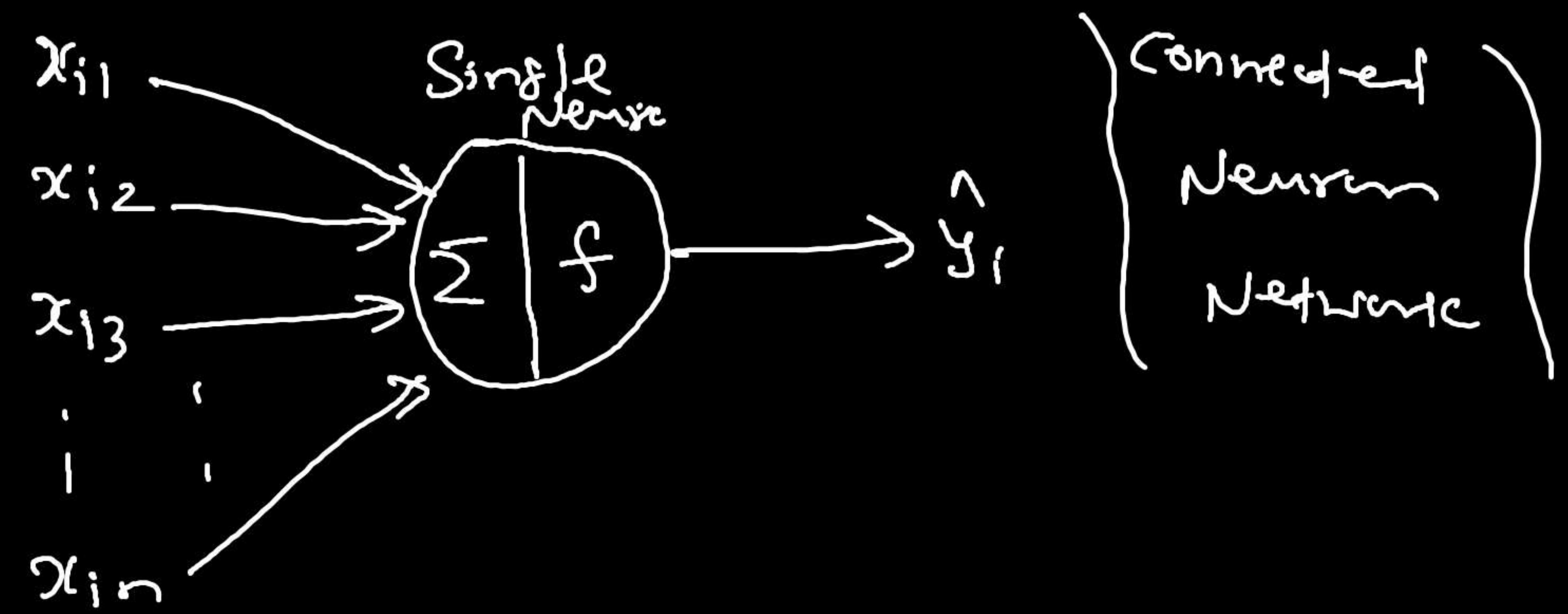# Deep Neural Network (DNN)/MLP

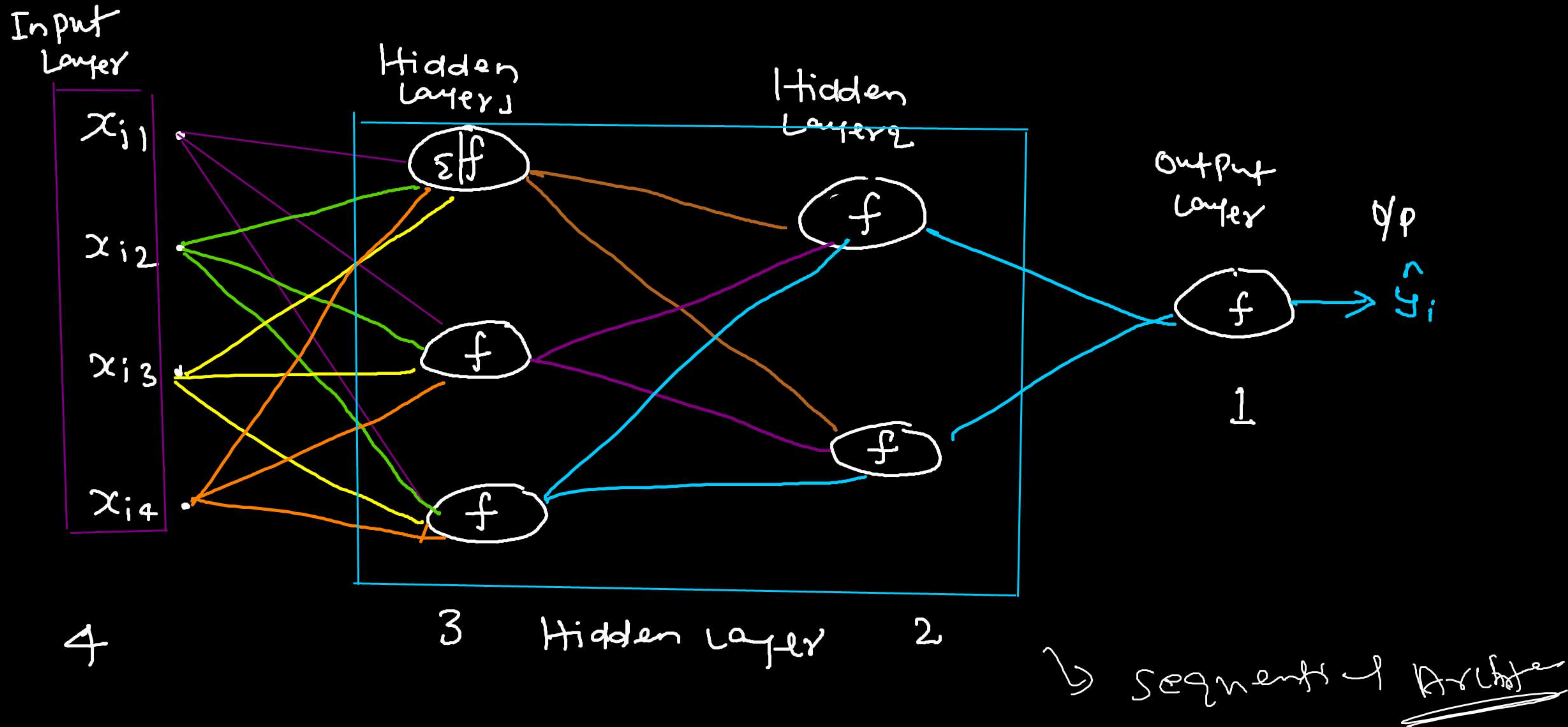## Perceptron model → Single Neuron

↳ Logistic Regression

Multi-Layer perceptron (MLP)

ANN = DNN = MLD

Input Layer

x_{j1}

x_{i2}

x_{i3}

x_{i4}

Hidden Layer₁

Σf

f

f

Hidden Layer₂

f

f

Output Layer

f

O/P

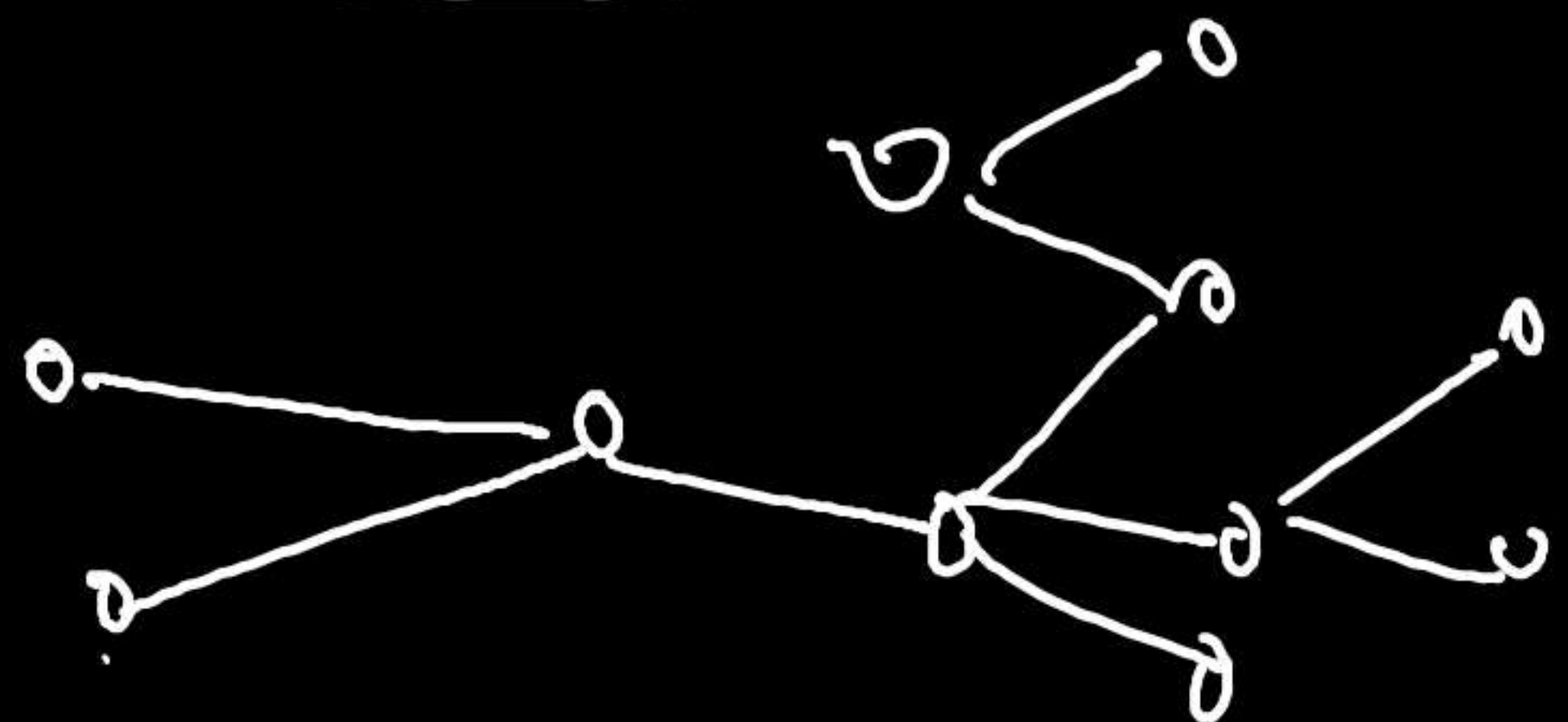$\hat{y}_i$

1

4

3   Hidden Layer   2

↳ sequential Archote

Q: why should we care about MLP?

Ans:- (a) Biological inspiration ✓

Neuroscience → human, monkey, rat, cat, Dogs, ants etc. _____

millions or billions of connection

(b) mathematical Arguments ✓

Regression :- $\left(x_i , y_i \right)$ = Data

Idv ↳ DV = continous variable $\in \mathbb{R}$

$$\boxed{y_i = f(x_i)}$$

eg :- Plot (2 * Sin(x²) + Sqrt (x * 5))

MLP - like structure

Functions

case I :-
f_1 = Add ()

f_2 = Square ()

f_3 = Sqrt ()

f_4 = Sin ()

f_5 = multi ()

Variable = | 2 , 5 , x |
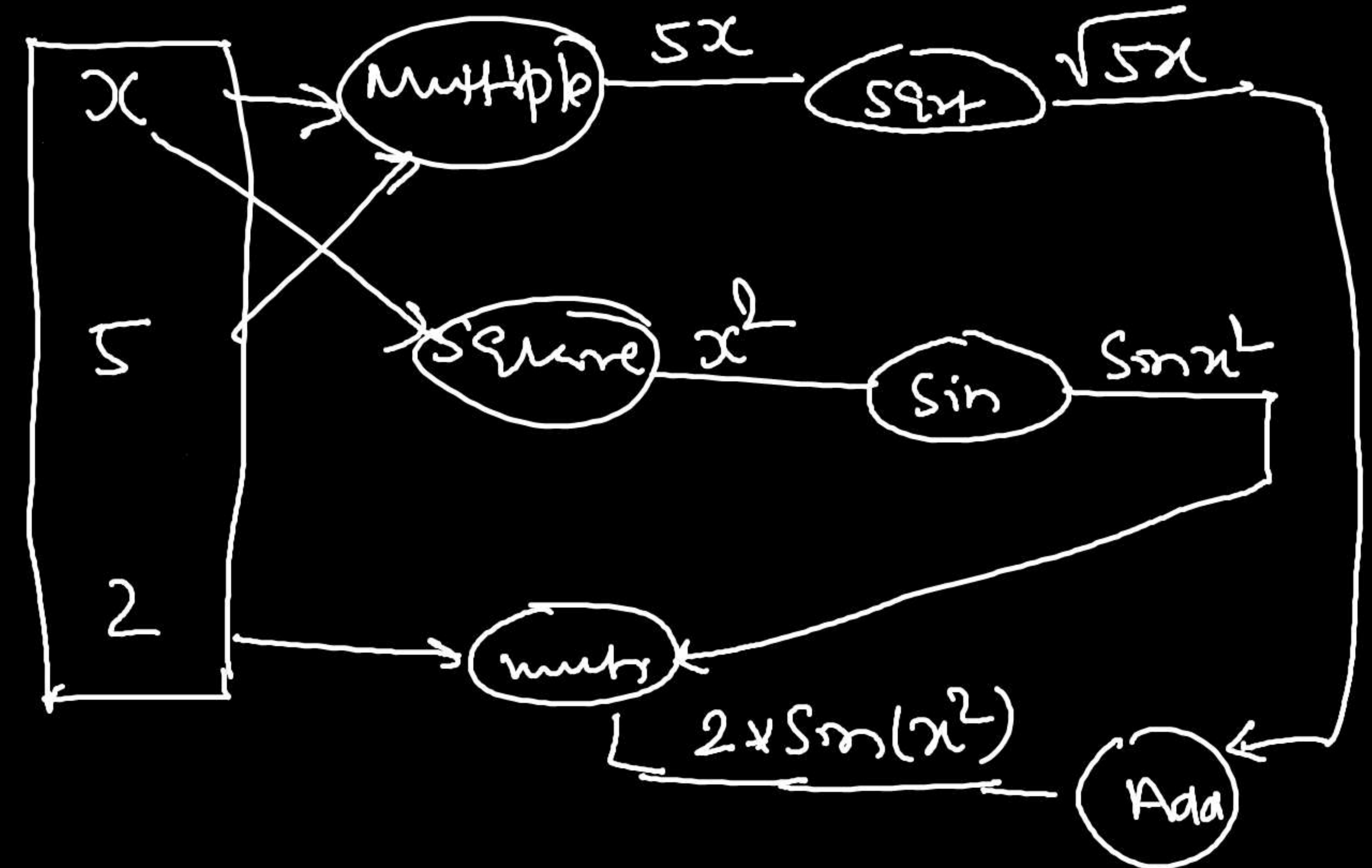
NOTE :- By using MLP Structure, we can come-up
with complex maths functs - to solve
your regression Problem.

$2 Sin(x²) + \sqrt{5x}$

High School — Function compossition ut

$$f(g(x)) = f \circ g(x) \quad or \quad g \circ f(x) = g(f(x))$$

Function

$f_1 = add()$

$f_2 = square()$

$f_3 = sqrt()$

$f_4 = sin()$

$f_5 = mult()$

$f(x) = 2 \sin(x^2) + \sqrt{5x} = $ equation

$5 * x = f5(5, x)$

$\sqrt{5x} = f3(f5(5, x))$ ——①

$x^2 = f2(x)$

$\sin(x^2) = f4(f2(x))$

$2 * \sin(x^2) = f5(2, f4(f2(x)))$ ——②

$2 \sin(x^2) + \sqrt{5x}$

$= f_1 \{ f5(2, f4(f2(x)), f3(f5, $

$(5, x)$

Composite Function

NOTE :- MLP - Graphical way of representing

$f \circ g(x)$ or $g \circ f(x)$ — composition function

MLP — Powerful Structure

Caveat :- MLP - Structure — very easily

↓

MLP | DNN — sequential   Overfitted - tons of

Functional A   Input layer

+ 15+

Input

X_{ij}

Notation — MLP — Fully connected NN — Sequential Architecture
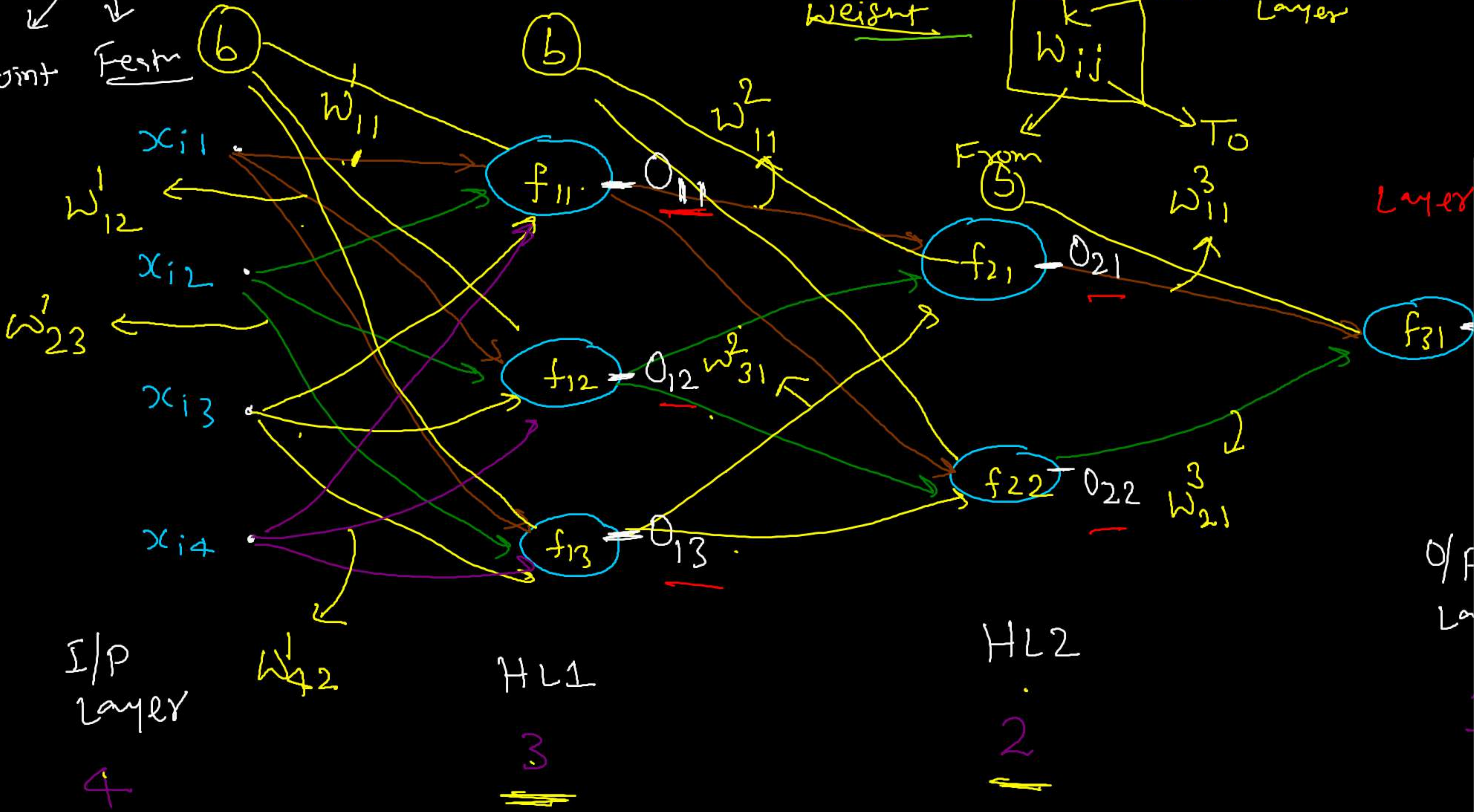
Point Feature

W'_{12}

W'_{23}

Weight

W_{ij}^k

Next Layer

From

To

Feature

f_{ij}

X_{i1}

W_{11}

f_{11} O_{11}

W_{11}^2

f_{21} O_{21}

W_{11}^3

Layer

X_{i2}

f_{12} O_{12} W_{31}^2

f_{31}

X_{i3}

f_{13} O_{13}

f_{22} O_{22} W_{21}^3

X_{i4}

W_{42}^1

HL1

HL2

O/P Layer

I/P Layer

3

2

4

Weight Calculation

I/P	HL1	HL2	O/P
4	3	2	1

$$= 4 \times 3 + 3 \times 2 + 2 \times 1 = 20 \text{ Weights}$$

$$\underline{Bias} = 3 + 2 + 1 = 6$$

$$x_{ij}$$
Point Feature 1

x_1	x_2	x_3	x_4
2	a	e	x
3	b	f	y
4	c	g	z
5	d	h	Q

$$\text{Total Parameter} = \text{Weight} + \text{Bias} = \boxed{26}$$
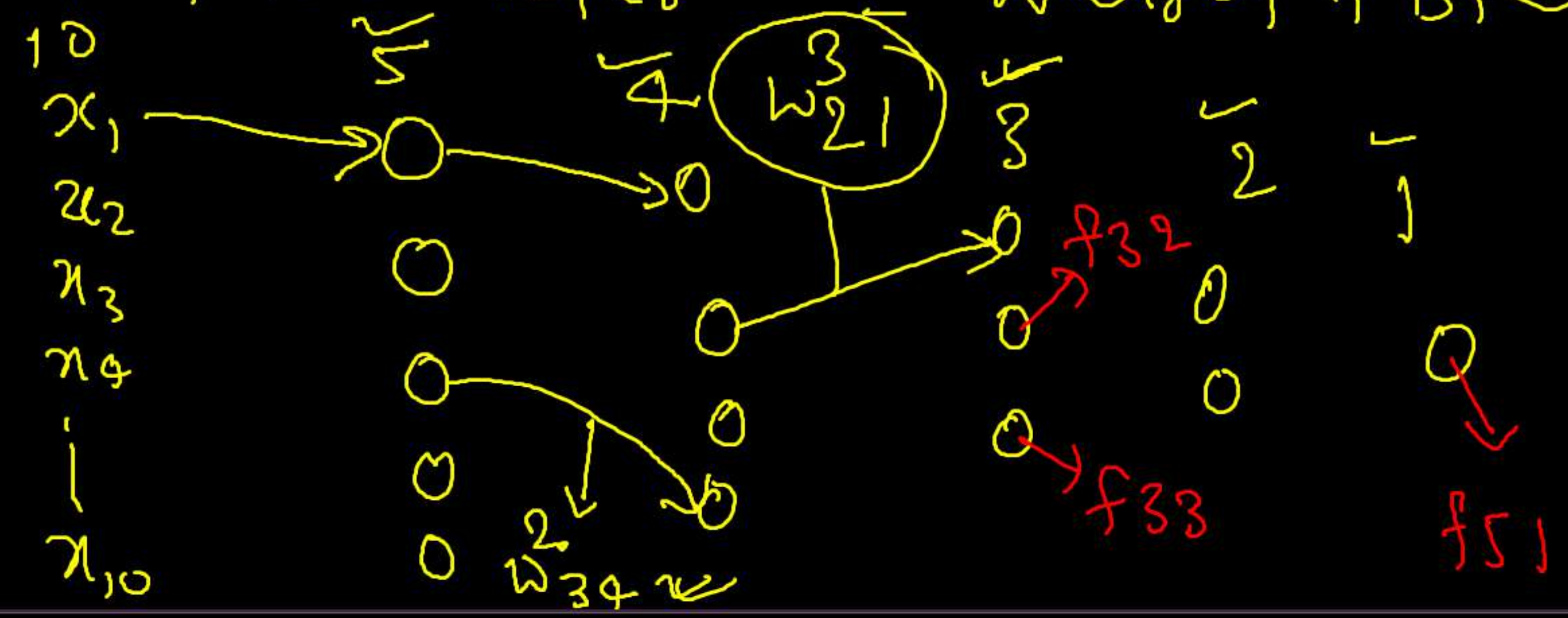
w_{21}^{3} $f32$ $f33$ $f51$

10 5 4 3 2 1

x_1
x_2
x_3
x_4
:
x_{10}

w_{34}^{2}

$$\text{Weight} = 10 \times 5 + 5 \times 4$$
$$\text{Bias} = 15 \qquad + 4 \times 3 + 3 \times 2 + 2 \times 1 = \boxed{90}$$
$$\text{Param} = \text{Weight} + \text{Bias} = \boxed{105}$$

$X_{ij} \to$

Point $\leftarrow$ Feature

X_{11}

x_1	x_2	x_3	x_4
a	b	c	d
1	2	3	4
p	q	r	s

X_{i1} W_{11}^1 f_{11} O_{11} W_{11}^2 f_{21} O_{21} W_{11}^3 f_{31} O_{31} $\hat{Y}_1$

W_{21}^1 W_{12}^1 O_{11}

X_{i2} W_{22}^1 W_{13}^1 W_{12}^2

W_{23}^1 f_{12} O_{12} W_{21}^2

W_{31}^1 W_{32}^1 O_{12} W_{31}^2 W_{22}^2 f_{22} O_{22} W_{21}^3

X_{i3}

W_{41}^1 W_{33}^1 W_{42}^1 f_{13} O_{13} W_{32}^2

X_{i4}

W_{43}^1

4 3 2 1
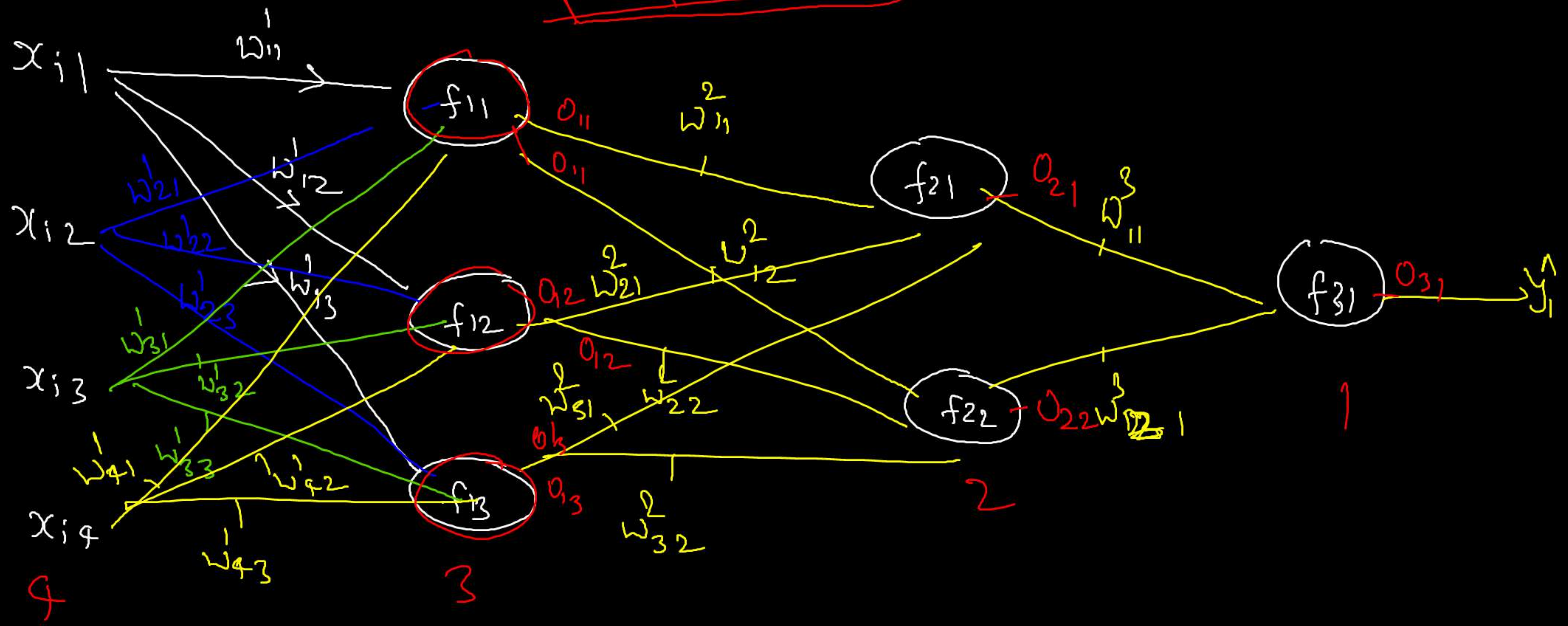
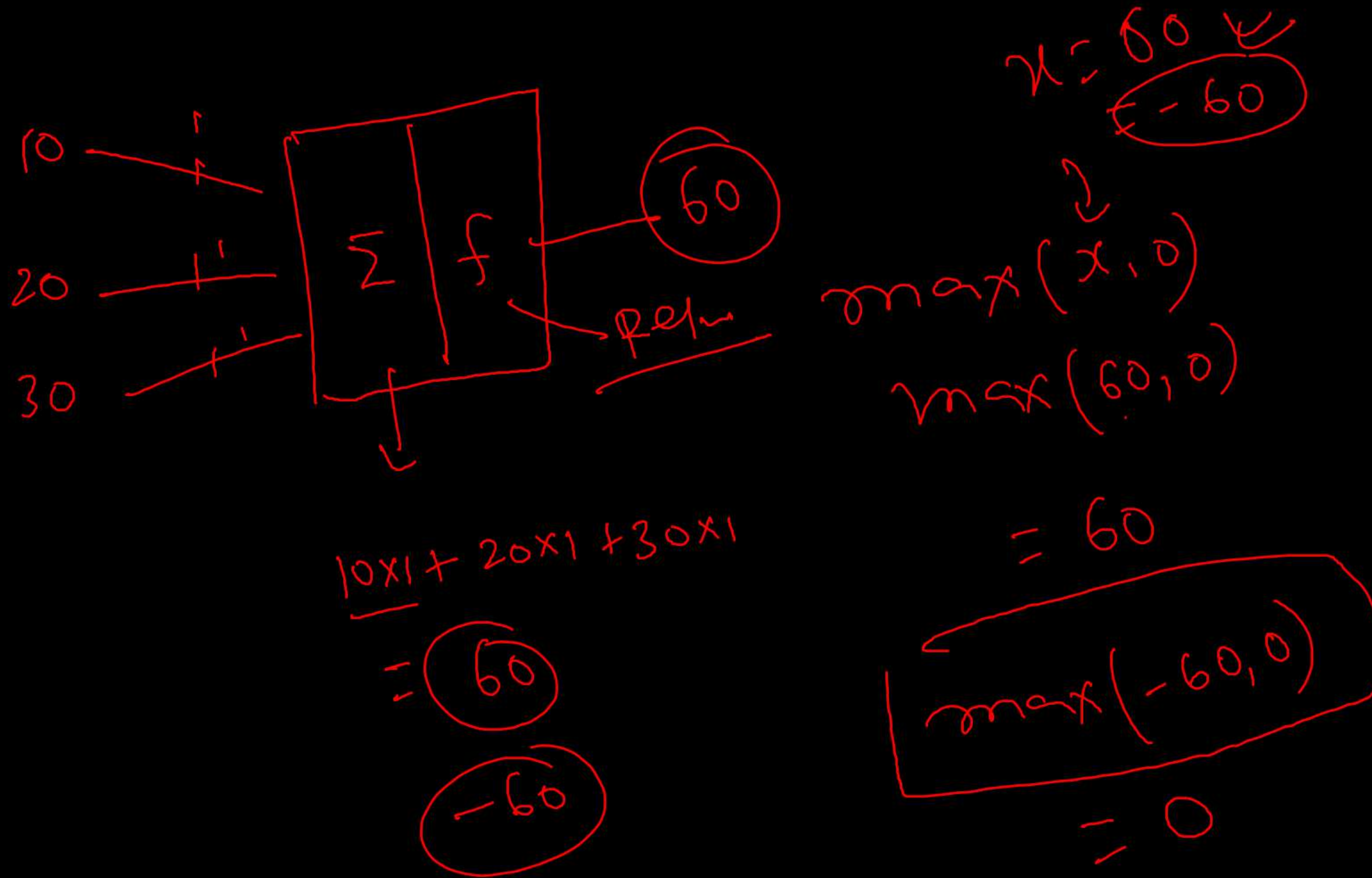$$\text{Total Param} = (4 \times 3 + 3) + (3 \times 2 + 2) + (2 \times 1 + 1) =$$

$$= 15 + 8 + 3 = 26 \quad \text{Ans}$$

Regression + classification - code - easy

10

20

30

Σ | f

ReLu

60

$x = 60$
-60

$\max(x, 0)$

$\max(60, 0)$
$= 60$

$10 \times 1 + 20 \times 1 + 30 \times 1$

$= 60$

-60

$\max(-60, 0)$
$= 0$