BADF: Bat inspired Optimize solution for model transformation assisted with fitness function of Adaptive dragonfly algorithm (ADF)

Pramod Pandurang Jadhav (ppjadhav21@gmail.com)
G H Raisoni Institute of Engineering and Technology https://orcid.org/0000-0002-0737-4836

Research Article

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BADF: Bat inspired Optimize solution for model transformation assisted with fitness function of Adaptive dragonfly algorithm (ADF)

Dr. Pramod Pandurang Jadhav
Associate Professor, Department of Computer Engineering
G H Raisoni Institute of Engineering and Technology, wagholi, Pune, Maharashtra, India.
ppjadhav21@gmail.com

Abstract:

Model transformation is the conspicuous research statement in the area of software engineering. Model transformation (MT) is playing the measure role in the Model driven engineering (MDE), which is helpful to transfer the model from one set of databases to another set of databases by considering the simulation and also support to various language. Propose work elaborate the Bat inspired optimize solution for model transformation using Adaptive Dragonfly Algorithm (BADF), and transform Class diagram (CLD) in to the relational schema (RS), accompanied by fitness function. Further performance of the proposed algorithm is appraised using Automatic Correctness (AC) and fitness measure, by comparing existing algorithm.

Keywords: *Model transformation, MT, Dragonfly Algorithm, class diagram, Relational schema, Model driven Engineering, AC, Fitness,*

Introduction:

Model transformation is the prominent research problem in the software engineering domain. Mode driven Engineering (MDE) and model driven development (MDD) are the most significant concept, which help to motivate and support for model transformation. Earlier researcher are use various algorithm for the model transformation like, whale optimization with adaptive dragonfly algorithm (WOADF), Adaptive dragonfly Algorithm (ADF), Artificial Bee Colony Algorithm (ABC), Ant Colony algorithm unified with ADF (ACADF) ,etc. Model transformation is generally written in the model transformation language (MTL), developer write a code to transformation of one model to another model with considering their specification [3][4]. MT be contingent upon sequential and memory implementation mechanism [7], so it has less impending to transform the model from one set to another set of databases. Various transformation language are progressed which is based on the bidirectional form. Object Management group (OMG) is the family which give basic platform to the model and its modification [14]. OMG contain Query/View/Transformation (QVT) platform which provide some transformation based on bidirectional form of model. Triple Graph Grammar (TGG) is concept which support the graphical form of language and transform the one model to another in the form of sequencing and bidirectional method. Proposed research work is transforming the class diagram/ model (CLD) to the Relational Schema (RS) on the basis of algorithm called Bat inspired Adaptive dragonfly (BADF) algorithm, assisted with the fitness function [5][6]. This is meta-heuristics-based algorithm express the behavior of the bat as well as dragonfly and use fitness function to improve

Corresponding Author: ppjadhav21@gmail.com

the accuracy of the transformation. Algorithm is based on combine property of bat and dragonfly algorithm. Here CLD model are consider as input and various block set are generated, to find out the best suitable block phase –I is work along with fitness function sometime called module one. After the selection of the best suitable block as output of the module one, is consider as a input of the module two called testing phase-II, which produce the Relational schema (RS) as a final output. The major involvement of the research work with reference to MT is as stated follow,[3][5]

- First involvement is Produce the model transformation framework by using the properties of the bat and dragonfly algorithm along with the fitness function of the proposed algorithm, and find out the best suitable block in module one [16].
- Second involvement is to generate the optimal solution using proposed algorithm by taking CLD as a input and convert it into relational schema model with improved performance.

Model transformation can be takes place with the help of various other method, languages, and algorithm, but at the same time various challenges also face this method such as low performance, complexity, Accuracy of the result [7][4]. Proposed method is addressing this issue and develop an algorithm called BADF, which is interfacing of the Bat and dragonfly algorithm, which determine the best mapping block and transform UML CLD to RS model with improve performance [13].

The paper is organized as:

Section 1 introduce the research work, section 2 elaborates the Motivation and prepared a literature review of proposed system, Segment 3 simplifies the core idea of proposed research work, segment 4 discus the result and outcomes of the proposed system, also compare the result with existing work. And to end with conclude remark which clarifies the conclusion of proposed work.

2. Literature Survey

This section brief about the literature survey of the existing Model Transformation (MT) idea and illustrates the crucial knowledge about the model transformation.
As discussed above, model transformation can be performed with the various approaches, these approaches are including some merits and demerits, this section are providing some existing methodology for model transformation.

By TDD: Test Driven development (TDD) is method which is based on testing form and that can be reusable. Communication between user and software can use the testing process as per the requirement. But most of the cases it does not check he quality of the test cases which is the limitation of this system [4][6].

By Optimization: Various other optimization method is considered for model transformation like Particle swarm optimization (PSO) this method is benefited for some industry purpose, but it should be upgrade the quality evaluation, and fitness function [8][9].

By Example: Model transformation by example is the best strategy of transformation where multiple blocks are selected in terms of number of aggregations, Association, Class etc. this is the instances of the model which help to find out the suitable block, here technique face the challenges like time issue, and appropriate fitness function [15].

Corresponding Author: ppjadhav21@gmail.com

By genetic programming: It is the method which contain some component-based method which is used for the getting well performance of the system, Atlas transformation Language (ATL) is one of them, this method is reused the existing information for further transformation process, which can be opted meta-model pruning technique [16].

By Fuzzy: This is quite different technique from other, because it used Fuzzy system for the UML transformation to the RS transformation. This is more mathematical and form a transformation by fuzzy methods. It describes fuzzy classes while develop the transformation. Due to mathematical term, it is more complicated to use and implementation. This method achieves more accuracy comparative to other techniques [2].

2.1 Challenges

The challenges originate in this work:

- Literature review focus on some reusable pattern consider for model transformation, while using it specific transformation pattern are not mention properly, for more clear and accurate transformation, Ultimate prototype are requiring for good performance [1].
- Behavior of the system is considered for better performance, but while considering this it may face the problem like redundancy aspect in model transformation [8].
- Most of the researcher are work on fitness function which can be helpful to maintain the accuracy in the system, but while using fitness function most of the time it is inconsistent and have lack of efficiency [14].
- Another limitation of the system is wrongly choosing the transformation language, incorrect notation, and hence face the performance issue at the end of work [9].

3. Modified Bat algorithm for effective model transformation

Modern optimization algorithm is inspired from a nature and its intelligent behavior. It is used in various research and application for optimized solution. Practical swarm optimization (PSO) is based on the behavior and daily routine of the birds, fish, insects, etc. The novel feature of the Bat was based on the echolocation feature of the micro bat. It generally used for frequency tuning technique to intensification the diversity of solution in the available population [10]. It uses the automatic zooming for harmonizing the exploration and exploitation during search process. It is possible by impersonator the variation of pulse emission rate and loudness of the bat, while searching the prey. They are the only mammals with wing having echolocation feature. Micro bat is using the types of sonar called echolocation, to detect the prey, to avoid the disturbance, and place their settling crannies in the dark. When they emit sound wave in the dark then, it bounces back after the surrounding object and get idea about the obstacle in the travelling path [11].

Acoustic Echolocation

Generally, it has the constant frequency contain 25 kHz to 150 kHz. The emitting frequency of the bat is depending upon the bat species, some of the bat species are emitting higher than 150 KHz, where as some species are having frequency up to 100 kHz. At the time of hunting the preys, pulse emission rate can be increase up to the 200 pulses per second, when preys are very close to bat.

Corresponding Author: ppjadhav21@gmail.com

Speed of sound (s) in the air are generally 340 m/s. wavelength (γ) can be calculated in term of frequency (*f*) and speed of sound is,[11]

$$\gamma = \frac{s}{f} \tag{1}$$

While hunting the prey there are lot of other factor are considered like, speed of sound, time delay, frequency factor, type of prey, distance from prey, darkness frequency, etc. all these factors are considered at the time of the hunting the prey [12].

Algorithm

Above factor are consider to develop the algorithm of Bat, most important feature is echolocation of bat is considered for the algorithm development, bat algorithm is used for the various purpose or applications, following are some standard protocols for bat algorithm

- All the bat are use the feature echolocation to sense the distance between preys and bat, and they know the background barrier in magical way.
- Generally, bat flies randomly with position p and velocity V_i , by constant frequency f_{min} and loudness l_0 to search the prey. They automatically adjust the wavelength γ or frequency, of their emitted pulse, and adjust the pulse rate emission $p \in [0,1]$, depending on the proximity of the target.
- Loudness can vary in many ways; in the algorithm it assumes that it can be vary from large (positive) *A0* to minimum constant value *Amin.*[10][11]

Another important thing is no ray tracing technique is used to calculating the time delay and other perspective, which is very important for avoiding the further complications in the algorithm. For more simplification some standard protocols are follow and define some standard range for frequency $[f_{min}, f_{max}]$ and wavelength $[\gamma_{min}, \gamma_{max}]$. Wavelength are also used for more ease of implementation and also used flexible wavelength for early implementation. Another ultimate aim to form the magic formula which is applicable to solve the problem like Newton- Raphson and quadratic function. This could be work like a magic and solve the various problem to taking very less efforts to solve the optimization issue. Optimization issuer are iterative and algorithm to solve the problem called Q are defined as following way.

$$s^{t+1} = g(s^t, p, Q) \tag{2}$$

Where p as a dependent parameter, which is start with the initial solutionss^t, this is iterative function and depend upon the factor, problem Q, and objective function (f_s). This algorithm works on multiple agent available in the practical swarm optimization intelligent methods, above formula can be extended by using the population or solution exist in the system. Where above parameter can be depicted as below.

$$g[(s_{1,}\, s_{2,}s_{3,} \ldots\ldots s_{n,})^t, (p_{1,}\, p_{2,}p_{3,} \ldots\ldots p_{m,})^t, Q] \tag{3}$$

So, putting the value in the equation and get the below equation.

$$(s_{1,}\, s_{2,}s_{3,}s_4 \ \ldots\ldots\ldots\ldots\ldots s_{n,})^{t+1} = g[(s_{1,}\, s_{2,}s_{3,} \ldots\ldots s_{n,})^t, (p_{1,}\, p_{2,}p_{3,} \ldots\ldots p_{m,})^t, Q] \tag{4}$$

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Where, $s_{1,}$ is the total population, and $p_{m,}$ is algorithmic dependent parameter. Which is used for the further calculation. Here each iteration produces new solution as $s_{n,}$ were depicted in $(s_{1,}\ s_{2,}s_{3,}s_4\ \ldots\ldots\ldots\ldots..s_{n,})$ this form. Some meta-heuristic methods are used in various application and can be consider for various algorithm, to mention the randomness in the system [12].

$$(s_{1,}\ s_{2,}s_{3,}s_4\ \ldots\ldots\ldots\ldots..s_{n,})^{t+1} = g[(s_{1,}\ s_{2,}s_{3,}\ \ldots..s_{n,})^t, (p_{1,}\ p_{2,}p_{3,}\ \ldots..p_{m,})^t, (\omega_{1,}\ \omega_{2,}\omega_{3,}\ \ldots..\omega_{k,})^t\ Q] \quad (5)$$

