# Deep-learning based breast cancer detection for cross-staining histopathology images

Breast cancer is the leading disease in new incidence and high death rate of global cancer statistics. Current diagnosis of breast cancer relies on pathology patterns of tumor morphology, especially structural variation in nuclear and membrane. Although nuclear staining using visible dye hematoxylin and eosin (H&E) and fluorescent dye (FLUO) is common in basic biomedical research, at clinical sites the former is more adopted than the latter, leading to accumulation of more abundant H&E-stained than FLUO-stained slides. In the digital pathology era, the size of training dataset is critical to performance of AI models. Here we have developed an AI model workflow including color normalization and nucleus extraction methods for processing both H&E- and FLUO-stained digital pathology slides to ensure accurate segmentation of the images. The architecture is designed based on hybrid machine learning and deep learning, which overcomes the challenges of color variation between the two types of staining technologies.

The key feature of our model is a world-first universal cross-staining breast cancer segmentation methodology for precision prediction between H&E and FLUO images. Such advantage expands the application of current computational pathology and lowers the barrier for clinical researchers to adopt AI analysis in studies with fluorescence-stained image data. Our initial AI model accurately recognizes specific tumor features in both H&E- and FLUO-stained pathological images with > 80% accuracy. This innovative cross-staining inference AI model paves a solid ground for further implement of tumor recognition AI models into practical application for next generation pathology platform.
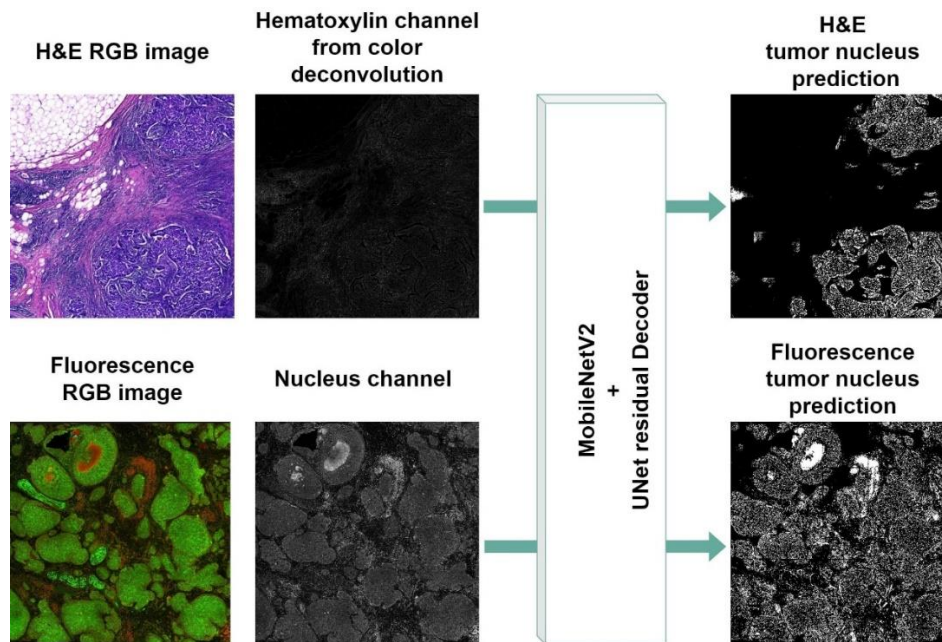
A cross-staining inference workflow between H&E image and FLUO image. [Blue and dark purple: nuclei, Pink: cytoplasm and extracellular matrix, Red: nuclei, Green: cell membrane]