Diabetes Prediction

Predict whether a person has diabetes or not.

Dataset Link: https://www.kaggle.com/johndasilva/diabetes

In [0]:
```
# Importing essential libraries
import numpy as np
import pandas as pd
```

In [0]:
```
# Loading the dataset
df = pd.read_csv('kaggle_diabetes.csv')
```

Exploring the dataset

In [43]:
```
# Returns number of rows and columns of the dataset
df.shape
```

Out[43]:
```
(2000, 9)
```

In [44]:
```
# Returns an object with all of the column headers
df.columns
```

Out[44]:
```
Index(['Pregnancies', 'Glucose', 'BloodPressure', 'SkinThickness', 'Insulin',
       'BMI', 'DiabetesPedigreeFunction', 'Age', 'Outcome'],
      dtype='object')
```

In [45]:
```
# Returns different datatypes for each columns (float, int, string, bool, etc.)
df.dtypes
```

Out[45]:
```
Pregnancies                   int64
Glucose                       int64
BloodPressure                 int64
SkinThickness                 int64
Insulin                       int64
BMI                         float64
DiabetesPedigreeFunction    float64
Age                           int64
Outcome                       int64
dtype: object
```

In [46]:
```
# Returns the first x number of rows when head(num). Without a number it returns 5
df.head()
```

Out[46]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age
0	2	138	62	35	0	33.6	0.127	47
1	0	84	82	31	125	38.2	0.233	23
2	0	145	0	0	0	44.2	0.630	31
3	0	135	68	42	250	42.3	0.365	24
4	1	139	62	41	480	40.7	0.536	21

In [47]:

```
# Returns basic information on all columns
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2000 entries, 0 to 1999
Data columns (total 9 columns):
 #   Column                    Non-Null Count  Dtype  
---  ------                    --------------  -----  
 0   Pregnancies               2000 non-null   int64  
 1   Glucose                   2000 non-null   int64  
 2   BloodPressure             2000 non-null   int64  
 3   SkinThickness             2000 non-null   int64  
 4   Insulin                   2000 non-null   int64  
 5   BMI                       2000 non-null   float64
 6   DiabetesPedigreeFunction  2000 non-null   float64
 7   Age                       2000 non-null   int64  
 8   Outcome                   2000 non-null   int64  
dtypes: float64(2), int64(7)
memory usage: 140.8 KB
```

In [48]:

```
# Returns basic statistics on numeric columns
df.describe().T
```

Out[48]:

	count	mean	std	min	25%	50%	75%	max
Pregnancies	2000.0	3.70350	3.306063	0.000	1.000	3.000	6.000	17.00
Glucose	2000.0	121.18250	32.068636	0.000	99.000	117.000	141.000	199.00
BloodPressure	2000.0	69.14550	19.188315	0.000	63.500	72.000	80.000	122.00
SkinThickness	2000.0	20.93500	16.103243	0.000	0.000	23.000	32.000	110.00
Insulin	2000.0	80.25400	111.180534	0.000	0.000	40.000	130.000	744.00
BMI	2000.0	32.19300	8.149901	0.000	27.375	32.300	36.800	80.60
DiabetesPedigreeFunction	2000.0	0.47093	0.323553	0.078	0.244	0.376	0.624	2.42
Age	2000.0	33.09050	11.786423	21.000	24.000	29.000	40.000	81.00
Outcome	2000.0	0.34200	0.474498	0.000	0.000	0.000	1.000	1.00

In [49]:

```
# Returns true for a column having null values, else false
df.isnull().any()
```

Out[49]:

```
Pregnancies                 False
Glucose                     False
BloodPressure               False
SkinThickness               False
Insulin                     False
BMI                         False
DiabetesPedigreeFunction    False
Age                         False
Outcome                     False
dtype: bool
```

In [50]:

```
df = df.rename(columns={'DiabetesPedigreeFunction':'DPF'})
df.head()
```

Out[50]:

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

In [0]:

```
# Importing essential libraries for visualization
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

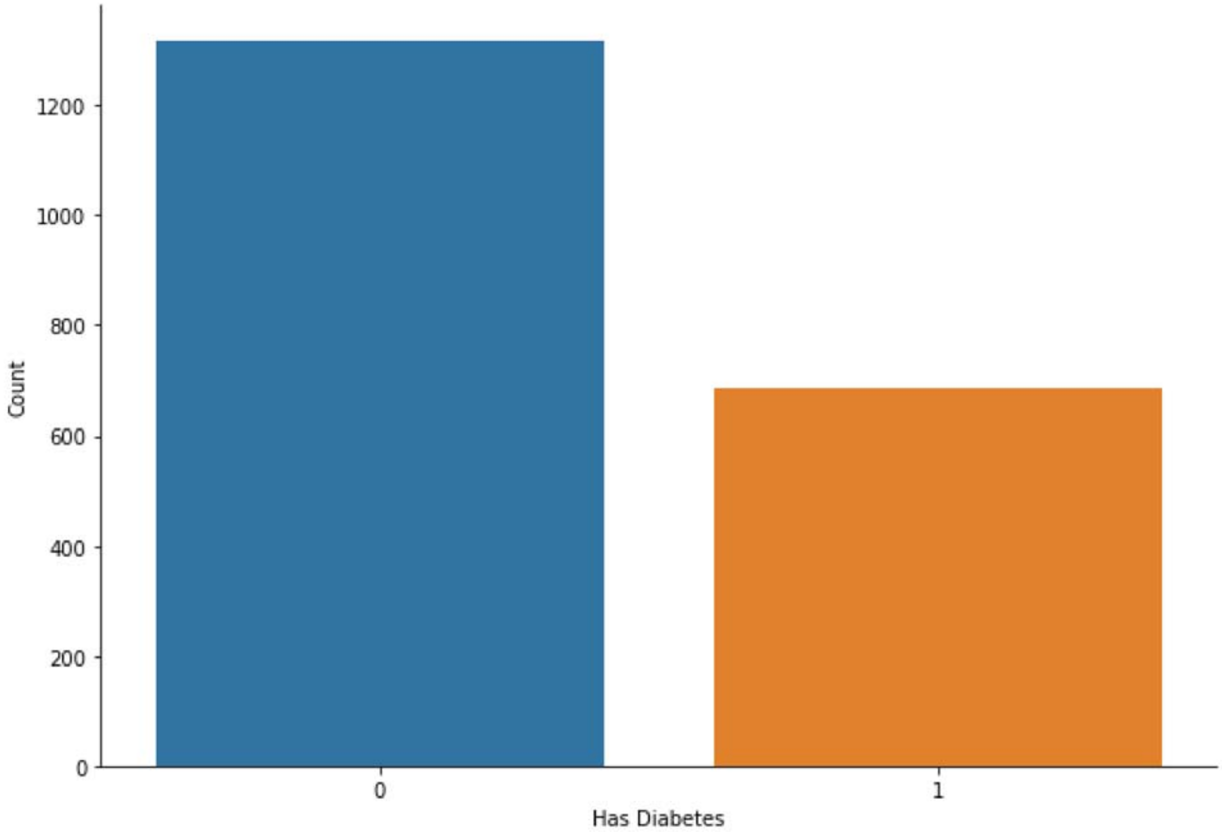
In [52]:

```
# Plotting the Outcomes based on the number of dataset entries
plt.figure(figsize=(10,7))
sns.countplot(x='Outcome', data=df)

# Removing the unwanted spines
plt.gca().spines['top'].set_visible(False)
plt.gca().spines['right'].set_visible(False)

# Headings
plt.xlabel('Has Diabetes')
plt.ylabel('Count')

plt.show()
```



Data Cleaning

In [53]:

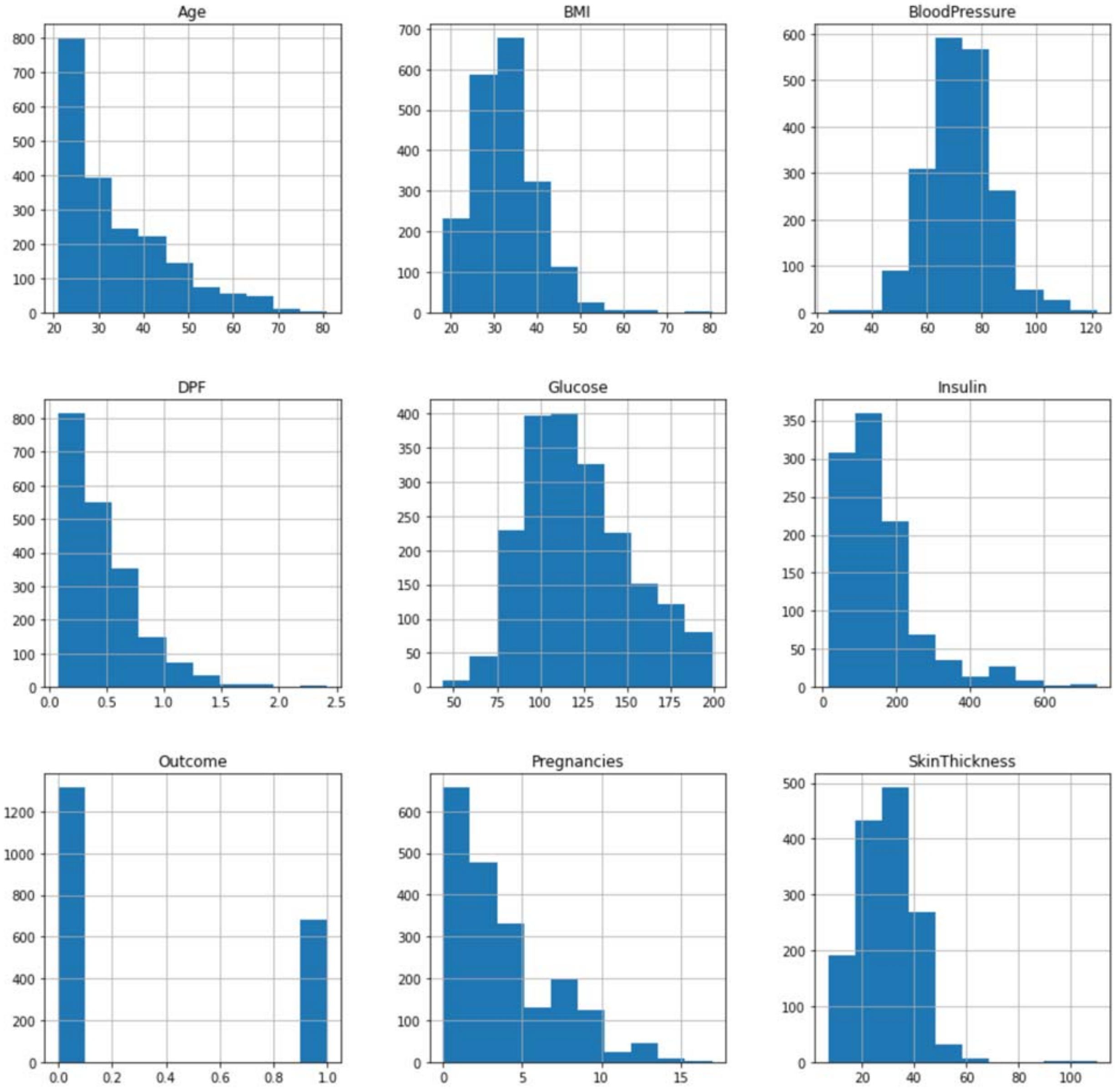
```
# Replacing the 0 values from ['Glucose','BloodPressure','SkinThickness','Insulin','BM
df_copy = df.copy(deep=True)
df_copy[['Glucose','BloodPressure','SkinThickness','Insulin','BMI']] = df_copy[['Gluco
df_copy.isnull().sum()
```

Out[53]:

```
Pregnancies        0
Glucose           13
BloodPressure     90
SkinThickness    573
Insulin          956
BMI               28
DPF                0
Age                0
Outcome            0
dtype: int64
```

In [54]:

```
# To fill these Nan values the data distribution needs to be understood
# Plotting histogram of dataset before replacing NaN values
p = df_copy.hist(figsize = (15,15))
```

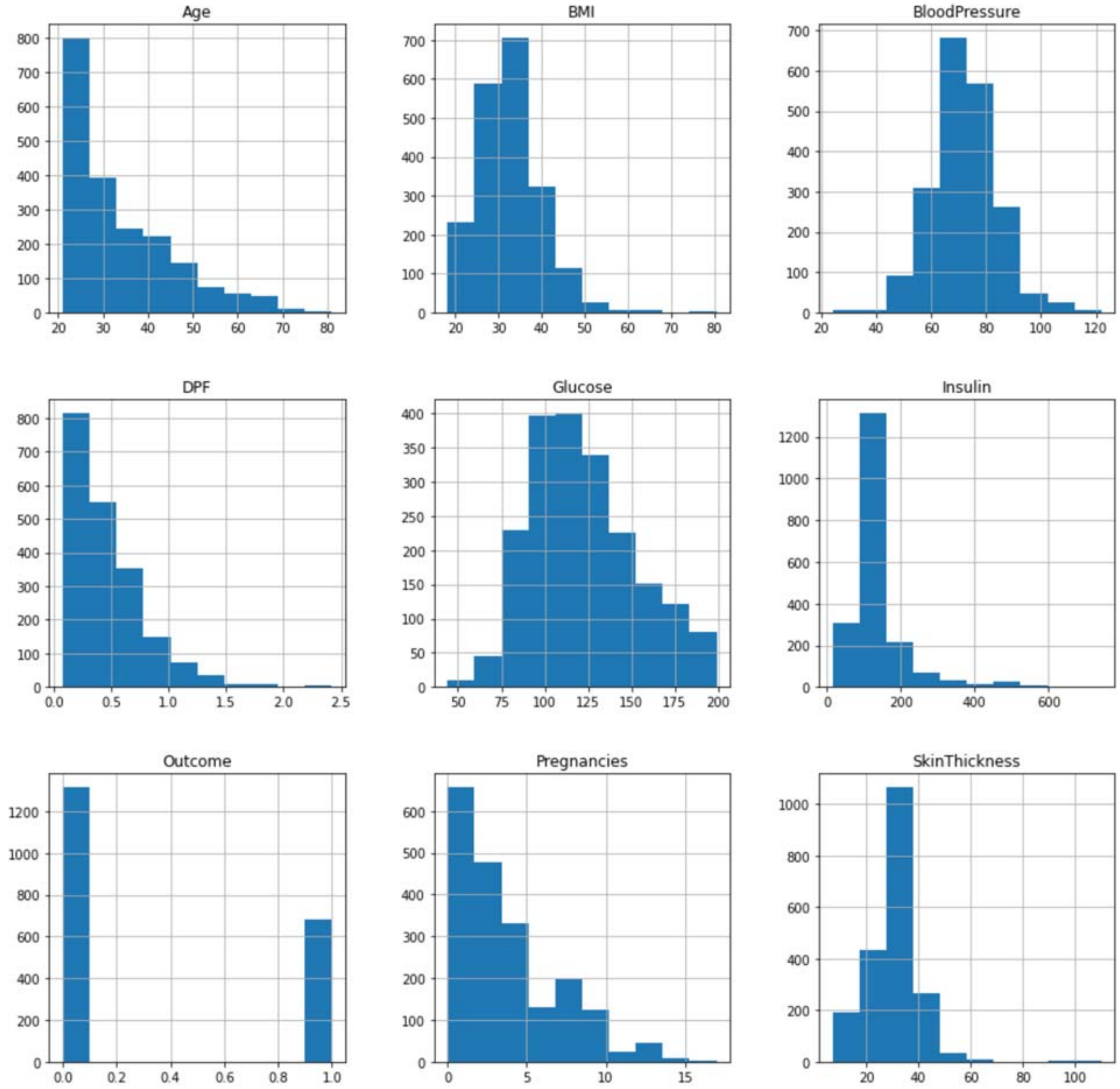


In [0]:

```
# Replacing NaN value by mean, median depending upon distribution
df_copy['Glucose'].fillna(df_copy['Glucose'].mean(), inplace=True)
df_copy['BloodPressure'].fillna(df_copy['BloodPressure'].mean(), inplace=True)
df_copy['SkinThickness'].fillna(df_copy['SkinThickness'].median(), inplace=True)
df_copy['Insulin'].fillna(df_copy['Insulin'].median(), inplace=True)
df_copy['BMI'].fillna(df_copy['BMI'].median(), inplace=True)
```

In [56]:

```
# Plotting histogram of dataset after replacing NaN values
p = df_copy.hist(figsize=(15,15))
```



In [57]:

```
df_copy.isnull().sum()
```

Out[57]:

```
Pregnancies      0
Glucose          0
BloodPressure    0
SkinThickness    0
Insulin          0
BMI              0
DPF              0
Age              0
Outcome          0
dtype: int64
```

Model Building

In [58]:

```
from sklearn.model_selection import train_test_split

X = df.drop(columns='Outcome')
y = df['Outcome']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.20, random_state
print('X_train size: {}, X_test size: {}'.format(X_train.shape, X_test.shape))
```

```
X_train size: (1600, 8), X_test size: (400, 8)
```

In [0]:

```
# Feature Scaling
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

In [0]:

```
# Using GridSearchCV to find the best algorithm for this problem
from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import ShuffleSplit
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
```

In [61]:

```
# Creating a function to calculate best model for this problem
def find_best_model(X, y):
    models = {
        'logistic_regression': {
            'model': LogisticRegression(solver='lbfgs', multi_class='auto'),
            'parameters': {
                'C': [1,5,10]
               }
        },

        'decision_tree': {
            'model': DecisionTreeClassifier(splitter='best'),
            'parameters': {
                'criterion': ['gini', 'entropy'],
                'max_depth': [5,10]
            }
        },

        'random_forest': {
            'model': RandomForestClassifier(criterion='gini'),
            'parameters': {
                'n_estimators': [10,15,20,50,100,200]
            }
        },

        'svm': {
            'model': SVC(gamma='auto'),
            'parameters': {
                'C': [1,10,20],
                'kernel': ['rbf','linear']
            }
        }

    }

    scores = []
    cv_shuffle = ShuffleSplit(n_splits=5, test_size=0.20, random_state=0)

    for model_name, model_params in models.items():
        gs = GridSearchCV(model_params['model'], model_params['parameters'], cv = cv_
        gs.fit(X, y)
        scores.append({
            'model': model_name,
            'best_parameters': gs.best_params_,
            'score': gs.best_score_
        })

    return pd.DataFrame(scores, columns=['model','best_parameters','score'])

find_best_model(X_train, y_train)
```

Out[61]:

	model	best_parameters	score
0	logistic_regression	{'C': 10}	0.763125
1	decision_tree	{'criterion': 'entropy', 'max_depth': 10}	0.896250
2	random_forest	{'n_estimators': 100}	0.948125
3	svm	{'C': 20, 'kernel': 'rbf'}	0.869375

Note: Since the Random Forest algorithm has the highest accuracy, we futher fine tune the model using hyperparameter optimization.

In [62]:

```
# Using cross_val_score for gaining average accuracy
from sklearn.model_selection import cross_val_score
scores = cross_val_score(RandomForestClassifier(n_estimators=20, random_state=0), X_tr
print('Average Accuracy : {}%'.format(round(sum(scores)*100/len(scores)), 3))
```

```
Average Accuracy : 95.0%
```

In [63]:

```
# Creating Random Forest Model
classifier = RandomForestClassifier(n_estimators=20, random_state=0)
classifier.fit(X_train, y_train)
```

Out[63]:

```
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=20,
                       n_jobs=None, oob_score=False, random_state=0, verbose=0,
                       warm_start=False)
```

Model Evaluation

In [64]:

```
# Creating a confusion matrix
from sklearn.metrics import confusion_matrix, classification_report, accuracy_score
y_pred = classifier.predict(X_test)
cm = confusion_matrix(y_test, y_pred)
cm
```

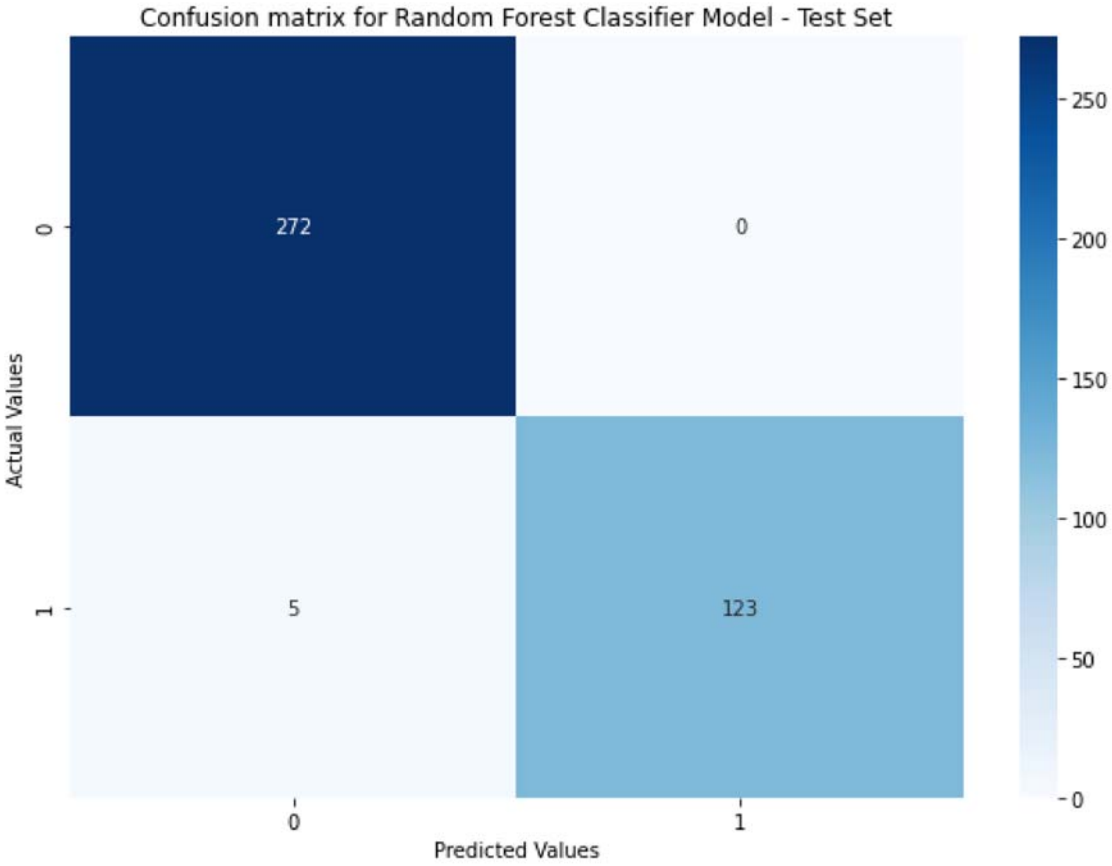
Out[64]:

```
array([[272,   0],
       [  5, 123]])
```

In [65]:

```
# Plotting the confusion matrix
plt.figure(figsize=(10,7))
p = sns.heatmap(cm, annot=True, cmap="Blues", fmt='g')
```

```
plt.title('Confusion matrix for Random Forest Classifier Model - Test Set')
plt.xlabel('Predicted Values')
plt.ylabel('Actual Values')
plt.show()
```



In [66]:

```
# Accuracy Score
score = round(accuracy_score(y_test, y_pred),4)*100
print("Accuracy on test set: {}%".format(score))
```

```
Accuracy on test set: 98.75%
```

In [67]:

```
# Classification Report
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.98      1.00      0.99       272
           1       1.00      0.96      0.98       128

    accuracy                           0.99       400
   macro avg       0.99      0.98      0.99       400
weighted avg       0.99      0.99      0.99       400
```

In [68]:

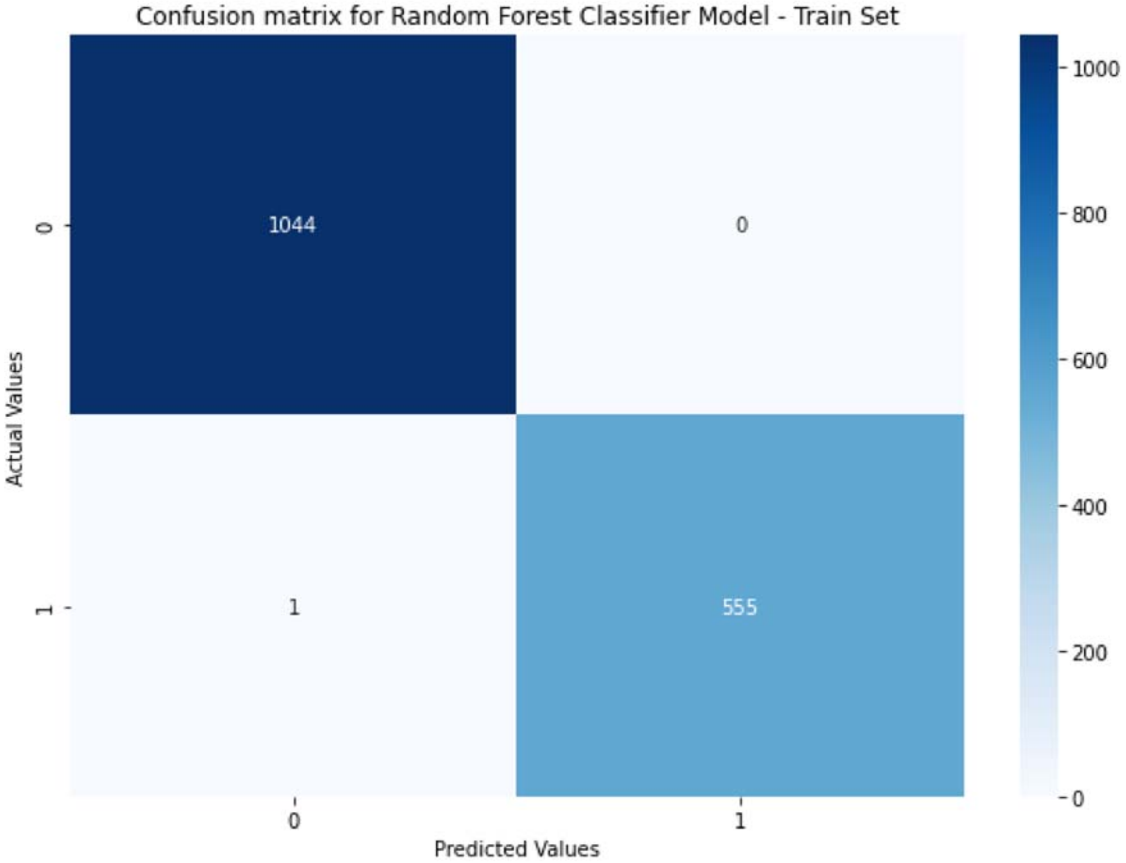
```
# Creating a confusion matrix for training set
y_train_pred = classifier.predict(X_train)
cm = confusion_matrix(y_train, y_train_pred)
cm
```

Out[68]:

```
array([[1044,    0],
       [   1,  555]])
```

In [69]:

```
# Plotting the confusion matrix
plt.figure(figsize=(10,7))
p = sns.heatmap(cm, annot=True, cmap="Blues", fmt='g')
plt.title('Confusion matrix for Random Forest Classifier Model - Train Set')
plt.xlabel('Predicted Values')
plt.ylabel('Actual Values')
plt.show()
```



In [76]:

```
# Accuracy Score
score = round(accuracy_score(y_train, y_train_pred),4)*100
print("Accuracy on trainning set: {}%".format(score))
```

```
Accuracy on trainning set: 99.94%
```

In [77]:

```
# Classification Report
print(classification_report(y_train, y_train_pred))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00      1044
           1       1.00      1.00      1.00       556

    accuracy                           1.00      1600
   macro avg       1.00      1.00      1.00      1600
weighted avg       1.00      1.00      1.00      1600
```

Predictions

In [0]:

```python
# Creating a function for prediction
def predict_diabetes(Pregnancies, Glucose, BloodPressure, SkinThickness, Insulin, BMI,
    preg = int(Pregnancies)
    glucose = float(Glucose)
    bp = float(BloodPressure)
    st = float(SkinThickness)
    insulin = float(Insulin)
    bmi = float(BMI)
    dpf = float(DPF)
    age = int(Age)

    x = [[preg, glucose, bp, st, insulin, bmi, dpf, age]]
    x = sc.transform(x)

    return classifier.predict(x)
```

In [73]:

```python
# Prediction 1
# Input sequence: Pregnancies, Glucose, BloodPressure, SkinThickness, Insulin, BMI, DP
prediction = predict_diabetes(2, 81, 72, 15, 76, 30.1, 0.547, 25)[0]
if prediction:
  print('Oops! You have diabetes.')
else:
  print("Great! You don't have diabetes.")
```

```
Great! You don't have diabetes.
```

In [74]:

```python
# Prediction 2
# Input sequence: Pregnancies, Glucose, BloodPressure, SkinThickness, Insulin, BMI, DP
prediction = predict_diabetes(1, 117, 88, 24, 145, 34.5, 0.403, 40)[0]
if prediction:
  print('Oops! You have diabetes.')
else:
  print("Great! You don't have diabetes.")
```

```
Oops! You have diabetes.
```

In [75]:

```python
# Prediction 3
# Input sequence: Pregnancies, Glucose, BloodPressure, SkinThickness, Insulin, BMI, DP
prediction = predict_diabetes(5, 120, 92, 10, 81, 26.1, 0.551, 67)[0]
if prediction:
  print('Oops! You have diabetes.')
else:
  print("Great! You don't have diabetes.")
```

```
Great! You don't have diabetes.
```