Concept Drift Handling for Online Voltage Security Analysis using Random Forest

Aleksei V. Zhukov, Denis N. Sidorov, Nikita V. Tomin, and Victor G. Kurbatsky

Energy Systems Institute SB RAS, Irkutsk, Russia
dsidorov@isem.irk.ru,

Ensemble methods are core machine learning methods employ various learning algorithms in order to achieve better predictive accuracy comparing with individual classifiers. For real world power engineerings applications learning algorithms are supposed to work in dynamic environments. In such situation data continuously generated in the form of a stream. Data stream processing normally employ single scans of the training data and implies strict restrictions on memory and time.Changes caused by dynamic environments (e.g. consumer/load behaviour in power grids) can be categorised into sudden or gradual concept drift subject to appearance of novel classes in a stream and the rate of changing definitions of classes.

The objective of this submission is to employ Proximity Driven Streaming Random Forest (or PDSRF) algorithm [1] to assess and control voltage stability in power system in real time. As a target indicator of system stability when training the PDSRF model we use L-index [2] as an indicator of impeding voltage stability.

Based on this idea, we also suggest modifying a L-Q sensitivity analysis method for reactive power optimization, when the reactive power injections are calculated from the L-index minimization conditions, and keep a system under heavy load conditions away from instability boundaries. In traditional statement, this method requires considerable computational efforts and its application in the real time problems can be complicated.

We suggest supplementing a classical sensitivity analysis method by using PDSRF-based models able "to learn" to calculate both the global L-index for the security assessment of an entire system, and the required reactive power injections, when determining the place and magnitude of corrective actions. This allow us to apply this methodology in real time. Comparative analysis on various IEEE test schemes against the state of the art methods is fulfilled.

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References

1. A.V. Zhukov, D.N. Sidorov and A.M. Foley, "Random Forest Based Approach for Concept Drift Handling", Communications in Computer and Information Science J. 2017, vol. 661, pp. 1-9.
2. P. Kessel and H. Glavitsch, "Estimating the voltage stability of a power system", IEEE Trans. on Power Delivery, vol. PWRD-1, 1986, no. 3, pp. 346-353.