**Extensions of robust optimization methodology with applications to the optimization problems in telecommunication and logistics = 강건 최적화 기법의 확장과 통신 및 물류 최적화 문제에 대한 응용**

Robust optimization has been successfully applied to optimization problems subject to data uncertainty over the last decade, due to its computational attractiveness as well as the modeling power. The aim of this thesis is to enhance the applicability of robust optimization methodology to a broad range of situations occuring in real world applications. Specifically, this research contributes to the field of robust optimization by: 1. Proposing a new uncertainty set model that has a more flexibility on describing uncertain data than is possible using the traditional interval uncertainty set model and showing its applicability to various kinds of optimization problems; 2. Presenting an efficient algorithm to solve the robust optimization problem that is a large-scale mixed-integer programming problem in practice; 3. Incorporating robust optimization into stochastic programming framework to deal with the situation arising when the insufficient information of probability distributions of uncertain data is available. First, we present a robust optimization model with a generalized interval uncertainty set which enables practitioners to obtain a more elaborate description of uncertain data than is possible using the traditional interval uncertainty set of Bertsimas and Sim. In this uncertainty set, we allow for several choices of deviation for each coefficient, whereas the traditional uncertainty set allows only maximum deviation. We also show that in some cases the robust problem preserves the tractability of the original problem and present a cut generation approach for the other cases. Our robust optimization model is applied to the dynamic facility location problem under the condition of demand uncertainty. Computational results on randomly generated instances demonstrate that the proposed robust optimization approach can successfully handle the uncertainty of the data. Next, we consider the bandwidth packing problem which selects calls from a given set and assigns single path to each selected call in a network subject to demand uncertainty. To obtain solutions that are insensitive to this uncertainty, we propose a robust optimization approach. In this approach, the robust problem formulation becomes a large-scale mixed integer programming problem which may not be solved directly. Therefore, we apply the Dantzig-Wolfe decomposition and propose the branch-and-price procedure to find optimal solution. Moreover, in order to solve the relatively large-sized problems in a reasonable time, we propose a column generation acceleration scheme which is based on aggregation of variables. Computational results on cases of randomly generated networks demonstrate that the robust solutions are attractive when the demands are uncertain and our branch-and-price algorithm significantly outperforms the general integer programming solver. Further, we consider queueing delays in the network, which may cause in a deterioration in the quality of service to users if they exceed the acceptable limits. The integer programming formulation for the bandwidth packing problem with the queueing delay restriction contains a nonlinear constraint that is intrinsic to the model. We apply the Dantzig-Wolfe decomposition to this nonlinear constraint, and since the Dantzig-Wolfe decomposition has exponentially many variables, we propose the branch-and-price procedure to find optimal solutions. We also propose a generalized Dantzig-Wolfe reformulation based on the aggregation of variables, which makes our branch-and-price algorithm more competitive. Computational results on cases of randomly generated networks and some real-life telecommunication networks demonstrate that our algorithm performs well for large networks. Next, we study a robust knapsack problem under the generalized interval uncertainty set. We show that this problem can be solved by solving several ordinary knapsack problems repeatedly, and therefore it enables us to solve the problem of practical size in almost real-time. We present two applications that can benefit from this property of fast computation. First, we show that our robust knapsack problem can quickly produce a good approximate solution for a certain class of chance-constrained knapsack problem. Second, we apply our robust knapsack problem to a column generation subproblem of the branch-and-price algorithm for solving the robust bandwidth packing problem and show that the fast algorithm for the robust knapsack problem makes the branch-and-price algorithm computationally attractive. Lastly, we consider a vehicle routing problems on a network with stochastic travel times, where a penalty for each vehicle is incurred in excess of a given time limit. Traditional stochastic programming approach would require a precise knowledge of the underlying probability distributions of the random data. However, such precise knowledge is rarely available in practice, and a solution obtained from wrong inputs might show poor performance when implemented. In our approach, we assume that we have only rough information of future travel times; in particular, range forecasts of travel times and the probabilities of each range being realized are available in advance. In this setting, we replace point estimates of travel times on a scenario by range estimates of them. Then, for each scenario we find a robust route that protects the solution against the worst case within the given ranges, and finally we find the route that has minimum cost in a stochastic sense. Therefore our approach incorporates robust optimization technique into stochastic programming framework. We propose a branch-and-cut algorithm to solve the problem and report computational results on the well-known Solomon`s instances, which shows our approach is favorable when the exact information of probability distributions is not available.