Review on Scheduling-Job Scheduling

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Abstract

Scheduling is a decision making process that plays a vital role in most manufacturing industries. The Scheduling function optimizes the limited resources allocation to the processing of jobs (Pinedo 2005). Resources include machines, robots, tools, material handling equipment and materials to be processed. A job consists of a number of operations or tasks to be done in the manufacturing system.

This article discusses the development of the job shop problem and the development of methods to be used in solving JSSP. It also defines the groups JSS problems, which are divided according to the complexity of the solution. Traditional job shop scheduling is concentrated on centralized scheduling or semi distributed scheduling

Keywords

Scheduling, Job Shop scheduling, scheduling problems, process layout, genetic algorithm, variable Neighbourhood, search makes fan.

I. INTRODUCTION

The job shop problem is to schedule a set of jobs on a set of machines. Subject to the constraints that each machine can handle at most one job at a time and the fact that each job has a specified processing order through the machines. The objective is to schedule the job so as to minimize the maximum of their completion times.

It is well known that meta-heuristics approaches are extensively applied in order to find the solutions for the practical problems of optimization. During last decades, a large number of algorithms have be developed in order to solve the job shop scheduling viz. genetic algorithm, particle sworn optimization, Ant colony optimization, Artificial bee colony, and Bee colony optimization. Literature reveals that Genetic Algorithm has been used widely for every type of scheduling problems as well.

Researchers discovered parallel Genetic Algorithm approach in 1980's and 1990's and practices the Genetic Algorithm on parallel computers in order to create this approach much quicker.

A. *Types of Scheduling Problems*

Scheduling problems are theoretically categorized by a number of types. French (1982), Blazewicz et al (1994) and Pinedo (2012) classified scheduling problems according to several criteria such as production volume, nature of production, production capacity and manufacturing systems. Each type of scheduling problem has different levels. The common types of scheduling problems with their levels are summarized in the table.

Table: Different types of scheduling problems (Arisha 2003)

CLASSIFICATION BASED ON	SCHEDULING LEVEL
Production Volume	High Volume scheduling Intermediate volume scheduling low volume scheduling
Nature of Production	Activity scheduling Batch Scheduling Network Scheduling
Production Capacity	Infinite Capacity Scheduling finite Capacity Scheduling
Manufacturing Systems	Flow Shop Scheduling Job Shop Scheduling Flexible manufacturing system Scheduling
State of Scheduling	Static Scheduling Dynamic Scheduling

Many Researchers have studied the scheduling problems when the system status is either static or dynamic. These two scheduling levels are defined as follows.

Static scheduling is a process that produces a fixed plan based on a set of activities when all information about the jobs in known, prior to the start of the scheduling process. The outcome of this type of scheduling cannot be changed or adapted during operating time (Jain and Elmaraghy 1997).

Dynamic scheduling represents a process that creates a variable plan. Hence dynamic scheduling is flexible, accommodating additional unexpected events such as order cancellation, arrival of urgent orders, due date changing and unavailability of tools. A dynamic Scheduling Plan is therefore able to respond to the market environment (ouelhadj and petrovic 2009 a,b,chryssolouris and subramaniyam 2001).

II. OPTIMIZATION ALGORITHM FOR SCHEDULING

After the identification of a new type of Scheduling for industry , we continued to summarize the characteristics of existing optimization algorithms and identify their challenges for SFFJSP. The optimization algorithms for Scheduling are divided into two kinds, which are mono/multi-objective algorithm and distributed optimization algorithm. For the traditional problems, JSP, FJSP, MrFJSP, and MpFJSP are concentrated on semi distributed scheduling problems, which can be solved by mono/multi-objective optimization algorithms. For the future job shop scheduling problems under SFFJSP, It is a smart distributed Scheduling problem, which should use distributed optimization algorithm to deal with. In fact, in a smart distributed scheduling problem, the system is divided into several lead subsystems and every subsystem builds its own structure according to the related smart agent(s).

To say that the original problem can be decomposed into different smaller and more flexible parallel sub problems and all these sub

Problems can be deal with separately, therefore we can used the mono/multi objective optimization algorithms to solve sub-problems more easily than a concentrated scheduling problem and achieve better solutions with less time.

There are many ways to solve a traditional job shop scheduling problem and many scholars have also made a summary of this work, such as the early scholar, Jain and meeran (1998), who classified, introduced and compared various earlier algorithms. In recent years, due to the development of intelligent algorithms, most of the scholars (such as calis and Bulkan 2015). Pay more attention to intelligent algorithms, meta heuristic and some special forms of JSP.

The Optimization algorithms for scheduling are mainly divided into exact optimization methods and approximate methods. The exact optimization methods include efficient rule approaches, mathematical programming approaches, branch definition methods and etc. The approximate methods include constructive methods,

Artificial intelligence, local search and meta-heuristic algorithms. In the smart factories oriented scheduling under industrial, smart agents or intelligent bodies become the dominant factors. So that a previous centralized scheduling system can be replaced with multiple connected smart scheduling agents. For a single agent, the complexity of scheduling drops substantially. Therefore, it is very possible that the earlier methods only for small scale scheduling can be used again in specific circumstances. This is the reason why we still have a summary of the various methods including contemporary and early

Approaches in order to give play to the advantages of different methods in the future smart manufacturing system.

A. Position of the Job Shop Production System

According to Grover (9) there are three types of productions associated with discrete product manufacture.

1. Job shop production (Low Volume Production)

2. Batch Production (Medium – Sized lots of the same item or product)

3. Mass production (two categories of mass production can be distinguished)

(i) Quantity production (Production of simple single parts such as screws).

(ii) Flow Production (Production of complex single parts such as automotive engine blocks) [9]

This classification can also serve for plans used in the process industries.

For each type of production is more or less suitable one of the following principle types of plan layout.

(i) Fixed position layout (large units, such as a ship)

(ii) Process layout (according to you, Technology oriented manufacturing)

(iii) Production – flow layout (according to you, object oriented manufacturing)

B. Definition and Classification of the Job – Shop Problem

The job shop problem can be formulated as follows. Given are in machines M1, M2, ……Mn and n jobs J1, J2, …….. Jn. Job Jj consists of nj operations Oij (i=1, …..nj) which have to be processed in the order O1j, O2j, ….. Onj. It is convenient to enumerate all operations of all jobs by k=1, …… N where N= nj . For each operation K=1, …….N. We have a processing time pk > 0 and a dedicated machine M(K).

K must be processed for Pk time units without preemptions on M(K)

Additionally a dummy starting operation o and a dummy finishing operation N+1, each which zero processing time are introduced.

We assure that for two succeeding operations K=Oij and S(k)=Oi+1,j of the same job M(K) not equal to M(S(k)) holds. Let Sk be the starting time of operation K.

Then Ck=Sk-Sk+Pk is the finishing time of K and (Sk) defines a schedule. A Schedule (Sk) is feasible if for any succeeding operations k and (Sk) of the same job Sk+Pk<S Sk holds and for two operations K and h with M(k) = M(h) either Sk+Pk<Sk or Sh+Ph<Sk. One has to find a feasible schedule (Sk) which minimizes the max ofCk

Lageweg et al in 1981 developed a computer program MSPCLASS for an automatic classification of scheduling problems. This program based on the mod Br classification scheme calculates problems which are :

Maximal PolynominallySolvable :The hardest problems which are polynomially solvable (i.e.) problems which are known to be polynomially solvable, but any harder cases are not known to be polynomially solvable.

Maximal Pseudo polynominally Solvable: The hardest problems which are known to be Pseudo polynominally (but not polynomially) solvable.

Minimal NP-hard: The easiest problems which are NP-hand, ie) Problems which are known to be NP-hard. But any easier cases are not known to be NP-hard.

Minimal open : Problems for which the complexity status is not known, but all easier cases are known to be NP-hard[10].

C. Approaches and Methods To Solve JSSP

Bruckor and schile (II) were the first authors to describe this problem in 1990. They developed a polynomial graphical algorithm for a two-job problem. In the scheduling of job-shops, the most common methodology is materials requirement planning (MRP) [9]. However, MRP is mostly a planning tool and is not really designed for detailed-level scheduling.

In many companies, scheduling is performed by experienced shop-floor personnel with pencil, paper, a few graphical aids and perhaps a modern industrial database [12], [13]. Simple dispatching rules are often used for solving immediate problems, such as sequencing at the work centre level.

The result can be scheduling chaos, where completion dates cannot be predicted and work – in – progress (WIP) inventory builds [13]. Sometimes even high-level management must chase down high-priority jobs on the shop floor.

Many dispatching rules have been presented and implemented based on due dates, criticality of operations, processing times, and resource utilization. The 'Critical ratio' defined by one definition as a ratio of remaining processing time over remaining time to due date has been very popular in job-shops[12]. More complicated heuristics take into account some combination of the above factors. For example, viviers algorithm incorporates three priority classes in the shortest processing tim (SPT) rule [14]. Each job is assigned an index equal to its processing time plus a value graded to its priority class. High-priority jobs have low index values and are processed first according to the SPT rule. Heuristics have been comparatively evaluated. However each algorithm is not effective for solving JSSP and large instances. Several heuristic procedures have been developed in recent years for the JSSP[15]. The methods in this category include dynamic programming and the branch and bound method. Simulated annealing (SA) and genetic algorithm (GA) [16].

However, the meta-heuristics methods have led to better results than the traditional dispatching or greedy heuristic algorithm. JSSP could be turned into the job shop scheduling problem when a routing is chosen. So when solving JSSP, hierarchical approach and integrated approach have been used [17], [18]. The hierarchical approach could reduce difficulty by decomposing the JSSP into a sequence of sub problems. In literature, various researchers have provided the survey of latest contributions for the job shop scheduling problem. Implemented with different mix approaches of the genetic algorithm. A local search Genetic Algorithm is Is proposed by Ombuki and Ventresca[19].

At the stage of local search, a new type of mutation operation was supplied for solution excellence. Wang and Zheng[20] proposed a hybrid, simulated annealing and Genetic algorithm approach for job shop scheduling which works in parallel.

III. CONCLUSION

Job shop scheduling problems are summarized and reviewed, which are one of the most concerned problems currently in manufacturing. The actual job shop scheduling system is becoming more and more complex, dynamic and flexible. According to the development direction of the system we not only need to consider JSP, but multi-machines, multi resources, even a number of factories and logistics system. So there are four types of job shop scheduling, which are JSP, FJSP, MRFJSP AND MPFJSP.

The intention of this paper was to provide an overview of one class of a large group of job shop scheduling problem. A part of the main objectives of this study, considerable attention has been paid to the concept of classification of job shop problems and algorithms classifications that are pertinent to solve specified problems.

REFERENCES

[1] French.S.(1982) Sequencing and Scheduling. An introduction to the mathematics of the job-shop, New York.

[2] Blazewrcz.J, Ecker.K.H, Schmidt.G&Weglarz.J.(1984). Scheduling in computer and manufacturing systems. Berlin : Springer verlag.

[3] Pinedo.M.(2005) Planning and Scheduling in manufacturing and services. New York : Springer.

[4] Jain.A.K, &Elmaraghy.H.A, (1997). ProdutionScheudling rescheduling in flexible manufacturing. International Journal of production Research 35(1). 281-309.

[5] Ouelhadj.D, &Petroric.S.(2009b). A survey of dynamic scheduling in manufacturing system
proposed by ombuki and ventresca[19].

[6] Chryssolouris.G., &Subramanian.E(2001). Dynamic Scheduling of manufacturing job shops using genetic algorithm. Journal of Intelligent & Manufacturing 12(3), 281-293.

[7] Jain A.S, &Meeran.S(1998). A state of the art review of job shop scheduling techniques.

[8] Calis.B.&Bulkan.S(2015). A research survey : Review of A1 solution strategies of job shop scheduling problem. Journal of Intelligent Manufacturing. 26(5), 961-973.

[9] Groover.M.P, Automatin Production systems and computer – Integrated Manufacturing 3rd edition. (2007), ISBN – 13 : 978-0132393218 August 3.

[10] Lageweg.B.J. Lenstra . J.K. and Rinnooykan A.H.G., Computational complexity of discrete optimization problems (1979). An Discrete Math, 4 ; 121-140.

[11] Bruchor.P., Sctile.R. Job-shop scheduling with multi-purpose machines. Computing 45(4), 369-375(1990)

[12] Graves.S.C, A review of production scheduling (1981). Operation Research, 29, 648-675.

[13] Mackay J.Elder P.A Porteous.D.JSteel.C.M. Partial delefin of chromosome IIP in beast cancer correlates with size of primary tumer and estrogen receptor level (1988).

[14] Vivers.F (1983). A decision support system for job shop scheduling. European journal of operational Research. Sep14(1), 95-103.

[15] Fezzella, F., organti.G.Ciaschetti.G, A genetic algorithm for the flexible job-shop scheduling problem(2008). Computer and operation Research Vol 35, No.10 PP 3202-3212.

[16] Fisher M.I. optional solution of scheduling problems using Lagrange multipliers. Part-I (1973). Operation Res.Vol-21, PP. 1114-1127.Journal of Scheduling 12(4), 417-431.

[17] Mastrolilli.M. Ganbordella.2M., Effective neighbourhood function for the flexible job shop problem (1996) journal of scheduling Vol-3 PP3-20.

[18] Mati.Y: Dauzore-Pores.S.Lallu CH.2011, A general approach for optimizing regular criteria in the job shop scheduling problem (2011). European journal of operation Research 212, 33-4.

[19] B.M.Ombuki and M.Ventresca. 'Local search genetic algorithm for the job shop scheduling problem'. Applied intelligence, Vol 21, 2004, PP 99-109.

[20] LWang and DZ zheng, "An effective hybrid optimization strategy for job shop scheduling problems". Comp &Oper. Res. Vol 28, 2001. PP 585-596.