東北大学 電気通信研究所

研究室外部評価資料

(2013 年度-2018 年度)

Activity Report of Research Laboratory for External Review

April 2013 - March 2019
(FY.2013-2018)

Research Institute of Electrical Communication

Tohoku University

コンピューティング情報理論研究室

Computing Information Theory

A. 研究室名 / Research Laboratory

コンピューティング情報理論研究室
Computing Information Theory

B. 構成員 / Faculty and Research Staff (as of May 1, 2019)

※ 欄を適宜追加削除等調整して下さい．期間内に異動等があった場合には，在籍期間を記載して下さい．

教授 / Professor	
氏名 Name	中野 圭介 Keisuke Nakano (April 2018 -)
分野名 Research Field	コンピューティング情報理論研究分野 Computing Information Theory
准教授 / Associate Professor	
氏名 Name	
分野名 Research Field	
助教 / Assistant Professor	
氏名 / Name	浅田 和之 / Kazuyuki Asada (September 2018 -)
他 / Others	

C. 研究目的 / Research Purpose

本研究室では，高信頼ソフトウェアを開発する上で不可欠な理論基盤を確立し，それを実用的なソフトウェアへ応用するための研究を行っている．具体的には，形式言語理論やプログラミング言語理論などの基礎理論を通じて，意味や構造に基づいたプログラムの解析や検証を行う枠組みを確立し，意味を保ちながら実行効率を高めるプログラム変換についても研究を進めている．

Our research group is working on establishment of theoretical foundation which is indispensable for developing highly dependable software and studying how our theory can be applied to practical software. Specifically, we employ the fundamental theory of formal languages and programming languages to establish a framework for analyzing and verifying programs by their semantics and structures and explore how to transform programs to efficient ones without changing their meanings.

D. 主な研究テーマ / Research Topics

1. 形式言語理論の研究とプログラム検証への応用
2. 定理証明支援系を利用した既存の理論的計算機科学の形式化
3. 双方向変換の原理の追究と自律分散データベースシステムの応用
4. 結合子論理における結合子の性質の解明
5. 代数的なアプローチによるプログラム意味論の研究

1. Study of formal language theory and its application to program verification
2. Formalization of theoretical computer science in a proof assistant system
3. Pursuit of the principle of bidirectional transformation and its application to autonomous collaborative database systems
4. Unraveling of properties of combinators in combinatory logic
5. Study of semantics of programming languages through algebraic approaches

E. 学術論文等の編数 / The Number of Research Papers							
	2013	2014	2015	2016	2017	2018	Total
(1) 査読付学術論文 Refereed journal papers	4	0	2	1	2	2	11
(2) 原著論文と同等に扱う 査読付国際会議発表論文 Full papers in refereed conference proceedings equivalent to journal papers	2	1	1	1	3	3	11
(3) 査読付国際会議 Papers in refereed conference proceedings	0	0	1	1	1	3	6
(4) 査読なし国際会議・シンポジウム等 Papers in conference proceedings	0	0	0	0	0	0	0
(5) 総説・解説 Review articles	0	0	0	0	0	0	0
(6) 査読付国内会議 Refereed proceedings in domestic conferences	0	0	0	2	4	2	8
(7) 査読なし国内研究会・講演会 Proceedings in domestic conferences	0	1	0	4	0	3	8
(8) 著書 Books	0	0	0	0	1	0	1,
(9) 特許 Patents	0	0	0	0	0	0	0
(10) 招待講演 Invited Talks	0	0	0	0	0	0	0

F. 特筆すべき研究成果 / Significant Research Achievements (FY.2013-2018)

See Ref. 1. "#" mark indicates research carried out at a former organization.

2013-2018 年度の研究成果（論文・特許など）のうち，前半（2013-2015 年度）と後半（2016-2018 年度）それぞれで代表的な数件（2-3 件程度ずつ）について，参考資料を引用して，その特徴と学術的意義などを簡単に紹介する．英文のみ，もしくは和文と英文で記載．
要約は 300 字程度．論文誌の要約/Abstract のコピー可．学術面での国際的インパクトならびに社会的影響を 100 字程度で記載．
必ずしも当該期間内に発表・出版したものに限るのではなく，例えば過去に発表したものでもこの期間内に成果が得られたり，評価されるようになったりしたものも含むものとする．
インパクトファクターや被引用件数など，できる限り第三者が定量的に評価できる指標を用いてアピールすること．それらの指標にはそぐわない場合には，その事情とそれに変わる適当な評価指標・尺度を示すこと．

[2013-2015]

1. Soichiro Hidaka, Zhenjiang Hu, Kazuhiro Inaba, Hiroyuki Kato, and Keisuke Nakano. GRoundTram: An Integrated Framework for Developing Well-Behaved Bidirectional Model Transformations. Progress in Informatics, No. 10, pp. 131-148, 2013. [#], [Times Cited: 63 (Google Scholar)]

Abstract: Bidirectional model transformation is useful for maintaining consistency between two models. However, the lack of a practical tool supporting for systematic development prevents it from being widely used. We solve this problem by proposing an integrated framework called GRoundTram, which is carefully designed and implemented for compositional development of well-behaved and efficient bidirectional model transformations.

International impact on both academic and social aspects : Most of existing systems for bidirectional transformation only support a synchronization between two data given as either relational database or tree-structured data such as XML database. The GRoundTram system can deal with graph-structured models which are given in more general data representation. The idea presented in this paper has been applied to many succeeding researches in this area. This is why the paper has been cited in many articles.

2. Shizuya Hakuta, Sebastian Maneth, Keisuke Nakano, and Hideya Iwasaki. XQuery Streaming by Forest Transducers. 30th IEEE International Conference on Data Engineering (ICDE 2014), Chicago, Illinois, USA, March-April 2014. [#], [Times Cited: 14 (Google Scholar)]

Abstract: This paper presents a principled approach to streaming XQuery-based transformations with an elegant transducer model called MFT for which many static analysis problems are well-understood. We show that a large fragment of XQuery can be translated into MFTs — indeed, a fragment of XQuery, that can express important features that are missing from other XQuery stream engines and then use an existing streaming engine for MFTs.

International impact on both academic and social aspects: Although several stream processors for XQuery had been proposed, their approaches are ad-hoc and applied only to tiny fragments of XQuery. Since our approach using tree transducers is based on well-studied theory, it is possible to be applied to not only streaming but also optimization and verification. The paper has been cited even in different contexts from stream processing.

[2016-2018]

1. Kazuyuki Asada, Ryosuke Sato and Naoki Kobayashi. Verifying Relational Properties of Functional Programs by First-Order Refinement. Science of Computer Programming, Vol. 137, No. 1 (2017), pp. 2-62. [#], [Times Cited: 18 (Google Scholar)]

Abstract: Most of existing verification techniques are based on first-order refinement types, hence unable to verify

certain properties of functions. To relax this limitation, this work introduces a restricted form of higher-order refinement types where refinement predicates can refer to functions, and reduce type checking/inference for the higher-order refinement types to that for first-order refinement types, which can be automatically solved by using an existing model checker.

International impact on both academic and social aspects: This paper took a first step toward an automated higher-order program verification where we can verify property on functions. Although there exist some other work for similar purpose, this work introduced a unique technique using program transformations.

2. Mirai Ikebuchi and Keisuke Nakano. On repetitive right application of B-terms, 3rd International Conference on Formal Structures for Computation and Deduction (FSCD 2018), pp.18:1-18:15, Oxford, UK, July 2018.

Abstract: B-terms are built from the B combinator alone which is well-known as a function composition operator. This paper investigates an interesting property of B-terms, that is, whether repetitive right applications of a B-term circulates or not. We discuss conditions for B-terms to and not to have the property through a sound and complete equational axiomatization.

International impact on both academic and social aspects: In this paper, we explore an interesting property of combinators in combinatory logic which has never been discussed despite of a long history of the theory. After the second author published the property and its open problems 10 years ago, he gave talks about it in many countries and received numbers of favorable comments from the audience. The paper gives a partial solution to the problem.

G. 特筆すべき活動 / Significant Activities (FY.2013-2018)

See Ref. 2-9. "#" mark indicates research carried out at a former organization.

研究室外部評価参考資料の 2 以降を参照しながら，2013-2018 年度のなどの活動の中から特筆すべきものを取り出し，前半（2013-2015 年度）と後半（2016-2018 年度）に分けて簡単に紹介する．英文のみ，もしくは和文と英文で記載．

[2013-2015]

該当なし.

[2016-2018]

該当なし.