

The adjoint equation method for constructing first integrals of difference equations

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A new method for finding first integrals of discrete equations is presented. It can be used for discrete equations which do not possess a variational (Lagrangian or Hamiltonian) formulation. The method is based on a newly established identity which links symmetries of the underlying discrete equations, solutions of the discrete adjoint equations and first integrals. The method can be applied to invariant mappings (discrete equations) and to discretizations of ordinary differential equations. If a sufficient number of first integrals can be obtained, it is possible to find the general solution of the discrete equations.

[1] Winternitz P, Dorodnitsyn V, Kaptsov E and Kozlov R, First integrals of difference equations which do not possess a variational formulation, *Doklady Math.* **89** (2014), 106–109.

[2] Dorodnitsyn V, Kaptsov E, Kozlov R and Winternitz P, The adjoint equation method for constructing first integrals of difference equations, *J. Phys. A: Math. Theor.* **48** (2015), 055202