Data Envelopment Analysis without Linear Programming and an Application of DEA in Radiation Oncology

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Abstract

Data envelopment analysis (DEA) is a very popular parameter free method for performance measurement of decision making units. Based on linear programming (LP), DEA is closely related to multi-objective linear programming (MOLP) in the sense that efficient decision making units represent efficient solutions of an MOLP problem. We exploit this relationship and apply the primal and dual variants of Benson's outer approximation algorithm for MOLP as presented in Ehrgott et al. (2012) in order to solve DEA problems. We show that many of the LPs that need to be solved in these algorithms reduce to trivial problems of finding the minima of finite sets when applied to DEA. The geometric duality of multi-objective linear programming furthermore allows us to identify all efficient DMUs without solving a linear programme for every DMU, indeed without solving any linear programme, using the dual outer approximation algorithm. Moreover the primal outer approximation algorithm directly finds all hyperplanes defining the efficient frontier of the production possibility set. We demonstrate the effectiveness of our algorithm on a number of DEA reference problems.

In the second part of the talk we will present an application of the DEA methodology in radiation oncology, namely the assessment of the quality of treatment plans for radiation therapy of prostate cancer. Because commercial radiotherapy treatment planning systems require treatment planners to iteratively adjust the plan parameters in order to find a satisfactory plan, the quality of a plan may not be the best achievable one. We propose a quality assessment method based on Data Envelopment Analysis (DEA) to address this inefficiency. This method compares a plan of interest to a set of past delivered plans and searches for evidence of potential further improvement. With the assistance of DEA, planners will be able to make informed decisions on whether further planning is required and ensure that a plan is only accepted when the plan quality is close to the best attainable one. We demonstrate the potential of the DEA method on a set of 37 clinically acceptable prostate cancer treatment plans.

Biography

Dr Matthias Ehrgott is a Professor in the Department of Management Science at Lancaster University Management School in the UK. He received his Diploma in Management Mathematics as well as his PhD and Habilitation in Mathematics from the University of Kaiserslautern, Germany, in 1992, 1997, and 2001, respectively. After three years as Assistant Professor at the same institution, he worked at the Department of Engineering Science of the University of Auckland for 13 years, before moving to Lancaster in 2013. Dr Ehrgott is an expert in multi-objective optimisation and its application, with numerous publications on the subject. He is a member of the executive committee of the International Society on Multiple Criteria Decision Making, has won the society's Edgeworth-Pareto award, and is vice-president and president elect of the INFORMS section on MCDM.