EEG Mental State Classification

NICOLAS WAGNER

CSC 597 STATISTICAL LEARNING

Introduction

Epileptic seizures

Electroencephalogram (EEG)

Seizure vs healthy state

Classifying mental states

State-Of-The-Art

- Shoeb, A. H., & Guttag, J. V. (2010). Application of machine learning to epileptic seizure detection. In *Proceedings of the 27th International Conference on Machine Learning (ICML-10)* (pp. 975-982).
  - 96% Accuracy (SVM)
- Subasi, A., Kevric, J., & Canbaz, M. A. (2019). Epileptic seizure detection using hybrid machine learning methods. *Neural Computing and Applications*, *31*(1), 317-325.
  - 99% Accuracy (PSO-SVM)
- Shoeb, A. H. (2009). *Application of machine learning to epileptic seizure onset detection and treatment* (Doctoral dissertation, Massachusetts Institute of Technology).
  - 95% Accuracy
- Müller, K. R., Tangermann, M., Dornhege, G., Krauledat, M., Curio, G., & Blankertz, B. (2008). Machine learning for real-time single-trial EEG-analysis: from brain–computer interfacing to mental state monitoring. *Journal of neuroscience methods*, *167*(1), 82-90.
  - 98% Accuracy

Methods - Dataset

- Epileptic Seizure Recognition (UCI ML Repository, Kaggle)
- Instances: 11,500
- Attributes: 179
- Classes: 5 (2,300)

Methods - Algorithms

- KNN Classifier
- LDA
- QDA
- Decision Trees
- Boosting
- Random Forests
- Bagging
- SVC
- SVM

Methods - Evaluation

10-FOLD CROSS VALIDATION

ACCURACY

COMPARISON ACROSS ALGORITHM PARAMETERS

Results

- Logistic Regression
- Boosting
- Higher dimensionality
- Execution times

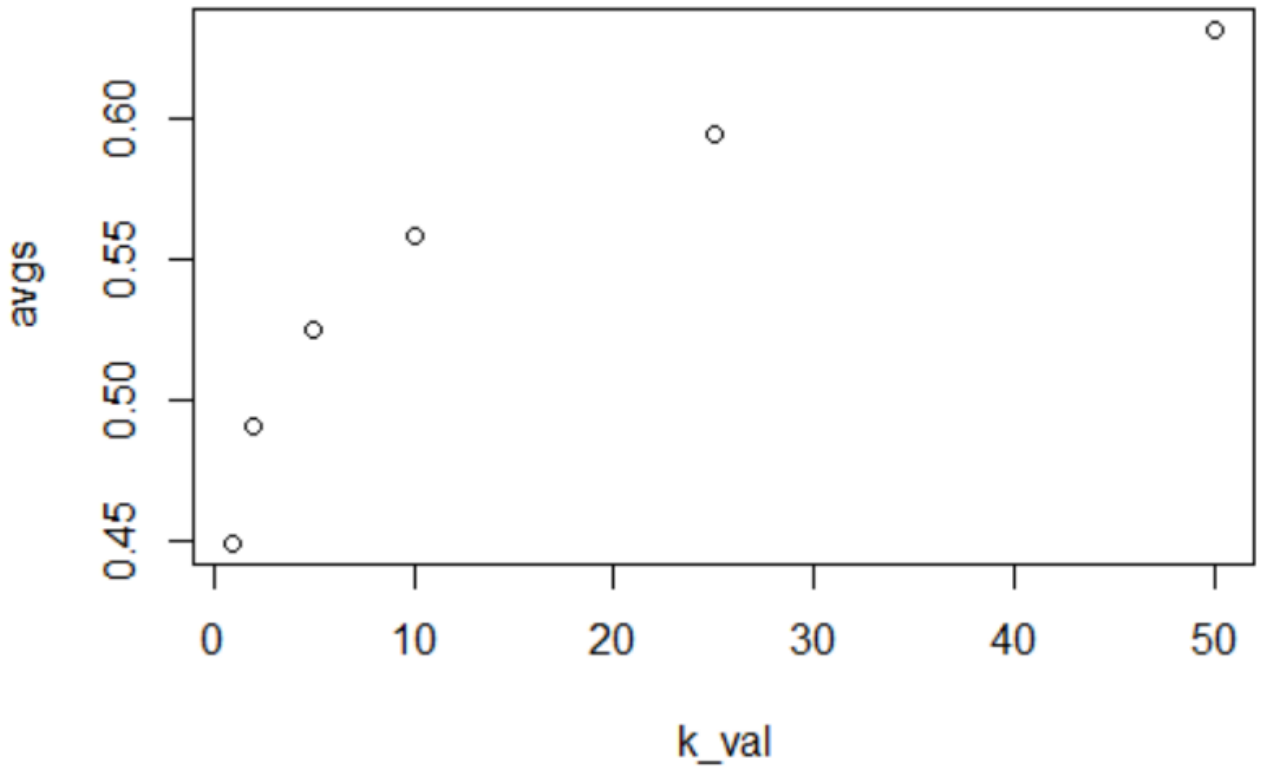
Conclusion & Future Work

- QDA, RF
- Dealing with high dimensionality
- TBI (Concussions)
- Real-time detection

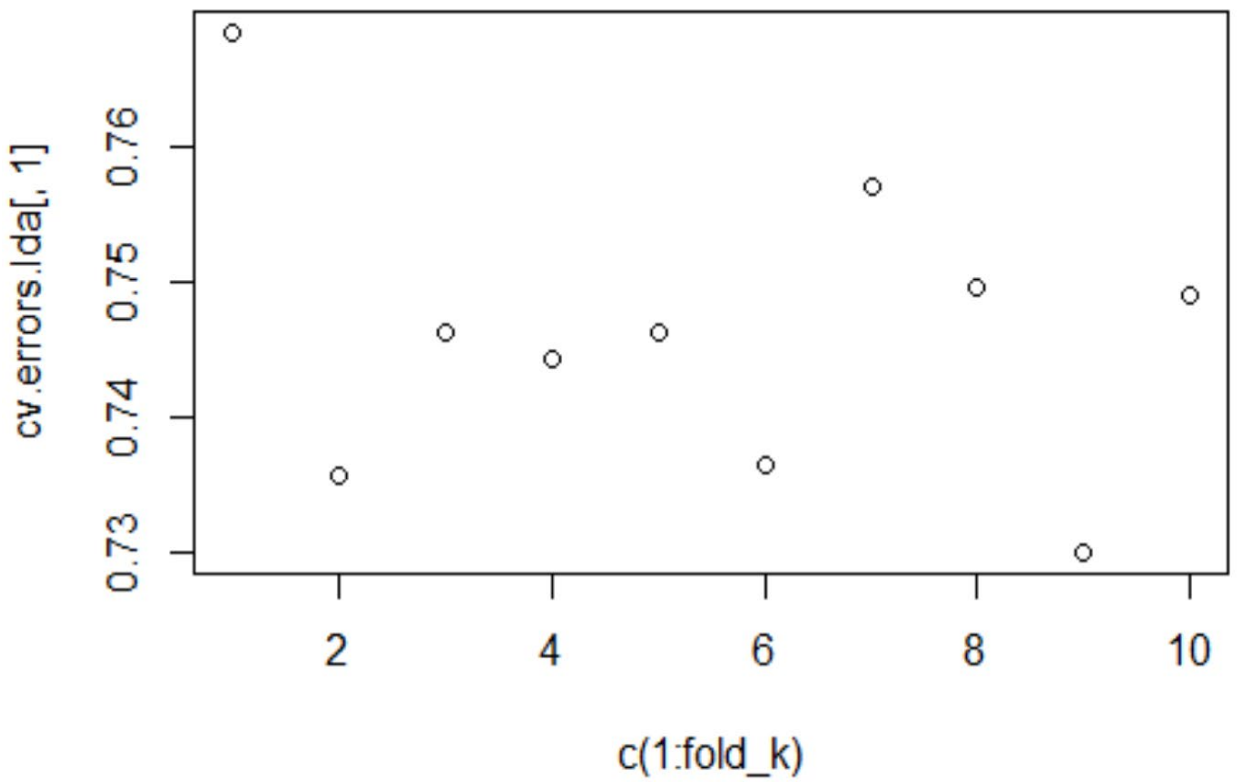
	KNN	LDA	QDA	DT	Pruned DT	Boosting	RF	Bagging	SVC	SVM
Error	0.4494	0.7463	0.3545	0.6285	0.6284	0.8298	**0.2687**	0.2723	0.7179	0.5791

Citations

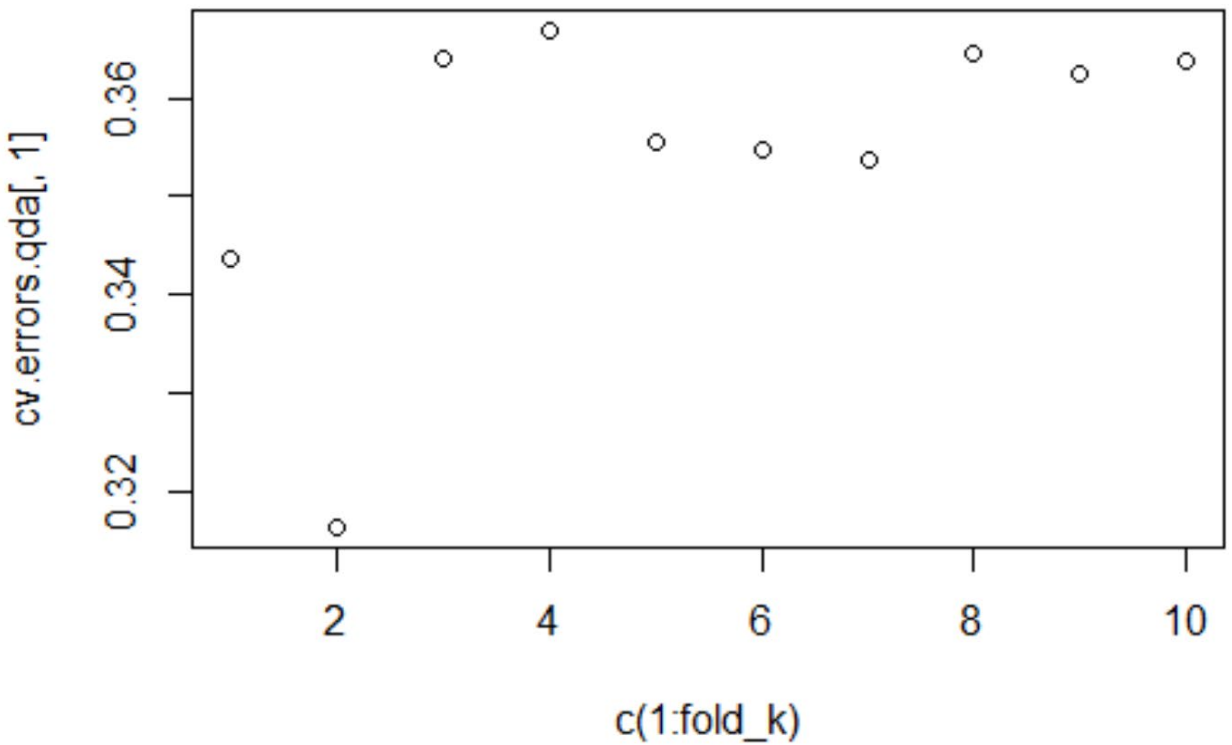
- Stafstrom, C. E., & Carmant, L. (2015). Seizures and epilepsy: an overview for neuroscientists. Cold Spring Harbor perspectives in medicine, 5(6), a022426. https://doi.org/10.1101/cshperspect.a022426
- Andrzejak RG, Lehnertz K, Rieke C, Mormann F, David P, Elger CE (2001) Indications of nonlinear deterministic and finite dimensional structures in time series of brain electrical activity: Dependence on recording region and brain state, Phys. Rev. E, 64, 061907
- Shoeb, A. H., & Guttag, J. V. (2010). Application of machine learning to epileptic seizure detection. In *Proceedings of the 27th International Conference on Machine Learning (ICML-10)* (pp. 975-982).
- Subasi, A., Kevric, J., & Canbaz, M. A. (2019). Epileptic seizure detection using hybrid machine learning methods. *Neural Computing and Applications*, *31*(1), 317-325.
- Shoeb, A. H. (2009). *Application of machine learning to epileptic seizure onset detection and treatment* (Doctoral dissertation, Massachusetts Institute of Technology).
- Müller, K. R., Tangermann, M., Dornhege, G., Krauledat, M., Curio, G., & Blankertz, B. (2008). Machine learning for real-time single-trial EEG-analysis: from brain–computer interfacing to mental state monitoring. *Journal of neuroscience methods*, *167*(1), 82-90.



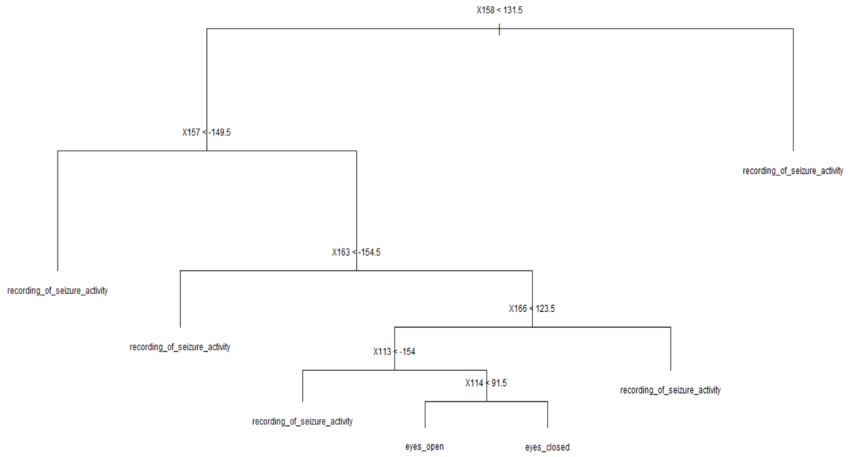
Appendix – KNN Error

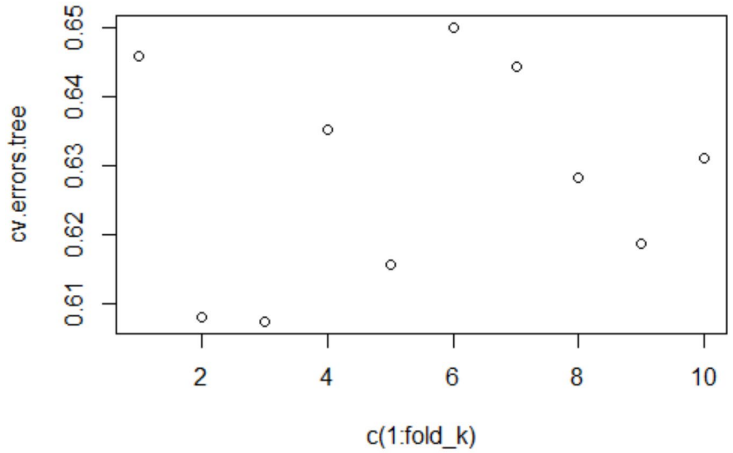


Appendix – LDA Error

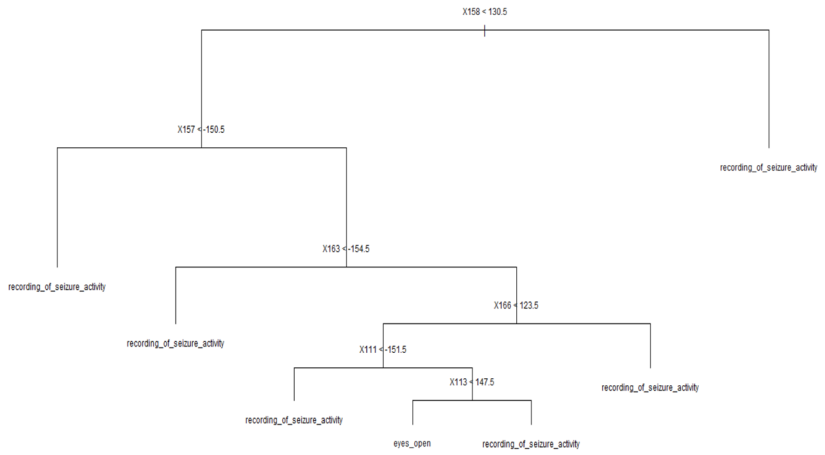


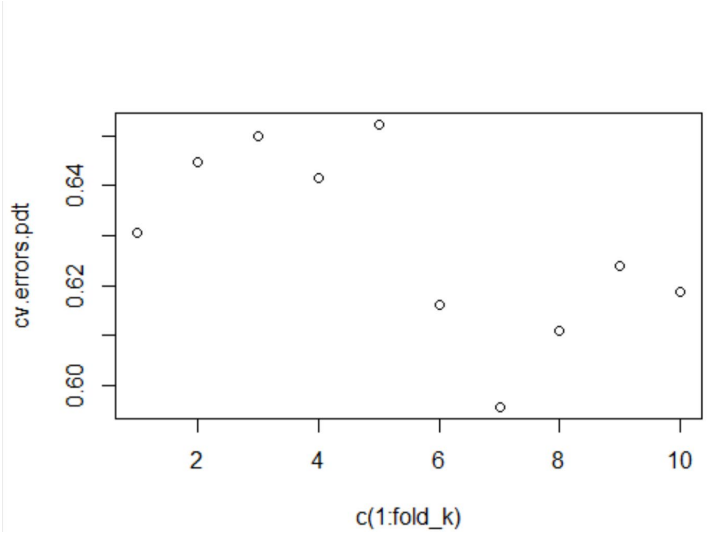
Appendix – QDA Error



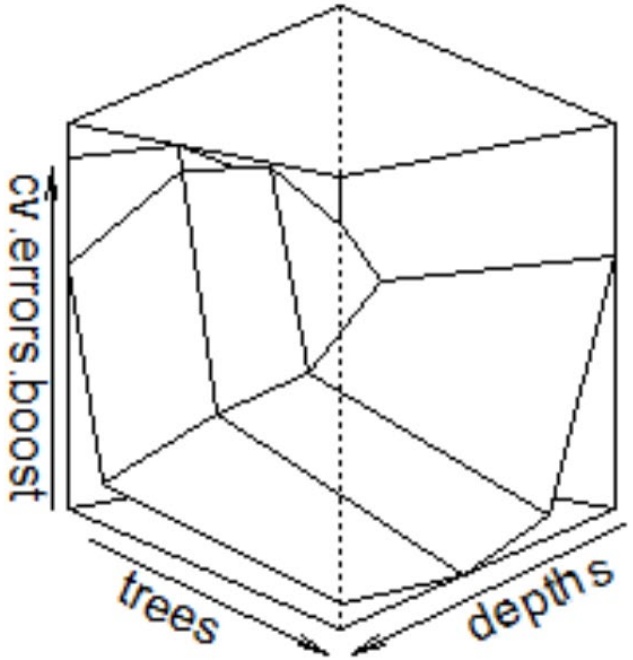


Appendix – Decision Tree

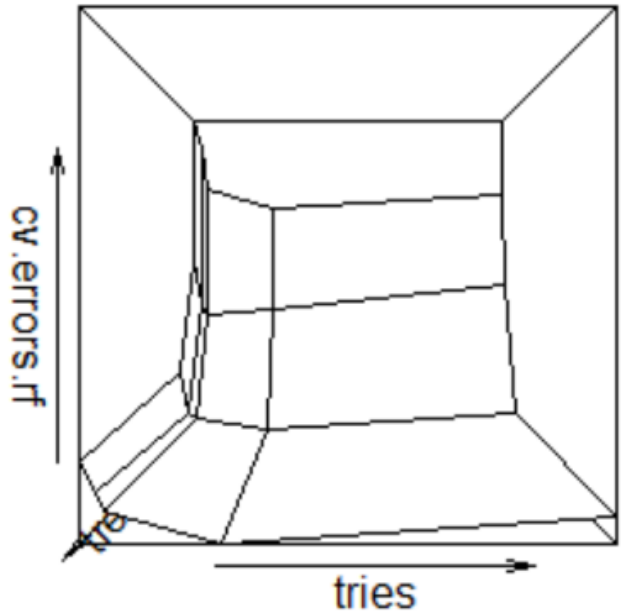




Appendix – Pruned Decision Tree



Appendix – Multinomial Boosting Error



Appendix – RF and Bagging Error

Questions?