In [1]:
```
import numpy as np
import pandas as pd
```

In [2]:
```
df = pd.read_csv('task_3_dataset.csv')
```

In [3]:
```
df
```

Out[3]:

	age	job	marital	education	default	balance	housing	loan	contact	day	month	duration	campaign	pdays	previo
0	30	unemployed	married	primary	no	1787	no	no	cellular	19	oct	79	1	-1	
1	33	services	married	secondary	no	4789	yes	yes	cellular	11	may	220	1	339	
2	35	management	single	tertiary	no	1350	yes	no	cellular	16	apr	185	1	330	
3	30	management	married	tertiary	no	1476	yes	yes	unknown	3	jun	199	4	-1	
4	59	blue-collar	married	secondary	no	0	yes	no	unknown	5	may	226	1	-1	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
4516	33	services	married	secondary	no	-333	yes	no	cellular	30	jul	329	5	-1	
4517	57	self-employed	married	tertiary	yes	-3313	yes	yes	unknown	9	may	153	1	-1	
4518	57	technician	married	secondary	no	295	no	no	cellular	19	aug	151	11	-1	
4519	28	blue-collar	married	secondary	no	1137	no	no	cellular	6	feb	129	4	211	
4520	44	entrepreneur	single	tertiary	no	1136	yes	yes	cellular	3	apr	345	2	249	

4521 rows × 17 columns

In [4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4521 entries, 0 to 4520
Data columns (total 17 columns):
 #   Column     Non-Null Count  Dtype 
---  ------     --------------  ----- 
 0   age        4521 non-null   int64 
 1   job        4521 non-null   object
 2   marital    4521 non-null   object
 3   education  4521 non-null   object
 4   default    4521 non-null   object
 5   balance    4521 non-null   int64 
 6   housing    4521 non-null   object
 7   loan       4521 non-null   object
 8   contact    4521 non-null   object
 9   day        4521 non-null   int64 
 10  month      4521 non-null   object
 11  duration   4521 non-null   int64 
 12  campaign   4521 non-null   int64 
 13  pdays      4521 non-null   int64 
 14  previous   4521 non-null   int64 
 15  poutcome   4521 non-null   object
 16  y          4521 non-null   object
dtypes: int64(7), object(10)
memory usage: 600.6+ KB
```

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

Out[5]:

	age	balance	day	duration	campaign	pdays	previous
count	4521.000000	4521.000000	4521.000000	4521.000000	4521.000000	4521.000000	4521.000000
mean	41.170095	1422.657819	15.915284	263.961292	2.793630	39.766645	0.542579
std	10.576211	3009.638142	8.247667	259.856633	3.109807	100.121124	1.693562
min	19.000000	-3313.000000	1.000000	4.000000	1.000000	-1.000000	0.000000
25%	33.000000	69.000000	9.000000	104.000000	1.000000	-1.000000	0.000000
50%	39.000000	444.000000	16.000000	185.000000	2.000000	-1.000000	0.000000
75%	49.000000	1480.000000	21.000000	329.000000	3.000000	-1.000000	0.000000
max	87.000000	71188.000000	31.000000	3025.000000	50.000000	871.000000	25.000000

In [7]:
```
df.isnull().any()
```

Out[7]:
```
age          False
job          False
marital      False
education    False
default      False
balance      False
housing      False
loan         False
contact      False
day          False
month        False
duration     False
campaign     False
pdays        False
previous     False
poutcome     False
y            False
dtype: bool
```

In [8]:
```
df['y'].value_counts()
```

Out[8]:
```
no     4000
yes     521
Name: y, dtype: int64
```

In [9]:
```
from sklearn.preprocessing import OneHotEncoder, StandardScaler
cat_col=df.select_dtypes(include=['object']).columns
# drop target variable
cat_col=cat_col.drop('y')
df1=df[cat_col]
df1
```

Out[9]:

	job	marital	education	default	housing	loan	contact	month	poutcome
0	unemployed	married	primary	no	no	no	cellular	oct	unknown
1	services	married	secondary	no	yes	yes	cellular	may	failure
2	management	single	tertiary	no	yes	no	cellular	apr	failure
3	management	married	tertiary	no	yes	yes	unknown	jun	unknown
4	blue-collar	married	secondary	no	yes	no	unknown	may	unknown
...	...	...	...	...	...	...	...	...	...
4516	services	married	secondary	no	yes	no	cellular	jul	unknown
4517	self-employed	married	tertiary	yes	yes	yes	unknown	may	unknown
4518	technician	married	secondary	no	no	no	cellular	aug	unknown
4519	blue-collar	married	secondary	no	no	no	cellular	feb	other
4520	entrepreneur	single	tertiary	no	yes	yes	cellular	apr	other

4521 rows × 9 columns

In [10]:
```
# using OneHotEncorder for categorical variable
en=OneHotEncoder(drop='first',sparse_output=False)
en_data=en.fit_transform(df1)
```

In [11]:
```
num_col=df.select_dtypes(include=np.number).columns
df2=df[num_col]
df2
```

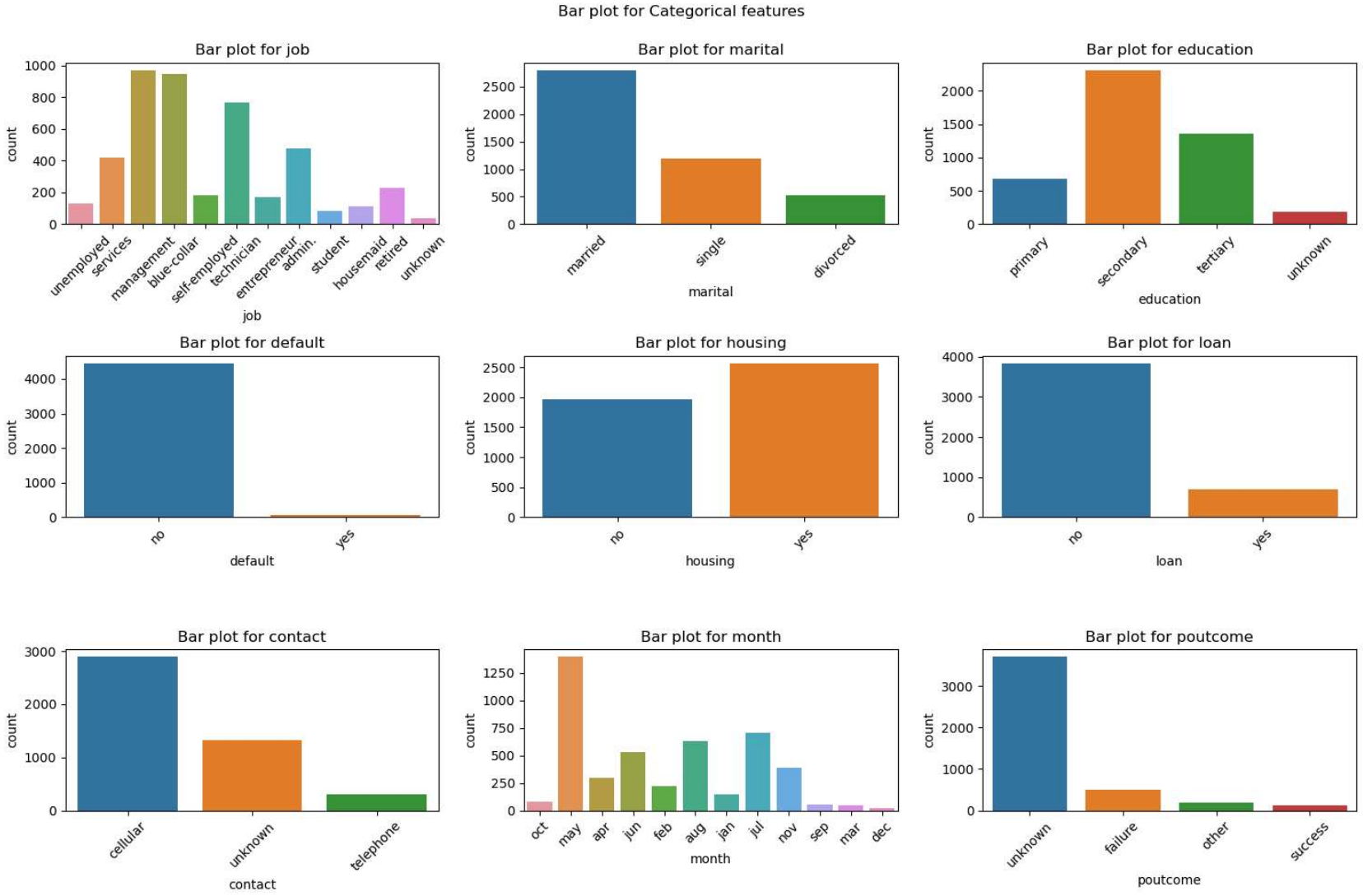
Out[11]:

	age	balance	day	duration	campaign	pdays	previous
0	30	1787	19	79	1	-1	0
1	33	4789	11	220	1	339	4
2	35	1350	16	185	1	330	1
3	30	1476	3	199	4	-1	0
4	59	0	5	226	1	-1	0
...	...	...	...	...	...	...	...
4516	33	-333	30	329	5	-1	0
4517	57	-3313	9	153	1	-1	0
4518	57	295	19	151	11	-1	0
4519	28	1137	6	129	4	211	3
4520	44	1136	3	345	2	249	7

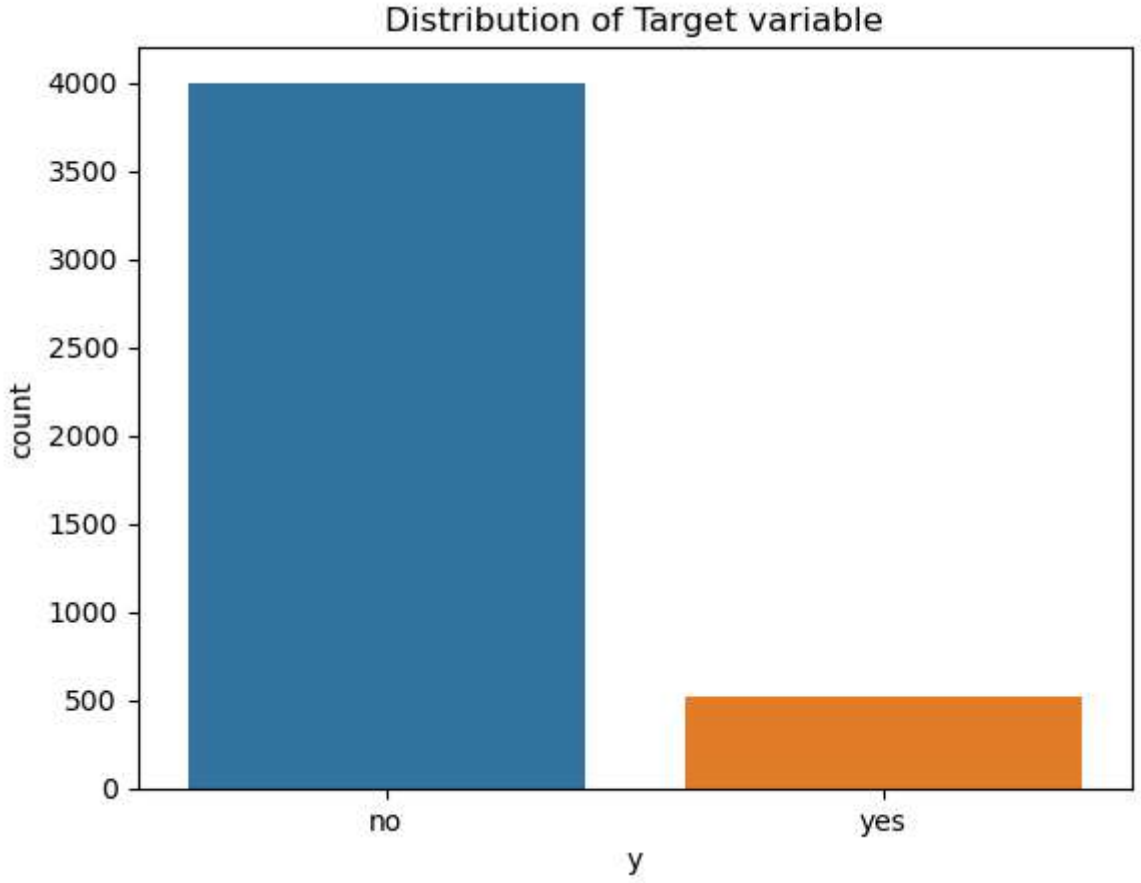
4521 rows × 7 columns

In [12]:
```
# using Scaler for numerical variable
sc=StandardScaler()
sc_data=sc.fit_transform(df2)
```

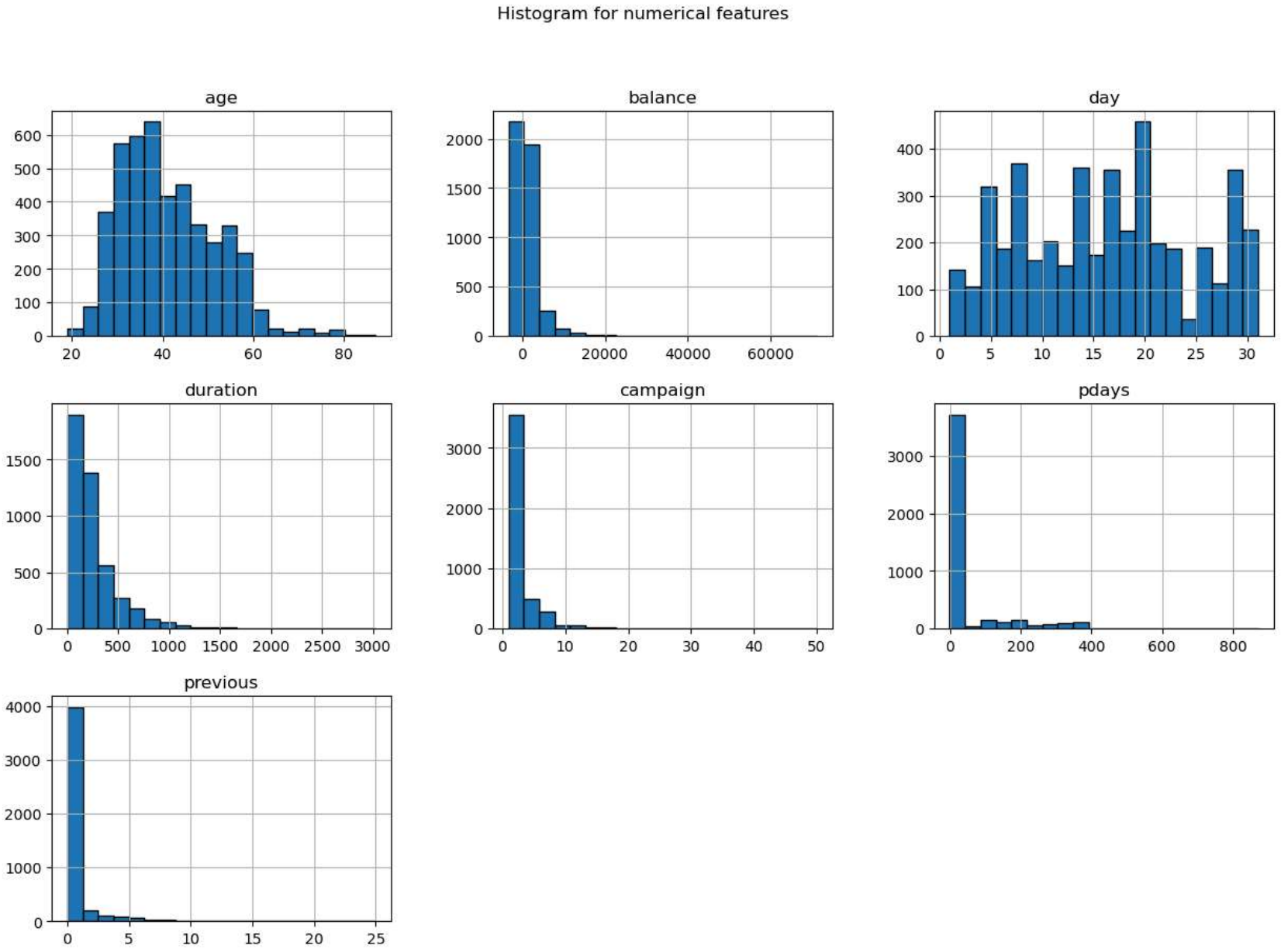
In [20]:
```
# categorical variable distribution
plt.figure(figsize=(15,10))
for i,col in enumerate(cat_col,1):
    plt.subplot(3,3,i)
    sns.countplot(x=col,data=df)
    plt.title(f"Bar plot for {col}")
    plt.xticks(rotation=45)
plt.suptitle("Bar plot for Categorical features\n")
plt.tight_layout()
plt.show()
```


Bar plot for Categorical features
Bar plot for job
count
job
unemployed
services
management
blue-collar
self-employed
technician
entrepreneur
admin.
student
housemaid
retired
unknown
Bar plot for marital
marital
married
single
divorced
Bar plot for education
education
primary
secondary
tertiary
unknown
Bar plot for default
default
no
yes
Bar plot for housing
housing
Bar plot for loan
loan
Bar plot for contact
contact
cellular
unknown
telephone
Bar plot for month
month
oct
may
apr
jun
feb
aug
jan
jul
nov
sep
mar
dec
Bar plot for poutcome
poutcome
failure
other
success

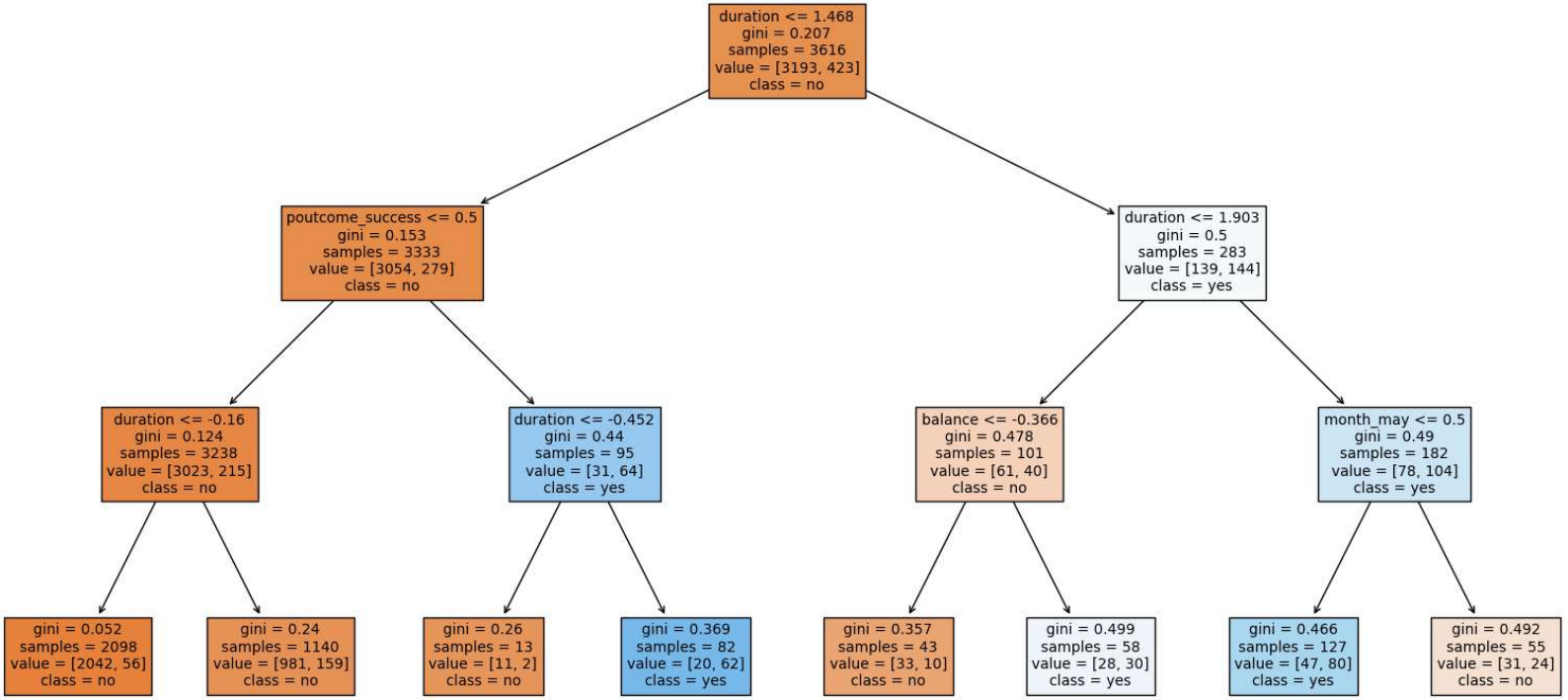
In [13]:
```
import seaborn as sns
import matplotlib.pyplot as plt
# target variable distribution
sns.countplot(x='y',data=df)
plt.title("Distribution of Target variable")
plt.show()
```



In [15]:
```
# numerical variable distribution
df[num_col].hist(figsize=(15,10),bins=20,edgecolor='k')
plt.suptitle("Histogram for numerical features")
plt.show()
```



In [21]:
```
# Visualize the Pruned Decision Tree
plt.figure(figsize=(20,10))
plot_tree(clf, filled=True, feature_names=list(num_col) + en.get_feature_names_out(cat_col).tolist(), class_r
plt.show()
```



In [16]:
```
# combine encoded categorical and scaled numerical features
X=np.hstack((sc_data,en_data))
y=df['y'].apply(lambda x: 1 if x=='yes' else 0)
```

In [17]:
```
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier, plot_tree
# split the data
X_train,X_test,y_train,y_test=train_test_split(X,y,test_size=0.2, random_state=42)
# Build and prune the Decision Tree Classifier
clf=DecisionTreeClassifier(random_state=42,max_depth=3)
clf.fit(X_train,y_train)
```

Out[17]:
```
DecisionTreeClassifier(max_depth=3, random_state=42)
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [18]:
```
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score, confusion_matrix
# evaluate the pruned model
y_pred=clf.predict(X_test)
print(f"Accuracy score : {accuracy_score(y_test,y_pred)}")
print(f"Precision score : {precision_score(y_test,y_pred)}")
print(f"Recall score : {recall_score(y_test,y_pred)}")
print(f"F1 score : {f1_score(y_test,y_pred)}")
print(f"Confusion matrix:\n{confusion_matrix(y_test,y_pred)}")
```

```
Accuracy score : 0.8939226519337017
Precision score : 0.515625
Recall score : 0.336734693877551
F1 score : 0.4074074074074074
Confusion matrix:
[[776  31]
 [ 65  33]]
```