Desafio_v1.0

July 26, 2019

1 Data: Bank Marketing

1.1 O seguinte desafio pretende resolver uma série de perguntas associadas à base de dados que pode ser encontrada nos sites:

1.2 Fonte oficial do dataset : https://archive.ics.uci.edu/ml/datasets/bank+marketing

1.3 Dados: https://archive.ics.uci.edu/ml/machine-learning-databases/00222/bank.zip

Arquivos incluídos no link acima:

1. bank. csv: uma versão reduzida do conjunto de dados;
2. bank-full.csv: o conjunto completo;
3. bank-names.txt: com a descrição

As bases de dados encontran-se associadas aos artigos :

1. S. Moro, P. Cortez and P. Rita. A Data-Driven Approach to Predict the Success of Bank Telemarketing. Decision Support Systems, Elsevier, 62:22-31, June 2014

2. S. Moro, R. Laureano and P. Cortez. Using Data Mining for Bank Direct Marketing: An Application of the CRISP-DM Methodology. In P. Novais et al. (Eds.), Proceedings of the European Simulation and Modelling Conference - ESM'2011, pp. 117-121, Guimaraes, Portugal, October, 2011. EUROSIS.

Os métodos de análise de sensibilidade e random forrest usados em > 1. podem ser vistos em:

3. Paulo Cortez, Mark J. Embrechts, Using sensitivity analysis and visualization techniques to open black box data mining models, Information Sciences 225 (2013) 1–17.

1.4 Inicialmente é realizada uma análise preliminar dos dados, empregando histogramas.

1.5 As graficas são elaboradas usando as librarias e dados a seguir:

```
In [110]: import pandas as pd
          import matplotlib.pyplot as plt
          import numpy as np
          ### arquivo csv
```

```python
col_df = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/bank-full.csv',sep
print("Conjunto de dados a serem usados na análise:")
print(col_df)
plt.close("all")
```

```
Conjunto de dados a serem usados na análise:
       age           job   marital  education default  balance housing loan  \
0       58    management   married   tertiary      no     2143     yes   no
1       44    technician    single  secondary      no       29     yes   no
2       33  entrepreneur   married  secondary      no        2     yes  yes
3       47   blue-collar   married    unknown      no     1506     yes   no
4       33       unknown    single    unknown      no        1      no   no
5       35    management   married   tertiary      no      231     yes   no
6       28    management    single   tertiary      no      447     yes  yes
7       42  entrepreneur  divorced   tertiary     yes        2     yes   no
8       58       retired   married    primary      no      121     yes   no
9       43    technician    single  secondary      no      593     yes   no
10      41        admin.  divorced  secondary      no      270     yes   no
11      29        admin.    single  secondary      no      390     yes   no
12      53    technician   married  secondary      no        6     yes   no
13      58    technician   married    unknown      no       71     yes   no
14      57      services   married  secondary      no      162     yes   no
15      51       retired   married    primary      no      229     yes   no
16      45        admin.    single    unknown      no       13     yes   no
17      57   blue-collar   married    primary      no       52     yes   no
18      60       retired   married    primary      no       60     yes   no
19      33      services   married  secondary      no        0     yes   no
20      28   blue-collar   married  secondary      no      723     yes  yes
21      56    management   married   tertiary      no      779     yes   no
22      32   blue-collar    single    primary      no       23     yes  yes
23      25      services   married  secondary      no       50     yes   no
24      40       retired   married    primary      no        0     yes  yes
25      44        admin.   married  secondary      no     -372     yes   no
26      39    management    single   tertiary      no      255     yes   no
27      52  entrepreneur   married  secondary      no      113     yes  yes
28      46    management    single  secondary      no     -246     yes   no
29      36    technician    single  secondary      no      265     yes  yes
...    ...           ...       ...        ...     ...      ...     ...  ...
45181   46   blue-collar   married  secondary      no     6879      no   no
45182   34    technician   married  secondary      no      133      no   no
45183   70       retired   married    primary      no      324      no   no
45184   63       retired   married  secondary      no     1495      no   no
45185   60      services   married   tertiary      no     4256     yes   no
45186   59       unknown   married    unknown      no     1500      no   no
45187   32      services    single  secondary      no     1168     yes   no
45188   29    management    single  secondary      no      703     yes   no
45189   25      services    single  secondary      no      199      no   no
45190   32   blue-collar   married  secondary      no      136      no   no
```

45191	75	retired	divorced	tertiary	no	3810	yes	no
45192	29	management	single	tertiary	no	765	no	no
45193	28	self-employed	single	tertiary	no	159	no	no
45194	59	management	married	tertiary	no	138	yes	yes
45195	68	retired	married	secondary	no	1146	no	no
45196	25	student	single	secondary	no	358	no	no
45197	36	management	single	secondary	no	1511	yes	no
45198	37	management	married	tertiary	no	1428	no	no
45199	34	blue-collar	single	secondary	no	1475	yes	no
45200	38	technician	married	secondary	no	557	yes	no
45201	53	management	married	tertiary	no	583	no	no
45202	34	admin.	single	secondary	no	557	no	no
45203	23	student	single	tertiary	no	113	no	no
45204	73	retired	married	secondary	no	2850	no	no
45205	25	technician	single	secondary	no	505	no	yes
45206	51	technician	married	tertiary	no	825	no	no
45207	71	retired	divorced	primary	no	1729	no	no
45208	72	retired	married	secondary	no	5715	no	no
45209	57	blue-collar	married	secondary	no	668	no	no
45210	37	entrepreneur	married	secondary	no	2971	no	no

	contact	day	month	duration	campaign	pdays	previous	poutcome	y
0	unknown	5	may	261	1	-1	0	unknown	no
1	unknown	5	may	151	1	-1	0	unknown	no
2	unknown	5	may	76	1	-1	0	unknown	no
3	unknown	5	may	92	1	-1	0	unknown	no
4	unknown	5	may	198	1	-1	0	unknown	no
5	unknown	5	may	139	1	-1	0	unknown	no
6	unknown	5	may	217	1	-1	0	unknown	no
7	unknown	5	may	380	1	-1	0	unknown	no
8	unknown	5	may	50	1	-1	0	unknown	no
9	unknown	5	may	55	1	-1	0	unknown	no
10	unknown	5	may	222	1	-1	0	unknown	no
11	unknown	5	may	137	1	-1	0	unknown	no
12	unknown	5	may	517	1	-1	0	unknown	no
13	unknown	5	may	71	1	-1	0	unknown	no
14	unknown	5	may	174	1	-1	0	unknown	no
15	unknown	5	may	353	1	-1	0	unknown	no
16	unknown	5	may	98	1	-1	0	unknown	no
17	unknown	5	may	38	1	-1	0	unknown	no
18	unknown	5	may	219	1	-1	0	unknown	no
19	unknown	5	may	54	1	-1	0	unknown	no
20	unknown	5	may	262	1	-1	0	unknown	no
21	unknown	5	may	164	1	-1	0	unknown	no
22	unknown	5	may	160	1	-1	0	unknown	no
23	unknown	5	may	342	1	-1	0	unknown	no
24	unknown	5	may	181	1	-1	0	unknown	no
25	unknown	5	may	172	1	-1	0	unknown	no

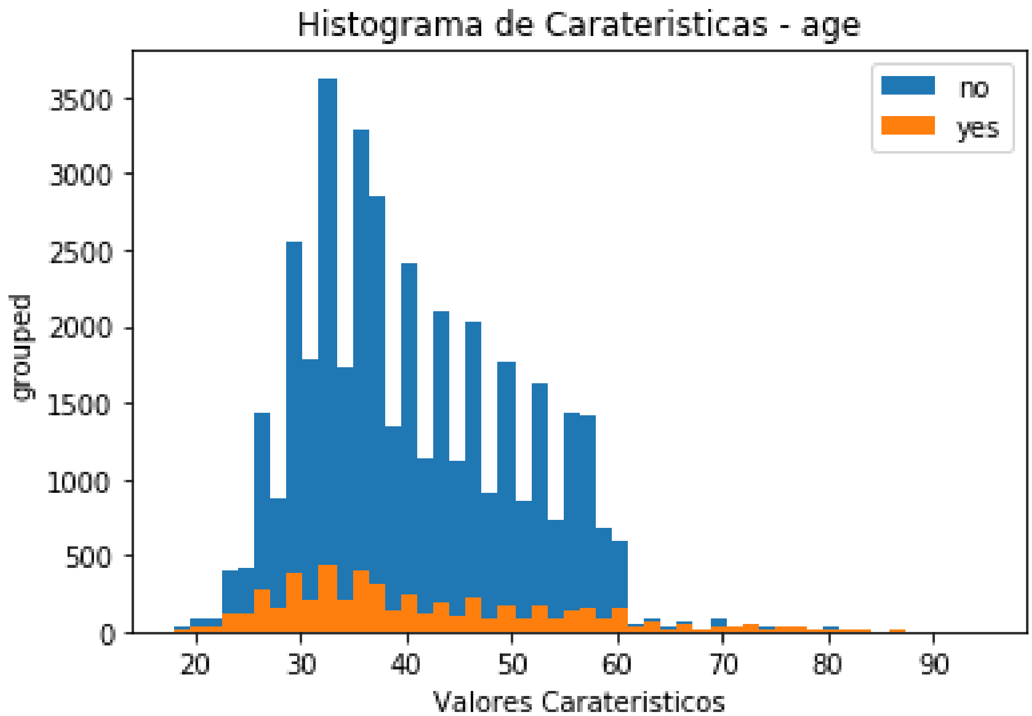
```
26       unknown   5  may       296         1     -1         0  unknown   no
27       unknown   5  may       127         1     -1         0  unknown   no
28       unknown   5  may       255         2     -1         0  unknown   no
29       unknown   5  may       348         1     -1         0  unknown   no
...          ...  ...  ...      ...       ...    ...       ...      ...  ...
45181  cellular  15  nov        74         2    118         3  failure   no
45182  cellular  15  nov       401         2    187         5  success  yes
45183  cellular  15  nov        78         1     96         7  success   no
45184  cellular  16  nov       138         1     22         5  success   no
45185  cellular  16  nov       200         1     92         4  success  yes
45186  cellular  16  nov       280         1    104         2  failure   no
45187  cellular  16  nov       411         1     -1         0  unknown  yes
45188  cellular  16  nov       236         1    550         2  success  yes
45189  cellular  16  nov       173         1     92         5  failure   no
45190  cellular  16  nov       206         1    188         3  success  yes
45191  cellular  16  nov       262         1    183         1  failure  yes
45192  cellular  16  nov       238         1     -1         0  unknown  yes
45193  cellular  16  nov       449         2     33         4  success  yes
45194  cellular  16  nov       162         2    187         5  failure   no
45195  cellular  16  nov       212         1    187         6  success  yes
45196  cellular  16  nov       330         1     -1         0  unknown  yes
45197  cellular  16  nov       270         1     -1         0  unknown  yes
45198  cellular  16  nov       333         2     -1         0  unknown   no
45199  cellular  16  nov      1166         3    530        12    other   no
45200  cellular  16  nov      1556         4     -1         0  unknown  yes
45201  cellular  17  nov       226         1    184         4  success  yes
45202  cellular  17  nov       224         1     -1         0  unknown  yes
45203  cellular  17  nov       266         1     -1         0  unknown  yes
45204  cellular  17  nov       300         1     40         8  failure  yes
45205  cellular  17  nov       386         2     -1         0  unknown  yes
45206  cellular  17  nov       977         3     -1         0  unknown  yes
45207  cellular  17  nov       456         2     -1         0  unknown  yes
45208  cellular  17  nov      1127         5    184         3  success  yes
45209 telephone  17  nov       508         4     -1         0  unknown   no
45210  cellular  17  nov       361         2    188        11    other   no

[45211 rows x 17 columns]
```

2 construção das classes para os histogramas

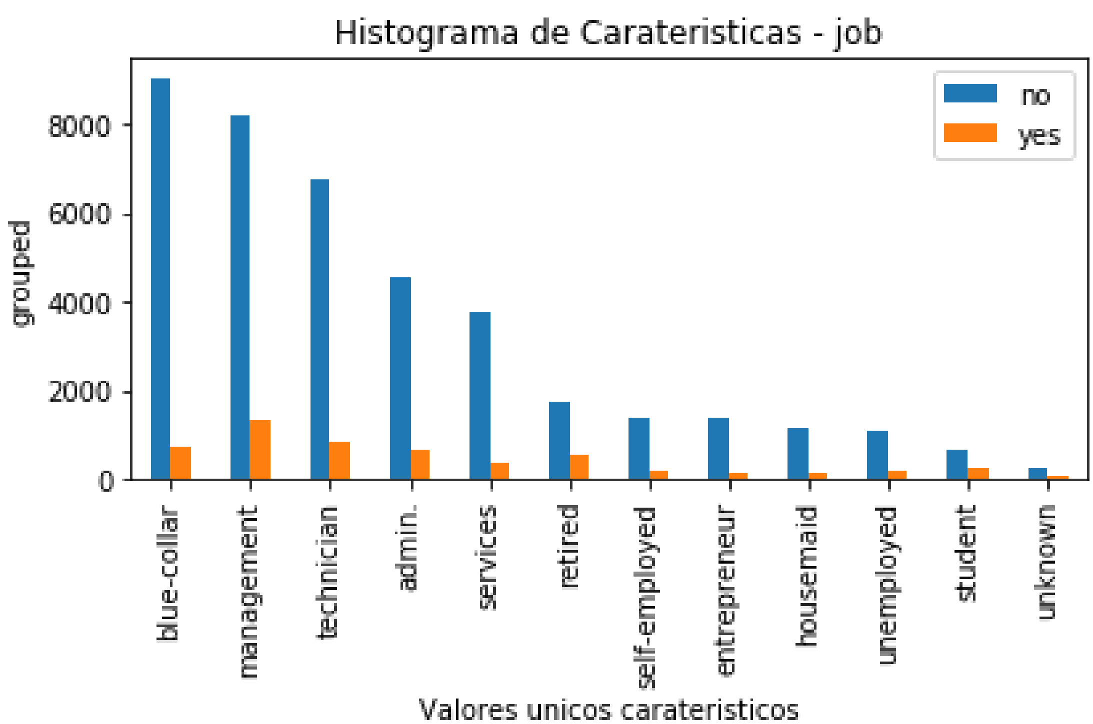
In [111]:
```python
class Dados_iniciais:

    def __init__(self, col_df):
        self.col_df = col_df
        self.col_df_grouped = col_df.groupby("y")
        self.nome_classe_nao = "no"
```

```
        self.nome_classe_sim = "yes"
        self.col_df_grouped_nao = self.col_df_grouped.get_group(self.nome_classe_nao)
        self.col_df_grouped_sim = self.col_df_grouped.get_group(self.nome_classe_sim)

    def plot_histograma_continuo(self, nome_carateristica, bin_tamanho):
        plt.figure()
        plt.hist(self.col_df_grouped_nao[nome_carateristica], bins=bin_tamanho, label
        plt.hist(self.col_df_grouped_sim[nome_carateristica], bins=bin_tamanho, label
        plt.legend()
        plt.title("Histograma de Carateristicas - "+nome_carateristica)
        plt.xlabel("Valores Carateristicos")
        plt.ylabel("grouped")

    def plot_histogram_categorical(self, nome_carateristica):
        carateristica_df = pd.DataFrame()
        carateristica_df["no"] = self.col_df_grouped_nao[nome_carateristica].value_co
        carateristica_df["yes"] = self.col_df_grouped_sim[nome_carateristica].value_c

        carateristica_df.plot(kind='bar')
        plt.title("Histograma de Carateristicas - "+nome_carateristica)
        plt.ylabel("grouped")
        plt.xlabel("Valores unicos carateristicos")
        plt.tight_layout()
# uso da classe dados iniciais
Dados_iniciais_obj = Dados_iniciais(col_df)
```

In [112]:
```
# 1 age

Dados_iniciais_obj.plot_histograma_continuo("age", 50)
```

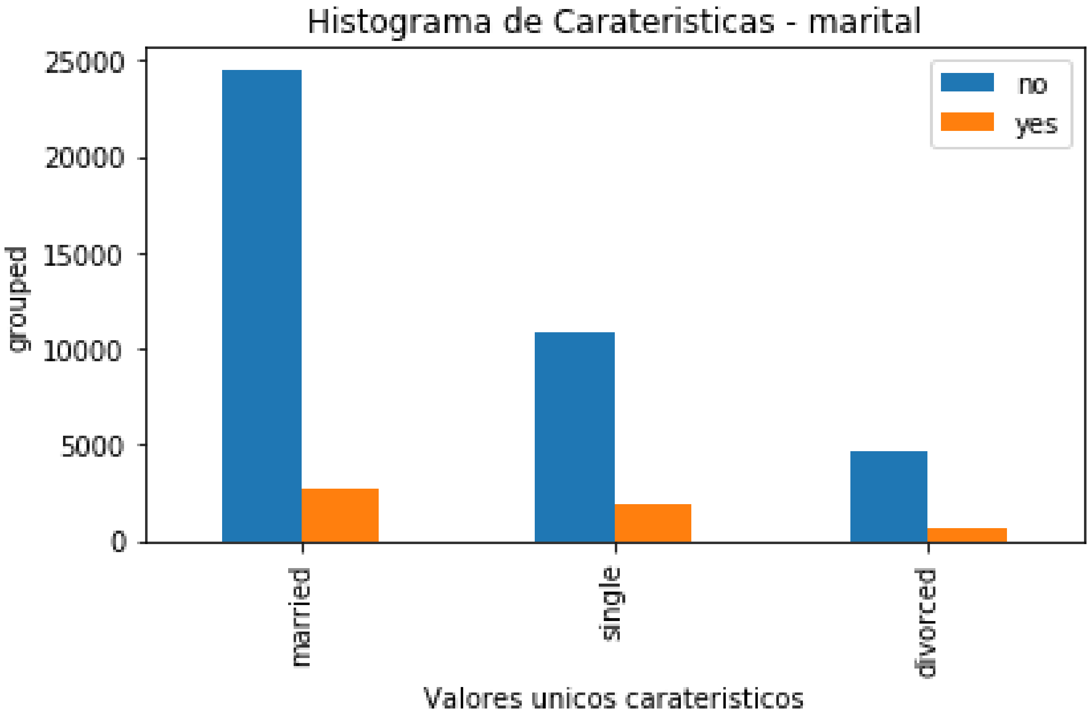



```
In [113]: # 2 job

          Dados_iniciais_obj.plot_histogram_categorical("job")
```



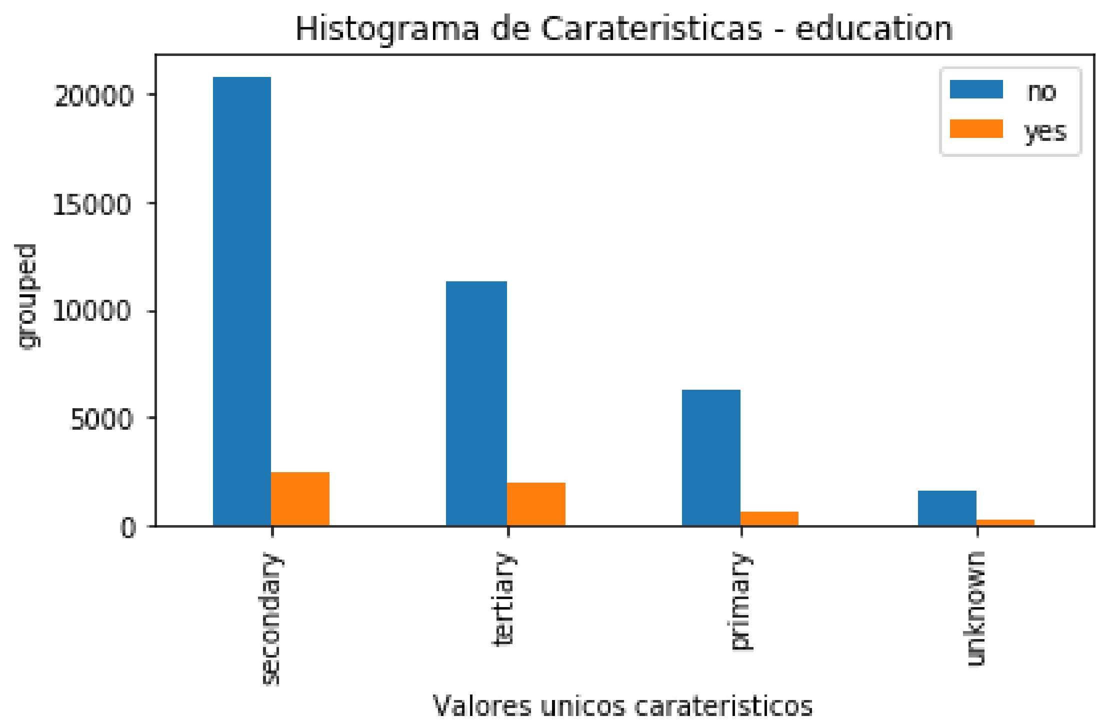
In [114]: # 3 marital

```
Dados_iniciais_obj.plot_histogram_categorical("marital")
```

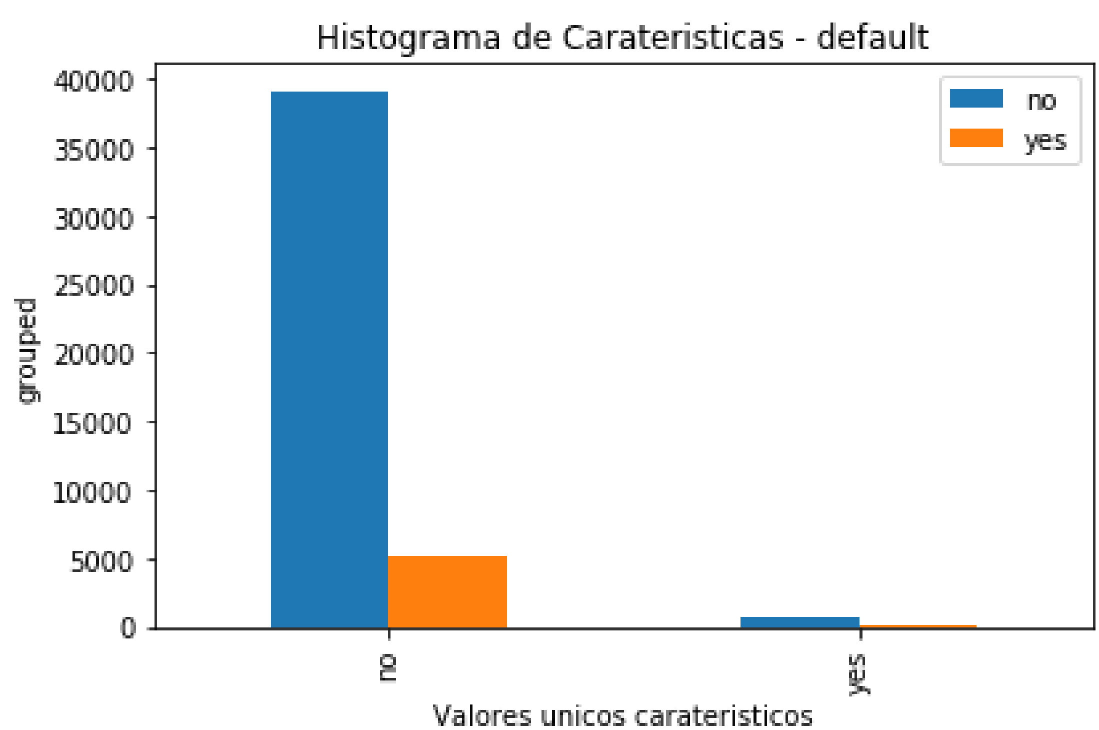


In [115]: # 4 education

```
Dados_iniciais_obj.plot_histogram_categorical("education")
```

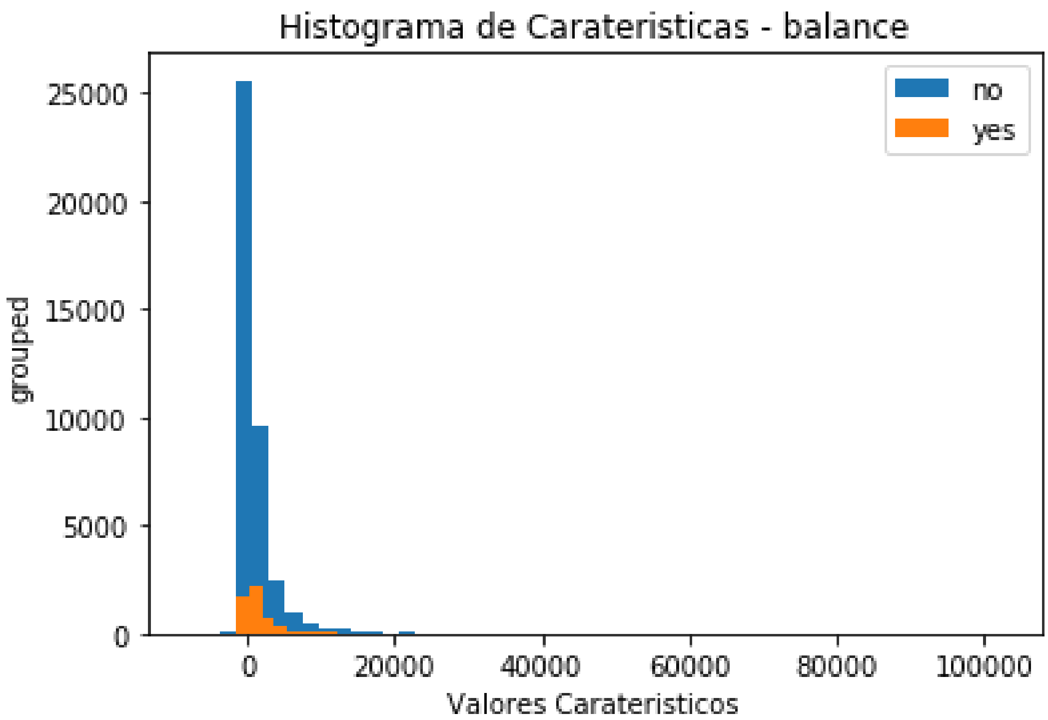



```
In [116]: # 5 default

          Dados_iniciais_obj.plot_histogram_categorical("default")
```



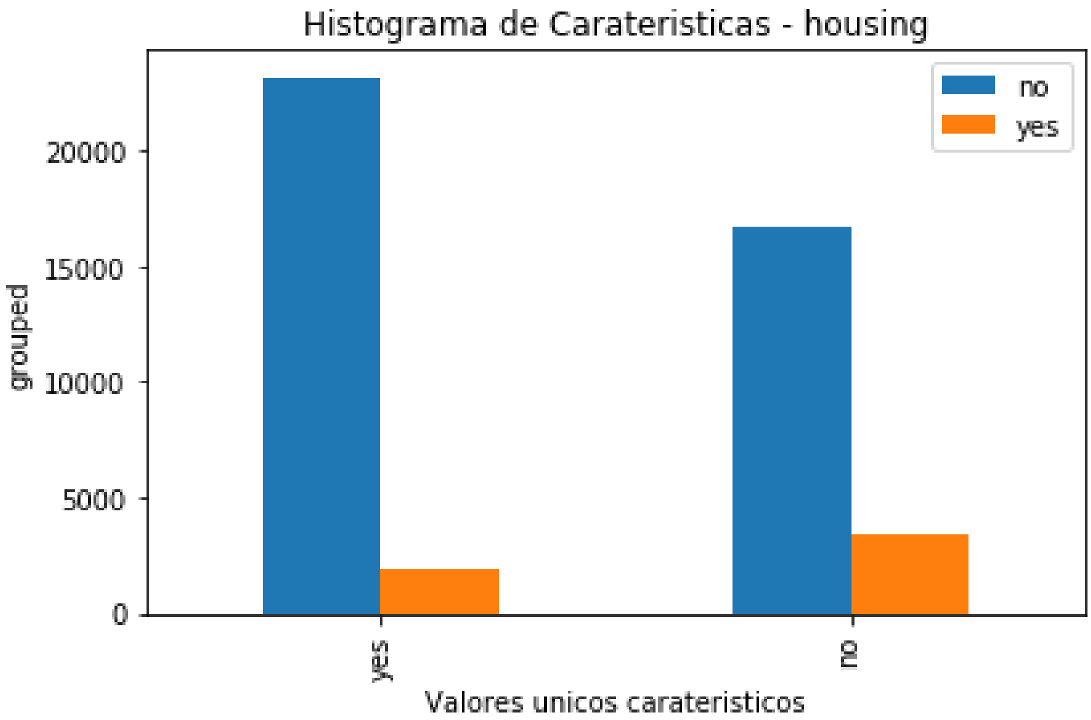
In [117]: # 6 balance

```
Dados_iniciais_obj.plot_histograma_continuo("balance", 50)
```

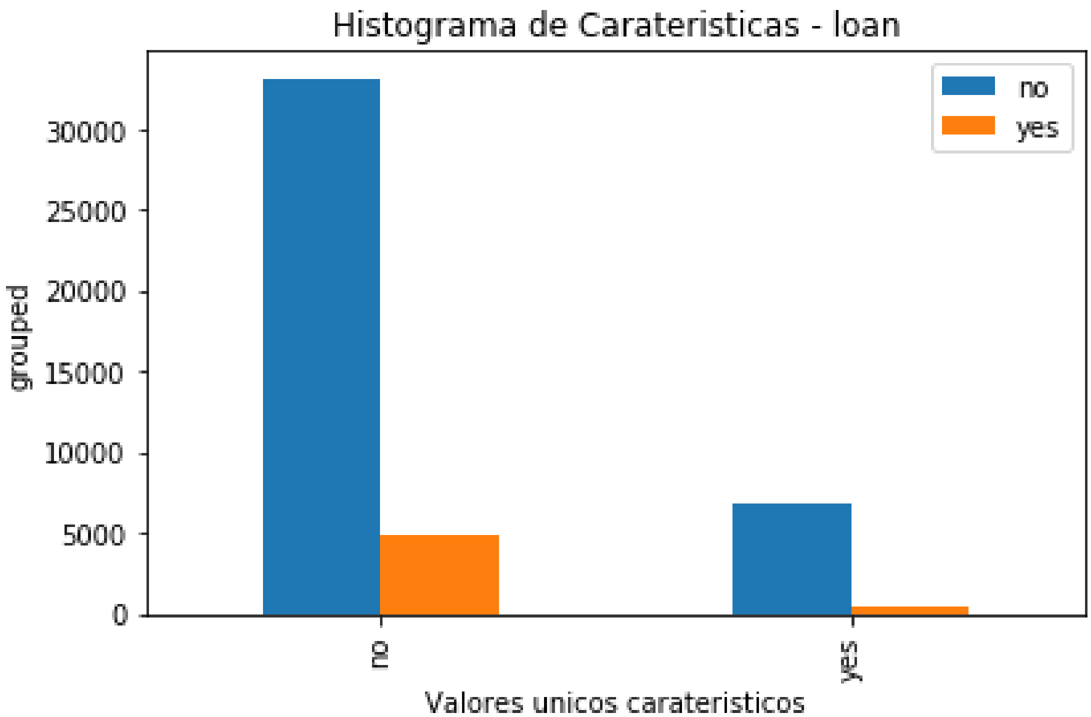


In [118]: # 7 housing

```
Dados_iniciais_obj.plot_histogram_categorical("housing")
```

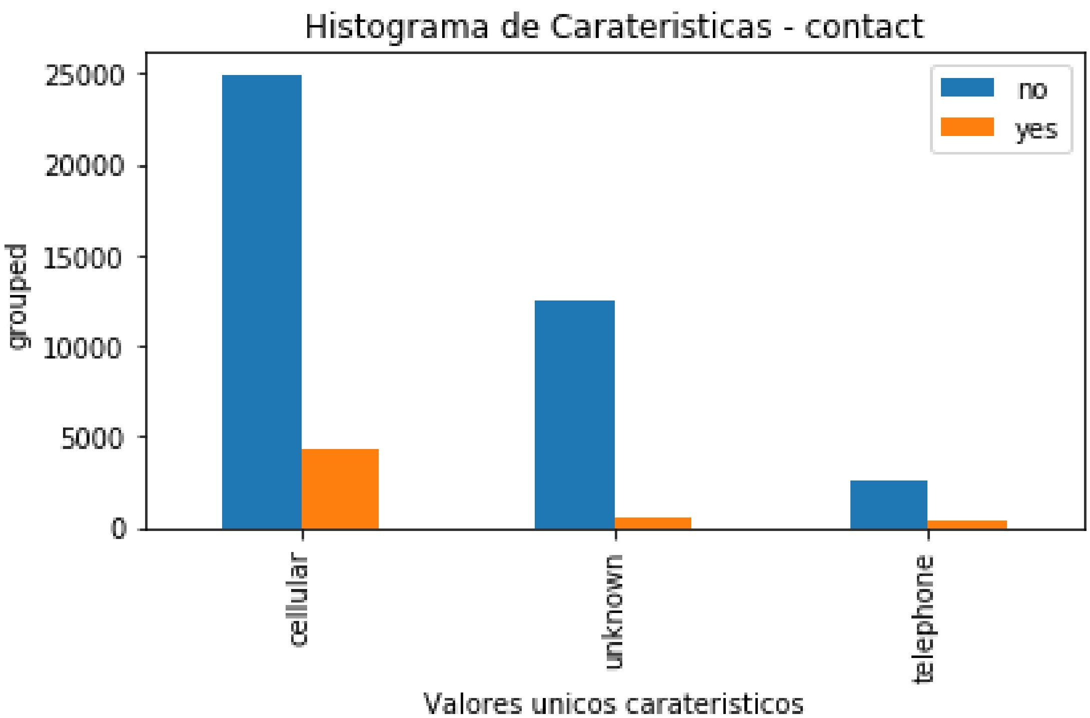



```
In [119]: # 8 loan

          Dados_iniciais_obj.plot_histogram_categorical("loan")
```



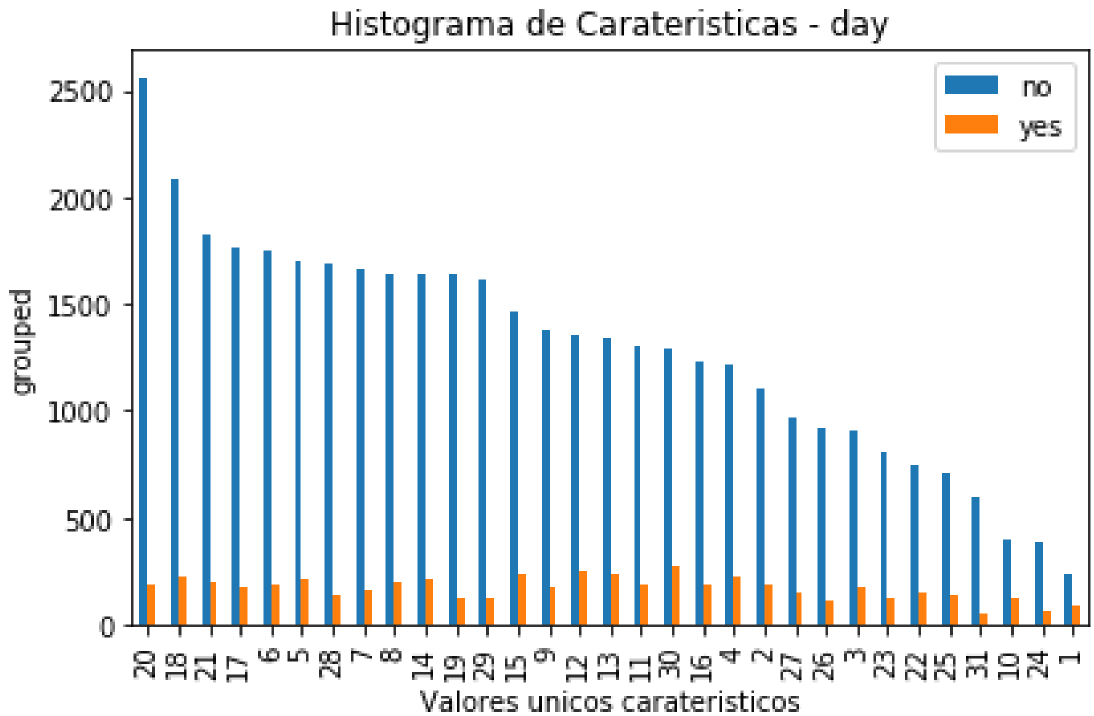
In [120]: # 9 contact

```
Dados_iniciais_obj.plot_histogram_categorical("contact")
```



