Contextualization in Decision Making and Decision Support

Patrick Brézillon
University Paris 6, France
Université Pierre et Marie Curie, France

Jean-Charles Pomerol
Université Pierre et Marie Curie, France

INTRODUCTION

Decision makers face a very large number of heterogeneous contextual cues; some of these pieces are always relevant (time period, unpredicted event, etc.), but others are only used in some cases (an accompanying person in the car, etc.). Actors then must deal with a set of heterogeneous and incomplete information on the problem-solving state to make their decisions. As a consequence, a variety of strategies are observed, including those involving an actor to another one, but also for the same actor according to the moment. It is not obvious how to get a comprehensive view of the mental representations at work in a person's brain during many human tasks, and the argumentation rather than the explicit decision proposal is crucial (Forslund, 1995): It is better to store advantages and disadvantages rather than the final decisions for representing decision making.

Procedures are diagnosis or action plans elaborated by the enterprise (Brézillon, Pomerol, & Pasquier, 2003; Pomerol, Brézillon, & Pasquier, 2002). Diagnosis and actions constitute a continuous interlocked process, not two distinct and successive phases. Actions introduce changes in the situation or in the knowledge about the situation, and imply a revision of the diagnosis, and thus of the decision-making process itself. As a consequence, actors prefer to adapt procedures to reality in order to deal with the richness of the situation. The actor establishes a practice that is based on procedures and a set of contextual cues depending on the actor's experience and situation characteristics. Practice results from a kind of contextualization of a procedure in which knowledge pieces and contextual cues are structured together in comprehensive knowledge about actions.

Modeling actors' reasoning through practices is a difficult task because a number of contextual elements are used. We propose in this article a formalism for an experience-based representation called contextual graphs for dealing with practices.

BACKGROUND

Context has played an important role for a long time in domains where reasoning must intervene, such as in decision making, understanding, interpretation, diagnosis, and so forth. This activity relies heavily on background or experience that is generally not made explicit but gives an enriched contextual dimension to the reasoning and the knowledge used. Context is always relative to the focus (the context of the reasoning, the context of an action, the context of an object, etc.) and gives meaning to items related to the focus. Thus, on the one hand, context guides the focus of attention, that is, the subset of common ground that is pertinent to the current task. On the other hand, the focus allows identifying the relevant elements to consider in the context. It specifies what must be contextual knowledge and external knowledge in the context at a given step of decision making. The focus evolves with the actions executed along the decision-making process, and its context also presents dynamics (some external events may also modify the context of the focus): Focus and its context are interlocked.

In reference to focus, Brézillon and Pomerol (1999) consider context as the sum of two types of knowledge. There is the part of the context that is relevant at this step of decision making, and the other part that is not relevant. The latter part is called external knowledge. External knowledge appears in different sources, such as the knowledge known by the decision maker but left implicit with respect to the current focus, the knowledge unknown to the decision maker (out of his competence), contextual knowledge of other actors in a team, and so forth. The former part is called contextual knowledge and obviously depends on the decision maker and on the decision at hand. Here, the focus acts as a discriminating factor between the external and contextual knowledge. However, the frontier between external and contextual knowledge is porous and moves with the progress of the focus and eventually with an unpredicted event.

A subset of the contextual knowledge is chosen and proceduralized for addressing specifically the current focus. We call it the proceduralized context. The proceduralized context is invoked, assembled, organized, structured, and situated according to the given focus and is common to the various people involved in decision making. A proceduralized context is quite similar, in the spirit, to the chunk of knowledge discussed in SOAR (Laird, Newell, & Rosenbloom, 1987). In a distinction reminiscent to cognitive ergonomics (Leplat & Hoc, 1983), we could say that the contextual knowledge is useful to identify the activity whereas the proceduralized context is relevant to characterize the task at hand (i.e., concerned by the activity).

An important point is the passage of elements from contextual knowledge to a proceduralized context. This is a proceduralization process that depends on the focus on a task and is task oriented just as the know-how and is often triggered by an event or primed by the recognition of a pattern. In its building view, the proceduralized context is similar to Clancey's view (1992) on diagnosis as the building of a situation-specific model. This proceduralization process provides a consistent explanatory framework to anticipate the results of a decision or an action. This consistency is obtained by reasoning about causes and consequences and particularly their relationships in a given situation. Thus, we can separate the reasoning between diagnosing the real context and anticipating the follow-up (Pomerol, 1997).

A second type of proceduralization is the instantiation of contextual elements (see also Grimshaw, Mott, & Roberts, 1997, for a similar observation). This means that the contextual knowledge or background knowledge needs some further specifications to perfectly fit the decision making at hand. For each instantiation of a contextual element, a particular action (e.g., a specific method for a task realization) will be executed. Once the corresponding action is executed, the instantiation does not matter anymore and the contextual element leaves the proceduralized context and goes back in the contextual knowledge. For example, arriving at a crossroad, a driver looks at the traffic light. If it is the green signal, then the driver will decide to cross. The instantiation of the contextual element *traffic light* (green signal) has guided the decision-making process and then the decision is made. The color of the traffic light does not matter after the decision is made (and this could be a problem if the light turns yellow immediately). We call this type of proceduralization by instantiation a contextualization process.

MAIN FOCUS OF THE ARTICLE

In this article, we present contextual graphs, a context-based formalism for representing reasoning. Contextual graphs are used in a large spectrum of domains such as decision support, medicine, ergonomics, psychology, army, information retrieval, computer security, road safety, and so forth.

A contextual graph proposes a representation of a problem-solving instance by a combination of diagnoses and actions as evoked in the introduction. Contextual nodes represent diagnoses. When a contextual node is encountered, an element of the situation is analyzed, and the value of the contextual element, its instantiation, is taken into account in the decision-making process. Thus, contextual graphs allow a wide category of diagnoses and action representations for a given problem-solving situation.

Contextual graphs are acyclic due to the time-directed representation and guarantees algorithm termination. Each contextual graph (and any subgraphs in it) has exactly one root and one end node because the decision-making process starts in a state of affairs and ends in another state of affairs (not necessarily with a unique solution for all the paths), and the branches express only different contextual-dependent ways to achieve this goal (i.e., different processes of contextualization). A path represents a practice developed by an actor, and there are as many paths as practices known by the system. Figure 1 gives the example of how to buy a subway ticket in Paris, on which we are working. This contextual graph represents the experience of persons living (and working) in Paris, a kind of expert for this problem solving. We develop also contextual graphs for tourists on the same problem solving (different types of novice) coming into Paris regularly or for the first time in order to compare the different graphs.

Related Content

Backward and Forward Linkages in Chinese Steel Industry Using Input Output Analysis
Lafang Wang, Rui Xieand Jun Liu (2013). *Management Theories and Strategic Practices for Decision Making (pp. 139-158).*
www.irma-international.org/chapter/backward-forward-linkages-chinese-steel/70955

An Efficient Data Mining Technique for an Intrusion Detection System in Network
Santosh Kumar Das, Sagar Samal, Priya Ranjanand Shom Prasad Das (2023). *Constraint Decision-Making Systems in Engineering (pp. 1-17).*
www.irma-international.org/chapter/an-efficient-data-mining-technique-for-an-intrusion-detection-system-in-network/316947

Performance Measurement: From DEA to MOLP
João Carlos Namorado Clímaco, João Carlos Soares de Melloand Lidia Angulo Meza (2008). *Encyclopedia of Decision Making and Decision Support Technologies (pp. 709-715).*
www.irma-international.org/chapter/performance-measurement-dea-molp/11312

An Entropy-based Mathematical Formulation for Straight Assembly Line Balancing Problem
Ahmad Heydari, Ali Mahmoodiradand Sadegh Niroomand (2016). *International Journal of Strategic Decision Sciences (pp. 57-68).*
www.irma-international.org/article/an-entropy-based-mathematical-formulation-for-straight-assembly-line-balancing-problem/163961

A Bat Algorithm with Generalized Walk for the Two-Stage Hybrid Flow Shop Problem
Latifa Dekhiciand Khaled Belkadi (2015). *International Journal of Decision Support System Technology (pp. 1-16).*
www.irma-international.org/article/a-bat-algorithm-with-generalized-walk-for-the-two-stage-hybrid-flow-shop-problem/133848