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RANDOM FOREST-BASED APPROACH FOR VOLTAGE SECURITY MONITORING IN A POWER SYSTEM;

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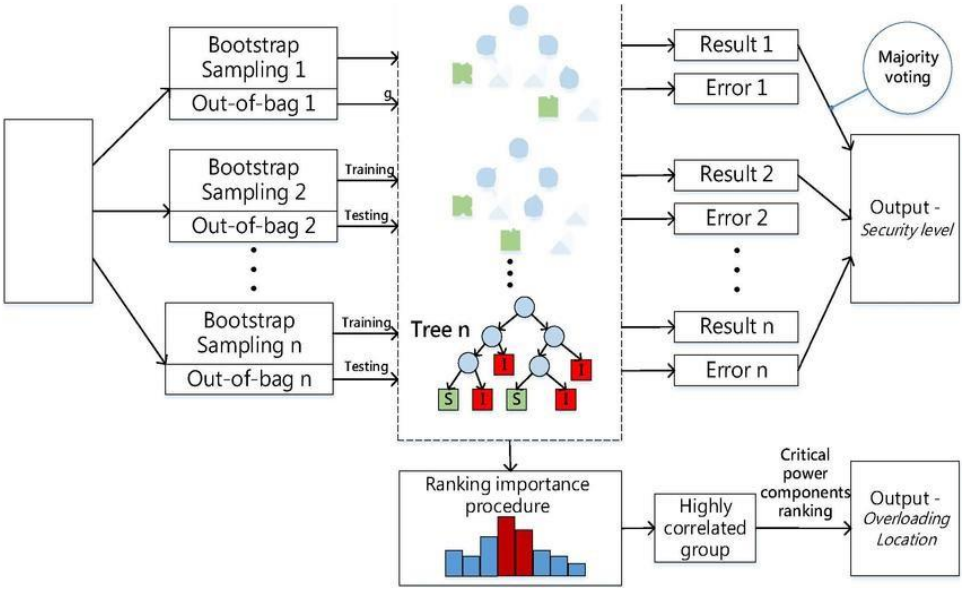
INTRODUCTION: Voltage collapse is a critical problem that impacts power system operational security. Timely and accurate assessment of voltage security is necessary to detect alarm states in order to prevent a large-scale blackout. This paper presents an on-line voltage security assessment scheme using periodically updated random forest-based decision trees.

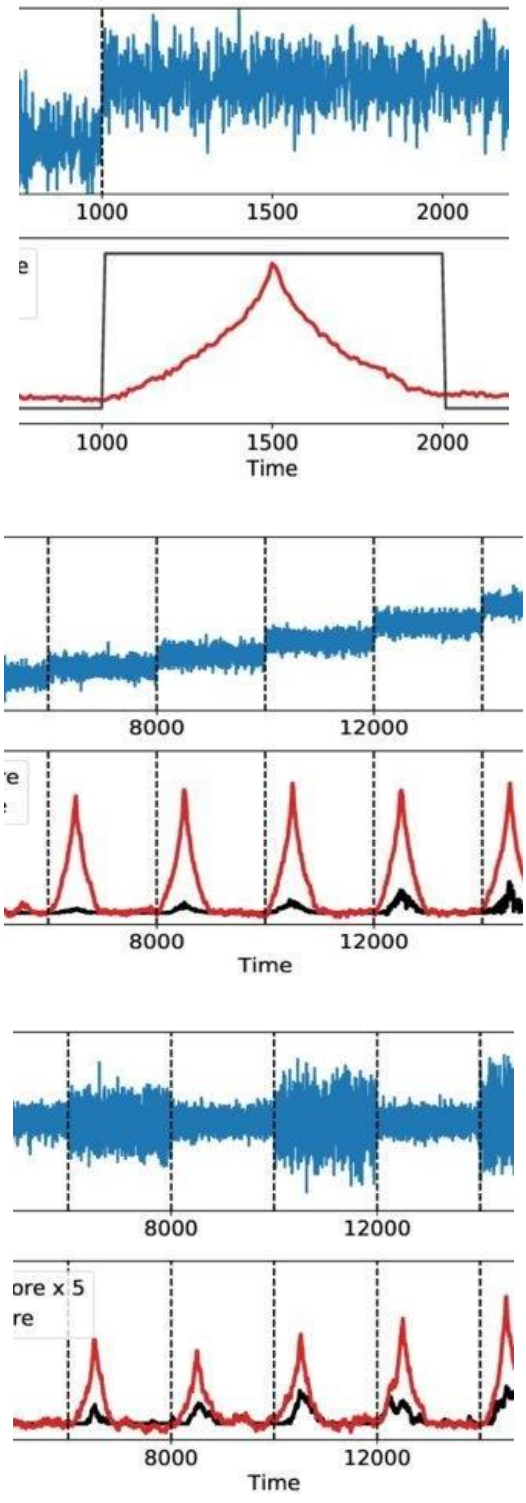
KEYWORD: A random forest-based approach for voltage security monitoring in a power system.

