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Solving binary-state multi-objective reliability redundancy allocation series-parallel problem using efficient epsilon-constraint, multi-start partial bound enumeration algorithm, and DEA

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Abstract

In this paper, a procedure based on efficient epsilon-constraint method and data envelopment analysis (DEA) is proposed for solving binary-state multi-objective reliability redundancy allocation series-parallel problem (MORAP). In first module, a set of qualified non-dominated solutions on Pareto front of binary-state MORAP is generated using an efficient epsilon-constraint method. In order to test the quality of generated non-dominated solutions in this module, a multi-start partial bound enumeration algorithm is also proposed for MORAP. The performance of both procedures is compared using different metrics on well-known benchmark instance. The statistical analysis represents that not only the proposed efficient epsilon-constraint method outperform the multi-start partial bound enumeration algorithm but also it improves the founded upper bound of benchmark instance. Then, in second module, a DEA model is supplied to prune the generated non-dominated solutions of efficient epsilon-constraint method. This helps reduction of non-dominated solutions in a systematic manner and eases the decision making process for practical implementations.

Highlights

► A procedure based on efficient epsilon-constraint method and DEA was proposed for solving MORAP. ► The performance of proposed procedure was compared with a multi-start PBEA. ► Methods were statistically compared using multi-objective metrics.

Keywords

ε-constraint method; Pareto front; Multi-objective redundancy allocation problem; DEA

Figures and tables from this article:

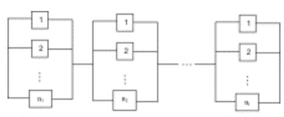

Fig. 1. Series-parallel system.

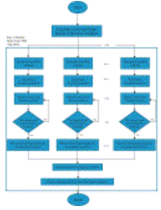

Fig. 2. Schematic view of proposed multi-start PBEA for multi-objective redundancy allocation problem.

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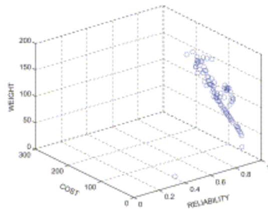

Fig. 3. Non-dominated solutions of efficient epsilon-constraint method in 3D-view.

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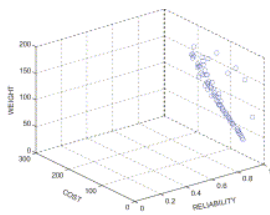

Fig. 4. Non-dominated solutions of multi-start PBE algorithm in 3D-view.

Figure options

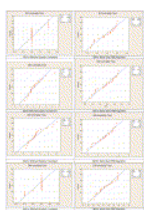

Fig. 5. Results of Kolmogorov – Smirnov test for metrics on both methods.

Figure options

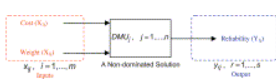

Fig. 6. A given non-dominated solution as a DMU.

Figure options

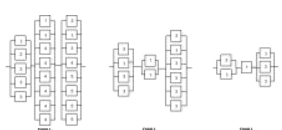

Fig. 7. Proposed structures.

Figure options

Table 1. Data of benchmark instance.

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Table 2. Pay-off of original MORAP.

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Table 3. Configuration of parameters of proposed methods.

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Table 4. Computational results of quality and diversity metrics on benchmark instance.

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Table 5. The results of ANOVA on comparison metrics.

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Table 6. Pruning the non-dominated solutions by additive model (15).

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