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Incorporation of Fuzzy Preferences into Evolutionary Multiobjective Optimization

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Abstract

A method for incorporating fuzzy preferences into evolutionary multiobjective optimization is proposed. Fuzzy preferences are converted into interval-based weights instead of single-valued crisp weights. The weight intervals are combined with the evolutionary dynamic weighted aggregation to obtain the preferred Pareto-optimal solutions.

Finding all Pareto-optimal solutions is not the final goal: a decision has to be made based-on users' preferences. Such preferences can usually be represented with the help of fuzzy logic. Before fuzzy preferences can be incorporated into multiobjective optimization, fuzzy preferences in inform of fuzzy relations are converted to a set of single-valued weights [1], during which a lot of information is lost. One more natural way to do this is to convert the fuzzy preferences into weights in intervals.

The weight intervals can then be combined with random weighted method (RWA) and dynamic weighted method (DWA) [2]. Suppose the maximal and minimal value of a weight is $\bar{w}$ and $\underline{w}$, the weights can be changed as follows:

$$w_1^i = \underline{w}_1 + (\bar{w}_1 - \underline{w}_1)\ \mathrm{rdm}(P)/P, \text{ (RWA) (1)}$$
$$w_1(t) = \underline{w}_1 + (\bar{w}_1 - \underline{w}_1)\ \sin(2\pi t/F)| \text{ (DWA).(2)}$$

In this way, the evolutionary algorithm can achieve a set of Pareto solutions reflected by the fuzzy preferences.

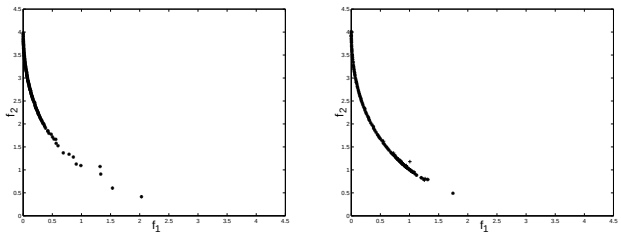
To illustrate how this method works, one example on two-objective optimization is presented in the following. In the simulations, we consider the following fuzzy preferences: "Objective 1 is more important than objective 2".

Then we can get the following preference matrix:

$$P = \begin{bmatrix} 0.5 & \delta \\ \gamma & 0.5 \end{bmatrix}, \quad (3)$$

where $0.5 < \delta < 1$ and $0 < \gamma < 0.5$. Therefore, we have $0.5 \leq w_1 \leq 1.0$, and $0.0 \leq w_2 \leq 0.5$.

Simulation are carried out on the Schaffer's function and the results are shown in Fig. 1



(a) (b)

Figure 1: Results on the Schaffer's function. a) RWA, b) DWA.

The main idea is to convert the fuzzy preferences into interval-based weights. With the help of the dynamic weighted aggregation method, preferred Pareto-optimal solutions can be obtained.

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