[CV’25] Introduction to Computer Vision and Robotics

Lung Tumor Detection and Segmentation

The objective of this project is to develop a computer vision system capable of detecting and segmenting lung tumors in medical images. This system can be used in various applications such as tumor analysis, localization and tracking.

Project Main Objectives and Minimum Requirements:

1. Apply object detection to localize the lung tumor/s in an image.
2. Apply semantic segmentation to segment the tumor in a lung image from the rest of the lung.
3. Connect the two modules by detecting the location of a tumor in an image, cropping this tumor and then passing it to a segmentation module and comparing the performance accuracy when doing that versus applying Modules 1 and 2 independently.
4. Prepare a test script that takes a single lung scan and generates a report that has information about the lung tumor existence/nonexistence, location, size (based on segmentation) and number of fragments if more than one was detected.

Dataset Description

The project dataset can be found [here].

The dataset contains two folders (train, val):
Each of them has three subfolders: (images, masks and detections)

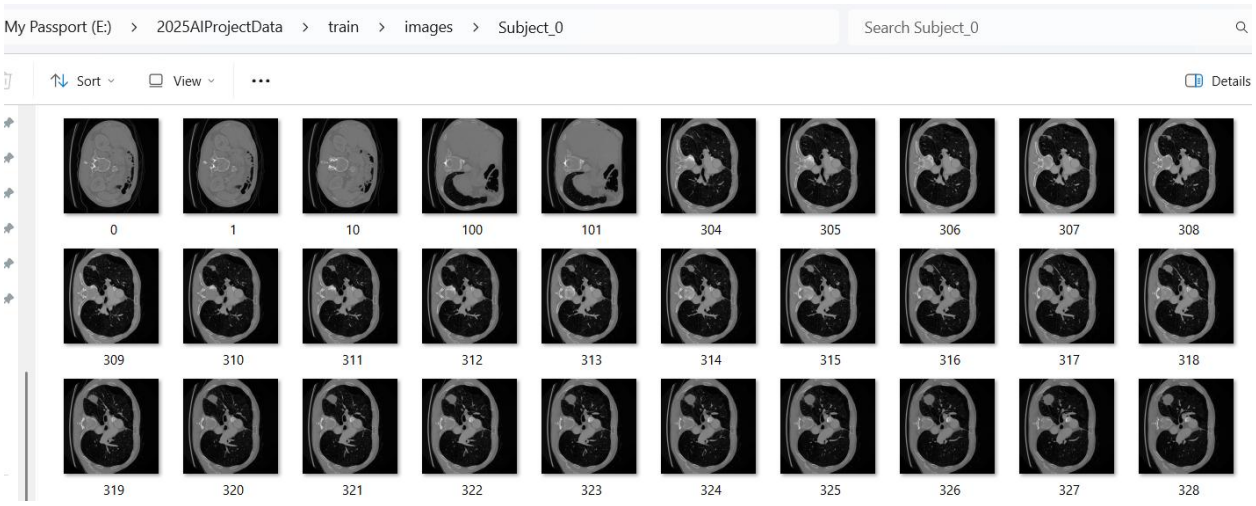
1- Images: has subfolders according to a number of patients/subjects. Each subject has multiple images
2- Masks: has subfolders according to a number of patients/subjects. Each subject has multiple masks each file corresponding to a file in

the images/subject folder. The mask corresponding to an image has the same name as the image

3- Detections: Contains the object detection annotations to be used for the object detection task. Has subfolders according to a number of patients/subjects. Each subject has detection files corresponding to an image in the images folder.

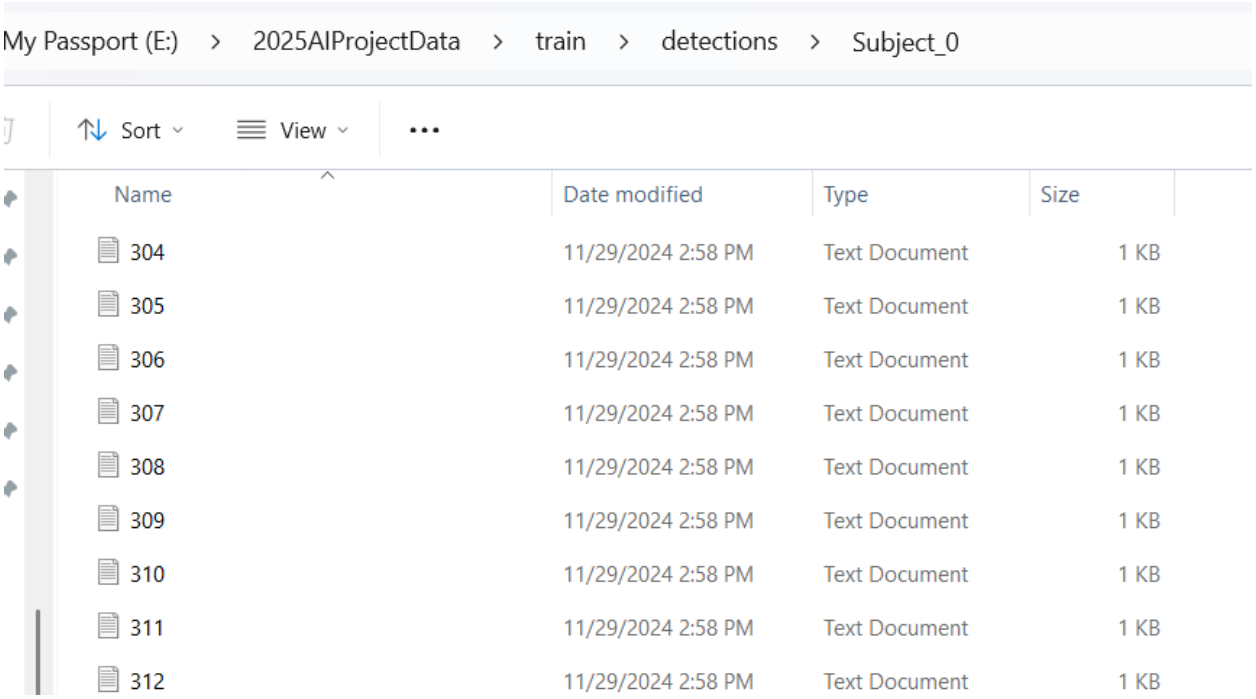
Example:

Images:

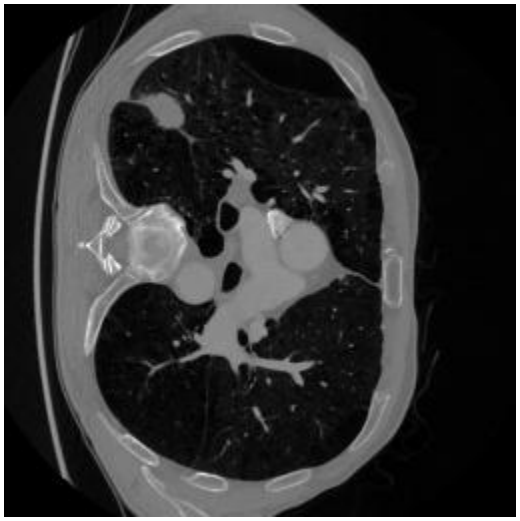


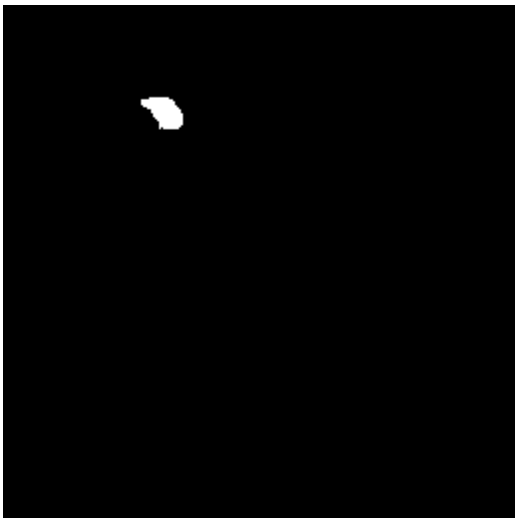
Segmentation Masks:

Detections:

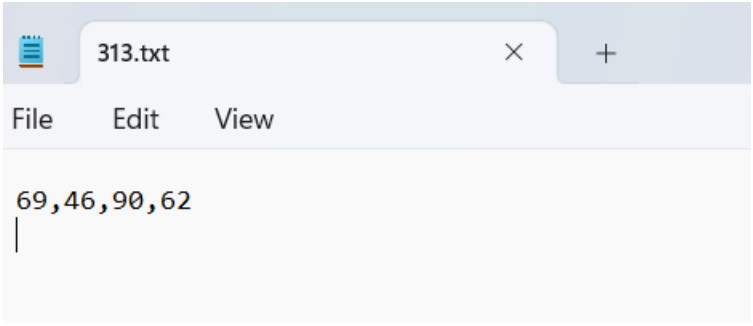


- The mask for the image ‘train/images/subject0/313.png’ can be found at ‘train/masks/subject0/313.png’



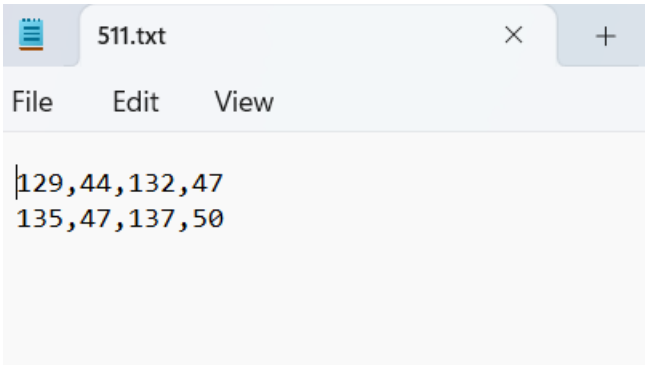


- The detections for the same image would be found in ‘train/detections/subject0/313.txt’ if there is a tumor in the image. If the image has no tumor, then it will not have a detections file.
- The detection file will look like this:

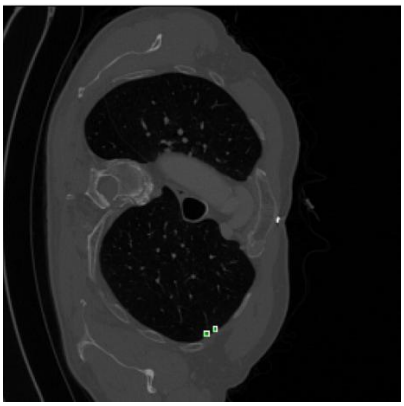


The four values represent: ‘xmin, ymin, xmax, ymax’ respectively

Some files will have more than one line. This means that there are two fragments of the tumor



The two lines represent two detections in the same image



Practical Exam Project Deliverables:

1. Apply and train an object detection model. You can use Faster RCNN or YOLO or any preferred deep learning model for object detection. (Deliver Code).
2. Apply and train a deep learning segmentation model on the tumor segmentation task taking the full images as input.
3. Apply a segmentation module on the tumor segmentation task taking the cropped detection as input.
4. Run the valid set on each model to acquire the validation performance and decide which technique is the best from 2 and 3.
5. If you trained the deep learning models using a notebook, you must deliver the notebook with the output cell saved displaying the training logs. If you trained the model using IDE (i.e Pycharm). **You must deliver screenshots of the training process**.
6. You will be given new samples on the practical exam day. **You should prepare test scripts such that**:
   - It takes an image and passes it to the object detection model and outputs the bounding box coordinates.
   - The image should be sent to the chosen segmentation model to generate the segmentation mask (cropped or full mode based on what you chose).
   - Visualize the output from both stages.
   - Save a PDF file that has information about the existence/non-existence of tumor, its location, size and number of fragments.
7. A Report that includes description of:
   - Your data preparation process and brief description of the models and techniques used in each task.
   - Training and valid performance metrics for all three models (object detection, segmentation on full image and segmentation on cropped detection).
   - Provide screenshots of the validation set results in both phases (detection and segmentation)