



**AMRITA**  
**VISHWA VIDYAPEETHAM**

**B Tech -AIE**

**21AIE302 ADVANCED COMPUTER NETWORKS**

**SDN-DDOS-MONITOR:**

**A SIMPLE MACHINE-LEARNING TOOL  
FOR DETECTING AND MITIGATING BOTNET ATTACKS**

**- Ganga Gowri**

**Submitted on**

**23 - 01 – 2023, Wednesday**

**Submitted by**

**Team - 06**

<b>Menta Sai Akshay</b>	<b>- CB.EN. U4AIE20040</b>
<b>Penaka Vishnu Reddy</b>	<b>- CB.EN. U4AIE20048</b>
<b>Sajja Bala Karthikeya</b>	<b>- CB.EN. U4AIE20065</b>
<b>Dharavathu Rohith</b>	<b>- CB.EN. U4AIE20060</b>
<b>Rachure Charith Sai</b>	<b>- CB.EN. U4AIE20055</b>

## **TABLE OF CONTENTS**

1. Abstract
2. Introduction
3. DDOS botnet attack
  - a. Distributed Denial of Service (DDoS)
  - b. Botnet Attack
  - c. DDOS Attack Types
4. Detection using entropy
  - a. Why We Use Entropy
  - b. Entropy Detection
  - c. POX Controller
  - d. Connecting to POX Controller
  - e. Creating a Topology
  - f. Anomaly Detection Using Entropy
5. Generating normal traffic
6. Generation DDOS traffic
7. Detection and mitigation Using ML algorithms
8. Commands
9. Output & Results
10. Future Works
11. Conclusion

## **ABSTRACT**

### **Title: Sdn-Ddos-Monitor: A Simple Machine Learning Tool For Detecting And Mitigating Botnet**

Software defined networking is going to be an essential part of networking domain which moves the traditional networking domain to automation network. Data security is going to be an important factor in this new networking architecture. The packets which travel through the network are prone to attacks and this paper aims to classify the traffic into normal and malicious classes based on features given in dataset by using various machine learning techniques using RapidMiner tool. The generated dataset is processed and applied on various Machine learning models. Out of which best performing model will be chosen and used to detect attacks in real-time on our SDN.

This project aims to implement different Machine Learning (ML) algorithms in RAPIDMINER tool to analyze the detection performance for DDoS attacks using realtime dataset generated on our SDN network. This research has used four different types of ML algorithms which are K\_Nearest\_Neighbors (K-NN), Super Vector Machine (SVM), Deep Learning (DL) and Random Forest (RF). The best accuracy result in the presented evaluation was achieved when utilizing the Random Forest (RF) algorithms.

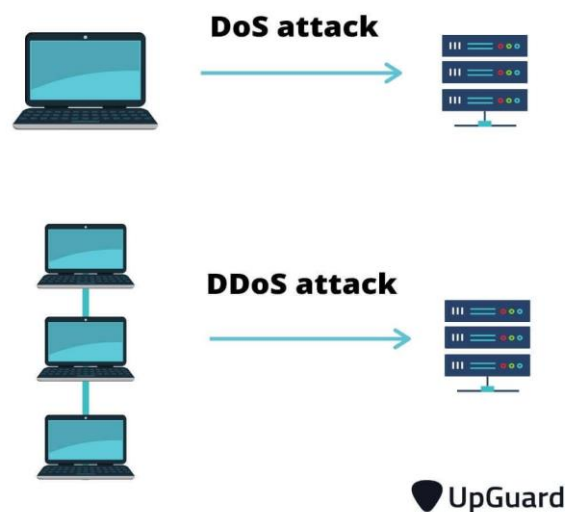
## **Introduction**

SDN breaks the shackles of traditional network complexity and coupling and makes it possible for network architecture to satisfy flexibility, reliability and security at the same time. It separates the control plane from the data plane and separates the control function of the network from the data forwarding function. The control plane is only responsible for routing decisions, while the data plane realizes these decisions by forwarding packets and other behaviors. The separation of the two planes can improve the abstraction and programming ability of the network and makes the network structure less tedious and redundant. Although SDN architecture has many advantages compared with traditional network, it is often subjected to network threats and attacks. Network threats to SDN are mainly reflected in security device licensing and global view acquisition. Because packets are passed according to flow rules, physical security devices do not have the right to decide, and attackers can bypass security devices before deployment. The controller is the core of the entire network and can obtain various network status information. The attacker can use the controller to directly grasp the global view of the network to launch serious attacks. SDN has a clear plane structure, and the attack objects at different planes are different. At the control plane, because the controller manages the entire network, an attacker damaging the controller can cause serious damage. Controllers are the main targets of attacks in recent years.

DDoS attacks send a large amount of traffic to the network and consume network resources and cause network congestion. Many DDoS attacks are launched from distributed hosts. A DDoS attack is an aggressive and destructive network attack that causes the system to stop working by depleting system resources. It can destroy the user's available network services, thus seriously threatening the network. When malicious data packets are sent by attackers on the network, normal traffic is processed or even cannot be processed due to the consumption of network resources. As a result, the network and servers become jammed and normal services are interrupted. Attackers who apply DDoS often target SDN mainly because of its unique characteristics

## DDoS Botnet Attack

DDoS is short for distributed denial of service. A DDoS attack occurs when a threat actor uses resources from multiple, remote locations to attack an organization's online operations. Usually, DDoS attacks focus on generating attacks that manipulate the default, or even proper workings, of network equipment and services (e.g., routers, naming services or caching services). In fact, that's the main problem. When a DDoS attack takes place, the targeted organization experiences a crippling interruption in one or more of its services because the attack has flooded their resources with HTTP requests and traffic, denying access to legitimate users. DDoS attacks are ranked as one of the top four cybersecurity threats of our time, amongst social engineering, ransomware and supply chain attacks.

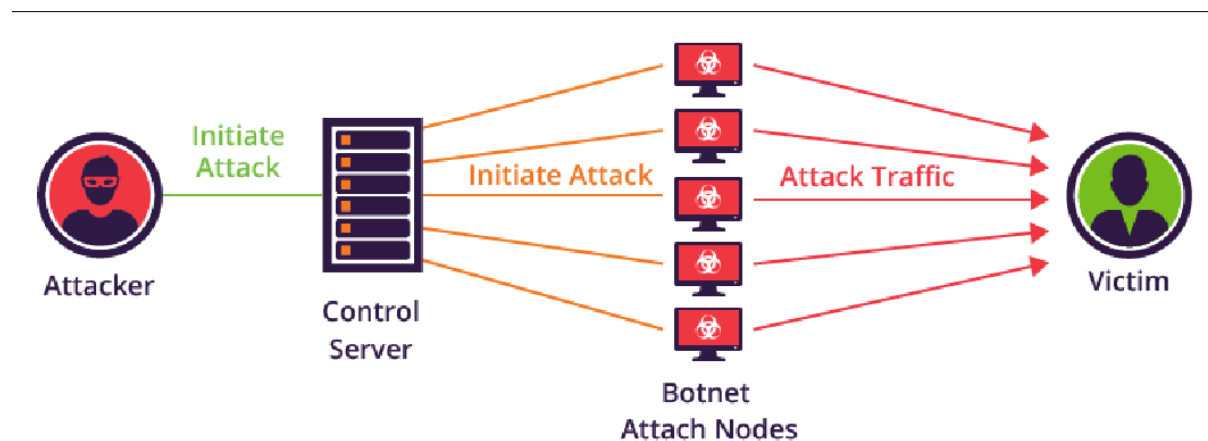


**Denial of Service (DoS):** Attacks using single compromised system to disrupt the authorized use of networks, systems, or applications

**Distributed Denial of Service (DDoS):** Employ multiple compromised computers to perform a coordinated and widely distributed DoS attack

**Botnet Attack :** Collection of compromised computers that are controlled for the purposes of carrying out DDoS attacks or other activities

- Can be large in number
- Systems join a botnet when they become infected by certain types of malware
- Like a virus, but instead of harming the system, it wants to take it over and control it
- Through email attachments, website links, or IM links
- Through unpatched operating system vulnerabilities



## DDOS Attack Types

### Flood Attack

- **TCP SYN flood :** Short for synchronize, SYN is a TCP packet sent to another computer requesting that a connection be established between them. If the SYN is received by the second machine, an SYN/ACK is sent back to the address requested by the SYN. Lastly, if the original computer receives the SYN/ACK, a final ACK is sent
- **UDP flood :** UDP flood is a type of denial-of-service (DoS) attack designed to render a system, server, bandwidth, or machine unavailable for legitimate users and requests. A session less protocol, UDP floods are highly effective and require few resources to execute.
- **ICMP flood :** A ping flood is a denial-of-service attack in which the attacker attempts to overwhelm a targeted device with ICMP echo-request packets, causing the target to become inaccessible to normal traffic. When the attack traffic comes from multiple devices, the attack becomes a DDoS or distributed denial-of-service attack.

## DDOS Attack Detection Using Entropy

This entropy detection method is mainly used to calculate the distribution randomness of some attributes in the network packets' headers. These attributes could be the packet's source IP address, TTL value, or some other values indicating the packet's properties. The higher the randomness the higher is the entropy and vice versa. So, whenever the entropy is less than a threshold value we can say that a DDos attack is occurred.

### Entropy Detection :

$$p_i = \frac{x_i}{\sum_{i=1}^n x_i}$$

x = Defines destination IP address ; n = No. of packets in window ;

p = Probability of each element in the window

$$H1 = - \sum_{i=1}^n p_i \log p_i$$

H1 = Information entropy of destination IP address Packets ;

P = Probability of each element in the Window ; n = No. of Packets in window

**POX Controller :** The Pox controller is used in this experiment. It is widely used in experiments with highspeed and light weight. It is designed as a platform, so a user-defined controller can be built on it. Pox provides OpenFlow interface for topology and path selection. The kernel is the assembly point for all components, and components can interact with each other through the kernel. Pox provides Openflow interface for topology discovery and path selection and can customize components to realize specific functions. Pox controller supports rapid development of controller prototype functions and it can produce superior performance applications, which decreases the burden of developers and improves development efficiency

**Connecting to POX Controller :**

```
Activities Terminal Jan 22 21:51
vishnu@mtlp-520: ~/pox
vishnu@mtlp-520: ~/pox$ python3 ./pox.py forwarding_learning_file
POX 0.7.0 (gar) / Copyright 2011-2020 James McCauley, et al.
WARNING:version:Support for Python 3 is experimental.
INFO:core:POX 0.7.0 (gar) is up.
INFO:openflow.of_01:[00-00-00-00-00-06 1] connected
INFO:openflow.of_01:[00-00-00-00-00-01 2] connected
INFO:openflow.of_01:[00-00-00-00-00-03 3] connected
INFO:openflow.of_01:[00-00-00-00-00-02 4] connected
INFO:openflow.of_01:[00-00-00-00-00-08 5] connected
INFO:openflow.of_01:[00-00-00-00-00-09 6] connected
INFO:openflow.of_01:[00-00-00-00-00-07 7] connected
INFO:openflow.of_01:[00-00-00-00-00-04 8] connected
INFO:openflow.of_01:[00-00-00-00-00-05 9] connected
```

