Context-based Representation of the task/method Paradigm

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Abstract

The simultaneous consideration of various notions (practice, procedure, prescribed task, effective task, task space, task search, task, method, activity) shows that the task accomplishment cannot be discussed at a general level, as classical approaches do. Rather, this paper points out the importance to distinguish the task definition and the task realization because the former is mainly static while the latter is dynamic, dynamicity coming from making context explicit. The task realization supposes the choice of a method for accomplishing the task and of the available resources. Context constrains the choice of the method and availability of resources. This leads us to make context explicit in the representation of this task/method paradigm and the need to take into account the actor in the task realization because he selects the method to accomplish the task on the basis of the current context.

Introduction[1]

Several notions such as practice and procedure, prescribed task and effective task, task space and search space are more or less related to some more fundamental notions as task and method. For understanding, we need to distinguish the task definition and the task realization, but not at the general level of the task accomplishment as other approaches do.

The task definition is rather static and defined by the designer prior to the task realization on the basis of experience. Conversely, the task realization is dynamic because intervenes the choice of the method that is used for accomplishing the task and of the available resources. That choice of a method and the availability of resources depend on different factors where the task must be accomplished, such as its place, the time, the weather, etc. Thus context must be made explicit by the actor that has to select a method to accomplish the task in the most efficient way. At this level, the notion of task is related to the notion of role that an actor plays in an enterprise.

For the purpose of this paper, we assimilate an enterprise to an architecture of roles. Each role is, in the one hand, defined by a set of tasks to accomplish, and, in the other hand, by its attribution to an actor that will realize the tasks corresponding to the role, taking into account the context in which the task is realized.

This paper is organized in the following way. The following section discusses the task/method paradigm with an emphasis on some distinctions between different couples of terms found in the literature such as {procedure and practice}, {prescribed and effective tasks}, {task space and task search} and {task and method}. A key finding is that it is better to consider the choice of the method and the role played by the context in the task realization rather than to consider the task as a whole. All along these sections, we provide different examples coming from the application of the incident management on a subway line presented in (Brézillon, Pomerol and Pasquier, 2003). In the next section, we give our view on context, as a key element in the task accomplishment. The section after provides information on the place of the task in the enterprise and presents its relationships with roles and actors. Then, the following section presents how we understand the notion of activity considering in particular the notions of procedure, practice and action scheme. Finally, the last section gives a synthetic view of the different concepts we discuss, proposes a context-based task model and provides a little example.

The paradigm task/method

Brézillon and Marquois (2003) discuss a distinction between procedure and practice. For each incident solving, the enterprise establishes a procedure on the basis of their experience and operators develop a practice on the basis of the current context. This distinction can be better considered in the framework of the paradigm task/method, which is a classical model in artificial intelligence. Within this framework, one or more methods can be used for realizing a given task. Chandrasekaran, Johnson and Smith (1992), and, up to a given point, Trichet, Leclère, Choquet (2000), have made research within this framework. For them, a task can

be defined by an objective, input(s), pre-condition(s), a method to use, and output(s). The choice of the method imposes the selection of a formalism for the knowledge representation and a structure of eventual sub-tasks.

The inputs, the objective, the post-conditions and the outputs are relatively fixed elements. Conversely, the method is not a fixed element because its choice depends on the context in which the task must be accomplished. For example, for a task such as « take the object fallen on the track », one observes that it can be realized by cut-off or not the power. The choice of the method by the actor depends on contextual factors (such as avoid writing the incident report with the power cut-off). Thus, the definition of a task is relatively static when its realization, taking into account the context in which the task must be accomplished (through the choice of the method), presents a dynamic aspect.

On the basis of his working context, an actor makes the choice of a method. For example, three methods can be used for the realization of the task « evacuation of a damaged train », depending on the train position with respect to the platform (the train is at a platform, a part of the train is along a platform at a station, the train is entirely in the tunnel). The position of the train with respect to a platform belongs to the working context (i.e. this information does not intervene directly in travellers evacuation but constrains the way in which this operation is lead).

The main purposes of this section are to point out that:

- The choice of the method imposes a type of formalism for representing knowledge and, eventually, the execution of an organized set of sub-tasks. In other words, there are as many architectures for a task as methods to realize the task;
- A task must be considered at two levels: the level of the task definition which presents static aspects and the level of the task realization which presents dynamic aspects;
- The procedure, which is specified by the enterprise as a rule to follow, corresponds mainly to the level of the task definition, when the practice, which is elaborated by the actor in charge of the task, corresponds to the task realization;
- The distinction between task definition and task realization allows making explicit the role played by the context in the task realization (conditioning the choice of the method).

The notion of context

As seen in the previous section, the key element is to account for the context in the task realization. To understand accurately the relationships between task realization and context, we have to be more specific about what we call context. There are various viewpoints about context and it is considered in a number of domains, some ones being rather far from computer science as psychology and geology. However, we think that context is more than a buzzword. In this section, we propose our view on it.

At a given step of decision making, context is the sum of all the knowledge possessed by an actor on the whole task. Brézillon and Pomerol (1999) separate the part of the context that is relevant at this step of the decision making, and the part that is not relevant. The latter part is called external knowledge. The former part is called contextual knowledge, and obviously depends on the actor and on the decision making at hand. A part of the contextual knowledge is directly concerned by the actor in his decision making and is called proceduralized context. It is invoked, structured and situated according to a given focus and is common to the various people involved in decision making. This type of context may be compiled but can generally be elicited with the usual techniques of knowledge acquisition.

Contextual knowledge is more or less similar to what people generally have in mind about the term 'context'. Contextual knowledge is personal to an actor and it has no clear limit (McCarthy, 1993). Contextual knowledge is evoked by situations and events, and loosely tied to a task or a goal. When the task becomes more precise, a large part of this contextual knowledge can be proceduralized according to the current focus of the decision making. Although the contextual knowledge exists in theory, it is actually implicit and latent, and is not usable unless a goal (or an intention) emerges. When a new event occurs, the attention of the actor becomes focused on it and a part of the contextual knowledge will be proceduralized. In our definition, the contextual knowledge depends on the situation (date, location, and participants).

The context must rather be considered as a status of knowledge (external, contextual or proceduralized context) linked to the focus of attention. At one step of the decision making, we have a static definition of the context through the three types: a part of the context is contextual knowledge, another part is proceduralized context. When the decision making process progresses from one step to the following one, there is a movement between the contextual knowledge and the proceduralized context because a new item enters or leaves the focus of attention. An external event can also impacts the decision making process. These two situations show that context has also a dynamic at the level of the decision making level.

This discussion points out that the context and the actor are two key elements in the task realization which are closely related. The role, attributed to an actor by an enterprise, is also an important element in this task realization. The relationships between the notions of actor, task and role are the object of the next section.

The task in the enterprise

For the purpose discusses in this paper, we suppose that the architecture of an enterprise relies on three elements: the roles, the tasks and the actors. Roles are considered to have a central place in the enterprise architecture because roles

are affected to actors and actors accomplish the tasks corresponding to their roles in the enterprise. We illustrate this architecture in Figure 1.

In the application of the incident management on a subway line presented in (Brézillon, Pomerol and Pasquier, 2003), one observes that relationships between the roles of operator (i.e. the responsible of the subway line) and of a train driver are clearly established, and a set of tasks is attached to each role. This distinction is important because a given actor can have in charge different roles. For example, when an incident occurs, there is a shift of context from the context of a normal exploitation to the context of the incident. The incident solving requires that the operator of the subway line, which is concerned by the incident, takes in charge the additional role of "head of the incident", and two colleagues (operators on other subways lines) take in charge the roles of assessors to help the head of the incident. Thus, each operator has to deal with their normal role (operator of a subway line) and their specific role in the incident solving. This corresponds for each operator to a negotiation of contexts (exploitation context and incident solving context) will influence the choice of the methods to accomplish these different tasks. Conversely, different actors can take in charge a given role (the role of assessor is assumed by the operator that has no problem with his subway line). The roles of operator and driver in the subway application are played by different actors.

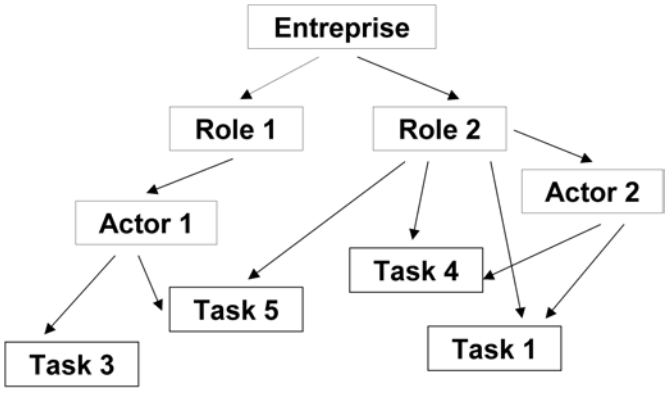

Figure 1: An organization of tasks through roles in the enterprise

The distinction between task and role is also important because the tasks associated with a role can vary according to the enterprise. In the example of a family unit (a type of enterprise) that is given below, the actor who plays the role of housewife generally realizes the tasks of cooking, ironing, and housekeeping. However, these tasks are not systematically associated with the role of housewife. In one family unit, the housewife must only cook and iron. In another family unit, the housewife must cook, iron, do the housework and do the washing-up.

The tasks of each actor, playing a specific role, are considered differently by other actors. For example, the given task "make empty the train" in the subway application consists in a simple action for the responsible of the subway line (he just has to give an order to the driver) but in a complex action for the driver who must realize a set of different sub-tasks to reach the goal of this task.

The relationships between the role and the task are more or less close. Coming back to the subway example, one observes that the operators who become "assessors" play at the same time the role of operator and the role of assessor, and realize the tasks associated to these two roles. Thus, the relationships between the role and the task are very close. In other cases, the relationships between the role and the task are less close. For example, an actor can, on the one hand, play the role of cooker and realize the tasks associated with this role (to make a cake, to think about a menu, etc.) and realize other tasks (to wash up and to iron), associated to the role of housewife, played by another actor. In this case, the actor realizes only a few tasks (not all of them), associated with the role of housewife. Thus, the actor doesn't play this role. In other words, to play a role supposes for an actor to realize all the tasks associated to the role.

The activity

In Artificial Intelligence, as illustrated in the formalism of the contextual graphs (Brézillon, 2003b), an activity is similar to an action more or less complex. The activity is represented by a sub-graph and appears in several contextual graphs, as a recurring structure (each contextual graph corresponds to a given incident solving). For example, « Make empty the train of travellers » in the subway application is a simple action for the operator who is responsible of the subway line and an activity (a complex action) for the driver who must: stop at the next station, announce to travellers to leave the train, go and check that nobody is still in the train, close the doors and leave the station.

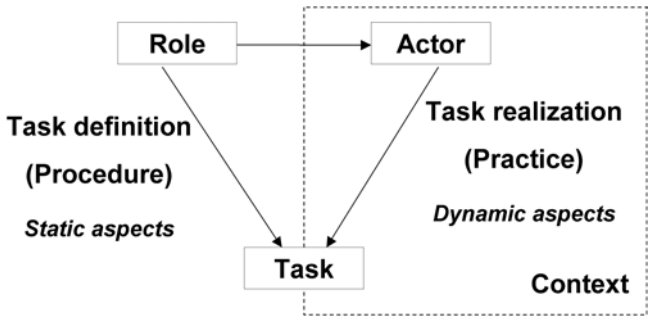

Figure 2: The activity (the dotted box)

Figure 2 represents a part of the Figure 1 with three elements and their interaction, namely the role, the actor and the task. As already said, the arrow from the role to the task corresponds to the task definition, when the arrow from the actor to the task corresponds to the task realization. The first arrow corresponds to the static aspects of the task and the second arrow to the dynamic aspects of the task, mainly

because the context intervenes in the method choice. In other terms, the task definition corresponds to the procedure developed by the enterprise and the task realization is associated with the practice developed by the actor, the practice being a contextualization of the procedure.

An activity corresponds to a task realization by an actor in a given context. It is a complex action for the actor that has in charge the action, but could be considered as a simple action for a colleague of this actor. Thus, an activity is more than a task with its sub-tasks (i.e., an architecture of tasks) because an activity depends directly on an actor and integrates explicitly contextual elements with different actions (decision making). This is illustrated by the activity representation in contextual graphs.

At the implementation level, an activity is a very interesting item. A first interest is to simplify drastically the representation of a contextual graph because a complex part of the contextual graph (the activity) can be represented by a unique (but complex) action. Second, any change in an activity is immediately put in any contextual graph using this activity.

