#K-Means Clustering:-

K-means is an unsupervised algorithm that groups data into K clusters by minimizing distance within each cluster.

the objective is to minimize the within-cluster sum of squares:

$$J = \sum_{i=1}^{n} \|x_i - \mu_{c_i}\|^2$$

where μ_{c_i} is the centroid of the cluster assigned to point x_i.

each iteration has two steps:

1. assignment:

$$c_i = \arg\min_k \|x_i - \mu_k\|^2$$

assign each point to the nearest centroid.

2. update:

$$\mu_k = \frac{1}{|C_k|} \sum_{x_i \in C_k} x_i$$

update centroids as the mean of their cluster points.

these steps repeats until centroids stop changing. K-means always converges, but only to a local minimum, not necessarily the global best solutions.