

A Method of Retrieving Similar Construction Plans for Conpla-CBR (Construction Planning by CBR)

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Abstract

Construction project is the dynamic entity to be actively managed in the internal and external conditions. Thus, project planning must be systematic, flexible enough to handle unique activities, disciplined through reviews and controls, and capable of accepting multifunctional inputs (Kerzner, 1998). The schedule related information can be accumulated from the company's operating systems such as ERP, PMIS to CSDM (Construction Schedule Data Mart) through ODS (operational data store). The ODS serves as a point of integration for operational systems. The cumulated information of CSDM can be used through CBR (Case-Based Reasoning). CBR can be regarded both as a cognitively sound modeling approach for explaining human problem solving in domains where experience plays an important role (Strube and Jantzko, 1990). It is especially appealing to those professionals who solve problems by recalling what they did in similar situations that happened in the past. Likewise, many human schedulers create schedules by reusing past similar schedules (Dzeng and Tommelein, 2004).

The implementaton of Conpla-CBR (Construction planning by CBR) is subject to matching problem to determine which features are important when selecting construction project plan cases. Thus, the purpose of this paper is to propose a method to retrieve useful and efficient similar project planning cases from the CSDM. This study will be contributed to the planner for effectively and efficiently planning the construction project.

Keywords

Construction plan, Data Warehous, Data Mart, Case-Based Reasoning, Decision Support System

1. Introduction

In most cases, there are lots of unexpected events during the construction process that hinder a timely completion of the project. For example, unexpected weather, change order and less availability of resources

such as trades, labor forces, machine can affect the flow of construction. One plausible solution to overcome the hindrance would be accumulation of the experienced events in a DB and using them for future similar projects. Normally, similar problems would have similar solutions. Thus, when some unexpected events occur, the events can be solved by get the information from the past case solution accumulated in the DB. The planner also needs to consider the events occurred similar past project during planning or scheduling. It is difficult for a project planner to generate a project schedule without referring to any previous as-built schedules because the amount of the required knowledge is too enormous. As A project schedule consists of hundreds of activities and precedence relationships, project planning is a time-consuming and knowledge-intensive task (Lee et al, 1998). For example, even for a senior engineer with 10 years of experience in construction planning, it takes almost 25 days to make a project network. 25 days include estimation of objective construction duration (1 day), creation of WBS (5 days), creation of activity logic and duration (15 days), creation of scheduling (4 days). Thus, many human schedulers create schedules by reusing past similar schedules. The retrieval and reuse of similar schedules are subjective and experience-based (Lee et al, 1998; Dzeng and Tommelein, 2004).

However, the retrieval and reuse of similar schedules are subjective and experience-based (Lee et al, 1998; Dzeng and Tommelein, 2004). Traditional scheduling tools provide only limited features to facilitate such reuse. For example, Primavera Project Planner (P3) has a limitation that can be retrieved only by its name (Dzeng and Tommelein, 2004; Primavera Systems, 1999). Although the similarity measuring method is very important to retrieve more accurately similar project schedule, few studies focused on this method. Although Lee et al (1998) developed the FASTra-APT, similarity measuring method and its attributes are very simple. Dzeng and Tommelein (2004) also developed the CasePlan system for manufacturing boiler, however the similarity measuring methods are based on the product breakdown. However the construction project activities and relations are very difficult to be divided exactly.

To address this, the Construction planning by CBR (namely Conpla-CBR) was developed in this paper. Conpla-CBR reuses more similar schedules on the hypothesis that as-built schedule data including the unexpected variables during construction have been accumulated in the construction schedule data mart (namely CSDM). Data mart is a logical subset of the complete data warehouse. A data warehouse is made up of the union of all its data marts. The schedule related information is accumulated from the company's operating system such as ERP, PMIS, daily report system, construction schedule system to database of the CSDM through ODS (operational data store). The ODS serves as a point of integration for operational systems. In many cases, these ODS are implemented to better support one-to-one customer relationships in the order entry or customer service function. The ODS should be a subject-oriented (schedule-oriented in this study), integrated, frequently updated store of detailed data to support transaction systems with integrated data. Any detailed data used for decision support should simply be viewed as the lowest atomic level of the data warehouse (Ryu and Lee, 2004).

2. Conpla-CBR

CBR can be regarded both as a cognitively sound modeling approach for explaining human problem solving in domains where experience plays an important role (Strube and Janetzko, 1990). It is especially appealing to those professionals who solve problems by recalling what they did in similar situations that happened in the past. The basic idea of CBR is to adapt solutions that have been used to solve old problems for use in solving new problems (Turban and Aronson, 2001). A case is the primary knowledge-base element in a case-based reasoning application. It defines a situation or problem and answers to questions and associates with each situation. Case base can be constructed from historical cases that reflect human experience. The experience can be that of the decision makers or of others. CBR is the essence of how people reason from experience.

Dubitzky (1999) proposed that case-based reasoning process as a knowledge management process. The construction schedule based on the CBR can be managed as a knowledge management. Conpla-CBR can

be categorized largely into two items : case accumulation and case utilization. Data or information from the construction schedule problem (real world problem) are documented or recorded to the Data Sources and learned or retained to the Conpla-CBR Libraries. Therefore the knowledge management of Conpla-CBR is that the case information from the Shared, Updated Conpla-CBR Case Libraries are retrieved, reused, applied, and explained to solve the construction schedule problems. Fig. shows the knowledge management of Conpla-CBR.

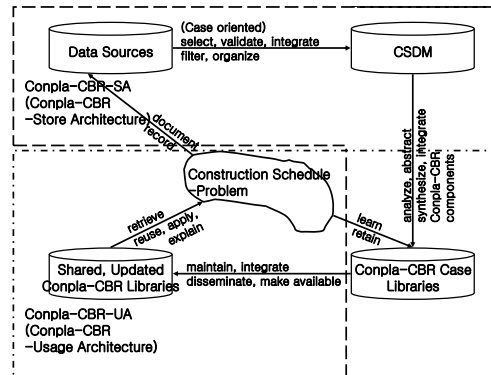


Figure 1: Knowledge management of Conpla-CBR

Dynamic case approach of Conpla-CBR is the proposed retrieval algorithm from the Shared, Updated Conpla-CBR Case Libraries. Dynamic case approach is composed of macro approach and micro approach. Macro approach starts from the outline of the new project to get the most similar schedule. The more the new project has more data or information about the critical works of the new project, the more the users can get similar schedule. That approach is micro approach. The users can adapt the retrieved schedule by replacing the more similar critical works' detail schedule based on the micro approach.

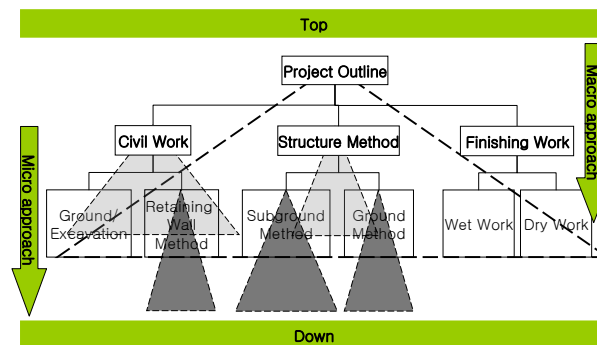


Figure 2: Dynamic Case Approach

3. Retrieving and generating algorithm

Similarity index can be calculated according to the k-nearest neighbor approach. The similarity can be determined in many ways, calculating the weighted sum of attribute distances (e.g. a Hamming or Euclidean distance) is the most common approach (Wilson and Martinez, 1997). Matching and ranking is a procedure in case retrieval that selects which cases are appropriate among the cases in the Conpla-CBR Case Libraries. Following the data attributes' character, the degree of match among cases' attributes is computed. Based on the result of the matches is then ranked to identify which best address the requirements of the new situation. The most similar schedule can be revised and generated by the dynamic case approach.

The algorithm for checking the similarity of Conpla-CBR is explained as follows.

1. Checking the corresponding attributes

- A. Checking the corresponding attributes in the new case as much as user has information about the new project. Checking the corresponding attributes is performed to determine which attributes in the new project should be matched to which features in Conpla-CBR Case Libraries. The more users have information about the new project attributes, the more users can get similar past project schedules.
- B. Filling the attributes' value in the new project information.
2. Computing the similarity score
 - A. Computing the weight of the each attributes. Conpla-CBR supplies default weight values. The weight values are different according to the new project character. Therefore the users can revise the weight value for retrieving the most similar past schedule.
 - B. Computing the similarity score (the degree of similarity of corresponding attributes) by qualitative and quantitative data. The attributes have their own character, following the similarity scoring method the computing the degree of similarity of attributes can be performed.
3. Computing the similarity index
 - A. Computing the similarity index (the degree of similarity of corresponding cases) by following the nearest neighbor equation.

$$SI = \frac{\sum_{i=1}^n (W_i \times SS_i)}{\sum_{i=1}^n W_i} \times 100$$

- B. Adding the results for all attributes to derive an aggregate similarity score.
- C. Ranking cases from highest to lowest.
4. Performing the dynamic case approach (Revising the retrieved schedule)
 - A. Retrying from 1 to 3. The retrieved schedule is not ready to use in the new project. Therefore the dynamic case approach is needed to revise the retrieved schedule to fit the new situation. The user can retrieve the critical path works' schedules from each project schedule, e.g. ground work, excavation work, retaining wall work, structural work and finishing work.
 - B. Replacing the critical path work schedule. Each critical work schedule which is most similar to the attributes of new project critical works can be retrieved. User can replace the more similar critical path works' schedule from the retrieved schedule.
5. Generating the new schedule.
 - A. Adapting the partially replaced schedule. The retrieved schedule after the dynamic case approach may not correct exactly to the new project. Therefore the partially replaced schedule needs to be added or deleted some activities, to be linked or cut the activities' relations, and to be increased or reduced the activities' durations.
 - B. Creating the new schedule.

4. Conclusion

Dynamic case approach starts from the outline attributes of the new project to get the previously generated schedule and proceeds by the attributes of critical path works. And then the scheduler can readapt the most similar schedule by replacing the retrieved critical path works. Although the Conpla-CBR was developed to be utilized for retrieving similar project master schedules during pre-construction stage, especially the concept of the Conpla-CBR can be extended to the construction stage for retrieving more detail schedules such as weekly or monthly schedule.

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