POPULATION SIZE ADJUSTMENT OF THE GENETIC ALGORITHM FOR INTEGRATED CIRCUITS ELEMENTS PLACEMENT

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The population size is one of the crucial parameters of the genetic algorithm, which drives to explore the solution space of the problem. There are multiple techniques to manipulate the size of the population, but this study implemented and discussed the remaining lifetime technique which is well suited to the placement problem. The achieved algorithm is tested on various integrated circuits with a different cell quantity, and the results are compared with the genetic algorithm with the same operators without adaptive population size.

Keywords: integrated circuit, placement of elements, genetic algorithms, self-adaptive genetic algorithm, residual resource.

With the development of microelectronic technology and the increase in the integration of integrated circuits (ICs), there is an exponential growth of physical effects and their impact on the operability of the IC, and therefore the importance of developing new ways of solving the placement problem that considers existing relations increases. In the general setting, the placement problem is NP-hard and, in practice, can not be solved exactly. There are several approximate methods for solving the placement problem, one of which is applying genetic algorithm (GA) to find an optimal placement [1, 2].

This paper proposes to adjust the GA population size by adaptive selection of chromosomes. The proposed method is based on the remaining lifetime (RLT) [3] technique. The realization of the said technique, which is well suited to the placement problems, is as follows. Let P be the population pool with the size N_p, and C_i: $i = 1, 2, \ldots, N_p$, and X_j: $j = 1, 2, \ldots, N_j$ be the chromosome and gene in chromosome respectively. The representation of population pool will be $P = [C_1, C_2, \ldots, C_{Np}]$ and $C_i = [X_1, X_2, \ldots, X_{Nj}]$. So, the definition of the problem is to adjust population size by adding better chromosomes in it. Let us assume the quality of the chromosome is calculated by its minimum value of fitness function

$$C^{opt} = min[F(C_i)]. \quad (1)$$

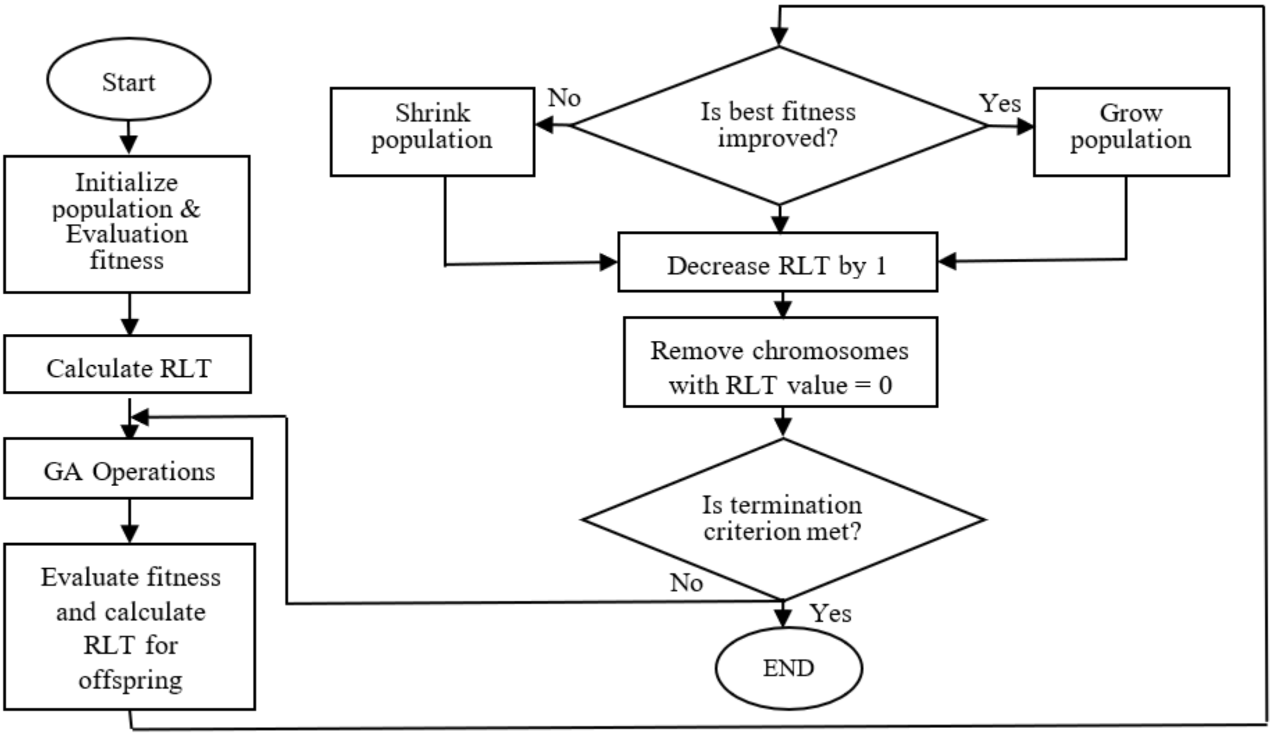
In this case, the population size will be adjust based on the i^{th} chromosome's RLT(i) value, with the condition that if it is equal to 0 then it should be removed from the population. RLT value will be calculated with below formula (2), which is linear interpolation of chromosomes from LT^{min} to LT^{max} based on their fitness value:

$$RLT(i) = LT^{min} + LT^{max} \frac{F^{worst} - F(C_i)}{F^{worst} - F^{best}} \quad (2)$$

where LT^{min} and LT^{max} are the minimum and maximum lifetimes based on the experiments we took 1 and 10 respectively;

F^{best}, F^{worst} are the best and worst fitness values for that iteration.

From formula (2) follows that if the fitness function of the given chromosome tends to F^{worst}, RLT of that chromosome gets closer to LT^{min} value, and the opposite if it tends to F^{best}. Thus, the actual algorithm looks like the diagram below.



Algorithm scheme

The designed algorithm was compared with the fixed population size GA with the same crossover and mutation operators to a cell placement problem with a cell quantity range from 10 to 3000. The termination criteria for both cases were fixed at 15% deviation from the minimum value. The results show that using the RLT technique allows exploring the solution space more quickly and widely, which helps finding the global minimum with less iterations. The experimental results show that the method decreases the iterations by an average of 17.6%.

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Регулювання розміру популяції генетичного алгоритму розміщення елементів інтегральних схем

Розмір популяції є одним з найважливіших параметрів генетичного алгоритму, який спонукає досліджувати простір розв'язків задачі. Існує багато методів управління розміром популяції, але в цій роботі реалізовано й обговорено метод залишкового ресурсу, який добре себе проявляє в задачі розміщення. Отриманий алгоритм був протестований на різних інтегральних схемах з різною кількістю комірок, а результати порівнювалися з генетичним алгоритмом з тими ж операторами без адаптивного розміру популяції.

Ключові слова: інтегральна схема, розміщення елементів, генетичні алгоритми, самоадаптивний генетичний алгоритм, залишковий ресурс.