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ALGORITHM APPROACH FOR UNRELATED PARALLEL MACHINE WITH BREAKDOWN, REPAIR AND BACKUP MACHINE TO DIMINISH MAKESPAN

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ABSTRACT. In this paper, an algorithm approach for unrelated parallel machine with breakdown, repair and backup machine is to diminish the makespan time are considered. The group of b products to be processed on a machines that are group in parallel without preemption. If any of the machines is breakdown, then immediately the backup machine will start the production process at lower rate. When the main machine ready to serve until the backup machine doing production work. The mixed integer programming technique is utilized in order to diminish the makespan in this paper. A algorithm approach such as Genetic algorithm (GA) and Simulated Annealing (SA) for solved the problem effectively and the performance measure has been analyzed numerically.

1. INTRODUCTION

The customer satisfaction is very important for manufacturing industry with lowest cost. The responsibility of the manufacturing industry is to scrutinize the level of performance and level of priority. In manufacturing, the achievement is based on the quality of the product, the worker contribution and the safety atmosphere.

The customer is receiving the product on time for the purpose of the production planning. In a planning horizon, the allocation of limited resources to the set of arrived jobs that should be processed is known as scheduling. It is often

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viewed as the best tool of a decision maker. For example, scheduling can be seen in many areas like production process, communication networks, airlines sector, etc,. In many manufacturing industries, due to rapid arrival of jobs, the available resources or the machines are said to be operated in parallel depending on identical and non-identical jobs.

Every product is allocated into the multiple resources are called the parallel machine scheduling. When the level of the speed is different ratio then it is called unrelated. If any of the machines is breakdown, then immediately the backup machine will start the production process at lower rate. When the main machine ready to serve until the backup machine doing production work.

Details can be found in [1–6].

2. Model Description

The group of b products to be processed on a machines that are group in parallel without preemption. Only one job is allowed at a time for every machine. If any of the machines is breakdown, then immediately the backup machine will start the production process at lower rate.

a = Set of machines $(p = 1, 2, \ldots, a)$.

b = Set of jobs (q=1,2,. . . ,b).

P_{pq} = Processing time for jobs q on machine p.

S_{pqk} = Backup time of machine p between the processing of job q and k.

r_{pqk} = Repairable resources to be backup on machine p between job q and k.

D_{max} = Makespan.

R_{max} = Number of available resources needed for backup.

3. Mixed Integer Programming Model

The objective is to diminish the makespan subject to breakdown, repair and backup machine. In this model, the equation (3.1) explains about only one job is allowed to process at a time. The equation (3.2) gives constraints that indicate at most one job is allowed to process in each machine at a time. Equation (3.3) and (3.4) ensure that each job that is processed on machine has a successor k and a predecessor q.

Equation (3.5) ensure that for every machine p and for each pair of successive job q and k on machine, the backup between q and k must end in one and only one moment before D_{max}. The backup server between two successive job q and k on machine p is considered in equation (3.6). Equation (3.7) is the number of resources will not exceed R_{max} at time t. Equation (3.8) ensure that the completion period must be greater than or equal to backup server on machine p. Equation (3.9) is the completion time of decision variable.

Objective function: Minimize $Z = D_{max}$

$$\sum_{k=1}^{b} Y_{pqk} \leq 1; p = 1, 2, \ldots, a \tag{3.1}$$

$$\sum_{p=1}^{a} Z_{pq} = 1; q = 1, 2, \ldots, b \tag{3.2}$$

$$Z_{pq} = \sum_{k=1}^{b} Y_{pqk}; k = 1, 2, \ldots, b \tag{3.3}$$

$$Z_{pk} = \sum_{k=1}^{b} Y_{pqk}; p = 1, 2, \ldots, a; q = 1, 2, \ldots, b \tag{3.4}$$

$$\sum_{(t \leq D_{max})} F_{pqkt} = Y_{pqk} \tag{3.5}$$

$$\sum_{t} tF_{pqkt} \geq \sum_{r=1}^{a} \sum_{(t \leq D_{max})} F_{prqt}(t + S_{pqk} + P_{pq}) - S(1 - Y_{pqk}) \tag{3.6}$$

$$\sum_{t' \in t, \ldots, t+S_{pqk}^{-1}} r_{pqk} F_{pqkt'} \leq R_{max} \tag{3.7}$$

$$\sum_{(t \leq D_{max})} tF_{pqkt} = D_{max}; k = 1, 2, \ldots, b; t \leq t_{max} \tag{3.8}$$

$$Y_{pqk} \geq 0, Z_{pq} \geq 0, F_{pqkt} \in 0, 1 \tag{3.9}$$

4. Computational Results

Genetic algorithm is considered as adaptive algorithm. It is natural selection and genetic idea base. It is widely used to evaluate solutions of high quality and for problem optimization. These are intelligence algorithms which bring us direct to research into the region, by exploiting historical data. These genetic algorithms are used for optimization in purpose to generate the high quality of best results.

Table 1 describes the objective function and the computational time for both SA and GA with varying different types of machines and jobs. When compared to both method SA and GA, the computation time taken to complete the work for GA seems to be more impressive and take less number of CPU time. The number of job varying the computational time for SA and GA with respect to two machines are given as bar graph in Figure 1. In Figure 2 and 3 presents bar graph, the number of jobs versus CPU time for 3 and 5 machines compared with SA and GA.

In Figure 4 and 5, the number of job is compared with CPU time for SA and GA for 7 and 10 machine respectively. When compared to all bar graphs, GA seems to be more effective and useful. In Figure 6, the number of job versus CPU time is analyzed for SA and GA for 5 machines. The number of job is illustrated with the computational time for 7 and 10 machines with respect to SA and GA is given in Figure 7 and 8 respectively.