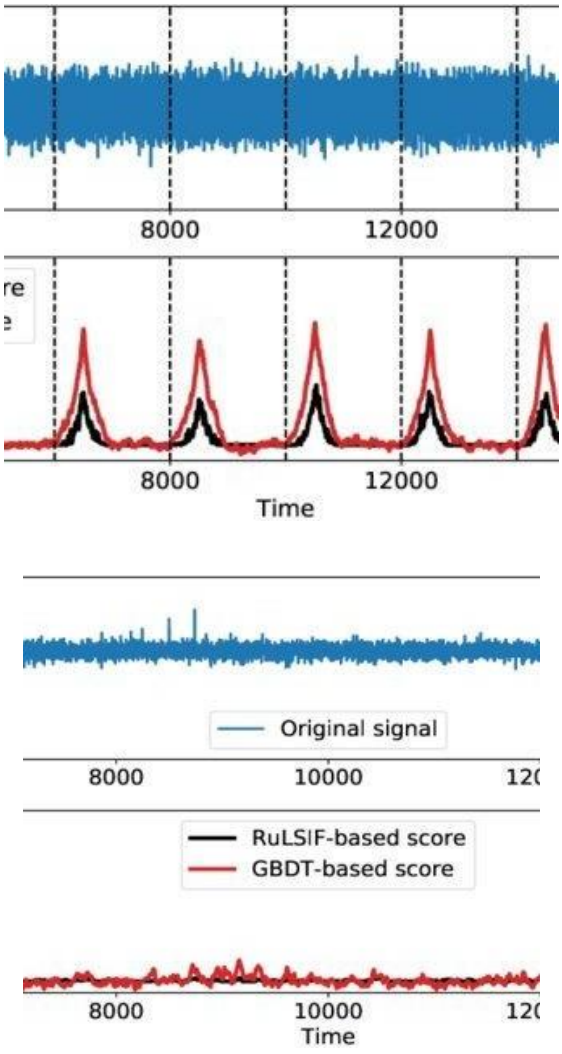
A random forest-based approach for voltage security monitoring in a power system



Voltage collapse is a critical problem that impacts power system operational security. Timely

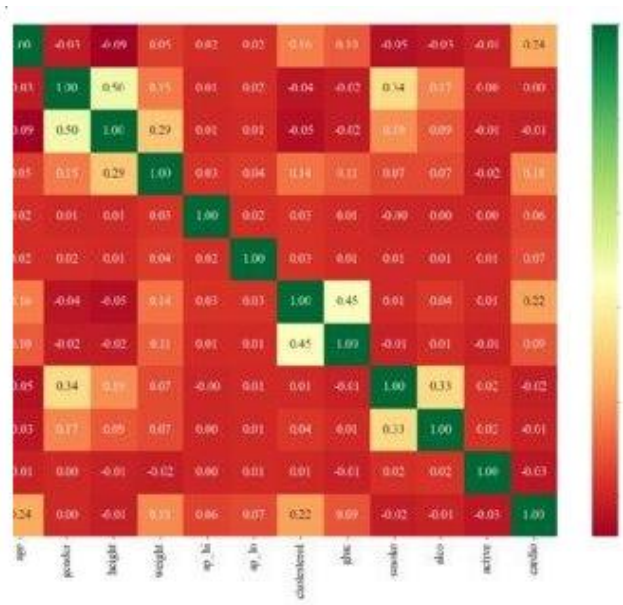
and accurate assessment of voltage security is necessary to detect alarm states in order to prevent a large- scale blackout. This paper presents an on-line voltage security assessment scheme using periodically updated random forest-based decision trees.



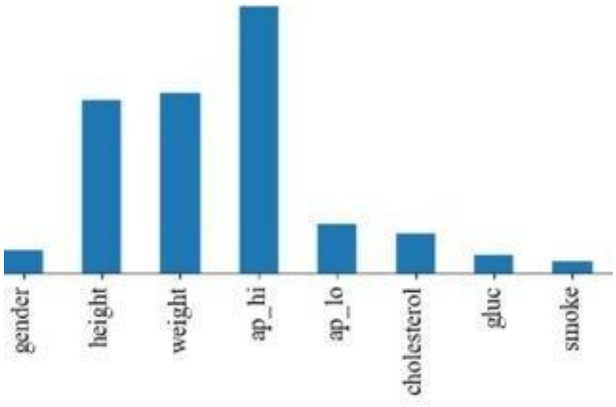


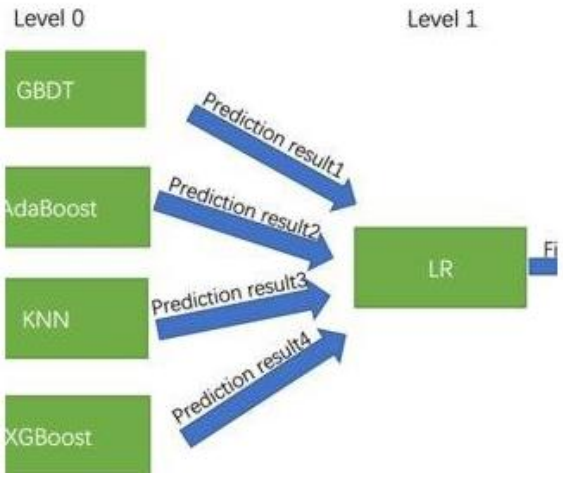
Generalization of change-point Detection in Time series Data Based on Direct Density Ratio Estimation

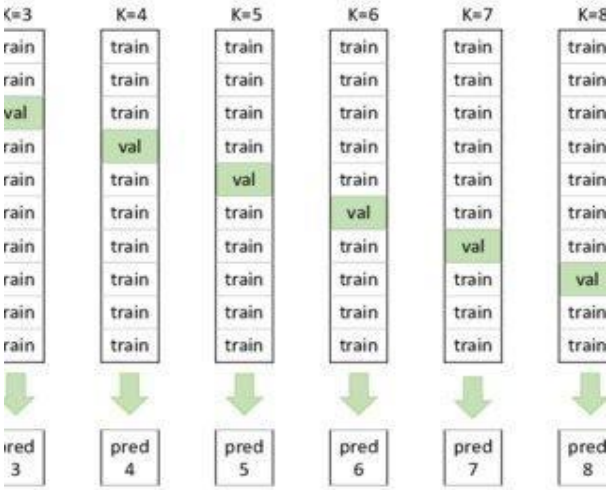
The goal of the change-point detection is to discover changes of time series distribution. One of the state of the art approaches of the change-point detection are based on direct density ratio estimation. In this work we show how existing algorithms can be generalized using various binary classification and regression models. In particular, we show.



Decision Tree Feature Importance

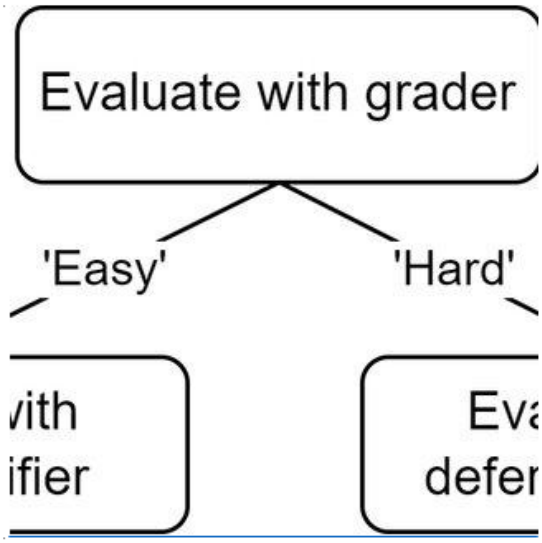


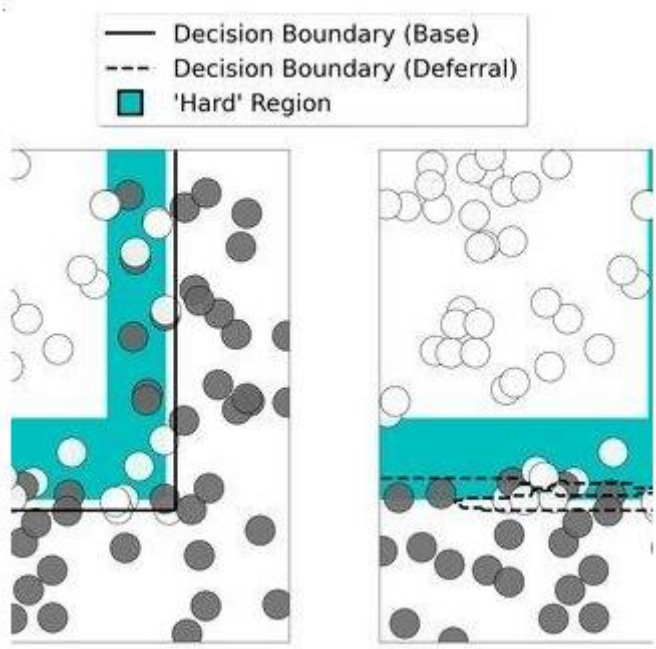




F	GBDT	AdaBoost
)	(%)	(%)
0±	85.26±	85.38±
43	16.61	17.75
0±	86.08±	86.98±
38	15.64	16.33
5±	84.07±	82.19±
45	19.28	20.90
2±	85.18±	84.52±
92	17.71	18.69

- Jul 2024





set	Abbr.	# Features	#
hentication	Bnk	4	
Service Center	Bld	4	
nson (Diagnosis)	Brst	30	
ulation Crashes	Clim	20	
State	EEG	14	
rray Drift	Gas	128	
here	Ins	34	
atellite	Land	36	
Detection	Ozn	72	
gradation	QSAR	41	
ase	Spm	57	
s Faults	Stl	27	
le	Veh	18	
t	Yst	8	

ng	Test	Training	Test	Ti
)	95.42	99.79	98.57	
1	77.62	90.05	75.26	
7	93.28	99.98	93.92	
7	90.22	99.66	90.48	
7	70.19	93.51	87.92	
7	72.96	96.16	95.50	
7	87.35	99.62	89.35	
3	78.83	96.98	90.46	
2	92.97	99.40	93.99	
2	80.92	96.83	85.01	
3	89.53	97.45	94.38	
9	60.76	95.08	76.86	
7	68.21	96.26	72.88	
4	56.85	92.95	61.16	

Integrating White and Black Box Techniques for Inter pre table Machine Learning

In machine learning algorithm design, there exists a trade-off between the interpretability and performance of the algorithm. In general, algorithms which are simpler and easier for humans to comprehend tend to show worse performance than more complex, less transparent algorithms. For example, a random forest classifier is likely to be more accurate.

e	Description
	Sparse
	Sparse
	Dense
	Sparse
	Sparse

ıe values in the table

gb_his	lgb_baseline
2.63	6.07
1.05	1.39
0.63	0.49
OOM	39.85
OOM	168.26

LightGBM: A highly Efficient Gradient Boosting Decision Tree:

>Conference Paper;

Gradient Boosting Decision Tree (GBDT) is a popular machine learning algorithm , and has quite a few effective implementations such as XGBoost and pGBRT. Although many engineering optimizations have been adopted in these implementations , the efficiency and scalability are still unsatisfactory when the feature dimension is high and data size is large

>Jan 2023

A DT-based online voltage security assessment scheme focused on voltage collapse problems caused by severe disturbances was proposed in [71]. The authors simulated an N-l contingency case for each considered operating scenario, and real-time measurements were carried out periodically to update the system information. ...

A Review on Data-Driven Security Assessment of Power system: Trends and Application of Artificial Intelligence

>Jan 2023

Boosting the complexity of the electricity network, penetration of renewable resources, and modernization of power systems has resulted in an increase in the complexity of the power systems security assessment (PSSA). In this context, to decrease the vulnerability of the systems to multiple instability threats and security issues while ensuring the safe operation of the power systems, providing effective online security assessment methods capable of monitoring the systems' security under varying conditions is vital. However, although the traditional methods have demonstrated efficient PSSA performance, intelligent data-driven approaches have effectively overcome the traditional approaches by delivering impressive and rapid PSSA performance. Artificial intelligence (AI) -based techniques are required to guarantee the efficient, optimal, and safe security assessment. The usage of AI is emphasized due to its computational speed for online performance and its flexibility for providing corrective actions for insecure operating conditions to achieve a seamless transition in power systems. In this review, various available data-driven methods in power system security are comprehensively reviewed into two primary classifications: static and dynamic security assessment. The evaluated study aims to highlight the merits and demerits of developed techniques as well as their limitations to provide decision-making assistant for future investigations.

... RF uses ensemble learning, which is a strategy that join many classifiers to deliver solutions to complex problems A RF algorithm stands on many

All the countries are in needs of renewable energy (RE) penetration into their power system. As Bangladesh power system (BPS) depends on fossil fuel by 99% of its total generation capacity, it is very much focusing on having RE. In its Western grid, it has planned to install 55 MW wind turbine generator (WTG) and 100 MW solar photovoltaic generator (SPVG). It is expected that the system will be upset from stability perspective. To increase the power system security, contingency analysis is needed. But the power system operation parameters are always variable, with conventional load flow method, it is impossible to carry out contingency analysis according to such variations in parameters. So, this present work adopts machine learning (ML) to predict the contingency analysis by determining the performance indices (PI) with variable operating conditions in a quick time. Decision tree (DT), random forest (RF) and extra tree (ET) methods based supervised learning will be used to predict the result for the contingency analysis. Comparison among these methods will be carried out to get the most suitable one. Also, due to RE penetration, the system will be vulnerable to voltage due to reduction in reactive power. Adoption of static synchronous compensator (STATCOM) will help to reduce the voltage stress of the system. Effective location of it is very essential, so that it can enhance the voltage stability. In this paper, modal analysis technique will be used to find out the optimal location for a STATCOM and to calculate the enhancement in stability.

... The proposed method takes into account the distributed generations and demands in order to predict the system security. The security assessment is carried out within short intervals considering the possibilities of a major three phase fault takes place in the near future [16,17].

...

... This analysis explores the idea that under different energy demand and distributed energy generation, the impact of a three phase fault can either be critical or non-critical [16]. The proposed method figures out that criticality and prepares a set of optimized contingent scenarios for restoring the system. …

>ELECTRO POWER SYSTEM RESOURSE:

A machine learning based optimized energy dispatching scheme for restoring a hybrid microgrid

... The main idea here lies in an intelligent model learning to independently determine the current value of an assumed indicator on the basis of input data, thus identifying the current state of the EPS. As the studies [95,96] show, such a modified approach makes it possible to neutralize the drawbacks of traditional algorithmic approaches, owing to the original

properties of the machine learning technologies. ...

... The authors tested the most popular machine learning models that have been proposed recently to solve the problems of security assessment of EPSs. These are: neural networks of Kohonen, SVMs, hybrid neural network models, and various decision-tree algorithms [96,115,116]. The capability of these algorithms to effectively identify operating conditions of EPSs was demonstrated on various test schemes of IEEE involving different stability indicators as target vectors for training the models. ...

Intelligent control and protection in the russia electric power system

... The main idea here lies in an intelligent model learning to independently determine current value of an assumed indicator on the basis of input data, thus identifying the current state of power system. As the studies [5,6] show such a modified approach makes it possible to neutralize the drawbacks of traditional algorithmic approaches owing to the original properties of the machine learning technologies. ...

... The authors tested the most popular machine learning models such as neural networks, support vector machines, various decision tree algorithms that have been proposed recently to solve the problems of security assessment of electric power systems [6][7][8]. Capability of these algorithms to effectively identify operating conditions of electric power systems was demonstrated on various test schemes of IEEE involving different stability indicators as target vectors for training the models. ...

Development of automatic intelligent system for online voltage security of power system

>Conference Paper

... The paper proposes a new semi-automated algorithm based on ML models for on-line security assessment of electric power system (Fig. 3). The main idea of this approach lies in constructing a universal classifier of power system states, which is capable, using certain security indices of the system, to trace dangerous pre-emergency conditions and predict emergencies [12]. The innovation of this approach consists in the use of an automatic procedure for empirical evaluation of generalization abilities of the models such as ANN, decision trees, support vector machine (SVM), etc. included in the test research. ...

Development of computational intelligence intelligence-based algorithm of preventing voltage collapse in power system with a complex

>Conference Paper

Majority of recent large-scale blackouts have been caused by voltage instability. This paper

proposes new algorithms and implementation principles of an intelligent emergency control based on machine learning models and decentralized adaptive models that can effectively prevent voltage instability before they lead to major blackouts and overall collapse of the system. The proposed algorithms have been implemented using MATLAB and R environments. The feasibility of the approach in a proof-of-concept has been demonstrated on the IEEE 118.

Contingency-based Voltage Stability Monitoring via Neural network with Multi-level Feature Fusion

To monitor the voltage stability state of complex power grid, a four-category stability classification problem that incorporates a set of serious contingencies is posed. Quick decision-making and high accuracy are critical for the safety operation of power system. However, this problem involves feature of different types, levels and dimensions and is hard to be handled by the traditional classifier. This paper utilizes the deep learning technique and proposes a multi-level deep neural network (ML-DNN) that achieves feature fusion of the electrical parameter measurements, topology and contingency information. experiments are implemented on IEEE-39 system, the ML-DNN performs better in four main evaluation indices comparing with five existing models, which demonstrates its advantage for online voltage stability monitoring.

Improvement in the computational Efficiency of a Technique for a Assessing the Reliability of Electric Power System Based on the Monte Carlo Method

>RELIABALE ENGINEERING SYSTEM SAFE

The reliability of energy systems is assessed to control their operation and expansion. An effective method for reliability assessment is the Monte Carlo method. This process, however, is often time- consuming due to the large size of the power system. This interferes with subsequent control problems. The speed of reliability assessment and the accuracy of the result for the Monte Carlo method directly depend on the number of randomly generated states of the system, their quality and the complexity of the subproblem to be solved for each state. When solving such a subproblem for reliability assessment, random states can be defined as a shortage and shortage-free ones. To assess the reliability of power systems using the Monte Carlo method, one should analyze only the state of the system with a shortage. We suggest the use of machine learning methods to eliminate or sort the shortage and shortage-free states. The paper demonstrates the effectiveness of two methods: a support vector

machine and a random forest. It also shows their performance when the Monte Carlo and quasi-Monte Carlo methods are used.

Automated Classification of Power Plants by Generation Type

>Conference Paper

Construction of decision tree based on C4.5 algorithm for online voltage stability assessment

>INTECT JUNCTION ELECTRO POWER

This paper constructs decision tree (DT) using C4.5 algorithm for online voltage stability assessment. The entire process includes three steps: sample acquisition, attribute selection and DT construction. First, P-V curves analysis is performed to generate samples for DT. Participation factor analysis and relief algorithm are then used to select attributes for DT. C4.5 algorithm is finally applied to construct DT. The case study on a practical power system demonstrates that DT can extract operating guidelines from offline analysis
results, and helps system operators assess voltage stability status in real-time.

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