Title: SA-MLP: Accurate and Interpretable Breast Cancer Detection with Feature Selection and Explainable AI

Authur names: Md. Shakhauat Hossan Sumon, Apon Chandra Paul, Shakil Mia, Shamik Dey, Iqbal Hossain Safy & Md. Tanvir Hasan Misu

Abastact: Breast cancer is among the most lethal cancers, and early and precise identification is crucial for enhancing patient survival chances. In this domain, machine learning (ML) models have been promising yet existing many of them suffers from redundant features, suboptimal hyperparameters, and overfitting, limiting their diagnostic and clinical applicability. Based on the above, this study proposes SA-MLP, a new approach that combines the use of Simulated Annealing (SA) for feature selection in Multi Layer Perceptron (MLP) with a tuned LIME (Local Interpretable Model-agnostic Explanations) for model interpretability. The model was evaluated against the Wisconsin Breast Cancer Dataset (WBCD) and Simulated Annealing was applied to select the features of the model by reducing the irrelevant attributes with MLP being optimized through hyperparameter tuning. Key metrics including accuracy, AUC, precision, recall, and F1-score were used to evaluate the performance. The method proposed obtained accuracy of 98.60% best and outperforms models in the literature. These results demonstrate the robustness, efficiency and generalization of SA-MLP and its interpretability with LIME for breast cancer diagnosis. The results of SA-MLP show that this could be a decision support tool for oncologists in early diagnosis, risk assessment, and personalizing treatment, offering an enormous value for the early diagnosis and predicting risk and personalizing treatment.

Keywords: **Fiber Optics Fibre Optics Optical Sensor**

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