Decision Making and Optimization in Recent ICT Applications

Editors: Shahreen Kasim[1], Mohd Farhan Md. Fudzee[2], Nureize Arbaiy[3], Hairulnizam Mahdin[3]

Email:

shahreen@uthm.edu.my[1], farhan@uthm.edu.my[2], nureize@uthm.edu.my[3], hairuln@uthm.edu.my[4]

Abstract: This volume is devoted to the recent developments and applications of the Decision Making tools in the fields of ICT. It seeks to illustrate recent methods, procedures, and applications designed to solve problems related to recent Information Communication and Technology applications formulated through a mathematical programming framework e.g., stochastic, possibilistic, linear, non-linear, fuzzy, rough set, soft set, evolutionary.

The aim of this volume is to enable researchers and practitioners to introduce recent theoretical, methodological, and empirical developments of decision making that includes selection, multiple criteria/attributes/ objectives analysis in recent Information Communication and Technology applications.

This book contains five interrelated chapters that emphasize soft computing techniques and methods. These chapters have been aligned in such a manner to give the readers a specific, continuity, yet practical understanding of recent works on decision making and optimization in recent applications.

Keywords: Rare event (RE), APSO-BP, propagation

Decision Making and Optimization in Recent ICT Applications

EDITORS:
Shahreen Kasim
Mohd Farhan Md. Fudzee
Nureize Arbaiy
Hairulnizam Mahdin

Penerbit UTHM

Decision Making and Optimization in Recent ICT Applications

PENYUNTING:
Shahreen Kasim
Mohd Farhan Md. Fudzee
Nureize Arbaiy
Hairulnizam Mahdin

Penerbit UTHM
2016

Perpustakaan Negara Malaysia Cataloguing—in—Publication Data

Decision Making and Optimization in Recent ICT Applications/
Penyunting Shahreen Kasim, Mohd Farhan Md. Fudzee, Nureize Arbaiy, Hairulnizam Mahdin
Includes index
Bibliography: 978-967-0764-67-2
1. Information technology--Research.
2. Communication and technology--Research.
I. Shahreen Kasim. II. Mohd Farhan Md. Fudzee. III. Nureize Arbaiy
IV. Hairulnizam Mahdin.
303.4833072

Published by:
Penerbit UTHM
Universiti Tun Hussein Onn Malaysia
86400 Parit Raja,
Batu Pahat, Johor
No. Tel: 07-453 7051 / 7454
No. Faks: 07-453 6145

Website: http://penerbit.uthm.edu.my
E-mail: pt@uthm.edu.my
http://e-bookstore.uthm.edu.my

Penerbit UTHM is a member of
Majlis Penerbitan Ilmiah Malaysia
(MAPIM)

Printed by:
PERCETAKAN IMPIAN SDN. BHD.
No. 10, Jalan Bukit 8,
Kawasan Perindustrian Miel,
Bandar Baru Seri Alam,
81750 Masai, Johor

Table of Contents

Preface

This volume is devoted to the recent developments and applications of the Decision Making tools in the fields of ICT. It seeks to illustrate recent methods, procedures, and applications designed to solve problems related to recent Information Communication and Technology applications formulated through a mathematical programming framework e.g., stochastic, possibilistic, linear, non-linear, fuzzy, rough set, soft set, evolutionary. The aim of this volume is to enable researchers and practitioners to introduce recent theoretical, methodological, and empirical developments of decision making that includes selection, multiple criteria/attributes/objectives analysis in recent Information Communication and Technology applications.

This book contains five interrelated chapters that emphasize soft computing techniques and methods. These chapters have been aligned in such a manner to give the readers a specific, continuity, yet practical understanding of recent works on decision making and optimization in recent applications. This book is organized as follows:

Chapter 1 provides readers with a review on a new classification approach, namely group-based classification (GBC). The GBC approach is about labeling data of multiple instances as a group. The objective of this chapter is to present the motivation of the GBC approach, distinguish GBC from other existing classification approaches, briefly describe existing GBC algorithms, and finally identify research topics which are at the forefront of this exciting and challenging approach.

In **Chapter 2**, readers are introduced to the organizational decision-making situations. Multi-level decision-problem confronts several crucial managerial issues, such as coordinating decisions in multi-level processes and in compromising conflicting objectives for each decision unit level. Consequently, it is essential to figure out the

CHAPTER 1

A REVIEW ON GROUP-BASED CLASSIFICATION PROBLEM

Noor Azah Samsudin

Abstract. In this chapter we review a relatively new classification approach, namely group-based classification (GBC). The GBC approach is about labeling data of multiple instances as a group. In this way GBC can take advantage of a given prior knowledge that all of the instances belong to a same unknown class. The objective of this chapter is to present the motivation of the GBC approach, distinguish GBC from other existing classification approaches, briefly describe existing GBC algorithms, and finally identify research topics which are at the forefront of this exciting and challenging approach.

Keywords: group-based classification, Bayes, nearest neighbour, F-test.

1.1 INTRODUCTION

Among the various frameworks in which classification problem has been formulated, the labelling of single instance has been most

1.7 BIBLIOGRAPHY

Aha, D. W., Kibler, D. and Albert, M. K. (1991). Instance-based Learning Algorithms. *Machine Learning*. 6: 37-66.

Alpaydin, E. (2004). *Introduction to machine learning*. London: The MIT Press.

Amin, A. and Mari, J. (1989). Machine recognition and correction of printed Arabic text. *IEEE Transactions on Systems, Man and Cybernetics*. 19: 1300-1306.

Anderson, T. L. (1994). Automatic screening of conventional papanicolaou smears. G. L. Wied, P. H. Bartels, D. L. Rosenthal, and U. Shenck, (Eds). *In Compendium on the computerized cytology and histology laboratory*. 306-311. Illinois, Chicago: Tutorials of Cytology.

Ani, T. A. and Hamam, Y. (2003). A Hidden Markov Model-based Scilab Diagnosis Toolbox. *Simulation News Europe (SNE)*. 38/39.

Baker, J. K. (1975). The Dragon System - an overview. *IEEE Trans. ASSP*. 23: 24-29.

Bamford, P. C. (1999). *Segmentation of cell images with application to Cervical Cancer Screening*. Brisbane: The University of Queensland, Australia.

Bar-Hillel, Y. (1960). A demonstration of the nonfeasibility of fully automatic high quality translation. *Advances in Computers*. New York: Academic Press. 158-163.

Barakat, N. H. (2007). *Rule-extraction from Support Vector Machines: Medical Diagnosis, prediction and explanation.* Brisbane: The University of Queensland, Australia.

Baum, L. E., Petrie, T., Soules, G. and Weiss, N. (1970). A maximisation technique occurring in the statistical analysis of probabilistic functions of Markov chains. *Annals of Mathematical Statistics*. 41: 164-171.

Bayes, T. (1763). An essay towards solving a problem in the doctrine of chances. *Philosophical Transactions of the Royal Society (London)*. 53: 370-418.

Bellman, R. E. (1961). *Adaptive control processes*. Princeton: University Press.

Bengio, Y., Cun, Y. L., Nohl, C. and Burges, C. (1995). LeRec: A NN/HMM hybrid for on-line handwriting recognition. *Neural Computation*. 7: 1289-1303.

Bengtsson, E. (2003). Computerized cell image analysis: past, present, and future. *Proceeding of the 13th Scandinavian Conference on Image Analysis (SCIA), Gothenberg, Sweden*. 395-407.

Bradley, A. P. (1996). *Machine learning for medical diagnostics: Techniques for feature extraction, classification, and evaluation*. Brisbane: The University of Queensland, Australia.

Bunke, H., Wang, P. S. P. and Baird, H. S. (1997). *Handbook of character recognition and document image analysis*. Singapore: World Scientific.

Cecic, I. K., Li, G. and MacAulay, C. (2012). Technologies supporting analytical cytology: clinical, research and drug discovery applications. *Journal of Biophotonics*. 5: 313-326.

Chapelle, O., Scholkopf, B. and Zien, A. (2006). *Semi-supervised learning*. London: The MIT Press.

Chen, M. (1992). Off-line handwritten word recognition using Hidden Markov Models. *Proc. U.S. Postal Service Adv. Techno. Conf., Washington, DC*. 563-579.

Chen, M. Y., Kundu, A. and Srihari, S. N. (1995). Variable duration hidden markov model and morphological segmentation for handwritten word recognition. *IEEE Transactions on Image Processing*. 4: 1675-1688.

Cover T. M. and Hart, P. E. (1967). Nearest neighbor pattern classification. *IEEE Trans*. IT-13: 21-27.

Dasarathy, B. V. (1991). *Nearest neighbor norms: NN pattern classification techniques*.

Dietterich, T. G., Lathrop, R. H. and Lozano-Perez, T. (1997). Solving the multiple-instance problem with axis-parallel rectangles. *Artificial Intelligence*. 89: 31-71.

Dreyfus, H. (1972). *What Computers Can't Do?*. New York: Harper & Row.

Duda, R. O., Hart, P. E. and Stork, D. G. (2001). *Pattern Classification*. New York: John Wiley & Sons.

Dudani, S. A. (1976). The distance-weighted k-nearest neighbor rule. *IEEE Transactions on Systems, Man, and Cybernetics*. SMC-6: 325-327.

Dybowski, R., Gant, V. A., Riley, P. A. and Phillips, I. (1995). Rapid compound pattern classification by recursive partitioning of feature space: An application in flow cytometry. *Pattern Recognition Letters*. 16: 703-709.

El-Yacoubi, A., Gilloux, M., Sabourin, R. and Suen, C. Y. (1999). Unconstrained handwrittten word recognition using hidden markov models. *IEEE Transactions on Pattern Analysis and Machine Intelligence*. 21: 752-760.

Everitt, B. S. (2003). *Cluster Analysis*. London: Arnold.

Gillies, A. (1992). Cursive word recognition using Hidden Markov Models. *Proc. U.S. Postal Service Adv. Technol. Conf*. 557-563.

Gruner, O. C. (1916). A study of the changes met with in the leucocytes in certain cases of malignant disease. *The British Journal of Surgery*. 3: 506-525.

Guillaud, M., Cox, D., Adler-Storthz, K., Malpica, A., Staerkel, G., Matisic, J., Niekerk, D.V., Poulin, N., Follen, M. and MacAulay, C. (2004). Exploratory analysis of quantitative histopathology of cervical intraepithelial neoplasia: objectivity, reproducibility, malignancy-associated changes, and human papillomavirus. *Cytometry Part A*. 60A: 81-89.

Gurney, C. M. (1981). The use of contextual information to improve land cover classification of digital remotely sensed data. *International Journal of Remote Sensing*. 2: 379-388.

Guzman, A. (1971). Analysis of curved line drawings using context and global information. *Machine Intelligence*. 6.

Hallinan, J. (2005). Evolving neural networks for the classification of malignancy associated changes. *Intelligent Data Engineering and Automated Learning (IDEAL 2005)*. 382-389.

Hallinan, J. S. (2000). *Detection of Malignancy Associated Changes in Cervical Cells using Statistical and Evolutionary Computation Techniques*. Brisbane: The University of Queensland, Australia.

Hannan J. F. and Robbins, H. (1955). Asymptotic solutions of the compound decision problem for two completely specified distributions. *The Annals of Mathematical Statistics*. 26: 37-51.

Husain, O. A. N. (1994). The History of Automated Cell Scanners. H. K. Grohs and O. A. N. Husain, (Eds). *Automated Cervical Cancer Screening*. 3-18. New York: IGAKU-SHOIN.

Hutchinson, M., Lapen, D. and Werneke, S. (2003). Cancer detection with the ThinPrep Imaging Systems. *Acta Cytology*. 47: 858.

Jain A. K. and Mao, J. (1996). Artificial neural networks: A tutorial. *IEEE*.

Jain, A. K., Duin, R. P. W. and Mao, J. (2000). Statistical pattern recognition. *IEEE Transactions on Pattern Analysis and Machine Intelligence*. 22: 4-37.

Jelinek, F. (1997). *Statistical Methods for Speech Recognition*. Cambridge: MIT Press.

Kanoun, S., Alimi, A. M. and Lecourtier, Y. (2011). Natural language morphology integration in off-line Arabic optical test recognition. *IEEE Transactions on Systems, Man, and Cybernetics Part B*. 41: 579-590.

Kemp, R. A., MacAulay, C., Garner, D. and Palcic, B. (1997). Detection of malignancy associated changes in cervical cell nuclei using feed-forward neural networks. *Analytical Cellular Pathology*. 14: 31-40.

Koerich, A. L., Sabourin, R., Suen, C. Y. and El-Yacoubi, A. (2000). A syntax-directed level building algorithm for large vocabulary handwritten word recognition. Proc. *4th International Workshop on Document Analysis Systems*. 255-266.

Kundu, A., He, Y. and Bahl, P. (1989). Recognition of handwritten word: First and second order hidden Markov model based approach. *Pattern Recognition*. 22: 283-297.

Lam L. and Suen, C. Y. (1997). Application of majority voting to pattern recognition: An analysis of its behavior and performance. *IEEE Transactions on Systems, Man and Cybernetics- Part A: Systems and Humans*. 27: 553-567.

Landgrebe, T. C. W., Paclik, P., Tax, D. M. J. and Duin, R. P. W. (2005). Optimising two-stage recognition systems. *International Workshop on multiple classifier systems*.

Levinson, S. E., Rabiner, L. R. and Sondhi, M. M. (1983). An introduction to the application of the theory of probabilistic functions of a Markov process to automatic speech recognition. *Bell Syst. Tech. Journal*. 62: 1035-1074.

Levow, G.-A., Oard, D. W. and Resnik, P. (2005). Dictionary-based techniques for cross-language information retrieval. *Information Processing and Management: Special Issue on Cross-language Information Retrieval*.

Lewis, D.(1998). Naive Bayes at Forty: The Independence Assumption in Information Retrieval. *ECML-98, 10th European Conference on Machine Learning*. 4-15.

Li, G., Guillaud, M., LeRiche, J., McWilliams, A., Gazdar, A., Lam, S. and MacAulay, C. (2012). Automated sputum cytometry for detection of intraepithelial neoplasias in the lung. *Analytical Cellular Pathology*. 35: 187-201.

Linder, J. (1994). Considerations in automated cytology. G. L. Wied, P. H. Bartels, D. L. Rosenthal, and U. Schenk, (Eds). *Compendium on the computerized sytology and histology laboratory*. 25-31. Chicago: Tutorials of cytology.

Man, Y.-G. Grinkmeyer, M., Izadjoo, M. and Stojadinvic, A. (2011). Malignant transformation and stromal invasion from normal or hyperplastic tissues: True or false?. *Journal of Cancer*. 2.

Mango, L. J. and Herriman, J. M. (1994). The PAPNET cytological screening system. G. L. Wied, P. H. Bartels, D. L. Rosenthal, and U. Schenck, (Eds). *Compendium on the computerized cytology and histology laboratory*. 320-334. Illinois, Chicago: Tutorials of Cytology.

Mehnert, A. J. H. (2003). *Image analysis for the study of chromatic distribution in cell nuclei with application to cervical cancer screening*. Brisbane: The University of Queensland, Australia.

Mellors, R. C., Glassman, A. and Papanicolaou, G. N. (1952). A microfluorometric scanning method for the detection of cancer cells in smears of exfoliated cells. *Cancer*. 5: 458-468.

Mitani Y. and Hamamoto, Y. (2006). A local mean-based nonparametric classifier. *Pattern Recognition Letters*. 27: 1151-1159.

Mohamed M. A. and Gader, P. (2000). Generalized Hidden Markov Model- Part II: Application to Handwritten Word Recognition. *IEEE Transactions on Fuzzy Systems*. 8: 82-94.

Moshavegh, R., Bejnordi, B. E., Mehnert, A., Sujathan, K., Malm, P. and Bengtsson, E. (2012). Automated segmentation of free-lying cell nuclei in Pap smears for malignancy associated change analysis. *34th Annual International Conference of the IEEE EMBS*. 5372-5375.

Mujat, C., Greiner, C., Baldwin, A., Levitt, J. M., Tian, F., Stucenski, L. A., Hunter, M., Kim, Y. L., Backman, V., Feld, M., Munger, K. and Georgakoudi, I. (2008). Endogenous optical biomarkers of normal and human papillovavirus immortalized epithelial cells. *International Journal of Cancer*. 122: 363-371.

Nandakumar, V., Kelbauskas, L., Johnson, R. and Meldrum, D. (2011). Quantitative characterization of preneoplastic progression using single-cell computed tomography and three-dimensional karyometry. *Cytometry Part A*. 79A: 25-34.

Nash-Webber, B. (1975). The role of semantics in automatic speech understanding. D. G. Bobrow and A. Collins, (Eds). *Representation and Understanding*. 351-382. New York: Academic Press.

Nieburgs, H. E. and Goldberg, A. F. (1968). Changes in polymorphonclear leukocytes as a manifestation of malignant neoplasia. *Cancer*. 22: 35-42.

Nieburgs, H. E., Zak, F. G., Allen, D. C., Reisman, H. and Clardy, T. (1959). Systemic cellular changes in material from human and animal tissues. *Transactions, 7th Annual Meeting Inter-Soc. Cytology Council*. 137-144.

Nordin, B. and Bengtsson, E. (1994). Specimen analysis by rare event, cell population, and/or contextual evaluation. H. K. Grohs and O. A. N. Husain, (Eds). *Automated Cervical Cancer Screening*, 44-51. New York: IGAKU-SHOIN Medical Publishers.

Rabiner L. R. and Juang, B. H. (1993). *Fundamentals of Speech Recognition*. Englewood Cliffs, New Jersey, USA: Prentice Hall.

Rabiner, L. R. (1989). A tutorial on Hidden Markov Models and selected applications in speech recognition. *IEEE Proceedings*. 77: 257-286.

Ripley, B. D. (1996). *Pattern Recognition and Neural Networks*. Cambridge, UK: Cambridge University Press.

Robbins, H. (1951). Asymptotically subminimax solutions of compound statistical decision problems. *Proc. 2nd Berkeley Symposium Math. Statist. Prob.* 131-148.

Robbins, H. (1962). Some numerical results on a compound decision problem. *Recent Developments in Information and Decision Processes*. New York: The Macmillan Co. 56-62.

Salton G. and McGill, M. J. (1983). *Introduction to Modern Information Retrieval*. New York: McGraw-Hill.

Samsudin N. A. and Bradley, A. P. (2008). Group-based meta-classification. *IEEE Proc. 19th International Conference on Pattern Recognition*.

Samsudin N. A. and Bradley, A. P. (2010). Nearest neighbour group-based classification. *Pattern Recognition*. 43: 3458-3467.

Sarkar P. and Nagy, G. (2005). Style consistent classification of isogenous patterns. *IEEE Transactions on PAMI*. 27: 88-98.

Torralba, A., Murphy, K. P. and Freeman, W. T. (2005). Contextual models for object detection using boosted random fields. L. K. Saul, Y. Weiss, and L. Bottou, (Eds). *Advances in Neural Information Processing Systems*. 17: 1401-1408. Cambridge: MIT Press.

Toussaint, G. T. (1974). Bibliography on estimation of misclassification. *IEEE Transaction on IT*. 20: 472-479.

Toussaint, G. T. (1978). The use of context in pattern recognition. *Pattern Recognition*. 10: 189-204.

Wang, Y., Wei, X., Han, L. and Wu, X. (2009). A novel character recognition algorithm based on hidden markov model. *International Conference on Artificial Intelligence and Computational Intelligence*. 298-305.

Wonnacott R. J. and Wonnacott, T. H. (1982). *Statistics: Discovering its power*. New York: John Wiley & Sons.

Yang S. and Browne, A. (2004). Neural network ensembles: combining multiple models for enhanced performance using a multistage approach. *Expert Systems*. 21: 279-288.

CHAPTER 2

HIERARCHICAL MULTI-OBJECTIVE EVALUATION TO IMPROVE FUZZY MULTI-LEVEL DECISION MAKING

Nureize Arbaiy, Lin Pei Chun

Abstract. In organizational decision-making situations, a multi-level decision-problem confronts several crucial managerial issues, such as coordinating decisions in multi-level processes and in compromising conflictingobjectives for each decision unit level. Consequently, it is essential work to figure out the real situation by mathematical programs. In this chapter, anadditive model of Fuzzy Goal Programming (FGP) is utilized to solve multi-level multi-objective problem while the objective functions of the model are developed by Fuzzy Random Regression Model (FRRM). The algorithm uses the concepts of satisfaction in multi-objective optimization at every level until a preferred solution is achieved. Although the algorithm is in an iterative process, it can be executed along with times. The decision-maker can re-examine the problem to achieve the satisfactory result of the overall system target.

Keywords: multi-level problem; multi-objective problem; additive fuzzy goal programming; objective functions, fuzzy random regression model.

decision process by introducing the relative importance evaluation in the additive-FGP model. This is an important criterion because the solution of multiple objective optimization problems is dependent upon the decision maker's preferences.

The author expresses her appreciation to the University Tun Hussein Onn Malaysia (UTHM) and Research Acculturation Grant Scheme (RAGS) Vot R044.

2.6 BIBLIOGRAPHY

Ahlatcioglu, M. and Tiryaki, F. (2007). Interactive Fuzzy Programming for Decentralized Two-Level Linear Fractional Programming (DTLLFP) Problems. *Omega*, Elsevier, 35(4): 432–450.

Anandalingam, G. (1988). A Mathematical Programming Model of Decentralized Multilevel Systems. *Journal of Operational Research Society*. 39(11): 1021-1033.

Baky, I. A. (2010). Solving Multi-Level Multi-Objective Linear Programming Problems Through Fuzzy Goal Programming Approach. *Applied Mathematical Modeling*. 34 (9): 2377-2387.

Hannan, E. L. (1981). Linear Programming with Multiple Fuzzy Goals. *Fuzzy Sets and Systems*. 6 (3): 235-248.

Leisten, R. (1998). An LP-aggregation View on Aggregation in Multi-Level Production Planning. *Annals of Operations Research*. 82: 413-434.

Lenstra, J. K., Rinnooykan, A. H. G., and Stougie, L. (1984). A Framework for The Probabilistic Analysis Of Hierarchical Planning Systems. *Annals of Operations Research*. 1(1):23-42.

Lin, P-C., and Nureize, A. (2014). Two-Echelon Logistic Model Based on Game Theory with Fuzzy Variable, Recent Advances on Soft Computing and Data Mining. *Advances in Intelligent*

Systems and Computing. 287: 325-334.

Lin, P-C., Watada, J., and Wu, B. (2014). A Parametric Assessment Approach to Solving Facility Location Problems with Fuzzy Demands. *IEEJ Transactions on Electronics, Information, and Systems*. 9(5): 484-493.

Mesarovic, M., Macko, D., and Takahara, Y. (1970). *Theory of Hierarchical Multi-level Systems*. Academic Press, New York.

Nahmias, S. (1978). Fuzzy variables. *Fuzzy Sets and Systems*. 1(2): 97 – 111.

Narasimhan, R. (1980). Goal Programming in A Fuzzy Environment. *Decision Sciences*. 11: 243-252.

Nureize, A., and Watada J. (2010b). A Fuzzy Regression Approach to Hierarchical Evaluation Model For Oil Palm Grading. *Fuzzy Optimization Decision Making*. 9 (1): 105–122.

Nureize, A., and Watada, J. (2010). Constructing Fuzzy Random Goal Constraints for Stochastic Fuzzy Goal Programming, V.-N. Huynh et al. (Eds.): *Integrated Uncertainty Management and Applications*. 293-304, Springer-Verlag Berlin Heidelberg.

Nureize, A., and Watada, J. (2010a). Building Fuzzy Random Objective Function for Interval Fuzzy Goal Programming. *In Proc. IEEE International Conference on Industrial Engineering and Engineering Management*. 980-984.

Shih, H-S., Lai, Y-J., and Lee, E. S. (1996). Fuzzy Approach for Multi-Level Programming Problems. Computers Operations Research, 23(1):73–91.

Sinha, S. B., and Sinha, S. (2004). A Linear Programming Approach for Linear Multi-Level Programming Problems. Journal of the Operational Research Society. 55(3):312–316.

Tiwari, R. N., Dharmar, S., and Rao, J. R. (1987). Fuzzy Goal Programming an Additive Model. *Fuzzy Sets and Systems*. 24(1):27-34.

Wang, H-F., and Huang, Z-H. (2002). Top-Down Fuzzy Decision Making With Partial Preference Information. Fuzzy Optimization and Decision Making. 1(2): 161–176.

Watada, J., Wang, S., and Pedrycz, W. (2009). Building Confidence-Interval-Based Fuzzy Random Regression Model. *IEEE Transactions on Fuzzy Systems*. 17(6): 1273 – 1283.

Zimmermann, H-J. (1978). Fuzzy Programming and Linear Programming with Several Objective Functions. *Fuzzy Sets System*. 1(1): 45-55.

CHAPTER 3

ENHANCED AUDIO FEATURE EXTRACTION TECHNIQUES FOR PRECISE CLASSIFICATION DECISION

KohshelanSundararajoo and Noorhaniza Wahid

Abstract. One of the issues in audio feature extraction problem is to deal with noisy audio signal. Audio features which have been extracted from the noisy signal will contribute to less quality features as well as reducing the performance of the audio classification. Mel-Frequency Cepstral Coefficient (MFCC), Linear Predictive Coding (LPC) and Zero-Crossing Rate (ZCR) are traditional methods which have been widely used in audio extraction. Nevertheless, these techniques have shown some shortcomings by amplifying the noise in the audio signal. Thus, Zero Forcing Equalizer (ZFE) is proposed to be integrated with MFCC, LPC and ZCR in order to equalize the noise in the higher amplitude of the audio signal obtained from the string instrument of traditional Indian musical instrument. The performance of the proposed techniques which based on classification accuracy is compared with the traditional technique by using three existing state-of-art classifiers, namely k-Nearest Neighbor (kNN), Bayesian Network (BNs) and Support Vector Machine (SVM) for an audio dataset being classified into five classes of traditional Indian musical instruments. The experimental results show that the proposed

deciding the audio data classes in most of the cases. The combination of audio features has shown a good classification performance. By using kNN classifier, the combination of improved audio features can archived 98.3% of audio classification accuracy. In summary, the combination of LPC-ZFE and ZCR-ZFE with MFCC-ZFE could improve by more than 80% of classification accuracy for three classifiers. Overall, the three classifiers have shown better decision making in determining the audio data classes by using more quality audio features extracted from the improved techniques. In future, the work will emphasize more on the audio classification by using Swarm Intelligence classifier such as Simplified Swarm Optimization (SSO) and Artificial Bee Colony (ABC).

3.6 BIBLIOGRAPHY

Anusuya, M.A. and Katti, S.K. (2011). Comparison of Different Speech Feature Extraction Techniques with and without Wavelet Transform to Kannada Speech Recognition, *International Journal of Computer Applications*. 26 (4): 19-24.

Aviv, A., and Grichman, K. (2011). *Long-term prediction*. Retrieved from http://health.tau.ac.il

Bormane, D. S., and Dusane, M. (2013). A Novel Techniques for Classification of Musical Instruments. *In Information and Knowledge Management*. 3 (10): 1-8.

Chen, J., Ma, T., Chen, W., and Peng, Z. (2013). Unsupervised robust recursive least-squares algorithm for impulsive noise filtering. *Journal Science China Information Sciences*. 56 (4): 1-10.

Chougule, S. V., and Chavan, M. S. (2014). Channel Robust MFCCs for Continuous Speech Speaker Recognition. *In Advances in Signal Processing and Intelligent Recognition Systems*. 557-568.

Elminir, H. K., ElSoud, M. A., and El-Maged, L. A. (2012). Evaluation of Different Feature Extraction Techniques for Continuous Speech Recognition. *International Journal of Science and Technology*. 2 (12): 906-913.

Gunasekaran, S., and Revathy, K. (2008). Fractal dimension analysis of audio signals for Indian musical instrument recognition. *In Proc. IEEE International Conference on Audio, Language and Image Processing*. 257-261.

Gunasekaran, S., and Revathy, K. (2008). Recognition of Indian Musical Instruments with Multi- Classifier Fusion. *International Conference on Computer and Electrical Engineering*, Phuket. 947-851.

Instruments using Spectral Features. *Journal of Computer Science and Telecommunications (GESJ)*. 6 (29): 11-24.

Kaur, N., and Kansal, L. (2013). Performance Comparison of MIMO Systems over AWGN and Rician Channels with Zero Forcing Receivers. *International Journal of Wireless and Mobile Networks*. 5 (1): 73-84.

Khan, A.U., Bhaiya, L.P., and Banchhor, S.K. (2012). Hindi Speaking Person Identification Using Zero Crossing Rate. *International Journal of Soft Computing and Engineering*. 2 (3): 1-4.

Kohshelan, S., and Wahid, N. (2014). Improvement of Audio Feature Extraction Techniques in Traditional Indian Musical Instrument, Recent Advances on Soft Computing and Data Mining. *Advances in Intelligent Systems and Computing*. 287: 507-516.

Kumari, M., Kumar, P., and Solanki, S. S. (2010). Classification of North Indian Musical

Li, T., Ogihara, M., and Li, Q. (2003). A comparative study on content-based music genre classification. *In Proceedings of the 26th annual international ACM SIGIR conference on Research and development in information retrieval*. 282-289.

McCree, A. (2008). *Springer Handbook of Speech Processing*. CBS, India.

Raju, N., Arjun, N., Manoj, S., Kabilan, K., and Shivaprakaash, K. (2013). Obedient Robot withTamil Mother Tongue. *Journal of Artificial Intelligence*. 6 (2): 161-167.

Sukor, A. S. (2012). *Speaker identification using MFCC procedure and noise reduction method*. Universiti Tun Hussein Onn Malaysia. Master's Project Report.

Weeks, M. (2010). *Digital Signal Processing Using MATLAB and Wavelets*. 2nd ed. Jones and Bartlett, USA.

WEKA (2010). *Downloading and Installing WEKA*. Retrieved from http://www.cs.waikato.ac.nz/ml/weka/

Xie, C., Cao, X., and He, L. (2012). Algorithm of Abnormal Audio Recognition Based on Improved MFCC. *International Workshop on Information and Electronics Engineering (IWIEE)*. Elsevier, China. 731-737.

Zytrax (2014). *Digital Sound Primer*. Retrieved from http://www.zytrax.com

CHAPTER 4

AN ACCELERATED PARTICLE SWARM OPTIMIZATION BACK PROPAGATION NEURAL NETWORK ALGORITHM

Abdullah Khan, Shaikh Mohd Ashraf, Nazri Mohd Nawi and Zubair Rehman

Abstract. Back propagation (BP) is one of the most popular algorithms and widely used in neural network. However, BP algorithm tends to have slow convergence rate and local minima problem in gradient descent which affects the result from achieving global minima. Recently accelerated particle swarm optimization (APSO) derived from particle swarm optimization (PSO) algorithm's principle becomes a very popular method in solving many hard optimization problems particularly the weight in BP. Therefore, this chapter proposed an accelerated particle swarm optimization back propagation neural network (APSO-BP) algorithm in order to overcome the problem faced in BP algorithm. By using APSO to optimize the weights at each iteration of BP algorithm, the proposed APSO-BP is able to increase the convergence speed and avoid local minima. The simulation

4.5 CONCLUSIONS

BPNN algorithm is one of the most widely used and a popular procedure to optimize the feed forward neural network training. Conventional BPNN algorithm has some drawbacks, such as getting stuck in local minima and slow speed of convergence. Meta-heuristic algorithms provide derivative-free solution to optimize complex problems. A new meta-heuristic search algorithm, called accelerated particle swarm optimization (APSO) is proposed to train BPNN to achieve fast convergence rate and to minimize the training error as well as well as avoid local minima. The performance of the proposed APSO-BP algorithm are compared with BPNN, ABCNN, ABC-BP and ABC-LM by means of simulation on four datasets such as breast cancer, card, diabetes and iris datasets. The simulation results show that the proposed APSO-BP is far better than the previous methods in terms of simplicity, MSE and accuracy.

The Authors would like to thank Office of Research, Innovation, Commercialization and Consultancy Office (ORICC), UniversitiTun Hussein Onn Malaysia (UTHM) and Ministry of Higher Education (MOHE) Malaysia for financially supporting this Research under Fundamental Research Grant Scheme (FRGS) vote no. 1236. The Research is also supported by Gates IT Solution Sdn. Bhd. Under its publication scheme.

4.6 BIBLIOGRAPHY

Cichocki, A., Unbehauen, R.(1993) Neural Network for Optimization and Signal Processing. Wiley, Chichester

Coppin, B.(2004) Artificial Intelligence Illuminated, 1st edition. John and Bartlett Publishers Sudbury, Massachusetts

Deng, W. J., Chen W. C., and Pei, W. (2008) Back-propagation neural network based importance-performance analysis for determining critical service attributes. J. Expert Systems with Applications, 34(2): 1115-1125.

Fergany, A. E. L.(2013) Accelerated Particle Swarm Optimization-based Approach to the Optimal Design of Substation Grounding Grid. J. PrzegladElektrotechniczny. 89:30-34

Fisher, R. A.(1936)The use of multiple measurements in taxonomic problems. J. Annual Eugenics,7(3): 179-188

Haikun WEI.(2005) Theory and Method of Neural Network Structure. National Defense Industry Press.2:37.

Karaboga, D., Akay, B., and Ozturk, C.(2007) Artificial Bee Colony (ABC) Optimization Algorithm for Training Feed-Forward Neural Networks. In: 4th International Conference on Modeling Decisions for Artificial Intelligence (MDAI 2007), Kitakyushu, Japan, August 16-18

Kosko, B.(1994) Neural Network and Fuzzy Systems, 1st edition, Prentice Hall, India

Lee, K., Booth, D., and Alam, P. A.(2005) Comparison of Supervised and Unsupervised Neural Networks in Predicting Bankruptcy of Korean Firms. J. Expert Systems with Applications,29(1):1-16.

Lee, T.(2008) Back-propagation neural network for the prediction of the short-term storm surge in Taichung harbor, Taiwan. J. Engineering Applications of Artificial Intelligence, 21(1): 63 – 72.

Lippman, R.P.(1987)An introduction to computing with neural networks. IEEE ASSP. Magazine,4(2)

Lowery, A. J., Miller, N., Devaney, A., McNeill, R. E. et al.(2009) MicroRNA Signatures Predict Oestrogen Receptor, Progesterone Receptor and HER2/neu Receptor Status in Breast Cancer. J. Breast Cancer Resourse, 11(3).

Mendes, R., Cortez, P., Rocha, M., and Neves, J.(2002) Particle swarm for feed forward neural network training. In: Proceedings of the International Joint Conference on Neural Networks, 1895—1899

Montana, D. J., & Davis, L.(1989) Training feed forward neural networks using genetic algorithms. In: Proceedings of

the eleventh international joint conference on artificial Intelligence, 762—767

Nandy, S., Sarkar, P. P., and Das, A.(2012) Training a Feed-forward Neural Network with Artificial Bee Colony Based Back propagation Method. J. International Journal of Computer Science & Information Technology (IJCSIT). 4 (4):33-46

Nawi, N. M., Khan, A., &Rehman, M. Z (2013) A New Levenberg Marquardt based Back Propagation Algorithm Trained with Cuckoo Search. J. Procedia Technology, 11: 18—23.

Nawi, N. M., Khan, A., &Rehman, M. Z.(2013)A New Back-Propagation Neural Network Optimized with Cuckoo Search. In: ICCSA 2013: 413—426

Nawi, N. M., Rehman M. Z., and Khan A.(2014) A New Bat based Back-Propagation (Bat-BP) algorithm. J. Advances in Systems Science: Advances in Intelligent systems and Computing,240: 395-404, Springer International Publishing

Nawi, N.M., Khan, A., and Rehman, M. Z.(2013) A new back-propagation neural network optimized with cuckoo search algorithm. In: Computational Science and Its Applications (ICCSA 2013), 413-426. Springer Berlin Heidelberg

Nawi, N.M., Rehman, M.Z, Ghazali, M.I, Yahya, M.N, Khan, A. (2014) Hybrid Bat-BP: A New Intelligent Tool for Diagnosing Noise-Induced Hearing Loss (NIHL) in Malaysian Industrial Workers. J. Applied Mechanics and Materials, 465:652-656

Quinlan. J.R.(1987) Simplifying decision trees. J. Man Machine Studies. v27: 221-234

Rehman, M. Z., and Nawi, N. M.(2011) The Effect of Adaptive Momentum in Improving the Accuracy of Gradient Descent Back Propagation Algorithm on Classification Problems. J. CCIS Journal of Software Engineering and Computer Systems, Springer Heidelberg,vol. 179 (6):380—390.

Rehman, M.Z., Nawi, N. M., and Ghazali, R.(2012) Studying the effect of adaptive momentum in improving the accuracy of gradient descent back propagation algorithm on classification

problems, J. International Journal of Modern Physics (IJMPCS),1(1):1-5

Rumelhart, D. E., Hinton, G.E., Williams, R. J.(1986) Learning Internal Representations by error Propagation. J. Parallel Distributed Processing: Explorations in the Microstructure of Cognition, 1: 318-362

Smith, J. W., Everhart, J. E., Dickson, W. C., Knowler, W. C., & Johannes, R.S(1988).: Using the ADAP learning algorithm to forecast the onset of diabetes mellitus. In: Proceedings of the Symposium on Computer Applications and Medical Care: 261—265. IEEE Computer Society Press

Wolberg, W.H., &Mangasarian, O. L.(1990)Multisurface method of pattern separation for medical diagnosis applied to breast cytology. In: Proceedings of the National Academy of Sciences, 87: 9193-9196.

Yang, X. S.(2010) A new metaheuristic bat-inspired algorithm. In: Nature Inspired Cooperative Strategies for Optimization (NICSO 2010), 65—74

Yao, X.(1993) Evolutionary artificial neural networks. J. International Journal of Neural Systems, 4(3): 203—222

Zhang J, Xia MI.(1996) Neural Network and its Engineering Application. Mechanism Press

CHAPTER 5

STUDYING THE EFFECT OF BACK PROPAGATION BASED CUCKOO SEARCH ON DATA CLASSIFICATION

Nazri Mohd. Nawi , Abdullah Khan
M. Z. Rehman

Abstract. Meta-heuristic Cuckoo Search (CS) Optimized technique provides derivative-free solution to optimize complex problems. The conventional Back-propagation Neural Network (BPNN) algorithm is one of the most widely used and a popular technique to train the feed forward neural network training. But BPNN algorithm has some drawbacks, such as getting stuck easily in local minima and slow speed of convergence. This chapter proposed a new meta-heuristic Cuckoo Search based Back-Propagation (CSBP) algorithm in-order to achieve fast convergence rate and to avoid local minima problem. The performance of the proposed CSBP is compared with Artificial Bee Colony using BPNN algorithm, and other hybrid variants. Specifically, 7-Bit Parity, OR, XOR and selected benchmark classification datasets are used for training and testing the network. The simulation results show that the computational efficiency of BP training process is highly enhanced when coupled with the nature inspired Cuckoo Search (CS) algorithm.

5.7 BIBLIOGRAPHY

Chaowanawate, K., & Heednacram, A.: Implementation of Cuckoo Search in RBF Neural Network for Flood Forecasting. In: 4th International Conference on Computational Intelligence, Communication Systems and Networks. pp. 22—26 (2012)

Cichocki, A. & Unbehauen, R.: Neural Network for Optimization and Signal Processing, Chichester, U.K. Wiley. (1993)

Contreras, J., Rosario, E., Nogales, F. J., & Conejos, A. J.: ARIMA Models to Predict Next-Day Electricity Prices. J. IEEE Transactions on Power Systems. vol. 18 (3), pp. 1014—1020 (2003)

Dayhoff, J. E.: Neural-Network Architectures: An Introduction. Van Nostrand Reinhold Publishers, New York (1990)

Du, K. L.: Clustering: A neural network approach. J. Neural Networks. vol. 23(1), pp. 89—107 (2010)

Guojin, C., Miaofen, Z. *et al*.: Application of Neural Networks in Image Definition Recognition, Signal Processing and Communications. In: ICSPC. pp. 1207—1210 (2007)

Gupta, J. N. D., and Sexton, R. S.: Comparing back propagation with a genetic algorithm for neural network training. J. The International Journal of Management Science. vol. 27, pp. 679—684 (1999)

Hayati, M., and Mohebi, Z.: Application of Artificial Neural Networks for Temperature forecasting. J. World Academy of Science, Engineering and Technology. vol. 28 (2), pp. 275—279 (2007)

Haykin, S.: Neural Networks: A Comprehensive Foundation. Prentice Hall, New Jersey. (1999)

Ilonen, J., Kamarainen, J. I., & Lampinen, J.: Differential Evolution Training Algorithm for Feed-Forward Neural Networks. J. Neural Processing Letters. vol. 17 (1), pp. 93—105 (2003)

Karaboga, D., Basturk, B., & Ozturk, C.: Artificial Bee Colony (ABC) optimization algorithm for training feed-forward neural net-

works. J. LNCS: Modeling Decisions for Artificial Intelligence. vol. 4617, pp. 318—319 (2007)

Khan, A. U., Bandopadhyaya, T. K., & Sharma, S.: Comparisons of Stock Rates Prediction Accuracy using Different Technical Indicators with Back propagation Neural Network and Genetic Algorithm Based Backpropagation Neural Network. In: The First International Conference on Emerging Trends in Engineering and Technology. IEEE Computer Society, Nagpur, India (2008)

Lahmiri, S.: Wavelet transform, neural networks and the prediction of S & P price index: a comparative paper of back propagation numerical algorithms. J. Business Intelligence Journal. vol. 5 (2), pp. 235—244 (2012)

Leigh, W., Hightower, R., & Modena, N.: Forecasting the New York Stock exchange composite index with past price and invest rate on condition of volume spike. J. Expert System with Applications. vol. 28 (1), pp. 1—8 (2005)

Leung, C., and Member, C.: A Hybrid Global Learning Algorithm Based on Global Search and Least Squares Techniques for back propagation neural network Networks. In: International Conference on Neural Networks. pp.1890—1895 (1994)

Lippman, R. P.: An introduction to computing with neural networks. J. IEEE ASSP. Magazine. vol. 4 (2) (1987)

Liu, Y. P., & Wu, M.G., *et al*.: Evolving Neural Networks Using the Hybrid of Ant Colony Optimization and BP Algorithms. J. Advances in Neural Networks. vol. 3971, pp. 714—722 (2006)

Mendes, R., Cortez, P., Rocha, M., & Neves, J.: Particle swarm for feed forward neural network training. In: International Joint Conference on Neural Networks. vol. 2, pp. 1895—1899 (2002)

Nawi, N. M., Ghazali, R., & Salleh, M. N. M.: The development of improved back-propagation neural networks algorithm for predicting patients with heart disease. J. LNCS. vol. 6377, pp.

317—324 (2010)

Nawi, N. M., Khan, A., & Rehman, M. Z.: A New Back-propagation Neural Network optimized with Cuckoo Search Algorithm. J. LNCS Journal of Springer. vol. 7971 (1),pp. 413—426 (2013)

Nawi, N. M., Ransing, R. S., Salleh, M. N. M., Ghazali, R., & AbdulHamid, N.: An improved back propagation neural network algorithm on classification problems, J. Communications in Computer and Information Science (CCIS). vol. 118, pp.177—188 (2011)

Nawi, N. M., Rehman, M. Z., & Khan, A.: A New Bat Based Back-Propagation (BAT-BP) Algorithm. J. Advances in Systems Science, Springer Series. vol. 240, pp. 395—404 (2014)

Ozturk, C., and Karaboga, D.: Hybrid Artificial Bee Colony algorithm for neural network training. In: IEEE Congress of Evolutionary Computation (CEC), pp. 84—88. IEEE (2011)

Pavlyukevich, I.: Levy flights, non-local search and simulated annealing. J. of Computational Physics. vol. 226 (2), pp.1830—1844 (2007)

Perez, M.: Artificial neural networks and bankruptcy forecasting: a state of the art. J. Neural Computing & Application. vol. 15, pp. 154—163 (2006)

Rehman, M. Z., Nawi, N. M., Ghazali, R.: Studying the Effect of adaptive momentum in improving the accuracy of gradient descent back propagation algorithm on classification problems. J. International Journal of Modern Physics (IJMPCS). vol. 9 (1), pp.432—439 (2012)

Romano, M., Liong S., *et al*.: Artificial neural network for tsunami forecasting. J. Asian Earth Sciences. vol. 36, pp. 29—37 (2009)

Rumelhart, D. E., Hinton, G. E., & Williams, R. J., Learning Internal Representations by error Propagation. J. Parallel Distributed Processing: Explorations in the Microstructure of Cognition. vol. 1 (1986)

Shah, H., Ghazali, R., & Nawi, N. M.: Hybrid ant bee colony algorithm for volcano temperature prediction. J. Communications in Computer and Information Science. vol. 281, pp. 453—465 (2012)

Shah, H., Ghazali, R., Nawi, N. M., & Deris, M. M.: Global hybrid ant bee colony algorithm for training artificial neural networks. J. LNCS, vol. 7333 (1), pp. 87—100 (2012)

Tuba, M., Subotic, M., & Stanarevic, N.: Modified cuckoo search algorithm for unconstrained optimization problems. In: European Computing Conference (ECC'11), Paris, France. pp. 263—268 (2011)

Tuba, M., Subotic, M., & Stanarevic, N.: Performance of a Modified Cuckoo Search Algorithm for Unconstrained Optimization Problems. J. WSEAS TRANSACTIONS on SYSTEMS. vol. 11(2), pp. 62—74 (2012)

Walton, S., Hassan, O., Morgan, K., & Brown, M.: Modified cuckoo search: A new gradient free optimisation algorithm. J. Chaos, Solitons & Fractals. vol. 44 (9), pp. 710—718 (2011)

WAM, A., ESM, S., and ESA, A.: Modified Back Propagation Algorithm for Learning Artificial Neural Networks. In: Eighteenth National Radio Science Conference (NRSC). pp. 345—352 (2001)

Wen, J., Zhao, J. L., Luo, S. W., and Han, Z.: The Improvements of BP Neural Network Learning Algorithm. In: 5th Int. Conf. on Signal Processing WCCC-ICSP. pp. 1647—1649 (2000)

Yang, X. S., & Deb, S.: Cuckoo search via Lévy flights. In: World Congress on Nature & Biologically Inspired Computing, India. pp. 210—214 (2009)

Yang, X. S., & Deb, S.: Engineering Optimisation by Cuckoo Search. J. International Journal of Mathematical Modelling and Numerical Optimisation. vol. 1(4), pp. 330—343 (2010)

Yang, X. S., & Deb, S.: Engineering Optimisation by cuckoo search. J. International Journal of Mathematical Modelling and Numerical Optimisation. vol. 1(4), pp. 330—343 (2010)

Yao, X.: Evolutionary artificial neural networks. J. International Journal of Neural Systems. vol. 4 (3), pp. 203—222 (1993)

Zhang, J., Lok, T., & Lyu, M.: A hybrid particle swarm optimization back propagation algorithm for feed forward neural network training. J. Applied Mathematics and Computation, Elsevier. vol. 185, pp. 1026—1037 (2007)