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]:
                                   education default
                         marital
                                                       balance housing loan
                                                                               contact
        age
     0
         59
                 admin.
                          married
                                   secondary
                                                   no
                                                           2343
                                                                    yes
                                                                               unknown
     1
         56
                 admin.
                          married
                                                                               unknown
                                   secondary
                                                   no
                                                             45
                                                                     no
                                                                          no
     2
             technician married
                                   secondary
                                                           1270
                                                                    yes
                                                                               unknown
                                                   no
                                                                          no
     3
         55
               services married
                                   secondary
                                                           2476
                                                                               unknown
                                                   no
                                                                    yes
                                                                          no
         54
                 admin.
                                                            184
                                                                               unknown
                          married
                                    tertiary
                                                   no
                                                                     no
                                                                          nο
        day month
                   duration
                              campaign
                                        pdays
                                                previous poutcome deposit
     0
          5
                        1042
                                      1
                                            -1
                                                          unknown
                                                                       yes
              may
     1
          5
                                      1
                                            -1
              may
                        1467
                                                        0 unknown
                                                                       yes
     2
          5
                        1389
                                      1
                                            -1
                                                       0 unknown
              may
                                                                       yes
     3
                         579
                                      1
                                            -1
                                                          unknown
              may
                                                                       yes
                         673
                                     2
                                            -1
                                                          unknown
              may
                                                                       yes
[6]:
     data.tail()
[6]:
                          job marital
                                        education default
                                                            balance housing loan
            age
                 blue-collar
     11157
             33
                                single
                                           primary
                                                                         yes
                                                        no
                                                                   1
                                                                                no
     11158
             39
                     services married
                                         secondary
                                                                 733
                                                        no
                                                                          no
                                                                                no
     11159
                                                                  29
             32
                  technician
                                single
                                         secondary
                                                        no
                                                                          no
                                                                                no
     11160
                  technician married
                                        secondary
                                                                   0
                                                        no
                                                                          no
                                                                               yes
     11161
                  technician married secondary
                                                        no
                                                                          no
                                                                                no
             contact day month duration campaign pdays previous poutcome \
```

```
4
      11158
              unknown
                               jun
                                          83
                                                             -1
                                                                         0
                                                                            unknown
                         16
                                                      2
      11159
              cellular
                         19
                               aug
                                         156
                                                             -1
                                                                            unknown
                                                      2
                                                            172
                                                                            failure
      11160
             cellular
                          8
                               may
                                            9
      11161
             cellular
                               jul
                                         628
                                                      1
                                                             -1
                                                                            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')
     data.describe()
[10]:
[10]:
                       age
                                  balance
                                                     day
                                                               duration
                                                                              campaign
             11162.000000
                             11162.000000
                                            11162.000000
                                                           11162.000000
                                                                          11162.000000
      count
      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
                 95.000000
                             81204.000000
                                               31.000000
                                                            3881.000000
                                                                             63.000000
      max
                     pdays
                                 previous
             11162.000000
                             11162.000000
      count
      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
```

11157

cellular

20

apr

257

1

-1

unknown

```
education
                  0
     default
                  0
     balance
                  0
     housing
                  0
     loan
                  0
     contact
                  0
     day
                  0
                  0
     month
                  0
     duration
     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
          _____
                     _____
                     11162 non-null int64
      0
          age
                     11162 non-null object
      1
          job
      2
          marital
                     11162 non-null object
      3
          education 11162 non-null object
      4
          default
                     11162 non-null object
      5
          balance
                     11162 non-null int64
          housing
                     11162 non-null object
      6
      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
          poutcome
                     11162 non-null
                                    object
      15
      16 deposit
                     11162 non-null object
```

```
[16]: features = ['age', 'job', 'marital', 'education', 'default', 'balance', \( \times \) 'housing', 'loan', 'contact', 'day', 'month', 'duration', 'campaign', \( \times \) 'pdays', 'previous', 'poutcome']