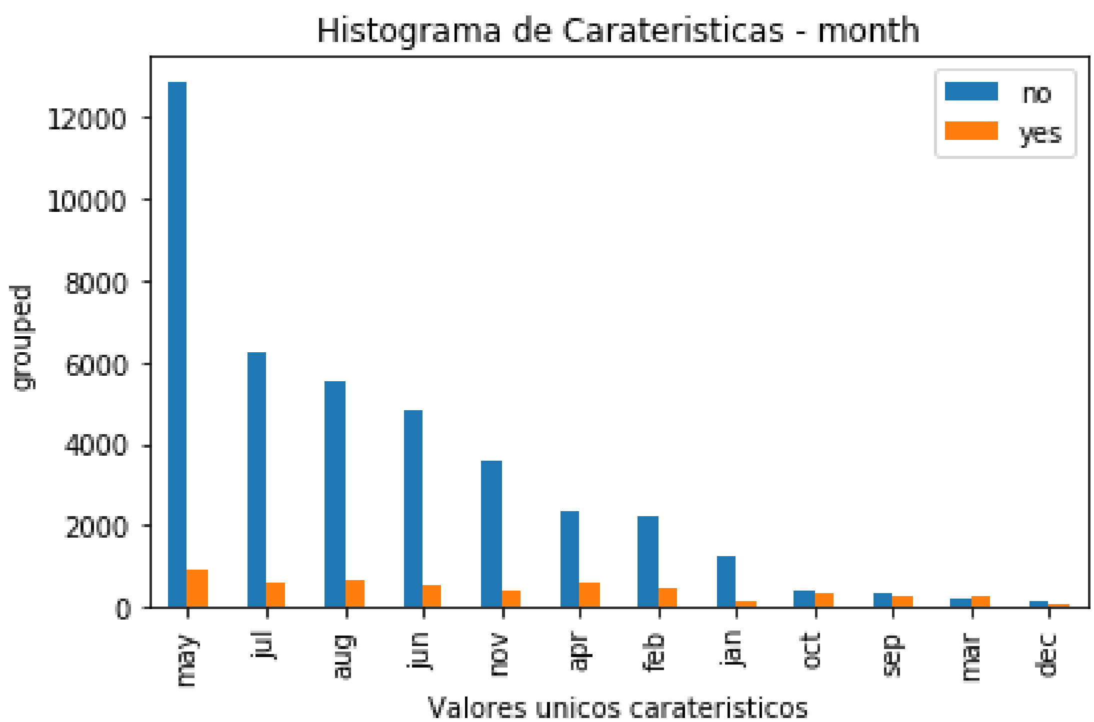
In [121]: # 10 day

```
Dados_iniciais_obj.plot_histogram_categorical("day")
```

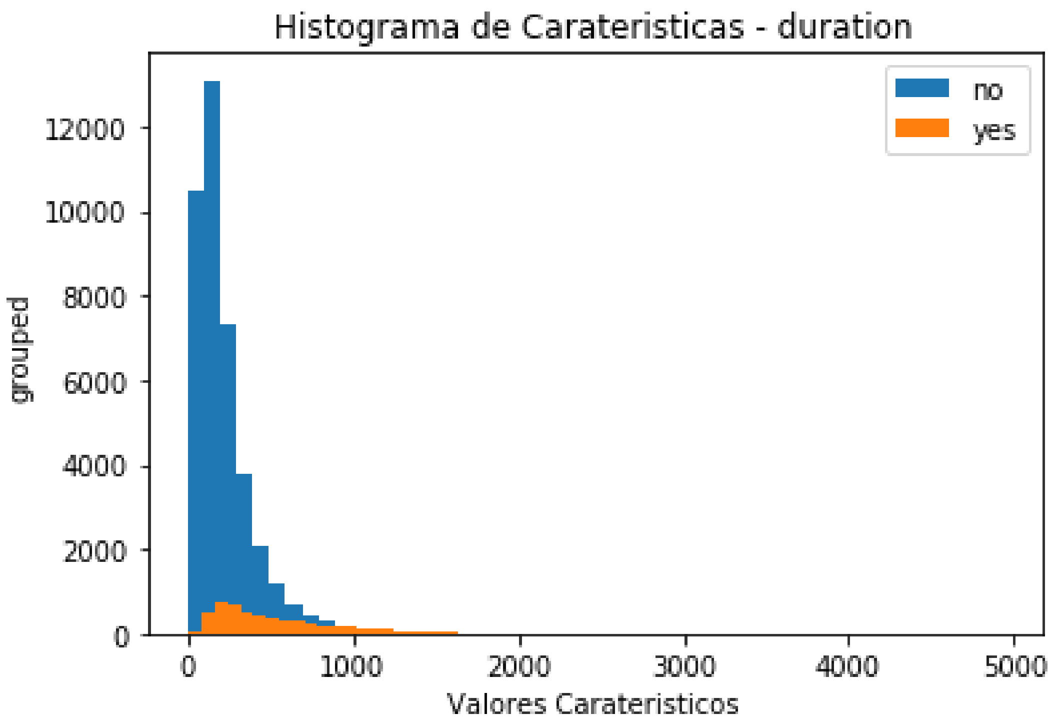


In [122]: # 11 month

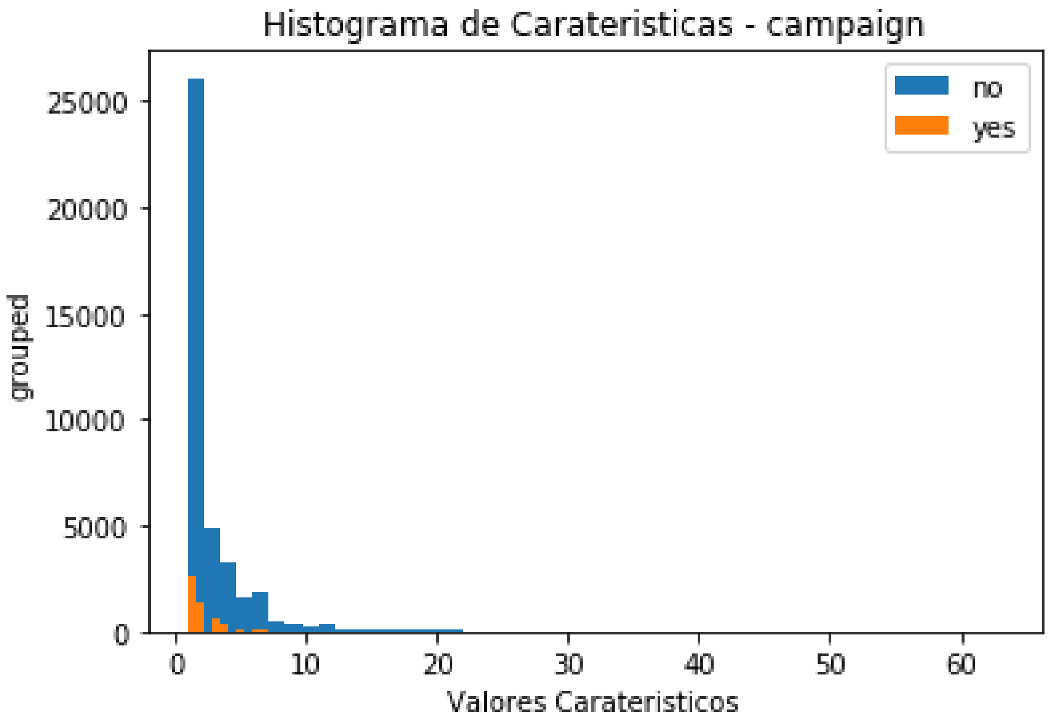
```
Dados_iniciais_obj.plot_histogram_categorical("month")
```



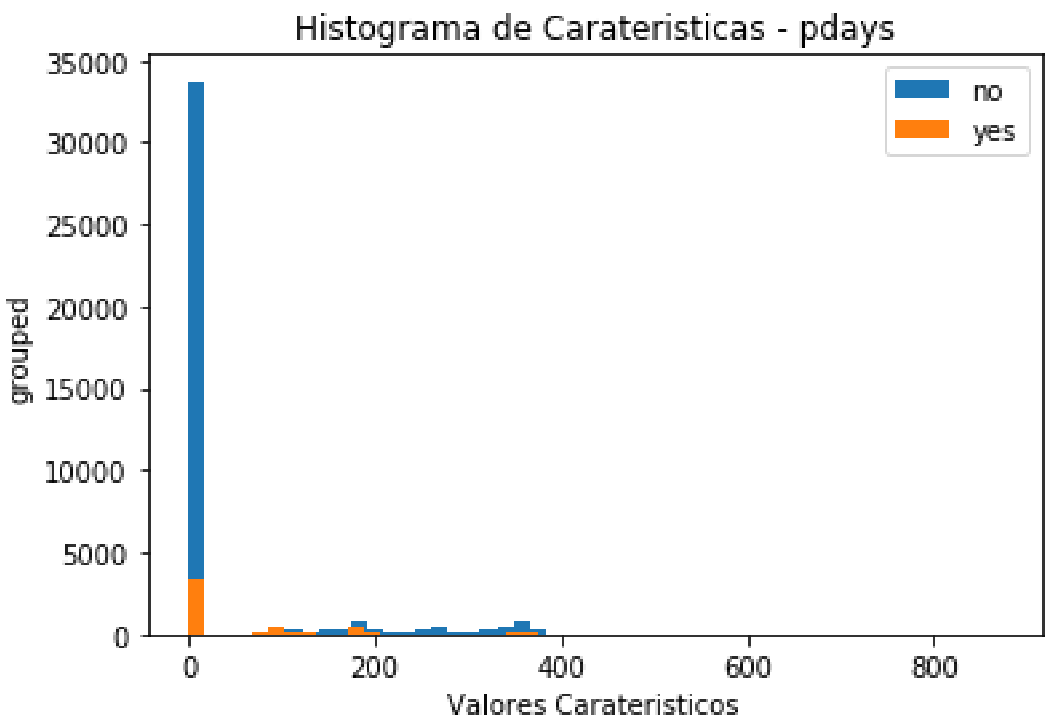
```
In [123]: # 12 duration

          Dados_iniciais_obj.plot_histograma_continuo("duration",50)
```




```
In [124]: # 13 campaign

          Dados_iniciais_obj.plot_histograma_continuo("campaign", 50)
```

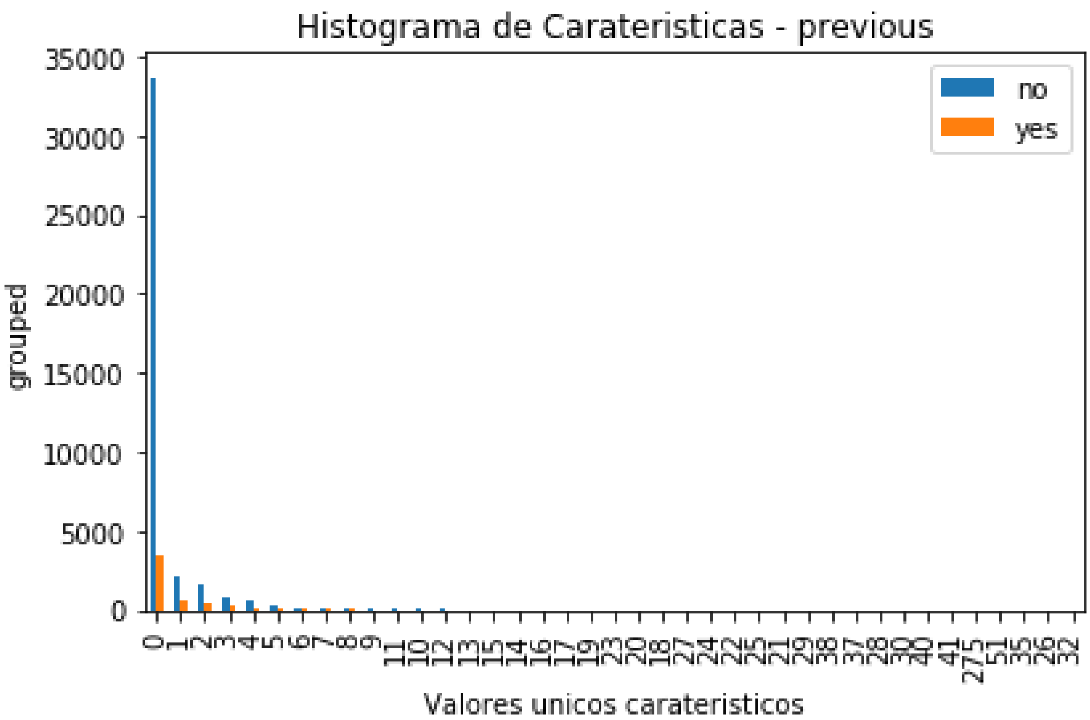



```
In [125]: # 14 pdays
          Dados_iniciais_obj.plot_histograma_continuo("pdays", 50)
```



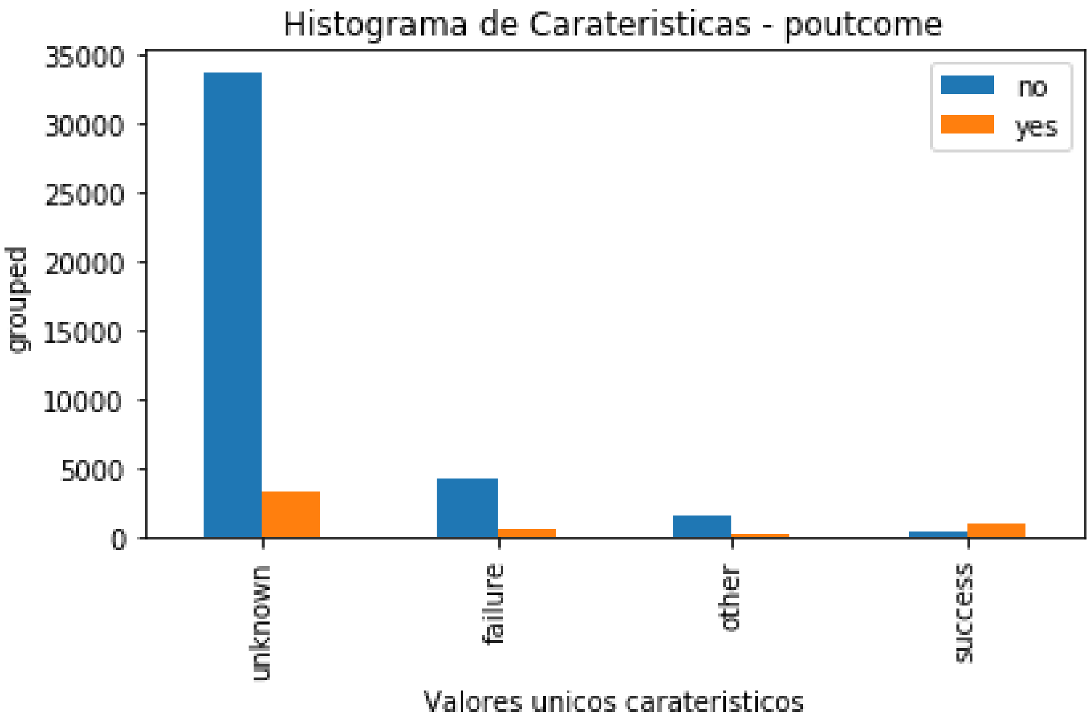
In [126]: # 15 previous

```
Dados_iniciais_obj.plot_histogram_categorical("previous")
```



In [127]: # 16 poutcome

```
Dados_iniciais_obj.plot_histogram_categorical("poutcome")
```




```
In [128]: import pandas as pd
          import numpy as np
          from sklearn.preprocessing import LabelEncoder
          from sklearn.preprocessing import OneHotEncoder
          from sklearn.preprocessing import StandardScaler
          from sklearn.preprocessing import MinMaxScaler
          from sklearn.svm import SVC

          print('Estadisticos:')
          descrip_stat=col_df.describe()
          print (descrip_stat)
```

```
Estadisticos:
                age        balance           day      duration      campaign  \
count  45211.000000   45211.000000  45211.000000  45211.000000  45211.000000
mean      40.936210    1362.272058     15.806419    258.163080      2.763841
std       10.618762    3044.765829      8.322476    257.527812      3.098021
min       18.000000   -8019.000000      1.000000      0.000000      1.000000
25%       33.000000      72.000000      8.000000    103.000000      1.000000
50%       39.000000     448.000000     16.000000    180.000000      2.000000
75%       48.000000    1428.000000     21.000000    319.000000      3.000000
max       95.000000  102127.000000     31.000000   4918.000000     63.000000

              pdays      previous
```

```
count  45211.000000  45211.000000
mean      40.197828      0.580323
std      100.128746      2.303441
min       -1.000000      0.000000
25%       -1.000000      0.000000
50%       -1.000000      0.000000
75%       -1.000000      0.000000
max      871.000000    275.000000
```

```
In [129]: print('Correlação  Canônica entre as variáveis de entrada:')
          descrip_corr=col_df.corr()
          print (descrip_corr)
```

```
Correlação  Canônica entre as variáveis de entrada:
               age   balance       day  duration  campaign     pdays  previous
age       1.000000  0.097783 -0.009120 -0.004648  0.004760 -0.023758  0.001288
balance   0.097783  1.000000  0.004503  0.021560 -0.014578  0.003435  0.016674
day      -0.009120  0.004503  1.000000 -0.030206  0.162490 -0.093044 -0.051710
duration -0.004648  0.021560 -0.030206  1.000000 -0.084570 -0.001565  0.001203
campaign  0.004760 -0.014578  0.162490 -0.084570  1.000000 -0.088628 -0.032855
pdays    -0.023758  0.003435 -0.093044 -0.001565 -0.088628  1.000000  0.454820
previous  0.001288  0.016674 -0.051710  0.001203 -0.032855  0.454820  1.000000
```

2.0.1 Como pode ser apreciado na tabela acima as maiores correlações encontram-se nas variáveis previous e pdays, seguidas de campaing e day. O qual deve ser levado em conta na análise dos dados.

