# Assignment 3 – GAN Theory (Part 3)

## Q1

Given: I=8, K=4, S=2, P=1, OP=1.

Formula: $O = (I-1)\cdot S - 2P + K + OP$

Computation: $O = (8-1)\cdot 2 - 2\cdot 1 + 4 + 1 = 7\cdot 2 - 2 + 4 + 1 = 14 - 2 + 4 + 1 = 17$

Answer: 17×17

## Q2

Change stride from S=2 to S=3.

$O = (8-1)\cdot 3 - 2\cdot 1 + 4 + 1 = 7\cdot 3 - 2 + 4 + 1 = 21 - 2 + 4 + 1 = 24$

Answer: Output becomes 24×24 (it increases roughly proportionally to the stride).

## Q3

General formula (no dilation): $O = (I-1)\cdot S - 2P + K + OP$

If dilation D is used: $O = (I-1)\cdot S - 2P + D\cdot(K-1) + OP + 1$

When D=1, it reduces to the first formula since $D\cdot(K-1)+1=K$.

## Q4

Upsample 16×16 $\rightarrow$ 32×32 with no padding (P=0) and OP=0.

We want $(16-1)\cdot S + K = 32$. Pick S=2 $\rightarrow$ $(15)\cdot 2 + K = 30 + K = 32 \Rightarrow K=2$.

One valid configuration: K=2, S=2, P=0, OP=0.

## Q5

Batch of values: [6, 8, 10, 6]. BatchNorm (without $\gamma$, $\beta$) standardizes to zero mean, unit variance.

Mean: $\mu = (6 + 8 + 10 + 6)/4 = 7.5$

Variance: $\sigma^2 = ((6-7.5)^2 + (8-7.5)^2 + (10-7.5)^2 + (6-7.5)^2)/4 = 2.75$

Standard deviation: $\sigma = \sqrt{2.75} \approx 1.6583$

Normalized values: [-0.9045, 0.3015, 1.5076, -0.9045]

## Q6

$\mathrm{ReLU}(x) = \max(0, x) =$

$\{ 0, \text{if } x < 0 \ ; \ x, \text{if } x \geq 0 \}$

$\mathrm{LeakyReLU}(x; \alpha) = \max(\alpha x, x) =$

$\{ \alpha x, \text{if } x < 0 \ ; \ x, \text{if } x \geq 0 \}$

Key difference: ReLU has zero slope for $x<0$; LeakyReLU has a small positive slope $\alpha$.

## Q7

Why prefer LeakyReLU over ReLU in deep networks (and often in GANs)?

- Avoids 'dying ReLUs' – ReLU can output 0 for many negatives, leading to zero gradients.
- Maintains gradient flow on negative inputs for better optimization stability.
- Empirically stabilizes GAN discriminator training and reduces mode collapse.