Expert Systems with Applications 36 (2009) 12143–12150

Contents lists available at ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

Gene expression programming based due date assignment in a simulated job shop

Adil Baykasoğlu *, Mustafa Göçken

University of Gaziantep, Department of Industrial Engineering, 27310 Gaziantep, Turkey

ARTICLE INFO

Keywords:
Due date assignment
Flowtime estimation
Gene expression programming
Simulation

ABSTRACT

In this paper, a new approach for due date assignment in a multi-stage job shop is proposed and evaluated. The proposed approach is based on a genetic programming technique which is known as gene expression programming (GEP). GEP is a relatively new member of the genetic programming family. The primary objective of this research is to compare the performance of the proposed due date assignment model with several previously proposed conventional due date assignment models. For this purpose, simulation models are developed and comparisons of the due date assignment models are made mainly in terms of the mean absolute percent error (MAPE), mean percent error (MPE) and mean tardiness (MT). Some additional performance measurements are also given. Simulation experiments revealed that for many test conditions the proposed due date assignment method dominates all other compared due date assignment methods.

© 2009 Elsevier Ltd. All rights reserved.

1. Introduction

The importance of meeting promised delivery dates, or due dates, in manufacturing and service industry is recognized by practicing production managers and academic researchers (Ragartz & Mabert, 1984a). Recent trends in time based competition and inventory reduction require products to be completed in shorter time and with more reliable delivery dates. At the operational level, this can be made possible via better scheduling and due date management. Due date management always wants to increase due date performance. Due date performance depends not only on the scheduling procedure followed but also on the reasonability of the assigned due dates. There are two aspects of due date performance: "delivery reliability" and "delivery speed" (Hill, 1991). Delivery reliability which is also referred to as missed due date (Cheng & Jiang, 1998) is the ability to consistently meet promised delivery dates. Delivery speed is the ability to deliver orders to the customer with shortest lead times (Philipoom, 2000). In fact, production managers want neither early nor tardy jobs. They all want to meet the target due date. This is mainly because, an early job completion results in inventory carrying costs, such as storage and insurance costs while a tardy job completion results in penalties, such as loss of customer goodwill and damaged reputation. Hence meeting due dates tends to be the primary concern of the most production managers (Melnyk, Vickery, & Carier, 1986) including those of the job shops, which usually have process type of layouts and are suitable for high variety, low volume, make to order production (Chang, 1997). In summary, due date management's main problem is to increase due date performance in terms of "delivery reliability" and "delivery speed" in order to avoid storage and/or insurance cost or loss of customer goodwill and damaged reputation.

Increasing due date reliability depends on assigning more reasonable due dates to the arriving jobs. This can be achieved only by estimating the flowtime of jobs more accurately and precisely (Kuo, Chang, & Huang, 2009). In fact, the flowtime prediction problem is really the crux of the due date management problem. The due date assignment process consists of making an estimate of flowtime for a job and then setting a due date on the basis of that estimate and some performance criteria (Ragartz & Mabert, 1984b). Because the flowtime estimation is used to assign order due dates, the problem has been mostly studied within the context of due date assignment (Sabuncuoglu & Comlekci, 2002).

In this study, a genetic programming technique which is known as gene expression programming (GEP) algorithm is employed to estimate flowtime of jobs in a multi-stage job shop. The main objective of this research is to compare the performance of the GEP with previously proposed due date assignment models (DDAM) from the literature with respect to some selected performance criteria. The main reason for this comparison is to find out the best DDAM that has the best due date performance in terms of "delivery reliability" and "delivery speed". The rest of the paper is organized as follows: Section 2 presents the literature review and research outline; Section 3 gives a brief overview of GEP; Section 4 introduces the hypothetical job shop and gives information about the simulation model; Section 5 gives a brief explanation of the methodology; Section 6 states the performance measurements; Section 7 presents experimental results; Finally, the paper is concluded.

* Corresponding author. Tel./fax: +90 0342 3604383.
E-mail address: baykasoglu@gantep.edu.tr (A. Baykasoğlu).

0957-4174/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.eswa.2009.03.061

2. Literature review and research outline

It has been observed that some of the DDAM in the early literature only focus on the job related information (Baker, 1984; Baker & Kanet, 1983; Chiu, Chang, & Chiu, 2003; Conway, 1965; Eilon & Chowdhury, 1967; Enns, 1993; Moses, Grant, Gruenwald, & Pulat, 2004; Ragartz & Mabert, 1984b; Sha, Storch, & Liu, 2007; Vig & Dooley, 1991). For example; the "Total Work Content" (*TWK*)" rule requires that each job has to be assigned an allowance that is a multiple of job processing time (Anderson & Nyirenda, 1990; Chiu et al., 2003; Conway, 1965; Enns, 1993; Ragartz & Mabert, 1984b; Sha et al., 2007). Another due date assignment rule which is known as "number of operations (*NOP*)" defined flowtime of a job as a function of its number of operations to be performed (Conway, 1965; Ragartz & Mabert, 1984b). "Equal Slack (*SLK*)" determines the due date of jobs based on a common slack (q) which is added to the sum of the release dates and processing times of individual jobs (Baker & Bertrand, 1981; Vig & Dooley, 1991). "Constant flow allowance (*CON*)" gives equal allowance to each job (Baker & Bertrand, 1981; Cheng, 1987; Wilson & Keating, 2002). "Process plus waiting (*PPW*)" combines the *CON*, *SLK* and *TWK* into one model; in which due dates are linear functions of the job's processing time (Chiu et al., 2003; Enns, 1995). For convenience, the formal definitions of these DDAMs are given in Table 1:

Where; r_i and p_i denote the arrival time for job i and processing time of job i, respectively. The parameter k is a constant that would be chosen differently for each rule in order to achieve a given average flow allowance, q is a slack allowance which may be negative, m_i is the number of operations required to complete job i.

Several other studies in the literature aimed to develop more sophisticate DDAMs. The main purpose was to assign more reasonable due dates. In these studies researchers used shop related information together with job related information for assigning due dates in order to increase due date related performances. For example, "jobs in queue (*JIQ*)" (Conway, 1965; Ragartz & Mabert, 1984b; Sha et al., 2007; Udo, 1994), "jobs in system (*JIS*)" (Philipoom, 2000; Ragartz & Mabert, 1984b), "Work in Queue (*WIQ*)" (Ragartz & Mabert, 1984a), can be considered as some examples of these more sophisticated DDAMs. In the *JIQ* model; all work center queues on job *i*'s routing are polled for the number of jobs in queue (JIQ_i) at the release time of job i to the shop. This shop status information is then combined with the total process time (p_i) to estimate job *i*'s flowtime. In the *WIQ* model; the total processing time of all jobs in the work center queues on job *i*'s route is utilized. *JIS* incorporates total congestion level of the shop rather than only congestion by work center which are placed on job *i*'s route. The formal definitions of these DDAMs are given in Table 2.

In either DDAMs which use job or shop related information, more accurate and precise flowtime can be obtained only by using the most appropriate k. However, determination of the most appropriate k for all jobs and different system state is not an easy task. In order to overcome this difficulty, dynamic DDAMs, which can update k for all jobs and different system states, was proposed in the literature. In its most basic form a dynamic DDAM should let k to be dynamically updated. Various techniques for updating k dynamically have been investigated. For example Vig and Dooley (1991) proposed two rules, "operation flowtime sampling (*OFS*)", "congestions and operation flowtime sampling (*COFS*)" which estimates job flowtime, based on a sampling of recently completed jobs. These rules are compared with other established DDAMs (*JIQ*, *TWK* and *NOP*). Each of the DDAMs require estimates of one or more parameters. Vig and Dooley (1991) employed the multiple linear regression technique in order to obtain the best values for the parameters of each DDAMs. Enns (1993) employed CON_p, $DCON_p$, PPW_p, $DPPW_p$ *DDAMs* under conditions where Jackson's decomposition principle can be applied. The subscript "p" associated with each of these models indicate that the due date rule multipliers are being set to be consisted with predicted flow times. These DDAMs assign due date of jobs dynamically by using queue analysis. Enns (1995) developed three analytically derived DDAMs, which are called, dynamic forecasting model (*DFM*), jobs in system feedback model (*JFM*), and work in process feedback model (*WFM*). Cheng and Jiang (1998) proposed two DDAMs in order to improve the performance criteria based on missed due dates. The proposed DDAMs, which were named as dynamic *TWK* (*DTWK*) and dynamic *PPW* (*DPPW*), were analytically derived and were capable of adjusting dynamically the flowtime estimation by using feedback information about current shop load conditions. Sha and Liu (2004) proposed rule based *TWK* (*RTWK*) that incorporates a data mining tool to be able to adjust an appropriate factor k according to the condition of the shop at the instant of job arrival. Raghu and Rajendran (1995) proposed three different methodologies for setting up the parameter coefficients for the due date setting rule. The methods are: a search algorithm, a simulated annealing algorithm, and, a combination of a simulated annealing algorithm and regression analysis. Baykasoğlu, Göçken, and Unutmaz (2008a) employed simulating annealing to set the parameter coefficients for their DDAMs. Chiu et al. (2003) suggested a case based reasoning (*CBR*) approach for solving the due date assignment problem since most production orders are similar to those previously manufactured orders. The proposed *CBR* approach employs the k-nearest neighbor's concept with dynamic future weights and non-linear similarity functions. Sha and Liu (2004) developed artificial neural networks based DDAMs combined with simulation. Regression-based DDAMs were used as benchmarking in most of these studies. Recently, Baykasoğlu, Göçken, and Unutmaz (2008b) proposed ADRES DDAM which uses the estimation of mean processing time of each arriving job and each job's estimated total queue waiting times. Estimation of job *i*'s queue waiting time for each station on its route is determined by using adaptive response rate exponential smoothing (ADRES) technique because of its simplicity and ability to adapt to changing circumstances.

In early studies, all of these dynamic DDAMs were compared with their static counterparts and it was observed that dynamic DDAMs was able to reduced due date prediction errors. In the present paper, the proposed GEP based due date assignment model is compared with dynamic DDAMs such as ADRES, DTWK, DPPW and also static DDAMs such as TWK, NOP, and regression based DDAM. Simulation experiments revealed that the proposed GEP based due date assignment approach is very effective and generates due dates with better accuracy than the compared DDAMs. Results are summarized for each DDAM in the following subsections.

Table 1
Due date assignment models that utilize only job related information.

Due date assignment method	
TWK: $d_i = r_i + kp_i$	
NOP: $d_i = r_i + km_i$	
SLK: $d_i = r_i + p_i + q$	$i = 1,2,3,\dots,n$
PPW: $d_i = r_i + kp_i + q$	
CON: $d_i = r_i + k$	

Table 2
Due date assignment methods that utilizes job and shop related information.

Due date assignment method	
JIQ: $FLOWi = k_1p_i + k_2(JIQ_i)$	
WIQ: $FLOWi = k_1p_i + k_2(WIQ_i)$	$i = 1,2,\ 3,\dots,n$
JIS: $FLOWi = k_1p_i + k_2(JIS_i)$	

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات