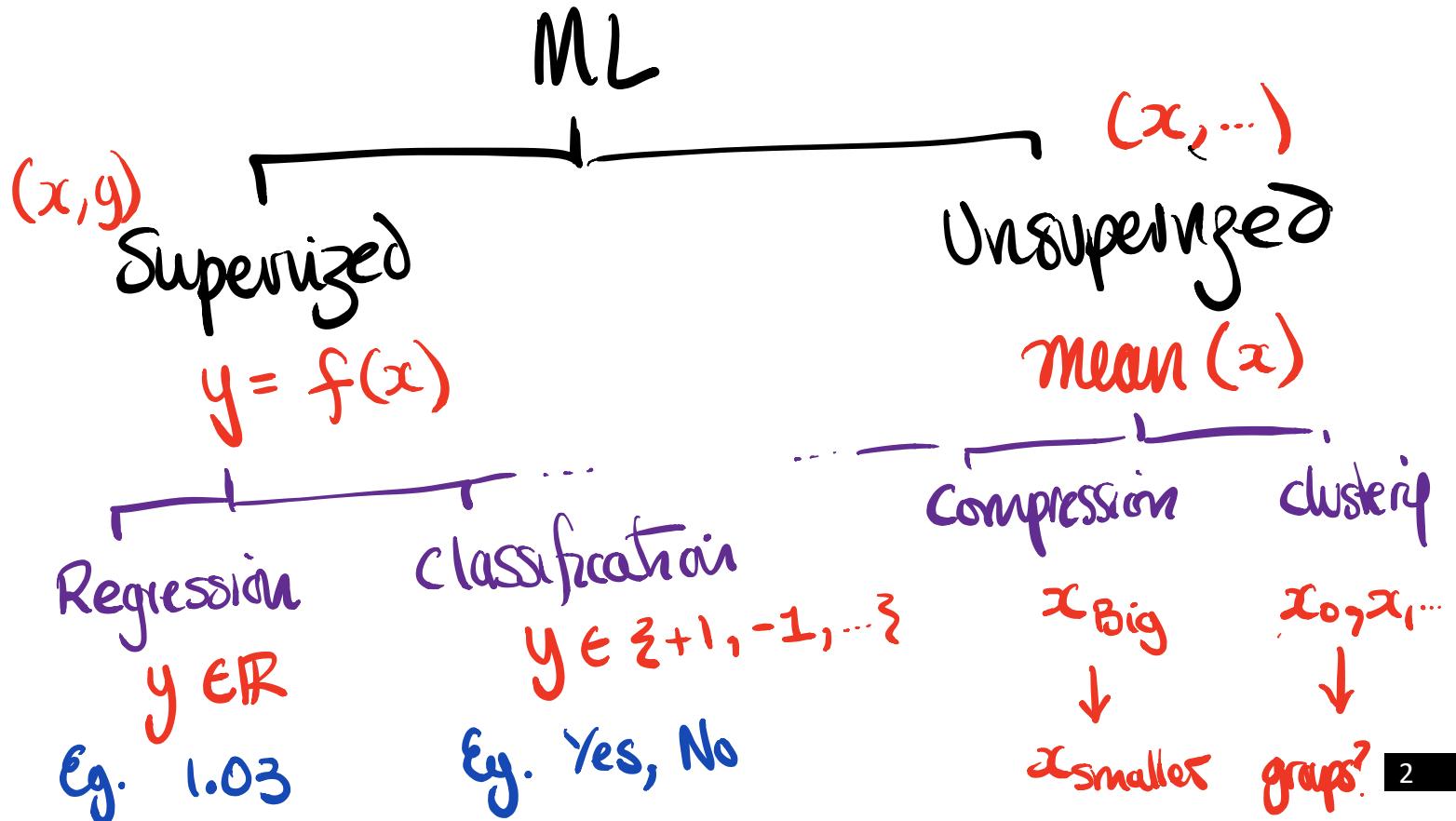


Introduction to Machine learning

How do Machines "learn"?

