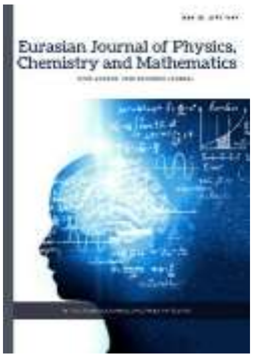

Improving the system using the bee algorithm and the ant algorithm and comparing them

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ABSTRACT

In The allocation of reliability and optimization for each part of the complex system has been determined in this paper, in order to solve the problem of allocation and to improve network stability we will use Bees Colony Optimization (BCO) and the ant colony optimization (ACO) algorithm. The three cost functions are also introduced (exponential behavior with feasibility factor model, exponential behavior model and logarithmic model). After solving the allocation problem. The aim of this paper is to compare the effects of the three cost functions using Bees Colony algorithm and the ant colony optimization algorithm in terms of reliability allocation and optimization to determine which is more efficient.

Keywords:

1. Introduction

The present article, we watched the installed complex system's efficiency. By using limited paths across relation matrices, this system was found to be efficient. (To create minimum paths, remove nodes) as well as Boolean algebra. The goal of evaluating to be learn about the protection of the sophisticated unit that has been built [1-3]. Despite the networks' foundations, the optimum distribution dependability is treated as a mathematical task in this research. Each and every dynamic component Each device offers a unique set of features. dependability standards that are optimized and reliant on its importance [2, 4-6]. In order to achieve the highest level of efficiency in general, depending on the allocation of every element in the System, which varies between the component and the component, such components may require large allocations. Engineers working on improving mechanical and electrical systems encounter a variety of challenges [7]. The focus of this work is on complicated structure allocation and improvement, in addition to the cost system, which can be assessed in terms of size, and proportion, or other criteria. The dependability of this component is based on two keys needs. To begin, the model should be used to determine the input variable reliability. You will change the parameters of the suggested cost parameter [3, 8-10]. Engineers may now upgrade their duties for each machine and prepare for the utmost Each device's productivity, second, the model's analytical performance should be balanced of the input system. This can be a huge difficulty in simple structures, but it can be In complex systems, this is a significant issue [11]. The expenses are calculated using the Bees Colony Optimization algorithm (BCO) and the ant colony optimization (ACO) algorithm which uses [2] complex systems to solve optimization problems. The algorithm uses three cost functions " Modeling activity exponentially with the viability factor, The exponential behavior paradigm and a logarithmic model". The goal is to improve device reliability while lowering total expenses.

2. Optimization of the complex network

Think about a sophisticated network made up of parts. [2-4]. We are reliant on statements.: $0 \le R_i \le 1$ dependability of a component i ; $C_i(R_i)$ the Individual Costs, Components i , C $(R_1,\ldots,R_n) = \sum_{i=1}^{n} a_i c_i$ (Ri) Parts' Prices $a_i > 0$; The effectiveness of the system is measured in R_s , the device's reliability objective is denoted by the letter RG. Each component of the scheme has a distinct goal, and there are several options. Device modules have their own set of features. varying levels of assurance in the same characteristics. The objective is to ensure that any or all gadget components are trustworthy. The Q issue is a non-linear threshold with an evaluable cost and function [12-15]. Seek out

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

within the terms of

$$R_G \le R_S$$
$$0 \le R_i < 1, i = 1, \ldots, n.$$

Let's pretend the cost function is appropriate.. $C_i(R_i)$ satisfies those requirements [12, 16]. The favorable, unique role is being improved.

$$\left[\Rightarrow \frac{dC_i}{dR_i} \ge 0\right].$$

The goal of the prior strategy was to achieve a cost basis that included everything [2, 4]. The stability limit of the system has been lowered. However It's in the vicinity the scope of R_G.

3. Application to complex network

All components in the complex network illustrated have the same as in fig. (1) primary trust level of 90% at the specified periods [11]. The system's aim for stability is 90 percent at any given time. The dependability polynomial for the proposed technique was found using the approach to minimal path [14].

$R_S = R_1R_9 R_{10} + R_2 R_8 R_{10} + R_2R_5R_7R_{10} + R_3R_4R_7R_{10} + R_1R_6R_8R_{10} + R_2R_6R_9R_{10} - R R_2R_6$
$R_8 R_{10} - R_1 R_2 R_6 R_9 R_{10} + R_1 R_5 R_6 R_7 R_{10} - R_1 R_2 R_8 R_9 R_{10} + R_3 R_4 R_5 R_8 R_{10} - R_2 R_5 R_7 R_8$
$R_{10} - R_1 R_6 R_8 R_9 R_{10} - R_2 R_6 R_8 R_9 R_{10} - R_1 R_2 R_5 R_6 R_7 R_{10} - R_2 R_3 R_4 R_5 R_7 R_{10} - R_2 R_3 R_4 R_5 R_8 R_{10} - R_1 R_2 R_5 R_7 R_9 R_{10} - R_1 R_3 R_4 R_7 R_9 R_{10} - R_2 R_3 R_4 R_7 R_8 R_{10} + 2R_1 R_2 R_6 R_8 R_9 R_{10} - R_1 R_5 R_6 R_7 R_8 R_{10} + R_3 R_4 R_5 R_6 R_9 R_{10} - R_3 R_4 R_5 R_7 R_8 R_{10} - R_1 R_5 R_6 R_7 R_9 R_{10} -$
$R_2 R_5 R_6 R_7 R_9 R_{10} - R_1 R_3 R_4 R_5 R_6 R_7 R_{10} - R_1 R_3 R_4 R_5 R_6 R_8 R_{10} - R_1 R_3 R_4 R_5 R_6 R_9 R_{10} +$
$R_1 R_2 R_5 R_6 R_7 R_8 R_{10} - R_1 R_3 R_4 R_6 R_7 R_8 R_{10} - R_2 R_3 R_4 R_5 R_6 R_9 R_{10} + 2R_2 R_3 R_4 R_5R_7 R_8 R_{10} + 2R_1 R_2 R_5 R_6R_7 R_9 R_{10} - R_1 R_3 R_4 R_5 R_8 R_9 R_{10} - R_2 R_3 R_4 R_6 R_7 R_9 R_{10} + R_1 R_2 R_5 R_7 R_8 R_9 R_{10} - R_3 R_4 R_5 R_6 R_7 R_9 R_{10} - R_3 R_4 R_5 R_6 R_8 R_9 R_{10} + R_1 R_5 R_6 R_7 R_8 R_9 R_{10} + R_2 R_5 R_6R_7 R_8 R_9 R_{10} + R_1 R_2 R_3 R_4 R_5 R_6 R_7 R_{10} + R_1 R_2 R_3 R_4 R_5 R_6 R_8 R_{10} + R_1 R_2 R_3 R_4 R_5 R_6 R_9R_{10} + R_1 R_2 R_3 R_4 R_5 R_7 R_9 R_{10} + R_1 R_2 R_3 R_4 R_6 R_7 R_8 R_{10} + R_1 R_2 R_3 R_4 R_5 R_8 R_9 R_{10} + R_1 R_2 R_3 R_4 R_6 R_7 R_9 R_{10} + R_1 R_2 R_3 R_4 R_7 R_8 R_9 R_{10} + 2 R_1 R_3 R_4 R_5 R_6 R_7 R_8 R_{10} +$
$2 R_1 R_3 R_4 R_5 R_6 R_7 R_9 R_{10} + 2 R_1 R_3 R_4 R_5 R_6 R_8 R_9 R_{10} + 2 R_2 R_3 R_4 R_5 R_6 R_7 R_9 R_{10} +$
$R_1 R_3 R_4 R_5 R_7 R_8 R_9 R_{10} + R_2 R_3 R_4 R_5 R_6 R_8 R_9 R_{10} - 2 R_1 R_2 R_5 R_6 R_7 R_8 R_9 R_{10} +$
$R_1 R_3 R_4 R_6 R_7 R_8 R_9 R_{10} + R_2 R_3 R_4 R_6 R_7 R_8 R_9 R_{10} + R_3 R_4 R_5 R_6 R_7 R_8 R_9 R_{10} -$
$2 R_1 R_2 R_3 R_4 R_5 R_6 R_7 R_8 R_{10} - 3 R_1 R_2 R_3 R_4 R_5 R_6 R_7 R_9 R_{10} - 2 R_1 R_2 R_3 R_4 R_5 R_6 R_8 R_9 R_{10} - 2 R_1 R_2 R_3 R_4 R_5 R_7 R_8 R_9 R_{10} - 2 R_1 R_2 R_3 R_4 R_6 R_7 R_8 R_9 R_{10} - 3 R_1 R_3 R_4 R_5 R_6 R_7 R_8$
$R_9 R_{10} -2 R_2 R_3 R_4 R_5 R_6 R_7 R_8 R_9 R_{10} + 4 R_1 R_2 R_3 R_4 R_5 R_6 R_7 R_8 R_9 R_{10}$

