Machine Learning

Session 6 - Advanced neural networks

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introduction-to-data-science

Introduction

What did we do last time?

Course outline

Machine learning course

Session 1: Regression

Session 2: Supervised classification

Session 3: Clustering

Session 4: Decision trees and ensemble methods

Session 5: Introduction to neural networks

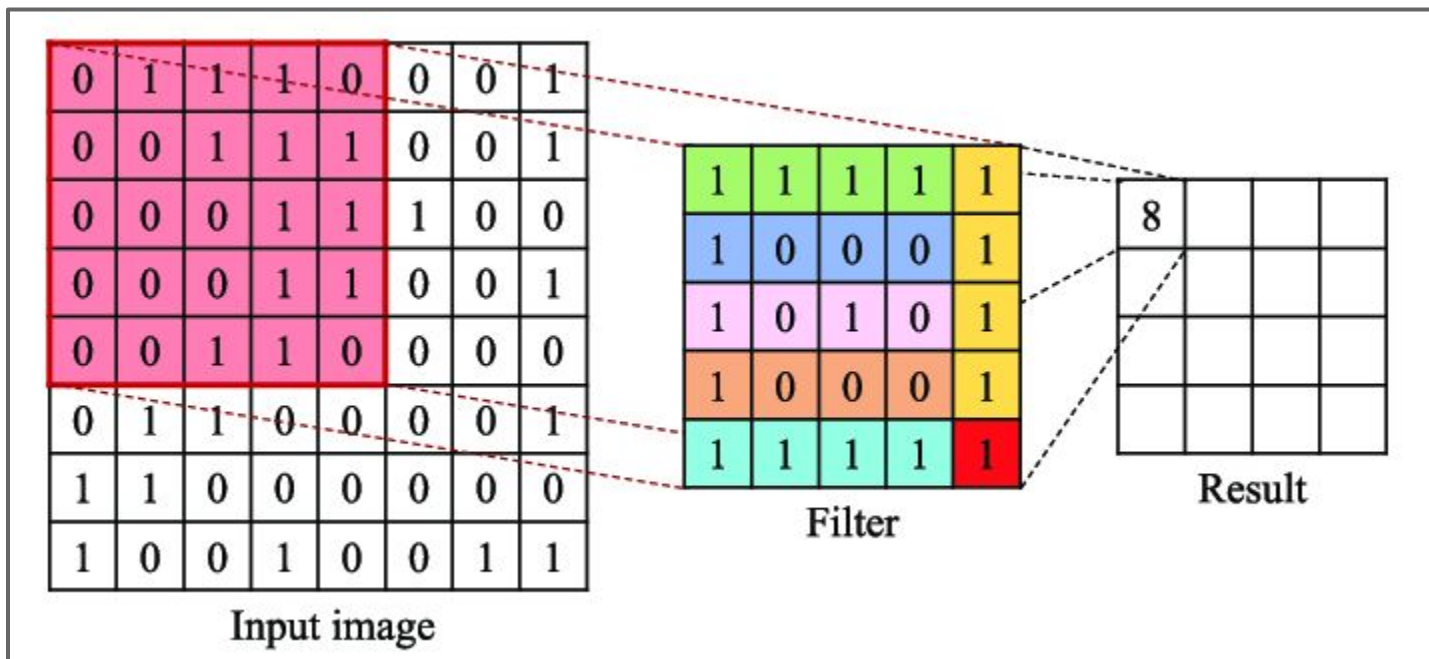**Session 6: Advanced neural networks**

Session 7: Introduction to reinforcement learning
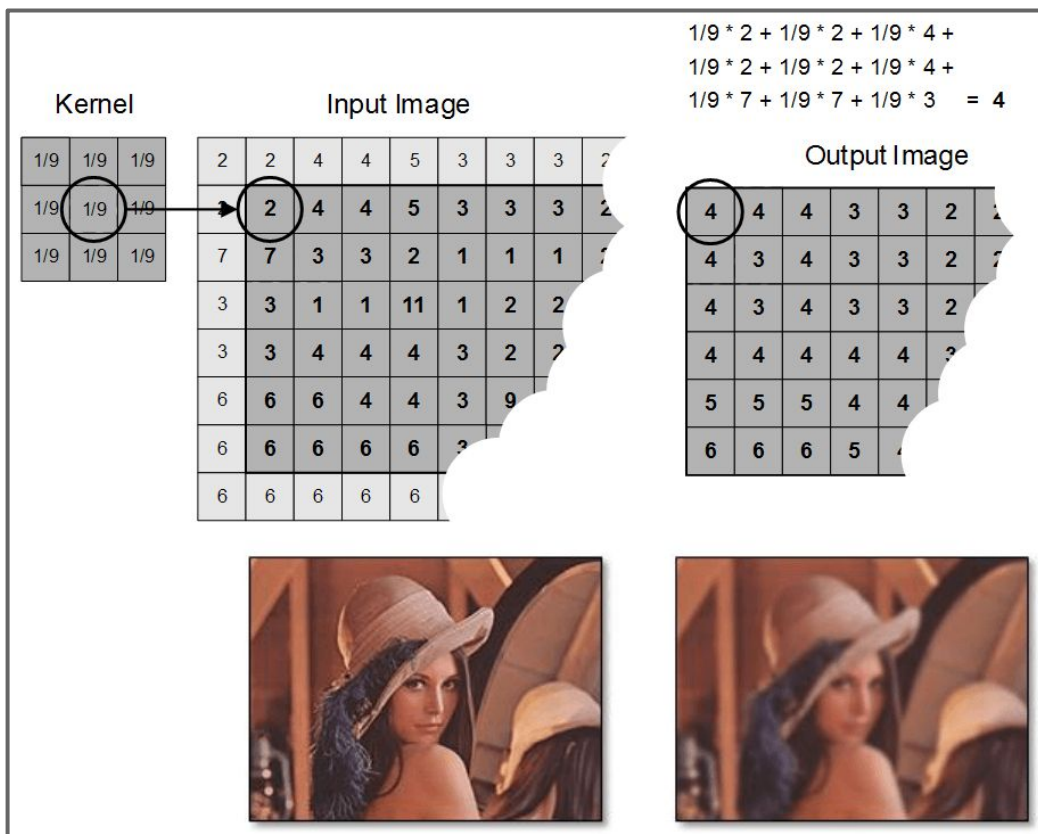
Session 8: Reading science papers

Project

Convolutional Neural Networks

Input image

Filter

Result

$1/9 * 2 + 1/9 * 2 + 1/9 * 4 +$
$1/9 * 2 + 1/9 * 2 + 1/9 * 4 +$
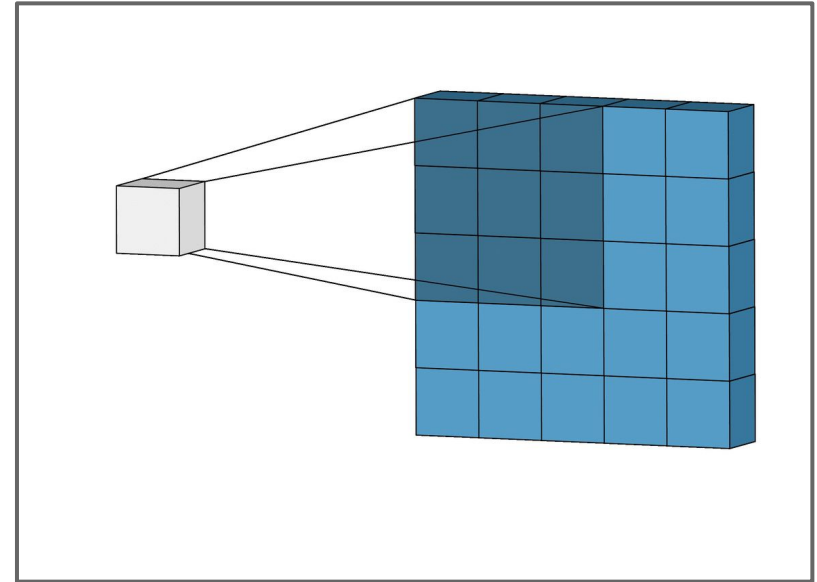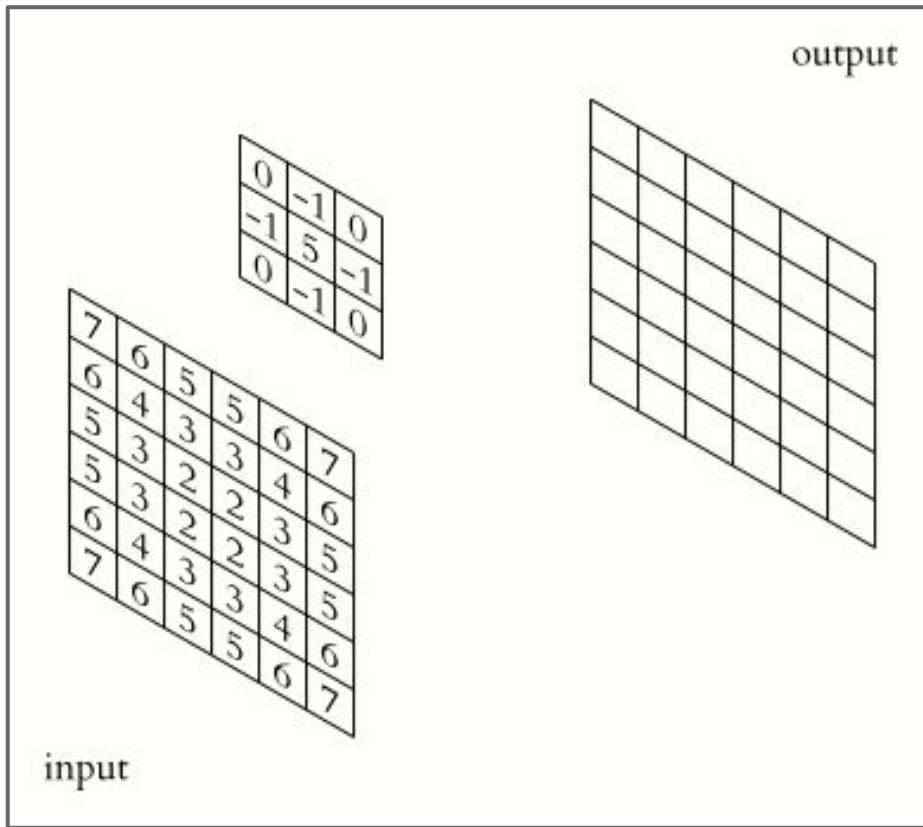$1/9 * 7 + 1/9 * 7 + 1/9 * 3 = 4$

Kernel

Input Image

Output Image

Filters create an output image with different properties (capturing certain characteristics)
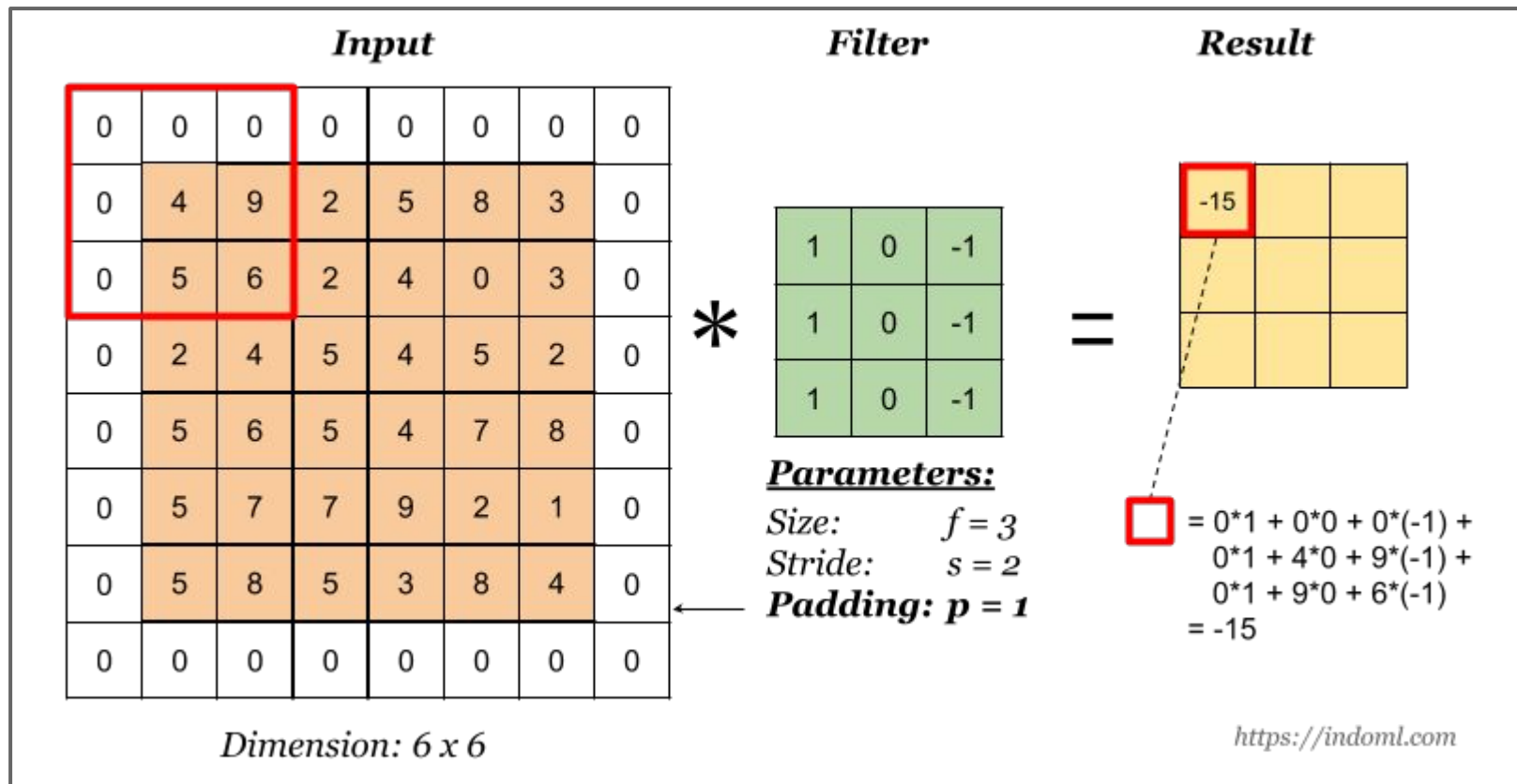
8

input

output

0 | -1 | 0
-1 | 5 | 0
0 | -1 | -1
0 | -1 | 0

7
6 6
5 4 5 5
5 3 3 5 6 7
5 3 2 3 4 7
6 3 2 2 3 5
7 4 3 2 3 5
6 3 3 3 5
5 5 4 6
6 7

Convolutional product

9

Input

0	0	0	0	0	0	0	0
0	4	9	2	5	8	3	0
0	5	6	2	4	0	3	0
0	2	4	5	4	5	2	0
0	5	6	5	4	7	8	0
0	5	7	7	9	2	1	0
0	5	8	5	3	8	4	0
0	0	0	0	0	0	0	0

Dimension: 6 x 6

Filter

1	0	-1
1	0	-1
1	0	-1

Parameters:

Size: $f = 3$
Stride: $s = 2$
Padding: $p = 1$

Result

-15		

= 0*1 + 0*0 + 0*(-1) +
  0*1 + 4*0 + 9*(-1) +
  0*1 + 9*0 + 6*(-1)
= -15

https://indoml.com

Parameters for the convolutional product

Pooling as a dimensionality reduction technique

INPUT   CONVOLUTION + RELU   POOLING   CONVOLUTION + RELU   POOLING   FLATTEN   FULLY CONNECTED   SOFTMAX

CAR
TRUCK
VAN
BICYCLE

FEATURE LEARNING

CLASSIFICATION
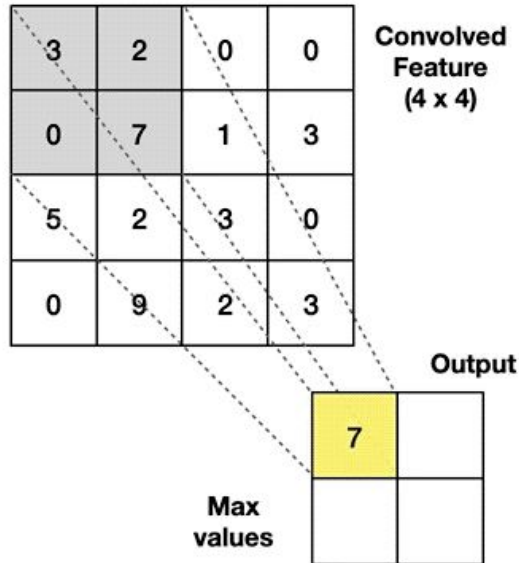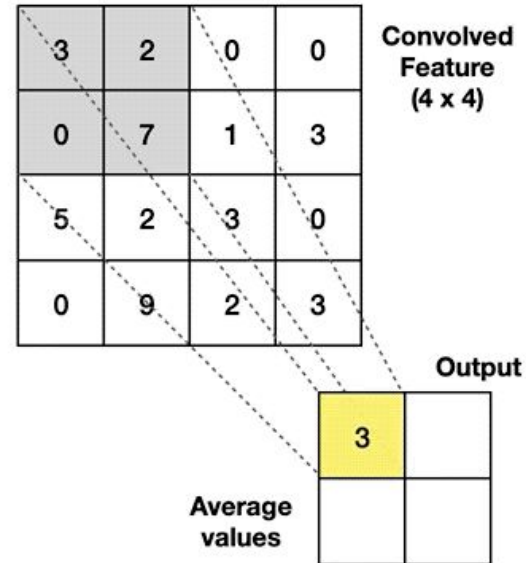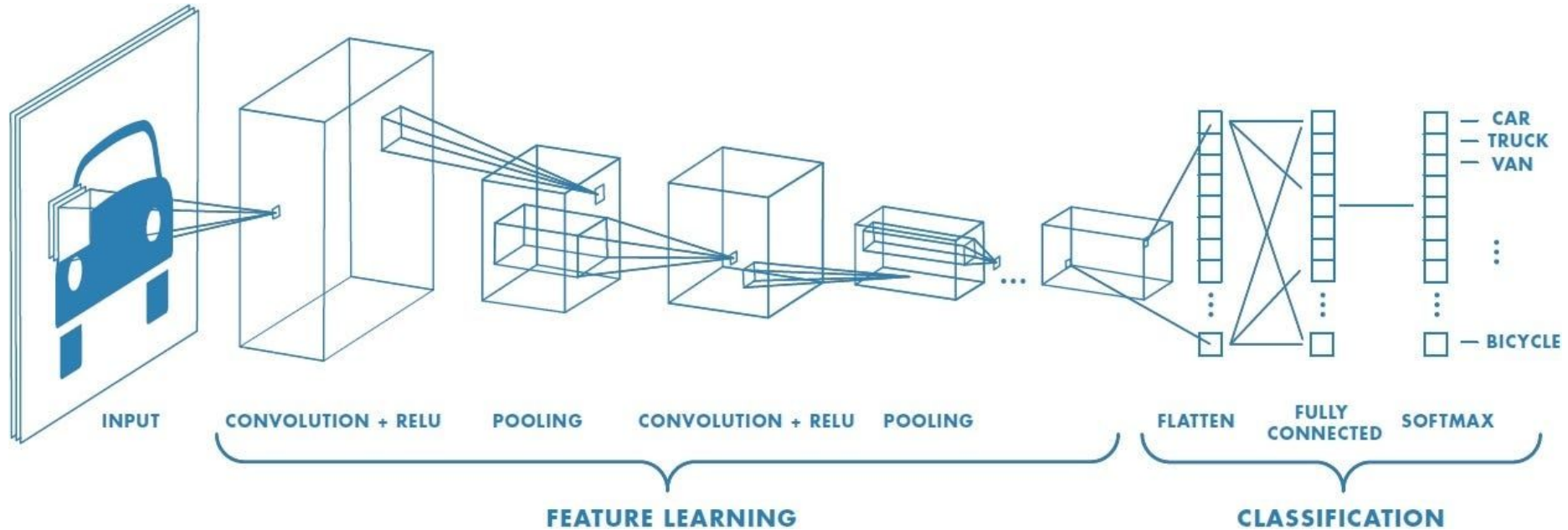
Convolutional neural networks: learning filters (learning a representation of your data)

Generative Adversarial Networks
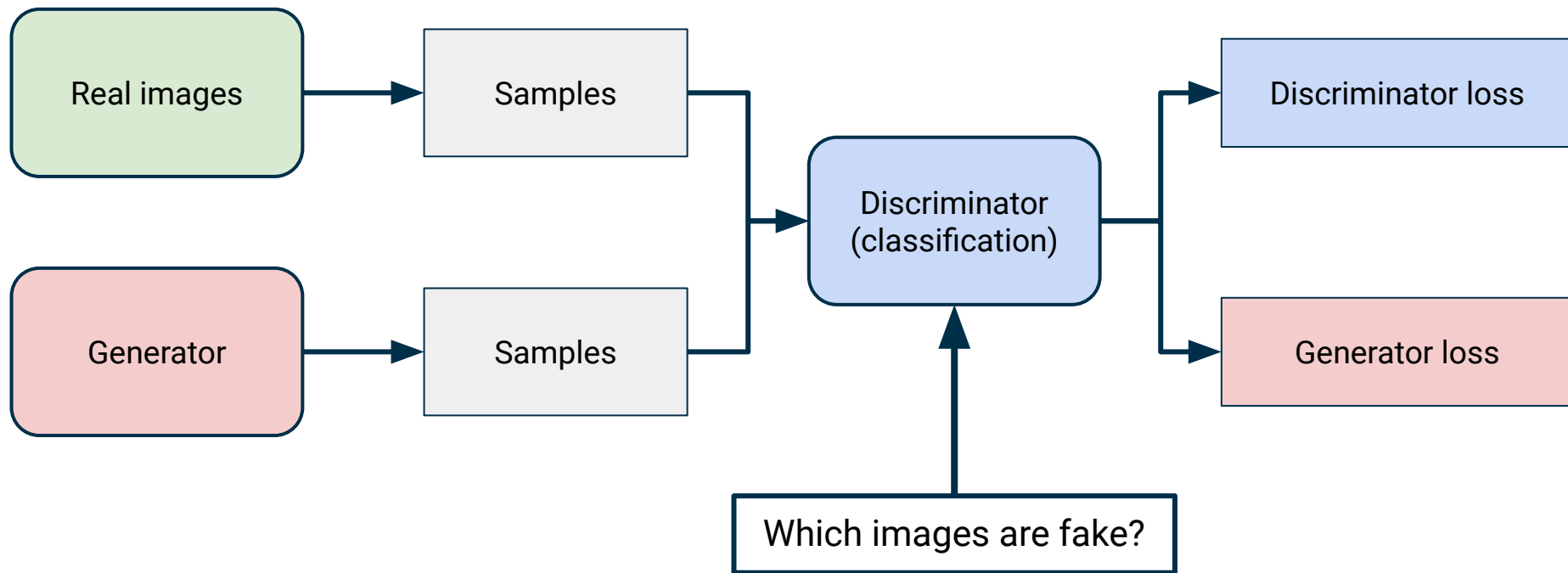
GANs rely on a generator and a discriminator, trained simultaneously

GANs let you generate artificial data

Other state-of-the-art networks

Other neural network architectures

In recent years, several ANN architectures have been invented to solve a wide variety of problems

Recurrent Neural Network (RNN)

- Designed for processing sequences of data
- Connections that loop back on themselves to capture information from previous steps
- Used for NLP and time series processing

Long Short-Term Memory (LSTM)

- Designed as an improvement to RNNs (addresses the vanishing gradient problem)
- Capture long-range dependencies (e.g. in NLP)

U-Net

- Encoder-decoder architecture
- Mostly used for medical image segmentation

Practical work

The notebook contains all the necessary instructions

Debrief

Debrief – G3

https://forms.gle/iLE8fborrAuNgAnX9

Debrief

What did we learn today?

What could we have done better?

What are we doing next time?