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Designing a Group Decision-Making System Using a Fuzzy Combination of Regression Methods for Prediction of Benign or Malignant Breast Tumors

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Abstract

Introduction: In cancer research, early detection of breast cancer is effective in prognosis and increasing the survival of patients. Artificial intelligence and data mining methods are predictive methods that can be useful in this case. The purpose of this paper is to design and evaluate an automatic computer-aided diagnosis system to predict the type of breast tumor by using a fuzzy combination of regression methods.

Methods: In this descriptive-analytic study, a group decision-making system was designed by using the combination of PCA (Principal Components Analysis), RSM (Response Surface Methodology) and SVR-Firefly (Support Vector Regression- Firefly) methods to predict the type of breast tumor (benign or malignant). To evaluate the designed system, we used the Wisconsin Breast Cancer Dataset stored in the UCI (University of California, Irvine) Machine Learning Repository. After pre-processing, the data was split into training and testing datasets, which were evaluated by each of mentioned regression methods. Finally the results of the regression methods were combined by fuzzy voting and fuzzy averaging approaches. The proposed group decision-making system was simulated by MATLAB software.

Results: This study was conducted on 683 women with breast cancer, including 444 cases with benign tumors, as well as 239 cases with malignant tumors. For each case, nine clinical variables were used as inputs. The performance of the proposed group decision-making system in test phase is based on accuracy, precision, sensitivity and specificity. The values of these indicators were obtained, on average, 0.9832, 0.9588, 0.9900, 0.9832 in fuzzy voting method and 0.9820, 0.9524, 0.9929, 0.9804 in fuzzy averaging method while the performance indicators were obtained 1 by both methods in the best case.

Conclusion: The results of experiments show the effectiveness of the proposed group decision-making system in predicting the type of breast tumors (benign or malignant). It can help the physicians to choose the best treatment method and prevent the cancer progression. The developed software can also be used for training physicians.

Keywords: Breast Cancer, Fuzzy Voting, Fuzzy Averaging, PCA, RSM, SVR-Firefly, Wisconsin Breast Cancer Dataset.

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