Application of Stochastic Differential Games for Optimal Investment Strategy Selection

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Abstract:

In game theory, differential games are a group of problems related to the modeling and analysis of conflict in the context of a dynamical system. The problem usually consists of two actors, a pursuer and an evader, with conflicting goals. The dynamics of the pursuer and the evader are modeled by systems of differential equations. Differential games are related closely with optimal control problems. In an optimal control problem there is single control u(t) and a single criterion to be optimized; differential game theory generalizes this to two controls u(t), v(t) and two criteria, one for each player. Each player attempts to control the state of the system so as to achieve his goal; the system responds to the inputs of both players.
In this paper, a stochastic differential equation, approach to a risk-based, optimal investment problem of an insurer is discussed. A simplified continuous-time economy with two investment vehicles, namely, a fixed interest security and a share, is considered. The insurer's risk process is modeled by a diffusion approximation to a compound Poisson risk process. The goal of the insurer is to select an optimal portfolio so as to minimize the risk described by a convex risk measure of his/her terminal wealth. The optimal investment problem is then formulated as a zero-sum stochastic differential game between the insurer and the market.

Keywords: Optimal investment, Stochastic differential equation, Zero-sum stochastic differential game.

1. Introduction

Stochastic control has its wide applications in manufacturing, communication theory, signal processing, and wireless networks; see for example Kushner and Dupuis (2001), Fleming and Soner (2006) and references therein. On the other hand, zero-sum stochastic differential games, as the theory of two controller, extends the control theory into more realistic problems. Many problems arising in, for example, pursuit evasion games, queueing systems in heavy traffic, risk sensitive control, and constrained optimization problems, can be formulated as two-player stochastic differential games.