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Management of health care expenditure by soft computing methodology

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HIGHLIGHTS

- Expenditures on health care throughout most of the developed world.
- To analyze the economic growth based on health care expenditures.
- Gross domestic product (GDP) as economic growth indicator.
- Support Vector Regression (SVR) is implemented.

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ABSTRACT

In this study was managed the health care expenditure by soft computing methodology. The main goal was to predict the gross domestic product (GDP) according to several factors of health care expenditure. Soft computing methodologies were applied since GDP prediction is very complex task. The performances of the proposed predictors were confirmed with the simulation results. According to the results, support vector regression (SVR) has better prediction accuracy compared to other soft computing methodologies. The soft computing methods benefit from the soft computing capabilities of global optimization in order to avoid local minimum issues.

1. Introduction

Healthcare expenditure could be describe to be a function of gross domestic product (GDP). There are some reasons why a bilateral relationship between healthcare expenditure and GDP could exist. Social security, tranquility, safety, and welfare could be increased by increasing of the healthcare expenditure. Healthcare expenditure could help people to recover and return to work quickly [1,2].

Serious concern has been raised about the sustainability of public health care systems as a result of the economic crisis but positive and cost effective healthcare programs are still possible [3]. The economic components and benefits of a predictive, preventive and personalized health plan for lung as well as head and neck cancer show how prospective care could relate to a community or group of covered individuals was described in article [4]. The health care can be an important economic factor in the regional context and thus should not only be regarded as a cost factor but should be developed [5]. The well-known health-led growth hypothesis claims a positive correlation between health expenditure and economic growth [6]. Inadequate provision of public health care, the near-absence of health insurance and increasing dependence on the private

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Table 1
Input health expenditure parameters.

Parameter 1	Private health expenditure, private (GDP percentage)
Parameter 2	Public health expenditure (total health expenditure percentage)
Parameter 3	Public health expenditure (government expenditure percentage)
Parameter 4	Public health expenditure (GDP percentage)
Parameter 5	Total Health expenditure (GDP percentage)

health sector have impoverished the poor and the marginalized, especially the scheduled tribe population [7]. Private health expenditures have negative influence on economic growth while public health expenditures have both negative and statistically significant effects [8]. In paper [9] was suggested increasing of access to health insurance and public spending on geriatric care to reduce the out-of-pocket expenditure on health care. High unemployment and low economic growth continue to plague many countries, putting strong pressures on governments to reduce social spending. Health is the second largest social expenditure program and has been one of the fastest growing [10]. The results in article [11] were shown that health care expenditure and GDP are cointegrated.

The relationship between health care expenditure and health outcomes is of interest to policy makers in the light of steady increases in health care spending for most industrialized countries. However, establishing causal relationships is complex because, firstly, health care expenditure is only one of many quantitative and qualitative factors that contribute to health outcomes, and, secondly, measurement of health status is an imperfect process [12]. Therefore in this study was applied soft computing methodology [13–17] to manage the health care expenditure.

2. Methodology

2.1. Health care expenditure

In this investigation five health expenditure parameters were selected. The data are taken from EUROSTAT for 28 countries in European Union. Table 1 shows input parameters which are used in this investigation. GDP was used as output.

2.2. Support vector regression application

SVR algorithm is based on the data mapping in defined spaces by nonlinear algorithm. A linear algorithm was performed in the feature space. If the inner product in the feature space is available as a function directly based on the original input points, it is possible to make nonlinear learning machine which is known as kernel function, K. The kernel function could implicitly chart the data to the higher dimensional feature space. Linear solution in the higher dimensional feature space is connected to nonlinear solution in the original, lower dimensional input space. There are different kernel functions. In this study we used radial basis function as kernel function since it is the most common kernel function. The main benefit of the radial basis function is computationally efficiency. The non-linear radial basis kernel function is defined as:

$$K(x, x_i) = \exp\left(-\frac{1}{\sigma^2}\|x - x_i\|^2\right) \quad (1)$$

where x and x_i are vectors in the input space.

3. Results and discussion

3.1. SVR results

As the kernel functions for SVR model, polynomial functions were applied in this study. SVM model accuracy is dependent on model parameter selection. A large number of trial and error were carried out with different combinations for polynomial kernels.

Fig. 1(a) shows SVR forecasting of the GDP based on health care expenditure. Very high value for coefficient of determination can be noted for the SVR model. There is very limited number of underestimated values. It is obvious that the forecasted values have high level precision. Fig. 1(b) shows artificial neural network (ANN) results for the forecasting of the GDP based on health care expenditure. Finally, Fig. 1(c) shows genetic programming (GP) results for the forecasting of the GDP based on health care expenditure ANN and GP models were used as benchmark models for comparative study with the SVR mode. The best forecasting accuracy can be observed for SVR model in comparison with ANN and GP models.

The root-mean-square error (RMSE) and coefficient of determination (R^2) served to evaluate the differences between the expected and actual values for SVR and other soft computing techniques. Table 2 compares the SVR model with ANN and GP. The results in Table 2 indicate that the SVR model has the best capabilities of GDP forecasting based on the health care expenditure.

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