GENETIC ALGORITHM BASED APPROACH FOR FLOW SHOP SCHEDULING PROBLEM

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Introduction

Scheduling concerned with the optimal allocation of limited resources to activities over time. A flow shop consist of number of different machines and each jobs different operations have be processed from the different machines available and number of operations for a each job is equal with the number of machines.

Proper allocation of jobs to machines is very important in flow shop problem and there are number of approaches proposed to solve. Johnson's method is one of the methods which can be applied to small scale problems. When problem size increases it is very difficult to schedule flow shops in order to get optimal results. In these situations optimal approaches will not work since problem size increases time taken to generate results increased in an exponential manner hence categorized as NP-hard problems. There are number of attempts to solve this type of problems. Most popular methods are Heuristic algorithms, Branch and bound methods, Fuzzy approach, neural networks Hamad A *.et.al.*, (Hamad A, et.al, 2002) Evolutionary algorithms *etc*.

This study is focusing on a fabric printing plant where number of different machines are arranged to print different varieties of printing jobs where each job has different constraints to be satisfied. Therefore scheduling a problem in this nature is very complex problem to handle in order to generate productive schedule.

This printing plant scheduling problem is considered as a flow shop problem. The main objective here is to minimize the earliness and lateness of set jobs waiting to be processed. Add a penalty to jobs considering their lateness or earliness and try to minimize the total penalty is introduced. Genetic algorithm is used as the solution tool. Genetic algorithms maintain a population of possible solutions to a problem, encoded as chromosomes based on a particular representation scheme. After generating an initial population, new are generated via the process of reproduction. There are number of variations of the way GA is applied: Initializing the string in real domain, PMX crossover method (Zhu K. Q, 2000), and permutation technique (Weise T. 2009) are some of them. These concepts are used such a way that, they will not allow jobs to repeat in the schedule.

Mathematical Model

Scheduling is done to minimize the earliness (E) and the lateness (L) of n number of jobs in multi stage, single line continuous processing flow shop. That mean; all the jobs are processed start to end without intermediate stopping. Therefore, this will be equal to single machine flow shop problem. This flow shop problem can be write in standard format as

$n/1//\bar{E},\bar{L}$

Objective function will be, minimize

$$f(s) = \sum_{i=1}^{n} \alpha E_i + \beta L_i \qquad (1)$$

$$E_i = |d_i - c_i| \quad L_i = |c_i - d_i|$$

E_i= Earliness of i^{th} job
L_i= Lateness of i^{th} job
d_i= Due date of job i
α = Penalty weight for the earliness
β= Penalty weight for the lateness
n= number of jobs

Since the process is single continues production line, all the processes can be combined to one. The flow chart of the algorithm is given in Figure 1. Following assumptions considered when modeling this problem;

- single production line
- Same processing sequence
- All the jobs are available at start
- The required details of the jobs are known in advance
- All machines are available and ready to start processing at $t = 0$

Results and Discussion

After coding the Model, it was tested in AMD Turion64 Machine with randomly generated 20 jobs with relevant details. It was assumed that penalty for 1 unit lateness (α) is 10 and penalty for 1 unit earliness (β) is 5. Other variables used in Genetic algorithm: 30 strings, 1000 generations, 1-mutation points for string, crossover probability of 0.6, mutation probability of 0.55 are used for the simulation, average time of 38.6 S was taken to solve the problem. Total penalty of the 14860 was gained for the final schedule by developed method. It was 18605 for earliest due date first sequence and 18215 for the sequence with first come first serve basis. This result clearly shows that, developed technique gives the reasonable solutions.

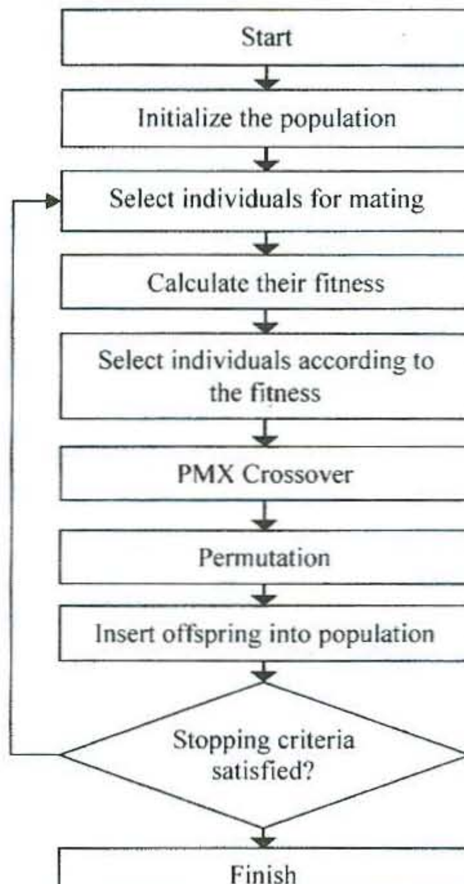

Figure 1: Flow chart for the model

In the model, new mutation technique is implemented to preserve the diversity of the solution candidates. Mutation probability was acquired according to the fitness level of the strings. In final testing, it was observed that the optimum level

(accuracy level) is changing with the number of strings, number of jobs and number of generations. Therefore, solutions can be improved by changing the above parameters.
As seen in the Figure 2, Genetic method improves the solution (minimize the penalty) with the increase in generation, But increment is random and unpredictable one.

Conclusion
Scheduling is very important task for the production process, because using a proper schedule; the profit and productivity can be increased by utilizing the resources while minimizing the lateness, earliness, setup time *etc*. In this research, the lateness and earliness of the jobs in a flow shop was reduced by applying Genetic Algorithm. The method showed a good improvement with reasonable time consumption. Further improvements can be done on mutation method and the crossover technique to enhance the solution further. Since the research focused only about single line production processes this can be modified for parallel line systems.

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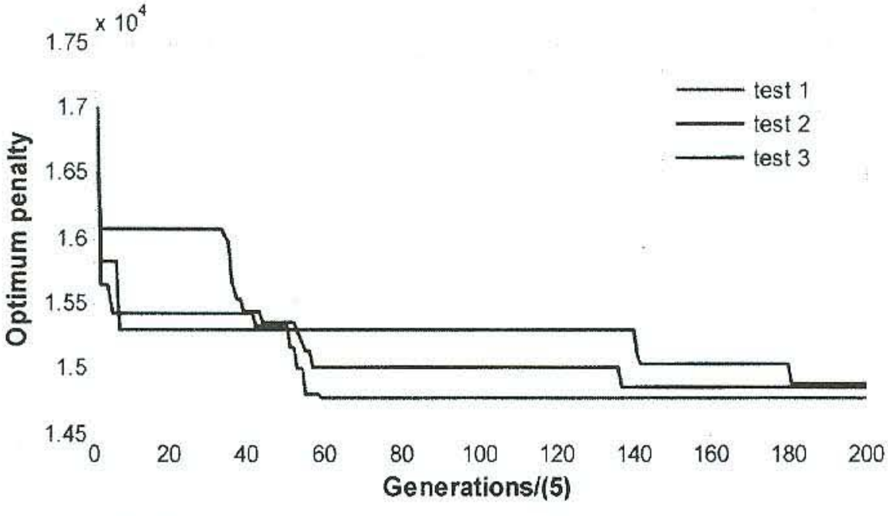

Figure 2: Variation of optimum total penalty with generation