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¹ Clustering

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$i=1,\cdots,k$ (\vec{w}_i) - D

$i=1,\cdots,k$ D \vec{x} :

$$u_i = \begin{cases} 1, & \text{if } i=c \text{ such that } \|\vec{x}-\vec{w}_c\|^2 = \min_j \|\vec{x}-\vec{w}_j\|^2, \\ 0, & \text{otherwise.} \end{cases} \quad ()$$

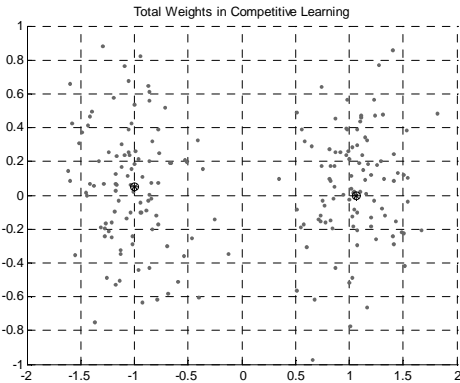
\vec{w}_i :

$$\Delta \vec{w}_i = \alpha_i u_i (\vec{x}-\vec{w}_i) \quad i.e., \Delta \vec{w}_i = \begin{cases} \alpha_i (\vec{x}-\vec{w}_i), & \text{if } u_i = 1, \\ 0, & \text{otherwise.} \end{cases} \quad ()$$

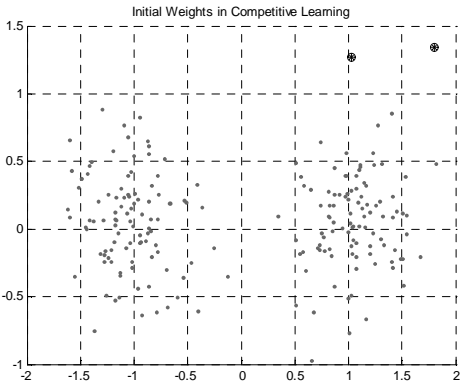
α_c () (\vec{w}_c) $0 \leq \alpha_c \leq 1$

winner-Take all () ()

() ()



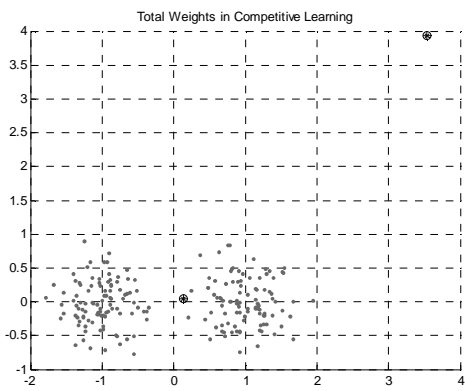
CL



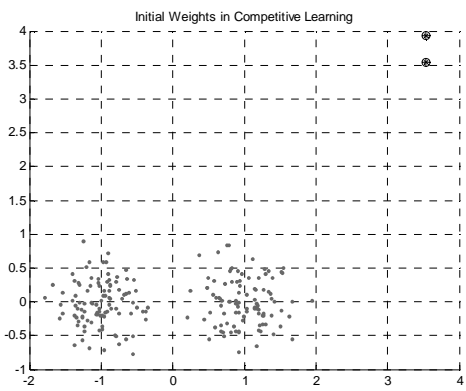
CL

() ()

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) CL



) CL

(dead unit

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FSCL

$$u_i = \begin{cases} 1, & \text{if } i = c \text{ such that } \gamma_c \|\vec{x} - \vec{w}_c\|^2 = \min_j \gamma_j \|\vec{x} - \vec{w}_j\|^2, \\ 0, & \text{otherwise} \end{cases} \quad ()$$

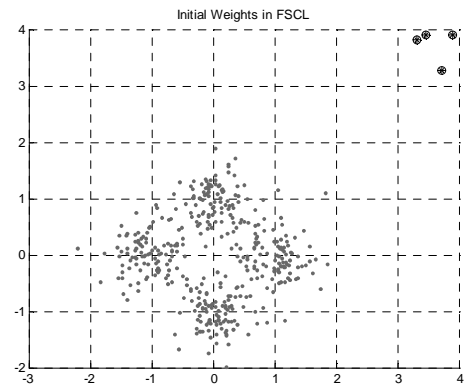
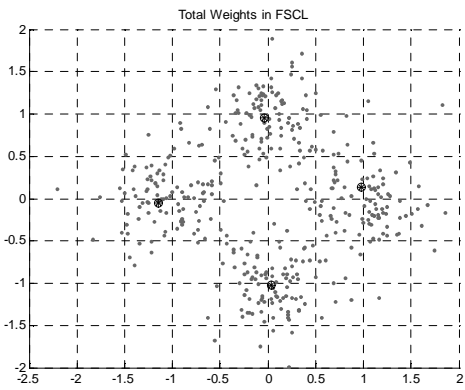
$$\gamma_j = \frac{n_j}{\sum_{i=1}^k n_i} \quad ()$$

k

n_i = 1

n_i

() ()

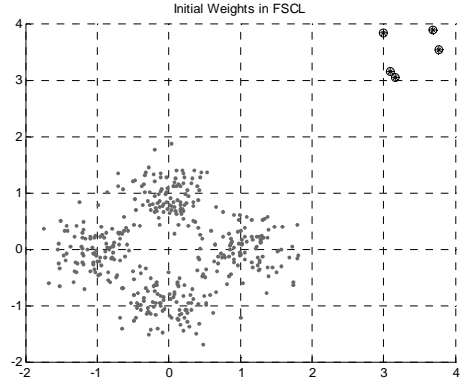
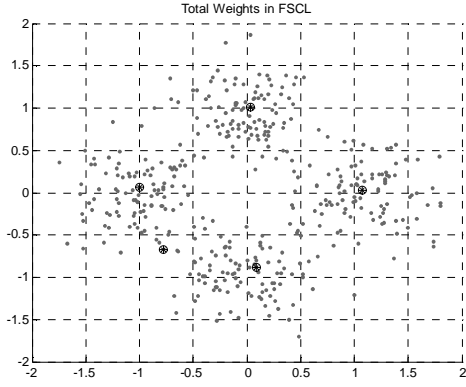


¹ -Dead Unit
² -Frequency Sensitive Competitive Learning

FSCL

FSCL

() ()



FSCL

FSCL

() ()

RPCL

(\vec{w}_c)

RPCL

$i = 1, \dots, k$

D

\vec{x}

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$$u_i = \begin{cases} 1, & \text{if } i = c \text{ such that } \gamma_c \left\| \vec{x} - \vec{w}_c \right\|^2 = \min_j \gamma_j \left\| \vec{x} - \vec{w}_j \right\|^2, \\ -1, & \text{if } i = r \text{ such that } \gamma_r \left\| \vec{x} - \vec{w}_r \right\|^2 = \min_{j \neq c} \gamma_j \left\| \vec{x} - \vec{w}_j \right\|^2, \\ 0, & \text{otherwise.} \end{cases} \quad ()$$

\vec{w}_i

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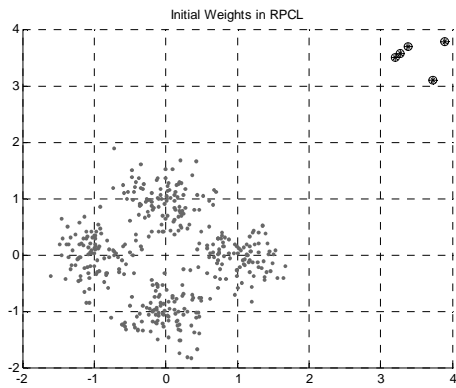
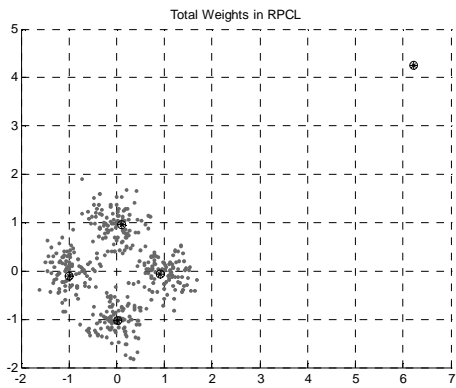
$$\Delta \vec{w}_i = \alpha_i u_i (\vec{x} - \vec{w}_i) \quad \text{i.e., } \Delta \vec{w}_i = \begin{cases} \alpha_i (\vec{x} - \vec{w}_i), & \text{if } u_i = 1, \\ -\alpha_r (\vec{x} - \vec{w}_i), & \text{if } u_i = -1, \\ 0, & \text{otherwise.} \end{cases} \quad ()$$

$$0 \leq \alpha_c, \alpha_r \leq 1$$

() ()

$$\alpha_c(t) \gg \alpha_r(t)$$

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RPCL

RPCL

RPCL

$$\bar{z}^{n+1} = \frac{1}{c} \sum_{k=1}^K (\bar{w}_c) \quad \text{RPCL} \quad (\bar{Z}=(\bar{x},y))$$

$$[\quad] [\quad]$$

$$d(\bar{Z},\overline{w})=\gamma_k \parallel \bar{z}_k-\overline{w}_k \parallel \quad k=1,...,K \quad ()$$

$$k \in L_2 \quad n_k, \quad \gamma_k = \frac{n_k}{\sum_{k=1}^K n_k}$$

$$\left\{ \begin{array}{l} d(\bar{z},\overline{w}_c)=\min_k d(\bar{z},\overline{w}_k) \\ d(\bar{z},\overline{w}_r)=\min_{k \neq c} d(\bar{z},\overline{w}_k) \end{array} \right. \quad () \quad ()$$

$$\overline{w}_c = \overline{w}_c + \alpha_c \parallel \bar{z} - \overline{w}_c \parallel, \quad \overline{w}_r = \overline{w}_r - \alpha_r \parallel \bar{z} - \overline{w}_r \parallel \quad () \quad ()$$

$$0 \leq \alpha_r \leq \alpha_c \leq 1$$

$$d(\overline{z},\overline{w}_k)\geq c*\max_p\left\|\overline{z}_p\right\| \quad : \\ \text{k=1,...,K} \qquad \qquad \qquad \text{c} \qquad \qquad \qquad .$$

$$\frac{I}{k}\sum_{k=I}^K//\overline{w}_k(t+I)-\overline{w}_k(t)||^2<\varepsilon \qquad :$$

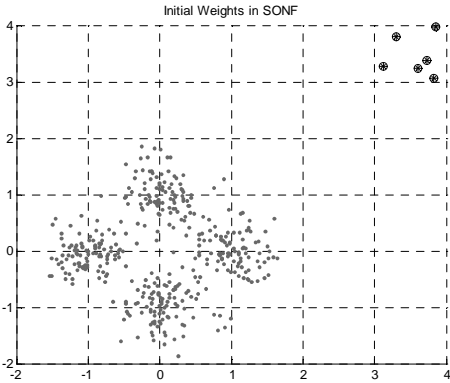
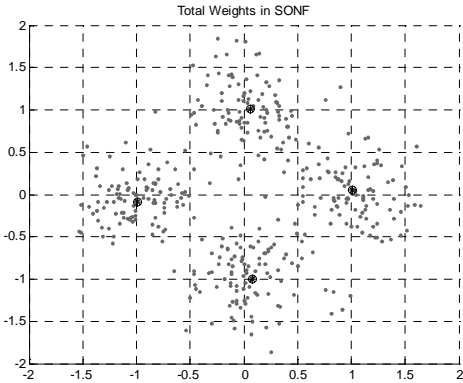
$$\text{H} \qquad \qquad \qquad \left\{\overline{w}_1,\overline{w}_2,...,\overline{w}_k\right\} \qquad \qquad \qquad \text{H} \qquad \qquad \qquad \overline{w}_k=\left\{\overline{w}_{1k},\overline{w}_{2k},...,\overline{w}_{n+I,k}\right\} \qquad \qquad \qquad . \qquad \qquad \qquad L_2$$

$$IF\left(x_i\text{ is around }w_{1k}\right)\text{ AND ... AND }\left(x_n\text{ is around }w_{nk}\right)\text{ THEN} \qquad \qquad \qquad \left(\quad\right) \\ \left(y\text{ is around }w_{\left(n+I\right)k}\right)$$

$$\sigma_{ik}=\frac{\left|w_{ik}-w_{ih}\right|}{r} \qquad \qquad \qquad \left(\quad\right) \\ \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \left[\quad,\quad\right]$$

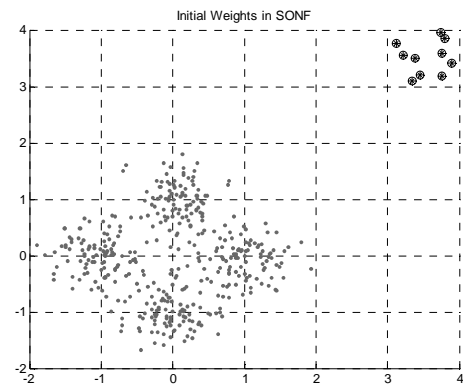
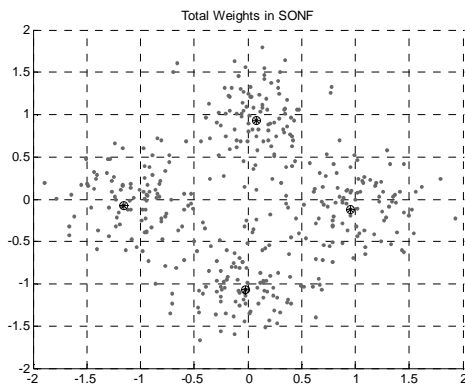
$$\text{r} \quad w_{ir} \qquad \qquad \qquad w_{ih} \\ \text{.} \left[\quad\right] \left[\quad\right]$$

$$\left(\quad\right) \left(\quad\right) \qquad \qquad \qquad .$$



$$\left(\quad\quad\quad\right) \qquad \qquad \qquad \left(\quad\quad\quad\right)$$

$$\left(\quad\right) \left(\quad\right)$$



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