Optimal Zone Breadth for Parallel and Distributed MOEA/D with Virtual Overlap Zone and Exclusively Evaluated Mating

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Background

[1] Y. Sato, M. Sato, M. Miyakawa, "Parallel and Distributed MOEA/D with Exclusively Evaluated Mating and Migration", Proceedings of 2020 IEEE Congress on Evolutionary Computation (CEC), pp. 1-8, 2020.

[2] M. Sato, Y. Sato, M. Miyakawa, "Inconstant Update of Reference Point Value for Parallel and Distributed MOEA/D", Proceedings of 2021 IEEE Congress on Evolutionary Computation (CEC), pp. 1495-1502, 2021.

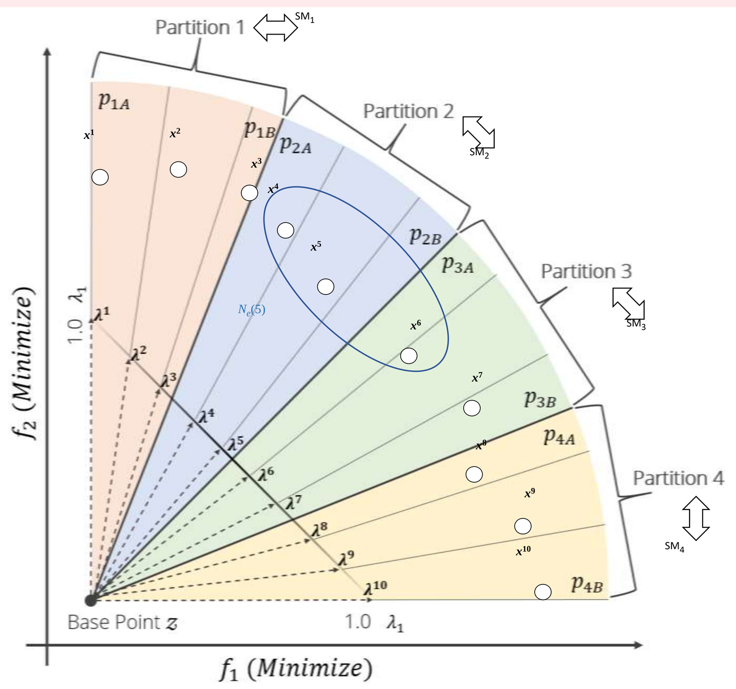

Fig. 1 Standard distribution of solutions in case of four cores.

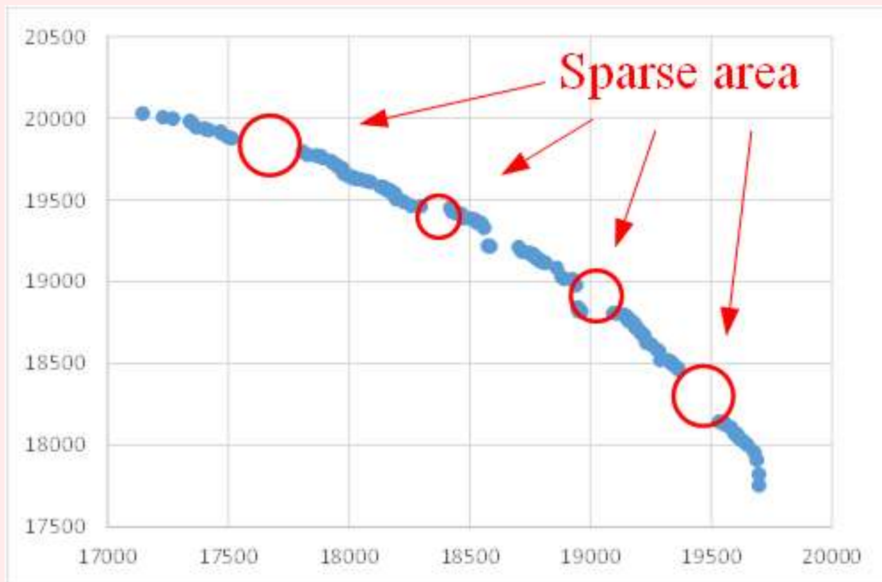

Fig. 2 Space area of Pareto optimal front in standard parallelization.

The standard parallel MOEA/D achieves acceleration by ***assigning weight vectors to different computational cores*** for simultaneous calculations.

- This method ***substantially accelerates significantly*** more than the Non-parallelized MOEA/D.
- On the other hand, ***the solution distribution becomes sparse because the T-neighborhood is divided at the partition boundary*** as shown in Fig. 2.

Proposed Method: Virtual Overlap Zone and Exclusively Evaluated Mating

◆ Proposed ***virtual overlapping method define the virtual overlap zone and sharing weight near the boundaries between partitions*** [1, 2].

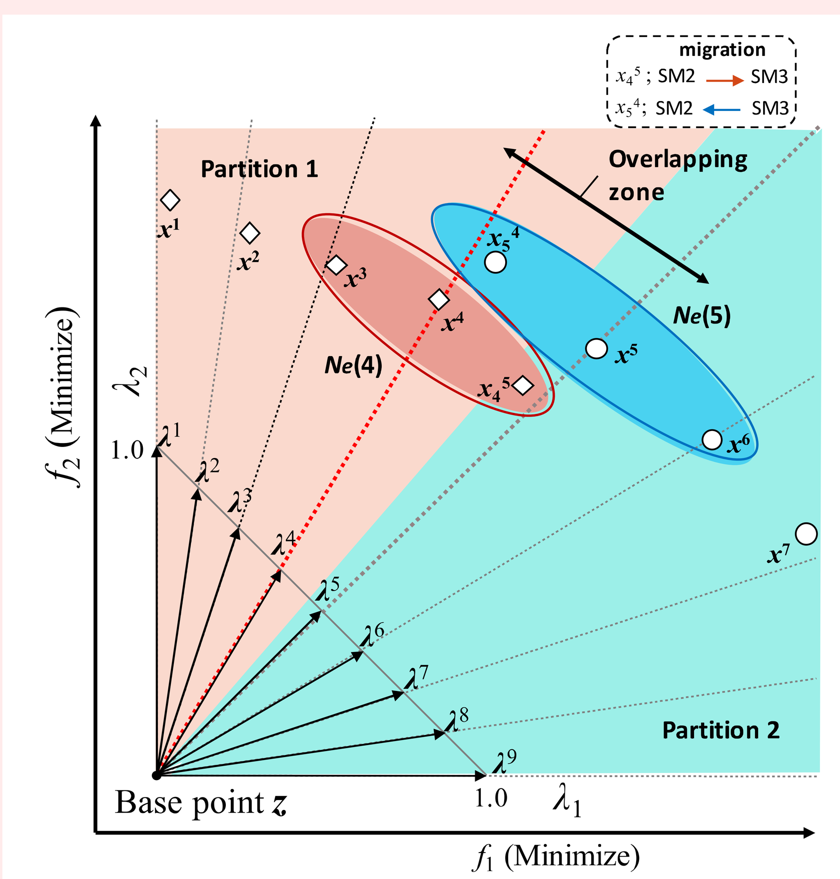

Fig. 3 Exclusively evaluated solutions inside a fold created between partitions.

➢ The virtual overlapping method significantly improves the sparse areas in the PF as shown in Fig. 4.

➢ As the ***overlapping zone breadth increases, the HV value and execution time both tend to increase*** in Fig. 5.

Our aim is to ***investigate and identify indicators for determining the overlapping size***.

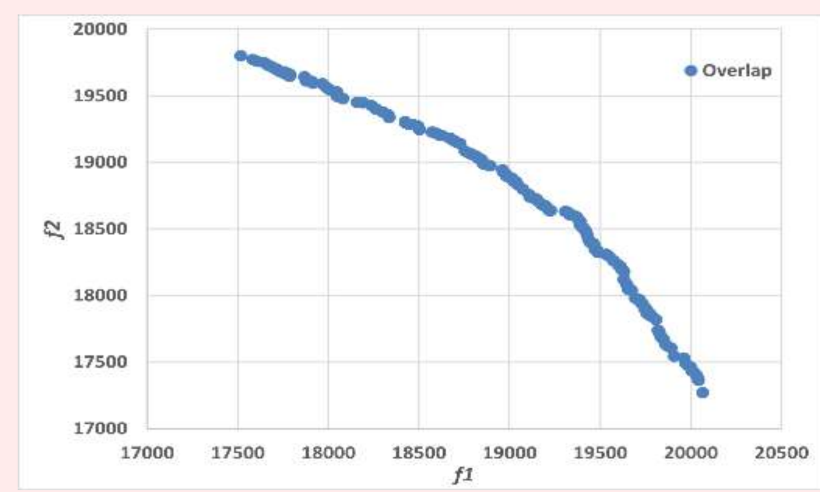

Fig. 4 Pareto optimal front in Virtual Overlapping method.

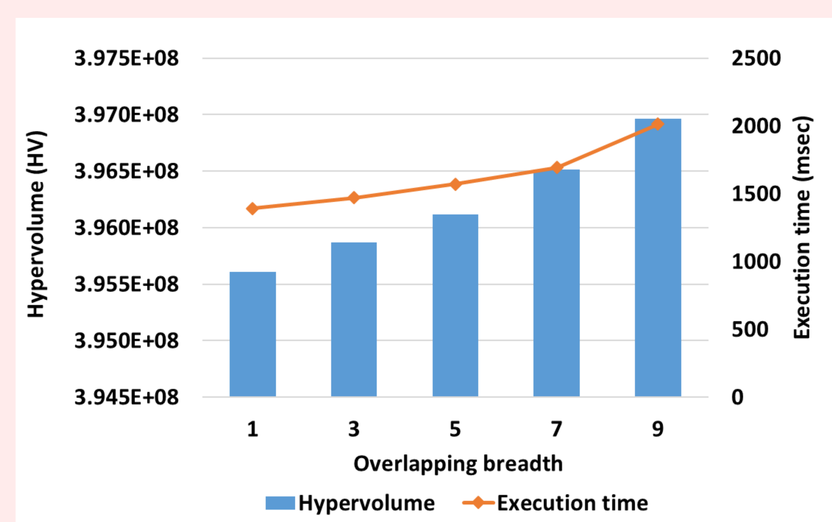

Fig. 5 HV evaluation after 2,500 generations while changing the overlapping zone breadth.

Evaluation

◆ **We investigated the HV value per unit time by varying the degree of parallelism and overlapping breadth as parameters using the *multi-objective knapsack problem*.**

Table 1: Experimental parameters for the knapsack problems.

Population Size		320, 480, 640
Parallelism (the number of cores)		8, 12, 16
Timeframe (unit time)		1 second
Number of Objectives		2
T-Neighborhood Size		5, 7, 9
Decomposition Method		Tchebycheff
Crossover Rate		1.0
Mutation Rate		0.05
Knapsack Problem Parameter	Number of Items	500
	Feasibility ratio	0.5

$$\begin{cases} Maximize\ f_j(x) = \sum_{i=1}^{n} p_{ij} x_i \ (j = 1,2,\dots,m) \\ Subject\ to\ \sum_{i=1}^{n} w_{il} x_i \le c_l \ (l = 1,2,\dots,m) \end{cases}$$

$$c_l = \varphi \sum_{i=1}^{n} w_{il} \ (l = 1,2,\dots,m)$$

➢ The investigation of suitable overlapping zone breadths for T-neighborhood sizes of 5, 7, and 9 using 8, 16 cores system.

(0* means "without overlapping.")

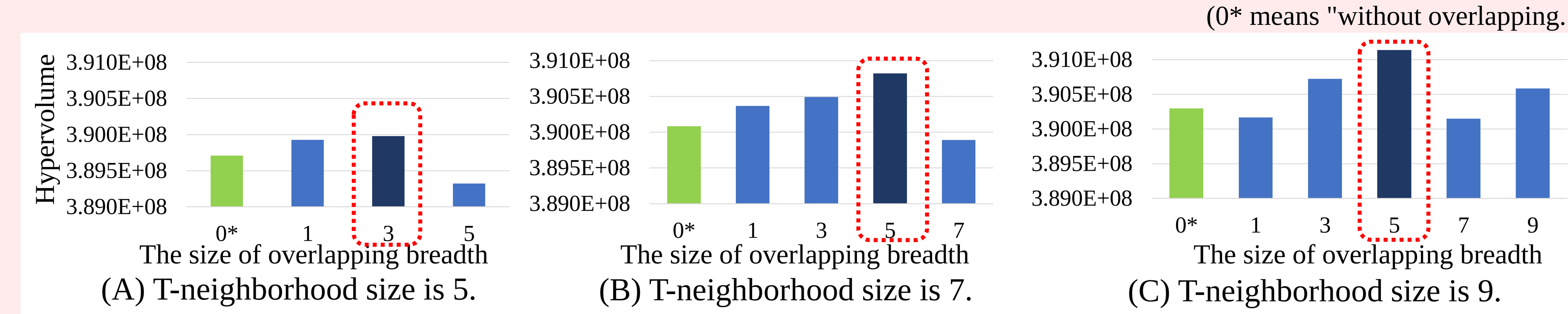

Fig. 6 Comparison of HV values using 8-cores when varying the overlapping zone breadths (1sec execution).

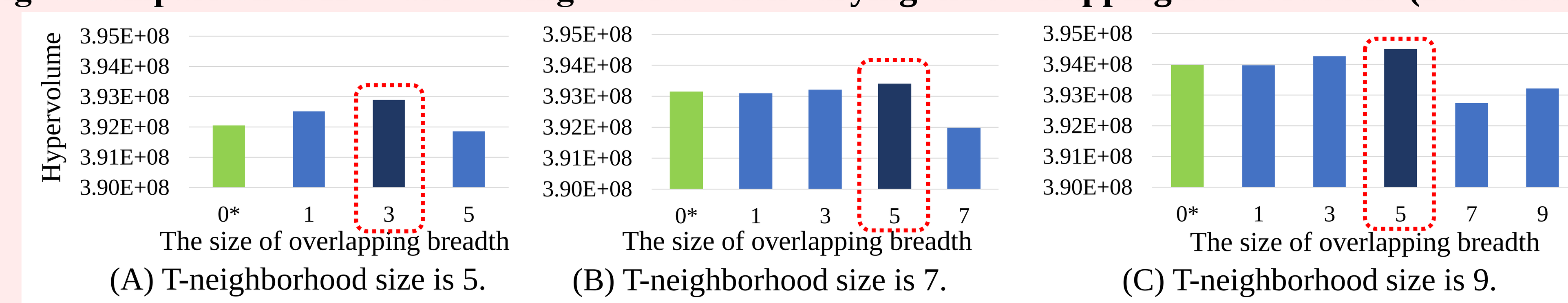

Fig. 7 Comparison of HV values using 16-cores when varying the overlapping zone breadths (1sec execution).

➢ The investigation of suitable overlapping zone breadths for 8, 12, and 16 cores system with T-neighborhood sizes of 9.

(0* means "without overlapping.")

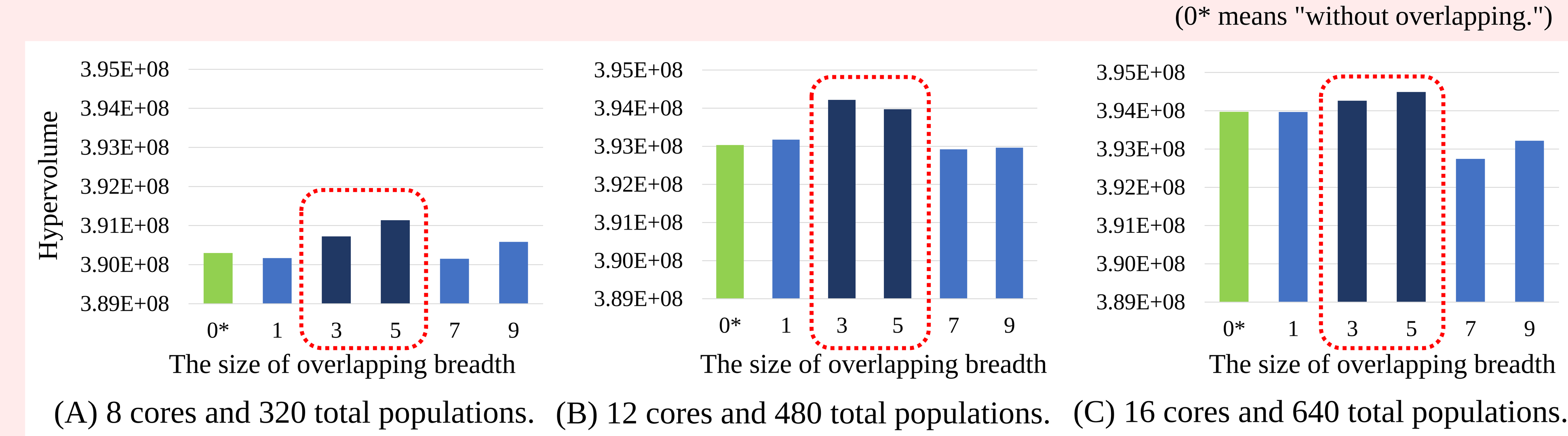

Fig. 8 Comparison of HV values for varying the overlapping zone breadths with T-neighborhood size of 9.

Conclusion

◆ Setting the ***Overlapping Zone Breadth to approximately half of the T-neighborhood size*** yielded the highest HV values.

◆ It can be also seen that with an appropriate overlapping zone breadth ***setting significantly improves the sparse areas*** in the PF, and ***the HV values achieved by the overlapping method are higher than the standard parallelization method***.

Future works

(1)The detailed investigation of the three-objective optimization.

(2) It is necessary to experiment with another application programs for real-world problems.