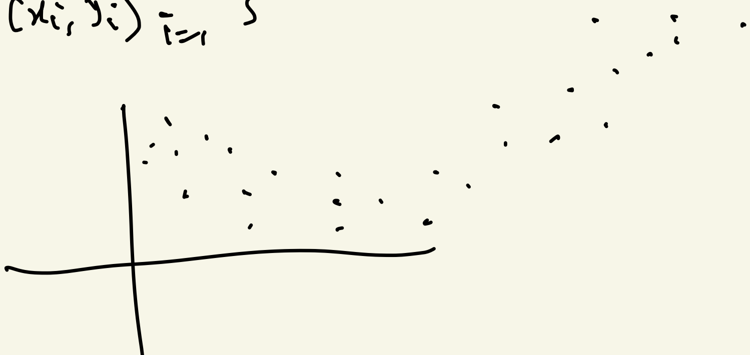
$\mathcal{D} = \{(x_i, y_i)_{i=1}^{N}\}$ ← given data

$x_i^T \in \mathbb{R}^p \quad \forall i \in \{1, \dots, N\}$

Choose basis functions $f_j(z) = z_j \quad \forall j = 1, 2, \dots, p$ where $z \in \mathbb{R}^p$ is $z = \begin{pmatrix} z_1 \\ z_2 \\ \vdots \\ z_p \end{pmatrix}$

Projection fns will give rise to our usual regression problem.

$\mathcal{D} = \{(x_i, y_i)_{i=1}^{N}\}$ and $x_i \in \mathbb{R} \quad \forall i = 1, 2, \dots, N$



$f_0(x_i) = 1 \quad \forall x_i$

$f_1(x_i) = x_i$

$f_2(x_i) = x_i^2$

$\vdots$

$f_p(x_i) = x_i^p$

$$f \approx \hat{f} = \alpha_0 f_0 + \alpha_1 f_1 + \cdots + \alpha_p f_p$$

$$\hat{f}(x) = \alpha_0 + \alpha_1 x + \cdots + \alpha_p x^p$$

Vandermonde matrix.

$$\Phi = \begin{bmatrix} 1 & x_1 & x_1^2 & \cdots & x_1^p \\ 1 & x_2 & x_2^2 & \cdots & x_2^p \\ \vdots & & & & \\ 1 & x_j & x_j^2 & \cdots & x_j^p \\ \vdots & & & & \\ 1 & x_N & x_N^2 & \cdots & x_N^p \end{bmatrix}_{N\times(p+1)} ; \quad y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_j \\ \vdots \\ y_N \end{bmatrix}_{N\times 1} ; \quad \alpha = \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \vdots \\ \alpha_p \end{bmatrix}_{(p+1)}$$

$$\hat{\alpha} = \underset{\alpha \in \mathbb{R}^{p+1}}{\operatorname{argmin}} \|\Phi\alpha - y\|_2^2$$

Binary classification problem:

$\mathcal{D} = \{ (x_i, y_i)_{i=1}^{N} \}$ $\quad$ $y_i \in \{1, -1\}$