In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn import  metrics
from sklearn.neighbors import KNeighborsClassifier
```

In [2]:
```
df = pd.read_csv('D:\\24 - Machine_Learning\\download files\\bank\\bank.csv', sep=';')
df
```

Out[2]:

	age	job	marital	education	default	balance	housing	loan	contact	day	month	duration	campaign	pdays	previous	poutcome	y
0	30	unemployed	married	primary	no	1787	no	no	cellular	19	oct	79	1	-1	0	unknown	no
1	33	services	married	secondary	no	4789	yes	yes	cellular	11	may	220	1	339	4	failure	no
2	35	management	single	tertiary	no	1350	yes	no	cellular	16	apr	185	1	330	1	failure	no
3	30	management	married	tertiary	no	1476	yes	yes	unknown	3	jun	199	4	-1	0	unknown	no
4	59	blue-collar	married	secondary	no	0	yes	no	unknown	5	may	226	1	-1	0	unknown	no
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4516	33	services	married	secondary	no	-333	yes	no	cellular	30	jul	329	5	-1	0	unknown	no
4517	57	self-employed	married	tertiary	yes	-3313	yes	yes	unknown	9	may	153	1	-1	0	unknown	no
4518	57	technician	married	secondary	no	295	no	no	cellular	19	aug	151	11	-1	0	unknown	no
4519	28	blue-collar	married	secondary	no	1137	no	no	cellular	6	feb	129	4	211	3	other	no
4520	44	entrepreneur	single	tertiary	no	1136	yes	yes	cellular	3	apr	345	2	249	7	other	no

4521 rows × 17 columns

In [3]:
```
df.shape
```

Out[3]:
```
(4521, 17)
```

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

Out[4]:

	age	job	marital	education	default	balance	housing	loan	contact	day	month	duration	campaign	pdays	previous	poutcome	y
0	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
4	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4516	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
4517	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
4518	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
4519	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False
4520	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False	False

4521 rows × 17 columns

In [5]:
```
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 [6]:
```
df['poutcome'] = df['poutcome'].map({'failure' : -1, 'unknown' : 0, 'success' : 1, 'other' : 0})
```

In [7]:
```
df['default'] = df['default'].map({'yes': 0, 'no':1})
df['housing'] = df['housing'].map({'yes': 0, 'no':1})
df['loan'] = df['loan'].map({'yes': 0, 'no':1})
```

In [8]:
```
df
```

Out[8]:

	age	job	marital	education	default	balance	housing	loan	contact	day	month	duration	campaign	pdays	previous	poutcome	y
0	30	unemployed	married	primary	1	1787	1	1	cellular	19	oct	79	1	-1	0	0	no
1	33	services	married	secondary	1	4789	0	0	cellular	11	may	220	1	339	4	-1	no
2	35	management	single	tertiary	1	1350	0	1	cellular	16	apr	185	1	330	1	-1	no
3	30	management	married	tertiary	1	1476	0	0	unknown	3	jun	199	4	-1	0	0	no
4	59	blue-collar	married	secondary	1	0	0	1	unknown	5	may	226	1	-1	0	0	no
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4516	33	services	married	secondary	1	-333	0	1	cellular	30	jul	329	5	-1	0	0	no
4517	57	self-employed	married	tertiary	0	-3313	0	0	unknown	9	may	153	1	-1	0	0	no
4518	57	technician	married	secondary	1	295	1	1	cellular	19	aug	151	11	-1	0	0	no
4519	28	blue-collar	married	secondary	1	1137	1	1	cellular	6	feb	129	4	211	3	0	no
4520	44	entrepreneur	single	tertiary	1	1136	0	0	cellular	3	apr	345	2	249	7	0	no

4521 rows × 17 columns

In [9]:
```
nominal = ['job', 'marital', 'education', 'contact', 'month']
data = pd.get_dummies(df, columns = nominal)
```

In [10]:
```
df.shape
```

Out[10]:
```
(4521, 17)
```

In [11]:
```
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   int64 
 5   balance    4521 non-null   int64 
 6   housing    4521 non-null   int64 
 7   loan       4521 non-null   int64 
 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   int64 
 16  y          4521 non-null   object
dtypes: int64(11), object(6)
memory usage: 600.6+ KB
```

In [12]:
```
data['y'] = data['y'].map({'yes':1, 'no':0})
```

In [13]:
```
data = data.drop(['duration'], axis=1)
```

In [14]:
```
op = data.pop('y')
```

In [15]:
```
train_feat, test_feat, train_classes, test_classes = train_test_split(data,op,train_size = 0.8, random_state=40)
```

In [16]:
```
knn = KNeighborsClassifier(n_neighbors=2)
```

In [17]:
```
knn.fit(train_feat, train_classes)
```

Out[17]:
```
KNeighborsClassifier(n_neighbors=2)
```

In [18]:
```
pred = knn.predict(test_feat)
```

In [19]:
```
print("Accuracy: ", metrics.accuracy_score(test_classes, pred))
```

```
Accuracy:  0.876243093922652
```

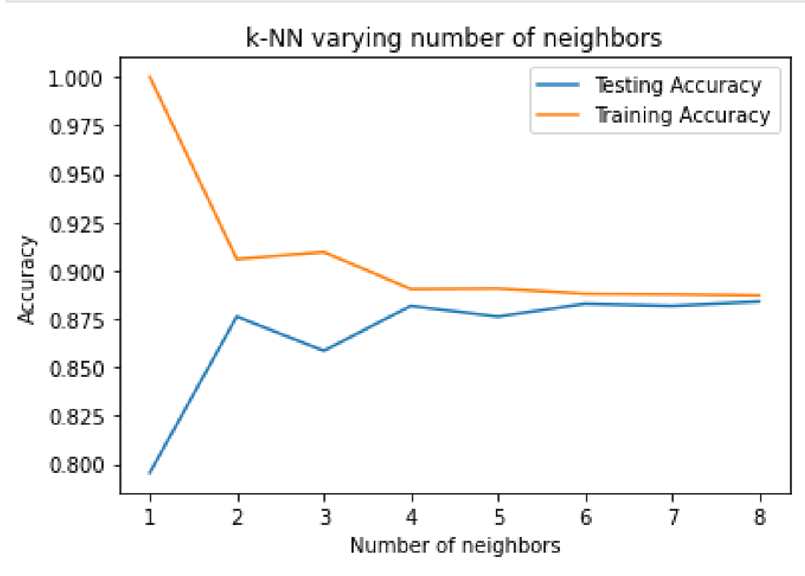
In [20]:
```
neighbors = np.arange(1,9)
```

In [21]:
```
train_accuracy = np.empty(len(neighbors))
```

In [22]:
```
test_accuracy = np.empty(len(neighbors))
```

In [23]:
```
for i,k in enumerate(neighbors):
    #Setup a knn classifier with k neighbors
    knn = KNeighborsClassifier(n_neighbors=k)
    #Fit the model
    knn.fit(train_feat, train_classes)
    #compute accuracy on training set
    train_accuracy[i] = knn.score(train_feat, train_classes)
    #compute accuracy on test set
    test_accuracy[i] = knn.score(test_feat, test_classes)
```

In [24]:
```
plt.title('k-NN varying number of neighbors')
plt.plot(neighbors, test_accuracy, label='Testing Accuracy')
plt.plot(neighbors, train_accuracy, label='Training Accuracy')
plt.legend()
plt.xlabel('Number of neighbors')
plt.ylabel('Accuracy')
plt.show()
```


k-NN varying number of neighbors
Testing Accuracy
Training Accuracy
Accuracy
Number of neighbors