Designing a Deep Learning-Based Resource-Efficient Diagnostic System for Metastatic Breast Cancer: Reducing Long Delays of Clinical Diagnosis and Improving Patient Survival in Developing Countries

Gao, William (School: Centennial High School)

Breast cancer is the most diagnosed cancer among women and the 5th leading cause of cancer-related mortality. Women in developing countries, especially sub-Saharan Africa, suffer from the highest mortality rates in the world. This disparity in mortality rate is largely attributed to long delay of diagnosis, which consequently leads to a large proportion of late-stage presentation at diagnosis. A review of 83 studies across 17 sub-Saharan African countries finds that 77% of all staged breast cancer cases were stage III/IV at diagnosis. Due to severe shortages of trained pathologists and inadequate health care infrastructure, delays could stretch upwards of 15 months. To address this critical health care disparity, this project developed a deep learning-based diagnostic system for metastatic breast cancer that achieved high classification accuracy (91.2% accuracy on unseen images) and computational efficiency. The visual comparisons between the model prediction and ground truth demonstrated the system's capacity for identifying small and subtle cancerous regions. Furthermore, the light-weight models based on MobileNetV2 outperformed the more complex networks in classification accuracy, model generalization, and efficiency in model training. The high efficiency and mobile readiness of this system makes it well suited to remote and resource-constrained environments. This project explored the prospects of integrating the diagnostic system into local sub-Saharan African health care systems. The system can be applied in a geographically distributed mode to remote and diverse areas, paving the way towards reducing long diagnosis delays and improving patient survival in developing countries.

Awards Won:

Fourth Award of $500