Weakly Supervised Prostate Cancer Score Prediction

1. General Info

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Outcome: The result of the project will potentially be published in MICCAI 2022.

2. Project Abstract

This project will delve into the prostate cancer prediction problem on MRI/PET data. The goal is to predict the Gleason score (which is derived using biopsies in clinical practice) for each 12 prostate regions. We will explore whether a model that is trained on malignant/benign labels on MRI data implicitly discovers the cancerous regions and their score. To this end, we will attribute the final prediction of our classifier to different regions of the input using feature attribution (aka saliency) methods[1][2]. We will compare the results of the previous steps with active regions in PET or marked regions by the radiologist and the Gleason score which is available from biopsies.

3. Background and Motivation

Prostate cancer is the most common cancer amongst men, with over 1.6 million new cases each year in the united states only. Currently, the standard of practice for the detection of cancer is through prostate biopsies. Usually, the urologist gets 12 samples from the prostate, one from each region. The pathology report from these samples shows if a tumor exists and how significant it is. The significance score is reported as the Gleason score, ranging from 0 (no cancer) to 5.
Researchers have attempted to train deep networks to address the problem of detecting significant prostate cancer based on the preoperative images, MR and PET [3, 4]. While the results are promising for cancer/no-cancer problems, the results for inferring the Gleason score for each region are still far from perfect. On the other hand, before the biopsies, a radiologist inspects the MR and marks suspicious areas in case the PET image is not available. In this project, the objective is to infer gleason scores from models trained on cancer/no-cancer problems (also taking advantage of marked suspicious areas).

4. Technical Prerequisites

- Background in deep learning
- Python and PyTorch skills

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[1] Zhou, Bolei, et al. "Learning deep features for discriminative localization." Proceedings of the IEEE conference on computer vision and pattern recognition. 2016.
[2] Khakzar, Ashkan, et al. "Explaining COVID-19 and Thoracic Pathology Model Predictions by Identifying Informative Input Features." arXiv preprint arXiv:2104.00411 (2021).
3 Aldoj, N., Lukas, S., Dewey, M. *et al.* Semi-automatic classification of prostate cancer on multi-parametric MR imaging using a multi-channel 3D convolutional neural network. *Eur Radiol* 30, 1243–1253 (2020). https://doi.org/10.1007/s00330-019-06417-z
4 Yuan, Yixuan, et al. "Prostate cancer classification with multiparametric MRI transfer learning model." Medical physics 46.2 (2019): 756-765.

5. Benefits:

- Working on an “actual” medical project which is clinically relevant
- Learning the data processing pipeline (in-house data from Klinikum Rechts der Isar)
- Getting familiar with Explainable AI
- Possibility of writing a scientific paper (MICCAI or MIDL)

6. Work packages and Time-plan:

	Description	#Students	From	To
WP1	Literature review on the application domain	Group 1	01.11	01.12
WP2	Literature review on explainability methods	Group 2	01.11	01.12
WP3	Implement the learning pipeline (data processing, model training)	Group 1	01.12	Intermediate Presentation
WP4	Apply the explanation methods to the trained models	Group 2	01.12	Intermediate Presentation
M1	Intermediate Presentation II	4		
WP5		4		
WP6		4		
WP7		4		
WP8	Prepare Final Documentation	4		
M2	Final Presentation	4		