In [1]:

```
### BREAST CANCER CASES ###
###### Random Forest CODE IN JUPYTER NOTEBOOK #####
```

In [2]:

```
## Modules required
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import math
import keras
import tensorflow as tf
import warnings
```

In [3]:

```
# Code
BC = (pd.read_excel('cancer.xlsx'))
```

In [4]:

```
BC.head()
```

Out[4]:

	PatStatus	Race	MarST	Gender	AgeDiag	Grade	Stability	No.Visits	Lstay	Laterality	...	LyNode	Amorp
0	1	3	1	0	52	3	0	5	1	4	...	1	
1	1	3	1	0	48	3	0	4	3	5	...	1	
2	0	3	0	0	69	2	0	7	9	8	...	1	
3	1	3	0	0	47	2	0	15	9	9	...	1	
4	1	3	0	0	66	3	0	9	5	4	...	1	

5 rows × 25 columns

In [5]:

```
#Import 'train_test_split' from 'sklearn.model_selection'
from sklearn.model_selection import train_test_split

#Import numpy#
import numpy as np
```

In [6]:

```
y = BC.PatStatus
x = BC.drop(['PatStatus'], axis = 1)
```

In [7]:

```
#Split the data into train and test sets #
#Import 'train_test_split' from 'sklearn.model_selection'
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test=train_test_split(x,y, test_size=0.2, random_state=
123)


## Scaling the data
from sklearn.preprocessing import MinMaxScaler
from sklearn import preprocessing
import numpy as np

min_max_scaler = preprocessing.MinMaxScaler()
x_train_minmax = min_max_scaler.fit_transform(x_train)
x_test_minmax = min_max_scaler.fit_transform(x_test)
```

In [8]:

```
x_train = x_train_minmax
x_test = x_test_minmax
```

In [9]:

```
x_train.shape
```

Out[9]:

```
(80001, 24)
```

In [10]:

```
x_test.shape
```

Out[10]:

```
(20001, 24)
```

In [15]:

```
## Fitting the model
## Models required
from keras.applications.imagenet_utils import decode_predictions
import tensorflow as tf
from hyperas.distributions import choice, uniform
from sklearn.datasets import make_classification
from sklearn.metrics import confusion_matrix, roc_curve, roc_auc_score, plot_roc_cu
rve
from sklearn.model_selection import cross_val_score, cross_validate
from sklearn.ensemble import RandomForestClassifier

#Create a Gaussian Classifier
clf=RandomForestClassifier(n_estimators=100)

#Train the model using the training sets
rand_forest_model=clf.fit(x_train,y_train)
rand_forest_model
```

Out[15]:

```
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                       criterion='gini', max_depth=None, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=100,
                       n_jobs=None, oob_score=False, random_state=None,
                       verbose=0, warm_start=False)
```

In [16]:

```
# predict with splitted test data
y_pred = clf.predict(x_test)
```

In [17]:

```
##Fitting the neural network model using training dataset
tns_probs=[0 for _ in range(len(y_test))]
```

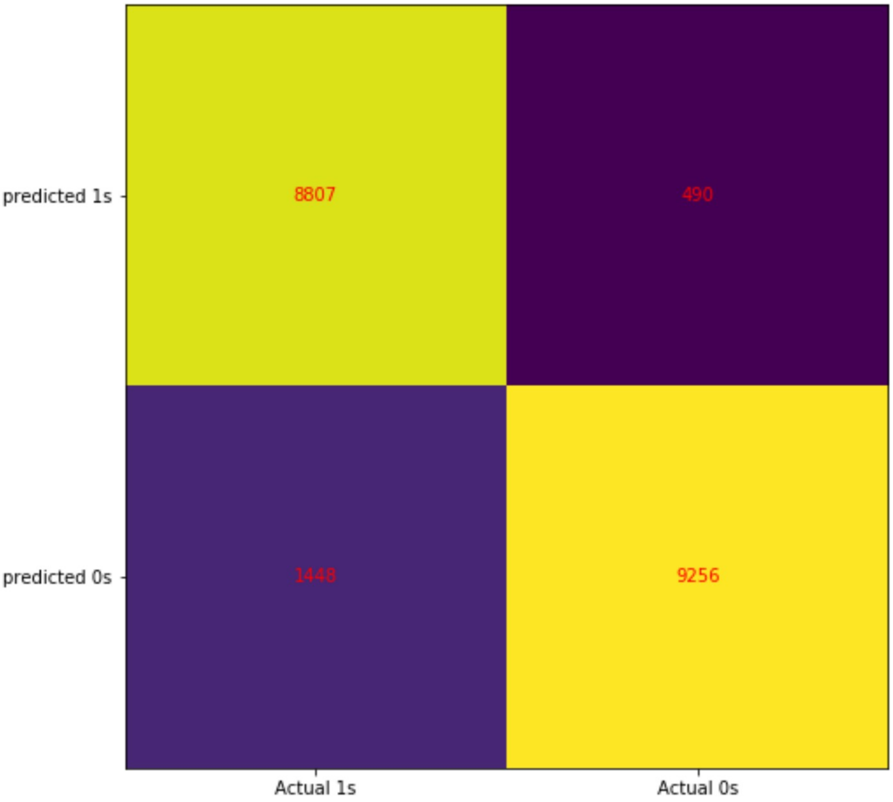
In [18]:

```
#Import scikit-learn metrics module for accuracy calculation
from sklearn import metrics

# Model Accuracy, how often is the classifier correct?
print("Accuracy:",metrics.accuracy_score(y_test, y_pred))
```

```
Accuracy: 0.9031048447577621
```

In [19]:

```
## CONFUSION MATRIX FOR BOTH SEX DATA
test_cm = confusion_matrix(y_test, np.round(y_pred))
fig, ax = plt.subplots(figsize = (8, 8))
ax.imshow(test_cm)
ax.grid(False)
ax.xaxis.set(ticks=(0,1), ticklabels=('Actual 1s', 'Actual 0s'))
ax.yaxis.set(ticks=(0,1), ticklabels=('predicted 1s', 'predicted 0s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, test_cm[i, j], ha= 'center', va= 'center', color= 'red')
plt.show()
```



In [20]:

```
## Error for the prediction for test dataset outcomes
test_error = (test_cm[0,1] + test_cm[1,0])/np.sum(test_cm)
print(test_error)
```

```
0.0968951552422379
```

In [21]:

```
## Accuracy of prediction
1-test_error
```

Out[21]:

```
0.9031048447577621
```

In [22]:

```
## Sensitivity Analysis
test_sens = test_cm[1, 1]/(test_cm[1, 1] + test_cm[0, 1])
print(test_sens)
```

```
0.9497229632669814
```

In [23]:

```
## Specificity Analysis
test_spec = test_cm[0, 0]/(test_cm[0, 0]+test_cm[1, 0])
print(test_spec)
```

```
0.8588005850804485
```

In [24]:

```
## PPV Analysis
test_npv = test_cm[1, 1]/(test_cm[1, 1] + test_cm[1, 0])
print(test_npv)
```

```
0.8647234678624813
```

In [25]:

```
## NPV Analysis
test_npv = test_cm[0, 0]/(test_cm[0, 0]+test_cm[0, 1])
print(test_npv)
```

```
0.94729482628805
```

In [26]:

```
## The AUC Score
test_auc = roc_auc_score(y_test, tns_probs)
y_pred_auc = np.round(roc_auc_score(y_test, y_pred), decimals = 2)
```

In [27]:

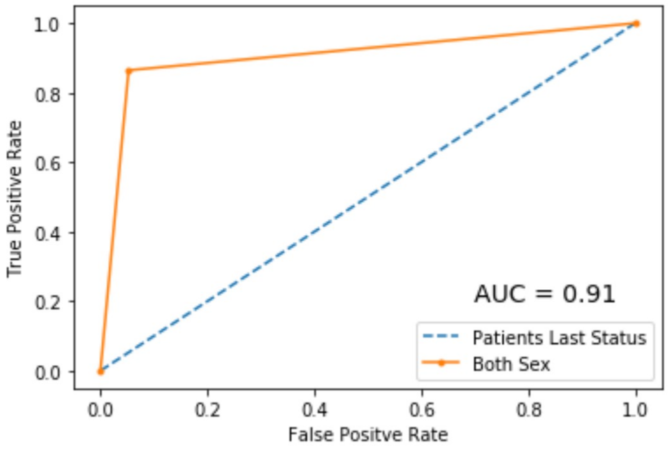
```
## calculate ROC Curves
test_fpr, test_tpr, _ = roc_curve(y_test, tns_probs)
y_pred_fpr, y_pred_tpr, _ = roc_curve(y_test, y_pred)
```

In [28]:

```
## Plot Curve for the model
import numpy as np
import matplotlib.pyplot as plt

plt.plot(test_fpr, test_tpr, linestyle = '--', label = 'Patients Last Status')
plt.plot(y_pred_fpr, y_pred_tpr, marker = '.', label = 'Both Sex')
plt.text(0.7, 0.2, "AUC = " + str(y_pred_auc), fontsize = 14)

## Axis lable
plt.xlabel("False Positve Rate")
plt.ylabel("True Positive Rate")

## Show Legend
plt.legend()
```

Out[28]:

```
<matplotlib.legend.Legend at 0x1600da42708>
```



In [ ]:

```
In [ ]:
```

```
In [ ]:
```

```
In [1]: ## CONSIDER THE NEURAL NETWORK FOR EACH GENDER SEPARATELY
        ## Modules required
        import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
        %matplotlib inline
```

```
In [2]: # Code
        MBC = (pd.read_excel('MBC.xlsx'))
```

```
In [3]: #Import 'train_test_split' from 'sklearn.model_selection'
        from sklearn.model_selection import train_test_split
        #Import numpy#
        import numpy as np
```

```
In [4]: #### THE MALE DATASET
        my=MBC.PatStatus
        mx=MBC.drop(['PatStatus', 'Gender'], axis=1)
```

```
In [5]: ## CONSIDER RBF FITTING FOR THE MALE GENDER
```

```
In [6]: #Split the Male data into train and test sets #
        mx_train, mx_test, my_train, my_test=train_test_split(mx,my, test_size=0.2, random_
        state=124)
```

```
In [7]: mx_train.head()
```

Out[7]:

	Race	MarST	AgeDiag	Grade	Stability	No.Visits	Lstay	Laterality	FamHist	PrioBSurgy	...	LyNode
12535	5	0	75	3	0	10	9	9	1	0	...	1
12133	1	0	64	2	0	16	9	9	1	0	...	1
12924	1	0	88	3	0	10	9	4	1	0	...	1
3857	1	0	59	3	0	15	9	9	1	0	...	1
2532	1	1	50	3	0	15	1	3	1	0	...	1

5 rows × 23 columns

```
In [8]: mx_test.head()
```

Out[8]:

	Race	MarST	AgeDiag	Grade	Stability	No.Visits	Lstay	Laterality	FamHist	PrioBSurgy	...	LyNode
738	1	1	52	3	0	1	8	9	1	1	...	1
4352	1	0	87	3	0	10	9	2	1	0	...	1
14248	1	1	55	1	0	15	9	8	1	0	...	1
1058	2	1	46	3	1	5	5	4	1	0	...	1
14218	5	0	66	2	0	16	9	4	1	0	...	1

5 rows × 23 columns

In [9]:
```
mx_train.shape
```

Out[9]:
```
(8224, 23)
```

In [10]:
```
mx_test.shape
```

Out[10]:
```
(2056, 23)
```

In [11]:
```
## Scaling the male data set
from sklearn.preprocessing import MinMaxScaler
from sklearn import preprocessing
import numpy as np

min_max_scaler = preprocessing.MinMaxScaler()
mx_train_minmax = min_max_scaler.fit_transform(mx_train)
mx_test_minmax = min_max_scaler.fit_transform(mx_test)
```

In [12]:
```
mx_train = mx_train_minmax
mx_test = mx_test_minmax

mx_train = np.array(mx_train)
mx_test = np.array(mx_test)
my_train = np.array(my_train)
my_test = np.array(my_test)
```

In [13]:
```
## FITTING NEURAL NETWORK FOR MALE DATA
```

In [14]:
```
from sklearn.datasets import make_classification
from sklearn.metrics import confusion_matrix, roc_curve, roc_auc_score, plot_roc_cu
rve
from sklearn.model_selection import cross_val_score, cross_validate
```

In [15]:
```
##Fitting the neural network model using training dataset
tns_probs=[0 for _ in range(len(my_test))]
```

In [16]:

```
## Fitting the model
## Models required
from keras.applications.imagenet_utils import decode_predictions
import tensorflow as tf
from hyperas.distributions import choice, uniform
from sklearn.datasets import make_classification
from sklearn.metrics import confusion_matrix, roc_curve, roc_auc_score, plot_roc_cu
rve
from sklearn.model_selection import cross_val_score, cross_validate
from sklearn.ensemble import RandomForestClassifier

#Create a Gaussian Classifier
clf=RandomForestClassifier(n_estimators=100, random_state = 5)

#Train the model using the training sets
mrand_forest_model=clf.fit(mx_train, my_train)
mrand_forest_model
```

Out[16]:

```
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                       criterion='gini', max_depth=None, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=100,
                       n_jobs=None, oob_score=False, random_state=5, verbose=0,
                       warm_start=False)
```

In [17]:

```
### PREDICTION USING THE TEST DATASET
```

In [18]:

```
# predict with splitted test data
my_pred = clf.predict(mx_test)
```

In [19]:

```
#Import scikit-learn metrics module for accuracy calculation
from sklearn import metrics

# Model Accuracy, how often is the classifier correct?
print("Accuracy:",metrics.accuracy_score(my_test, my_pred))
```

```
Accuracy: 0.9494163424124513
```

In [20]:

```
# feature importance variable
import pandas as pd
MBC = pd.DataFrame(MBC.values, columns=[["PatStatus",
                                         "Race","MarST",
                                         "Gender",
                                         "AgeDiag",
                                         "Grade",
                                         "Stability",
                                         "No.Visits",
                                         "Lstay",
                                         "Laterality",
                                         "FamHist",
                                         "PrioBSurgy",
                                         "Suture",
                                         "Density",
                                         "NipRet",
                                         "LyNode",
                                         "Amorph",
                                         "Size",
                                         "Eggshell",
                                         "Milk",
                                         "AxiAden",
                                         "Distroph",
                                         "Lucent",
                                         "Dermal",
                                         "SkinnLesson"
]])

feature_imp = pd.Series(clf.feature_importances_, index = [
                                         "Race",
                                         "MarST",
                                         "AgeDiag",
                                         "Grade",
                                         "Stability",
                                         "No.Visits",
                                         "Lstay",
                                         "Laterality",
                                         "FamHist",
                                         "PrioBSurgy",
                                         "Suture",
                                         "Density",
                                         "NipRet",
                                         "LyNode",
                                         "Amorph",
                                         "Size",
                                         "Eggshell",
                                         "Milk",
                                         "AxiAden",
                                         "Distroph",
                                         "Lucent",
                                         "Dermal",
                                         "SkinnLesson"]).sort_values(ascending =Fal
se)
```

