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Numerical solution of linear stochastic differential equations driven by Brownian bridg motion through the block pulse functions

Z. Sadati*
Department of Mathematics, khomein Branch, Islamic Azad University, khomein, Iran
E-mail: z-sadati@iaukhomein.ac.ir

Abstract
This article is proposed a method for solving the stochastic differential equation driven Brownian Bridge motion by using stochastic operational matrix based on the block pulse functions and the collocation method. Finally, numerical result state by using some examples.
Keywords: Block pulse function; Brownian bridge motion; stochastic differential equation.

Keywords and phrases: Block pulse functions; Backward stochastic differential equations.

1. Introduction

The Brownian Bridge (or pinned Brownian motion) is a martingale, also it is Gaussian process. In process have many applications in mathematical finance, biology, medical, social, scienes, etc (see [1], [2]).
In this artical, we consider the stochastic differential equation

$$dX(s) = \frac{b - X(s)}{T - s} ds + dB(s).$$

or

$$X(t) = X_0 + \int_0^t \frac{b - X(s)}{T - s} ds + \int_0^t dB(s) \qquad 0 \le t < T. \tag{1.1}$$

where $X_0 = a$ and $X(T) = b$ and $B(s)$ is the Brownian Bridge.
This paper is organized as follows. In section 2, is described the basic properties of the block pulse functions and functions approximation by using block pulse functions. Then, It is introduced the concept of the stochastic integration operational matrix. In section 3, Eq. (1) is solved by using the stochastic integration operational matrix and collocation method. In section 4, The proposed method is tested with an example. Finally, in Section 5, is given a brief conclusion.

2. Preliminaries

BPFs have been studied by many authors and applied for solving the different problems, for example [5]. The goal of this section is to recall the notations and definition of the block pulse functions, state some known results, and derive the useful formulas that are important for this paper. These have been thoroughly discussed in [3, 4, 5].