ELTE

Thematic Excellence Program

Industry and Digitalisation

Application Domain Specific Highly Reliable IT Solutions

Application of Model-2-Program Approaches on Workflows of Various Fields of Services

Kherbouche Meriem, Molnár Bálint

Department of Information Systems, Faculty of Informatics,
Eötvös Loránd University (ELTE)
{meriemkherbouche, molnarba}@inf.elte.hu

Introduction

Nowadays, the variety and complexity of applications arise the requirement of the creation of new flexible models more complex than the existing models. Business processes modeling and verification became essential to control and assure organizational evolution, and the transformation between models becomes more important. The model transformation bridges the gaps between models and source codes, or between models at different levels of formality. We proposed two approaches of model transformation for the Unified Modeling Language (UML) that aim to make models more formal and abstract using Alloy and YAWL. Recently, we overview the opportunities for the Application of blockchain in Business Process Management and Modelling. We investigate the utilization of blockchain technology for model checking of Workflow, Business Processes to ensure consistency, integrity, and security in a dynamically changing business environment.

Problem & motivation

The challenges of modelling are to reflect the dynamic and static side of Information Systems where the rapidly changing business environment directly influences the behavior of Information Systems through documents, their related actions and events.

Publications

Published and accepted publications:

[1] M. Kherbouche, K. Bouafia, and B. Molnár, “Transformation of uml state machine to yawl,” in *2019 Ninth International Conference on Intelligent Computing and Information Systems (ICICIS)*. IEEE, 2019, pp. 215–220.

[2] M. Kherbouche and B. Molnár, “Formal model checking and transformations of models represented in uml with alloy,” in *Dahanayake A., Pastor O., Thalheim B. (eds) Modelling to Program. M2P 2020. Communications in Computer and Information Science, vol 1401*. Springer, 2021, pp. 127–136.

[3] M. Kherbouche, G. Pisoni, and B. Molnár, “Model to program and block-chain approaches for business processes and workflows,” *Modelling*, p. 2021, 2021, journal Ranking: Cite Score Q2, under review.

Transformation of UML State Machine To YAWL

In this section we present briefly a transformation from the basic components of the UML state machine diagram to a formal workflow language YAWL. It simplifies the semantics of the SM diagram via a mapping to YAWL, which makes the verification and analysis of SM models easier and provides a chance to operationalize the model. We created a transformation algorithm to treat all the cases [1].

State machine	YAWL
Initial state	Input condition
Final state	Output condition
Exit point	Remove tokens
Simple state	Atomic task
Composite state	Composite task
Join	And join task
Fork	And split task
Choice pseudo-state	XOR split
Merge	Xor join task

Fig. 1. Transformation rules from UML SM to YAWL.

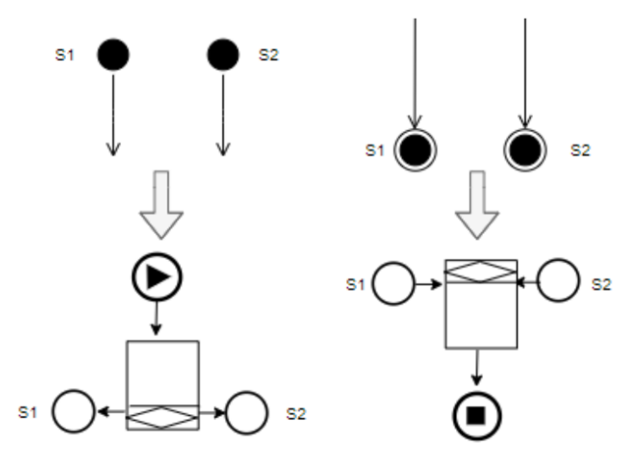
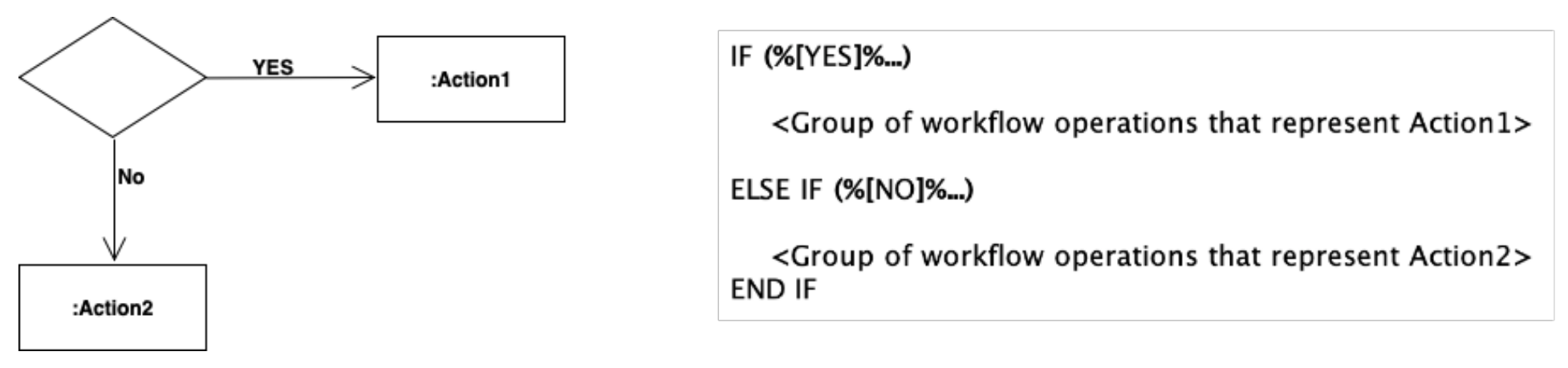


Fig. 2. From UML-SM multiple and initial vertices to YAWLinput and output conditions.

If there are multiple initial vertices, we have to add an empty task with OR-split following the input condition. Similarly, every multiple UML-SM final vertexes are transformed into a YAWL condition linked with an OR-join to a YAWL output condition.

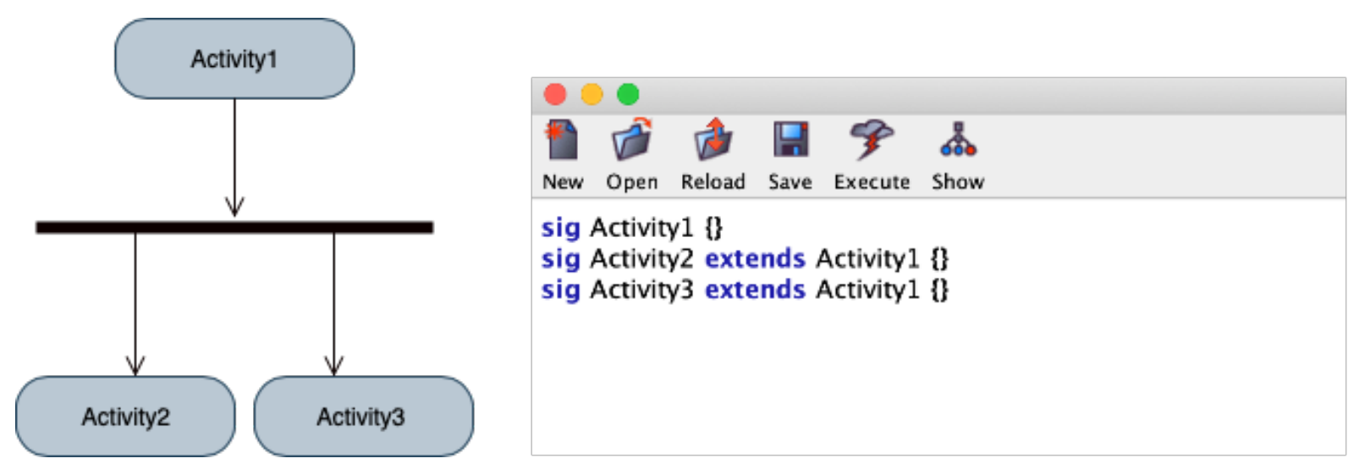
Transformation from UML to Alloy for a formal model checking

We use the properties of the Activity Diagram, represented by Alloy–an operationalizable specification language for software architecture–together with the underlying mathematical model to simplify the semantics of the models and to facilitate their analysis, verification, and validation.



```
IF (%[YES]%...)
    <Group of workflow operations that represent Action1>
ELSE IF (%[NO]%...)
    <Group of workflow operations that represent Action2>
END IF
```

Fig. 3. Example of fork in UML-AD and extends between signatures in Alloy.



```
sig Activity1 {}
sig Activity2 extends Activity1 {}
sig Activity3 extends Activity1 {}
```

Fig. 4. Transforming UML-AD decision node and guards into Alloy if formula.

Conclusion & future works; Technical description of the results

- As a result from [1] and [2] we managed to transform model to program to help us in completing the missing part of verification in the UML-AD and UML-SM. It helped mainly in checking and verification of the new model with the YAWL verification and Alloy Analyser. Then, it makes the semantics of UML-AD clearer.
- For future works:
  1. We are planing to make the transformation reversible and the prototype executable to operationalize the models.
  2. We are working on Financial Services technologies applications (Model to Program and Block-chain approaches for Business Processes and Workflows).

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