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Preprocessing in Matlab inconsistent linear system for a meaningful least squares solution.

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Summary: Mathematical models of many physical/statistical problems are systems of linear equations. Due to measurement and possible human errors/mistakes in modeling/data, as well as due to certain assumptions to reduce complexity, inconsistency (contradiction) is injected into the model, viz. the linear system. While any inconsistent system irrespective of the degree of inconsistency has always a least-squares solution, one needs to check whether an equation i.e. an information is too much inconsistent or, equivalently, too much contradictory. Such an equation will affect/distort the least-squares solution to such an extent that it becomes unacceptable/unfit to be used in a real-world application. We propose an algorithm, in Matlab, which (i) can detect and prune numerically redundant linear equations from the system, if necessary, as these do not add any new information to a non-least-squares model, although they do have significant impact in a least-squares model, (ii) detects contradictory linear equations along with a degree of contradiction (inconsistency index) and then (iii) obtain the minimum norm least-squares solution of the acceptably inconsistent reduced (pruned) linear system as well as that of non-reduced linear system without too contradictory equations. The resulting two solution vectors will be different in general and have important implication in a real-world environment. The algorithms presented in Matlab may reduce the computational and storage complexities and also may improve the accuracy of the solution. These also detect and provide the necessary warning if there exists a highly contradictory equation in the model. In addition, we suggest a thorough relook into the mathematical modeling to determine the reason why unacceptable contradiction has occurred thus prompting one to make necessary corrections/modifications to the models – both mathematical and, if necessary, physical. We will focus here mainly on the non-over-determined linear systems rather than over-determined systems which are often usually the case in a least-squares problem.

Keywords: numerical examples; minimum-norm least-squares solution; non-over-determined systems; pruning; redundant linear equations; systems of linear equations; inconsistency; algorithm; over-determined systems