Hiromi ISHII

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Education

Ph.D. in Math 2016 - present	University of Tsukuba, Tsukuba-city, Ibaraki, Japan
M.S. in Math 2016	University of Tsukuba, Tsukuba-city, Ibaraki, Japan *Thesis:* On Regularity Properties of Sets of Reals and Inaccessible Cardinals
B.A, 2014	Waseda University, Tokyo, Japan, 2014, *Summa cum laude.*

Job Career

Apr 2018– Part-time developper at Clear Code, Inc.

2014 Google Summer of Code 2014. Theme: "An Efficient Computational Algebra and Symbolic Linear Algebra Library in Haskell"

Apr 2014–Mar 2017 Part-time Job of System Administrator at College of Mathematics, Tsukuba University

Oct 2010–Mar 2014 Part-time developper in Preferred Infrastructure, Inc.

Aug–Sep 2010 Internship student in Preferred Infrastructure, Inc.

Research Experiences

April 2018– Joint research on discrete mathematics with Momoko Hayamizu (the Institute of Statistical Mathematics).

April 2017–March 2019 Research Fellowship for Young Scientists (DC2), Japan Society for the Promotion of Science (2017-2019).

Theme: "Properties of sets of reals and its applications to Computer"

2014–2017 Teaching Assistant of "Programming Exercise", University of Tsukuba.

Selected Fellowships, Awards and Special Note

- Research Fellowship for Young Scientists (DC2), Japan Society for the Promotion of Science (2017-2019)
- 14th Meikei Prize (2016)
- Highest Award of Deans' Prize of School of Fundamental Science and Engineering, Waseda University (2014)
- A committer of KaTeX, a Web Math Renderer, and Yesod, a Web Framework.

Research

Main research area is mathematics, especially mathematical logic (especially axiomatic set theory) and computational algebra. My main interests are set-theoretic properties of sets of reals and their computational application; the related area includes Gröbner basis computation, functional programming, theoretical computer science and discrete mathematics.

Conference Presentations

- September 2018, *A Purely Functional Computer Algebra System Embedded in Haskell*, Computer Algebra in Scientific Computing

(CASC) 2018, Lille, France, September 17-21. (Refereed)

- March 2016, *Freer Monads, More Extensible Effects.* Programming and Programming Language Workshop (PPL) 2016, Okayama, Japan (Refereed).

- November 2017, *Reflection Principle and construction of saturated ideals on $\mathcal{P}_{\omega_1} \lambda$.* Workshop on Iterated Forcing Theory and Cardinal Invariants, Kyoto, Japan, (Non-refereed).

Papers

[1]   Horomi Ishii, *A purely functional computer algebra system embedded in Haskell*, Computer Algebra in Scientific Computing (Lille, France), ed. by Vladimir P. Gerdt, Wolfram Koepf, and Werner M. Seiler, vol. 11077, Lecture Notes in Computer Science, Springer, Cham, 2018, pp. 288–303, ISBN: 978-3-319-99638-7, DOI: 10.1007/978-3-319-99639-4_20, arXiv: 1807.01456.

[2]   Hiromi Ishii, *On regularity properties of set of reals and inaccessible cardinals*, MA thesis, Tsukuba University, 2016.

[3]   Oleg Kiselyov and Hiromi Ishii, *Freer monads, more extensible effects*, Proceedings of the 2015 ACM SIGPLAN Symposium on Haskell, Haskell '15, Vancouver, BC, Canada: ACM, 2015, pp. 94–105, ISBN: 978-1-4503-3808-0, DOI: 10.1145/2804302.2804319.

Selected Development Examples

Main Language: *Haskell*,
Experienced Languages: *JavaScript, Objective-C, Ruby, Rust.*

λ**eport, an automatic report rating system**

Keywords: *Property-based Testing, Let's Encrypt, Distributed Programming, Linux Containers, EventSrouce.*

At the University of Tsukuba, we teach Haskell to students as an exercise. The λeport provides an automatic report rating service and is mainly used by teaching assistants.

Applying the method of *Property-based Testing* in the realm of functional programming, it accepts formal specifications of exercises and automatically evaluate students' answers using *QuickCheck* library in Haskell.

Since λeport treats privacy-sensitive information, we use HTTPs and use the TLS certificate issued by *Let's Encrypt*. λeport makes use of *Cloud Haskell*, a distributed programming framework, and adopting *Work-stealing model* to build distributed rating system, enabling multiple users to rate reports simultaneously. It also utilises *Software Transactional Memory* of Haskell to achieve efficient concurrency. To prevent malicious program from being executed and control the resource usage, it compiles and runs the report source-codes in isolated containers provided by *Linux Containers*. To make rating process seamless, rating results will be communicated to web frontend per-exercise. Linux Container's *WebSocket* interface for inter-process communication and *EventSource* technology made this possible.

Computer Algebra System `computational-algebra`

WEB SITE: https://konn.github.io/computational-algebra
Keywords: *Google Summer of Code 2014, CASC 2018, Computer Algebra, Type-level programming, Formal Method.*

A safe and reliable computational algebra system implemented as an EDSL in Haskell, powered by the progressive type-system of Glasgow Haskell Compiler. It enjoys the following advantages:

Type-Safety Encoding fields and arity as a type, it prevents wrong operations;

Extensibility Providing type-classes for polynomials and algebraic systems, users can enjoy various algorithms regardless to implementation detail;

Intuitive The library automatically gives the injection mapping between two distinct rings such as $\mathbb{Q}[x, y, z]$ and $\mathbb{Q}[x, z, y, w]$, based on their types. One can also write polynomials much alike to ordinary Math, for example: `#x ^ 2 + #z * #x - 2`.

Static Verification Using QuickCheck, correctness of algorithms are statically verified.

In *Google Summer of Code 2014*, I tried to implement two algorithms F_4 and F_5, which are known to be fast algorithms for Gröbner basis computation. To that end, I implemented a framework to treat multiple matrix libraries uniformly. Also, other algorithms, such as polynomial factorisation and algebraic real computation, are provided.

To achieve type-safety in a full spectrum, I implemented two libraries: the `type-natural` package and the `ghc-typelits-presburger` compiler plugin. The former provides the abstraction over various type-level naturals, and the latter augments the GHC's type-checker with Presburger Arithmetic solver. Based on them, I implemented the `sized` package, which provides a functionality to turn arbitrary sequential data-types into fixed-size container, indexed with type-level naturals, used for efficient representation of monomials.

As a teaching assistant, I supervised the graduation work using this library in Mathematics Department in University of Tsukuba. For more details, see the recent paper [1].

Other Development Activity

- I contributed to KaTeX, a Open-source Web Math Renderer, and become a committer. Although I'd never experienced modern JavaScript development, I could caught up with it within half a day.

- I'm the original author of OAuth library for *Yesod*, a Haskell Web Framework.

- As a pre-publication reviewer, I contributed to Japanese translation of famous textbooks such as "Types and Programming Languages" (B. Pierce) and "Parallel and Concurrent Programming in Haskell" (S. Marlow).

- See GitHub (`https://github.com/konn`) for more about my development activity.