Representations for the parameter derivatives of the classical orthogonal polynomials

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Rend. Circ. Mat. Palermo 68 (2002), Suppl.

Abstract

Let $\{P_k(x;\mathbf{c})\}$ be any sequence of the classical orthogonal polynomials, i.e.,

(i) "continuous" classical orthogonal polynomials, or

(ii) classical orthogonal polynomials of a discrete variable, or

(iii) q-classical orthogonal polynomials,

depending on a parameter vector $\mathbf{c} = [c_1, c_2, \ldots, c_p]$.

A general procedure is given to produce iteratively explicit parameter derivative representations of the form

$$\frac{\partial^r}{\partial c_i^r} P_n(x;\mathbf{c}) = \sum_{k=0}^{n} C_k^{(r)} P_k(x;\mathbf{c}) \qquad (r = 1, 2, \ldots),$$

for almost all the classical orthogonal polynomial families.