213 -
wine_quality_root_mean_squared_error: 0.5252 - wine_type_accuracy: 0.9962 -
val_loss: 0.3333 - val_wine_quality_loss: 0.3055 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5529 - val_wine_type_accuracy:
0.9949

Epoch 105/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.2969 -
wine_quality_loss: 0.2760 - wine_type_loss: 0.0212 -
wine_quality_root_mean_squared_error: 0.5250 - wine_type_accuracy: 0.9962 -
val_loss: 0.3356 - val_wine_quality_loss: 0.3078 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5550 - val_wine_type_accuracy:
0.9949

Epoch 106/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.2961 -
wine_quality_loss: 0.2757 - wine_type_loss: 0.0211 -
wine_quality_root_mean_squared_error: 0.5244 - wine_type_accuracy: 0.9962 -
val_loss: 0.3348 - val_wine_quality_loss: 0.3070 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5543 - val_wine_type_accuracy:
0.9949

Epoch 107/180

3155/3155 [=====] - 0s 74us/sample - loss: 0.2948 -
wine_quality_loss: 0.2736 - wine_type_loss: 0.0210 -
wine_quality_root_mean_squared_error: 0.5233 - wine_type_accuracy: 0.9962 -
val_loss: 0.3400 - val_wine_quality_loss: 0.3121 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5589 - val_wine_type_accuracy:
0.9949

Epoch 108/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.2944 -
wine_quality_loss: 0.2729 - wine_type_loss: 0.0209 -
wine_quality_root_mean_squared_error: 0.5229 - wine_type_accuracy: 0.9962 -
val_loss: 0.3355 - val_wine_quality_loss: 0.3076 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5549 - val_wine_type_accuracy:

0.9937

Epoch 109/180

3155/3155 [=====] - 0s 92us/sample - loss: 0.2951 -
 wine_quality_loss: 0.2741 - wine_type_loss: 0.0208 -
 wine_quality_root_mean_squared_error: 0.5237 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3371 - val_wine_quality_loss: 0.3095 - val_wine_type_loss: 0.0272 -
 val_wine_quality_root_mean_squared_error: 0.5564 - val_wine_type_accuracy:
 0.9949

Epoch 110/180

3155/3155 [=====] - 0s 74us/sample - loss: 0.2946 -
 wine_quality_loss: 0.2738 - wine_type_loss: 0.0207 -
 wine_quality_root_mean_squared_error: 0.5233 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3385 - val_wine_quality_loss: 0.3109 - val_wine_type_loss: 0.0273 -
 val_wine_quality_root_mean_squared_error: 0.5576 - val_wine_type_accuracy:
 0.9949

Epoch 111/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.2933 -
 wine_quality_loss: 0.2726 - wine_type_loss: 0.0206 -
 wine_quality_root_mean_squared_error: 0.5221 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3316 - val_wine_quality_loss: 0.3039 - val_wine_type_loss: 0.0272 -
 val_wine_quality_root_mean_squared_error: 0.5514 - val_wine_type_accuracy:
 0.9949

Epoch 112/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.2928 -
 wine_quality_loss: 0.2722 - wine_type_loss: 0.0205 -
 wine_quality_root_mean_squared_error: 0.5217 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3354 - val_wine_quality_loss: 0.3079 - val_wine_type_loss: 0.0273 -
 val_wine_quality_root_mean_squared_error: 0.5548 - val_wine_type_accuracy:
 0.9949

Epoch 113/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.2928 -
 wine_quality_loss: 0.2722 - wine_type_loss: 0.0205 -
 wine_quality_root_mean_squared_error: 0.5218 - wine_type_accuracy: 0.9965 -
 val_loss: 0.3412 - val_wine_quality_loss: 0.3133 - val_wine_type_loss: 0.0272 -
 val_wine_quality_root_mean_squared_error: 0.5600 - val_wine_type_accuracy:
 0.9937

Epoch 114/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.2914 -
 wine_quality_loss: 0.2713 - wine_type_loss: 0.0204 -
 wine_quality_root_mean_squared_error: 0.5205 - wine_type_accuracy: 0.9962 -
 val_loss: 0.3403 - val_wine_quality_loss: 0.3125 - val_wine_type_loss: 0.0272 -
 val_wine_quality_root_mean_squared_error: 0.5593 - val_wine_type_accuracy:
 0.9937

Epoch 115/180

3155/3155 [=====] - 0s 75us/sample - loss: 0.2912 -
 wine_quality_loss: 0.2709 - wine_type_loss: 0.0203 -
 wine_quality_root_mean_squared_error: 0.5205 - wine_type_accuracy: 0.9965 -
 val_loss: 0.3319 - val_wine_quality_loss: 0.3042 - val_wine_type_loss: 0.0271 -

```

val_wine_quality_root_mean_squared_error: 0.5518 - val_wine_type_accuracy:
0.9937
Epoch 116/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.2911 -
wine_quality_loss: 0.2706 - wine_type_loss: 0.0202 -
wine_quality_root_mean_squared_error: 0.5204 - wine_type_accuracy: 0.9965 -
val_loss: 0.3303 - val_wine_quality_loss: 0.3028 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5503 - val_wine_type_accuracy:
0.9937
Epoch 117/180
3155/3155 [=====] - 0s 89us/sample - loss: 0.2903 -
wine_quality_loss: 0.2699 - wine_type_loss: 0.0201 -
wine_quality_root_mean_squared_error: 0.5197 - wine_type_accuracy: 0.9962 -
val_loss: 0.3324 - val_wine_quality_loss: 0.3048 - val_wine_type_loss: 0.0269 -
val_wine_quality_root_mean_squared_error: 0.5524 - val_wine_type_accuracy:
0.9937
Epoch 118/180
3155/3155 [=====] - 0s 74us/sample - loss: 0.2884 -
wine_quality_loss: 0.2690 - wine_type_loss: 0.0200 -
wine_quality_root_mean_squared_error: 0.5180 - wine_type_accuracy: 0.9962 -
val_loss: 0.3353 - val_wine_quality_loss: 0.3078 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5549 - val_wine_type_accuracy:
0.9937
Epoch 119/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.2894 -
wine_quality_loss: 0.2691 - wine_type_loss: 0.0200 -
wine_quality_root_mean_squared_error: 0.5189 - wine_type_accuracy: 0.9962 -
val_loss: 0.3308 - val_wine_quality_loss: 0.3032 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5508 - val_wine_type_accuracy:
0.9937
Epoch 120/180
3155/3155 [=====] - 0s 89us/sample - loss: 0.2883 -
wine_quality_loss: 0.2691 - wine_type_loss: 0.0199 -
wine_quality_root_mean_squared_error: 0.5180 - wine_type_accuracy: 0.9965 -
val_loss: 0.3392 - val_wine_quality_loss: 0.3116 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5583 - val_wine_type_accuracy:
0.9937
Epoch 121/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.2887 -
wine_quality_loss: 0.2685 - wine_type_loss: 0.0199 -
wine_quality_root_mean_squared_error: 0.5184 - wine_type_accuracy: 0.9965 -
val_loss: 0.3387 - val_wine_quality_loss: 0.3111 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5579 - val_wine_type_accuracy:
0.9937
Epoch 122/180
3155/3155 [=====] - 0s 74us/sample - loss: 0.2881 -
wine_quality_loss: 0.2681 - wine_type_loss: 0.0197 -
wine_quality_root_mean_squared_error: 0.5179 - wine_type_accuracy: 0.9965 -

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val_loss: 0.3434 - val_wine_quality_loss: 0.3160 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5622 - val_wine_type_accuracy:
0.9937

Epoch 123/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.2877 -
wine_quality_loss: 0.2685 - wine_type_loss: 0.0197 -
wine_quality_root_mean_squared_error: 0.5176 - wine_type_accuracy: 0.9965 -
val_loss: 0.3412 - val_wine_quality_loss: 0.3135 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5602 - val_wine_type_accuracy:
0.9937

Epoch 124/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2869 -
wine_quality_loss: 0.2668 - wine_type_loss: 0.0196 -
wine_quality_root_mean_squared_error: 0.5169 - wine_type_accuracy: 0.9965 -
val_loss: 0.3364 - val_wine_quality_loss: 0.3086 - val_wine_type_loss: 0.0269 -
val_wine_quality_root_mean_squared_error: 0.5559 - val_wine_type_accuracy:
0.9937

Epoch 125/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.2869 -
wine_quality_loss: 0.2674 - wine_type_loss: 0.0195 -
wine_quality_root_mean_squared_error: 0.5170 - wine_type_accuracy: 0.9965 -
val_loss: 0.3315 - val_wine_quality_loss: 0.3040 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5515 - val_wine_type_accuracy:
0.9937

Epoch 126/180

3155/3155 [=====] - 0s 73us/sample - loss: 0.2861 -
wine_quality_loss: 0.2667 - wine_type_loss: 0.0194 -
wine_quality_root_mean_squared_error: 0.5163 - wine_type_accuracy: 0.9965 -
val_loss: 0.3361 - val_wine_quality_loss: 0.3084 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5556 - val_wine_type_accuracy:
0.9937

Epoch 127/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2862 -
wine_quality_loss: 0.2664 - wine_type_loss: 0.0194 -
wine_quality_root_mean_squared_error: 0.5165 - wine_type_accuracy: 0.9965 -
val_loss: 0.3311 - val_wine_quality_loss: 0.3033 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5510 - val_wine_type_accuracy:
0.9937

Epoch 128/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2848 -
wine_quality_loss: 0.2654 - wine_type_loss: 0.0193 -
wine_quality_root_mean_squared_error: 0.5152 - wine_type_accuracy: 0.9965 -
val_loss: 0.3324 - val_wine_quality_loss: 0.3050 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5522 - val_wine_type_accuracy:
0.9937

Epoch 129/180

3155/3155 [=====] - 0s 87us/sample - loss: 0.2844 -
wine_quality_loss: 0.2653 - wine_type_loss: 0.0193 -

wine_quality_root_mean_squared_error: 0.5149 - wine_type_accuracy: 0.9965 -
val_loss: 0.3284 - val_wine_quality_loss: 0.3009 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5486 - val_wine_type_accuracy:
0.9937

Epoch 130/180

3155/3155 [=====] - 0s 77us/sample - loss: 0.2843 -
wine_quality_loss: 0.2649 - wine_type_loss: 0.0192 -
wine_quality_root_mean_squared_error: 0.5149 - wine_type_accuracy: 0.9965 -
val_loss: 0.3321 - val_wine_quality_loss: 0.3046 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5520 - val_wine_type_accuracy:
0.9937

Epoch 131/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.2840 -
wine_quality_loss: 0.2651 - wine_type_loss: 0.0192 -
wine_quality_root_mean_squared_error: 0.5146 - wine_type_accuracy: 0.9965 -
val_loss: 0.3325 - val_wine_quality_loss: 0.3050 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5524 - val_wine_type_accuracy:
0.9937

Epoch 132/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.2833 -
wine_quality_loss: 0.2640 - wine_type_loss: 0.0191 -
wine_quality_root_mean_squared_error: 0.5140 - wine_type_accuracy: 0.9965 -
val_loss: 0.3316 - val_wine_quality_loss: 0.3045 - val_wine_type_loss: 0.0269 -
val_wine_quality_root_mean_squared_error: 0.5517 - val_wine_type_accuracy:
0.9937

Epoch 133/180

3155/3155 [=====] - 0s 73us/sample - loss: 0.2830 -
wine_quality_loss: 0.2634 - wine_type_loss: 0.0189 -
wine_quality_root_mean_squared_error: 0.5138 - wine_type_accuracy: 0.9965 -
val_loss: 0.3307 - val_wine_quality_loss: 0.3034 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5508 - val_wine_type_accuracy:
0.9937

Epoch 134/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.2820 -
wine_quality_loss: 0.2629 - wine_type_loss: 0.0192 -
wine_quality_root_mean_squared_error: 0.5129 - wine_type_accuracy: 0.9968 -
val_loss: 0.3305 - val_wine_quality_loss: 0.3029 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5506 - val_wine_type_accuracy:
0.9937

Epoch 135/180

3155/3155 [=====] - 0s 88us/sample - loss: 0.2822 -
wine_quality_loss: 0.2632 - wine_type_loss: 0.0188 -
wine_quality_root_mean_squared_error: 0.5131 - wine_type_accuracy: 0.9965 -
val_loss: 0.3304 - val_wine_quality_loss: 0.3030 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5505 - val_wine_type_accuracy:
0.9937

Epoch 136/180

3155/3155 [=====] - 0s 76us/sample - loss: 0.2820 -

wine_quality_loss: 0.2636 - wine_type_loss: 0.0188 -
 wine_quality_root_mean_squared_error: 0.5130 - wine_type_accuracy: 0.9965 -
 val_loss: 0.3336 - val_wine_quality_loss: 0.3061 - val_wine_type_loss: 0.0271 -
 val_wine_quality_root_mean_squared_error: 0.5533 - val_wine_type_accuracy:
 0.9937
 Epoch 137/180
 3155/3155 [=====] - 0s 92us/sample - loss: 0.2809 -
 wine_quality_loss: 0.2628 - wine_type_loss: 0.0187 -
 wine_quality_root_mean_squared_error: 0.5120 - wine_type_accuracy: 0.9965 -
 val_loss: 0.3312 - val_wine_quality_loss: 0.3035 - val_wine_type_loss: 0.0270 -
 val_wine_quality_root_mean_squared_error: 0.5511 - val_wine_type_accuracy:
 0.9937
 Epoch 138/180
 3155/3155 [=====] - 0s 90us/sample - loss: 0.2794 -
 wine_quality_loss: 0.2609 - wine_type_loss: 0.0187 -
 wine_quality_root_mean_squared_error: 0.5106 - wine_type_accuracy: 0.9965 -
 val_loss: 0.3362 - val_wine_quality_loss: 0.3086 - val_wine_type_loss: 0.0271 -
 val_wine_quality_root_mean_squared_error: 0.5556 - val_wine_type_accuracy:
 0.9937
 Epoch 139/180
 3155/3155 [=====] - 0s 90us/sample - loss: 0.2800 -
 wine_quality_loss: 0.2613 - wine_type_loss: 0.0189 -
 wine_quality_root_mean_squared_error: 0.5112 - wine_type_accuracy: 0.9965 -
 val_loss: 0.3345 - val_wine_quality_loss: 0.3070 - val_wine_type_loss: 0.0271 -
 val_wine_quality_root_mean_squared_error: 0.5541 - val_wine_type_accuracy:
 0.9937
 Epoch 140/180
 3155/3155 [=====] - 0s 76us/sample - loss: 0.2796 -
 wine_quality_loss: 0.2615 - wine_type_loss: 0.0184 -
 wine_quality_root_mean_squared_error: 0.5110 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3353 - val_wine_quality_loss: 0.3077 - val_wine_type_loss: 0.0271 -
 val_wine_quality_root_mean_squared_error: 0.5548 - val_wine_type_accuracy:
 0.9937
 Epoch 141/180
 3155/3155 [=====] - 0s 94us/sample - loss: 0.2788 -
 wine_quality_loss: 0.2602 - wine_type_loss: 0.0184 -
 wine_quality_root_mean_squared_error: 0.5102 - wine_type_accuracy: 0.9965 -
 val_loss: 0.3381 - val_wine_quality_loss: 0.3105 - val_wine_type_loss: 0.0270 -
 val_wine_quality_root_mean_squared_error: 0.5574 - val_wine_type_accuracy:
 0.9937
 Epoch 142/180
 3155/3155 [=====] - 0s 90us/sample - loss: 0.2776 -
 wine_quality_loss: 0.2592 - wine_type_loss: 0.0182 -
 wine_quality_root_mean_squared_error: 0.5092 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3403 - val_wine_quality_loss: 0.3124 - val_wine_type_loss: 0.0272 -
 val_wine_quality_root_mean_squared_error: 0.5592 - val_wine_type_accuracy:
 0.9937
 Epoch 143/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2772 -
wine_quality_loss: 0.2586 - wine_type_loss: 0.0183 -
wine_quality_root_mean_squared_error: 0.5087 - wine_type_accuracy: 0.9965 -
val_loss: 0.3359 - val_wine_quality_loss: 0.3086 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5553 - val_wine_type_accuracy:
0.9937
Epoch 144/180
3155/3155 [=====] - 0s 89us/sample - loss: 0.2779 -
wine_quality_loss: 0.2595 - wine_type_loss: 0.0182 -
wine_quality_root_mean_squared_error: 0.5095 - wine_type_accuracy: 0.9968 -
val_loss: 0.3419 - val_wine_quality_loss: 0.3144 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5608 - val_wine_type_accuracy:
0.9937
Epoch 145/180
3155/3155 [=====] - 0s 78us/sample - loss: 0.2783 -
wine_quality_loss: 0.2598 - wine_type_loss: 0.0182 -
wine_quality_root_mean_squared_error: 0.5100 - wine_type_accuracy: 0.9968 -
val_loss: 0.3302 - val_wine_quality_loss: 0.3027 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5503 - val_wine_type_accuracy:
0.9937
Epoch 146/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.2764 -
wine_quality_loss: 0.2582 - wine_type_loss: 0.0181 -
wine_quality_root_mean_squared_error: 0.5081 - wine_type_accuracy: 0.9968 -
val_loss: 0.3345 - val_wine_quality_loss: 0.3071 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5542 - val_wine_type_accuracy:
0.9937
Epoch 147/180
3155/3155 [=====] - 0s 97us/sample - loss: 0.2765 -
wine_quality_loss: 0.2582 - wine_type_loss: 0.0180 -
wine_quality_root_mean_squared_error: 0.5084 - wine_type_accuracy: 0.9968 -
val_loss: 0.3331 - val_wine_quality_loss: 0.3059 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5529 - val_wine_type_accuracy:
0.9937
Epoch 148/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.2747 -
wine_quality_loss: 0.2568 - wine_type_loss: 0.0180 -
wine_quality_root_mean_squared_error: 0.5067 - wine_type_accuracy: 0.9968 -
val_loss: 0.3346 - val_wine_quality_loss: 0.3069 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5542 - val_wine_type_accuracy:
0.9937
Epoch 149/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.2755 -
wine_quality_loss: 0.2574 - wine_type_loss: 0.0180 -
wine_quality_root_mean_squared_error: 0.5075 - wine_type_accuracy: 0.9968 -
val_loss: 0.3368 - val_wine_quality_loss: 0.3094 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5562 - val_wine_type_accuracy:
0.9937

Epoch 150/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.2747 -
wine_quality_loss: 0.2569 - wine_type_loss: 0.0178 -
wine_quality_root_mean_squared_error: 0.5068 - wine_type_accuracy: 0.9968 -
val_loss: 0.3359 - val_wine_quality_loss: 0.3082 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5555 - val_wine_type_accuracy:
0.9937

Epoch 151/180
3155/3155 [=====] - 0s 74us/sample - loss: 0.2751 -
wine_quality_loss: 0.2571 - wine_type_loss: 0.0178 -
wine_quality_root_mean_squared_error: 0.5072 - wine_type_accuracy: 0.9968 -
val_loss: 0.3350 - val_wine_quality_loss: 0.3079 - val_wine_type_loss: 0.0269 -
val_wine_quality_root_mean_squared_error: 0.5547 - val_wine_type_accuracy:
0.9937

Epoch 152/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.2739 -
wine_quality_loss: 0.2560 - wine_type_loss: 0.0176 -
wine_quality_root_mean_squared_error: 0.5062 - wine_type_accuracy: 0.9968 -
val_loss: 0.3354 - val_wine_quality_loss: 0.3078 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5551 - val_wine_type_accuracy:
0.9937

Epoch 153/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.2746 -
wine_quality_loss: 0.2566 - wine_type_loss: 0.0177 -
wine_quality_root_mean_squared_error: 0.5068 - wine_type_accuracy: 0.9968 -
val_loss: 0.3375 - val_wine_quality_loss: 0.3100 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5569 - val_wine_type_accuracy:
0.9937

Epoch 154/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.2728 -
wine_quality_loss: 0.2556 - wine_type_loss: 0.0176 -
wine_quality_root_mean_squared_error: 0.5052 - wine_type_accuracy: 0.9968 -
val_loss: 0.3350 - val_wine_quality_loss: 0.3073 - val_wine_type_loss: 0.0269 -
val_wine_quality_root_mean_squared_error: 0.5547 - val_wine_type_accuracy:
0.9937

Epoch 155/180
3155/3155 [=====] - 0s 74us/sample - loss: 0.2736 -
wine_quality_loss: 0.2562 - wine_type_loss: 0.0175 -
wine_quality_root_mean_squared_error: 0.5060 - wine_type_accuracy: 0.9968 -
val_loss: 0.3385 - val_wine_quality_loss: 0.3108 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5577 - val_wine_type_accuracy:
0.9937

Epoch 156/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.2729 -
wine_quality_loss: 0.2556 - wine_type_loss: 0.0175 -
wine_quality_root_mean_squared_error: 0.5054 - wine_type_accuracy: 0.9968 -
val_loss: 0.3365 - val_wine_quality_loss: 0.3087 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5560 - val_wine_type_accuracy:

0.9937

Epoch 157/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2718 -
 wine_quality_loss: 0.2548 - wine_type_loss: 0.0174 -
 wine_quality_root_mean_squared_error: 0.5043 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3302 - val_wine_quality_loss: 0.3025 - val_wine_type_loss: 0.0271 -
 val_wine_quality_root_mean_squared_error: 0.5503 - val_wine_type_accuracy:
 0.9937

Epoch 158/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.2721 -
 wine_quality_loss: 0.2551 - wine_type_loss: 0.0173 -
 wine_quality_root_mean_squared_error: 0.5047 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3326 - val_wine_quality_loss: 0.3047 - val_wine_type_loss: 0.0272 -
 val_wine_quality_root_mean_squared_error: 0.5523 - val_wine_type_accuracy:
 0.9937

Epoch 159/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2704 -
 wine_quality_loss: 0.2526 - wine_type_loss: 0.0173 -
 wine_quality_root_mean_squared_error: 0.5030 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3332 - val_wine_quality_loss: 0.3053 - val_wine_type_loss: 0.0271 -
 val_wine_quality_root_mean_squared_error: 0.5530 - val_wine_type_accuracy:
 0.9937

Epoch 160/180

3155/3155 [=====] - 0s 88us/sample - loss: 0.2706 -
 wine_quality_loss: 0.2529 - wine_type_loss: 0.0172 -
 wine_quality_root_mean_squared_error: 0.5033 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3374 - val_wine_quality_loss: 0.3097 - val_wine_type_loss: 0.0270 -
 val_wine_quality_root_mean_squared_error: 0.5568 - val_wine_type_accuracy:
 0.9937

Epoch 161/180

3155/3155 [=====] - 0s 79us/sample - loss: 0.2698 -
 wine_quality_loss: 0.2526 - wine_type_loss: 0.0172 -
 wine_quality_root_mean_squared_error: 0.5026 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3363 - val_wine_quality_loss: 0.3086 - val_wine_type_loss: 0.0270 -
 val_wine_quality_root_mean_squared_error: 0.5558 - val_wine_type_accuracy:
 0.9937

Epoch 162/180

3155/3155 [=====] - 0s 91us/sample - loss: 0.2698 -
 wine_quality_loss: 0.2523 - wine_type_loss: 0.0171 -
 wine_quality_root_mean_squared_error: 0.5026 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3411 - val_wine_quality_loss: 0.3134 - val_wine_type_loss: 0.0271 -
 val_wine_quality_root_mean_squared_error: 0.5601 - val_wine_type_accuracy:
 0.9937

Epoch 163/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.2696 -
 wine_quality_loss: 0.2525 - wine_type_loss: 0.0170 -
 wine_quality_root_mean_squared_error: 0.5026 - wine_type_accuracy: 0.9968 -
 val_loss: 0.3439 - val_wine_quality_loss: 0.3162 - val_wine_type_loss: 0.0271 -

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val_wine_quality_root_mean_squared_error: 0.5625 - val_wine_type_accuracy:
0.9937
Epoch 164/180
3155/3155 [=====] - 0s 92us/sample - loss: 0.2699 -
wine_quality_loss: 0.2530 - wine_type_loss: 0.0169 -
wine_quality_root_mean_squared_error: 0.5029 - wine_type_accuracy: 0.9968 -
val_loss: 0.3432 - val_wine_quality_loss: 0.3156 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5618 - val_wine_type_accuracy:
0.9937
Epoch 165/180
3155/3155 [=====] - 0s 75us/sample - loss: 0.2685 -
wine_quality_loss: 0.2513 - wine_type_loss: 0.0169 -
wine_quality_root_mean_squared_error: 0.5016 - wine_type_accuracy: 0.9968 -
val_loss: 0.3307 - val_wine_quality_loss: 0.3031 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5506 - val_wine_type_accuracy:
0.9937
Epoch 166/180
3155/3155 [=====] - 0s 90us/sample - loss: 0.2676 -
wine_quality_loss: 0.2504 - wine_type_loss: 0.0169 -
wine_quality_root_mean_squared_error: 0.5007 - wine_type_accuracy: 0.9968 -
val_loss: 0.3334 - val_wine_quality_loss: 0.3059 - val_wine_type_loss: 0.0270 -
val_wine_quality_root_mean_squared_error: 0.5531 - val_wine_type_accuracy:
0.9937
Epoch 167/180
3155/3155 [=====] - 0s 94us/sample - loss: 0.2676 -
wine_quality_loss: 0.2502 - wine_type_loss: 0.0168 -
wine_quality_root_mean_squared_error: 0.5007 - wine_type_accuracy: 0.9968 -
val_loss: 0.3325 - val_wine_quality_loss: 0.3050 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5523 - val_wine_type_accuracy:
0.9937
Epoch 168/180
3155/3155 [=====] - 0s 90us/sample - loss: 0.2678 -
wine_quality_loss: 0.2507 - wine_type_loss: 0.0167 -
wine_quality_root_mean_squared_error: 0.5010 - wine_type_accuracy: 0.9968 -
val_loss: 0.3336 - val_wine_quality_loss: 0.3060 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5533 - val_wine_type_accuracy:
0.9937
Epoch 169/180
3155/3155 [=====] - 0s 75us/sample - loss: 0.2663 -
wine_quality_loss: 0.2494 - wine_type_loss: 0.0168 -
wine_quality_root_mean_squared_error: 0.4995 - wine_type_accuracy: 0.9968 -
val_loss: 0.3472 - val_wine_quality_loss: 0.3193 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5655 - val_wine_type_accuracy:
0.9937
Epoch 170/180
3155/3155 [=====] - 0s 91us/sample - loss: 0.2668 -
wine_quality_loss: 0.2502 - wine_type_loss: 0.0166 -
wine_quality_root_mean_squared_error: 0.5002 - wine_type_accuracy: 0.9968 -

```

val_loss: 0.3333 - val_wine_quality_loss: 0.3055 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5530 - val_wine_type_accuracy:
0.9937

Epoch 171/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.2662 -
wine_quality_loss: 0.2492 - wine_type_loss: 0.0165 -
wine_quality_root_mean_squared_error: 0.4996 - wine_type_accuracy: 0.9968 -
val_loss: 0.3365 - val_wine_quality_loss: 0.3087 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5558 - val_wine_type_accuracy:
0.9937

Epoch 172/180

3155/3155 [=====] - 0s 72us/sample - loss: 0.2657 -
wine_quality_loss: 0.2489 - wine_type_loss: 0.0165 -
wine_quality_root_mean_squared_error: 0.4991 - wine_type_accuracy: 0.9968 -
val_loss: 0.3308 - val_wine_quality_loss: 0.3031 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5506 - val_wine_type_accuracy:
0.9937

Epoch 173/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.2658 -
wine_quality_loss: 0.2499 - wine_type_loss: 0.0165 -
wine_quality_root_mean_squared_error: 0.4993 - wine_type_accuracy: 0.9968 -
val_loss: 0.3369 - val_wine_quality_loss: 0.3091 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5562 - val_wine_type_accuracy:
0.9937

Epoch 174/180

3155/3155 [=====] - 0s 89us/sample - loss: 0.2650 -
wine_quality_loss: 0.2481 - wine_type_loss: 0.0164 -
wine_quality_root_mean_squared_error: 0.4986 - wine_type_accuracy: 0.9968 -
val_loss: 0.3322 - val_wine_quality_loss: 0.3044 - val_wine_type_loss: 0.0272 -
val_wine_quality_root_mean_squared_error: 0.5519 - val_wine_type_accuracy:
0.9937

Epoch 175/180

3155/3155 [=====] - 0s 74us/sample - loss: 0.2646 -
wine_quality_loss: 0.2480 - wine_type_loss: 0.0164 -
wine_quality_root_mean_squared_error: 0.4982 - wine_type_accuracy: 0.9968 -
val_loss: 0.3344 - val_wine_quality_loss: 0.3068 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5540 - val_wine_type_accuracy:
0.9937

Epoch 176/180

3155/3155 [=====] - 0s 90us/sample - loss: 0.2643 -
wine_quality_loss: 0.2485 - wine_type_loss: 0.0169 -
wine_quality_root_mean_squared_error: 0.4980 - wine_type_accuracy: 0.9968 -
val_loss: 0.3381 - val_wine_quality_loss: 0.3103 - val_wine_type_loss: 0.0271 -
val_wine_quality_root_mean_squared_error: 0.5574 - val_wine_type_accuracy:
0.9937

Epoch 177/180

3155/3155 [=====] - 0s 93us/sample - loss: 0.2636 -
wine_quality_loss: 0.2478 - wine_type_loss: 0.0164 -

```
wine_quality_root_mean_squared_error: 0.4973 - wine_type_accuracy: 0.9968 -  
val_loss: 0.3328 - val_wine_quality_loss: 0.3053 - val_wine_type_loss: 0.0270 -  
val_wine_quality_root_mean_squared_error: 0.5527 - val_wine_type_accuracy:  
0.9937
```

Epoch 178/180

```
3155/3155 [=====] - 0s 88us/sample - loss: 0.2640 -  
wine_quality_loss: 0.2478 - wine_type_loss: 0.0161 -  
wine_quality_root_mean_squared_error: 0.4978 - wine_type_accuracy: 0.9968 -  
val_loss: 0.3393 - val_wine_quality_loss: 0.3118 - val_wine_type_loss: 0.0271 -  
val_wine_quality_root_mean_squared_error: 0.5584 - val_wine_type_accuracy:  
0.9937
```

Epoch 179/180

```
3155/3155 [=====] - 0s 76us/sample - loss: 0.2635 -  
wine_quality_loss: 0.2474 - wine_type_loss: 0.0161 -  
wine_quality_root_mean_squared_error: 0.4974 - wine_type_accuracy: 0.9968 -  
val_loss: 0.3331 - val_wine_quality_loss: 0.3056 - val_wine_type_loss: 0.0272 -  
val_wine_quality_root_mean_squared_error: 0.5528 - val_wine_type_accuracy:  
0.9937
```

Epoch 180/180

```
3155/3155 [=====] - 0s 89us/sample - loss: 0.2623 -  
wine_quality_loss: 0.2464 - wine_type_loss: 0.0160 -  
wine_quality_root_mean_squared_error: 0.4962 - wine_type_accuracy: 0.9968 -  
val_loss: 0.3368 - val_wine_quality_loss: 0.3092 - val_wine_type_loss: 0.0270 -  
val_wine_quality_root_mean_squared_error: 0.5563 - val_wine_type_accuracy:  
0.9937
```

```
[47]: utils.test_history(history)
```

All public tests passed

```
[48]: # Gather the training metrics  
loss, wine_quality_loss, wine_type_loss, wine_quality_rmse, wine_type_accuracy_  
    => model.evaluate(x=norm_val_X, y=val_Y)  
  
print()  
print(f'loss: {loss}')  
print(f'wine_quality_loss: {wine_quality_loss}')  
print(f'wine_type_loss: {wine_type_loss}')  
print(f'wine_quality_rmse: {wine_quality_rmse}')  
print(f'wine_type_accuracy: {wine_type_accuracy}')
```

EXPECTED VALUES
~ 0.30 - 0.38
~ 0.30 - 0.38
~ 0.018 - 0.030
~ 0.50 - 0.62
~ 0.97 - 1.0

```
# Example:
#0.3657050132751465
#0.3463745415210724
#0.019330406561493874
#0.5885359048843384
#0.9974651336669922
```

```
789/789 [=====] - 0s 21us/sample - loss: 0.3368 -
wine_quality_loss: 0.3092 - wine_type_loss: 0.0270 -
wine_quality_root_mean_squared_error: 0.5563 - wine_type_accuracy: 0.9937
```

```
loss: 0.3367999849890575
wine_quality_loss: 0.3091645836830139
wine_type_loss: 0.026983363553881645
wine_quality_rmse: 0.5562899112701416
wine_type_accuracy: 0.9936628937721252
```