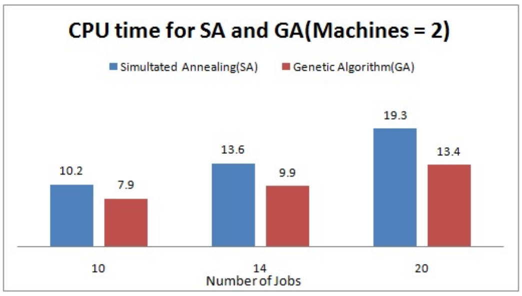

FIGURE 1. CPU(M=2)

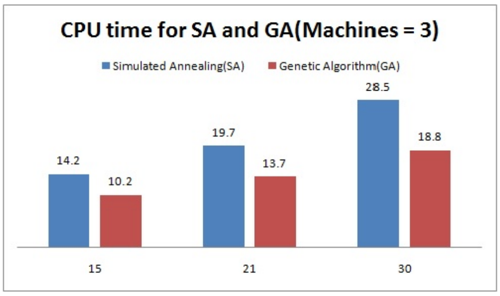

FIGURE 2. CPU(M=3)

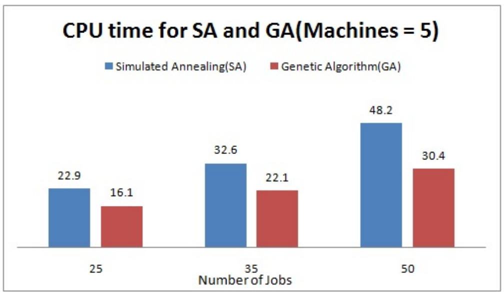

FIGURE 3. CPU(M=5)

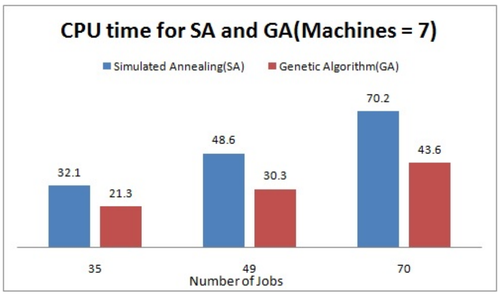

FIGURE 4. CPU (M=7)

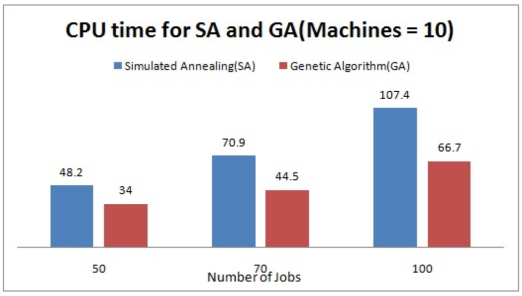

FIGURE 5. CPU(M=10)

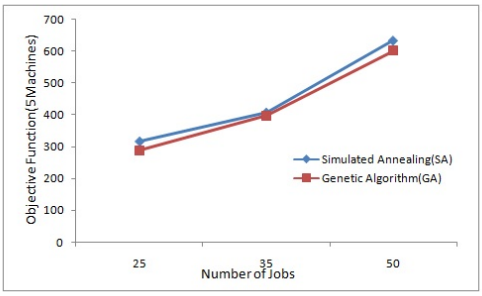

FIGURE 6. Job Vs objective(M=5)

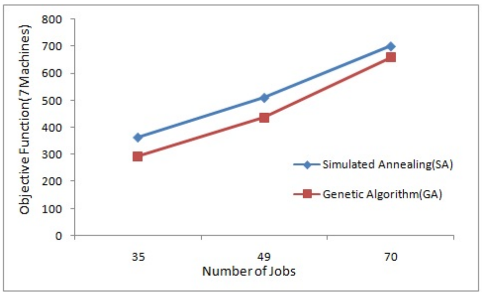

FIGURE 7. Job Vs M=7

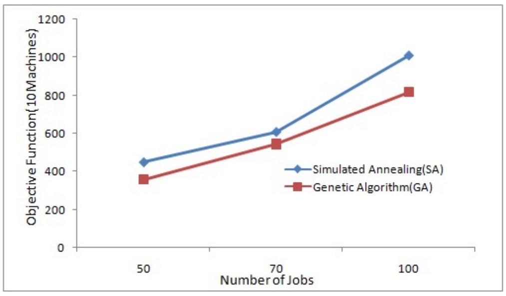

FIGURE 8. Job Vs M=10

Table 1: CPU and Objective Function for SA and GA

Machine	Job	SA	SA	GA	GA
a	b	objective	CPU	objective	CPU
2	10	278	10.19	278	7.9
2	14	379	13.6	377	9.9
2	20	538	19.3	537	13.4
3	15	277	14.2	277	10.2
3	21	378	19.7	378	13.7
3	30	551	28.5	551	18.8
5	25	317	22.9	289	16.1
5	35	408	32.6	397	22.1
5	50	634	48.2	601	30.4
7	35	363	32.1	293	21.3
7	49	510	48.6	436	30.3
7	70	701	70.2	659	43.6

10	50	450	48.2	357	34.0
10	70	609	70.9	542	44.5
10	100	1004	107.4	815	66.7

5. Conclusion

In this paper, an algorithm approach for unrelated parallel machine with breakdown, repair and backup machine is to diminish the makespan time are considered. If any of the machines is breakdown, then immediately the backup machine will start the production process at lower rate. The mixed integer programming technique is utilized in order to diminish the makespan in this paper. A algorithm approach such as GA and SA for solved the problem effectively and the performance measure has been analyzed numerically.

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