

A REVIEW OF CONDITIONAL RARE EVENT SIMULATION FOR TAIL PROBABILITIES OF HEAVY TAILED RANDOM VARIABLES

LEONARDO ROJAS-NANDAYAPA

ABSTRACT. Approximating the tail probability of a sum of heavy-tailed random variables is a difficult problem. In this review we exhibit the challenges of approximating such probabilities and concentrate on a rare event simulation methodology capable of delivering the most reliable results: Conditional Monte Carlo. To provide a better flavor of this topic we further specialize on two algorithms which were specifically designed for tackling this problem: the Asmussen-Binswanger estimator and the Asmussen-Kroese estimator. We extend the applicability of these estimators to the non-independent case and prove their efficiencies.

1. Introduction

The term *rare event* is used to designate all those events whose probabilities are small, yet non-negligible and characterized by the difficulty of its calculation. Often, these rare events are extremely important in applications; for instance, consider the consequences of a natural disaster for an insurance company, or an economic crisis for a financial institution or the sudden arrival of huge number of jobs to a server as it often occurs in a web server. Many of the probability models employed for dealing with these problems contain multiple random variables (not necessarily independent) and the quantities of interest are given in terms of transformations such as sums, products or extremes. In consequence, the explicit calculation of a distribution of interest is often non-trivial and one must rely on approximation methods. Among these, the Monte Carlo method is considered to be one the most reliable, specially in cases where analytical approximations are not available.

In this review we mainly focus on the Monte Carlo method for approximating rare event probabilities, but we also discuss asymptotic approximations; the reason for this is that the implementation of efficient Monte Carlo estimators often requires to draw elements from asymptotic theory. In particular, we specialize on tail probabilities of a sum of random variables

$$P(S_n > x), \quad x \rightarrow \infty.$$

When the involved random variables are light tailed, the approximation of such probabilities is dealt via Large Deviations theory. Notwithstanding, certain phenomena are better modeled with heavy-tailed distributions. However, the approximation of rare event probabilities in the presence of heavy tails is often more involved and it has been considered a challenging problem among the applied

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Rare Event Simulation In Models With Heavytailed Random Variables

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Table of Contents Rare Event Simulation In Models With Heavytailed Random Variables

1. Understanding the eBook Rare Event Simulation In Models With Heavytailed Random Variables
 - The Rise of Digital Reading Rare Event Simulation In Models With Heavytailed Random Variables
 - Advantages of eBooks Over Traditional Books
2. Identifying Rare Event Simulation In Models With Heavytailed Random Variables
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Rare Event Simulation In Models With Heavytailed Random Variables
 - User-Friendly Interface
4. Exploring eBook Recommendations from Rare Event Simulation In Models With Heavytailed Random Variables
 - Personalized Recommendations
 - Rare Event Simulation In Models With Heavytailed Random Variables User Reviews and Ratings
 - Rare Event Simulation In Models With Heavytailed Random Variables and Bestseller Lists
5. Accessing Rare Event Simulation In Models With Heavytailed Random Variables Free and Paid eBooks
 - Rare Event Simulation In Models With Heavytailed Random Variables Public Domain eBooks
 - Rare Event Simulation In Models With Heavytailed Random Variables eBook Subscription Services
 - Rare Event Simulation In Models With Heavytailed Random Variables Budget-Friendly Options
6. Navigating Rare Event Simulation In Models With Heavytailed Random Variables eBook Formats

- ePub, PDF, MOBI, and More
 - Rare Event Simulation In Models With Heavytailed Random Variables Compatibility with Devices
 - Rare Event Simulation In Models With Heavytailed Random Variables Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Rare Event Simulation In Models With Heavytailed Random Variables
 - Highlighting and Note-Taking Rare Event Simulation In Models With Heavytailed Random Variables
 - Interactive Elements Rare Event Simulation In Models With Heavytailed Random Variables
 8. Staying Engaged with Rare Event Simulation In Models With Heavytailed Random Variables
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Rare Event Simulation In Models With Heavytailed Random Variables
 9. Balancing eBooks and Physical Books Rare Event Simulation In Models With Heavytailed Random Variables
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Rare Event Simulation In Models With Heavytailed Random Variables
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Rare Event Simulation In Models With Heavytailed Random Variables
 - Setting Reading Goals Rare Event Simulation In Models With Heavytailed Random Variables
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Rare Event Simulation In Models With Heavytailed Random Variables
 - Fact-Checking eBook Content of Rare Event Simulation In Models With Heavytailed Random Variables
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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