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On Legendre-Radau Quadrature Rule: Derivation via hypergeometric series and application

An n-point Legendre-Radau rule (LG-R) has a one-end fixed node and is widely used in applied problems. Its derivation, as mostly found in the literature, is either based on certain orthogonality condition or is directly related to the difference of two consecutive Legendre polynomials. On the other hand, LG-R is also retrieved from the Gauss Hypergeometric series (G-H Series). In this work, we analyze the structure of the coefficients of the nodal polynomials obtained from different approaches and establish their equivalence. The nodes and weights of the LG-R via G-H Series are simple to compute. We use them in finding numerical solution of a quadratic optimal control problem. The outcomes are compared with traditional methods. In addition, we discuss the role of LG-R nodes in economizing the degree of polynomial approximants.