EvoDetect: A Dual-Encoder NAS Model and Custom Microscopy Platform for H&E-Based, Cross-Malignancy TP53 Mutation Detection

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Around 40% of the world's population (approximately 3.3 billion people) are at risk of developing cancer at some point in their lives. TP53 (Tumor Protein 53) is a gene altered in most human cancers (being mutated in up to 50% in some cancer sites), yet current detection methods like Next Generation Sequencing (NGS) and Immunohistochemistry (IHC) are limited by turnaround times and costs of up to thousands of dollars per patient. This project is EvoDetect: a neural network designed to predict TP53 mutation status across 26 cancer sites using Hematoxylin and Eosin (H&E) Whole Slide Images. The model architecture combines a ResNet-50 (RetCCL) backbone (for feature extraction from cancer images) with a Vision Transformer (specifically PhikonV2) to learn from sites without quality loss in a dual encoder setup. EvoDetect also uses meta-learning in a gated ABMIL attention setup to weight patches by attention to prevent overfitting (producing false positives). The model was pre-trained and fine-tuned on around 1,500 WSIs (Whole Slide Images) from The Cancer Genome Atlas, which were patched into millions of cancer image patches. The final model implemented NAS (Neural Architecture Search) by using pruning to get rid of weak weights in the model's structure, and was quantized to be deployed on low-level hardware. The model was able to get a clinically relevant AUC (Area Under the Curve) of 0.80 for 10+ cancer sites. The final model was then put on a microscope and exists for a demonstration of clinical deployment. Because of this, EvoDetect is able to be deployed on microscopes and low-level machines, with the ability to scale in size, which acts as an accessible alternative to early cancer detection.

Awards Won: