ISSN : 0974 - 7435 Volume 10 Issue 12

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(12), 2014 [6835-6843]

The research of fuzzy dynamic Bayesian network in cognitive network QoS student study assessment

Jiang Hao*, Zhang Liang
Bozhou Teachers College, Anhui, Bozhou, 236800, (CHINA)

ABSTRACT

In terms of network operating QoS analysis, we propose a cascading network QoS analyzing algorithm based on K-means and C4.5 algorithm. The algorithm was testified to be suitable for multiple analyze requirements. Also based on the monitoring data captured from the real Internet, the algorithm was proved to be effective and efficient The algorithm processes the data captured from the project "User-oriented Active 4G Network Measurement System. The system is deployed at multiple wireless network accessing points; conducting 4G network QoS monitoring 24 hours. The paper covers experiments to find a proper K and C4.5 discrete value, and use the KKZ algorithm to initialize the cluster center values. Based on the six traces of monitoring data, we compared the performances of cascading network QoS analyzing algorithm, K-mean algorithm and C4.5 algorithm. As a result, the cascading algorithm was highly efficient and reduces the noise of single algorithm; also it proved to be suitable to several types of monitoring data.

KEYWORDS

Cognitive network; QoS control; Bayesian network; Student study assessment.

INTRODUCTION

The Internet has developed into a huge and complex system with the characteristics of nonlinear and dynamic. Meanwhile, QoS management and control in the traditional network is undergoing many challenges with the new network access technologies and continuous enrichment of network bearing service. Due to the lack of autonomy and intelligence, the network does not have a comprehensive knowledge of its own conditions and behaviors. And the increasingly complex network contributes to the results that the traditional QoS guarantee method of isolated and static performs inefficient and makes decisions passively. Then the network is often congested and its QoS performance becomes deteriorated. When service transmission and QoS guarantee cannot be dynamically adjusted according to changes in the environment, both network resource utilization and User Satisfaction Degree will be degraded. Cognitive network is proposed as an active network with the characteristic of cognitive with the inspiration of the technology of cognitive radio. A cognitive network is a network with cognitive process that can perceive current network conditions. It can plan, decide and act on those conditions. It is considered to be the inevitable trend of future communication network with fundamental features of wireless, mobile, broadband and all-IP.

Existing research mainly focused on QoS control adaptive QoS framework and QoS algorithm, etc., mostly on a local, specific control methods, basically is to use external control mechanism, is difficult to rise to the method and mechanism of global significance. Literature[1] proposed a three layer of primer adaptive QOS framework, can adaptively adjust the existing object primer bandwidth allocation in order to satisfy the demands of real-time asynchronous SMIL. Literatures[2-5] study the cognitive rules of dynamic network QOS management strategy and the various methods and strategies for library is limited to solve the problem of local and/or services to a single QOS goals. Literature[6] in prophase research work[7]and[8] on the basis of high put forward a method based on adaptive cross layer communication mobile Web service QOS framework, this paper studies the user how to use the framework to define various QOS standards and select the most appropriate service providers. From the Angle of the feedback and heterogeneous QOS, literature[9] is proposed for multicast and multimedia stream can be configured system, aims to provide real-time dynamic heterogeneous network with adaptive control mechanism. Proposed in ref.[4]. QOS control system, the regulation of the operation behavior based on rules on component, at the same time the introduction of predictive control, can predict the QOS components in the current environment of operation, is deduced from the QOS component what should make the necessary changes. Literature[10] proposed a cognitive network QOS from management system, based on the rules of the management structure, the use of information processing and pattern recognition with the combination of event analyzer help policy decision point in the process of monitoring the environment variables for the network QOS long-term trend. Literature[11] use online control and predictive filtering QOS performance management, as well as to the network QOS requirements in terms of prediction and automatic allocation of resources in advance, to complete a closed loop network control process. Literature[12] with decision tree learning method to find network failure part, at the wrong cycle, classification of decision tree to operation request, the results based on the request on the path of right and wrong is used to strengthen and predict the fault location, fault the positioning of the lack of real time, and hard to fault handling in a timely manner. Xin MingJun et al.[13] a composite model is put forward based on Agent collaborative solving independent QOS architecture, designed to solve the problem of distributed collaborative network environment to solve the efficiency and service level. Shen Fuhui et al.[14] is proposed based on a knowledge base and decision mechanism of combining the QOS architecture, designed to reduce human intervention. Literature[15] with the aid of the utility function using a combination of local and global optimization of QOS of network learning and optimization, the method on the different levels of network while considering the overall efficiency, but the lack of QOS guarantee, no users (business) and the Internet. Yao Yinxiong et al. Literature[16] proposed an adaptive QOS framework structure, can realize dynamic mobile access resource adjustment and QOS guarantee mechanism. Literature[17] DiffServ thought for reference, this paper puts forward a dynamic adaptive QOS distribution control based on hierarchical structure model, has certain adaptability and extensibility. Literature[18] based on graph theory and Markov theory to study the cognitive network QOS, this paper puts forward a robust strategy of autonomous core network QOS management system, realize the self management of traffic engineering and adaptive robust control.

Shang Yong et al. Literatures[19-21] proposes a priority-based autonomic QOS control framework and an IP-based independent QOS negotiation mechanism, enables the system to get the current resources situation the best QOS guarantee.

Autonomous control technology of QoS for cognitive network studied in this thesis mainly refers to the autonomous, intelligent and self-adaptive methods during the implementation of Qos decision and control in the cognitive environment. It can ensure end-to-end QoS of network and promote the resource utility. According to the problems such as multi-service, demand differences, dynamic change, resource scarcity in current network, several issues are taken into consideration in the paper, such as QoS students study degree assessment, QoS degradation location and QoS autonomous control, etc. Bayesian network theory is used to realize global monitoring, analyzability, control ability in the dynamic and complex cognitive network environment. Bayesian network theory is used to realize global monitoring, analyzability, control ability in the dynamic and complex cognitive network environment.

FUZZY DYNAMIC BAYESIAN NETWORK

Fuzzy set theory

The fuzzy set is a description of the concept of fuzzy, which is a powerful tool for dealing with fuzzy concept. Its main characteristic is to explicitly set to join the fuzzy concept, fuzzy sets to describe the input mode space. It is using the fuzzy subset of the input space synthesis fuzzy rules to describe complex or uncertain system. Fuzzy set theory is strictly precise mathematical method is used to deal with the phenomenon of "fuzzy", in order to achieve the elimination of "fuzzy" a science.

Definition 2-1: set X is a set of all possible values of object X, is called X is theory field of x

Definition 2-2: set theory domain X collection $A=\left\{\left(x,\mu_A\left(x\right)\right)\mid x\in X\right\}$, among them, $\mu_A\left(x\right)$ stands the characterization of A belongs to the extent of agv is [0, 1], which A is referred to as fuzzy set. $\mu_A\left(x\right)$ called membership function of A (the membership function, FM). It reflects the theory of domain elements belong to the degree of the fuzzy set, if close to 1, then said X belongs to A with high degree, if close to 0, belong to A with low degree. The membership function has a variety of forms, such as: triangular, normal, pointed, etc.

Dynamic bayesian networks

DBN is extension of BN in the sequential process modeling, in describing nonlinear, time sequence, evolutionary and uncertainty has significant characteristics. DBN and static BN, demand probability distribution must be based on the assumption of independence variable conditions.

Under this assumption, a DBN can be defined as $(B_0, B_{\rightarrow})$. Including B_0 said initial BN, $\Pr(X_0)$ can be get from any one node from the figure of prior probability, $B_{\rightarrow}$ said a time slice of more than two and graphics composed of BN. $X=\{X^1, X^2, ..., X^n\}$ is set as random variables is dynamic Bayesian model, X_t^i is a variable corresponding to the random variables X^i in t time. Figure 1, 2 shows a simple of the initial network of DBN and transition network.

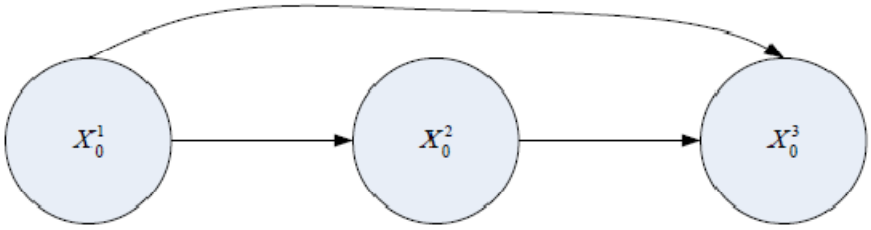

Figure 1: The initial network of a simple DBN

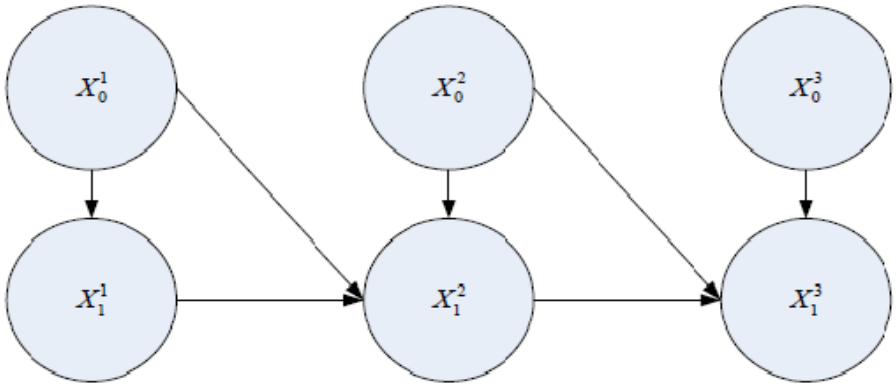

Figure 2: The transition network of a simple DBN

We respected to observe the joint probability distribution of the initial network and transformation. For the given system under the initial state of the network structure of the initial network of B_0. The joint probability distribution is as follows:

$$\Pr(X_0) = \prod_{i=1}^{n} \Pr(X_0^i \mid Pa(X_0^i)) \quad \textbf{(1)}$$

And $B_{\rightarrow}$ aims at all the time points from $0,1,...,t$, before and after the specified set of state variables between the two times of transition probability $\Pr(X_i \mid X_{i-1})$.

Finally we get the joint probability distribution of DBN on $X = \{X^1, X^2, ..., X^n\}$ is :

$$\Pr_B(X^1, X^2, ..., X^n) = \Pr_B(X_0) \prod_{t=1}^{T-1} \Pr_{B_{\rightarrow}}(X_i \mid X_{i-1}) \quad \textbf{(2)}$$

DBN can be viewed as random process graphics mode, and random process. DBN variables are divided into random observation variable and random variable. Based on graph model of hidden variables discrete DBN inference both probability theory as a mathematical basis, and the basis of static BN, therefore in the reasoning of complex random process has more and more application.

The representation of dynamic bayesian networks

Hidden Markov model (Hidden Markov models, HMM) is the foundation of all discrete DBN. As the DBN inference, a kind of simple processing method is to transform it into Markov models (Markov models, MM), and calculated with the boundary algorithm. In different circumstances, DBN with MM based on Gaussian mixture probability model, autoregressive model and mixed connection type MM and MM equivalent respectively.

HMM is a kind of stochastic finite automata, in which each status of node corresponds to a node, as shown in Figure 3.

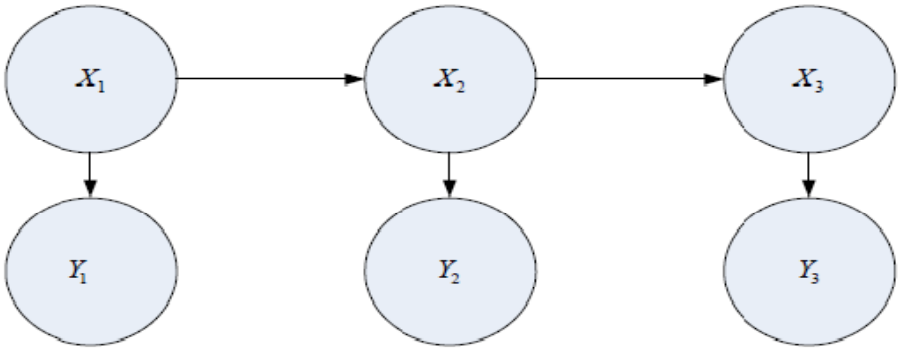

Figure 3: Graphical representation of the HMM

DYNAMIC BAYESIAN NETWORK MODEL OF COGNITIVE NETWORK QOS STUDENT STUDY ASSESSMENT

Cognitive network QoS students study assessment can be seen as a diagnostic process. Students study assessment from detection of events, is detected after the incident, as a new type of evidence, events affect students study by Bayesian logic to update the backward propagation, the updated situation and through the forward reasoning to predict the occurrence of the event, to complete a students study assessment.

Therefore, to construct a cognitive network QoS based on expert knowledge of Bayesian networks prior students study evaluation model, as shown in Figure 4.

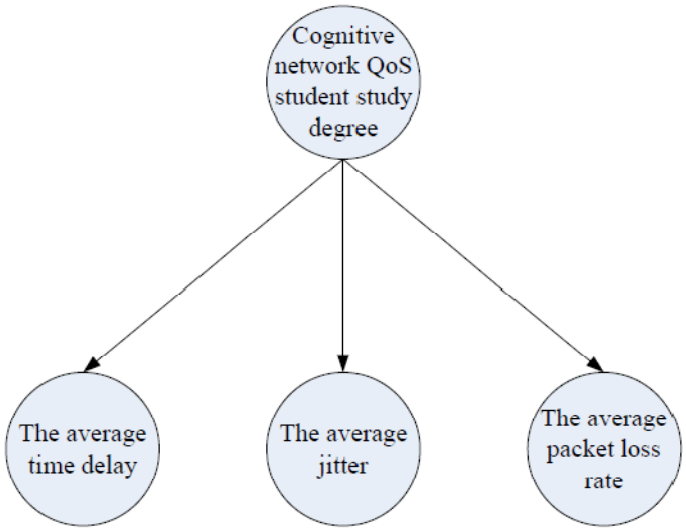

Figure 4: Cognitive network QoS of BN prior students study evaluation model

Transfer the Bayesian network model is on the basis of the prior model, coupled with time factor. The adjustment to the edge of the initial network, according to the mutual influence between adjacent time variables to establish cause and effect, which can reflect the probability of the dependent relationships between variables and their change over time. The resulting cognitive network QoS students study degree evaluation of dynamic bayesian network model as shown in Figure 5:

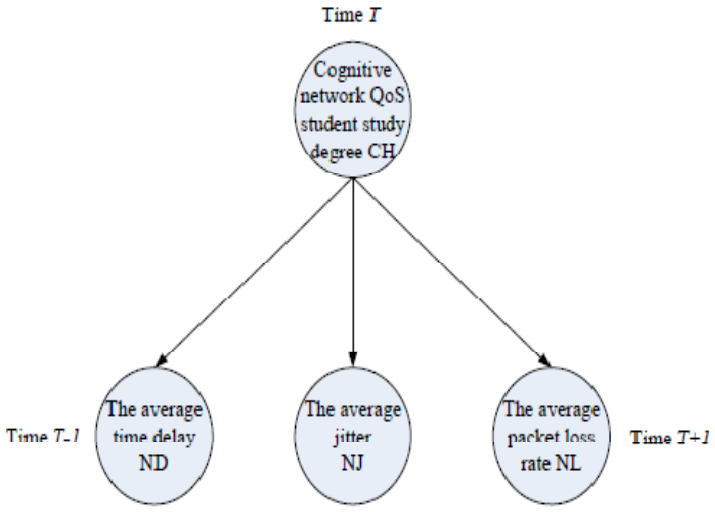

Figure 5: DBN model of cognitive network QoS students study assessment

As time goes on, the network status information more and more, in the current time T, according to the mathematical models of BN, prior knowledge and historical knowledge can be when time T+1 cognitive inference network QoS students study CH [T+1], time to time T+1, the students study information CH [T] is on the basis of reasoning can be used as a time T+1 makes a priori information continuous learning and improvement of get DBN model of cognitive network QoS Students study assessment.

THE METHOD OF FUZZY DYNAMIC BAYESIAN NETWORK IN COGNITIVE NETWORK QOS STUDENT STUDY ASSESSMENT

QoS students study assessment DBN inference is to point to, from the perspective of the students study degree of prior knowledge, using known DBN structure and parameter learning of CPT, in a given ND, NJ, NL observation value, calculate the probability distribution of CH, namely the calculation process of the a posteriori probability of CH. Due to this chapter constructs the QoS students study degree evaluation of DBN model has simple structure, can be directly reasoning.

Reasoning is as follows: with the specified initial state and conditional probability to initialize the model. Detected at a certain moment when the new classification of students study information network, namely the leaf node of the network information update, trigger the reasoning model. Through reasoning algorithms, the students study degree of posterior probability, to update the probability distribution of the whole network node status, the updated posterior probability distribution as the basis of the next moment reasoning; By sequential observational evidence of the input model, model for real-time estimate the match in the most reasonable students study sequence of observable CH1: T. Assuming continuous observation T time to the network, the observational evidence ND, NJ, NL input model, and finally, the resulting cognitive network QoS students study CH as:

$$CH_{1:T}^{*} = \arg\max_{CH(1:H)} \Pr(CH_{1:H} \mid ND_{1:H}, NJ_{1:H}, NL_{1:H}) \quad \textbf{(3)}$$

Cognitive network QoS students study assessment of DBN reasoning is as shown in Figure 6.

DBN is static BN in the continuous extension of the time and space, the essence of reasoning and static BN is consistent, is based on the bayesian formula:

$$\Pr(x \mid y) = \frac{\Pr(yx)}{\Pr(y)} = \frac{\Pr(yx)}{\sum_{x} \Pr(yx)} \quad \textbf{(4)}$$

By BN conditional independence, with n and m a hidden node monitoring node discrete static BN, the essence of reasoning is:

$$\Pr(x_1, x_2, ..., x_n \mid y_1, y_2, ..., y_n) = \frac{\prod_{j} j(y_i \mid Pa(Y_i)) \prod_{i=1} \Pr(x_i \mid Pa(X_i))}{\sum_{x_1, x_2, ... x_n} \prod_{j} j(y_i \mid Pa(Y_i)) \prod_{i=1} \Pr(x_i \mid Pa(X_i))} \quad \textbf{(5)}$$

Among them, $i \in [1, n], j \in [1, m]$, x_i said a state values of X_i, y_i said monitoring variable values of Y_i,. $Pa(X_i)$ said X_i parents node collection. Type on the denominator expressed monitoring joint distribution of the composite state and hidden variables are summed up, the essence of which is for determining the distribution of the composite state monitoring variables.

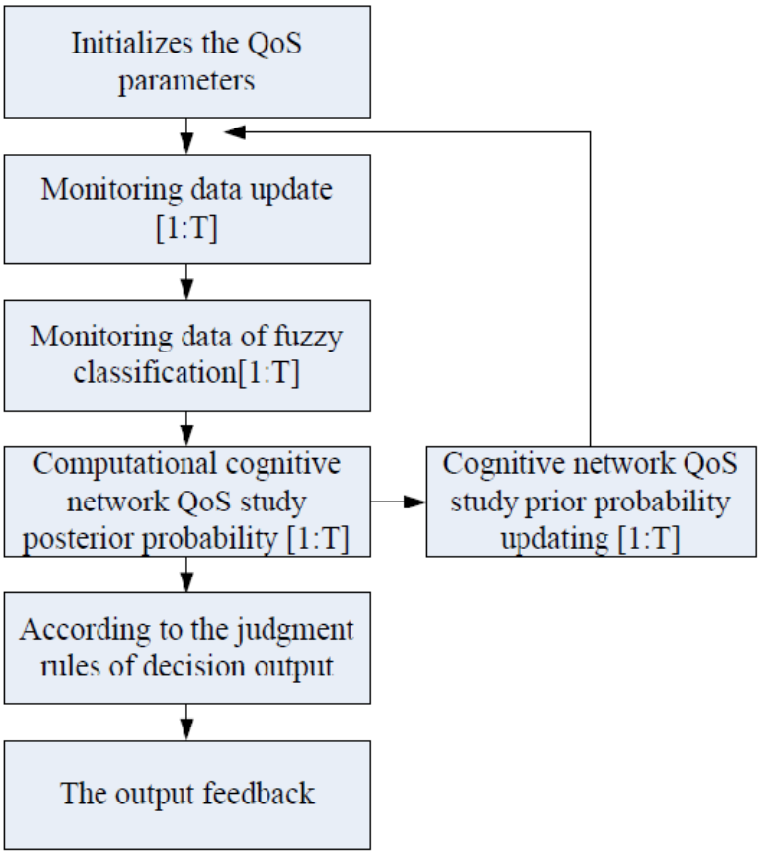

Figure 6: DBN inference process of cognitive network QoS study assessment

SIMULATION EXPERIMENTS AND ANALYSIS

A topology structure is as shown in Figure 7 using NS2 simulation to obtain the real data to verify the accuracy of the models.

To simplify the calculation, this chapter first structures, as shown in Figure 7 topology using NS2 simulation to obtain the real data. Figure in the link for bottleneck link between R1 ↔ R2, R2↔R3, the bandwidth is set to 10 m, R1, R2 ↔ R3 ↔ R2 time delay between 10 ms; Other link bandwidth is set to 10 m, delay 5 ms. Add contains Web business network, FTP, Telnet, VOD video on demand, such as business, in addition with the Traffic generator to generate random Traffic interference to simulate real network environment, the simulation time of 500 s, according to the definition given by the section II track calculated within 500 s students study run time average history average delay, jitter, historical value, the average packet loss rate of $\overline{d}$ = 50 ms, $\overline{j}$ = 40 us, $\overline{l}$ = 2%;And to determine the network general learning ability runtime, delay, jitter, packet loss rate allowed by the $d_{\max}$ = 150ms, $j_{\max}$ = 120 us, $l_{\max}$ = 6%.

The simulation time of 500 s, every 0.1 s sampling time, access to 5000 groups of sample data, through the number of DBN learning and combined with the Delphi method based on expert consultation, Figure 7 topology environment, cognitive network QoS DBN students study evaluation model of conditional probability table such as TABLE 1, DBN model conditional transfer probability table as shown in TABLE 2.

Business deployment topology and the same, the simulation time setting of 300 s, from 110 s to 195 s and 220 s - 265 s two periods, the host N30 to ARP attack by R1, R1 and the whole domain of communication situation, cause the network congestion, affect the normal transfer video on demand (VOD) service. Every 30 seconds in the 300 s, as a time slice, the time T = 10.

On 10 time slices respectively get 10 real monitoring data, as shown in TABLE 3.

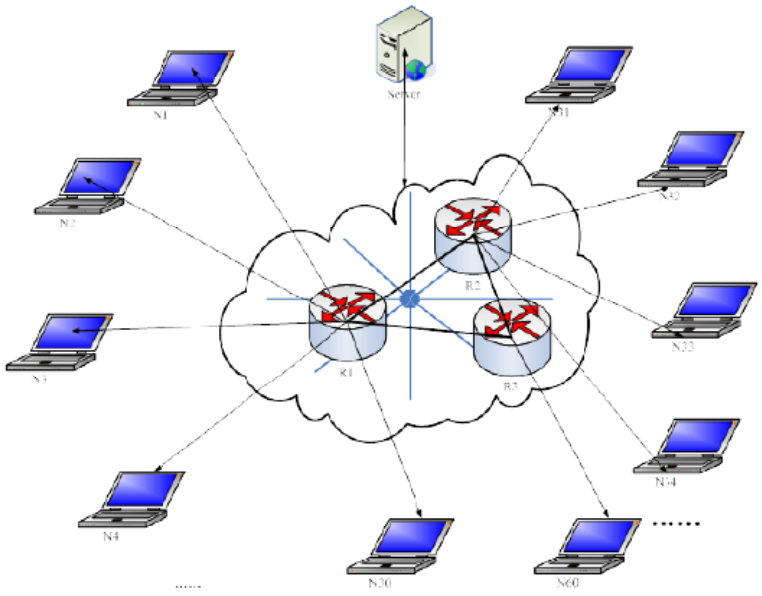

Figure 7: Simulation topology

TABLE 1: Conditional probability tables of the cognitive network QoS students study degree

CH	Pr（ND|SH）			Pr（NJ|SH）			Pr（NL|SH）		
	Small	Middle	Big	Small	Middle	Big	Small	Middle	Big
Strong learning ability	0.6	0.3	0.1	0.6	0.3	0.1	0.8	0.1	0.1
General learning ability	0.2	0.6	0.2	0.2	0.6	0.2	0.1	0.7	0.2
Poor learning ability	0.1	0.3	0.6	0.1	0.3	0.6	0.1	0.1	0.8

TABLE 2: DBN model conditional transfer probability tables

CH[T+1]|CH[T]	Strong learning ability [T+1]	General learning ability [T+1]	Poor learning ability [T+1]
Strong learning ability [T]	0.6	0.3	0.1
General learning ability [T]	0.1	0.6	0.3
Poor learning ability [T]	0.1	0.3	0.6

TABLE 3: Real monitoring data

Varia-bles	1	2	3	4	5	6	7	8	9	10
ND（ms）	48	46	42	75	215	184	131	146	223	45
NJ（us）	30	27	25	52	133	114	75	88	141	26
NL（%）	2	1.8	1.7	2.5	6.9	6.3	4.6	5.1	6.8	1.8

CONCLUTION

This paper proposes a cognitive network QoS students study degree evaluation method based on FDBN. From the macro perspective of cognitive network QoS Students study assessment, considering the Internet as much as possible in the network, business and link, established a cognitive network QoS DBN model of Students study assessment. Then continuous variable fuzzy classification for DBN can apply evidence reasoning information, resulting in continuous time slices on the QoS of students study and its developing trend, provides the network decision-making and control has the reference value of the evaluation results. The simulation results show that the method has good accuracy and dynamic, real-time and effective. Because the DBN model was established based on expert knowledge, the next

step will be the introduction of dynamic bayesian network structure learning algorithm to learn about the structure of the model, in order to get a more accurate and objective DBN model.

REFERENCES

[1] C.Ing-Chau, H.Sheng-Wen; An adaptive QoS guarantee framework for SMIL, multimedia presentations with ATM ABR service[C], Proceedings of IEEE Global Telecommunications Conference. San Francisco, USA, **2**, 1784-1788 **(2002)**.

[2] S.Aiber, D.Gilat, A.Landau et al.; Autonomic self-optimization according to business objectives[C], IEEE 1st International Conference on Autonomic Computing, 206-213 May **(2004)**.

[3] V.Bhat, M.Parashar, H.Liu et al.; Enabling self-managing applications using model-based online control strategies[C], IEEE International Conference on Autonomic and Autonomous Systems, 15-24 July **(2006)**.

[4] R.Bahati, M.Bauer, E.Vieira et al.; Using policies to drive autonomic management[C], IEEE 7th International Symposium on a World of Wireless Mobile and Multimedia Networks, June **(2006)**.

[5] H.Liu, M.Parashar; Accord: a programming framework for autonomic applications[J], IEEE Transactions on Systems, Man and Cybernetics, **36(3)**, 341-52 **(2006)**.

[6] N.Samman, A.Karmouch; An automated policy-based management framework for differentiated communication systems[J], IEEE Journal on Selected Areas in Communications, **23(12)**, 2236-47 **(2005)**.

[7] M.Tian, A.Gramm, H.Ritter et al.; Adaptive QoS for mobile web services through cross-layer communication[J], Computer, **40(2)**, 59-63 **(2007)**.

[8] D.Tsesmetzis, I.Roussaki; QoS-aware web service maximization[J], Simulation Sykas E. Modeling and simulation of selection for provider profit, **83(1)**, 93-106 **(2007)**.

[9] M.Tian, A.Gramm, T.Naumowicz et al.; A concept for QoS integration in web services[C], Proceedings of 4th International Conference on Web Information Systems Engineering Workshops, Roman Italy, 149-155 **(2003)**.

[10] K.Hsu-Yang, L.Yen-Yen, L.Chia-Ni L; A configurable multicast multimedia framework supporting adaptive QoS [C], Proceeding of IEEE International Symposium on Communications and Information Technology, **1**, 356-361 **(2004)**.

[11] S.Abdelwahed, N.Kandasamy, S.Neema; A control-based framework for self-managing distributed computing systems[C], ACM Workshop on Self-Healing Systems, October **(2004)**.

[12] J.Suzuki, T.Suda; A middleware platform for a biologically inspired network architecture supporting autonomous and adaptive applications[J], IEEE Journal on Selected Areas in Communications, **23(12)**, 249-260 **(2005)**.

[13] H.F.Daniel, Y.E.Mustafa et al.; Architecture and Performance of an Island Genetic Algorithm-based Cognitive Network[C], In Proceedings of Fifth IEEE Consumer Communications & Networking Conference (CCNC 2008) **(2008)**.

[14] Xin Mingjun Wu Chao, Wei-hwa lee; Based on the Agent of the composite model adaptive QoS mechanism [J], computer engineering, **33(18)**, 72-74 **(2007)**.

[15] Shen FuHui, Zhou Ya; One with ten white to adapt to the QoS of wireless system structure [J], Network security technology and applications, **8**, 92-94 **(2006)**.

[16] E.Gelenbe, P.Liu; QoS and routing in the cognitive packet network[C], IEEE 6th International Symposium on a World of Wireless Mobile and Multimedia Networks, June **(2005)**.

[17] Yao Yinxiong; MAQF: a new white mobile Ad2Hoc network adaptive QoS framework structure [J], journal of power, **30(5)**, 727-730 **(2002)**.

[18] Liu Jun Qing-hua Zheng; a dynamic white based on hierarchical structure to adapt to the distribution of QoS control model [J], journal of communication, **23(9)**, 100-106 **(2002)**.

[19] Ali Tizghadam, Alberto Leon-Garcia; Autonomic Traffic Engineering for Network Robustness [J], IEEE Journal on Selected Areas in Communications, **28(1)**, 39-50 **(2010)**.

[20] Shang Yong, Yeung Hok-leung; White adaptive QoS management scheme based on IP network study [J], journal of computers, **24(1)**, 32-39 **(2001)**.

[21] Shang Yong, Yeung Hok-leung; Qos mapping suit with white I do business mechanism research and implementation of the [J], journal of software, **12(5)**, 751-757 **(2001)**.