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Forecasting Residential Water Consumption in Hamilton, New Zealand

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Abstract : Many people in New Zealand believe that the access to water is inexhaustible, and it comes from a history of virtually unrestricted access to it. For the region like Hamilton which is one of New Zealand's fastest growing cities, it is crucial for policy makers to know about the future water consumption and implementation of rules and regulation such as universal water metering. Hamilton residents use water freely and they do not have any idea about how much water they use. Hence, one of proposed objectives of this research is focusing on forecasting water consumption using different methods. Residential water consumption time series exhibits seasonal and trend variations. Seasonality is the pattern caused by repeating events such as weather conditions in summer and winter, public holidays, etc. The problem with this seasonal fluctuation is that, it dominates other time series components and makes difficulties in determining other variations (such as educational campaign's effect, regulation, etc.) in time series. Apart from seasonality, a stochastic trend is also combined with seasonality and makes different effects on results of forecasting. According to the forecasting literature, preprocessing (de-trending and de-seasonalization) is essential to have more performed forecasting results, while some other researchers mention that seasonally non-adjusted data should be used. Hence, I answer the question that is pre-processing essential? A wide range of forecasting methods exists with different pros and cons. In this research, I apply double seasonal ARIMA and Artificial Neural Network (ANN), considering diverse elements such as seasonality and calendar effects (public and school holidays) and combine their results to find the best predicted values. My hypothesis is the examination the results of combined method (hybrid model) and individual methods and comparing the accuracy and robustness. In order to use ARIMA, the data should be stationary. Also, ANN has successful forecasting applications in terms of forecasting seasonal and trend time series. Using a hybrid model is a way to improve the accuracy of the methods. Due to the fact that water demand is dominated by different seasonality, in order to find their sensitivity to weather conditions or calendar effects or other seasonal patterns, I combine different methods. The advantage of this combination is reduction of errors by averaging of each individual model. It is also useful when we are not sure about the accuracy of each forecasting model and it can ease the problem of model selection. Using daily residential water consumption data from January 2000 to July 2015 in Hamilton, I indicate how prediction by different methods varies. ANN has more accurate forecasting results than other method and preprocessing is essential when we use seasonal time series. Using hybrid model reduces forecasting average errors and increases the performance.

Keywords : artificial neural network (ANN), double seasonal ARIMA, forecasting, hybrid model
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