Project 2- Mitali Bharali - Group 12

Project Description:

- Use same datasets as Project 1.
- Preprocess data: Explore data and apply data scaling.

Regression Task:

- Apply any two models with bagging and any two models with pasting.
- Apply any two models with adaboost boosting
- Apply one model with gradient boosting
- Apply PCA on data and then apply all the models in project 1 again on data you get from PCA. Compare your results with results in project 2. You don't need to apply all the models twice. Just copy the result table from project 1, prepare similar table for all the models after PCA and compare both tables. Does PCA help in getting better results?
- Apply deep learning models covered in class

Classification Task:

- Apply two voting classifiers - one with hard voting and one with soft voting
- Apply any two models with bagging and any two models with pasting.
- Apply any two models with adaboost boosting
- Apply one model with gradient boosting
- Apply PCA on data and then apply all the models in project 1 again on data you get from PCA. Compare your results with results in project 1. You don't need to apply all the models twice. Just copy the result table from project 1, prepare similar table for all the models after PCA and compare both tables. Does PCA help in getting better results?
- Apply deep learning models covered in class

Deliverables:

- Use markdown to provide inline comments for this project.
- Your outputs should be clearly executed in the notebook i.e. we should not need to rerun the code to obtain the outputs.
- Visualization encouraged.
- If you are submitting two different files, then please only one group member submit both the files. If you submit two files separately from different accounts, it will be submitted as two different attempts.
- If you are submitting two different files, then please follow below naming convetion:
  Project2_Regression_GroupXX_Firstname1_Firstname2.ipynb
  Project2_Classification_GroupXX_Firstname1_Firstname2.ipynb
- If you are submitting single file, then please follow below naming convetion:
  Project2_Both_GroupXX_Firstname1_Firstname2.ipynb

Questions regarding the project:

- We have created a discussion board under Projects folder on e-learning. Create threads over there and post your queries related to project there.
- We will also answer queries there. We will not be answering any project related queries through the mail.

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```
audit_risk = pd.read_csv('audit_risk.csv')
trial = pd.read_csv('trial.csv')
```

In [3]:
```
audit_risk.describe()
```

Out[3]:

	Sector_score	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B
count	776.000000	776.000000	776.000000	776.000000	776.000000	776.000000	776.000000
mean	20.184536	2.450194	0.351289	1.351029	10.799988	0.313144	6.334008
std	24.319017	5.678870	0.174055	3.440447	50.083624	0.169804	30.072845
min	1.850000	0.000000	0.200000	0.000000	0.000000	0.200000	0.000000
25%	2.370000	0.210000	0.200000	0.042000	0.000000	0.200000	0.000000
50%	3.890000	0.875000	0.200000	0.175000	0.405000	0.200000	0.081000
75%	55.570000	2.480000	0.600000	1.488000	4.160000	0.400000	1.840500
max	59.850000	85.000000	0.600000	51.000000	1264.630000	0.600000	758.778000

8 rows × 26 columns

In [4]:
```
trial.describe()
```

Out[4]:

	Sector_score	PARA_A	SCORE_A	PARA_B	SCORE_B	TOTAL	numbers
count	776.000000	776.000000	776.000000	776.000000	776.000000	776.000000	776.000000
mean	20.184536	2.450194	3.512887	10.799988	3.131443	13.218481	5.067655
std	24.319017	5.678870	1.740549	50.083624	1.698042	51.312829	0.264449
min	1.850000	0.000000	2.000000	0.000000	2.000000	0.000000	5.000000
25%	2.370000	0.210000	2.000000	0.000000	2.000000	0.537500	5.000000
50%	3.890000	0.875000	2.000000	0.405000	2.000000	1.370000	5.000000
75%	55.570000	2.480000	6.000000	4.160000	4.000000	7.707500	5.000000
max	59.850000	85.000000	6.000000	1264.630000	6.000000	1268.910000	9.000000

In [5]:
```
audit_risk.isna().sum()
```

Out[5]:
```
Sector_score      0
LOCATION_ID       0
PARA_A            0
Score_A           0
Risk_A            0
PARA_B            0
Score_B           0
Risk_B            0
TOTAL             0
numbers           0
Score_B.1         0
Risk_C            0
Money_Value       1
Score_MV          0
Risk_D            0
District_Loss     0
PROB              0
RiSk_E            0
History           0
Prob              0
Risk_F            0
Score             0
Inherent_Risk     0
CONTROL_RISK      0
Detection_Risk    0
Audit_Risk        0
Risk              0
dtype: int64
```

In [6]:
```
trial.isna().sum()
```

Out[6]:
```
Sector_score     0
LOCATION_ID      0
PARA_A           0
SCORE_A          0
PARA_B           0
SCORE_B          0
TOTAL            0
numbers          0
Marks            0
Money_Value      1
MONEY_Marks      0
District         0
Loss             0
LOSS_SCORE       0
History          0
History_score    0
Score            0
Risk             0
dtype: int64
```

In [7]:
```
nan_rows = audit_risk[audit_risk['Money_Value'].isnull()]
nan_rows
```

Out[7]:

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TOTAl
642	55.57	4	0.23	0.2	0.046	0.0	0.2	0.0	0.2:

1 rows × 27 columns

In [8]:
```
nan_rows_trial = trial[trial['Money_Value'].isnull()]
nan_rows_trial
```

Out[8]:

	Sector_score	LOCATION_ID	PARA_A	SCORE_A	PARA_B	SCORE_B	TOTAL	numbers	M
642	55.57	4	0.23	2	0.0	2	0.23	5.0	

In [9]:
```
audit_risk.dtypes
```

Out[9]:
```
Sector_score       float64
LOCATION_ID         object
PARA_A             float64
Score_A            float64
Risk_A             float64
PARA_B             float64
Score_B            float64
Risk_B             float64
TOTAL              float64
numbers            float64
Score_B.1          float64
Risk_C             float64
Money_Value        float64
Score_MV           float64
Risk_D             float64
District_Loss        int64
PROB               float64
RiSk_E             float64
History              int64
Prob               float64
Risk_F             float64
Score              float64
Inherent_Risk      float64
CONTROL_RISK       float64
Detection_Risk     float64
Audit_Risk         float64
Risk                 int64
dtype: object
```

In [10]:
```
audit_risk.fillna(audit_risk.median(), inplace=True)
```

In [11]:
```
audit_risk.isna().sum()
```

Out[11]:
```
Sector_score      0
LOCATION_ID       0
PARA_A            0
Score_A           0
Risk_A            0
PARA_B            0
Score_B           0
Risk_B            0
TOTAL             0
numbers           0
Score_B.1         0
Risk_C            0
Money_Value       0
Score_MV          0
Risk_D            0
District_Loss     0
PROB              0
RiSk_E            0
History           0
Prob              0
Risk_F            0
Score             0
Inherent_Risk     0
CONTROL_RISK      0
Detection_Risk    0
Audit_Risk        0
Risk              0
dtype: int64
```

In [12]:
```
trial.fillna(trial.median(), inplace=True)
```

In [13]:
```
trial.isna().sum()
```

Out[13]:
```
Sector_score     0
LOCATION_ID      0
PARA_A           0
SCORE_A          0
PARA_B           0
SCORE_B          0
TOTAL            0
numbers          0
Marks            0
Money_Value      0
MONEY_Marks      0
District         0
Loss             0
LOSS_SCORE       0
History          0
History_score    0
Score            0
Risk             0
dtype: int64
```

In [14]:
```
audit_risk.info()

trial.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 776 entries, 0 to 775
Data columns (total 27 columns):
Sector_score      776 non-null float64
LOCATION_ID       776 non-null object
PARA_A            776 non-null float64
Score_A           776 non-null float64
Risk_A            776 non-null float64
PARA_B            776 non-null float64
Score_B           776 non-null float64
Risk_B            776 non-null float64
TOTAL             776 non-null float64
numbers           776 non-null float64
Score_B.1         776 non-null float64
Risk_C            776 non-null float64
Money_Value       776 non-null float64
Score_MV          776 non-null float64
Risk_D            776 non-null float64
District_Loss     776 non-null int64
PROB              776 non-null float64
RiSk_E            776 non-null float64
History           776 non-null int64
Prob              776 non-null float64
Risk_F            776 non-null float64
Score             776 non-null float64
Inherent_Risk     776 non-null float64
CONTROL_RISK      776 non-null float64
Detection_Risk    776 non-null float64
Audit_Risk        776 non-null float64
Risk              776 non-null int64
dtypes: float64(23), int64(3), object(1)
memory usage: 163.8+ KB
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 776 entries, 0 to 775
Data columns (total 18 columns):
Sector_score     776 non-null float64
LOCATION_ID      776 non-null object
PARA_A           776 non-null float64
SCORE_A          776 non-null int64
PARA_B           776 non-null float64
SCORE_B          776 non-null int64
TOTAL            776 non-null float64
numbers          776 non-null float64
Marks            776 non-null int64
Money_Value      776 non-null float64
MONEY_Marks      776 non-null int64
District         776 non-null int64
Loss             776 non-null int64
LOSS_SCORE       776 non-null int64
History          776 non-null int64
History_score    776 non-null int64
Score            776 non-null float64
Risk             776 non-null int64
dtypes: float64(7), int64(10), object(1)
memory usage: 109.2+ KB
```

In [15]:
```
audit_risk.describe(include = 'O')
```

Out[15]:

	LOCATION_ID
count	776
unique	45
top	8
freq	76

In [16]:
```
audit_risk.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 776 entries, 0 to 775
Data columns (total 27 columns):
Sector_score      776 non-null float64
LOCATION_ID       776 non-null object
PARA_A            776 non-null float64
Score_A           776 non-null float64
Risk_A            776 non-null float64
PARA_B            776 non-null float64
Score_B           776 non-null float64
Risk_B            776 non-null float64
TOTAL             776 non-null float64
numbers           776 non-null float64
Score_B.1         776 non-null float64
Risk_C            776 non-null float64
Money_Value       776 non-null float64
Score_MV          776 non-null float64
Risk_D            776 non-null float64
District_Loss     776 non-null int64
PROB              776 non-null float64
RiSk_E            776 non-null float64
History           776 non-null int64
Prob              776 non-null float64
Risk_F            776 non-null float64
Score             776 non-null float64
Inherent_Risk     776 non-null float64
CONTROL_RISK      776 non-null float64
Detection_Risk    776 non-null float64
Audit_Risk        776 non-null float64
Risk              776 non-null int64
dtypes: float64(23), int64(3), object(1)
memory usage: 163.8+ KB
```

In [17]:
```
audit_risk=audit_risk.drop(['Risk'],axis=1)
audit_risk
```

Out[17]:

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TO
0	3.89	23	4.18	0.6	2.508	2.5000	0.2	0.50000	6.6
1	3.89	6	0.00	0.2	0.000	4.8300	0.2	0.96600	4.8
2	3.89	6	0.51	0.2	0.102	0.2300	0.2	0.04600	0.7
3	3.89	6	0.00	0.2	0.000	10.8000	0.6	6.48000	10.8
4	3.89	6	0.00	0.2	0.000	0.0800	0.2	0.01600	0.0
5	3.89	6	0.00	0.2	0.000	0.8300	0.2	0.16600	0.8
6	3.89	7	1.10	0.4	0.440	7.4100	0.4	2.96400	8.5
7	3.89	8	8.50	0.6	5.100	12.0300	0.6	7.21800	20.5
8	3.89	8	8.40	0.6	5.040	11.0500	0.6	6.63000	19.4
9	3.89	8	3.98	0.6	2.388	0.9900	0.2	0.19800	4.9
10	3.89	8	5.43	0.6	3.258	10.7700	0.6	6.46200	16.2
11	3.89	8	15.38	0.6	9.228	40.1400	0.6	24.08400	55.5
12	3.89	8	5.47	0.6	3.282	7.6300	0.4	3.05200	13.1
13	3.89	8	1.09	0.4	0.436	0.3500	0.2	0.07000	1.4
14	3.89	8	0.00	0.2	0.000	0.8400	0.2	0.16800	0.8
15	3.89	13	1.95	0.4	0.780	9.0100	0.4	3.60400	10.9
16	3.89	37	8.54	0.6	5.124	31.6300	0.6	18.97800	40.1
17	3.89	37	4.18	0.6	2.508	4.8300	0.2	0.96600	9.0
18	3.89	37	1.81	0.4	0.724	1.0300	0.2	0.20600	2.8
19	3.89	37	4.86	0.6	2.916	46.7800	0.6	28.06800	51.6
20	3.89	24	6.26	0.6	3.756	14.1000	0.6	8.46000	20.3
21	3.89	3	0.02	0.2	0.004	5.9400	0.4	2.37600	5.9
22	3.89	3	5.31	0.6	3.186	22.7900	0.6	13.67400	28.1
23	3.89	3	0.94	0.2	0.188	0.0100	0.2	0.00200	0.9
24	3.89	4	5.78	0.6	3.468	57.9200	0.6	34.75200	63.7
25	3.89	4	7.42	0.6	4.452	2.2400	0.2	0.44800	9.6
26	3.89	4	0.00	0.2	0.000	1.1000	0.2	0.22000	1.1
27	3.89	14	6.85	0.6	4.110	31.7600	0.6	19.05600	38.6
28	3.89	14	0.00	0.2	0.000	1.0300	0.2	0.20600	1.0
29	3.89	37	0.00	0.2	0.000	0.7500	0.2	0.15000	0.7
...	...	...	...	...	...	...	...	...	
746	55.57	13	0.25	0.2	0.050	0.0017	0.2	0.00034	0.2
747	55.57	13	0.31	0.2	0.062	0.0015	0.2	0.00030	0.3
748	55.57	13	0.00	0.2	0.000	0.0000	0.2	0.00000	0.0
749	55.57	13	0.84	0.2	0.168	0.0000	0.2	0.00000	0.8

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TO
750	55.57	13	1.09	0.4	0.436	0.0000	0.2	0.00000	1.0
751	55.57	13	1.29	0.4	0.516	0.0000	0.2	0.00000	1.2
752	55.57	13	0.51	0.2	0.102	0.3700	0.2	0.07400	0.8
753	55.57	21	0.09	0.2	0.018	0.0000	0.2	0.00000	0.0
754	55.57	18	0.39	0.2	0.078	0.9100	0.2	0.18200	1.3
755	55.57	21	1.07	0.4	0.428	0.0000	0.2	0.00000	1.0
756	55.57	25	0.00	0.2	0.000	0.0000	0.2	0.00000	0.0
757	55.57	32	0.50	0.2	0.100	2.9700	0.6	1.78200	3.4
758	55.57	22	0.49	0.2	0.098	0.5500	0.2	0.11000	1.0
759	55.57	14	0.84	0.2	0.168	0.6500	0.2	0.13000	1.4
760	55.57	12	0.90	0.2	0.180	1.1100	0.4	0.44400	2.0
761	55.57	12	0.00	0.2	0.000	0.0000	0.2	0.00000	0.0
762	55.57	14	0.59	0.2	0.118	0.0000	0.2	0.00000	0.5
763	55.57	36	0.02	0.2	0.004	0.0000	0.2	0.00000	0.0
764	55.57	14	1.48	0.4	0.592	4.4800	0.6	2.68800	5.9
765	55.57	22	0.00	0.2	0.000	3.3000	0.6	1.98000	3.3
766	55.57	8	0.80	0.2	0.160	0.5700	0.2	0.11400	1.3
767	55.57	18	0.36	0.2	0.072	0.5400	0.2	0.10800	0.9
768	55.57	9	0.44	0.2	0.088	0.5300	0.2	0.10600	0.9
769	55.57	16	0.51	0.2	0.102	0.5000	0.2	0.10000	1.0
770	55.57	18	0.75	0.2	0.150	0.4500	0.2	0.09000	1.2
771	55.57	9	0.49	0.2	0.098	0.4000	0.2	0.08000	0.8
772	55.57	16	0.47	0.2	0.094	0.3700	0.2	0.07400	0.8
773	55.57	14	0.24	0.2	0.048	0.0400	0.2	0.00800	0.2
774	55.57	18	0.20	0.2	0.040	0.0000	0.2	0.00000	0.2
775	55.57	15	0.00	0.2	0.000	0.0000	0.2	0.00000	0.0

776 rows × 26 columns

In [18]:
```
audit_risk = audit_risk.drop_duplicates(keep='first')
audit_risk.shape
```

Out[18]: (763, 26)

In [19]:
```
trial = trial.drop_duplicates(keep='first')
trial.shape
```

Out[19]: (763, 18)

In [20]:
```
result = audit_risk.join(trial.set_index(['Sector_score', 'LOCATION_ID', 'PARA_A', 'PARA_B', 'TOTAL', 'numbers', 'Money_Value',
       'History', 'Score']), on= ['Sector_score', 'LOCATION_ID', 'PARA_A', 'PARA_B', 'TOTAL', 'numbers', 'Money_Value',
       'History', 'Score'])
```

In [21]:
```
result=result.drop(['SCORE_A','SCORE_B'],axis=1)
```

In [22]:
```
result.isna().sum()
```

Out[22]:
```
Sector_score      0
LOCATION_ID       0
PARA_A            0
Score_A           0
Risk_A            0
PARA_B            0
Score_B           0
Risk_B            0
TOTAL             0
numbers           0
Score_B.1         0
Risk_C            0
Money_Value       0
Score_MV          0
Risk_D            0
District_Loss     0
PROB              0
RiSk_E            0
History           0
Prob              0
Risk_F            0
Score             0
Inherent_Risk     0
CONTROL_RISK      0
Detection_Risk    0
Audit_Risk        0
Marks             0
MONEY_Marks       0
District          0
Loss              0
LOSS_SCORE        0
History_score     0
Risk              0
dtype: int64
```

In [23]:
```
result.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 763 entries, 0 to 775
Data columns (total 33 columns):
Sector_score      763 non-null float64
LOCATION_ID       763 non-null object
PARA_A            763 non-null float64
Score_A           763 non-null float64
Risk_A            763 non-null float64
PARA_B            763 non-null float64
Score_B           763 non-null float64
Risk_B            763 non-null float64
TOTAL             763 non-null float64
numbers           763 non-null float64
Score_B.1         763 non-null float64
Risk_C            763 non-null float64
Money_Value       763 non-null float64
Score_MV          763 non-null float64
Risk_D            763 non-null float64
District_Loss     763 non-null int64
PROB              763 non-null float64
RiSk_E            763 non-null float64
History           763 non-null int64
Prob              763 non-null float64
Risk_F            763 non-null float64
Score             763 non-null float64
Inherent_Risk     763 non-null float64
CONTROL_RISK      763 non-null float64
Detection_Risk    763 non-null float64
Audit_Risk        763 non-null float64
Marks             763 non-null int64
MONEY_Marks       763 non-null int64
District          763 non-null int64
Loss              763 non-null int64
LOSS_SCORE        763 non-null int64
History_score     763 non-null int64
Risk              763 non-null int64
dtypes: float64(23), int64(9), object(1)
memory usage: 202.7+ KB
```

In [24]:
```
result = result.dropna()
```

In [25]:
```
result.shape
```

Out[25]:
```
(763, 33)
```

In [26]:
```
dup = result.duplicated(subset=None, keep = 'first')
dup
```

Out[26]:
```
0      False
1      False
2      False
3      False
4      False
5      False
6      False
7      False
8      False
9      False
10     False
11     False
12     False
13     False
14     False
15     False
16     False
17     False
18     False
19     False
20     False
21     False
22     False
23     False
24     False
25     False
26     False
27     False
28     False
29     False
       ...
744    False
745    False
746    False
747    False
748    False
749    False
750    False
751    False
752    False
753    False
754    False
755    False
756    False
757    False
758    False
759    False
760    False
762    False
763    False
764    False
765    False
766    False
767    False
768    False
769    False
770    False
```

```
772    False
773    False
774    False
775    False
Length: 763, dtype: bool
```

In [27]:
```
dup.sum()
```

Out[27]:
```
0
```

In [28]:
```
result=result.drop_duplicates(keep='first')
```

In [29]:
```
result.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 763 entries, 0 to 775
Data columns (total 33 columns):
Sector_score      763 non-null float64
LOCATION_ID       763 non-null object
PARA_A            763 non-null float64
Score_A           763 non-null float64
Risk_A            763 non-null float64
PARA_B            763 non-null float64
Score_B           763 non-null float64
Risk_B            763 non-null float64
TOTAL             763 non-null float64
numbers           763 non-null float64
Score_B.1         763 non-null float64
Risk_C            763 non-null float64
Money_Value       763 non-null float64
Score_MV          763 non-null float64
Risk_D            763 non-null float64
District_Loss     763 non-null int64
PROB              763 non-null float64
RiSk_E            763 non-null float64
History           763 non-null int64
Prob              763 non-null float64
Risk_F            763 non-null float64
Score             763 non-null float64
Inherent_Risk     763 non-null float64
CONTROL_RISK      763 non-null float64
Detection_Risk    763 non-null float64
Audit_Risk        763 non-null float64
Marks             763 non-null int64
MONEY_Marks       763 non-null int64
District          763 non-null int64
Loss              763 non-null int64
LOSS_SCORE        763 non-null int64
History_score     763 non-null int64
Risk              763 non-null int64
dtypes: float64(23), int64(9), object(1)
memory usage: 202.7+ KB
```

In [30]:
```
result.LOCATION_ID.replace(['LOHARU', 'NUH', 'SAFIDON'], [10, 26, 45], inplace
=True)
result.dtypes
```

Out[30]:
```
Sector_score      float64
LOCATION_ID        object
PARA_A            float64
Score_A           float64
Risk_A            float64
PARA_B            float64
Score_B           float64
Risk_B            float64
TOTAL             float64
numbers           float64
Score_B.1         float64
Risk_C            float64
Money_Value       float64
Score_MV          float64
Risk_D            float64
District_Loss       int64
PROB              float64
RiSk_E            float64
History             int64
Prob              float64
Risk_F            float64
Score             float64
Inherent_Risk     float64
CONTROL_RISK      float64
Detection_Risk    float64
Audit_Risk        float64
Marks               int64
MONEY_Marks         int64
District            int64
Loss                int64
LOSS_SCORE          int64
History_score       int64
Risk                int64
dtype: object
```

In [31]:
```
result["LOCATION_ID"]=result["LOCATION_ID"].astype(int)
result.dtypes
```

Out[31]:
```
Sector_score      float64
LOCATION_ID         int32
PARA_A            float64
Score_A           float64
Risk_A            float64
PARA_B            float64
Score_B           float64
Risk_B            float64
TOTAL             float64
numbers           float64
Score_B.1         float64
Risk_C            float64
Money_Value       float64
Score_MV          float64
Risk_D            float64
District_Loss       int64
PROB              float64
RiSk_E            float64
History             int64
Prob              float64
Risk_F            float64
Score             float64
Inherent_Risk     float64
CONTROL_RISK      float64
Detection_Risk    float64
Audit_Risk        float64
Marks               int64
MONEY_Marks         int64
District            int64
Loss                int64
LOSS_SCORE          int64
History_score       int64
Risk                int64
dtype: object
```

In [32]:
```
def plot_corr(result,size=10):
    '''Function plots a graphical correlation matrix for each pair of columns
 in the dataframe.

