Bayesian Artificial Neural Networks in the Computerized Detection of Mass Lesions

Artificial neural networks (ANNs) are frequently used as classifiers in computer-aided diagnosis methods. In the limit of large sample sizes, an ANN approximates an ideal observer discriminant function which is a monotonic transformation of the likelihood ratio. A disadvantage of ANNs is the over-parameterization of the mapping function which results in a poor approximation of an ideal observer discriminant function for smaller sample sizes. Recently, Bayesian methods have been applied to ANNs in order to regularize training to improve the robustness of the classifier. A Bayesian ANN (BANN) should thus better approximate an ideal observer discriminant function given small sample sizes. We evaluated the accuracy of BANN models of ideal observer discriminant functions by varying the number of hidden units, the signal-to-noise ratio of the data, and the number of features or dimensionality of the data. Results on simulated data show that BANNs can effectively model the ideal observer discriminant function even when excess hidden units and limited sample sizes are present. We have used these results to design BANNs to classify mammographic regions as either malignant or normal. Initial comparisons of BANNs with conventional, early-stopping ANNs suggest that BANNs produce more robust results in the task of distinguishing between malignant lesions and false detections.

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