ETH zürich

Medical Imaging Segmentation

Project 1

Xinrui Lyu

02.03.2021

Types of medical imaging

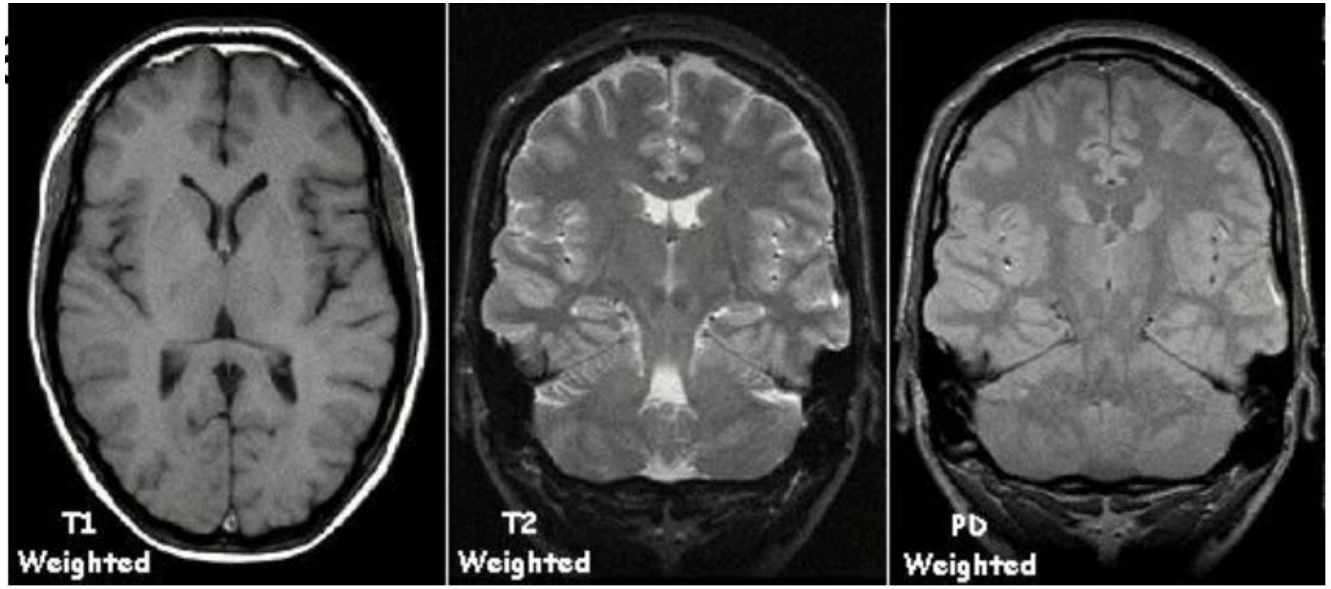
Computer Tomography (CT) is often used to evaluate:

- Presence, size and location of tumors
- Organs in the pelvis, chest and abdomen
- Colon health (CT colongraphy)
- Vascular condition/blood flow
- Pulmonary embolism (CT angiography)
- Abdominal aortic aneurysms (CT angiography)
- Bone injuries
- Cardiac tissue
- Traumatic injuries
- Cardiovascular disease

Types of medical imaging

Magnetic Resonance Imaging (MRI) is often used to evaluate:

