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One-Step estimation procedure in univariate and multivariate GLMs with categorical explanatory variables

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Generalized linear models are commonly used for modeling relationships in both univariate and multivariate contexts, with parameters traditionally estimated via the maximum likelihood estimator (MLE). MLE, while efficient, often requires a Newton-Raphson type algorithm for computation, making it time-intensive particularly with large datasets or numerous variables. Although faster, alternative closed form estimators lack the efficiency. In this topic, we propose a fast and asymptotically efficient estimation of the parameters of generalized linear models with categorical explanatory variables. It is based on a one-step procedure where a single step of the gradient descent is performed on the log-likelihood function initialized from the explicit estimators. This work presents the theoretical results obtained, the simulations carried out and an application to car insurance pricing.

Multivariate GLMs are studied in many scientific contexts. In insurance sector actuaries and risk managers precisely, they allow to assess the joint probabilities of various events occurring simultaneously, such as multiple claims or correlated risks across different insurance policy types (e.g., life, property, and auto). Copula models provide flexible tools to model multivariate variables by distinguish marginal effects from the dependence structure. In this setting, the copula parameter which quantify the (non-linear) dependency of the coordinates and the parameters of the marginal distributions are unknown and have to be estimated jointly.

In order to infer the parameters, maximum likelihood estimators (MLE) can be used due to the asymptotic properties. However, MLE is generally not in closed-form expression and is consequently time consuming. An alternative procedure, called inference for margins estimators (IFM), has been proposed in (Xu 1996, Joe 1997, 2005). In the IFM procedure, parameters of the marginals are estimated separately and simultaneously and plug-in to obtain finally the copula parameter. Although, IFM-MLE can still be time-consuming for this reason in order to estimate the copula parameter, fast and asymptotically efficient OS-CFE are used to estimate the parameters of the marginals and plug-in to estimate the copula parameter with the IFM method.

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