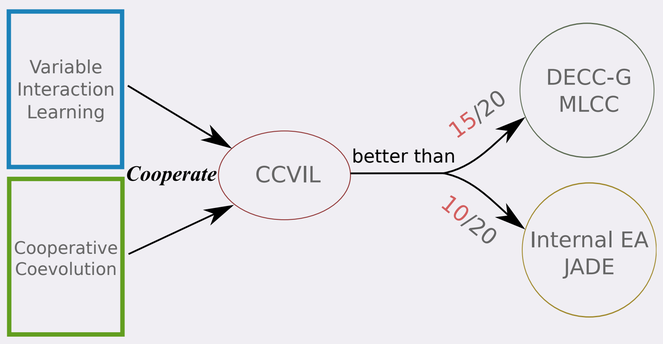
Large-Scale Global Optimization using Cooperative Coevolution with Variable Interaction Learning

Wenxiang Chen[1], Thomas Weise[2], Zhenyu Yang[3], and Ke Tang[4]

Nature Inspired Computation and Applications Laboratory *(NICAL)*, URL: `nical.ustc.edu.cn`
School of Computer Science and Technology, University of Science and Technology of China *(USTC)*

Introduction

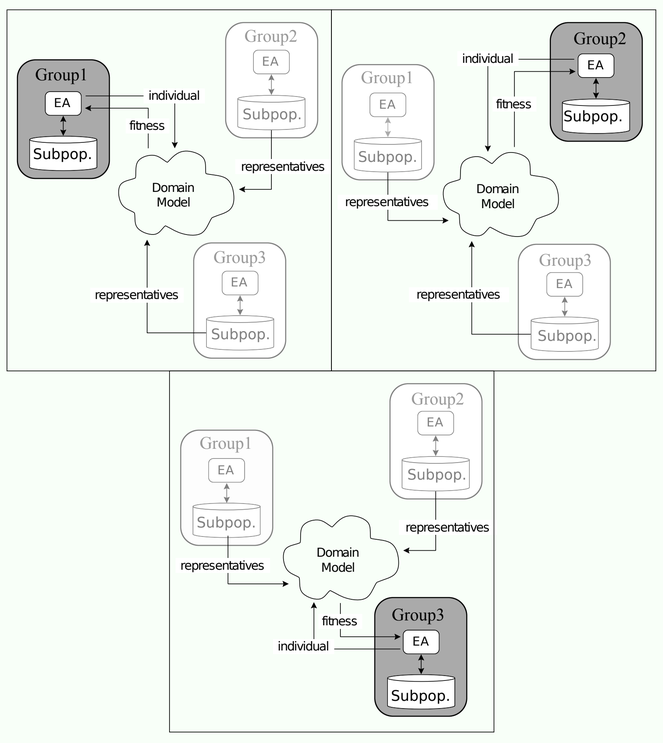


- a novel framework for tackling large-scale scale global optimization(CCVIL), which cooperates variable interaction learning mechanism (VIL) and cooperative coevolution (CC)
- CCVIL is significantly better than DECC-G and MLCC (two state-of-the-art CC-based algorithms), the internal optimizer JADE

Cooperative Coevolution

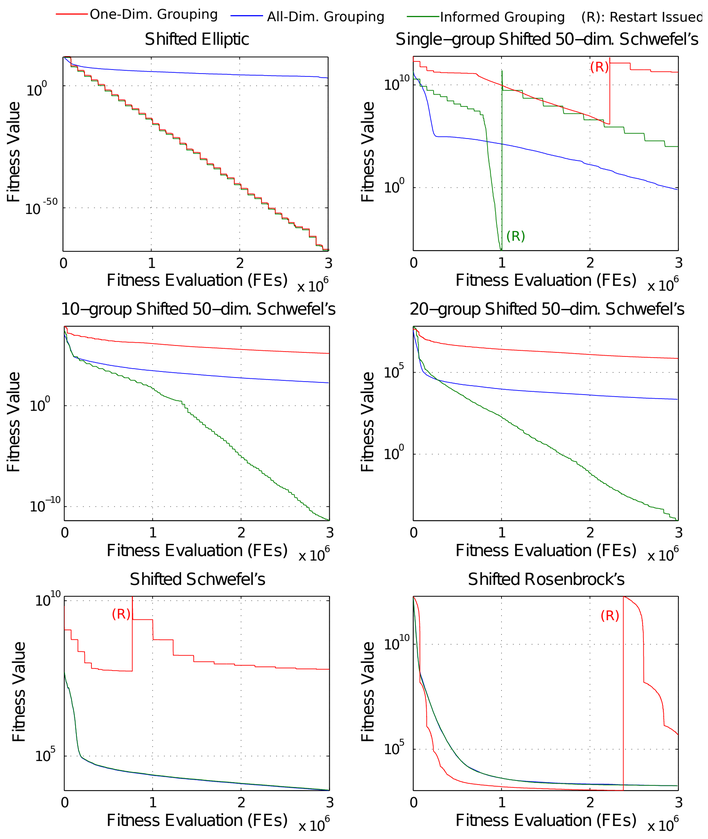
Basic Steps of CC

- divide the decision vector into groups of variables
- evolve each subpopulation by groups
- combine the best representatives from all other dimensions to compose the vector for fitness evaluation



The Importance of Exact Grouping

6 benchmark functions CEC'2010 special session on large-scale global optimization, different degree of separability.



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Theoretical Base for Interaction Learning

Separable Function

A function is separable, if it satisfies the Equation 1

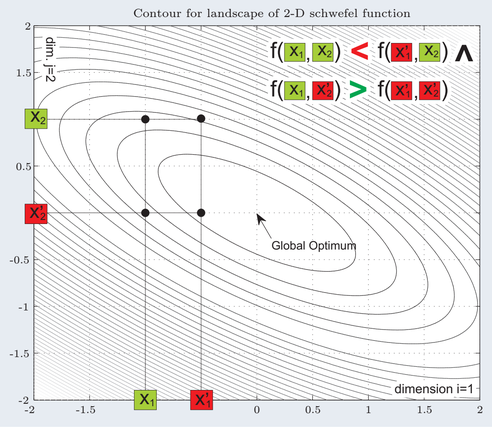
$$\arg\min_{(x_1,\ldots,x_N)} f(x_1,\ldots,x_N) = \left(\arg\min_{(x_1)} f(x_1,\cdots),\ldots,\arg\min_{(x_N)} f(\cdots,x_N)\right) \quad (1)$$

Variable Interactions

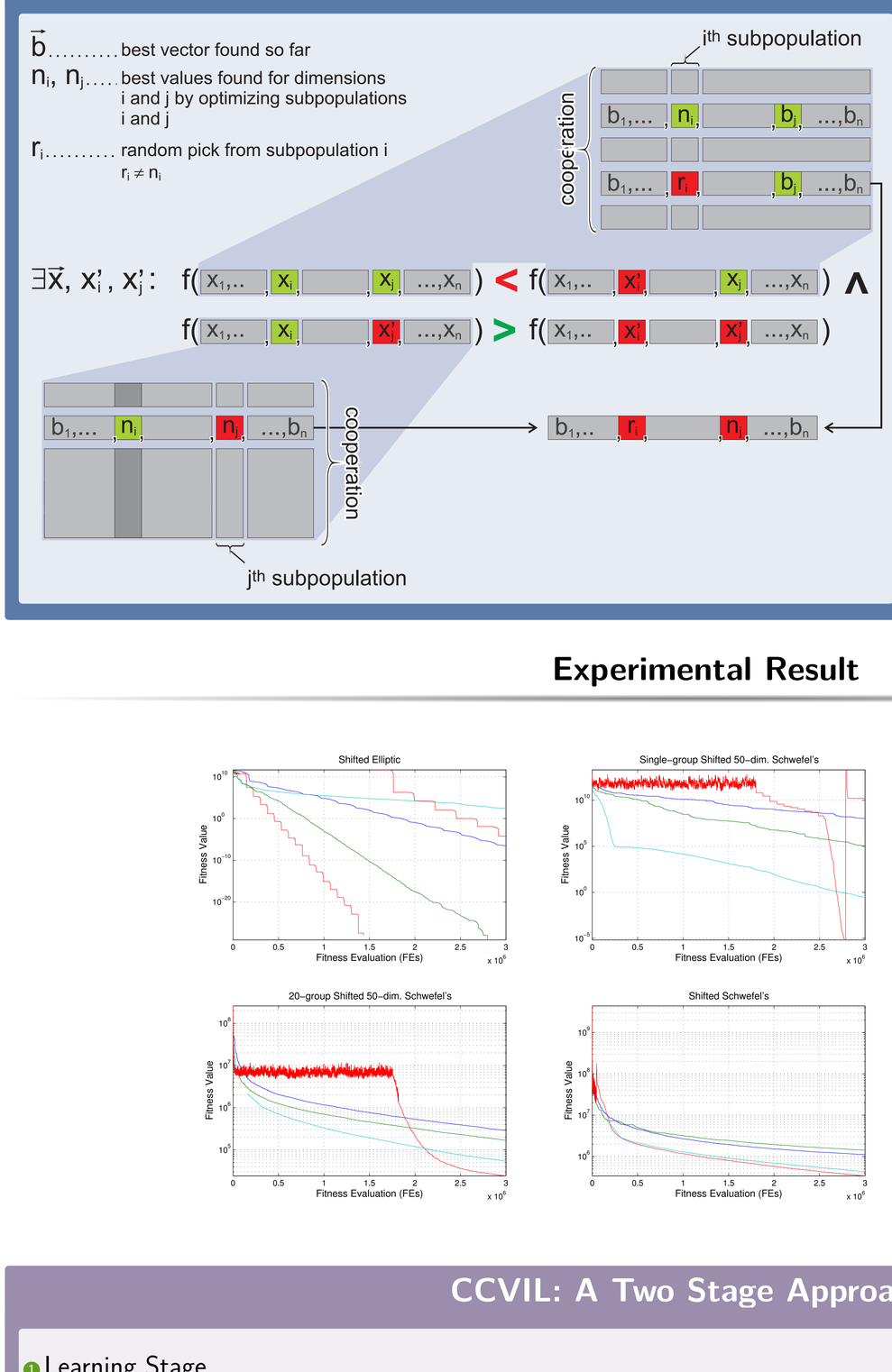
Define interaction between dimension i and j of decision vector as follow:

$\exists\vec{x}, x_i', x_j'$: $f(x_1,..,x_i,..,x_j,..,x_n) < f(x_1,..,x_i',..,x_j,..,x_n) \wedge$

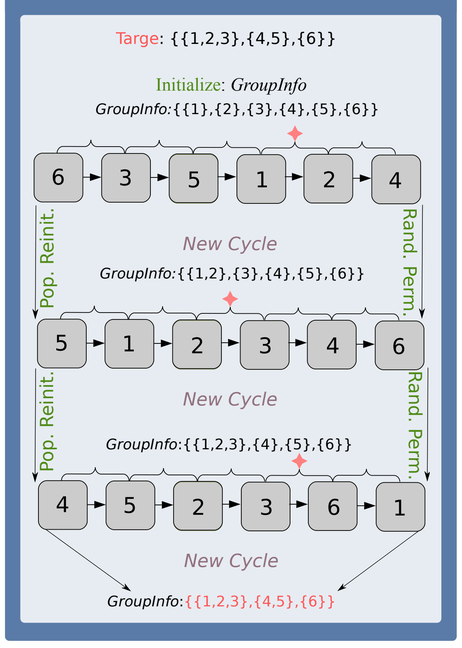
$f(x_1,..,x_i,..,x_j',..,x_n) > f(x_1,..,x_i',..,x_j',..,x_n)$



Cooperate Variable Interactions within CC



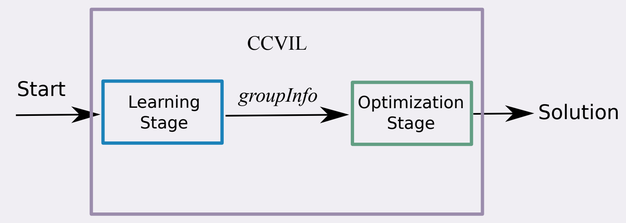
Interaction Learning Procedure



Experimental Result

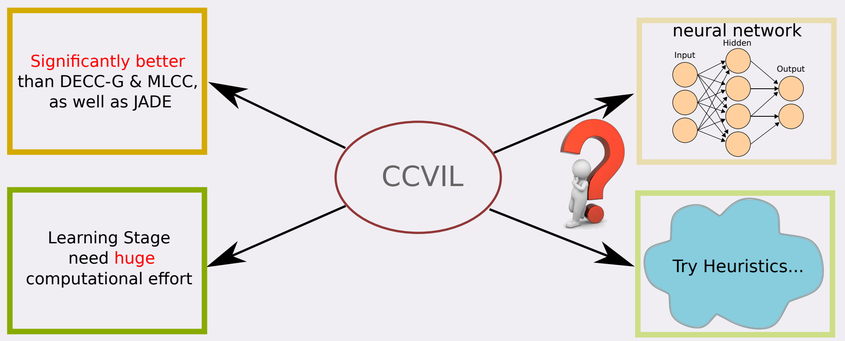
CCVIL: A Two Stage Approaches

1. Learning Stage
   - population size = 3, generation limit for each subcomponent = 1
   - population re-initialization in each cycle
   - the sequence of the dimensions to optimize is randomly permuted in each cycle
   - store the learned interaction knowledge in $groupInfo$
2. Optimization Stage
   - apply a certain EA as the sub-optimizer (in our case, it is JADE)
   - evolve the subpopulation in CC with respect to $groupInfo$



Discussion and Conclusion

- Proper grouping strategy is essential in CC
- Although VIL employed in this paper need vast computational effort, CCVIL still achieve performance
- It is worthy developing a more effective learning strategy
- The effectiveness of CCVIL within real-world application domain is still unknown



Contact

Email: {**chenwx**[1],zhyuyang[3]}@mail.ustc.edu.cn; {tweise[2],ketang[4]}@ustc.edu.cn
WWW: home.ustc.edu.cn/∼{**chenwx**[1],zhyuyang[3]}; it-weise.de[2]; staff.ustc.edu.cn/∼ketang[4]