K-means Clustering

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Agenda of Today's Session

- What is Clustering?
- Types of Clustering
- What is K- Means Clustering?
- How does a K-Means Algorithm works?
- K-Means with Python

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What is Clustering?
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What is Clustering?

"Clustering is the process of dividing the datasets into groups, consisting of similar data-points"

- Points in the same group are as similar as possible
- Points in different group are as dissimilar as possible

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What is Clustering?

Group of diners in a restaurant

Items arranged in a mall

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Where is it Used?

Recommendation System

Recommended Movies

Fickr's Photos

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How business use Clustering?

Retail Store

Banking

Insurance Companies

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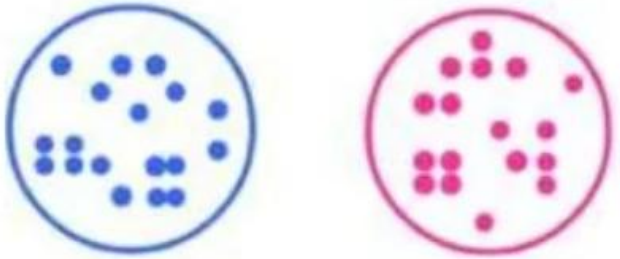
Types of Clustering

- Exclusive Clustering
- Overlapping Clustering
- Hierarchical Clustering

Exclusive Clustering

- Hard Clustering
- Data Point / Item belongs exclusively to one cluster
- For Example: K-Means Clustering



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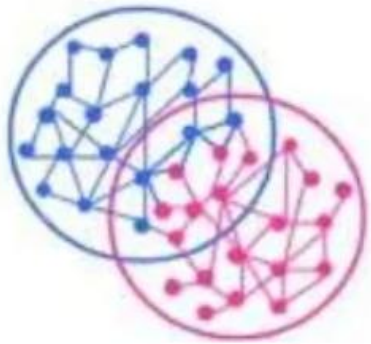
Types of Clustering

- Exclusive Clustering
- Overlapping Clustering
- Hierarchical Clustering

Overlapping Clustering

- Soft Cluster
- Data Point/ Item belongs to multiple cluster
- For Example: Fuzzy/ C-Means Clustering



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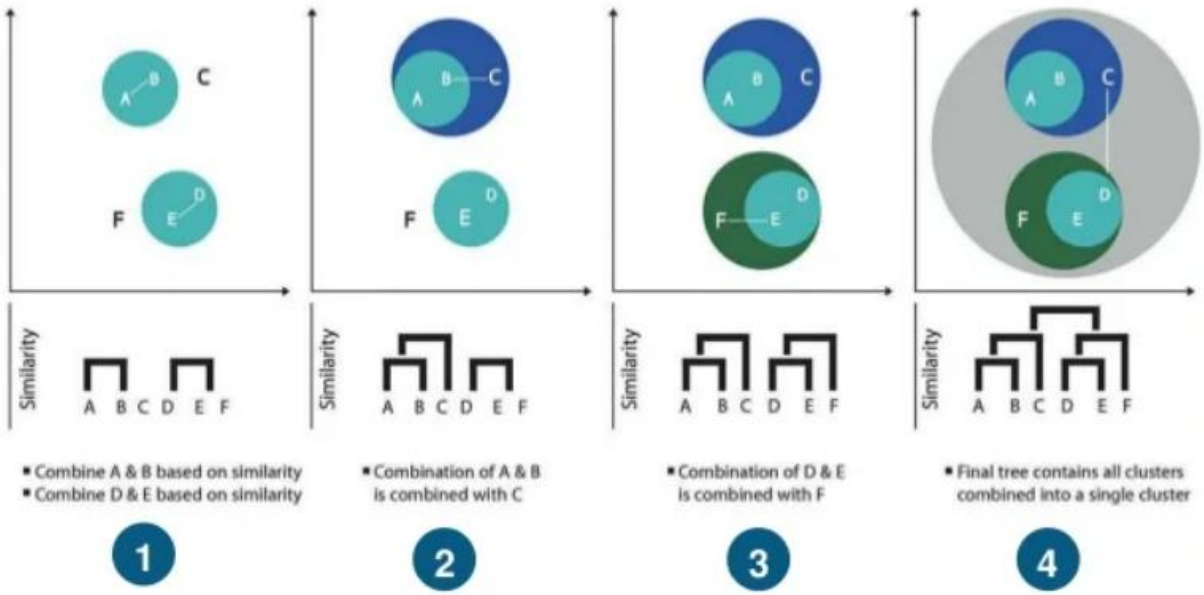
Types of Clustering

- Exclusive Clustering
- Overlapping Clustering
- Hierarchical Clustering

Hierarchical Clustering



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What is K-Means Clustering?

"K-Means is a clustering algorithm whose mail goal is to group similar elements or data points into a cluster."

NOTE: 'K' in K-Means represent the number of clusters

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What is K-Means Clustering?

Pile of dirty clothes

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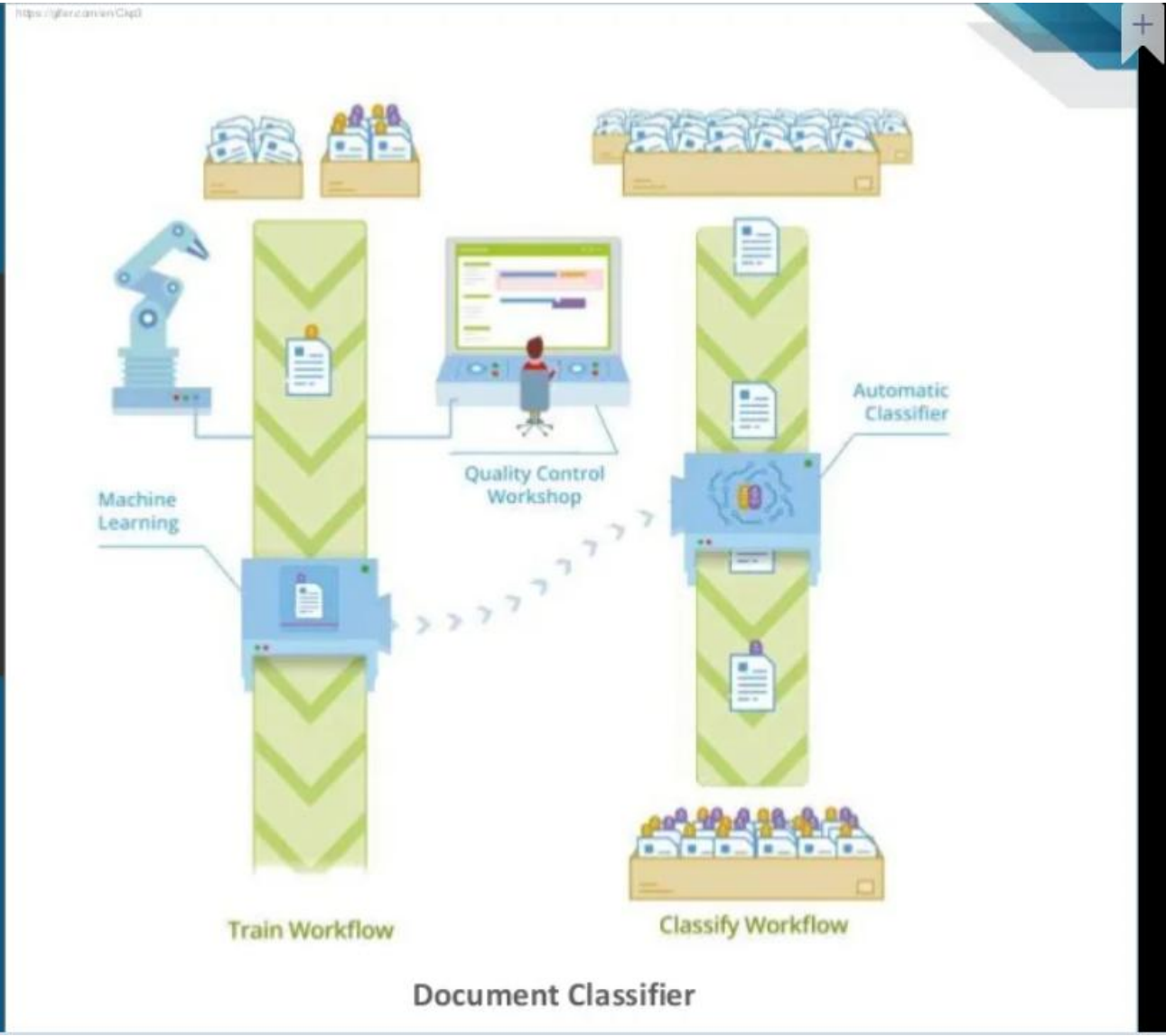
Where Can I apply K-Means?



