

SomniMAT: An Interactive Machine-Learning Platform for Automated Mouse Sleep Staging with Cross-Condition Validation

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Objective: Manual sleep scoring is a labor-intensive and time-consuming in experimental sleep research. Although automated scoring methods have been developed, integrating machine-learning classification with accessible tools for visual inspection and manual correction remains important. We developed SomniMAT, a MATLAB-based application intended for open-source release that integrates automated sleep-stage classification with an interactive graphical interface for researcher-guided review and correction.

Methods: Electroencephalographic (EEG) and accelerometer (ACC) recordings were obtained from 40 mice, each undergoing two 12-hour sessions under control and clozapine-related experimental conditions (80 sessions; 960 hours). Following manual annotation and quality control, 287,638 non-overlapping 12-second epochs were retained, and 143 predictors were extracted. Twelve classifier configurations were evaluated, with a Gaussian-kernel error-correcting output-code support vector machine (ECOC-SVM) achieving the highest observed mean macro-F1. Performance was assessed using leave-one-animal-out (LOAO) cross-validation, bidirectional cross-condition evaluation, and independent validation involving 14 additional mice.

Results: Under combined-condition LOAO evaluation, ECOC-SVM achieved $89.7 \pm 5.0\%$ accuracy, a macro-F1 of 0.851 ± 0.061 , and Cohen's kappa of 0.810 ± 0.091 . Cross-condition evaluation yielded mean macro-F1 scores of 0.825 and 0.839 for control-to-treatment and treatment-to-control transfer, respectively. Independent validation achieved 87.3% pooled accuracy and a macro-F1 of 0.825.

Conclusion: SomniMAT integrates automated EEG/ACC-based sleep classification with an interactive interface for researcher-guided correction. Its performance across animal-held-out, cross-condition, and independent evaluations supports its potential as a researcher-assisted sleep-scoring platform. Planned open-source distribution aims to facilitate further development, adaptation, and external validation across research laboratories.