Design and Development of Expert system through Artificial Intelligence for Task Scheduling

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Abstract.
Extensive research has been conducted on the Cooperation Mission (FMS) program; the primary emphasis has been on the widely recognized learning process. An innovative approach for enhancing interaction options within JSSE (Computer Scheduling Environment), often employing uncomplicated models, is required. The documentation within the FMS program is relatively uninformative in this regard. This article is dedicated to scrutinizing machine and AGV (Automated Guided Vehicle) planning to establish criteria for diminishing the average delay within the FMS system through the application of an Expert System (ES). The viability of this approach can be tested across various scenarios using the 40-question FMS entertainment model.

Keywords: Hadoop Scheduler, Task scheduling, Artificial intelligence and Makespan

1. Introduction

While there is no universally accepted definition for FMS (Flexible Manufacturing System), Groover (1987) characterizes it as an integrated system encompassing the configuration of Numerical Control (NC) machines coupled with PC-controlled Automated Guided Vehicles (AGVs) and configuration control for low to medium production rates across diverse locations. Given the multitude of Computer Numerical Control (CNC) machine tools and their interplay with material handling, several classes of production models have been examined by Dupont (1982), Browne et al. (1984), and Kuciak (1985).Throughout its lifecycle, FMS confronts numerous challenges, as recognized by Buzacott and Yao (1985), Suri (1985), and Kusiak (1986a), who explore planning processes that can be categorized by tasks, values, and concepts. FMS is not merely a computer repository; rather, it involves the interaction of equipment, tools, robotic vehicles (AGVs), workstations, and more. The equilibrium between machinery and materials in the system is pivotal and must be maintained. Considerations include job selection, course scheduling, and the intricate nature of FMS, which intensifies these challenges.This article delves into research design, particularly focusing on the FMS reservation problem, which is a significant business-class challenge in the market. Planning policies pertaining to FMS have evolved, and the use of average flow time as a representative model with valid decision rules has become customary. Various methods are employed, such as online planning of machinery and equipment transportation based on real-time operations and offline planning algorithms. Panwalkar and Iskander (1977) introduced over 100 rules, distinguishing them into assignment rules, allocation rules, and priority rules. A substantial body of literature exists on these policies (Conway et al. 1967, Blackstone et al. 1982, Kiran and Smith 1984a, b).

2. Expert System Design

The foundation of the concepts in this research was inspired by a study carried out by Bilge and Ulusoy in 1995. Their study incorporated data that encompassed details on different machines, their respective operating hours, and a matrix illustrating the travel times for these systems.

This configuration, as depicted in Figure 1, comprises four Computer Numerical Control (CNC) machines, each equipped with pallet changers and tool setters.

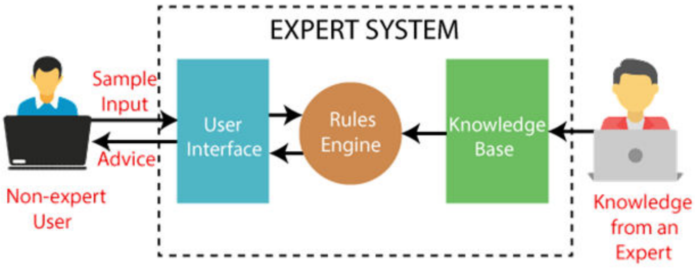

Figure 1: Basic structure of Expert System

2.1. Methodology

In Scheme 2, Task 4 is tasked with executing an Expert System (ES) using movement time as an illustrative example. The decision-making process involves setting decisions according to the following steps:

Step 1: Position "7" is prioritized and placed first in the main sequence, which follows the order: 1-2-3-4-5-6-11-12-13-14-7-8-9-10-15-16-17-18-19.

Step 2: The objective is to determine the time required to achieve maximum performance. This is typically represented as the completion time or makespan of a group of tasks.

Stability estimates of various parameters for each activity are detailed in Table 1. These estimates likely play a critical role in the decision-making process and performance evaluation.

Completion Time Using ES

Layout-1

JobSet-1

OPCOUNT : 13

~~~~~~

[1, 2, 3]
[4, 5, 6]
[7, 8, 9]
[10, 11]
[12, 13]

Start Process

Sbpt--UnSorted---36 48 35 32 25 Sbpt--Sorted---4 3 2 0 1 25 32 35 36 48

===

Job Number in jobset : 4
Job Number : 4
k+i : 00
k+i : 00
The Process 12 Completion Time : 25
k+i : 01
~~~~~~

k+i : 01
The Process 13 Completion Time : 59
1The op num is : 12
1The op num is : 13
Job Number in jobset : 3
Job Number : 3
k+i : 20
k+i : 20
The Process 10 Completion Time : 43
k+i : 21
k+i : 21
The Process 11 Completion Time : 83
1The op num is : 12
1The op num is : 13
1The op num is : 10
1The op num is : 11
Job Number in jobset : 2
Job Number : 2
k+i : 40
k+i : 40
The Process 7 Completion Time : 64
k+i : 41
k+i : 41
The Process 8 Completion Time : 83
k+i : 42
k+i : 42
The Process 9 Completion Time : 118
1The op num is : 12
1The op num is : 13
1The op num is : 10
1The op num is : 11
1The op num is : 7
1The op num is : 8
1The op num is : 9
Job Number in jobset : 0
Job Number : 0
k+i : 70
k+i : 70
The Process 1 Completion Time : 134
k+i : 71
k+i : 71
The Process 2 Completion Time : 169
k+i : 72
k+i : 72

The Process 3 Completion Time : 197
1The op num is : 12
1The op num is : 13
1The op num is : 10
1The op num is : 11
1The op num is : 7
1The op num is : 8
1The op num is : 9
1The op num is : 1
1The op num is : 2
1The op num is : 3
Job Number in jobset : 1
Job Number : 1
k+i : 100
k+i : 100
The Process 4 Completion Time : 185
k+i : 101
k+i : 101
The Process 5 Completion Time : 209
k+i : 102
k+i : 102
The Process 6 Completion Time : 248
1The op num is : 12
1The op num is : 13
1The op num is : 10
1The op num is : 11
1The op num is : 7
1The op num is : 8
1The op num is : 9
1The op num is : 1
1The op num is : 2
1The op num is : 3
1The op num is : 4
1The op num is : 5
1The op num is : 6
job count is : 5
jobs order : 5, 4, 3, 1, 2,
ops order : [12, 13] [10, 11] [7, 8, 9] [1, 2, 3] [4, 5, 6]
1The op num is : 12
1The op num is : 13
1The op num is : 10
1The op num is : 11
1The op num is : 7
1The op num is : 8

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Research Paper **UGC CARE Listed (Group -I) Journal Volume 11, Iss 9, 2022**

1The op num is : 9
1The op num is : 1
1The op num is : 2
1The op num is : 3
1The op num is : 4
1The op num is : 5
1The op num is : 6

Above procedure shows activity planning of through ES rule for work set 1 design 1 is appeared with process time triple and process time double. The operational culmination time (makespan) is 248.

3. Results and Discussion

The FMS workshop situation introduced here with exhibits the job set EX4 and layout 2. In last digits 0 or 1 represents process time double and triple in two cases travel times are half only.

TABLE 1. Execution examination

Job	Layout	(Di)	(Li)	(Ti)	No of Operations	Avg No of Opera are Tardy
EX 10	30	283	143	143	21	7
EX 10	20	281	142	142	21	7
EX 10	40	305	140	140	21	7
EX 10	10	297	132	132	21	6
EX 9	20	281	74	74	17	4
EX 9	40	305	74	74	17	4
EX 9	30	283	73	73	17	4
EX 9	10	297	70	70	17	4
EX 8	10	297	41	41	20	2
EX 8	20	281	38	38	20	2
EX 8	40	305	38	38	20	2
EX 8	30	283	37	37	20	2
EX 4	30	283	34	34	19	2
EX 4	10	297	31	31	19	2
EX 4	20	281	31	31	19	2
EX 4	40	305	31	31	19	2
EX 3	10	297	30	30	16	2
EX 3	20	281	30	30	16	2
EX 3	30	283	29	29	16	2
EX 3	40	305	25	25	16	2
EX1	10	297	-49	0	13	0
EX 2	10	297	-80	0	15	0
EX 5	10	297	-107	0	13	0
EX 6	10	297	-16	0	17	0

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EX 7	10	297	-57	0	19	0
EX1	20	281	-43	0	13	0
EX 2	20	281	-87	0	15	0
EX 5	20	281	-101	0	13	0
EX 6	20	281	-21	0	17	0
EX 7	20	281	-63	0	19	0
EX1	30	283	-44	0	13	0
EX 2	30	283	-86	0	15	0
EX 5	30	283	-102	0	13	0
EX 6	30	283	-22	0	17	0
EX 7	30	283	-62	0	19	0
EX1	40	305	-50	0	13	0
EX 2	40	305	-84	0	15	0
EX 5	40	305	-108	0	13	0
EX 6	40	305	-17	0	17	0
EX 7	40	305	-54	0	19	0

Within the context of optimizing the configuration of Automated Guided Vehicles (AGVs) and machines, priority rules are utilized to handle three distinct processing time values. These rules are detailed in two separate tables. An examination of the make span and mean flow time for various job sets and layouts is visually depicted in Figures 2.

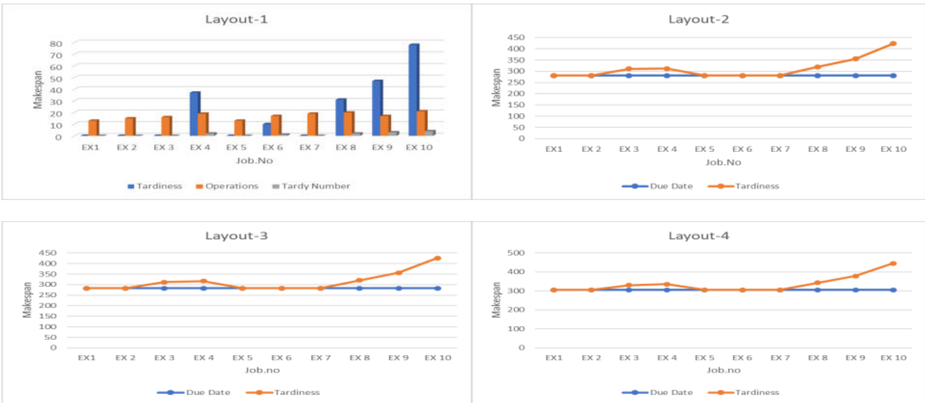

Figure 2: No of Operations in Expert System

4. Conclusions.

The FMS problem was effectively addressed with the assistance of an Expert System (ES), resulting in a reduction of delayed tasks within the system. This study employed four different layouts, each consisting of four identical machines and two transport machines. The investigation encompassed not only machine scheduling but also the scheduling of Automated Guided Vehicles (AGVs), with the subsequent findings as follows: According to the research findings, as the workload within the system increases, adjustments are made, leading to an increase in both the number of machines and AGVs. A critical aspect of FMS completion is the avoidance of tardy tasks. Notably, as the scheduling complexity intensifies and the number of tasks within the system grows, the likelihood of delayed tasks also rises. In the context of this study, the Expert System (ES) rule was tested a total of 40 times, encompassing various aspects of the system. The combination of the ES rule with the AGV rule yielded the most favorable results. This suggests that there is room for the development and application of novel rules to address the daily challenges within the FMS environment.

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