Research Interests and Experience

Overview and Research Directions/Projects

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Agenda

1. Main Research Interests and Experience
2. Rewriting Logic Overview and Applications
3. Case Study: NASA's PLEXIL Language
4. Current, Future, and Potential(?) Research Projects

Research Interests

My main research interests are in **formal methods** and techniques for building reliable software systems.

- Specification and verification
- Computational logic
- Algorithms

Research Experience (0)

My recent research experience is in:

- The development of symbolic verification techniques and tools for safety properties (i.e., invariants)

- The specification and verification of safety-critical systems.

Research Experience (1)

In general, my research experience is in **rewriting logic** and in **logic**.

- Formal specification and verification of concurrent and reactive systems

  communication protocols, real-time scheduling algorithms, robotic systems

- Techniques and tools for symbolic verification of infinite-state systems

  inductive reasoning, rewriting + SMT

- Formal semantics of languages

- Decision and semi-decision procedures

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Rewriting Logic

Rewriting logic is a logic for specifying **concurrent systems**, in which both **invisible** and **visible** transitions can be expressed.

- Logical framework

  invisible transitions correspond to the "modulo" part in "deduction modulo" and visible transitions to inference steps

- Semantic framework

  invisible transitions correspond to internal computation and visible transitions to observable behavior

Domain-specific Uses

Rewriting logic has been used in several domains, both in academy and industry:

- Automated deduction
- Formal programming language semantics
- Software and hardware specification and verification
- Security
- Real-time and cyber-physical systems
- Probabilistic systems
- Bio-informatics, chemical systems, and membranes

Suggested Reading

Twenty Years of Rewriting Logic by José Meseguer. The Journal of Logic and Algebraic Programming 81(7–8), 2012.

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The Plan Execution Interchange Language (PLEXIL)

- It is a **synchronous** plan execution language developed by NASA for spacecraft automation

  tasks advance in parallel

- It is designed to be flexible, efficient, and reliable in space mission operations

  also semantically clear and deterministic

Uses of PLEXIL in NASA

- Mars Drill
  - executive for the Drilling Automation for Mars Exploration drilling application
  - used at the Haughton Crater on Devon Island, perhaps, in the first fully automated drill rig
- International Space Station
  - demonstrate automation for ISS operations
- Habitat Demonstration Unit
  - automated control of several subsystems

Main Contributions to PLEXIL

- Formal and executable rewriting logic semantics of the language

  design issues were found and corrections were suggested

- Tools for assisting in the simulation and verification tasks of the language

- Symbolic executable rewriting logic semantics of the language based on "rewriting modulo SMT"

  detection of race conditions for PLEXIL plans

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Rewriting Modulo SMT

In Collaboration with J.Meseguer and C.Muñoz

The goal is to extend the current capabilities of rewriting logic with support for symbolic computation with the help of SMT technology.

- Based on one chapter in my Ph.D. dissertation.
- Some support will be offered in the upcoming Maude release.
- Currently working on theory and implementation of new ideas.

Calculational Axiomatic Set Theory

In Collaboration with E.Acosta, J.Bohórquez, B.Aldana

The goal is to obtain a calculational formulation and full development of axiomatic set theory in the logic of E.W.Dijkstra and C.S.Scholten.

- Maybe more elegant and succinct formulations and proofs
- Help in bringing computer assisted proofs to undergrad math courses
- Calculational finite model theory
- Novel book

Kidney Exchange Program Support

In Collaboration with V.Ospina, W.Guerrero

The goal is to come up with suggestions on how technology can assist in finding good solutions for the problem of optimal cycles of exchanges for kidney donors.

- Finding an optimal cycle of exchanges is NP-hard
- There are social factors involved
- There are logistic problems too
- There is no legislation in place for performing cycles of exchange for kidney donors

Social and Spatial Interactive Computation

AVISPA

The goal is to advance the state of the art of domains such as mathematical logic, order theory, and concurrency for reasoning about spatial and epistemic behavior in multi-agent systems.

- How to reason about information acquired by agents during computation?
- Use of probabilistic reasoning to quantify epistemic concepts
- Techniques and tools to verify a system against an epistemic specification

PLEXIL + Drones + Automation + Image Recognition + "Caña de Azúcar"

In Collaboration with A.Burbano, S.Rodríguez, ???

The goal is to build a platform for automating the evaluation and control of crops with the help of drones.

- Collaboration potential with CIAT
- ???

Entrevista en Javeriana Estéreo Cali
Programa INGenium
Domingo 14 de febrero (9am)

http://camilorocha.info