
A Meta-Heuristic Bat Inspired Algorithm for Flow Shop Scheduling

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Abstract

Flowshop scheduling algorithm is used for utilization and decreasing the idleness time of the machine. There are various algorithms are proposed for reducing the idleness of the machine and maximizing the utilization. In this paper, we proposed an bat algorithm for optimizing the machine idleness and maximization of machine productivity. For maintaining this, jobs are scheduled before coming for execution of the machine and it should be predicted well in advance and utilization is estimated well in advance and with the help of the bats behavior. With this machine makespan time is minimized and utility is maximized and this helps to schedule jobs properly.

Keywords: Bat Algorithm, flow shop scheduling, optimization, make span

1. INTRODUCTION

In present situation all companies are concentrating on productivity, in this scenario large amount of resources are utilized for these jobs. These jobs are scheduled and released into the machine before proper estimation of requirement of resource, duration of the task, start and termination of the task and if any constraints are there, that can be described in duration of the execution of the task. Some authors provided some solutions for this task scheduling for optimization likely A Jukuntla gave the faster solution for this with artificial bee colony algorithm.

Although these optimization techniques are successful to solve scheduling problem, when it reaches to optimization. So here an meta-heuristic technique is used for solving flowshop scheduling problem and these technique will try to solve large number of optimization problems.

1.1 FLOWSHOP SCHEDULING PROBLEM

Flowshop scheduling problem is one of the emerging problem in shop scheduling problems. In this it controls the flow of the tasks for machines were processed with other resources for completion of the jobs and maintaining of these jobs flow is very difficult at machine level and it eats all memory of the machine for remembering the order of the jobs in the resource. For this we have to maintain the flow of the jobs in machine for reducing the waiting time and idle time of the machine. This flowshop scheduling strictly maintains the flow of the operations to be performed in order. Technically the route of the machine are available for all jobs in the task. The machine route like M₁-M₂-M₃-M₄ or M₁-M₃-M₂-M₄ multiple routes may be available and job sequence may like this J₁-J₂-J₃-J₄ ...etc. The following figure is referred as the process in the manufacturing company. For maximization of resource utilization and

minimization of the idleness new algorithm is proposed to enhance the flowshop scheduling problem.

Figure 1: Flowshop scheduling in manufacturing industry

2. Bat Algorithm

Bat is an meta-heuristic algorithm and is used for optimization. This is one of the best algorithm compared with existing optimization techniques. It follows microbats echolocation and uses the loudness and pulse rates of emission. It imitates the natural bat behavior.

2.1 Behavior of echolocation

Following key point are referred as the behavior of echolocation of the bats.

- ✓ Bats are having an outrageous hearing sense.
- ✓ These Bats emit sounds that the objects that will send echoes back to it by using reflection method. Means, that objects will be in their path, so reflection of that object can reach to the bat.
- ✓ From the echoes of that reflected object, it sense the size of reflected objects in their path with distance and also movement of that reflected object with speed.
- ✓ The bat can determine where exactly the object is whether it is right or left compared with the echoes of the objects reaches it left ear or its right ear.

2.2 Microbats echolocations

All kind of bats are used echolocation for hunting food. These micro bats uses an extreme sound pulses in dark for paying attention for surrounding objects echo should be reached to microbat, so that can sense that object properties like size, direction of the object like left, right, upwards and downwards and it uses ultra-sonic wave signals for echolocation. The band width of the signal may vary from one object to another object and more harmonics are used for increasing in bats in greater number. Such echolocation operation is used in micro bats and it inspired for association with objects and microbats can be optimized. This will helpful for association between machine and job for executing task.

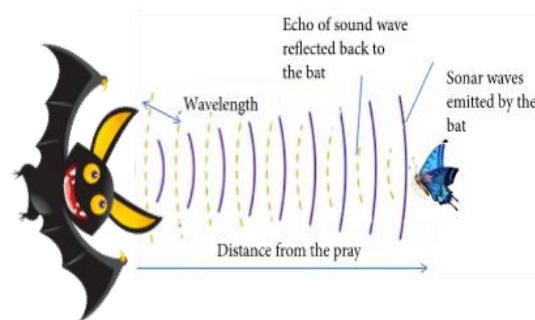


Figure 2: Echolocation of bats

3. Proposed Algorithm

The main goal of this echolocation is to develop various algorithms on bat. The algorithm as follows some rules

- It uses the echolocation to sense the object parameters like distance between food and background barriers.
- It flies with velocity V_{el_i} with certain position called P_i with $f_{re_{min}}$ embed frequency with ' λ ' wavelength and A_0 loudness to search for food and that can be automatically

adjusted with wavelength of the pulse which is emitted and rate of pulse emission $e \in [0, 1]$, and the target object proximity depends on it.

- Loudness can be varying in many ways, it can be assumed that loudness varies from a minimum constant value $Loud_{min}$ to large $Loud_0$.

Here no, ray tracing is used and the frequency f varies in $[Fre_{min}, Fre_{max}]$ and corresponding wave length varies from $[\lambda_{min}, \lambda_{max}]$.

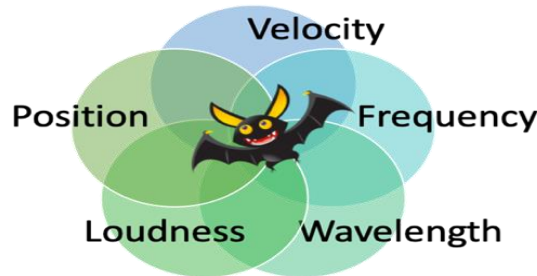


Figure 3: Bat Parameters

3.1 Bat Motion

The virtual bat movement is calculated by using Yang's Method, by Eq.[1] and Eq.[3]:

$$fre_i = fre_{min} + (fre_{max} - fre_{min}) \cdot \beta \quad (1)$$

$$Vel_{ji}(t) = Vel_{ji}(t-1) + [P_j - P_{ji}(t-1)] \cdot fre_i \quad (2)$$

$$P_{ji}(t) = P_{ji}(t-1) + Vel_{ji}(t), \quad (3)$$

Where randomly generated number is denoted with β in $[0,1]$, $P_{ij}(t)$: decision variable j , in step t for bat i . The output of fre_i (eq.1) is used for controlling movements of bats and plaes.

The variable P_j denotes the current global location with solution, for j variable decision. These achieved solution is compared among the bats for improving the variance of solutions.

3.2 Loudness and pulse rate variations

An employ random walks proposed in Yang[7] method. Firstly, best solution is selected which is currently find and it is applied among good solutions, after bat solution is generated with the help of random walk.

$$P_{new} = P_{old} + \epsilon \cdot Loud(t), \quad (4)$$

Here $Loud(t)$ is average at time t and each and every iteration loudness and emission pulse is updated, as given

$$Loud_i(t+1) = \alpha Loud_i(t) \quad (5)$$

and

$$E_i(t+1) = e_i(0) [1 - \exp(-\gamma^t)] \quad (6)$$

These values are taken for calculating the loudness and pulse rate of the algorithm in initial step after that only the bats are entered in to the main framework of the furth coming section algorithm and that is the proposed one.

4. Bat in Flow Shop Scheduling Problems

As we mentioned earlier, flowshop scheduling is if there are number of jobs working together and want to access the resources like particular machine or processor, the scheduling can be done in the strict order of all the operations must be performed by all the jobs.

Likewise, while the bats (jobs) in search of the food/prey it will use echolocation (targeted resources) making the loudness and pulses (sensors) which will give information about the resources (allocating resources) where it can be available. After completion of its search (available resources) it will occupy the food/prey (use the resources).

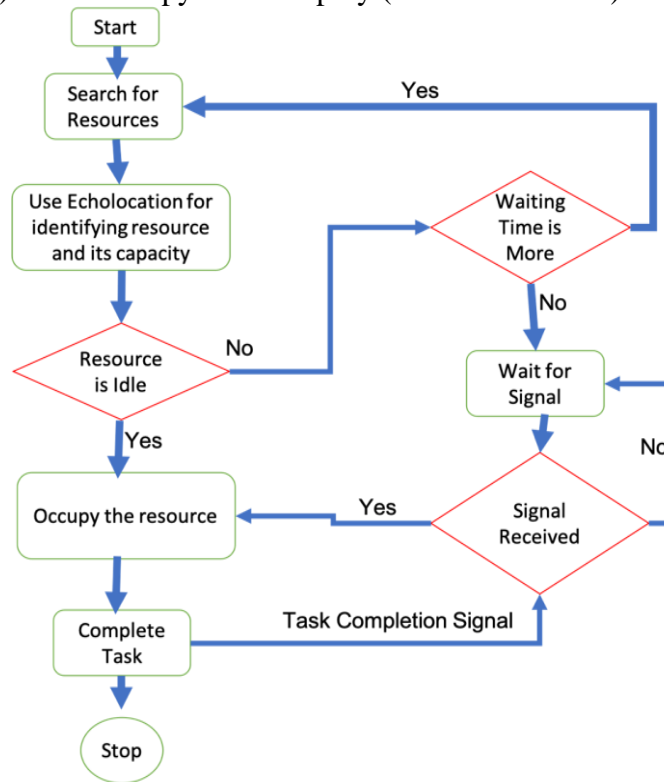


Figure 4: Algorithm Flow

Algorithm as follows

1. Bats (Job) starts for searching for resources for completion of the job.
2. Use echolocation for finding the targeted resource and identify the machine resource capacity and time slots for execution of the jobs.
3. If resource is idle, occupy immediately for completion of the task.
4. If resource is busy with executing other jobs and these jobs are in waiting mode for completion of job based on the priority of the resource. If the resource having less priority it goes and occupies the next machine based on the availability of the resource.
5. If waiting time is more, start with step 1, waiting is less wait for the completion of task and then occupy the resource.

5. RESULT

In section we took four workstations and five jobs for scheduling. Here we took an numerical example, in this matrix we mentioned resource utilization time for each job on workstation. We compared all parameters like waiting time, late jobs, tardiness, makespan, total tardiness, total time these are compared with existing approaches and shown in the following figures.

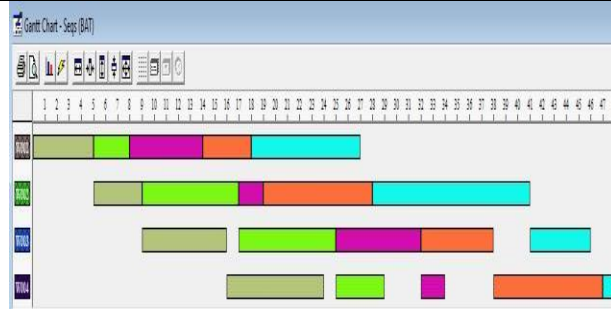


Figure 5: BAT Algorithm in Flow shop scheduling problem

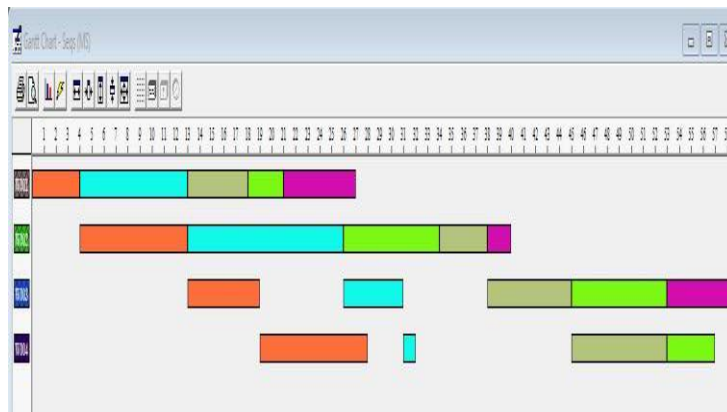


Figure 6: Existing Algorithm

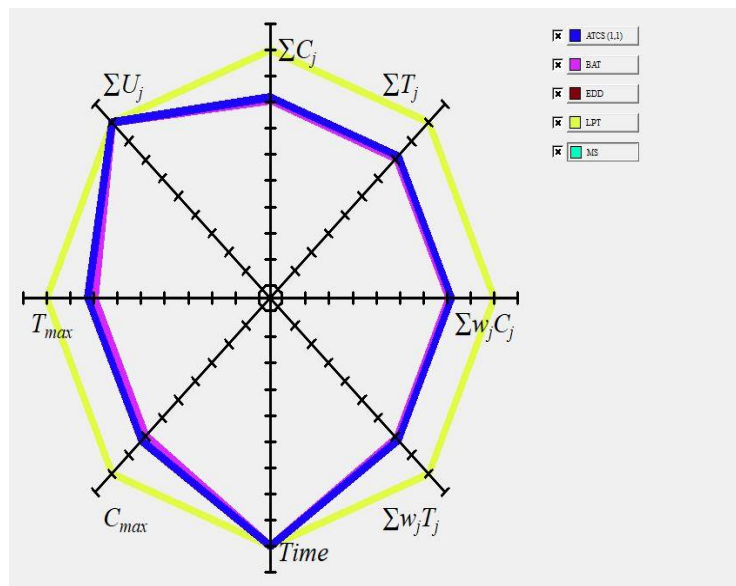


Figure 7: Comparison Graph BAT with other existing algorithms

CONCLUSION

Meta-heuristics are utilized for combinatorial advancement in which an ideal arrangement is looked for over a discrete inquiry space. In spite of the fact that we have examined flow shop scheduling issue by utilizing bat calculation we can get an ideal arrangement which is utilized to get the insignificant make range time. When contrasted and transformative calculations, commonsense swarm enhancement is increasingly effective. For

advance upgrade there are other arrangement strategies like branch and bound, heuristic and Dynamic Programming are actualized to improve framework execution.

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