KMeans clustering

Medical Dataset

Eric Yarger

In [1]:
```
# Import Libraries
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
import seaborn as sns
import missingno as msno
from scipy import stats
```

In [2]:
```
# Windows 10, Anaconda, JupyterLab, JupyterNotebook
# Jupyter environment version
!jupyter --version
```

```
jupyter core     : 4.6.3
jupyter-notebook : 6.0.3
qtconsole        : 4.7.2
ipython          : 7.13.0
ipykernel        : 5.1.4
jupyter client   : 6.1.2
jupyter lab      : 1.2.6
nbconvert        : 5.6.1
ipywidgets       : 7.5.1
nbformat         : 5.0.4
traitlets        : 4.3.3
```

In [3]:
```
# Python Environment version
import platform
print(platform.python_version())
```

```
3.7.7
```

In [4]:
```
df = pd.read_csv('C:/Users/ericy/Desktop/medical_clean.csv')
```

Dataset, Initial Investigation

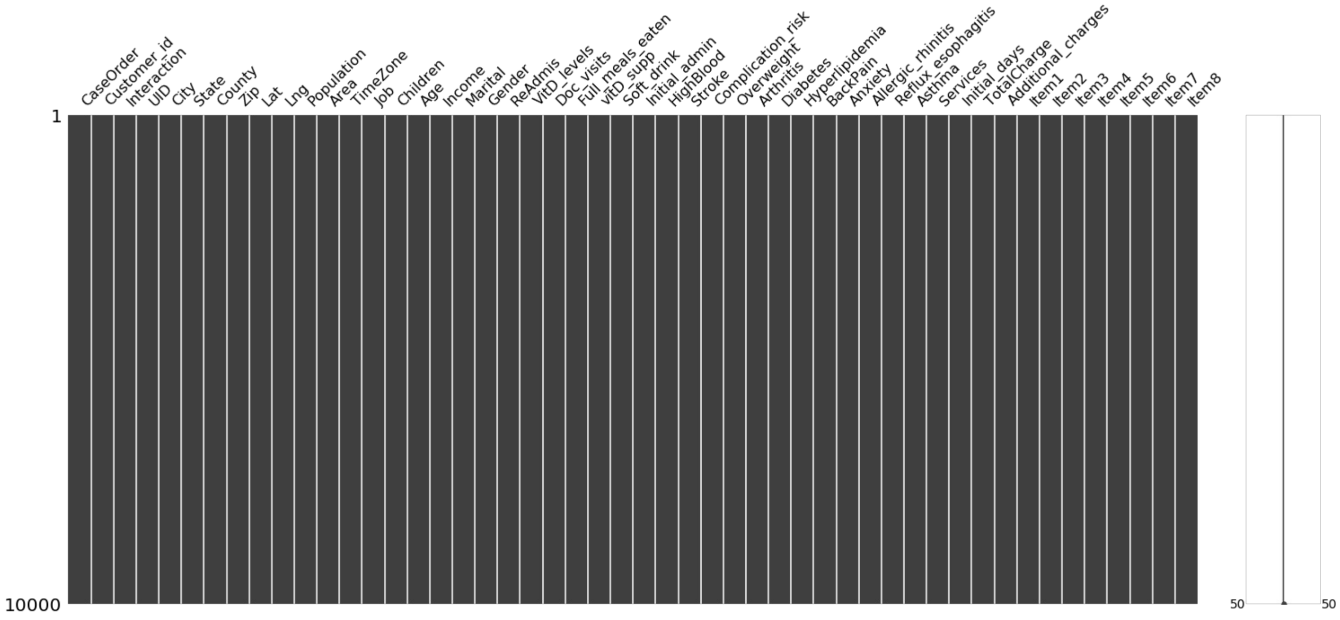
In [5]:
```
# Dataset, first glance
```

In [6]:
```
df.isnull().sum()
```

Out[6]:
```
CaseOrder             0
Customer_id           0
Interaction           0
UID                   0
City                  0
State                 0
County                0
Zip                   0
Lat                   0
Lng                   0
Population            0
Area                  0
TimeZone              0
Job                   0
Children              0
Age                   0
Income                0
Marital               0
Gender                0
ReAdmis               0
VitD_levels           0
Doc_visits            0
Full_meals_eaten      0
vitD_supp             0
Soft_drink            0
Initial_admin         0
HighBlood             0
Stroke                0
Complication_risk     0
Overweight            0
Arthritis             0
Diabetes              0
Hyperlipidemia        0
BackPain              0
Anxiety               0
Allergic_rhinitis     0
Reflux_esophagitis    0
Asthma                0
Services              0
Initial_days          0
TotalCharge           0
Additional_charges    0
Item1                 0
Item2                 0
Item3                 0
Item4                 0
Item5                 0
Item6                 0
Item7                 0
Item8                 0
dtype: int64
```

In [7]:
```
msno.matrix(df)
```

Out[7]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1e7e60776c8>
```



Data Preprocessing

Step P1, Data Cleaning

In [8]:

```
# Duplicate Check
df.duplicated().sum()
```

Out[8]:

```
0
```

In [9]:

```
# Removing unnecessary columns
# Selecting ReAdmis (Target)
# Selecting continuous dependent features
dfs = df[['Income','Additional_charges']]
dfs
```

Out[9]:

	Income	Additional_charges
0	86575.93	17939.403420
1	46805.99	17612.998120
2	14370.14	17505.192460
3	39741.49	12993.437350
4	1209.56	3716.525786
...	...	...
9995	45967.61	8927.642000
9996	14983.02	28507.150000
9997	65917.81	15281.210000
9998	29702.32	7781.678000
9999	62682.63	11643.190000

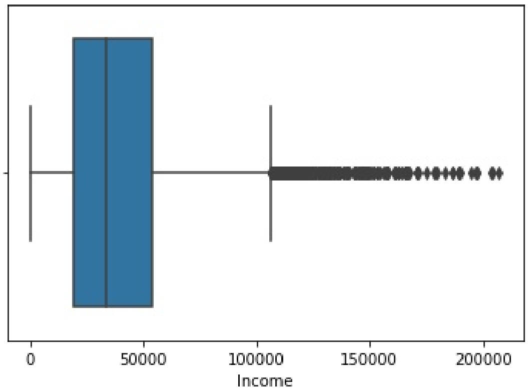
10000 rows × 2 columns

In [10]:

```
# Outlier Removal
# Boxplots, outlier detection
sns.boxplot(dfs['Income'])
```

Out[10]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e7e6532d08>
```

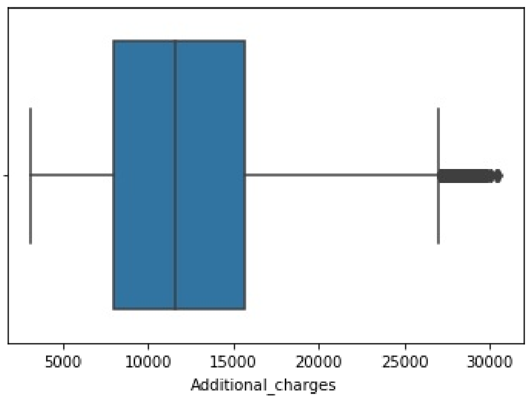


In [11]:

```
sns.boxplot(dfs['Additional_charges'])
```

Out[11]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e7e65906c8>
```

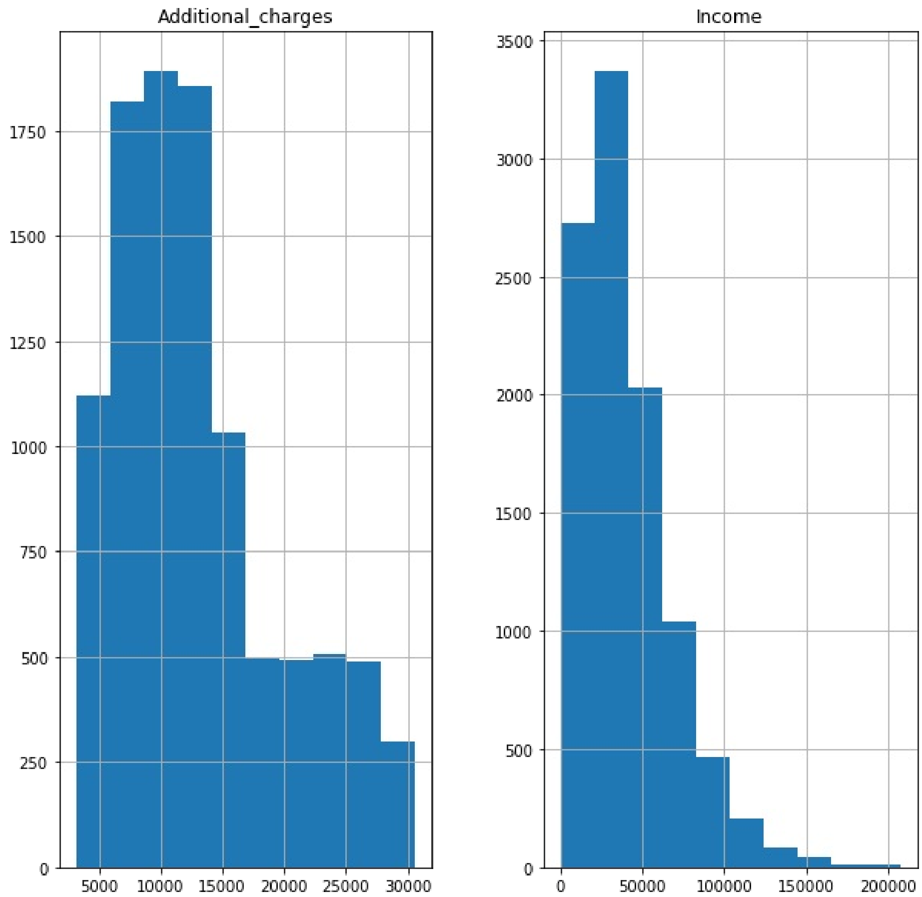


In [12]:

```
dfs.hist(figsize=(10,10))
```

Out[12]:

```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x000001E7E7464788>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001E7E667DF08>]],
      dtype=object)
```



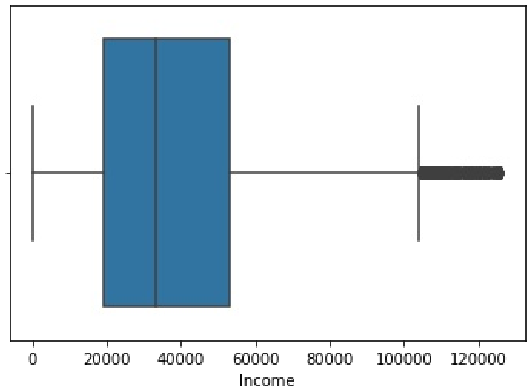
In [13]:
```
# Outlier removal method via Z-score, Code reference (Bushmanov, 2019)

num_data = dfs.select_dtypes(include=['number'])
cat_data = dfs.select_dtypes(exclude=['number'])
```

In [14]:
```
idx = np.all(stats.zscore(num_data) <3, axis=1)
```

In [15]:
```
dfs = pd.concat([num_data.loc[idx], cat_data.loc[idx]], axis=1)
```

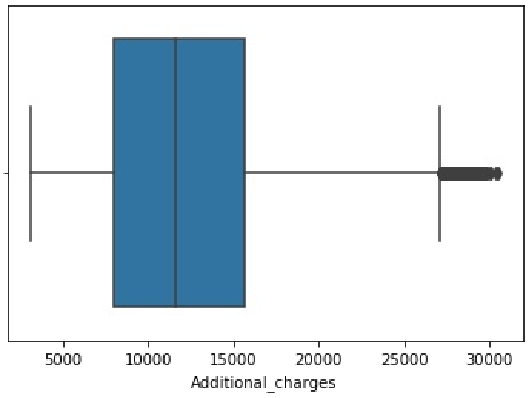
In [16]:
```
# Post Outlier Removal
# Boxplots
sns.boxplot(dfs['Income'])
```

Out[16]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1e7e6972ac8>
```



In [17]:
```
sns.boxplot(dfs['Additional_charges'])
```

Out[17]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1e7e679ecc8>
```



In [18]:
```
dfs
```

Out[18]:

	Income	Additional_charges
0	86575.93	17939.403420
1	46805.99	17612.998120
2	14370.14	17505.192460
3	39741.49	12993.437350
4	1209.56	3716.525786
...	...	...
9995	45967.61	8927.642000
9996	14983.02	28507.150000
9997	65917.81	15281.210000
9998	29702.32	7781.678000
9999	62682.63	11643.190000

9857 rows × 2 columns

Step P2, Missing Data

In [19]:
```
# Check for and Handle any missing data
dfs.isnull().sum()
```

Out[19]:
```
Income                0
Additional_charges    0
dtype: int64
```

In [20]:
```
dfs.isna().sum()
```

Out[20]:
```
Income                0
Additional_charges    0
dtype: int64
```

In [21]:
```
dfs.isnull().any()
```

Out[21]:
```
Income                False
Additional_charges    False
dtype: bool
```

In [22]:
```
dfs
```

Out[22]:

	Income	Additional_charges
0	86575.93	17939.403420
1	46805.99	17612.998120
2	14370.14	17505.192460
3	39741.49	12993.437350
4	1209.56	3716.525786
...	...	...
9995	45967.61	8927.642000
9996	14983.02	28507.150000
9997	65917.81	15281.210000
9998	29702.32	7781.678000
9999	62682.63	11643.190000

9857 rows × 2 columns

Step P3, Data Transformation

In [23]:
```
X = dfs
```

In [24]:
```
# Set Before Normalization
X
```

Out[24]:

	Income	Additional_charges
0	86575.93	17939.403420
1	46805.99	17612.998120
2	14370.14	17505.192460
3	39741.49	12993.437350
4	1209.56	3716.525786
...	...	...
9995	45967.61	8927.642000
9996	14983.02	28507.150000
9997	65917.81	15281.210000
9998	29702.32	7781.678000
9999	62682.63	11643.190000

9857 rows × 2 columns

In [25]:
```
# Data Normalization using Min/Max Scaling
# Code Reference (Data normalization with pandas, 2020)
X = (X - X.min()) / (X.max() - X.min())
```

In [26]:
```
# Set After Normalization
X
```

Out[26]:

	Income	Additional_charges
0	0.686851	0.539851
1	0.370773	0.527956
2	0.112984	0.524027
3	0.314627	0.359607
4	0.008389	0.021531
...	...	...
9995	0.364110	0.211438
9996	0.117855	0.924967
9997	0.522667	0.442979
9998	0.234839	0.169676
9999	0.496955	0.310400

9857 rows × 2 columns

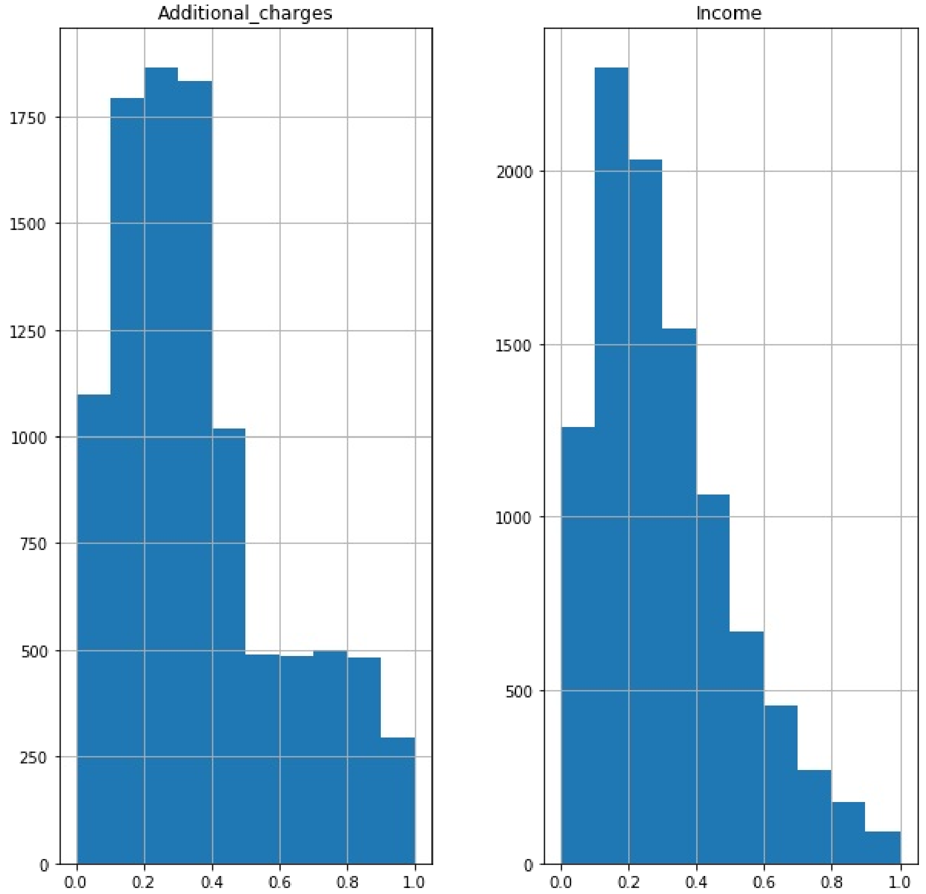
In [27]:
```
# Check for Skew
# Code Reference (Python | Pandas dataframe.skew(), 2022)
```

```
X.skew(axis = 0, skipna = True)
```

Out[27]:
```
Income                0.942369
Additional_charges    0.831749
dtype: float64
```

In [28]:
```
X.hist(figsize=(10,10))
```

Out[28]:
```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x000001E7E6838F48>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001E7E686F3C8>]],
      dtype=object)
```



In [29]:
```
X.mean()
```

Out[29]:
```
Income                0.308010
Additional_charges    0.357885
dtype: float64
```

In [30]:
```
X.median()
```

Out[30]:
```
Income                0.263370
Additional_charges    0.308104
dtype: float64
```

In [31]:
```
# Square-Root Transformation on dataset
Xs = X.apply(np.sqrt)
```

In [32]:
```
Xs.skew()
```

Out[32]:
```
Income                0.201145
Additional_charges    0.127993
dtype: float64
```

In [33]:
```
Xs.mean()
```

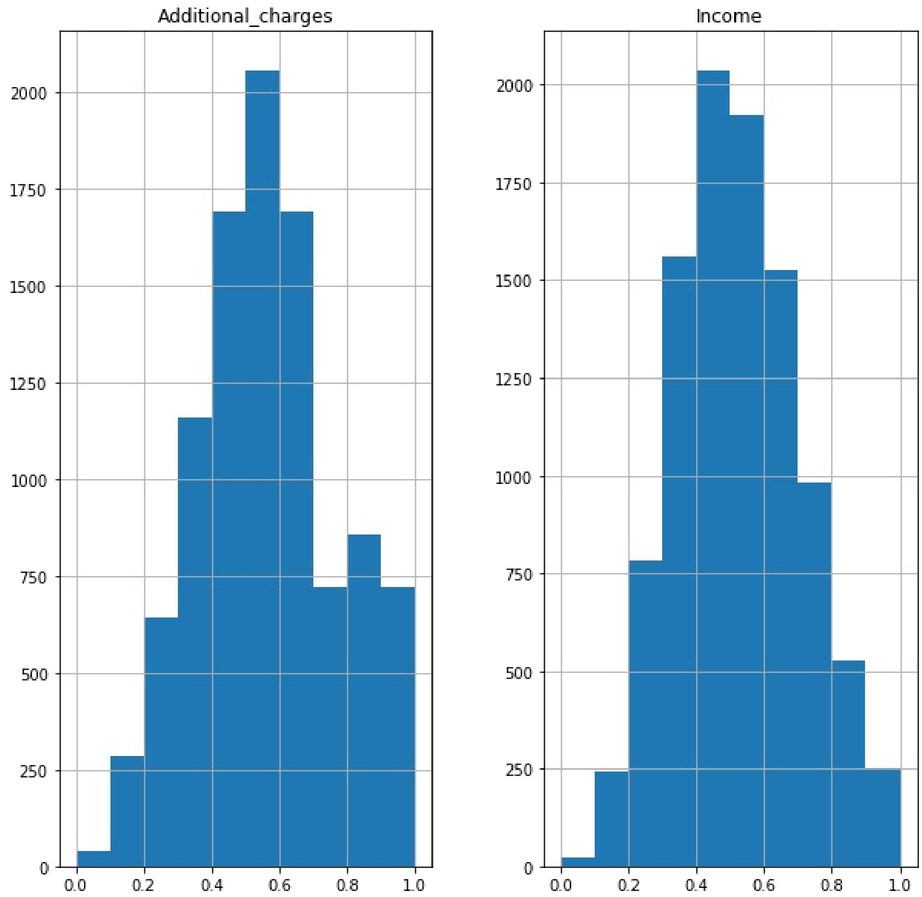
Out[33]:
```
Income                0.524266
Additional_charges    0.562884
dtype: float64
```

In [34]:
```
Xs.median()
```

Out[34]:
```
Income                0.513196
Additional_charges    0.555071
dtype: float64
```

In [35]:
```
Xs.hist(figsize=(10,10))
```

Out[35]:
```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x000001E7E6946848>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001E7E69C04C8>]],
      dtype=object)
```



In [36]:
```
Xs
```

Out[36]:

	Income	Additional_charges
0	0.828765	0.734745
1	0.608912	0.726606
2	0.336131	0.723897
3	0.560916	0.599672
4	0.091589	0.146735
...	...	...
9995	0.603415	0.459824
9996	0.343301	0.961752
9997	0.722957	0.665567
9998	0.484602	0.411918
9999	0.704951	0.557135

9857 rows × 2 columns

In [37]:
```
X = Xs
```

In [38]:
```
# Read out dataset
X.to_excel('C:/Users/ericy/Desktop/cleaned_data.xlsx')
```

K-means clustering

In [39]:
```
# Prepared dataset cleaned_data
# Code reference (Sklearn.cluster.KMeans, n.d.)
import sklearn
```

In [40]:
```
from sklearn.cluster import KMeans
```

In [41]:
```
X
```

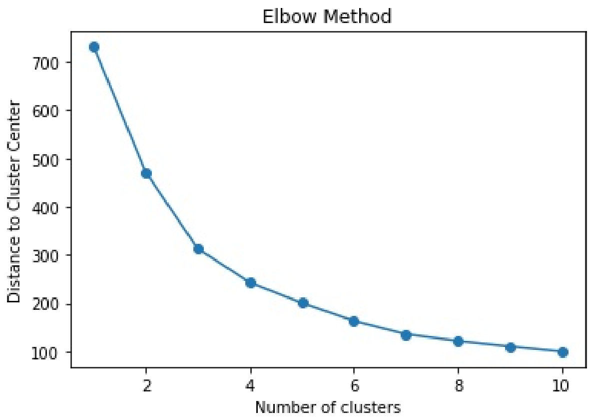
Out[41]:

	Income	Additional_charges
0	0.828765	0.734745
1	0.608912	0.726606
2	0.336131	0.723897
3	0.560916	0.599672
4	0.091589	0.146735
...	...	...
9995	0.603415	0.459824
9996	0.343301	0.961752
9997	0.722957	0.665567
9998	0.484602	0.411918
9999	0.704951	0.557135

9857 rows × 2 columns

In [42]:

```
# Initial KMeans.  run for 1-11 clusters.
# Elbow Plot
#Code Reference (Machine learning - K-means, n.d.)
# Sum of square distance from cluster center
ssdistance = []


# Kmeans from 1 to 11 loop
for i in range(1,11):
    kmeans = KMeans(n_clusters=i)
    kmeans.fit(X)
    ssdistance.append(kmeans.inertia_)

plt.plot(range(1,11), ssdistance, marker='o')
plt.title('Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('Distance to Cluster Center')
plt.show()
```



In [43]:

```
from sklearn.metrics import silhouette_score
# Code Reference (Arvai, 2020)
```

In [44]:

```
# KMeans clusters = 2
kmeans2 = KMeans(n_clusters = 2, init='k-means++', random_state=10)

# Fit the model
kmeans2.fit(X)

# Silhouette Score
kmeans2_silhouette = silhouette_score(X, kmeans2.labels_)

# Print Silhouette Score
print('Silhouette Score: %.3f' %kmeans2_silhouette)
```

```
Silhouette Score: 0.320
```

In [45]:

```
# KMeans clusters = 3
kmeans3 = KMeans(n_clusters = 3, init='k-means++', random_state=10)

# Fit the model
kmeans3.fit(X)

# Silhouette Score
kmeans3_silhouette = silhouette_score(X, kmeans3.labels_)

# Print Silhouette Score
print('Silhouette Score: %.3f' %kmeans3_silhouette)
```

```
Silhouette Score: 0.352
```

In [46]:
```python
# KMeans clusters = 4
kmeans4 = KMeans(n_clusters = 4, init='k-means++', random_state=10)

# Fit the model
kmeans4.fit(X)

# Silhouette Score
kmeans4_silhouette = silhouette_score(X, kmeans4.labels_)

# Print Silhouette Score
print('Silhouette Score: %.3f' %kmeans4_silhouette)
```

```
Silhouette Score: 0.347
```

In [47]:
```python
# KMeans clusters = 5
kmeans5 = KMeans(n_clusters = 5, init='k-means++', random_state=10)

# Fit the model
kmeans5.fit(X)

# Silhouette Score
kmeans5_silhouette = silhouette_score(X, kmeans5.labels_)

# Print Silhouette Score
print('Silhouette Score: %.3f' %kmeans5_silhouette)
```

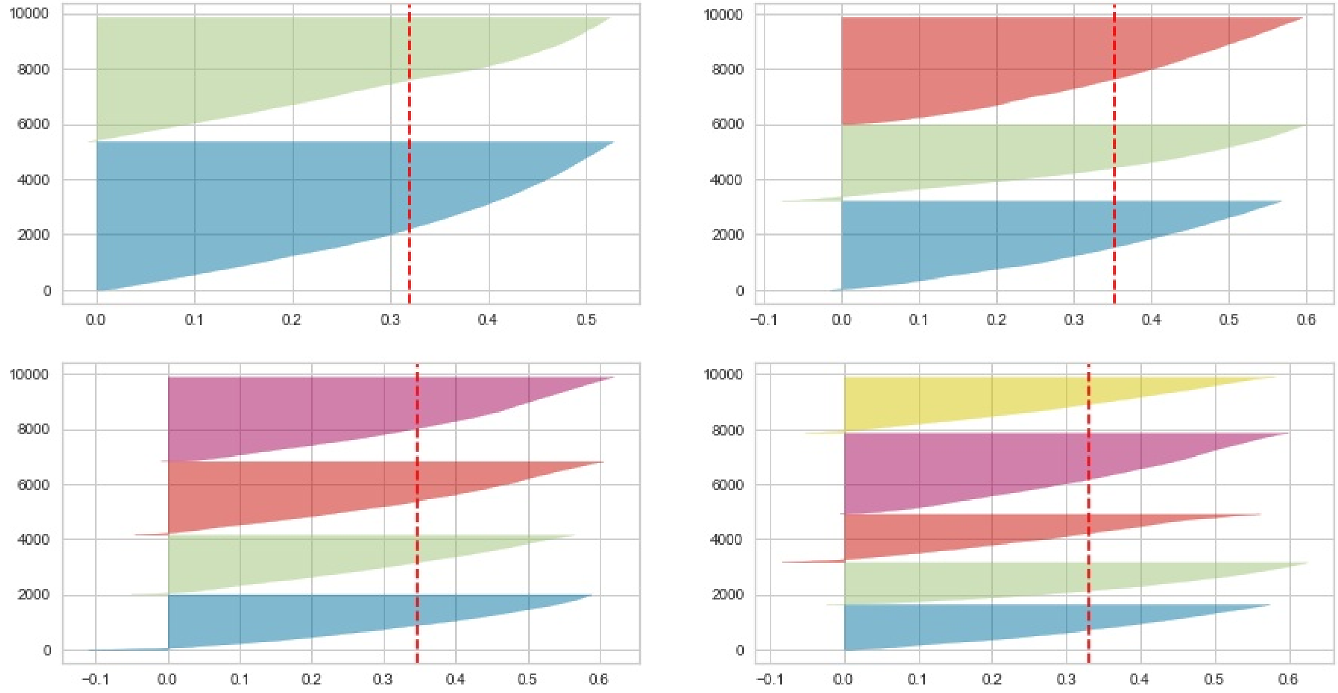
```
Silhouette Score: 0.332
```

In [48]:
```python
# KMeans clusters = 10
kmeans10 = KMeans(n_clusters = 10, init='k-means++', random_state=10)

# Fit the model
kmeans10.fit(X)

# Silhouette Score
kmeans10_silhouette = silhouette_score(X, kmeans10.labels_)

# Print Silhouette Score
print('Silhouette Score: %.3f' %kmeans10_silhouette)
```

```
Silhouette Score: 0.332
```

In [49]:
```python
import yellowbrick
from yellowbrick.cluster import SilhouetteVisualizer
#Code Reference (Yellowbrick :: Anaconda.org, n.d.)
```

In [50]:
```python
# Code Reference (Kumar, 2020)
# Silhouette score.  Visualization using yellowbrick's Silhouette Visualizer


    #plot sizing
fig, ax = plt.subplots(2, 2, figsize=(15,8))


#KMeans for 2,3,4,5 'k' clusters
for i in [2, 3, 4, 5]:

    km = KMeans(n_clusters=i, init='k-means++', n_init=10, max_iter=100, random_state=42)
    q, mod = divmod(i, 2)

    #Create SilhouetteVisualizer instance with KMeans instance

    visualization = SilhouetteVisualizer(km, colors='yellowbrick', ax=ax[q-1][mod])

    #Fit the visualizer

    visualization.fit(X)
```



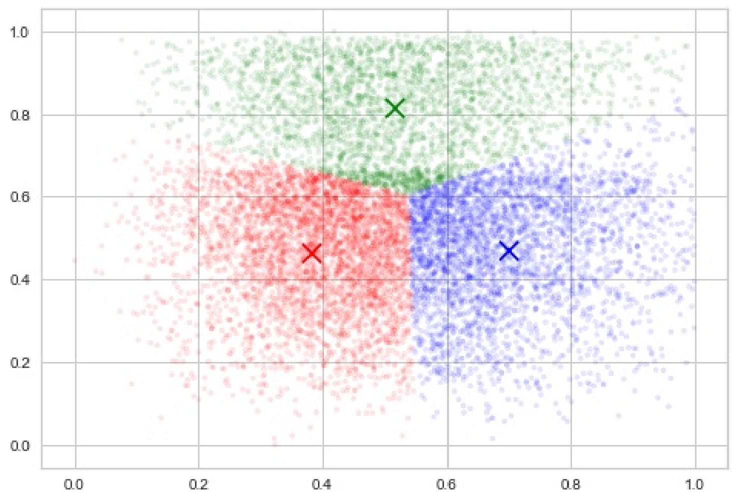
In [51]:

```
# Code Reference (How to plot KMeans?, n.d.)

centroids = kmeans3.cluster_centers_
labels = kmeans3.labels_

print(centroids)
print(labels)
```

```
[[0.51699125 0.81334543]
 [0.38289295 0.46267265]
 [0.70073493 0.46864602]]
[2 0 0 ... 2 1 2]
```

In [52]:

```
colors = ["green","red","blue"]

plt.scatter(X.iloc[:,0], X.iloc[:,1], c=np.array(colors)[labels],
    s = 10, alpha=.1)

plt.scatter(centroids[:, 0], centroids[:, 1], marker = "x", s=150,
    linewidths = 5, zorder = 10, c=['green', 'red','blue'])
plt.show()
```



In [53]:

```
X
```

Out[53]:

	Income	Additional_charges
0	0.828765	0.734745
1	0.608912	0.726606
2	0.336131	0.723897
3	0.560916	0.599672
4	0.091589	0.146735
...	...	...
9995	0.603415	0.459824
9996	0.343301	0.961752
9997	0.722957	0.665567
9998	0.484602	0.411918
9999	0.704951	0.557135

9857 rows × 2 columns

In [ ]:

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