Discounted Duration Calculus
To formally reason about the temporal quality of systems discounting was introduced to CTL and LTL. However, these logic are discrete and they cannot express duration properties. In this work we introduce discounting for a variant of Duration Calculus. We prove decidability of model checking for a useful fragment of discounted Duration Calculus formulas on timed automata under mild assumptions. Further, we provide an extensive example to show the usefulness of the fragment.

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Organisations: Department of Applied Mathematics and Computer Science, Embedded Systems Engineering, Carl Von Ossietzky University Oldenburg, Carl von Ossietzky Universität Oldenburg
Authors: Ody, H. (Ekstern), Fränzle, M. (Ekstern), Hansen, M. R. (Intern)
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Duration calculus, Temporal logic, Model checking, Timed automata, Discounting
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Game-based verification and synthesis

Infinite-duration games provide a convenient way to model distributed, reactive and open systems in which several entities and an uncontrollable environment interact. Here, each entity as well as the uncontrollable environment are modelled as players.

A strategy for an entity player in the model corresponds directly to a program for the corresponding entity of the system. A strategy for a player which ensures that the player wins no matter how the other players behave then corresponds to a program ensuring that the specification of the entity is satisfied no matter how the other entities and the environment behaves. Synthesis of strategies in games can thus be used for automatic generation of correct-by-construction programs from specifications.

We consider verification and synthesis problems for several well-known game-based models. This includes both model-checking problems and satisfiability problems for logics capable of expressing strategic abilities of players in games with both qualitative and quantitative objectives.

A number of computational complexity results for model-checking and satisfiability problems in this domain are obtained. We also show how the technique of symmetry reduction can be extended to solve finitely-branching turn-based games more efficiently. Further, the novel concept of winning cores in parity games is introduced. We use this to develop a new polynomial-time under-approximation algorithm for solving parity games. Experimental results show that this algorithm performs better than the state-of-the-art algorithms in most benchmark games.

Two new game-based modelling formalisms for distributed systems are presented. The first makes it possible to reason about systems where several identical entities interact. The second provides a game-based modelling formalism for distributed systems with continuous time and probability distributions over the duration of delays. For these new models we provide decidability and undecidability results for problems concerning computation of symmetric Nash equilibria and for deciding existence of strategies that ensure reaching a target with a high probability.

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Organisations: Department of Applied Mathematics and Computer Science, Algorithms and Logic, Embedded Systems Engineering
Authors: Vester, S. (Intern), Hansen, M. R. (Intern)
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Organisations: Department of Applied Mathematics and Computer Science, Embedded Systems Engineering, Utah State University, Vassar College
Authors: Dyreson, C. (ed.) (Ekstern), Hansen, M. R. (ed.) (Intern), Hunsberger, L. (ed.) (Ekstern)
Number of pages: 206
In this work, we show the feasibility of using functional programming (more specifically F#) in connection with game-based methods for synthesis of correct-by-construction controllers (also called signaling plans) for railway networks. This is a massively resource-demanding application. A model for railway networks comprising trains, signals, linear sections, and points is established together with a domain-specific language capturing the important concepts in the model. A translation from railway network models to two-player reachability games is provided. In these games, the existential player (the control system) controls signals and points and the universal player (the antagonistic environment) controls movement of trains. A winning strategy for the existential player provides a signaling plan that will safely guide trains through the network. The concepts from the railway network model and the twoplayer reachability game are captured, in a natural manner, by type declarations in F#. Furthermore, the F# translation functions are formulated in a manner that is close to the mathematical formulations. This increases confidence in the correctness of the implementation and it decreases the development time. Imperative features of F# proved useful in two places: Hash tables and arrays were used in the representations of the railway network model and the reachability game. This allowed for more compact representations and a more efficient game solver (providing the winning strategy). Experiments show that we are able to synthesize signaling plans for real railway networks of substantial size.

In this paper we investigate multicore parallelism in the context of functional programming by means of two quantifier-elimination procedures for Presburger Arithmetic: one is based on Cooper’s algorithm and the other is based on the Omega Test.

We first develop correct-by-construction prototype implementations in a functional programming language. Thereafter, the parallelism inherent in the decision procedures is analyzed using the Directed Acyclic Graph (DAG) model of multicore
parallelism. In the step from a DAG model to a parallel implementation, the parallel implementation is optimized taking into account negative factors such as cache misses, garbage collection and overhead due to task creations, because such factors may introduce sequential bottlenecks with severe consequences for the parallel efficiency.

The experiments were conducted using the functional programming language F# and .NET platform executing on an 8-core machine. A speedup of approximately 4 was obtained for Cooper’s algorithm and a speedup of approximately 6 was obtained for the exact-shadow part of the Omega Test.

The considered procedures are complex, memory-intensive algorithms on huge formula trees and the case study reveals more general applicable techniques and guideline for deriving parallel algorithms from sequential ones in the context of data-intensive tree algorithms. The obtained insights should apply for any strict and impure functional programming language.

Furthermore, the results obtained for the exact-shadow elimination procedure have a wider applicability because they can directly be transferred to the Fourier–Motzkin elimination method.

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BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.523 SNIP 1.773 CiteScore 1.31
BFI (2013): BFI-level 2
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Scopus rating (2012): SJR 0.622 SNIP 1.434 CiteScore 1.37
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Scopus rating (2011): SJR 0.594 SNIP 1.223 CiteScore 1.11
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.569 SNIP 1.105
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 0.718 SNIP 1.949
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.778 SNIP 1.771
Web of Science (2008): Indexed yes
Modelling and Analysis for Cyber-Physical Systems: An SMT-based approach
This thesis focuses on high-level modelling and analysis of Cyber-Physical Systems (CPS). The rationale is that: since modelling and analysis phases are closely related to the design phase, having better modelling and analysis techniques would tremendously increase quality of designs. Moreover, better designs have positive impacts on the product quality, development time and price, etc.

We developed tools, theories and techniques that make use of SMT solving as a back-end engine for analysis and employ Duration Calculus as a front-end technology for modelling. The proposed techniques have been validated via a few interesting case studies.

In particular, a combination of techniques including reduction to SMT solving, novel simplification for quantified formulas in Linear Integer Arithmetic and multicore parallelism has been used to make Duration Calculus feasible for practical use. Duration Calculus has shown its potential as a domain specific language in a Smart Meter case study. Moreover, counting semantics has proven useful in connection with tool-based support for Duration Calculus.

To extend SMT techniques towards better support for analysis of CPS, we proposed algorithms for handling quantifier alternations and implemented SMT-based optimization procedures. The optimization procedures, available as an extension to Z3 SMT solver, have been instrumental to provide solutions for our case studies in a natural way.

No Need Knowing Numerous Neighbours: Towards a Realizable Interpretation of MLSL
The Multi-Lane Spatial Logic MLSL introduced by Hilscher et al. in [4] is a two-dimensional spatial logic geared towards modelling and analysis of traffic situations, where the two dimensions are interpreted as the lanes of a road and the distance travelled down that road, respectively. The intended use of MLSL is for capturing (and reasoning about) guards and invariants in decision-making schemes for highly automated driving [12]. Unfortunately, the logic turns out to be undecidable [7,8,11], rendering implementability and thus the actual use of such guard conditions in real-time decision making questionable in general. We here show that under a reasonable model of technical observation of the traffic
situation, the actual decidability and implementability issues take a much more pleasing form: given that an actual autonomous car can only sample state information of a finite set of environmental cars in real-time, we show that it is decidable whether truth of an arbitrary MLSL formula can be safely determined on a given sample size. For such feasible formulas, we furthermore state a procedure for determining their truth values based on such a sample.

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Highly automated driving, Real-time decision making, Spatial logic, Decidability
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**A practical approach to model checking Duration Calculus using Presburger Arithmetic**

This paper investigates the feasibility of reducing a model-checking problem $K \models \phi$ for discrete time Duration Calculus to the decision problem for Presburger Arithmetic. Theoretical results point at severe limitations of this approach: (1) the reduction in Fränzle and Hansen (Int J Softw Inform 3(2–3):171–196, 2009) produces Presburger formulas whose sizes grow exponentially in the chop-depth of $\phi$, where chop is an interval modality originating from Moszkowski (IEEE Comput 18(2):10–19, 1985), and (2) the decision problem for Presburger Arithmetic has a double exponential lower bound and a triple exponential upper bound. The generated Presburger formulas have a rich Boolean structure, many quantifiers and quantifier alternations. Such formulas are simplified using so-called guarded formulas, where a guard provides a context used to simplify the rest of the formula. A normal form for guarded formulas supports global effects of local simplifications. Combined with quantifier-elimination techniques, this normalization gives significant reductions in formula sizes and in the number of quantifiers. As an example, we solve a configuration problem using the SMT-solver Z3 as backend. Benefits and the current limits of the approach are illustrated by a family of examples.

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- BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.441 SNIP 1.069 CiteScore 1.27

Although energy consumption of wireless sensor network has been studied extensively, we are far behind in understanding the dynamics of the power consumption along with energy production using harvesters. We introduce Energy Harvesting Routing Analysis (EHRA) as a formal modelling framework to study wireless sensor networks (WSN) with energy-harvesting capabilities. The purpose of the framework is to analyze WSNs at a high level of abstraction, that is, before the protocols are implemented and before the WSN is deployed. The conceptual basis of EHRA comprises the environment, the medium, computational and physical components, and it captures a broad range of energy-harvesting-aware routing protocols. The generic concepts of protocols are captured by a many-sorted signature, and concrete routing protocols are specified by corresponding many-sorted algebras. A first analysis tool for EHRA is developed as a simulator implemented using the functional programming language F#. This simulator is used to analyze global properties of WSNs such as network fragmentation, routing trends, and energy profiles for the nodes. Three routing protocols, with a progression in the energy-harvesting awareness, are analyzed on a network that is placed in a heterogeneous environment.

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Authors: Dung, P. A. (Intern), Hansen, M. R. (Intern), Madsen, J. (Intern)
Pages: 520-540

This thesis develops a unified framework wherein to specify, verify and optimise stochastic business processes.

This framework provides for the modelling of business processes via a mathematical structure which captures business processes as a series of connected activities. This structure is extended with stochastic branching, message passing and reward annotations which allow for the modelling of resources consumed during the execution of a business process. Further, it is shown how this structure can be used to formalise the established business process modelling language Business Process Model and Notation (BPMN).

The automated analysis of business processes is done by means of quantitative probabilistic model checking which allows verification of validation and performance properties through use of an algorithm for the translation of business process models into a format amenable to model checking. This allows for a rich set of both qualitative and quantitative properties of a business process to be precisely determined in an automated fashion directly from the model of the business process.

A number of advanced applications of this framework are presented which allow for automated fault tree analysis and the automated optimisation of business processes by means of an evolutionary algorithm.

This work is motivated by problems that stem from the healthcare sector, and examples encountered in this field are used to illustrate these developments.

General information

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Publication: Research › Ph.D. thesis – Annual report year: 2014

Formal methods for design and simulation of embedded systems

Cyper physical systems (CPSSs) are present in many variants in our daily life. The complexity of developing a CPS is quickly increasing and the interaction between different CPSSs is increasingly important. The interaction of the systems is
This thesis presents the development of a formal systems modelling (ForSyDe) framework for modelling CPSs. The formalism of the framework makes computer aided design (CAD) a possibility for developing CPSs. The framework consists of four models of computation (MoCs): synchronous (SY), synchronous data flow (SDF), discrete event (DE), and continuous time (CT).

Usage of the framework is demonstrated with two use cases. A company use case featuring a hearing aid calibration device and the distributed energy harvesting aware routing (DEHAR) algorithm for wireless sensor networks (WSNs). These two use cases illustrate different design challenges. With the ForSyDe framework, the use cases are expressed as homogeneous and heterogeneous models.

The company use case illustrates that the ForSyDe framework handles systems with well defined interactions very well. The WSN use case illustrates that networked systems with complex interaction are more challenging to express naturally, yet the ForSyDe framework is able to express such systems.
Guest Editor's foreword

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Authors: Hansen, M. R. (Intern)
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Scopus rating (2007): SJR 1.827 SNIP 2.219
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Scopus rating (2004): SJR 0.628 SNIP 1.2
Scopus rating (2003): SJR 0.676 SNIP 1.73
Scopus rating (2002): SJR 0.987 SNIP 2.006
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Scopus rating (1999): SJR 0.982 SNIP 1.205
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From functional programming to multicore parallelism: A case study based on Presburger Arithmetic

The overall goal of this work is studying parallelization of functional programs with the specific case study of decision procedures for Presburger Arithmetic (PA). PA is a first order theory of integers accepting addition as its only operation. Whereas it has wide applications in different areas, we are interested in using PA in connection with the Duration Calculus Model Checker (DCMC) [5]. There are effective decision procedures for PA including Cooper’s algorithm and the Omega Test; however, their complexity is extremely high with doubly exponential lower bound and triply exponential upper bound [7]. We investigate these decision procedures in the context of multicore parallelism with the hope of exploiting multicore powers. Unfortunately, we are not aware of any prior parallelism research related to decision procedures for PA. The closest work is the preliminary results on parallelism in the SMT-solver Z3 [8] which has the capability of solving Presburger formulas. Functional programming is well-suited for the domain of decision procedures, and its immutability feature helps to reduce parallelization effort. While Haskell has progressed with a lot of parallelism-related research [6], we choose F# to be able to have explicit control over parallelism on the .NET framework and utilize its option to resort to mutation when optimizing performance.
chop depth of the Duration Calculus formulas, so it is not clear whether this is a feasible approach. The decision procedure is partitioned into a frontend with reductions including "cheap", equation-based quantifier eliminations, and a general quantifier-elimination procedure, where we have experimented with an implementation based on Cooper’s algorithm and with the SMT solver Z3. The formula reductions are facilitated using a new ‘guarded normal form’. Applying the frontend before a general quantifier elimination procedure gave significant improvements for most of the experiments.

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Analysis for Embedded Systems: Experiments with Priced Timed Automata
Analysis of resource consumption of embedded systems is a major challenge in the industry since the number of components that can be included in a single chip keeps getting bigger. In this paper, we consider simple models of embedded systems and the automated analysis about timing and memory access costs of those models. In order to achieve this, a basic model is built using priced timed automata and some resource consumption scenarios are verified. Even though the experiments are performed on small and basic models, we believe we have taken a basis step in showing that it is promising to use priced timed automata and Uppaal Cora as a model checking tool in reasoning about resource consumption of embedded systems.

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Authors: Ovatman, T. (Ekstern), Brekling, A. W. (Intern), Hansen, M. R. (Intern)
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BFI (2014): BFI-level 1

One of the key design goals in Wireless Sensor Networks is long lasting or even continuous operation. Continuous operation is made possible through energy harvesting. Keeping the network operational imposes a demand to prevent network segmentation and power loss in nodes. It is therefore important that the best energy-wise route is found for each data transfer from a source node to the sink node. We present a new adaptive and distributed routing algorithm for finding energy optimised routes in a wireless sensor network with energy harvesting. The algorithm finds an energy efficient route from each source node to a single sink node, taking into account the current energy status of the network. By simulation, the algorithm is shown to be able to adapt to changes in harvested and stored energy. Simulations show that continuous operation is possible.

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Authors: Jakobsen, M. K. (Intern), Madsen, J. (Intern), Hansen, M. R. (Intern)
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Publisher: IEEE
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DOIs:
Efficient Model Checking for a Hybrid Duration Calculus.

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Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern)
Pages: 1-7
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Modelling and Analyses of Embedded Systems Design
We present the MoVES languages: a language with which embedded systems can be specified at a stage in the
development process where an application is identified and should be mapped to an execution platform (potentially multi-
core). We give a formal model for MoVES that captures and gives semantics to the elements of specifications in the
MoVES language. We show that even for seemingly simple systems, the complexity of verifying real-time constraints can
be overwhelming - but we give an upper limit to the size of the search-space that needs examining. Furthermore, the
formal model exposes important scheduling situations that become central in establishing timed-automata models that can
be used for analysis of MoVES specifications effectively. Finally we present the MoVES tool, which can conduct automatic
verification of interesting properties of MoVES specifications. In several examples, we use the MoVES tool to conduct
analysis that identifies timing anomalies. We also conduct design space exploration in an example using the MoVES tool.
And we show that it can be used for analysis of systems that, in size, resemble industrially-interesting systems. We find
that semantically-based verification is a promising approach for assisting developers of embedded systems. We provide
examples of system verifications that, in size and complexity, point in the direction of industrially-interesting systems.

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Modelling and Analysis for Embedded Systems

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A modelling and analysis framework for embedded systems

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Analysis of Quantitative Properties of Hardware Specifications

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Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling
Authors: Brekling, A. W. (Intern), Madsen, J. (Intern), Hansen, M. R. (Intern)
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A prototype model checker for Duration Calculus

General information
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Authors: Heise, W. P. (Ekstern), Fränzle, M. (Intern), Hansen, M. R. (Intern)
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Publication date: 2009
Declarative Business Process Modelling and the Generation of ERP Systems
We present an approach to the construction of Enterprise Resource Planning (ERP) Systems, which is based on the Resources, Events and Agents (REA) ontology. This framework deals with processes involving exchange and flow of resources in a declarative, graphically-based manner describing what the major entities are rather than how they engage in computations. We show how to develop a domain-specific language on the basis of REA, and a tool which automatically can generate running web-applications. A main contribution is a proof-of-concept showing that business-domain experts can generate their own applications without worrying about implementation details. In order to have a well-defined domain-specific language, a formal model of REA has been developed using the specification language Object-Z and this led to clarifications as well as the introduction of new concepts. The compiler for our language is written in Objective CAML and as implementation platform we used Ruby on Rails. Our aim here is to give an overview of whole construction of a running application from a REA specification and to illustrate the adequacy of the development process.

Efficient model checking for duration calculus

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Organisations: Department of Informatics and Mathematical Modeling, Embedded Systems Engineering
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Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Leight-weight hybrid model checking facilitating online prediction of temporal properties

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Authors: Sauter, G. (Ekstern), Dierks, H. (Ekstern), Fränzle, M. (Intern), Hansen, M. R. (Intern)
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Publisher: DTU Informatik, Danmarks Tekniske Universitet
ISBN (Print): 978-87-643-0565-4
Main Research Area: Technical/natural sciences
Workshop: 21st Nordic Workshop on Programming Theory, Lyngby, Denmark, 14/12/2009 - 14/12/2009
Source: orbit
Source-ID: 257290
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

MoVES - A Framework for Modelling and Verifying Embedded Systems
The MoVES framework is being developed to assist in the early phases of embedded systems design. A system is modelled as an application running on an execution platform. The application is modelled through the individual tasks, and the execution platform is modelled through the processing elements, including the operating systems, and their interconnections. The tasks and processing elements are characterized by their real-time properties. The framework can be used to conduct schedulability analysis and has the potential to reason about different types of resource usage such as memory usage and power consumption. A simple specification language for embedded systems and a verification backend are presented. The framework has a modular, parameterized structure supporting easy extension and adaptation of the specification language as well as of the verification backend. We show, using a number of small examples, how MoVES can be used to model and analyze embedded systems.

General information
State: Published
Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling
Authors: Brekling, A. W. (Intern), Hansen, M. R. (Intern), Madsen, J. (Intern)
Pages: 143-146
Publication date: 2009

Host publication information
Title of host publication: 2009 International Conference on Microelectronics
Publisher: IEEE
ISBN (Print): 978-1-4244-5815-8
Main Research Area: Technical/natural sciences
Conference: The 21st International Conference on Microelectronics, Marakesh, Morocco, 01/01/2009
Efficient model checking for duration calculus based on branching-time approximations

Duration Calculus (abbreviated to DC) is an interval-based, metric-time temporal logic designed for reasoning about embedded real-time systems at a high level of abstraction. But the complexity of model checking any decidable fragment featuring both negation and chop, DC's only modality, is non-elementary and thus impractical. We here investigate a similar approximation as frequently employed in model checking situation-based temporal logics, where linear-time problems are safely approximated by branching-time counterparts amenable to more efficient model-checking algorithms. Mimicking the role that a situation has in (A)CTL as origin of a set of linear traces, we define a branching-time counterpart to interval-based temporal logics building on situation pairs spanning sets of intervals. While this branching-time interval semantics yields the desired reduction in complexity of the model-checking problem, from non-elementary to linear in the size of the formula and cubic in the size of the model, the approximation is too coarse to be practical. We therefore refine the semantics by an occurrence count for crucial states (e.g., cuts of loops) in the model, arriving at a 4-fold exponential model-checking problem sufficiently accurately approximating the original one.

Experiences with Functional Programming in an Introductory Curriculum

State: Published
Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling, Software Engineering
Authors: Hansen, M. R. (Intern), Kristensen, J. T. (Intern)
Pages: 31-47
Publication date: 2008
Faults Analysis in Distributed Systems: Quantitative Estimation of Reliability and Resource Requirements

General information
State: Published
Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling, Algorithms and Logic
Authors: Sellberg, C. (Ekstern), Hansen, M. R. (Intern), Fischer, P. (Intern)
Pages: 45-52
Publication date: 2008

Host publication information
Title of host publication: Third International Conference on Software and Data Technologies
Volume: Software Engineering
Publisher: Institute for Systems and Technologies of Information, Control and Communication
Main Research Area: Technical/natural sciences
Conference: 3rd International Conference on Software and Data Technologies, Porto, Portugal, 05/07/2008 - 05/07/2008
Source: orbit
Source-ID: 233184
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Formal Verification of Design Properties of Hardware Architectures.

General information
State: Published
Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling
Authors: Brekling, A. W. (Intern), Hansen, M. R. (Intern), Madsen, J. (Intern)
Publication date: 2008
Event: Poster session presented at 2008 Design, Automation and Test in Europe, Munich, Germany.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 233174
Publication: Research - peer-review › Poster – Annual report year: 2008

Generation of ERP systems from REA specifications.

General information
State: Published
Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling
Authors: Schultz-Møller, N. (Ekstern), Hølmer, C. (Ekstern), Hansen, M. R. (Intern)
Pages: 12-19
Publication date: 2008

Host publication information
Title of host publication: Third International Conference on Software and Data Technologies
Volume: Information Systems and Data Management
Publisher: Institute for Systems and Technologies of Information, Control and Communication
Main Research Area: Technical/natural sciences
Conference: 3rd International Conference on Software and Data Technologies, Porto, Portugal, 05/07/2008 - 05/07/2008
Source: orbit
Source-ID: 233178
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Models and formal verification of multiprocessor system-on-chips
In this article we develop a model for applications running on multiprocessor platforms. An application is modelled by task graphs and a multiprocessor system is modelled by a number of processing elements, each capable of executing tasks according to a given scheduling discipline. We present a discrete model of computation for such systems and characterize the size of the computation tree it suffices to consider when checking for schedulability. Analysis of multiprocessor system on chips is a major challenge due to the freedom of interrelated choices concerning the application level, the configuration of the execution platform and the mapping of the application onto this platform. The computational model provides a basis for formal analysis of systems. The model is translated to timed automata and a tool for system verification and simulation has been developed using Uppaal as backend. We present experimental results on rather small systems with high complexity, primarily due to differences between best-case and worst-case execution times. Considering worst-case execution times only, the system becomes deterministic and using a special version of {Uppaal}, where the no history is
saved, we could verify a smart-phone application consisting of 103 tasks executing on 4 processing elements.
System-level verification of multi-core embedded systems using timed automata

**General information**
State: Published
Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling
Authors: Madsen, J. (Intern), Hansen, M. R. (Intern), Knudsen, K. S. (Ekstern), Nielsen, J. E. (Ekstern), Brekling, A. W. (Intern)
Pages: 9302-9307
Publication date: 2008

**Host publication information**
Title of host publication: 17th World Congress International Federation of Automatic Control
Publisher: International Federation of Automatic Control
Main Research Area: Technical/natural sciences
Conference: 17th World Congress International Federation of Automatic Control, Seoul, 01/01/2008
Source: orbit
Source-ID: 233139
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Towards Traceability in Descriptive Software Models

**General information**
State: Published
Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling
Authors: Larsen, P. (Intern), Hansen, M. R. (Intern), Madsen, J. (Intern)
Pages: 63-72
Publication date: 2008

**Host publication information**
Title of host publication: Nordic Workshop and Doctoral Symposium on Dependability and Security
Publisher: Department of Computer Science, Tallinn Technical University
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 233198
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

A theory of Duration Calculus with applications

**General information**
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern), Hung, D. V. (Ekstern)
Pages: 119-176
Publication date: 2007

**Host publication information**
Title of host publication: Domain Modelling and Duration Calculus
Publisher: Springer
Editors: George, C. W., Liu, Z., Woodcock, J.
Series: Lecture Notes in Computer Science
Number: 4710
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 208227
Publication: Research - peer-review › Book chapter – Annual report year: 2007

Decidability of a Hybrid Duration Calculus

**General information**
Deciding an Interval Logic with Accumulated Durations

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern), Fränzle, M. (Intern)
Hardware modelling language and verification of design properties

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Brekling, A. W. (Intern), Hansen, M. R. (Intern), Madsen, J. (Intern)
Pages: 49-51
Publication date: 2007

Host publication information
Title of host publication: NWPT'07/FLACOS'07
Publisher: Institute for Informatics, Univ. of Olso
Main Research Area: Technical/natural sciences
Conference: Nordic Workshop on Programming Theory 2007, Olso, 01/01/2007
Source: orbit
Source-ID: 208232
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

MOVES - A tool for Modeling and Verification of Embedded Systems
We demonstrate MOVES, a tool which allows designers of embedded systems to explore possible implementations early in the design process. The demonstration of MOVES will show how designers can explore different designs by changing the mapping of tasks on processing elements, the number and/or speed of processing elements, the size of local memories, and the operating systems (scheduling algorithm).

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Ellebæk, J. (Ekstern), Knudsen, K. S. (Ekstern), Brekling, A. W. (Intern), Hansen, M. R. (Intern), Madsen, J. (Intern)
Publication date: 2007

Host publication information
Title of host publication: DATE'07 University Booth
Publisher: EEDA
Main Research Area: Technical/natural sciences
Electronic versions: MOVES_UBooth.pdf
Source: orbit
Source-ID: 196108
Publication: Research › Article in proceedings – Annual report year: 2007

Semantics and verification of a language for modelling hardware architectures

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern), Madsen, J. (Intern), Brekling, A. W. (Intern)
Pages: 300-319
Publication date: 2007
Timed Traces and Strand Spaces

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern), Sharp, R. (Intern)
Pages: 373-386
Publication date: 2007

A Timed-Automaton Semantics for a System-Level MPSoC model

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Brekling, A. W. (Intern), Hansen, M. R. (Intern), Madsen, J. (Intern)
Publication date: 2006

A robust interpretation of duration calculus
We transfer the concept of robust interpretation from arithmetic first-order theories to metric-time temporal logics. The idea is that the interpretation of a formula is robust iff its truth value does not change under small variation of the constants in the formula. Exemplifying this on Duration Calculus (DC), our findings are that the robust interpretation of DC is equivalent to a multi-valued interpretation that uses the real numbers as semantic domain and assigns Lipschitz-continuous interpretations to all operators of DC. Furthermore, this continuity permits approximation between discrete and dense time, thus allowing exploitation of discrete-time (semi-)decision procedures on dense-time properties.

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Franzle, M. (Ekstern), Hansen, M. R. (Intern)
Publication date: 2005
Bounded Model Construction for Duration Calculus

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Enslev, J. (Ekstern), Nielsen, A. (Ekstern), Fränzle, M. (Intern), Hansen, M. R. (Intern), Jones, N. D. (ed.)
(Ekstern)
Publication date: 2005

Host publication information
Title of host publication: Proceedings of the 17th Nordic Workshop on Programming Theory
Main Research Area: Technical/natural sciences
Links:
http://www2.imm.dtu.dk/pubdb/p.php?4350
Source: orbit
Source-ID: 185682
Publication: Research - peer-review › Article in proceedings – Annual report year: 2005

