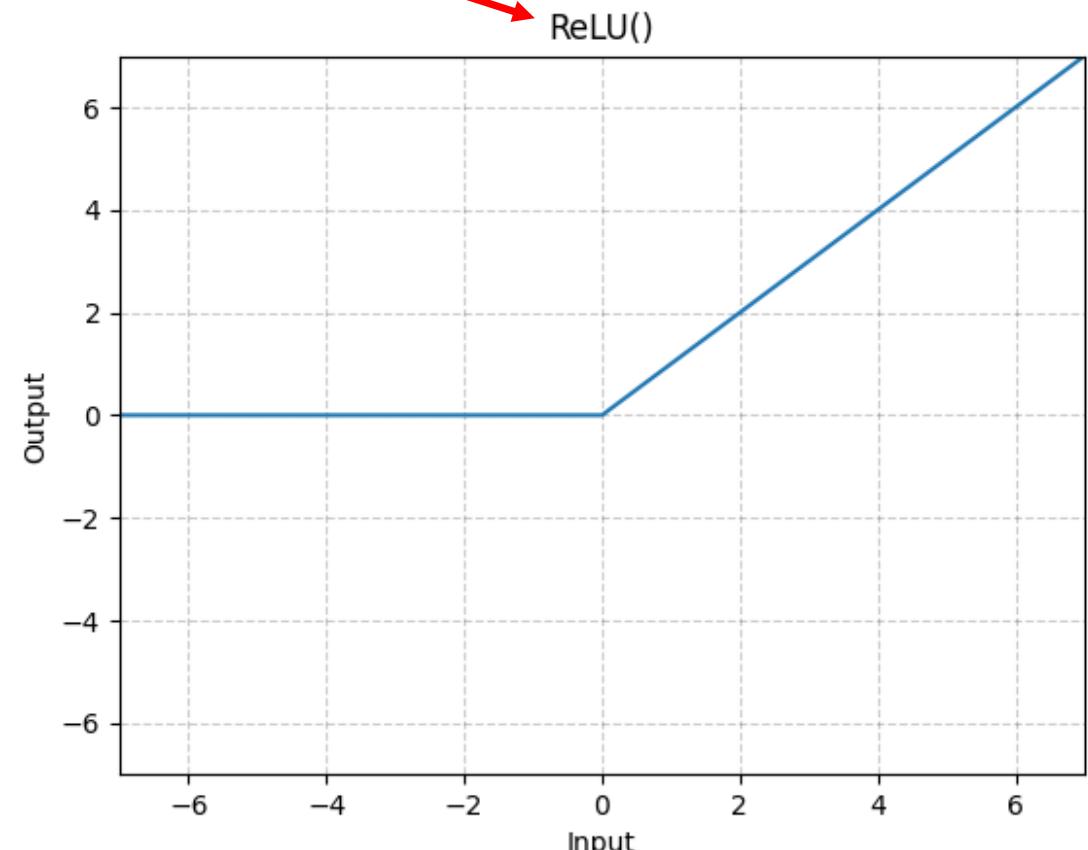


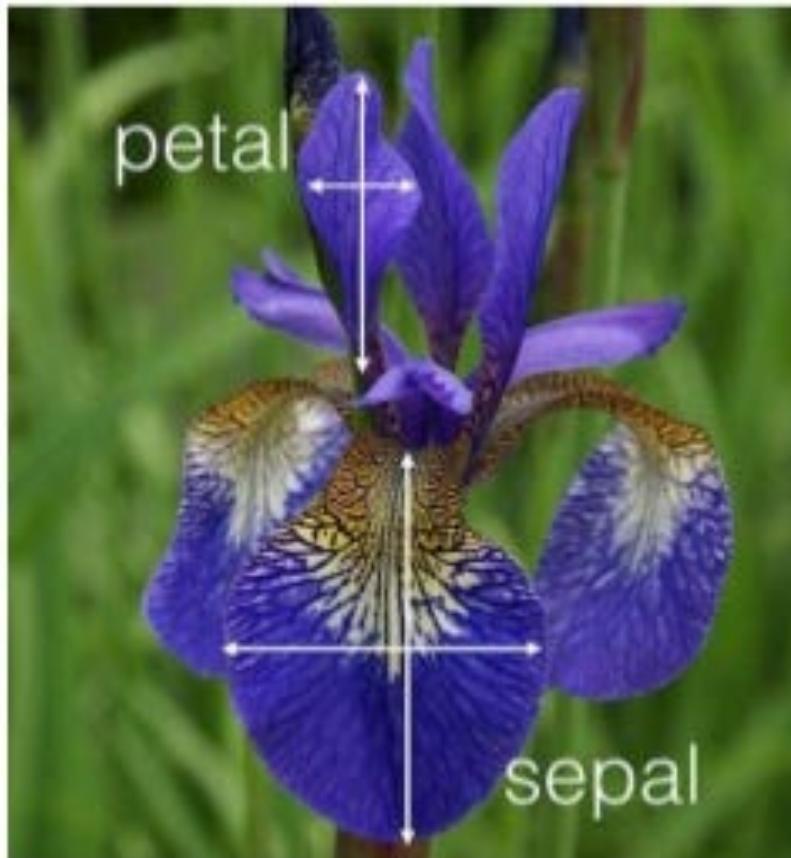
$x_0, x_1 \dots$  : input of neural node  
 $y$ : output of neural node  
 $w_0, w_1, \dots$ , bias: parameters of neural node

