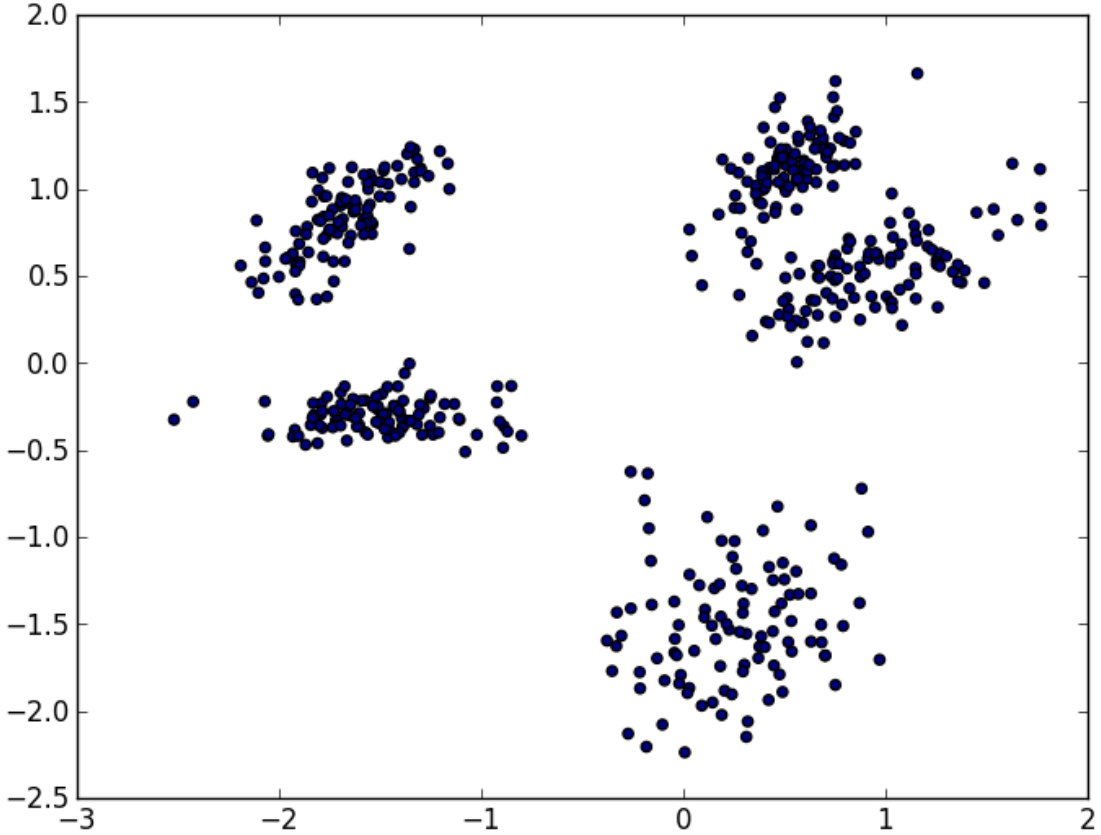
Lab Course

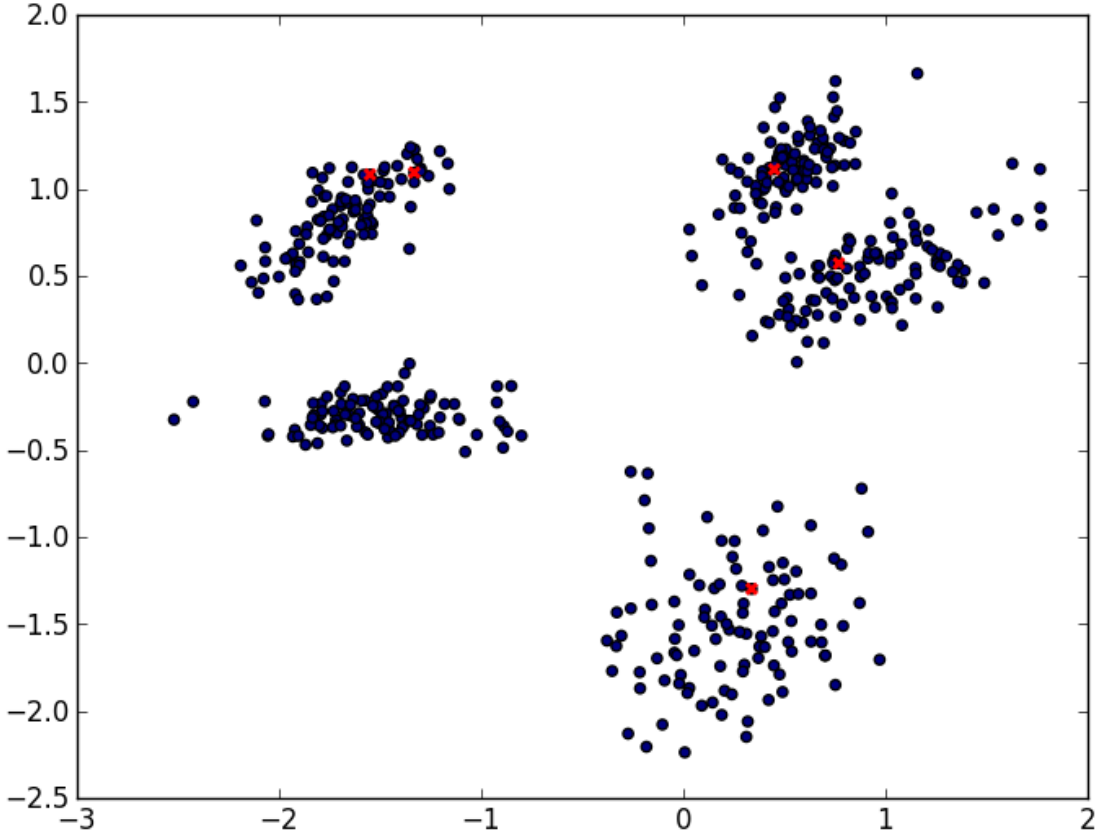
Clustering

K-Means



Goal: find clusters

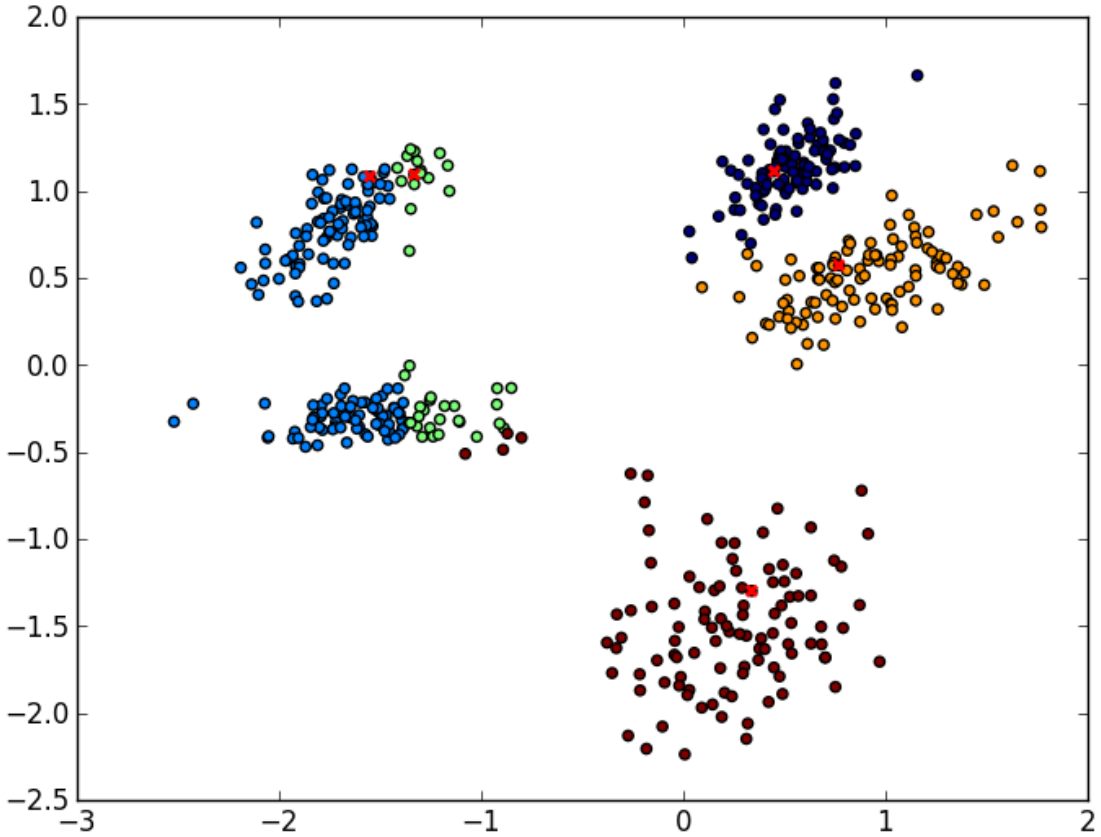
K-Means



Goal: find clusters

Start with random assignment of cluster

K-Means



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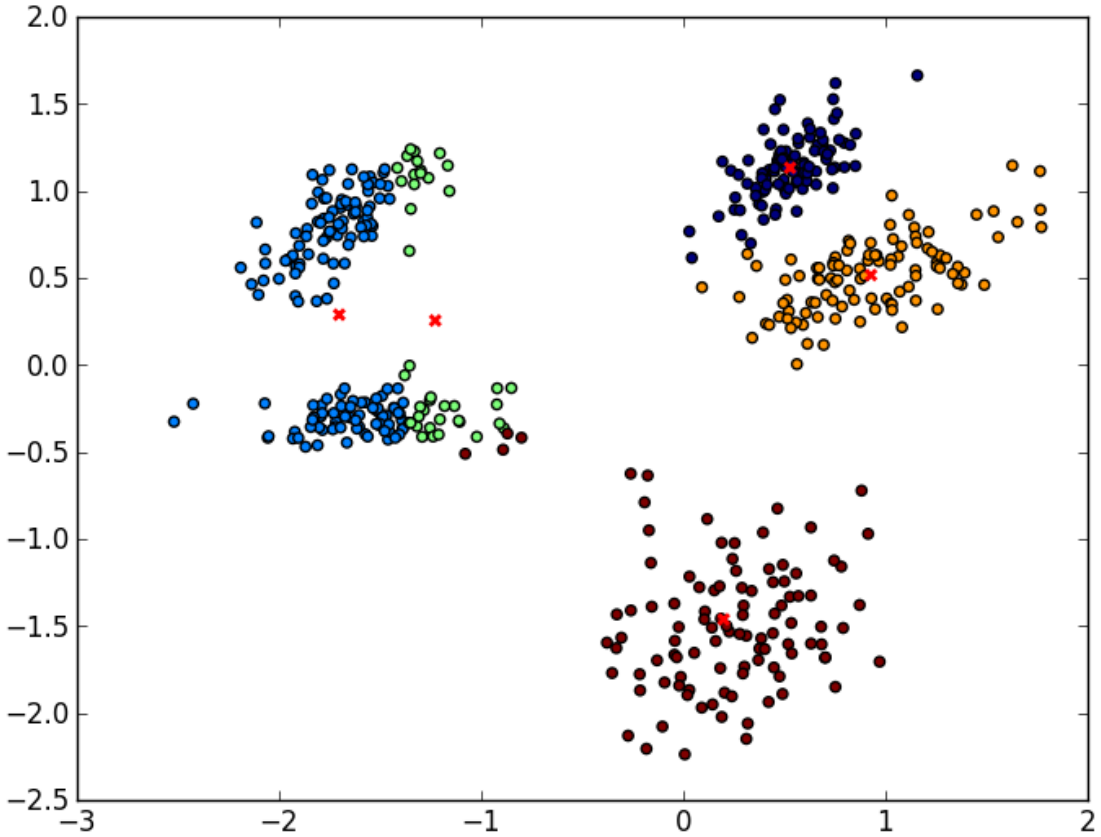
Start with random assignment of cluster

