Passion_v5.1

July 20, 2020

1 Welcome to Passion!

Passion is a model that can detection anomaly using different methods (Both supervised and unsupervised)

1. The goal for this project is to study the difference between different anomnaly detection model, and to find the state of art method for detecting anomaly in real world data
2. Evaluate the results based on this :real server data+ https://www.kaggle.com/sohier/30-years-of-european-wind-generation + https://github.com/numenta/NAB
3. Also use real data generated from server.
4. The model has the following fuctions:

   a. Visualize the input data. Help the user to find critical features within the inputs.
   b. Give user options to choose different models that are suitable for different circumstances.
   c. Evaluate the performance based on the rules in this link https://github.com/numenta/NAB
   d. Save model. Easy to be appplied to other dataset.

5. Add un-labeled and labeled data

2 What's new in version 5.1

1. Add labeled data
2. Apply MLSTM_FCN to labeled data
3. Apply ATTLSTM_FCN to labeled data
4. More plots

```
In [1]: # import packages


        from matplotlib.pylab import rc
        import torch
        from scipy.stats import chisquare
        from scipy.stats import pearsonr
        import pickle
        import pandas as pd
        import datetime
```

```
import matplotlib
import tensorflow as tf
import sklearn
import math
import matplotlib.pyplot as plt
import xgboost
from xgboost import XGBClassifier
from xgboost import plot_importance
import numpy as np
from sklearn.model_selection import train_test_split
import sklearn
from sklearn import preprocessing
from sklearn.preprocessing import LabelEncoder
import copy
import scipy
import datetime
import time
import os
from sklearn.model_selection import KFold
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from sklearn.decomposition import PCA
from sklearn.cluster import KMeans
from sklearn.covariance import EllipticEnvelope
from sklearn.ensemble import IsolationForest
from sklearn.svm import OneClassSVM
import gc
import json
plot_path = "plots/"
```

In [2]:
```
# Real server data

root_path = "Data/Ant_202007/"


cif = pd.read_json(root_path+'cif.json', orient='index')
paycore = pd.read_json(root_path+'paycore.json', orient='index')
paydecision = pd.read_json(root_path+'paydecision.json', orient='index')
paydecision2 = pd.read_json(root_path+'paydecision2.json', orient='index')
paydecision3 = pd.read_json(root_path+'paydecision3.json', orient='index')

df = pd.DataFrame()
df["time_stamp"] = cif.index
df["cif"] = cif[0].values
df["paycore"] = paycore[0].values
df["paydecision"] = paydecision[0].values
df["paydecision2"] = paydecision2[0].values
df["paydecision3"] = paydecision3[0].values
```

```
    # Optional
    if False:
        df.to_csv(root_path+"fusion.csv")


    # convert time stamp
    df['time_stamp'] = pd.to_datetime(df['time_stamp'])
    names_array = np.array(df.keys()[1:],dtype="str")
    os.listdir(root_path)
```

Out[2]:
```
['.ipynb_checkpoints',
 'cif.json',
 'fusion.csv',
 'paycore.json',
 'paydecision.json',
 'paydecision2.json',
 'paydecision3.json']
```

In [3]:
```
if False:

    # calculate previous hour high low:
    # convert to seconds
    temp = df['time_stamp'] - min(df['time_stamp'])
    temp = temp.dt.total_seconds().astype(int)
    df["hours"] = temp//3600

    h_max = max(df["hours"])+1

    for n in range(len(names_array)):
        df[names_array[n]+"_open"] = df[names_array[n]]
        df[names_array[n]+"_close"] = df[names_array[n]]
        df[names_array[n]+"_max"] = df[names_array[n]]
        df[names_array[n]+"_min"] = df[names_array[n]]

    for j in range(1,h_max):
        mask_j = df["hours"]==j-1
        max_val = df[mask_j][names_array].max(axis=0).values
        min_val = df[mask_j][names_array].max(axis=0).values
        open_val = df[mask_j][names_array].values[0,:]
        close_val = df[mask_j][names_array].values[-1,:]
        mask_i = df["hours"]==j
        r = df[mask_i][names_array].shape[0]
        df.loc[mask_i,[r+"_open" for r in names_array]] = np.tile(open_val,(r,1))
        df.loc[mask_i,[r+"_close" for r in names_array]] = np.tile(close_val,(r,1))

        df.loc[mask_i,[r+"_max" for r in names_array]] = np.tile(max_val,(r,1))
        df.loc[mask_i,[r+"_min" for r in names_array]] = np.tile(min_val,(r,1))
```

