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Introducing decision-aware business processes

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ABSTRACT

Business processes are designed to smoothly operate under multiple contexts (or business situations). Each context technically implies taking a different course of action. Be that as it may, going for the most appropriate action is still left up to the business process participant without any kind of assistance. Such a situation demonstrates that there is a lack of a context-aware decision-making feature. This paper addresses the issue of enabling a context-aware decision-making within the frame of business processes. We combine the concepts of business process, context-awareness and decision-making to introduce a new concept of Decision-Aware Business Processes in which decision partitions are the cornerstones. A decision partition reacts to the collected contextual parameters by selecting or recommending the most appropriate decision(s). In fact, the focus of this research is to introduce a new formalism for designing these partitions by means of patterns. Throughout our approach, each proposed pattern leads to building decision partitions in a straight-forward fashion. An overall example is proposed to illustrate our approach. It is inspired from the banking industry and introduces a decision-aware business process that handles loan applications. To sum up, whether seasoned, novice or in-between, business process participants will be able to save time in taking action(s). Moreover, the workflow becomes no longer stagnant across the business process. Instead, it dynamically adapts itself to each new set of business requirements imposed by the collected contextual input(s).

1. Introduction

Facing keen demand, Business Processes (BPes) are becoming a key platform for many innovative ideas in both the academic and business sectors. Each of these entities offers a variety of benefits that were otherwise difficult to obtain within functional organizations [8]. In a process-oriented organization, the participants, the activities, the participants' assigned activities and their order of accomplishments are all meticulously posed. Everything is smoothly organized to avoid unexpectedness. Therefore, reduce time, save money and better the quality.

Nevertheless, BPes at present, are still deficient when it comes to the critical ability of offering assistance to their users [38]. Although able to handle a variety of business situations, they cannot yet recommend one or some over others, resulting in a lack of decision-making ability, which, clearly is an open space for further contributions.

To provide an overview of what business processes are lacking in the decision-making area, let us consider the following real life examples in order of increasing complexity:

Example 1 (basic): *Railroad Track Junction*

A railroad track junction describes the location where multiple railroads intersect. Switches are placed to direct each train to its destination. A basic embedded Decision Support System (DSS) [36] automatically alters the switches' orientation depending on the train provenance, destination and time. Although this idea seems trivial since the data upon which determining the position of the switch is easily perceivable by the human mind, this example is a clear illustration of how the process of orienting the switches is made easier due to the embedded DSS coupled with the data characterizing each train.

Example 2 (medium): *United Parcel Service*

In its Worldport hub located in Louisville, Kentucky, the United Parcel Service (UPS) operates the most technologically advanced system for sorting packages and steering them to their destination transporter (e.g., aircraft, truck) via approximately a hundred miles of conveyor belts. Even if the packages are headed to the same destination, they do not necessarily take the same path on the conveyor belts. For example, two packages headed to Pittsburgh,

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Pennsylvania can end up on the same plane after taking different paths on the conveyor belts. The path adopted by each package is determined by a DSS based on the data collected with the DWS (Dimension Weight Scan) system: dimension of the package, its weight and its final destination. Using this data, the decisions are made in real-time, which leads to sorting an average of one million packages per day.

Example 3 (advanced): *Internet Protocol Suite*

The Internet protocol suite offers a set of communication protocols such as the TCP/IP (Transmission Control Protocol/Internet Protocol). Before proceeding to the transmission, the TCP transforms the information into packets. Each packet is characterized by distinctive traits (e.g., port of source, port of destination, sequence number, acknowledgment number). In a transmission, even though related packets have the same source (e.g., application software, host), the same destination (e.g., application software, host) and the same delivery protocol (e.g., IP), they do not necessarily take the same path on the way to the other host. In other words, for a message conveyed from the United States to Germany that is split into three packets; one packet can take the route USA–Morocco–Germany, the second takes the route USA–Germany while the third takes the route USA–Canada–Germany. The idea here is to deliver the packets using the most efficient route, which is not necessarily the shortest in terms of distance, and to avoid network congestions, traffic load balancing, or other unpredictable network behaviors. This example can be considered a more generic version of the UPS system since they both share the same goal. However, details such as the diversity of software applications (e.g., port of source, port of destination), the large number of hosts (e.g., servers, desktops), the larger and more complex routes (e.g., transatlantic optical fiber cable, subnetworks) make this system a more sophisticated version of the UPS Worldport system.

