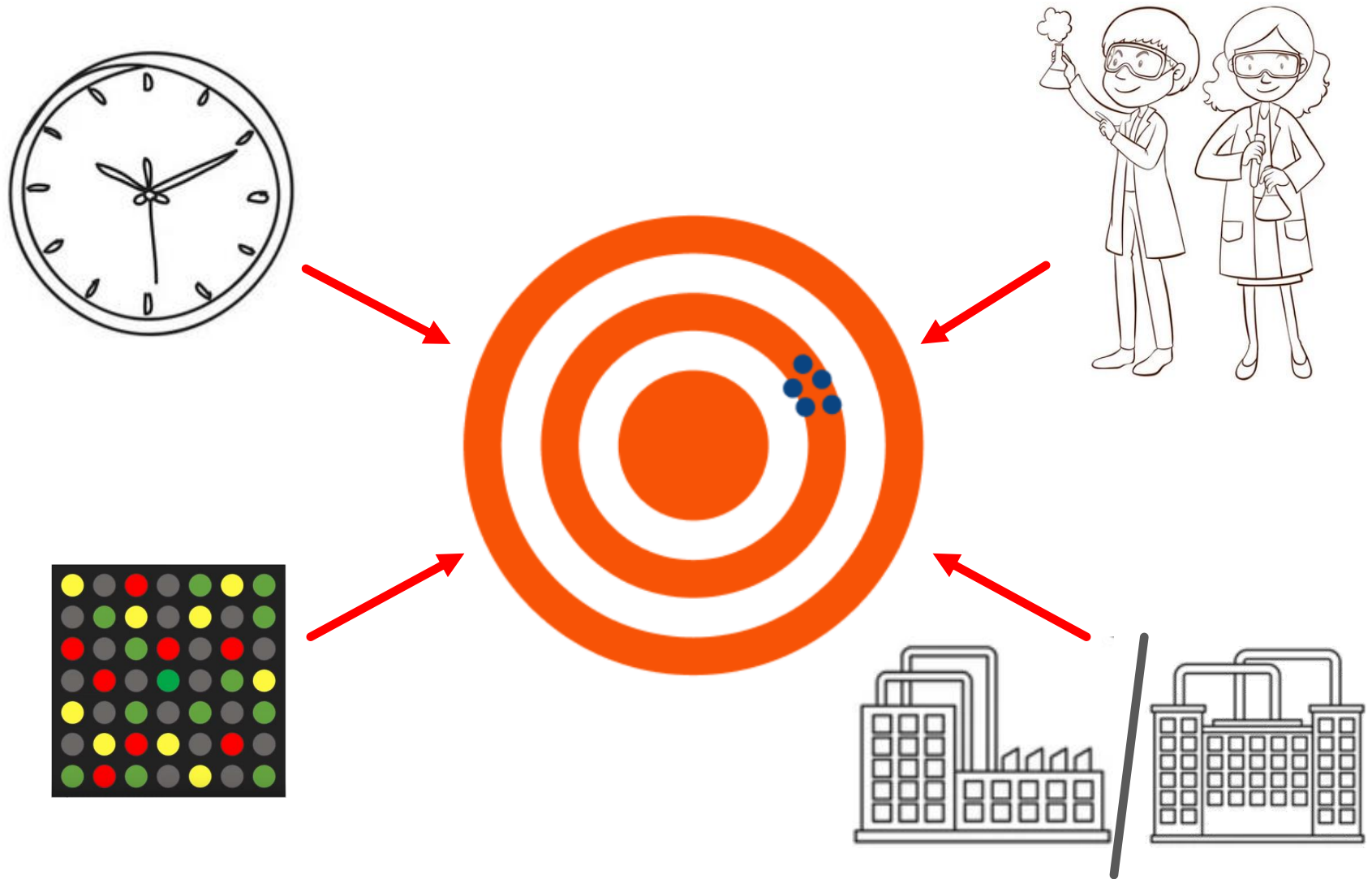


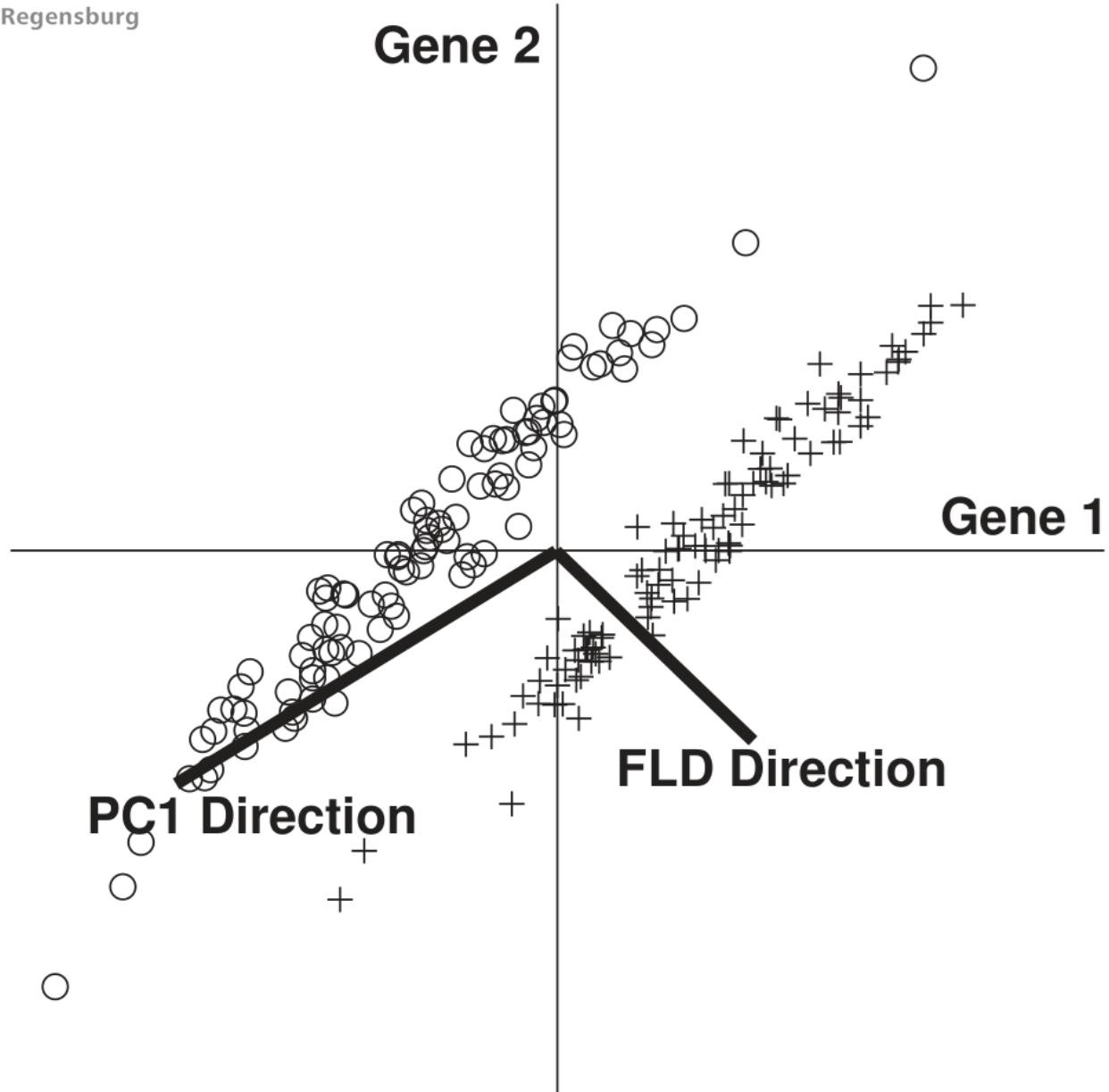
# ***Distance Weighted Discrimination (Benito & Marron, 2004)***

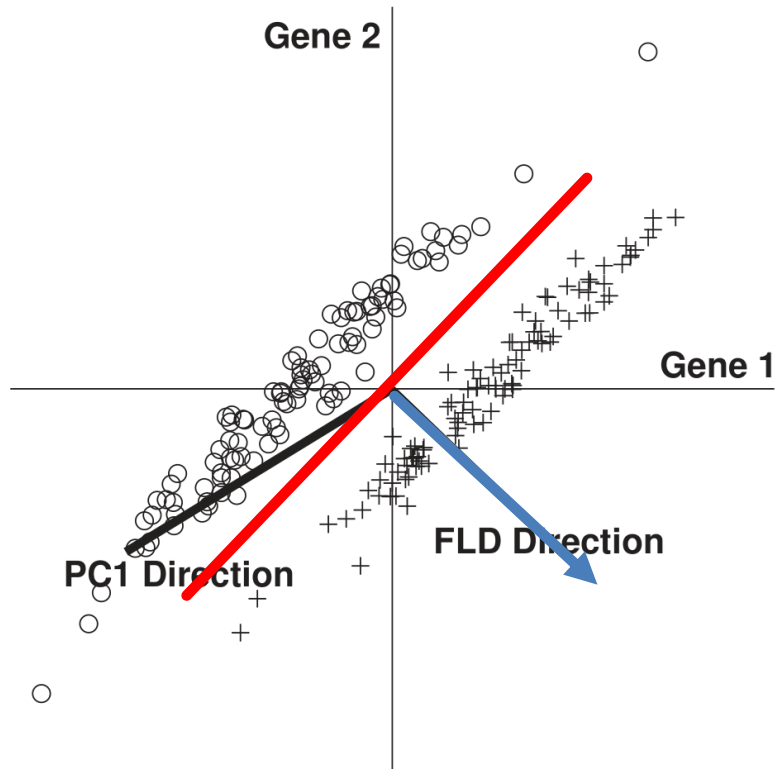
Alexander Glötzl  
Statistische Bioinformatik  
FAKULTÄT FÜR PHYSIK



Universität Regensburg





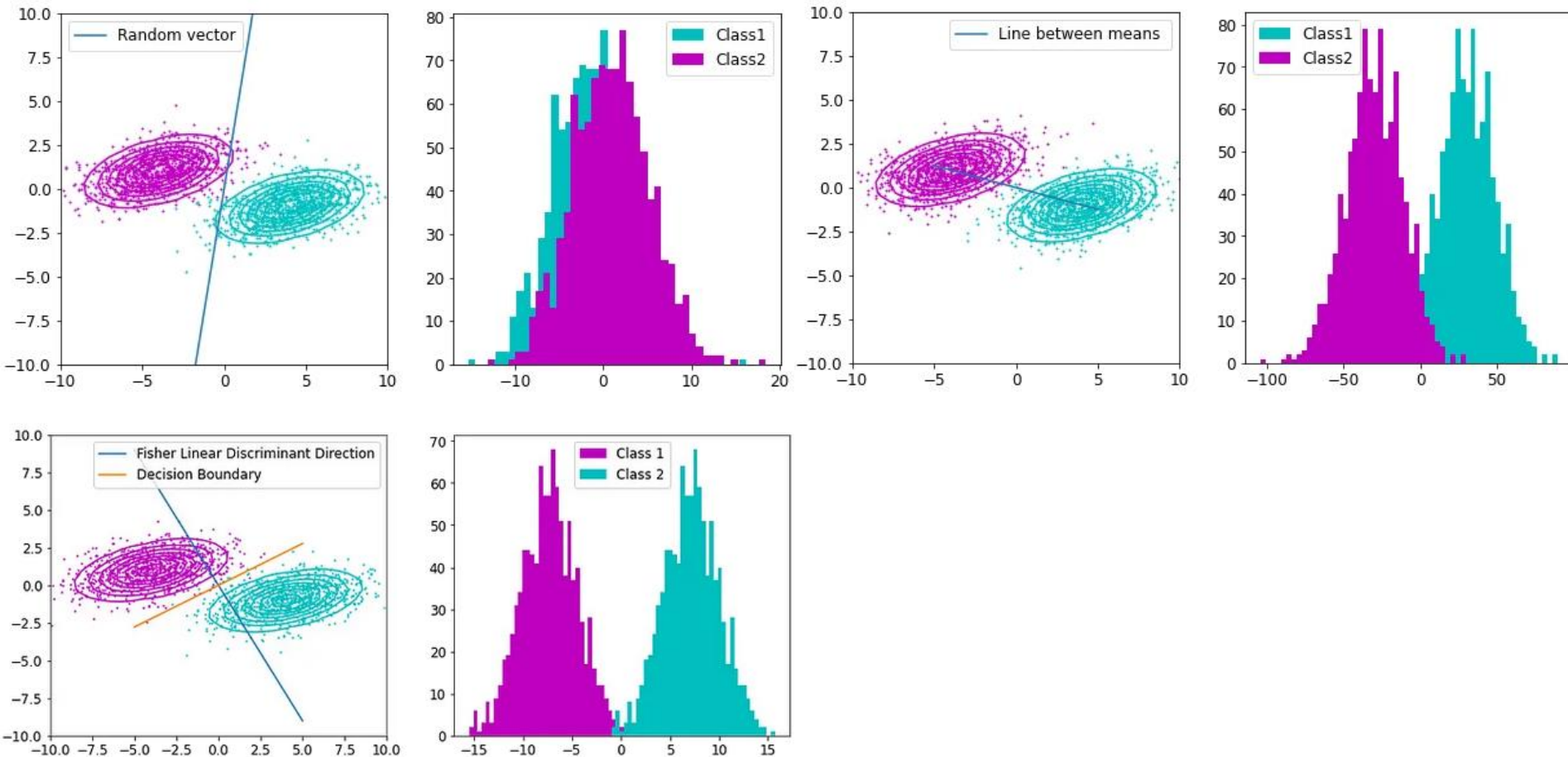


$$\vec{\Theta} \cdot \vec{x}_1 + c = 0$$

$$\vec{\Theta} \cdot \vec{x}_2 + c = 0$$

$$\vec{\Theta} \cdot (\vec{x}_2 - \vec{x}_1) = 0$$

# Fisher Linear Discriminant (FLD)



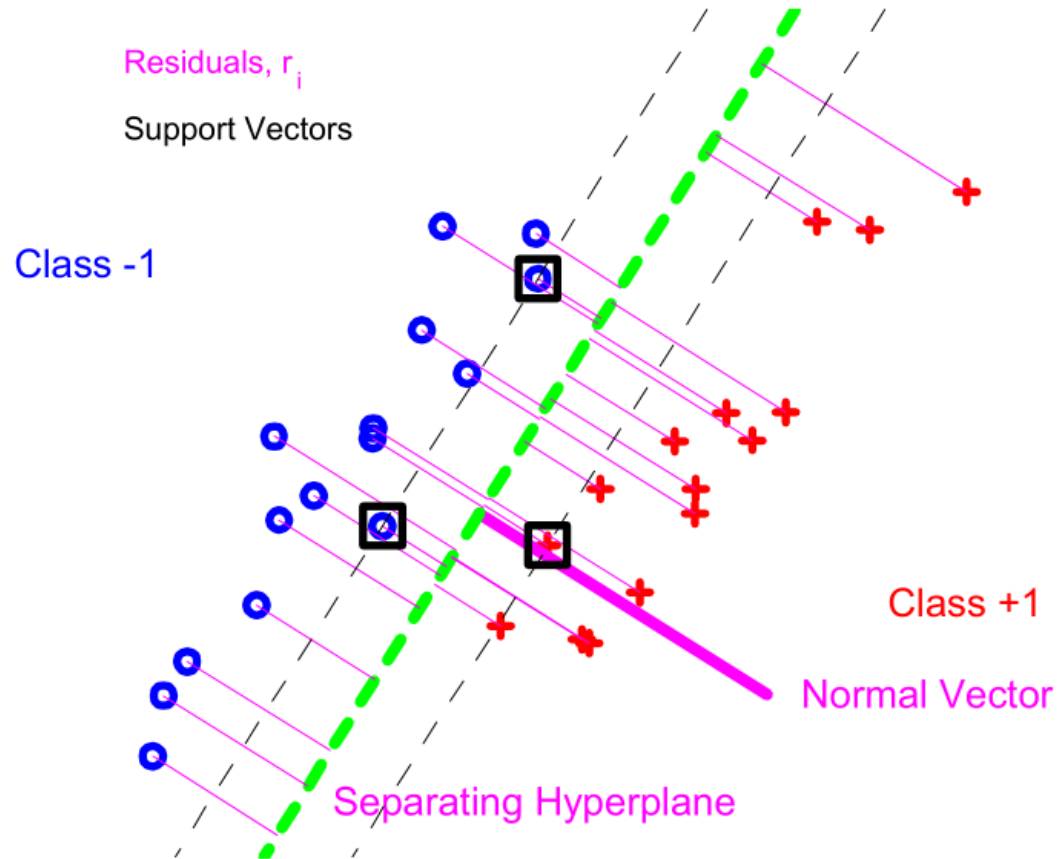
## Fisher Linear Discriminant (FLD)

$$J(\mathbf{w}) = \frac{(m_1 - m_2)^2}{s_1^2 + s_2^2}$$

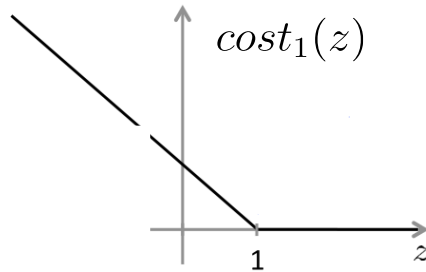
$$\frac{\partial J(w)}{\partial w} = 0$$

$$w \propto S_w^{-1}(\mathbf{m}_2 - \mathbf{m}_1) \quad \text{with } S_w = \Sigma_2 + \Sigma_1$$

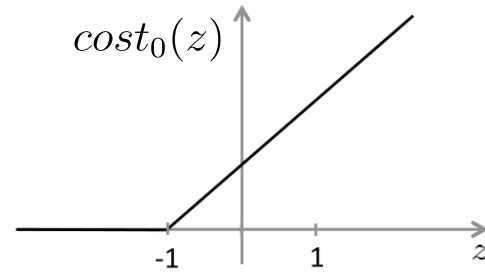
# Support Vector Machine (SVM)



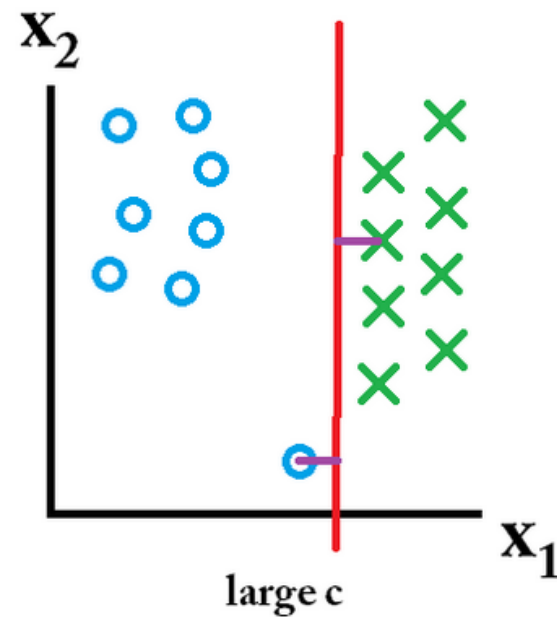
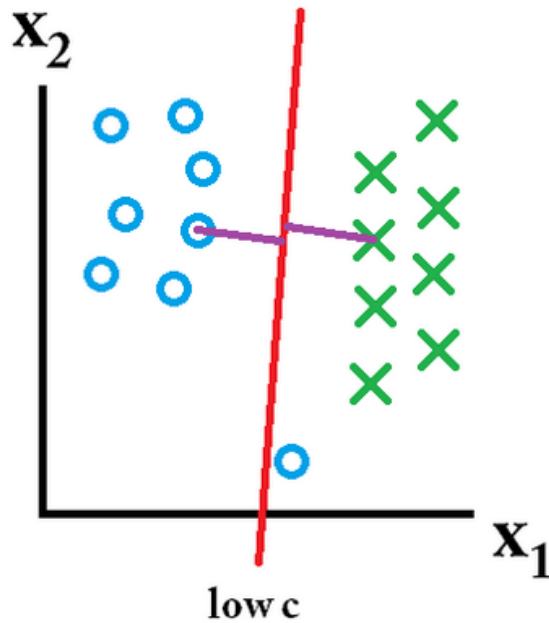
$$\min_w C \cdot \sum_{i=1}^n [y^{(i)} \text{cost}_1(w^T x^{(i)}) + (1 - y^{(i)}) \text{cost}_0(w^T x^{(i)})] + \frac{1}{2} \sum_{j=1}^d w_j^2$$



$$w^T x^{(i)} \geq 1$$

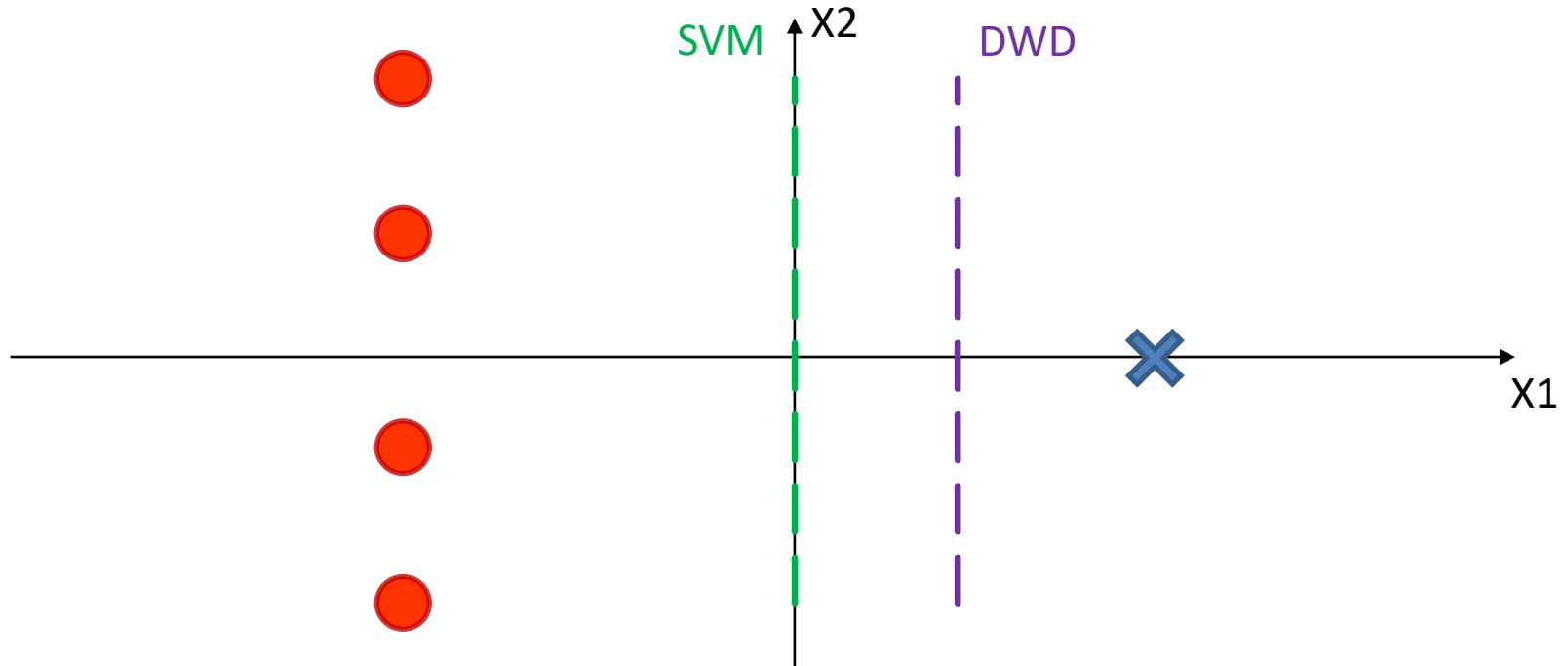


$$w^T x^{(i)} \leq -1$$





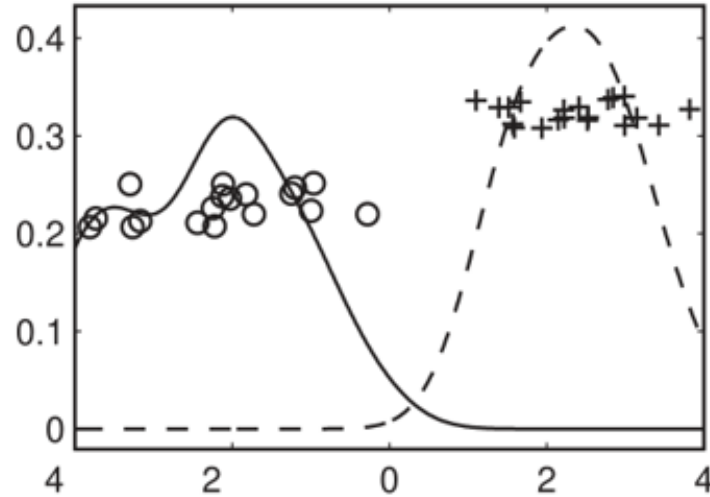
## Distance Weighted Discriminant (DWD)



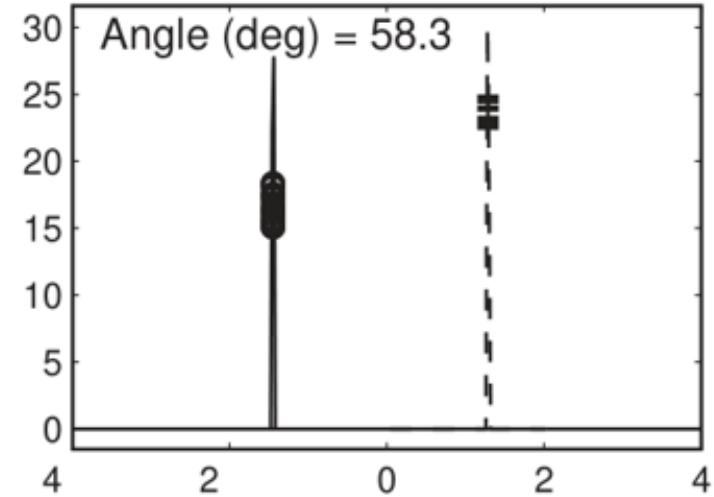
$$\min_{\omega_0, \omega} \left[ \sum_{i=1}^n \frac{1}{d_i} + c \sum_{i=1}^n \eta_i \right],$$

subject to  $d_i = y_i(\omega_0 + \mathbf{x}_i^T \boldsymbol{\omega}) + \eta_i \geq 0$ ,  $\eta_i \geq 0$ ,  $\forall i$ , and  $\boldsymbol{\omega}^T \boldsymbol{\omega} = 1$ .

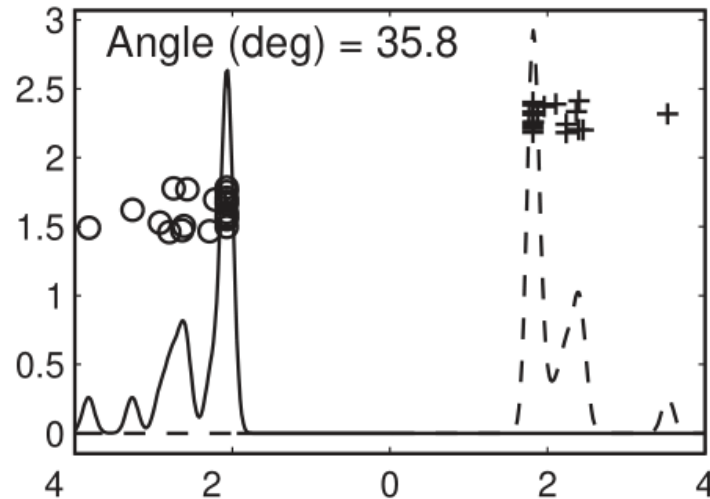
**A - Example Data**



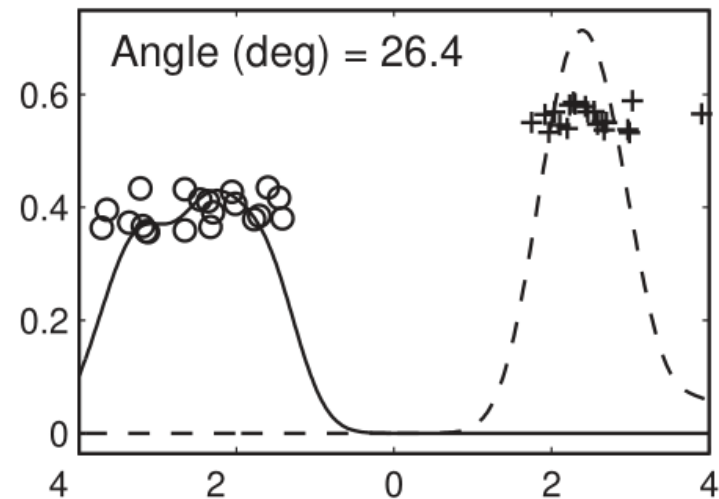
**B - FLD**



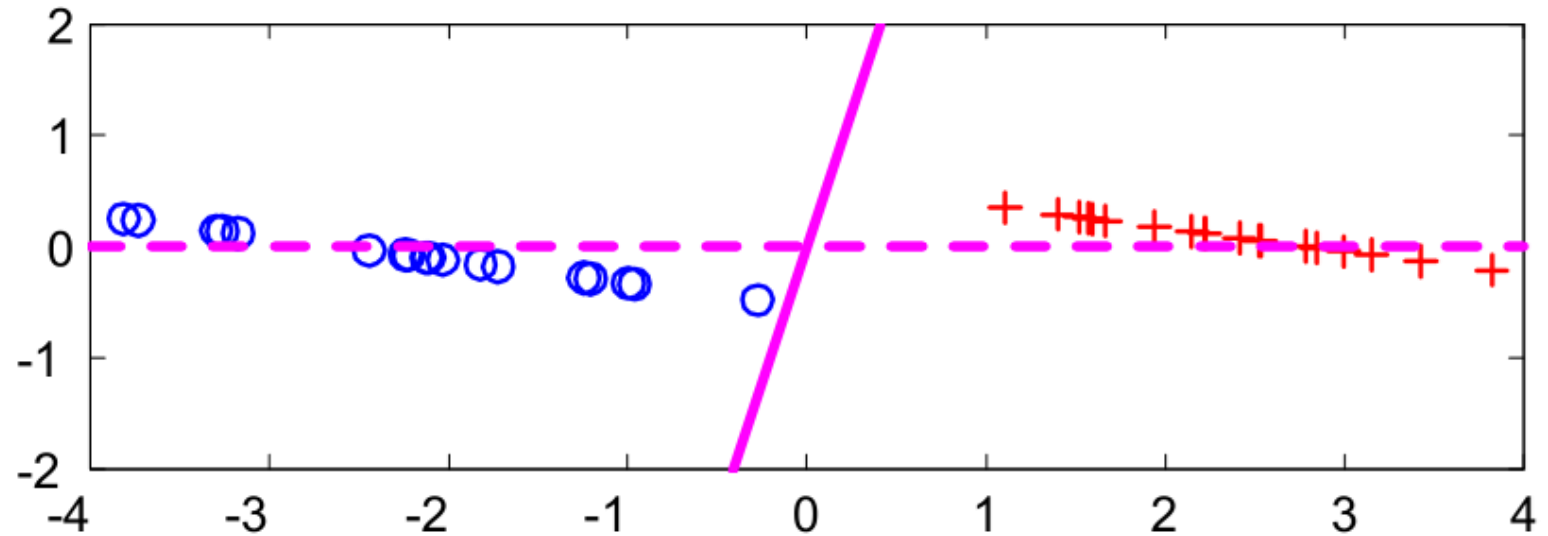
**C - SVM**



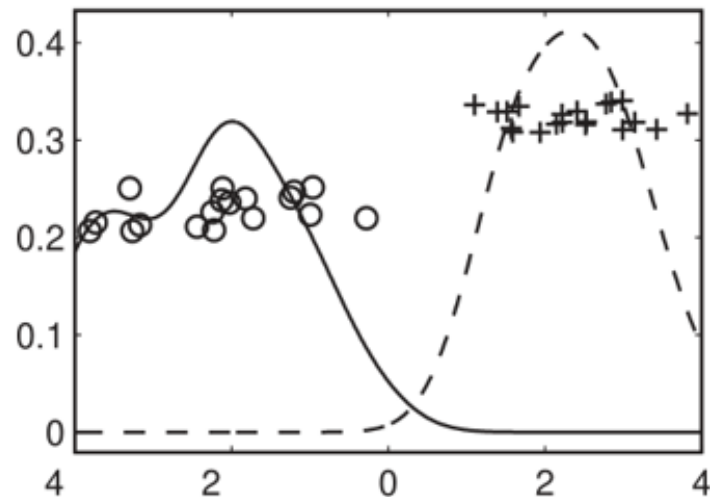
**D - DWD**



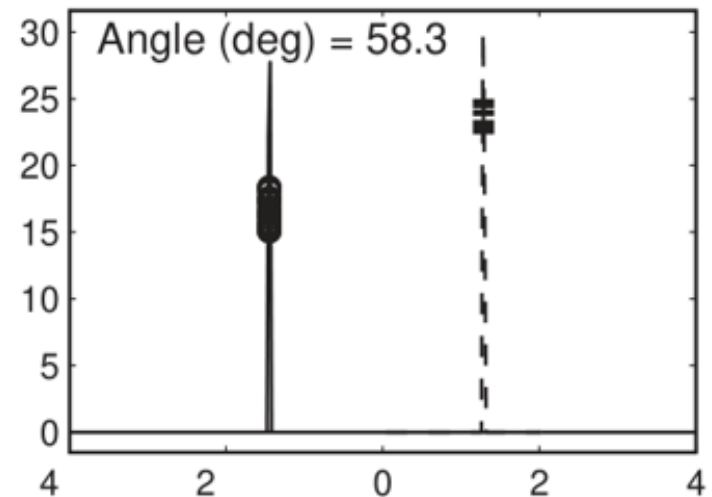
## Maximal Data Piling, dimension = 39



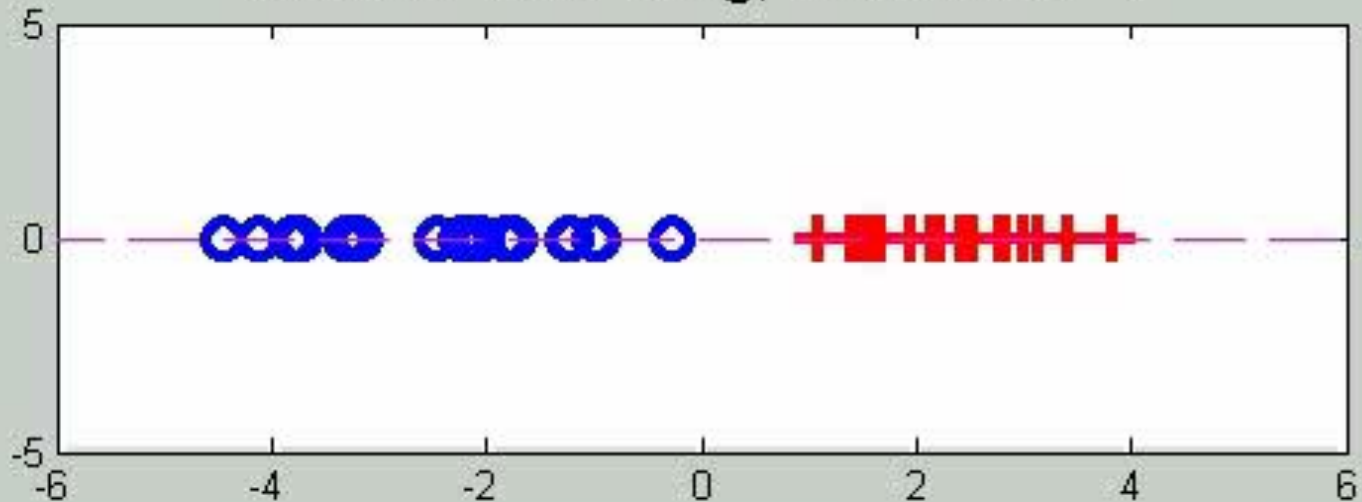
**A - Example Data**



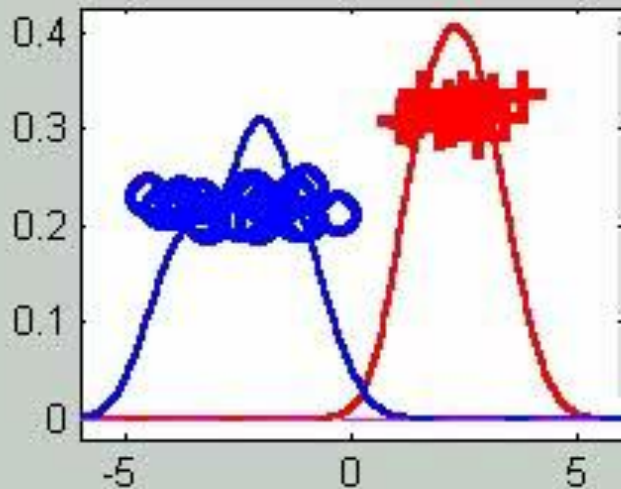
**B - FLD**



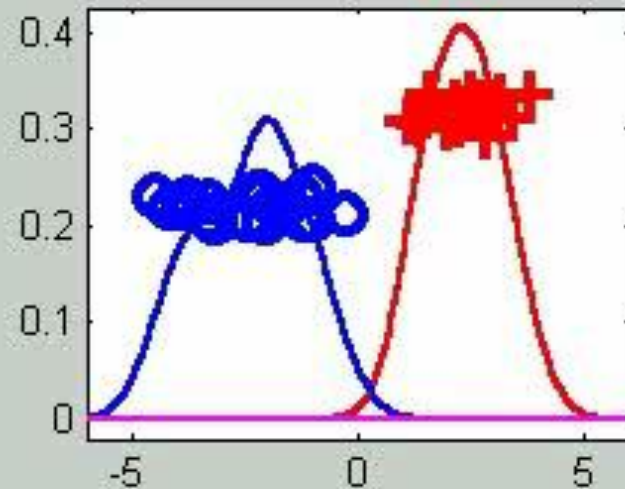
## Maximal Data Piling, dimension = 1

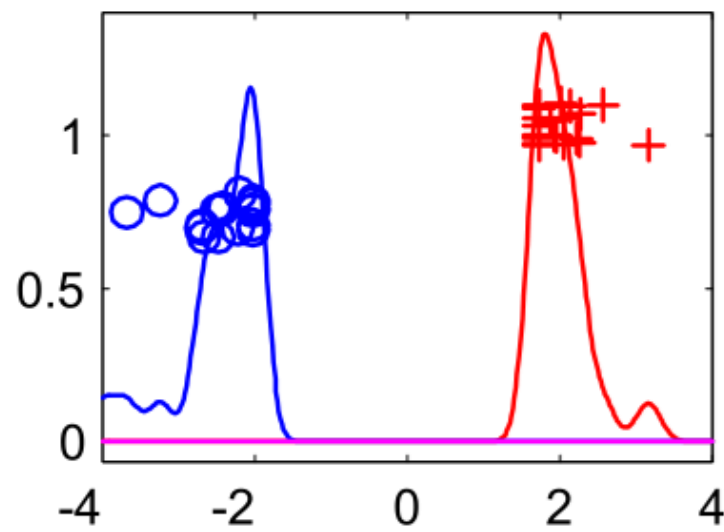
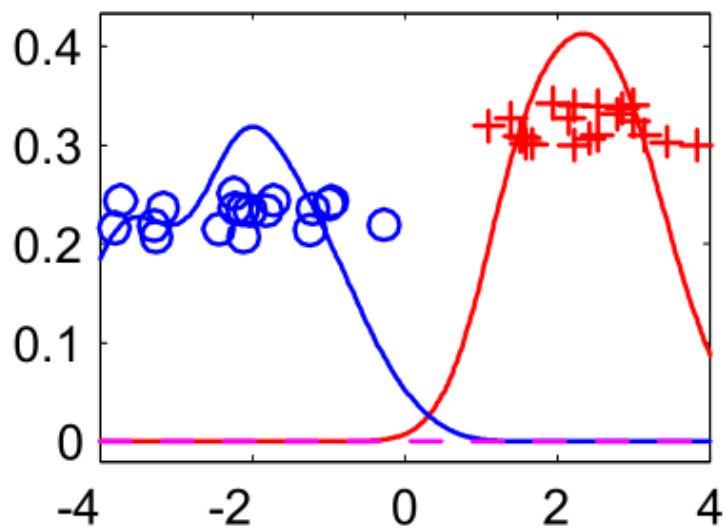
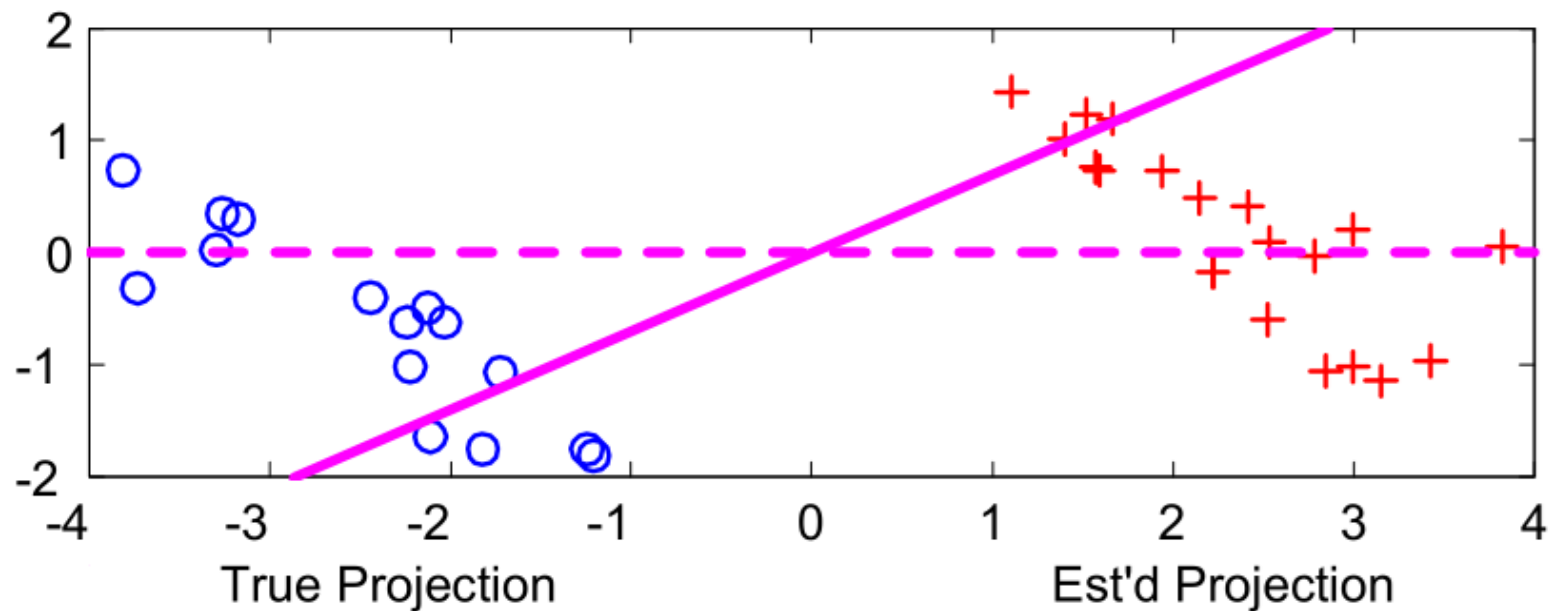


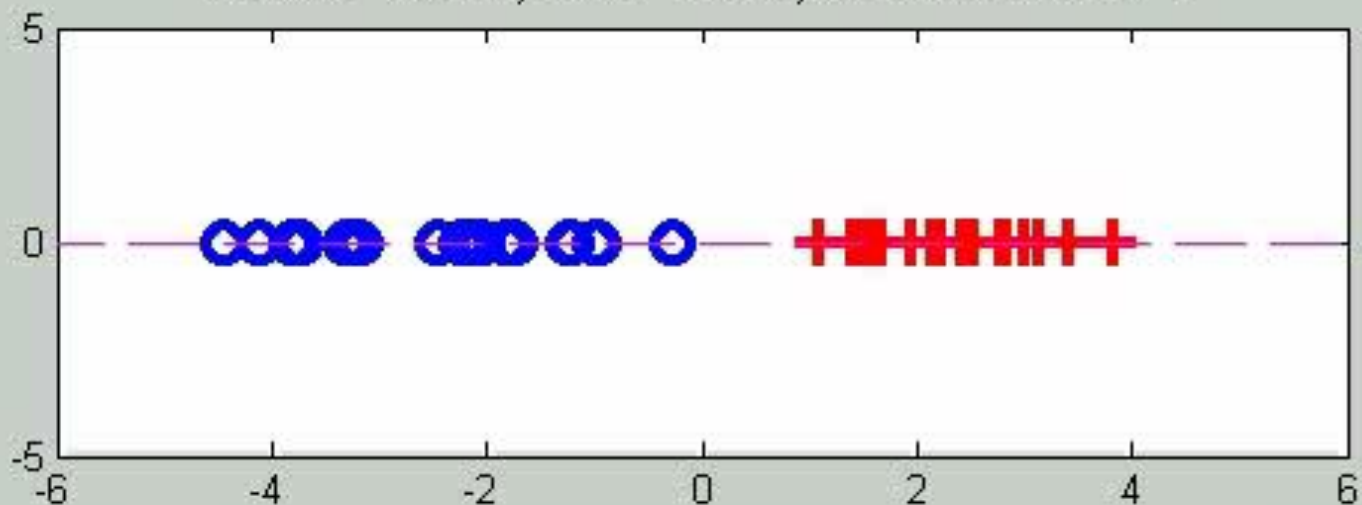
True Projection



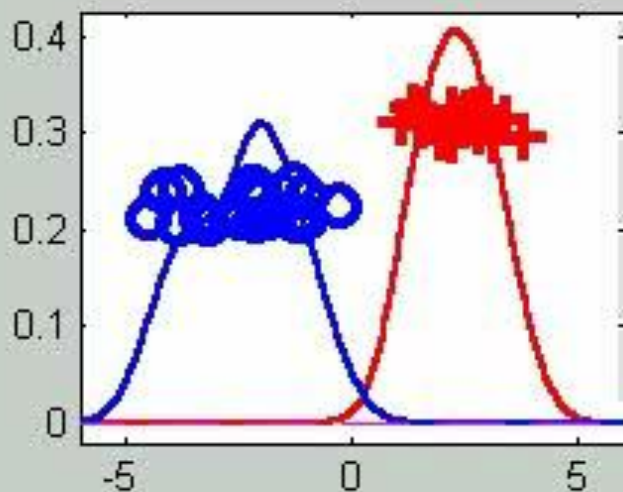
Est'd Projection



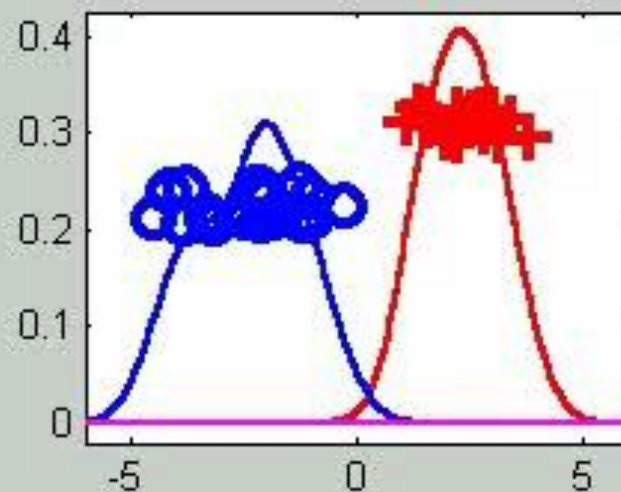
Linear SVM,  $C = 1000$ , dimension = 39

Linear SVM,  $C = 1000$ , dimension = 1

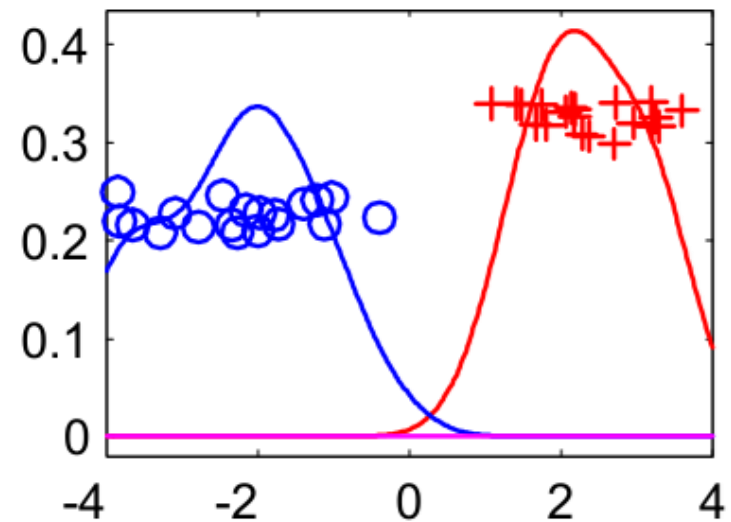
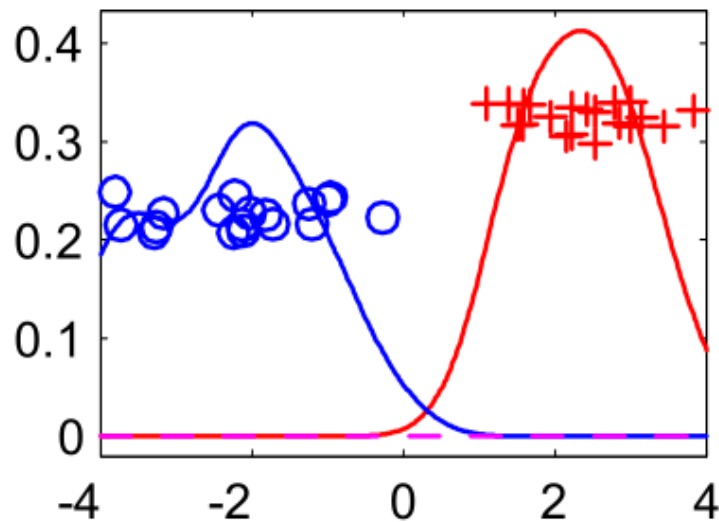
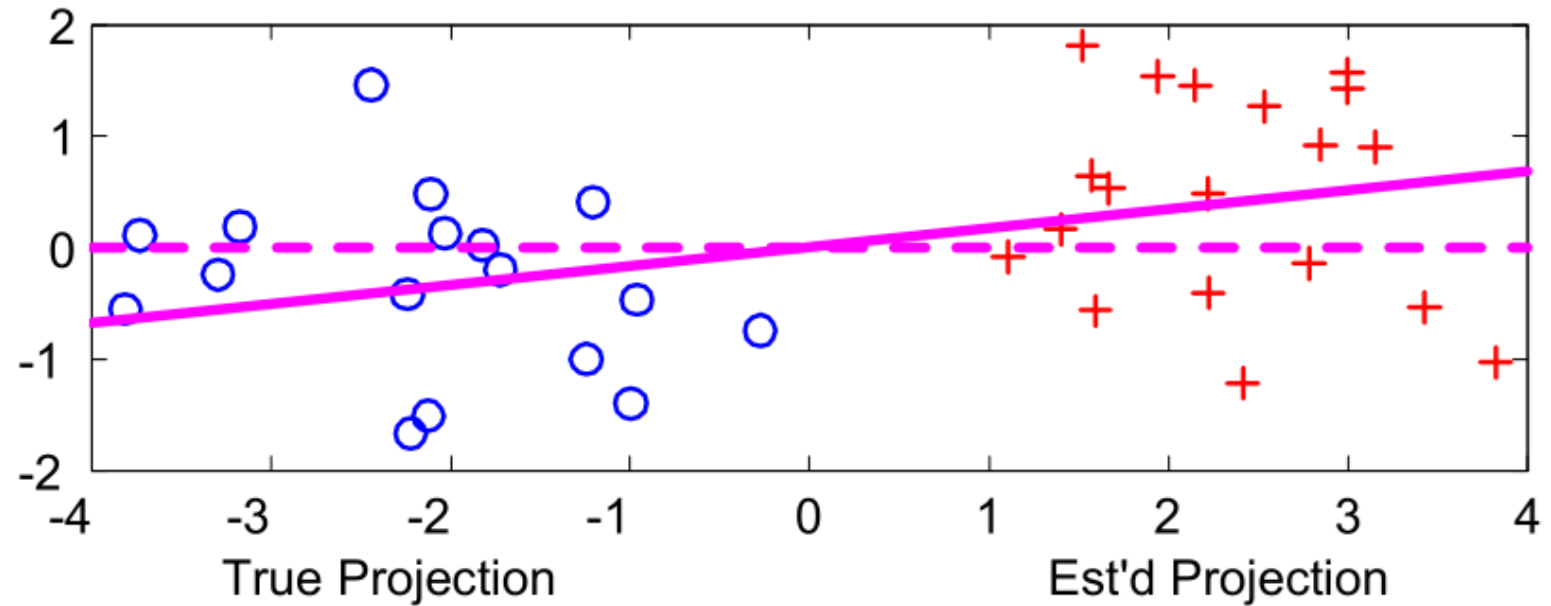
True Projection

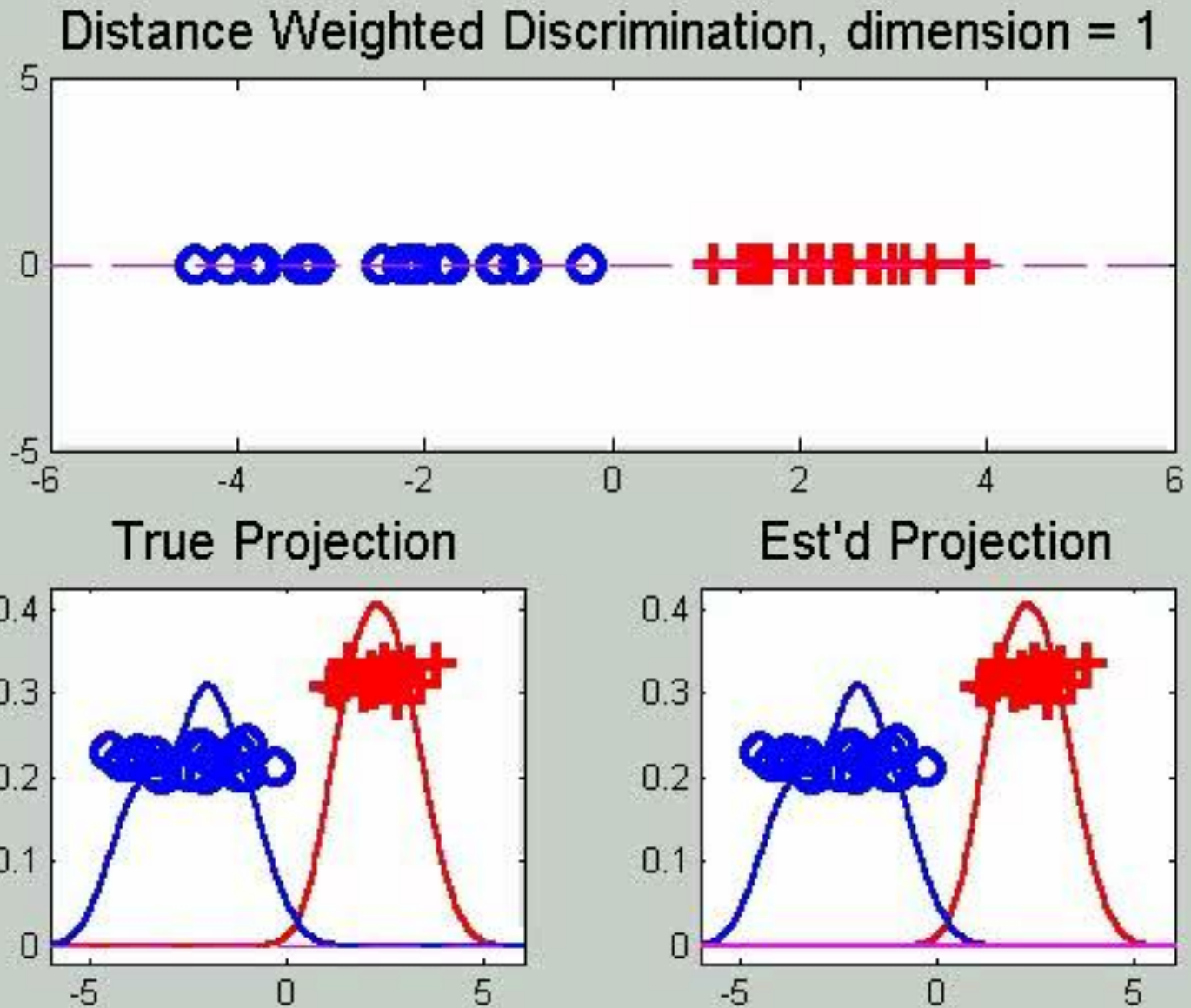


Est'd Projection



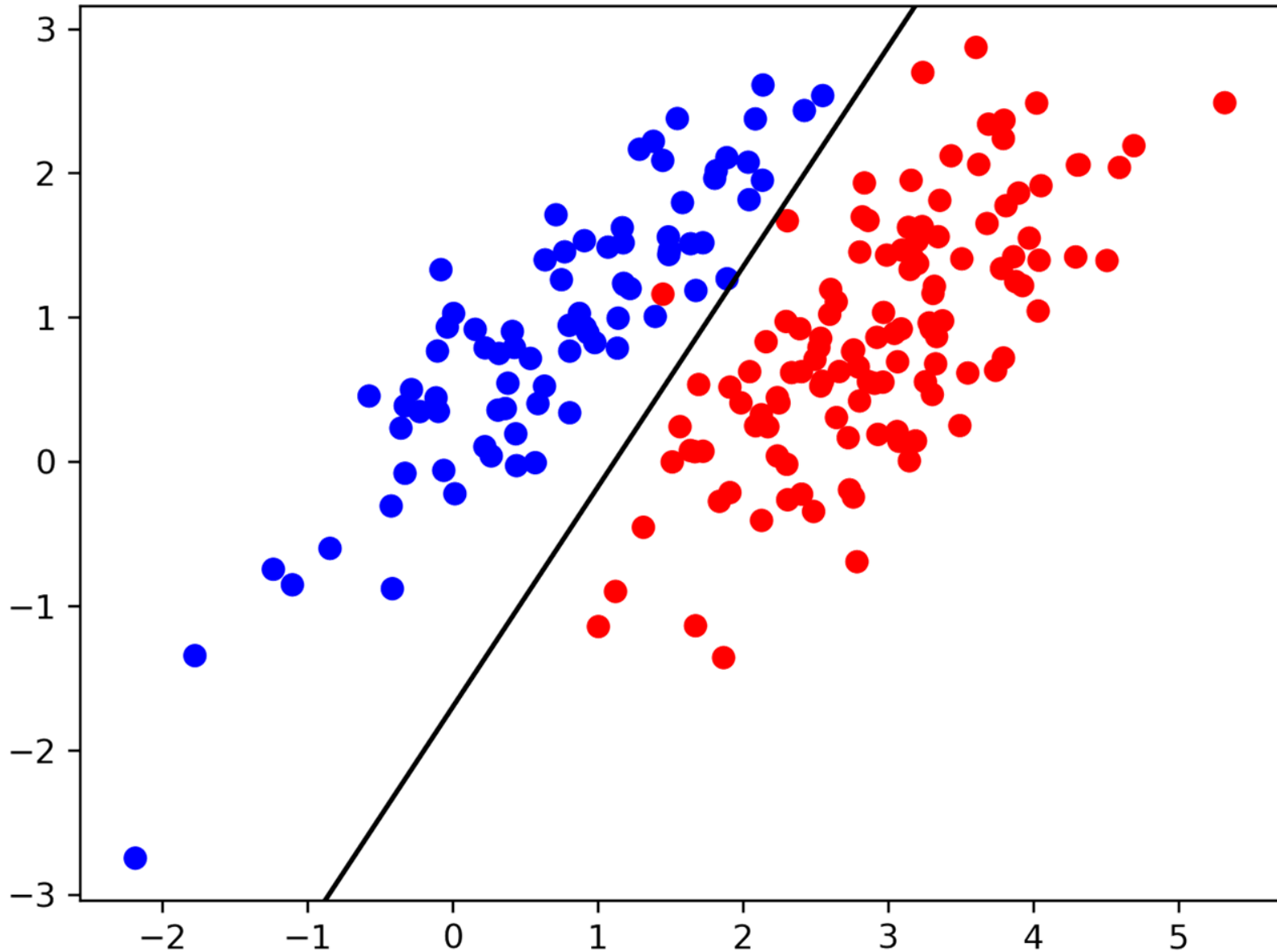
## Distance Weighted Disc., dimension = 39



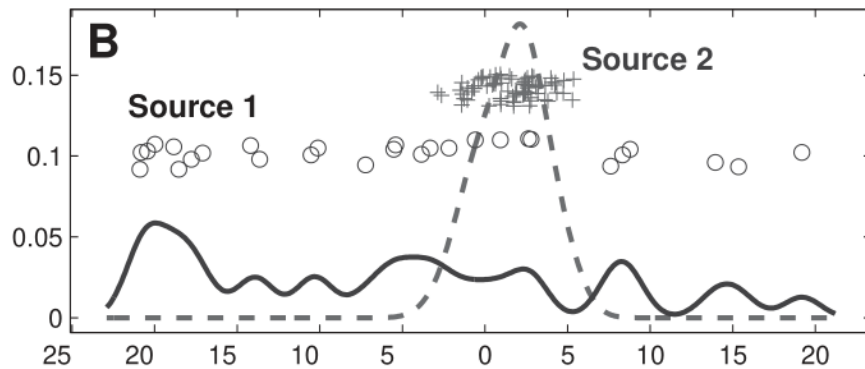
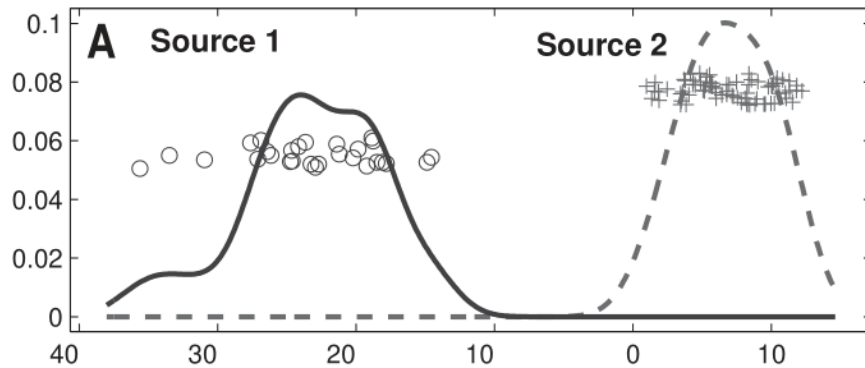




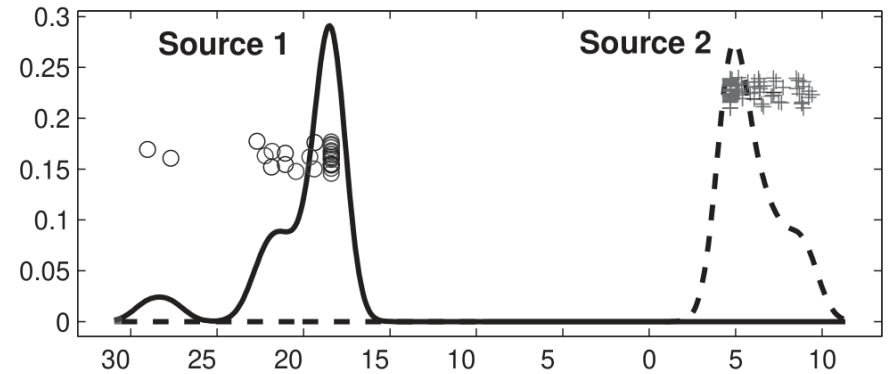
Universität Regensburg DWD linear classifier (tr acc = 0.995)



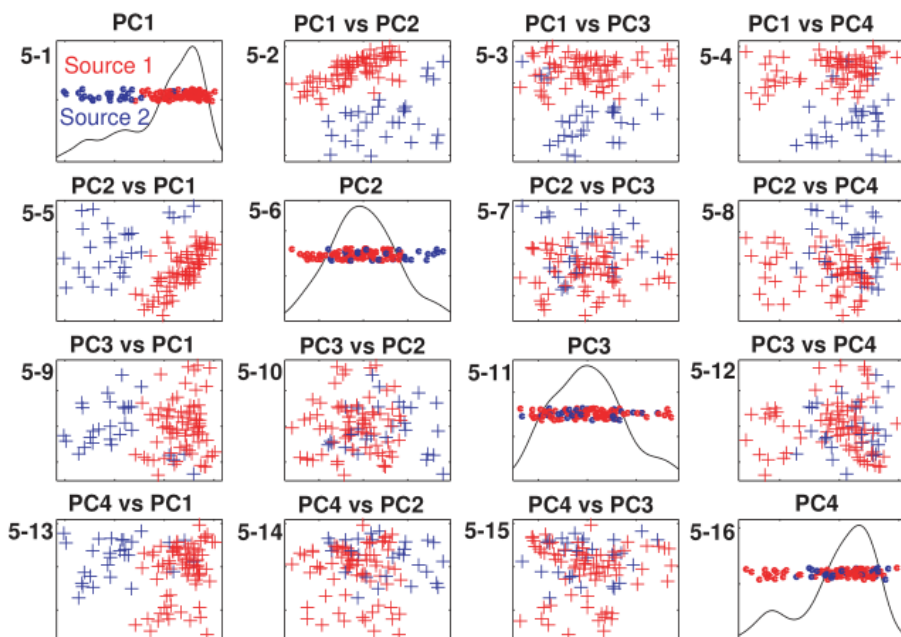
## DWD



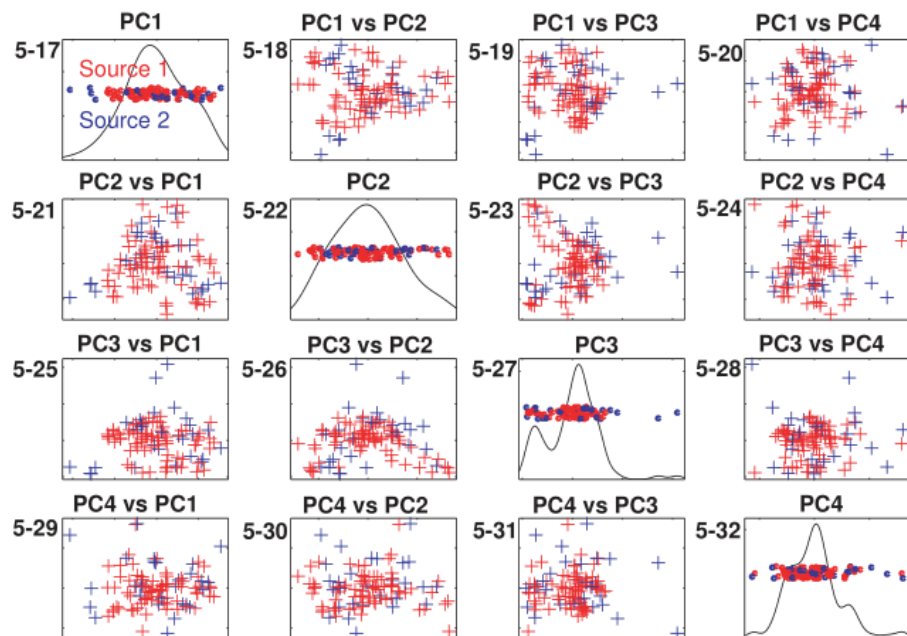
## SVM

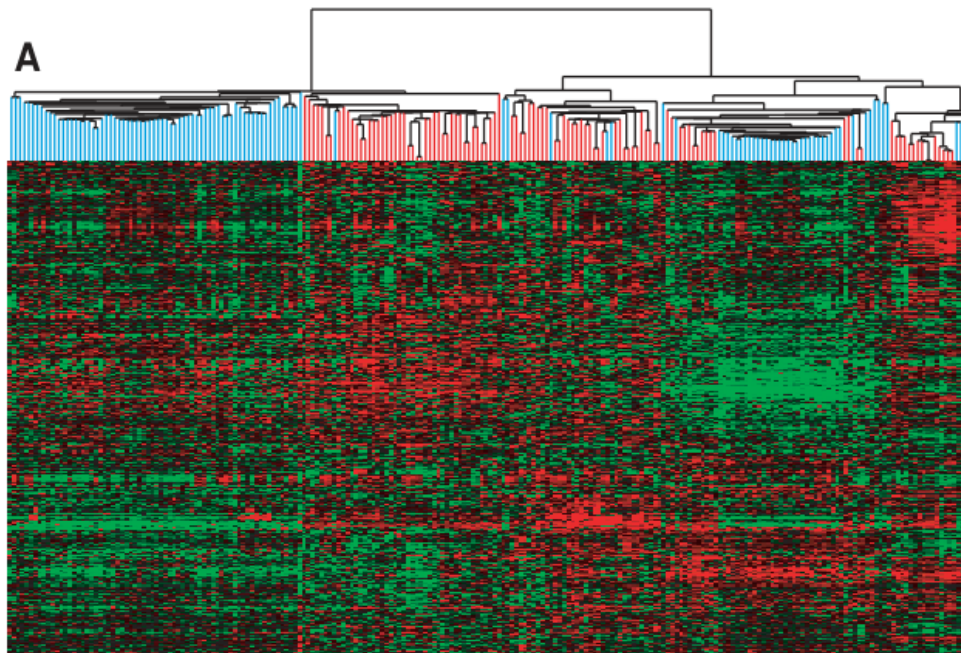


before DWD

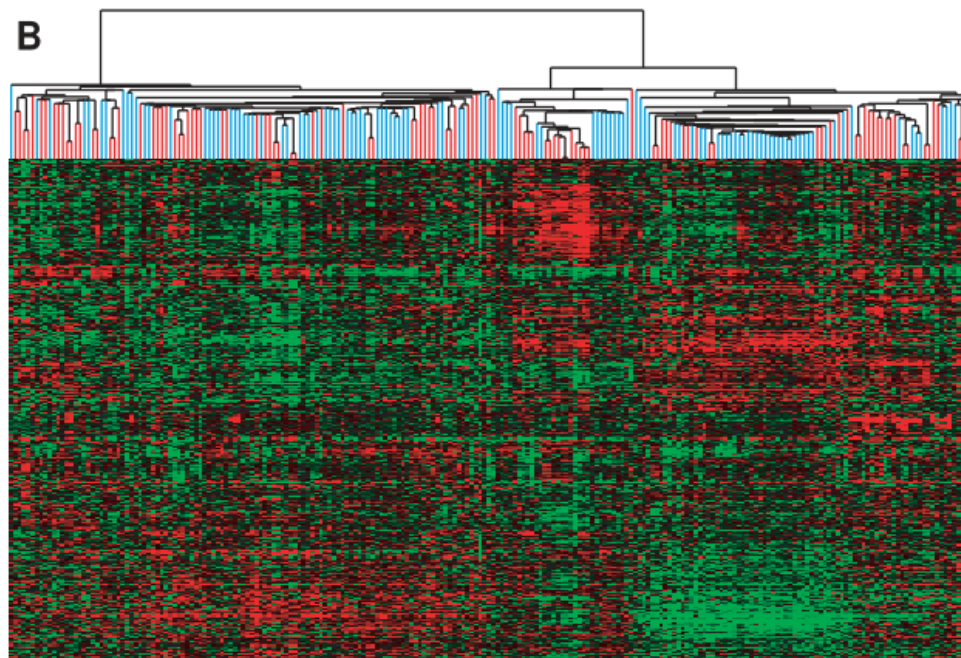


after DWD

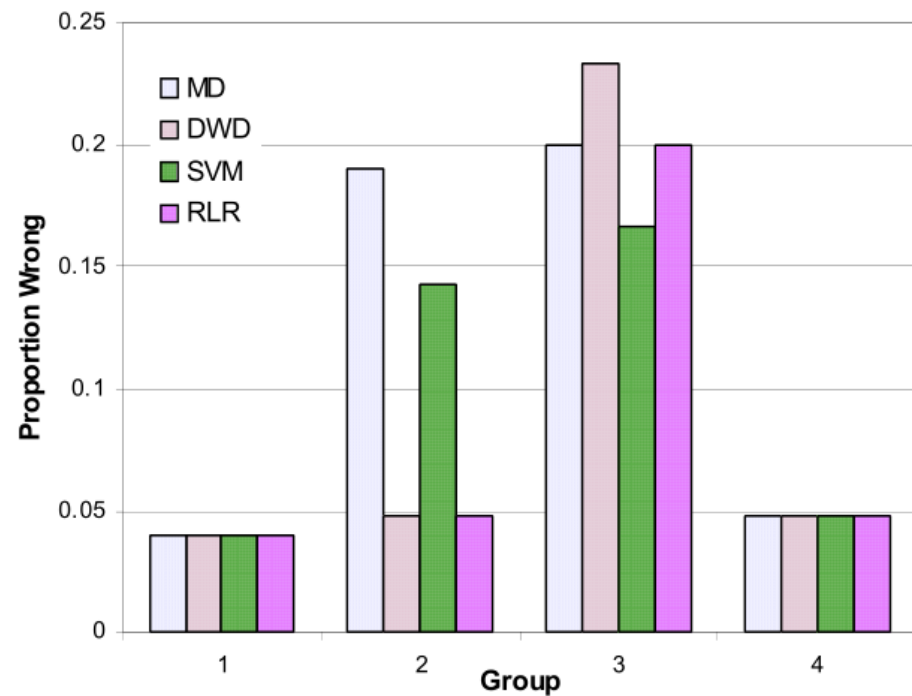




before DWD



after DWD



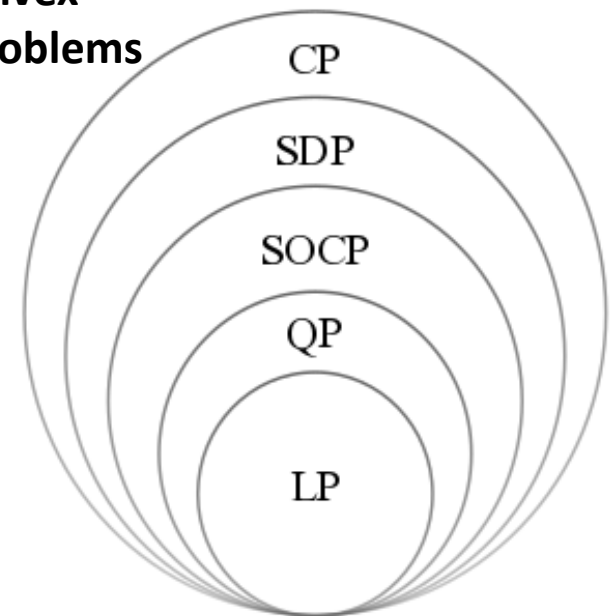
**(Group 1) Luminal vs. other cancer types**

**(Group 2) Luminal A vs. Luminal B & C types**

**(Group 3) Normal vs. Erb & Basal cancer types**

**(Group 4) Erb vs. Basal cancer types**

**hierarchy of convex  
optimization problems**



# Thank you!