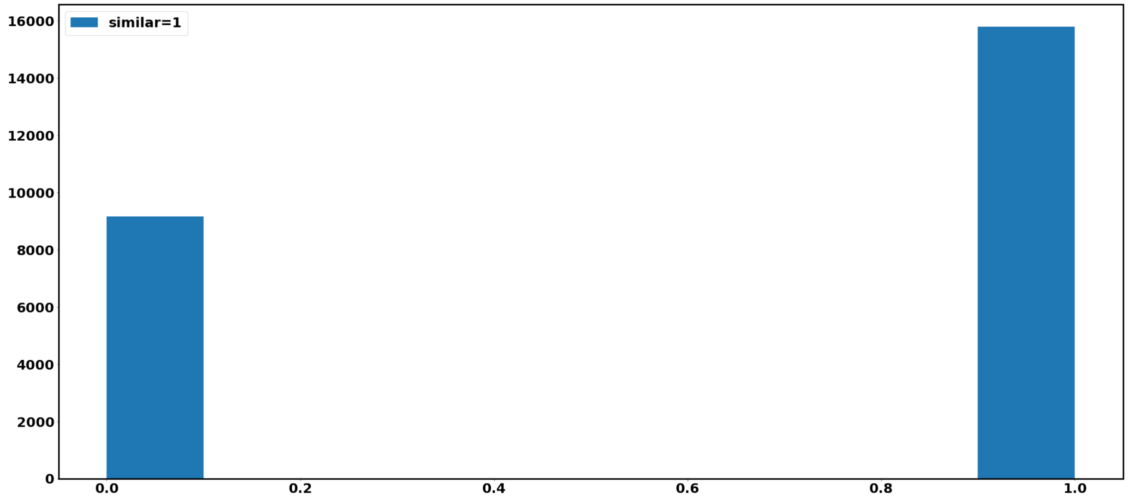
```
In [4]: # labeled data:
        root_path2 = "Data/Ant_labeled/"

        today = []
        history = []
        label = []
        count=0
        with open(root_path2+"train_data.txt") as f:
            for line in f:
                temp = json.loads(line)
                today.append(temp["today"])
                history.append(temp["history"])
                label.append(temp["label"])
                count+=1
        today = np.array(today)
        history = np.array(history)
        label = np.array(label).ravel()
```

```
In [20]: # For labeled data, we use today+history+diff to check them:
         X = np.c_[today,history]
         #X = np.atleast_3d(X)
         # X = np.dstack((today,history))
         y = label


         # Hyper parameters
         # Attention LSTM simple model
         n_epoch=40
         n_cell = 50
         # predict 1 minute for now
         N_output=1
         N_input = 5
         index_name= 0
         rate_dropout=0.2


         checkpoint_path = "CNN_1D/cp.ckpt"
         checkpoint_dir = os.path.dirname(checkpoint_path)

         ## Try log10?
         np_scaled = np.log10(X)

         # split train test:
         X_train, X_test, y_train, y_test = train_test_split(np_scaled, y, test_size=0.3, shuf
```

```
<ipython-input-20-fab922c116ee>:23: RuntimeWarning: divide by zero encountered in log10
```

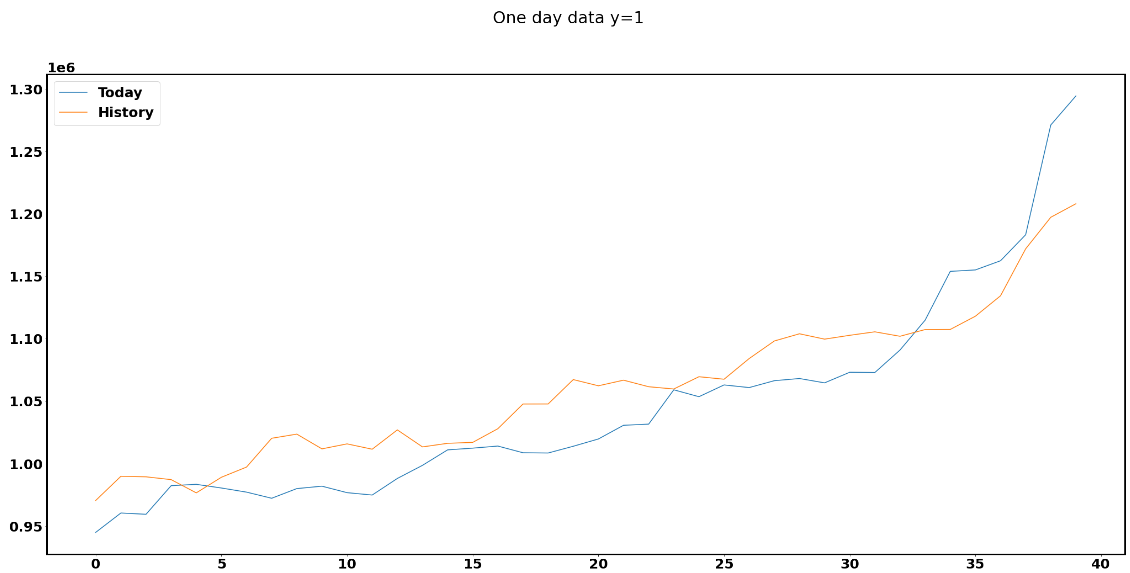
```
np_scaled = np.log10(X)
```

```
In [31]: font = {'family': 'normal','weight': 'bold',
                 'size': 25}

         matplotlib.rc('font', **font)
         rc('axes', linewidth=3)

         plt.hist(y,label="similar=1")

         plt.legend()

         fig = matplotlib.pyplot.gcf()


         fig.set_size_inches(35,16)
         save_path = plot_path + "labeled_y" + ".png"

         fig.savefig(save_path, dpi=150)
```




```
In [37]: font = {'family': 'normal','weight': 'bold',
                 'size': 25}

         matplotlib.rc('font', **font)
         rc('axes', linewidth=3)

         plt.plot(today[0,:],label = "Today")
         plt.plot(history[0,:],label = "History")
         plt.legend()
         plt.suptitle("One day data y=%d"%y[0])
```

```
fig = matplotlib.pyplot.gcf()


fig.set_size_inches(35,16)
save_path = plot_path + "labeled_example" + ".png"

fig.savefig(save_path, dpi=150)
```



