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Medical School: University of Aberdeen

Topic of Elective: Exploring the utility of self-supervised learning in the analysis of multiplex immunofluorescence lung adenocarcinoma images

Department: Le Quesne group at Cancer Research UK Scotland Institute

My elective project aimed to explore the utility of a self-supervised deep learning model (SSDLM), which does not require expert pathologist labels, in identifying patterns used for clustering multiplex immunofluorescence (mIF) lung adenocarcinoma images. As antibodies targeting proteins representative of major cancer hallmarks (1–3) were used in the mIF imaging, the clusters represent groups of similar tissue areas in terms of both, morphology and hallmark expression. Next, we set out to outline and quantify the expression of the hallmarks in individual clusters. Thereafter, the clusters were linked to overall survival.

The SSDLM was able to learn patterns from the data and after clustering, we gained 26 unique clusters in terms of the morphology and hallmark expression without the need for annotations. These clusters can be thought of as an atlas, or a tool to navigate the complex patterns identified in our data by the SSDLM. Moreover, we quantified the hallmark expression for every cluster and mapped the hallmark signatures. Hence, we identified cellular neighbourhoods enriched or depleted in important protein markers and were able to gain insights into the complex interplay of tissue structure and the underlying molecular processes crucial for tumorigenesis.

Using our clusters to model overall survival in LUAD patients, we were able to identify 3 clusters with significant prognostic potential. Furthermore, we classified patient samples into low and high-risk groups based on the sample cluster composition. Interestingly, the cluster-based patient risk groups had statistically significant differences in overall survival. Lastly, our model achieved a concordance index of 0.56 in predicting survival on unseen data.

Given the use of self-supervised learning in the analysis of lung adenocarcinoma mIF imaging is largely unexplored, these results warrant further investigation, and the project will be continued by the Le Quesne group.

As such, this project has allowed me to improve my computational skills which, with the rise of artificial intelligence tools in histopathology research, are inevitably becoming a part of an essential skillset in the field. As a medical student with a keen interest in computational pathology, I have thoroughly enjoyed my project and feel inspired to continue deepening my understanding of the subject.

The elective project bursary has allowed me to pursue my interest and expand my knowledge of both computer science and histopathology. I am very grateful for this opportunity and honoured to have had a chance to participate in and contribute to cutting-edge research.

I would like to thank my supervisors, Professor John Le Quesne and Dr Kai Rakovic for their support and help throughout my project. Finally, I would like to thank the British Division of the International Academy of Pathology for the generous elective bursary, which has allowed me to pursue my elective project.

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