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On Darboux Integrable Semi-Discrete Chains

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Differential-difference equation $\frac{d}{dx}t(n+1,x)=f(x,t(n,x),t(n+1,x),\frac{d}{dx}t(n,x))$ with unknown $t(n,x)$ depending on continuous and discrete variables x and n is studied. We call an equation of such kind Darboux integrable, if there exist two functions F and I of a finite number of arguments n, x, $\{t(n+ k,x)\}_{k=-\infty}^\infty$, ${\frac{d^k}{dx^k}t(n,x)}_{k=1}^\infty$, such that $D_xF=0$ and $DI=I$, where D_x is the operator of total differentiation with respect to x, and D is the shift operator: $Dp(n)=p(n+1)$. It is proved that the chain is Darboux integrable if and only if its characteristic Lie algebras in both directions are of finite dimension. Structure of the integrals is described. Numerous examples of Darboux integrable chains are given together with their integrals and characteristic Lie algebras.

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