6TH WORLD FORUM ON BREAST AND CERVICAL CANCER

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Improving Digital Health Diagnosis and Interpretation with Deep Learning

Many conventional diagnostic tools are often inadequate when it comes to identifying early-stage disease symptoms—particularly in cases such as breast cancer—resulting in delays to timely intervention and treatment. Early detection is essential for accurate prognosis and the formulation of personalised treatment plans. In recent years, artificial intelligence (AI), and more specifically Graph Neural Networks (GNNs), have demonstrated significant promise in structured data analysis for outcome prediction in oncology. This research introduces three novel AI-driven methodologies designed to enhance disease diagnosis and improve predictive accuracy for breast cancer outcomes.

The first proposed approach, AIM-X (Attention-Infused Multimodal Cross-Interaction for X-ray), is a sophisticated diagnostic system that integrates recent advances in computer-aided diagnosis (CAD). AIM-X combines multimodal imaging analysis with automated radiology report generation to support informed clinical decision-making. The system employs attention mechanisms and multiscale feature extraction, complemented by hyperparameter optimisation using a genetic algorithm. These components collectively enhance diagnostic accuracy and the interpretability of AI-generated results. By simultaneously processing both radiological images and associated medical texts, AIM-X demonstrates strong potential not only in diagnostic imaging but also in broader domains such as pathology, cardiology, and other clinical areas. This model underscores how scalable and explainable AI solutions can contribute meaningfully to early detection and precision oncology.

Building on this, the second approach—GraphX-Net—introduces a graph neural network architecture enhanced with Shapley Values to predict cancer recurrence with a high degree of interpretability. In this model, each patient is represented as a node within a graph, and clinical features such as tumour cellularity and hormone therapy status serve as node attributes. By utilising graph convolutional layers in conjunction with Shapley Value analysis, GraphX-Net effectively captures both individual-level clinical characteristics and complex inter-patient relationships. This dual capacity contributes to its superior performance in forecasting the risk of cancer recurrence.

The third method, BG-MBC (BERT-GNN for Metastatic Breast Cancer), focuses on predicting metastatic progression through the analysis of unstructured clinical text, particularly histopathology reports. This approach integrates large language models (LLMs) and GNNs, combining the contextual understanding of BERT-based embeddings with graph-based modelling of patient relationships. BERT is used to extract semantic features from medical texts, while the GNN component captures relational patterns from patient histories. This fusion of natural language processing and graph learning enables the system to provide accurate and interpretable predictions of metastatic breast cancer, reinforcing the value of multi-modal AI in clinical applications.

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Together, these three methods contribute to the growing field of AI in medical diagnostics, offering powerful tools for early disease detection, enhanced recurrence prediction, and accurate identification of metastatic conditions. By bridging image analysis, clinical narratives, and relational modelling, this research highlights how advanced AI techniques can transform diagnostic strategies and improve outcomes in oncology.

Biography

Prof. Shadi Basurra is a Professor of Intelligent Systems with a PhD from the University of Bath, UK, supported by Toshiba and the Yemeni government. He previously worked at Sony Corporation in Japan and has been an academic at Birmingham City University since 2014. He heads the Department of Computer and Data Science and co-founded the Data Analytics and AI (DAAI) research group. Under his leadership, DAAI includes six labs and a team of 55 researchers working on health, sustainability, NLP, and computer vision. He has led or co-led over £8.25M in research projects, with £3.25M as Principal Investigator. Prof. Basurra has published widely and established UKRI and international research partnerships. He leads the Software Engineering Track at BCU's Software House, supporting over 142 businesses. More than 100 companies have benefited from his CPD courses and tailored tech solutions. He has delivered several intelligent products (MVPs), including SmartSketcher and i-Magine Sensor. Currently, he is leading the commercialisation of SmartSketcher, targeting a significant share of the homeowner market. His work bridges academia and industry, with impact spanning research, innovation, and enterprise.

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