

## FORECASTING TOURISM DEMAND WITH ARTIFICIAL NEURAL NETWORKS

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### ABSTRACT

Tourism has been viewed as an important player for the economic redevelopment of certain rural regions because of the attraction of landscapes, mountain, and the interest in second-home or investment opportunities at lower prices (Jackson & Murphy, 2002). Even with tourism's potential for development at all levels, there have been very few studies regarding models for estimating the local impact of tourism (Jackson & Murphy, 2006). To enhance understanding of the nature of forecasting in tourism destinations it is valuable to study systematically the possible estimative of influence that tourism destination has on an area.

The main objective of this study is to present a set of models for tourism destinations competitiveness, using the Artificial Neural Networks methodology. This study focuses on two Portuguese regions - North and Centre - as tourism destinations offering a large range of tourist products, that goes beyond the beach, the mountains, the thermals not forgetting the rural tourism that has growing in the last years. These tourism destinations offer an interesting alternative to the 'mass tourism' and have become more competitive, since the last one is normally associated with negative environmental impacts.

### KEYWORDS

Artificial Neural Networks, Nonlinear Time Series, Modelling, Tourism Forecasting.

### 1. LITERATURE REVIEW AND METHODOLOGY

As a way of explaining the behaviour and to obtain values about future movements for tourism demand, for each tourism destinations studied, for the years 2008 and 2009, it was used the methodology of the Artificial Neural Networks (ANN). This methodology has been considered interesting in economics and business areas since it is viewed as a valid alternative to the classical forecast approaches event in complex situations. Neural networks are the most versatile nonlinear models that can represent both nonseasonal and seasonal time series. The most important

capability of neural networks compared to other nonlinear models is their flexibility in modelling any type of nonlinear pattern without the prior assumption of the underlying data generating process (Rumelhart & McClelland, 1986; Haykin, 1999). The Artificial Neural Networks model used in this study is the standard three-layer feedforward network. Since the one-step-ahead forecasting is considered, only one output node is employed. The activation function for hidden nodes is the logistic function [Logsig<sup>2</sup>]; and for the output node the identity function [Lin<sup>3</sup>]. The fast Resilient Backpropagation algorithm (Riedmiller & Braun, 1993; Law, 2000) is employed in training process. The selection of the architecture, activation function and training algorithm is supported in the author’s work (Fernandes *et al.*, 2008; Fernandes & Teixeira, 2009). The elected architecture consists of 12 input nodes in the entrance layer, 4 hidden nodes in the second layer and one node in the output layer (1-12;4;1). The input of the model consists of the 12 previous numbers, corresponding to the last 12 months overnights. The output is the predicted overnights for the next month. The time series with the original data were divided into three distinct sets: the training set (228 observations for both series, corresponding to the period between January 1988 and December 2006); the validation set (12 observations, corresponding to the year 2007); and the test set (24 observations, corresponding to the years 2008 and 2009). The time series used in this study for forecasting was “Monthly Guest Nights in Hotels in the North [GRN] and in Centre [GRC]” of Portugal, registered between January 1987 and December 2009, corresponding to 276 monthly observations over the 23-year period (INE, 1987-2009).

**2. RESULTS AND ANALYSIS**

Table 1 shows the empirical results for both models and regarding the performance in the test set presented by RMSE and *r*, we can say that the final results are stable and reached an interesting and satisfactory performance. According to the criterion of MAPE for Model Evaluation in Lewis (1982), the predicted data with the selected model has a highly accurate forecast, because the results are lower than 10%. When the MAPE was calculated for the test set, for each of the regions, it was seen that, for the North region, the ANN model presented a value of 7.32%, for 2008 year, and 5.42%, for 2009 year. Similar values were also produced for the Centre region, 7.01% and 9.33%, for 2008 and 2009 years, respectively. This fact confirms the ability of the model to produce similar performance for different time series. It is fair to be mentioned that the authors have been using this model over several years with similar performance, despite some variation introduced for instance in the input variables (Fernandes & Teixeira, 2009).

**Table 1. Results of ANN models**

Tourism Destination	Forecast Year	Performance Measured - Test Set		
		<i>r</i>	<i>RMSE</i>	<i>MAPE</i>
GRN <sub>ANN(1-12;4;1)</sub>	2008	0.968	30 323	7.32%
	2009	0.983	24 701	5.42%
GRC <sub>ANN(1-12;4;1)</sub>	2008	0.975	26 456	7.01%
	2009	0.960	35 850	9.33%

$$^2 f(x) = \frac{1}{1+e^{(-x)}} .$$

$$^3 f(x) = x .$$

### 3. CONCLUSION

Experimental results indicated that the artificial neural network models attained the highest forecasting accuracy and it was concluded that the models obtained, for both regions, are valid for the sets of data that were used as a support and presented satisfactory statistical and adjustment qualities, showing themselves to be suitable for modelling and forecasting the reference series. The artificial neural network methodology suggested that this method should be used in time series with non-linear behaviour.

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