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Makespan Minimization in Job Shop Scheduling

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ABSTRACT

In industries, the completion time of job problems in the manufacturing unit has risen significantly. In several types of current study, the job's completion time, or makespan, is reduced by taking straight paths, which is time-consuming. In this paper, we used an Improved Ant Colony Optimization and Tabu Search (ACOTS) algorithm to solve this problem by precisely defining the fault occurrence location in order to rollback. We have used a short-term memory-based rollback recovery strategy to minimise the job's completion time by rolling back to its own short-term memory. The recent movements in Tabu quest are visited using short term memory. As compared to the ACO algorithm, our proposed ACOTS-Cmax solution is more efficient and takes less time to complete.

***Keywords*--** Makespan, Minimization, Job Shop, Scheduling

I. INTRODUCTION

The job shop scheduling problem (JSSP) is defined as the jobs assigned to some resources at a particular time. Each job consists of some specific operations. Using that operation, jobs are scheduled for the resources.

The job shop problem is considered to be NP-Hard because each job may or may not be processed on all machines and also the time of processing of each job is different in a different machine. It is one of the most complex problems and optimum scheduling is also hard to calculate.

According to JSSP, the jobs are unable to complete on time. The industry should provide good service to consumers with on-time delivery of products. Good production scheduling is needed to make on-time delivery of products to the consumers. So makespan is not optimal. This work addresses the makespan problem which is defined as the maximum completion time of all jobs that are minimized in this work.

II. ANT COLONY OPTIMIZATION

Ant Colony Optimization Algorithm (ACO) is used to solve complex problems thatare used to identify the problems with the shortest path. In general, Ants couldn't see a food source, so ants are collecting the routes around their nest as well as producing the pheromone chemical which is used to communicate between the ants. The objective of this work is to follow the ant colony optimization rules and execute a job in the shortest possible time.

III. TABU SEARCH WITH JOB SHOP SCHEDULING

Tabu is one of the heuristic search methods used for an improved solution. Tabu list consists of two types of memory, they are Long-term memory and Short-term memory. Long-term memory is used to maintain the history of all processes in tabu search. Short-term memory is used to keep the recently visited tabu movements. In this work, short-term memory of the tabu list is used for better results. Rollback is one of the recovery technique which is used to avoid the restart the process from the beginning of the whole application in the conventional system due to the occurrence of failure.
Fucai et al (2018) investigated the blocking Flow shop scheduling problem with both makespan and energy consumption criteria. First, the multi-objective model of blocking Flow shop scheduling is formulated in consideration of machine energy consumed in blocking and idle time. Then, a multi-objective parallel variable neighborhood search (MPVNS) algorithm is proposed to solve this problem. An improved Nawaz- Enscore-Ham-based heuristic is developed to generate initial solutions, and a variable neighborhood search is designed to explore these solutions in parallel.

Jun et al (2018) investigated a Hybrid Pareto-based tabu search algorithm (HPTSA) to minimize four objectives simultaneously, i.e., the makespan, the maximal workload, the total workload, and the earliness/tardiness (E/T) criteria. In the proposed algorithm, several approaches considering both the problem characteristics and the objective features are used to initialize the group of solutions. Then, five types of neighborhood structures that consider both problem structures are developed to enhance the exploitation and exploration capabilities. Also, a well-designed backward method is proposed to optimize the E/T criteria.

Parviz et al (2018) proposed a cyclic algorithm based on a tabu search algorithm to improve the exploration and exploitation powers of these encodings. This algorithm had good features of the two representations and improved the exploration and exploitation of the algorithm by sequential transforming from each solution seed to the other. Also, a cyclic manner was applied in a tabu search algorithm.

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Numerical experiments confirmed the effectiveness of this algorithm. This work has, some reformations in the neighboring rule and tabu length were applied to improve the obtained solutions of the tabu search algorithm.

Mageed et al (2015) solved the two-stage no-wait flexible flow shop scheduling problem (NWFFSSP) using two meta-heuristics, which are Tabu Search (TS) and Particle Swarm Optimization (PSO). They solved the NWFFSSP with minimum makespan as a performance measure. The flexible flow-shop scheduling problem (FFSSP) is an important branch of production scheduling, the flexible flow shop is a combination of two well-known machine environments, which are flow shops and parallel machines, and it is well known that this problem is NP-hard.

Safia et al (2010) addressed the one machine scheduling problem in which n jobs have distinct due dates with earliness and tardiness costs. Fast neighborhoods are proposed for the problem. They are based on a block representation of the schedule and can be computed in o (n^2). A timing operator is presented as well as swap and extracts and reinsert neighborhoods. They are used in iterated local search framework.

Miguel et al (2013) defined a new local search neighborhood structure, which is then incorporated into the proposed tabu search algorithm. To tackle the job shop scheduling problem with sequence-dependent setup times and maximum lateness minimization using a tabu search algorithm.6 Conclusions and Future Work Proposed method TS–NSL, to solve the SDST-JSP with maximum lateness minimization.

The problem of job shop is handled with the help of heuristic algorithms. The improved ant colony optimization algorithm is proposed for reducing the makespan ($ACOC_{max}$) based on short-term memory and rollback technique.

In the first technique, the major problem of job shop scheduling is handled which is raised before the job is completed because when the job crashed between processing time and completion time. In general, if anyone's job is crashed, again the process can be started from the beginning. So, the completion of job time is high. To overcome this problem, addressed the rollback technique to avoid the process is restarted from the beginning and also used the STM memory structure to store the recent job.

The efficiency of the proposed work $ACOC_{max}$ is compared to ACO with Fault Tolerance (ACOwFT). In comparison analysis, proposed work $ACOC_{max}$ achieves less completion time than ACOwFT.

The scheduling of n jobs are assigned to m machines which are possible to deal with many dispatching rules such as shortest processing time (SPT), longest processing time (LPT), first come first serve (FCFS), and last come first serve (LCFS), etc. But these rules are hard to deal single machine problems with n jobs as it has a low performance.

In a single machine, the processing times of the jobs are simultaneously determined by a decreasing function of their corresponding scheduled position. The jobs are hard to process in a single machine because the lowest number of capabilities are only available in a single machine.

IV. REDUCE THE MAKESPAN

In the first technique, the process cannot starts from the beginning. Because the recent jobs are fetched from the STM using rollback technique and also the completion time of the job is reduced. But this work couldn't perform multiple jobs on a single machine. Because jobs are not flexible to work in a single machine. It contains one STM and has minimum space. So, it couldn't handle the multiple loads of jobs and also couldn't visit the recent jobs.

The novelty of this work, address the single machine problems with the help of Bee-colony optimization based on parameter condition. BCO is to create a multi-agent system (a colony of artificial bee) capable to solve different combinatorial optimization problems which are described by Hemant and Rohit (2012).

The second technique is an Integrated STM scheduling Replacement Algorithm (ISSRA) to reduce STM pollution. STM is one of the memory structures of tabu search and it visited only a recent past.

In existing, the cache pollution is reduced which is solved by (Kavita et al) using Integrated Cache Scheduling Replacement Algorithm. This work using this algorithm for novelty. The Bee-colony optimization algorithm has been used for the efficiency of this work.

Kavita et al (2019) proposed the Integrated STM Scheduling Replacement Algorithm consists of three parameters. These parameters help us to reduce cache pollution. That is job load & frequency, and timestamp and size.

V. STM STORAGE AND SINGLE MACHINE PROBLEMS

In the second technique, considered the three parameters like Job load: the job contains how much load, frequency: how many times the job is requested, timestamp: latest time of requesting the jobs. These three parameters help us to reduce the STM storage and the process of jobs is sequentially run on STM without interruption. The flexibility is done by ISSRA.

The efficiency of the second technique is compared to other scheduling algorithms. In comparison analysis, the ISSRA establishes to reduce the waiting time during process, which is compared to other state-of-the-art algorithms.

This work handles the two types of technique, the first technique is used to reduce the makespan time in job shop scheduling problem and executed the jobs with minimum time. The second technique is used to reduce the STM storage and solved single machine problems. Both techniques have better functionalities when compared to other techniques.

VI. CONCLUSION

This paper investigates how to minimise makespan in job shop scheduling using short-term based rollback recovery techniques in the Ant Colony Algorithm (ACO). Use this method to find the makespan in the shortest amount of time. This technique reduces the makespan, throughput time, and turnaround time factors. Finally, (ACO-Cmax) investigates efficient and effective comparisons (ACOwFT)

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