In [21]:
```
# Try xgboost
params={}
params['booster'] = "gbtree"
params['gpu_id'] = 0
params['max_bin'] = 512
params['tree_method'] = 'gpu_hist'

model = XGBClassifier(n_estimators=1000,n_jobs=-1,**params)
model.fit(X_train,y_train)
```

```
[20:55:41] WARNING: /workspace/src/learner.cc:480:
Parameters: { verbose } might not be used.

  This may not be accurate due to some parameters are only used in language bindings but
  passed down to XGBoost core.  Or some parameters are not used but slip through this
  verification. Please open an issue if you find above cases.
```

```
Out[21]: XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
                       colsample_bynode=1, colsample_bytree=1, gamma=0, gpu_id=0,
                       importance_type='gain', interaction_constraints='',
                       learning_rate=0.300000012, max_bin=512, max_delta_step=0,
                       max_depth=6, min_child_weight=1, missing=nan,
                       monotone_constraints='(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
                       n_estimators=3000, n_jobs=-1, num_parallel_tree=1, random_state=0,
                       reg_alpha=0, reg_lambda=1, scale_pos_weight=1, subsample=1,
                       tree_method='gpu_hist', validate_parameters=1, verbose=2,
                       verbosity=None)
```

```
In [26]: Y_predict_test = model.predict(X_test)

         mask_good = abs(Y_predict_test-y_test)<0.01

         print("Good=%d Bad=%d"%(len(Y_predict_test[mask_good]),len(Y_predict_test)-len(Y_predi

         print("Accuracy=%.4f for testing set"%(len(Y_predict_test[mask_good])/len(Y_predict_te
```

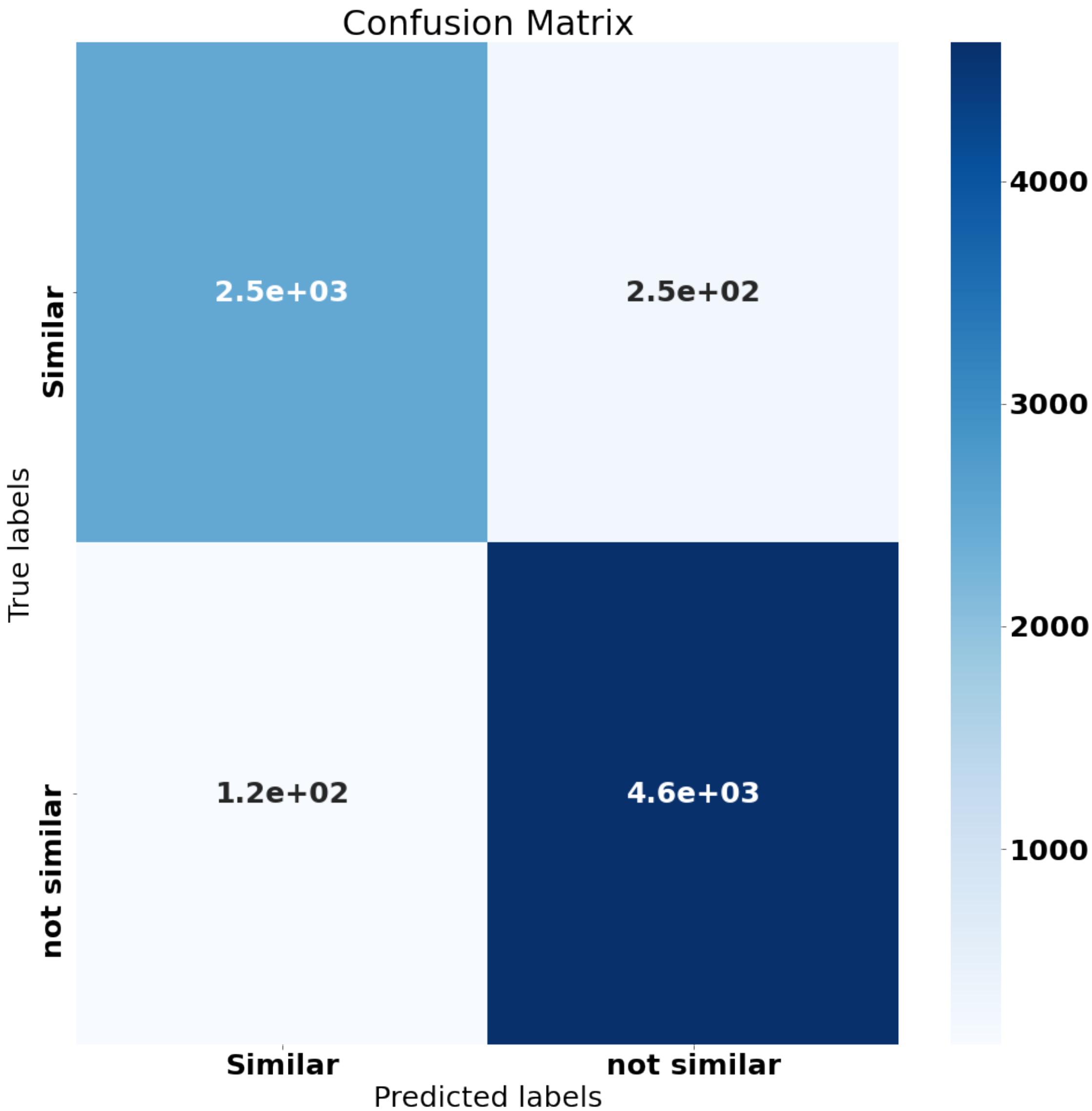
```
Good=7115 Bad=370
Accuracy=0.9506 for testing set
```

```
In [48]: def confusion_matrix(y_pred,y_true):
             TP = len(y_pred[(y_pred==1)&(y_true==1)])
             TN = len(y_pred[(y_pred==1)&(y_true==0)])
             # type1 error : false alarm
             FP = len(y_pred[(y_pred==1)&(y_true==0)])
             # type 2 error. Fail to make alarm
             FN = len(y_pred[(y_pred==0)&(y_true==1)])

             recall = TP/(TP+FN)
             precision = TP/(TP+FP)
             accuracy = (TP+TN)/len(y_pred)

             f1_score = 2/(1/precision+1/recall)
             return TP,TN,FP,FN,recall,precision,accuracy,f1_score

         temp = confusion_matrix(y_pred=y_pred,y_true=y_test)
         f1 = temp[-1]
         print("F1 score=%.4f"%f1)
```

```
F1 score=0.9615
```

```
In [43]: from sklearn.metrics import confusion_matrix
         import seaborn as sns
```

