Support Vector Machine(SVM)

21BCE1964

What is the support vector machine(SVM)?
Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.

In [1]:

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import matplotlib.pyplot as plt
import seaborn as sns

import os

root_folder = '/'
for dirname, _, filenames in os.walk(root_folder):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
/kaggle/input/raisin-dataset/Raisin_Dataset/Raisin_Dataset.xlsx
/kaggle/input/raisin-dataset/Raisin_Dataset/Raisin_Dataset.arff
/kaggle/input/raisin-dataset/Raisin_Dataset/Raisin_Dataset_Citation_Request.txt
```

In [2]:

```
!pip install openpyxl
```

```
Collecting openpyxl
  Downloading openpyxl-3.1.2-py2.py3-none-any.whl (249 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 250.0/250.0 kB 6.3 MB/s eta 0:00:0000:01
Collecting et-xmlfile
  Downloading et_xmlfile-1.1.0-py3-none-any.whl (4.7 kB)
Installing collected packages: et-xmlfile, openpyxl
Successfully installed et-xmlfile-1.1.0 openpyxl-3.1.2
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting
behaviour with the system package manager. It is recommended to use a virtual environment
instead: https://pip.pypa.io/warnings/venv
```

Data Review

In [3]:

```
# Reading data with pandas library.
data = pd.read_excel('Raisin_Dataset.xlsx', engine="openpyxl")
```

In [4]:

```
data
```

Out[4]:

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter	Class
0	87524	442.246011	253.291155	0.819738	90546	0.758651	1184.040	Kecimen
1	75166	406.690687	243.032436	0.801805	78789	0.684130	1121.786	Kecimen
2	90856	442.267048	266.328318	0.798354	93717	0.637613	1208.575	Kecimen
3	45928	286.540559	208.760042	0.684989	47336	0.699599	844.162	Kecimen

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter	Class
4	79408	352.190770	290.827533	0.564011	81463	0.792772	1073.251	Kecimen
...	...	...	...	...	...	...	...	...
895	83248	430.077308	247.838695	0.817263	85839	0.668793	1129.072	Besni
896	87350	440.735698	259.293149	0.808629	90899	0.636476	1214.252	Besni
897	99657	431.706981	298.837323	0.721684	106264	0.741099	1292.828	Besni
898	93523	476.344094	254.176054	0.845739	97653	0.658798	1258.548	Besni
899	85609	512.081774	215.271976	0.907345	89197	0.632020	1272.862	Besni

900 rows × 8 columns

In [5]:

```
# information of data
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 900 entries, 0 to 899
Data columns (total 8 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   Area             900 non-null    int64  
 1   MajorAxisLength  900 non-null    float64
 2   MinorAxisLength  900 non-null    float64
 3   Eccentricity     900 non-null    float64
 4   ConvexArea       900 non-null    int64  
 5   Extent           900 non-null    float64
 6   Perimeter        900 non-null    float64
 7   Class            900 non-null    object 
dtypes: float64(5), int64(2), object(1)
memory usage: 56.4+ KB
```

In [6]:

```
# Dataset Values(Max, min, std..)
data.describe()
```

Out[6]:

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter
count	900.000000	900.000000	900.000000	900.000000	900.000000	900.000000	900.000000
mean	87804.127778	430.929950	254.488133	0.781542	91186.090000	0.699508	1165.906636
std	39002.111390	116.035121	49.988902	0.090318	40769.290132	0.053468	273.764315
min	25387.000000	225.629541	143.710872	0.348730	26139.000000	0.379856	619.074000
25%	59348.000000	345.442898	219.111126	0.741766	61513.250000	0.670869	966.410750
50%	78902.000000	407.803951	247.848409	0.798846	81651.000000	0.707367	1119.509000
75%	105028.250000	494.187014	279.888575	0.842571	108375.750000	0.734991	1308.389750
max	235047.000000	997.291941	492.275279	0.962124	278217.000000	0.835455	2697.753000

In [7]:

