Deep learning and radiomics for prognostic models in lung cancer

Thesis Location: Laboratory of Medical Information Processing (LaTIM), French Institute of Health and Medical Research (INSERM UMR 1101), Brest, France (https://latim.univ-brest.fr/)

Period: 3 years, starting on September 2021

Context: Lung cancer is a frequent pathology whose therapeutic strategy has evolved in the last years with the new targeted therapies and immunotherapy. Despite this fact, its prognosis stays grim and lung cancer is the first death cause in cancer, which explains the numerous studies aiming to optimize therapeutic care, and the research of pertinent biomarkers to guide the therapeutic choices. Among these, radiotherapy is still a key element when the tumor is localized or even locally advanced. For these patients, multimodal imaging is determinant for the diagnosis, extension study, treatment planning and patient follow-up. The usually considered criteria are simple: size, density or intensity of the tumor lesion. Nowadays, the radiomics features [1] characterize multiple aspects of tumors via image intensity histograms, texture matrices or morphological descriptors. In total, thousands of radiomics features can be extracted and therefore, giving a biological interpretation to each feature and analyzing them separately is not anymore possible. The potential interest of radiomics has been extensively studied in lung cancer [2,3]. The new approaches based on machine learning have proved to be efficient in treating such a big number of parameters for a limited number of patients.

Objectives: The main aim of this project is to investigate a new fully automatic approach based on straightforward image usage bypassing the pre-treatment steps. For this, deep learning- and machine learning-based approaches will be compared in order to provide the most reliable models and clinically-friendly usage. To start, for machine learning, the following challenges will be addressed [4]: 1) pre-treatment and harmonization of data in order to make radiomics features comparable, 2) parameters selection and models construction, 3) choosing a global model design in order to limit over-fitting making models overly specific for the analyzed data and not generic for the external ones. For the deep-learning approach: 1) bypassing or making automatic the steps of the machine learning approach, and 2) making the outcome more clinically comprehensive [5]. We expect the results of this thesis to lead to the production of clinical models for a computer-guided patient management based on multimodal and multicentric images, from diagnosis and prognosis to treatment monitoring and assessment of therapies response.

Education: The candidate must hold a master's degree in physics, computer science, applied mathematics or equivalent and have a background in deep learning/machine learning and image analysis

Scientific Interests: Machine learning/deep learning, medical image analysis, interest in resolving clinical challenges

Programming Skills: Python, R, C/C++

Languages: English, French optional

Contact: Send before the 5th of May (at the latest) your CV, cover letter, grades/marks (Master, License/Bachelor) and a reference letter by e-mail to: visvikis@univ-brest.fr

References:

[1] Lambin, P., Rios-Velazquez, E., Leijenaar, R., Carvalho, S., Van Stiphout, R. G., Granton, P., ... & Aerts, H. J. (2012). Radiomics: extracting more information from medical images using advanced feature analysis. European journal of cancer, 48(4), 441-446.

[2] Sollini, M., Cozzi, L., Antunovic, L., Chiti, A., & Kirienko, M. (2017). PET Radiomics in NSCLC: state of the art and a proposal for harmonization of methodology. Scientific reports, 7(1), 1-15.

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[4] Visvikis, D., Le Rest, C. C., Jaouen, V., & Hatt, M. (2019). Artificial intelligence, machine (deep) learning and radio (geno) mics: definitions and nuclear medicine imaging applications. European journal of nuclear medicine and molecular imaging, 46(13), 2630-2637.

[5] Quellec et al. (2017). Deep image mining for diabetic retinopathy screening. Medical Image Analysis. 39, 178-193.