Lab-05_Unsupervised_Anamoly_Detection

321910302051

K.Kalyani

In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
```

In [2]:
```
data=pd.read_csv("creditcard_lab_5.csv")
```

In [3]:
```
data.shape
```

Out[3]:
```
(284807, 31)
```

In [4]:
```
data.head()
```

Out[4]:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	V24	
0	0.0	-1.359807	-0.072781	2.536347	1.378155	-0.338321	0.462388	0.239599	0.098698	0.363787	...	-0.018307	0.277838	-0.110474	0.066928	0.
1	0.0	1.191857	0.266151	0.166480	0.448154	0.060018	-0.082361	-0.078803	0.085102	-0.255425	...	-0.225775	-0.638672	0.101288	-0.339846	0.
2	1.0	-1.358354	-1.340163	1.773209	0.379780	-0.503198	1.800499	0.791461	0.247676	-1.514654	...	0.247998	0.771679	0.909412	-0.689281	-0.
3	1.0	-0.966272	-0.185226	1.792993	-0.863291	-0.010309	1.247203	0.237609	0.377436	-1.387024	...	-0.108300	0.005274	-0.190321	-1.175575	0.
4	2.0	-1.158233	0.877737	1.548718	0.403034	-0.407193	0.095921	0.592941	-0.270533	0.817739	...	-0.009431	0.798278	-0.137458	0.141267	-0.

5 rows × 31 columns

In [5]:
```
data.tail()
```

Out[5]:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	
284802	172786.0	-11.881118	10.071785	-9.834783	-2.066656	-5.364473	-2.606837	-4.918215	7.305334	1.914428	...	0.213454	0.111864	1.014480	-0.5(
284803	172787.0	-0.732789	-0.055080	2.035030	-0.738589	0.868229	1.058415	0.024330	0.294869	0.584800	...	0.214205	0.924384	0.012463	-1.01
284804	172788.0	1.919565	-0.301254	-3.249640	-0.557828	2.630515	3.031260	-0.296827	0.708417	0.432454	...	0.232045	0.578229	-0.037501	0.6
284805	172788.0	-0.240440	0.530483	0.702510	0.689799	-0.377961	0.623708	-0.686180	0.679145	0.392087	...	0.265245	0.800049	-0.163298	0.1
284806	172792.0	-0.533413	-0.189733	0.703337	-0.506271	-0.012546	-0.649617	1.577006	-0.414650	0.486180	...	0.261057	0.643078	0.376777	0.0(

5 rows × 31 columns

In [6]:
```
data.describe()
```

Out[6]:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	
count	284807.000000	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.848070
mean	94813.859575	3.919560e-15	5.688174e-16	-8.769071e-15	2.782312e-15	-1.552563e-15	2.010663e-15	-1.694249e-15	-1.927028e-16	-3.13702
std	47488.145955	1.958696e+00	1.651309e+00	1.516255e+00	1.415869e+00	1.380247e+00	1.332271e+00	1.237094e+00	1.194353e+00	1.098632
min	0.000000	-5.640751e+01	-7.271573e+01	-4.832559e+01	-5.683171e+00	-1.137433e+02	-2.616051e+01	-4.355724e+01	-7.321672e+01	-1.343407
25%	54201.500000	-9.203734e-01	-5.985499e-01	-8.903648e-01	-8.486401e-01	-6.915971e-01	-7.682956e-01	-5.540759e-01	-2.086297e-01	-6.43097
50%	84692.000000	1.810880e-02	6.548556e-02	1.798463e-01	-1.984653e-02	-5.433583e-02	-2.741871e-01	4.010308e-02	2.235804e-02	-5.14287
75%	139320.500000	1.315642e+00	8.037239e-01	1.027196e+00	7.433413e-01	6.119264e-01	3.985649e-01	5.704361e-01	3.273459e-01	5.97139
max	172792.000000	2.454930e+00	2.205773e+01	9.382558e+00	1.687534e+01	3.480167e+01	7.330163e+01	1.205895e+02	2.000721e+01	1.559499

8 rows × 31 columns

In [7]:
```
data.info
```

Out[7]:
```
<bound method DataFrame.info of            Time         V1         V2        V3        V4        V5  \
0             0.0  -1.359807  -0.072781  2.536347  1.378155 -0.338321
1             0.0   1.191857   0.266151  0.166480  0.448154  0.060018
2             1.0  -1.358354  -1.340163  1.773209  0.379780 -0.503198
```

```
3            1.0  -0.966272  -0.185226  1.792993 -0.863291 -0.010309
4            2.0  -1.158233   0.877737  1.548718  0.403034 -0.407193
...          ...        ...        ...       ...       ...       ...
284802  172786.0 -11.881118  10.071785 -9.834783 -2.066656 -5.364473
284803  172787.0  -0.732789  -0.055080  2.035030 -0.738589  0.868229
284804  172788.0   1.919565  -0.301254 -3.249640 -0.557828  2.630515
284805  172788.0  -0.240440   0.530483  0.702510  0.689799 -0.377961
284806  172792.0  -0.533413  -0.189733  0.703337 -0.506271 -0.012546

              V6        V7        V8        V9  ...       V21       V22  \
0       0.462388  0.239599  0.098698  0.363787  ... -0.018307  0.277838
1      -0.082361 -0.078803  0.085102 -0.255425  ... -0.225775 -0.638672
2       1.800499  0.791461  0.247676 -1.514654  ...  0.247998  0.771679
3       1.247203  0.237609  0.377436 -1.387024  ... -0.108300  0.005274
4       0.095921  0.592941 -0.270533  0.817739  ... -0.009431  0.798278
...          ...       ...       ...       ...  ...       ...       ...
284802 -2.606837 -4.918215  7.305334  1.914428  ...  0.213454  0.111864
284803  1.058415  0.024330  0.294869  0.584800  ...  0.214205  0.924384
284804  3.031260 -0.296827  0.708417  0.432454  ...  0.232045  0.578229
284805  0.623708 -0.686180  0.679145  0.392087  ...  0.265245  0.800049
284806 -0.649617  1.577006 -0.414650  0.486180  ...  0.261057  0.643078

             V23       V24       V25       V26       V27       V28  Amount  \
0      -0.110474  0.066928  0.128539 -0.189115  0.133558 -0.021053  149.62
1       0.101288 -0.339846  0.167170  0.125895 -0.008983  0.014724    2.69
2       0.909412 -0.689281 -0.327642 -0.139097 -0.055353 -0.059752  378.66
3      -0.190321 -1.175575  0.647376 -0.221929  0.062723  0.061458  123.50
4      -0.137458  0.141267 -0.206010  0.502292  0.219422  0.215153   69.99
...          ...       ...       ...       ...       ...       ...     ...
284802  1.014480 -0.509348  1.436807  0.250034  0.943651  0.823731    0.77
284803  0.012463 -1.016226 -0.606624 -0.395255  0.068472 -0.053527   24.79
284804 -0.037501  0.640134  0.265745 -0.087371  0.004455 -0.026561   67.88
284805 -0.163298  0.123205 -0.569159  0.546668  0.108821  0.104533   10.00
284806  0.376777  0.008797 -0.473649 -0.818267 -0.002415  0.013649  217.00

        Class
0           0
1           0
2           0
3           0
4           0
...       ...
284802      0
284803      0
284804      0
284805      0
284806      0
```

```
[284807 rows x 31 columns]>
```

In [8]:
```
data.nunique()
```

Out[8]:
```
Time      124592
V1        275663
V2        275663
V3        275663
V4        275663
V5        275663
V6        275663
V7        275663
V8        275663
V9        275663
V10       275663
V11       275663
V12       275663
V13       275663
V14       275663
V15       275663
V16       275663
V17       275663
V18       275663
V19       275663
V20       275663
V21       275663
V22       275663
V23       275663
V24       275663
V25       275663
V26       275663
V27       275663
V28       275663
Amount     32767
Class          2
dtype: int64
```

In [9]:
```
data['V10'].unique()
```

Out[9]:
```
array([ 0.09079417, -0.16697441,  0.20764287, ..., -0.48478176,
       -0.39912565, -0.91542665])
```

In [10]:
```
data['Amount'].unique()
```

Out[10]:
```
array([149.62,   2.69, 378.66, ..., 381.05, 337.54,  95.63])
```

In [11]:
```
data.isnull().sum()
```

Out[11]:
```
Time      0
V1        0
V2        0
V3        0
V4        0
V5        0
V6        0
V7        0
V8        0
V9        0
V10       0
V11       0
V12       0
V13       0
V14       0
V15       0
V16       0
V17       0
V18       0
V19       0
V20       0
V21       0
V22       0
V23       0
V24       0
V25       0
V26       0
V27       0
V28       0
Amount    0
Class     0
dtype: int64
```

In [12]:
```
data.isnull()
```

Out[12]:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	V24	V25	V26	V27	V28	Amount	Class
0	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	V24	V25	V26	V27	V28	Amount	Class
4	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
284802	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
284803	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
284804	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
284805	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
284806	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False

284807 rows × 31 columns

In [13]:
```
data.notnull().head()
```

Out[13]:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	V24	V25	V26	V27	V28	Amount	Class
0	True	True	True	True	True	True	True	True	True	True	...	True	True	True	True	True	True	True	True	True	True
1	True	True	True	True	True	True	True	True	True	True	...	True	True	True	True	True	True	True	True	True	True
2	True	True	True	True	True	True	True	True	True	True	...	True	True	True	True	True	True	True	True	True	True
3	True	True	True	True	True	True	True	True	True	True	...	True	True	True	True	True	True	True	True	True	True
4	True	True	True	True	True	True	True	True	True	True	...	True	True	True	True	True	True	True	True	True	True

5 rows × 31 columns

In [14]:
```
data.notnull().sum()
```

Out[14]:
```
Time      284807
V1        284807
V2        284807
V3        284807
V4        284807
V5        284807
V6        284807
V7        284807
```

```
V8        284807
V9        284807
V10       284807
V11       284807
V12       284807
V13       284807
V14       284807
V15       284807
V16       284807
V17       284807
V18       284807
V19       284807
V20       284807
V21       284807
V22       284807
V23       284807
V24       284807
V25       284807
V26       284807
V27       284807
V28       284807
Amount    284807
Class     284807
dtype: int64
```

In [15]:
```
data.dropna()
```

Out[15]:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	
0	0.0	-1.359807	-0.072781	2.536347	1.378155	-0.338321	0.462388	0.239599	0.098698	0.363787	...	-0.018307	0.277838	-0.110474	0
1	0.0	1.191857	0.266151	0.166480	0.448154	0.060018	-0.082361	-0.078803	0.085102	-0.255425	...	-0.225775	-0.638672	0.101288	-0
2	1.0	-1.358354	-1.340163	1.773209	0.379780	-0.503198	1.800499	0.791461	0.247676	-1.514654	...	0.247998	0.771679	0.909412	-0
3	1.0	-0.966272	-0.185226	1.792993	-0.863291	-0.010309	1.247203	0.237609	0.377436	-1.387024	...	-0.108300	0.005274	-0.190321	-1
4	2.0	-1.158233	0.877737	1.548718	0.403034	-0.407193	0.095921	0.592941	-0.270533	0.817739	...	-0.009431	0.798278	-0.137458	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
284802	172786.0	-11.881118	10.071785	-9.834783	-2.066656	-5.364473	-2.606837	-4.918215	7.305334	1.914428	...	0.213454	0.111864	1.014480	-0
284803	172787.0	-0.732789	-0.055080	2.035030	-0.738589	0.868229	1.058415	0.024330	0.294869	0.584800	...	0.214205	0.924384	0.012463	-1
284804	172788.0	1.919565	-0.301254	-3.249640	-0.557828	2.630515	3.031260	-0.296827	0.708417	0.432454	...	0.232045	0.578229	-0.037501	0
284805	172788.0	-0.240440	0.530483	0.702510	0.689799	-0.377961	0.623708	-0.686180	0.679145	0.392087	...	0.265245	0.800049	-0.163298	0

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	
284806	172792.0	-0.533413	-0.189733	0.703337	-0.506271	-0.012546	-0.649617	1.577006	-0.414650	0.486180	...	0.261057	0.643078	0.376777	0

284807 rows × 31 columns

In [16]:
```
data1=data.dropna()
```

In [17]:
```
data1.isnull()
```

Out[17]:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	V24	V25	V26	V27	V28	Amount	Class
0	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
4	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
284802	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
284803	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
284804	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
284805	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
284806	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False

284807 rows × 31 columns

In [18]:
```
import pandas as pd
import numpy as np
import math
import random
%matplotlib inline
import random
```

