```
import pandas as pd
import numpy as np
```

+ Code + Text

```
data = pd.read_csv("diabetes.csv")
data.head()
```

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

```
data.isnull().any()
```

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

```
data.describe().T
```

	count	mean	std	min	25%	50%	75%	max
Pregnancies	768.0	3.845052	3.369578	0.000	1.00000	3.0000	6.00000	17.00
Glucose	768.0	120.894531	31.972618	0.000	99.00000	117.0000	140.25000	199.00
BloodPressure	768.0	69.105469	19.355807	0.000	62.00000	72.0000	80.00000	122.00
SkinThickness	768.0	20.536458	15.952218	0.000	0.00000	23.0000	32.00000	99.00
Insulin	768.0	79.799479	115.244002	0.000	0.00000	30.5000	127.25000	846.00
BMI	768.0	31.992578	7.884160	0.000	27.30000	32.0000	36.60000	67.10
DiabetesPedigreeFunction	768.0	0.471876	0.331329	0.078	0.24375	0.3725	0.62625	2.42
Age	768.0	33.240885	11.760232	21.000	24.00000	29.0000	41.00000	81.00
Outcome	768.0	0.348958	0.476951	0.000	0.00000	0.0000	1.00000	1.00

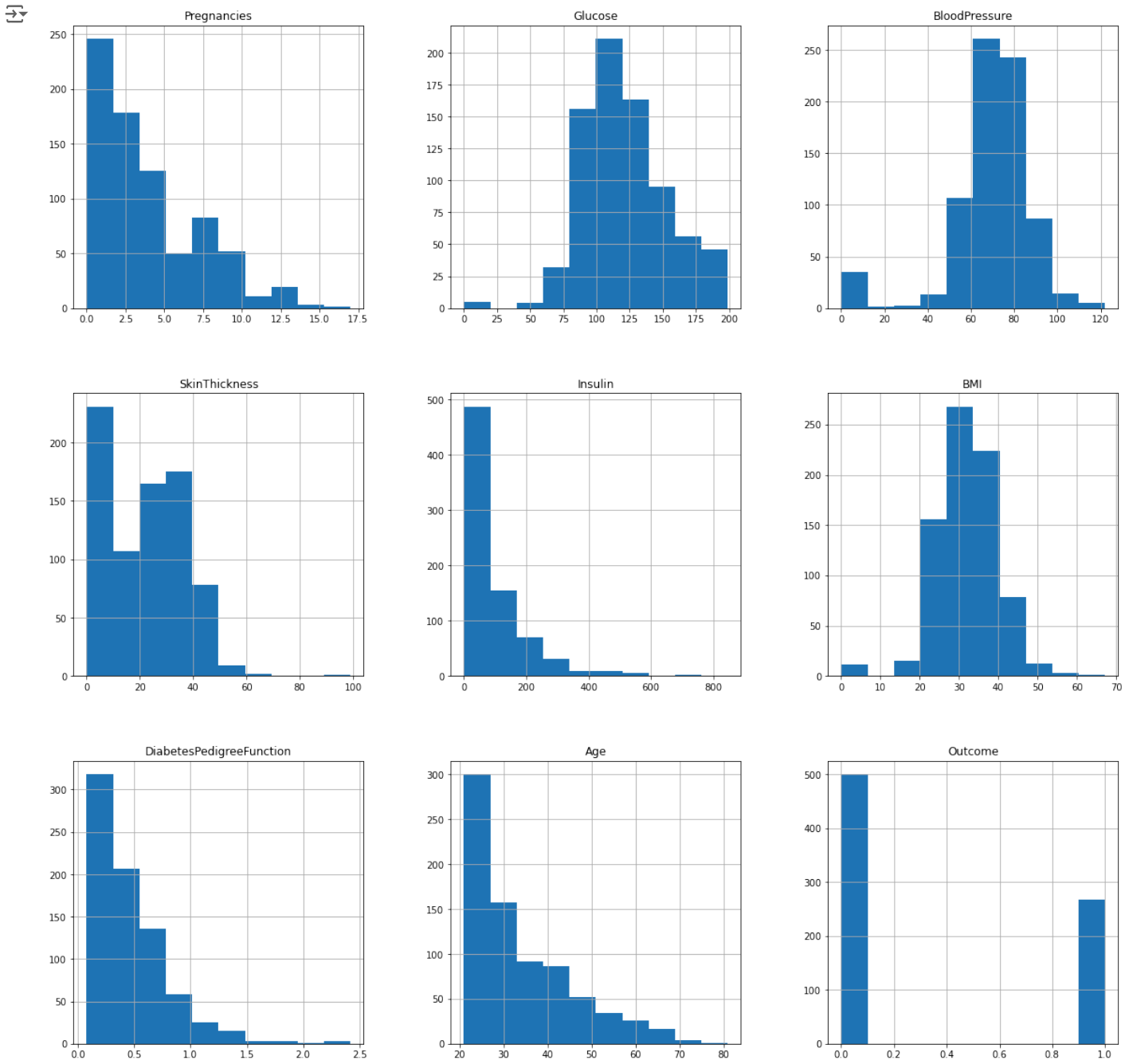
Glucose, BloodPressure, SkinThickness, Insulin, BMI
columns have values 0 which does not ake sense , hence are missing values

