impro_v3_main

June 25, 2018

```
In [1]: from IPython.core.interactiveshell import InteractiveShell
        InteractiveShell.ast_node_interactivity = "all"
```

```
In [1]: import numpy as np
        import matplotlib.pyplot as plt
        %matplotlib inline
        from sklearn.linear_model import LinearRegression
        from sklearn.metrics import accuracy_score
        from sklearn.externals import joblib
        import pandas as pd
```

```
In [2]: # Data loading...
        #C1 (records not containing acute hypotensive episodes)
        #C2 (AHE, but not in forecast window)
        #H1 (acute hypotensive episode in forecast window, treated with pressors)
        #H2 (AHE in forecast window, not treated with pressors)
        c1 = np.loadtxt('c1_matrix.txt') #14x600
        c2 = np.loadtxt('c2_matrix.txt') #14x600
        h1 = np.loadtxt('h1_matrix.txt') #14x600
        h2 = np.loadtxt('h2_matrix.txt') #15x600
        c1_afterT0=np.loadtxt('c1_matrix_afterT0.txt') #14x60
        c2_afterT0=np.loadtxt('c2_matrix_afterT0.txt') #14x60
        h1_afterT0=np.loadtxt('h1_matrix_afterT0.txt') #14x60
        h2_afterT0=np.loadtxt('h2_matrix_afterT0.txt') #15x60
        labels=np.loadtxt('labels.txt')
```

```
In [32]: testA=np.loadtxt('test_a.txt')
         testB=np.loadtxt('test_b.txt')
         print(testA.shape,testB.shape)
```

```
(9, 600) (40, 600)
```

```
In [213]: #solve the problem with nan in testB
          idx_nan=np.isnan(testB)
          print(len(idx_nan))
          testB[idx_nan]=0
```

```
40
```

1 Way 1

1.1 Feature Extraction in Training dataset– Linear Regression

```
In [33]: #used to store the features
         list_feature=[]
         #store the predictions after TO
         #used for Linear Regression-->predict to count the ABPmean value
         pred_afterT0=[]

         Dict={'C1':c1,'C2':c2,'H1':h1,'H2':h2}
         print('mean of ABPmean above the line\nmean below the line\nsize+\nsize-\n')
         for k,v in Dict.items():
             print('This is',k)
             for i in range(len(v)):
                 y=v[i]
                 cond=np.where(((y>130)|(y<10)),-1,y)
                 y=np.delete(cond,np.argwhere(cond==-1))

                 x=np.arange(len(y))
                 model = LinearRegression()

                 model.fit(np.reshape(x,[len(x),1]), np.reshape(y,[len(y),1]))
                 x_test=x_test=np.arange(len(x),len(x)+60)
                 y_pred = model.predict(np.reshape(x_test,[len(x_test),1]))

                 w = model.coef_[0][0] # parameters of model
                 b = model.intercept_[0] #intercept of model

                 g1=np.where(y>w*x+b,y,-1).flatten()
                 g11=np.delete(g1,np.argwhere(g1==-1))
                 g11_mean=np.mean(g11)

                 g2=np.where(y<w*x+b,y,-1).flatten()
                 g21=np.delete(g2,np.argwhere(g2==-1))
                 g21_mean=np.mean(g21)
         #         list_feature.append([g11_mean,g21_mean,len(g11),len(g21)])
                 list_feature.append([g11_mean,g21_mean,len(g11)])
                 pred_afterT0.append(y_pred.flatten())
                 print('Patient',i+1, 'in ',k,':','%0.2f'%g11_mean,'%0.2f'%g21_mean,len(g11),le

         #convert into the type of numpy.arry
         list_feature=np.array(list_feature)
         pred_afterT0=np.array(pred_afterT0)
```

```
mean of ABPmean above the line
mean below the line
size+
size-
```

```
This is C1
Patient 1 in  C1 : 97.18 85.80 282 318
Patient 2 in  C1 : 90.99 85.00 307 292
Patient 3 in  C1 : 112.81 90.68 290 266
Patient 4 in  C1 : 111.21 104.33 355 242
Patient 5 in  C1 : 105.50 94.76 274 318
Patient 6 in  C1 : 101.90 98.96 267 331
Patient 7 in  C1 : 109.74 90.02 313 287
Patient 8 in  C1 : 109.63 102.79 248 315
Patient 9 in  C1 : 92.36 77.30 321 279
Patient 10 in  C1 : 101.29 81.69 310 289
Patient 11 in  C1 : 84.00 75.87 299 301
Patient 12 in  C1 : 103.56 94.93 281 319
Patient 13 in  C1 : 82.05 75.45 242 357
Patient 14 in  C1 : 82.92 75.27 259 341
This is C2
Patient 1 in  C2 : 78.56 70.49 296 304
Patient 2 in  C2 : 92.29 84.19 307 292
Patient 3 in  C2 : 87.49 77.11 255 337
Patient 4 in  C2 : 75.39 62.84 270 323
Patient 5 in  C2 : 97.46 81.67 331 268
Patient 6 in  C2 : 89.66 76.51 314 285
Patient 7 in  C2 : 90.78 74.59 321 279
Patient 8 in  C2 : 119.54 95.32 194 158
Patient 9 in  C2 : 71.75 66.34 251 349
Patient 10 in  C2 : 80.31 67.58 310 288
Patient 11 in  C2 : 79.54 69.30 306 289
Patient 12 in  C2 : 71.56 63.08 268 332
Patient 13 in  C2 : 82.79 72.40 265 335
Patient 14 in  C2 : 79.15 70.38 264 334
This is H1
Patient 1 in  H1 : 100.17 85.10 262 165
Patient 2 in  H1 : 119.83 102.14 162 156
Patient 3 in  H1 : 96.45 66.21 222 368
Patient 4 in  H1 : 68.91 63.28 277 323
Patient 5 in  H1 : 97.21 67.95 322 276
Patient 6 in  H1 : 92.53 84.20 306 292
Patient 7 in  H1 : 87.72 75.27 291 307
Patient 8 in  H1 : 70.49 63.73 299 296
Patient 9 in  H1 : 72.96 67.51 270 329
Patient 10 in  H1 : 72.51 60.92 246 354
Patient 11 in  H1 : 92.43 69.96 275 324
Patient 12 in  H1 : 117.86 107.02 269 290
Patient 13 in  H1 : 90.07 86.16 305 291
Patient 14 in  H1 : 93.43 75.96 279 305
This is H2
Patient 1 in  H2 : 77.98 70.43 248 349
```

```
Patient 2 in  H2 : 72.04 63.90 292 307
Patient 3 in  H2 : 68.07 62.11 298 300
Patient 4 in  H2 : 73.40 61.98 228 368
Patient 5 in  H2 : 70.82 63.47 236 364
Patient 6 in  H2 : 80.47 71.39 302 297
Patient 7 in  H2 : 87.61 70.00 286 310
Patient 8 in  H2 : 74.67 64.91 282 313
Patient 9 in  H2 : 125.79 115.42 194 207
Patient 10 in  H2 : 122.43 109.64 206 263
Patient 11 in  H2 : 76.86 62.15 316 282
Patient 12 in  H2 : 73.16 67.34 271 329
Patient 13 in  H2 : 77.22 65.37 249 351
Patient 14 in  H2 : 84.31 73.74 217 381
Patient 15 in  H2 : 96.82 74.26 301 292
```

1.2 Feature Extraction in Test dataset– Linear Regression

In [41]:

```
#used to store the features
testset_feature=[]
#store the predictions(60points) after T0
#used for Linear Regression-->predict to count the ABPmean value
testset_pred_afterT0=[]

Dict={'testA':testA,'testB':testB}
print('mean of ABPmean above the line\nmean below the line\nsize+\nsize-\n')
for k,v in Dict.items():
    print('This is',k)
    for i in range(len(v)):
        y=v[i]
        cond=np.where(((y>130)|(y<10)),-1,y)
        y=np.delete(cond,np.argwhere(cond==-1))

        x=np.arange(len(y))
        model = LinearRegression()

        model.fit(np.reshape(x,[len(x),1]), np.reshape(y,[len(y),1]))
        x_test=x_test=np.arange(len(x),len(x)+60)
        y_pred = model.predict(np.reshape(x_test,[len(x_test),1]))

        w = model.coef_[0][0] # parameters of model
        b = model.intercept_[0] #intercept of model

        g1=np.where(y>w*x+b,y,-1).flatten()
        g11=np.delete(g1,np.argwhere(g1==-1))
        g11_mean=np.mean(g11)

        g2=np.where(y<w*x+b,y,-1).flatten()
```

```
                g21=np.delete(g2,np.argwhere(g2==-1))
                g21_mean=np.mean(g21)
                testset_feature.append([g11_mean,g21_mean,len(g11)])
                testset_pred_afterT0.append(y_pred.flatten())
                print('Patient',i+1, 'in ',k,':','%0.2f'%g11_mean,'%0.2f'%g21_mean,len(g11),le

        #convert into the type of numpy.arry
        testset_feature=np.array(testset_feature)
        testset_pred_afterT0=np.array(testset_pred_afterT0)

        testA_feature=testset_feature[:len(testA)]
        testB_feature=testset_feature[len(testA):]
        testA_pred_afterT0=testset_pred_afterT0[:len(testA)]
        testB_pred_afterT0=testset_pred_afterT0[len(testA):]
```

```
mean of ABPmean above the line
mean below the line
size+
size-

This is testA
Patient 1 in  testA : 72.30 63.84 252 348
Patient 2 in  testA : 75.45 67.33 315 285
Patient 3 in  testA : 71.69 62.34 236 363
Patient 4 in  testA : 85.31 69.38 233 366
Patient 5 in  testA : 105.40 91.34 274 317
Patient 6 in  testA : 95.79 80.37 240 360
Patient 7 in  testA : 75.59 69.88 296 304
Patient 8 in  testA : 72.96 66.89 241 359
Patient 9 in  testA : 62.74 58.04 280 317
This is testB
Patient 1 in  testB : 92.05 85.54 270 330
Patient 2 in  testB : 71.17 62.66 210 388
Patient 3 in  testB : 66.43 61.59 269 331
Patient 4 in  testB : 92.51 84.22 315 285
Patient 5 in  testB : 81.66 71.52 244 356
Patient 6 in  testB : 76.81 69.35 271 329
Patient 7 in  testB : 90.48 77.77 242 356
Patient 8 in  testB : 112.54 104.82 296 303
Patient 9 in  testB : 84.93 69.90 265 335
Patient 10 in  testB : 84.36 77.15 307 285
Patient 11 in  testB : 100.84 94.00 289 309
Patient 12 in  testB : 88.64 73.52 210 383
Patient 13 in  testB : 111.97 91.63 252 243
Patient 14 in  testB : 76.63 64.86 336 264
Patient 15 in  testB : 77.73 73.08 250 350
Patient 16 in  testB : 88.43 66.14 220 369
Patient 17 in  testB : 79.71 72.97 313 285
```

```
Patient 18 in  testB : 80.24 70.14 296 303
Patient 19 in  testB : 82.31 65.02 296 299
Patient 20 in  testB : 98.08 86.20 278 282
Patient 21 in  testB : 88.64 75.48 257 329
Patient 22 in  testB : 79.91 70.82 226 372
Patient 23 in  testB : 69.51 63.12 206 389
Patient 24 in  testB : 76.91 73.40 269 331
Patient 25 in  testB : 84.72 69.40 313 286
Patient 26 in  testB : 80.13 66.23 244 355
Patient 27 in  testB : 75.43 64.57 228 367
Patient 28 in  testB : 113.29 101.66 249 337
Patient 29 in  testB : 87.19 76.81 286 314
Patient 30 in  testB : 82.57 68.14 301 299
Patient 31 in  testB : 71.23 65.57 264 335
Patient 32 in  testB : 117.51 97.10 321 236
Patient 33 in  testB : 87.42 77.93 279 316
Patient 34 in  testB : 79.79 64.77 237 362
Patient 35 in  testB : 77.40 71.49 301 299
Patient 36 in  testB : 84.47 78.65 246 352
Patient 37 in  testB : 108.37 88.71 213 354
Patient 38 in  testB : 85.47 63.45 218 379
Patient 39 in  testB : 76.05 63.72 236 364
Patient 40 in  testB : 116.59 104.73 290 301
```

1.3 Classification –Random Forest in Way 1

In [7]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import GridSearchCV
from sklearn import metrics
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
```

In [48]:
```
'''
split the data into train and test parts for training in CrossValidation
'''
testsize=10
# testIdx=np.random.choice(len(list_feature), testsize,replace=False)
idx=np.random.permutation(len(list_feature))
trainIdx=idx[testsize:]
testIdx=idx[:testsize]

print(testIdx)
x_train=list_feature[trainIdx]
x_test=list_feature[testIdx]
print(x_train.shape,x_test.shape)
y_train=labels[trainIdx]
y_test=labels[testIdx]
```

```
print(y_train.shape,y_test.shape)
```

```
[55 12 31 25 26  7 46 29 32 17]
(47, 3) (10, 3)
(47,) (10,)
```

In [94]:
```
%%time
rf_test = RandomForestClassifier(n_estimators= 50,max_depth=4,random_state=10,criteri
rf_test.fit(x_train,y_train)
y_pred=rf_test.predict(x_test)
print (y_pred)
print(y_test)
print('the accuracy is:',accuracy_score(y_test,y_pred))
```

```
[1. 0. 1. 1. 0. 0. 1. 1. 0. 1.]
[1. 0. 1. 0. 0. 0. 1. 1. 1. 0.]
the accuracy is: 0.7
CPU times: user 71.1 ms, sys: 3.07 ms, total: 74.2 ms
Wall time: 73.4 ms
```

In [22]:
```
%%time
'''
Tuning the parameters of RandomForest via GridSearchCV
'''
params= {'n_estimators':np.arange(10,100,10),'min_samples_leaf':np.arange(1,50,3),
         'max_depth':np.arange(2,10,2)}
cv_rf= GridSearchCV(estimator = RandomForestClassifier(),
                    param_grid =params, scoring='roc_auc',cv=5)
cv_rf.fit(list_feature,labels)
# y_pred=cv_rf.predict(x_test)
print('the best params of the model:\n',cv_rf.best_params_)
# print('the accuracy is:',accuracy_score(y_test,y_pred))
print('Mean cross-validated score of the best_estimator :',cv_rf.best_score_)
```

```
the best params of the model:
 {'max_depth': 4, 'min_samples_leaf': 1, 'n_estimators': 50}
Mean cross-validated score of the best_estimator : 0.7543859649122808
CPU times: user 3min 12s, sys: 528 ms, total: 3min 13s
Wall time: 3min 14s
```

In [150]:
```
#save the model1
joblib.dump(cv_rf,'randomforest1.m')
```

Out[150]: ['randomforest1.m']

In [151]:
```
#read the model
rf=joblib.load('randomforest.m')
```

```
resultA=rf.predict(testA_feature)
resultB=rf.predict(testB_feature)
print('Way 1 with Random Forest:')
print('the number of AHE in testA',np.sum(resultA))
print('the number of AHE in testB',np.sum(resultB))
```

```
Way 1 with Random Forest:
the number of AHE in testA 7.0
the number of AHE in testB 17.0
```

1.4 Classification–Support Vector Machine in Way 1

In [119]:
```
from sklearn.svm import SVC
#use the optimal parameters to construct the SVC model
clf_test = SVC(kernel='rbf',gamma=1e-3,C=5)
clf_test.fit(x_train,y_train)

#predict the test data
y_pred = clf_test.predict(x_test)
accuracy = metrics.accuracy_score(y_test, y_pred)
print('the accuracy of the classification is %0.3f'%accuracy)
```

```
the accuracy of the classification is 0.500
```

In [133]:
```
%%time
'''
Tuning the parameters of SVC via GridSearchCV
'''
#C is the Penalty parameter of the error term.
params_svc= {'C':np.arange(1,50,1),'gamma':np.linspace(1e-9,20,2000)}
cv_clf= GridSearchCV(estimator = SVC(decision_function_shape='ovo',kernel='rbf',max_
                                     probability=False, random_state=None,
                                     shrinking=True,tol=0.001, verbose=False),
                                     param_grid = params_svc, cv=5)
cv_clf.fit(list_feature,labels)
print(cv_clf.best_params_)
print('Mean cross-validated score of the best_estimator :',cv_clf.best_score_)
```

```
{'C': 11, 'gamma': 0.010005003500750375}
Mean cross-validated score of the best_estimator : 0.7543859649122807
CPU times: user 17min 34s, sys: 19.7 s, total: 17min 54s
Wall time: 18min 53s
```

In [153]:
```
#save the model1
joblib.dump(cv_clf,'SVC1.m')
```

Out[153]: ['SVC1.m']

In [156]:
```
#save the model1_1
joblib.dump(cv_clf,'SVC1_1.m')
```

Out[156]: ['SVC1_1.m']

In [155]:
```
cv_clf=joblib.load('SVC2.m')
resultA=cv_clf.predict(testA_feature)
resultB=cv_clf.predict(testB_feature)
print('Way 1 with Support Vector Machine:')
print('the number of AHE in testA',np.sum(resultA))
print('the number of AHE in testB',np.sum(resultB))
```

```
Way 1 with Support Vector Machine:
the number of AHE in testA 3.0
the number of AHE in testB 19.0
```

2 Way 2

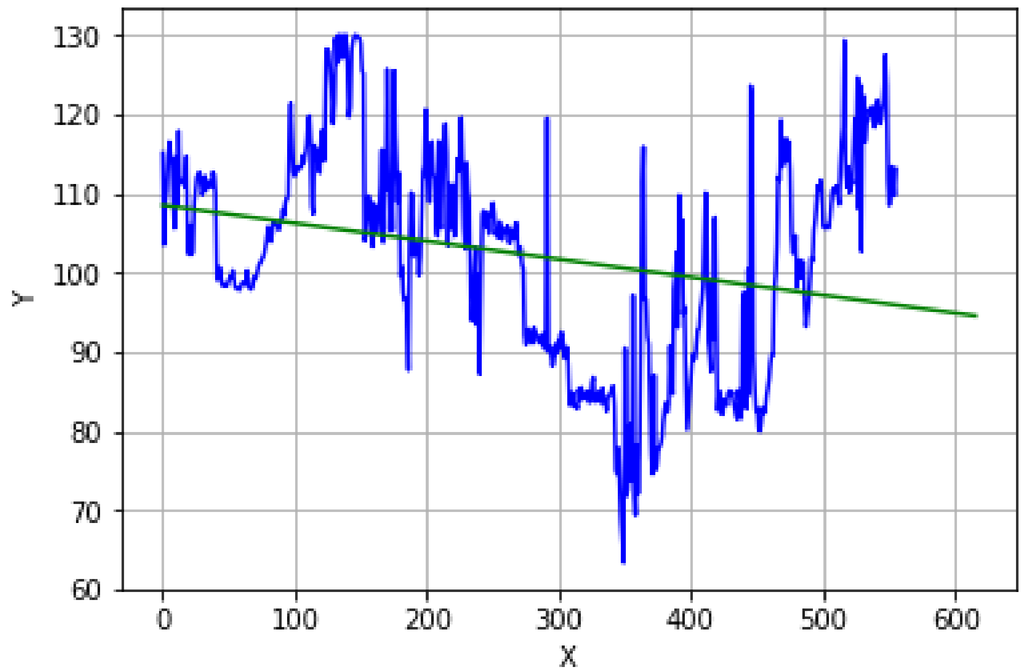
2.1 Linear Regression to fit the data after T0

In [31]:
```
#Example for visualization
#the third patient in c1
y=c1[2]
#select the value between 10 and 130
cond=np.where(((y>130)|(y<10)),-1,y).flatten()
y=np.delete(cond,np.argwhere(cond==-1))
print(y.shape)
x=np.arange(len(y))

