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Amsterdam Neuroscience

Supervised Machine Learning Algorithms for Diagnosing Chronic Inflammatory Demyelinating Polyradiculoneuropathy

Preliminary Results

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Objective: to evaluate if ML models can predict a CIDP diagnosis based on NCS data with a higher accuracy than the current EAN/PNS guideline.

Background

- Diagnosis of chronic inflammatory demyelinating polyneuropathy (CIDP) relies on consensus guidelines, with nerve conduction study (NCS) interpretations playing a crucial role.
- Errors made during manual interpretation of NCS can potentially lead to misdiagnosis. Machine learning (ML) algorithms may detect complex patterns in NCS data and accurately classify patients with CIDP, potentially improving diagnostic accuracy compared to manual interpretation.

Methods

- NCS data from patients suspected of subacute and chronic immune-mediated neuropathies (2009-2021) were extracted.
- CIDP patients meeting the EAN/PNS criteria, including those not meeting electrodiagnostic criteria but showing treatment response or ≥2 supportive criteria, were included.
- Patients were matched by age, sex, and height with controls who received an alternative diagnosis (1:1 ratio).
- 80-20 train-test split.
- Missing data handled with K-Nearest Neighbour.
- Models used for diagnostic classification included Logistic Regression **(LR)**, Decision Trees **(DT)**, Random Forest **(RF)**, Support Vector Machine **(SVM)**, ADAboost **(ADA)**, XGBoost **(XGB)**, and Bayesian Additive Regression Trees **(BART)** with a nested k-fold (k=5) cross-validation.

Results

- Selected 141 CIDP patients and matched with 141 controls.
- 150 features used for model training, shown in table 1.
- Model metrics based on training data are summarized in table 2.
- ROC curves of the ML models are shown in figure 1.

Table 1. Overview of selected NCS features

Nerves	**Motor:** median, ulnar, peroneal, tibial **Sensory:** median, ulnar, radial, sural
Features per nerve	**Motor:** distal onset latency, velocity per segment, negative peak CMAP amplitude, area, duration **Sensory:** velocity per segment, negative peak SNAP amplitude, duration
Derived features	CMAP amplitude, duration and area change between neighbouring proximal and distal stimulation sites (%)

Table 2. Model metrics based on training data

	Accuracy mean (±SD)	Precision mean (±SD)	Sensitivity mean (±SD)	Specificity mean (±SD)
Log	0.76 (0.07)	0.81 (0.09)	0.70 (0.08)	0.83 (0.09)
DT	0.71 (0.06)	0.73 (0.06)	0.66 (0.08)	0.76 (0.05)
SVM	0.76 (0.07)	0.82 (0.11)	0.69 (0.07)	0.84 (0.11)
RF	0.78 (0.07)	0.83 (0.07)	0.71 (0.09)	0.85 (0.09)
ADA	0.74 (0.04)	0.80 (0.06)	0.67 (0.09)	0.82 (0.08)
XGB	0.76 (0.05)	0.78 (0.06)	0.73 (0.09)	0.79 (0.07)
BART	0.77 (0.02)	0.82 (0.08)	0.71 (0.08)	0.83 (0.08)
EAN/PNS guideline	0.76	0.85	0.63	0.89

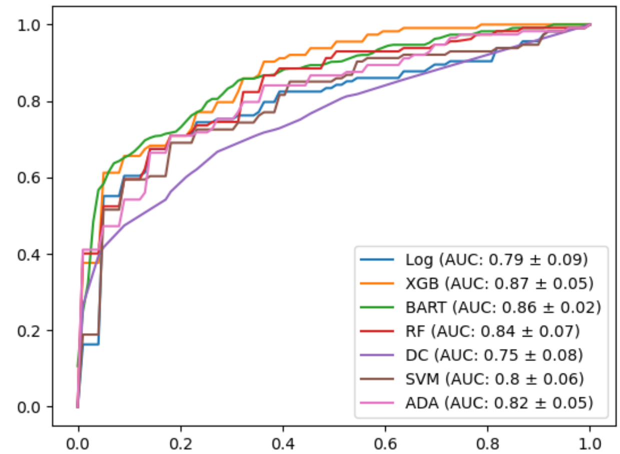

Figure 1. ROC curves of ML models

Conclusion/Discussion

- Preliminary results based on training data suggest that machine learning models are effective in classifying CIDP based on NCS data.
- Further validation using test data and an independent external datasets from UMC Utrecht is needed to confirm these findings and assess clinical applicability.

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Amsterdam Neuroscience is a collaboration between: Amsterdam UMC University Medical Centers, VU Vrije Universiteit Amsterdam, University of Amsterdam