import libraries

In [3]:

```
import pandas as pd
import numpy as np
```

In [4]:

```
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

import dataset

In [61]:

```
data = pd.read_csv('teleCust.csv')
data.head()
```

Out[61]:

	region	tenure	age	marital	address	income	ed	employ	retire	gender	reside	custca
0	2	13	44	1	9	64.0	4	5	0.0	0	2	
1	3	11	33	1	7	136.0	5	5	0.0	0	6	
2	3	68	52	1	24	116.0	1	29	0.0	1	2	
3	2	33	33	0	12	33.0	2	0	0.0	1	1	
4	2	23	30	1	9	30.0	1	2	0.0	0	4	

In [62]:

```
data.drop(['employ'], axis = 1 , inplace = True)
```

In [63]:

```
data.head()
```

Out[63]:

	region	tenure	age	marital	address	income	ed	retire	gender	reside	custcat
0	2	13	44	1	9	64.0	4	0.0	0	2	1
1	3	11	33	1	7	136.0	5	0.0	0	6	4
2	3	68	52	1	24	116.0	1	0.0	1	2	3
3	2	33	33	0	12	33.0	2	0.0	1	1	1
4	2	23	30	1	9	30.0	1	0.0	0	4	3

Data Preprocessing

In [64]:

```
data.describe()
```

Out[64]:

	region	tenure	age	marital	address	income	
count	1000.0000	1000.000000	1000.000000	1000.000000	1000.000000	1000.000000	1000.000
mean	2.0220	35.526000	41.684000	0.495000	11.551000	77.535000	2.671
std	0.8162	21.359812	12.558816	0.500225	10.086681	107.044165	1.222
min	1.0000	1.000000	18.000000	0.000000	0.000000	9.000000	1.000
25%	1.0000	17.000000	32.000000	0.000000	3.000000	29.000000	2.000
50%	2.0000	34.000000	40.000000	0.000000	9.000000	47.000000	3.000
75%	3.0000	54.000000	51.000000	1.000000	18.000000	83.000000	4.000
max	3.0000	72.000000	77.000000	1.000000	55.000000	1668.000000	5.000

In [65]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 11 columns):
 #   Column   Non-Null Count  Dtype  
---  ------   --------------  -----  
 0   region   1000 non-null   int64  
 1   tenure   1000 non-null   int64  
 2   age      1000 non-null   int64  
 3   marital  1000 non-null   int64  
 4   address  1000 non-null   int64  
 5   income   1000 non-null   float64
 6   ed       1000 non-null   int64  
 7   retire   1000 non-null   float64
 8   gender   1000 non-null   int64  
 9   reside   1000 non-null   int64  
 10  custcat  1000 non-null   int64  
dtypes: float64(2), int64(9)
memory usage: 86.1 KB
```

In [66]:

```
data.isnull().sum()
```

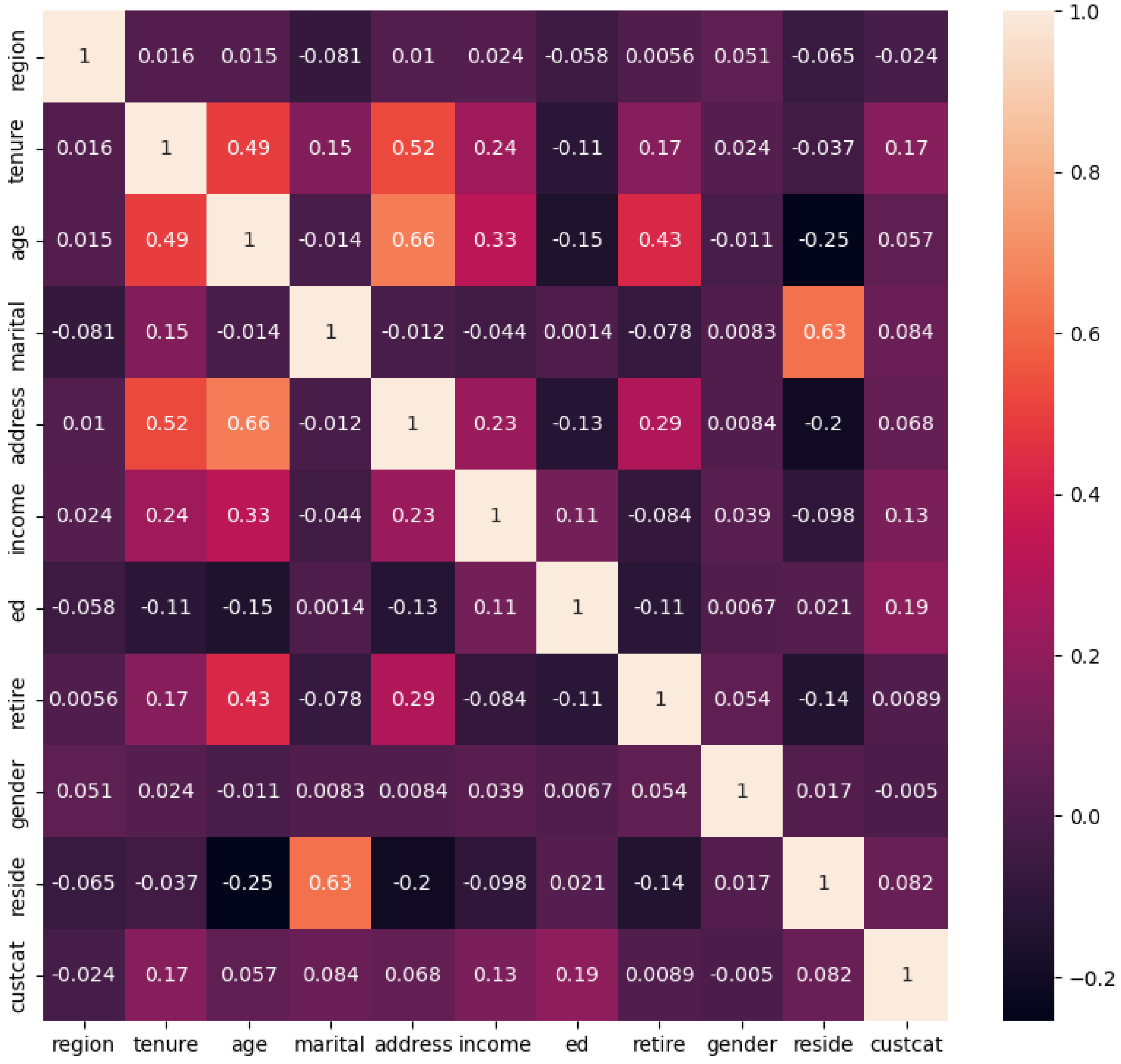
Out[66]:

```
region     0
tenure     0
age        0
marital    0
address    0
income     0
ed         0
retire     0
gender     0
reside     0
custcat    0
dtype: int64
```

corelation map

In [67]:

```
plt.figure(figsize = (10,9))
sns.heatmap(data.corr(),annot = True)
plt.show()
```



In [68]:

```
data.drop(['retire','gender'] , axis = 1 , inplace = True)
```

In [69]:

```
data.head()
```

Out[69]:

	region	tenure	age	marital	address	income	ed	reside	custcat
0	2	13	44	1	9	64.0	4	2	1
1	3	11	33	1	7	136.0	5	6	4
2	3	68	52	1	24	116.0	1	2	3
3	2	33	33	0	12	33.0	2	1	1
4	2	23	30	1	9	30.0	1	4	3

In [70]:

```
region = pd.get_dummies(data['region'],drop_first=True, prefix = "region")
reside = pd.get_dummies(data['reside'],drop_first=True, prefix = "reside")
```

In [71]:

```
data.drop(['region','reside'],axis=1,inplace=True)
```

In [72]:

```
data = pd.concat([data, region, reside], axis=1)
```

In [73]:

```
data.head()
```

Out[73]:

	tenure	age	marital	address	income	ed	custcat	region_2	region_3	reside_2	reside_
0	13	44	1	9	64.0	4	1	1	0	1	
1	11	33	1	7	136.0	5	4	0	1	0	
2	68	52	1	24	116.0	1	3	0	1	1	
3	33	33	0	12	33.0	2	1	1	0	0	
4	23	30	1	9	30.0	1	3	1	0	0	

Standardisation of variables

In [74]:

```
from sklearn.preprocessing import StandardScaler
```

In [75]:

```
Scaled_variable = data[['tenure','age', 'address', 'income' , 'ed']]
```

In [76]:

```
Scaled_variable
```

Out[76]:

	tenure	age	address	income	ed
0	13	44	9	64.0	4
1	11	33	7	136.0	5
2	68	52	24	116.0	1
3	33	33	12	33.0	2
4	23	30	9	30.0	1
...	...	...	...	...	...
995	10	39	0	27.0	3
996	7	34	2	22.0	5
997	67	59	40	944.0	5
998	70	49	18	87.0	2
999	50	36	7	39.0	3

1000 rows × 5 columns

In [77]:

```
scaler = StandardScaler()
```

In [78]:

```
scaler.fit(Scaled_variable)
```

Out[78]:

```
▾ StandardScaler
StandardScaler()
```

In [79]:

```
Scaled_variable = scaler.transform(Scaled_variable)
```

In [80]:

```
Scaled_variable.head()
```

```
---------------------------------------------------------------------------
-
AttributeError                            Traceback (most recent call las
t)
Cell In[80], line 1
----> 1 Scaled_variable.head()

AttributeError: 'numpy.ndarray' object has no attribute 'head'
```

In [81]:

```
df_scaled = pd.DataFrame(Scaled_variable, columns = ['tenure','age', 'address', 'income'
```

In [82]:

```
df_scaled.head()
```

Out[82]:

	tenure	age	address	income	ed
0	-1.055125	0.184505	-0.253034	-0.126506	1.087753
1	-1.148806	-0.691812	-0.451415	0.546450	1.906227
2	1.521092	0.821826	1.234819	0.359517	-1.367671
3	-0.118319	-0.691812	0.044536	-0.416251	-0.549196
4	-0.586722	-0.930808	-0.253034	-0.444291	-1.367671

In [83]:

```
data.head()
```

Out[83]:

	tenure	age	marital	address	income	ed	custcat	region_2	region_3	reside_2	reside_
0	13	44	1	9	64.0	4	1	1	0	1	
1	11	33	1	7	136.0	5	4	0	1	0	
2	68	52	1	24	116.0	1	3	0	1	1	
3	33	33	0	12	33.0	2	1	1	0	0	
4	23	30	1	9	30.0	1	3	1	0	0	

In [84]:

```
data.drop(['tenure','age', 'address', 'income' , 'ed'] , axis = 1, inplace = True)
```

In [85]:

```
data.head()
```

Out[85]:

	marital	custcat	region_2	region_3	reside_2	reside_3	reside_4	reside_5	reside_6	res
0	1	1	1	0	1	0	0	0	0	
1	1	4	0	1	0	0	0	0	1	
2	1	3	0	1	1	0	0	0	0	
3	0	1	1	0	0	0	0	0	0	
4	1	3	1	0	0	0	1	0	0	

In [86]:

```
data = pd.concat([data , df_scaled] , axis = 1)
```

In [87]:

```
data.head()
```

Out[87]:

	marital	custcat	region_2	region_3	reside_2	reside_3	reside_4	reside_5	reside_6	res
0	1	1	1	0	1	0	0	0	0	
1	1	4	0	1	0	0	0	0	1	
2	1	3	0	1	1	0	0	0	0	
3	0	1	1	0	0	0	0	0	0	
4	1	3	1	0	0	0	1	0	0	

Modelling

In [90]:

```
X = data.drop(['custcat'] , axis = 1)
y = data['custcat']
```

In [91]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split( X, y, test_size=0.2, random_state=4
```

In [92]:

```
from sklearn.neighbors import KNeighborsClassifier
```

In [93]:

```
k = 4
knn_model = KNeighborsClassifier(n_neighbors = k)
knn_model.fit(X_train,y_train)
knn_model
```

Out[93]:

```
▾       KNeighborsClassifier
KNeighborsClassifier(n_neighbors=4)
```

In [94]:

```
y_pred = knn_model.predict(X_test)
```

In [95]:

```
from sklearn import metrics
print("Accuracy Score:", metrics.accuracy_score(y_test, y_pred))
```

```
Accuracy Score: 0.325
```

Hyper parameter optimization

In [96]:

```
from sklearn.model_selection import GridSearchCV
```

In [97]:

```
knn_model3 = KNeighborsClassifier()
```

In [99]:

```
knn_params = {"n_neighbors": np.arange(1,50),
              "metric" : ["minkowski", "euclidean", "manhattan"],
              "weights" : ["uniform", "distance"]}
```

In [100]:

```
knn_cv_model = GridSearchCV(estimator = knn_model3, param_grid = knn_params, cv = 10)
```

In [101]:

```
knn_cv_model.fit(X_train, y_train)
```

Out[101]:

```
▸            GridSearchCV
▸ estimator: KNeighborsClassifier
        ▸ KNeighborsClassifier
```

In [102]:

```
knn_cv_model.best_params_
```

Out[102]:

```
{'metric': 'minkowski', 'n_neighbors': 49, 'weights': 'uniform'}
```

In [103]:

```
knn_tuned = KNeighborsClassifier(n_neighbors = 49)
```

In [104]:

```
knn_tuned.fit(X_train, y_train)
```

Out[104]:

```
▾        KNeighborsClassifier
KNeighborsClassifier(n_neighbors=49)
```

In [105]:

```
KNeighborsClassifier(n_neighbors=49)
```

Out[105]:

```
▾        KNeighborsClassifier
KNeighborsClassifier(n_neighbors=49)
```

In [106]:

```
y_pred = knn_tuned.predict(X_test)
```

In [107]:

```
print("Accuracy Score:", metrics.accuracy_score(y_test, y_pred))
```

```
Accuracy Score: 0.44
```

In [ ]: