

The Research Group

Software Languages Lab

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

Thierry RENAUX

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

*A Distributed Logic Reactive Programming Model
and its Application to Monitoring Security*

Curriculum vitae

Promotors:

Prof. dr. Wolfgang De Meuter
Prof. dr. Joeri De Koster

The defence will take place on

Thursday March 28 2019 at 17:00h

in Auditorium D.0.07 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. Viviane Jonckers (chairman)
Prof. dr. Katrien Beuls (secretary)
Prof. dr. Tias Guns
Prof. dr. Coen De Roover
Prof. dr. Sebastian Erdweg (TU Delft, NL.)
Prof. dr. Robert Hirschfeld
(Hasso Plattner Inst. Potsdam)

Thierry Renaux acquired his Master's degree in Computer Science (specialization Software Engineering) in 2012. Afterwards, he started a PhD at the Software Languages Lab of the VUB. His work focuses on the design and implementation of declarative, rule-based programming languages that exploit the parallelism of multi-core processors and computer clusters. He co-authored two journal papers, two full conference papers, and three workshop papers presenting the results of his research. He presented these results at several international, peer-reviewed workshops and conferences.

Abstract of the PhD research

Processes in the world are increasingly managed by software systems that are centered around the notion of *events*. For instance, banking software responds to the occurrence of financial transaction *events* and parcel services respond to the arrival *event* of a package at a depot. To, e.g., identify fraud in a series of financial transactions, multiple transaction events must be correlated.

How to efficiently extract patterns from a stream of events – in an online fashion – is an active research topic. The state of the art enables extracting complex patterns from large streams, or performing simple processing with predictable latency. There are, however, no techniques which combine expressive event correlation mechanisms with guaranteed upper bounds on resource usage. Lacking such guarantees, event monitoring systems risk falling behind on the live data, or even crashing due to memory exhaustion. Preventing this is of utmost importance for modern systems that are online 24/7.

In this dissertation, we propose a novel programming paradigm for large-scale online event correlation: Logic Reactive Programming. LRP overcomes the issues in the state of the art by imposing maximum lifetimes on stored event data. Through temporal reasoning, LRP then guarantees that a fixed upper limit exists on the number of events whose data needs to be retained. Stale data is automatically discarded, thus enabling LRP systems to operate in a fixed resource budget. We introduce PARTElang, the first Logic Reactive Programming language. Its formal foundations are defined by means of an event algebra. We define Featherweight PARTE, an operational semantics for PARTElang, which guarantees that every operation evaluates in constant time, using constant space. We prove correctness of Featherweight PARTE, i.e., that steps defined by the formal model ensure that a PARTElang program is translated to a number of concurrent units of computation which jointly arrive at the results prescribed by the event algebra. We further validate PARTElang by building a security monitoring application on top of a prototypical implementation of the Featherweight PARTE model.