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Power series expansions and realization theory for noncommutative rational functions around a matrix point

Abstract

A noncommutative rational function which is regular at 0 can be expanded into a noncommutative formal power series. In fact, by the results of Kleene, Schützenberger, and Fliess, a noncommutative formal power series is rational (i.e., belongs to the smallest subring containing the noncommutative polynomials and closed under the inversion of invertible power series) if and only if the corresponding Hankel matrix has finite rank, and the image of the Hankel matrix can be used to construct the unique minimal (equivalently, controllable and observable) state space realization of a noncommutative rational function which is regular at 0. We use the Taylor–Taylor expansion around an arbitrary matrix point coming from noncommutative function theory to generalize these results to noncommutative rational function regular at an arbitrary matrix point, covering thereby all noncommutative rational functions.

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