PSY9511: Seminar 7

Deep learning for image processing tasks

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10.11.25

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Outline

1. Reflections on exercise 5
2. Deep learning with artificial neural networks
3. Convolutional neural networks for image processing

Computer vision

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Image processing: Background

Cat

Image processing: Background


Sunflower


Ladybug


Cat


Airplane


Shark

ImageNet: ∼14m images, ∼22k categories

Image processing: Background

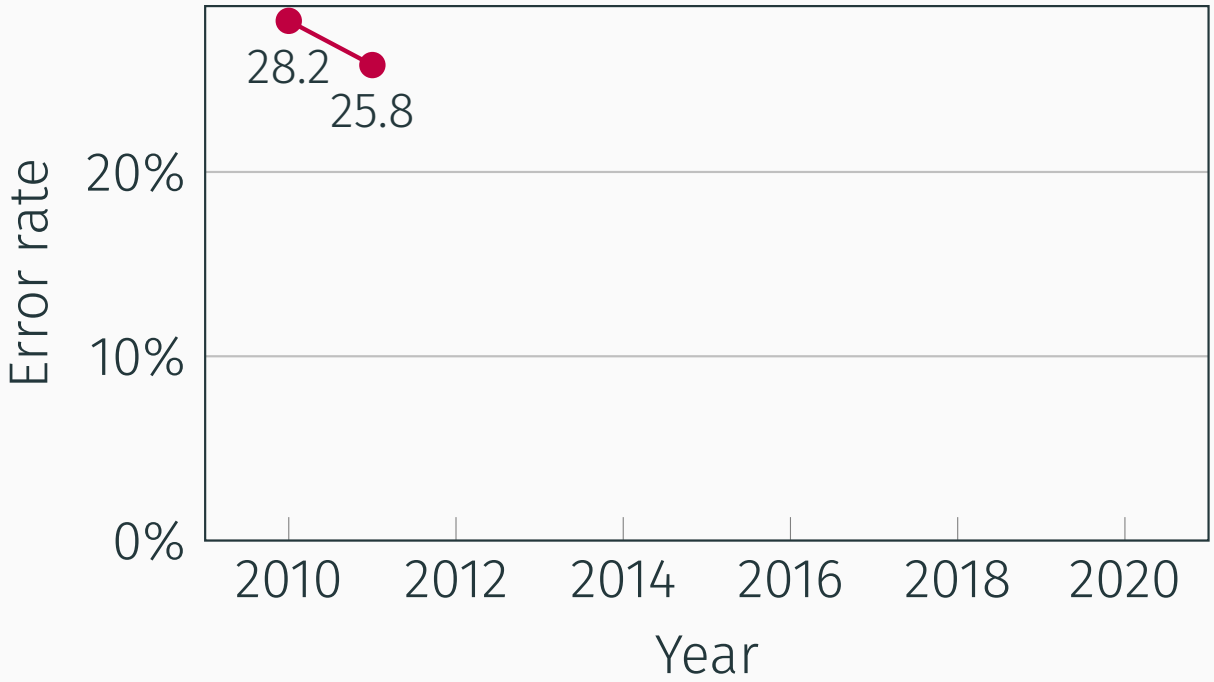
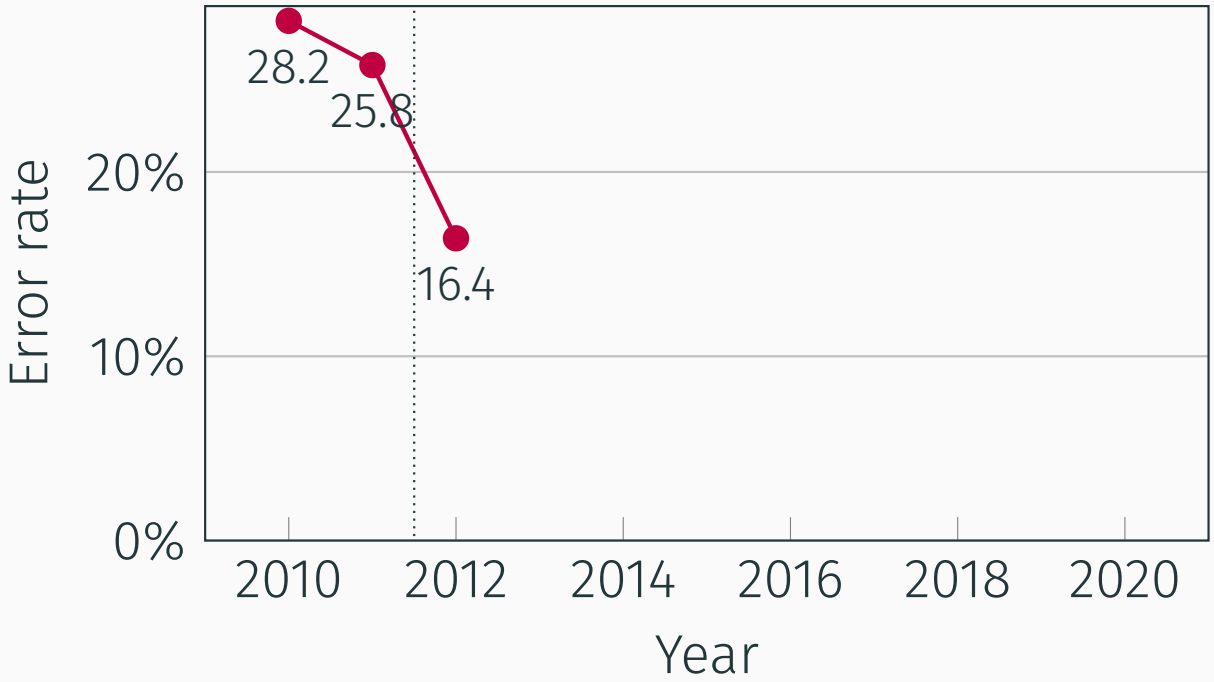


Image processing: Background



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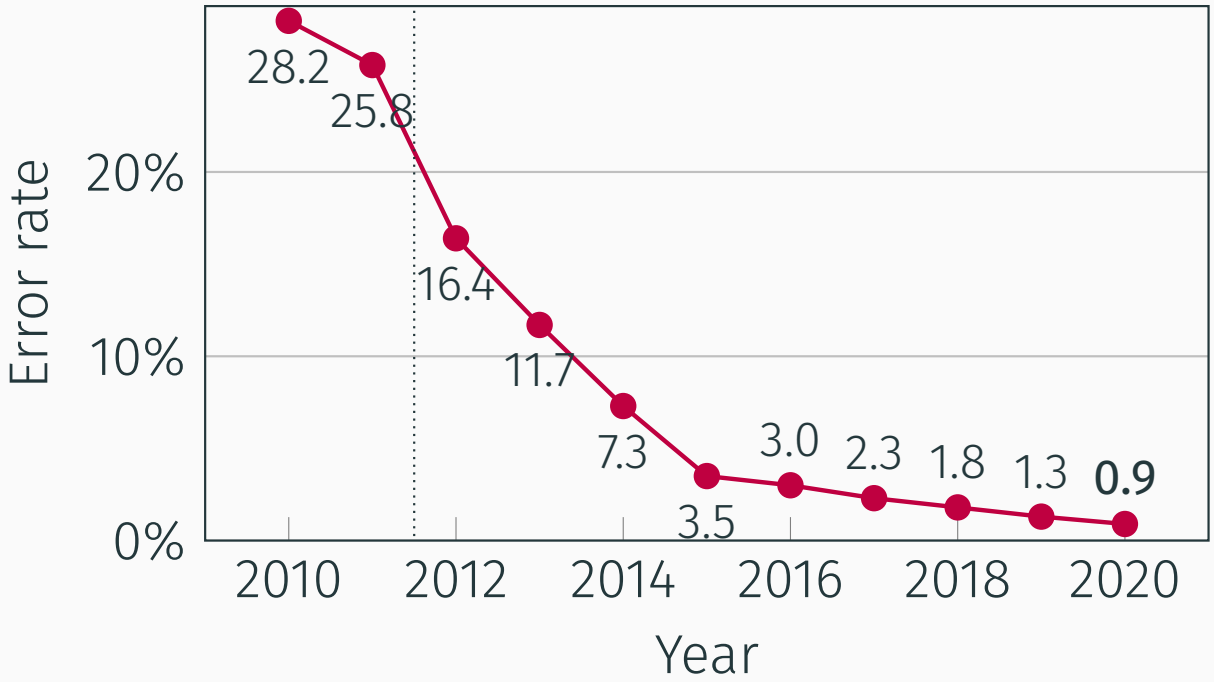

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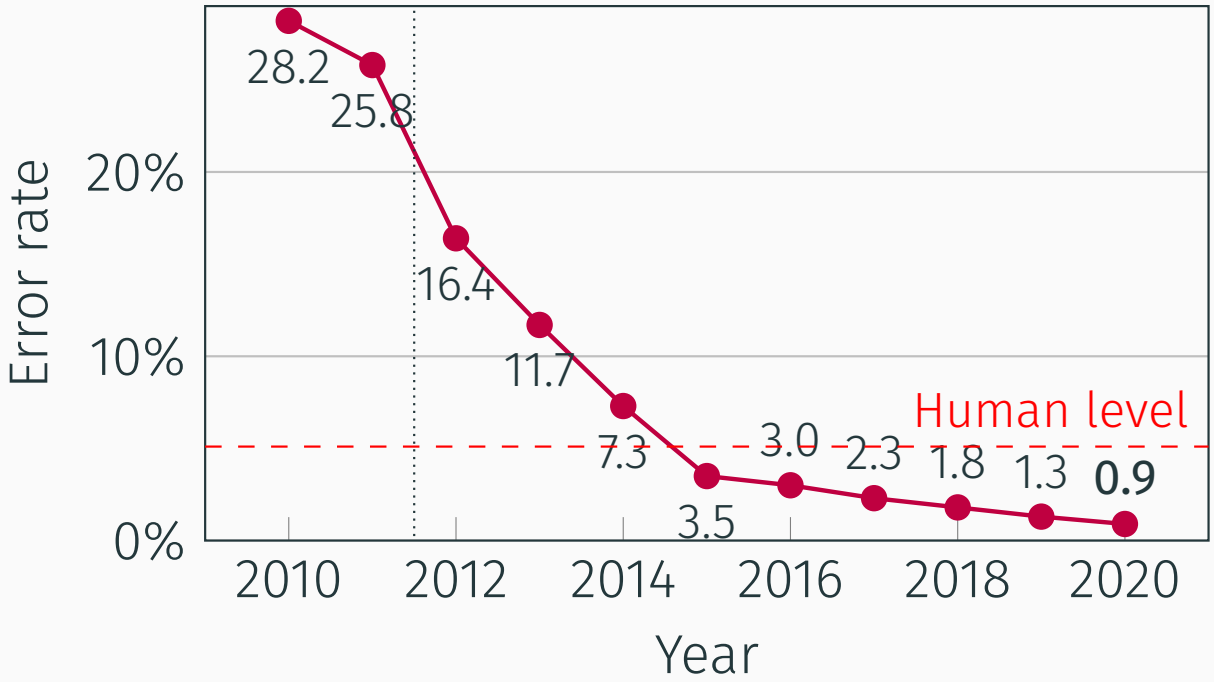

Image processing: Image data

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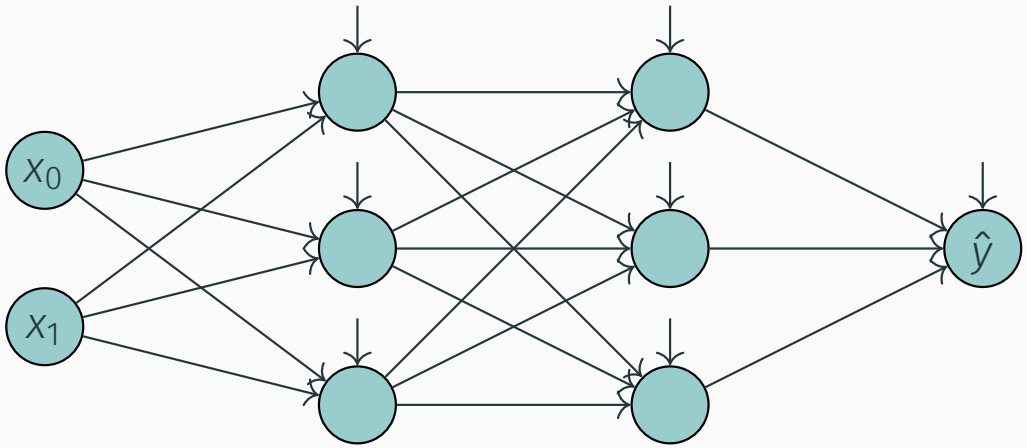
Convolutional neural networks: Inputs



Convolutional neural networks: Inputs

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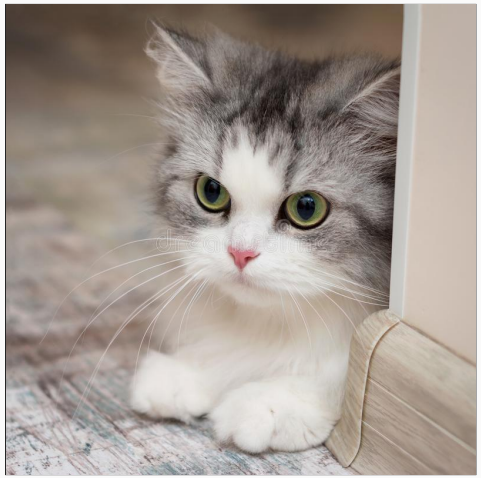
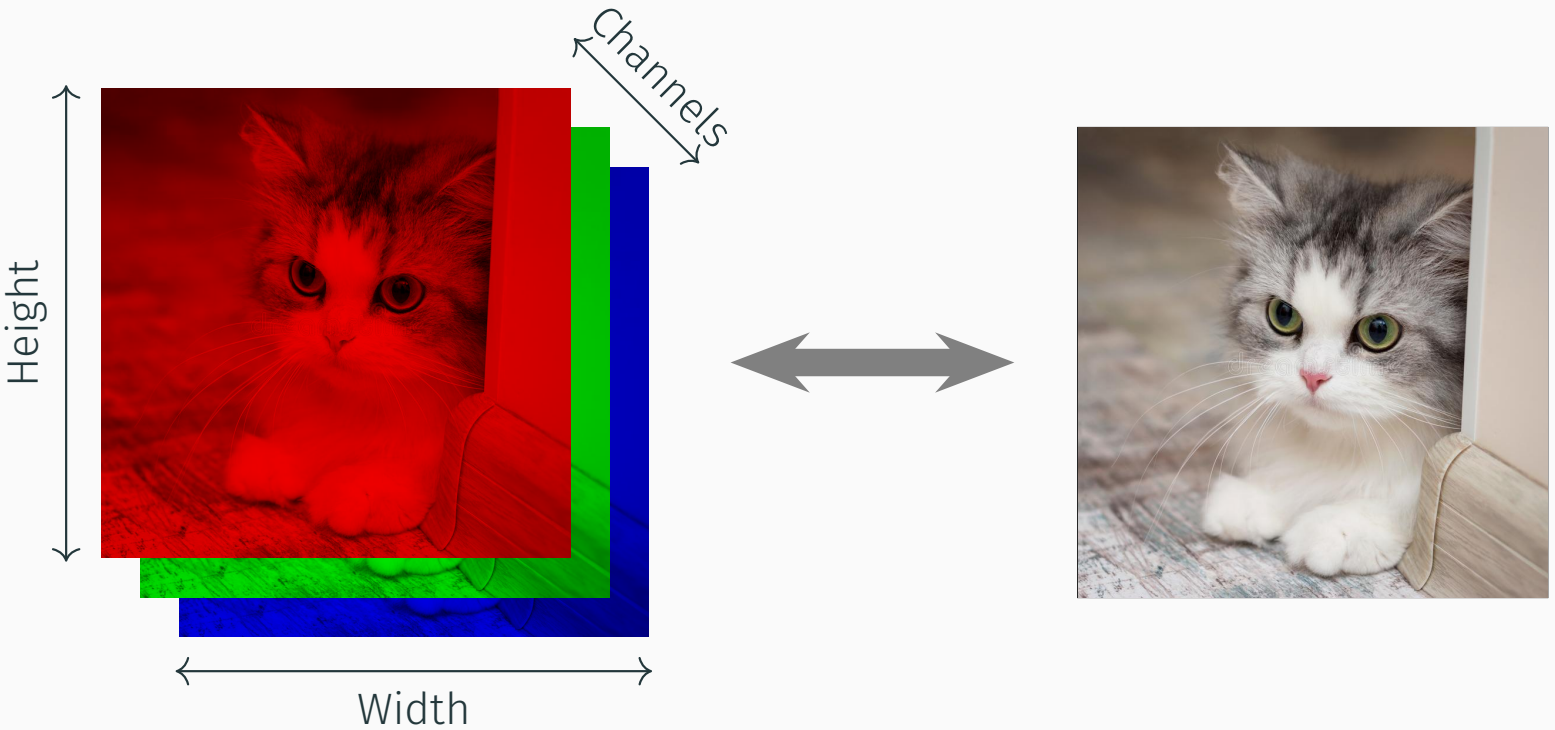
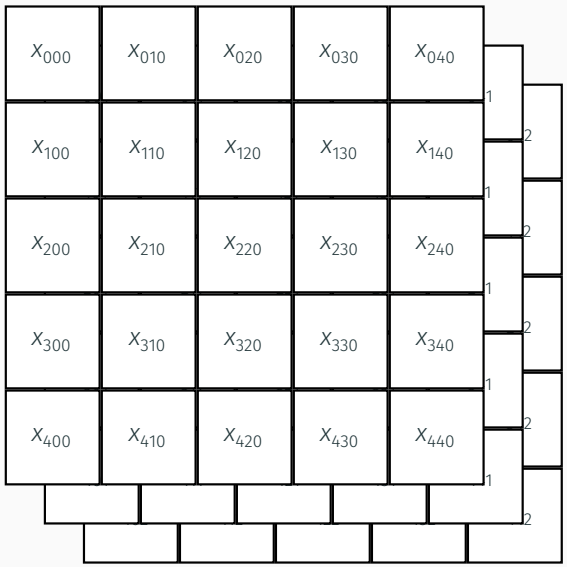
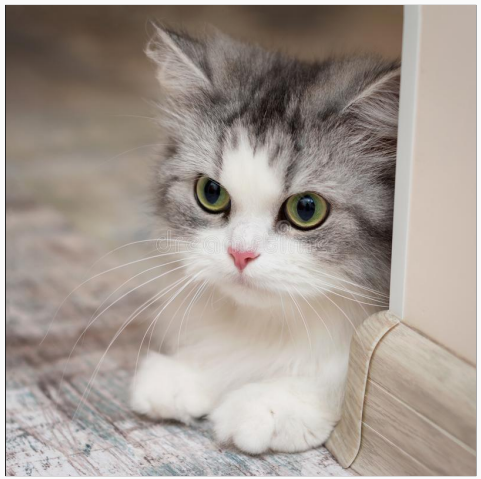


Convolutional neural networks: Inputs

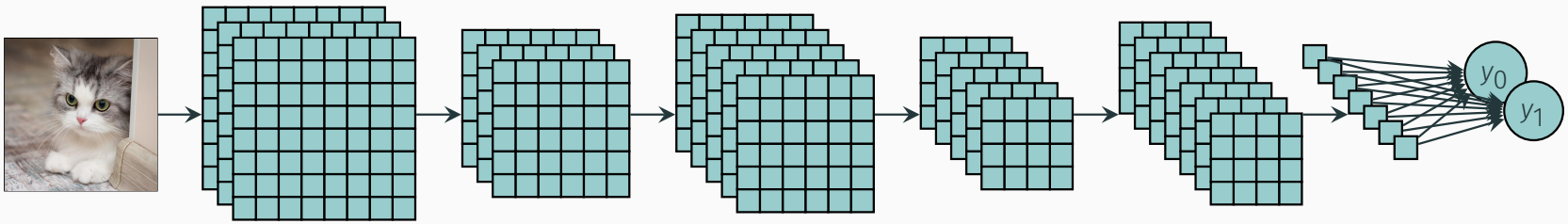


Convolutional neural networks: Inputs

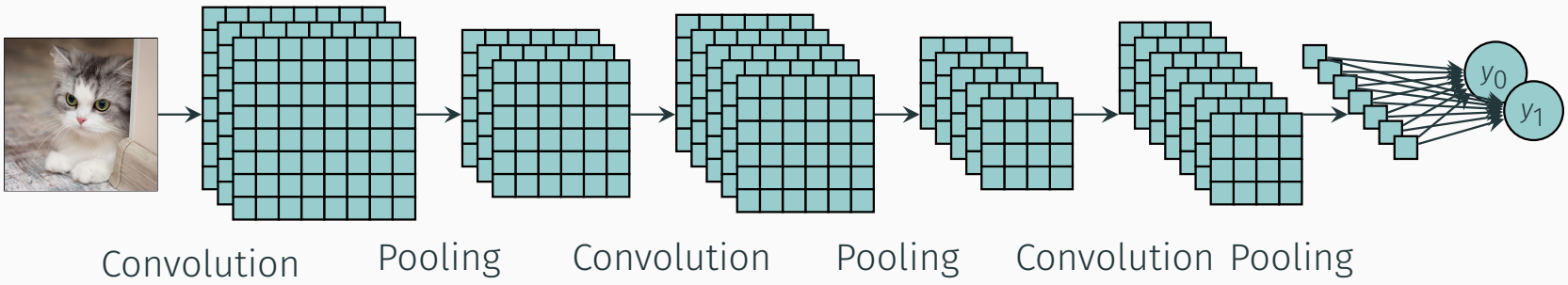




Convolutional neural networks: Architecture

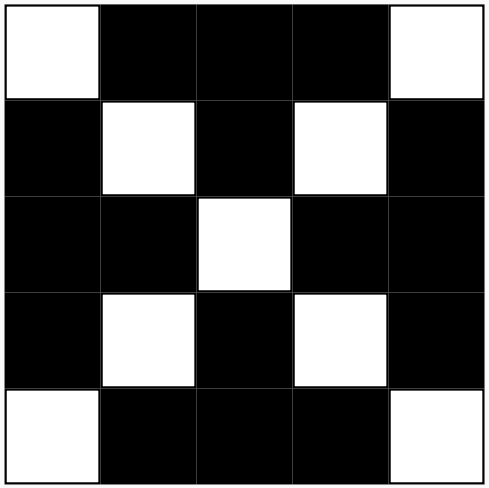


Convolutional neural networks: Architecture



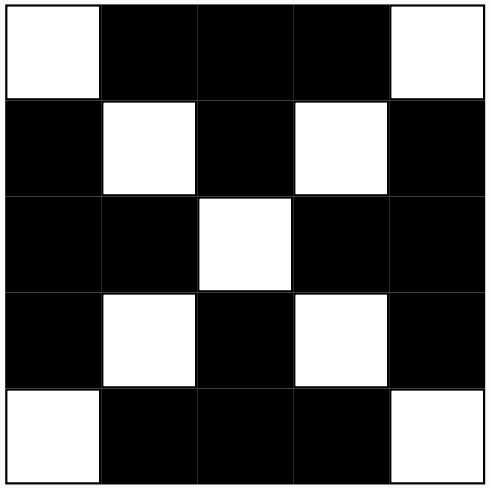
Convolutional neural networks: Convolution

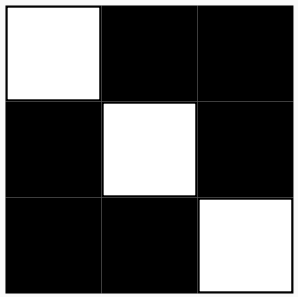
Image



Convolutional neural networks: Convolution

Image

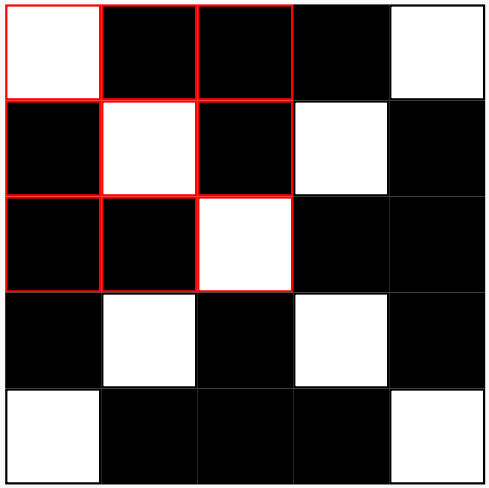




Pattern 1

Convolutional neural networks: Convolution

Image



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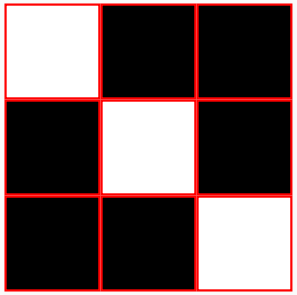

Pattern 1

Convolutional neural networks: Convolution

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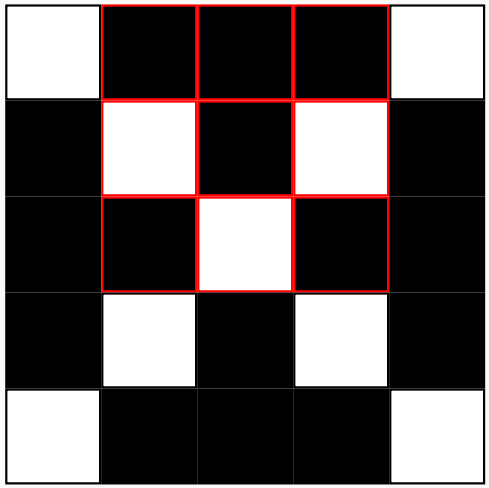

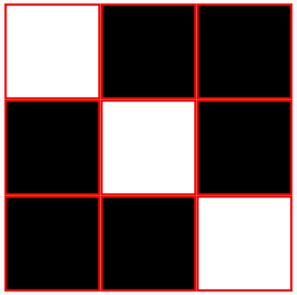

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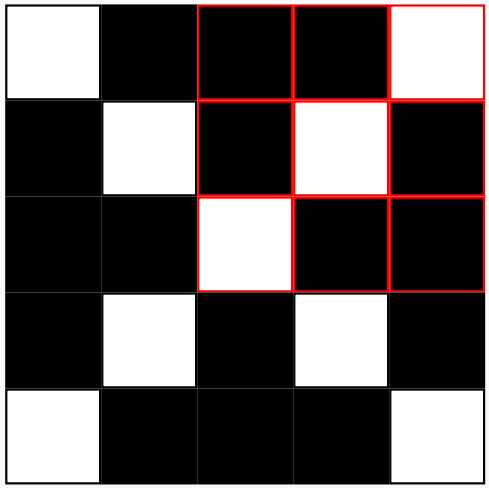
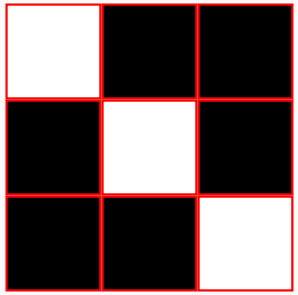


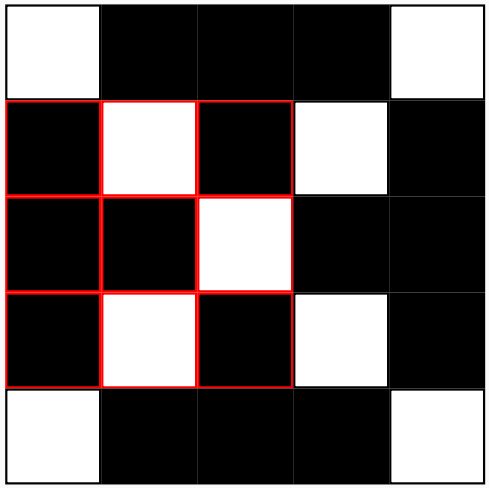


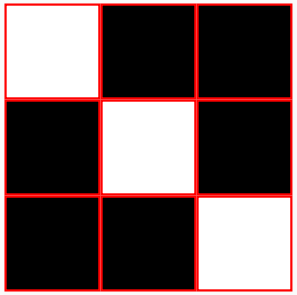
Pattern 1

3	0	1

Convolutional neural networks: Convolution

Image



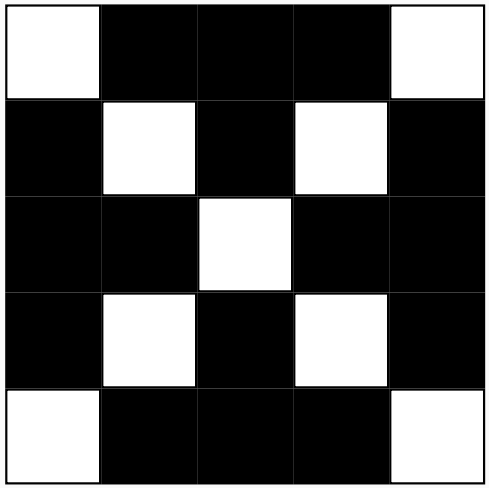


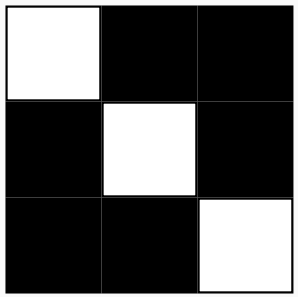
Pattern 1

0		
3	0	1

Convolutional neural networks: Convolution

Image



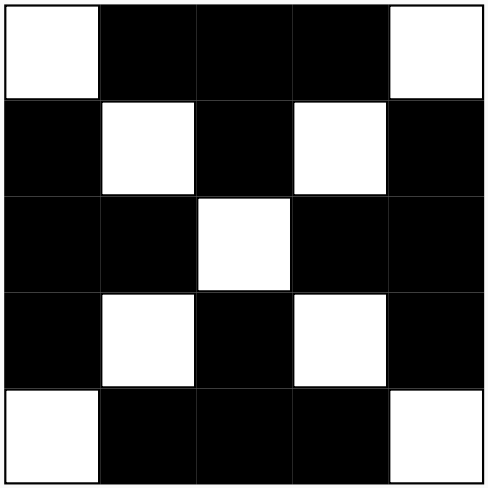


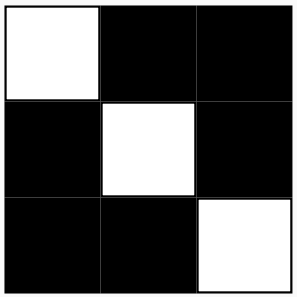
Pattern 1

3	0	1
0	3	0
1	0	3

Convolutional neural networks: Convolution

Image





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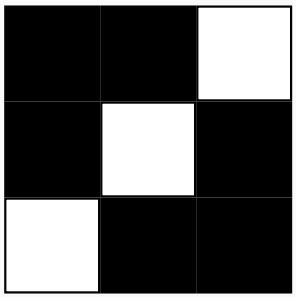
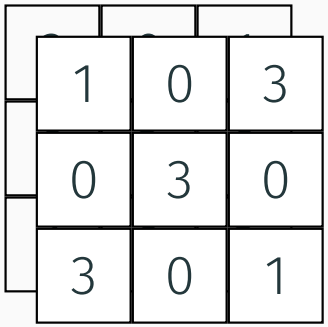
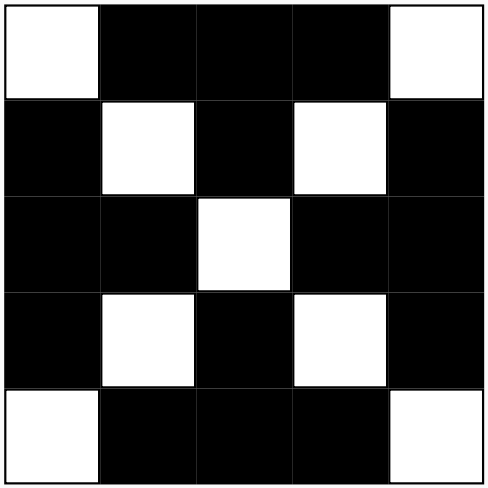


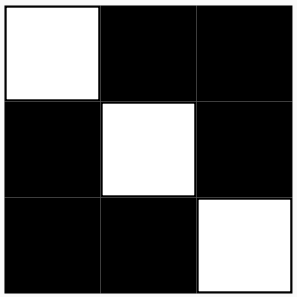
Pattern 2



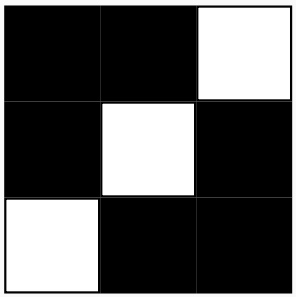
Convolutional neural networks: Convolution

Image

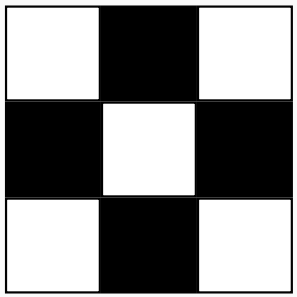




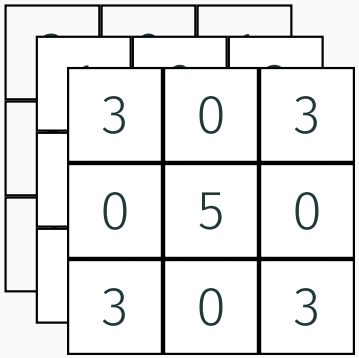
Pattern 1



Pattern 2

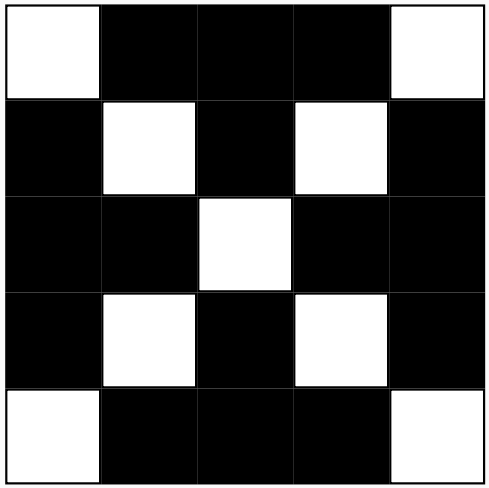


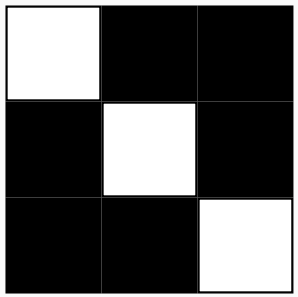
Pattern 3



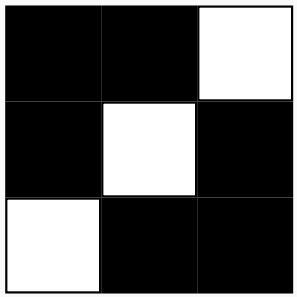
Convolutional neural networks: Convolution

Image





Pattern 1



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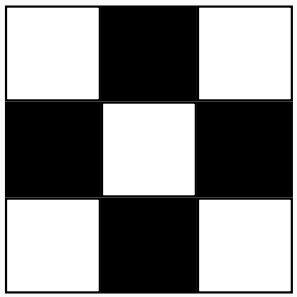
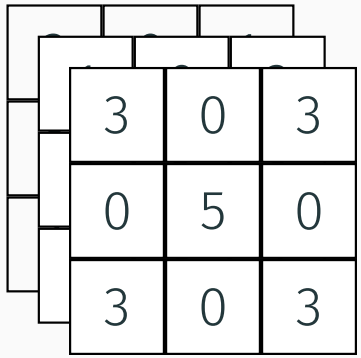
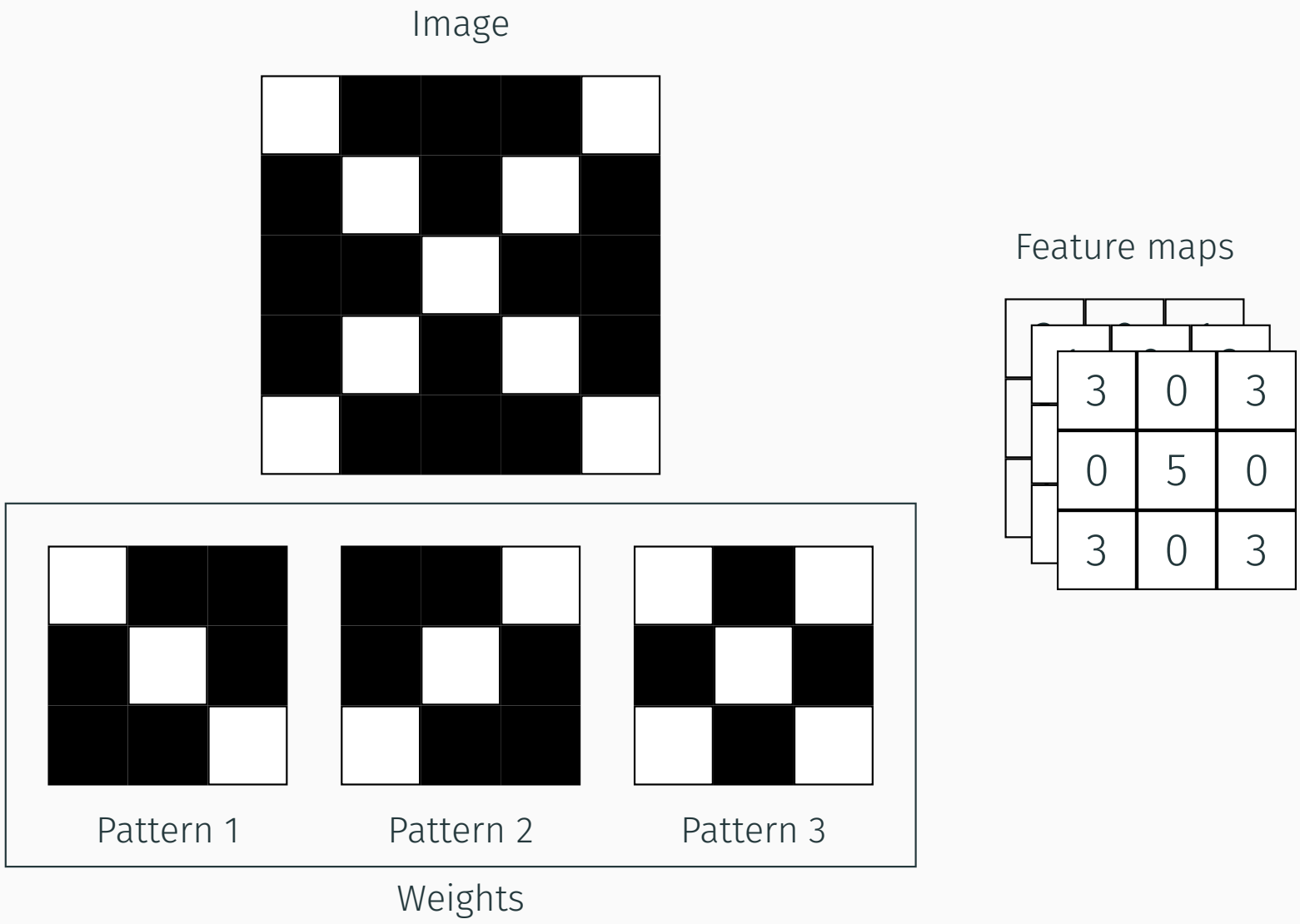


Pattern 3

Feature maps



Convolutional neural networks: Convolution



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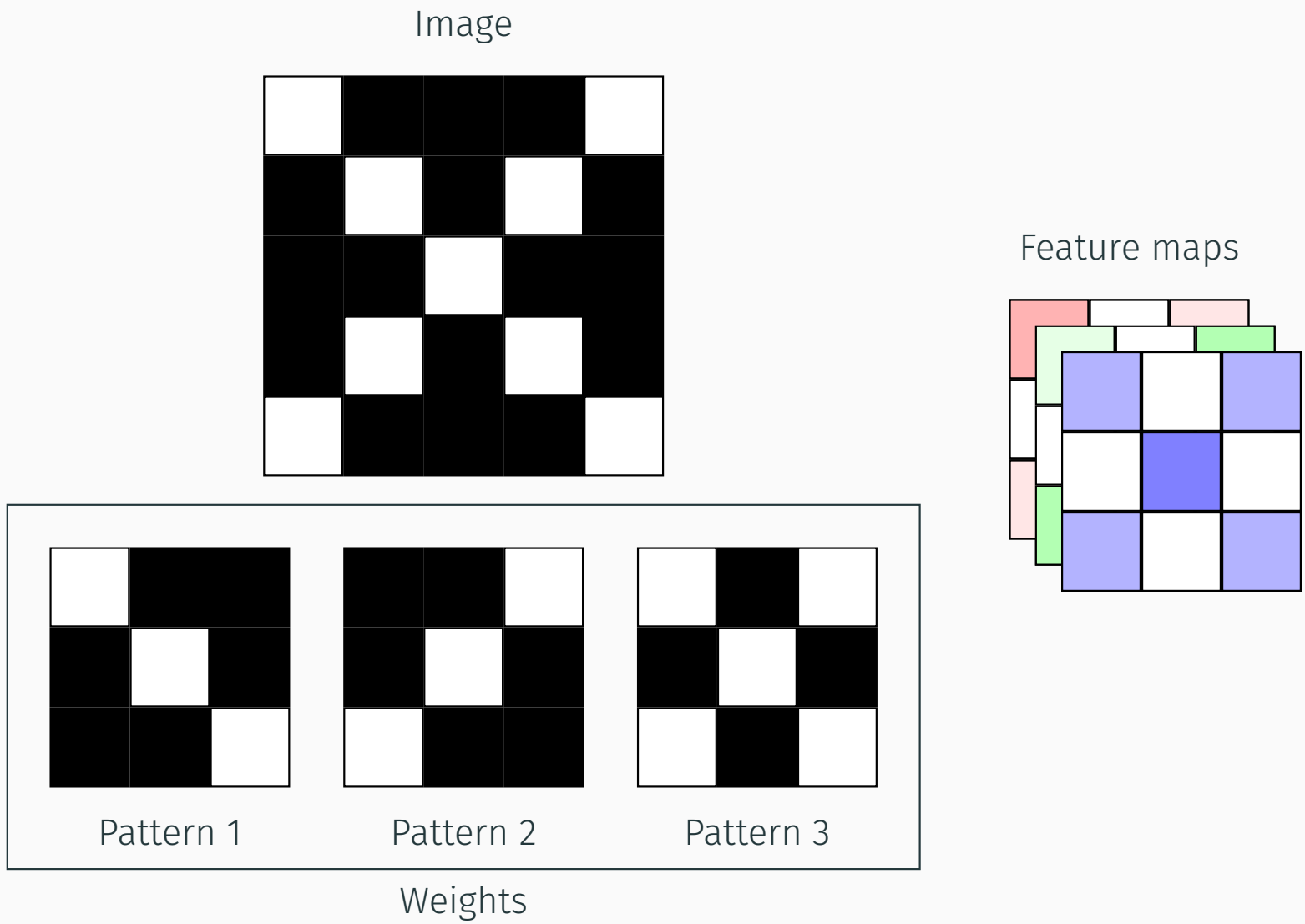


Convolutional neural networks: (Max-)Pooling

Feature map

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

Convolutional neural networks: (Max-)Pooling

Feature map

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

5

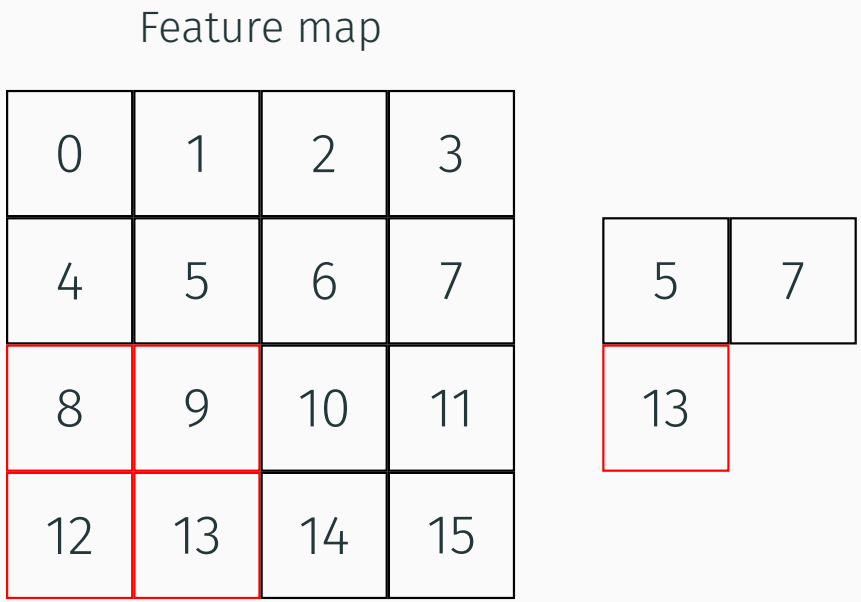
Convolutional neural networks: (Max-)Pooling

Feature map

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

5	7

Convolutional neural networks: (Max-)Pooling



Convolutional neural networks: (Max-)Pooling

Feature map

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Convolutional neural networks: (Max-)Pooling

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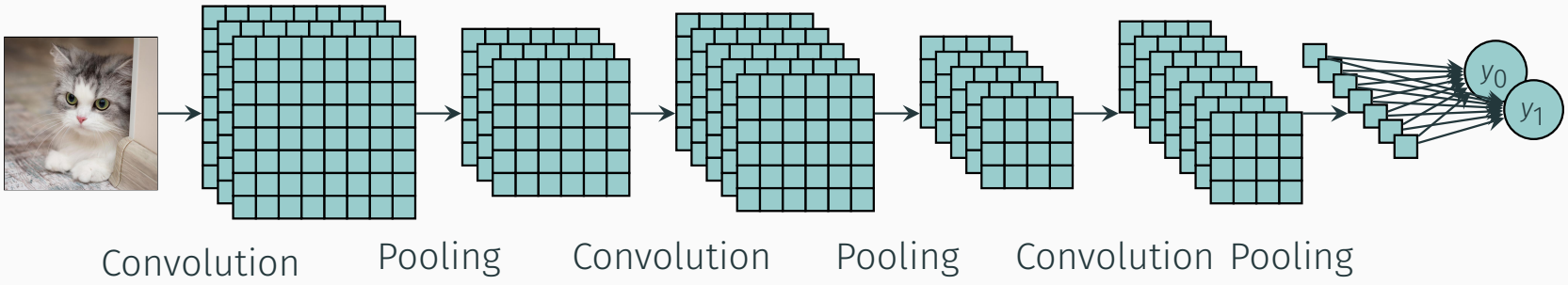
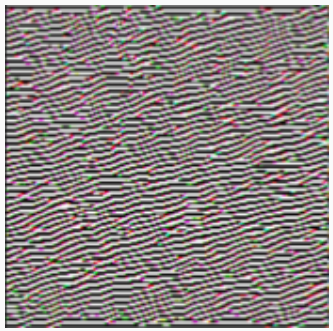
Convolutional neural networks: Overview





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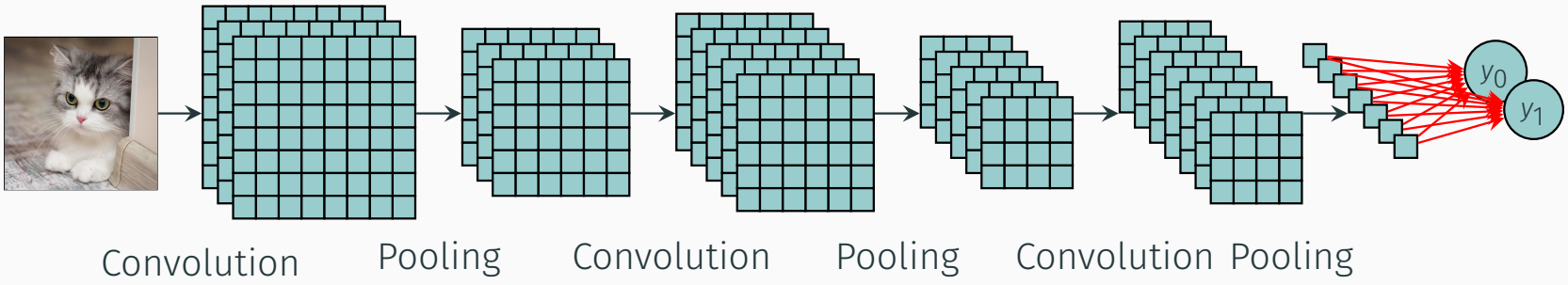
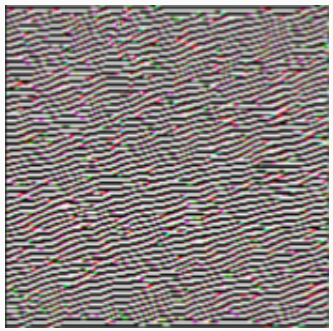
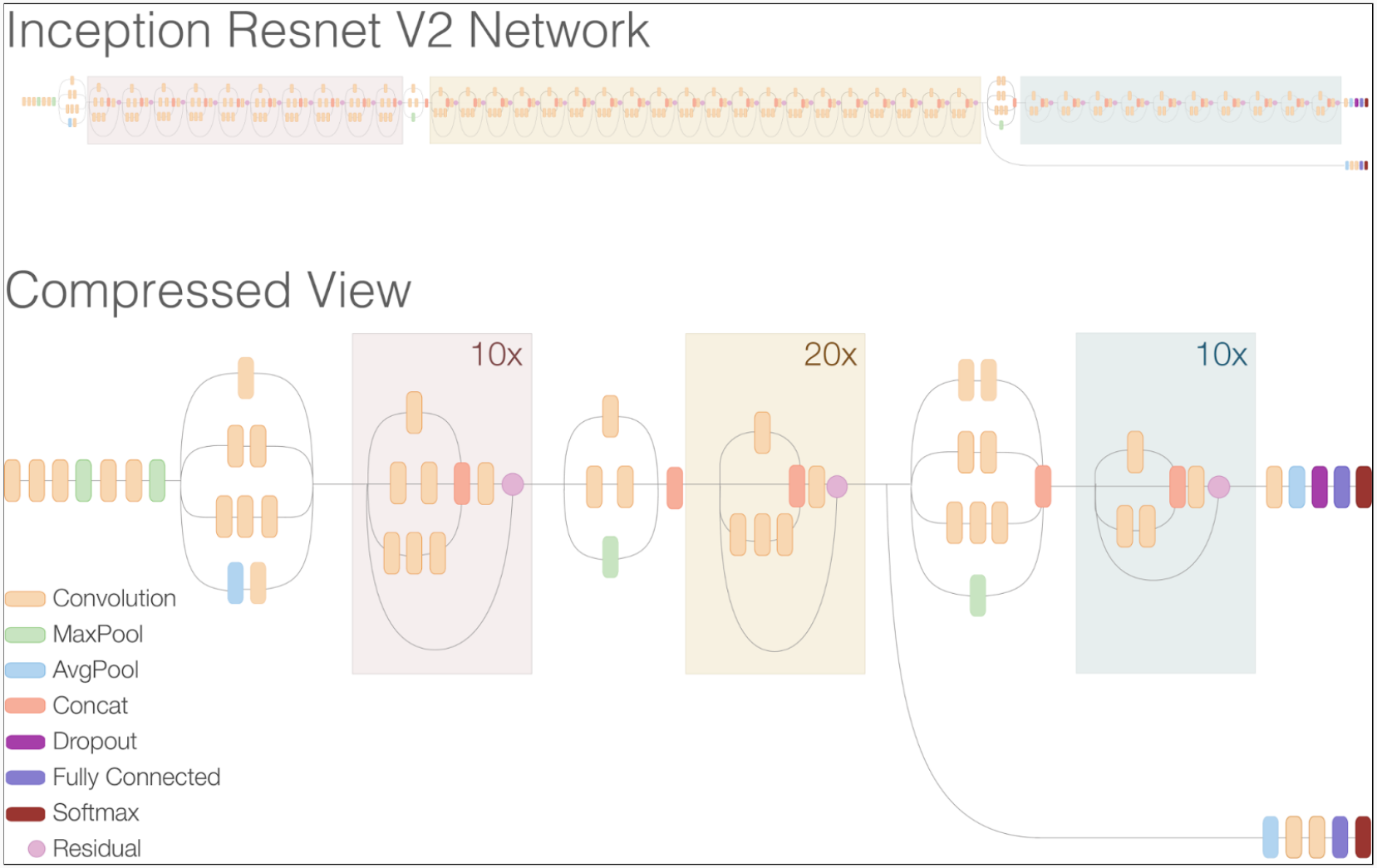




Convolutional neural networks: Overview

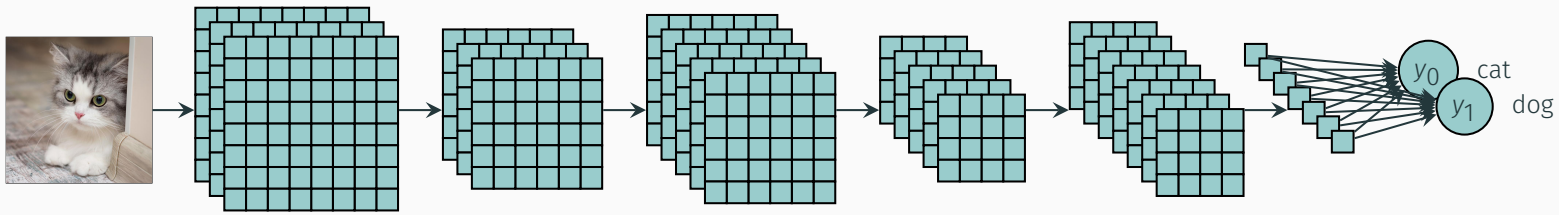


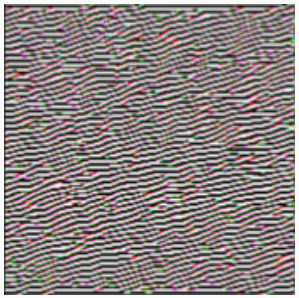
Convolutional neural networks: Overview

Convolutional neural networks (CNNs): Artificial neural networks tailored specifically for image data.

- Takes raw pixel data as input, e.g. arrays of size HxWxC
- Mainly consists of convolutions and pooling operations, which lets us recognize larger and more abstract patterns the deeper we get in the model
- The trainable parameters are the weights of the convolutional kernels, e.g. the patterns the model is looking for
- **New architectures extend beyond this basic formula, by employing residual connections, attention mechanisms etc.**

Image processing: Transfer learning





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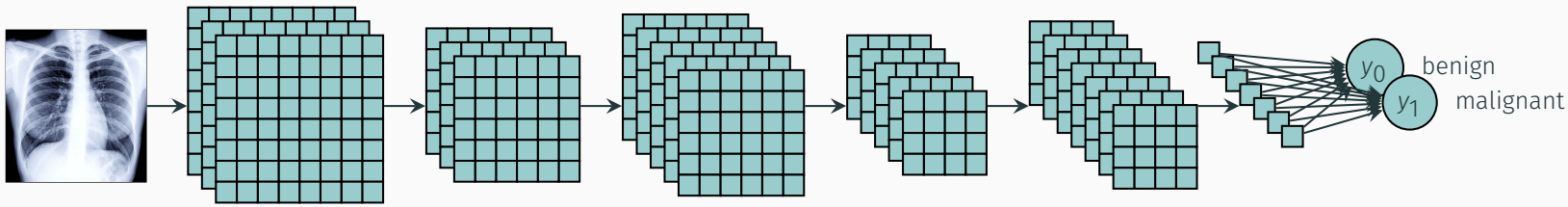


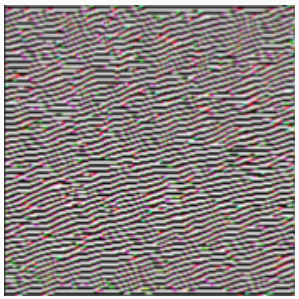
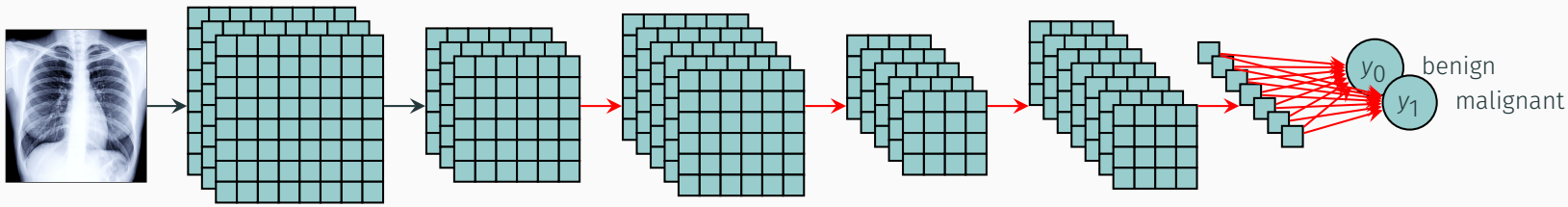


Image processing: Transfer learning



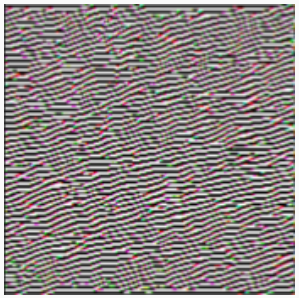
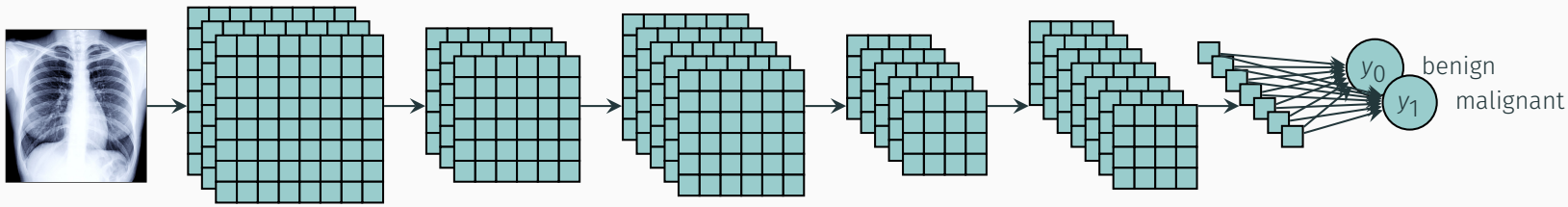


Image processing: Transfer learning



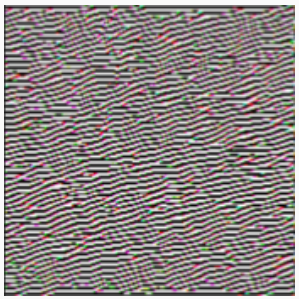
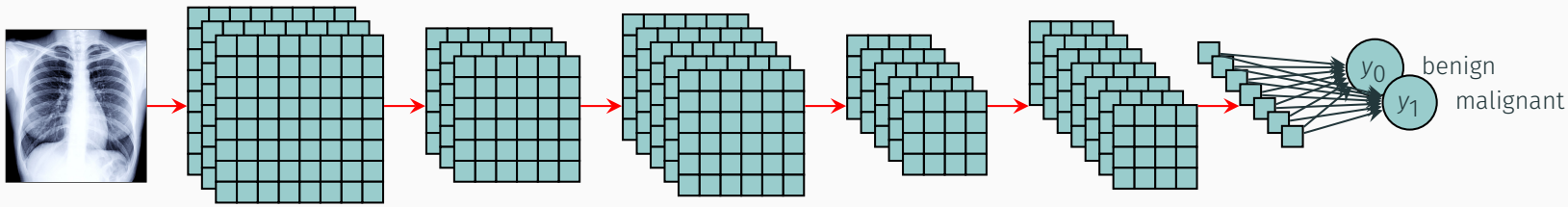


Image processing: Transfer learning



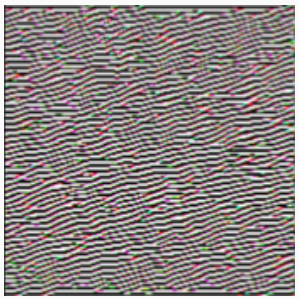


Image processing: Transfer learning

Transfer learning: Utilizing pretrained models to solve new tasks.

- Allows us to solve tasks where we don't have enough data to train a model from scratch
- Common to either freeze the weights of the convolutional part of the pre-trained model and train a new classifier on top of them, or to finetune the entire model

Image processing: Transfer learning

https://keras.io/api/applications/

Image processing: Data augmentation

Image processing: Data augmentation

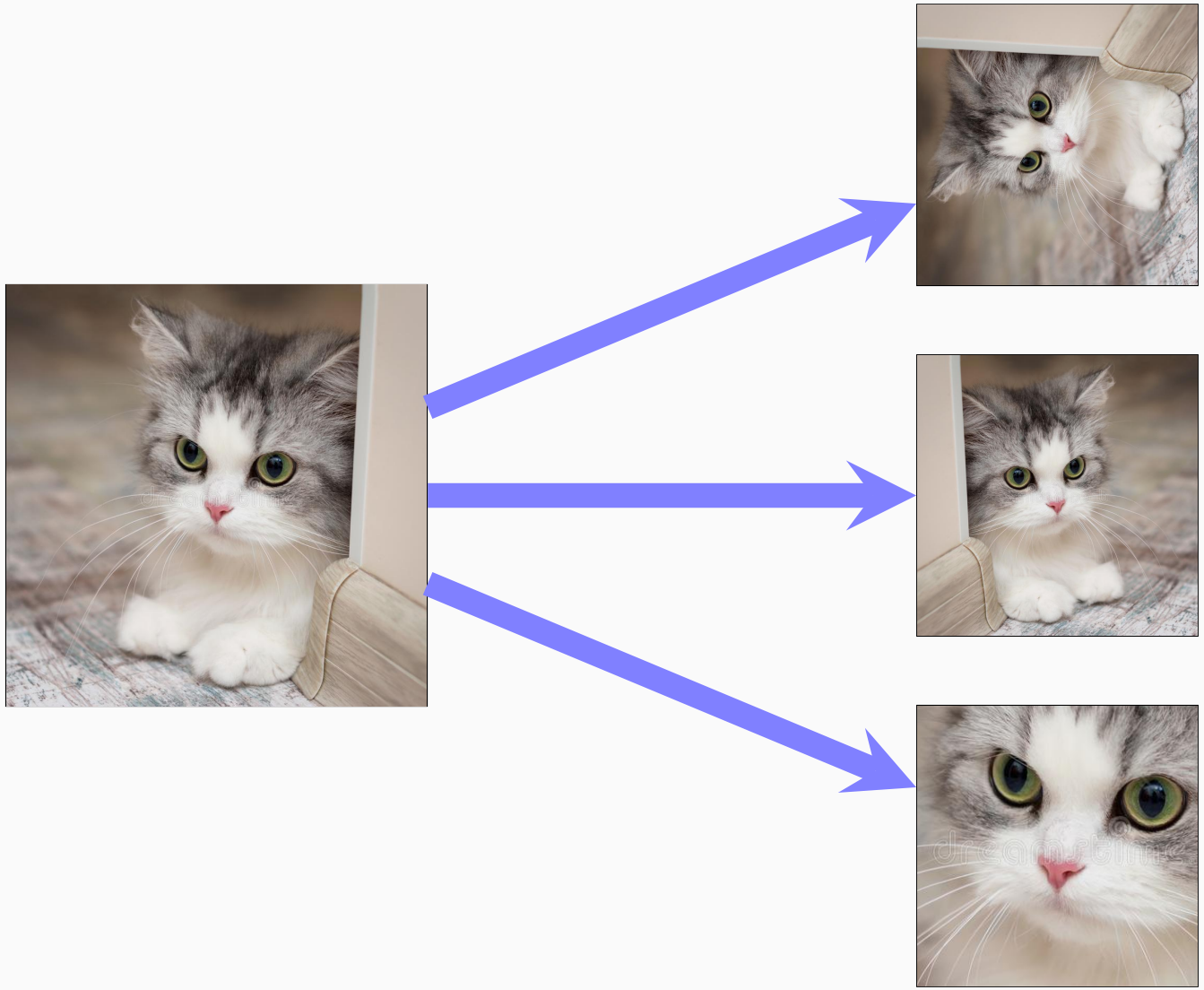


Image processing: Data augmentation

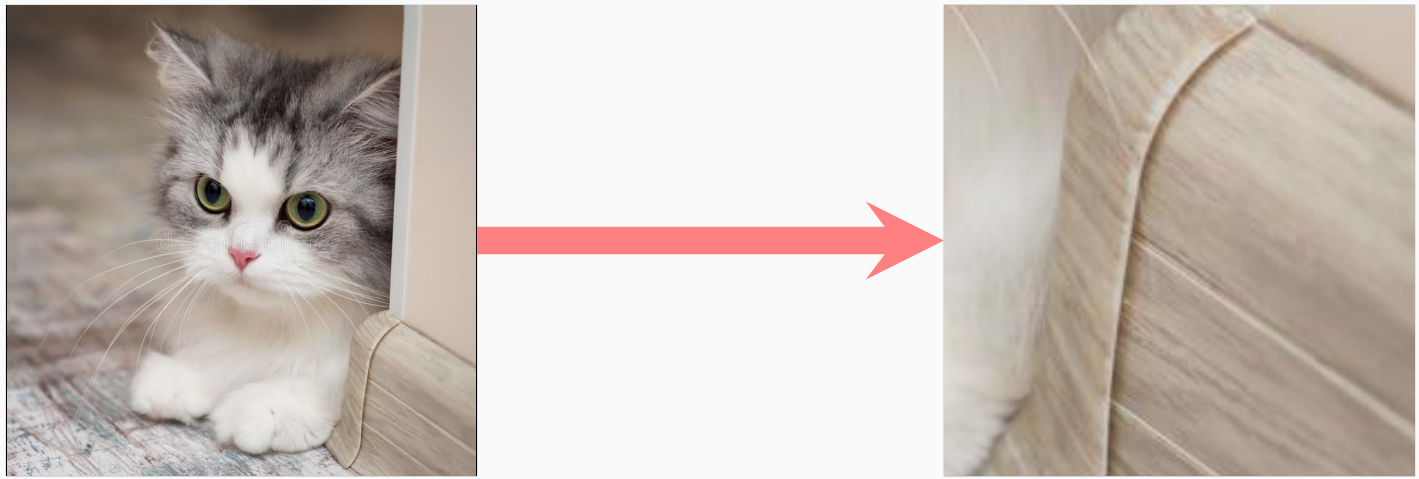


Image processing: Data augmentation

https://albumentations.ai/

Image processing: Tutorial

https://github.com/estenhl/flowers