```
# Data Correlation: Relationship between columns
data.corr()
```

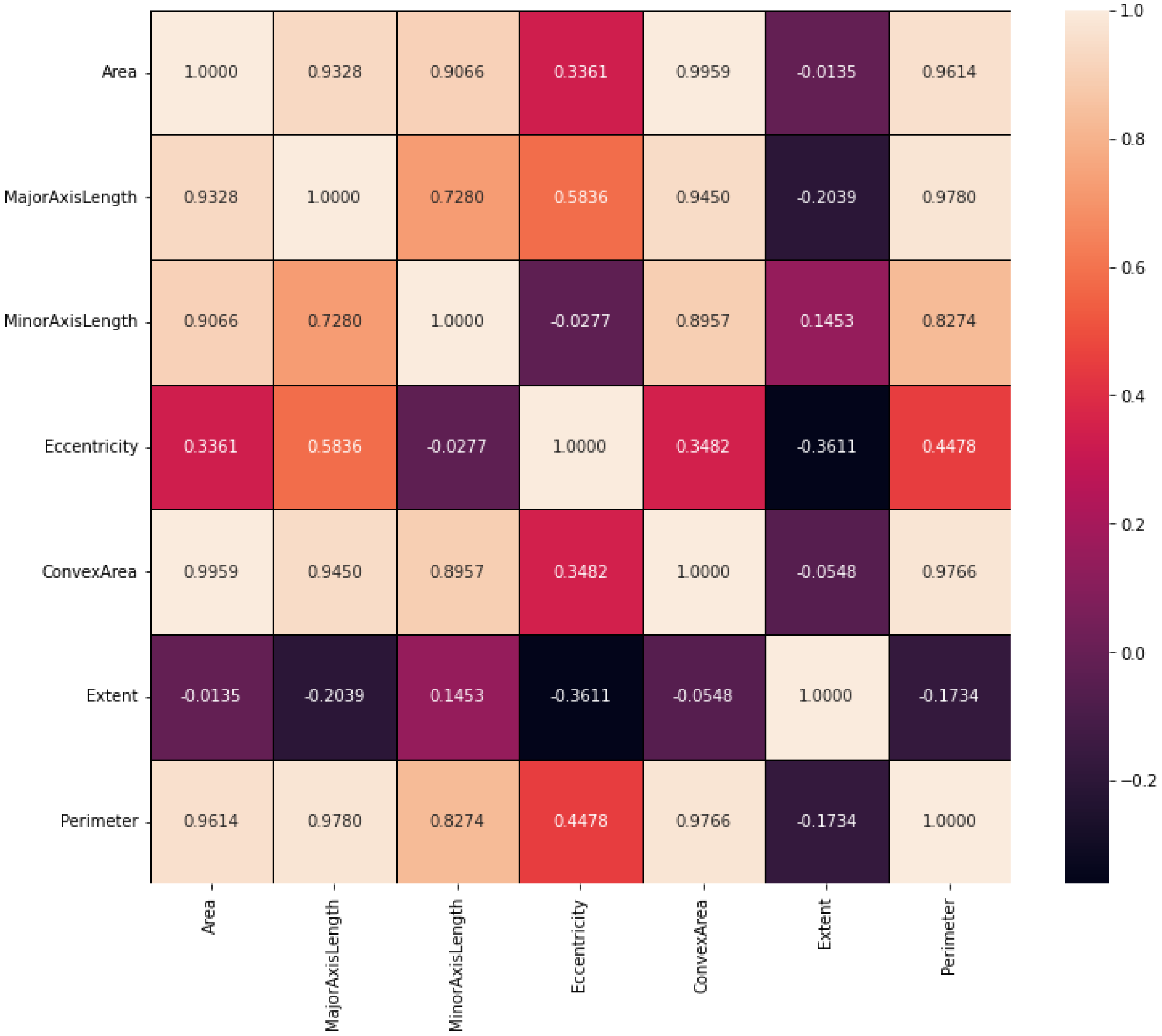
Out[7]:

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter
Area	1.000000	0.932774	0.906650	0.336107	0.995920	-0.013499	0.961352
MajorAxisLength	0.932774	1.000000	0.728030	0.583608	0.945031	-0.203866	0.977978
MinorAxisLength	0.906650	0.728030	1.000000	-0.027683	0.895651	0.145322	0.827417
Eccentricity	0.336107	0.583608	-0.027683	1.000000	0.348210	-0.361061	0.447845

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter
ConvexArea	0.995920	0.945031	0.895651	0.348210	1.000000	-0.054802	0.976612
Extent	-0.013499	-0.203866	0.145322	-0.361061	-0.054802	1.000000	-0.173449
Perimeter	0.961352	0.977978	0.827417	0.447845	0.976612	-0.173449	1.000000

In [8]:

```python
# Visualization of correlation result with seaborn library heatmap.
f, ax = plt.subplots(figsize = (12,10))
sns.heatmap(data.corr(), annot = True, linewidths=0.5, linecolor = "black", fmt = ".4f", ax = ax)
plt.show()
```



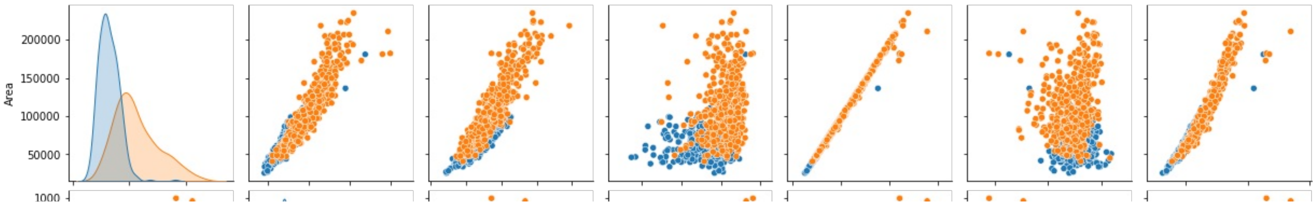
When I looked at correlation I generally am seeing direct proportion in between the columns.

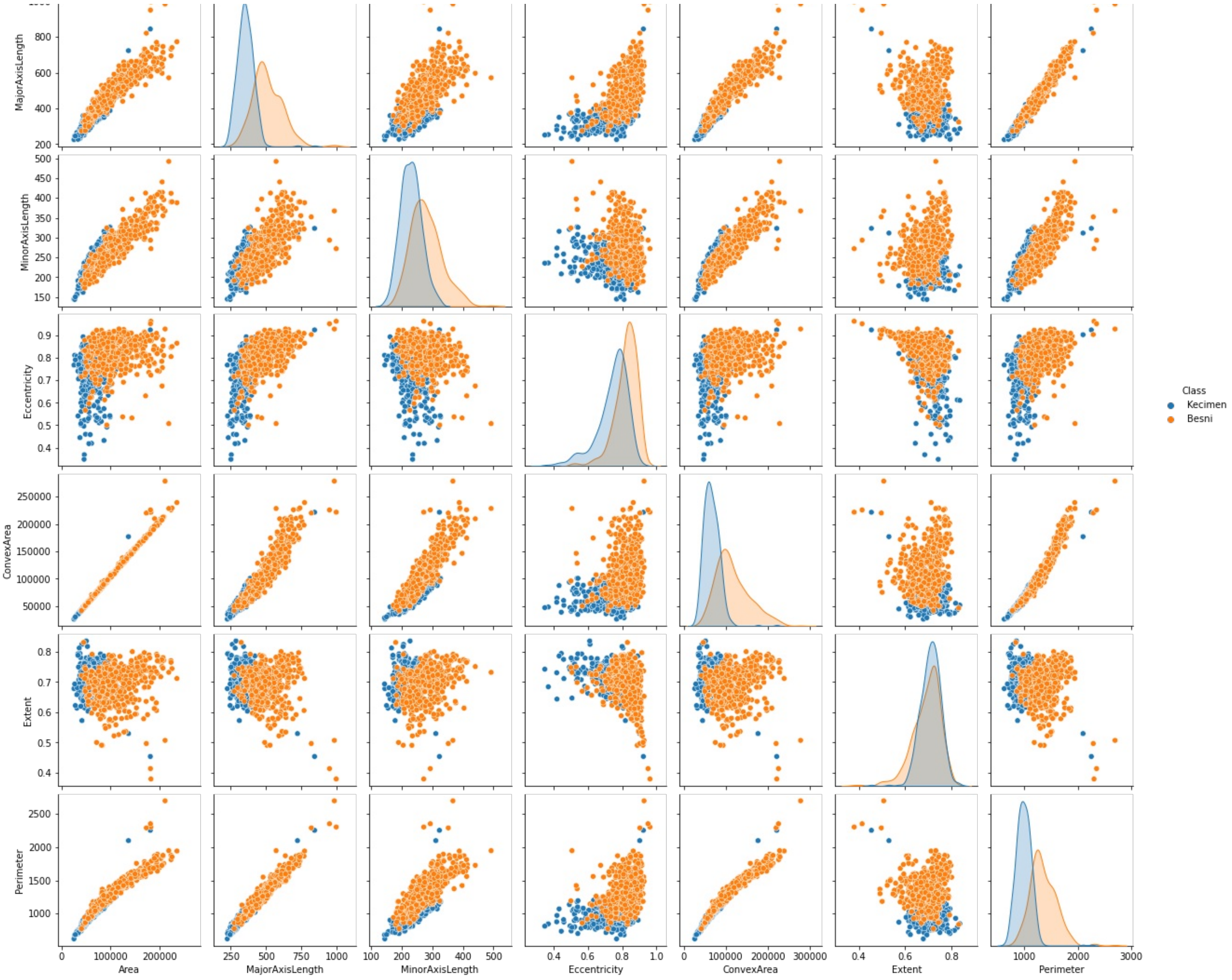
In [9]:

```python
# Visualization of correlation results with seaborn library pairplot
sns.pairplot(data, hue = "Class")
```

Out[9]:

```
<seaborn.axisgrid.PairGrid at 0x7e4c4efd0e10>
```





In [10]:

```
# Dataset columns names
data.columns
```

Out[10]:

```
Index(['Area', 'MajorAxisLength', 'MinorAxisLength', 'Eccentricity',
       'ConvexArea', 'Extent', 'Perimeter', 'Class'],
      dtype='object')
```

Data Visuzalization

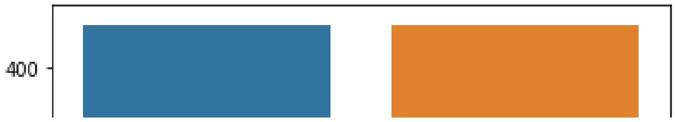
The Second visual has zero correlations between columns.

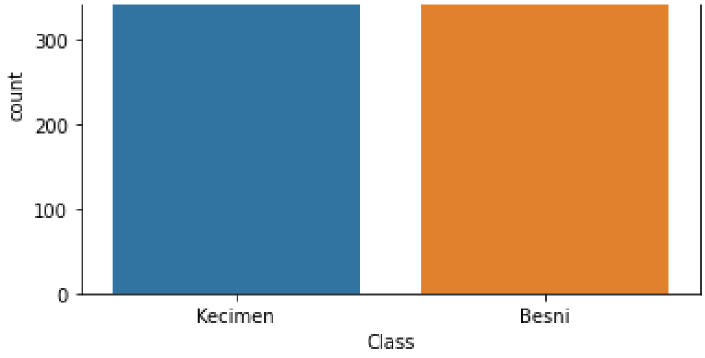
In [11]:

```
# First Visual
# The number of Class in the dataset and its graphic.
sns.countplot(x = "Class", data = data)
data.loc[:,"Class"].value_counts()
```

Out[11]:

```
Kecimen    450
Besni      450
Name: Class, dtype: int64
```

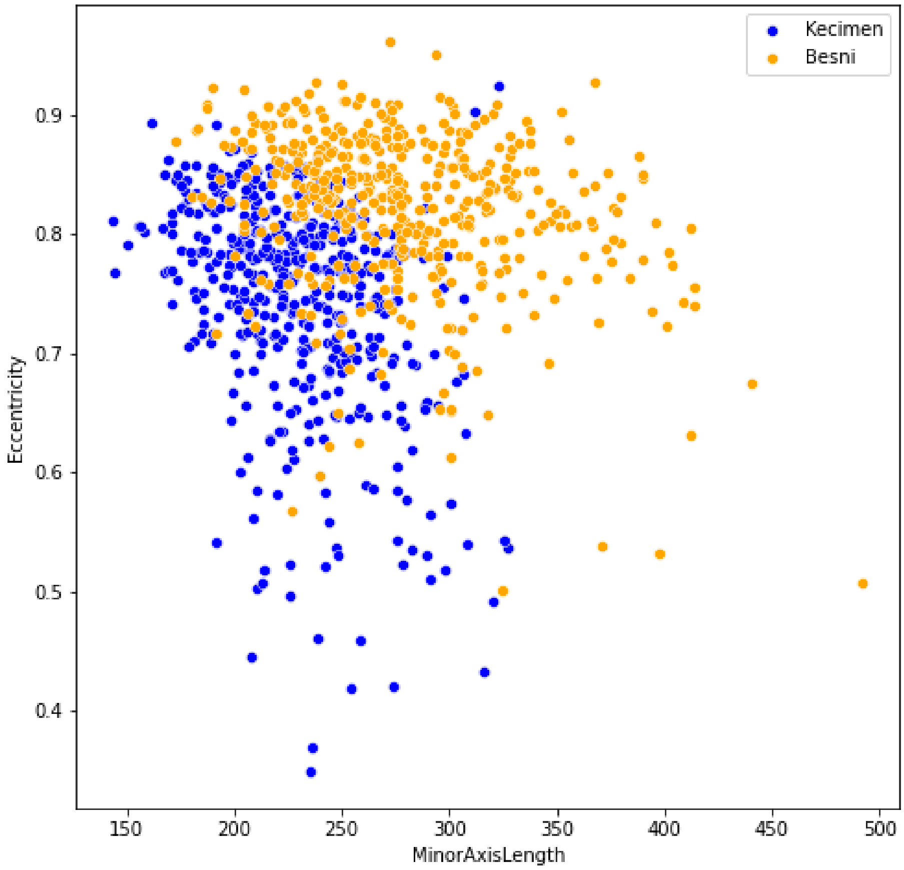




In [12]:

```
# Second Visual
Kecimen = data[data.Class == "Kecimen"]
Besni = data[data.Class == "Besni"]

plt.figure(figsize = (8,8))
plt.scatter(Kecimen.MinorAxisLength, Kecimen.Eccentricity, color = "blue", label = "Kecimen", linewidths=0.5 ,edgecolors="white")
plt.scatter(Besni.MinorAxisLength, Besni.Eccentricity, color = "orange", label = "Besni", linewidths=0.5, edgecolors="white")
plt.xlabel("MinorAxisLength")
plt.ylabel("Eccentricity")
plt.legend()
plt.show()
```



Data Preparing for SVM

I prepare x_data and y_data and I will normalize to x_data. The reason I do normalization is that the values do not match with each other, so the number 72.61 and the number 1.59 are not in the same range, I will reduce these numbers to the same range. My range will be 0-1. I read dataset again beacause I will change in dataset. The class column is a string type and I want to that be an integer. In the block of code, I will specify.

In [13]:

```
# Read dataset
data_svm = pd.read_excel('Raisin_Dataset.xlsx', engine="openpyxl")
```

In [14]:

```
data_svm
```

Out[14]:

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter	Class
0	87524	442.246011	253.291155	0.819738	90546	0.758651	1184.040	Kecimen
1	75166	406.690687	243.032436	0.801805	78789	0.684130	1121.786	Kecimen
2	90856	442.267048	266.328318	0.798354	93717	0.637613	1208.575	Kecimen
3	45928	286.540559	208.760042	0.684989	47336	0.699599	844.162	Kecimen
4	79408	352.190770	290.827533	0.564011	81463	0.792772	1073.251	Kecimen
...	...	...	...	...	...	...	...	...
895	83248	430.077308	247.838695	0.817263	85839	0.668793	1129.072	Besni
896	87350	440.735698	259.293149	0.808629	90899	0.636476	1214.252	Besni
897	99657	431.706981	298.837323	0.721684	106264	0.741099	1292.828	Besni
898	93523	476.344094	254.176054	0.845739	97653	0.658798	1258.548	Besni
899	85609	512.081774	215.271976	0.907345	89197	0.632020	1272.862	Besni

900 rows × 8 columns

In [15]:

```
# Change class type.
# Kecimen = 1
# Bensi = 0
data_svm.Class = [1 if i == "Kecimen" else 0 for i in data.Class]
```

In [16]:

