Import library

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

Import airfoils data

In [2]:
```
df = pd.read_csv('Airfoil.csv')
df.drop(['upper0.75c', 'lower0.75c', 'AoF_Cl0.5'], axis=1, inplace=True)
df.sample(5)
```

Out[2]:

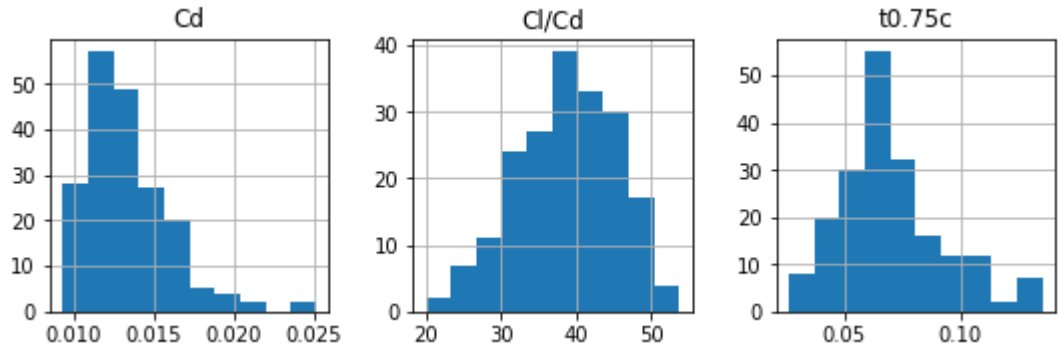
	Airfoils	t0.75c	Cd	Cl/Cd
146	NACA M24	0.068897	0.01671	29.922202
21	NACA 63-206	0.026840	0.01011	49.455984
50	NACA 65-206	0.031880	0.01026	48.732943
135	EPPLER 858	0.086440	0.01118	44.722719
89	NACA 0010	0.052400	0.01299	38.491147

Scaler processing

In [3]:
```
from sklearn import preprocessing
from sklearn.cluster import KMeans
```

In [4]:
```
cols = ['t0.75c', 'Cd', 'Cl/Cd']
```

In [5]:
```
df[cols].hist(layout=(1, len(cols)), figsize=(3*len(cols),2.5));
```



In [6]:
```
scaler = preprocessing.PowerTransformer(standardize=True)
S = scaler.fit_transform(df[cols])
S[:5]
```

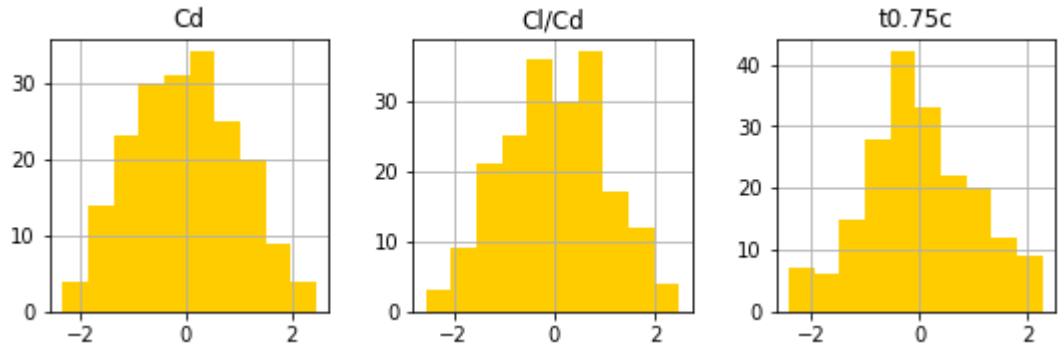
Out[6]:
```
array([[-0.83578211, -0.23485399,  0.21170231],
       [-0.32948228, -0.19339815,  0.17074216],
       [ 0.32569592,  0.36453259, -0.37220145],
       [-1.27289825, -0.92403057,  0.90990085],
       [-0.82361619, -0.86052133,  0.8440273 ]])
```

In [7]:
```
X = pd.DataFrame(S, columns=cols)
X.head()
```

Out[7]:

	t0.75c	Cd	Cl/Cd
0	-0.835782	-0.234854	0.211702
1	-0.329482	-0.193398	0.170742
2	0.325696	0.364533	-0.372201
3	-1.272898	-0.924031	0.909901
4	-0.823616	-0.860521	0.844027

In [8]:
```
X[cols].hist(layout=(1, len(cols)), figsize=(3*len(cols),2.5), color='#ffcc00'
);
```



Used K means clustering algorithm (Machine Learning)

In [9]:
```
from sklearn.cluster import KMeans
from sklearn.metrics import silhouette_samples, silhouette_score
from yellowbrick.cluster import SilhouetteVisualizer
```

In [10]:
```
def sil_score(X, from_k=2, to_k=6):
    '''
    calculate silhouette score for k clusters
    '''
    sils=[]
    for k in range(from_k, to_k + 1):
        m = KMeans(n_clusters=k)
        m.fit(X)
        # The silhouette_score gives the average value for all the samples
        silhouette_avg = silhouette_score(X, m.labels_).round(4)
        sils.append([silhouette_avg, k])

    return sils
```

This is function for calculate the number of cluster.

In [11]:
```
ss=sil_score(X, 2, 5)
print(f'scores = {ss}')
print(f'optimal number of clusters = {max(ss)[1]}')
```

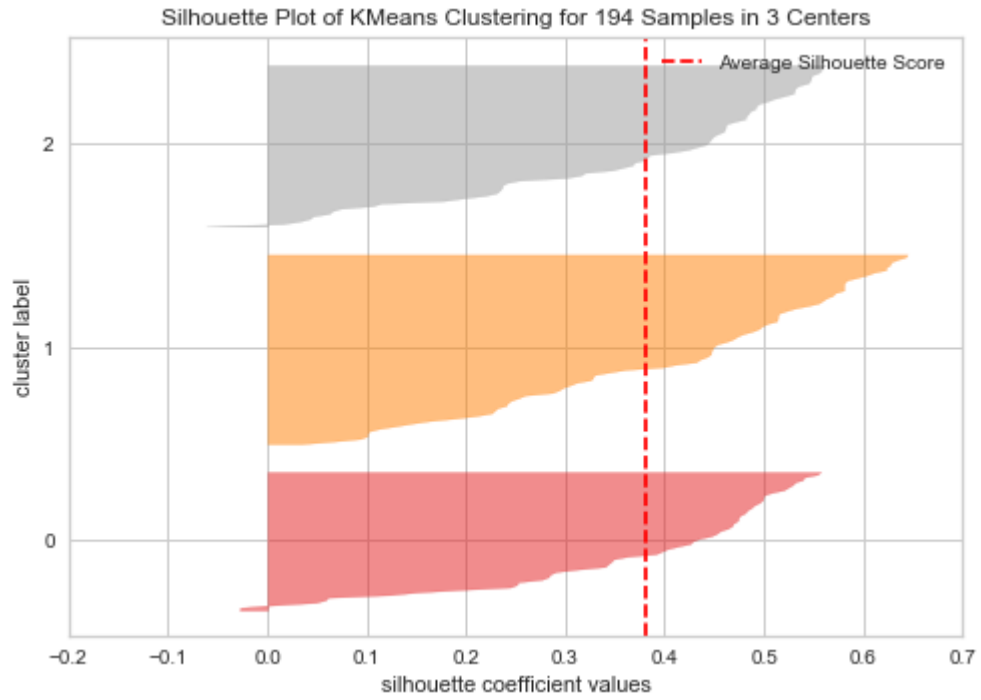
```
scores = [[0.4772, 2], [0.3816, 3], [0.3514, 4], [0.3585, 5]]
optimal number of clusters = 2
```

If score is high that's mean it's good. But we choose divide in 3 cluster, because it's expediently for analysis.

In [12]:
```
def silhouette_plot(X, from_k, to_k):
    sil_scores=[]
    for k in range(from_k, to_k + 1):
        # Instantiate the clustering model and visualizer
        m = KMeans(n_clusters=k)
        visualizer = SilhouetteVisualizer(m)
        visualizer.fit(X) # Fit the training data to the visualizer
        visualizer.poof() # Draw/show/poof the data
#         print(visualizer.silhouette_score_)
#         sil_scores.append([k, visualizer.silhouette_score_])
        sil_scores.append([visualizer.silhouette_score_, k])
    return sil_scores
```

This is function for plot the mean score cluster.

In [13]:
```
scores=silhouette_plot(X, 3, 3)
```



In [14]:
```
model = KMeans(n_clusters=3)
```

In [15]:
```
model.fit(X)
```

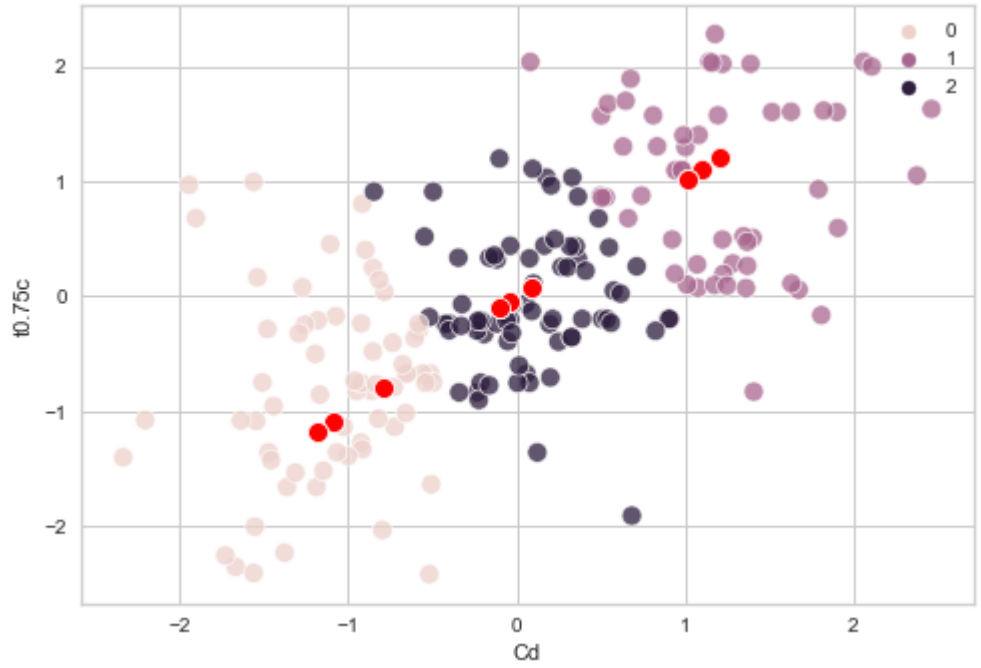
Out[15]:
```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=3, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

In [16]:
```
point = model.cluster_centers_
point
```

Out[16]:
```
array([[-0.79522635, -1.09414976,  1.09683056],
       [ 1.01168643,  1.20138708, -1.1858663 ],
       [-0.04325773,  0.08407664, -0.09819412]])
```

In [17]:
```
X['cluster'] = model.labels_
```

In [32]:
```
sns.scatterplot(x=X['Cd'], y=X['t0.75c'], s=100, hue=X['cluster'], alpha=0.75)
for i in range(3):
    sns.scatterplot(x=point[i], y=point[i], s=100, color='red')
    sns.scatterplot(x=point[i], y=point[i], s=100, color='red')
    sns.scatterplot(x=point[i], y=point[i], s=100, color='red')
```



In [19]:
```
model.labels_
```

Out[19]:
```
array([2, 2, 2, 0, 0, 2, 2, 0, 2, 0, 0, 2, 2, 2, 0, 0, 0, 2, 0, 2, 1, 0,
       0, 2, 2, 2, 2, 0, 2, 1, 2, 2, 0, 0, 0, 0, 0, 2, 2, 2, 2, 2, 1, 1,
       2, 0, 0, 2, 2, 0, 0, 0, 0, 2, 2, 2, 1, 1, 0, 1, 1, 1, 1, 2, 0, 0,
       2, 2, 2, 1, 1, 1, 1, 2, 2, 1, 1, 1, 1, 2, 2, 2, 0, 2, 1, 1, 0, 0,
       0, 2, 2, 1, 1, 1, 1, 0, 2, 2, 0, 0, 0, 2, 1, 1, 1, 2, 2, 1, 1, 1,
       2, 1, 1, 0, 2, 2, 1, 0, 0, 0, 0, 2, 1, 1, 1, 1, 2, 0, 0, 0, 2, 1,
       1, 1, 1, 0, 2, 0, 2, 0, 0, 1, 2, 1, 1, 1, 1, 1, 2, 2, 0, 1, 0, 1,
       0, 0, 0, 2, 2, 0, 1, 0, 1, 0, 0, 0, 2, 0, 0, 0, 0, 1, 0, 2, 2, 1,
       0, 2, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 0, 0, 0, 0, 2])
```

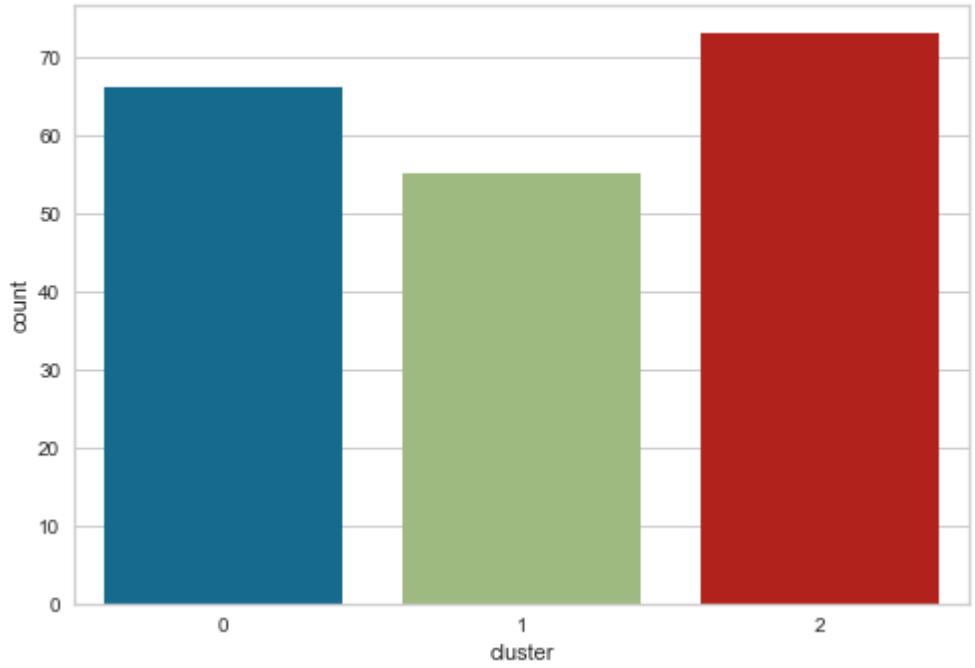
Cluster was divide in 3 as 0, 1, 2.

In [20]:
```
df['cluster']=model.labels_
df.head()
```

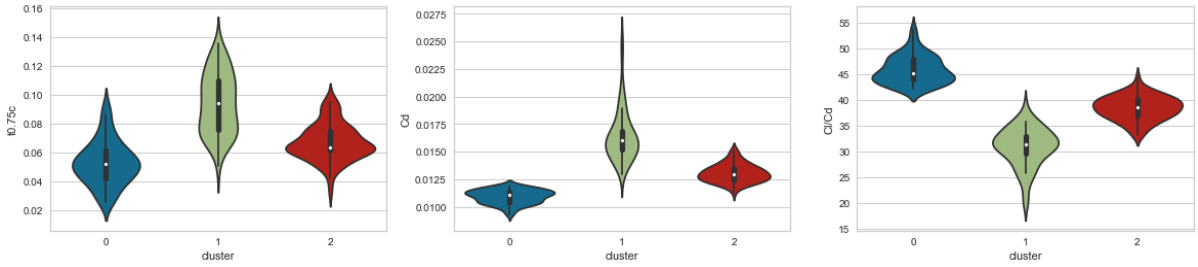
Out[20]:

	Airfoils	t0.75c	Cd	Cl/Cd	cluster
0	NACA 63A010	0.05090	0.01236	40.453074	2
1	NACA 63012A	0.06052	0.01244	40.192926	2
2	NACA 63-015A	0.07462	0.01364	36.656892	2
3	NACA 63-210	0.04332	0.01117	44.762757	0
4	NACA 63-212	0.05112	0.01127	44.365572	0

In [21]:
```
sns.countplot(x='cluster', data=df);
```



In [22]:
```
cols = ['t0.75c', 'Cd', 'Cl/Cd']
fig, ax = plt.subplots(nrows=1, ncols=3, figsize=(20, 4))
ax=ax.ravel()
for i, col in enumerate(cols):
    sns.violinplot(x='cluster', y=col, data=df, ax=ax[i])
```



In [23]:
```
dx=X
dx['cluster']=model.labels_
dx.head()
```

Out[23]:

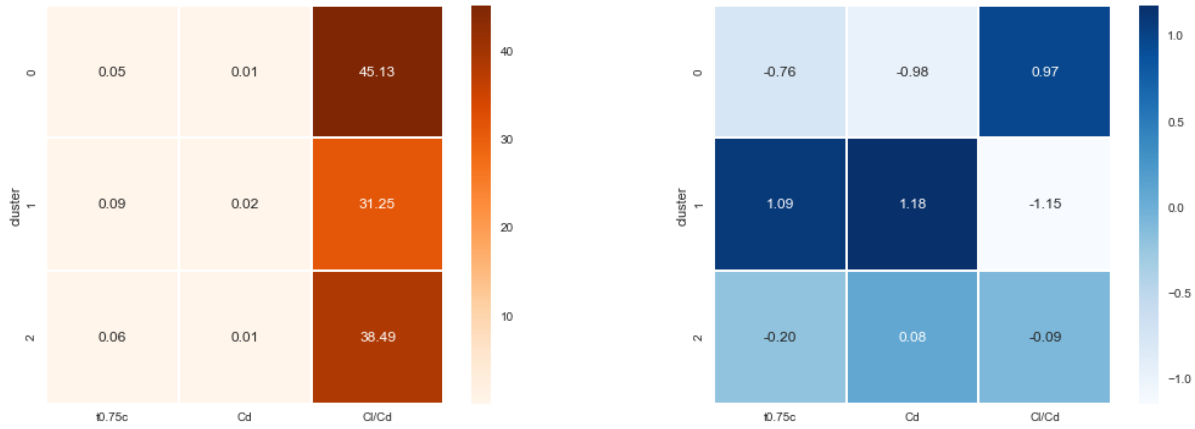
	t0.75c	Cd	Cl/Cd	cluster
0	-0.835782	-0.234854	0.211702	2
1	-0.329482	-0.193398	0.170742	2
2	0.325696	0.364533	-0.372201	2
3	-1.272898	-0.924031	0.909901	0
4	-0.823616	-0.860521	0.844027	0

In [24]:
```
dx.groupby('cluster').median()
```

Out[24]:

cluster	t0.75c	Cd	Cl/Cd
0	-0.759969	-0.982184	0.970541
1	1.093808	1.176513	-1.150768
2	-0.197421	0.076658	-0.093793

In [33]:
```
cols = ['t0.75c', 'Cd', 'Cl/Cd', 'cluster']
fig, ax = plt.subplots(ncols=2, figsize=(18, 6))
ax=ax.ravel()
sns.heatmap(df[cols].groupby('cluster').median(), cmap="Oranges", linewidths=1
,
            square=True, annot=True, fmt='.2f',ax=ax[0]);
sns.heatmap(dx[cols].groupby('cluster').median(), cmap="Blues", linewidths=1,
            square=True, annot=True, fmt='.2f', ax=ax[1]);
```



For compare before scaling and after scaling.

In [26]:
```
df.groupby('cluster').head(3).sort_values('cluster')
```

Out[26]:

	Airfoils	t0.75c	Cd	Cl/Cd	cluster
3	NACA 63-210	0.04332	0.01117	44.762757	0
4	NACA 63-212	0.05112	0.01127	44.365572	0
7	NACA 63-412	0.05108	0.01113	44.923630	0
20	NACA 66-021	0.12502	0.01682	29.726516	1
29	NACA 63(4)-221	0.08318	0.01440	34.722222	1
42	NACA 64(4)-221	0.08830	0.01462	34.199726	1
0	NACA 63A010	0.05090	0.01236	40.453074	2
1	NACA 63012A	0.06052	0.01244	40.192926	2
2	NACA 63-015A	0.07462	0.01364	36.656892	2

In [27]:
```
df_cluster_0 = df[df.cluster==0]
df_cluster_1 = df[df.cluster==1]
df_cluster_2 = df[df.cluster==2]
df_cluster_1.head()
```

Out[27]:

	Airfoils	t0.75c	Cd	Cl/Cd	cluster
20	NACA 66-021	0.12502	0.01682	29.726516	1
29	NACA 63(4)-221	0.08318	0.01440	34.722222	1
42	NACA 64(4)-221	0.08830	0.01462	34.199726	1
43	NACA 64(4)-421	0.08826	0.01397	35.790981	1
56	NACA 65(3)-218	0.08790	0.01405	35.587189	1

Save to file after finish

In [28]:
```
# df.to_csv('AirfoilsCluster.csv', index=False)
```

In [29]:
```
# df_cluster_0.to_csv('airfoil_cluster_0.csv', index=False)
# df_cluster_1.to_csv('airfoil_cluster_1.csv', index=False)
# df_cluster_2.to_csv('airfoil_cluster_2.csv', index=False)
```