Week6_6_Bagging_boosting_classifiers

May 14, 2021

Bagging and Boosting

Import Libraries

[57]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

from sklearn.decomposition import PCA
import sklearn
from sklearn import preprocessing
from sklearn import tree

from sklearn import tree
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import BaggingClassifier
from sklearn.ensemble import AdaBoostClassifier

from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error as MSE
from sklearn.metrics import mean_absolute_error as MAE
from sklearn.metrics import confusion_matrix
from sklearn.metrics import classification_report
from sklearn.metrics import accuracy_score

import warnings
warnings.filterwarnings('ignore')
```

Load sample dataset

[2]:
```
# df = pd.read_csv("~/Downloads/ML_classwork/DT_RF_Ensemble/
 ↪Somerville-Happiness-Survey-master/data/SomervilleHappinessSurvey2015.csv",␣
 ↪sep = ",")
df = pd.read_csv("~/Downloads/ML_classwork/DT_RF_Ensemble/
 ↪Somerville-Happiness-Survey-master/data/SomervilleHappinessSurvey2015.csv",␣
 ↪sep = ",")

df.head()
```

```
[2]:    D  X1  X2  X3  X4  X5  X6
     0  0   3   3   3   4   2   4
     1  0   3   2   3   5   4   3
     2  1   5   3   3   3   3   5
     3  0   5   4   3   3   3   5
     4  0   5   4   3   3   3   5
```

Data Shape

```
[3]: df.shape
```

```
[3]: (143, 7)
```

```
[4]: # label = df['label']
     # for i in range(len(label)):
     #     if (label[i] == '<=50K'):
     #         label[i] = 0
     #     elif (label[i]=='>50K'):
     #         label[i] = 1
     # df['label'] = label
     # df.head(10)
```

Checking NULL values

```
[5]: df.isnull().values.any()
```

```
[5]: False
```

Data Statistics

```
[6]: df.describe().T
```

```
[6]:     count      mean       std  min  25%  50%  75%  max
     D   143.0  0.538462  0.500271  0.0  0.0  1.0  1.0  1.0
     X1  143.0  4.314685  0.799820  1.0  4.0  5.0  5.0  5.0
     X2  143.0  2.538462  1.118155  1.0  2.0  3.0  3.0  5.0
     X3  143.0  3.265734  0.992586  1.0  3.0  3.0  4.0  5.0
     X4  143.0  3.699301  0.888383  1.0  3.0  4.0  4.0  5.0
     X5  143.0  3.615385  1.131639  1.0  3.0  4.0  4.0  5.0
     X6  143.0  4.216783  0.848693  1.0  4.0  4.0  5.0  5.0
```

Replacing Missing Values

```
[7]: # Replacing Missing Values
     df.replace('?', np.nan, inplace=True)
     df=df.fillna(df.mean())
     df = df.apply(lambda x:x.fillna(x.value_counts().index[0]))
```

```
[8]: # Handle missing values
     num_missing = (df[df.columns] == 0).sum()

     print(num_missing)
```

```
D     66
X1     0
X2     0
X3     0
X4     0
X5     0
X6     0
dtype: int64
```

Checking the Data Type

```
[9]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 143 entries, 0 to 142
Data columns (total 7 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   D       143 non-null    int64
 1   X1      143 non-null    int64
 2   X2      143 non-null    int64
 3   X3      143 non-null    int64
 4   X4      143 non-null    int64
 5   X5      143 non-null    int64
 6   X6      143 non-null    int64
dtypes: int64(7)
memory usage: 7.9 KB
```

Print all values of particular column

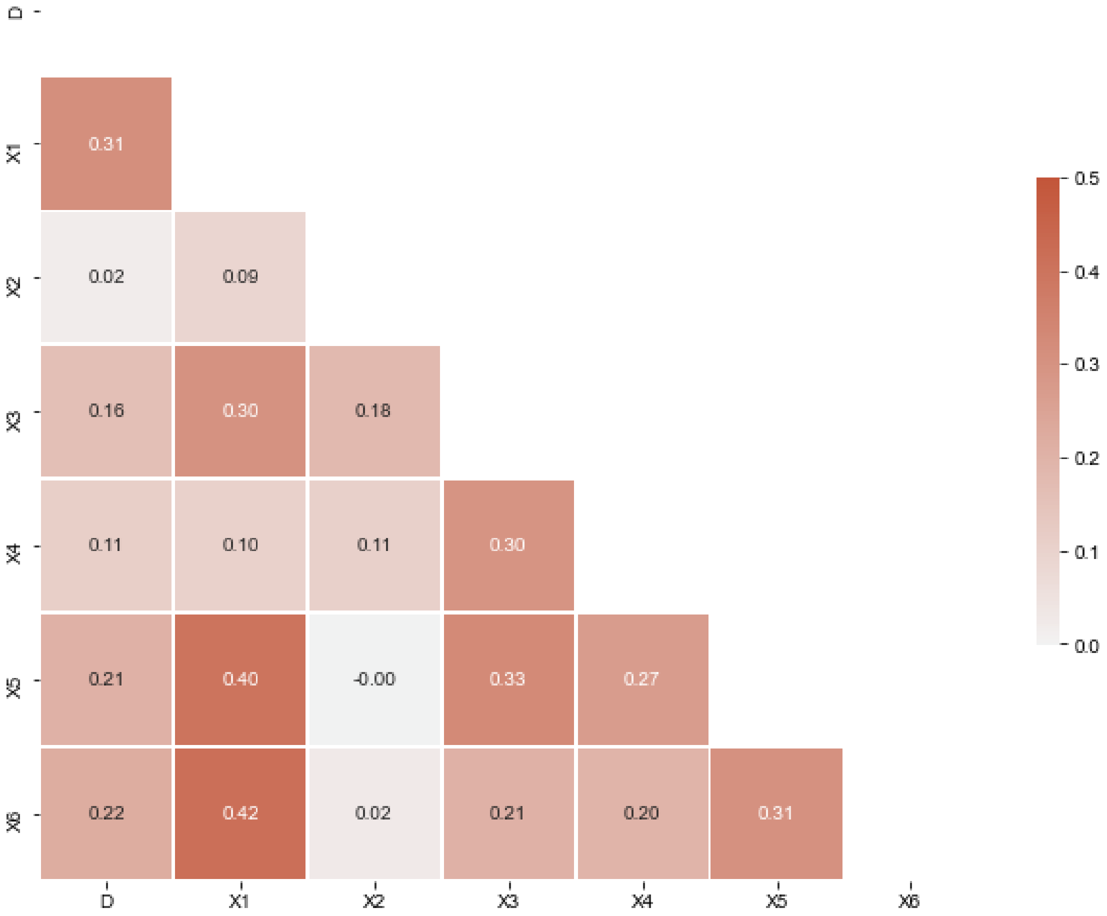
```
[10]: dd = df['D']
      print(*dd)
```

```
0 0 1 0 0 1 0 1 0 0 0 0 1 0 0 1 0 1 0 0 1 1 0 0 1 1 0 1 1 1 1 0 0 0 1 1 1 0 1 1
1 1 0 0 1 0 0 1 1 1 0 1 1 1 1 1 1 1 1 0 0 1 1 1 0 1 1 0 1 1 0 0 1 1 1 1 0 0 1 0
0 1 0 0 1 0 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 1 1 1 0 1 0 1 1 0 1 1 0 1 0 1 0 0 1 0
1 0 0 1 1 0 0 0 0 0 0 0 1 1 1 1 0 1 0 1 1 0 0
```

Correlation Plot

```
[11]: from string import ascii_letters
      corr = df.corr()
      # Generate a mask for the upper triangle
      mask = np.triu(np.ones_like(corr, dtype=bool))
```

```
# Set up the matplotlib figure
f, ax = plt.subplots(figsize=(11, 9))

# Generate a custom diverging colormap
cmap = sns.diverging_palette(230, 20, as_cmap=True)

# Draw the heatmap with the mask and correct aspect ratio
sns.heatmap(corr, mask=mask, cmap=cmap, vmax=.5, center=0,
            square=True, linewidths=.5, cbar_kws={"shrink": .5},␣
↪annot=True,fmt='.2f')
sns.set(font_scale=1.1)
```



Pearson Correlation Results

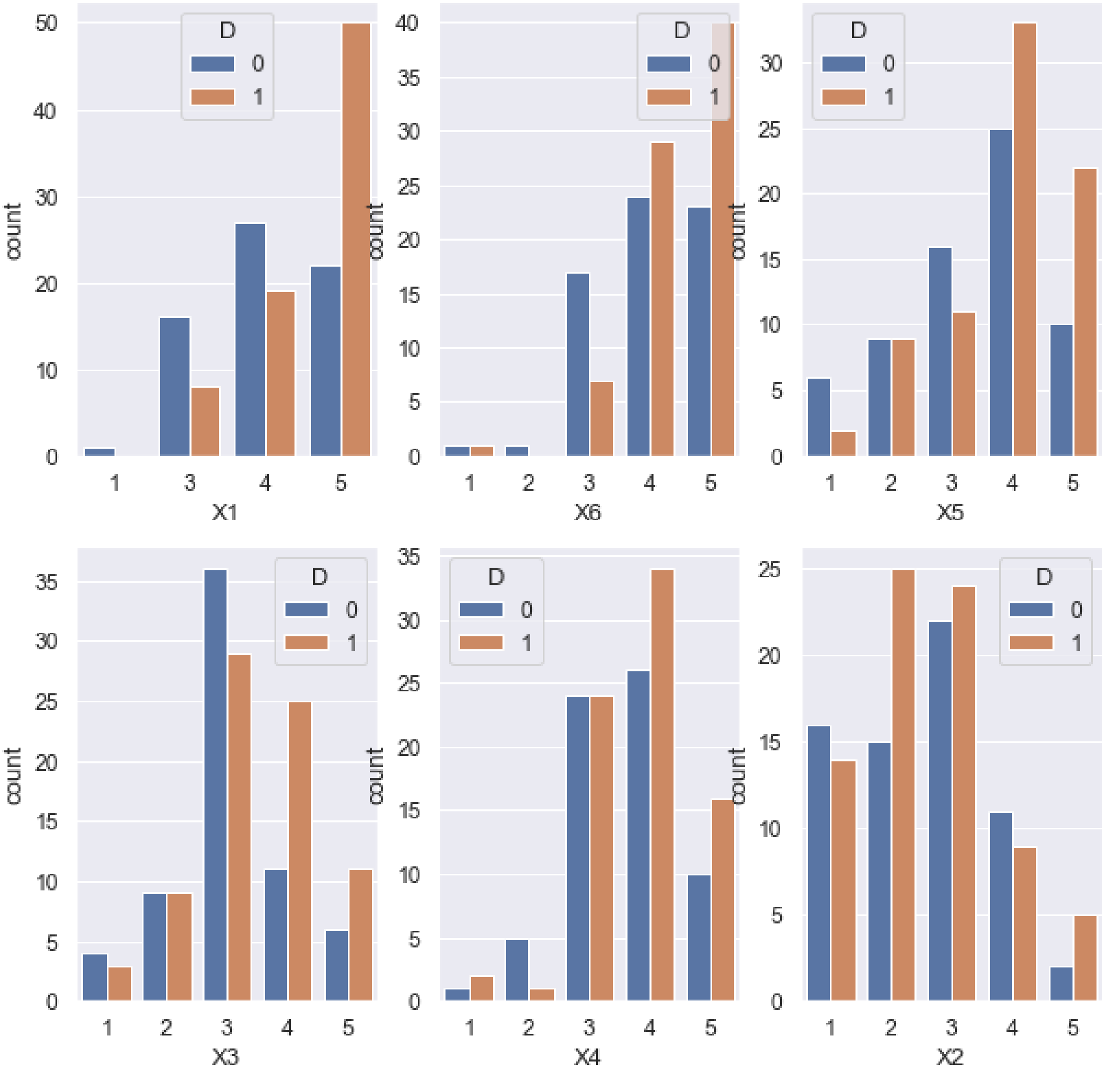
```
[12]: #Correlation with output variable
cor_target = abs(corr['D']).sort_values(ascending=False)[1:]
```

```
cor_target
```

```
[12]: X1    0.312740
      X6    0.220729
      X5    0.206685
      X3    0.163639
      X4    0.113356
      X2    0.019368
      Name: D, dtype: float64
```

Histograms

```
[13]: import math
      from matplotlib import rcParams
      import numpy as np

      # figure size in inches
      rcParams['figure.figsize'] = 10,10

      def plot_multiple_countplots(df, cols):
          num_plots = len(cols)
          num_cols = math.ceil(np.sqrt(num_plots))
          num_rows = math.ceil(num_plots/num_cols)

          fig, axs = plt.subplots(num_rows, num_cols)

          for ind, col in enumerate(cols):
              i = math.floor(ind/num_cols)
              j = ind - i*num_cols

              if num_rows == 1:
                  if num_cols == 1:
                      sns.countplot(x=df[col], hue=df["D"], ax=axs)
                  else:
                      sns.countplot(x=df[col], hue=df["D"], ax=axs[j])
              else:
                  sns.countplot(x=df[col], hue=df["D"], ax=axs[i, j])


      plot_multiple_countplots(df, cor_target.keys())
```



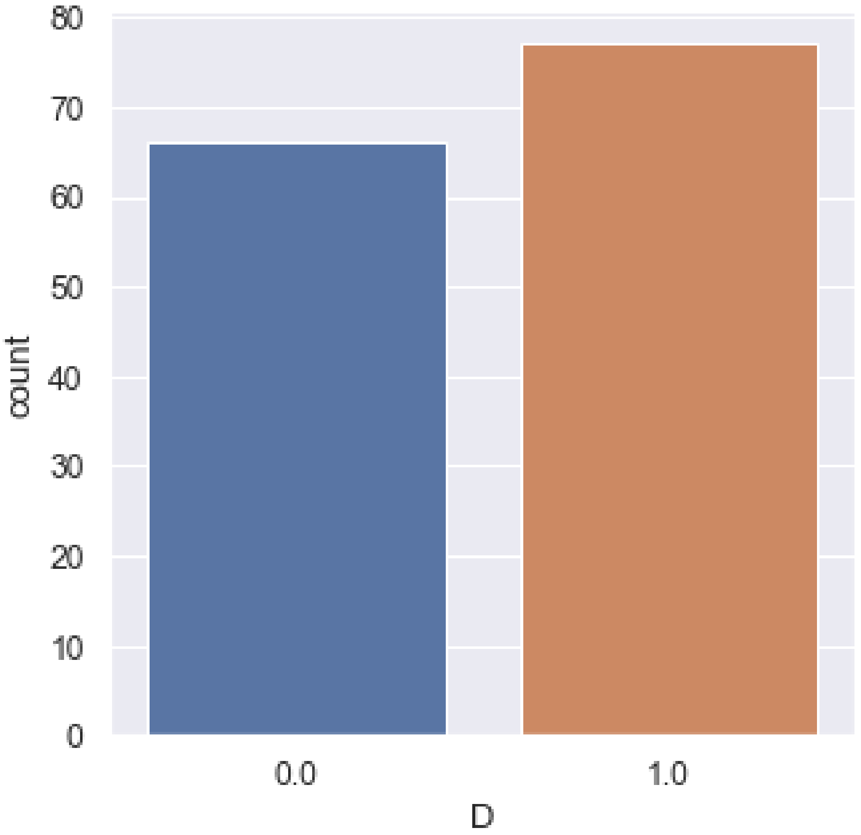
Preprocessing

[14]:
```
min_max_scaler = preprocessing.MinMaxScaler()
np_scaled = min_max_scaler.fit_transform(df)
data_norm= pd.DataFrame(np_scaled, columns = df.columns)
data_norm.head()
```

[14]:
```
     D   X1    X2   X3    X4    X5    X6
0  0.0  0.5  0.50  0.5  0.75  0.25  0.75
1  0.0  0.5  0.25  0.5  1.00  0.75  0.50
2  1.0  1.0  0.50  0.5  0.50  0.50  1.00
3  0.0  1.0  0.75  0.5  0.50  0.50  1.00
4  0.0  1.0  0.75  0.5  0.50  0.50  1.00
```

[15]:

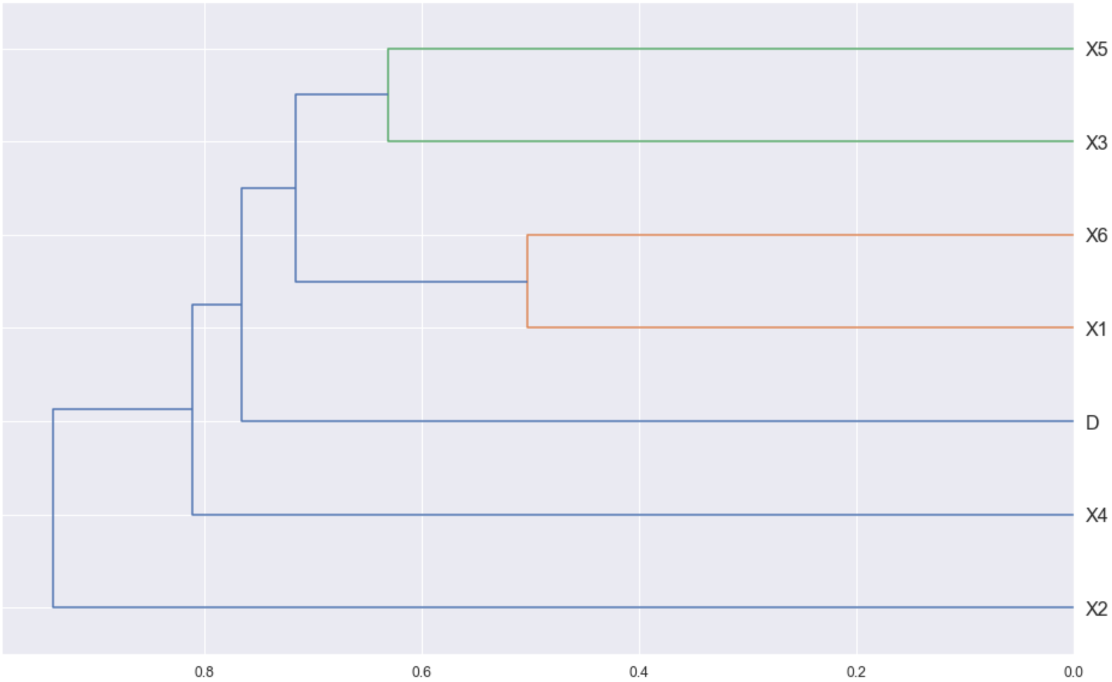
```
# figure size in inches
rcParams['figure.figsize'] = 5,5
ax = sns.countplot(x="D", data=data_norm)
```



Dendogram plot

[18]:

```
# Dendogram
import scipy
from scipy.cluster import hierarchy as hc
# Redundant Features
corr = np.round(scipy.stats.spearmanr(df).correlation, 4)
corr_condensed = hc.distance.squareform(1-corr)
z = hc.linkage(corr_condensed, method='average')
fig = plt.figure(figsize=(16,10))
dendrogram = hc.dendrogram(z, labels=df.columns, orientation='left', leaf_font_size=16)
plt.show()
```



```
[59]: # g = sns.PairGrid(df, hue = "D", vars=['X1','X2','X3','X4','X5','X6'])
      # g.map(plt.scatter)
      # plt.show()
```

Split Train and Test

```
[20]: # Split Dataset into Training and Testing sets
      class_df = df['D']
      class_df.head()
```

```
[20]: 0    0
      1    0
      2    1
      3    0
      4    0
      Name: D, dtype: int64
```

```
[21]: features_df=df.drop('D',axis=1)
      features_df.head()
```

```
[21]:    X1  X2  X3  X4  X5  X6
      0   3   3   3   4   2   4
      1   3   2   3   5   4   3
      2   5   3   3   3   3   5
      3   5   4   3   3   3   5
```

```
4    5    4    3    3    3    5
```

[22]:

```
import numpy as np
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(features_df,class_df,␣
 ↪test_size=0.2, random_state=42)
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(114, 6)
(29, 6)
(114,)
(29,)
```

Decision Tree: Grid Search

[23]:

```
from sklearn.model_selection import GridSearchCV
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import classification_report,confusion_matrix
from sklearn.metrics import accuracy_score

param_grid = {
    'max_depth': [3, 4, 5, 6,7,8],
    'max_features' : ['auto', 'sqrt', 'log2']
}


grid_search = GridSearchCV(estimator = DecisionTreeClassifier(), param_grid =␣
 ↪param_grid, cv = 3)

grid_search.fit(x_train, y_train)
grid_search.best_params_
```

[23]:

```
{'max_depth': 5, 'max_features': 'sqrt'}
```

[24]:

```
best_grid = grid_search.best_estimator_

print("Decision Trees's Accuracy: ", best_grid.score(x_test, y_test))
```

```
Decision Trees's Accuracy:  0.5517241379310345
```

[25]:

```
grid_search.fit(x_train, y_train)
grid_search_predicted = best_grid.predict(x_test)

DT_score      = round(best_grid.score(x_train, y_train) * 100, 2)
DT_score_test = round(best_grid.score(x_test, y_test) * 100, 2)
```

```
print('Decision Tree Train Score: ', DT_score)
print('Decision Tree Test Score: ', DT_score_test)
print('Accuracy: ', (accuracy_score(y_test,grid_search_predicted)) *100)
```

```
Decision Tree Train Score:  78.95
Decision Tree Test Score:  55.17
Accuracy:  55.172413793103445
```

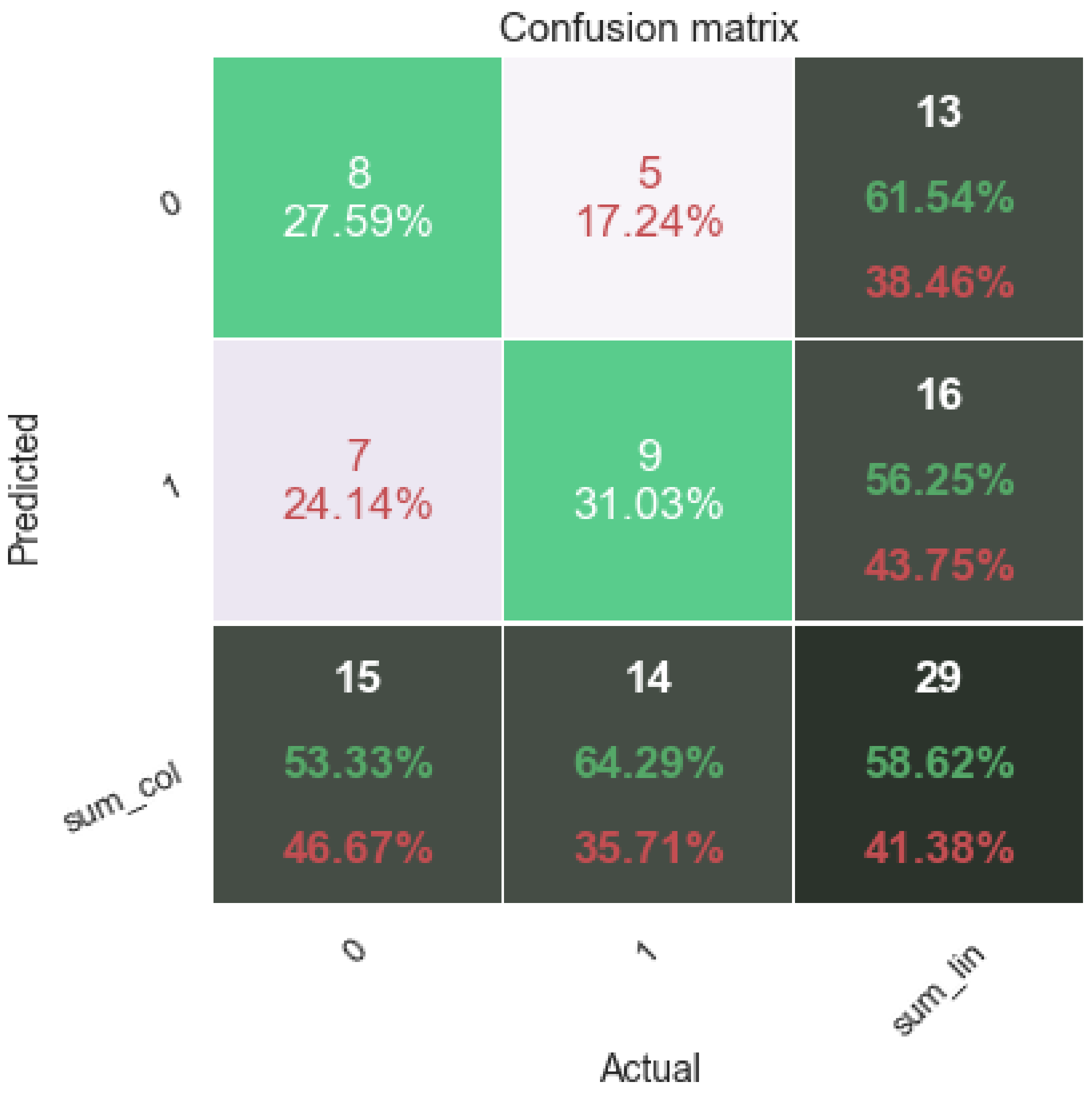
[26]:

```
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix, accuracy_score

y_pred = grid_search.predict(x_test)
con_res = confusion_matrix(y_test,y_pred)
# con_res = metrics.confusion_matrix(y_test,y_pred, labels=[0, 1])

print("Confusion matrix:")
print(confusion_matrix(y_test,y_pred))
print("Accuracy: {:.2f}%".format(accuracy_score(y_test, y_pred)*100))
```

```
Confusion matrix:
[[8 7]
 [5 9]]
Accuracy: 58.62%
```

[27]:

```
# %run -i '/home/jayanthikishore/Desktop/Analysis/Work/ML_EIT/
 ↪confusion_matrix_different_ways1.py'
%run -i '/Users/preethamvignesh/Desktop/Work/ML_EIT/
 ↪confusion_matrix_different_ways1.py'

df_confmatrx = pd.DataFrame(con_res, range(2),range(2))
df_confmatrx
cmap = 'PuRd'
confusion_matrix_dfrntway(df_confmatrx, cmap=cmap,fz=17)
```



Bagging: Grid search

[29]:
```
from sklearn.ensemble import BaggingClassifier

param_grid = {
    'max_samples': [1, 2, 3,4],
    'max_features':[1, 2, 3, 4, 5],
    'n_estimators': [50, 100, 150, 200]
}


grid_search1 = GridSearchCV(estimator = BaggingClassifier(), param_grid =␣
 ↪param_grid, cv = 3)
```

```python
grid_search1.fit(x_train, y_train)
grid_search1.best_params_
```

[29]:
```
{'max_features': 1, 'max_samples': 4, 'n_estimators': 50}
```

[30]:
```python
best_grid1 = grid_search1.best_estimator_

print("Bagging's Accuracy: ", best_grid1.score(x_test, y_test))
```

```
Bagging's Accuracy:  0.6551724137931034
```

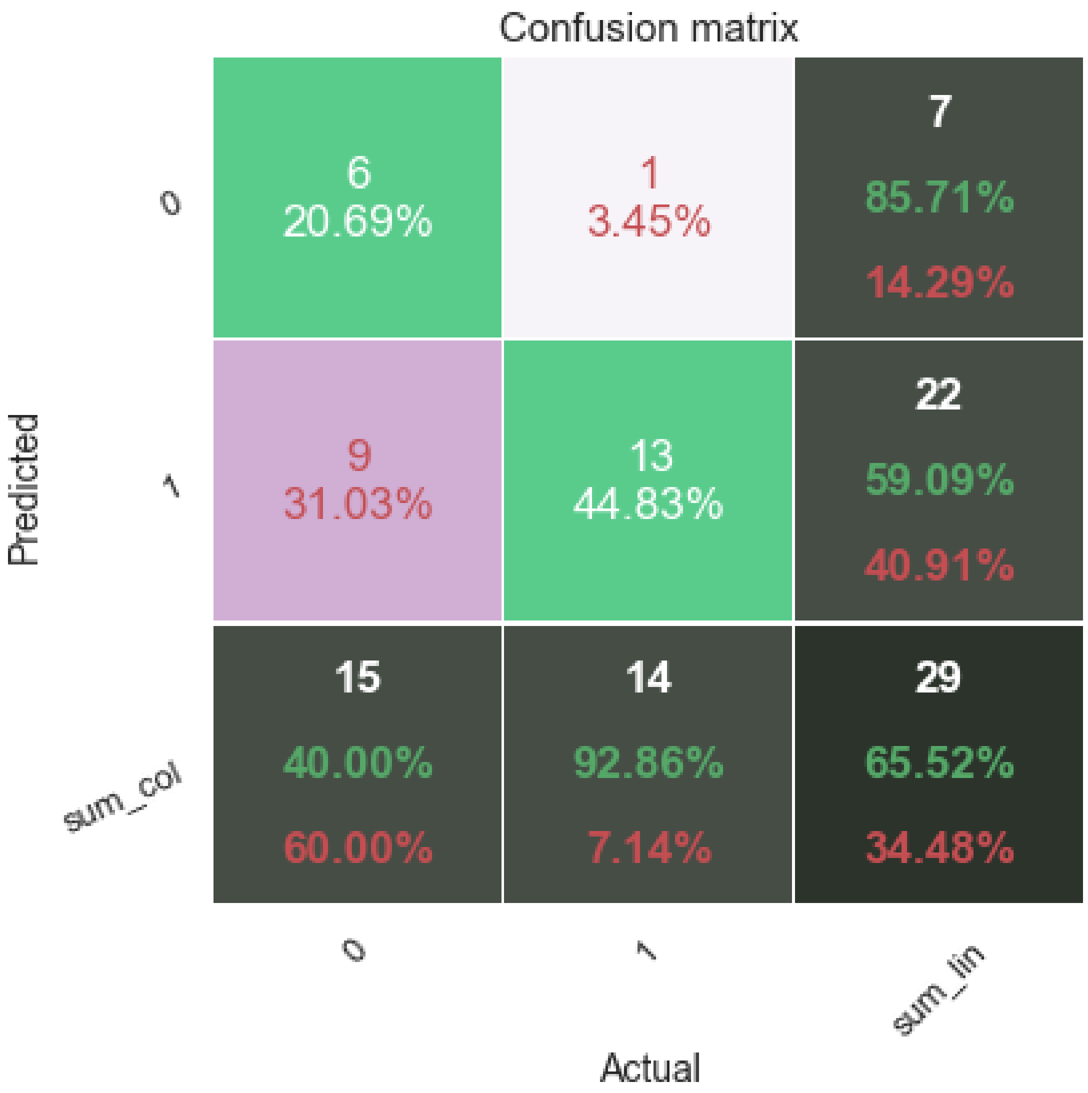
[31]:
```python
grid_search1.fit(x_train, y_train)
grid_search1_predicted = best_grid1.predict(x_test)

DT_score      = round(best_grid1.score(x_train, y_train) * 100, 2)
DT_score_test = round(best_grid1.score(x_test, y_test) * 100, 2)

print('Bagging Train Score: ', DT_score)
print('Bagging Test Score: ', DT_score_test)
print('Accuracy: ', (accuracy_score(y_test,grid_search1_predicted)) *100)
```

```
Bagging Train Score:  60.53
Bagging Test Score:  65.52
Accuracy:  65.51724137931035
```

[32]:
```python
predictions = best_grid1.predict(x_test)
confusion_matrix(y_test, predictions)

print("Confusion matrix:")
print(confusion_matrix(y_test,predictions))
print("Accuracy: {:.2f}%".format(accuracy_score(y_test, y_pred)*100))
```

```
Confusion matrix:
[[ 6  9]
 [ 1 13]]
Accuracy: 58.62%
```

[33]:
```python
# %run -i '/home/jayanthikishore/Desktop/Analysis/Work/ML_EIT/
 ↪confusion_matrix_different_ways1.py'
%run -i '/Users/preethamvignesh/Desktop/Work/ML_EIT/
 ↪confusion_matrix_different_ways1.py'
con_res = confusion_matrix(y_test,predictions)
df_confmatrx = pd.DataFrame(con_res, range(2),range(2))
df_confmatrx
cmap = 'PuRd'
confusion_matrix_dfrntway(df_confmatrx, cmap=cmap,fz=17)
```



Bagging Classifier

[34]:
```
#Bagging Classifier
bag = BaggingClassifier(n_estimators=5)
bag.fit(x_train, y_train.values.ravel())
y_pred_bag = bag.predict(x_test)
```

[35]:
```
bag_score      = round(bag.score(x_train, y_train) * 100, 2)
bag_score_test = round(bag.score(x_test, y_test) * 100, 2)

print('Bagging Train Score: ', DT_score)
print('Bagging Test Score: ', DT_score_test)
print('Accuracy: ', (accuracy_score(y_test,y_pred_bag)) *100)
```

```
Bagging Train Score:  60.53
Bagging Test Score:  65.52
Accuracy:  51.724137931034484
```

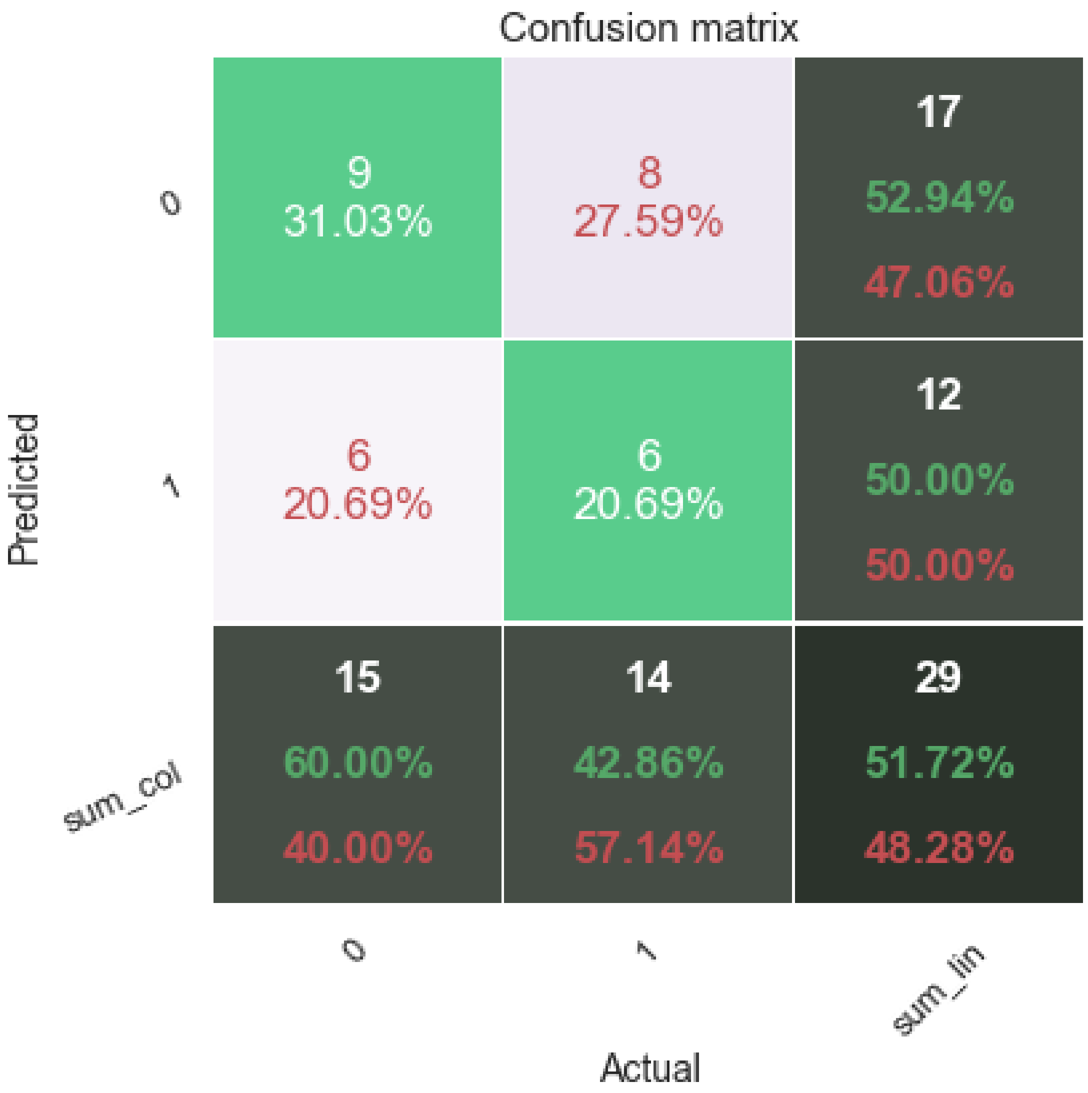
[36]:

```
predictions = bag.predict(x_test)
confusion_matrix(y_test, predictions)

print("Confusion matrix:")
print(confusion_matrix(y_test,predictions))
print("Accuracy: {:.2f}%".format(accuracy_score(y_test, predictions)*100))
```

```
Confusion matrix:
[[9 6]
 [8 6]]
Accuracy: 51.72%
```

[37]:

```
# %run -i '/home/jayanthikishore/Desktop/Analysis/Work/ML_EIT/
 ↪confusion_matrix_different_ways1.py'
# %run -i '/Users/preethamvignesh/Desktop/Work/ML_EIT/
 ↪confusion_matrix_different_ways1.py'
con_res = confusion_matrix(y_test,predictions)
df_confmatrx = pd.DataFrame(con_res, range(2),range(2))
df_confmatrx
cmap = 'PuRd'
confusion_matrix_dfrntway(df_confmatrx, cmap=cmap,fz=17)
```



Ada Boost Calssifier

[38]:
```
#Ada Boost Classifier
ada = AdaBoostClassifier(n_estimators=5)
ada.fit(x_train, y_train.values.ravel())
y_pred_ada = ada.predict(x_test)
```

[39]:
```
ada_score      = round(ada.score(x_train, y_train) * 100, 2)
ada_score_test = round(ada.score(x_test, y_test) * 100, 2)

print('AdaBoost Classifier Train Score: ', ada_score)
print('AdaBoost Classifier Test Score: ',ada_score_test)
print('Accuracy: ', (accuracy_score(y_test,y_pred_ada)) *100)
```

```
AdaBoost Classifier Train Score:  64.04
AdaBoost Classifier Test Score:  55.17
Accuracy:  55.172413793103445
```

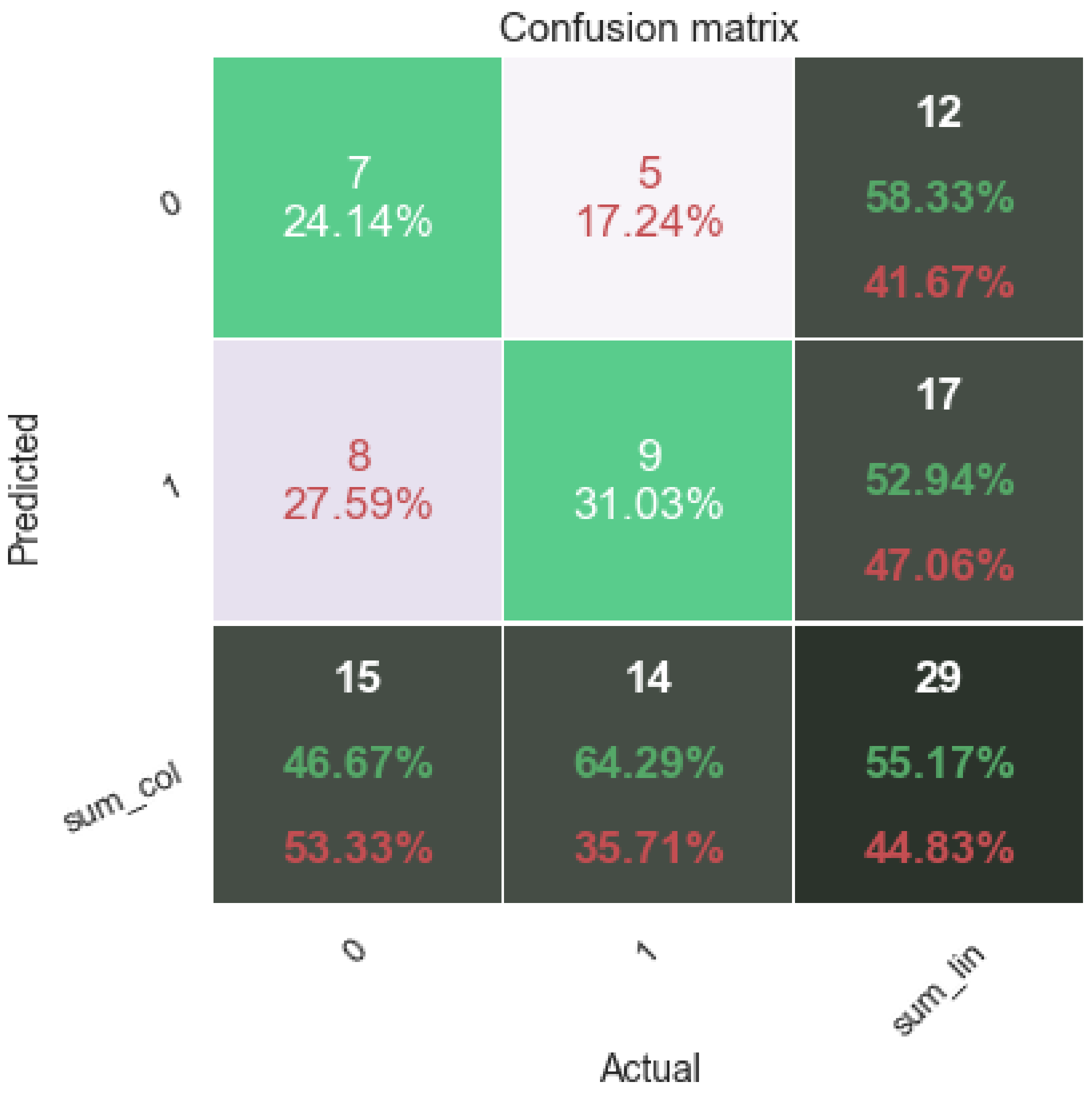
[40]:

```
predictions = ada.predict(x_test)
confusion_matrix(y_test, predictions)

print("Confusion matrix:")
print(confusion_matrix(y_test,predictions))
print("Accuracy: {:.2f}%".format(accuracy_score(y_test, predictions)*100))
```

```
Confusion matrix:
[[7 8]
 [5 9]]
Accuracy: 55.17%
```

[41]:

```
con_res = confusion_matrix(y_test,predictions)
df_confmatrx = pd.DataFrame(con_res, range(2),range(2))
df_confmatrx
cmap = 'PuRd'
confusion_matrix_dfrntway(df_confmatrx, cmap=cmap,fz=17)
```



Support Vector Machine (SVM)

[43]:
```python
from sklearn import svm
clf = svm.SVC()
```

[44]:
```python
clf.fit(x_train, y_train)
clf_predicted = clf.predict(x_test)

svc_score      = round(clf.score(x_train, y_train) * 100, 2)
svc_score_test = round(clf.score(x_test, y_test) * 100, 2)

print('SVC Score: ', svc_score)
print('SVC Test Score: ', svc_score_test)
print('Accuracy: ', (accuracy_score(y_test,clf_predicted)) *100,4)
```

```
SVC Score:  75.44
SVC Test Score:  51.72
Accuracy:  51.724137931034484 4
```

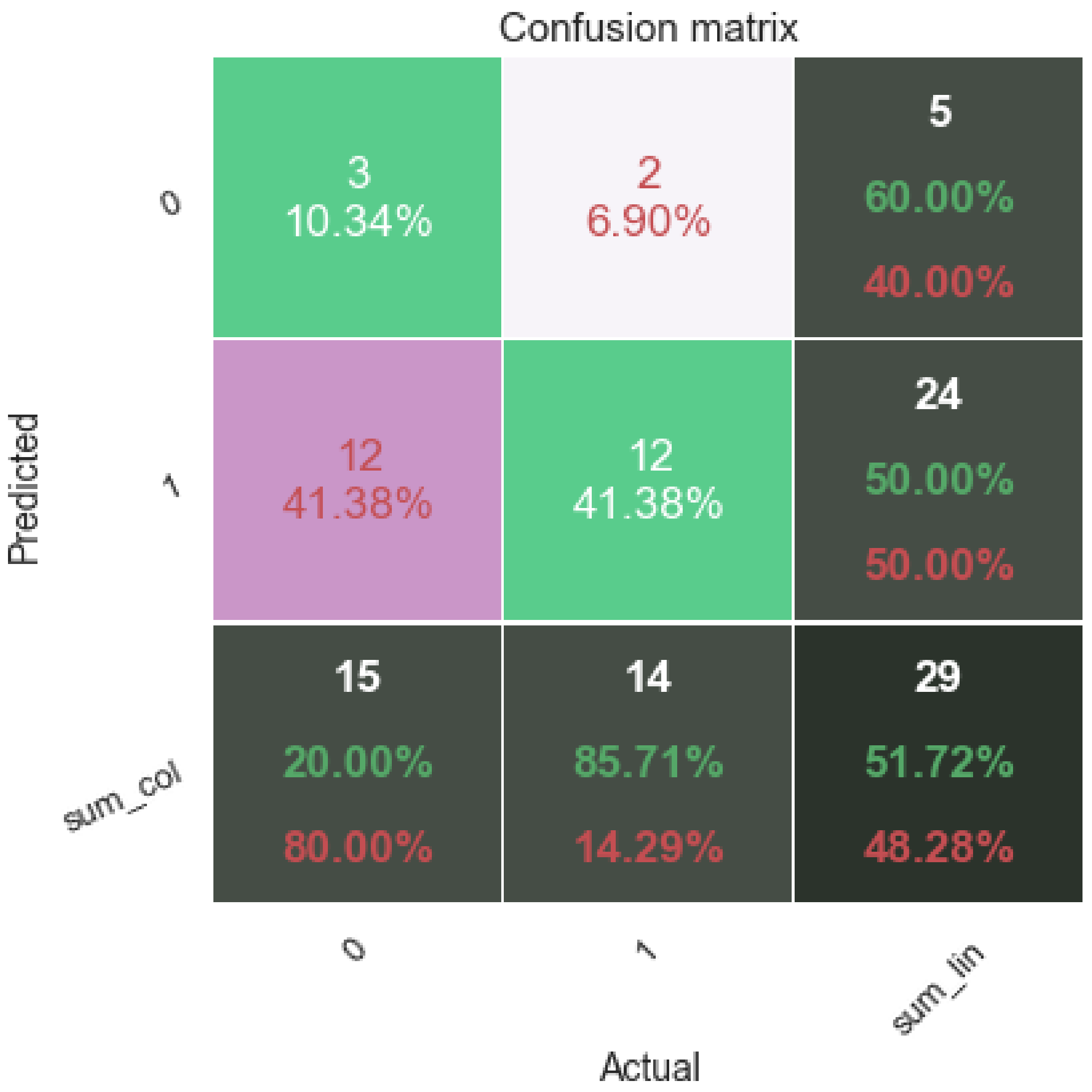
[45]:

```
predictions = clf.predict(x_test)
confusion_matrix(y_test, predictions)

print("Confusion matrix:")
print(confusion_matrix(y_test,predictions))
print("Accuracy: {:.2f}%".format(accuracy_score(y_test, predictions)*100))
```

```
Confusion matrix:
[[ 3 12]
 [ 2 12]]
Accuracy: 51.72%
```

[46]:

```
con_res = confusion_matrix(y_test,predictions)
df_confmatrx = pd.DataFrame(con_res, range(2),range(2))
df_confmatrx
cmap = 'PuRd'
confusion_matrix_dfrntway(df_confmatrx, cmap=cmap,fz=17)
```



	0	1	sum_lin
0	3 10.34%	2 6.90%	5 60.00% 40.00%
1	12 41.38%	12 41.38%	24 50.00% 50.00%
sum_col	15 20.00% 80.00%	14 85.71% 14.29%	29 51.72% 48.28%

Support Vector Machine (SVM)(Kernel=Linear)

[48]:
```
clf_linear = svm.SVC(kernel='linear')
```

[49]:
```
clf_linear.fit(x_train, y_train)
clf_linear_predicted = clf_linear.predict(x_test)

svc_linear_score      = round(clf_linear.score(x_train, y_train) * 100, 2)
svc_linear_score_test = round(clf_linear.score(x_test, y_test) * 100, 2)

print('SVC Linear Score: ', svc_linear_score)
print('SVC Linear Test Score: ', svc_linear_score_test)
print('Accuracy: ', (accuracy_score(y_test,clf_linear_predicted)) *100,4)
```

```
SVC Linear Score:  65.79
SVC Linear Test Score:  58.62
Accuracy:  58.620689655172406 4
```

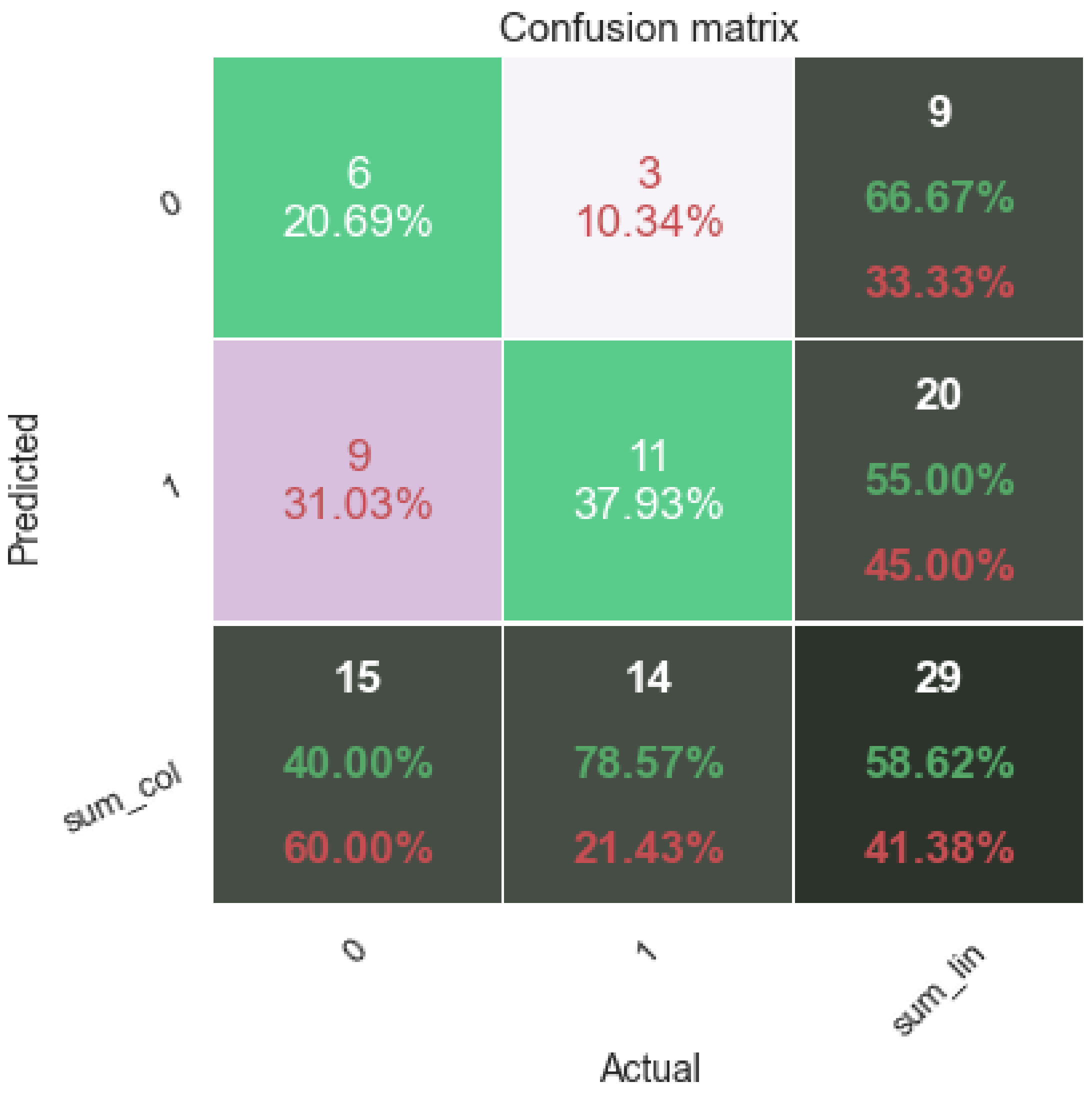
[50]:

```
pred_linear = clf_linear.predict(x_test)
confusion_matrix(y_test, pred_linear)

print("Confusion matrix:")
print(confusion_matrix(y_test,pred_linear))
print("Accuracy: {:.2f}%".format(accuracy_score(y_test, pred_linear)*100))
```

```
Confusion matrix:
[[ 6  9]
 [ 3 11]]
Accuracy: 58.62%
```

[51]:

```
con_res = confusion_matrix(y_test,pred_linear)
df_confmatrx = pd.DataFrame(con_res, range(2),range(2))
df_confmatrx
cmap = 'PuRd'
confusion_matrix_dfrntway(df_confmatrx, cmap=cmap,fz=17)
```



Support Vector Machine (SVM) (Kernel=Poly)

[53]:
```
clf_poly = svm.SVC(kernel='poly')
```

[54]:
```
clf_poly.fit(x_train, y_train)
clf_poly_predicted = clf_poly.predict(x_test)

svc_poly_score      = round(clf_poly.score(x_train, y_train) * 100, 2)
svc_poly_score_test = round(clf_poly.score(x_test, y_test) * 100, 2)

print('SVC Poly Score: ', svc_poly_score)
print('SVC Poly Test Score: ', svc_poly_score_test)
print('Accuracy: ', (accuracy_score(y_test,clf_poly_predicted)) *100,4)
```

```
SVC Poly Score:  75.44
SVC Poly Test Score:  58.62
Accuracy:  58.620689655172406 4
```

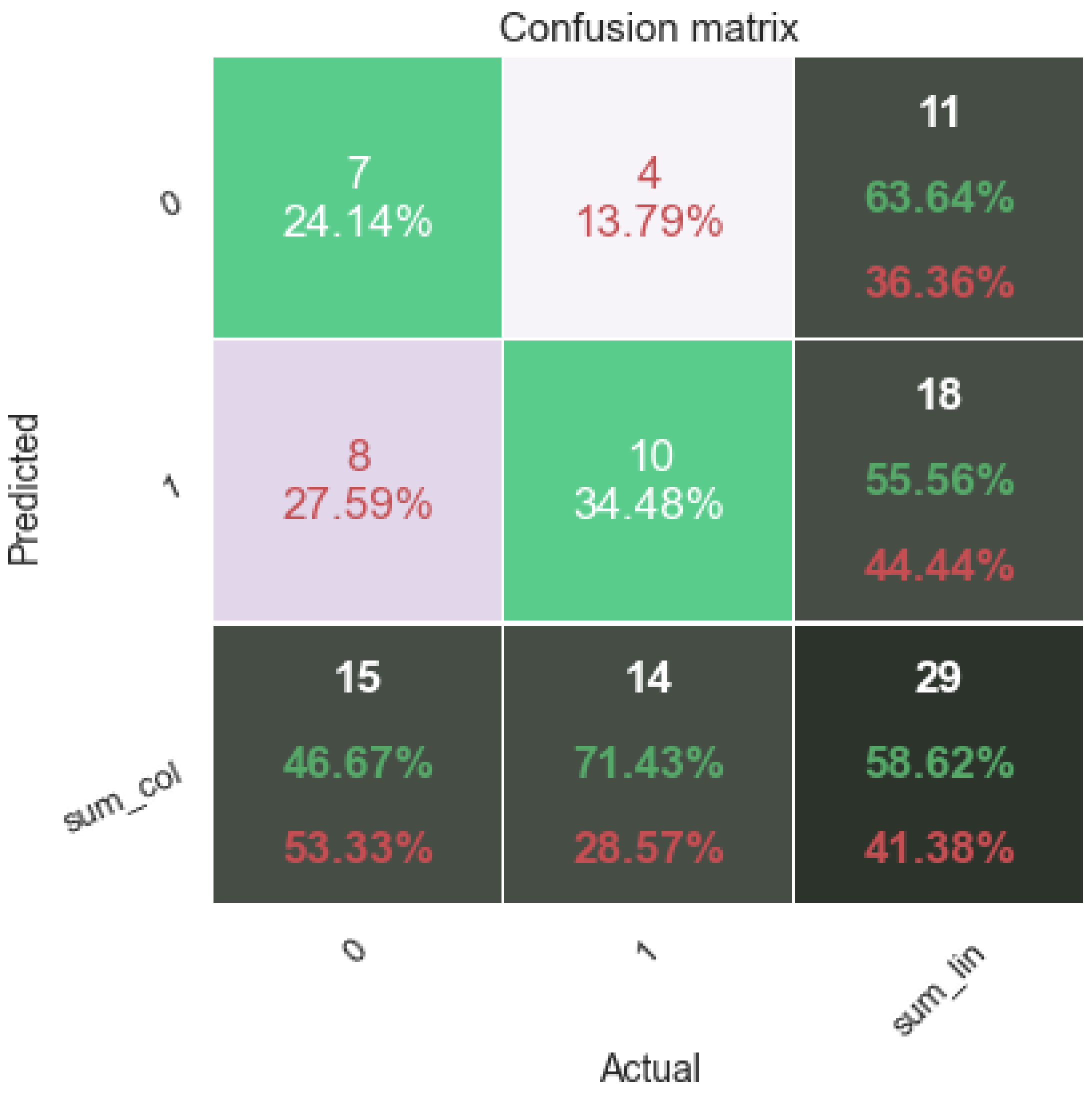
[55]:

```
pred_poly = clf_poly.predict(x_test)
confusion_matrix(y_test, pred_poly)

print("Confusion matrix:")
print(confusion_matrix(y_test,pred_poly))
print("Accuracy: {:.2f}%".format(accuracy_score(y_test, pred_poly)*100))
```

```
Confusion matrix:
[[ 7  8]
 [ 4 10]]
Accuracy: 58.62%
```

[56]:

```
con_res = confusion_matrix(y_test,pred_poly)
df_confmatrx = pd.DataFrame(con_res, range(2),range(2))
df_confmatrx
cmap = 'PuRd'
confusion_matrix_dfrntway(df_confmatrx, cmap=cmap,fz=17)
```


Confusion matrix
Predicted
0
1
sum_col
7
24.14%
4
13.79%
11
63.64%
36.36%
8
27.59%
10
34.48%
18
55.56%
44.44%
15
46.67%
53.33%
14
71.43%
28.57%
29
58.62%
41.38%
0
1
sum_lin
Actual

[ ]: