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AN IMPROVED GENETIC ALGORITHM OPTIMIZATION OF MULTI OBJECTIVE CRITERIA IN HYBRID FLOW SHOP SCHEDULNG

V.Karpagam[1], KR.Senthil Murugan[2]
[1]Assistant Professor (Sr.Gr.), Computer Science and Engineering, KLNCE, Madurai, TamilNadu, India,
[2]Assistant Professor, Computer Science and Engineering, SKCET, Coimbatore, TamilNadu, Inida

Abstract: Flow Shop Scheduling Problem consists of scheduling a set of n jobs on a set of m machines. For this problem, all jobs have the same sequence of operations. In this work, we considered the problem with respect to the objectives of makespan and total tardiness, flow time. An improved Genetic Algorithm based approach in order to solve this scheduling problem. A parameter analysis was done to determine suitable values for various parameters which were then used for analysing the performance of the algorithm on benchmark problems. Also, job data from a company (four drawer furniture component (4dfc)) was taken and the time sequence for each operation was manually calculated and the results are shown and discussed.

Index Terms: 4dfc – Four drawer Furniture Component, GA – Genetic Algorithm.

I. INTRODUCTION

Scheduling is an activity by which any work is done in an orderly manner without any kind of restriction or disturbance during the planned work process. Generally scheduling is the basic idea of accomplishing a work. The work may be a job or a project, and they are composed of constraints known as operations, availability, delay etc., in a general manufacturing system jobs or work are parts or assemblies and activities are machining, assembly and availability and delay are tardiness and machine availability. A good schedule has a series of objectives:

- Maximize shop throughput over a certain time period.
- Minimize steady costs.
- Improve quality for customer satisfaction. In general, a flow shop schedule consists of a sequence of n machines aligned in series. Where each machine cell is a group and each machine may or may not be identical, and each group consists of only one machine performing a single operation at a time. Whereas in a hybrid flow shop system, every group has one or more machines performing different operations in the group. Thus, reducing make span, in turn the lead time of production.
- Scheduling is an important tool for manufacturing and engineering, where it can have a major impact on the productivity of a process. In manufacturing, the purpose of scheduling is to minimize the production time and costs, by telling a production facility when to make, with which staff, and on which equipment. Production scheduling aims to maximize the efficiency of the operation and reduce costs.

II. RELATED WORK

Hybrid flow shop scheduling problem was first proposed by Arthanari and Ramamurthy [1971]. Gupta [1988] proved that simple two stage hybrid flowshop scheduling problem with each stage having two identical machines was NP – hard.ChandrasekharanRajendran and DipakChaudhuri [1992] developed a heuristic algorithm for scheduling in a two-stage parallel-processor flowshop problem to minimize total flowtime.

A hybrid heuristic algorithm was addressed by Portmann et al. [1998]. They used Branch and bound algorithm and a Genetic Algorithm to solve the multi stage Hybrid Flowshop Scheduling problems. NajiYounes, et al. [1998] used Simulated Annealing algorithm to minimize makespan in a Flow Shop with Multiple Processors.They generated initial solutions by using some heuristics in the first stage and the solutions were improved by Simulated Annealing algorithm in the second stage.

Nour El HoudaSaadani et al. [2003] suggested a new heuristic to minimize makespan in a three stage no idle flow shops. Lee and Kim [2004]addressed a branch and bound algorithm for a two stage hybrid flow shop with the objective of minimizing total tardiness of jobs. In that Hybrid Flowshop Scheduling Problem they considered one machine at the first stage and multiple identical parallel machines at the second stage.

CeydaOguz et al. [2004] developed anefficient and effective approximation algorithm based on the tabu search algorithm to minimize makespan for Hybrid Flowshop scheduling problems. A Bottleneck focused scheduling heuristic was presented by Lee et al. [2004] to minimize the total tardiness for a Hybrid Flowshop. The Bottleneck stage was identified and the schedule was constructed first for it. They used the random problems for testing the algorithm.

Hamid Allaoui et al. [2006] developed a branch and bound algorithm for a two stage hybrid flow shop scheduling problems to minimize makespan. They considered a single machine in the first stage and m machines in the second stage. They also considered the unavailability of machines for their research. George Kyparisis and Koulamas [2006] proposed a heuristic to minimize makespan for multistage flexible flowshop problem with uniform parallel machines in each stage.

III. GENETIC ALGORITHM

This section describes the basic idea and design methodology of GA.

3.1 GENERATION OF INITIAL POPULATION:

First step is the generation of initial population randomly. Each processing sequence is represented by chromosomes corresponds to one job. The chromosomes length equal to number of jobs 'N'. The elements of the chromosome are generated randomly, andone chromosome provides one sequence. The population size is problem dependent and assumed here as twice the number of jobs to be processed.
i.e. Population size =2*number of jobs
Population size =2*N

3.2 EVALUATION:

In this step, the population is evaluated for fitness and probability of selection of each chromosome is to be found out. The process of evaluating the fitness of chromosome(c) is given below.

A. Evaluation of objective function;

Objective function f(c) is evaluated by loading jobs corresponding to the
Sequence in the chromosomes(c)
f(c)=makespan time of the corresponding sequence of the chromosomes(c).

B. Fitness value

The next step is to convert the objective function to a fitness value fit(c) s
For the minimization objective and scaling them high so that few extremely superior individuals would be selected as parents too many times.the best conversion function that has been found to be generally useful is the exponential.

i.e. f(v)=d^k,

where k is a negative number
This conversion function has been used to find the fit(c) value

i.e. fit(c)=e^-k*f(c)

The value of the constant k is assumed as 0.05 in order to scale the fitness function reasonably such at least half of the good chromosomes in the population find place in the new population. Hence, the fitness parameter value has been found out using the formula given below,

i.e. fit(c)=e^-0.05*f(c

C. Probability:

Finally to convert the fitness parameter to expected probability of selection (p(c)) of chromosomes (c) by sum of fitness values of all chromosomes the formula to calculate p(c) is
p(c)=fit(c)/∑ p(c)
Then the cumulative probabilities of survival (cp(c)) of all chromosomes are found using formula.
cp(c)=∑p(c)

3.3 SELECTION OF NEW POPULATION:

A random selection procedure, generates the next population of the same size. A random number r between 0 and 1 is obtained and a chromosome(c) is selected which satisfies the following condition

cp(c-1)≤ r ≤ cp(c)

This selection process is repeated a number of items equal to the population size. The method used here is more reliable in that it guarantees that the most fit individuals will be selected, and that the actual number of times each is selected will be its expected frequency ±1. This procedure enables the fittest chromosome to have multiple copies and the worst to die off.

3.4 CROSS OVER:

Crossover is a genetic operator that combines (mates) two chromosomes (parents) to produce a new chromosome (offspring). The idea behind crossover is that the new chromosome may be better than both of the parents if it takes the best characteristics from each of the parents. Crossover occurs during evolution according to a user definable cross over probability. The probability of crossover (pcross) is the one vital parameter that needs attention at this juncture. The value for process has been assumed to be 0.4, so that at least 40% of the chromosomes selected for the new population will undergo the crossover operation and produce offspring.

3.5 MUTATION:

The purpose of mutation is to reduce new genetic material, or to recreate good genes that were lost by chance through a poor selection of mates. To do this effectively, the effect of the mutation must be a major one. At the same time, the valuable gene pool must be protected from wanton destruction. Thus, the probability of mutation would be small. The value of the probability of mutation (pmut) has been assumed to be 0.05. Actually, the mutation here exchanges the game within the chromosome.

3.6 CHECK FOR TERMINATION:

The repetition of the whole process of evaluation, selection, reproduction and mutation depends on the size of the problem. No generalization is possible with respect to the behavior of model constraint. The number of iterations is considered as the termination criterion and fixed as square of the total number of jobs 'N'. The best chromosome in each iteration is stored, and the best among those stored in the optimal one.

IV. A CALCULATION RESULT IN SINGLE MACHINE & MULTI MACHINE

4.1 Calculation

Tables 4.2 & 4.3 shows the calculated results for using single machine and multi machine. Time is calculated manually for various sequence of operations. It is found that for single machine the sequence drilling, power pressing, welding, bending, punching in order produced less makespan time. For multi machine the sequence bending, welding, power pressing, drilling, punching in order produced less makespan time.

Table 4.2 SINGLE MACHINE CALCULATION RESULTS

SEQUENCE OF OPERATIONS	TIME (Sec)
1-19	763
19-1	824
Random sequence	666

Table 4.3 MULTIMACHINE CALCULATION RESULTS

SEQUENCE OF OPERATIONS	TIME (Sec)
1-19	168
19-1	156
Random sequence	135

V. CONCLUSION

In this paper, the concept of GA, which is a genetic algorithm, to achieve fast and combinational flow shop and job shop which schedules the single & multi objective functions in single machine the sequence drilling, power pressing, welding, bending, punching in order produced less makespan time. For multi machine the sequence bending, welding, power pressing, drilling, punching in order produced less makespan time. Finally this paper conclude the algorithm minimize the flow time & Make span.

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