# Ensemble Deep Learning-Based Image Classification for Breast Cancer Subtype and Invasiveness Diagnosis from Whole Slide Image Histopathology

**Prof. Saeed Amal, PhD**
Research Professor, Northeastern University, 360 Huntington Avenue, Boston, Massachusetts 02115, USA

## Abstract

Cancer diagnosis and classification are pivotal for effective patient management and treatment planning. In this study, a comprehensive approach is presented utilizing ensemble deep learning techniques to analyze breast cancer histopathology images. Our datasets were based on two widely employed datasets from different centers for two different tasks: BACH and BreakHis. Within the BACH dataset, a proposed ensemble strategy was employed, incorporating VGG16 and ResNet50 architectures to achieve precise classification of breast cancer histopathology images. Introducing a novel image patching technique to preprocess a high-resolution image facilitated a focused analysis of localized regions of interest. The annotated BACH dataset encompassed 400 WSIs across four distinct classes: Normal, Benign, In Situ Carcinoma, and Invasive Carcinoma. In addition, the proposed ensemble was used on the BreakHis dataset, utilizing VGG16, ResNet34, and ResNet50 models to classify microscopic images into eight distinct categories (four benign and four malignant). For both datasets, a five-fold cross-validation approach was employed for rigorous training and testing. Preliminary experimental results indicated a patch classification accuracy of 95.31% (for the BACH dataset) and WSI image classification accuracy of 98.43% (BreakHis). This research significantly contributes to ongoing endeavors in harnessing artificial intelligence to advance breast cancer diagnosis, potentially fostering improved patient outcomes and alleviating healthcare burdens.