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"STUDY AND ANALYSIS OF FLOW SHOP SCHEDULING PROBLEM WITH HEURISTIC APPROACH"

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ABSTRACT

Turnaround time is the time between to start and complete the job. In the case of production turnaround time is very important to determine the processing time. Processing time of jobs depend on resource available in the production environment. Scheduling is the process to create the sequence of jobs and generally tells the happening of things and shows a plan for the timing of certain activities.

KEYWORDS: Sequencing, Scheduling, Flow Shop, Heuristic, Makespan

INTRODUCTION

A general job shop problem suppose having n jobs $\{j_1, j_2, j_3$ --------- $j_n\}$ to be processed through m machine $\{m_1, m_2, m_3$ ----------- $m_m\}$. Technological constraints demand that each job should be processed through the machine in a particular order and gives an important special case named as flow shop. Thus in case of flow shop jobs pass between the machine in the same order i.e. if j_1 must be processed on m_1 before machine m_2 then the same the true for all jobs. This technological limitation therefore gives the form like:

Job	Processing Order
j_1	$m_1\ m_2\ m_3$ .... m_m
j_2	$m_1\ m_2\ m_3$ .... m_m
-	----------------------
j_n	$m_1\ m_2\ m_3$ .... m_m

LITERATURE REVIEW

Patrik Haslum and H´ector Geffner 2014 developed an optimal, heuristic search planner that handles concurrent actions, time and resources, and minimizes makespan. The two main issues we have addressed are the formulation of an admissible heuristic estimating completion time and a branching scheme for actions with durations. In addition, the planner incorporates an admissible estimator for consumable resources that allows more of the search space to be avoided. Similar ideas can be used to optimize a combination of time and resources as opposed to time alone.

Pinedo, Michael L 2012 focuses on the problem of determining a permutation schedule for *n* jobs in an *m*-machine flow shop that operates in a sequence-dependent setup time (SDST) environment. Two constructive heuristic algorithms are developed with the minimization of makespan as the objective. The first heuristic algorithm termed as setup ranking algorithm obtains the sequence using the setup times of jobs only. The second heuristic algorithm, fictitious job setup ranking algorithm (FJSRA), is developed using the concept of fictitious jobs. Pairs of jobs with minimum setup time between them constitute the fictitious jobs. Both these algorithms are compared with an existing constructive algorithm. For larger problems and for smaller problems with higher level of setup time. The results of statistical analysis are used to develop setup time dominance matrix for deciding upon the algorithm to be used for a particular size of problem.

The Proposed Algorithm

The proposed heuristic algorithm is applied to the processing of n-jobs through m-machines with each job following the same technological order of machines. The algorithm is based on the weightage scheme of machines which is reduced at each stage to generate different combination of sequences of processing jobs to minimize the given performance measure. Similar to CDS heuristic, the algorithm generates m-1 sequences to minimize makespan.

fori = 1 to n

for j = 1 to m-r

$w_{i,j}$ = (m-r) - (j-1) = weight parameter for job i on machine j

$\mathrm{AM}_{(i,1)} = \sum_{j=1}^{m-r} (w_{i,j} * t_{i,j})$= the processing time of i^{th} job on artificial machine 1

$\mathrm{AM}_{(i,2)} = \sum_{j=1}^{m-r} (w_{i,j} * t_{i,m+1-j})$= the processing time of i^{th} job on artificial machine 2

Table 1: Processing Time on Artificial Two-machines at Each Stage

Stage r	Processing Time on Artificial Two-machines	
	AM1	AM2
1	$(m-1)*t_{i,1}+(m-2)*t_{i,2}+\ldots\ldots+t_{i,m-1}$	$(m-1)*t_{i,m}+(m-2)*t_{i,m-1}+\ldots\ldots+t_{i,2}$
2	$(m-2)*t_{i,1}+(m-3)*t_{i,2}+\ldots\ldots+t_{i,m-2}$	$(m-2)*t_{i,m}+(m-3)*t_{i,m-1}+\ldots\ldots+t_{i,3}$
3	$(m-3)*t_{i,1}+(m-4)*t_{i,2}+\ldots+t_{i,m-3}$	$(m-3)*t_{i,m}+(m-4)*t_{i,m-1}+\ldots+t_{i,4}$
...	…………………	………………………
m-2	$2*t_{i,1}+t_{i,2}$	$2*t_{i,m}+t_{i,m-1}$
m-1	$t_{i,1}$	$t_{i,m}$

Experimental Result

Makespan and percentage goodness is calculated for the said four heuristic algorithms namely, Proposed Heuristic, Palmer, CDS and RA. The makespan is determined by the sequence obtained by the corresponding algorithm. All of the values of makespan shown in the table are taken in time measurable units (tmu). These values are the minimum makespan for the completion of the process obtained by each heuristic algorithm. Then, percentage goodness from the best-known lower bound value is determined for each problem instances

Table 2: Makespan and Percentage Goodness for 5-Job, 10-Machine Problems

Problem Description		Makespan (tmu)			
Problem Instance	Lower Bound	Proposed Heuristic	Palmer	CDS	RA
1.	5770	6153	6161	6239	6256
2.	5349	5745	5889	5851	5962
3.	5677	5945	6127	6023	6090
4.	5791	6262	6313	6408	6494
5.	5468	5915	6070	6018	6147
6.	5303	5745	5870	5751	5995
7.	5599	6229	6442	6202	6281
8.	5623	6194	6168	6196	6330
9.	5875	6281	6081	6349	6405
10.	5845	6117	6259	6387	6199

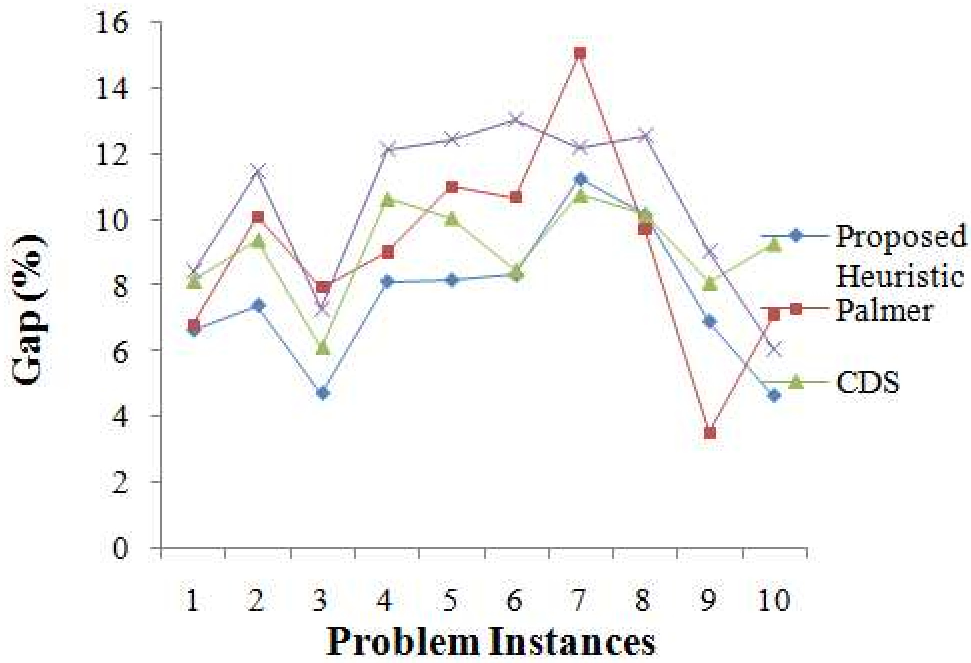

Figure 1: Percentage Goodness vs Problem Instances for 5-Job, 10-MachineProblems

Comparative Analysis of Heuristic Algorithms

Table 3 shows the variation of APG for 5, 10 and 20 machine cases for 3 and 5 jobs for all problem sets.

Table 3: Average Percentage Goodness (APG) for Various Database Problems

Jobs	Machines	APG (%)			
		Proposed Heuristic	Palmer	CDS	RA
3	5	4.09	5.33	6.37	6.18
	10	10.60	15.27	12.02	15.39
	20	8.75	16.34	9.38	16.35
5	5	10.95	13.49	12.42	14.49
	10	7.63	9.09	9.11	10.46
	20	5.32	5.01	7.43	6.15
Overall		7.89	10.76	9.46	11.50

CONCLUSIONS

This work has presented successful development of a heuristic algorithm for makespan minimization in a flow shop scheduling environment. The algorithm is based on a reduced weightage scheme of machines followed by the application of Johnson's rule to find the optimal sequence of jobs. The problem belongs to NPhard and four heuristic algorithms have beenanalyzed for said scheduling problem. The comparative analysis has been made on the instances up to 20 machines with the help of a defined performance index.

REFERENCES

1. Baker, Kenneth R., and Dominik Altheimer. "Heuristic solution methods for the stochastic flow shop problem." *European Journal of Operational Research*216.1 (2012): 172-177.
2. Yenisey, Mehmet Mutlu, and Betul Yagmahan. "Multi-objective permutation flow shop scheduling problem: Literature review, classification and current trends." *Omega* 45 (2014): 119-135.
3. Ren, Tao, et al. "A Local Search Algorithm for the Flow Shop Scheduling Problem with Release Dates." *Discrete Dynamics in Nature and Society* (2014).
4. Emmons, Hamilton, and George Vairaktarakis. "The m-Machine Flow Shop."*Flow Shop Scheduling*. Springer US, 2013. 97-160.
5. Pinedo, Michael L. *Scheduling: theory, algorithms, and systems*. Springer Science & Business Media, 2012.
6. Haslum, Patrik, and Hector Geffner. "Heuristic planning with time and resources." *Sixth European Conference on Planning*. 2014.