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NEW DISCOVERIES IN FAST EVOLUTIONARY PROGRAMMING

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Abstract. *It had been stated in both the theoretical analysis and the empirical results on fast evolutionary programming (FEP) that long jumps of Cauchy mutations were the cause of the better performance of FEP on optimizing both unimodal and multimodal functions. Such a statement about long jumps of Cauchy mutations has been so widely held in the applications of evolutionary programming (EP) that the effectiveness of long jumps of Cauchy mutations has seldom been put in doubt. Through carefully examining the relationship between the step sizes of mutations and their performance, it has been discovered that not long jumps but short jumps with large variances among Cauchy mutations had led to the better performance of FEP than that of classical EP (CEP). Experimental results given in this paper show that effective Cauchy mutations in FEP had often had even shorter step sizes on average than effective Gaussian mutations in CEP, although the average step sizes of Cauchy mutations were much longer than those of Gaussian mutations. It has been further discovered that the same self-adaptation used in CEP and FEP had shown quite different behaviors on optimizing the same test functions from the same initial populations. These two discoveries shed light on why the shorter effective Cauchy mutations performed better than the longer effective Gaussian mutations, and how effective Cauchy mutations had had the shorter step sizes than effective Gaussian mutations.*

1. **Introduction.** Evolutionary programming (EP) was first proposed as an evolutionary approach to artificial intelligence, in which finite state machines were evolved in a learning process through simulated evolution [1]. It has been applied with success to many numerical and combinatorial optimization problems [2, 3]. Mutations are the only search operators to generate new solutions in EP, while a selection scheme is applied to test which of the newly generated solutions should survive to the next generation. Such a population-based EP by generate-and-test indicates that the generating process of an offspring mutated from its parent is controlled completely by the search bias of a mutation, including mutation steps and mutation directions [4].

The step size is crucial for the performance of a search operator [4, 5, 6]. Different search operators often have different step sizes, and thus are appropriate for different problems as well as different evolutionary search stages for a single problem [4, 7, 8, 9]. Since the global optimum is generally unknown in real world applications, it is impossible to know a priori what step sizes should be applied in an EP. Self-adaptation was therefore adopted in Gaussian mutation in which the strategy parameters are encoded and evolved together with each individual in EP [10, 11, 12]. Through evolving the strategy parameters, step sizes could therefore be controlled in EP. For an one-dimensional Gaussian mutation, its step size is actually a product of a strategy parameter and the absolute value of a random number generated from a Gaussian distribution used in the mutation. Step sizes