Goal-Oriented Patterns for Business Processes

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Abstract: Organizations of today are becoming ever more focused on their business processes. This has resulted in an increasing interest in business process patterns, which can be used in order to understand where from one can adopt best practices, or how to build computer systems supporting business processes. However, to fully exploit patterns, they need to be defined in a structured, and even formal way. This paper proposes to explore the state-oriented approach for defining and formalizing patterns based on the notion of goal rather than the sequence of events/activities.

1. Motivation

Most of the research and practice connected to business processes has one aim: to make business processes more cost-effective, which means reducing costs, time, increasing quality, etc. One of the proven approaches in this field is reengineering of the processes by using best practices, which can also include adoption of information systems used in these best practices.

Borrowing a best practice from another organization cannot be done literally. We always need to abstract from the details in order to introduce the best practice in a new environment. What is more, before trying to take over somebody else's best practice, we need to be sure that we are borrowing from the process that has the same nature that the one we want to substitute with the best practice.

Abstracting from enough details to see the similarity of the phenomena that can look different at the first glance is often referred as to finding a common *pattern*. Patterns are used in many application fields from construction to software design. We believe that the idea of patterns can be useful for business process reengineering, especially for finding an appropriate best practice.

The most important aspect to consider when looking for a better organized process is whether the goal of this process is the same as the one we want to substitute. Thus, the notion of goal is central for defining business-process patterns. In order to fully exploit patterns, they need to be defined in a structured, and even formal way. Below, we propose one approach to constructing such definitions.

The rest of the text is structured in the following way. In section 2, we present an example of informal definition of a generalized process, i.e. pattern. In section 3, we demonstrate how this pattern can be described formally. In section 4, we give a definition of business process pattern. In section 5, we compare our approach with those of others. In section 6, we summarize the results achieved, and draw plans for future research.

2. An example of generalized processes - sales/collection

The idea of generalized description of business processes is not new. For example, [Denna et. al., 1995] identifies three most important business processes for industrial organizations: acquisition/payment, conversion, and sales/collection. Each such process is described in a sequence of activities, called business events in the terminology of [Denna et. al., 1995]). The events may be defined with more or less level of details. For example, the "sales/collection" process may be described as:

- Accept customer order
- Select, inspect, and package merchandise
- Ship merchandise
- Receive customer payment

The same process may be described in less details:

- Ship merchandise
- Receive payment

According to [Denna et. al., 1995], the sequence of events may differ from organization to organization, and from customer to customer. Therefore, the generalized sales/collection process cannot be defined as a prescribed sequence of events, but rather as a set of business objectives, i.e. the goal of the business processes. The objectives of the sales/collection process can be defined as achieving the state of the business world in which the following two propositions are true:

- The customer has the merchandise he ordered
- The organization received the payment agreed upon with the customer

We believe that such definition can give us a clue of how to define a generalized business process (i.e., a pattern) in a formal way.

3. Structured representation of the example

To define a generalized process from the previous section in a structured way we use the state oriented view on business processes from [Khomyakov & Bider, 2000]. According to the most general definition of a business process, see for example [Hammer et. al., 1994], a business process is a set of partially ordered activities aimed at reaching a well-defined goal. The state-oriented view is focused on the changes that each activity introduces in the part of the world that is relevant to the given process, each change moving the process closer to the goal.

The state oriented view considers a business process as a trajectory in a multidimensional state space. An example of a state space constructed for the sales/collection process taken from our previous work [Khomyakov & Bider., 2000] is presented in Fig. 1. Let us analyze the most important characteristics of this space. We have two dimensions for each product being sold: *ordered* and *delivered*. The number of such pairs of dimensions can be considered as variable, or as equal to the size of the company's assortment. Denote the product dimensions as $X_1,\ldots, X_n$ (ordered) and $Y_1,\ldots, Y_n$ (delivered). Additionally we have two dimensions that concern payment; *invoiced* and *paid*; denote them as Z^{in}, and Z^{pa}.

Having introduced the above dimensions, we can represent a sales/collection process as a point moving in the state space we just defined. The operational goal of this process may be express as reaching the surface in the state space defined by the equations:

$x_1 = y_1,\ldots, x_n = y_n, z^{in} = k_1x_1 + \ldots + k_nx_n,\ z^{pa} = z^{in}$, where $k_1, \ldots, k_n$ represent prices of the products ordered.

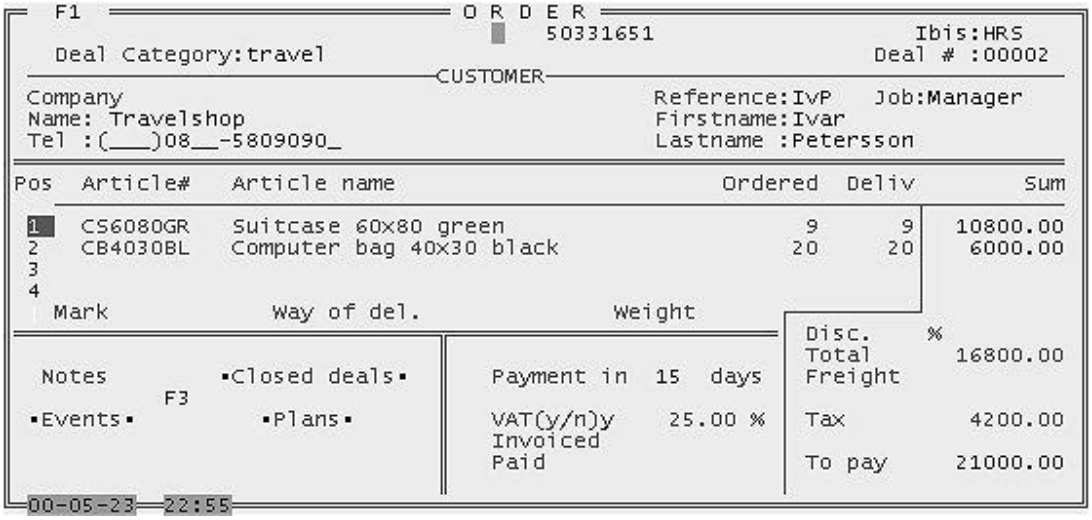

Fig.1 State space of the sales/collection process from [Khomyakov & Bider, 2001].

After defining the state space and the goal, we can classify the movements along the various axes. Moving along *X*-axes normally means the customer changes his order. Moving along *Y*-axes forward means delivery. Moving along *Y*-axes backward means return. Moving along Z^{in}-axes forward means invoicing. Moving along Z^{in}-axes backward means crediting. Moving along Z^{pa}-axes forward means receiving payment. Moving along Z^{pa}-axes backward means paying back (for example after return).

Classification of the movements gives us the possibility to compare activities in different sales/collection processes independently how they are called and how they are done, and in what order. We just need to understand in which direction each activity moves the position of the process in the state space.

4. Pattern definition

Based on the discussion in Section 3, we can define an operational procedure for comparing business processes. Two business processes are considered as similar if:

1. Their state spaces have a similar topology. It means that there is a mapping *m* from one state space into another that possesses some kind of "morphism". The strong similarity requires isomorphism, but other types of mappings could be considered as well.
2. They have similar goals. Goals are defined as surfaces in the state space. Similarity of goals means that the goal of the second process can be obtained via mapping the goal of the first process by applying mapping *m* defined above.
3. They have the same kind of valid movements in the state space towards the goal. Again, it means that valid movements of the second process can be obtained by applying mapping *m* to the valid movements of the first process.

According to our objective to find similarities when comparing different business processes, we consider *patterns* as means for defining *practically interesting* sets of business processes. We believe that for this end, a pattern can be defined as a triad

$$P=<p\text{-}state\text{-}state, p\text{-}goal, p\text{-}movements>$$

complemented with properties of a mapping function *m* (e.g. isomorphism) that can be used for comparing the state-space of a particular business process with the one of the pattern. A business process is considered belonging to pattern *P* if there is a mapping *m* that satisfies the properties defined by the pattern, and maps this process's state space, goal and set of valid movements into *p-state-state*, *p-goal*, *p-movements* respectively.

The above definition is more conceptual than formal. To make it formal, we need to understand what kinds of state spaces can be useful for representing business processes, and what kind of properties the mapping functions should possess. However, even now, this definition can be used as a leading thread when comparing the state pictures of the type represented on Fig.1. We use such pictures in our analysis practice to present a business process model to non-technical participants of the business process.

5. Related research

There are a number of research works that concern patterns for business process. The one that is most closed to us is described in [Malone et al., 1999]. A process pattern is defined as a number of abstract activities of the type discussed in section 2.1. The general pattern is then specialized (synthesis) by specializing each of the abstract activities and establishing a particular order in the flow. A large collection of general and specialized patterns has been built based on this approach, and it is in use for process improvement purposes (analysis and synthesis).

The approach in [Malone et al., 1999] requires to distinguish some abstract activities before creating a pattern. In our analysis practice, we often had situations when the nature of activities was not clear in the beginning, and we needed to start with defining state-

space and goals first. Our valid movements in state space are similar to the abstract activities from [Malone et al., 1999]. However, they differ from the latter in two respects. In one respect, our movements are more abstract as they refer only to the changes in the constructed state-space, not to what happens in the real world. In another respect, they are more concrete as they are tied to concrete movements in the state space.

6. Conclusion

With this work, we made only the first step to formal definition of goal-oriented patterns for business processes. The definition is based on the notions of state-space, goal (as a surface in the state space), and valid movements towards the goal. The suggested approach allows to abstract from the most of the details, without loosing the essential nature of a particular business process. We believe that the suggested approach can be useful for the task of identifying the nature business processes in order to understand wherefrom one can adopt best practices, or computer support systems.

In this work, we concentrated on patterns for analysis. However, patterns for analysis are only half-useful if we cannot add to them solutions for synthesis, i.e. (re)engineering. Synthesis (specialization in terms of [Malone et al., 1999]) from the state-oriented pattern can be done in two directions:

- Specializing valid movement by adding an operational procedure of what should be done in the real world to move the process from one state to another. This corresponds to the external action of activity, discussed in [Andersson et al., 2002].
- Establishing constrains on the permissible trajectories of the process in state space, i.e. introducing some order in activities. This can be done by rules of dynamic planning discussed in [Khomyakov & Bider, 2000].

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