Least Squares Discretization and Preconditioning of Mixed Formulations

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We introduce a least squares method for discretizing boundary value problems written as mixed variational formulations. At the continuous level we assume a stability LBB condition and data compatibility. The proposed discretization method is associated with standard discretization of an equivalent saddle point reformulation of the original mixed system. Choices for the discrete spaces can be done such that a discrete $\inf - \sup$ condition is automatically satisfied. We choose a natural test spaces first and the corresponding trial spaces is chosen second by using the action of the continuous operator that defines the mixed method. The implementation of the proposed iterative process does not require nodal bases for the trial space. A natural preconditioning strategy based on the general theory of preconditioning symmetric problems and the standard approximation theory for symmetric saddle point problems is proposed. Applications of the method include discretizations of first order systems of parametric PDEs, such as the time-hamonic Maxwell equations and second order PDEs with variable coefficients or interface problems. This is joint work with Jacob Jacavage.