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Effective Methods of Scheduling

Sayali C.[1*] and Ritu K.[2]

[1] *Saraswati college of engineering, Kharghar, Mumbai University, INDIA*
[2] *Pacific college of engineering, Udaipur University, Rajasthan, INDIA*

[*] *Correspondence: E-mail: sdc16.maths@gmail.com*

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ABSTRACT: Scheduling is a term which we used in our day to day life. It is a plan prepared for smooth conduction of any activity. Schedule gives us the answer of the question 'when'. In industries scheduling plays an important role for getting maximum output using available resources and raw material. One of the important tasks is designing model to understand the schedule and finding the solution for the problem. There are several methods of machine scheduling which are often used in production. A model may be of single machine or multiple machine models. Depending on number of machines the optimization techniques are developed and used. In this paper we have tried to compare the different methods of machine scheduling. In scheduling problems there are two common types of constraints. One of the constraints is limitations of number of machines and another is restriction of jobs performed on machines. Depending on this factors the various methods of scheduling like Gantt chart method, Johnson's rule, Proposed method, Palmers heuristic method etc. are discussed in this paper and tried to find the effective method for optimization problem.

Keywords: Branch and bound technique; Gantt chart; Johnson's rule; Machine scheduling; proposed method and Palmer'sheuriic.

INTRODUCTION: Proper sequencing determines the scheduling of jobs performance which gives the deterministic schedule of the production in industries. In machine scheduling, machines are arranged in series or parallel combination. There are three types of scheduling problems for m-machines and n-jobs- job shop scheduling, flow shop scheduling and open shop scheduling problems. In job shop scheduling problems the jobs are operated on different machines with some relation among them that is all jobs are not operated on every machine. In flow shop scheduling problems all the jobs are performed on all machines in a fixed sequence. In open shop scheduling problem there is not restriction on the job performance. The jobs are freely operated on the machines with their priority. In most of the industries the tasks implementation needs use of available resources in particular order or every job has to perform on every machine. Hence flow shop scheduling problem is widely used in scheduling problems. Every scheduling problem must satisfy the following conditions:

1) The jobs must be ready with particular operation on every machine.
2) Only one job should be processed on a machine at a time.
3) Processing time of the job and set up time of the jobs may be independent or included.
4) Breakdown interval of the machine should be avoided.
5) Sequence of jobs must be decided initially.
6) Machines should not be kept idle while jobs are processing.
7) Once the production starts, jobs should be operated on machines continuously.
8) There should not be two machines of same type.
9) Initially all jobs must be available for dealing out at time zero.
10) All jobs are independent means there is no relation between them.
11) Each job is performed in fixed order, preemption of jobs is not allowed.

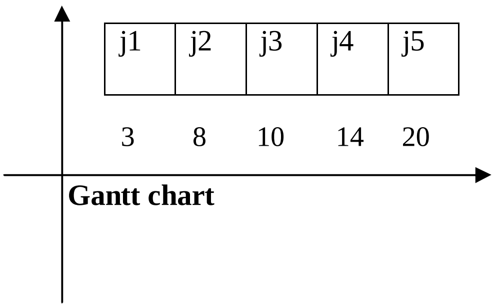
METHOD:

Gantt chart: In case of single machine all jobs have to be processed through only one machine. Since the total manufacturing time is fixed or it is equal to the processing time of all the jobs, the other constraints like to decrease the mean flow time, cost minimization etc. are to be considered. The jobs are processed by using SPT rule (shortest processing time) means according to their increasing order of completion time. It means jobs taking minimum time for completion should be processed first. It minimizes the average waiting time as well as total make-span of production.

Gantt chart is widely used for getting the optimum solution in case of single machine as well as m-machine scheduling problem. The static flow shop problems are decided while considering the schedule by using this Gantt chart as the release time for all the jobs are zero. In Gantt chart the schedule is represent-ed in graphical way. In graph, time is shown on x-axis and number of machines is shown on y-axis. The bars are drawn and the processing time of each machine is indicated by the length of the bar. Bar also shows the starting and completion time of the machine.

Following is the single machine scheduling problem with fixed jobs and processing time considered. Gantt chart is drawn for given sequence. Also the same problem is considered by using Shortest processing time (SPT) rule and the chart is drawn .It is observed that the average values of waiting time and the flow time by using SPT rule are minimum.

Job(j)	1	2	3	4	5
pj	3	5	4	2	6



Gantt chart

Johnson's Rule: In case of two machines the objec-tive of minimizing of make-span is achieved by using Johnson's rule. Two machines optimization problem is renowned by Johnson's rule.

Johnson's Rule for n-jobs m-machines scheduling problem: For applying Johnson's Rule there are some conditions like fixed time period of each job, no prior-ity for the jobs is given that is preemption of jobs is not allowed. For n-jobs m-machines scheduling prob-lem the number of schedules possible is $(n!)^m$. The main aim of this rule is to decrease the total time peri-od of production and increasing the production.

Johnson's Rule for two machines scheduling: As Per Baker, **Johnson's rule** is defined as follows:
Job i precedes job j in an optimal sequence
if min (ai, bj) ≤ min (aj, bi), Where a and b are two machines.

There are 5 steps in Johnson's rule -

i) The number of jobs assigned to each machine and their processing time are decided.

ii) The minimum time taken by any machine should be observed and if it is at first machine then the first machine will be arranged as early as possible or in the starting of sequence.

iii) If the time taken by the job is least on second machine, then second machine should be at the last position of sequence.

iv) Remove the job from the sequence which is al-ready put in the sequence.

v) Above steps should be repeated for sequencing of all the jobs.

In short, if Min [a, b] = a then it will be arranged at first position and if Min [a, b] = b then it will be arranged at last position.

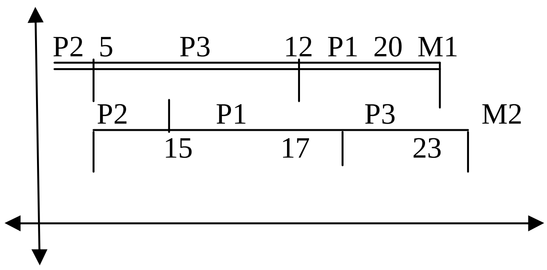
If any work starts with two machines then we know that first machine that is machine1 always starts work-ing at time (t) equal to zero. When machine1 is in working of first job that time machine 2 is not in working hence the job of minimum time should do on machine 1first .This will decrease the rest period of machine 2.If machine 2 finished job early and pro-cessing of first job of next part of machine 1 is not finished then machine 2 has to wait for next job. So Johnson's Rule states that second job should be ar-ranged in such a way that it will take maximum time for second operation.

For example:

	j_1	j_2	j_3
M_1	7	5	8
M_2	8	10	6

According to Johnson's Rule the sequence for given example is P_2, P_1, P_3

Gantt chart:



Johnson's two machine algorithm can be expanded to **three** machine flow shop problem if the time taken by first machine and third machine is maximum than the time taken by the job on second machine so that no job has to wait on second machine .The process of obtaining optimal sequence is similar to two ma-chines, only difference is that we have to consider two fictitious machines so that optimum sequence can be obtained by applying Johnson's Rule to these ficti-tious machines.

For example:

Job	M1	M2	M3
j1	4	6	7
j2	3	5	4
j3	5	4	3

Three machines problem is converted into two machines problem by considering 2 fictitious machines P and Q where P=M1 + M2 and Q = M2+M3.

Job	P	Q
j1	10	13
j2	8	9
j3	9	7

According to Johnson's Rule the sequence for given example is j2, j1, j3

Calculation of total working period

Job	M1	M2	M3
j2	3,3	3,8	8,12
j1	3,7	8,14	14,21
j3	7,12	14,18	21,24

Total make-span using Johnson's algorithm is **24 hrs.**

By using this sequence we can minimize the total working period of the production.

Proposed method: The objective of flow shop scheduling problems is to reduce the total working period of production. Proposed method is similar to Jhonsons rule method. The steps of the above method are as follows-

Step I-Choose the job having minimum time from the first column and the respective row will be transferred in the first row.

Step II- Similarly we have to choose the minimum processing time job from the last column and shifted this complete row down and continue the same method for all jobs involved in the table.

For example:

Job	M1	M2	M3
j1	4	6	7
j2	3	5	4
j3	5	4	3

By using step I and step II we get

Job	M1	M2	M3
j2	3	5	4
j1	4	6	7
j3	5	4	3

Hence we get the sequencing schedule as j2, j1, j3

To find total working hours of the production-

Job	M1	M2	M3
j2	0, 3	3,8	8,12
j1	3,7	8,14	14,21
j3	7,12	14,18	21,24

Hence the total make-span by using Proposed method is **24 hrs**.

Palmer's Heuristic algorithm: In this method initially we have to calculate the slopes of Sj for all the fobs and these jobs will be arranged in decreasing order of slopes .The same problem of three machine three jobs is considered for finding the optimum solution.

Job	M1	M2	M3
j1	4	6	7
j2	3	5	4
j3	5	4	3

The slope is calculated by using following formula

Spj = $-\sum_{i=1}^{n}\big(n-(2i-1)\big)Pij$, where n=3 and j=3.

Therefore Spj = $-\sum_{i=1}^{3}\big(3-(2i-1)\big)Pij$,

Sp_1= - [(3-(2-1))4+(3-(2*2-1))6+(3-(2*3-1))7] = -6

Sp_2 = - [(3-(2-1))3+(3-(2*2-1))5+(3-(2*3-1))4] = -2

Sp_3=- [(3-(2-1))5+(3-(2*2-1))4+(3-(2*3-1))3]= -(14+0-12) = 4

The order of sequence in descending order is either J1,J2,J3

Calculation of total makespan:

	j1	j2	j3
M1	4, 4	3,7	5,12
M2	6,10	5,17	4, 21
M3	7,17	4,21	3,24

Hence Total make-span by using Palmer's Heuristic algorithm is = **24hrs**.

CONCLUSION: Three methods of optimization are discussed and studied for getting total working hours of the process. All the methods are combination of Johnson's rule. From the output it is observed that for the same data different methods are applied and outputs by using these different methods are obtained. By using Johnson's rule the total make-span is **24 hrs**, by using

Proposed method **24 hrs** and by using Palmer's Heuristic algorithm it is **24 hrs**. So it is observed that by using all the methods result is same. So both the methods are equivalent to Johnson's algorithm. But for n-machines problem Johnson's algorithm is widely used in optimization. Also Gantt chart gives the graphical representation of working period of machines in total production process.

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