model = LinearRegression()
model.fit(np.reshape(x,[len(x),1]), np.reshape(y,[len(y),1]))
# x_test=np.arange(len(x),len(x)+60)
x_test=np.arange(len(x)+60)
y_pred = model.predict(np.reshape(x_test,[len(x_test),1]))
w = model.coef_[0][0] # parameters of model
b = model.intercept_[0] #intercept of model

plt.figure()
plt.xlabel('X')
plt.ylabel('Y')
plt.grid(True)
plt.plot(x,y,'b')
plt.plot(x_test,y_pred,'g-')
plt.show()
```

```
(556,)
```




```
In [140]: pred_afterT0.shape
          labels.shape
```

```
Out[140]: (57,)
```

```
In [26]: s=np.where(pred_afterT0>87,0,1)
         counts=s.sum(axis=1)
         #any period of 30 minutes or more during which at least 90% of
         #the MAP measurements were at or below 60 mmHg.
         results=np.where(counts>27,1,0)
         print('the accuracy is:',accuracy_score(labels,results))
         print(counts)
         print(results)
```

```
the accuracy is: 0.6491228070175439
[ 0  0  0  0  0  0  0  0  0  0 60  0 60 60 60  0  0 60  0  0 60  0 60 60
 60 60 60 60  0  0 60 60 60  0 60 60 60 60 60  0  0 60 36 60 60 60 60 60
 60 60  0  0 60 60 60 60  0]
[0 0 0 0 0 0 0 0 0 0 1 0 1 1 1 0 0 1 0 0 1 0 1 1 1 1 1 1 0 0 1 1 1 0 1 1 1
 1 1 0 0 1 1 1 1 1 1 1 1 1 0 0 1 1 1 1 0]
```

2.2 Random Forest in Way 2

```
In [159]: %%time
          '''
```

```
    Tuning the parameters of RandomForest via GridSearchCV
    '''
    params_rf2= {'n_estimators':np.arange(10,100,10),'min_samples_leaf':np.arange(1,50,3)
             'max_depth':np.arange(1,10,1)}
    cv_rf2= GridSearchCV(estimator = RandomForestClassifier(),
                        param_grid =params_rf2,cv=5)
    cv_rf2.fit(pred_afterT0,labels)
    print('the best params of the model:\n',cv_rf2.best_params_)
    print('Mean cross-validated score of the best_estimator :',cv_rf2.best_score_)
```

```
the best params of the model:
 {'max_depth': 3, 'min_samples_leaf': 1, 'n_estimators': 70}
Mean cross-validated score of the best_estimator : 0.6491228070175439
CPU times: user 7min 58s, sys: 3.32 s, total: 8min 2s
Wall time: 8min 13s
```

```
In [157]: #save the model2
          joblib.dump(cv_rf2,'randomforest2.m')
```

```
Out[157]: ['randomforest2.m']
```

```
In [161]: joblib.dump(cv_rf2,'randomforest2_1.m')
```

```
Out[161]: ['randomforest2_1.m']
```

```
In [212]: cv_rf2=joblib.load('randomforest2_1.m')
          resultA=cv_rf2.predict(testA_pred_afterT0)
          resultB=cv_rf2.predict(testB_pred_afterT0)
          print('Way 2 with Random Forest:')
          print('the number of AHE in testA',np.sum(resultA))
          print('the number of AHE in testB',np.sum(resultB))
```

```
Way 2 with Random Forest:
the number of AHE in testA 4.0
the number of AHE in testB 20.0
```

2.3 Support Vector Machine in Way 2

