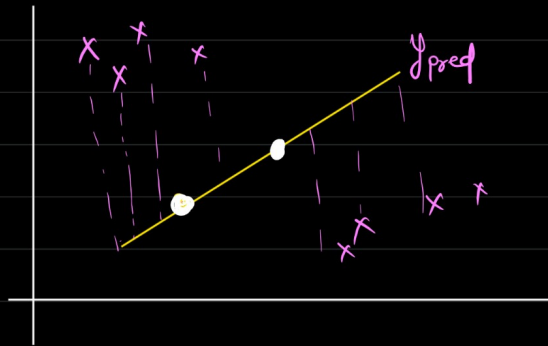


# \* Regularized linear models

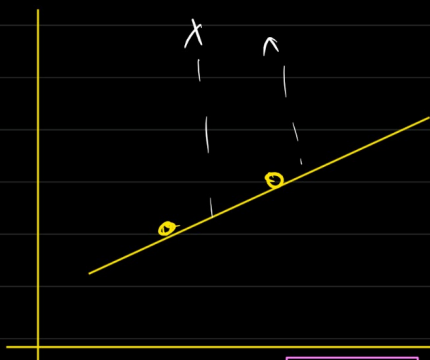
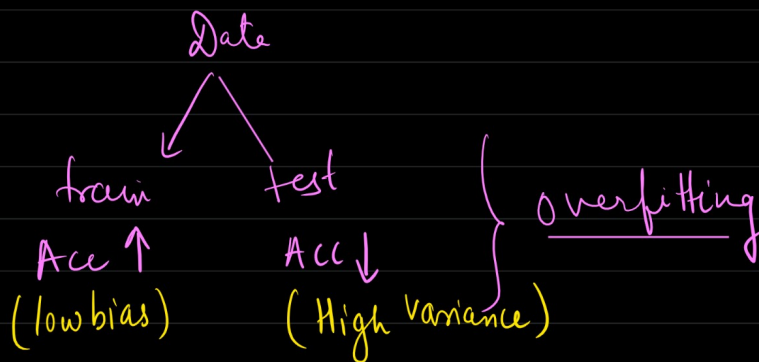
\* Regularisation → To add something to reduce overfitting.

↓  
To regularise  
↓  
To penalize.



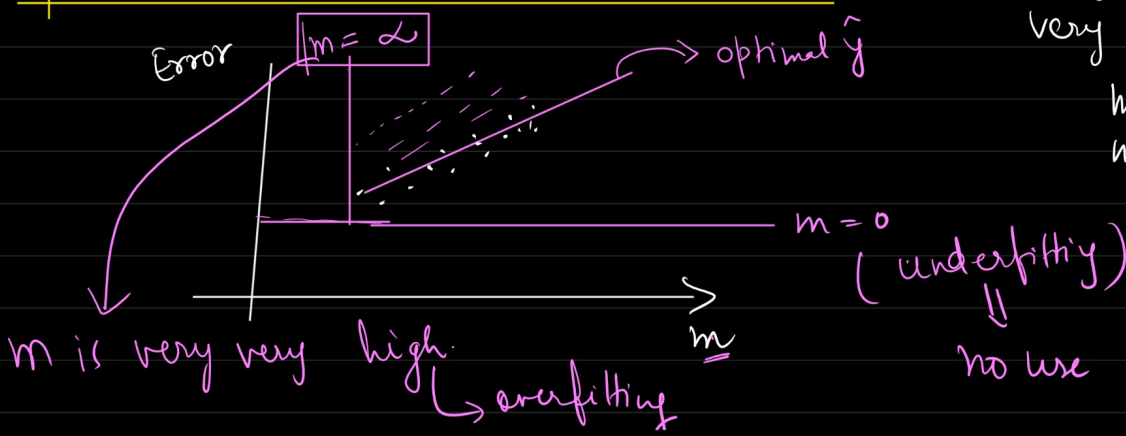
overfitting.

⇓  
model performing well  
on train data, bad  
on test data



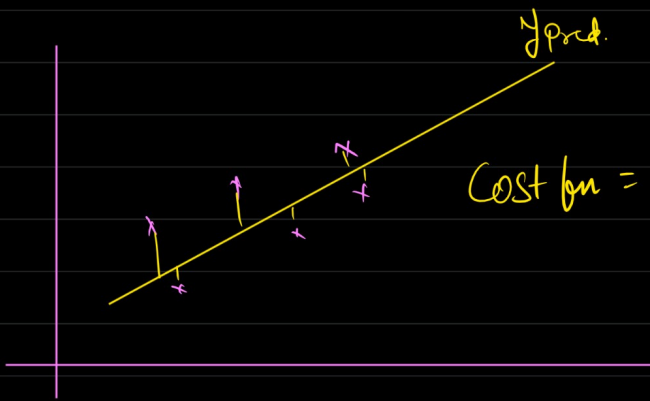
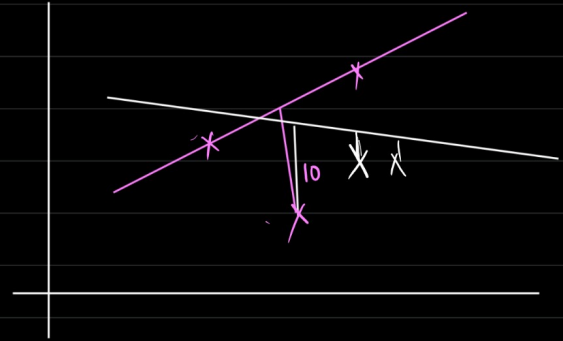
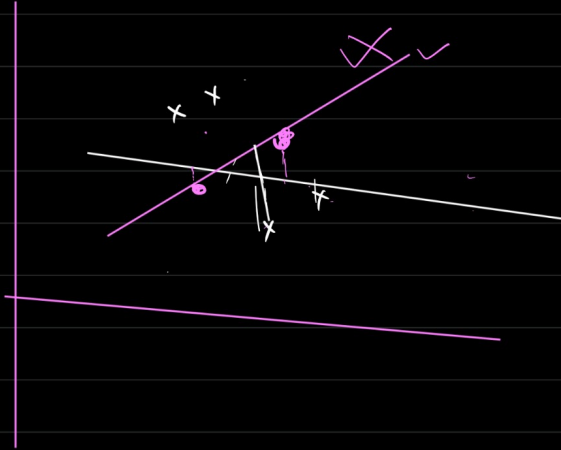
$$y = \textcircled{m}x + c$$

$m$  magnitude is  
very very high →  
model has  
memorised the  
datapoints



$$y = \underbrace{m}_{\infty} x + \underbrace{c}_{\infty}$$

$\infty \rightarrow$  very very large  $\rightarrow$  Overfitting.

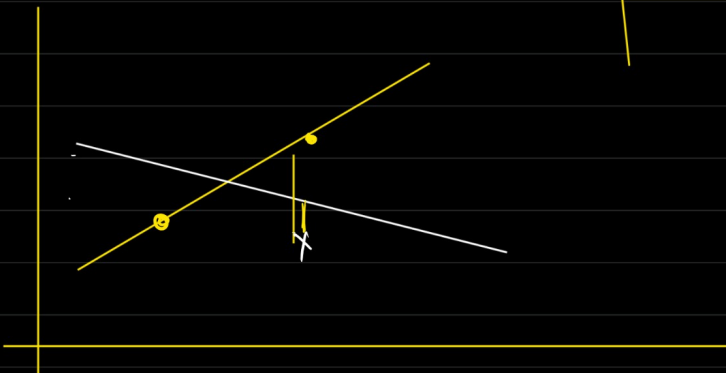
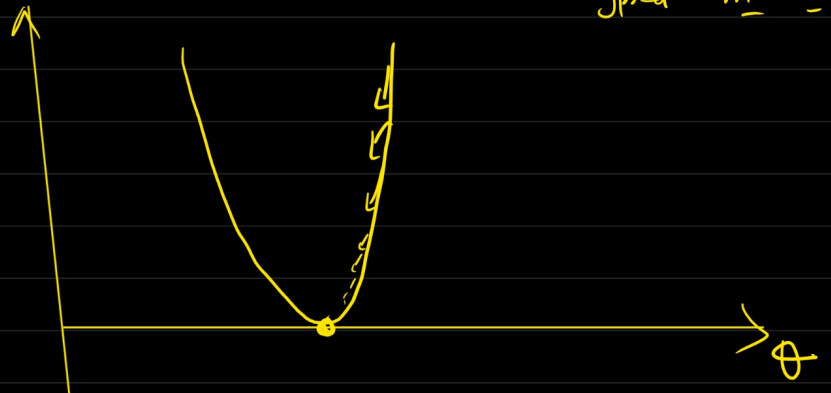


$$\text{Cost fn} = \frac{1}{n} \sum_{i=1}^n (y_{\text{fact}} - y_{\text{pred}})^2$$

$$h_{\theta}(x) = \theta_0 + \theta_1 x$$

$$y_{\text{pred}} = \underline{m}x + \underline{c}$$

$J(\theta)$



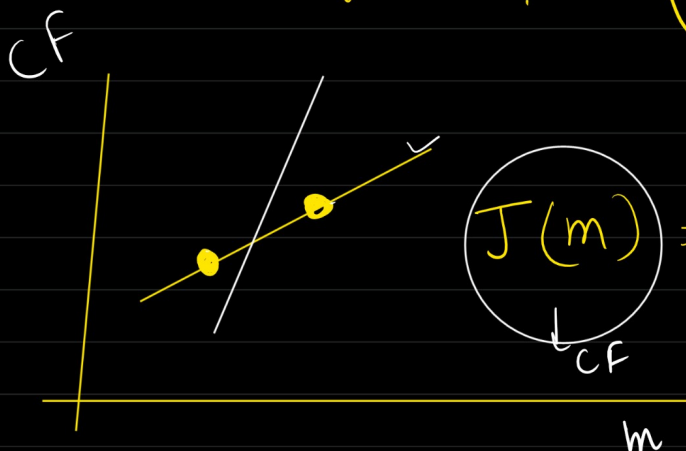
$$\text{Cost fn} = \frac{1}{n} \sum_{i=1}^n (y_{\text{act}} - y_{\text{pred}})^2 + \lambda(m^2)$$

$$h_0(x) = \theta_0 + \theta_1 x$$

$$y_{\text{pred}} = mx + c$$

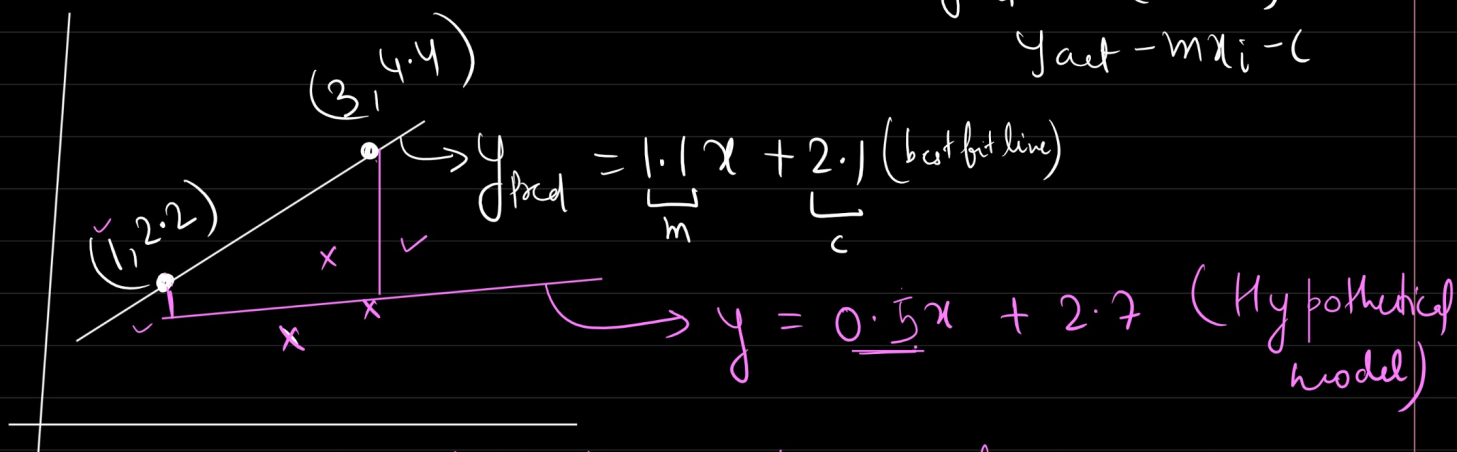
regularisation  
parameter

$$= \frac{1}{n} \sum_{i=1}^n (y_{\text{act}} - \underline{mx_i - c})^2 + \underline{\lambda m^2}$$



$$J(m) = \frac{1}{n} \sum_{i=1}^n (y_{\text{act}} - y_{\text{pred}})^2 + \lambda(m^2)$$

Annotations:  $y_{\text{act}} - (mx_i + c)$  and  $mx_i + c$  are shown below the equation.



$\lambda = 1$  (best fit line)

$$y_{\text{pred}} = 1.1x + 2.1$$

$$\begin{aligned} CF &= (y_{\text{act}} - y_{\text{pred}})^2 + \lambda m^2 \\ &= 0 + 1 \cdot (1.1)^2 \\ &= 1.21 \end{aligned}$$

$\lambda = 1$  for hypothetical model.

$$y_{\text{pred}} = 0.5x + 2.7$$

$$\begin{aligned} CF &= (y_{\text{act}} - y_{\text{pred}})^2 + \lambda m^2 \\ &= (2.2 - 0.5 \times 1 - 2.7)^2 \\ &\quad + (4.4 - 0.5 \times 3 - 2.7)^2 \\ &\quad + (0.5)^2 \end{aligned}$$

$$CF = 1.29$$

the hypothetical line will make  
wrt a lot of error  
to training data  
 $\rightarrow \lambda m^2$

bias  $\uparrow$  Variance  $\downarrow$

$CF + \lambda m^2$   
 $\rightarrow$  Ridge regression

\* Regularisation:-

- ① Ridge regression.
- ② Lasso regression
- ③ Elastic regression