Smoothing Covariate Effects in Zero-Inflated Poisson Models with Its Applications

Chin-Shang Li
Department of Biostatistics St. Jude Children's Research Hospital Memphis, U.S.A.

Analyzing counts of rare events often involves datasets that contain many zeros. For example, patients with congestive heart failure who take their medications regularly may not require hospital admissions or emergency department visits; therefore, analyzing these events can be challenging. Counts of rare events are often modeled by zero-inflated Poisson (ZIP) distributions. In the regression analysis of ZIP data, the effect of an independent variable of interest is usually modeled via a linear predictor, which imposes a restrictive, thus potentially questionable, functional form on the relation between the independent and dependent variables. I propose a flexible parametric procedure to model the effect of the independent variable as a linear combination of fixed knot cubic Schoenberg's B-splines or Basic-splines. I fit the proposed semiparametric ZIP regression model by maximizing the penalized likelihood through an expectation-maximization algorithm; hence this approach yields a smooth estimate of the functional form of the independent variable effect. I contend that this semiparametric regression model greatly enhances modeling flexibility. By introducing a likelihood ratio test, my research also provides a practical way to assess the functional adequacy of the independent variable effect. This research is a useful addition to the existing ZIP literature. Results from a simulation study show that the proposed test has excellent power in detecting the lack-of-fit of a linear predictor. Finally, I illustrate the practical use of this method by modeling the counts of hospital or emergency department visits in a real clinical trial. In this application, 74 of the 92 patients with congestive heart failure did not have a hospital or emergency department visit during the 1-year follow-up period.

[Chin-Shang Li, Department of Biostatistics St. Jude Children's Research Hospital Memphis, TN 38105, U.S.A. ; chinshang.li@stjude.org]