Information Systems ▮ (▮▮▮▮) ▮▮▮–▮▮▮

Contents lists available at SciVerse ScienceDirect

Information Systems

journal homepage: www.elsevier.com/locate/infosys

On modeling context-aware social collaboration processes ☆

Vitaliy Liptchinsky *, Roman Khazankin, Stefan Schulte, Benjamin Satzger, Hong-Linh Truong, Schahram Dustdar

Distributed Systems Group, Vienna University of Technology, Austria

ARTICLE INFO

Keywords:
Process modeling
Social context
Collaboration
Visual language

ABSTRACT

Modeling collaboration processes is a challenging task. Existing modeling approaches are not capable of expressing the unpredictable, non-routine nature of human collaboration, which is influenced by the social context of involved collaborators. We propose a modeling approach which considers collaboration processes as the evolution of a network of collaborative documents along with a social network of collaborators. Our modeling approach, accompanied by a graphical notation and formalization, allows to capture the influence of complex social structures formed by collaborators, and therefore facilitates such activities as the discovery of socially coherent teams, social hubs, or unbiased experts. We demonstrate the applicability and expressiveness of our approach and notation, and discuss their strengths and weaknesses.

1. Introduction

Business process modeling (BPM) allows companies to describe and document their enterprise processes. If captured accurately, such knowledge allows to analyze, improve, and execute those processes with higher efficiency. Although a variety of techniques and tools have been introduced for BPM, modeling of highly dynamic non-routine processes, such as human collaboration, is still a subject of discussion in research and very few approaches have been proposed so far [1].

While collaboration in general means working together to achieve a goal [2,3], with the proliferation of collaboration software, such as groupware or wikis, the manner of human collaboration has taken the form of incremental contributions to a network of shared documents, e.g., source code files, wiki pages and so on. Relations between documents, actors, and other artifacts may influence the collaboration process. For example, some tasks should be done by actors chosen based on social relations, actions on some documents should not be performed before related documents reach certain conditions, or a change in a related document might force to re-do an activity. Moreover, social structures formed by collaborators affect produced network of artifacts. Indeed, Conway's law suggests that “organizations which design systems are constrained to produce designs which are copies of the communication structures of these organizations” [4]. For example, socially coherent teams tend to produce more seamless solutions. Therefore, a proper modeling of collaboration processes must consider both semantic structures in networks of artifacts and structural formations in social networks formed by collaborators. Although artifact-based process models have already been researched [5–7], existing modeling approaches do not emphasize the relations between artifacts and actors, and are not capable of capturing complex social structures formed by collaborators.

We thus propose a novel modeling approach and a graphical notation for collaboration processes. The key idea is to treat each document's evolution as an individual

* Corresponding author. Tel.: +14258022813.
E-mail address: v.liptchinsky@infosys.tuwien.ac.at (V. Liptchinsky).
URL: http://www.infosys.tuwien.ac.at/ (V. Liptchinsky).

0306-4379/$ - see front matter © 2013 The Authors. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.is.2013.05.007

Please cite this article as: V. Liptchinsky, et al., On modeling context-aware social collaboration processes, Information Systems (2013), http://dx.doi.org/10.1016/j.is.2013.05.007

process that is explicitly influenced by the states of related documents and patterns in the surrounding social network. We propose to formalize the relations in line with the data from collaboration software, e.g., two developers can be considered related if they committed code to the same project folder in a source code repository. The amount of such data will grow with social computing pervading the enterprise IT,[1] thus allowing process modelers to create richer models of people-intensive processes that support information-centric, bottom-up and context-aware and social modeling techniques for collaborative tasks.

The main research contributions of this paper are (i) a novel approach for modeling context-aware social collaboration business processes, (ii) an expressive formalism that allows to define complex dependencies as network of artifacts and people, and (iii) a visual graphical modeling notation. The visual notation is a result of linking two threads of research in a novel way by combining graph query languages and control flow languages. Moreover, with the introduction of the notion of *groups*, this combination is further extended with fundamental concepts of social network analysis by allowing to express such advanced patterns as clique, k-plex, betweenness centrality, closeness centrality, structural equivalence and so on [8]. This paper substantially extends our previous work [9] by (i) introducing the notion of *groups* as first class citizen into the modeling approach, (ii) giving a more detailed discussion of the motivation and related work, and (iii) discussing additional use cases to illustrate the benefits of the concept of groups.

The rest of this paper is organized as follows: Section 2 describes the motivation behind the modeling approach and presents a motivating example. In Section 3 we show the lack of expressiveness in existing modeling approaches with regard to the scenario at hand. Section 4 describes the proposed modeling paradigm and the corresponding graphical notation. Section 5 demonstrates the usability of the approach through realistic use cases. Our modeling approach is critically discussed in Section 6. The paper is concluded in Section 7.

2. Motivation

Collaboration is a recursive process composed of human interactions towards realization of shared goals [2,3]. Groupware and social software foster collaboration of individuals who work across time, space, cultural and organizational boundaries, i.e., virtual teams [10]. Using this type of software, people interact through conversations (e.g., e-mails and instant messages) and transactions (e.g., create/modify/assign/restructure a document) in order to augment a common deliverable, e.g., the documentation of an idea, a technical specification, a source code file, or a wiki page. Typically, such interactions are disorganized, non-routine, and are hard to predict and model. However, as side-effects they produce semantical and social relations between actors and artifacts (e.g., *authorship*, *friendship*). Furthermore, artifacts are usually semantically connected into hierarchical or network structures, e.g., references in wiki pages, or dependencies between software components. Likewise, actors contributing to artifacts form complex social or communication formations, whose structure significantly influences collaboration processes and artifacts themselves. For example, given that a group of collaborators can be represented by a graph with edges denoting regular communication, a group forming a complete graph has more chances to produce a successful artifact(s) than a group forming a sparse graph with many isolates. Patterns of interest differ in artifact and social networks in the sense that structural patterns in artifact networks focus rather on types of relations and artifacts, and their states, while structural patterns in social networks focus on the density of edges by considering single type of relation, e.g., such social formations as clique, k-plex, and notions of structural equivalence, betweenness centrality (broker), and so on [8].

As a motivating example, let us consider in-house software engineering in a dot-com company. Projects, or ventures, in such a company can be classified as engineering ventures (development of new functionality), or analysis ventures (incident investigation, proof-of-concepts). Both types of ventures produce deliverables, such as source code or technical documentation. Fig. 1 demonstrates a snapshot of a collaboration process as a directed graph of venture deliverables and collaborating actors.

Edges connecting ventures represent functional dependencies (i.e., a venture depends on either an investigation report or a software component produced by other ventures). Edges connecting actors depict social relations, i.e., there is a regular communication over instant messaging channels between them, or they contribute to the same venture. Contrarily, the edge `NO Social Relation` denotes absence of social ties, e.g., actors never worked on the same venture. Analysis ventures, representing rather creative and non-routine work, can reside only in two possible phases, namely `In Progress` and `Finished`, while engineering ventures, representing more structured and long-running work, can reside in more phases, such as `Design`, `Implementation`, `Testing`, and `Finished`.

Now, let us consider a process modeler that possesses knowledge of the working environment, the culture, and the scale of the company, and aims at modeling the following rules (we refer to them as context dependency rules (CDRs)):

CDR 1. *A venture project team should be notified of any changes in the technical documentation of other ventures it depends on. However, if two functionally interdependent ventures share any team members, then enforced communication is not required.* This rule ensures proper knowledge sharing between functionally interdependent ventures while avoiding overcommunication. For example, any new technical reports of `Analysis Venture 2` should be communicated to the project team of `Engineering Venture 2`. However, the same synchronization between `Engineering Venture 2` and `Engineering Venture 4` is not critical, because `Engineer 3` is anyway aware of any such changes.

[1] http://www.gartner.com/it/page.jsp?id=1470115

Please cite this article as: V. Liptchinsky, et al., On modeling context-aware social collaboration processes, Information Systems (2013), http://dx.doi.org/10.1016/j.is.2013.05.007