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Факультет «Информатика, искусственный и системы управления»

Кафедра «Системы обработки информации и управления»

Отчет по Лабораторной работе №4

«*Линейные модели,*

SVM и деревья решений»

по дисциплине «Технология машинного обучения»

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2023 г.

In [1]:
```
%pip install graphviz
```

```
Requirement already satisfied: graphviz in ./opt/anaconda3/lib/python3.9/site-packages (0.20.1)
Note: you may need to restart the kernel to use updated packages.
```

In [2]:
```
%pip install pydotplus
```

```
Requirement already satisfied: pydotplus in ./opt/anaconda3/lib/python3.9/site-packages (2.0.2)
Requirement already satisfied: pyparsing>=2.0.1 in ./opt/anaconda3/lib/python3.9/site-packages (from pydotplus)
(3.0.9)
Note: you may need to restart the kernel to use updated packages.
```

Предварительный анализ

Загрузим необходимые библиотеки

In [47]:
```
from io import StringIO
from IPython.display import Image
import graphviz
import pydotplus
import numpy as np
import pandas as pd
from typing import Dict, Tuple
from sklearn.datasets import load_iris, load_wine, load_boston
from sklearn.tree import DecisionTreeClassifier, DecisionTreeRegressor, export_graphviz
from sklearn.model_selection import train_test_split
from sklearn.model_selection import GridSearchCV
from sklearn.ensemble import RandomForestRegressor, GradientBoostingRegressor
from sklearn.ensemble import RandomForestClassifier, GradientBoostingClassifier
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import median_absolute_error, r2_score
from sklearn.svm import NuSVR
from sklearn import tree
import matplotlib.pyplot as plt
%matplotlib inline
```

In [4]:
```
df = pd.read_csv('gym.csv')
```

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

Out[5]:

	Unnamed: 0	gender	Near_Location	Partner	Promo_friends	Phone	Contract_period	Group_visits	Age	Avg_additional_charges_total	Mont
0	0	1	1	1	1	0	6	1	29	14.227470	
1	1	0	1	0	0	1	12	1	31	113.202938	
2	2	0	1	1	0	1	1	0	28	129.448479	
3	3	0	1	1	1	1	12	1	33	62.669863	
4	4	1	1	1	1	1	1	0	26	198.362265	

In [6]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4000 entries, 0 to 3999
Data columns (total 15 columns):
 #   Column                             Non-Null Count  Dtype  
---  ------                             --------------  -----  
 0   Unnamed: 0                         4000 non-null   int64  
 1   gender                             4000 non-null   int64  
 2   Near_Location                      4000 non-null   int64  
 3   Partner                            4000 non-null   int64  
 4   Promo_friends                      4000 non-null   int64  
 5   Phone                              4000 non-null   int64  
 6   Contract_period                    4000 non-null   int64  
 7   Group_visits                       4000 non-null   int64  
 8   Age                                4000 non-null   int64  
 9   Avg_additional_charges_total       4000 non-null   float64
 10  Month_to_end_contract              4000 non-null   float64
 11  Lifetime                           4000 non-null   int64  
 12  Avg_class_frequency_total          4000 non-null   float64
 13  Avg_class_frequency_current_month  4000 non-null   float64
 14  Churn                              4000 non-null   int64  
dtypes: float64(4), int64(11)
memory usage: 468.9 KB
```

С использованием метода train_test_split разделим выборку на обучающую и тестовую.

Построим модель бинарной классификации пользователей, где целевой признак - факт оттока пользователя в следующем месяце.

In [8]:

```
X = df.drop(['Churn'], axis = 1)
y = df['Churn']
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=0)
scaler = StandardScaler()
X_train_st = scaler.fit_transform(X_train)
X_test_st = scaler.transform(X_test)
```

Логистическая регрессия

In [9]:

```
lr_model = LogisticRegression(random_state=0)
lr_model.fit(X_train_st, y_train)
lr_predictions = lr_model.predict(X_test_st)
lr_probabilities = lr_model.predict_proba(X_test_st)[:,1]
print('Метрики для модели логистической регрессии:')
print('accuracy_score: {}\nprecision_score: {}\nrecall_score:{}'.format(
    accuracy_score(y_test, lr_predictions),
    precision_score(y_test, lr_predictions),
    recall_score(y_test, lr_predictions)
))
```

```
Метрики для модели логистической регрессии:
accuracy_score: 0.92375
precision_score: 0.8586387434554974
recall_score:0.8282828282828283
```

In [10]:

```
features = pd.DataFrame(lr_model.coef_.T, X.columns).reset_index()
features.columns = ['feature', 'coef']
features['coef'] = features['coef'].apply(lambda x: abs(x))
features = features.sort_values(by='coef', ascending=False)
print('\nКоэффициенты признаков в оптимальной функции логистической регрессии:')
print(features)
```

```
Коэффициенты признаков в оптимальной функции логистической регрессии:
                              feature      coef
13  Avg_class_frequency_current_month  4.464397
11                           Lifetime  3.847031
12          Avg_class_frequency_total  3.310909
8                                 Age  1.091190
6                     Contract_period  0.719265
9        Avg_additional_charges_total  0.554970
10             Month_to_end_contract  0.530538
7                        Group_visits  0.394999
4                       Promo_friends  0.278891
3                             Partner  0.079610
2                        Near_Location  0.073833
0                          Unnamed: 0  0.053905
1                              gender  0.012632
5                               Phone  0.006023
```

SVM

In [11]:

```
# SVM
scaler = StandardScaler().fit(X_train)
x_train_scaled = pd.DataFrame(scaler.transform(X_train), columns=X_train.columns)
x_test_scaled = pd.DataFrame(scaler.transform(X_test), columns=X_train.columns)
x_train_scaled.describe()
```

Out[11]:

	Unnamed: 0	gender	Near_Location	Partner	Promo_friends	Phone	Contract_period	Group_visits	Ag
count	3.200000e+03	3.200000e+03	3.200000e+03	3.200000e+03	3.200000e+03	3.200000e+03	3.200000e+03	3.200000e+03	3.200000e+0
mean	-3.629042e-17	-2.720046e-17	6.068063e-17	-4.127254e-16	3.320261e-16	-7.208470e-16	5.218048e-17	-4.921064e-16	3.892026e-
std	1.000156e+00	1.000156e+00	1.000156e+00	1.000156e+00	1.000156e+00	1.000156e+00	1.000156e+00	1.000156e+00	1.000156e+0
min	-1.747211e+00	-1.015114e+00	-2.395171e+00	-9.692234e-01	-6.756712e-01	-3.161734e+00	-8.129907e-01	-8.476923e-01	-3.437389e+0
25%	-8.567368e-01	-1.015114e+00	4.175068e-01	-9.692234e-01	-6.756712e-01	3.162821e-01	-8.129907e-01	-8.476923e-01	-6.565017e-0
50%	6.519114e-04	9.851108e-01	4.175068e-01	-9.692234e-01	-6.756712e-01	3.162821e-01	-8.129907e-01	-8.476923e-01	-3.852687e-0
75%	8.615233e-01	9.851108e-01	4.175068e-01	1.031754e+00	1.480010e+00	3.162821e-01	2.861095e-01	1.179673e+00	5.794480e-0
max	1.733713e+00	9.851108e-01	4.175068e-01	1.031754e+00	1.480010e+00	3.162821e-01	1.605030e+00	1.179673e+00	3.669322e+0

In [12]:

```
nusvr_05 = NuSVR(nu=0.7, gamma = 'scale')
nusvr_05.fit(X_train, y_train)
```

Out[12]:

```
NuSVR(nu=0.7)
```

Дерево решений

In [53]:

```
dt_none = DecisionTreeRegressor(max_depth=3)
dt_none.fit(X_train, y_train)
```

Out[53]:

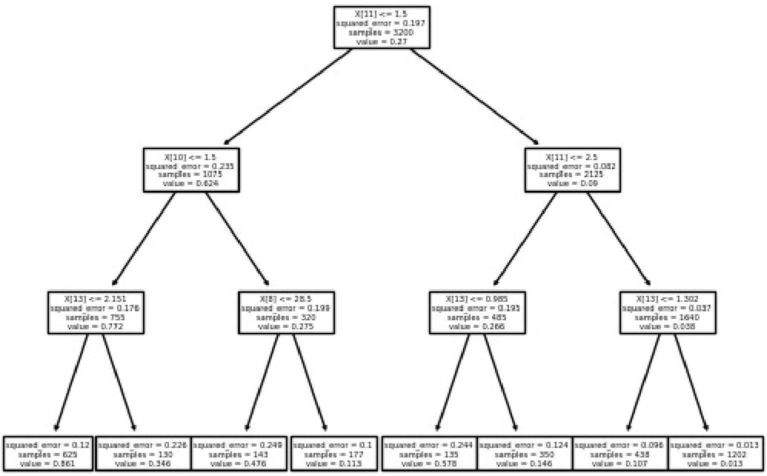
```
DecisionTreeRegressor(max_depth=3)
```

In [54]:

```
tree.plot_tree(dt_none)
```

Out[54]:

```
[Text(0.5, 0.875, 'X[11] <= 1.5\nsquared_error = 0.197\nsamples = 3200\nvalue = 0.27'),
 Text(0.25, 0.625, 'X[10] <= 1.5\nsquared_error = 0.235\nsamples = 1075\nvalue = 0.624'),
 Text(0.125, 0.375, 'X[13] <= 2.151\nsquared_error = 0.176\nsamples = 755\nvalue = 0.772'),
 Text(0.0625, 0.125, 'squared_error = 0.12\nsamples = 625\nvalue = 0.861'),
 Text(0.1875, 0.125, 'squared_error = 0.226\nsamples = 130\nvalue = 0.346'),
 Text(0.375, 0.375, 'X[8] <= 28.5\nsquared_error = 0.199\nsamples = 320\nvalue = 0.275'),
 Text(0.3125, 0.125, 'squared_error = 0.249\nsamples = 143\nvalue = 0.476'),
 Text(0.4375, 0.125, 'squared_error = 0.1\nsamples = 177\nvalue = 0.113'),
 Text(0.75, 0.625, 'X[11] <= 2.5\nsquared_error = 0.082\nsamples = 2125\nvalue = 0.09'),
 Text(0.625, 0.375, 'X[13] <= 0.985\nsquared_error = 0.195\nsamples = 485\nvalue = 0.266'),
 Text(0.5625, 0.125, 'squared_error = 0.244\nsamples = 135\nvalue = 0.578'),
 Text(0.6875, 0.125, 'squared_error = 0.124\nsamples = 350\nvalue = 0.146'),
 Text(0.875, 0.375, 'X[13] <= 1.302\nsquared_error = 0.037\nsamples = 1640\nvalue = 0.038'),
 Text(0.8125, 0.125, 'squared_error = 0.096\nsamples = 438\nvalue = 0.107'),
 Text(0.9375, 0.125, 'squared_error = 0.013\nsamples = 1202\nvalue = 0.013')]
```



In [22]:

```
clf = DecisionTreeClassifier(random_state=1)
clf.fit(X_train, y_train)
```

Out[22]:

```
DecisionTreeClassifier(random_state=1)
```

In [19]:

```
def test_model(model):
    print("mean_absolute_error:",
          mean_absolute_error(y_test, model.predict(X_test)))
    print("median_absolute_error:",
          median_absolute_error(y_test, model.predict(X_test)))
    print("r2_score:",
          r2_score(y_test, model.predict(X_test)))
```

In [17]:

```
test_model(dt_none)
```

```
mean_absolute_error: 0.10875
median_absolute_error: 0.0
r2_score: 0.4160877881808114
```

In [21]:

```
from IPython.core.display import HTML
from sklearn.tree import export_text
tree_rules = export_text(dt_none, feature_names=list(X.columns))
HTML('<pre>' + tree_rules + '</pre>')
```

Out[21]:

```
|--- Lifetime <= 1.50
|   |--- Contract_period <= 3.50
|   |   |--- Avg_class_frequency_current_month <= 2.15
|   |   |   |--- Age <= 32.50
|   |   |   |   |--- Avg_additional_charges_total <= 309.60
|   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.26
|   |   |   |   |   |   |--- Avg_additional_charges_total <= 246.27
|   |   |   |   |   |   |   |--- Unnamed: 0 <= 10.50
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.05
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.05
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Unnamed: 0 >  10.50
|   |   |   |   |   |   |   |   |--- Age <= 29.50
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 122.85
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  122.85
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 123.42
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  123.42
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 5
|   |   |   |   |   |   |   |   |--- Age >  29.50
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 2216.00
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 2055.50
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 5
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  2055.50
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  2216.00
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_additional_charges_total >  246.27
|   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 0.76
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.07
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  0.07
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 289.65
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  289.65
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_total >  0.76
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.08
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.08
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.14
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.14
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Avg_class_frequency_current_month >  1.26
|   |   |   |   |   |   |--- Age <= 28.50
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 130.86
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.07
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.61
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.61
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.61
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.61
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  2.07
|   |   |   |   |   |   |   |   |   |--- Phone <= 0.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Phone >  0.50
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  130.86
|   |   |   |   |   |   |   |   |--- Lifetime <= 0.50
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Lifetime >  0.50
|   |   |   |   |   |   |   |   |   |--- Age <= 25.50
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 133.23
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  133.23
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Age >  25.50
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 213.80
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 4
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  213.80
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 3
|   |   |   |   |   |   |--- Age >  28.50
|   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.70
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 172.76
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.65
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.36
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 3
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.36
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 4
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.65
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  172.76
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.70
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.65
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.65
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.92
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 146.80
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  146.80
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 2
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.92
|   |   |   |   |   |   |   |   |   |   |--- Partner <= 0.50
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 2
|   |   |   |   |   |   |   |   |   |   |--- Partner >  0.50
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 2
|   |   |   |   |--- Avg_additional_charges_total >  309.60
|   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.33
|   |   |   |   |   |   |--- Group_visits <= 0.50
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Group_visits >  0.50
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |--- Avg_class_frequency_current_month >  1.33
|   |   |   |   |   |   |--- value: [0.00]
|   |   |   |--- Age >  32.50
|   |   |   |   |--- Avg_class_frequency_current_month <= 0.33
|   |   |   |   |   |--- value: [1.00]
|   |   |   |   |--- Avg_class_frequency_current_month >  0.33
|   |   |   |   |   |--- Avg_class_frequency_total <= 2.16
|   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.49
|   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.40
|   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 1206.00
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.22
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.22
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Unnamed: 0 >  1206.00
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 3388.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  3388.50
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.80
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  0.80
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.40
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.49
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 214.89
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  214.89
|   |   |   |   |   |   |   |   |--- gender <= 0.50
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- gender >  0.50
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |--- Avg_class_frequency_total >  2.16
|   |   |   |   |   |   |--- value: [1.00]
|   |   |--- Avg_class_frequency_current_month >  2.15
|   |   |   |--- Age <= 26.50
|   |   |   |   |--- Avg_class_frequency_total <= 2.48
|   |   |   |   |   |--- Avg_additional_charges_total <= 181.75
|   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Avg_additional_charges_total >  181.75
|   |   |   |   |   |   |--- Unnamed: 0 <= 2037.50
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Unnamed: 0 >  2037.50
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |--- Avg_class_frequency_total >  2.48
|   |   |   |   |   |--- Lifetime <= 0.50
|   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Lifetime >  0.50
|   |   |   |   |   |   |--- Unnamed: 0 <= 1761.00
|   |   |   |   |   |   |   |--- Age <= 24.50
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Age >  24.50
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Unnamed: 0 >  1761.00
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |--- Age >  26.50
|   |   |   |   |--- Avg_class_frequency_total <= 3.18
|   |   |   |   |   |--- Unnamed: 0 <= 1981.00
|   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.58
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 144.18
|   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 941.00
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 699.00
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  699.00
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Unnamed: 0 >  941.00
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  144.18
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.27
|   |   |   |   |   |   |   |   |   |--- Partner <= 0.50
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Partner >  0.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  2.27
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.64
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.64
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_class_frequency_current_month >  2.58
|   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.48
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.48
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 3.15
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 3.05
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  3.05
|   |   |   |   |   |   |   |   |   |   |--- Group_visits <= 0.50
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Group_visits >  0.50
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  3.15
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Unnamed: 0 >  1981.00
|   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.85
|   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.87
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.87
|   |   |   |   |   |   |   |   |--- Near_Location <= 0.50
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.38
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.38
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Near_Location >  0.50
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 208.73
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  208.73
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 214.80
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  214.80
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_total >  2.85
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 135.20
|   |   |   |   |   |   |   |   |--- Group_visits <= 0.50
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Group_visits >  0.50
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  135.20
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |--- Avg_class_frequency_total >  3.18
|   |   |   |   |   |--- value: [0.00]
|   |--- Contract_period >  3.50
|   |   |--- Age <= 28.50
|   |   |   |--- Avg_class_frequency_current_month <= 2.17
|   |   |   |   |--- Month_to_end_contract <= 7.50
|   |   |   |   |   |--- Age <= 25.50
|   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Age >  25.50
|   |   |   |   |   |   |--- Unnamed: 0 <= 3233.00
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 96.39
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 0.03
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  0.03
|   |   |   |   |   |   |   |   |   |--- Age <= 26.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Age >  26.50
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  96.39
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.11
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  0.11
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.03
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 347.69
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  347.69
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.03
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Unnamed: 0 >  3233.00
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |--- Month_to_end_contract >  7.50
|   |   |   |   |   |--- Avg_class_frequency_total <= 1.74
|   |   |   |   |   |   |--- Avg_additional_charges_total <= 82.53
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 63.11
|   |   |   |   |   |   |   |   |--- gender <= 0.50
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- gender >  0.50
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  63.11
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_additional_charges_total >  82.53
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |--- Avg_class_frequency_total >  1.74
|   |   |   |   |   |   |--- Group_visits <= 0.50
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Group_visits >  0.50
|   |   |   |   |   |   |   |--- Promo_friends <= 0.50
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Promo_friends >  0.50
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |--- Avg_class_frequency_current_month >  2.17
|   |   |   |   |--- Avg_additional_charges_total <= 10.85
|   |   |   |   |   |--- value: [1.00]
|   |   |   |   |--- Avg_additional_charges_total >  10.85
|   |   |   |   |   |--- Avg_class_frequency_total <= 2.50
|   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.37
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.74
|   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 3720.50
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Unnamed: 0 >  3720.50
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  2.74
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_class_frequency_total >  2.37
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 169.49
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.42
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.42
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  169.49
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Avg_class_frequency_total >  2.50
|   |   |   |   |   |   |--- value: [0.00]
|   |   |--- Age >  28.50
|   |   |   |--- Avg_class_frequency_current_month <= 0.03
|   |   |   |   |--- Avg_additional_charges_total <= 31.69
|   |   |   |   |   |--- value: [0.00]
|   |   |   |   |--- Avg_additional_charges_total >  31.69
|   |   |   |   |   |--- value: [1.00]
|   |   |   |--- Avg_class_frequency_current_month >  0.03
|   |   |   |   |--- Lifetime <= 0.50
|   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.01
|   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.64
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 2.74
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  2.74
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.17
|   |   |   |   |   |   |   |   |   |--- Age <= 29.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Age >  29.50
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  0.17
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_total >  1.64
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Avg_class_frequency_current_month >  2.01
|   |   |   |   |   |   |--- Age <= 29.50
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.72
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  2.72
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Age >  29.50
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |--- Lifetime >  0.50
|   |   |   |   |   |--- Avg_additional_charges_total <= 57.65
|   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.67
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.06
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.06
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.67
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |--- Avg_additional_charges_total >  57.65
|   |   |   |   |   |   |--- Age <= 31.50
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.08
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.10
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 86.57
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 1294.00
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  1294.00
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  86.57
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 2451.00
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  2451.00
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 2
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.10
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  2.08
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Age >  31.50
|   |   |   |   |   |   |   |--- value: [0.00]
|--- Lifetime >  1.50
|   |--- Lifetime <= 2.50
|   |   |--- Avg_class_frequency_current_month <= 0.98
|   |   |   |--- Avg_class_frequency_total <= 0.94
|   |   |   |   |--- Avg_class_frequency_current_month <= 0.13
|   |   |   |   |   |--- Avg_class_frequency_total <= 0.19
|   |   |   |   |   |   |--- Avg_additional_charges_total <= 130.77
|   |   |   |   |   |   |   |--- Unnamed: 0 <= 1401.50
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Unnamed: 0 >  1401.50
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_additional_charges_total >  130.77
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |--- Avg_class_frequency_total >  0.19
|   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |--- Avg_class_frequency_current_month >  0.13
|   |   |   |   |   |--- Month_to_end_contract <= 4.50
|   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.33
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 297.30
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  297.30
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_current_month >  0.33
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 128.67
|   |   |   |   |   |   |   |   |--- Age <= 28.50
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 61.52
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 0.69
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  0.69
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  61.52
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Age >  28.50
|   |   |   |   |   |   |   |   |   |--- Promo_friends <= 0.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Promo_friends >  0.50
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  128.67
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |--- Month_to_end_contract >  4.50
|   |   |   |   |   |   |--- value: [0.00]
|   |   |   |--- Avg_class_frequency_total >  0.94
|   |   |   |   |--- Avg_class_frequency_current_month <= 0.96
|   |   |   |   |   |--- value: [1.00]
|   |   |   |   |--- Avg_class_frequency_current_month >  0.96
|   |   |   |   |   |--- Group_visits <= 0.50
|   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Group_visits >  0.50
|   |   |   |   |   |   |--- value: [0.00]
|   |   |--- Avg_class_frequency_current_month >  0.98
|   |   |   |--- Month_to_end_contract <= 2.00
|   |   |   |   |--- Age <= 27.50
|   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.17
|   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.72
|   |   |   |   |   |   |   |--- Group_visits <= 0.50
|   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 2212.00
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Unnamed: 0 >  2212.00
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Group_visits >  0.50
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.02
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.02
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_total >  1.72
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Avg_class_frequency_current_month >  2.17
|   |   |   |   |   |   |--- Avg_additional_charges_total <= 56.52
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_additional_charges_total >  56.52
|   |   |   |   |   |   |   |--- gender <= 0.50
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 115.69
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  115.69
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- gender >  0.50
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |--- Age >  27.50
|   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.85
|   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.82
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 107.02
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 86.30
|   |   |   |   |   |   |   |   |   |--- Near_Location <= 0.50
|   |   |   |   |   |   |   |   |   |   |--- Age <= 31.00
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |   |--- Age >  31.00
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Near_Location >  0.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  86.30
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  107.02
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_total >  1.82
|   |   |   |   |   |   |   |--- Unnamed: 0 <= 700.50
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.53
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.53
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Unnamed: 0 >  700.50
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Avg_class_frequency_current_month >  1.85
|   |   |   |   |   |   |--- Avg_additional_charges_total <= 252.90
|   |   |   |   |   |   |   |--- Phone <= 0.50
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.96
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.96
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Phone >  0.50
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_additional_charges_total >  252.90
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 259.20
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  259.20
|   |   |   |   |   |   |   |   |--- Promo_friends <= 0.50
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Promo_friends >  0.50
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 315.49
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  315.49
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |--- Month_to_end_contract >  2.00
|   |   |   |   |--- Avg_class_frequency_current_month <= 1.67
|   |   |   |   |   |--- Age <= 25.50
|   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.09
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.09
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Age >  25.50
|   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.66
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 47.81
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 43.49
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  43.49
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  47.81
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 279.96
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  279.96
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 285.07
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  285.07
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.66
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |--- Avg_class_frequency_current_month >  1.67
|   |   |   |   |   |--- value: [0.00]
|   |--- Lifetime >  2.50
|   |   |--- Avg_class_frequency_current_month <= 1.30
|   |   |   |--- Avg_class_frequency_total <= 1.43
|   |   |   |   |--- Contract_period <= 3.50
|   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.22
|   |   |   |   |   |   |--- Avg_class_frequency_total <= 0.41
|   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 52.66
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 0.02
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  0.02
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_additional_charges_total >  52.66
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_total >  0.41
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Avg_class_frequency_current_month >  0.22
|   |   |   |   |   |   |--- Avg_class_frequency_total <= 0.15
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_class_frequency_total >  0.15
|   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.26
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.27
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 0.95
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  0.95
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.81
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  0.81
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 3
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.27
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 77.08
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  77.08
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.26
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.93
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  0.93
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 339.00
|   |   |   |   |   |   |   |   |   |   |--- Group_visits <= 0.50
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |   |--- Group_visits >  0.50
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  339.00
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |--- Contract_period >  3.50
|   |   |   |   |   |--- Avg_class_frequency_current_month <= 0.01
|   |   |   |   |   |   |--- Avg_class_frequency_total <= 0.30
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Avg_class_frequency_total >  0.30
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |--- Avg_class_frequency_current_month >  0.01
|   |   |   |   |   |   |--- value: [0.00]
|   |   |   |--- Avg_class_frequency_total >  1.43
|   |   |   |   |--- Lifetime <= 7.50
|   |   |   |   |   |--- value: [1.00]
|   |   |   |   |--- Lifetime >  7.50
|   |   |   |   |   |--- value: [0.00]
|   |   |--- Avg_class_frequency_current_month >  1.30
|   |   |   |--- Avg_additional_charges_total <= 0.70
|   |   |   |   |--- Unnamed: 0 <= 3794.00
|   |   |   |   |   |--- value: [0.00]
|   |   |   |   |--- Unnamed: 0 >  3794.00
|   |   |   |   |   |--- value: [1.00]
|   |   |   |--- Avg_additional_charges_total >  0.70
|   |   |   |   |--- Age <= 24.50
|   |   |   |   |   |--- Unnamed: 0 <= 398.00
|   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.51
|   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_class_frequency_current_month >  2.51
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |--- Unnamed: 0 >  398.00
|   |   |   |   |   |   |--- Near_Location <= 0.50
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 2.05
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  2.05
|   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |--- Near_Location >  0.50
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |--- Age >  24.50
|   |   |   |   |   |--- Lifetime <= 3.50
|   |   |   |   |   |   |--- Partner <= 0.50
|   |   |   |   |   |   |   |--- Unnamed: 0 <= 3844.00
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.93
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.08
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.83
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.83
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 2
|   |   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.08
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.93
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 23.62
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 19.58
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  19.58
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  23.62
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 2737.50
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  2737.50
|   |   |   |   |   |   |   |   |   |   |   |--- truncated branch of depth 2
|   |   |   |   |   |   |   |--- Unnamed: 0 >  3844.00
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 2.65
|   |   |   |   |   |   |   |   |   |--- Month_to_end_contract <= 3.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Month_to_end_contract >  3.50
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 3953.50
|   |   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  3953.50
|   |   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |--- Avg_class_frequency_total >  2.65
|   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Partner >  0.50
|   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |--- Lifetime >  3.50
|   |   |   |   |   |   |--- Avg_class_frequency_current_month <= 1.58
|   |   |   |   |   |   |   |--- Avg_class_frequency_total <= 1.84
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 39.48
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 34.00
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  34.00
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  39.48
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Avg_class_frequency_total >  1.84
|   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |--- Avg_class_frequency_current_month >  1.58
|   |   |   |   |   |   |   |--- Unnamed: 0 <= 3681.00
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 24.33
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total <= 23.87
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  23.87
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |--- Avg_additional_charges_total >  24.33
|   |   |   |   |   |   |   |   |   |--- value: [0.00]
|   |   |   |   |   |   |   |--- Unnamed: 0 >  3681.00
|   |   |   |   |   |   |   |   |--- Unnamed: 0 <= 3690.50
|   |   |   |   |   |   |   |   |   |   |--- value: [1.00]
|   |   |   |   |   |   |   |   |   |--- Unnamed: 0 >  3690.50
|   |   |   |   |   |   |   |   |   |   |--- value: [0.00]
```

Важность признаков

In [41]:

```
list(zip(X_train.columns.values, clf.feature_importances_))
```

Out[41]:

```
[('Unnamed: 0', 0.03890444087977608),
 ('gender', 0.00583693983884679),
 ('Near_Location', 0.0012667344323994687),
 ('Partner', 0.002845916239263289),
 ('Promo_friends', 0.002961742125806938),
 ('Phone', 0.0007880349584736334),
 ('Contract_period', 0.08862262628999662),
 ('Group_visits', 0.008962379294846418),
 ('Age', 0.07710914767980905),
 ('Avg_additional_charges_total', 0.08100038165972405),
 ('Month_to_end_contract', 0.020922651769533434),
 ('Lifetime', 0.3659062244517595),
 ('Avg_class_frequency_total', 0.14481449149670683),
 ('Avg_class_frequency_current_month', 0.1600582888830579)]
```

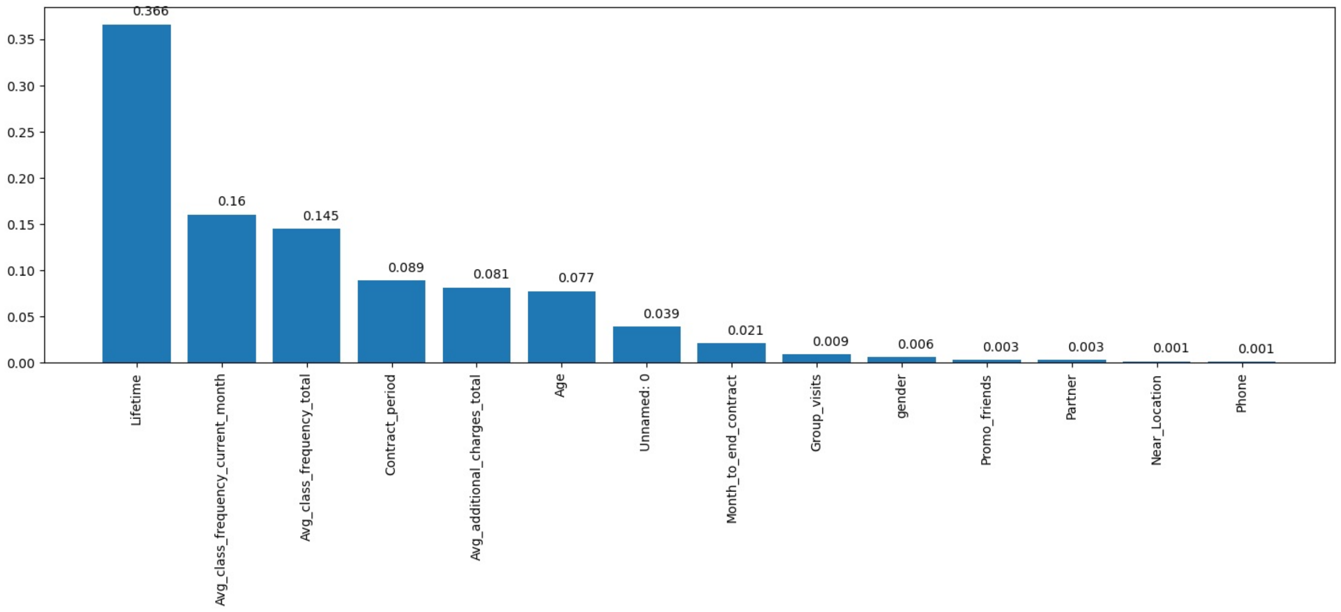
In [42]:

```
from operator import itemgetter

def draw_feature_importances(tree_model, X_dataset, figsize=(18,5)):
    """
    Вывод важности признаков в виде графика
    """
    # Сортировка значений важности признаков по убыванию
    list_to_sort = list(zip(X_dataset.columns.values, tree_model.feature_importances_))
    sorted_list = sorted(list_to_sort, key=itemgetter(1), reverse = True)
    # Названия признаков
    labels = [x for x,_ in sorted_list]
    # Важности признаков
    data = [x for _,x in sorted_list]
    # Вывод графика
    fig, ax = plt.subplots(figsize=figsize)
    ind = np.arange(len(labels))
    plt.bar(ind, data)
    plt.xticks(ind, labels, rotation='vertical')
    # Вывод значений
    for a,b in zip(ind, data):
        plt.text(a-0.05, b+0.01, str(round(b,3)))
    plt.show()
    return labels, data
```

In [43]:

```
dt_fl, dt_fd = draw_feature_importances(clf, X_train)
```



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