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Alan Krinik* (ackrinik@cpp.edu), **Gerardo Rubino**, **Hubertus von Bremen**, **Jeremy J. Lin**, **Thuy Vu Dieu Lu**, **Mark Dela**, **David Perez**, **David Beecher** and **Weizhong Wong**.

Explicit expressions for M^k for $k = 2, 3, 4$, etc. and $\exp(Mt)$ for certain matrices M .

We are interested in explicit eigenvalue and eigenvector formulas for different families of matrices. In particular, we seek exact eigenvalue and eigenvector formulas that scale up as the dimension of our matrices, M , increase. For simplicity, we usually assume that our $n \times n$ matrices, M , have real entries and distinct eigenvalues. We seek exact expressions for M^k for $k = 2, 3, 4$, etc. and $\exp(Mt)$.

Our applications are mainly determining the probability of sample paths of Markov (or sub Markov) chains and processes under different conditions. This includes finding the transient probability distributions of certain types of Markov chains (or processes) and finding the solution of the generalized ballot box problem.

We start with tridiagonal, Toeplitz matrices and generalize to tridiagonal matrices having alternating entries along the sub and super diagonals. Using duality theory, we are able to extend our results to a family of non-tridiagonal $n \times n$ matrices having catastrophe-like matrix entries. Connections to nonnegative matrices are discussed as time allows. (Received September 14, 2020)