```
In [194]: %%time
          '''
          Tuning the parameters of SVC via GridSearchCV
          '''
          #C is the Penalty parameter of the error term.
          params_svc2= {'C':np.arange(1,20,1),'gamma':np.linspace(1e-9,20,5000)}
          cv_clf2= GridSearchCV(estimator = SVC(decision_function_shape='ovo',kernel='rbf',max_
                                                probability=False, random_state=None,
                                                shrinking=True,tol=0.001, verbose=False),
```

```
                                        param_grid = params_svc2, cv=5)
cv_clf2.fit(pred_afterT0,labels)
print(cv_clf2.best_params_)
print('Mean cross-validated score of the best_estimator :',cv_clf2.best_score_)
```

```
{'C': 2, 'gamma': 0.004000801159831967}
Mean cross-validated score of the best_estimator : 0.6842105263157895
CPU times: user 16min 12s, sys: 5.57 s, total: 16min 18s
Wall time: 16min 31s
```

```
In [168]: #save the model2
          joblib.dump(cv_clf2,'SVC2.m')
```

```
Out[168]: ['SVC2.m']
```

```
In [200]: joblib.dump(cv_clf2,'SVC2_1.m')
```

```
Out[200]: ['SVC2_1.m']
```

```
In [201]: cv_clf2=joblib.load('SVC2_1.m')
          resultA=cv_clf2.predict(testA_pred_afterT0)
          resultB=cv_clf2.predict(testB_pred_afterT0)
          print('Way 2 with Support Vector Machine:')
          print('the number of AHE in testA',np.sum(resultA))
          print('the number of AHE in testB',np.sum(resultB))
```

```
Way 2 with Support Vector Machine:
the number of AHE in testA 6.0
the number of AHE in testB 24.0
```

3 Way 3

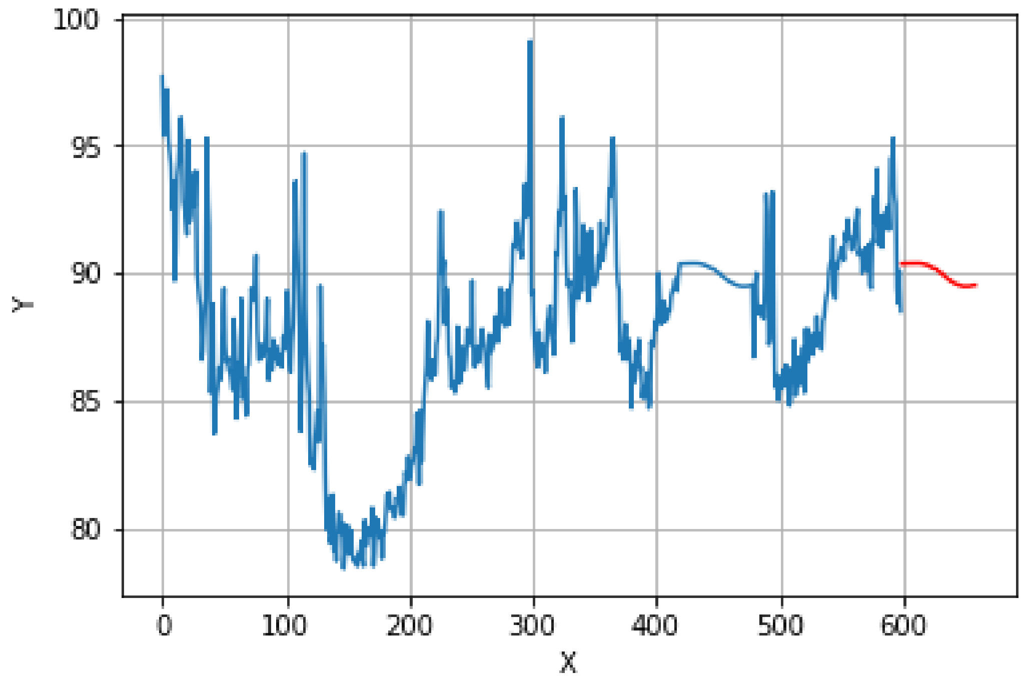
3.1 Calculate per average value before 3hours as the value after T0

```
In [202]: #Example for visualizaiton
          #the first patient in h2
          y=c1[1]
          #select the value between 10 and 130
          cond=np.where(((y>130)|(y<10)),-1,y).flatten()
          y=np.delete(cond,np.argwhere(cond==-1))

          #180 means 3 hours (240 means 4hours)
          segment_size=180
          ys=y[-segment_size:]
          y_avg_pred=np.zeros(60)
          for i in range(60):
              y_avg_pred[i]=np.mean(ys)
```

```
        ys[i]=y_avg_pred[i]

    plt.figure()
    plt.xlabel('X')
    plt.ylabel('Y')
    plt.grid(True)
    plt.plot(range(len(y)),y)
    plt.plot(range(len(y),len(y)+60),y_avg_pred,'r-')
    plt.show()
```



3.1.1 Training set

```
In [203]: #store the predictions after T0
          #Calculate per average value before 3hours as the value after T0ű
          avgpred_afterT0=[]

          segment_size=180
          Dict={'C1':c1,'C2':c2,'H1':h1,'H2':h2}
          for k,v in Dict.items():
              for i in range(len(v)):

                  y=v[i]
                  cond=np.where(((y>130)|(y<10)),-1,y)
                  y=np.delete(cond,np.argwhere(cond==-1))
```

```
            ys=y[-segment_size:]
            y_avg_pred=np.zeros(60)
            for i in range(60):
                y_avg_pred[i]=np.mean(ys)
                ys[i]=y_avg_pred[i]

            avgpred_afterT0.append(y_avg_pred)

    #convert into the type of numpy.arry
    avgpred_afterT0=np.array(avgpred_afterT0)

    print(avgpred_afterT0.shape)
```

```
(57, 60)
```

3.1.2 Testing set

In [204]:
```
#store the predictions after T0
#Calculate per average value before 3hours as the value after T0ű
testA_avgpred_afterT0=[]
testB_avgpred_afterT0=[]
segment_size=180
for i in range(len(testA)):
    y=testA[i]
    cond=np.where(((y>130)|(y<10)),-1,y)
    y=np.delete(cond,np.argwhere(cond==-1))

    ys=y[-segment_size:]
    y_avg_pred=np.zeros(60)
    for i in range(60):
        y_avg_pred[i]=np.mean(ys)
        ys[i]=y_avg_pred[i]
    testA_avgpred_afterT0.append(y_avg_pred)

for i in range(len(testB)):
    y=testB[i]
    cond=np.where(((y>130)|(y<10)),-1,y)
    y=np.delete(cond,np.argwhere(cond==-1))

    ys=y[-segment_size:]
    y_avg_pred=np.zeros(60)
    for i in range(60):
        y_avg_pred[i]=np.mean(ys)
        ys[i]=y_avg_pred[i]
    testB_avgpred_afterT0.append(y_avg_pred)
```

```
#convert into the type of numpy.arry
testA_avgpred_afterT0=np.array(testA_avgpred_afterT0)
testB_avgpred_afterT0=np.array(testB_avgpred_afterT0)

print(testA_avgpred_afterT0.shape,testB_avgpred_afterT0.shape)
```

```
(9, 60) (40, 60)
```

3.2 Random Forest in Way 3

In [205]:
```
%%time
'''
Tuning the parameters of RandomForest via GridSearchCV
'''
params_rf3= {'n_estimators':np.arange(2,100,5),'min_samples_leaf':np.arange(1,50,2),
         'max_depth':np.arange(1,10,1)}
cv_rf3= GridSearchCV(estimator = RandomForestClassifier(),
                    param_grid =params_rf3,cv=5)
cv_rf3.fit(avgpred_afterT0,labels)
print('the best params of the model:\n',cv_rf3.best_params_)
print('Mean cross-validated score of the best_estimator :',cv_rf3.best_score_)
```

```
the best params of the model:
 {'max_depth': 1, 'min_samples_leaf': 15, 'n_estimators': 47}
Mean cross-validated score of the best_estimator : 0.6666666666666666
CPU times: user 23min 58s, sys: 5.3 s, total: 24min 4s
Wall time: 32min 26s
```

In [206]:
```
#save the model3
joblib.dump(cv_rf3,'randomforest3.m')
```

Out[206]: ['randomforest3.m']

In [207]:
```
cv_rf3=joblib.load('randomforest3.m')
resultA=cv_rf3.predict(testA_avgpred_afterT0)
resultB=cv_rf3.predict(testB_avgpred_afterT0)
print('Way 3 with Random Forest:')
print('the number of AHE in testA',np.sum(resultA))
print('the number of AHE in testB',np.sum(resultB))
```

```
Way 3 with Random Forest:
the number of AHE in testA 8.0
the number of AHE in testB 28.0
```

3.3 Support Vector Machine in Way 3

In [208]:
```
%%time
'''
Tuning the parameters of SVC via GridSearchCV
'''
#C is the Penalty parameter of the error term.
params_svc3= {'C':np.arange(1,20,1),'gamma':np.linspace(1e-9,20,6000)}
cv_clf3= GridSearchCV(estimator = SVC(decision_function_shape='ovo',kernel='rbf',max_
                                      probability=False, random_state=None,
                                      shrinking=True,tol=0.001, verbose=False),
                                      param_grid = params_svc3, cv=5)
cv_clf3.fit(avgpred_afterT0,labels)
print(cv_clf3.best_params_)
print('Mean cross-validated score of the best_estimator :',cv_clf3.best_score_)
```

```
{'C': 1, 'gamma': 0.006667778962660444}
Mean cross-validated score of the best_estimator : 0.631578947368421
CPU times: user 19min 57s, sys: 8.53 s, total: 20min 5s
Wall time: 20min 20s
```

In [209]:
```
#save the model2
joblib.dump(cv_clf3,'SVC3.m')
```

Out[209]:
```
['SVC3.m']
```

In [210]:
```
# cv_clf3=joblib.load('SVC3.m')
resultA=cv_clf3.predict(testA_avgpred_afterT0)
resultB=cv_clf3.predict(testB_avgpred_afterT0)
print('Way 3 with Support Vector Machine:')
print('the number of AHE in testA',np.sum(resultA))
print('the number of AHE in testB',np.sum(resultB))
```

```
Way 3 with Support Vector Machine:
the number of AHE in testA 6.0
the number of AHE in testB 29.0
```

4 Kernel Ridge Regression

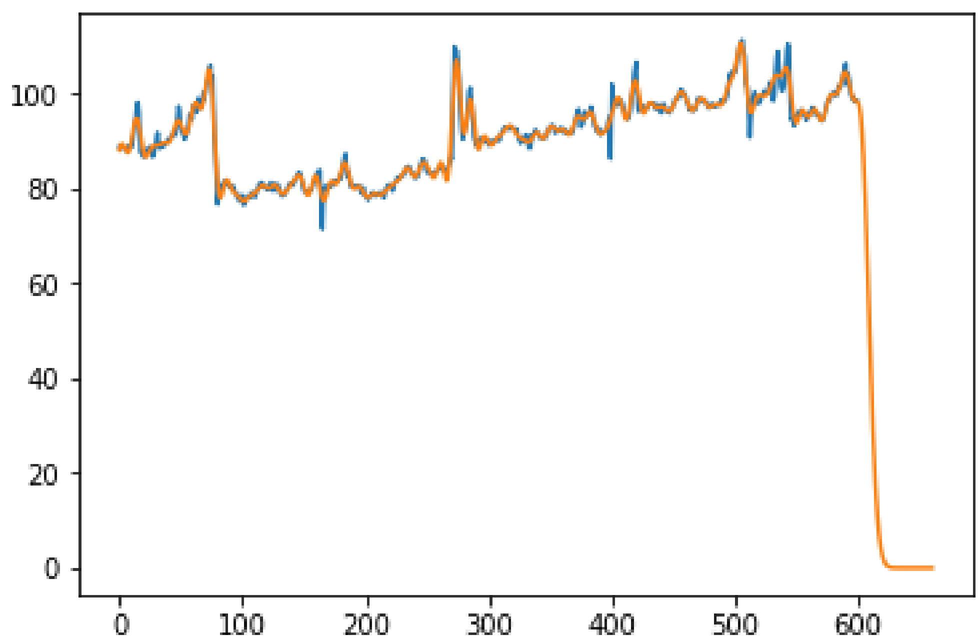
In [111]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.kernel_ridge import KernelRidge

#Example
#the first patient in c1
y=c1[0]
#select the value between 10 and 130
cond=np.where(((y>130)|(y<10)),-1,y).flatten()
```

```
y=np.delete(cond,np.argwhere(cond==-1))
print(y.shape)
x=np.arange(len(y)).reshape(len(y),1)

x_test=np.arange(0,len(x)+60,0.01).reshape((len(x)+60)*100,1)
print(x_test.shape)
train_size=600
krr = GridSearchCV(KernelRidge(kernel='rbf', gamma=0.1), cv=5,
                   param_grid={"alpha": [1e0, 0.1, 1e-2, 1e-3],
                               "gamma": np.logspace(-2, 2, 5)})
krr.fit(x[:train_size], y[:train_size])
y_pred=krr.predict(x_test)
plt.plot(x,y)
plt.plot(x_test,y_pred)
plt.show()
```

```
(600,)
(66000, 1)
```



5 Time series Analysis —to be continued

```
In [5]: from pandas import Series
        import pandas
```

```
In [16]: test=Series.from_csv('a40282n.csv',header=None)
         # p=pandas.read_csv('a40282n.csv',header=None)
         test.head()
```

```
/usr/local/Cellar/python3/3.6.4_2/Frameworks/Python.framework/Versions/3.6/lib/python3.6/site-p
  infer_datetime_format=infer_datetime_format)
```

```
Out[16]: '[10:00:00 30/06/2016]'    60.3
         '[10:01:00 30/06/2016]'    64.3
         '[10:02:00 30/06/2016]'    60.9
         '[10:03:00 30/06/2016]'    59.8
         '[10:04:00 30/06/2016]'    60.5
         dtype: float64
```