Título: NONPARAMETRIC CIRCULAR METHODS FOR DENSITY AND REGRESSION

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Resumen: In a large variety of applied fields such as biology, medicine or environmental sciences, measurements from the process under study are directions. Circular data are a particular case of directional data where the observations are directions in two dimensions. Due to the circular nature of this kind of data, which implies fixing a reference point and a sense of rotation in order to define a circular observation, the statistical methods for the analysis of linear data are not appropriate for the analysis of circular data.

Within this framework, the specific goal of this dissertation is the study of nonparametric methods, focusing on the density estimation with circular data and regression with a scalar response and a circular covariate. Thus, the circular kernel density estimator, which depends on a smoothing parameter, is introduced and several methods for selecting the smoothing parameter are reviewed. The main contribution in the density setting is the introduction of a smoothing parameter selector that allows estimating complex circular densities, accounting for asymmetry and/or multimodality. In the regression setting, a review of the methods for regression estimation with scalar response and circular covariate is provided, considering both kernel and spline estimators. Specifically,

the periodic smoothing spline estimator and the adaptations of Nadaraya-Watson and Local Linear estimators to the circular nature of the covariate are compared.

With the goal of assessing which observed features in the smoothed curve (density or regression) are statistically significant and which features are simply artifacts of the sampling noise, a nonparametric technique, namely CircSiZer, is developed. CircSiZer provides a graphical tool which, by means of different colors, shows the significant increasing and decreasing patterns of the smoothed curve for different values of the smoothing parameter, which avoids the selection problem.

All the proposed techniques are illustrated with simulated datasets and real datasets from different scientific fields. Moreover, the methods have been implemented in the R computing environment, freely available under the GNU General Public License, so that they can be used in practice. All implemented functions are gathered in the R library NPCirc.