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Title: On the iterative solution of systems of the form $A^TAx = A^Tb + c$

Abstract: Given a full column rank matrix $A \in R^{m\times n}$ $(m \geq n)$, we consider a special class of linear systems of the form $A^TAx = A^Tb + c$ with $x, c \in R^n$ and $b \in R^m$. The occurrence of c on the right-hand side of the equation prevents the direct application of standard methods for least squares problems. Hence, we investigate alternative solution methods that, as in the case of normal equations, take advantage of the peculiar structure of the system to avoid unstable computations, such as forming A^TA explicitly. We propose two iterative methods that are based on specific reformulations of the problem and we provide explicit closed formulas for the structured condition number related to each problem. These formula allow us to compute a more accurate estimate of the forward error than the standard one used for generic linear systems, that does not take into account the structure of the perturbations. We show the relevance of our estimates and the increased robustness and accuracy of the proposed methods compared to the standard conjugate gradient method.