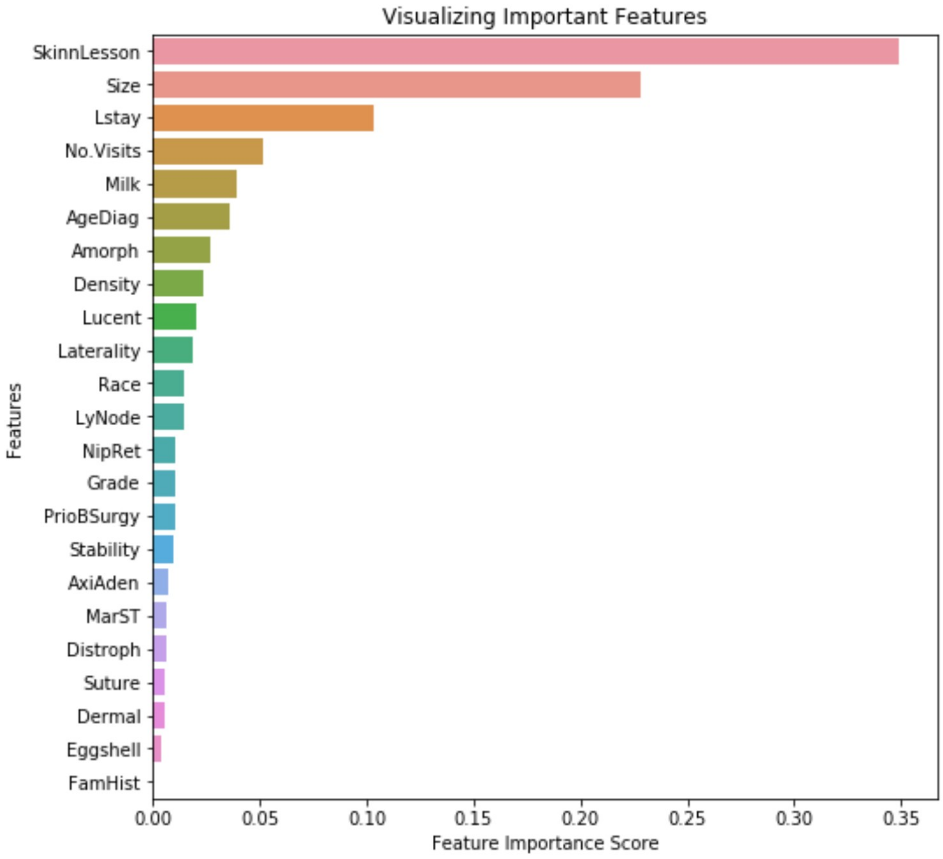
```
In [21]: feature_imp
```

```
Out[21]: SkinnLesson    0.349386
         Size           0.227863
         Lstay          0.103242
         No.Visits      0.051164
         Milk           0.039392
         AgeDiag        0.035818
         Amorph         0.026599
         Density        0.023298
         Lucent         0.020689
         Laterality     0.018861
         Race           0.014629
         LyNode         0.014476
         NipRet         0.010778
         Grade          0.010599
         PrioBSurgy     0.010189
         Stability      0.009298
         AxiAden        0.006768
         MarST          0.006625
         Distroph       0.005998
         Suture         0.005569
         Dermal         0.005270
         Eggshell       0.003468
         FamHist        0.000021
         dtype: float64
```

```
In [22]: # List of features for later use
         feature_list = list(MBC.columns)

         # Get numerical feature importances
         importances = list(clf.feature_importances_)

         # List of tuples with variable and importance
         feature_importances = [(feature, round(importance, 2)) for feature, importance in z
         ip(feature_list, importances)]

         # list of x locations for plotting
         x_values = list(range(len(importances)))
```

In [23]:

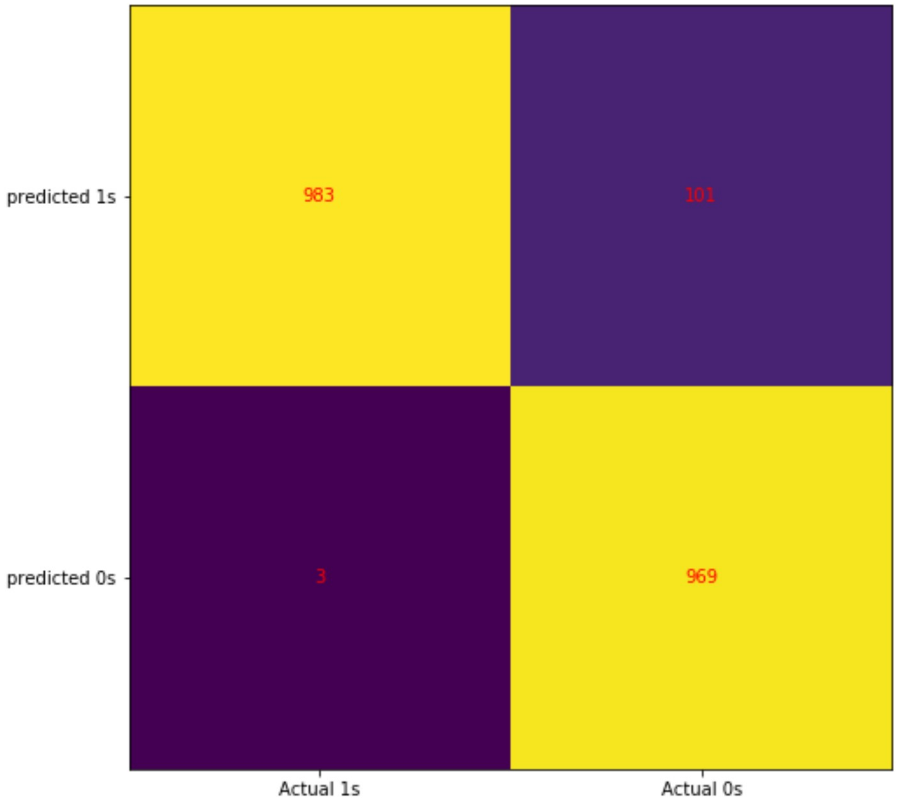
```
# use the feature importance variable to see feature importance scores
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline

plt.figure(figsize=(8,8))
# Creating a bar plot
sns.barplot(x=feature_imp, y=feature_imp.index)
# Add labels to your graph
plt.xlabel('Feature Importance Score')
plt.ylabel('Features')
plt.title("Visualizing Important Features")
#plt.legend()
plt.show()
```



In [24]:

```
##Fitting the neural network model using training dataset
tns_probs=[0 for _ in range(len(my_test))]
```

In [26]:
```
## CONFUSION MATRIX FOR MALE DATA
mtest_cm = confusion_matrix(my_test, np.round(my_pred))
fig, ax = plt.subplots(figsize = (8, 8))
ax.imshow(mtest_cm)
ax.grid(False)
ax.xaxis.set(ticks=(0,1), ticklabels=('Actual 1s', 'Actual 0s'))
ax.yaxis.set(ticks=(0,1), ticklabels=('predicted 1s', 'predicted 0s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, mtest_cm[i, j], ha= 'center', va= 'center', color= 'red')
plt.show()
```



In [27]:
```
## Error for the prediction for test dataset outcomes
mtest_error = (mtest_cm[0,1] + mtest_cm[1,0])/np.sum(mtest_cm)
print(mtest_error)
```

```
0.05058365758754864
```

In [28]:
```
## Accuracy of prediction
1-mtest_error
```

Out[28]:
```
0.9494163424124513
```

In [29]:
```
## Sensitivity Analysis
mtest_sens = mtest_cm[1, 1]/(mtest_cm[1, 1] + mtest_cm[0, 1])
print(mtest_sens)
```

```
0.905607476635514
```

In [30]:
```
## Specificity Analysis
mtest_spec = mtest_cm[0, 0]/(mtest_cm[0, 0]+ mtest_cm[1, 0])
print(mtest_spec)
```

```
0.9969574036511156
```

In [31]:
```
## PPV Analysis
mtest_npv = mtest_cm[1, 1]/(mtest_cm[1, 1] + mtest_cm[1, 0])
print(mtest_npv)
```

```
0.9969135802469136
```

In [32]:
```
## NPV Analysis
mtest_npv = mtest_cm[0, 0]/(mtest_cm[0, 0] + mtest_cm[0, 1])
print(mtest_npv)
```

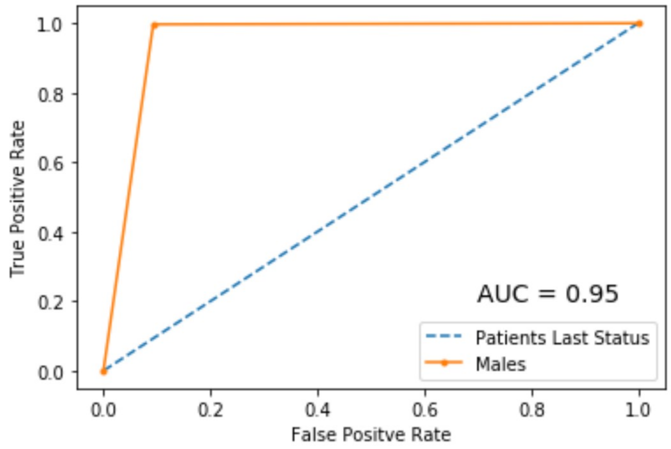
```
0.9068265682656826
```

In [33]:
```
## The AUC Score
mtest_auc = roc_auc_score(my_test, tns_probs)
my_pred_auc = np.round(roc_auc_score(my_test, my_pred), decimals = 2)
```

In [34]:
```
## calculate ROC Curves
mtest_fpr, mtest_tpr, _ = roc_curve(my_test, tns_probs)
my_pred_fpr, my_pred_tpr, _ = roc_curve(my_test, my_pred)
```

In [35]:
```
## Plot Curve for the model
import numpy as np
import matplotlib.pyplot as plt

plt.plot(mtest_fpr, mtest_tpr, linestyle = '--', label = 'Patients Last Status')
plt.plot(my_pred_fpr, my_pred_tpr, marker = '.', label = 'Males')
plt.text(0.7, 0.2, "AUC = " + str(my_pred_auc), fontsize = 14)

## Axis lable
plt.xlabel("False Positve Rate")
plt.ylabel("True Positive Rate")

## Show Legend
plt.legend()
```

Out[35]:
```
<matplotlib.legend.Legend at 0x1634e913408>
```



In [ ]:

In [ ]:

```

```

In [ ]:

```

```

In [1]:

```
## CONSIDERING THE FEMALE DATA
## Modules required
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
FBC = (pd.read_excel('FBC.xlsx'))

fy=FBC.PatStatus
fx=FBC.drop(['PatStatus', 'Gender'],axis=1)
```

In [2]:

```
FBC.shape
```

Out[2]:

```
(84403, 25)
```

In [3]:

```
#Import 'train_test_split' from 'sklearn.model_selection'
from sklearn.model_selection import train_test_split

#Import numpy#
import numpy as np
#Split the Male data into train and test sets #
fx_train, fx_test, fy_train, fy_test=train_test_split(fx,fy, test_size=0.2, random_
state=125)
```

In [4]:

```
# Scaling the female data
from sklearn.preprocessing import MinMaxScaler
from sklearn import preprocessing
import numpy as np

min_max_scaler = preprocessing.MinMaxScaler()
fx_train_minmax = min_max_scaler.fit_transform(fx_train)
fx_test_minmax = min_max_scaler.fit_transform(fx_test)
```

In [5]:

```
fx_train = fx_train_minmax
fx_test = fx_test_minmax
```

In [6]:

```
### FITTING THE NEURAL NETWORK USING THE FEMALE TRAINING DATASET
from sklearn.neural_network import MLPClassifier
from sklearn.datasets import make_classification
from sklearn.metrics import confusion_matrix, roc_curve, roc_auc_score, plot_roc_cu
rve
from sklearn.model_selection import cross_val_score, cross_validate

tns_probs=[0 for _ in range(len(fy_test))]
```

In [7]:

```
## Fitting the model
## Models required
from keras.applications.imagenet_utils import decode_predictions
import tensorflow as tf
from hyperas.distributions import choice, uniform
from sklearn.datasets import make_classification
from sklearn.metrics import confusion_matrix, roc_curve, roc_auc_score, plot_roc_cu
rve
from sklearn.model_selection import cross_val_score, cross_validate
from sklearn.ensemble import RandomForestClassifier

#Create a Gaussian Classifier
clf=RandomForestClassifier(n_estimators=5, random_state = 5)

#Train the model using the training sets
frand_forest_model=clf.fit(fx_train,fy_train)
frand_forest_model
```

Out[7]:

```
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                       criterion='gini', max_depth=None, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=5,
                       n_jobs=None, oob_score=False, random_state=5, verbose=0,
                       warm_start=False)
```

In [8]:

```
## PREDICTION USING THE TEST DATASET
```

In [9]:

```
### Getting the prediction for the Testing dataset
fy_pred = clf.predict(fx_test)
```

In [10]:

```
#Import scikit-learn metrics module for accuracy calculation
from sklearn import metrics

# Model Accuracy, how often is the classifier correct?
print("Accuracy:",metrics.accuracy_score(fy_test, fy_pred))
```

```
Accuracy: 0.889402286594396
```

In [11]:

```
# feature importance variable
import pandas as pd
FBC = pd.DataFrame(FBC.values, columns=[["PatStatus",
                                         "Race","MarST",
                                         "Gender",
                                         "AgeDiag",
                                         "Grade",
                                         "Stability",
                                         "No.Visits",
                                         "Lstay",
                                         "Laterality",
                                         "FamHist",
                                         "PrioBSurgy",
                                         "Suture",
                                         "Density",
                                         "NipRet",
                                         "LyNode",
                                         "Amorph",
                                         "Size",
                                         "Eggshell",
                                         "Milk",
                                         "AxiAden",
                                         "Distroph",
                                         "Lucent",
                                         "Dermal",
                                         "SkinnLesson"
]])

feature_imp = pd.Series(clf.feature_importances_, index = [
                                         "Race","MarST",
                                         "AgeDiag",
                                         "Grade",
                                         "Stability",
                                         "No.Visits",
                                         "Lstay",
                                         "Laterality",
                                         "FamHist",
                                         "PrioBSurgy",
                                         "Suture",
                                         "Density",
                                         "NipRet",
                                         "LyNode",
                                         "Amorph",
                                         "Size",
                                         "Eggshell",
                                         "Milk",
                                         "AxiAden",
                                         "Distroph",
                                         "Lucent",
                                         "Dermal",
                                         "SkinnLesson"]).sort_values(ascending =Fal
se)
```

In [12]:

```
feature_imp
```

Out[12]:

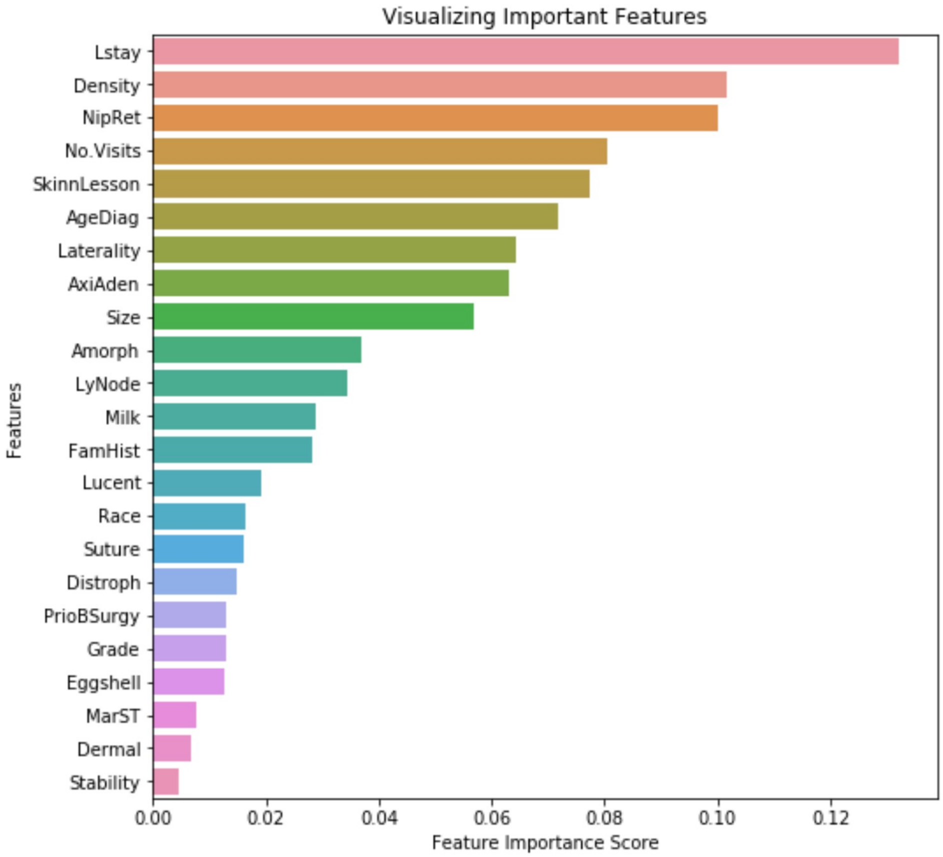
```
Lstay           0.132272
Density         0.101575
NipRet          0.100182
No.Visits       0.080408
SkinnLesson     0.077362
AgeDiag         0.071854
Laterality      0.064168
AxiAden         0.063047
Size            0.056779
Amorph          0.036994
LyNode          0.034484
Milk            0.028956
FamHist         0.028135
Lucent          0.019203
Race            0.016249
Suture          0.015950
Distroph        0.014919
PrioBSurgy      0.013072
Grade           0.012817
Eggshell        0.012590
MarST           0.007673
Dermal          0.006710
Stability       0.004602
dtype: float64
```

In [13]:

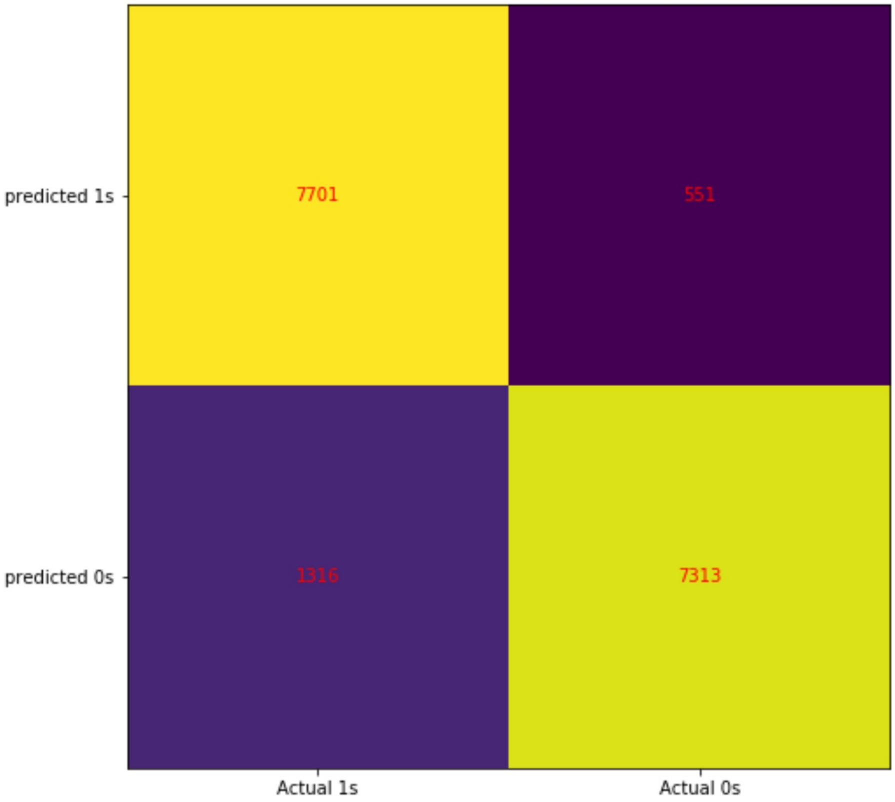
```
# List of features for later use
feature_list = list(FBC.columns)

# Get numerical feature importances
importances = list(clf.feature_importances_)

# List of tuples with variable and importance
feature_importances = [(feature, round(importance, 2)) for feature, importance in z
ip(feature_list, importances)]

# list of x locations for plotting
x_values = list(range(len(importances)))
```

In [14]:

```
# use the feature importance variable to see feature importance scores
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline

plt.figure(figsize=(8,8))
# Creating a bar plot
sns.barplot(x=feature_imp, y=feature_imp.index)
# Add labels to your graph
plt.xlabel('Feature Importance Score')
plt.ylabel('Features')
plt.title("Visualizing Important Features")
#plt.legend()
plt.show()
```



In [15]:
```
## CONFUSION MATRIX FOR MALE DATA
ftest_cm = confusion_matrix(fy_test, np.round(fy_pred))
fig, ax = plt.subplots(figsize = (8, 8))
ax.imshow(ftest_cm)
ax.grid(False)
ax.xaxis.set(ticks=(0,1), ticklabels=('Actual 1s', 'Actual 0s'))
ax.yaxis.set(ticks=(0,1), ticklabels=('predicted 1s', 'predicted 0s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, ftest_cm[i, j], ha= 'center', va= 'center', color= 'red')
plt.show()
```



In [16]:
```
## Error for the prediction for test dataset outcomes
ftest_error = (ftest_cm[0,1] + ftest_cm[1,0])/np.sum(ftest_cm)
print(ftest_error)
```

```
0.11059771340560394
```

In [17]:
```
## Accuracy of prediction
1-ftest_error
```

Out[17]:
```
0.889402286594396
```

In [18]:
```
## Sensitivity Analysis
ftest_sens = ftest_cm[1, 1]/(ftest_cm[1, 1] + ftest_cm[0, 1])
print(ftest_sens)
```

```
0.9299338758901322
```

In [19]:
```
## Specificity Analysis
ftest_spec = ftest_cm[0, 0]/(ftest_cm[0, 0]+ ftest_cm[1, 0])
print(ftest_spec)
```

```
0.8540534545857824
```

In [20]:
```
## PPV Analysis
ftest_npv = ftest_cm[1, 1]/(ftest_cm[1, 1] + ftest_cm[1, 0])
print(ftest_npv)
```

```
0.8474910186580137
```

In [21]:
```
## NPV Analysis
ftest_npv = ftest_cm[0, 0]/(ftest_cm[0, 0] + ftest_cm[0, 1])
print(ftest_npv)
```

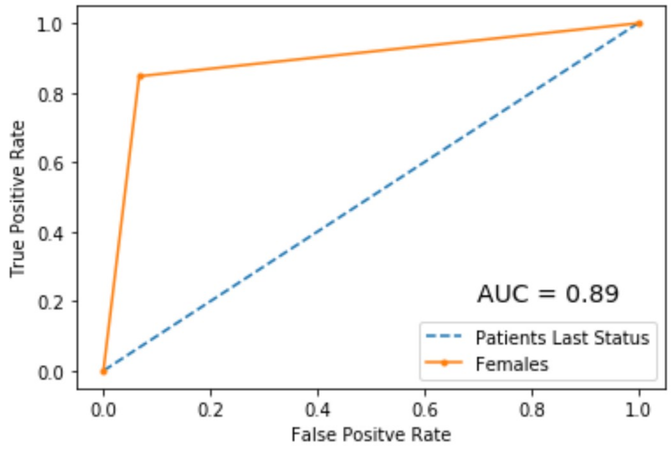
```
0.9332283082888997
```

In [22]:
```
## The AUC Score
ftest_auc = roc_auc_score(fy_test, tns_probs)
fy_pred_auc = np.round(roc_auc_score(fy_test, fy_pred), decimals = 2)
```

In [23]:
```
## calculate ROC Curves
ftest_fpr, ftest_tpr, _ = roc_curve(fy_test, tns_probs)
fy_pred_fpr, fy_pred_tpr, _ = roc_curve(fy_test, fy_pred)
```

In [24]:
```
## Plot Curve for the model
import numpy as np
import matplotlib.pyplot as plt

plt.plot(ftest_fpr, ftest_tpr, linestyle = '--', label = 'Patients Last Status')
plt.plot(fy_pred_fpr, fy_pred_tpr, marker = '.', label = 'Females')
plt.text(0.7, 0.2, "AUC = " + str(fy_pred_auc), fontsize = 14)

## Axis lable
plt.xlabel("False Positve Rate")
plt.ylabel("True Positive Rate")

## Show Legend
plt.legend()
```

Out[24]:
```
<matplotlib.legend.Legend at 0x1dafc166ec8>
```



In [ ]:

```
In [ ]:
```

```
In [ ]:
```