A Hybrid Method for Density Power Divergence Minimization with Application to Robust Univariate Location and Scale Estimation

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Abstract

We develop a new globally convergent optimization method for solving the constrained minimization problem underlying the minimum density power divergence estimator of univariate Gaussian location and scale parameters in the presence of outliers or other model violations. Our hybrid procedure combines the classical Newton's method with a gradient descent iteration with a step control mechanism based on Armijo's stepping rule. We prove the global convergence of the resulting scheme and show the convergence speed is quadratic in the interior of the feasible set. Based on extensive simulations, we compare the resulting estimation procedure with a more prominent robust competitor – the Minimum Covariance Determinant (MCD) estimator of P. Rousseeuw (1984) – in terms of efficiency across a wide range of breakdown point values. Application to estimation and inference for a real-world "notifiable conditions" dataset from the City of El Paso Department of Public Health is also given.

Keywords: Miminum density power divergence estimator; Rousseeuw's minimum covariance determinant estimator; Gradient descent; Armijo rule; Newton's method.