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Shaping the directions of evolution on the basis of design and evaluation criteria

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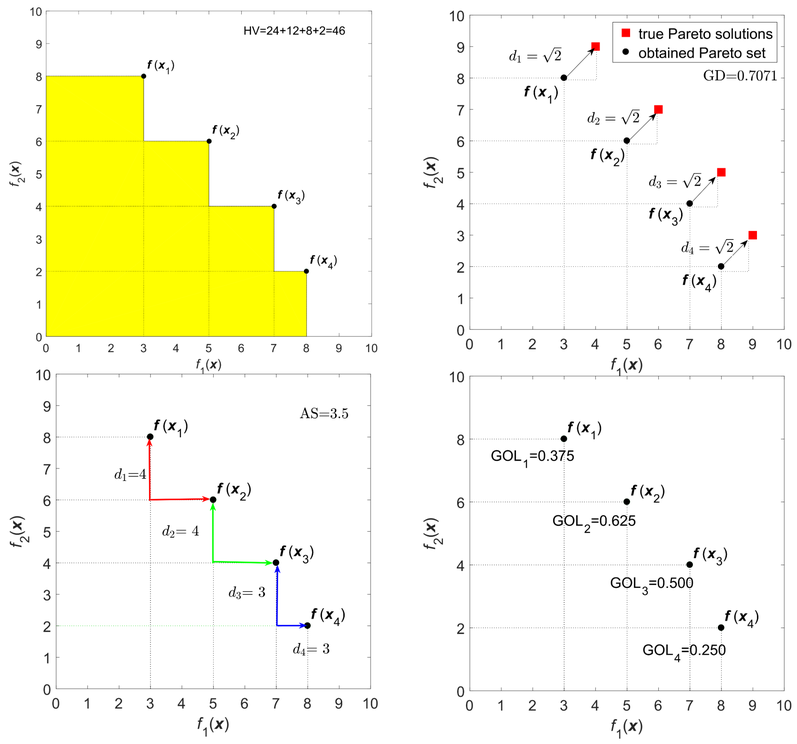
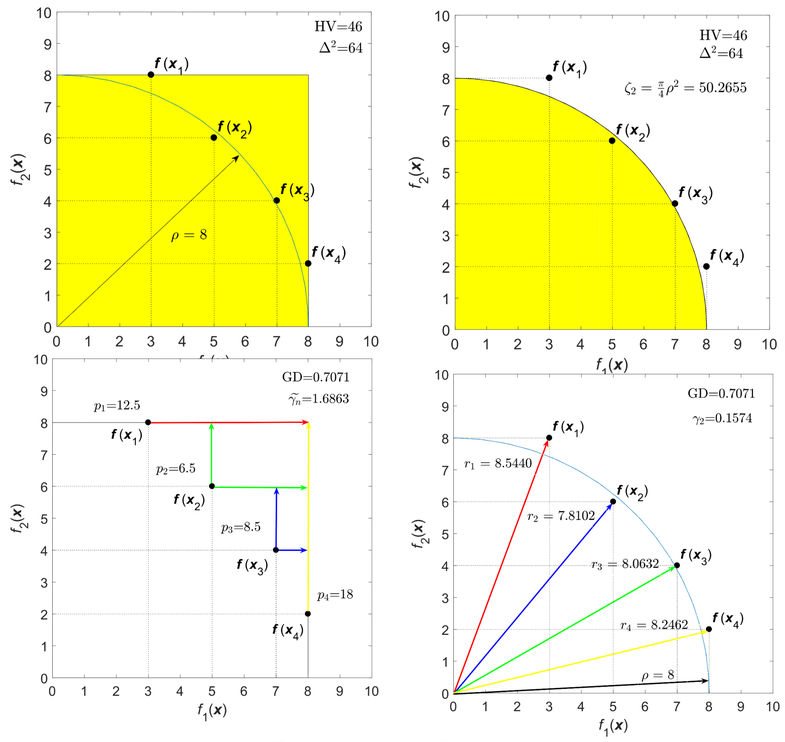
Abstract

Usually, the direct shaping of evolution in multi-criteria and multi-dimensional optimization problems is based on the adopted design criteria. On the other hand, the assessment of the overall evolutionary effectiveness of the analyzed multi-criteria optimization (EMO) procedures requires other quality indicators. Such indicators, based on knowledge of the true Pareto front in highly multidimensional spaces, can be very expensive or impossible to calculate. In contrast, the proposed approximate synthetic quality criteria are easy to implement, computationally inexpensive, and sufficiently informative and effective.

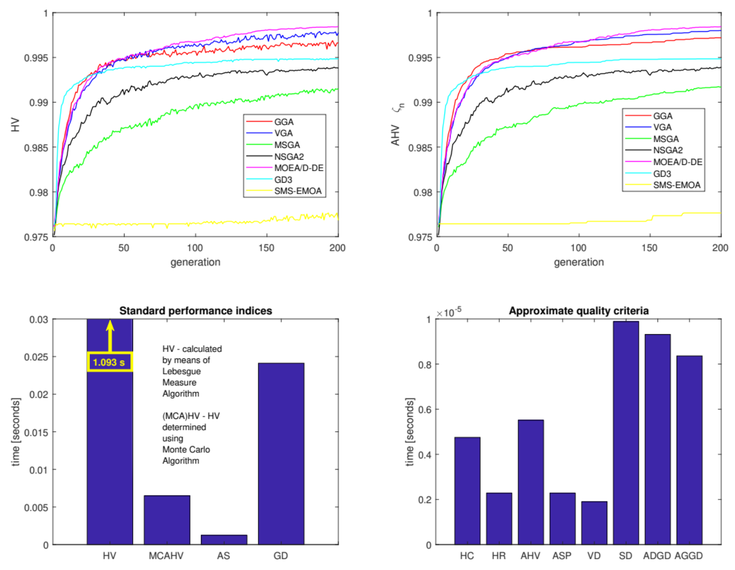
Standard evaluation criteria



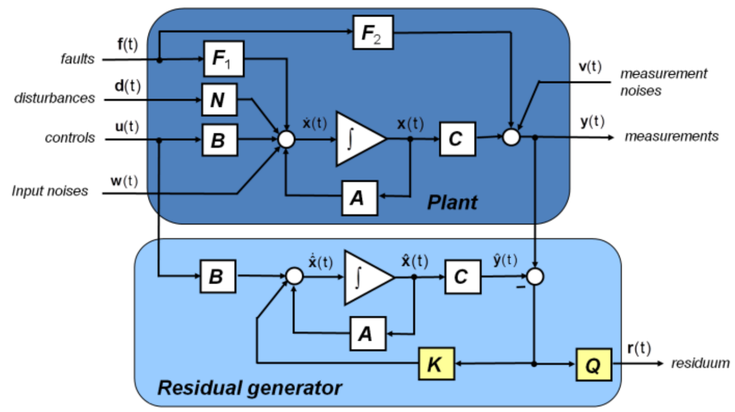
Approximate evaluation criteria



Benchmark results



Design criteria for detection observers



$$\underset{(\boldsymbol{K},\boldsymbol{Q})}{\text{opt}}\ \boldsymbol{J}(\boldsymbol{K},\boldsymbol{Q}) = \begin{bmatrix} \underset{(\boldsymbol{K},\boldsymbol{Q})}{\max}\left\{\sup_s \bar{\sigma}\left[\boldsymbol{W}_1(s)\boldsymbol{G}_{rf}(s)\right]\right\} \\ \underset{(\boldsymbol{K},\boldsymbol{Q})}{\min}\left\{\sup_s \bar{\sigma}\left[\boldsymbol{W}_2(s)\boldsymbol{G}_{rd}(s)\right]\right\} \\ \underset{(\boldsymbol{K},\boldsymbol{Q})}{\min}\left\{\sup_s \bar{\sigma}\left[\boldsymbol{W}_3(s)\boldsymbol{G}_{rw}(s)\right]\right\} \\ \underset{(\boldsymbol{K},\boldsymbol{Q})}{\min}\left\{\sup_s \bar{\sigma}\left[\boldsymbol{W}_4(s)\boldsymbol{G}_{rv}(s)\right]\right\} \\ \underset{(\boldsymbol{K})}{\min}\left\{\bar{\sigma}\left[(\boldsymbol{A}-\boldsymbol{K}\boldsymbol{C})^{-1}\right]\right\} \\ \underset{(\boldsymbol{K})}{\min}\left\{\bar{\sigma}\left[(\boldsymbol{A}-\boldsymbol{K}\boldsymbol{C})^{-1}\boldsymbol{K}\right]\right\} \end{bmatrix}$$

Conclusions

The main advantages of the proposed approximate evaluation functions are their efficiency and computational cheapness (ease) in relation to the original functions.

The proposed approximate functions (AGGD, ADGA) do not require knowledge of the real Pareto front.

The obtained results indicate a high agreement of approximated indices with the original functions.

The above conclusions define a huge advantage over the original indicators in solving complex problems of multi-criteria optimization.