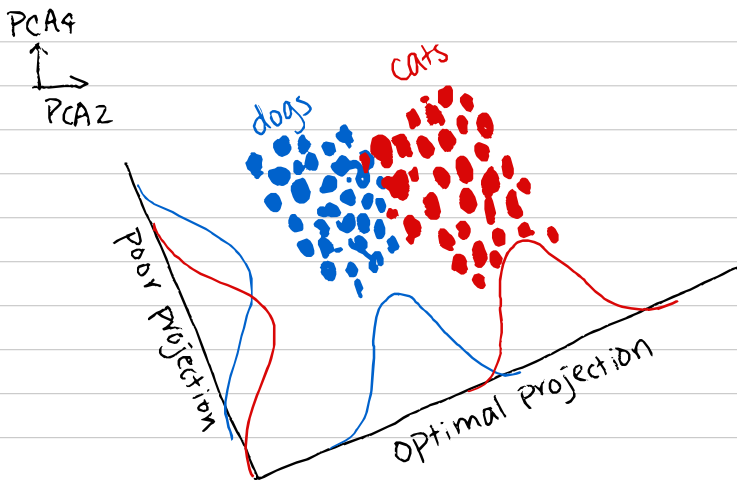## 5.6 Supervised Learning and Linear Discriminants

* Linear Discriminants Analysis (LDA)
  Goal: find a suitable projection that maximizes the distance
  between the inter-class data while minimizing the
  intra-class data.

* Mathematical Formulation for two-class LDA

Find a projection W such that: $W = \underset{W}{\text{argmax}} \dfrac{W^T S_B W}{W^T S_w W}$

S_B: between class. S_w: within class

$$S_B = (\mu_2 - \mu_1)(\mu_2 - \mu_1)^T$$

$$S_w = \sum_{j=1}^{2} \sum_{x \in D_j} (x - \mu_j)(x - \mu_j)^T$$

μ_1, μ_2: means of the first and second class
x: input data

These quantities measure the variance of the data sets as

well as the variance of the difference in the means.

We can find a solution for W via a generalized eigenvalue problem

$$S_B W = \lambda S_W W$$

where the maximum eigenvalue λ and its associated eigenvector give the quantity of interest and the projection basis.