An Evolutionary Technique for Multicriterial Optimization Based on Endocrine Paradigm

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1 MENDA Technique

We propose a new evolutionary algorithm (*M*ultiobjective *End*ocrine *A*lgorithm) for multiobjective optimization, which applies several principles inspired of endocrine system. Even if hormonal system has a particular dependence of nervous system, due to the intrinsic mechanisms of control and its functions, it represents by itself a suitable paradigm in evolutionary computation's landscape.

The principle of the proposed method relies on keeping two populations: an active population of hormones, H_t, and a passive population of non-dominated solutions, A_t. The members of the passive population behave as a population of elite and also have a supplementary function: to lead the hormones toward the Pareto front, keeping them as much as possible well distributed among the search space. These two populations correspond to the two classes of hormones in endocrine paradigm: specific hormones, which are released by different glands of the body and the hormones of control (tropes), which are produced by the control level of the endocrine system in order to supervise the density of each type of specific hormones.

Population of control, A_t, is modified at each generation, gathering all non-dominated solutions from the population U_t, which has resulted from merging current population of hormones H_t and the previous population A_t. The passive population, A_t, doesn't suffer modification at the individual's level. It behaves as an elite population of non-dominated solutions from the current generation, which is only rebuild at each generation. Finally, population A_t contains a predetermined number of non-dominated vectors and provides a good approximation of Pareto front.

At each generation t, the members of H_t are classified. A corresponding controller from A_t supervises a particular class. The idea is that each hormone from H_t is supervised by the nearest controller from A_t. A member of the population A_t has a similar control function as a trop from endocrine paradigm.

We use two fitness functions. The first fitness function measures the crowding degree of the class of the individual. The second fitness of each individual calculates the number of dominated solutions from the current generation.

Another specific issue of the proposed algorithm is the manner of selecting and recombining the hormones in order to generate descendants. First parent is selected from entire population H_t, proportionally with the crowding degree of the classes. By this manner of selecting first parent, the less crowded hormones are preferred and those zones from the search space, which are apparently disappearing, would be re-

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vived. The second parent is selected only from the class of the first parent, accordingly to the value of the second fitness function. By selecting the second parent accordingly to the values of the second fitness function, the method assures a faster convergence of the population toward Pareto front. Crossover operator recombines two parents and produces a single descendant, which is accepted into the next population.

2 Results and Conclusions

Nature offers complex phenomena, processes and systems, which can inspire us in many ways. An example of this kind is the natural endocrine system. Our work essentially attempts to mimic hormones' behavior in order to solve difficult problems like multiobjective optimization. Consequently, we propose a new technique based on endocrine paradigm, called *MENDA* (*M*ultiobjective *End*ocrine *A*lgorithm). It provides satisfactory solutions in our tests.

We used in our tests many bi-objective test functions found in the literature. The results were satisfactory. Among these, the popular test suit of 6 bi-objective functions proposed by Deb [1], [3] was a real challenge. We had to modify the crossover operator in order to overcome the initial fails. The results were evaluated using *Spacing* metric and *Error Ratio* metric [2]. The values of those metrics were encouraging.

Table 1. The results obtained for the first four test functions proposed by Deb[3]. The algorithm run for 20 times and the average values for the considered metrics are shown.

Test Function	Number of Generations	Non-dominated Solutions	Spacing Metric	Error Ratio Metric
F1	60	83	0.0056	0
F2	65	83	0.0058	0
F3	121	97	0.0061	0
F4	37	82	0.0059	0

References

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