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Efficient penalised likelihood estimation for the Cox model

In this work we propose to use penalised likelihood to fit the Cox model. We first adopt an approximation such as discretization to the baseline hazard function, and then estimate this approximated baseline hazard and the regression coefficients simultaneously. A new iterative optimization algorithm, which combines the Newton's algorithm and a multiplicative iterative algorithm, is developed. This algorithm has two interesting properties: 1) it always increases the penalised likelihood ensuring fast convergence; 2) the baseline hazard is always positive. We show that, under independent censoring, the maximum penalised likelihood estimator is consistent, asymptotically normal, and retains full efficiency provided that the smoothing parameter tends to zero sufficiently fast. A simulation study reveals that this method can be more efficient than the partial likelihood, particularly for small to moderate samples. In addition, the new estimator is substantially less biased under informative censoring. The approach provides new insight on a critical care dataset.