Testing Detection Accuracy of IOT Threats With Deep Learning Techniques

Project Update V1.0

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CSCE5933:Deep Learning

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INTRODUCTION

Distributed denial of services attacks (DDoS attacks) is one of the most common network attacks that occurs. An average of 28,700 DDoS attacks occur every day, with an average cost of $40,000- $50,000 per hour. With how serious and frequent of a financial threat these are, it is extremely important for security models to detect these botnets before they can crash a network.

BoT-IoT dataset was created by designing a realistic network environment in the Cyber Range Lab of The center of UNSW Canberra Cyber, as shown in Figure 1

PROJECT ORGANIZATION & TEAM

No	Member	Email	Responsibility	Meeting Schedule	Team Adviser
1	Syed Badruddoja	syedbadruddoja@my.unt.edu	Perform CNN and Documentation	Every thursday after class online via discord	Dr. Mark Albert
2	Keith Santamaria	keithsantamaria@my.unt.edu	Perform RNN & Documentation		
3	Justin Hicks	justinhicks@my.unt.edu	Perform CNN and Documentation		

Project Repository: https://github.com/JJHicks/IoT-Botnet-Attack-Detection

RELATED PROJECTS

[8] discusses about ways to detect Tor traffic using deep learning methods. Tor traffic is kind of a encrypted tunnel between the client and a vpn server which is hidden from internet and it is hard to trace them without any specialized software.

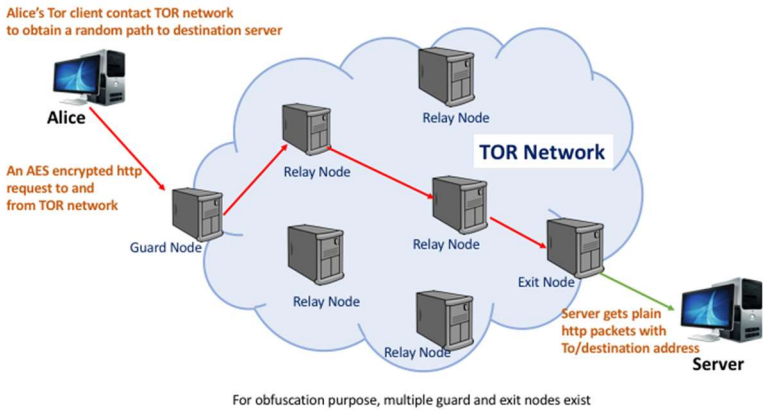


FIGURE 1: AN ILLUSTRATION OF TOR COMMUNICATION BETWEEN ALICE AND A DESTINATION SERVER.

"The communication starts with Alice requesting a path to the server. TOR network gives the path which is AES encrypted. The randomization of the path happens inside the TOR network. The encrypted path of the packet is shown in red. Upon reaching the exit node, which is the periphery node of the TOR network, the plain packet is transferred to the server."

[4] discussed about A Deep Learning Approach for Botnet Traffic Detection. While botnets have been extensively studied, bot malware is constantly advancing and seeking to exploit new attack vectors and circumvent existing measures. Existing intrusion detection systems are unlikely to be effective countering advanced techniques deployed in recent botnets. This chapter proposes a deep learning-based botnet traffic analyser called Botnet Traffic Shark (BoTShark). BoTShark uses only network transactions and is independent of deep packet inspection technique; thus, avoiding inherent limitations such as the inability to deal with encrypted payloads. This also allows us to identify correlations between original features and extract new features in every layer of an Autoencoder or a Convolutional Neural Networks (CNNs) in a cascading manner. Moreover, we utilise a Softmax classifier as the predictor to detect malicious traffics efficiently. © Springer International Publishing AG, part of Springer Nature 2018

[6] is about Recurrent neural networks for Cyber security. Recurrent neural network (RNN) is an effective neural network in solving very complex supervised and unsupervised tasks. There has been a significant improvement in RNN field such as natural language processing, speech processing, computer vision and other multiple domains. This paper deals with RNN application on different use cases like Incident Detection, Fraud Detection, and Android Malware Classification. The best performing neural network architecture is chosen by conducting different chain of experiments for different network parameters and structures. The network is run up to 1000 epochs with learning rate set in the range of 0.01 to 0.5.Obviously, RNN performed very well when compared to classical machine learning algorithms. This is mainly possible because RNNs implicitly extracts the underlying features and also identifies the characteristics of the data. This helps to achieve better accuracy.

PROBLEM DEFINITION

Our aim is to create a deep learning model that can accurately distinguish legitimate network traffic from an IoT botnet attack. The dataset was created by designing a realistic network environment that generates both normal and botnet traffic. The dataset consists of features made from fields in packet information, like what you would find using Wireshark, along with labels for the attack categories and subcategories. The benefit of generating this data in a controlled environment is that it addresses the issues of incomplete network information and inaccurate labeling, in addition to giving better data for more complex and diverse attacks.

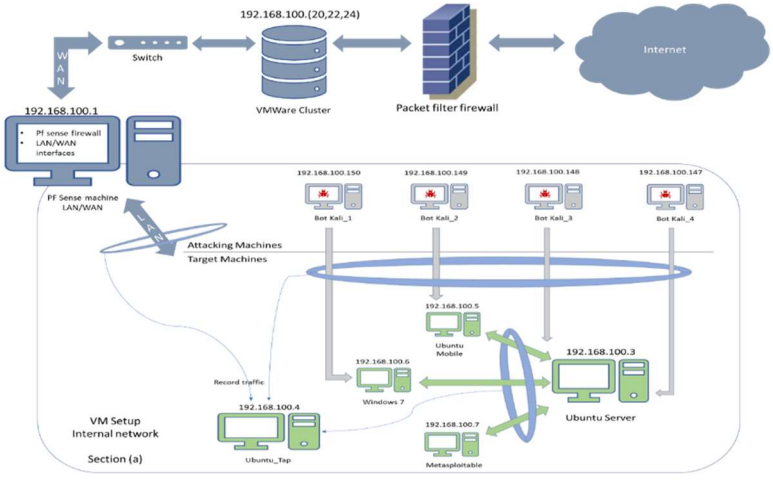


FIGURE 2: THE TESTBED CONFIGURATION FOR THE BOT-IOT DATASET FROM UNSW CANBERRA

PROJECT DESIGN AND MILESTONES:

Project design is made simple to test the neural network deep learning methods to test the performance and check feasibility of suggesting deep learning method as suitable for cyber security threat predictions.

DESIGN METHODS

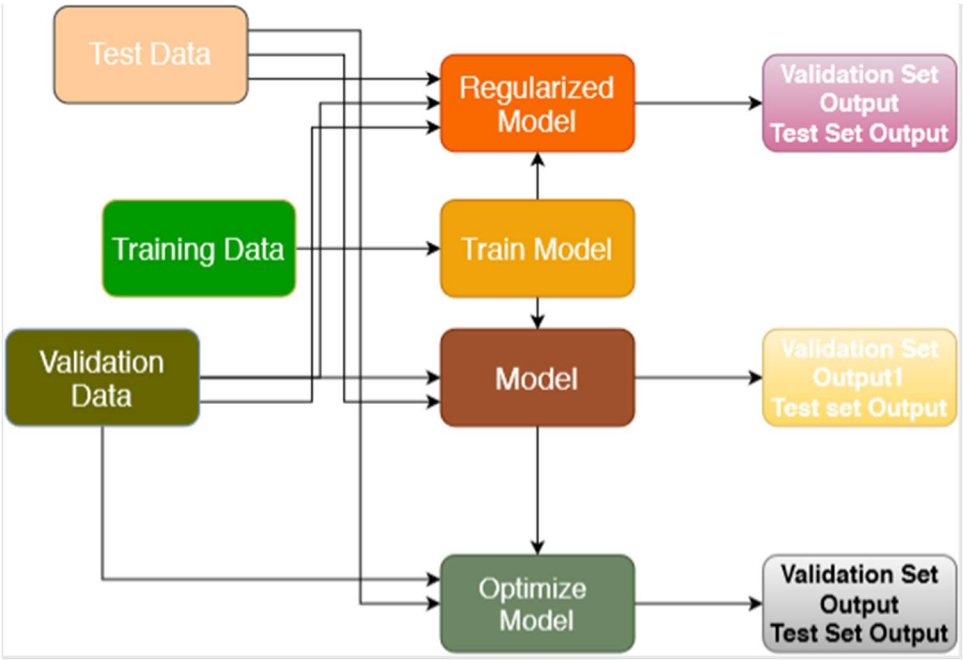


FIGURE 3: GENERAL DESIGN OF PREDICTION FOR IOT BOT DATASET

TRAINING MODEL

The dataset will go through the training phases of fitting through a model of CNN. Initially we will be using less number of neurons at 2 layers to check the accuracy of the model, later on we will be checking for more results

REGULARIZATION

Noise robustness will be tested for accuracy differences and a comprehensive study is planned for this.

ACTIVATION FUNCTION:

Rectified linear unit activation function will be used for making the outputs positives and have a comprehensive understanding of the data. We will explore more on this in coming days

OPTIMIZED MODEL:

Adam Optimization is an optimization technique which is a combination of RMSprop, Stochastic gradient descent and momentum. We have planned to implement this and make adjustments to see how the accuracy differs.

Figure 2 describes the flow chart that will be used for this project as a basic model. We will be using several deep learning models to study how cyber security attacks can be predicted out of the test data. .

TOOLS & LIBRARIES

As per current planning, we would like to perform our deep learning prediction with tensorflow and keras packages in a local machine that has good ram to perform the operation on a reasinable time. If we get time, we would like to perform the same on google cloud platform to test the prediction with respect to time and accuracy.

DATASET

The IoT Botnet dataset comes in a series of 75 csv files totaling ~15GB. We plan to use this, Tensorflow (Python), and Git for source control to get started in setting up our first model. We will update this section as we progress into the project.For hardware accelerated model training, we have a Nvidia GTX 1080 and 1060 available

The features we have in our dataset are enumerated below.

Feature	Description
pkSeqID	Row Identifier
Stime	Record start time
Flgs	Flow state flags seen in transactions
flgs_number	Numerical representation of feature flags
Proto	Textual representation of transaction protocols present in network flow
proto_number	Numerical representation of feature proto
Saddr	Source IP address
Sport	Source port number
Daddr	Destination IP address
Dport	Destination port number
Pkts	Total count of packets in transaction
Bytes	Totan number of bytes in transaction
State	Transaction state
state_number	Numerical representation of feature state
Ltime	Record last time
Seq	Argus sequence number
Dur	Record total duration

Mean	Average duration of aggregated records
Stddev	Standard deviation of aggregated records
Sum	Total duration of aggregated records
Min	Minimum duration of aggregated records
Max	Maximum duration of aggregated records
Spkts	Source-to-destination packet count
Dpkts	Destination-to-source packet count
Sbytes	Source-to-destination byte count
Dbytes	Destination-to-source byte count
Rate	Total packets per second in transaction
Srate	Source-to-destination packets per second
Drate	Destination-to-source packets per second
TnBPSrcIP	Total Number of bytes per source IP
TnBPDstIP	Total Number of bytes per Destination IP.
TnP_PSrcIP	Total Number of packets per source IP.
TnP_PDstIP	Total Number of packets per Destination IP.
TnP_PerProto	Total Number of packets per protocol.
TnP_Per_Dport	Total Number of packets per dport
AR_P_Proto_P_SrcIP	Average rate per protocol per Source IP. (calculated by pkts/dur)
AR_P_Proto_P_DstIP	Average rate per protocol per Destination IP.
N_IN_Conn_P_SrcIP	Number of inbound connections per source IP.
N_IN_Conn_P_DstIP	Number of inbound connections per destination IP.
AR_P_Proto_P_Sport	Average rate per protocol per sport
AR_P_Proto_P_Dport	Average rate per protocol per dport
Pkts_P_State_P_Protocol_P_DestIP	Number of packets grouped by state of flows and protocols per destination IP.
Pkts_P_State_P_Protocol_P_SrcIP	Number of packets grouped by state of flows and protocols per source IP.
Attack	Class label: 0 for Normal traffic, 1 for Attack Traffic
Category	Traffic category
Subcategory	Traffic subcategory

TABLE 1: FEATURE DETAILS

PROJECT PLAN:

No	Task	Description	Work Type	Deadline	Status
1	Get Dataset and Filter dataset	Study relevant dataset if required to add or delete	Coding and Documentation	4th April	Completed
2	Normalize dataset	using normalization technique if required	Coding and Documentation	4th April	Completed
3	label encoding	Classify objects as numbers, we can also use one hot encoding	Coding and Documentation	4th April	Completed
4	Perform Basic ANN Learning	Study time, accuracy and relevant metrics if possible	Coding and Documentation	5th April	Ongoing
5	Perform CNN Prediction	Not sure if this one is possible	Coding and Documentation	6th april	Completed
6	Perform RNN prediction	Study time, accuracy and relevant metrics if possible	Coding and Documentation	7th April	Ongoing
7	Perform Regularization	Study time, accuracy and relevant metrics if possible	Coding and Documentation	8th April	Partially Done
8	Perform Optimization	Study time, accuracy and relevant metrics if possible	Coding and Documentation	8th April	Partially Done
9	Study loss and Accuracy Behaviour	Compare the results	Documentation	9th April	Ongoing
10	Additional reports	Addition to what we have done, like autoencoders	Coding and Documentation	9th April	Ongoing
11	Prepare Project update	All deails of project should be ready	Documentation	10th April	Completed
12	Prepare Final Project Report	Includes everything with metrics and results	Documentation	18th April	Ongoing
13	Prepare Final Project Presentation	Prepare a complete documentation similar to a conference paper if possible	Documentation	18th April	Ongoing

IMPLEMENTATION

LABEL ENCODING

No.	Service State/ Encoding	Service/Encoding	Attack/Encoding
1	CON/1	dhcp / 1	generic / 0
2	FIN/2	dns / 2	normal / 1
3	INT/3	ftp / 3	Analysis / 2
4	REQ/4	ftpprotocoldata / 4	Backdoor / 3
5	RST/5	http / 5	Dos / 4
6	ACC/6	irc / 6	exploits / 5
7	CLO-7	pop3 / 7	Fuzzers / 6
8	NA	protocol / 8	Reconnaissance / 7
9	NA	radius / 9	shellcode / 8
10	NA	snmp / 10	worms / 9
11	NA	smtp / 11	NA
12	NA	ssh / 12	NA
13	NA	ssl / 13	NA

TABLE 2: LABEL ENCODING REFERENCES

PREPROCESSING

[Under Construction]

BASE NEURAL NETWORKS

[Under Construction]

OPTIMIZERS

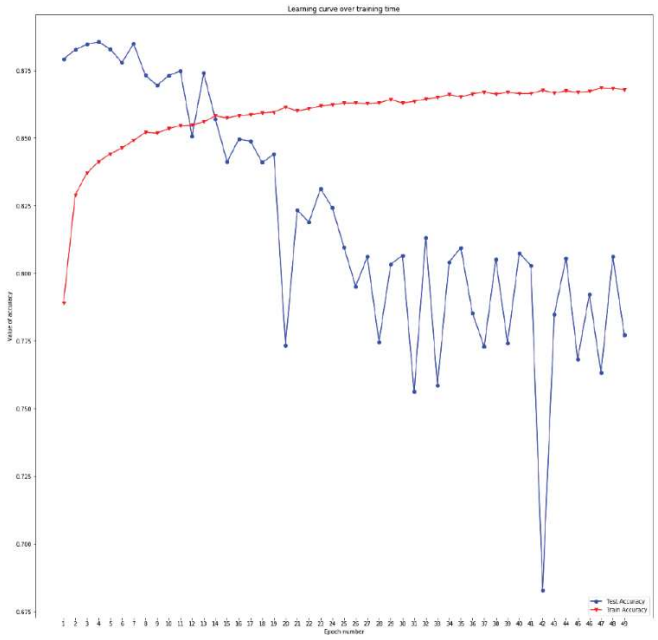
[Under Construction]

REGULARIZATION

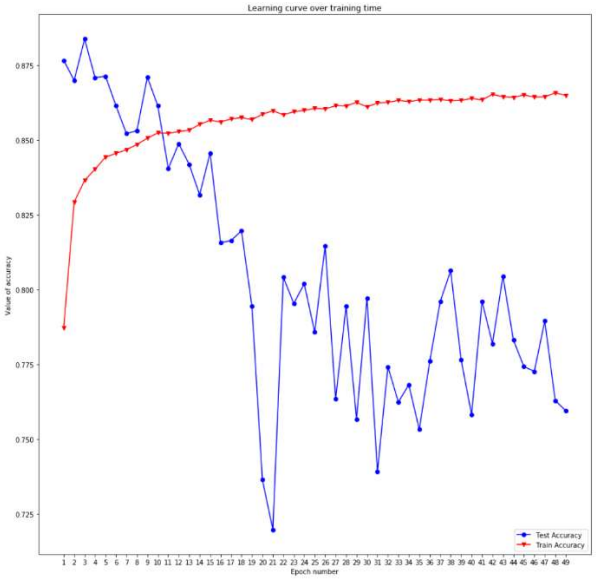
[Under Construction]

RESULTS:

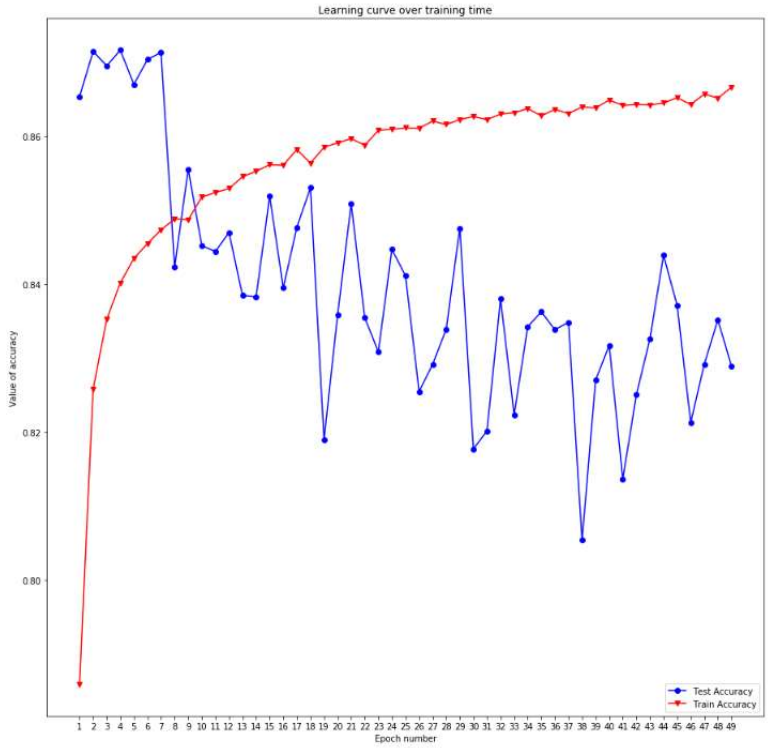
[Under Construction]



GRAPH 1: REGULAR CNN TRAINING AND TESTING ACCURACY



GRAPH 2: REGULARIZED CNN TRAINING & TESTING GRAPH



GRAPH 3: ADAM OPTIMIZED CNN TRAINING & TESTING ACCURACY

No	CNN Accuracy(Average)	Regularized CNN (Average)	Optimized CNN(Average)
Accuracy			
Loss			

TABLE 3: AVERAGE ACCURACY COMPARISON FOR CNN MODEL

CONCLUSION

[Under Construction]

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