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ARTICLE

Tourism time series forecast with artificial neural networks

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Abstract The modulation of tourism time series was used in this work for forecast purposes. The Tourism Revenue and Total Overnights registered in the hotels of the North region of Portugal were used for the experimented models. Several feed-forward Artificial Neural Networks (ANN) models using different input features and number of hidden nodes were experimented to forecast the Tourism time series. Empirical results indicate that the Dedicated ANN models perform better than models with several outputs. Generally the usage of previous 12 values of the same time series is very important to a good quality forecast. For the prediction of Tourism Revenue the Foreign Overnights and GDP of contributing countries are relevant. This time series was predicted with an error of 4.7% and a Pearson correlation of 0.98. The forecast of Total Overnights had an error of 6.0% and Pearson correlation of 0.98. Domestic Overnights are more predictable than Foreign Overnights.

1. Introduction

Tourism has been seen as one of the important drivers of economic growth. As a consequence it has become a vital economic activity for developing countries. The role of this activity to the global and national economies, in terms of national outcomes, employment opportunities, foreign exchange earnings and exports, is noteworthy. According to the World Travel and Tourism Council (WTTC), the direct contribution of Travel and Tourism to Gross Domestic Product (GDP) was USD 2,056 billion (2.9% of total GDP) in 2012, and it is forecast to rise by 3.1% in 2013, and also generate over 260 million jobs in 2012 (WTTC, 2013). Travel and Tourism investment in 2012 was USD 764.7 billion, or 4.7% of total investment and it should rise by 4.2% in 2013, according to recent results from WTTC (2013).

Similar to what has been happening in the world, it has been noted in Portugal. Hence, and according to WTTC

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(2013), the total contribution of tourism sector to GDP was EUR 26.4 billion (15.9% of GDP) in 2012, and it is forecast to rise by 0.2% in 2013; the total contribution to employment, including jobs indirectly supported by the industry, was 18.5% of total employment (860,500 jobs), in 2012, and it is expected to rise by 1% to 954,000 jobs in 2023; the investment in 2012 was EUR 3.5 billion, or 13.2% of total investment and it should rise by 3.3% in 2013.

In the North Region of Portugal and according to the data produced by Portuguese National Institute of Statistics (INE) in 2011, tourism accommodation activity establishments hosted around 3 million guests, originating 4,547 million overnight stays, INE (2012). According to the same source the average stay on the establishment were approximately 2 nights. The total number of establishment registered were around 453 hotels and boarding houses. The net bed-occupancy rate in 2011 were 32.1% and 3.8 thousand euros lodging income per lodging capacity (INE, 2012).

In this regard and because of the continuing growth of tourism, at the international and national levels, and its importance in the economy of a country, there is a need to analyze and forecast the tourism revenues, tourism demand and other time series related with the tourism sector. Indeed, each country wants to know its international and national tourist behaviour and tourism revenues in order to select a suitable strategy for its economic health.

Hence, considering this important factor several studies have been published in the field of tourism in recent years using different methodologies based on versatile nonlinear models that can represent both nonseasonal and seasonal time series. *E.g.*: Law and Au (1999), Law (2000), Pai and Hong (2005), Chen and Wang (2007), Fernandes, Teixeira, Ferreira, and Azevedo (2008), Fernandes and Teixeira (2009), Machado, Teixeira, and Fernandes (2010), Hong, Dong, Chen, and Wei (2011), Chen (2011), Shen, Li, and Song (2011), Lin, Chen, and Lee (2011), Chen, Lai, and Yeh (2012), Teixeira and Fernandes (2012), Shahrabi, Hadavandi, and Asadi (2013), Lin, Pai, Lu, and Chang, (2013), Pai, Hung, and Lin (2014), and Claveria and Torra (2014). For example Law and Au (1999) used a feed-forward neural network model to forecast Japanese tourism demand. Law (2000) applied a backpropagation neural network to forecast tourism demand. Pai and Hong (2005) employed support vector machines neural networks with genetic algorithms to forecast the arrival data in Barbados. Chen and Wang (2007) applied support vector regression neural networks with genetic algorithms in forecasting tourism demand. Fernandes et al. (2008) investigated and highlighted the usefulness of the Artificial Neural Networks methodology as an alternative to the Box–Jenkins methodology in analysing tourism demand. Fernandes and Teixeira (2009) developed a new approach of the Artificial Neural Networks methodology using the time in its input instead of the previous 12 registered observations, as usually used; the authors intended to compare the classic usage of the Artificial Neural Networks methodology with a new modulation using the years and month in the input. Machado et al. (2010), performed a comparative study between the models based on the linear regression and based on the methodology of artificial neural networks. Hong et al. (2011) presented a support vector regression with chaotic genetic algorithm to forecast tourism demand. Chen (2011) used support vector regression technology to forecast tourism demand. Shen et al. (2011) developed six combination methods to forecast UK outbound tourism demand in seven destination countries. Lin et al. (2011), tried to build the forecasting model of visitors to Taiwan using three commonly adopted ARIMA, artificial neural networks, and multivariate adaptive regression splines. Chen et al. (2012) developed a new forecasting model based on empirical mode decomposition and neural network to predict tourism demand. Teixeira and Fernandes (2012) applied the traditional feed-forward architecture, the cascade forwards, a recurrent Elman architecture and a radial based architecture to forecast the tourism demand. Shahrabi et al. (2013) proposed a new hybrid intelligent model that is called Modular Genetic-Fuzzy Forecasting System by a combination of genetic fuzzy expert systems and data pre-processing which includes K-means clustering and the Takagi–Sugeno–Kang. Lin et al. (2013), developed a fuzzy least-squares support vector regression model with genetic algorithms to forecast seasonal revenues. Pai et al. (2014) developed a novel forecasting system for accurately forecasting tourism demand where the construction of the new forecasting system combines fuzzy c-means with logarithm least-squares support vector regression technologies.

Claveria and Torra (2014) evaluated the forecasting performance of an artificial neural network approach relative to different tourism time series models, autoregressive integrated moving average models and self-exciting threshold autoregressions. Empirical evidence of the studies presented above shows that nonlinear models that can represent both nonseasonal and seasonal time series generally outperform the linear methods in modelling tourism behaviour, as classical time series models, such as ARIMA, linear regression model, multivariate adaptive regression splines and multiple regression, exponential smoothing, moving average and naïve.

Therefore, the aim of this paper is to forecast the time series of tourism, namely the Tourism Revenue, Total Overnights, Domestic and Foreign Overnights in establishment registered in the North of Portugal, using the ANN methodology and find the best architecture to achieve it.

In order to answer the objective of this study the rest of the paper is organized as follows: Section 2 briefly describes the times series and data set under study; Section 3 presents the methodological approach; Section 4 presents the empirical results and analysis, while the final section summarizes the conclusions.

2. Description of time series

All data were collected from Portuguese National Institute of Statistics, EUROSTAT and Statistical Yearbook for the North Region of Portugal. The data corresponds to 72 monthly observations between January 2006 and December 2011.

The variables used in this study are symbolized and described in Table 1, accompanied by a descriptive statistics. It should be noted that the selection of GDP for only 4 countries: Portugal, Spain, France and the United Kingdom, were because they are the tourism outbound markets with the main market share for the years under analysis

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