Mathematical Problems in Engineering

Hindawi

Special Issue on

Bilevel Optimal Control, Equilibrium, and Combinatorial Problems with Applications to Engineering

CALL FOR PAPERS

In recent years, a large literature on bilevel programming in finite-dimensional spaces has emerged, much of it focusing on optimality conditions, theory, and algorithms associated with certain classes of such problems. The topic proposed to treat in this special issue goes one step further in attempting to deal with bilevel programming problems extended to infinite-dimensional spaces at the upper level, at the lower level, and at both. Such classes of optimal control problems often arise in engineering applications: robotics, water and waste control problems, ecology in various environments, and so forth.

Bilevel optimal control problems are a special class of optimization problems combining Bilevel Programming Programs and optimal control theory. These problems are a generalization of the optimal control problems in cases with more than one decision maker. However, this new type of problem is much more complicated than optimal control problems in the sense that it is no longer obvious what constitutes a solution, for example, in the particular case of optimistic/pessimistic Stackelberg differential games. A lot of new ideas and approaches have been developed in this area by the outstanding researchers throughout the world (S. Dempe, B. Mordukhovich, M. Labbé, P. Marcotte, among others).

A general formulation for bilevel optimal control problems includes an optimal control problem in both levels, commonly linked with the dynamical system. Nevertheless, other less investigated problems in this field of research can be treated. Hence, this special issue also invites contributions dealing with a special class of optimistic bilevel optimal control problems where only the upper level possesses an optimal control problem whereas the lower level is a finite-dimensional problem whose parameter is the final state of the upper level state function. Recall that the optimistic approach models a cooperative behavior of leader and follower while the pessimistic one depicts a competitive situation. Thus, various optimality conditions can be derived by replacing the lower level problem by either its primal-dual optimality conditions or its optimal value function.

Although a wide range of applications fit the bilevel optimal control framework, real-life implementations are scarce, due mainly to the lack of efficient algorithms for tackling medium- and large-scale bilevel programming problems to which the bilevel optimal control problems are often reduced. Solving a bilevel (more generally, hierarchical) optimization problem, even in its simplest form, is a difficult task. A lot of different alternative methods may be used based on the structure of the problem analyzed, but there is no general method that guarantees convergence, performance, or optimality for every type of problem.

Mixed-integer bilevel programming problems (with part of variables at the upper and/or lower level being integer/Boolean ones) are even harder for the well-known conventional optimization techniques. For instance, a usual replacement of the lower level optimization problem with a corresponding KKT condition may not work if some lower level variables are not continuous. Therefore, the solid theoretical base including elements of combinatorial methods is necessary to be found, in order to propose efficient algorithmic procedures aimed at finding local or global solutions of such a problem.

Last but not least, many new applied problems in the area of energy networks have recently arisen that can be efficiently solved only as mixed-integer bilevel optimal control programs. Among them are the natural gas cash-out problem, the deregulated electricity market equilibrium problem, biofuel problems, a problem of designing coupled energy carrier networks, waste water control problems, and so forth, if we mention only part of such applications. Bilevel models to describe migration processes are also in the running of the most popular new themes in the area of bilevel programming.

Engineering applications of bilevel optimization and combinatorial problems also include facility location, environmental regulation, energy and agricultural policies, hazardous materials management, and optimal designs for chemical and biotechnological processes.

The primary purpose of the special issue is to discuss these problems with the researchers working in this and in adjacent areas. The people interested in this field are cordially invited to contribute to this volume.

Potential topics include but are not limited to the following:

- Fundamentals of variational inequality theory, bilevel optimal control, and combinatorial optimization
- Conjectural variations equilibrium (CVE) and its applications to decision processes
- Bilevel optimal control problems and their reduction to single-level ones
- Heuristics solving bilevel programming problems
- Equilibrium in models of classical and mixed oligopoly: existence and uniqueness results
- Combinatorial problems and the coding theory
- Generalized positional calculus systems: descriptions and applications in specialized digital devices
- Methods and algorithms for the information coding and compression

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Papers are published upon acceptance, regardless of the Special Issue publication date.

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