## Creating a Topology :

```
Activities Terminal Jan 22 21:45
vishnu@mtlp-520: ~/pox
vishnu@mtlp-520: ~/pox$ sudo mn --switch ovsk --topo tree,depth=2,fanout=8 --controller=remote,ip=127.0.0.1,port=6633
[sudo] password for vishnu:
*** Creating network
*** Adding controller
Unable to contact the remote controller at 127.0.0.1:6633
*** Adding hosts:
h1 h2 h3 h4 h5 h6 h7 h8 h9 h10 h11 h12 h13 h14 h15 h16 h17 h18 h19 h20 h21 h22 h23 h24 h25 h26 h27 h28 h29 h30 h31 h32 h33 h34 h35 h36 h37 h38
h39 h40 h41 h42 h43 h44 h45 h46 h47 h48 h49 h50 h51 h52 h53 h54 h55 h56 h57 h58 h59 h60 h61 h62 h63 h64
*** Adding switches:
s1 s2 s3 s4 s5 s6 s7 s8 s9
*** Adding links:
(s1, s2) (s1, s3) (s1, s4) (s1, s5) (s1, s6) (s1, s7) (s1, s8) (s1, s9) (s2, h1) (s2, h2) (s2, h3) (s2, h4) (s2, h5) (s2, h6) (s2, h7) (s2, h8)
(s3, h9) (s3, h10) (s3, h11) (s3, h12) (s3, h13) (s3, h14) (s3, h15) (s3, h16) (s4, h17) (s4, h18) (s4, h19) (s4, h20) (s4, h21) (s4, h22) (s4, h23) (s4, h24)
(s5, h25) (s5, h26) (s5, h27) (s5, h28) (s5, h29) (s5, h30) (s5, h31) (s5, h32) (s6, h33) (s6, h34) (s6, h35) (s6, h36) (s6, h37) (s6, h38) (s6, h39) (s6, h40)
(s7, h41) (s7, h42) (s7, h43) (s7, h44) (s7, h45) (s7, h46) (s7, h47) (s7, h48) (s8, h49) (s8, h50) (s8, h51) (s8, h52) (s8, h53) (s8, h54) (s8, h55) (s8, h56)
(s9, h57) (s9, h58) (s9, h59) (s9, h60) (s9, h61) (s9, h62) (s9, h63) (s9, h64)
*** Configuring hosts
h1 h2 h3 h4 h5 h6 h7 h8 h9 h10 h11 h12 h13 h14 h15 h16 h17 h18 h19 h20 h21 h22 h23 h24 h25 h26 h27 h28 h29 h30 h31 h32 h33 h34 h35 h36 h37 h38
h39 h40 h41 h42 h43 h44 h45 h46 h47 h48 h49 h50 h51 h52 h53 h54 h55 h56 h57 h58 h59 h60 h61 h62 h63 h64
*** Starting controller
c0
*** Starting 9 switches
s1 s2 s3 s4 s5 s6 s7 s8 s9 ...
*** Starting CLI:
mininet>
```

## Anomaly Detection Using Entropy :

Entropy = 1 Normal Traffic , Change in Entropy = DDOS Attack



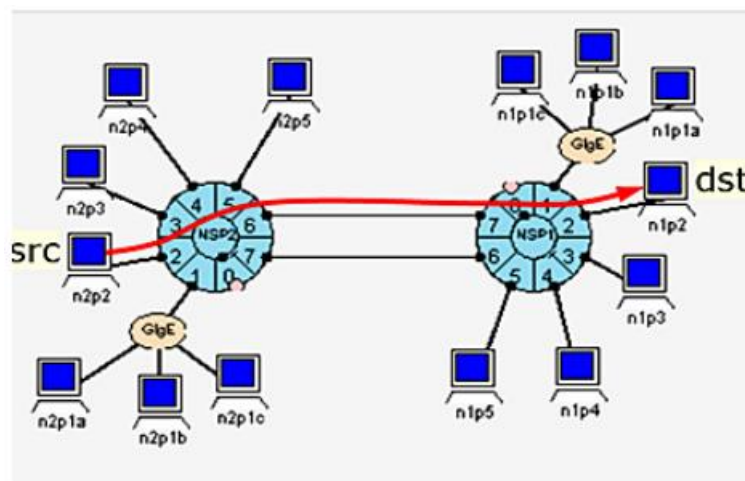
```

Activities  Terminal  Jan 22 22:22
vishnu@mtlp-520: ~/pox
vishnu@mtlp-520: ~
vishnu@mtlp-520: ~
ERROR:packet:(dns) parsing questions: ord() expected string of length 1, but int found
***** Entropy Value = 1 *****
***** Entropy Value = 1 *****
***** Entropy Value = 1 *****
***** Entropy Value = 1 *****
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.07067264104535233
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.1046520411320727
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.13863144121879306
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.17261084130551343
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.2065902413922338
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.24056964147895418
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.27454904156567456
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.3085284416523949
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.3425078417391153
INFO:forwarding.detection:Entropy =
INFO:forwarding.detection:0.3764872418258357
INFO:forwarding.detection:{IPAddr('10.0.0.56'): 41, IPAddr('10.0.0.26'): 1, IPAddr('10.0.0.6'): 1, IPAddr('10.0.0.12'): 1, IPAddr('10.0.0.59')
: 1, IPAddr('10.0.0.55'): 1, IPAddr('10.0.0.47'): 1, IPAddr('10.0.0.9'): 1, IPAddr('10.0.0.50'): 1, IPAddr('10.0.0.58'): 1}

```

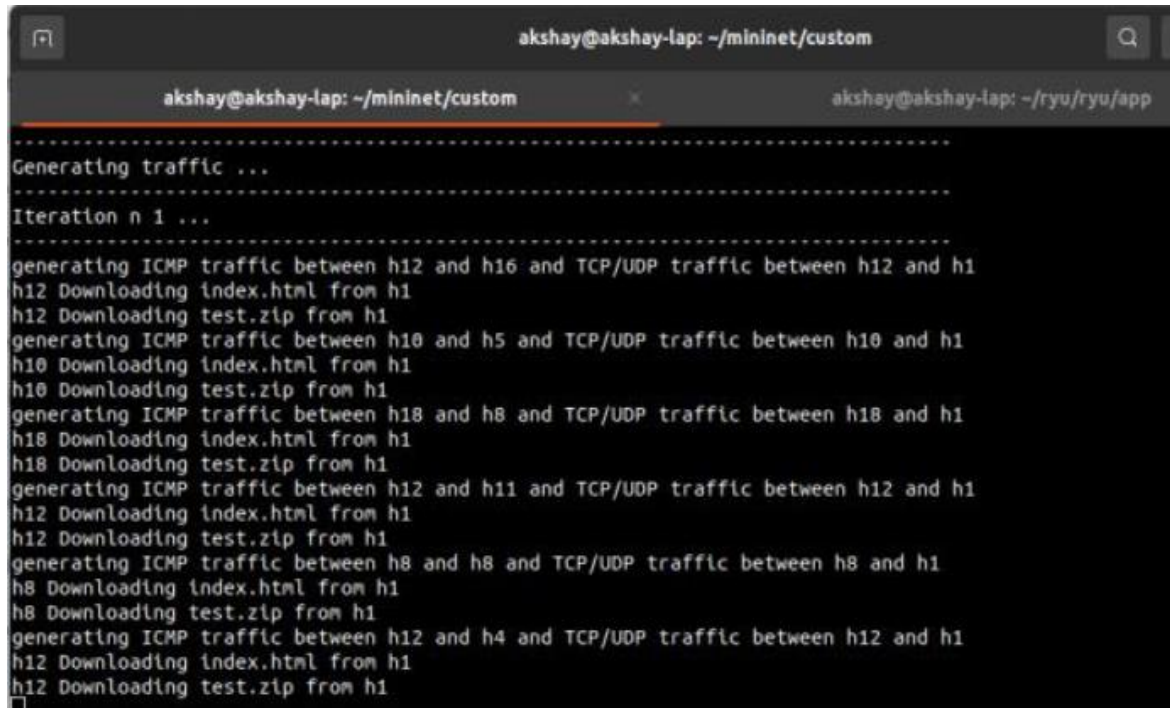
## Generating Normal Traffic

IPERF is a traffic generation tool that allows the user to experiment with different TCP and UDP parameters to see how they affect network performance. The typical way that IPERF is used is to first start one IPERF process running in server mode as the traffic receiver, and then start another IPERF process running in client mode on another host as the traffic sender.



The typical way that IPERF is used is to first start one IPERF process running in server mode as the traffic receiver, and then start another IPERF process running in client mode on another host as the traffic sender. In order to send a single UDP stream from n2p2 to n1p2 as shown in Fig we would run IPERF in server mode on n1p2 and IPERF in client mode on n2p2.

```
src.cmd("iperf -p 5050 -c 10.0.0.1")
src.cmd("iperf -p 5051 -u -c 10.0.0.1")
.
```

A screenshot of a terminal window with a dark background. The window title is 'akshay@akshay-lap: ~/mininet/custom'. There are two tabs: 'akshay@akshay-lap: ~/mininet/custom' (active) and 'akshay@akshay-lap: ~/ryu/ryu/app'. The terminal output shows a series of commands and their results. It starts with 'Generating traffic ...', followed by 'Iteration n 1 ...'. Then, it lists several traffic generation tasks: generating ICMP traffic between h12 and h16, h10 and h5, h18 and h8, and h12 and h11, along with TCP/UDP traffic between h12 and h1. For each task, it shows the download of 'index.html' and 'test.zip' from h1. The output ends with 'h12 Downloading test.zip from h1'.

## Generating DDOS Traffic

A Distributed Denial of Service attack (DDOS) is similar to a DOS attack but carried out from different nodes (or different attackers) simultaneously. Commonly DDOS attacks are carried out by botnets. Botnets are automated scripts or programs which infect computers to carry out an automated task (in this case a DDOS attack). A hacker can create a botnet and infect many computers from which botnets will launch DOS attacks, the fact many botnets are shooting simultaneously turn the DOS attack into a DDOS attack (that's why it is called "distributed"). The tool hping3 allows you to send manipulated packets. This tool allows you to control the size, quantity and fragmentation of packets in order to overload the target and bypass or attack firewalls. Hping3 can be useful for security or capability testing purposes, using it you can test firewalls effectivity and if a server can handle a big amount of packets .

```

print("-----")
print("Performing ICMP (Ping) Flood")
print("-----")
src.cmd("timeout 20s hping3 -1 -V -d 120 -w 64 -p 80 --rand-source --flood {}".format(dst))
sleep(100)

src = choice(hosts)
dst = ip_generator()
print("-----")
print("Performing UDP Flood")
print("-----")
src.cmd("timeout 20s hping3 -2 -V -d 120 -w 64 --rand-source --flood {}".format(dst))
sleep(100)

```

The screenshot shows a terminal window with the title 'akshay@akshay-lap: ~/mininet/custom'. It displays the output of a Mininet script, including adding switches (s1-s6), links, hosts (h1-h18), and starting the controller (c0). The script then performs several attacks: ICMP (Ping) Flood, UDP Flood, TCP-SYN Flood, and LAND Attack. The output is formatted with dashed lines separating the different attack sections.

```

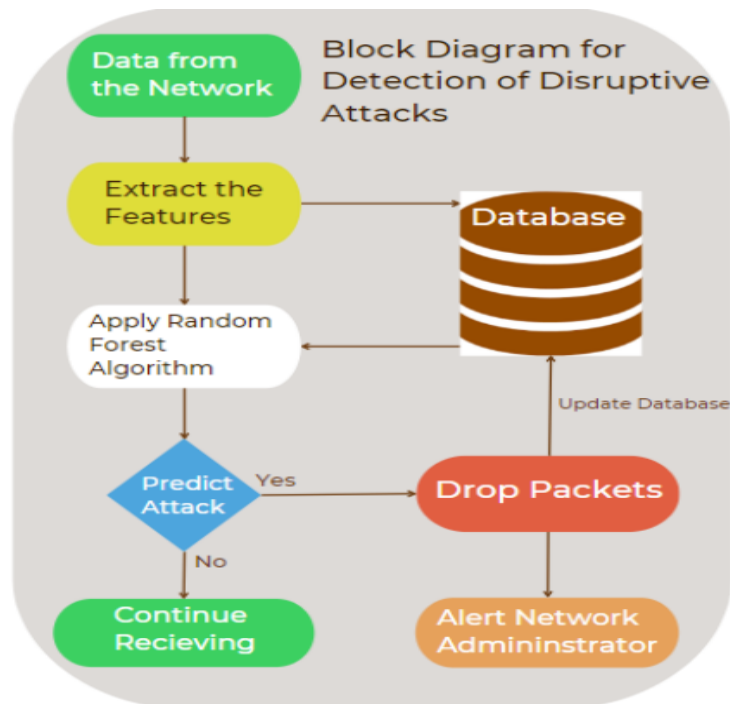
akshay@akshay-lap: ~/mininet/custom
*** Adding switches:
s1 s2 s3 s4 s5 s6
*** Adding links:
(h1, s1) (h2, s1) (h3, s1) (h4, s2) (h5, s2) (h6, s2) (h7, s3) (h8, s3) (h9, s3) (h10, s4) (h11, s4) (h12, s4) (h13, s5) (h14, s5) (h15, s5) (h16, s6) (h17, s6) (h18, s6) (s1, s2) (s2, s3) (s3, s4) (s4, s5) (s5, s6)
*** Configuring hosts
h1 h2 h3 h4 h5 h6 h7 h8 h9 h10 h11 h12 h13 h14 h15 h16 h17 h18
*** Starting controller
c0
*** Starting 6 switches
s1 s2 s3 s4 s5 s6 ...
-----
Performing ICMP (Ping) Flood
-----
Performing UDP Flood
-----
Performing TCP-SYN Flood
-----
Performing LAND Attack
-----

```

## DDOS Attack Detection Using ML Algorithms

Depending on the source of the data to be studied or the method used to identify anomalous occurrences, there are several categories that might be used to classify intrusion detection. Flow-based or packet-based detection is employed depending on the data to be processed, and depending on the detection method, signature-based or anomaly-based detection can be utilized. Flow-based detection was selected based on the source of the data to be evaluated since it would be more suited for high-speed networks and more effective than packet-based detection in terms of processing and memory overhead. Anomaly-based intrusion detection is implemented as a detection method, and more specifically, detection with ML Algorithms (KNN, Naïve Bayes, Logistic Regression, Decision Tree, Random Forest)

### Process Flow



**Mitigating DDOS Traffic :** Once a malicious flow has been verified by the anomaly detection module, the Anomaly Mitigation module is in charge of implementing mitigation measures to prevent network disruption or performance degradation. When label is 1 It will block the traffic generated port for some time and after mitigation done it will unblock the port.

## Commands

### Generating Normal Traffic:

run command `ryu-manager start_traffic_collection.py` in `ryu/ryu/app/`

run command `sudo python2 generate_normal_traffic.py` in `mininet/custom/`

### Generating DDos Traffic:

run command `ryu-manager collect_ddos_traffic.py` in `ryu/ryu/app/`

run command `sudo python2 generate_ddos_traffic.py` in `mininet/custom/`

### Detecting DDos and Normal Traffic:

run command `ryu-manager mitigation_module.py` in `ryu/ryu/app/`

run command `sudo python2 topology.py` in `mininet/custom/`

after the above commands, run command `xterm h1 h2 h3 h6 h17` in `mininet`

## Normal Traffic:

ping 10.0.0.15 on node h17 and then ping 10.0.0.4 on h6

## DDoS Traffic:

on node h17 ping 10.0.0.18

on node h1 hping3 10.0.0.12 --icmp --rand-source --flood

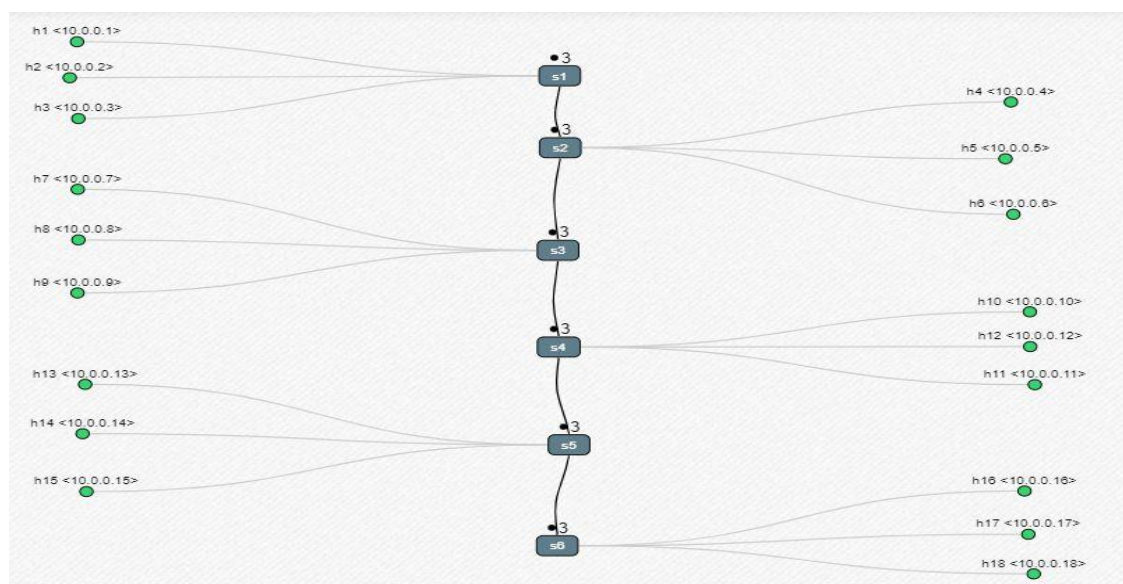
on node h2 hping3 10.0.0.12 --udp --rand-source --flood

on node h3 hping3 10.0.0.12 --syn --rand-source --flood

## Output & results

### TOPOLOGY GENERATION

```
vishnu@mtlp-520: ~/mininet/custom
vishnu@mtlp-520: ~/ryu/ryu/app
vishnu@mtlp-520:~/mininet/custom$ sudo python2 topology.py
Connecting to remote controller at 127.0.0.1:6653
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2 h3 h4 h5 h6 h7 h8 h9 h10 h11 h12 h13 h14 h15 h16 h17 h18
*** Adding switches:
s1 s2 s3 s4 s5 s6
*** Adding links:
(h1, s1) (h2, s1) (h3, s1) (h4, s2) (h5, s2) (h6, s2) (h7, s3) (h8, s3) (h9, s3) (h10, s4) (h11, s4) (h12, s4) (h13, s5) (h14, s5) (h15, s5) (
h16, s6) (h17, s6) (h18, s6) (s1, s2) (s2, s3) (s3, s4) (s4, s5) (s5, s6)
*** Configuring hosts
h1 h2 h3 h4 h5 h6 h7 h8 h9 h10 h11 h12 h13 h14 h15 h16 h17 h18
*** Starting controller
c0
*** Starting 6 switches
s1 s2 s3 s4 s5 s6 ...
*** Starting CLI:
mininet>
```





## LOADING CONTROLLER

```
vishnu@mtlp-520: ~/ryu/ryu/app
vishnu@mtlp-520:~/ryu/ryu/app$ ryu-manager mitigation_module.py
loading app mitigation_module.py
loading app ryu.controller.ofp_handler
instantiating app mitigation_module.py of SimpleMonitor13
Flow Training ...
-----
Confusion Matrix
[[226596      0]
 [190669 249616]]
Training Accuracy:  0.7137368904581629
Success Accuracy = 71.41 %
Fail Accuracy = 28.59 %
-----
Training time:  0:00:31.196145
instantiating app ryu.controller.ofp_handler of OFPHandler
```

## WHEN TRAFFIC IS NORMAL

```
Activities Terminal Jan 22, 20:57

Open mitigation vishnu@mtlp-520: ~/ryu/ryu/app vishnu@mtlp-520: ~/mininet/cu...

"Node: h2"
S4 Bytes from 10.0.0.11: icmp_seq=40 ttl=64 time=0.205 ms
S4 Bytes from 10.0.0.11: icmp_seq=41 ttl=64 time=0.176 ms
S4 Bytes from 10.0.0.11: icmp_seq=42 ttl=64 time=0.251 ms
S4 Bytes from 10.0.0.11: icmp_seq=43 ttl=64 time=0.176 ms
S4 Bytes from 10.0.0.11: icmp_seq=44 ttl=64 time=0.206 ms
S4 Bytes from 10.0.0.11: icmp_seq=45 ttl=64 time=0.161 ms
S4 Bytes from 10.0.0.11: icmp_seq=46 ttl=64 time=0.206 ms
S4 Bytes from 10.0.0.11: icmp_seq=47 ttl=64 time=0.157 ms
S4 Bytes from 10.0.0.11: icmp_seq=48 ttl=64 time=0.172 ms
S4 Bytes from 10.0.0.11: icmp_seq=49 ttl=64 time=0.132 ms
S4 Bytes from 10.0.0.11: icmp_seq=50 ttl=64 time=0.177 ms
S4 Bytes from 10.0.0.11: icmp_seq=51 ttl=64 time=0.263 ms
S4 Bytes from 10.0.0.11: icmp_seq=52 ttl=64 time=0.150 ms
S4 Bytes from 10.0.0.11: icmp_seq=53 ttl=64 time=0.154 ms
S4 Bytes from 10.0.0.11: icmp_seq=54 ttl=64 time=0.160 ms
S4 Bytes from 10.0.0.11: icmp_seq=55 ttl=64 time=0.153 ms
S4 Bytes from 10.0.0.11: icmp_seq=56 ttl=64 time=0.154 ms
S4 Bytes from 10.0.0.11: icmp_seq=57 ttl=64 time=0.127 ms
S4 Bytes from 10.0.0.11: icmp_seq=58 ttl=64 time=0.179 ms
S4 Bytes from 10.0.0.11: icmp_seq=59 ttl=64 time=0.162 ms
S4 Bytes from 10.0.0.11: icmp_seq=60 ttl=64 time=0.252 ms
S4 Bytes from 10.0.0.11: icmp_seq=61 ttl=64 time=0.162 ms
S4 Bytes from 10.0.0.11: icmp_seq=62 ttl=64 time=0.163 ms

"Node: h4"
S4 Bytes from 10.0.0.5: icmp_seq=33 ttl=64 time=0.125 ms
S4 Bytes from 10.0.0.5: icmp_seq=34 ttl=64 time=0.123 ms
S4 Bytes from 10.0.0.5: icmp_seq=35 ttl=64 time=0.125 ms
S4 Bytes from 10.0.0.5: icmp_seq=36 ttl=64 time=0.123 ms
S4 Bytes from 10.0.0.5: icmp_seq=37 ttl=64 time=0.126 ms
S4 Bytes from 10.0.0.5: icmp_seq=38 ttl=64 time=0.121 ms
S4 Bytes from 10.0.0.5: icmp_seq=39 ttl=64 time=0.123 ms
S4 Bytes from 10.0.0.5: icmp_seq=40 ttl=64 time=0.128 ms
S4 Bytes from 10.0.0.5: icmp_seq=41 ttl=64 time=0.121 ms
S4 Bytes from 10.0.0.5: icmp_seq=42 ttl=64 time=0.123 ms
S4 Bytes from 10.0.0.5: icmp_seq=43 ttl=64 time=0.109 ms
S4 Bytes from 10.0.0.5: icmp_seq=44 ttl=64 time=0.117 ms
S4 Bytes from 10.0.0.5: icmp_seq=45 ttl=64 time=0.113 ms
S4 Bytes from 10.0.0.5: icmp_seq=46 ttl=64 time=0.121 ms
S4 Bytes from 10.0.0.5: icmp_seq=47 ttl=64 time=0.108 ms
S4 Bytes from 10.0.0.5: icmp_seq=48 ttl=64 time=0.124 ms
S4 Bytes from 10.0.0.5: icmp_seq=49 ttl=64 time=0.122 ms
S4 Bytes from 10.0.0.5: icmp_seq=50 ttl=64 time=0.111 ms
S4 Bytes from 10.0.0.5: icmp_seq=51 ttl=64 time=0.101 ms
S4 Bytes from 10.0.0.5: icmp_seq=52 ttl=64 time=0.124 ms
S4 Bytes from 10.0.0.5: icmp_seq=53 ttl=64 time=0.123 ms
S4 Bytes from 10.0.0.5: icmp_seq=54 ttl=64 time=0.096 ms
S4 Bytes from 10.0.0.5: icmp_seq=55 ttl=64 time=0.101 ms
S4 Bytes from 10.0.0.5: icmp_seq=56 ttl=64 time=0.101 ms
S4 Bytes from 10.0.0.5: icmp_seq=57 ttl=64 time=0.101 ms
S4 Bytes from 10.0.0.5: icmp_seq=58 ttl=64 time=0.101 ms
S4 Bytes from 10.0.0.5: icmp_seq=59 ttl=64 time=0.101 ms
S4 Bytes from 10.0.0.5: icmp_seq=60 ttl=64 time=0.096 ms

vishnu@mtlp-520:~/ryu/ryu/app$ python3 ryu-manager mitigation_module.py
loading app ryu.mitigation_module.py
loading app ryu.controller.ofp_handler
installing app mitigation_module.py of SimpleMonitor13
Flow training: ...

-----
Confusion Matrix
[[225596  0]
 [  3 440282]]
Training Accuracy: 1.0
Success Accuracy = 100.00 %
Fail Accuracy = 0.00 %

Training time: 0:00:33.997819
installing app ryu.controller.ofp_handler of OFPHandler

Traffic is Legitimate!
-----

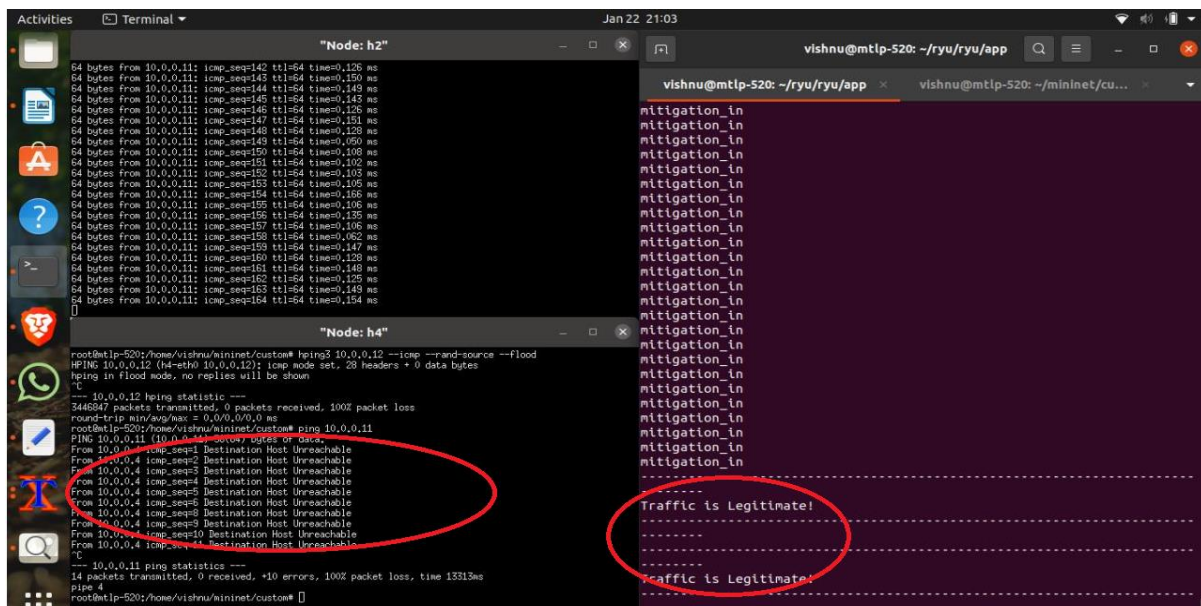
Traffic is Legitimate!
-----

Traffic is Legitimate!
-----
```

## WHEN DDOS TRAFFIC IS DETECTED

The screenshot displays a Kali Linux desktop environment. On the left is a vertical dock with various application icons. The main workspace contains two terminal windows. The first terminal, titled "Node: h2", shows a successful ping to 10.0.0.11 and a series of ICMP echo requests from 10.0.0.12 to 10.0.0.11, all received. The second terminal, titled "Node: h4", shows a similar setup but with a flood of "mitigation in" messages and "Block the port 1" messages, indicating a port blocking or mitigation process.

## AFTER MITIGATION

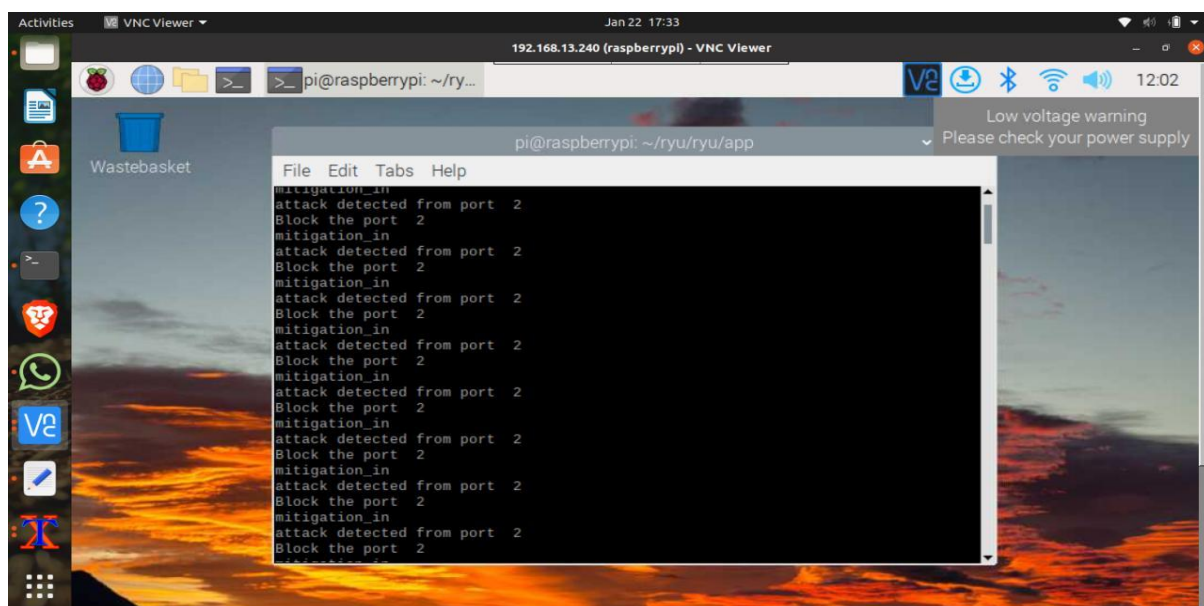


## IMPLEMENTATION IN RASPBERRYPI

## Connect the Raspberry Pi to your Computer.

Change the IP Address in topology file to RaspberryPi's IP Address.

## Run Ryu Controller in RaspberryPi environment.



## RESULTS

K Nearest Neighbors = 100%

Logistic Regression = 66.6%

Naïve Bayes = 71.41%

Decision Tree = 100%

Random Forest = 100 %

## Future Works

It may fail to detect the attack traffic in a multi-controller environment. So, in the future, these models are also evaluated to detect attacks in a multi-controller context. The presented model acquired findings from a single dataset, which serves as a limitation of the model. Consequently, a distributed dataset can be examined in order to provide directions for future enhancements. Memory and other limited resources and computing abilities, as well as a diversity of standards and protocols, characterize the Internet of Things. These variables add significantly to the difficulties in researching IoT security issues, including anomaly mitigation utilizing IDS. In spite of the extensive study on anomaly detection in IoT networks, there are numerous key outstanding challenges that require additional investigation. The following are a few of these issues:.. There are no publicly available IoT network traffic datasets. Because assessing and validating anomaly prevention strategies on a real network will be difficult, efforts to create an IoT dataset are essential. This will make evaluating and validating suggested anomaly mitigation techniques in the IoT much easier. There are not any standard authentication apps for IoT. The validation of implemented structures is critical since it guarantees that they are developed acceptably. The implemented structures are put to the test in a variety of ways, including simulations and tests. However, because of a lack of standard authentication applications, most of implemented IDS structures in the IoT are not evaluated in contrast to other IDS structures in the IoT. As a result, efforts must be made to produce standard authentication, which will assure duplication, reproducibility, and research continuity. RNN and CNN are examples of supervised and unsupervised ML techniques, and both can be discovered using the CICDDoS2019 dataset.. It is possible to gather and examine real-time packets against the classified training dataset. It is possible to use a technique for splitting the data and comparing it with the performance of the classifiers utilized fold cross authentication



## **Conclusion**

In this work, 5 machine learning algorithms are used to develop a model that can automatically identify and mitigate DDoS assaults in SDN networks. All of the traffic flow entries are regularly collected by the model, which then extracts the native flow features and expands them by including additional features. A detection module uses five criteria to categorize each flow as normal or anomalous. When an attack is discovered, its source is prevented. Three ML algorithms were assessed with regard to the classification ML method utilized in the detection module, including random forest, Decision Tree, Logistic Regression, Naïve Bayes, and KNN. The outcomes of the experiment demonstrated that Random Forest is the best classifier for the generated network. Without disrupting regular traffic, the implemented methodology proved effective at swiftly and correctly identifying and thwarting threats.