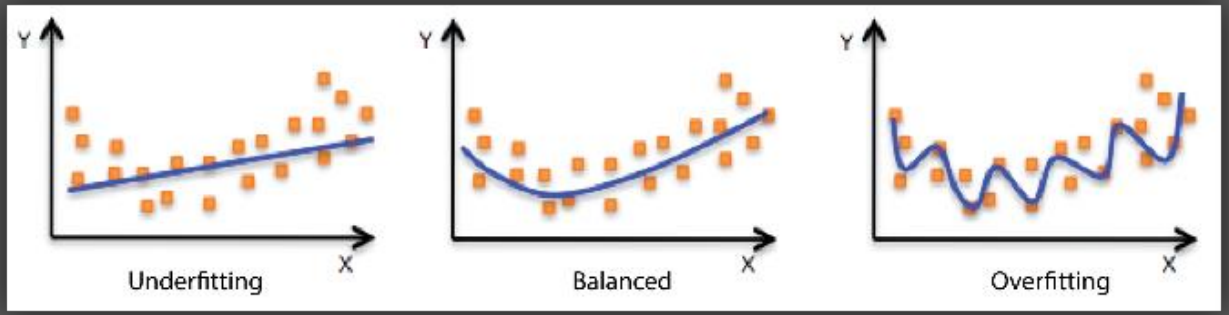
Discussion CAEsaaaaaar

Recap

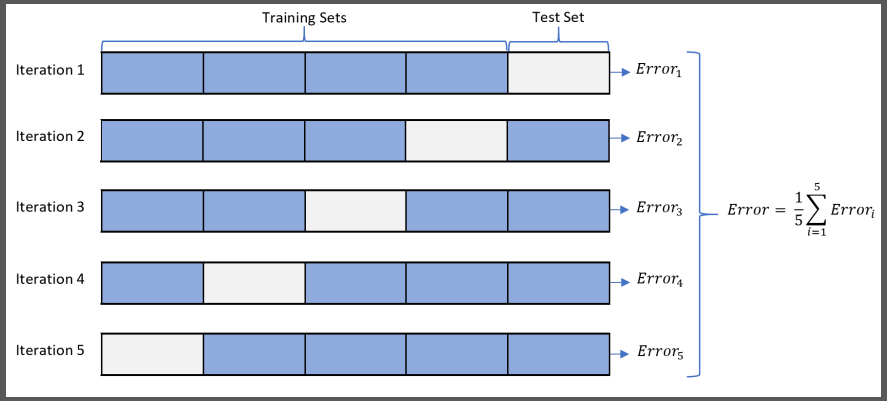


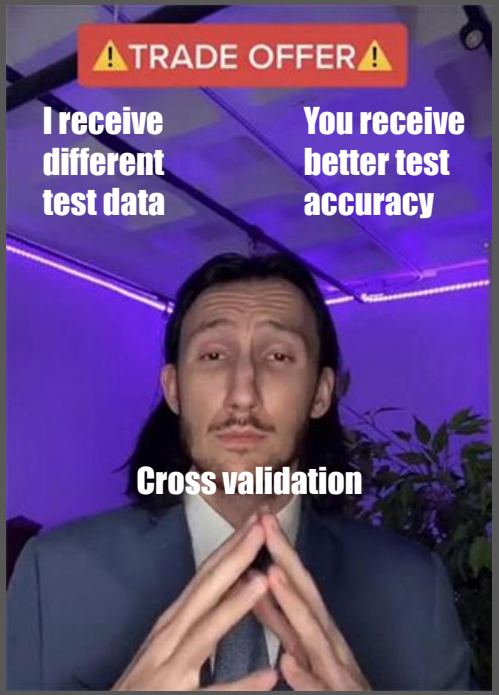
Motivation: we have validation dataset to measure how well the model is. But what if the validation dataset is poorly-chosen?

// for now, we can think validation is similar to test data //

← result in poor score

Solution: repeat the trials, change validation dataset, (test) average accuracy across all trials

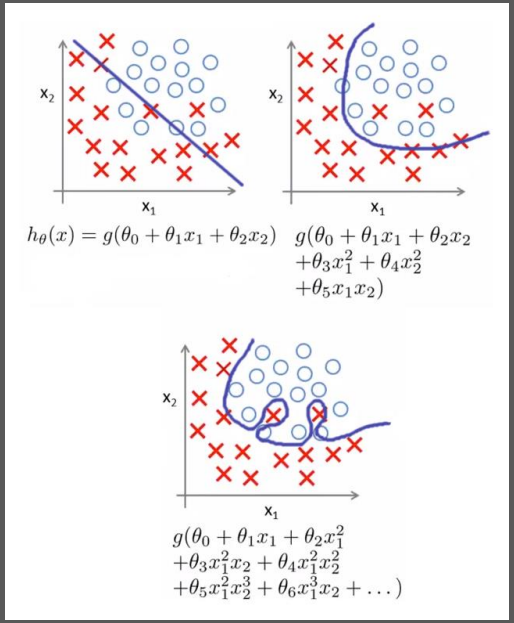




Recap: We can make the model more complex to capture non-linear data

Problem: What is the right degree complexity?

Or what features should be dropped?

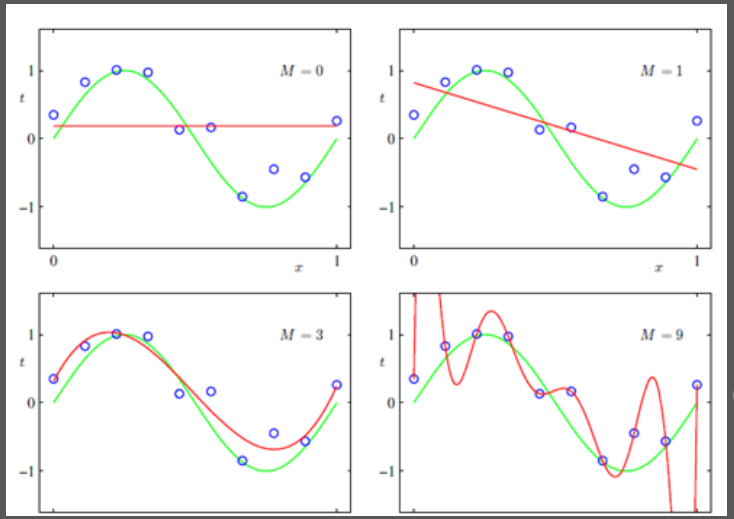


Solution: Re  rization

gura

Regularization

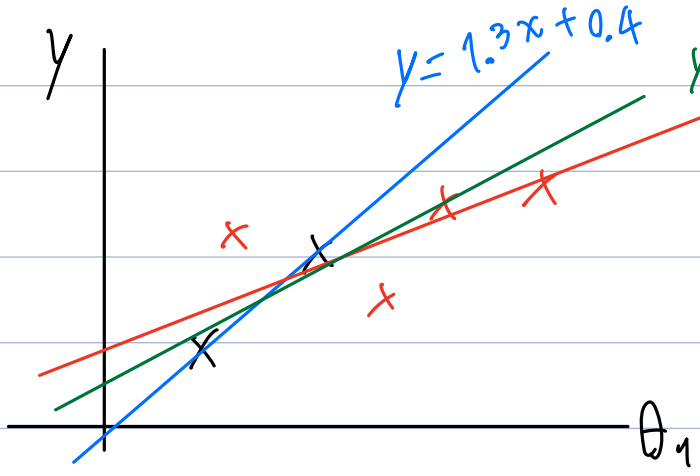
$y = ax + b$



$y = a_1 x + a_2 x^2 + a_3 x^3 + b$

$y = a_1 x + a_2 x^2 + \ldots + a_9 x^9 + b$

reminder : $\text{Cost}(\Theta) = \frac{1}{2m} \sum_i \left[\text{predicted}^{(i)} - \text{observed}^{(i)}\right]^2$



point: (1, 1.7), (2, 3)

Modify $Cost(\theta_1)$ to be $= \sum_i \left[predicted^{(i)}_{\theta_1} - observed^{(i)}_0 \right]^2$

$+ \lambda \times (slope)^2$

penalty term

$\lambda = 1$

Ex. Blue: $0 + (1)(1.3)^2 = 1.69$

Green: $\left[(1.7-1.5)^2 + (2.5-3)^2 \right] + 1(0.8)^2$

$= 0.04 + 0.25 + 0.64$

$= 0.93$

lower cost function value

Expand from this 2D example to 3D, each feature has its own slope a_i, then in general

Ridge regression: $Cost(a) = \frac{1}{2m} \sum_i (pred^{(i)}_a - obs^{(i)})^2$

$+ \lambda \left(a_1^2 + a_2^2 + \dots + a_n^2 \right)$

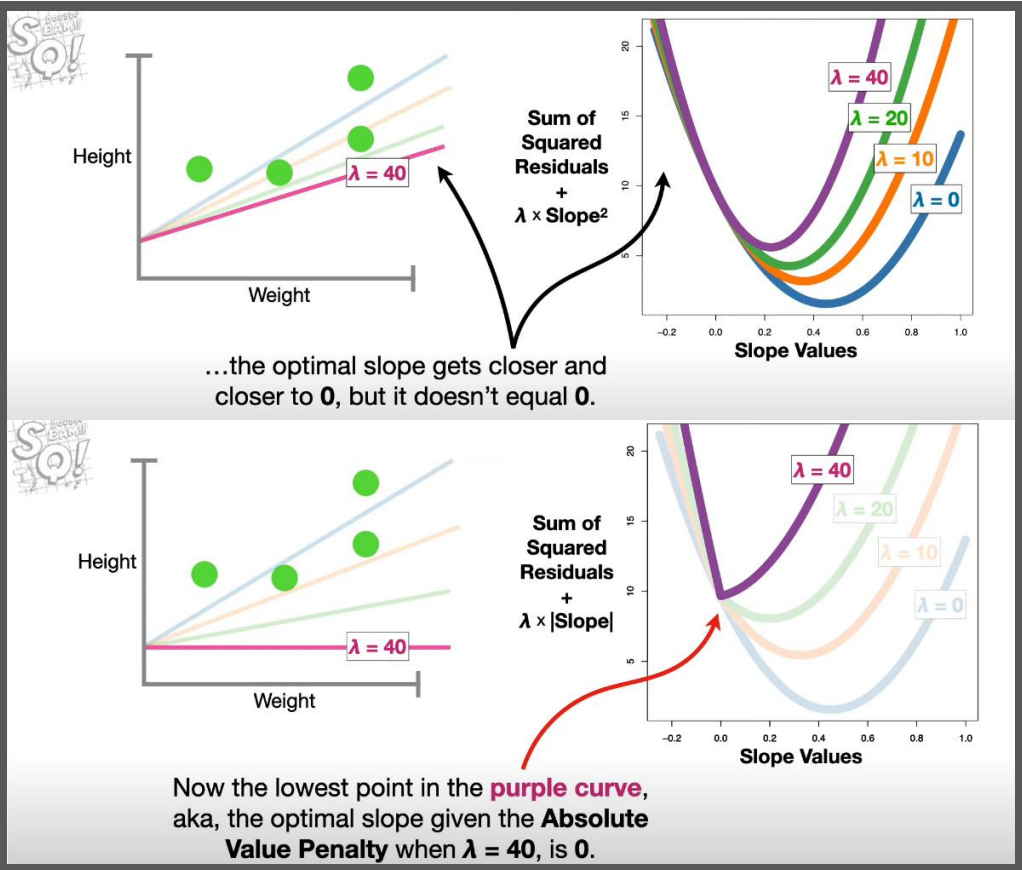
Key takeaway: We find a way to make the model underfits, so we can get higher testing accuracy even if training accuracy is low

Note: there is another type of regularization, which is called **Lasso**

The difference is that the penalty term, we use **absolute** instead of squaring the parameters

Ridge	Lasso
Squared the parameters	Take absolute of the parameters
Parameters get close to zero	Parameters can reach zero
Better when we believe every parameters are useful	Can exclude useless parameters

$$\text{Cost}(\theta) = \frac{1}{2}\sum_{i=1}^{n}(\text{predicted}_{\theta}(x_i) - y_i)^2 + \lambda\sum_{i}^{n}|\theta_i|$$



Statquest Youtube video: Ridge vs Lasso Regression, Visualized!!!

https://www.youtube.com/watch?v=Xm2C_gTAl8c

But you know, I learned something today

- We use cross validation to average models across all trials, instead of accidentally pick the invalid test data
- We use ridge/lasso regression to lower training accuracy, but get higher test accuracy