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A Comparative Study of Hidden Layer Configurations in Multi-Layer Perceptrons (MLP) for Liver Cirrhosis Prediction

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Abstract: This study presents the design and simulation of a Multilayer Perceptron (MLP)-based Artificial Neural Network for predicting stages of liver cirrhosis using the Cirrhosis Prediction Dataset from Kaggle. The dataset includes medical and demographic records of 418 individuals, with 20 attributes such as age, sex, treatment type, and clinical conditions (ascites, edema, hepatomegaly), as well as biochemical test results (bilirubin, cholesterol, albumin, copper, alkaline phosphatase, SGOT, triglycerides, platelet count, and prothrombin time). The target variable is patient status (alive, transplant, or deceased), while the “stage” variable indicates histological severity from 1 to 4. After preprocessing, 15 features were selected for model input, including categorical encoding and normalization of numerical data. The dataset was split into training (70%), validation (15%), and testing (15%) subsets using stratified sampling to maintain class balance. Random shuffling minimized ordering bias, and validation data was employed to tune hyperparameters such as learning rate, activation functions, and hidden layer sizes, while early stopping was used to reduce overfitting. Two MLP architectures were implemented: a two-hidden-layer network and a three-hidden-layer network. For the two-layer model, a configuration of 60 neurons in the first layer and 30 in the second was simulated with sigmoid activation in hidden layers and softmax in the output layer. The best validation performance (0.25544 at epoch 22) achieved an overall accuracy of 52.9%, with training, testing, and validation accuracies of 54.1%, 58.7%, and 41.3%, respectively. Varying neurons between 10 and 100 in hidden layers showed no consistent trend but indicated that configurations between 60–100 neurons provided relatively stable performance. The highest overall accuracy in this set was 55.5% with 100 neurons. For the three-layer MLP, the first and second hidden layers were fixed at 100 and 60 neurons, while the third layer varied. The best performance was achieved with 80 neurons, reaching 55.3% overall accuracy and 63.5% validation accuracy. However, extreme configurations with very low or very high neurons showed reduced performance, highlighting a trade-off between model complexity and generalization.

In conclusion, MLP-based models demonstrate potential in non-invasive cirrhosis stage prediction using routine clinical and laboratory data. Results show that moderate network sizes (60–80 neurons per hidden layer) yield the most reliable accuracy. While deeper architectures can capture complex nonlinear patterns, careful tuning is required to avoid underfitting or overfitting. This work provides a foundation for further refinement of AI-based tools for liver disease prediction, supporting early diagnosis and clinical decision-making.

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