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Computation of the matrix exponential via the dynamic solution

Let A be a square matrix with characteristic (or minimal) polynomial $w(x)$, of degree $n+1$. The dynamical solution $g(t)$ associated with w is the solution of the homogeneous differential equation $w(D)y(t)=0$ that has the initial values $D^k g(0)=0$ for $0 \leq k < n$ and $D^n g(0)=1$.

The matrix exponential is given by

$$e^{tA} = \sum_{k=0}^{n} D^k g(t) w_{n-k}(t),$$

where the w_j are the Horner polynomials associated with w. We explore some analytic and numerical aspects of the use of the above formula, and try to explain the sources of the main computational problems. Other functions of matrices can be computed by analogous formulas. See L. Verde-Star, *Functions of matrices*, Linear Alg. Appl. **406**(2005), 285–300.