```
from matplotlib import pyplot
import os
```

Anomaly Detection Algorithms: Isolation

Forest vs the Rest

Isolation Forests in Python

1. Forest
2. Isolation Tree
3. Evaluation (Path Length)

In [20]:
```
class ExNode:
 def __init__(self,size):
     self.size=size

class InNode:
 def __init__(self,left,right,splitAtt,splitVal):
     self.left=left
     self.right=right
     self.splitAtt=splitAtt
     self.splitVal=splitVal
```

FOREST

In [23]:
```
def iForest(X,noOfTrees,sampleSize):
     forest=[]
     hlim=math.ceil(math.log(sampleSize,2))
     for i in range(noOfTrees):
        X_train=X.sample(sampleSize)
        forest.append(iTree(X_train,0,hlim))
     return forest
```

ISOLATION TREE

In [24]:
```
def iTree(X,currHeight,hlim):
    if currHeight>=hlim or len(X)<=1:
        return ExNode(len(X))
    else:
        Q=X.columns
        q=random.choice(Q)
        p=random.choice(X[q].unique())
        X_l=X[X[q]<p]
        X_r=X[X[q]>=p]
        return InNode(iTree(X_l,currHeight+1,hlim),iTree(X_r,currHeight+1,hlim),q,p)
```

PATH LENGTH

In [25]:
```
def pathLength(x,Tree,currHeight):
    if isinstance(Tree,ExNode):
        return currHeight
    a=Tree.splitAtt
    if x[a]<Tree.splitVal:
        return pathLength(x,Tree.left,currHeight+1)
    else:
        return pathLength(x,Tree.right,currHeight+1)
```

TEST RUN

In [26]:
```
df=pd.read_csv("creditcard_lab_5.csv")
y_true=df['Class']
df_data=df.drop('Class',1)
```

CREATING THE FOREST

In [27]:
```
sampleSize=10000
ifor=iForest(df_data.sample(100000),10,sampleSize)
```

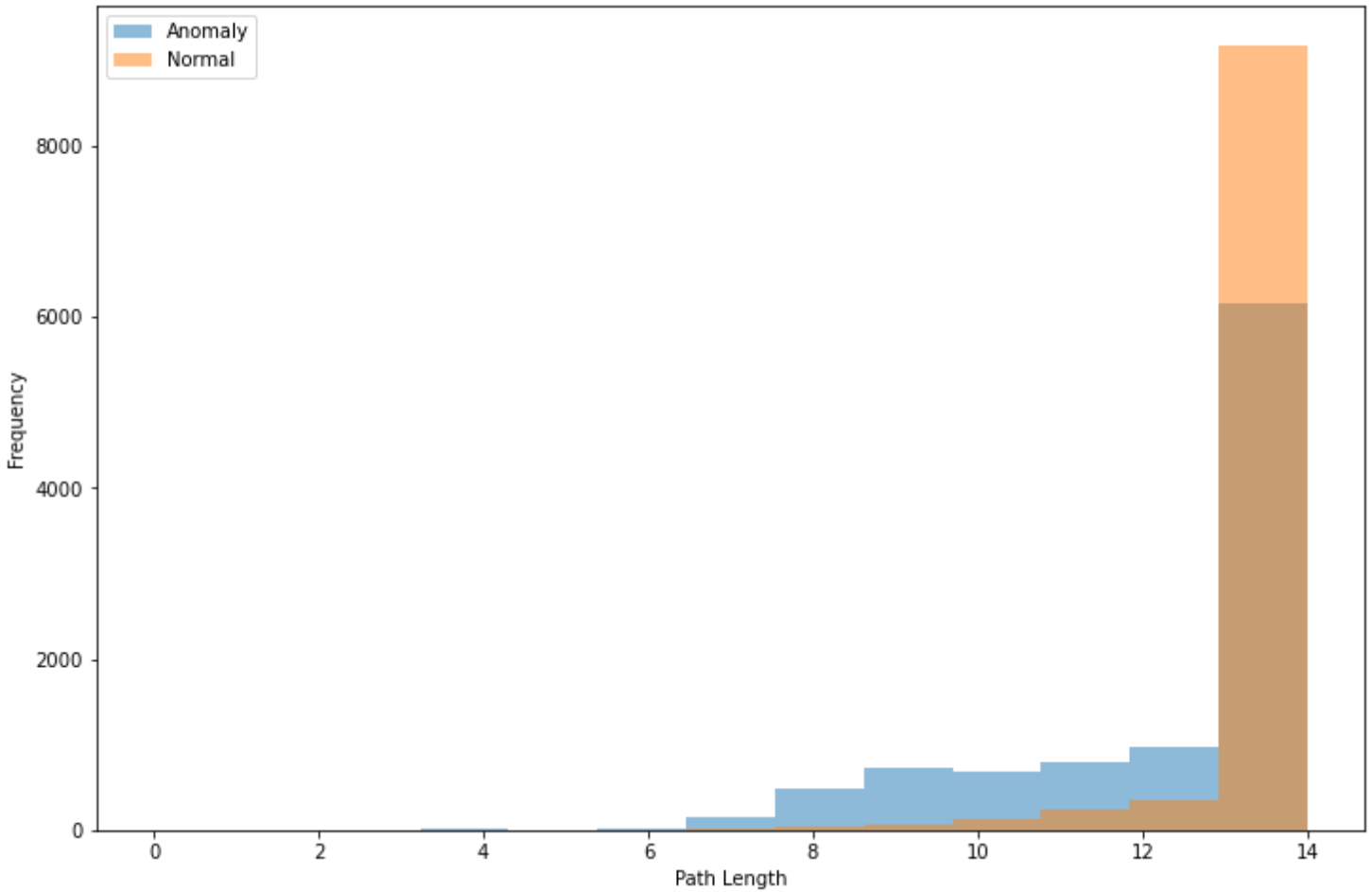
Selecting1000 random datapoints to get their path lengths. The purpose for this is to plot and see if anomalies actually have shorter path lengths.

In [28]:
```
posLenLst=[]
negLenLst=[]
for sim in range(1000):
     ind=random.choice(df_data[y_true==1].index)
     for tree in ifor:
         posLenLst.append(pathLength(df_data.iloc[ind],tree,0))

     ind=random.choice(df_data[y_true==0].index)
     for tree in ifor:
         negLenLst.append(pathLength(df_data.iloc[ind],tree,0))
```

Plotting the Path Lengths

In [32]:
```
bins = np.linspace(0,math.ceil(math.log(sampleSize,2)), math.ceil(math.log(sampleSize,2)))

pyplot.figure(figsize=(12,8))
pyplot.hist(posLenLst, bins, alpha=0.5, label='Anomaly')
pyplot.hist(negLenLst, bins, alpha=0.5, label='Normal')
pyplot.xlabel('Path Length')
pyplot.ylabel('Frequency')
pyplot.legend(loc='upper left')
```

Out[32]:
```
<matplotlib.legend.Legend at 0x1b92df25b20>
```


Anomaly
Normal
Frequency
Path Length
0
2000
4000
6000
8000
0
2
4
6
8
10
12
14

In [ ]: