Jump preserving filters for short-term growth data

D. M. Kelmansky[1]

[1] Instituto de Clculo, Facultad de Ciencias Exactas y Naturales - U.B.A.
Pabellon II - 2do. Piso Intendente Guiraldes 2160 Ciudad Universitaria Ciudad Autonoma Buenos Aires (1428) Argentina Telfono / Fax (54)(11) 4576 3375 dkelman@ic.fcen.uba.ar

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Abstract

Classical non-parametric methods are inadequate when sharp changes in the regression function are present. A two-step robust filter (2step-RF) is introduced that preserves jumps while showing a smooth pattern where the regression function is smooth that is insensitive to outlying observations. It is a two-step procedure based on local symmetric kernel estimation, weighted with hard rejection criteria. This proposal originated in the controversy respect to the continuous or discontinuous structure of short-term growth.

Growth features, when studied in the short term, belong to a controversial area of knowledge. Some authors assume that growth occurs as a series of distinct positive growth events (saltation) separated by extended periods of stasis (Lampl, Veldhuis and Johnson 1992, Lampl (1992,1999)) others (Hermanussen, Geiger-Benoit Burmeister and Sippell 1988, Hermanussen, Thiel Von Bren 1998) state that growth is a continuous process with a chaotic series of "mini growth spurts" in which velocity varies considerably.

One of the challenges that daily measurements provide is the separation of noise from the real value. Several measurement errors - from the equipment, the observer, the positioning of the subjects and the cooperation of the subject - and the real height, combine resulting in the observed data value. To attain this goal, a noise decreasing method -not assuming the existence of any predetermined regression function- is necessary. The method should not mask the real changes and should not generate inexistent ones in order to reveal the true underlying growth pattern.

Smoothing techniques have been criticized for adding noise while removing the meaningful patterns in the original data (Lampl and Johnson 1998). This shortcoming is due to the fact that many of the commonly used nonparametric methods including kernel estimators (for example Mller (1988) y Hrdle (1990)) and smoothing splines (for example, Eubank (1988) y Wabba (1990)) are based on the smoothness of regression functions. More recently, several jump-estimation proposals have appeared (H. Mller (1992), J. Gao (1998) Oushoorn (1998)). They have studied one-sided kernel estimators for the location of jump points, but these type of proposals are not appropriate for short-term growth measurements data because a previous knowledge of the existence of the jump is needed.

Chu, Glad, Godtliebsen and Marron 1998 introduce, in the image processing field, the sigma filter and the M smoother.

In this paper we introduce a two-step sigma-filter-type method. This is a robust non-parametric technique and therefore it does not predetermine any structure of the regression function and is not sensitive to outlying observations. It inherits the edge-preserving properties of the sigma filter while improving even further the smoothing properties of the M-smoother. These characteristics turn the proposal in an adequate method for the analysis of short-term growth. Its explicit expression avoids the computational difficulties that occasionally appear in solving a non linear equation as the one defining the M-smoother with a redescending psi-function.

A Monte-Carlo simulation is carried out to compare the mean square error of the 2step-RF estimators with the edge-preserving smoothers (sigma-filter and M-smoother).

Several examples are shown for real and simulated data sets.

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