Using Chaos Theory to Investigate the Development Process of the Most Popular Blog

Kwoting Fang/National Yunlin University of Science & Technology
dept. of Information Management
Yunlin, Touliu, ROC
fangkt@yuntech.edu.tw

Shu Chuan Wang/Feng Chia University
Institute of Electronic Commerce
Taichung, ROC
scwang@mail.fcu.edu.tw

Abstract—**Advances in information and networking technology, in terms of online recreation, have continuously set an overwhelming pace for rapid growth in new applications of Internet-based activities in personal lives such as Blog. The main purpose of this study is to explore whether chaos exists in the blog development and discover any particular point in time worth further discussion by conducting quantitative analysis of chaos theory in the time dimension. Given with emergent events that cause divergence and uncontrollable behavior, the results revealed that the development behaviors of popular blogs undergo dynamic evolution over time and the future development is uncertain and unpredictable.**

Keywords- Blog; Chaos theory; Lyapunov exponents

I. INTRODUCTION

Blogs evolved from the online diary owned by Justin Hall in 1994. In 2003 Google bought blogger.com. In 2005, Bill Gates, Chairman of Microsoft, pointed out that blog was one of the important network applications, while Business Week featured blog on its cover as the theme of its 2005 Spring issue [1]. With the extensive use of blogs, more and more people became famous by writing articles or drawing comic strips on blogs. Popular blogs with huge numbers of daily visitors and responses often attract advertisers' attention and the bloggers may be invited to give public speeches, publish books or appear on product promotion events; fame and fortune soon ensue. However, in one of the commentaries entitled "The Blogging Iceberg" provided by Peruses Development suggested that the majority of blogs only attracted a small number of readers, and often became inactive rather quickly [2]. The company conducted research on the blog population development in eight blog service providers in 2008 and found that 30% of the blogs were active for only one day, and up to 66% of the blogs were not updated for over two months. The average active period was 126 days overall [3]. This data shows that it is not an easy task to keep a blog over a long period of time.

The existing theoretical models suggest that most of the studies on blog management tend to assume linear relationships among members interactions [4]. However, a closer observation found that blogs were an open platform, and some topics caused heated discussions through internal (bloggers, readers) and external (readers) interactions. These emergent events drew the blogs from stabilization to dissipation, which eventually returned to stabilization after a period of time until the next heated discussion began. The interactions in each phase also served as the feedback for the bloggers to post the next topic. It showed that blogs were a changing dynamic system [5], and there should be a theoretical framework different from linear relationships to explain the dynamic changes in blogs. Levy [6] proposed that Chaos Theory, derived from natural science, could be used to explain the unpredictable nature of social phenomena and to reveal the hidden pattern which changed over time. A number of scholars had also proposed the similar application of chaos theory in the enlightenment of social phenomena [7,8]. In addition, the existing literature [4,8] found that most research in blog behavior observation was confined to a fixed period, and only a few were longitudinal studies. If an observation is carried out within an extended period of time, the blog behavior changes over time can be tracked.

Therefore, the main purpose of this study is to explore whether chaos exists in the blog development and discover any particular point in time worth further discussion by conducting quantitative analysis of chaos theory in the time dimension. The results of this study should provide valuable insights for researchers who can improve techniques used in study for identifying exactly chaos situations. It can also be helpful for managers who can better understand how to bridge the gap between demand for Blog users and to make advertising more effective to fulfill Blog users in a competitive era.

The paper is structured as follows: Section II presents a literature review in terms of blog and chaos theory. Section III explains research model followed by Section IV, which uses Lyapunov exponent to identify the chaos exist or not. Finally, Section V concludes the paper and provides further discussions.

II. LITERATURE REVIEW

Justin Hall, a student at Swarthmore College, started his web-based diary in 1994 and was considered the earliest form of blog [9]. In July 1999 pitas.com released the first

 ISBN: 978-1-61208-280-6

free and user-friendly blog software "pitas", and launched blogger.com. It was a big deal when Google acquired blogger.com in 2003. Microsoft Chairman Bill Gates introduced MSN Space blog with MSN integrated in 2003. Since then, Blog has been rapidly developed and spread on the internet [10].

Several researches have been conducted on blogging in different areas since blogs began gaining popularity in 2003. Trammell and Keshelashvili [11] found that many popular blogs were diary-type and often contain illustrated texts. Zhang [12] attempted to predict the sustainability of blogs with chaos theory. The research period spanned from the first day of the blog till the end of year 2006. He concluded that when the Lyapunov exponent decreased and the system became less chaotic, the bloggers should take the initiative to post new entries to improve the situation. Hsu and Lin [13] undertook research on acceptance of blog usage and found that perceived ease of use, entertainment, altruism, reputation, and community identification were important factors that influence the behavioral intention to adopt blog service.

Chaos Theory, originated from Mathematics and Physics in the 1960 and 1970 [6], argued that the direct causal relationship proposed by the Newton theory in which it believed "one cause produced one result" was only a special case in the real world. Chaos theory proposed that nonlinear system was widespread in nature, included biological growth and fall of ethnic groups. In a dynamic system, objects were extremely simple in operation at the beginning, and unexpected results were produced with continuous duplications of the status in the previous phases by a certain rule over time [14].

Concomitant with the markedly increasing number of Blog users, it is not surprising that Blogs have garnered significant attention from the academic setting at large, from scholars in disciplines as diverse as sociology, psychology, education, and information systems to explore the potential research issues.

In the field of finance, some scholars [15,16] used chaotic phenomena in well-log time series to analyze the changes in the United States Treasury bill rate and stock market price index. Their results confirmed that chaos theory was valid for explaining the real market situation. In information system based research, McBride [17] applied the concepts of initial condition, strange attractor and dissipative structure to interpret the interactions between the system and its members. Utilizing secondary data to review the revolution in monitor technology, Tu and Hung [18] applied chaos theory to explore the changing process of technical environment dynamic cycle.

III. RESEARCH METHOD

This study presents the research model (Figure 1) that analyzes of blog data and that is used to identify whether chaos exists.

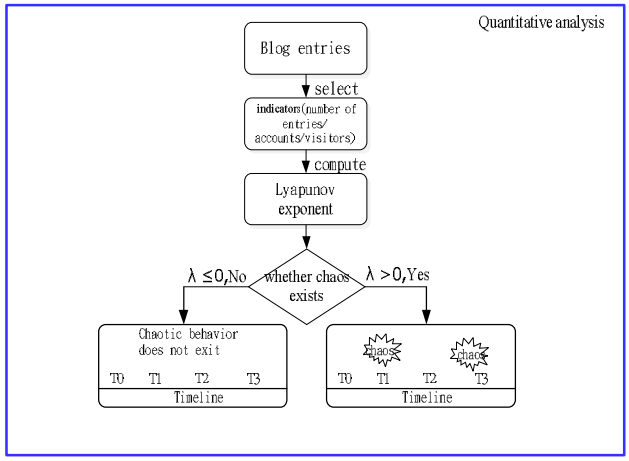

Figure 1. Research model

To investigate whether chaos exists in the most popular web blog, and to understand the driving events that cause chaos and its implications, we define "the most popular web blog" as "the blog which has the most visitors since the first day the blog". The data is obtained from web site [19] which began tracking blog popularity and ranking blog growth in real time since September 2006 (Blog Observation System, 2009). As of June 2009 there were 211,574 blogs on file. This study picked the top ranked Chinese personal blog *Wan Wan's Comic Blog* as the research object (Blog Observation Chinese Personal Blog, 2009).

Identify suitable indicators for measuring the behavior of blog development, this study collected the information which is publicly available on the blog service website, including the number of entries, accounts and visitors as the indicators for measuring whether chaos exists during the course of the blog development, and analyzes the results to get the most discriminative indicator. For minimum sample size consideration, this study collects the data from the first day of the blog to the end of August 2009, and selects "week" as the appropriate time interval for the indicator analyses to meet the minimum sample size 200 required by Lyapunov exponent analysis [17]. *Wan Wan's Comic Blog* began in October 2004. Totally, 256 sample data are collected for each indicator (October 2004 to August 2009, a total of 64 months. 64 * 4 = 256 samples)

IV. DATA ANALYSIS

In line with above sense, the data was analyzed in two phases. The first phase calculated the total number of the entries, account numbers and visitors within one week. The number was used as λ in phase two for the Lyapunov exponent calculation to determine whether each indicator denotes chaotic behavior. The raw data was collected from the entries on Wan Wan's Comic Blog. The results of the Lyapunov exponent were shown in Fig.2 to Fig.4. Fig.2 was the λ value for entry number. To meet the minimum

 ISBN: 978-1-61208-280-6

requirement of sample number, the data was aggregated using one week as interval to minimize the difference in the number of entries for each week, which made the do or dn in the Lyapunov exponent equation λ = LN(dn/do) to be 0 and λ to be undefined. Therefore it could not be used as an indicator of chaos. Fig.3 and Fig.4 showed the trend map using account numbers and visitors for further analysis.

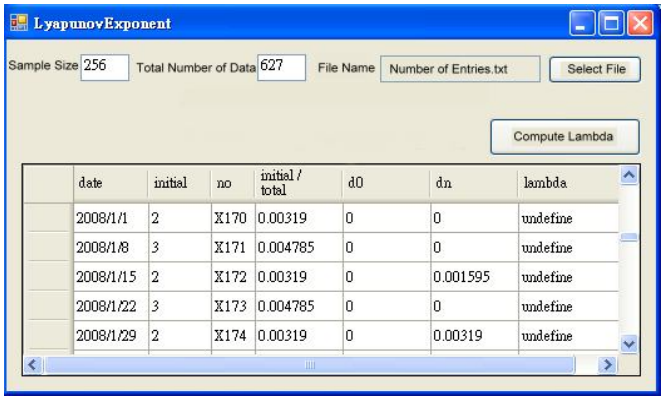

Figure 2. λ value for entry number

Kiel & Elliott [7] proposed in the chaos theory study that for any system if there was at least one positive value ofλ, the system would have chaotic behavior, and the higher the value the greater the degree of chaos. The results from the Lyapunov exponent find that for both the account numbers and visitors, the λ values were greater than 0 during the period 2004/12/23 to 2009/4/21 (Fig.3 and Fig.4). Since there was at least one positive λ value, it could be assumed that chaotic behavior existed in the system. The result is shown in Table 2.

The analysis of Lyapunov exponent in Table 2 showed that the results of testing chaos using account numbers and visitors are quite consistent. During the period 2004/10/5 – 2004/12/22 the λ values were less than 0, which meant the blog was stable without chaotic behavior. However, during the period 2004/12/23 – 2009/4/21 there was at least one λ value greater than 0, which meant chaos existed in the blog development and the development had become uncertain and unpredictable.

According to Hilborn [20] the subsystems were formed with different initial values, we could further understand the extent of chaos in certain intervals by the $\overline{\lambda}$ values. To better observe the chaotic behavior in the system the study uses "one year" as the time interval and observes the changes of the $\overline{\lambda}$ values in each interval to understand the changes in chaos each year. The reason for selecting one year as the interval was to avoid the low number of entries and critical events in a short period of time. Table 3 and Fig.5 showed the λ values of account numbers and visitors in each year.

Table 3 used account numbers as an indicator for chaos and showed that the $\overline{\lambda}$ value before 2004/12/22 was less than 0 ($\overline{\lambda}$ =-0.440); this meant chaotic behavior did not exist during the development. However, the values moved from negative to positive in 2005-2009 and went up increasingly, which meant that chaos existed in the blog development and the extent of chaos was becoming more significant. The value was highest in 2008, indicating there was a critical event worth attention during this period. However, the value in 2009 decreased slightly compared to 2008. It might be attributed to the requirements for Lyapunov exponent calculation. The data collecting stopped at the end of April 2009, which affected the $\overline{\lambda}$ value for the year 2009. The analysis result of the $\overline{\lambda}$ value for visitors was consistent with that for account numbers.

Table 2 and Table 3 both revealed that the identification of chaos using account numbers and visitors is consistent with both one year or the entire period as an interval, which meant both indicators were valid in identifying chaos. The change in $\overline{\lambda}$ value each year showed that blog development involved both positive and negative forces. The negative force led the system to a stable status, and with certain events the system diverged from stability. Table 3 showed the $\overline{\lambda}$ value changed from negative to positive at the end of 2004 to 2005. The positive force led the system away from stability to chaotic behavior.

In this section we adopted the chaotic behavior - time matrix to express chaos in blog development. (Fig.6)

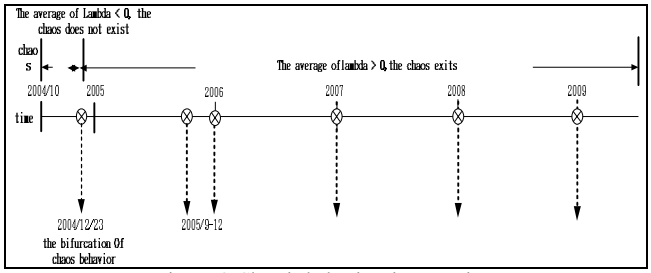

Figure 6. Chaotic behavior-time matrix

The Lyapunov exponent analysis showed that both positive and negative feedback forces existed in the blog development process. The positive feedback force meant the system was chaotic, divergent, and was unpredictable and difficult to explain. The negative feedback force meant the system was stable and seeking internal development and recognition. The system was relatively closed. In the initial stage the blog was not well-known and only attracted a few visitors, therefore the $\overline{\lambda}$ value prior to 2004/12/22 was smaller than zero, meaning chaos did not exist and the blog was stable and convergent. The system underwent a

 ISBN: 978-1-61208-280-6

transition from non-chaotic to chaotic on 2004/12/23. The λ values from 2005 through 2009 were greater than zero and were steadily increasing; indicating critical events existed during these periods and led the system to go from the state of equilibrium to disorder.

V. CONCLUSIONS AND DISCUSSIONS

The main purpose of the study is to explore whether chaos exists during blog development and find out the timing when this behavior occurs. The results show that the non-linear and dynamic chaos does exist during the course of the blog development and there exists both positive and negative forces in the system. Basically, the negative force leads the blog towards stability and convergence, and during this period the blog seeks readers' recognition and cohesion. Critical events bring in the external energy and resources, which causes internal and external interactions under the dissipative structure of the system. In contrast, the positive force therefore leads the system to move from the state of stability towards disturbance, divergence and disorder and makes the situation difficult to predict and control. The time, chaos occurs, is when Lyapunvo exponent turns from negative to positive. This is the demarcation of ordered structure and disorder, meaning there're emergent events that cause divergence and uncontrollable behavior. These are events that require discussion to understand the applications of the quantitative data. The demarcation of the negative force and positive force is on December 23rd 2004 when MSN emoticons are released. The blog goes into a state of chaos and unpredictable situation. In addition, the $\overline{\lambda}$ values for accounting numbers/visitors (Fig.4) from the result of quantitative data analysis show that the $\overline{\lambda}$ values have increased over the years since the demarcation and reached the highest number in 2008, meaning the degree of chaos disturbance peaks in 2008

The chaotic behavior - time matrix (Figure 6) shows that under the operation of self-organization feedback mechanism, the blog develops diversely and grows continuously. Although the blog features the blogger's personal style and taste, it needs to be further extended and broadened to attract more visitors. From a commercial viewpoint, specific topics are needed to generate discussion, however in addition to the linear thinking where cause and effect have a direct relationship, it should be noted that small cause may also bring large effects. Finally, the virtual online community is not sufficient, face-to-face interactions also help boost popularity. The update on the blog finds heated discussion after the Wan Wan's first face-to-face interaction with the fans.

ACKNOWLEDGMENT

The authors would like to thank the National Science Council of Taiwan for partial financially supporting this research under NSC 100-2410-H-224-002-MY2.

REFERENCES

[1] Business Wire. The blogging iceberg: Of 4.12 million weblogs, most little seen and quickly, abandoned, according to perseus survey. Retrieved on May, 31, 2013, from the: http://www.businesswire.com/portal/site/home/

[2] R. Harmanci. Time to get a life - pioneer blogger Justin Hall bows out at 31. Retrieved on May, 31, 2013, from: http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2005/02/20/MNGBKBEJO01.DT

[3] T. A. Brown. Measuring chaos using the lyapunov exponent. In L. K. Douglas & E. Elliott (Eds.). *Chaos theory in the social science, pp*.53-66. Ann Arbor, MI: University of Michigan Press, 1996..

[4] P. V. Mcdonough, J. P. Noonan, & G. R. Hall. A new chaos detector. *Computers and Electrical Engineering*, vol. 21(6), pp. 417-431, 1995.

[5] S. H. Kellert. In the wake of chaos: Unpredictable order in dynamical systems. USA, Chicago: University of Chicago Press, 1993.

[6] D. Levy, D. Chaos theory and strategy: Theory, application, and managerial implications. *Strategic Management Journal*, vol. 15(2), pp. 167-178, 1994.

[7] L. D. Kiel, & E. W. Elliott. Chaos theory in the social sciences: Foundations and applications. Ann Arbor, MI: University of Michigan Press, 1997.

[8] L. L. Hsu, V. Xu, & H. C. Wu. The antecedents of influencing usage intention in blog context. *Journal of E-Business*, vol. 11(1), pp. 1-28, 2009.

[9] J. Gleick. Chaos: Making a new science. New York, NY: Penguin, 1987.

[10] Blog Observation System. Retrieved on May,31, 2013, from : http://look.urs.tw/hitsrank.php?type=1

[11] K. D. Trammell,, & A. Keshelashvili. Examining the new influencers: A self-presentation study of a-list blogs. *Journalism & Mass Communication Quarterly*, vol. 82 (4), pp. 968 – 982, 2005.

[12] J. X. Zhang. A study on the prediction of blog duration. Unpublished master's thesis, National Chung Cheng University, Chiayi, 2006.

[13] C. L. Hsu, & J. C. Lin. Acceptance of blog usage: The roles of technology acceptance, social influence and knowledge sharing motivation. *Information and Management*, vol. 45(1), pp. 65-74, 2008.

[14] S. Irene. Chaos theory and institutional economics: metaphor or model? *Journal of Economic Issue*, vol. 33(1), pp. 141-167, 1999.

[15] R. F. Bobner, I. Newman, & C. Wessinger. Chaos modeling: Increasing educational researchers' awareness of a new tool. *Proceeding of the Mid-Wester Educational Research Association*, Chicago, IL, 1989.

[16] T. Miyazoe, & T. Anderson. Learning outcomes and students' perceptions of online writing: Simultaneous implementation of a forum, blog, and wiki in an EFL blended learning setting. *System*, vol. 38(2), pp. 185-199, 2010.

[17] N. McBride. Chaos theory as a model for interpreting information systems in organization. *Information Systems Journal*, vol. 15(3), pp. 233-254, 2005.

[18] M. F. Tu, & S. C. Hung. Finding cycles in technological change: An analysis of displays from 1976-2003. *Journal of Management*, vol. 25(3), pp. 291-308, 2008.

 ISBN: 978-1-61208-280-6

[19] The data is obtained retrieved on September 20 2012 from http://look.urs.tw/

[20] R. C. Hilborn. Chaos and nonlinear dynamics. New York, NY: Oxford University Press, 1994.

TABLE 1 Data format

Number of sample	Entry date	week	Lyapunov exponent analysis indicator		
			number of entries	number of accounts (responses +trackbacks)	visitors
1	October 2004	Week1	data	data	data
⋮	⋮	⋮	⋮	⋮	⋮
256	August 2009	Week4	data	data	data

TABLE 2 λ value for account number/visitors

Exponent	2004/10/5~2004/12/22	2004/12/23~2009/4/21
Account Numbers	The system is stable (all λ values in the interval are <0)	The system is chaotic (at least one λ value>0 in the interval)
Visitors	The system is stable (all λ value in the interval are <0)	The system is chaotic (at least one λ value>0 in the interval)

TABLE 3 $\overline{\lambda}$ value for account numbers/visitors

indicator	Prior to 2004/12/22	2004/12/23	2005	2006	2007	2008	2009
Account numbers $\overline{\lambda}$	-0.440	0.403	0.0049	0.1901	0.3416	0.4023	0.3137
Visitors $\overline{\lambda}$	-0.389	0.427	0.0170	0.0588	0.3121	0.4138	0.3331

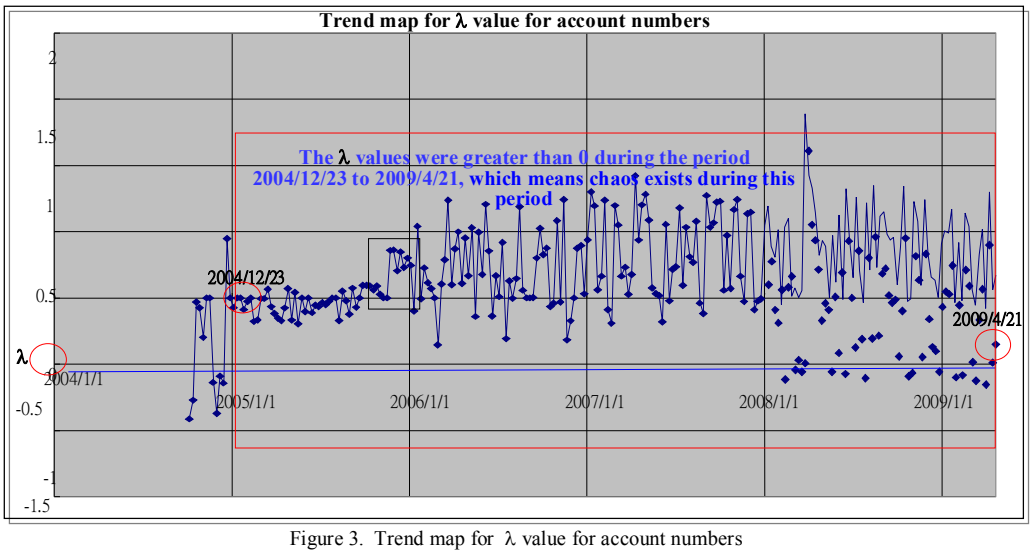

Figure 3. Trend map for λ value for account numbers

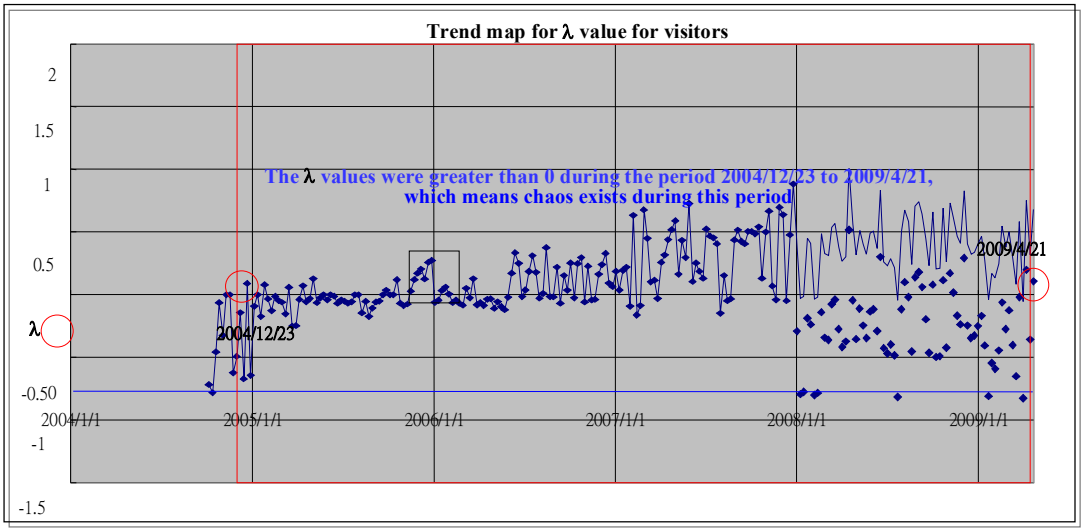

Figure 4. Trend map for λ value for visitors

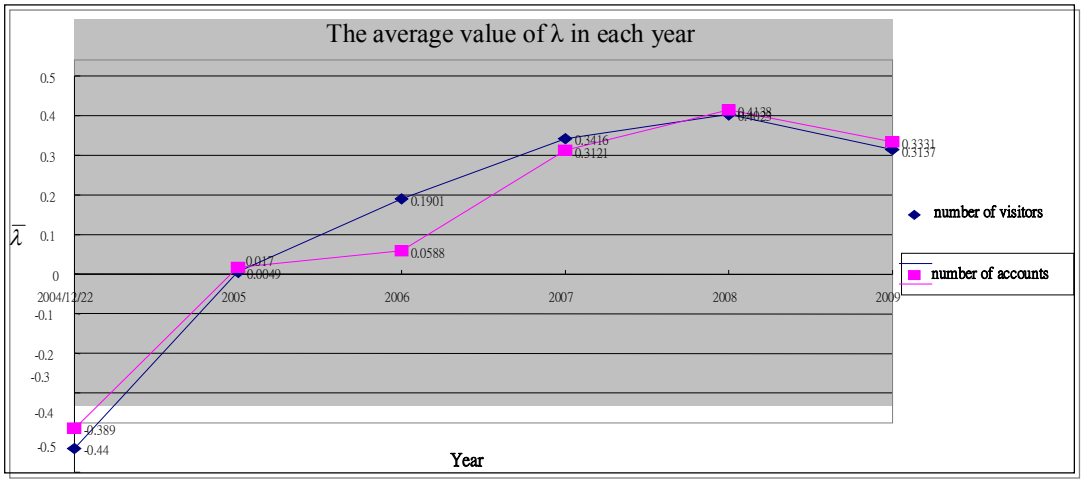

Figure 5. $\overline{\lambda}$ Value for account numbers/visitors