APPLYING GREY THEORY WITH TWO-PARAMETER EXPONENTIAL SMOOTHING TO FORECAST 4G TELECOMMUNICATION

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ABSTRACT

In this abstract, we propose a predicting method which combines GM (1,1) model and two-parameter exponential smoothing to estimate the development of 4G telecommunication. This is because, as well known, these two methods are good at predicting the trends of industries in the different phases. Therefore, in order to locate the late development stage, we intuitively think the combination may do well for this purpose. To test our proposal, the data of Taiwan 4G user population are collected and used in the numerical experiments. The results indicate the proposed method can better predict the trend of 4G telecommunication.

MOTIVATION, METHOD AND RESULTS

As observed within the online shopping market in recent years, the e-commerce business has started to enlarge the mobile sector. The mobile shopping population and the amount of consumption is continuously rising year after year. Therefore the construction of cellular networking infrastructure becomes the most important factor for the success of mobile-commerce promotion. 4G, short for fourth generation, telecommunication has provided services recently across the world and it was also emerging in Taiwan since 2014. To meet the users' demand of high-speed communication, carriers must enhance the network construction as soon as possible to improve the coverage of 4G service. However as the 4G usage entering the mature period, the related constructing plan should also slow down correspondingly so that the cost of infrastructure may not be wasted. Actually, 5G (short for 5th generation mobile networks) denoting the next major phase of mobile telecommunications standards beyond the current 4G standards is already on the way. Therefore, how to forecast the trend of 4G telecommunication to optimize the return and then turn to 5G at the right time is a critical problem for mobile service providers. Therefore, in this abstract, we would like to propose a predicting method which combines GM (1,1) model and two-parameter exponential smoothing to handle this problem. Forecasting is a very old research topic and a lot of applicable methods have been proposed in academic papers by scholars. We have reviewed some related literatures and summarized their advantages and shortcomings as follows. Time series analysis [4] is easy to use for periodic, seasonal and cyclical trends but the good model selection needs great skill and experience. The accuracy of regression analysis [1] is often good enough but the coefficients are fixed so it lacks flexibility for external change. Neural network [6] could be applied to any input-output relationship but it can't be guaranteed to find the best point. Grey Theory [2] does not need prior distribution of data but the results may be biased sometimes.

As well known, the grey model is good at predicting the development of industries in the mature stage. However, Holt's two-parameter exponential smoothing model can better predict the trend of early growth stage [3]. It is quite straightforward to imagine that the combination of both methods should perform well for the late growth stage. Therefore, we suggest to adopt different methods to foresee the developments of industries in different stages. As for the combination procedure, it should be preferable to execute GM(1,1) model first and then Holt's two-parameter exponential smoothing model later due to the reason that, in general, the performance of Holt's two-parameter exponential smoothing is better than

that of GM(1,1) model. Therefore, the results of the later Holt's two-parameter exponential smoothing could be used for prediction purpose. In later context, we name this method as hybrid method. Until now, we have collected data regarding to 4G LTE wireless network (2014/5~2015/5) in Taiwan from National Communication Commission (NCC) [5]. The data from 2014/7-2015/3 are used to generate the revised data series. 2014/5 and 2014/6 are ignored due to the reason that not all service providers are running the business at that time and 2015/4 and 2015/5 will be used for evaluating purpose. We analyze all the generating results in the following Table 1. As shown, it is easy to find that the hybrid method generates the smallest absolute percentage error (APE) and mean absolute percentage error (MAPE).

Table 1 The generating results of all models

Forecasting Model	The APE (%)	The MAPE (%)
Gm(1,1) model	1.02%	24%
Ameliorating GM (1, 1) model	6.5%	38%
Holt's exponential smoothing	0.21%	12.97%
The hybrid model	**0.04%**	**9.0%**

Then we use the generating series to forecast the future two months (2015/4 and 2015/5) and the results are recorded in Table 2. The comparison also indicates that the hybrid method can better predict the future population than the other methods do.

Table 2 The comparison of forecasting methods

Year/month	Real number of 4G user	GM(1,1) model	APE (%)	Holt's exponential smoothing	APE (%)	The hybrid model	APE (%)
2015/4	5,852,935	7219590	23.3%	6304391	7.71%	6,210,702	**6.1%**
2015/5	6,485,911	8882051	36.9%	7375235	13.71%	6,864,263	**5.8%**

We propose a fine method to foretell the development of 4G; however, there is only one assessment case in this abstract and we think it still needs more tests in order to validate its superior performance.

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