INdAM Workshop: Low-rank Structures and Numerical Methods in Matrix and Tensor Computations

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On the Numerical Solution of NonLocal Boundary Value Problems by Matrix Function Computations

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Given a matrix $A \in \mathbb{R}^{s\times s}$ and a vector $\mathbf{f} \in \mathbb{R}^{s}$, under mild assumptions the non-local boundary value problem
\begin{eqnarray}
&&\odv{\mathbf{u}}{\tau} = A \mathbf{u}, \quad 0<\tau<1, \label{l1} \\
&&\displaystyle \int_0^1 \mathbf{u}(\tau) \,\mathrm{d}\tau = \mathbf {f}, \label{l2}
\end{eqnarray}
admits as unique solution
\[
\mathbf{u}(\tau)= q(\tau,A) \mathbf {f}, \quad q(\tau,w)= \frac{w e^{w\tau}}{e^w -1}.
\]
This talk deals with efficient numerical methods for computing the action
of $q(\tau, A)$ on a vector, when A is a large and
sparse matrix. Methods based on the Fourier expansion of $q(\tau, w)$
are considered. First, we place
these methods in the classical framework of Krylov-Lanczos
(polynomial-rational) techniques for accelerating Fourier series.
This allows us to apply the convergence results developed in this
context to our function. Second, we design some new acceleration schemes for computing $q(\tau, A)\mathbf{f}$. Numerical results are presented to show the effectiveness of
the proposed algorithms.

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