Importing Libraries

```
from sklearn.ensemble import AdaBoostClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.datasets import load_breast_cancer
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix
from sklearn.preprocessing import LabelEncoder
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline

```

Loading dataset

```
breast_cancer = load_breast_cancer()
X = pd.DataFrame(breast_cancer.data, columns=breast_cancer.feature_names)
print("\n \t The data frame has {0[0]} rows and {0[1]} columns. \n".format(X.shape))
X.info()
y = pd.Categorical.from_codes(breast_cancer.target, breast_cancer.target_names)

```

```
The data frame has 569 rows and 30 columns.

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 569 entries, 0 to 568
Data columns (total 30 columns):
 #   Column                  Non-Null Count  Dtype  
---  ------                  --------------  -----  
 0   mean radius             569 non-null    float64
 1   mean texture            569 non-null    float64
 2   mean perimeter          569 non-null    float64
 3   mean area               569 non-null    float64
 4   mean smoothness         569 non-null    float64
```

Visualizing data

```
 9   mean fractal dimension   569 non-null    float64
```

```
X.head(3)
X.info()
features_mean= list(X.columns[1:11])
plt.figure(figsize=(10,10))
sns.heatmap(X[features_mean].corr(), annot=True, square=True, cmap='coolwarm')
plt.show()
```

```
<class 'pandas.core.frame.DataFrame'>
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---  ------                   --------------  -----  
 0   mean radius              569 non-null    float64
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 2   mean perimeter           569 non-null    float64
 3   mean area                569 non-null    float64
 4   mean smoothness          569 non-null    float64
 5   mean compactness         569 non-null    float64
 6   mean concavity           569 non-null    float64
 7   mean concave points      569 non-null    float64
 8   mean symmetry            569 non-null    float64
 9   mean fractal dimension   569 non-null    float64
 10  radius error             569 non-null    float64
 11  texture error            569 non-null    float64
 12  perimeter error          569 non-null    float64
 13  area error               569 non-null    float64
 14  smoothness error         569 non-null    float64
 15  compactness error        569 non-null    float64
 16  concavity error          569 non-null    float64
 17  concave points error     569 non-null    float64
 18  symmetry error           569 non-null    float64
 19  fractal dimension error  569 non-null    float64
 20  worst radius             569 non-null    float64
 21  worst texture            569 non-null    float64
 22  worst perimeter          569 non-null    float64
 23  worst area               569 non-null    float64
 24  worst smoothness         569 non-null    float64
 25  worst compactness        569 non-null    float64
 26  worst concavity          569 non-null    float64
 27  worst concave points     569 non-null    float64
 28  worst symmetry           569 non-null    float64
 29  worst fractal dimension  569 non-null    float64
dtypes: float64(30)
memory usage: 133.5 KB
```
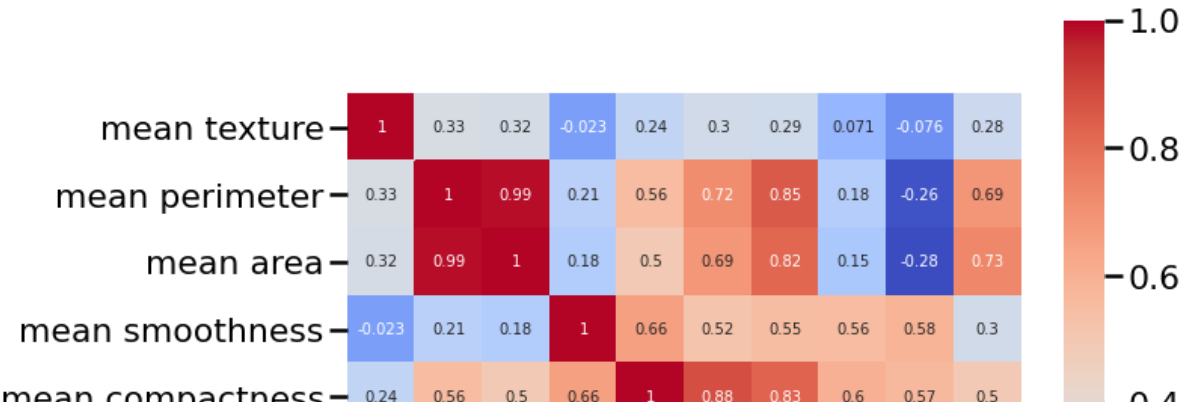




```
1 encoder = LabelEncoder()
2 binary_encoded_y = pd.Series(encoder.fit_transform(y))
3 binary_encoded_y.head()
```

```
0    1
1    1
2    1
3    1
4    1
dtype: int64
```

Splitting to train and test

```
train_X, test_X, train_y, test_y = train_test_split(X, binary_encoded_y, random_state=1
```

Invoking classifier

```
classifier = AdaBoostClassifier(
    DecisionTreeClassifier(max_depth=1),
    n_estimators=200
)
classifier.fit(train_X, train_y)
```

```
AdaBoostClassifier(algorithm='SAMME.R',
                   base_estimator=DecisionTreeClassifier(ccp_alpha=0.0,
                                                         class_weight=None,
                                                         criterion='gini',
                                                         max_depth=1,
                                                         max_features=None,
                                                         max_leaf_nodes=None,
                                                         min_impurity_decrease=0.0,
                                                         min_impurity_split=None,
                                                         min_samples_leaf=1,
                                                         min_samples_split=2,
                                                         min_weight_fraction_leaf=0.0
                                                         presort='deprecated',
                                                         random_state=None,
                                                         splitter='best'),
                   learning_rate=1.0, n_estimators=200, random_state=None)
```

```
predictions = classifier.predict(test_X)
```

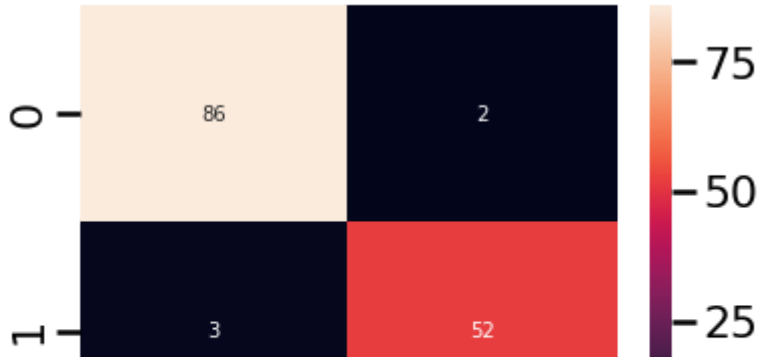
Printing the confusion matrix

```
cf=confusion_matrix(test_y, predictions)
cf
```

```
array([[86,  2],
       [ 3, 52]])
```

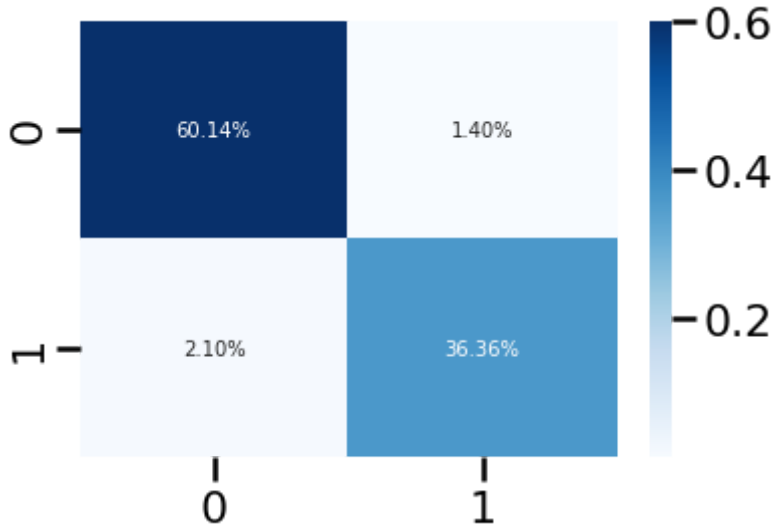
```
#Printing confusion matrix as a Heat Map
sns.heatmap(cf, annot=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdc687bbd68>
```



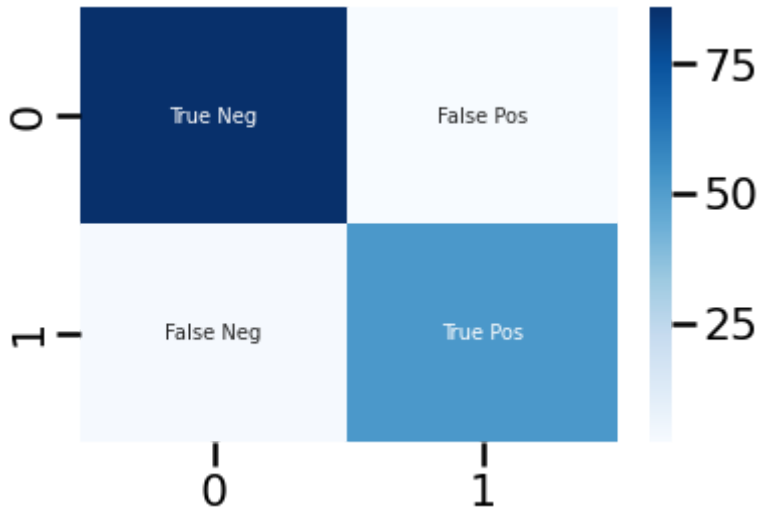

```
sns.heatmap(cf/np.sum(cf), annot=True,
            fmt='.2%', cmap='Blues')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdc68730898>
```




```
labels = ['True Neg','False Pos','False Neg','True Pos']
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cf, annot=labels, fmt='', cmap='Blues')
```

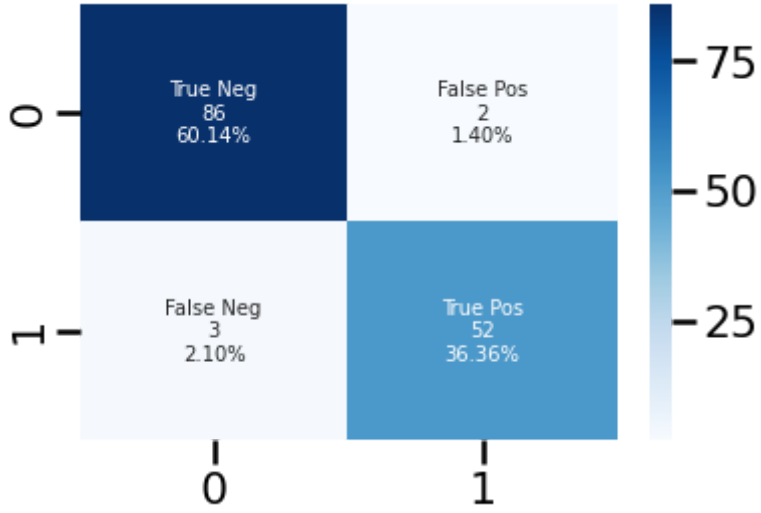
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdc686c7c50>
```




```
group_names = ['True Neg','False Pos','False Neg','True Pos']
group_counts = ["{0:0.0f}".format(value) for value in
                cf.flatten()]
```

```
group_percentages = ["{0:.2%}".format(value) for value in
                     cf.flatten()/np.sum(cf)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names,group_counts,group_percentages)]
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cf, annot=labels, fmt='', cmap='Blues')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdc6864de80>
```



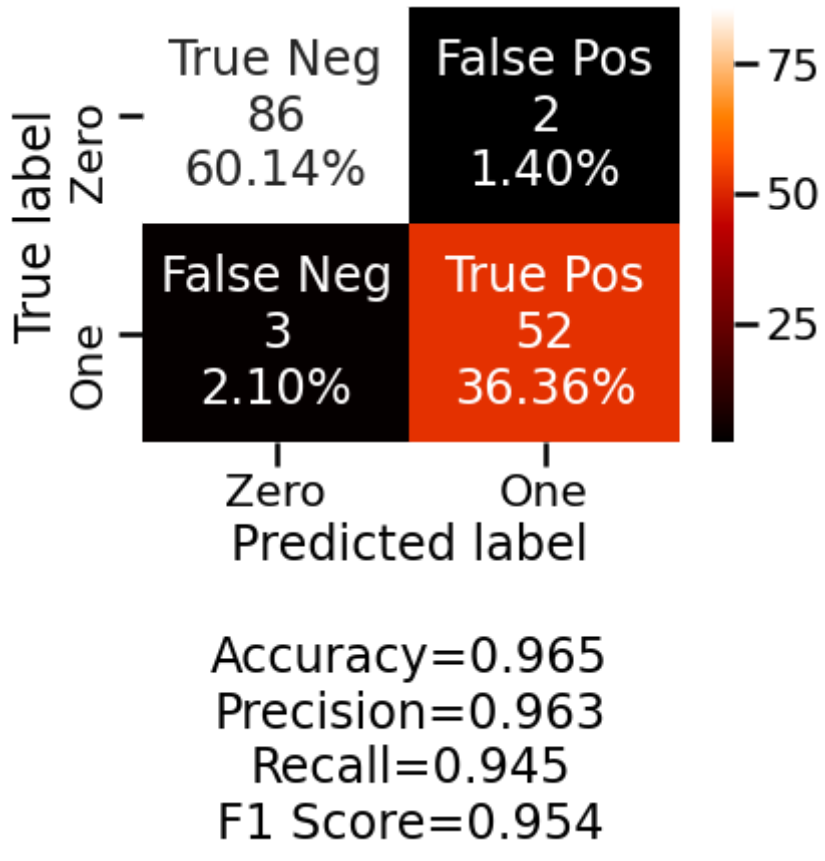
Function definition make_confusion_matrix

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

def make_confusion_matrix(cf,
                          group_names=None,
                          categories='auto',
                          count=True,
                          percent=True,
                          cbar=True,
                          xyticks=True,
                          xyplotlabels=True,
                          sum_stats=True,
                          figsize=None,
                          cmap='Blues',
                          title=None):
    '''
    This function will make a pretty plot of an sklearn Confusion Matrix cm using a Sea
    Arguments
    ---------
    cf:            confusion matrix to be passed in
    group_names:   List of strings that represent the labels row by row to be shown in
    categories:    List of strings containing the categories to be displayed on the x,y
    count:         If True, show the raw number in the confusion matrix. Default is Tru
    normalize:     If True, show the proportions for each category. Default is True.
    cbar:          If True, show the color bar. The cbar values are based off the value
                   Default is True.
    xyticks:       If True, show x and y ticks. Default is True.
    xyplotlabels:  If True, show 'True Label' and 'Predicted Label' on the figure. Defa
```

```
    xyplotlabels:  If True, show "True label" and "Predicted label" on the figure. Defa
    sum_stats:     If True, display summary statistics below the figure. Default is Tru
    figsize:       Tuple representing the figure size. Default will be the matplotlib r
    cmap:          Colormap of the values displayed from matplotlib.pyplot.cm. Default
                   See http://matplotlib.org/examples/color/colormaps_reference.html

    title:         Title for the heatmap. Default is None.
    '''


    # CODE TO GENERATE TEXT INSIDE EACH SQUARE
    blanks = ['' for i in range(cf.size)]

    if group_names and len(group_names)==cf.size:
        group_labels = ["{}\n".format(value) for value in group_names]
    else:
        group_labels = blanks

    if count:
        group_counts = ["{0:0.0f}\n".format(value) for value in cf.flatten()]
    else:
        group_counts = blanks

    if percent:
        group_percentages = ["{0:.2%}".format(value) for value in cf.flatten()/np.sum(c
    else:
        group_percentages = blanks

    box_labels = [f"{v1}{v2}{v3}".strip() for v1, v2, v3 in zip(group_labels,group_coun
    box_labels = np.asarray(box_labels).reshape(cf.shape[0],cf.shape[1])


    # CODE TO GENERATE SUMMARY STATISTICS & TEXT FOR SUMMARY STATS
    if sum_stats:
        #Accuracy is sum of diagonal divided by total observations
        accuracy  = np.trace(cf) / float(np.sum(cf))

        #if it is a binary confusion matrix, show some more stats
        if len(cf)==2:
            #Metrics for Binary Confusion Matrices
            precision = cf[1,1] / sum(cf[:,1])
            recall    = cf[1,1] / sum(cf[1,:])
            f1_score  = 2*precision*recall / (precision + recall)
            stats_text = "\n\nAccuracy={:0.3f}\nPrecision={:0.3f}\nRecall={:0.3f}\nF1 S
                accuracy,precision,recall,f1_score)
        else:
            stats_text = "\n\nAccuracy={:0.3f}".format(accuracy)
    else:
        stats_text = ""


    # SET FIGURE PARAMETERS ACCORDING TO OTHER ARGUMENTS
    if figsize==None:
        #Get default figure size if not set
        figsize = plt.rcParams.get('figure.figsize')

```

```
    if xyticks==False:
        #Do not show categories if xyticks is False
        categories=False


    # MAKE THE HEATMAP VISUALIZATION
    plt.figure(figsize=figsize)
    sns.heatmap(cf,annot=box_labels,fmt="",cmap=cmap,cbar=cbar,xticklabels=categories,y

    if xyplotlabels:
        plt.ylabel('True label')
        plt.xlabel('Predicted label' + stats_text)
    else:
        plt.xlabel(stats_text)

    if title:
        plt.title(title)
```

```
labels = ['True Neg','False Pos','False Neg','True Pos']
categories = ['Zero', 'One']
sns.set_context("poster")
make_confusion_matrix(cf,
                      group_names=labels,
                      categories=categories,
                      cmap='gist_heat')
```




```
1
```