Interpolatory (P)MOR via low-rank (tensor) approximation in general linear matrix equations

J. Saak\textsuperscript{1} and H. Al Daas\textsuperscript{2}

\textsuperscript{1}Computation Methods in Systems and Control Theory, Max Planck Institute for Dynamics of Complex Technical Systems
\textsuperscript{2}Scientific Computing Department, STFC-Rutherford Appleton Laboratory

It is a well known fact that interpolation of the transfer function
\[ H(s) = C(sE - A)^{-1}B \] (1)
in certain points \( s_j = i\omega_j \in i\mathbb{R} \), in projection-based model order reduction, can be achieved via projection to rational Krylov subspaces \([1]\). Further it has been shown that the solutions \( X \) and \( Y \) of the Sylvester equations
\[ -AX + EXS = BL, \] (2)
\[ -A^TY + E^TYS = C^TL, \] (3)
with the spectrum of \( S \) equal to the set of all \( s_j \), span these exact Krylov subspaces, as long as none of the \( s_j \) is a pole of \( H \) and \((S, L)\) is controllable. It is a well observed fact that the low rank of the right hand sides often transfers to a low (numerical) rank of the solutions \( X \) and \( Y \). This is especially true when many interpolation points are used, i.e. \( S \) gets large. Our solvers aim to exploit this fact to automatically decide about the reduced orders after massive oversampling.

When \( H \) additionally depends on parameters, i.e. there are parameter dependencies in \( E, A, B \), or \( C \), we derive tensor versions of (2), (3) and suggest low-rank tensor solvers to compute the truncation matrices.

References