Research for Accident Decision Making Method of Water Supply Network Based on Case Reasoning

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Abstract. Case-based reasoning is an important reasoning method in the field of artificial intelligence, and it also is a reasoning mode with rapid development in recent years and widely used. Firstly, the paper introduced the basic concepts of case-based reasoning; and then the key technologies of case-based reasoning were described, including knowledge representation of case, case retrieval, case reuse and revision and case study. The solutions for accidents of water supply network can be found quickly through the first three steps; finally, a good solution will be added to the case base for the future learning through case study. This paper bases on the working principle of case-based reasoning to study accident decision making method of water supply network, and it can provide references for decision making and improve the solving speed while responding emergencies.

Introduction

Water supply system is an important part of urban lifeline system, and the failures of water supply system will bring inconvenience to residents and industrial production and even can cause losses. With the rapid development of construction, urban residents need more and more water, the area of water supply is increasing. The water supply network accidents endangered the public personal and attribute safety have also been rising, it brings a huge threat to the national security, social stability and daily life of the people, so that people are paying more and more attention to the research for accident decision making method of water supply network [1]. When the water supply network has accidents, you must timely and quickly find a solution for the accident in order to ensure the disaster minimization. If you want to solve the problem fundamentally, analysis should be carried on from cause and mechanism of the accident to provide a basis for the selection of an accident control method. This paper uses CBR algorithm, emergency decision method of water supply network when the accident occurred will be studied from uncertain the knowledge representation and reasoning of case in order to improve the emergency response ability of the government [2]. Therefore, the research of accident decision-making method of water supply network based on case reasoning has urgent practical significance.

The Working Principle of CBR

CBR conforms to human cognitive processes, which is a memory-based reasoning essentially. When people encounter new problems, they will search for previously solved similar cases in the brain, and then amend such method to resolve the current problems. CBR technology first appeared in the 1982 when Roger Schank described dynamic memory, and it belongs to the new, important, knowledge-based problem solving and learning method in the field of artificial intelligence [3]. The basic idea: it looks for similarly old cases, and then these old cases will be reapplied to the environment of new problems. That is searching for the old cases to obtain the matching cases that have similar characteristic parameters with target case, and then you should amend the solutions of these matching cases depending on the specific situation, final applying them to the current problem. The basic steps of solving process of a typical CBR problem can be summarized in four main

processes: case retrieval, case reuse, case revise and case retain, namely 4R model [4], its working process shows in Fig. 1.

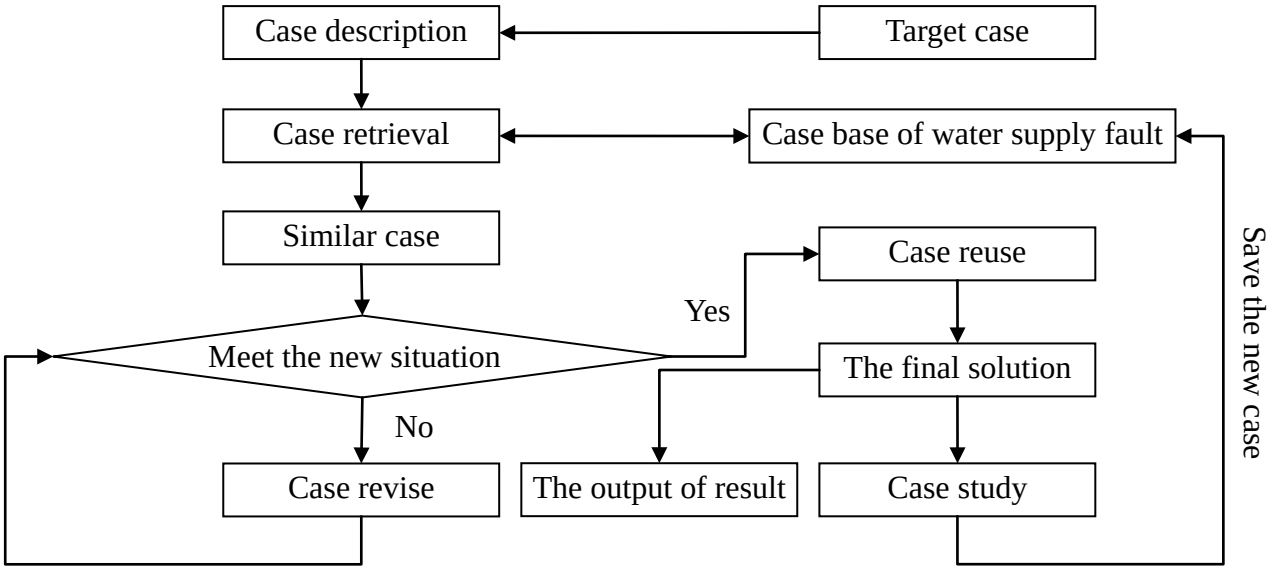

Fig.1. The working process of CBR

In the CBR, the problem or condition to be solved usually is referred to target case, the historical case is called the source case, and the collection of source cases case is also known as case base. A new problem appears to be solved, this is the target case; using the description of target case to obtain the source cases that similar with the target case; the resulting solutions of the source cases are certainly more than one, you should determine whether these solutions can solve the target case; if them can be solved, then reuse solutions; if not, then modify and adjust them to obtain an successful case that can be saved. Solutions have been tested, evaluated and revised to get the final solution for the target case. In the process of CBR, case representation, case retrieval and case revise is the core issue of the study of CBR.

The Key Technologies of CBR

People sometimes tend to think that CBR system is a reasoning method, knowledge and technologies in many other aspects will be used in the process of reasoning, here we mainly analyze some related technologies in the process of CBR.

(1) Knowledge representation of case: the knowledge representation of case is the most core and foundation content of CBR technology. The new problem should be described to problematic case in accordance with the formulary case representation method in order to retrieve case. The representation is also varying for different problems, a reasonable case representation not only make the problem easier to solve, but also has high solution efficiency. Case generally consists of the following three main components: (1) a problem or scenario description: the problem to be solved when case occurred; (2) solution: solutions to the problem; (3) result: a result after implemented program. General knowledge representation can be used to represent the case, such as based on first-order predicate, based on the framework, based on semantic network and based on neural network [5]. Table 1 summarizes the knowledge representation methods of case.

(2) Case retrieval: the so-called case retrieval is matching the information and knowledge of historical cases from the case base. Case retrieval is a key technical aspect of CBR system and the quality of retrieval has the relationship with the efficiency of the entire system. There are three case indexing techniques: the nearest neighbor, inductive reasoning and knowledge guided method. The nearest neighbor method is one of the most widely used and the simplest methods in the CBR system. This approach calculates the similarity of the various attributes between target case and source case, and then obtains the overall similarity of the two cases after comprehension. The paper uses Euclidean distance algorithm based on improved due to a wide range of cases. First the

attributes for the cases of water supply network should be given weights in order to represent the degree of importance of this attribute for the case similarity; and then calculating the similarity of the various attributes between target case and source cases; and finally calculating the similarity of the entire case. Here are some types of calculation methods of similarity.

Table 1. Knowledge representation method of case

Representation method	Description	Advantages
First-order predicate	The facts of a variety of natural language are represented by predicate calculus.	It is easily understood with common logical calculus methods to ensure the integrity of reasoning process.
Framework	It simulates storage structure of similar framework of knowledge in the human brain.	It reflects people's thinking with good structured programming, high search efficiency and flexible reasoning mode.
Semantic network	It is a directed graph of binary relation with nodes and arcs.	It can represent complex knowledge structure, and hierarchy has inheritance, and it can complete information sharing.

a) Numerical attribute: you can compare the value of the attribute of *i* directly between target case and source cases; if the value is same, it indicates that they are similar to set the value to 1; if not, it indicates that they are not similar to set the value to 0.

$$\mathrm{Sim}(x_i,y_i)=\begin{cases}1, & x_i=y_i\\ 0, & x_i\neq y_i\end{cases} \tag{1}$$

b) Symbol attribute: symbol attribute value belongs to a simple enumeration value, which lists all the possible values of the attribute. You should compare the meaning of two symbol attributes.

$$\mathrm{Sim}(x_i,y_i)=\begin{cases}1, & x_i=y_i\\ 0.5, & x_i\in y_i\\ 0, & x_i\neq y_i\end{cases} \tag{2}$$

c) Enumerated attribute: first calculating the absolute value of the distance between the attributes' values, and then finding the linear distance of enumerated type, and finally the similarity is determined by the ratio of them.

$$d_1=\left|\mathrm{Order}(x_i)-\mathrm{Order}(y_i)\right| \tag{3}$$

$$d_2=\mathrm{num(type)}-1 \tag{4}$$

$$\mathrm{Sim}(x_i,y_i)=1-\frac{d_1}{d_2} \tag{5}$$

d) Fuzzy concept attribute: this paper uses the similarity calculation method based on membership function by calculating the corresponding overlapping of two membership functions as the similarity between fuzzy sets.

$$\mathrm{Sim}(x_i,y_i)=\frac{\left|S(x_i\cap y_i)\right|}{S(x_i\cup y_i)} \tag{6}$$

By calculating the similarity among the above attributes' values, you can calculate the overall similarity between target case and source cases, that is:

$$\mathrm{Sim}(x,y)=\sum_{i=1}^{n}(w_i\times \mathrm{Sim}_i(x_i,y_i)) \tag{7}$$

In the formula, $Sim(x,y)$ is the overall similarity of the two cases; w_i is the weight of the feature *i*, and the value of w_i is in $[0,1]$; $Sim_i(x_i,y_i)$ is the similarity of the feature *i* of *x* and *y*.

(3) Case reuse and case revise: there are two search results for decision cases: one is that the target case is exact same with source case in case base, then you can call up the solution of historical case directly to solve target case without revise; the other is that the target case and the source case are not identical, the solution of source case will need to be modified to meet the situation of target case, then you can solve the target case ultimately. There are many revise ways, primarily replacing certain content in the old solutions, or adding new content or deleting old content in the old solutions, or revising some values in the old solutions according to some models

[6]. There are three revise methods: (1) replacement method; (2) conversion method; (3) combined adjustment method.

(4) Case study: case study is a process of continuous summary. Case study is an important mean to ensure the quality of the case base, and case study not only includes maintenance of the case base, but also includes case evaluation [7]. After dealt with the failure, experienced troubleshooting experts can evaluate the level of satisfaction and the similarity. If the case is solved well, then the problem case and solution should be stored in the case base, the types and numbers of the cases in case base are expanded to complete self-learning of case base; if the solution is not good, it is not added to the case base to reduce redundancy of case base.

Conclusion

CBR is an important reasoning method in the field of artificial intelligence, which is taking advantage of the experiences and knowledge of people solving similar problems in the past to reason, then you can obtain a result of current problem. CBR plays an important role in the decision support system, and the paper studies the accident decision-making method of water supply network. The method bases on the case base of water supply network to find a solution to solve the target case by calculating the similarity of the various attributes and the overall structure between the target case and source case. Through the above algorithm and research, you can find strategy quickly to solve the fault of water supply network. The study can greatly improve the ability of improvisation for decision makers, thus it can save valuable time and minimize all kinds of losses caused by the accidents of water supply network [8]. With the rich of system case base, the operating efficiency will also continue to improve.

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