A Group Work Inspired Generation Alternation Model of Real-Coded GA

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ABSTRACT

Genetic algorithms (GAs) are stochastic optimization methods that mimic the evolution of living organisms. Among them, GA which uses real-coded genes is called Real-Coded GA (RCGA). Several generation alternation models have been proposed to improve RCGA. Problem decomposition is a known method for improving search performance. Therefore, in this study, a practical, real-world method of problem decomposition was considered. Here, it was considered that the individual evaluation method utilized in group work could be applied to the individual evaluation of RCGA. We focused on the group work which practice problem decomposition in the real world. In group work, each of members collaborates with the others and is evaluated comprehensively from the group's outcome and personal contribution to the group. Therefore, in this study, a model is proposed to introduce the concept of group work into a generation alternation model of RCGA. We evaluated the search performance of the proposed method using benchmark functions and confirmed the performance improvement by comparing with the conventional methods.

CCS CONCEPTS

• **Computing methodologies → Heuristic function construction**; *Continuous space search.*

KEYWORDS

Co-evolution, Genetic algorithms, Empirical study

ACM Reference Format:
Takatoshi Niwa, Koya Ihara, and Shohei Kato. 2019. A Group Work Inspired Generation Alternation Model of Real-Coded GA . In *Proceedings of the Genetic and Evolutionary Computation Conference 2019 (GECCO '19).* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3319619.3322081

1 INTRODUCTION

Genetic algorithms (GAs) are stochastic optimization methods that mimic the evolution of living organisms. When a bit string is used for a genotype, since it is a discrete expression, there is a problem that continuity is not considered at all. On the other hand, GA which takes real value for genotype is effective in continuous function optimization problem in real number genetic algorithm (RCGA). Recent studies to increase the search performance of RCGA have proposed generation alternation models. One of them,Just Generation Gap (JGG)[1] is improved search efficiency compared to the others when using RCGA[2]. In this research, we introduce collaboration model to improve search efficiency of RCGA.

2 COLLABORATION MODEL

2.1 Cooperative Coevolution

First, in the Cooperative Coevolution (CC), the decision variable vector is divided. The initial fitness of each individual is evaluated by combining it with random individuals from the other species. Next, the fitness of each individual is evaluated by combining it with the current best combination of individuals. Assuming that the number of divisions is D and the number of individuals in each species is N, fitness calculation is conducted $D \times N$ times to determine the fitness of all individuals.

2.2 Group Work

We thought that individual evaluation method of group work could be applied to individual evaluation of GA. The fitness of each individual belonging to a group was calculated based on the fitness of the group. Assuming that the number of individuals in each species is N, fitness evaluation needs to be conducted only N times to obtain the fitness of all individuals regardless of the number of divisions D.

3 PROPOSED METHOD

We propose a new generational alternation model introducing collaboration model into JGG. Figure 1 shows the conceptual figure of proposed method. The procedure of the proposed method can be summarized as follows:

(1) Divide decision variable vector.
(2) Generate of initial population for each species.
(3) Execute the following in each species.
  (a) Selection for reproduction:
    select N individuals by random sampling.
  (b) Apply crossover to parents and generate offspring.
(4) Evaluate fitness of each individual by collaboration model.
(5) Selection for survival in each species:
  select the top ranked N individuals from offspring;
  replace the parents with N individuals.
(6) Repeat (3) to (5) until stop condition is satisfied.

We proposed Cooperative Coevolutionary Just Generation Gap (CCJGG) combining JGG and Cooperative Coevolution and Group

GECCO '19, July 13–17, 2019, Prague, Czech Republic

ACM ISBN 978-1-4503-6748-6/19/07...$15.00
https://doi.org/10.1145/3319619.3322081

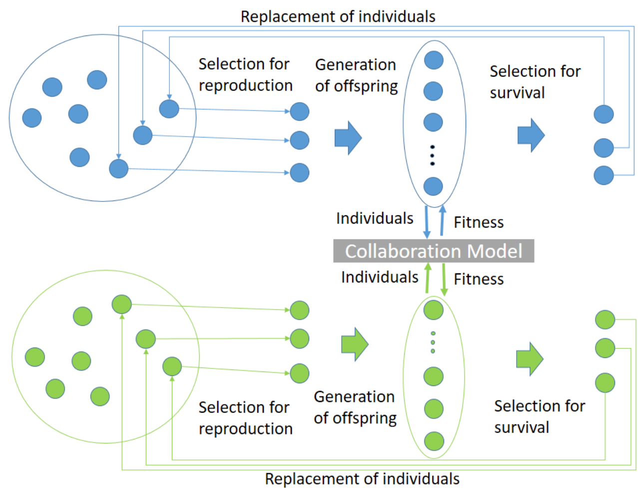

Figure 1: Conceptual figure of proposed method

Working Just Generation Gap (GWJGG) combining JGG and Group Work.

4 EXPERIMENT

4.1 Experimental Setting

To investigate the performance of the proposed method, we use benchmark functions from CEC2013[3]. The number of dimension is 20 and the number of divisions is varied to 2, 4, 5, 10, and 20. In the trials, the number of divisions are determined by preliminary experiments and the best performance is compared. Population size N is set to 200 and offspring size N_c is set to 120. Each method performs 30 trials. Each run stops either when the error obtained less than 10^{-7}, or when the maximal number of evaluations (2000000) is achieved. The crossover performed was the simplex crossover (SPX) and UNDX-n. Compare the search performance of the proposed methods and JGG using t test.

4.2 Results

Table 1 shows experimental results. Significance levels is set to 1%. $+$ means that the proposed method is better than JGG. $-$ means that JGG is better than proposed method. $\approx$ means that there is no significance. The results indicated that the proposed method is effective with many functions.

Table 1: Comparisons of CCJGG, GWJGG and JGG

	SPX		UNDX-n	
	CCJGG	GWJGG	CCJGG	GWJGG
f_1	$+$	$+$	$-$	$-$
f_2	$-$	$-$	$-$	$-$
f_3	$\approx$	$+$	$-$	$\approx$
f_4	$-$	$-$	$-$	$-$
f_5	$\approx$	$+$	$\approx$	$+$
f_6	$\approx$	$\approx$	$\approx$	$\approx$
f_7	$\approx$	$+$	$\approx$	$\approx$
f_8	$\approx$	$\approx$	$\approx$	$\approx$
f_9	$-$	$\approx$	$-$	$-$
f_{10}	$\approx$	$\approx$	$-$	$-$
f_{11}	$+$	$+$	$+$	$+$
f_{12}	$\approx$	$+$	$-$	$+$
f_{13}	$\approx$	$+$	$-$	$+$
f_{14}	$+$	$+$	$+$	$+$
f_{15}	$-$	$+$	$-$	$\approx$
f_{16}	$+$	$+$	$\approx$	$+$
f_{17}	$+$	$+$	$+$	$+$
f_{18}	$+$	$+$	$+$	$+$
f_{19}	$+$	$+$	$+$	$+$
f_{20}	$\approx$	$+$	$\approx$	$+$
f_{21}	$+$	$+$	$+$	$\approx$
f_{22}	$+$	$+$	$+$	$+$
f_{23}	$-$	$+$	$-$	$\approx$
f_{24}	$-$	$\approx$	$-$	$\approx$
f_{25}	$-$	$+$	$-$	$+$
f_{26}	$\approx$	$-$	$\approx$	$-$
f_{27}	$-$	$\approx$	$-$	$\approx$
f_{28}	$+$	$+$	$\approx$	$\approx$

5 CONCLUSION AND FUTURE WORK

We introduced group work to collaboration model and proposed a new generation alternation model introducing collaboration model to JGG. Performance evaluations were conducted using benchmark functions, and the results confirmed that GWJGG yields better solutions than JGG. The results suggested that GWJGG is more effective in RCGA. In this research, we divide search space evenly, but in order to improve the performance, it is important to consider the dependency between variables in search space. Therefore, a function to analyze the dependency relationship of the fitness function is required, we will develop it in a future work. We will also conduct experiments on whether group work method works effectively for other evolutionary algorithms.

ACKNOWLEDGMENTS

This work was supported in part by the Ministry of Education, Science, Sports and Culture, Grant–in–Aid for Scientific Research under grant #19H01137.

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