Review : Map of ML



Supervised ML

$\omega = (x, y)$ Actual Historical cases

FIND: $\hat{y} = \hat{f}(x)$

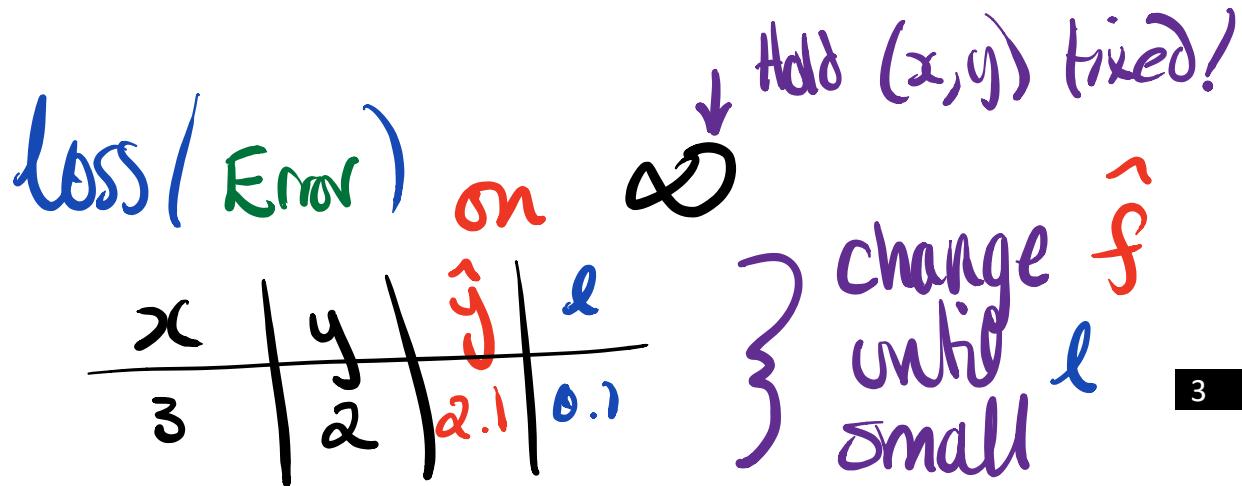
↑ Estimate

$\hat{y} - y$

Error

USE:

z



Aside :

MODEL

$$\hat{y} = \hat{f}(x) = \underbrace{ax + b}_{\text{Variable}} \quad \begin{matrix} \text{constant} \\ \leftarrow \end{matrix}$$

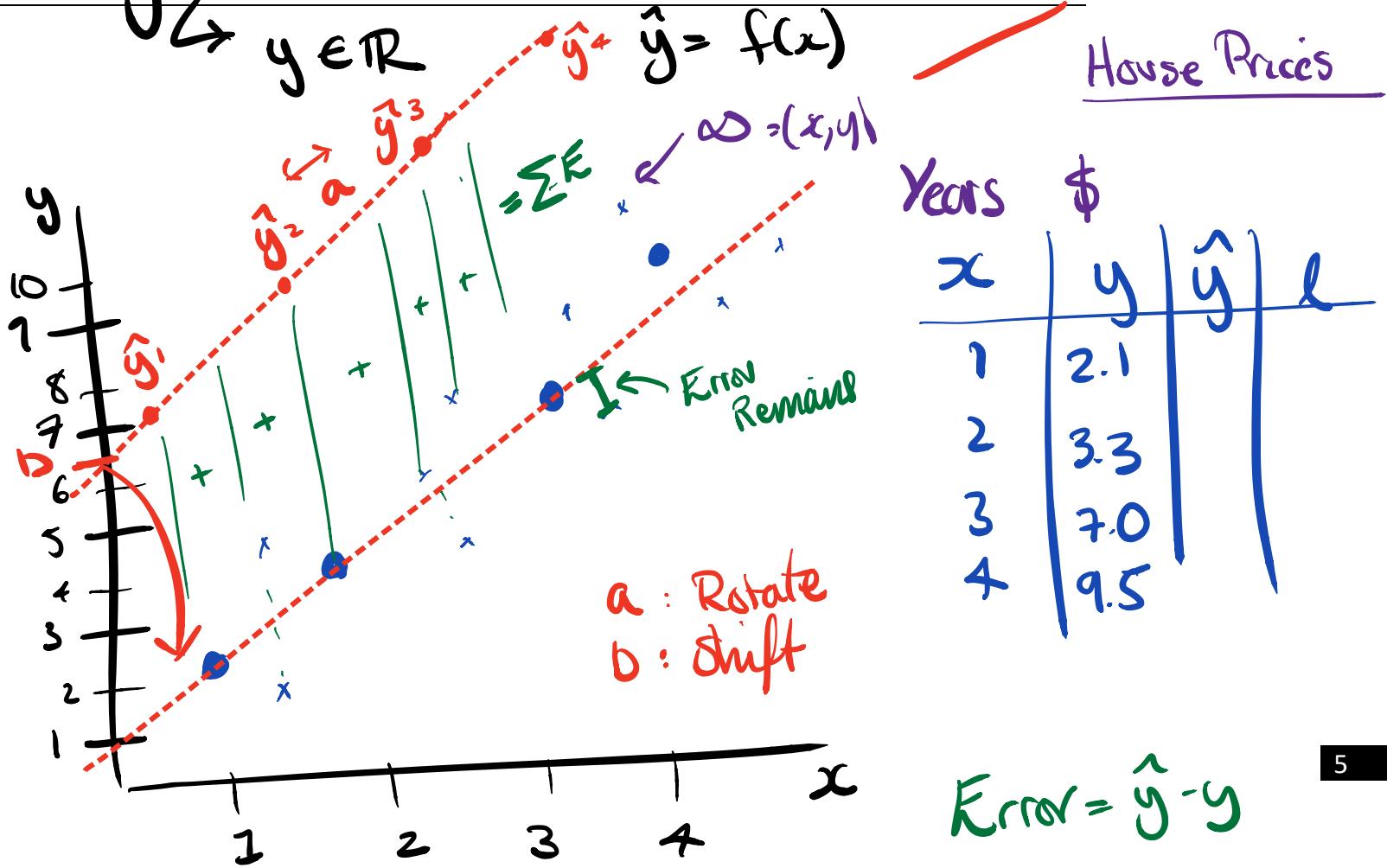
$$= \hat{f}(x; a, b)$$

\leftarrow variable \rightarrow Parameters = Constants

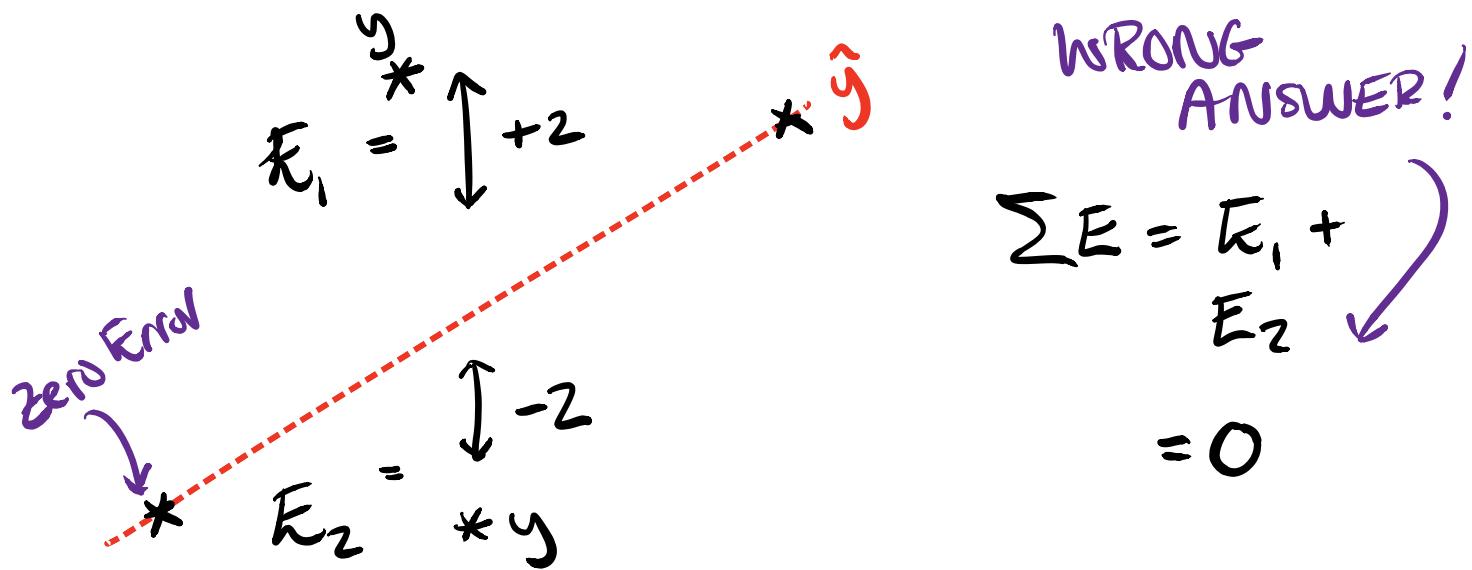
LOSS : Bespoke formula, Error per Point

$$l(\hat{y}, y) = (\hat{y} - y)^2 = \left[\underbrace{(ax + b)}_{\substack{\text{fixed from} \\ \infty}} - \underbrace{y}_{\text{fixed from } \infty} \right]^2$$

Regression : linear

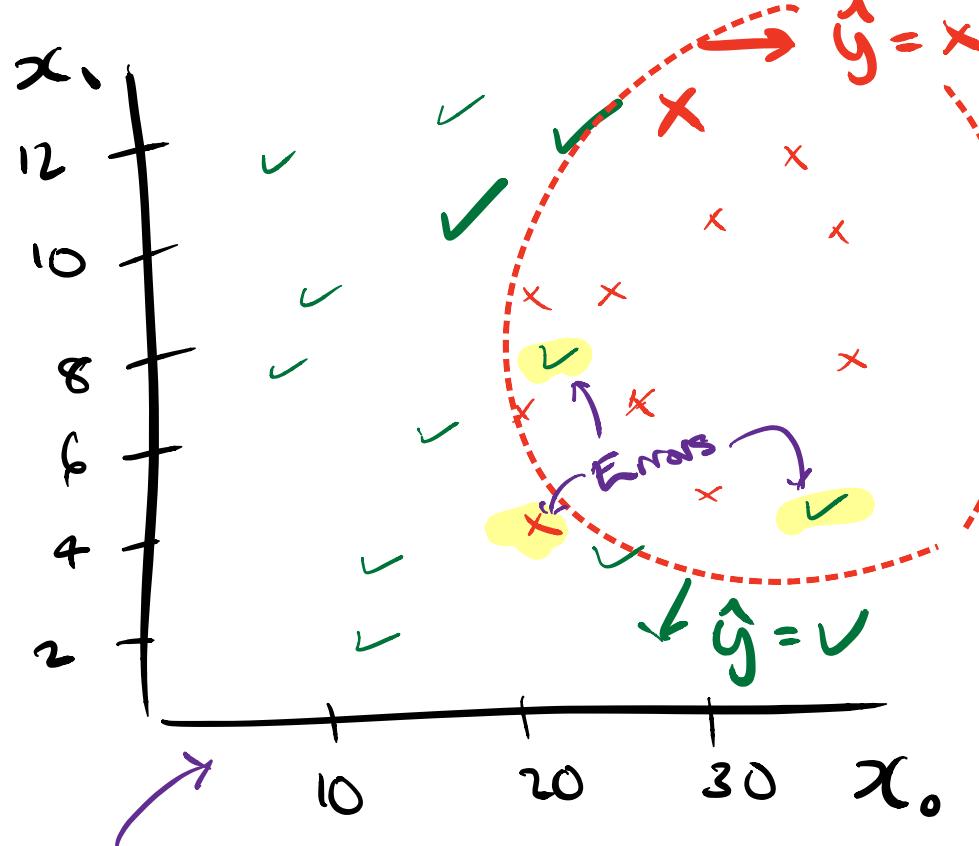


Why $\ell(\hat{y} - y) = (\hat{y} - y)^2$?



$$(-2)^2 + (2)^2 = 4 + 4 = \underline{\underline{8}}$$

Classification



$$f(x) = a / (x_0 + x_1 - r)^2$$

Age Ticket Like?

x_0	x_1	y	\hat{y}
18	10	✓	✗
30	12	✗	✗
25	11	✓	✓

Axis Shows IR No., e.g. x

Unsupervised learning

Compression

Clustering

aka.

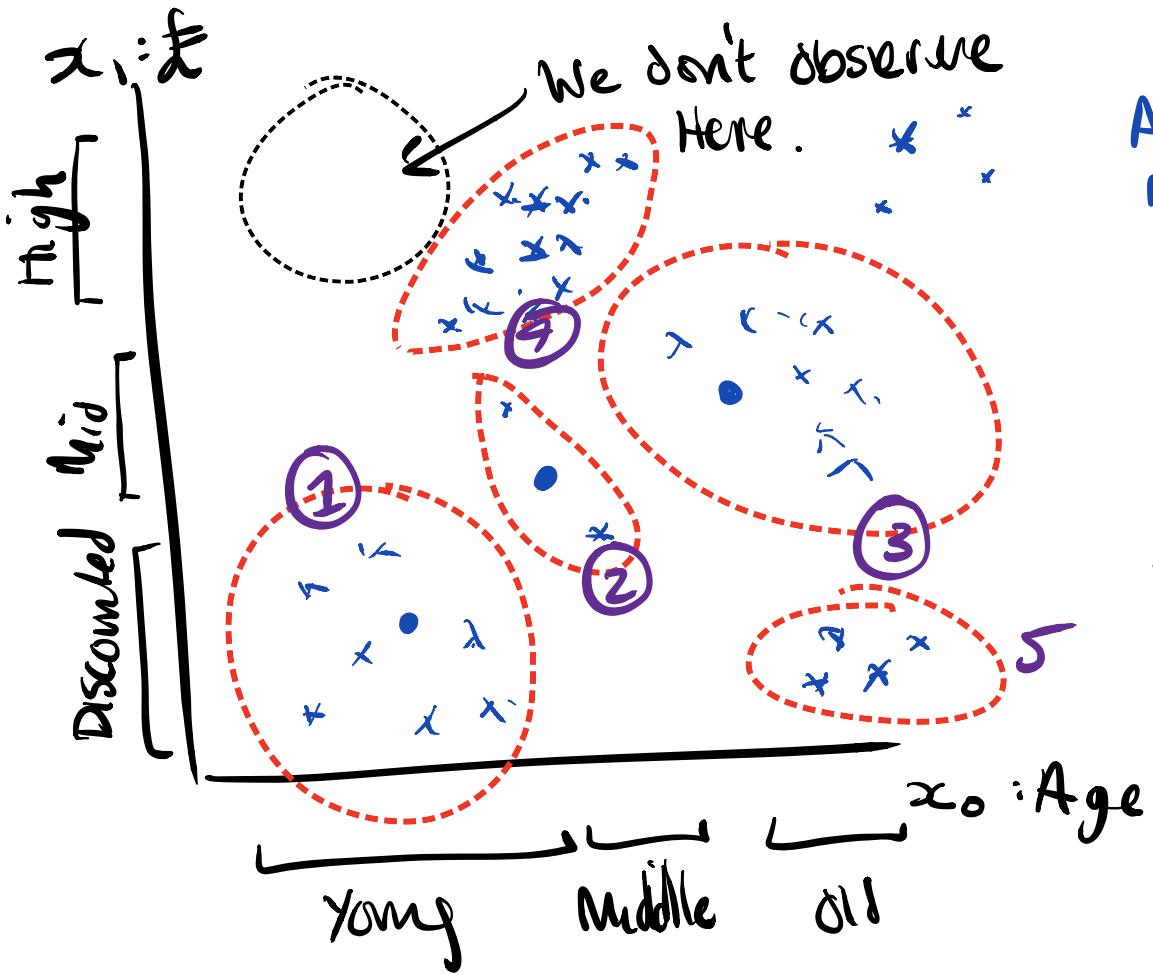
"Dimensionality
Reduction"

aka.

"Grouping"

Clustering

① Machine Draws Group Boundaries
 ↳ ② We Interpret



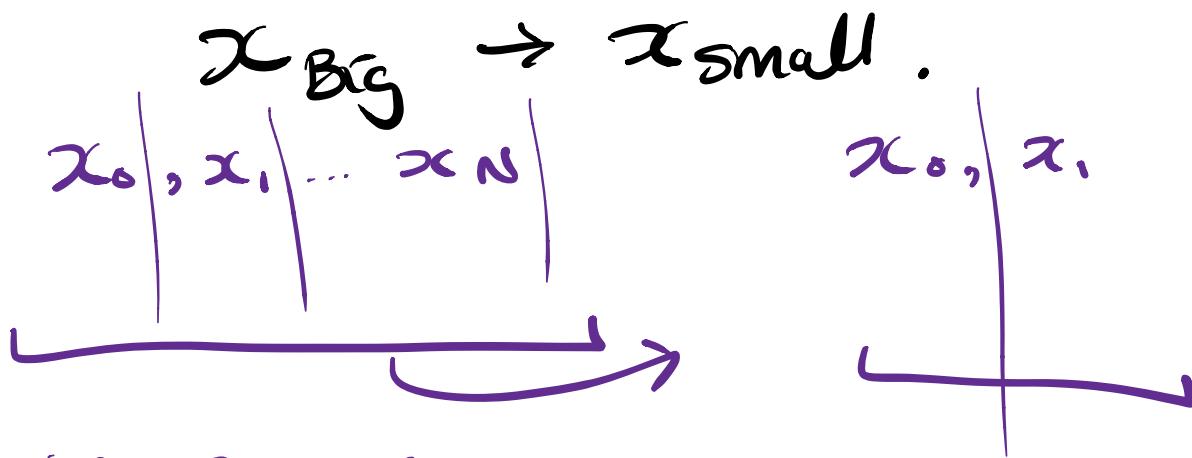
Add ③

Age	Ticket
x_0	x_1
18	10
30	12
25	11

~~Y~~ H

- 1: Children
- 2: Unemployed
- 3: Employed
- 4: High Taxes
- 5: Retired

Compression



Reducing columns

aka Dimensions

Dimension \cong "Distinct Column"

Eg. Compression #1

$$m = \text{mean}(x_s)$$

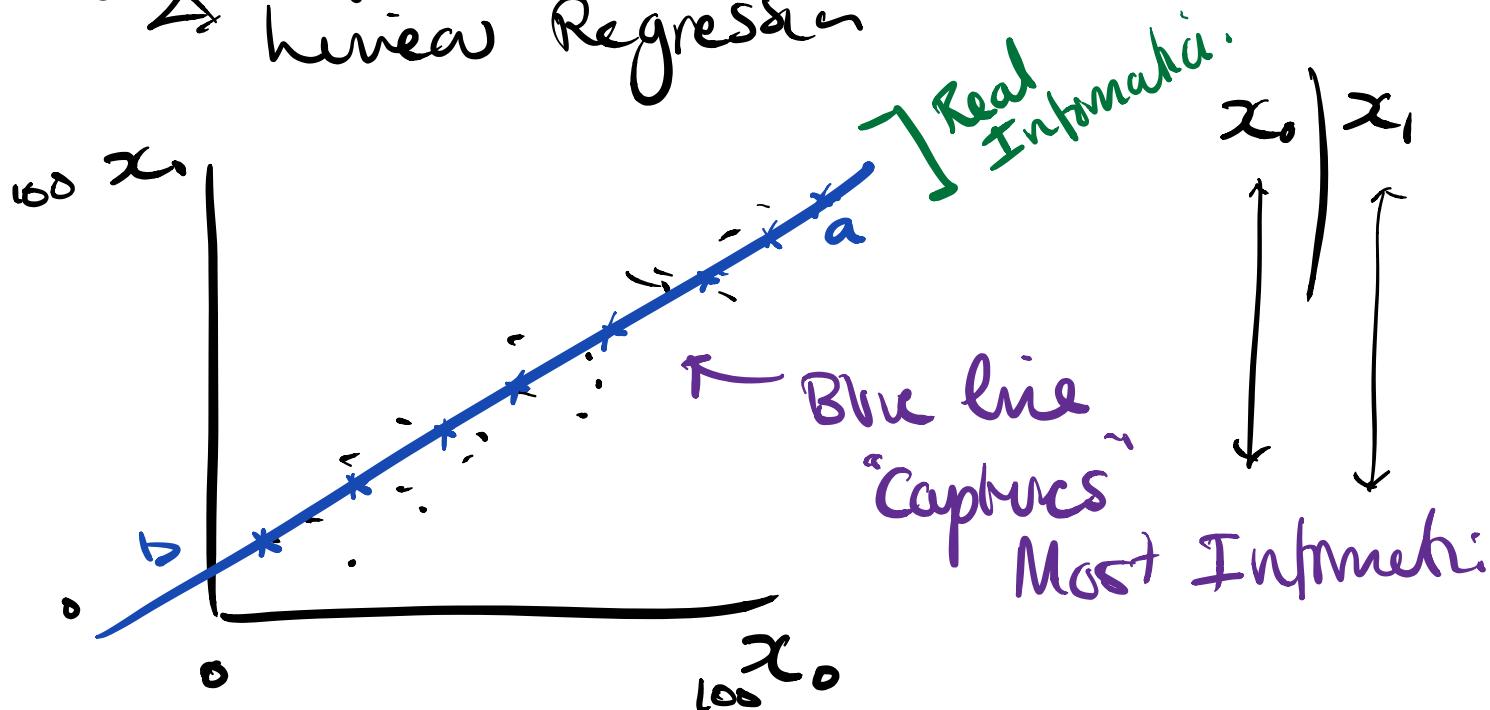
single value

column

Means Are
Compression

Eg. Compression #2

↳ Linear Regression



$$x_1 = \alpha x_0 + \beta$$

0 to 160 0 to 100

Aside : PCA

↳ Aprox. linear Reg. for All Cols

x_0	x_1	x_2	\dots	x_{1000}
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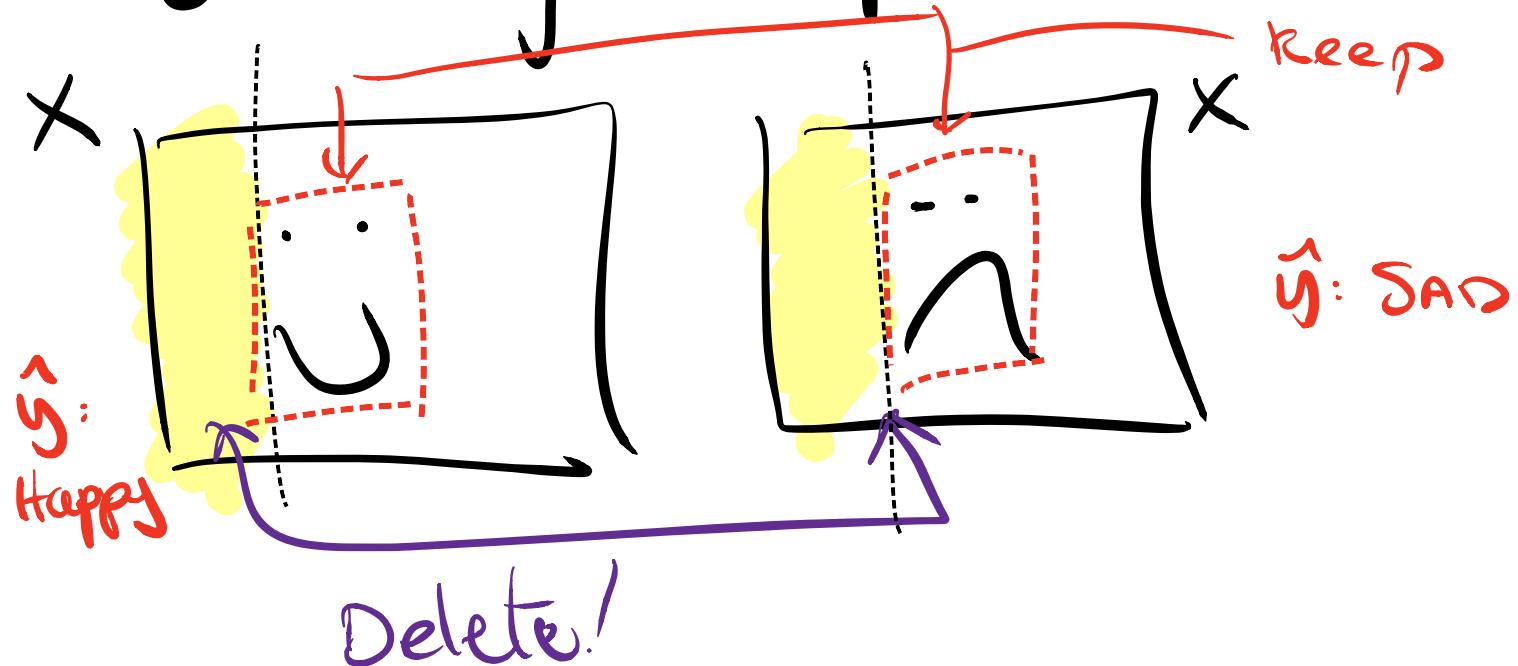
$$x_0 = \textcircled{a} x_1 + \textcircled{a} x_2 - \dots + \textcircled{a} x_{1000}$$

$$\begin{aligned} x_1 &= \\ x_2 &= \end{aligned}$$

Judgement: How to Compress



Eg. Image Compression



Goal: keep distinct areas,
delete repeated areas

Aside: Images are Matrices

A hand-drawn diagram illustrating that images can be represented as matrices. On the left, a small 2D image of a face is shown. An arrow points from this image to an equals sign. To the right of the equals sign is a large square matrix. The matrix has several zero entries, indicated by purple circles with arrows pointing to them, labeled "Zero". The matrix is defined as:

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & \dots \\ 0 & 0 & 0 & 0 & 0 & \dots \\ 0 & 0 & 1 & 0 & 1 & \dots \\ 0 & 0 & \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & \dots & \dots & \dots \end{bmatrix}$$

Below this, another equals sign leads to a second matrix:

$$= \begin{bmatrix} x_0 & x_1 & \dots \\ \vdots & \ddots & \ddots \\ x_{1000} & & \end{bmatrix}$$