Import Libs

System

Change directory to main

In [1]:
```
import os
# Change dir
os.chdir('C:\\Users\\ThalesFerreira\\projetos python\\data_view\\shipping_data')
#import models and libs
import joblib
```

Data

Import libs to analyse data

In [ ]:
```
# treat data
import pandas as pd
import numpy as np
# data scaling data
from sklearn.preprocessing import StandardScaler
# data labelencoder
from sklearn.preprocessing import LabelEncoder
# data onehotencoder
from sklearn.preprocessing import OneHotEncoder
# multilinear correlations
from statsmodels.stats.outliers_influence import variance_inflation_factor
# anomalies
from sklearn.neighbors import LocalOutlierFactor
```

In [94]:
```
# plot graphcs of data
import matplotlib.pyplot as plt
import seaborn as sns
```

Models

Import libs divinding data and analyse models results

In [3]:
```
# calcular score do modelo
from sklearn.metrics import accuracy_score, classification_report
#Metricas para avaliação do modelo
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score, c
#Divisão de bases e crossvalidation.
from sklearn.model_selection import train_test_split, cross_val_score, KFold
# Confusion matrix
from yellowbrick.classifier import ConfusionMatrix
```

Statistical validation

In [92]:
```
#Anova
from scipy.stats import f_oneway
#normalization teste
from scipy.stats import shapiro
#Turkey teste
from statsmodels.stats.multicomp import MultiComparison
```

Import libs models

In [ ]:
```
#ramdom parameters
from sklearn.model_selection import RandomizedSearchCV
# tests models
from sklearn.model_selection import GridSearchCV
# Logistic Regression models
from sklearn.linear_model import LogisticRegression
#Bayes
from sklearn.naive_bayes import GaussianNB
# Decision Tree
from sklearn.tree import DecisionTreeClassifier
# KNN
from sklearn.neighbors import KNeighborsClassifier
# Random Forest
from sklearn.ensemble import RandomForestClassifier
# Neural Network
from sklearn.neural_network import MLPClassifier
# SVM
from sklearn.svm import SVC
```

Import Data

Context An international e-commerce company based wants to discover key insights from their customer database. They want to use some of the most advanced machine learning techniques to study their customers. The company sells electronic products.

Content The dataset used for model building contained 10999 observations of 12 variables. The data contains the following information:

- ID: ID Number of Customers.
- Warehouse block: The Company have big Warehouse which is divided in to block such as A,B,C,D,E.
- Mode of shipment:The Company Ships the products in multiple way such as Ship, Flight and Road.
- Customer care calls: The number of calls made from enquiry for enquiry of the shipment.
- Customer rating: The company has rated from every customer. 1 is the lowest (Worst), 5 is the highest (Best).
- Cost of the product: Cost of the Product in US Dollars.
- Prior purchases: The Number of Prior Purchase.

- Product importance: The company has categorized the product in the various parameter such as low, medium, high.
- Gender: Male and Female.
- Discount offered: Discount offered on that specific product.
- Weight in gms: It is the weight in grams.
- Reached on time: It is the target variable, where 1 Indicates that the product has NOT reached on time and 0 indicates it has reached on time.

URL -> https://www.kaggle.com/datasets/prachi13/customer-analytics

In [189…
```
df = pd.read_csv('./base/Train.csv',sep=',',decimal='.',encoding='utf-8')
```

Explore Data pt 1

Check DataFrame Size

In [190…
```
df.shape
```

Out[190…
```
(10999, 12)
```

Check data resume

In [191…
```
df.describe(include='all').transpose()
```

Out[191…

	count	unique	top	freq	mean	std	min	
ID	10999.0	NaN	NaN	NaN	5500.0	3175.28214	1.0	27
Warehouse_block	10999	5	F	3666	NaN	NaN	NaN	
Mode_of_Shipment	10999	3	Ship	7462	NaN	NaN	NaN	
Customer_care_calls	10999.0	NaN	NaN	NaN	4.054459	1.14149	2.0	
Customer_rating	10999.0	NaN	NaN	NaN	2.990545	1.413603	1.0	
Cost_of_the_Product	10999.0	NaN	NaN	NaN	210.196836	48.063272	96.0	1
Prior_purchases	10999.0	NaN	NaN	NaN	3.567597	1.52286	2.0	
Product_importance	10999	3	low	5297	NaN	NaN	NaN	
Gender	10999	2	F	5545	NaN	NaN	NaN	
Discount_offered	10999.0	NaN	NaN	NaN	13.373216	16.205527	1.0	
Weight_in_gms	10999.0	NaN	NaN	NaN	3634.016729	1635.377251	1001.0	18
Reached.on.Time_Y.N	10999.0	NaN	NaN	NaN	0.596691	0.490584	0.0	

