Combining visual and textual information for enhancing pathologic case retrieval systems in radiological practices

Master internship

General information

- Keywords : medical imaging, computer vision, content-based image retrieval, deep learning, fusion of image and text, MRI
- Duration : 6 months (standard stipend). To start between February and April 2022.
- Institutes : Université de Paris, Laboratoire d'Informatique Paris Descartes (LIPADE), et Hôpital Européen Georges-Pompidou (HEGP)
- Location : 45 rue des Saints-Pères, 75006 Paris (LIPADE)
- Supervision : Florence Cloppet, Camille Kurtz, Laure Fournier (first.lastname@u-paris.fr)
- Application : Please send a cover letter and a CV to Florence Cloppet with Camille Kurtz in cc. The position is opened until filled.

Proposed topic

Motivation

The field of diagnostic imaging in Radiology has experienced tremendous growth both in terms of technological development (with new modalities such as MRI, PET-CT, etc.) and market expansion. This leads to an exponential increase in the production of imaging data, moving the diagnostic imaging task in a big data challenge. However, the production of a large amount of data does not automatically allow the real exploitation of its intrinsic value for healthcare. In modern hospitals, all imaging data acquired during clinical routines are stored in a picture archiving and communication system (PACS). A PACS is a medical imaging technology providing economical storage and convenient access to images from multiple modalities. Digital images linked to patient examinations are often accompanied by a medical report in text format, summarizing the radiologist's report and the clinical data associated with the patient (age, sex, medical history, report of previous examinations, etc.). The problem with PACS systems is that they were primarily designed for archival purposes and not for image retrieval exploitation. They therefore only allow a search by keywords (name of the patient, date of the examination, type of examination, etc.) and not by pathologies or by content of the image, and they cannot therefore fulfill the function of diagnostic aid when the doctor is confronted with an image of difficult interpretation or of rare pathology. The objective of this internship is to combine current research in computer vision and AI to implement a method making it possible to query PACS through example images in order to search for images containing similar pathological cases and to benefit radiologists as a potential decision-making aid during hospital routines.

Background and state of the art

In this context, research is being carried out by LIPADE and the Radiology department of the HEGP (Hôpital Européen Georges Pompidou), to propose different approaches to improve these

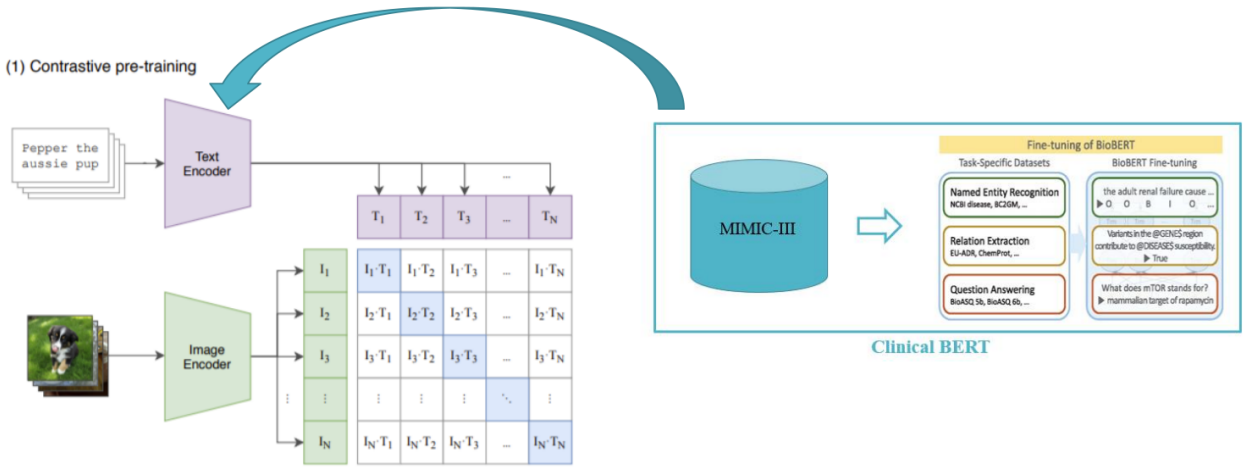

Figure 1 – Towards Clinical CLIP. Contributions : Architecture improvements for a clinical application and training on the ROCO dataset.

image search systems. The first is the integration of higher-level image descriptors such as annotations / semantic terms in these processes [KUR14]. These terms can be used to describe a significant amount of information about the visual content of images and are directly related to the high-level understanding of the content of images. Some semantic terms can also be automatically predicted from the visual content of the image or regions of interest. The second approach consists in integrating relevance feedback mechanisms [KUR2015], approaches which take into account the validation or not of radiologists on the images found by the system to improve performance. The scientific work resulting from this collaboration has shown the potential of content-based image retrieval (CBIR) systems for the field of Radiology, however they remain at the stage of academic research for the moment. To allow this research to be disseminated and to benefit radiologists as a potential decision-making aid, it is now necessary to integrate it directly into the hospital routine tools by combining all the information contained in PACS used on a daily basis by the experts when novel studying pathological cases.

Proposed work and implementation

Contributions of the work to the state-of-the-art Historically, searches were carried out by keywords, and then extended to the search by the example where one wishes to find images visually similar to an example given in image query. To do this, the images are described by their visual characteristics (e.g. gray levels, texture) deduced directly from their pixels and / or from regions of interest delimited in the images. A distance measure is used to find similar images in feature space. Nowadays, state-of-the-art approaches related to most of the sub-tasks underlying to CBIR are based on deep learning approaches [QAY17]. They led to promising results both for textual radiological report mining and for visual image search. In practice, these two data sources are extremely complementary (for example taking into account a priori that a patient is a smoker in order to search for similar lung scans) but their combination within the framework of a CBIR process remains complex since these data are not structured in the same way. In a previous Master project (funded by diiP in 2021), we have shown that it was possible to learn efficiently discriminant visual representations of medical images from text supervision. In particular, we were able to achieve such results by adapting the CLIP framework (based on a contrastive learning that uses positive pairs of image and text [LEK20]), initially proposed for natural images, to the medical / clinical domain [SER21] (Figure 1). In this project, we aim to investigate the extension of this method to pathological case retrieval, in order to take into account multi-parametric or multi-modal image queries in the retrieval. The query will no longer consist of a single image, but of sets of images

representing the same clinical case.

Considered data We will work on a database of ovarian masses developed by HEGP allowing retrospective studies on patient cohorts and databases for education. These IRM data will be used here to validate a first use case of the system developed by the LIPADE. The patients have given their consent and regulatory procedures are underway for the reuse of this data in this research project. The images are already annotated. Methods will be also evaluated on public data sets (ROCO, CheXpert, MedICaT) and the MICCAI Brain Tumor Segmentation (BraTS) Challenge 2021.

Program of the internship The intern will start by preparing the data (images, metadata, and ground-truth) and by choosing precisely the radiological reports, with the help of the Radiology department of HEGP. The approach will be based on the use of Variational Autoencoders to find shared latent space for multimodal or multiparametric data.

Desired background

We are looking for a student in Master 2 or engineering school in computer science. The ideal candidate would have knowledge in image processing, computer vision, machine learning and Python programming and an interest in handling large amount of data, and medical imaging.

References

KUR14 Kurtz, C., Depeursinge, A., Napel, S., Beaulieu, C. and Rubin, D. (2014) On combining image-based and ontological semantic dissimilarities for medical image retrieval applications, Medical Image Analysis, 18(7) :1082-1100, Elsevier.

KUR15 Kurtz, C., Idoux, P., Thangali, A., Cloppet, F., Beaulieu, C. and Rubin, D. (2015) Semantic retrieval of radiological images with relevance feedback, In Proceedings of the Multimodal Retrieval in the Medical Domain workshop – MRMD 2015, 9059 :11-25, Springer.

QAY17 Adnan Qayyum, Syed Muhammad Anwar, Muhammad Awais, Muhammad Majid, Medical image retrieval using deep convolutional neural network, Neurocomputing, Volume 266, 2017, Pages 8-20

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