Master internship: Self-supervised Learning for SPECT reconstruction

1 Context

Radiopharmaceutical Therapy (RPT), such as ^{177}Lu-PSMA for castration-resistant prostate cancer, has grown rapidly in recent years [1], [2]. Personalized dosimetry is essential to maximize tumor control while minimizing the risk to healthy organs. This process relies on SPECT/CT imaging to estimate patient-specific pharmacokinetics of radiopharmaceuticals. However, image quality is degraded by factors such as attenuation and scatter [3], [4], [5]. To reconstruct these images accurately, numerous methods have been proposed over the years, ranging from classical iterative algorithms such as MLEM/OSEM [6] and their regularized variants [7] to recent deep learning approaches [8].

Supervised deep learning methods, although promising, rely on ground truth data for training, which is unavailable in SPECT imaging. To overcome this limitation, we aim to investigate self-supervised learning strategies. Recently some proposition has been made in PET imaging, another emission tomography modality [9].

2 Objective

The internship will focus on developing and validating self-supervised algorithms for SPECT image reconstruction. The intern will begin with a state-of-the-art review of self-supervised methods in emission tomography. Subsequently, these algorithms will be implemented and applied to SPECT imaging, and their performance will be compared against classical iterative and supervised approaches. Reconstructions will be carried out using Pytomography [10] and PyTorch. The main tasks are:

- Conducting a state-of-the-art review of self-supervised learning methods in emission tomography based on [9].
- Adapt the algorithm of [9] from PET to SPECT
- Validating and comparing these methods with iterative and supervised algorithms already developed in the team

3 Environment

The student will joined the TOMORADIO team and work in a multidisciplinary team of nuclear physicians, medical physicists, researchers, and computer scientists of CREATIS laboratory in the Leon-Bérard Cancer Center.

4 Expected skills and other information

- **Expected skills:** deep learning, medical physics, image processing
- **Technical skills:** Python is required, experience with Pytorch (or Tensorflow) is a strong asset.
- English or French
- Location: Léon Bérard cancer center, Lyon, France

Supervisors:

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5 Application

Interested applicants are required to send a cover letter, CV and any other relevant documents (reference letter, recent transcripts of marks, ...) to david.sarrut@creatis.insa-lyon.fr, ane.etxebeste@creatis.insa-lyon.fr and corentin.constanza@creatis.insa-lyon.fr.

References

[1] O. Sartor et al., "Lutetium-177–PSMA-617for metastatic castration-resistant prostate cancer," *New England Journal of Medicine*, vol. 385, no. 12, pp. 1091–1103, 2021.

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[4] E. Hippeläinen et al., "Quantitative accuracy of 177Lu SPECT reconstruction using different compensation methods: Phantom and patient studies," *EJNMMI research*, vol. 6, no. 1, p. 16, 2016.

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[6] G. L. Zeng et al., "Three-dimensional iterative reconstruction algorithms with attenuation and geometric point response correction," *IEEE transactions on nuclear science*, vol. 38, no. 2, pp. 693–702, 1991.

[7] P. J. Green, "Bayesian reconstructions from emission tomography data using a modified EM algorithm," *IEEE transactions on medical imaging*, vol. 9, no. 1, pp. 84–93, 1990.

[8] T. Kaprélian et al., "Partial volume correction on 177 Lu-SPECT sinogram with deep learning trained on synthetic data," in *2024 IEEE Nuclear Science Symposium (NSS), Medical Imaging Conference (MIC) and Room Temperature Semiconductor Detector Conference (RTSD)*, IEEE, 2024, pp. 1–2.

[9] A. J. Reader, "Self-supervised and supervised deep learning for PET image reconstruction," in *AIP Conference Proceedings*, AIP Publishing LLC, vol. 3061, 2024, p. 030 003.

[10] L. A. Polson et al., "Pytomography: A python library for medical image reconstruction," *SoftwareX*, vol. 29, p. 102 020, 2025.