International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 24 (2017) pp. 14964-14969

Performance Analysis of Novel Hybrid A-BAT Algorithm in Crowdsourcing Environment

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Abstract

In the crowdsourcing environment query optimization is the biggest problem. In order to optimize the quires, Meta heuristics techniques are used. Artificial bee colony (ABC) algorithm is an optimization algorithm which has low, merging speed. Another meta-heuristic algorithm is bat algorithm. BAT is good at exploitation and poor at exploration. This work is to hybrid the presentation of ABC algorithm and bat algorithm in order to overawe the limitations, to improve the convergence speed, and the optimal accuracy. In this proposed work, a new hybrid ABC BAT algorithm that contains a preprocessing method, which is used to derive the information from the Crowdsourcing systems. Random walk phase has been used in this algorithm. The simulation endings show that the presentation of the hybrid A-BAT algorithm and that is compared to GA, PSO algorithms. It is clearly obvious that the new Hybrid algorithms outperform the other algorithms. The proposed algorithm improves the optimization accuracy, better performance in convergence rate, cost and time. The simulation results show that the hybrid A-BAT algorithm have the superior conclusion than the existing algorithms.

Keywords: Swarm intelligence; ABC, PSO, GA, BAT, Query Optimization, Crowdsourcing

INTRODUCTION

There are numerous modern meta-heuristic algorithms for resolving combinations and numeric optimization problems [1]. By considering the criteria such as population-based, iterative based, stochastic, deterministic, etc. These algorithms categorized into different groups. While an algorithm functioning with a couple of results and managing to make better, is called population-based, the usage of multiple repetitions to approach the result required is an iterative algorithm. If an algorithm implies a probabilistic rule for giving the result better it is called probabilistic or stochastic. Other than this, classification can also be made dependent on the nature of miracle simulated by the algorithm. These are mainly classified into two main groups, (population-based algorithms) evolutionary algorithms (EA) and swarm intelligence based algorithms. The well-known EA is a Genetic Algorithm (GA). GA works on simulating the remarkable development of natural evolution. In natural evolution, all species search for promoting variations in a continuously varying atmosphere.

MATERIALS AND METHODS

Queries results are produced by accessing relevant database and manipulating it in a way that yields the important information [14], [15]. Since in most particular cases database structures are complex, for not very simple queries, the needed data for a query can be collected from a database by accessing it in different ways, through different data-structures, and in different orders. The Rise of Crowdsourcing [18]. Among the past couple of years crowdsourcing has ended up in style among firm, foundations and colleges. Crowdsourcing is the new method of using the power of people in projects, which usually requires a large number of people. Crowdsourcing is also meant to reach a wide range of people, which may sometimes be required to obtain a solution correctly and efficiently [16], [17].

Nature has always been an encouragement for researchers. One of the best meta-heuristic algorithms is the artificial bee colony (ABC) algorithm in the literature. Karaboga suggested the ABC algorithm in 2005 [2] by observing the smart behavior of honey bees. Bees exhibit some intelligent behavior while they perform their tasks such as foraging, navigation, and task selection. The foraging mechanism as one of these tasks is more significant because the ABC algorithm was improved by mimicking food searching behavior of honey bees. In the mechanism of foraging, honey bees are divided into three groups depending on their task; that is, employed onlooker and scout bees. Employed bees fly on a source and exploit that source, while onlooker bees select a source with respect to the dance performed by the employed bees, and scout bees randomly search a new place by using internal motivation or possible external clues.

In the history, such a lot of new nature enthused algorithms are developed to overcome the issues in optimization. Many versions of ABC and their improvements may be found in the literature (E. Gerhardt and H. Gomes, 2005; D. Karaboga and B. Basturk,2008; Abraham et al, 2012……..).

Uma et al [3] studied the problem of discovering interaction pattern in the semantic knowledge. Author enhanced the ABC algorithm using the partial least square mechanism (PLS). The frequent interactions made by the algorithm are used to reduce the execution time. The enhanced ABC algorithm is used for interpretation of human behavior. Priya et al [4] studied the problem of information retrieval. The authors try to improve the searching efficiency using the Hybrid Genetic algorithm-Particle swarm optimization. The New HGAPSO algorithm helps to improve the results. The fitness function used in the algorithm gives the more sophisticated result.

Saudi et al [5] focused on constrained optimization problems. To overcome the insufficiencies in ABC algorithm author try to implement a new algorithm efficient constrained Artificial Bee Colony Algorithm. Smart flight operator is used in the scout bee phase. The e-ABC algorithm is tested on several constrained benchmark problems. EABC algorithm is a competitive one.

Sandeep et al [6] focused the search procedure in ABC Algorithm. ABC is one of the population-based technique. ABC algorithm has some drawbacks in the search procedure. So author introduces a new search method that is used to balance the convergence capability and diversity. The steps in employed bee phase and onlooker bee phase are changed with the support of a memetic algorithm. The memetic algorithm is used for fitness calculation and probability calculation. The author proposed improved memetic ABC algorithm that is superiority than other ABC algorithm.

Bat algorithm (BA) was proposed by Yang in 2010 [7]. It is considered a new meta-heuristic algorithm for continuous optimization. BA is based on the capability of bats to find their food and different types of insects even in the full darkness. BA has established to perform some well-known nature-inspired optimization methods like GA, and PSO algorithms [8]. BA is applied in continuous optimization in the context of engineering design optimization.BAT algorithm is more essential one to designing the context of continuous optimization problems. Highly nonlinear problems are solved efficiently with the help of BA algorithm and can find out the optimal solutions accurately [9]. BA can handle multi-objective problems are handled effectively by the BAT algorithm [10], [11].

In the literature have many other variations of PSO were proposed for other optimization problems, (Cui, 2009; Yang, 2010; Yang and Deb, 2010; Yang et al., 2011; Yang et al.., 013).

The remaining section of the paper is arranged as follows: Section 1 presents the Artificial Bee Colony Algorithm; Section 2 presents the BAT (BA) algorithm; Section 3 presents the Genetic Algorithm (GA) algorithm; Section 4 presents the PSO algorithm; Section 5 presents devoted for the proposed models and its implementation. Results are discussed in section 6.In section 7, the main conclusions of the work are presented.

Hybrid A-BAT Algorithm

The standard ABC algorithm had disadvantages of easily prematurely falling into local optima and slow convergence rate in later stage [2, 12, and 13]. So that we are using random walk step in this place. The New Algorithm is named as Hybrid A-BAT Algorithm. The initial food sources are produced randomly in the search space due to dissimilar problems. In the employed bee stage, worker bees search for the local optimization value in the neighborhood of food source. Generally, different local food hunt strategies will are utilized for various issues. In our paper, Random walk of BAT algorithm is applied in the place of onlooker bee phase. In the onlooker bee phase, the random selection process will be utilized here to search for local optimization value in the neighborhood of food source and the higher probability solution will be preferred by onlooker bees.

A random walk with direct exploitation is used for the local search that corrects the current best solution. ε denotes path and intensity of random-walk that is known as scaling factor. The process for updating the position of the bats and the velocity is parallel to that of the PSO (Particle Swarm Optimization) algorithm. In this way, the BAT algorithm can be seen as a well-known equilibrium between the standard Particle swarm optimization algorithms. The intensive local search controlled by the loudness and pulse rate. The local search is propelled with the proximity relying upon the rate ri of pulse emission for the i-th bat. When the bat discovered its prey decrease loudness and rising the pulse emission. The loudness can be preferred as any value of expediency. The Hybrid A-BAT Algorithm [19] has 3 stages they are the initialization of food sources, optimization phase, and Random walk phase.

The procedure of Hybrid A-BAT

The input control parameters of ABC are set as:

Colony Size, CS=5, and

Dimension of the problem, D = 2

Limit of scout is calculated as

$$LS = \frac{size\,of\ colony * d}{2} = \frac{5*2}{2} = 5$$

Control parameters of BAT are set as:

Pulse rate r_i^t and

Loudness A_i^t

Calculation of the objective function:

$$obj(i) = \left[\min\{(x_{\max}(i))^2 + (x_{\min}(i))^2\}\right] \quad (1)$$

In the above equation (1),

$x_{\max}(i)$ -Maximum of the confidence value

$x_{\min}(i)$ -Minimum of the confidence value

The **Hybrid A-BAT** consists of four main phases:

Step 1: Initialization of population

First, 3 food sources will be initialized the positions of employed bees (CS/2), randomly using uniform distribution in the range (50, 500).

$$x_i^j = x_{\min}^j + rand[0,1] * (x_{\max}^j - x_{\min}^j) \quad (2)$$

Where $i = 1, 2, \cdots, N$ and

$j = 1, 2, \cdots, D$.

x_i^j - ith employed bee on the dimension j of the D-dimensional space.

N - Number of the employed bee.

$x_{\max}^j$ -Upper bound for x_i^j.

$x_{\min}^j$ -Lower bound for x_i^j.

Step 2: Calculation of the fitness function:

$$F(i) = \begin{cases} \dfrac{1}{(1+obj(i))} & if\ (obj(i) \geq 0) \\ 1 + abs(obj(i)) & if\ (obj(i) < 0) \end{cases} \quad (3)$$

$obj(i)$ Is separate objective functions

Step 3: Employed bee phase (Update new position)

For each employed bee produce new solution (food source position)

$$v_{ij} = x_{ij} + \psi_{ij}(x_{ij} - x_{kj}), \quad (4)$$

Where, $j = 1, 2, \cdots, D$ and $k = 1, 2, \cdots, N$.

In the above equation (4)

x_i^j is the i^{th} employed bee,

v_i^j is the new solution for x_i^j,

x_k^j is the neighbor bee of x_i^j in employed bee population,

φ -Randomly selected in the range [-1, 1],

D - is the dimension of the problem and

N denotes the number of the employed bee.

In the above equation (4), j and k values are nominated randomly. Best Solution will be memorized.

Step 4: Random Walk Phase

A solution is selected amongst the best solution and random walk is applied in order to increase exploration. Thus a new candidate solution is produced.

$$x_{new} = x_{old} + \varepsilon A^t \quad (5)$$

Where Ɛ [-1, 1] is a random number that signifies the path and intensity of random walk, while A^t is the average loudness of all the bats at this time step.

Loudness and pulse emission rate must be altered as repetitions continued. When the bat gets closer to its prey the loudness normally decreases and pulse emission rate r increases. By the resulting equations, loudness and pulse emission rate are modernized.

$$A_i^{t+1} = \alpha A_i^t$$

$$r_i^{t+1} = r_i^0[1 - e^{(-\gamma t)}]$$

Where α and γ are constants and is set to 0.9 in our simulation. Here the initial loudness can typically be [1, 2], while the initial emission rate can be normally [0, 1].

As mentioned above, in this article we propose a new A-BAT, called Hybrid ABC and BAT Algorithm. It was obtained by hybridizing the original ABC and BAT using the Random strategies.

HYBRID A-BAT Algorithm

The Hybrid A-BAT pseudo-code is illustrated here,

Step 1: *Generate the initial population Xi where i=1,2,3,.....N*
Step 2: *Estimate the fitness value of the Crowd.*
Step 3: *Gen=1*
Step 4: *Gen ≤ Gen $_{max}$(Recap)*
Step 5: *For each employed bee yield new solution(Food source position)*

$$v_{ij} = x_{ij} + \psi_{ij}(x_{ij} - x_{kj}),$$

Calculate the value fi
Apply greedy selection process between Xi and Vi.
Step 6: *Select a solution amongst the best solutions.*
Step 7:*Solution updating* ***using random walk***
Apply greed selection process for the random walk between Xi and Vi.
If(ran<Ai)and obj(i)<obj(i*)
Accept new Solutions
Increase ri reduce Ai
Ranks the bats and
*Find current best X**
End While
Display results
Step 8:*If there is an abandoned Solution then replace by with a new random formed solution Xi for the Scout.*
Memorize the best food source position
Step 9:*Gen-Gen+1*
Until cycle=Maximum cycle number
Step 10:*End.*

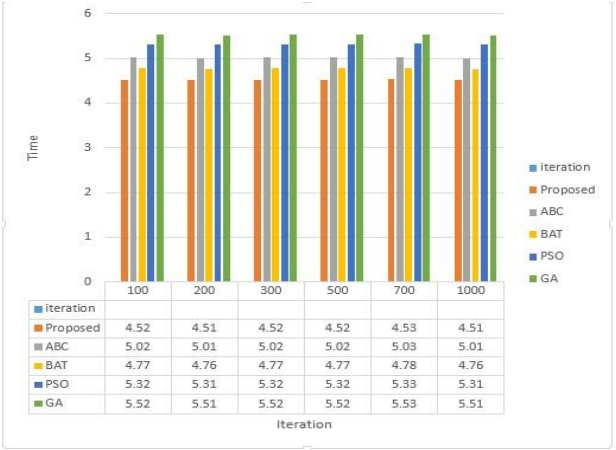
As a result, Hybrid A-BAT from the original ABC and BAT in step 7, where the solution is modified using Random walk phase.

Simulation Analysis:

The performance of the proposed algorithm is evaluated in MATLAB 2016, the results are compared against the conventional algorithms such as PSO, GA, ABC, and BAT. The results obtained for different iterations are given below graph 1 to 4.

A comparative study is made between these algorithms to various constraints such as time, convergence speed, no of iterations and applications. The result of a graphical representation of comparison is shown below.

From the figure 1, we can understand that for different iterations PSO, GA, ABC, BAT algorithm take more execution time compared to Hybrid A-BAT algorithm.



iteration	100	200	300	500	700	1000
Proposed	4.52	4.51	4.52	4.52	4.53	4.51
ABC	5.02	5.01	5.02	5.02	5.03	5.01
BAT	4.77	4.76	4.77	4.77	4.78	4.76
PSO	5.32	5.31	5.32	5.32	5.33	5.31
GA	5.52	5.51	5.52	5.52	5.53	5.51

Figure 1: Time.

So based on the above graph we can say that Hybrid A-BAT Algorithm uses moderate time, and that is best one. The above graph shows that the Response time of proposed methodology by varying iterations. Here x-axis represent the iterations and y-axis represents the response time in milli seconds. The proposed work runs with totally 1000 iterations. When analyzing the graph our proposed approach achieves the minimum execution time of 4.525 which is 5.025 for using ABC based query processing and 4.775 BAT based query processing 5.528 for using GA based query processing and 5.327 for PSO based query processing for 1000 iterations. When analyzing graph, our proposed approach takes minimum time compare to other works. Next, we compared the Accuracy of each algorithm.

Convergence Rate:

In numerical analysis, the speed at which a convergent sequence approaches its limit is called the rate of convergence.

Convergence= (log (fitness new/fitness old))

	100	200	300	500	700	1000
Proposed	8.79	9.78	9.769	9.79	9.795	9.795
ABC	9.19	9.198	9.171	9.193	9.195	9.195
BAT	9.5	9.598	9.57	9.593	9.595	9.595
PSO	8.69	8.698	8.693	8.693	8.696	8.696
GA	8.49	8.499	8.473	8.494	8.496	8.496

Figure 2: Accuracy.

Accuracy: From the above figure, it is observed that the proposed A-BAT algorithm improves Accuracy when compared to ABC, BAT, GA, and PSO. For A-BAT, the percentage of Accuracy slightly changes, when the no.of iterations increases. From the above graph, we clearly understand our proposed approach achieves the better performance compare to other approaches.

Accuracy due to mean objective function value. Nectar amount is the objective function value.

Accuracy= fitness*100

Next, we compared the Latency of the algorithm.

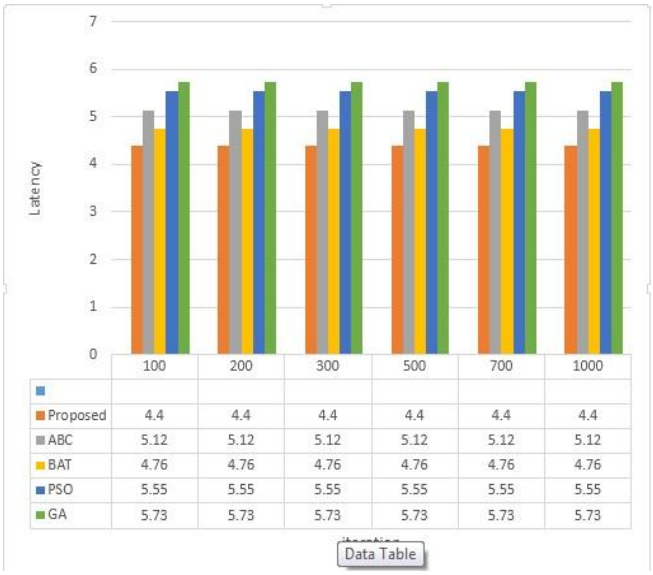


Figure. 3: Latency.

Latency: As crowdsourcing takes time, latency is obviously introduced to compute the quickness of question analysis. However, it is non-trivial to calculate and enhance latency from the above Figure 3, it is well clear that Hybrid A-BAT algorithm has lower latency in the crowdsourcing environment compared with other algorithms.

The latency of any request processing is the difference between the request time and response time. (How long people wait for results).

Latency=T_1~ T_2

T1-Starting Time

T2-Ending Time

Then we compared the cost of the algorithm in the crowdsourcing environment.

Cost:

The monetary price of query strategy, represented by cost, is that the overall rewards obtained for executing all crowdsourcing operators in the query plan. The cost of an operator depends on the price given to crowd for each query produced by the operator.

In the figure. 4, we compared particle swarm optimization algorithm, GA, ABC and BAT algorithm cost in the crowdsourcing environment. From the figure 4, we can understand Hybrid A-BAT algorithm have less cost compared with other algorithms.

Cost=CPU Cost + I/O Cost + Processing Cost

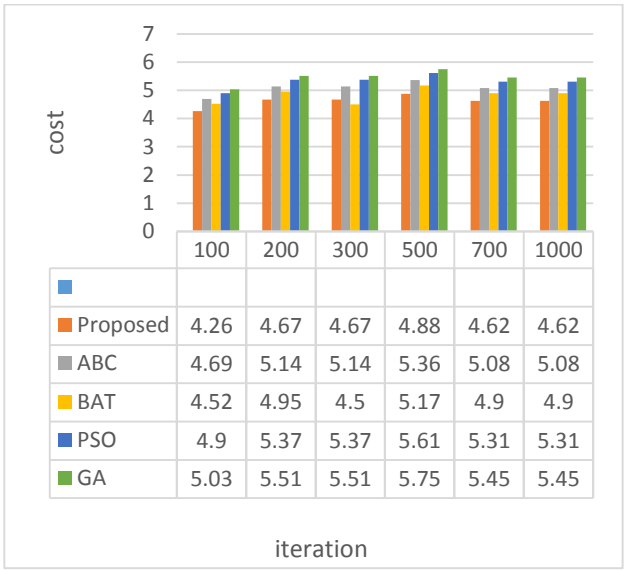


Figure 4: Cost

CONCLUSION

In this paper, optimization techniques such as Particle Swarm Optimization, Artificial bee colony, Genetic Algorithm and BAT Algorithm like that various algorithms are analyzed. From the comparative analysis, the proposed method is effectively maintained in the crowdsourcing environment. The results demonstrate the effectiveness and robustness algorithms to improve latency in the crowdop. It is concluded that this algorithm has good convergence characteristics, high computational efficiency and the ability to find the better quality solution.

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