k_means

November 16, 2020

[1]:
```
import numpy as np
import pandas as pd
```

[2]:
```
data_path = 'data/iris.data'
```

0.0.1 Dataset Description

- Number of features for each data-point: 4
- Number of classes: 3 (although we need to cluster the data points to identify what works the best)

0.0.2 Read data from file in X, y

[3]:
```
iris = pd.read_csv(data_path, sep=',', names=['sepal_length', 'sepal_width',␣
↪'petal_length', 'petal_width', 'type'])
```

[4]:
```
iris
```

[4]:

	sepal_length	sepal_width	petal_length	petal_width	type
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3.0	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa
4	5.0	3.6	1.4	0.2	Iris-setosa
..	…	…	…	…	…
145	6.7	3.0	5.2	2.3	Iris-virginica
146	6.3	2.5	5.0	1.9	Iris-virginica
147	6.5	3.0	5.2	2.0	Iris-virginica
148	6.2	3.4	5.4	2.3	Iris-virginica
149	5.9	3.0	5.1	1.8	Iris-virginica

[150 rows x 5 columns]

[5]:
```
# Each class has 50 datapoints
iris.type.value_counts()
```

[5]:
```
Iris-versicolor    50
Iris-virginica     50
Iris-setosa        50
Name: type, dtype: int64
```

[6]:
```
for i, flower_type in enumerate(['Iris-setosa', 'Iris-versicolor',␣
↪'Iris-virginica']):
    iris.loc[iris['type'] == flower_type, 'type'] = i
```

[7]:
```
X = iris[['sepal_length', 'sepal_width', 'petal_length', 'petal_width']].
↪to_numpy()
```

[8]:
```
X.shape
```

[8]:
```
(150, 4)
```

[9]:
```
y = iris[['type']].to_numpy()
```

[10]:
```
y.shape
```

[10]:
```
(150, 1)
```

0.0.3 k-Means Clustering

[11]:
```
class KMeans:

    def __init__(self, k=3, tolerance=0.0001):
        self.k = k
        self.tolerance = tolerance

    def fit(self, X, max_iters=500):
        self.centroids = self._init_centroids(X)
        #print(self.centroids)

        # Create empty clusters based on the value of k
        # This will be used to store the data points that lie on the respective␣
↪clusters
        self.clusters = {i: [] for i in range(self.k)}

        # Calculate distances of each data point from the centroids
        # Find the one with the minimum and assign to that cluster
        trained = False
        iters = 0
        while not trained or not iters < max_iters:
            y_pred = []
            for data_point in X:
```

```
                distances = [np.linalg.norm(data_point - centroid) for _,␣
↪centroid in self.centroids.items()]
                # Take the index of the one with the minimum distance and␣
↪assign that cluster to the data point
                pred_cluster = distances.index(min(distances))
                y_pred.append(pred_cluster)
                self.clusters[pred_cluster].append(data_point)

            # Calculate the new centroids based on the new clusters
            prev_centroids = dict(self.centroids)
            self.centroids = self._get_centroids(self.clusters)
            trained = self._is_trained(prev_centroids, self.centroids)
            iters += 1

        print(f'Iterations taken === {iters}')
        return np.array(y_pred)


    def _init_centroids(self, X):
        centroid_ids = np.random.choice(X.shape[0], self.k, replace=False)
        return {i: X[c_id] for i, c_id in enumerate(centroid_ids)}

    def _get_centroids(self, clusters):
        centroids = dict()
        for i in clusters:
            centroids[i] = np.average(clusters[i], axis=0)

        #print(centroids)
        return centroids

    def _is_trained(self, prev_centroids, new_centroids):
        diffs = []
        for i in prev_centroids:
            diff = np.average(np.subtract(prev_centroids[i], new_centroids[i]))
            diffs.append(abs(diff))
        if max(diffs) <= self.tolerance:
            return True
        else:
            return False
```

[ ]:

0.0.4 Plotting cluserting results for validation

[12]:
```
%matplotlib inline
import matplotlib.pyplot as plt
plt.style.use('seaborn-whitegrid')
```

[13]:
```
# Take first two features for plotting the graph
def plot_clusters(data, y_pred, ax):
    colors = {0: 'red', 1: 'blue', 2: 'green', 3: 'orange', 4: 'yellow', 5:␣
↪'gray', 6: 'cyan'}
    y_pred = [colors[pred] for pred in y_pred]
    x = data[:, 0]
    y = data[:, 1]
    ax.scatter(x, y, c=y_pred, s=50)
```

