

This paper studies the outlier detection and variable selection problem in linear regression. A mean shift parameter is added to the linear model to reflect the effect of outliers, where an outlier has a nonzero shift parameter. We then apply an adaptive regularization on these shift parameters to shrink most of them to zero. For those observations with nonzero mean shift parameter estimates, they are regarded as outliers. Meanwhile, an L1 penalty is added to the regression parameters to select important predictors. We propose an efficient algorithm to solve this jointly penalized optimization problem and use the extended Bayesian information criteria tuning method to select the regularization parameters since the number of parameters exceeds the sample size. Theoretical results are provided in terms of high breakdown point, full efficiency as well as outlier detection consistency. We illustrate our method with simulation and real data. Our method is extended to high-dimensional problems with dimension much larger than the sample size.