Workshop 8

COMP90051 Statistical Machine Learning

Semester 2, 2024

Learning Outcomes

By the end of this workshop you should be able to:

1. Be able to define and fit models in PyTorch
2. Be able to explain the architecture of a basic convolutional neural network
3. Be able to implement autoencoder

Convolutional neural nets

- Convolutional layers
  - Complex input representations based on convolution operation
  - Filter weights are learned from training data
- Downsampling, usually via Max Pooling
  - Re-scales to smaller resolution, limits parameter explosion
- Fully connected parts and output layer
  - Merges representations together

Convolutional in 2D

- Use kernel to perform element-wise multiplication and sum for every local patch

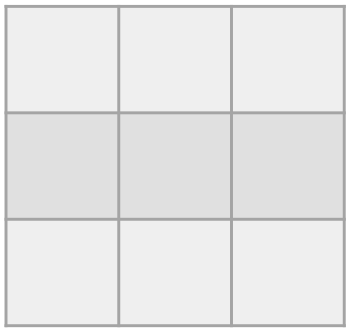
Stride:1

2	3	5	0
1	5	7	-9
-5	2	1	1
2	0	-2	4

Input

1	**0**
0	**-1**

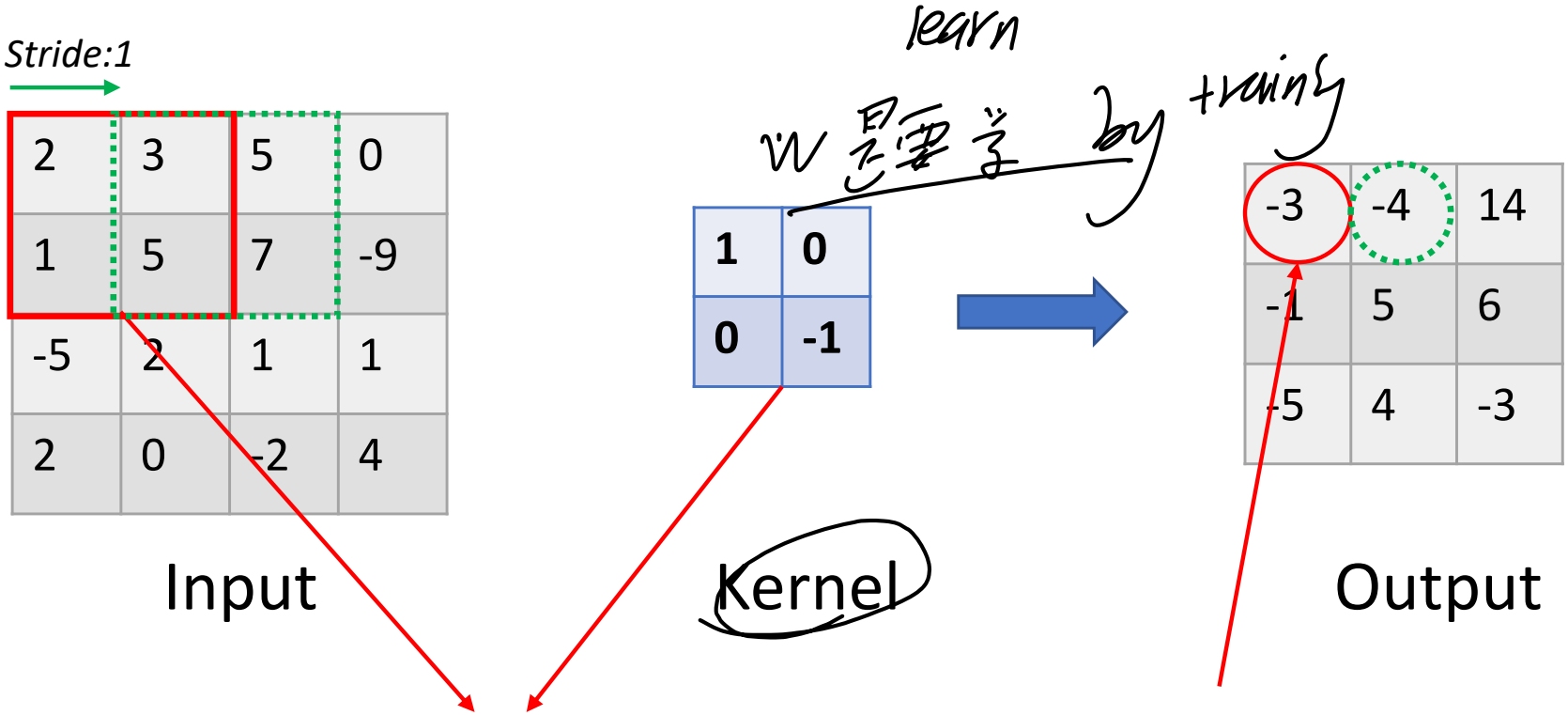
Kernel



Output

Convolutional in 2D

- Use kernel to perform element-wise multiplication and sum for every local patch



$$2 \times 1 + 3 \times 0 + 1 \times 0 + 5 \times (-1) + bias = -3$$

Max Pooling in 2D

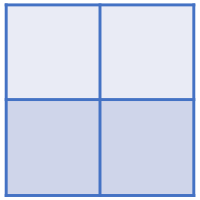
- Use kernel to perform element-wise multiplication and sum for every local patch

Stride:1

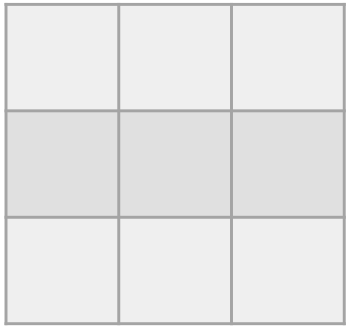
2	3	5	0
1	5	7	-9
-5	2	1	1
2	0	-2	4

Input

no trainable parameters



Kernel

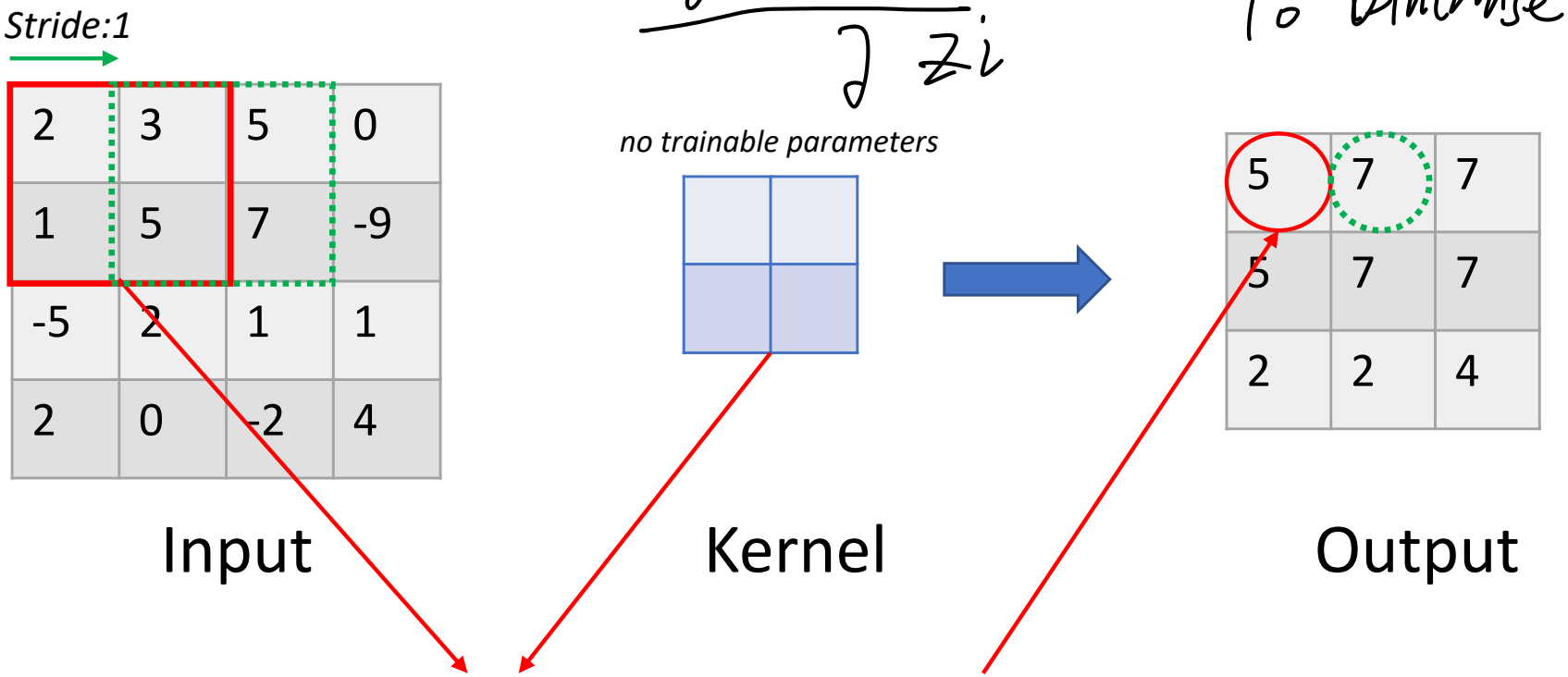


Output

Max Pooling in 2D

- Use kernel to perform element-wise multiplication and sum for every local patch

$$\frac{\partial \max(z_1,\dots,z_n)}{\partial z_i} = \begin{cases} 1 & \text{if } z_i \text{ is max} \\ 0 & \text{otherwise} \end{cases}$$

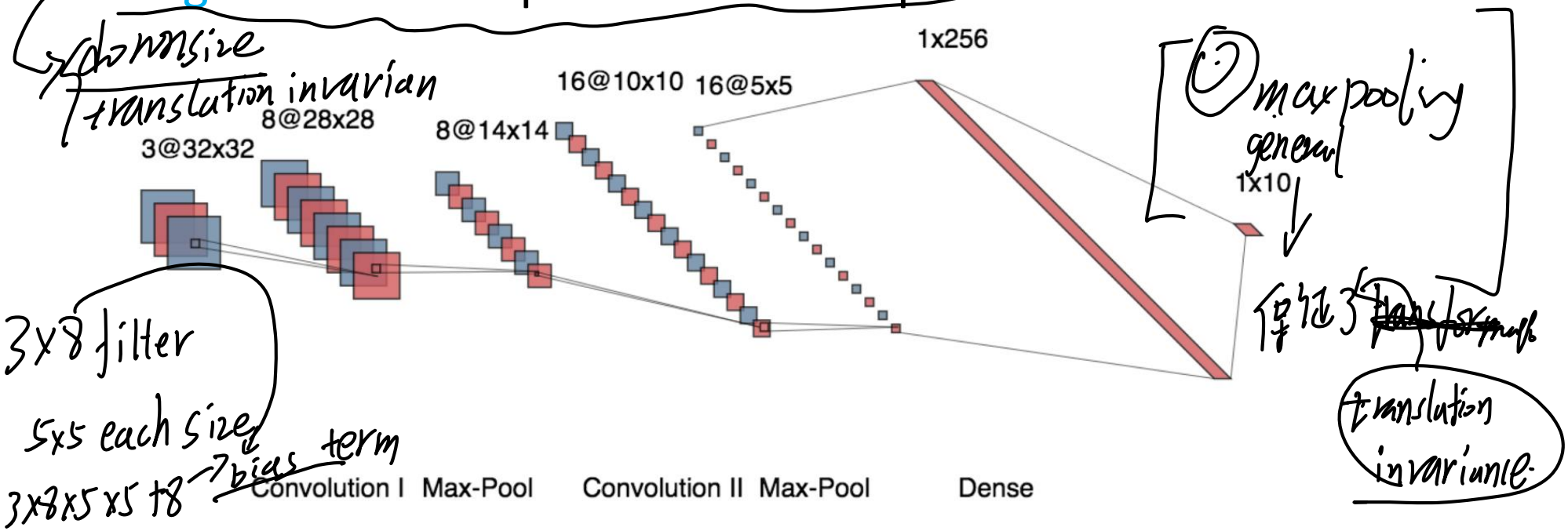


$$Max(2,3,1,5) = 5$$

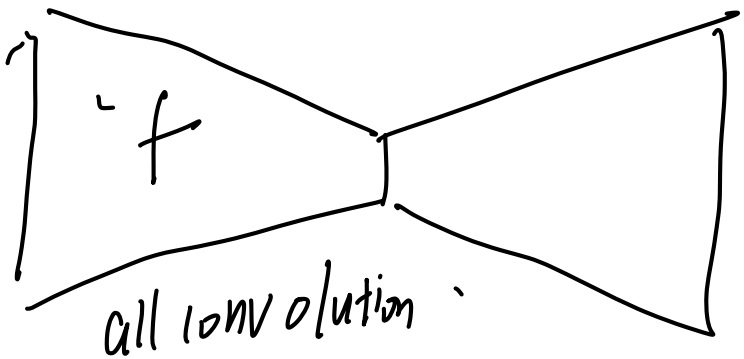
$$|O| = \left\lfloor \frac{(|I| + 2P) - |K| + 1}{S} \right\rfloor$$ P → padding S: step size

Convolutional neural nets

- Local connectivity pattern between adjacent layers
- Shared weights—filters are replicated across the spatial dimensions of the input
- Pooling reduces the spatial extent deeper into the network



We'll implement this architecture for CIFAR-10



all convolution layers

conv-relu

conv-relu

conv-relu

No fully connect

ConvoTranspose2d

Worksheet 8