

The Research Group

Software Languages Lab

has the honor to invite you to the public defense of the PhD thesis of

Nathalie OOSTVOGELS

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Statically Checking Inter-property Constraints
and its Applications in Web APIs

Promotor:

Prof. dr. Wolfgang De Meuter

The defense will take place on

Friday April 26th 2019 at 17:00h

in Auditorium E.0.12 at the Campus
Humanities, Sciences and Engineering of the
Vrije Universiteit Brussel, Pleinlaan 2 - 1050
Elsene, and will be followed by a reception.

Members of the jury:

Prof. dr. Ann Nowé (chairman)
Prof. dr. Dominique Devriese (secretary)
Prof. dr. Joeri De Koster (co-promotor)
Prof. dr. Ann Dooms
Prof. dr. Tobias Wrigstad (Uppsala Univ.)
Dr. Manuel Serrano (INRIA)

Curriculum vitae

Nathalie Oostvogels acquired her Master's degree in Computer Science (specialization Software Engineering) in 2013. Afterwards, she started with her PhD at the Software Languages Lab (VUB). Her work focuses on the identification of inter-property constraints as well as the incorporation of these constraints in programming languages and API specification languages.

The results of her research have been published in two international peer-reviewed conferences. She presented at several international conferences and workshops, and disseminated her work at international industry conferences.

Abstract of the PhD research

Software applications do not stand on their own: their code often uses libraries to incorporate functionality to facilitate the development process (such as abstractions and helper functions) or to integrate functionality from third parties. Libraries offer their functionality via an Application Programming Interface (API), which is a contract between the library and the user. It defines which methods are provided and imposes constraints on the data or fields that are exchanged.

Constraints dictate the presence of fields, the type of fields, and the allowed values for fields. Constraints imposed on a singular field are clearly indicated in the documentation and well-supported in tooling and specification languages. Next to singular constraints, API documentation often describe relations *between* fields. For example, some fields may only be provided together, or the value of a field may impose constraints on other parts of the data. In this dissertation, we demonstrate the prevalence of such constraints in web APIs.

We show that there is no structural support for these *inter-property constraints*: they cannot be expressed by contemporary API specification languages such as OpenAPI. This lack of support extends to programming languages, whose type system can only express and validate single-property constraints, but not inter-property constraints. This dissertation presents a statically-typed programming language that fills this gap.

Our programming language, TIPC, features a natural extension to interface definitions which allows enforcing presence constraints between properties. TIPC ensures that objects with inter-property constraints satisfy these constraints throughout the program. Furthermore, it enables programmers to refine interface types using its flow-sensitive type system.

We present a formal specification of the syntax, operational semantics and type system of TIPC, along with soundness proofs. As a proof of concept, we use TIPC as a model to extend the TypeScript compiler with support for inter-property constraints. Finally, we extend the OpenAPI specification language with support for fully generalised inter-property constraints. This language serves as a proving ground for inter-property aware tooling. Concretely, a first artefact presents an intercepting middleware that verifies constraints on both the caller and the library side. A second artefact shows how interfaces enabled with inter-property constraints can be generated from an API specification.