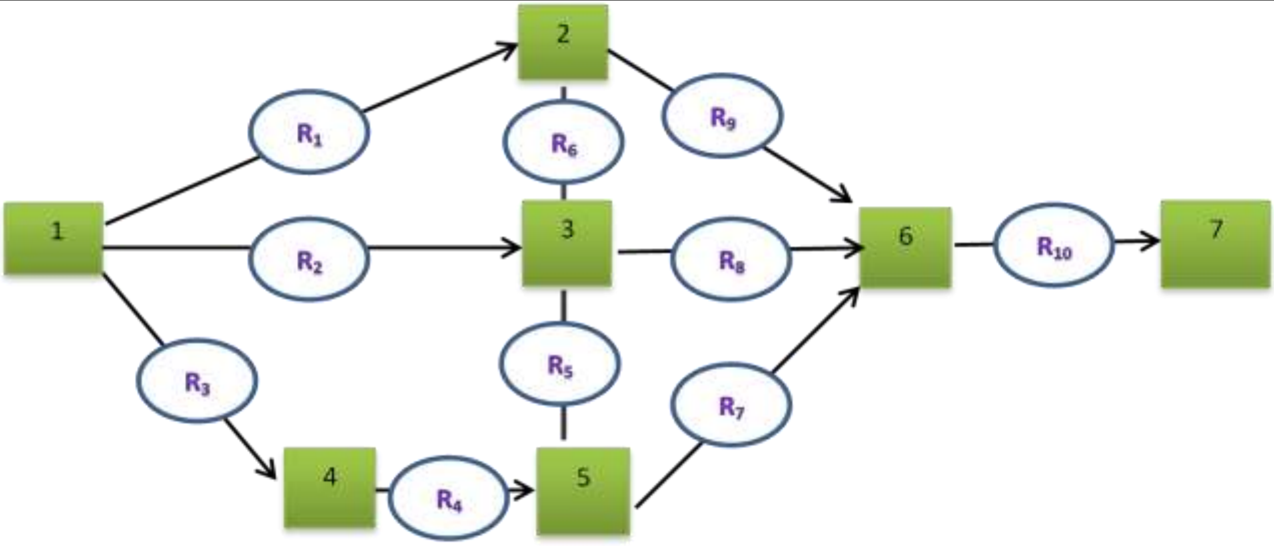

Figure 1: Complex Network

4. Three significant cost models for reliability

4.1 Model of exponential behavior with a feasibility parameter

Suppose $0 < f_i < 1$ be the feasibility factor, $R_{i,min}$ be minimum reliability[5,17] and $R_{i,max}$ be maximum reliability[3,4]. Exponential behavior is another important cost function.

$$C_i(R_i) = \exp[(1-f_i)\frac{R_i - R_{i,min}}{R_{i,max} - R_i}],\ R_{i,min} \le R_i \le R_{i,max}\ , i = 1,2,3,\ldots,n. \quad (4.1)$$

The issue of optimization then:

Minimize $C(R_i,\ldots,R_n) = \sum_{i=1}^{n} a_i\ \exp[(1-f_i)\frac{R_i - R_{i,min}}{R_{i,max} - R_i}], i = 1,2,\ldots,n.$

Subject to:

$$\text{Rs} \ge R_G$$

$$R_{i,min} \le R_i < R_{i,max}\ , i = 1,\ldots,n.$$

Table 1: The Optimal Reliability Allocation (ACO, BCO).

Components	BCO	ACO
R_1	0.85675	0.88761
R_2	0.91404	0.88761
R_3	0.805	0.81776
R_4	0.86674	0.87665
R_5	0.77627	0.81568
R_6	0.78884	0.61178
R_7	0..86263	0.84618
R_8	0..775	0.75824
R_9	0.91404	0.87665
R_{10}	0.91404	0.9133
R_S	0..90555	0.90166

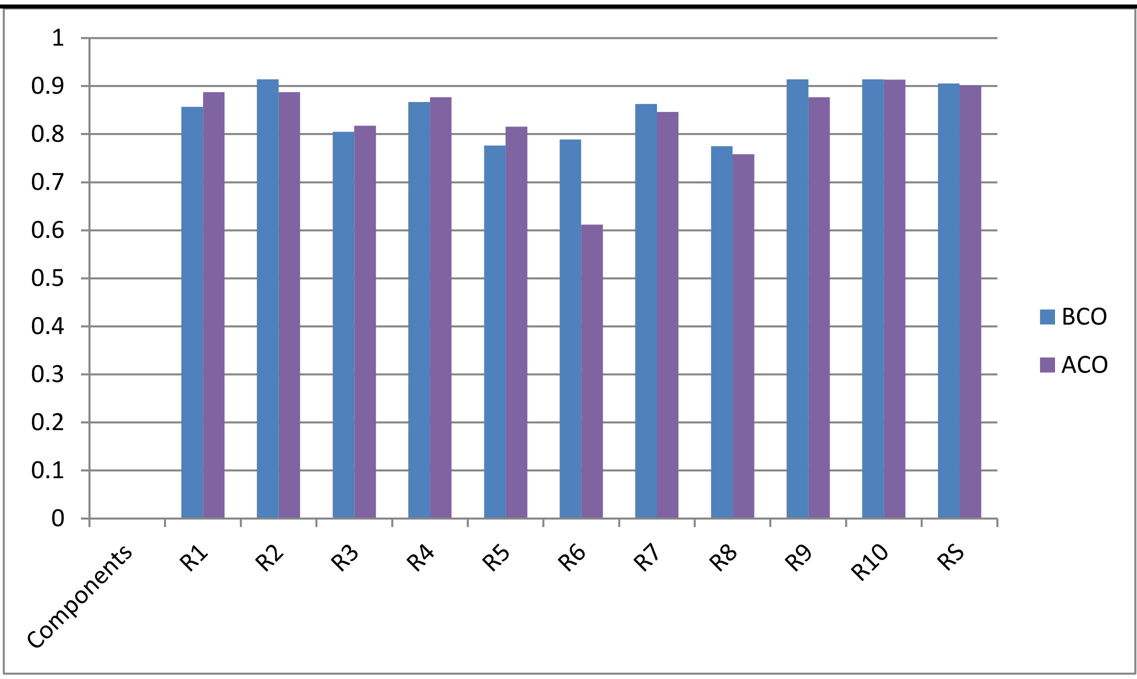

Figure 2: Allocation of reliability utilizing the given feasibility factor model and ACO and BCO.

4.2 Exponential behavior model

Suppose $0 \le R_i$, and $R_i \le 1$ and, [9,15] Constants a_i and b_i, where $i = 1, \dots, n$.. The exponential procedure is the most important cost function. Suggested it in the following format:

$$C_i\ (R_i) = a_i e^{\left(\frac{b_i}{1-R_i}\right)}, a_i > 0\ , b_i > 0\ , \quad \text{where} \quad i = 1, \dots, n. \qquad (4.2)$$

The issue of optimization then:

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

Subject to:

$$R_G \le\ R_S$$
$$0 \le R_i < 1, i = 1, \dots, n.$$

Table 2: The Optimal Reliability Allocation (ACO, BCO).

Components	BCO	ACO
R_1	0.863	0.88761
R_2	0.877	0.88761
R_3	0.87131	0.81776
R_4	0.87117	0.87665
R_5	0.825	0.81568
R_6	0.912	0.61178
R_7	0.912	0.84618
R_8	0.876	0.75824
R_9	0.79158	0.88761
R_{10}	0.912	0.9133
R_S	0.90461	0.90222

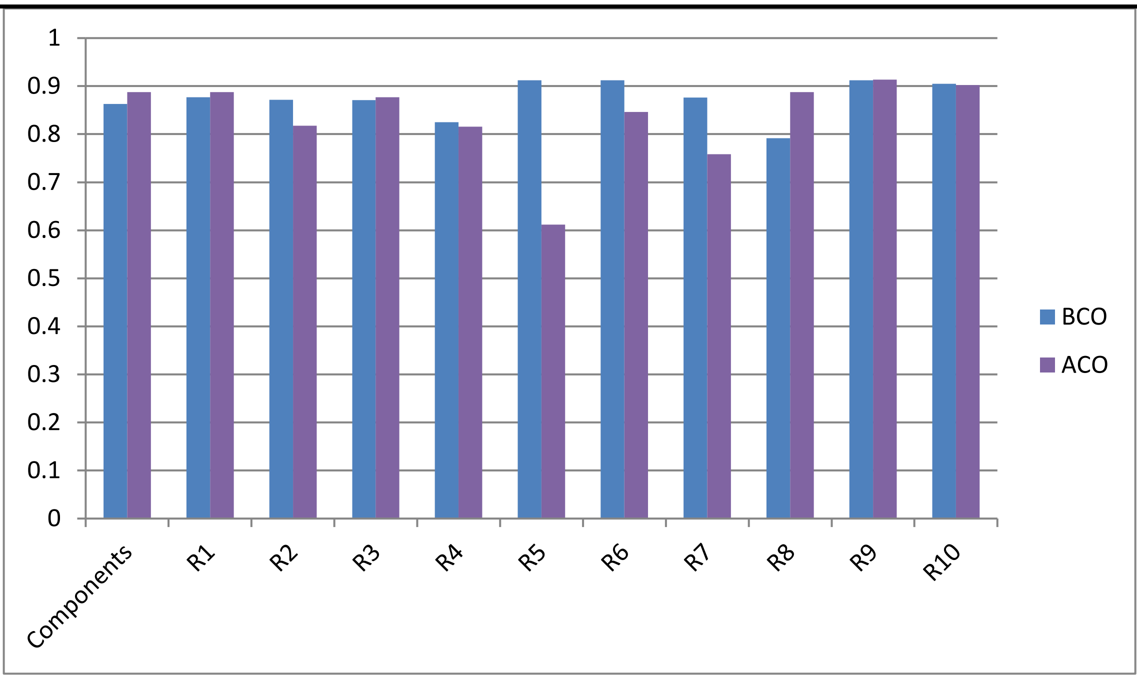

Figure 3: Utilizing ACO and BCO to allocate reliability using the exponential behavior model.

4.3 Logarithmic model

Let $0 \le R_i$, and $R_i \le 1$ and, Constants a_i where $i = 1, \dots, n$. Let's suppose it in the form

$$C_i(R_i) = a_i \ln\left(\frac{1}{1-R_i}\right), a_i > 0\ ,\ i = 1, \dots, n \qquad (4.3)$$

The issue of optimization then.:

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

Subject to:

$$R_G \le R_S$$
$$0 \le R_i < 1, i = 1, \dots, n. \ .$$

Table 3: Table for (ACO , BCO) -Based Optimal Reliability Allocation

Components	BCO	ACO
R_1	0.997	0.94267
R_2	0.852	0.994
R_3	0.55	0.54326
R_4	0.586	0.61
R_5	0.57	0.56
R_6	0.592	0.86697
R_7	0.637	0.738
R_8	0.997	0.912
R_9	0.977	0.994
R_{10}	0.997	0.999
R_S	0.99564	0.99818

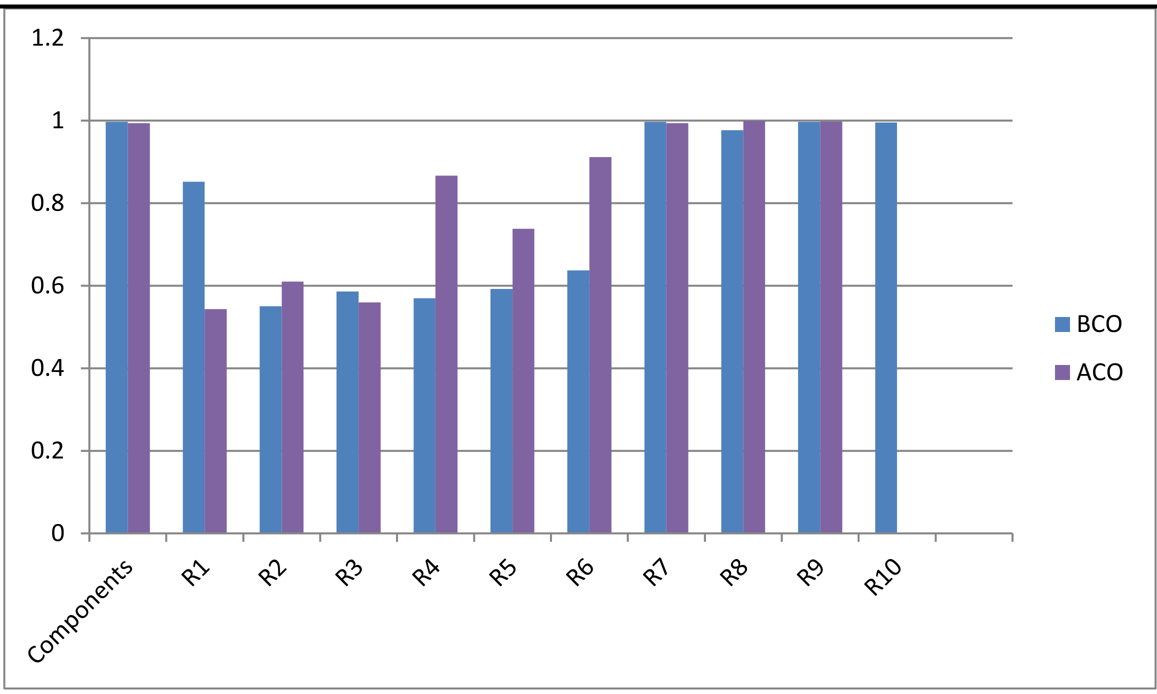

Figure 4: Utilizing ACO and BCO to allocate reliability using the provided Logarithmic model

5. Conclusions

In this paper, the optimal reliability allocation by to optimally distribute reliability for each component of the system was calculated using algorithms (ACO and BCO), in addition to calculating the exact reliability Rs. After solving the problem of system's component assignment and optimization, the results are generally better in terms of BCO assignment than ACO. The highest component allocation was through the use of the cost function (*logarithmic model*) where Rs in the ant algorithm it was equal to (0.99818), while in the Bees Colony Optimization algorithm it was equal to (0.99564), The cost function *exponential behavior model* was used to determine the lowest allocation to the system's parts; Rs in the ant colony optimization algorithm was equal to (0.90461) and (0.90222) in the Bees Colony Optimization algorithm technique, as indicated in Table (1, 2, 3).

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