```
from math import e

class Node:



    def __init__(self, x, gradient, hessian, idxs, subsample_cols = 0.8 , min_leaf

        self.x, self.gradient, self.hessian = x, gradient, hessian
        self.idxs = idxs
        self.depth = depth
        self.min_leaf = min_leaf
        self.lambda_ = lambda_
        self.gamma  = gamma
        self.min_child_weight = min_child_weight
        self.row_count = len(idxs)
        self.col_count = x.shape[1]
        self.subsample_cols = subsample_cols
        self.eps = eps
        self.column_subsample = np.random.permutation(self.col_count)[:round(self.s

        self.val = self.compute_gamma(self.gradient[self.idxs], self.hessian[self.i

        self.score = float('-inf')
        self.find_varsplit()
    def compute_gamma(self, gradient, hessian):

        return(-np.sum(gradient)/(np.sum(hessian) + self.lambda_))
    def find_varsplit(self):

        for c in self.column_subsample: self.find_greedy_split(c)
        if self.is_leaf: return
        x = self.split_col
        lhs = np.nonzero(x <= self.split)[0]
        rhs = np.nonzero(x > self.split)[0]
        self.lhs = Node(x = self.x, gradient = self.gradient, hessian = self.hessia
        self.rhs = Node(x = self.x, gradient = self.gradient, hessian = self.hessia

    def find_greedy_split(self, var_idx):

        x = self.x.values[self.idxs, var_idx]

        for r in range(self.row_count):
            lhs = x <= x[r]
            rhs = x > x[r]

            lhs_indices = np.nonzero(x <= x[r])[0]
            rhs_indices = np.nonzero(x > x[r])[0]
            if(rhs.sum() < self.min_leaf or lhs.sum() < self.min_leaf
```

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```
               or self.hessian[rhs_indices].sum() < self.min_child_weight): continu

            curr_score = self.gain(lhs, rhs)
            if curr_score > self.score:
                self.var_idx = var_idx
                self.score = curr_score
                self.split = x[r]
    def weighted_qauntile_sketch(self, var_idx):

        x = self.x.values[self.idxs, var_idx]
        hessian_ = self.hessian[self.idxs]
        df = pd.DataFrame({'feature':x,'hess':hessian_})

        df.sort_values(by=['feature'], ascending = True, inplace = True)
        hess_sum = df['hess'].sum()
        df['rank'] = df.apply(lambda x : (1/hess_sum)*sum(df[df['feature'] < x['fea

        for row in range(df.shape[0]-1):
            # look at the current rank and the next ran
            rk_sk_j, rk_sk_j_1 = df['rank'].iloc[row:row+2]
            diff = abs(rk_sk_j - rk_sk_j_1)
            if(diff >= self.eps):
                continue

            split_value = (df['rank'].iloc[row+1] + df['rank'].iloc[row])/2
            lhs = x <= split_value
            rhs = x > split_value

            lhs_indices = np.nonzero(x <= split_value)[0]
            rhs_indices = np.nonzero(x > split_value)[0]
            if(rhs.sum() < self.min_leaf or lhs.sum() < self.min_leaf
               or self.hessian[lhs_indices].sum() < self.min_child_weight
               or self.hessian[rhs_indices].sum() < self.min_child_weight): continu

            curr_score = self.gain(lhs, rhs)
            if curr_score > self.score:
                self.var_idx = var_idx
                self.score = curr_score
                self.split = split_value

    def gain(self, lhs, rhs):

        gradient = self.gradient[self.idxs]
        hessian  = self.hessian[self.idxs]

        lhs_gradient = gradient[lhs].sum()
        lhs_hessian  = hessian[lhs].sum()

        rhs_gradient = gradient[rhs].sum()
        rhs_hessian  = hessian[rhs].sum()
```

```
        lhs_hessian = hessian[lhs].sum()

        gain = 0.5 *( (lhs_gradient**2/(lhs_hessian + self.lambda_)) + (rhs_gradien
        return(gain)
    @property
    def split_col(self):

        return self.x.values[self.idxs , self.var_idx]

    @property
    def is_leaf(self):

        return self.score == float('-inf') or self.depth <= 0
    def predict(self, x):
        return np.array([self.predict_row(xi) for xi in x])

    def predict_row(self, xi):
        if self.is_leaf:
            return(self.val)

        node = self.lhs if xi[self.var_idx] <= self.split else self.rhs
        return node.predict_row(xi)


class XGBoostTree:

    def fit(self, x, gradient, hessian, subsample_cols = 0.8 , min_leaf = 5, min_ch
        self.dtree = Node(x, gradient, hessian, np.array(np.arange(len(x))), subsam
        return self

    def predict(self, x):
        return self.dtree.predict(X.values)


class XGBClassifier:

    def __init__(self):
        self.estimators = []

    @staticmethod
    def sigmoid(x):
        return 1 / (1 + np.exp(-x))

    # first order gradient logLoss
    def grad(self, preds, labels):
        preds = self.sigmoid(preds)
        return(preds - labels)

    # second order gradient logLoss
    def hess(self, preds, labels):
        preds = self.sigmoid(preds)
```

```
        return(preds * (1 - preds))
    @staticmethod
    def log_odds(column):
        binary_yes = np.count_nonzero(column == 1)
        binary_no  = np.count_nonzero(column == 0)
        return(np.log(binary_yes/binary_no))


    def fit(self, x, y, subsample_cols = 0.8 , min_child_weight = 1, depth = 5, min

        self.x, self.y = x, y.values
        self.depth = depth
        self.subsample_cols = subsample_cols
        self.eps = eps
        self.min_child_weight = min_child_weight
        self.min_leaf = min_leaf
        self.learning_rate = learning_rate
        self.boosting_rounds = boosting_rounds
        self.lambda_ = lambda_
        self.gamma  = gamma

        self.base_pred = np.full((x.shape[0], 1), 1).flatten().astype('float64')

        for booster in range(self.boosting_rounds):
            Grad = self.grad(self.base_pred, self.y)
            Hess = self.hess(self.base_pred, self.y)
            boosting_tree = XGBoostTree().fit(self.x, Grad, Hess, depth = self.dept
            self.base_pred += self.learning_rate * boosting_tree.predict(self.x)
            self.estimators.append(boosting_tree)
    def predict_proba(self, x):
        pred = np.zeros(x.shape[0])

        for estimator in self.estimators:
            pred += self.learning_rate * estimator.predict(x)

        return(self.sigmoid(np.full((x.shape[0], 1), 1).flatten().astype('float64')

    def predict(self, x):
        pred = np.zeros(x.shape[0])
        for estimator in self.estimators:
            pred += self.learning_rate * estimator.predict(x)

        predicted_probas = self.sigmoid(np.full((x.shape[0], 1), 1).flatten().astyp
        preds = np.where(predicted_probas > np.mean(predicted_probas), 1, 0)
        return(preds)
```

Double-click (or enter) to edit

```
import numpy as np
```

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sn
import warnings
warnings.filterwarnings('ignore')

data1=pd.read_csv('/content/drive/MyDrive/Half_Data/ack_h.csv')
data2=pd.read_csv('/content/drive/MyDrive/Half_Data/benign_traffic_h.csv')
data3=pd.read_csv('/content/drive/MyDrive/Half_Data/combo_h.csv')
data4=pd.read_csv('/content/drive/MyDrive/Half_Data/junk_h.csv')
data5=pd.read_csv('/content/drive/MyDrive/Half_Data/scan_h.csv')
data6=pd.read_csv('/content/drive/MyDrive/Half_Data/syn_h.csv')
data7=pd.read_csv('/content/drive/MyDrive/Half_Data/tcp_h.csv')
data8=pd.read_csv('/content/drive/MyDrive/Half_Data/udp_h.csv')
data9=pd.read_csv('/content/drive/MyDrive/Half_Data/udpplain_h.csv')


data1['class']='ack'
data2['class']='benign_traffic'
data3['class']='scan'
data4['class']='junk'
data5['class']='scan'
data6['class']='syn'
data7['class']='tcp'
data8['class']='udp'
data9['class']='udpplain'

data=pd.concat([data1,data2,data3,data4,data5,data6,data7,data8,data9],
               axis=0, sort=False, ignore_index=True)

data.groupby('class')['class'].count()
data
```

	MI_dir_L5_weight	MI_dir_L5_mean	MI_dir_L5_variance	MI_dir_L3_weight
0	1.000000	566.000000	0.000000e+00	1.000000
1	1.996585	566.000000	5.820000e-11	1.997950
2	2.958989	566.000000	0.000000e+00	2.975291
3	3.958979	566.000000	0.000000e+00	3.975285
4	4.914189	566.000000	1.160000e-10	4.948239
...	...	...	...	...
813555	107.013362	451.270414	4.019486e+04	177.665918
813556	108.012301	452.221506	3.991953e+04	178.664861
813557	108.716218	453.157691	3.964675e+04	179.370847
813558	109.580657	454.077947	3.937690e+04	180.236616

813559	109.981077	454.986486	3.910882e+04	180.644259

813560 rows × 116 columns

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
```

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
data["class"]= le.fit_transform(data["class"])
from sklearn.model_selection import train_test_split
```

```
target = "class"

y = data[target]

x = data.drop(target,axis = 1)
```

```
x.shape
```

```
(813560, 115)
```

```
x.head()
```

	MI_dir_L5_weight	MI_dir_L5_mean	MI_dir_L5_variance	MI_dir_L3_weight	MI_c
0	1.000000	566.0	0.000000e+00	1.000000	
1	1.996585	566.0	5.820000e-11	1.997950	
2	2.958989	566.0	0.000000e+00	2.975291	
3	3.958979	566.0	0.000000e+00	3.975285	
4	4.914189	566.0	1.160000e-10	4.948239	

5 rows × 115 columns

Remove correlated features

Remove correlated features

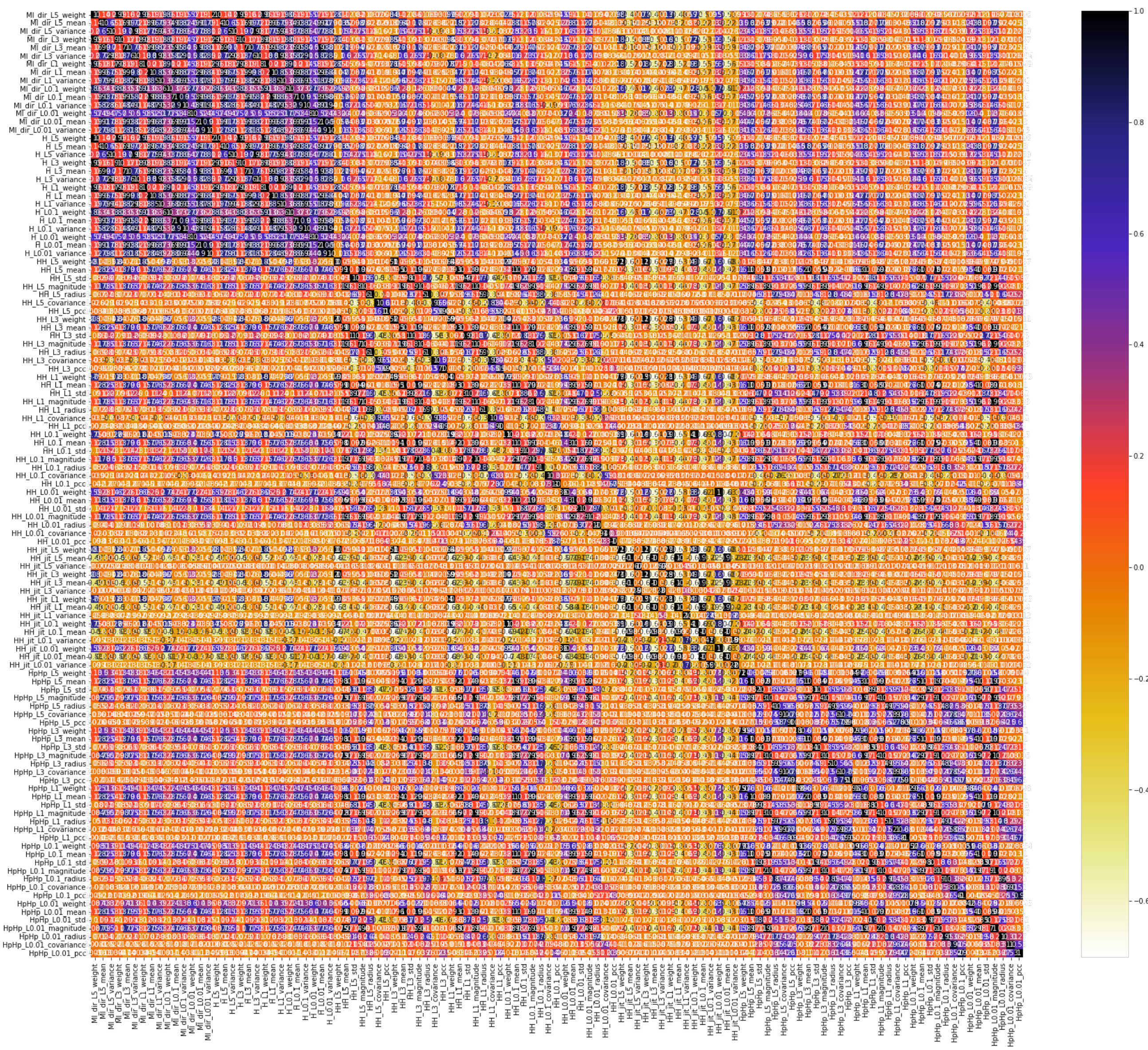
```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.3,random_state=
```

```
x_train.shape, x_test.shape
```

```
((569492, 115), (244068, 115))
```

check the pearson correaltion on "X_train" data only

```
import seaborn as sns
plt.figure(figsize=(30,25))
cor = x_train.corr()
sns.heatmap(cor, annot=True, cmap=plt.cm.CMRmap_r)
plt.show()
```



select highly correlated features

```
def correlation(dataset, threshold):
    col_corr = set()
    corr_matrix = dataset.corr()
    for i in range(len(corr_matrix.columns)):
        for j in range(i):
            if abs(corr_matrix.iloc[i,j]) > threshold:
                colname = corr_matrix.columns[i]
                col_corr.add(colname)
    return col_corr
```

```
corr_features = correlation(x_train, 0.8)
len(set(corr_features))
print("correlated features: ", len(set(corr_features)))
```

```
    correlated features:  95
```

```
print("correlated features are: ", corr_features )
```

```
    correlated features are:  {'H_L5_weight', 'HH_L0.01_mean', 'HpHp_L1_magnitude'
```

```
x_train.shape
```

```
    (569492, 115)
```

```
x_train_noncorr = x_train.drop(corr_features, axis=1)
```

```
x_train_noncorr.shape
```

```
(569492, 20)
```

```
x_test_noncorr = x_test.drop(corr_features, axis =1)
```

```
x_test_noncorr.shape
```

```
(244068, 20)
```

```
y_train.shape
```

```
(569492,)
```

```
x_train.shape, y_train.shape
```

```
((569492, 115), (569492,))
```

```
x_train_noncorr.shape, x_test_noncorr.shape
```

```
((569492, 20), (244068, 20))
```

```
import datetime
start = datetime.datetime.now()
model_ncr = XGBClassifier()
model_ncr.fit(x_train_noncorr, y_train)
end = datetime.datetime.now()
print("Total execution time on 20 features: ", end-start)
```

```
from sklearn.metrics import confusion_matrix,classification_report,accuracy_score
y_pred_ncr = model_ncr.predict(x_test_noncorr)

print("Accuracy score on 20 features: ", accuracy_score(y_test,y_pred_ncr)*100)
print("Confusion matrix:\n ", confusion_matrix(y_test,y_pred_ncr))

print("Corect prediction are: ",sum(y_test == y_pred_ncr))
print("Incorrect predictions are :", sum(y_test!= y_pred_ncr))
```

```
Accuracy score on 20 features:  54.44444444444444
Confusion matrix:
  [[27  0  0]
 [ 2 22  0]
 [ 0 39  0]]
Corect prediction are:  49
```

```
Corect prediction are:  49
Incorrect predictions are : 41
```

```
confusion_m =  pd.crosstab(y_test,model_ncr.predict(x_test_noncorr))

print("Accuracy is: ",(np.diag(confusion_m).sum()/confusion_m.sum().sum())*100)

fig = plt.figure(figsize=(10,5))

sn.heatmap(confusion_m,annot=True,cmap='Blues')
```