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STHEORETICAL ADVANCES IN BILEVEL OPTIMIZATION: REFORMULATIONS, STATIONARITY, AND OPTIMALITY CONDITIONS

Abstract:

This thesis is devoted to the study of bilevel optimization problems, specifically focusing on the derivation of optimality conditions in various contexts using different approaches and reformulations. After introducing the problem under consideration and its different forms, we begin by deriving primal and dual second-order necessary optimality conditions for both smooth and non-smooth data. This is accomplished by using two different reformulations of the hierarchical model to transform it into a single-level problem: the lower-level value function reformulation and the Ψ -reformulation.

Subsequently, we explore the KKT reformulation and derive second-order necessary optimality conditions for local solutions to bilevel programs. First, we treat the reformulated problem as a standard nonlinear programming (NLP) problem and establish optimality conditions within the framework of recently developed constraint qualifications for NLPs. Next, we consider the KKT reformulation of the original bilevel problem as a mathematical program with equilibrium constraints (MPEC). Specifically, we present three types of second-order necessary optimality conditions of this structure, based on Clarke, Mordukhovich, and strong stationarity concepts.

Finally, we consider a more general problem called bilevel programs with variational inequality, for which we derive first- and second-order optimality conditions without assuming any smoothness regularity or constraint qualifications. This is done for two reformulations of our bilevel problem: the KKT reformulation and the gap function reformulation, while highlighting the advantages of each approach.

Key Words : Bilevel optimization; Value function; Set-valued mappings; KKT reformulation; Optimality conditions; MPEC structure; NLP structure; Stationarity; Variational inequality; Approximations; Subdifferentials