

In [42]: runfile('E:/MU_Study/Course/2019-02/RADS_602_DM_ML/2020-01-29_Assignment_DueDate_9Mar/Lab/diabetic_retinopathy.py',
wdir='E:/MU_Study/Course/2019-02/RADS_602_DM_ML/2020-01-29_Assignment_DueDate_9Mar/Lab')

Reloaded modules: Experiment

```
df.head()
   qa  pre_screening  ma_05  ma_06  ...  distance  optic_disc_dia  am_fm  Class
0  1.0             1.0   22.0   22.0  ...   0.486903         0.100025    1.0      0
1  1.0             1.0   24.0   24.0  ...   0.520908         0.144414    0.0      0
2  1.0             1.0   62.0   60.0  ...   0.530904         0.128548    0.0      1
3  1.0             1.0   55.0   53.0  ...   0.483284         0.114790    0.0      0
4  1.0             1.0   44.0   44.0  ...   0.475935         0.123572    0.0      1
```

[5 rows x 20 columns]

```
df_relation
      qa  pre_screening  ...  am_fm  Class
qa      1.000000      -0.017611  ... -0.051723  0.062816
pre_screening -0.017611      1.000000  ...  0.010782 -0.076925
ma_05      0.035576      0.053300  ... -0.344317  0.292603
ma_06      0.035929      0.054839  ... -0.360716  0.266338
ma_07      0.033395      0.053056  ... -0.389384  0.234691
ma_08      0.036506      0.059063  ... -0.411806  0.197511
ma_09      0.034817      0.060557  ... -0.437036  0.161631
ma_10      0.031889      0.060152  ... -0.435127  0.127861
ex_01      0.063597      0.062930  ...  0.390304  0.058015
ex_02      0.063061      0.052453  ...  0.291554  0.000479
ex_03      0.044449      0.053534  ...  0.284990  0.038281
ex_04      0.027656      0.041607  ...  0.172499  0.104254
ex_05      0.013336      0.015900  ...  0.072363  0.142273
ex_06      0.011864      0.018950  ...  0.053580  0.151424
ex_07      0.012695      0.023268  ...  0.040861  0.184772
ex_08      0.012289      0.023861  ...  0.028232  0.177313
distance     -0.021943      0.004751  ... -0.009871  0.008466
optic_disc_dia -0.067325     -0.079577  ... -0.082398 -0.030868
am_fm        -0.051723      0.010782  ...  1.000000 -0.042144
Class         0.062816     -0.076925  ... -0.042144  1.000000
```

[20 rows x 20 columns]

```
X_features
   qa  pre_screening  ma_05  ex_07  distance  optic_disc_dia  am_fm
0  1.0             1.0   22.0  0.003923  0.486903         0.100025    1.0
1  1.0             1.0   24.0  0.003903  0.520908         0.144414    0.0
2  1.0             1.0   62.0  0.041817  0.530904         0.128548    0.0
3  1.0             1.0   55.0  0.007653  0.483284         0.114790    0.0
```

```

4      1.0      1.0  44.0  0.000000  0.475935      0.123572  0.0
...    ...    ...    ...    ...    ...
1146   1.0      1.0  34.0  0.000000  0.537470      0.116795  0.0
1147   1.0      1.0  49.0  0.000000  0.516733      0.124190  0.0
1148   1.0      0.0  49.0  0.000000  0.560632      0.129843  0.0
1149   1.0      1.0  39.0  0.239568  0.485972      0.106690  1.0
1150   1.0      1.0   7.0  0.000000  0.556192      0.088957  0.0

```

[1151 rows x 7 columns]

```

y_features
  Class
0      0
1      0
2      1
3      0
4      1
...    ...
1146   0
1147   0
1148   0
1149   1
1150   0

```

[1151 rows x 1 columns]

```

y_features['Class'].value_counts()
1      611
0      540
Name: Class, dtype: int64

```

logistic_regression() is activated...

C:\ProgramFiles_Anaconda\Anaconda3\envs\math_stat_class\lib\site-packages\sklearn\utils\validation.py:760: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().

```
y = column_or_1d(y, warn=True)
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```

[illegible]

file:///E:/MU Study/Course/2019-02/RADS 602 DM ML/2020-01-29 Assignment DueDate 9Mar/Lab/Output/ipython.html

file:///E:/MU Study/Course/2019-02/RADS 602 DM ML/2020-01-29 Assignment DueDate 9Mar/Lab/Output/ipython.html

Intercept

-2.333317135302525

Coefficients

[1.52768758 -0.77797138 0.02533477 5.20695126 0.92878072 -1.31828015
0.25946629]

pop_DR

[0.27980486 0.47229 0.65029367 0.3284751 0.35256446 0.40804117
0.29780462 0.52941623 0.58560539 0.5196293 0.3604798 0.75191915
0.49749918 0.27835849 0.56837389 0.41943383 0.35539184 0.67438113
0.49629279 0.27676195 0.40279903 0.51939979 0.57761868 0.61961109
0.40268621 0.56531866 0.45165816 0.59079445 0.29405333 0.43219196
0.5383003 0.99896368 0.44190341 0.6453752 0.4298271 0.59327174
0.31888774 0.72534435 0.73633472 0.73991036 0.48799685 0.58375789
0.53248426 0.22161299 0.51806333 0.99999999 0.28273398 0.41204854
0.9979454 0.27633647 0.42923316 0.5673887 0.76191362 0.62610275
0.3985431 0.45038389 0.52007837 0.3038204 0.24774617 0.79891625
0.43726042 0.99665462 0.45598943 0.51676727 0.39836104 0.33588629
0.58240358 0.37648558 0.49641067 0.84958948 0.5036092 0.99643577
0.61408564 0.68343473 0.48757077 0.59383417 0.80509705 0.82020292
0.36891824 0.58620004 0.44814518 0.36607712 0.25499526 0.55711964
0.26458926 0.38110176 0.74736543 0.70357215 0.47617588 0.27026269
0.54627106 0.84248128 0.585841 0.22608082 0.28390207 0.65751342
0.24204471 0.38165245 0.49071468 0.81597898 0.37746517 0.84469907
0.44234194 0.63372684 0.3068522 0.40383687 0.44612129 0.43793453
0.42913225 0.24294255 0.62015324 0.27190694 0.65499038 0.29127197
0.53153102 0.34628393 0.48945598 0.32641847 0.99356139 0.36206316
0.39499064 0.50661773 0.49069816 0.6062702 0.73698133 0.32519497
0.90458885 0.60343083 0.50334143 0.54172703 0.37284761 0.47928841
0.37299833 0.76688128 0.39508723 0.4506598 0.61667322 0.45557751
0.41610964 0.41874524 0.36829933 0.73385991 0.41268157 0.33759371
0.57468696 0.5643593 0.29714014 0.54359759 0.87670333 0.29101943
0.34261604 0.93387889 0.51628256 0.38401212 0.32700448 0.52738714
0.27450487 0.38932216 0.54774299 0.56174332 0.31322142 0.94650977
0.37382735 0.54392912 0.78827085 0.44136273 0.68437799 0.30930815
0.38230492 0.3600889 0.81035867 0.4536968 0.54544381 0.38905714
0.38246714 0.50264771 0.5028372 0.33217439 0.69826127 0.31821996
0.27269399 0.36900293 0.50319889 0.32315905 0.51492693 0.32242993
0.35019337 0.31454649 0.45736387 0.4927583 0.55454062 0.62494699
0.77242488 0.46427423 0.11780871 0.65794966 0.39286142 0.33408532
0.36889906 0.29872894 0.5718093 0.43136483 0.6312066 0.96425741
0.29915367 0.61818035 0.99287149 0.28389401 0.35132154 0.64485531
0.84088228 0.46963869 0.53835467 0.99832196 0.5975178 0.42044709
0.34862035 0.2801904 0.41773266 0.50142234 0.99936383 0.33867644]

