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Improving Mont Carlo method for ranking using DEA

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ABSTRACT

Jahanshahloo developed a ranking approach based on Mont Carlo method by taking advantage of Data Envelopment Analysis (DEA). In this article, we expend the mentioned approach so that the new method takes ranking of inefficient decision making units (DMUs) in to account and presents a higher rank for efficient DMUs compared with inefficient ones.

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INTRODUCTION

We introduce the Mont Carlo method [2] briefly as our starting point. This method evaluates the approximate volume of the area, dominated by under study DMUs, not by other DMUs, named stability area.

The Mont Carlo-based ranking approach suggested by Jahanshahloo *et al.* [1], considers the magnitude of the stability area as the criterion for ranking.

In this method, we measure the area which each specific DMU dominates and other DMUs don't. By calculating and comparing the volume (area) of mentioned areas by means of Mont Carlo method [2], the ranking will form; this means each DMU with larger area volume (area) achieves a better grade [1]. In this article it will be highlighted that the mentioned method will not get to the desired results if the DMUs are situated in a CCR production possibility set. Finally a method is proposed as the solution for this problem.

To illustrate the Mont Carlo ranking method, we consider a simple numerical example including 3 DMUs with one input and one output as are A(2,2), B(5,5), C(9,6).

Area dominated by each efficient DMU is shown in Fig.1. The volume of these areas for DMU_A and DMU_B by the Mont Carlo method is 6 and 12 respectively. So DMU_B has a higher rank compared with DMU_A.

*Comment***:**

It is noteworthy that under constant return to scale (CRS),multiplying all outputs and inputs to scalar, does change the nature of unit. It is clear that this cannot guarantee that the rank of DMUs would remain unchanged.

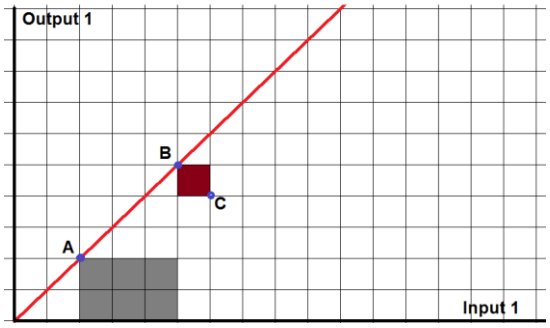

Fig. 1:

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Now we condense DMU_C from (x_c , y_c) to (2/3 x_c,2/3y_c). Fig. 2 plots the new condition. As it is clear this change leads to the replacement of the rank of DMU_A and DMU_B.

To overcome the mentioned shortcoming, we suggest that the dimension of DMUs is decreased from (m + s) to (m+s-1), then the volume corresponding to each DMU is evaluated based on Farel cut. By applying this method, DMUs will not be able to change their coordinates. In these plots, we only consider DMU3 with three different scales in which the resulted areas have been changed apparently. So changes in scale of DMUs can be resulted in wide changes in ranking.

Using this remedy not only decreases 1 dimension of general program but also causes the Mont Carlo method to reach the suitable solution by less points.

As mentioned in Mont Carlo method, the volume corresponding to each DMU is evaluated by generating some points randomly. So these points take place in a (m + s) dimensional cubic whose ribs are as follows:

$$l_i = \max_{j=1,\dots,n} \{x_{ij}\} \quad i = 1,\dots,m$$

$$l_{m+k} = \max_{j=1,\dots,n} \{y_{kj}\} \quad k = 1,\dots,s$$

This cubic is the smallest cubic which consists of all DMUs with volume V.

$$V = \prod_{i=1}^{m+s} l_i$$

Consider 4 DMUs and their corresponding volume in Fig. 3. Obviously the rank of inefficient DMU_2 is higher than that of efficient DMU_3, while it is contrary to our expectation.

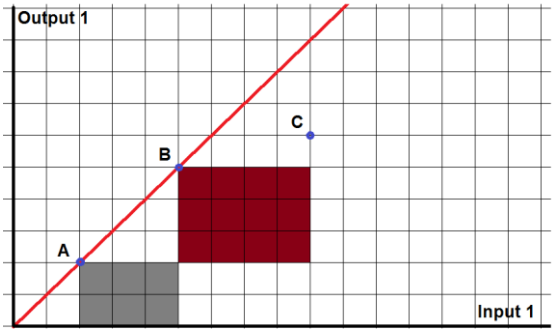

Fig. 2:

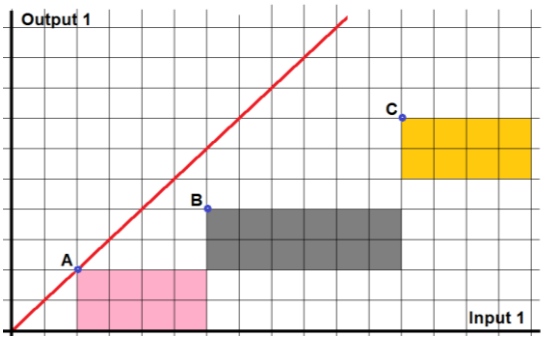

Fig. 3:

To overcome this problem, we obtain the summation V and the corresponding volume of each DMU through the Mont Carlo method. Clearly, the value of this summation for efficient DMUs is more than that of inefficient DMUs.

Ranking result obtained from Mont Carlo method and the recommended approach are provided in the Table.1.

Table 1:

DMUs	The volume obtained from Mont Carlo method	Ranking result obtained from the recommended approach	The volume obtained from the recommended approach	Ranking result obtained from Mont Carlo method
DMU1	6	3	6	3
DMU2	12	1	12	2
DMU3	8	2	97	1

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