Offer for a PhD preparation

Potential of large language models and vision-language models in nuclear medicine
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Background

Large language models (LLMs) are artificial intelligence systems designed to understand and generate human-like texts. Vision-language models (VLMs), on the other hand, can analyze both text and images, for example, to caption images, or answer questions about images. These models have been trained on massive datasets containing various texts and/or images from the Internet, books, articles and other sources. LLMs and VLMs are already performing remarkably well in natural language and image processing. They enable the generation of coherent, contextually relevant text, and are now proving invaluable tools for a wide range of applications, such as content creation and conversational artificial intelligence. In medical imaging, many foundation models already exist (https://arxiv.org/pdf/2310.18689), but their use has not yet been widely explored in the context of positron emission tomography coupled with computed tomography (PET/CT).

Objectives

The aim of the thesis will be to identify highly relevant and original uses of LLMs, VLMs and foundation models in the context of the analysis of positron emission tomography coupled with computed tomography (PET/CT) scans performed in the field of oncology, based on the large databases available in the laboratory and in public repositories.

Methods

1) Using LLMs to analyze texts and automatically calculate the METRICS score

We have already successfully explored the use of LLM to analyze scientific publications (1). Based on very encouraging results, and after optimizing the publication screening pipeline, the aim is to perform a large-scale study to draw lessons from 10 years of radiomic analysis in PET imaging. For over 10 years, numerous teams have been carrying out radiomic studies, which involve extracting a large number of sophisticated numerical features from images, and designing radiomic models using these features to solve a classification or prediction problem. As a result, thousands of new radiomic features have been studied, and several hundred publications (referred to below as radiomic publications) have been produced. However, no sophisticated radiomic model has yet been transferred to the clinic because of lack of sufficient validation. A large-scale analysis of radiomic publications, to draw clear conclusions and identify the characteristics that are truly informative, therefore seems necessary. It would be all the more relevant as we have concomitantly taken part in the design of a score, METRICS (2), enabling the quality of studies to be assessed according to a large number of criteria. The automatic calculation of the METRICS score by LLM is conceivable, which would make it possible to integrate a weight associated with the quality of published studies into an automated bibliographic analysis. The aim will therefore be to 1) finalize an LLM-based pipeline for analyzing radiomic literature and automatically assigning a METRICS score to articles, 2) make the automatic METRICS score calculation tool available, 3) identify the most reliable and relevant innovative radiomic features, based on the level of published evidence, so that these can be studied further.

2) Using VLMs to analyze PET/CT images

In the laboratory, we have several hundred annotated PET/CT images, i.e. images enriched with information on the pathology, location and nature of abnormalities. In addition to these images, we have access to a large number of public databases already at least partially annotated (at least the type of cancer is known). We will therefore study whether the synthetic representation of 3D images

that we have already validated (3), combined with existing annotations and available reports, can be used to train a VLM capable of providing a textual description of the image (eg, location of tumor foci, type of cancer). In particular, we will study the impact of the information given as input to the model (digital biomarker values, images, simplified image representation, combination of different types of information) on the accuracy and completeness of textual descriptions.

Logistics

Supervision will be provided jointly by Fanny Orlhac (CR Inserm) and Irène Buvat (DR CNRS), in partnership with a company expert in the AI field.
The workplace is the Institut Curie's Laboratory of Translational Imaging in Oncology, Building 101B, rue de la Chaufferie, Orsay.
The student will take part in weekly team meetings and will be integrated into the laboratory's radiomics team, in which a dozen master's students, PhD students, post-docs and research engineers are developing and exploiting AI methods for the analysis of medical signals and images.

Contact

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References

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