    Input:
        df: pandas DataFrame
        size: vertical and horizontal size of the plot'''

    corr = result.corr()
    fig, ax = plt.subplots(figsize=(size, size))
    ax.matshow(corr)
    plt.xticks(range(len(corr.columns)), corr.columns);
    plt.yticks(range(len(corr.columns)), corr.columns);
```

In [33]:
```
rc = result.corr()
print(rc)
```

```
                Sector_score  LOCATION_ID    PARA_A   Score_A    Risk_A  \
Sector_score        1.000000    -0.054881 -0.212488 -0.417980 -0.215317
LOCATION_ID        -0.054881     1.000000 -0.008273  0.074465 -0.006064
PARA_A             -0.212488    -0.008273  1.000000  0.494335  0.999277
Score_A            -0.417980     0.074465  0.494335  1.000000  0.502990
Risk_A             -0.215317    -0.006064  0.999277  0.502990  1.000000
PARA_B             -0.130719     0.005488  0.160693  0.247950  0.164133
Score_B            -0.210417     0.121297  0.355618  0.568595  0.360367
Risk_B             -0.128688     0.005144  0.160618  0.246756  0.164016
TOTAL              -0.150939     0.005253  0.265743  0.295824  0.269016
numbers            -0.149438     0.005455  0.132210  0.240587  0.134158
Score_B.1          -0.167585    -0.018951  0.138827  0.272179  0.141426
Risk_C             -0.163772    -0.016387  0.138702  0.263648  0.141093
Money_Value        -0.115674    -0.067059  0.448695  0.204516  0.448094
Score_MV           -0.313937     0.103871  0.283084  0.474807  0.288129
Risk_D             -0.114090    -0.067431  0.447912  0.201991  0.447281
District_Loss      -0.109003    -0.106627  0.127700  0.087413  0.127310
PROB               -0.084987    -0.004209  0.042588  0.091817  0.042701
RiSk_E             -0.128644    -0.098154  0.118286  0.100879  0.118056
History            -0.112895    -0.082191  0.117074  0.176214  0.120019
Prob               -0.134424    -0.055019  0.171202  0.263507  0.174835
Risk_F             -0.101534    -0.089318  0.102896  0.149330  0.105559
Score              -0.329635     0.083136  0.423919  0.717350  0.430160
Inherent_Risk      -0.170498    -0.047922  0.480815  0.318829  0.482307
CONTROL_RISK       -0.153803    -0.125519  0.147995  0.168668  0.149681
Detection_Risk           NaN          NaN       NaN       NaN       NaN
Audit_Risk         -0.090077    -0.086868  0.218880  0.200587  0.220754
Marks              -0.167585    -0.018951  0.138827  0.272179  0.141426
MONEY_Marks        -0.313937     0.103871  0.283084  0.474807  0.288129
District           -0.109003    -0.106627  0.127700  0.087413  0.127310
Loss               -0.081408     0.005591  0.044306  0.091572  0.044863
LOSS_SCORE         -0.084987    -0.004209  0.042588  0.091817  0.042701
History_score      -0.134424    -0.055019  0.171202  0.263507  0.174835
Risk               -0.364573     0.038772  0.288588  0.668401  0.286694

                  PARA_B   Score_B    Risk_B     TOTAL   numbers    ...      \
Sector_score   -0.130719 -0.210417 -0.128688 -0.150939 -0.149438    ...
LOCATION_ID     0.005488  0.121297  0.005144  0.005253  0.005455    ...
PARA_A          0.160693  0.355618  0.160618  0.265743  0.132210    ...
Score_A         0.247950  0.568595  0.246756  0.295824  0.240587    ...
Risk_A          0.164133  0.360367  0.164016  0.269016  0.134158    ...
PARA_B          1.000000  0.346575  0.999936  0.994109  0.209116    ...
Score_B         0.346575  1.000000  0.347208  0.378068  0.275868    ...
Risk_B          0.999936  0.347208  1.000000  0.994035  0.208873    ...
TOTAL           0.994109  0.378068  0.994035  1.000000  0.216765    ...
numbers         0.209116  0.275868  0.208873  0.216765  1.000000    ...
Score_B.1       0.230030  0.311858  0.229745  0.237256  0.908033    ...
Risk_C          0.222251  0.301124  0.221957  0.229741  0.955255    ...
Money_Value     0.124403  0.203696  0.124452  0.167957  0.185493    ...
Score_MV        0.313450  0.564819  0.312027  0.336096  0.445663    ...
Risk_D          0.124006  0.200657  0.124066  0.167483  0.185837    ...
District_Loss   0.082933 -0.006549  0.083129  0.093308  0.125199    ...
PROB            0.041972  0.091058  0.042309  0.045786  0.035115    ...
RiSk_E          0.079085  0.013186  0.079437  0.088824  0.136833    ...
History         0.203008  0.199429  0.202260  0.210080  0.201648    ...
Prob            0.315925  0.308031  0.315773  0.325670  0.208747    ...
Risk_F          0.195534  0.169967  0.194788  0.201559  0.201786    ...
```

```
Score            0.396568  0.900613  0.396414  0.432972  0.502386    ...
Inherent_Risk    0.654114  0.363949  0.654178  0.689380  0.270176    ...
CONTROL_RISK     0.186326  0.125771  0.186041  0.196824  0.228255    ...
Detection_Risk        NaN       NaN       NaN       NaN       NaN    ...
Audit_Risk       0.887734  0.206814  0.887508  0.888060  0.220874    ...
Marks            0.230030  0.311858  0.229745  0.237256  0.908033    ...
MONEY_Marks      0.313450  0.564819  0.312027  0.336096  0.445663    ...
District         0.082933 -0.006549  0.083129  0.093308  0.125199    ...
Loss             0.044251  0.097432  0.044558  0.048197 -0.002188    ...
LOSS_SCORE       0.041972  0.091058  0.042309  0.045786  0.035115    ...
History_score    0.315925  0.308031  0.315773  0.325670  0.208747    ...
Risk             0.160900  0.511017  0.159674  0.188507  0.195569    ...

                 CONTROL_RISK  Detection_Risk  Audit_Risk     Marks  \
Sector_score        -0.153803             NaN   -0.090077 -0.167585
LOCATION_ID         -0.125519             NaN   -0.086868 -0.018951
PARA_A               0.147995             NaN    0.218880  0.138827
Score_A              0.168668             NaN    0.200587  0.272179
Risk_A               0.149681             NaN    0.220754  0.141426
PARA_B               0.186326             NaN    0.887734  0.230030
Score_B              0.125771             NaN    0.206814  0.311858
Risk_B               0.186041             NaN    0.887508  0.229745
TOTAL                0.196824             NaN    0.888060  0.237256
numbers              0.228255             NaN    0.220874  0.908033
Score_B.1            0.256114             NaN    0.259112  1.000000
Risk_C               0.251150             NaN    0.249409  0.990399
Money_Value          0.068913             NaN    0.333663  0.219590
Score_MV             0.216156             NaN    0.290894  0.506159
Risk_D               0.068898             NaN    0.333773  0.219843
District_Loss        0.643255             NaN    0.200204  0.150658
PROB                 0.338443             NaN    0.073371  0.036104
RiSk_E               0.728427             NaN    0.203344  0.157480
History              0.755577             NaN    0.329378  0.225430
Prob                 0.642710             NaN    0.430907  0.247494
Risk_F               0.762193             NaN    0.327396  0.222685
Score                0.355182             NaN    0.332500  0.565489
Inherent_Risk        0.172515             NaN    0.750774  0.307511
CONTROL_RISK         1.000000             NaN    0.358182  0.256114
Detection_Risk            NaN             NaN         NaN       NaN
Audit_Risk           0.358182             NaN    1.000000  0.259112
Marks                0.256114             NaN    0.259112  1.000000
MONEY_Marks          0.216156             NaN    0.290894  0.506159
District             0.643255             NaN    0.200204  0.150658
Loss                 0.277699             NaN    0.048845  0.003955
LOSS_SCORE           0.338443             NaN    0.073371  0.036104
History_score        0.642710             NaN    0.430907  0.247494
Risk                 0.295708             NaN    0.135449  0.225623

                 MONEY_Marks  District      Loss  LOSS_SCORE  History_score  \
Sector_score       -0.313937 -0.109003 -0.081408   -0.084987      -0.134424
LOCATION_ID         0.103871 -0.106627  0.005591   -0.004209      -0.055019
PARA_A              0.283084  0.127700  0.044306    0.042588       0.171202
Score_A             0.474807  0.087413  0.091572    0.091817       0.263507
Risk_A              0.288129  0.127310  0.044863    0.042701       0.174835
PARA_B              0.313450  0.082933  0.044251    0.041972       0.315925
Score_B             0.564819 -0.006549  0.097432    0.091058       0.308031
Risk_B              0.312027  0.083129  0.044558    0.042309       0.315773
```

```
TOTAL             0.336096  0.093308  0.048197    0.045786        0.325670
numbers           0.445663  0.125199 -0.002188    0.035115        0.208747
Score_B.1         0.506159  0.150658  0.003955    0.036104        0.247494
Risk_C            0.491932  0.146522  0.000285    0.035448        0.236813
Money_Value       0.390606  0.027951  0.024007    0.031247        0.111452
Score_MV          1.000000  0.080284  0.117463    0.128705        0.333416
Risk_D            0.390261  0.028124  0.024081    0.031350        0.110715
District_Loss     0.080284  1.000000  0.036170    0.055227        0.083839
PROB              0.128705  0.055227  0.981502    1.000000        0.140883
RiSk_E            0.103296  0.912644  0.369421    0.407786        0.123525
History           0.245733  0.069317  0.060137    0.109571        0.859198
Prob              0.333416  0.083839  0.103904    0.140883        1.000000
Risk_F            0.215924  0.070687  0.053737    0.105594        0.815510
Score             0.756871  0.209063  0.155573    0.166452        0.442709
Inherent_Risk     0.481191  0.080846  0.047138    0.051913        0.272914
CONTROL_RISK      0.216156  0.643255  0.277699    0.338443        0.642710
Detection_Risk         NaN       NaN       NaN         NaN             NaN
Audit_Risk        0.290894  0.200204  0.048845    0.073371        0.430907
Marks             0.506159  0.150658  0.003955    0.036104        0.247494
MONEY_Marks       1.000000  0.080284  0.117463    0.128705        0.333416
District          0.080284  1.000000  0.036170    0.055227        0.083839
Loss              0.117463  0.036170  1.000000    0.981502        0.103904
LOSS_SCORE        0.128705  0.055227  0.981502    1.000000        0.140883
History_score     0.333416  0.083839  0.103904    0.140883        1.000000
Risk              0.436335  0.312959  0.122909    0.126025        0.188357

                    Risk
Sector_score   -0.364573
LOCATION_ID     0.038772
PARA_A          0.288588
Score_A         0.668401
Risk_A          0.286694
PARA_B          0.160900
Score_B         0.511017
Risk_B          0.159674
TOTAL           0.188507
numbers         0.195569
Score_B.1       0.225623
Risk_C          0.217610
Money_Value     0.159010
Score_MV        0.436335
Risk_D          0.157010
District_Loss   0.312959
PROB            0.126025
RiSk_E          0.312168
History         0.150227
Prob            0.188357
Risk_F          0.133955
Score           0.627851
Inherent_Risk   0.225050
CONTROL_RISK    0.295708
Detection_Risk       NaN
Audit_Risk      0.135449
Marks           0.225623
MONEY_Marks     0.436335
District        0.312959
Loss            0.122909
```

```
LOSS_SCORE       0.126025
History_score    0.188357
Risk             1.000000

[33 rows x 33 columns]
```

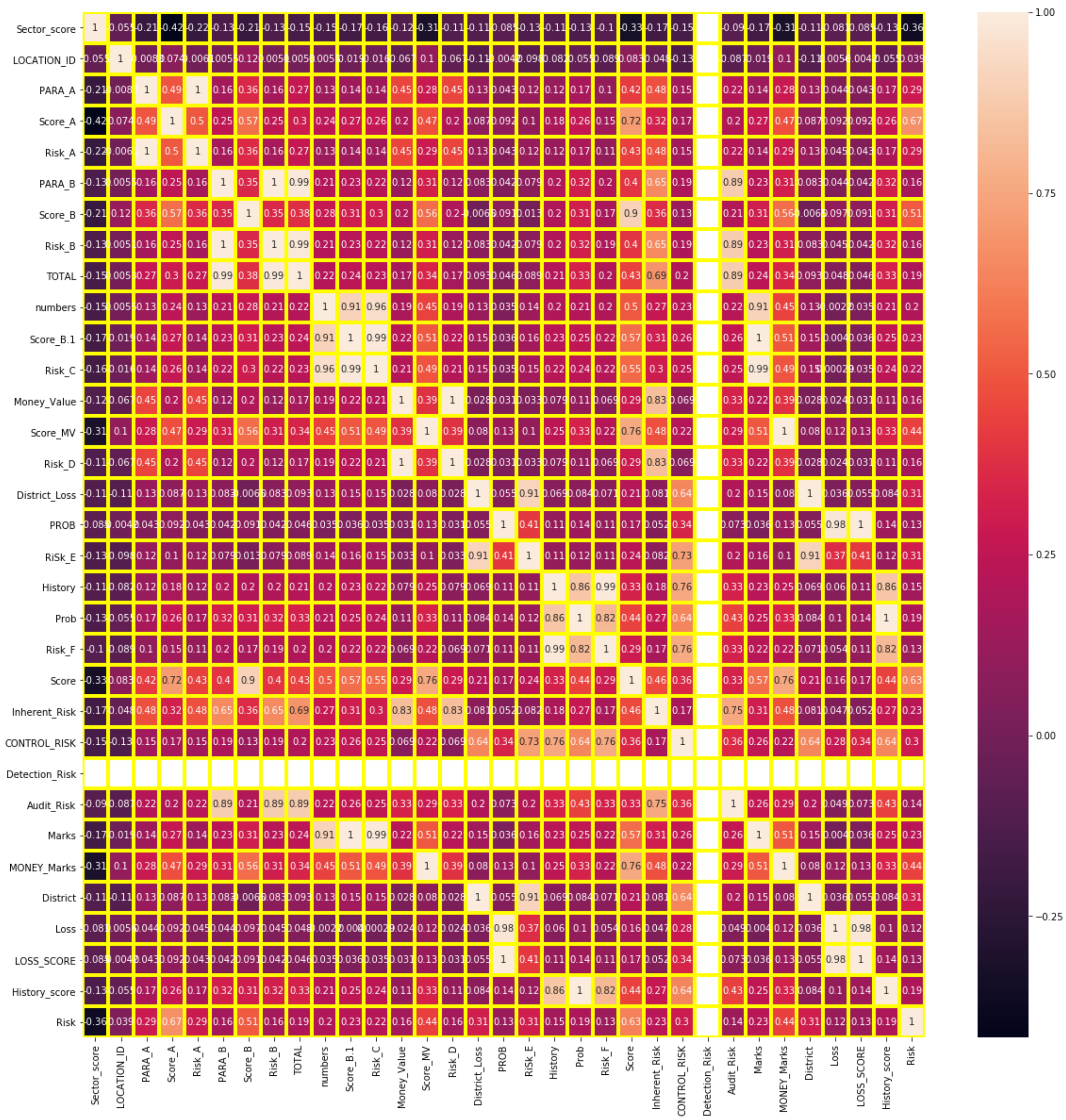
In [255]:

```python
#CORREL MATRIX
import seaborn as sns

fig=plt.figure(figsize=(20,20))
sns.heatmap(rc,annot= True,linecolor='yellow',linewidths=3)
```

Out[255]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x2179cb31518>
```



In [34]:

```python
x = result[['Sector_score','PARA_A','PARA_B','numbers','Money_Value','History'
,'Score','District_Loss','Loss']]
y = result[['Audit_Risk']]
```

After a final analysis, the feature set was decided to include the outliers as well the specific features without much correlation. The Risk has been removed because it is an interval reflection of the Audit Risk value.

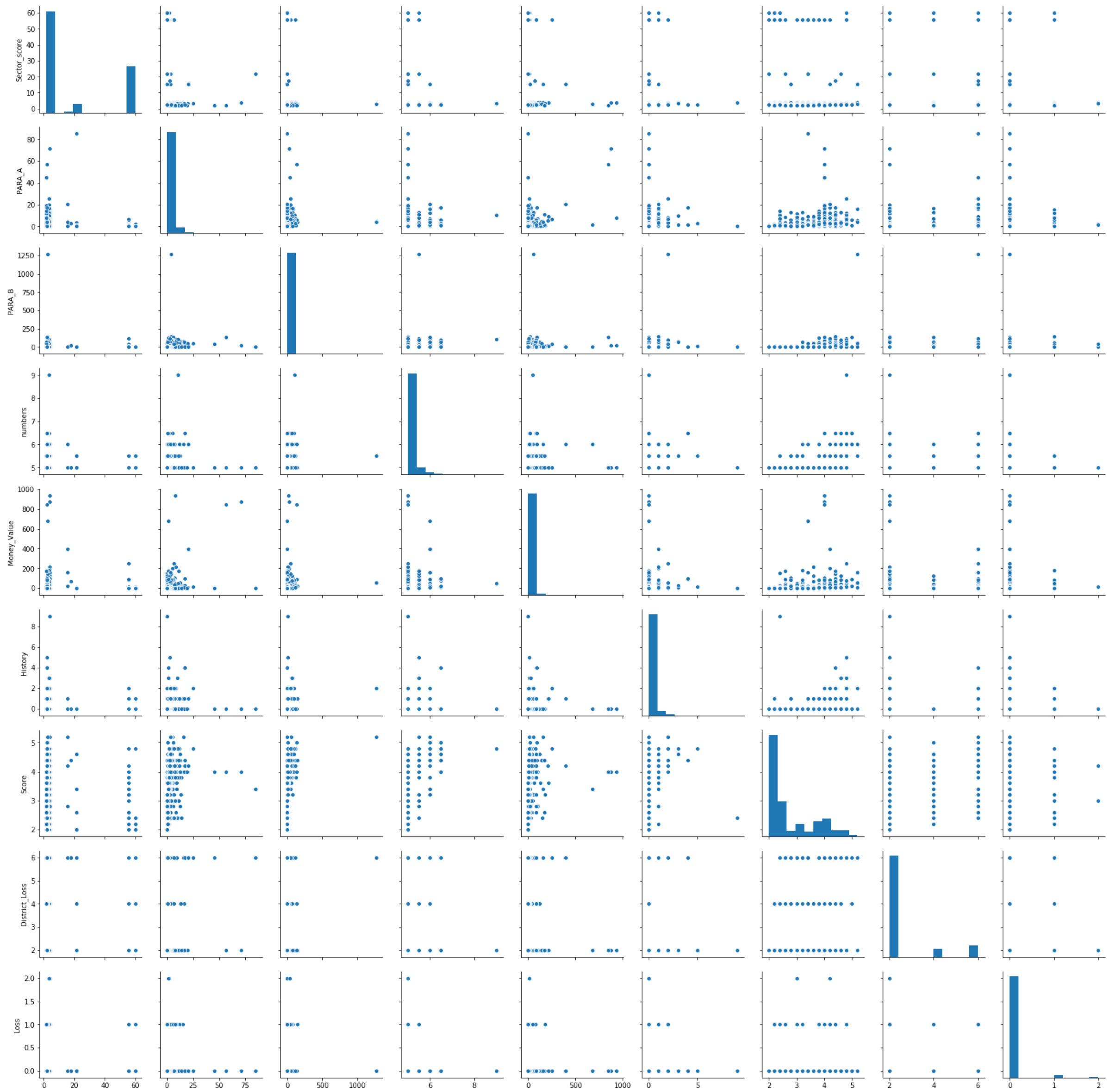
The Audit Risk and the trial table has been merged as one final dataset and while merging, the Risk column from the Audit_risk table has been removed as the same column was present even in the trial table and that was the main column to be used as the risk from the Audit Risk table was just an extension of the Audit Risk value. Similarly, the SCORE_A and the SCORE_B column from the tiral table has been removed as they were present in the Audit Risk table and were on a different scale(it was scaled by 10). Finally, the LOCATION_ID was converted to numeric and each of the letter values were converted to numeric. The money_marks and Score_MV were the same values on a different scale and they were also dropped from the feature set for the same purpose.

Data Visualization

In [35]:
```
import seaborn as sns
```

In [36]:
```
sns.pairplot(x)
```

Out[36]: <seaborn.axisgrid.PairGrid at 0x2178c43ea90>



In [37]:
```
from sklearn.preprocessing import StandardScaler

from sklearn.model_selection import train_test_split

X_train_org, X_test_org, y_train, y_test = train_test_split(x,y, random_state
= 0)

scaler = StandardScaler()
X_train = scaler.fit_transform(X_train_org)
X_test = scaler.transform(X_test_org)
```

For each of the values in the combined Result dataset, a correlation heat map was made to check for the overall correlation between the columns to decide the final feature dataset. The boxplot in each case, has been utilized to check for outliers and determine whether they should be included in the final feature set. In comparison to the previoud project, the outliers have been left in the feature set because they are of utmost importance in judging the risk factors as compared to our previous cases. The reason being that such firms with a high risk factor and probability are the ones most likely to default and hence, cannot be ignored.

Bagging and Pasting

Bagging -

Linear and Ridge Regression

In [38]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.ensemble import BaggingRegressor
from sklearn.linear_model import LinearRegression
#base model

lreg = LinearRegression()

#grid params
grid_param = {'n_estimators':[300, 400, 500, 600, 700],
             'max_samples':[50, 100, 150, 200, 250, 300]}

#grid search model
bag_grid= GridSearchCV(BaggingRegressor(lreg), grid_param, cv = 3, return_trai
n_score=True)

#train grid search model
bag_grid.fit(X_train, y_train)

#find the best params
print('Best param:', bag_grid.best_params_)
print('Best score:', bag_grid.best_score_)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\ensemble\weight_boosting.p
y:29: DeprecationWarning: numpy.core.umath_tests is an internal NumPy module
and should not be imported. It will be removed in a future NumPy release.
  from numpy.core.umath_tests import inner1d
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
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  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
```

```
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
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Best param: {'max_samples': 50, 'n_estimators': 500}
Best score: 0.4827047444401013
```

In [39]:

```
bag_lreg = BaggingRegressor(lreg, n_estimators=300, max_samples=50, bootstrap=
True, random_state=0)
bag_lreg.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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```

Out[39]:

```
BaggingRegressor(base_estimator=LinearRegression(copy_X=True, fit_intercept=T
rue, n_jobs=1, normalize=False),
         bootstrap=True, bootstrap_features=False, max_features=1.0,
         max_samples=50, n_estimators=300, n_jobs=1, oob_score=False,
         random_state=0, verbose=0, warm_start=False)
```

In [40]:

```
bag_lreg.fit(X_train, y_train)
print('Train score: {:.2f}'.format(bag_lreg.score(X_train, y_train)))
print('Test score: {:.2f}'.format(bag_lreg.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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Train score: 0.56
Test score: 0.68
```

In [41]:
```
from sklearn.linear_model import Ridge

ridge = Ridge()

param_grid = {'alpha': [0.001, 0.01, 0.1, 1, 10, 100]}

ridge_grid = GridSearchCV(ridge, param_grid, cv=5, return_train_score=True)


#grid search model
#log_grid= GridSearchCV(logreg, grid_param, cv = 3, n_jobs= -1, scoring='preci
sion')

#train grid search model
ridge_grid.fit(X_train, y_train)
```

Out[41]:
```
GridSearchCV(cv=5, error_score='raise',
       estimator=Ridge(alpha=1.0, copy_X=True, fit_intercept=True, max_iter=N
one,
   normalize=False, random_state=None, solver='auto', tol=0.001),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'alpha': [0.001, 0.01, 0.1, 1, 10, 100]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [42]:
```
#find the best params
print('Best param:', ridge_grid.best_params_)
print('Best score:', ridge_grid.best_score_)
```

```
Best param: {'alpha': 100}
Best score: 0.330670504572707 47
```

In [43]:
```
ridge_bag = Ridge(alpha = 100)
```

In [44]:
```
from sklearn.ensemble import BaggingRegressor
#from sklearn.svm import SVR

#from sklearn.linear_model import LogisticRegression
#base model


#grid params
grid_param = {'n_estimators':[100, 200, 300, 400, 500, 600, 700],
             'max_samples':[50, 100, 150, 200, 250, 300]}

#grid search model
bag_grid= GridSearchCV(BaggingRegressor(ridge_bag), grid_param, cv = 3)
#train grid search model
bag_grid.fit(X_train, y_train)
```

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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[44]:
```
GridSearchCV(cv=3, error_score='raise',
       estimator=BaggingRegressor(base_estimator=Ridge(alpha=100, copy_X=Tru
e, fit_intercept=True, max_iter=None,
   normalize=False, random_state=None, solver='auto', tol=0.001),
         bootstrap=True, bootstrap_features=False, max_features=1.0,
         max_samples=1.0, n_estimators=10, n_jobs=1, oob_score=False,
         random_state=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'n_estimators': [100, 200, 300, 400, 500, 600, 700], 'max_
samples': [50, 100, 150, 200, 250, 300]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [45]:
```
print('Best param:', bag_grid.best_params_)
print('Best score:', bag_grid.best_score_)
```

```
Best param: {'max_samples': 150, 'n_estimators': 100}
Best score: 0.49267637948374665
```

In [46]:
```
bag_ridge = BaggingRegressor(ridge, n_estimators=100, max_samples=150, bootstr
ap=True, random_state=0)
bag_ridge.fit(X_train, y_train)
y_pred = bag_ridge.predict(X_test)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [47]:
```
bag_ridge.fit(X_train, y_train)
print('Train score: {:.2f}'.format(bag_ridge.score(X_train, y_train)))
print('Test score: {:.2f}'.format(bag_ridge.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)

Train score: 0.65
Test score: 0.65
```

Pasting -

Linear Regression and Ridge Regression

In [48]:
```
paste_lreg = BaggingRegressor(lreg, n_estimators=300, max_samples=50, bootstra
p=False, random_state=0)
paste_lreg.fit(X_train, y_train)
y_pred = paste_lreg.predict(X_test)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [49]:
```
paste_lreg.fit(X_train, y_train)
print('Train score: {:.2f}'.format(paste_lreg.score(X_train, y_train)))
print('Test score: {:.2f}'.format(paste_lreg.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

```
Train score: 0.57
Test score: 0.69
```

In [50]:
```
paste_ridge = BaggingRegressor(Ridge(alpha = 100), n_estimators=100, max_sampl
es=150, bootstrap=False, random_state=0)
paste_ridge.fit(X_train, y_train)
y_pred = paste_ridge.predict(X_test)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [51]:
```
paste_ridge.fit(X_train, y_train)
print('Train score: {:.2f}'.format(paste_ridge.score(X_train, y_train)))
print('Test score: {:.2f}'.format(paste_ridge.score(X_test, y_test)))
```

```
Train score: 0.53
Test score: 0.47
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Adaboost Boosting

Linear Regression and Ridge Regression

In [52]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.ensemble import AdaBoostRegressor
#from sklearn.linear_model import LogisticRegression
#base model


#grid params
grid_param = {'n_estimators':[300, 400, 500, 600, 700],
             'learning_rate':[0.25, 0.5, 0.75, 1, 1.25, 1.5, 2]}

#grid search model
adaboost_grid= GridSearchCV(AdaBoostRegressor(lreg), grid_param, cv = 3, retur
n_train_score=True)

#train grid search model
adaboost_grid.fit(X_train, y_train)

#find the best params
print('Best param:', adaboost_grid.best_params_)
print('Best score:', adaboost_grid.best_score_)
```

```
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Best param: {'learning_rate': 1, 'n_estimators': 700}
Best score: -0.032556047264094175

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```

In [53]:

```
adaboost_lreg = AdaBoostRegressor(lreg, n_estimators=700, learning_rate=2)
adaboost_lreg.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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  y = column_or_1d(y, warn=True)
```

Out[53]:

```
AdaBoostRegressor(base_estimator=LinearRegression(copy_X=True, fit_intercept=
True, n_jobs=1, normalize=False),
         learning_rate=2, loss='linear', n_estimators=700,
         random_state=None)
```

In [54]:

```
adaboost_lreg.fit(X_train, y_train)
print('Train score: {:.2f}'.format(adaboost_lreg.score(X_train, y_train)))
print('Test score: {:.2f}'.format(adaboost_lreg.score(X_test, y_test)))
```

```
Train score: 0.89
Test score: 0.34

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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```

In [55]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.ensemble import AdaBoostRegressor
#from sklearn.linear_model import LogisticRegression
#base model

ridge = Ridge(alpha = 100)

#grid params
grid_param = {'n_estimators':[300, 400, 500, 600, 700],
              'learning_rate':[0.25, 0.5, 0.75, 1, 1.25, 1.5, 2]}

#grid search model
adaboost_grid_ridge= GridSearchCV(AdaBoostRegressor(ridge), grid_param, cv = 3
, return_train_score=True)

#train grid search model
adaboost_grid_ridge.fit(X_train, y_train)
```

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```

```
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[55]:
```
GridSearchCV(cv=3, error_score='raise',
       estimator=AdaBoostRegressor(base_estimator=Ridge(alpha=100, copy_X=Tru
e, fit_intercept=True, max_iter=None,
   normalize=False, random_state=None, solver='auto', tol=0.001),
         learning_rate=1.0, loss='linear', n_estimators=50,
         random_state=None),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'n_estimators': [300, 400, 500, 600, 700], 'learning_rat
e': [0.25, 0.5, 0.75, 1, 1.25, 1.5, 2]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [56]:
```
print('Best param:', adaboost_grid_ridge.best_params_)
print('Best score:', adaboost_grid_ridge.best_score_)
```

```
Best param: {'learning_rate': 1, 'n_estimators': 700}
Best score: 0.37954748155212087
```

In [57]:
```
adaboost_ridge = AdaBoostRegressor(ridge, n_estimators=500, learning_rate=1.5)
adaboost_ridge.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[57]:
```
AdaBoostRegressor(base_estimator=Ridge(alpha=100, copy_X=True, fit_intercept=
True, max_iter=None,
   normalize=False, random_state=None, solver='auto', tol=0.001),
         learning_rate=1.5, loss='linear', n_estimators=500,
         random_state=None)
```

In [58]:
```
adaboost_ridge.fit(X_train, y_train)
print('Train score: {:.2f}'.format(adaboost_ridge.score(X_train, y_train)))
print('Test score: {:.2f}'.format(adaboost_ridge.score(X_test, y_test)))
```

```
Train score: 0.97
Test score: 0.55

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Gradient Boosting

In [59]:
```
from  sklearn.ensemble import GradientBoostingRegressor

gbrt = GradientBoostingRegressor(max_depth=2, n_estimators=3, learning_rate=1.
0, random_state=42)
gbrt.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[59]:
```
GradientBoostingRegressor(alpha=0.9, criterion='friedman_mse', init=None,
             learning_rate=1.0, loss='ls', max_depth=2, max_features=None,
             max_leaf_nodes=None, min_impurity_decrease=0.0,
             min_impurity_split=None, min_samples_leaf=1,
             min_samples_split=2, min_weight_fraction_leaf=0.0,
             n_estimators=3, presort='auto', random_state=42,
             subsample=1.0, verbose=0, warm_start=False)
```

In [60]:
```
gbrt.fit(X_train, y_train)
print('Train score: {:.2f}'.format(gbrt.score(X_train, y_train)))
print('Test score: {:.2f}'.format(gbrt.score(X_test, y_test)))
```

```
Train score: 0.98
Test score: 0.82

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

PCA

In [61]:
```
from sklearn.decomposition import PCA

#create model
pca = PCA(n_components= 0.95, random_state = 0)

#train pca model
pca.fit(X_train)

#transforming X_train and X_test
X_train_reduced = pca.transform(X_train)
X_test_reduced = pca.transform(X_test)
```

In [62]:
```
pca.n_components_
```

Out[62]:
```
8
```

In [63]:
```
pca.explained_variance_
```

Out[63]:
```
array([2.55388211, 1.27867555, 1.07922397, 0.92283121, 0.87670892,
       0.81201425, 0.77432263, 0.41293598])
```

In [64]:
```
pca.explained_variance_ratio_
```

Out[64]:
```
array([0.28326859, 0.14182668, 0.11970414, 0.10235754, 0.0972418 ,
       0.09006607, 0.08588544, 0.04580156])
```

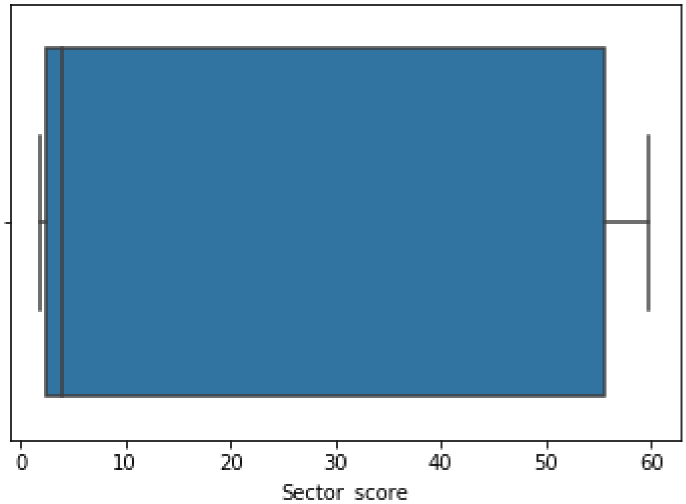
In [65]:
```
pca.n_features_
```

Out[65]:
```
9
```

Outlier Detection for PCA

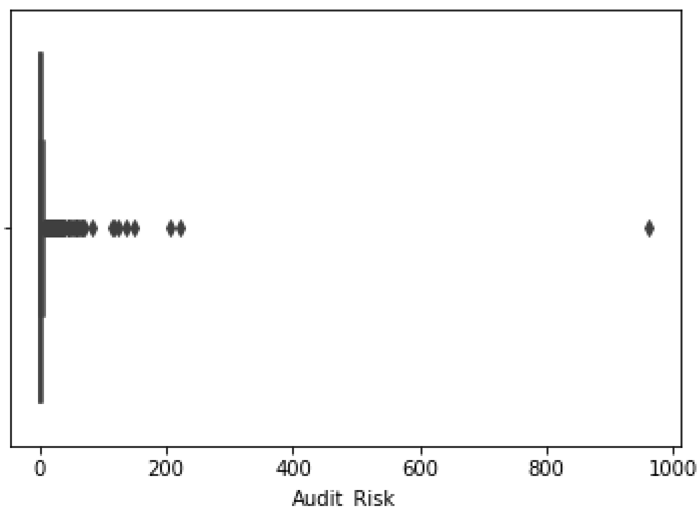
In [66]:
```
import seaborn as sns
sns.boxplot(x=result['Sector_score'])
```

Out[66]: <matplotlib.axes._subplots.AxesSubplot at 0x21793b8b160>



In [67]:
```
import seaborn as sns
sns.boxplot(x=result['Audit_Risk'])
```

Out[67]: <matplotlib.axes._subplots.AxesSubplot at 0x21793bd8128>



In [68]:
```
result.loc[result['Audit_Risk'] == 961.514400]
```

Out[68]:

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TOT/
241	2.72	2	4.28	0.6	2.568	1264.63	0.6	758.778	1268.

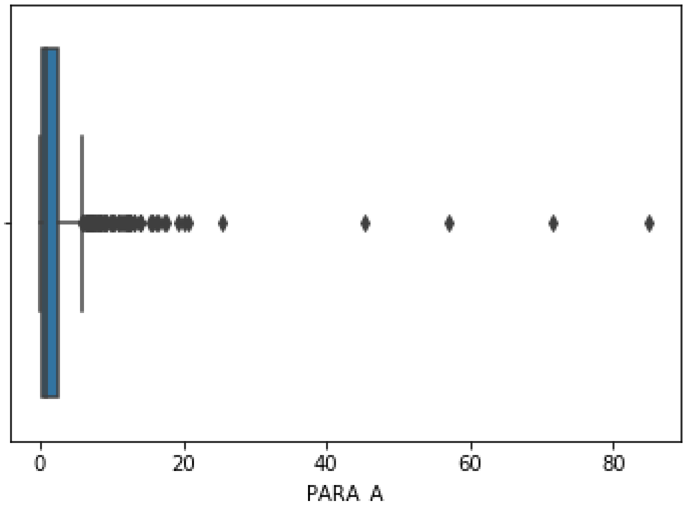
1 rows × 33 columns

In [69]:
```
i = result[result['Audit_Risk'] == 961.514400].index
```

In [70]:
```
result = result.drop(i)
```

In [71]:
```
sns.boxplot(x=result['PARA_A'])
```

Out[71]: <matplotlib.axes._subplots.AxesSubplot at 0x21793c272b0>



In [72]:
```
result.loc[result['PARA_A'] > 40.000000]
```

Out[72]:

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TOTAl
81	3.89	2	71.48	0.6	42.888	25.63	0.6	15.378	97.1
342	1.99	2	57.03	0.6	34.218	134.33	0.6	80.598	191.3
467	1.85	19	45.23	0.6	27.138	36.18	0.6	21.708	81.4
509	21.61	9	85.00	0.6	51.000	1.06	0.4	0.424	86.0

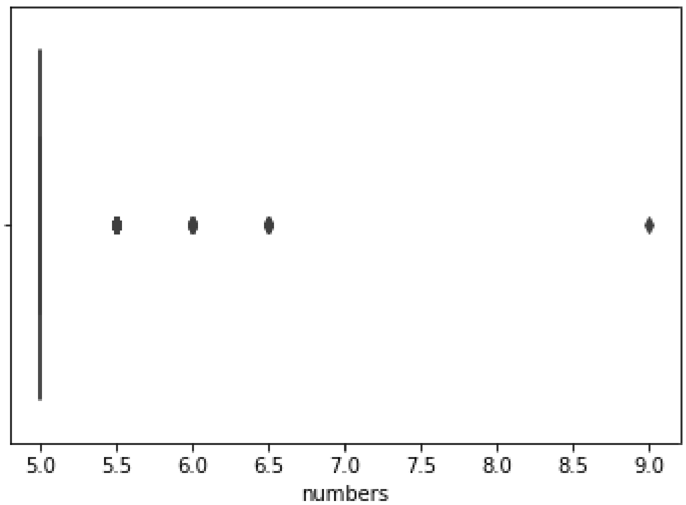
4 rows × 33 columns

In [73]:
```
i = result.loc[result['PARA_A'] > 40.000000].index
```

In [74]:
```
result = result.drop(i)
```

In [75]:
```
sns.boxplot(x=result['numbers'])
```

Out[75]: <matplotlib.axes._subplots.AxesSubplot at 0x21793c86400>

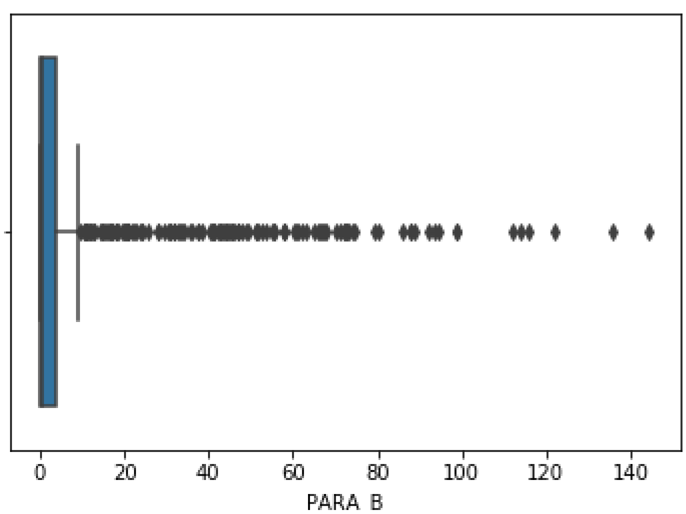


In [76]:
```
i = result.loc[result['numbers'] > 6.000000].index
```

In [77]:
```
result = result.drop(i)
```

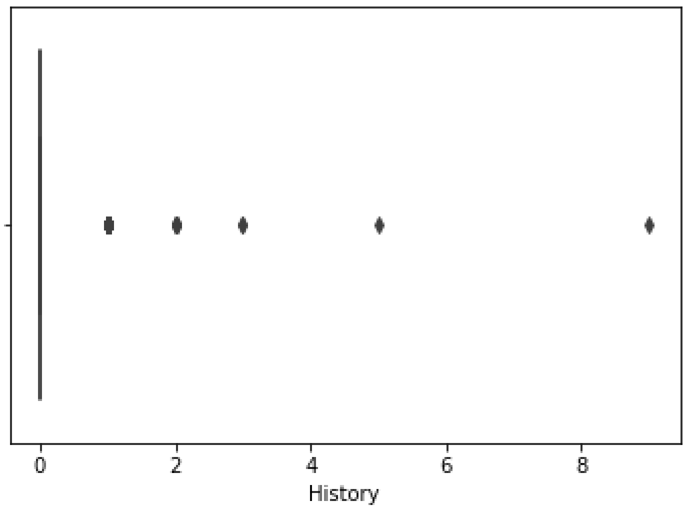
In [78]:
```
sns.boxplot(x=result['PARA_B'])
```

Out[78]: <matplotlib.axes._subplots.AxesSubplot at 0x21793ce7160>



In [79]:
```
sns.boxplot(x=result['History'])
```

Out[79]: <matplotlib.axes._subplots.AxesSubplot at 0x21793d43c50>



In [80]:
```
result.loc[result['History'] > 4.000000]
```

Out[80]:

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TOTAl
80	3.89	2	0.00	0.2	0.000	3.72	0.2	0.744	3.7:
276	2.37	6	2.51	0.6	1.506	8.59	0.6	5.154	11.1(

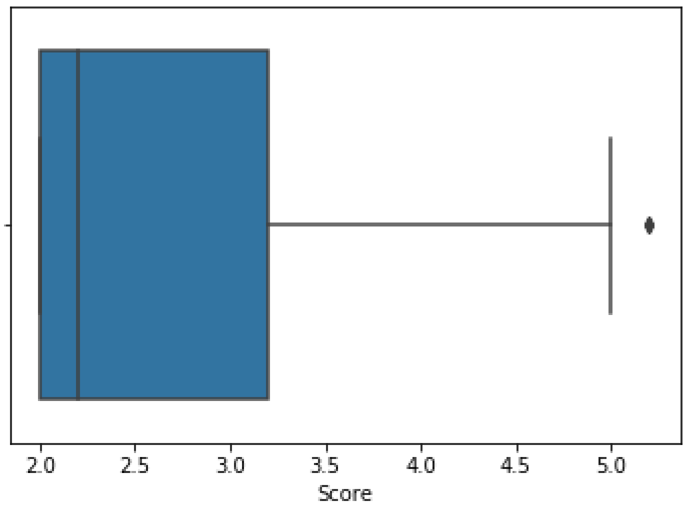
2 rows × 33 columns

In [81]:
```
i = result.loc[result['History'] > 4.000000].index
```

In [82]:
```
result = result.drop(i)
```

In [83]:
```
sns.boxplot(x=result['Score'])
```

Out[83]: <matplotlib.axes._subplots.AxesSubplot at 0x21793d9a208>



In [84]:
```
result.loc[result['Score'] > 5.000000]
```

Out[84]:

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TOTAl
93	3.89	16	15.72	0.6	9.432	57.94	0.6	34.764	73.6
190	2.72	18	5.11	0.6	3.066	53.76	0.6	32.256	58.8
495	15.56	1	3.73	0.6	2.238	2.82	0.6	1.692	6.5

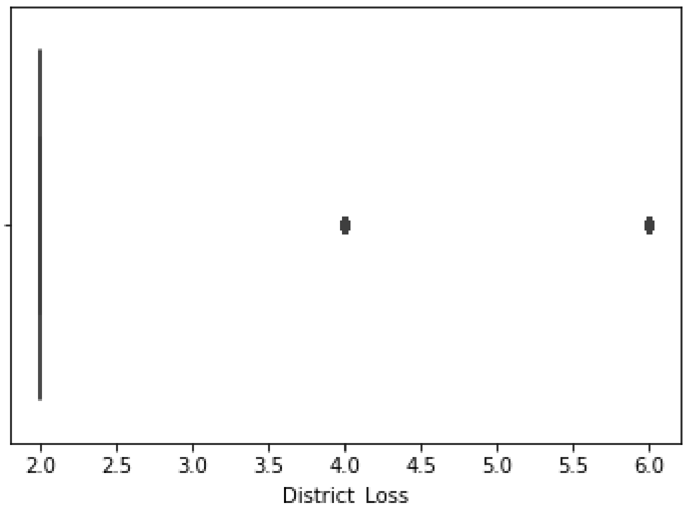
3 rows × 33 columns

In [85]:
```
i = result.loc[result['Score'] > 5.000000].index
```

In [86]:
```
result = result.drop(i)
```

In [87]:
```
sns.boxplot(x=result['District_Loss'])
```

Out[87]: <matplotlib.axes._subplots.AxesSubplot at 0x21793dfdb00>



In [88]:
```
result.loc[result['District_Loss'] >= 6.000000]
```

Out[88]:

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TO
94	3.89	16	4.9500	0.6	2.97000	42.61	0.6	25.566	47.
95	3.89	16	0.0000	0.2	0.00000	0.08	0.2	0.016	0.
96	3.89	16	1.1900	0.4	0.47600	12.88	0.6	7.728	14.
97	3.89	16	0.0000	0.2	0.00000	2.72	0.2	0.544	2.
98	3.89	16	0.0000	0.2	0.00000	1.66	0.2	0.332	1.
99	3.89	16	6.4700	0.6	3.88200	12.18	0.6	7.308	18.
100	3.89	16	1.3300	0.4	0.53200	0.00	0.2	0.000	1.
101	3.89	16	0.0000	0.2	0.00000	1.10	0.2	0.220	1.
125	3.41	12	25.4000	0.6	15.24000	51.74	0.6	31.044	77.
126	3.41	12	3.2100	0.6	1.92600	72.07	0.6	43.242	75.
172	3.41	12	1.0700	0.4	0.42800	0.00	0.2	0.000	1.
205	2.72	2	3.2600	0.6	1.95600	5.55	0.4	2.220	8.
242	2.72	1	4.3600	0.6	2.61600	33.91	0.6	20.346	38.
243	2.72	2	2.2300	0.6	1.33800	4.54	0.2	0.908	6.
274	2.37	1	3.7500	0.6	2.25000	1.25	0.4	0.500	5.
297	2.37	28	0.4400	0.2	0.08800	0.02	0.2	0.004	0.
298	2.37	28	1.3100	0.4	0.52400	0.12	0.2	0.024	1.
313	2.37	28	0.3200	0.2	0.06400	0.49	0.2	0.098	0.
314	2.37	28	0.5100	0.2	0.10200	0.00	0.2	0.000	0.
319	2.37	2	0.7300	0.2	0.14600	0.05	0.2	0.010	0.
320	2.37	2	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
324	2.37	2	2.1800	0.6	1.30800	0.93	0.2	0.186	3.
325	2.37	2	7.5900	0.6	4.55400	1.47	0.4	0.588	9.
326	2.37	2	0.7600	0.2	0.15200	0.34	0.2	0.068	1.
338	2.37	2	1.6600	0.4	0.66400	0.83	0.2	0.166	2.
339	2.37	2	0.5000	0.2	0.10000	0.04	0.2	0.008	0.
340	2.37	2	0.9000	0.2	0.18000	0.29	0.2	0.058	1.
341	2.37	2	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
360	1.99	20	0.8600	0.2	0.17200	0.00	0.2	0.000	0.
361	1.99	19	1.6200	0.4	0.64800	0.00	0.2	0.000	1.
...	...	...	...	...	...	...	...	...	
413	1.85	19	0.1800	0.2	0.03600	0.00	0.2	0.000	0.
414	1.85	19	5.9000	0.6	3.54000	0.00	0.2	0.000	5.
415	1.85	19	4.0400	0.6	2.42400	0.00	0.2	0.000	4.
416	1.85	19	2.8100	0.6	1.68600	0.11	0.2	0.022	2.

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TC
417	1.85	19	5.8700	0.6	3.52200	0.00	0.2	0.000	5.
418	1.85	19	1.7500	0.4	0.70000	0.00	0.2	0.000	1.
419	1.85	19	2.0500	0.6	1.23000	0.00	0.2	0.000	2.
420	1.85	19	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
452	1.85	19	1.1600	0.4	0.46400	0.00	0.2	0.000	1.
453	1.85	19	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
456	1.85	19	3.2800	0.6	1.96800	0.25	0.2	0.050	3.
457	1.85	19	0.9000	0.2	0.18000	0.00	0.2	0.000	0.
477	1.85	19	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
478	1.85	19	0.9900	0.2	0.19800	0.11	0.2	0.022	1.
487	2.37	4	0.5600	0.2	0.11200	0.70	0.2	0.140	1.
488	2.37	8	0.5600	0.2	0.11200	0.08	0.2	0.016	0.
489	2.34	2	3.9500	0.6	2.37000	0.00	0.2	0.000	0.
494	15.56	2	20.6500	0.6	12.39000	0.00	0.2	0.000	0.
496	15.56	19	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
497	17.68	1	2.5200	0.6	1.51200	20.28	0.6	12.168	22.
539	59.85	1	1.9400	0.4	0.77600	6.69	0.6	4.014	8.
582	55.57	2	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
583	55.57	2	2.5900	0.6	1.55400	111.90	0.6	67.140	114.
584	55.57	2	6.4800	0.6	3.88800	43.08	0.6	25.848	49.
603	55.57	2	1.2400	0.4	0.49600	2.27	0.6	1.362	3.
604	55.57	1	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
605	55.57	44	0.0006	0.2	0.00012	1.11	0.4	0.444	1.
638	55.57	2	0.7400	0.2	0.14800	0.00	0.2	0.000	0.
639	55.57	2	0.0000	0.2	0.00000	0.00	0.2	0.000	0.
717	55.57	2	1.0600	0.4	0.42400	0.63	0.2	0.126	1.

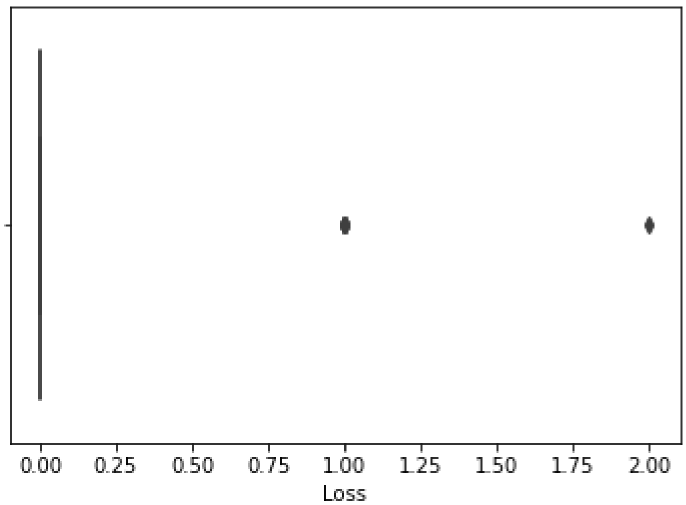
64 rows × 33 columns

In [89]:
```
i = result.loc[result['District_Loss'] >= 6.000000].index
```

In [90]:
```
result = result.drop(i)
```

In [91]:
```
sns.boxplot(x=result['Loss'])
```

Out[91]: <matplotlib.axes._subplots.AxesSubplot at 0x21793d3aa20>



In [92]:
```
result.loc[result['Loss'] >= 1.000000]
```

Out[92]:

	Sector_score	LOCATION_ID	PARA_A	Score_A	Risk_A	PARA_B	Score_B	Risk_B	TOTAL
11	3.89	8	15.38	0.6	9.228	40.14	0.6	24.084	55.5
50	3.89	22	1.97	0.4	0.788	2.10	0.2	0.420	4.0
85	3.89	9	8.46	0.6	5.076	72.76	0.6	43.656	81.2
121	3.41	27	1.41	0.4	0.564	36.16	0.6	21.696	37.5
143	3.41	7	6.61	0.6	3.966	55.62	0.6	33.372	62.2
151	3.41	29	12.29	0.6	7.374	25.74	0.6	15.444	38.0
164	3.41	19	0.31	0.2	0.062	58.12	0.6	34.872	58.4
170	3.41	2	1.18	0.4	0.472	0.00	0.2	0.000	1.1
206	2.72	13	3.84	0.6	2.304	144.39	0.6	86.634	148.2
219	2.72	22	3.22	0.6	1.932	55.64	0.6	33.384	58.8
272	2.37	18	3.43	0.6	2.058	1.00	0.4	0.400	4.4
283	2.37	27	3.61	0.6	2.166	2.13	0.6	1.278	5.7
391	1.85	6	8.53	0.6	5.118	0.16	0.2	0.032	8.6
398	1.85	8	0.95	0.2	0.190	0.00	0.2	0.000	0.9
464	1.85	22	7.84	0.6	4.704	2.81	0.6	1.686	10.6
550	59.85	2	0.00	0.2	0.000	0.00	0.2	0.000	0.0
647	55.57	4	0.32	0.2	0.064	0.00	0.2	0.000	0.3

17 rows × 33 columns

In [93]:
```
i = result.loc[result['Loss'] >= 1.000000].index
```

In [94]:
```
result = result.drop(i)
```

PCA

In [95]:
```
x_pca = result[['Sector_score','PARA_A','PARA_B','numbers','Money_Value','Hist
ory','Score','District_Loss','Loss']]
y_pca = result[['Audit_Risk']]
```

In [96]:
```
from sklearn.preprocessing import StandardScaler