Note for the examples above, decision support systems offer real-time guidance for trains, packages and packets. It mayhap, for instance, that the packages/packets in Examples 2 and 3 have the same source, destination, transporter/protocol. Nevertheless, the paths taken are not necessarily the same for each instance. The embedded DSS takes into account different input parameters and reacts to them by redirecting the package/packet to the most appropriate alternative (conveyor belt segment/route). This phenomenon is scientifically referred to as context-awareness. *A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task* [13]. *Context*, indeed, is appropriate for *Relevancy* because it distinguishes each situation/object by a set of quantified parameters. The impact of context for better decision-making has been the focus of many research efforts [24,2,26]. Such a strong interest stems from the fact that a context-aware decision support system takes into account miscellaneous and abundant contextual parameters. Sometimes, these parameters are more than what the human mind can perceive, to use in decision-making. Hence, combining context-awareness and decision-making in one system makes it more desirable to users. Context in the previous examples includes, but is not limited to: trains timetable, data on the package tag, conveyor belt traffic status, data fields of the packet and network status. The awareness part, is the reaction to each contextual input, which is orienting the switch for Example 1, transiting the package through the adequate conveyor belt segment for Example 2 and transmitting the packet via an appropriate route for Example 3. For all cases, the action of collecting context and the reaction of taking a decision are in real-time. Moreover, Examples 2 and 3 clearly demonstrate that the shortest path is not necessarily short because of the distance. Still, the number of packages that UPS handles per day (one million on average), plus the number of packets that transit throughout the Internet (exponential?) represent a cogent indicator of the practicality of a context-aware DSS.

Based on this analysis, a major point is highlighted: *What is important is to reach the destination in an efficient way but not necessarily the same way*. Analogically to the previous examples, BPes have a mission objective (starting point), a business objective (destination) and a workflow (a sequence of connected steps). Context-awareness is about coping with the changing contexts. Decision-making is about assisting in selecting the appropriate decision(s). Within BPes, the vision of context-aware decision-making would be about assisting in coping with the appropriate context. So, *can we enable it?*

The purpose of this paper is to provide an approach to solving this question. The solution will enable business processes to control workflow in a smart fashion. Imagine a business process participant, either novice or seasoned, pausing the workflow because she/he does not know how to proceed (novice) or needs time to be able to assess the practicality of the alternatives before making a decision (seasoned). Actually, a workflow should not be stagnant to one sequence of activities or be subject to manual and time-consuming guidance. This manual approach makes business processes deviate from their foundational goals since workflows must always run on real-time. Here we aim to reach a business process that examines the contextual inputs as well as the history of previous executions, then directs the workflow to the most appropriate alternative(s): i.e., a business process that goes from the mission objective to the business objective in an efficient way, but not necessarily the same way each time it is executed. To do so, we do not focus on developing any particular data-mining and/or machine learning technique (usually known for being part of a DSS). Here, we provide a set of *generic* mechanisms, open to existing ones [41,20,42] and able to manage changes in the context by making reactive decisions, all within the frame of business processes.

The remainder of this manuscript is structured as follows: Section 2 reviews the work done in the literature and highlights how it does not fulfill the objective of our vision. Section 3 introduces our definition of a decision-aware business process and a decision partition as well as underlines the relationship between both; the latter is the cornerstone of the former. Section 4 sets the design specifications for these new decision partitions while Section 5 illustrates our approach with an example from the banking industry. Finally, Section 6 concludes this paper, discusses the results and presents an outlook for future work.

2. Literature review

Business Process Improvement (BPI) is a methodology [32] for optimizing one or more of the business processes' performance metrics: time, cost and quality. BPI can be regarded as a repository of business process optimization techniques such as Balanced Scorecard [17], Six Sigma [15] and X-Aware business processes [30]. Throughout this section, we focus on reviewing the X-Aware business process literature to position ourselves within prior work. So far, no similar classification has been established in the literature. We stress how none of the current X-Aware business processes can help us achieve our goal, which is to enable a context-aware decision-making within the business process worklow.

Table 1 draws a comparison between the foundational features of the most recurrent X-Aware business processes in the literature. It is important to bear in mind that we only report the foundational features of each X-Aware entity; we do not draw any implications from the references examined. For example, an Efficacy-Aware Business Process could also be Context-Aware. However, its foundational features do not include context-awareness. The foundational feature(s) of each X-Aware entity is/are distinctive to that entity. To clarify the classification features, *Context Knowledge*