Generative AI with Diffusion Models

Part 3: Optimizations
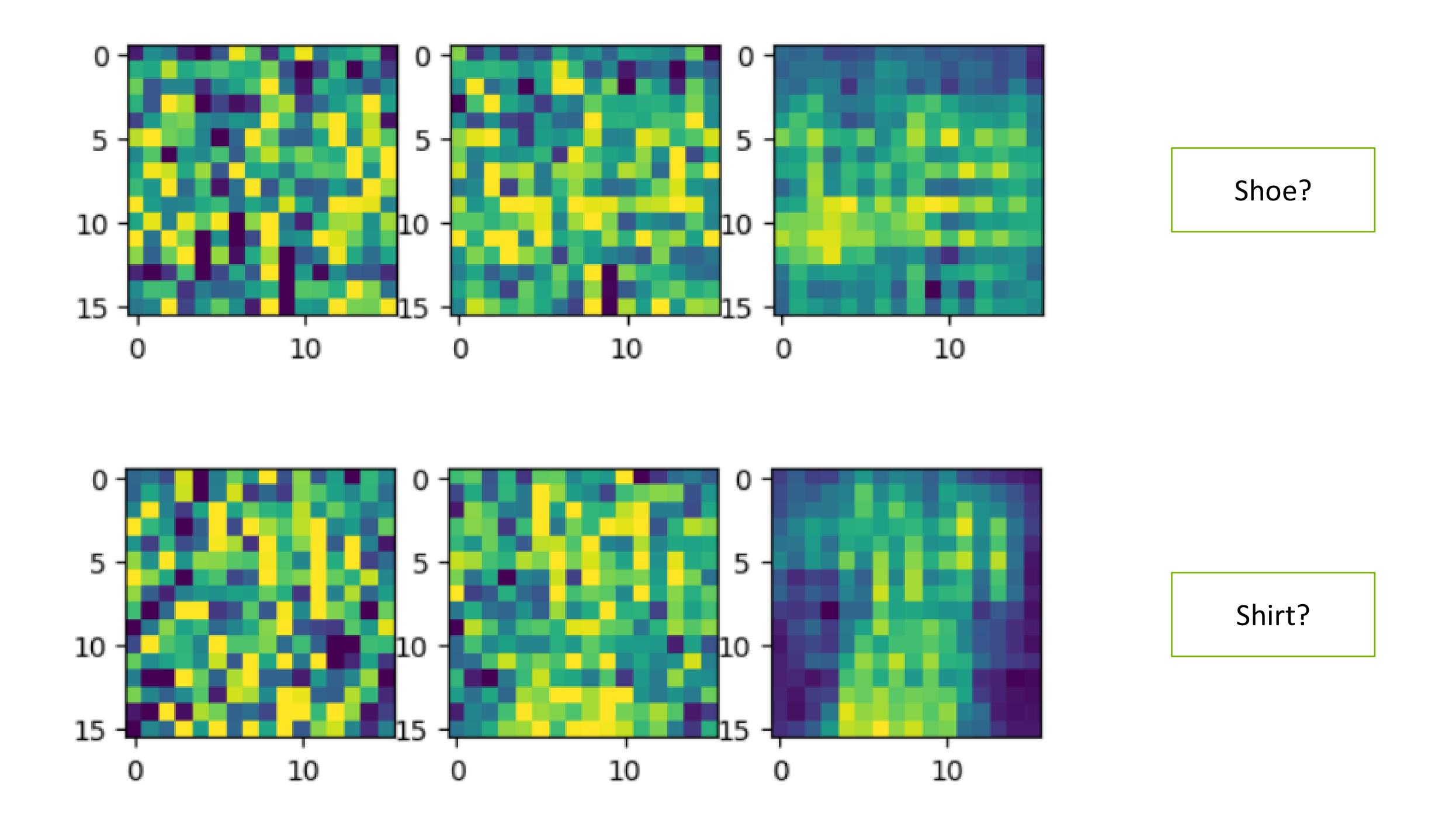
Agenda

The Checkerboard Problem

The Checkerboard Problem
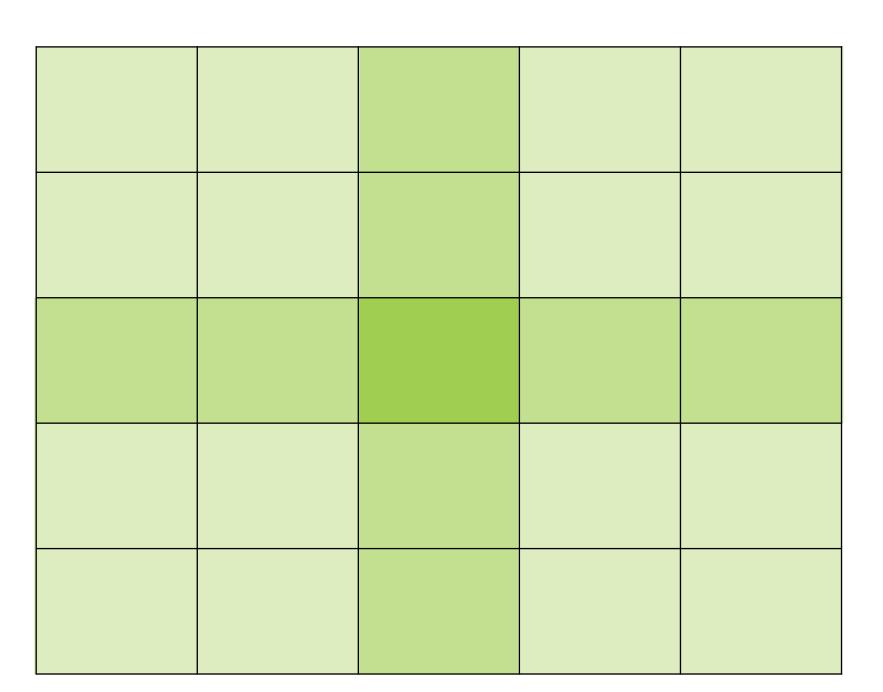

Shoe?

Shirt?

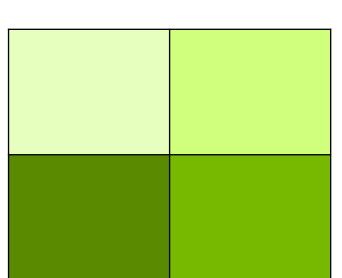# The Checkerboard Problem
The Impact of Stride

Kernel Size = 3
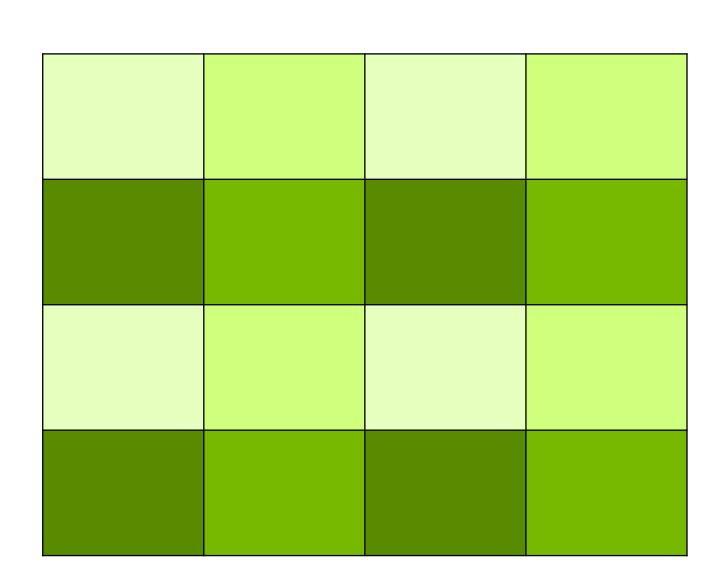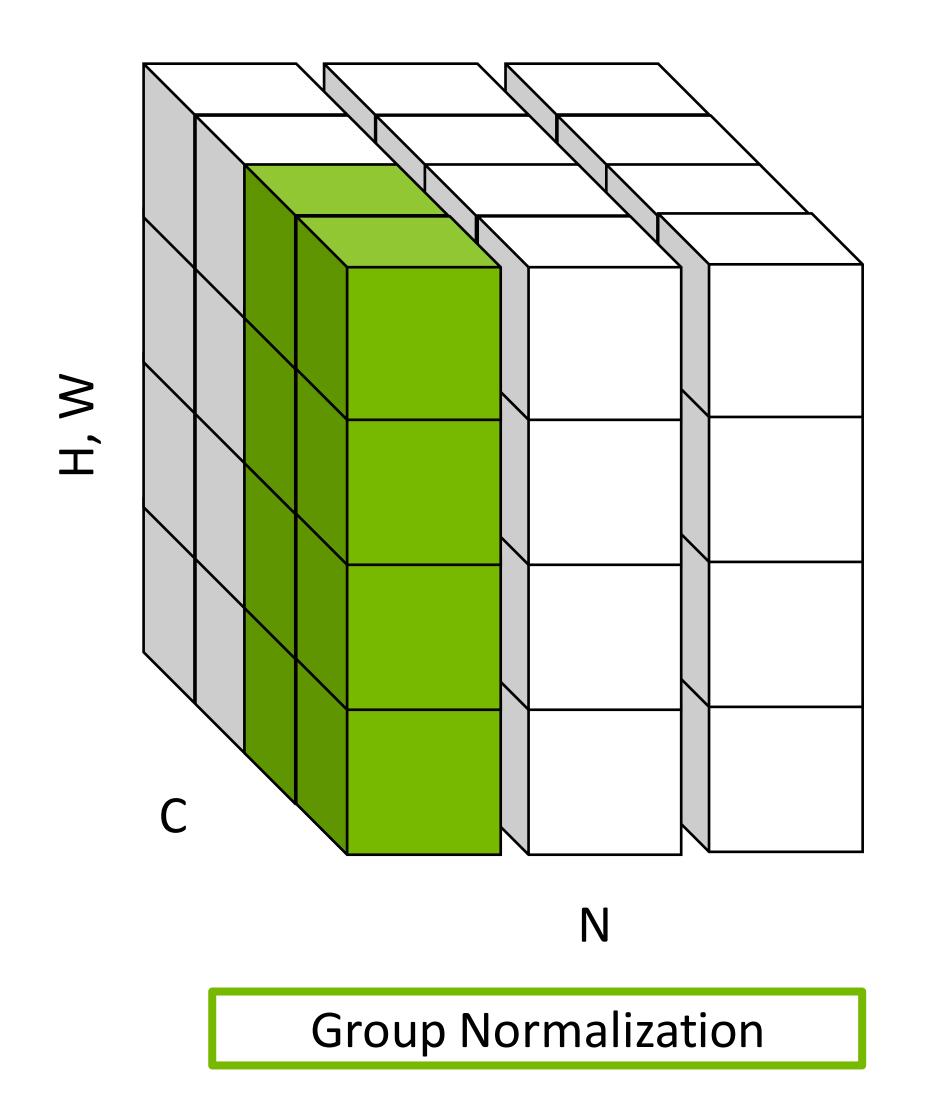
Stride = 2

A cozy green plaid blanket, fairy tale drawing

The Checkerboard Problem
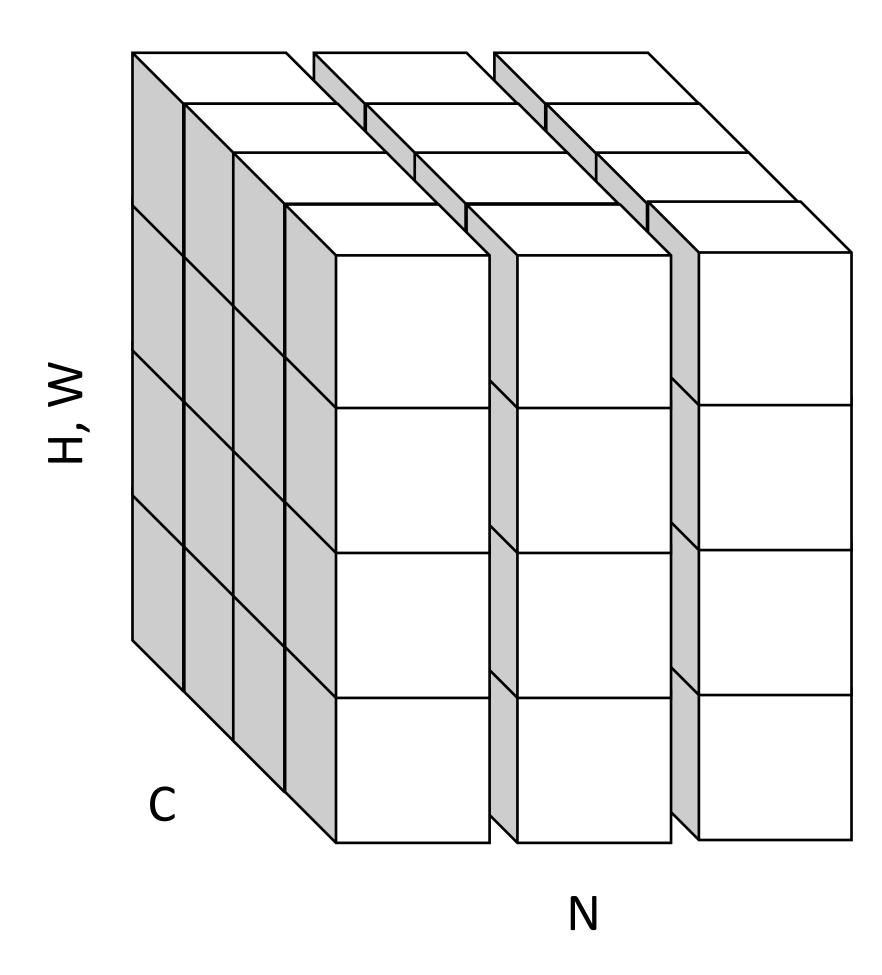## The Impact of Stride

Stride = 2

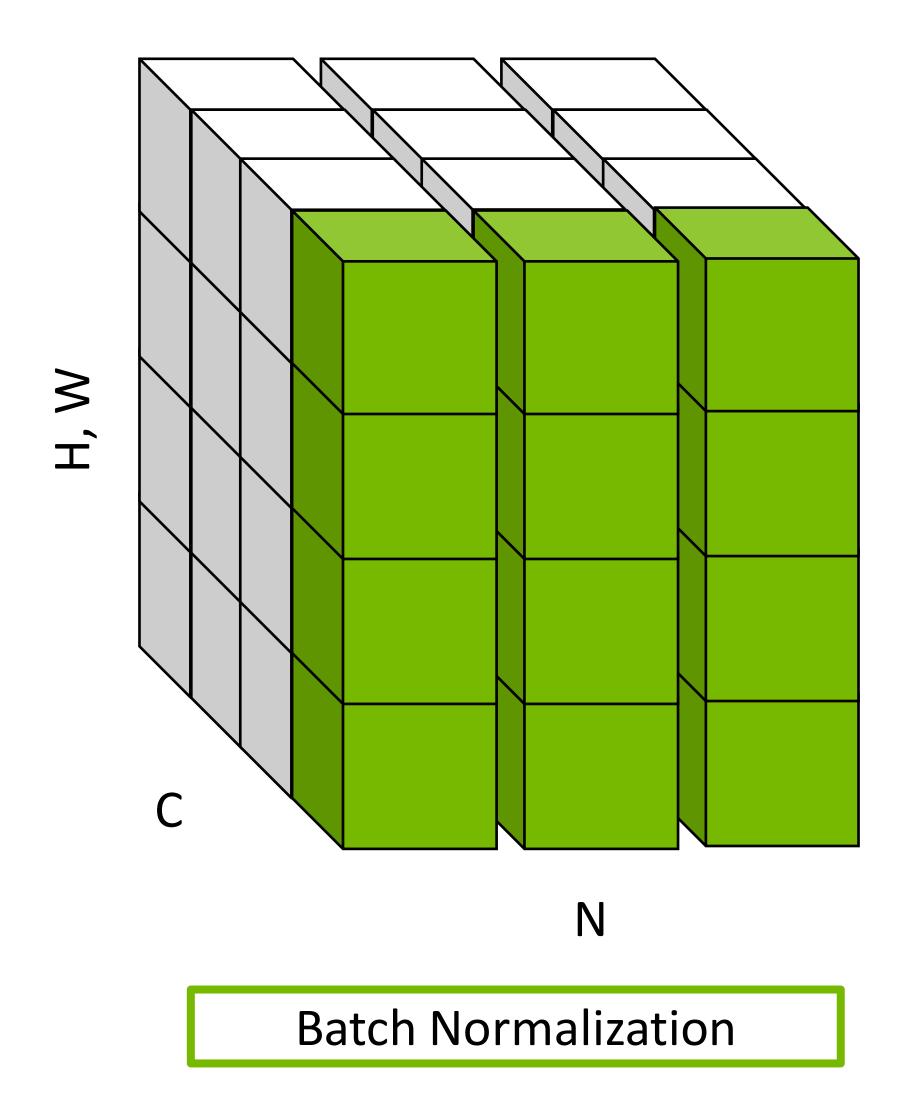Kernel Size = 2

Group Normalization

Group Normalization
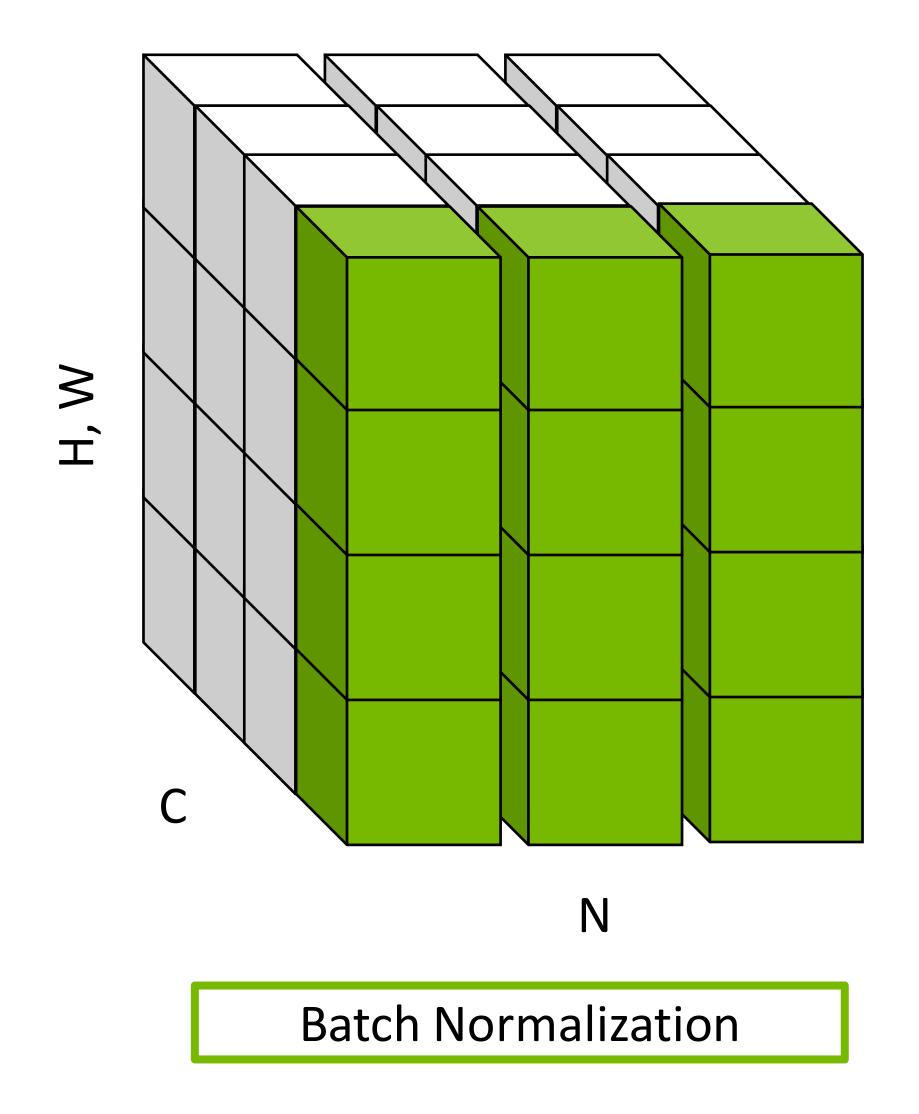
Batch Normalization Review

Group Normalization

Batch Normalization Review

Group Normalization

Types of Group Normalization

Group Normalization

Types of Group Normalization
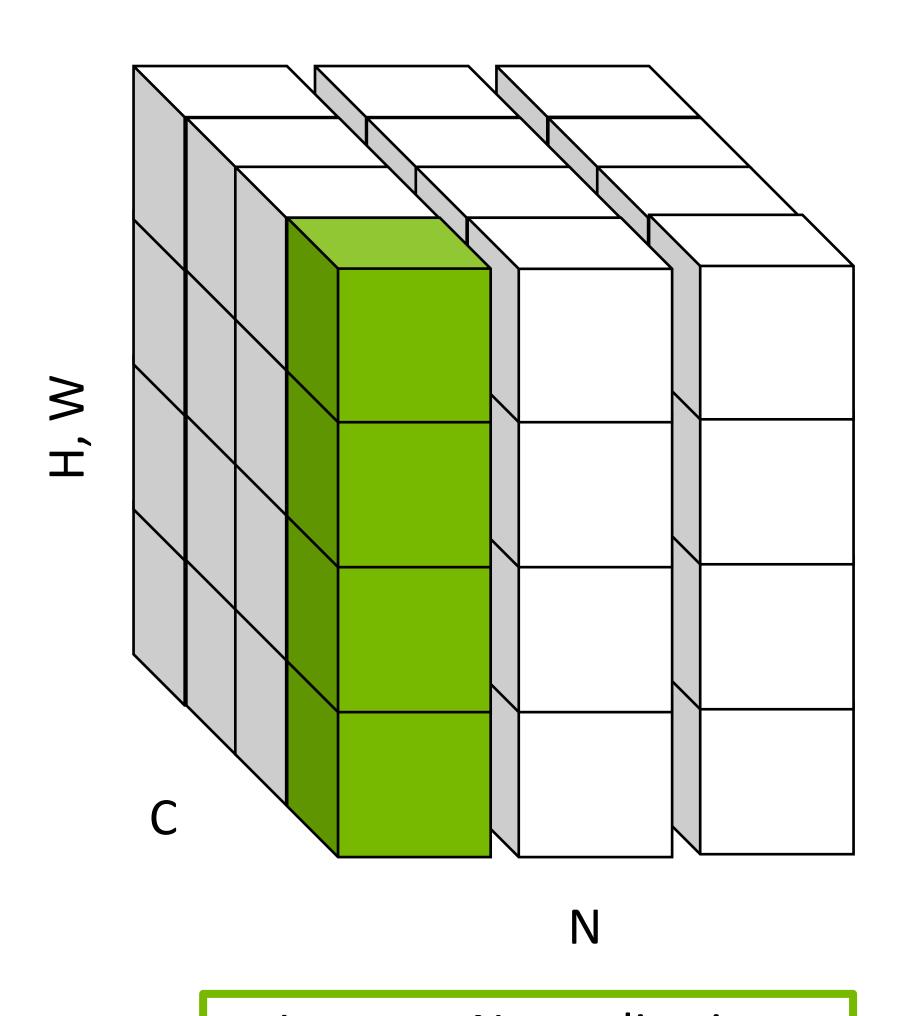
Group Normalization

Types of Group Normalization
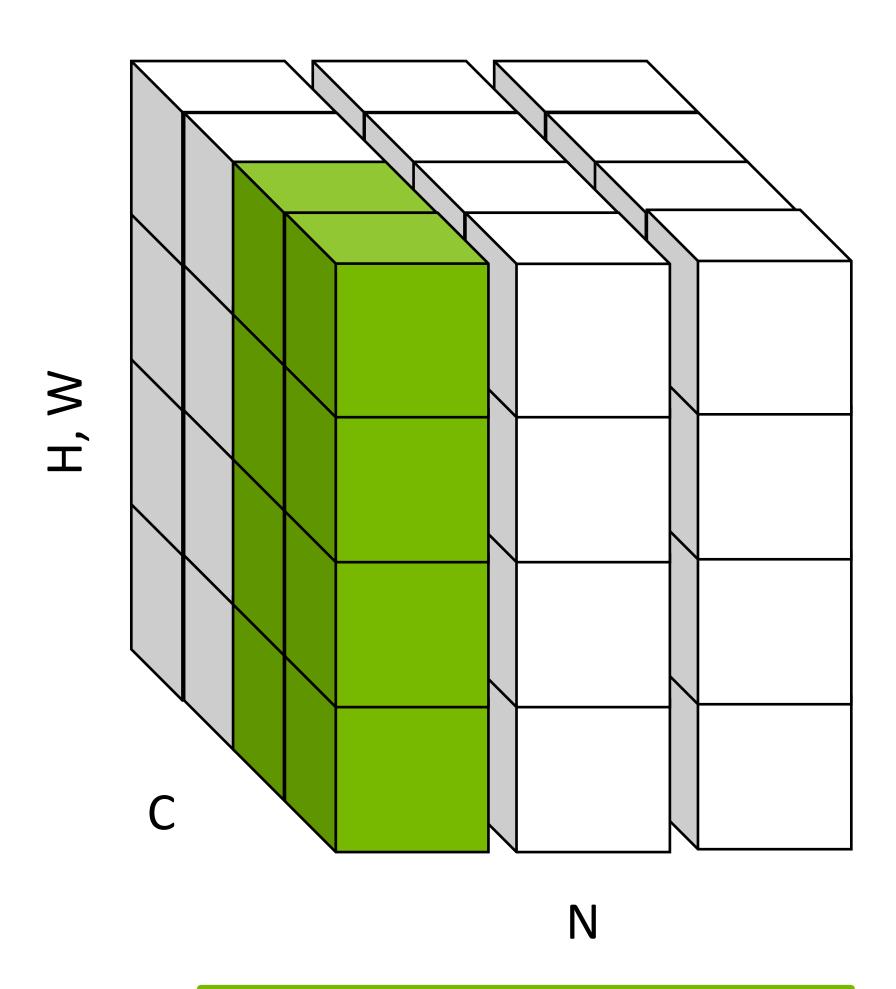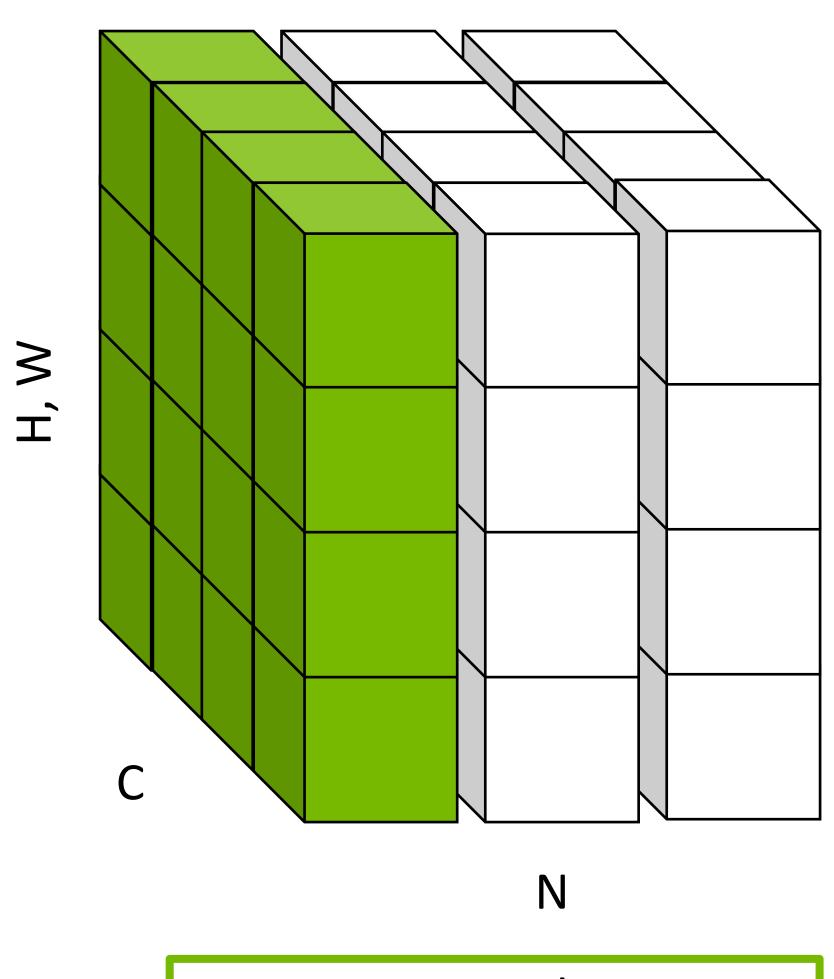
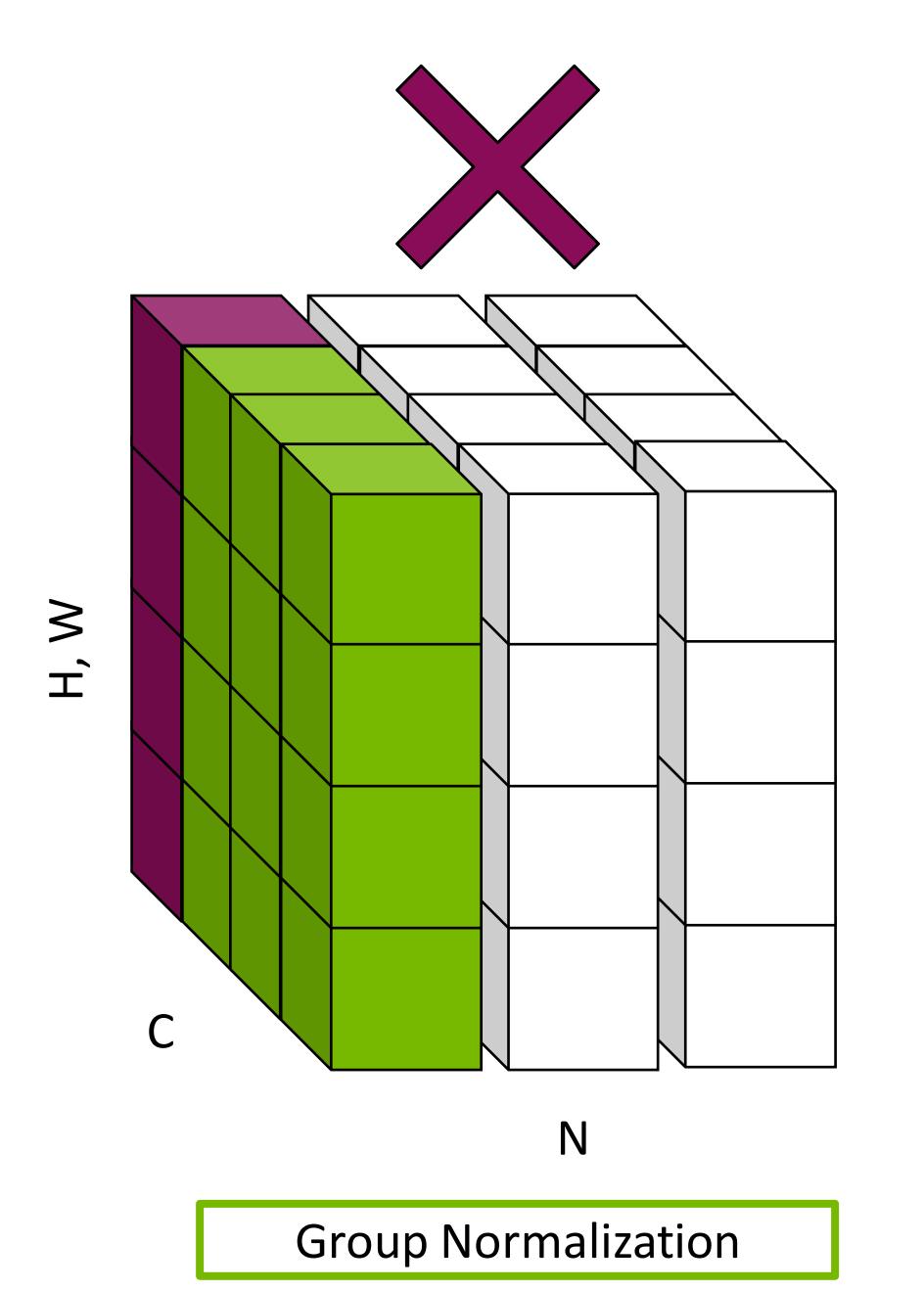Group Normalization

Group Size = 2
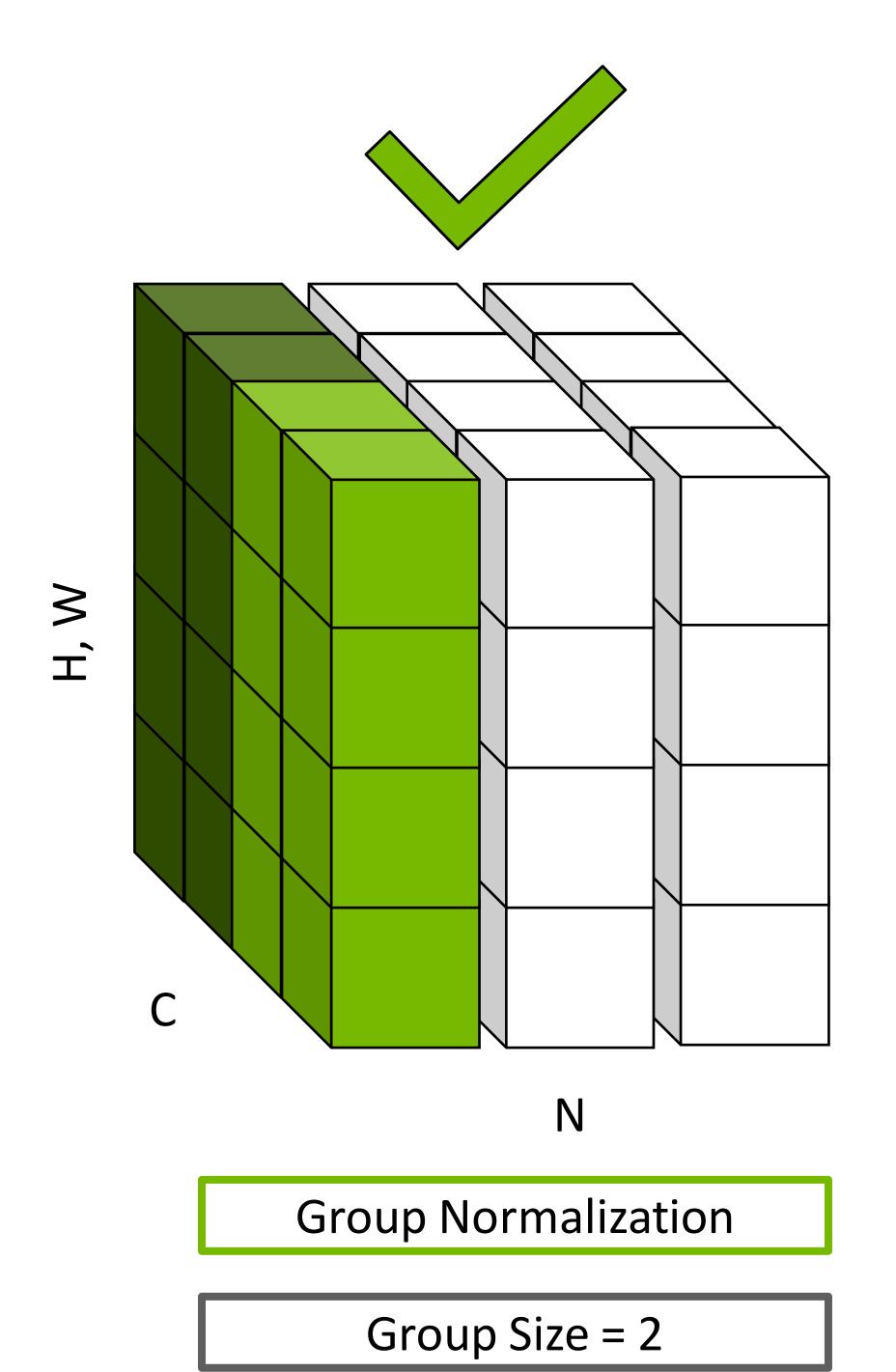
Group Normalization

Group Size = 3

Gaussian Error Linear Unit (GELU)
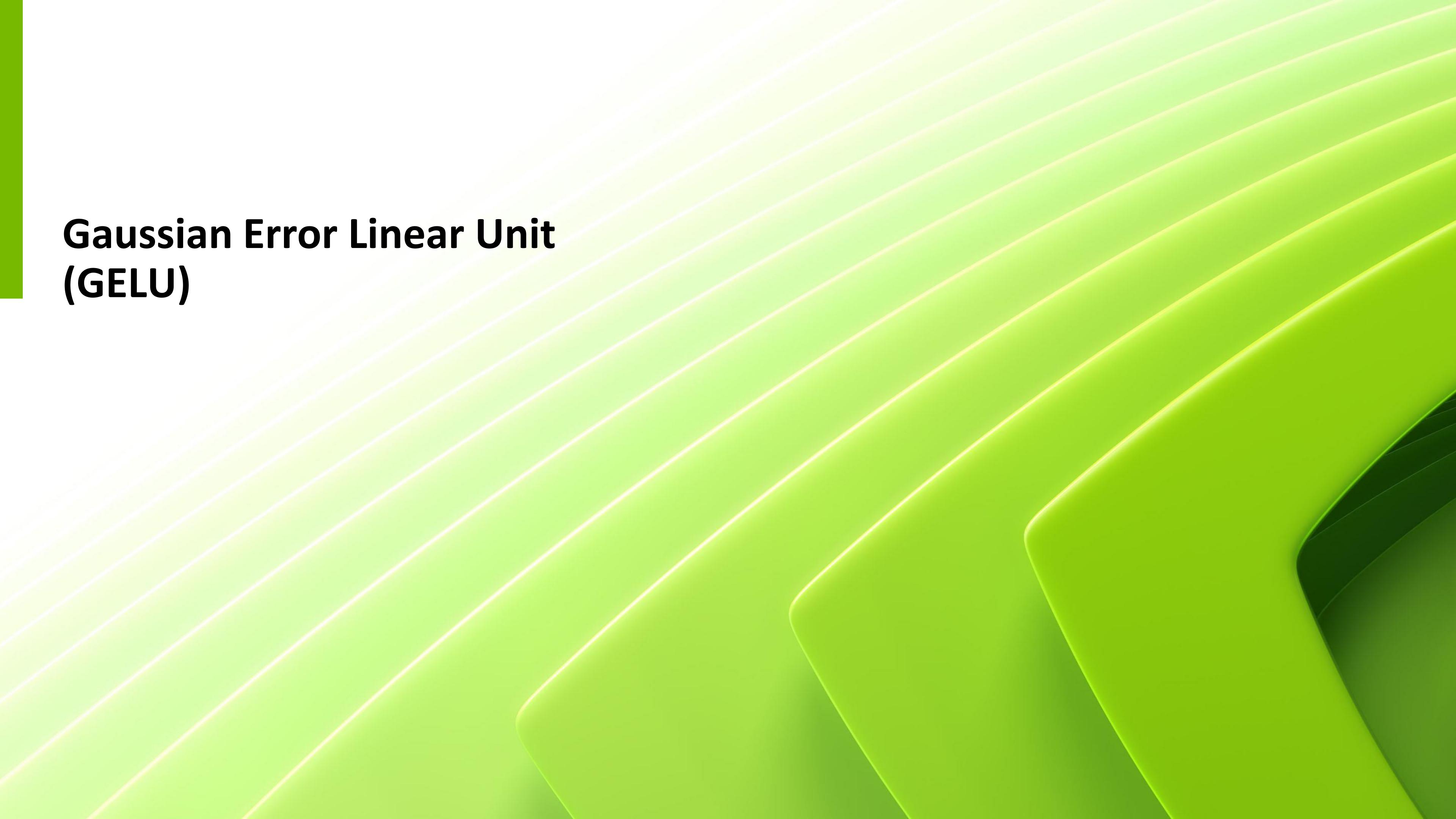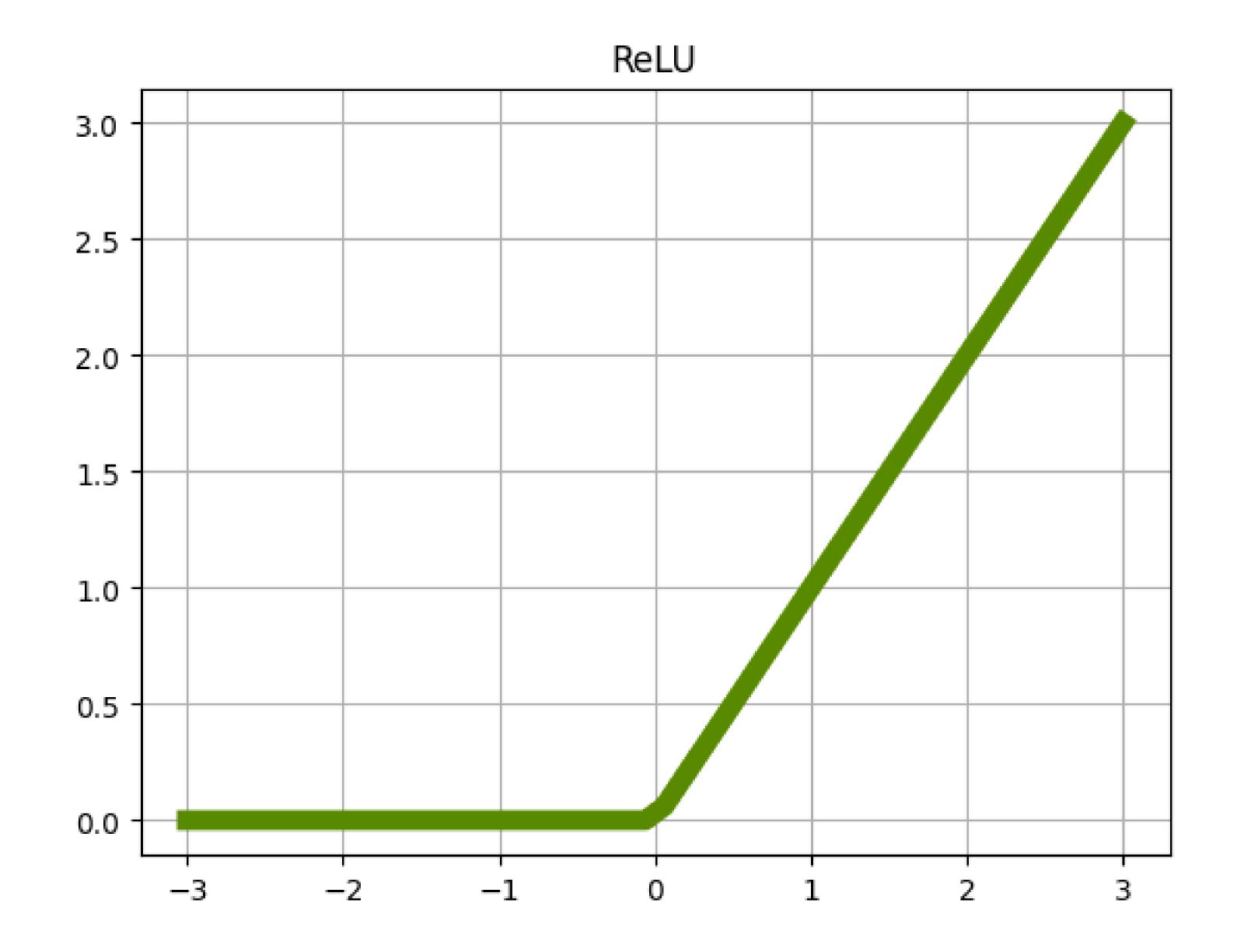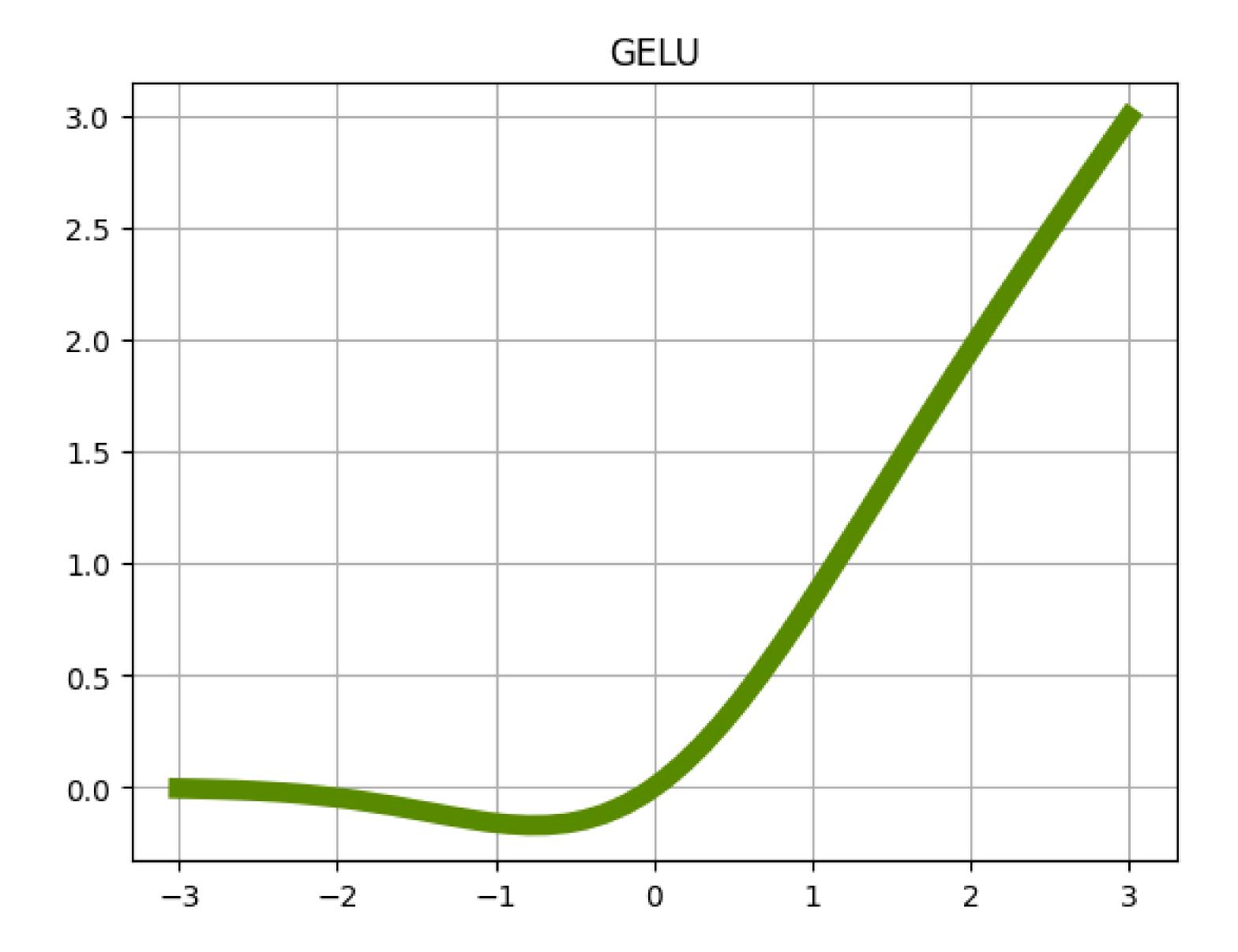
GELU

Gaussian Error Linear Unit

Rearrange Pooling
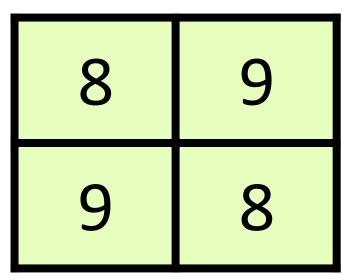
Pooling
Max Pooling Review

Image

1	8	6	7
5	3	0	9
0	5	6	1
9	3	7	8

Pooled Image

8	9
9	8

Information lost

Einops

Better Dimension Manipulation

```
Rearrange(
  "c (h p1) (w p2) -> (c p1 p2) h w",
  p1=2, p2=2
)
```

Cut image into strips and stack

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Einops
Better Dimension Manipulation

```
Rearrange(
  "c (h p1) (w p2) -> (c p1 p2) h w",
  p1=2, p2=2
)
```
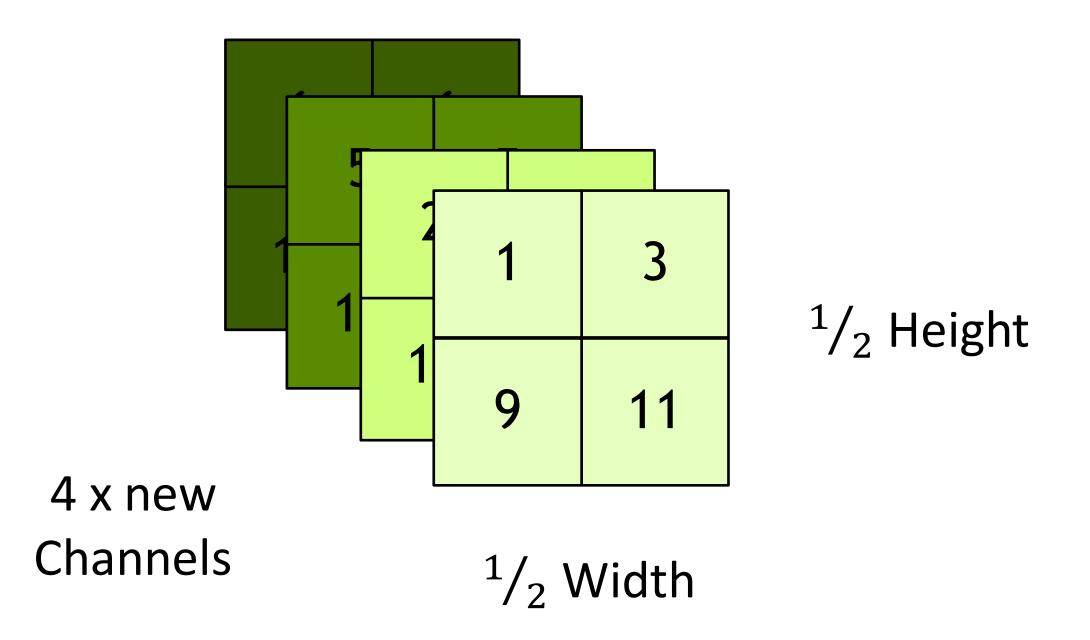
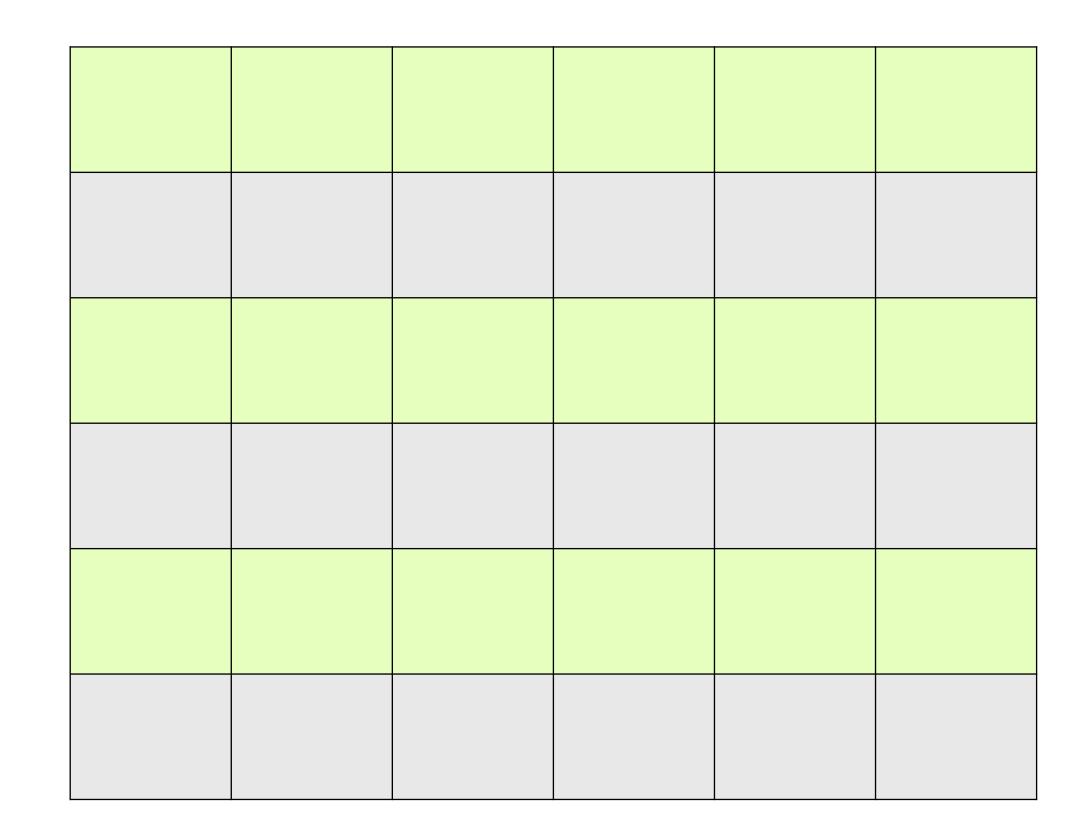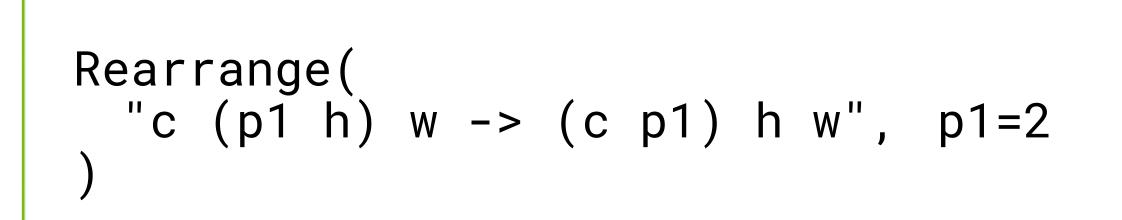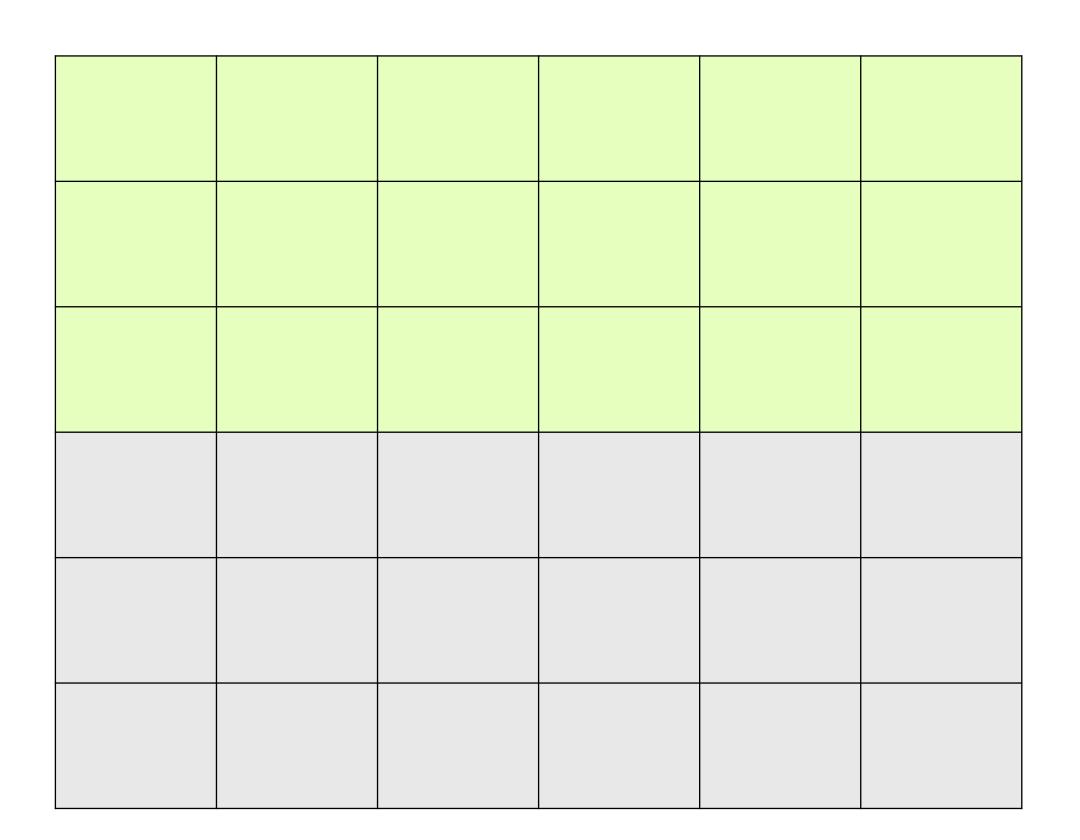Cut image into strips and stack

4 x new Channels

$^1/_2$ Height

$^1/_2$ Width

Einops

Order Matters

```
Rearrange(
  "c (h p1) w -> (c p1) h w", p1=2
)
```

```
Rearrange(
  "c (p1 h) w -> (c p1) h w", p1=2
)
```

Sinusoidal Position Embeddings

Time as a Sequence

How to Represent Time as Discrete Steps?

| t | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ... |

| As a one-hot encoding? | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | ... |

t = 7
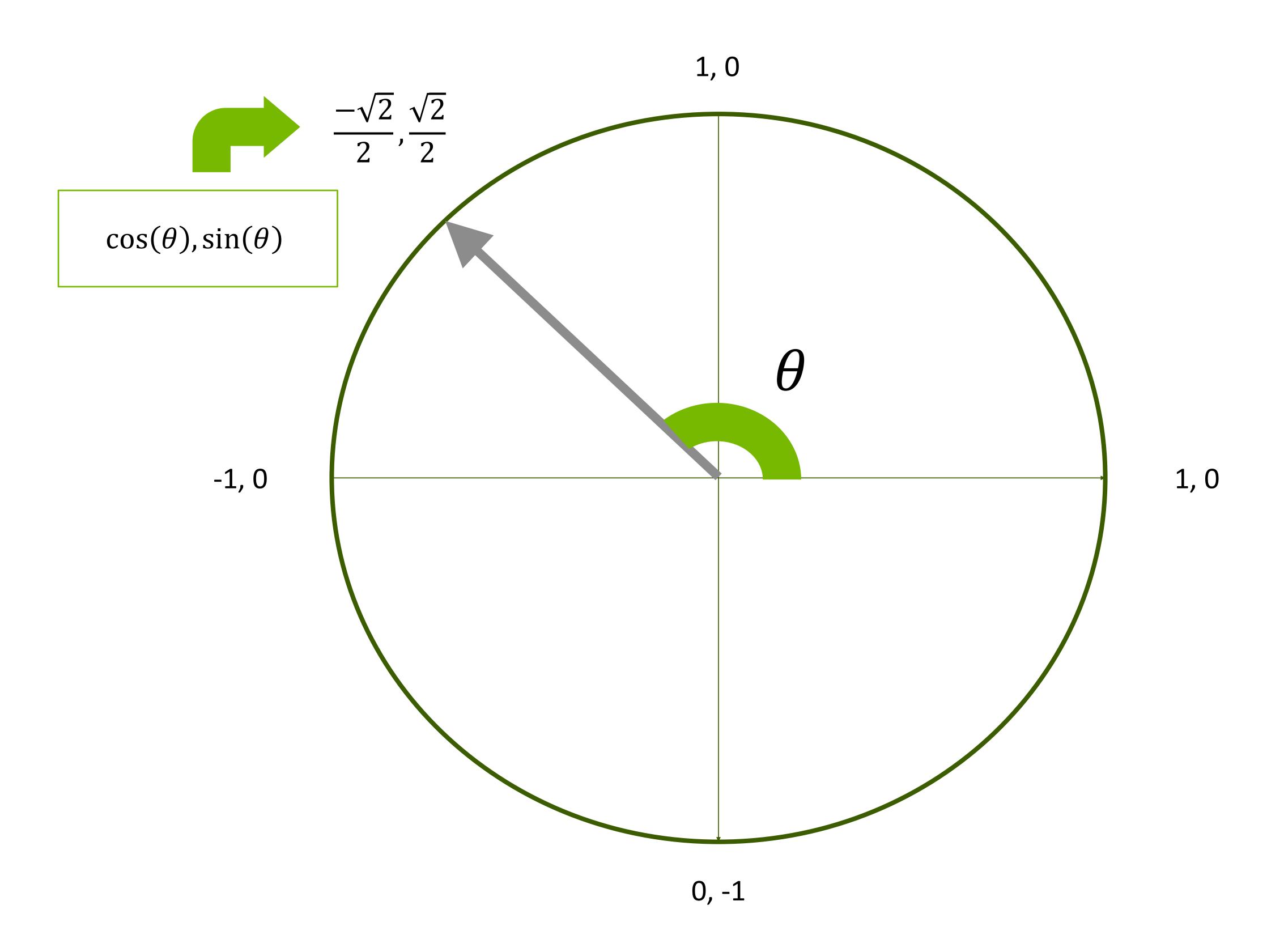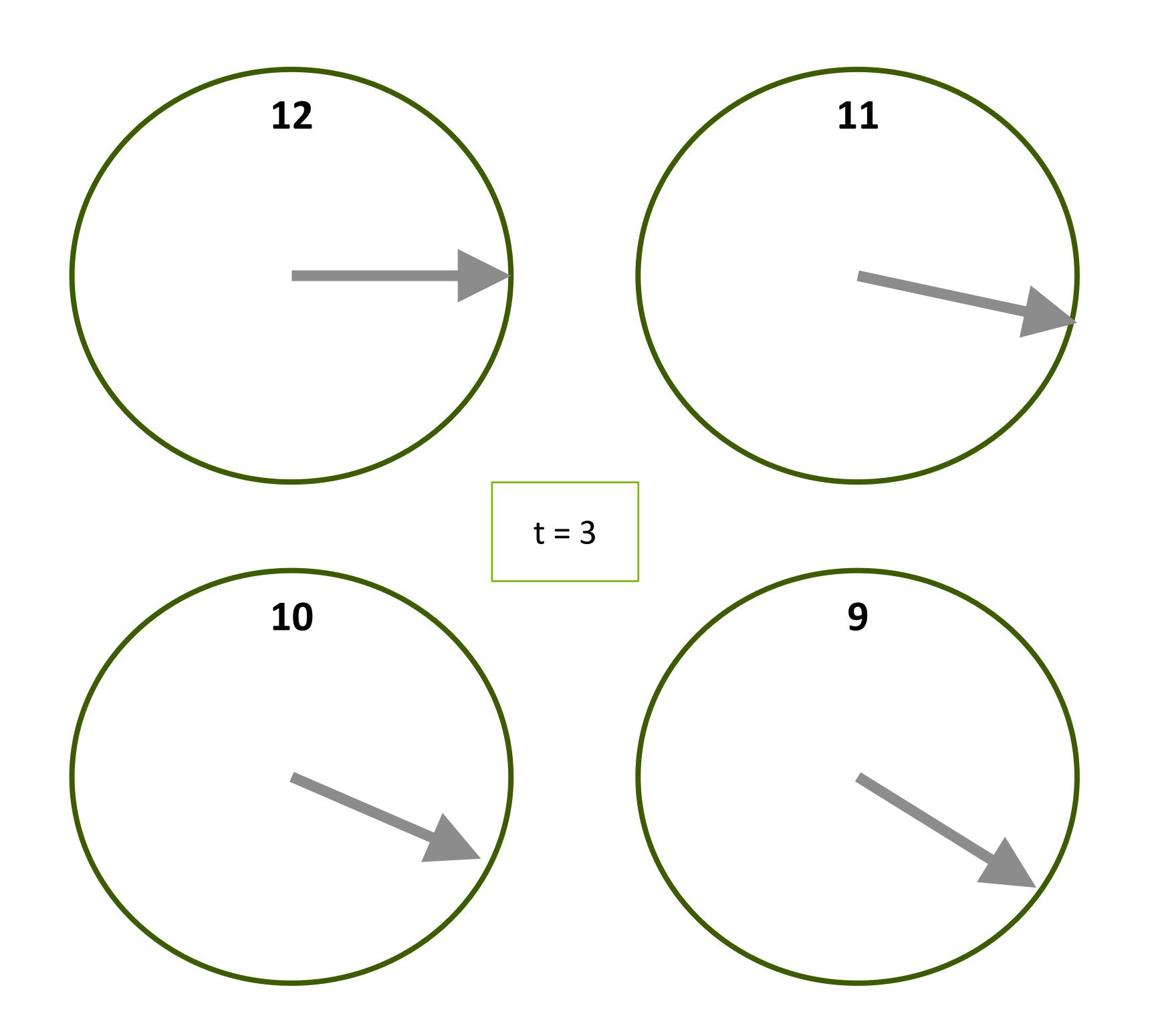
As binary?		0	0	0	0	0	0	0	0	1	1	...
		0	0	0	0	1	1	1	1	0	0	...
		0	0	1	1	0	0	1	1	0	0	...
		0	1	0	1	0	1	0	1	0	1	...

Time as a Sequence

As a Unit Circle?

Time as a Sequence

As Unit Circles?

Time as a Sequence

As Unit Circles?

12

11

t = 15

10

9
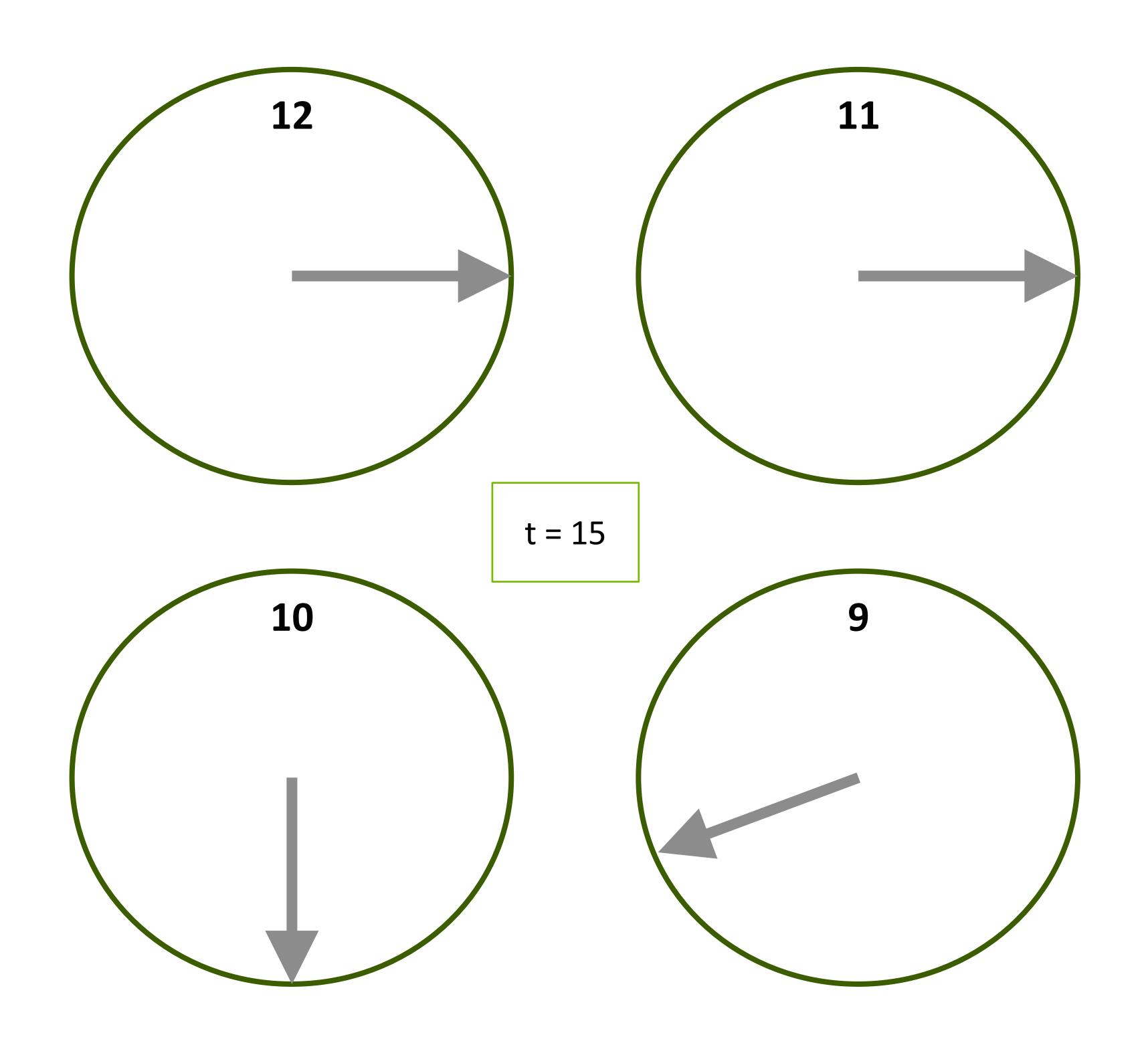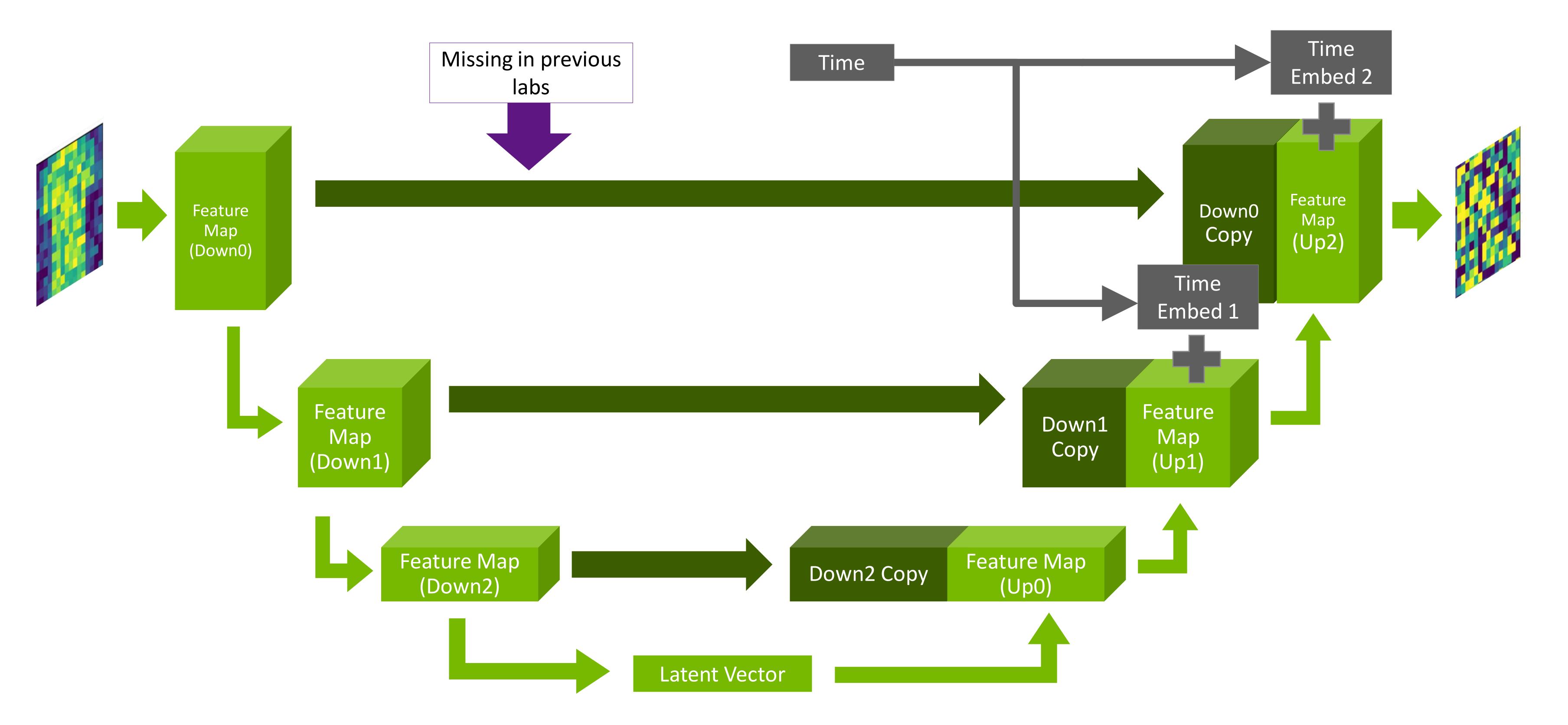
A bunch of abstract clocks with different numbers on them

Deeper Networks

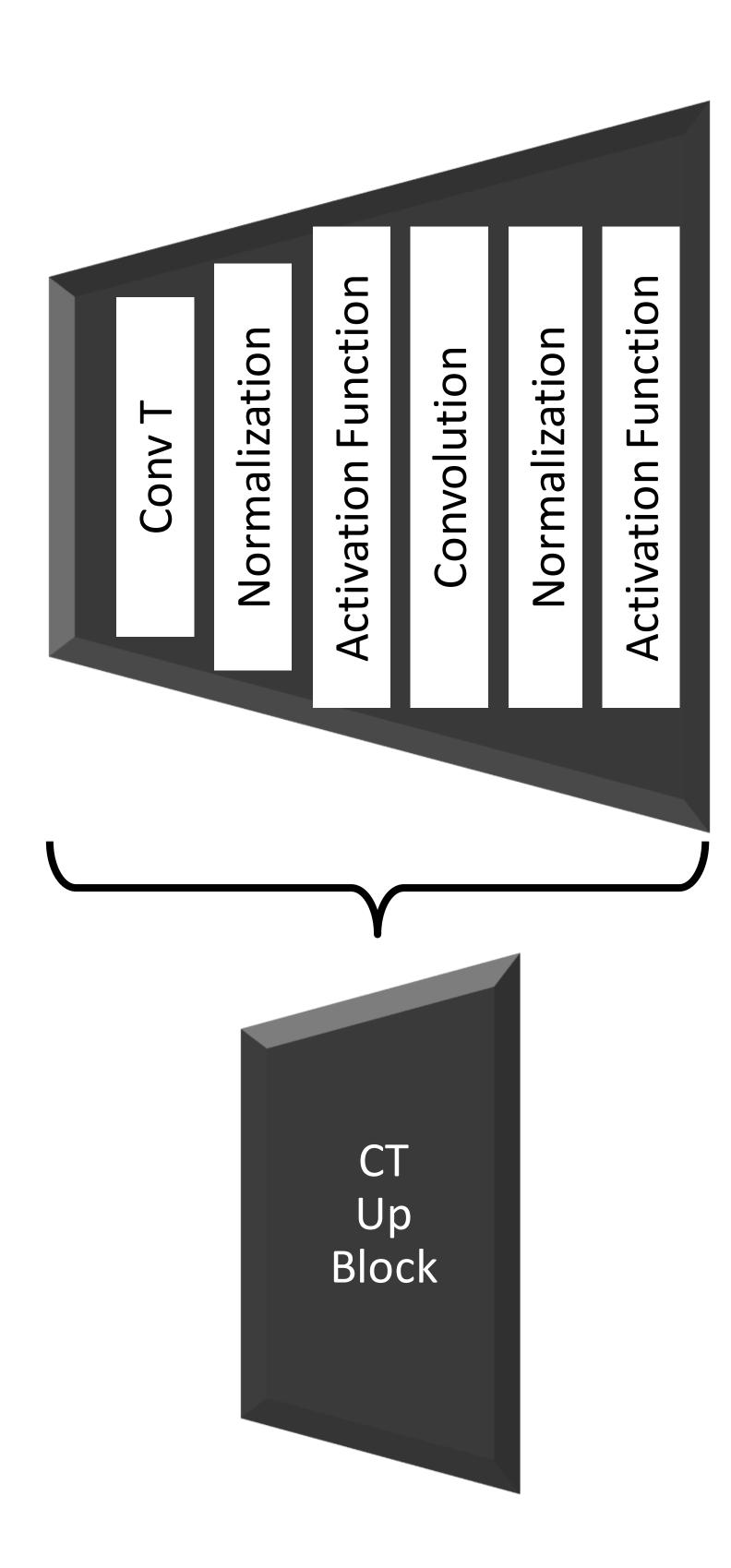# The U-Net Architecture

Adding Time

Adding Depth

Conv T · Normalization · Activation Function · Convolution · Normalization · Activation Function

CT
Up
Block

Adding Depth

Let's get started!