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

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

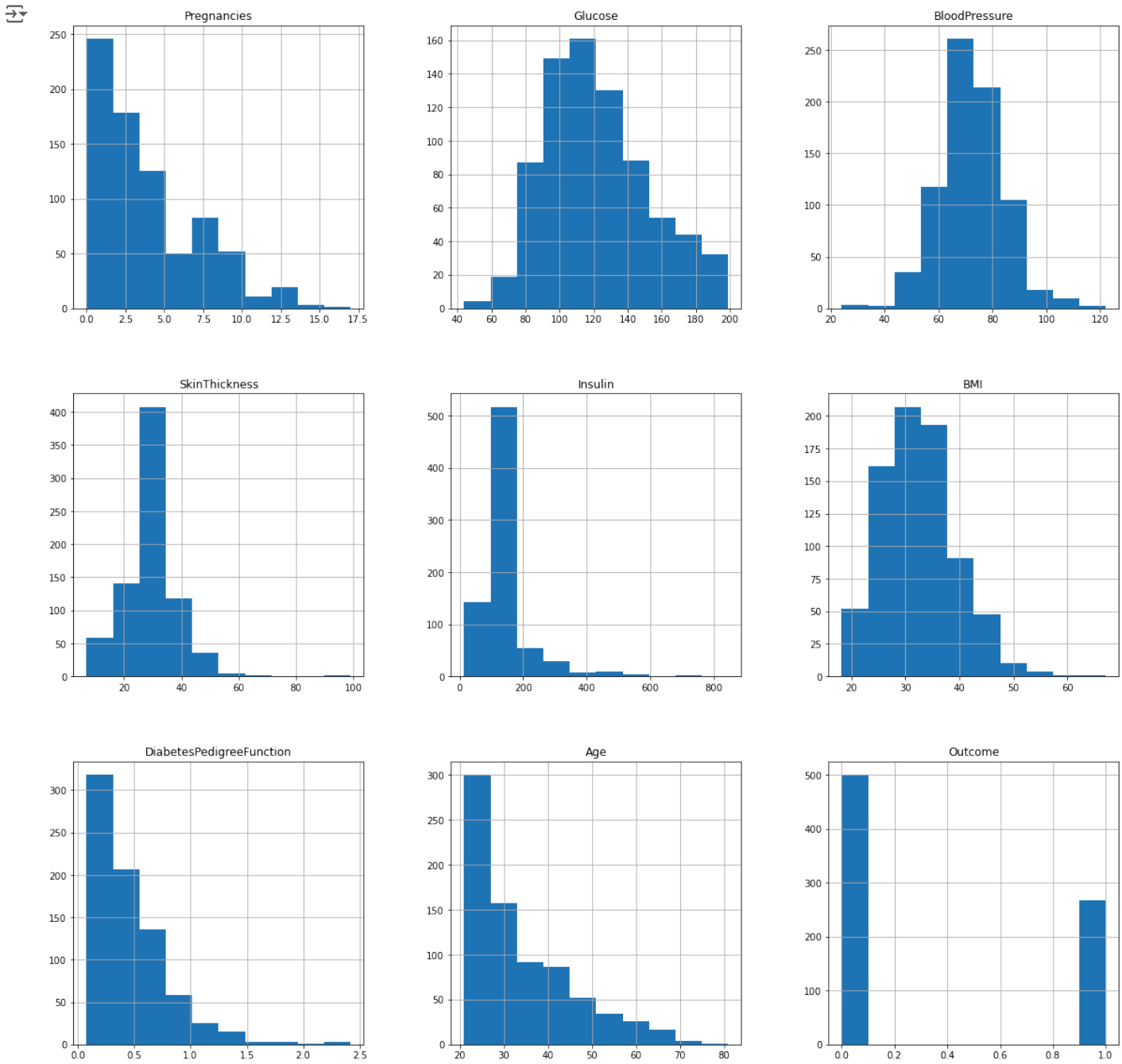
To fill these Nan values the data distribution needs to be understood

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

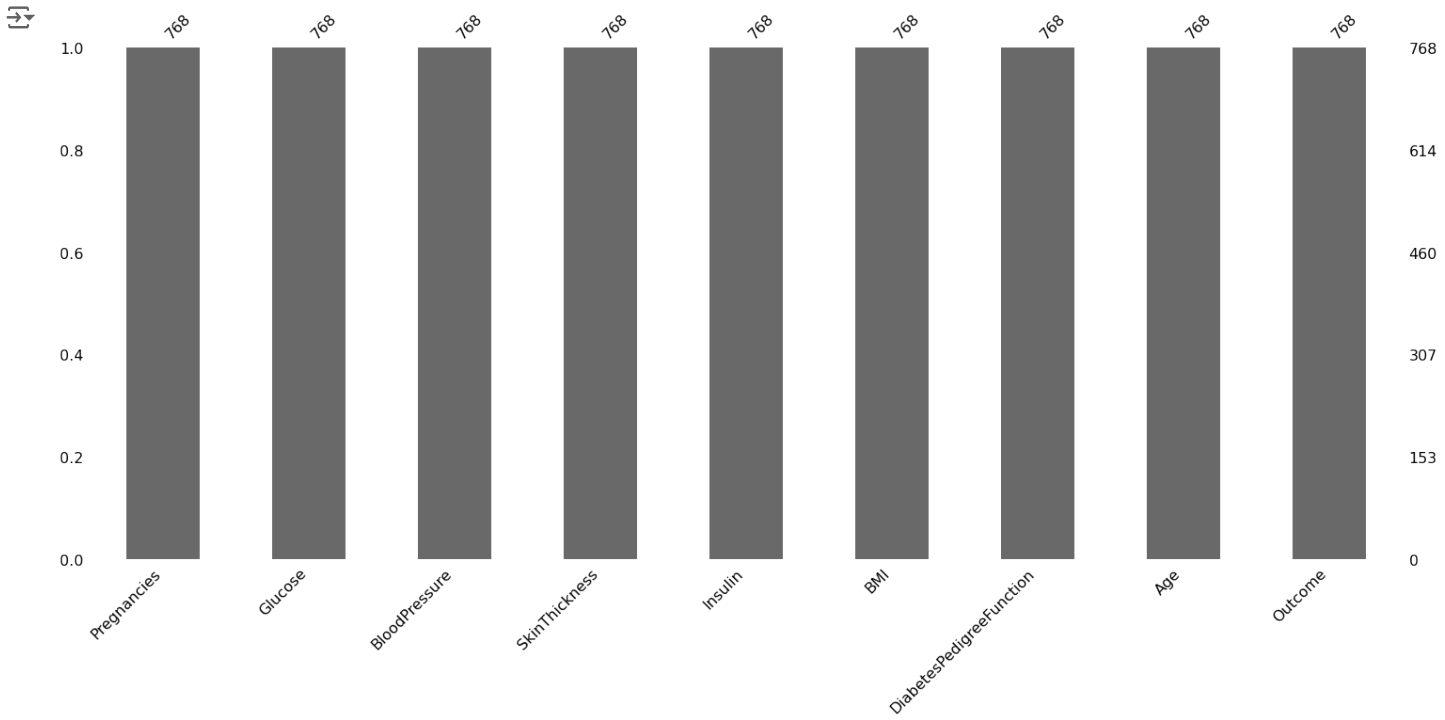



```
data_copy['Glucose'].fillna(data_copy['Glucose'].mean(), inplace = True)
data_copy['BloodPressure'].fillna(data_copy['BloodPressure'].mean(), inplace = True)
data_copy['SkinThickness'].fillna(data_copy['SkinThickness'].median(), inplace = True)
data_copy['Insulin'].fillna(data_copy['Insulin'].median(),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

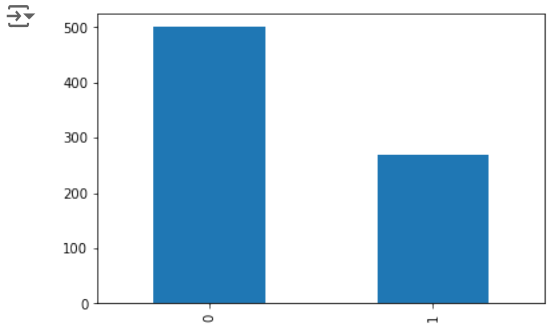
```
p = data_copy.hist(figsize = (20,20))
```




```
import missingno as msno
p = msno.bar(data)
```

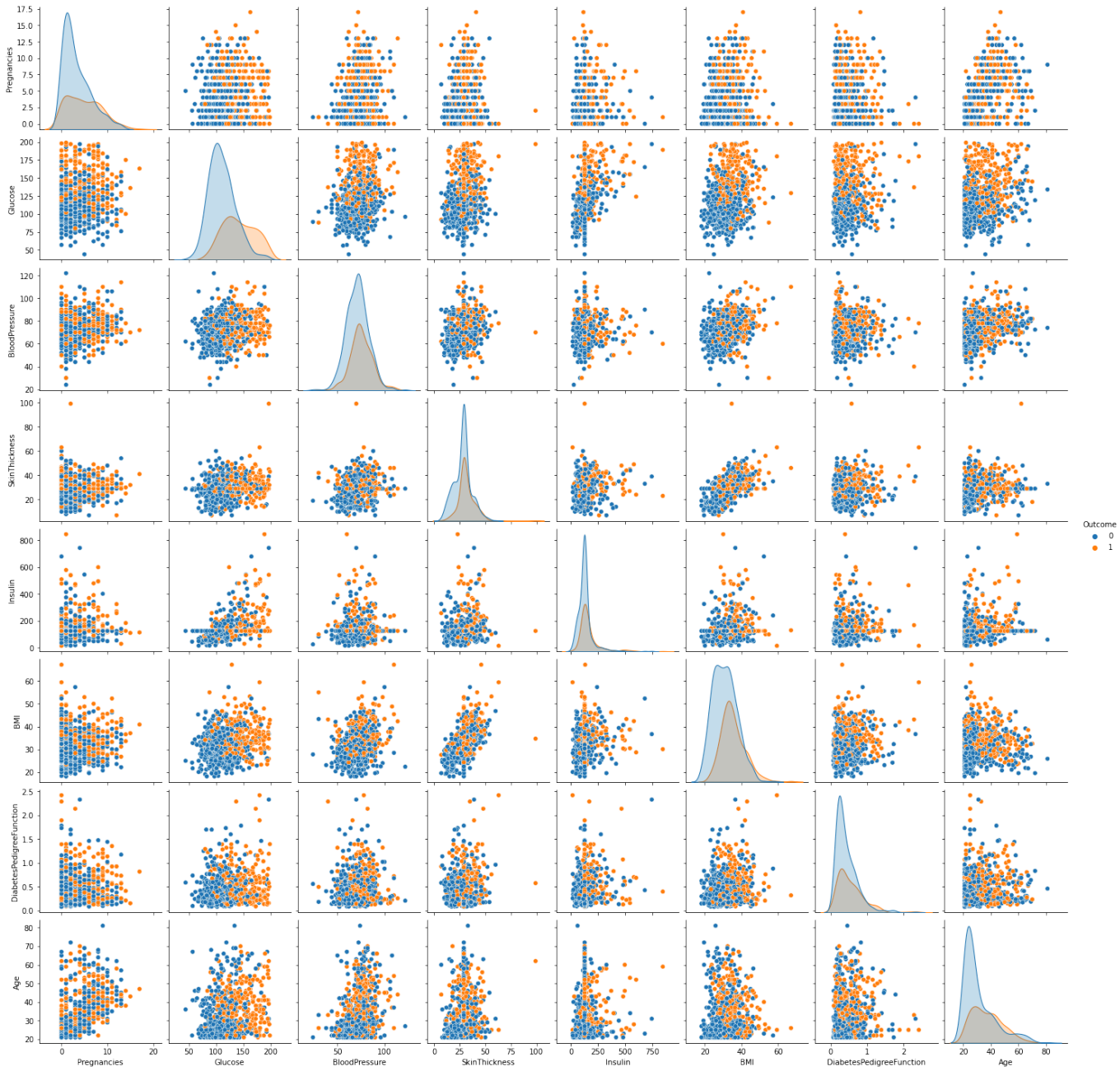



```
p=data.Outcome.value_counts().plot(kind="bar")
```

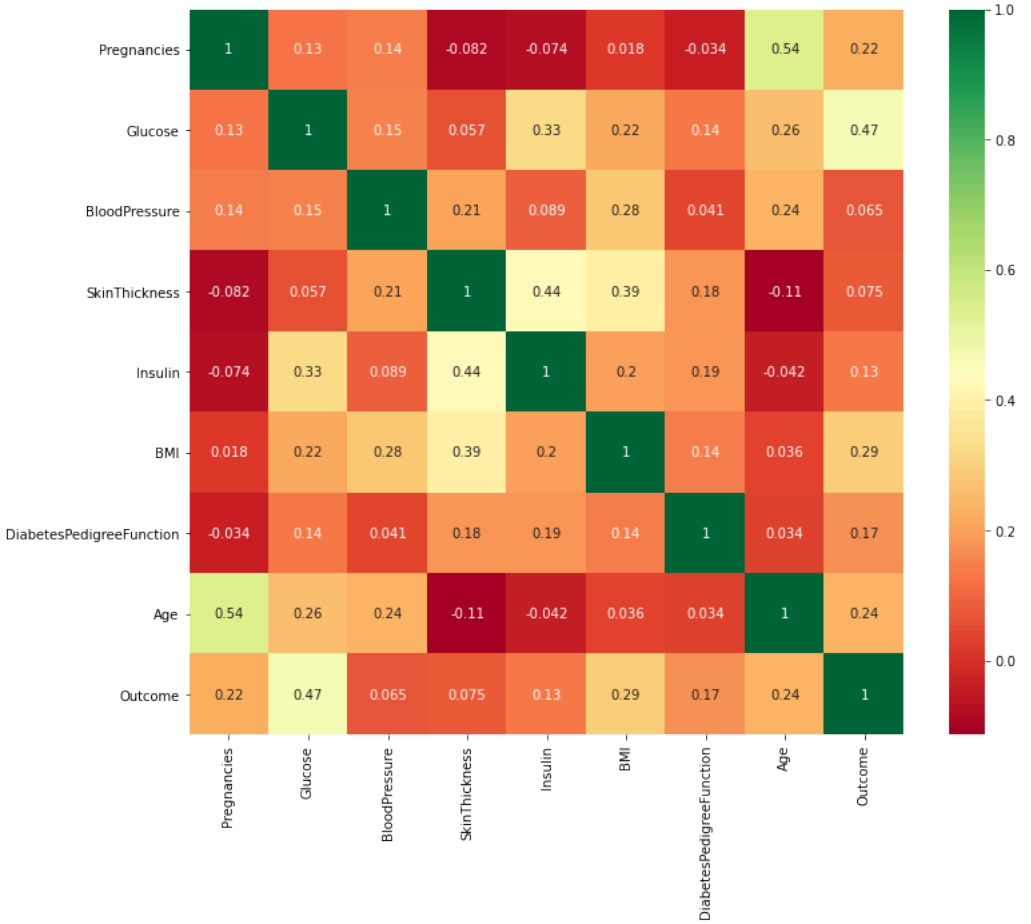


The above graph shows that the data is biased towards datapoints having outcome value as 0 where it means that diabetes was not present actually. The number of non-diabetics is almost twice the number of diabetic patients

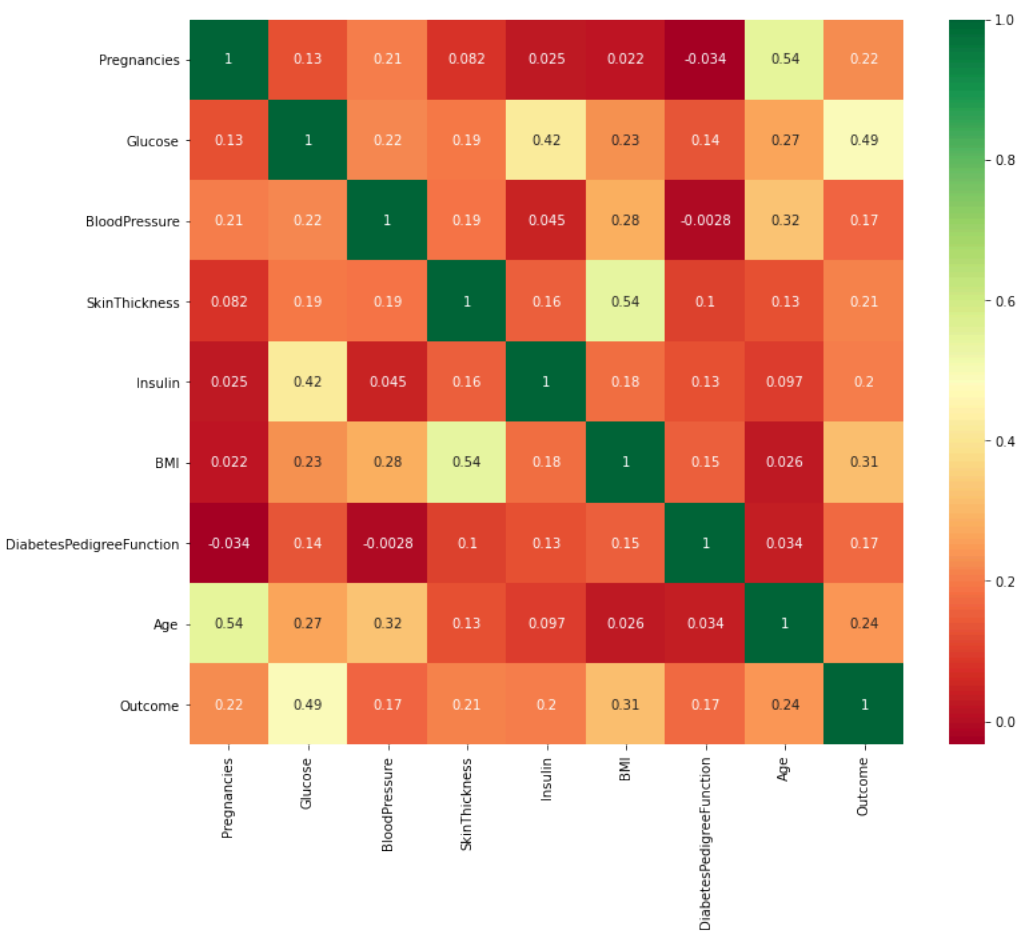
```
import seaborn as sns
p=sns.pairplot(data_copy, hue = 'Outcome')
```




```
import matplotlib.pyplot as plt
plt.figure(figsize=(12,10))  # on this line I just set the size of figure to 12 by 10.
p=sns.heatmap(data.corr(), annot=True,cmap ='RdYlGn')  # seaborn has very simple solution for heatmap
```




```
plt.figure(figsize=(12,10))  # on this line I just set the size of figure to 12 by 10.
p=sns.heatmap(data_copy.corr(), annot=True,cmap ='RdYlGn')  # seaborn has very simple solution for heatmap
```




```
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', 'SkinThicknes
       'BMI', 'DiabetesPedigreeFunction', 'Age'])
```

```
X.head()
```

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age
0	0.639947	0.865108	-0.033518	0.670643	-0.181541	0.166619	0.468492	1.425995
1	-0.844885	-1.206162	-0.529859	-0.012301	-0.181541	-0.852200	-0.365061	-0.190672
2	1.233880	2.015813	-0.695306	-0.012301	-0.181541	-1.332500	0.604397	-0.105584
3	-0.844885	-1.074652	-0.529859	-0.695245	-0.540642	-0.633881	-0.920763	-1.041549
4	-1.141852	0.503458	-2.680669	0.670643	0.316566	1.549303	5.484909	-0.020496

```
y =data_copy.Outcome
```

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 1/3, random_state = 42, stratify=y)
```

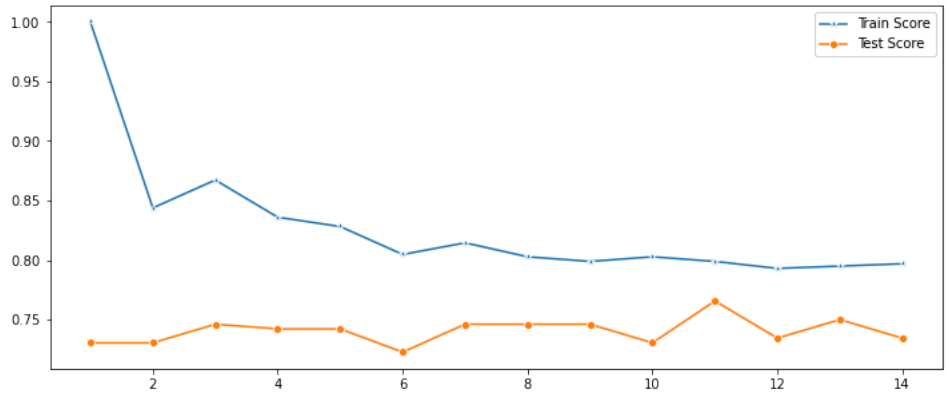
```
from sklearn.neighbors import KNeighborsClassifier

train_scores = []
test_scores = []

for i in range(1,15):
    knn = KNeighborsClassifier(i)
    knn.fit(X_train, y_train)
    train_scores.append(knn.score(X_train, y_train))
    test_scores.append(knn.score(X_test, y_test))
```

```
max_test_score =max(test_scores)


test_score_index = [i for i, v in enumerate(test_scores) if v== max_test_score]

print('Max test score {} % and k = {}'.format(max_test_score*100,list(map(lambda x: x+1, test_score_index))))
```

```
Max test score 76.5625 % and k = [11]
```

```
plt.figure(figsize=(12,5))
p = sns.lineplot(range(1,15),train_scores,marker='*',label='Train Score')
p = sns.lineplot(range(1,15),test_scores,marker='o',label='Test Score')
```

```
C:\Users\Admin\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variables as keyword args: x, y.
  warnings.warn(
C:\Users\Admin\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variables as keyword args: x, y.
  warnings.warn(
```

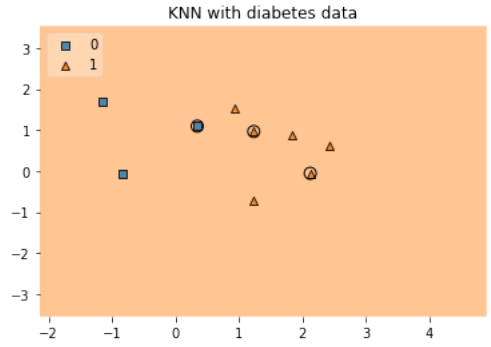



```
# K=11
#Setup a knn classifier with k neighbors
knn = KNeighborsClassifier(11)

knn.fit(X_train,y_train)
knn.score(X_test,y_test)
```

```
0.765625
```

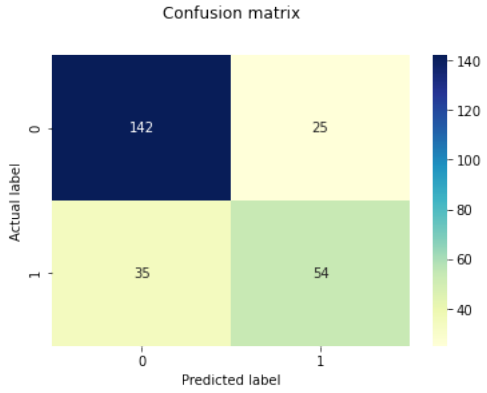
```
from mlxtend.plotting import plot_decision_regions
value = 20000
width  =20000

plot_decision_regions(X.values, y.values, clf = knn, legend =2,filler_feature_values={2: value, 3: value, 4: value, 5: value, 6: value, 7: v
                      filler_feature_ranges={2: width, 3: width, 4: width, 5: width, 6: width, 7: width},
                      X_highlight=X_test.values)
plt.title("KNN with diabetes data")
plt.show()
```

```
C:\Users\Admin\anaconda3\lib\site-packages\mlxtend\plotting\decision_regions.py:244: UserWarning: No contour levels were found within th
  ax.contour(xx, yy, Z, cset.levels,
C:\Users\Admin\anaconda3\lib\site-packages\mlxtend\plotting\decision_regions.py:316: MatplotlibDeprecationWarning: Using a string of sin
  ax.scatter(x_data,
```



```
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score, fbeta_score
y_pred = knn.predict(X_test)

cnf_matrix = confusion_matrix(y_test, y_pred)


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

```
Text(0.5, 15.0, 'Predicted label')
```




```
def model_evaluation(y_test, y_pred, model_name):
    acc = accuracy_score(y_test, y_pred)
    prec = precision_score(y_test, y_pred)
    rec = recall_score(y_test, y_pred)
    f1 = f1_score(y_test, y_pred)
    f2 = fbeta_score(y_test, y_pred, beta = 2.0)

    results = pd.DataFrame([[model_name, acc, prec, rec, f1, f2]],
                       columns = ["Model", "Accuracy", "Precision", "Recall",
                                  "F1 SCore", "F2 Score"])
    results = results.sort_values(["Precision", "Recall", "F2 Score"], ascending = False)
    return results



model_evaluation(y_test, y_pred, "KNN")
```

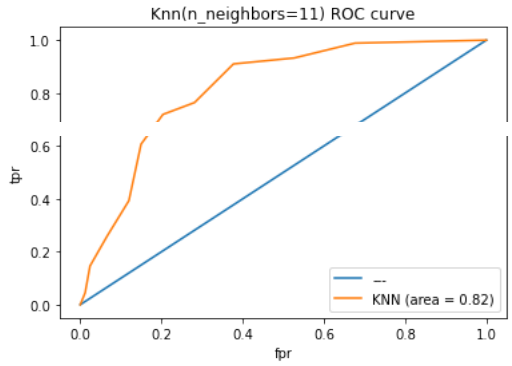
	Model	Accuracy	Precision	Recall	F1 SCore	F2 Score
0	KNN	0.765625	0.683544	0.606742	0.642857	0.62069

```
# Alternate way
from sklearn.metrics import classification_report
print(classification_report(y_test,y_pred))
```

```
              precision    recall  f1-score   support

           0       0.80      0.85      0.83       167
           1       0.68      0.61      0.64        89

    accuracy                           0.77       256
   macro avg       0.74      0.73      0.73       256
weighted avg       0.76      0.77      0.76       256
```

```
from sklearn.metrics import auc, roc_auc_score, roc_curve

y_pred_proba = knn.predict_proba(X_test)[:,-1]
fpr, tpr, threshold = roc_curve(y_test, y_pred_proba)


classifier_roc_auc = roc_auc_score(y_test, y_pred_proba)
plt.plot([0,1],[0,1], label = "---")

plt.plot(fpr, tpr, label ='KNN (area = %0.2f)' % classifier_roc_auc
plt.xlabel("fpr")
```

```
plt.ylabel("tpr")
plt.title('Knn(n_neighbors=11) ROC curve')
plt.legend(loc="lower right", fontsize = "medium")
plt.xticks(rotation=0, horizontalalignment="center")
plt.yticks(rotation=0, horizontalalignment="right")
```




```
#Hyper parameters tuning using GridSearchCV


from sklearn.model_selection import GridSearchCV
parameters_grid = {"n_neighbors": np.arange(0,50)}
knn= KNeighborsClassifier()
knn_GSV = GridSearchCV(knn, param_grid=parameters_grid, cv = 5)
knn_GSV.fit(X, y)
```

```
C:\Users\Admin\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:548: FitFailedWarning: Estimator fit failed. The sc
Traceback (most recent call last):
  File "C:\Users\Admin\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 531, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Admin\anaconda3\lib\site-packages\sklearn\neighbors\_base.py", line 1157, in fit
    return self._fit(X)
  File "C:\Users\Admin\anaconda3\lib\site-packages\sklearn\neighbors\_base.py", line 467, in _fit
    raise ValueError(
ValueError: Expected n_neighbors > 0. Got 0
```