2.3 Analyze the Model Performance

Note that the model has two outputs. The output at index 0 is quality and index 1 is wine type. So, round the quality predictions to the nearest integer.

```
[49]: predictions = model.predict(norm_test_X)
      quality_pred = predictions[0]
      type_pred = predictions[1]
```

```
[50]: print(quality_pred[0])

# EXPECTED OUTPUT
# 5.6 - 6.0
```

```
[5.796217]
```

```
[51]: print(type_pred[0])
      print(type_pred[944])

# EXPECTED OUTPUT
# A number close to zero
# A number close to or equal to 1
```

```
[0.00023307]
[0.99999845]
```

2.3.1 Plot Utilities

We define a few utilities to visualize the model performance.

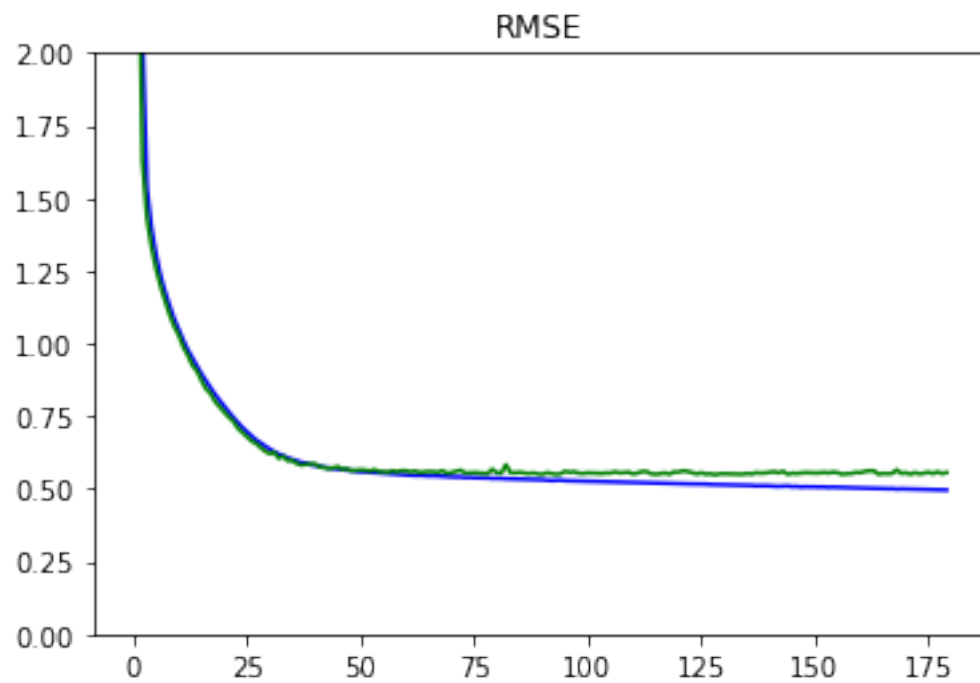
```
[52]: def plot_metrics(metric_name, title, ylim=5):
        plt.title(title)
        plt.ylim(0,ylim)
        plt.plot(history.history[metric_name],color='blue',label=metric_name)
        plt.plot(history.history['val_' + metric_name],color='green',label='val_' +
        ↪metric_name)
```

```
[53]: def plot_confusion_matrix(y_true, y_pred, title='', labels=[0,1]):
        cm = confusion_matrix(y_true, y_pred)
        fig = plt.figure()
        ax = fig.add_subplot(111)
        cax = ax.matshow(cm)
        plt.title('Confusion matrix of the classifier')
        fig.colorbar(cax)
        ax.set_xticklabels([''] + labels)
        ax.set_yticklabels([''] + labels)
        plt.xlabel('Predicted')
        plt.ylabel('True')
        fmt = 'd'
        thresh = cm.max() / 2.
        for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
            plt.text(j, i, format(cm[i, j], fmt),
                    horizontalalignment="center",
                    color="black" if cm[i, j] > thresh else "white")
        plt.show()
```

