Supervised Image Classification Using an Artificial Neural Network for Optical Digit Recognition and Diagnosis of Fine Needle Aspirates of Breast Cancer

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Artificial Neural Networks (ANN) are machine learning models loosely based on the biological structure of the brain. In the past, they have shown success in approximating solutions for multivariate prediction and classification problems, including stock market analysis and the Travelling Salesman Problem (TSP). In this investigation, the goal was to build an extensible, multipurpose ANN for the analysis and classification of images. The neural network was built using an object-oriented approach in Python with an input layer, a hidden layer, and an output layer with variable numbers of neurons per each layer. A logistic sigmoid function was implemented in order to transform the propagated values, and the quasi-Newton Conjugate Gradient algorithm was implemented in order to perform batch gradient descent to minimize the cost of the ANN.

In order to test the viability of this neural network, it was applied for the recognition and classification of optical handwritten digits. An application was built in order to collect supervised pixel maps and images of optical digits, which were then used to train the neural network. Ultimately, the neural network was able to identify test samples of digits with an accuracy of 82.4% across 1560 trials; however, the ANN did show some signs of overfitting. Multiple techniques were employed to overcome overfitting including early stoppage and regularization, although it is hypothesized that an increased training sample size will diminish overfitting and increase accuracy.

Furthermore, this ANN was also applied for the categorical diagnosis of fine needle aspirates (FNA) of breast cancer tumors. Supervised biopsy data was acquired from the UCI Machine Learning Database consisting of 32 attributes compiled from each FNA image. The neural network was able to diagnose test samples as either malignant or benign with an accuracy of 97% across 715 trials with no signs of overfitting. Future endeavors include investigations into more applications as well as more convoluted, deep neural networks.