COMPARISON OF USING SIMPLE GENETIC ALGORITHM ANDPARALLEL GENETIC ALGORITM IN HEAT TRANSFER MODEL OPTIMIZATION

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Abstract: In this paper the comparison of using simple genetic algorithm and parallel genetic algorithm is presented. As the optimization problems the parameter setting of the heat transfer model of a building

and the building's model calibration were chosen. The model simulation requires huge computing capacity and it is time consuming. Therefore the pressure of simulation evaluations number is concerned and the use of parallelism is desirable. Genetic algorithms and parallelization were implemented in Matlab and the simulation of heat transfer model, which is the part of the fitness function, is performed in Comsol

Keywords: genetic algorithm, parallel genetic algorithm, building model optimization, heat transfer, Matlab, Comsol Multiphysics

1 INTRODUCTION

Multiphysics.

Genetic algorithms (GA) are effective stochastic optimization approaches imitating natural evolution process (Sekaj, 2005). Despite the fact, that there has been progress in the area of GA, the premature convergence sometimes occurred and large computing capacity is needed. Especially when more complicated system is to be optimized or a model simulation takes a lot of time. In such cases it's necessary to reduce the number of the cost function (fitness) evaluations (simulations).

There are many options to improve GA's. Most common is to tune GA setting to reach the best algorithm performance. However, it is sometimes not possible to tune the algorithm to be able to achieve a sufficient convergence rate to the global optimum. Therefore another option is to use parallelism. Parallel genetic algorithms (PGA) are able to improve the performance of simple genetic algorithms with a single population (Cantú-Paz, 1995).

This paper presents practical comparison of using simple genetic algorithm (SGA) with a single population and parallel genetic algorithm with population distributed into several interconnected subpopulations.

2 PARALLEL GENETIC ALGORITHM

In parallel genetic algorithms (PGA) the evolution is distributed into many more or less isolated subpopulations, where the transfer of genetic information among these subpopulations

has an important influence on the evolution process. In this case we don't consider

parallelisation into more processors or more computers respectively, which can extend the computational power of the computer system. Let us consider such parallelisation, wich is realised on a single processor or PC.

In our comparison a single GA with 50 individuals in the population and PGA with 5 subpopulations (nodes) with 10 individuals in each subpopulation are experimentally compared. The migrations are performed by replacing a randomly selected individual in the target node (except of the best one) by a copy of the best individual from the source node (best-random policy). The migration in the PGA according to the defined architecture is realized periodically after 5 generations.

The architecture of the considered PGA is depicted in Fig.1 (Cantú-Paz, 2001).

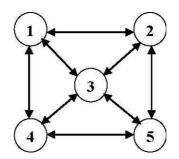


Figure 1: Considered PGA architecture

The genetic algorithm which is used in each node of the PGA and in the SGA is as follows:

- 1 Random population initialization and fitness calculation.
- 2. Selection of individuals :
 - a. Best individuals which are copied into the new population without any change Pop1 (2 in PGA and 5 in SGA)
 - b. Random selection of a group of individuals which are copied without any change into the new population Pop2 (4 in PGA and 30 in SGA).
 - c. Tournament selection of parents Pop3 (4 in PGA and 15 in SGA).
- 3. Mutation and crossover of parents (Pop3) with global mutation rate 0.02, local mutation rate 0.02 and probability of one-point crossover 0.75 Pop3*
- 4. Completion of the new population by unification of the groups Pop1, Pop2 and Pop3*.
- 5. New population fitness calculation.
- 6. Test of terminating condition, if not fulfilled, then jump to the Step 2.

Table 1: Nr. of evaluations required to reach the best solution in heater proportion optimization

	SGA	PGA	PGA/SGA [%]
run 1	480	476	99.2
run 2	510	532	104.3
run 3	450	448	99.5
run 4	420	448	106.7
run 5	540	504	93.4
average	480	481.6	100.4

Table 2: Nr. of evaluations required to reach the best solution in building's model calibration

	SGA	PGA	PGA/SGA [%]
run 1	1980	1036	52.3
run 2	2250	1288	57.2
run 3	2430	1176	48.4
run 4	2160	1232	57.0
run 5	1710	952	55.7
average	2106	1140.8	54.2

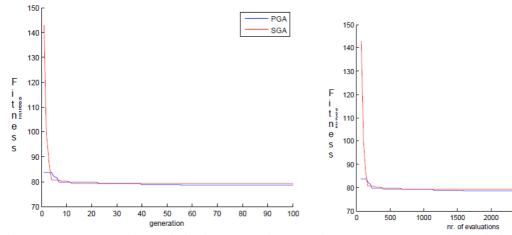


Figure 4: Heater proportion optimization (generations)

Figure 5: Heater proportion optimization (nr. of evaluations)

2500

3000

3500

PGA SGA

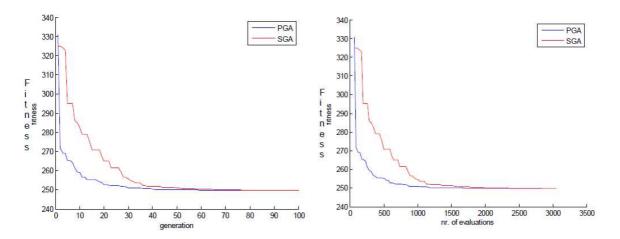


Figure 6: Building's model calibration (generations)

Figure 7: Building's model calibration (nr. of evaluations)

4 CONCLUSION

In the paper the use of PGA and SGA for selected heat transfer optimisation problems are compared. Due to migration and information exchange between nodes, the proper PGA configuration brings decrease of computation time in comparison with using simple GA with a single population. This is true mailny in complex and time consuming optimisation/design applications. Next, PGA is able to decrease the measure of premature convergence (local optimum) and to find better solutions (better sub-optimal or global optimum).

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