```
0.48297318 0.34509455 0.50036487 0.2640028 0.42164659 0.55602033
0.26770847 0.2584176 0.57935249]
```

```
yhat
```

```
[0 0 1 0 0 0 0 1 1 1 0 1 0 0 1 0 0 1 0 0 1 1 1 0 1 0 1 0 0 1 1 0 1 0
1 1 1 0 1 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1 0 0 1 0 1 0 1 0 0 1 0 0 1 1 1 1
0 1 1 1 0 1 0 0 0 1 0 0 1 1 0 0 1 1 1 0 0 1 0 0 0 1 0 1 0 1 0 0 0 0 0 1
0 1 0 1 0 0 0 1 0 0 1 0 1 1 0 1 1 1 1 0 0 0 1 0 0 1 0 0 0 1 0 0 1 1 0 1
1 0 0 1 1 0 0 1 0 0 1 1 0 1 0 1 1 0 1 0 0 0 1 0 1 0 0 1 1 0 1 0 0 0 1 0 1
0 0 0 0 0 1 1 1 0 0 1 0 0 0 0 1 0 1 1 0 1 1 0 0 1 1 0 1 1 1 0 0 0 1 1 0
0 0 1 0 0 1 0 0 1]
```

```
auc
```

```
0.7
```

```
model_logr_baseline["con_matrix"]
```

```
[[77 31]
 [50 73]]
```

```
Model performance calculate from confusion matrix:
```

```
accuracy: 0.6493506493506493
recall: 0.5934959349593496
specificity: 0.7129629629629629
precision: 0.7019230769230769
```

```
model_logr_baseline["class_report"]
```

	precision	recall	f1-score	support
0	0.61	0.71	0.66	108
1	0.70	0.59	0.64	123
accuracy			0.65	231
macro avg	0.65	0.65	0.65	231
weighted avg	0.66	0.65	0.65	231

```
clf_ex_tree.feature_importances_
```

```
[0.00319962 0.01040492 0.29629009 0.16557296 0.24981388 0.25634166
0.01837687]
```

```
X_features.columns[feature_imp_argsort_top_most]
```

```
Index(['ma_05', 'optic_disc_dia', 'distance', 'ex_07', 'am_fm'], dtype='object')
```

```
clf_ex_tree.feature_importances_[feature_imp_argsort_top_most]
```

```
[0.29629009 0.25634166 0.24981388 0.16557296 0.01837687]
```

```
X_train.shape  
(920, 5)
```

```
X_test.shape  
(231, 5)
```

```
y_train.shape  
(920, 1)
```

```
y_test.shape  
(231, 1)
```

```
logistic_regression() is activated...
```

```
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C:\ProgramFiles_Anaconda\Anaconda3\envs\math_stat_class\lib\site-packages\sklearn\model_selection\_search.py:281: UserWarning: The total
space of parameters 6 is smaller than n_iter=10. Running 6 iterations. For exhaustive searches, use GridSearchCV.
% (grid_size, self.n_iter, grid_size), UserWarning)
C:\ProgramFiles_Anaconda\Anaconda3\envs\math_stat_class\lib\site-packages\sklearn\model_selection\_validation.py:515: DataConversionWarning:
A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
estimator.fit(X_train, y_train, **fit_params)
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```

```

Intercept
-1.469997519886666

```

```

Coefficients
[ 0.02444863 -0.93568268  0.84374374  5.08940414  0.22639967]

```

```

pop_DR
[0.29945075 0.49236255 0.65532013 0.34718059 0.36614128 0.42927158
 0.31874324 0.54552252 0.59723167 0.53336947 0.37514749 0.75894716
 0.51801002 0.29871322 0.58244175 0.43997471 0.36877615 0.68220478
 0.51272706 0.30224674 0.41512574 0.53531858 0.58727032 0.63181761
 0.41469146 0.57680128 0.47132713 0.60422297 0.30942083 0.44975234]

