Asymptotic properties of functional maximum-likelihood ARH parameter estimators

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Résumé. Dans cet article, nous nous intéressons au problème du calcul de la variance asymptotique des estimateurs du maximum de vraisemblance des paramètres de projection de processus autorégressifs hilbertiens. Ces estimateurs obtenus à partir d'observations fonctionnelles gaussiennes incomplètes ont été étudiés dans Ruiz-Medina et Salmerón (2010). Notre approche consiste à estimer ces variances à l'aide d'une version fonctionnelle de l'algorithme SEM (Supplemented Expectation Maximization) par Meng et Rubin (1991). La mise en oeuvre de l'algorithme est basée sur l'extraction des fonctions propres et valeurs propres de l'opérateur d'autocorrélation et de son adjoint. Les effets de l'ordre de troncature du spectre et de la discrétisation des fonctions sont illustrés par des simulations.

1 Introduction

Functional Statistics (see, for example, Bosq, 2000 ; Bosq and Blanke, 2007 ; Ferraty and Vieu, 2006 ; Ramsay and Silverman, 2005) provides a suitable framework to analyze large dimensional data sets. Complex biological and artificial systems can then be studied from this perspective. In particular, in Biomedicine, Bioinformatics and image processing (see, for instance, Germain *et al.*, 1999 ; Haoudi and Bensmail, 2006 ; Hyndman and Ullah, 2006 ; Leng and Müller, 2006 ; Monk, 2003 ; Song *et al.*, 2007, among others), the most extended projection estimation methodology has been Functional Principal Component Analysis (FPCA), implemented from the spectral decomposition of the empirical covariance operator, which is usually computed by application of the method of moments. However, the ML (Maximum Likelihood) estimation methodology has not been considered in these applications. In Ruiz-Medina and Salmerón (2010), ML projection estimators are computed from the application of the forward and backward Kalman recursion, combined with EM algorithm (see, for example, Hartley, 1958 ; Dempster, Laird and Rubin, 1977), in terms of the eigenfunction bases of the autocorrelation operator and its adjoint. This projection methodology is most suitable than FPCA in the case of ML estimation. The motivation of our paper lies on this fact, since, for the application of the ML projection estimation methodology, information on its performance is obviously needed. Specifically, the asymptotic variance of the ML projection estimators must be computed. The