

## Math Behind Fuzzy C-Means (FCM)

Fuzzy C-Means (FCM) is a clustering algorithm that is similar to K-Means but with a key difference: **instead of assigning each point to a single cluster, each data point belongs to every cluster with a certain degree of membership.** This allows data points to be partially assigned to multiple clusters, making it a more flexible clustering technique.

### Steps in the Fuzzy C-Means Algorithm:

#### 1. Initialization:

- Choose  $K$  (the number of clusters).
- Initialize a **membership matrix**  $U$  of size  $n \times K$ , where  $n$  is the number of data points and  $K$  is the number of clusters. This matrix contains values between 0 and 1, and each entry represents the membership degree of a data point to a cluster. The sum of each row should equal 1.

////////step 2and 3 in pics

#### 4. Repeat:

- Repeat the update of centroids and membership matrix until convergence, i.e., when the membership matrix stops changing significantly.