$x = x_0.w_0 + \dots x_n.w_n + \text{bias}$  (linear function  $\sim$  regression)  
 $y = f(x)$  (non-linear function)

$\rightarrow y = f(x_0.w_0 + \dots x_n.w_n + \text{bias})$

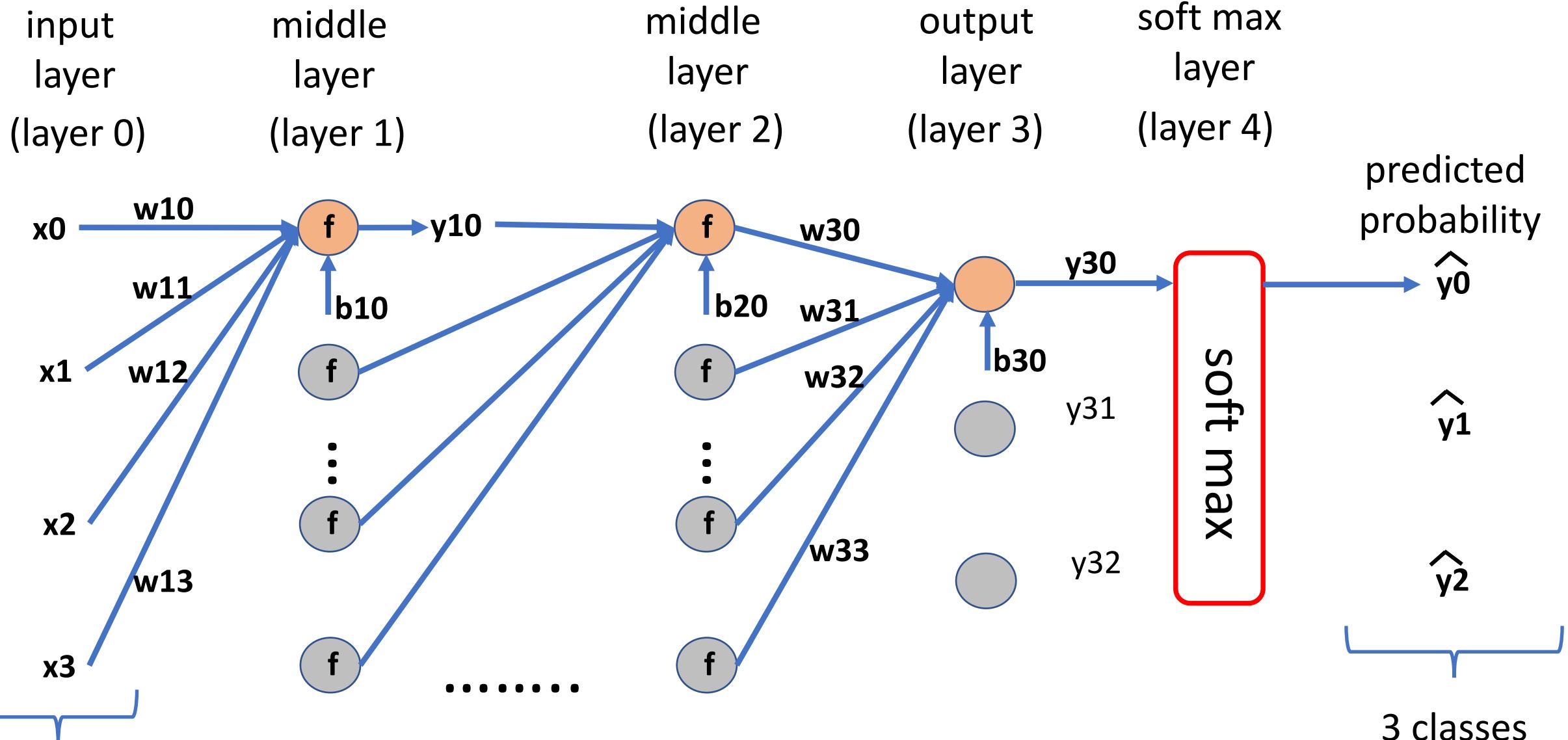


## Supervised learning *classification* problem (using the [Iris flower data set](#))



Training / test data				
Features		Labels		
Sepal length	Sepal width	Petal length	Petal width	Species
5.1	3.5	1.4	0.2	Iris setosa
4.9	3.0	1.4	0.2	Iris setosa
7.0	3.2	4.7	1.4	Iris versicolor
6.4	3.2	4.5	1.5	Iris versicolor
6.3	3.3	6.0	2.5	Iris virginica
5.8	3.3	6.0	2.5	Iris virginica

1 sample (4 features)    3 classes  
4-dimensional vector



1 sample (4 features)  
4-dimensional vector

**One-hot encoding**

Output layer      Softmax activation function      Probabilities

$$\begin{bmatrix} 1.3 \\ 5.1 \\ 2.2 \\ 0.7 \\ 1.1 \end{bmatrix} \xrightarrow{\text{Softmax activation function}} \frac{e^{z_i}}{\sum_{j=1}^K e^{z_j}} \xrightarrow{\text{Probabilities}} \begin{bmatrix} 0.02 \\ 0.90 \\ 0.05 \\ 0.01 \\ 0.02 \end{bmatrix}$$

$\sim 0$   
 $\sim 1$

a<sub>1</sub>

a<sub>2</sub>

...

a<sub>n</sub>

b<sub>1</sub>

b<sub>2</sub>

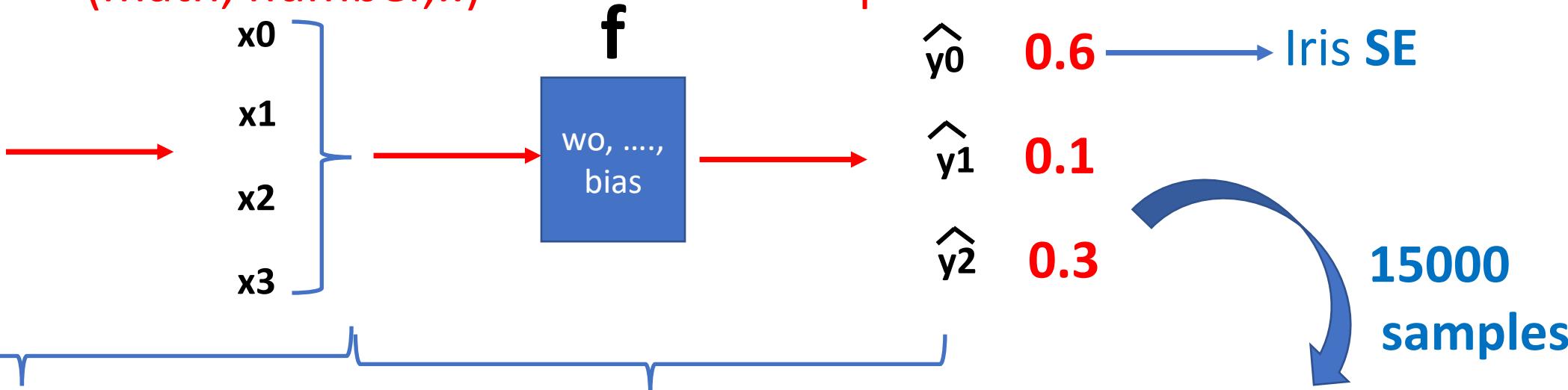
...

b<sub>n</sub>

$$b_1 + b_2 + \dots + b_n = 1$$



fine data  
(math, number,...)

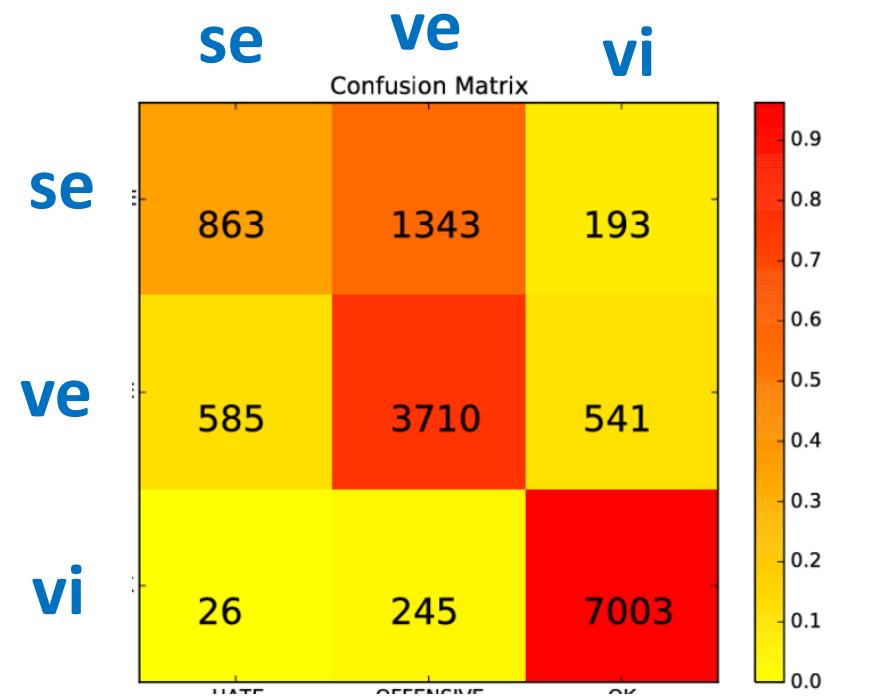


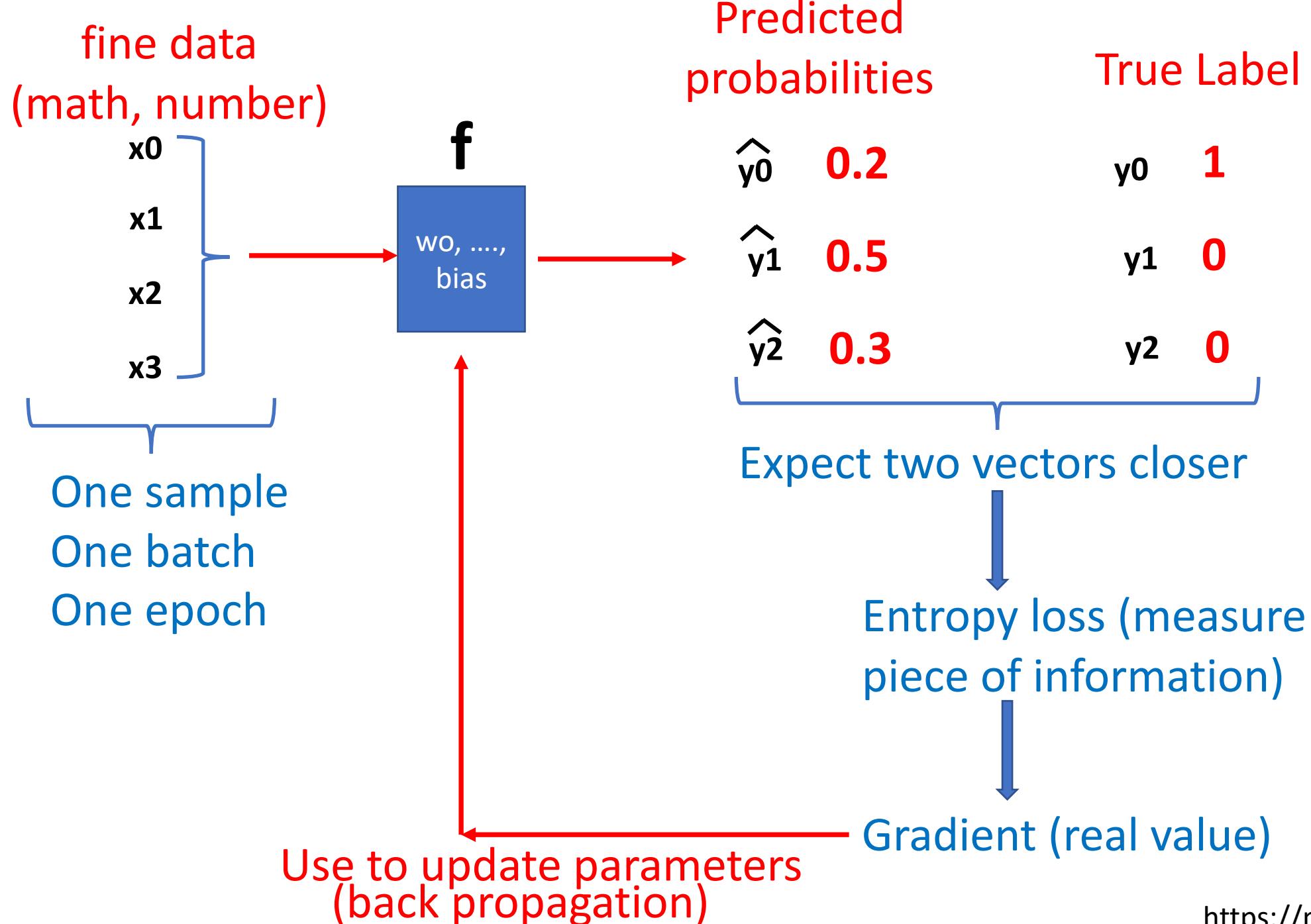
Feature engineering  
(feature extraction,  
Augmentation, ...)

Inference process  
(assume we have  
golden model/ available  
trainable para)

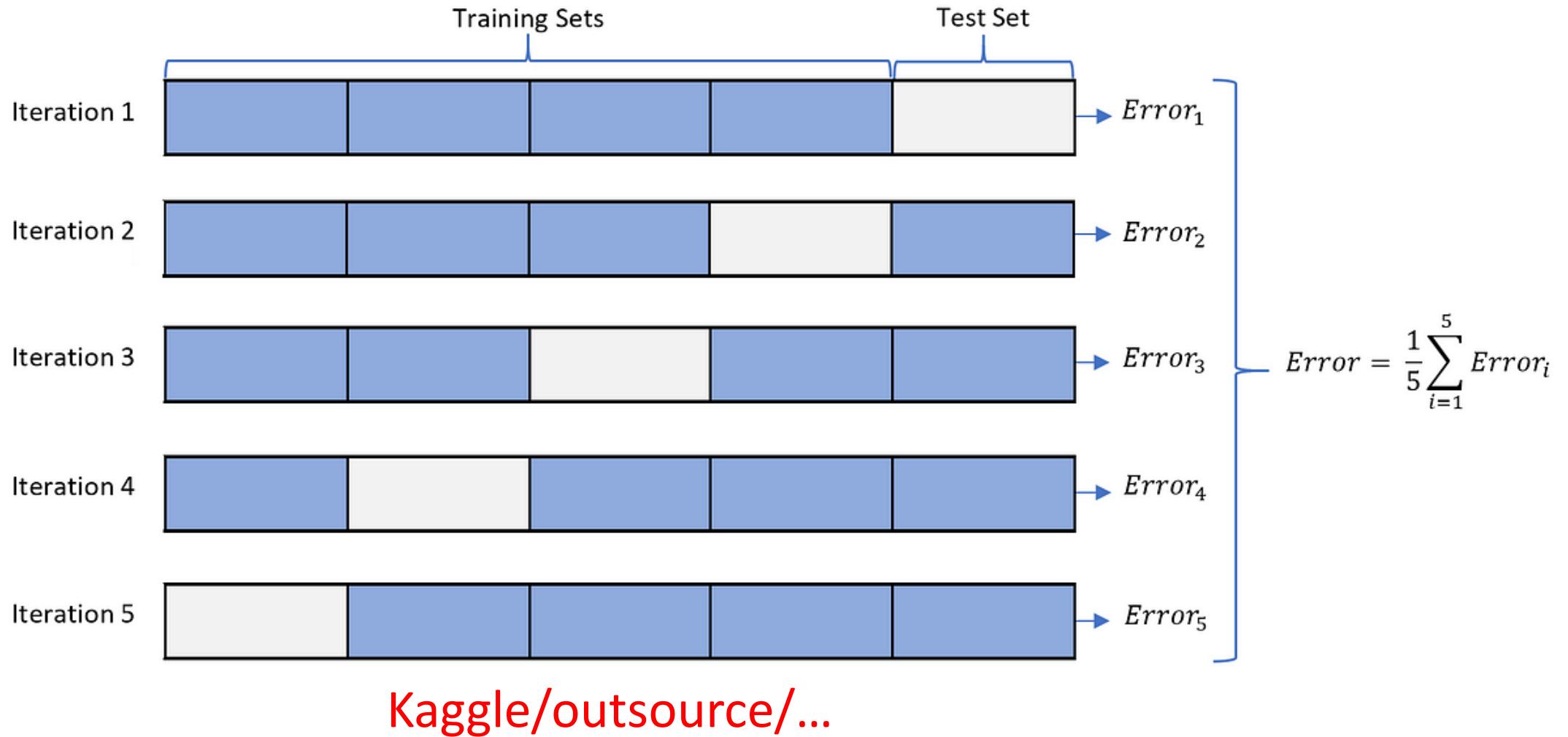
Accuracy, F1, AuC , ... scores

metrics



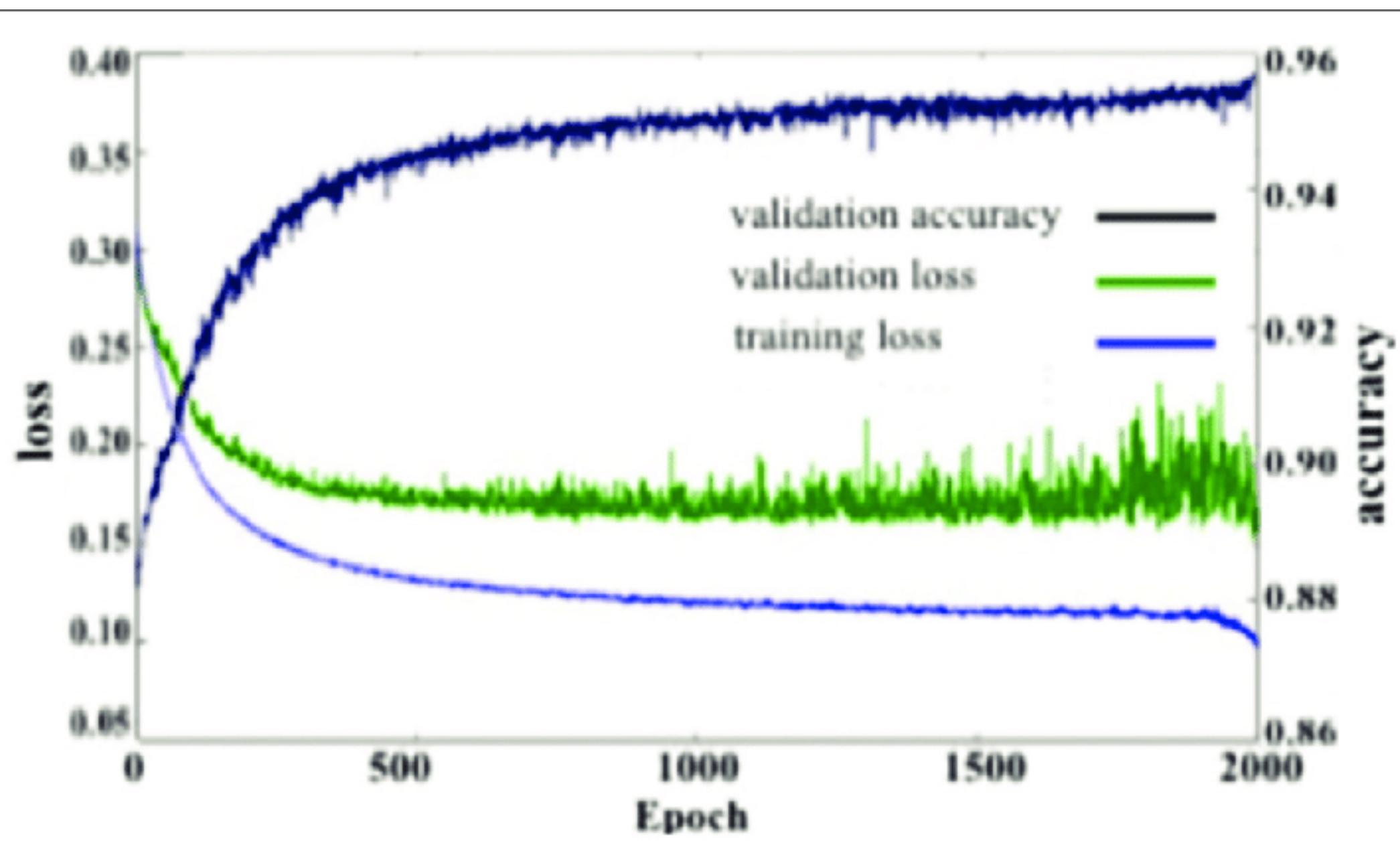


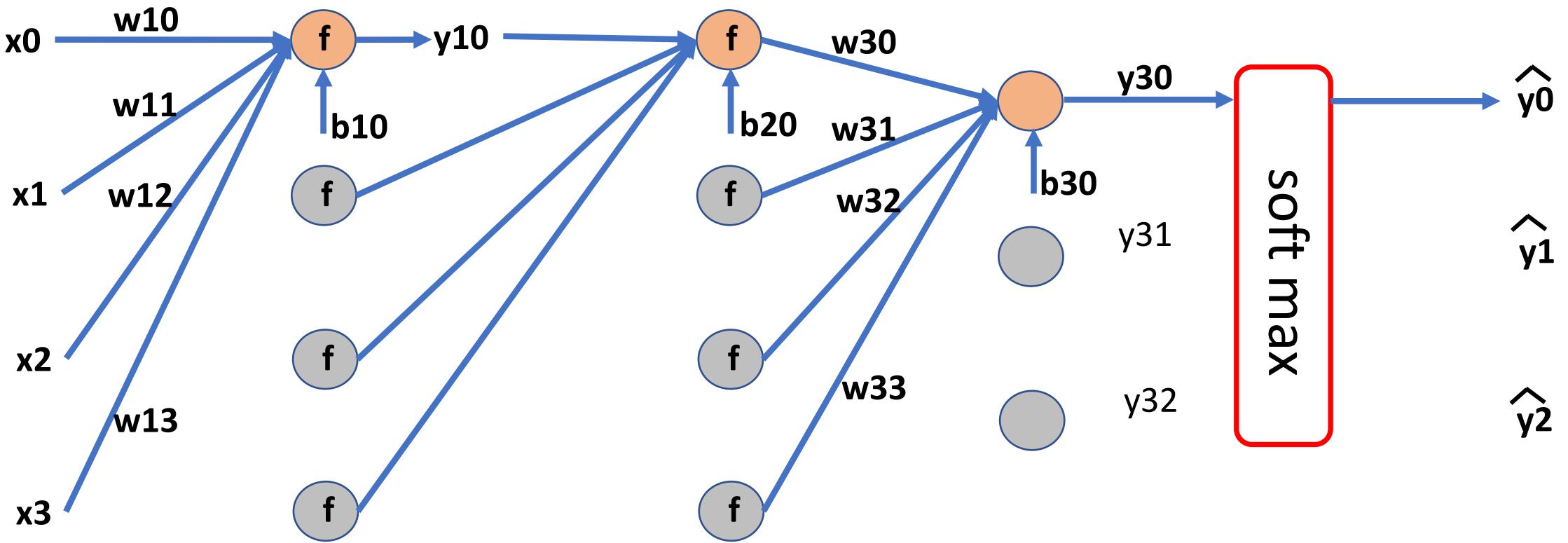
# Five-fold cross validation



Kaggle/outsource/...







Run on CPU, GPU (multi threads, multi process, C++/Python),  
FPGA, ASIC chip, photonic and quantum based chip

<http://ict.jst.udn.vn/index.php/jst/article/view/22>

[https://github.com/pham dang lam1986/ASIC--A\\_Full\\_Designed\\_CHIP\\_Applied\\_For\\_Vietnamese\\_Speech\\_Recognition](https://github.com/pham dang lam1986/ASIC--A_Full_Designed_CHIP_Applied_For_Vietnamese_Speech_Recognition)