In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:
```
df=pd.read_csv('Test2_dataset.csv')
```

In [3]:
```
df.head()
```

Out[3]:

	Pid	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	con points_m
0	8670	M	15.46	19.48	101.70	748.9	0.10920	0.12230	0.14660	0.08
1	8913	B	12.89	13.12	81.89	515.9	0.06955	0.03729	0.02260	0.0
2	8915	B	14.96	19.10	97.03	687.3	0.08992	0.09823	0.05940	0.0
3	9047	B	12.94	16.17	83.18	507.6	0.09879	0.08836	0.03296	0.0
4	85715	M	13.17	18.66	85.98	534.6	0.11580	0.12310	0.12260	0.0

5 rows × 32 columns

EDA

In [4]:
```
#Understanding Data
df.describe()
```

Out[4]:

	Pid	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	co points_
count	5.690000e+02	569.000000	569.000000	569.000000	569.000000	569.000000	569.000000	566.000000	566.0
mean	3.037183e+07	14.127292	19.289649	91.969033	654.889104	0.096360	0.104341	0.089270	0.0
std	1.250206e+08	3.524049	4.301036	24.298981	351.914129	0.014064	0.052813	0.079667	0.0

	Pid	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	co points_
min	8.670000e+03	6.981000	9.710000	43.790000	143.500000	0.052630	0.019380	0.000000	0.0
25%	8.692180e+05	11.700000	16.170000	75.170000	420.300000	0.086370	0.064920	0.029680	0.0
50%	9.060240e+05	13.370000	18.840000	86.240000	551.100000	0.095870	0.092630	0.061680	0.0
75%	8.813129e+06	15.780000	21.800000	104.100000	782.700000	0.105300	0.130400	0.131600	0.0
max	9.113205e+08	28.110000	39.280000	188.500000	2501.000000	0.163400	0.345400	0.426800	0.2

8 rows × 31 columns

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 569 entries, 0 to 568
Data columns (total 32 columns):
 #   Column                   Non-Null Count  Dtype
---  ------                   --------------  -----
 0   Pid                      569 non-null    int64
 1   diagnosis                569 non-null    object
 2   radius_mean              569 non-null    float64
 3   texture_mean             569 non-null    float64
 4   perimeter_mean           569 non-null    float64
 5   area_mean                569 non-null    float64
 6   smoothness_mean          569 non-null    float64
 7   compactness_mean         569 non-null    float64
 8   concavity_mean           566 non-null    float64
 9   concave points_mean      566 non-null    float64
 10  symmetry_mean            569 non-null    float64
 11  fractal_dimension_mean   569 non-null    float64
 12  radius_se                569 non-null    float64
 13  texture_se               569 non-null    float64
 14  perimeter_se             569 non-null    float64
 15  area_se                  569 non-null    float64
 16  smoothness_se            569 non-null    float64
 17  compactness_se           569 non-null    float64
 18  concavity_se             566 non-null    float64
 19  concave points_se        567 non-null    float64
 20  symmetry_se              569 non-null    float64
```

```
 21  fractal_dimension_se     569 non-null    float64
 22  radius_worst             569 non-null    float64
 23  texture_worst            546 non-null    float64
 24  perimeter_worst          569 non-null    float64
 25  area_worst               569 non-null    float64
 26  smoothness_worst         569 non-null    float64
 27  compactness_worst        569 non-null    float64
 28  concavity_worst          569 non-null    float64
 29  concave points_worst     569 non-null    float64
 30  symmetry_worst           569 non-null    float64
 31  fractal_dimension_worst  569 non-null    float64
dtypes: float64(30), int64(1), object(1)
memory usage: 142.4+ KB
```

In [6]:

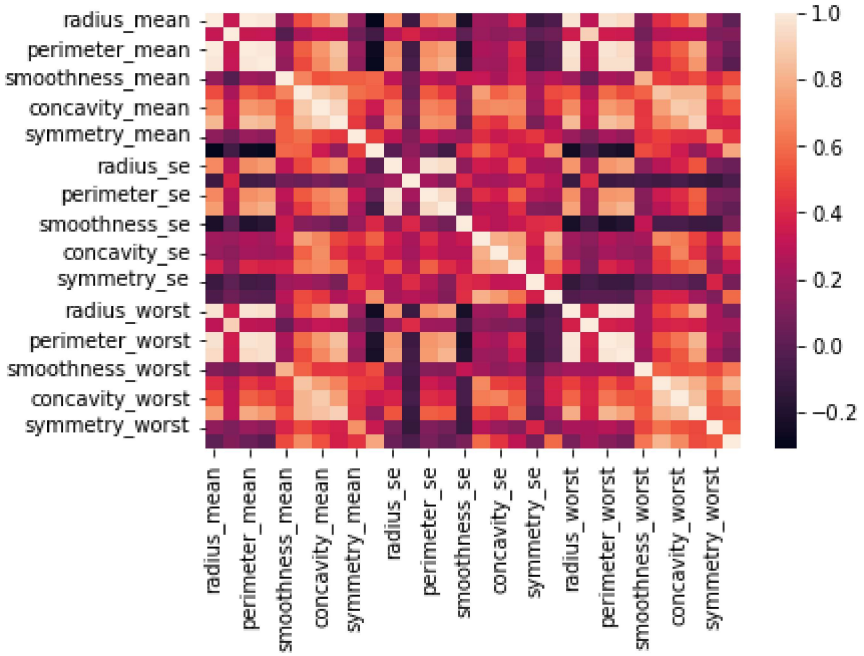
```
#Deleting unimportant columns
df.drop('Pid',axis=1,inplace=True)

#Deleting since unique and no impact on data
```

In [7]:

```
#Relationship b/w variables
sns.heatmap(df.corr())
```

Out[7]:

```
<AxesSubplot:>
```



In [8]:

```
#Univariate Analysis

l=list(df.loc[:, df.dtypes != object].columns)
len(l)

# plot all the columns present in list l together using subplot of dimension (2,3).

c=0
plt.figure(figsize=(15,10))
for i in l:
    c=c+1
    plt.subplot(6,7, c)
    plt.title(i)
    sns.distplot(df[i])
plt.show()
```

```
C:\Users\Admin\Anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated funct
ion and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with
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  warnings.warn(msg, FutureWarning)
```
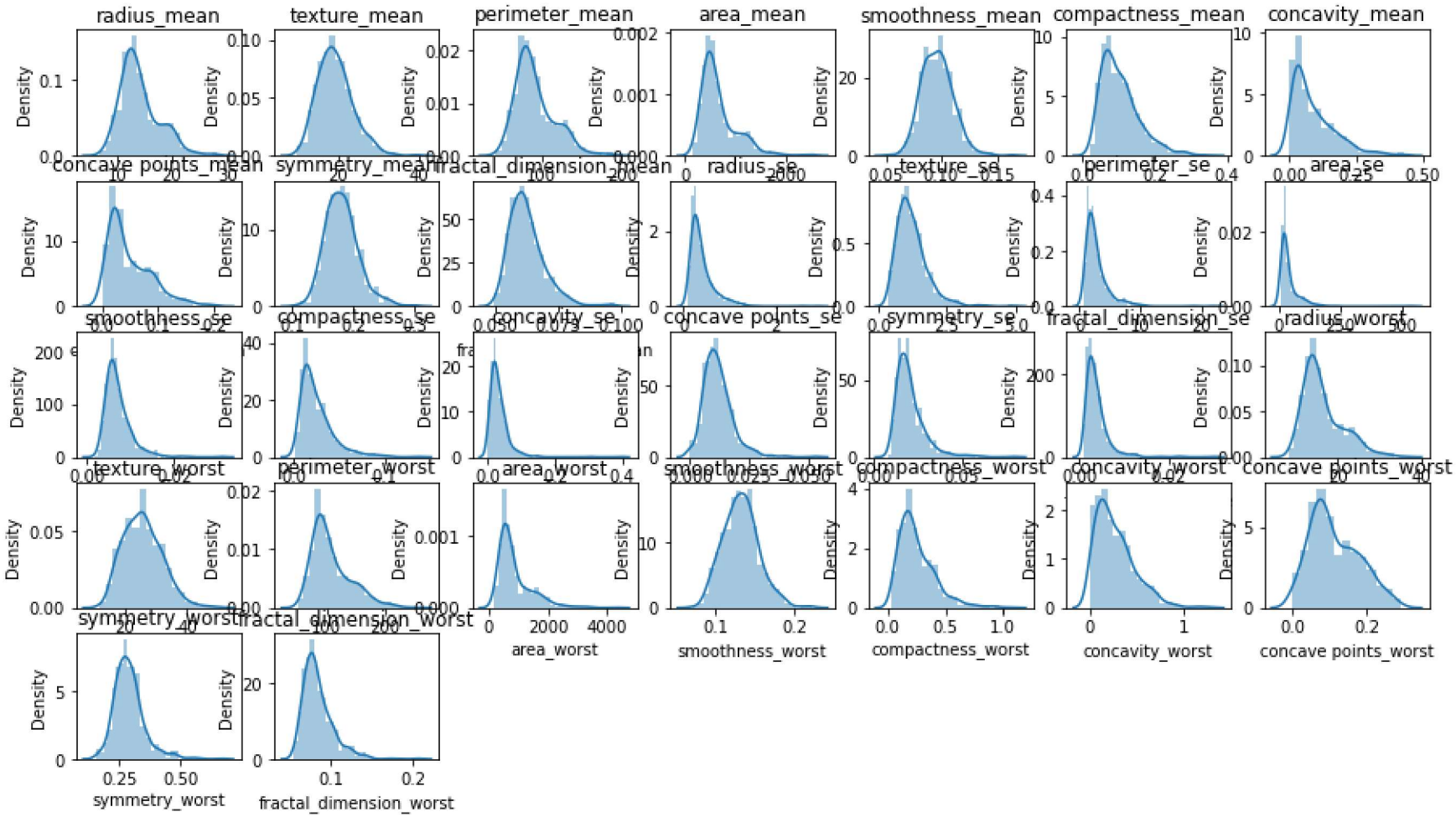
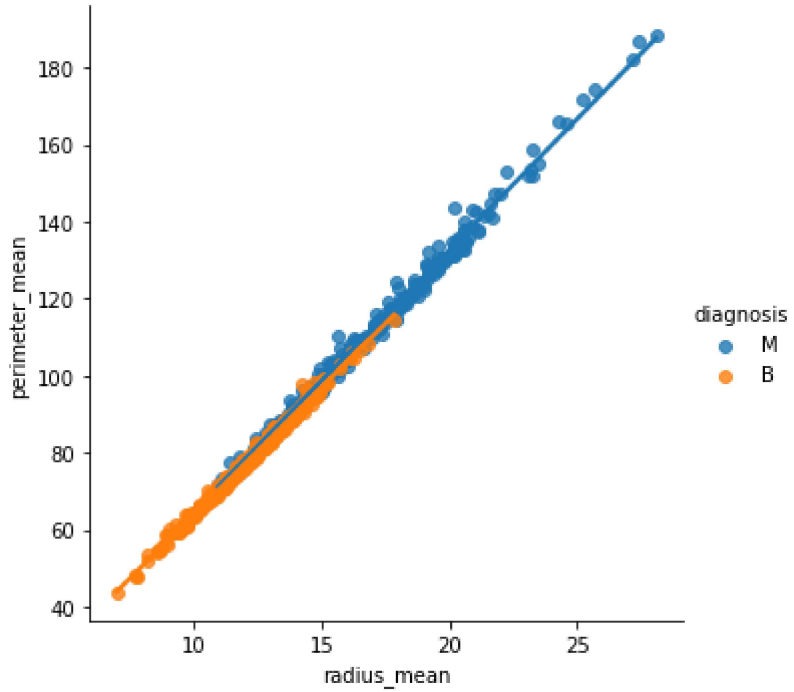



We can observe from the graphs that most of the variables are having a normal distribution,some variables such as texture_worst and parameter_worst are having a negatively-skewed distribution.

In [59]:
```
sns.lmplot('radius_mean','perimeter_mean',hue='diagnosis',data=df)
```

Out[59]:
```
<seaborn.axisgrid.FacetGrid at 0x1fe7e22d220>
```

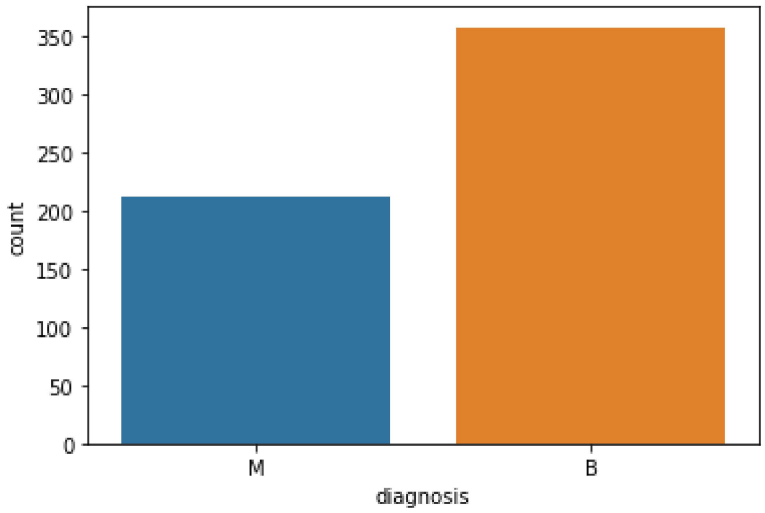


From the data we can observe a strong correlation vetween perimeter_mean and radius_mean and we can also observe that M have a higher value for both and F has comparatively smaller values.Hence we can eliminate one out of the 2 variables as they both are highly correlated.

In [21]:
```
sns.countplot(df['diagnosis'])
```

```
C:\Users\Admin\Anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[21]:
```
<AxesSubplot:xlabel='diagnosis', ylabel='count'>
```



In [10]:
```
df1=pd.get_dummies(df,drop_first=True)
df1.head()
```

Out[10]:

	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	symmetry_me
0	15.46	19.48	101.70	748.9	0.10920	0.12230	0.14660	0.08087	0.1
1	12.89	13.12	81.89	515.9	0.06955	0.03729	0.02260	0.01171	0.1
2	14.96	19.10	97.03	687.3	0.08992	0.09823	0.05940	0.04819	0.1
3	12.94	16.17	83.18	507.6	0.09879	0.08836	0.03296	0.02390	0.1
4	13.17	18.66	85.98	534.6	0.11580	0.12310	0.12260	0.07340	0.2

5 rows × 31 columns

In [ ]:
```
```

In [12]:
```
df1.isnull().sum()
```

Out[12]:
```
radius_mean                0
```

```
texture_mean               0
perimeter_mean             0
area_mean                  0
smoothness_mean            0
compactness_mean           0
concavity_mean             3
concave points_mean        3
symmetry_mean              0
fractal_dimension_mean     0
radius_se                  0
texture_se                 0
perimeter_se               0
area_se                    0
smoothness_se              0
compactness_se             0
concavity_se               3
concave points_se          2
symmetry_se                0
fractal_dimension_se       0
radius_worst               0
texture_worst             23
perimeter_worst            0
area_worst                 0
smoothness_worst           0
compactness_worst          0
concavity_worst            0
concave points_worst       0
symmetry_worst             0
fractal_dimension_worst    0
diagnosis_M                0
dtype: int64
```

Data Cleaning

Since texture_worst has highest number of missing values and it's graph is negatively skewed we've imputed the missing values with median.

In [13]:
```
df1.fillna(df.median(),inplace=True)
```

```
C:\Users\Admin\AppData\Local\Temp/ipykernel_20720/435454688.py:1: FutureWarning: Dropping of nuisance columns in DataFram
e reductions (with 'numeric_only=None') is deprecated; in a future version this will raise TypeError.  Select only valid
```

columns before calling the reduction.

```
df1.fillna(df.median(),inplace=True)
```

In [ ]:

In [ ]:

In [32]:

```
import math
#Since the classes are unbalanced we will apply oversampling

def _oversample_positives(df, target):
    """ Oversample the minority classes to match
    the majority class.

    :param df: pandas dataframe - input df.
    :param target: string - classification target column.

    :return: pandas datframe - oversampled version
    """

    class_count = df[target].value_counts()

    print("Before oversampling:\n %s" % class_count)

    for i in range(1,len(class_count)):
        df_i = df[df[target] == i]
        oversampling_factor_i = class_count[0] / float(class_count[i])
        print(len(df_i))
        print("Oversampling factor for class %i: %s" %(i, str(oversampling_factor_i)))

        # Integer part of oversampling
        df = df.append(
            [df_i] * int(math.floor(oversampling_factor_i) - 1),
            ignore_index=False)

        # Float part of oversampling
        df = df.append(
            [df_i.sample(frac=oversampling_factor_i % 1)],
            ignore_index=False)

    print("After oversampling:\n %s" % df[target].value_counts())
    print("Shape after oversampling: %s" % str(df.shape))
```

```
    return df
df_oversampled = _oversample_positives(df1, 'diagnosis_M')
```

```
Before oversampling:
 0    357
1    212
Name: diagnosis_M, dtype: int64
212
Oversampling factor for class 1: 1.6839622641509433
After oversampling:
 1    357
0    357
Name: diagnosis_M, dtype: int64
Shape after oversampling: (714, 31)
```

In [33]:

```
#Storing Target variable in y and independent variables in x

X = df_oversampled.drop(["diagnosis_M"],axis=1)
Y = df_oversampled["diagnosis_M"]
```

In [34]:

```
# Scaling the Data : MinMax Scaler

#import MinMaxScaler from sklearn.preprocessing
from sklearn.preprocessing import MinMaxScaler

#storing MinMaxScalar in scaler
scaler = MinMaxScaler()

#fitting and transforming X
X = scaler.fit_transform(X)
```

In [35]:

```
# Train Test Split

#import train_test_split from sklearn.model_selection
from sklearn.model_selection import train_test_split

#splitting the data with size=0.2
x_train,x_test,y_train,y_test =train_test_split(X,Y,test_size = 0.2)
```

Dimensionality Reduction

In [36]:
```
from sklearn.decomposition import PCA
# Make an instance of the Model
pca = PCA(.95)
```

In [37]:
```
pca.fit(x_train)
```

Out[37]:
```
PCA(n_components=0.95)
```

In [38]:
```
x_train = pca.transform(x_train)
x_test = pca.transform(x_test)
```

Model Building

In [39]:
```
from sklearn.linear_model import LogisticRegression
```

In [40]:
```
model = LogisticRegression(random_state=0)
```

In [41]:
```
model.fit(x_train, y_train)
```

Out[41]:
```
LogisticRegression(random_state=0)
```

In [43]:
```
y_pred=model.predict(x_test)
```

In [47]:
```
print('Accuracy of logistic regression classifier on test set: {:.2f}'.format(model.score(x_test, y_test)))
```

```
Accuracy of logistic regression classifier on test set: 0.98
```

Visualization and Interpretation

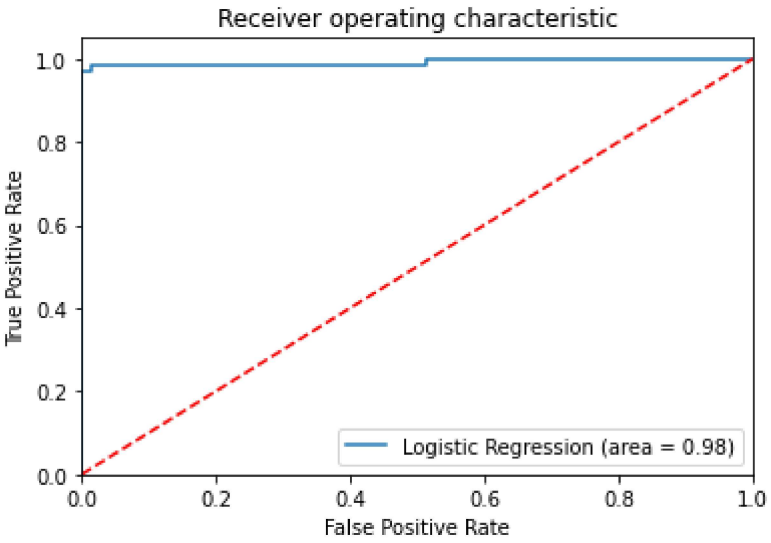
In [48]:
```
from sklearn.metrics import confusion_matrix
confusion_matrix = confusion_matrix(y_test, y_pred)
print(confusion_matrix)
```

```
[[74  0]
 [ 3 66]]
```

In [49]:
```
from sklearn.metrics import classification_report
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.96      1.00      0.98        74
           1       1.00      0.96      0.98        69

    accuracy                           0.98       143
   macro avg       0.98      0.98      0.98       143
weighted avg       0.98      0.98      0.98       143
```

In [51]:
```
#ROC Curve
from sklearn.metrics import roc_auc_score
from sklearn.metrics import roc_curve
logit_roc_auc = roc_auc_score(y_test, model.predict(x_test))
fpr, tpr, thresholds = roc_curve(y_test, model.predict_proba(x_test)[:,1])
plt.figure()
plt.plot(fpr, tpr, label='Logistic Regression (area = %0.2f)' % logit_roc_auc)
plt.plot([0, 1], [0, 1],'r--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.savefig('Log_ROC')
plt.show()
```



The optimum values for FPR and TPR are approximately(0.02,0.97)