Lecture - 2   Pytorch tutorials.

18/1/25

$v = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix} \rightarrow v^T$

$v^T = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \rightarrow v$

Mathematical terms.

$v\,v^T$ or $v^T v$

$\begin{bmatrix} 1 & 2 & 3 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} = 1+4+9$

$= 14$ scalar

inner product

$v^T v$

$\begin{array}{c} a \\ b \\ c \end{array} \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \underbrace{\begin{bmatrix} 1 & 2 & 3 \end{bmatrix}}_{v} = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{bmatrix}$

$\begin{bmatrix} av & bv & cv \end{bmatrix} \rightarrow$ outer product?

(28, 28, 3) channel last.

↓ 2×2

(3, 28, 28)

↓ 2×2

(3, 14, 14)

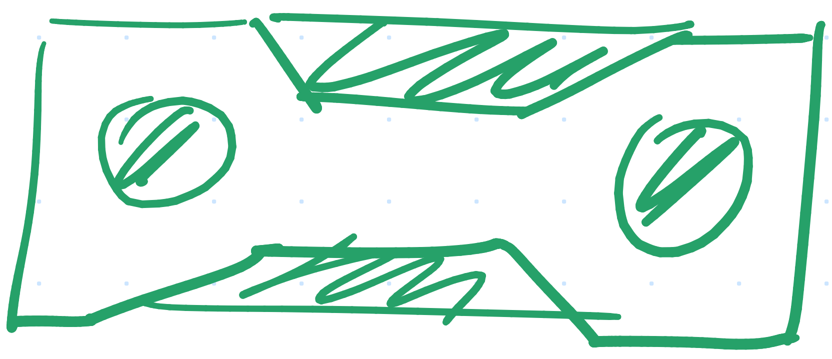
(B, C, H, W)

np array → var → → CPU ↓

{8-core / 10-core, 128-core.}

parallalizable ⊗. ↓

multiple cores → 50K ⊗ more.



GPU.

img files

HDD, SSD

var

CPU

Pytorch

GPU

→ fast computations & optimizations / Tensor graphs & cores.

↓

cv2 → numpy

PIL →

tensor.todevice'

tensor

cudacore.

device = cuda. tensor format /GPU

↓ numpy

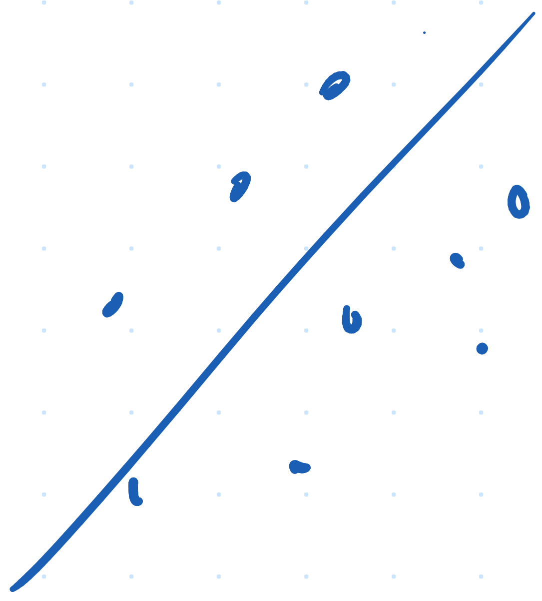
.cpu().detatch().numpy().

CPU → (save) →

etc. opencv/PIL.

$$y = mx + c$$

$$\downarrow$$



$$\hat{y} = y = \underbrace{W}_{\text{weight}}x + \underbrace{b}_{\text{bias}}.$$

$$Y = \{y\}_{i=1}^{N} = \{y_1, y_2, \cdots, y_N\}.$$

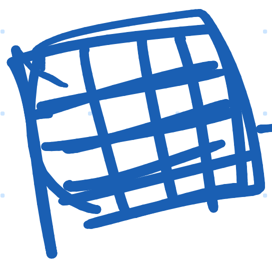
$$X = \{x_1, x_2, x_3, \ldots, x_N\} = \{x\}_{i=1}^{N}$$

Cats/Dogs. $x = \{\ldots, \ldots, \ldots, \ldots, \cdots\}.$

$$y = \{0, 1, 0, 0, \cdots\}$$

Gradient descent

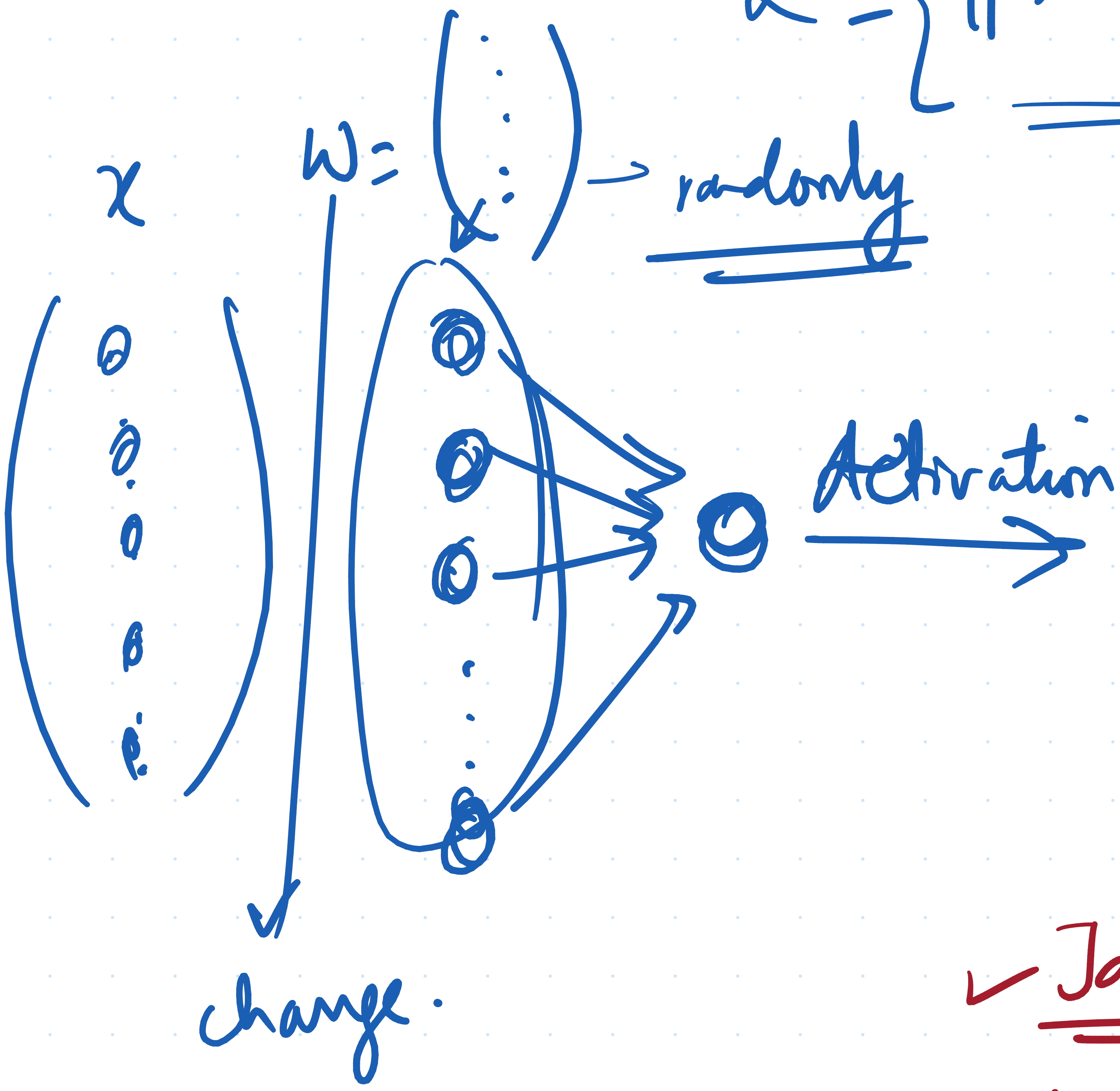
$$W_{new} = W_{old} - \alpha \frac{\partial L}{\partial w}$$ → Gradient computation. (1st derivative)

x →  → (- - - -)

$$\mathcal{L} = \left\{ \| \hat{y}^{(i)} - (W.x^{(i)}+b)\|_2^2 \right\}_{i=1}^{N}.$$

$$\frac{\partial}{\partial w}\left(y^{(i)} - (Wx+b)\right)^2$$

$$2\left(y^{(i)} - (Wx+b)\right).Wx$$



✓ Jacobian

✓ Hessian.

✓

Jacobian ←

$$\begin{pmatrix} \frac{\partial y_1}{\partial x_1} & \frac{\partial y_1}{\partial x_2} & \cdots & \frac{\partial y_1}{\partial x_n} \\ \frac{\partial y_2}{\partial x_1} & \frac{\partial y_2}{\partial x_2} & \ddots & \vdots \\ \vdots & & \ddots & \frac{\partial y_m}{\partial x_n} \\ \frac{\partial y_m}{\partial x_1} & \frac{\partial y_m}{\partial x_2} & \cdots & \frac{\partial y_m}{\partial x_n} \end{pmatrix}$$

$\{y\}_{i=1}^{m}$.

$\{x\}_{i=1}^{n}$

Gradient $\leftarrow$ $\left(\frac{\partial y_1}{\partial x_1} \quad \frac{\partial y_2}{\partial x_2} \quad \cdots \quad \frac{\partial y_m}{\partial x_n} \right)$.

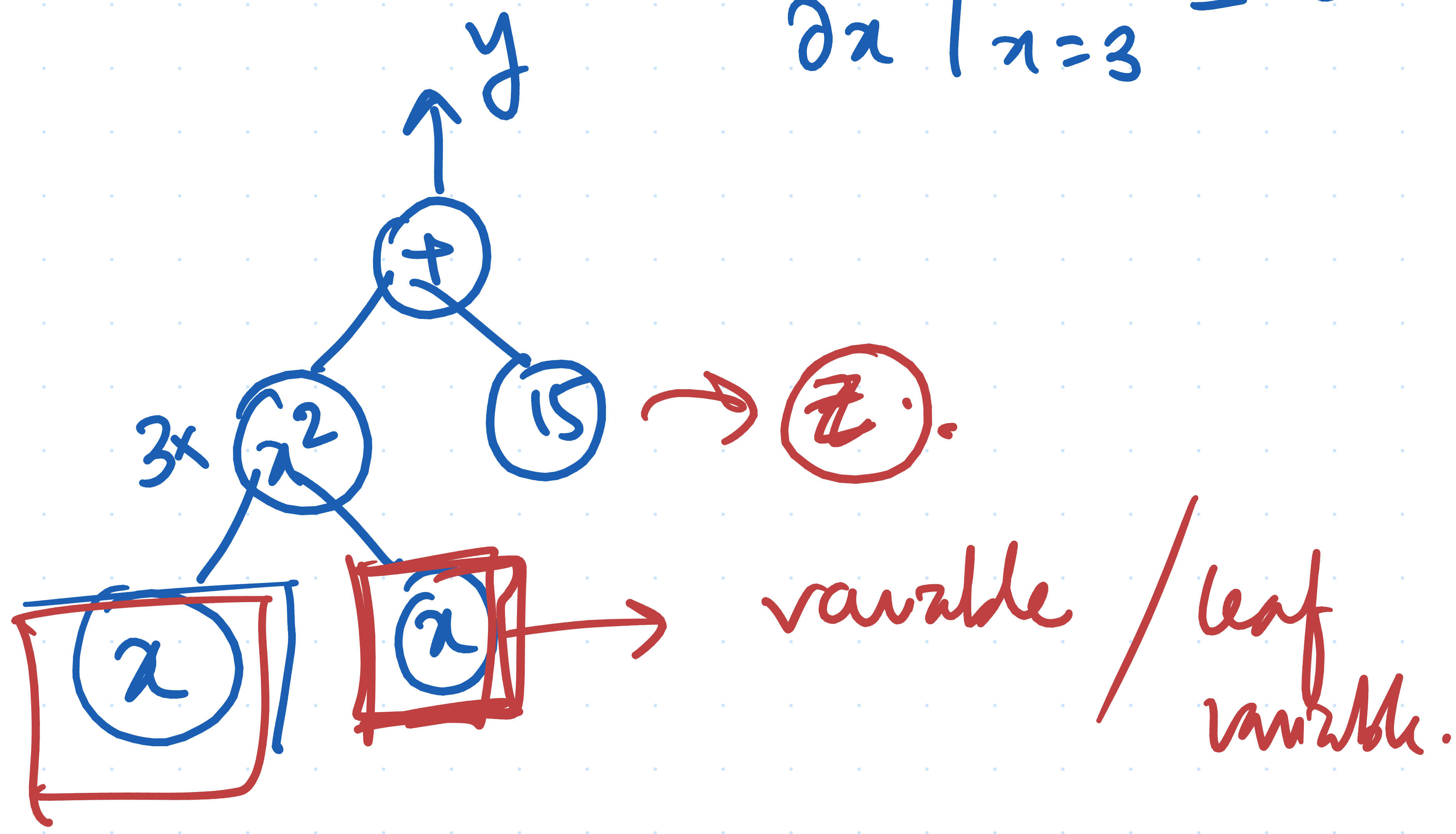
derivative.

(Jacobian's → diagonal.)

$$y = 3x^2 + 15$$

$$\frac{\partial y}{\partial x} = 6x.$$

$$\left.\frac{\partial y}{\partial x}\right|_{x=3} = 18$$



$$y = x_1^3 + x_2^2 + 4x_1x_2 + 5.$$

$x_1 \to 3$

$x_2 \to 4.$

$$\left.\frac{\partial y}{\partial x_1}\right|_{x_1=3,\, x_2=4} = 3x_1^2 + 4x_2$$

$$= 3(3)^2 + 4(4)$$

$$= 3 \times 9 + 16 = 43.$$

$$\left.\frac{\partial y}{\partial x_2}\right|_{x_1=3,\,x_2=4} = 2x_2 + 4x_1$$
$$= 2(4) + 4(3)$$
$$= 8 + 12 = 20$$

$$\phi \begin{cases} x = 2 \\ u = 4 \\ k = 3 \\ l = 1 \end{cases}$$

$$z = 3x^5 + 2u^2kx + lx + l$$

$$\left.\frac{\partial z}{\partial x}\right|_{\phi} = 15x^4 + 2u^2k + l$$
$$= 15(2)^4 + 2(4)^2 \times 3 + 1$$
$$= 337$$

$$\left.\frac{\partial z}{\partial u}\right|_{\phi} = 4ukx = 4 \times (4) \times 3 \times 2$$
$$= 96.$$

$$\left.\frac{\partial z}{\partial k}\right|_{\phi} = 2u^2x = 2 \times (4)^2 \times 2$$
$$= 64.$$

$$\left.\frac{\partial z}{\partial l}\right|_{\phi} = x + 1 = 3.$$