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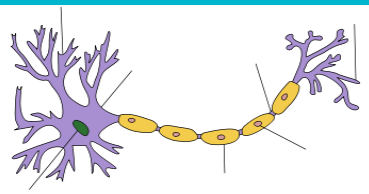

Advanced Deep Learning (I-ILIA-202)

Deep Neural networks “Auto encoders”

PyTorch

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ILIA
Informatique, Logiciel & IA
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Introduction

I. Encoder/decoder for images segmentation

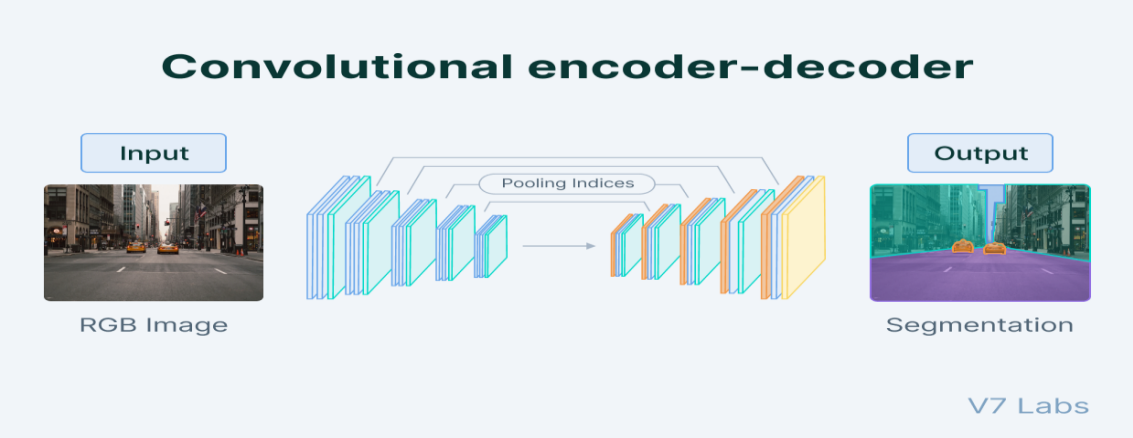
II. Encoder/decoder : operations

III. Encoder/decoder : images segmentation architectures

Conclusion

Introduction

- Autoencoders : category of neural networks, designed to learn an efficient representation (encoding) of input data, used for several tasks
- Autoencoders : consist of two main parts: encoder and decoder.
    1. **Encoder:** transforms the input data into a more compact representation and retain important information while reducing the size of the data “compression”
    2. **Decoder :** takes the compressed code and to reconstruct the input data. The idea is to recover the original data wherever possible



Introduction

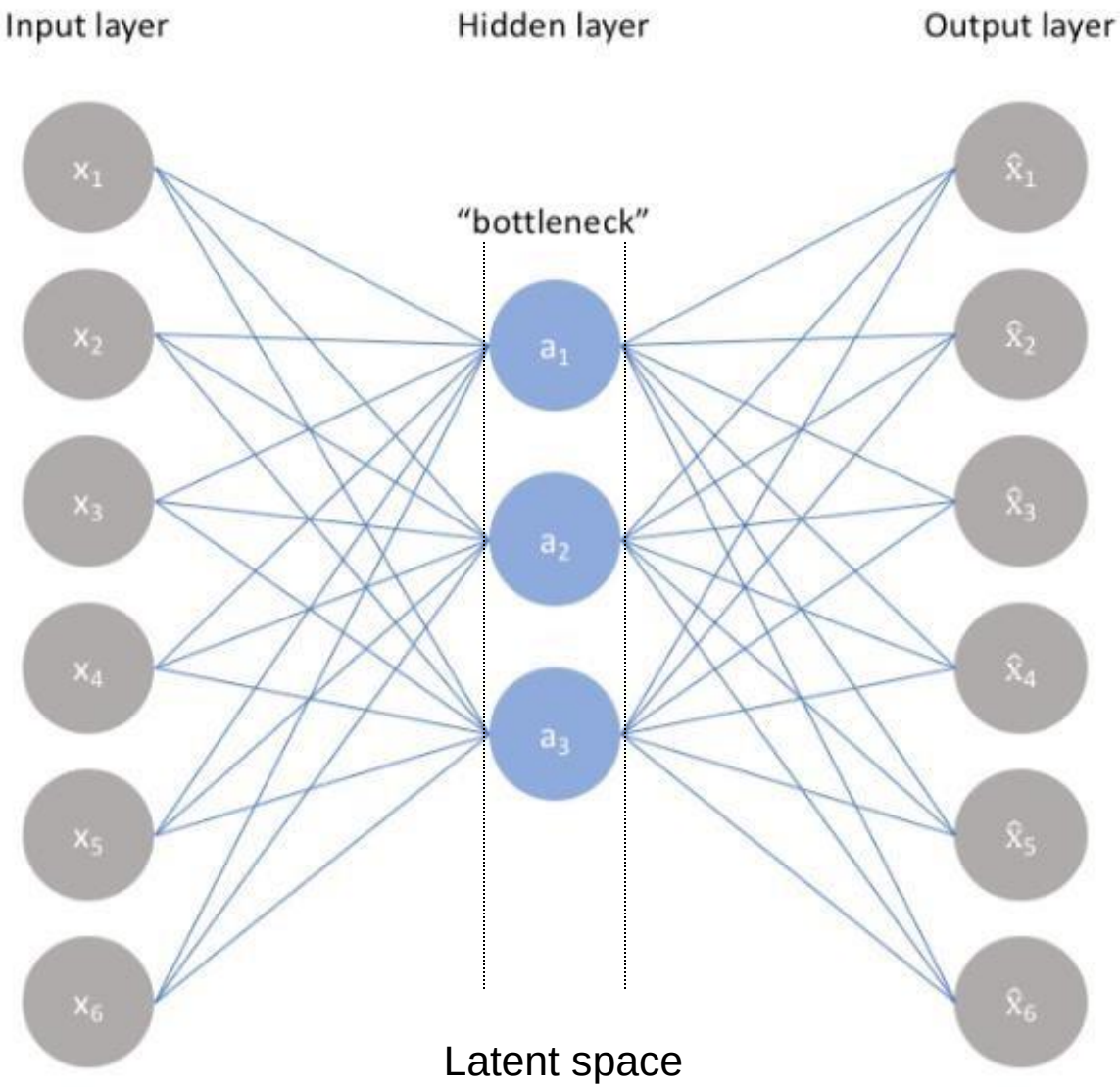
Encoder

- Takes an input image and generates a feature vector
- Apply convolutional and max Pooling layers
- Aggregate features at multiple levels

Decoder

- Takes a high dimensional feature vector and generates a segmentation mask with the same input dimensions
- Apply Down-Sampling and up pooling layers
- Decode features aggregated by encoder at multiple levels

Introduction



Introduction

Use cases :

- Images compression
- Anomalies detection
- Dimensionality Reduction
- Data generation
- Denoising

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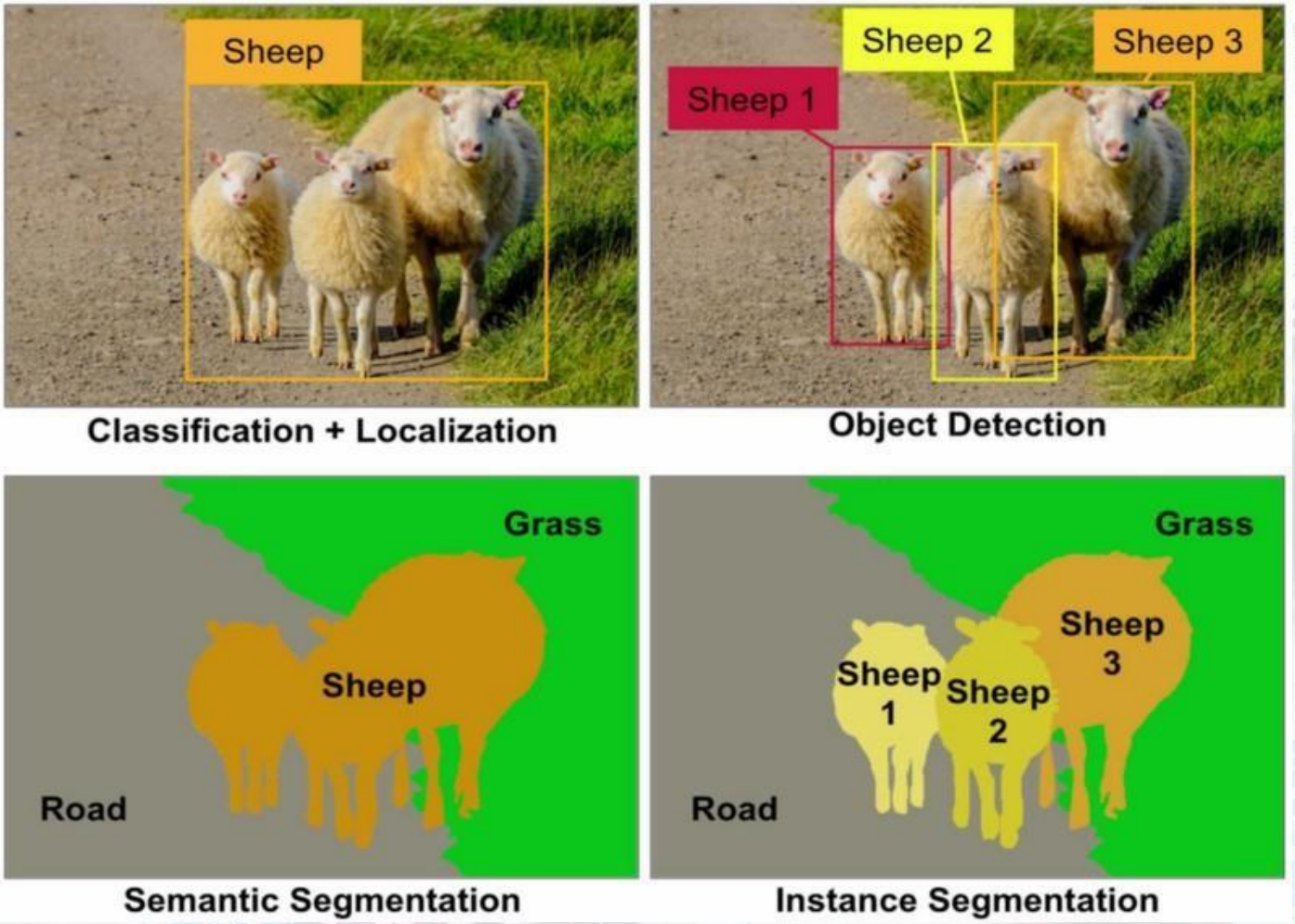
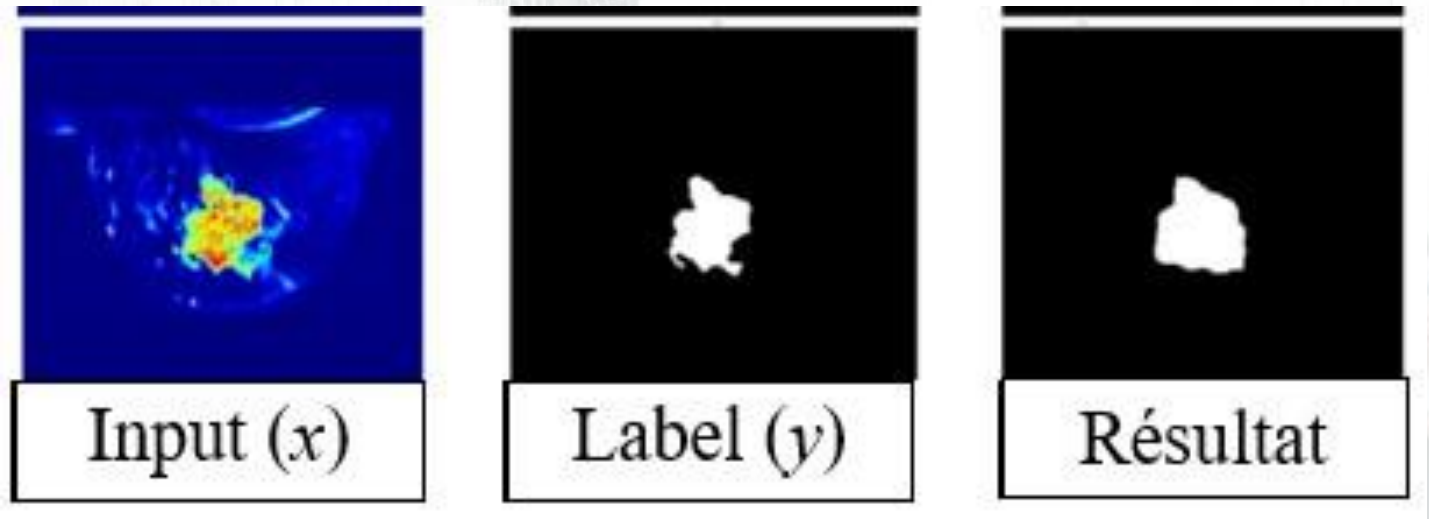
Classification vs Detection vs *Segmentation*



Introduction

Segmentation



Input

Output

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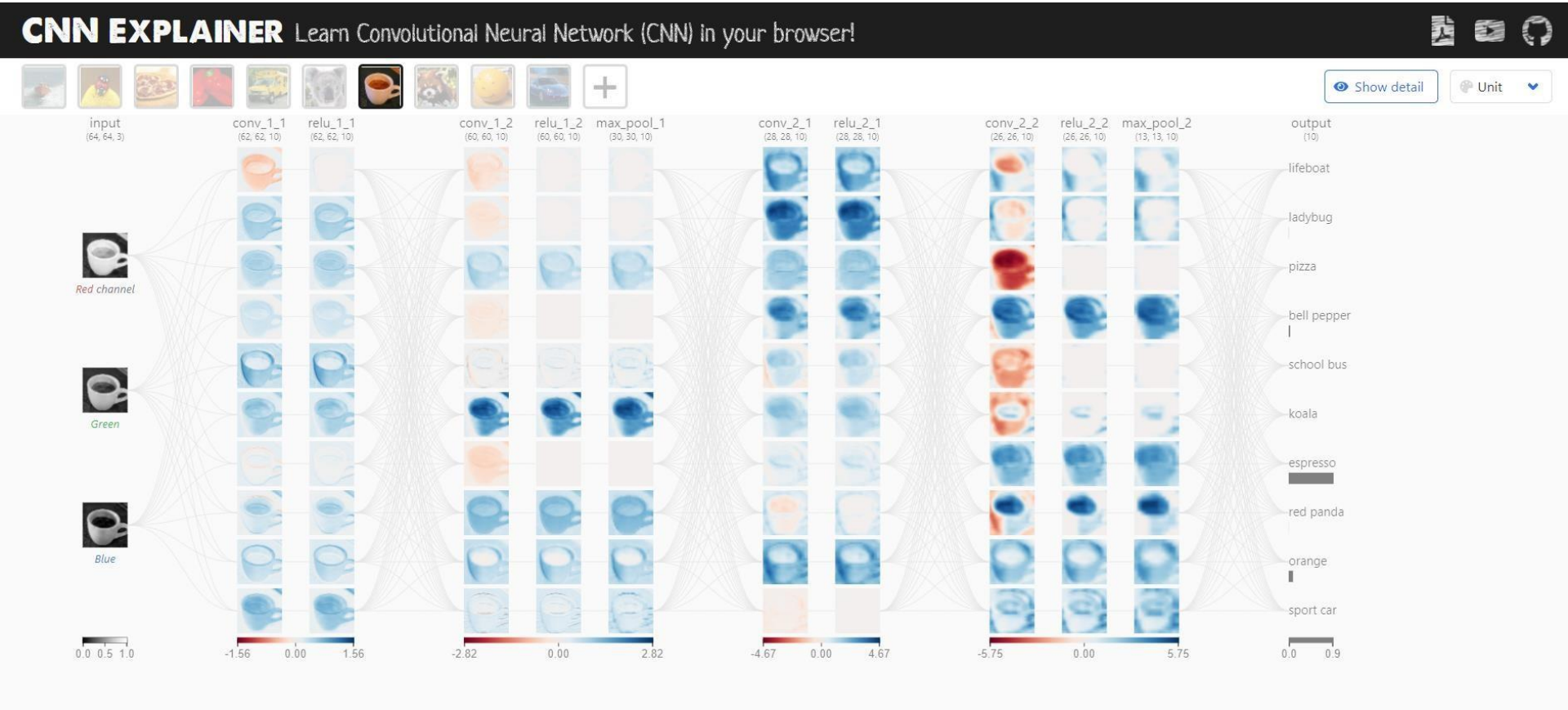
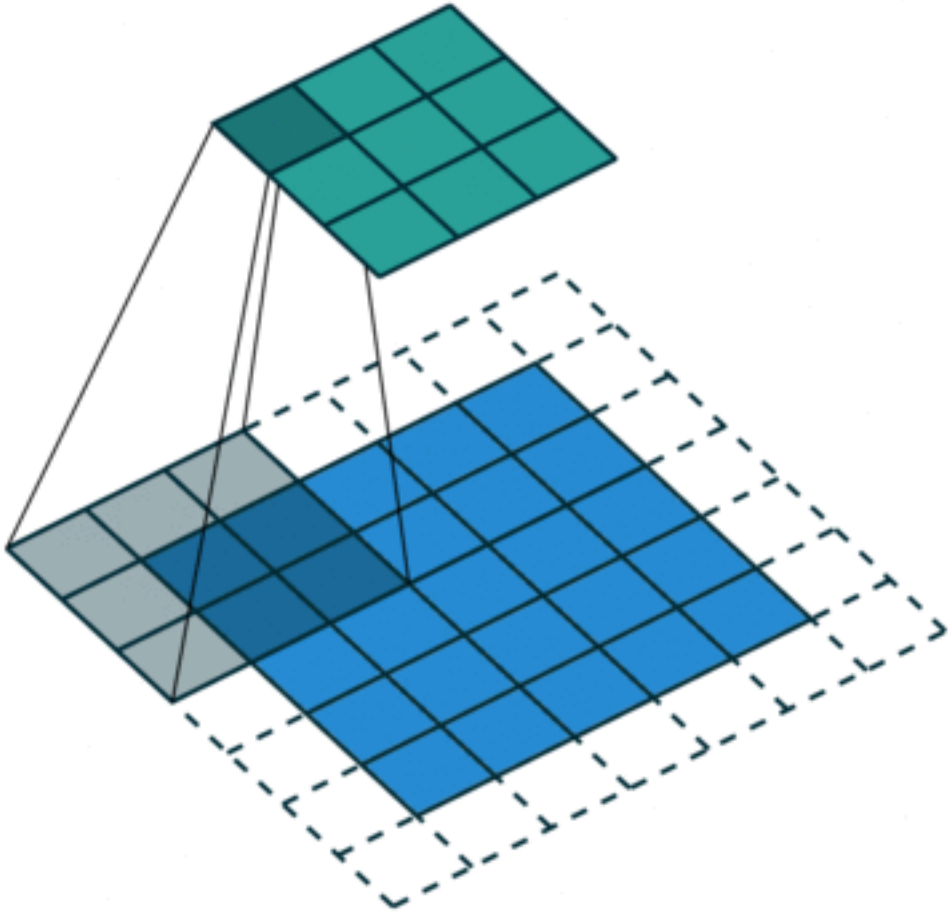
Convolutional Neural Networks



https://poloclub.github.io/cnn-explainer/

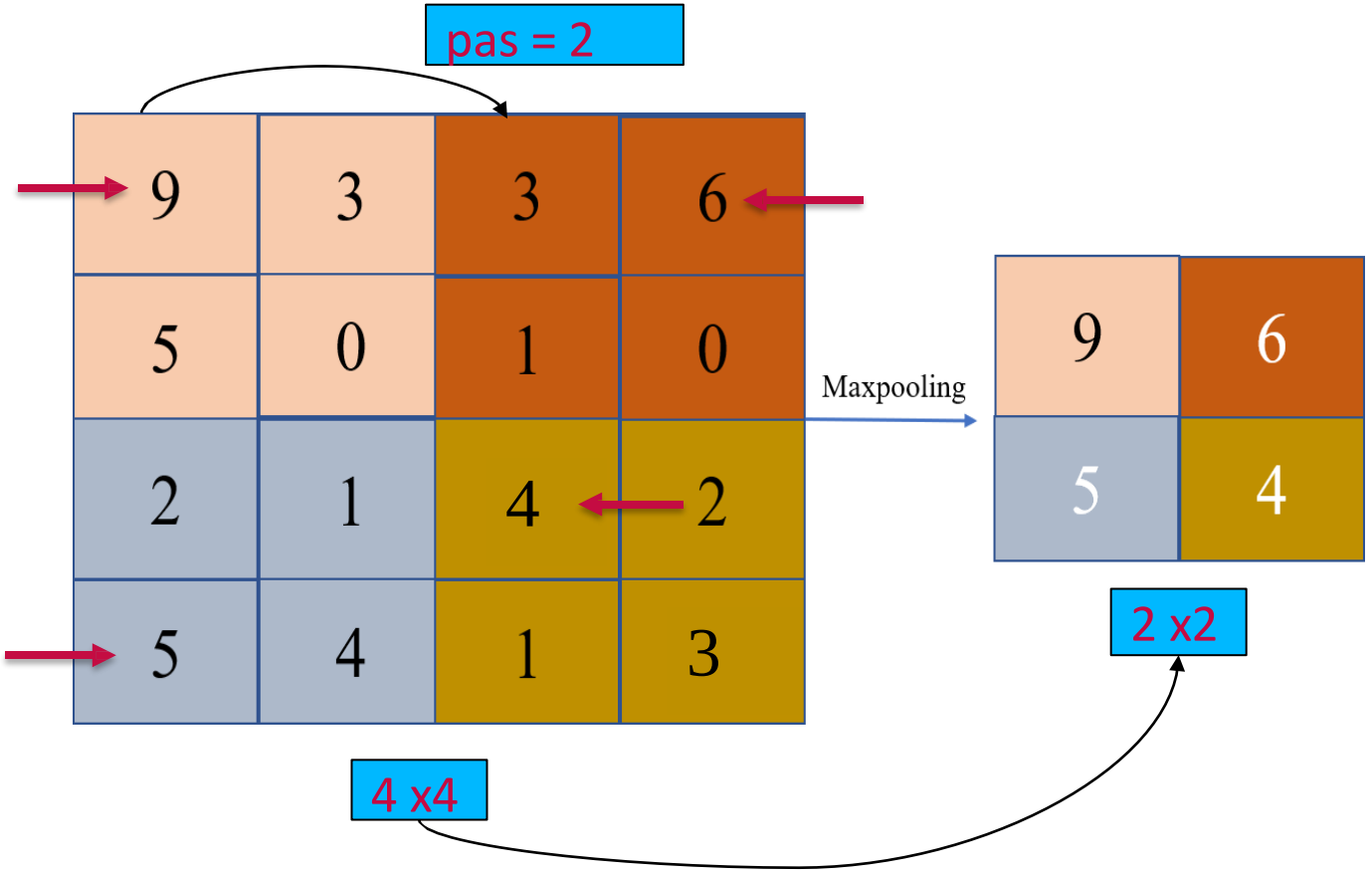
https://www.cs.ryerson.ca/~aharley/vis/conv/

Convolution



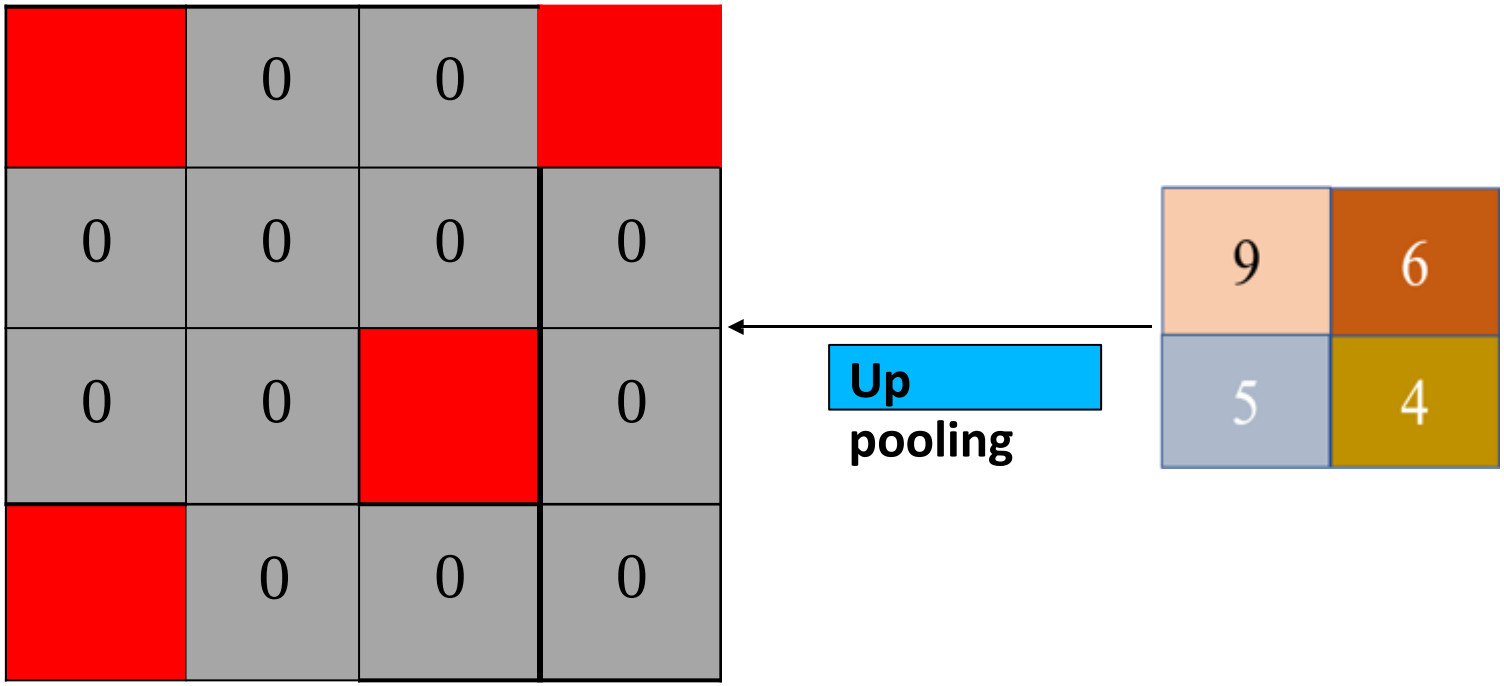
Max Pooling layer : reminder

- **Max pooling**



Up Pooling layer : reminder

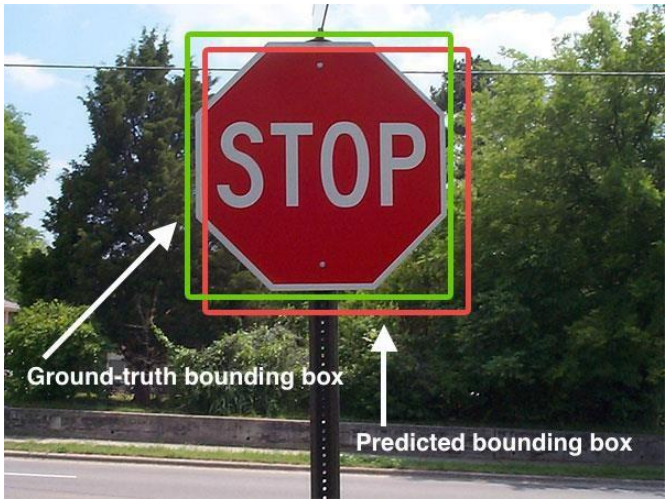
- **Up-pooling**



Max pooling locations are stored. Then they are used in the up-pooling layer

Evaluation metric for image detection & segmentation

IOU – Intersection Over Union



$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$

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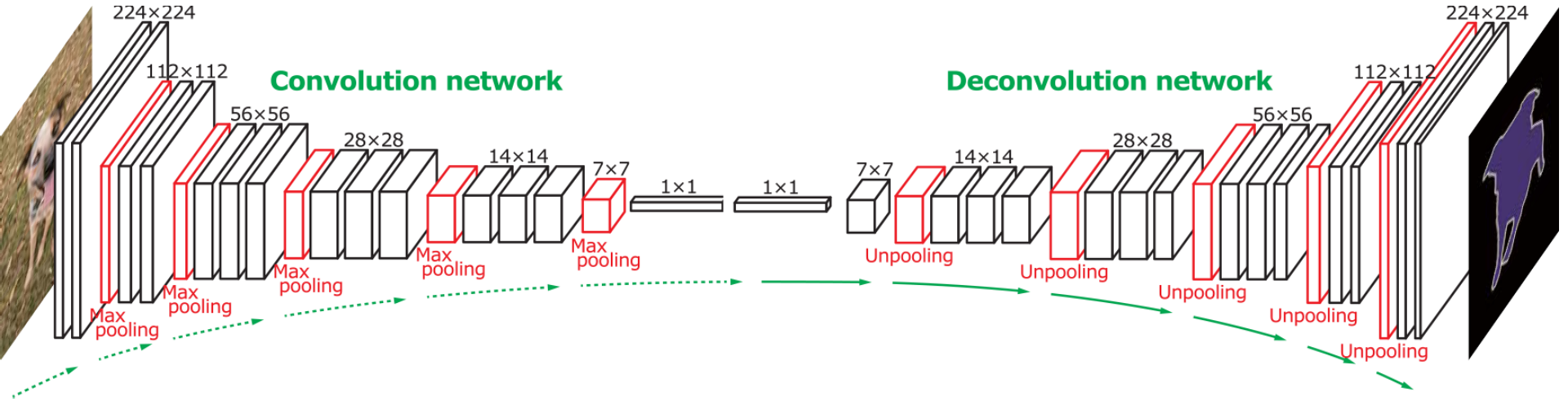
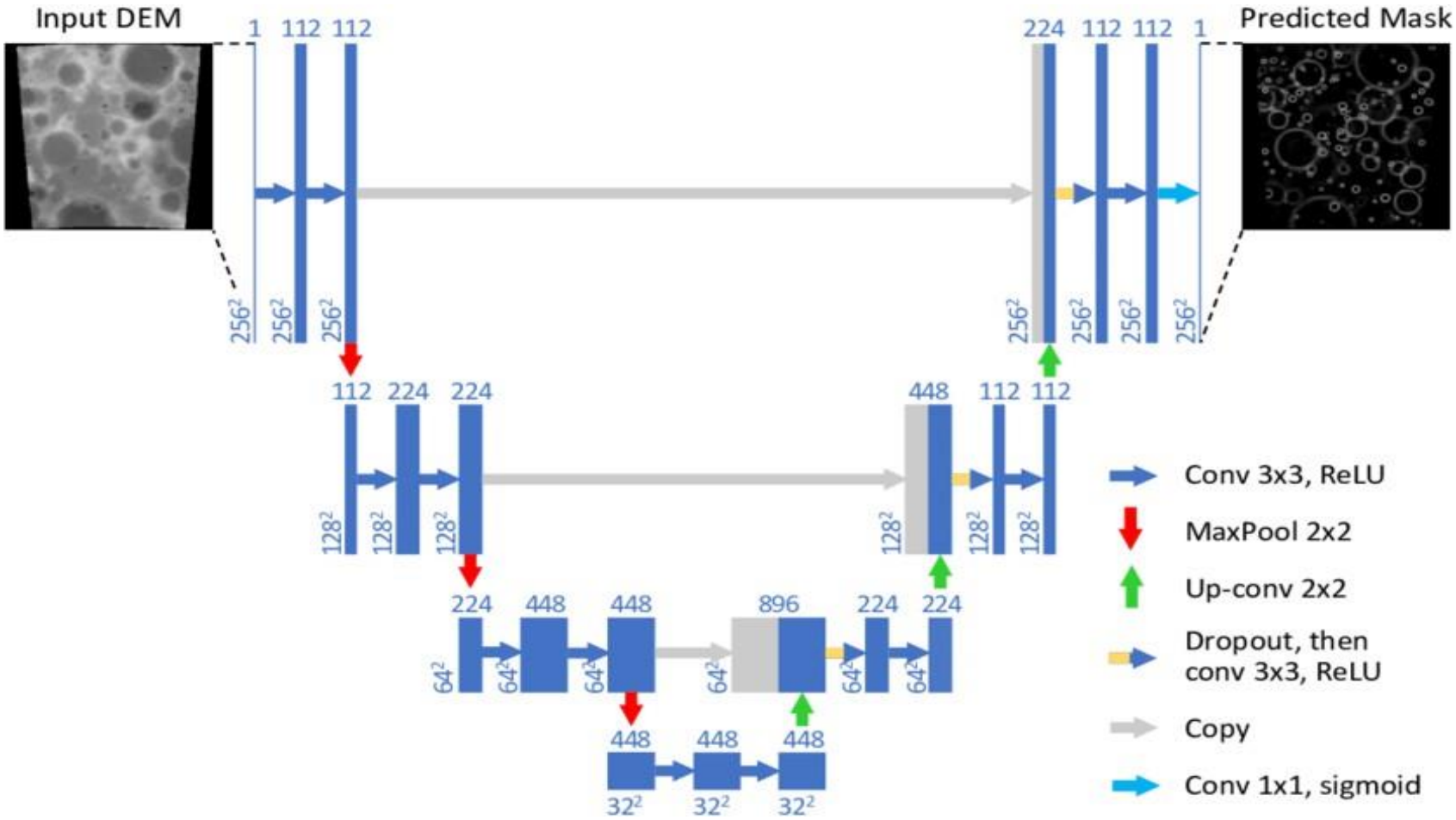
Encoder/Decoder : basic architecture



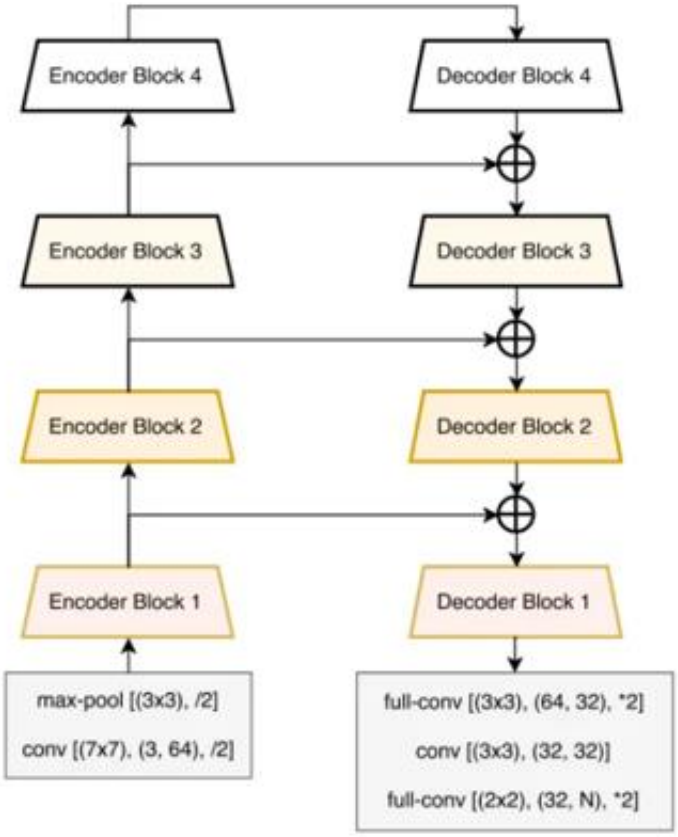
Conv/Deconv network

Encoder/Decoder : U-Net architecture



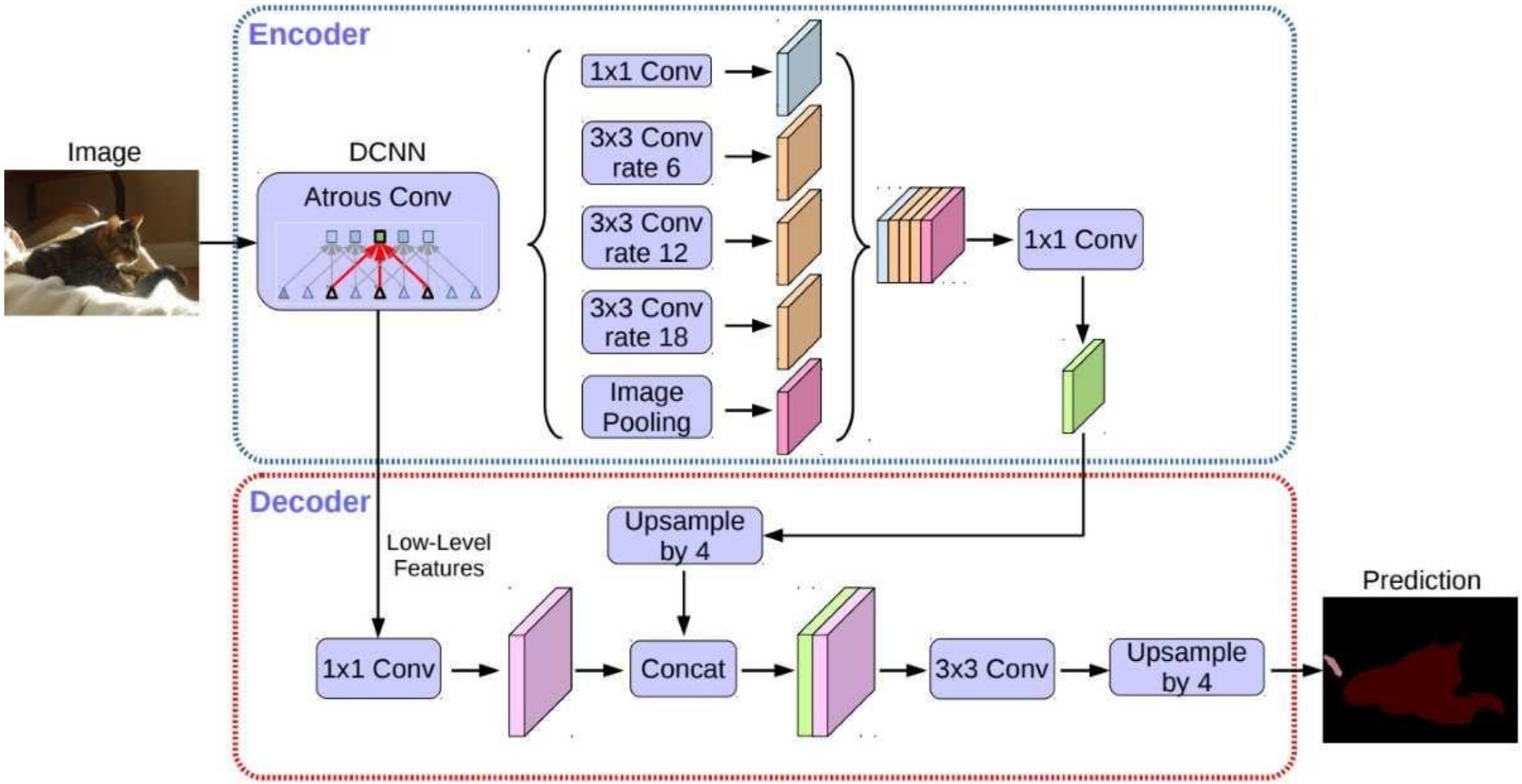
Ronneberger, O., Fischer, P., & Brox, T. (2015). U-net: Convolutional networks for biomedical image segmentation. In *Medical image computing and computer-assisted intervention–MICCAI 2015: 18th international conference, Munich, Germany, October 5-9, 2015, proceedings, part III 18* (pp. 234-241). Springer International Publishing.

Encoder/Decoder : LinkNet architecture



Chaurasia, A., & Culurciello, E. (2017, December).
Linknet: Exploiting encoder representations for efficient semantic segmentation.
In *2017 IEEE visual communications and image processing (VCIP)* (pp. 1-4). IEEE.

Encoder/Decoder : DeepLabv3 architecture



Chen, L. C. (2017). Rethinking atrous convolution for semantic image segmentation. *arXiv preprint arXiv:1706.05587*.

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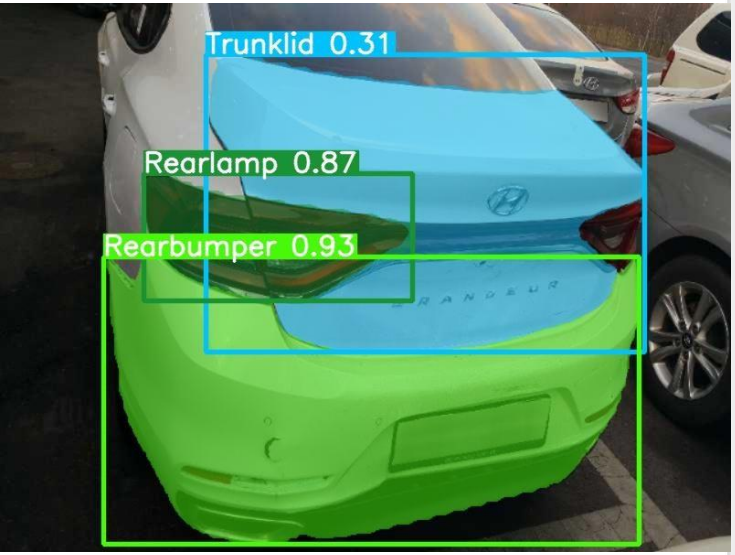
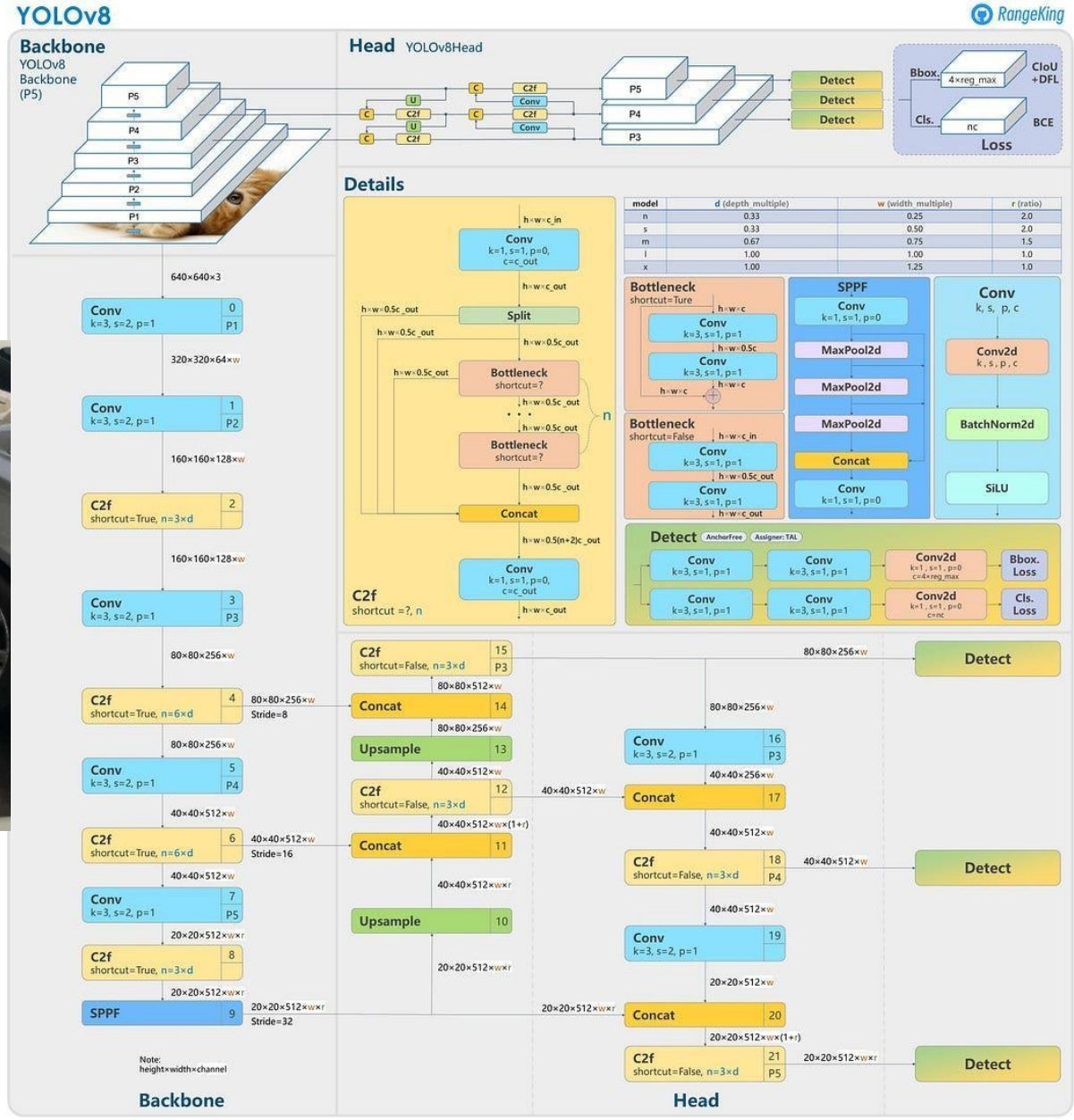
Yolo V8 (V9 and V10) for Images Segmentation





Support for the 2nd Lab (19/12)

Advanced Deep Learning (I-INFO-202) – Practical work

Lab N° 02: Brain tumor segmentation using encoder-decoder deep learning models

Introduction: the objective of this lab is to manipulate another type of deep neural networks : encoder/decoder neural network architecture. This kind of DNN can used for to segment one or more objects in an image. This involves extracting the contours of these objects to enable further processing (such as shape analysis, object type identification, etc.). This type of network is widely used in applications dedicated to autonomous vehicles as well as in medical applications (Fig. 1).

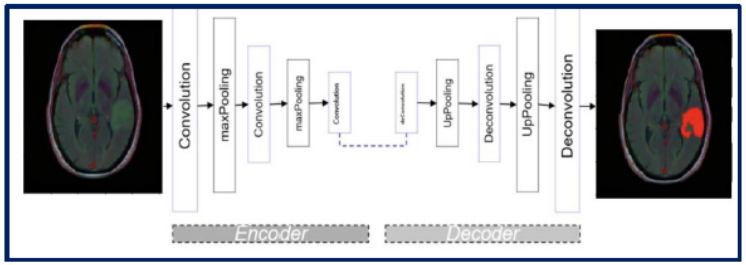


Figure 1 : Encoder/decoder neural network illustrating an example of brain tumor segmentation.

1. Lab objective :

The objective of this lab is to develop an encoder-decorder neural network for brain tumor segmentation using MRI image. For this aim, we propose to work with the dataset obtained from a Kaggle challenge, providing MRI images of the brain along with manually segmented FLAIR (Fluid-Attenuated Inversion Recovery) anomaly masks. The images were sourced from The Cancer Imaging Archive (TCIA) and correspond to 110 patients.
The objective of this practical session is to create a deep neural network capable of identifying tumors. In the dataset folder, we focus on the subfolders representing patients identified by an ID. Each folder contains scans in .tif format. Files with the keyword "mask" include a binary segmentation of the tumor.

As support, you can download from Moodle the starting code "Lab2_ADL_AutoEncoders_2024_Input.ipynb" and analyze the different cells allowing to import libraries, download and normalize the dataset. You can complete within this notebook by providing your codes related to the different encoder-decoder architectures.

Note : your lab solution should be submitted individually within Moodle before 20/12 at 23h59.

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Thank you