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CYBER ATTACK DETECTION AND CLASSIFICATION USING MACHINE LEARNING TECHNIQUE USING MICROSOFT AZURE CLOUD

Rajshri Pohekari[1], Vaibhav Patel[2], Anurag Shrivastava[3]

[1] M.Tech Scholar, Computer Science Engineering, NRI Institute of research &Technology, Bhopal
[2]Assistant Professor, Computer Science Engineering, NRI Institute of research &Technology, Bhopal
[1]Asso. Professor &Head, Computer Science Engineering, NRI Institute of research &Technology, Bhopal

Abstract—Information security is always a very important issue for modern computer world. Intrusion Detection System (IDS) as the security technique and is widely used against intrusions. Researchers use Data Mining and Machine learning techniques in intrusion detection research area. Many machine learning methods have also been useful to obtain high detection rate and low false alarm rate. This work aims in design and development of an approach for boost cyber attack detection system using cloud. Uses of cloud computing is increases very progressively. Applying popular and traditional ML Techniques do not support well processing of large datasets, so new approaches and platforms are needed. This paper proposes that cloud based machine learning can be used in order to detect and classify attack into a cloud based machine learning platform. The work proposes a framework to attack classification using KDD Cup99 dataset. The classifier is build which is based on 'Multiclass Decision Forest' Machine Learning Algorithm and is deployed on Microsoft's Azure Machine Learning (Azure ML) platform. Azure ML is public cloud platform. The results obtained by proposed model are evaluated in terms of accuracy and the comparison is done with benchmarks provided by competition administrators. The results obtained are promising and the paper also directs the future research work in the field.

Keywords— Attack Detection, IDS, Classification, Machine Learning, Microsoft Azure Cloud, Cloud Computing.

1. INTRODUCTION

1.1 Machine Learning and Information security using Cloud: [1].

Machine learning can be defined as an intelligent way to find secret patterns or information even in large datasets or databases. In machine learning, computer algorithms (learners) attempt to automatically distill knowledge from example data. This knowledge can be used to make predictions about novel data in the future and to provide insight into the nature of the target concepts applied to the research at hand, this means that a computer would learn to classify alerts into incidents and non-incidents task. A possible performance measure (P) for this task would be the Accuracy with which the machine learning program classifies the instances correctly. Machine learning often included in the category of predictive analytics as it helps to predict the future analysis.

Intrusion Detection System (IDS) is an active process or device that analyzes system and network activity for unauthorized activity [2]. An ID is hardware or software or a combination of both which is used to monitor a system or network of systems against any malicious or unauthorized activities [2]. Intrusion Detection Systems (IDSs) are used to improve network security. An ID improves the security of the network by identifying, assessing, and reporting unauthorized network activities. IDS are categorized into two classes: network-based and host-based. Network based Intrusion Detection Systems analyses network packets retrieved from the network. Host-based Intrusion Detection System analyses system calls generated by individual hosts [2].The data flows through a network is very large and it is difficult to analyze and detect the attacks using traditional methods. Today we have number of Machine learning techniques available which are very useful for analyzing the data and detecting the attacks. In this paper we have used various machine learning techniques for network intrusion detection [2].

1.2 Microsoft Azure Cloud Computing Environment for Machine learning [3]: Microsoft's Azure Machine Learning (Azure ML) [3] is a cloud service that enables execution of machine learning process. Microsoft Azure is a public cloud platform. The benefits of using public cloud computing platform (Azure ML) includes: handling big data and access from anywhere in the world. The process of Azure ML is shown in Figure – 2, which is same as that of basic process of ML. Azure ML provides a graphical tool for managing the ML process, a set of

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data pre-processing modules, a set of machine learning algorithms, and an API to launch a model to applications. ML Studio is a graphical tool that is used to control the process from beginning to end i.e. from data pre-processing to run experiments using a machine learning algorithm, and test the resulting model. ML Studio also helps its users deploy that model on real cloud.

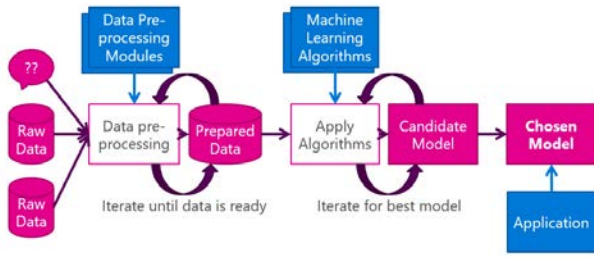

Figure 1: Machine Learning Process

The need of cloud platforms to classify KDD data is established in next section. The rest of the paper organized as: Section 2 briefly surveys the need of cloud platforms fir IDS in KDD dataset. The work proposed is presented in section 3.Experimental setup and result analysis is shown in section 4 and paper is concluded in section 5.

2. Literature Review (Need of Cloud Platforms for IDS)

Traditional Intrusion detection system using data mining and machine learning techniques are work on information system they are not working on cloud environment. Here give some literature about Intrusion detection system and using cloud for classification with machine learning techniques. Multiple choices of cloud computing models are available for different work load management, performance and computational requirements. The popular statistical tools and environments like Octave, R and Python are now embedded in the cloud as well [5].

A. Fast Analysis: The important findings of work [6] indicate the area of customer retention received most research attention.

B. Machine Learning on Cloud environment for Fast Prediction in Big Data: As the data is growing at faster rate and becoming "Big Data", the computation speed for prediction and other operations is inevitable. This paper [7] focused on the specific problem of classification of network intrusion traffic which is a Big Data.

Authors [3] worked on IDS for web proxy, taking inspiration from Intrusion Detection Systems that make use of machine learning capabilities to improve anomaly detection accuracy, this paper proposes that cloud based machine learning can be used in order to detect and classify web proxy usage by capturing packet data and feeding it into a cloud based machine learning web service.

In this paper, [22] authors examine different machine learning techniques that have been proposed for detecting intrusion by focusing on the hybrid classifier algorithms. The objective is to determine their strengths and weaknesses. From the comparison, authors hope to identify the gap for developing an efficient intrusion detection system that is yet to be researched.

Authors [23] said about the cloud based attack system. Authors add new valued feature to the cloud-based websites and at the same time introduces new threats for such services. DDoS attack is one such serious threat. Covariance matrix approach is used in this article to detect such attacks. The results were encouraging, according to confusion matrix and ROC descriptors.

3. Proposed Framework for CLASSIFICATION:

The Proposed Framework which employs simple ML model with little change. The input KDDcup99 dataset is suitably processed and converted into a suitable format. The machine learning algorithms are iteratively applied in the next step, and candidate model is determined. These ML algorithms typically apply some statistical analysis like regression or more complex approaches like decision forest to the data. Here in the proposed framework, the ensemble methods [12] are also applied to the model for better accuracy. At last the model is deployed and tested on test data the snapshot of actual model build using specified steps, at Microsoft Azure ML platform, is shown in Figure – 2.

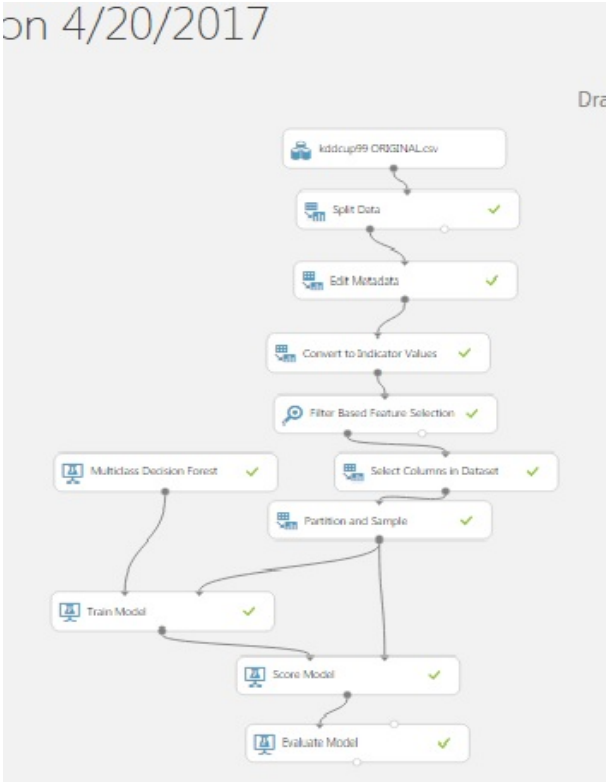

Figure 2: Model built using Azure ML

4. Simulation Environment Setup and Result Analysis:

Azure ML provides ML studio, a graphical tool that can be used to control the process from beginning to end. It includes: a set of data pre-processing modules; a set of machine learning algorithms; An Azure ML API to access model deployed on Azure. ML Studio allows a user to import datasets and data pre-processing methods.

4.1 KDD CUP 99 DATASET: Used in the evaluate machine learning technique. In practice, we recognize

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that this dataset is decade old and has many criticisms for Current research. But we believe that it is still sufficient for our experiment which aims to reflect the performance of distinct machine learning approaches in a general way and find out relevant issues. In addition, the full KDD99 dataset Contain 4,898,431 records and each record contain 41 features. Due to the computing power, we do not use the full dataset of KDD99 in the experiment but a 10% portion use of it. This 10% KDD99 dataset contains 494,021 records (each with 41 features) and 4 categories of attacks. The details of attack categories and specific types are shown in Table1. According to Table1, there are four attack categories in 10% KDD99 dataset:

(1) Probing: Scan networks to gather deeper information
(2) DoS: Denial of service
(3) U2R: Illegal access to gain super user privileges
(4) R2L: Illegal access from a remote machine.

4.2 Execution of Implemented Work (Experiment Steps): The experimental steps that are and represented in Figure–2, are explained below:

1. Create New Resource: Machine Learning Analytics solution.
2. Import/Upload the dataset.
3. Pre-process the dataset. Data pre-processing can also be done using modules written in R or Python.
4. Randomly split and partition the data into 70% training and 30% testing, using the 'Split Data' module.
5. Identify categorical attributes and cast them into categorical features using the 'Edit Metadata' module.
6. Convert to Indicator Values module to convert columns that contain categorical values which can more easily be used as features.
7. Select Columns in Dataset those are relevant
8. Apply Ensemble Method
9. Apply Machine Learning Algorithm to Train the model.
10. Now Score and Evaluate the Model. The 'Evaluate model' also visualizes the results through confusion matrix.

4.3 Experimental Results: Analysis and Discussion: The experiment is evaluated on a simple multi-class decision tree classification accuracy parameter. Accuracy is defined as the number of correctly classified instances divided by the total number of instances:

$$\text{Accuracy} = \frac{\text{Number of correct Predictions}}{\text{Number of Instances}}$$

The results obtained using the benchmark code by setting the neural network model with 100 trees got the accuracy of 0.9302 in [8], while the benchmark results given by competition administrators with 10 trees is 0.50241. Here we have performed experiment at cloud platform with Multicast Decision tree ML [10] method with 10 trees and an ensemble method. The evaluation results are inferred from confusion matrix shown in Figure – 3. A confusion matrix also known as error matrix and is used to describe the performance of a classifier (classification model). The overall accuracy obtained with our simulation is 0.9841, which is higher than the benchmark provided. The comparison of proposed model is done with benchmark provided by administrators and competition's winning results.

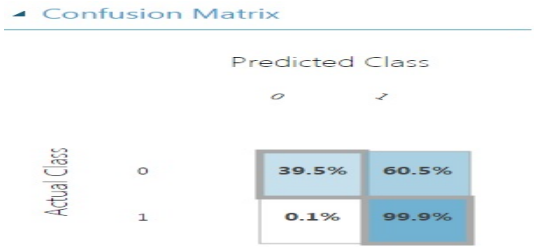

Figure 3: Confusion Matrix with Multicast Decision forest

The comparison for accuracy obtained, is shown in Figure–4.

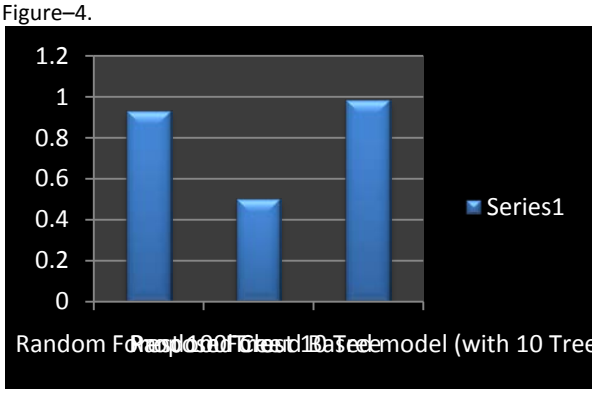

Figure 4: Comparison for Accuracy

5. Conclusion & Future Work

In this paper, Machine Learning technique have been proposed in terms of accuracy, detection rate, false alarm rate and accuracy for four categories of attack under different percentage of normal data. The purpose of this proposed method efficiently classify abnormal and normal data by using very large data set and detect intrusions even in large datasets with short training and testing times. With proposed method we get high accuracy for many categories of attacks and detection rate with low false alarm. In this paper, we proposed an Azure ML based model for attack classification. The model used Multicast Decision tree algorithm to train the classifier. The evaluation results show that the proposed classifier performs better in terms of accuracy. We have performed experiment with 10 trees and an ensemble method. Our experiments showed the better accuracy than benchmark .The proposed research can provide potential approach for training and testing of big data for addressing multi-class classification problems. So, further research will evaluate the framework with different ML algorithms. In future the model can be optimized to handle imbalanced datasets from various sources and domains. Also, the model can be modified for applying on Hadoop MapReduce [11] platform.

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