Balancing Transformations for Infinite-Dimensional Systems

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We consider model reduction by balanced truncation for infinite-dimensional linear systems. The goal is to apply balancing and truncation to $L^2$-well-posed linear system with a nuclear Hankel operator in order to obtain a finite dimensional system approximating the input-output behavior in the $H_\infty$ norm.

Our main result is that we explicitly construct pseudo-similarity transformations from factors of the gramians in analogy to the finite dimensional transformations in [3]. These possibly unbounded transformations can be applied to the generators $(A, B, C)$ of the system and yield a new well-posed system on $\ell_2$, which is balanced in the sense that its gramians are both equal to a diagonal operator on $\ell_2$. This also generalizes results on $\ell_2$ balanced realizations from [1] to a larger class of systems. Subsequently, a balanced realization may be truncated, making an error which is bounded by the Hankel singular values as recently proved by [2]. Moreover, we consider reduced transformations which yield the truncated system directly. It should be mentioned that we do not need any controllability or observability assumptions for our approach.

References


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