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Project Synopsis

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Persistent Systems Limited, Pune

Job Scheduling in Networked Manufacturing Using Game Theory

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1.SOFTWARE PROJECT SYNOPSIS

1.1 Context :

- **Networked Manufacturing Systems**

1. Characterized by Globalization, Collaboration, Customization, Digitalization and Agility.
2. Provides a Collaborative environment for customers, manufacturers and suppliers to work together.
3. Job Scheduling plays an important role that guarantees that suitable jobs be allocated and manufactured on suitable geographically distributive machines belonging to different shops or enterprises to achieving the respective objectives regarding the correspondent dynamic constraints.

- **Game Theory**

1. Game theory reflects calculated circumstances (games) where a person's success is based upon the choices of others .
2. It is mainly used in economics, political science, and psychology, and other, more prescribed sciences, like logic or biology.
3. There are two main branches of game theory: Co-operative and Non Co-operative game theory.
4. A non-cooperative game is one in which players make decisions independently.
5. A co-operative game is a game where groups of players ("coalitions") may enforce cooperative behaviour, hence the game is a competition between coalitions of players, rather than between individual players.

- **Genetic Algorithms**

1. It is class of evolutionary algorithms which generate the solution by using natural evolution such as inheritance, mutation, selection and crossover.
2. A typical genetic algorithm requires :
   (a) A genetic representation of the solution domain: It involves appearance, physical characteristics.
   (b) A fitness function to evaluate the solution domain.
3. Genetic representation is a way of representing the solution on evolutionary computation method.
4. Fitness function is a particular type of objective function that determines the optimality of the solution. So the most optimal chromosones can be mixed

together to give next the next generation . This new generation can be used in the next iteration of the algorithm as input.

This project presents a new kind of scheduling solution for jobs in networked manufacturing environments. The main contributions of this study can be focused on three points: The first is to distinguish the concepts and requirements of job scheduling in the networked manufacturing environment form those in the traditional manufacturing Environment. The second is to construct a game-theory mathematical model to deal with this new job scheduling problem. In this presented mathematical model, this new job Scheduling problem is formulated as an N-person no cooperative game with complete information. The players correspond to the jobs submitted, respectively, by related customers and the payoff of each job is defined as its makespan. Each player has a set of strategies which correspond to the feasible geographical distributive machines. Therefore, obtaining the optimal scheduling results is determined by the Nash equilibrium (NE) point of this game. In order to find the NE point, the last point is to design and develop a genetic algorithm (GA)-based solution algorithm to effectively solve this mathematical model.

1.2 Problem :

Job scheduling for Networked Manufactured Systems using Game Theory Approach and Genetic Algorithm

Job scheduling involves scheduling, sequencing, and routing of jobs on various machines. The traditional job scheduling problem is always limited inside a shop which considers n jobs arrived at the shop at a certain points of time and schedule them on m machines regarding the technological constraints while achieving some relevant criteria such as minimal make span, minimal mean flow time and minimal cost. However, in networked manufacturing, the job scheduling problem is somewhat different from the traditional one. It extends the concept of traditional job scheduling and possesses some new network-oriented characteristics described as follows:

(1) It is a customer-centric job scheduling method. Because the jobs come from different customers having competitive relationships, this type of job scheduling mainly focuses on satisfying the individual objective of each job. However, traditional job scheduling always considers the whole scheduling objective of all jobs under some manufacturing constraints.

(2) The machines are distributive, ranging from an intrashop to inter-shop and even inter-enterprise, which means the job scheduling bound is no longer limited to a single shop but extends to geographically distributive shops and even different enterprises.

Considering these new characteristics, job scheduling in networked manufacturing can be described as a series of jobs submitted by different customers compete with each other to occupy the corresponding machines according to their own respective objectives, e.g., minimal makespan and finally arrive at satisfying their own requirements. Therefore, this job scheduling problem can be stated as follows. There are a given number of jobs on order submitted by customers denoted as n and each job contains a series of sequential operations. There are also a given number of machines dispersed in different shops or enterprises denoted as m. We determine the job schedule for each job while optimizing a certain objective without violating restrictions imposed on the networked manufacturing environment. In this study, we mainly consider the minimal makespan as the objective for every job which decides the time of delivery to market of products. Before solving this job scheduling problem, the following assumptions are made:

(1) When an operation of a job is being processed on a machine, it cannot be interrupted until finished;
(2) Job preemption is not allowed;
(3) No two jobs are scheduled to be processed on the same machine at the same time;
(4) The transportation time exists. After an operation of a job is processed on a machine, it is immediately transported to the next machine according to its own routing;
(5) All jobs can be simultaneously available at the time of zero.

According to the above definition and assumptions, the job scheduling in networked manufacturing is actually a collection of individuals (jobs) acting selfishly and interacting to fulfill their own goals. The challenge we face is therefore in how to generate a scheduling solution to produce an effective and efficient scheduling result for each job. Currently, because traditional job scheduling solutions cannot effectively deal with the proposed job scheduling problem, exploring the new strategy and solution is becoming the key point.

1.3 Solution :

In the networked manufacturing environment, the job assignment may take place in several distributed shops or even enterprises, which makes the job scheduling problem more complex . The job scheduling problem is customer-driven and the objectives are to arrive at the local optimization for each job.

In order to deal with the presented job scheduling problem satisfactorily the project aims to develop a mathematical model and a game-theory scheduling model. In this scheduling model, the job scheduling problem will be described as an N-person non-cooperative with complete information. The optimal result for each job will be derived from the Nash equilibrium (NE) point of the game.

After constructing the job scheduling game, The project aims to utilize the genetic algorithm (GA) as a solution procedure to find the perfect NE point and finally arrive at obtaining the optimal result for each job.