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A visual language and environment for enterprise system modelling and automation ☆

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ABSTRACT

Objective: We want to support enterprise service modelling and generation using a more end user-friendly metaphor than current approaches, which fail to scale to large organisations with key issues of "cobweb" and "labyrinth" problems and large numbers of hidden dependencies.
Method: We present and evaluate an integrated visual approach for business process modelling using a novel tree-based overlay structure that effectively mitigate complexity problems. A tree-overlay based visual notation (EML) and its integrated support environment (MaramaEML) supplement and integrate with existing solutions. Complex business architectures are represented as service trees and business processes are modelled as process overlay sequences on the service trees.
Results: MaramaEML integrates EML and BPMN to provide complementary, high-level business service modelling and supports automatic BPEL code generation from the graphical representations to realise web services implementing the specified processes. It facilitates generated service validation using an integrated LTSA checker and provides a distortion-based fisheye and zooming function to enhance complex diagram navigation. Evaluations of EML show its effectiveness.
Conclusions: We have successfully developed and evaluated a novel tree-based metaphor for business process modelling and enterprise service generation. Practice implications: a more user-friendly modelling approach and support tool for business end users.

1. Introduction

Business processes play a crucial role in running an organisation. In order to achieve process excellence, people carry out various process improvement initiatives, such as business process reengineering (BPR) and business process management (BPM) [31,2], along with business process-based services [38] and service composition [22]. BPM has been defined as "a structured, coherent and consistent way of understanding, documenting, modelling, analyzing, simulating, executing and continuously changing end-to-end business processes and all involved resources in light of their contribution to business success" [54]. BPM covers the overall management of organisations by looking at the lifecycle of their business processes [8]; Kraemer and Herrmann [36]. However, no matter which process improvement initiative people wish to conduct, they need to understand business processes, perform analyses to design or redesign them, and build or reuse

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appropriate services or service orchestrations to realise them [33,27].

BPM and business process-based service composition have thus emerged as popular approaches in practice and research. However, while organisations appear to be well aware of the need for BPM and the advantages of using service-oriented architectures, implementation remains a challenging task. Indeed, many organisations still struggle with an efficient modelling approach to discover, visualise and document their business processes [55]. Examples of BPM approaches include Entity-Relationship models [12], Data Flow Diagrams, Flow Charts [58], Scenarios, Use Cases, Integration Definition for Functional and workflow Modelling [17], and Business Process Modelling Notation (BPMN) [9]. Many types of workflow management and service modelling and composition systems have been developed to model and implement enterprise business processes [37,50,53,59]. Their goal is to specify, compose, co-ordinate, enact and evolve business processes using a high-level visual modelling approach. Using workflow approaches, business processes are typically modelled as stages, tasks and links. These models are then used to control the execution of software components that comprise an enterprise system. Process technology can also be used to model processes executed within systems e.g. in Enterprise Resource Planning (ERP) systems.

Despite this ongoing proliferation of process modelling languages, only a few have been widely accepted by practitioner communities. Research shows that visual process modelling methods differ significantly in their features and characteristics, such as, for instance, their representational capabilities, their support for expressing workflow patterns or their support for formal analysis of correctness criteria [16,20]. Actual practice, on the other hand, informs us that certain BPM languages have achieved higher levels of adoption and dissemination in visual modelling practice than others while many visual modelling languages exist as objects of interest only to academic scholars [24,27]. Most existing workflow based Enterprise visual modelling languages adopt box-and-line style diagrams, which work well for small to medium diagrams. A common difficulty with such approaches is a lack of scalability. Most existing modelling technologies are effective in only limited problem domains or have major weaknesses when applied to large system models resulting in “cobweb” and “labyrinth” problems, where users have to deal with many cross diagram flows. Most modelling tools use multi-view and multi-level approaches to mitigate this problem [26]. These approaches have achieved some success but do not fully solve the problem, as using the same notation and flow method in a multi-view environment just reduces individual diagram complexity, but increases hidden dependencies between diagrams. This requires use of the long-term memory of the users, as they have to build and retain the mappings between views mentally. In addition, most existing flow based business modelling notations lack multiple levels of abstraction support.

We have been developing a new approach, Enterprise Modelling Language (EML) and a support environment, MaramaEML, to overcome some of these issues in a novel way [41,42]. Our principal goal that directed the design of EML was to provide a simple, intuitive and executable visual notation to support rapid, user-friendly development of business process-based services. Our key target end-users are business process domain experts and service composition experts. EML adopts several visual metaphors to enhance the representation, navigation and management of large organisational hierarchies and process flows. It attempts to address many of the above limitations by modelling processes primarily by a novel tree overlay structure. In this new approach, complex business systems are represented as service trees and business processes are modelled as process overlay sequences on the service trees. By combining these two mechanisms, EML gives users a clear overview of a whole enterprise system with business processes modelled by overlays on the same view. However, our approach does not exclude existing modelling notations such as BPMN. We incorporate them in our EML support tool while providing additional richer, integrative views for enterprise process modelling. The objective of EML is to support business process management by both technical users and business users by providing a novel tree overlay based notation that is intuitive to business users yet able to represent complex process semantics. MaramaEML is an Eclipse-based integrated design environment for creating EML specifications. This IDE provides a platform for efficient visual EML model creation, inspection, editing, storage, model driven code generation of web services, and integration with other diagram types. Distortion-based fisheye and zooming functions have also been implemented to enhance MaramaEML's navigability for complex diagrams. MaramaEML supports BPEL code that is automatically generated from graphical EML representations and mapped to a Labelled Transition System Analyser (LTSA) [19] for validation.

The remainder of this paper is organised as follows: Section 2 describes the motivation for our research and Section 3 provides an overview of the approach taken and its development. Section 4 introduces the detailed design of the Enterprise Modelling Language (EML), describing the visual representations of service tree structure, process overlay and exception handlers; as well as some more advanced constructs such as dependency / trigger, iteration and conditions. This section uses a complex business process example (a University enrolment system) to demonstrate the capabilities of EML and MaramaEML. The architecture and implementation of MaramaEML are discussed in Section 5. Section 6 described a formal user evaluation of EML and MaramaEML with analysis of the evaluation feedback and possible improvements. We conclude the paper with a discussion and future work directions.

2. Motivation and related work

Our primary motivation for this research came from an attempt to model a large university enrolment system as part of a process improvement exercise, and to derive executable service orchestrations from these models to be enacted by a workflow system. This is a complex service-oriented enterprise system that involves dynamic collaborations among five distinguished parties: Student, Enrolment Office, Department, Finance Office and StudyLink