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ON SOLVING THE DEA CCR RATIO MODEL

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Abstract. *The Data Envelopment Analysis (DEA) CCR ratio model has been extensively adopted to assess the efficiency of decision-making units (DMUs) using common inputs and outputs. The original CCR ratio model proposed by Charnes et al. evaluates the relative efficiency of DMUs by maximizing the ratio of the weighted sum of outputs to that of inputs. For computational convenience, the CCR ratio model is transformed into the linear programming (LP) problem by choosing a representative solution from each equivalence class for which the weighted sum of inputs equals 1. However, this assumption may be inconsistent with the real-world systems, and the LP approach can only obtain the local optimum for the original problem. This study proposes a solution to the DEA CCR ratio model. The proposed approach transforms the ratios into a signomial program. Based on the convexification strategies, the signomial terms are converted into convex and non-convex functions. Subsequently, an efficient method of piecewisely linearizing the concave function is established.*
Keywords: Data envelopment analysis, CCR ratio model, Reformulated piecewise linearization.

1. **Introduction.** This study considers the DEA CCR ratio model developed by Charnes et al. [4], which assesses the relative efficiency of decision-making units (DMUs) by maximizing the ratio of the weighted sum of outputs to that of inputs. The CCR ratio model is as follows [4]. Consider n DMUs ($j = 1, \ldots, n$) that require assessment. Each DMU consumes m inputs ($i = 1, \ldots, m$) and produces s outputs ($r = 1, \ldots, s$), denoted by $x_{1j}, \ldots, x_{mj}$, and $y_{1j}, \ldots, y_{sj}$, respectively:

CCR ratio model

$$\max_{U,V} \frac{\sum_r u_r y_{ro}}{\sum_i v_i x_{io}} \tag{1}$$

$s.t.$

$$\frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \leq 1, j = 1, \ldots, n \tag{2}$$

$$\frac{u_r}{\sum_i v_i x_{io}} \geq \varepsilon \geq 0, r = 1, \ldots, s \tag{3}$$

$$\frac{v_i}{\sum_i v_i x_{io}} \geq \varepsilon \geq 0, i = 1, \ldots, m \tag{4}$$