ELECTRICITY DEMAND FORECASTING IN TURKEY AND INDONESIA USING LINEAR AND NONLINEAR MODELS BASED ON REAL-VALUE GENETIC ALGORITHM AND EXTENDED NELDER-MEAD LOCAL SEARCH

WAHAB MUSA

DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
2014

Awang Had Salleh
Graduate School
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Abstract

Electricity demand patterns have many variables related to uncertainty behaviour such as gross domestic product, population, import and export. The characteristics of these variables lead to two problems in forecasting the electricity demand. The first problem is the fitness evaluation in the electricity demand forecasting model in which more than one variable are included which leads to increase the sum of squared deviations. The second problem is the use of a single algorithm that failed to solve local optima. These problems resulted in estimation errors and high computational cost. Hybrid genetic algorithm (GA) and Nelder-Mead local search model has been used to minimize demand estimation errors. However, hybrid GA and Nelder-Mead local search failed to reach the global optimum solution and involve high number of iteration. Hence, an electricity demand forecasting model that reflects the characteristics of electricity demand has been developed in this research. The model is known as the hybrid Real-Value GA and Extended Nelder-Mead (RVGA-ENM). The GA has been enhanced to accept real value while the Nelder-Mead local search is extended to assist in overcoming the local optima problem. The actual electricity demand data of Turkey and Indonesia were used in the experiments to evaluate the performance of the proposed model. Results of the proposed model were compared to the hybrid GA and Nelder-Mead local search, Real Code Genetic Algorithm and Particle Swarm Optimisation. The findings indicate that the proposed model produced higher accuracy for electricity demand estimation. The proposed RVGA-ENM model can be used to assist decision-makers in forecasting electricity demand.

Keywords: Genetic algorithm, Electricity demand forecasting, Nelder-Mead local search, Local optimal.

Abstrak

Corak permintaan elektrik mempunyai banyak pembolehubah yang berkaitan dengan tingkah laku tidak menentu seperti keluaran dalam negara kasar, penduduk, import dan eksport. Ciri pembolehubah ini membawa kepada dua masalah dalam ramalan permintaan elektrik. Masalah pertama ialah penilaian kecergasan dalam model ramalan permintaan elektrik di mana lebih daripada satu pembolehubah yang dimasukkan yang membawa kepada peningkatan jumlah sisihan kuasa dua. Masalah kedua ialah penggunaan algoritma tunggal yang gagal menyelesaikan optima setempat. Masalah ini mengakibatkan kesilapan anggaran dan kos pengkomputeran tinggi. Model hibrid algoritma genetik (*GA*) dan pencarian setempat *Nelder-Mead* telah digunakan untuk mengurangkan kesilapan anggaran permintaan. Walau bagaimanapun, hibrid *GA* dan pencarian setempat *Nelder-Mead* gagal mencapai penyelesaian optimum global dan melibatkan jumlah lelaran yang tinggi. Oleh itu, satu model ramalan permintaan elektrik yang menggambarkan ciri permintaan elektrik telah dibangunkan dalam kajian ini. Model ini dikenali sebagai hibrid *GA* bernilai real dan *Nelder-Mead* yang diperluaskan (*RVGA-ENM*). *GA* telah dipertingkatkan untuk menerima nilai real manakala pencarian setempat *Nelder-Mead* telah diperluaskan untuk membantu dalam mengatasi masalah optima setempat. Data sebenar permintaan elektrik Turki dan Indonesia telah digunakan dalam eksperimen untuk menilai prestasi model yang dicadangkan. Keputusan model yang dicadangkan dibandingkan dengan keputusan model hibrid *GA* dan pencarian setempat *Nelder-Mead*, algoritma genetik kod real dan pengoptimuman zarah swarm. Dapatan kajian menunjukkan bahawa model yang dicadangkan menghasilkan ketepatan anggaran yang lebih tinggi untuk permintaan bekalan elektrik. Model *RVGA-ENM* yang dicadangkan boleh digunakan untuk membantu pembuat keputusan dalam ramalan permintaan bekalan elektrik.

Kata kunci: Algoritma genetik, Ramalan permintaan elektrik, Pencarian setempat *Nelder-Mead*, Optimal setempat.

Acknowledgement

I would like to express my appreciation and gratitude to everyone contributed in completing this thesis. It was my pleasure to study under Prof. Dr. Hj Ku Ruhana Ku-Mahamud's supervision. It is not enough to say thank you very much for her guidance in helping me to achieve my goal. Without her valuable support, my thesis would not have been possible. I would like to express my thanks to my co-supervisor Assoc. Prof. Dr. Azman Yasin for his comments which helped improve my work.

I would also like to give my thanks to my parents, my wife and all of my relatives for their love and support. My goal would not have been achieved without them. I dedicate this work to my parents and my wife Hjh. Hally M. Doda and other family members.

Many thanks to the Indonesian Ministry of Education and Universitas Negeri Gorontalo for providing financial assistance in form of a scholarship.

I am very fortunate to study at Universiti Utara Malaysia (UUM). Not only it has a beautiful nature, the university also has helpful staff. Finally, I would like to thank all of my friends for their encouragement during my study.

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List of Abbreviations

ABE	Analogy based estimation
AI	Artificial intelligence
AIC	Akaike information criterion
ANN	Artificial neural network
ANFIS	Artificial neural network with fuzzy inference system
CHA	Continuous hybrid algorithm
DC	Distribution-centers
DD	Degree days
DE	Differential evolution
DNA	Deoxyribonucleic acid
DOA	Direction-of-arrival
EA	Evolutionary algorithm
EDA	Estimation of distribution algorithm
EDF	Electricity demand forecasting
EDP	Electricity demand pattern
EDPF	Electricity demand pattern forecasting
EE	Estimation error
EGA	Enhanced genetic algorithm
EKPF	Extended Kalman particle filter
EM	Expectation maximization
GAED	Genetic algorithm electricity demand
GA-EKPF	Genetic particle filter
GDP	Gross domestic product
GP	Genetic programming
HGA	Hybrid genetic algorithm
HGAED	Hybrid genetic algorithm electricity demand
ENM	Extended Nelder Mead
KF	Kalman filter
LO	Local optimality
LS	Least square

LTEDF	Long-term electricity demand forecasting
MAE	Mean absolute error
MAI	Multiple access interference
MAPE	Mean absolute percentage error
MC-CDMA	Multi-carrier code-division multiple access
ME	Mean error
MSE	Mean squared error
MTOE	Million ton oil equivalent
MTEDF	Medium-term electricity demand forecasting
NP	Non-deterministic polynomial
OLS	Ordinary least squares
PWM	Pulse width modulation
RBFNN	Radial basis function neural network
EDP	Electricity demand pattern
RNN	Recurrent neural nets
RSS	Residual sum of squares
RVGA	Real-value genetic algorithm
RVGA-ENM	Real-value genetic algorithm - extended Nelder Mead
SA	Simulated annealing
SAA	Sample average approximation
SC	Schwarz Criteria
SDE	Standard deviation of error
SDMA	Spatial division multiple access
SS	Simplex search
STLF	Short-term load forecasting
STEDF	Short-term electricity demand forecasting
SVM	Support vector machine
SVR	Support vector regression
TDE	Time delay estimation
TS	Tabu search
TSP	Traveling salesman problem

CHAPTER ONE
INTRODUCTION

Sound and realistic electricity demand forecasting (EDF) is essential to good planning in any industry. One of the most important things in the planning of electricity demand in the utility industry is electricity demand forecasting that is more realistic. This means that the development of the electricity demand forecasts is essential in the planning of new resources for the system to meet the future demand. The importance of electricity demand forecasting is becoming clear to best demand utilities as they must sustain the demand expectations. However, the impossibility of developing truly accurate demand forecasts must be recognised. Results obtained from the electricity demand forecasting process are used in areas such as planning and operation (EL-Naggar & AL-Rumaih, 2005; Ghods & Kalantar, 2008; Ghods & Kalantar, 2011).

The soundness of a method for electricity demand forecasting performances should not be assessed only in a single case over the short term but using its record of success or failure over the long term. The usefulness of an electricity demand forecasting method should focus on issues such as the relationship of demand and weather, demand characteristics, pressure demand, demand growth patterns, and socioeconomic data (Ali, 2012; Fan, Methaprayoon, & Lee, 2010).

Based on the time horizon, electricity demand forecasting can be categorised into three types: (i) short-term electricity demand forecasting (STEDF), (ii) medium-term

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REFERENCES

Al-Dabbagh, R. D., Baba, M. S., Mekhilef, S., & Kinsheel, A. (2012). The compact Genetic Algorithm for likelihood estimator of first order moving average model. *Second International Conference on Digital Information and Communication Technology and it's Applications,* 474–481.

Alaei, H. K., & Alaei, H. K. (2011). Design of new soft sensors based on PCA, genetic algorithm and neural network for parameters estimation of a petroleum reservoir. *2nd International Conference on Control, Instrumentation and Automation,* 823 –828.

Ali, M. A. M. (2012). The influences of urban forms on residential energy consumption: a demand-side forecasting method for energy scenarios. *PhD Thesis,* University of North Carolina.

Ali, M., Pant, M., & Nagar, A. (2010). Two local search strategies for differential evolution. *Bio-Inspired Computing: Theories and Applications,* 1429 -1435.

Aljanabi, A. I. (2010). Interacted Multiple Ant Colonies for Search Stagnation Problem. *PhD Thesis,* Universiti Utara Malaysia.

An, A., Hao, X., Yuan, G., Zhao, C., & Su, H. (2009). Parallel adaptive hybrid genetic optimisation algorithm and its application. *Asia-Pacific Conference on Computational Intelligence and Industrial Applications,* 1, 471-475.

Asyikin, S.N. (2011). Menu planning model for Malaysian boarding school using self-adaptive hybrid genetic algorithms. *PhD Dissertation,* Universiti Utara Malaysia.

Azadeh, A., Ghaderi, S. F., Tarverdian, S., & Saberi, M. (2006). Integration of Artificial Neural Networks and Genetic Algorithm to Predict Electrical

Energy consumption. *32nd Annual Conference on Industrial Electronics,* 2552 -2557.

Bahabadi, H. B., Mirzaei, A., & Moallem, M. (2011). Optimal Placement of Phasor Measurement Units for Harmonic State Estimation in Unbalanced Distribution System Using Genetic Algorithms. *21st International Conference on Systems Engineering,* 100 –105.

Babayan, A. V., Savic, D. A., & Walters, G. A. (2007). Multiobjective optimisation of water distribution system design under uncertain demand and pipe roughness. *Computer Science and Mathematics Work Paper,* University of Exeter, UK. 3, 810-817.

BPS Indonesia. (2010). Statistical Yearbook of Indonesian 2009. *Badan Pusat Statistik Indonesia*, Jakarta.

Cai, Z.-jian, Lu, S., & Zhang, X.-bin. (2009). Tourism demand forecasting by support vector regression and genetic algorithm. *2nd IEEE International Conference on Computer Science and Information Technology,* 144 -146

Chunyu, R., & Xiaobo, W. (2009). Study on hybrid genetic algorithm for hybrid picking-delivery strategy vehicle routing problem. *Control and Decision Conference,* 2846 -2851.

Contos, G., Eftekharzadeh, A., Guyton, J., Erard, B., & Stilmar, S. (2009). Econometric simulation of the income tax compliance process for small businesses. *Proceedings of the 2009 Winter Simulation Conference,* 2902 – 2914.

Dalvand, M. M., Azami, S., & Tarimoradi, H. (2008). Long-term load forecasting of Iranian power grid using fuzzy and artificial neural networks. *43rd International Universities Power Engineering Conference,* 1–4.

Delgado, M., Cuellar, M. P., & Pegalajar, M. C. (2008). Multiobjective Hybrid Optimisation and Training of Recurrent Neural Networks. *IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics, 38*(2), 381 –403.

Deng, J. (2010). Modeling and prediction of China's electricity consumption using Artificial Neural Network. *Sixth International Conference on Natural Computation ,* 4, 1731 -1733.

Ding, J., & Liu, X. (2011). Supply chain optimisation with deterministic and uncertain demand: A brief review. *2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce ,* 2453 -2456.

Eghbal, M., Saha, T. K., & Hasan, K. N. (2011). Transmission expansion planning by meta-heuristic techniques: A comparison of Shuffled Frog Leaping Algorithm, PSO and GA. *IEEE Power and Energy Society General Meeting,* 1–8.

EL-Naggar, K. M., & AL-Rumaih, K. A. (2005). Electric Load Forecasting Using Genetic Based Algorithm, Optimal Filter Estimator and Least Error Squares Technique: Comparative Study. *World Academy of Science, Engineering and Technology,* 6.

El-Mihoub T.A., Hopgood A.A., Nolle L., & Battersby A. (2006). Hybrid Genetic Algorithm: A Review. *Enggineering Letters,* 13, 2-11

Enerdata (2012). Global Energy and CO2 data.
Retrieved on 20 February 2013 at http://www.enerdata.net.

Fan, S., Chen, L., & Lee, W.-J. (2009). Short-Term Load Forecasting Using Comprehensive Combination Based on Multimeteorological Information. *IEEE Transactions on Industry Applications*, *45*(4), 1460 -1466.

Fan, S., Methaprayoon, K., & Lee, W.-J. (2010). Multi-region load forecasting considering alternative meteorological predictions. *IEEE Power and Energy Society General Meeting,* 1 -7.

Feinberg, E.A., Hajagos, J.T., & Genethliou, D. (2003). Statistical Load Modeling. *Proceedings of the 7th IASTED International Multi-Conference: Power and Energy Systems*, 88–91.

Franco, M., Blanco, D., Blequett, W., Guglia, M., & Alvarado, E. (2006). Cointegration Methodology and Error Correction Model used to Forecast The Electricity Demand of The Venezuelan Electric System - Period 2004-2024. *IEEE/PES Transmission Distribution Conference and Exposition,* 1-8.

Gancarski, P., & Blansche, A. (2008). Darwinian, Lamarckian, and Baldwinian (Co)Evolutionary Approaches for Feature Weighting in K-means-Based Algorithms. *IEEE Transactions on Evolutionary Computation* , *12*(5), 617 - 629.

Gao, Q., Qi, K., Lei, Y., & He, Z. (2005). An Improved Genetic Algorithm and Its Application in Artificial Neural Network Training. *Fifth International Conference on Information, Communications and Signal Processing,* 357 - 360.

Ghanbari, A., Hadavandi, E., & Abbasian-Naghneh, S. (2010). Comparison of Artificial Intelligence Based Techniques for Short Term Load Forecasting. *Third International Conference on Business Intelligence and Financial Engineering,* 6 -10.

Ghods, L., & Kalantar, M. (2008). Methods for long-term electric load demand forecasting; a comprehensive investigation. *IEEE International Conference on Industrial Technology,* 1-4.

Ghods, L., & Kalantar, M. (2011). Different Methods of Long-Term Electric Load Demand Forecasting; A Comprehensive Review. *Iranian Journal of Electrical & Electronic Engineering, 7*(4)*,* 249-259.

Giglio, D., Minciardi, R., Sacone, S., & Siri, S. (2009). Service rate optimisation in inventory-production systems with time-varying and incomplete deterministic demand. *IEEE Conference on Emerging Technologies Factory Automation,* 1-8.

Guimaraes, F. G., Campelo, F., Igarashi, H., Lowther, D. A., & Ramirez, J. A. (2007). Optimisation of Cost Functions Using Evolutionary Algorithms With Local Learning and Local Search. *IEEE Transactions on Magnetics, 43*(4), 1641 -1644.

Hai, B. L., Ashida, T., Thawonmas, R., & Rinaldo, F. (2012). A hybrid Differential Evolution method and its application to the physical travelling salesman problem. *IEEE 1st Global Conference on Consumer Electronics,* 265–266.

Hor, C.-L., Watson, S. J., & Majithia, S. (2006). Daily Load Forecasting and Maximum Demand Estimation using ARIMA and GARCH. *International Conference on Probabilistic Methods Applied to Power Systems,* 1 -6.

Hu, S. (2007). Akaike information criteria. *North Carolina State University Raleigh*, North Carolina.

Huang, T., Huang, J., & Zhang, J. (2008). An orthogonal local search genetic algorithm for the design and optimisation of power electronic circuits. *IEEE Congress on Evolutionary Computation,* 2452 –2459.

Huang, Y. (2009). Hybrid genetic algorithms and neural network based function approximators for water quality modeling. Dalhousie University (Canada). *ProQuest Dissertations and Theses,* 276. Retrieved from http: //eserv.uum.edu.my/docview/305060608?accountid=42599. (305060608).

Hyndman, R. J., & Fan, S. (2010). Density Forecasting for Long-Term Peak Electricity Demand. *IEEE Transactions on Power Systems*, *25*(2), 1142 - 1153.

Ibrahim, H.D. (2010). Indonesian Energy Overview and Change Adaptation Scenario for Indonesia Energy Sector. *Proceeding of the 3rd Conference and Workshop on* CECAR, 5, 2010.

Jian-Chao, H., Zhong-Fu, T., & Xiao-jun, L. (2008). Electricity Consumption and Economic Growth in China: Multivariable Cointegration Analysis and Electricity Demand Forecasting. *4th International Conference on Wireless Communications, Networking and Mobile Computing,* 1-4.

Jing, H., Jing, M., Xian-Yong, X., & Mei, X. (2011). Mid-Long-term Load Forecasting Based on Fuzzy Optimal Theory. *Asia-Pacific Power and Energy Engineering Conference,* 1-4.

Li, C.-X., & Meng, L.-M. (2008). Comprehensive Model for Mid-Long Term Load Forecasting Basing Three-Target Quantities and RBFNN. *Fourth International Conference on Natural Computation,* 4, 486–491.

Li, Z., Wu, C., Zhang, X., Weng, Z., & Qi, G. (2010). Using a Genetic Algorithm for Ore-Grade Estimation. *Second WRI Global Congress on Intelligent Systems,* 2, 123 –126.

Lian, K., Zhang, C., Li, X., & Gao, L. (2009). An Effective Hybrid Genetic Simulated Annealing Algorithm for Process Planning Problem. *Fifth International Conference on Natural Computation,* 5, 367 -373.

Like, Y., & Zongyi, Z. (2007). A Spatial Econometric Analysis on the Relationship between Power Consumption and Regional Economic Development. *International Conference on Service Systems and Service Management,* 1 –6.

Liu, X. Q., Ang, B. W., & Goh, T. N. (1991). Forecasting of electricity consumption: a comparison between an econometric model and a neural network model. *IEEE International Joint Conference on Neural Networks, 2,* 1254–1259.

Lo, I.-H., Li, Yiming, & Li, K.-F. (2010). Hybrid Genetic Algorithm with Mixed Mutation Mechanism for Optimal Display Panel Circuit Design. *International Conference on Technologies and Applications of Artificial Intelligence,* 222 -225.

Mahmuddin M., & Yusof Y. (2011). A Hybrid Simplex Search and Bio-Inspired Algorithm for Faster Convergence. *International Conference on Machine Learning and Computing ,* 3, 203-207.

Mamta, M., & Sushila, M. (2010). Convalesce Optimisation for Input Allocation Problem Using Hybrid Genetic Algorithm. *Journal of Computer Science,* 4, 413 -416.

Marra, S., Morabito, F. C., & Versaci, M. (2003). Neural networks and Cao's method: A novel approach for air pollutants time series forecasting. *Proceedings of the International Joint Conference on Neural Networks,* 4, 2448–2453.

Mei, Y., Tang, K., & Yao, X. (2011). Decomposition-Based Memetic Algorithm for Multiobjective Capacitated Arc Routing Problem. *IEEE Transactions on Evolutionary Computation*, *15*(2), 151–165.

MEMR (2009). *Handbook of Energy and Economic Statistic of Indonesia*. Ministry of Energy and Mineral Resources: Jakarta.

Mohammad Zadeh, S., & Masoumi, A. A. (2010). Modeling residential electricity demand using neural network and econometrics approaches. *40th International Conference on Computers and Industrial Engineering,* 1-6.

Nguyen, Q. H., Ong, Y.-S., & Lim, M. H. (2009). A Probabilistic Memetic Framework. *IEEE Transactions on Evolutionary Computation, 13*(3), 604 - 623.

Ozturk, H. K., & Ceylan, H. (2005). Forecasting total and industrial sector electricity demand based on genetic algorithm approach: Turkey case study. *International Journal of Energy Research*, 29, 829-840.

Pham, N., Malinowski, A., & Bartczak, T. (2011). Comparative Study of Derivative Free Optimization Algorithms. *IEEE Transactions on Industrial Informatic, 7*(4), 592–600.

Pham, N.D. (2012). Improved Nelder Mead's Simplex Method and Applications. *ProQuest Dissertations and Theses,* 109. Retrieved from http: //eserv.uum.edu.my/docview/1033783541?accountid=42599. (1033783541).

Peng, X., Gui, W., Li, Yonggang, Hu, Z., & Wang, L. (2007). Operational Pattern Optimisation for Copper Flash Smelting Process Based on Pattern Decomposition of Fuzzy Neural Networks. *IEEE International Conference on Control and Automation,* 2328 -2333.

Piltan, M., Shiri, H., & Ghaderi., S.F. (2012). Energy Demand Forecasting in Iranian Metal Industry using Linear and Nonlinear Models Based on Evolutionary Algorithms. *Energy Conversion and Management,* 58, 1-9.

Pimentel, D., Cheriti, A., Ben Slima, M., & Sicard, P. (2006). Pulse Density Modulation Pattern Optimisation using Genetic Algorithms. *32nd IEEE Annual Conference on Industrial Electronics,* 1655 -1660.

Pingping, W., & Jie, X. (2010). The Game of Closed Loop Supply Chain Based on Remanufacturability and Random Demand. *International Conference on Intelligent Computation Technology and Automation,* 3, 819 -824.

Qiu, Y., Liu, Feng, & Huang, X. (2008). Network Optimisation based on Genetic Algorithm and Estimation of Distribution Algorithm. *International Conference on Computer Science and Software Engineering,* 4, 1058 -1061.

Qiusheng, W., Hao, Y., & Xiaoyao, S. (2011). A Modified Shuffled Frog Leaping Algorithm with Convergence of Update Process in Local Search. *First International Conference on Instrumentation, Measurement, Computer, Communication and Control,* 1016–1019.

Reyhani, R., & Moghadam, A.-M. E. (2011). A heuristic method for forecasting chaotic time series based on economic variables. *Sixth International Conference on Digital Information Management,* 300–304.

Rios, J., & Morando, A. (2011). The value of reduced uncertainty in air traffic flow management. *Work Paper, NASA Ames Reasearch Center, Moffett Field,* 1-14.

Sanjoyo (2006). Aplikasi Algoritma Genetika, 1-23.

Senjyu, T., Chakraborty, S., Saber, A. Y., Toyama, H., Urasaki, N., & Funabashi, T. (2008). Generation scheduling methodology for thermal units with wind energy system considering unexpected load deviation. *2nd IEEE International Power and Energy Conference,* 860 -865.

Shi, Y., Yang, H., Ding, Y., & Pang, N. (2008). Research on Long Term Load Forecasting Based on Improved Genetic Neural Network. *Pacific-Asia Workshop on Computational Intelligence and Industrial Application,* 2, 80–84.

Singh, A. K., Ibraheem, I., Khatoon, S., Muazzam, M., & Chaturvedi, D. K. (2012). Load forecasting techniques and methodologies: A review. *2nd International Conference on Power, Control and Embedded Systems,* 1–10.

Singh, N., Mutnury, B., Pham, N., Cases, M., & Wesley, C. (2008). Bit-pattern optimisation for accurate analysis of complex high-speed interfaces. *Electronic Components and Technology Conference, 58,* 669 -675.

Singh, Y., & Khandelwal, S. (2010). Genetic Algorithm Based Optimisation of Threshold Parameters in Fingerprint Quality Estimation. *3rd International Conference on Emerging Trends in Engineering and Technology,* 11 -14.

Song, Y., & Xi, P. (2009). Genetic algorithm and gradient-based algorithm optimisation of vehicle turning mechanism. *2nd IEEE International Conference on Computer Science and Information Technology,* 81 -84.

Soelaiman, R., Martoyo, A., Purwananto, Y., & Purnomo, M. H. (2009). Implementation of recurrent neural network and boosting method for time-series forecasting. *International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering,* 1–8.

Tan, T.-H., Huang, Y.-F., Hsu, L.-C., & Wu, C.-H. (2010). Joint channel estimation and multi-user detection for MC-CDMA system using genetic algorithm and simulated annealing. *IEEE International Conference on Systems Man and Cybernetics,* 249 -256.

Tang, L.-C., Xu, X., & Lu, L. (2012). Forecast Model of V-SVR Based on an Improved GA-PSO Hybrid Algorithm. *Fourth International Conference on Multimedia Information Networking and Security,* 725–728.

Tanuwijaya, K., & Chen, S.-M. (2009). A new method to forecast enrollments using fuzzy time series and clustering techniques. *International Conference on Machine Learning and Cybernetics,* 5, 3026–3029.

Toksari, M.D. (2007). Ant colony optimisation approach to estimate energy demand of Turkey. *Energy Policy, 3*(5), 3984-3990.

Toyama, N. (2006). Radiation Pattern Optimisation of Aperiodic Arrays Consisting of Sub-arrays. *IEEE Antennas and Propagation Society International Symposium ,* 4229 -4232.

Tutum, C. C., & Fan, Z. (2011). Multi-criteria layout synthesis of MEMS devices using memetic computing. *IEEE Congress on Evolutionary Computation,* 902–908.

Wang, C.-X., Li, C.-H., Qi, F., & Li, Z.-J. (2008). A Novel Genetic Algorithm Based on Dynastic Changes Mechanism of Nation. *Second International Conference on Genetic and Evolutionary Computing,* 109–112.

Wang, J., Ren, W., Liu, D., & Zhang, J. (2008). Ant Genetic Algorithm Based on Immune Mechanism and Its Application in Parameters Estimation of Heavy Oil Thermal Cracking Model. *Fourth International Conference on Natural Computation,* 1, 56 –60.

Wang, W.-chuan, Cheng, C.-tian, & Qiu, L. (2008). Genetic Programming with Rough Sets Theory for Modeling Short-term Load Forecasting. *Fourth International Conference on Natural Computation,* 6, 306 -310.

Wang, X., Sun, J., & Ren, C. (2009). Study on hybrid genetic algorithm for multi-type vehicles vehicle routing problem with backhauls. *6th International Conference on Service Systems and Service Management,* 120 -125.

Wu, L., Wang, Y., Yuan, X., & Zhou, S. (2010). A hybrid simplex differential evolution algorithm. *Chinese Control and Decision Conference,* 3039–3045.

Xhafa, F., Kolodziej, J., Barolli, L., & Fundo, A. (2011). A GA+TS Hybrid Algorithm for Independent Batch Scheduling in Computational Grids. *14th International Conference on Network-Based Information Systems,* 229 -235.

Xie, Y., & Li, Mu. (2010). Application of Gray Forecasting Model Optimised by Genetic Algorithm in Electricity Demand Forecasting. *Second International Conference on Computer Modeling and Simulation,* 4, 275 -277.

Xu, Q., Zhang, G., Zhao, C., & An, A. (2011). A robust adaptive hybrid genetic simulated annealing algorithm for the global optimisation of multimodal functions. *Control and Decision Conference*, 7 -12.

Xu, Q., Zhao, C., Zhang, D., & An, A. (2011). A robust parallel adaptive genetic simulated annealing algorithm and its application in process synthesis. *International Symposium on Advanced Control of Industrial Processes,* 547 -552.

Yafeng, Y., Yue, L., Junjun, G., & Chongli, T. (2008). A new fuzzy neural networks model for demand forecasting. *IEEE International Conference on Automation and Logistics,* 372-376.

Yan, T.-shan. (2010). An Improved Genetic Algorithm and Its Blending Application with Neural Network. *2nd International Workshop on Intelligent Systems and Applications,* 1-4.

Yang, S.-X., & Li, N. (2006). Power Demand Forecast Based on Optimised Neural Networks by Improved Genetic Algorithm. *International Conference on Machine Learning and Cybernetics,* 2877 -2881.

Yang, S., Huang, W., & Ma, Q. (2009). A Method of Genetic Algorithm Optimised Extended Kalman Particle Filter for Nonlinear System State Estimation. *Fifth International Conference on Natural Computation,* 5, 313 -316.

Yang, X. M., Yuan, J. S., Mao, H. N., & Yuan, J. Y. (2006). A Novel Cloud Theory Based Time-series Predictive Method for Middle-term Electric Load Forecasting. *Multiconference on Computational Engineering in Systems Applications,* 2, 1920–1924.

Yen, J., Randolph, D., Lee, B., & Liao, J.C. (1995). A Hybrid Approach to Modelling Metabolic System Using Genetic Algorithm and Simplex Method. *IEEE Transaction on System, Man and Cybernetics*, 1205 - 1210.

Yue, L., Zhenjiang, L., Yafeng, Y., Zaixia, T., Junjun, G., & Bofeng, Z. (2010). Selective and Heterogeneous SVM Ensemble for Demand Forecasting. *IEEE 10th International Conference on Computer and Information Technology,* 1519 -1524.

Zablotskiy, S., Pitakrat, T., Zablotskaya, K., & Minker, W. (2011). Optimal Operators of Hybrid Genetic Algorithm for GMM Parameter Estimation. *7th International Conference on Intelligent Environments,* 61–65.

Zhang, X., Pu, Y., Ishida, K., Ryu, Y., Okuma, Y., Chen, P.-H., Watanabe, K., et al. (2010). A 1-V input, 0.2-V to 0.47-V output switched-capacitor DC-DC converter with pulse density and width modulation (PDWM) for 57% ripple reduction. *IEEE Asian Solid State Circuits Conference,* 1–4.

Zhang, Z., & Ye, S. (2011). Long Term Load Forecasting and Recommendations for China Based on Support Vector Regression. *International Conference on Information Management, Innovation Management and Industrial Engineering,* 3, 597–602.

Zhao, W., & Niu, D. (2010). A mid-long term load forecasting model based on improved grey theory. *The 2nd IEEE International Conference on Information Management and Engineering,* 633–635.

Zied, H., Sofiene, D., & Nidhal, R. (2009). An optimal production/maintenance planning under stochastic random demand, service level and failure rate. *IEEE International Conference on Automation Science and Engineering,* 292 -297.

Zied, H., Sofiene, D., & Nidhal, R. (2010). An optimal maintenance planning according to production rate satisfying random demand. *Conference on Control and Fault-Tolerant Systems,* 418 -423.

Zuniga, V., Erdogan, A. T., & Arslan, T. (2010). Adaptive radiation pattern optimisation for antenna arrays by phase perturbations using particle swarm optimisation. *NASA/ESA Conference on Adaptive Hardware and Systems,* 209 -214.