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Intrusion Detection System Using Machine Learning

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Abstract: For protecting and securing the network, Intrusion Detection Systems through hidden intrusion have become a popular and important issue in the network security sphere. The detection of attacks is the first step to securing any system. In this paper, the focus is on seven different attacks, including Brute Force attacks, Heartbleed/ Denial- of-service(dos), Web Attacks, Infiltration, Botnet, Port overlook, and Distributed Denial of Service (DDoS). We calculate features deduced from CICIDS- 2017 Dataset for these attacks. By using colorful subset-grounded point selection ways the performance of the attack has been linked to numerous features. Using these ways, the applicable group of attributes for changing every attack with affiliated bracket algorithms has been determined. Simulations of these ways present that unwanted points can be removed from attack detection ways and find the most precious set of attributes for a definite bracket algorithm with discretization and without discretization, which ameliorates the performance of the IDS preface.

1. INTRODUCTION

The Intrusion Detection Evaluation collection (CICIDS2017) is a collection of network businesses that includes both regular business and dissembled data brought on by deliberate attacks on a test network. For computer networks to be properly defended against outside threats, intrusion detection, and prevention systems are essential. For these systems to perform well and constantly distinguish between a secure network and one that has been compromised, current and material data must be used to educate them. With a variety of realistic typical network assaults used to pretend attacks on a controlled network, the IDS 2017 Dataset was developed with the mitigation of ultramodern attacks in mind.

The Intrusion Detection System (IDS) is a important tool for defending networks from numerous kinds of attacks. IDSs are primarily used to identify and stop unauthorized network access. Host-based intrusion detection systems (HIDS) and network-based intrusion detection systems (NIDS) are the two subcategories of IDS. While NIDS analyses network business, HIDS focuses on a single host's conduct. NIDS will be the main content of this essay. Different Intrusion Detection Method Types of Intrusion Detection ways There are several ways used in intrusion detection systems. The most generally used are – Signature-Based Detection – it also known as a rule- based detection, which involves comparing the network business against a set of predefined rules or signatures. However, the IDS raises an alarm If the business matches a hand. Anomaly- Based Detection Anomaly- based detection involves covering the network business and relating diversions from normal gester. The IDS raises an alarm if the business deviates from the anticipated gester. Hybrid Detection combines signature-based and anomaly-based detection ways. This approach provides better detection delicacy than either of the individual ways.

Literature Survey

According to Vilhelm Gustavsson's [1] study proposal, the collection of attacks that were tested for this project are assaulted from the CICIDS2017 dataset. Since Zeek is unable to block malicious traffic, the emphasis of this thesis is on detecting it. No neural networks or deep learning are used; machine learning is restricted to statistical learning techniques. There is no user interface created for the alarms generated by machine learning categorization; they are just output to a text file or terminal. Both Luke Hsiao and Stephen Ibanez. [2] In this study, we use a standard approach to applying machine learning for NIDS, framing the issue as an unsupervised anomaly detection challenge, where we want to train a model to recognize regular, attack-free data and afterward recognize abnormal, potentially malicious traffic. To detect anomalies, we use two different techniques: a non-stationary model based on the Packet Header Anomaly Detection and a stationary model utilizing a combination of Gaussians without taking time into account.

Xilei Wang, Liru Long, and Xiaoxi Zhu. This study got its training and test data sets from the KDDCup99 website, which hosts an annual Data Mining and Knowledge Detection competition on behalf of the ACM Special Interest Group. To create network connection records, which each contain 41 feature fields and a class field, raw TCP dump data from a simulated LAN is analyzed.

A Hiten Patel. In this study, a classical machine learning (ML)-based anomaly detection system is used to identify and classify network traffic by examining manually derived network traffic attributes. Such methods continue to have a high false positive rate, which severely reduces the effectiveness of in-time detection, adds a significant amount of manual scrutinizing work, and is unable to identify any undiscovered and novel (0-day) assaults. On the other hand, Deep Learning-based systems have been demonstrated to automatically detect new features and attack patterns to uncover new attacks in this constantly changing environment. Deep Learning-based systems can not only analyze the manually extracted features but can also automatically extract the features from the original traffic.

Ziadoon Salama A. Mostafa, Robiah Yusof, Nazrulzhar Bahaman, and Kamil Maseer. presented in [5] Both supervised and unsupervised learning techniques can be used to train an ML or DL system. Classification is carried out through supervised learning using data instances that have been marked during the training stage. The ANN, DT (both versions c4.5, ID3), k-NN, NB, RF, SVM, and CNN are examples of supervised learning algorithms. Unsupervised learning is used to identify unlabeled data instances, with clustering as the main learning strategy. The techniques for unsupervised learning include SOM, EM clustering, and k-means clustering.

2. METHODOLOGY

The following are important modules that were implemented in the project:

1. Dataset preparation
2. Multiple-class categorization
3. assessing ML models
4. Predicting network packet outcomes

1. Dataset preparation on the CI-CIDS 2017 Dataset, exploratory data analysis was carried out, and feature extraction was completed using Python libraries and domain knowledge research.

2. Different attacks are identified in the dataset using a multi-class classification method by joining the dataset's files together. SMOTE-TOMEK function data balancing for multi-class classification.

3. Importing multiple machine learning models from the Sklearn package for evaluation. dividing the data into training and testing, fitting the training and test sets of data to the models, and analyzing the confusion metrics derived from those models.

4. Network packet outcome prediction- The flask-web framework is made to examine real-time network packets using our most accurate machine learning model, and network sniffing is carried out using the sniffer tool Cyc flowmeter.

3. Diagram

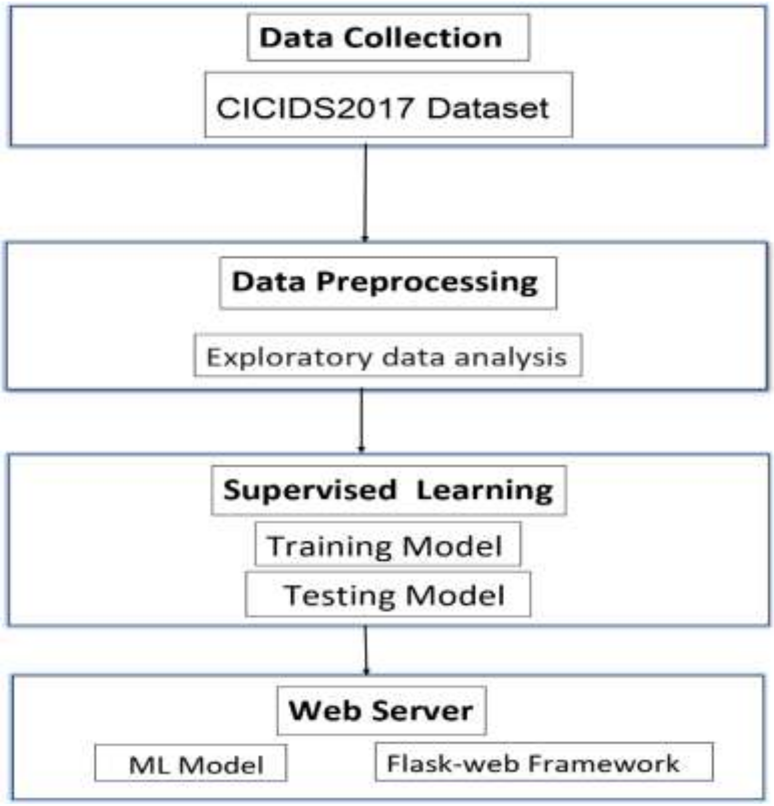


Figure 1.1: Flowchart Diagram

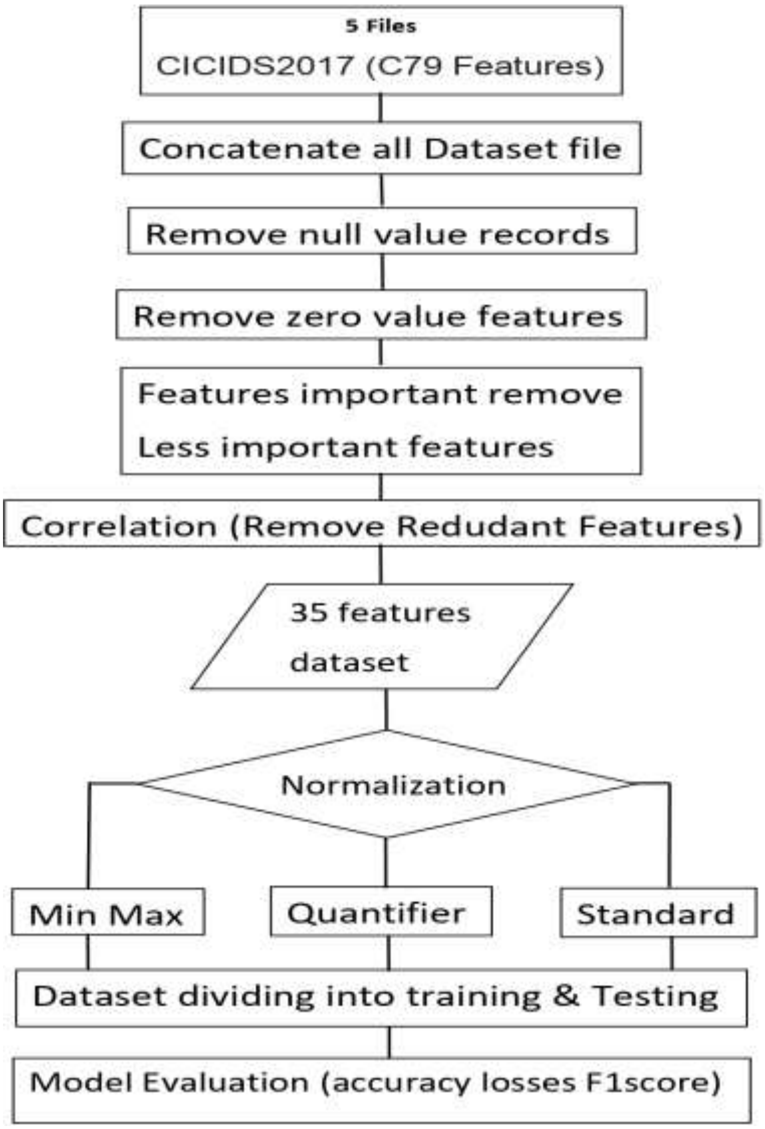
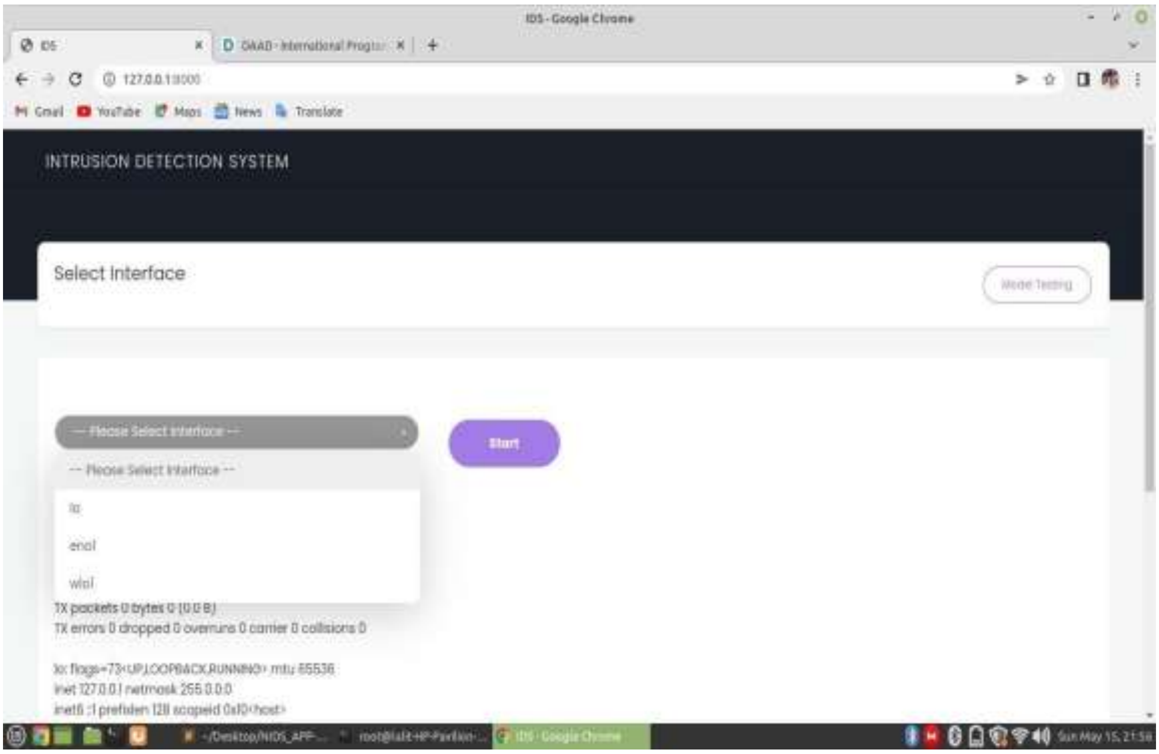

5 Files
CICIDS2017 (C79 Features)
Concatenate all Dataset file
Remove null value records
Remove zero value features
Features important remove
Less important features
Correlation (Remove Redudant Features)
35 features
dataset
Normalization
Min Max
Quantifier
Standard
Dataset dividing into training & Testing
Model Evaluation (accuracy losses F1score)

Figure 1.2: Data Flow Diagram

3. RESULTS

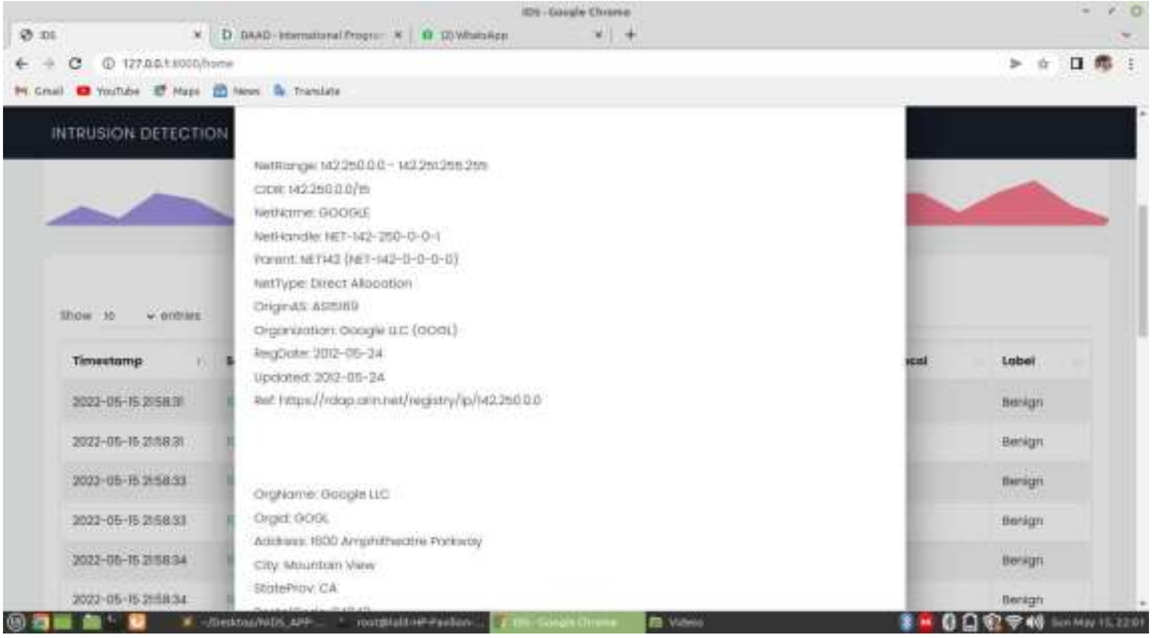
The purpose is to validate that each unit of the software performs as designed. The Proposed System works in following manner: In Network Sniffing Module, we select Interface, easily track and analyze network traffic & also get information about IP Address. In Packets storing module, all the sniffed packages are gathered. In Packets labeling module stage, all the Packets are Identified and Labelled. In Result storing module, we collect information about of total flows and also it stores total number of data flows and data attacks. UI (User Interface) displays Machine Learning Model Information, attacks, Data Flows Information, & How many packets transferred.



```
TX packets 0 bytes 0 (0.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
inet6 ::1 prefixlen 128 scopeid 0x10<host>
```

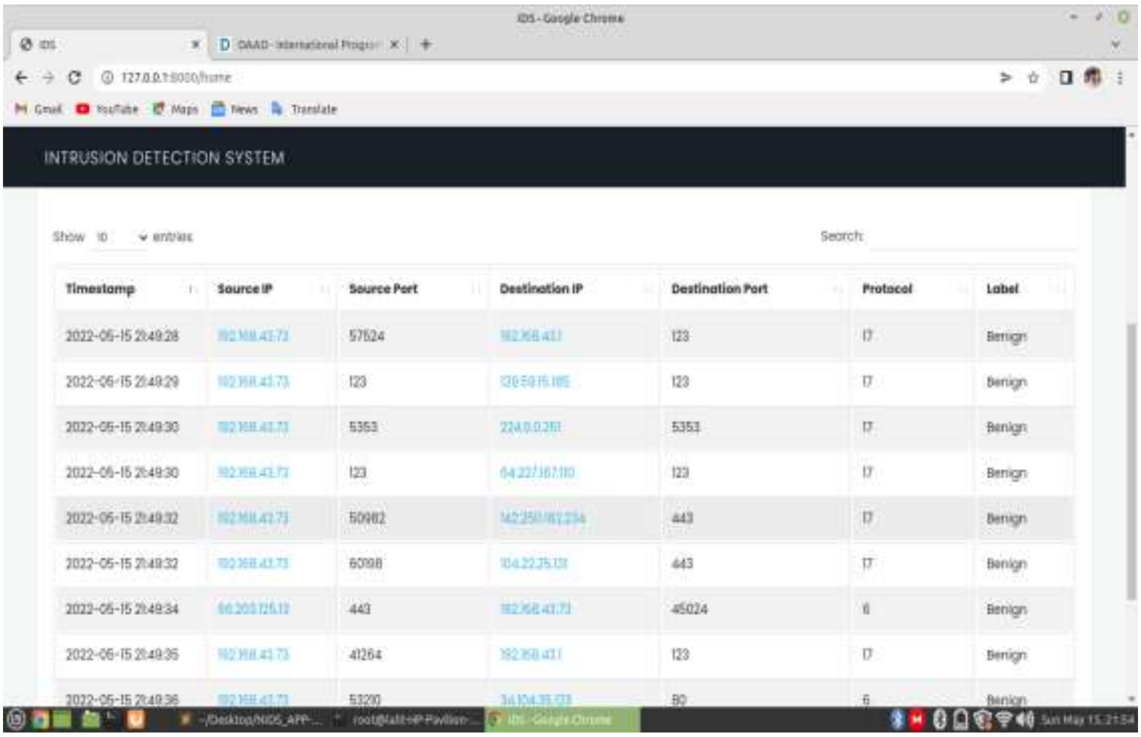
Fig 2.1 Home Page For Selecting Interface



```
NetRange: 142.250.0.0 - 142.251.255.255
CIDR: 142.250.0.0/15
NetName: GOOGLE
NetHandle: NET-142-250-0-0-1
Parent: NET142 (NET-142-0-0-0-0)
NetType: Direct Allocation
OriginAS: AS15169
Organization: Google LLC (GOGL)
RegDate: 2012-05-24
Updated: 2012-05-24
Ref: https://rdap.arin.net/registry/ip/142.250.0.0


OrgName: Google LLC
OrgId: GOGL
Address: 1600 Amphitheatre Parkway
City: Mountain View
StateProv: CA
```

Fig 2.2 IP Information

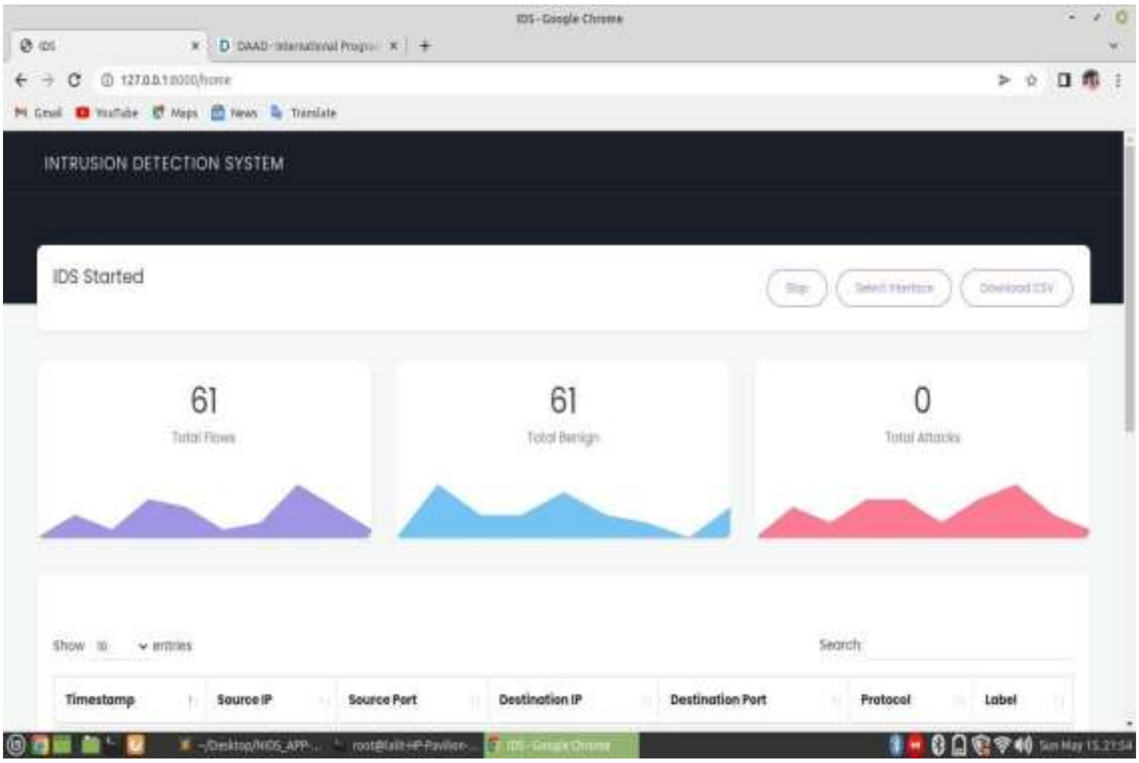


INTRUSION DETECTION SYSTEM

Show 10 entries Search:

Timestamp	Source IP	Source Port	Destination IP	Destination Port	Protocol	Label
2022-05-15 21:49:28	192.168.43.73	57524	192.168.43.1	123	17	Benign
2022-05-15 21:49:29	192.168.43.73	123	139.59.15.185	123	17	Benign
2022-05-15 21:49:30	192.168.43.73	5353	224.0.0.251	5353	17	Benign
2022-05-15 21:49:30	192.168.43.73	123	64.227.167.110	123	17	Benign
2022-05-15 21:49:32	192.168.43.73	50982	142.250.182.234	443	17	Benign
2022-05-15 21:49:32	192.168.43.73	60198	104.22.25.131	443	17	Benign
2022-05-15 21:49:34	66.203.125.12	443	192.168.43.73	45024	6	Benign
2022-05-15 21:49:35	192.168.43.73	41264	192.168.43.1	123	17	Benign
2022-05-15 21:49:36	192.168.43.73	53210	34.104.35.123	80	6	Benign

Fig 2.3 Gathered Sniffed Packets



INTRUSION DETECTION SYSTEM

IDS Started

61 Total Flows

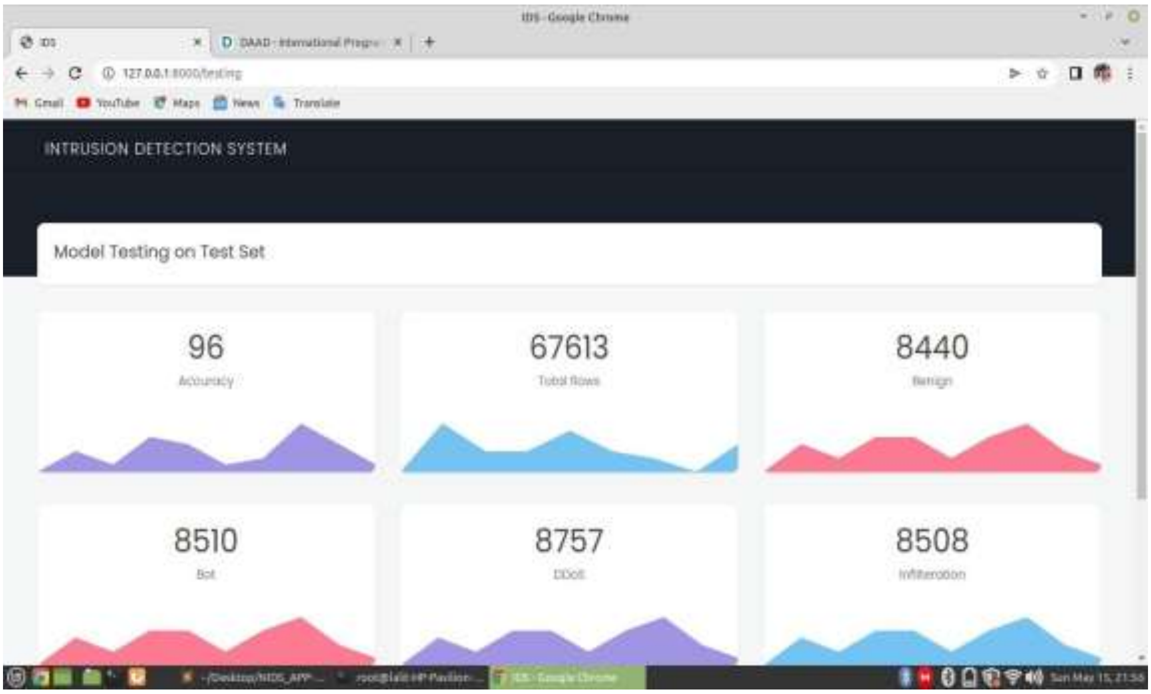
61 Total Benign

0 Total Attacks

Show 10 entries Search:

Timestamp	Source IP	Source Port	Destination IP	Destination Port	Protocol	Label

Fig 2.4 Total Number of Network Packets Gathered and Total Attacks



INTRUSION DETECTION SYSTEM

Model Testing on Test Set

96
Accuracy

67613
Total Rows

8440
Benign

8510
Bot

8757
DDoS

8508
Infilteration

Fig 2.5 Machine Learning Model Information

4. CONCLUSION

When using signature-based detection, sometimes referred to as rule-based detection, network data is compared to a list of predetermined rules or signatures. The IDS triggers an alarm if the traffic matches a signature. This publication analyses earlier studies on AIDS that make use of various datasets. Additionally, testing is how well similar ML-AIDS models perform while trying to identify attacks on a binary dataset. These models demonstrate limits in the multi-classification detection of novel attack types. Additionally, most of these studies employ accuracy as a primary evaluation criterion, which prevents them from fairly comparing and evaluating different ML-AIDS. This work offers a benchmarking approach that leverages real data and several procedures to address this issue, ensuring an accurate assessment of AIDS performance based on ML Algorithms. The evaluation considers several distinct factors, different types of raw network datasets, and suggested performance indicators. Benchmarking experiments are also run utilizing supervised and unsupervised ML techniques (such as ANN, DT, k-NN, NB, RF, SVM, CNN, EM, K-means, and SOM) to evaluate the development of successful ML-AIDS. By executing web assaults against the CICIDS2017 datasets, the tests are carried out. The findings of the experiment demonstrate the lack of a single ML algorithm capable of identifying all kinds of web attacks. Due to their high FP and FN alarms, the SOM-AIDS and EM-AIDS models perform poorly compared to the K-NN-AIDS, DT-AIDS, and NB-AIDS models, which all achieve great performance. Researchers can build a better AIDS model and compare their findings to those of this study with the assistance of the benchmarking approach that has been suggested. Future studies should focus on measuring the impact of feature selection and consider new methodological steps for developing a deep-learning CNN-AIDS model.

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