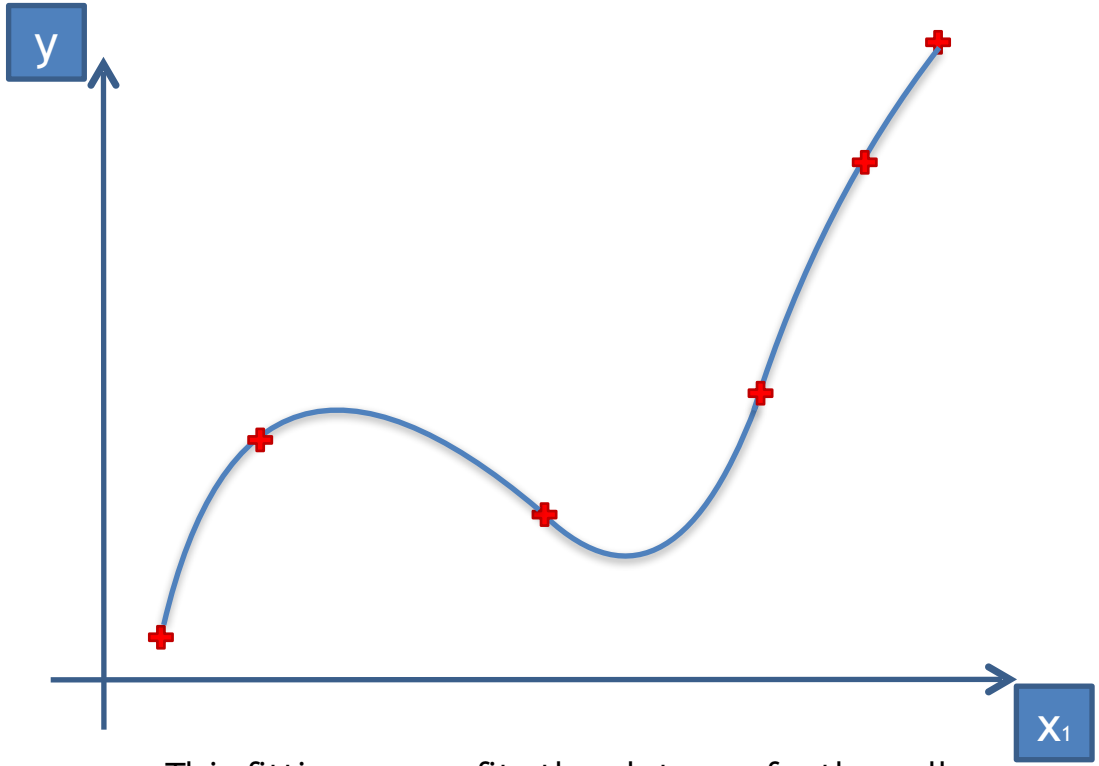
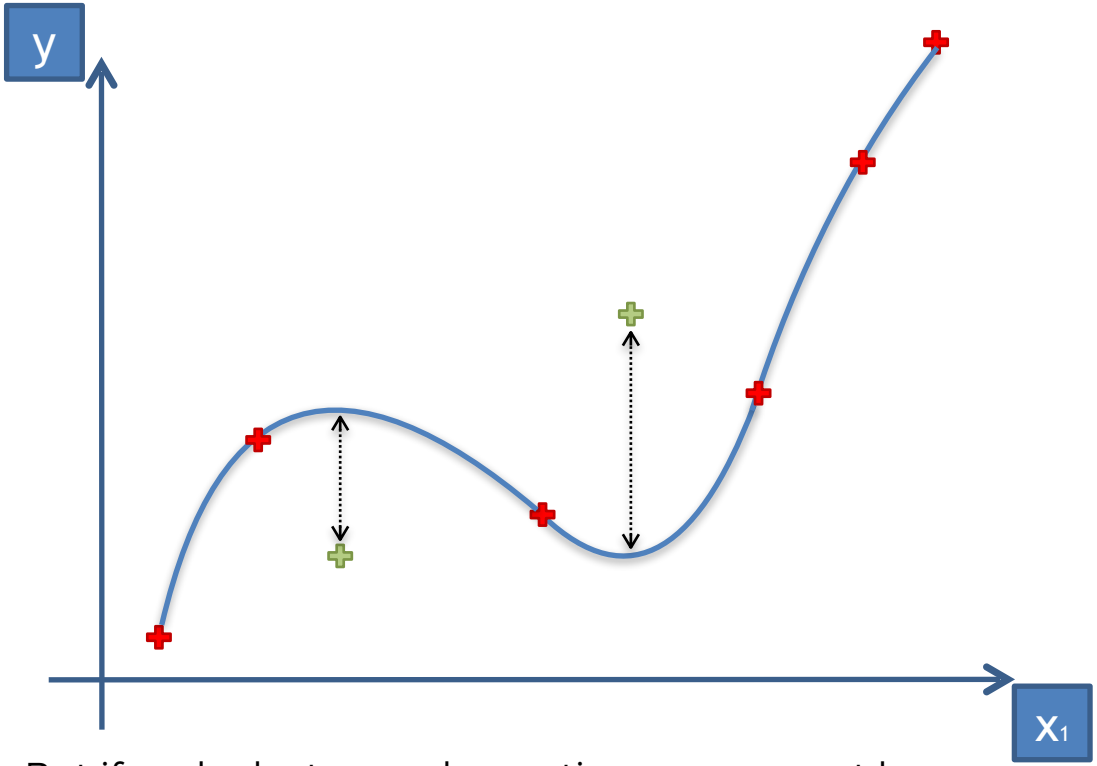
# Regularization Intuition

# The problem of Overfitting



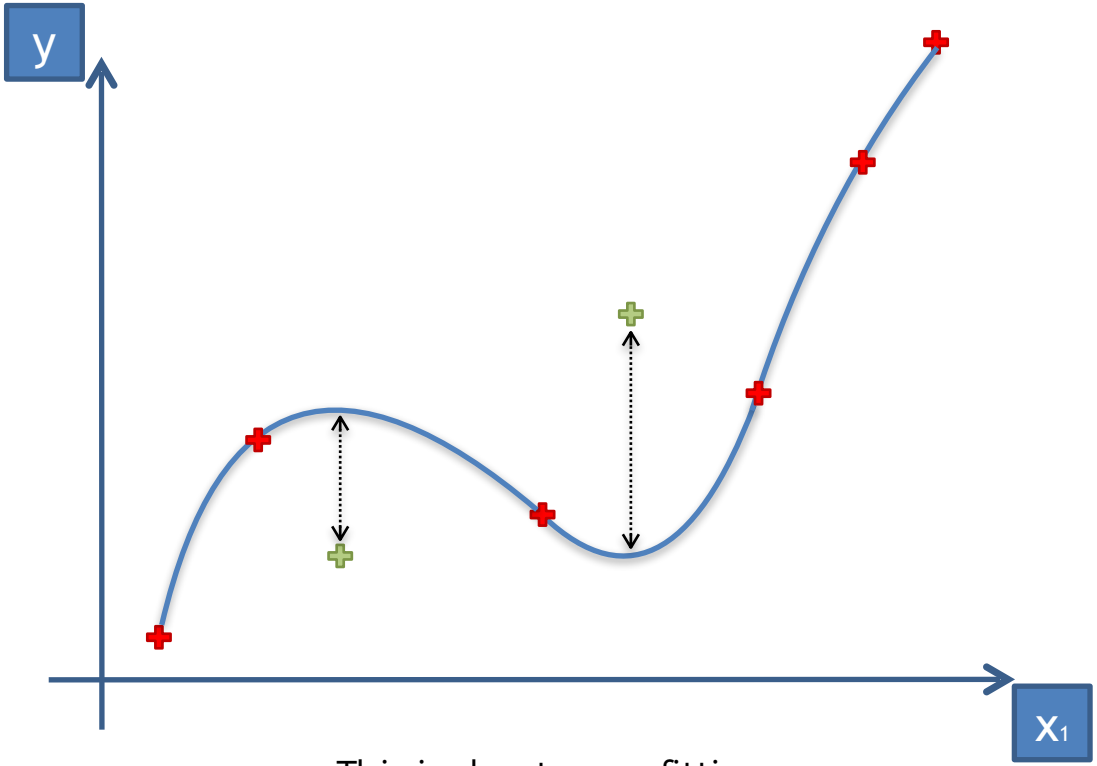

This fitting curve fits the data perfectly well

# The problem of Overfitting




But if we look at new observations, we can get large errors

# The problem of Overfitting

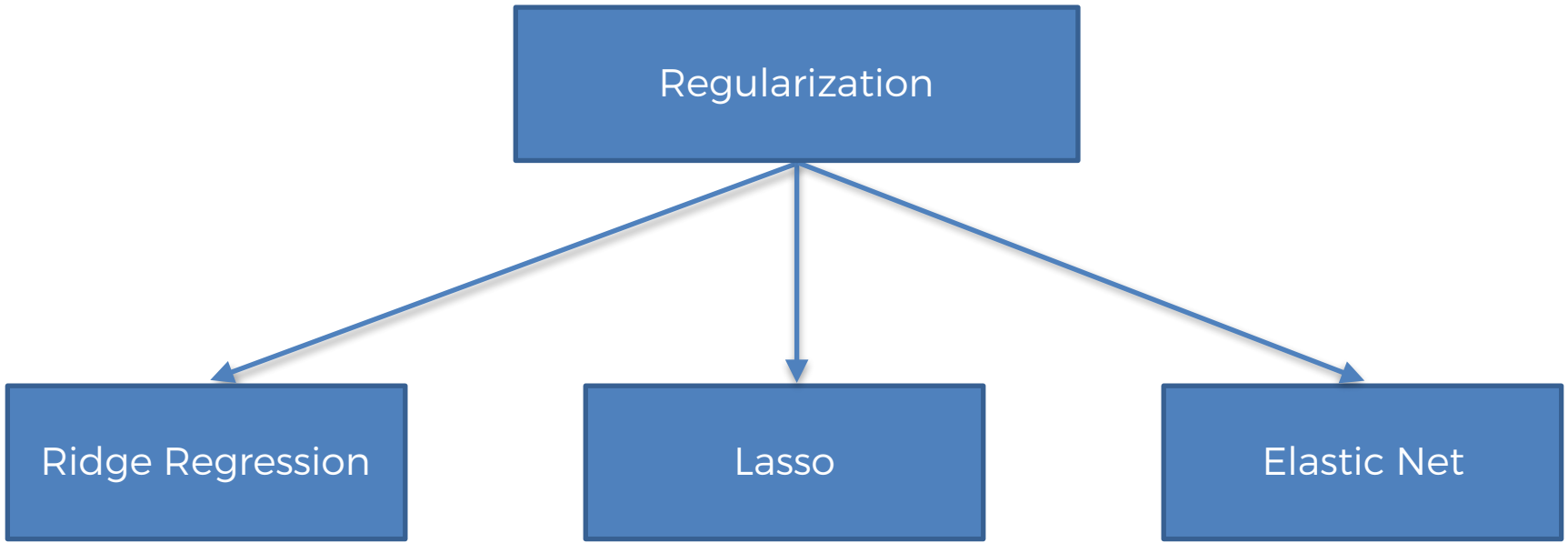



This is due to overfitting

# Solution

Regularization

# Examples of Regularization



# No Regularization

$$\text{Minimize} \sum_{i=1}^{n} \left(y^i - (b_0 + b_1 x_1^i + \ldots + b_m x_m^i)\right)^2$$

# Ridge Regression

$$\text{Minimize} \sum_{i=1}^{n} \left(y^i - (b_0 + b_1 x_1^i + \ldots + b_m x_m^i)\right)^2 + \lambda(b_1^2 + \ldots + b_m^2)$$

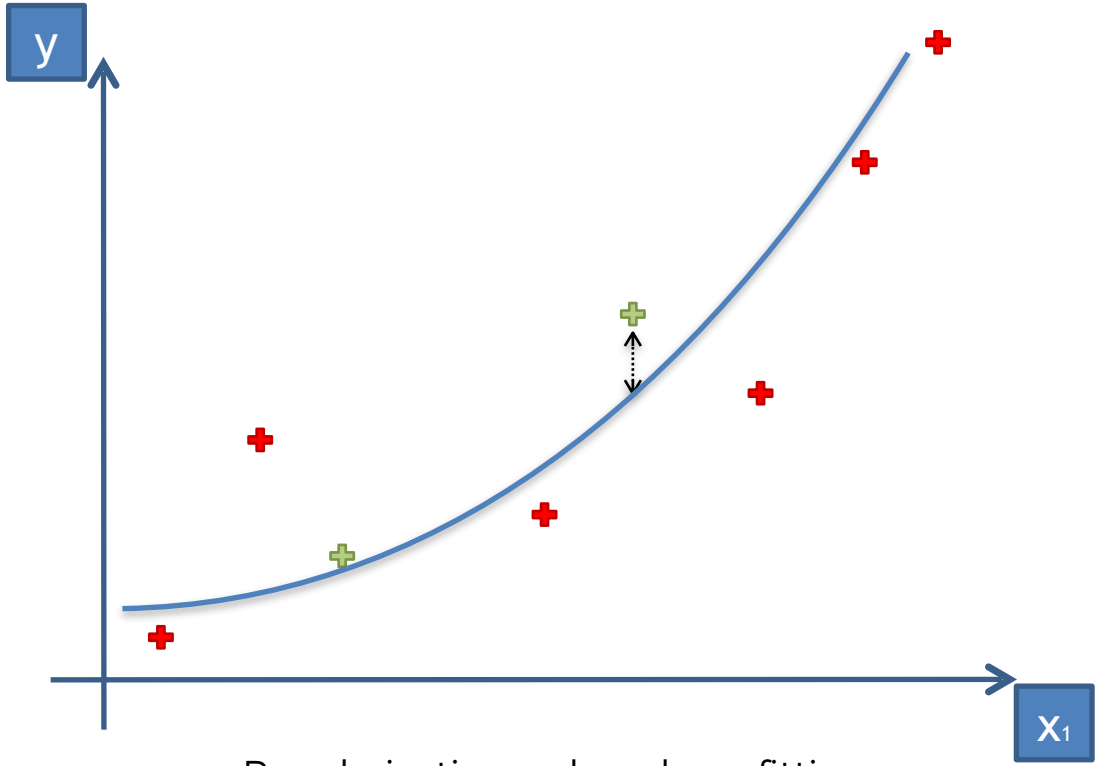
# Lasso

$$\text{Minimize} \sum_{i=1}^{n} \left(y^i - \left(b_0 + b_1 x_1^i + \ldots + b_m x_m^i\right)\right)^2 + \lambda\left(|b_1| + \ldots + |b_m|\right)$$

# Elastic Net

$$\text{Minimize} \sum_{i=1}^{n} \left(y^i - (b_0 + b_1 x_1^i + \ldots + b_m x_m^i)\right)^2 + \lambda_1 (|b_1| + \ldots + |b_m|) + \lambda_2 (b_1^2 + \ldots + b_m^2)$$

# Regularization




Regularization reduced overfitting