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New formulae for higher order derivatives and applications

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We present new formulae (The Slevinsky-Safouhi formulae I and II) for the analytical development of higher order derivatives. These formulae, which are analytic and exact, represent the k^{th} derivative as a discrete sum of only $k + 1$ terms. Involved in the expression for the k^{th} derivative are coefficients of the terms in the summation. These coefficients can be computed recursively and they are not subject to any computational instability. As examples of applications, we develop higher order derivatives of Legendre functions, Chebyshev polynomials of the first kind, Hermite functions and Bessel functions. Numerically speaking, the analytical development of new formulae is *critical*. We give numerical examples where Maple is unable to produce results effectively.