K_in_K_means_Clustering

July 17, 2020

[1]:
```
import pandas as pd
import numpy as np
from sklearn import datasets
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import sklearn.metrics as sm
import math
%matplotlib inline
```

[3]:
```
iris = datasets.load_iris()
print(iris.data)
```

```
[[5.1 3.5 1.4 0.2]
 [4.9 3.  1.4 0.2]
 [4.7 3.2 1.3 0.2]
 [4.6 3.1 1.5 0.2]
 [5.  3.6 1.4 0.2]
 [5.4 3.9 1.7 0.4]
 [4.6 3.4 1.4 0.3]
 [5.  3.4 1.5 0.2]
 [4.4 2.9 1.4 0.2]
 [4.9 3.1 1.5 0.1]
 [5.4 3.7 1.5 0.2]
 [4.8 3.4 1.6 0.2]
 [4.8 3.  1.4 0.1]
 [4.3 3.  1.1 0.1]
 [5.8 4.  1.2 0.2]
 [5.7 4.4 1.5 0.4]
 [5.4 3.9 1.3 0.4]
 [5.1 3.5 1.4 0.3]
 [5.7 3.8 1.7 0.3]
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 [5.1 3.7 1.5 0.4]
 [4.6 3.6 1.  0.2]
 [5.1 3.3 1.7 0.5]
 [4.8 3.4 1.9 0.2]
```

```
[5.  3.  1.6 0.2]
[5.  3.4 1.6 0.4]
[5.2 3.5 1.5 0.2]
[5.2 3.4 1.4 0.2]
[4.7 3.2 1.6 0.2]
[4.8 3.1 1.6 0.2]
[5.4 3.4 1.5 0.4]
[5.2 4.1 1.5 0.1]
[5.5 4.2 1.4 0.2]
[4.9 3.1 1.5 0.2]
[5.  3.2 1.2 0.2]
[5.5 3.5 1.3 0.2]
[4.9 3.6 1.4 0.1]
[4.4 3.  1.3 0.2]
[5.1 3.4 1.5 0.2]
[5.  3.5 1.3 0.3]
[4.5 2.3 1.3 0.3]
[4.4 3.2 1.3 0.2]
[5.  3.5 1.6 0.6]
[5.1 3.8 1.9 0.4]
[4.8 3.  1.4 0.3]
[5.1 3.8 1.6 0.2]
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[5.  3.3 1.4 0.2]
[7.  3.2 4.7 1.4]
[6.4 3.2 4.5 1.5]
[6.9 3.1 4.9 1.5]
[5.5 2.3 4.  1.3]
[6.5 2.8 4.6 1.5]
[5.7 2.8 4.5 1.3]
[6.3 3.3 4.7 1.6]
[4.9 2.4 3.3 1. ]
[6.6 2.9 4.6 1.3]
[5.2 2.7 3.9 1.4]
[5.  2.  3.5 1. ]
[5.9 3.  4.2 1.5]
[6.  2.2 4.  1. ]
[6.1 2.9 4.7 1.4]
[5.6 2.9 3.6 1.3]
[6.7 3.1 4.4 1.4]
[5.6 3.  4.5 1.5]
[5.8 2.7 4.1 1. ]
[6.2 2.2 4.5 1.5]
[5.6 2.5 3.9 1.1]
[5.9 3.2 4.8 1.8]
[6.1 2.8 4.  1.3]
[6.3 2.5 4.9 1.5]
```

```
[6.1 2.8 4.7 1.2]
[6.4 2.9 4.3 1.3]
[6.6 3.  4.4 1.4]
[6.8 2.8 4.8 1.4]
[6.7 3.  5.  1.7]
[6.  2.9 4.5 1.5]
[5.7 2.6 3.5 1. ]
[5.5 2.4 3.8 1.1]
[5.5 2.4 3.7 1. ]
[5.8 2.7 3.9 1.2]
[6.  2.7 5.1 1.6]
[5.4 3.  4.5 1.5]
[6.  3.4 4.5 1.6]
[6.7 3.1 4.7 1.5]
[6.3 2.3 4.4 1.3]
[5.6 3.  4.1 1.3]
[5.5 2.5 4.  1.3]
[5.5 2.6 4.4 1.2]
[6.1 3.  4.6 1.4]
[5.8 2.6 4.  1.2]
[5.  2.3 3.3 1. ]
[5.6 2.7 4.2 1.3]
[5.7 3.  4.2 1.2]
[5.7 2.9 4.2 1.3]
[6.2 2.9 4.3 1.3]
[5.1 2.5 3.  1.1]
[5.7 2.8 4.1 1.3]
[6.3 3.3 6.  2.5]
[5.8 2.7 5.1 1.9]
[7.1 3.  5.9 2.1]
[6.3 2.9 5.6 1.8]
[6.5 3.  5.8 2.2]
[7.6 3.  6.6 2.1]
[4.9 2.5 4.5 1.7]
[7.3 2.9 6.3 1.8]
[6.7 2.5 5.8 1.8]
[7.2 3.6 6.1 2.5]
[6.5 3.2 5.1 2. ]
[6.4 2.7 5.3 1.9]
[6.8 3.  5.5 2.1]
[5.7 2.5 5.  2. ]
[5.8 2.8 5.1 2.4]
[6.4 3.2 5.3 2.3]
[6.5 3.  5.5 1.8]
[7.7 3.8 6.7 2.2]
[7.7 2.6 6.9 2.3]
[6.  2.2 5.  1.5]
[6.9 3.2 5.7 2.3]
```

```
[5.6 2.8 4.9 2. ]
[7.7 2.8 6.7 2. ]
[6.3 2.7 4.9 1.8]
[6.7 3.3 5.7 2.1]
[7.2 3.2 6.  1.8]
[6.2 2.8 4.8 1.8]
[6.1 3.  4.9 1.8]
[6.4 2.8 5.6 2.1]
[7.2 3.  5.8 1.6]
[7.4 2.8 6.1 1.9]
[7.9 3.8 6.4 2. ]
[6.4 2.8 5.6 2.2]
[6.3 2.8 5.1 1.5]
[6.1 2.6 5.6 1.4]
[7.7 3.  6.1 2.3]
[6.3 3.4 5.6 2.4]
[6.4 3.1 5.5 1.8]
[6.  3.  4.8 1.8]
[6.9 3.1 5.4 2.1]
[6.7 3.1 5.6 2.4]
[6.9 3.1 5.1 2.3]
[5.8 2.7 5.1 1.9]
[6.8 3.2 5.9 2.3]
[6.7 3.3 5.7 2.5]
[6.7 3.  5.2 2.3]
[6.3 2.5 5.  1.9]
[6.5 3.  5.2 2. ]
[6.2 3.4 5.4 2.3]
[5.9 3.  5.1 1.8]]
```

[3]:
```
print(iris.target_names)
```

```
['setosa' 'versicolor' 'virginica']
```

[4]:
```
print(iris.target)
```

```
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2]
```

[5]:
```
x = pd.DataFrame(iris.data, columns=['Sepal Length', 'Sepal Width',
                                     'Petal Length', 'Petal Width'])
y = pd.DataFrame(iris.target, columns=['Target'])
```

[6]:
```
x.head()
```

[6]:
```
   Sepal Length  Sepal Width  Petal Length  Petal Width
0           5.1          3.5           1.4          0.2
1           4.9          3.0           1.4          0.2
2           4.7          3.2           1.3          0.2
3           4.6          3.1           1.5          0.2
4           5.0          3.6           1.4          0.2
```

[7]:
```
y.head()
```

[7]:
```
   Target
0       0
1       0
2       0
3       0
4       0
```

[8]:
```
iris_k_mean_model = KMeans(n_clusters=3)
iris_k_mean_model.fit(x)
```

[8]:
```
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)
```

[9]:
```
print(iris_k_mean_model.labels_)
```

```
[1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 2 2 2 2 0 2 2 2 2
 2 2 0 0 2 2 2 2 0 2 0 2 0 2 2 0 0 2 2 2 2 2 0 2 2 2 2 0 2 2 2 0 2 2 2 0 2
 2 0]
```

[11]:
```
print(iris_k_mean_model.cluster_centers_)
```

```
[[5.9016129  2.7483871  4.39354839 1.43387097]
 [5.006      3.428      1.462      0.246     ]
 [6.85       3.07368421 5.74210526 2.07105263]]
```

[12]:
```
predictedY = np.choose(iris_k_mean_model.labels_, [0, 1, 2]).astype(np.int64)
```

[13]:
```
sm.accuracy_score(predictedY, y['Target'])
```

[13]:
```
0.24
```

0.1 Interpretation of Confusion Matrix

Correctly identifed all 0 classes as 0's correctly classified 48 class 1's but miss-classified 2 class 1's as class 2 correctly classified 36 class 2's but miss-classified 14 class 2's as class 1

[14]:
```
sm.confusion_matrix(predictedY, y['Target'])
```

[14]:
```
array([[ 0, 48, 14],
       [50,  0,  0],
       [ 0,  2, 36]], dtype=int64)
```

[15]:
```
x.shape
```

[15]:
```
(150, 4)
```

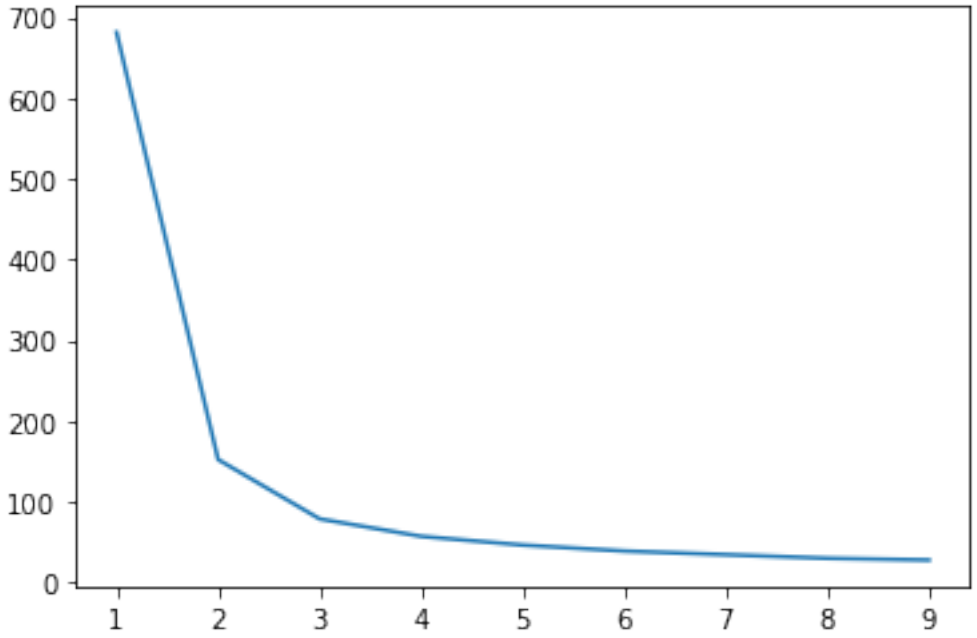
[16]:
```
dist_points_from_cluster_center = []
K = range(1,10)
for no_of_clusters in K:
  k_model = KMeans(n_clusters=no_of_clusters)
  k_model.fit(x)
  dist_points_from_cluster_center.append(k_model.inertia_)
```

[17]:
```
dist_points_from_cluster_center
```

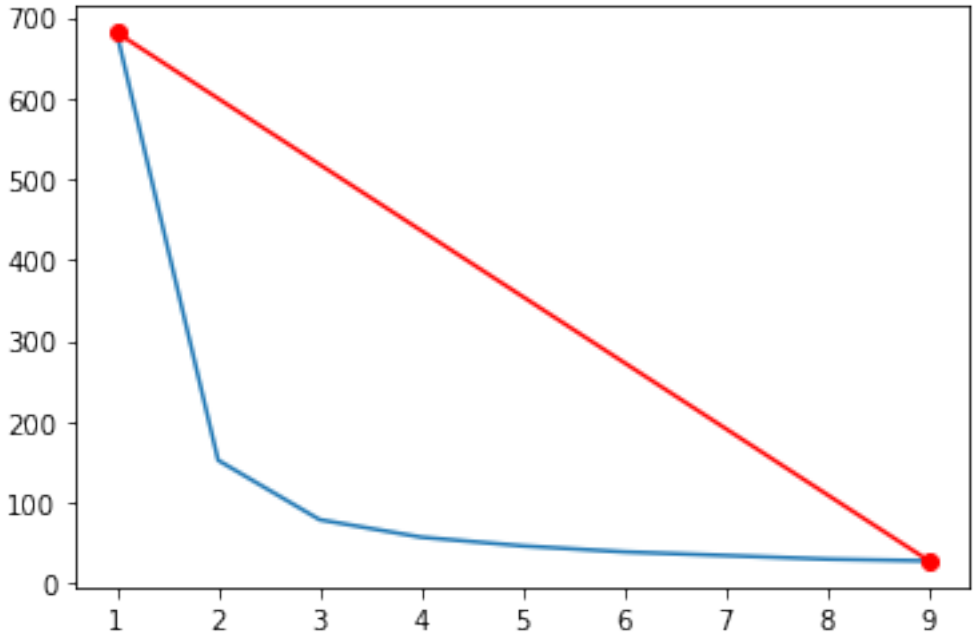
[17]:
```
[681.3706,
 152.34795176035792,
 78.85144142614601,
 57.228473214285714,
 46.44618205128205,
 39.03998724608725,
 34.57303082786779,
 30.063110617452725,
 27.940751666462198]
```

[18]:
```
plt.plot(K, dist_points_from_cluster_center)
```

[18]:
```
[<matplotlib.lines.Line2D at 0x1811866d7f0>]
```

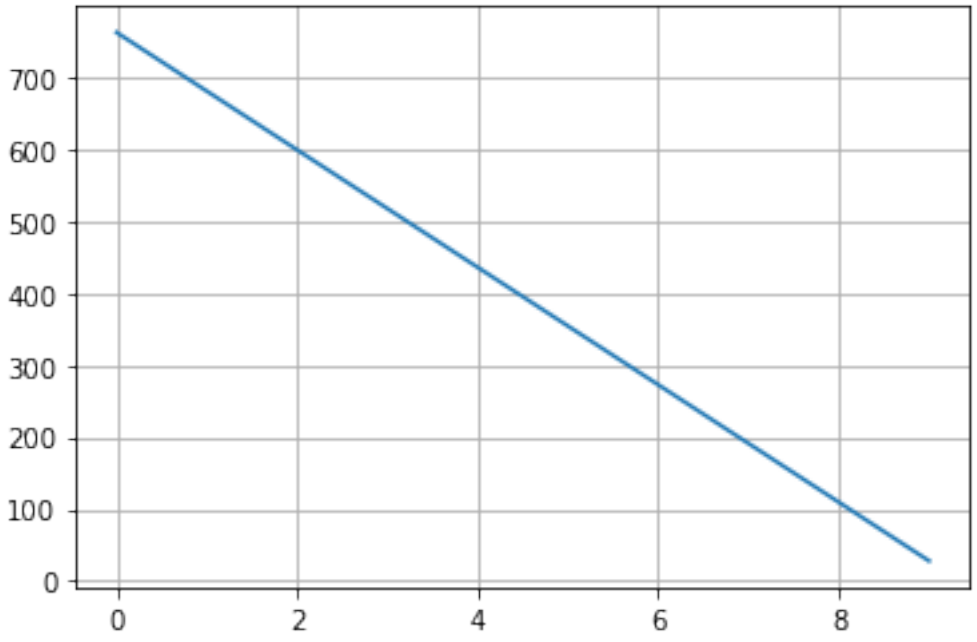


[19]:
```
plt.plot(K, dist_points_from_cluster_center)
plt.plot([K[0], K[8]], [dist_points_from_cluster_center[0],
                        dist_points_from_cluster_center[8]], 'ro-')
plt.show()
```



[20]:
```
x = [K[0], K[8]]
y = [dist_points_from_cluster_center[0], dist_points_from_cluster_center[8]]

# Calculate the coefficients. This line answers the initial question.
coefficients = np.polyfit(x, y, 1)

# Print the findings
print('a =', coefficients[0])
print ('b =', coefficients[1])

# Let's compute the values of the line...
polynomial = np.poly1d(coefficients)
x_axis = np.linspace(0,9,100)
y_axis = polynomial(x_axis)

# ...and plot the points and the line
plt.plot(x_axis, y_axis)
plt.grid('on')
plt.show()
```

```
a = -81.67873104169225
b = 763.0493310416921
```



[21]:
```
# Function to find distance
# https://www.geeksforgeeks.org/perpendicular-distance-
# between-a-point-and-a-line-in-2-d/
```

```
def calc_distance(x1, y1, a, b, c):
  d = abs((a * x1 + b * y1 + c)) / (math.sqrt(a * a + b * b))
  return d
```

[22]:
```
# (y1 - y2)x + (x2 - x1)y + (x1y2 - x2y1) = 0
# https://bobobobo.wordpress.com/2008/01/07/solving-linear-equations-ax-by-c-0/
a = dist_points_from_cluster_center[0] - dist_points_from_cluster_center[8]
b = K[8] - K[0]
c1 = K[0] * dist_points_from_cluster_center[8]
c2 = K[8] * dist_points_from_cluster_center[0]
c = c1 - c2
```

[23]:
```
dist_points_from_cluster_center
```

[23]:
```
[681.3706,
 152.34795176035792,
 78.85144142614601,
 57.228473214285714,
 46.44618205128205,
 39.03998724608725,
 34.57303082786779,
 30.063110617452725,
 27.940751666462198]
```

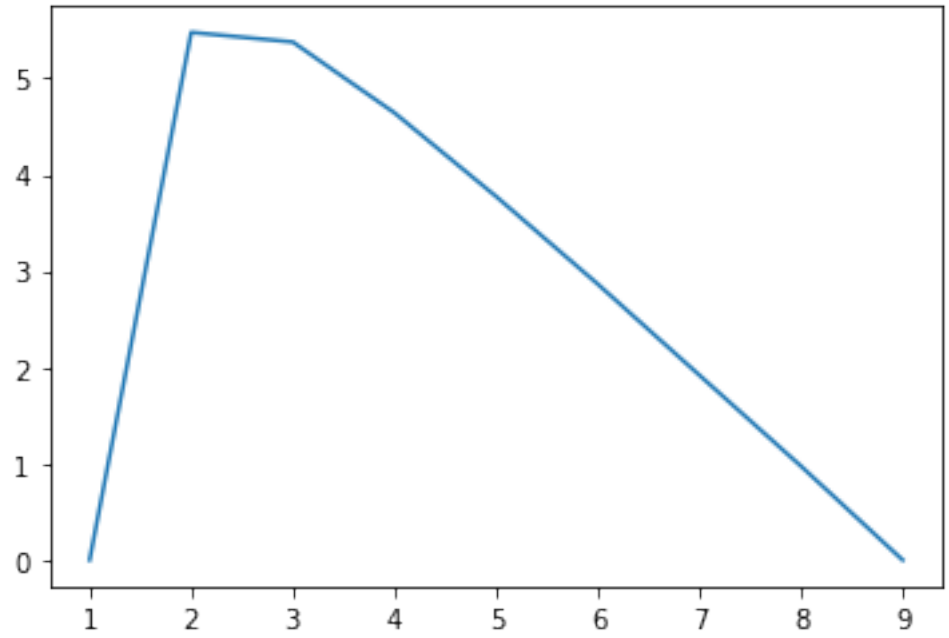
[24]:
```
distance_of_points_from_line = []
for k in range(9):
  distance_of_points_from_line.append(
      calc_distance(K[k], dist_points_from_cluster_center[k], a, b, c))
```

[25]:
```
distance_of_points_from_line
```

[25]:
```
[0.0,
 5.476461109863801,
 5.376292957857814,
 4.64107998878274,
 3.7731535883179514,
 2.863896436062676,
 1.918656622369384,
 0.9739427788034284,
 0.0]
```

[26]:
```
plt.plot(K, distance_of_points_from_line)
```

[26]:
```
[<matplotlib.lines.Line2D at 0x181187d8fd0>]
```


5
4
3
2
1
0
1
2
3
4
5
6
7
8
9