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Performance comparison of Evolutionary Algorithms for Airfoil Shape Design

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1 Introduction

The airfoil aerodynamic design (AAD) is a challenge problem in aerodynamic engineering and optimization. In the AAD, the goal is to calculate an optimal airfoil shape that maximizes the lift-drag ratio, where lift and drag are forces that interact between themselves. In this study we use the Parametric Section (PARSEC) method that is a linear combination of shape functions describing the airfoil shape [1]. In general, the optimizer techniques seek to calculate the parameters of PARSEC that improves lift-drag ratio.

Evolutionary Algorithms (EA) are efficient strategies to solve complex problems. There are several families of EA as Genetic Algorithms (GA) [2] and Differential Evolutionary Algorithms (DEA) [3]. Typically, AAD is approached with GA-based techniques [2]. The performance of other metaheuristic-based approaches in AAD have not yet been explored in the literature in our best knowledge. In this context, this work compares the GA and DEA's performances where each solution (airfoil shape) is evaluated by the Xfoil simulator [4].

2 Experiments

Experiments show that DEA is a promissory technique that gets airfoil shapes with good lift-drag ratio when compared to GA solutions. Basically, both algorithms start with the same population of 100 individuals, each algorithm was run 30 times independently generating 30 candidate solutions. The best solution of those 30 for each algorithm was taken to compare their performances. Each independent run took an average time of 80 minutes for 100 generations. Figure 1 shows the evolutionary process of the algorithms. In Figure 1.c it is observed that the GA is stagnant while the DEA achieves a better

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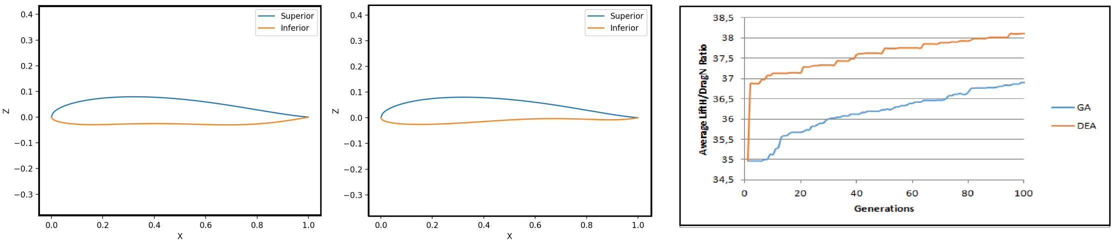

a) Best airfoil shape of GA   b) Best airfoil shape of DEA   c) Evolutionary Process

Figure 1: Experimental Result

convergence. On the other hand, Figures 1.a and 1.b shows the best airfoil shapes (normalized) calculated by GA and DEA respectively; note the slight difference between the forms which determines the DEA solution outperforms to GA solution.

3 Conclusion

This work proposes a competitive DEA for AAD problem in mono-objective context. For future work, the authors will consider to extend to Multi-Airfoil Shape Design (MAAD) and multi-objective optimization problem.

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