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Numerical solution of Heun equation via linear stochastic differential equation

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Abstract
In this paper, the numerical approach of the following Stochastic differential equation which is named "Heun equation", will be represented.

$$\begin{cases} y'' + (\alpha + \frac{\beta+1}{x} + \frac{\gamma+1}{x-1})y' + (\frac{\mu}{x} + \frac{\nu}{x-1})y = \xi, \\ y(0) = y_0, \;\; y'(0) = y_1. \end{cases}$$

such that $\alpha, \beta, \gamma, \mu, \nu$ and ξ, could be coefficients of Gaussian random numbers which is named wiener process. Making linear equations system from this equation, it could be solved by computing fundamental matrix of this system, with different methods. Finally, this stochastic equation is solved by numerical methods like E.M. and Milstein. Also its asymptotic stability and statistical concepts like expectation and variance of solutions are discussed.

Keywords and phrases: Heun Equation, Stochastic Differential Equation, Linear Equations System, Gaussian Random Numbers.

1. Introduction

Most of the known theoretical physics in nowadays is being involved in using a number of differential equations (O.D.E.or P.D.E.) in different orders [1, 2, 5, 6, 7]. If we intend to study just linear systems, various forms of the hypergeometric or the confluent and integrated hypergeometric equations often suffice to describe and identify this problem. In general case, these equations have power series solutions with simple relations between uninterrupted coefficients and can be generally represented in terms of simple integral transforms. In the case of nonlinear problem, we often utilize one form of the Painleve