target = 'deposit'
```

dtypes: int64(7), object(10)

memory usage: 1.4+ MB

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

o'housing', 'loan', 'contact', 'month', 'poutcome'], drop_first=True)

	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]	l :	Х	test

[18]:		age	balanc	ce day	, dur	ation	camr	oaign	pdav	s p	revio	us	\		
	5527	65		14 5		182	1	1	- •	·1		0	`		
	4541	38	162	27 16	3	1323		9	_	1		0			
	1964	35	496	33 14	1	456		1	30	0		1			
	5007	47	822	29 8	3	784		2	_	1		0			
	8928	35	147	73 12	2	84		3	_	·1		0			
				••	•	•••		•••							
	1052	30	49	95 21	L	641		1	_	·1		0			
	10702	44	1	l2 19	9	126		2	_	·1		0			
	10466	44	194	1 5 14	l	191		1	_	1		0			
	8809	55	50)5 17	7	58		1	31	.6		1			
	99	35		0 20)	1205		1	_	1		0			
		job_	blue-co		job_e	_		_	_			moı	nth_jul	\	
	5527		F	Talse					False			True			
	4541		True True True False							False			False		
	1964					False False False				False			False		
	5007									False			False		
	8928									False	e		False		
	•••	•••				•••					•••				
	1052		False			False				False			False		
	10702		False			False				False			False		
	10466		False			False			False			False			
	8809		ŀ	Talse			False			False			False		
	99		True			False			False	e		False			
		mont	h iun	month	mar ı	month	mav	month	nov	mon-	th oc	t r	month_se	/ a	
	5527		False		alse		alse		alse		Fals		Fals	_	
	4541		True		alse		alse		alse		Fals		Fals		
	1964		False		alse		Γrue		alse		Fals		Fals		

	8928	False	False	True	False	False	False		
	1052		False	False	True	False	False		
	10702	False	False	False	True	False	False		
	10466		False	True	False	False	False		
	8809			False	False	False	False		
	99			True			False		
		poutcome_other	poutc	ome_success	poutcome_u	ınknown			
	5527	False	_	False	_	True			
	4541	False		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 r	rows x 42 column	ns]						
[25]:	y_trair	1							
[05]	7060								
[25]:	7968								
	1456	yes							
	361	•							
	812	yes							
	1092	yes							
	5734	m no							
	5191	ves							
	5390	no							
	860	yes							
	7270	no							
		deposit, Length	7813	dtwne: ohie	ct				
	wanc. c	reposit, hengon	, ,010,	atype. obje					
[27]:	y_test								
	3 - 1								
[27]:	5527	no							
	4541	yes							
	4541 1964	yes yes							
		yes							
	1964								

False

False

5007

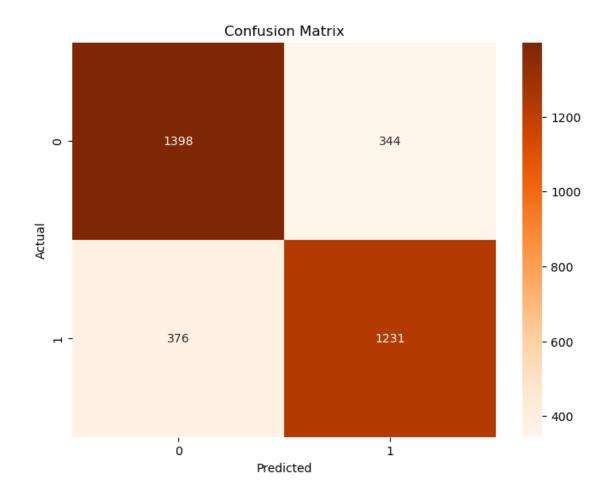
False

False

False

False

```
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
                        0.79
                                   0.80
                                             0.80
                                                       1742
               no
                        0.78
                                   0.77
                                             0.77
                                                       1607
              yes
                                             0.79
                                                       3349
         accuracy
                                             0.78
                        0.78
                                   0.78
                                                       3349
        macro avg
                        0.78
                                   0.79
                                             0.78
     weighted avg
                                                       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

| | | | | | |--- day <= 1.50

| | | | | | | |--- day <= 36.50

| | | | | | | | |--- class: no

| | | | | | | | |--- class: yes

| | | | | | | | |--- day > 1.50

| | | | | | | | |--- duration <= 88.50
```

```
|--- month_sep <= 0.50
               |--- campaign <= 1.50
                   |--- truncated branch of depth 9
               |--- campaign > 1.50
                   |--- truncated branch of depth 4
              -- month_sep > 0.50
               |--- campaign <= 2.00
                   |--- class: no
               |--- campaign > 2.00
                   |--- class: yes
         -- duration > 88.50
           |--- pdays <= 478.00
               |--- month_sep <= 0.50
                   |--- truncated branch of depth 14
               |--- month_sep > 0.50
               |--- truncated branch of depth 2
           |--- pdays > 478.00
               |--- class: yes
    job_student > 0.50
   |--- month_may \le 0.50
       |--- age <= 31.00
           |--- month_jun <= 0.50
               |--- class: yes
           |--- month_jun > 0.50
               |--- day <= 18.50
                   |--- class: no
               |--- day > 18.50
                   |--- class: yes
       |--- age > 31.00
           |--- class: no
    --- month_may > 0.50
       |--- class: no
month_feb > 0.50
    day \le 10.00
   |--- duration <= 122.50
       |--- age <= 29.50
           |--- education_tertiary <= 0.50
               |--- class: no
           |--- education_tertiary > 0.50
               |--- balance <= 387.50
                   |--- class: no
               |--- balance > 387.50
               |--- class: yes
                   29.50
         -- age >
           |--- balance <= -15.00
               |--- balance <= -165.00
               1
                   |--- class: no
               |--- balance > -165.00
```

```
|--- class: yes
                         |--- balance > -15.00
                         |--- class: no
             |--- duration > 122.50
                 |--- class: yes
            - day > 10.00
             |--- balance <= 185.00
                 |--- job_technician <= 0.50</pre>
                     |--- class: no
                 |--- job_technician > 0.50
                     |--- class: yes
                 |--- balance > 185.00
                 |--- education_unknown <= 0.50
                     |--- age <= 62.00
                         |--- class: yes
                     |--- age > 62.00
                         |--- housing_yes <= 0.50
                             |--- class: no
                         |--- housing_yes > 0.50
                         |--- class: yes
                 |--- education_unknown > 0.50
                     |--- class: no
     month_oct > 0.50
     |--- age <= 43.00
         |---| day <= 26.50
             |--- class: no
         |--- day > 26.50
             |--- class: yes
     |--- age > 43.00
         |--- balance <= 196.00
             |--- class: no
         |--- balance > 196.00
             |--- job_technician <= 0.50
                 |--- marital_single <= 0.50
                     |--- class: yes
                 |--- marital_single > 0.50
                     |--- class: no
             |--- job_technician > 0.50
                 |--- class: no
- month_mar > 0.50
   -- poutcome_other <= 0.50
     |--- age <= 62.00
         |--- job_services <= 0.50
             |--- age <= 29.50
                 |---| day <= 4.00
                     |--- class: no
                 |--- day > 4.00
                     |--- class: yes
```

```
|--- 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
                            1
                    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</pre>
                 |---| 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</pre>
                     |--- 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
```

```
|--- pdays > 97.50
                        |--- month_aug <= 0.50
                            |--- truncated branch of depth 9
                        |--- month_aug > 0.50
                            |--- truncated branch of depth 2
                        I
               - month_oct > 0.50
                |--- age <= 43.00
                    |--- campaign <= 3.50
                        |--- class: yes
                    |--- campaign > 3.50
                        |--- class: no
                |--- age > 43.00
                    |--- age <= 67.50
                        |--- class: no
                    |--- age > 67.50
                        |--- class: yes
          -- month_mar > 0.50
            |--- poutcome_other <= 0.50
                |--- campaign <= 3.50
                    |--- class: yes
                |--- campaign > 3.50
                    |--- age <= 32.50
                        |--- class: yes
                    |--- age > 32.50
                        |--- class: no
            |--- poutcome_other > 0.50
                |--- class: no
      -- month_jun > 0.50
        |--- duration <= 141.00
            |--- class: no
          -- duration > 141.00
            |--- education_tertiary <= 0.50
                |--- class: yes
            |--- education_tertiary > 0.50
                |--- balance <= 706.50
                    |--- class: yes
                |--- balance > 706.50
                    |--- age <= 42.50
                        |--- class: no
                    |--- age > 42.50
                        |--- class: yes
contact_unknown >
|--- month_oct <= 0.50
    |--- month_nov <= 0.50
        |--- age <= 26.50
            |--- job_management <= 0.50
            Ι
                |--- housing_yes <= 0.50
                | |--- balance <= 95.00
```

```
|--- 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
        1
            |--- 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
```

```
|--- pdays > 81.00
                                     |--- class: no
                             |--- pdays > 82.50
                                 |--- age <= 39.50
                                     |--- month_aug <= 0.50
                                        |--- class: yes
                                     |--- month_aug > 0.50
                                         |--- truncated branch of depth 3
                                   -- age > 39.50
                                     |--- balance <= 803.00
                                     | |--- truncated branch of depth 2
                                     |--- balance > 803.00
                                         |--- class: yes
                         |--- age > 47.50
                             |--- month_jun <= 0.50
                                 |--- marital_single <= 0.50
                                     |--- job_unknown <= 0.50
                                         |--- truncated branch of depth 4
                                     |--- job_unknown > 0.50
                                         |--- class: no
                                 |--- marital_single > 0.50
                                     |--- class: no
                                - month_jun > 0.50
                                 |--- pdays <= 81.50
                                     |--- class: yes
                                 |--- pdays > 81.50
                                     |--- class: no
                       -- campaign > 3.50
                         |--- duration <= 160.00
                             |--- class: no
                         |--- duration > 160.00
                             |---| day <= 6.00
                                 |--- class: no
                             |--- day > 6.00
                                 |--- class: yes
                 |--- pdays > 508.00
                     |--- class: no
             |--- previous > 21.00
                 |--- class: no
- duration > 251.50
   -- duration <= 474.50
     |--- contact_unknown <= 0.50
         |--- poutcome_success <= 0.50</pre>
             |--- housing_yes <= 0.50
                 |--- loan_yes <= 0.50
                     |--- month_aug <= 0.50
                     1
                         |--- month_jul <= 0.50
                         | |--- month_jan <= 0.50
```

```
|--- month_nov <= 0.50
             |--- day <= 14.50
                |--- truncated branch of depth 12
             |--- day > 14.50
                |--- truncated branch of depth 12
           -- month_nov > 0.50
             |---| day <= 16.50
                |--- truncated branch of depth 4
             |--- day > 16.50
                |--- truncated branch of depth 9
      -- month_jan > 0.50
         |---| day <= 27.50
             |--- class: yes
         |--- day > 27.50
             |--- balance <= -248.50
                |--- class: yes
             |--- balance > -248.50
             | |--- truncated branch of depth 5
     month_jul > 0.50
       -- duration <= 308.50
         |--- age <= 60.50
            |--- education_unknown <= 0.50
             | |--- truncated branch of depth 6
             |--- education_unknown > 0.50
                |--- truncated branch of depth 2
         |--- age > 60.50
             |--- class: yes
       -- duration > 308.50
         |--- day <= 8.50
             |--- campaign <= 6.00
             | |--- truncated branch of depth 2
             |--- campaign > 6.00
                |--- class: no
             -- day > 8.50
             |--- duration <= 422.00
                |--- truncated branch of depth 6
             |--- duration > 422.00
                |--- class: yes
- month_aug > 0.50
 |--- campaign <= 1.50
    |--- day <= 21.50
         |--- duration <= 341.00
             |--- duration <= 310.00
                |--- truncated branch of depth 5
             |--- duration > 310.00
                |--- truncated branch of depth 3
         |--- duration > 341.00
            |--- class: yes
```

```
|--- 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
                        1
                            |--- 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
                        1
                    |--- 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
            Ι
                |--- 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</pre>
                              |--- 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 \leq 4.50
         |--- month_jun <= 0.50
             |--- pdays <= 186.50
             Ι
                 |--- month_nov <= 0.50
                 | |--- class: yes
```

```
|--- month_nov > 0.50
                  |--- job_technician <= 0.50</pre>
                      |--- 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</pre>
                          |--- 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
```

```
contact_unknown > 0.50
       |--- poutcome_unknown <= 0.50
           |--- class: yes
       |--- poutcome_unknown > 0.50
           |--- month_oct <= 0.50
               |--- duration <= 380.50
                   |--- month_nov <= 0.50
                       |--- age <= 50.50
                           |--- class: no
                       |--- age > 50.50
                           |--- job_services <= 0.50
                               |--- age <= 51.50
                                   |--- month_may <= 0.50
                                       |--- class: yes
                                   |--- month_may > 0.50
                                       |--- class: no
                               |--- age > 51.50
                                   |--- class: no
                             -- job_services > 0.50
                               |--- class: yes
                       - month nov > 0.50
                       |--- job_retired <= 0.50
                           |--- class: yes
                       |--- job_retired > 0.50
                           |--- class: no
               |--- duration > 380.50
                   |--- default_yes <= 0.50
                       |--- job_entrepreneur <= 0.50
                           |--- duration <= 472.50
                               |---| day <= 2.50
                                   |--- class: yes
                               |--- day > 2.50
                                   |--- campaign <= 1.50
                                       |--- truncated branch of depth 5
                                   |--- campaign > 1.50
                                       |--- truncated branch of depth 6
                           |--- duration > 472.50
                               |--- class: yes
                       |--- job_entrepreneur > 0.50
                           |--- class: yes
                   |--- default_yes > 0.50
                       |--- class: yes
           |--- month_oct > 0.50
               |--- class: yes
|--- duration > 474.50
   |--- duration <= 648.50
       |--- contact_unknown <= 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</pre>
                |--- 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</pre>
```

```
|--- campaign <= 6.50
                        |--- class: yes
                    |--- campaign > 6.50
                        |--- duration <= 585.00
                            I--- 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</pre>
                    |--- balance <= 55.00
                        |--- class: no
                    |--- balance > 55.00
                        |--- previous <= 1.50
                            |--- truncated branch of depth 6
                        |--- previous > 1.50
                            |--- truncated branch of depth 2
                        1
                  -- 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</pre>
                    | |--- 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
               1
                  |--- 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</pre>
                    |--- 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
                    3.50
           - day >
                 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
```

```
|--- class: no
              -- marital_married > 0.50
                |---| pdays <= 4.00
                    |--- month_feb <= 0.50
                        |--- truncated branch of depth 13
                    |--- month_feb > 0.50
                        |--- truncated branch of depth 4
                |--- pdays > 4.00
                    |--- job_self-employed <= 0.50</pre>
                        |--- truncated branch of depth 4
                    |--- job_self-employed > 0.50
                        |--- class: no
        --- balance >
                       1841.50
            |--- month_aug <= 0.50
                |--- class: no
            |--- month_aug > 0.50
                |--- class: yes
    |--- balance > 1911.00
        |--- day <= 14.50
            |--- age <= 69.50
                |--- class: yes
            |--- age > 69.50
                |--- age <= 70.50
                    |--- class: no
                |--- age > 70.50
                    |--- class: yes
        |--- day >
                   14.50
            |---| day <= 17.50
                |--- campaign \leq 2.50
                    |--- duration <= 709.00
                        |--- class: no
                    |--- duration > 709.00
                        |--- truncated branch of depth 3
                  -- campaign > 2.50
                    |--- class: yes
              -- day > 17.50
                |--- job_self-employed <= 0.50
                    |--- duration <= 920.50
                        |--- truncated branch of depth 5
                    |--- duration > 920.50
                        |--- truncated branch of depth 2
                |--- job_self-employed > 0.50
                    |--- day <= 27.50
                        |--- class: no
                    |--- day > 27.50
                        |--- class: yes
|--- duration > 922.50
   |--- duration <= 1081.50
```

```
|--- previous <= 7.50
    |--- month_oct <= 0.50
        |--- balance <= -685.50
            |--- age <= 35.00
                |--- class: no
                        35.00
            |--- age >
                |--- class: yes
        |--- balance > -685.50
            |--- contact_unknown <= 0.50
                |--- truncated branch of depth 5
            |--- contact_unknown > 0.50
                |--- truncated branch of depth 6
      -- month_oct > 0.50
        |--- job_retired <= 0.50
            |--- class: no
        |--- job_retired > 0.50
            |--- class: yes
--- previous > 7.50
    |--- marital_single <= 0.50
       |--- class: no
    |--- marital_single > 0.50
        |--- class: yes
duration > 1081.50
|--- age <= 64.50
    |--- duration <= 1083.50
        |--- balance <= 155.00
            |--- class: yes
        |--- balance > 155.00
            |--- class: no
     -- duration > 1083.50
        |--- pdays <= 315.00
            |--- age <= 30.50
                |--- truncated branch of depth 3
            |--- age > 30.50
                |--- truncated branch of depth 19
        |--- pdays > 315.00
            |--- age <= 30.00
                |--- class: no
            |--- age > 30.00
            I
                |--- truncated branch of depth 3
    age >
           64.50
    |--- previous <= 1.50
        |--- duration <= 1129.00
            |--- class: yes
        |--- duration > 1129.00
            |--- class: no
    |--- previous > 1.50
        |--- class: yes
```

[]: