

task-3

August 3, 2024

```
[2]: import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.tree import DecisionTreeClassifier, plot_tree
from sklearn.metrics import accuracy_score, confusion_matrix, \
    classification_report
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.tree import export_text
```

```
[4]: data = pd.read_csv('bank.csv')
data.head()
```

```
[4]:   age      job  marital  education  default  balance  housing  loan  contact  \
0   59  admin.  married  secondary     no     2343      yes   no  unknown
1   56  admin.  married  secondary     no        45      no   no  unknown
2   41 technician  married  secondary     no    1270      yes   no  unknown
3   55  services  married  secondary     no    2476      yes   no  unknown
4   54  admin.  married   tertiary     no     184      no   no  unknown
```

```
   day month  duration  campaign  pdays  previous  poutcome  deposit
0    5   may     1042         1     -1         0  unknown     yes
1    5   may     1467         1     -1         0  unknown     yes
2    5   may     1389         1     -1         0  unknown     yes
3    5   may       579         1     -1         0  unknown     yes
4    5   may       673         2     -1         0  unknown     yes
```

```
[6]: data.tail()
```

```
[6]:   age      job  marital  education  default  balance  housing  loan  \
11157  33 blue-collar  single   primary     no         1      yes   no
11158  39  services  married  secondary     no      733      no   no
11159  32 technician  single  secondary     no       29      no   no
11160  43 technician  married  secondary     no        0      no  yes
11161  34 technician  married  secondary     no        0      no   no
```

```
   contact  day month  duration  campaign  pdays  previous  poutcome  \
```

11157	cellular	20	apr	257	1	-1	0	unknown
11158	unknown	16	jun	83	4	-1	0	unknown
11159	cellular	19	aug	156	2	-1	0	unknown
11160	cellular	8	may	9	2	172	5	failure
11161	cellular	9	jul	628	1	-1	0	unknown

	deposit
11157	no
11158	no
11159	no
11160	no
11161	no

```
[8]: data.columns
```

```
[8]: Index(['age', 'job', 'marital', 'education', 'default', 'balance', 'housing',
          'loan', 'contact', 'day', 'month', 'duration', 'campaign', 'pdays',
          'previous', 'poutcome', 'deposit'],
          dtype='object')
```

```
[10]: data.describe()
```

```
[10]:
```

	age	balance	day	duration	campaign \
count	11162.000000	11162.000000	11162.000000	11162.000000	11162.000000
mean	41.231948	1528.538524	15.658036	371.993818	2.508421
std	11.913369	3225.413326	8.420740	347.128386	2.722077
min	18.000000	-6847.000000	1.000000	2.000000	1.000000
25%	32.000000	122.000000	8.000000	138.000000	1.000000
50%	39.000000	550.000000	15.000000	255.000000	2.000000
75%	49.000000	1708.000000	22.000000	496.000000	3.000000
max	95.000000	81204.000000	31.000000	3881.000000	63.000000

	pdays	previous
count	11162.000000	11162.000000
mean	51.330407	0.832557
std	108.758282	2.292007
min	-1.000000	0.000000
25%	-1.000000	0.000000
50%	-1.000000	0.000000
75%	20.750000	1.000000
max	854.000000	58.000000

```
[12]: data.isna().sum()
```

```
[12]: age      0
      job      0
      marital  0
```

```

education    0
default      0
balance      0
housing      0
loan         0
contact      0
day          0
month        0
duration     0
campaign     0
pdays       0
previous     0
poutcome     0
deposit      0
dtype: int64

```

```
[14]: data.info()
```

```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 11162 entries, 0 to 11161
Data columns (total 17 columns):
 #   Column          Non-Null Count  Dtype
---  -
 0   age             11162 non-null  int64
 1   job             11162 non-null  object
 2   marital         11162 non-null  object
 3   education       11162 non-null  object
 4   default         11162 non-null  object
 5   balance         11162 non-null  int64
 6   housing         11162 non-null  object
 7   loan            11162 non-null  object
 8   contact         11162 non-null  object
 9   day             11162 non-null  int64
10  month           11162 non-null  object
11  duration        11162 non-null  int64
12  campaign        11162 non-null  int64
13  pdays           11162 non-null  int64
14  previous        11162 non-null  int64
15  poutcome        11162 non-null  object
16  deposit         11162 non-null  object
dtypes: int64(7), object(10)
memory usage: 1.4+ MB

```

```

[16]: features = ['age', 'job', 'marital', 'education', 'default', 'balance',
    ↪ 'housing', 'loan', 'contact', 'day', 'month', 'duration', 'campaign',
    ↪ 'pdays', 'previous', 'poutcome']
target = 'deposit'

```

```

data = pd.get_dummies(data, columns=['job', 'marital', 'education', 'default', 'housing', 'loan', 'contact', 'month', 'poutcome'], drop_first=True)
X = data.drop(target, axis=1)
y = data[target]
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)
X_train

```

```

[16]:
   age  balance  day  duration  campaign  pdays  previous  job_blue-collar \
7968  57      950   9    1272         1    -1          0          False
1456  34      925  13     709         1    -1          0          False
361   41       75   1     479         9    -1          0           True
812   46     4414  18     504         7    -1          0          False
1092  28     4465  28     769         1    -1          0          False
...  ...      ...  ...      ...      ...      ...      ...
5734  47       761  11      80         2    -1          0          False
5191  28       159  16     449         2    33          4          False
5390  35     1144  20     197        13    -1          0          False
860   51       746  25     372         5    -1          0          False
7270  30         2  23     269         1    -1          0          False

   job_entrepreneur  job_housemaid  ...  month_jul  month_jun  month_mar \
7968              False           False  ...      True      False      False
1456              False           False  ...      False      False      False
361               False           False  ...      True      False      False
812               False           False  ...      False      False      False
1092              False           False  ...      False      False      False
...              ...             ...  ...      ...      ...      ...
5734              False           False  ...      True      False      False
5191              False           False  ...      False      False      False
5390              False           False  ...      False      False      False
860               False           False  ...      False      False      False
7270              False           False  ...      False      False      True

   month_may  month_nov  month_oct  month_sep  poutcome_other \
7968      False      False      False      False      False
1456      False      False      False      False      False
361       False      False      False      False      False
812       False      False      False      False      False
1092      False      False      False      False      False
...      ...      ...      ...      ...      ...
5734      False      False      False      False      False
5191      False      True       False      False      False
5390      False      False      False      False      False
860       False      False      False      False      False
7270      False      False      False      False      False

```

	poutcome_success	poutcome_unknown
7968	False	True
1456	False	True
361	False	True
812	False	True
1092	False	True
...
5734	False	True
5191	True	False
5390	False	True
860	False	True
7270	False	True

[7813 rows x 42 columns]

[18]: X_test

```
[18]:
```

	age	balance	day	duration	campaign	pdays	previous	\
5527	65	744	5	182	1	-1	0	
4541	38	1627	16	1323	9	-1	0	
1964	35	4963	14	456	1	300	1	
5007	47	8229	8	784	2	-1	0	
8928	35	1473	12	84	3	-1	0	
...	
1052	30	495	21	641	1	-1	0	
10702	44	12	19	126	2	-1	0	
10466	44	1945	14	191	1	-1	0	
8809	55	505	17	58	1	316	1	
99	35	0	20	1205	1	-1	0	

	job_blue-collar	job_entrepreneur	job_housemaid	...	month_jul	\
5527	False	False	False	...	True	
4541	True	False	False	...	False	
1964	True	False	False	...	False	
5007	True	False	False	...	False	
8928	False	False	False	...	False	
...	
1052	False	False	False	...	False	
10702	False	False	False	...	False	
10466	False	False	False	...	False	
8809	False	False	False	...	False	
99	True	False	False	...	False	

	month_jun	month_mar	month_may	month_nov	month_oct	month_sep	\
5527	False	False	False	False	False	False	
4541	True	False	False	False	False	False	
1964	False	False	True	False	False	False	

5007	False	False	False	False	False	False
8928	False	False	True	False	False	False
...
1052	False	False	False	True	False	False
10702	False	False	False	True	False	False
10466	False	False	True	False	False	False
8809	False	False	False	False	False	False
99	False	False	True	False	False	False

	poutcome_other	poutcome_success	poutcome_unknown
5527	False	False	True
4541	False	False	True
1964	False	False	False
5007	False	False	True
8928	False	False	True
...
1052	False	False	True
10702	False	False	True
10466	False	False	True
8809	True	False	False
99	False	False	True

[3349 rows x 42 columns]

```
[25]: y_train
```

```
[25]: 7968    no
      1456    yes
      361    yes
      812    yes
      1092   yes
      ...
      5734    no
      5191    yes
      5390    no
      860     yes
      7270    no
      Name: deposit, Length: 7813, dtype: object
```

```
[27]: y_test
```

```
[27]: 5527    no
      4541    yes
      1964    yes
      5007    yes
      8928    no
      ...
```

```

1052    yes
10702   no
10466   no
8809    no
99      yes
Name: deposit, Length: 3349, dtype: object

```

```
[30]: clf = DecisionTreeClassifier(random_state=42)
      clf.fit(X_train, y_train)
```

```
[30]: DecisionTreeClassifier(random_state=42)
```

```
[32]: y_pred = clf.predict(X_test)
```

```
[34]: accuracy = accuracy_score(y_test, y_pred)
      print("Accuracy:", accuracy)
```

```
Accuracy: 0.78501045088086
```

```
[36]: conf_matrix = confusion_matrix(y_test, y_pred)
      print("Confusion Matrix:\n", conf_matrix)
```

```
Confusion Matrix:
[[1398  344]
 [ 376 1231]]
```

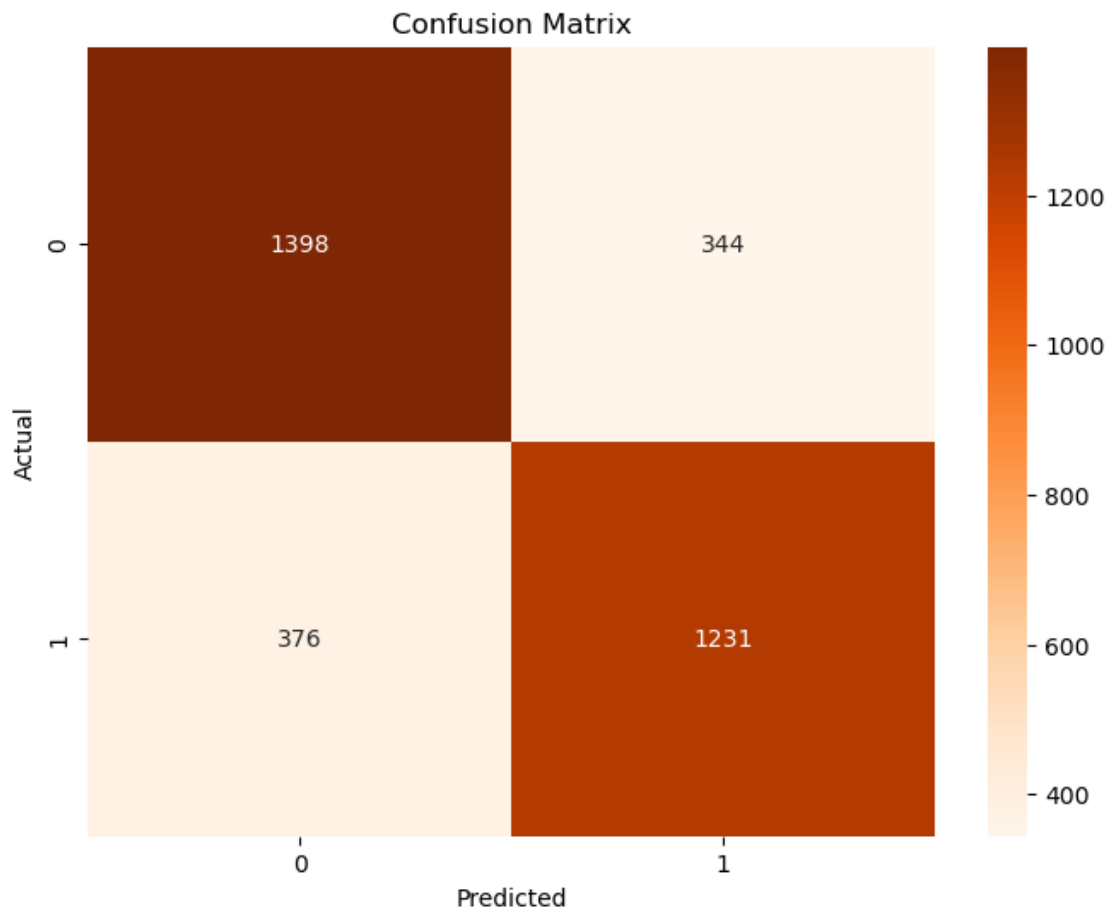
```
[38]: class_report = classification_report(y_test, y_pred)
      print("Classification Report:\n", class_report)
```

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

     no           0.79         0.80         0.80         1742
     yes           0.78         0.77         0.77         1607

 accuracy                   0.79         0.79         0.79         3349
 macro avg           0.78         0.78         0.78         3349
weighted avg           0.78         0.79         0.78         3349
```

```
[40]: confusion = confusion_matrix(y_test, y_pred)
      plt.figure(figsize=(8, 6))
      sns.heatmap(confusion, annot=True, fmt="d", cmap="Oranges")
      plt.xlabel('Predicted')
      plt.ylabel('Actual')
      plt.title('Confusion Matrix')
      plt.show()
```



```
[42]: tree_structure = export_text(clf, feature_names=list(X.columns))
      print("Decision Tree Structure:")
      print(tree_structure)
```

Decision Tree Structure:

```
|--- duration <= 251.50
|   |--- poutcome_success <= 0.50
|   |   |--- duration <= 123.50
|   |   |   |--- month_mar <= 0.50
|   |   |   |   |--- month_oct <= 0.50
|   |   |   |   |   |--- month_feb <= 0.50
|   |   |   |   |   |   |--- job_student <= 0.50
|   |   |   |   |   |   |   |--- day <= 1.50
|   |   |   |   |   |   |   |   |--- age <= 36.50
|   |   |   |   |   |   |   |   |   |--- class: no
|   |   |   |   |   |   |   |   |   |   |--- age > 36.50
|   |   |   |   |   |   |   |   |   |   |   |--- class: yes
|   |   |   |   |   |   |   |   |   |   |   |   |--- day > 1.50
|   |   |   |   |   |   |   |   |   |   |   |   |   |--- duration <= 88.50
```


[illegible]

[illegible]

```
| | | | | | |--- age > 29.50  
| | | | | | |--- class: yes  
| | | | | | |--- job_services > 0.50  
| | | | | | |--- class: no  
| | | | | |--- age > 62.00  
| | | | | | |--- age <= 69.00  
| | | | | | |--- class: no  
| | | | | | |--- age > 69.00  
| | | | | | |--- class: yes  
| | | |--- poutcome_other > 0.50  
| | | |--- class: no  
| |--- duration > 123.50  
| | |--- contact_unknown <= 0.50  
| | | |--- housing_yes <= 0.50  
| | | | |--- month_aug <= 0.50  
| | | | |--- month_jul <= 0.50  
| | | | |--- month_nov <= 0.50  
| | | | | |--- month_jan <= 0.50  
| | | | | | |--- month_feb <= 0.50  
| | | | | | |--- month_may <= 0.50  
| | | | | | |--- truncated branch of depth 20  
| | | | | | |--- month_may > 0.50  
| | | | | | |--- truncated branch of depth 8  
| | | | | |--- month_feb > 0.50  
| | | | | | |--- day <= 7.50  
| | | | | | |--- truncated branch of depth 11  
| | | | | | |--- day > 7.50  
| | | | | | |--- truncated branch of depth 3  
| | | | | |--- month_jan > 0.50  
| | | | | | |--- day <= 27.50  
| | | | | | |--- class: yes  
| | | | | | |--- day > 27.50  
| | | | | | |--- balance <= 1643.50  
| | | | | | |--- truncated branch of depth 5  
| | | | | | |--- balance > 1643.50  
| | | | | | |--- truncated branch of depth 3  
| | | |--- month_nov > 0.50  
| | | | |--- day <= 16.50  
| | | | |--- balance <= 154.00  
| | | | |--- duration <= 217.50  
| | | | |--- class: no  
| | | | |--- duration > 217.50  
| | | | |--- class: yes  
| | | |--- balance > 154.00  
| | | |--- job_retired <= 0.50  
| | | | |--- truncated branch of depth 3  
| | | | |--- job_retired > 0.50  
| | | | |--- truncated branch of depth 2
```

```
| | | | | | | | |--- day > 16.50  
| | | | | | | | |--- day <= 23.00  
| | | | | | | | |--- day <= 17.50  
| | | | | | | | |--- truncated branch of depth 2  
| | | | | | | | |--- day > 17.50  
| | | | | | | | |--- class: no  
| | | | | | | | |--- day > 23.00  
| | | | | | | | |--- class: yes  
| | | | | | |--- month_jul > 0.50  
| | | | | | |--- pdays <= 200.00  
| | | | | | |--- day <= 6.50  
| | | | | | |--- balance <= 2.50  
| | | | | | |--- class: no  
| | | | | | |--- balance > 2.50  
| | | | | | |--- class: yes  
| | | | | | |--- day > 6.50  
| | | | | | |--- age <= 26.00  
| | | | | | |--- job_services <= 0.50  
| | | | | | |--- class: yes  
| | | | | | |--- job_services > 0.50  
| | | | | | |--- class: no  
| | | | | | |--- age > 26.00  
| | | | | | |--- previous <= 1.50  
| | | | | | |--- truncated branch of depth 9  
| | | | | | |--- previous > 1.50  
| | | | | | |--- truncated branch of depth 2  
| | | | | | |--- pdays > 200.00  
| | | | | | |--- class: yes  
| | | | | | |--- month_aug > 0.50  
| | | | | | |--- pdays <= 32.00  
| | | | | | |--- campaign <= 1.50  
| | | | | | |--- duration <= 183.00  
| | | | | | |--- job_unemployed <= 0.50  
| | | | | | |--- day <= 13.50  
| | | | | | |--- class: no  
| | | | | | |--- day > 13.50  
| | | | | | |--- truncated branch of depth 2  
| | | | | | |--- job_unemployed > 0.50  
| | | | | | |--- class: yes  
| | | | | | |--- duration > 183.00  
| | | | | | |--- day <= 27.00  
| | | | | | |--- job_technician <= 0.50  
| | | | | | |--- truncated branch of depth 3  
| | | | | | |--- job_technician > 0.50  
| | | | | | |--- class: no  
| | | | | | |--- day > 27.00  
| | | | | | |--- class: no  
| | | | | | |--- campaign > 1.50
```

```
| | | | | | | | |--- age <= 26.50  
| | | | | | | | |---- duration <= 164.00  
| | | | | | | | |    |-- class: no  
| | | | | | | | |---- duration > 164.00  
| | | | | | | | |    |-- class: yes  
| | | | | | | | |---- age > 26.50  
| | | | | | | | |---- age <= 62.00  
| | | | | | | | |    |-- job_retired <= 0.50  
| | | | | | | | |      |-- truncated branch of depth 6  
| | | | | | | | |      |-- job_retired > 0.50  
| | | | | | | | |        |-- truncated branch of depth 3  
| | | | | | | | |---- age > 62.00  
| | | | | | | | |---- class: yes  
| | | | | | | | |---- pdays > 32.00  
| | | | | | | | |      |-- job_unemployed <= 0.50  
| | | | | | | | |        |-- pdays <= 586.00  
| | | | | | | | |          |-- balance <= 31.00  
| | | | | | | | |            |-- poutcome_other <= 0.50  
| | | | | | | | |              |-- class: yes  
| | | | | | | | |                |-- poutcome_other > 0.50  
| | | | | | | | |                  |-- class: no  
| | | | | | | | |                    |-- balance > 31.00  
| | | | | | | | |                      |-- class: yes  
| | | | | | | | |                        |-- pdays > 586.00  
| | | | | | | | |                          |-- class: no  
| | | | | | | | |                            |-- job_unemployed > 0.50  
| | | | | | | | |                              |-- class: no  
| | | | | | | | |---- housing_yes > 0.50  
| | | | | | | | |      |-- month_jun <= 0.50  
| | | | | | | | |        |-- month_mar <= 0.50  
| | | | | | | | |          |-- month_oct <= 0.50  
| | | | | | | | |            |-- pdays <= 1.50  
| | | | | | | | |              |-- age <= 59.50  
| | | | | | | | |                |-- month_sep <= 0.50  
| | | | | | | | |                  |-- truncated branch of depth 16  
| | | | | | | | |                    |-- month_sep > 0.50  
| | | | | | | | |                      |-- class: yes  
| | | | | | | | |                        |-- age > 59.50  
| | | | | | | | |                          |-- job_blue-collar <= 0.50  
| | | | | | | | |                            |-- class: yes  
| | | | | | | | |                              |-- job_blue-collar > 0.50  
| | | | | | | | |                                |-- class: no  
| | | | | | | | |---- pdays > 1.50  
| | | | | | | | |      |-- pdays <= 97.50  
| | | | | | | | |        |-- job_management <= 0.50  
| | | | | | | | |          |-- class: yes  
| | | | | | | | |            |-- job_management > 0.50  
| | | | | | | | |              |-- truncated branch of depth 3
```



```
| | | | | | | | | | |--- class: no  
| | | | | | | | | | |--- balance > 95.00  
| | | | | | | | | | | |--- class: yes  
| | | | | | | | | | |--- housing_yes > 0.50  
| | | | | | | | | | | |--- class: no  
| | | | | | | | | | |--- job_management > 0.50  
| | | | | | | | | | | |--- class: yes  
| | | | | | | | | |--- age > 26.50  
| | | | | | | | | | |--- month_jul <= 0.50  
| | | | | | | | | | |--- day <= 2.50  
| | | | | | | | | | | |--- duration <= 228.50  
| | | | | | | | | | | |--- class: no  
| | | | | | | | | | | |--- duration > 228.50  
| | | | | | | | | | | |--- class: yes  
| | | | | | | | | | |--- day > 2.50  
| | | | | | | | | | | |--- job_blue-collar <= 0.50  
| | | | | | | | | | | |--- class: no  
| | | | | | | | | | | |--- job_blue-collar > 0.50  
| | | | | | | | | | | |--- day <= 5.50  
| | | | | | | | | | | | |--- truncated branch of depth 2  
| | | | | | | | | | | | |--- day > 5.50  
| | | | | | | | | | | | |--- truncated branch of depth 4  
| | | | | | | | | | |--- month_jul > 0.50  
| | | | | | | | | | |--- education_secondary <= 0.50  
| | | | | | | | | | | |--- class: no  
| | | | | | | | | | |--- education_secondary > 0.50  
| | | | | | | | | | | |--- balance <= 862.50  
| | | | | | | | | | | |--- class: no  
| | | | | | | | | | | |--- balance > 862.50  
| | | | | | | | | | | |--- class: yes  
| | | | | | | | | |--- month_nov > 0.50  
| | | | | | | | | | |--- class: yes  
| | | | | | | | | |--- month_oct > 0.50  
| | | | | | | | | |--- class: yes  
|--- poutcome_success > 0.50  
| |--- duration <= 79.50  
| | |--- balance <= 1742.00  
| | | |--- class: no  
| | |--- balance > 1742.00  
| | | |--- duration <= 68.00  
| | | | |--- class: no  
| | | |--- duration > 68.00  
| | | | |--- class: yes  
|--- duration > 79.50  
| |--- duration <= 147.00  
| | |--- duration <= 145.50  
| | | |--- contact_telephone <= 0.50  
| | | |--- pdays <= 82.50
```

```
| | | | | | | |--- balance <= 98.00
| | | | | | | |--- class: yes
| | | | | | | |--- balance > 98.00
| | | | | | | |--- month_jun <= 0.50
| | | | | | | |   |--- class: no
| | | | | | | |   |--- month_jun > 0.50
| | | | | | | |     |--- age <= 43.00
| | | | | | | |       |--- class: yes
| | | | | | | |       |--- age > 43.00
| | | | | | | |         |--- class: no
| | | | | | | |--- pdays > 82.50
| | | | | | | |   |--- pdays <= 99.50
| | | | | | | |     |--- duration <= 86.50
| | | | | | | |       |--- pdays <= 93.50
| | | | | | | |         |--- class: no
| | | | | | | |         |--- pdays > 93.50
| | | | | | | |           |--- class: yes
| | | | | | | |     |--- duration > 86.50
| | | | | | | |       |--- class: yes
| | | | | | | |--- pdays > 99.50
| | | | | | | |   |--- housing_yes <= 0.50
| | | | | | | |     |--- day <= 13.50
| | | | | | | |       |--- pdays <= 182.50
| | | | | | | |         |--- class: no
| | | | | | | |         |--- pdays > 182.50
| | | | | | | |           |--- truncated branch of depth 2
| | | | | | | |     |--- day > 13.50
| | | | | | | |       |--- previous <= 6.00
| | | | | | | |         |--- truncated branch of depth 5
| | | | | | | |         |--- previous > 6.00
| | | | | | | |           |--- class: no
| | | | | | | |     |--- housing_yes > 0.50
| | | | | | | |       |--- class: yes
| | | | | | | |--- contact_telephone > 0.50
| | | | | | | |   |--- class: no
| | | | | | | |--- duration > 145.50
| | | | | | | |   |--- class: no
| | | | | | | |--- duration > 147.00
| | | | | | | |   |--- previous <= 21.00
| | | | | | | |     |--- pdays <= 508.00
| | | | | | | |       |--- campaign <= 3.50
| | | | | | | |         |--- age <= 47.50
| | | | | | | |         |--- pdays <= 82.50
| | | | | | | |         |--- pdays <= 81.00
| | | | | | | |           |--- month_may <= 0.50
| | | | | | | |             |--- class: yes
| | | | | | | |             |--- month_may > 0.50
| | | | | | | |               |--- truncated branch of depth 2
```


[illegible]

```
| | | | | | | | |--- day > 21.50  
| | | | | | | | | |--- balance <= 1036.50  
| | | | | | | | | |--- class: no  
| | | | | | | | | |--- balance > 1036.50  
| | | | | | | | | |--- class: yes  
| | | | | | | | |--- campaign > 1.50  
| | | | | | | | |--- age <= 59.50  
| | | | | | | | |--- duration <= 361.50  
| | | | | | | | |--- pdays <= 152.00  
| | | | | | | | | |--- truncated branch of depth 10  
| | | | | | | | | |--- pdays > 152.00  
| | | | | | | | | |--- class: yes  
| | | | | | | | |--- duration > 361.50  
| | | | | | | | |--- balance <= 2.50  
| | | | | | | | |--- class: no  
| | | | | | | | |--- balance > 2.50  
| | | | | | | | | |--- truncated branch of depth 7  
| | | | | | | | |--- age > 59.50  
| | | | | | | | |--- class: yes  
| | | | | | | |--- loan_yes > 0.50  
| | | | | | | |--- duration <= 414.00  
| | | | | | | |--- balance <= 116.00  
| | | | | | | |--- day <= 1.50  
| | | | | | | |--- class: yes  
| | | | | | | |--- day > 1.50  
| | | | | | | |--- class: no  
| | | | | | | |--- balance > 116.00  
| | | | | | | |--- month_sep <= 0.50  
| | | | | | | |--- duration <= 370.50  
| | | | | | | |--- age <= 61.50  
| | | | | | | | |--- truncated branch of depth 5  
| | | | | | | | |--- age > 61.50  
| | | | | | | | |--- class: yes  
| | | | | | | |--- duration > 370.50  
| | | | | | | |--- class: yes  
| | | | | | | |--- month_sep > 0.50  
| | | | | | | |--- class: yes  
| | | | | | | |--- duration > 414.00  
| | | | | | | |--- campaign <= 3.50  
| | | | | | | |--- class: yes  
| | | | | | | |--- campaign > 3.50  
| | | | | | | |--- class: no  
| | | | | | |--- housing_yes > 0.50  
| | | | | | |--- pdays <= 374.50  
| | | | | | |--- month_jun <= 0.50  
| | | | | | |--- duration <= 392.50  
| | | | | | |--- month_mar <= 0.50  
| | | | | | |--- month_sep <= 0.50
```

```
| | | | | | | | | |--- day <= 29.50  
| | | | | | | | | |--- truncated branch of depth 19  
| | | | | | | | | |--- day > 29.50  
| | | | | | | | | |--- truncated branch of depth 4  
| | | | | | | | | |--- month_sep > 0.50  
| | | | | | | | | |--- class: yes  
| | | | | | | | | |--- month_mar > 0.50  
| | | | | | | | | |--- class: yes  
| | | | | | | | |--- duration > 392.50  
| | | | | | | | |--- duration <= 460.00  
| | | | | | | | |--- job_blue-collar <= 0.50  
| | | | | | | | | |--- duration <= 453.50  
| | | | | | | | | |--- truncated branch of depth 14  
| | | | | | | | | |--- duration > 453.50  
| | | | | | | | | |--- class: yes  
| | | | | | | | |--- job_blue-collar > 0.50  
| | | | | | | | |--- balance <= 622.00  
| | | | | | | | |--- truncated branch of depth 3  
| | | | | | | | |--- balance > 622.00  
| | | | | | | | |--- truncated branch of depth 4  
| | | | | | | | |--- duration > 460.00  
| | | | | | | | |--- balance <= 1227.00  
| | | | | | | | |--- job_management <= 0.50  
| | | | | | | | |--- class: no  
| | | | | | | | |--- job_management > 0.50  
| | | | | | | | |--- truncated branch of depth 2  
| | | | | | | | |--- balance > 1227.00  
| | | | | | | | |--- previous <= 6.00  
| | | | | | | | |--- truncated branch of depth 2  
| | | | | | | | |--- previous > 6.00  
| | | | | | | | |--- class: no  
| | | | | | | | |--- month_jun > 0.50  
| | | | | | | | |--- job_services <= 0.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- job_services > 0.50  
| | | | | | | | |--- age <= 40.50  
| | | | | | | | |--- class: no  
| | | | | | | | |--- age > 40.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- pdays > 374.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- poutcome_success > 0.50  
| | | | | | | | |--- previous <= 10.50  
| | | | | | | | |--- campaign <= 4.50  
| | | | | | | | |--- month_jun <= 0.50  
| | | | | | | | |--- pdays <= 186.50  
| | | | | | | | |--- month_nov <= 0.50  
| | | | | | | | |--- class: yes
```

```
| | | | | | | | |--- month_nov > 0.50  
| | | | | | | | |--- job_technician <= 0.50  
| | | | | | | | |   |--- class: yes  
| | | | | | | | |--- job_technician > 0.50  
| | | | | | | | |   |--- pdays <= 92.50  
| | | | | | | | |     |--- class: yes  
| | | | | | | | |     |--- pdays > 92.50  
| | | | | | | | |       |--- class: no  
| | | | | | | | |--- pdays > 186.50  
| | | | | | | | |   |--- age <= 74.50  
| | | | | | | | |     |--- month_jan <= 0.50  
| | | | | | | | |       |--- day <= 2.50  
| | | | | | | | |         |--- truncated branch of depth 2  
| | | | | | | | |           |--- day > 2.50  
| | | | | | | | |             |--- class: yes  
| | | | | | | | |               |--- month_jan > 0.50  
| | | | | | | | |                 |--- job_retired <= 0.50  
| | | | | | | | |                   |--- class: no  
| | | | | | | | |                     |--- job_retired > 0.50  
| | | | | | | | |                       |--- class: yes  
| | | | | | | | |--- age > 74.50  
| | | | | | | | |   |--- previous <= 5.00  
| | | | | | | | |     |--- class: no  
| | | | | | | | |       |--- previous > 5.00  
| | | | | | | | |         |--- class: yes  
| | | | | | | | |--- month_jun > 0.50  
| | | | | | | | |   |--- previous <= 6.50  
| | | | | | | | |     |--- balance <= 4454.00  
| | | | | | | | |       |--- balance <= 219.50  
| | | | | | | | |         |--- job_blue-collar <= 0.50  
| | | | | | | | |           |--- class: yes  
| | | | | | | | |             |--- job_blue-collar > 0.50  
| | | | | | | | |               |--- class: no  
| | | | | | | | |                 |--- balance > 219.50  
| | | | | | | | |                   |--- class: yes  
| | | | | | | | |                     |--- balance > 4454.00  
| | | | | | | | |                       |--- class: no  
| | | | | | | | |--- previous > 6.50  
| | | | | | | | |   |--- class: no  
| | | | | | | | |--- campaign > 4.50  
| | | | | | | | |   |--- balance <= 3110.50  
| | | | | | | | |     |--- class: yes  
| | | | | | | | |       |--- balance > 3110.50  
| | | | | | | | |         |--- class: no  
| | | | | | | | |--- previous > 10.50  
| | | | | | | | |   |--- marital_married <= 0.50  
| | | | | | | | |     |--- class: yes  
| | | | | | | | |--- marital_married > 0.50
```



```

| | | | |--- poutcome_success <= 0.50
| | | | |   |--- month_nov <= 0.50
| | | | |     |--- month_jul <= 0.50
| | | | |       |--- month_jun <= 0.50
| | | | |         |--- duration <= 609.50
| | | | |           |--- housing_yes <= 0.50
| | | | |             |--- duration <= 604.50
| | | | |               |--- truncated branch of depth 12
| | | | |                 |--- duration > 604.50
| | | | |                   |--- truncated branch of depth 3
| | | | |                     |--- housing_yes > 0.50
| | | | |                       |--- age <= 35.50
| | | | |                         |--- truncated branch of depth 8
| | | | |                           |--- age > 35.50
| | | | |                             |--- truncated branch of depth 10
| | | | |                               |--- duration > 609.50
| | | | |                                 |--- age <= 62.00
| | | | |                                   |--- day <= 2.00
| | | | |                                     |--- class: no
| | | | |                                       |--- day > 2.00
| | | | |                                         |--- truncated branch of depth 5
| | | | |                                           |--- age > 62.00
| | | | |                                             |--- pdays <= 185.50
| | | | |                                               |--- class: no
| | | | |                                                 |--- pdays > 185.50
| | | | |                                                   |--- class: yes
| | | | |             |--- month_jun > 0.50
| | | | |               |--- class: yes
| | | | |         |--- month_jul > 0.50
| | | | |           |--- job_blue-collar <= 0.50
| | | | |             |--- balance <= 1933.00
| | | | |               |--- age <= 32.50
| | | | |                 |--- duration <= 488.50
| | | | |                   |--- class: no
| | | | |                     |--- duration > 488.50
| | | | |                       |--- truncated branch of depth 5
| | | | |                         |--- age > 32.50
| | | | |                           |--- job_management <= 0.50
| | | | |                             |--- truncated branch of depth 9
| | | | |                               |--- job_management > 0.50
| | | | |                                 |--- truncated branch of depth 3
| | | | |                                   |--- balance > 1933.00
| | | | |                                     |--- duration <= 502.00
| | | | |                                       |--- class: no
| | | | |                                         |--- duration > 502.00
| | | | |                                           |--- class: yes
| | | | |                                             |--- job_blue-collar > 0.50
| | | | |                                               |--- education_tertiary <= 0.50

```

```
| | | | | | | | | |-- campaign <= 6.50  
| | | | | | | | | |-- class: yes  
| | | | | | | | | |-- campaign > 6.50  
| | | | | | | | | | |-- duration <= 585.00  
| | | | | | | | | | | |-- class: no  
| | | | | | | | | | | |-- duration > 585.00  
| | | | | | | | | | | | |-- class: yes  
| | | | | | | | | | | |-- education_tertiary > 0.50  
| | | | | | | | | | | | |-- class: no  
| | | | | | | |-- month_nov > 0.50  
| | | | | | | |-- duration <= 629.00  
| | | | | | | | |-- day <= 19.50  
| | | | | | | | | |-- contact_telephone <= 0.50  
| | | | | | | | | |-- balance <= 55.00  
| | | | | | | | | | |-- class: no  
| | | | | | | | | | |-- balance > 55.00  
| | | | | | | | | | |-- previous <= 1.50  
| | | | | | | | | | | |-- truncated branch of depth 6  
| | | | | | | | | | | |-- previous > 1.50  
| | | | | | | | | | | | |-- truncated branch of depth 2  
| | | | | | | | | |-- contact_telephone > 0.50  
| | | | | | | | | |-- class: yes  
| | | | | | | | |-- day > 19.50  
| | | | | | | | | |-- balance <= 12433.50  
| | | | | | | | | |-- balance <= 734.50  
| | | | | | | | | | |-- balance <= 174.00  
| | | | | | | | | | | |-- class: yes  
| | | | | | | | | | | |-- balance > 174.00  
| | | | | | | | | | | | |-- truncated branch of depth 2  
| | | | | | | | | | | |-- balance > 734.50  
| | | | | | | | | | | |-- class: yes  
| | | | | | | | | |-- balance > 12433.50  
| | | | | | | | | |-- job_management <= 0.50  
| | | | | | | | | | |-- class: no  
| | | | | | | | | | |-- job_management > 0.50  
| | | | | | | | | | | |-- class: yes  
| | | | | | | |-- duration > 629.00  
| | | | | | | |-- duration <= 642.50  
| | | | | | | | |-- class: no  
| | | | | | | | |-- duration > 642.50  
| | | | | | | | | |-- age <= 32.50  
| | | | | | | | | |-- class: no  
| | | | | | | | | |-- age > 32.50  
| | | | | | | | | | |-- class: yes  
| | | | | | |-- poutcome_success > 0.50  
| | | | | | |-- job_student <= 0.50  
| | | | | | | |-- balance <= 13362.50  
| | | | | | | | |-- day <= 3.50
```



```
| | | | | | | | --- month_jul <= 0.50  
| | | | | | | | |--- class: no  
| | | | | | | | |--- month_jul > 0.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- day > 3.50  
| | | | | | | | |--- pdays <= 67.50  
| | | | | | | | |--- pdays <= 57.00  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- pdays > 57.00  
| | | | | | | | |--- class: no  
| | | | | | | | |--- pdays > 67.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- balance > 13362.50  
| | | | | | | | |--- class: no  
| | | | | | | | |--- job_student > 0.50  
| | | | | | | | |--- duration <= 526.50  
| | | | | | | | |--- class: no  
| | | | | | | | |--- duration > 526.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- contact_unknown > 0.50  
| | | | | | | | |--- month_may <= 0.50  
| | | | | | | | |--- balance <= 2910.50  
| | | | | | | | |--- balance <= 273.50  
| | | | | | | | |--- job_entrepreneur <= 0.50  
| | | | | | | | |--- day <= 3.50  
| | | | | | | | |--- campaign <= 2.50  
| | | | | | | | |--- balance <= 136.00  
| | | | | | | | |--- class: no  
| | | | | | | | |--- balance > 136.00  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- campaign > 2.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- day > 3.50  
| | | | | | | | |--- age <= 50.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- age > 50.50  
| | | | | | | | |--- duration <= 540.00  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- duration > 540.00  
| | | | | | | | |--- class: no  
| | | | | | | | |--- job_entrepreneur > 0.50  
| | | | | | | | |--- class: no  
| | | | | | | | |--- balance > 273.50  
| | | | | | | | |--- campaign <= 2.50  
| | | | | | | | |--- class: yes  
| | | | | | | | |--- campaign > 2.50  
| | | | | | | | |--- balance <= 2076.50  
| | | | | | | | |--- duration <= 597.00
```

```
| | | | | | | | | |-- class: yes  
| | | | | | | | | |--- duration > 597.00  
| | | | | | | | | |--- age <= 38.00  
| | | | | | | | | |--- class: no  
| | | | | | | | | |--- age > 38.00  
| | | | | | | | | |--- class: yes  
| | | | | | | | |--- balance > 2076.50  
| | | | | | | | |--- class: no  
| | | | | | | |---- balance > 2910.50  
| | | | | | | |--- marital_married <= 0.50  
| | | | | | | |--- class: yes  
| | | | | | | |--- marital_married > 0.50  
| | | | | | | |--- class: no  
| | | | | |---- month_may > 0.50  
| | | | | |--- balance <= 1488.50  
| | | | | |--- age <= 57.50  
| | | | | |--- duration <= 519.00  
| | | | | |--- education_unknown <= 0.50  
| | | | | |--- balance <= 791.50  
| | | | | | |--- duration <= 485.50  
| | | | | | |--- truncated branch of depth 2  
| | | | | | |--- duration > 485.50  
| | | | | | |--- truncated branch of depth 3  
| | | | | | |--- balance > 791.50  
| | | | | | |--- class: yes  
| | | | | | |--- education_unknown > 0.50  
| | | | | | |--- class: yes  
| | | | | |--- duration > 519.00  
| | | | | |--- balance <= -439.50  
| | | | | |--- class: no  
| | | | | |--- balance > -439.50  
| | | | | |--- balance <= 57.00  
| | | | | | |--- age <= 42.50  
| | | | | | |--- class: yes  
| | | | | | |--- age > 42.50  
| | | | | | |--- truncated branch of depth 2  
| | | | | | |--- balance > 57.00  
| | | | | | |--- age <= 51.50  
| | | | | | |--- truncated branch of depth 5  
| | | | | | |--- age > 51.50  
| | | | | | |--- class: no  
| | | | | |--- age > 57.50  
| | | | | |--- class: no  
| | | | |---- balance > 1488.50  
| | | | |--- balance <= 4907.50  
| | | | |--- class: no  
| | | | |--- balance > 4907.50  
| | | | |--- class: yes
```

```

| | |--- duration > 648.50
| | | |--- balance <= 19640.00
| | | | |--- day <= 3.50
| | | | | |--- pdays <= 201.50
| | | | | | |--- job_self-employed <= 0.50
| | | | | | | |--- job_management <= 0.50
| | | | | | | |--- month_oct <= 0.50
| | | | | | | |--- age <= 42.50
| | | | | | | | |--- job_housemaid <= 0.50
| | | | | | | | |--- truncated branch of depth 5
| | | | | | | | |--- job_housemaid > 0.50
| | | | | | | | |--- class: no
| | | | | | | | |--- age > 42.50
| | | | | | | | |--- class: yes
| | | | | | | |--- month_oct > 0.50
| | | | | | | |--- class: no
| | | | | | | |--- job_management > 0.50
| | | | | | | |--- education_tertiary <= 0.50
| | | | | | | |--- class: no
| | | | | | | |--- education_tertiary > 0.50
| | | | | | | |--- campaign <= 4.00
| | | | | | | |--- class: yes
| | | | | | | |--- campaign > 4.00
| | | | | | | |--- class: no
| | | | | | | |--- job_self-employed > 0.50
| | | | | | | |--- class: no
| | | | | | |--- pdays > 201.50
| | | | | | |--- pdays <= 266.50
| | | | | | | |--- class: no
| | | | | | |--- pdays > 266.50
| | | | | | |--- day <= 2.50
| | | | | | | |--- class: yes
| | | | | | |--- day > 2.50
| | | | | | | |--- class: no
| | | | | |--- day > 3.50
| | | | | |--- duration <= 922.50
| | | | | |--- balance <= 1911.00
| | | | | |--- balance <= 1841.50
| | | | | |--- marital_married <= 0.50
| | | | | |--- poutcome_other <= 0.50
| | | | | |--- duration <= 915.50
| | | | | | |--- truncated branch of depth 13
| | | | | | |--- duration > 915.50
| | | | | | | |--- class: no
| | | | | | |--- poutcome_other > 0.50
| | | | | | |--- duration <= 817.50
| | | | | | |--- truncated branch of depth 2
| | | | | | |--- duration > 817.50

```

[illegible]

[illegible]

```
| | | |--- balance > 19640.00  
| | | | |--- class: no
```

[]: