VIETNAM NATIONAL UNIVERSITY, HANOI   **SOCIALIST REPUBLIC OF VIETNAM**

VNU UNIVERSITY OF ENGINEERING AND TECHNOLOGY   **Independence – Freedom – Happiness**

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INFORMATION ON DOCTORAL THESIS

1. Full name : Nguyen Thi Hanh   2. Sex: Female

3. Date of birth: 12/12/1986   4. Place of birth: Hanoi

5. Decision on recognition of PhD students No. 654/QD-CTSV Dated September 5, 2016 of the Rector of the University of Engineering and Technology, Vietnam National University, Hanoi.

6. Changes in academic process: Extension of the education time according to Decision No. 1127/QD-DT Dated October 17, 2019 of the Rector of the University of Engineering and Technology, Vietnam National University, Hanoi.

7. Official thesis title: A formal framework to support quality assurance for model transformations

8. Major: Software engineering   9. Code: 9480103.01

10. Supervisors:

     Main advisor: Assoc.Prof. Dr. Ho Si Dam - the University of Engineering and Technology, Vietnam National University, Hanoi.

     Co-advisor: Dr. Dang Duc Hanh - the University of Engineering and Technology, Vietnam National University, Hanoi.

11. Summary of the new findings of the thesis

     The thesis has proposed a specification-driven testing framework to ensure the quality of model transformations with the following main contributions.

     First, the thesis proposes a contract-based transformation specification language called TC4MT (Test Cases for Model Transformations). The TC4MT language specifies the formal requirements of a model transformation at three contract levels (type contracts, behavioral contracts, and protocol contracts). The TC4MT language is designed based on the representation syntax and semantics of the graph transformation. Transformation rules representing protocol contracts are designed based on triple rules of the Triple Graph Grammars which not only help to represent complex features of different model transformations but also support systematic analysis of test conditions at the specification level to verify the quality attributes of the transformation implementation.

Second, the thesis proposes a method of combining partitions on the metamodel expressing type contracts and partitions on behavioral contracts to generate effective test suites according to two positive and negative testing strategies.

Third, the thesis proposes a method to test model transformations based on an analysis of rule dependency relationships. The proposed method analyzes the dependencies between the specification-level transformation rules to design test cases based on the grammar testing approach. Analyzing the quality attributes based on the triple graph grammars, the thesis proposes to combine the test case set generated from the rule dependency with the assignment of the corresponding test oracle functions.

Besides, the thesis installs support tools and conducts experiments to evaluate the proposed method. The thesis conducts test experiments on some model transformation examples to show the applicability of the proposed method and the effectiveness of the test cases created using the mutation score analysis technique.

12. Practical applicability, if any

Model-Driven Engineering (MDE) is becoming a popular engineering technique for developing large-scale software applications. Model transformations are the key industry principle for realizing the software development process. Testing to ensure the quality of model transformations is an inevitable need to successfully realize MDE in the industry. The methods proposed by the thesis can apply to software models at different levels of abstraction (computation-independence models, platform-independent models, and platform-dependent models), provided that the models and these types can are represented based on the Meta Object Facility (MOF) standard.

13. Further research directions, if any

- Developed the TC4MT language to allow specification of attribute value update behaviors within the element of input and output models to specify automatic model synchronization scenarios.

- Install high-level model transformations (HOT: Higher Order Transformations) to enable the automatic generation of model transformation implementations from the TC4MT transformation specification.

- Install a support tool to automate some remain tasks of the TC4MT framework and execute more experiments to verify dynamic behavior preservation, confluence, and termination of industry model transformation applications.

14. Thesis-related publications

[1] Thi-Hanh Nguyen, and Duc-Hanh Dang (2018). *An approach for testing model transformations*. In Proc. of the 10th International Conference on Knowledge and Systems Engineering, IEEE Xplore pp.264-269. (DBLP)

[2] Thi-Hanh Nguyen, Duc-Hanh Dang, and Quang-Trung Nguyen (2019). *On Analyzing Rule-Dependencies to Generate Test Cases for Model Transformations.* In Proc. of the 11th International Conference on Knowledge and Systems Engineering, IEEE Xplore pp.181-186. (DBLP)

[3] Thi-Hanh Nguyen, Duc-Hanh Dang (2021). *A Graph Analysis Based Approach for Specification-Driven Testing of Model Transformations.* In Proc. Of the 8th NAFOSTED Conference on Information and Computer Science, IEEE Xplore pp.224-230.

[4] Thi-Hanh Nguyen, Duc-Hanh Dang. *On integrating multiple restriction domains to automatically generate test cases of model transformations.* Informatica - An International Journal of Computing and Informatic (Accepted).

[5] Thi-Hanh Nguyen, Duc-Hanh Dang. *A Contract-Based Specification Method for Model Transformations.* Submitted to VNU Journal of Science: Computer Science and Communication Engineering (Accept with revisions).

[6] Thi-Hanh Nguyen, Duc-Hanh Dang. *TC4MT: A SpecificationDriven Testing Framework for Model Transformations.* Submitted to International Journal of Software Engineering and Knowledge Engineering.

Date: ……………………..   Date: ……………………..

Scientific advisor   Ph.D. Candidate

Signature: …………………   Signature: …………………

Full name: ………………   Full name: ………………