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ORIGNAL ARTICLE

Multi-purpose hybrid optimization (DA-ALO) algorithm for efficient job shop scheduling issues

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Abstract

The Job-Shop Scheduling (JSSP) is the most vital modern exercises, particularly in manufacturing industry. In this paper the Hybrid (DA-ALO) is presented in the fasteners industry, combination type plant layout is used. There are numerous types of machines, numerous operations to be performed on the numerous jobs. This is the reason in these days for controlling the make span time in the fasteners industry. For solving the scheduling problem in the fasteners industry, it is necessary to use hybrid algorithms i.e. Dragon fly Algorithm (DA) and Ant Lion Optimization(ALO) algorithm that forms Hybrid (DA-ALO). It is concluded that there is 2% gain in the make span time by using the hybrid model. The above said gain is very significant and recommended in the fasteners industry.

1. Introduction

Each job consists of a group of operation that required to be controlled in a fixed pre-specified order and every operation is to be operated on a special resource for a predetermined duration of time. In this context, emphasis has been done to minimizing the completion time of the end task of the job. In the last two decades' metaheuristics approaches such as PSO algorithm, ABC algorithm, GA etc. have been applied to resolve the JSSP. A couple of frameworks have been planned in the writing for JSSP that is essentially in view of the optimization algorithm, for example, Dragonfly Optimization (DO) algorithm and Antlion Optimization (ALO) is assessed for beating the issues. This segment depicts to limit the makes span time and tardiness for different jobs and the ideal esteem is acquired by the mixture (DA-ALO) optimization algorithm by conquering the benchmark issues and getting the minimize the make span time. In this paper 17 benchmark problems have been taken of the fasteners industry and each problem consists of numerous types of products and corresponding required machines. One problem i.e. LA21 whose size is 15×20. It means that there are 15 kinds of Jobs/Products having different lengths, diameters and designs & each product is required 20 machines irrespective of their size and shape. It is one of the complex and complicated problem among the all 17 benchmark problems. The developed algorithm (Hybrid DA & ALO) will be executed on the working platform

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of MATLAB 2015a & the outcome/result will be studied and compared with the traditional strategies of DA and ALO algorithm. Sharma Nirmala et al 2018 [1] had analyzed JSSP is an imperative combinatorial optimization issue in the field of machine scheduling. This article exhibits an adjusted ABC algorithm to explain JSSP. The (Beer froth artificial bee colony algorithm) Be F ABC has been surveyed on 25 benchmark test issues and contrasted and other condition of-craftsmanship calculations. Further, it is connected to tackle 62 surely understood occasions of discrete JSSP. The acquired numerical outcomes and factual examination delineate that the proposed algorithm is equipped in managing the discrete JSSP. Huang Rong-Hwa et al 2017 [2]. had researched a few novel hybrid ant colony optimizations (ACO)- based algorithms to determine multi-target job-shop scheduling issue with a square with estimate parcel part. The fundamental issue examined in this strategy is part of jobs and tradeoff between parcel part expenses and make the traverse. The destinations that are utilized to quantify the nature of the created plans are weighted-total of make traverse, the lateness of jobs and parcel part cost. An ACO based calculation is utilized to produce calendars and improve the outcome and minimize the make span time tardiness. Li Jun-qing et al 2013 [3] had proposed a hybrid algorithm joining particle swarm optimization (PSO) and Tabu Search (TS) was proposed to take care of the job shop scheduling issue with fuzzy handling time. The question is to limit the greatest fuzzy fulfillment time, i.e., the fuzzy make span. In the proposed algorithm, PSO plays out the worldwide hunt, i.e., the investigation stage, while TS leads the neighborhood to seek, i.e., the abuse procedure. The proposed algorithm is tried on sets of the notable benchmark occurrences. Through the examination of trial comes about, the exceedingly compelling execution of the proposed algorithm appears against the best performing outcome. KS Sree Ranjini et al 2017 [4]. had proposed optimization algorithm in view of the static and dynamic swarming conduct of dragonflies. Because of its effortlessness and effectiveness, DA has gotten enthusiasm of specialists from various fields. The p best and g best idea of Particle Swarm Optimization (PSO) are added to regular DA to manage the look procedure for potential candidate arrangements and PSO is then introduced with p best of DA to additionally misuse the hunting space. The outcomes demonstrate that MHDA gives preferred execution over customary DA and PSO. Also, it gives focused outcomes as far as meeting, precision, and pursuit capacity when contrasted with state-of-the-art algorithms. Zhang Rui et al 2014 [5]. had proposed to propose a hybrid Differential Evolution (DE) algorithm for the job shop scheduling issue with random handling times under the target of limiting the normal aggregate lateness (a measure of benefit quality). To begin with, they propose an execution evaluate for generally looking at the nature of candidate arrangements. At that point, a parameter perturbation algorithm was connected as a neighborhood look module for quickening the joining of DE. At long last, the K-outfitted bandit display is used for decreasing the computational weight in the correct assessment of arrangements in view of recreation. The computational outcomes on various scale test issues approve the viability and proficiency of the proposed approach.

2. Methodology

Job Shop Scheduling Problem (JSSP) has been to a great degree of the most important industrial model and it has ascended insignificance because of the demands of industry. The methodology gives a JSSP issue set of jobs on an arrangement of machines and each of having particular and conceivably extraordinary times and conveyance. The object is to discover a preparing time which limits a given make time to lessen the cost. This examination of JSSP gives almost seventeen benchmark issues are considered to lessen the make span time used to empower distinctive optimization techniques. The make span time and tardiness esteem limits and getting the target work as best by utilizing the hybrid (DA-ALO) optimization algorithms. This methodology gives the optimal yield esteem with limit the time when contrasted with actual BKS.

2.1 Assumption

Consider the different 17 benchmarks issue and this strategy is identified with the job and the procedure utilized different methodologies. To assess the execution of the framework, most often considered execution measure, for example, minimization of make span for add up to finishing to the time of the procedures are considered. The procedure was legitimate with any sort of job and framework expects the adaptable job shop conditions where period might be skipped. This job the resulting hypothesis is being done and they are as clarified underneath.

- Let J_i = {1,2, ...n} be set n jobs are scheduled.
- M_j = {1,2, ...m} be a set m machines are schedule.
- At a time, it is possible to process only one operation on one machine.
- Execution of each operation M j requires a resource from a set of alternative machines
- Processing of operations on the machines should not be interrupted.
- Release times and due dates are not specified.

The make span value to be definite as below: each job has a number of operations and each function has an explicit make value at this place

2.2 Objective Function

This job examination considers multi-target initial one is slightest make span time and of different jobs performed in machine.

$$M_j = \min (M_t) \quad (1)$$

2.3 An Optimization Algorithm for JSSP

Consider different jobs with the relating machine and every one of them achieve an alternate time and distinctive conveyance period. We will probably limit the make span time and tardiness by utilizing the optimization algorithm, for example, Dragonfly (DA) and Ant Lion (AL) Optimization Several benchmark issues are settled by the JSSP issue with hybrid (DA-AL) and getting the optimal incentive with BKS.

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2.4 Hybrid Model for (DA-ALO)

In JSSP, the two swarms-based hybrid approach model is utilized to get the ideal value. This hybrid approach is acquired to resolve optimization scheduling issues, for example, seventeen benchmark issues and it needs to limit the make span time and tardiness for each job and machines with ideal to esteem

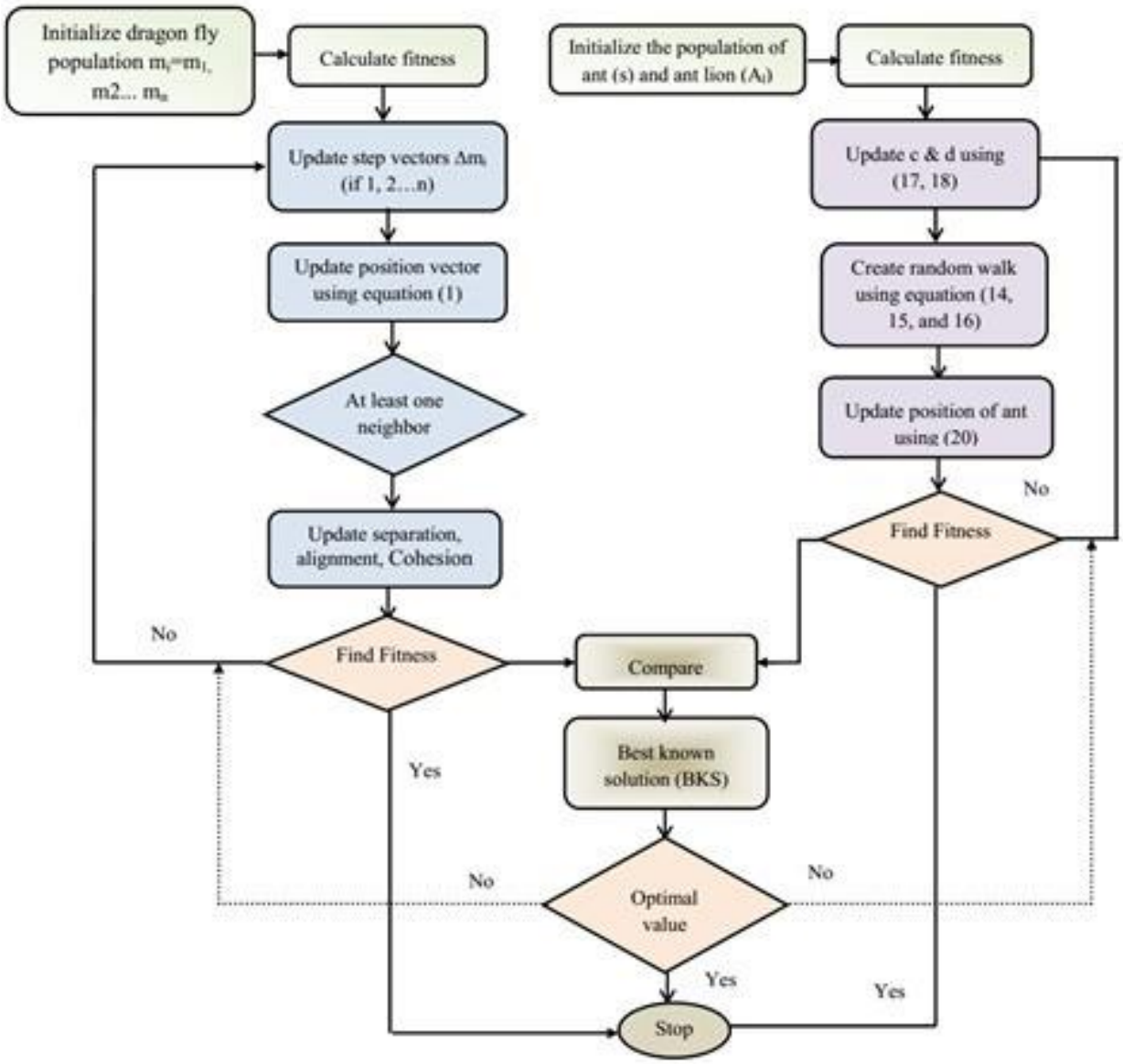

Figure 1: Flowchart for Hybrid model

The hybrid model algorithm is explained in the above figure. The detailed explanation for DA and ALO algorithm with the behavioral process has been shown. The left portion depicts the DA algorithm and right portion depicts the ALO algorithm and compare the output with both the algorithms. Whichever the best-known solution, then check it for optimal value. If yes, then stop and if no repeat the whole process for DA as well as ALO algorithm.

3. Results and Discussion

Fig-1 demonstrates the comparable analysis of make span time for the benchmark problems ABZ5, ABZ6, FT10, LA05, LA10, LA11, LA12, LA14. The performance of proposed algorithms is analyzed and compared among one another. For the problem ABZ5, DA takes 1250 minutes, ALO takes 1260 minutes and hybrid DA-ALO takes 1215 minutes. From the analysis, the least make span time is gained in the proposed DA-ALO mathematical model. Similarly, make span time comparative analysis of other problems like ABZ6, FT10, LA05, LA10, LA11, LA12, LA14. is depicted in that figure-2.

The comparative analysis of make span time for the benchmark issues LA21, LA30, LA31, ORB01, ORB02, ORB03, ORB04, ORB05, ORB06 have been carried out. For the benchmark problem LA21, DA takes 1010 minutes, ALO takes 1015 minutes and DA-ALO takes 990 minutes. Similarly, for LA30 benchmark problem, DA takes 1380 minutes, ALO takes 1405 minutes and DA-ALO takes 1360 minutes. In the same manner, make span time a comparative analysis of other benchmark problems like LA31, ORB01, ORB02, ORB03, ORB04, ORB05, ORB06 are represented in chart. On comparing those benchmark issues, the least make span time is accomplished by the developed hybrid DA-ALO algorithm

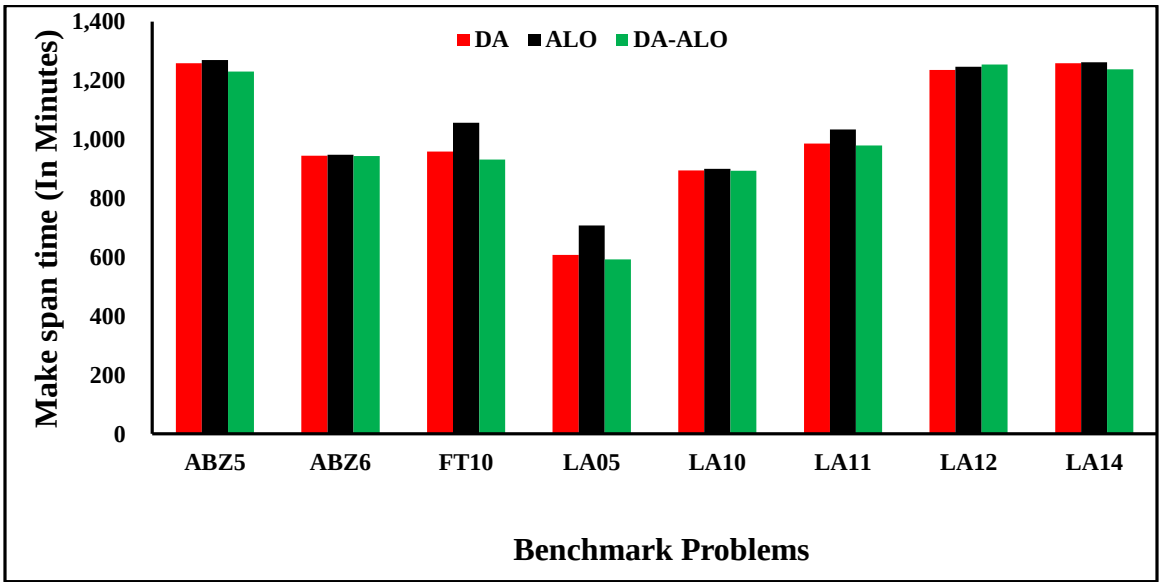

Figure 2: Comparable analysis of make span time for the benchmark problems

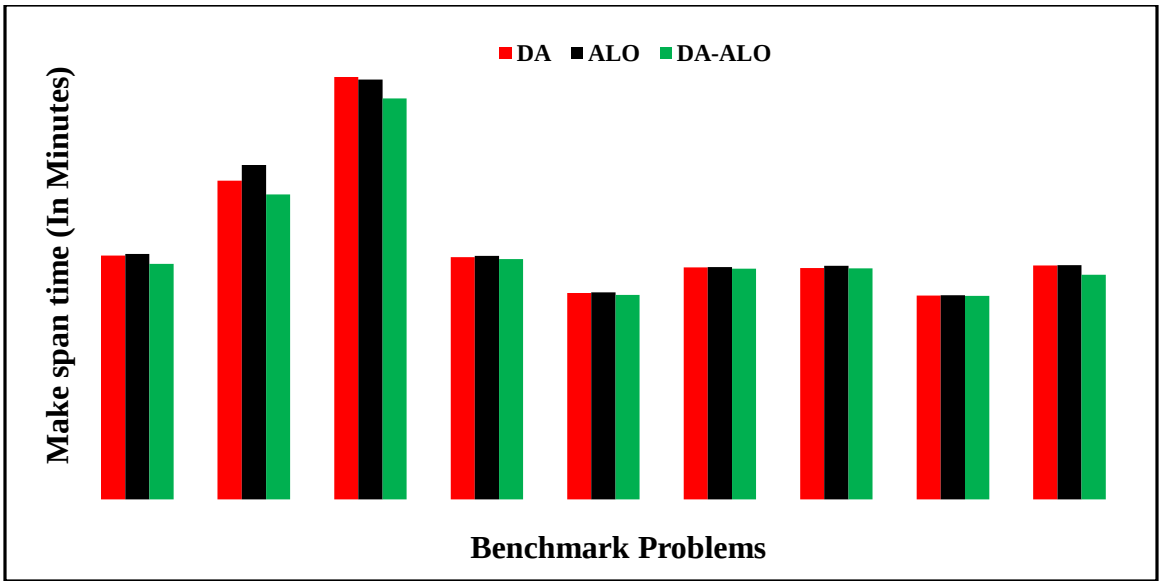

Figure 3: Comparable analysis of make span time for the benchmark problems

Fig-3 shows the bar chart which illustrates the comparative analysis of make span time for the benchmark issues LA21, LA30, LA31, ORB01, ORB02, ORB03, ORB04, ORB05, ORB06. For the benchmark problem LA21, DA takes 1010 minutes, ALO takes 1015 minutes and DA-ALO takes 990 minutes. Similarly, for LA30 benchmark problem, DA takes 1380 minutes, ALO takes 1405 minutes and DA-ALO takes 1360 minutes. In the same manner, make span time a comparative analysis of other benchmark problems like LA31, ORB01, ORB02, ORB03, ORB04, ORB05, ORB06 are represented in chart. On comparing those benchmark issues, the least make span time is accomplished by the developed hybrid DA-ALO algorithm.

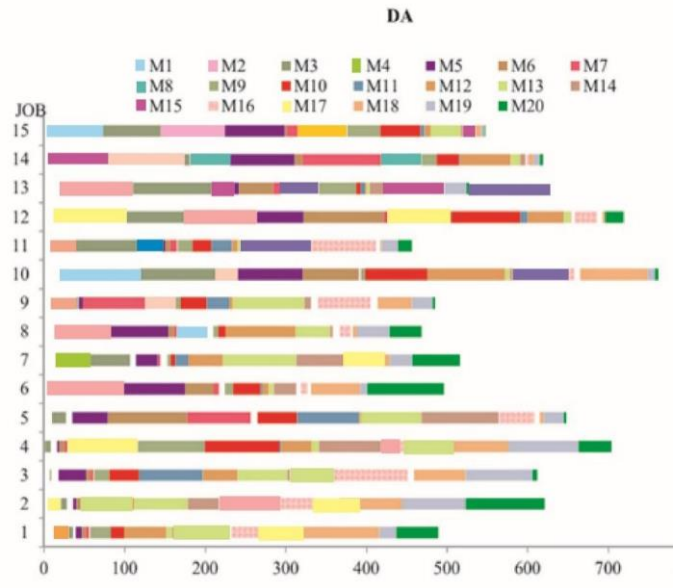

Figure 4: Gantt-Chart found by the DA based method for the LA21 (15X20) problem

The Fig-4 presents the Gantt-Chart found by the DA based method for the LA21 (15X20) problem. In the Fig-4, different combination of operations was done for LA21 (15X20) problem and found the make span time. While running the DA based algorithm, comparison has been done for make span time of all the products on all the machines.

Fig-5 presents the Gantt-Chart found by the algorithm ALO based method for the LA21 (15X20) problem. In the Figure, it is noted that a different combination of operations can be done for LA21 (15X20) problem and While running the ALO based algorithm, comparison has been done for make span time of all the products on all the machines. Fig-6 presents the Gantt-Chart found by the developed hybrid algorithm DA-ALO based method for the LA21 (15X20) problem. In the Figure, it is noted that a different combination of operations can be done for LA21 (15X20) problem and found the make span as a minimum. When comparing all algorithms, the developed hybrid DA-ALO achieves minimum make span time for all benchmark problems.

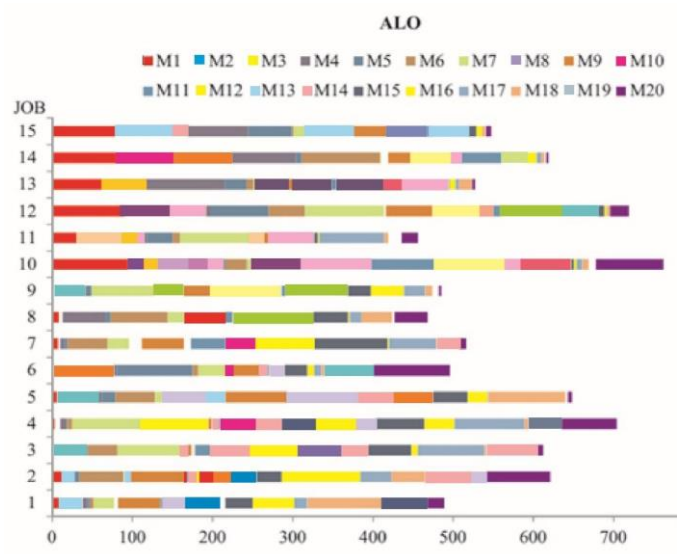

Figure 5: Gantt-Chart by the algorithm ALO based method for the LA2

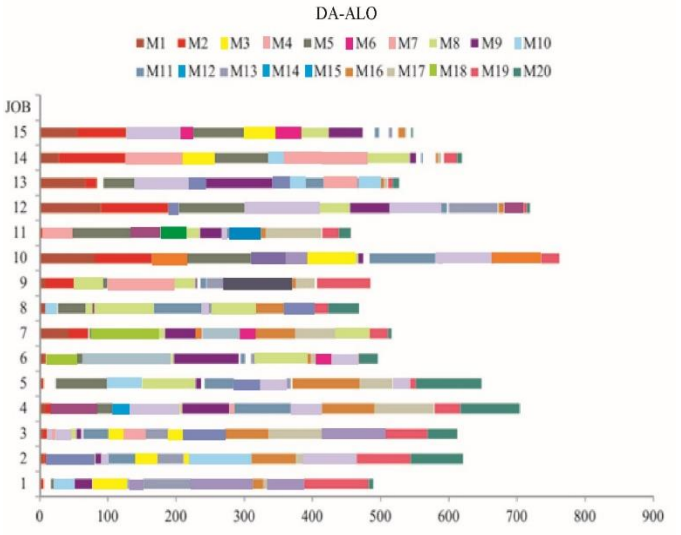

Figure 6: Gantt-Chart hybrid algorithm DA-ALO

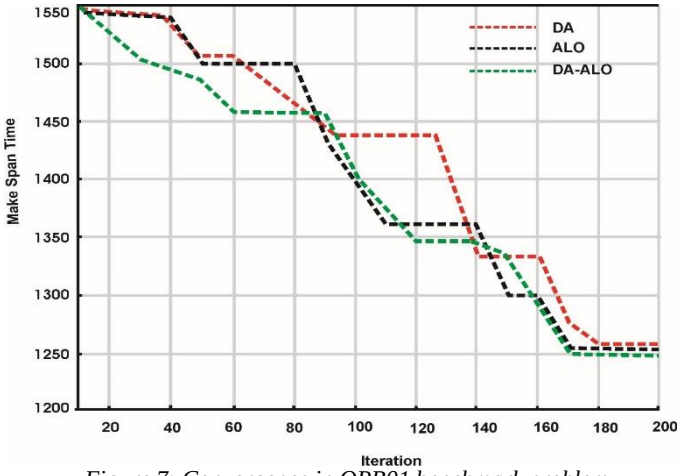

Figure 7: Convergence in ORB01 benchmark problem

The convergence graph analyzing the benchmark problems of *ORB01*. The performance of different algorithms such as DA, ALO and DA-ALO algorithm for 20th, 40th, 60th, 80th, 100th, 120th, 140th, 160th, 180th& 200thiteration are shown in fig-7 respectively for the benchmark problem ORB01 by DA algorithm, in Fig-7, it was found that the fitness value starts from 1550 and then decrease to 1250 at 175 iterations and remains constant up to 200th iteration. For ALO algorithm the fitness value starts from 1550 and then decrease to 1255 at 170 iterations and remains constant up to 200th iteration. For the hybrid DA-ALO algorithm the fitness value starts from 1550 and then decrease to 1245 at 170 iterations and remains constant up to 200th iteration. Fig-08: shows the convergence in LA11. It was found in the DA algorithm, the fitness value starts from 1550 and then decrease to 1340 at 150 iterations and remains constant up to 200th iteration. For ALO algorithm the fitness value starts from 1550 and then decrease to 1245 at 190 iterations and remains constant up to 200th iteration. For the hybrid DA-ALO algorithm the fitness value starts from 1550 and then decrease to 1230 at 110 iterations and remains constant up to 200th iteration.

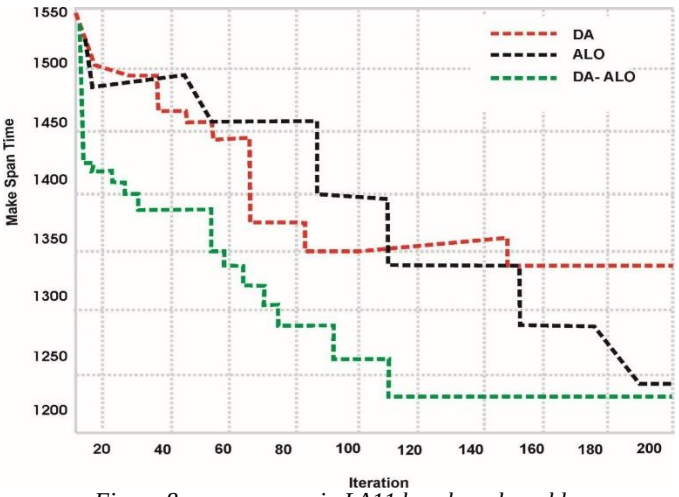

Figure 8: convergence in LA11 benchmark problem

4. Conclusions

From the validation perspective, I have compared all 17 benchmark issues by the optimization algorithm such as DA, ALO and hybrid (DA-ALO) is utilized to obtain optimal values with best fitness function of the algorithm and minimize the given objectives. The DA model has been used and same model has been implemented in the industry. Results are obtained. Another model using Ant Lion (ALO) has also used. The model has been implemented on the same set of data as for DA algorithm and deduce the result. The main model by hybrid of above two algorithms has been developed. The same set of data collected from the industry has been implemented on the developed model i.e. (Hybrid of DA and ALO). It is observed that the result of the hybrid model developed in present work are better than the two independent models i.e. DA and ALO. On observing the result, it is concluded that there is 2% gain in the make span time by using the hybrid model. The above said gain is very significant and recommended in the industry under observation.

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