Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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M. Sonology (Royal Conservatoire, The Hague, 2012)
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“A Programming Language Based on Recurrence Equations and Polyhedral Compilation for Stream Processing”

Department of Computer Science

Monday, July 22, 2019
9:30 A.M.
Clearihue Building
Room B017

Supervisory Committee:
Dr. George Tzanetakis, Department of Computer Science, University of Victoria (Supervisor)
Dr. Yvonne Coady, Department of Computer Science, UVic (Member)
Dr. Amirali Baniasadi, Department of Electrical and Computer Engineering, UVic (Outside Member)

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Chair of Oral Examination:
Dr. Ricardo Flores, School of Business, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

The work presented in this dissertation contributes to the field of programming language design and implementation for stream processing applications. There is a fast-expanding domain of stream processing applications which demand processing high-volume streams quickly and often in real time. Examples include analysis and synthesis of audio, video and other digital media, sensor array signals, real-time physical simulation etc. High performance is crucial in this domain. When choosing between available programming methods, the programmer often chooses one that maximizes performance while sacrificing ease of programming, code comprehension, maintainability and reusability. This work contributes towards improving the state of the art by jointly maximizing these aspects.

High-volume streams are often most naturally represented as multi-dimensional arrays with one infinite dimension representing time. Algorithms working with such streams are typically defined mathematically using recurrence equations. A programming language is presented in this dissertation which enables an almost literal translation of such mathematical definitions to computer programs. The language also supports powerful facilities for abstraction and code reuse such as polymorphic and higher-order functions. Together, these features enable a more natural expression of algorithms and improve code modularity and reusability.

A major contribution of this dissertation is the compilation of the proposed language in the polyhedral framework, specifically targeting general-purpose multi-core processors. This framework provides powerful means of analysis and transformations of computations on multi-dimensional arrays, which enables data-locality optimizations essential for high performance on general-purpose processors with deep memory hierarchies. The benefit of this framework for computations on finite arrays has been extensively explored. However, this dissertation presents essential extensions that enable the application of state-of-the-art optimizations in this framework on infinite arrays representing streams.