Throughput analysis of network coding in the internet of things

Si Chen

College of Computer Science and Technology, Changchun Normal University, Changchun, 130032, China

Corresponding author's e-mail: 47116227@qq.com

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Abstract

Network coding is one of the most important breakthroughs of information transmission technology in communication network, whose main idea is using intelligent function of Router and encoding transmit information by intermediate node of network to improve the efficiency of network transmission. The throughput about IOT in military based on the network coding is analyzed. The simulation results indicate that the network coding can enhance the throughput about IOT in military more than before.

Keywords: component, network coding, Internet of things in military, throughput

1 Introduction

Along with the rapid development of the Internet, network attack species have continuously evolved and updated, the frequency of occurrence has grown sustainably. As a result of that the traditional intrusion detection system based on pattern matching cannot find the unknown attack and its complete attack feature library requires constantly upgraded, its development has significant limitations. So the research emphasis of intrusion detection technology facing network traffic data has turned to the anomaly detection. Anomaly detection can judge and predict possible attacks trough calculation of the deviation degree between the established normal network business models. Current anomaly detection research mainly focuses on training and detection speed, accuracy of test and efficiency model adaptability. Self-organizing feature map (SOM) [1] as a kind of neural network model, has the ability of invert complex high-dimensional data to lower dimension one, the clustering characteristics can be adaptive to the division of normal data and abnormal data, which providing better solutions in order to ensure the veracity and adaptability of anomaly detection system [2 ~ 3].

ISOM system proposed by ref. [4] trains different services to generate a SOM (such as F T P, HT T P), judging through the description of the deviation value of tested data deviate from normal degree. Ref. [5] uses similar approaches to build a SOM for each kind of agreement, multiple SOMs distribution in different levels of the corresponding agreement, training and testing according to traffic data of the different agreements. Ref. [6] apply the clustering and visualization features of SOM to intrusion detection, normal behaviour can gather one or more clusters around the centre, and the abnormal pattern represented possible attack will be distributed outside of the regular classes. This article mainly aims at the problems of time performance of SOM algorithm, applying the hierarchical self-organizing feature map (HSOM) [7] algorithm to the data analysis module of anomaly detection system (HSOMDA).

2 Self-organizing feature map network and hierarchical self-organizing feature mapping algorithm

2.1 SELF-ORGANIZING FEATURE MAP NETWORK

Self-organizing feature map network is carried out in 1981 year. Input layer constitutes of d dimension vector data x ∊ Rd. Output layer constitutes of K pieces of neurons (I = 1, 2, K) ∊ Wd, each neuron and input data has the same dimension, each neuron has an adjacency core area. Adjacency intra-nuclear neuronal collection denoted by Nc (t).

Select a sampling value x vector from the training data set, then elect the neuron which has minimum distance from x and name it BMU (Best matching unit).

$$\left\| x - m_{BMU} \right\| = min\left\{ \left\| x - m_i \right\|_{i\,:\,1 \to k} \right\}. \tag{1}$$

Then BMU and the neurons in its nuclear regions and carry out value change in iteratively way, the rule of modify are shown in (2):

$$\begin{cases} \dfrac{\mathrm{m}_i(t+1) = m_i(t) + a(t)\left[x - m_i(t)\right] i \in Nc(t)}{\mathrm{m}_i(t+1) = m_i(t) i \notin Nc(t)} \end{cases}. \tag{2}$$

In the last type t acts as training time count, α (t) act as training rate parameter. Each neuron in the nuclear regions of SOM can be gradually changed in the iterative process and tend to be accordant.

We can see the self-organizing feature map network in Figure 1.

2.2 HIERARCHICAL SELF-ORGANIZING FEATURE MAPPING ALGORITHM

At the beginning of the training phase, the neurons in which place of the competitive layer will have a maximum response on what kind of input mode is uncertain. When the category of the input mode changes, the weight vectors of winning neurons in two-dimensional plane are all adjusted to the direction of the input vector nodes in varying degrees and the adjust intensity gradually decay according to the distance of the winning node. Network uses the organization way, with a large number of training samples to adjust the network weights, and finally all output layer neurons become sensitive to specific pattern class of neural network. Thus, the connection power of each neuron can correctly reflect the input mode of space distribution of loud space probability distribution.

In this paper, the application of the HSOM algorithm in network anomaly detection is put forward [7]. HSOM is the hierarchical structure extending of conventional SOM algorithm.

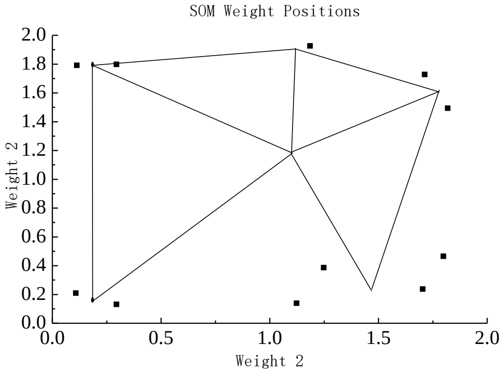


FIGURE 1 self-organizing feature map network

HSOM training algorithm is described as follows:

Input: training data set D, HSOM hierarchical structure and training parameters

Output: HSOM hierarchical network after training

1) Set hierarchy structure parameters, and set up training current layer as the first layer.
2) Determine the current input data vector x SOM associated with the current layer.
3) Select the best match neurons of x in SOM B M U.
4) Adjustment, including BMU adjacency weights to neurons in the nuclear area and train parameters.
5) Repeat step 2 ~ 4 until complete the self-organizing system practice process of the neurons in the current layer.
6) Divide the input data set into several data sets according to the corresponding best match neuron of each data.
7) If the centralized data in the sub data correspondence the neuron is more than 1, it generates a lower SOM connected with it, and trains using the data set according to the step 2 ~ 4.
8) Execute step 7 until reach the algorithm set the maximum number of layers.

HSOM algorithm relative to the SOM algorithm, the amount of calculation between the input data and neurons has remarkably reduced. For N pieces of neurons on behalf of all the network model, the time complexity of a single BMU search reduce from O (N) to O (mlogm N), m is the amount of neurons in the SOM of the top of HSOM structure.

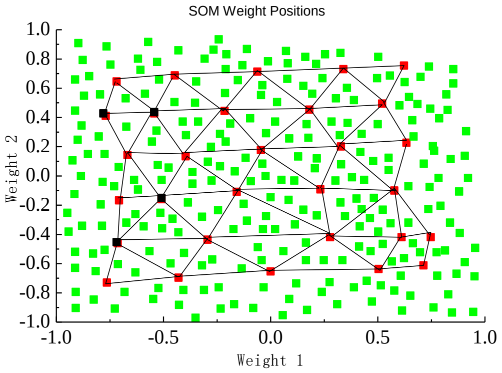


FIGURE 2 Design visualizer weights after the network training

3 Design and implementation of HSOMDA

3.1 WHOLE PROCESSES OF DATA ANALYZER

HSOMDA mainly divided into training module, detection module, and data standardization process these three parts. Training modules trains the normal of network traffic data, which has been standardization deal with. Detection analysis modules according to SOM hierarchical network after the training, detect and analysis the detecting network traffic data efficiently, generate attack reports and all test results of network data records.

3.2 EACH MODUL FUNCTIONS AND IMPLEMENTATION

HSOM DA training modules based on two layer HSOM network structure composed of 5 * 5SO M, training with normal network data, which have been standardized treatment, 1 port of SOM in the first layer , 25 port of SO M in the the second layer. Use HSOM Train algorithm to carry on training in normal network behavior patterns on the neurons in SOM. Set training rate as 0.1, adjacency nuclear radius as 10, adjacency nuclear area as hexagon.

After SOM network training, all the output layer nodes and input mode of the specific relationships are fixed, therefore it can be used as a pattern classifier. Whent a pattern input, the network input layer belongs to the automatic classification. When input mode does not belong to any met network training modes, the SOM network will classify it into the closest model type.

HSOMDA using the way of calculate the quantitative deviation, realizing the detection of network traffic data. Quantitative deviation (Quantization Error, QE) calculated by type (3):

$$QE_n = \left\| x_n - \mu_{y_n} \right\| . \qquad (3)$$

Yn act as neurons label closest to the current input data. For each network data characteristic vector, look for the neighbouring neurons in the hierarchy a top-down. If QE above a certain threshold, it will be judged to be abnormal patterns of behaviours, and report will be generated. The test results of all the testing data will all generate into log files, for future check.

4 Design patterns based on MVC

Fund declaration system uses the mode of design and development based on the MVC (Model [1] View [1] Controller), JSP constitutes the development model of VCM in combination with Servlet and Java Bean, the object of View is carried out by the page documents generated by JSP, the Servlet complete the dispose task for Controller object, Java Bean makes up the object part of the model.

When MVC design pattern is combined with J2EE components, it can be regarded as a system architectural pattern. It separates J2EE rules in business logic (Java Bean and EJB components), the controller logic (Servlests, JSP action), and customer views (the client end such as IE) clearly.

The design of presentation layer combines the front controller, view assistants and transfer objects, front controller separates the request processing and logic of Http, transmit all the requests to one object and carry on centralized data processing, the object distributes the requests to the matching processing programs and display them in views.

Business layers use the Session Facade pattern to encapsulate business layer components and provide coarse-grained services to remote clients, the clients' access to the Session Facade without directly accessing to the business components. It packages data information into transmitting objects and submits them to the presentation layer components. In the system, interactive manipulations of all the management notifications are combined together into an App Facade Session Bean in the Session Facade. It includes all management application using cases, such as the messages of creation, modifying, and viewing of the application forms.

Make use of DAO in combination with transfer objects to map the relational database, DAO hides the implementation details of data sources completely , when the underlying data source implementation changes, the interfaces DAO exposes to users does not require any change.

5 The design of the component

According to the J2EE hierarchical division, the fund declaration system have different components at different levels, main components concentrate in the EJB containers, business logic layer contains declaration, applicants, contacts, these EJB components, adopting the Entity Beans to achieve the goal, which are permanent and persistent, accessing through the session bean.

Declaration and examination behaviour are associated with the status of declaration forms, using the Statef l Session Beans in Session Beans to achieve that. Browse and query is a business processes, which has nothing to do with user state, no need to save state as a result, using a stateless Bean implementation, the advantage of using a stateless session Bean is to keep the stateless session Bean share the invocation in the pool for multiple clients to use, improving the efficiency of the system.

6 System implementation

Reporting system is based on J2EE and MVC, using SQL Server 2000 as the background database, the JSP runs in the foreground, the background Servlet accept users' input and invoke different JSPs application to feedback to the client, the JSP/Servlet through passing arguments to Java Beans and EJB components to access the database. Using dynamic authorization mechanism based on roles for users' identification and the protection of sensitive data.

7 Experiment and analysis

7.1 EXPERIMENTAL DATA AND ENVIRONMENT

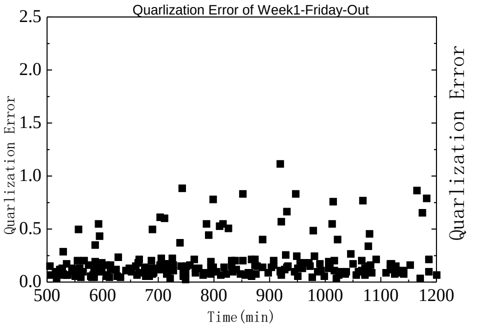
Experimental data sets are DARPA 1999 intrusion detection evaluation data sets of the SYN Flood, Apache2, Back, Selfping, Port sweep, NT Info scan, M scan, Queso, Satan which are total of nine main object detections. Experiments uses Shuguang server: Pentium III; CPU: 932.926 MHz; Size: 2064 MB memory; Linux 2420.

7.2 THE EXPERIMENT DETECTION EFFECT OF THE HSOMDA

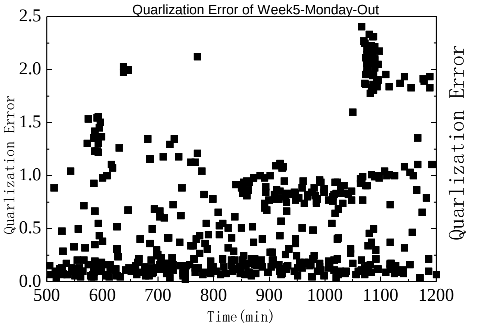
This paper has carried out the HSOM DA test effective experiment. The HSOM training phases use normal TCP connection eigenvector with the number of 541048.

Figure 3 is an affection comparison chart of the detection between normal data and abnormal data.

1) The network connection records are all composed of normal data, QE concentration distribution between 0 ~ 0.5. Some QE value is beyond the value scope of normal network data QE in
2) Such as the Port sweep attack in 09:43:34 (583 min), etc. For 9 kinds of targets, HSOMDA reached a higher detection rate (8 2. 4%), and has a low rate of false positives (0. 93%).



(a) Network data of QE figure without contain attack



(b) Network data of QE figure with contain attack

FIGURE 3 Test results contrast of normal data and abnormal data

7.3 TIME PERFORMANCE CONTRAST EXPERIMENT OF THE HSOM AND SOM ALGORITHM

This article has carried on the time performance contrast experiment of HSOM and SOM algorithms. The experimental results are shown in Table 1. Under the premises of the size in neurons are the same, and the other training parameters are similar, the training time and testing time of H S O M algorithm are significantly less than these of S O M algorithm.

TABLE 1 The consumption time of data analysis comparison based on HSOM and SOM algorithm

Anomaly detection algorithm	**Training Time(S)**	**Test time (S/ 1000 data records)**
SOM	1483.5	0.2228
HSOM	372.4	0.0359

8 Conclusions

On account of the speed and detection effect problem of anomaly detection system, this article designs and implements a data analyser of anomaly detection system HSOMDA based on self-organizing feature map neural network algorithm, which has these main features, has the following main features:

1) HSOM algorithm using the top-down generate layer-by-layer and the way of refine and clustering, which has on training the normal network traffic data.
2) The organization and connection ways of H S O M neurons are extended from planar to level combined with planar connection, which greatly accelerate the search process of the best match neurons. Experiments show that H SO M D A have good detection ability, the training and detection time performance of HSOM D A algorithm are improved greatly compared with SOM algorithm .

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Authors

Si Chen, 12.12.1977, Changchun

Current position, grades: A lecturer
University studies: The computer network
Scientific interest: Embedded direction
Publications: 7copies
Experience: Ten years of experience in teaching