STUDENT INTERNSHIP

Topic: Proposition of automatic tumor detection framework
Duration: 3 to 6 months start on February
Location: Oncodesign HQ – Dijon
Benefits: Monthly indemnity + meal Ticket

Our Company

OPM is a technological company specialized in precision medicine. OPM's mission is to bring innovative therapeutic and diagnostic solutions to treat therapeutic resistance and metastasis evolution. The patient is at the center of our reflection, of our unique innovative model, and our investments. For OPM "our collective success is paramount", there can be no value creation without exchange, without dialogue. The value creation resulting for us from reciprocity, i.e. balanced and fair exchanges at all levels, whether between internal collaborators, or with our partners, therapists, patients, experts and investors.

Context

Standard of care hospital practice includes several exams to diagnose and follow up patient's cancer. One of the routine exams is the imaging, including radiology (CT, MRI) and/or nuclear medicine (PET, scintigraphy) scans. Those scans allow for the detection of internal anomalies (not visible on the surface) and their characterization. In the case of oncology, so-called anomalies are cancer cell mass that accumulates in a tissue to form the primary tumor. Those cells can propagate and migrate though the bloodstream into a new tissue to form metastasis.

Collected images can be used for (i) the evaluation of the patient's clinical outcome and (ii) fundamental research. In this master thesis proposal, we want to focus on the fundamental research of collected standard of care images from a clinical trial that is managed by OPM. This will involve image processing, including segmentation (i.e. the extraction of anatomical structures from images) of the primary tumor and/or metastasis.

Even if deep learning has achieved remarkable results in many computer vision tasks, deep neural networks typically need a large amount of training data to avoid overfitting. Unfortunately, in our case, labeled data for clinical applications are limited. By improving the quantity and diversity of training data, data augmentation algorithms [4] have become an inevitable part of deep learning model training with image data.

The aim of this internship is to study and implement automated segmentation methods of tumors, combining unsupervised and supervised approaches with label uncertainty for tumor detection and segmentation in volumes of CT data and/or MRI data in three specific pathologies (triple negative breast cancer (TNBC) [1], non-small cell lung cancer (NSCLC) [2], pancreatic ductal adenocarcinoma (PDAC) [3]). The methods implemented should allow to automatically perform metrology operations (localization of the tumor in the volume, quantification of the volume of tumors, ...) and propose a level of confidence in the measurements performed. Finally, algorithms of data augmentation should also be tested to study their impact on the prediction results.

The icing on the cake: Building models allowing the segmentation of the **vascularity** of the tumor

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Missions & activities of the internship

- State of the art: Identification of different automated segmentation methods (supervised/unsupervised) (bibliography)
- State of the art: Identification of data augmentation algorithms (bibliography)
- Recovery of imaging datasets (annotated)
- Implementation of the most relevant algorithms
- Test data augmentation process
- Evaluation of the proposed solutions

Student expected background/Knowledge

M2 or Engineer in Computer Science / Bioinformatics with the following technical skills, or strong interest in:

- Machine Learning/Deep Learning (Tensor Flow, etc.) applied to images
- Applied mathematics
- Statistical knowledges
- Python / R languages
- Knowledge of medical imaging and/or human anatomy and/or cancer is a plus!

Bibliography

[1] Guo, Ying-Ying et al. "Breast MRI Tumor Automatic Segmentation and Triple-Negative Breast Cancer Discrimination Algorithm Based on Deep Learning." *Computational and mathematical methods in medicine* vol. 2022 2541358. 31 Aug. 2022, doi:10.1155/2022/2541358

[2] Primakov, S.P., Ibrahim, A., van Timmeren, J.E. *et al.* Automated detection and segmentation of non-small cell lung cancer computed tomography images. *Nat Commun* **13**, 3423 (2022). https://doi.org/10.1038/s41467-022-30841-3

[3] Mahmoudi, T., Kouzahkanan, Z.M., Radmard, A.R. *et al.* Segmentation of pancreatic ductal adenocarcinoma (PDAC) and surrounding vessels in CT images using deep convolutional neural networks and texture descriptors. *Sci Rep* **12**, 3092 (2022). https://doi.org/10.1038/s41598-022-07111-9

[4] Chlap, P., Min, H., Vandenberg, N., Dowling, J., Holloway, L., & Haworth, A. (2021). *A review of medical image data augmentation techniques for deep learning applications. Journal of Medical Imaging and Radiation Oncology, 65(5), 545–563.* doi:10.1111/1754-9485.13261

How apply?

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