Proof support for RAISE - by a Reuse Approach Based on Institutions

Formal methods are mathematically based methods for developing software. Such methods usually involve that software and requirements are specified in a formal specification language, after which it is verified that the software meets the requirements. RAISE is a formal method with the associated specification language RSL and a proof system. Computer-based proof tools are available for RAISE, but a higher degree of automation is desired. Isabelle/HOL is a proof assistant for higher-order logic (HOL). It is an instantiation of the generic proof assistant Isabelle which offers a suitable degree of automation and flexibility. In order to use the Isabelle/HOL proof assistant for the RAISE method, translation from RSL to HOL is considered. The translation is based on institutions which formalize the informal notion of "a logical system". Institutions and morphisms between institutions are presented together with specifications over institutions and model-theoretic semantics of specifications. The concept of "light institution comorphisms" is introduced as a modification of well-known institution comorphisms, and it is proved that a light institution comorphism enables sound reuse of proof assistants when it has certain properties. Moreover, the concept of looser semantics of specifications is introduced as a model-theoretic description of the semantics of RSL specifications, and an equivalence result is proved. An institution for an applicative, deterministic subset of RSL, referred to as "mRSL", is defined. Then, a well-known institution for HOL is presented, and Isabelle/HOL is briefly described. An institution comorphism from the mRSL institution to the HOL institution is defined, providing a translation from mRSL to Isabelle/HOL, and it is proved that the light institution comorphism has the properties that enable sound reuse of the Isabelle/HOL proof assistant. The use of the translation is described in connection with three examples: logical circuits, a generalized railway crossing, and an encoding of Duration Calculus in RSL. In Danish: Formelle metoder er matematisk baserede metoder til udvikling af programm. Sådanne metoder involverer som regel, at programm og krav beskrives i et formelt specificationssprog, hvorefter det verificeres, at programmemet opfylder de ønskede krav. RAISE er en formel metode med det tilhørende specificationssprog RSL og et bevisssystem. Der findes datamatbaserede bevisværktøjer til RAISE, men en højere grad af automation er ønskværdig. Isabelle/HOL er en bevisfører for højereordens logik (HOL). Bevisførelser er en instantiering af den generiske bevisfører Isabelle, der tilbyder en passende grad af automation og fleksibilitet. Med henblik på at benytte bevisføreren Isabelle/HOL i forbindelse med RAISE metoden, betragtes oversættelse fra RSL til HOL. Oversættelsen baseres på institutioner, der formaliserer det uformelle begreb "logisk system ". Institutioner og morfier mellem institutioner gennemgås sammen med specifikationer over institutioner og modelteoretisk semantik af specifikationer. Begrebet "let institutionscomorfi" introduceres som en modifikation af velkendte institutionscomorfi, og det bevises, at en let institutionscomorfi muligvis sund genbrug af bevisførere, når den har visse egenskaber. Derudover introduceres begrebet løsere semantik af specifikationer som en modelteoretisk beskrivelse af semantikken af RSL- specifikationer, og et ekvivalensresultat bevises. Der defineres en institution for en applikativ, deterministisk delmængde af RSL, der benævnes "mRSL". Herefter præsenteres en velkendt institution for HOL, og Isabelle/HOL gennemgås kort. Der defineres en let institutionscomorfi fra mRSL- institutionen til HOL-institutionen, hvorefter der fås en oversættelse fra mRSL til Isabelle/HOL, og det bevises, at den definerede lette institutionscomorfi har de egenskaber, der muligvis sund genbrug af bevisføreren Isabelle/HOL. Brugen af den definerede oversættelse beskrives i forbindelse med tre eksempler: logiske kredsløb, en jernbaneoverskæring og en indkodning af varighedskalkylen i RSL.
A Robust Interpretation of Duration Calculus

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Computer Science and Engineering
Authors: Fränzle, M. (Intern), Hansen, M. R. (Intern)
Number of pages: 2
Publication date: 2004

Host publication information
Title of host publication: Nordic Workshop on Programming Theory 2004
Publisher: Informatics and Mathematical Modelling, Technical University of Denmark, DTU
Main Research Area: Technical/natural sciences
metric time, Temporal logic, approximability
Electronic versions:
imm3350.pdf
Links:
Source: orbit
Source-ID: 154696
Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

Duration Calculus: A Formal Approach to Real-Time Systems

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Chaochen, Z. (Intern), Hansen, M. R. (Intern)
Number of pages: 247
Publication date: 2004

Publication information
Publisher: Springer
ISBN (Print): 3-540-40823-1
Original language: English
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 154713
Publication: Research - peer-review › Book – Annual report year: 2004

Generating Web-based Systems from Specifications
General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Jensen, T. B. (Ekstern), Tolstrup, T. K. (Ekstern), Hansen, M. R. (Intern)
Publication date: 2004

Host publication information
Title of host publication: The 19th ACM Symposium on Applied Computing (SAC 2004)
Publisher: ACM Press
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 154626
Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

Special Issue on Duration Calculus

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Jones, C. (Ekstern), Hansen, M. R. (Intern)
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Formal Aspects of Computing
Volume: 16
Issue number: 2
ISSN (Print): 0934-5043
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 0.425 SNIP 1.487 CiteScore 1.1
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.414 SNIP 1.073 CiteScore 0.95
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.677 SNIP 2.373 CiteScore 1.72
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.775 SNIP 1.634 CiteScore 1.39
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.459 SNIP 1.193 CiteScore 1.09
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.496 SNIP 1.023 CiteScore 1.06
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.691 SNIP 1.538
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.042 SNIP 1.886
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.003 SNIP 1.482
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.593 SNIP 1.302
Timed Traces and Strand Spaces

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Sharp, R. (Intern), Hansen, M. R. (Intern)
Pages: 96-98
Publication date: 2004

Host publication information
Title of host publication: Proceedings of the 16th Nordic Workshop on Programming Theory
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 154666
Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

Untitled

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Jones, C. (Ekstern), Hansen, M. R. (Intern)
Pages: 95-95
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Formal Aspects of Computing
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ISSN (Print): 0934-5043
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 0.425 SNIP 1.487 CiteScore 1.1
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.414 SNIP 1.073 CiteScore 0.95
BFI (2014): BFI-level 2
An Approach to Analyzing Availability Properties of Security Protocols

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Computer Science and Engineering
Authors: Pilegaard, H. (Intern), Hansen, M. R. (Intern), Sharp, R. (Intern)
Pages: 337-373
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: Nordic Journal of Computing
Volume: 10
Issue number: 4
ISSN (Print): 1236-6064
Ratings:
BFI (2016): BFI-level 1
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
BFI (2013): BFI-level 1
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Using Interval Logics for Temporal Analysis of Security Protocols

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Computer Science and Engineering
Authors: Hansen, M. R. (Intern), Sharp, R. (Intern), Backes et a., M. (ed.) (Ekstern)
Pages: 24-31
Publication date: 2003

Host publication information
Title of host publication: First ACM Workshop on Formal Methods in Security Engineering (FMSE’03)
Publisher: ACM Press
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 58524
Publication: Research - peer-review › Article in proceedings – Annual report year: 2003

Interval logic. Proof theory and theorem proving
Real-time systems are computer systems which have to meet real-time constraints. To increase the confidence in such systems, formal methods and formal verification are utilized. The class of logics known as interval logics can be used for expressing properties and requirements of real-time systems. By theorem proving we understand the activity of proving theorems of a logic with the assistance of a computer. The goal of this thesis is to improve theorem proving support for interval logics such that larger and more realistic case-studies of real-time systems can be conducted using these formalisms. For achieving this goal we (1) investigate the foundations necessary for providing a useful theorem proving system for interval logics, and (2) actually provide such a system as well as conduct experiments with it. We introduce an interval logic, Signed Interval Logic (SIL), which includes the notion of a direction of an interval, and present a sound and complete Hilbert proof system for it. Because of its generality, SIL can conveniently act as a general formalism in which other interval logics can be encoded. We develop proof theory for SIL including both a sequent calculus system and a labelled natural deduction system. We conduct theoretical investigations of the systems with respect to subformula properties, proof search, etc. The generic theorem proving system Isabelle is used as a framework for encoding both proof theoretical systems. We consider a number of examples/small case-studies and discuss strengths and weaknesses of the encodings. >From both a theoretical and a practical viewpoint, the labelled natural deduction system is the clear winner. We discuss how to scale the approach to larger case-studies.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Computer Science and Engineering
Authors: Rasmussen, T. M. (Intern), Rischel, H. (Intern), Hansen, M. R. (Intern)
Publication date: Aug 2002

Publication information
Original language: English
Main Research Area: Technical/natural sciences
theorem proving, Duration Calculus, |automated reasoning, Isabelle, real-time systems, proof theory, interval logic
Electronic versions:
imm802.pdf
Links:
Source: orbit
Source-ID: 58365
**Selected Papers of the 13th Nordic Workshop on Programming Theory (NWPT'01)**

**General information**
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Haaveraaen, M. (Ekstern), Hansen, M. R. (Intern)
Publication date: 2002
Main Research Area: Technical/natural sciences

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Journal: Nordic Journal of Computing
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Ratings:
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BFI (2013): BFI-level 1
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BFI (2012): BFI-level 1
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
BFI (2009): BFI-level 1
BFI (2008): BFI-level 1
Original language: English
Links:
Source: orbit
Source-ID: 199597

**Proof Support for RAISE**

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Computer Science and Engineering
Authors: Lindegaard, M. P. (Intern), Hansen, M. R. (ed.) (Intern)
Publication date: 2001
Event: Poster session presented at NWPT'01, The 13th Nordic Workshop on Programming Theory
Main Research Area: Technical/natural sciences
proof support, RAISE, institutions, HOL, RSL, Isabelle

**Bibliographical note**
IMM-TR-2001-12
Source: orbit
Source-ID: 201215
Publication: Research › Poster – Annual report year: 2001

**Systematic design and implementation of web-based systems**

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Larsen, S. (Ekstern), Hansen, M. R. (Intern)
Pages: 38-41
Publication date: 2001
Teaching object-oriented programming on top of functional programming

In the Informatics Programme at the Technical University of Denmark, the authors base the first course in object-oriented programming (using the Java language) on a preceding course in functional programming (using the SML language). The students may hence exploit concepts from functional programming in the construction of OO programs. This is done following a method where the program design is expressed in SML and afterwards implemented in Java. The use of different languages in design and implementation is an advantage as it makes the distinction between these two stages very clear. They give examples showing that SML designs allow them to develop and compare OO implementations with different class structures for the same programming problem. A discussion of this kind is not supported in traditional OO methodology. The program design in SML has also shown to be useful for the students when documenting the program.
A Theory Based Introductory Programming Course

This paper presents an introductory programming course designed to teach programming as an intellectual activity. The course emphasizes understandable concepts which can be useful in designing programs, while the oddities of today's technology are considered of secondary importance. An important goal is to fight the trial-and-error approach to programming which is a result of the students battles with horribly designed and documented systems and languages prior to their studies at university. Instead, the authors strive for giving the students a good experience of programming as a systematic, intellectual activity where the solution of a programming problem can be described in an understandable way. The approach is illustrated by an example which is a commented solution of a problem posed to the students in the course.

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern), Kristensen, J. T. (Intern), Rischel, H. (Intern)
Publication date: 1999

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Publisher: IEEE
ISBN (Print): 0-7803-5643-8
Main Research Area: Technical/natural sciences
Conference: 29th Annual Frontiers in Education Conference, San Juan, Puerto Rico, 01/01/1999
Electronic versions:
Hansen.pdf
DOIs:
10.1109/FIE.1999.839230

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Source-ID: 175600
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Introduction to Programming using SML

General information
State: Published
Organisations: Department of Information Technology
Authors: Hansen, M. R. (Intern), Rischel, H. (Intern)
Number of pages: 367
Publication date: 1999

Publication information
Place of publication: Harlow, England
Publisher: Addison-Wesley
Original language: English
Main Research Area: Technical/natural sciences
Source-ID: 175601
Publication: Research - peer-review › Book – Annual report year: 1999

10th European Summer School in Logic Language and Information: Duration Calculus: A Logical Approach to Real-Time Systems

General information
State: Published
Organisations: Department of Information Technology
Authors: Hansen, M. R. (ed.) (Intern)
Number of pages: 159
Publication date: 1998
**An Adequate First Order Logic of Intervals**

This paper introduces left and right neighbourhoods as primitive interval modalities to define other unary and binary modalities of intervals in a first order logic with interval length. A complete first order logic for the neighbourhood modalities is presented. It is demonstrated how the logic can support formal specification and verification of liveness and fairness, and also of various notions of real analysis.

**General information**

State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Pages: 584-608
Publication date: 1998

**Host publication information**

Title of host publication: Compositionality: The Significant Difference
Publisher: Springer Verlag
Main Research Area: Technical/natural sciences
Conference: Compositionality: The Significant Difference, 01/01/1998
Source: orbit
Source-ID: 200015
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

**Duration Calculus: A Logical Approach to Real-Time Systems**

**General information**

State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (ed.) (Intern)
Publication date: 1998

**Publication information**

Publisher: DFKI Saarbrücken
Original language: English
Main Research Area: Technical/natural sciences
Links:
http://www2.imm.dtu.dk/pubdb/p.php?1902
Source: orbit
Source-ID: 200602
Publication: Research - peer-review › Book – Annual report year: 1998

**Events in Duration Calculus**

**General information**

State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Sun, H. (Ekstern), Hansen, M. R. (Intern), Hansen, M. R. (ed.) (Intern)
Pages: 133-140
Publication date: 1998

**Host publication information**

Title of host publication: Proc. of the 10th European Summer School in Logic Language and Information (ESSLLI'98) Workshop on Duration Calculus
Publisher: DFKI Saarbrücken
Main Research Area: Technical/natural sciences
Modelling Invoicing using SML

General information
State: Published
Organisations: Department of Information Technology, Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Pages: 297-311
Publication date: 1998

Host publication information
Title of host publication: Proceedings of the International workshop on Comparing System specification Techniques
Place of publication: Nantes
Publisher: ERIN, Nantes
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200203
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Traces in PC/DC

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Computer Science and Engineering, CAI
Authors: Hoffmann, T. (Intern), Petersen, M. B. (Ekstern), Rischel, H. (Intern), Hansen, M. R. (Intern)
Publication date: 1998

Host publication information
Title of host publication: Proc. of the 10th European Summer School in Logic Language and Information
Place of publication: Saarbrücken
Publisher: DFKI
Main Research Area: Technical/natural sciences
Conference: 10th European Summer School in Logic, Languages and Information, Saarbrücken, Germany, 01/01/1998
Source: orbit
Source-ID: 170266
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Duration Calculus: Logical Foundations

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling, United Nations University
Authors: Hansen, M. R. (Intern), Chaochen, Z. (Ekstern)
Pages: 283-330
Publication date: 1997
Conference: Unknown, 01/01/1997
Main Research Area: Technical/natural sciences

Publication information
Journal: Formal Aspects of Computing
Volume: 9
Issue number: 3
ISSN (Print): 0934-5043
Ratings:
From Design Specifications to Parallel Implementations

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Kaaramees, M. (Ekstern), Hansen, M. R. (Intern), Haveeraaen, M. (ed.) (Ekstern), Owe, O. (ed.) (Ekstern)
Pages: 129-138
Publication date: 1997

Host publication information
Title of host publication: Selected papers from the 8th Nordic Workshop on Programming Theory
Main Research Area: Technical/natural sciences
Conference: Selected papers from the 8th Nordic Workshop on Programming Theory, 01/01/1997
Source: orbit
A Timed Semantics for SDL

An alternative formal semantics for describing the temporal aspects for the ITU-T specification language SDL is proposed, based on the interval temporal logic Duration Calculus (DC). It is shown how DC can be used to give an SDL semantics with a precise treatment of temporal phenomena. The semantics allows true concurrency. We show how it can be used to address issues such as the verification of temporal properties, process scheduling, and the nature of viewed (shared) variables.

Chopping a Point

This paper introduces a super-dense chop modality into the Duration Calculi. The super-dense chop can be used to specify a super-dense computation, where a number of operations happen simultaneously, but in a specific order. With this modality, the paper defines a real-time semantics for an OCCAM-like language. In the semantics, assignments and passings of messages in communications are assumed to be timeless operations.

Real-Time Semantics for Data Flow Graphs

This paper introduces a super-dense chop modality into the Duration Calculi. The super-dense chop can be used to specify a super-dense computation, where a number of operations happen simultaneously, but in a specific order. With this modality, the paper defines a real-time semantics for an OCCAM-like language. In the semantics, assignments and passings of messages in communications are assumed to be timeless operations.
Model-Checking Discrete Duration Calculus

Duration calculus was introduced by Chaochen Zhou et al. (1991) as a logic to specify and reason about requirements for real-time systems. It is an extension of interval temporal logic where one can reason about integrated constraints over time-dependent and Boolean valued states without explicit mention of absolute time. Several major case studies have shown that duration calculus provides a high level of abstraction for both expressing and reasoning about specifications. Using timed automata one can express how real-time systems can be constructed at a level of detail which is close to an actual implementation. We consider in the paper the correctness of timed automata with respect to duration calculus formulae. For a subset of duration calculus, we show that one can automatically verify whether a timed automaton $\mathcal{M}$ is correct with respect to a formula $\mathcal{D}$, abbreviated $\mathcal{M} \models \mathcal{D}$, i.e. one can do model-checking. The subset we consider is expressive enough to formalize the requirements to the gas burner system given by A.P. Ravn (1993); but only for a discrete time domain. Model-checking is done by reducing the correctness problem $\mathcal{M} \models \mathcal{D}$ to the inclusion problem of regular languages.
An Extended Duration Calculus for Hybrid Systems

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Pages: 36-59
Publication date: 1993

Host publication information
Title of host publication: Hybrid Systems
Publisher: Springer Verlag
Main Research Area: Technical/natural sciences
Conference: Hybrid Systems, 01/01/1993
Source: orbit
Source-ID: 200018
Publication: Research - peer-review › Article in proceedings – Annual report year: 1993

Constructing Circuits from Decidable Duration Calculus

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern), Olderog, E. (Ekstern)
Publication date: 1993

Publication information
Publisher: Fachbereich Informatik, University Oldenburg, Germany
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200925
Publication: Research - peer-review › Report – Annual report year: 1993

Decidability and Undecidability Results for Duration Calculus

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Pages: 58-68
Publication date: 1993

Host publication information
Title of host publication: STACS'93
Publisher: Springer Verlag
Main Research Area: Technical/natural sciences
Conference: STACS'93, 01/01/1993
Source: orbit
Source-ID: 200017
A Real-Time Duration Semantics for Circuits

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling, Department of Information Technology
Authors: Hansen, M. R. (Intern), Chaochen, Z. (Ekstern), Staunstrup, J. (Intern)
Publication date: 1992

Host publication information
Publisher: ACM/SIGDA
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200125
Publication: Research - peer-review » Article in proceedings – Annual report year: 1992

Semantics and Completeness of Duration Calculus

General information
State: Published
Organisations: Embedded Systems Engineering, Department of Informatics and Mathematical Modeling, Department of Information Technology
Pages: 209-225
Publication date: 1992

Host publication information
Title of host publication: Real-Time: Theory in Practice, REX Workshop
Publisher: Springer Verlag
Main Research Area: Technical/natural sciences
Conference: Real-Time: Theory in Practice, REX Workshop, 01/01/1992
Source: orbit
Source-ID: 200124
Publication: Research - peer-review » Article in proceedings – Annual report year: 1992

Duration Specifications for Shared Processors

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Pages: 21-32
Publication date: 1991

Host publication information
Title of host publication: Symposium on Formal Techniques in Real-Time and Fault Tolerant Systems
Publisher: Springer Verlag
Main Research Area: Technical/natural sciences
Conference: Symposium on Formal Techniques in Real-Time and Fault Tolerant Systems, 01/01/1991
Source: orbit
Source-ID: 200019
Publication: Research - peer-review » Article in proceedings – Annual report year: 1991

Specification & Verification of Higher Order Processes
Integrating Relational Databases and Constraint Languages

A new structure of application programs is suggested, which separates the algorithmic parts from factual information (data and rules). The latter is to be stored in a repository that can be shared among multiple applications. It is argued that rules stating pure relations are better suited for sharing among different applications than procedural or functional rules because these latter rules always determine inputs and outputs. To support such a repository, an extended relational algebra is explored. This algebra serves as the semantic model for a proposed rules language and is the basis for a seamless integration of data and rules. The paper focuses on equational rules. A number of potentially useful algebraic laws are stated. Examples will demonstrate the use of these algebraic laws in query evaluation and optimization. The paper elaborates the Rules/Database system from a programming language point of view. There are two language aspects: the rules language and the application programming interface. The concepts of data types and modules are incorporated into the rules language. The implementation is envisioned as a subsystem with an application programming interface. The interface is outlined. The relation of this approach to PROLOG and expert systems technology (production rules) is discussed.

Algebraic Optimization of Recursive Database Queries

Queries are expressed by relational algebra expressions including a fixpoint operation. A condition is presented under which a natural join commutes with a fixpoint operation. This condition is a simple check of attribute sets of sub-expressions of the query. The work may be considered a generalization of Aho and Ullman, (1979). The result is interpreted in function free logic database terms as a transformation of the recursively defined predicate involving: (a) elimination of an argument, and (b) propagation of selections (instantiations) to the extensionally defined predicates. A collection of examples shows that this transformation abstracts some optimizations which otherwise are done by more complex graph algorithms (e.g. Bancilhon et al., (1986); Chang, (1985); Gardarin and DeMaindreville, (1986); Henschen and Naqvi, (1984); Kifer and Lozinskii, (1986)). Thus, this optimization is expressed in a form which is not biased towards any evaluation method.
Algebraic Optimization of Recursive Database Queries

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern)
Pages: 223-230
Publication date: 1987

Host publication information
Title of host publication: Intelligence Integration
Publisher: Canadian Information Processing Society
Main Research Area: Technical/natural sciences
Conference: Intelligence Integration, 01/01/1987
Source: orbit
Source-ID: 200127
Publication: Research - peer-review › Article in proceedings – Annual report year: 1987

Non-Redundant Representation of Computations: The Integration of Equations and Relations

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. R. (Intern)
Publication date: 1987

Publication information
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
ISSN 0902-2821
Source: orbit
Source-ID: 200793
Publication: Research › Ph.D. thesis – Annual report year: 1987

An Abstract Model of a Distributed Office System

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Hansen, B. S. (Ekstern), Hansen, M. R. (Intern), Pletat, U. (Ekstern), Studer, R. (Ekstern)
Publication date: 1984

Host publication information
Title of host publication: First International Conference on Office Automation
Publisher: IEEE Computer Society Press
Main Research Area: Technical/natural sciences
Conference: First International Conference on Office Automation, 01/01/1984
Source: orbit
Source-ID: 200128
Publication: Research - peer-review › Article in proceedings – Annual report year: 1984

Eine SEQUELARTIGE Sprachschnittstelle Für das NF2-Modell

General information
State: Published
Organisations: Department of Information Technology, Department of Informatics and Mathematical Modeling
Authors: Pistor, P. (Ekstern), Hansen, B. S. (Intern), Hansen, M. R. (Intern), Schmidt, J. W. (ed.) (Ekstern)
Publication date: 1983

Host publication information
Title of host publication: Sprachen Für Datenbanken
Projects:

A top-down approach to genetic circuit synthesis

Department of Applied Mathematics and Computer Science
Period: 15/08/2014 → 15/11/2017
Number of participants: 5
Phd Student:
Baig, Hasan (Intern)
Main Supervisor:
Madsen, Jan (Intern)
Examiner:
Hansen, Michael Reichhardt (Intern)
Bhatia, Swapnil (Ekstern)
Myers, Chris John (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)

Relations
Publications:
Methods and Tools for the Analysis, Verification and Synthesis of Genetic Logic Circuits, PhD

Logical and Computational Aspects of Infinite Games

Department of Applied Mathematics and Computer Science
Period: 01/05/2013 → 23/11/2016
Number of participants: 6
Phd Student:
Vester, Steen (Intern)
Supervisor:
Goranko, Valentin (Intern)
Main Supervisor:
Hansen, Michael Reichhardt (Intern)
Examiner:
Witt, Carsten (Intern)
Larsen, Kim Guldstrand (Ekstern)
Olderog, Ernest-Rüdiger (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)

Relations
Publications:
Game-based verification and synthesis
Project: PhD

Formal development and verification of railway control systems

Department of Applied Mathematics and Computer Science
Period: 01/11/2012 → 21/01/2016
Number of participants: 6
Phd Student:
Vu, Linh Hong (Intern)
Supervisor:
Peleska, Jan (Ekstern)
Main Supervisor:
Haxthausen, Anne Elisabeth (Intern)
Examiner:
Hansen, Michael Reichhardt (Intern)
Fantechi, Alessandro (Ekstern)
Larsen, Peter Gorm (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Autonomous Planning and Scheduling of Mission Operations
Department of Applied Mathematics and Computer Science
Period: 01/02/2012 → 14/07/2014
Number of participants: 4
Phd Student:
Bøg, Søren (Intern)
Supervisor:
Bolander, Thomas (Intern)
Løvengreen, Hans Henrik (Intern)
Main Supervisor:
Hansen, Michael Reichhardt (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Modelling and analysis for Cyber-Physical Systems
Department of Applied Mathematics and Computer Science
Period: 01/11/2011 → 30/09/2015
Number of participants: 6
Phd Student:
Dung, Phan Anh (Intern)
Supervisor:
Madsen, Jan (Intern)
Main Supervisor:
Hansen, Michael Reichhardt (Intern)
Examiner:
Haxthausen, Anne Elisabeth (Intern)
Sestoft, Peter (Intern)
Vain, Jüri (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 FUU, 1/3 inst 1/3 Andet
Project: PhD

Multi-agent Story Planning
Department of Applied Mathematics and Computer Science
Period: 01/02/2011 → 23/01/2015
Number of participants: 5
Phd Student: Andersen, Mikkel Birkegaard (Intern)
Main Supervisor: Bolander, Thomas (Intern)
Examiner: Hansen, Michael Reichhardt (Intern)
Petrick, Ronald P. A. (Ekstern)
Smets, Sonja (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Specifying and verifying medical robotics software to ensure harmless operation
Department of Informatics and Mathematical Modeling
Period: 01/03/2010 → 24/06/2014
Number of participants: 6
Phd Student: Herbert, Luke Thomas (Intern)
Supervisor: Hansen, Michael Reichhardt (Intern)
Main Supervisor: Sharp, Robin (Intern)
Examiner: Kindler, Ekkart (Intern)
Fränzle, Martin (Intern)
Weske, Mathias (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Formal methods for design and simulation of embedded systems
Department of Informatics and Mathematical Modeling
Period: 01/06/2009 → 30/08/2013
Number of participants: 6
Phd Student: Jakobsen, Mikkel Koefoed (Intern)
Supervisor: Hansen, Michael Reichhardt (Intern)
Main Supervisor: Madsen, Jan (Intern)
Examiner: Dragoni, Nicola (Intern)
Plosila, Juha Petteri (Ekstern)
Vain, Jüri (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 FUU, 1/3 inst 1/3 Andet
Project: PhD

Models and Analyses for Embedded Systems Design
Department of Informatics and Mathematical Modeling
Period: 01/04/2007 → 02/02/2011
Number of participants: 6
Phd Student:
Brekling, Aske Wiid (Intern)

Supervisor:
Madsen, Jan (Intern)
Main Supervisor:
Hansen, Michael Reichhardt (Intern)
Examiner:
Sparsø, Jens (Intern)
Ravn, Anders P. (Intern)
Vain, Jüri (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Chip Area Interconnection Networks
Department of Informatics and Mathematical Modeling
Period: 01/09/2002 → 18/04/2006
Number of participants: 6
Phd Student:
Mahadevan, Shankar (Intern)

Supervisor:
Madsen, Jan (Intern)
Main Supervisor:
Sparsø, Jens (Intern)
Examiner:
Hansen, Michael Reichhardt (Intern)
Kuchcinski, Krzysztof (Ekstern)
Wolf, Wayne Hendrix (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Anden EU-finansiering
Project: PhD

Sprog og logikker for ontologier
Department of Informatics and Mathematical Modeling
Period: 01/08/2000 → 16/02/2004
Number of participants: 6
Phd Student:
Oldager, Steen Nikolaj (Intern)

Supervisor:
Bruun, Hans (Intern)
Main Supervisor:
Nilsson, Jørgen Fischer (Intern)
Examiner:
Hansen, Michael Reichhardt (Intern)
Gehrke, Mai (Ekstern)
Øhrstrøm, Peter (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD
Proof support for raise

Department of Informatics and Mathematical Modeling
Period: 01/04/2000 → 25/05/2004
Number of participants: 6
Phd Student:
Lindegaard, Morten Peter (Intern)
Supervisor:
Hansen, Michael Reichhardt (Intern)
Main Supervisor:
Haxthausen, Anne Elisabeth (Intern)
Examiner:
Sharp, Robin (Intern)
Janowski, Tomasz (Ekstern)
Krieg-Brückner, Bernd (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Formelle notationer til specifikation og verification af indlejrede, tidstro systemer

Department of Informatics and Mathematical Modeling
Period: 01/02/1999 → 23/08/2002
Number of participants: 6
Phd Student:
Rasmussen, Thomas Marthedal (Intern)
Supervisor:
Rischel, Hans (Intern)
Main Supervisor:
Hansen, Michael Reichhardt (Intern)
Examiner:
Løvengreen, Hans Henrik (Intern)
Larsen, Kim Guldstrand (Ekstern)
Nipkow, Tobias (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

High-level program design of telecommunication software

Department of Informatics and Mathematical Modeling
Period: 01/12/1997 → 01/02/2001
Number of participants: 2
Phd Student:
Hoffmann, Torben (Intern)
Main Supervisor:
Hansen, Michael Reichhardt (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Erhvervsforskerordningen
Project: PhD