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Non-sparse Companion Matrices

Given a polynomial $p(z)$, a companion matrix can be thought of as a simple template for placing the coefficients of $p(z)$ in a matrix such that the characteristic polynomial of this matrix is $p(z)$. The Frobenius companion matrix and the more recently discovered Fiedler companion matrices are examples. Both the Frobenius and Fiedler companion matrices have the maximum possible number of zero entries, and in that sense are sparse. In this presentation we will discuss the Frobenius and Fiedler companion matrices and explore the question of finding non-sparse companion matrices with more nonzero entries. We will also give some bounds on the minimum number of zeros that must appear in a companion matrix.