

Lab5: Image segmentation (MONAI)

3099704 AI for Digital Health (2025/2)

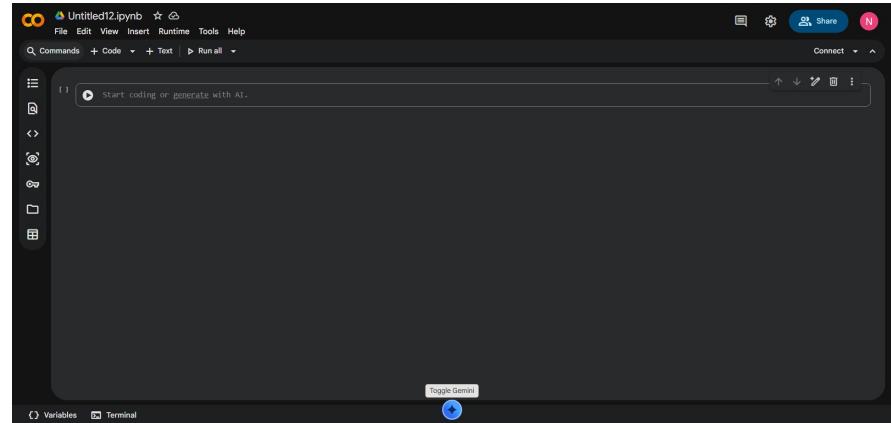
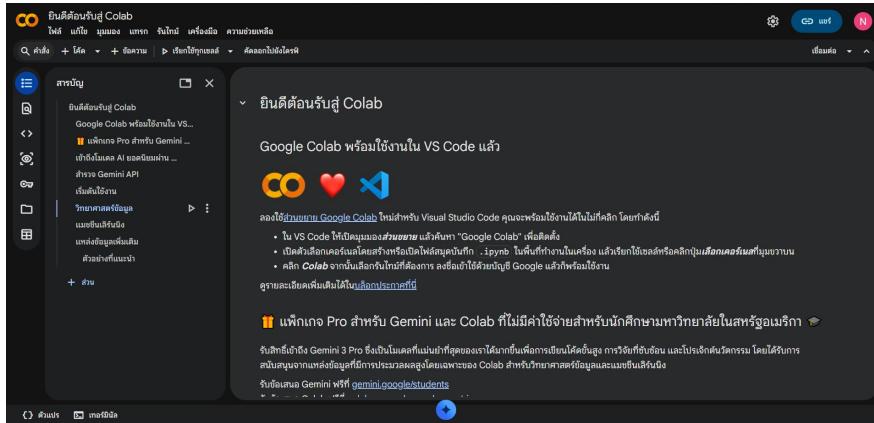
Objective

- Create segmentation model
- Use the **MONAI library** to build deep learning model (UNet)



Material

- With **Google Colab**, you don't need to install any software. All you need is a Google account, and you can start using it right away. Simply visit: <https://colab.research.google.com/> or select NEW NOTEBOOK to start a new file.



Pytorch VS MONAI

PyTorch is a general-purpose framework for deep learning, while MONAI is built on PyTorch but adds specialized functions for medical imaging tasks, such as

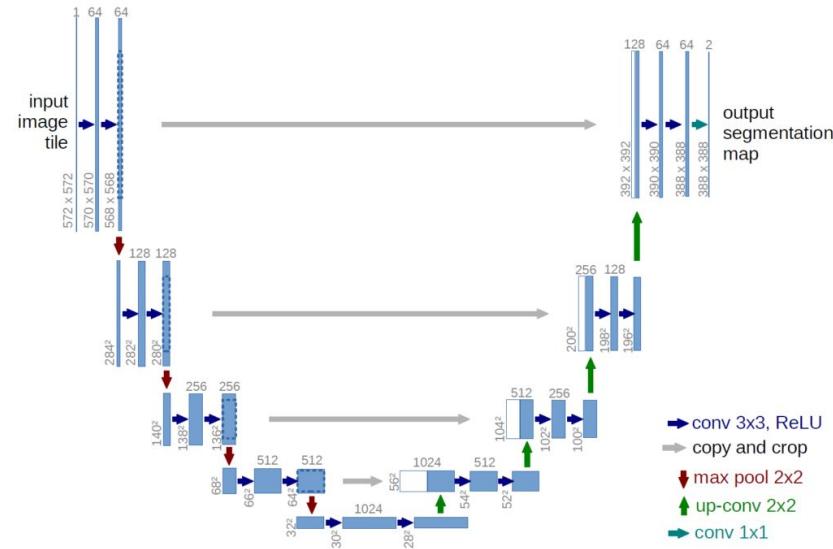
- **Data Loading:** CacheDataset supports big data and caching
- **Transforms:** monai.transforms supports 3D medical volume
- **Networks:** build-in models, such as UNet and SegResNet
- **Inferers:** sliding_window_inference enable inference 3D volumes by 2D models



UNet

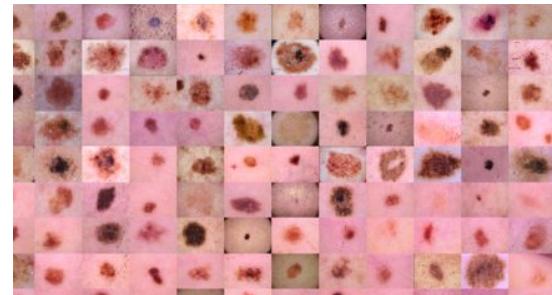
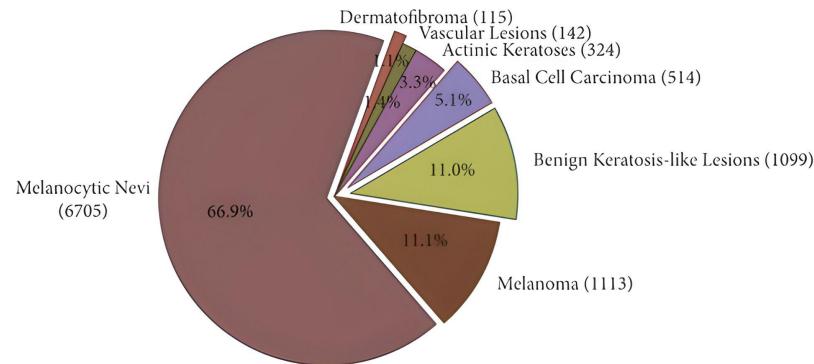
In this lab, we chose to use Unet, which has the following key architectural innovations:

- The left side (**encoder**) progressively downsamples the image to capture context.
- The right side (**decoder**) upsamples to recover spatial resolution for pixel-level predictions.
- **Skip Connections** are directly connected feature maps from the encoder to the decoder at corresponding levels.



Dataset: Skin Cancer MNIST (HAM10000)

- The dataset consists of 10015 images with 10013 labeled objects belonging to 7 skin cancer classes.
- The data contains image in JPG format and documents in JSON format
- In the experiment, we reduced the amount of data and formatted it to simplify the experiment.



Lab5.1: UNet (2D segmentation)

In this lab, you will create and evaluate an skin cancer segmentation model (UNet) using the **MONAI library**. Code can be executed in [Lab_5_1_MONAI\(2Dsegmentaton\)](#) on Google Colab.

This notebook will consist of:

- 1) Setup
- 2) Load Data & Set Transforms
- 3) Define Model & Set Parameter
- 4) Train Model
- 5) Inference & Evaluate & save

The screenshot shows a Google Colab interface with a notebook titled "Lab_5_1_MONAI(2Dsegmentaton).ipynb". The first cell contains the following text and code:

Lab 5.1 – Skin cancer segmenataion: UNet (MONAI)

This notebook implements training of a 2D UNet from MONAI library (https://monai-dev.readthedocs.io/en/stable/_modules/monai/networks/nets/unet.html#UNet) to segment skin cancer. The training code is also customizable to enable training with a different target. In this notebook, we are using the HAM10000 Dataset (<https://www.kaggle.com/datasets/surajhuwalela/ham10000-segmentation-and-classification?select=masks>)

This example code will consist of:

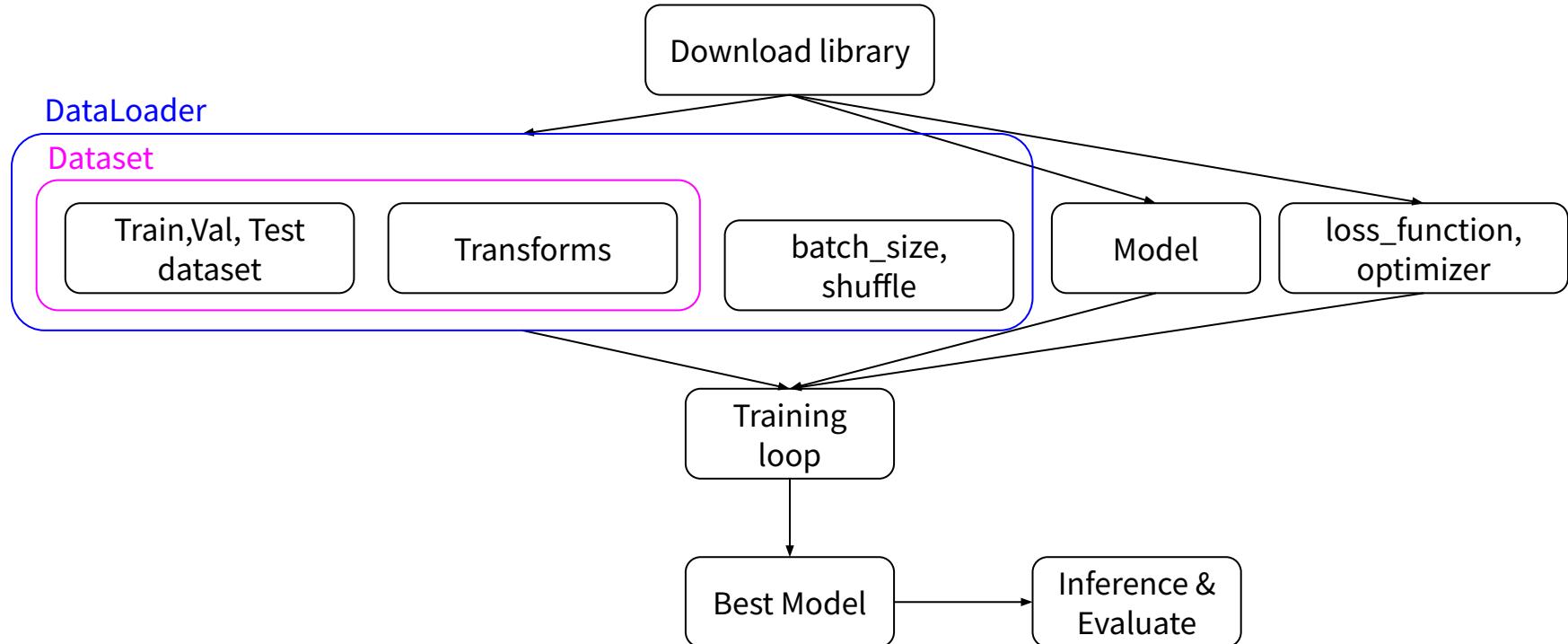
1. Setup
2. Load Data & Set Transforms
3. Define Model & Set Hyper Parameter
4. Train Model
5. Inference & Evaluate & Save

1) Setup

The code below download dataset, imports all required libraries and defines utility functions that will be used in the rest of this notebook.

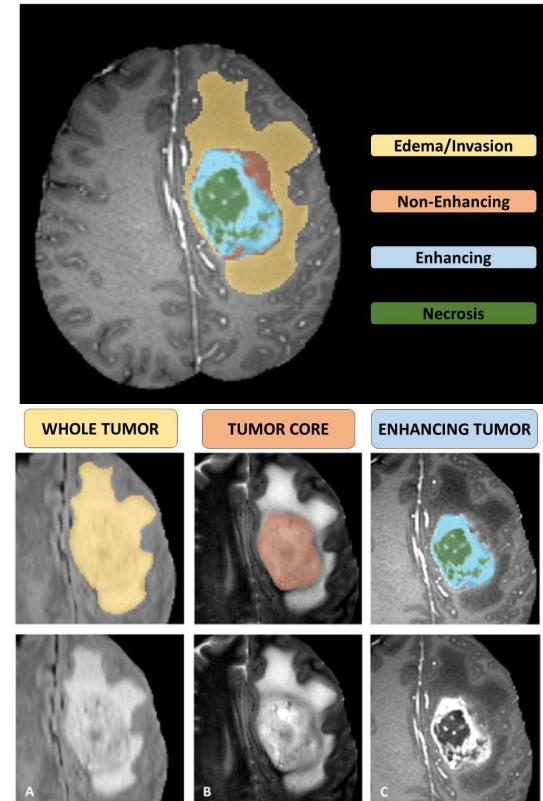
```
# Download Dataset
!wget https://github.com/pvateekul/digitalhealth-ai2025/raw/main/dataset/Ham10000_segment.zip
!unzip -q -o 'Ham10000_segment.zip'
```

Lab5.1: UNet (2D segmentation)



Dataset: Brain Tumor Segmentation 2020 Dataset (BraTS2020)

- BraTS 2020 is dataset for brain tumor segmentation, consisting of T1, T1ce, T2, FLAIR with tumors, which contains image in [nii.gz](#) format
- BraTS 2020 includes **369 training cases**, with further validation/test subjects provided for evaluation.
- In the experiment, we reduced the amount of data and formatted it to simplify the experiment.



Lab5.2: UNet (3D segmentation)

In this lab, you will create and evaluate a brain tumor segmentation model(UNet). Unlike Lab 5.1, this lab focuses on a 3D segmentation task, with the main differences in the DataLoader and inference process. All code can be executed in [Lab 5.2 MONAI\(3Dsegmentaton\).](#)

This notebook will consist of:

- 1) Setup
- 2) Load Data & Set Transforms
- 3) Define Model & Set Parameter
- 4) Train Model
- 5) Inference & Evaluate & save

The screenshot shows a Jupyter Notebook interface with the following details:

- Title:** Lab_5_2_MONAI(3Dsegmentaton).ipynb
- Header:** File Edit View Insert Runtime Tools Help
- Toolbar:** Commands + Code + Text ▶ Run all ▶ Copy to Drive
- Content Area:**
 - Section:** Lab 5.2 – Brain cancer segmentaion: UNet (MONAI)
 - Description:** This notebook aims to segment brain cancer. BraTS2020 Dataset (<https://www.kaggle.com/datasets/awsaif49/brats20-dataset-training-validation/data>) and UNet from MONAI library (https://monai-dev.readthedocs.io/en/latest/_spinx/_modules/monai/networks/nets/unet.html#UNet) are employed for the trial.
 - Note:** This lab will use 2D UNet, which operates on 2D input and can be sliced from a 3D volume, unlike Lab 4.1. After editing sliding window inferer in described in this tutorial, it can handle the entire flow as shown.
 - Example code:** This example code will consist of:
 1. Setup
 2. Load Data & Set Transforms
 3. Define Model & Set Hyper Parameter
 4. Train Model
 5. Inference & Evaluate
 - Code Cell:** 1) Setup
- Bottom:** # Download Dataset, Variables, Terminal

Lab5.2: UNet (3D segmentation)

