CBR in Design: Towards more creative system using adaptation knowledge

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適合知識を用いた独創的な設計用 CBR システム

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Abstract: Design is a task that there can be no specific and completely predefined knowledge for that. CBR is a kind of reasoning which is quite suitable for this kind of tasks. Since design without creativity is not that much valuable, taking this issue into account is gaining more popularity. In this paper, we want to investigate the role of adaptation knowledge in increasing creativity. We have based the procedure of assessing situation on adaptation knowledge. We have also introduced dynamic similarity to assimilate the solution considering adaptation. To implement the idea we use adaptation knowledge and make a network which may help us to reformulate the problem and assimilate and evaluate the solution.

1 Introduction

Design is a kind of task which normally we can not fully cover it by predefined knowledge. Going through the design procedures, intelligence is the first necessity which may arise. This makes design an interesting topic for artificial intelligence. To formulate the problem of design, although we can find different ideas, but there is general agreement to characterize it as[1]: formulation (the problem)+ synthesis+ analysis+ evaluation.

In many works, design task has been clustered into three categories: routine, innovative and creative. While usually routine design stands for a kind of design which problem solving knowledge and strategy are well defined, in innovative design only problem solving knowledge is well defined and in creative design neither of them is well defined.

Because of ill-structured nature of design (specially creative design), CBR happens to be a good solution for this task. In case based design, designer remembers his old design for similar problem and attempts to adapt it to fit the new situation.

Here we are interested in creative design. Although in the literature we can find some suggested models for creativity, we have based our work on the model introduced by Kolodner and Wills [2]. We believe that this model can cover the task well. They have introduced their model as re-interpretation, evaluation, assimilation, strategic control. The initial problem may be incomplete, contradictory and underconstrained. The process of understanding and formulating the problem is re-interpretation. Evaluation is the process of weighting the alternative solutions. Assimilation is not only a means for recalling relevant solution alternatives, but also a vocabulary for describing and in many cases reinterpreting objects in the designer's environment. And finally strategic control has been defined as breaking typically rigid control structure and allow more interaction among process.

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2 Interaction of Adaptation Knowledge with the other Knowledge sources

Adaptation is compensatory part of CBR [3]. It allows us to consider the knowledge missed from the other parts and derive a better solution. This may imply the idea of using adaptation knowledge in the other steps of reasoning.

The idea of using adaptation knowledge in the other procedures of reasoning has been previously used in many works. While Richter [5] has explained four containers for storing the knowledge in CBR (Vocabulary used to describe the domain, case-base, similarity measure used for retrieval, solution transformation used during adaptation), Wilke et. al.[4] have introduced a framework of transforming knowledge from one container to other when there is lack of knowledge in one of the containers.

Here we want to investigate the role of adaptation knowledge in situation assessment step. Situation assessment is the process of analyzing a raw situation and elaborating it such that its description is in the same vocabulary as cases already in the case library. Using adaptation knowledge we will re-describe each constraint in the design problem in possible adaptable way. It means we re-interpret the problem in the first step in possible adaptable ways. Then we can index it and retrieve the similar cases again considering adaptability. Next section will explain the approach in more detail.

3 Expressing the Concepts of Creativity in Our Approach

In the following we want to explain how we take into account each of the concepts described in the creativity model of [2].

- **Re-description:** In the last section we pointed out how to use adaptation knowledge in other steps of reasoning. Base on that idea, here we want to use adaptation knowledge in situation assessment stage which may help us to interpret the problem in any possible adaptable way, which may lead us to re-formulate the problem in the first step. This means even before looking for similarity we are considering adaptability.

- **Assimilation:** By assimilation we mean not only recalling relevant solution, but also describing the reason of our selection. To formulate this concept we describe the *dynamic similarity* term. By dynamic similarity we mean that two constraint may be highly similar in a situation while they may differ in the other situation. For example a little red ball may be highly similar to an apple considering the shape, while they are too different considering the other properties (like vitamins, etc). It is to say that here also we define similarity based on adaptability.

- **Evaluation:** To formulate this concept we have defined another metric as *probability of acting well*. We have not only based situation assessment on adaptability of constraints, but also define adaptability as a framework to define similarity. This enables us to have an interaction between two knowledge sources. Then whenever we are using a link we already know which adaptation we want to use then considering the likelihood of deriving a good solution using that adaptation knowledge we will evaluate the solution, when analyzing the alternatives.

  Dynamic similarity and *probability of acting well* together provide a framework to evaluate the solutions and rank the selected alternatives to derive the best solution.

- **Strategic Control:** We use adaptation knowledge in situation assessment step, we also take into account adaptation knowledge when finding similarity, it means instead of following a strict consequence of predefined procedure, we are using an interaction between the knowledge sources whenever it is necessary. This enables us to be more flexible and more creative.

4 Computational Model

To implement the above idea, we have defined a network and depict the complementary knowledge necessary for reasoning with cases in that. The nodes in the network represent the constraint with which we describe cases. The links have been made based on any available knowledge source for adaptation. The weight of a link contains dynamic similarity and probability of acting well.

The input to the network is a set of constraints defined by query case, the output is an extended set of constraints with a weight for each of them which expresses the degree of similarity to the primary constraint. Then considering this extended set and the weight for the constraints, we can recall and rank the cases which satisfy an appropriate subset of this set. Figure1 may give us the better view about that.

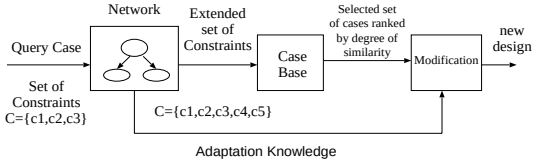

Figure 1: General view of the approach

5 Summary

To implement the creativity model introduced by [2], we have made a network which includes complementary knowledge for reasoning with cases. The knowledge depicted in the network reflects adaptation knowledge as basis and similarity measure in the second place. Similarity measure is in fact based on adaptability. The nodes in the network express the vocabulary needed to define the domain. All together we can see three containers of four containers in Richter model [5] has been covered here. The last container which is Case-based itself will be additional knowledge in a database. Therefore the network will cover all the complementary knowledge necessary for casebase, and these complementary knowledge can interact with each other in a flexible way. The different point in this work with the other works is introducing the concept of dynamic similarity in attribute based similarity, and using adaptation in situation assessment step.

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