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FACHBEREICH MATHEMATIK

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Referee Report on

Incomplete Information in Stochastic Programming Problems

Doctoral Thesis by Jana Čerbáková

In stochastic programming, it is often tacitly assumed that the probability distributions underlying the models are perfectly known. In practice, however, this assumption hardly can be maintained. Rather, there is only limited qualitative and quantitative information, from where the modeler derives "the" distribution.
This given, researchers spend efforts to study with mathematical rigour incomplete information on underlying probability distributions in stochastic programming.
The present thesis contributes to this line of research. The author establishes important original results on theoretical underpinning and numerical treatment of stochastic programming models under incomplete information.

Altogether, the thesis is comprised of seven chapters and a bibliography. The first two chapters provide an introduction and mathematical prerequisites for the subsequent investigations.
Chapter 3 deals with stability of Bayes actions. General stability results due to Römisch and Salinetti are used to (a) derive new improved error bounds for optimal values and optimal solutions in the context of Bayes decision analysis, and to (b) analyse the behaviour of these bounds in case of weak convergence of probability measures.

Chapters 4-6 deal with the minimax approach, the underlying idea of which is to optimize over worst cases with respect to sets of probability measures. In the thesis, these sets are given by either moment conditions or consistency with special types of qualitative information.
In Chapter 4, concepts of worst-case Value-at-Risk and worst-case Conditional Value-at-Risk are studied,

where probability sets are given by moment conditions. The author puts into perspective recent results of Popescu, and extends and corrects some of them. In particular, as a new result, the worst-case Conditional Value-at-Risk is computed for symmetric probability distributions with given first two moments. A corresponding result concerns the Value-at-Risk and symmetric, unimodal distributions, where the author corrects a previous proof by Popescu.
Chapters 5 and 6 are devoted to extensions of L-shaped and nested decomposition to minimax two- and multi-stage stochastic programs, respectively. Probability sets are given by consistency with special types of qualitative information. In my opinion, these chapters contain the most important creative results of the thesis. The author presents a skillful analysis of relevant cutting planes leading to substantial extensions of the counterparts to the mentioned decomposition methods under complete information. In particular for the multi-stage case this analysis is technically quite demanding. The presentation of the results, inspired by the treatment of the complete-information counterparts in the textbook of Kall and Mayer, is very clear. The numerical illustration provides convincing indication of the potential behind the new algorithms.

The present thesis proves the author's ability for creative scientific work. Highlights in this respect are the algorithms developed in Chapters 5 and 6. The original structural results in Chapters 3 and 4 contribute to this judgement, too. In particular, they prove the authors competence regarding underlying and related theory.
The thesis is written in a clear and logic style. Investigations are well-motivated, and original contributions are marked clearly. The relevant research literature is covered appropriately. Linguistically, the text would need some polishing, although the basic understanding of the development of ideas is always possible. Some author names are mis-spelled in the bibliography (Frauendorfer, Gaivoronski, Rogosinski), reference [27] has appeared in the SIAM Journal on Optimization.

It is my pleasure to recommend acceptance of the doctoral thesis to the Faculty of Mathematics and Physics of the Charles University in Prague.

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