

IMPROVED MODELS IN FUZZY TIME SERIES FOR FORECASTING

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To my wife

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## ABSTRACT

The focus of this research is in the area of fuzzy time series. Such a study is important in order to improve the forecasting performance. The research approach adopted in this thesis includes introducing polynomial fuzzy time series, differential fuzzy logic relationships model, multi-layer stock forecasting model, data pre-processing approach, and k-step-ahead forecasting. The findings from this research provide evidence that integration of the polynomial concept and non-linear optimization transfer the fuzzy time series to a parametric model. By using polynomial fuzzy time series, 83% of experiments were improved significantly. Differential fuzzy logical relationships were defined to be used for establishing differential fuzzy logical relationship groups. By utilizing differential fuzzy time series in Taiwan Capitalization Weighted Stock Index (TAIEX) datasets, 90% of the results were improved and as for enrollment datasets this statistic was 100%. Data pre-processing approach managed to reduce the negative effects of noisy data by transforming the data into a new domain. By applying integrated data pre-processing fuzzy time series algorithm to short term load data and TAIEX, the average of Mean Absolute Percentage Errors (MAPEs) and Root Mean Square Errors (RMSEs) were reduced by 12.05 and 1.98, respectively. The multi-layer forecasting model enhances the performance of stock forecast values. Many experiments that were carried out on the forty years' stock data indicated that multi-layer fuzzy time series model could be considered as an advanced model for stock market forecasting. The one-day ahead forecasting was successfully employed to England and France 2006 half-hourly load data. The main conclusion drawn from this study suggests that the proposed methods were accurate compared to their counterparts. In addition, the functionality of the proposed methods was enhanced through the proposed algorithms which were tested to be robust and reliable. All of these findings were confirmed through various tests of the proposed methods on numerous case studies. The thesis also recommends that the fuzzy time series model should be considered in forecasting alongside with classical approaches.

## ABSTRAK

Fokus kajian ini adalah dalam bidang siri masa kabur. Kajian sedemikian adalah penting dalam usaha untuk meningkatkan prestasi ramalan. Pendekatan penyelidikan yang disesuaikan dalam kajian ini termasuk memperkenalkan siri masa kabur polinomial, model hubungan perbezaan logik kabur, model ramalan saham pelbagai lapisan, pendekatan pra-pemprosesan data, dan ramalan langkah hadapan. Dapatan kajian ini memberikan bukti bahawa integrasi pengoptimuman polinomial konsep dan bukan linear memberi skim parametrik kepada model. Dengan menggunakan siri masa kabur polinomial, 83% daripada eksperimen telah meningkat dengan ketara. Perhubungan logik terbitan kabur telah ditakrifkan untuk digunakan bagi mewujudkan kumpulan hubungan kebezaan logik kabur. Dengan menggunakan perbezaan siri masa kabur dalam dataset TAIEX, 90% keputusan telah diperbaiki dan untuk dataset enrolmen, statistik ini adalah 100%. Data pendekatan pra-pemprosesan berjaya untuk mengurangkan kesan negatif data bising dengan mengubah data ke domain baru. Dengan menggunakan data bersepadu pra-pemprosesan siri masa kabur algoritma data beban jangka pendek dan TAIEX, peratusan ralat min mutlak (MAPEs) dan ralat min punca kuasa dua (RMSEs) masing-masing berkurang sebanyak 12.05 dan 1.98. Model ramalan pelbagai lapisan meningkatkan prestasi nilai ramalan saham. Banyak eksperimen telah dijalankan ke atas data saham untuk empat puluh tahun menunjukkan yang bahawa pelbagai lapisan model siri masa kabur boleh dianggap sebagai model lanjutan untuk ramalan pasaran saham. Ramalan satu hari ke hadapan telah berjaya digunakan untuk data beban setiap setengah jam England dan Perancis untuk tahun 2006. Kesimpulan utama yang dapat dibuat daripada kajian ini adalah kaedah yang dicadangkan lebih tepat berbanding dengan kaedah daripada kaedah lain yang setanding dengannya. Selain itu, fungsi kaedah yang dicadangkan ini telah dipertingkatkan melalui algoritma yang dicadangkan yang telah diuji kukuh dan boleh dipercayai. Semua penemuan ini telah disahkan melalui pelbagai ujian terhadap kaedah yang dicadangkan ke atas pelbagai kajian kes. Tesis ini juga mencadangkan bahawa model siri masa kabur perlu dipertimbangkan bersama-sama dengan pendekatan klasik dalam membuat ramalan.