customer-personality-analysis

May 6, 2024

[1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import warnings
from datetime import datetime
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
from sklearn.decomposition import PCA
warnings.filterwarnings('ignore')
```

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

[3]:
```
df.head(5)
```

[3]:

	ID	Year_Birth	Education	Marital_Status	Income	Kidhome	Teenhome	\
0	5524	1957	Graduation	Single	58138.0	0	0	
1	2174	1954	Graduation	Single	46344.0	1	1	
2	4141	1965	Graduation	Together	71613.0	0	0	
3	6182	1984	Graduation	Together	26646.0	1	0	
4	5324	1981	PhD	Married	58293.0	1	0	

	Dt_Customer	Recency	MntWines	…	NumWebVisitsMonth	AcceptedCmp3	\
0	4/9/2012	58	635	…	7	0	
1	8/3/2014	38	11	…	5	0	
2	21-08-2013	26	426	…	4	0	
3	10/2/2014	26	11	…	6	0	
4	19-01-2014	94	173	…	5	0	

	AcceptedCmp4	AcceptedCmp5	AcceptedCmp1	AcceptedCmp2	Complain	\
0	0	0	0	0	0	
1	0	0	0	0	0	
2	0	0	0	0	0	
3	0	0	0	0	0	
4	0	0	0	0	0	

	Z_CostContact	Z_Revenue	Response
0	3	11	1

```
1              3         11         0
2              3         11         0
3              3         11         0
4              3         11         0

[5 rows x 29 columns]
```

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2240 entries, 0 to 2239
Data columns (total 29 columns):
 #   Column               Non-Null Count  Dtype  
---  ------               --------------  -----  
 0   ID                   2240 non-null   int64  
 1   Year_Birth           2240 non-null   int64  
 2   Education            2240 non-null   object 
 3   Marital_Status       2240 non-null   object 
 4   Income               2216 non-null   float64
 5   Kidhome              2240 non-null   int64  
 6   Teenhome             2240 non-null   int64  
 7   Dt_Customer          2240 non-null   object 
 8   Recency              2240 non-null   int64  
 9   MntWines             2240 non-null   int64  
 10  MntFruits            2240 non-null   int64  
 11  MntMeatProducts      2240 non-null   int64  
 12  MntFishProducts      2240 non-null   int64  
 13  MntSweetProducts     2240 non-null   int64  
 14  MntGoldProds         2240 non-null   int64  
 15  NumDealsPurchases    2240 non-null   int64  
 16  NumWebPurchases      2240 non-null   int64  
 17  NumCatalogPurchases  2240 non-null   int64  
 18  NumStorePurchases    2240 non-null   int64  
 19  NumWebVisitsMonth    2240 non-null   int64  
 20  AcceptedCmp3         2240 non-null   int64  
 21  AcceptedCmp4         2240 non-null   int64  
 22  AcceptedCmp5         2240 non-null   int64  
 23  AcceptedCmp1         2240 non-null   int64  
 24  AcceptedCmp2         2240 non-null   int64  
 25  Complain             2240 non-null   int64  
 26  Z_CostContact        2240 non-null   int64  
 27  Z_Revenue            2240 non-null   int64  
 28  Response             2240 non-null   int64  
dtypes: float64(1), int64(25), object(3)
memory usage: 507.6+ KB
```

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

[5]:

	ID	Year_Birth	Income	Kidhome	Teenhome
count	2240.000000	2240.000000	2216.000000	2240.000000	2240.000000
mean	5592.159821	1968.805804	52247.251354	0.444196	0.506250
std	3246.662198	11.984069	25173.076661	0.538398	0.544538
min	0.000000	1893.000000	1730.000000	0.000000	0.000000
25%	2828.250000	1959.000000	35303.000000	0.000000	0.000000
50%	5458.500000	1970.000000	51381.500000	0.000000	0.000000
75%	8427.750000	1977.000000	68522.000000	1.000000	1.000000
max	11191.000000	1996.000000	666666.000000	2.000000	2.000000

	Recency	MntWines	MntFruits	MntMeatProducts
count	2240.000000	2240.000000	2240.000000	2240.000000
mean	49.109375	303.935714	26.302232	166.950000
std	28.962453	336.597393	39.773434	225.715373
min	0.000000	0.000000	0.000000	0.000000
25%	24.000000	23.750000	1.000000	16.000000
50%	49.000000	173.500000	8.000000	67.000000
75%	74.000000	504.250000	33.000000	232.000000
max	99.000000	1493.000000	199.000000	1725.000000

	MntFishProducts	…	NumWebVisitsMonth	AcceptedCmp3	AcceptedCmp4
count	2240.000000	…	2240.000000	2240.000000	2240.000000
mean	37.525446	…	5.316518	0.072768	0.074554
std	54.628979	…	2.426645	0.259813	0.262728
min	0.000000	…	0.000000	0.000000	0.000000
25%	3.000000	…	3.000000	0.000000	0.000000
50%	12.000000	…	6.000000	0.000000	0.000000
75%	50.000000	…	7.000000	0.000000	0.000000
max	259.000000	…	20.000000	1.000000	1.000000

	AcceptedCmp5	AcceptedCmp1	AcceptedCmp2	Complain	Z_CostContact
count	2240.000000	2240.000000	2240.000000	2240.000000	2240.0
mean	0.072768	0.064286	0.013393	0.009375	3.0
std	0.259813	0.245316	0.114976	0.096391	0.0
min	0.000000	0.000000	0.000000	0.000000	3.0
25%	0.000000	0.000000	0.000000	0.000000	3.0
50%	0.000000	0.000000	0.000000	0.000000	3.0
75%	0.000000	0.000000	0.000000	0.000000	3.0
max	1.000000	1.000000	1.000000	1.000000	3.0

	Z_Revenue	Response
count	2240.0	2240.000000
mean	11.0	0.149107
std	0.0	0.356274
min	11.0	0.000000
25%	11.0	0.000000
50%	11.0	0.000000

```
75%          11.0     0.000000
max          11.0     1.000000

[8 rows x 26 columns]
```

[6]:
```
df.clip()
```

[6]:
```
          ID  Year_Birth   Education Marital_Status   Income  Kidhome  \
0       5524        1957  Graduation         Single  58138.0        0
1       2174        1954  Graduation         Single  46344.0        1
2       4141        1965  Graduation       Together  71613.0        0
3       6182        1984  Graduation       Together  26646.0        1
4       5324        1981         PhD        Married  58293.0        1
…        …           …           …              …       …        …
2235   10870        1967  Graduation        Married  61223.0        0
2236    4001        1946         PhD       Together  64014.0        2
2237    7270        1981  Graduation       Divorced  56981.0        0
2238    8235        1956      Master       Together  69245.0        0
2239    9405        1954         PhD        Married  52869.0        1

      Teenhome Dt_Customer  Recency  MntWines  …  NumWebVisitsMonth  \
0            0    4/9/2012       58       635  …                  7
1            1    8/3/2014       38        11  …                  5
2            0  21-08-2013       26       426  …                  4
3            0   10/2/2014       26        11  …                  6
4            0  19-01-2014       94       173  …                  5
…          …          …       …         …  …                  …
2235         1  13-06-2013       46       709  …                  5
2236         1   10/6/2014       56       406  …                  7
2237         0  25-01-2014       91       908  …                  6
2238         1  24-01-2014        8       428  …                  3
2239         1  15-10-2012       40        84  …                  7

      AcceptedCmp3  AcceptedCmp4  AcceptedCmp5  AcceptedCmp1  AcceptedCmp2  \
0                0             0             0             0             0
1                0             0             0             0             0
2                0             0             0             0             0
3                0             0             0             0             0
4                0             0             0             0             0
…              …             …             …             …             …
2235             0             0             0             0             0
2236             0             0             0             1             0
2237             0             1             0             0             0
2238             0             0             0             0             0
2239             0             0             0             0             0

      Complain  Z_CostContact  Z_Revenue  Response
```

```
0            0              3          11          1
1            0              3          11          0
2            0              3          11          0
3            0              3          11          0
4            0              3          11          0
…          …              …          …           …
2235         0              3          11          0
2236         0              3          11          0
2237         0              3          11          0
2238         0              3          11          0
2239         0              3          11          1

[2240 rows x 29 columns]
```

[7]:
```
df.duplicated()
```

[7]:
```
0       False
1       False
2       False
3       False
4       False
        …
2235    False
2236    False
2237    False
2238    False
2239    False
Length: 2240, dtype: bool
```

[8]:
```
df.isnull()
```

[8]:
```
          ID  Year_Birth  Education  Marital_Status  Income  Kidhome  Teenhome  \
0     False       False      False           False   False    False     False
1     False       False      False           False   False    False     False
2     False       False      False           False   False    False     False
3     False       False      False           False   False    False     False
4     False       False      False           False   False    False     False
…     …           …          …               …       …        …
2235  False       False      False           False   False    False     False
2236  False       False      False           False   False    False     False
2237  False       False      False           False   False    False     False
2238  False       False      False           False   False    False     False
2239  False       False      False           False   False    False     False

      Dt_Customer  Recency  MntWines  …  NumWebVisitsMonth  AcceptedCmp3  \
0           False    False     False  …              False         False
1           False    False     False  …              False         False
```

```
2           False    False     False  …              False         False
3           False    False     False  …              False         False
4           False    False     False  …              False         False
…             …        …         …    …                …             …
2235        False    False     False  …              False         False
2236        False    False     False  …              False         False
2237        False    False     False  …              False         False
2238        False    False     False  …              False         False
2239        False    False     False  …              False         False

      AcceptedCmp4  AcceptedCmp5  AcceptedCmp1  AcceptedCmp2  Complain  \
0            False         False         False         False     False
1            False         False         False         False     False
2            False         False         False         False     False
3            False         False         False         False     False
4            False         False         False         False     False
…              …             …             …             …         …
2235         False         False         False         False     False
2236         False         False         False         False     False
2237         False         False         False         False     False
2238         False         False         False         False     False
2239         False         False         False         False     False

      Z_CostContact  Z_Revenue  Response
0             False      False     False
1             False      False     False
2             False      False     False
3             False      False     False
4             False      False     False
…               …          …         …
2235          False      False     False
2236          False      False     False
2237          False      False     False
2238          False      False     False
2239          False      False     False

[2240 rows x 29 columns]
```

[9]:
```
df.isnull().sum()
```

[9]:
```
ID                    0
Year_Birth            0
Education             0
Marital_Status        0
Income               24
Kidhome               0
Teenhome              0
```

```
Dt_Customer             0
Recency                 0
MntWines                0
MntFruits               0
MntMeatProducts         0
MntFishProducts         0
MntSweetProducts        0
MntGoldProds            0
NumDealsPurchases       0
NumWebPurchases         0
NumCatalogPurchases     0
NumStorePurchases       0
NumWebVisitsMonth       0
AcceptedCmp3            0
AcceptedCmp4            0
AcceptedCmp5            0
AcceptedCmp1            0
AcceptedCmp2            0
Complain                0
Z_CostContact           0
Z_Revenue               0
Response                0
dtype: int64
```

[10]:
```
df['Income'].fillna(df['Income'].mean(),inplace=True)
```

[11]:
```
df.dropna()
```

[11]:

	ID	Year_Birth	Education	Marital_Status	Income	Kidhome	\
0	5524	1957	Graduation	Single	58138.0	0	
1	2174	1954	Graduation	Single	46344.0	1	
2	4141	1965	Graduation	Together	71613.0	0	
3	6182	1984	Graduation	Together	26646.0	1	
4	5324	1981	PhD	Married	58293.0	1	
…	…	…	…	…	…	…	
2235	10870	1967	Graduation	Married	61223.0	0	
2236	4001	1946	PhD	Together	64014.0	2	
2237	7270	1981	Graduation	Divorced	56981.0	0	
2238	8235	1956	Master	Together	69245.0	0	
2239	9405	1954	PhD	Married	52869.0	1	

	Teenhome	Dt_Customer	Recency	MntWines	…	NumWebVisitsMonth	\
0	0	4/9/2012	58	635	…	7	
1	1	8/3/2014	38	11	…	5	
2	0	21-08-2013	26	426	…	4	
3	0	10/2/2014	26	11	…	6	
4	0	19-01-2014	94	173	…	5	

```
…         …          …       …        …  …                  …
2235         1  13-06-2013       46       709  …                  5
2236         1   10/6/2014       56       406  …                  7
2237         0  25-01-2014       91       908  …                  6
2238         1  24-01-2014        8       428  …                  3
2239         1  15-10-2012       40        84  …                  7

      AcceptedCmp3  AcceptedCmp4  AcceptedCmp5  AcceptedCmp1  AcceptedCmp2  \
0                0             0             0             0             0
1                0             0             0             0             0
2                0             0             0             0             0
3                0             0             0             0             0
4                0             0             0             0             0
…              …             …             …             …             …
2235             0             0             0             0             0
2236             0             0             0             1             0
2237             0             1             0             0             0
2238             0             0             0             0             0
2239             0             0             0             0             0

      Complain  Z_CostContact  Z_Revenue  Response
0            0              3         11         1
1            0              3         11         0
2            0              3         11         0
3            0              3         11         0
4            0              3         11         0
…          …              …         …          …
2235         0              3         11         0
2236         0              3         11         0
2237         0              3         11         0
2238         0              3         11         0
2239         0              3         11         1

[2240 rows x 29 columns]
```

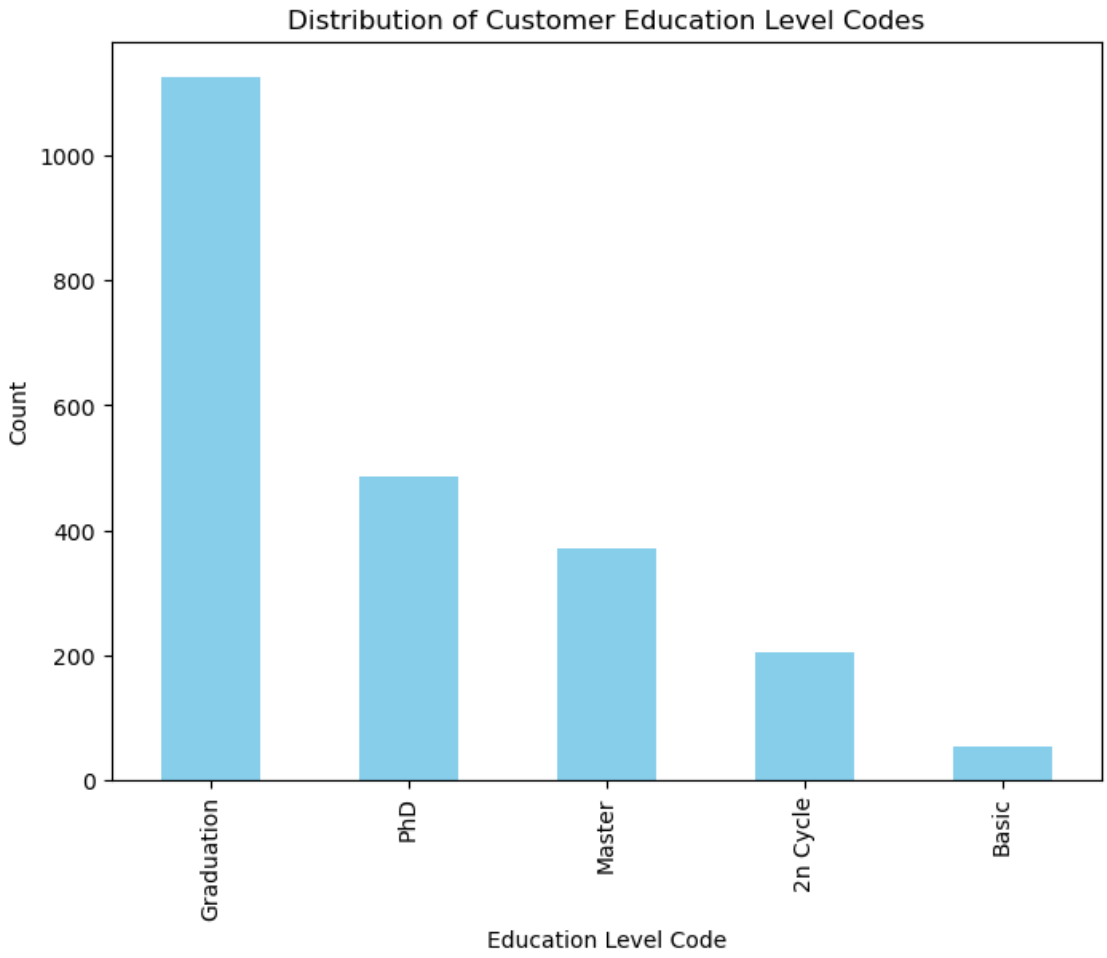
1 distribution of customer education level

[12]:
```
education_level_distribution = df['Education'].value_counts()
education_level_distribution
```

[12]:
```
Education
Graduation    1127
PhD            486
Master         370
2n Cycle       203
Basic           54
```

```
Name: count, dtype: int64
```

[13]:
```
plt.figure(figsize=(8, 6))
education_level_distribution.plot(kind='bar', color='skyblue')
plt.title('Distribution of Customer Education Level Codes')
plt.xlabel('Education Level Code')
plt.ylabel('Count')
plt.show()
```



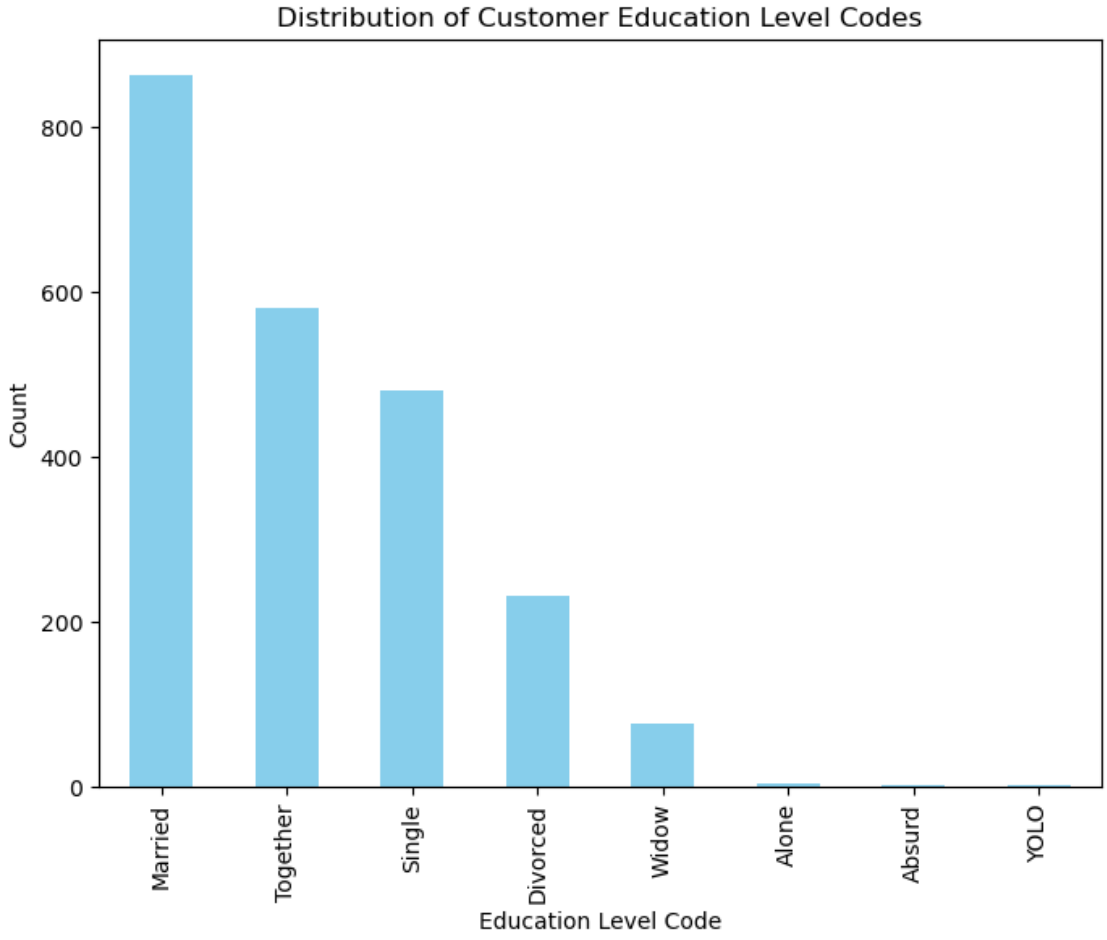
2 martial status vary among customers

[14]:
```
marital_status_distribution = df['Marital_Status'].value_counts()
marital_status_distribution
```

[14]:
```
Marital_Status
Married     864
```

```
Together    580
Single      480
Divorced    232
Widow        77
Alone         3
Absurd        2
YOLO          2
Name: count, dtype: int64
```

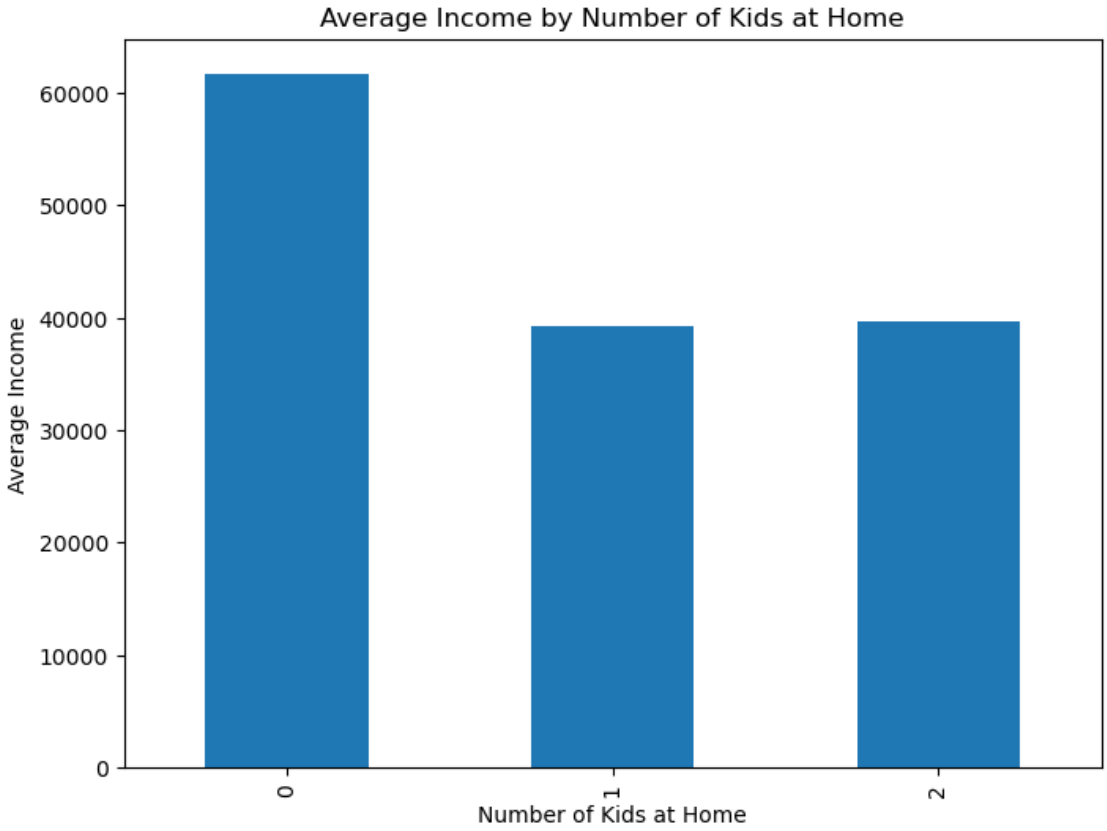
[15]:
```
plt.figure(figsize=(8, 6))
marital_status_distribution.plot(kind='bar', color='skyblue')
plt.title('Distribution of Customer Education Level Codes')
plt.xlabel('Education Level Code')
plt.ylabel('Count')
plt.show()
```



[16]:
```
average_income=df['Income'].mean()
average_income
```

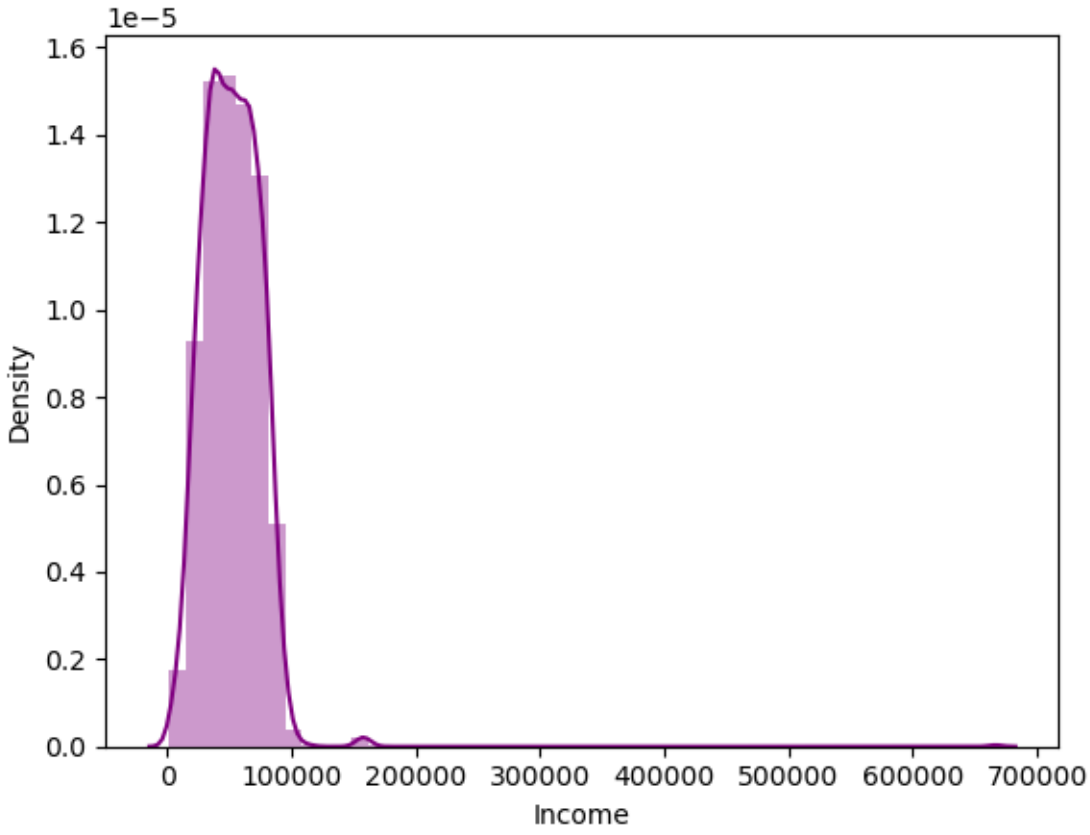
[16]: 52247.25135379061

[17]:
```
income_by_kids = df.groupby('Kidhome')['Income'].mean()
plt.figure(figsize=(8, 6))
income_by_kids.plot(kind='bar')
plt.title('Average Income by Number of Kids at Home')
plt.xlabel('Number of Kids at Home')
plt.ylabel('Average Income')
plt.show()
```

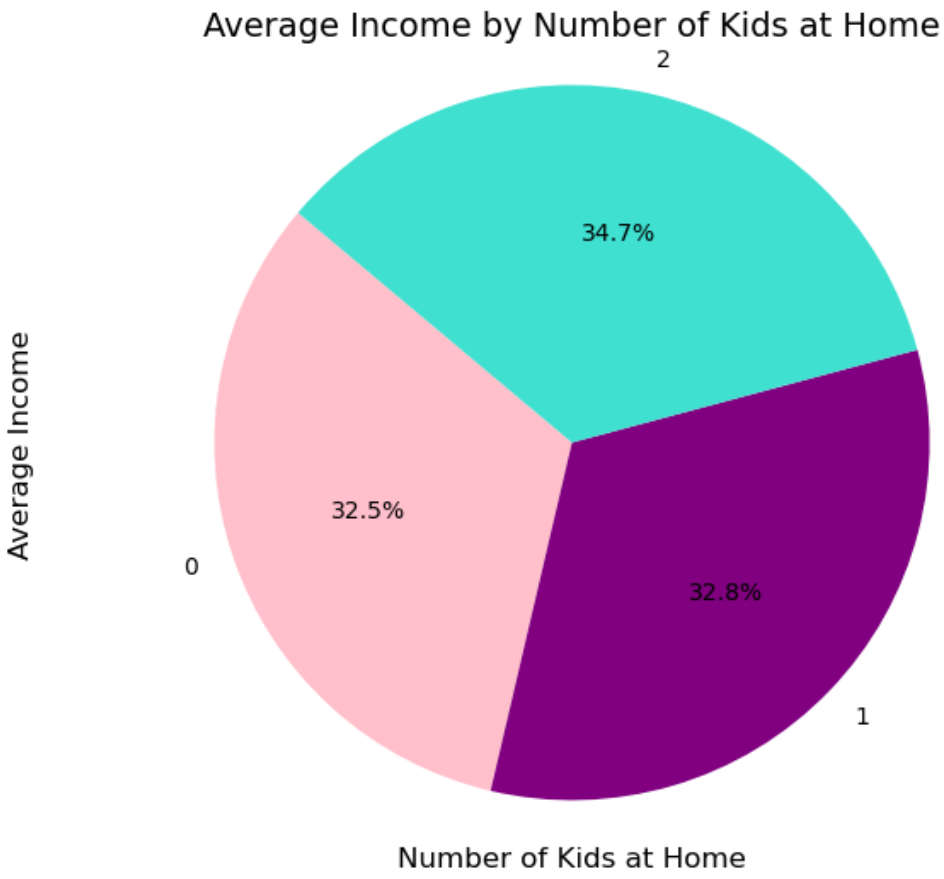


[18]:
```
sns.distplot(df['Income'],color='purple')
```

[18]: <Axes: xlabel='Income', ylabel='Density'>



[19]:
```
# Calculate the mean income by number of kids at home
income_by_kids = df.groupby('Teenhome')['Income'].mean()

# Define custom colors for the pie chart
colors = ['pink', 'purple', 'turquoise']
plt.figure(figsize=(8, 6))
income_by_kids.plot(kind='pie', colors=colors, autopct='%1.1f%%',␣
 ↪startangle=140)

# Adding title and labels
plt.title('Average Income by Number of Kids at Home', fontsize=14)
plt.xlabel('Number of Kids at Home', fontsize=12)
plt.ylabel('Average Income', fontsize=12)

# Display the plot
plt.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a circle.
plt.show()
```

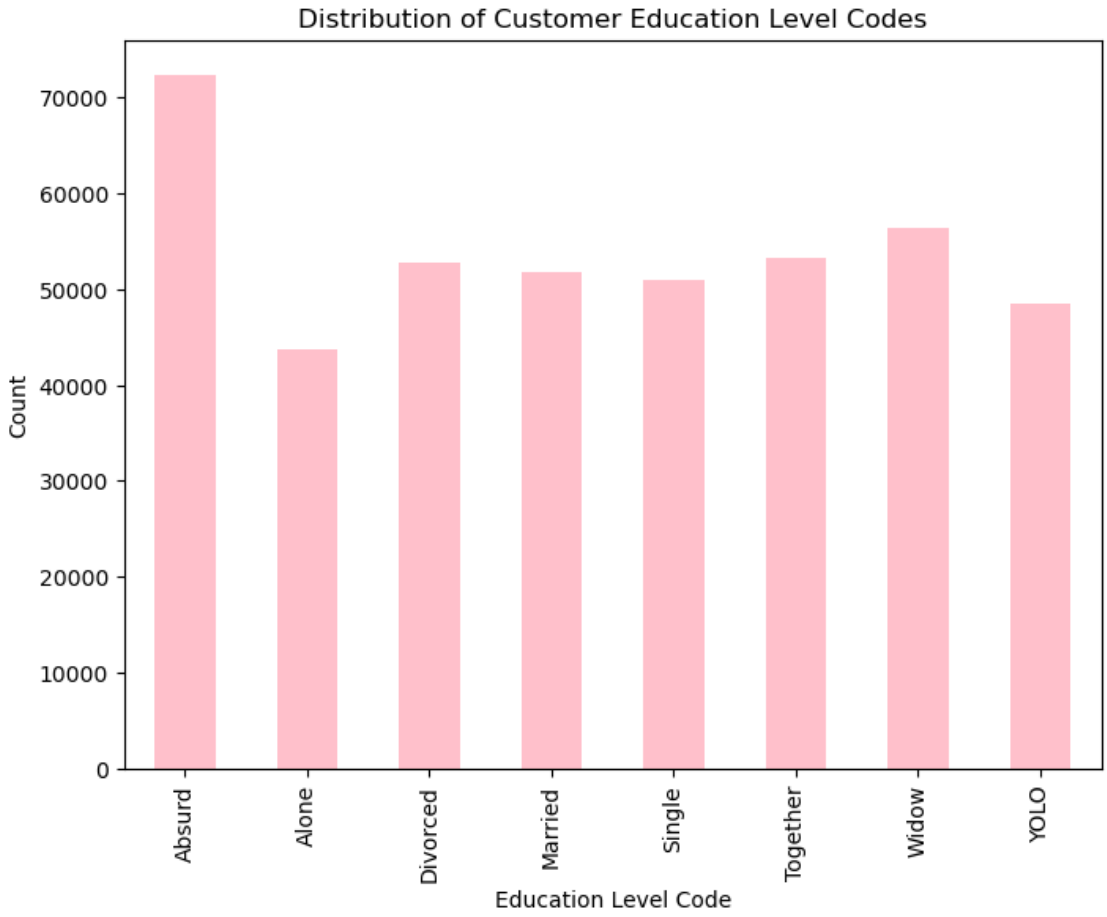


[20]:
```
income_by_martialstatus = df.groupby('Marital_Status')['Income'].mean()
income_by_martialstatus
```

[20]:
```
Marital_Status
Absurd      72365.500000
Alone       43789.000000
Divorced    52834.228448
Married     51729.210370
Single      51018.823463
Together    53233.485792
Widow       56426.561706
YOLO        48432.000000
Name: Income, dtype: float64
```

[21]:
```
plt.figure(figsize=(8, 6))
income_by_martialstatus.plot(kind='bar', color='pink')
plt.title('Distribution of Customer Education Level Codes')
plt.xlabel('Education Level Code')
plt.ylabel('Count')
```

```
plt.show()
```

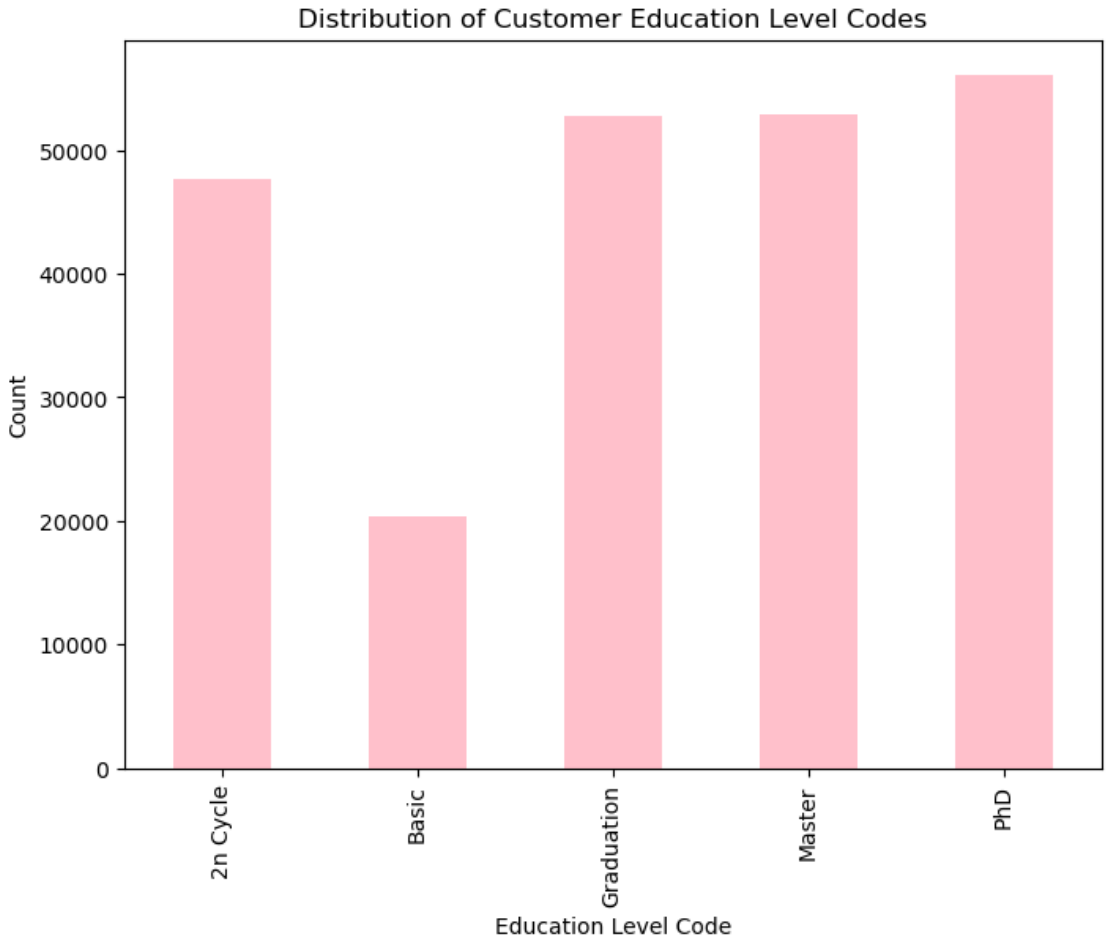


[22]:
```
income_by_Education = df.groupby('Education')['Income'].mean()
income_by_Education
```

[22]:
```
Education
2n Cycle      47701.378099
Basic         20306.259259
Graduation    52715.755781
Master        52908.476370
PhD           56105.210405
Name: Income, dtype: float64
```

[23]:
```
plt.figure(figsize=(8, 6))
income_by_Education.plot(kind='bar', color='pink')
plt.title('Distribution of Customer Education Level Codes')
plt.xlabel('Education Level Code')
plt.ylabel('Count')
```

```
plt.show()
```



[24]:
```
# Clean and preprocess the 'Dt_Customer' column (example: replacing '/' with␣
 ↪'-')
df['Dt_Customer'] = df['Dt_Customer'].str.replace('/', '-')

# Convert 'Dt_Customer' column to datetime format with specific format and␣
 ↪error handling
df['Dt_Customer'] = pd.to_datetime(df['Dt_Customer'], format='%d-%m-%Y',␣
 ↪errors='coerce')

# Get the current date
current_date = pd.to_datetime(datetime.now().date())

# Calculate recency in days
df['Recency'] = (current_date - df['Dt_Customer']).dt.days
```

```
# Display 'Dt_Customer' and 'Recency' columns
print(df[['Dt_Customer', 'Recency']])
```

```
     Dt_Customer  Recency
0      2012-09-04     4252
1      2014-03-08     3702
2      2013-08-21     3901
3      2014-02-10     3728
4      2014-01-19     3750
…           …       …
2235   2013-06-13     3970
2236   2014-06-10     3608
2237   2014-01-25     3744
2238   2014-01-24     3745
2239   2012-10-15     4211

[2240 rows x 2 columns]
```

[25]:
```
correlation = df['Recency'].corr(df['Income'])
correlation
```

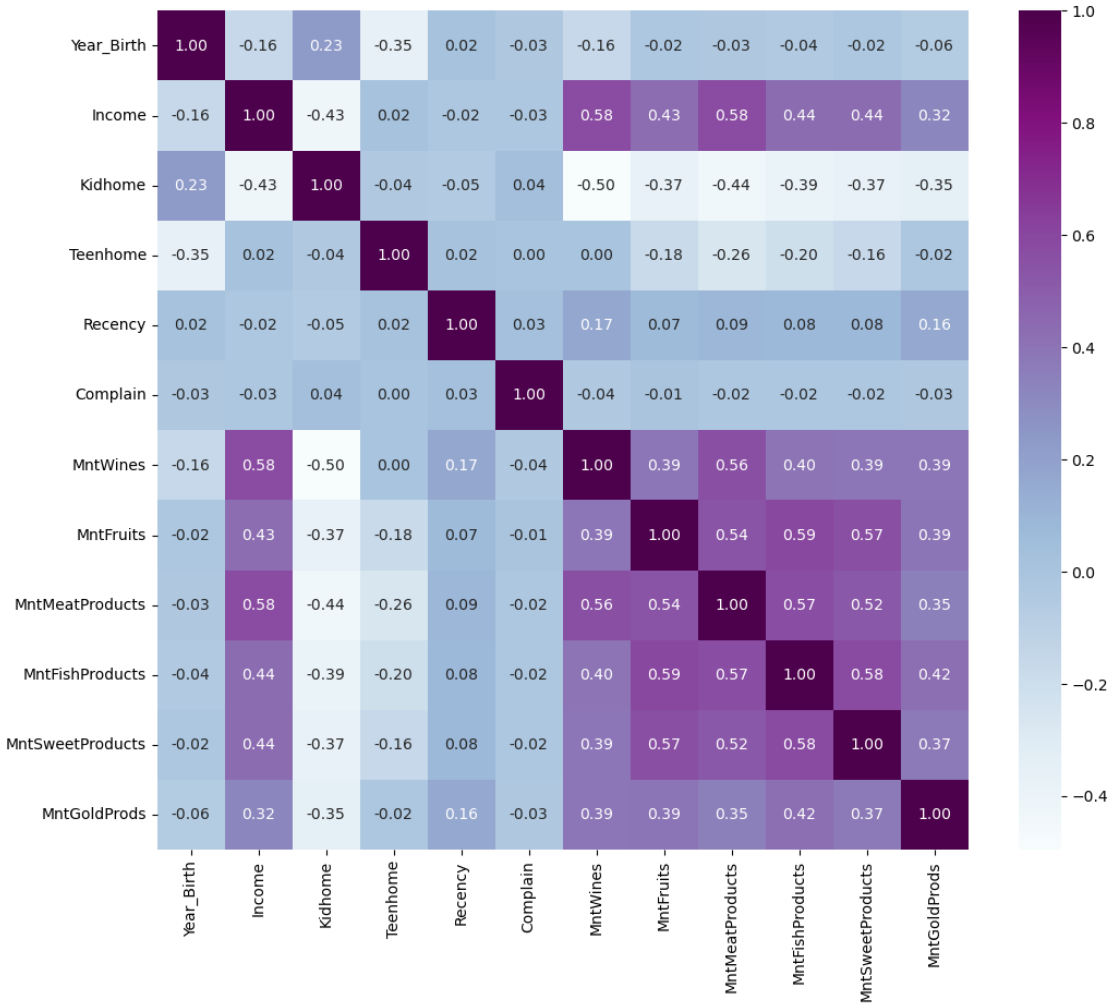
[25]:
```
-0.018459657536445878
```

[26]:
```
columns_of_interest = ['Year_Birth', 'Income', 'Kidhome', 'Teenhome',␣
 ↪'Recency', 'Complain',
                       'MntWines', 'MntFruits', 'MntMeatProducts',␣
 ↪'MntFishProducts',
                       'MntSweetProducts', 'MntGoldProds']
correlation_matrix = df[columns_of_interest].corr()
correlation_matrix
```

[26]:
```
                  Year_Birth    Income   Kidhome  Teenhome   Recency  \
Year_Birth          1.000000 -0.160942  0.230176 -0.352111  0.022431
Income             -0.160942  1.000000 -0.425176  0.019018 -0.018460
Kidhome             0.230176 -0.425176  1.000000 -0.036133 -0.053343
Teenhome           -0.352111  0.019018 -0.036133  1.000000  0.017465
Recency             0.022431 -0.018460 -0.053343  0.017465  1.000000
Complain           -0.030128 -0.027223  0.040207  0.003138  0.033120
MntWines           -0.157773  0.576789 -0.496297  0.004846  0.166264
MntFruits          -0.017917  0.428747 -0.372581 -0.176764  0.066928
MntMeatProducts    -0.030872  0.577802 -0.437129 -0.261160  0.092713
MntFishProducts    -0.041625  0.437497 -0.387644 -0.204187  0.080769
MntSweetProducts   -0.018133  0.436162 -0.370673 -0.162475  0.081268
MntGoldProds       -0.061818  0.321978 -0.349595 -0.021725  0.159596

                   Complain  MntWines  MntFruits  MntMeatProducts  \
Year_Birth        -0.030128 -0.157773  -0.017917        -0.030872
```

```
Income            -0.027223  0.576789   0.428747         0.577802
Kidhome            0.040207 -0.496297  -0.372581        -0.437129
Teenhome           0.003138  0.004846  -0.176764        -0.261160
Recency            0.033120  0.166264   0.066928         0.092713
Complain           1.000000 -0.039007  -0.005166        -0.023483
MntWines          -0.039007  1.000000   0.389637         0.562667
MntFruits         -0.005166  0.389637   1.000000         0.543105
MntMeatProducts   -0.023483  0.562667   0.543105         1.000000
MntFishProducts   -0.020953  0.399753   0.594804         0.568402
MntSweetProducts -0.022485  0.386581   0.567164         0.523846
MntGoldProds      -0.030861  0.387516   0.392995         0.350609

                  MntFishProducts  MntSweetProducts  MntGoldProds
Year_Birth              -0.041625         -0.018133     -0.061818
Income                   0.437497          0.436162      0.321978
Kidhome                 -0.387644         -0.370673     -0.349595
Teenhome                -0.204187         -0.162475     -0.021725
Recency                  0.080769          0.081268      0.159596
Complain                -0.020953         -0.022485     -0.030861
MntWines                 0.399753          0.386581      0.387516
MntFruits                0.594804          0.567164      0.392995
MntMeatProducts          0.568402          0.523846      0.350609
MntFishProducts          1.000000          0.579870      0.422875
MntSweetProducts         0.579870          1.000000      0.369724
MntGoldProds             0.422875          0.369724      1.000000
```

[27]:
```
plt.figure(figsize=(12, 10))
sns.heatmap(correlation_matrix, annot=True, cmap='BuPu', fmt=".2f")
plt.show()
```



[28]:
```
df.hist(bins=30, figsize=(40, 20))
plt.show()
```

[29]:
```
maxincome=df['Income'].std()*3
```

[30]:
```
df[df['Income']>maxincome +5000]
```

[30]:

	ID	Year_Birth	Education	Marital_Status	Income	Kidhome	\
15	2114	1946	PhD	Single	82800.0	0	
29	1966	1965	PhD	Married	84618.0	0	
53	2225	1977	Graduation	Divorced	82582.0	0	
55	6260	1955	Master	Together	82384.0	0	
67	9369	1979	2n Cycle	Single	88194.0	0	
…	…	…	…	…	…	…	
2193	8722	1957	2n Cycle	Married	82347.0	0	
2211	10469	1981	Graduation	Together	88325.0	0	
2213	3661	1995	2n Cycle	Single	80617.0	0	
2217	9589	1948	PhD	Widow	82032.0	0	
2233	9432	1977	Graduation	Together	666666.0	1	

	Teenhome	Dt_Customer	Recency	MntWines	…	NumWebVisitsMonth	\
15	0	2012-11-24	4171	1006	…	3	
29	0	2013-11-22	3808	684	…	2	
53	0	2014-06-07	3611	510	…	1	
55	0	2012-11-19	4176	984	…	1	
67	1	2014-03-19	3691	688	…	5	
…	…	…	…	…	…	…	
2193	0	2012-11-06	4189	556	…	3	
2211	0	2014-02-05	3733	519	…	2	
2213	0	2012-10-12	4214	594	…	2	
2217	0	2014-04-05	3674	332	…	1	

```
2233         0  2013-06-02     3981         9  …                   6

      AcceptedCmp3  AcceptedCmp4  AcceptedCmp5  AcceptedCmp1  AcceptedCmp2  \
15               0             0             1             1             0
29               0             0             1             0             0
53               1             0             0             1             0
55               0             0             1             0             0
67               1             0             0             1             0
…              …             …             …             …             …
2193             1             0             0             1             0
2211             0             0             0             0             0
2213             0             0             0             0             0
2217             0             0             0             0             0
2233             0             0             0             0             0

      Complain  Z_CostContact  Z_Revenue  Response
15           0              3         11         1
29           0              3         11         0
53           0              3         11         1
55           0              3         11         1
67           0              3         11         1
…          …              …         …          …
2193         0              3         11         1
2211         0              3         11         0
2213         0              3         11         0
2217         0              3         11         0
2233         0              3         11         0

[215 rows x 29 columns]
```

[31]:
```
amounts=df.columns.tolist()[9:15]
```

[32]:
```
df[amounts].sum()
```

[32]:
```
MntWines            680816
MntFruits            58917
MntMeatProducts     373968
MntFishProducts      84057
MntSweetProducts     60621
MntGoldProds         98609
dtype: int64
```

[33]:
```
df.Response.value_counts()
```

[33]:
```
Response
0    1906
1     334
```

```
Name: count, dtype: int64
```

[34]:
```
coupons=df.columns.tolist()[20:25]
df[coupons].sum()
```

[34]:
```
AcceptedCmp3    163
AcceptedCmp4    167
AcceptedCmp5    163
AcceptedCmp1    144
AcceptedCmp2     30
dtype: int64
```

[35]:
```
df['AcceptedCmp3'].value_counts()
```

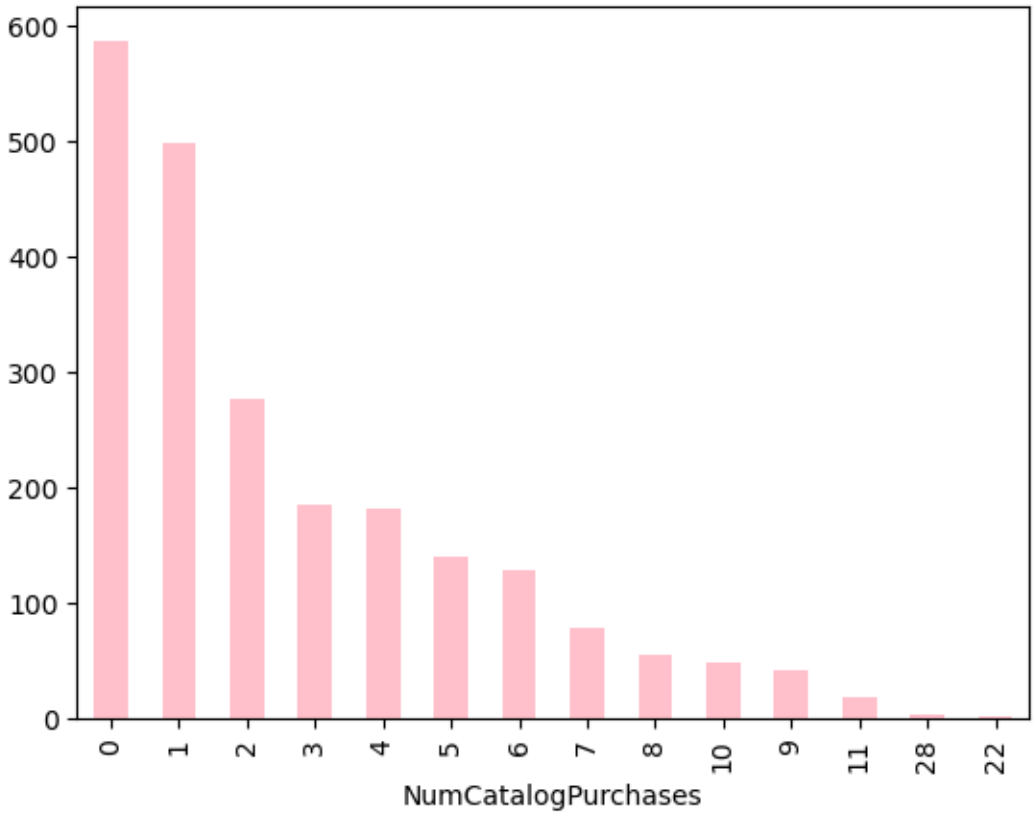
[35]:
```
AcceptedCmp3
0    2077
1     163
Name: count, dtype: int64
```

[36]:
```
df['NumCatalogPurchases'].value_counts()
```

[36]:
```
NumCatalogPurchases
0     586
1     497
2     276
3     184
4     182
5     140
6     128
7      79
8      55
10     48
9      42
11     19
28      3
22      1
Name: count, dtype: int64
```

[37]:
```
df['NumCatalogPurchases'].value_counts().plot(kind='bar',color='pink')
```

[37]:
```
<Axes: xlabel='NumCatalogPurchases'>
```



[38]:
```
visits=df.columns.tolist()[16:19]
df[visits]
```

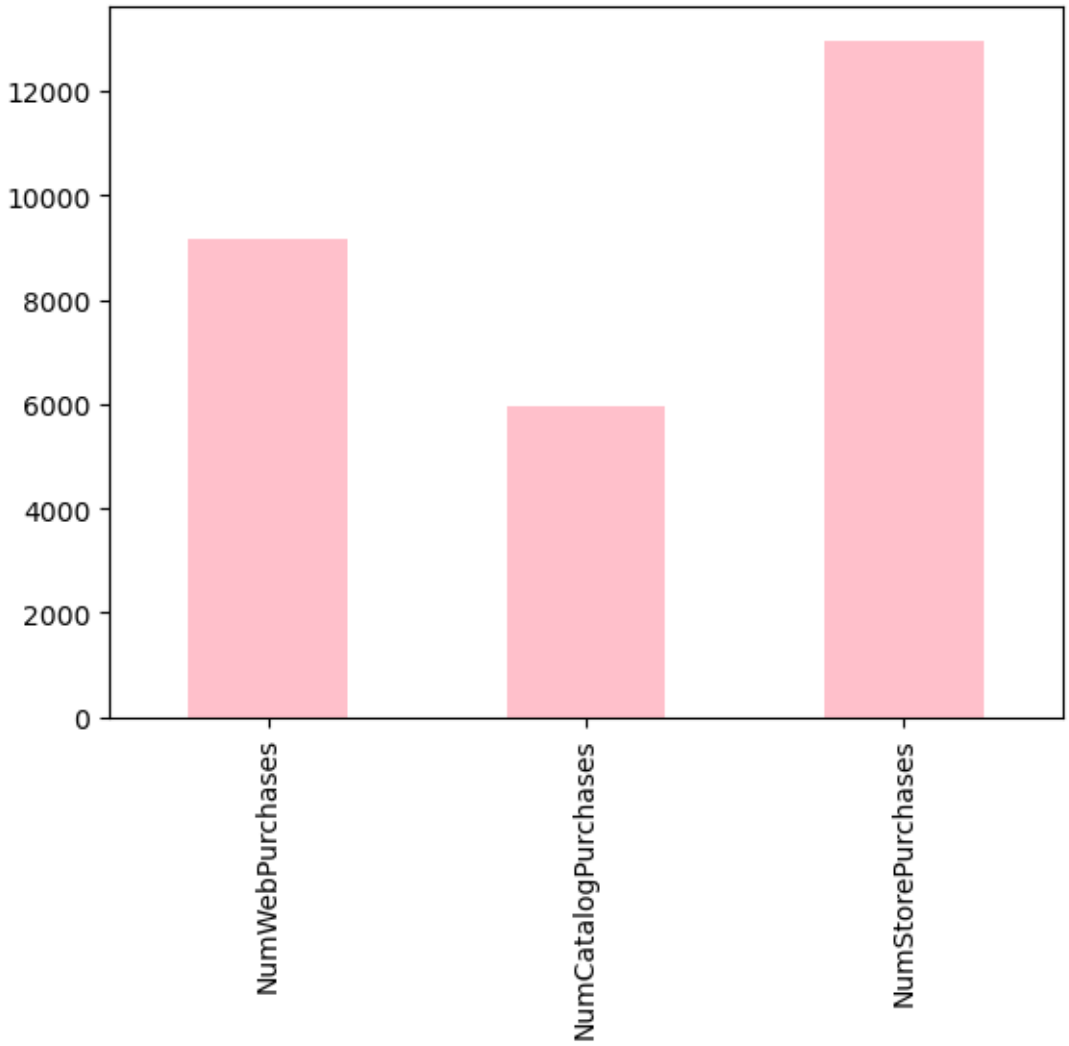
[38]:

	NumWebPurchases	NumCatalogPurchases	NumStorePurchases
0	8	10	4
1	1	1	2
2	8	2	10
3	2	0	4
4	5	3	6
…	…	…	…
2235	9	3	4
2236	8	2	5
2237	2	3	13
2238	6	5	10
2239	3	1	4

[2240 rows x 3 columns]

[39]:
```
df[visits].sum().plot(kind='bar',color='pink')
```

[39]: <Axes: >



[40]:
```
pd.crosstab(df.Education, df.Income)
```

[40]:
```
Income      1730.0    2447.0    3502.0    4023.0    4428.0    4861.0    \
Education
2n Cycle         0         0         0         0         0         0
Basic            0         0         0         0         0         0
Graduation       1         1         1         0         1         1
Master           0         0         0         0         0         0
PhD              0         0         0         1         0         0

Income      5305.0    5648.0    6560.0    6835.0    …  105471.0  113734.0  \
Education                                            …
2n Cycle         0         0         0         0  …         0         0
Basic            0         0         0         0  …         0         0
```

```
Graduation          1          0          0          0  …          1          0
Master              0          0          1          0  …          0          0
PhD                 0          1          0          1  …          0          1

Income      153924.0   156924.0   157146.0   157243.0   157733.0   160803.0  \
Education
2n Cycle            0          0          0          0          0          0
Basic               0          0          0          0          0          0
Graduation          1          0          1          0          0          0
Master              0          0          0          0          1          0
PhD                 0          1          0          1          0          1

Income      162397.0   666666.0
Education
2n Cycle            0          0
Basic               0          0
Graduation          0          1
Master              0          0
PhD                 1          0

[5 rows x 1975 columns]
```

[41]:
```
df.groupby("Education").describe()["Income"].mean()
```

[41]:
```
count       448.000000
mean      45947.415983
min        5462.600000
25%       31386.750000
50%       45186.350271
75%       59079.900000
max      223557.600000
std       19353.354315
dtype: float64
```

[42]:
```
df.groupby("Education")["Income"].mean()
```

[42]:
```
Education
2n Cycle      47701.378099
Basic         20306.259259
Graduation    52715.755781
Master        52908.476370
PhD           56105.210405
Name: Income, dtype: float64
```

[43]:
```
df.groupby("Marital_Status")["Income"].mean()
```

[43]:
```
Marital_Status
Absurd      72365.500000
Alone       43789.000000
Divorced    52834.228448
Married     51729.210370
Single      51018.823463
Together    53233.485792
Widow       56426.561706
YOLO        48432.000000
Name: Income, dtype: float64
```

[44]:
```
pd.crosstab(df.Income,df.Teenhome)
```

[44]:
```
Teenhome  0  1  2
Income
1730.0    1  0  0
2447.0    1  0  0
3502.0    1  0  0
4023.0    0  1  0
4428.0    0  1  0
…        .. .. ..
157243.0  0  1  0
157733.0  1  0  0
160803.0  1  0  0
162397.0  0  1  0
666666.0  1  0  0

[1975 rows x 3 columns]
```

[45]:
```
df.groupby(visits).describe()
```

[45]:
```
                                                      ID                \
                                                   count          mean
NumWebPurchases NumCatalogPurchases NumStorePurchases
0               0                   0                  6.0   8099.000000
                                    1                  3.0   4842.000000
                                    3                 28.0   7482.857143
                1                   0                  1.0  10749.000000
                                    2                  7.0   3335.857143
…                                                      …           …
11              10                  11                 2.0   4640.000000
                11                  5                  1.0   4299.000000
23              1                   1                  1.0   6237.000000
25              0                   0                  1.0  10311.000000
27              0                   0                  2.0   4937.000000

                                                                      \
```

```
                                                      min       25%
NumWebPurchases NumCatalogPurchases NumStorePurchases
0               0                    0                3955.0   5881.75
                                     1                1503.0   2903.00
                                     3                  73.0   6341.50
                1                    0               10749.0  10749.00
                                     2                 624.0   1484.50
…                                                       …       …
11              10                   11               4127.0   4383.50
                11                   5                4299.0   4299.00
23              1                    1                6237.0   6237.00
25              0                    0               10311.0  10311.00
27              0                    0                4619.0   4778.00

                                                                      \
                                                      50%       75%
NumWebPurchases NumCatalogPurchases NumStorePurchases
0               0                    0                8396.5  10815.25
                                     1                4303.0   6511.50
                                     3                8255.0   9528.00
                1                    0               10749.0  10749.00
                                     2                2518.0   4435.50
…                                                       …       …
11              10                   11               4640.0   4896.50
                11                   5                4299.0   4299.00
23              1                    1                6237.0   6237.00
25              0                    0               10311.0  10311.00
27              0                    0                4937.0   5096.00

                                                                           \
                                                      max           std
NumWebPurchases NumCatalogPurchases NumStorePurchases
0               0                    0               11181.0  3069.068588
                                     1                8720.0  3638.566064
                                     3               10492.0  2776.182467
                1                    0               10749.0          NaN
                                     2                8369.0  2869.855132
…                                                       …          …
11              10                   11               5153.0   725.491557
                11                   5                4299.0          NaN
23              1                    1                6237.0          NaN
25              0                    0               10311.0          NaN
27              0                    0                5255.0   449.719913

                                                    Year_Birth               \
                                                         count          mean
NumWebPurchases NumCatalogPurchases NumStorePurchases
```

0	0	0	6.0	1966.000000
		1	3.0	1970.333333
		3	28.0	1968.571429
	1	0	1.0	1991.000000
		2	7.0	1976.714286
…			…	…
11	10	11	2.0	1967.000000
	11	5	1.0	1960.000000
23	1	1	1.0	1966.000000
25	0	0	1.0	1969.000000
27	0	0	2.0	1965.500000

			…	Z_Revenue	
			…	max	std
NumWebPurchases	NumCatalogPurchases	NumStorePurchases	…		
0	0	0	…	11.0	0.0
		1	…	11.0	0.0
		3	…	11.0	0.0
	1	0	…	11.0	NaN
		2	…	11.0	0.0
…			…	…	…
11	10	11	…	11.0	0.0
	11	5	…	11.0	NaN
23	1	1	…	11.0	NaN
25	0	0	…	11.0	NaN
27	0	0	…	11.0	0.0

			Response			
			count	mean	min	
NumWebPurchases	NumCatalogPurchases	NumStorePurchases				
0	0	0	6.0	0.000000	0.0	
		1	3.0	0.000000	0.0	
		3	28.0	0.000000	0.0	
	1	0	1.0	0.000000	0.0	
		2	7.0	0.142857	0.0	
…			…	…	…	
11	10	11	2.0	1.000000	1.0	
	11	5	1.0	1.000000	1.0	
23	1	1	1.0	0.000000	0.0	
25	0	0	1.0	0.000000	0.0	
27	0	0	2.0	0.000000	0.0	

							\
			25%	50%	75%	max	
NumWebPurchases	NumCatalogPurchases	NumStorePurchases					
0	0	0	0.0	0.0	0.0	0.0	
		1	0.0	0.0	0.0	0.0	

```
                                    3                   0.0  0.0  0.0  0.0
                  1                 0                   0.0  0.0  0.0  0.0
                                    2                   0.0  0.0  0.0  1.0
…                                                     …  …   …   …
11                10                11                  1.0  1.0  1.0  1.0
                  11                5                   1.0  1.0  1.0  1.0
23                1                 1                   0.0  0.0  0.0  0.0
25                0                 0                   0.0  0.0  0.0  0.0
27                0                 0                   0.0  0.0  0.0  0.0


                                                              std
NumWebPurchases NumCatalogPurchases NumStorePurchases
0                 0                 0                   0.000000
                                    1                   0.000000
                                    3                   0.000000
                  1                 0                        NaN
                                    2                   0.377964
…                                                          …
11                10                11                  0.000000
                  11                5                        NaN
23                1                 1                        NaN
25                0                 0                        NaN
27                0                 0                   0.000000

[601 rows x 192 columns]
```

[46]:
```
df["total_amounts"]=df[amounts].sum(axis=1)
df["total_amounts"]
```

[46]:
```
0       1617
1         27
2        776
3         53
4        422
        …
2235    1341
2236     444
2237    1241
2238     843
2239     172
Name: total_amounts, Length: 2240, dtype: int64
```

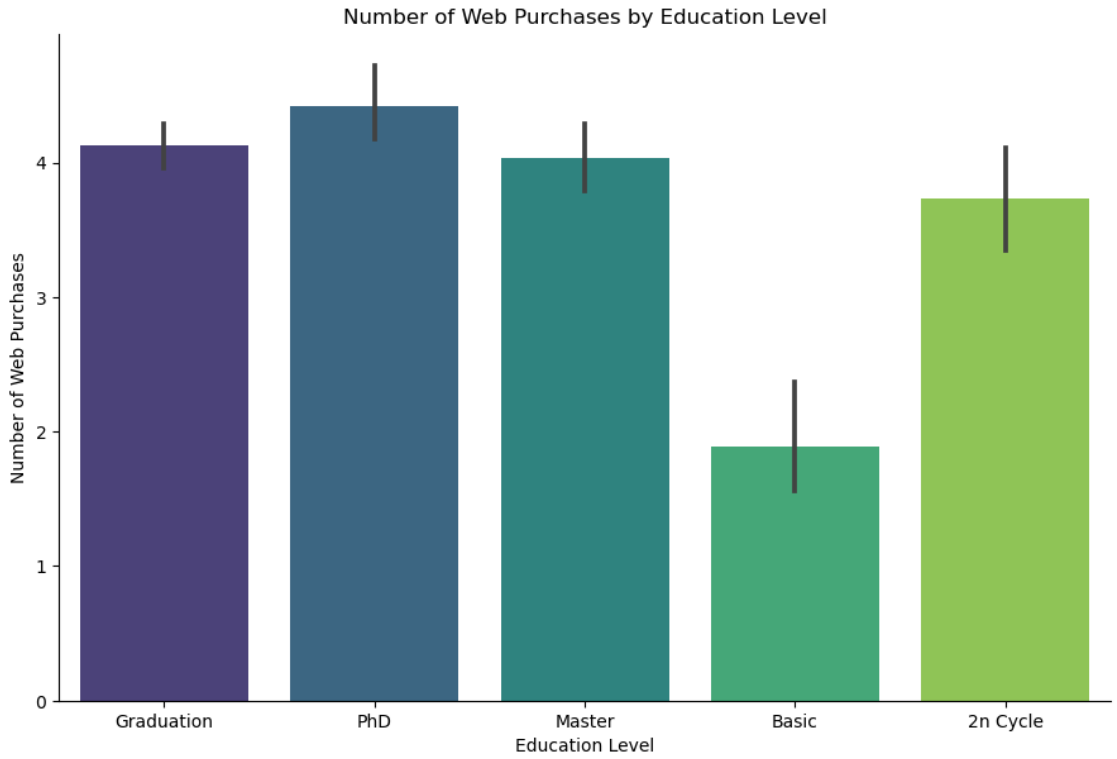
[47]:
```
df[amounts][0:1].sum(axis=1)
```

[47]:
```
0    1617
dtype: int64
```

[48]:
```
df.groupby("Marital_Status")["total_amounts"].sum()
```

[48]:
```
Marital_Status
Absurd        2385
Alone          770
Divorced    141666
Married     510453
Single      291112
Together    352865
Widow        56889
YOLO           848
Name: total_amounts, dtype: int64
```

[49]:
```
g = sns.catplot(x="Education", y="NumWebPurchases", kind="bar", data=df,␣
↪height=6, aspect=1.5, palette="viridis")
g.set_ylabels("Number of Web Purchases")
g.set_xlabels("Education Level")
g.set(title="Number of Web Purchases by Education Level")
plt.show()
```



[50]:
```
df.drop(["ID","Year_Birth","Z_CostContact","Z_Revenue","Dt_Customer"], axis=1,␣
↪inplace=True)
```

[51]:
```
education_ctgrs = pd.Categorical(df["Education"], categories=["Basic",␣
 ↪"Graduation", "2n Cycle", "Master", "PhD"], ordered=True)
df["educations"], CAT = pd.factorize(education_ctgrs, sort=True)
```

[52]:
```
df[['Education','educations']]
```

[52]:
```
       Education  educations
0     Graduation           1
1     Graduation           1
2     Graduation           1
3     Graduation           1
4            PhD           4
…            …           …
2235  Graduation           1
2236         PhD           4
2237  Graduation           1
2238      Master           3
2239         PhD           4

[2240 rows x 2 columns]
```

[53]:
```
df.drop(["Education"],axis=1, inplace=True)
df.head()
```

[53]:
```
  Marital_Status   Income  Kidhome  Teenhome  Recency  MntWines  MntFruits  \
0         Single  58138.0        0         0     4252       635         88
1         Single  46344.0        1         1     3702        11          1
2       Together  71613.0        0         0     3901       426         49
3       Together  26646.0        1         0     3728        11          4
4        Married  58293.0        1         0     3750       173         43

   MntMeatProducts  MntFishProducts  MntSweetProducts  …  NumWebVisitsMonth  \
0              546              172                88  …                  7
1                6                2                 1  …                  5
2              127              111                21  …                  4
3               20               10                 3  …                  6
4              118               46                27  …                  5

   AcceptedCmp3  AcceptedCmp4  AcceptedCmp5  AcceptedCmp1  AcceptedCmp2  \
0             0             0             0             0             0
1             0             0             0             0             0
2             0             0             0             0             0
3             0             0             0             0             0
4             0             0             0             0             0

   Complain  Response  total_amounts  educations
0         0         1           1617           1
```

```
1          0          0             27           1
2          0          0            776           1
3          0          0             53           1
4          0          0            422           4

[5 rows x 25 columns]
```

[54]:
```
df = df.replace(to_replace="Single",value=0)
df = df.replace(to_replace="Divorced",value=0)
df = df.replace(to_replace="Widow",value=0)
df = df.replace(to_replace="Alone",value=0)
df = df.replace(to_replace="Absurd",value=0)
df = df.replace(to_replace="YOLO",value=0)
df = df.replace(to_replace="Married",value=1)
df = df.replace(to_replace="Together",value=1)
```

[55]:
```
df = df.drop(df[df.Income > 400000].index)
```

[56]:
```
pca = PCA(n_components=2, whiten=True)
pca.fit(df)
data_pca = pca.transform(df)
print("Explained Variance Ratios: ", pca.explained_variance_ratio_)
print("Total Explained Variance: ", sum(pca.explained_variance_ratio_))
```

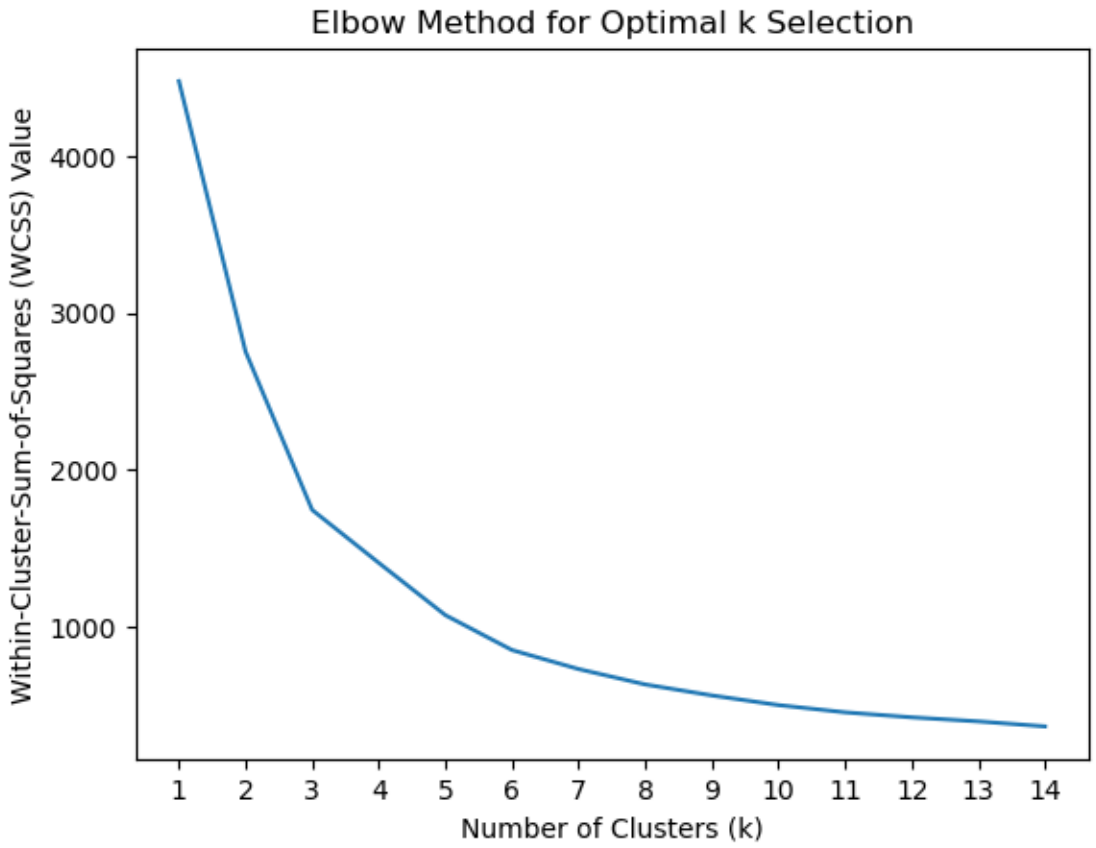
```
Explained Variance Ratios:  [9.99408364e-01 4.21819157e-04]
Total Explained Variance:  0.9998301827572521
```

[57]:
```
data_pca
```

[57]:
```
array([[ 0.2891123 , -2.2497778 ],
       [-0.26353011,  1.26902889],
       [ 0.91692912,  0.70815563],
       …,
       [ 0.23473511, -1.50868381],
       [ 0.80650329,  0.45733602],
       [ 0.04122349,  1.0712852 ]])
```

[58]:
```
wcss = []
for k in range(1, 15):
    kmeans = KMeans(n_clusters=k)
    kmeans.fit(data_pca)
    wcss.append(kmeans.inertia_)
plt.plot(range(1, 15), wcss)
plt.xlabel("Number of Clusters (k)")
plt.xticks(range(1, 15, 1))
plt.ylabel("Within-Cluster-Sum-of-Squares (WCSS) Value")
plt.title("Elbow Method for Optimal k Selection")
```

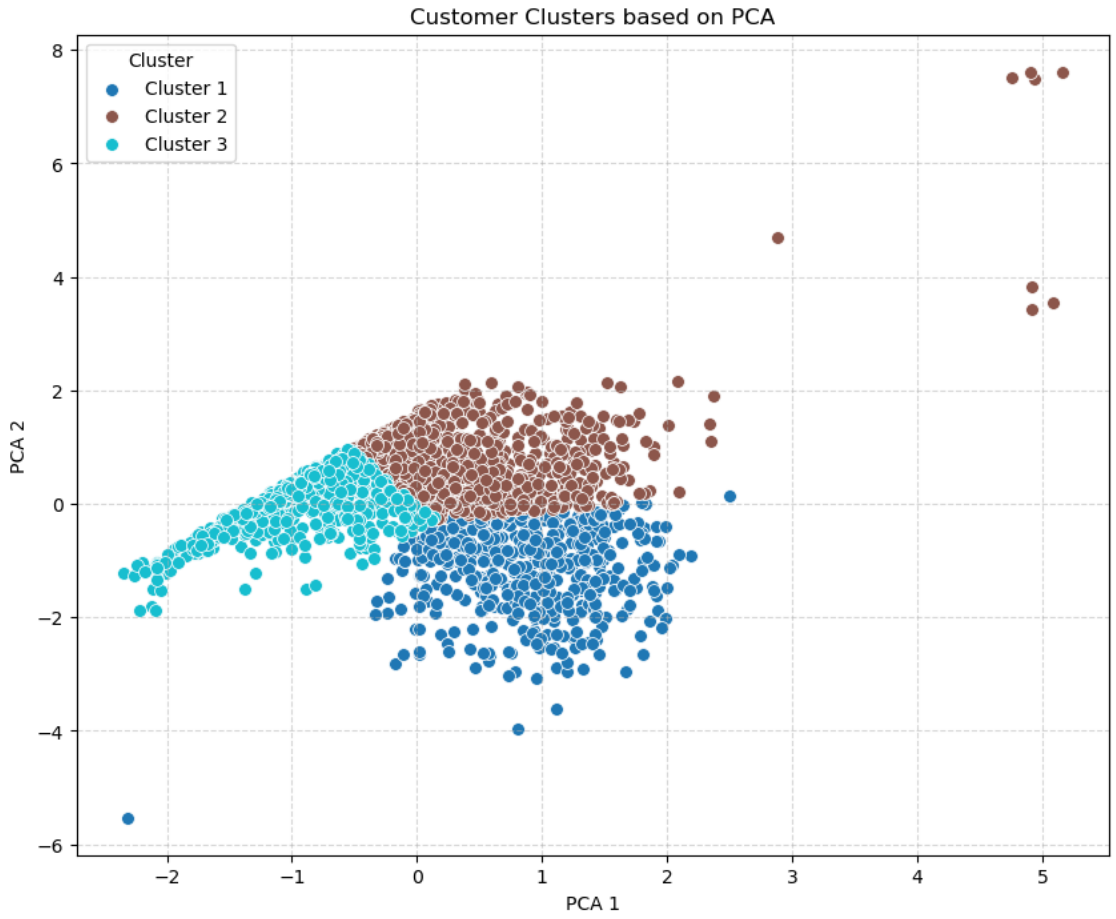
```
plt.show()
```



[59]:
```
kmeans2 = KMeans(n_clusters=3)
clusters = kmeans2.fit_predict(data_pca)
```

[61]:
```
colors = plt.cm.get_cmap('tab10', 3)

# Plotting the customer clusters using seaborn scatter plot
plt.figure(figsize=(10, 8))
for cluster_num in range(3):
    sns.scatterplot(
        x=data_pca[clusters == cluster_num, 0],
        y=data_pca[clusters == cluster_num, 1],
        label=f'Cluster {cluster_num + 1}',
        color=colors(cluster_num),
        s=50  # Adjust marker size for better visibility
    )

# Adding title and labels
plt.title('Customer Clusters based on PCA')
```

```
plt.xlabel('PCA 1')
plt.ylabel('PCA 2')

# Customize legend
plt.legend(title='Cluster')

# Add grid for better readability
plt.grid(True, linestyle='--', alpha=0.5)

# Show plot
plt.show()
```



[ ]: