Solving large-scale DEA models using modelling languages

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Abstract: Data envelopment analysis (DEA) is a tool for performance and efficiency evaluation and measurement of a set of n homogenous decision making units (DMUs) that consume multiple (m) inputs and produce multiple (r) outputs. DEA models find many applications in evaluation of performance in finance, banking, health care, education, etc. The efficiency measure of each DMU is defined as weighted sum of outputs divided by weighted sum of inputs. This measure for the DMU under evaluation is maximized subject to constraints that the efficiency measure of all other units is limited by unity. This problem is a standard optimization problem with linear constraints and objective function defined as a ratio of two linear functions. This problem can be simply linearized using Charnes-Cooper transformation and then it is standard linear program with n constraints and (m+r) variables.

The number of DMUs can be generally quite high. In order to analyze the set of n DMUs it is necessary to solve n linear optimization problems of the mentioned size where n can be in thousands in some applications. Even each one particular problem is not large, solving such a big number of problems can be time demanding. Another possibility is to formulate DEA model that allows analysis of all DMUs within one optimization run. Nevertheless, this model is very large and it is questionable what is more efficient solving n small programs or one large program. The paper discusses computational aspects of both approaches and analyzes their implementation on the set of randomly generated problems. The analysis is carried out using top linear optimization solvers (GUROBI, CPLEX, XPRESS, and LINDO). Models are written using current modelling systems (MPL for Windows, XPRESS-MP, and LINGO). The results given by different solvers and modelling systems are compared and discussed.

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