2.1 os dados apesentados nos histogramas anteriores, podem ser tratados a fim de reduzir o erro devido viés e distribuição. Para isto a seguir apresenta-se a estandarização dos dados

2.2 a estandirização e o codigo de avaliação do modelo apresentada a seguir basea-se no relatorio apresentado em GitHub de ABINAYA MANIMARAN.

```
In [130]: # a estandarizacao

          def caracteristicas_preprocessadas(df_train, df_test, process_continuous):

              to_delete_features = []
              continuous_features = ['age', 'balance', 'duration', 'campaign', 'pdays', 'previo
              categorical_ordered_features = ['marital','default','education', 'housing', 'loan
              categorical_unordered_features = ['job']

              unknown_present_features = ['contact','poutcome','job','education']
              all_present_features = ['age', 'balance', 'duration', 'campaign', 'pdays', 'previ

              ### Delete Features
```

```
for feat in to_delete_features:
    print ("\n--------- deleting feature --------- ",feat)
    del df_train[feat]
    del df_test[feat]

### Normalization or Standardization of Continuous Features
if process_continuous == "Standardize":
    print ("\n--------- Standardizing Continuous Features (Mean=0, Standard Devia
    standardization = StandardScaler()
    standardization.fit(df_train[continuous_features])
    print ("Mean: ",standardization.mean_)
    print ("Variance: ",standardization.var_)
    df_train[continuous_features] = standardization.transform(df_train[continuous
    df_test[continuous_features] = standardization.transform(df_test[continuous_

elif process_continuous == "Normalize":
    print ("\n--------- Normalizing Continuous Features (Min=0, Max=1) ---------
    min_max_scaling = MinMaxScaler()
    min_max_scaling.fit(df_train[continuous_features])
    print (min_max_scaling.data_min_)
    print (min_max_scaling.data_max_)
    df_train[continuous_features] = min_max_scaling.transform(df_train[continuous
    df_test[continuous_features] = min_max_scaling.transform(df_test[continuous_


### Label Categorical Ordered Features -- Features used for Imputation (All Pres
label_dict = {'education':{'primary':0, 'secondary':1, 'tertiary':2},
              'housing':{'no':0,'yes':1},
              'loan':{'no':0,'yes':1},
              'contact':{'telephone':0,'cellular':1},
              'month':{'jan':1,'feb':2,'mar':3,'apr':4,'may':5,'jun':6,'jul':7,'a
              'default':{'no':0,'yes':1},
              'marital':{'single':0, 'married':1, 'divorced':2},
              'poutcome':{'other':0,'failure':1,'success':2}}

for feat in categorical_ordered_features:
    if feat not in unknown_present_features:
        print ("\n--------- Labelling feature Before Imputation --------- ",feat)
        df_train = df_train.replace({feat:label_dict[feat]})
        df_test = df_test.replace({feat:label_dict[feat]})
        print ("Labelled as: ",label_dict[feat])

### Imputation using SVM
df_train_impute = df_train.loc[:,df_train.columns.isin(all_present_features)]
df_test_impute = df_test.loc[:,df_test.columns.isin(all_present_features)]

for feat in unknown_present_features:
    print ("\nFilling Unkowns for Feature: ",feat)
```

```
    train_impute = df_train[feat]
    test_impute = df_test[feat]

    train_impute_no_unknowns = train_impute[train_impute != 'unknown']
    train_impute_unknowns = train_impute[train_impute == 'unknown']
    test_impute_unknowns = test_impute[test_impute == 'unknown']

    df_train_impute_train_features = df_train_impute.loc[train_impute_no_unknowns
    df_train_impute_test_features = df_train_impute.loc[train_impute_unknowns.inc
    df_test_impute_test_features = df_test_impute.loc[test_impute_unknowns.index]

    svm_model = SVC()
    svm_model.fit(df_train_impute_train_features, train_impute_no_unknowns)
    df_train.loc[df_train_impute_test_features.index, feat] = svm_model.predict(d
    print ("Train Filled with: ",df_train.loc[df_train_impute_test_features.inde
    df_test.loc[df_test_impute_test_features.index, feat] = svm_model.predict(df_
    print ("Test Filled with: ", df_test.loc[df_test_impute_test_features.index,

### Label Categorical Ordered Features -- Features Imputated (Unkowns were Prese
for feat in categorical_ordered_features:
    if feat in unknown_present_features:
        print ("\n--------- Labelling feature After  Imputation --------- ",feat)
        df_train = df_train.replace({feat:label_dict[feat]})
        df_test = df_test.replace({feat:label_dict[feat]})
        print ("Labelled as: ",label_dict[feat])

### One hot encoding Categorical Un-ordered Features
for feat in categorical_unordered_features:
    print ("\n--------- One Hot Encoding feature --------- ",feat)
    label_encoder = LabelEncoder()
    label_encoder.fit(df_train[feat])
    df_train[feat] = label_encoder.transform(df_train[feat])
    df_test[feat] = label_encoder.transform(df_test[feat])

one_hot_encoder = OneHotEncoder(sparse=False)
one_hot_encoder.fit(df_train[categorical_unordered_features])
one_hot_encoded_array_train = one_hot_encoder.transform(df_train[categorical_unor
one_hot_encoded_df_train = pd.DataFrame(one_hot_encoded_array_train, index=df_tra
one_hot_encoded_array_test = one_hot_encoder.transform(df_test[categorical_unorde
one_hot_encoded_df_test = pd.DataFrame(one_hot_encoded_array_test, index=df_test

df_train = pd.concat([df_train,one_hot_encoded_df_train], axis=1) #concatenate o
df_test = pd.concat([df_test,one_hot_encoded_df_test], axis=1) #concatenate old

df_train = df_train.drop(categorical_unordered_features, axis=1) #Delete columns
df_test = df_test.drop(categorical_unordered_features, axis=1) #Delete columns wh

### Return pre-processed df
```

```
    return df_train, df_test

def classe_preprocessamento(df_train, df_test):
    "\n--------- Labelling Class Information --------- "
    class_col = 'y'
    label_dict = {class_col:{'no':0,'yes':1}}
    df_train = df_train.replace({class_col:label_dict[class_col]})
    df_test = df_test.replace({class_col:label_dict[class_col]})
    return df_train, df_test
```

In [131]:
```
#  rotina usada para a avaliação da qualidade do modelo usando criterios ROC e AUC

import matplotlib.pyplot as plt
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.metrics import precision_score, recall_score, f1_score
from sklearn.metrics import roc_curve, auc
from sklearn.metrics import classification_report

def avaliacao_PerformanceC(df_train_class, predicted_train, predicted_prob_train, df_
    ### Confusion Matrix
    confusion_matrix_train = confusion_matrix(df_train_class, predicted_train)
    confusion_matrix_test = confusion_matrix(df_test_class, predicted_test)
    print ("\nTraining Confusion Matrix:\n ", confusion_matrix_train)
    print ("\nTesting Confusion Matrix:\n ", confusion_matrix_test)

    ### Accuracy score
    score_train = accuracy_score(df_train_class, predicted_train)
    score_test = accuracy_score(df_test_class, predicted_test)
    print ("\nTraining Accuracy Score: ", score_train)
    print ("\nTesting Accuracy Score: ", score_test)

    ### Precision, Recall
    precision_train = precision_score(df_train_class, predicted_train)
    precision_test = precision_score(df_test_class, predicted_test)
    print ("\nTraining Precision: ", precision_train)
    print ("\nTesting Precision: ", precision_test)

    recall_train = recall_score(df_train_class, predicted_train)
    recall_test = recall_score(df_test_class, predicted_test)
    print ("\nTraining Recall: ", recall_train)
    print ("\nTesting Recall: ", recall_test)

    ### Classification Report
    print ("\nTrain Classification Report: \n",classification_report(df_train_class,
    print ("\nTest Classification Report: \n",classification_report(df_test_class, p

    ### F1 Score
    f1score_train = f1_score(df_train_class, predicted_train)#, average='weighted')
```

```
f1score_test = f1_score(df_test_class, predicted_test)#, average='weighted')
print ("\nTraining F1score: ", f1score_train)
print ("\nTesting F1score: ", f1score_test)

f1score_train = f1_score(df_train_class, predicted_train, average='weighted')
f1score_test = f1_score(df_test_class, predicted_test, average='weighted')
print ("\nTraining Weigted F1score: ", f1score_train)
print ("\nTesting Weighted F1score: ", f1score_test)


### ROC-AUC
if roc_y_n == 'y':
    fpr, tpr, threshold = roc_curve(df_train_class, predicted_prob_train[:,1])
    roc_auc_train = auc(fpr, tpr)
    print ("\nTraining AUC for ROC: ",roc_auc_train)
    plt.figure()
    plt.plot(fpr, tpr, 'b', label = 'AUC = %0.2f' % roc_auc_train)
    plt.plot([0, 1], [0, 1],'r--')
    plt.xlim([0, 1])
    plt.ylim([0, 1])
    plt.ylabel('True Positive Rate')
    plt.xlabel('False Positive Rate')
    plt.legend(loc = 'lower right')
    plt.title('Training - Receiver Operating Characteristic')

    fpr, tpr, threshold = roc_curve(df_test_class, predicted_prob_test[:,1])
    roc_auc_test = auc(fpr, tpr)
    print ("\nTesting AUC for ROC: ",roc_auc_test)
    plt.figure()
    plt.plot(fpr, tpr, 'b', label = 'AUC = %0.2f' % roc_auc_test)
    plt.plot([0, 1], [0, 1],'r--')
    plt.xlim([0, 1])
    plt.ylim([0, 1])
    plt.ylabel('True Positive Rate')
    plt.xlabel('False Positive Rate')
    plt.legend(loc = 'lower right')
    plt.title('Testing - Receiver Operating Characteristic')
```

2.3 A seguir usamos a estandirização acima dividimos dados para train e test e posteriormente salvamos os dados.

O procedimento a seguir permite:

1. substituir os atributos yes ou no contidos nas variáveis por valores numericos
2. substituir os labels unknow a través do uso de SVM para ajustar a mostra a valores conhecidos
3. permite a criação de subconjuntos de dados de treino e teste
4. separa as variáveis emtre numericas, categoricas ordenadas e categoricas não ordenadas

5. as variáveis categoricas não ordenadas como jobs são sub clasificadas em labels

In [132]:
```
from sklearn.model_selection import train_test_split

def train_teste_dados(df):
    df_class = pd.DataFrame(df['y'])
    df_features = df.loc[:, df.columns != 'y']

    df_features_train, df_features_test, df_class_train,  df_class_test = train_test_

    df_train = pd.concat([df_features_train, df_class_train], axis=1)
    df_test = pd.concat([df_features_test, df_class_test], axis=1)

    return df_train, df_test

df = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/bank-full.csv',sep=';')
df_train,df_test = train_teste_dados(df)
df_train,df_test = caracteristicas_preprocessadas(df_train, df_test,"Standardize")
df_train,df_test = classe_preprocessamento(df_train, df_test)

df_train.to_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_standa
df_test.to_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_standar
```

```
--------- Standardizing Continuous Features (Mean=0, Standard Deviation=1) ---------
Mean:  [4.09314321e+01 1.36675192e+03 2.58952283e+02 2.75681255e+00
 4.01849416e+01 5.85171641e-01 1.57916126e+01]
Variance:  [1.12572478e+02 9.30091391e+06 6.67362994e+04 9.60465602e+00
 1.00098333e+04 5.81783132e+00 6.89238391e+01]

--------- Labelling feature Before Imputation ---------  marital
Labelled as:  {'single': 0, 'married': 1, 'divorced': 2}

--------- Labelling feature Before Imputation ---------  default
Labelled as:  {'no': 0, 'yes': 1}

--------- Labelling feature Before Imputation ---------  housing
Labelled as:  {'no': 0, 'yes': 1}

--------- Labelling feature Before Imputation ---------  loan
Labelled as:  {'no': 0, 'yes': 1}

--------- Labelling feature Before Imputation ---------  month


/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/preprocessing/data.py:645: DataConv
  return self.partial_fit(X, y)
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:26: DataConversionWar
```

```
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:27: DataConversionWar


Labelled as:  {'jan': 1, 'feb': 2, 'mar': 3, 'apr': 4, 'may': 5, 'jun': 6, 'jul': 7, 'aug': 8,

Filling Unkowns for Feature:  contact


/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The
  "avoid this warning.", FutureWarning)


Train Filled with:  cellular    9802
Name: contact, dtype: int64
Test Filled with:  cellular    3218
Name: contact, dtype: int64

Filling Unkowns for Feature:  poutcome


/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The
  "avoid this warning.", FutureWarning)


Train Filled with:  failure    19426
success     6312
other       1953
Name: poutcome, dtype: int64
Test Filled with:  failure    6483
success    2109
other       676
Name: poutcome, dtype: int64

Filling Unkowns for Feature:  job


/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The
  "avoid this warning.", FutureWarning)


Train Filled with:  management     104
blue-collar     79
retired         37
technician       3
student          1
Name: job, dtype: int64
Test Filled with:  management     27
blue-collar    22
retired        14
```

```
technician      1
Name: job, dtype: int64

Filling Unkowns for Feature:  education


/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The
  "avoid this warning.", FutureWarning)


Train Filled with:  secondary    1296
tertiary       84
primary        18
Name: education, dtype: int64
Test Filled with:  secondary    428
tertiary      22
primary        9
Name: education, dtype: int64

--------- Labelling feature After  Imputation ---------  education
Labelled as:  {'primary': 0, 'secondary': 1, 'tertiary': 2}

--------- Labelling feature After  Imputation ---------  contact
Labelled as:  {'telephone': 0, 'cellular': 1}

--------- Labelling feature After  Imputation ---------  poutcome
Labelled as:  {'other': 0, 'failure': 1, 'success': 2}

--------- One Hot Encoding feature ---------  job


/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/preprocessing/_encoders.py:371: Futu
If you want the future behaviour and silence this warning, you can specify "categories='auto'"
In case you used a LabelEncoder before this OneHotEncoder to convert the categories to integers
  warnings.warn(msg, FutureWarning)
```

2.4 Modelos obtidos e avaliação dos mesmos

2.5 Os modelos a seguir são obtidos a partir dos métodos

1. de regressão logistica usando PCA
2. de Perceptron
3. de Random forrest

2.6 LR com PCA

In [133]:
```
import numpy as np
import pandas as pd
```

```
import matplotlib.pyplot as plt
from sklearn.linear_model import LogisticRegression
from sklearn.decomposition import PCA
from sklearn.model_selection import StratifiedKFold


df_train = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_
df_test = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_s

del df_train['Unnamed: 0']
del df_test['Unnamed: 0']

df_train_class = pd.DataFrame(df_train['y'])
df_train_features = df_train.loc[:, df_train.columns != 'y']

df_test_class = pd.DataFrame(df_test['y'])
df_test_features = df_test.loc[:, df_test.columns != 'y']

# Reducao usando Analise de Componentes Principais
modelo_PCA = PCA(n_components=5)
modelo_PCA.fit(df_train_features)
df_train_features = pd.DataFrame(modelo_PCA.transform(df_train_features))
df_test_features = pd.DataFrame(modelo_PCA.transform(df_test_features))

#Modelo de Regressao Logistica

C_list = np.linspace(0.1, 1, 10)
lista_punicao = ['l1','l2']

skf_model = StratifiedKFold(n_splits=5,shuffle=True)

# minimo de 3 iteracoes
numero_iteracoes = 3
for t in range(0,numero_iteracoes):
    print ("---Iteration: ",t)
    AVG_ACC = np.zeros(shape=[len(C_list),len(lista_punicao)])
    STD_ACC = np.zeros(shape=[len(C_list),len(lista_punicao)])

    x_count = 0
    for c_value in C_list:

        y_count = 0
        for punicao in lista_punicao:

            temp_accuracy_list = []
            for train_subset_index, cv_index in skf_model.split(df_train_features,df_
                df_train_features_subset = df_train_features.loc[train_subset_index]
                df_train_class_subset = df_train_class.loc[train_subset_index]
```

```
                    df_train_features_cv = df_train_features.loc[cv_index]
                    df_train_class_cv = df_train_class.loc[cv_index]

                    lr_model = LogisticRegression(penalty=punicao, C=c_value, class_weig
                    lr_model.fit(df_train_features_subset, df_train_class_subset)
                    score_value = lr_model.score(df_train_features_cv, df_train_class_cv
                    temp_accuracy_list.append(score_value)

                AVG_ACC[x_count,y_count] = np.mean(temp_accuracy_list)
                STD_ACC[x_count,y_count] = np.std(temp_accuracy_list)
                y_count += 1

            x_count += 1

        if t==0:
            final_AVG_ACC = AVG_ACC
            final_STD_ACC = STD_ACC
        else:
            final_AVG_ACC = np.dstack([final_AVG_ACC, AVG_ACC])
            final_STD_ACC = np.dstack([final_STD_ACC, STD_ACC])

    final_accuracy_mean_list = np.mean(final_AVG_ACC, axis=2)
    max_ind = np.unravel_index(np.argmax(final_accuracy_mean_list, axis=None), final_accu

    Escolha_C = C_list[max_ind[0]]
    Escolha_punicao = lista_punicao[max_ind[1]]
    print ("Cross Validation - C pela Regressao Logistica: ",Escolha_C)
    print ("Cross Validation - Punicao pela Regressao Logistica: ",Escolha_punicao)

    RL_modelo_F = LogisticRegression(penalty=Escolha_punicao, C=Escolha_C, class_weight=
    RL_modelo_F.fit(df_train_features, df_train_class)

    Predicao_train = RL_modelo_F.predict(df_train_features)
    Predicao_test = RL_modelo_F.predict(df_test_features)

    Predicao_prob_train = RL_modelo_F.predict_proba(df_train_features)
    Predicao_prob_test = RL_modelo_F.predict_proba(df_test_features)

    avaliacao_PerformanceC(df_train_class, Predicao_train, Predicao_prob_train, df_test_
```

```
---Iteration:  0
```

```
/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:433: Futur
  FutureWarning)
/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/utils/validation.py:761: DataConver
  y = column_or_1d(y, warn=True)
/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:433: Futur
```

```
  FutureWarning)
/home/andres/anaconda3/lib/python3.7/site-packages/sklearn/utils/validation.py:761: DataConvers
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Cross Validation - C pela Regressao Logistica:  0.5
Cross Validation - Punicao pela Regressao Logistica:  l2

Training Confusion Matrix:
  [[23495  6457]
 [ 1200  2756]]

Testing Confusion Matrix:
  [[7909 2061]
 [ 376  957]]

Training Accuracy Score:  0.7741830836380795

Testing Accuracy Score:  0.7843935238432275

Training Precision:  0.29914251600998587

Testing Precision:  0.31709741550695825

Training Recall:  0.6966632962588474

Testing Recall:  0.7179294823705926

Train Classification Report:
              precision    recall  f1-score   support

           0       0.95      0.78      0.86     29952
           1       0.30      0.70      0.42      3956

   micro avg       0.77      0.77      0.77     33908
   macro avg       0.63      0.74      0.64     33908
weighted avg       0.88      0.77      0.81     33908


Test Classification Report:
              precision    recall  f1-score   support

           0       0.95      0.79      0.87      9970
           1       0.32      0.72      0.44      1333

   micro avg       0.78      0.78      0.78     11303
```

```
   macro avg       0.64      0.76      0.65     11303
weighted avg       0.88      0.78      0.82     11303


Training F1score:  0.4185587364264561

Testing F1score:  0.4398988738221099


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Training Weigted F1score:  0.8083938764225234

Testing Weighted F1score:  0.8161915783644864

Training AUC for ROC:  0.8191824816572034

Testing AUC for ROC:  0.8296755231937374
```

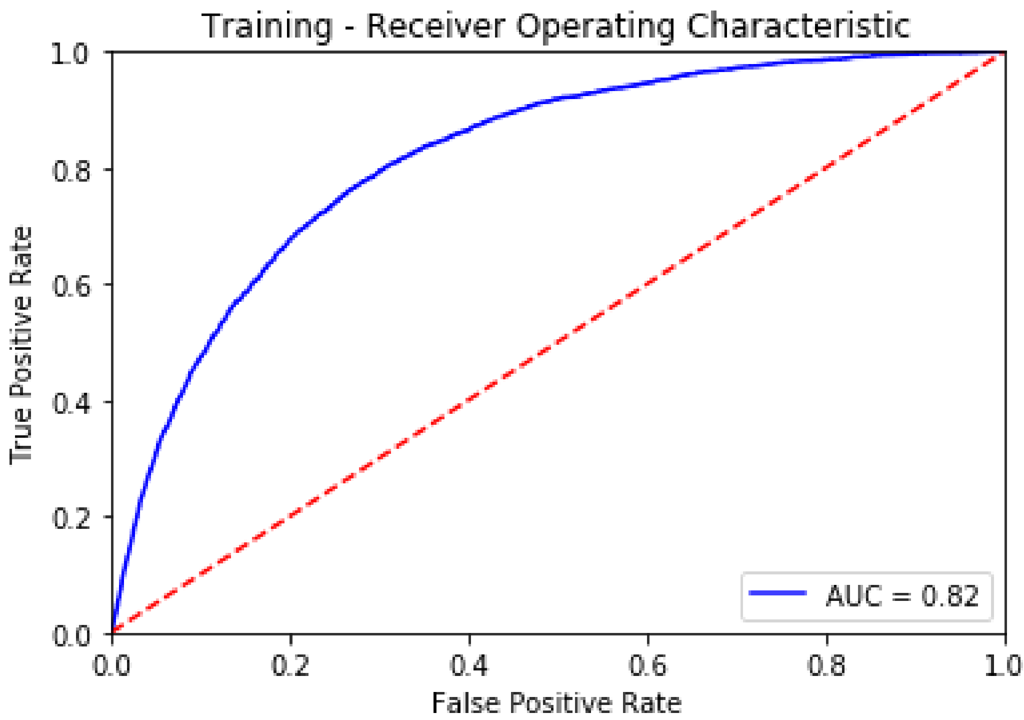

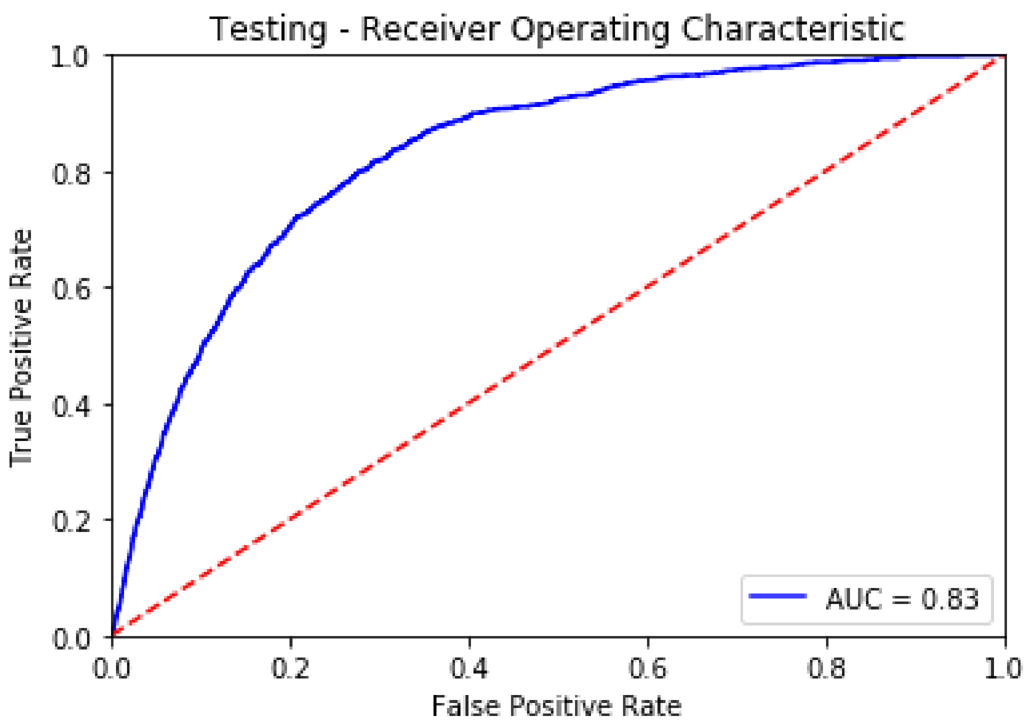

2.7 Perceptron

In [134]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.linear_model import Perceptron
from sklearn.calibration import CalibratedClassifierCV
from sklearn.model_selection import StratifiedKFold

df_train = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_
df_test = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_s


del df_train['Unnamed: 0']
del df_test['Unnamed: 0']

df_train_class = pd.DataFrame(df_train['y'])
df_train_features = df_train.loc[:, df_train.columns != 'y']

df_test_class = pd.DataFrame(df_test['y'])
df_test_features = df_test.loc[:, df_test.columns != 'y']
```

```
# Perceptrao
lista_alpha = np.linspace(0.00001, 1, 15)
lista_punicao = ['l1','l2','elasticnet']

skf_model = StratifiedKFold(n_splits=5,shuffle=True)

numero_iteracoes = 2
for t in range(0,numero_iteracoes):
    print ("---Iteration: ",t)
    AVG_ACC = np.zeros(shape=[len(lista_alpha),len(lista_punicao)])
    STD_ACC = np.zeros(shape=[len(lista_alpha),len(lista_punicao)])

    x_count = 0
    for valor_alpha in lista_alpha:

        y_count = 0
        for punicao in lista_punicao:

            lista_temp_acuidade = []
            for indice_suCbtrain, cv_indice in skf_model.split(df_train_features,df_t
                df_train_features_subset = df_train_features.loc[indice_suCbtrain]
                df_train_class_subset = df_train_class.loc[indice_suCbtrain]
                df_train_features_cv = df_train_features.loc[cv_indice]
                df_train_class_cv = df_train_class.loc[cv_indice]

                modelo_perceptrao = Perceptron(penalty=punicao, alpha=valor_alpha, cl
                modelo_perceptrao.fit(df_train_features_subset, df_train_class_subset
                pontagem = modelo_perceptrao.score(df_train_features_cv, df_train_cla
                lista_temp_acuidade.append(pontagem)

            AVG_ACC[x_count,y_count] = np.mean(lista_temp_acuidade)
            STD_ACC[x_count,y_count] = np.std(lista_temp_acuidade)
            y_count += 1

        x_count += 1

    if t==0:
        final_AVG_ACC = AVG_ACC
        final_STD_ACC = STD_ACC
    else:
        final_AVG_ACC = np.dstack([final_AVG_ACC, AVG_ACC])
        final_STD_ACC = np.dstack([final_STD_ACC, STD_ACC])

final_accuracy_mean_list = np.mean(final_AVG_ACC, axis=2)
max_ind = np.unravel_index(np.argmax(final_accuracy_mean_list, axis=None), final_accu

Escolha_alpha = lista_alpha[max_ind[0]]
Escolha_Punicao = lista_punicao[max_ind[1]]
```

```python
    print ("Cross Validation - alpha pelo Perceptron: ",Escolha_alpha)
    print ("Cross Validation - Punicao pelo Perceptron: ",Escolha_Punicao)

    modelo_perceptrao_final = Perceptron(penalty=Escolha_Punicao, alpha=Escolha_alpha, cl
    modelo_perceptrao_final = CalibratedClassifierCV(base_estimator=modelo_perceptrao_fin
    modelo_perceptrao_final.fit(df_train_features, df_train_class)

    Predicao_train = modelo_perceptrao_final.predict(df_train_features)
    Predicao_test = modelo_perceptrao_final.predict(df_test_features)

    Predicao_prob_train = modelo_perceptrao_final.predict_proba(df_train_features)
    Predicao_prob_test  = modelo_perceptrao_final.predict_proba(df_test_features)

    avaliacao_PerformanceC(df_train_class, Predicao_train, Predicao_prob_train, df_test_c
```

```
---Iteration:  0


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```

```
Cross Validation - alpha pelo Perceptron:  1e-05
Cross Validation - Punicao pelo Perceptron:  elasticnet


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  FutureWarning)



Training Confusion Matrix:
  [[29673   279]
 [ 3505   451]]

Testing Confusion Matrix:
  [[9870  100]
 [1182  151]]

Training Accuracy Score:  0.8884039164798867

Testing Accuracy Score:  0.8865787843935239

Training Precision:  0.6178082191780822

Testing Precision:  0.601593625498008

Training Recall:  0.11400404448938321

Testing Recall:  0.11327831957989497
```
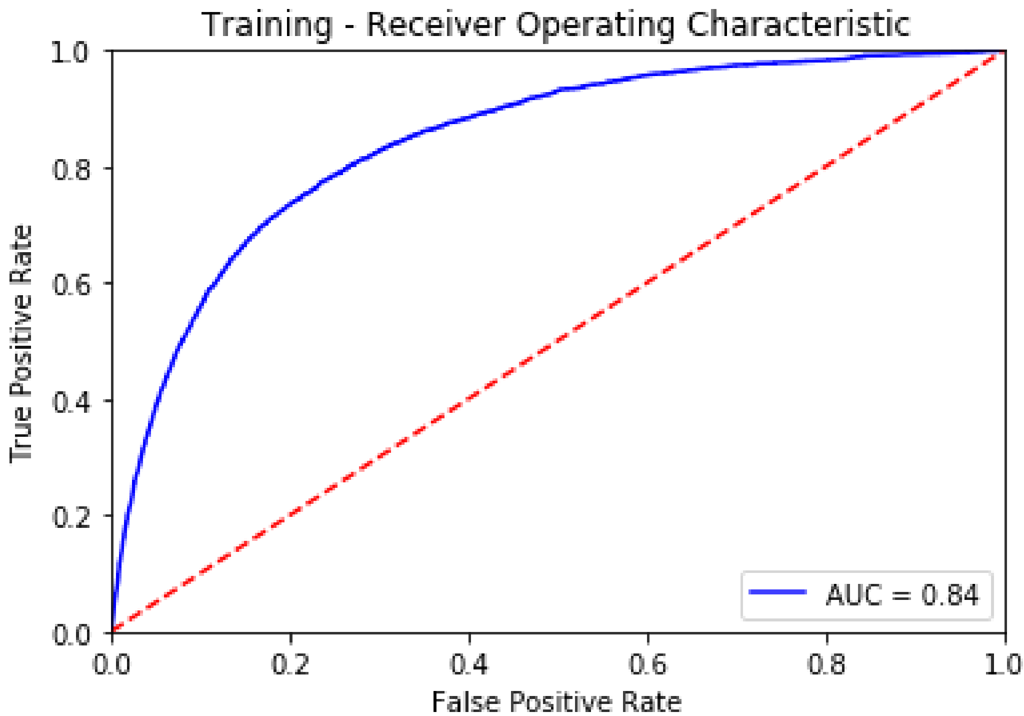
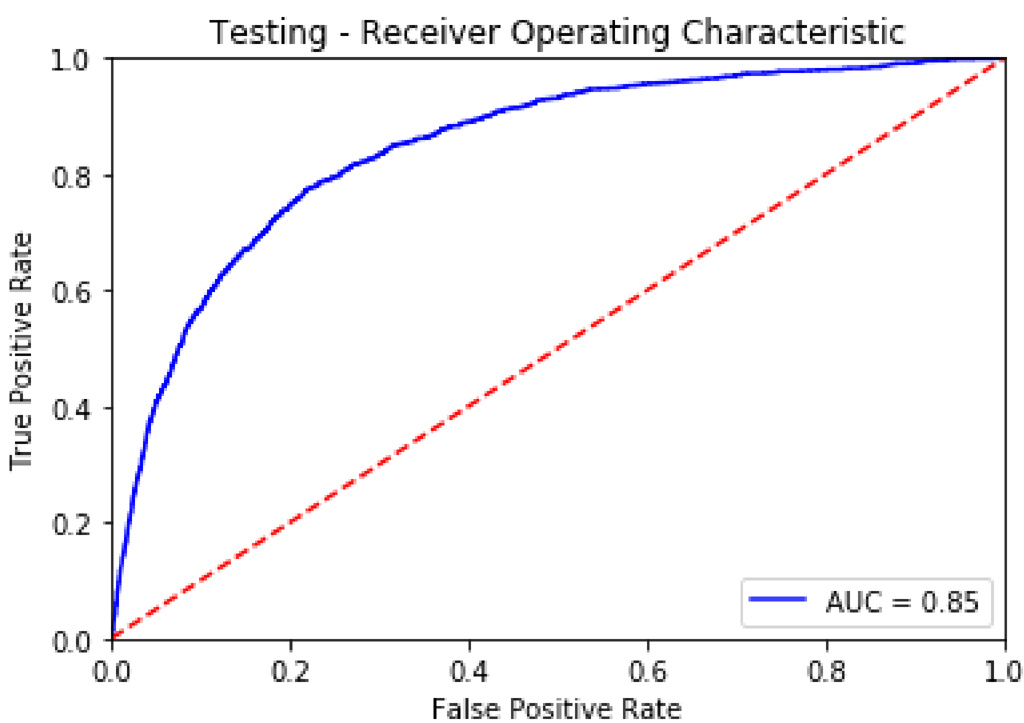

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.89      0.99      0.94     29952
           1       0.62      0.11      0.19      3956

   micro avg       0.89      0.89      0.89     33908
   macro avg       0.76      0.55      0.57     33908
weighted avg       0.86      0.89      0.85     33908


Test Classification Report:
              precision    recall  f1-score   support

           0       0.89      0.99      0.94      9970
           1       0.60      0.11      0.19      1333

   micro avg       0.89      0.89      0.89     11303
   macro avg       0.75      0.55      0.56     11303
weighted avg       0.86      0.89      0.85     11303


Training F1score:  0.19248826291079812

Testing F1score:  0.19065656565656566

Training Weigted F1score:  0.8528419982411115

Testing Weighted F1score:  0.8507597452595979

Training AUC for ROC:  0.8435902102953535

Testing AUC for ROC:  0.8465573013112856
```


Training - Receiver Operating Characteristic
True Positive Rate
False Positive Rate
AUC = 0.84
0.0
0.2
0.4
0.6
0.8
1.0


Testing - Receiver Operating Characteristic
True Positive Rate
False Positive Rate
AUC = 0.85
0.0
0.2
0.4
0.6
0.8
1.0

2.8 Floresta Aleátoria

In [135]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import StratifiedKFold

df_train = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_
df_test = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_s


del df_train['Unnamed: 0']
del df_test['Unnamed: 0']

df_train_class = pd.DataFrame(df_train['y'])
df_train_features = df_train.loc[:, df_train.columns != 'y']

df_test_class = pd.DataFrame(df_test['y'])
df_test_features = df_test.loc[:, df_test.columns != 'y']

# Classificador Aleatorio de floresta
n_estimador_lista = range(10, 50, 5)

skf_model = StratifiedKFold(n_splits=5,shuffle=True)

Numero_iteracoes = 1
for t in range(0,Numero_iteracoes):
    print ("---Iteration: ",t)
    AVG_ACC = np.zeros(shape=[len(n_estimador_lista)])
    STD_ACC = np.zeros(shape=[len(n_estimador_lista)])

    x_count = 0
    for k_val in n_estimador_lista:
        Lista_Acuracia_Temp = []

        for Indice_subCindice, cv_index in skf_model.split(df_train_features,df_trai
            df_train_features_subset = df_train_features.loc[Indice_subCindice]
            df_train_class_subset = df_train_class.loc[Indice_subCindice]
            df_train_features_cv = df_train_features.loc[cv_index]
            df_train_class_cv = df_train_class.loc[cv_index]

            BA_modelo = RandomForestClassifier(n_estimators=k_val, class_weight='bala
            BA_modelo.fit(df_train_features_subset, df_train_class_subset)
            contagem = BA_modelo.score(df_train_features_cv, df_train_class_cv)
            Lista_Acuracia_Temp.append(contagem)

        AVG_ACC[x_count] = np.mean(Lista_Acuracia_Temp)
```

```python
                STD_ACC[x_count] = np.std(Lista_Acuracia_Temp)
                x_count += 1

            if t==0:
                final_AVG_ACC = AVG_ACC
                final_STD_ACC = STD_ACC
            else:
                final_AVG_ACC = np.vstack([final_AVG_ACC, AVG_ACC])
                final_STD_ACC = np.vstack([final_STD_ACC, STD_ACC])

        Lista_Acc_meia_final = np.mean(final_AVG_ACC, axis=0)
        final_k_indice = np.argmax(Lista_Acc_meia_final)

        Escolha_k= n_estimador_lista[final_k_indice]
        print ("Cross Validation - Numero de Estimadores pela Floresta A : ",Escolha_k)

        BA_modelo_final = RandomForestClassifier(n_estimators=Escolha_k, class_weight='balanc
        BA_modelo_final.fit(df_train_features, df_train_class)

        Predicao_train = BA_modelo_final.predict(df_train_features)
        Predicao_test = BA_modelo_final.predict(df_test_features)

        Predicao_prob_train = BA_modelo_final.predict_proba(df_train_features)
        Predicao_prob_test = BA_modelo_final.predict_proba(df_test_features)

        avaliacao_PerformanceC(df_train_class, Predicao_train, Predicao_prob_train, df_test_c
```

```
---Iteration:  0


/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:42: DataConversionWarn
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:42: DataConversionWarn
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```

```
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:42: DataConversionWarn
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Cross Validation - Numero de Estimadores pela Floresta A :  10


/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:64: DataConversionWarn




Training Confusion Matrix:
  [[29941    11]
 [  275  3681]]

Testing Confusion Matrix:
  [[9740  230]
 [ 946  387]]

Training Accuracy Score:  0.9915654122920845

Testing Accuracy Score:  0.8959568256215165

Training Precision:  0.997020585048754

Testing Precision:  0.6272285251215559

Training Recall:  0.9304853387259858
```

```
Testing Recall:  0.2903225806451613

Train Classification Report:
              precision    recall  f1-score   support

           0       0.99      1.00      1.00     29952
           1       1.00      0.93      0.96      3956

   micro avg       0.99      0.99      0.99     33908
   macro avg       0.99      0.97      0.98     33908
weighted avg       0.99      0.99      0.99     33908


Test Classification Report:
              precision    recall  f1-score   support

           0       0.91      0.98      0.94      9970
           1       0.63      0.29      0.40      1333

   micro avg       0.90      0.90      0.90     11303
   macro avg       0.77      0.63      0.67     11303
weighted avg       0.88      0.90      0.88     11303


Training F1score:  0.9626046025104602

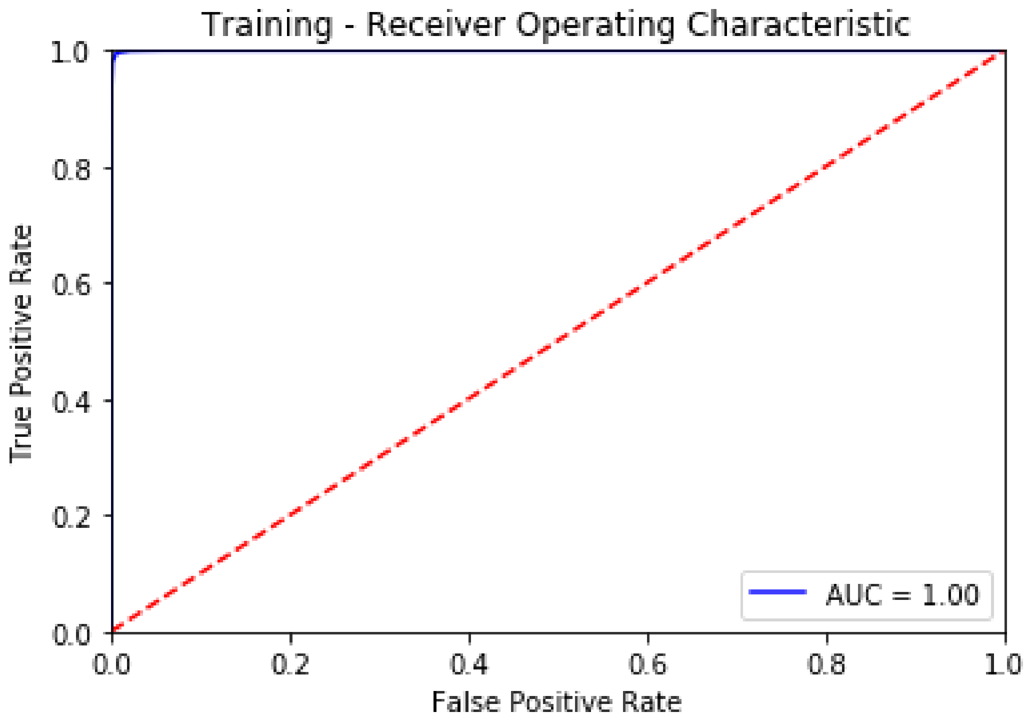
Testing F1score:  0.39692307692307693

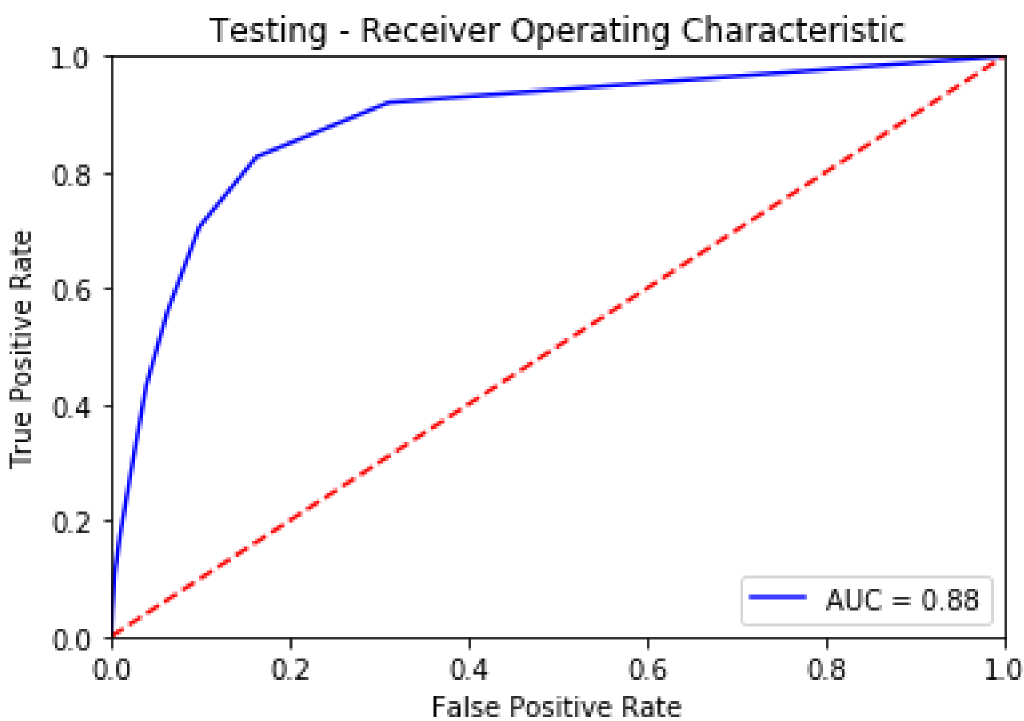
Training Weigted F1score:  0.9914383405299793

Testing Weighted F1score:  0.878658792891652

Training AUC for ROC:  0.9997920754771503

Testing AUC for ROC:  0.8844188981046666
```


Training - Receiver Operating Characteristic
1.0
0.8
0.6
0.4
0.2
0.0
True Positive Rate
AUC = 1.00
0.0
0.2
0.4
0.6
0.8
1.0
False Positive Rate


Testing - Receiver Operating Characteristic
1.0
0.8
0.6
0.4
0.2
0.0
True Positive Rate
AUC = 0.88
0.0
0.2
0.4
0.6
0.8
1.0
False Positive Rate

3 Nesta seção são apresentados alguns resultados analiticos

3.1 A primeira análise, está associado à tendencia a fazer um emprestimo entre as profissões dos participantes da campanha de adeção via telemarketing.

3.1.1 Os dados associados à cedito são:

1. housing: has housing loan? (binary: “yes”,“no”)
2. loan: has personal loan? (binary: “yes”,“no”)
3. default: has credit in default? (binary: “yes”,“no”)

com os quais pretende-se responder à pergnta:
1. Qual profissão tem mais tendência a fazer um emprestimo? De qualtipo?
Primeiramente revisa-se a tendencia dos dados

In [136]:
```
## declaração de  classe a usar para os histogramas associados a emprestimos
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
plt.close("all")
col_df = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/bank-full.csv',sep=
loan=col_df.groupby("loan")
housing=col_df.groupby("housing")
default=col_df.groupby("default")

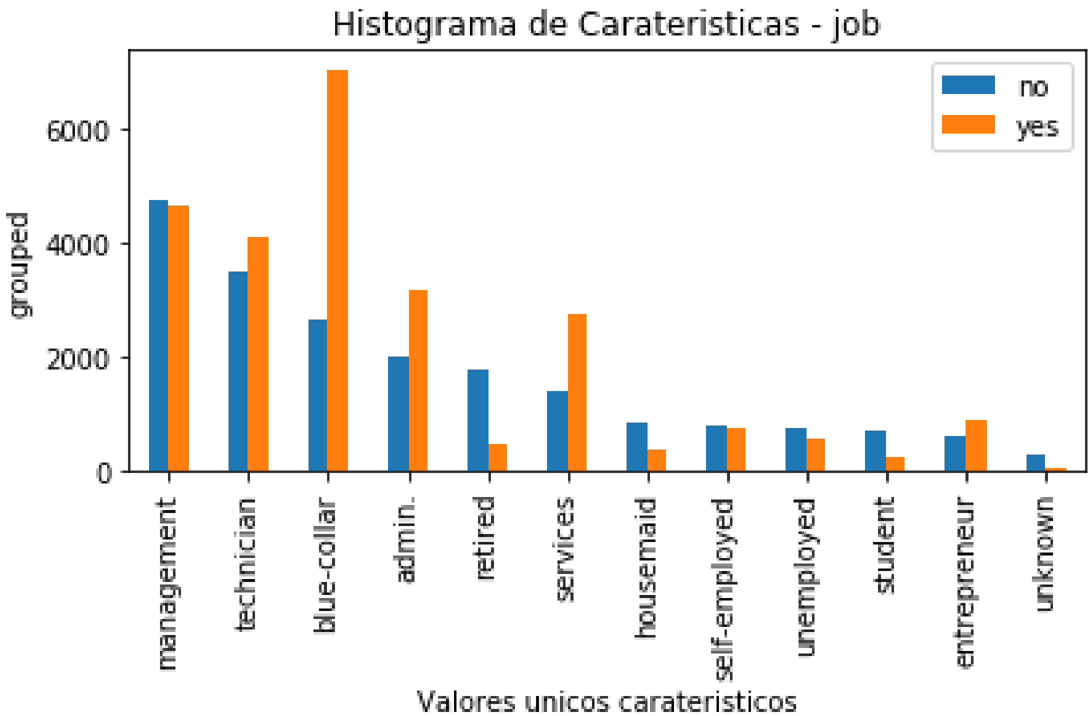
class Dados_iniciais1:

    def __init__(self, col_df, var):
        self.col_df = col_df
        self.col_df_grouped = var
        self.nome_classe_nao = "no"
        self.nome_classe_sim = "yes"
        self.col_df_grouped_nao = self.col_df_grouped.get_group(self.nome_classe_nao
        self.col_df_grouped_sim = self.col_df_grouped.get_group(self.nome_classe_sim

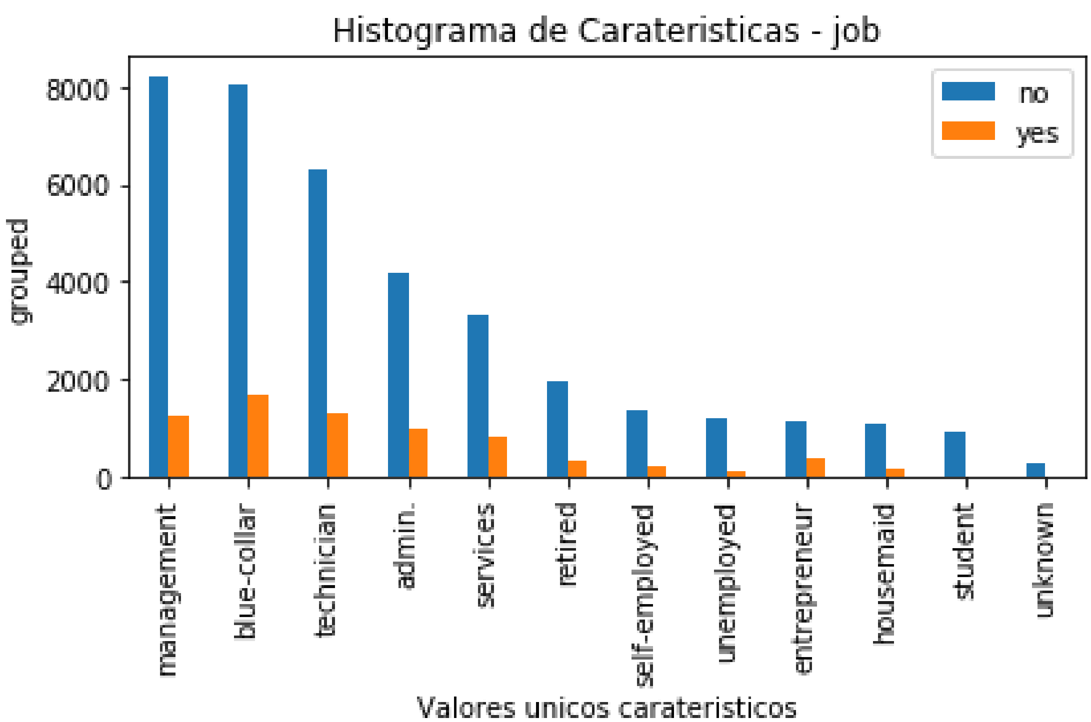
    def plot_histogram_categorical(self, nome_carateristica):
        carateristica_df = pd.DataFrame()
        carateristica_df["no"] = self.col_df_grouped_nao[nome_carateristica].value_c
        carateristica_df["yes"] = self.col_df_grouped_sim[nome_carateristica].value_


        carateristica_df.plot(kind='bar')
        plt.title("Histograma de Carateristicas - "+nome_carateristica)
        plt.ylabel("grouped")
        plt.xlabel("Valores unicos carateristicos")
        plt.tight_layout()
```

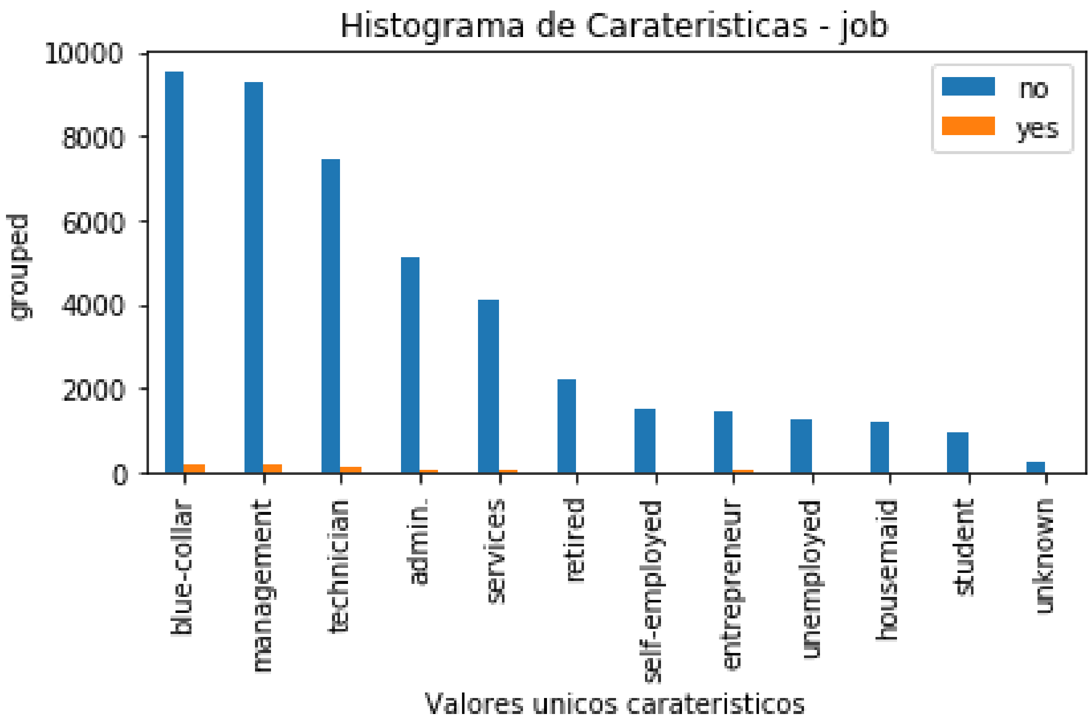
In [137]:
```
Dados_iniciais_obj = Dados_iniciais1(col_df,housing)
Dados_iniciais_obj.plot_histogram_categorical("job")
```




```
In [138]: Dados_iniciais_obj = Dados_iniciais1(col_df,loan)
          Dados_iniciais_obj.plot_histogram_categorical("job")
```



```
In [139]: Dados_iniciais_obj = Dados_iniciais1(col_df,default)
          Dados_iniciais_obj.plot_histogram_categorical("job")
```



3.1.2 A partir dos histogramas acima podemos formular que o blue-colar, management, e technician tem o mair numero de emprestimos segundo os dados, e que por sua vez este grupo pode ser considerado como o grupo de maior tendência a realizar emprestimos de vivienda e personais.

4 2. Fazendo uma relação entre o número de cotactos e sucesso da campanha quais são os pontos mais relevantes a serem observados?

```
In [140]: from sklearn.ensemble import RandomForestClassifier
          from sklearn.model_selection import StratifiedKFold

          df_train = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_
          df_test = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_s


          del df_train['Unnamed: 0']
          del df_test['Unnamed: 0']
```

```
df_train_class = pd.DataFrame(df_train['y'])
df_train_features = df_train.loc[:, df_train.columns != 'y']

# Classificador Aleatorio de floresta
n_estimador_lista = range(10, 50, 5)

skf_model = StratifiedKFold(n_splits=5,shuffle=True)

Numero_iteracoes = 1
for t in range(0,Numero_iteracoes):
    print ("---Iteration: ",t)
    AVG_ACC = np.zeros(shape=[len(n_estimador_lista)])
    STD_ACC = np.zeros(shape=[len(n_estimador_lista)])

    x_count = 0
    for k_val in n_estimador_lista:
        Lista_Acuracia_Temp = []

        for Indice_subCindice, cv_index in skf_model.split(df_train_features,df_trai
            df_train_features_subset = df_train_features.loc[Indice_subCindice]
            df_train_class_subset = df_train_class.loc[Indice_subCindice]
            df_train_features_cv = df_train_features.loc[cv_index]
            df_train_class_cv = df_train_class.loc[cv_index]

            BA_modelo = RandomForestClassifier(n_estimators=k_val, class_weight='bala
            BA_modelo.fit(df_train_features_subset, df_train_class_subset)
            contagem = BA_modelo.score(df_train_features_cv, df_train_class_cv)
            Lista_Acuracia_Temp.append(contagem)

        AVG_ACC[x_count] = np.mean(Lista_Acuracia_Temp)
        STD_ACC[x_count] = np.std(Lista_Acuracia_Temp)
        x_count += 1

    if t==0:
        final_AVG_ACC = AVG_ACC
        final_STD_ACC = STD_ACC
    else:
        final_AVG_ACC = np.vstack([final_AVG_ACC, AVG_ACC])
        final_STD_ACC = np.vstack([final_STD_ACC, STD_ACC])

Lista_Acc_meia_final = np.mean(final_AVG_ACC, axis=0)
final_k_indice = np.argmax(Lista_Acc_meia_final)

Escolha_k= n_estimador_lista[final_k_indice]
print ("Cross Validation - Numero de Estimadores pela Floresta A : ",Escolha_k)

BA_modelo_final = RandomForestClassifier(n_estimators=Escolha_k, class_weight='balan
```

```
BA_modelo_final.fit(df_train_features, df_train_class)

importance=BA_modelo_final.feature_importances_

std1 = np.std([tree.feature_importances_ for tree in BA_modelo_final.estimators_],
             axis=0)
indices = np.argsort(importance)[::-1]
```

```
---Iteration:  0


/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWarn
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWarn
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```

```
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Cross Validation - Numero de Estimadores pela Floresta A :  10


/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:58: DataConversionWarn
```

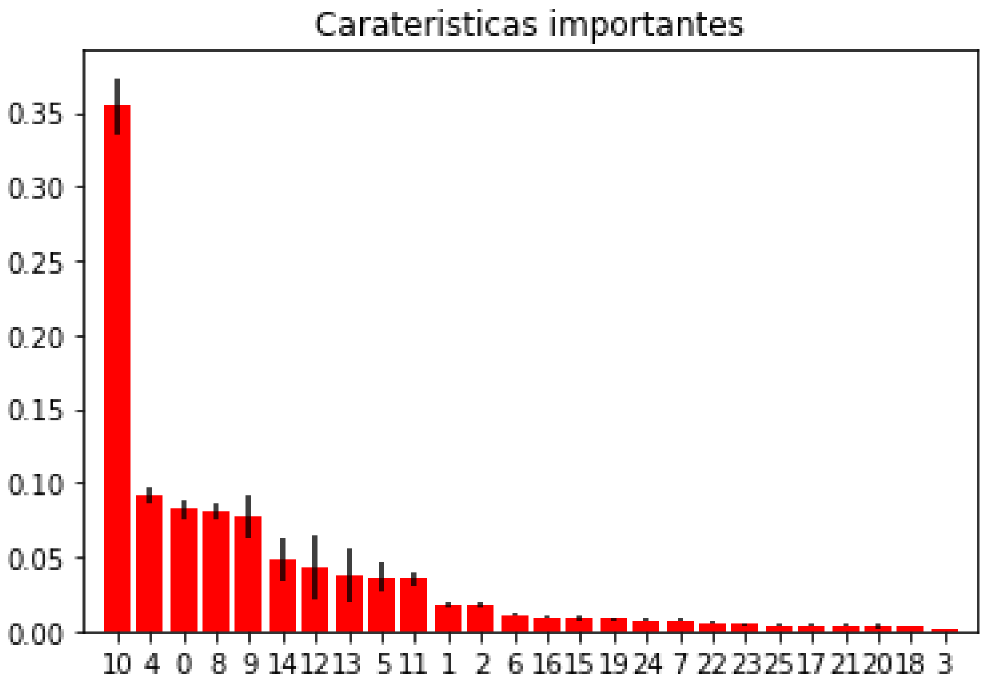
```
In [141]: print("ranking das Caracteristicas:")

          for f in range(df_train_features_subset.shape[1]):
              print("%d. feature %d (%f)" % (f + 1, indices[f], importance[indices[f]]))

          # Plot the feature importances of the forest
          plt.figure()
          plt.title("Carateristicas importantes")
          plt.bar(range(df_train_features_subset.shape[1]), importance[indices],
                 color="r", yerr=std1[indices], align="center")
          plt.xticks(range(df_train_features_subset.shape[1]), indices)
          plt.xlim([-1, df_train_features_subset.shape[1]])
          plt.show()
```

```
ranking das Caracteristicas:
1. feature 10 (0.353740)
2. feature 4 (0.090681)
3. feature 0 (0.081947)
4. feature 8 (0.081156)
5. feature 9 (0.077302)
6. feature 14 (0.048171)
7. feature 12 (0.042330)
8. feature 13 (0.036917)
9. feature 5 (0.036398)
10. feature 11 (0.035134)
11. feature 1 (0.017955)
12. feature 2 (0.017305)
13. feature 6 (0.011233)
14. feature 16 (0.009257)
15. feature 15 (0.008145)
16. feature 19 (0.007789)
17. feature 24 (0.007619)
18. feature 7 (0.007405)
19. feature 22 (0.005513)
20. feature 23 (0.004223)
21. feature 25 (0.004129)
22. feature 17 (0.003930)
23. feature 21 (0.003690)
```

```
24. feature 20 (0.003599)
25. feature 18 (0.003059)
26. feature 3 (0.001372)
```



5 A través da análise ao modelo pode se corroborar a hipotese apresentada em [1] onde se se determina como um dos mais importantes elementos da toma de decisão dos clientes está associada ao tempo da ligação; em [1] determinam que um tempo superior a 8 seg, garante o maior numero de adesões à campanha.

5.1 Por outra parte pode se ver que outros elementos importantes para a adeção à campanha estão associados ao balance idade o dia e o mês de contacto. Por outra parte os clientes que se aderem à campanha estão ubicados maioritariamente no setor de serviço, desempregados, auto-empregados ou blue-collar.

[1] S. Moro, P. Cortez and P. Rita. A Data-Driven Approach to Predict the Success of Bank Telemarketing. Decision Support Systems, Elsevier, 62:22-31, June 2014

6 3. Baseando-se nos resultados de adeção desta campanha cual é o número medio e máximo que você indica para otimizar a adesão?

```
In [142]: train_col_df = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_pre

          col_df = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/bank-full.csv',sep=




          class Dados_iniciais2:

              def __init__(self, col_df, var,val_n,val_p):
                  self.col_df = col_df
                  self.col_df_grouped = var
                  self.nome_classe_nao = val_n
                  self.nome_classe_sim = val_p
                  self.col_df_grouped_nao = self.col_df_grouped.get_group(self.nome_classe_nao
                  self.col_df_grouped_sim = self.col_df_grouped.get_group(self.nome_classe_sim


              def plot_histograma_continuo(self, nome_carateristica, bin_tamanho):
                  plt.figure()
                  plt.hist(self.col_df_grouped_nao[nome_carateristica], bins=bin_tamanho, label
                  plt.hist(self.col_df_grouped_sim[nome_carateristica], bins=bin_tamanho, label
                  plt.legend()
                  plt.title("Histograma de Carateristicas - "+nome_carateristica)
                  plt.xlabel("Valores Carateristicos")
                  plt.ylabel("grouped")

          y=col_df.groupby("y")
          val_n=col_df.nome_classe_nao = "no"
          val_p=col_df.nome_classe_sim = "yes"

          Dados_iniciais_obj = Dados_iniciais2(col_df,y,val_n,val_p)

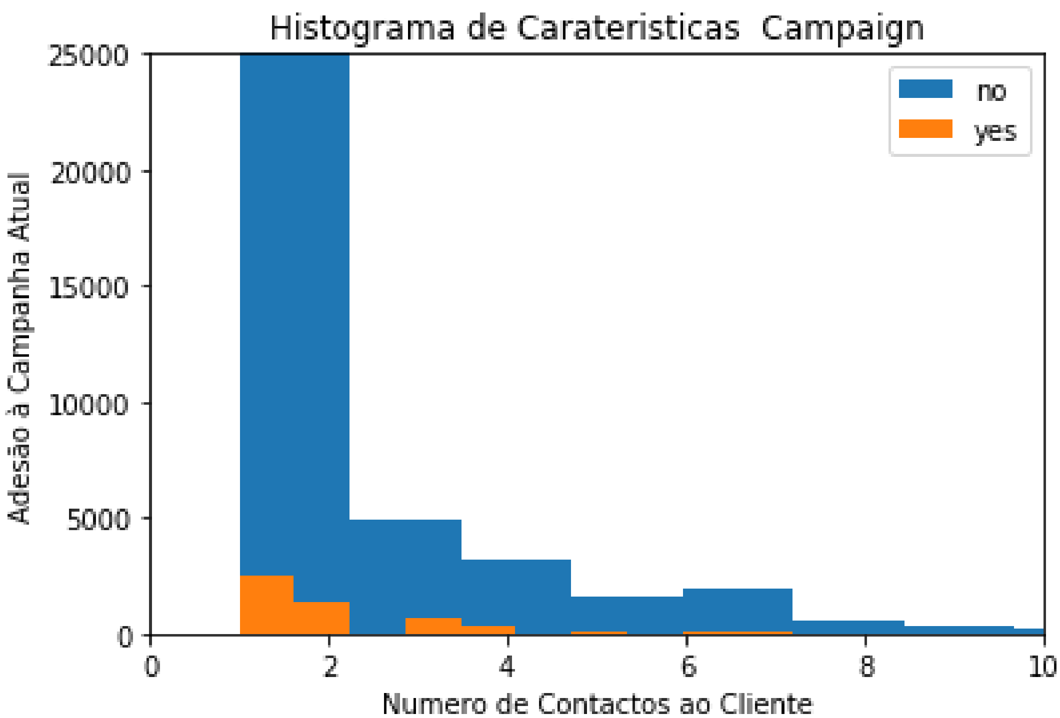
          Dados_iniciais_obj.plot_histograma_continuo("campaign", 50)
          plt.axis([ 0, 10, 0, 25000])
          plt.title("Histograma de Carateristicas  Campaign")
          plt.ylabel("Adesão à Campanha Atual")
          plt.xlabel("Numero de Contactos ao Cliente")

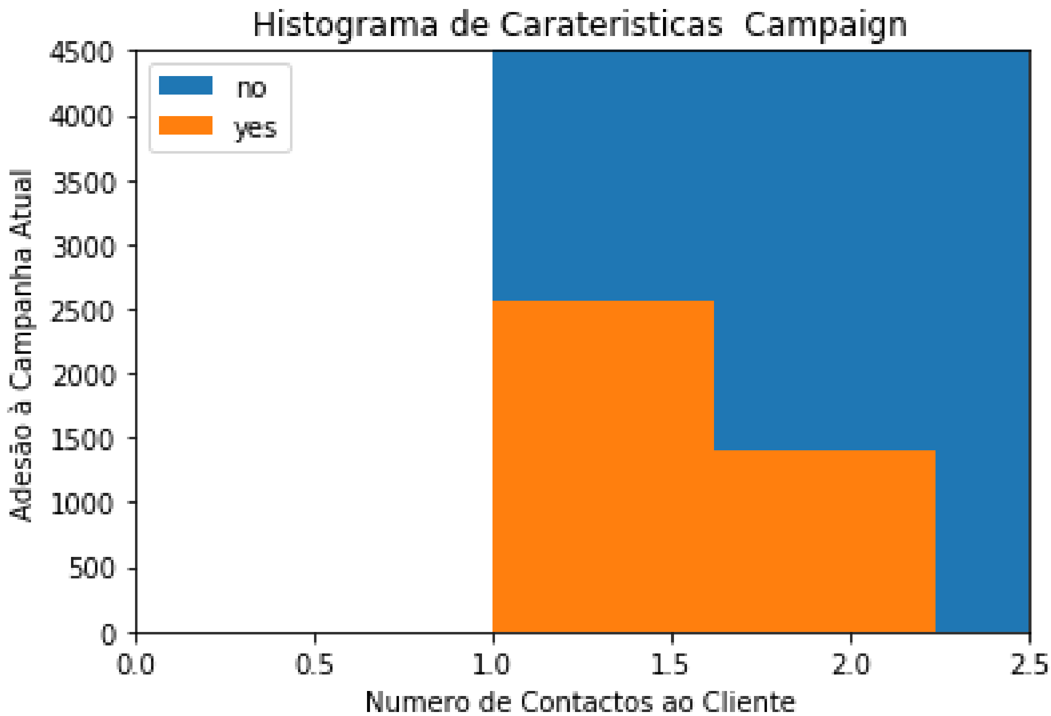
          Dados_iniciais_obj.plot_histograma_continuo("campaign", 50)
          plt.axis([ 0, 2.5, 0, 4500])
          plt.title("Histograma de Carateristicas  Campaign")
          plt.ylabel("Adesão à Campanha Atual")
          plt.xlabel("Numero de Contactos ao Cliente")
```

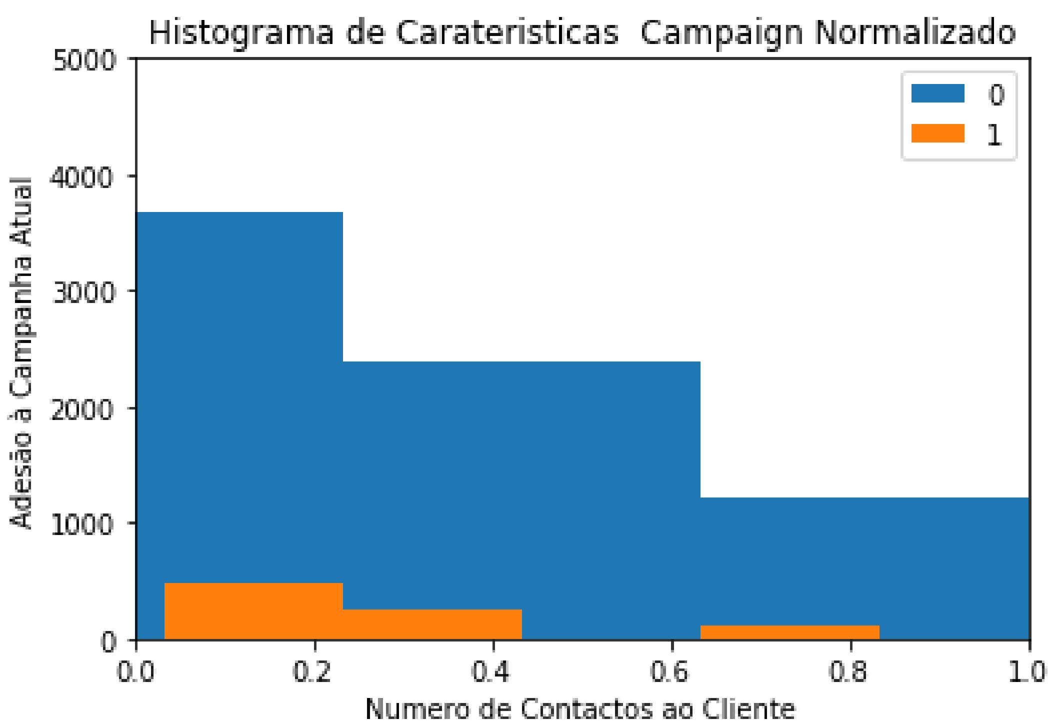
```
y=train_col_df.groupby("y")
val_n=train_col_df.nome_classe_nao = 0
val_p=train_col_df.nome_classe_sim = 1
Dados_iniciais_obj = Dados_iniciais2(train_col_df,y,val_n,val_p)

Dados_iniciais_obj.plot_histograma_continuo("campaign", 50)
plt.axis([ 0, 1., 0, 5000])
plt.title("Histograma de Carateristicas  Campaign Normalizado")
plt.ylabel("Adesão à Campanha Atual")
plt.xlabel("Numero de Contactos ao Cliente")
```

Out[142]: Text(0.5, 0, 'Numero de Contactos ao Cliente')




Histograma de Carateristicas Campaign
4500
4000
3500
3000
2500
2000
1500
1000
500
0
no
yes
Adesão à Campanha Atual
0.0
0.5
1.0
1.5
2.0
2.5
Numero de Contactos ao Cliente


Histograma de Carateristicas Campaign Normalizado
5000
4000
3000
2000
1000
0
0
1
Adesão à Campanha Atual
0.0
0.2
0.4
0.6
0.8
1.0
Numero de Contactos ao Cliente

6.1 deacordo com os dados e a frequencia apresentada na tabela abaixo, pode-se concluir que o maior numero de adesões ocorre um numero de ligaçãoes inferior a 6.

6.2 Portanto, recomenda-se em media ligar 4 vezes e no máximo 6.

In [143]:
```
Camp=col_df.groupby(["campaign","y"])
Camp_count=Camp['y'].count().unstack()
Camp_count.head(15)
```

Out[143]:
```
y              no     yes
campaign
1         14983.0  2561.0
2         11104.0  1401.0
3          4903.0   618.0
4          3205.0   317.0
5          1625.0   139.0
6          1199.0    92.0
7           688.0    47.0
8           508.0    32.0
9           306.0    21.0
10          252.0    14.0
11          185.0    16.0
12          151.0     4.0
13          127.0     6.0
14           89.0     4.0
15           80.0     4.0
```

7 4. O resultado da campanha anterior tem relevância na campanha atual?

7.1 Para isto usaremos os resultados apresentados em na resposta à pergunta 1.

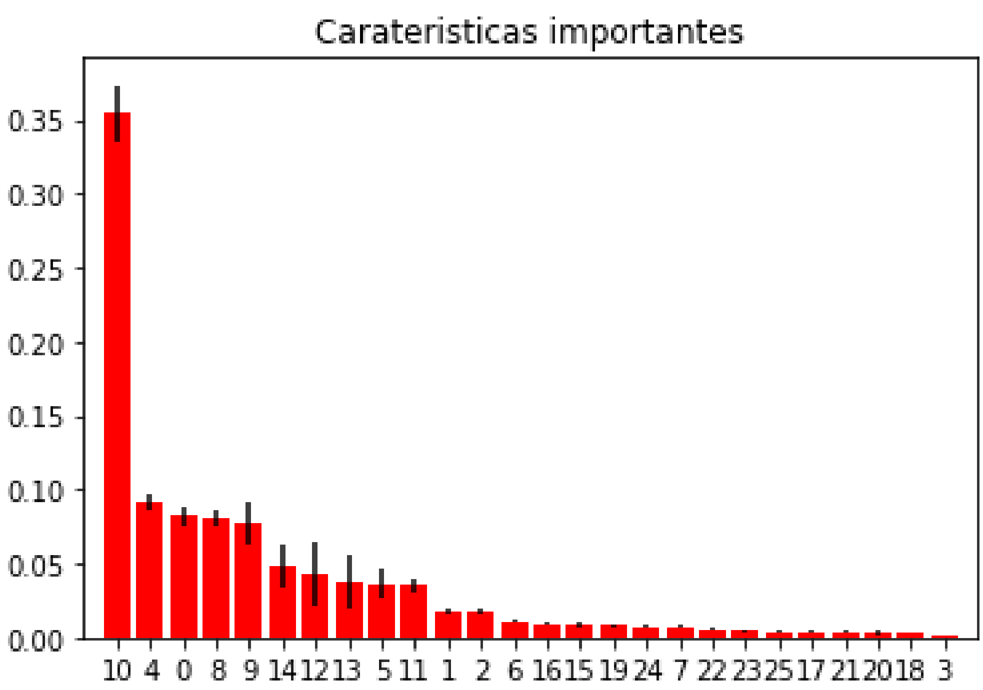
7.2 Usando os valores 9 a 16 deacordo com o bank-names.csv fornecido com o problema, como valores de entrada no modelo. E y (17) como saída do mesmo.

In [144]:
```
print("ranking das Caracteristicas:")

for f in range(df_train_features_subset.shape[1]):
    print("%d. feature %d (%f)" % (f + 1, indices[f], importance[indices[f]]))

# Plot the feature importances of the forest
plt.figure()
plt.title("Carateristicas importantes")
plt.bar(range(df_train_features_subset.shape[1]), importance[indices],
       color="r", yerr=std1[indices], align="center")
plt.xticks(range(df_train_features_subset.shape[1]), indices)
plt.xlim([-1, df_train_features_subset.shape[1]])
plt.show()
```

```
ranking das Caracteristicas:
1. feature 10 (0.353740)
2. feature 4 (0.090681)
3. feature 0 (0.081947)
4. feature 8 (0.081156)
5. feature 9 (0.077302)
6. feature 14 (0.048171)
7. feature 12 (0.042330)
8. feature 13 (0.036917)
9. feature 5 (0.036398)
10. feature 11 (0.035134)
11. feature 1 (0.017955)
12. feature 2 (0.017305)
13. feature 6 (0.011233)
14. feature 16 (0.009257)
15. feature 15 (0.008145)
16. feature 19 (0.007789)
17. feature 24 (0.007619)
18. feature 7 (0.007405)
19. feature 22 (0.005513)
20. feature 23 (0.004223)
21. feature 25 (0.004129)
22. feature 17 (0.003930)
23. feature 21 (0.003690)
24. feature 20 (0.003599)
25. feature 18 (0.003059)
26. feature 3 (0.001372)
```



7.3 Levando em conta o anteriora tabela acima pode ser reescrita como:

1. duration
2. month
3. pdays
4. poutcome
5. previous
6. campaign

7.4 sendo confirmado que os dados mais relevantes associados à campanha anterior são a duração o mês de contacto e a ligação poutcome. Por outra parte campaign contes a informação do ultimo contacto portanto a informação está correlata com previous.

8 6. Quais são as caracteristicas mais prominentes de um cliente para que possua um emprestimo imobiliario

8.1 Para este fim creamos um modelo de regressão entre a variável housing que inclui o credito imobiliario e as variáveis caracteristicas incluidas as de jobs, deacordo com a lassificação do item 3 e dos dados standarizados e salvos como bank_prepro_standardize_train.csv

In [145]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import StratifiedKFold

df_train = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_
df_test = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_s


del df_train['Unnamed: 0']
del df_test['Unnamed: 0']

df_train_class = pd.DataFrame(df_train['housing'])
df_train_features = df_train.loc[:, df_train.columns != 'housing']

# Classificador Aleatorio de floresta
n_estimador_lista = range(10, 50, 5)

skf_model = StratifiedKFold(n_splits=5,shuffle=True)

Numero_iteracoes = 1
for t in range(0,Numero_iteracoes):
    print ("---Iteration: ",t)
    AVG_ACC = np.zeros(shape=[len(n_estimador_lista)])
    STD_ACC = np.zeros(shape=[len(n_estimador_lista)])
```

```
        x_count = 0
        for k_val in n_estimador_lista:
            Lista_Acuracia_Temp = []

            for Indice_subCindice, cv_index in skf_model.split(df_train_features,df_trai
                df_train_features_subset = df_train_features.loc[Indice_subCindice]
                df_train_class_subset = df_train_class.loc[Indice_subCindice]
                df_train_features_cv = df_train_features.loc[cv_index]
                df_train_class_cv = df_train_class.loc[cv_index]

                BA_modelo = RandomForestClassifier(n_estimators=k_val, class_weight='bala
                BA_modelo.fit(df_train_features_subset, df_train_class_subset)
                contagem = BA_modelo.score(df_train_features_cv, df_train_class_cv)
                Lista_Acuracia_Temp.append(contagem)

            AVG_ACC[x_count] = np.mean(Lista_Acuracia_Temp)
            STD_ACC[x_count] = np.std(Lista_Acuracia_Temp)
            x_count += 1

        if t==0:
            final_AVG_ACC = AVG_ACC
            final_STD_ACC = STD_ACC
        else:
            final_AVG_ACC = np.vstack([final_AVG_ACC, AVG_ACC])
            final_STD_ACC = np.vstack([final_STD_ACC, STD_ACC])

    Lista_Acc_meia_final = np.mean(final_AVG_ACC, axis=0)
    final_k_indice = np.argmax(Lista_Acc_meia_final)

    Escolha_k= n_estimador_lista[final_k_indice]
    print ("Cross Validation - Numero de Estimadores pela Floresta A : ",Escolha_k)

    BA_modelo_final = RandomForestClassifier(n_estimators=Escolha_k, class_weight='balan
    BA_modelo_final.fit(df_train_features, df_train_class)

    importance=BA_modelo_final.feature_importances_

    std1 = np.std([tree.feature_importances_ for tree in BA_modelo_final.estimators_],
                 axis=0)
    indices = np.argsort(importance)[::-1]
```

```
---Iteration:  0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```

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```

```
Cross Validation - Numero de Estimadores pela Floresta A :  10
```

```
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:58: DataConversionWar
```

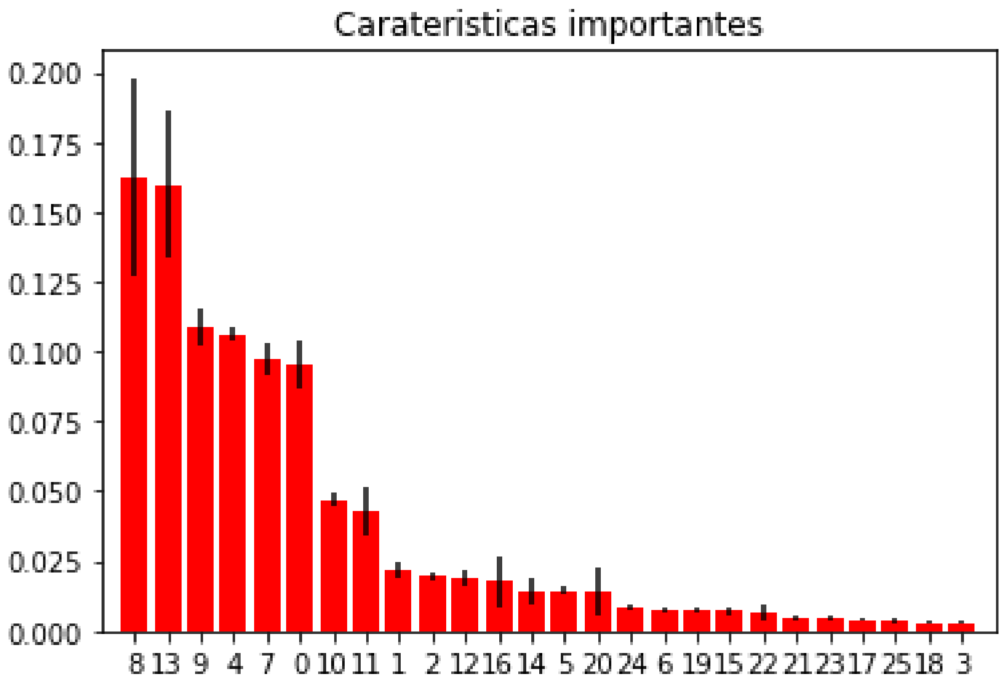
In [146]:
```python
print("ranking das Caracteristicas:")

for f in range(df_train_features_subset.shape[1]):
```

```
            print("%d. feature %d (%f)" % (f + 1, indices[f], importance[indices[f]]))

        # Plot the feature importances of the forest
        plt.figure()
        plt.title("Carateristicas importantes")
        plt.bar(range(df_train_features_subset.shape[1]), importance[indices],
               color="r", yerr=std1[indices], align="center")
        plt.xticks(range(df_train_features_subset.shape[1]), indices)
        plt.xlim([-1, df_train_features_subset.shape[1]])
        plt.show()
```

```
ranking das Caracteristicas:
1. feature 8 (0.162519)
2. feature 13 (0.159573)
3. feature 9 (0.108606)
4. feature 4 (0.106350)
5. feature 7 (0.097721)
6. feature 0 (0.095319)
7. feature 10 (0.047008)
8. feature 11 (0.042828)
9. feature 1 (0.021796)
10. feature 2 (0.019566)
11. feature 12 (0.019360)
12. feature 16 (0.017659)
13. feature 14 (0.014380)
14. feature 5 (0.014318)
15. feature 20 (0.014080)
16. feature 24 (0.008648)
17. feature 6 (0.007427)
18. feature 19 (0.007372)
19. feature 15 (0.007062)
20. feature 22 (0.006427)
21. feature 21 (0.004410)
22. feature 23 (0.004246)
23. feature 17 (0.003681)
24. feature 25 (0.003627)
25. feature 18 (0.003018)
26. feature 3 (0.002999)
```



9 deacordo ao modelo e os dados analizados, pode se concluir que as 5 variáveis mais importantes associadas ao credito de vivienda são:

1. Month
2. Outcome
3. duration
4. balance
5. age

10 5. Qual o fator determinante para que o banco exija um seguro de credito

In [147]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import StratifiedKFold

df_train = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_
df_test = pd.read_csv('/media/andres/dados1/semantix_teste/desafio/Data/bank_prepro_s


del df_train['Unnamed: 0']
del df_test['Unnamed: 0']

df_train_class = pd.DataFrame(df_train['default'])
```

```python
df_train_features = df_train.loc[:, df_train.columns != 'default']

# Classificador Aleatorio de floresta
n_estimador_lista = range(10, 50, 5)

skf_model = StratifiedKFold(n_splits=5,shuffle=True)

Numero_iteracoes = 1
for t in range(0,Numero_iteracoes):
    print ("---Iteration: ",t)
    AVG_ACC = np.zeros(shape=[len(n_estimador_lista)])
    STD_ACC = np.zeros(shape=[len(n_estimador_lista)])

    x_count = 0
    for k_val in n_estimador_lista:
        Lista_Acuracia_Temp = []

        for Indice_subCindice, cv_index in skf_model.split(df_train_features,df_trai
            df_train_features_subset = df_train_features.loc[Indice_subCindice]
            df_train_class_subset = df_train_class.loc[Indice_subCindice]
            df_train_features_cv = df_train_features.loc[cv_index]
            df_train_class_cv = df_train_class.loc[cv_index]

            BA_modelo = RandomForestClassifier(n_estimators=k_val, class_weight='bal
            BA_modelo.fit(df_train_features_subset, df_train_class_subset)
            contagem = BA_modelo.score(df_train_features_cv, df_train_class_cv)
            Lista_Acuracia_Temp.append(contagem)

        AVG_ACC[x_count] = np.mean(Lista_Acuracia_Temp)
        STD_ACC[x_count] = np.std(Lista_Acuracia_Temp)
        x_count += 1

    if t==0:
        final_AVG_ACC = AVG_ACC
        final_STD_ACC = STD_ACC
    else:
        final_AVG_ACC = np.vstack([final_AVG_ACC, AVG_ACC])
        final_STD_ACC = np.vstack([final_STD_ACC, STD_ACC])

Lista_Acc_meia_final = np.mean(final_AVG_ACC, axis=0)
final_k_indice = np.argmax(Lista_Acc_meia_final)

Escolha_k= n_estimador_lista[final_k_indice]
print ("Cross Validation - Numero de Estimadores pela Floresta A : ",Escolha_k)

BA_modelo_final = RandomForestClassifier(n_estimators=Escolha_k, class_weight='balan
BA_modelo_final.fit(df_train_features, df_train_class)
```

```python
importance=BA_modelo_final.feature_importances_

std1 = np.std([tree.feature_importances_ for tree in BA_modelo_final.estimators_],
             axis=0)
indices = np.argsort(importance)[::-1]
```

```
---Iteration:  0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/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWar
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWar
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWar
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWar
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWar
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWar
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWar
```

```
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:36: DataConversionWarr
```

```
Cross Validation - Numero de Estimadores pela Floresta A :  10
```

```
/home/andres/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:58: DataConversionWarr
```

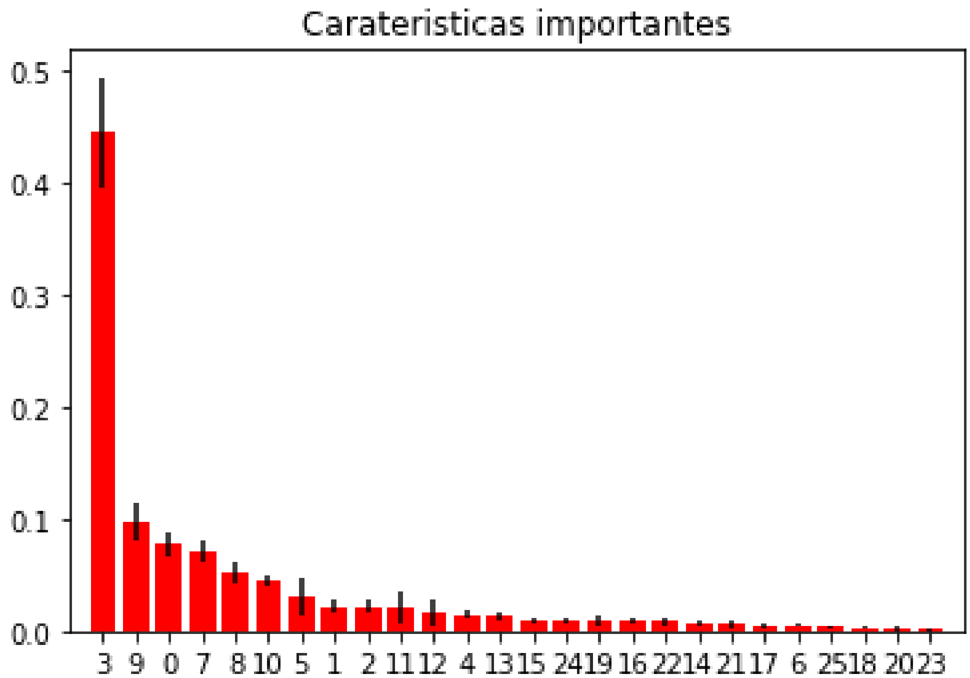
In [148]:
```python
print("ranking das Caracteristicas:")

for f in range(df_train_features_subset.shape[1]):
    print("%d. feature %d (%f)" % (f + 1, indices[f], importance[indices[f]]))

# Plot the feature importances of the forest
plt.figure()
plt.title("Carateristicas importantes")
plt.bar(range(df_train_features_subset.shape[1]), importance[indices],
       color="r", yerr=std1[indices], align="center")
plt.xticks(range(df_train_features_subset.shape[1]), indices)
plt.xlim([-1, df_train_features_subset.shape[1]])
plt.show()
```

```
ranking das Caracteristicas:
1. feature 3 (0.443842)
2. feature 9 (0.097340)
3. feature 0 (0.076962)
4. feature 7 (0.070953)
5. feature 8 (0.051983)
6. feature 10 (0.044437)
7. feature 5 (0.031281)
8. feature 1 (0.021719)
9. feature 2 (0.021610)
10. feature 11 (0.020790)
11. feature 12 (0.016020)
12. feature 4 (0.014135)
13. feature 13 (0.012688)
14. feature 15 (0.009145)
15. feature 24 (0.008780)
16. feature 19 (0.008718)
17. feature 16 (0.008671)
18. feature 22 (0.008200)
19. feature 14 (0.007275)
20. feature 21 (0.005696)
21. feature 17 (0.005054)
22. feature 6 (0.004727)
23. feature 25 (0.003779)
24. feature 18 (0.003027)
25. feature 20 (0.002227)
```

```
26. feature 23 (0.000942)
```



11 Analizando também o modelo de balance vs as outras carateristica também podemos inferir algunas informações relevantes, dado que o cliente com saldo negativo anuual pode também representar um risco e precisar de um seguro de emprestimo. No ponto 6. pode ser visto que o balance é um ponto relevante para adquirir um emprestimo. Dado isto e a imformação acima, pode se concluir que as 5 variáveis mais importantes associadas ao seguro para credito são:

1. balance (3)
2. age (0)
3. loan (5)
4. marital (1)
5. education (2)

```
In [ ]:
```