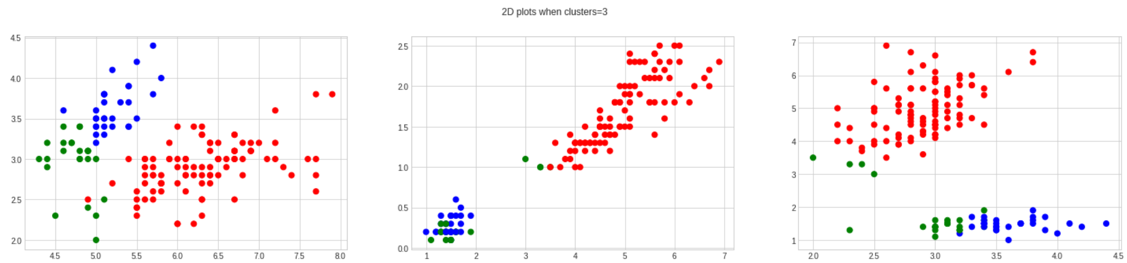
[14]:
```
def visualize_results(y_pred, k):
    fig, (ax1, ax2, ax3) = plt.subplots(1, 3, figsize=(25, 5))
    fig.suptitle(f'2D plots when clusters={k}')
    plot_clusters(data=X[:, :2], y_pred=y_pred, ax=ax1)
    plot_clusters(data=X[:, 2:], y_pred=y_pred, ax=ax2)
    plot_clusters(data=X[:, 1:3], y_pred=y_pred, ax=ax3)
```

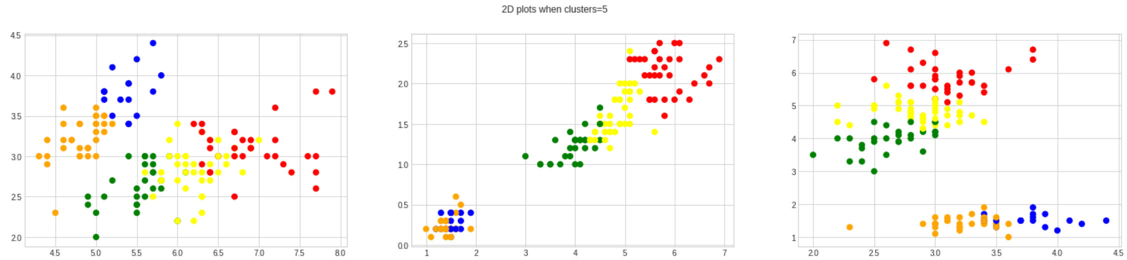
[ ]:
```

```

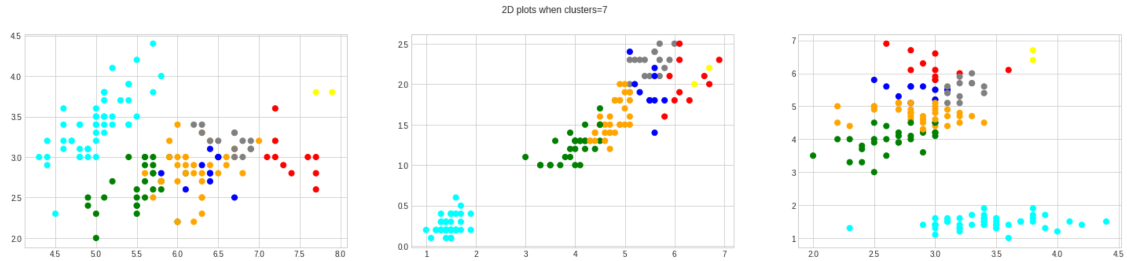
0.0.5 Fitting k-Means Clustering

[15]:
```
for k in [3, 5, 7]:
    k_means = KMeans(k=k)
    y_pred = k_means.fit(X)
    #print(f'\n----{k}-clusters----')
    #print(y_pred)
    (pred_type, counts) = np.unique(y_pred, return_counts=True)
    freq = np.asarray((pred_type, counts)).T
    #print(freq)
    visualize_results(y_pred, k)
```

```
Iterations taken === 24
Iterations taken === 103
Iterations taken === 37
```




2D plots when clusters=5


2D plots when clusters=7

```
[ ]:
```