In [ ]:

```python
# Basic Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px

# ML Libraries
from sklearn.model_selection import train_test_split
from sklearn.ensemble import VotingClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.neural_network import MLPClassifier

# Confusion Matrix Library
from sklearn import metrics

from sklearn.metrics import accuracy_score
from sklearn.metrics import f1_score

from sklearn.metrics import roc_curve
```

In [ ]:

```python
data = pd.read_csv('diabetes.csv')
```

In [ ]:

```python
data.head()
```

Out[ ]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age
0	6	148	72	35	0	33.6	0.627	50
1	1	85	66	29	0	26.6	0.351	31
2	8	183	64	0	0	23.3	0.672	32
3	1	89	66	23	94	28.1	0.167	21
4	0	137	40	35	168	43.1	2.288	33

In [ ]:

```python
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
 #   Column                    Non-Null Count  Dtype  
---  ------                    --------------  -----  
 0   Pregnancies               768 non-null    int64  
 1   Glucose                   768 non-null    int64  
 2   BloodPressure             768 non-null    int64  
 3   SkinThickness             768 non-null    int64  
 4   Insulin                   768 non-null    int64  
 5   BMI                       768 non-null    float64
 6   DiabetesPedigreeFunction  768 non-null    float64
 7   Age                       768 non-null    int64  
 8   Outcome                   768 non-null    int64  
dtypes: float64(2), int64(7)
memory usage: 54.1 KB
```

In [ ]:

```
data.describe()
```

Out[ ]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedig
count	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	
mean	3.845052	120.894531	69.105469	20.536458	79.799479	31.992578	
std	3.369578	31.972618	19.355807	15.952218	115.244002	7.884160	
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	1.000000	99.000000	62.000000	0.000000	0.000000	27.300000	
50%	3.000000	117.000000	72.000000	23.000000	30.500000	32.000000	
75%	6.000000	140.250000	80.000000	32.000000	127.250000	36.600000	
max	17.000000	199.000000	122.000000	99.000000	846.000000	67.100000	

In [ ]:

```
data.shape
```

Out[ ]:

```
(768, 9)
```

In [ ]:

```
data.isnull().sum()
```

Out[ ]:

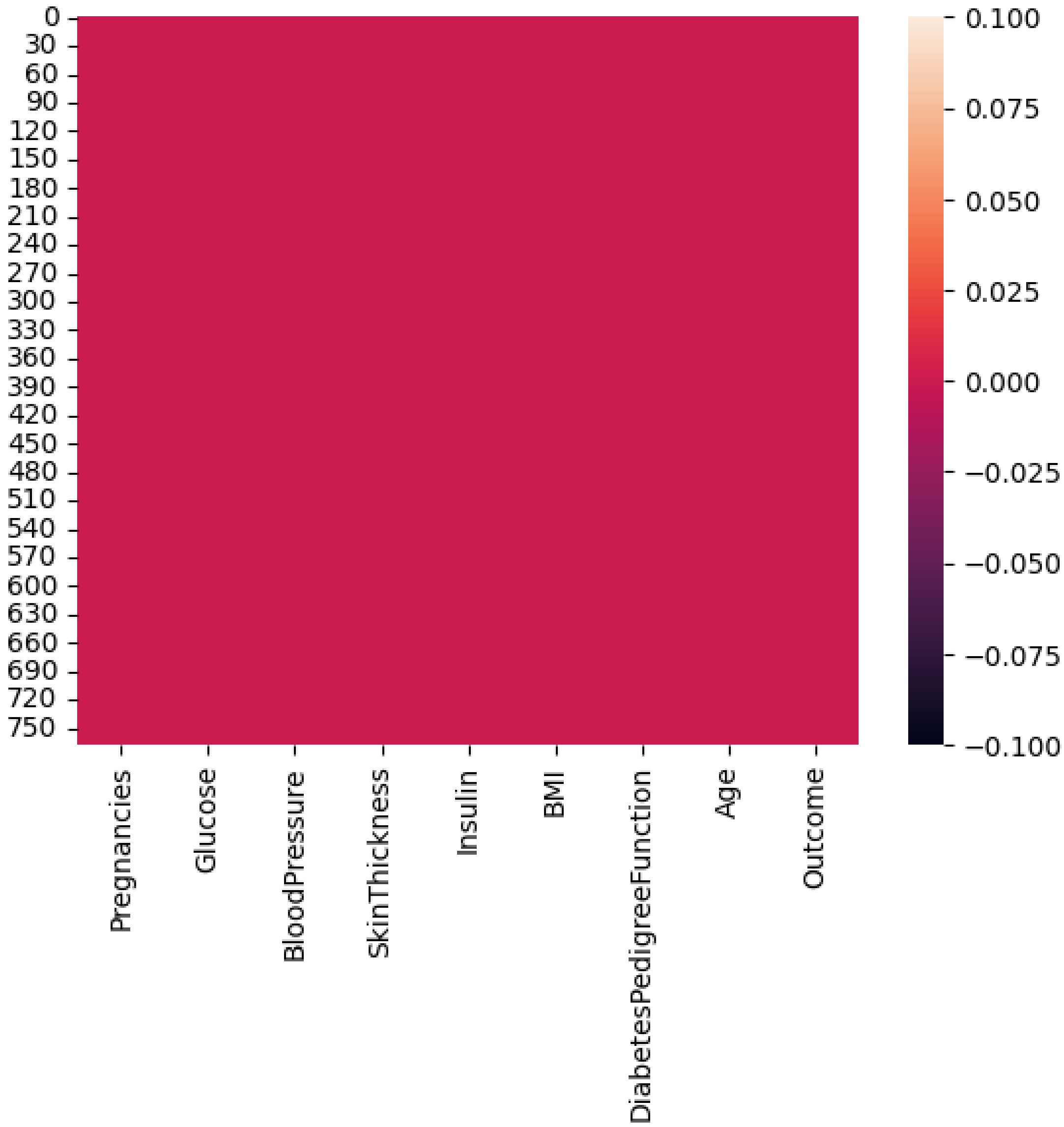
```
Pregnancies                 0
Glucose                     0
BloodPressure               0
SkinThickness               0
Insulin                     0
BMI                         0
DiabetesPedigreeFunction    0
Age                         0
Outcome                     0
dtype: int64
```

