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Fast, matrix-free matrix-vector product with the Loewner matrix

The Loewner framework is one of the most successful data-driven model order reduction techniques.
Given k right interpolation data and h left interpolation data, the standard layout of this approach is composed of two stages.
First, the $kh \times kh$ Loewner matrix $\mathbb{L}$ and shifted Loewner matrix $\mathbb{L}_s$ are constructed. Then, an SVD of $\mathbb{L}_s - \gamma\mathbb{L}$, $\gamma \in \mathbb{C}$ belonging to one of the data sets, provides the projection matrices used to compute the sought reduced model.
These two steps become numerically challenging for large k and h in terms of both computational time and storage demand.
We show how the structure of $\mathbb{L}$ and $\mathbb{L}_s$ can be exploited to reduce the cost of performing $(\mathbb{L}_s - \gamma\mathbb{L})x$ while avoiding the explicit allocation of $\mathbb{L}$ and $\mathbb{L}_s$.

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