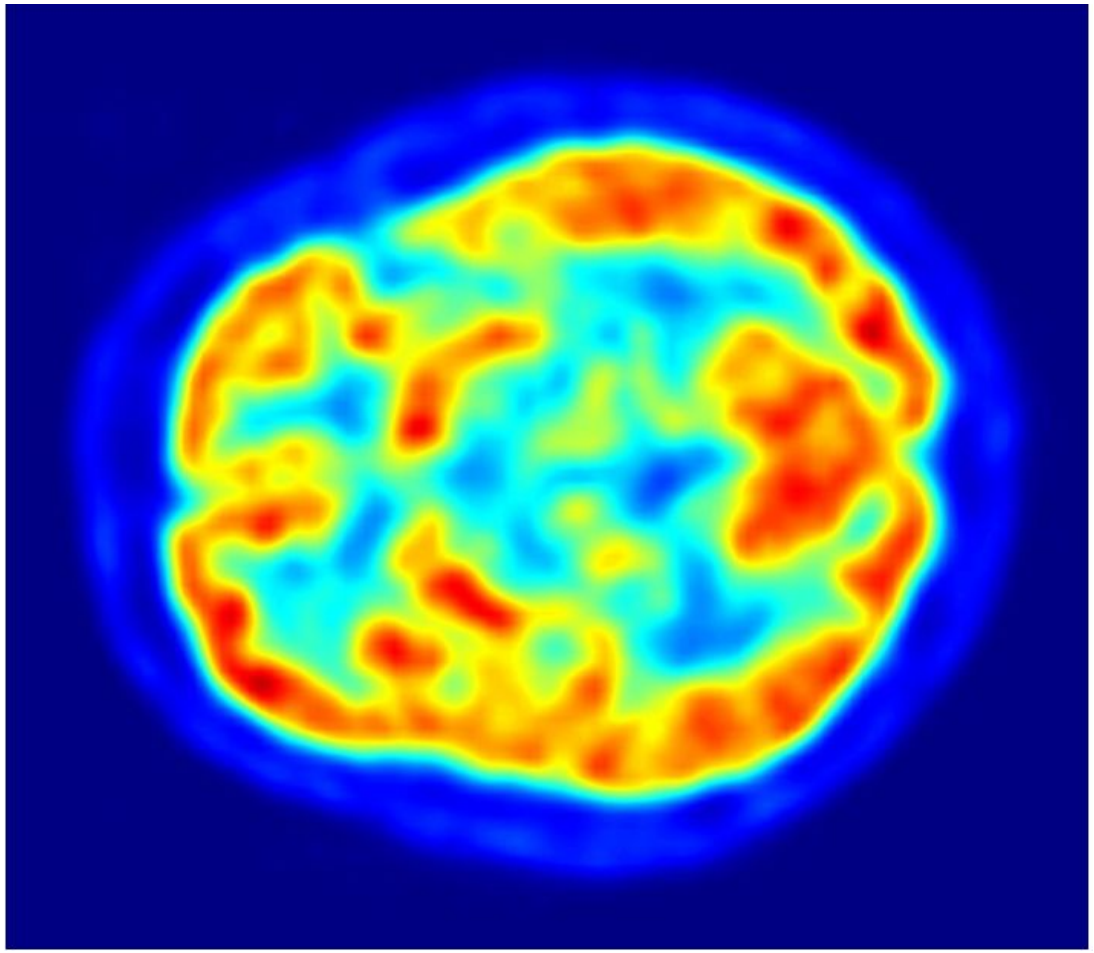
- Blood vessels
- Abnormal tissue
- Breasts
- Bones and joints
- Organs in the pelvis, chest and abdomen (heart, liver, kidney, spleen)
- Spinal injuries
- Tendon and ligament tears



Types of medical imaging

Positron Emission Tomography (PET) is often used to evaluate:

- Neurological diseases such as Alzheimer's and Multiple Sclerosis
- Cancer
- Effectiveness of treatments
- Heart conditions



Types of medical imaging

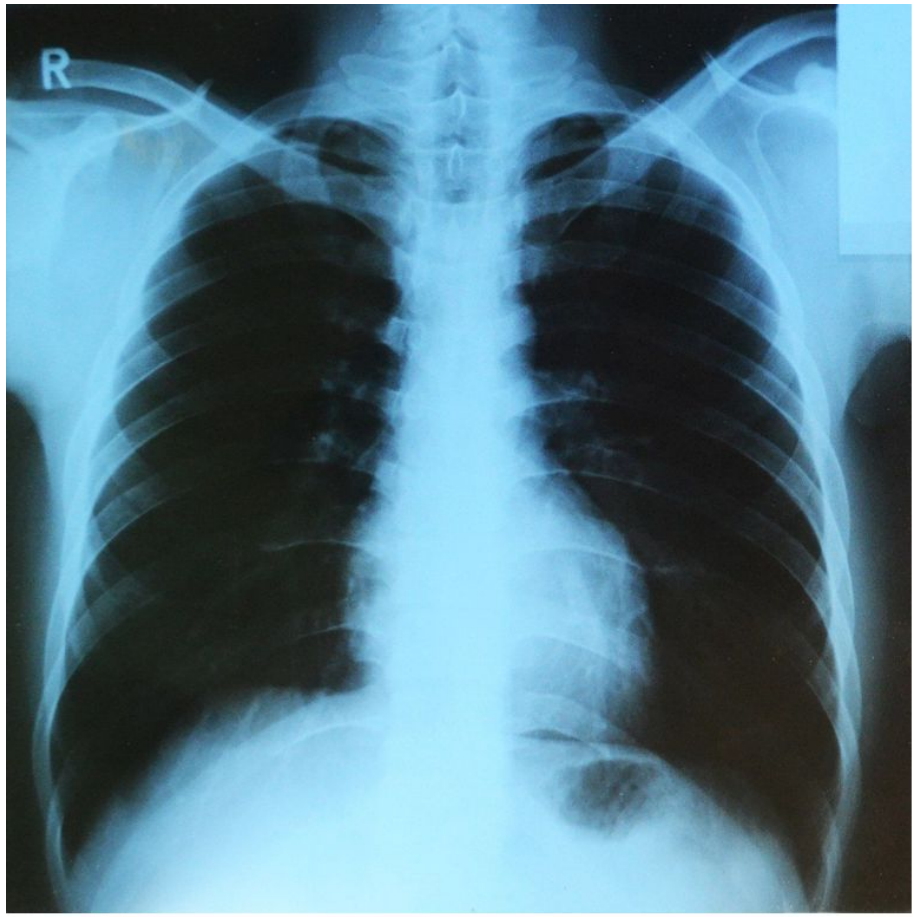
Ultrasound is often used to evaluate:

- Pregnancy
- Abnormalities in the heart and blood vessels
- Organs in the pelvis and abdomen
- Symptoms of pain, swelling and infection

Types of medical imaging

X-Ray is typically used to evaluate:

- Broken bones
- Cavities
- Swallowed objects
- Lungs
- Blood vessels
- Breast (mammography)



Data for Project 1 (available on Moodle)

Input

- CT scans of size: 512 x 512 x depth (varying)

Label (Primaries mask)

- 0: background
- 1: primary

Dataset

- Training data: 100 3D CT scans (“imagesTr”, “labelsTr”)
- Testing data: 26 3D CT scans (“imagesTs”)

Colon cancer CT scan slice example

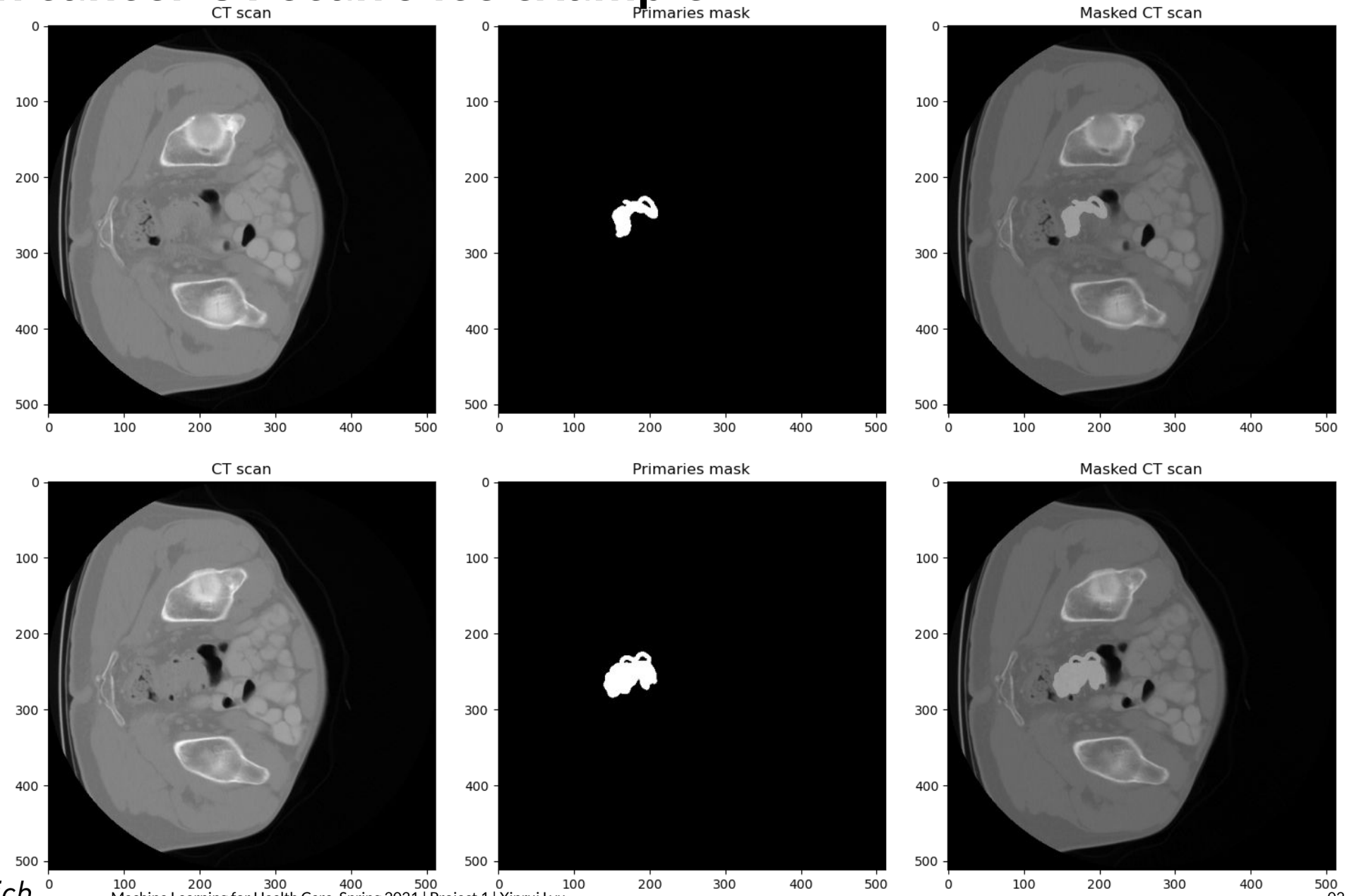
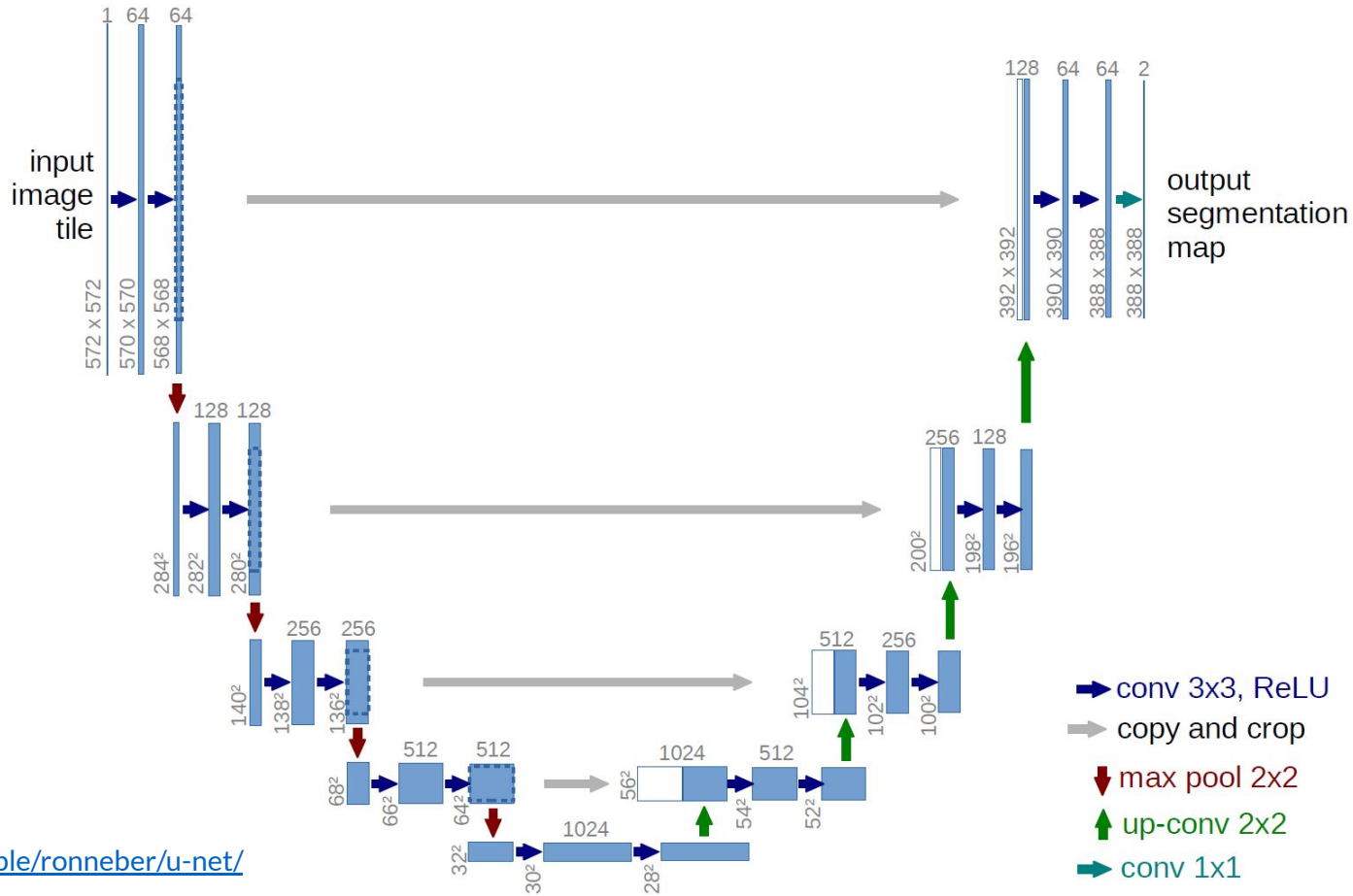


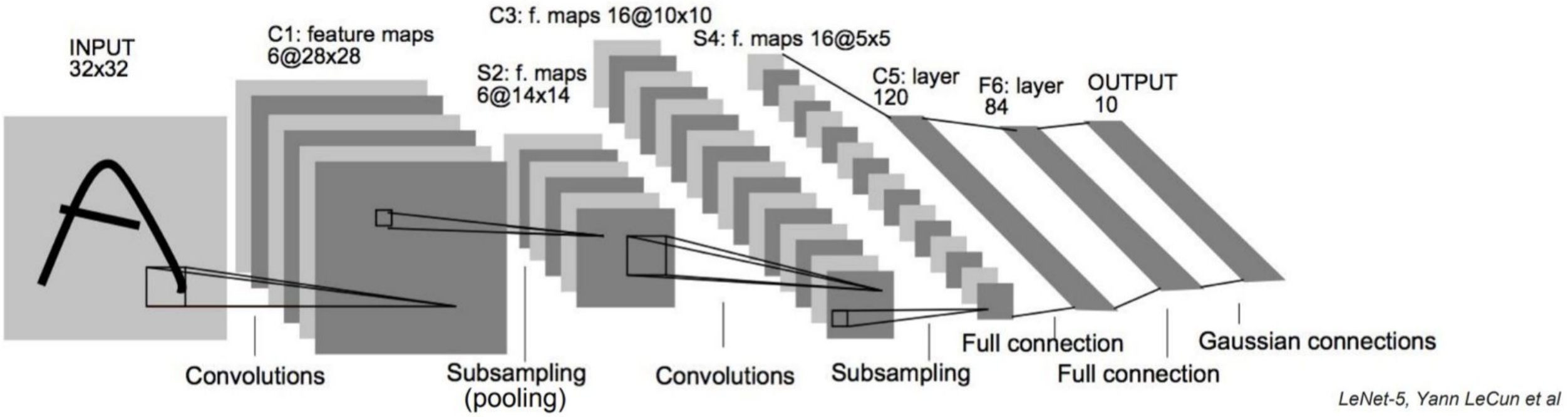
Image segmentation method

- Simple Linear Iterative Clustering (SLIC)
- Markov random field (MRF)
- **U-net**



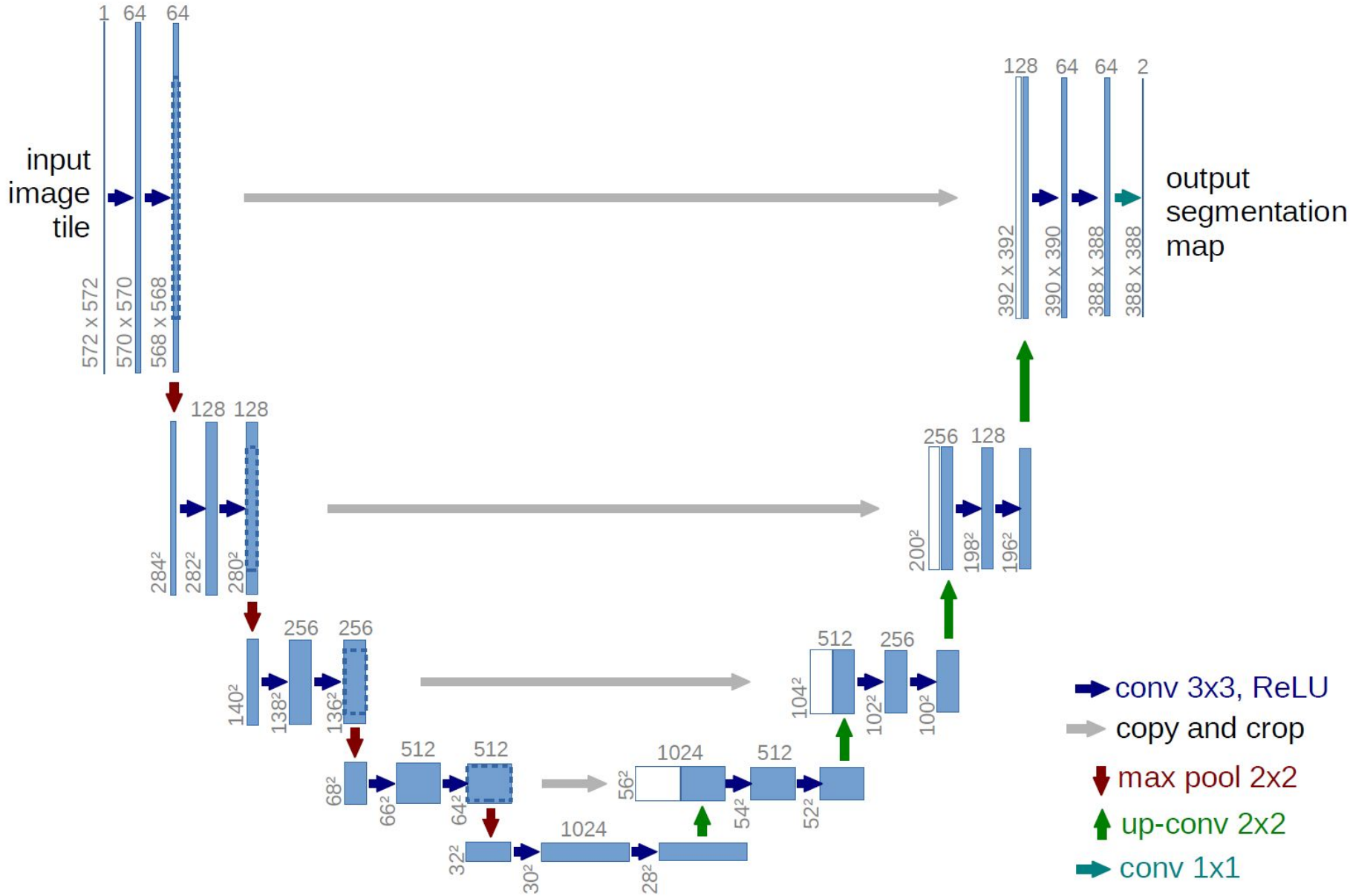
https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/

Traditional Convolutional Neural Network



LeNet-5, Yann LeCun et al

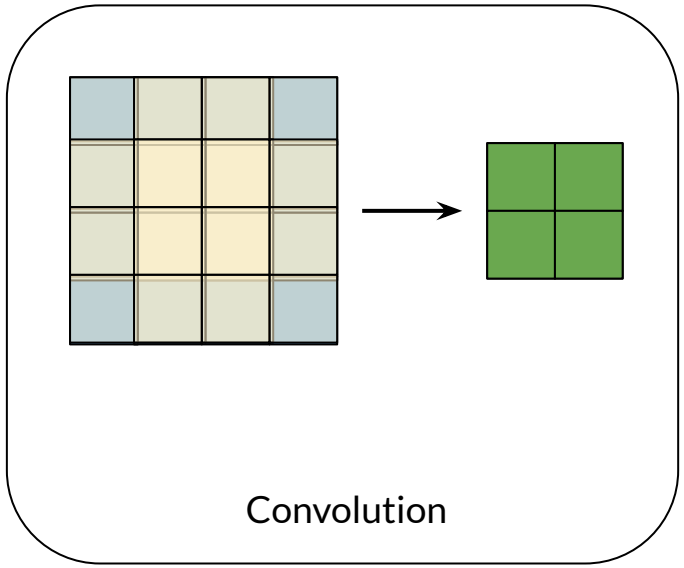
U-Net

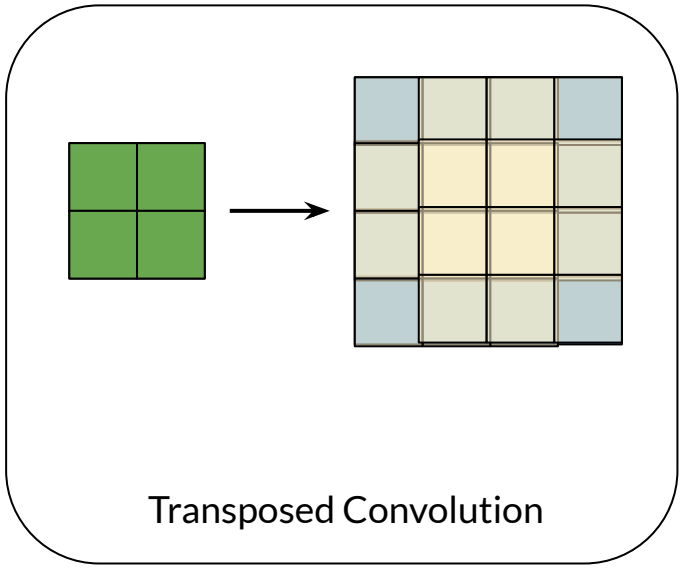


https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/

Up-conv

or transposed convolution





Segmentation evaluation metric

Intersection over Union (IoU, also called Jaccard index)

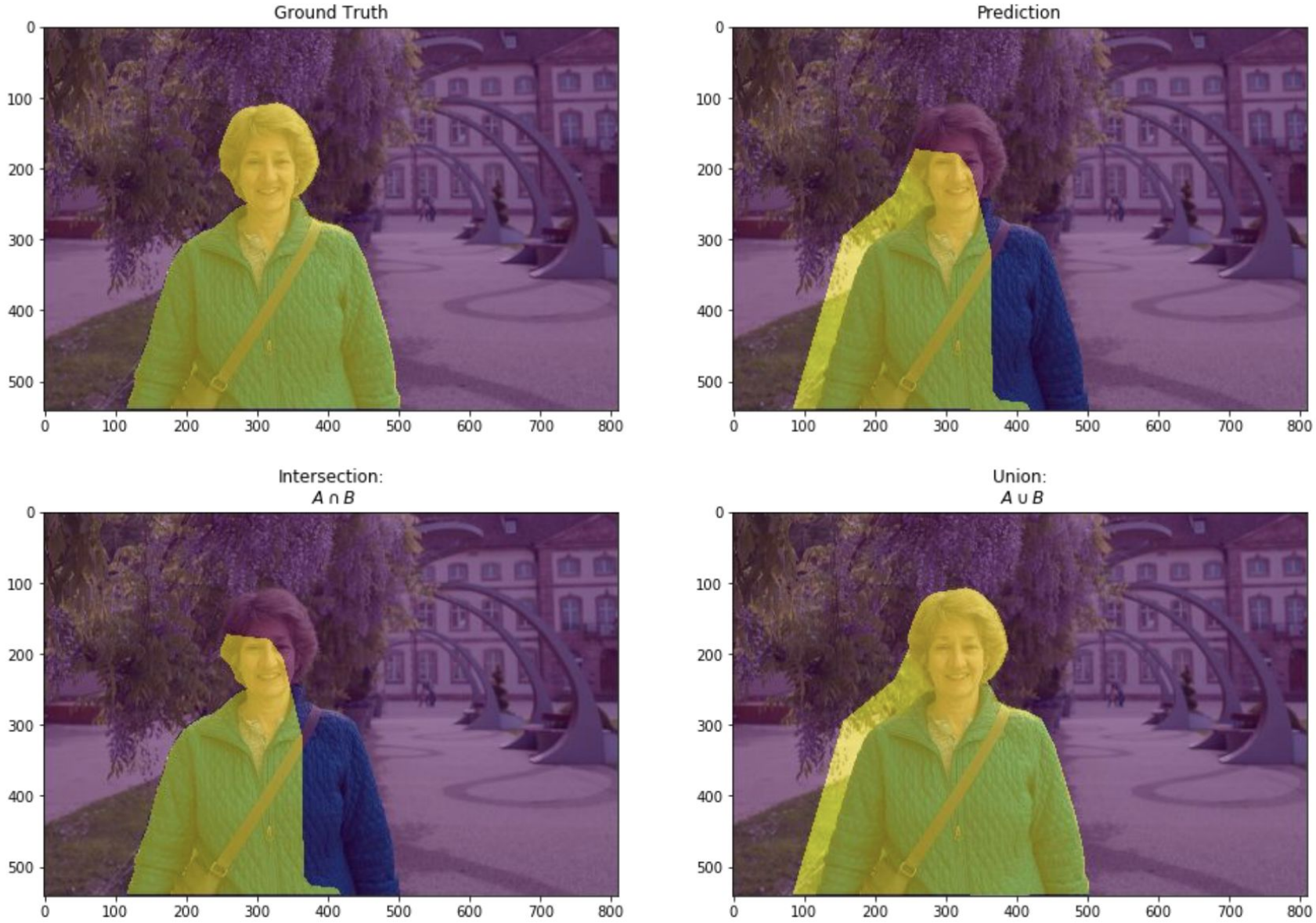
- measures the intersection over the union of the labelled segments **for each class** and **reports the average**

$$\text{IoU} = \frac{\text{groundtruth} \cap \text{prediction}}{\text{groundtruth} \cup \text{prediction}}$$

- limitation: it evaluates the amount of pixels correctly labelled, but not necessarily how accurate the segmentation boundaries are.

Intersection over Union (IoU)

Example



Tasks for Project 1

- Train a U-net to segment colon cancer CT scan images into background/primary
- Try several set of hyperparameters, and use cross-validation to find an optimal set of hyperparameters
- Produce the predicted masks for testing data and save as pickle or npz file(s). (need to include the id details)
- Report the training IoU performance from your best model
- Write a max. 2-page report on the model construction/cross-validation/evaluation details.

Deliverables:

- Report (Detailing the contribution of the individual member as well)
- Testing segmentation masking images
- Environment/Code/README.txt (document the usage of each script in details)

Deadline: 22.03.2021 (Please submit on Moodle. If the submission file is too big send the zip file to xinrui.lyu@inf.ethz.ch)

Recommended API

- Tensorflow: e.g. Pix2Pix
- Keras