```
data_svm
```

Out[16]:

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter	Class
0	87524	442.246011	253.291155	0.819738	90546	0.758651	1184.040	1
1	75166	406.690687	243.032436	0.801805	78789	0.684130	1121.786	1
2	90856	442.267048	266.328318	0.798354	93717	0.637613	1208.575	1
3	45928	286.540559	208.760042	0.684989	47336	0.699599	844.162	1
4	79408	352.190770	290.827533	0.564011	81463	0.792772	1073.251	1
...	...	...	...	...	...	...	...	...
895	83248	430.077308	247.838695	0.817263	85839	0.668793	1129.072	0
896	87350	440.735698	259.293149	0.808629	90899	0.636476	1214.252	0
897	99657	431.706981	298.837323	0.721684	106264	0.741099	1292.828	0
898	93523	476.344094	254.176054	0.845739	97653	0.658798	1258.548	0
899	85609	512.081774	215.271976	0.907345	89197	0.632020	1272.862	0

900 rows × 8 columns

In [17]:

```
# x_data
x_data = data_svm.drop(["Class"], axis = 1)

#y_data
```

```
y_data = data_svm.Class.values
```

In [18]:

```
x_data
```

Out[18]:

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter
0	87524	442.246011	253.291155	0.819738	90546	0.758651	1184.040
1	75166	406.690687	243.032436	0.801805	78789	0.684130	1121.786
2	90856	442.267048	266.328318	0.798354	93717	0.637613	1208.575
3	45928	286.540559	208.760042	0.684989	47336	0.699599	844.162
4	79408	352.190770	290.827533	0.564011	81463	0.792772	1073.251
...	...	...	...	...	...	...	...
895	83248	430.077308	247.838695	0.817263	85839	0.668793	1129.072
896	87350	440.735698	259.293149	0.808629	90899	0.636476	1214.252
897	99657	431.706981	298.837323	0.721684	106264	0.741099	1292.828
898	93523	476.344094	254.176054	0.845739	97653	0.658798	1258.548
899	85609	512.081774	215.271976	0.907345	89197	0.632020	1272.862

900 rows × 7 columns

In [19]:

```
y_data
```

Out[19]:

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

In [20]:

```
#Normalization
x_data = (x_data - np.min(x_data))/(np.max(x_data) - np.min(x_data))
```

In [21]:

```
x_data
```

Out[21]:

	Area	MajorAxisLength	MinorAxisLength	Eccentricity	ConvexArea	Extent	Perimeter
0	0.296370	0.280714	0.314376	0.767872	0.255504	0.831422	0.271791
1	0.237427	0.234638	0.284945	0.738636	0.208864	0.667854	0.241842
2	0.312263	0.280741	0.351778	0.733009	0.268084	0.565754	0.283594
3	0.097973	0.078935	0.186620	0.548194	0.084089	0.701809	0.108284
4	0.257660	0.164011	0.422064	0.350968	0.219472	0.906315	0.218493
...	...	...	...	...	...	...	...
895	0.275975	0.264945	0.298733	0.763836	0.236831	0.634192	0.245347
896	0.295540	0.278757	0.331595	0.749761	0.256905	0.563259	0.286325
897	0.354240	0.267056	0.445044	0.608017	0.317858	0.792897	0.324126
898	0.324983	0.324902	0.316915	0.810259	0.283698	0.612254	0.307635
899	0.287236	0.371214	0.205302	0.910695	0.250153	0.553478	0.314521

900 rows × 7 columns

In [22]:

```
# Train test split
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x_data, y_data, test_size=0.3, rando
m_state = 1)
```

Traning Model

In [23]:

```
from sklearn.svm import SVC
svm = SVC(random_state = 1)

svm.fit(x_train, y_train)

print("print accuracy of svm algo:", svm.score(x_test, y_test))
```

```
print accuracy of svm algo: 0.9037037037037037
```

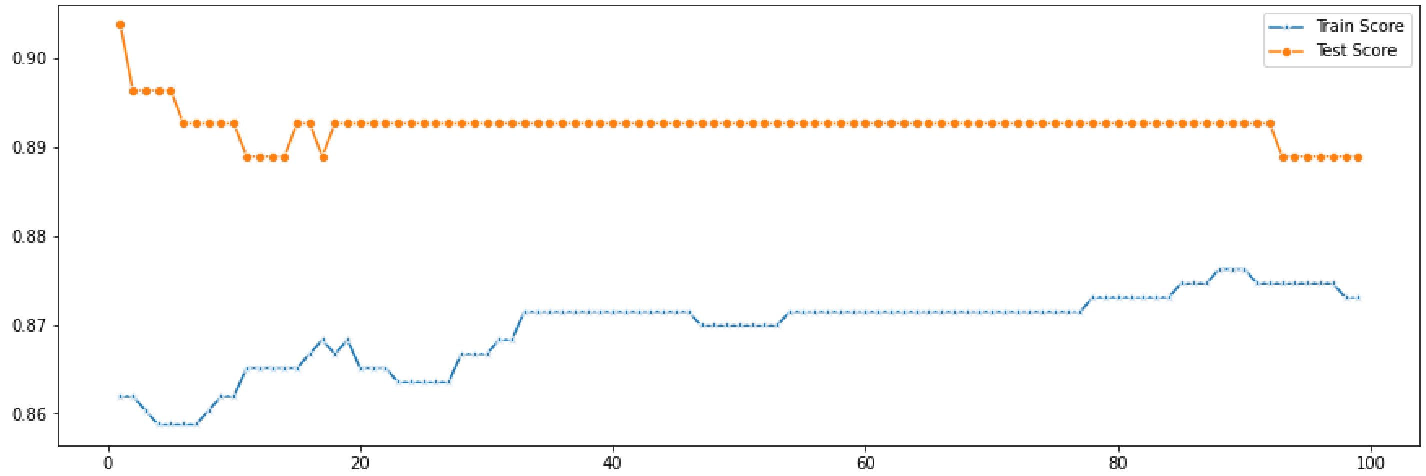
In [24]:

```
test_score_list = []
train_score_list = []

for i in range(1,100):
    svm2 = SVC(C = i)
    svm2.fit(x_train, y_train)
    test_score_list.append(svm2.score(x_test, y_test))
    train_score_list.append(svm2.score(x_train, y_train))
```

```
plt.figure(figsize=(15,5))
p = sns.lineplot(range(1,100),train_score_list,marker='*',label='Train Score')
p = sns.lineplot(range(1,100),test_score_list,marker='o',label='Test Score')
```

```
/opt/conda/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning: Pass the
following variables as keyword args: x, y. From version 0.12, the only valid positional a
rgument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  FutureWarning
/opt/conda/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning: Pass the
following variables as keyword args: x, y. From version 0.12, the only valid positional a
rgument will be `data`, and passing other arguments without an explicit keyword will resu
lt in an error or misinterpretation.
  FutureWarning
```



In [25]:

```
#import GridSearchCV
from sklearn.model_selection import GridSearchCV

grid={"C":[1, 100, 1000],"kernel":["linear","poly","sigmoid"]}

svm3 = SVC(random_state = 1)

svm3.fit(x_train, y_train)

print("test accuracy {}".format(svm3.score(x_test,y_test)))
print("Train accuracy {}".format(svm3.score(x_train, y_train)))

svm3_gscv=GridSearchCV(svm3,grid,cv=10)
svm3_gscv.fit(x_test,y_test)
```

```
test accuracy 0.9037037037037037
Train accuracy 0.861904761904762
```

Out[25]:

```
GridSearchCV(cv=10, estimator=SVC(random_state=1),
             param_grid={'C': [1, 100, 1000],
                         'kernel': ['linear', 'poly', 'sigmoid']})
```

In [26]:

```
print("best hyperparameters: ", svm3_gscv.best_params_)
print("accuracy: ", svm3_gscv.best_score_)
```

```
best hyperparameters:  {'C': 1, 'kernel': 'poly'}
accuracy:  0.8925925925925926
```

In [27]:

```
from sklearn.svm import SVC
svm4 = SVC(C = 1, kernel="poly")
```

```
print("test accuracy: {} ".format(svm4.fit(x_test, y_test).score(x_test, y_test)))
print("train accuracy: {} ".format(svm4.fit(x_train, y_train).score(x_train, y_train)))
```

```
test accuracy: 0.9037037037037037
train accuracy: 0.8523809523809524
```