Chapter 15
Optimization Models for Calculation of Personalized Strategies

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ABSTRACT

The chapter considers the problem of calculating the best individual strategy based on models obtained from observations of a given sample object's reaction to the applied control actions. In order to improve the calculation efficiency, the construction of the optimization problem with line dependence on the control variables is offered. To ensure the calculation adequacy, the object state models of optimal complexity, nonlinear with respect to the initial conditions and parameters, are considered. Examples of optimal personalized treatment strategies calculation are given. The proposed approach can be extended to other practical areas to solve the decision making, provided the development of adequate the object state models in the optimization field.

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INTRODUCTION

Optimizing the dynamics of social and organizational processes is quite a challenge and is a multi-step procedure. There are a stage of process identification (Kiparissides, Koutinas, Kontoravdi, Mantalaris & Pistikopoulos, 2011), a stage of constructing an area in which control actions take place (Cevikalp, Larlus, Neamtu, Triggs & Jurie, 2010), and finally, the most important stage is the formation of a goal and optimization criteria (Jakob & Blume, 2014). Then you should construct an optimization problem and find effective means of solving it (Crown et al., 2017). However, the solving the original problem process also requires optimization since the problems successful solution of individual stages (except the last) does not guarantee the problem effective solution as a whole. For a successfully formalized dynamic optimization problem with adequate process and optimization domain models, there may simply not exist an effective solution tool. Therefore, it is desirable to simplify the problem representation at each stage of the solution search in order to obtain a sufficiently effective tool in terms of the calculation procedure. Following the above in the task below, the dynamic essence of the optimization problem is simplified to the maximum extent. This led the problem formulation to a single management stage: the input state of the object with the applied control action - the output state of an object. Simplified, this is a one-step optimization task "in" - "out". Since the above representation assumes the Markov property possession during the object transition from state to state, the problem has a good prospect for generalization to n control stages. Then, to solve a multi- stage optimization problem, it is possible to apply dynamic programming. The controlled object structural identification of state equations should also strive to obtain the most simple structures (or structures of optimal complexity). If simple with respect to control variables (for example, linear) equations of the object state can be obtained, then effective computational procedures can be applied to solve the optimization problem. The authors tried to follow the above principles in solving the delivered problem - the calculation of the optimal individual impact strategies according to the monitoring data or the active experiment on objects from a given sample. The considered approach to the formalization of the calculation is illustrated by examples of obtaining optimal personalized treatment strategies for patients undergoing coronary artery bypass grafting.

BACKGROUND

Almost any formalized problem can be assigned to one of the three problem classes: design, control, and modeling. And each of these tasks is always dominated by the requirement to solve it in the best way within a definition given area. It would seem that any practical task would have to be formulated and solved as a kind of optimization problem. However, now the optimization statements in the problems of decision making or control actions calculation are usually used only in case when the constraints and the object state models can be obtained analytically. Researchers often avoid statistical estimates of parameters or statistical models due to the introduction of uncertainty related to the modeling error. Nevertheless, the use of stochastic programming methods, the creation of statistical models with an appropriate level of adequacy in the problem variables study area allows us to count on obtaining solutions suitable, at least for expert evaluation of specialists and application in practice. However, the first report of the ISPOR dedicated to best practices in

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