K Means Clustering Project

For this project we will attempt to use KMeans Clustering to cluster Universities into to two groups, Private and Public.

Note this is a Workthrough Excerise

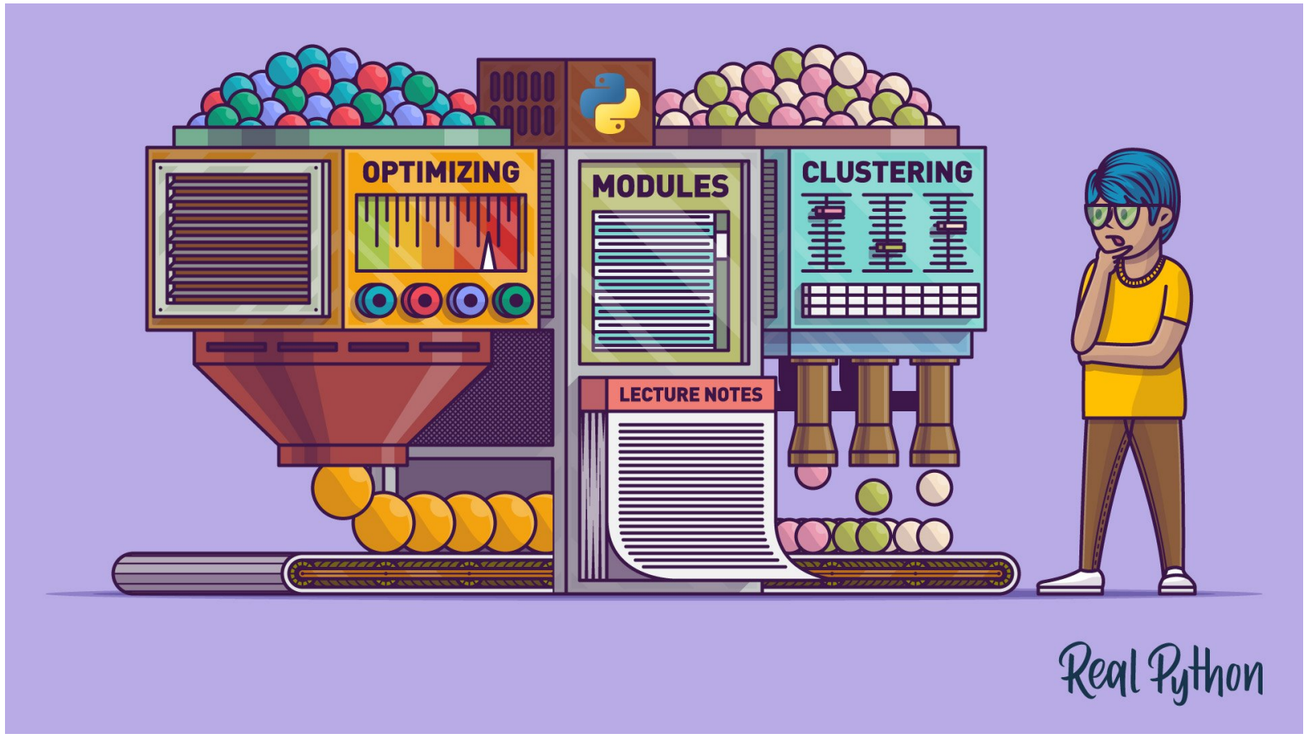
It is very important to note, we actually have the labels for this data set, but we will NOT use them for the KMeans clustering algorithm, since that is an unsupervised learning algorithm.

When using the Kmeans algorithm under normal circumstances, it is because you don't have labels. In this case we will use the labels to try to get an idea of how well the algorithm performed, but you won't usually do this for Kmeans, so the classification report and confusion matrix at the end of this project, don't truly make sense in a real world setting!.

The Data

We will use this data frame with 777 observations on the following 18 variables.

- Private A factor with levels No and Yes indicating private or public university
- Apps Number of applications received
- Accept Number of applications accepted
- Enroll Number of new students enrolled
- Top10perc Pct. new students from top 10% of H.S. class
- Top25perc Pct. new students from top 25% of H.S. class
- F.Undergrad Number of fulltime undergraduates
- P.Undergrad Number of parttime undergraduates
- Outstate Out-of-state tuition
- Room.Board Room and board costs
- Books Estimated book costs
- Personal Estimated personal spending
- PhD Pct. of faculty with Ph.D.'s
- Terminal Pct. of faculty with terminal degree
- S.F.Ratio Student/faculty ratio
- perc.alumni Pct. alumni who donate
- Expend Instructional expenditure per student
- Grad.Rate Graduation rate



In [25]:
```
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
%matplotlib inline
```

In [26]:
```
df=pd.read_csv('College_Data',index_col=0)
```

In [27]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 777 entries, Abilene Christian University to York College of Pennsylvania
Data columns (total 18 columns):
Private        777 non-null object
Apps           777 non-null int64
Accept         777 non-null int64
Enroll         777 non-null int64
Top10perc      777 non-null int64
Top25perc      777 non-null int64
F.Undergrad    777 non-null int64
P.Undergrad    777 non-null int64
Outstate       777 non-null int64
Room.Board     777 non-null int64
Books          777 non-null int64
Personal       777 non-null int64
PhD            777 non-null int64
Terminal       777 non-null int64
S.F.Ratio      777 non-null float64
perc.alumni    777 non-null int64
Expend         777 non-null int64
Grad.Rate      777 non-null int64
dtypes: float64(1), int64(16), object(1)
memory usage: 115.3+ KB
```

In [6]:
```
df.head()
```

Out[6]:

	Private	Apps	Accept	Enroll	Top10perc	Top25perc	F.Undergrad	P.Undergrad	Outstate	Room.Board	Books	Personal	PhD	Terminal	S.F.Ratio	perc.alumni	Expend	Grad.Rate
Abilene Christian University	Yes	1660	1232	721	23	52	2885	537	7440	3300	450	2200	70	78	18.1	12	7041	60
Adelphi University	Yes	2186	1924	512	16	29	2683	1227	12280	6450	750	1500	29	30	12.2	16	10527	56
Adrian College	Yes	1428	1097	336	22	50	1036	99	11250	3750	400	1165	53	66	12.9	30	8735	54
Agnes Scott College	Yes	417	349	137	60	89	510	63	12960	5450	450	875	92	97	7.7	37	19016	59
Alaska Pacific University	Yes	193	146	55	16	44	249	869	7560	4120	800	1500	76	72	11.9	2	10922	15

In [12]:
```
df.describe()
```

Out[12]:

	Apps	Accept	Enroll	Top10perc	Top25perc	F.Undergrad	P.Undergrad	Outstate	Room.Board	Books	Personal	PhD	Terminal	S.F.Ratio	perc.alumni	Expend	Grad.Rate
count	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.000000	777.00000
mean	3001.638353	2018.804376	779.972973	27.558559	55.796654	3699.907336	855.298584	10440.669241	4357.526384	549.380952	1340.642214	72.660232	79.702703	14.089704	22.743887	9660.171171	65.46332
std	3870.201484	2451.113971	929.176190	17.640364	19.804778	4850.420531	1522.431887	4023.016484	1096.696416	165.105360	677.071454	16.328155	14.722359	3.958349	12.391801	5221.768440	17.17771
min	81.000000	72.000000	35.000000	1.000000	9.000000	139.000000	1.000000	2340.000000	1780.000000	96.000000	250.000000	8.000000	24.000000	2.500000	0.000000	3186.000000	10.00000
25%	776.000000	604.000000	242.000000	15.000000	41.000000	992.000000	95.000000	7320.000000	3597.000000	470.000000	850.000000	62.000000	71.000000	11.500000	13.000000	6751.000000	53.00000
50%	1558.000000	1110.000000	434.000000	23.000000	54.000000	1707.000000	353.000000	9990.000000	4200.000000	500.000000	1200.000000	75.000000	82.000000	13.600000	21.000000	8377.000000	65.00000
75%	3624.000000	2424.000000	902.000000	35.000000	69.000000	4005.000000	967.000000	12925.000000	5050.000000	600.000000	1700.000000	85.000000	92.000000	16.500000	31.000000	10830.000000	78.00000
max	48094.000000	26330.000000	6392.000000	96.000000	100.000000	31643.000000	21836.000000	21700.000000	8124.000000	2340.000000	6800.000000	103.000000	100.000000	39.800000	64.000000	56233.000000	118.00000

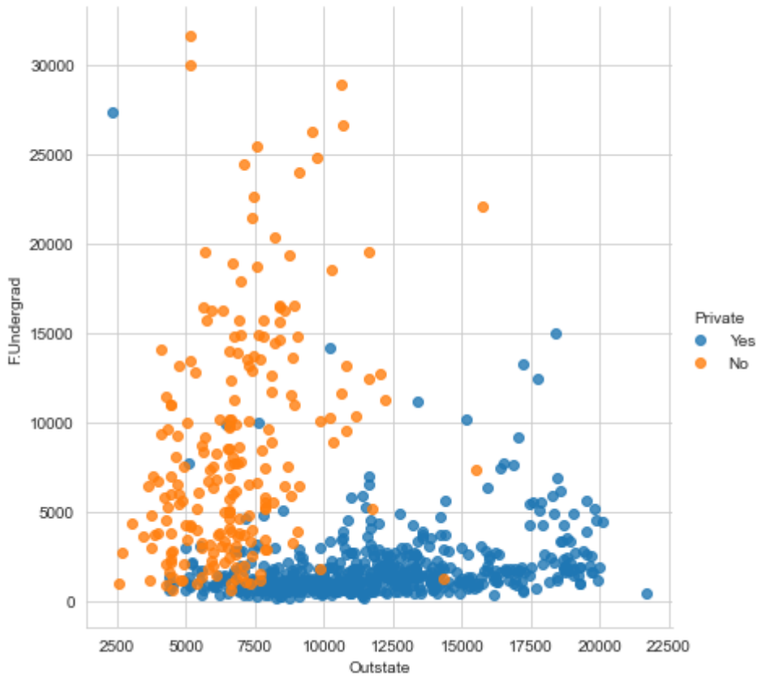
Exploratory data analysis (EDA)

In [34]:
```
sns.set_style('whitegrid')
sns.lmplot(x='Room.Board', y='Grad.Rate', data=df, hue='Private',fit_reg=False,
           palette ='coolwarm',size =6, aspect=1)
```

Out[34]:
```
<seaborn.axisgrid.FacetGrid at 0x1e5992d78c8>
```

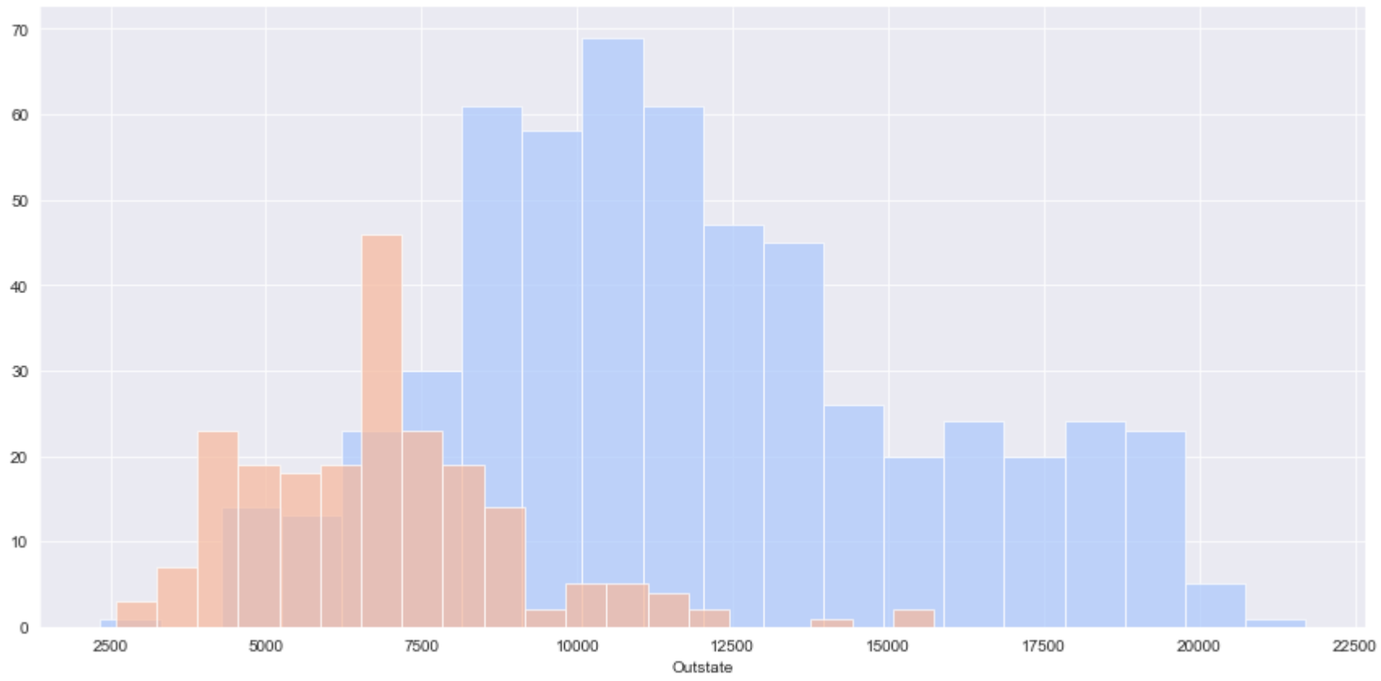
In [37]:
```
sns.set_style('whitegrid')
sns.lmplot(x='Outstate', y='F.Undergrad', data=df, hue='Private',fit_reg=False,
           size =6, aspect=1)
```

Out[37]: <seaborn.axisgrid.FacetGrid at 0x1e5993706c8>

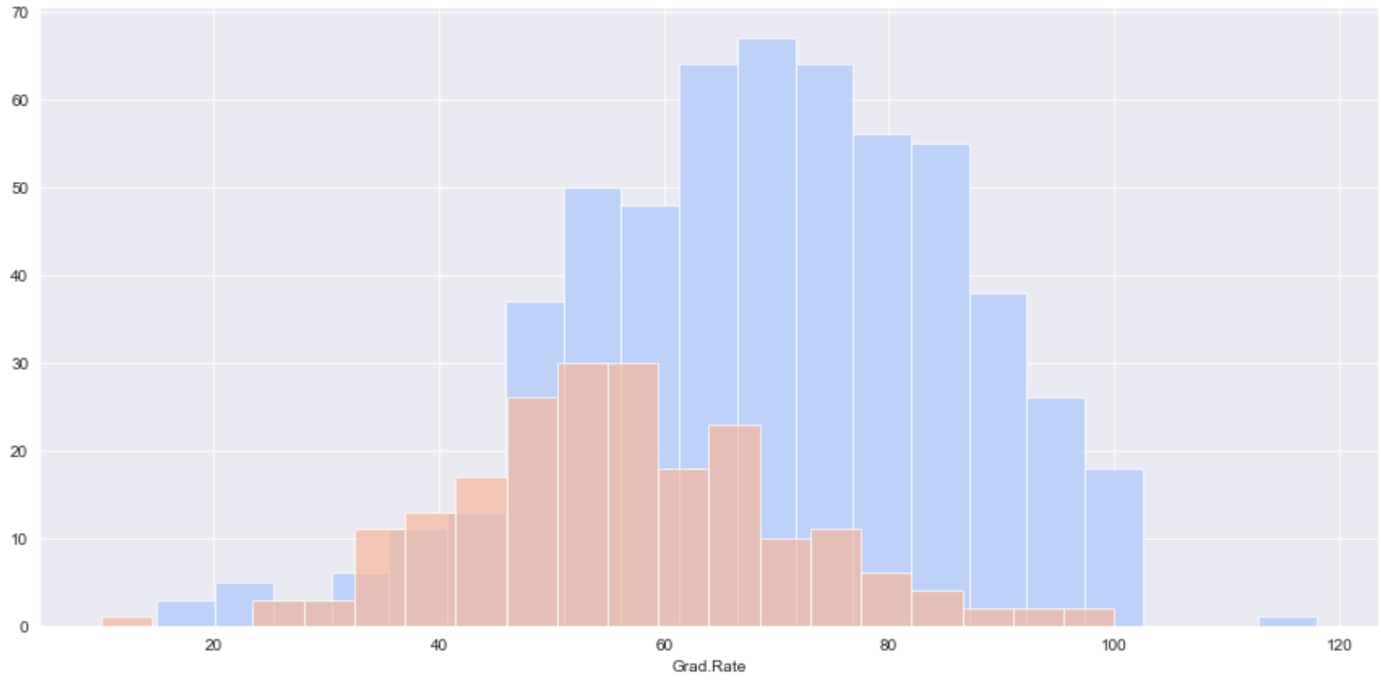


In [7]:
```
sns.set_style('darkgrid')
g = sns.FacetGrid(df,hue="Private",palette='coolwarm',size=6,aspect=2)
```

```
g = g.map(plt.hist,'Outstate',bins=20,alpha=0.7)
```



In [11]:
```
g=sns.FacetGrid(df, hue='Private',palette='coolwarm',size=6,aspect=2)
g=g.map(plt.hist, 'Grad.Rate', bins=20,alpha=0.7)
```



Note we are having over 100 graudate in a university, a unversity can not have over 100% graudate so we will have to search the over 100% graduate using pandas data frame. below is the code of the university over 100%

In [13]:
```
df[df['Grad.Rate']>100]
```

Out[13]:

	Private	Apps	Accept	Enroll	Top10perc	Top25perc	F.Undergrad	P.Undergrad	Outstate	Room.Board	Books	Personal	PhD	Terminal	S.F.Ratio	perc.alumni	Expend	Grad.Rate
Cazenovia College	Yes	3847	3433	527	9	35	1010	12	9384	4840	600	500	22	47	14.3	20	7697	118

The code to correct it to 100%

In [19]:
```
df['Grad.Rate']['Cazenovia College']=100
```

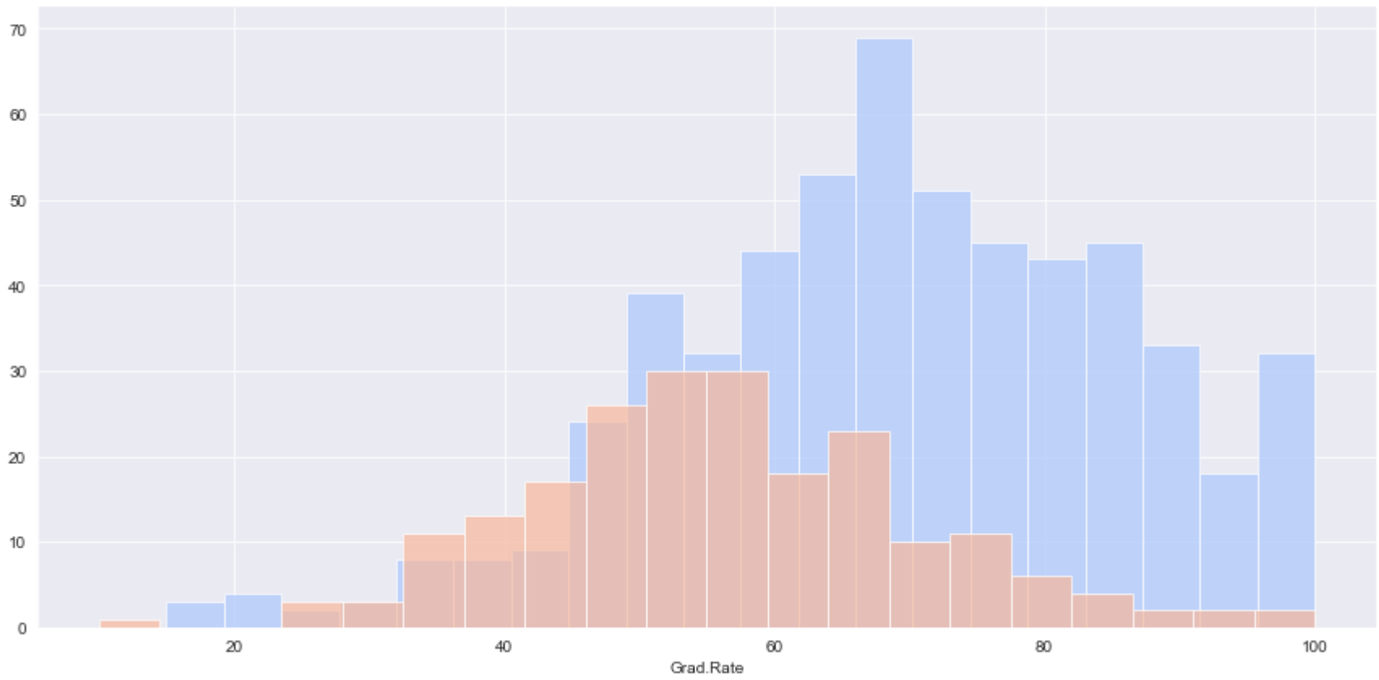
```
C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """Entry point for launching an IPython kernel.
```

In [20]:
```
df[df['Grad.Rate']>100]
```

Out[20]:

	Private	Apps	Accept	Enroll	Top10perc	Top25perc	F.Undergrad	P.Undergrad	Outstate	Room.Board	Books	Personal	PhD	Terminal	S.F.Ratio	perc.alumni	Expend	Grad.Rate

In [21]:
```
g=sns.FacetGrid(df, hue='Private',palette='coolwarm',size=6,aspect=2)
g=g.map(plt.hist, 'Grad.Rate', bins=20,alpha=0.7)
```



K Means Cluster Creation

In [37]:
```
from sklearn.cluster import KMeans
```

In [38]:
```
Kmeans = KMeans(n_clusters=2)
```

In [39]:
```
Kmeans.fit (df.drop('Private', axis=1))
```

Out[39]:
```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=2, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

In [40]:
```
Kmeans.cluster_centers_
```

Out[40]:
```
array([[1.81323468e+03, 1.28716592e+03, 4.91044843e+02, 2.53094170e+01,
        5.34708520e+01, 2.18854858e+03, 5.95458894e+02, 1.03957085e+04,
        4.31136472e+03, 5.41982063e+02, 1.28033632e+03, 7.04424514e+01,
        7.78251121e+01, 1.40997010e+01, 2.31748879e+01, 8.93204634e+03,
        6.51195815e+01],
       [1.03631389e+04, 6.55089815e+03, 2.56972222e+03, 4.14907407e+01,
        7.02037037e+01, 1.30619352e+04, 2.46486111e+03, 1.07191759e+04,
        4.64347222e+03, 5.95212963e+02, 1.71420370e+03, 8.63981481e+01,
        9.13333333e+01, 1.40277778e+01, 2.00740741e+01, 1.41705000e+04,
        6.75925926e+01]])
```

Evaluation

There is no perfect way to evaluate clustering if you don't have the labels, however since this is just an exercise, we do have the labels, so we take advantage of this to evaluate our clusters.

- Creating a new column for df called 'Cluster', which is a 1 for a Private school, and a 0 for a public school.

In [42]:
```
def conveter (Private):
    if Private=='Yes':
        return 1
    else:
        return 0
```

In [43]:
```
df['Cluster'] = df ['Private'].apply(conveter)
```

In [44]:
```
df.head()
```

Out[44]:

	Private	Apps	Accept	Enroll	Top10perc	Top25perc	F.Undergrad	P.Undergrad	Outstate	Room.Board	Books	Personal	PhD	Terminal	S.F.Ratio	perc.alumni	Expend	Grad.Rate	Cluster
Abilene Christian University	Yes	1660	1232	721	23	52	2885	537	7440	3300	450	2200	70	78	18.1	12	7041	60	1
Adelphi University	Yes	2186	1924	512	16	29	2683	1227	12280	6450	750	1500	29	30	12.2	16	10527	56	1
Adrian College	Yes	1428	1097	336	22	50	1036	99	11250	3750	400	1165	53	66	12.9	30	8735	54	1
Agnes Scott College	Yes	417	349	137	60	89	510	63	12960	5450	450	875	92	97	7.7	37	19016	59	1
Alaska Pacific University	Yes	193	146	55	16	44	249	869	7560	4120	800	1500	76	72	11.9	2	10922	15	1

In [53]:
```
from sklearn.metrics import confusion_matrix,classification_report
print(confusion_matrix(df['Cluster'],Kmeans.labels_))
print('\n')
print(classification_report(df['Cluster'],Kmeans.labels_))
```

```
[[138  74]
 [531  34]]


              precision    recall  f1-score   support
```

```
                0       0.21      0.65      0.31       212
                1       0.31      0.06      0.10       565

         accuracy                           0.22       777
        macro avg       0.26      0.36      0.21       777
     weighted avg       0.29      0.22      0.16       777
```

In [ ]: