Early-stage stratification of Hodgkin lymphoma patients through the use of deep learning, molecular imaging and clinical data

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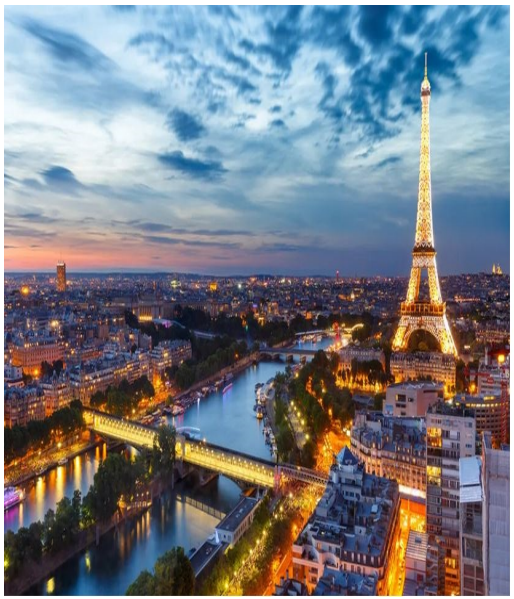
HOLY2020

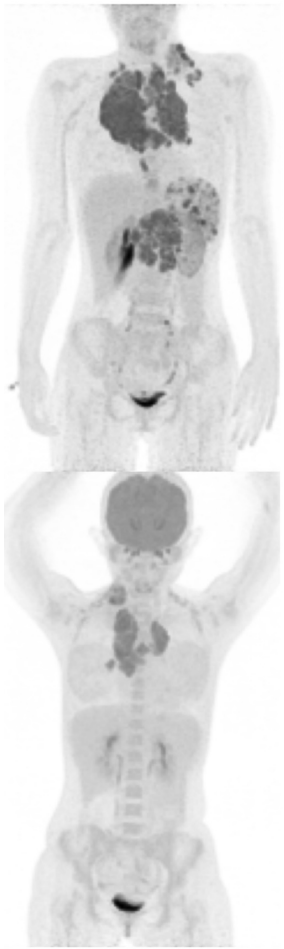
1. *Laboratoire d'Imagerie Translationnelle en Oncologie (LITO), Orsay, France*
2. *Hospital Sant Pau. Department of Nuclear Medicine, Barcelona, Spain*
3. *Medical University of Vienna, Department of Biomedical Imaging and Image-Guided Therapy, Vienna, Austria*



Images taken from the internet.

Background

Hodgkin lymphoma patients and treatment options



- Bimodal age range (between 20-24, and 75-79 years) with majority between 20-40 years
- Combination of chemotherapy and radiotherapy
- Long-term treatment-related complication remains a significant concern
- Avoid over-treatment with the risk of unnecessary toxicity without jeopardizing cure rates

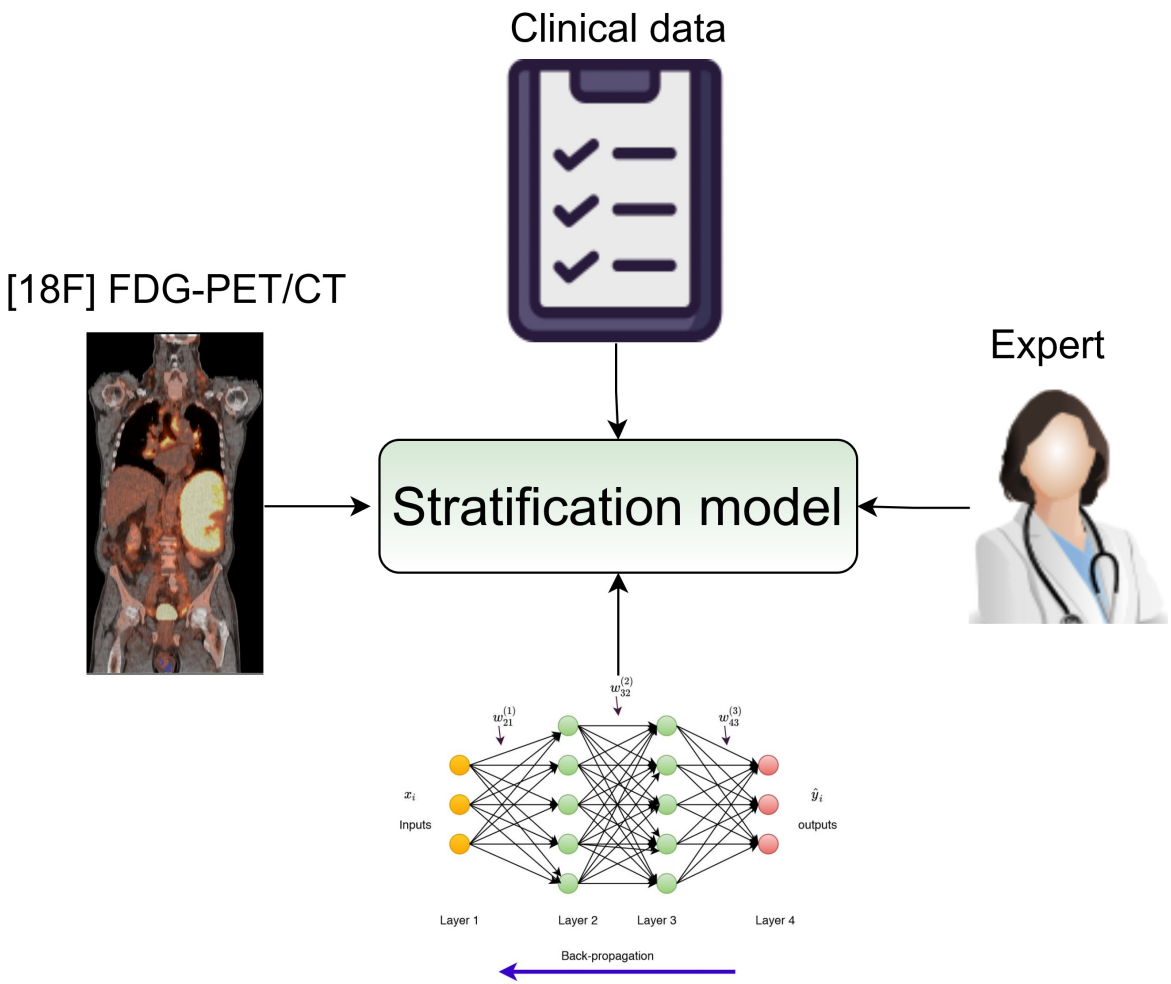
LITO

State-of-the-art

- International Prognostic Score (IPS) together with level of albumin, hemoglobin, white cell count, lymphocyte count, age, sex, and Ann Arbor classification are used for prognostic stratification
- The **current stratification options fail** to reliably identify patients with the need for radiotherapy
- For example, radiation therapy of the mediastinum significantly increases the risk of secondary malignancies such as breast cancer and are causing cardio-toxicity

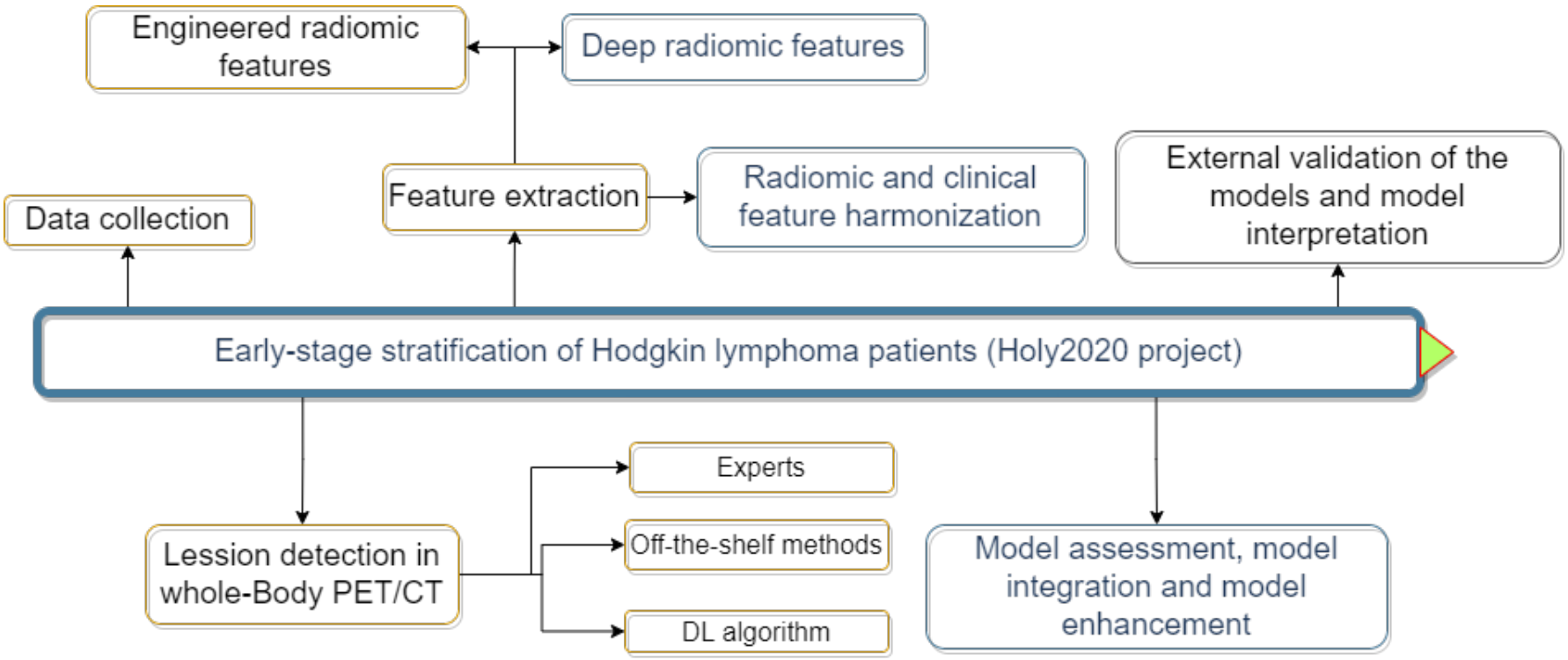
Hypothesis

- *Can we build an improved treatment stratification model using deep learning (DL), molecular imaging, and relevant clinical data?*

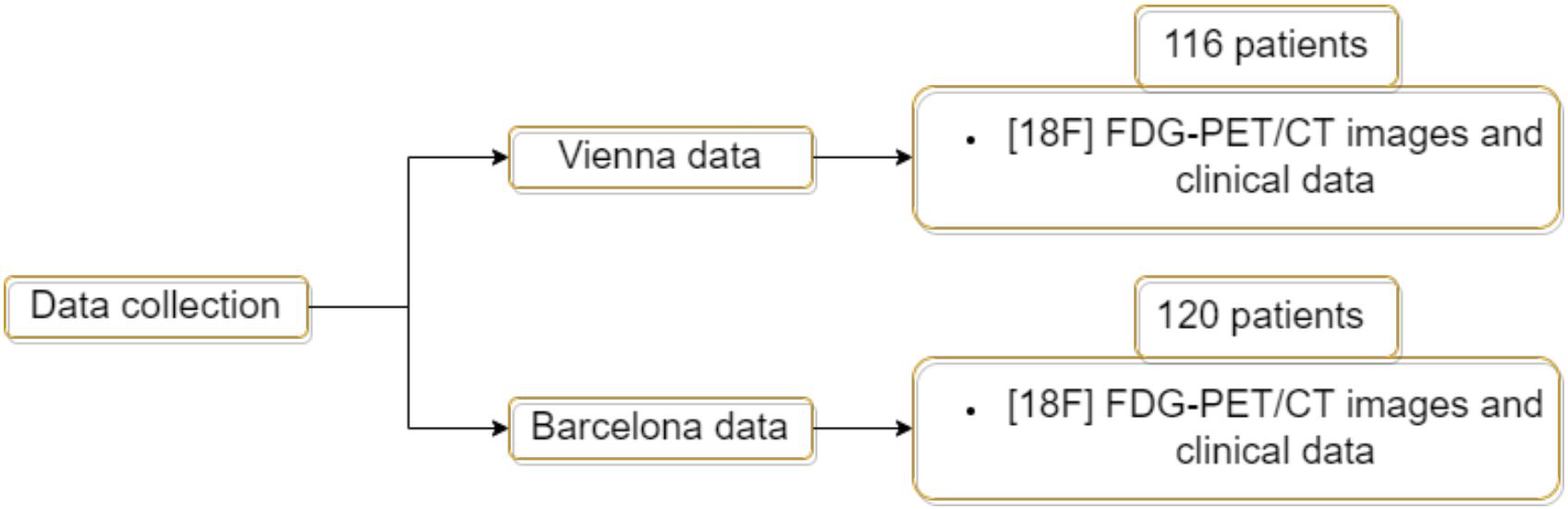


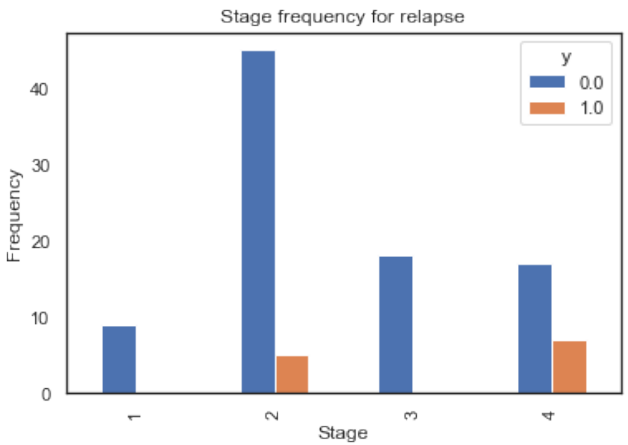
Objectives

- Identify patients with a high risk of relapse, towards personalized medicine

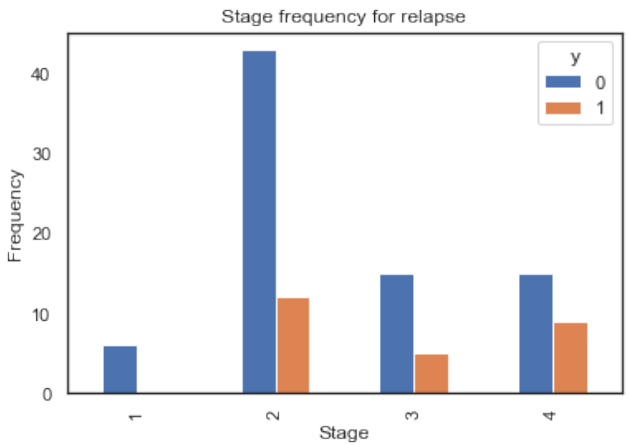


Data

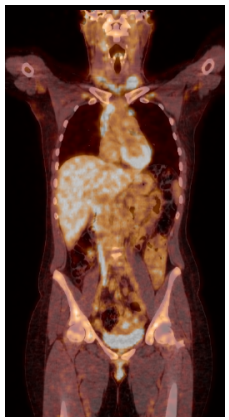




Vienna



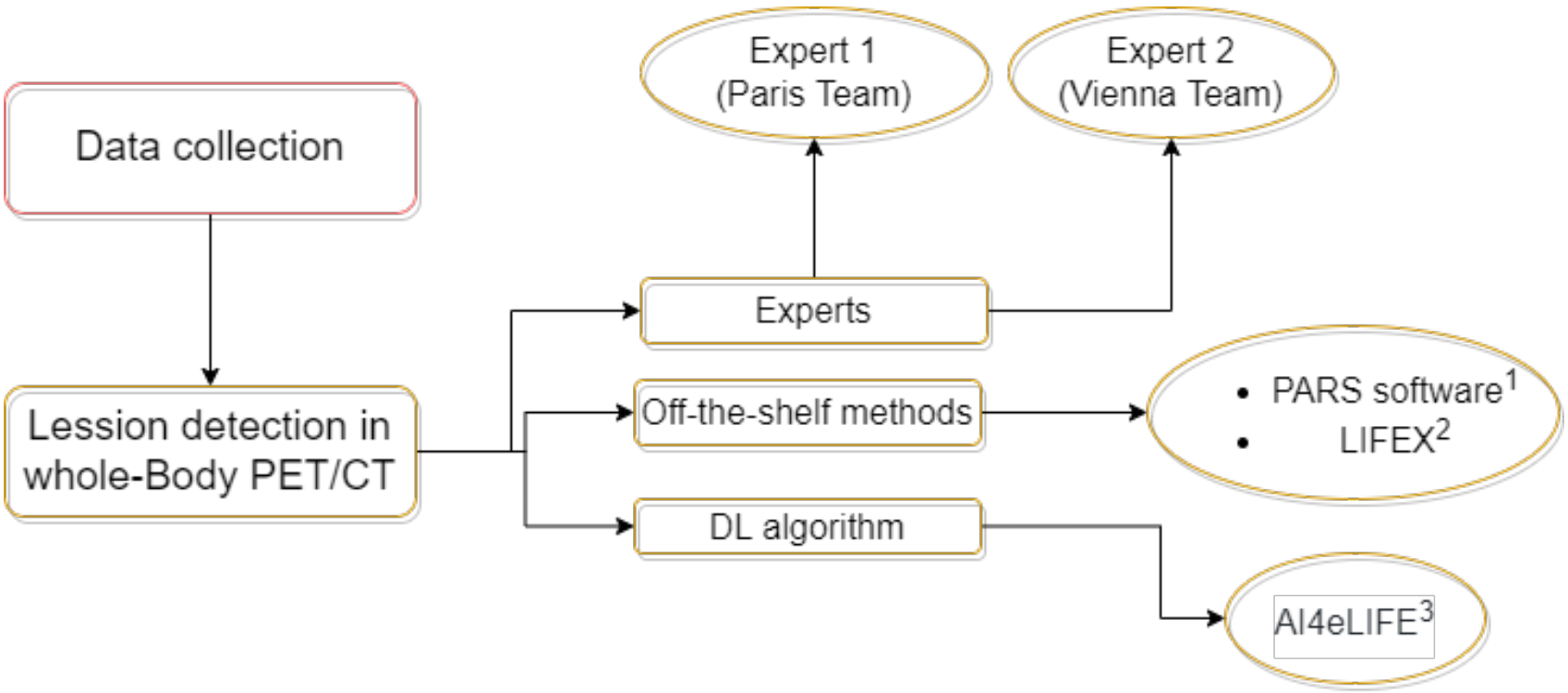
Barcelona



PET/CT

Highly imbalanced data: Vienna (10.3%) and Barcelona (22.5%) relapse.

Whole-body lesion segmentation

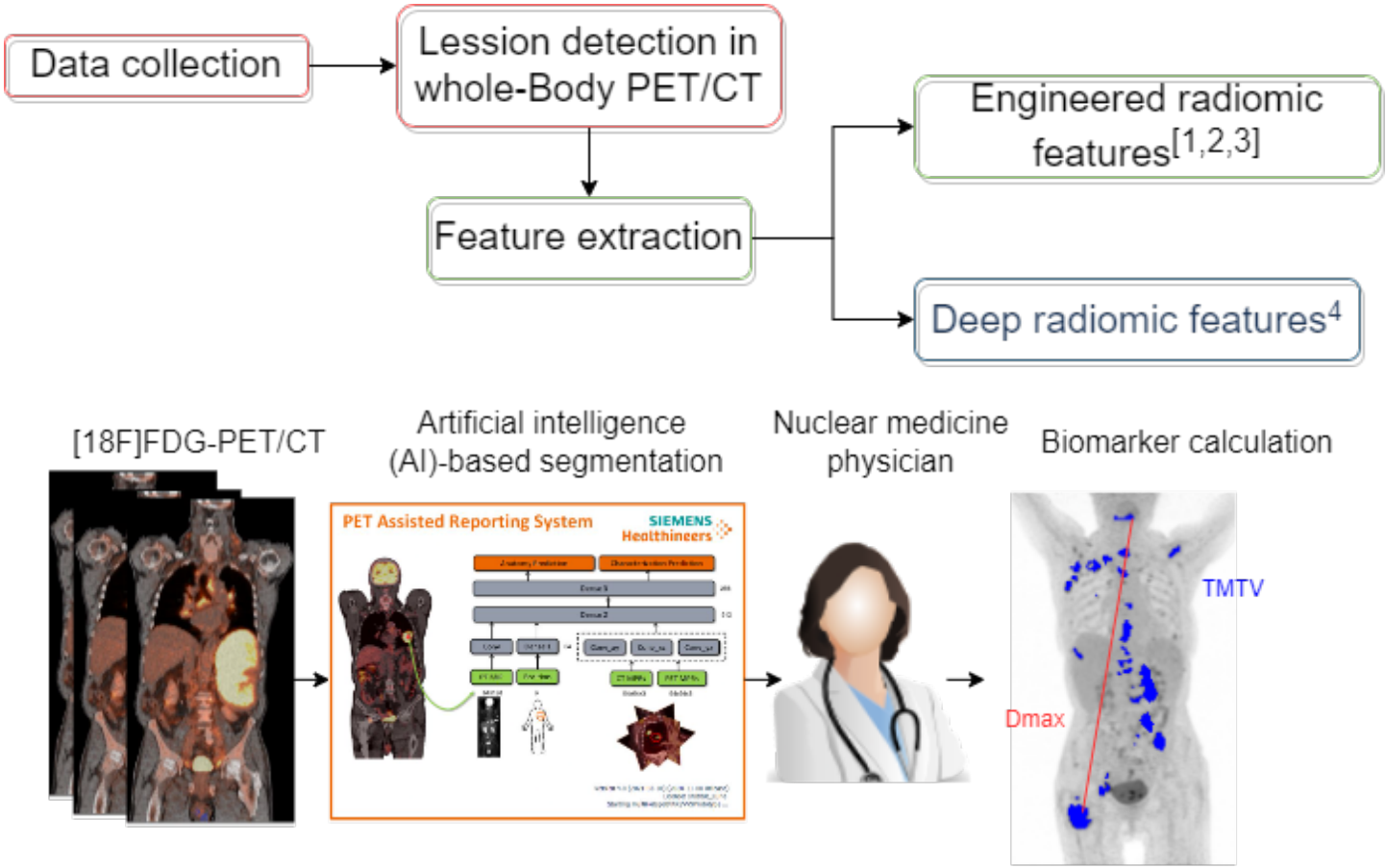


[1] Sibille L. et al. Radiology 2020

[2] Nioche CL. et al. Cancer Res. 2018

[3] Girum KB. et al. J. Nucl. Med. 2022

Biomarker calculation



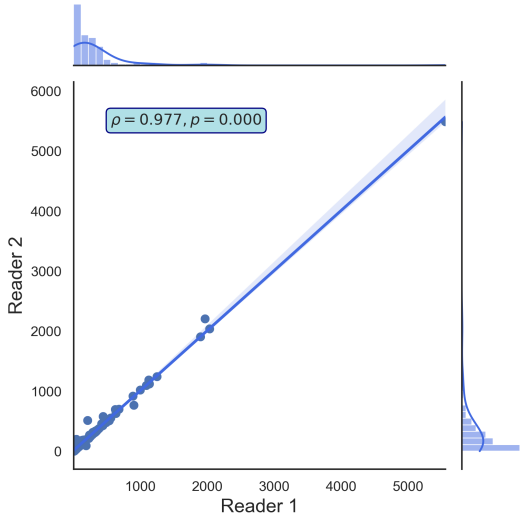
[1] Vercellino L. et al, Blood 2020

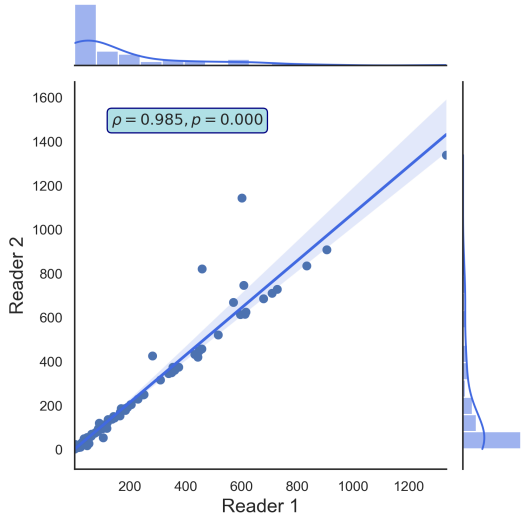
[2] Cottereau A-S,. et al, J Nucl Med 2020

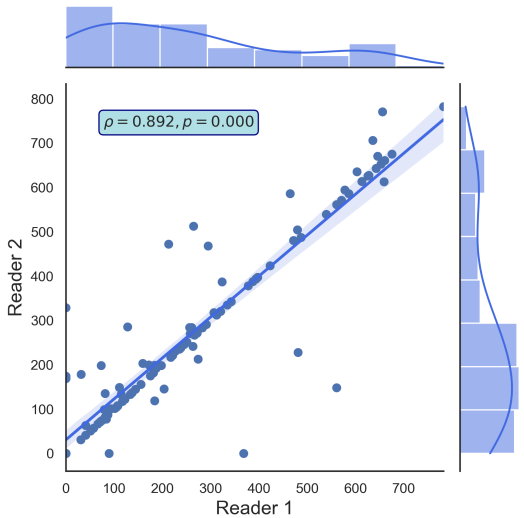
[3] Sibille L. et al. Radiology 2020

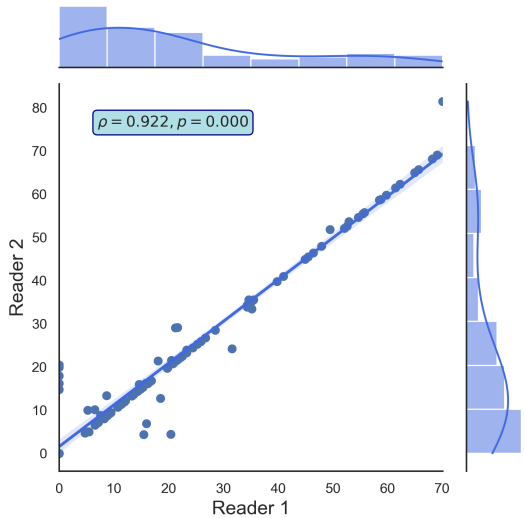
[1] Chen T. CL. et al. PMLR. 2020

Inter-operator variability: reader 1 & 2







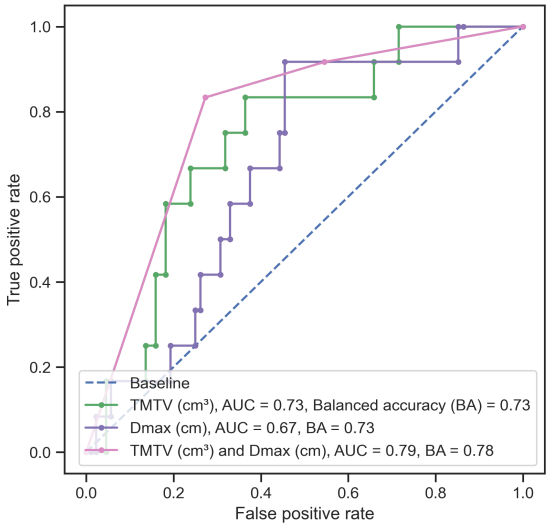


Vienna

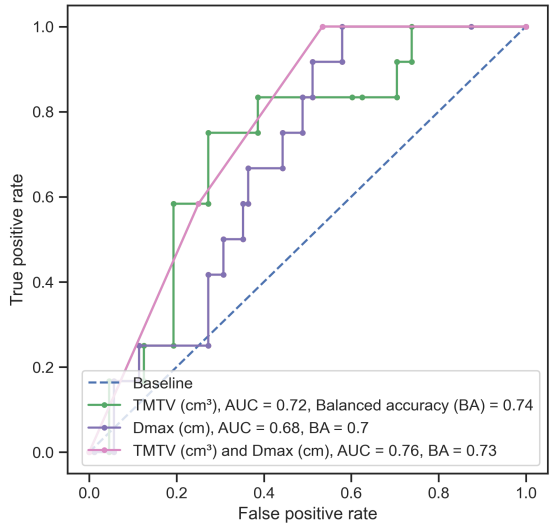
Barcelona

- 1st row: TMTV
- 2nd row: Dmax
- P< 0.05 (Dmax, P = 0.00958, and TMTV, P « 0.005): Vienna
- P< 0.05 (Dmax, P = 0.0285, and TMTV, P = 0.00279: Barcelona

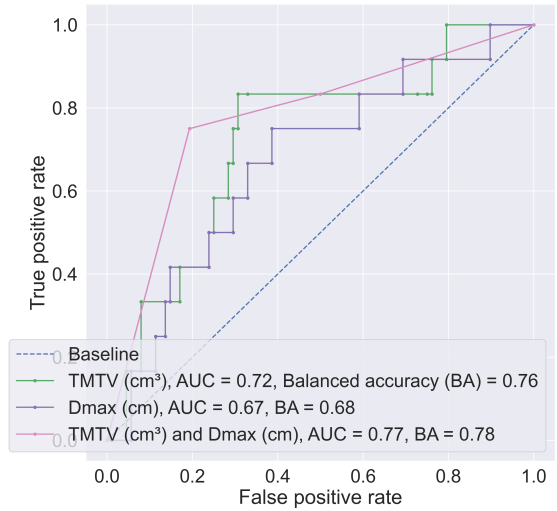
ROC AU: reader 1, 2, and MIP AI



reader 1



reader 2



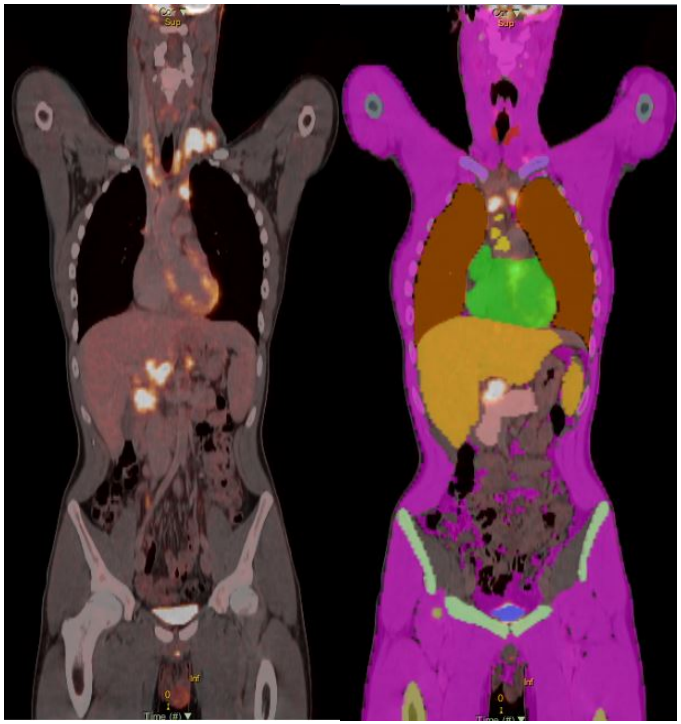
MIP-based AI [2]

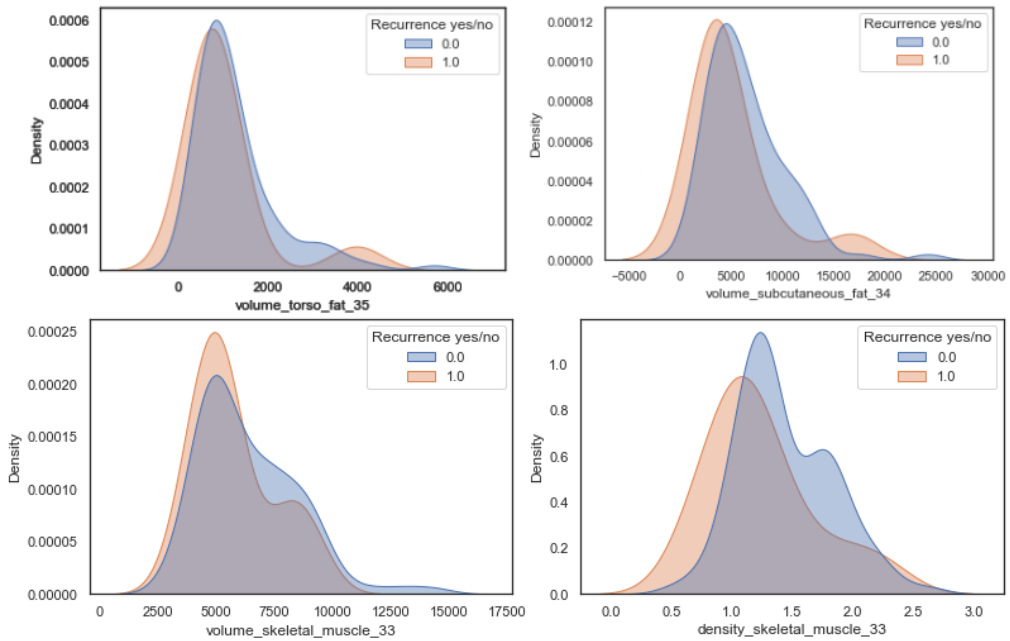
- Identification of patients with a high risk of relapse for Vienna data

[1] Girum KB. et al. J. Nucl. Med. (supplement 2). 2022

[2] https://github.com/KibromBerihu/ai4elife

Healthy tissues: MOOSE software





- Work in progress ...

[1] https://github.com/QIMP-Team/MOOSE

Future works

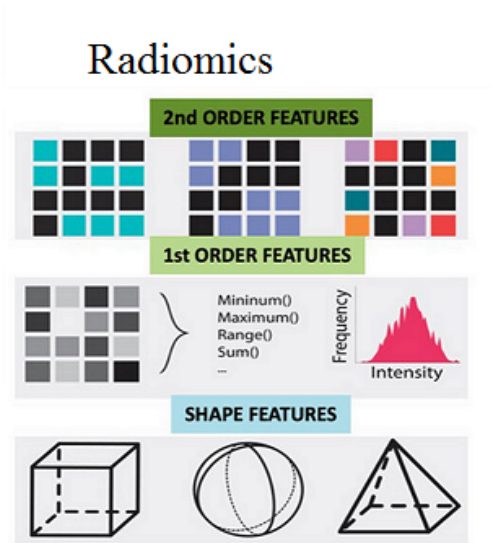
Tasks to do

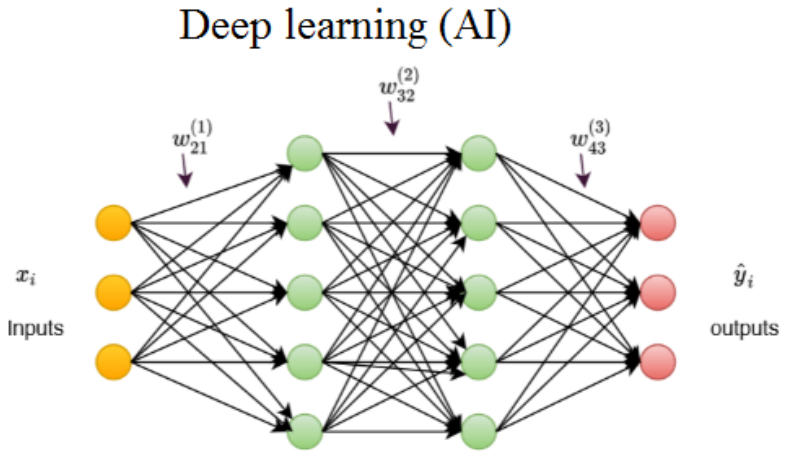
- Finalize and analyze engineered radiomic features efficacy in stratifying lymphoma patients
- Harmonize radiomic and clinical features

Future works

Tasks to do

- Continue to explore deep learning-based feature extraction from the whole-body PET/CT images[1]
- Model assessment, integration, and enhancement





[1] Chen T. CL. et al. PMLR. 2020

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