```

```

0.55704174 0.99882491 0.46324071 0.65678427 0.44987425 0.6039617
0.33438374 0.73028443 0.7410701 0.74517619 0.50542071 0.40385627
0.35840608 0.24351207 0.53226455 0.99999999 0.30347289 0.42504336
0.99776409 0.29565894 0.44933167 0.57451655 0.7654364 0.63743635
0.41470204 0.46008295 0.53667952 0.32418413 0.26935423 0.80565198
0.44832482 0.99230865 0.46827275 0.35181334 0.41068463 0.35887249
0.59481922 0.38835719 0.51185315 0.8500882 0.52169011 0.99612981
0.6246219 0.69091226 0.50548022 0.60560242 0.80516715 0.82277729
0.382719 0.59883053 0.46583373 0.38613521 0.27607939 0.57143595
0.28476977 0.40026446 0.75710354 0.71066937 0.49620314 0.29199918
0.55993696 0.84201965 0.5974446 0.24747398 0.30141758 0.66683251
0.26225531 0.4008832 0.50994687 0.81692949 0.39005088 0.84674344
0.46117593 0.45544972 0.32882691 0.4169984 0.28859969 0.448473
0.44823766 0.26098706 0.63176723 0.29131071 0.66302868 0.31303106
0.54657444 0.36396299 0.50740647 0.34039476 0.99309281 0.38109701
0.40878327 0.52312737 0.50758972 0.43288691 0.74256184 0.3402029
0.90297741 0.61479685 0.5189731 0.55530992 0.38411666 0.48939853
0.38699905 0.76683007 0.40889564 0.46887048 0.62891311 0.47242865
0.42700052 0.43852513 0.3903277 0.73709495 0.43069325 0.35808854
0.58903831 0.57177594 0.31818133 0.56174221 0.76876165 0.30940499
0.35489179 0.93532933 0.53195753 0.39749661 0.34348338 0.54300241
0.29350987 0.4018932 0.56011044 0.39305396 0.33048101 0.94645865
0.38615786 0.55394746 0.79097991 0.46129326 0.69236272 0.32516167
0.39539028 0.38017024 0.81282431 0.4671856 0.5614914 0.41048145
0.39842046 0.51985162 0.52294539 0.34739387 0.7056165 0.33831723
0.29202775 0.38379637 0.52160026 0.33883277 0.53037781 0.33776447
0.36685845 0.32931593 0.47379243 0.51160648 0.56913922 0.63760683
0.77545343 0.47398993 0.40200371 0.66933333 0.41508066 0.35322152
0.38587089 0.31873337 0.58455514 0.4426741 0.64406043 0.96270458
0.31767124 0.43794146 0.99257013 0.30279325 0.36476858 0.65453092
0.84051933 0.48691429 0.54656769 0.99820471 0.60909622 0.44218587
0.3610418 0.29743905 0.43791211 0.51230052 0.99929424 0.3541027
0.49892123 0.36063572 0.51672454 0.28447245 0.43575467 0.57069041
0.28837682 0.27964471 0.59113311]

```

yhat

```

[0 0 1 0 0 0 0 1 1 1 0 1 1 0 1 0 0 1 1 0 0 1 1 1 0 1 0 1 0 0 1 1 0 1 0 1 0
1 1 1 1 0 0 0 1 1 0 0 1 0 0 1 1 1 0 0 1 0 0 1 0 1 0 0 0 0 1 0 1 1 1 1 1 1
1 1 1 1 0 1 0 0 0 1 0 0 1 1 0 0 1 1 1 0 0 1 0 0 1 1 0 1 0 0 0 0 0 0 0 0 1
0 1 0 1 0 1 0 1 0 0 1 1 0 1 0 1 1 1 1 0 0 0 1 0 0 1 0 0 0 0 1 0 0 1 1 0 1
1 0 0 1 1 0 0 1 0 0 1 0 0 1 0 1 1 0 1 0 0 0 1 0 1 0 0 1 1 0 1 0 0 0 1 0 1
0 0 0 0 1 1 1 1 0 0 1 0 0 0 0 1 0 1 1 0 0 1 0 0 1 1 0 1 1 1 0 0 0 0 1 1 0
0 0 1 0 0 1 0 0 1]

```

auc

0.68

```
model_logr["con_matrix"]
[[77 31]
 [48 75]]
```

Model performance calculate from confusion matrix:

```
accuracy: 0.658008658008658
recall: 0.6097560975609756
specificity: 0.7129629629629629
precision: 0.7075471698113207
```

```
model_logr["class_report"]
```

	precision	recall	f1-score	support
0	0.62	0.71	0.66	108
1	0.71	0.61	0.66	123
accuracy			0.66	231
macro avg	0.66	0.66	0.66	231
weighted avg	0.66	0.66	0.66	231

random_forest() is activated...

```
C:\ProgramFiles_Anaconda\Anaconda3\envs\math_stat_class\lib\site-packages\sklearn\model_selection\_validation.py:515: DataConversionWarning:
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```

[illegible]

```
C:\ProgramFiles_Anaconda\Anaconda3\nvs\math_stat_class\lib\site-packages\sklearn\model_selection\_validation.py:515: DataConversionWarning:  
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```

file:///E:/MU Study/Course/2019-02/RADS 602 DM ML/2020-01-29 Assignment DueDate 9Mar/Lab/Output/ipython.html

[illegible]

```
estimator.fit(X_train, y_train, **fit_params)
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```


[illegible]

```
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```

```

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    self.best_estimator_.fit(X, y, **fit_params)

```

pop_DR

```

[0.34464253 0.42673779 0.48143488 0.32040693 0.36803176 0.45263069
0.36099352 0.43063344 0.58481463 0.55034162 0.31818992 0.79097693
0.69767856 0.28631023 0.83636021 0.4343475 0.38782179 0.75431033
0.4330947 0.40177565 0.29946466 0.43682731 0.81269854 0.67268894
0.47311478 0.75699614 0.39296993 0.61655308 0.32128359 0.48443456
0.54357474 0.98064074 0.41191294 0.83944905 0.40482733 0.45436202
0.35140059 0.67159881 0.67268019 0.71204687 0.40880083 0.49971812
0.35280322 0.28065216 0.34325487 0.85723459 0.30292226 0.43332576
0.93625143 0.38818857 0.42217178 0.71546429 0.78442855 0.77773433
0.45691963 0.48119463 0.41275791 0.36308067 0.32624309 0.89375658
0.46265094 0.96764255 0.54110367 0.4610384 0.30200963 0.44718015
0.8655789 0.42100055 0.43773487 0.82252157 0.42292044 0.97483277
0.64763593 0.83094358 0.39481049 0.63577105 0.62740916 0.87923318
0.32944697 0.62722245 0.41984079 0.43869239 0.35070883 0.52213798
0.26157945 0.43671459 0.79027652 0.86487636 0.44432617 0.36192175
0.50531661 0.78747892 0.59777338 0.36873248 0.34659186 0.86649656
0.34223957 0.49148403 0.40884387 0.90685454 0.41818256 0.93242296
0.41491413 0.41683313 0.37064952 0.40708323 0.30150385 0.48760847
0.42822512 0.30168941 0.77089838 0.38596789 0.72178173 0.37296104
0.41614931 0.50163749 0.40976274 0.36772439 0.92802788 0.45919452
0.36654623 0.43878111 0.41056766 0.43326521 0.70000006 0.2548511
0.87087022 0.65436599 0.44029006 0.51642269 0.46362232 0.47951196
0.42084101 0.81432299 0.36062213 0.73081865 0.652598 0.44687729
0.51899953 0.78630834 0.46341292 0.85102544 0.4610459 0.39330618
0.5856056 0.4750769 0.37871172 0.47985141 0.70618542 0.44570315
0.40851737 0.78072711 0.44262375 0.39408023 0.32172211 0.41869281
0.28039254 0.43272928 0.60681119 0.4619693 0.36204254 0.90842364
0.50557459 0.45421956 0.75768197 0.40618651 0.79245766 0.24338117
0.43846553 0.74090899 0.78586354 0.35430273 0.39228513 0.42479071
0.41381706 0.38741905 0.38512425 0.31458618 0.86487636 0.38911826
0.23926693 0.2756524 0.42296237 0.30064695 0.43027621 0.30348364
0.37992364 0.20515959 0.45330674 0.42691084 0.39924219 0.73360756
0.87625826 0.48491768 0.43751366 0.85878518 0.46823785 0.51346016]

```

```
0.44162971 0.40516036 0.56039164 0.45747052 0.80199886 0.96477793
0.47725341 0.48040313 0.90787198 0.45233123 0.22248373 0.74634528
0.87366293 0.41976247 0.66067619 0.83593241 0.62497633 0.44361304
0.34334432 0.32358417 0.41620136 0.44697792 0.90957782 0.31617215
0.43864747 0.30037419 0.43735232 0.36469452 0.44439878 0.9058301
0.32759853 0.37784856 0.56583266]
```

```
yhat
```

```
[0 0 0 0 0 0 0 1 1 0 1 1 0 1 0 0 1 0 0 0 1 1 0 1 0 1 0 0 1 1 0 1 0 0 0
1 1 1 0 0 0 0 0 1 0 0 1 0 0 1 1 1 0 0 0 0 0 1 0 1 1 0 0 0 1 0 0 1 0 1 1 1
0 1 1 1 0 1 0 0 0 1 0 0 1 1 0 0 1 1 1 0 0 1 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1
0 1 0 0 1 0 0 1 0 0 0 0 0 1 0 1 1 0 1 0 0 0 1 0 1 1 0 1 1 0 1 0 0 1 0 0 0
1 0 0 1 0 0 0 0 0 0 1 0 0 1 1 0 1 0 1 0 0 1 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 1 1 0 0 1 0 1 0 0 1 0 1 1 0 0 1 0 0 1 1 0 1 1 1 0 0 0 0 0 1 0
0 0 0 0 0 1 0 0 1]
```

```
auc
```

```
0.67
```

```
model_rf["con_matrix"]
```

```
[[84 24]
 [64 59]]
```

Model performance calculate from confusion matrix:

```
accuracy: 0.6190476190476191
recall: 0.4796747967479675
specificity: 0.7777777777777778
precision: 0.7108433734939759
```

```
model_rf["class_report"]
```

	precision	recall	f1-score	support
0	0.57	0.78	0.66	108
1	0.71	0.48	0.57	123
accuracy			0.62	231
macro avg	0.64	0.63	0.61	231
weighted avg	0.64	0.62	0.61	231

```
gnb() is activated...
```

```
pop_DR
```

```
[0.0377543 0.07198836 0.08856794 0.03684697 0.02893851 0.05073802
0.03350486 0.08173874 0.1342158 0.09339764 0.02674801 0.99999964]
```

```

0.99954806 0.03404903 0.23040016 0.05103793 0.0319282 0.25238557
0.07339342 0.07511409 0.02878736 0.07546956 0.99011967 0.16196324
0.0362566 0.75080652 0.05676826 0.13272208 0.02636813 0.05656786
0.11166263 1. 0.06007746 0.50388574 0.05075155 0.08511296
0.02747815 0.39278513 0.47997686 0.44195535 0.06867807 0.0367437
0.02817852 0.03411267 0.06737616 1. 0.03364633 0.0318094
1. 0.03890139 0.05261058 0.07713628 0.48975105 0.17195757
0.02765143 0.03923738 0.08139447 0.03667503 0.03192108 0.99973758
0.03898302 1. 0.04678754 0.04454084 0.02732669 0.03306369
0.23788058 0.0385741 0.07986369 0.88553339 0.07791902 1.
0.16698844 0.25019899 0.06671598 0.13990392 0.77641108 0.77810561
0.02970211 0.12888394 0.05816235 0.04190008 0.03529304 0.09659339
0.0311009 0.04542782 1. 0.28370928 0.07219572 0.02750386
0.10562147 0.73183201 0.12746212 0.03652147 0.0219908 0.21673812
0.0311456 0.04335592 0.06433846 0.99995913 0.0328766 0.99999991
0.05501423 0.0285229 0.03580195 0.02897997 0.03952338 0.03906649
0.04937525 0.04078091 0.16492189 0.03987574 0.25655042 0.02800646
0.08614404 0.05725628 0.06953168 0.0311255 1. 0.04266858
0.02907001 0.06950535 0.0694097 0.05107417 0.44875188 0.0269933
1. 0.13997932 0.0718648 0.10618912 0.03852878 0.03849008
0.02378812 0.30040907 0.02671048 0.99509074 0.16247272 0.06431674
0.03683281 0.82389119 0.04370913 0.37942065 0.05348786 0.03689589
0.11840072 0.0603985 0.03586929 0.099115 0.51321166 0.04913332
0.03447978 1. 0.07643736 0.02870711 0.02440896 0.08359846
0.03441054 0.03376135 0.12595158 0.04763471 0.02475883 1.
0.03697608 0.04640719 0.63495519 0.05362047 0.28497679 0.02591202
0.03228968 0.10280285 0.7401553 0.03187516 0.08622559 0.04139222
0.03039404 0.06415265 0.074184 0.02733067 0.27079133 0.03671759
0.03386085 0.0268228 0.07718506 0.02305368 0.07596556 0.02726985
0.02777318 0.02105682 0.06751928 0.0755904 0.08068246 0.1792599
1. 0.0404838 0.04367088 0.99418897 0.05202511 0.04183237
0.02783893 0.0334457 0.10592405 0.03517135 0.18142693 1.
0.04425286 0.03336288 1. 0.04424532 0.02476146 0.18752333
1. 0.06429262 0.07144731 1. 0.1491928 0.05729884
0.0306611 0.0222917 0.04766073 0.03968628 1. 0.02657249
0.06884519 0.02327801 0.07503793 0.03521373 0.03104126 0.26307636
0.04978932 0.03503278 0.13184688]

```

yhat

```

[0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 1 0 0
0 0 1 1 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0
1 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0
0 0 0 0 0 0 0 0 0]

```

```
auc
0.67
```

```
model_gnb["con_matrix"]
[[103  5]
 [ 94 29]]
```

Model performance calculate from confusion matrix:

```
accuracy: 0.5714285714285714
recall: 0.23577235772357724
specificity: 0.9537037037037037
precision: 0.8529411764705882
```

```
model_gnb["class_report"]
      precision    recall  f1-score   support

     0       0.52       0.95       0.68        108
     1       0.85       0.24       0.37        123

 accuracy          0.57          231
  macro avg       0.69       0.59       0.52          231
 weighted avg     0.70       0.57       0.51          231
```

```
===Logistic Regression (Baseline)===
accuracy = 0.6493506493506493
recall = 0.5934959349593496
specificity = 0.7129629629629629
precision = 0.7019230769230769
auc = 0.7
```

```
===Logistic Regression===
accuracy = 0.658008658008658
recall = 0.6097560975609756
specificity = 0.7129629629629629
precision = 0.7075471698113207
auc = 0.68
```

