

Case-based reasoning in the design of a decision support system for forest fire management

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ABSTRACT

This article presents briefly the methodology developed for the building of cases for the design of decision support system for forest fires. It describes the analysis of decisions that are made during an event (forest fire) and the integration of case-based reasoning as an approach to building the support system.

BACKGROUND

INTRODUCTION

Organizations today are looking for ways to obtain systematic information. The globalization of markets has created a need for instant and accurate information available worldwide. This globalization does not exclude crucial information needed in time of disasters. Organizations such as the SOPFEU (Société de Protection des Forêts contre le feu; fire protection agency in Quebec) are looking for ways to take an advantageous position in this exchange of information networks. This last organization has presently an information system and is participating in this research. Organizations faced with a

disaster such as a catastrophic forest fire need tools to exchange and treat information in a more systematic way. They also need to use the experience that they gained in past similar events in order to better deal with a new event. The development of decision support systems is a way to complement this approach by improving the use of information and of past knowledge.

Case-based reasoning was the methodology retained for the development of the decision support system we plan to develop for the management of forest fires. In dynamically changing situations and other situations where much is unknown and when solutions are not clear cut, it seems to be the preferred method of reasoning (Kolodner, 1991, cited from Klein and Calderwood, 1988). Case-based reasoning is an analogical reasoning method...It means reasoning from old cases or experiences in an effort to solve problems, critique solutions, explain anomalous situations, or interpret situations (Kolodner, 1991). This paper presents an overview of the methodology we will be using to build cases of past forest fires, how they will be represented and finally how we plan to represent the similarity and the quality of cases so they can be useful for forest fire managers to use.

BACKGROUND

The use of case-based reasoning

Different ways of thinking a problem involves a search. There are two general ways of finding any object: recall from memory, and use of external aids, such as other people, written sources, and computers (Baron, 1994). According to Kolodner (1991), there are two styles of case-based reasoning: problem solving and interpretive. "The problem solving style is characterized by substantial use of adaptation processes to generate solutions. The interpretive style uses cases to provide justifications for solutions, allowing the evaluation of solutions when no clear cut methods are available and the

interpretation of situations when definitions of the situation's boundaries are open-ended or fuzzy" (Kolodner, 1991). Because the management of forest fires is quite a complex task and can be considered as management under great uncertainty, we will be using the interpretive style of case-based reasoning.

Decision analysis

According to Baron (1994), decision analysis consists of reducing the appropriate data to a common useful unit. Once this unit is measured, we can understand the purpose of making the decision. We therefore have to build a common construct of forest fire management to be able to have somekind of common measure. If this is not done, analogy between cases would be almost impossible. Managers working in the concerned organizations are in a better position to express the utility (measure) of each attribute of the construct.

Memory in decision making

"Memory is the store that provides many if not most of the inputs to decision making. It is therefore important to understand how this store is organised (...)" (Hogarth, 1987). Decision makers may have difficulties in remembering past events with accuracy of details, details that are crucial to the decision making of a new forest fire for example. People usually focus on particular pieces of information to construct their memories (Hogarth, 1987). We use our understanding of the world to select information in our memory, to interpret it and to anticipate events (Hogarth, 1987). Hogarth also mentions that "the process of recall is based on reconstruction, it follows that person's memory can also be affected by what happens after the critical event. Indeed, research shows that recall can be influenced by post event information and particularly by the manner in which questions are asked to elicit". Questions should asked in a way for the person not to build any mental onstruct and in a simple language in order not to divert

their attention. Subjects should be asked to relate the case (or story) in a very open fashion, with no direct questions, and much empathy because people may not always remember details.

DESCRIPTION OF THE DEVELOPED METHODOLOGY

The building of a construct for the decision analysis

In order to build a decision support system using case-based reasoning it is imperative obviously to have access to an important number of cases. It is also a question of the “chicken before the egg” story. We need to have cases to build the system but we also need some kind of system (construct) to build (or retrieve) cases.

We first met with different managers at SOPFEU and with the firefighters in the south of France. These managers were at top levels in the hierarchy in their respective organizations. Different group interviews and single interviews were done to include all of the points of view of the different managers. In all, twelve (12) interviews were done. The process was simple. Managers were asked to express what elements were important to them in the management of a forest fire: temporal, physical, strategical, etc. Managers were seen more than once. Each time, we would bring back the information they had given to us in an organized format for them to validate. We made changes according to the comments until all managers were satisfied with the proposed construct.

The proposed construct consists of organizing forest fires in categories. These categories were determined by the managers and are represented by their initial attack and the weight of the success (or failure) at extinction of the fire. For example, forest fire type #2 represents a fire where the initial attack was done under acceptable organizational norms and the finality (extinction) was in acceptable norms also. In a case

construct, different aspects of the fire are represented such a general criterias (topography, wind speed, relative humidity, etc.), forest fire criterias (type of fire, positioning, etc.), and the management criterias (firefighting strategy, cost, presence of other organizations, social pressure, etc.) The building of this construct permits us now to stand on more solid ground to retrieve forest fire cases and do more focused observations of upcoming forest fires that will be observed over the upcoming summer months.

An observation grid to improve memory

In order for us to retrieve forest fire cases efficiently, we decided to build an observation grid from the acquired construct. We therefore think we can increase our chances of success because the observations will be more focused. Managers at a firefighting unit level and at a multi-unit level will be chosen for the completion of the grid. We will then interview each person using the "running commentary" technique (Witkin & Poupart, 1985). This method "replaces the normal interview with one in which the researcher encourages and assists the subject to develop a "commentary" in the present tense on imaginatively re-lived events that are deemed to be of significance in the life world or work world of the subject. Literally, the subject is asked to imagine that these events are happening now and to run a commentary on them so as to make them "visible" to the researcher" (Witkin & Poupart, 1985). The use of this technique will enable us to develop a typology of the decisions made during a forest fire. Managers telling their story about a fire will inevitably mention the decisions they made in their running commentary. We plan on retrieving 40 cases and interviewing more than 120 managers. We will also be using the point of view of more than one manager on each case (a minimum of two managers per case).

The observation grid is composed of the elements in the construct but a notion of time and evaluation of each criteria is added. For example, the criteria of temperature

will be needed at the beginning, the initial attack, the culminant point and at the end of the fire. At each period, a value of the temperature will have to be indicated (in degrees Celsius for this criteria). Some criterias will be weighted in numbers and some with a more general measure, for example topography will be flat or undulated, slope. Open ended general questions are also added at the end of the observation grid. These open-ended questions are to analyze the management issues used in the combat of a forest fire.

It is also very important for this observation grid to be as short and as simple as possible. Forest fire managers do not have much time to answer to these questions (they are fighting quite a dangerous element), and they are very often redirected to another fire as soon as the one they are fighting has ended. Some of them (multi-unit managers) are often managing more than one fire at a time. It is very important to obtain the information but it is also imperative to keep the paper work of the managers to a minimum. That is why we also choose to interview each manager after the fires (or after the fire season if they are not available).

CONCLUSION

We are confident that the methodology rendered in this article will give us rich qualitative data on decision making during forest fires. The methodology will permit us to construct cases and apply case-based reasoning as an approach to the decision support system. Forest fire managers will then have a new opportunity to confront their firefighting strategies to cases from the past and new managers will be able to learn from the past cases of their colleagues.

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