Where $\omega_{k,}$ is the random solution consider in the algorithm, which is depicted in various optimization algorithm. One of the optimization algorithm called cuckoo search is based on the levy flight movement. Here bat movement also take into consideration for further calculation in the algorithm called velocity update v_n^t and position p_n^t in t iteration, and multiple d-dimensions for searching space. Above mention rule are illustrated in the form of velocity v_n^t and position p_n^t update

$$f_i = f_{\min} + (f_{max} - f_{min})\delta \quad (6)$$

$$v_n^t = v_n^{t-1} + (p_n^{t-1} - p_n)f_i \quad (7)$$

$$p_n^t = p_n^{t-1} + v_n^t \quad (8)$$

Where $\delta \in [0,1]$ is the random position drawn from the uniform distribution, for the algorithmic calculation $f_{\min} = 0$ and $f_{\max} = 1$ depending on the domain size of problem. Every bat is randomly allocating the frequency which is uniformly drawn by standard function(f_{max}, f_{min}). Loudness is another factor which is consider for the algorithm and use equation for adjusting the loudness, which is take a control over the exploration and exploitation, exploitation is flexible and used whenever necessary, this kind of strategy are used when bat find the prey and stop the emitting the sound and echo automatically [10].

$$l_i^{t+1} = \propto (l_i^t) \quad (9)$$

$$P_i^{t+1} = P_i^t\ [\ 1 - exp(-\gamma t)\ ] \quad (10)$$

Where l_i^{t+1} is the loudness used for the calculation, and P_i^{t+1} is the pule emission rate when stop echo sound, where $\propto$ and γ are the constant value which is work as cooling factor and depict the value of simulation annealing (SA) having value between 0 and 1 so $(0 < \propto > 1)$ and $\gamma > 0$,

$$l_i^t = 0 \quad (11)$$

$$P_i^t = P_i^0 \quad (12)$$

Loudness and pulse emission rate can be considered for above mention value, this is used to value of fitness in most of the research function. To get the continuous optimization some changes are made in the bat algorithm for effective outcomes, some researchers are using the Binary Bat Algorithm (BBA) for efficient optimization concept called as discretization [12][6].

3.1 Block set selection using proposed BADF algorithm

Corresponding Author: ppjadhav21@gmail.com

First phase of proposed BADF algorithm is indicate that CLD UML diagram consider as a input of the initial state. Various block is available in the input, these blocks are selected using the ADF and proposed BADF algorithm which include the bat algorithm as a key operation. Proposed BADF algorithm are consider the properties of the Bat and ADF algorithm, all this process comes under the Phase one called training phase. Output of the first module is finding the best solution and provide the input to the second phase [4].

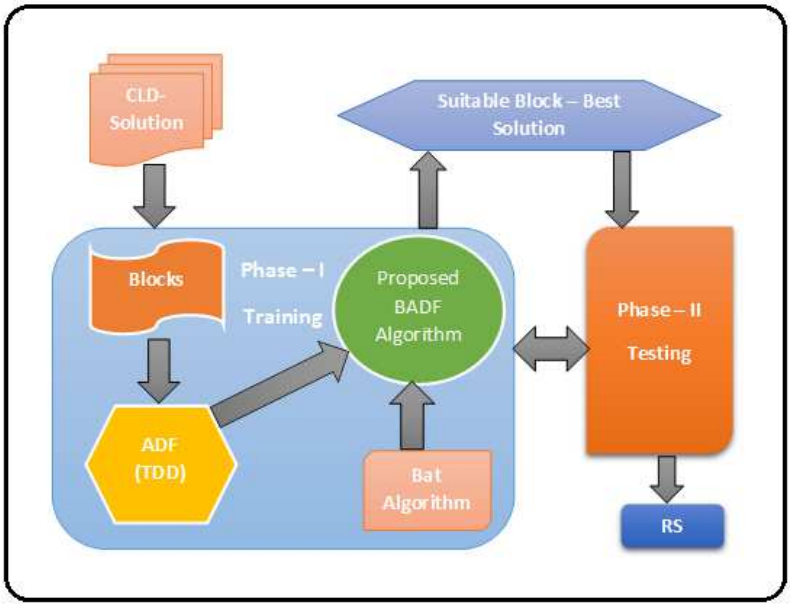

Figure 1: The Architecture of proposed BADF based model transformation

a) Block sets scenario

Block set are categorized as Bc. and it is denoted as Bc= {bc1, bc2, bc3…bc….bt}, in this bc is the selected block among the entire available block represented as bt. Block set boundary can be specified as 1< bc< bt selected block set will customized for further process [5].

$$Bc= \{bc1, bc2, bc3\ldots bc\ldots.bt\} \tag{13}$$

b) Fitness function

Fitness function is play as key role in proposed system. Fitness function affect the overall result in the system and can be used in algorithm for improvement in the accuracy. Fitness function comprehends External coherence, internal coherence, Adequacy, Association factor which is used for renovation in algorithm. Complemented by these factors, fitness function also includes TDD properties. Which is illustrated as follows [7].

$$F = F_1 + F_2 \tag{14}$$

where, the fitness F_1 and F_2 are specify by using the subsequent equation,

$$F_1 = \sum_{k=1}^{n} Ad_k \times (\mathrm{I}_k + E_k) \tag{15}$$

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where, Ad_k is adequacy factor, I_k is an internal coherence, and E_k deliberate as external coherence factor for n^{th} construct. The TDD fitness is as follows, [3]

$$F_2 = \frac{Satisfied\ Test\ case}{Total\ Test\ Case} \tag{16}$$

By considering the Bat search algorithm present location is detected and reform the fitness function. Where F_1 and F_2 are the fitness function consider for the calculation. By consider the random position of the Bat algorithm in the proposed system and get the renew equation and found the formula which helpful for the improvement in the result [5].

$$F_i = F_1 + (f_{max} - f_{min})\delta + F_2 \tag{17}$$

$$F_i = \sum_{k=1}^{n} Ad_k \times (I_k + E_k) + (f_{max} - f_{min})\delta + F_2 \tag{18}$$

Where δ is the random position for the factor used in the bat algorithm. Where F_1 and F_2 are the fitness value of the adaptive dragonfly algorithm (ADF).

c) Position update of ADF

Position update in the adaptive dragonfly algorithm (ADF) is consider at the time of the improvement in the algorithm and also consider for the various factor affecting for the ADF such as Alignment, Cohesion, separation, attraction towards the food, and distraction from the enemy, these are key aspect which ADF can progressed. These parameter can choose the velocity and ultimatly position of the dragonfly. To get the simplified position following equestion are framed.

$$\Delta P(l+1) = (gG_i + hH_i + sS_i + aA_i + dD_i) + \sigma_2 * \Delta K(l) \tag{19}$$

Where, $\Delta P(l+1)$ is a velocity update by considering above five constraint g, h, s, a, and d denote the weight for updating the value of alignment, cohesion, separation, attraction, and distraction, congruently. Constraint G_i, H_i, S_i, A_i,and D_i are describe as alignment, cohesion, separation, attraction, and distraction, which convey the velocity of the ith dragonfly. The term σ_2 is the iteration by allowing for the weight of ith dragonfly. For supplementary simplification the equation can be rearrange and form a new version of equation as follows. Here new equation can be restructuring by replace the value of g = h = s = a = d = σ_1, for all the iterations [5].

$$\Delta P(l+1) = \sigma_1(G_i + H_i + S_i + A_i + D_i) + \sigma_2 * \Delta K(l) \tag{20}$$

Where σ_1 and σ_2 are the conveying weight component which can be fluctuate subject to position updates and its conforming value along with number of iterations. Further the equation of the adaptive weight is transformed as follows [5].

$$\sigma_2 = v_n^{t-1} + (p_n^{t-1} - p_n)f_i \tag{21}$$

$$\Delta P(l+1) = \sigma_1(G_i + H_i + S_i + A_i + D_i) + (v_n^{t-1} + (p_n^{t-1} - p_n)f_i) * \Delta K(l) \tag{22}$$

d) Modified BADF algorithm for position update:

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Position can be update using the factor of the ADF and the Bat algorithm and reform the new equation as follows and prepare for the algorithmic formulation.

$$\Delta P(l+1) = \sigma_1(G_i + H_i + S_i + A_i + D_i) + (p_n^{t-1} + v_n^t) * \Delta K(l) \tag{23}$$

Where $p_n^{t-1} + v_n^t$ is the position value of the bat algorithm and used for the ADF algorithm and also used in proposed algorithm for model transformation [5][13].

e) Update the position based on Levy flight movement

Levy flight movement of dragonfly must be deliberate for the calculation. After updating the position and receiving accurate value, then random movement should contemplate in algorithm, succeeding calculation specify the levy flight movement of dragonfly.

$$L(u+1) = L(u) + Levy(\mathrm{r}) * \mathrm{L(u)} \tag{24}$$

Here $L(u+1)$ is the Levy flight movement, $Levy(\mathrm{r})$ indicate the levy movement with dimension r. and u is the weight value of the position [1]. Loudness factor can be considered for the bat algorithm as follows and consider further in algorithm [6].

$$P_i^{t+1} = P_i^t\ [\,1 - exp(-\gamma t)\,] \tag{25}$$

$$L(u+1) = L(u) + Levy(P_i^t\ [\,1 - exp(-\gamma t)\,) * \mathrm{L(u)} \tag{26}$$

Where l_i^{t+1} is the loudness used in algorithm, and P_i^{t+1} is the pule emission rate when stopover echo sound, where $\propto$ and γ are the constant value which is work as cooling factor and depict the value between 0 and 1 so ($0 < \propto > 1$) and $\gamma > 0$,

Table1: propose BADF Algorithm[5]

Sl. no	*Proposed CSADF*
1	**Input:** Available Population P_i
2	**Output:** Best solutionP_i
3	**Start**
4	Initial Population
5	**do**
6	{
7	**For** $(s = 1; s < i_{\max})$
8	**For the entire solution**
9	Calculate the fitness using equation (18)
10	**If** (solution s has neighbor)
11	Change the velocity using equation (22)
12	Change the position using equation (23)
13	**Else**
14	Change the position using equation (26)
15	**End if**

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```
        End for
}
While ($s < i_{max}$)
Return $P_i$
End if
 End
```

3.2 Testing of BADF method

Second phase contain testing phase which having best solution and by supporting the proposed BADF algorithm it transforms the CLD UML model to RS model. Output of the first phase is given to the input of the second phase and after testing it convert it into RS model, which is the ultimate aim of this research work [16][17].

4. Results and discussions

This section portrays the result of proposed BADF algorithm, output of this proposed work is further comparing with the existing algorithm such as PSO, ADF, ABCADF, WOADF. Proposed BADF algorithm which is Bat inspired optimal solution for model transformation is depicted and convert CLD model to RS model at the end with improved performance.

4.1 Database description

Bat inspired proposed algorithm are take a various CLD as input and processed further towards the algorithm, CLD contain different instances which contain classes, aggregation, association, total instances are counted in one CLD model and data base are consider according to that. This work contains two CLD model first contain 7 instances, and second contain 8 instances.

Input CLD 1: first CLD having total 7instances, having 4 classes, 2 aggregation, and 1 association.

Input CLD2: second CLD having 8 instances, include 4classes, 2 aggregation, and 2 association.

4.1.2 Evaluation metrics

Proposed system contains two evaluation metrics AC (Automatic correctness) and fitness function both the metrics are ranging value from 0 to 1. Each CLD input can be depicted in AC and fitness function evaluation perspective. Fitness function is preferable in most of the research experiment used for the evaluation [3][4].

4.2 Algorithm used for comparison.

Algorithm used for comparison which is already exist. For the better performance comparison is takes place with PSO, ADF, ABCADF, and WOADF. All these algorithms are based on optimization method which compare with the proposed system.

4.2.1 Analysis for CLD 1 with Comparison

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Analysis of the CLD model one is done using the consideration factor such as AC, Fitness function, and scaling with iteration of 100 to 500. Analysis is based on above factor and compare with PSO, ADF, ABCADF, and WOADF to proposed algorithm BADF. Graph indicate that 100 iteration having following values with AC measure 0.712, 0.874, 0.714, 0.589, 0.859, and for 500 iteration the value is 0.754, 0.784,0.754, 0.712, and 0.876 respectively. While in another case called fitness, function is considered for the analysis and the value of 100 iteration is 0.741, 0.784, 0.744, 0.615, 0.854 and value of 500 iteration is 0.758, 0.811, 0.725, 0.637, 0.819 respectively. Both the AC and Fitness measure indicate the higher performance of proposed system with comparing to the existing one.

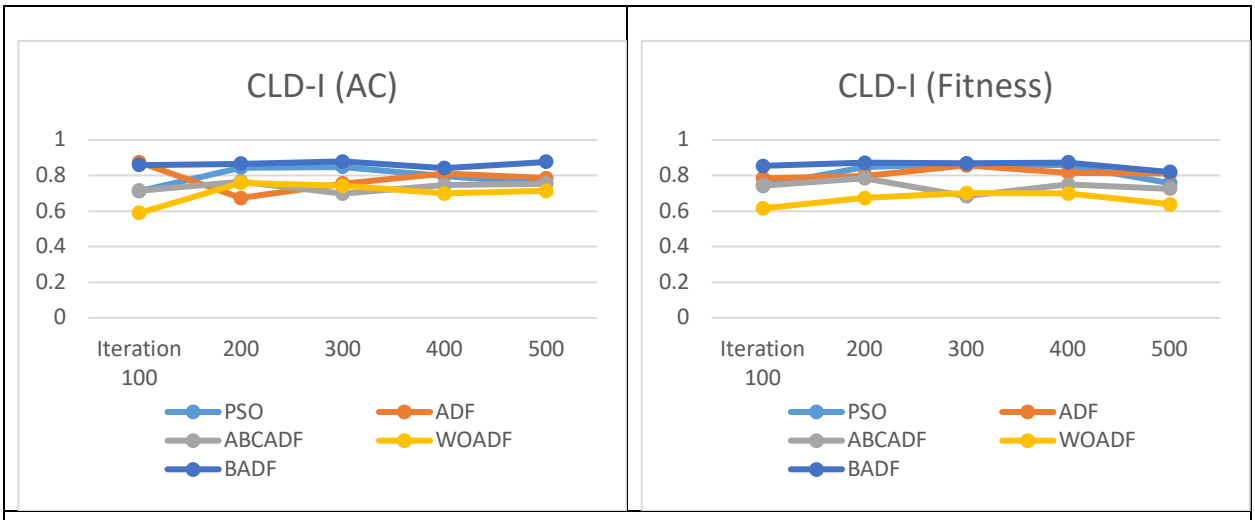

Figure1 : Comparison Analysis of CLD-1 Model with AC and Fitness Measure

4.2.2 Analysis for CLD 2 with Comparison

Analysis of the CLD 2 having the same measure for the as discuss in above CLD 1 model. CLD 2 contain again AC and Fitness function with the scaling of 100 to 500 iteration, and comparison with PSO, ADF, ABCADF, WOADF and BADF. So, for AC measure, 100 iteration value are 0.789, 0.874, 0.698, 0.687, and 0.859 respectively. 500 iteration contain 0.758, 0.859, 0.781, 0.684, 0.862value. For fitness measure 100 iteration value are 0.751, 0.698, 0.713, 0.732, 0.839 respectively, 500 iteration having following value 0.789, 0.745, 0.811, 0.745, and 0.846.

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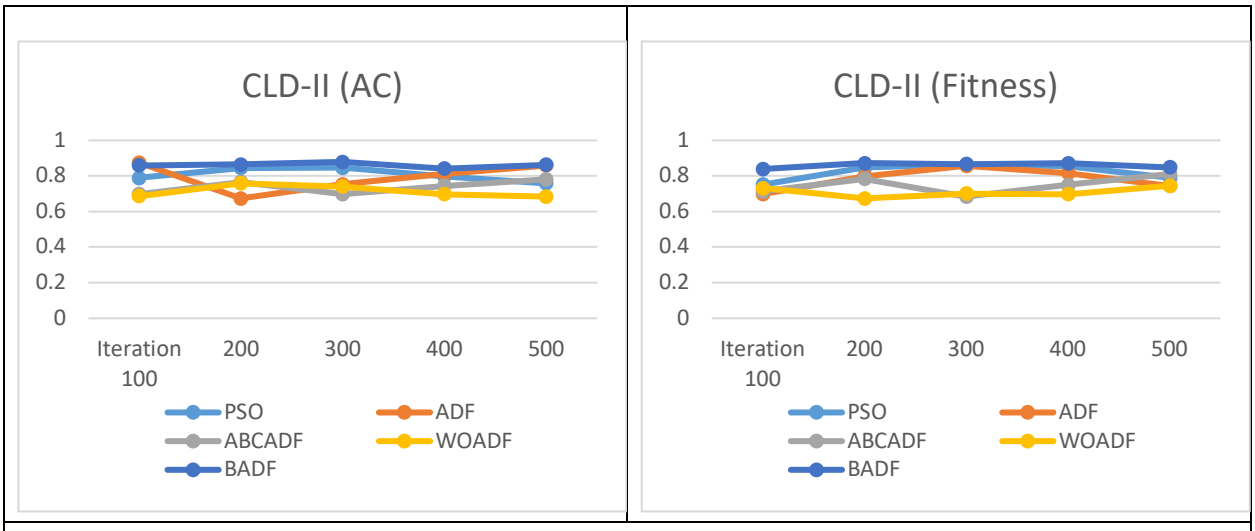

Figure2 : Comparison Analysis of CLD-2 Model with AC and Fitness Measure

4.3 Comparative discussion

In Overall scenario it proves that proposed work is perform better that the existing one. Comparison can take place with PSO, ADF, ABCADF, WOADF and BADF. If 500 iteration are considered and value of the AC, Fitness and count of Iteration are the measure factor, following Table indicate that 500 iteration value for both the CLD model, and value of proposed BADF algorithm is

Input	**Performance metrics**	**Comparative Study**				
		PSO	**ADF**	**ABCADF**	**WOADF**	**Proposed BADF**
CLD 1	**AC**	0.754	0.784	0.754	0.712	0.876
	Fitness	0.758	0.811	0.725	0.637	0.819
CLD 2	**AC**	0.758	0.859	0.781	0.684	0.862
	Fitness	0.789	0.745	0.811	0.745	0.849

5. Conclusion

Proposed BADF algorithm which is having the properties of the Bat algorithm and adaptive dragonfly (ADF) algorithm. Basically, this research work is inspired by bat algorithm to find out the optimize solution for the model transformation, Here CLD model is transfer to the RS model by using BADF algorithm including training and testing phase. For better performance various

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performance metrics are consider like AC, Fitness function, along with the count of Iteration is also consider for the analysis. After comparing the existing algorithm, proposed system encompasses the value 0.876, 0.819, 0.862, 0.849 which is better than the existing algorithm, hence It proves that proposed system is perform better, which portrayed in the result.

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Authorship Contributions:

- Conceived and design the analysis
- Collect the Data
- Contributed Data / Analysis tools
- Performed the Analysis
- Wrote the Paper

Conflict of interest

Authors Pramod Pandurang Jadhav declare that they have no conflict of interest.

Ethical approval

This article does not contain any studies with human participants or animal performed by any of the authors.

Inform Consent

Informed consent was obtained from all individual participants included in the study

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Corresponding Author: ppjadhav21@gmail.com

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Corresponding Author: ppjadhav21@gmail.com