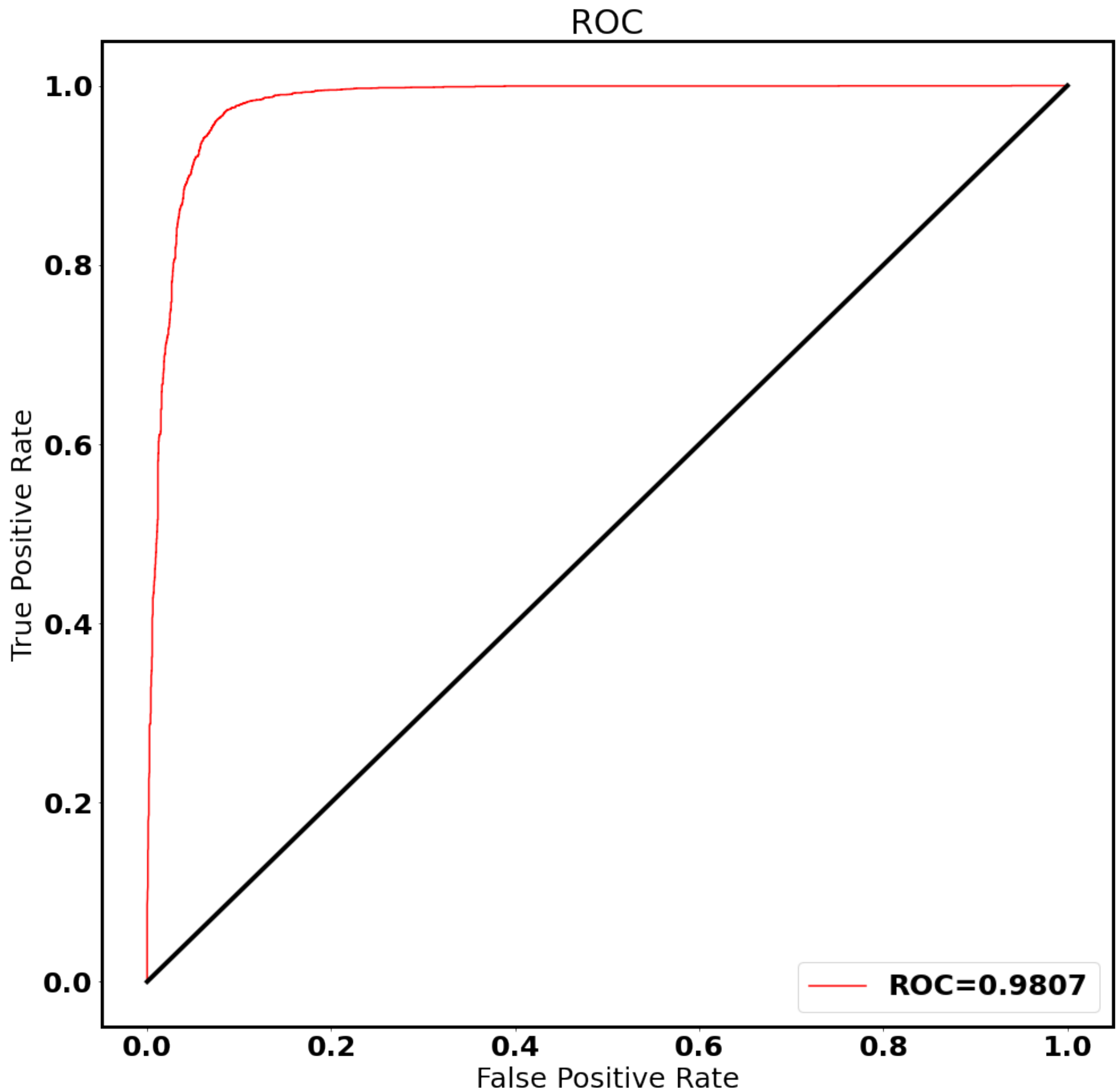
```
font = {'family': 'normal','weight': 'bold',
        'size': 25}

matplotlib.rc('font', **font)
rc('axes', linewidth=3)


labels = ["Similar","not similar"]
cm = confusion_matrix(y_test, Y_predict_test)
ax= plt.subplot()
sns.heatmap(cm, annot=True, ax = ax,cmap=plt.cm.Blues)
# labels, title and ticks
ax.set_xlabel('Predicted labels')
ax.set_ylabel('True labels')
ax.set_title('Confusion Matrix')
ax.xaxis.set_ticklabels(labels)
ax.yaxis.set_ticklabels(labels)


fig = matplotlib.pyplot.gcf()


fig.set_size_inches(16,16)
save_path = plot_path + "labeled_confusion" + ".png"

fig.savefig(save_path, dpi=150)
```



In [40]:
```
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score


testy = y_test
prob = model.predict_proba(X_test)
probs = prob[:,1]



auc = roc_auc_score(testy, probs)
print('AUROC: %.4f' % auc)
```

```python
## draw ROC:
fpr, tpr, thresholds = roc_curve(testy, probs)

font = {'family': 'normal','weight': 'bold',
        'size': 25}

matplotlib.rc('font', **font)
rc('axes', linewidth=3)


plt.plot(fpr, tpr, color='r', label='ROC=%.4f'%auc)
plt.plot([0, 1], [0, 1], color='k',linewidth=4)
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC')
plt.legend()
fig = matplotlib.pyplot.gcf()


fig.set_size_inches(16,16)
save_path = plot_path + "labeled_AUROC" + ".png"

fig.savefig(save_path, dpi=150)
```

```
AUROC: 0.9807
```



2.1 Now we reach 95% accuracy and 0.98 AUROC, which means the model has high robustness

3 Try NN model since it's faster in testing:

```
In [ ]: if False:
            #### Model: need to re-think first
            from keras.models import Model
            from keras.layers import Input, Dense, LSTM, multiply, concatenate, Activation, Mas
            from keras.layers import Conv1D, BatchNormalization, GlobalAveragePooling1D, Permu


            # data:
```

```
#X = np.c_[today,history]
#X = np.atleast_3d(X)
X = np.dstack((today,history))
y = label




# Hyper parameters
# Attention LSTM simple model
n_epoch=40
n_cell = 50

index_name= 0
rate_dropout=0.2


checkpoint_path = "NN_classifier/cp.ckpt"
checkpoint_dir = os.path.dirname(checkpoint_path)

## Try log10?
np_scaled = np.log10(X)

# split train test:
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, shuffle=Tr


# model:

def generate_model(MAX_TIMESTEPS,MAX_NB_VARIABLES):
    ip = Input(shape=(MAX_TIMESTEPS,MAX_NB_VARIABLES))
    # split into x and y two channels
    x = Masking()(ip)
    x = Flatten()(x)
    x = Dense(100)(x)
    x = Dropout(rate_dropout)(x)
    x = Dense(50, activation='relu')(x)



    out = Dense(1, activation='softmax')(x)
    print(out.shape)

    model = Model(ip, out)
    model.summary()

    # add load model code here to fine-tune
```

```
    return model

model = generate_model(X.shape[1],X.shape[2])

model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
#model.summary()



callback = tf.keras.callbacks.ModelCheckpoint(filepath=checkpoint_path,
                                                 save_weights_only=True,
                                                 verbose=1)







# Let's do it!

h = model.fit(X_train, y_train, epochs=n_epoch, batch_size=64, validation_data=(X_
```

In [ ]:
```
# NN model doesn't perform well due to low dimension. Maybe try logistic regression?
```

4 Logistic regression

not as good as xgboost

In [69]:
```
from sklearn.datasets import load_iris
from sklearn.linear_model import LogisticRegression


X = np.c_[today,history]
#X = np.atleast_3d(X)
# X = np.dstack((today,history))
y = label

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, shuffle=True

clf = LogisticRegression(random_state=0).fit(X_train, y_train)
y_pred = clf.predict(X_test)
```

```
/home/jc6933/anaconda3/envs/tf22/lib/python3.8/site-packages/sklearn/linear_model/_logistic.py
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
```

```
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

In [70]:
```python
mask_good = abs(y_pred-y_test)<0.01

print("Good=%d Bad=%d"%(len(y_pred[mask_good]),len(y_pred)-len(y_pred[mask_good])))

print("Accuracy=%.4f for testing set"%(len(y_pred[mask_good])/len(y_pred)))
```

```
Good=6586 Bad=899
Accuracy=0.8799 for testing set
```

In [71]:
```python
def confusion_matrix(y_pred,y_true):
    TP = len(y_pred[(y_pred==1)&(y_true==1)])
    TN = len(y_pred[(y_pred==1)&(y_true==0)])
    # type1 error : false alarm
    FP = len(y_pred[(y_pred==1)&(y_true==0)])
    # type 2 error. Fail to make alarm
    FN = len(y_pred[(y_pred==0)&(y_true==1)])

    recall = TP/(TP+FN)
    precision = TP/(TP+FP)
    accuracy = (TP+TN)/len(y_pred)

    f1_score = 2/(1/precision+1/recall)
    return TP,TN,FP,FN,recall,precision,accuracy,f1_score

temp = confusion_matrix(y_pred=y_pred,y_true=y_test)
f1 = temp[-1]
print("F1 score=%.4f"%f1)
```

```
F1 score=0.9052
```

In [73]:
```python
# not very good :(
clf.score(X, y)
```

Out[73]: 0.8785072951739619

In [ ]:

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In [ ]:

In [108]:

In [109]:

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