Master student internship at CREATIS lab

Self-supervised deep learning to improve thoracic CT-scan embedding

Laboratory: CREATIS CNRS 5220, INSERM U1294 (MYRIAD Team), 69621 Villeurbanne, France
Supervisors: Ludmilla Penarrubia – Emmanuel Roux – Maciej Orkisz
Keywords: Deep Learning, Self-supervision, Medical Imaging, Lung diseases
Duration: 5-6 months.
Starting date: february/march 2022.
Internship grant: $\sim$ 560 euros/month

1 Scientific context

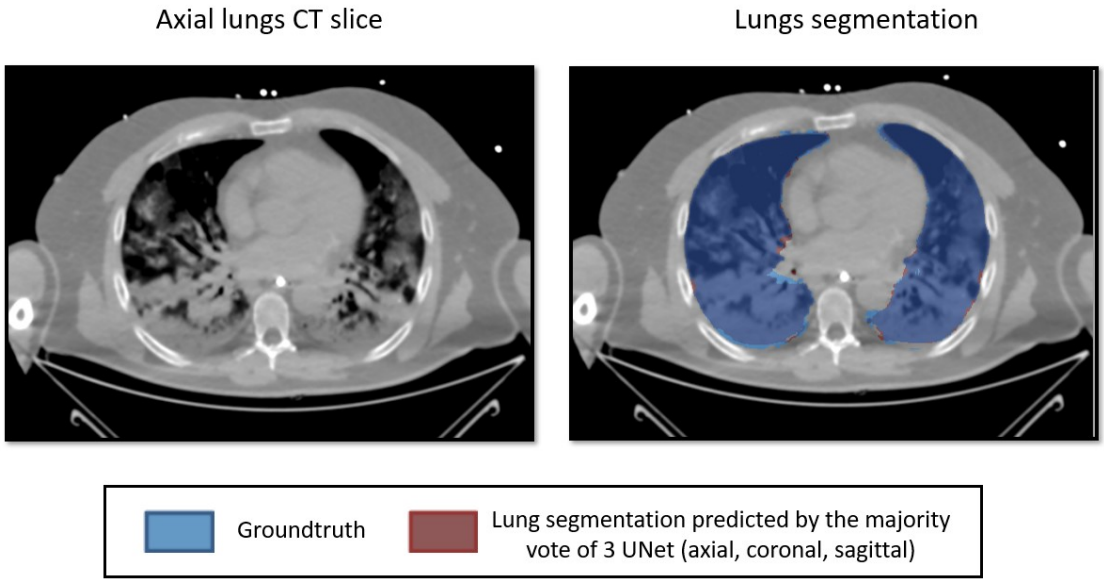

Figure 1: Current lung segmentation results obtained on CT-scans from pathological patients.

Deep learning techniques are achieving impressive performance in many medical applications (e.g., image reconstruction, lesion segmentation or patient diagnosis) and CREATIS has an intense activity in developing novel deep/machine learning methods for medical image processing and analysis.
The proposed MASTER project will take place within the **Computational Lung working group** (MYRIAD team) which focuses on the acute respiratory distress syndrome (ARDS) to help intensive care clinicians by using **computed tomography (CT) acquired at different respiratory conditions** (e.g., end-inhale and end-exhale). Indeed, changes between CT scans can be used to assess such phenomena as alveolar recruitment or cyclic hyperinflation. The question that we raise is whether (or not) a **novel self-supervised training strategy based on both end-inhale and end-exhale images** can improve CT-lung image analysis (segmentation or registration) compared to using only one respiratory condition (i.e., improving the latent space embedding by taking advantage of having a pair of images).

2 Objective of the internship

- The objective of this master project is to enhance the **encoding of thoracic CT-scans** by developping a novel **self-supervised deep representation** [1] based on a dual respiratory CT imaging of the patient.
- The candidate will **train deep models** on several hundreds of thoracic CT-scans gathered from several databases among them the COVID database acquired in CREATIS during last year (REF).
- The developed deep models and self-supervised strategies will be specifically designed to handle the challenging specificity of having **high dimensional 3-D medical data** and data of the same patient acquired at several respiratory phases.
- Finally, the **comparison between several self-supervised approaches** will yield the best pretraining strategy to improve the performance of several deep models dedicated to CT-lungs analysis (segmentation, registration, ...).

3 Skills

The candidate should have strong background either in **deep learning** and some experience in **image processing** or vice-versa, as well as **good programming skills** (Python, PyTorch). We are looking for an enthusiastic and autonomous student with strong motivation and interest in multidisciplinary research (image processing and machine learning in a **medical context**). The candidate will have the opportunity to interact with a PhD student working within the Computational Lung working group.

References

[1] M. Caron, H. Touvron, I. Misra, H. Jégou, J. Mairal, P. Bojanowski, and A. Joulin. Emerging properties in self-supervised vision transformers. In *Proceedings of the International Conference on Computer Vision (ICCV)*, 2021.

V. Agarwal et al., "Weakly Supervised Lesion Co-Segmentation on CT Scans", in IEEE 17th International Symposium on Biomedical Imaging (ISBI), 2020, doi : 10.1109/ISBI45749.2020.9098657

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