Logistic Regression

Imports

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

Data

An experiment was conducted on 5000 participants to study the effects of age and physical health on hearing loss, specifically the ability to hear high pitched tones. This data displays the result of the study in which participants were evaluated and scored for physical ability and then had to take an audio test (pass/no pass) which evaluated their ability to hear high frequencies. The age of the user was also noted. Is it possible to build a model that would predict someone's liklihood to hear the high frequency sound based solely on their features (age and physical score)?

- Features
  - age - Age of participant in years
  - physical_score - Score achieved during physical exam
- Label/Target
  - test_result - 0 if no pass, 1 if test passed

```
df = pd.read_csv("D:\\Study\\Programming\\python\\Python course from udemy\\Udemy - 2022 Python for Machine Learning & Data Science Masterclass\\01 - Introduction to Course\\1UNZIP-FOR-NOTEBOOKS-FINAL\\DATA\\hearing_test.csv")
df.head()
```

```
    age  physical_score  test_result
0  33.0            40.7            1
1  50.0            37.2            1
2  52.0            24.7            0
3  56.0            31.0            0
4  35.0            42.9            1
```

Exploratory Data Analysis and Visualization

Feel free to explore the data further on your own.

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5000 entries, 0 to 4999
Data columns (total 3 columns):
 #   Column          Non-Null Count  Dtype
```

```
---  ------           --------------  -----
 0   age              5000 non-null   float64
 1   physical_score   5000 non-null   float64
 2   test_result      5000 non-null   int64
dtypes: float64(2), int64(1)
memory usage: 117.3 KB
```

```
df.describe()
```

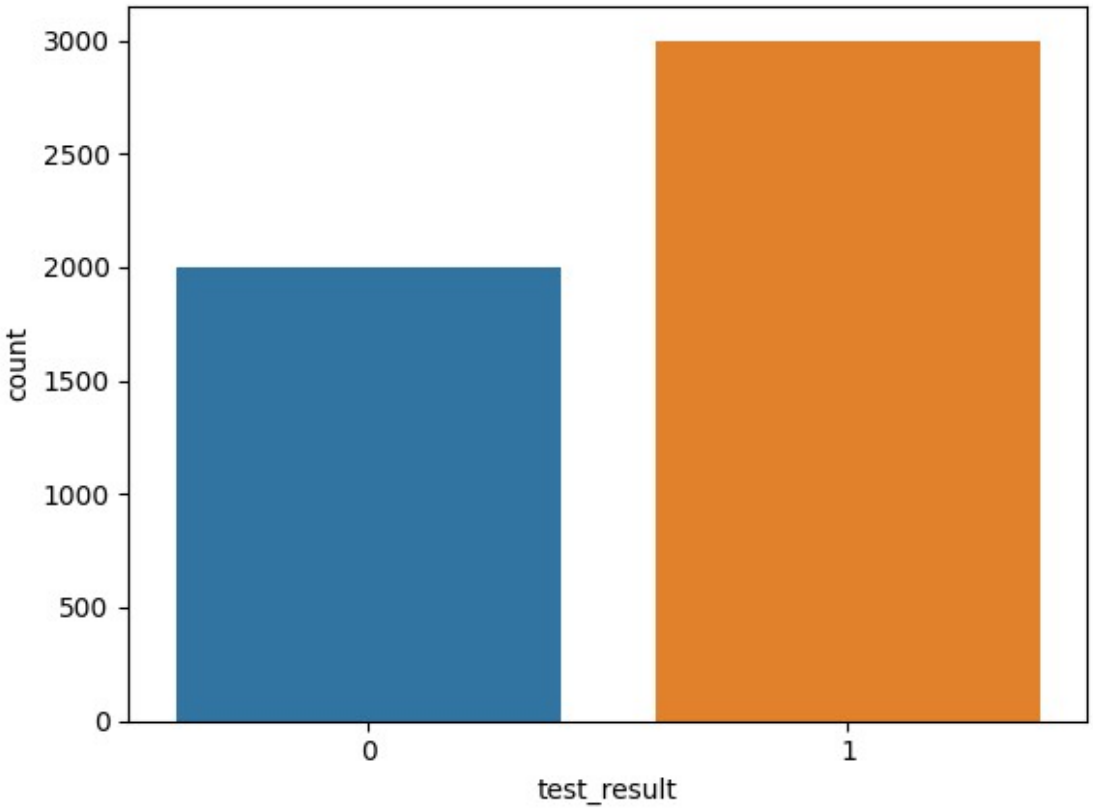
```
                age  physical_score  test_result
count  5000.000000     5000.000000  5000.000000
mean     51.609000       32.760260     0.600000
std      11.287001        8.169802     0.489947
min      18.000000       -0.000000     0.000000
25%      43.000000       26.700000     0.000000
50%      51.000000       35.300000     1.000000
75%      60.000000       38.900000     1.000000
max      90.000000       50.000000     1.000000
```

```
df['test_result'].value_counts()
```

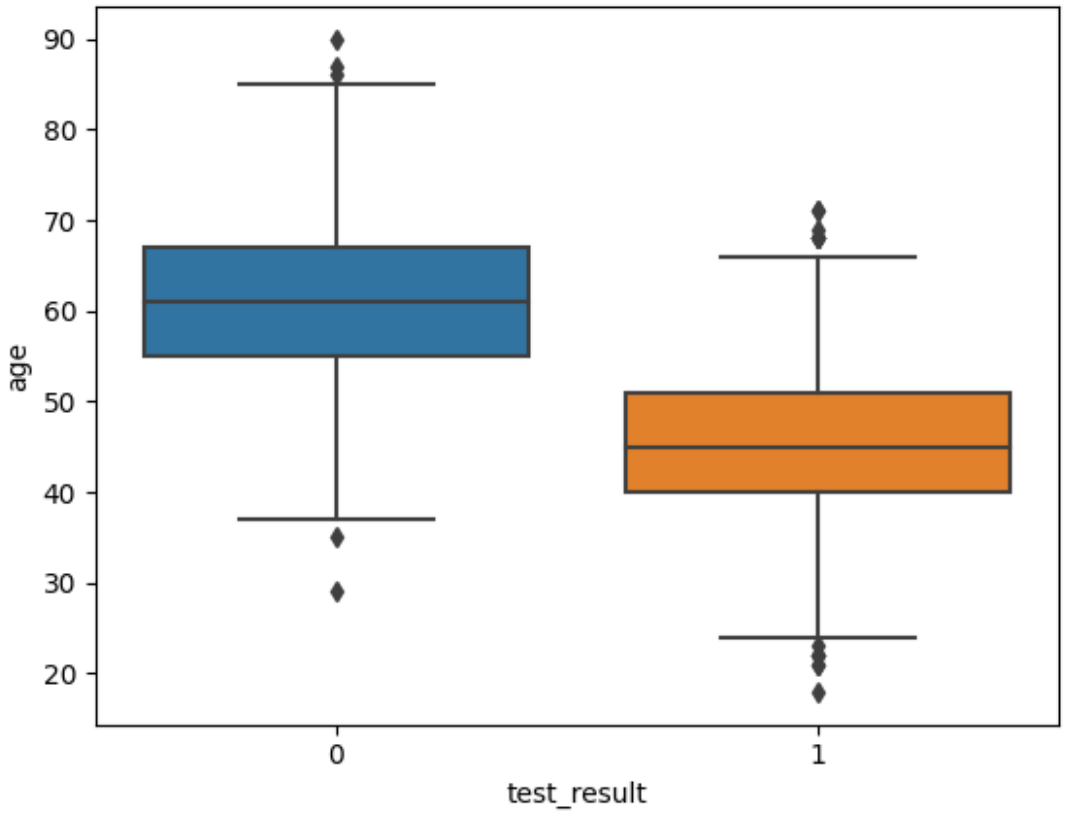
```
1    3000
0    2000
Name: test_result, dtype: int64
```

