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Rank-deficient and Ill-conditioned Nonlinear Least Squares Problems

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It is easy to construct models with nonlinearly dependent parameters, parameters to which the model is insensitive, or redundant parameters. When one uses conventional nonlinear least squares methods to solve these problems, the iteration can perform poorly. A common remedy for this is a combination of the Levenberg-Marquardt method and a truncated singular value decomposition. We will show how this approach is affected by ill-conditioning and errors in the evaluations of the residual and Jacobian. We show how subset selection can be applied to the Jacobian to diagnose problems of this type and improve the quality of the results. These results are motivated by applications to cardiovascular modeling.