Stochastic Optimization in Smoothing Time Series of Labour Market Descriptors

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1. Introduction

This contribution deals with an application of our stochastic algorithms to solving the problem of time series smoothing. The time series of some Czech labour market descriptors were treated using the Holt-Winters exponential smoothing algorithm with multiplicative seasonal adjustment.

2. Stochastic optimization

Two stochastic algorithms were used to optimizing the values of smoothing constants: the modified controlled random search and the evolutionary search (Tvrdík and Křivý, 1997). Both the algorithms starts from a population P of N uniformly distributed points in a searching space. The new trial point $\mathbf{x}$ is generated from a simplex S by the relation

$$\mathbf{x} = \mathbf{g} - Y(\mathbf{z} - \mathbf{g}),$$

where $\mathbf{z}$ is one (randomly taken) pole of the simplex S, $\mathbf{g}$ the centroid of the remaining d poles of the simplex and Y a multiplication factor distributed uniformly in the interval $\langle 0, \delta \rangle$.

Suppose that $f_1, f_2, \ldots, f_N$ is a nondecreasing sequence of the objectve function values in a given iteration of the algorithms. The optimization process was stopped when $f_{15} - f_1 \leq \varepsilon$.

The values of common input parameters of the algorithms were set as follows: $N = 30, \delta = 8, \varepsilon = 1\mathrm{E} - 7$.

3. Holt-Winters exponential smoothing

Let $a(t), b(t)$ and $Sz_t(t)$ be estimates of the time series level, its slope and its seasonal factor at time t, respectively. The Holt-Winters multiplicative seasonality algorithm makes use of the following formulas:

$$a(t) = \alpha \frac{X_t}{Sz_{t-L}(t-L)} + (1-\alpha)[a(t-1) + b(t-1)],$$
$$b(t) = \beta[a(t) - a(t-1)] + (1-\beta)b(t-1),$$
$$Sz_t(t) = \gamma \frac{X_t}{a(t)} + (1-\gamma)Sz_{t-L}(t-L),$$

where α, β, γ are smoothing constants and L represents the number of periods per year.

The smoothing constants α, β and γ were optimized with respect to the criterion SSE, the searching space being constrained to $0 < \alpha, \beta, \gamma \leq 1$. The empirical formulas proposed by Cipra (1986) were used for estimating the initial values $a(0), b(0)$ and $Sz_t(t)$ for $t = -(L-1), -(L-2), \ldots, 0$.

4. Experiments and their results

The original data covered the period from September 1990 to December 1999. The following four labour market descriptors were studied: labour force, number of job applicants, unemployment rate, and number of job vacancies. For each individual time series at least 10 independent runs were performed.

The analysis of the optimum values of smoothing constants showed that some of them reach their upper limit value, which indicates that the mechanism generating them has recently gone through some fundamental changes.

Using the optimum values of smoothing constants, all the time series were smoothed and the forecasts for the year 2000 were calculated and compared with the real data.

REFERENCES

Cipra, T. (1986). *Analýza časových řad s aplikacemi v ekonomii. Praha: SNTL.*

Tvrdík, J. and Křivý, I. (1997). Evolution algorithms in Regression, In *Proceedings of 51st session of ISI*, book 2, 37–40. State Institute of Statistics. Istanbul.

RESUME

Les séries temporelles de quelques caracteristiques du marché tchèque de travail sont élaboré par l'aider de l'algorithme d'Holt–Winters du lissage exponentiel avec la composante multiplicative de saison. Deux algorithmes stochastiques sont appliqués pour l'optimalisation des valeurs des constantes du lissage.

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