Capturing Information Sharing Strategy in a Problem-Solving Team Playing ColPMan Game

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Abstract

Informal group-level human algorithm, such as the one for collaborative group problem solving in a supply chain, can be captured as a two-step process of sharing information and making decisions incorporating the shared information. This work proposes an analysis approach for the first step of the algorithm taken in playing a collaborative supply chain management game, ColPMan, which captures the relationship between the kinds of information shared and the game situations.

Introduction

Human computation games, which are also called as games with a purpose, have been effectively used for collecting training data for analyzing informal individual-level human algorithms, such as image-tagging. The players first recall various words related to the specified image, and then choose and input some of them which they think are most relevant for the image. Thus, the informal algorithm can be captured as a two-step process of recalling a lot of words through watching an image and choosing the most suitable words for tagging the image. This work argues that a similar approach can also be applied to analyzing an informal group-level human algorithm, such as the one for the collaborative group problem solving in a supply chain. For collecting the training data for the analysis, the authors proposed ColPMan game, which is also a game with a purpose (Furukawa et al 2016, Nonaka et al 2016, Mizuyama et al 2016). The game has been played by several teams for a number of times and the game logs are collected. Based on the analyses of the log-data, it is suggested that the informal group-level human algorithm can also be captured as a two-step process of sharing information with members of the chain and making individual decision by each member with incorporating only the beneficial part of the shared information.

The game results are different according to the human algorithm taken on each stage, for example, what information the members of the chain tend to share in what situation, and which of the shared information is deemed to be effective and taken into account for individual decision making and how. Thus, this work proposes an analysis approach for the first step of the informal group-level human algorithm taken by the supply chain members, by capturing the relationship between the kinds of information shared and the game situations from the game logs of ColPMan.

The Serious Game

Supply Chain Model

There are two types of orders, repetitive and spot. The supply chain is composed of five sites; a headquarters (HQ) which accepts orders from customers, three downstream factories (DSFs) which make products, and an upstream factory (USF) which manufactures materials for the products, as shown in Figure 1. HQ assigns spot orders received from customers and repetitive orders to fill inventory to DSFs. Each DSF makes assigned products from materials and places material orders to USF. USF creates and delivers the materials to DSFs. After a product is made, it is delivered to the customer if it is a spot-ordered, and is kept in the warehouse until being pulled by the customer if it is repetitive-ordered. Each DSF and USF can hold the materials as inventory until processed or delivered.

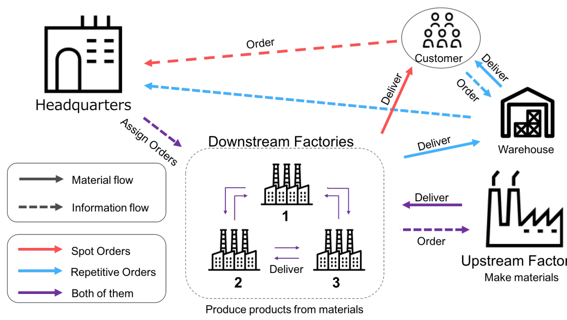

Figure 1: Supply Chain Model.

Game Flow and Interface

Each player is assigned the manager's role of a site of the chain and makes its production and/or delivery plans. The time axis is divided into terms and periods, where one term consists of five periods. At the beginning of each term, HQ player can assign accepted orders to DSFs, and DSF players can update the production schedule for delivering ordered products to customers by the time limit and order some materials. Finally, USF player determines the material manufacturing schedule and material delivery plan. After they finished inputting those decisions, how the supply chain operations progress according to those decisions under stationary fluctuations (and an unexpected disturbance in some cases) is calculated by a computer simulation. This cycle is repeated for a pre-set number of terms. At the beginning of each period, each player observers the operational progress and can modify the corresponding plans if necessary.

Figure 2 shows, for example, the DSF player's interface of the ColPMan game. This player can input production and/or delivery plans on the interface while checking the stock of materials and machine state, and then communicate with other players to share some information. When HQ player is assigning accepted orders to DSFs, DSF players and/or USF player can share not only the current material inventory levels but also the future levels estimated with ordering, production and delivery plans. Further, DSFs players and/or HQ players can share the future material demand levels with USF player who plans material manufacturing schedule and material delivery plan. In this way, the players often share information related to their production or delivery plans in different situations.

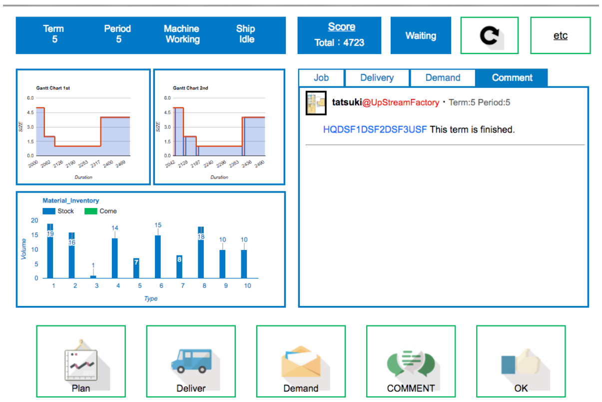

Figure 2: Interface of DSF Player.

Analysis Approach

The ColPMan game has been played by several teams for a number of times and then the results were analyzed by an analysis model proposed earlier (Furukawa et al 2016). As a result, it was observed that the players communicated with one another to share different information. Further, major information shared through the communication can be classified into several kinds, for example, material inventory, demand and production conditions. From the perspective of capturing the player's informal group-level human algorithm as a two-step process of information sharing and utilizing the shared information, the next step would be analyzing (1) what information is shared in what situation, and (2) which information is chosen and how it is utilized. This work focuses on (1), and (2) is dealt with in a separate work (Furukawa et al. 2017).

The analysis approach proposed here studies the informal algorithm of sharing information by capturing the relationship between the shared information and the situation when it is shared. Further, how different teams share different information in different situations is compared. In ColPMan game, several situations, such as inventory shortage in a DSF situation and inventory excess in a DSF situation, may co-occur with other situations, such as manufacturing failure in a DSF situation and machine breakdown in a DSF situation. Thus, this paper classifies the interrelated situations into some classes by applying cluster analysis. For example, class A is represented the complex situation where inventory shortage in a DSF situation and machine breakdown in a DSF situation co-occur. Table 1 shows a matrix constructed from the game logs representing which team shares which information in a specific situation class. As a result, several combination patterns of shared information and situation classes are found by analyzing manually, and differences among teams are also found. As shown in Table 1, for each game there are several classes from A to D. In class A, the game, which is played by a team for second times, shared inventory information of USF, inventory information of each DSF, and material demand information of each DSF. Subsequently, in class B, the game shared re-scheduling information, such as manufacturing sequence, in addition to inventory information of each DSF.

Class	Inventory Info. of a DSF	Inventory Info. of USF	Demand Info. of a DSF	Re-Scheduling Info.	· · ·
A	○	○	○	×	· · ·
B	○	×	×	○	· · ·
C	○	○	×	×	· · ·
D	○	×	○	○	· · ·

Table 1: Shared Information in Different Situations Classes.

The game score is dependent on the strategy of sharing information in different situation classes. Thus, this work establishes a model of the strategy by comparing the shared information in similar classes for each game.

Conclusion

This work captures the informal group-level human algorithm such as the one for collaborative group problem solving as a two-step process of sharing information and making decisions incorporating the shared information, and proposed an analysis approach for capturing its first step from the game logs of ColPMan game.

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