```
sns.countplot(data=df,x='test_result')
```

```
<AxesSubplot: xlabel='test_result', ylabel='count'>
```

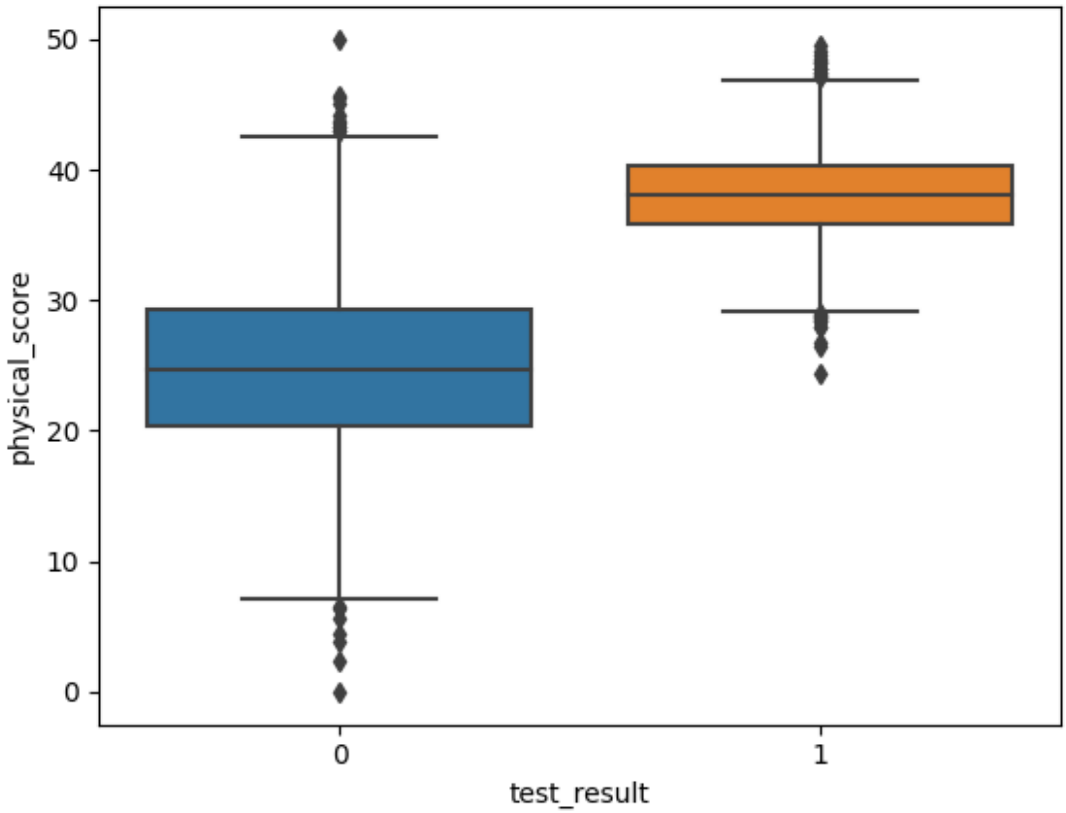



```
plt.figure(dpi=100)
sns.boxplot(x='test_result',y='age',data=df);
```

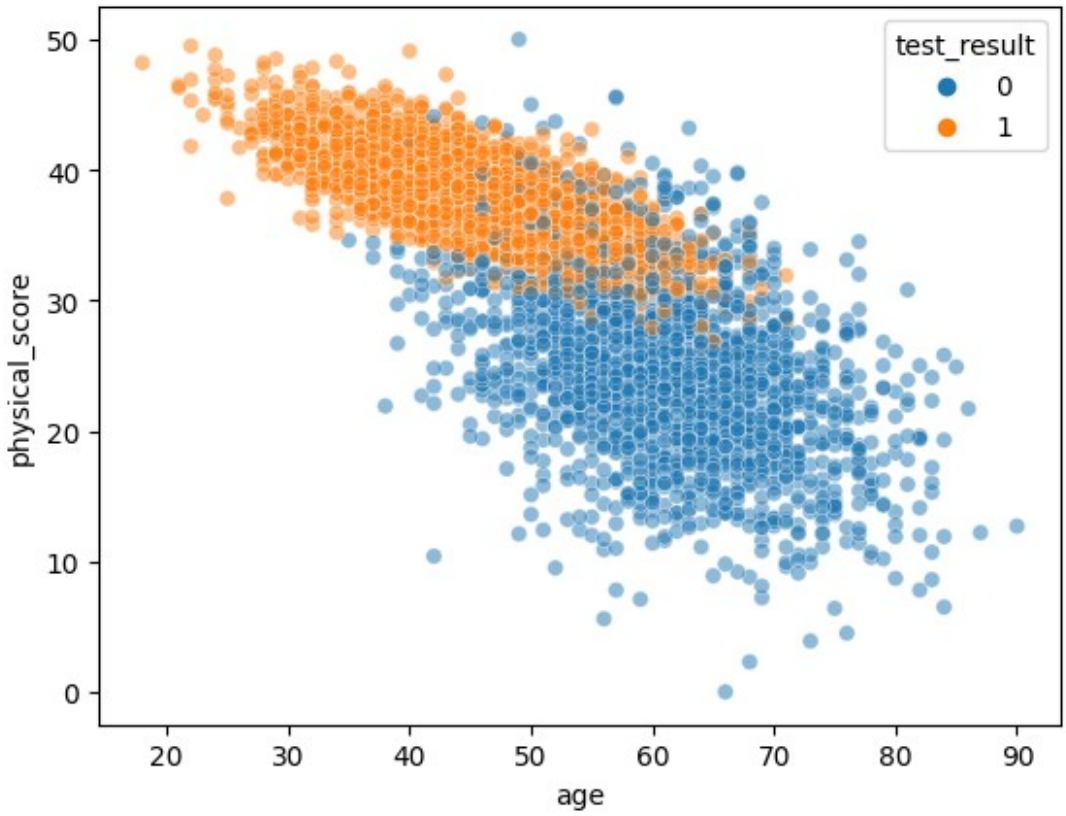



```
plt.figure(dpi=100)
sns.boxplot(x='test_result',y='physical_score',data=df)
```

```
<AxesSubplot: xlabel='test_result', ylabel='physical_score'>
```

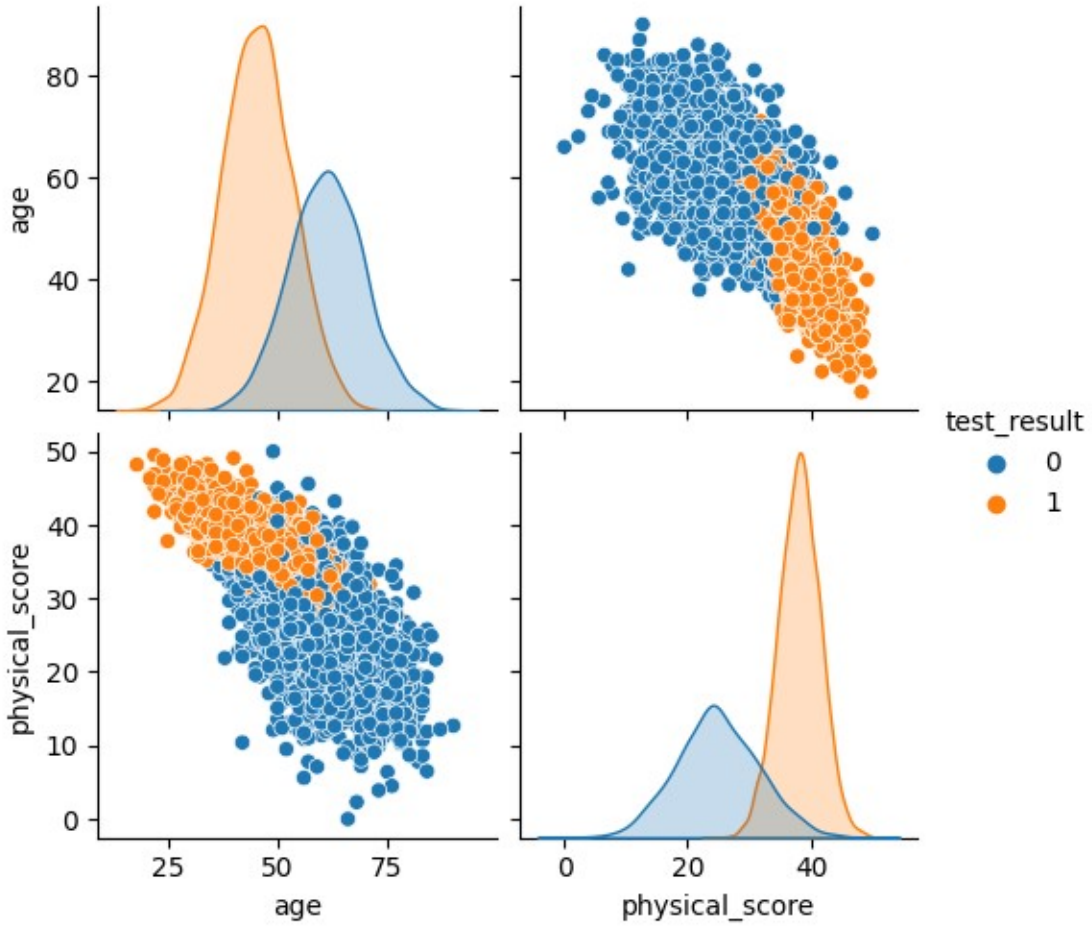



```
plt.figure(dpi=100)
sns.scatterplot(x='age',y='physical_score',hue='test_result',
                data=df,alpha=0.5);
```

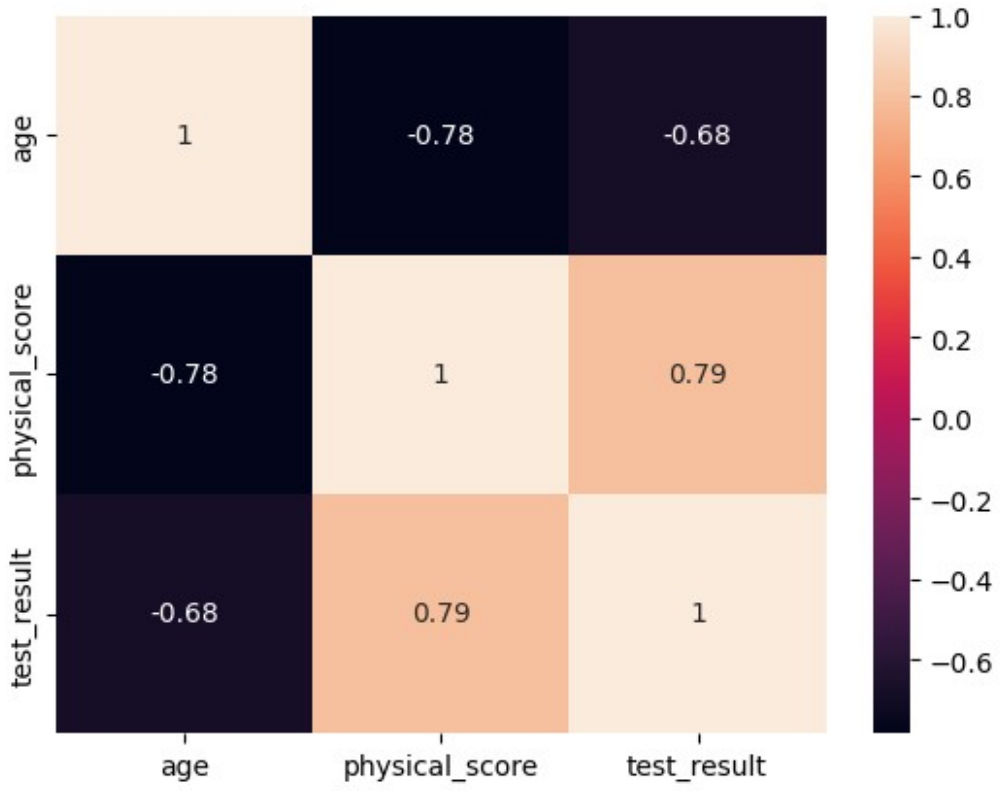



```
plt.figure(dpi=100);
sns.pairplot(data=df,hue='test_result');
```

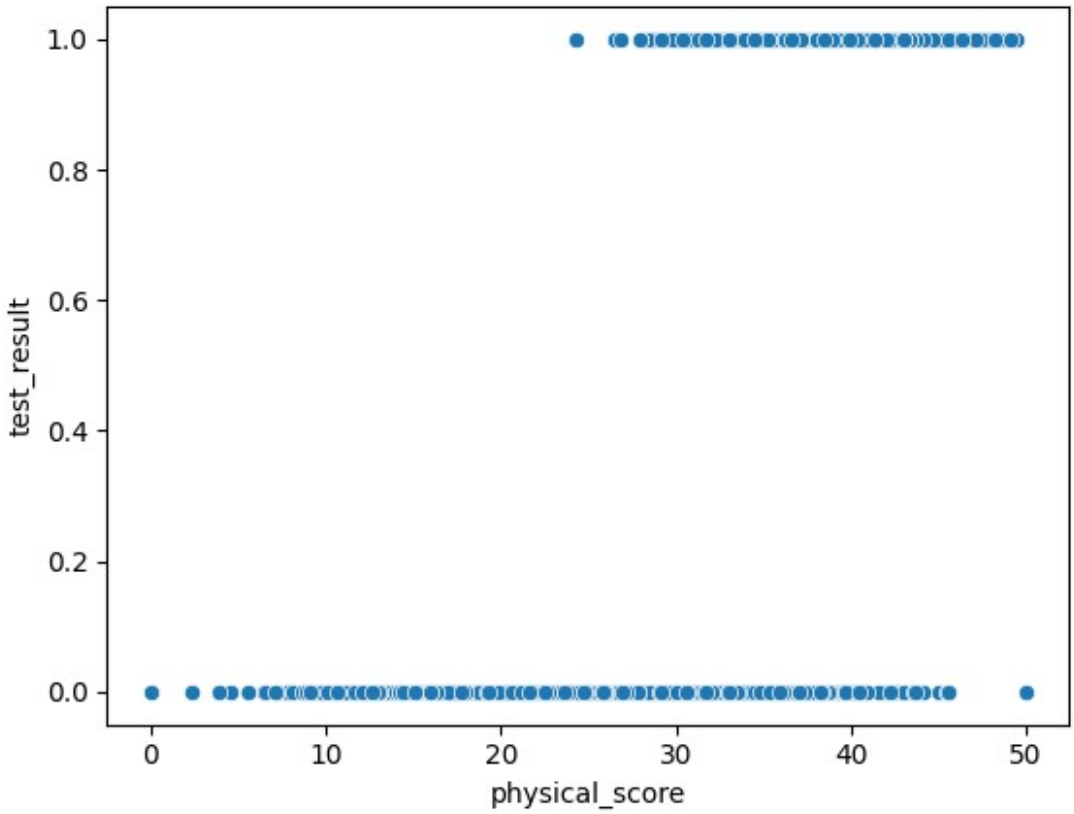
```
<Figure size 640x480 with 0 Axes>
```



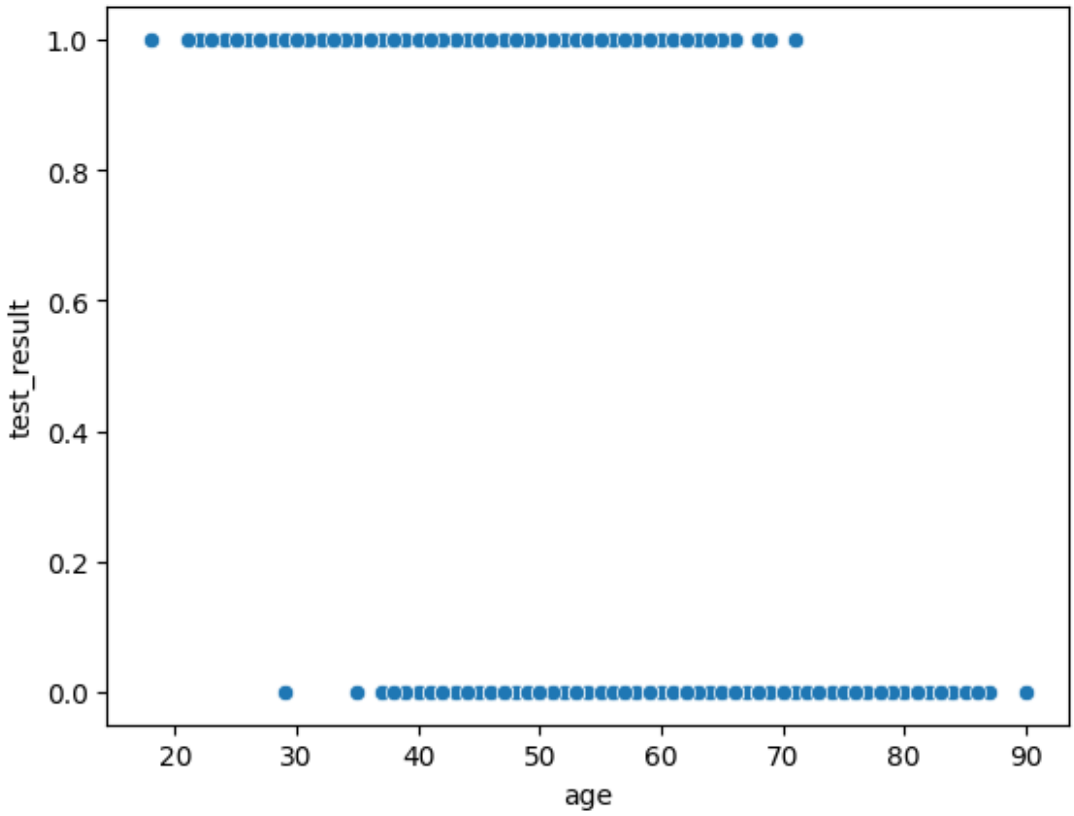

```
sns.heatmap(df.corr(),annot=True);
```




```
# If we want to plot scatterplot it will show as boxplot so better we
use boxplot
sns.scatterplot(data=df,x='physical_score',y='test_result');
```



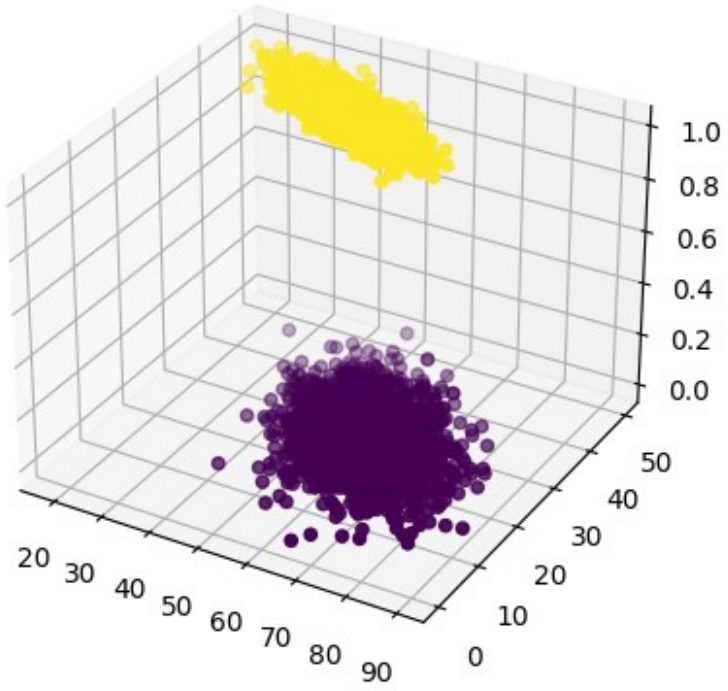

```
sns.scatterplot(x='age',y='test_result',data=df);
```



Easily discover new plot types with a google search! Searching for "3d matplotlib scatter plot" quickly takes you to: https://matplotlib.org/3.1.1/gallery/mplot3d/scatter3d.html

```
from mpl_toolkits.mplot3d import Axes3D
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.scatter(df['age'],df['physical_score'],df['test_result'],c=df['test
_result'])
```

```
<mpl_toolkits.mplot3d.art3d.Path3DCollection at 0x17efd5ff910>
```



Train | Test Split and Scaling

```
X = df.drop('test_result',axis=1)
Y= df['test_result']

from sklearn.model_selection import train_test_split

X_train,X_test,Y_train,Y_test =
train_test_split(X,Y,test_size=.1,random_state=101)

from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

scaler.fit(X_train)

StandardScaler()

scaler_x_train = scaler.transform(X_train)
scaler_x_test = scaler.transform(X_test)
```

Logistic Regression Model

```
from sklearn.linear_model import LogisticRegression

# help(LogisticRegression)

# help(LogisticRegressionCV)

log_model = LogisticRegression()
```

```
log_model.fit(scaler_x_train,Y_train)
```

```
LogisticRegression()
```

Coefficient Interpretation

Things to remember:

- These coeffecients relate to the *odds* and can not be directly interpreted as in linear regression.
- We trained on a *scaled* version of the data
- It is much easier to understand and interpret the relationship between the coefficients than it is to interpret the coefficients relationship with the probability of the target/label class.

Make sure to watch the video explanation, also check out the links below:

- https://stats.idre.ucla.edu/stata/faq/how-do-i-interpret-odds-ratios-in-logistic-regression/
- https://stats.idre.ucla.edu/other/mult-pkg/faq/general/faq-how-do-i-interpret-odds-ratios-in-logistic-regression/

The odds ratio

For a continuous independent variable the odds ratio can be defined as:

This exponential relationship provides an interpretation for

$$\beta_1$$

The odds multiply by

$$e_1^{\beta}$$

for every 1-unit increase in x.

This means:

- We can expect the **odds** of passing the test to **decrease** (the original coeff was negative) per unit increase of the age.
- We can expect the **odds** of passing the test to **increase** (the original coeff was positive) per unit increase of the physical score.
- Based on the ratios with each other, the physical_score indicator is a stronger predictor than age.

```
log_model.coef_
```

```
array([[-0.94953524,  3.45991194]])
```

This means:

- We can expect the **odds** of passing the test to **decrease** (the original coeff was negative) per unit increase of the age.
- We can expect the **odds** of passing the test to **increase** (the original coeff was positive) per unit increase of the physical score.
- Based on the ratios with each other, the physical_score indicator is a stronger predictor than age.

Model Performance on Classification Tasks

```
y_pred = log_model.predict(scaler_x_test)
```

```
from sklearn.metrics import
accuracy_score,confusion_matrix,classification_report
```

```
accuracy_score(Y_test,y_pred)
```

```
0.93
```

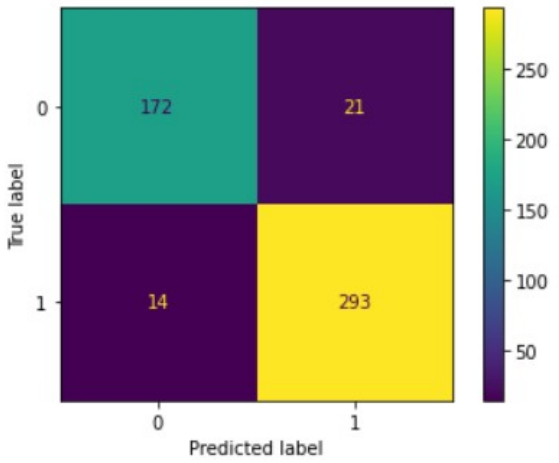
```
confusion_matrix(Y_test,model_predict)
```

```
array([[172,  21],
       [ 14, 293]], dtype=int64)
```

```
# It is not working it with version
from sklearn.metrics import plot_confusion_matrix

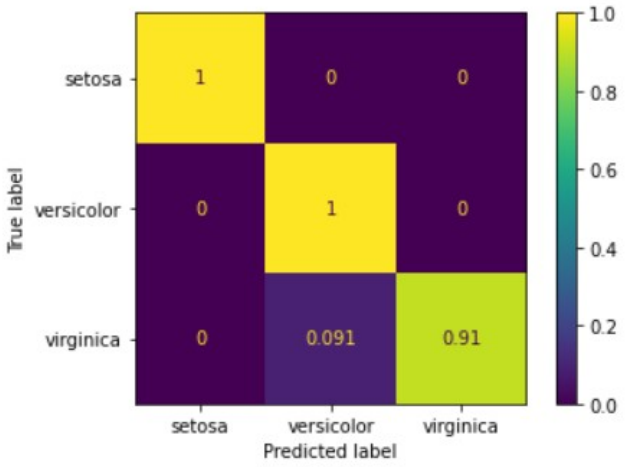
# Here one thing to notice that we just input our model ,scaler_x_test
( on which we want to predict over values)
#
Y_test( actuall values to compare)
plot_confusion_matrix(log_model,scaler_x_test,Y_test)
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x19ceb65e588>
```




```
# Scaled so highest value=1, it convert into row-wise percentage
plot_confusion_matrix(log_model,scaler_x_test,Y_test,normalize='true')
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2a1a843ac48>
```




```
# Here it in form of print command so we need to use print function
for  that as show in next line
classification_report(Y_test,y_pred)
```

```
'              precision    recall  f1-score   support\n\n           0
0.92      0.89      0.91       193\n           1       0.93      0.95
0.94       307\n\n    accuracy                           0.93
500\n   macro avg       0.93      0.92      0.93       500\nweighted
avg       0.93      0.93      0.93       500\n'
```

```
# Here it showinf in form of table
print(classification_report(Y_test,y_pred))
```

```
              precision    recall  f1-score   support

           0       0.92      0.89      0.91       193
           1       0.93      0.95      0.94       307

    accuracy                           0.93       500
   macro avg       0.93      0.92      0.93       500
weighted avg       0.93      0.93      0.93       500
```

```
# Lets see that data
X_train.iloc[0]
```

```
age               32.0
physical_score    43.0
Name: 141, dtype: float64
```

```
Y_train.iloc[0]
```

```
1
```

```
# 0% probability of 0 class
# 100% probability of 1 class
log_model.predict_proba(X_train.iloc[0].values.reshape(1, -1))
```

```
array([[0., 1.]])
```

```
log_model.predict(X_train.iloc[0].values.reshape(1, -1))
```

```
array([1], dtype=int64)
```

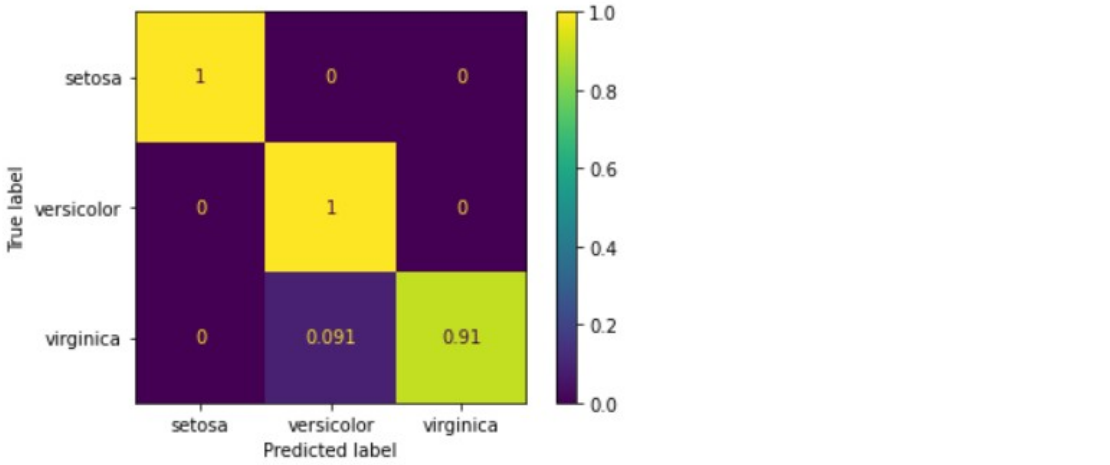
Evaluating Curves and AUC (Area Under Curve)

Make sure to watch the video on this!

```
from sklearn.metrics import
precision_recall_curve,plot_precision_recall_curve,plot_roc_curve
```

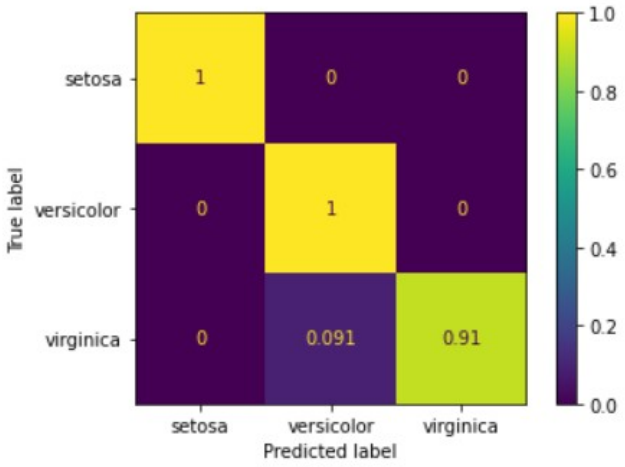
```
plot_precision_recall_curve(log_model,scaled_X_test,Y_test)
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2a1a843ac48>
```



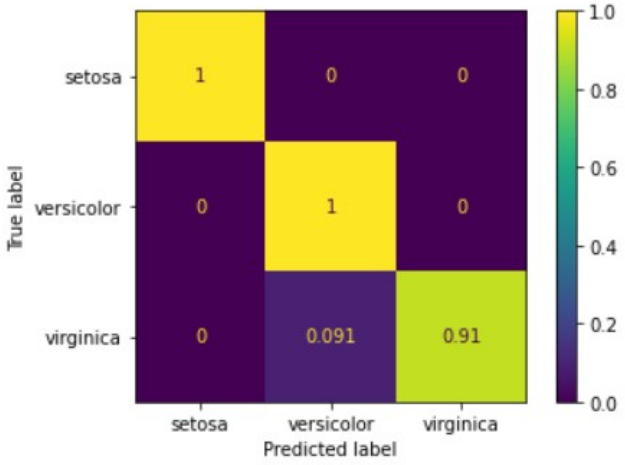

```
plot_roc_curve(log_model,scaled_X_test,Y_test)
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2a1a843ac48>
```



if we want to change the size of plot then we have to use this ax=ax

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2a1a843ac48>
```




```
from sklearn.metrics import precision_score,recall_score
```

```
precision_score(Y_test,y_pred)
```

```
0.9331210191082803
```

```
recall_score(Y_test,y_pred)
```

```
0.9543973941368078
```

```
#if we want to predict the probality of each row so we can use this
# Here it showing that there is 0.02384343 chance to belong to class 0
and 0.97615657 chance to belong to class 1
log_model.predict_proba(scaler_x_test)[0] # here we see for first row
```

```
array([0.02384343, 0.97615657])
```

```
# Here we see data real data
Y_test[0]
```

```
1
```

Multi-Class Logistic Regression

Students often ask how to perform non binary classification with Logistic Regression. Fortunately, the process with scikit-learn is pretty much the same as with binary classification. To expand our understanding, we'll go through a simple data set, as well as seeing how to use LogisiticRegression with a manual GridSearchCV (instead of LogisticRegressionCV).

Data

We will work with the classic Iris Data Set. The Iris flower data set or Fisher's Iris data set is a multivariate data set introduced by the British statistician, eugenicist, and biologist Ronald Fisher in his 1936 paper The use of multiple measurements in taxonomic problems as an example of linear discriminant analysis.

Full Details: https://en.wikipedia.org/wiki/Iris_flower_data_set

```
# Few data are preloaded in libraries like this
df = sns.load_dataset('iris')
df.head()
```

	sepal_length	sepal_width	petal_length	petal_width	species
0	5.1	3.5	1.4	0.2	setosa
1	4.9	3.0	1.4	0.2	setosa
2	4.7	3.2	1.3	0.2	setosa
3	4.6	3.1	1.5	0.2	setosa
4	5.0	3.6	1.4	0.2	setosa

Exploratory Data Analysis and Visualization

Feel free to explore the data further on your own.

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   sepal_length  150 non-null    float64
 1   sepal_width   150 non-null    float64
 2   petal_length  150 non-null    float64
 3   petal_width   150 non-null    float64
 4   species       150 non-null    object 
```

```
dtypes: float64(4), object(1)
memory usage: 6.0+ KB
```

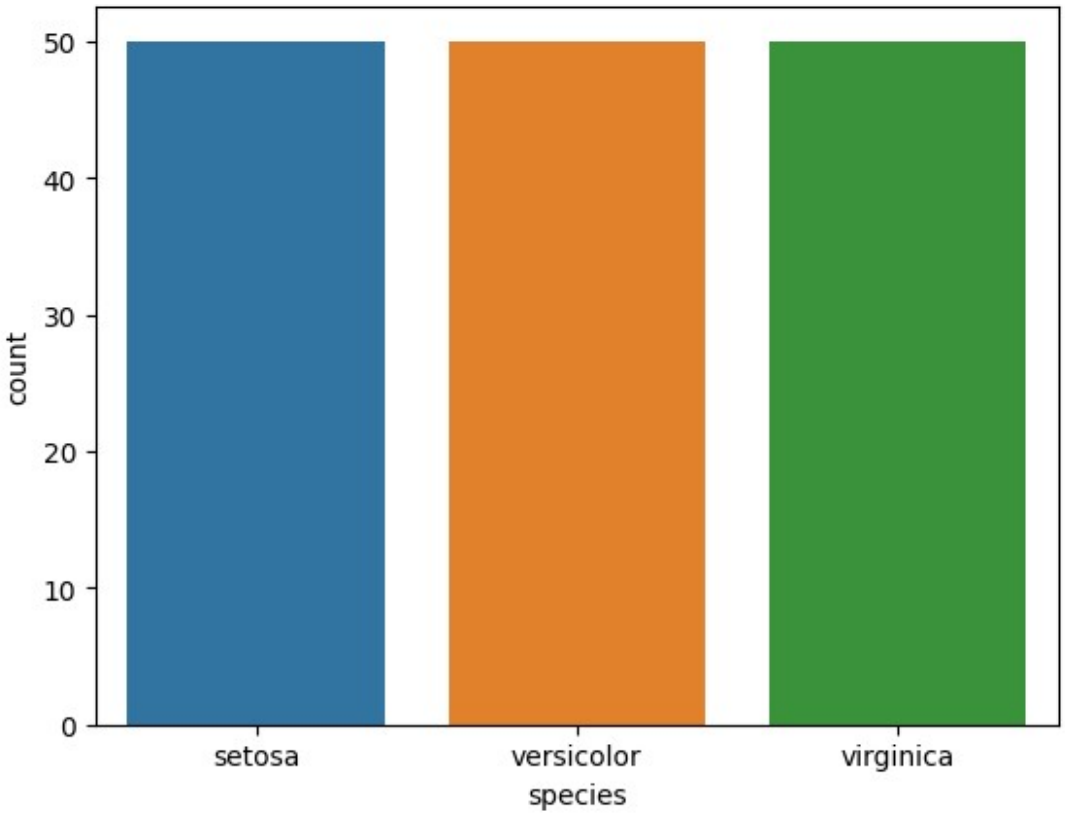
```
df.describe()
```

```
       sepal_length  sepal_width  petal_length  petal_width
count    150.000000   150.000000    150.000000   150.000000
mean       5.843333     3.057333      3.758000     1.199333
std        0.828066     0.435866      1.765298     0.762238
min        4.300000     2.000000      1.000000     0.100000
25%        5.100000     2.800000      1.600000     0.300000
50%        5.800000     3.000000      4.350000     1.300000
75%        6.400000     3.300000      5.100000     1.800000
max        7.900000     4.400000      6.900000     2.500000
```

```
df['species'].value_counts()
```

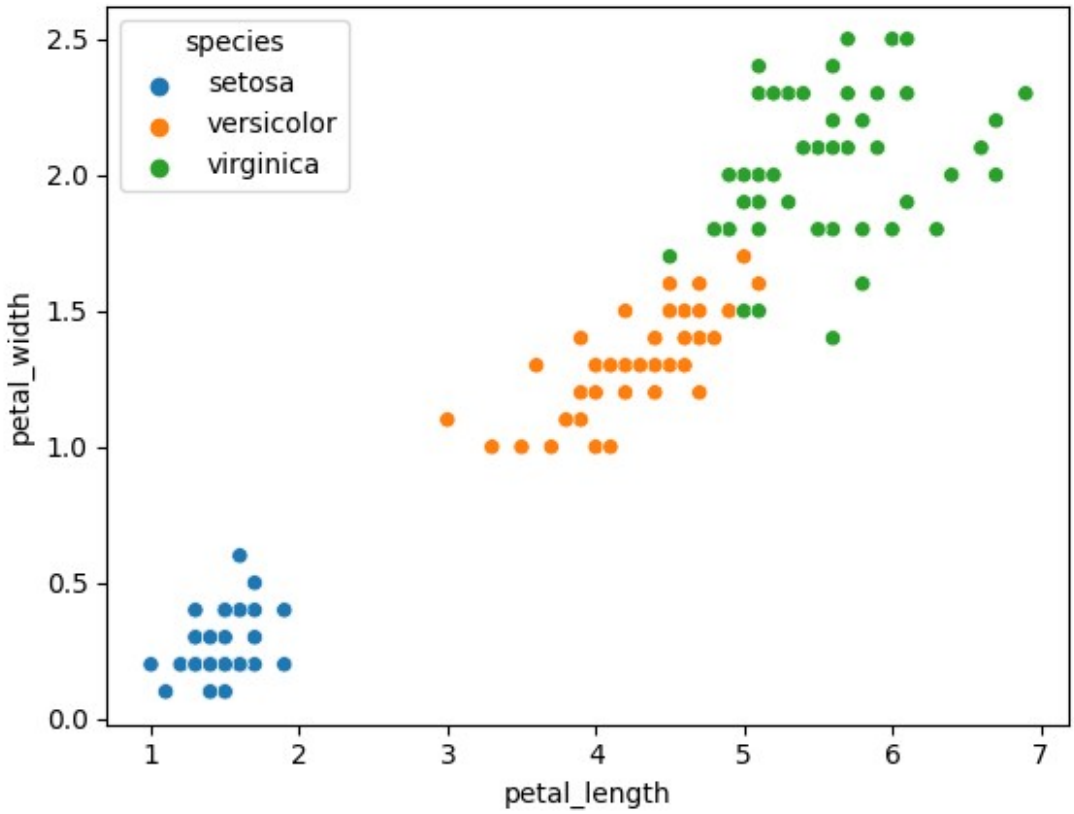
```
setosa        50
versicolor    50
virginica     50
Name: species, dtype: int64
```

```
sns.countplot(x='species',data=df)
plt.show()
```



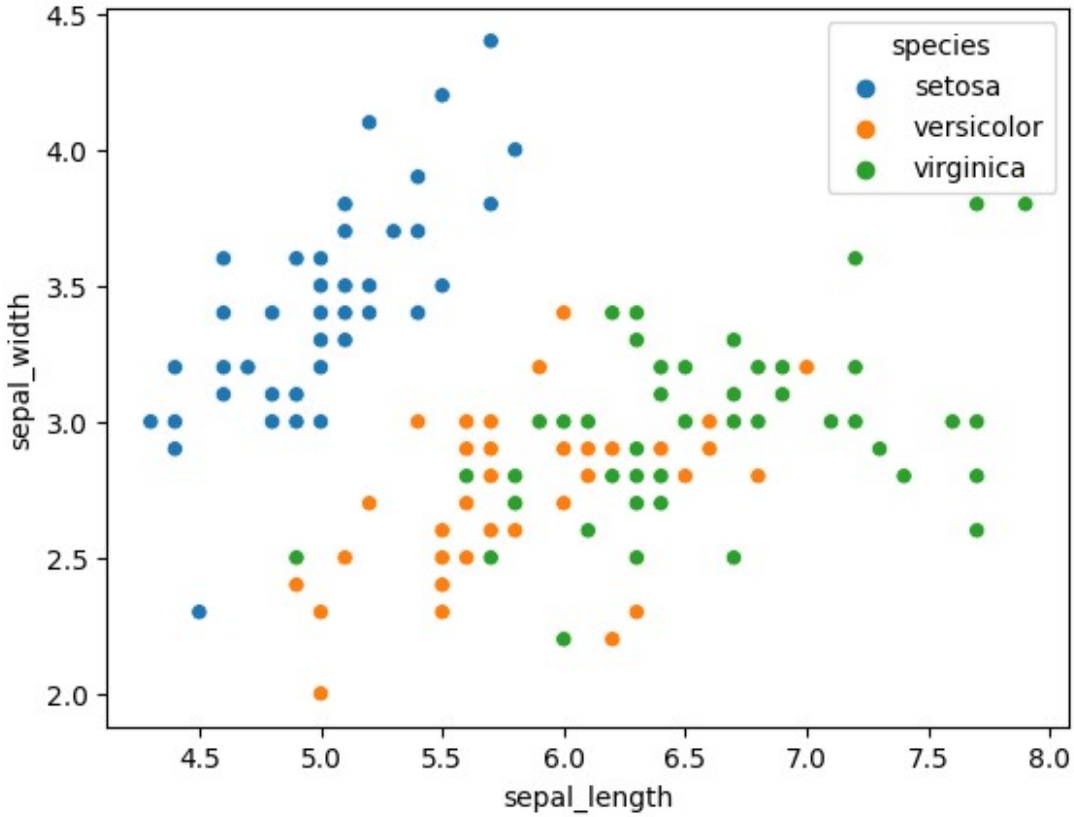
```
# if showing high corelaltion between the petal_width and petal_length
sns.scatterplot(x='petal_length',y='petal_width',data=df,hue='species'
)
```

```
<AxesSubplot: xlabel='petal_length', ylabel='petal_width'>
```



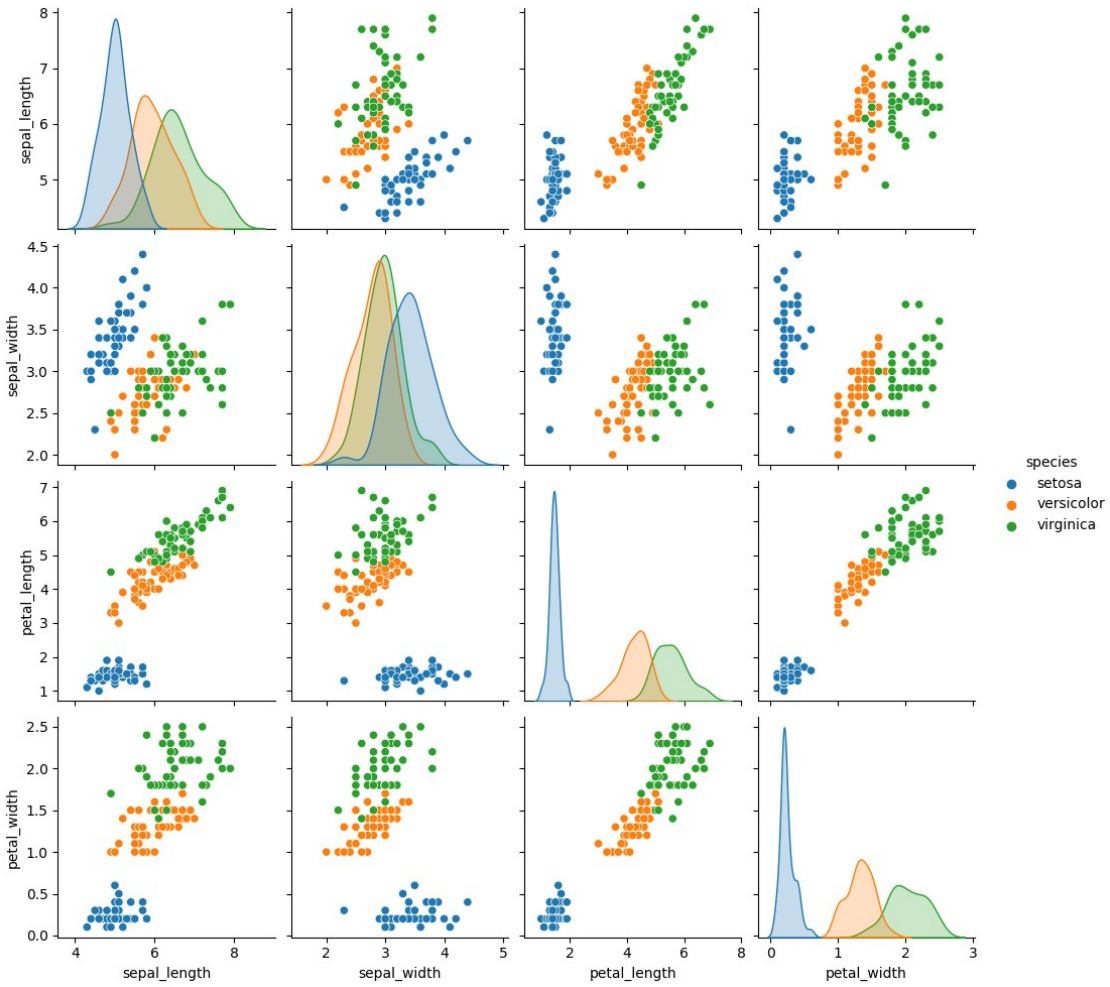

```
# Here we observe that sepal_width and sepal_length are mixed with
versicolor and virginica
sns.scatterplot(x='sepal_length',y='sepal_width',data=df,hue='species'
)
```

```
<AxesSubplot: xlabel='sepal_length', ylabel='sepal_width'>
```




```
sns.pairplot(data=df,hue='species')
```

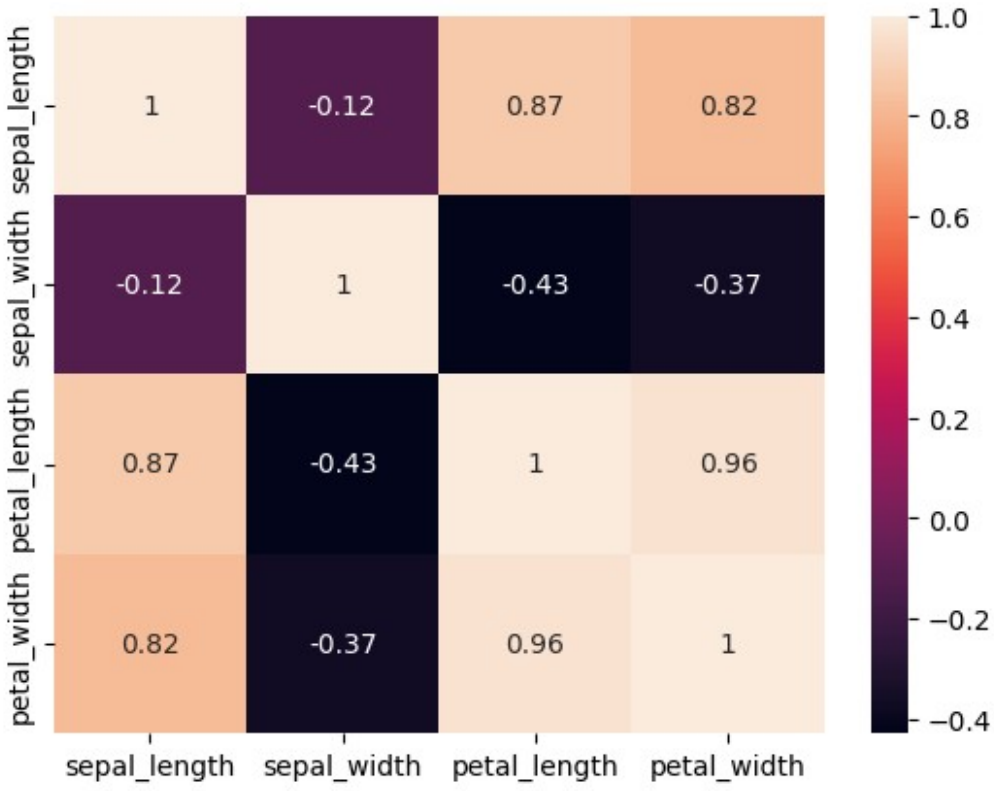
```
<seaborn.axisgrid.PairGrid at 0x17e83687f70>
```




```
sns.heatmap(df.corr(),annot=True)
```

```
C:\Users\Chromsy\AppData\Local\Temp\ipykernel_2264\4277794465.py:1:
FutureWarning: The default value of numeric_only in DataFrame.corr is
deprecated. In a future version, it will default to False. Select only
valid columns or specify the value of numeric_only to silence this
warning.
  sns.heatmap(df.corr(),annot=True)
```

```
<AxesSubplot: >
```




```
X=df.drop('species',axis=1)
y=df['species']

from sklearn.model_selection import train_test_split

X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.25,
random_state=101)

from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

scaler_x_train=scaler.fit_transform(X_train)
scaler_x_test=scaler.fit_transform(X_test)
```

Multi-Class Logistic Regression Model

```
from sklearn.linear_model import LogisticRegression

from sklearn.model_selection import GridSearchCV

# Depending on warnings you may need to adjust max iterations allowed
# Or experiment with different solvers, press shift + tab to know
about solver,multi_class
#
https://scikit-learn.org/stable/modules/generated/sklearn.linear_model
.LogisticRegression.html
```

```
log_model = 
LogisticRegression(solver='saga',multi_class="ovr",max_iter=5000)
```

GridSearch for Best Hyper-Parameters

Main parameter choices are regularization penalty choice and regularization C value.

```
# Penalty Type
penalty = ['l1', 'l2','elasticnet']

# Use logarithmically spaced C values (recommended in official docs)
l1_ratio = np.logspace(0, 1, 20)
C = np.logspace(0,10,20)

param_grid = {'penalty':penalty,'l1_ratio':l1_ratio, 'C':C }

grid_model = GridSearchCV(log_model,param_grid=param_grid)

grid_model.fit(scaler_x_train,y_train)
```

```
C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-packages\
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sklearn\model_selection\_validation.py:378: FitFailedWarning:
5700 fits failed out of a total of 6000.
The score on these train-test partitions for these parameters will be
set to nan.
If these failures are not expected, you can try to debug them by
setting error_score='raise'.

Below are more details about the failures:
----------------------------------------------------------------------
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300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 1.128837891684689 instead.
```

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    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 1.2742749857031337 instead.

--------------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 1.4384498882876628 instead.

--------------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
```

```
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 1.6237767391887217 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 1.8329807108324359 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
```

```
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 2.0691380811147897 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 2.3357214690901222 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
```

```
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 2.636650898730358 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 2.976351441631318 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 3.3598182862837818 instead.

--------------------------------------------------------------------
----------
```

```
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 3.79269019073225 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 4.281332398719393 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
```

```
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 4.832930238571752 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 5.455594781168519 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
```

```
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 6.158482110660264 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 6.951927961775605 instead.

--------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
```

```
None. Got 7.847599703514611 instead.

--------------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 8.858667904100825 instead.

--------------------------------------------------------------------------
----------
300 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\model_selection\_validation.py", line 686, in
_fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\linear_model\_logistic.py", line 1160, in fit
    self._validate_params()
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-
packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'l1_ratio'
parameter of LogisticRegression must be a float in the range [0, 1] or
None. Got 10.0 instead.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-packages\
sklearn\model_selection\_search.py:952: UserWarning: One or more of
the test scores are non-finite: [0.91897233 0.90158103 0.91897233 ...
```

```
nan        nan        nan]
  warnings.warn(
C:\Users\Chromsy\AppData\Roaming\Python\Python39\site-packages\
sklearn\linear_model\_logistic.py:1165: UserWarning: l1_ratio
parameter is only used when penalty is 'elasticnet'. Got (penalty=l1)
  warnings.warn(

GridSearchCV(estimator=LogisticRegression(max_iter=5000,
multi_class='ovr',
                                          solver='saga'),
             param_grid={'C': array([1.00000000e+00, 3.35981829e+00,
1.12883789e+01, 3.79269019e+01,
       1.27427499e+02, 4.28133240e+02, 1.43844989e+03, 4.83293024e+03,
       1.62377674e+04, 5.45559478e+04, 1.83298071e+05, 6.15848211e+05,
       2.06913808e+06, 6.95192796e+06, 2.33572147e+07, 7.84759970e+07,
       2.63665090e+08, 8.85866790e+08, 2.97635144e+09,
1.00000000e+10]),
                         'l1_ratio': array([ 1.        ,  1.12883789,
1.27427499,  1.43844989,  1.62377674,
        1.83298071,  2.06913808,  2.33572147,  2.6366509 ,
2.97635144,
        3.35981829,  3.79269019,  4.2813324 ,  4.83293024,
5.45559478,
        6.15848211,  6.95192796,  7.8475997 ,  8.8586679 ,
10.        ]),
                         'penalty': ['l1', 'l2', 'elasticnet']})

grid_model.best_params_

{'C': 11.28837891684689, 'l1_ratio': 1.0, 'penalty': 'l1'}
```

Model Performance on Classification Tasks

```
from sklearn.metrics import
accuracy_score,confusion_matrix,classification_report

# Not working in my Laptop
from sklearn.metrics import plot_confusion_matrix

y_pred = grid_model.predict(scaler_x_test)

accuracy_score(y_test,y_pred)

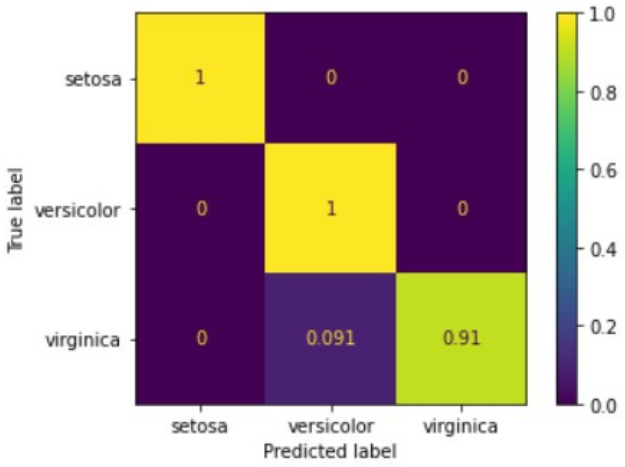
0.9736842105263158

confusion_matrix(y_test,y_pred)

array([[10,  0,  0],
       [ 0, 17,  0],
       [ 0,  1, 10]], dtype=int64)

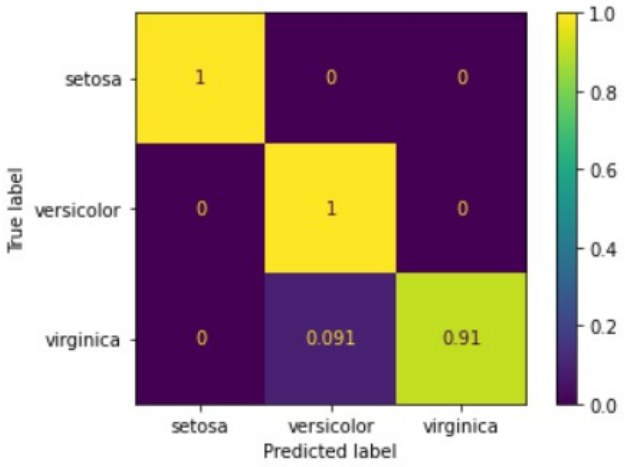
plot_confusion_matrix(grid_model,scaled_X_test,y_test)
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2a1a843ac48>
```




```
# Scaled so highest value=1
plot_confusion_matrix(grid_model,scaled_X_test,y_test,normalize='true'
)
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2a1a843ac48>
```




```
print(classification_report(y_test,y_pred))
```

```
              precision    recall  f1-score   support

      setosa       1.00      1.00      1.00        10
  versicolor       0.94      1.00      0.97        17
   virginica       1.00      0.91      0.95        11

    accuracy                           0.97        38
   macro avg       0.98      0.97      0.97        38
weighted avg       0.98      0.97      0.97        38
```

Evaluating Curves and AUC

Make sure to watch the video on this! We need to manually create the plots for a Multi-Class situation. Fortunately, Scikit-learn's documentation already has plenty of examples on this.

Source: https://scikit-learn.org/stable/auto_examples/model_selection/plot_roc.html

We have created a function for you that does this automatically, essentially creating and plotting an ROC per class.

```
from sklearn.metrics import roc_curve, auc

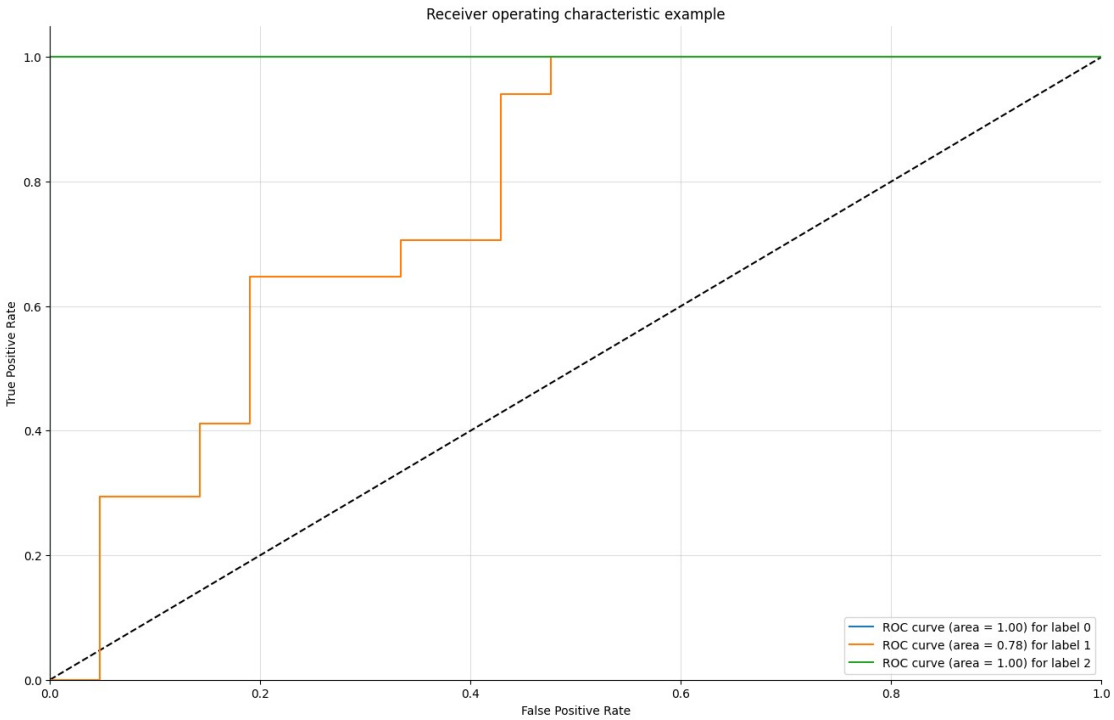
def plot_multiclass_roc(clf, X_test, y_test, n_classes,
figsize=(5,5)):
    y_score = clf.decision_function(X_test)

    # structures
    fpr = dict()
    tpr = dict()
    roc_auc = dict()

    # calculate dummies once
    y_test_dummies = pd.get_dummies(y_test, drop_first=False).values
    for i in range(n_classes):
        fpr[i], tpr[i], _ = roc_curve(y_test_dummies[:, i], y_score[:,
i])
        roc_auc[i] = auc(fpr[i], tpr[i])

    # roc for each class
    fig, ax = plt.subplots(figsize=figsize)
    ax.plot([0, 1], [0, 1], 'k--')
    ax.set_xlim([0.0, 1.0])
    ax.set_ylim([0.0, 1.05])
    ax.set_xlabel('False Positive Rate')
    ax.set_ylabel('True Positive Rate')
    ax.set_title('Receiver operating characteristic example')
    for i in range(n_classes):
        ax.plot(fpr[i], tpr[i], label='ROC curve (area = %0.2f) for
label %i' % (roc_auc[i], i))
    ax.legend(loc="best")
    ax.grid(alpha=.4)
    sns.despine()
    plt.show()

plot_multiclass_roc(grid_model, scaler_x_test, y_test, n_classes=3,
figsize=(16, 10))
```


Receiver operating characteristic example
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
ROC curve (area = 1.00) for label 0
ROC curve (area = 0.78) for label 1
ROC curve (area = 1.00) for label 2