Psychogenic Tremor Disorders Identified Using Tree-Based Statistical Algorithms and Quantitative Tremor Analysis

Panida Piboolmurak, Natalia Rothey, Dong Xu, Blair Ford, Qiping Yu and Seth L. Pullman, Columbia University Medical Center, New York, NY

Objective
To combine novel tree-based statistical algorithms with computerized quantitative tremor analysis to aid in the diagnosis of psychogenic tremor (PsychT).

Background
PsychT is a condition with a psychiatric basis, the diagnosis of which is challenging as it often mimics or coexists with organic disorders. It is generally diagnosed clinically without objective methods of confirmation. Sedation onset, distractibility, inconsistency or underlying psychopathology are helpful but not diagnostic. Tree-based statistical modeling is an exploratory classification algorithm that uncovers hidden structure in data and devises prediction branch rules (conditional statements at nodes that provide guidance on how to proceed on the tree) for rapid evaluation.

Methods
Severely subjects including 23 with clinically established PsychT, 22 with Parkinson’s disease (PD), 10 with dystonia (DT), and 15 with essential tremor (ET) as well as 28 age-matched normal control subjects underwent quantitative tremor analysis to obtain tremor amplitude (amp) and frequency (freq) data. For all subjects, movement data from both arms were acquired at rest (AR), with arms extended (AE) and with finger-to-nose movement (F-N). The tree was developed using a binary partitioning algorithm recursively splitting data in each node by a variable selected by S-PHD statistics software until the nodes were as homogeneous as possible. Subjects were classified into normal or into one of 4 tremor groups based on their physiologic measurements.

Results
In our study, 5 predictor variables (tremor amplitude and frequency with arm at rest, arm extended and finger-to-nose movement) were selected for growing the tree model. Box plots of variable distributions (Figure 2) indicate that the amplitude of the tremor is greater at rest than in any of the task conditions. Furthermore, the frequency of the tremor is higher in the task conditions than at rest (Figure 3). Our final tree model consisted of 12 nodes and 22 branches (Figure 3). The number under each terminal node indicates probability of having that diagnosis. The tree model predicted the classification of PsychT at 4 terminal nodes with probabilities of having that diagnosis from 60% to 100% depending on the path that directs to the terminal node.

Discussion
A tree-based statistical algorithm is an exploratory technique for uncovering structure in data. The trees are obtained using an algorithm that recursively partitions the given training data into smaller subsets until either the node is homogeneous or contains too few observations. Each inner node of the tree is a logical test on a predictor variable. There are two outcomes of the test at each node to the left or right: predictor variable ≤ cut-off value, and predictor variable > cut-off value. Each path will direct to the terminal node, which indicates the final prediction. One of the more interesting aspects of this tree model is that a predictor variable can lead to more than one and at different range of values. Therefore, it is recommended to use the tree model for complex statistical manipulations that may be otherwise impossible or difficult to handle. Based on the model, PD and ET showed more similar patterns of tremor amplitude and frequency, whereas DT and PsychT showed more distinct patterns.

Conclusion
Tree-based statistical algorithms provide powerful, yet easy to use guidelines for prediction of PsychT. In this study, by applying tremor amplitude and frequency data from the commonly used clinical conditions for tremor assessment (rest, posture and action) to a series of binary rules, we have developed an objective and reproducible method for diagnosis PsychT. This technique represents an interesting novel application of tree-based modeling in neurology and is potentially quite useful as an adjunctive tool in diagnosing elusive tremor disorders such as PsychT.