In [ ]:

```
sns.heatmap(data.isnull())
```

Out[ ]:

```
<Axes: >
```



No Null Values Spotted

In [ ]:
```
data.duplicated().sum()
```

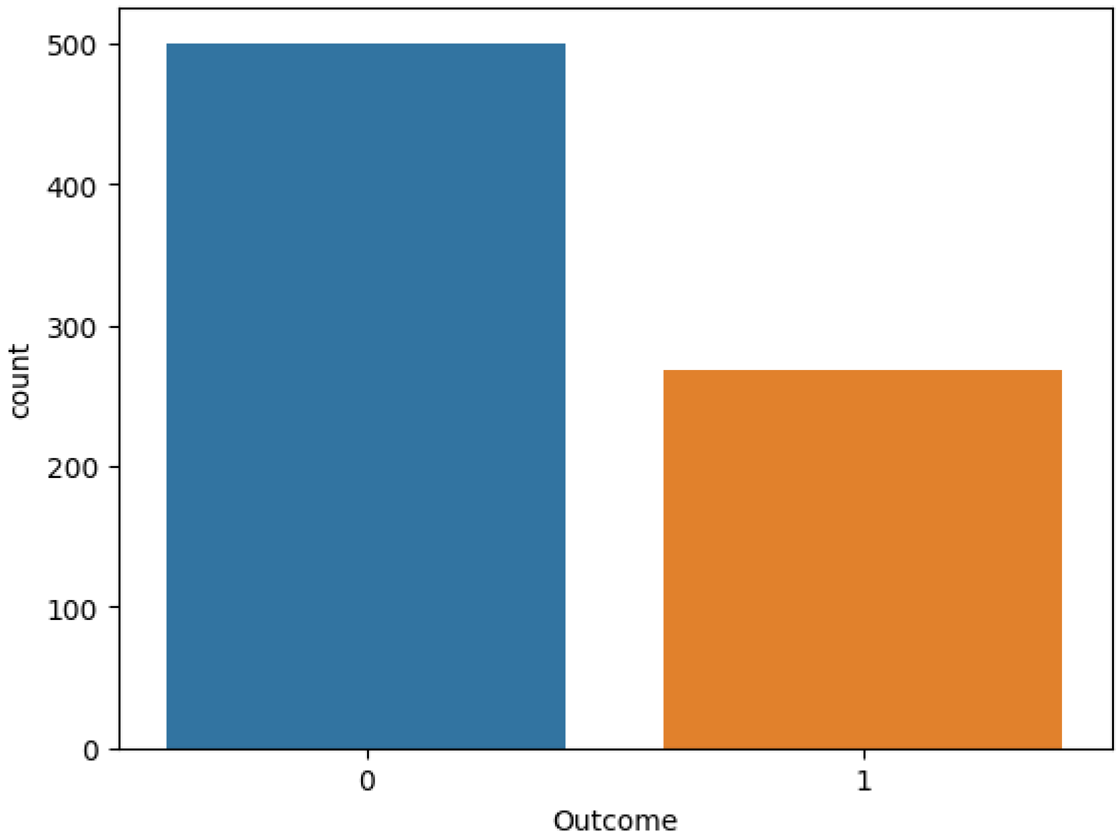
Out[ ]:
```
0
```

No Duplicated Values Spotter

In [ ]:
```
data.skew()
```

Out[ ]:
```
Pregnancies                 0.901674
Glucose                     0.173754
BloodPressure              -1.843608
SkinThickness               0.109372
Insulin                     2.272251
BMI                        -0.428982
DiabetesPedigreeFunction    1.919911
Age                         1.129597
Outcome                     0.635017
dtype: float64
```

In [ ]:
```
sns.countplot(x='Outcome',data=data)
plt.show()
```



Now We will Convert the Values which are 0 in the columns to Nan (Null Values)

In [ ]:

```
data_copy = data.copy(deep = True)
data_copy[['Glucose','BloodPressure','SkinThickness','Insulin','BMI']] = data_copy[[



## showing the count of Nans
print(data_copy.isnull().sum())
```

```
Pregnancies                   0
Glucose                       5
BloodPressure                35
SkinThickness               227
Insulin                     374
BMI                          11
DiabetesPedigreeFunction      0
Age                           0
Outcome                       0
dtype: int64
```

Check Null Values

In [ ]:

```
data_copy.isnull().sum()
```

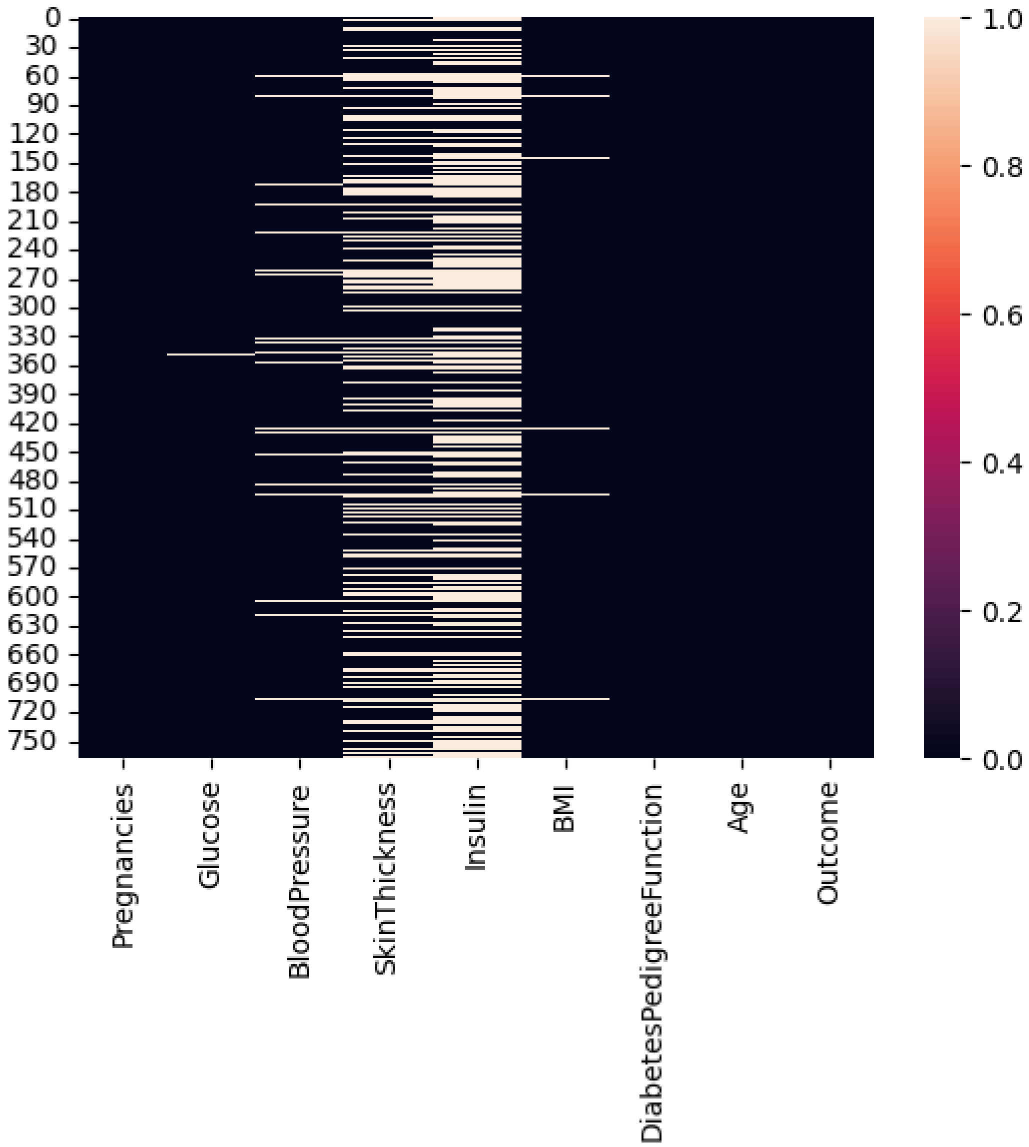
Out[ ]:

```
Pregnancies                   0
Glucose                       5
BloodPressure                35
SkinThickness               227
Insulin                     374
BMI                          11
DiabetesPedigreeFunction      0
Age                           0
Outcome                       0
dtype: int64
```

In [ ]:

```
sns.heatmap(data_copy.isnull())
```

Out[ ]: <Axes: >

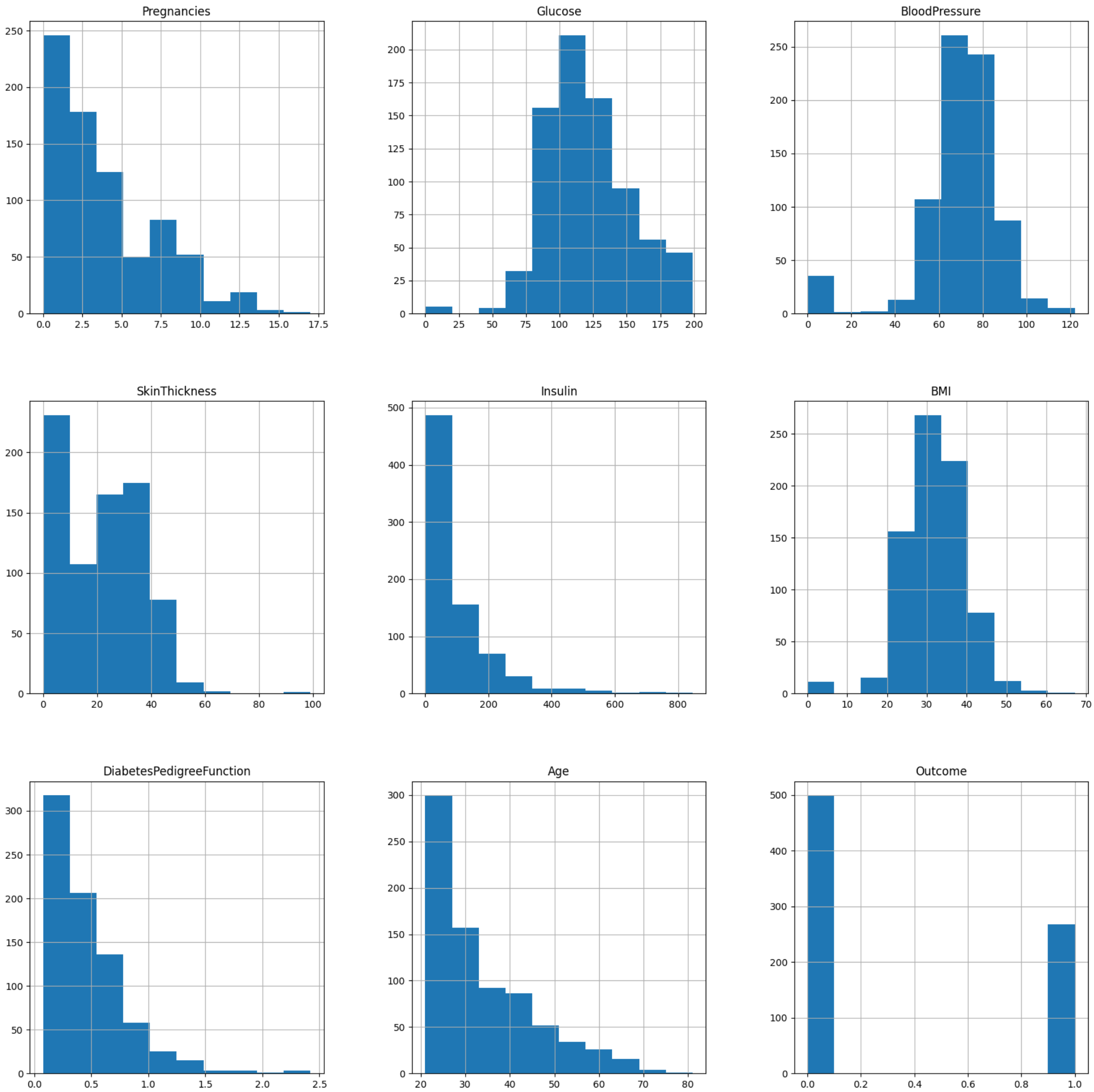


In [ ]:

```
data.hist(figsize = (20,20))
```

Out[ ]:

```
array([[<Axes: title={'center': 'Pregnancies'}>,
        <Axes: title={'center': 'Glucose'}>,
        <Axes: title={'center': 'BloodPressure'}>],
       [<Axes: title={'center': 'SkinThickness'}>,
        <Axes: title={'center': 'Insulin'}>,
        <Axes: title={'center': 'BMI'}>],
       [<Axes: title={'center': 'DiabetesPedigreeFunction'}>,
        <Axes: title={'center': 'Age'}>,
        <Axes: title={'center': 'Outcome'}>]], dtype=object)
```



In [ ]:

```
data_copy.isnull().sum()
```

Out[ ]:

```
Pregnancies                   0
Glucose                       5
BloodPressure                35
SkinThickness               227
Insulin                     374
BMI                          11
DiabetesPedigreeFunction      0
Age                           0
Outcome                       0
dtype: int64
```

In [ ]:

```
data_copy['Glucose'].fillna(method='ffill',inplace =True)
data_copy['BloodPressure'].fillna(data_copy['BloodPressure'].mean(),inplace =True)
data_copy['SkinThickness'].fillna(data_copy['SkinThickness'].mean(),inplace =True)
data_copy['Insulin'].fillna(data_copy['Insulin'].median(),inplace =True)
data_copy['BMI'].fillna(method='bfill',inplace =True)
```

In [ ]:

```
data_copy.isnull().sum()
```

Out[ ]:

```
Pregnancies                 0
Glucose                     0
```

```
BloodPressure               0
SkinThickness               0
Insulin                     0
BMI                         0
DiabetesPedigreeFunction    0
Age                         0
Outcome                     0
dtype: int64
```

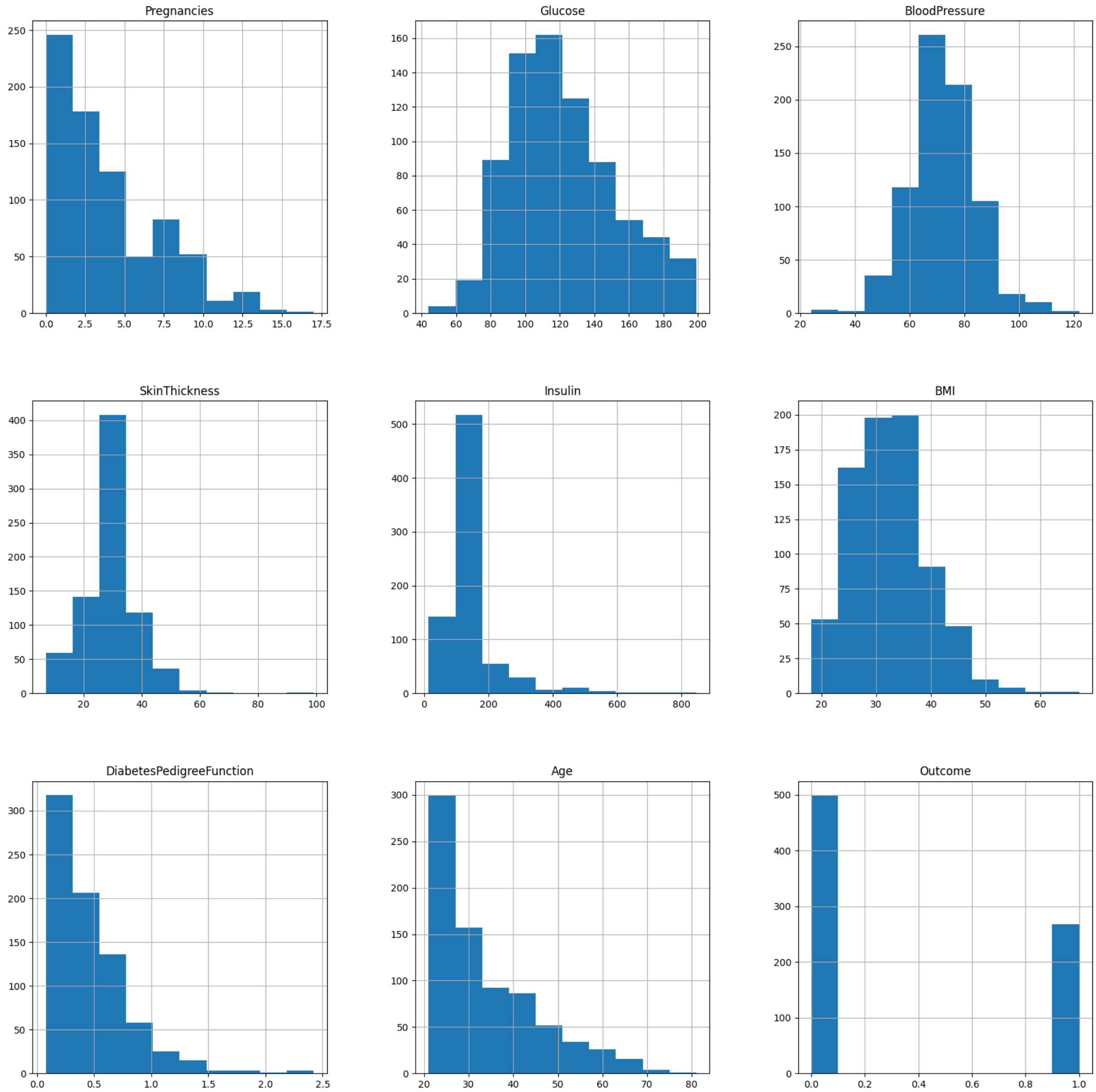
All the Null Values which we added in the place of "0" are now Filled.

In [ ]:

```python
data_copy.hist(figsize = (20,20))
```

Out[ ]:

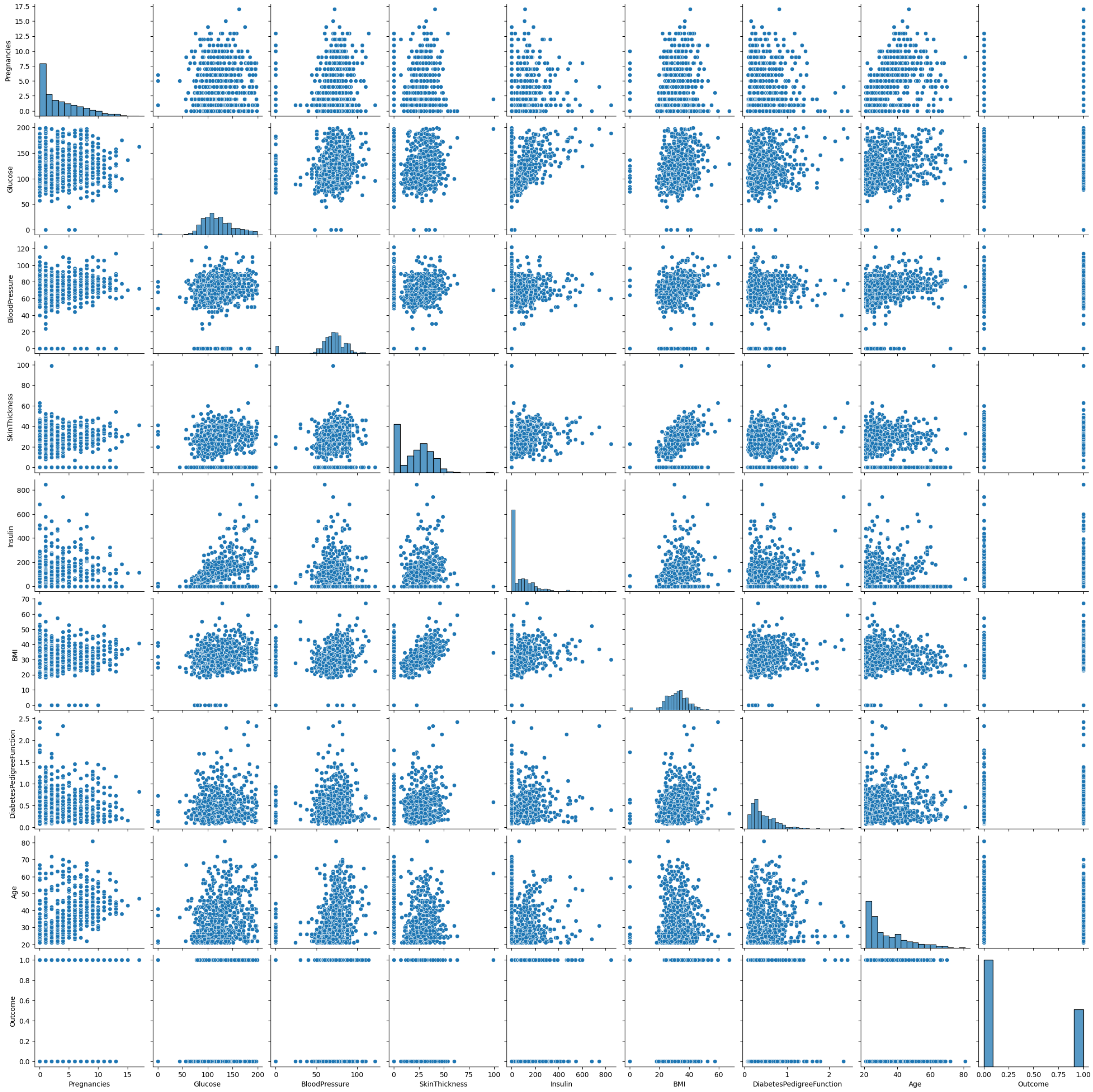
```
array([[<Axes: title={'center': 'Pregnancies'}>,
        <Axes: title={'center': 'Glucose'}>,
        <Axes: title={'center': 'BloodPressure'}>],
       [<Axes: title={'center': 'SkinThickness'}>,
        <Axes: title={'center': 'Insulin'}>,
        <Axes: title={'center': 'BMI'}>],
       [<Axes: title={'center': 'DiabetesPedigreeFunction'}>,
        <Axes: title={'center': 'Age'}>,
        <Axes: title={'center': 'Outcome'}>]], dtype=object)
```



In [ ]:

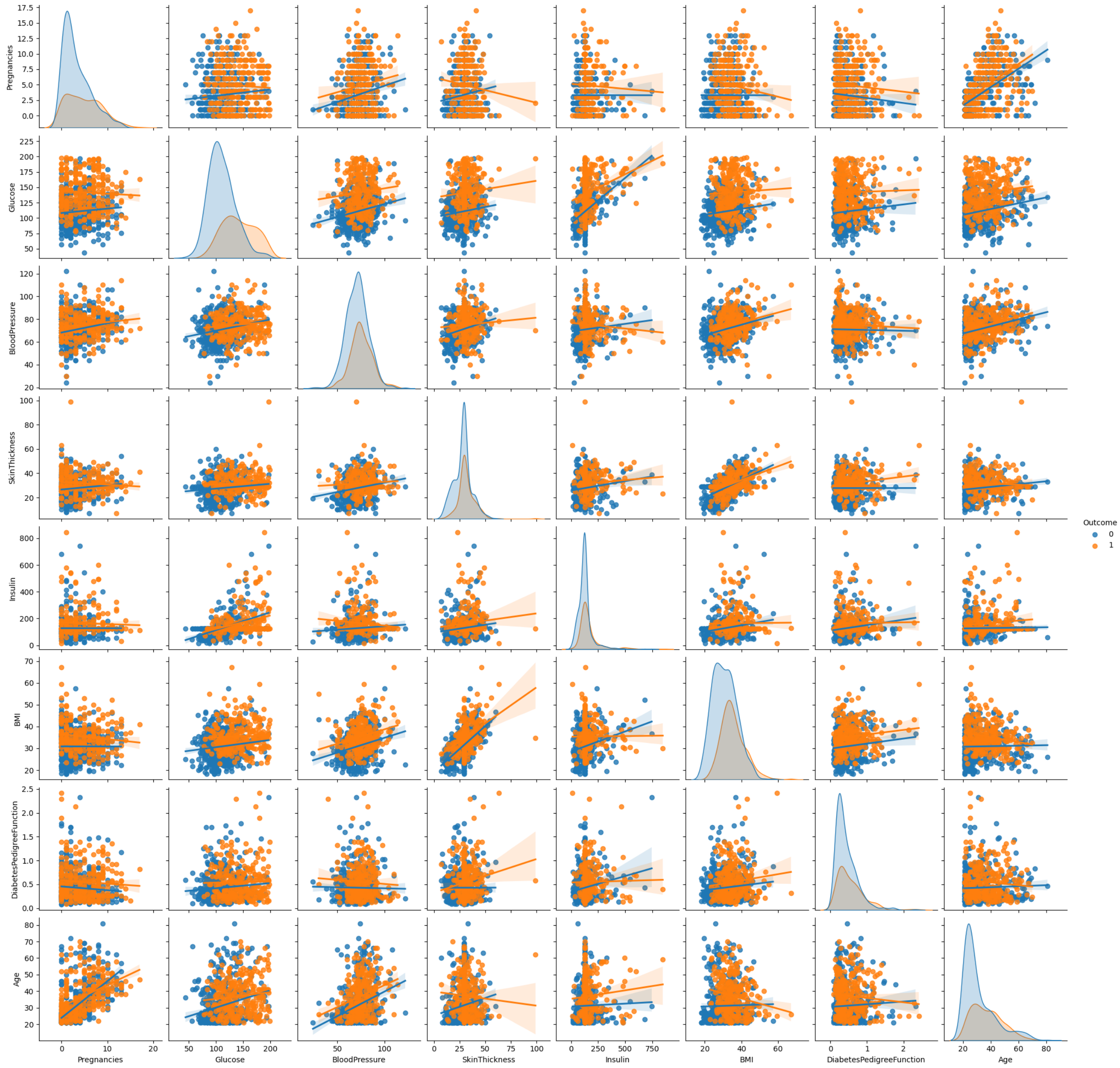
```python
sns.pairplot(data)
```

Out[ ]: <seaborn.axisgrid.PairGrid at 0x1f696d86bd0>



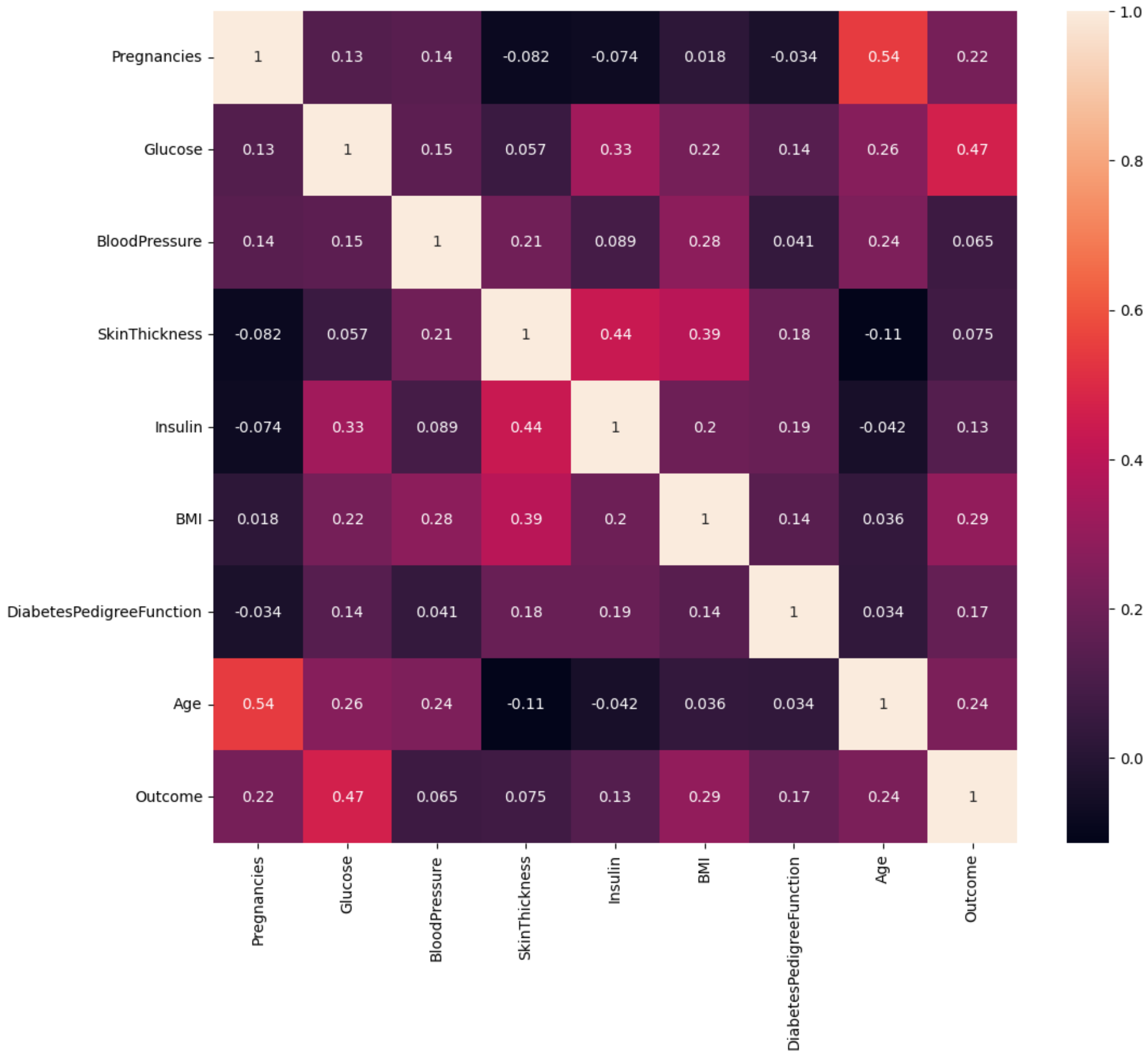
In [ ]:

```python
sns.pairplot(data=data_copy,hue='Outcome',diag_kind='kde', kind="reg")
plt.show()
```



In [ ]:

```
plt.figure(figsize=(12,10))
ax = sns.heatmap(data.corr(),annot = True)
```



In [ ]:

```
from sklearn.preprocessing import StandardScaler
sc_X = StandardScaler()
x =  pd.DataFrame(sc_X.fit_transform(data_copy.drop(["Outcome"],axis = 1),),
        columns=['Pregnancies', 'Glucose', 'BloodPressure', 'SkinThickness','Insulin
       'BMI', 'DiabetesPedigreeFunction', 'Age'])
x.head()
```

Out[ ]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunct
0	0.639947	0.868061	-0.033518	6.655021e-01	-0.181541	0.166964	0.468
1	-0.844885	-1.196747	-0.529859	-1.746338e-02	-0.181541	-0.848188	-0.365
2	1.233880	2.015177	-0.695306	8.087936e-16	-0.181541	-1.326759	0.604
3	-0.844885	-1.065648	-0.529859	-7.004289e-01	-0.540642	-0.630655	-0.920
4	-1.141852	0.507539	-2.680669	6.655021e-01	0.316566	1.544669	5.484

In [ ]:

```
y = data_copy.Outcome
```

In [ ]:

```
x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=1/3,random_state=42,
```

Voting Classifier

- A Voting Classifier is a machine learning model that trains on an ensemble of numerous models and predicts an output (class) based on their highest probability of chosen class as the output.
- It simply aggregates the findings of each classifier passed into Voting Classifier and predicts the output class based on the highest majority of voting. The idea is instead of creating separate dedicated models and finding the accuracy for each them, we create a single model which trains by these models and predicts output based on their combined majority of voting for each output class.

In [ ]:

```
L_R_model = LogisticRegression(solver = 'lbfgs', multi_class='multinomial',random_st
R_F_model = RandomForestClassifier(n_estimators=100, criterion='gini', max_depth=5,
KNC_model = KNeighborsClassifier(n_neighbors=10,weights='uniform',algorithm='auto')
MLP_C_model = MLPClassifier(solver='lbfgs',hidden_layer_sizes=(1000,20),learning_rat
                            power_t=0.4, max_iter=250)

# Voting Classifier

v_classifier_model = VotingClassifier(estimators=[('LRModel',L_R_model),('RFModel',R
                                                   ('NNModel',MLP_C_model)], voting=
v_classifier_model.fit(x_train, y_train)
```

Out[ ]:

```
VotingClassifier
LRModel                RFModel                   KNNModel               NNModel
LogisticRegression     RandomForestClassifier    KNeighborsClassifier   MLPClassifi
```

In [ ]:

```
#Calculating Details
print('VotingClassifierModel Train Score is : ' , v_classifier_model.score(x_train,
print('VotingClassifierModel Test Score is : ' , v_classifier_model.score(x_test, y_
print('----------------------------------------------------')
```

```
VotingClassifierModel Train Score is :  0.93359375
VotingClassifierModel Test Score is :  0.72265625
----------------------------------------------------
```

Prediction Calculation

In [ ]:

```
y_pred = v_classifier_model.predict(x_test)
print('Predicted Value for VotingClassifierModel is : ' , y_pred[:10])
```

```
Predicted Value for VotingClassifierModel is :  [0 1 0 0 0 0 1 1 0 0]
```

Predictions

In [ ]:

```
y_pred
```

Out[ ]:

```
array([0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
       0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0,
```

```
0, 1, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0,
0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0,
0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 1,
0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0], dtype=int64)
```

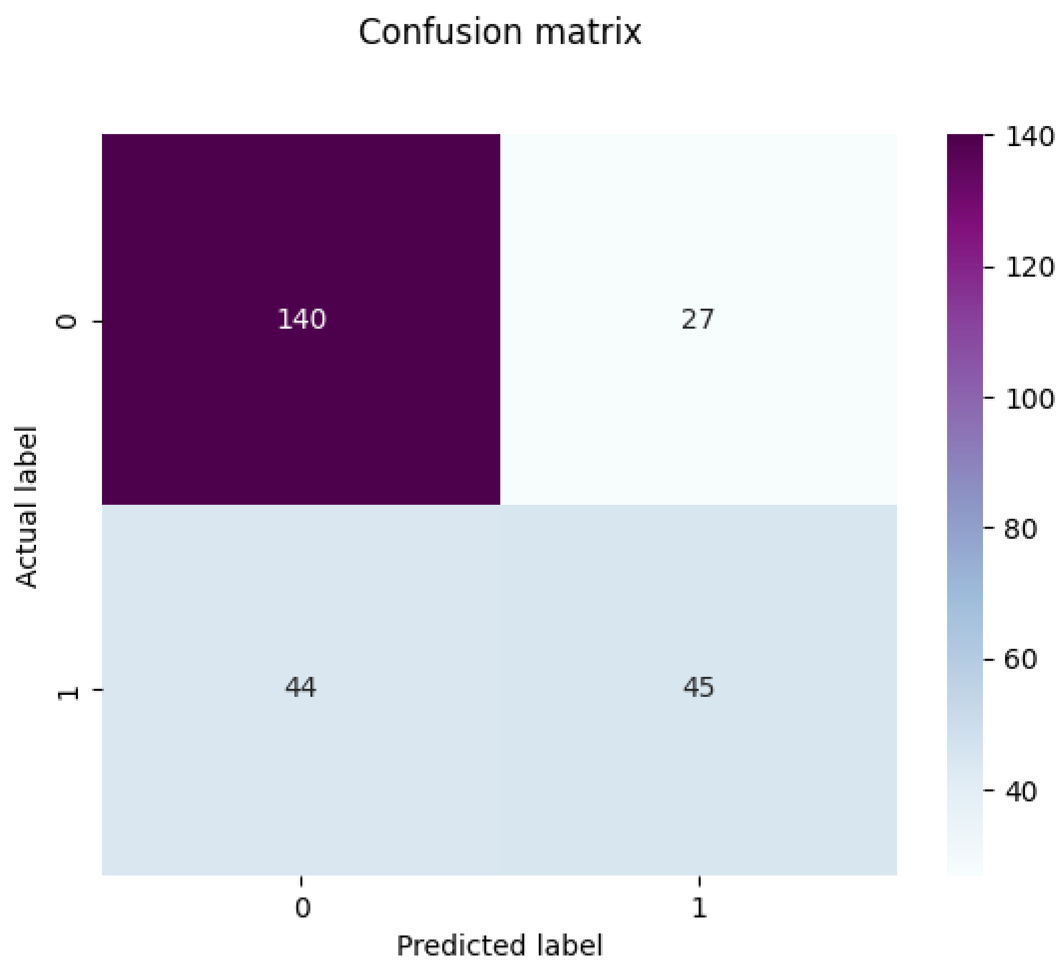
Confusion Matrix

In [ ]:

```
confusion_matrix = metrics.confusion_matrix(y_test, y_pred)
p = sns.heatmap(pd.DataFrame(confusion_matrix), annot=True, cmap="BuPu" ,fmt='g')
plt.title('Confusion matrix', y=1.1)
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
```

Out[ ]:

```
Text(0.5, 23.52222222222222, 'Predicted label')
```



Calculating Accuracy

In [ ]:

```
#Calculating Accuracy Score  : ((TP + TN) / float(TP + TN + FP + FN))
AccScore = accuracy_score(y_test, y_pred, normalize=False)
print('Accuracy Score is : ', AccScore)
```

```
Accuracy Score is :  185
```

In [ ]:

```
#Calculating F1 Score  : 2 * (precision * recall) / (precision + recall)
```

```python
# Precision : measures the percentage of predictions made by the model that are corr
# Recall    : measures the percentage of relevant data points that were correctly id
F1Score = f1_score(y_test, y_pred, average='micro') #it can be : binary,macro,weight
print('F1 Score is : ', F1Score)
```

```
F1 Score is :  0.72265625
```

In [ ]:

```python
y_pred_proba = v_classifier_model.predict_proba(x_test)[:,1]
fpr, tpr, thresholds = roc_curve(y_test, y_pred_proba)
plt.plot([0,1],[0,1],'k--')
plt.plot(fpr,tpr, label='Knn')
plt.xlabel('fpr')
plt.ylabel('tpr')
plt.title('VotingClassifierModel ROC curve')
plt.show()
```