from sklearn.model_selection import train_test_split

X_train_org_pca, X_test_org_pca, y_train_pca, y_test_pca = train_test_split(x_
pca,y_pca, random_state = 0)

scaler = StandardScaler()
X_train_pca = scaler.fit_transform(X_train_org_pca)
X_test_pca = scaler.transform(X_test_org_pca)
```

In [97]:
```
from sklearn.decomposition import PCA

#create model
pca = PCA(n_components= 0.95, random_state = 0)

#train pca model
pca.fit(X_train_pca)

#transforming X_train and X_test
X_train_reduced = pca.transform(X_train_pca)
X_test_reduced = pca.transform(X_test_pca)
```

In [98]:
```
from sklearn.linear_model import LinearRegression

lreg = LinearRegression()
lreg.fit(X_train_reduced, y_train_pca)
print(lreg.score(X_train_reduced, y_train_pca))
print(lreg.score(X_test_reduced, y_test_pca))
```

```
0.9155741910477005
0.8609561054304146
```

In [99]:
```
from sklearn.model_selection import cross_val_score

scores_tr = cross_val_score(lreg, X_train_reduced, y_train_pca, cv=5)
scores_ts = cross_val_score(lreg, X_test_reduced, y_test_pca, cv=5)
print("Cross-validation scores for train: {}".format(scores_tr))
print("Cross-validation scores for test : {}".format(scores_ts))
print("Average cross-validation score for train: {:.2f}".format(scores_tr.mean
()))
print("Average cross-validation score for test: {:.2f}".format(scores_ts.mean
()))
```

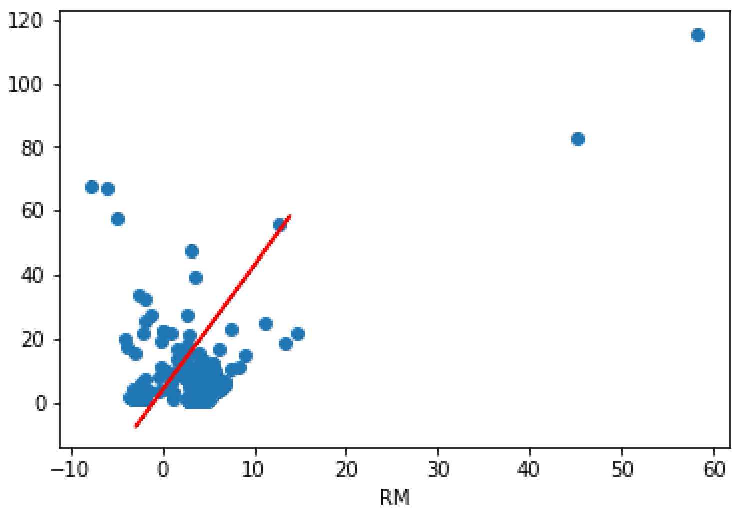
```
Cross-validation scores for train: [0.92237127 0.956345   0.82217371 0.848321
53 0.86899876]
Cross-validation scores for test : [0.75260048 0.70506159 0.64873966 0.812566
06 0.88283747]
Average cross-validation score for train: 0.88
Average cross-validation score for test: 0.76
```

In [100]:
```
from sklearn.model_selection import KFold
kfold = KFold(n_splits=3)

print("Cross-validation scores for train:\n{}".format(cross_val_score(lreg, X_
train_reduced, y_train_pca, cv=kfold)))
print("Cross-validation scores for test:\n{}".format(cross_val_score(lreg, X_t
est_reduced, y_test_pca, cv=kfold)))
```

```
Cross-validation scores for train:
[0.89992463 0.76052777 0.82312879]
Cross-validation scores for test:
[0.66791643 0.73002429 0.82760677]
```

In [101]:
```
%matplotlib inline
import matplotlib.pyplot as plt

X_train_rm = X_train_reduced[:,2].reshape(-1,1)
lreg.fit(X_train_rm, y_train_pca)
y_predict = lreg.predict(X_train_rm)

plt.plot(X_train_rm, y_predict, c = 'r')
plt.scatter(y_predict,y_train_pca)
plt.xlabel('RM')
```

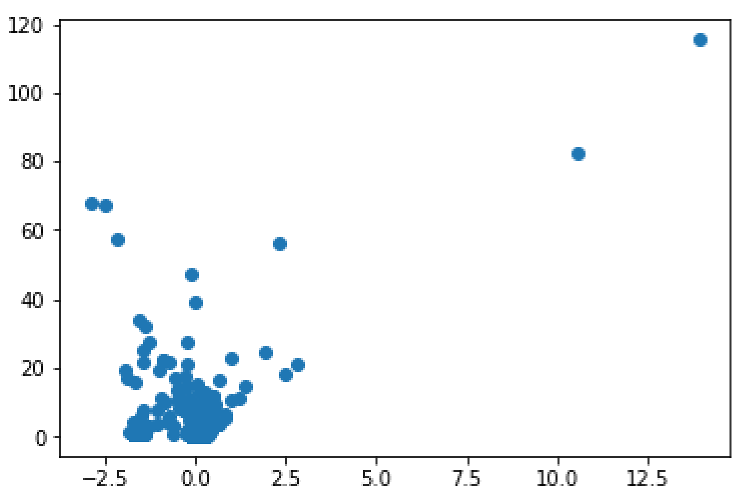
Out[101]: Text(0.5,0,'RM')



Polynomial Regression PCA

In [102]:
```
from  sklearn.preprocessing  import PolynomialFeatures

X_train_1 = X_train_reduced[:,2].reshape(-1,1)
plt.scatter(X_train_1,y_train_pca)
```

Out[102]: <matplotlib.collections.PathCollection at 0x21793fa2198>



In [103]:
```
train_score_list = []
test_score_list = []

for n in range(1,3):
    poly = PolynomialFeatures(n)
    X_train_poly = poly.fit_transform(X_train_reduced)
    X_test_poly = poly.transform(X_test_reduced)
    lreg.fit(X_train_poly, y_train_pca)
    train_score_list.append(lreg.score(X_train_poly, y_train_pca))
    test_score_list.append(lreg.score(X_test_poly, y_test_pca))
```

In [104]:
```
from sklearn.model_selection import cross_val_score

scores = cross_val_score(lreg, X_train_poly, y_train_pca, cv=5)
print("Cross-validation scores: {}".format(scores))
```

```
Cross-validation scores: [0.96369384 0.99225255 0.82511102 0.98627954 0.99550
248]
```

In [105]:
```
from sklearn.model_selection import KFold
kfold = KFold(n_splits=3)

print("Cross-validation scores for train:\n{}".format(cross_val_score(lreg, X_
train_poly, y_train_pca, cv=kfold)))
print("Cross-validation scores for test:\n{}".format(cross_val_score(lreg, X_t
est_poly, y_test_pca, cv=kfold)))
```

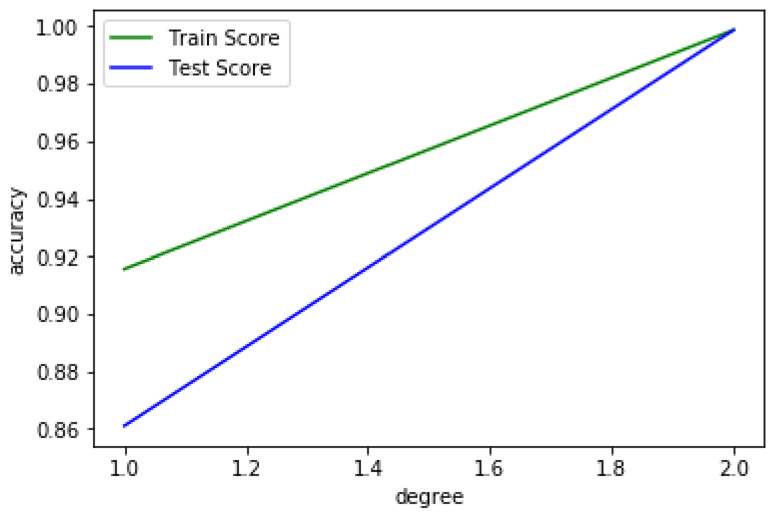
```
Cross-validation scores for train:
[0.98691486 0.98894759 0.99068921]
Cross-validation scores for test:
[-0.67960018  0.53907139 -9.94325378]
```

In [106]:
```
print("Average cross-validation score for train: {:.2f}".format(scores.mean
()))
print("Average cross-validation score for test: {:.2f}".format(scores_ts.mean
()))
```

```
Average cross-validation score for train: 0.95
Average cross-validation score for test: 0.76
```

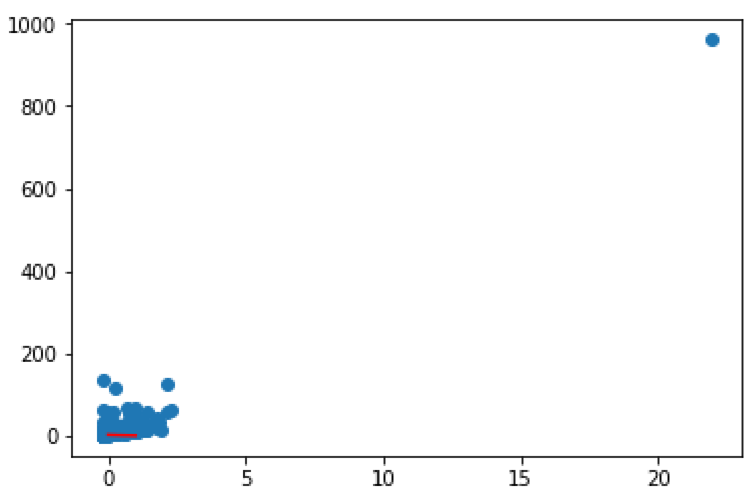
In [107]:
```
%matplotlib inline

x_axis = range(1,3)
plt.plot(x_axis, train_score_list, c = 'g', label = 'Train Score')
plt.plot(x_axis, test_score_list, c = 'b', label = 'Test Score')
plt.xlabel('degree')
plt.ylabel('accuracy')
plt.legend()
```

Out[107]: <matplotlib.legend.Legend at 0x2179523fb38>



In [108]:
```
poly = PolynomialFeatures(n)
X_train_poly = poly.fit_transform(X_train_1)
lreg.fit(X_train_poly, y_train_pca)

x_axis = np.linspace(0,1,100).reshape(-1,1)
x_poly = poly.transform(x_axis)
y_predict = lreg.predict(x_poly)

X_train_1 = X_train[:,2].reshape(-1,1)
plt.scatter(X_train_1,y_train)
plt.plot(x_axis, y_predict, c = 'r')
```

Out[108]: [<matplotlib.lines.Line2D at 0x21795291978>]



Ridge Regression

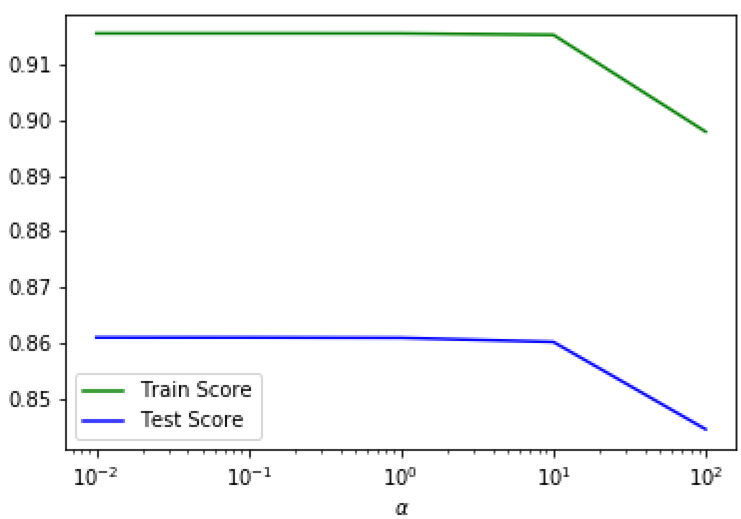
In [109]:
```
from  sklearn.linear_model import Ridge

x_range = [0.01, 0.1, 1, 10, 100]
train_score_list = []
test_score_list = []

for alpha in x_range:
    ridge = Ridge(alpha)
    ridge.fit(X_train_reduced,y_train_pca)
    train_score_list.append(ridge.score(X_train_reduced,y_train_pca))
    test_score_list.append(ridge.score(X_test_reduced, y_test_pca))
```

In [110]:
```
print(train_score_list)
print(test_score_list)
```

```
[0.9155741907721116, 0.9155741635016895, 0.9155714492737485, 0.91531229742194
85, 0.8978934302943397]
[0.8609554597792989, 0.860949633967569, 0.8608899045991464, 0.860153987750021
8, 0.8444465525327007]
```

In [111]:
```
%matplotlib inline
import matplotlib.pyplot as plt
plt.plot(x_range, train_score_list, c = 'g', label = 'Train Score')
plt.plot(x_range, test_score_list, c = 'b', label = 'Test Score')
plt.xscale('log')
plt.legend(loc = 3)
plt.xlabel(r'$\alpha$')
```

Out[111]:
```
Text(0.5,0,'$\\alpha$')
```



GRID SEARCH

In [112]:
```
from sklearn.model_selection import GridSearchCV
param_grid = {'alpha': [0.001, 0.01, 0.1, 1, 10, 100]}
grid_search = GridSearchCV(Ridge(), param_grid, return_train_score = True)
grid_search.fit(X_train_reduced, y_train_pca)
```

Out[112]:
```
GridSearchCV(cv=None, error_score='raise',
       estimator=Ridge(alpha=1.0, copy_X=True, fit_intercept=True, max_iter=N
one,
   normalize=False, random_state=None, solver='auto', tol=0.001),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'alpha': [0.001, 0.01, 0.1, 1, 10, 100]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [113]:
```
print("Best parameters: {}".format(grid_search.best_params_))
```

```
Best parameters: {'alpha': 10}
```

In [114]:
```
ridge = Ridge(alpha = 100)
ridge.fit(X_train_reduced,y_train_pca)
print('Train score: {:.4f}'.format(ridge.score(X_train_reduced,y_train_pca)))
print('Test score: {:.4f}'.format(ridge.score(X_test_reduced, y_test_pca)))
```

```
Train score: 0.8979
Test score: 0.8444
```

In [115]:
```
from sklearn.model_selection import cross_val_score

scores_tr = cross_val_score(ridge, X_train_reduced, y_train_pca, cv=5)
scores_ts = cross_val_score(ridge, X_test_reduced, y_test_pca, cv=5)
print("Cross-validation scores for train: {}".format(scores_tr))
print("Cross-validation scores for test : {}".format(scores_ts))
print("Average cross-validation score for train: {:.2f}".format(scores_tr.mean
()))
print("Average cross-validation score for test: {:.2f}".format(scores_ts.mean
()))
```

```
Cross-validation scores for train: [0.90918453 0.87064975 0.75000727 0.837795
93 0.86690374]
Cross-validation scores for test : [0.84228429 0.65134418 0.72906353 0.470432
96 0.78500438]
Average cross-validation score for train: 0.85
Average cross-validation score for test: 0.70
```

In [116]:
```
from sklearn.model_selection import KFold
kfold = KFold(n_splits=3)

print("Cross-validation scores for train:\n{}".format(cross_val_score(ridge, X
_train_reduced, y_train_pca, cv=kfold)))
print("Cross-validation scores for test:\n{}".format(cross_val_score(ridge, X_
test_reduced, y_test_pca, cv=kfold)))
```

```
Cross-validation scores for train:
[0.60415944 0.68947204 0.85016398]
Cross-validation scores for test:
[0.79819734 0.65548343 0.48838024]
```

LASSO

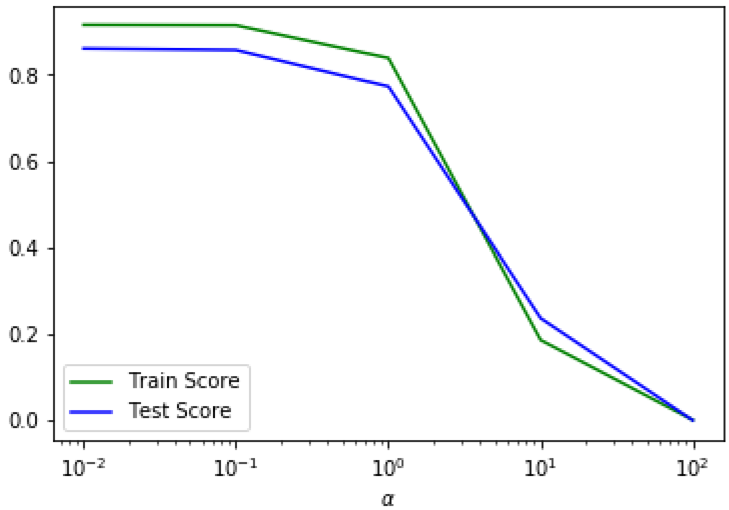
In [117]:
```
#on of them receive higher value, anf rest all are negligible
from sklearn.linear_model import Lasso
x_range = [0.01, 0.1, 1, 10, 100]
train_score_list = []
test_score_list = []

for alpha in x_range:
    lasso = Lasso(alpha)
    lasso.fit(X_train_reduced,y_train_pca)
    train_score_list.append(lasso.score(X_train_reduced,y_train_pca))
    test_score_list.append(lasso.score(X_test_reduced, y_test_pca))
```

In [118]:
```
print(train_score_list)
print(test_score_list)
```

```
[0.9155654916351755, 0.914704249795195, 0.8387001234473922, 0.185570852470551
5, 0.0]
[0.86065491750175, 0.8572228064206026, 0.7727388818949907, 0.2362074086289559
5, -0.0007457408497821838]
```

In [119]:
```
#suggests smaller power of alpha is the best parameter, power of 2
plt.plot(x_range, train_score_list, c = 'g', label = 'Train Score')
plt.plot(x_range, test_score_list, c = 'b', label = 'Test Score')
plt.xscale('log')
plt.legend(loc = 3)
plt.xlabel(r'$\alpha$')
```

Out[119]:
```
Text(0.5,0,'$\\alpha$')
```



GRID SEARCH

In [120]:
```
from sklearn.model_selection import GridSearchCV
param_grid = {'alpha': [0.001, 0.01, 0.1, 1, 10, 100]}
grid_search = GridSearchCV(Lasso(), param_grid, return_train_score = True)
grid_search.fit(X_train_reduced, y_train_pca)

print("Best parameters: {}".format(grid_search.best_params_))
```

```
Best parameters: {'alpha': 0.1}
```

In [121]:
```
lasso = Lasso(alpha = 100)
lasso.fit(X_train_reduced,y_train_pca)
print('Train score: {:.4f}'.format(ridge.score(X_train_reduced,y_train_pca)))
print('Test score: {:.4f}'.format(ridge.score(X_test_reduced, y_test_pca)))
```

```
Train score: 0.8979
Test score: 0.8444
```

CROSS VALIDATION scores

In [122]:
```
from sklearn.model_selection import cross_val_score

scores_tr = cross_val_score(lasso, X_train_reduced, y_train_pca, cv=5)
scores_ts = cross_val_score(lasso, X_test_reduced, y_test_pca, cv=5)
print("Cross-validation scores for train: {}".format(scores_tr))
print("Cross-validation scores for test : {}".format(scores_ts))
print("Average cross-validation score for train: {:.2f}".format(scores_tr.mean
()))
print("Average cross-validation score for test: {:.2f}".format(scores_ts.mean
()))
```

```
Cross-validation scores for train: [-3.79430171e-03 -2.22212602e-05 -9.539524
39e-04 -1.46277693e-02
 -1.61216950e-05]
Cross-validation scores for test : [-3.12012672e-02 -2.23446537e-02 -9.708547
12e-02 -4.31044748e-03
 -5.88169414e-05]
Average cross-validation score for train: -0.00
Average cross-validation score for test: -0.03
```

In [123]:
```
from sklearn.model_selection import KFold
kfold = KFold(n_splits=3)

print("Cross-validation scores for train:\n{}".format(cross_val_score(lasso, X
_train_reduced, y_train_pca, cv=kfold)))
print("Cross-validation scores for test:\n{}".format(cross_val_score(lasso, X_
test_reduced, y_test_pca, cv=kfold)))
```

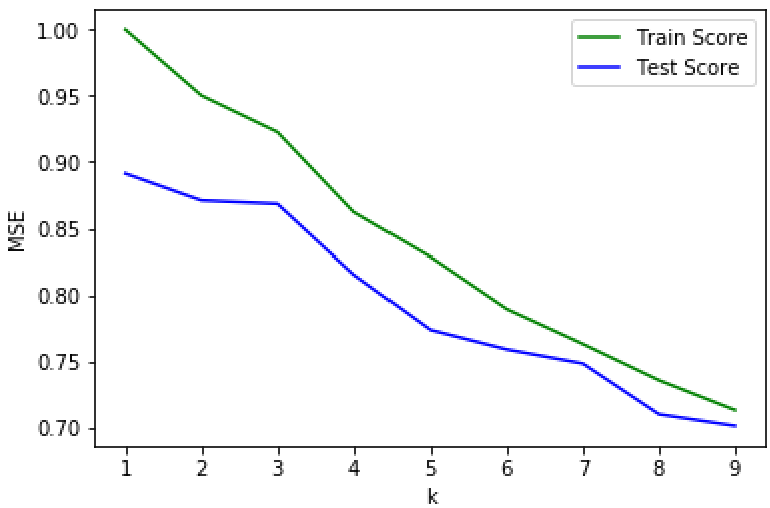
```
Cross-validation scores for train:
[-0.00450922 -0.00072537 -0.00661395]
Cross-validation scores for test:
[-2.37984342e-02 -1.56842050e-07 -5.96000207e-03]
```

KNN Regressor

In [124]:
```
from sklearn.neighbors import KNeighborsRegressor
```

In [125]:
```
#this generally overfits, but if still if we want, we choose 1, since atleast
#the test and train score is highest
%matplotlib inline
train_score_array = []
test_score_array = []

for k in range(1,10):
    knn_reg = KNeighborsRegressor(k)
    knn_reg.fit(X_train_reduced, y_train_pca)
    train_score_array.append(knn_reg.score(X_train_reduced, y_train_pca))
    test_score_array.append(knn_reg.score(X_test_reduced, y_test_pca))

x_axis = range(1,10)
plt.plot(x_axis, train_score_array, c = 'g', label = 'Train Score')
plt.plot(x_axis, test_score_array, c = 'b', label = 'Test Score')
plt.legend()
plt.xlabel('k')
plt.ylabel('MSE')
```

Out[125]:
```
Text(0,0.5,'MSE')
```

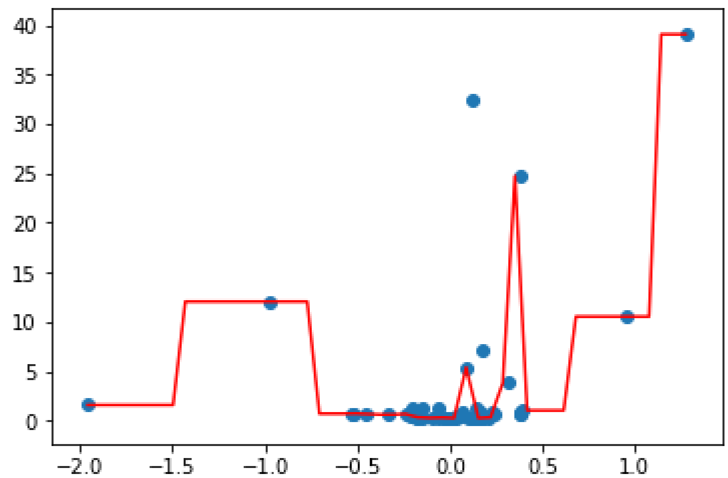


In [126]:
```
print(train_score_array)
print(test_score_array)
```

```
[1.0, 0.9501660764620422, 0.9226776686689147, 0.8623576281734537, 0.828634258
4213355, 0.7895475736988999, 0.7632004278702188, 0.7358896380674063, 0.713393
7487589562]
[0.8913583940961034, 0.8710017428478078, 0.8684940965612707, 0.81536410005492
17, 0.7737884303027047, 0.759134312548861, 0.7484991474824858, 0.710254466697
7644, 0.7014985706723535]
```

In [127]:
```
X_b = X_train_reduced[:50,6].reshape(-1,1)
y_b = y_train_pca[:50]

knn_reg = KNeighborsRegressor(1)
knn_reg.fit(X_b, y_b)

X_new=np.linspace(X_b.min(), X_b.max(), 50).reshape(50, 1)
y_predict = knn_reg.predict(X_new)

plt.plot(X_new, y_predict, c = 'r')
plt.scatter(X_b, y_b)
```

Out[127]:
```
<matplotlib.collections.PathCollection at 0x217956aa860>
```



CROSS VALIDATION SCORES

In [128]:
```
from sklearn.model_selection import KFold
kfold = KFold(n_splits=5)

print("Cross-validation scores for train:\n{}".format(cross_val_score(knn_reg,
X_train_reduced, y_train_pca, cv=kfold)))
print("Cross-validation scores for test:\n{}".format(cross_val_score(knn_reg,
X_test_reduced
                                                                    , y_test_
pca, cv=kfold)))
```

```
Cross-validation scores for train:
[0.75118328 0.77455652 0.80809642 0.87815124 0.69810887]
Cross-validation scores for test:
[0.90955034 0.83075882 0.62060624 0.31178303 0.55029848]
```

SVR

In [129]:
```
from sklearn.model_selection import KFold
from sklearn.svm import SVR
kfold1 = KFold(n_splits = 4, random_state=0)
from sklearn.model_selection import cross_val_score
```

In [130]:
```
svr_l = SVR(kernel = 'linear', C = 100, gamma = 10)
svr_l.fit(X_train_reduced, y_train_pca)
print(svr_l.score(X_train_reduced, y_train_pca))
print(svr_l.score(X_test_reduced, y_test_pca))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

```
0.901270191163776
0.8299719201171695
```

In [131]:
```
svr_r = SVR(kernel = 'rbf', C = 100, gamma = 10)
svr_r.fit(X_train_reduced, y_train_pca)
print(svr_r.score(X_train_reduced, y_train_pca))
print(svr_r.score(X_test_reduced, y_test_pca))
```

```
0.9996691509699482
0.42139847246393225
```

```
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```

GRID SEARCH for best parameters

In [132]:
```
from sklearn.svm import LinearSVR
from sklearn.model_selection import GridSearchCV

param_grid = {'C': [0.001, 0.01, 0.1, 1, 0.5, 10, 100], 'max_iter' :[50000]}
grid_search = GridSearchCV(LinearSVR(), param_grid, cv=kfold1, return_train_sc
ore = True)

grid_search.fit(X_train_reduced, y_train_pca)

test = cross_val_score(grid_search, X_test_reduced, y_test_pca, scoring='r2',c
v=kfold1).mean()
```

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```

In [133]:
```
print("Train Score: {:.5f}".format(grid_search.best_score_))
print("Test Score: {:.5f}".format(test))
print("best parameters are:",grid_search.best_params_)
```

```
Train Score: 0.84968
Test Score: 0.79888
best parameters are: {'C': 10, 'max_iter': 50000}
```

In [134]:
```
lsvr = LinearSVR(C = 10, max_iter = 50000)
```

In [135]:
```
lsvr.fit(X_train_reduced, y_train_pca)
```

```
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```

Out[135]:
```
LinearSVR(C=10, dual=True, epsilon=0.0, fit_intercept=True,
     intercept_scaling=1.0, loss='epsilon_insensitive', max_iter=50000,
     random_state=None, tol=0.0001, verbose=0)
```

In [136]:
```
print('Train score: {:.4f}'.format(lsvr.score(X_train_reduced,y_train_pca)))
print('Test score: {:.4f}'.format(lsvr.score(X_test_reduced, y_test_pca)))
```

```
Train score: 0.8939
Test score: 0.8294
```

In [137]:
```
from sklearn.model_selection import KFold
kfold1 = KFold(n_splits = 5, random_state=0)
from sklearn.model_selection import cross_val_score
```

In [138]:
```
from sklearn.svm import SVR
from sklearn.model_selection import GridSearchCV

param_grid = {'C': [0.001, 0.01, 0.1, 1, 0.5, 10, 100], 'max_iter' :[50000]}
grid_search = GridSearchCV(SVR(kernel='rbf'), param_grid, cv=kfold1, return_tr
ain_score = True)

grid_search.fit(X_train_reduced, y_train_pca)

test = cross_val_score(grid_search, X_test_reduced, y_test_pca, scoring='r2',c
v=kfold1).mean()
```

```
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  y = column_or_1d(y, warn=True)
```

In [139]:

```
print("Train Score: {:.5f}".format(grid_search.best_score_))
print("Test Score: {:.5f}".format(test))
print("best parameters are:",grid_search.best_params_)
```

```
Train Score: 0.68755
Test Score: 0.66147
best parameters are: {'C': 100, 'max_iter': 50000}
```

In [140]:

```
svrbf = SVR(kernel='rbf', C = 100, max_iter = 50000)
```

In [141]:

```
svrbf.fit(X_train_reduced, y_train_pca)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[141]:

```
SVR(C=100, cache_size=200, coef0=0.0, degree=3, epsilon=0.1, gamma='auto',
  kernel='rbf', max_iter=50000, shrinking=True, tol=0.001, verbose=False)
```

In [142]:

```
print('Train score: {:.4f}'.format(svrbf.score(X_train_reduced,y_train_pca)))
print('Test score: {:.4f}'.format(svrbf.score(X_test_reduced, y_test_pca)))
```

```
Train score: 0.9999
Test score: 0.8938
```

CROSS VALIDATION

In [143]:
```
from sklearn.model_selection import KFold
kfold = KFold(n_splits=3)

print("Cross-validation scores of linear for train:\n{}".format(cross_val_scor
e(svr_l, X_train_reduced, y_train_pca, cv=kfold)))
print("Cross-validation scores of linear for test:\n{}".format(cross_val_score
(svr_l, X_test_reduced, y_test_pca, cv=kfold)))
print("Cross-validation scores of rbf for train:\n{}".format(cross_val_score(s
vr_r, X_train_reduced, y_train_pca, cv=kfold)))
print("Cross-validation scores of rbf for test:\n{}".format(cross_val_score(sv
r_r, X_test_reduced, y_test_pca, cv=kfold)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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  y = column_or_1d(y, warn=True)

Cross-validation scores of linear for train:
[0.93217952 0.67640617 0.81149131]
Cross-validation scores of linear for test:
[0.91885094 0.66413691 0.73227429]
Cross-validation scores of rbf for train:
[0.22990691 0.29313814 0.60479285]
Cross-validation scores of rbf for test:
[0.52079569 0.21229357 0.20749492]
```

```
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```

SVR Kernel Poly

In [144]:

```
from sklearn.model_selection import KFold
kfold1 = KFold(n_splits = 5, random_state=0)
from sklearn.model_selection import cross_val_score
```

In [145]:
```
from sklearn.svm import SVR
from sklearn.model_selection import GridSearchCV

param_grid = {'C': [0.001, 0.01, 0.1, 1, 0.5, 10, 100], 'max_iter' :[50000]}
grid_search = GridSearchCV(SVR(kernel='poly'), param_grid, cv=kfold1, return_t
rain_score = True)

grid_search.fit(X_train_reduced, y_train_pca)

test = cross_val_score(grid_search, X_test_reduced, y_test_pca, scoring='r2',c
v=kfold1).mean()
```

```
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
```

```
  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
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  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
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  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
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  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [146]:

```
print("Train Score: {:.5f}".format(grid_search.best_score_))
print("Test Score: {:.5f}".format(test))
print("best parameters are:",grid_search.best_params_)
```

```
Train Score: 0.72051
Test Score: 0.24044
best parameters are: {'C': 0.1, 'max_iter': 50000}
```

In [147]:

```
svrp = SVR(kernel='poly', C = 0.1, max_iter = 50000)
```

In [148]:

```
svrp.fit(X_train_reduced, y_train_pca)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[148]:

```
SVR(C=0.1, cache_size=200, coef0=0.0, degree=3, epsilon=0.1, gamma='auto',
  kernel='poly', max_iter=50000, shrinking=True, tol=0.001, verbose=False)
```

In [149]:

```
print('Train score: {:.4f}'.format(svrp.score(X_train_reduced,y_train_pca)))
print('Test score: {:.4f}'.format(svrp.score(X_test_reduced, y_test_pca)))
```

```
Train score: 0.8848
Test score: 0.6414
```

Deep Learning

In [150]:
```
from tensorflow.keras import Sequential
from tensorflow.keras.layers import Dense
```

In [151]:
```
#step 1: build the model
model1 = Sequential()
#input layer
model1.add(Dense(20, input_dim = 7, activation = 'relu'))
#hidden layer
#output layer: no activation function
model1.add(Dense(1))

#step 2: compile the model
model1.compile(loss = 'mean_squared_error', optimizer = 'adam', metrics = ['me
an_squared_error'])

#step 3: train the model
model1.fit(X_train_reduced,y_train_pca, epochs = 150, batch_size = 300)

#step 4: model evaluation
```

```
WARNING:tensorflow:From C:\Users\prith\Anaconda3\lib\site-packages\tensorflow
\python\ops\resource_variable_ops.py:435: colocate_with (from tensorflow.pyth
on.framework.ops) is deprecated and will be removed in a future version.
Instructions for updating:
Colocations handled automatically by placer.
WARNING:tensorflow:From C:\Users\prith\Anaconda3\lib\site-packages\tensorflow
\python\keras\utils\losses_utils.py:170: to_float (from tensorflow.python.op
s.math_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.
WARNING:tensorflow:From C:\Users\prith\Anaconda3\lib\site-packages\tensorflow
\python\ops\math_ops.py:3066: to_int32 (from tensorflow.python.ops.math_ops)
is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.
Epoch 1/150
498/498 [==============================] - 0s 212us/sample - loss: 106.7873 -
mean_squared_error: 106.7873
Epoch 2/150
498/498 [==============================] - 0s 8us/sample - loss: 106.1561 - m
ean_squared_error: 106.1561
Epoch 3/150
498/498 [==============================] - 0s 10us/sample - loss: 105.5513 -
mean_squared_error: 105.5513
Epoch 4/150
498/498 [==============================] - 0s 8us/sample - loss: 105.0902 - m
ean_squared_error: 105.0902
Epoch 5/150
498/498 [==============================] - 0s 8us/sample - loss: 104.5552 - m
ean_squared_error: 104.5552
Epoch 6/150
498/498 [==============================] - 0s 9us/sample - loss: 103.9219 - m
ean_squared_error: 103.9219
Epoch 7/150
498/498 [==============================] - 0s 8us/sample - loss: 103.4656 - m
ean_squared_error: 103.4657
Epoch 8/150
498/498 [==============================] - 0s 6us/sample - loss: 102.9186 - m
ean_squared_error: 102.9186
Epoch 9/150
498/498 [==============================] - 0s 6us/sample - loss: 102.2863 - m
ean_squared_error: 102.2863
Epoch 10/150
498/498 [==============================] - 0s 6us/sample - loss: 101.7860 - m
ean_squared_error: 101.7860
Epoch 11/150
498/498 [==============================] - 0s 7us/sample - loss: 101.3552 - m
ean_squared_error: 101.3552
Epoch 12/150
498/498 [==============================] - 0s 5us/sample - loss: 100.8014 - m
ean_squared_error: 100.8014
Epoch 13/150
498/498 [==============================] - 0s 10us/sample - loss: 100.1866 -
mean_squared_error: 100.1866
Epoch 14/150
498/498 [==============================] - 0s 8us/sample - loss: 99.7706 - me
an_squared_error: 99.7706
```

```
Epoch 15/150
498/498 [==============================] - 0s 6us/sample - loss: 99.2307 - me
an_squared_error: 99.2308
Epoch 16/150
498/498 [==============================] - 0s 7us/sample - loss: 98.7123 - me
an_squared_error: 98.7123
Epoch 17/150
498/498 [==============================] - 0s 6us/sample - loss: 98.1907 - me
an_squared_error: 98.1907
Epoch 18/150
498/498 [==============================] - 0s 6us/sample - loss: 97.6355 - me
an_squared_error: 97.6355
Epoch 19/150
498/498 [==============================] - 0s 8us/sample - loss: 97.1097 - me
an_squared_error: 97.1097
Epoch 20/150
498/498 [==============================] - 0s 8us/sample - loss: 96.6152 - me
an_squared_error: 96.6152
Epoch 21/150
498/498 [==============================] - 0s 5us/sample - loss: 96.1823 - me
an_squared_error: 96.1823
Epoch 22/150
498/498 [==============================] - 0s 5us/sample - loss: 95.6242 - me
an_squared_error: 95.6242
Epoch 23/150
498/498 [==============================] - 0s 6us/sample - loss: 95.0576 - me
an_squared_error: 95.0576
Epoch 24/150
498/498 [==============================] - 0s 7us/sample - loss: 94.5311 - me
an_squared_error: 94.5310
Epoch 25/150
498/498 [==============================] - 0s 7us/sample - loss: 94.0935 - me
an_squared_error: 94.0935
Epoch 26/150
498/498 [==============================] - 0s 5us/sample - loss: 93.4822 - me
an_squared_error: 93.4822
Epoch 27/150
498/498 [==============================] - 0s 6us/sample - loss: 93.0224 - me
an_squared_error: 93.0224
Epoch 28/150
498/498 [==============================] - 0s 6us/sample - loss: 92.5041 - me
an_squared_error: 92.5041
Epoch 29/150
498/498 [==============================] - 0s 5us/sample - loss: 91.9526 - me
an_squared_error: 91.9526
Epoch 30/150
498/498 [==============================] - 0s 8us/sample - loss: 91.4950 - me
an_squared_error: 91.4950
Epoch 31/150
498/498 [==============================] - 0s 11us/sample - loss: 90.8982 - m
ean_squared_error: 90.8982
Epoch 32/150
498/498 [==============================] - 0s 6us/sample - loss: 90.3818 - me
an_squared_error: 90.3818
Epoch 33/150
498/498 [==============================] - 0s 8us/sample - loss: 89.9507 - me
an_squared_error: 89.9507
```

```
Epoch 34/150
498/498 [==============================] - 0s 6us/sample - loss: 89.3271 - me
an_squared_error: 89.3271
Epoch 35/150
498/498 [==============================] - 0s 6us/sample - loss: 88.8268 - me
an_squared_error: 88.8268
Epoch 36/150
498/498 [==============================] - 0s 7us/sample - loss: 88.3180 - me
an_squared_error: 88.3180
Epoch 37/150
498/498 [==============================] - 0s 6us/sample - loss: 87.8137 - me
an_squared_error: 87.8137
Epoch 38/150
498/498 [==============================] - 0s 5us/sample - loss: 87.2909 - me
an_squared_error: 87.2909
Epoch 39/150
498/498 [==============================] - 0s 6us/sample - loss: 86.7591 - me
an_squared_error: 86.7591
Epoch 40/150
498/498 [==============================] - 0s 7us/sample - loss: 86.2614 - me
an_squared_error: 86.2614
Epoch 41/150
498/498 [==============================] - 0s 6us/sample - loss: 85.7430 - me
an_squared_error: 85.7430
Epoch 42/150
498/498 [==============================] - 0s 6us/sample - loss: 85.1756 - me
an_squared_error: 85.1756
Epoch 43/150
498/498 [==============================] - 0s 11us/sample - loss: 84.6681 - m
ean_squared_error: 84.6681
Epoch 44/150
498/498 [==============================] - 0s 10us/sample - loss: 84.1026 - m
ean_squared_error: 84.1026
Epoch 45/150
498/498 [==============================] - 0s 9us/sample - loss: 83.6403 - me
an_squared_error: 83.6403
Epoch 46/150
498/498 [==============================] - 0s 10us/sample - loss: 83.1171 - m
ean_squared_error: 83.1171
Epoch 47/150
498/498 [==============================] - 0s 10us/sample - loss: 82.5946 - m
ean_squared_error: 82.5946
Epoch 48/150
498/498 [==============================] - 0s 10us/sample - loss: 82.0470 - m
ean_squared_error: 82.0471
Epoch 49/150
498/498 [==============================] - 0s 10us/sample - loss: 81.4315 - m
ean_squared_error: 81.4315
Epoch 50/150
498/498 [==============================] - 0s 7us/sample - loss: 80.9739 - me
an_squared_error: 80.9739
Epoch 51/150
498/498 [==============================] - 0s 8us/sample - loss: 80.3839 - me
an_squared_error: 80.3839
Epoch 52/150
498/498 [==============================] - 0s 6us/sample - loss: 79.8361 - me
an_squared_error: 79.8361
```

```
Epoch 53/150
498/498 [==============================] - 0s 5us/sample - loss: 79.3311 - me
an_squared_error: 79.3311
Epoch 54/150
498/498 [==============================] - 0s 7us/sample - loss: 78.7694 - me
an_squared_error: 78.7694
Epoch 55/150
498/498 [==============================] - 0s 6us/sample - loss: 78.1458 - me
an_squared_error: 78.1458
Epoch 56/150
498/498 [==============================] - 0s 6us/sample - loss: 77.6501 - me
an_squared_error: 77.6501
Epoch 57/150
498/498 [==============================] - 0s 7us/sample - loss: 77.0717 - me
an_squared_error: 77.0717
Epoch 58/150
498/498 [==============================] - 0s 6us/sample - loss: 76.5211 - me
an_squared_error: 76.5211
Epoch 59/150
498/498 [==============================] - 0s 6us/sample - loss: 75.9407 - me
an_squared_error: 75.9407
Epoch 60/150
498/498 [==============================] - 0s 4us/sample - loss: 75.4183 - me
an_squared_error: 75.4183
Epoch 61/150
498/498 [==============================] - 0s 6us/sample - loss: 74.7560 - me
an_squared_error: 74.7560
Epoch 62/150
498/498 [==============================] - 0s 6us/sample - loss: 74.2680 - me
an_squared_error: 74.2680
Epoch 63/150
498/498 [==============================] - 0s 6us/sample - loss: 73.6899 - me
an_squared_error: 73.6899
Epoch 64/150
498/498 [==============================] - 0s 8us/sample - loss: 73.0788 - me
an_squared_error: 73.0788
Epoch 65/150
498/498 [==============================] - 0s 6us/sample - loss: 72.4899 - me
an_squared_error: 72.4899
Epoch 66/150
498/498 [==============================] - 0s 8us/sample - loss: 71.9411 - me
an_squared_error: 71.9411
Epoch 67/150
498/498 [==============================] - 0s 10us/sample - loss: 71.3710 - m
ean_squared_error: 71.3710
Epoch 68/150
498/498 [==============================] - 0s 6us/sample - loss: 70.8583 - me
an_squared_error: 70.8583
Epoch 69/150
498/498 [==============================] - 0s 8us/sample - loss: 70.1875 - me
an_squared_error: 70.1875
Epoch 70/150
498/498 [==============================] - 0s 8us/sample - loss: 69.6223 - me
an_squared_error: 69.6223
Epoch 71/150
498/498 [==============================] - 0s 7us/sample - loss: 69.0486 - me
an_squared_error: 69.0486
```

```
Epoch 72/150
498/498 [==============================] - 0s 6us/sample - loss: 68.4274 - me
an_squared_error: 68.4274
Epoch 73/150
498/498 [==============================] - 0s 8us/sample - loss: 67.8635 - me
an_squared_error: 67.8635
Epoch 74/150
498/498 [==============================] - 0s 6us/sample - loss: 67.1867 - me
an_squared_error: 67.1867
Epoch 75/150
498/498 [==============================] - 0s 6us/sample - loss: 66.6623 - me
an_squared_error: 66.6623
Epoch 76/150
498/498 [==============================] - 0s 6us/sample - loss: 65.9987 - me
an_squared_error: 65.9987
Epoch 77/150
498/498 [==============================] - 0s 7us/sample - loss: 65.4234 - me
an_squared_error: 65.4234
Epoch 78/150
498/498 [==============================] - 0s 5us/sample - loss: 64.8456 - me
an_squared_error: 64.8456
Epoch 79/150
498/498 [==============================] - 0s 6us/sample - loss: 64.1894 - me
an_squared_error: 64.1894
Epoch 80/150
498/498 [==============================] - 0s 6us/sample - loss: 63.6641 - me
an_squared_error: 63.6641
Epoch 81/150
498/498 [==============================] - 0s 6us/sample - loss: 62.9209 - me
an_squared_error: 62.9209
Epoch 82/150
498/498 [==============================] - 0s 8us/sample - loss: 62.3959 - me
an_squared_error: 62.3958
Epoch 83/150
498/498 [==============================] - 0s 6us/sample - loss: 61.7529 - me
an_squared_error: 61.7529
Epoch 84/150
498/498 [==============================] - 0s 7us/sample - loss: 61.1038 - me
an_squared_error: 61.1038
Epoch 85/150
498/498 [==============================] - 0s 8us/sample - loss: 60.5309 - me
an_squared_error: 60.5309
Epoch 86/150
498/498 [==============================] - 0s 9us/sample - loss: 59.9575 - me
an_squared_error: 59.9575
Epoch 87/150
498/498 [==============================] - 0s 6us/sample - loss: 59.2859 - me
an_squared_error: 59.2859
Epoch 88/150
498/498 [==============================] - 0s 4us/sample - loss: 58.6483 - me
an_squared_error: 58.6483
Epoch 89/150
498/498 [==============================] - 0s 6us/sample - loss: 58.0296 - me
an_squared_error: 58.0296
Epoch 90/150
498/498 [==============================] - 0s 6us/sample - loss: 57.4330 - me
an_squared_error: 57.4330
```

```
Epoch 91/150
498/498 [==============================] - 0s 6us/sample - loss: 56.8626 - me
an_squared_error: 56.8626
Epoch 92/150
498/498 [==============================] - 0s 13us/sample - loss: 56.2496 - m
ean_squared_error: 56.2496
Epoch 93/150
498/498 [==============================] - 0s 9us/sample - loss: 55.6133 - me
an_squared_error: 55.6133
Epoch 94/150
498/498 [==============================] - 0s 6us/sample - loss: 54.9845 - me
an_squared_error: 54.9845
Epoch 95/150
498/498 [==============================] - 0s 6us/sample - loss: 54.3580 - me
an_squared_error: 54.3580
Epoch 96/150
498/498 [==============================] - 0s 7us/sample - loss: 53.8221 - me
an_squared_error: 53.8221
Epoch 97/150
498/498 [==============================] - 0s 6us/sample - loss: 53.0806 - me
an_squared_error: 53.0806
Epoch 98/150
498/498 [==============================] - 0s 7us/sample - loss: 52.5118 - me
an_squared_error: 52.5118
Epoch 99/150
498/498 [==============================] - 0s 6us/sample - loss: 51.9420 - me
an_squared_error: 51.9420
Epoch 100/150
498/498 [==============================] - 0s 8us/sample - loss: 51.3074 - me
an_squared_error: 51.3074
Epoch 101/150
498/498 [==============================] - 0s 6us/sample - loss: 50.7075 - me
an_squared_error: 50.7075
Epoch 102/150
498/498 [==============================] - 0s 6us/sample - loss: 50.1355 - me
an_squared_error: 50.1355
Epoch 103/150
498/498 [==============================] - 0s 6us/sample - loss: 49.4202 - me
an_squared_error: 49.4202
Epoch 104/150
498/498 [==============================] - 0s 6us/sample - loss: 48.8420 - me
an_squared_error: 48.8420
Epoch 105/150
498/498 [==============================] - 0s 4us/sample - loss: 48.2887 - me
an_squared_error: 48.2887
Epoch 106/150
498/498 [==============================] - 0s 5us/sample - loss: 47.6425 - me
an_squared_error: 47.6425
Epoch 107/150
498/498 [==============================] - 0s 5us/sample - loss: 47.0473 - me
an_squared_error: 47.0473
Epoch 108/150
498/498 [==============================] - 0s 12us/sample - loss: 46.4084 - m
ean_squared_error: 46.4084
Epoch 109/150
498/498 [==============================] - 0s 5us/sample - loss: 45.7971 - me
an_squared_error: 45.7971
```

```
Epoch 110/150
498/498 [==============================] - 0s 8us/sample - loss: 45.3214 - me
an_squared_error: 45.3214
Epoch 111/150
498/498 [==============================] - 0s 8us/sample - loss: 44.6450 - me
an_squared_error: 44.6450
Epoch 112/150
498/498 [==============================] - 0s 8us/sample - loss: 44.0371 - me
an_squared_error: 44.0371
Epoch 113/150
498/498 [==============================] - 0s 8us/sample - loss: 43.4467 - me
an_squared_error: 43.4467
Epoch 114/150
498/498 [==============================] - 0s 6us/sample - loss: 42.8668 - me
an_squared_error: 42.8668
Epoch 115/150
498/498 [==============================] - 0s 6us/sample - loss: 42.2484 - me
an_squared_error: 42.2484
Epoch 116/150
498/498 [==============================] - 0s 9us/sample - loss: 41.7371 - me
an_squared_error: 41.7371
Epoch 117/150
498/498 [==============================] - 0s 10us/sample - loss: 41.2056 - m
ean_squared_error: 41.2056
Epoch 118/150
498/498 [==============================] - 0s 9us/sample - loss: 40.6054 - me
an_squared_error: 40.6054
Epoch 119/150
498/498 [==============================] - 0s 8us/sample - loss: 40.0179 - me
an_squared_error: 40.0179
Epoch 120/150
498/498 [==============================] - 0s 8us/sample - loss: 39.5516 - me
an_squared_error: 39.5516
Epoch 121/150
498/498 [==============================] - 0s 10us/sample - loss: 38.9107 - m
ean_squared_error: 38.9107
Epoch 122/150
498/498 [==============================] - 0s 5us/sample - loss: 38.4186 - me
an_squared_error: 38.4186
Epoch 123/150
498/498 [==============================] - 0s 7us/sample - loss: 37.8890 - me
an_squared_error: 37.8890
Epoch 124/150
498/498 [==============================] - 0s 8us/sample - loss: 37.3284 - me
an_squared_error: 37.3284
Epoch 125/150
498/498 [==============================] - 0s 6us/sample - loss: 36.8547 - me
an_squared_error: 36.8547
Epoch 126/150
498/498 [==============================] - 0s 6us/sample - loss: 36.3403 - me
an_squared_error: 36.3403
Epoch 127/150
498/498 [==============================] - 0s 8us/sample - loss: 35.7951 - me
an_squared_error: 35.7951
Epoch 128/150
498/498 [==============================] - 0s 7us/sample - loss: 35.3299 - me
an_squared_error: 35.3299
```

```
Epoch 129/150
498/498 [==============================] - 0s 5us/sample - loss: 34.8260 - me
an_squared_error: 34.8260
Epoch 130/150
498/498 [==============================] - 0s 6us/sample - loss: 34.2586 - me
an_squared_error: 34.2586
Epoch 131/150
498/498 [==============================] - 0s 4us/sample - loss: 33.8335 - me
an_squared_error: 33.8335
Epoch 132/150
498/498 [==============================] - 0s 3us/sample - loss: 33.3017 - me
an_squared_error: 33.3017
Epoch 133/150
498/498 [==============================] - 0s 6us/sample - loss: 32.9024 - me
an_squared_error: 32.9024
Epoch 134/150
498/498 [==============================] - 0s 6us/sample - loss: 32.3214 - me
an_squared_error: 32.3214
Epoch 135/150
498/498 [==============================] - 0s 10us/sample - loss: 31.9320 - m
ean_squared_error: 31.9320
Epoch 136/150
498/498 [==============================] - 0s 11us/sample - loss: 31.4488 - m
ean_squared_error: 31.4488
Epoch 137/150
498/498 [==============================] - 0s 8us/sample - loss: 30.9481 - me
an_squared_error: 30.9481
Epoch 138/150
498/498 [==============================] - 0s 6us/sample - loss: 30.4998 - me
an_squared_error: 30.4998
Epoch 139/150
498/498 [==============================] - 0s 8us/sample - loss: 30.0648 - me
an_squared_error: 30.0648
Epoch 140/150
498/498 [==============================] - 0s 8us/sample - loss: 29.5259 - me
an_squared_error: 29.5259
Epoch 141/150
498/498 [==============================] - 0s 8us/sample - loss: 29.1527 - me
an_squared_error: 29.1527
Epoch 142/150
498/498 [==============================] - 0s 6us/sample - loss: 28.7014 - me
an_squared_error: 28.7014
Epoch 143/150
498/498 [==============================] - 0s 8us/sample - loss: 28.2606 - me
an_squared_error: 28.2606
Epoch 144/150
498/498 [==============================] - 0s 8us/sample - loss: 27.8360 - me
an_squared_error: 27.8360
Epoch 145/150
498/498 [==============================] - 0s 6us/sample - loss: 27.4137 - me
an_squared_error: 27.4137
Epoch 146/150
498/498 [==============================] - 0s 6us/sample - loss: 26.9607 - me
an_squared_error: 26.9607
Epoch 147/150
498/498 [==============================] - 0s 6us/sample - loss: 26.5535 - me
an_squared_error: 26.5535
```

```
Epoch 148/150
498/498 [==============================] - 0s 7us/sample - loss: 26.0772 - me
an_squared_error: 26.0772
Epoch 149/150
498/498 [==============================] - 0s 6us/sample - loss: 25.7538 - me
an_squared_error: 25.7538
Epoch 150/150
498/498 [==============================] - 0s 8us/sample - loss: 25.3187 - me
an_squared_error: 25.3187
```

Out[151]: <tensorflow.python.keras.callbacks.History at 0x21799ee2ba8>

In [152]:
```
model1.evaluate(X_train_reduced, y_train_pca)
```

```
498/498 [==============================] - 0s 126us/sample - loss: 24.9915 -
mean_squared_error: 24.9915
```

Out[152]: [24.99153002390421, 24.99153]

In [153]:
```
model1.evaluate(X_test_reduced, y_test_pca)
```

```
166/166 [==============================] - 0s 33us/sample - loss: 22.6933 - m
ean_squared_error: 22.6933
```

Out[153]: [22.693267029452038, 22.693266]

In [154]:
```
from sklearn.metrics import r2_score
y_pred = model1.predict(X_train_reduced)
```

In [155]:
```
r2_score(y_train_pca, model1.predict(X_train_reduced))
```

Out[155]: 0.7479094761826908

In [156]:
```
r2_score(y_test_pca, model1.predict(X_test_reduced))
```

Out[156]: 0.6742123747718369

CLASSIFICATION TASK

In [157]:
```
x = result[['Sector_score','PARA_A','PARA_B','numbers','Money_Value','History'
,'Score','District_Loss','Loss']]
y = result[['Risk']]
```

In [158]:
```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler

X_train_org, X_test_org , y_train, y_test = train_test_split(x, y, random_stat
e = 0)

scaler = MinMaxScaler()
scaler.fit(X_train_org)
X_train = scaler.transform(X_train_org)
X_test = scaler.transform(X_test_org)
```

In [159]:
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier

from sklearn.ensemble import BaggingClassifier
from sklearn.ensemble import AdaBoostClassifier

from sklearn.metrics import confusion_matrix
from sklearn.metrics import f1_score
from sklearn.metrics import classification_report
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import precision_recall_curve
```

HARD AND SOFT VOTING

In [160]:
```
from sklearn.ensemble import VotingClassifier
from sklearn.linear_model import LogisticRegression



log_clf = LogisticRegression()
log_clf.fit(X_train, y_train)#do for each of the models
knn_clf = KNeighborsClassifier(7)
knn_clf.fit(X_train, y_train)
svm_clf = SVC(C = 10, probability = True)#soft voting
svm_clf.fit(X_train, y_train)

voting_clf = VotingClassifier(estimators=[('lr', log_clf), ('knn', knn_clf), (
'svc', svm_clf)], voting='soft')
voting_clf.fit(X_train, y_train)

print('SOFT VOTING')
from sklearn.metrics import accuracy_score
for clf in (log_clf, knn_clf, svm_clf, voting_clf):
    clf.fit(X_train, y_train)
    y_pred = clf.predict(X_test)
    print(clf.__class__.__name__, accuracy_score(y_test, y_pred))
```

```
SOFT VOTING
LogisticRegression 0.9698795180722891
KNeighborsClassifier 1.0
SVC 0.9759036144578314
VotingClassifier 1.0

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:9: DataConve
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().
  if __name__ == '__main__':
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
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C:\Users\prith\Anaconda3\lib\site-packages\sklearn\preprocessing\label.py:95:
DataConversionWarning: A column-vector y was passed when a 1d array was expec
ted. Please change the shape of y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\preprocessing\label.py:12
8: DataConversionWarning: A column-vector y was passed when a 1d array was ex
pected. Please change the shape of y to (n_samples, ), for example using rave
l().
  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:19: DataConv
ersionWarning: A column-vector y was passed when a 1d array was expected. Ple
ase change the shape of y to (n_samples, ), for example using ravel().
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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l().
  y = column_or_1d(y, warn=True)
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\preprocessing\label.py:15
1: DeprecationWarning: The truth value of an empty array is ambiguous. Return
ing False, but in future this will result in an error. Use `array.size > 0` t
o check that an array is not empty.
  if diff:
```

In [161]:
```
voting_clf = VotingClassifier(estimators=[('lr', log_clf), ('knn', knn_clf), (
'svc', svm_clf)], voting='hard')
voting_clf.fit(X_train, y_train)

print('HARD VOTING')

from sklearn.metrics import accuracy_score
for clf in (log_clf, knn_clf, svm_clf, voting_clf):
    clf.fit(X_train, y_train)
    y_pred = clf.predict(X_test)
    print(clf.__class__.__name__, accuracy_score(y_test, y_pred))
```

```
HARD VOTING
LogisticRegression 0.9698795180722891
KNeighborsClassifier 1.0
SVC 0.9759036144578314
VotingClassifier 0.9759036144578314

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ing False, but in future this will result in an error. Use `array.size > 0` t
o check that an array is not empty.
  if diff:
```

BAGGING AND PASTING

LOGISTIC REGRESSION

In [162]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
#base model
logreg = LogisticRegression()

#grid params
grid_param = {'C':[0.001, 0.01, 0.1, 1, 10, 100, 1000],
             'penalty':['l1', 'l2']}

#grid search model
log_grid= GridSearchCV(logreg, grid_param, cv = 3, n_jobs= -1, scoring='precis
ion')

#train grid search model
log_grid.fit(X_train, y_train)



#find the best params
print('Best param:', log_grid.best_params_)
print('Best score:', log_grid.best_score_)
```

```
Best param: {'C': 0.1, 'penalty': 'l1'}
Best score: 1.0

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [163]:
```
lgrg= LogisticRegression(C =0.1, penalty='l1')
```

In [164]:
```
from sklearn.ensemble import BaggingClassifier
#from sklearn.svm import SVR

#from sklearn.linear_model import LogisticRegression
#base model


#grid params
grid_param = {'n_estimators':[100, 200, 300, 400, 500, 600, 700],
             'max_samples':[50, 100, 150, 200, 250, 300]}

#grid search model
bag_grid= GridSearchCV(BaggingClassifier(lgrg), grid_param, cv = 5)
#train grid search model
bag_grid.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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```

Out[164]:
```
GridSearchCV(cv=5, error_score='raise',
       estimator=BaggingClassifier(base_estimator=LogisticRegression(C=0.1, c
lass_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
          penalty='l1', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start...n_estimators=10, n_jobs=1, oob_score=False,
         random_state=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'n_estimators': [100, 200, 300, 400, 500, 600, 700], 'max_
samples': [50, 100, 150, 200, 250, 300]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [165]:
```
#find the best params
print('Best param:', bag_grid.best_params_)
print('Best score:', bag_grid.best_score_)
```

```
Best param: {'max_samples': 250, 'n_estimators': 200}
Best score: 0.9598393574297188
```

In [166]:
```
bag_clf_log = BaggingClassifier(LogisticRegression(C= 0.1, penalty= 'l1'), n_e
stimators=200, max_samples=250, bootstrap=True, random_state=0)

bag_clf_log.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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  y = column_or_1d(y, warn=True)
```

Out[166]:
```
BaggingClassifier(base_estimator=LogisticRegression(C=0.1, class_weight=None,
dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
          penalty='l1', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start=False),
         bootstrap=True, bootstrap_features=False, max_features=1.0,
         max_samples=250, n_estimators=200, n_jobs=1, oob_score=False,
         random_state=0, verbose=0, warm_start=False)
```

In [167]:
```
#y_pred = bag_clf_log.predict(X_test)
print('Bagging Train score: {:.2f}'.format(bag_clf_log.score(X_train, y_train
)))
print('Bagging Test score: {:.2f}'.format(bag_clf_log.score(X_test, y_test)))
```

```
Bagging Train score: 0.95
Bagging Test score: 0.97
```

In [168]:
```
bag_clf_log_p = BaggingClassifier(LogisticRegression(C= 0.1, penalty= 'l1'), n
_estimators=200, max_samples=250, bootstrap=False, random_state=0)

bag_clf_log_p.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[168]:
```
BaggingClassifier(base_estimator=LogisticRegression(C=0.1, class_weight=None,
dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
          penalty='l1', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start=False),
         bootstrap=False, bootstrap_features=False, max_features=1.0,
         max_samples=250, n_estimators=200, n_jobs=1, oob_score=False,
         random_state=0, verbose=0, warm_start=False)
```

In [169]:
```
bag_clf_log_p = BaggingClassifier(LogisticRegression(C= 0.1, penalty= 'l1'), n
_estimators=200, max_samples=250, bootstrap=False, random_state=0)

bag_clf_log_p.fit(X_train, y_train)
```

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BaggingClassifier(base_estimator=LogisticRegression(C=0.1, class_weight=None,
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          penalty='l1', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start=False),
         bootstrap=False, bootstrap_features=False, max_features=1.0,
         max_samples=250, n_estimators=200, n_jobs=1, oob_score=False,
         random_state=0, verbose=0, warm_start=False)
```

In [170]:
```
#y_pred = bag_clf_log.predict(X_test)
print('Pasting Train score: {:.2f}'.format(bag_clf_log_p.score(X_train, y_trai
n)))
print('Pasting Test score: {:.2f}'.format(bag_clf_log_p.score(X_test, y_test
)))
```

```
Pasting Train score: 0.95
Pasting Test score: 0.97
```

SVC LINEAR

In [171]:
```
svc = SVC()

param_grid = {'C': [0.001, 0.01, 0.1, 1, 10, 100],
              'gamma': [0.001, 0.01, 0.1, 1, 10, 100]}

svc_grid = GridSearchCV(SVC(kernel = 'linear'), param_grid, cv=5, return_train
_score=True)


#grid search model
#log_grid= GridSearchCV(logreg, grid_param, cv = 3, n_jobs= -1, scoring='preci
sion')

#train grid search model
svc_grid.fit(X_train, y_train)
```

```
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```

Out[171]:

```
GridSearchCV(cv=5, error_score='raise',
       estimator=SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='linear',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'C': [0.001, 0.01, 0.1, 1, 10, 100], 'gamma': [0.001, 0.0
1, 0.1, 1, 10, 100]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [172]:
```
#find the best params
print('Best param:', svc_grid.best_params_)
print('Best score:', svc_grid.best_score_)
```

```
Best param: {'C': 10, 'gamma': 0.001}
Best score: 1.0
```

In [173]:
```
svc = SVC(C=10, gamma=0.001)#kernel='linear',
```

In [174]:
```
from sklearn.ensemble import BaggingClassifier
#from sklearn.svm import SVR

#from sklearn.linear_model import LogisticRegression
#base model


#grid params
grid_param = {'n_estimators':[100, 200, 300, 400, 500, 600, 700],
             'max_samples':[50, 100, 150, 200, 250, 300]}

#grid search model
bag_grid= GridSearchCV(BaggingClassifier(svc), grid_param, cv = 3)
#train grid search model
bag_grid.fit(X_train, y_train)
```

```
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```

Out[174]:
```
GridSearchCV(cv=3, error_score='raise',
       estimator=BaggingClassifier(base_estimator=SVC(C=10, cache_size=200, c
lass_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.001, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
         bootstrap=True, bootstrap_features=False, max_features=1.0,
         max_samples=1.0, n_estimators=10, n_jobs=1, oob_score=False,
         random_state=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'n_estimators': [100, 200, 300, 400, 500, 600, 700], 'max_
samples': [50, 100, 150, 200, 250, 300]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [175]:
```
#find the best params
print('Best param:', bag_grid.best_params_)
print('Best score:', bag_grid.best_score_)
```

```
Best param: {'max_samples': 50, 'n_estimators': 100}
Best score: 0.6004016064257028
```

In [176]:
```
bag_clf_svclb = BaggingClassifier(SVC(kernel ='linear', C = 10, gamma = 0.01),
n_estimators=100, max_samples=200, bootstrap=True, random_state=0)

bag_clf_svclb.fit(X_train, y_train)
y_pred = bag_clf_svclb.predict(X_test)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [177]:
```
bag_clf_svclb.fit(X_train, y_train)
print('Train score: {:.2f}'.format(bag_clf_svclb.score(X_train, y_train)))
print('Test score: {:.2f}'.format(bag_clf_svclb.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)

Train score: 1.00
Test score: 1.00
```

pasting

In [178]:
```
bag_clf_svclp = BaggingClassifier(SVC(kernel ='linear', C = 10, gamma = 0.01),
n_estimators=100, max_samples=50, bootstrap=False, random_state=0)

bag_clf_svclp.fit(X_train, y_train)
y_pred = bag_clf_svclb.predict(X_test)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [179]:
```
bag_clf_svclp.fit(X_train, y_train)
print('Train score: {:.2f}'.format(bag_clf_svclp.score(X_train, y_train)))
print('Test score: {:.2f}'.format(bag_clf_svclp.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

```
Train score: 0.89
Test score: 0.90
```

SVC rbf

In [180]:
```
param_grid = {'C': [0.001, 0.01, 0.1, 1, 10, 100],
              'gamma': [0.001, 0.01, 0.1, 1, 10, 100]}

svc_grid = GridSearchCV(SVC(kernel = 'rbf'), param_grid, cv=5, return_train_sc
ore=True)

#train grid search model
svc_grid.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
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```

Out[180]:
```
GridSearchCV(cv=5, error_score='raise',
       estimator=SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'C': [0.001, 0.01, 0.1, 1, 10, 100], 'gamma': [0.001, 0.0
1, 0.1, 1, 10, 100]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [181]:
```
#find the best params
print('Best param:', svc_grid.best_params_)
print('Best score:', svc_grid.best_score_)
```

```
Best param: {'C': 0.1, 'gamma': 100}
Best score: 1.0
```

In [182]:
```
svc_r= SVC(kernel='rbf', C= 0.1, gamma= 100)
```

In [183]:
```
from sklearn.ensemble import BaggingClassifier
#from sklearn.svm import SVR

#from sklearn.linear_model import LogisticRegression
#base model


#grid params
grid_param = {'n_estimators':[100, 200, 300, 400, 500, 600, 700],
             'max_samples':[50, 100, 150, 200, 250, 300]}

#grid search model
bag_grid_svcr= GridSearchCV(BaggingClassifier(svc_r), grid_param, cv = 3)
#train grid search model
bag_grid_svcr.fit(X_train, y_train)
```

```
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```

Out[183]:
```
GridSearchCV(cv=3, error_score='raise',
       estimator=BaggingClassifier(base_estimator=SVC(C=0.1, cache_size=200,
class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=100, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
         bootstrap=True, bootstrap_features=False, max_features=1.0,
         max_samples=1.0, n_estimators=10, n_jobs=1, oob_score=False,
         random_state=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'n_estimators': [100, 200, 300, 400, 500, 600, 700], 'max_
samples': [50, 100, 150, 200, 250, 300]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [184]:
```
#find the best params
print('Best param:', bag_grid_svcr.best_params_)
print('Best score:', bag_grid_svcr.best_score_)
```

```
Best param: {'max_samples': 200, 'n_estimators': 300}
Best score: 1.0
```

In [185]:
```
bag_clf_svcrb = BaggingClassifier(SVC(kernel ='rbf', C = 0.1, gamma = 100), n_
estimators=100, max_samples=200, bootstrap=True, random_state=0)

bag_clf_svcrb.fit(X_train, y_train)
#y_pred = bag_clf_svclb.predict(X_test)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[185]:
```
BaggingClassifier(base_estimator=SVC(C=0.1, cache_size=200, class_weight=Non
e, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=100, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
         bootstrap=True, bootstrap_features=False, max_features=1.0,
         max_samples=200, n_estimators=100, n_jobs=1, oob_score=False,
         random_state=0, verbose=0, warm_start=False)
```

In [186]:
```
bag_clf_svcrb.fit(X_train, y_train)
print('Train score: {:.2f}'.format(bag_clf_svcrb.score(X_train, y_train)))
print('Test score: {:.2f}'.format(bag_clf_svcrb.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)

Train score: 1.00
Test score: 1.00
```

Pasting

In [187]:
```
bag_clf_svcrp = BaggingClassifier(SVC(kernel ='rbf', C = 0.1, gamma = 100), n_
estimators=100, max_samples=200, bootstrap=False, random_state=0)

bag_clf_svcrp.fit(X_train, y_train)
y_pred = bag_clf_svcrp.predict(X_test)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [188]:
```
bag_clf_svcrp.fit(X_train, y_train)
print('Train score: {:.2f}'.format(bag_clf_svcrp.score(X_train, y_train)))
print('Test score: {:.2f}'.format(bag_clf_svcrp.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)

Train score: 1.00
Test score: 1.00
```

SVC in Poly

In [189]:
```
param_grid = {'C': [0.001, 0.01, 0.1, 1, 10, 100],
              'gamma': [0.001, 0.01, 0.1, 1, 10, 100]}

svc_grid_p = GridSearchCV(SVC(kernel = 'poly'), param_grid, cv=5, return_train
_score=True)

#train grid search model
svc_grid_p.fit(X_train, y_train)
```

```
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```

Out[189]:
```
GridSearchCV(cv=5, error_score='raise',
       estimator=SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='poly',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'C': [0.001, 0.01, 0.1, 1, 10, 100], 'gamma': [0.001, 0.0
1, 0.1, 1, 10, 100]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [190]:
```
#find the best params
print('Best param:', svc_grid_p.best_params_)
print('Best score:', svc_grid_p.best_score_)
```

```
Best param: {'C': 10, 'gamma': 100}
Best score: 1.0
```

In [191]:
```
svc_p= SVC(kernel= 'poly', C= 10, gamma= 100 )
```

In [192]:
```
from sklearn.ensemble import BaggingClassifier
#from sklearn.svm import SVR

#from sklearn.linear_model import LogisticRegression
#base model


#grid params
grid_param = {'n_estimators':[100, 200, 300, 400, 500, 600, 700],
             'max_samples':[50, 100, 150, 200, 250, 300]}

#grid search model
bag_grid_p= GridSearchCV(BaggingClassifier(svc_p), grid_param, cv = 3)
#train grid search model
bag_grid_p.fit(X_train, y_train)
```

```
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  y = column_or_1d(y, warn=True)
```

Out[192]:
```
GridSearchCV(cv=3, error_score='raise',
       estimator=BaggingClassifier(base_estimator=SVC(C=10, cache_size=200, c
lass_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=100, kernel='poly',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
         bootstrap=True, bootstrap_features=False, max_features=1.0,
         max_samples=1.0, n_estimators=10, n_jobs=1, oob_score=False,
         random_state=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'n_estimators': [100, 200, 300, 400, 500, 600, 700], 'max_
samples': [50, 100, 150, 200, 250, 300]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [193]:
```
#find the best params
print('Best param:', bag_grid_p.best_params_)
print('Best score:', bag_grid_p.best_score_)
```

```
Best param: {'max_samples': 200, 'n_estimators': 100}
Best score: 1.0
```

In [194]:
```
bag_clf_svcpb = BaggingClassifier(SVC(kernel ='poly', C =10, gamma =100), n_es
timators=100, max_samples=250, bootstrap=True, random_state=0)

bag_clf_svcpb.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[194]:
```
BaggingClassifier(base_estimator=SVC(C=10, cache_size=200, class_weight=None,
coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=100, kernel='poly',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
         bootstrap=True, bootstrap_features=False, max_features=1.0,
         max_samples=250, n_estimators=100, n_jobs=1, oob_score=False,
         random_state=0, verbose=0, warm_start=False)
```

In [195]:
```
bag_clf_svcpb.fit(X_train, y_train)
print('Train score: {:.2f}'.format(bag_clf_svcpb.score(X_train, y_train)))
print('Test score: {:.2f}'.format(bag_clf_svcpb.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

```
Train score: 1.00
Test score: 1.00
```

pasting

In [196]:
```
bag_clf_svcpp = BaggingClassifier(SVC(kernel ='poly', C =10, gamma =100), n_estimators=100, max_samples=250, bootstrap=False, random_state=0)

bag_clf_svcpp.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[196]:
```
BaggingClassifier(base_estimator=SVC(C=10, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=100, kernel='poly',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
         bootstrap=False, bootstrap_features=False, max_features=1.0,
         max_samples=250, n_estimators=100, n_jobs=1, oob_score=False,
         random_state=0, verbose=0, warm_start=False)
```

In [197]:
```
bag_clf_svcpp.fit(X_train, y_train)
print('Train score: {:.2f}'.format(bag_clf_svcpp.score(X_train, y_train)))
print('Test score: {:.2f}'.format(bag_clf_svcpp.score(X_test, y_test)))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)

Train score: 1.00
Test score: 1.00
```

In [ ]:

ADABOOST CLASSIFIER

In [198]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.tree import DecisionTreeClassifier
param_grid = {'max_depth': [1, 2, 3, 4, 5, 6]}
dt_grid = GridSearchCV(DecisionTreeClassifier(), param_grid, return_train_score = True)
dt_grid.fit(X_train, y_train)

print('Best param:', dt_grid.best_params_)
print('Best score:', dt_grid.best_score_)
```

```
Best param: {'max_depth': 1}
Best score: 1.0
```

In [199]:
```
dt= DecisionTreeClassifier(max_depth=1)
```

In [200]:
```
from sklearn.ensemble import AdaBoostClassifier
#from sklearn.svm import SVR

#from sklearn.linear_model import LogisticRegression
#base model


#grid params
grid_param = {'n_estimators':[100, 200, 300, 400, 500, 600, 700],
             'learning_rate':[0.25, 0.5, 0.75, 1, 1.25, 1.5, 2]}

#grid search model
ada_grid_dt= GridSearchCV(AdaBoostClassifier(dt), grid_param, cv = 5)
#train grid search model
ada_grid_dt.fit(X_train, y_train)
```

```
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  y = column_or_1d(y, warn=True)
```

Out[200]:

```
GridSearchCV(cv=5, error_score='raise',
       estimator=AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight=None, criterion
='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, presort=False, random_state=None,
            splitter='best'),
          learning_rate=1.0, n_estimators=50, random_state=None),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'n_estimators': [100, 200, 300, 400, 500, 600, 700], 'lear
ning_rate': [0.25, 0.5, 0.75, 1, 1.25, 1.5, 2]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [201]:

```python
print('Best param:', ada_grid_dt.best_params_)
print('Best score:', ada_grid_dt.best_score_)
```

```
Best param: {'learning_rate': 0.25, 'n_estimators': 100}
Best score: 1.0
```

In [202]:
```
from sklearn.ensemble import AdaBoostClassifier


ada_clf = AdaBoostClassifier(DecisionTreeClassifier(max_depth=1), n_estimators
=100, algorithm="SAMME.R", learning_rate=0.25, random_state=0)
ada_clf.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[202]:
```
AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight=None, criterion
='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, presort=False, random_state=None,
            splitter='best'),
          learning_rate=0.25, n_estimators=100, random_state=0)
```

In [203]:
```
print("Accuracy on training set: {:.3f}".format(ada_clf.score(X_train, y_train
)))
print("Accuracy on test set: {:.3f}".format(ada_clf.score(X_test, y_test)))
```

```
Accuracy on training set: 1.000
Accuracy on test set: 1.000
```

LOGISTIC REGRESSION

In [204]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
#base model
logreg = LogisticRegression()

#grid params
grid_param = {'C':[0.001, 0.01, 0.1, 1, 10, 100, 1000],
             'penalty':['l1', 'l2']}

#grid search model
log_grid= GridSearchCV(logreg, grid_param, cv = 3, n_jobs= -1, scoring='precis
ion')

#train grid search model
log_grid.fit(X_train, y_train)



#find the best params
print('Best param:', log_grid.best_params_)
print('Best score:', log_grid.best_score_)
```

```
Best param: {'C': 0.1, 'penalty': 'l1'}
Best score: 1.0

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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [205]:
```
logrg= LogisticRegression(C= 0.1, penalty= 'l1')
```

In [206]:
```
from sklearn.ensemble import AdaBoostClassifier
#from sklearn.svm import SVR

#from sklearn.linear_model import LogisticRegression
#base model


#grid params
grid_param = {'n_estimators':[100, 200, 300, 400, 500, 600, 700],
             'learning_rate':[0.25, 0.5, 0.75, 1, 1.25, 1.5, 2]}

#grid search model
ada_grid_log= GridSearchCV(AdaBoostClassifier(logrg), grid_param, cv = 5)
#train grid search model
ada_grid_log.fit(X_train, y_train)
```

```
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[206]:
```
GridSearchCV(cv=5, error_score='raise',
       estimator=AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=LogisticRegression(C=0.1, class_weight=None, dual=Fa
lse, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
          penalty='l1', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start=False),
          learning_rate=1.0, n_estimators=50, random_state=None),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'n_estimators': [100, 200, 300, 400, 500, 600, 700], 'lear
ning_rate': [0.25, 0.5, 0.75, 1, 1.25, 1.5, 2]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [207]:
```
print('Best param:', ada_grid_log.best_params_)
print('Best score:', ada_grid_log.best_score_)
```

```
Best param: {'learning_rate': 0.25, 'n_estimators': 100}
Best score: 0.39959839357429716
```

In [208]:
```
ada_clf_log = AdaBoostClassifier(logrg, n_estimators=100, algorithm="SAMME.R",
learning_rate=0.25, random_state=0)
ada_clf_log.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[208]:
```
AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=LogisticRegression(C=0.1, class_weight=None, dual=Fa
lse, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
          penalty='l1', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start=False),
          learning_rate=0.25, n_estimators=100, random_state=0)
```

In [209]:
```
print("Accuracy on training set: {:.3f}".format(ada_clf_log.score(X_train, y_train)))
print("Accuracy on test set: {:.3f}".format(ada_clf_log.score(X_test, y_test)))
```

```
Accuracy on training set: 0.400
Accuracy on test set: 0.476
```

SVC

In [210]:
```
ada_clf_svcl = AdaBoostClassifier(SVC(C=1, gamma=0.001, kernel = 'linear'), n_estimators=200, algorithm="SAMME", learning_rate=0.5, random_state=0)
ada_clf_svcl.fit(X_train, y_train)
```

```
C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[210]:
```
AdaBoostClassifier(algorithm='SAMME',
          base_estimator=SVC(C=1, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.001, kernel='linear',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False),
          learning_rate=0.5, n_estimators=200, random_state=0)
```

In [211]:
```
print("Accuracy on training set: {:.3f}".format(ada_clf_svcl.score(X_train, y_train)))
print("Accuracy on test set: {:.3f}".format(ada_clf_svcl.score(X_test, y_test)))
```

```
Accuracy on training set: 0.600
Accuracy on test set: 0.524
```

In [ ]:

GRADIENT BOOSTING

In [212]:
```
from sklearn.ensemble import GradientBoostingClassifier

gbrt_dt = GradientBoostingClassifier(random_state=0, max_depth=1)
gbrt_dt.fit(X_train, y_train)

print("Accuracy on training set: {:.3f}".format(gbrt_dt.score(X_train, y_train
)))
print("Accuracy on test set: {:.3f}".format(gbrt_dt.score(X_test, y_test)))
```

```
Accuracy on training set: 1.000
Accuracy on test set: 1.000

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [213]:
```
gbrt = GradientBoostingClassifier(random_state=0, learning_rate=0.01)
gbrt.fit(X_train, y_train)

print("Accuracy on training set: {:.3f}".format(gbrt.score(X_train, y_train)))
print("Accuracy on test set: {:.3f}".format(gbrt.score(X_test, y_test)))
```

```
Accuracy on training set: 1.000
Accuracy on test set: 1.000

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [ ]:

PCA

In [214]:
```
from sklearn.decomposition import PCA

#create model
pca = PCA(n_components= 0.95, random_state = 0)

#train pca model
pca.fit(X_train)

#transforming X_train and X_test
X_train_reduced = pca.transform(X_train)
X_test_reduced = pca.transform(X_test)
```

In [215]:
```
pca.n_components_
```

Out[215]: 6

In [216]:
```
pca.explained_variance_
```

Out[216]:
```
array([0.20804096, 0.09219366, 0.07016795, 0.01917128, 0.01109893,
       0.00970886])
```

In [217]:
```
pca.explained_variance_ratio_
```

Out[217]:
```
array([0.49298331, 0.21846628, 0.16627316, 0.04542914, 0.02630053,
       0.02300655])
```

In [218]:
```
pca.n_features_
```

Out[218]:
```
9
```

LOGISTIC REGRESSION

In [219]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
#base model
logreg = LogisticRegression()

#grid params
grid_param = {'C':[0.001, 0.01, 0.1, 1, 10, 100, 1000],
             'penalty':['l1', 'l2']}

#grid search model
log_grid= GridSearchCV(logreg, grid_param, cv = 5, n_jobs= -1, scoring='precis
ion')

#train grid search model
log_grid.fit(X_train_reduced, y_train)

#find the best params
print('Best param:', log_grid.best_params_)
print('Best score:', log_grid.best_score_)
```

```
Best param: {'C': 1, 'penalty': 'l1'}
Best score: 1.0

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [220]:
```
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score

y_pred = np.where(log_grid.decision_function(X_train_reduced)>-0.5, 1, 0)#what
parameters are these??
print('Accuracy (0.3):', accuracy_score(y_train, y_pred))
print('Precision (0.3):', precision_score(y_train, y_pred))
print('Recall (0.3):', recall_score(y_train, y_pred))
```

```
Accuracy (0.3): 1.0
Precision (0.3): 1.0
Recall (0.3): 1.0
```

In [221]:
```
y_pred = np.where(log_grid.decision_function(X_test_reduced)>-0.5, 1, 0)
print('on test :')
print('Accuracy on train (0.3):', accuracy_score(y_test, y_pred))
print('Precision (0.3):', precision_score(y_test, y_pred))
print('Recall (0.3):', recall_score(y_test, y_pred))
```

```
on test :
Accuracy on train (0.3): 1.0
Precision (0.3): 1.0
Recall (0.3): 1.0
```

In [222]:
```
logreg = LogisticRegression(C=1, penalty = 'l1').fit(X_train_reduced, y_train)
pred_logreg = logreg.predict(X_test_reduced)
print("logreg score: {:.2f}".format(logreg.score(X_test_reduced, y_test)))


from sklearn.metrics import confusion_matrix
print("\nLogistic Regression")
print(confusion_matrix(y_test, pred_logreg))



from sklearn.metrics import classification_report
print(classification_report(y_test, pred_logreg, target_names=["0", "1"]))
```

```
logreg score: 1.00

Logistic Regression
[[79  0]
 [ 0 87]]
             precision    recall  f1-score   support

          0       1.00      1.00      1.00        79
          1       1.00      1.00      1.00        87

avg / total       1.00      1.00      1.00       166


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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [ ]:

SVC IN LINEAR, RBF, POLY

In [224]:
```
from sklearn.svm import SVC
from sklearn.model_selection import GridSearchCV

#base model
svc = SVC(probability = True, random_state = 0, kernel = 'linear')

#grid params
grid_param = {'C':[0.001, 0.01, 0.1, 1, 10, 100],
             'gamma':[0.001, 0.01, 0.1, 1, 10, 100]}

#grid search model
svc_grid_l= GridSearchCV(svc, grid_param, cv = 5, n_jobs= -1, scoring='precisi
on')

#train grid search model
svc_grid_l.fit(X_train_reduced, y_train)

#find the best params
print('Best param:', svc_grid_l.best_params_)
print('Best score:', svc_grid_l.best_score_)
```

```
Best param: {'C': 1, 'gamma': 0.001}
Best score: 1.0

C:\Users\prith\Anaconda3\lib\site-packages\sklearn\utils\validation.py:578: D
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ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [225]:
```
y_pred = np.where(svc_grid_l.decision_function(X_train_reduced)>-0.5, 1, 0)
print('Accuracy (0.3):', accuracy_score(y_train, y_pred))
print('Precision (0.3):', precision_score(y_train, y_pred))
print('Recall (0.3):', recall_score(y_train, y_pred))
```

```
Accuracy (0.3): 1.0
Precision (0.3): 1.0
Recall (0.3): 1.0
```

In [226]:
```
svc_l = SVC(kernel = 'linear', C = 1, gamma = 0.001).fit(X_train_reduced, y_tr
ain)
pred_svc_l = svc_l.predict(X_test_reduced)
print("svc linear score: {:.2f}".format(svc_l.score(X_test_reduced, y_test)))


print("\nSVC-linear")
print(confusion_matrix(y_test, pred_svc_l))


from sklearn.metrics import classification_report

print(classification_report(y_test, pred_svc_l, target_names=["0", "1"]))
```

```
svc linear score: 0.90

SVC-linear
[[79  0]
 [17 70]]
             precision    recall  f1-score   support

          0       0.82      1.00      0.90        79
          1       1.00      0.80      0.89        87

avg / total       0.92      0.90      0.90       166


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```

In [227]:
```
from sklearn.svm import SVC
from sklearn.model_selection import GridSearchCV
param_grid = {'C': [0.001, 0.01, 0.1, 1, 10, 100],
              'gamma': [0.001, 0.01, 0.1, 1, 10, 100]}
svc_grid_r= GridSearchCV(SVC(kernel = 'rbf', probability = True, random_state
= 0), param_grid, cv=3, return_train_score=True)

#X_train, X_test, y_train, y_test = train_test_split(x, y, random_state=0)
svc_grid_r.fit(X_train_reduced, y_train)
```

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```

Out[227]:

```
GridSearchCV(cv=3, error_score='raise',
       estimator=SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='rbf',
  max_iter=-1, probability=True, random_state=0, shrinking=True, tol=0.001,
  verbose=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'C': [0.001, 0.01, 0.1, 1, 10, 100], 'gamma': [0.001, 0.0
1, 0.1, 1, 10, 100]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [228]:

```
#find the best params
print('Best param:', svc_grid_r.best_params_)
print('Best score:', svc_grid_r.best_score_)
```

```
Best param: {'C': 0.1, 'gamma': 100}
Best score: 1.0
```

In [229]:
```
y_pred = np.where(svc_grid_r.decision_function(X_train_reduced)>-0.5, 1, 0)
print('on train :')
print('Accuracy on train (0.3):', accuracy_score(y_train, y_pred))
print('Precision (0.3):', precision_score(y_train, y_pred))
print('Recall (0.3):', recall_score(y_train, y_pred))
```

```
on train :
Accuracy on train (0.3): 1.0
Precision (0.3): 1.0
Recall (0.3): 1.0
```

In [230]:
```
y_pred = np.where(svc_grid_r.decision_function(X_test_reduced)>-0.5, 1, 0)
print('on test :')
print('Accuracy on train (0.3):', accuracy_score(y_test, y_pred))
print('Precision (0.3):', precision_score(y_test, y_pred))
print('Recall (0.3):', recall_score(y_test, y_pred))
```

```
on test :
Accuracy on train (0.3): 1.0
Precision (0.3): 1.0
Recall (0.3): 1.0
```

In [231]:
```
svc_r = SVC(kernel = 'rbf', C = 0.1, gamma = 100).fit(X_train_reduced, y_train
)
pred_svc_r = svc_r.predict(X_test_reduced)
print("svc rbf score: {:.2f}".format(svc_r.score(X_test_reduced, y_test)))

print("\nSVC-rbf")
print(confusion_matrix(y_test, pred_svc_r))

from sklearn.metrics import classification_report

print(classification_report(y_test, pred_svc_r, target_names=["0", "1"]))
```

```
svc rbf score: 1.00

SVC-rbf
[[79  0]
 [ 0 87]]
             precision    recall  f1-score   support

          0       1.00      1.00      1.00        79
          1       1.00      1.00      1.00        87

avg / total       1.00      1.00      1.00       166


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  y = column_or_1d(y, warn=True)
```

In [232]:
```
from sklearn.svm import SVC
from sklearn.model_selection import GridSearchCV
param_grid = {'C': [0.001, 0.01, 0.1, 1, 10, 100],
              'gamma': [0.001, 0.01, 0.1, 1, 10, 100]}
svc_grid_p = GridSearchCV(SVC(kernel = 'poly', probability = True, random_stat
e = 0), param_grid, cv=3, return_train_score=True)

#X_train, X_test, y_train, y_test = train_test_split(x, y, random_state=0)
svc_grid_p.fit(X_train_reduced, y_train)

#svc_grid_l.fit(X_test_reduced, y_train)--- we dont fit to the test
```

```
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```

Out[232]:
```
GridSearchCV(cv=3, error_score='raise',
       estimator=SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='poly',
  max_iter=-1, probability=True, random_state=0, shrinking=True, tol=0.001,
  verbose=False),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'C': [0.001, 0.01, 0.1, 1, 10, 100], 'gamma': [0.001, 0.0
1, 0.1, 1, 10, 100]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [233]:
```
print("Best parameters for linear SVC: {}".format(svc_grid_p.best_params_))
print("Best cross-validation score: {:.2f}".format(svc_grid_p.best_score_))
```

```
Best parameters for linear SVC: {'C': 0.001, 'gamma': 100}
Best cross-validation score: 1.00
```

In [234]:
```
y_pred = np.where(svc_grid_l.decision_function(X_train_reduced)>-0.5, 1, 0)
print('on train :')
print('Accuracy on train (0.3):', accuracy_score(y_train, y_pred))
print('Precision (0.3):', precision_score(y_train, y_pred))
print('Recall (0.3):', recall_score(y_train, y_pred))
```

```
on train :
Accuracy on train (0.3): 1.0
Precision (0.3): 1.0
Recall (0.3): 1.0
```

In [235]:
```
svc_p = SVC(kernel = 'poly', C = 0.1, gamma = 100).fit(X_train_reduced, y_trai
n)
pred_svc_p = svc_r.predict(X_test_reduced)
print("svc rbf score: {:.2f}".format(svc_r.score(X_test_reduced, y_test)))

print("\nSVC-rbf")
print(confusion_matrix(y_test, pred_svc_r))

from sklearn.metrics import classification_report

print(classification_report(y_test, pred_svc_r, target_names=["0", "1"]))
```

```
svc rbf score: 1.00

SVC-rbf
[[79  0]
 [ 0 87]]
             precision    recall  f1-score   support

          0       1.00      1.00      1.00        79
          1       1.00      1.00      1.00        87

avg / total       1.00      1.00      1.00       166


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```

In [ ]:

KNN

In [237]:
```
from sklearn.neighbors import KNeighborsClassifier

train_score_array = []
test_score_array = []

for k in range(1,20):
    knn = KNeighborsClassifier(k)
    knn.fit(X_train_reduced, y_train)
    train_score_array.append(knn.score(X_train_reduced, y_train))
    test_score_array.append(knn.score(X_test_reduced, y_test))
```

```
C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
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C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
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se change the shape of y to (n_samples, ), for example using ravel().

C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().

C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().

C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
```

```
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().

C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().

C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().

C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().

C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:8: DataConve
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().
```

In [238]:

```
print(train_score_array)
print(test_score_array)
```

```
[1.0, 1.0, 1.0, 1.0, 1.0, 0.9939759036144579, 0.9939759036144579, 0.993975903
6144579, 0.9939759036144579, 0.9939759036144579, 0.9939759036144579, 0.993975
9036144579, 0.9939759036144579, 0.9939759036144579, 0.9939759036144579, 0.993
9759036144579, 0.9939759036144579, 0.9939759036144579, 0.9939759036144579]
[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
1.0, 1.0, 1.0, 1.0]
```

In [239]:

```
print("Train score: {:.2f}".format(knn.score(X_train_reduced, y_train)))
print("Test score: {:.2f}".format(knn.score(X_test_reduced, y_test)))
```

```
Train score: 0.99
Test score: 1.00
```

In [240]:
```
from sklearn.neighbors import KNeighborsClassifier
knn_e = KNeighborsClassifier().fit(X_train_reduced, y_train)
pred_knn_e = knn_e.predict(X_test_reduced)
print("Test score: {:.2f}".format(knn_e.score(X_test_reduced, y_test)))

from sklearn.metrics import confusion_matrix
print("\nKNN classifier:")
print(confusion_matrix(y_test, pred_knn_e))

from sklearn.metrics import classification_report
print(classification_report(y_test, pred_knn_e, target_names=["0", "1"]))
```

```
Test score: 1.00

KNN classifier:
[[79  0]
 [ 0 87]]
             precision    recall  f1-score   support

          0       1.00      1.00      1.00        79
          1       1.00      1.00      1.00        87

avg / total       1.00      1.00      1.00       166


C:\Users\prith\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: DataConve
rsionWarning: A column-vector y was passed when a 1d array was expected. Plea
se change the shape of y to (n_samples, ), for example using ravel().
```

DECISION TREE CLASSIFIER

In [241]:
```
from sklearn.tree import DecisionTreeClassifier


dtree = DecisionTreeClassifier(random_state=0)
#goes full length; no early stopping
dtree.fit(X_train_reduced, y_train)
print("Accuracy on training set: {:.3f}".format(dtree.score(X_train_reduced, y
_train)))
print("Accuracy on test set: {:.3f}".format(dtree.score(X_test_reduced, y_test
)))
```

```
Accuracy on training set: 1.000
Accuracy on test set: 1.000
```

In [242]:
```
from sklearn.model_selection import GridSearchCV
param_grid = {'max_depth': [1, 2, 3, 4, 5, 6]}
dtree_grid = GridSearchCV(DecisionTreeClassifier(), param_grid, return_train_s
core = True)
dtree_grid.fit(X_train_reduced, y_train)
```

Out[242]:
```
GridSearchCV(cv=None, error_score='raise',
       estimator=DecisionTreeClassifier(class_weight=None, criterion='gini',
max_depth=None,
            max_features=None, max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, presort=False, random_state=None,
            splitter='best'),
       fit_params=None, iid=True, n_jobs=1,
       param_grid={'max_depth': [1, 2, 3, 4, 5, 6]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
       scoring=None, verbose=0)
```

In [243]:
```
print("best parameters are:",dtree_grid.best_params_)
print('Best score:', dtree_grid.best_score_)
```

```
best parameters are: {'max_depth': 3}
Best score: 0.9939759036144579
```

In [244]:
```
dtree = DecisionTreeClassifier(max_depth=6, random_state=0)
#goes full length; no early stopping
dtree.fit(X_train_reduced, y_train)
print("Accuracy on training set: {:.3f}".format(dtree.score(X_train_reduced, y
_train)))
print("Accuracy on test set: {:.3f}".format(dtree.score(X_test_reduced, y_test
)))
```

```
Accuracy on training set: 1.000
Accuracy on test set: 1.000
```

In [245]:
```
from sklearn.tree import DecisionTreeClassifier
tree = DecisionTreeClassifier(max_depth=1).fit(X_train_reduced, y_train)
pred_tree = tree.predict(X_test_reduced)
print("Test score: {:.2f}".format(tree.score(X_test_reduced, y_test)))

from sklearn.metrics import confusion_matrix
print("\nDecision tree:")
print(confusion_matrix(y_test, pred_tree))

from sklearn.metrics import classification_report
print(classification_report(y_test, pred_tree, target_names=["0", "1"]))
```

```
Test score: 0.90

Decision tree:
[[79  0]
 [17 70]]
             precision    recall  f1-score   support

          0       0.82      1.00      0.90        79
          1       1.00      0.80      0.89        87

avg / total       0.92      0.90      0.90       166
```

In [ ]:

DEEP LEARNING

MODEL: PERCEPTRON

In [246]:
```
from tensorflow.keras import Sequential
from tensorflow.keras.layers import Dense
```

In [247]:
```
import tensorflow as tf
from tensorflow.keras import Sequential
from tensorflow.keras.layers import Dense
```

In [248]:
```
#step 1: build model
model1 = Sequential()
#input layer
model1.add(Dense(10, input_dim = 9, activation = 'relu'))
#hidden layers
#output layer
model1.add(Dense(1, activation = 'sigmoid'))

#step 2: make computational graph - compile
model1.compile(loss= 'mse' , optimizer = 'adam',metrics = ['accuracy'] )

#step 3: train the model - fit
model1.fit(X_train, y_train, epochs = 50, batch_size = 300)

#step 4: evaluation
```

```
Epoch 1/50
498/498 [==============================] - 0s 266us/sample - loss: 0.2510 - a
cc: 0.5482
Epoch 2/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2500 - ac
c: 0.5502
Epoch 3/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2489 - ac
c: 0.5743
Epoch 4/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2478 - ac
c: 0.5823
Epoch 5/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2468 - ac
c: 0.5884
Epoch 6/50
498/498 [==============================] - 0s 7us/sample - loss: 0.2458 - ac
c: 0.5924
Epoch 7/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2448 - ac
c: 0.5924
Epoch 8/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2439 - ac
c: 0.5924
Epoch 9/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2429 - ac
c: 0.5924
Epoch 10/50
498/498 [==============================] - 0s 9us/sample - loss: 0.2421 - ac
c: 0.5944
Epoch 11/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2412 - ac
c: 0.5964
Epoch 12/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2404 - ac
c: 0.5964
Epoch 13/50
498/498 [==============================] - 0s 11us/sample - loss: 0.2396 - ac
c: 0.5964
Epoch 14/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2388 - ac
c: 0.5964
Epoch 15/50
498/498 [==============================] - 0s 10us/sample - loss: 0.2380 - ac
c: 0.5984
Epoch 16/50
498/498 [==============================] - 0s 10us/sample - loss: 0.2372 - ac
c: 0.5984
Epoch 17/50
498/498 [==============================] - 0s 10us/sample - loss: 0.2363 - ac
c: 0.5984
Epoch 18/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2356 - ac
c: 0.5984
Epoch 19/50
498/498 [==============================] - 0s 9us/sample - loss: 0.2348 - ac
c: 0.5984
```

```
Epoch 20/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2340 - ac
c: 0.6004
Epoch 21/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2333 - ac
c: 0.6004
Epoch 22/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2326 - ac
c: 0.6004
Epoch 23/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2319 - ac
c: 0.6004
Epoch 24/50
498/498 [==============================] - 0s 10us/sample - loss: 0.2311 - ac
c: 0.6004
Epoch 25/50
498/498 [==============================] - 0s 12us/sample - loss: 0.2304 - ac
c: 0.6004
Epoch 26/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2297 - ac
c: 0.6004
Epoch 27/50
498/498 [==============================] - 0s 9us/sample - loss: 0.2290 - ac
c: 0.6004
Epoch 28/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2283 - ac
c: 0.6004
Epoch 29/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2276 - ac
c: 0.6004
Epoch 30/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2269 - ac
c: 0.6004
Epoch 31/50
498/498 [==============================] - 0s 7us/sample - loss: 0.2262 - ac
c: 0.6004
Epoch 32/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2255 - ac
c: 0.6004
Epoch 33/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2249 - ac
c: 0.6004
Epoch 34/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2242 - ac
c: 0.6004
Epoch 35/50
498/498 [==============================] - 0s 5us/sample - loss: 0.2235 - ac
c: 0.6004
Epoch 36/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2228 - ac
c: 0.6004
Epoch 37/50
498/498 [==============================] - 0s 14us/sample - loss: 0.2221 - ac
c: 0.6004
Epoch 38/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2214 - ac
c: 0.6004
```

```
Epoch 39/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2208 - ac
c: 0.6004
Epoch 40/50
498/498 [==============================] - 0s 7us/sample - loss: 0.2201 - ac
c: 0.6004
Epoch 41/50
498/498 [==============================] - 0s 7us/sample - loss: 0.2194 - ac
c: 0.6004
Epoch 42/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2187 - ac
c: 0.6004
Epoch 43/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2181 - ac
c: 0.6004
Epoch 44/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2174 - ac
c: 0.6004
Epoch 45/50
498/498 [==============================] - 0s 4us/sample - loss: 0.2167 - ac
c: 0.6004
Epoch 46/50
498/498 [==============================] - 0s 5us/sample - loss: 0.2160 - ac
c: 0.6004
Epoch 47/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2154 - ac
c: 0.6004
Epoch 48/50
498/498 [==============================] - 0s 6us/sample - loss: 0.2147 - ac
c: 0.6004
Epoch 49/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2140 - ac
c: 0.6004
Epoch 50/50
498/498 [==============================] - 0s 8us/sample - loss: 0.2133 - ac
c: 0.6004
```

Out[248]:
```
<tensorflow.python.keras.callbacks.History at 0x2179ccb7940>
```

In [249]:
```
model1.evaluate(X_train, y_train)
```

```
498/498 [==============================] - 0s 126us/sample - loss: 0.2127 - a
cc: 0.6004
```

Out[249]:
```
[0.21274458554135747, 0.6004016]
```

In [250]:
```
model1.evaluate(X_test, y_test)
```

```
166/166 [==============================] - 0s 32us/sample - loss: 0.2180 - ac
c: 0.5241
```

Out[250]:
```
[0.21796231223158088, 0.52409637]
```

MLP

In [251]:
```
#step 1: build model
model2 = Sequential()
#input layer
model2.add(Dense(20, input_dim = 9, activation = 'relu'))
#hidden layers
model2.add(Dense(10, activation = 'relu'))
model2.add(Dense(5, activation = 'relu'))
#output layer
model2.add(Dense(1, activation = 'sigmoid'))

#step 2: compile the model
model2.compile(loss= 'mse' , optimizer = 'adam',metrics = ['accuracy'] )

#step 3: train the model
model2.fit(X_train, y_train, epochs = 30, batch_size = 150)

#step 4: evaluate
```

```
Epoch 1/30
498/498 [==============================] - 0s 486us/sample - loss: 0.2551 - a
cc: 0.3795
Epoch 2/30
498/498 [==============================] - 0s 14us/sample - loss: 0.2489 - ac
c: 0.6064
Epoch 3/30
498/498 [==============================] - 0s 14us/sample - loss: 0.2436 - ac
c: 0.6807
Epoch 4/30
498/498 [==============================] - 0s 16us/sample - loss: 0.2394 - ac
c: 0.7108
Epoch 5/30
498/498 [==============================] - 0s 14us/sample - loss: 0.2355 - ac
c: 0.7349
Epoch 6/30
498/498 [==============================] - 0s 13us/sample - loss: 0.2319 - ac
c: 0.7490
Epoch 7/30
498/498 [==============================] - 0s 20us/sample - loss: 0.2285 - ac
c: 0.7510
Epoch 8/30
498/498 [==============================] - 0s 13us/sample - loss: 0.2251 - ac
c: 0.7510
Epoch 9/30
498/498 [==============================] - 0s 16us/sample - loss: 0.2218 - ac
c: 0.7490
Epoch 10/30
498/498 [==============================] - 0s 19us/sample - loss: 0.2183 - ac
c: 0.7490
Epoch 11/30
498/498 [==============================] - 0s 16us/sample - loss: 0.2148 - ac
c: 0.7490
Epoch 12/30
498/498 [==============================] - 0s 19us/sample - loss: 0.2113 - ac
c: 0.7992
Epoch 13/30
498/498 [==============================] - 0s 9us/sample - loss: 0.2075 - ac
c: 0.7851
Epoch 14/30
498/498 [==============================] - 0s 12us/sample - loss: 0.2033 - ac
c: 0.7771
Epoch 15/30
498/498 [==============================] - 0s 18us/sample - loss: 0.1989 - ac
c: 0.7771
Epoch 16/30
498/498 [==============================] - 0s 12us/sample - loss: 0.1943 - ac
c: 0.7771
Epoch 17/30
498/498 [==============================] - 0s 14us/sample - loss: 0.1893 - ac
c: 0.7751
Epoch 18/30
498/498 [==============================] - 0s 14us/sample - loss: 0.1840 - ac
c: 0.7751
Epoch 19/30
498/498 [==============================] - 0s 13us/sample - loss: 0.1787 - ac
c: 0.8173
```

```
Epoch 20/30
498/498 [==============================] - 0s 12us/sample - loss: 0.1737 - ac
c: 0.8554
Epoch 21/30
498/498 [==============================] - 0s 10us/sample - loss: 0.1687 - ac
c: 0.8855
Epoch 22/30
498/498 [==============================] - 0s 14us/sample - loss: 0.1635 - ac
c: 0.9016
Epoch 23/30
498/498 [==============================] - 0s 18us/sample - loss: 0.1581 - ac
c: 0.9177
Epoch 24/30
498/498 [==============================] - 0s 17us/sample - loss: 0.1527 - ac
c: 0.9277
Epoch 25/30
498/498 [==============================] - 0s 12us/sample - loss: 0.1475 - ac
c: 0.9337
Epoch 26/30
498/498 [==============================] - 0s 14us/sample - loss: 0.1424 - ac
c: 0.9378
Epoch 27/30
498/498 [==============================] - 0s 12us/sample - loss: 0.1374 - ac
c: 0.9378
Epoch 28/30
498/498 [==============================] - 0s 14us/sample - loss: 0.1328 - ac
c: 0.9378
Epoch 29/30
498/498 [==============================] - 0s 12us/sample - loss: 0.1283 - ac
c: 0.9357
Epoch 30/30
498/498 [==============================] - 0s 13us/sample - loss: 0.1240 - ac
c: 0.9378
```

Out[251]:
```
<tensorflow.python.keras.callbacks.History at 0x2179d63eb00>
```

In [252]:
```
model2.fit(X_train, y_train, epochs = 30, batch_size = 150)
```

```
Epoch 1/30
498/498 [==============================] - 0s 22us/sample - loss: 0.1198 - ac
c: 0.9378
Epoch 2/30
498/498 [==============================] - 0s 12us/sample - loss: 0.1158 - ac
c: 0.9378
Epoch 3/30
498/498 [==============================] - 0s 14us/sample - loss: 0.1119 - ac
c: 0.9378
Epoch 4/30
498/498 [==============================] - 0s 13us/sample - loss: 0.1082 - ac
c: 0.9378
Epoch 5/30
498/498 [==============================] - 0s 15us/sample - loss: 0.1045 - ac
c: 0.9378
Epoch 6/30
498/498 [==============================] - 0s 12us/sample - loss: 0.1012 - ac
c: 0.9418
Epoch 7/30
498/498 [==============================] - 0s 14us/sample - loss: 0.0977 - ac
c: 0.9518
Epoch 8/30
498/498 [==============================] - 0s 16us/sample - loss: 0.0942 - ac
c: 0.9558
Epoch 9/30
498/498 [==============================] - 0s 14us/sample - loss: 0.0908 - ac
c: 0.9578
Epoch 10/30
498/498 [==============================] - 0s 14us/sample - loss: 0.0874 - ac
c: 0.9578
Epoch 11/30
498/498 [==============================] - 0s 15us/sample - loss: 0.0845 - ac
c: 0.9578
Epoch 12/30
498/498 [==============================] - 0s 17us/sample - loss: 0.0817 - ac
c: 0.9598
Epoch 13/30
498/498 [==============================] - 0s 11us/sample - loss: 0.0787 - ac
c: 0.9618
Epoch 14/30
498/498 [==============================] - 0s 14us/sample - loss: 0.0759 - ac
c: 0.9598
Epoch 15/30
498/498 [==============================] - 0s 12us/sample - loss: 0.0730 - ac
c: 0.9598
Epoch 16/30
498/498 [==============================] - 0s 12us/sample - loss: 0.0704 - ac
c: 0.9598
Epoch 17/30
498/498 [==============================] - 0s 12us/sample - loss: 0.0682 - ac
c: 0.9598
Epoch 18/30
498/498 [==============================] - 0s 12us/sample - loss: 0.0661 - ac
c: 0.9618
Epoch 19/30
498/498 [==============================] - 0s 18us/sample - loss: 0.0641 - ac
c: 0.9618
```

```
Epoch 20/30
498/498 [==============================] - 0s 17us/sample - loss: 0.0621 - ac
c: 0.9618
Epoch 21/30
498/498 [==============================] - 0s 12us/sample - loss: 0.0603 - ac
c: 0.9618
Epoch 22/30
498/498 [==============================] - 0s 12us/sample - loss: 0.0584 - ac
c: 0.9639
Epoch 23/30
498/498 [==============================] - 0s 11us/sample - loss: 0.0566 - ac
c: 0.9639
Epoch 24/30
498/498 [==============================] - 0s 12us/sample - loss: 0.0549 - ac
c: 0.9639
Epoch 25/30
498/498 [==============================] - 0s 8us/sample - loss: 0.0532 - ac
c: 0.9639
Epoch 26/30
498/498 [==============================] - 0s 13us/sample - loss: 0.0516 - ac
c: 0.9639
Epoch 27/30
498/498 [==============================] - 0s 16us/sample - loss: 0.0499 - ac
c: 0.9639
Epoch 28/30
498/498 [==============================] - 0s 18us/sample - loss: 0.0484 - ac
c: 0.9639
Epoch 29/30
498/498 [==============================] - 0s 14us/sample - loss: 0.0470 - ac
c: 0.9639
Epoch 30/30
498/498 [==============================] - 0s 12us/sample - loss: 0.0454 - ac
c: 0.9639
```

Out[252]:

```
<tensorflow.python.keras.callbacks.History at 0x2179cb31f98>
```

In [253]:

```
model2.evaluate(X_train, y_train)
```

```
498/498 [==============================] - 0s 148us/sample - loss: 0.0443 - a
cc: 0.9639
```

Out[253]:

```
[0.04431599474336249, 0.96385545]
```

In [254]:

```
model2.evaluate(X_test, y_test)
```

```
166/166 [==============================] - 0s 30us/sample - loss: 0.0425 - ac
c: 0.9819
```

Out[254]:

```
[0.04252205881099385, 0.9819277]
```

CONCLUSION

In [ ]:

The comparision of accuracy scores are tabulated in the file below. We see for many cases, PCA don't necessarily improve the scores, however, it speed up the processing speed and hence is required in datasets with big columns values.

In [256]:
```
PCA = pd.read_csv('PCA comparison.csv')
```

In [257]:
```
PCA
```

Out[257]:

	Model	Regression	Regression with PCA
0	Linear Regression	0.941816678800454\n0.9186754620340319	\n0.9155741910477005 0.8609561054304146
1	Polynomial regression	0.998967852812949 0.99860111895787	0.998746127012955 0.9987362445124777
2	Ridge regression	0.9418 0.9187	0.8979 0.8444
3	Lasso Regression	0.941794184561213 0.9182640925282302	0.9147 0.8572
4	KNN Regression	0.922311941343433 0.8881863460878919	0.950166076462042 0.8710017428478078
5	SVR Linear	0.89534 0.89188	0.901270191163776 0.8299719201171695
6	SVR rbf	0.71018 0.69085	0.9996691509699482\n0.42139847246393225
7	SVR Poly	0.75328 0.82474	0.8848 0.6414
8	NaN	NaN	NaN
9	Model	Classification	Classification with PCA
10	Logistic Regression	0.96 0.97	0.998 0.989
11	Decision Tree	1.00 1.00	1.00 1.00
12	KNN	0.99 1.00	1.00 0.99
13	SVC Linear	0.931726907630522 0.9698795180722891	1.00 1.00
14	SVC rbf	0.931726907630522 0.9397590361445783	1.00 1.00
15	SVC Poly	0.925 0.94	1.00 1.00

We have also made a compariion of the scores of classification files as below

In [258]:
```
prf = pd.read_csv('prf.csv')
```

In [259]:
```
prf
```

Out[259]:

	Unnamed: 0	WITHOUT PCA	Unnamed: 2	Unnamed: 3	WITH PCA	Unnamed: 5	Unnamed: 6
0	NaN	precision	recall	f-1	precision	recall	f-1
1	LOGISTIC	0.97	0.97	0.97	0.92	0.9	0.9
2	KNN	1	1	1	1	1	1
3	SVC LINEAR	0.99	0.99	0.99	0.92	0.9	0.9
4	SVC RBF	0.81	0.76	0.66	1	1	1
5	SVC POLY	0.88	0.87	0.8	1	1	1
6	DECISION TREE	1	1	1	1	1	1