Title: Explainable AI for breast cancer detection: Biglycan biomarker classification with transfer learning

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Abstract : Background Breast cancer is a leading global cause of cancer-related mortality, where early diagnosis is essential for improved survival outcomes. Although deep learning has shown strong performance in pathology image classification, many models remain difficult to interpret, which limits clinical trust and practical adoption. This study aimed to develop an explainable deep learning framework for classifying breast tissue based on Biglycan (BGN) biomarker expression.

Methods Immunohistochemical photomicrographs from the publicly available Biglycan Breast Cancer Dataset were processed and classified into cancerous and healthy categories. Three transfer learning models, EfficientNet-B0, DenseNet-161, and ResNet-50, were fine-tuned using ImageNet pre-trained weights under a unified training setting with the Adam optimizer (learning rate = 0.001, batch size = 32, epochs = 50). Model performance was evaluated using accuracy, precision, recall, and F1-score. To enhance interpretability, Gradient-weighted Class Activation Mapping (Grad-CAM) was applied to visualize tissue regions that contributed most to the model's predictions.

ResultsEfficientNet-B0 achieved the best overall performance with 99 % accuracy, precision of 0.97, recall of 1.00 for the cancerous class, and an F1-score of 0.99. Grad-CAM heatmaps indicated that the model focused on diagnostically relevant tissue regions associated with strong BGN-related staining patterns. The best-performing model was integrated into a lightweight web-based application to enable real-time image upload and prediction.

Conclusion This study presents an explainable transfer learning approach for BGN-driven breast tissue classification with strong performance on the Biglycan dataset. The integration of Grad-CAM provides region-level visual explanations that improve transparency, while the web deployment demonstrates a practical pathway for accessible decision support in digital pathology.

Keywords: Breast cancer detection; Biglycan biomarker; Explainable AI; Transfer learning; Grad-Cam; Model interpretability

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