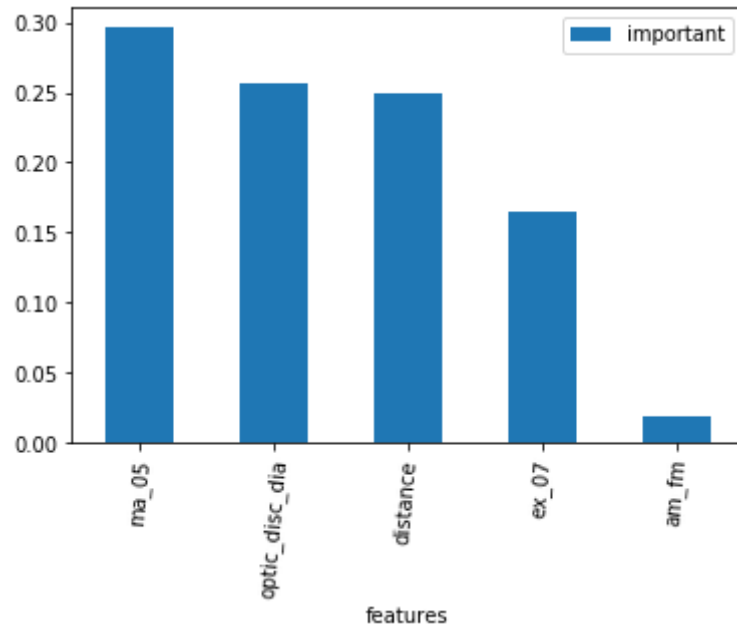
```
===Random Forest===
accuracy = 0.6190476190476191
recall = 0.4796747967479675
specificity = 0.7777777777777778
precision = 0.7108433734939759
auc = 0.67
```

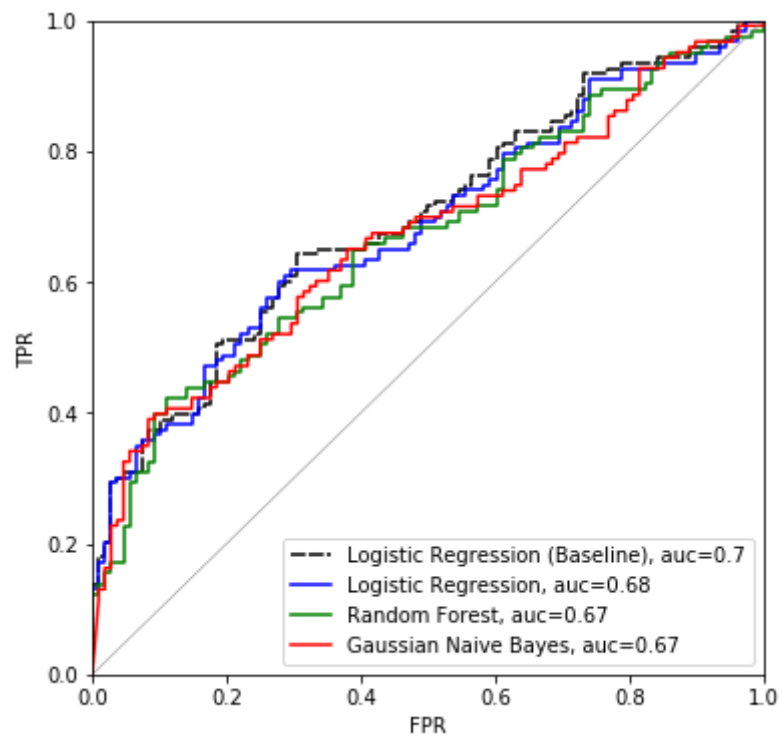
```
===Gaussian Naive Bayes===
```

```
accuracy = 0.5714285714285714  
recall = 0.23577235772357724  
specificity = 0.9537037037037037  
precision = 0.8529411764705882  
auc = 0.67
```

C:\ProgramFiles_Anaconda\Anaconda3\envs\math_stat_class\lib\site-packages\sklearn\naive_bayes.py:206: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().

```
y = column_or_1d(y, warn=True)
```





In [43]: