

INFORMATION ON DOCTORAL THESIS

1. Full name : Nguyen Ngoc Khai
2. Sex: Male
3. Date of birth: 27/10/1980
4. Place of birth: Thai Binh
5. Admission decision number: 1006/QĐ-CTSV Dated: 07/12/2015
6. Changes in academic process:
Changing thesis title (26/8/2019).
 - Old title: Estimating the resource usage of software systems.
 - New title: The type systems for statically estimating the resource usage of transactional programs.
7. Official thesis title: The type systems for statically estimating the resource usage of transactional programs.
8. Major: Software Engineering
9. Code: 9480103.01
10. Supervisors: Assoc. Prof. PhD. Truong Anh Hoang
11. Summary of the **new findings** of the thesis:

The main contributions of the thesis are two type systems to statically estimate maximum resources used by the STM (Software Transactional Memory) programs and a type inference tool for the program:

- The first type system consists of simple rules that are conducive to expansion and implementation. This type system requires a complete and well-typed program to be able to type, and they are suitable for small programs and are built by a few programmers.
- The second type system (compositional type system) offers more flexible typing. They can type any components of the program, then combine them to get the type of the program. This type system is suitable for complex programs, written by many programmers.
- Finally, based on the type rules of the first type system, we implemented a tool to infer the type of the program. The tool is implemented by functional programming methodology and F# programming language, and it has been passed by several test cases.

In addition to the main contributions above, we also refined the STM mechanism so that they use memory more efficiently.

12. Practical applicability:

The results of the thesis have contributed new type rules to the research community on type theory and formal methods. This type system can be used as a basis for developing type systems for the purpose of estimating other resources, such as the amount of gas required by smart contracts in Ethereum, CPU resources, network bandwidth.

For the type inference tool, when it is perfected, it can be integrated into compilers or editors to provide information to the programmer about the maximum resources to be used by the STM program.

This work is oriented towards theory and mathematical basis, as the foundation for future work. The implementation is only performed for the type inference tool. In order to be applicable in practical languages, we need to invest more time and effort.

13. Further research directions:

In our future work, we plan to solve the problems of sharpness of the found memory bound and general loop typing. In this work, our language is still in abstract form to focus on presenting the features of the STM mechanism, we plan to implement the type system with some STM languages in use in practice.

14. Thesis-related publications:

[1] Ngoc-Khai Nguyen, Anh-Hoang Truong, and Duc-Hanh Dang. *Finding transaction memory bound of STM programs*. (Submitted to International Journal of Software Engineering and Knowledge Engineering Journal (IJSEKE), 2021).

[2] Ngoc-Khai Nguyen, Anh-Hoang Truong, and Duc-Hanh Dang. *Estimate the memory bounds required by shared variables in software transactional memory programs*. (Accepted by VNU Journal of Science: Computer Science and Communication Engineering, 2021).

[3] Nguyễn Ngọc Khải, Trương Anh Hoàng. *Hệ thống kiểu để suy ra bộ nhớ log của chương trình giao dịch từ biến dùng chung*. Tạp chí Khoa học và Kỹ thuật, Học viện Kỹ thuật quân sự, pp. 18-33, 2018.

[4] Ngoc-Khai Nguyen, and Anh-Hoang Truong. *A Compositional Type Systems for Finding Log Memory Bounds of Transactional Programs*. Proceedings of the Eighth International Symposium on Information and Communication Technology, pp. 409-416, ACM, 2017.

[5] Anh-Hoang Truong, Ngoc-Khai Nguyen, Dang Van Hung and Duc-Hanh Dang. *Calculating statically maximum log memory used by multi-threaded transactional programs*. Theoretical Aspects of Computing, pp.82-99, Springer, 2016.

[6] Trương Anh Hoàng, Nguyễn Ngọc Khải. *Hệ thống kiểu tính cận trên số log cho ngôn ngữ giao dịch đa luồng tối giản*. Tạp chí Khoa học - Đại học Sư phạm Hà Nội, pp.

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