Preface

Optimal control theory in infinite horizon and discrete time offers a setting which is used in a lot of problems from various scientific fields: economics, management, sustainable development of fisheries and of forests, biology, and medicine. The theory of differential equations is not well known by all specialists of scientific fields, except mathematicians and physicists, whereas understanding the meaning of the equations of a discrete-time dynamical system does not necessitate sophisticated mathematical tools. So, in our opinion, discrete-time models can simplify the communication between mathematicians and researchers of other scientific fields. This opinion is not against the continuous-time models. When both discrete-time modeling and continuous-time modeling of the same phenomenon exist, the comparison between their respective results can provide interesting consequences.

In finite-horizon continuous-time optimal control theory, two main historical approaches exist: Pontryagin's approach and Bellman's approach. In infinite-horizon discrete-time optimal control problems, the dynamic programming of Bellman is currently used. In this book, we want to present in a mathematically rigorous way a treatment of Pontryagin's viewpoint for infinite-horizon discrete-time optimal control problems.

Pontryagin's viewpoint provides necessary conditions of optimality which are laws that the optimal solutions ought to satisfy, and these laws possess a meaning in the considered phenomenon. Moreover the role of necessary conditions of optimality is to narrow the set of all processes which are candidates to be solutions of the problem, and this can also improve the modeling. In some cases, it is also possible to formulate sufficient conditions of optimality in the spirit of the conditions initiated by Seierstad and Sydsaeter for the continuous-time problems.

In the first two chapters, we use an approach of reduction to finite horizon which consists of associating to an infinite-horizon problem a family of finite-horizon problems. In the third chapter, we use another approach for the bounded-process problems, which is based on nonlinear functional analysis in Banach spaces.

In Chap. 1, we present the problems and we give the tools of the finite-horizon case which can be translated into static optimization. We use various multiplier rules that are presented in Appendix B. In Chap. 2, we give necessary conditions theorems for infinite-horizon optimal control problems, under the form of weak or strong Pontryagin principles. We also study problems under constraints and multiobjective optimal control problems. The special case of the bounded processes is treated in Chap. 3, where necessary conditions and sufficient conditions of optimality are given. In Appendix A, we give some elements concerning sequences and sequence spaces, and in Appendix B, we provide many static optimization theorems which are essential for our approaches.

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