# Geographically weighted Poisson-Tweedie model for count data

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## Abstract

Geographically weighted regression (GWR) is a widely used localized modeling technique for exploring spatial heterogeneity in data relationships. Owing to its intuitive specification and interpretability, recent years have witnessed active developments in extending the GWR framework to accommodate count response variables. However, most existing approaches either rely on restrictive distributional assumptions (e.g., Poisson, negative binomial) that may not capture the full range of dispersion and distributional complexities, or adopt two-part mixture formulations (e.g., zero-inflated models) that can complicate estimation and interpretation. In this study, we propose the geographically weighted Poisson-Tweedie model (GWPTM), which integrates the Poisson–Tweedie family within the GWR framework to provide a unified and flexible tool for spatial count data analysis. By specifying variance as a power function of the mean, GWPTM accommodates a broad range of mean–variance relationships and embeds a class of count distributions under a single framework, including Poisson and negative binomial distributions as special cases along with other members of the Poisson–Tweedie family. This formulation enables the model to naturally account for features such as equi-, over-, and underdispersion, zero inflation, asymmetry, and tail heaviness, while allowing both regression coefficients and distributional parameters to vary across space. We develop estimation procedures, draw statistical inference for local parameters, and discuss practical modeling considerations. Simulation experiments are conducted to examine and validate the model performance. Finally, we apply the proposed method to analyze dengue data from Taiwan, demonstrating its practical value through empirical illustration.

Keyword: Geographically weighted regression, Spatial heterogeneity, Count data analysis, Poisson-Tweedie model, Overdispersion, Zero inflation