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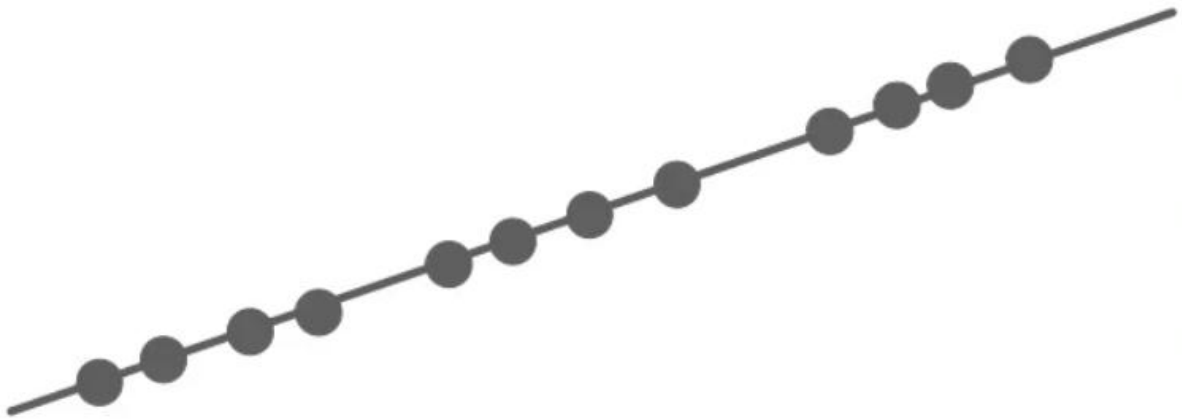
K-Means Algorithm



Number of Clusters = 3

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K-Means Algorithm

Number of Clusters, K = 3

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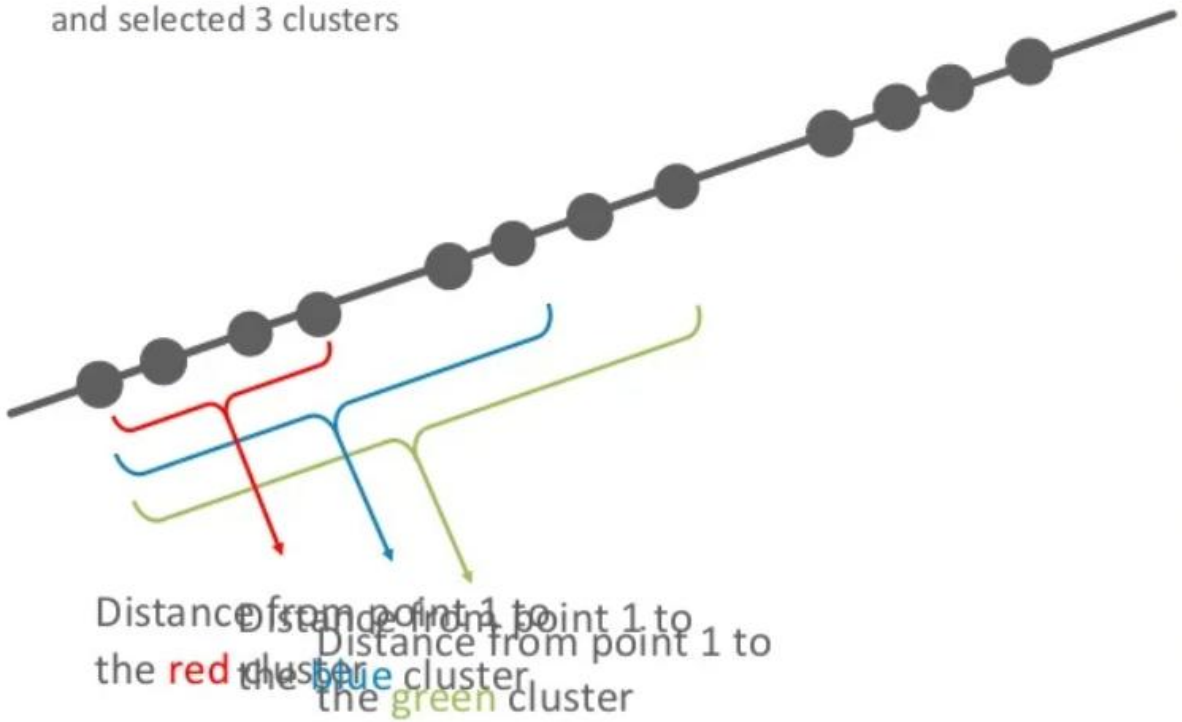
K-Means Algorithm

- **Step 1:** Select the number of clusters to be identified, i.e select a value for K =3 in this case
- **Step 2:** Randomly select 3 distinct data point
- **Step 3:** Measure the distance between the 1st point and selected 3 clusters



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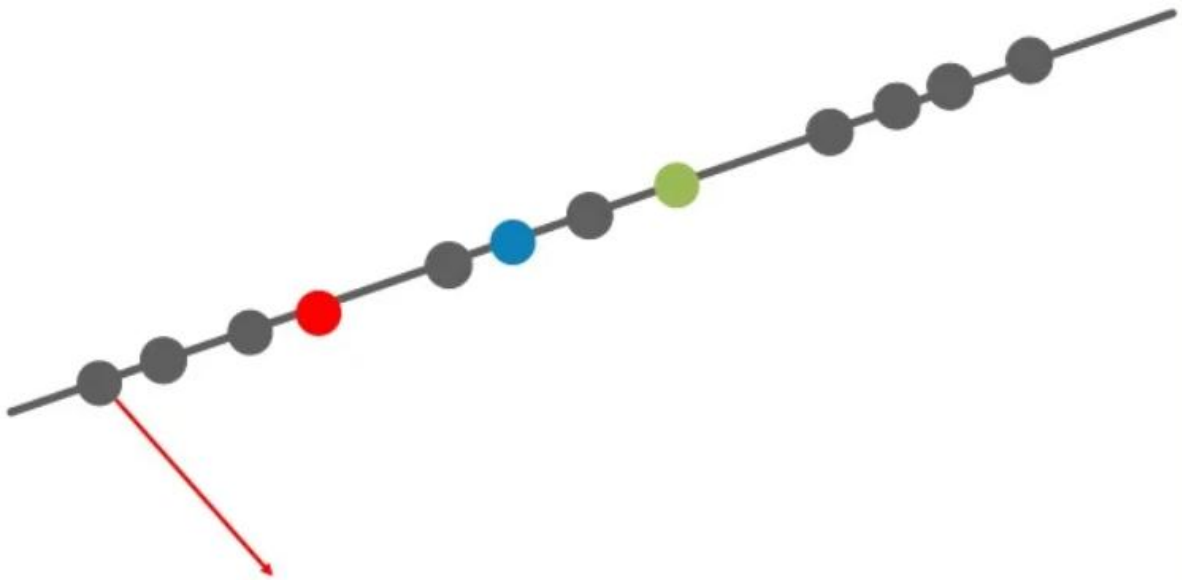
K-Means Algorithm



Step 4: Assign the 1st point to nearest cluster (red in this case).

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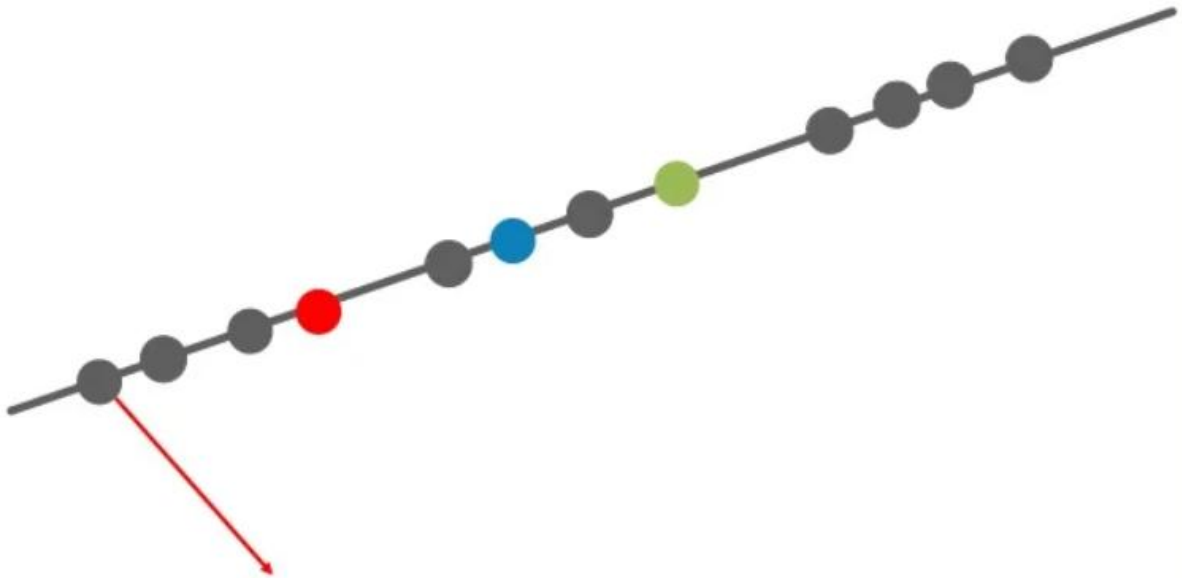
K-Means Algorithm



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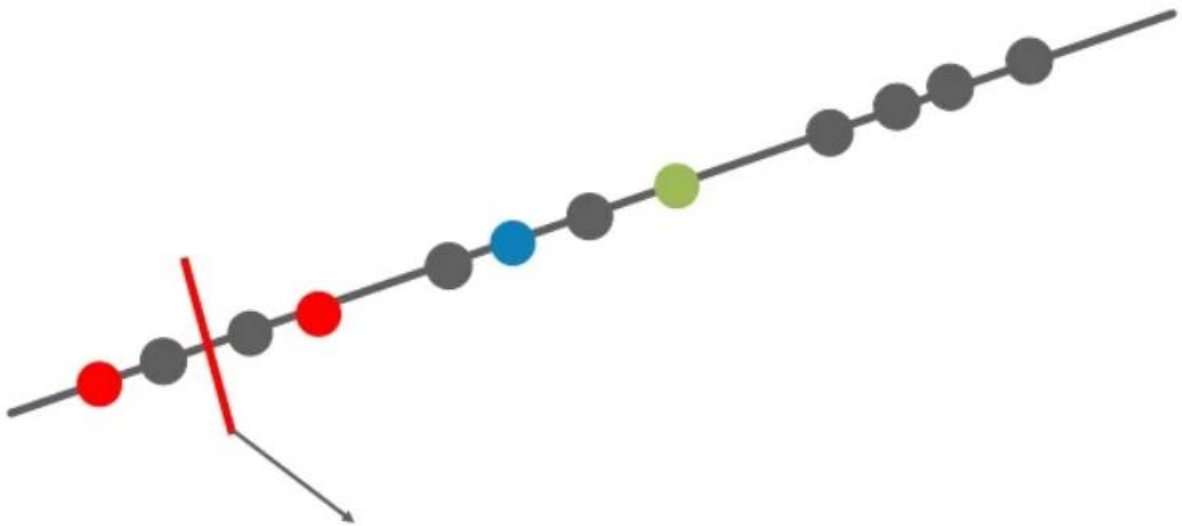
K-Means Algorithm



Step 5: Calculate the mean value including the new point for the red cluster

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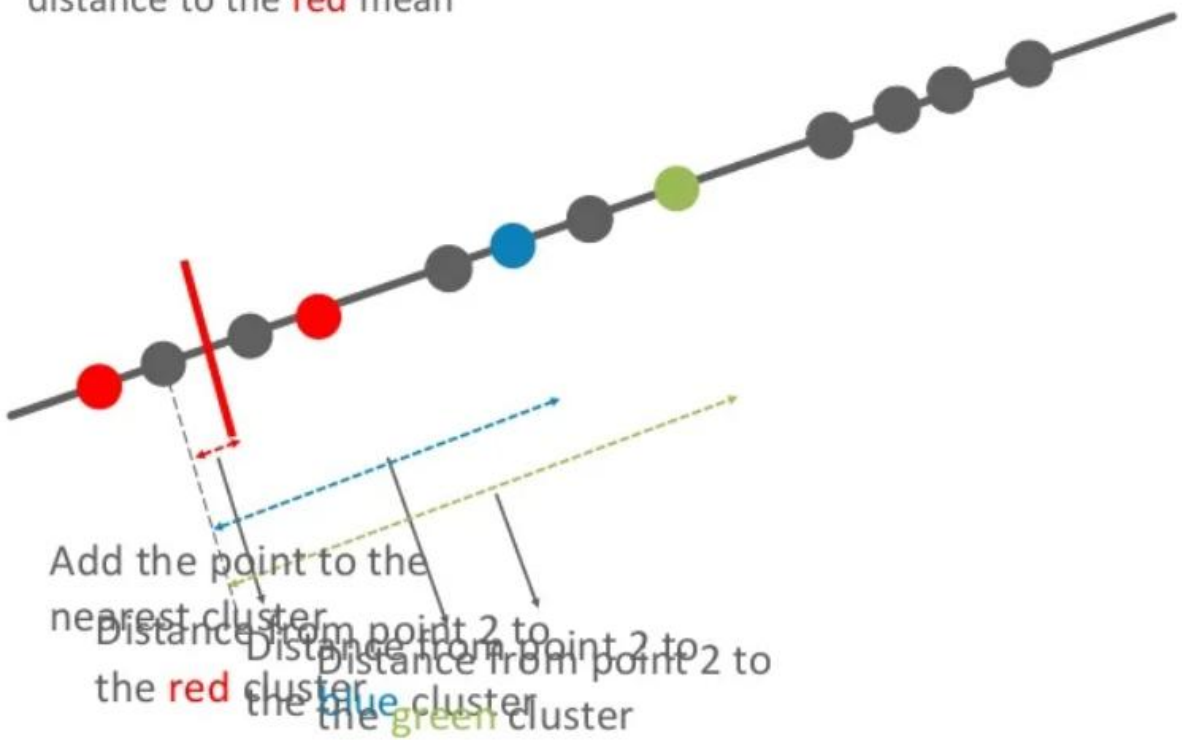
K-Means Algorithm

Find to which cluster does point 2 belongs to, how?

- Repeat the same procedure but measure the distance to the red mean



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K-Means Algorithm

Calculate the cluster mean including the new point

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K-Means Algorithm

Find to which cluster does point 3 belongs to, how?

- Repeat the same procedure but measure the distance to the red mean

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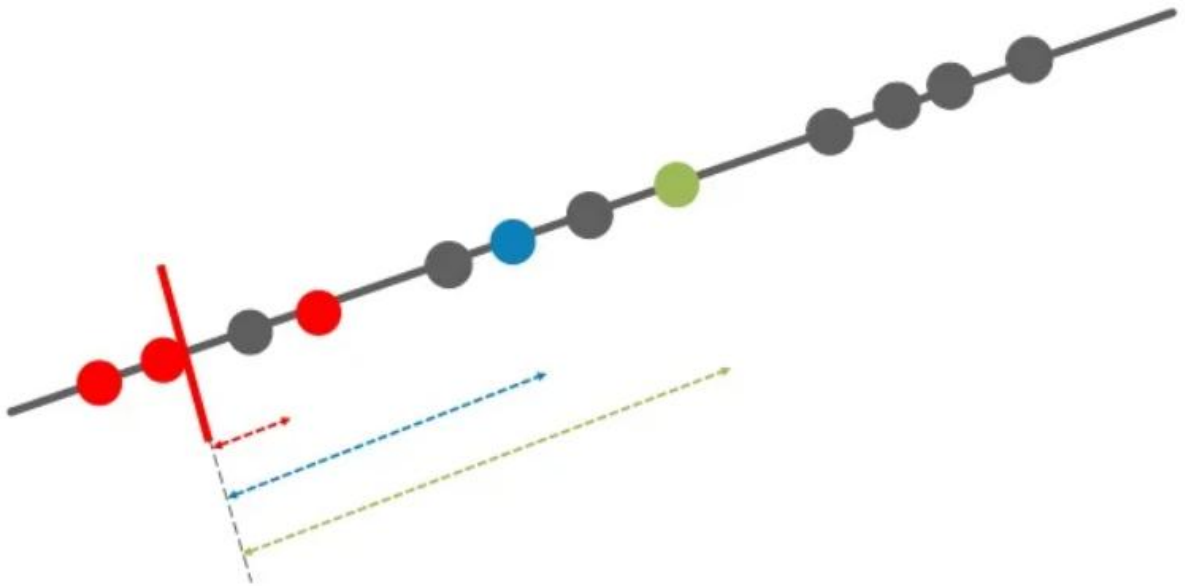
K-Means Algorithm



Measure the distance and add the 3rd point to the nearest cluster, (red)

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K-Means Algorithm

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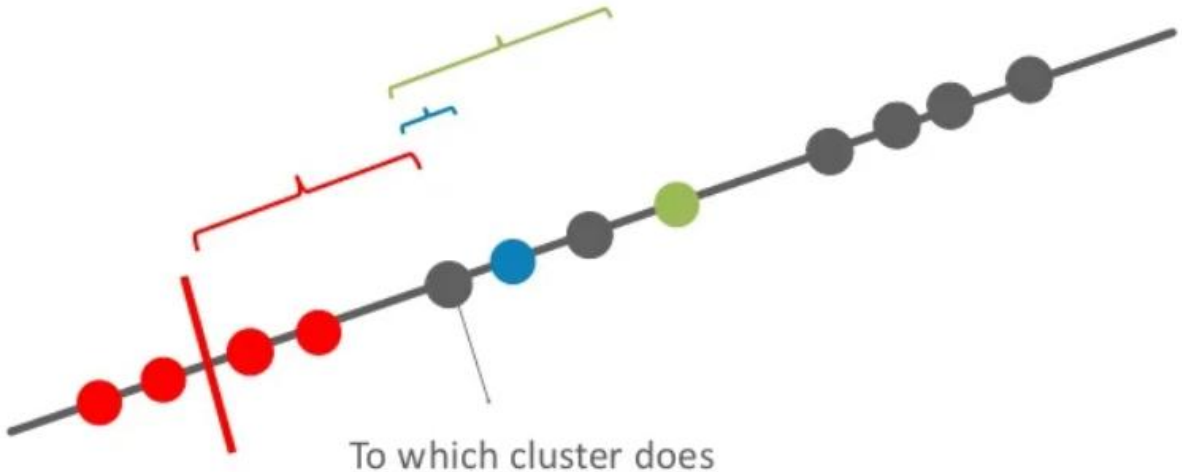
K-Means Algorithm

- Measure the distance
- Assign the point to the nearest cluster
- Calculate the cluster mean using the new point



To which cluster does this point belongs to?

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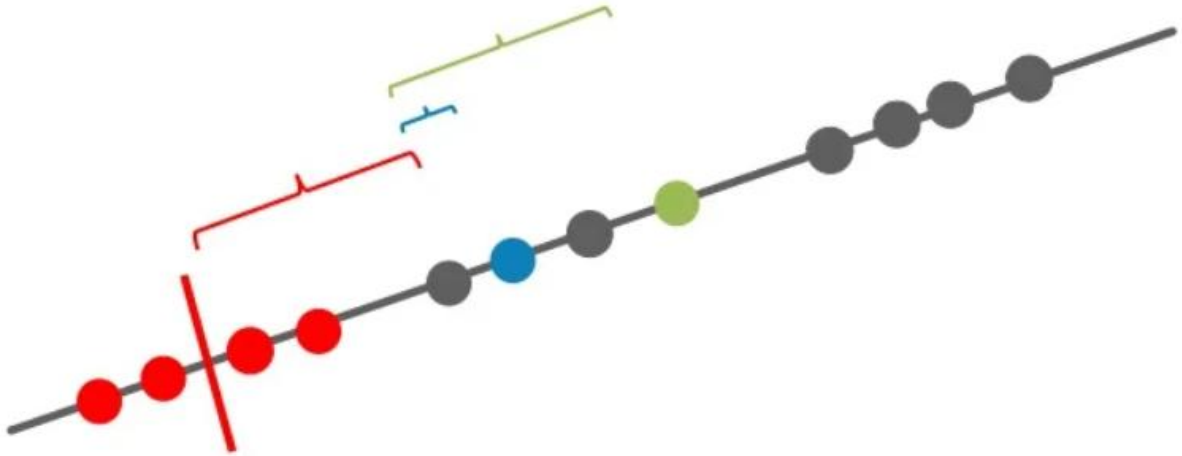
K-Means Algorithm

- Measure the distance
- Assign the point to the nearest cluster
- Calculate the cluster mean using the new point



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K-Means Algorithm

- Measure the distance
- Assign the point to the nearest cluster
- Calculate the cluster mean using the new point

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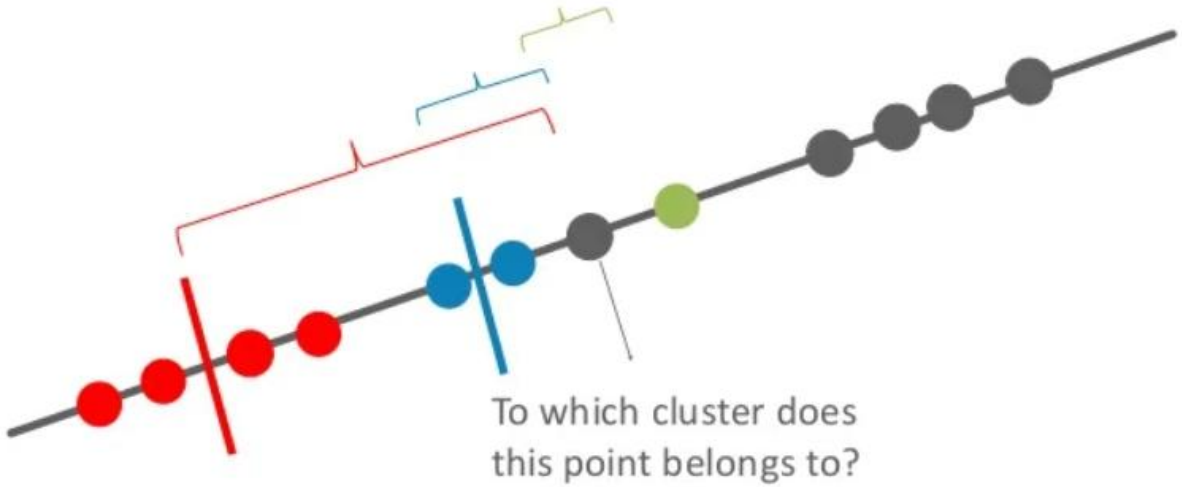
K-Means Algorithm

- Measure the distance from the cluster mean (centroids)
- Assign the point to the nearest cluster
- Calculate the cluster mean using the new point



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K-Means Algorithm

- Measure the distance from the cluster mean (centroids)
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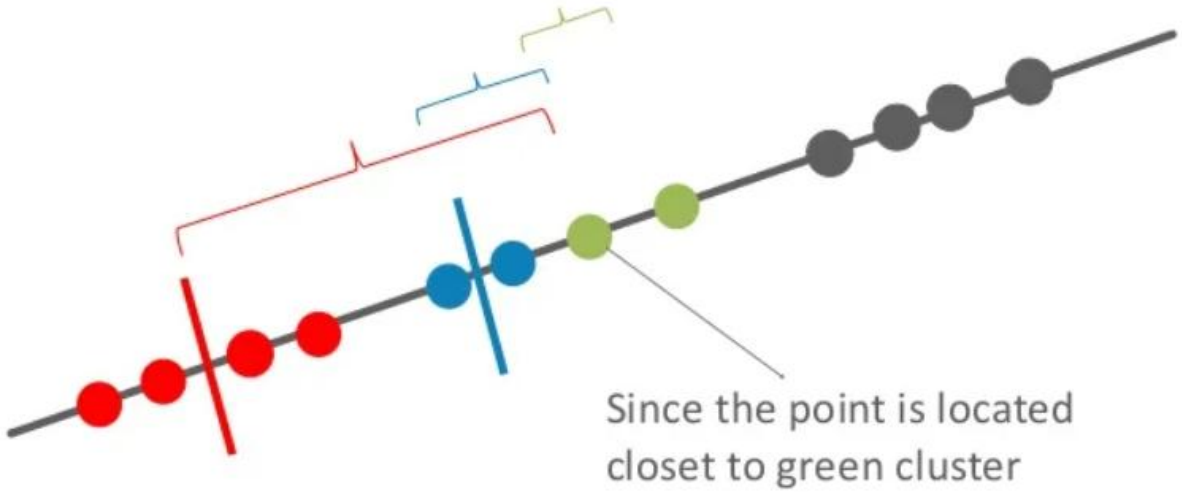

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K-Means Algorithm

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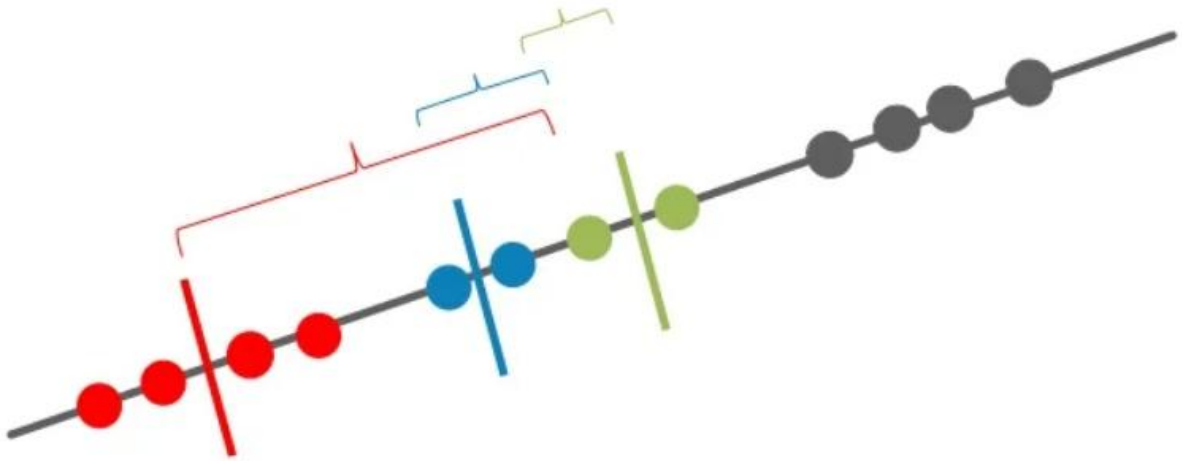

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K-Means Algorithm

Since all of these points are located closet to green cluster so all of them will be assigned to green cluster

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K-Means Algorithm

Result from 1st iteration

Original/Expected Result

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K-Means Algorithm

Total variation within the cluster

According to the K-Means Algorithm it iterates over again and again unless and until the data points within each cluster stops changing

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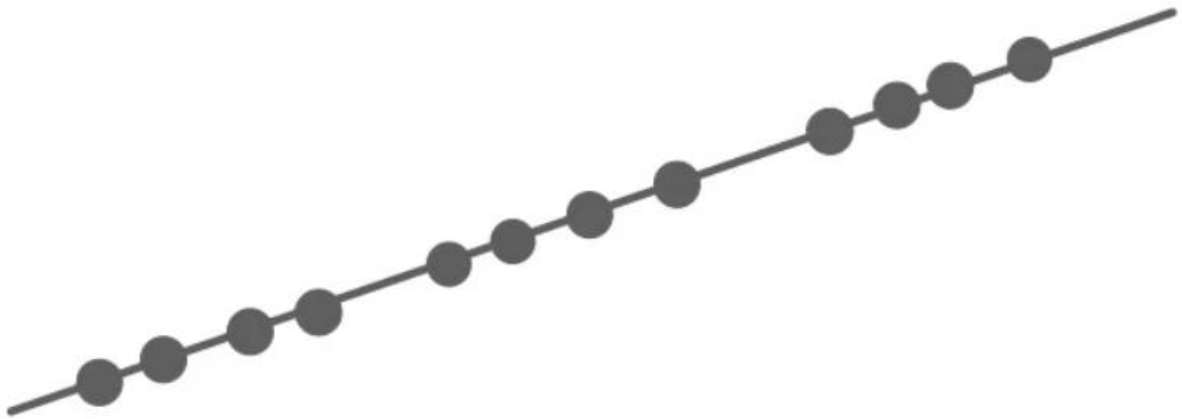
K-Means Algorithm

Iteration 2: Again we will start from the beginning. But this time we will be selecting different initial random point (as compared to what we chose in the 1st iteration)



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- **Step 2:** Randomly select 3 distinct data point
- **Step 3:** Measure the distance between the 1st point and selected 3 clusters

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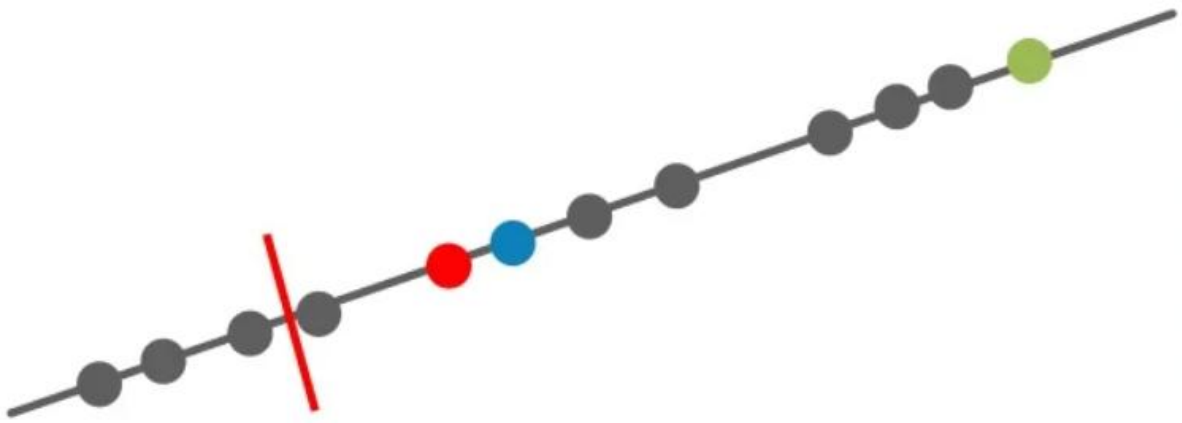
K-Means Algorithm

Algorithm picks 3 initial clusters and adds the remaining points to the cluster with the nearest mean, and again recalculating the mean each time a new point is added to the cluster



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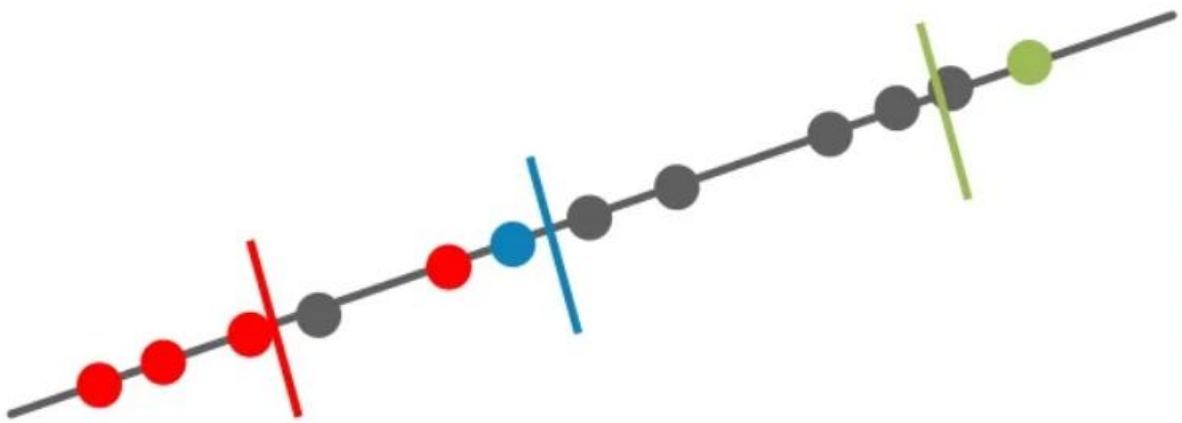

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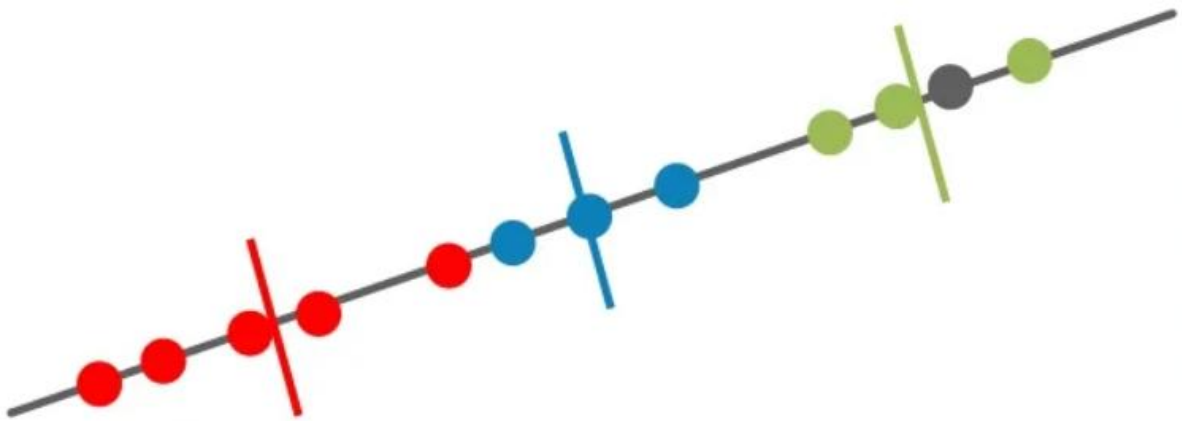

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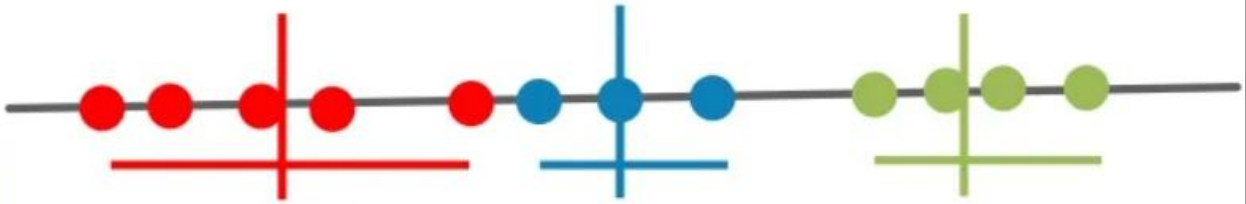

Total variation within the cluster

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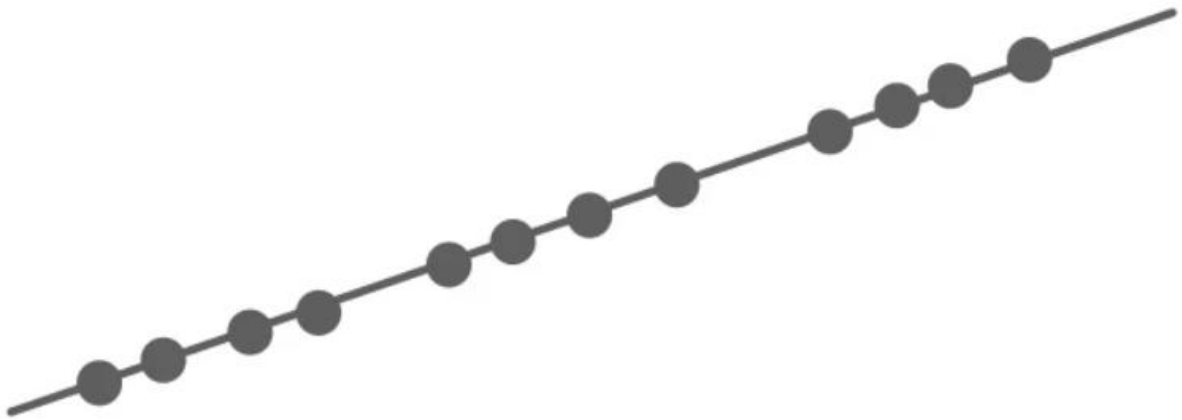
K-Means Algorithm

Iteration 3: Again we will start from the beginning and select different initial random point (as compared to what we chose in the 1st and 2nd iteration)



Pick 3 initial clusters

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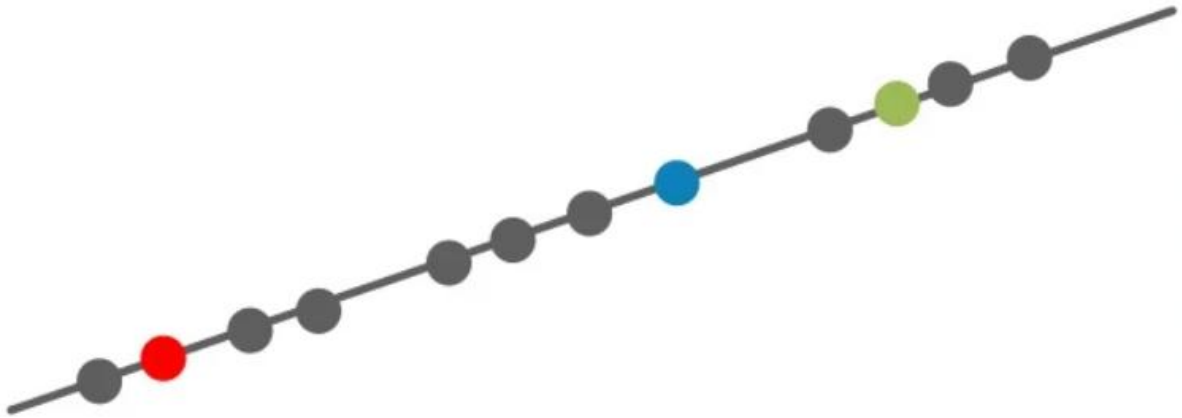
K-Means Algorithm



Cluster the remaining points

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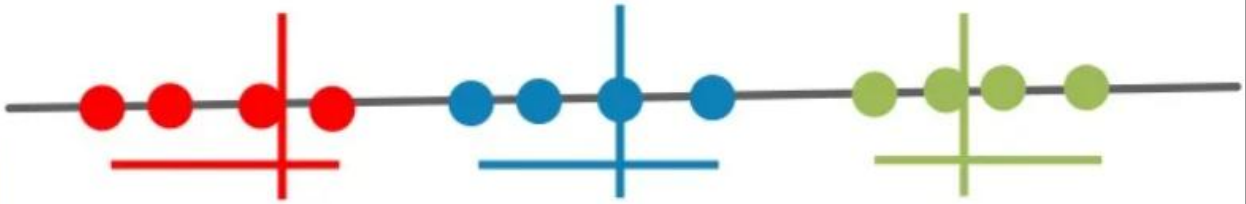
K-Means Algorithm

Finally sum the variation within each cluster



Total variation within the cluster

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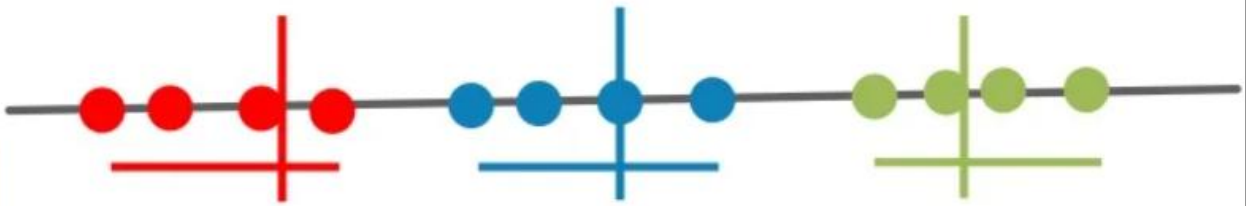
K-Means Algorithm

The algorithm can now compare the result and select the best variance out of it



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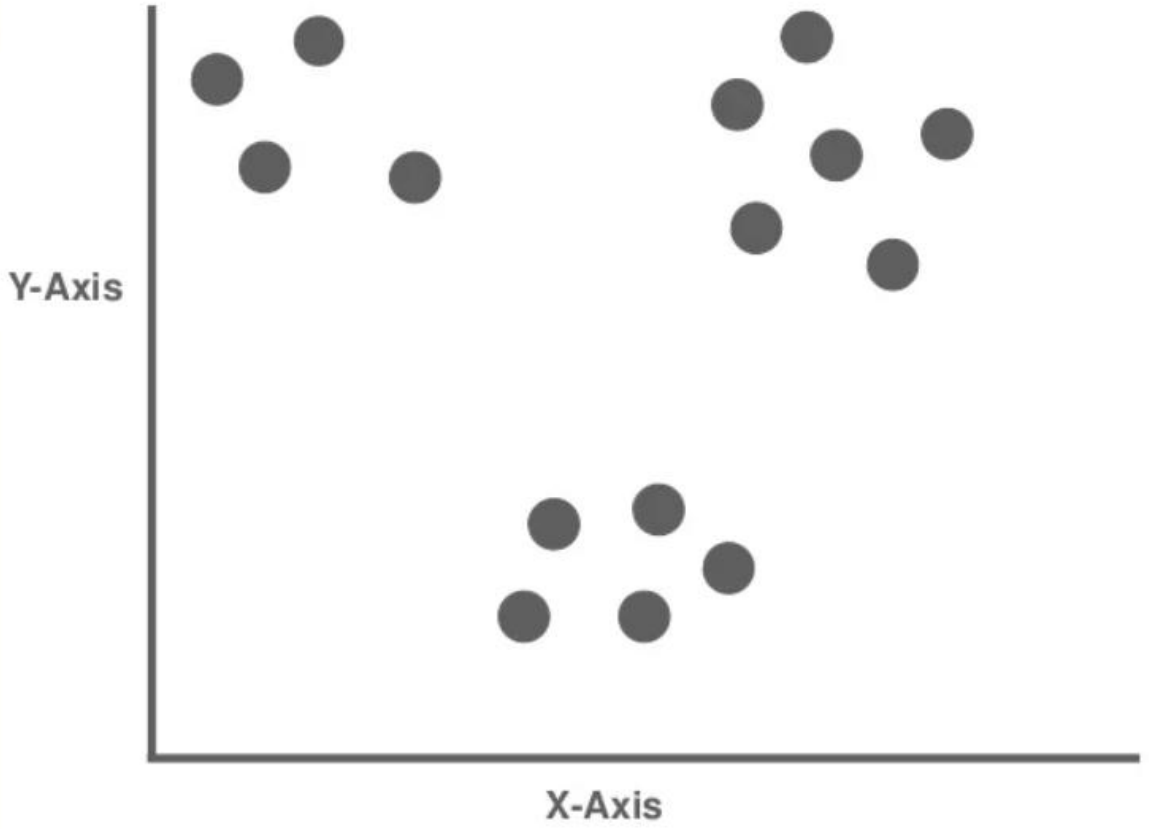
K-Means Algorithm

Now what if we have our data plotted on the X and Y axis



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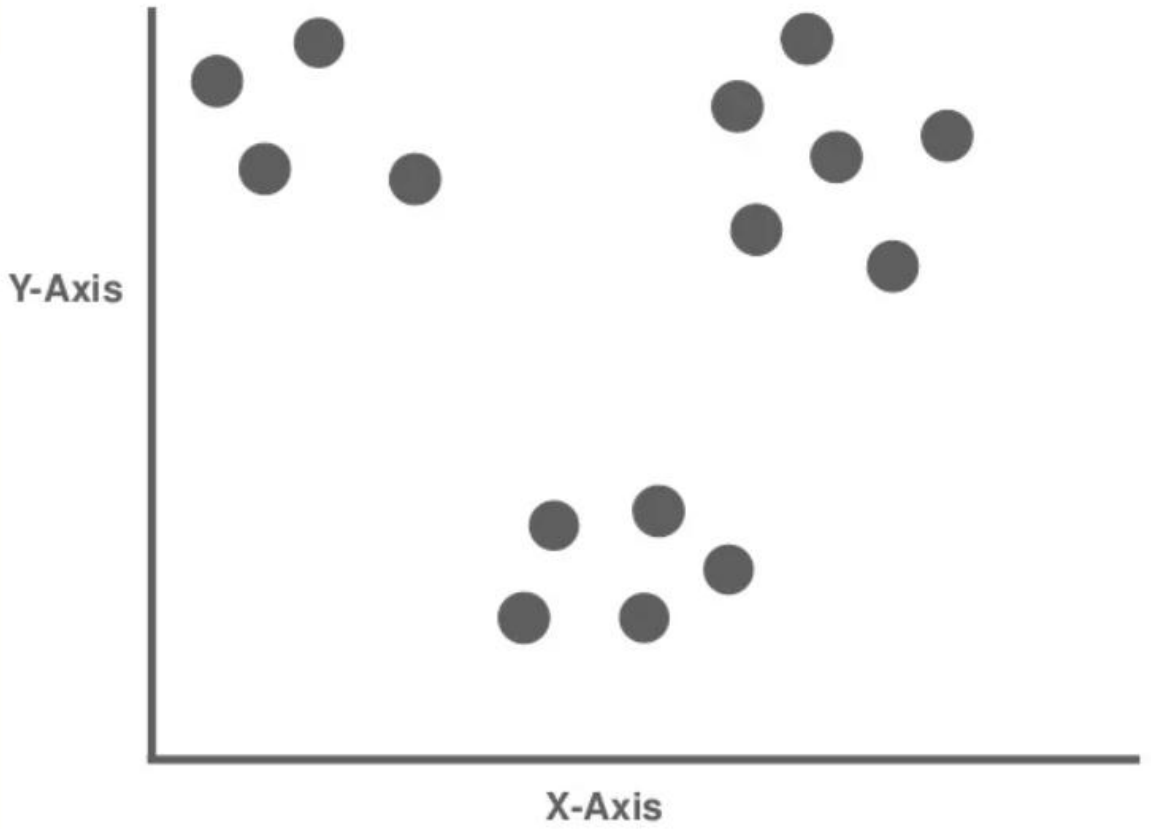
K-Means Algorithm

Similarly, pick initial 3 random points..



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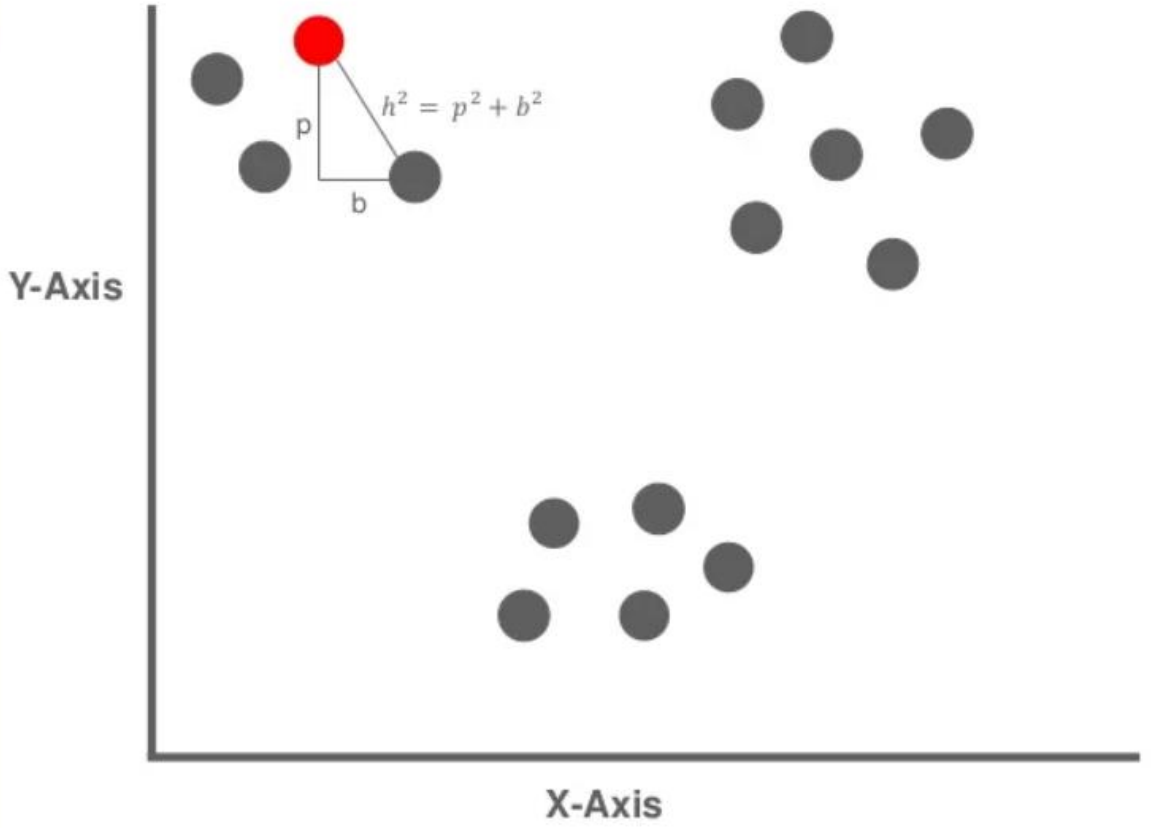
K-Means Algorithm

We will be using the Euclidean distance (in 2D its same as that of a Pythagorean Theorem)



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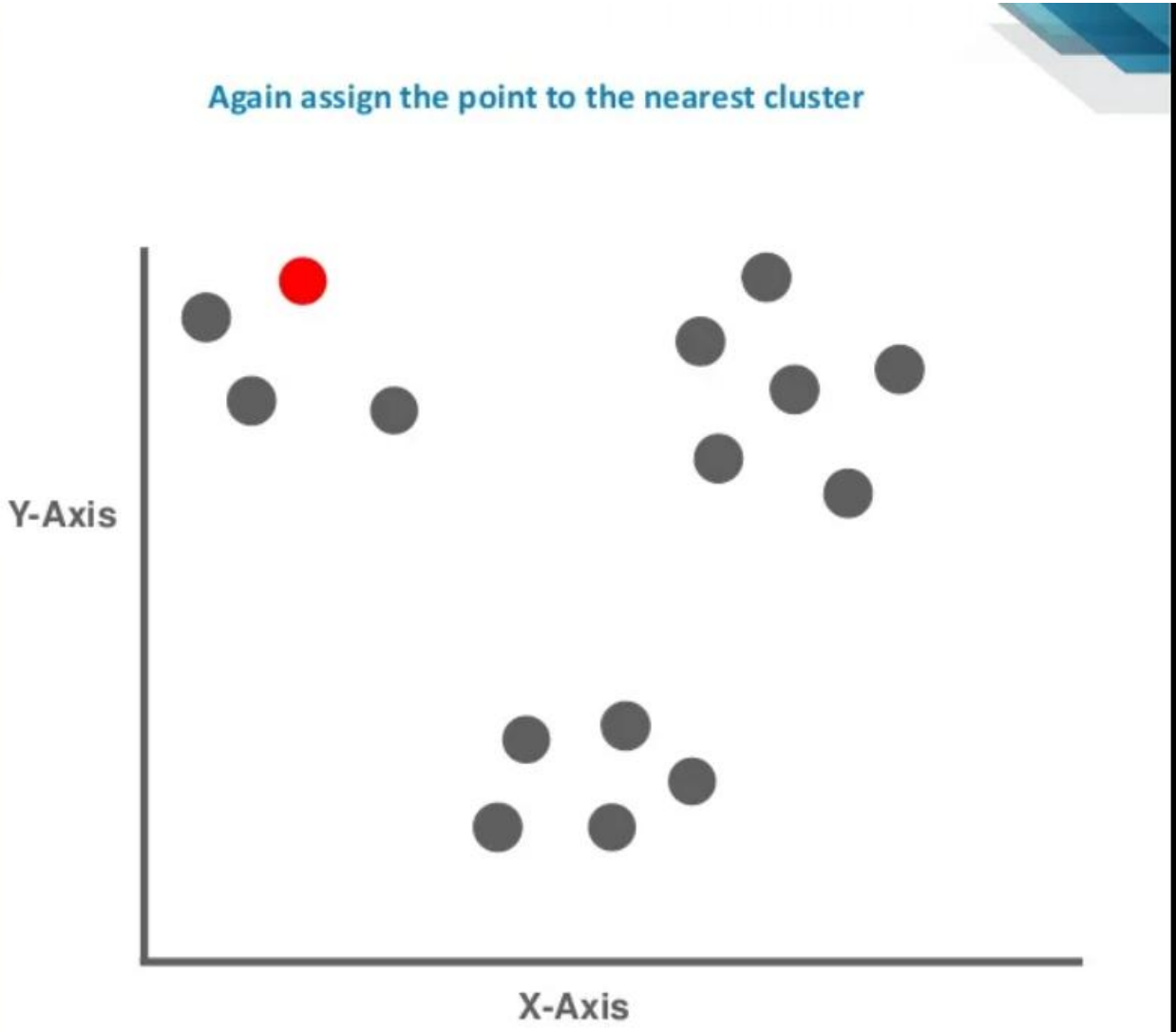
K-Means Algorithm



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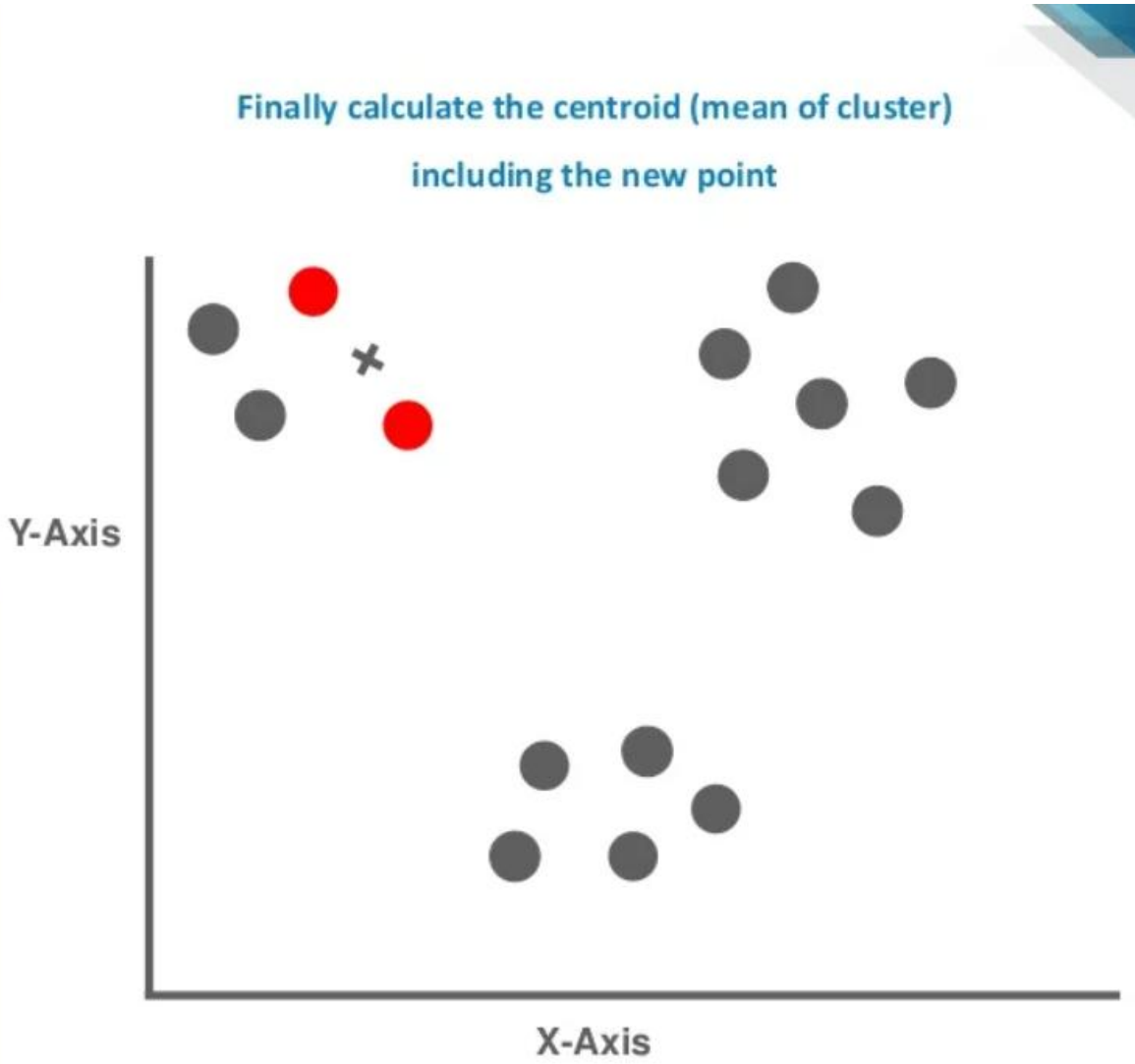
K-Means Algorithm



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K-Means Algorithm

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How will you find K value

In the previous scenario k value was known to be 3, but this is not always true

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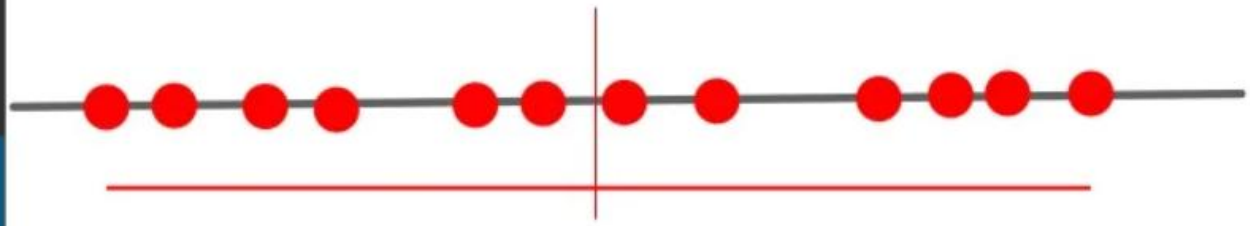
How will you find K value

For deciding the value of k, you have to use hit and trail method, starting from K = 1



K=1 is the worst case scenario, even you cross-verify it with total variation

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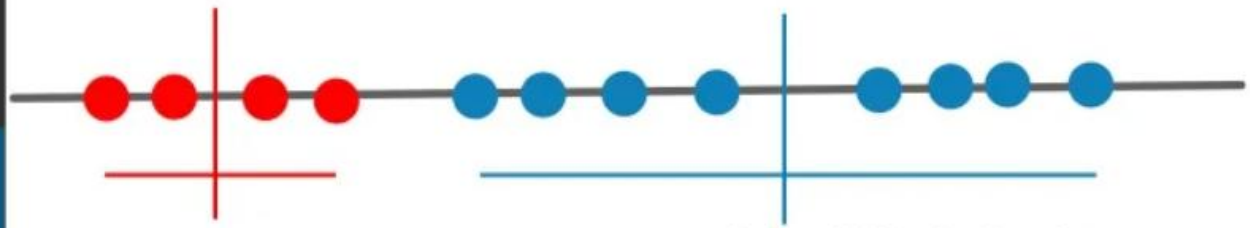
How will you find K value

Now try with K = 2



K=2 is still better then K = 1 (Total Variation)

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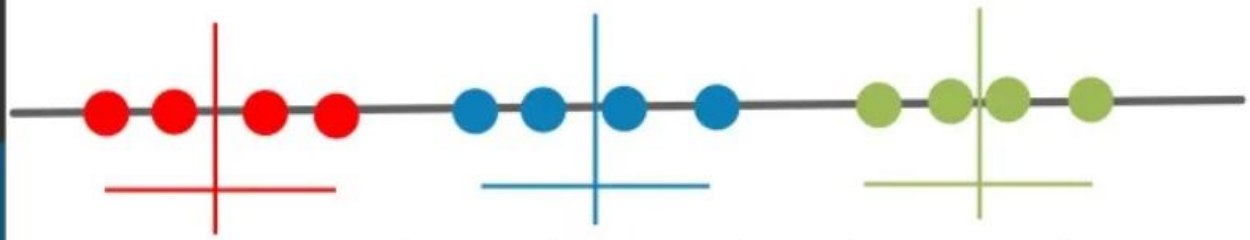
How will you find K value

Now try with K = 3



K=3 is even better than K =2 (Total Variation)

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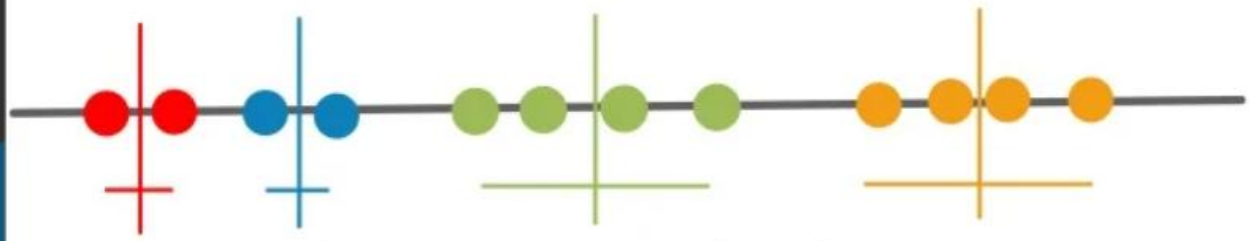
How will you find K value

Now try with K = 4



Total variation in K=4 is less than K =3

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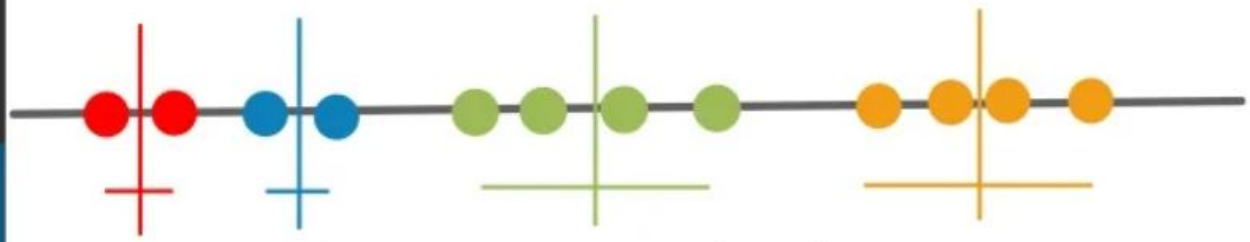
How will you find K value

Now try with K = 4



Total variation in K=4 is less than K =3

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How will you find K value

Now try with K = 4

Each time you increase the cluster the variation decreases, no. of clusters = no. of data points then in that case the variation = 0

Total variation in K=4 is less than K =3

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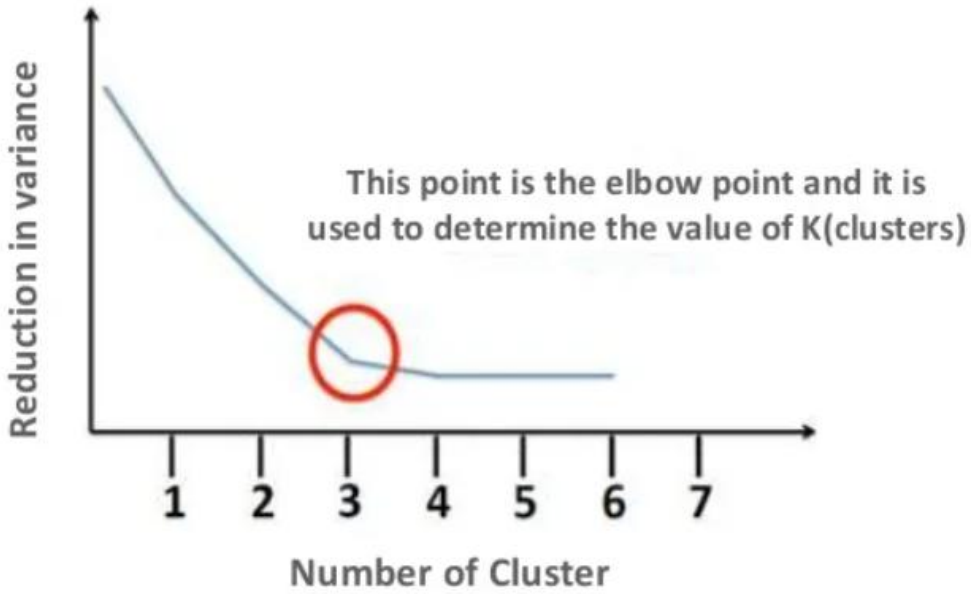
How will you find K value




Let’s learn to code
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K-Means Algorithm

Summarizing the K-Means Algorithm

```
randomly chose k examples as initial centroids
while true:
   create k clusters by assigning each
       example to closest centroid
   compute k new centroids by averaging
       examples in each cluster
   if centroids don't change:
       break
```


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