

**TOWARDS FORECASTING BUSINESS PREPAID MOBILE
TELECOMMUNICATION USING CONNECTIONIST MODEL**

**A thesis submitted to the Faculty of Information Technology in partial
fulfillment of the requirements for the degree
Master of Science (Intelligent System)
Universiti Utara Malaysia**

by

Tengku Halim Tengku Othman @ Tengku Ramli



JABATAN HAL EHWAL AKADEMIK
(*Department of Academic Affairs*)
Universiti Utara Malaysia

PERAKUAN KERJA KERTAS PROJEK
(*Certificate of Project Paper*)

Saya, yang bertandatangan, memperakukan bahawa
(*I, the undersigned, certify that*)

TENGKU HALIM TENGKU OTHMAN @ TENGKU RAMLI

calon untuk Ijazah
(*candidate for the degree of*) **MSc. (INTELLIGENT SYSTEM)**

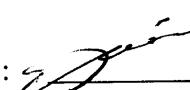
telah mengemukakan kertas projek yang bertajuk
(*has presented his/her project paper of the following title*)

**TOWARDS FORECASTING BUSINESS PREPAID MOBILE
TELECOMMUNICATION USING CONNECTIONIST MODEL**

seperti yang tercatat di muka surat tajuk dan kulit kertas projek
(*as it appears on the title page and front cover of project paper*)

bahawa kertas projek tersebut boleh diterima dari segi bentuk serta kandungan
dan meliputi bidang ilmu dengan memuaskan.
(*that the project paper acceptable in form and content, and that a satisfactory
knowledge of the filed is covered by the project paper*).

Nama Penyelia Utama
(*Name of Main Supervisor*) : **ENCIK WAN HUSSAIN WAN ISHAK**

Tandatangan
(*Signature*) :  Tarikh (Date): 21/3/04

Nama Penyelia Kedua
(*Name of 2nd Supervisor*) : **PUAN SHUZLINA ABDUL RAHMAN**

Tandatangan
(*Signature*) :  Tarikh (Date): 28/3/04

PERMISSION OF USE

In presenting this thesis in partial fulfilment of the requirements for a pos graduate degree from Universiti Utara Malaysia, I agree that the Universiti Library may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for schorlarly purposes may be granted by my supervisor(s) or, in their absence, by the Dean of the Faculty of Information Technology. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any shorlarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to :

Dean of Faculty of Information Technology
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman

ABSTRAK

Khidmat telefon mudah alih pascabayar merupakan suatu keperluan masyarakat dan telah menyumbang kejayaan yang besar dalam bidang perniagaan. Sehubungan dengan itu, rangkaian telefon mudah alih telah berubah kepada penghantaran data yang lebih tinggi dan juga transmisi data berdasarkan paket serta menjurus kepada ciri-ciri multimedia. Fakta ini telah memberi peluang terhadap beberapa teknologi mudah alih baru yang lebih menarik. Pada masa ini, kemajuan terkini dalam industri telekommunikasi telah menarik ramai pengguna untuk menggunakan telefon mudah alih dan mengakibatkan pembekal telekomunikasi mengaut keuntungan besar setiap tahun. Walau bagaimanapun, membuat peramalan keadaan perniagaan dalam bidang ini merupakan sesuatu yang sukar dilakukan kerana data diambil berdasarkan tempoh perjalanan masa. Justeru itu, kajian ini mencadangkan rangkaian neural sebagai alternatif untuk meramal keadaan perniagaan mudah alih. Di dalam kajian ini, data trafik telekomunikasi diperolehi dari Celcom khususnya Khidmat Kawalan Bertuju (SCP). Rangkaian neural telah dilatih dengan data tersebut untuk memberi peramalan urusniaga. adalah diharapkan, hasil daripada kajian ini dapat membantu Celcom dalam merancang perniagaan mereka kelak. Hasil kajian ini juga telah membuktikan kesahihan dan kebolehpercayaan rangkaian neural di dalam melaksanakan peramalan perniagaan dalam bidang telekomunikasi pascabayar mudah alih. Pencapaian dari pembangunan model perambatan balik telah memberi ketepatan melebihi 97 peratus. Rangkaian neural dapat mengambil rekod data panggilan menjurus kepada peramalan perniagaan telekomunikasi pascabayar serta menjadikan peramalan lebih pantas dan senang digunakan.

ABSTRACT

Prepaid mobile service has become a necessity to the society and contributed success to many businesses. Realizing its importance, the mobile networks are moving towards higher data rates and packet oriented data transmission and mobile having more multimedia features. This fact has open end opportunities for new and more attractive mobile technologies. However, forecasting the business trend in this domain is a difficult task as it involves time dependency data. Hence, this study proposed a connectionist model as an alternative for forecasting the mobile business trend. In this study, the teletraffic data was gathered from Celcom Service Control Point (SCP). Neural network was trained with SCP data to forecast Celcom mobile business trend. This result will help Celcom in their business planning. This study has proven the capability and reliability of the connectionist model in performing the forecasting business prepaid mobile telecommunication. The performance of the back propagation model with the accuracy above 97 percent is satisfactory. The model is able to capture data from the call event records towards forecasting the trends of business prepaid mobile Telco, thus making it short and simple to use.

ACKNOWLEDGEMENTS

I wish to gratefully acknowledge the Universiti Utara Malaysia, Sintok, Kedah Darul Aman for providing the facilities for this research undertaking. The same goes true to my family and the members of master student, which since the inception of this study support it through and through.

This study would not have materialized without the cooperation and support from local providers, Celcom. I wish to thank staff at Department of Intelligent Network for providing the initial materials and data collection phase. The contributions to the success of this study are very much appreciated.

Penultimately, I wish to acknowledge the support of the supervisors, namely Encik Wan Hussain Wan Ishak and Puan Shuzlina Abdul Rahman whose labored endlessly supervise me in time, all the way to its final reproduction.

Finally, I pray with most thankful to Allah SWT for being most gracious in blessing this study. Without which this study would not have been possible.

Tengku Halim Tengku Othman @ Tengku Ramli

March, 2004

TABLE OF CONTENTS

	Page
PERMISSION TO USE	i
ABSTRAK	ii
ABSTRACT	iii
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES	viii
CHAPTER ONE : INTRODUCTION	1
1.1 Problem Statement	5
1.2 Objective	7
1.3 Scope of the Study	8
1.4 Significance of the Study	9
1.5 Thesis Outline	9
CHAPTER TWO : LITERATURE REVIEW	10
2.1 Telecommunication	10
2.1.1 Types of Telecommunication Media	12
2.1.2 Mobile Usage	13
2.2 Tools for Analysing Mobile Telco	13
2.3 Connectionist Model for Forecasting	14
2.3.1 Introduction of Connectionist Model	15
2.3.2 Back propagation Neural Network	21
2.4 Connectionist Model in Forecasting Application	26
2.5 Summary	27
CHAPTER THREE : METHODOLOGY	28
3.1 Data Collection	28
3.2 Data Preprocessing	29
3.3 The Design and Development of Connectionist Model	32
3.4 Testing	35
3.5 Summary	38

CHAPTER FOUR : RESULTS AND DISCUSSIONS	39
4.1 Binary Data Testing	39
4.2 Bipolar Data Testing	48
4.3 Discussions	56
CHAPTER FIVE : CONCLUSION	58
5.1 Problem and Limitation	58
5.2 Contributions	58
5.3 Recommendation and Future Research	59
BIBLIOGRAPHY	
APPENDICES	
Appendix A : Sample of Raw Data for Service Control Point (SCP)	65
Appendix B : Sample of Normalized Data for Service Control Point (SCP)	67
Appendix C : Source Codes of <i>ForecasTelco</i> Simulator	69
Appendix D : Screen Shots <i>ForecasTelco</i> Simulator	121
Appendix E : The Result of Updated Weight Used For Both Activation Functions	126

LIST OF TABLES

	Page
Table 2.1: Types of Connectionist Models and Typical Applications (Delurgio, 1998)	14
Table 2.2: The Comparison of a Brain and Computer Capabilities (Klemiato, 2002)	16
Table 3.1: Data Type and Representation	31
Table 3.2 : Input-output Variables for Forecasting SCP Dataset	36
Table 3.3 : Dataset (Deo and Naidu, 1999)	36
Table 4.1 : Hidden Unit for Selecting Binary Network	40
Table 4.2 : Selected Hidden Unit of Binary Network with Different Seed Value	41
Table 4.3 : Learning Rates Selection for Binary Network	42
Table 4.4 : Selected Learning Rate of Binary Network with Different Seed Value	43
Table 4.5 : Momentums Selection for Binary Network	43
Table 4.6 : Selected Momentum of Binary Network with Different Seed Value	44
Table 4.7 : Weights Selection for Binary Network	45
Table 4.8 : Selected Weight of Binary Network with Different Seed Value	46
Table 4.9 : Stopping Criteria (Epoch) Selection for Binary Network	47
Table 4.10 : Hidden Units Selection for Bipolar Network	49
Table 4.11 : Selected Hidden Unit of Bipolar Network with Different Seed Value	50
Table 4.12 : Learning Rates Selection for Bipolar Network	50
Table 4.13 : Selected Learning Rate of Bipolar Network with Different Seed Value	51
Table 4.14 : Momentums Selection for Bipolar Network	52
Table 4.15 : Selected Momentum of Bipolar Network with Different Seed Value	53
Table 4.16 : Weights Selection for Bipolar Network	53
Table 4.17 : Selected Weight of Bipolar Network with Different Seed Value	54
Table 4.18 : Stopping Criteria (Epoch) Selection for Bipolar Network	55
Table 4.19 : Forecasting Results	57
Table A-1 : Sample of Raw Data for Service Control Point (SCP)	66
Table B-1 : Sample of Normalized Data for Service Control Point (SCP)	68
Table E-1 : Update Weight for Both Activation Functions	127

LIST OF FIGURES

	Page
Figure 1.1 : Intelligent Network Architecture in Prepaid Mobile Telco	3
Figure 1.2 : The Trend of Mobile Revenues in Malaysia (Nokia, 2004)	6
Figure 2.1 : Growth in Cellular Technology Usage	11
Figure 2.2 : The Human Brain	17
Figure 2.3 : The Neuron	18
Figure 2.4 : The Synapse	19
Figure 2.5 : An Artificial Neuron	19
Figure 2.6 : Structure of a Standard Two-layer Connectionist Model	21
Figure 2.7 : Back Propagation Neural Network Architecture	25
Figure 3.1 : Screen Shot of <i>ForecasTelco</i> System	33
Figure 3.2 : Flow Chart of Back Propagation <i>ForecasTelco</i> System	34
Figure C-1 : Splash Screen for <i>ForecasTelco</i> Simulator	70
Figure C-2 : Main Interface for <i>ForecasTelco</i> Simulator	72
Figure C-3 : Configure Dataset to be Trained for <i>ForecasTelco</i> Simulator	112
Figure C-4 : About <i>ForecasTelco</i> Simulator	114
Figure C-5 : Training Result for <i>ForecasTelco</i> Simulator after User click View Train	115
Figure C-6 : Testing Result for <i>ForecasTelco</i> Simulator after User click View Test	118
Figure D-1 : Splash Screen <i>ForecasTelco</i>	121
Figure D-2 : Main Interface <i>ForecasTelco</i>	123
Figure D-3 : Configure Dataset to be Trained with <i>ForecasTelco</i>	124
Figure D-4 : About <i>ForecasTelco</i> V1.0	124
Figure D-5 : Training Result for <i>ForecasTelco</i> after User click View Train	125
Figure D-6 : Testing Result for <i>ForecasTelco</i> after User click View Test	125

Chapter 1: INTRODUCTION

Mobile telecommunication or Telco industry is considered as a competitive industry nowadays. New Straits Times in its Business Times section on Oct 13, 2003 has reported that Telco industries are competing with each others in serving the latest prepaid services to customer by introducing new packages, reducing call rates and other interesting packages. Celcom, Maxis and DiGi are among the Telco providers or carriers in Malaysia.

There are two types of subscriber packages in mobile Telco which are known as postpaid and prepaid services. Currently, Telco business nowadays is talking about the prepaid service since it giving benefit for provider and users. According to Lucent Technologies (1998), prepaid service is known as service that enables customers to pay in advance for their call and other service features. This frees the customer from the inconvenience of handling regular bills or signing a contract, with the result that customer cash flow is optimised and fraud is minimised. Christensen (2000) also described prepaid or prepay are not unlike postpaid subscribers in sense the subscribers have certain basic needs and desires.

Prepaid subscribers have their own number of options when recharging their accounts. Other benefits by using prepaid include allowing student and international travellers to budget their call usage and controling their monthly spending. Besides that, each prepaid mobile serves different technology between its packages produced by the carriers such as the voice billing, roaming services, short message service, instant messaging and others. For the increasingly savvy of technology and its capabilities, the mobile device become a device to make lives not just easier but higher quality lives. Many of these services will be paid in advance before

The contents of
the thesis is for
internal user
only

Bibliography

Ahmad Zaki Abu Bakar, Tze Hiang, A.S., & Mod Zaidi Abd. Rozan (2003). PLAIDS: A profit and loss analysis intelligent decision support system using fuzzy logic, *Conference in Conjunction with the Public Institutions of Higher Learning (IPTA) R&D Exposition 2003: Vol. 4.* (pp. 169-172). Kuala Lumpur: Putra World Trade Centre (PWTC).

Awad, E.M. (1996). *Building expert system – Principles, procedures, and applications.* West Publishing.

Bennani, Y., & Bossaert, F. (2001). Modular connectionist modelling and classification approaches for local diagnosis in telecommunication traffic management. *International Journal of Computational Intelligence and Applications*, 1(1), 53-70.

Bigus, J.P. (1996). *Data mining with neural networks: Solving business problems - From application development to decision support.* McGraw-Hill.

Bossaerts, P., & Hillion, P. (1999). Implementing statistical criteria to select return forecasting models: What do we learn?. *The Review of Financial Studies*, 12(2), 405-428.

Camponovo, G., & Pigneur, Y. (2002). Analyzing the m-business landscape. *The Annals of Telecommunications 2002.*

Che Sobry Abdullah, Fadzilah Siraj, Yuhanis Yusof, Abu Bakar Mohamad Diah, & Ahmad Mahir Mokhtar (2002). *Neural network for the design of concrete mixes.* IRPA project code: s/o 19352. Universiti Utara Malaysia.

Christensen, G.T. (2000). *Yes 2 Prepay.* Mobile Streams Limited. Retrieved January 8, 2004, from <http://www.mobilePREPAY.com>

DARPA. (1988). *Neural network study.* New York: AFCEA International Press.

Decker, K. M., & Focardi, S. (1995). *Technology overview: A report on data mining. Technical Report*, Paris, Swiss Scientific Computing Center.

Delurgio, S.A. (1998). *Forecasting principles and application* (1st ed.). McGraw-Hill.

Deo, M.C., & Naidu, C.S. (1999). Real time wave forecasting using neural networks. *Ocean Engineering, Pergamon, 26*, 191-203.

Exclusive Ore Inc. (2001). *Data mining product features*. Retrieved July 1, 2001, from <http://www.xore.com/prodtable.html>

Fausett, L. (1994). *Fundamentals of neural networks*. Englewood Cliffs NJ: Prentice Hall.

Fildes, R., & Kumar, V. (2002). Telecommunications demand forecasting-A review. *International Journal of Forecasting, 18*, 489–522.

FileTek. (1999). *The use and value of call event data for the telecommunications provider. Confidential and Proprietary*. Rockville: FileTek, Inc.

Frank, R.J., Hunt, S.P., & Davey, N (1999). Applications of neural networks to telecommunications systems. Retrieved February 6, 2004 from homepages.feis.herts.ac.uk/~nngroup/pubs/papers/frank-eufit99.pdf

Freeman, J. A. & Skapula, D. M. (1992). *Neural networks: Algorithms, applications and programming techniques*. New York: Addison-Wesley Publishing Company.

Godet, M. (2000). The art of scenarios and strategic planning: Tools and pitfalls. *Technological Forecasting and Social Change, 65*, 3-22.

Heravi, S., Osborn, D.R., & Birchenhall, C.R. (2003). Linear versus neural network forecasts for european industrial production series. *International Journal of Forecasting, Article in Press*.

Hsu, C.C., & Chen, C.Y. (2002). Regional load forecasting in Taiwan-Applications of artificial neural networks. *Energy Conversion and Management, 44*, 1941-1949.

Klang, C.J., & Roos, M. (2001). *Virtual operators in mobile networks – A study of positioning strategies*. Master's Thesis. Sweden: Royal Institute of Technology.

Klemiato, M. (2002). *An introduction to artificial neural networks*. University of Data Mining and Metalurgy in Cracow, Instistute of Automatics. Retrieved January 28, 2004, from http://student.uci.agh.edu.pl/~best/summer/m/introduction_to_nets.pdf

Kuo, R.J. (2001). Theory and methodology: A sales forecasting system based on fuzzy neural network with initial weights generated by genetic algorithm. *European Journal of Operational Research*, 129, 496-517.

Lamoureux, C.G., & Lastrapes, W.D. (1993). Forecasting stock-return variance: Toward an understanding of stochastic implied volatilities. *The Review of Financial Studies* 1993, 6(2), 293-326.

Leung, M.T., Chen, A.S., & Daouk, H. (2000). Forecasting exchange rates using general regression neural networks. *Computers & Operations Research*, 27, 1093-1110.

Lucent Technologies. (1998). *Intelligent network: Platform & services for GSM networks*. Bell Labs Innovations. Retrieved January 8, 2004, from http://www.lucent.com/livelink/09009403800049d0_Brochure_datasheet.pdf

Luger, G.F., & Stubblefield, W.A. (1998). *Artificial intelligence: Structures and strategies for complex problem solving*. Harlow: Addison Wesley Longman, Inc.

Luxhoj, J.T., Riis, J.O., & Stensballe, B. (1996). A hybrid econometric-neural network modeling approach for sales forecasting. *International Journal Production Economics*, 43, 175-192.

McCulloch, W.S., & Pitts, W. (1943). A logical calculus of the ideas immanent in nervous activity, *Buletin of Mathematical Biophysics*, 5, 115-133. Retrieved January 25, 2004, from <http://pages.britishlibrary.net/alexandrew/McCullochWorks.html>

Mohd Yusof Abdullah (2003). *Profil remaja pengguna telefon bimbit*. Poster showed at the IPTA Research & Development Exposition 2003, Kuala Lumpur, Malaysia.

Nokia. (2004). *The mobile telecommunication revenues in Malaysia*. Singapore: Nokia Singapore.

Paungma, T., Sukkasem, M., Sangkhawijit, W., & Moungnoul, P. (2001a). Utilizing the neural network model for traffic prediction at heavily loaded area of GSM system. In Rosziati Ibrahim (Ed.), *Proceedings the 2nd Conference on Information Technology in Asia: Advances ICT for the millennium*. October 17-19th, 2001. (pp. 280-287). Kuching: Faculty of Information Technology, Universiti Malaysia Sarawak.

Paungma, T., Sukkasem, M., Innay, A., & Moungnoul, P. (2001b). Channel capacity optimization of GSM base transceiver station by least square method. In Rosziati Ibrahim (Ed.), *Proceedings the 2nd Conference on Information Technology in Asia: Advances ICT for the millennium*. October 17-19th, 2001. (pp. 361-372). Kuching: Faculty of Information Technology, Universiti Malaysia Sarawak.

Rumelhart, D.E., Hinton, G.E., & Williams, R.J. (1986). Learning internal representations by error propagation. In Rumelhart, D.E. & McClelland, J.L. (Ed.), *Parallel Distributed Processing*, 1. (pp. 318-362). MIT Press.

Schalkoff, R.J. (1997). *Artificial neural network*. New York: McGraw-Hill.

Silverajan, B. (2000). *Internetworking SS7 with IP and H.323. 83390 advanced topics in broadband networks*. Telecommunication Laboratory, Tampere University of Technology. Retrieved January 21, 2004, from http://www.cs.tut.fi/kurssit/83390/syksy00/Interworking_Report.pdf

Sing, K.Y., & Hock, O.S. (2003). Growth rate of mobile phone usage in Malaysia. *Conference in Conjunction with the Public Institutions of Higher Learning (IPTA) R&D Exposition 2003: Vol. 7*. (pp. 115-118). Kuala Lumpur: Putra World Trade Centre (PWTC).

Skapura, D.M. (1995). *Building neural networks*. New York: Addison Wesley.

Thorner, J. (1994). *Intelligent networks*. London: Boston, Artech House.

Tkacz, G. (2001). Neural network forecasting of Canadian GDP growth. *International Journal of Forecasting*, 17, 57-69.

Wang, M., & Kettinger, W.J. (1995). Technical opinion : Projecting the growth of cellular communications. *Communications of the ACM*, 38(10), October 1995, 119-122.

Welstead, S.T. (1994). *Neural network and fuzzy logic applications in c/c++*. John Wiley and Sons.

Yeap, C. (October 13, 2003). Competition among Mobile Phone Operators Hots Up. *New Straits Times on section Business Times*, 4.