REAL-TIME RESEARCH PROJECT

CSE-IDP II year II Sem

SYNERGISTIC AI DIAGNOSTICS FOR BREAST CANCER

Abstract:

Early detection of breast cancer is paramount in reducing mortality and enhancing patient outcomes. Despite significant advancements in screening technologies, the complex interplay of imaging, clinical, and genomic factors continues to challenge early diagnosis. This project is motivated by the need for a robust diagnostic approach that can accurately **integrate heterogeneous data sources** to provide personalized and timely insights, ultimately improving treatment decisions and patient prognoses.

We propose a novel, multi-paradigm framework that combines **ensemble learning, deep convolutional neural networks (CNNs) with transfer learning, reinforcement learning (RL), and graph-based methods**. The system is designed to analyze multi-view imaging data—specifically, craniocaudal and mediolateral mammograms—and to seamlessly fuse clinical information with genomic data, explicitly leveraging **gene expression matrices** from public datasets such as TCGA-BRCA, GEO, and METABRIC. By employing **graph neural networks (GNNs)** to model the latent interrelationships among **imaging features, clinical metrics, and genomic markers**, the framework aims to enhance diagnostic accuracy and prognostic relevance through intelligent feature integration and adaptive learning.

The implementation of this project will utilize a suite of advanced tools and software. For image processing and analysis, we will employ **3D Slicer**, **ITK-SNAP**, and **SimpleITK** for segmentation, visualization, and pre-processing tasks. Deep learning will be conducted using **PyTorch** with the **MONAI** framework to develop and fine-tune custom CNN architectures. Reinforcement learning components will be implemented using **Stable Baselines3** to dynamically optimize hyperparameters and adjust decision thresholds. Graph-based analyses will leverage **PyTorch Geometric** alongside **NetworkX** to model the interrelationships within multi-modal data. Additionally, specialized bioinformatics tools such as **Bioconductor** in R and **Scanpy** in Python will be integrated to process and analyze gene expression matrices, ensuring a comprehensive and seamless fusion of multi-modal data for early breast cancer detection.

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