Machine Learning & Deep Learning
(Barcha uchun)
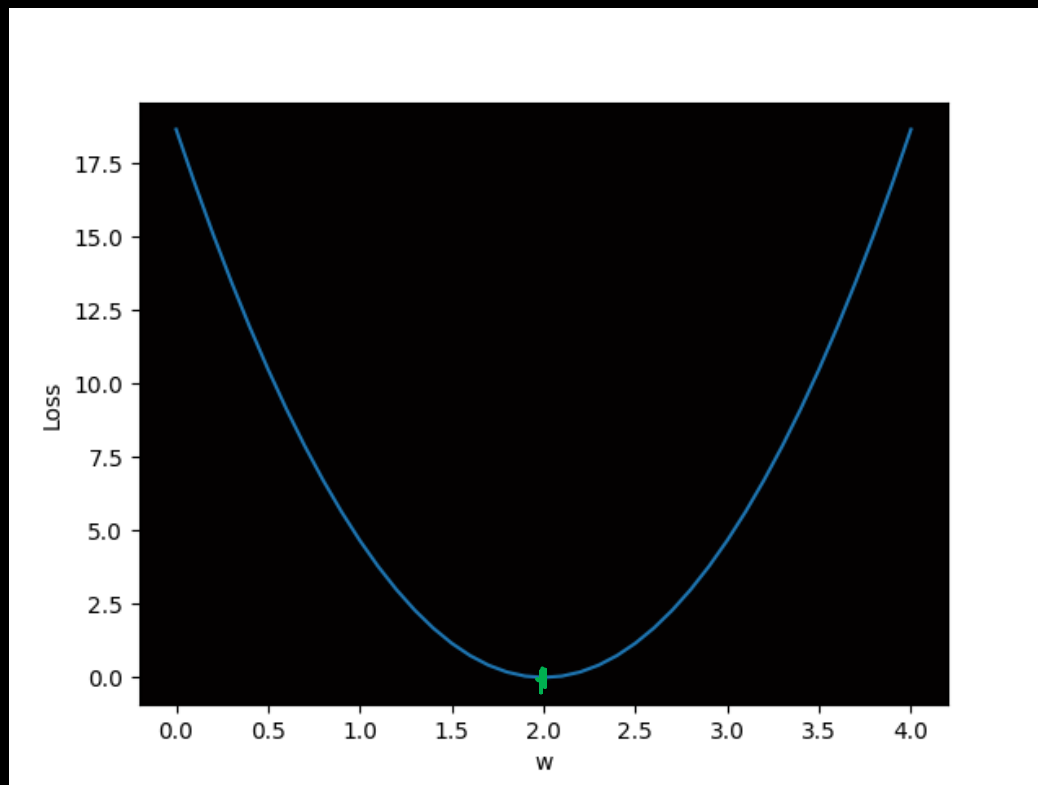
<03> Gradient pastlash
(Gradient Decent)

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O'rgatish : xatolikni minimallashtiruvchi *w* ning qiymatini toppish.

Loss(w=0)	Loss(w=1)	Loss(w=2)	Loss(w=3)	Loss(w=4)
MSE=56/3=18.7	MSE=14/3=4.7	MSE=0	MSE=14/3=4.7	MSE=56/3=18.7

$$loss = \frac{1}{N} \sum_{n=1}^{N} (\hat{y}_n - y_n)^2$$

Gradient Descent algoritmi

loss

Dastlabki
taxmin(w)

Gradient $\dfrac{\partial loss}{\partial w}$

Global minimal xatolik
(Global **loss** minimum)

W
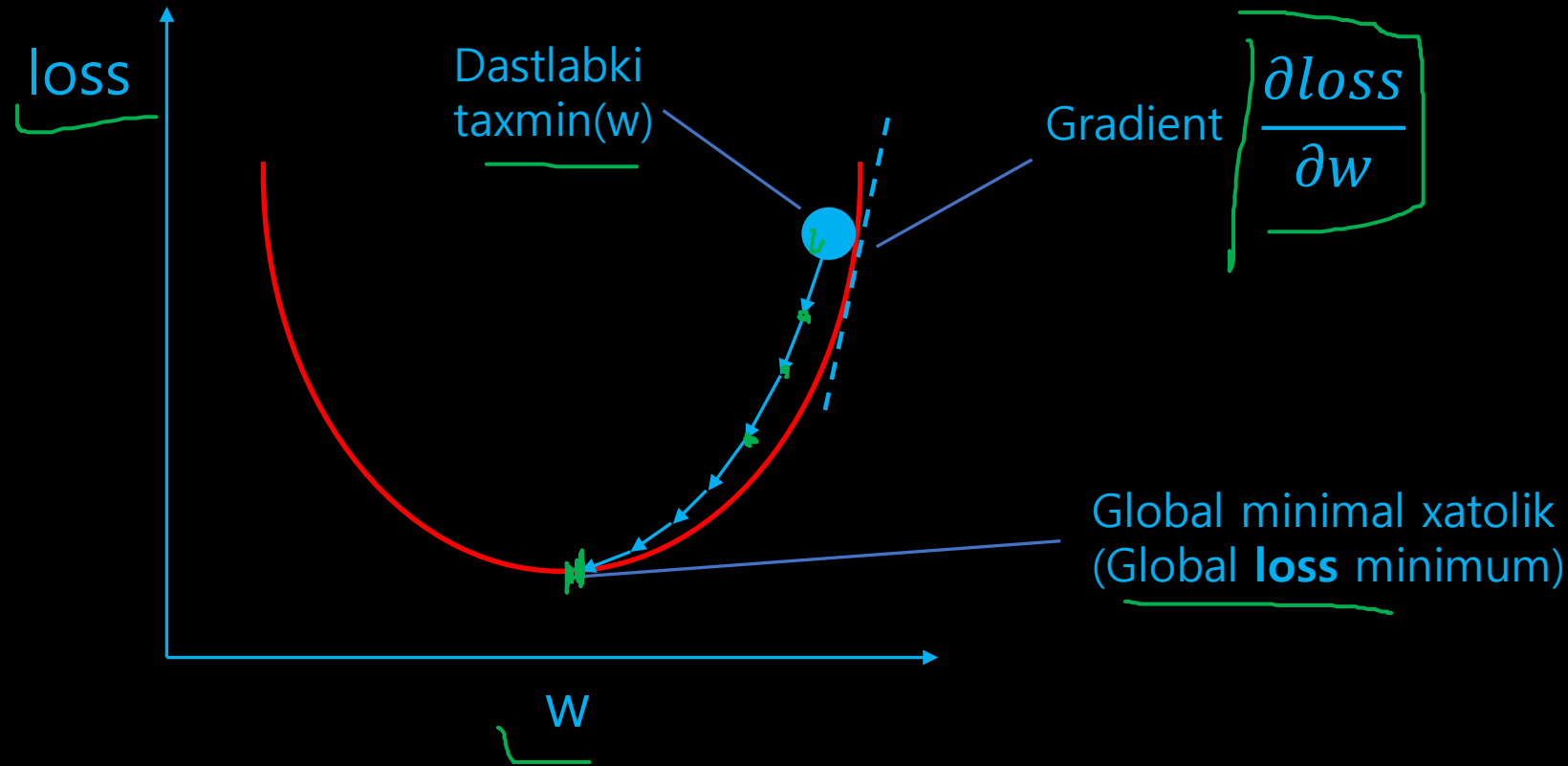
Gradient Descent algoritmi

$$\alpha - learning\ rate$$
$$(O'rganish\ qadami)$$

loss

Dastlabki taxmin(w)

Gradient $\dfrac{\partial loss}{\partial w}$

Global minimal xatolik
(Global **loss** minimum)

$$w_n := w_{n-1} - \alpha \dfrac{\partial loss}{\partial w}$$

0,01

w
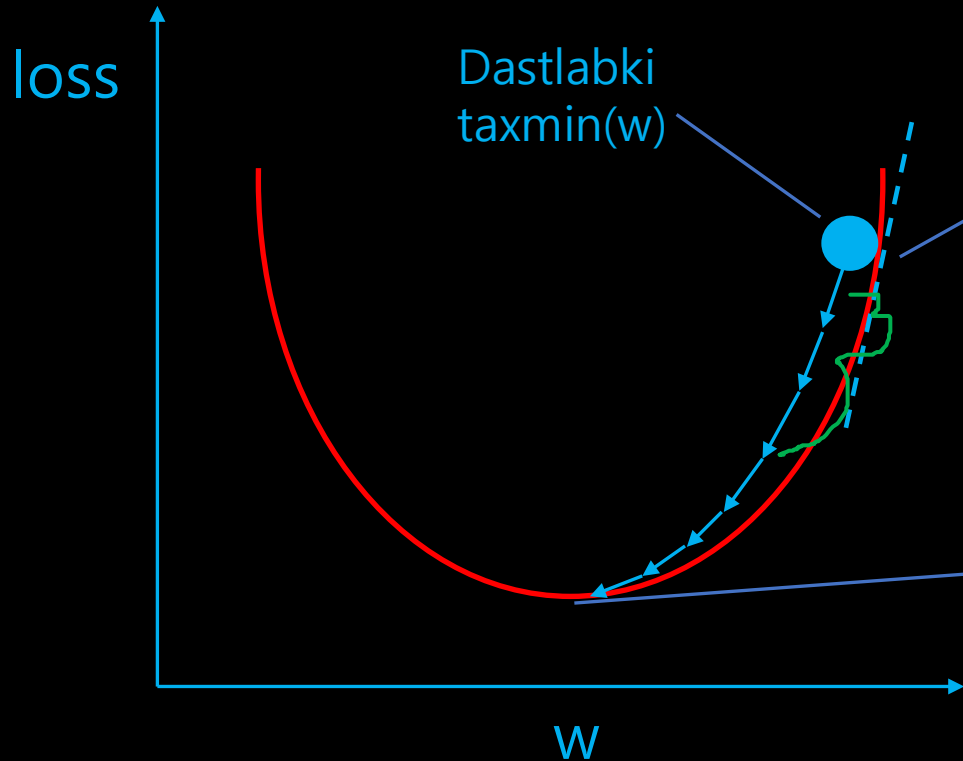
Hosilani hisoblash

$$loss = (\hat{y}-y)^2 = (x*w-y)^2$$

$$w = w - \alpha\frac{\partial loss}{\partial w}$$

Power rule

$$\frac{d}{dx}[g(x)]^n = n[g(x)]^{n-1}g'(x)$$

$$\frac{\partial loss}{\partial w} = ?$$

$$= 2(x\cdot w - y)'\cdot x =$$

$$= 2x(x\cdot w - y)$$

Hosila? $loss = (\hat{y}-y)^2 = (x*w - y)^2$

$\dfrac{\partial loss}{\partial w} = ?$

YOUR INPUT:

$f(w) =$

$$(xw - y)^2$$

Simplify | Roots/zeros

FIRST DERIVATIVE:

$\dfrac{d}{dw}[f(w)] = f'(w) =$

The steps of calculation are displayed.
Click at any derivative $\dfrac{d}{dw}[\ldots]$ in order to show the rule that was applied.

$$\dfrac{d}{dw}\left[(xw - y)^2\right]$$

$$= 2(xw - y) \cdot \dfrac{d}{dw}[xw - y]$$

$$= 2(xw - y)\left(x \cdot \dfrac{d}{dw}[w] + \dfrac{d}{dw}[-y]\right)$$

$$= 2(xw - y)(x \cdot 1 + 0)$$

$$= 2x(xw - y)$$

https://www.derivative-calculator.net

Gradient Descent algoritmi

loss

Dastlabki
taxmin(w)

Gradient $\dfrac{\partial loss}{\partial w}$

$$w = w - \alpha \dfrac{\partial loss}{\partial w}$$

$$= w - \alpha * 2\mathrm{x}(\mathrm{x}w - \mathrm{y})$$

Global minimal xatolik
(Global **loss** minimum)

w
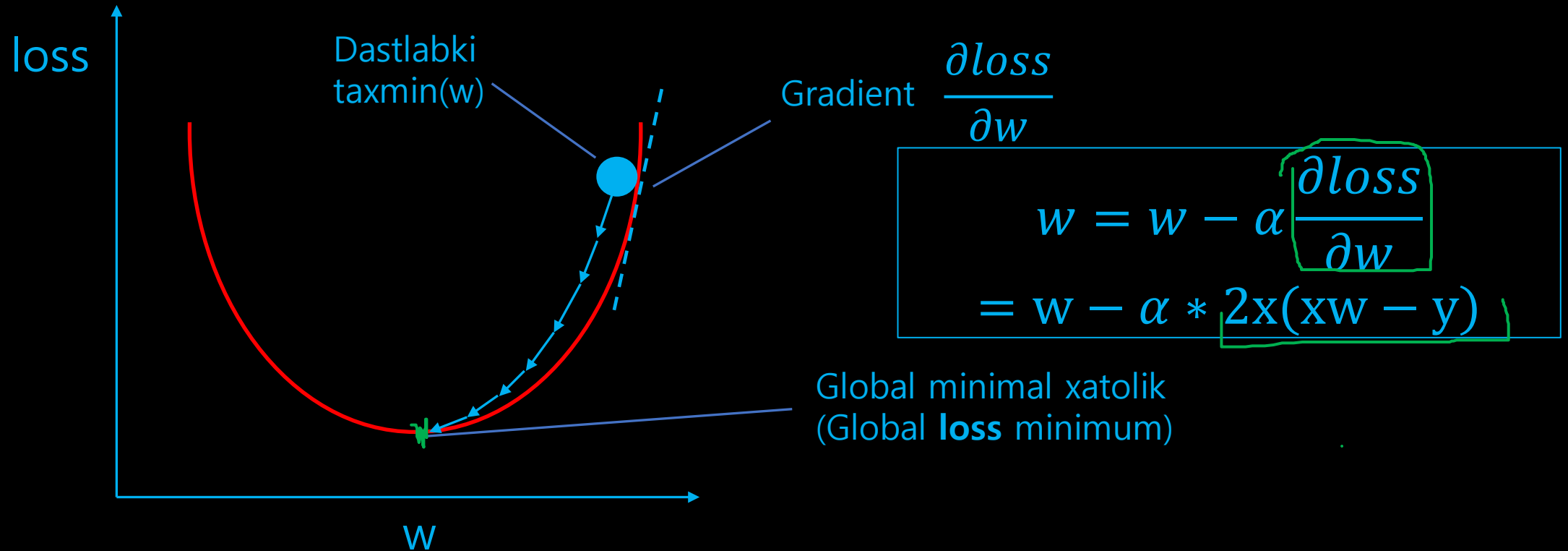
Ma'lumotlar, Model, Loss va Gradient

```python
# Training Data(O'rgatishdagi ma'lumotlar)
x_data = [1.0, 2.0, 3.0]
y_data = [2.0, 4.0, 6.0]


w = 1.0  #w uchun dastalbki taxminiy qiymat



# (Modelimiz)To'g'ri hisoblash uchun funksiya
def forward(x):
    return x * w



# Xatolik (Loss) ning funkisyasi
def loss(x, y):
    y_pred = forward(x)
    return (y_pred - y) * (y_pred - y)



# Gradient uchun funksiya
def gradient(x, y):  # d_loss/d_w
    return 2 * x * (x * w - y)
```

Soat (x)	Baho(y)
1	2
2	4
3	6
4	?

$$\hat{y} = x * w$$

$$loss = (\hat{y} - y)^2$$

$$w = w - \alpha * 2x(xw - y)$$

Gradientni hisoblash & w ning qiymatini yangilash

```python
# Training dan avval
print("Bashorat (training dan avval)",  "4 soat o'qilganda:", forward(4))

# Training zanjiri (loop)
learning_rate =0.01
for epoch in range(10):
    for x_hb_qiym, y_hb_qiym in zip(x_soat, y_baho):
        # Hosilani hisoblash
        # w ning qiymatini yangilash
        # xatolikni hisoblab progressni chop qilish
        grad = gradient(x_hb_qiym, y_hb_qiym)
        w = w - learning_rate * grad
        print("\tgrad: ", x_hb_qiym, y_hb_qiym, round(grad, 2))
        l = loss(x_hb_qiym, y_hb_qiym)
    print("progress:", epoch, "w=", round(w, 2), "loss=", round(l, 2))

# Traningdan so'ng
print("Bashorat (training dan keyin)",  "4 saot o'qilganda: ", forward(4))
```

```
Bashorat (training dan avval) 4 soat o'qilganda: 4.0
        grad:  1.0 2.0 -2.0
        grad:  2.0 4.0 -7.84
        grad:  3.0 6.0 -16.23
progress: 0 w= 1.26 loss= 4.92
        grad:  1.0 2.0 -1.48
        grad:  2.0 4.0 -5.8
        grad:  3.0 6.0 -12.0
progress: 1 w= 1.45 loss= 2.69
        grad:  1.0 2.0 -1.09
        grad:  2.0 4.0 -4.29
        grad:  3.0 6.0 -8.87
progress: 2 w= 1.6 loss= 1.47
        grad:  1.0 2.0 -0.81
        grad:  2.0 4.0 -3.17
        grad:  3.0 6.0 -6.56
progress: 3 w= 1.7 loss= 0.8
        grad:  1.0 2.0 -0.6
        grad:  2.0 4.0 -2.34
        grad:  3.0 6.0 -4.85
progress: 4 w= 1.78 loss= 0.44
        grad:  1.0 2.0 -0.44
        grad:  2.0 4.0 -1.73
        grad:  3.0 6.0 -3.58
progress: 5 w= 1.84 loss= 0.24
        grad:  1.0 2.0 -0.33
        grad:  2.0 4.0 -1.28
        grad:  3.0 6.0 -2.65
progress: 6 w= 1.88 loss= 0.13
        grad:  1.0 2.0 -0.24
        grad:  2.0 4.0 -0.95
        grad:  3.0 6.0 -1.96
progress: 7 w= 1.91 loss= 0.07
        grad:  1.0 2.0 -0.18
        grad:  2.0 4.0 -0.7
        grad:  3.0 6.0 -1.45
progress: 8 w= 1.93 loss= 0.04
        grad:  1.0 2.0 -0.13
        grad:  2.0 4.0 -0.52
        grad:  3.0 6.0 -1.07
progress: 9 w= 1.95 loss= 0.02
Bashorat (training dan keyin) 4 saot o'qilganda: 7.804863933862125
```