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Partial difference equations arising in numerical schemes and game theory

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Abstract

A functional analytic method is used to prove that some linear and non-linear partial difference equations of two, three and four variables, which arise in numerical schemes and game theory, have a unique solution in the spaces $l^2_{\mathbb{N}^2}$ or $l^1_{\mathbb{N}^2}$, $l^1_{\mathbb{N}^3}$ and $l^1_{\mathbb{N}^4}$, respectively. In the case of non-linear difference equations a region, which depends on the initial conditions and the parameters of the equation, where the solution holds, is given. For both linear and non-linear difference equations a bound of the solution is determined.

Keywords: Partial difference equations; Bounded solutions

1. Introduction

In this paper, we study various linear and non-linear partial difference equations of two, three and four variables, which arise in numerical schemes and game theory. Our aim is to prove that the corresponding linear equations have a unique solution in the Hilbert spaces:

$$l^2_{\mathbb{N}^p_{I_p}} = \left\{ u(i_1,\ldots,i_p) : \mathbb{N}^p_{I_p} \to \mathbb{C} / \underbrace{\sum_{i_1=1}^{I_1} \cdots \sum_{i_p=1}^{I_p}}_{p} |u(i_1,\ldots,i_p)|^2 < +\infty \right\}$$

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