**Title:** Deep Learning Classification Pediatric Spinal Cord Injury from Diffusion Tensor Imaging

**Purpose:** This study evaluates the performance of a custom deep learning architecture in the classification of spinal cord injury vs healthy controls from features derived from Diffusion Tensor Imaging and demographic information.

**Materials and Methods:**

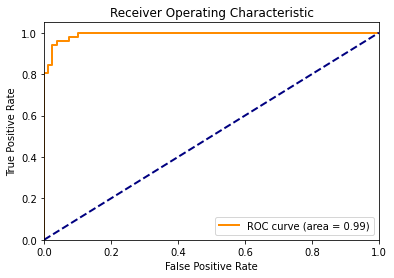
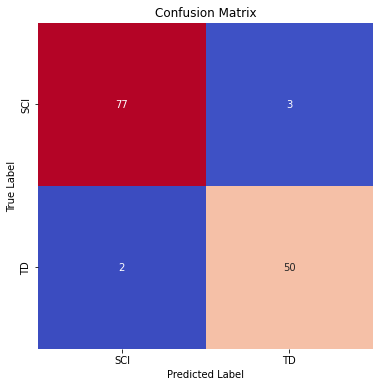
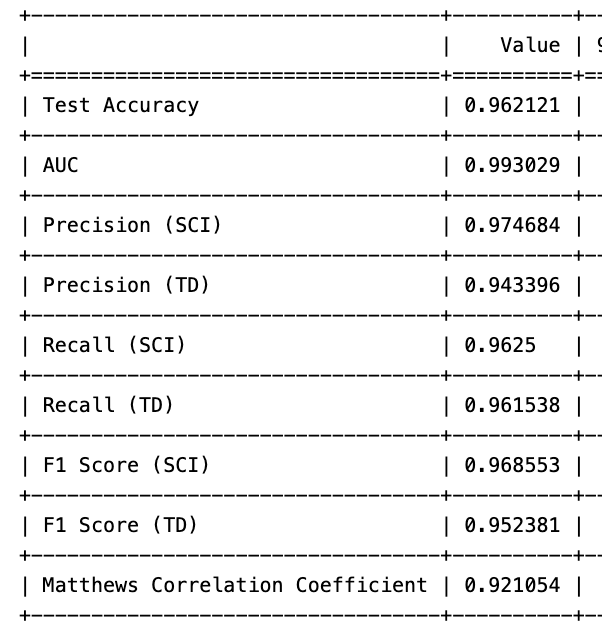
The custom deep learning architecture (SCI-CNN) was trained and validated using features derived from Diffusion Tensor Imaging (FA\_mean, ADC\_mean, RA\_mean, MD\_mean, AD\_mean, RD\_mean) of the whole spinal cord from a total of 69 pediatric patients with SCI (54, average age 11.64) and TD (84, average age 11.57). Each patient had 2 MRI scans which were treated independently during training, increasing the total images to 138. Validation and Testing were performed using a 5-fold cross-validation. SCI-CNN was composed of two components, a 1D-CNN for processing DTI features and a fully connected layer to process age features and optimized using the Adam optimizer with a learning rate = 0.0001, weight decay, and learning rate schedule. Training was performed for 50 epochs with batch size 32 using CrossEntropyLoss. Early stopping patience was set to 3 to avoid overfitting. Model performance was evaluated using best validation accuracy, test accuracy, AUC, and confusion matrices. Additionally, 5 supervised-learning frameworks (SVM, Gradient Boosting, Logistic Regression, K-NN, Random Forest) and the Ensemble were included for comparison and were trained and evaluated for comparison.

**Results:**

SCI-CNN achieved best validation accuracy of 94.534% and test accuracy 96.21% in the binary-classification task of SCI vs TD. The model demonstrated high precision (97.47% for SCI and 94.34% for TD) and recall (96.85% for SCI and 96.21% for TD) for both classes, resulting in F1-scores of 96.85% for SCI and 95.23% for TD. The macro-average F1-score was 96.21%. Matthews Correlation Coefficient (MCC) was 0.921. The highest performing supervised learning method was SVM (72.47% accuracy, precision 73% SCI and 91% TD, and recall 71% SCI and 51% TD).

**Conclusion:**

In the classification of pediatric spinal cord injury using DTI images, the custom deep learning architecture (SCI-CNN) achieved higher accuracy, precision, and recall than traditional supervised learning methods. The high performance of the deep learning model indicates its potential as an effective tool for aiding in the screening and assessment of pediatric spinal cord injuries. Further validation on larger DTI datasets to assess generalizability may support the model's utility as a screening tool for clinical practice.

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