In [192…
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10999 entries, 0 to 10998
Data columns (total 12 columns):
 #   Column               Non-Null Count  Dtype
---  ------               --------------  -----
 0   ID                   10999 non-null  int64
 1   Warehouse_block      10999 non-null  object
 2   Mode_of_Shipment     10999 non-null  object
 3   Customer_care_calls  10999 non-null  int64
 4   Customer_rating      10999 non-null  int64
 5   Cost_of_the_Product  10999 non-null  int64
 6   Prior_purchases      10999 non-null  int64
 7   Product_importance   10999 non-null  object
 8   Gender               10999 non-null  object
 9   Discount_offered     10999 non-null  int64
 10  Weight_in_gms        10999 non-null  int64
 11  Reached.on.Time_Y.N  10999 non-null  int64
dtypes: int64(8), object(4)
memory usage: 1.0+ MB
```

Check null cells

In [193…
```
df.isna().sum()
```

Out[193…
```
ID                   0
Warehouse_block      0
Mode_of_Shipment     0
Customer_care_calls  0
Customer_rating      0
Cost_of_the_Product  0
Prior_purchases      0
Product_importance   0
Gender               0
Discount_offered     0
Weight_in_gms        0
Reached.on.Time_Y.N  0
dtype: int64
```

Verify unique data on field

In [194…
```
df.nunique()
```

Out[194…
```
ID                   10999
Warehouse_block          5
Mode_of_Shipment         3
Customer_care_calls      6
Customer_rating          5
Cost_of_the_Product    215
Prior_purchases          8
Product_importance       3
Gender                   2
Discount_offered        65
Weight_in_gms         4034
Reached.on.Time_Y.N      2
dtype: int64
```

Verify classification columns

In [195…
```
df.select_dtypes(include=object).nunique()
```

Out[195...
```
Warehouse_block       5
Mode_of_Shipment      3
Product_importance    3
Gender                2
dtype: int64
```

View some lines

In [196...
```
df.sample(5)
```

Out[196...

	ID	Warehouse_block	Mode_of_Shipment	Customer_care_calls	Customer_rating
1697	1698	F	Ship	3	2
2536	2537	C	Ship	4	4
3513	3514	B	Ship	3	2
6586	6587	C	Flight	6	4
2215	2216	F	Ship	3	4

Count target

In [197...
```
df['Reached.on.Time_Y.N'].value_counts()
```

Out[197...
```
Reached.on.Time_Y.N
1    6563
0    4436
Name: count, dtype: int64
```

Treat pt 1

- Delete Id
- Rename target

delete id column

In [198...
```
# Delete colum ID
if 'ID' in df.columns:
    df.drop(columns=['ID'],inplace=True)
```

Rename target column, easier to treat

In [199...
```
#Rename columns
if 'Reached.on.Time_Y.N' in df.columns:
    df.rename(columns={'Reached.on.Time_Y.N':'on_time'},inplace=True)
```

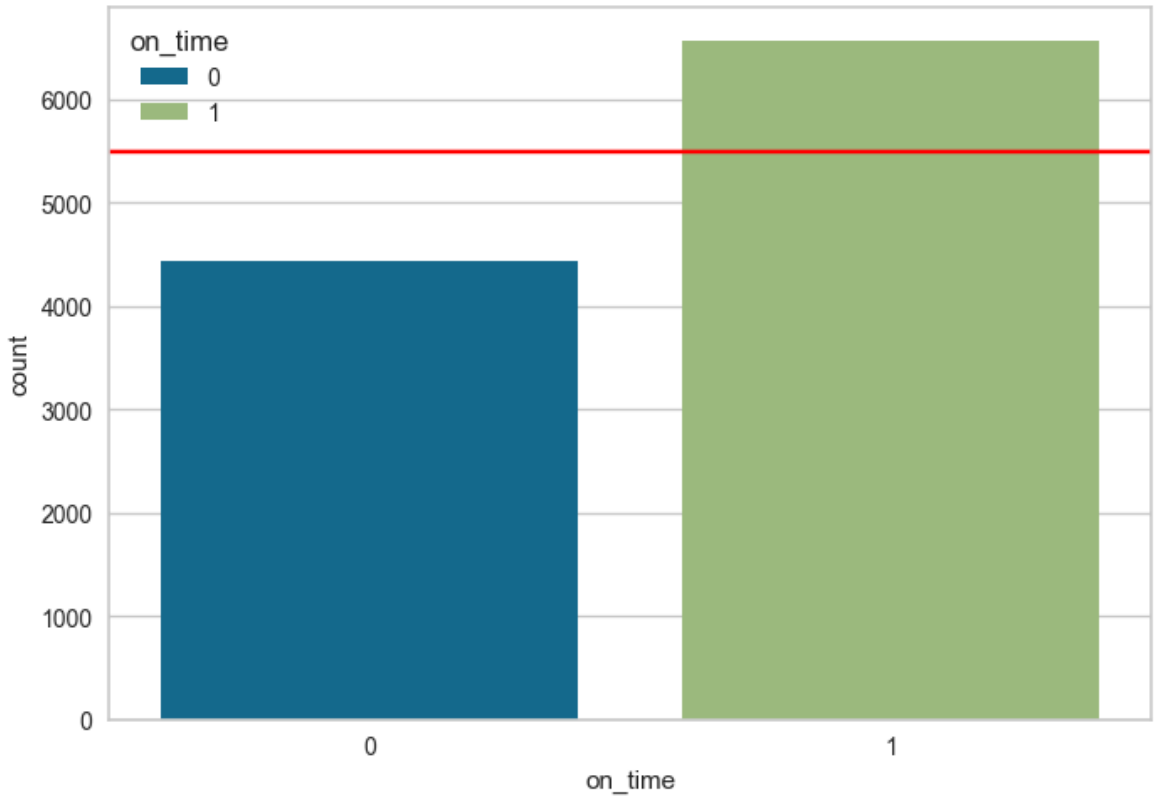
Data Visualisation

Plot graphs to view and analyse dataframe

Count on_time

Plot count target data lines

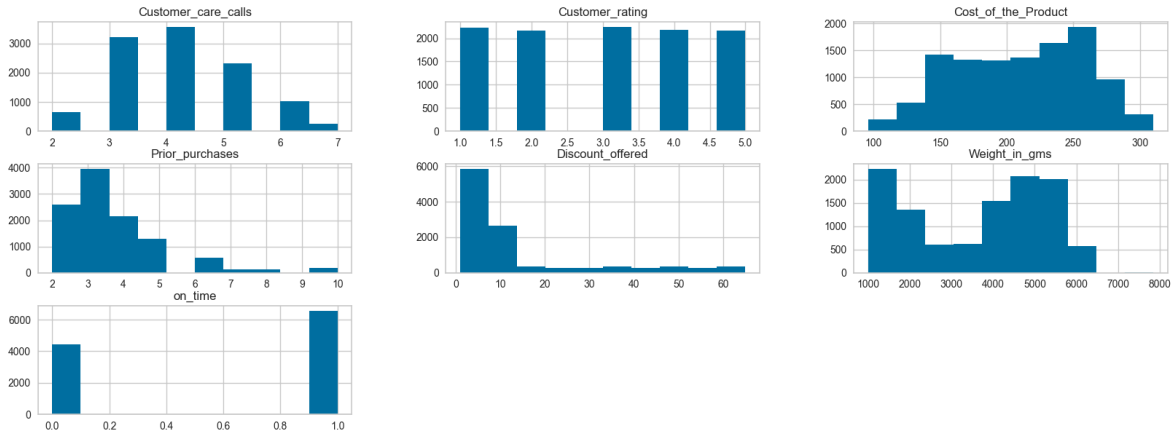
In [25]:
```
plt.Figure(figsize=(7,7))
plot = sns.countplot(data=df,x='on_time',hue='on_time')
plot.axhline(y=df.shape[0]/2,color='red')
plt.show()
```



View data frequency

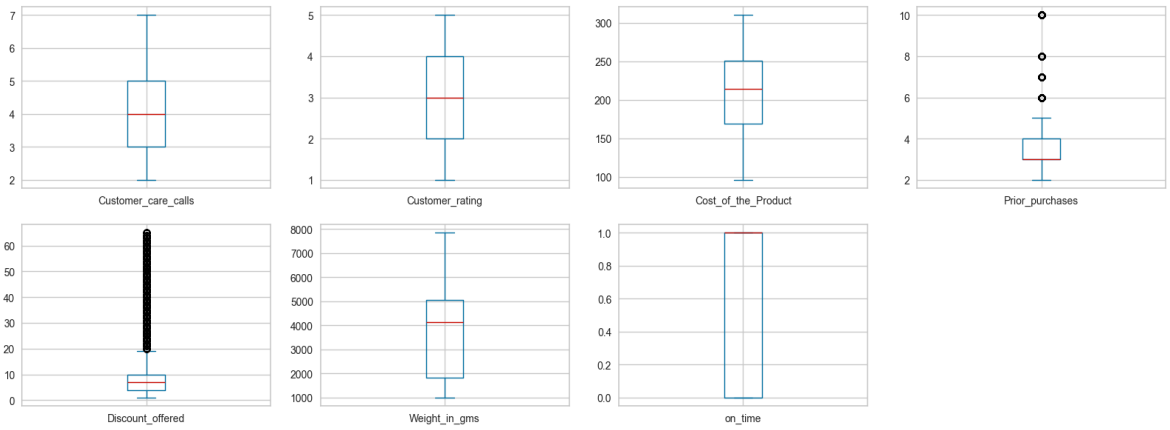
View histogram of count

In [26]:
```
df.select_dtypes(exclude=object).hist(layout=(3,3), figsize=(20,7))
plt.show()
```



View box graphics os coluns values

In [27]:
```
df.select_dtypes(exclude=object).plot(kind='box', subplots=True, layout=(2,4), f
plt.show()
```

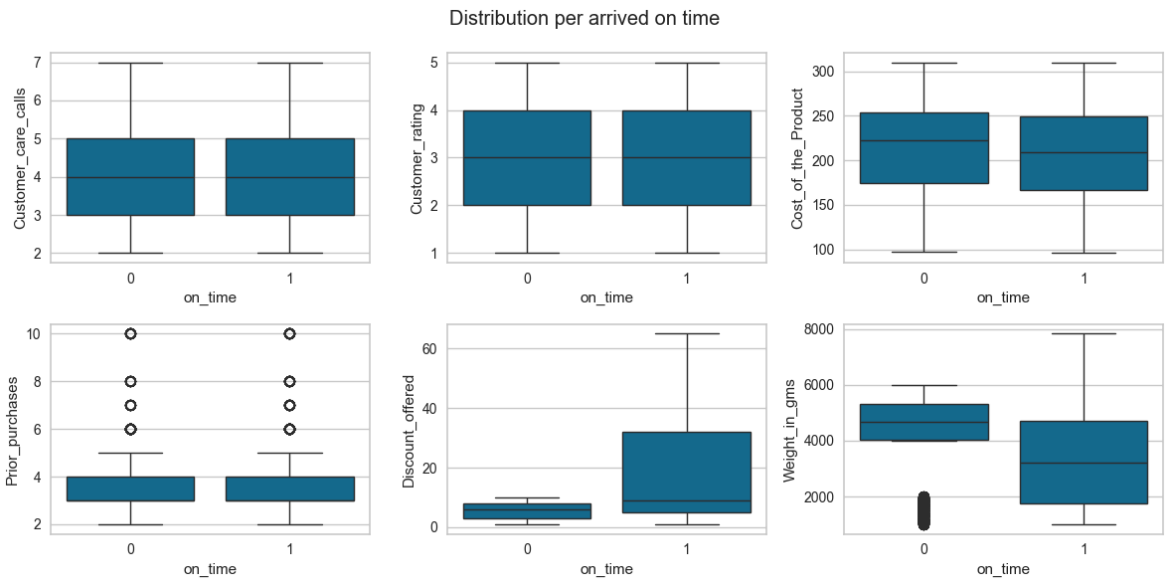


on_time relation visualization

Numeric Columns

view the relationship between target column and other numeric coluns

In [32]:
```
#reaching At the time
plt.figure(figsize=(12, 6))
for i, col in enumerate(df.drop('on_time',axis=1).select_dtypes(exclude=object).
    plt.subplot(2, 3, i+1)
    sns.boxplot(data=df, x='on_time', y=col)
plt.suptitle("Distribution per arrived on time")
plt.tight_layout()
plt.show()
```

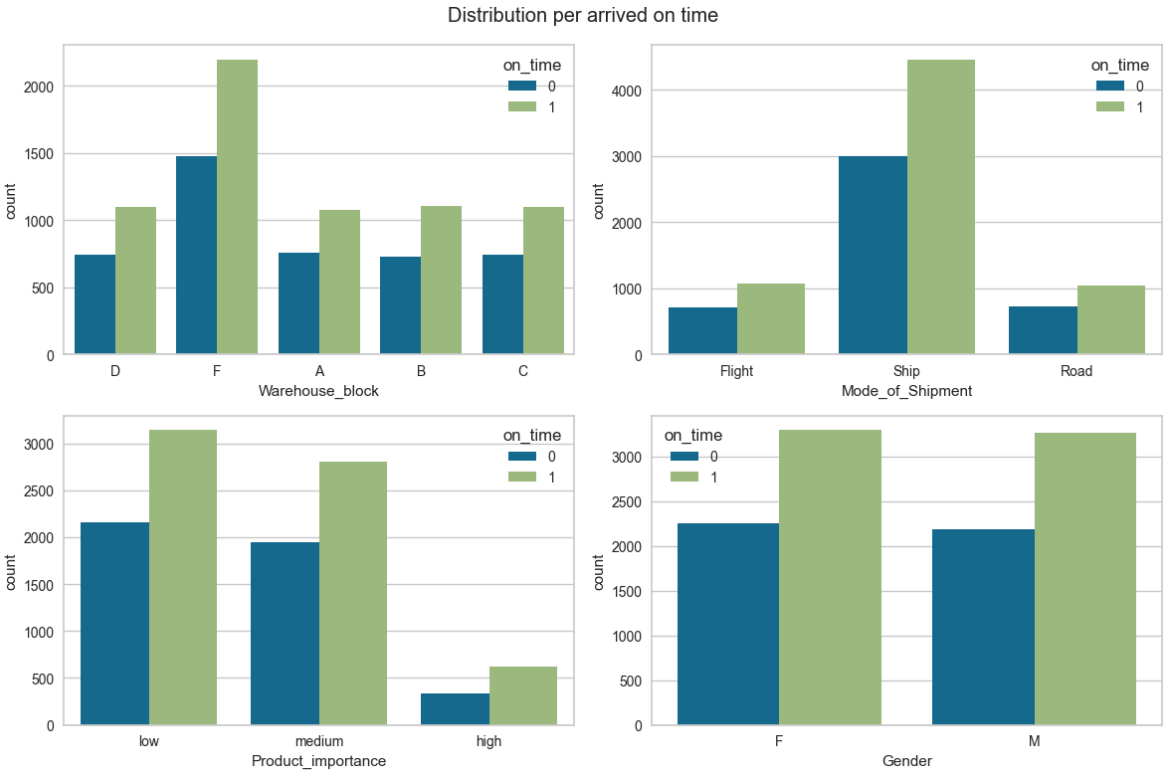


Category columns

Plot the count on each category

In [33]:
```
#reaching At the time count category
plt.figure(figsize=(12, 8))
```

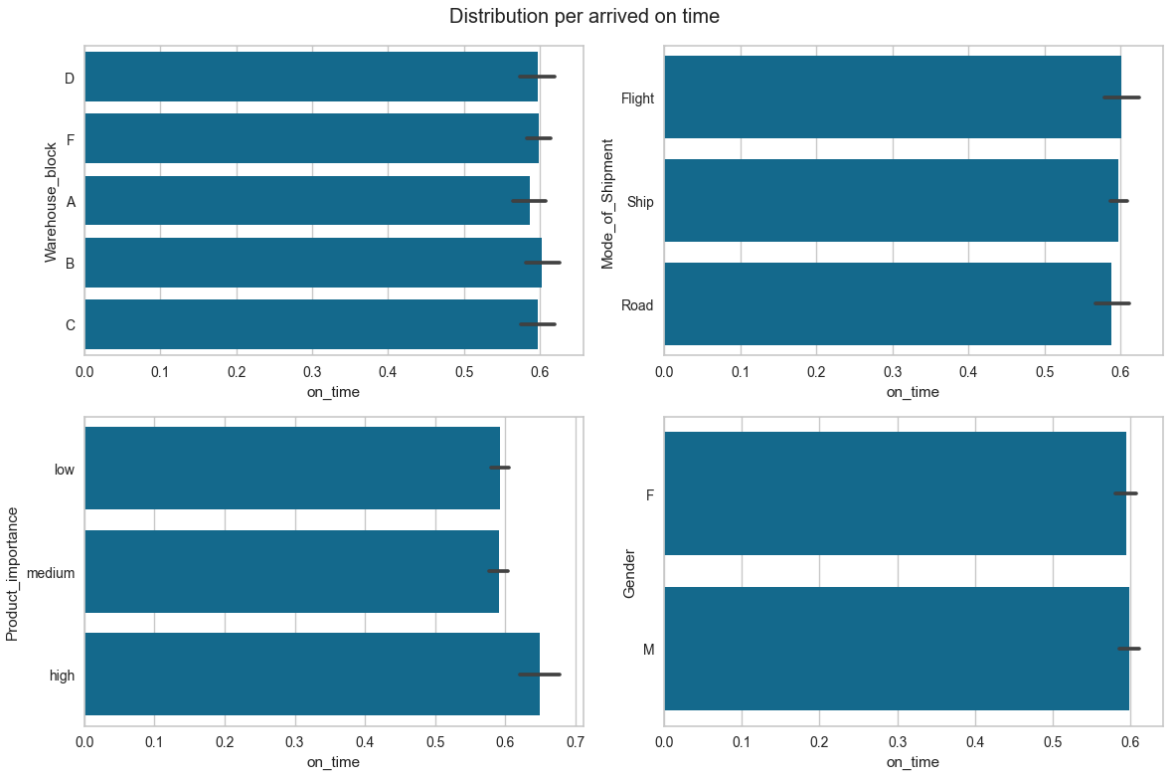
```
for i, col in enumerate(df.drop('on_time',axis=1).select_dtypes(include=object).
    plt.subplot(2, 2, i+1)
    sns.countplot(data=df,x=col,hue='on_time')
    #sns.barplot(data=df, x='on_time', y=col,estimator=np.count_nonzero)
plt.suptitle("Distribution per arrived on time")
plt.tight_layout()
plt.show()
```



View the mean of the target on each category.

mean of the values reference to % on this case

In [34]:
```
#reaching At the time mean category
plt.figure(figsize=(12, 8))
for i, col in enumerate(df.drop('on_time',axis=1).select_dtypes(include=object).
    plt.subplot(2, 2, i+1)
    sns.barplot(data=df, x='on_time', y=col,estimator=np.mean)
plt.suptitle("Distribution per arrived on time")
plt.tight_layout()
plt.show()
```



Outliers

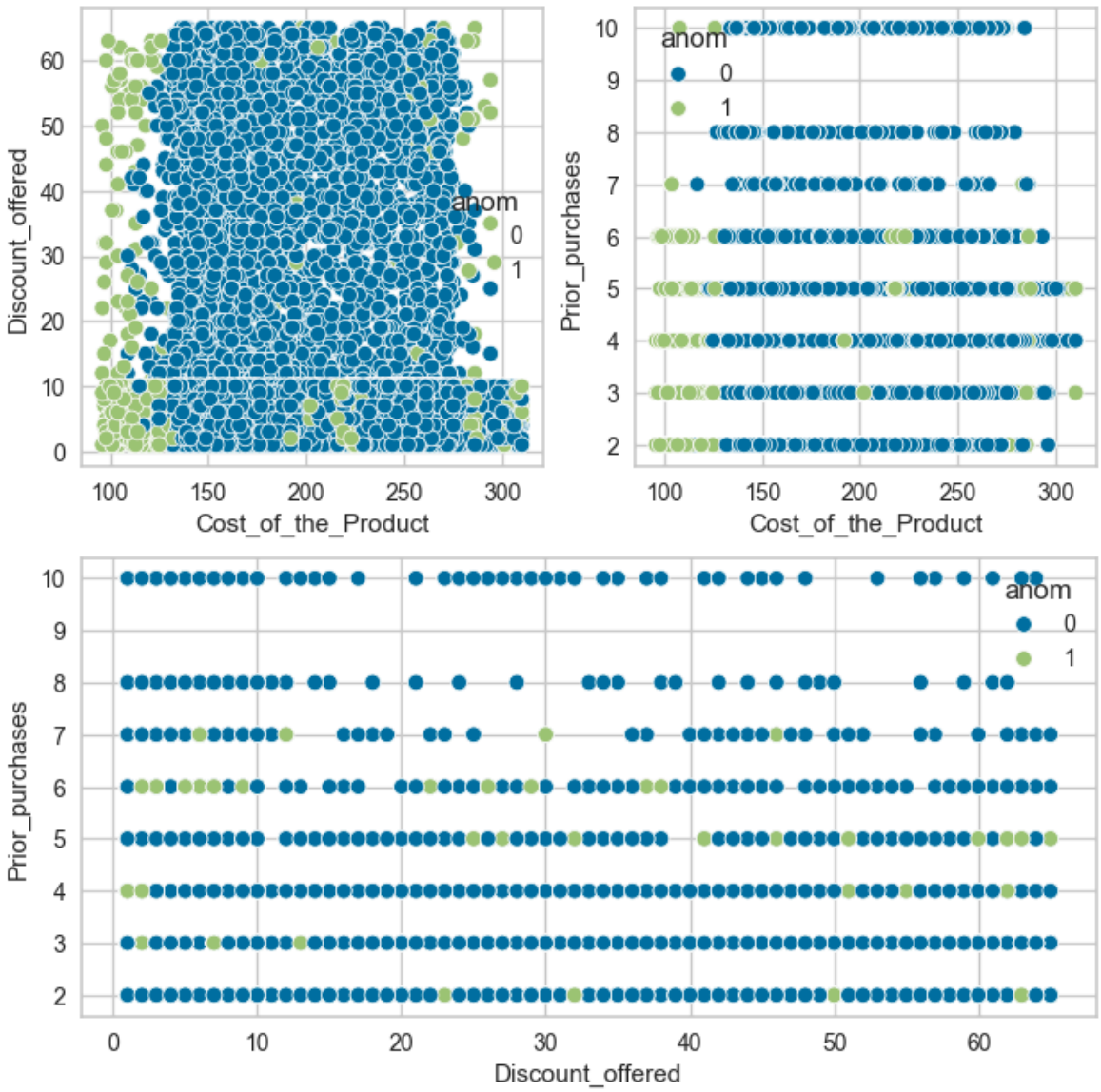
View

In [35]:
```
lof = LocalOutlierFactor(n_neighbors=20,contamination=0.05)
```

In [36]:
```
lof_ind = np.where(lof.fit_predict(df.select_dtypes(exclude=object))==-1)
```

In [37]:
```
df['anom'] = 0
df.loc[lof_ind[0],'anom'] = 1
```

In [38]:
```
plt.figure(figsize=(8,8))
plt.subplot(2, 2, 1)
sns.scatterplot(data=df,y='Discount_offered',x='Cost_of_the_Product',hue='anom')
plt.subplot(2, 2, 2)
sns.scatterplot(data=df,y='Prior_purchases',x='Cost_of_the_Product',hue='anom')
plt.subplot(2, 2, (3,4))
sns.scatterplot(data=df,y='Prior_purchases',x='Discount_offered',hue='anom')
plt.show()
```



In [39]:
```
df.drop(columns=['anom'],inplace=True)
```

Treat pt 2

- select numerical columns to scale
- label encoder

Treat the outliers with stardard scale

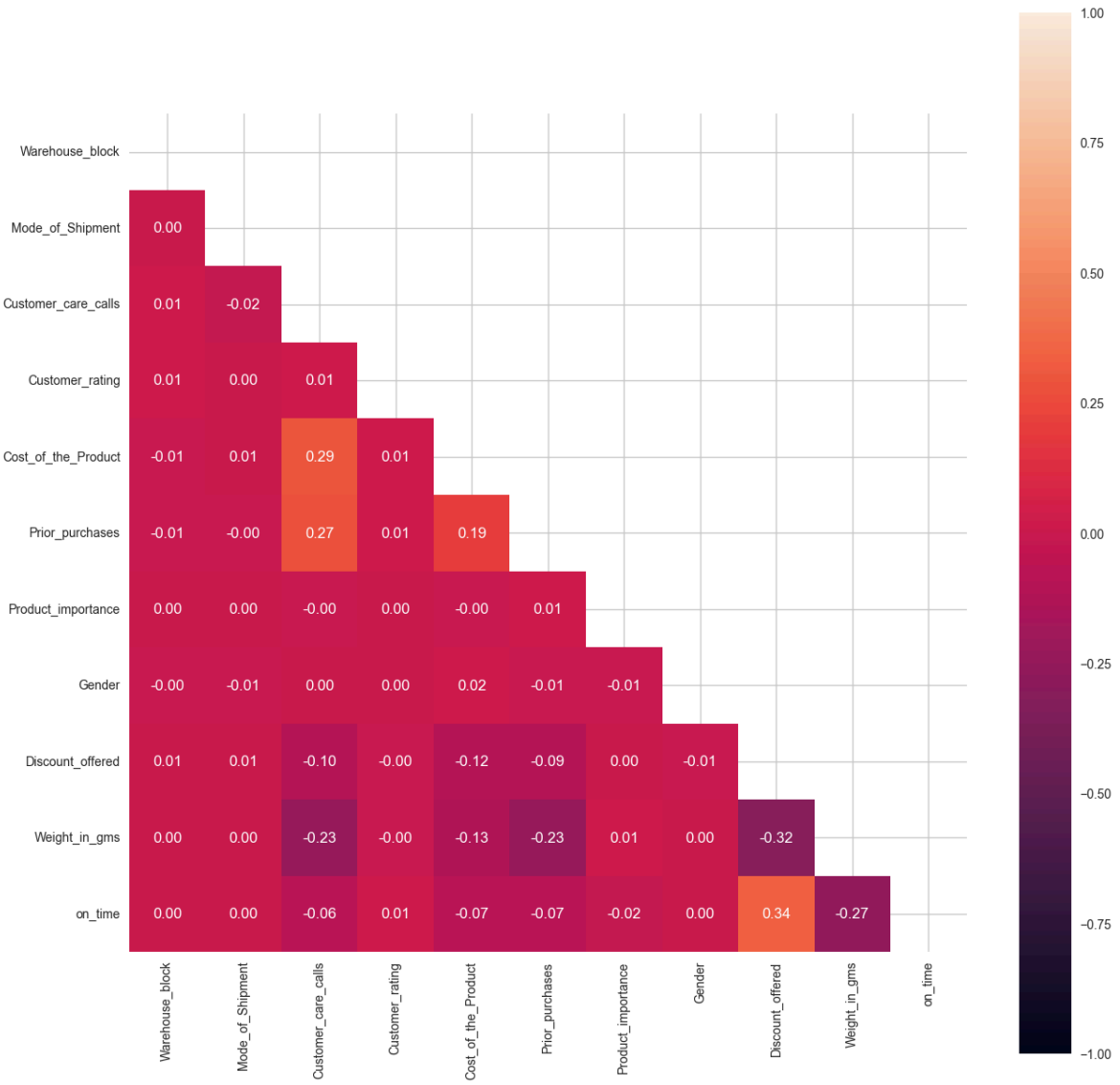
Treat categorical coluns with labelencoder

In [200…
```
for col in df.select_dtypes(include=object).columns:
    df[col] = LabelEncoder().fit_transform(df[col])
```

Multicolumns verification

Spearman Relation

In [43]:
```
mask = np.triu(np.ones_like(df.select_dtypes(exclude=object).corr(), dtype=np.bo
plt.figure(figsize=(15,15))
sns.heatmap(df.select_dtypes(exclude=object).corr(method='spearman')
            ,mask=mask,fmt='.2f' ,square = True
            ,annot=True, vmin=-1, vmax=1)
plt.show()
```

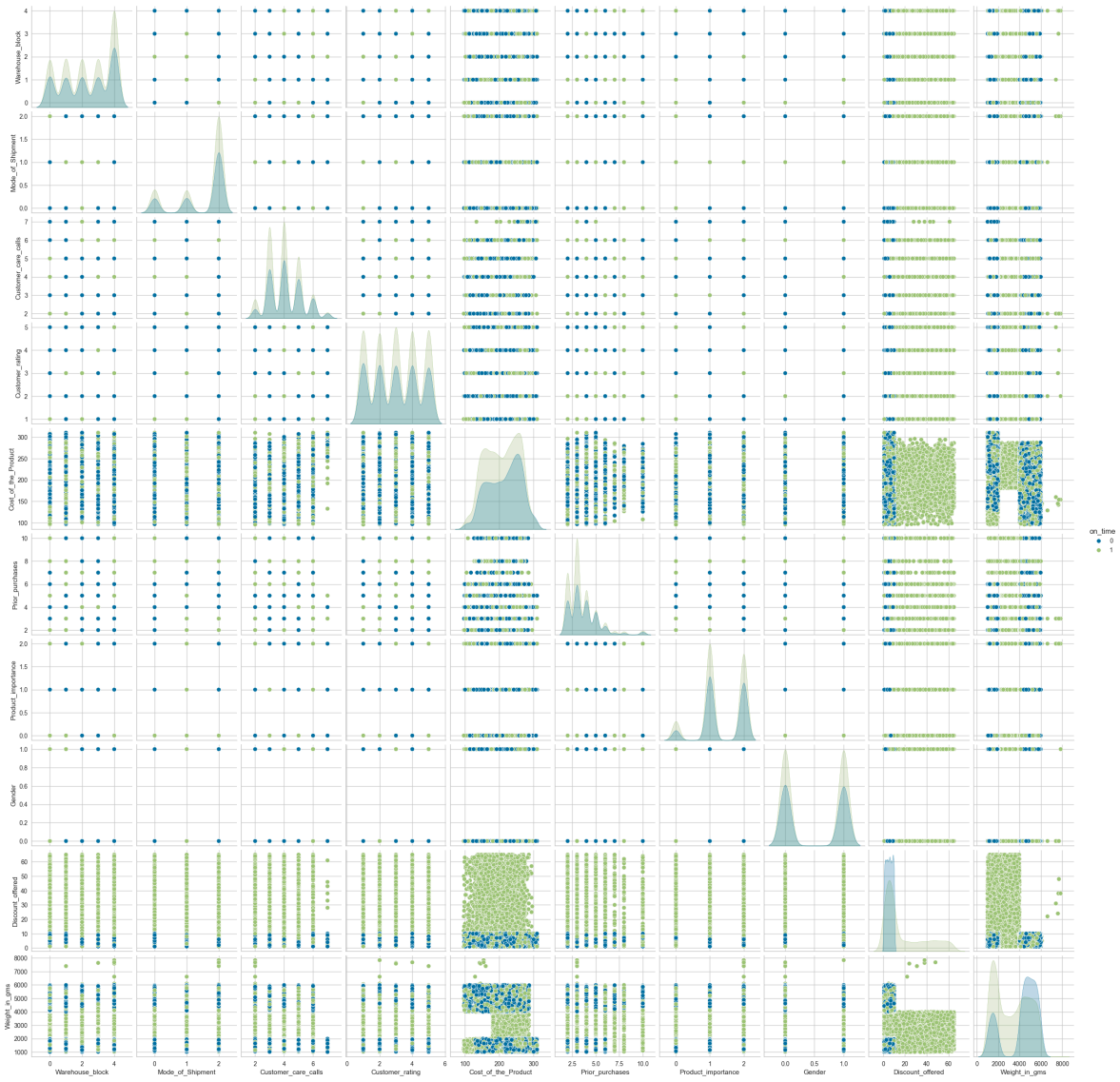


Multivariable view

All realtions with on_time

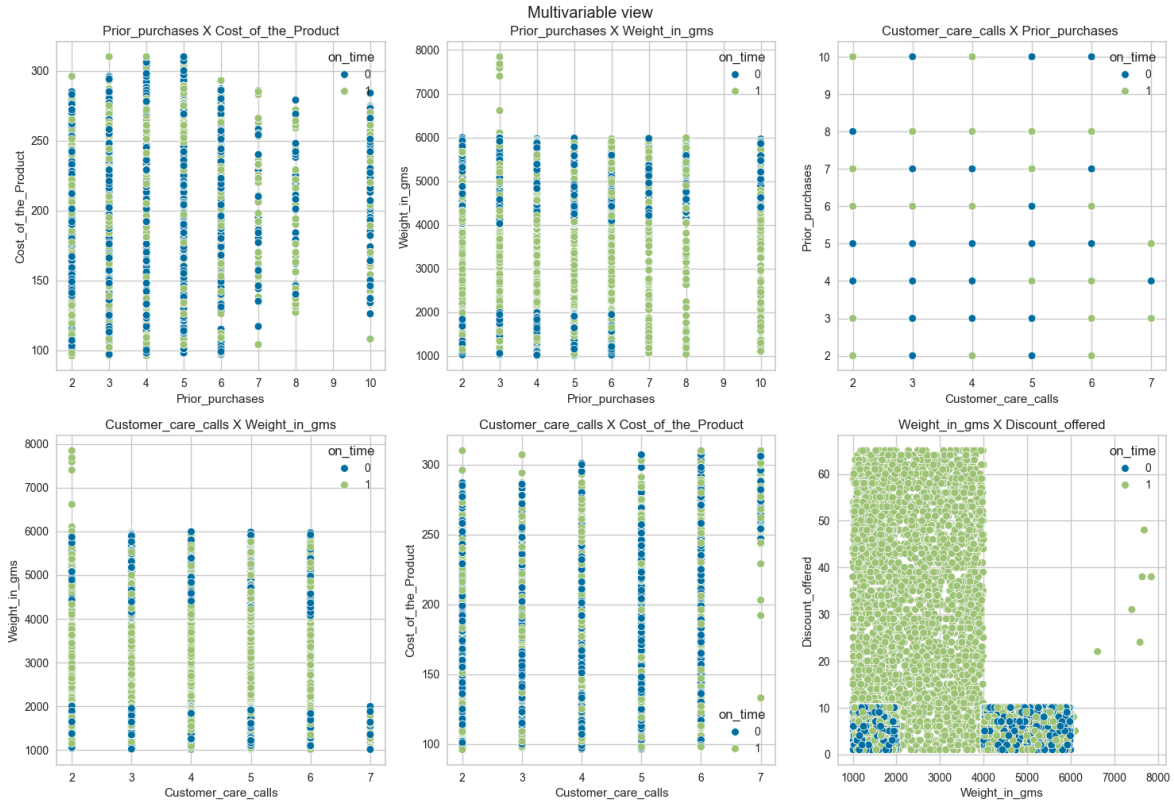
In [44]:
```
plt.figure(figsize=(15,15))
sns.pairplot(df.select_dtypes(exclude=(object)),hue='on_time')
plt.show()
```

```
<Figure size 1500x1500 with 0 Axes>
```



Some relations that I thought would be good to see with mode details

In [45]:
```
plt.figure(figsize=(15,15))
plt.subplot(3, 3, 1)
sns.scatterplot(data=df,x="Prior_purchases",y="Cost_of_the_Product",hue='on_time
plt.title("Prior_purchases X Cost_of_the_Product")
plt.subplot(3, 3, 2)
sns.scatterplot(data=df,x="Prior_purchases",y="Weight_in_gms",hue='on_time')
plt.title("Prior_purchases X Weight_in_gms")
plt.subplot(3, 3, 3)
sns.scatterplot(data=df,x="Customer_care_calls",y="Prior_purchases",hue='on_time
plt.title("Customer_care_calls X Prior_purchases ")
plt.subplot(3, 3, 4)
sns.scatterplot(data=df,x="Customer_care_calls",y="Weight_in_gms",hue='on_time')
plt.title("Customer_care_calls X Weight_in_gms")
plt.subplot(3, 3, 5)
sns.scatterplot(data=df,x="Customer_care_calls",y="Cost_of_the_Product",hue='on_
plt.title("Customer_care_calls X Cost_of_the_Product")
plt.subplot(3, 3, 6)
sns.scatterplot(data=df,x="Weight_in_gms",y="Discount_offered",hue='on_time')
plt.title("Weight_in_gms X Discount_offered")
#
plt.suptitle("Multivariable view")
plt.tight_layout()
plt.show()
```



VIF

- *No treat on columns*

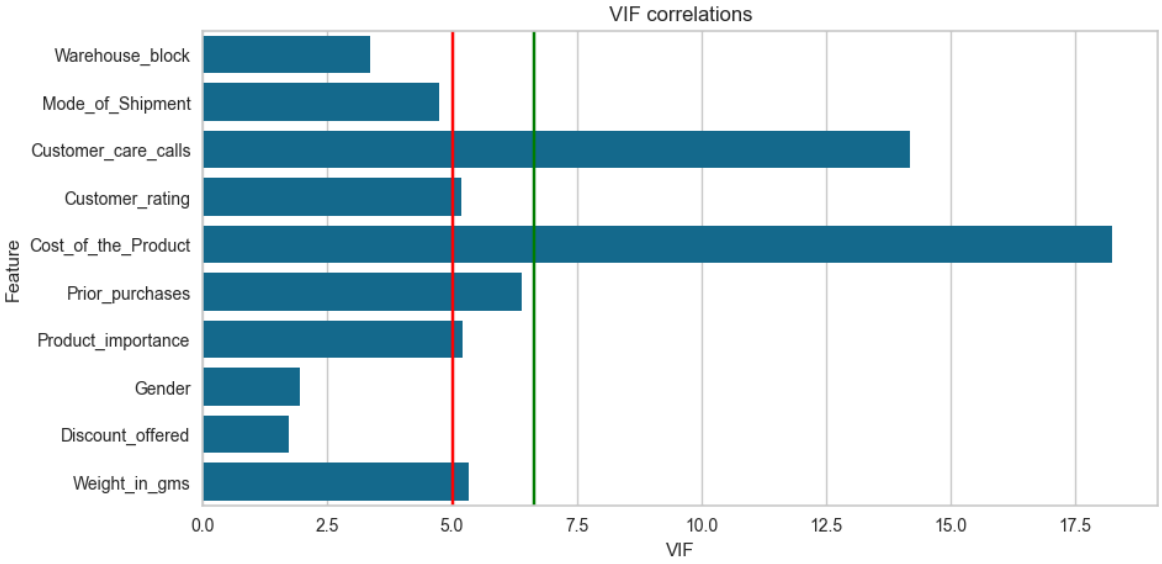
In [46]:
```
df_vif = df.drop(columns='on_time')
vif_data = pd.DataFrame()
vif_data["Feature"] = df_vif.columns
vif_data["VIF"] = [variance_inflation_factor(df_vif.values, i) for i in range(le
vif_data
```

Out[46]:

	Feature	VIF
0	Warehouse_block	3.350684
1	Mode_of_Shipment	4.733955
2	Customer_care_calls	14.182232
3	Customer_rating	5.173562
4	Cost_of_the_Product	18.247517
5	Prior_purchases	6.399117
6	Product_importance	5.211311
7	Gender	1.957789
8	Discount_offered	1.735545
9	Weight_in_gms	5.324983

In [47]:
```
plt.figure(figsize=(10,5))
plot = sns.barplot(data=vif_data,y='Feature',x='VIF',orient='h')
```

```
plot.axvline(x=5,color='red')
plot.axvline(x=vif_data['VIF'].mean(),color='green')
plt.title("VIF correlations")
plt.show()
```



Treat pt 3

- StandardScaler
- New features

New features

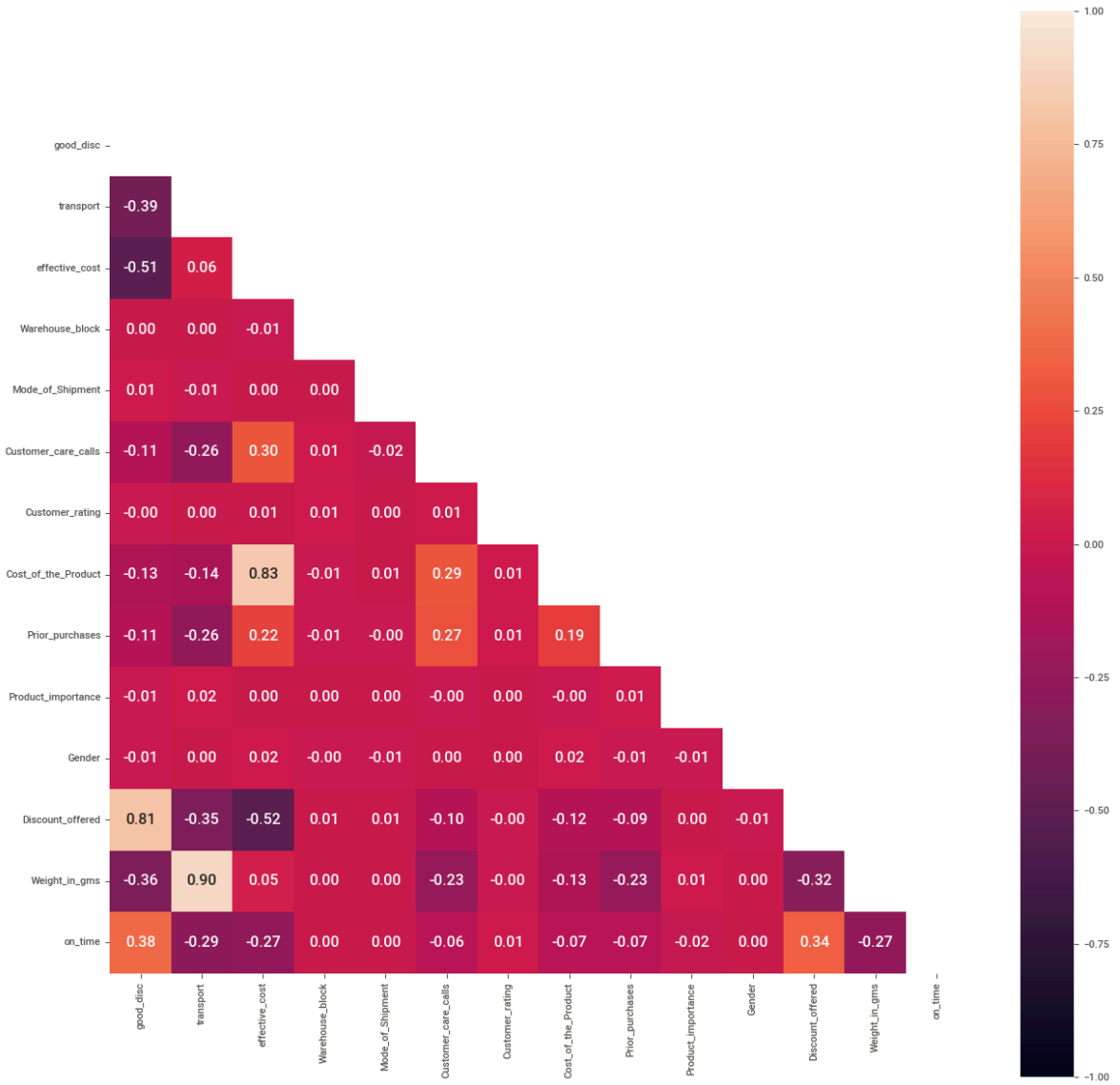
In [272…

```
df.insert(0,allow_duplicates=False,column='effective_cost',value = df['Cost_of_t
df.insert(0,allow_duplicates=False,column='transport',value = pd.cut(df['Weight_
df.insert(0,allow_duplicates=False,column='good_disc',value = pd.cut(df['Discoun
```

Spearman Relation

In [273…

```
mask = np.triu(np.ones_like(df.select_dtypes(exclude=object).corr(), dtype=np.bo
plt.figure(figsize=(15,15))
sns.heatmap(df.select_dtypes(exclude=object).corr(method='spearman'), mask=mask,
plt.show()
```



Columns

In [9]:
```
cols_model = ['transport',
              'good_disc',
              'effective_cost',
              'Warehouse_block',
              'Mode_of_Shipment',
              #'Customer_care_calls',
              #'Cost_of_the_Product','Gendder,
              'Prior_purchases',
              'Product_importance'
              ,'Discount_offered'
              #,'Weight_in_gms'
       ]
```

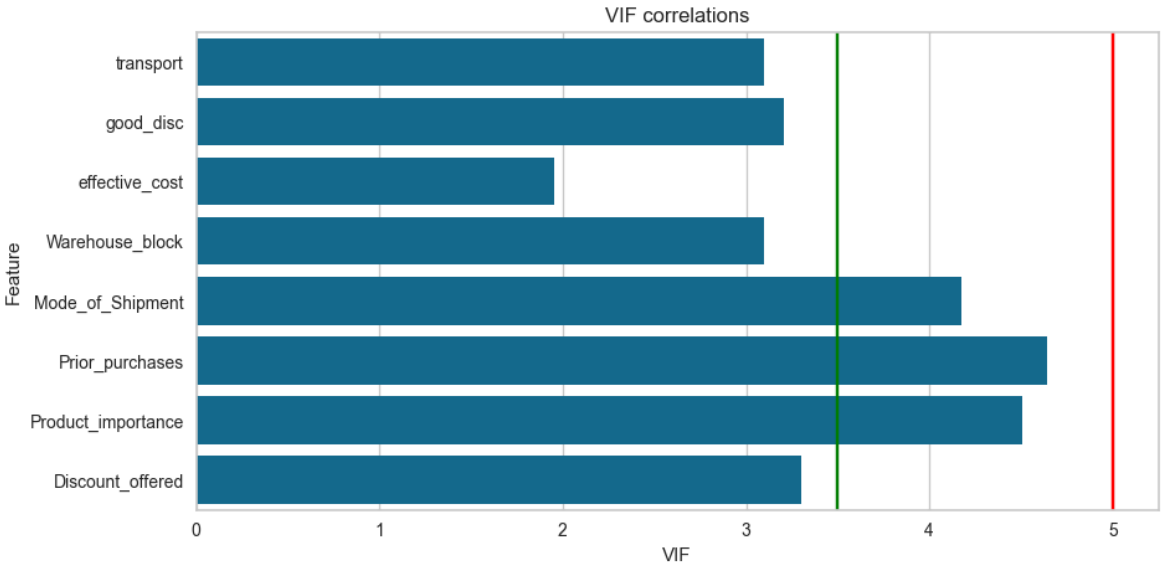
VIF after features

In [10]:
```
df_vif = df[cols_model]
vif_data = pd.DataFrame()
vif_data["Feature"] = df_vif.columns
vif_data["VIF"] = [variance_inflation_factor(df_vif.values, i) for i in range(le
vif_data
```

Out[10]:

	Feature	VIF
0	transport	3.098094
1	good_disc	3.203416
2	effective_cost	1.954329
3	Warehouse_block	3.101051
4	Mode_of_Shipment	4.176865
5	Prior_purchases	4.642797
6	Product_importance	4.508913
7	Discount_offered	3.303627

In [11]:
```
plt.figure(figsize=(10,5))
plot = sns.barplot(data=vif_data,y='Feature',x='VIF',orient='h')
plot.axvline(x=5,color='red')
plot.axvline(x=vif_data['VIF'].mean(),color='green')
plt.title("VIF correlations")
plt.show()
```



StandardScaler

In [12]:
```
col_scale = df.drop(columns=['on_time']).select_dtypes(exclude=object).columns
scale_index = np.where((df[col_scale].max() - df[col_scale].min()) > 10)
col_scale = col_scale[scale_index]
```

In [13]:
```
for col in col_scale:
    df[col] = StandardScaler().fit_transform(df[[col]])
```

Base to train

Save df treated

In [ ]:
```
joblib.dump(df,filename='./pkl/df_treat.pkl')
```

Out[ ]:
```
['df_treat.pkl']
```

load data

In [ ]:
```
df = joblib.load('./pkl/df_treat.pkl')
```

Split base

In [12]:
```
k = KFold(n_splits=5,random_state=42,shuffle=True)
```

In [14]:
```
cols_model = ['transport',
              'good_disc',
              'effective_cost',
              'Warehouse_block',
              'Mode_of_Shipment',
              #'Customer_care_calls',
              #'Cost_of_the_Product','Gendder,
              'Prior_purchases',
              'Product_importance'
              ,'Discount_offered'
              #,'Weight_in_gms'
       ]
```

creat base to test and train

In [15]:
```
ok = df[df['on_time']==1].index.to_list()
n_ok = df[df['on_time']==0].index.to_list()
```

In [16]:
```
lst_index = ok[0:len(n_ok)] + n_ok
```

In [17]:
```
X = df.loc[lst_index,cols_model].values
Y = df.loc[lst_index,'on_time'].values
```

In [ ]:
```
joblib.dump((X,Y),"./pkl/X_Y.pkl")
```

Out[ ]:
```
['X_Y.pkl']
```

In [ ]:
```
x_train, x_test, y_train, y_test = train_test_split(X,Y,test_size=0.10)
#cross_val = cross_val_score(X=X,y=Y,cv=k)
```

In [ ]:
```
joblib.dump((x_train,x_test,y_train,y_test),"./pkl/train_test.pkl")
```

Out[ ]:
```
['train_test.pkl']
```

Model training

Bayes

In [308…

```
bayes = GaussianNB()
bayes.fit(X=x_train,y=y_train)
pred = bayes.predict(X=x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=pred))
```

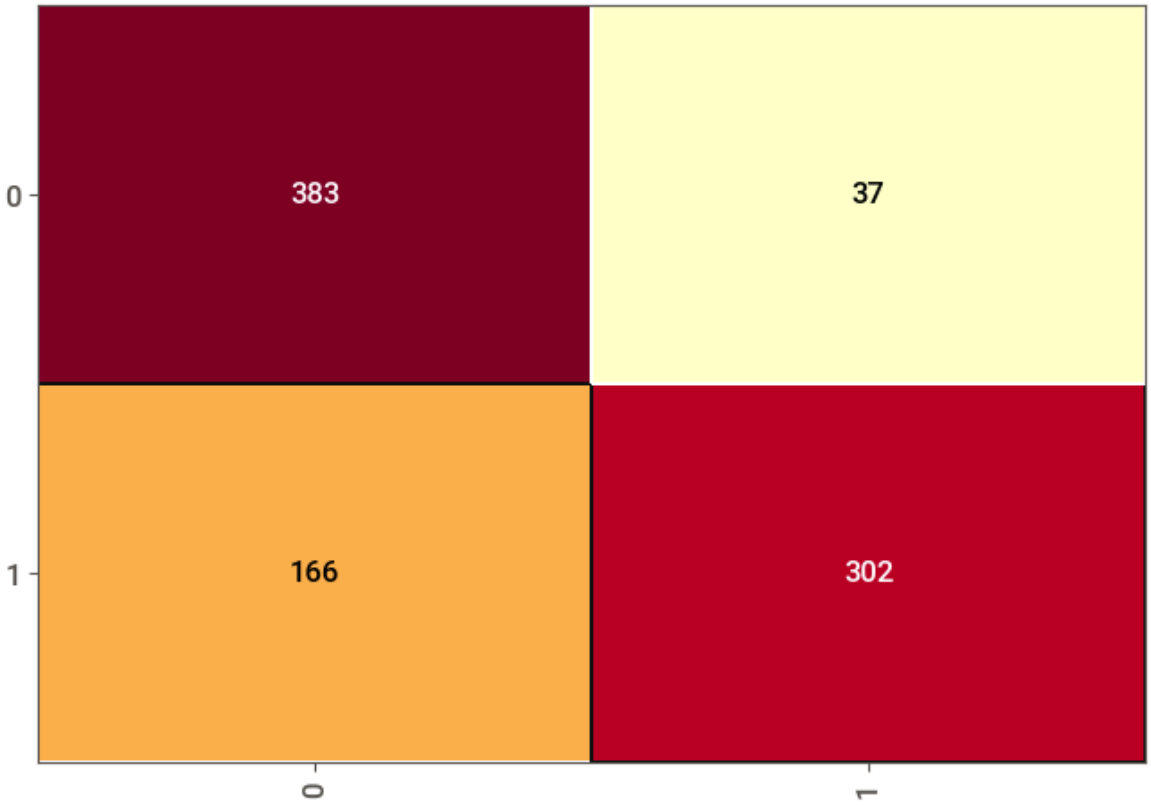
```
Accuracy
0.7713963963963963
Classification
              precision    recall  f1-score   support

           0       0.70      0.91      0.79       420
           1       0.89      0.65      0.75       468

    accuracy                           0.77       888
   macro avg       0.79      0.78      0.77       888
weighted avg       0.80      0.77      0.77       888

mean abs error
0.2286036036036036
mean sqd error
0.2286036036036036
R²
0.08290598290598283
```

In [309…

```
cm = ConfusionMatrix(bayes)
cm.fit(x_train,y_train)
cm.score(x_test,y_test)
```

Out[309…

```
0.7713963963963963
```



In [ ]:
```
joblib.dump(bayes,filename='./pkl/bayes_model.pkl')
```

Out[ ]:
```
['bayes_model.pkl']
```

Linear regression

In [310…
```
param = {'tol': [0.01, 0.001, 0.0001],
        'C': [1.0, 1.5, 2.0],
        'solver': ['lbfgs', 'sag', 'saga']}
test_grid = GridSearchCV(LogisticRegression(),param_grid=param)
test_grid.fit(X=x_train,y=y_train)
grid_pred = test_grid.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=grid_pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=grid_pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=grid_pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=grid_pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=grid_pred))
print("Best parameters")
print(test_grid.best_params_)
```

```
Accuracy
0.7804054054054054
Classification
              precision    recall  f1-score   support

           0       0.71      0.91      0.80       420
           1       0.89      0.67      0.76       468

    accuracy                           0.78       888
   macro avg       0.80      0.79      0.78       888
weighted avg       0.80      0.78      0.78       888

mean abs error
0.2195945945945946
mean sqd error
0.2195945945945946
R²
0.11904761904761896
Best parameters
{'C': 1.0, 'solver': 'saga', 'tol': 0.01}
```

In [311…
```
linear_model = LogisticRegression(**test_grid.best_params_)
```

In [312…
```
cross_val = cross_val_score(LogisticRegression(),X,Y,cv=k)
print(f"r²=\n\t{cross_val}\n mean r²:\n\t{np.mean(cross_val)}\n desv r²:\n\t{np.
```

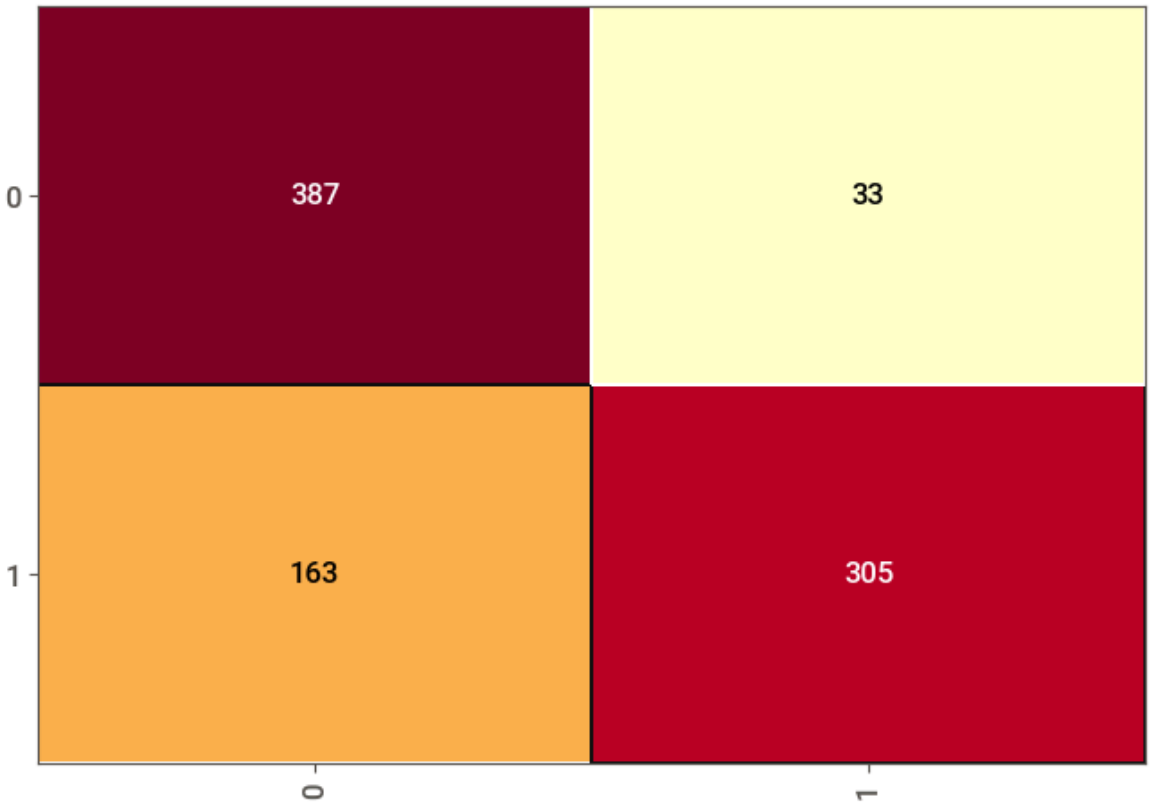
```
r²=
        [0.79774648 0.78028169 0.77903044 0.7886133  0.7897407 ]
 mean r²:
        0.787082522190641
 desv r²:
        0.006844216769937233
```

In [313…
```
linear_model.fit(X=x_train,y=y_train)
pred = linear_model.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=pred))
```

```
Accuracy
0.7792792792792793
Classification
              precision    recall  f1-score   support

           0       0.70      0.92      0.80       420
           1       0.90      0.65      0.76       468

    accuracy                           0.78       888
   macro avg       0.80      0.79      0.78       888
weighted avg       0.81      0.78      0.78       888

mean abs error
0.22072072072072071
mean sqd error
0.22072072072072071
R²
0.11452991452991446
```

In [314…
```
cm = ConfusionMatrix(linear_model)
cm.fit(x_train,y_train)
cm.score(x_test,y_test)
```

Out[314…
```
0.7792792792792793
```



In [ ]:
```
joblib.dump(linear_model,filename='./pkl/linear_reg_model.pkl')
```

Out[ ]:
```
['linear_reg_model.pkl']
```

KNN

In [320…
```
param = {
    'n_neighbors':[100,50,20,10],
```

```
    'weights':['uniform','distance'],
    'algorithm':['auto'],
    'p':[1,2]
    #metric='minkowski',
}
test_grid = GridSearchCV(KNeighborsClassifier(),param_grid=param)
test_grid.fit(x_train,y=y_train)
grid_pred = test_grid.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=grid_pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=grid_pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=grid_pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=grid_pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=grid_pred))
print("Best parameters")
print(test_grid.best_params_)
```

```
Accuracy
0.8288288288288288
Classification
              precision    recall  f1-score   support

           0       0.74      0.99      0.85       420
           1       0.99      0.68      0.81       468

    accuracy                           0.83       888
   macro avg       0.86      0.84      0.83       888
weighted avg       0.87      0.83      0.83       888

mean abs error
0.17117117117117117
mean sqd error
0.17117117117117117
R²
0.3133089133089132
Best parameters
{'algorithm': 'auto', 'n_neighbors': 20, 'p': 1, 'weights': 'uniform'}
```

In [321…

```
knn_model = KNeighborsClassifier(**test_grid.best_params_)
cross_val = cross_val_score(knn_model,X,Y,cv=k)
print(f"r²=\n\t{cross_val}\n mean r²:\n\t{np.mean(cross_val)}\n desv r²:\n\t{np.
```

```
r²=
        [0.84450704 0.82366197 0.81905299 0.83652762 0.83258174]
 mean r²:
        0.8312662718135192
 desv r²:
        0.009074358767660344
```

In [322…

```
knn_model = KNeighborsClassifier(**test_grid.best_params_)
```

In [323…

```
knn_model.fit(X=x_train,y=y_train)
pred = knn_model.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=pred))
print("Classification")
```

```
print(classification_report(y_true=y_test,y_pred=pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=pred))
```

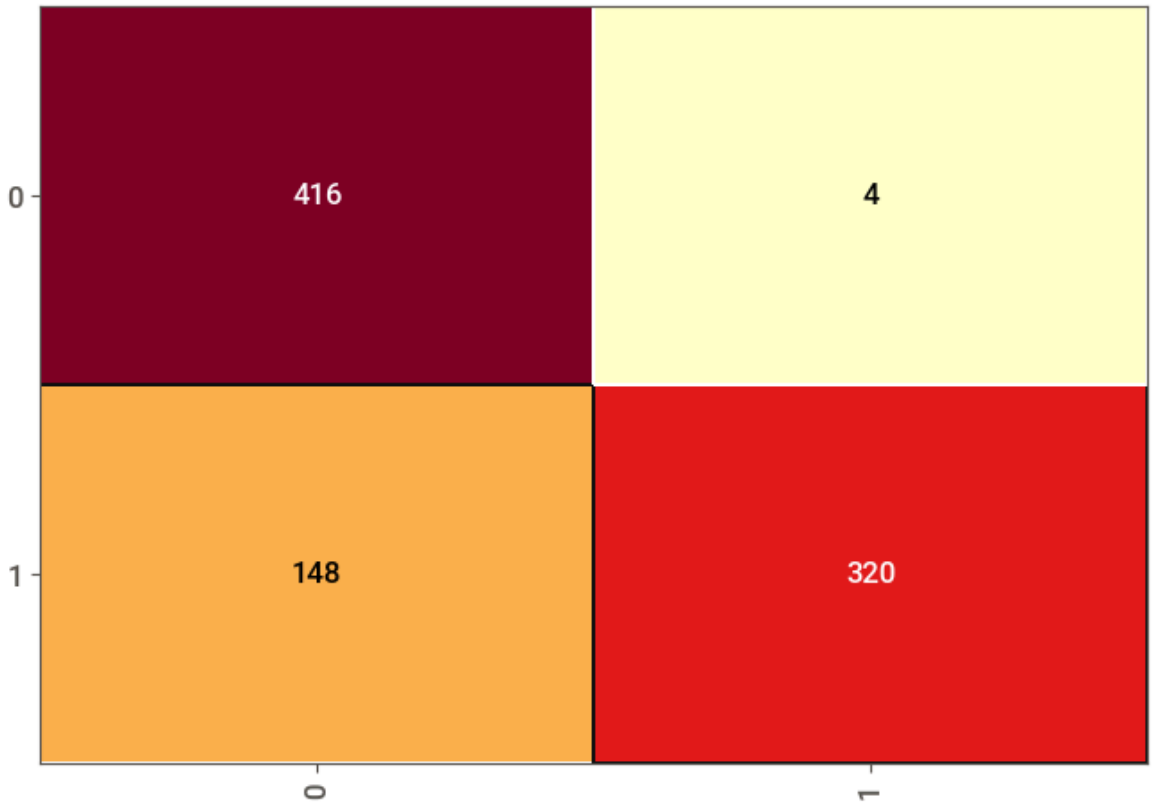
```
Accuracy
0.8288288288288288
Classification
              precision    recall  f1-score   support

           0       0.74      0.99      0.85       420
           1       0.99      0.68      0.81       468

    accuracy                           0.83       888
   macro avg       0.86      0.84      0.83       888
weighted avg       0.87      0.83      0.83       888

mean abs error
0.17117117117117117
mean sqd error
0.17117117117117117
R²
0.3133089133089132
```

In [324…

```
cm = ConfusionMatrix(knn_model)
cm.fit(x_train,y_train)
cm.score(x_test,y_test)
```

Out[324…

```
0.8288288288288288
```



In [ ]:

```
joblib.dump(knn_model,filename='./pkl/knn_model.pkl')
```

```
['knn_model.pkl']
```

Decision Tree

In [325…]
```
param = {
    'criterion':["gini", "entropy"],
    'splitter': ['best', 'random'],
    'min_samples_split':[2,5,15],
    'min_samples_leaf': [1,5,10],
    'random_state':[42]
}
test_grid = GridSearchCV(DecisionTreeClassifier(),param_grid=param)
test_grid.fit(X=x_train,y=y_train)
grid_pred = test_grid.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=grid_pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=grid_pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=grid_pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=grid_pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=grid_pred))
print("Best parameters")
print(test_grid.best_params_)
```

```
Accuracy
0.831081081081081
Classification
              precision    recall  f1-score   support

           0       0.75      0.95      0.84       420
           1       0.94      0.72      0.82       468

    accuracy                           0.83       888
   macro avg       0.85      0.84      0.83       888
weighted avg       0.85      0.83      0.83       888

mean abs error
0.16891891891891891
mean sqd error
0.16891891891891891
R²
0.3223443223443223
Best parameters
{'criterion': 'gini', 'min_samples_leaf': 10, 'min_samples_split': 2, 'random_sta
te': 42, 'splitter': 'random'}
```

In [326…]
```
tree_model = DecisionTreeClassifier(**test_grid.best_params_)
```

In [327…]
```
cross_val = cross_val_score(DecisionTreeClassifier(),X,Y,cv=k)
print(f"r²=\n\t{cross_val}\n mean r²:\n\t{np.mean(cross_val)}\n desv r²:\n\t{np.
```

```
r²=
        [0.77746479 0.77239437 0.75930101 0.76662909 0.76493799]
 mean r²:
        0.7681454499261635
 desv r²:
        0.006256429269677034
```

In [328…

```
tree_model.fit(X=x_train,y=y_train)
pred = tree_model.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=pred))
```

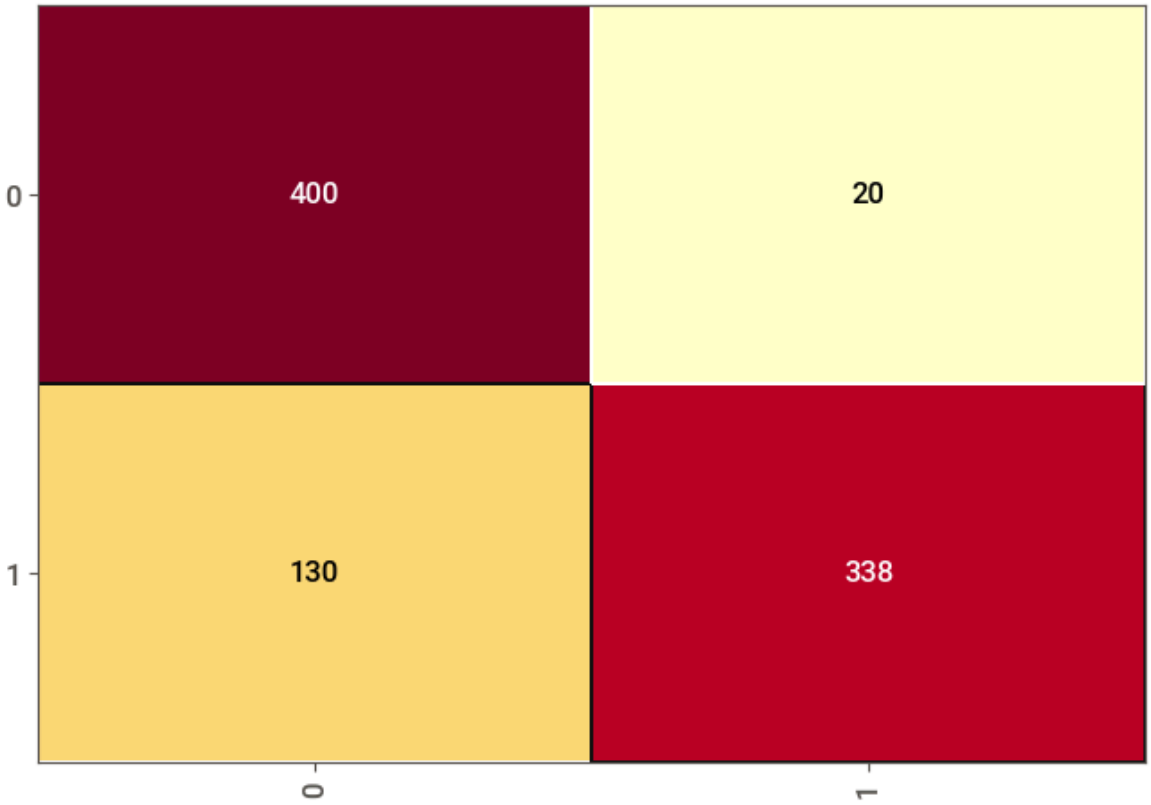
```
Accuracy
0.831081081081081
Classification
              precision    recall  f1-score   support

           0       0.75      0.95      0.84       420
           1       0.94      0.72      0.82       468

    accuracy                           0.83       888
   macro avg       0.85      0.84      0.83       888
weighted avg       0.85      0.83      0.83       888

mean abs error
0.16891891891891891
mean sqd error
0.16891891891891891
R²
0.3223443223443223
```

In [329…

```
cm = ConfusionMatrix(tree_model)
cm.fit(x_train,y_train)
cm.score(x_test,y_test)
```

Out[329…

```
0.831081081081081
```



In [ ]:
```
joblib.dump(tree_model,filename='./pkl/dec_tree_model.pkl')
```

Out[ ]:
```
['dec_tree_model.pkl']
```

Random Forest

In [330…
```
param = {
    'criterion':["gini", "entropy"],
    'n_estimators':[50,100,200],
    'min_samples_split':[2,5,10],
    'min_samples_leaf': [1,5,10],
    'random_state':[42]
}
test_grid = GridSearchCV(RandomForestClassifier(),param_grid=param)
test_grid.fit(X=x_train,y=y_train)
grid_pred = test_grid.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=grid_pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=grid_pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=grid_pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=grid_pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=grid_pred))
print("Best parameters")
print(test_grid.best_params_)
```

```
Accuracy
0.8412162162162162
Classification
              precision    recall  f1-score   support

           0       0.75      0.99      0.85       420
           1       0.99      0.71      0.82       468

    accuracy                           0.84       888
   macro avg       0.87      0.85      0.84       888
weighted avg       0.88      0.84      0.84       888

mean abs error
0.15878378378378377
mean sqd error
0.15878378378378377
R²
0.36300366300366294
Best parameters
{'criterion': 'entropy', 'min_samples_leaf': 5, 'min_samples_split': 2, 'n_estima
tors': 200, 'random_state': 42}
```

In [331…
```
rf_model = RandomForestClassifier(**test_grid.best_params_)
```

In [332…
```
cross_val = cross_val_score(rf_model,X,Y,cv=k)
print(f"r²=\n\t{cross_val}\n mean r²:\n\t{np.mean(cross_val)}\n desv r²:\n\t{np.
```

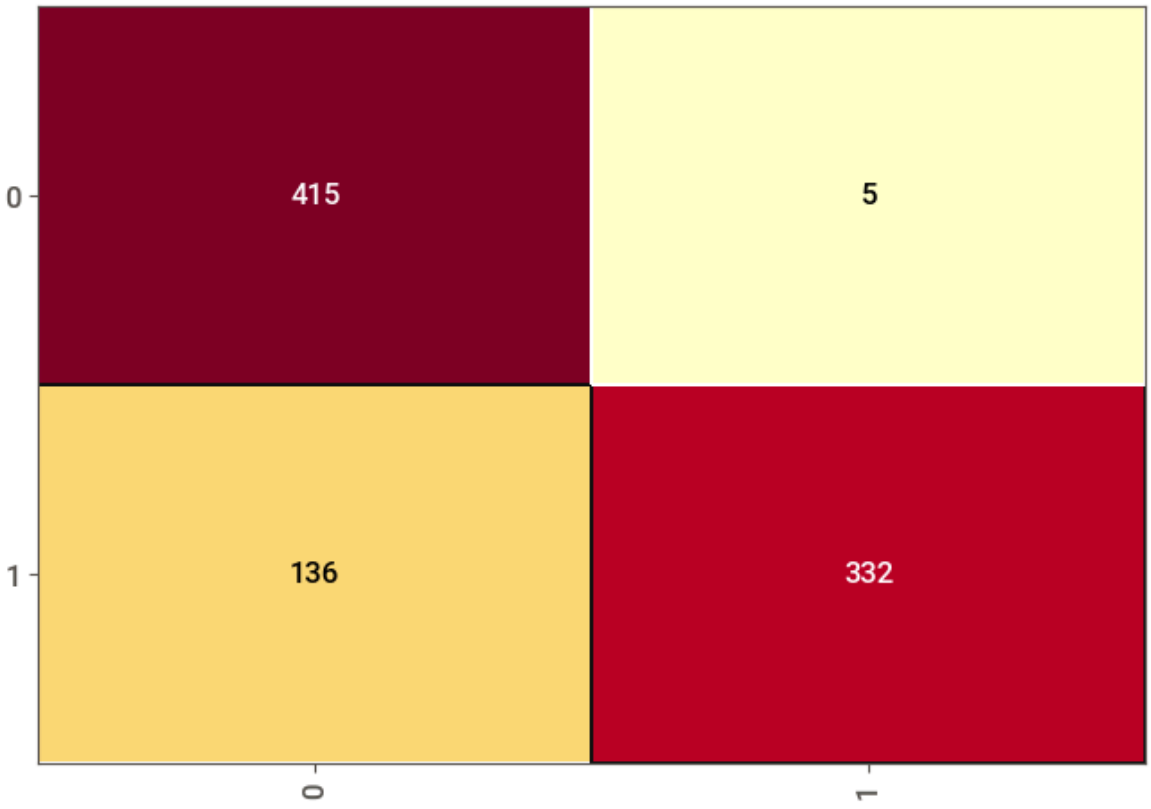
```
r²=
        [0.85915493 0.84394366 0.82919955 0.85005637 0.84949267]
 mean r²:
        0.8463694364609301
 desv r²:
        0.009874272907078164
```

In [333…
```
rf_model.fit(X=x_train,y=y_train)
pred = rf_model.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=pred))
```

```
Accuracy
0.8412162162162162
Classification
              precision    recall  f1-score   support

           0       0.75      0.99      0.85       420
           1       0.99      0.71      0.82       468

    accuracy                           0.84       888
   macro avg       0.87      0.85      0.84       888
weighted avg       0.88      0.84      0.84       888

mean abs error
0.15878378378378377
mean sqd error
0.15878378378378377
R²
0.36300366300366294
```

In [334…]
```
cm = ConfusionMatrix(rf_model)
cm.fit(x_train,y_train)
cm.score(x_test,y_test)
```

Out[334…] 0.8412162162162162



In [ ]:
```
joblib.dump(rf_model,filename='./pkl/rf_model.pkl')
```

Out[ ]: ['rf_model.pkl']

SVM

In [345…]
```
param = {'tol': [0.1, 0.01, 0.001],
         'C': [1.0,2.0],
```

```
        'kernel': ['rbf', 'linear', 'poly', 'sigmoid'],
        'random_state':[42]
        }
test_grid = GridSearchCV(SVC(),param_grid=param)
test_grid.fit(X=x_train,y=y_train)
grid_pred = test_grid.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=grid_pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=grid_pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=grid_pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=grid_pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=grid_pred))
print("Best parameters")
print(test_grid.best_params_)
```

```
Accuracy
0.8412162162162162
Classification
              precision    recall  f1-score   support

           0       0.75      0.99      0.85       420
           1       0.99      0.71      0.82       468

    accuracy                           0.84       888
   macro avg       0.87      0.85      0.84       888
weighted avg       0.88      0.84      0.84       888

mean abs error
0.15878378378378377
mean sqd error
0.15878378378378377
R²
0.36300366300366294
Best parameters
{'C': 2.0, 'kernel': 'rbf', 'random_state': 42, 'tol': 0.01}
```

In [346…
```
svc_model = SVC(**test_grid.best_params_)
```

In [347…
```
cross_val = cross_val_score(svc_model,X,Y,cv=k)
print(f"r²=\n\t{cross_val}\n mean r²:\n\t{np.mean(cross_val)}\n desv r²:\n\t{np.
```

```
r²=
        [0.85464789 0.8428169  0.82976325 0.85005637 0.85005637]
 mean r²:
        0.845468155040729
 desv r²:
        0.008718304874540717
```

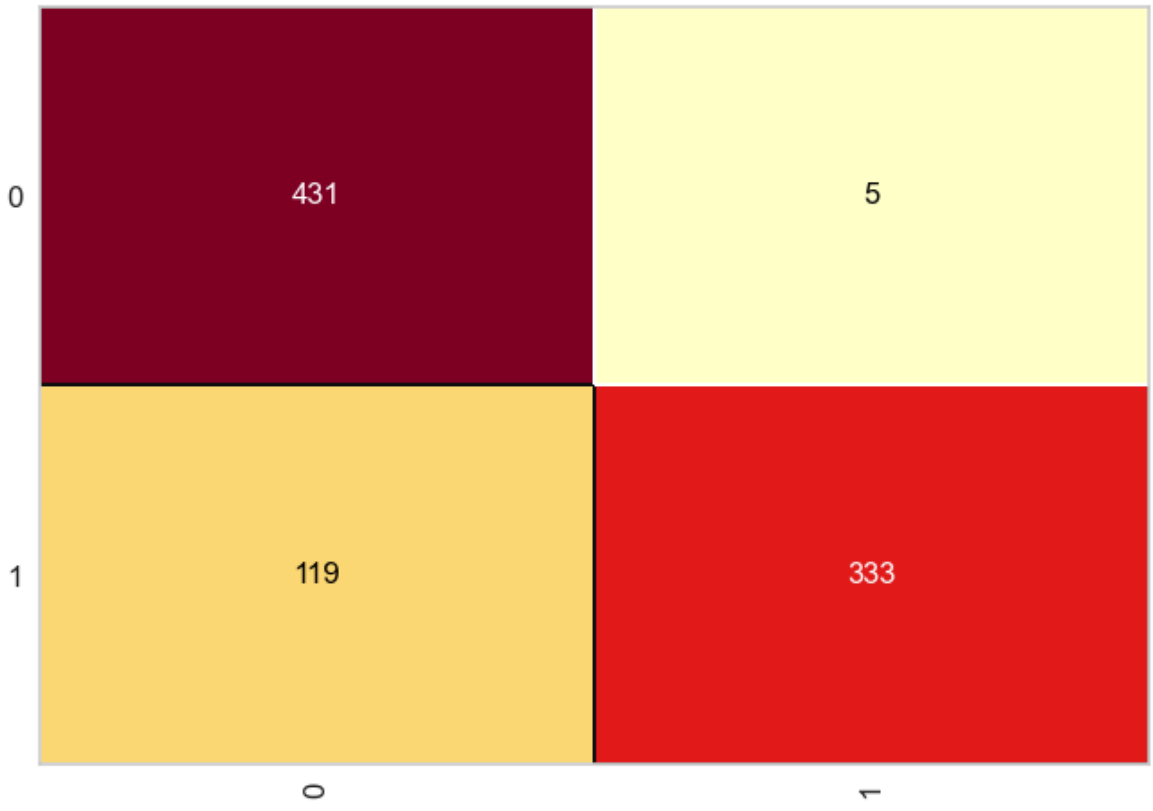
In [33]:
```
svc_model.fit(X=x_train,y=y_train)
pred = svc_model.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=pred))
```

```
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=pred))
```

```
Accuracy
0.8603603603603603
Classification
              precision    recall  f1-score   support

           0       0.78      0.99      0.87       436
           1       0.99      0.74      0.84       452

    accuracy                           0.86       888
   macro avg       0.88      0.86      0.86       888
weighted avg       0.89      0.86      0.86       888

mean abs error
0.13963963963963963
mean sqd error
0.13963963963963963
R²
0.4412600470893886
```

In [34]:
```
cm = ConfusionMatrix(svc_model)
cm.fit(x_train,y_train)
cm.score(x_test,y_test)
```

Out[34]: 0.8603603603603603



In [ ]:
```
joblib.dump(svc_model,filename='./pkl/svc_model.pkl')
```

Out[ ]: ['svc_model.pkl']

Neural Network

In [ ]:
```
param = {
    'hidden_layer_sizes':[(100),(10,10),(8,32,8)],
    'activation': ['relu', 'logistic'],
    'solver': ['adam', 'sgd'],
    'max_iter':[200],
    'verbose':[False],
    'tol':[0.0000010],
    'random_state': [42],
    'learning_rate':["constant", "invscaling", "adaptive"]
    ,'batch_size': ['auto']
}
test_grid = GridSearchCV(MLPClassifier(),param_grid=param,n_jobs=-1)
test_grid.fit(X=x_train,y=y_train)
grid_pred = test_grid.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=grid_pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=grid_pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=grid_pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=grid_pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=grid_pred))
print("Best parameters")
print(test_grid.best_params_)
```

```
Accuracy
0.8637387387387387
Classification
              precision    recall  f1-score   support

           0       0.79      0.99      0.88       436
           1       0.99      0.74      0.85       452

    accuracy                           0.86       888
   macro avg       0.89      0.87      0.86       888
weighted avg       0.89      0.86      0.86       888

mean abs error
0.13626126126126126
mean sqd error
0.13626126126126126
R²
0.4547779491759356
Best parameters
{'activation': 'relu', 'batch_size': 'auto', 'hidden_layer_sizes': (10, 10), 'lea
rning_rate': 'constant', 'random_state': 42, 'solver': 'adam', 'tol': 1e-06, 'ver
bose': False}
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

In [10]:
```
nn_model = MLPClassifier(**test_grid.best_params_)
```

In [13]:
```
cross_val = cross_val_score(nn_model,X,Y,cv=k)
print(f"r²=\n\t{cross_val}\n mean r²:\n\t{np.mean(cross_val)}\n desv r²:\n\t{np.
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
r²=
	[0.85183099 0.84225352 0.82863585 0.85005637 0.84723788]
 mean r²:
	0.8440029217015736
 desv r²:
	0.008337805947826288
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

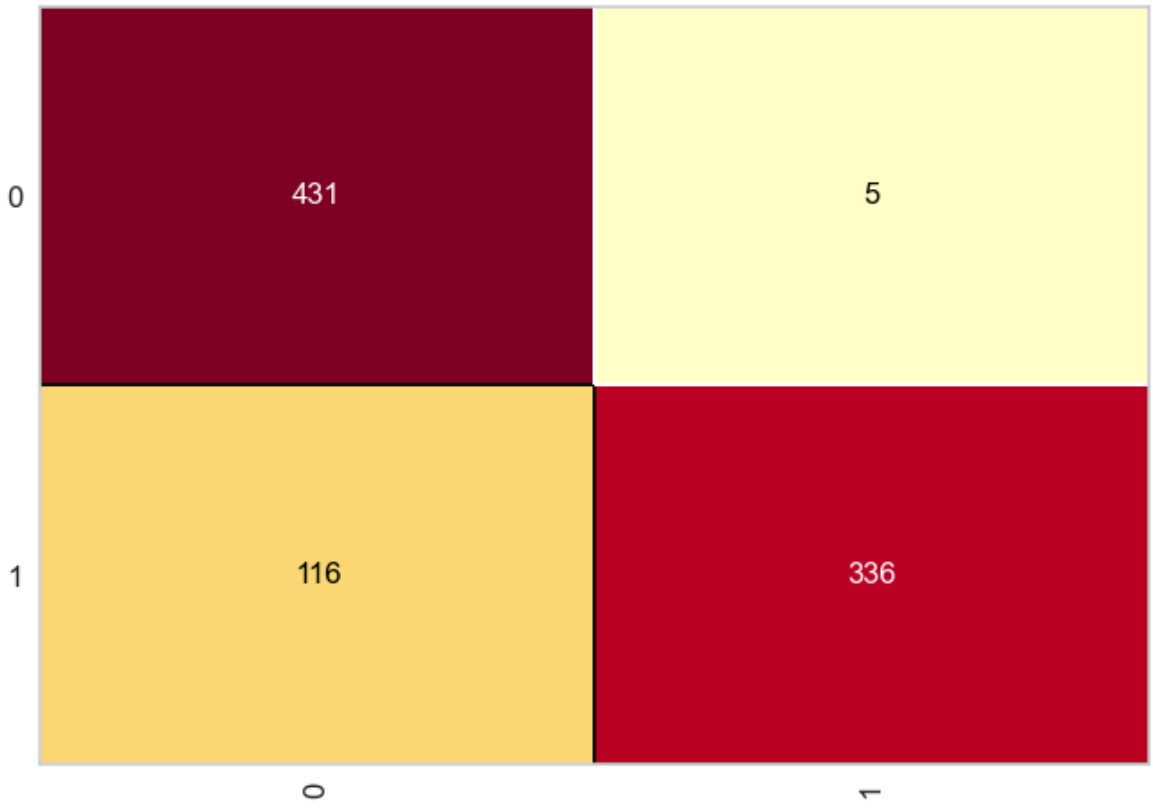
In [14]:
```
nn_model.fit(X=x_train,y=y_train)
pred = nn_model.predict(x_test)
print("Accuracy")
print(accuracy_score(y_true=y_test,y_pred=pred))
print("Classification")
print(classification_report(y_true=y_test,y_pred=pred))
print("mean abs error")
print(mean_absolute_error(y_true=y_test,y_pred=pred))
print("mean sqd error")
print(mean_squared_error(y_true=y_test,y_pred=pred))
print("R²")
print(r2_score(y_true=y_test,y_pred=pred))
```

```
Accuracy
0.8637387387387387
Classification
              precision    recall  f1-score   support

           0       0.79      0.99      0.88       436
           1       0.99      0.74      0.85       452

    accuracy                           0.86       888
   macro avg       0.89      0.87      0.86       888
weighted avg       0.89      0.86      0.86       888

mean abs error
0.13626126126126126
mean sqd error
0.13626126126126126
R²
0.4547779491759356
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

In [ ]:
```
cm = ConfusionMatrix(nn_model)
cm.fit(x_train,y_train)
'cm.score(x_test,y_test)
```

Out[ ]:
```
0.8637387387387387
```



In [ ]:
```
joblib.dump(nn_model,filename='./pkl/nn_model.pkl')
```

Out[ ]:
```
['nn_model.pkl']
```

Testes

Load Models

In [ ]:
```
bayes_model = joblib.load('./pkl/bayes_model.pkl')
tree_model = joblib.load('./pkl/dec_tree_model.pkl')
knn_model = joblib.load('./pkl/knn_model.pkl')
rf_model = joblib.load('./pkl/rf_model.pkl')
linear_model = joblib.load('./pkl/linear_reg_model.pkl')
svc_model = joblib.load('./pkl/svc_model.pkl')
nn_model = joblib.load('./pkl/nn_model.pkl')
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\base.py:380: InconsistentVersionWarning: Trying to unpickle estimator GaussianNB from version 1.7.0 when using version 1.6.1. This might lead to breaking code or invalid results. Use at your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-limitations
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\base.py:380: InconsistentVersionWarning: Trying to unpickle estimator DecisionTreeClassifier from version 1.7.0 when using version 1.6.1. This might lead to breaking code or invalid results. Use at your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-limitations
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\base.py:380: InconsistentVersionWarning: Trying to unpickle estimator KNeighborsClassifier from version 1.7.0 when using version 1.6.1. This might lead to breaking code or invalid results. Use at your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-limitations
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\base.py:380: InconsistentVersionWarning: Trying to unpickle estimator RandomForestClassifier from version 1.7.0 when using version 1.6.1. This might lead to breaking code or invalid results. Use at your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-limitations
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\base.py:380: InconsistentVersionWarning: Trying to unpickle estimator LogisticRegression from version 1.7.0 when using version 1.6.1. This might lead to breaking code or invalid results. Use at your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-limitations
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\base.py:380: InconsistentVersionWarning: Trying to unpickle estimator SVC from version 1.7.0 when using version 1.6.1. This might lead to breaking code or invalid results. Use at your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-limitations
  warnings.warn(
```

In [ ]:
```python
X, Y = joblib.load('./pkl/X_Y.pkl')
x_train, x_test, y_train, y_test = joblib.load('./pkl/train_test.pkl')
```

Cross validations

In [28]:
```python
tree_results = []
random_forest_results = []
knn_results = []
linear_result = []
svm_result = []
nn_results = []
bayes_result = []

for i in range(30):
  print(f'Teste: {i}')
```

```python
    # Tree model
    kfold = KFold(n_splits=5, shuffle=True, random_state=i)
    # bayes
    print(f'-- Bayes')
    scores = cross_val_score(bayes_model, X, Y, cv = kfold)
    bayes_result.append(scores.mean())
    # decision tree
    print(f'-- Trees')
    scores = cross_val_score(tree_model, X, Y, cv = kfold)
    tree_results.append(scores.mean())
    # random forest
    print(f'-- Random Rorest')
    scores = cross_val_score(rf_model,  X, Y, cv = kfold)
    random_forest_results.append(scores.mean())
    #KNN
    print(f'-- KNN')
    scores = cross_val_score(knn_model, X, Y, cv = kfold)
    knn_results.append(scores.mean())
    #Linear regression
    print(f'-- Linear regression')
    scores = cross_val_score(linear_model, X, Y, cv = kfold)
    linear_result.append(scores.mean())
    #SVC
    print(f'-- svc')
    scores = cross_val_score(svc_model, X, Y, cv = kfold)
    svm_result.append(scores.mean())
    # Neural Network
    print(f'-- Neural Network')
    scores = cross_val_score(nn_model, X, Y, cv = kfold)
    nn_results.append(scores.mean())
```

```
Teste: 0
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

```
Teste: 1
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

```
Teste: 2
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

```
Teste: 3
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 4
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 5
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 6
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 7
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

```
Teste: 8
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 9
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 10
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 11
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 12
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 13
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 14
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 15
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 16
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 17
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 18
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 19
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 20
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

```
Teste: 21
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

```
Teste: 22
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\ne
ural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

```
Teste: 23
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 24
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 25
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 26
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 27
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 28
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
Teste: 29
-- Bayes
-- Trees
-- Random Rorest
-- KNN
-- Linear regression
-- svc
-- Neural Network
```

```
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
C:\Users\ThalesFerreira\AppData\Roaming\Python\Python312\site-packages\sklearn\neural_network\_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

In [29]:
```
df_resultados = pd.DataFrame(
    {"bayes":bayes_result,'linear':linear_result,'knn':knn_results,
     "tree":tree_results,'random_forest':random_forest_results,
     'svc':svm_result,'neural_net':nn_results}
)
```

In [30]:
```
joblib.dump(df_resultados,filename='df_results.pkl')
```

Out[30]:
```
['df_results.pkl']
```

Statistical Test

In [37]:
```
df_resultados.mean()
```

Out[37]:
```
bayes            0.766761
linear           0.788721
knn              0.831117
tree             0.833934
random_forest    0.846660
svc              0.845638
neural_net       0.844210
dtype: float64
```

In [91]:
```
df_resultados.std()
```

Out[91]:
```
bayes            0.000170
linear           0.000809
knn              0.000781
tree             0.002340
random_forest    0.000450
svc              0.000205
neural_net       0.000485
dtype: float64
```

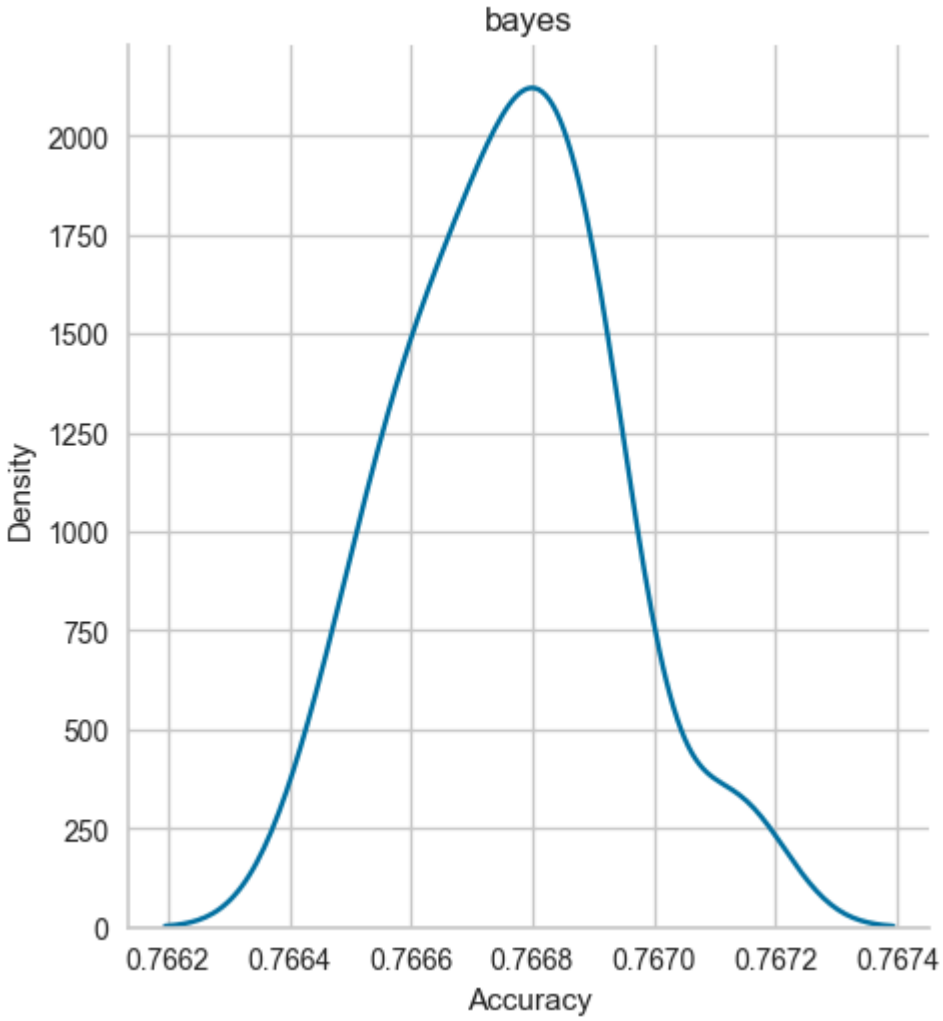
Shapiro

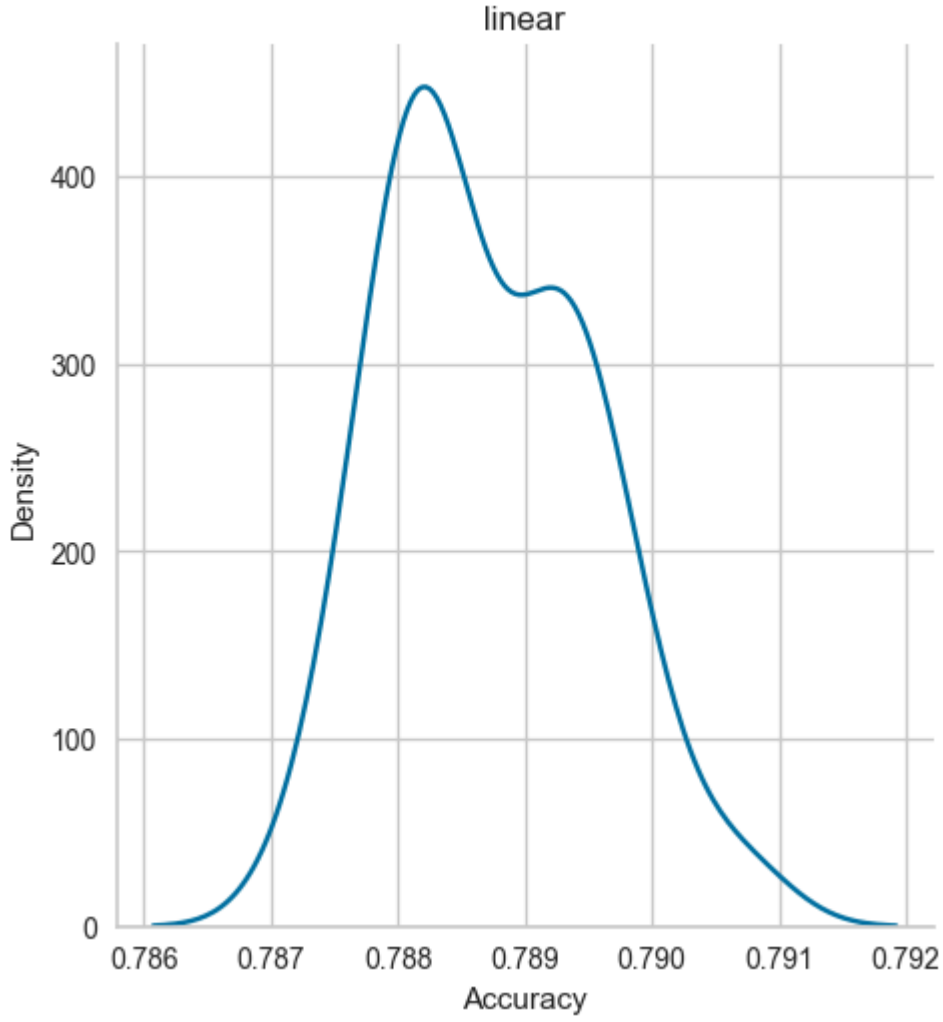
In [61]:
```
for col in df_resultados.columns:
    print(shapiro(df_resultados[col]))
```

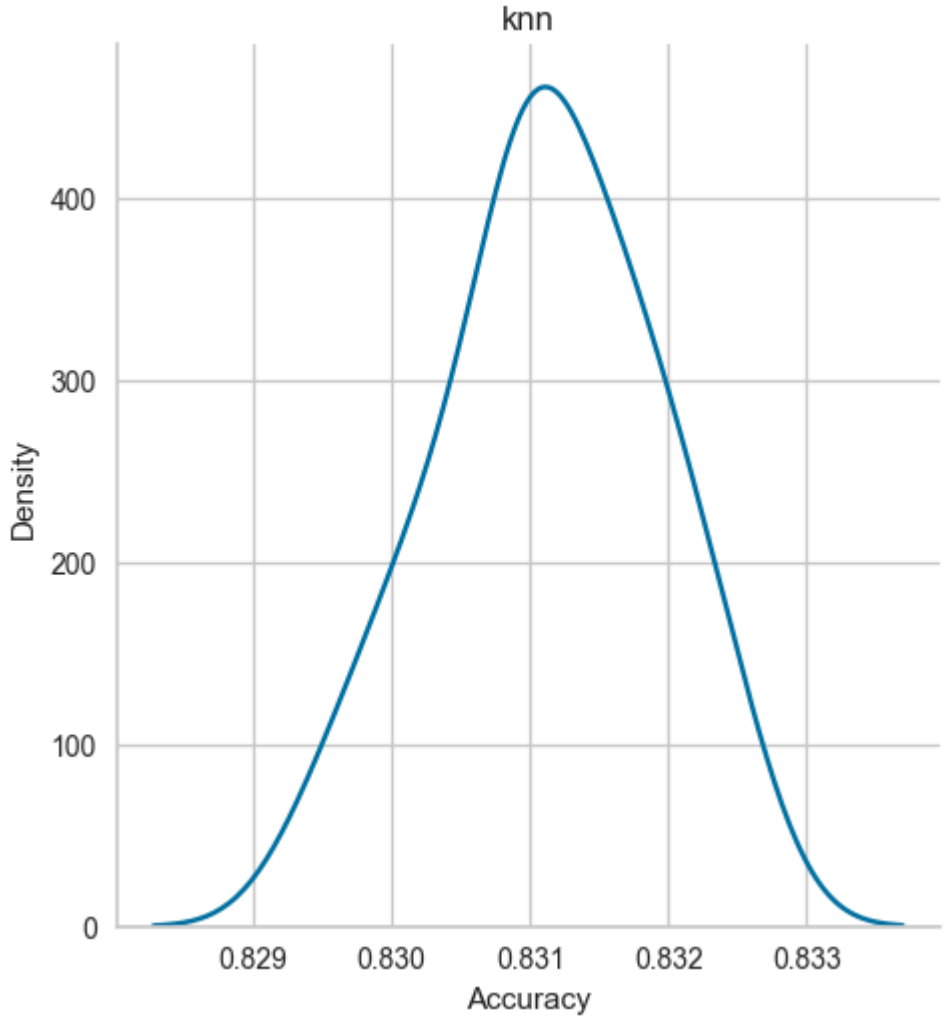
```
ShapiroResult(statistic=np.float64(0.9428308320517239), pvalue=np.float64(0.10842
600092552829))
ShapiroResult(statistic=np.float64(0.958842646295605), pvalue=np.float64(0.289287
84404866514))
ShapiroResult(statistic=np.float64(0.9817636637271815), pvalue=np.float64(0.87026
08042442374))
ShapiroResult(statistic=np.float64(0.9693575036013388), pvalue=np.float64(0.52174
74528397927))
ShapiroResult(statistic=np.float64(0.9784638643703881), pvalue=np.float64(0.78340
09057822708))
ShapiroResult(statistic=np.float64(0.9427677444389647), pvalue=np.float64(0.10800
219793792448))
ShapiroResult(statistic=np.float64(0.9704187344533626), pvalue=np.float64(0.55069
58651692518))
```

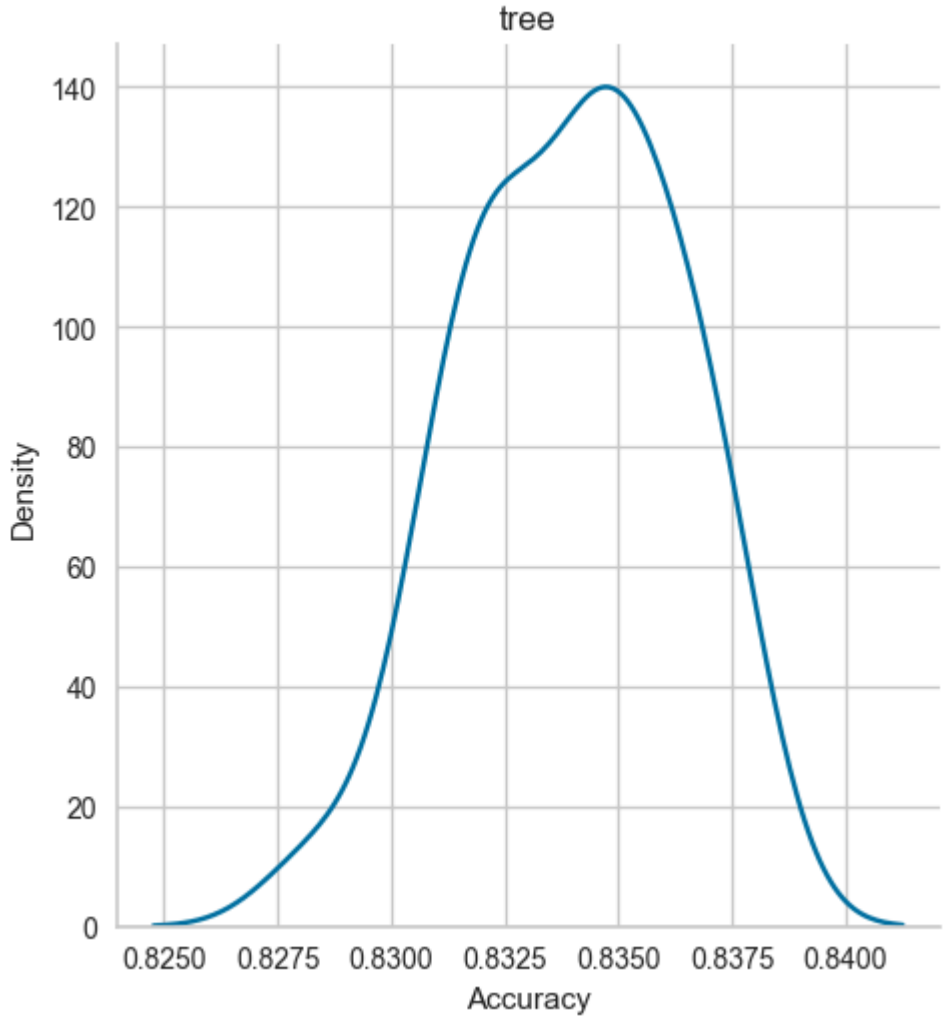
normality

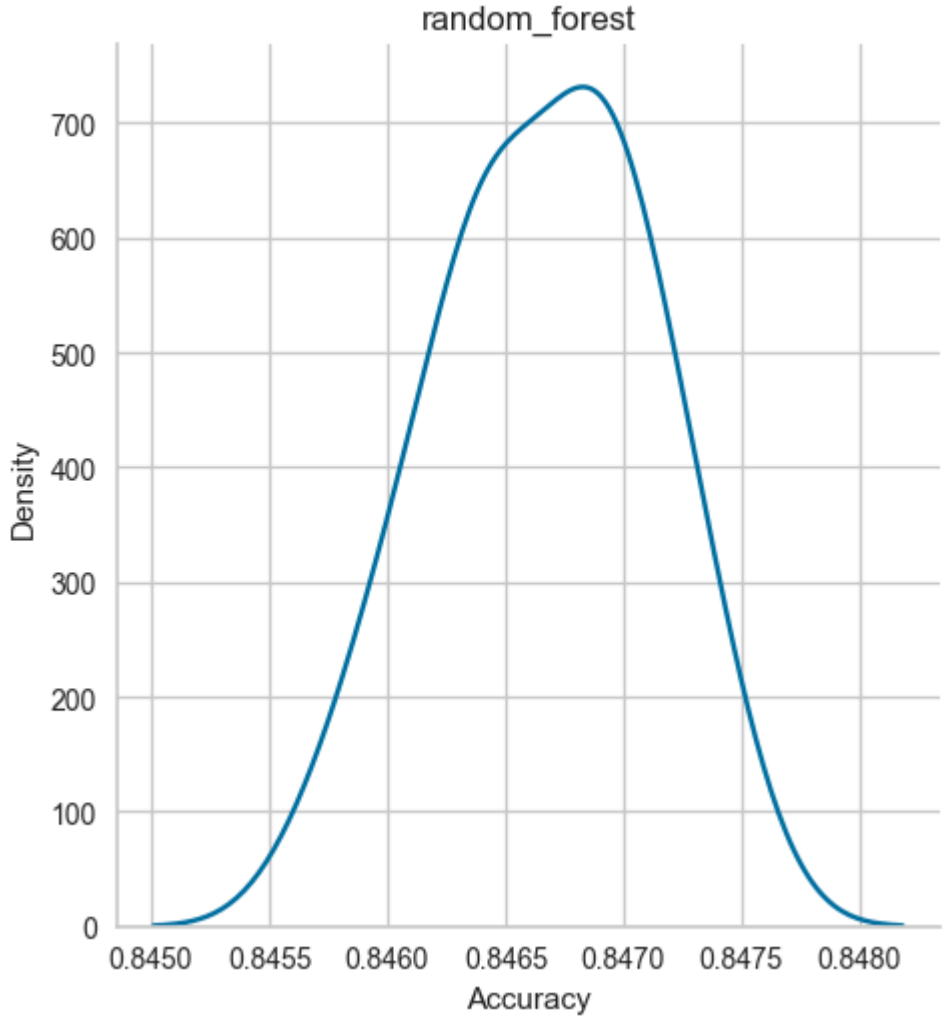
In [59]:
```
for i,col in enumerate(df_resultados.columns):
    sns.displot(df_resultados[col].values, kind = 'kde')
    plt.xlabel('Accuracy')
    plt.title(col)
```

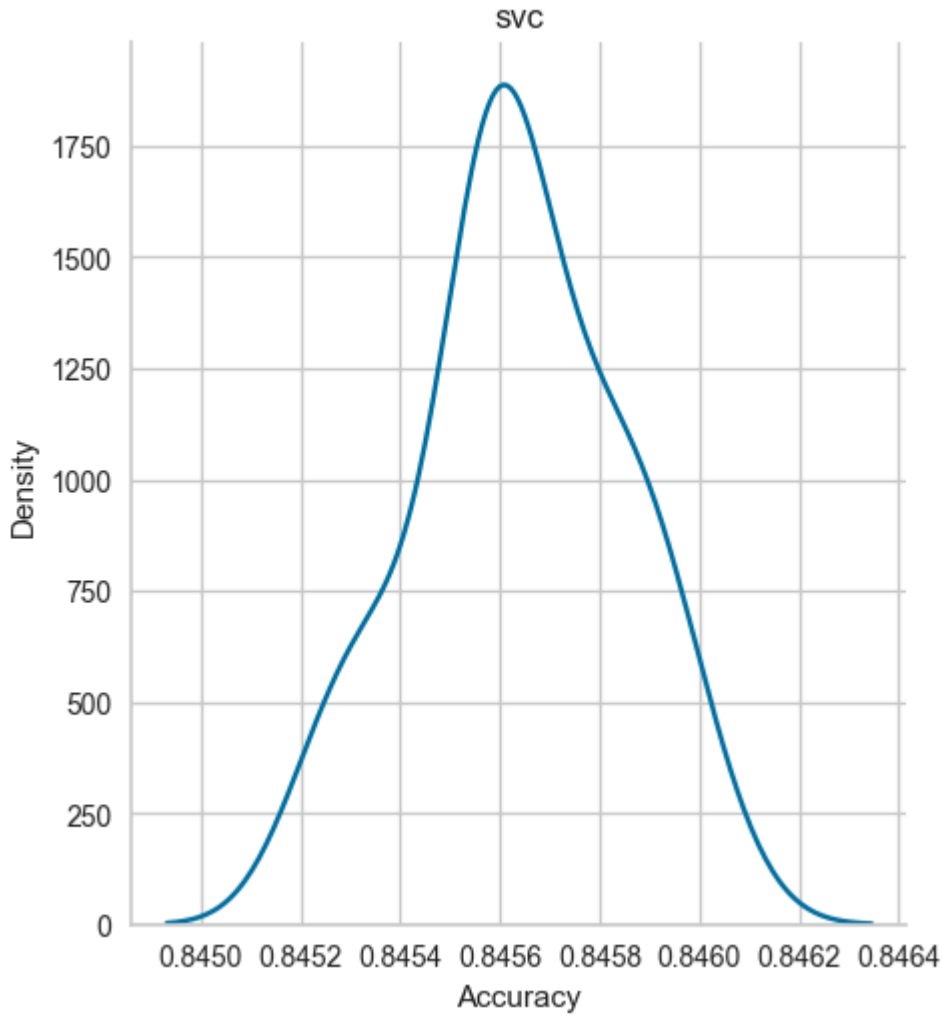


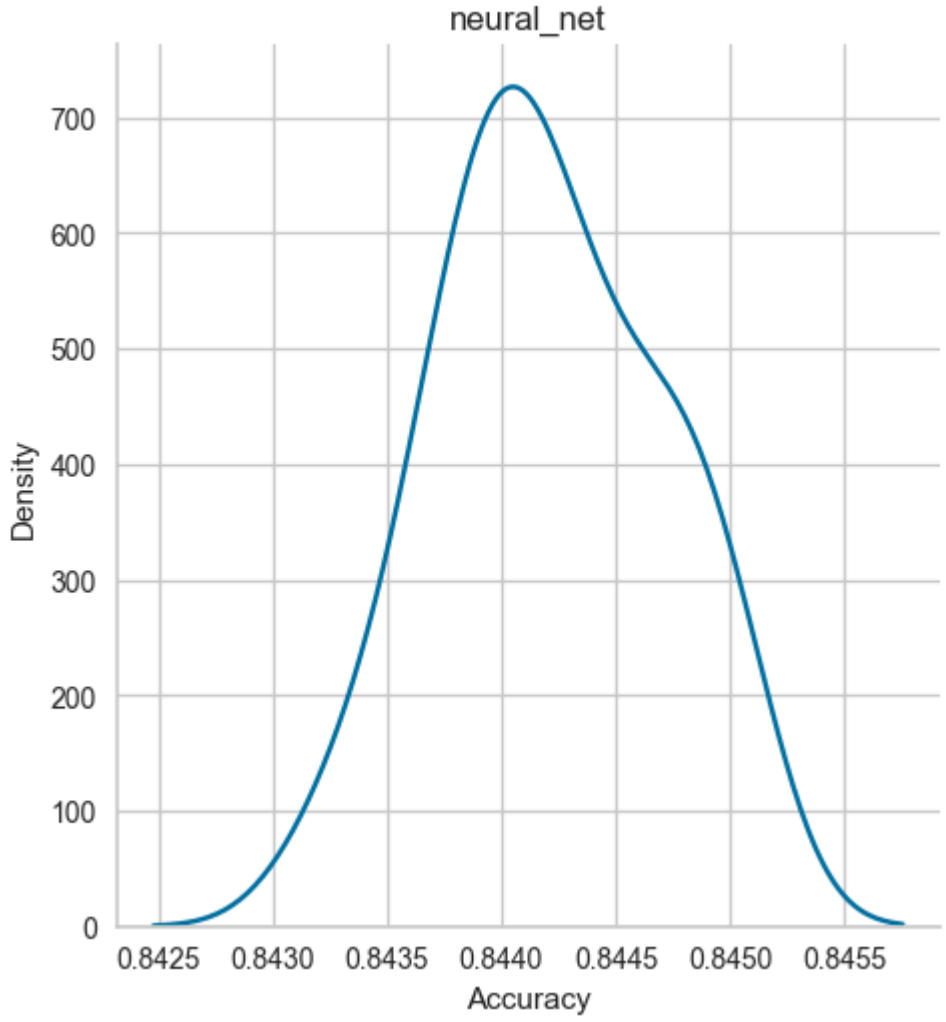

linear
Density
400
300
200
100
0
0.786
0.787
0.788
0.789
0.790
0.791
0.792
Accuracy


knn
Density
400
300
200
100
0
0.829
0.830
0.831
0.832
0.833
Accuracy


tree
Density
140
120
100
80
60
40
20
0
0.8250
0.8275
0.8300
0.8325
0.8350
0.8375
0.8400
Accuracy


random_forest
Density
0
100
200
300
400
500
600
700
0.8450
0.8455
0.8460
0.8465
0.8470
0.8475
0.8480
Accuracy


svc
1750
1500
1250
1000
750
500
250
0
Density
0.8450
0.8452
0.8454
0.8456
0.8458
0.8460
0.8462
0.8464
Accuracy



anova one_way

In [80]:
```
_, p = f_oneway(tree_results,random_forest_results,knn_results,linear_result,svm
p
```

Out[80]: np.float64(5.090282508519619e-295)

In [81]:
```
if p <= 0.05:
  print('Data are differents')
else:
  print('The results are equals')
```

```
Data are differents
```

turkey

In [86]:
```
df_result_melt = pd.melt(df_resultados,var_name='model',value_name='accuracy')
```

In [89]:
```
model_compare = MultiComparison(df_result_melt['accuracy'], df_result_melt['mode
```

In [90]:
```
statistic_test = model_compare.tukeyhsd()
print(statistic_test)
```

Multiple Comparison of Means - Tukey HSD, FWER=0.05

group1	group2	meandiff	p-adj	lower	upper	reject
bayes	knn	0.0644	0.0	0.0636	0.0651	True
bayes	linear	0.022	0.0	0.0212	0.0227	True
bayes	neural_net	0.0774	0.0	0.0767	0.0782	True
bayes	random_forest	0.0799	0.0	0.0791	0.0807	True
bayes	svc	0.0789	0.0	0.0781	0.0797	True
bayes	tree	0.0672	0.0	0.0664	0.068	True
knn	linear	-0.0424	0.0	-0.0432	-0.0416	True
knn	neural_net	0.0131	0.0	0.0123	0.0139	True
knn	random_forest	0.0155	0.0	0.0148	0.0163	True
knn	svc	0.0145	0.0	0.0137	0.0153	True
knn	tree	0.0028	0.0	0.002	0.0036	True
linear	neural_net	0.0555	0.0	0.0547	0.0563	True
linear	random_forest	0.0579	0.0	0.0572	0.0587	True
linear	svc	0.0569	0.0	0.0561	0.0577	True
linear	tree	0.0452	0.0	0.0444	0.046	True
neural_net	random_forest	0.0024	0.0	0.0017	0.0032	True
neural_net	svc	0.0014	0.0	0.0006	0.0022	True
neural_net	tree	-0.0103	0.0	-0.0111	-0.0095	True
random_forest	svc	-0.001	0.0026	-0.0018	-0.0002	True
random_forest	tree	-0.0127	0.0	-0.0135	-0.0119	True
svc	tree	-0.0117	0.0	-0.0125	-0.0109	True