Hands\_on\_Activity\_7\_1

|  |  |
| --- | --- |
| Technological Institute of the Philippines | Quezon City - Computer Engineering |
| Course Code: | CPE 019 |
| Code Title: | Emerging Technologies in CpE 2 |
| Summer | AY 2024 - 2025 |
|  |  |
| \*\*Hands-on Activity 7.1\*\* | \*\*Classifications and Regression\*\* |
| **Name** | Calvadores, Kelly Joseph |
| **Section** | CPE32S1 |
| **Date Performed**: | June 28, 2024 |
| **Date Submitted**: | June , 2024 |
| **Instructor**: | Engr. Roman M. Richard |

# Choose any dataset applicable to the classification problem, and also, choose any dataset applicable to the regression problem.[¶](#Xc2de825d37560b946d622b7c33ab1d1b5b057c0)

# Explain your datasets and the problem being addressed.[¶](#X328b202143c2b9a66105f89c123e69f19d2bc28)

* The problem that is currently being addressed is the quality of the 2 wines, the goal for this, is to model the wine quality based on the tests that has been made. To approach the quality of the wine based on the physicochemical properties that is given, the model can help to predict the aiding quality control of the wine and decision making in the wine industry

# For classification, do the following:[¶](#For-classification,-do-the-following:)

In [2]:

!pip install scikeras

Collecting scikeras  
 Downloading scikeras-0.13.0-py3-none-any.whl (26 kB)  
Collecting keras>=3.2.0 (from scikeras)  
 Downloading keras-3.4.1-py3-none-any.whl (1.1 MB)  
 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.1/1.1 MB 6.9 MB/s eta 0:00:00  
Collecting scikit-learn>=1.4.2 (from scikeras)  
 Downloading scikit\_learn-1.5.0-cp310-cp310-manylinux\_2\_17\_x86\_64.manylinux2014\_x86\_64.whl (13.3 MB)  
 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 13.3/13.3 MB 50.9 MB/s eta 0:00:00  
Requirement already satisfied: absl-py in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (1.4.0)  
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (1.25.2)  
Requirement already satisfied: rich in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (13.7.1)  
Collecting namex (from keras>=3.2.0->scikeras)  
 Downloading namex-0.0.8-py3-none-any.whl (5.8 kB)  
Requirement already satisfied: h5py in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (3.9.0)  
Collecting optree (from keras>=3.2.0->scikeras)  
 Downloading optree-0.11.0-cp310-cp310-manylinux\_2\_17\_x86\_64.manylinux2014\_x86\_64.whl (311 kB)  
 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 311.2/311.2 kB 28.3 MB/s eta 0:00:00  
Requirement already satisfied: ml-dtypes in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (0.2.0)  
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (24.1)  
Requirement already satisfied: scipy>=1.6.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.4.2->scikeras) (1.11.4)  
Requirement already satisfied: joblib>=1.2.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.4.2->scikeras) (1.4.2)  
Requirement already satisfied: threadpoolctl>=3.1.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.4.2->scikeras) (3.5.0)  
Requirement already satisfied: typing-extensions>=4.0.0 in /usr/local/lib/python3.10/dist-packages (from optree->keras>=3.2.0->scikeras) (4.12.2)  
Requirement already satisfied: markdown-it-py>=2.2.0 in /usr/local/lib/python3.10/dist-packages (from rich->keras>=3.2.0->scikeras) (3.0.0)  
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in /usr/local/lib/python3.10/dist-packages (from rich->keras>=3.2.0->scikeras) (2.16.1)  
Requirement already satisfied: mdurl~=0.1 in /usr/local/lib/python3.10/dist-packages (from markdown-it-py>=2.2.0->rich->keras>=3.2.0->scikeras) (0.1.2)  
Installing collected packages: namex, optree, scikit-learn, keras, scikeras  
 Attempting uninstall: scikit-learn  
 Found existing installation: scikit-learn 1.2.2  
 Uninstalling scikit-learn-1.2.2:  
 Successfully uninstalled scikit-learn-1.2.2  
 Attempting uninstall: keras  
 Found existing installation: keras 2.15.0  
 Uninstalling keras-2.15.0:  
 Successfully uninstalled keras-2.15.0  
ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is the source of the following dependency conflicts.  
tensorflow 2.15.0 requires keras<2.16,>=2.15.0, but you have keras 3.4.1 which is incompatible.  
Successfully installed keras-3.4.1 namex-0.0.8 optree-0.11.0 scikeras-0.13.0 scikit-learn-1.5.0

In [1]:

import pandas as pd  
from keras.models import Sequential  
from keras.layers import Dense  
from scikeras.wrappers import KerasClassifier  
from tensorflow.keras.utils import to\_categorical  
from sklearn.model\_selection import cross\_val\_score  
from sklearn.model\_selection import KFold  
from sklearn.preprocessing import LabelEncoder  
from sklearn.pipeline import Pipeline  
from sklearn.preprocessing import StandardScaler  
from sklearn.model\_selection import train\_test\_split

Resource: <https://archive.ics.uci.edu/dataset/186/wine+quality>

In [9]:

CData = pd.read\_csv('/content/drive/MyDrive/CPE 019 (Retake)/HOA 7.1/WineQualityData/winequality-white.csv', sep = ';')  
CData

Out[9]:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | fixed acidity | volatile acidity | citric acid | residual sugar | chlorides | free sulfur dioxide | total sulfur dioxide | density | pH | sulphates | alcohol | quality |
| 0 | 7.0 | 0.27 | 0.36 | 20.7 | 0.045 | 45.0 | 170.0 | 1.00100 | 3.00 | 0.45 | 8.8 | 6 |
| 1 | 6.3 | 0.30 | 0.34 | 1.6 | 0.049 | 14.0 | 132.0 | 0.99400 | 3.30 | 0.49 | 9.5 | 6 |
| 2 | 8.1 | 0.28 | 0.40 | 6.9 | 0.050 | 30.0 | 97.0 | 0.99510 | 3.26 | 0.44 | 10.1 | 6 |
| 3 | 7.2 | 0.23 | 0.32 | 8.5 | 0.058 | 47.0 | 186.0 | 0.99560 | 3.19 | 0.40 | 9.9 | 6 |
| 4 | 7.2 | 0.23 | 0.32 | 8.5 | 0.058 | 47.0 | 186.0 | 0.99560 | 3.19 | 0.40 | 9.9 | 6 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 4893 | 6.2 | 0.21 | 0.29 | 1.6 | 0.039 | 24.0 | 92.0 | 0.99114 | 3.27 | 0.50 | 11.2 | 6 |
| 4894 | 6.6 | 0.32 | 0.36 | 8.0 | 0.047 | 57.0 | 168.0 | 0.99490 | 3.15 | 0.46 | 9.6 | 5 |
| 4895 | 6.5 | 0.24 | 0.19 | 1.2 | 0.041 | 30.0 | 111.0 | 0.99254 | 2.99 | 0.46 | 9.4 | 6 |
| 4896 | 5.5 | 0.29 | 0.30 | 1.1 | 0.022 | 20.0 | 110.0 | 0.98869 | 3.34 | 0.38 | 12.8 | 7 |
| 4897 | 6.0 | 0.21 | 0.38 | 0.8 | 0.020 | 22.0 | 98.0 | 0.98941 | 3.26 | 0.32 | 11.8 | 6 |

4898 rows × 12 columns

In [10]:

CData.info()

<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 4898 entries, 0 to 4897  
Data columns (total 12 columns):  
 # Column Non-Null Count Dtype   
--- ------ -------------- -----   
 0 fixed acidity 4898 non-null float64  
 1 volatile acidity 4898 non-null float64  
 2 citric acid 4898 non-null float64  
 3 residual sugar 4898 non-null float64  
 4 chlorides 4898 non-null float64  
 5 free sulfur dioxide 4898 non-null float64  
 6 total sulfur dioxide 4898 non-null float64  
 7 density 4898 non-null float64  
 8 pH 4898 non-null float64  
 9 sulphates 4898 non-null float64  
 10 alcohol 4898 non-null float64  
 11 quality 4898 non-null int64   
dtypes: float64(11), int64(1)  
memory usage: 459.3 KB

In [11]:

CData.corr()

Out[11]:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | fixed acidity | volatile acidity | citric acid | residual sugar | chlorides | free sulfur dioxide | total sulfur dioxide | density | pH | sulphates | alcohol | quality |
| fixed acidity | 1.000000 | -0.022697 | 0.289181 | 0.089021 | 0.023086 | -0.049396 | 0.091070 | 0.265331 | -0.425858 | -0.017143 | -0.120881 | -0.113663 |
| volatile acidity | -0.022697 | 1.000000 | -0.149472 | 0.064286 | 0.070512 | -0.097012 | 0.089261 | 0.027114 | -0.031915 | -0.035728 | 0.067718 | -0.194723 |
| citric acid | 0.289181 | -0.149472 | 1.000000 | 0.094212 | 0.114364 | 0.094077 | 0.121131 | 0.149503 | -0.163748 | 0.062331 | -0.075729 | -0.009209 |
| residual sugar | 0.089021 | 0.064286 | 0.094212 | 1.000000 | 0.088685 | 0.299098 | 0.401439 | 0.838966 | -0.194133 | -0.026664 | -0.450631 | -0.097577 |
| chlorides | 0.023086 | 0.070512 | 0.114364 | 0.088685 | 1.000000 | 0.101392 | 0.198910 | 0.257211 | -0.090439 | 0.016763 | -0.360189 | -0.209934 |
| free sulfur dioxide | -0.049396 | -0.097012 | 0.094077 | 0.299098 | 0.101392 | 1.000000 | 0.615501 | 0.294210 | -0.000618 | 0.059217 | -0.250104 | 0.008158 |
| total sulfur dioxide | 0.091070 | 0.089261 | 0.121131 | 0.401439 | 0.198910 | 0.615501 | 1.000000 | 0.529881 | 0.002321 | 0.134562 | -0.448892 | -0.174737 |
| density | 0.265331 | 0.027114 | 0.149503 | 0.838966 | 0.257211 | 0.294210 | 0.529881 | 1.000000 | -0.093591 | 0.074493 | -0.780138 | -0.307123 |
| pH | -0.425858 | -0.031915 | -0.163748 | -0.194133 | -0.090439 | -0.000618 | 0.002321 | -0.093591 | 1.000000 | 0.155951 | 0.121432 | 0.099427 |
| sulphates | -0.017143 | -0.035728 | 0.062331 | -0.026664 | 0.016763 | 0.059217 | 0.134562 | 0.074493 | 0.155951 | 1.000000 | -0.017433 | 0.053678 |
| alcohol | -0.120881 | 0.067718 | -0.075729 | -0.450631 | -0.360189 | -0.250104 | -0.448892 | -0.780138 | 0.121432 | -0.017433 | 1.000000 | 0.435575 |
| quality | -0.113663 | -0.194723 | -0.009209 | -0.097577 | -0.209934 | 0.008158 | -0.174737 | -0.307123 | 0.099427 | 0.053678 | 0.435575 | 1.000000 |

In [12]:

CorrMatr = CData.corr()  
TargCorr = CorrMatr['quality']  
AbsTarCorr = TargCorr.abs()  
LowCorrFeat = AbsTarCorr[AbsTarCorr < 0.01]  
print(LowCorrFeat)

citric acid 0.009209  
free sulfur dioxide 0.008158  
Name: quality, dtype: float64

In [13]:

CData = CData.drop(columns = LowCorrFeat.index)  
CData

Out[13]:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | fixed acidity | volatile acidity | residual sugar | chlorides | total sulfur dioxide | density | pH | sulphates | alcohol | quality |
| 0 | 7.0 | 0.27 | 20.7 | 0.045 | 170.0 | 1.00100 | 3.00 | 0.45 | 8.8 | 6 |
| 1 | 6.3 | 0.30 | 1.6 | 0.049 | 132.0 | 0.99400 | 3.30 | 0.49 | 9.5 | 6 |
| 2 | 8.1 | 0.28 | 6.9 | 0.050 | 97.0 | 0.99510 | 3.26 | 0.44 | 10.1 | 6 |
| 3 | 7.2 | 0.23 | 8.5 | 0.058 | 186.0 | 0.99560 | 3.19 | 0.40 | 9.9 | 6 |
| 4 | 7.2 | 0.23 | 8.5 | 0.058 | 186.0 | 0.99560 | 3.19 | 0.40 | 9.9 | 6 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 4893 | 6.2 | 0.21 | 1.6 | 0.039 | 92.0 | 0.99114 | 3.27 | 0.50 | 11.2 | 6 |
| 4894 | 6.6 | 0.32 | 8.0 | 0.047 | 168.0 | 0.99490 | 3.15 | 0.46 | 9.6 | 5 |
| 4895 | 6.5 | 0.24 | 1.2 | 0.041 | 111.0 | 0.99254 | 2.99 | 0.46 | 9.4 | 6 |
| 4896 | 5.5 | 0.29 | 1.1 | 0.022 | 110.0 | 0.98869 | 3.34 | 0.38 | 12.8 | 7 |
| 4897 | 6.0 | 0.21 | 0.8 | 0.020 | 98.0 | 0.98941 | 3.26 | 0.32 | 11.8 | 6 |

4898 rows × 10 columns

In [21]:

CData.info()

<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 4898 entries, 0 to 4897  
Data columns (total 10 columns):  
 # Column Non-Null Count Dtype   
--- ------ -------------- -----   
 0 fixed acidity 4898 non-null float64  
 1 volatile acidity 4898 non-null float64  
 2 residual sugar 4898 non-null float64  
 3 chlorides 4898 non-null float64  
 4 total sulfur dioxide 4898 non-null float64  
 5 density 4898 non-null float64  
 6 pH 4898 non-null float64  
 7 sulphates 4898 non-null float64  
 8 alcohol 4898 non-null float64  
 9 quality 4898 non-null int64   
dtypes: float64(9), int64(1)  
memory usage: 382.8 KB

In [14]:

CX = CData.iloc[:, :-1]  
Cy = CData.iloc[:, -1]

In [15]:

SS = StandardScaler()  
CX = SS.fit\_transform(CX)

In [16]:

CX\_train, CX\_test, Cy\_train, Cy\_test = train\_test\_split(CX, Cy, test\_size = 0.25, random\_state = 123)

In [17]:

LE = LabelEncoder()  
Cy\_train = LE.fit\_transform(Cy\_train)  
Cy\_test = LE.fit\_transform(Cy\_test)  
Cy\_train = to\_categorical(Cy\_train)  
Cy\_test = to\_categorical(Cy\_test)

In [18]:

Cy\_train.shape

Out[18]:

(3673, 7)

## Create a base model[¶](#Create-a-base-model)

In [22]:

def Cbaseline\_model():  
 model = Sequential()  
 model.add(Dense(32, input\_dim = 9, activation = 'relu'))  
 model.add(Dense(7, activation = 'softmax'))  
  
 model.compile(loss = 'categorical\_crossentropy', optimizer = 'adam', metrics = ['accuracy'])  
 return model

## Evaluate the model with k-fold cross validation[¶](#X5ab3a772e6ec3c48b673d1acacba83ff8e598a5)

In [24]:

CEstimator = KerasClassifier(model = Cbaseline\_model, epochs = 500, batch\_size = 5000, verbose = 0)  
Ckfold = KFold(n\_splits = 10, shuffle = True)  
CResults = cross\_val\_score(CEstimator, CX\_train, Cy\_train, cv = Ckfold)  
print("Baseline: %.2f%% (%.2f%%)" % (CResults.mean()\*100, CResults.std()\*100))

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)

Baseline: 54.91% (2.19%)

## Improve the accuracy of your model by applying additional hidden layers[¶](#X6be9b6c1c28387b1c24795b7d7e13270a7578b2)

In [27]:

def Cbaseline\_model():  
 model = Sequential()  
 model.add(Dense(128, input\_dim = 9, activation = 'relu'))  
 model.add(Dense(64, activation = 'relu'))  
 model.add(Dense(32, activation = 'relu'))  
 model.add(Dense(7, activation = 'softmax'))  
  
 model.compile(loss = 'categorical\_crossentropy', optimizer = 'adam', metrics = ['accuracy'])  
 return model

In [28]:

CEstimator = KerasClassifier(model = Cbaseline\_model, epochs = 500, batch\_size = 5000, verbose = 0)  
Ckfold = KFold(n\_splits = 10, shuffle = True)  
CResults = cross\_val\_score(CEstimator, CX\_train, Cy\_train, cv = Ckfold)  
print("Baseline: %.2f%% (%.2f%%)" % (CResults.mean()\*100, CResults.std()\*100))

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)

Baseline: 56.25% (2.74%)

# For regression, do the following:[¶](#For-regression,-do-the-following:)

In [2]:

!pip install scikeras

Collecting scikeras  
 Downloading scikeras-0.13.0-py3-none-any.whl (26 kB)  
Collecting keras>=3.2.0 (from scikeras)  
 Downloading keras-3.4.1-py3-none-any.whl (1.1 MB)  
 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.1/1.1 MB 6.1 MB/s eta 0:00:00  
Collecting scikit-learn>=1.4.2 (from scikeras)  
 Downloading scikit\_learn-1.5.0-cp310-cp310-manylinux\_2\_17\_x86\_64.manylinux2014\_x86\_64.whl (13.3 MB)  
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Requirement already satisfied: absl-py in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (1.4.0)  
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (1.25.2)  
Requirement already satisfied: rich in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (13.7.1)  
Collecting namex (from keras>=3.2.0->scikeras)  
 Downloading namex-0.0.8-py3-none-any.whl (5.8 kB)  
Requirement already satisfied: h5py in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (3.9.0)  
Collecting optree (from keras>=3.2.0->scikeras)  
 Downloading optree-0.11.0-cp310-cp310-manylinux\_2\_17\_x86\_64.manylinux2014\_x86\_64.whl (311 kB)  
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Requirement already satisfied: ml-dtypes in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (0.2.0)  
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from keras>=3.2.0->scikeras) (24.1)  
Requirement already satisfied: scipy>=1.6.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.4.2->scikeras) (1.11.4)  
Requirement already satisfied: joblib>=1.2.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.4.2->scikeras) (1.4.2)  
Requirement already satisfied: threadpoolctl>=3.1.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.4.2->scikeras) (3.5.0)  
Requirement already satisfied: typing-extensions>=4.0.0 in /usr/local/lib/python3.10/dist-packages (from optree->keras>=3.2.0->scikeras) (4.12.2)  
Requirement already satisfied: markdown-it-py>=2.2.0 in /usr/local/lib/python3.10/dist-packages (from rich->keras>=3.2.0->scikeras) (3.0.0)  
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in /usr/local/lib/python3.10/dist-packages (from rich->keras>=3.2.0->scikeras) (2.16.1)  
Requirement already satisfied: mdurl~=0.1 in /usr/local/lib/python3.10/dist-packages (from markdown-it-py>=2.2.0->rich->keras>=3.2.0->scikeras) (0.1.2)  
Installing collected packages: namex, optree, scikit-learn, keras, scikeras  
 Attempting uninstall: scikit-learn  
 Found existing installation: scikit-learn 1.2.2  
 Uninstalling scikit-learn-1.2.2:  
 Successfully uninstalled scikit-learn-1.2.2  
 Attempting uninstall: keras  
 Found existing installation: keras 2.15.0  
 Uninstalling keras-2.15.0:  
 Successfully uninstalled keras-2.15.0  
ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is the source of the following dependency conflicts.  
tensorflow 2.15.0 requires keras<2.16,>=2.15.0, but you have keras 3.4.1 which is incompatible.  
Successfully installed keras-3.4.1 namex-0.0.8 optree-0.11.0 scikeras-0.13.0 scikit-learn-1.5.0

In [1]:

import pandas as pd  
from keras.models import Sequential  
from keras.layers import Dense  
from scikeras.wrappers import KerasRegressor  
from tensorflow.keras.utils import to\_categorical  
from sklearn.model\_selection import cross\_val\_score  
from sklearn.model\_selection import KFold  
from sklearn.preprocessing import LabelEncoder  
from sklearn.pipeline import Pipeline  
from sklearn.preprocessing import StandardScaler  
from sklearn.model\_selection import train\_test\_split

In [2]:

RData = pd.read\_csv('/content/drive/MyDrive/CPE 019 (Retake)/HOA 7.1/WineQualityData/winequality-red.csv', sep = ';')  
RData

Out[2]:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | fixed acidity | volatile acidity | citric acid | residual sugar | chlorides | free sulfur dioxide | total sulfur dioxide | density | pH | sulphates | alcohol | quality |
| 0 | 7.4 | 0.700 | 0.00 | 1.9 | 0.076 | 11.0 | 34.0 | 0.99780 | 3.51 | 0.56 | 9.4 | 5 |
| 1 | 7.8 | 0.880 | 0.00 | 2.6 | 0.098 | 25.0 | 67.0 | 0.99680 | 3.20 | 0.68 | 9.8 | 5 |
| 2 | 7.8 | 0.760 | 0.04 | 2.3 | 0.092 | 15.0 | 54.0 | 0.99700 | 3.26 | 0.65 | 9.8 | 5 |
| 3 | 11.2 | 0.280 | 0.56 | 1.9 | 0.075 | 17.0 | 60.0 | 0.99800 | 3.16 | 0.58 | 9.8 | 6 |
| 4 | 7.4 | 0.700 | 0.00 | 1.9 | 0.076 | 11.0 | 34.0 | 0.99780 | 3.51 | 0.56 | 9.4 | 5 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1594 | 6.2 | 0.600 | 0.08 | 2.0 | 0.090 | 32.0 | 44.0 | 0.99490 | 3.45 | 0.58 | 10.5 | 5 |
| 1595 | 5.9 | 0.550 | 0.10 | 2.2 | 0.062 | 39.0 | 51.0 | 0.99512 | 3.52 | 0.76 | 11.2 | 6 |
| 1596 | 6.3 | 0.510 | 0.13 | 2.3 | 0.076 | 29.0 | 40.0 | 0.99574 | 3.42 | 0.75 | 11.0 | 6 |
| 1597 | 5.9 | 0.645 | 0.12 | 2.0 | 0.075 | 32.0 | 44.0 | 0.99547 | 3.57 | 0.71 | 10.2 | 5 |
| 1598 | 6.0 | 0.310 | 0.47 | 3.6 | 0.067 | 18.0 | 42.0 | 0.99549 | 3.39 | 0.66 | 11.0 | 6 |

1599 rows × 12 columns

In [3]:

RData.info()

<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 1599 entries, 0 to 1598  
Data columns (total 12 columns):  
 # Column Non-Null Count Dtype   
--- ------ -------------- -----   
 0 fixed acidity 1599 non-null float64  
 1 volatile acidity 1599 non-null float64  
 2 citric acid 1599 non-null float64  
 3 residual sugar 1599 non-null float64  
 4 chlorides 1599 non-null float64  
 5 free sulfur dioxide 1599 non-null float64  
 6 total sulfur dioxide 1599 non-null float64  
 7 density 1599 non-null float64  
 8 pH 1599 non-null float64  
 9 sulphates 1599 non-null float64  
 10 alcohol 1599 non-null float64  
 11 quality 1599 non-null int64   
dtypes: float64(11), int64(1)  
memory usage: 150.0 KB

In [4]:

RX = RData.iloc[:, :-1]  
Ry = RData.iloc[:, -1]

In [5]:

#RX.shape  
Ry.shape

Out[5]:

(1599,)

## Create a base model[¶](#Create-a-base-model)

In [6]:

def Rbaseline\_model():  
 model = Sequential()  
 model.add(Dense(16, input\_dim = 11, kernel\_initializer = 'normal', activation = 'relu'))  
 model.add(Dense(1, activation = 'linear'))  
  
 model.compile(loss = 'mean\_squared\_error', optimizer = 'adam')  
 return model

In [7]:

REstimator = KerasRegressor(model = Rbaseline\_model, epochs = 100, batch\_size = 5000, verbose = 0)  
Rkfold = KFold(n\_splits = 10)  
RResults = cross\_val\_score(REstimator, RX, Ry, cv = Rkfold, scoring = 'neg\_mean\_squared\_error')  
print("Baseline: %.2f (%.2f)" % (RResults.mean(), RResults.std()))

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
WARNING:tensorflow:5 out of the last 5 calls to <function TensorFlowTrainer.make\_predict\_function.<locals>.one\_step\_on\_data\_distributed at 0x7fbbdee68280> triggered tf.function retracing. Tracing is expensive and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (1), please define your @tf.function outside of the loop. For (2), @tf.function has reduce\_retracing=True option that can avoid unnecessary retracing. For (3), please refer to https://www.tensorflow.org/guide/function#controlling\_retracing and https://www.tensorflow.org/api\_docs/python/tf/function for more details.  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
WARNING:tensorflow:6 out of the last 6 calls to <function TensorFlowTrainer.make\_predict\_function.<locals>.one\_step\_on\_data\_distributed at 0x7fbbded70ca0> triggered tf.function retracing. Tracing is expensive and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (1), please define your @tf.function outside of the loop. For (2), @tf.function has reduce\_retracing=True option that can avoid unnecessary retracing. For (3), please refer to https://www.tensorflow.org/guide/function#controlling\_retracing and https://www.tensorflow.org/api\_docs/python/tf/function for more details.  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)

Baseline: -1.37 (1.03)

## Improve the model by standardizing the dataset[¶](#Xc53a063c9819b1c2e410f052ef340a357b86a58)

In [8]:

REstimator = []  
REstimator.append(('standardize', StandardScaler()))  
REstimator.append(('mlp', KerasRegressor(model = Rbaseline\_model, epochs = 100, batch\_size = 5000, verbose = 0)))  
pipeline = Pipeline(REstimator)  
Rkfold = KFold(n\_splits = 10)  
RResults = cross\_val\_score(pipeline, RX, Ry, cv = Rkfold, scoring = 'neg\_mean\_squared\_error')  
print("Baseline: %.2f (%.2f)" % (RResults.mean(), RResults.std()))

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)

Baseline: -21.86 (3.47)

## Show tuning of layers and neurons (see evaluating small and larger networks)[¶](#Xa74ae8d97351336e65e39a0fc09691cbc9596ae)

### Smaller Network and Wider[¶](#Smaller-Network-and-Wider)

In [9]:

def Rbaseline\_model():  
 model = Sequential()  
 model.add(Dense(32, input\_dim = 11, kernel\_initializer = 'normal', activation = 'relu'))  
 model.add(Dense(1, activation = 'linear'))  
  
 model.compile(loss = 'mean\_squared\_error', optimizer = 'adam')  
 return model

In [10]:

REstimator = []  
REstimator.append(('standardize', StandardScaler()))  
REstimator.append(('mlp', KerasRegressor(model = Rbaseline\_model, epochs = 100, batch\_size = 5000, verbose = 0)))  
pipeline = Pipeline(REstimator)  
Rkfold = KFold(n\_splits = 10)  
RResults = cross\_val\_score(pipeline, RX, Ry, cv = Rkfold, scoring = 'neg\_mean\_squared\_error')  
print("Baseline: %.2f (%.2f)" % (RResults.mean(), RResults.std()))

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)

Baseline: -17.52 (2.71)

### Larger Network[¶](#Larger-Network)

In [11]:

def Rbaseline\_model():  
 model = Sequential()  
 model.add(Dense(16, input\_dim = 11, kernel\_initializer = 'normal', activation = 'relu'))  
 model.add(Dense(8, kernel\_initializer = 'normal', activation = 'relu'))  
 model.add(Dense(1, activation = 'linear'))  
  
 model.compile(loss = 'mean\_squared\_error', optimizer = 'adam')  
 return model

In [12]:

REstimator = []  
REstimator.append(('standardize', StandardScaler()))  
REstimator.append(('mlp', KerasRegressor(model = Rbaseline\_model, epochs = 100, batch\_size = 5000, verbose = 0)))  
pipeline = Pipeline(REstimator)  
Rkfold = KFold(n\_splits = 10)  
RResults = cross\_val\_score(pipeline, RX, Ry, cv = Rkfold, scoring = 'neg\_mean\_squared\_error')  
print("Baseline: %.2f (%.2f)" % (RResults.mean(), RResults.std()))

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.  
 super().\_\_init\_\_(activity\_regularizer=activity\_regularizer, \*\*kwargs)  
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Baseline: -18.43 (4.20)

In [ ]: