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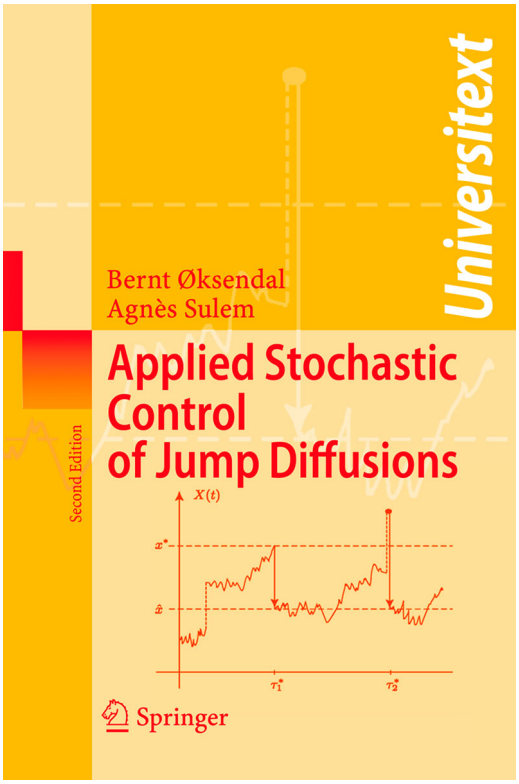
Book review



Applied Stochastic Control of Jump Diffusions, by Bernt Øksendal and Agnès Sulem, Springer (2019). E-Book. ISBN 978-3-030-02781-0.

During my PhD studies, the first edition of *Applied Stochastic Control of Jump Diffusions* by Bernt Øksendal and Agnès Sulem never strayed far from my hands. The reason is simple. When it was first published in 2004, *Applied Stochastic Control of Jump Diffusions* was at the cutting edge. In just over 200 pages, this book presented a clear, up-to-date and consistent treatment of the novel and fast-growing field of optimal stochastic control problems for jump-diffusion processes. Optimal stochastic control addresses problems in which one needs to steer a noisy dynamical system to optimize the performance of that system. The noisy dynamical system, typically a portfolio in financial applications or a profit stream in economics, is modelled using a controlled stochastic process. Here, 'controlled' refers to the control embedded in the stochastic process to steer its trajectory. In *Applied Stochastic Control of Jump Diffusions*, the controlled stochastic process is a jump-diffusion process.

The third edition of *Applied Stochastic Control of Jump Diffusions* comes a full twelve years after the second. It proposes a fully updated, and greatly expanded, treatment that reflects recent advances. However, this new, 440 page-long edition, has not lost the razor-sharp focus or clarity of exposition of its predecessors. Just like its predecessors, it also focuses squarely on stochastic calculus to solve stochastic control problems. Therefore, readers should be familiar with stochastic calculus at least at the level of Øksendal (2003). They should also possess a working knowledge of jump-diffusion processes, for example, from Sato (1999), Protter (2005), or Applebaum (2004).

The book begins with a clear and useful review of stochastic calculus for Lévy processes. The second chapter outlines applications of jump-diffusion processes to financial markets, such as hedging and option pricing. Then, the book proceeds with a discussion of optimal stopping in Chapter 3. Backward stochastic differential equations and applications to risk measures are presented next, in Chapter 4. Together, these four

chapters establish the foundations of the ideas and techniques developed in the rest of the book.

Chapter 5 presents stochastic control from both the classical Markovian perspective of dynamic programming and from a non-Markovian standpoint, via a stochastic maximum principle. The chapter also discusses the optimal control of forward-backward stochastic differential equations as well as applications stochastic delay equations. Next, the authors discuss stochastic differential games and mean-field games in Chapter 6. These two chapters are the longest and most detailed. They form the theoretical core of the book.

Later chapters discuss an array of advanced or specialized topics: combining optimal stopping and optimal control (Chapter 7), singular control (Chapter 8), impulse control (Chapters 9 to 11), viscosity solutions (Chapter 12), and stochastic partial differential equations and noisy observations (Chapter 13). These chapters are short, clear and to-the-point. They ideally focus the reader's attention on the main results and their applications.

Overall, *Applied Stochastic Control of Jump Diffusions* is an excellent textbook and a remarkable achievement. The authors strike a brilliant balance between depth and breadth, theory and application. The writing style is clear and engaging, and the chapters are short and focused. This makes it easier for readers to follow the flow of ideas, understand results, and grasp how these play out in applications.

Applications are at the heart of the book, as the title appropriately suggests. All the chapters illustrate the main theoretical results with applications to actual problems, mostly in finance and economics. Complex ideas are introduced intuitively, often with motivating examples. Additionally, each chapter concludes with a set of well-written exercises. Chapter 14 also includes solutions to selected exercises, which will appeal to readers using the book for self-study.

While the book will undeniably appeal to new readers, those already familiar with a previous edition will also benefit from it upgrading. The authors have made several worthwhile improvements. In addition to expanding their coverage of core stochastic control theory significantly, the authors added an impressive range of new topics. For instance, this new edition adds backward stochastic differential equations, stochastic differential games, mean-field games, and stochastic partial differential equations.

To conclude, *Applied Stochastic Control of Jump Diffusions* is an essential reference for researchers in optimal stochastic control. It will also appeal to anyone with a good command of stochastic calculus and an interest in potential applications of jump-diffusion processes.

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