Till convergence:
Step 1: Reassign data points

K-Means

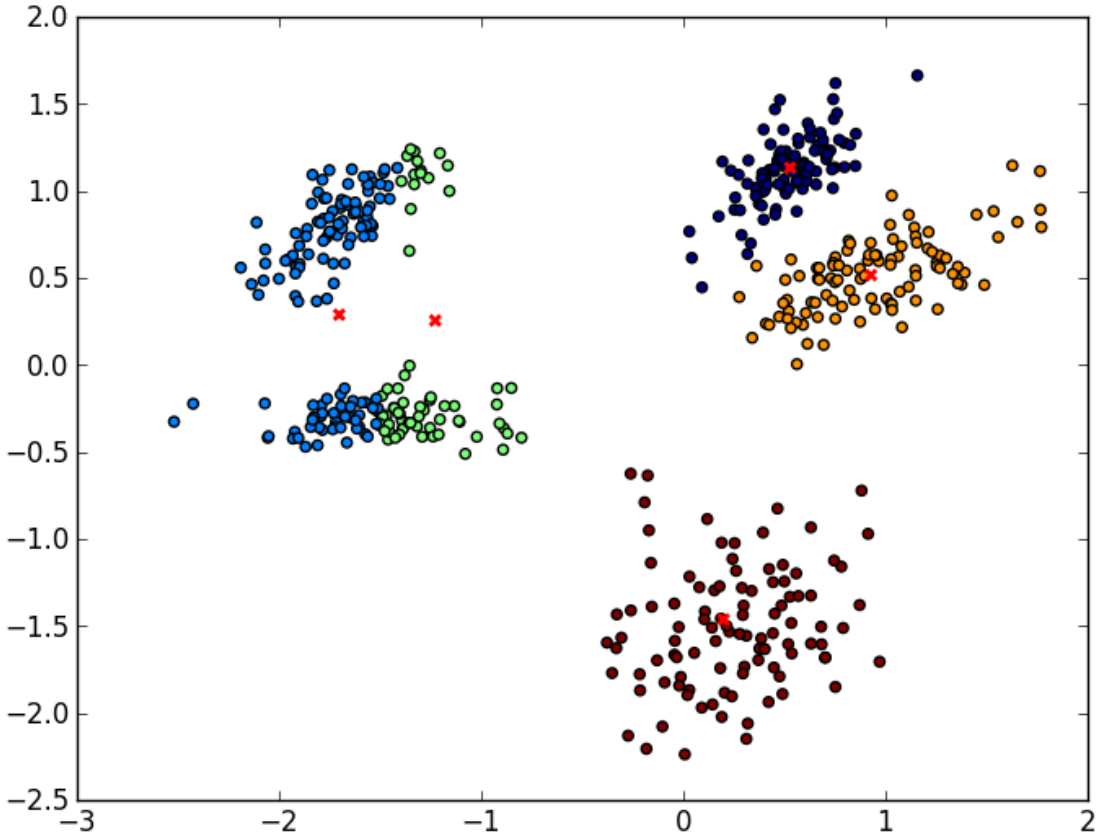


Goal: find clusters

Start with random assignment of cluster

Till convergence:
Step 1: Reassign data points
Step 2: Compute new cluster centers

K-Means



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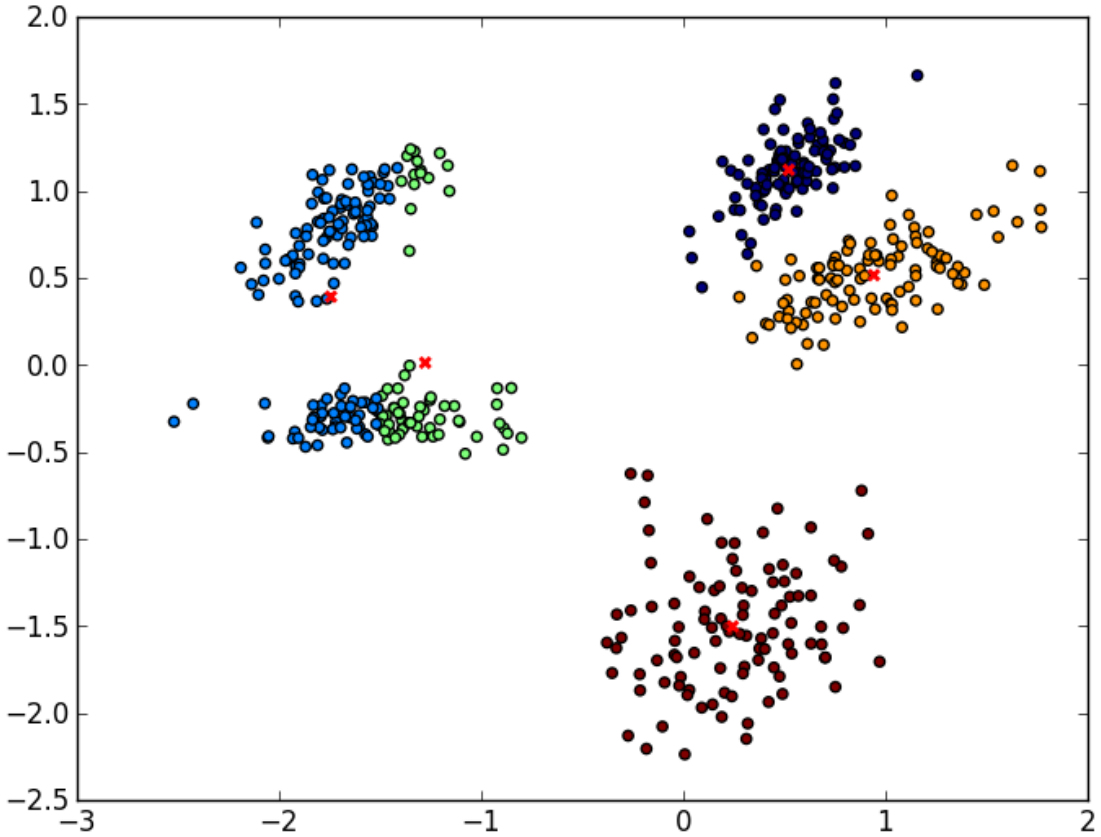

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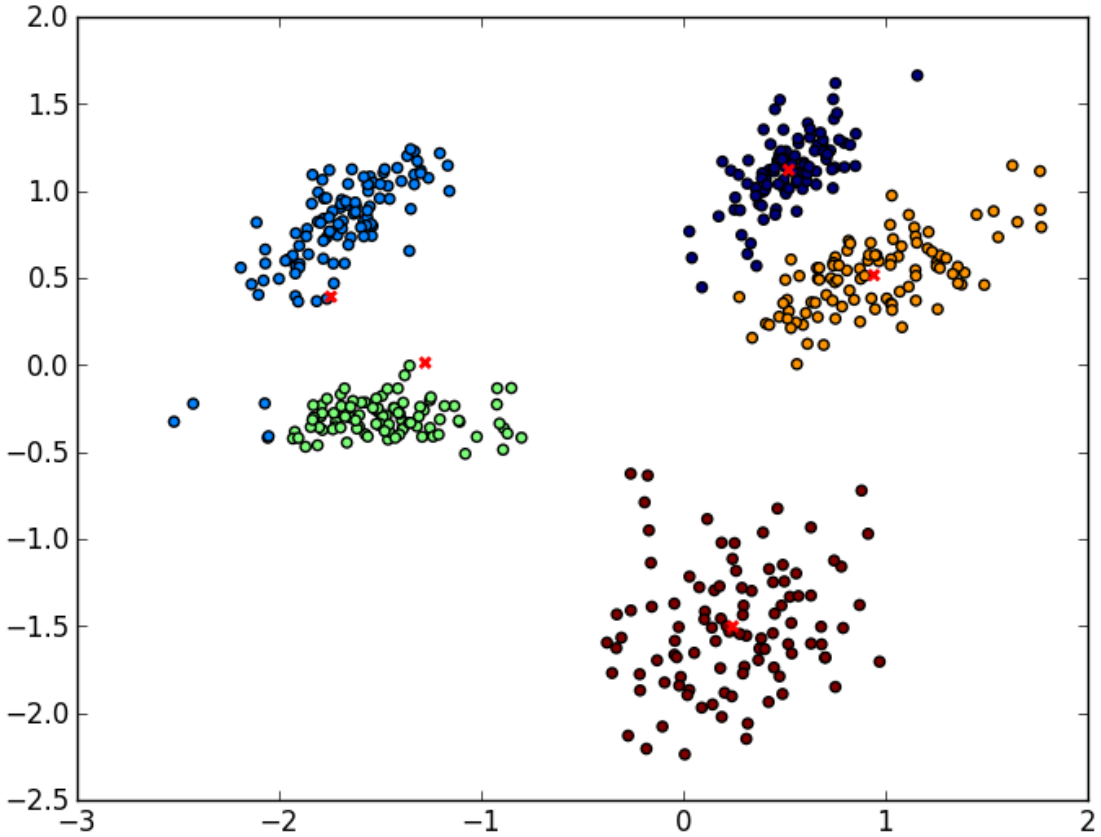

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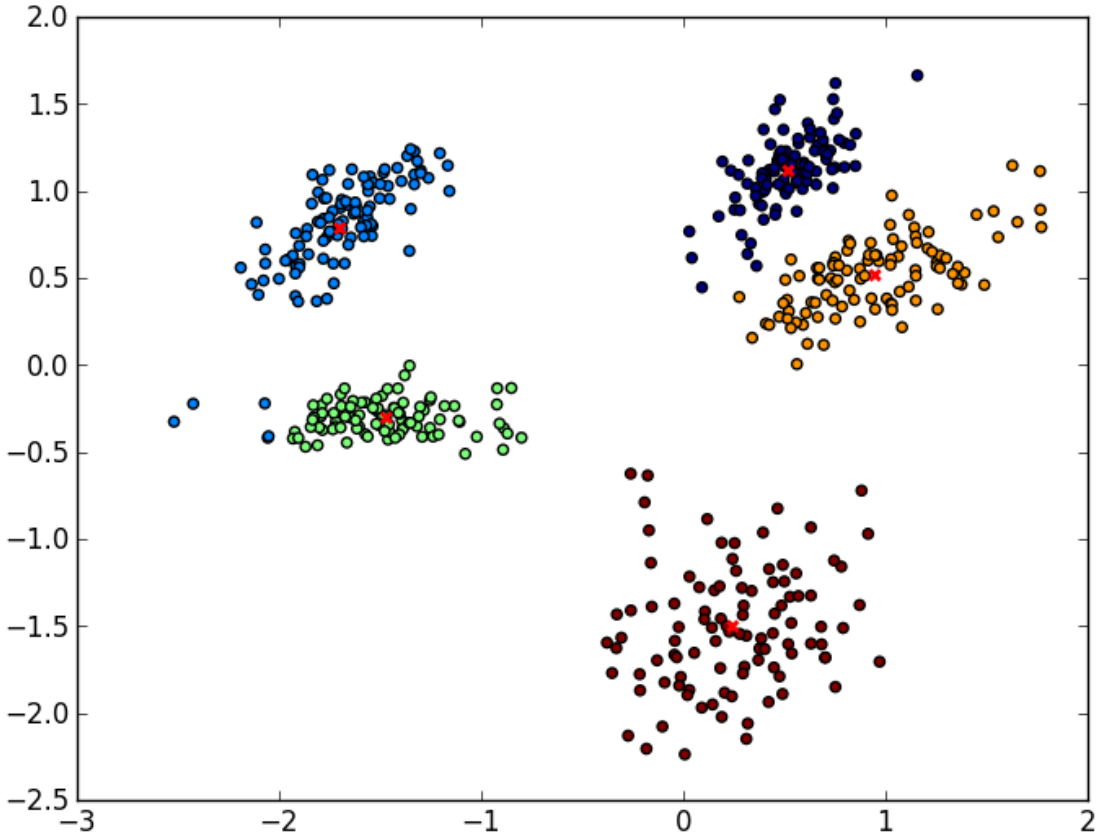

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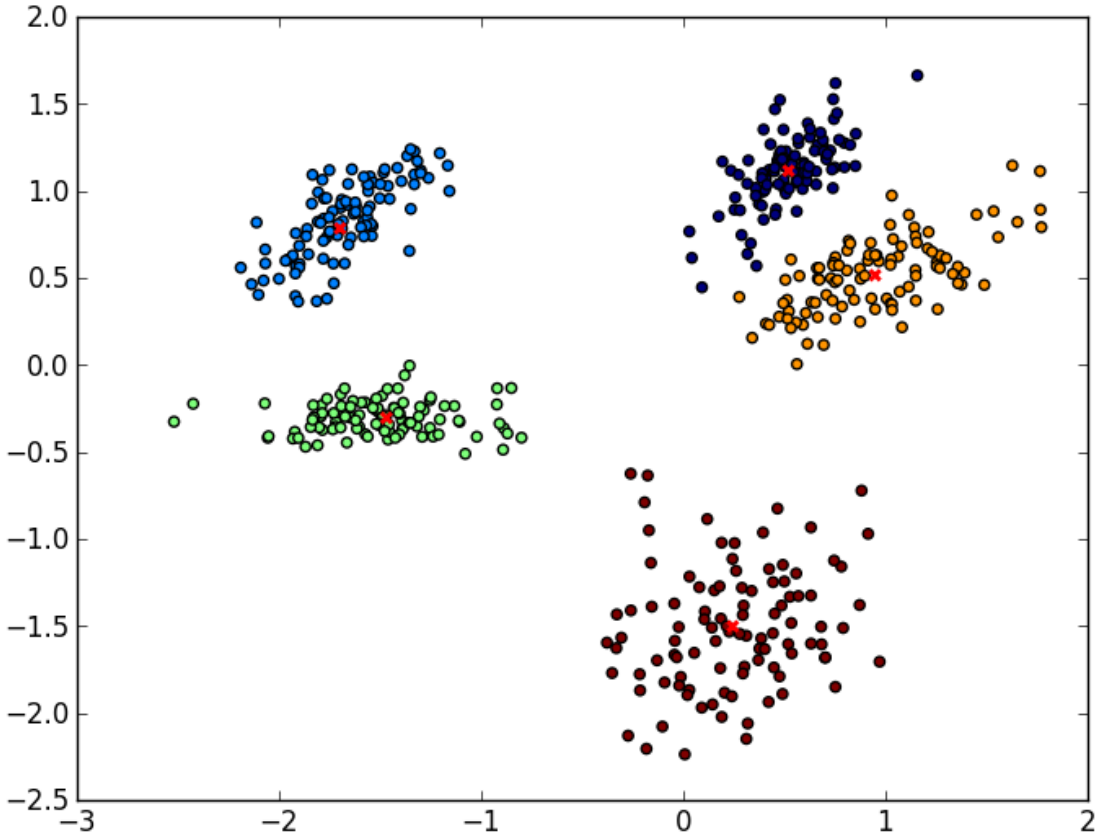

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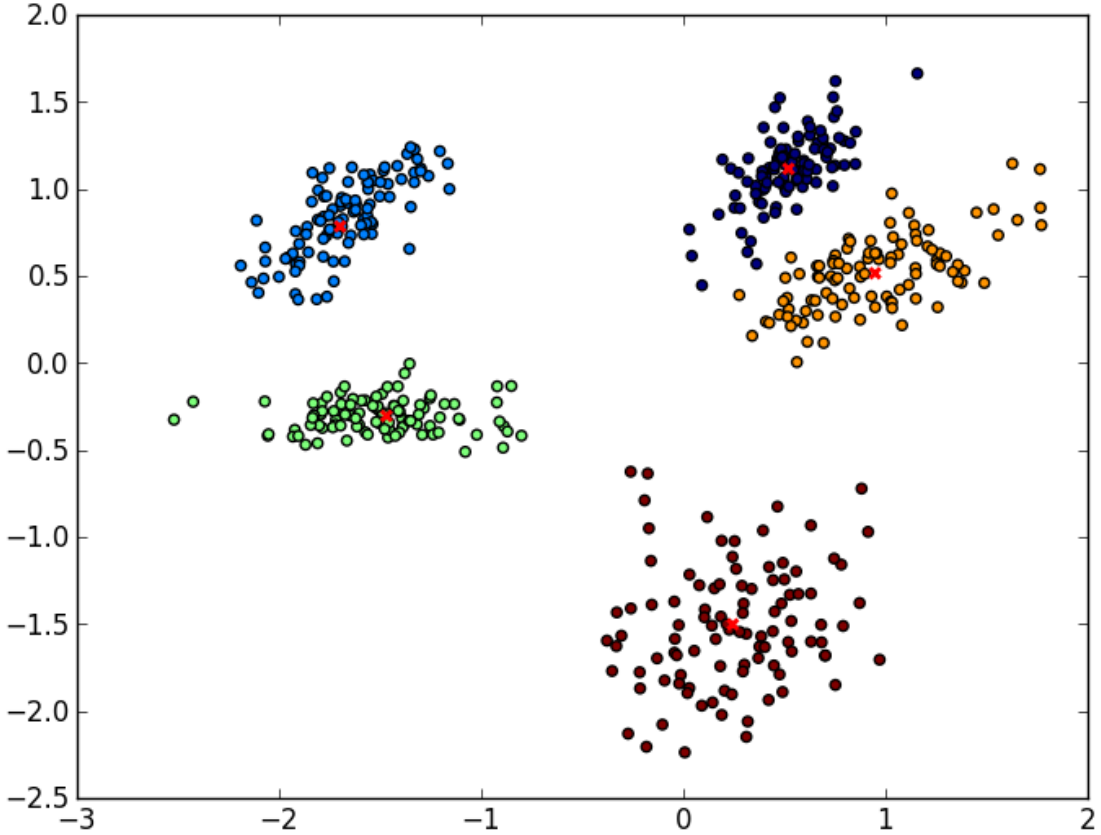
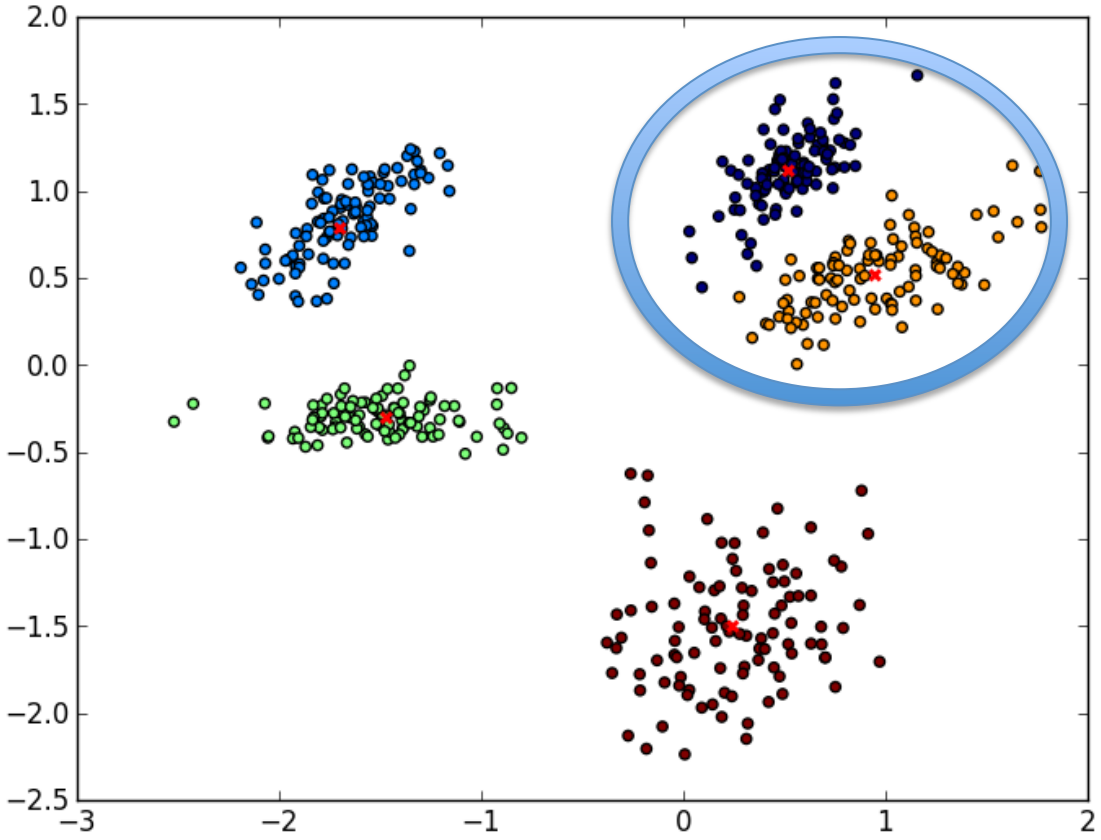
Hierarchical Clustering



Continuously merge clusters

<u>Loss function</u>
E.g. K-Means criterion
(Average distance of points to their cluster center)

Hierarchical Clustering



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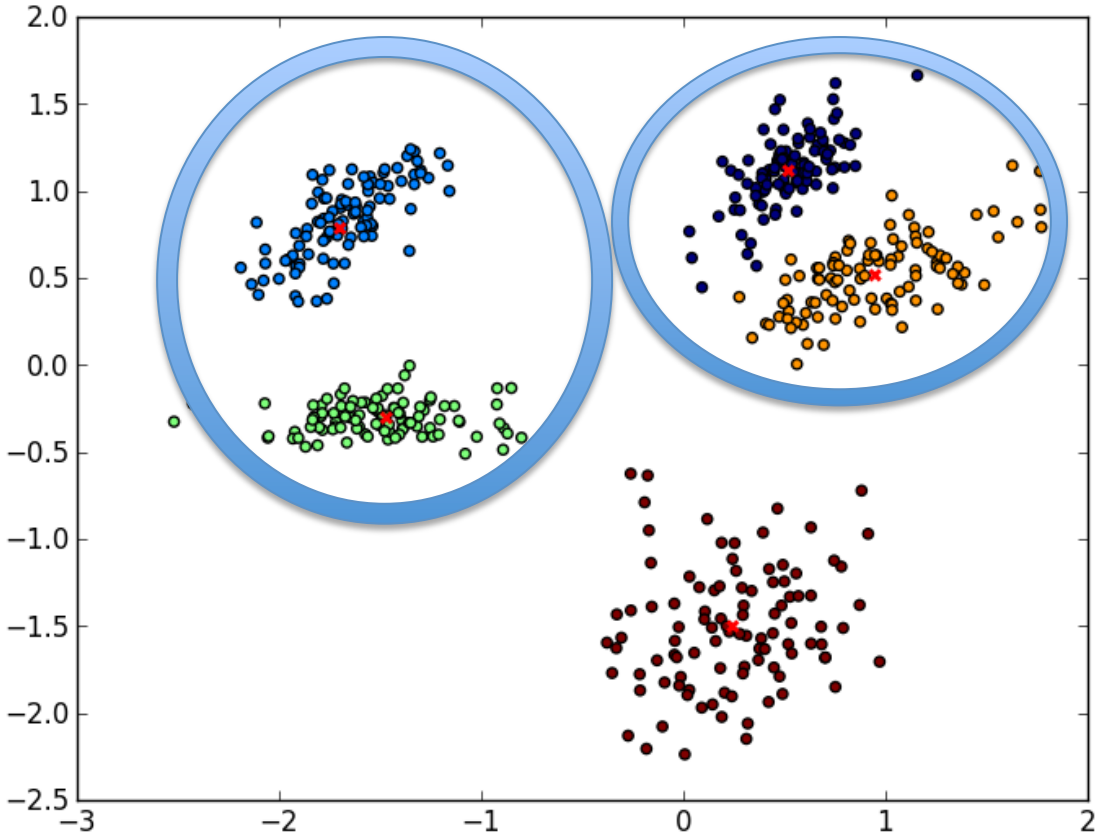
Hierarchical Clustering



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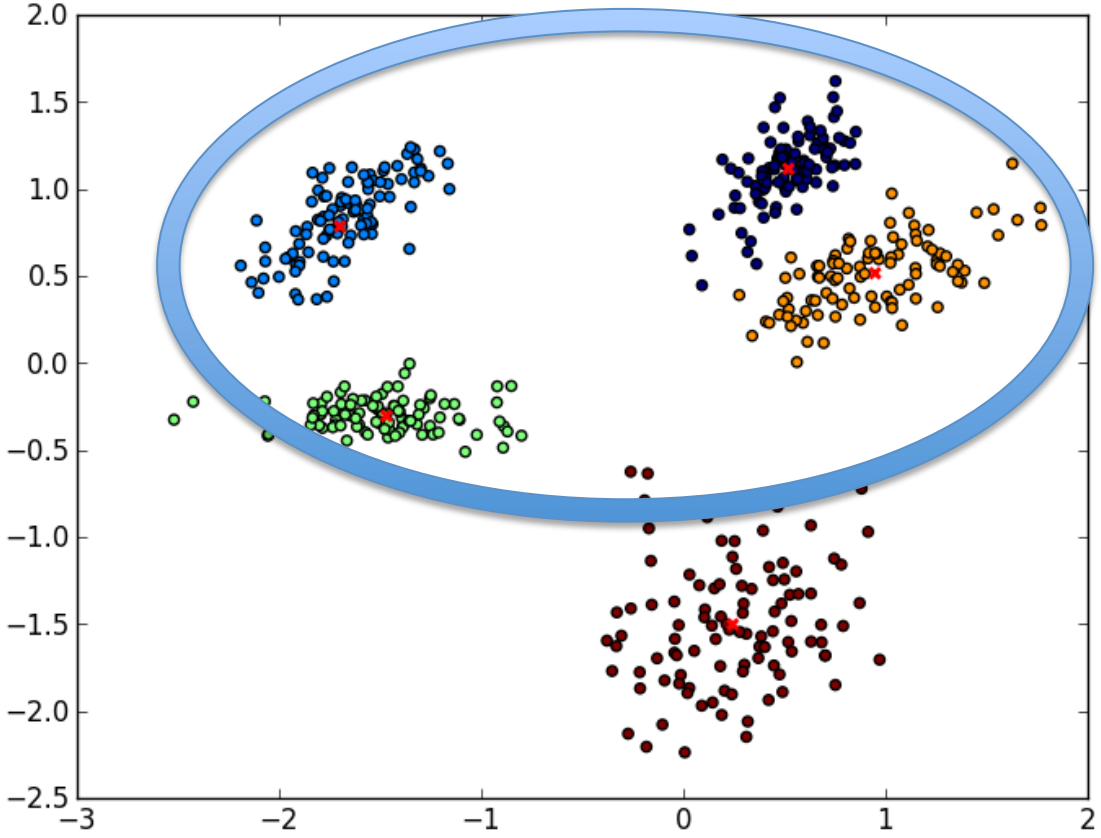

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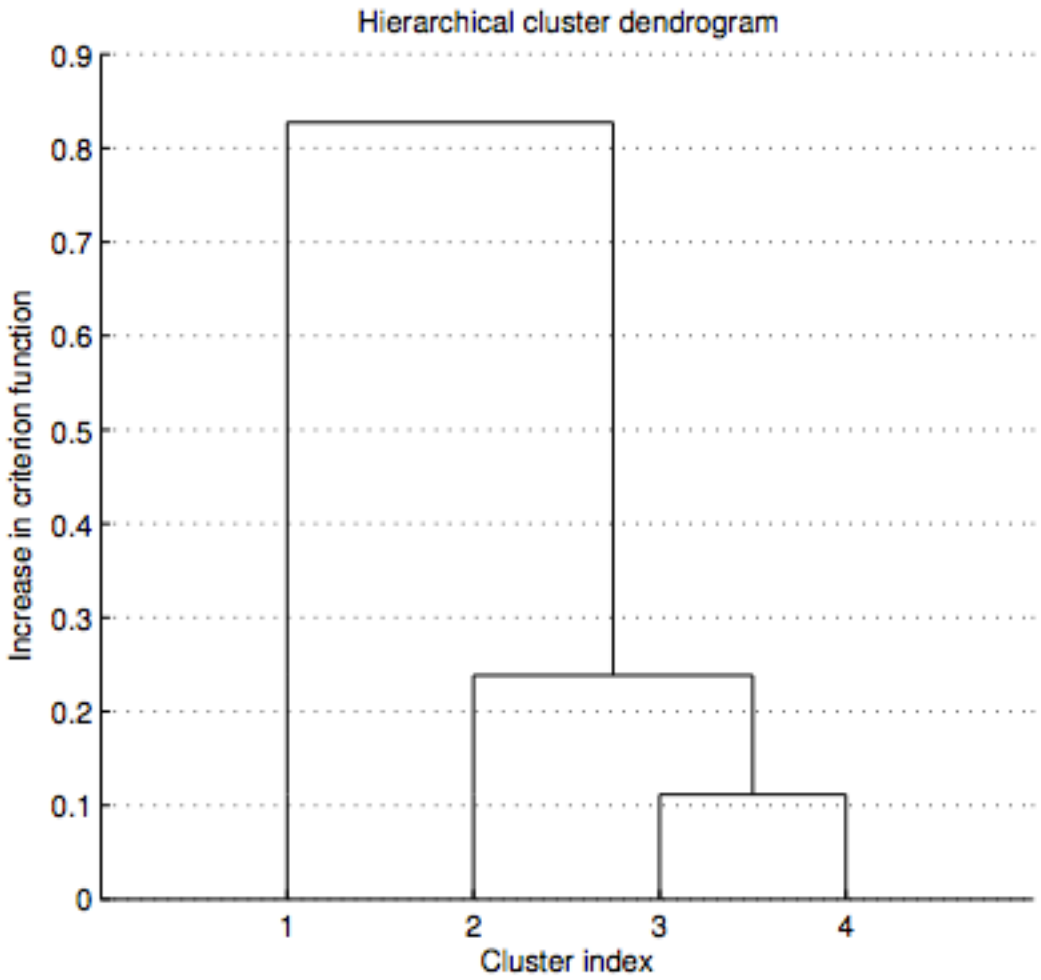
Visualization: Dendrogram plot



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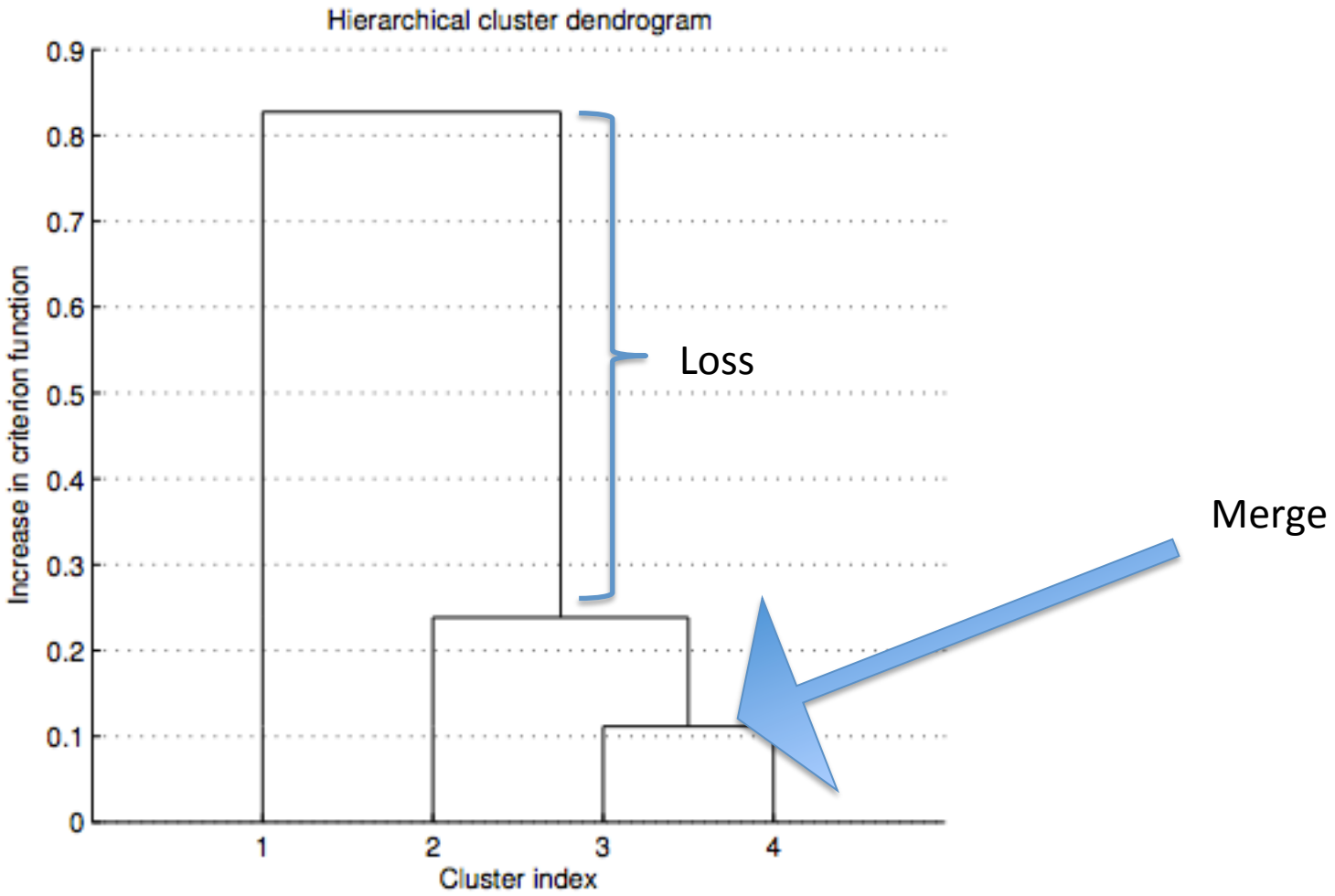
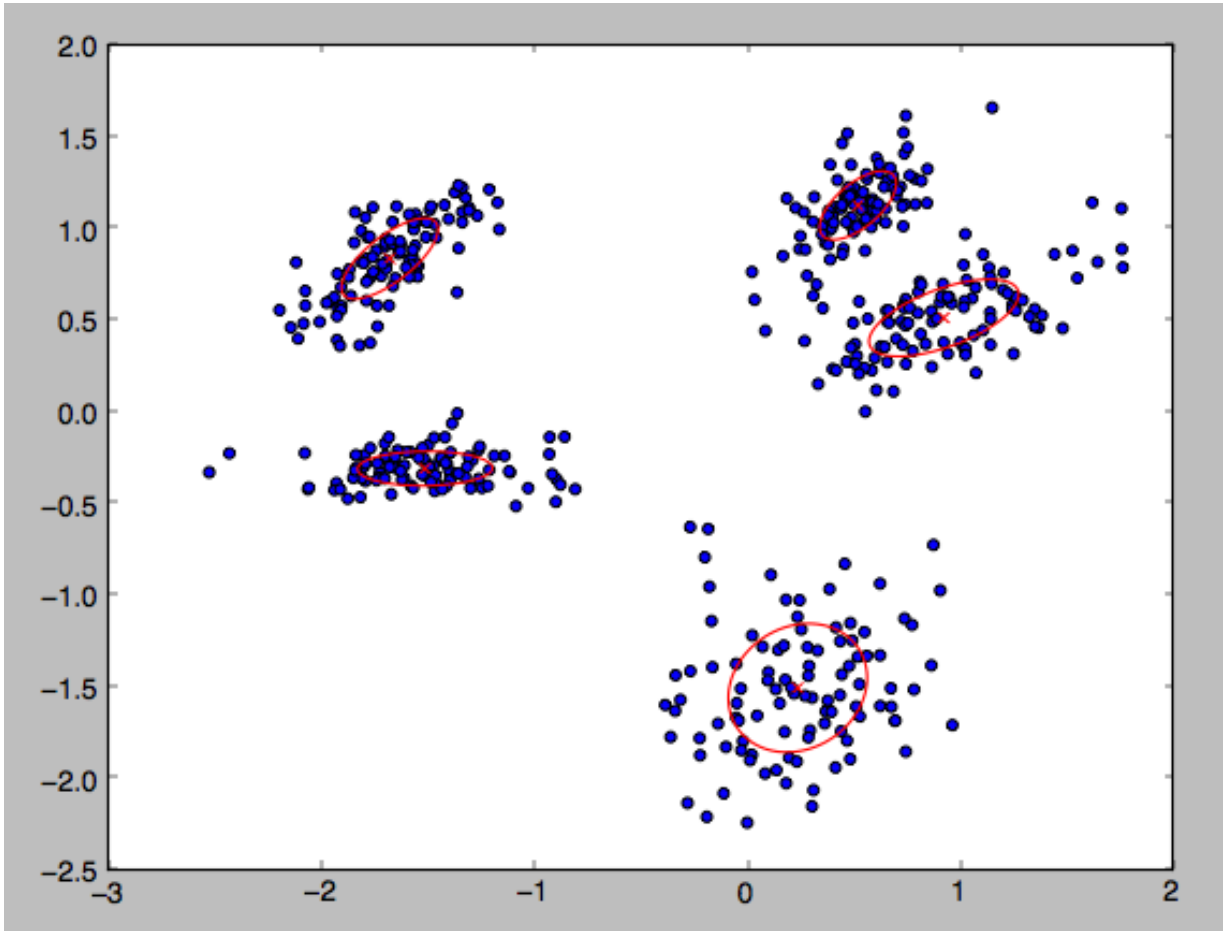


EM for Mixture of Gaussians



View clusters as mixtures of Gaussians

Consider not only cluster centers, but also Covariance matrices

EM for Mixture of Gaussians

Algorithm

$\hat{\pi}_k \leftarrow 1/K$ Prior distribution of cluster assignments
$\hat{\mu}_k \leftarrow$ random points out of $X_1, \ldots, X_n$
$\hat{\Sigma}_k \leftarrow \mathbf{I}_d$

Step 1 (E-Step)

for $k \leftarrow 1$ to K **do**
  for $n \leftarrow 1$ to N **do**
    Set $\gamma_{nk} \leftarrow \dfrac{\hat{\pi}_k g(X_n; \hat{\mu}_k, \hat{\Sigma}_k)}{\sum_{k'=1}^{K} \hat{\pi}_{k'} g(X_n; \hat{\mu}_{k'}, \hat{\Sigma}_{k'})}$
  end for
end for

Compute likelihood that point n belongs to cluster k given the cluster centers and covariance matrices

g is the Gaussian probability density function

Step 2 (M-Step)

for $k \leftarrow 1$ to K **do**
  $N_k \leftarrow \sum_{n=1}^{N} \gamma_{nk}$
  $\hat{\pi}_k \leftarrow N_k/N$
  $\hat{\mu}_k \leftarrow \frac{1}{N_k} \sum_{n=1}^{N} \gamma_{nk} X_n$
  $\hat{\Sigma}_k \leftarrow \frac{1}{N_k} \sum_{n=1}^{N} \gamma_{nk} (X_n - \hat{\mu}_k)(X_n - \hat{\mu}_k)^\top$
end for

Computer new cluster centers + covariance matrices + priors