Along the distinction made previously between procedure and practice, we consider that the activity is the application of a procedure. In the case of the procedure, the context is not considered when in the case of the practice the context is considered. The notions of procedure and practice could be discussed with respect to the notions of close activity and open activity used in the domain of education[1]. A close activity is a sort of procedure determined without the participation of the actor. Conversely, an open activity is a sort of practice because it is planed and realized by the actor.

In cognitive psychology, an activity is generally described in terms of action scheme. The notion of scheme has been proposed by Piaget (1936) to explain learning by young children. Action schemes are mental unities composed of action structures which organize and support the activity and the decisional choices of an actor. The actor takes into account the context, the objective, the resources, the action rules on used tools, the inferences on the objectives and the previous steps. This type of representation allows interpreting an activity in a way very close to a sub-graph in contextual graphs. Contextual graphs are implemented in machine, so it is possible to give not only a frame of reference to discuss on the activities, like with the action schemes, but specially to realize them in concrete cases like the SART application for the subway.

Proposal for a context-based task model

Chandrasekaran, Johnson and Smith (1992) give a static definition of the task (input(s), objective, pre-condition(s), post-condition(s) and output(s)) and consider one method (chosen by the designer) to reach the objective of the task.

[1] http://noemed.univ-rennes1.fr/sisrai/dico/

We consider that one has to distinguish between a selection of the method beforehand, and the selection of the method during the course of the decision making process. On the one hand, the method chosen by the designer covers a large class of problems in which the task is concerned. On the other hand, the method that is chosen by the actor, according to the current context, seems to be the most appropriate one. This distinction leads us to make a difference between the task definition and the task realization. Figure 1 indicates that the structure of an enterprise relies on an architecture of roles, associated with a set of tasks, and on actors who compose this enterprise and have the roles to accomplish. Figure 2 represents the task definition (or procedure), which corresponds to the static aspects of the task and to the relationships between the role and the task, and the task realization (or practice), which corresponds to the dynamic aspects of the task and to the relationships between the actor and the task. Along this approach, the context is also represented when we deal with a practice, not in the case of a procedure. Figure 3 presents our context-based task model that takes into account these figures and gives a synthetic view of the different concepts discussed in the previous sections. We begin to develop this model in our application on virtual community for France Telecom. Beginning just now this application, we prefer here to present a toy example easily comprehensible.

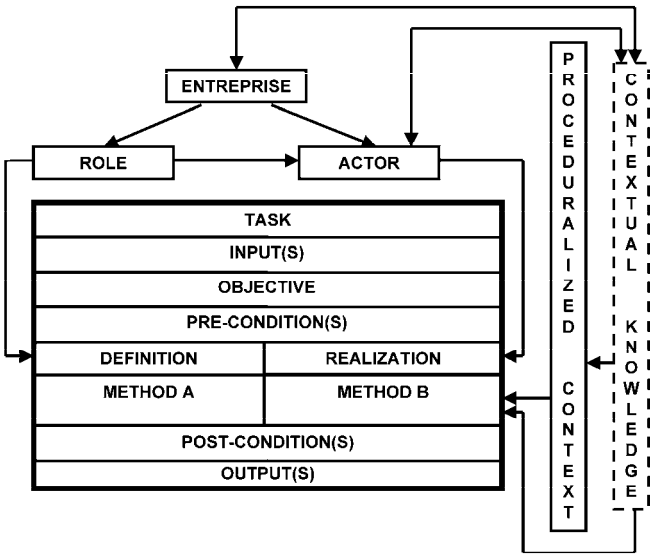

Figure 3: A context-based task model

Let's discuss this last Figure on the basis of the toy example of making a hard-boiled egg. There are a number of ways to make a hard-boiled egg. For us, the traditional recipe is the following one. You need some unshelled eggs, some water, some salt and some vinegar. You need also a saucepan and a mean of cooking. The preparation method is the following one: Put the egg(s) in a saucepan. Fill with cold water so it's an inch over the egg(s). Add salt. Add a few drops of vinegar. (These actions have the contextual information that this avoids that the egg to be broken with

the hot water) Put on high heat and bring the water to a rapid boil. Reduce heat and simmer for 15 minutes. Remove the pan from heat. Remove the egg(s) immediately from the pan. Plunge them into cold water until you can pick them out of the water without burning your hand (a bit under a minute). To remove the egg shell, top the egg against a hard surface and roll it between your hands until the shell is shattered. Then peel shell off.

This recipe can be implemented in the model of a task presented in Figure 3 in the following way: the actor (say Emilie) is at home (this is the enterprise) and she plays the role of housewife. Her task consists in obtaining a hard-boiled egg. The input is a fresh unshelled egg. Her objective is to make this egg hard-boiled. The pre-conditions include the ingredients, the saucepan and the mean of cooking. The preparation method consists in realizing different sub-task: to put the egg(s) in the saucepan, to cover the egg(s) with cold water, to add salt, etc. The post-conditions are rather evident: to eat the hard-boiled egg, it is necessary to refresh it and to remove the egg shell. The output is the hard boiled egg(s).

The traditional recipe, evoked previously, presents some degrees of freedom. For example, before putting the egg(s) in the saucepan, it is necessary to take first the saucepan, or, before removing the egg(s) from the pan, it is necessary to take first a slotted spoon. These sub-tasks and others can be also considered.

The first advantage of this model is that it can represent all the variants associated with this recipe which correspond to the current context. For example, we can imagine that Emilie is in a hurry, she wants less washing-up, and she has a micro-wave. This is what we call previously the proceduralized context. She decides to use her microwave rather than her hotplate. As we said previously, the input(s), the objective, the post-conditions and the outputs are fixed elements and then will not change. Conversely, the pre-conditions and the method will be different from the pre-conditions and the method proposed in the traditional recipe. The pre-conditions won't be: to have a saucepan, to have some water, etc., but: to have a microwave, a micro-egg, etc. And the method will not be: to take the saucepan, to put the unshelled fresh egg(s) in the saucepan, etc., but will become: to take the micro-egg(s), to put the fresh unshelled egg(s) in the micro-egg(s), etc. Other examples can be provided by the fact that she decides to make ten hard-boiled eggs rather than two which changes the pre-conditions (she must take a high saucepan rather than a little saucepan). Another time, she can be in a hurry and prefer to fill the saucepan with hot water rather than cold water because it is more rapid (the method is then different from the method of the traditional recipe).

The second advantage is that it allows decomposing precisely the realization of the task in sub-tasks, like the contextual graphs formalism, and indicates all the resources necessary.

Conclusion

In this paper, we point out that two contrasted positions (procedures versus practices, task space versus search space or prescribed task versus effective task) generally appear as unrelated because the focus is not at the right level: the focus was on a general consideration of a task rather than a focus on the way in which they are accomplished. The paradigm task/method, which is discussed in this paper, gives a support to understand the confusion of understanding of levels, and allows to analyze, first, the differences between the two positions and, second, the origin of the confusion: context was not make explicit in discourses. In the paradigm task/method, the choice of a method depends on the context in which an actor accomplished a task.

On the one hand, the designer chooses prior any use of the task a method for accomplishing the task. This choice is based on conditions of maximum of generality (e.g. cover the larger class of problems). On the other hand, the actor will choose the method that is the most adapted to the current situation, the context in which the task must be accomplished. Thus, a main finding is the need to distinguish between the designer's viewpoint and the actors' viewpoint, the second viewpoint being the most important because it deals with context and thus corresponds to concrete application of the task. Contextual graphs propose an approach by incremental acquisition of practices, the procedure being the initial frame.

On the other hand, making context explicit allows to join notions generally considered separately (such as actor, activity, task, context) that find a natural place in a general picture of the way in which an actor interact with a system in a given context. The actor selects the relevant method on the basis of what must be done, what are the available resources to do what must be done, the constraints that must be taken into account, some external factors having nothing to do with what must be done but constraining it. Thus, the actor makes the decision by building a proceduralized context from the available contextual knowledge in a dynamic way, i.e. with a movement between the contextual knowledge and the proceduralized context (just recall that the proceduralized context is a subset of the contextual knowledge that is organized, structured and compiled to be used in the decision making process. In that sense, the realization of a task is not a pure automatism but a real decision making process. This process and the interpretation process too are based on the context and then are related to the reasoning processes difficult to implement.

Maybe at a more general level, one observes that the paradigm task/method would be helpful to be considered in the light of its contextual texture.

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