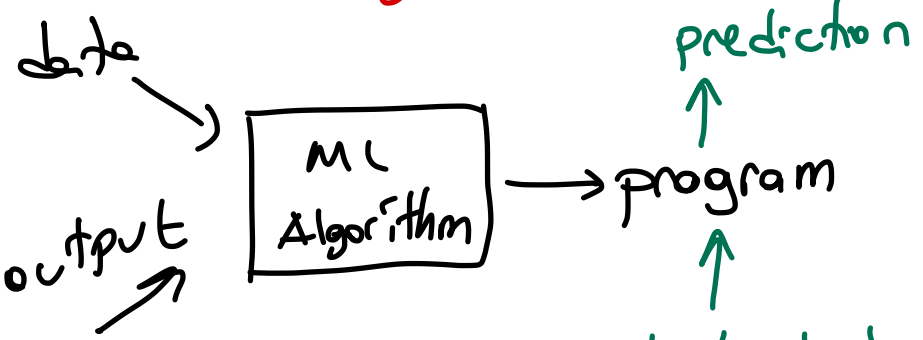
Algorithm vs ML Algorithm

- sorting
- searching
- ...

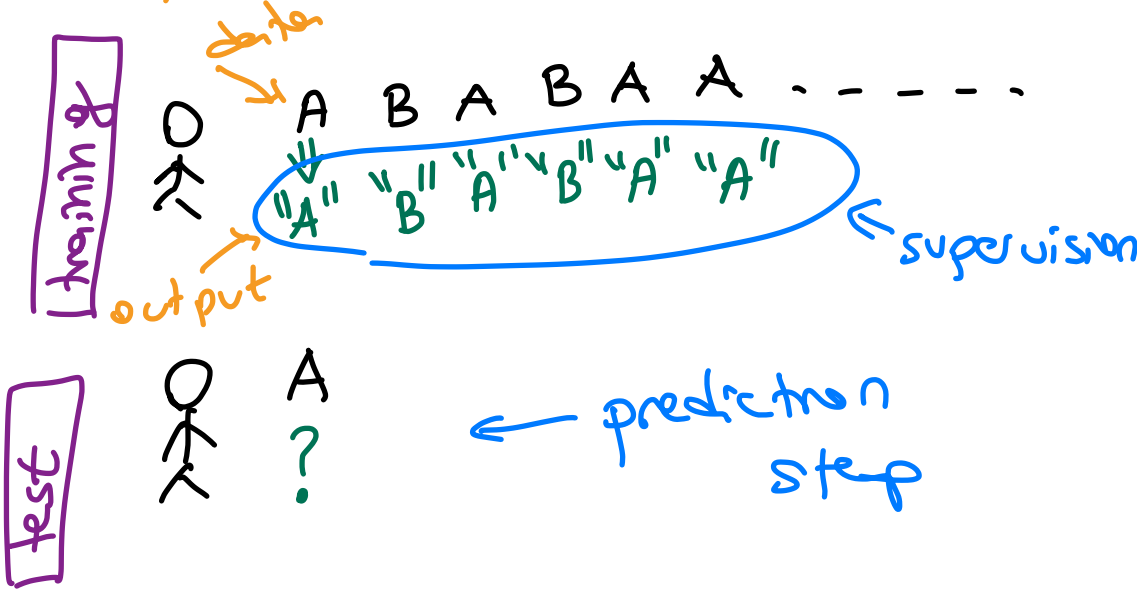
- given a list of #s
- task: to order these #s from smallest to largest

- fixed set of rules
- deterministic



- test data
- unseen data
- out-of-sample data

- subjectivity (example data past experience)



Machine Learning: programming computers to **optimize** learning a **performance criterion** using **example data or past experience**.

training set

loss/error function
→ depends on the application

inputs	predictions	
A	"A"	✓
B	"B"	✓
C	"O"	✗
E	"B"	✗
K	"K"	✓

$$\text{Accuracy} = \frac{3}{5}$$

$$\text{Error} = \frac{2}{5}$$

Error		Prediction	Truth
4°C	Tuesday	10°C	14°C
4°C	Wednesday	12°C	8°C
4°C	Thursday	8°C	12°C
1°C	Friday	11°C	12°C

absolute error

|truth − predicted|

$$|y_i - \hat{y}_i| = |e_i|$$

Supervised Learning:

$\mathcal{X} = \{(x_i, y_i)\}_{i=1}^{N}$ → # of data points

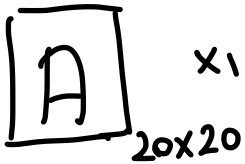
$\mathcal{X}$ ← training set

x_i ← ith training data point

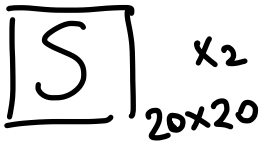
y_i ← ith label / ith output

$$\mathcal{X} = \{(x_1, y_1), (x_2, y_2), \dots, (x_N, y_N)\}$$

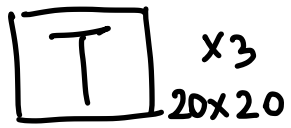
Classification



x_1 "A" y_1



x_2 "S" y_2



x_3 "T" y_3

$x_1 = \begin{bmatrix} \\ \\ \end{bmatrix}_{400\times 1}$ $y_1 = [A]_{1\times 1}$

$x_2 = \begin{bmatrix} \\ \\ \end{bmatrix}_{400\times 1}$ $y_2 = [S]_{1\times 1}$

$\mathcal{X} = \left\{ \left(\begin{bmatrix} \\ \\ \end{bmatrix}, \square \right) \right\}$

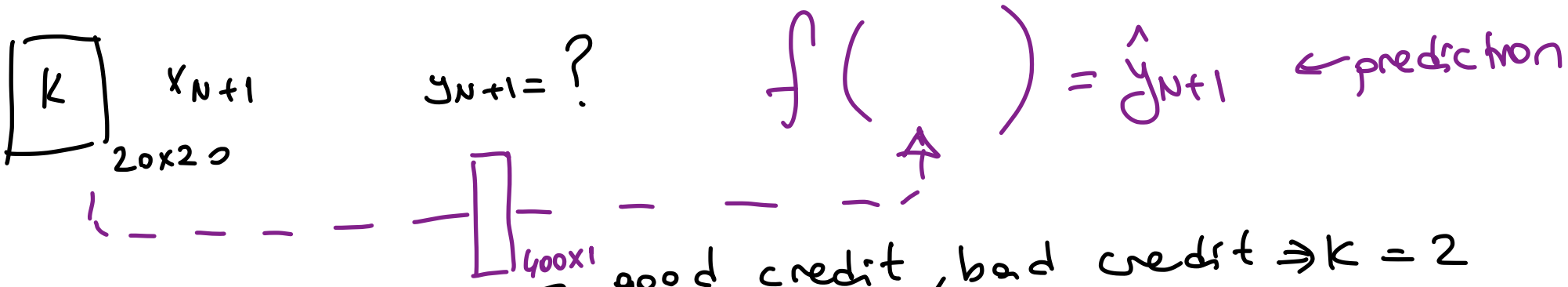
400x1 1x1

$x_i \in \mathbb{R}^{400}$

$y_i \in \{A, B, \dots, Z\}$

learning an $f(\cdot)$ function

$\mathbb{R}^{400}$ → $\{A, B, \dots, Z\}$



K = # of classes

- good credit, bad credit $\Rightarrow K = 2$
- cat or dog $\Rightarrow K = 2$
- A, B, C, ---, Z $\Rightarrow K = 26$

predefined class labels

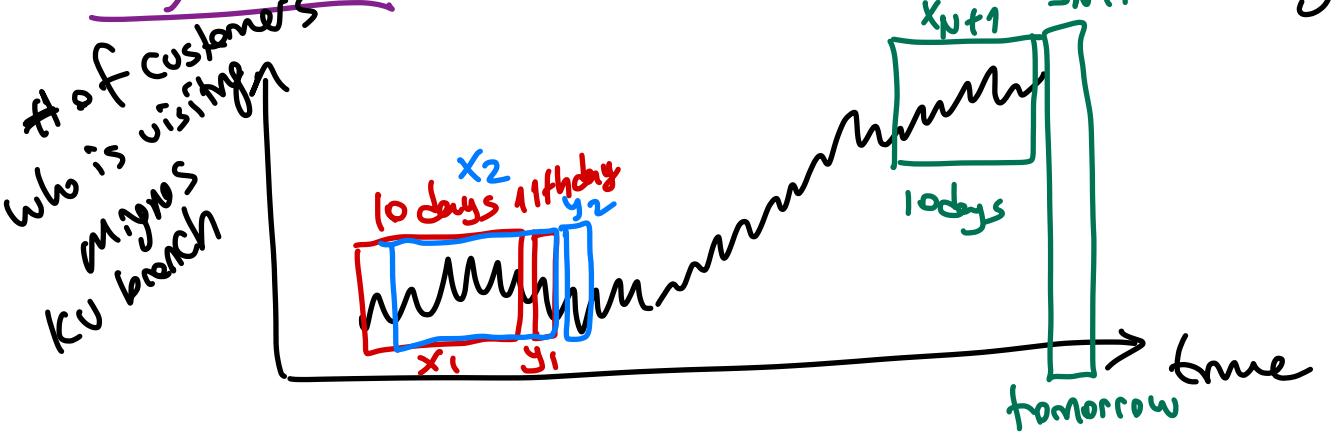
$K = 2 \Rightarrow$ binary classification

$K > 2 \Rightarrow$ multiclass classification

Regression: $\mathcal{X} = \{(x_i, y_i)\}_{i=1}^{N}$ $\quad y_{N+1} = ?$

$x_i \in \mathbb{R}^D$

$y_i \in \mathbb{R}$



using last 10 days customer counts, we are going to predict 11th day's #

$x_1 = \begin{bmatrix} \text{Feb 1 \#} \\ \text{Feb 2 \#} \\ \vdots \\ \text{Feb 10 \#} \end{bmatrix}$ $y_1 = [\text{Feb 11 \#}]$

$x_2 = \begin{bmatrix} \text{Feb 2 \#} \\ \text{Feb 3 \#} \\ \vdots \\ \text{Feb 11 \#} \end{bmatrix}$ $y_2 = [\text{Feb 12 \#}]$

$\vdots$ $\vdots$

Training set

 → 32

 → 45

$\vdots$ $\vdots$

 → 53

Test set

 → ? 41