PhD offer

Longitudinal follow-up of liver metastases from colorectal cancer using artificial intelligence

The laboratory of medical information processing (LaTIM[1] UMR 1101, Inserm) is opening a PhD position on medical image analysis and longitudinal follow-up using artificial intelligence (AI).

Clinical context

The management of patients with colorectal cancer, second most common cause of cancer deaths, is a major public health issue [1]. Half of patients with colorectal cancer develop a distant recurrence. The liver, via the development of liver metastases, is the most common site of spread, accounting for 15-25% of patients at diagnosis and a further 18-25% within 5 years [2]. The objective is to find a management adapted to each patient by integrating individual (age, comorbidity, stage...), tumoral (number, size, position...) and collective data. With an estimated 5-year survival rate between 37% and 58%, liver resection consists of the complete removal of lesions, leaving at least 30% of the parenchyma. When surgery is not an option, the treatment regimen consists of palliative oncological treatments. Computed Tomography (CT) image analysis is a crucial step in assessing the response to chemotherapy treatments.

Most assessment methods are based on measures related to lesion size. In particular, RECIST criteria are the most commonly used morphological criteria [3]. New radiomic criteria exploiting homogeneity, contours, texture or density information from the main lesion have recently shown an early prognostic contribution for both assessment of treatment response and survival prediction [4]. However, these assessments require accurate delineation of liver metastases. This task is time consuming and subject to high intra- and inter-expert variability. Furthermore, the contribution of medical image analysis represents a key prospect for improving, automating and predicting the therapeutic follow-up.

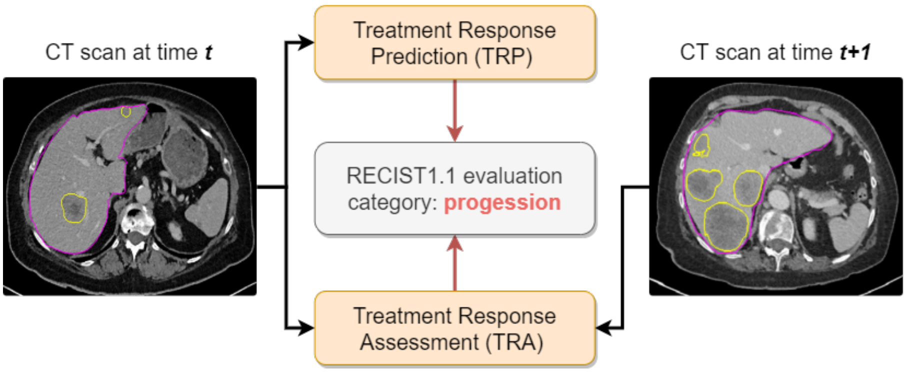

FIGURE 1 – Treatment response assessment and prediction. Liver and liver metastases are respectively with pink and yellow boundaries.

Main objective

We hypothezise that the development of AI-based tools dedicated to the characterization and the prediction of pathological tissue evolution, in relation to the selected therapy, can greatly guide clinicians in their decision making. In this context, we aim at developing deep learning (DL) methods able to characterize and predict the evolution of pathological liver tissues from follow-up CT scans (Fig.1).

Description of work

The thesis will be structured in 3 main steps : 1- segmentation of liver lesions from CT images, 2- automatic evaluation of the response to chemotherapy and 3- prediction of the pathological evolution using DL.

1. Laboratoire de Traitement de l'Information Médicale, `http://latim.univ-brest.fr/`

1. Based on our expertise in abdominal image segmentation [5], we will first develop a DL segmentation model combining convolutional networks and Transformers [6] to achieve automatic, reliable and reproducible delineation of liver and liver metastases visible from baseline and follow-up CT scans.
2. These delineations will then allow an automated measurement of the metastatic progression over time in order to provide the response to chemotherapy without interaction. This will improve patient management by standardizing the RECIST assessment [3] (which often differs between radiologists) and studying other parameters to refine the treatment response evaluation.
3. We will finally try to extract typical patterns of pathology evolution to optimize the therapeutic follow-up of patients. Beyond the RECIST evaluation [3], the objective will be to find early markers of response to chemotherapy and progression-free survival. Our contributions will support the development of a patient-specific chemotherapy regimen recommendation system.

More generally, the research lines will aim at providing decision support tools in oncology to guide clinicians in the therapeutic management of colorectal cancer patients with liver metastases. The work will benefit from the availability of databases collected at CHRU Brest as well as data obtained through the French Federation of Digestive Oncology (FFCD[2]) and arising from PRODIGE clinical trials [7].

Environment

The PhD student will be hosted in LaTIM. Born from the complementarity between health and communication sciences, the LaTIM laboratory develops a multi-disciplinary research driven by members from IMT Atlantique[3], CHRU Brest, University of Western Brittany and Inserm.

- advisors : P.-H. Conze (IMT Atlantique, LaTIM) and B. Badic (CHRU Brest, LaTIM)
- postal address : IBRBS, 22 avenue Camille Desmoulins, 29200 Brest, France
- gross salary ≈1975 €/month

Applications

Applications should be sent by e-mail to `pierre-henri.conze@imt-atlantique.fr` with the following documents :

- a full curriculum vitæ
- recommendation letter(s) from former teacher(s)/advisor(s)
- a cover letter stating your motivation and fit for this project
- grades obtained in M2 and/or engineering school

The following skills are required : strong theoretical/practical knowledge in applied mathematics, image processing, machine/deep learning, Python programming, organizational skills, fluent English for reading/writing scientific articles, interest in the fields of health and AI.

Hard deadline for application : **May 30, 2022**

Bibliography

[1] A. Kow, "Hepatic metastasis from colorectal cancer," *Journal of Gastrointestinal Oncology*, 2019.

[2] Y. van Gestel *et al.*, "Patterns of metachronous metastases after curative treatment of colorectal cancer," *Cancer Epidemiology*, 2014.

[3] E. Eisenhauer *et al.*, "New response evaluation criteria in solid tumours : revised RECIST guideline (version 1.1)," *European Journal of Cancer*, 2009.

[4] A. Dohan *et al.*, "Early evaluation using a radiomic signature of unresectable hepatic metastases to predict outcome in patients with colorectal cancer treated with FOLFIRI and bevacizumab," *GUT*, 2020.

[5] P.-H. Conze *et al.*, "Abdominal multi-organ segmentation with cascaded convolutional and adversarial deep networks," *Artificial Intelligence in Medicine*, 2021.

[6] J. Chen *et al.*, "TransUNet : Transformers make strong encoders for medical image segmentation," *arXiv preprint arXiv :2102.04306*, 2021.

[7] T. Aparicio *et al.*, "Geriatric analysis from PRODIGE 20 randomized phase II trial evaluating bevacizumab+ chemotherapy versus chemotherapy alone in older patients with untreated metastatic colorectal cancer," *European Journal of Cancer*, 2018.

2. `https://www.ffcd.fr/`
3. `https://www.imt-atlantique.fr/`