[ ]:

```
Summary :

    Training Accuracy : 0.99

    Testing Accuracy: 0.99

    No. of iteration to converge : 200

    Do you think your model overfits?
    -> No the model does not over fit


    Features with highest absoulute weight :
    -> 'dst_host_srv_serror_rate', 'serror_rate', 'dst_host_rerror_rate'


    Show how the train and test accuracy varies with different regularization␣
 ↪strengths.
    -> Different regularizations and solver combination tried tried using 'penalty = '␣
 ↪and 'solver ='.
    With the increase in strength , the convergence decreases
```

[14]:

```
import numpy as np
import pandas as pd

features =␣
 ↪['duration','protocol_type','service','flag','src_bytes','dst_bytes','land','wrong_fragment','u
'hot','num_failed_logins','logged_in','num_compromised','root_shell','su_attempted','num_root','nu
'num_shells','num_access_files','num_outbound_cmds','is_host_login','is_guest_login','count','srv_
'serror_rate','srv_serror_rate','rerror_rate','srv_rerror_rate','same_srv_rate','diff_srv_rate','s
'dst_host_count','dst_host_srv_count','dst_host_same_srv_rate','dst_host_diff_srv_rate','dst_host_
'dst_host_srv_diff_host_rate','dst_host_serror_rate','dst_host_srv_serror_rate','dst_host_rerror_r
'label']

#intrusion_type = ['back','buffer_overflow','ftp_write',
 #'guess_passwd','imap,ipsweep','land,loadmodule',
 #'multihop,neptune','nmap,normal','perl',
 #'phf','pod','portsweep','rootkit',
 #'satan','smurf','spy','teardrop',
 #'warezclient','warezmaster']
```

[15]:

```
data = pd.read_csv('kddcup.data', names = features, header=None)
data.drop(data.loc[data['label']=='normal.'].index, inplace=True)
```

Converting the label probe/non probe to 0 and 1

[16]:

```
l_nprobe = ['back.','buffer_overflow.','ftp_write.','guess_passwd.','imap.','land.
 ↪','loadmodule.','multihop.','neptune.','perl.','phf.','pod.','rootkit.','smurf.
 ↪','spy.','teardrop.','warezclient.','warezmaster.']
l_probe = ['ipsweep.','nmap.','portsweep.','satan.']
```

```
#0 if normal , 1 if non-probe , 2 if probe


data['label'] = data['label'].apply(lambda x: 2 if x == 'normal.' else (0 if (x in␣
 ↪l_nprobe ) else 1))

# Get unique labels : print(data['label'].unique())
# Review the columns which might need integer encoding data.dtypes
```

[17]:

```
from sklearn.preprocessing import LabelEncoder
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import cross_val_score

from sklearn.preprocessing import OneHotEncoder
from sklearn.compose import make_column_transformer
```

One Hot Encoding the columns

[18]:

```
protocol_end = pd.get_dummies(data.protocol_type)
service_end = pd.get_dummies(data.service)
flag = pd.get_dummies(data.flag)
```

[27]:

```
data_encoded = pd.concat([data,protocol_end,service_end,flag],axis = 'columns')
```

[29]:

```
data_encoded_final = data_encoded.drop(['protocol_type','flag','service'],axis =␣
 ↪'columns')
#data_encoded.drop('service',axis = 'columns')
#data_encoded.drop('flag',axis = 'columns')
```

le = LabelEncoder() protocol_end = le.fit_transform(data[‘protocol_type’]) data.drop(‘protocol_type’,axis = ‘columns’) data[‘protocol_type’] = protocol_end

le1 = LabelEncoder() service_end = le1.fit_transform(data[‘service’]) data.drop(‘service’,axis = ‘columns’) data[‘service’] = service_end

le2 = LabelEncoder() flag_end = le2.fit_transform(data[‘flag’]) data.drop(‘flag’,axis = ‘columns’) data[‘flag’] = flag_end

if validation of what all categories were mapped is needed

#le1.classes_ #le2.classes_

#Quick look at how the data looks #data.head(10) #data.dtypes #data.drop_duplicates(subset=features, keep=‘first’, inplace = True)

#Save the data to a pickle file to avoid reprocessing and enable restartability #data.to_pickle(‘data.pkl’)

X and y being created

[31]:

```
X = data_encoded_final.drop('label',axis = 'columns')
y =  data_encoded_final.label

# validate if X and y have same rows # y.shape
```

[33]:

```
y.shape
```

[33]:

```
(3925650,)
```

Test and Training Split and Scaling the data

[34]:

```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler


X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=1, stratify=y)


sc = StandardScaler()
sc.fit(X_train)

X_train_std = sc.transform(X_train)
X_test_std = sc.transform(X_test)

print('Labels count in y:', np.bincount(y))
print('Labels count in y_train:', np.bincount(y_train))

print('Labels count in y_test:', np.bincount(y_test))
```

```
Labels count in y: [3884548   41102]
Labels count in y_train: [3107638   32882]
Labels count in y_test: [776910   8220]
```

Logistic Regression using Scikit learn

[40]:

```
logreg = LogisticRegression(C=1e10, solver='lbfgs', multi_class='ovr',penalty = 'l2'␣
 ↪,max_iter = 1000 , random_state = 1)
logreg.fit(X_train_std, y_train)

#logreg.fit(X_train_std, y_train)
```

```
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/linear_model/logistic.py:947: ConvergenceWarning: lbfgs failed to
converge. Increase the number of iterations.
  "of iterations.", ConvergenceWarning)
```

[40]:

```
LogisticRegression(C=10000000000.0, class_weight=None, dual=False,
                   fit_intercept=True, intercept_scaling=1, l1_ratio=None,
                   max_iter=1000, multi_class='ovr', n_jobs=None, penalty='l2',
                   random_state=1, solver='lbfgs', tol=0.0001, verbose=0,
                   warm_start=False)
```

Training and Test Error

[37]:
```
y_pred = logreg.predict(X_test_std)
print('Misclassified examples: %d' % (y_test != y_pred).sum())
```

```
Misclassified examples: 12
```

[38]:
```
from sklearn.metrics import accuracy_score
print('Accuracy: %.3f' % accuracy_score(y_test, y_pred))
```

```
Accuracy: 1.000
```

Number of Iterations to Converge

[39]:
```
print(logreg.n_iter_)
```

```
[200]
```

Plottting the features with highest absoulute weight

[41]:
```
import numpy as np
import matplotlib.pyplot as plt

# We create a matrix with all the labels
x_labels_w = X.columns[1:]
Xw = np.array(X[x_labels_w].values)
print(Xw)
print("The matrix dimensions of Xw is " + str(Xw.shape))
```

```
[[1.511e+03 2.957e+03 0.000e+00 … 0.000e+00 1.000e+00 0.000e+00]
 [1.735e+03 2.766e+03 0.000e+00 … 0.000e+00 1.000e+00 0.000e+00]
 [2.810e+02 1.301e+03 0.000e+00 … 0.000e+00 1.000e+00 0.000e+00]
 …
 [2.800e+01 0.000e+00 0.000e+00 … 0.000e+00 1.000e+00 0.000e+00]
 [2.800e+01 0.000e+00 0.000e+00 … 0.000e+00 1.000e+00 0.000e+00]
 [2.800e+01 0.000e+00 0.000e+00 … 0.000e+00 1.000e+00 0.000e+00]]
The matrix dimensions of Xw is (3925650, 117)
```

[42]:
```
# For plotting in the Jupyter Notebook environment as an inline output
%matplotlib inline
```

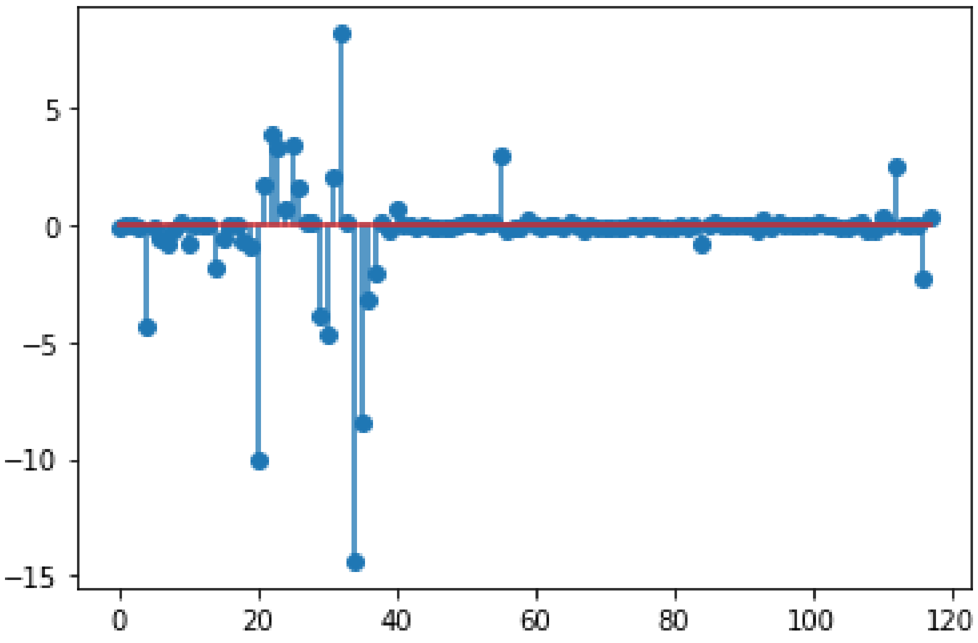
[43]:
```
# By default, LogisticRegression() is set on penalty as L2 and C=1.
# To simulate no regularization, we will select a large C to minimize regularization␣
 ↪to later
# show the effect of regularization

#logreg_w=LogisticRegression(C=1e10,solver = 'lbfgs')

#logreg_w.fit(Xw,y)

W=logreg.coef_

W=W.flatten()
```

```
plt.stem(W)
```

```
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:12:
UserWarning: In Matplotlib 3.3 individual lines on a stem plot will be added as a
LineCollection instead of individual lines. This significantly improves the performance
of a stem plot. To remove this warning and switch to the new behaviour, set the
"use_line_collection" keyword argument to True.
  if sys.path[0] == '':
```

[43]:

```
<StemContainer object of 3 artists>
```



[44]:

```
idx1=np.argsort(np.abs(W))[-1]
idx2=np.argsort(np.abs(W))[-2]
idx3=np.argsort(np.abs(W))[-3]

heavy=[x_labels_w[idx1], x_labels_w[idx2],x_labels_w[idx3]]
heavy
```

[44]:

```
['dst_host_srv_serror_rate', 'serror_rate', 'dst_host_rerror_rate']
```

[ ]: