A Comparison Between Genetic Algorithm and Practical Swarm to Investigate the Reliability Allocation of Complex Network

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Abstract. This paper focuses on the reliability of complex networks, which has been calculated as a complex system by using minimal cuts. The reliability of this system has been assigned to study the possible approaches to reliability values based on the reduction of total costs in this system. The genetic algorithm (GA) has been used to solve the allocation problem. Reliability and ability to solve complex problems and optimization also found in structures of engineering. Generally high implementation costs require high further duplicates. In addition to using GA, optimizing the swarm (PSO) and this algorithm is based on the action of the organisms living that accumulate. PSO is very close to GA because of the fact that these evolutionary approaches are all strategies, Using some probabilistic and some probable values. The main objective of this article is to investigate and compare between two algorithms GA and PSO.

1. Introduction

The reliability of the complex network in this paper [1, 2, 3]. By using the cuts through the contact matrices, the efficiency of this scheme was found. (Node removal method for building minimal path) and Boolean algebra for all paths [4, 5, 6, 7]. The algorithms were used by John Holland and his colleagues and students at the University of Michigan in the mid-1970s to solve the problem of assignment and optimization method reliability, including the genetic algorithm [7, 8, 18]. Often, GA gives very complicated solutions to different problems. GA uses various biological processes, such as inheritance, selection, cross-section, recombination, mutation and reproduction. In its quest for the choice and generation of individuals suited to the environment, the General Assembly uses the theory of 'survival of the fittest'. GA is used to address complex functionality enhancement issues where it is possible to manage both discrete and continuous variables, nonlinear functions and limitations without the need for additional details. Basically, via a concept called (Particle Swarm Optimization), optimization issues can be easily solved. Gerardo Penny and Wang Jing developed the idea of intelligence squadron in 1989, which was inspired by birds, ant colonies, fish education, and animal grazing. In the mid-1990s, Kennedy and Eberhardt developed the optimization of the particle swarm[9].
In the PSO, the fundamental principle is that each particle is a possible response that is modified accordingly using the decision-making process. In the PSO, there are no evolutionary factors such as junction and mutation, but particles are supplied with flights through the problem area by following the perfect current molecules. Due to its many advantages, such as reliability, longevity, efficiency and simplicity, PSO has been used in large numbers. Compared to other random algorithms, less arithmetic effort was found to require PSO [10, 11, 18]. Although PSO has demonstrated its ability in many ways to solve multiple optimization problems, it still takes considerable implementation time to discover solutions to large-scale engineering problems [12, 13]. The PSO vs. GA and the comparative scale are also shown. Posts concluding are included. The purpose of this paper was to study the comparison between the PSO and GA outcomes, and then the efficacy of these algorithms.

2. Optimization of complex system

Consider a complex system consisting of elements connected [1, 3, 15]. The statements are used by us: $0 \leq R_i \leq 1$. The reliability of components is $i : C_i(R_i)$ The Component Costs $i : C(R_1,...,R_n) = \sum_{i=1}^{n} a_i c_i (R_i)$ The Component Costs $a_i > 0$; $R_s$ is the system reliability; RG Is System Reliability Goal.

Every part of the system has a unique functionality and there are lots of possibilities, often system components provide us with the same features but different rates of reliability. The goal is to achieve the allocation of some or all parts of the system for efficiency. In nonlinear programming, the Q issue is included as a major issue [13, 15], a cost-and-function that can be assessed and is a nonlinear limit. Q: Find the

$$\text{Minimize} C(R_i, ..., R_n) = \sum_{i=1}^{n} a_i C_i(R_i), \quad a_i > 0,$$

subject to

$$R_s \geq R_G,$$

$$0 \leq R_i < 1, \quad i = 1, ..., n$$

Assuming that the function of the partial cost is sensible $C_i(R_i)$ meets certain conditions[16] Improving the constructive, differentiated function $[\frac{dC_i}{dR_i} \geq 0]$. The preceding method tries to achieve an all-encompassing cost base [1, 5,17], The stability cap of the device is lower, according to the $R_G$.

2.1 The exponential behavior model

Let $0 \leq R_i < 1, \quad i = 1, ..., n$ and $a_i, b_i$, are constants, $i=1,2,...,n$. The most important cost-function is exponential behavior. It has been suggested in the form of a [4,5,9,10]

$$C_i(R_i) = a_i e^{\left(\frac{b_i}{1-R_i}\right)}, \quad a_i > 0, \quad b_i > 0, \quad i = 1, ..., n$$

The optimization problem becomes the problem:

$$\text{Minimize} \quad C(R_i, ..., R_n) = \sum_{i=1}^{n} a_i e^{\left(\frac{b_i}{1-R_i}\right)}, \quad i = 1,2,...,n.$$

Subject to :

$$R_s \geq R_G,$$

$$0 \leq R_i < 1, \quad i = 1, ..., n$$

3 Solving the optimal reliability allocation by using PSO

PSO optimizes an objective function by means of a population based search. Populations it consists of possible alternatives, called particles, which are a bird in the ock yeah, metaphor. These particles are initialized randomly and $y$ is initialized through the multidimensional. Free exploration of space [13]. Each particle updates its own speed and
velocity throughout the eight place, based on the entire population's own and nest experience. The updating policy pushes the swarm of particles to migrate into the region with the higher objective function value, and all particles will eventually gather at the largest about the point, objective value.

3.1 PSO Method
An individual population is a particle swarm, each of which contains the necessary a number of characteristics or values to place it in the problem space of a swarm. The person's neighborhoods are arranged in which they can share information [7, 8]. The neighborhoods, "The set of points surrounding a specified point each inside is mathematical definition". "A specified distance from the specified point. For instance, the bit string "01110" is It is composed of 5 bits. Let bit number 3 (the middle bit) be the given point. The entire bit series, two on the left and two on the left, will include a size 3 neighborhood. The Right One. Like ANN, these neighborhoods may themselves have different topologies. While these topologies are largely divorced from ANN topologies. Typical topologies are topologies of circular or star-shaped in the vicinity of the particle swarm.

3.2 Algorithm of PSO
Step-1 : Initialize the particles with certain arbitrary speeds and speeds in the search space positions.
Step-2 : Start to measure the respective value of the swarm particles' fitness function.
Step-3 : Equate the value of the fitness with the present value of the p best of a particle. If the present value is higher than p best, set it as a fresh p best value and view the p best position to the present place in n-dimensional space;
Step-4 : The value of fitness is next best matched to the previous general value. If the present is the value is higher than g best, reset g best to the current value index and value collection of particles;
Step-5: Finally, allocate these values to the respective location of the swarm particle and The pace.
Step-6 : end.

4 Solving the optimal reliability allocation by using GA
The genetic algorithm is a well-known stochastic iterative search method based on iterative search. On Charles' evolutionary theory of the best survival” and natural genetics Darwin. GA is effectively applied to various problems such as engineering design, durability, optimization, optimal supervision, transport problems and allocation the important the genetic algorithm idea is to imitate, through genetic variables such as crossover, mutation and selection, the process of natural evolution witnessed artificially by the continuous population modifies cations. Definition GA was first proposed by Michigan Prof. John Holland's University [2]. A researcher subsequently developed a significant contribution to the development of significant of this field. Using programming from computers, the genetic algorithm can be applied quickly. The GA is in particular, used to solve the complex problems of optimization that guide or gradient mathematical techniques can't be solved easily [9].

4.1 GA Method
A population of solutions for a candidate (called persons, species, or phenotypes) to a in a genetic algorithm, the optimization problem is built for better alternatives. Every one there are a variety of features in the candidate solution (its chromosomes or genotype) alternatives are usually represented as 0s and 1s, which can be mutated and changed. Binary strings, but other encodings are also feasible [14] Evolution normally starts with a population of randomly generated individuals and an iterative strategy, with the generation in each iteration is called the population. Each individual's fitness in each generation, the population is evaluated; fitness is generally the value of the objective function in solving the optimization problem. The more people from the existing population and the genome of each individual are selected stochastically. A new generation is changed (recombined and possibly spontaneously
mutated) to shape. The next version of the algorithm uses a new generation of alternatives for candidates. The algorithm usually stops when there is a maximum number of generations. The population has been produced or has reached a satisfactory level of fitness.

4.2 Algorithm of GA
Step-1 : Set population size (p-size), reliability (p-cross), reliability of mutation(p-mute), peak generation (max-gen ) and variables boundaries.
Step-2 : Initialize Ri reliability (Ri represents the J-th generation population) individual population elements.
Step-3 : Evaluation of each component's cost function Ri Consider the aim function as a function of expense.
Step-4 : For the population of Ri, find the greatest reliability.
Step-5 : If the criteria for termination has been met, go to Step-12, or go to the criterion for termination.
   The next step.
Step-6 : Population selection Ri Population iteration j Ri iteration k, by previous population iteration j tournament Selection Generation Process.
Step-7 : Change the population of Ri by operators of transformation, mutation, and elitism.
Step-8 : Evaluate the value of each Ri cost function.
Step-9 : For each component, find the largest reliability.
Step-10: Compare and store the highest output of each Ri iteration variable j and better efficiency of each element of the iteration j.
Step-11 : Print out the greatest reliability of each variable (which is the solution to the optimization problem).
Step-12 : End.

5. Application to complex network
The complicated apparatus seen in Fig. (1) For all its computers at 90 percent specified periods, it has the same primary reliability. [15]. At a given time, the system stability target is 90%. The efficiency polynomial of the stated process was calculated by using the Minimal cut sets. [14].

\[
R_c = R_1R_3 + R_2R_4 + R_3R_6 + R_4R_7 + R_5R_8 + R_6R_9R_10 + R_7R_11R_12 - R_1R_2R_3R_4 - R_1R_1R_2R_3 - R_2R_3R_4R_5 - R_2R_3R_4R_5 - R_3R_4R_5R_6 - R_4R_5R_6R_7 - R_5R_6R_7R_8 - R_6R_7R_8R_9 - R_7R_8R_9R_{10} - R_8R_9R_{10} + R_2R_3R_4R_5R_6 - R_1R_2R_3R_4R_5R_6 - R_2R_3R_4R_5R_6 - R_3R_4R_5R_6R_7 - R_4R_5R_6R_7R_8 - R_5R_6R_7R_8R_9 - R_6R_7R_8R_9R_{10} \]

-\[+ R_1R_2R_3R_4R_5R_6R_7 - R_1R_2R_3R_4R_5R_6R_7 - R_2R_3R_4R_5R_6R_7 - R_3R_4R_5R_6R_7R_8 - R_4R_5R_6R_7R_8R_9 - R_5R_6R_7R_8R_9R_{10} - R_6R_7R_8R_9R_{10} - R_7R_8R_9R_{10} - R_8R_9R_{10} + R_1R_2R_3R_4R_5R_6R_7 - R_1R_2R_3R_4R_5R_6R_7 - R_2R_3R_4R_5R_6R_7 - R_3R_4R_5R_6R_7R_8 - R_4R_5R_6R_7R_8R_9 - R_5R_6R_7R_8R_9R_{10} - R_6R_7R_8R_9R_{10} - R_7R_8R_9R_{10} - R_8R_9R_{10} + R_1R_2R_3R_4R_5R_6R_7 - R_1R_2R_3R_4R_5R_6R_7 - R_2R_3R_4R_5R_6R_7 - R_3R_4R_5R_6R_7R_8 - R_4R_5R_6R_7R_8R_9 - R_5R_6R_7R_8R_9R_{10} - R_6R_7R_8R_9R_{10} - R_7R_8R_9R_{10} - R_8R_9R_{10} + R_1R_2R_3R_4R_5R_6R_7 - R_1R_2R_3R_4R_5R_6R_7 - R_2R_3R_4R_5R_6R_7 - R_3R_4R_5R_6R_7R_8 - R_4R_5R_6R_7R_8R_9 - R_5R_6R_7R_8R_9R_{10} - R_6R_7R_8R_9R_{10} - R_7R_8R_9R_{10} - R_8R_9R_{10} + R_1R_2R_3R_4R_5R_6R_7 - R_1R_2R_3R_4R_5R_6R_7 - R_2R_3R_4R_5R_6R_7 - R_3R_4R_5R_6R_7R_8 - R_4R_5R_6R_7R_8R_9 - R_5R_6R_7R_8R_9R_{10} - R_6R_7R_8R_9R_{10} - R_7R_8R_9R_{10} - R_8R_9R_{10} + \]

![Figure 1: Complex network](image)
6. Optimal Reliability Allocation

Through applying optimization of particle swarm and the genetic algorithm, the success of the reliability allocation was to (complex network). The outcomes were in the device reliability distribution is seen in the table below:

| Components | Algorithm Particle Swarm | Genetic Algorithm |
|------------|--------------------------|-------------------|
| R_1        | 0.799                    | 0.791             |
| R_2        | 0.855                    | 0.99              |
| R_3        | 0.68                     | 0.785             |
| R_4        | 0.519                    | 0.789             |
| R_5        | 0.602                    | 0.683             |
| R_6        | 0.653                    | 0.811             |
| R_7        | 0.739                    | 0.68              |
| R_8        | 0.755                    | 0.785             |
| R_9        | 0.811                    | 0.838             |
| R_10       | 0.774                    | 0.832             |
| R_{system} | 0.901                    | 0.984             |

Figure 2: Reliability allocation by using GA and PSO with the given exponential behavior model.

7. Results and discussion

The results were obtained using as shown the Particle Swarm Optimization yeah, in Fig.(2). The findings revealed that the distribution contains all the components of the allocation a dynamic structure, each based on its place in the system. The highest component 2 distribution, the value of which was (0.855), while the lowest was (0.519), part 4 is assigned (0.519). Data were obtained using Genetic Algorithm Optimization as shown in Fig.(2).
While the results demonstrate that all the elements of a dynamic distribution are included in the distribution network, each of which depends on its location on the unit. The largest value of component 2 is allocation (0.99), while the lowest value allocation for part 7 is (0.68).

8. Conclusion
The optimization of the network in this article, by assigning each factor of reliability, the problem was explored as a nonlinear programming problem with an exponential behavior model (cost function) and active constraints (complex network reliability system). Using the genetic algorithm and optimization of the particle swarm, all results in the solution field were appropriate. The findings of the genetic algorithm, however, were more successful than the optimization of the particle swarm. The allocation was GA $Rs = 0.984$ and the allocation was PSO $Rs = 0.901$.

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