H2-Optimal Model Reduction Using Projected Nonlinear Least Squares

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In many applications throughout science and engineering, model reduction plays an important role replacing expensive large-scale linear dynamical systems by inexpensive reduced order models that capture key features of the original, full order model. One approach to model reduction is to find reduced order models that are locally optimal approximations in the H2 norm, an approach taken by the Iterative Rational Krylov Algorithm (IRKA) and several others. Here we introduce a new approach for H2-optimal model reduction using the projected nonlinear least squares framework. Each iteration projects the H2 optimization problem onto a finite-dimensional subspace yielding a weighted least rational approximation problem. Subsequent iterations append this subspace such that the least squares rational approximant asymptotically satisfies the first order necessary conditions of the original, H2 optimization problem. This enables us to build reduced order models with similar H2 error using far fewer evaluations of the full order model than IRKA, TF-IRKA, and QuadVF. Additionally our algorithm only requires access to the transfer function of the full order model, unlike IRKA which requires a state-space representation and TF-IRKA which requires both the transfer function and its derivative.