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***Abstract*—Epilepsy is one of the most common neurological conditions, affecting nearly 1% of the global population. It is defined by the seemingly random occurrence of spontaneous seizures. Anti-epileptic drugs provide adequate treatment for about 70% of patients. The remaining 30%, on the other hand, continue to have seizures, which has a significant impact on their quality of life as they are constantly unsure when these seizures will occur. Reliable seizure detection methods would thus have a significant impact on the lives of these patients.**

Despite ongoing research efforts involving academia and industry in large international collaborations, epileptic seizure detection and especially prediction is still an unsolved problem. The key to the solution could lie within ultralong-term, real-life datasets that are currently being generated using wearable sensors. However, due to the size of these datasets, conventional learning techniques such as least-square support vector machines (LS-SVMs) can become intractable.

Therefore, this work proposes the use of a recently developed tensor network Kalman filtering approach for LS-SVMs (TNKF-LSSVM) to detect epileptic seizures [1]. In the TNKF-LSSVM algorithm, the dual problem of the LS-SVM is solved using a recursive Bayesian filtering approach. This way the least-square problem can be solved row-by-row using a Kalman filter, thereby avoiding explicit matrix inversions, while also being able to provide confidence bounds on the estimates. By making use of the tensor-train format [2] to represent the matrices and vectors in the Kalman equations, it is even possible to avoid the construction of the $(N+1)\times(N+1)$ covariance matrix[1].

To be able to apply the TNKF-LSSVM algorithm for seizure detection there are still some issues that need to be tackled. One such problem is that the TNKF-LSSVM only performs well when the dataset is properly balanced, which is generally not the case for seizure datasets. Furthermore, for the TNKF-LSSVM to work efficiently for large scale problems the modes of the tensor-trains representing the matrices and vectors should be as small as possible, thus it must hold that $N+1=\prod_i n_i$, such that n_i is 'small' for all i. To overcome both of these challenges we propose using the SMOTE method to oversample the seizure class, such that a balanced training set can be generated that has good factorization properties.

Some preliminary results using a small subset of data from a public EEG dataset [3] show that taking the above considerations into account, the TNKF-LSSVM method can have performance that is competitive with a regular LS-SVM. Where the TNKF-LSSVM method has the benefit of scaling log-linearly with the size of the dataset (in terms of memory usage) and can provide an uncertainty estimate of the detection. Future work will need to show whether this scaling up works as expected for the entire dataset.

***Index Terms*—tensors, tensor-train, Kalman filter, SVM, seizure, epilepsy, detection**

[1] N is the number of data points in the training set and 1 is added for the bias.

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