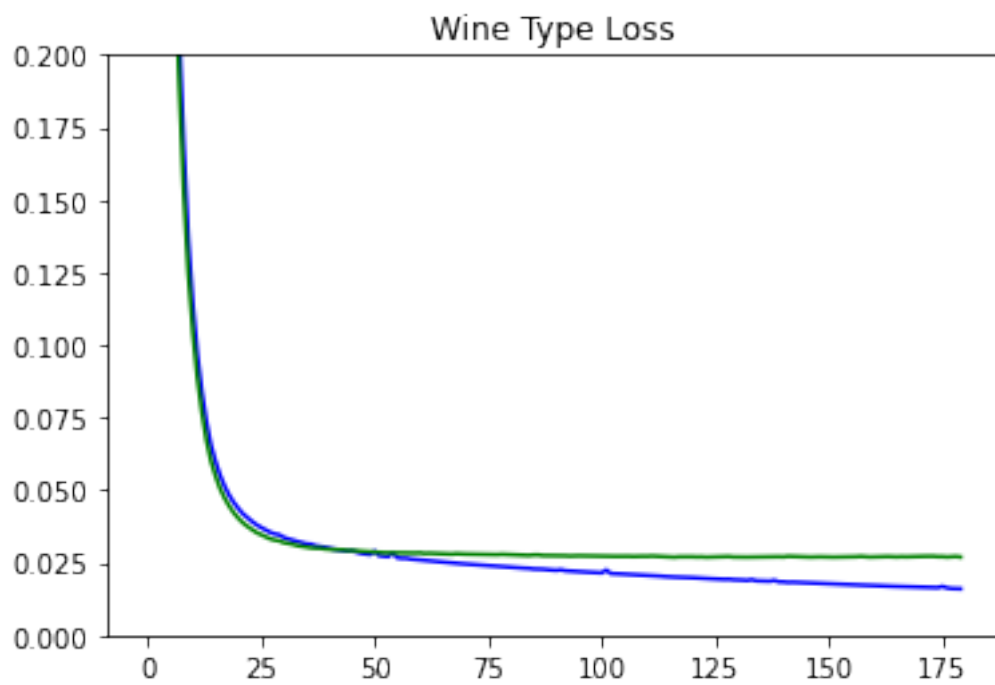
```
[54]: def plot_diff(y_true, y_pred, title = '' ):
        plt.scatter(y_true, y_pred)
        plt.title(title)
        plt.xlabel('True Values')
        plt.ylabel('Predictions')
        plt.axis('equal')
        plt.axis('square')
        plt.plot([-100, 100], [-100, 100])
        return plt
```

2.3.2 Plots for Metrics

```
[55]: plot_metrics('wine_quality_root_mean_squared_error', 'RMSE', ylim=2)
```

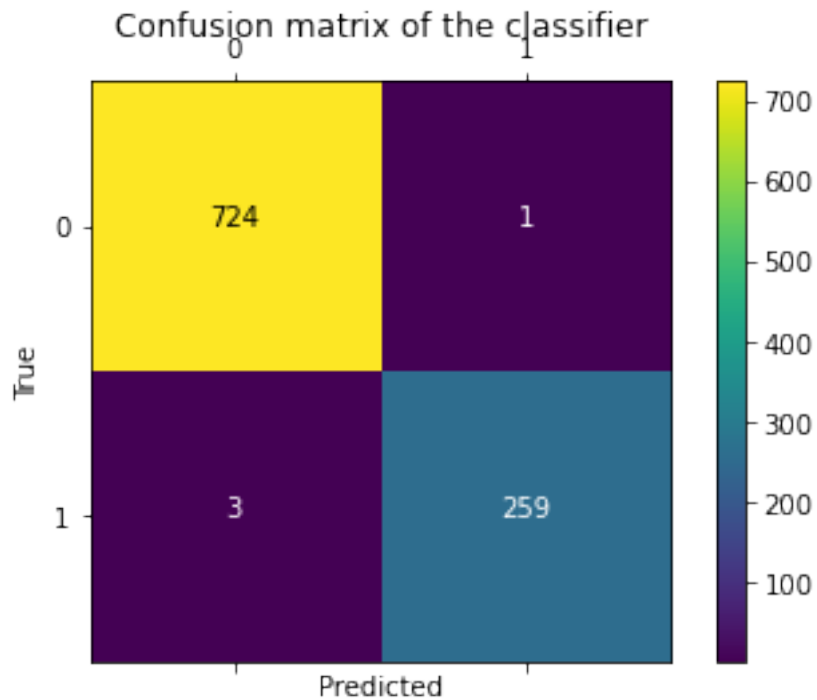
```
[56]: plot_metrics('wine_type_loss', 'Wine Type Loss', ylim=0.2)
```



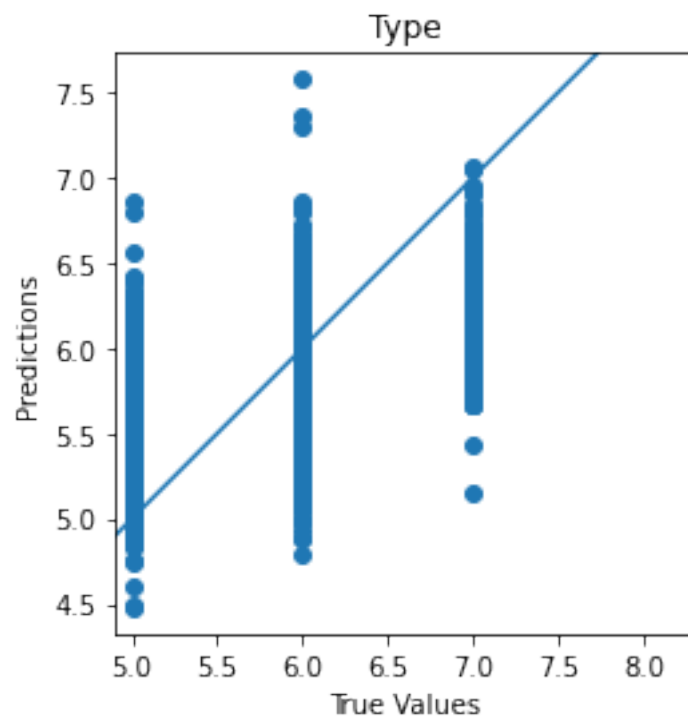
2.3.3 Plots for Confusion Matrix

Plot the confusion matrices for wine type. You can see that the model performs well for prediction of wine type from the confusion matrix and the loss metrics.

```
[57]: plot_confusion_matrix(test_Y[1], np.round(type_pred), title='Wine Type', labels_
      ↪= [0, 1])
```



```
[58]: scatter_plot = plot_diff(test_Y[0], quality_pred, title='Type')
```



[]: