Algorithm 1 Cluster-Based Membership Function (MF) Generation

Require: Dataset $D = \{X_1, X_2, \ldots, X_d, Y\}$, number of clusters k, clustering method (e.g., FCM, K-Means, MiniBatch K-Means)

Ensure: Centroids and Membership Functions (MFs) for each feature and target variable

Initialize the clustering method and number of clusters k
for each feature X_i in dataset D **do**
    Extract the column vector of X_i
    Perform clustering on X_i using the selected method
    Obtain centroids of the resulting clusters: $C_i = \{c_{i1}, c_{i2}, \ldots, c_{ik}\}$
    for each centroid c_{ij} in C_i **do**
        Define Membership Function MF_{ij} based on clustering results
        (*e.g., Gaussian, Triangular, or Trapezoidal shape*)
    end for
    Store C_i and corresponding MF_{ij}
end for
▷ Repeat the same process for the target variable Y
Perform clustering on Y
Obtain centroids: $C_Y = \{c_{Y1}, c_{Y2}, \ldots, c_{Yk}\}$
for each centroid c_{Yj} in C_Y **do**
    Define Membership Function MF_{Yj} based on clustering results
end for

Output: Centroids and MFs for all features $X_1, X_2, \ldots, X_d$ and target Y