Histological diagnostic tool for detecting and characterising portal tracts in liver disease using Artificial Intelligence.

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Background: AI-driven digital workflows for liver biopsy grading and staging have the potential to produce more accurate and reproducible results than traditional assessments. In particular, the identification of Portal Tracts (PTs) in liver Whole Slide Images (WSIs) is important for the assessment of fibrosis, inflammation, and sample adequacy. However, this can be challenging due to variations in size, structure, and overall appearance which are further impacted by changes linked to disease severity. To address this, we developed an AI algorithm capable of determining the location, boundary, and other metrics of portal tracts.

Methods: A training dataset of 43 H&E WSIs from three clinical cohorts were annotated for PTs using QuPath by three expert pathologists. All annotated PTs included two of the three key features of PTs (hepatic artery, portal vein, bile duct), while discrepancies between experts were resolved through the generation of a consensus geometry. Tiles were extracted from each WSI and given a binary classification depending on the presence of a PT within each tile according to pathologist consensus. A ResNet50 classification model was then trained to predict the presence of PTs in each tile. We applied the classifier via a sliding window to WSIs to produce multiple estimates of the presence of a PT at each pixel, which were averaged to generate a probability heatmap for the presence of PTs across tissue regions (Figure 1). We applied hysteresis thresholding to heatmaps to create semantic segmentation masks of PT content for the assessment of model accuracy.

Results: Heatmaps provided a useful visual aid to the identification of PTs in unseen images. A ROC curve was generated for a validation set of six WSIs by applying a series of thresholds between 0-1, resulting in an AUC value of 0.92 and a balanced accuracy value of 0.87 at the optimised threshold. Quantitative performance of the model was assessed on a held-out test dataset of 12 WSIs with median precision, recall and F1 score of 70.3%, 63.1% and 61.3% respectively.

Conclusion: Portal tract characterisation is key to establishing liver biopsy adequacy and accurately scoring liver fibrosis and inflammation. Our AI model for PT identification has the potential to assist in pathological review and clinical diagnosis.

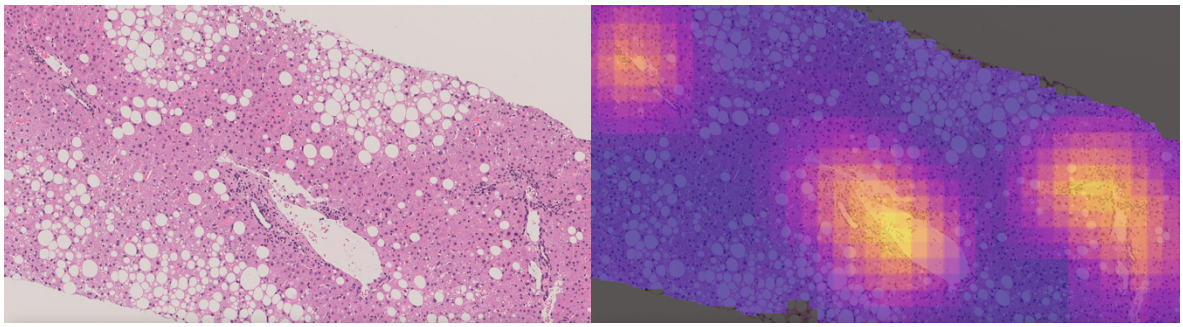

Figure 1: Heatmaps indicate tiles with the probability of containing PTs on WSIs.