Contact Information

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Personal Data

Date of Birth: September 10, 1973
Place of Birth: Moscow, Russia
Nationality: US Citizen
Languages: Fluent in English and Russian

Research Interests

Research Area: Programming Languages and Software Engineering (program analysis for program verification, reverse engineering, debugging, and security checking; numeric program analysis).

My research is centered on numeric program analysis. In my dissertation, I addressed a number of numeric analysis issues including improving the precision of extrapolation (widening), using weighted pushdown systems as an engine for numeric analysis, interfacing numeric analysis with shape analysis to establish numeric properties of dynamically-allocated storage, and analyzing array operations.

My current research focuses on leveraging existing numeric analyses to work precisely on low-level code. Low-level code poses a number of challenges to numeric analysis: bit-vector instructions are used to perform numeric operations, numeric values are bounded, the arithmetic is modular, the same numeric value can be interpreted differently (signed vs. unsigned) in different contexts. Overly-conservative treatment of these issues greatly degrades the precision of numeric analysis.

Education

Ph.D.	Computer Science Minor: Mathematics	**University of Wisconsin** Madison	expected Summer 2007
M.S.	Computer Science	**University of Wisconsin** Madison	September 1999 - May 2001
B.S.	Computer Science (with Honors)	**University of Wisconsin** Milwaukee	September 1994 - August 1996
–	Automated Control Systems (3yrs. of 5yr. program)	**State University of Oil and Gas** Moscow, Russia	September 1990 - May 1993

Dissertation Adviser: Professor Thomas W. Reps
Dissertation Title: Numeric Program Analysis Techniques

Research Experience

- **Research Assistant**   University of Wisconsin   January 2003 - present
  Adviser: Professor Thomas W. Reps

  My dissertation addresses the precision of numeric program analysis. A primary contribution of my thesis is a suite of techniques that address various aspects of numeric program analysis:

  Summarizing numeric abstractions. A framework for automatically lifting *existing* numeric abstractions to support reasoning about potentially unbounded groups of numeric variables. This framework allows to integrate exiting numeric abstractions with state-of-the-art shape abstractions (**TACAS**, 2004; **NSAD**, 2005; **SAS**, 2005).

  Array analysis. A technique for analyzing array operations. The technique combines shape-analysis techniques with summarizing numeric abstractions and is able to establish sophisticated properties of array elements, such as *sortedness* and *array kill* (**POPL**, 2005).

  Lookahead widening. A novel way of using existing widening and narrowing operators to recover precision lost to extrapolation. The technique is based on analyzing a sequence of program's under-approximations, each of which can be analyzed more precisely with existing methods than the entire program. (**CAV**, 2006).

  Low-level library analysis. A technique that uses numeric program analysis to synthesize *summaries* for library functions from the library's binary code. The technique relies on an existing binary-analysis tool, CodeSurfer/x86, to extract a numeric program from the library's executable. The generated summaries can be used by source-level analysis tools to model the effect of library calls (submitted to **CAV**, 2007).

- **Research Assistant**   University of Wisconsin   June 2000 - December 2003
  Adviser: Professor Rastislav Bodik

  My research centered on dynamic optimization and addressed topics that included removal of unnecessary bound checks and performing demand-driven point-to analysis for Java (**OOPSLA**, 2005). I also investigated the use of processor's performance counters (architectural counters that collect processor statistics, such as cache miss counts, etc.) for dynamic optimization of multiprocessor workloads (e.g., load balancing, efficient synchronization, etc.).

Refereed Conference Publications

1. **Low-Level Library Analysis and Summarization.**
   Gopan, D., Reps, T.,
   To appear in *Proceedings of Computer-Aided Verification (CAV)*, July 2007.

2. **Lookahead Widening.**
   Gopan, D., Reps, T.,
   In *Proceedings of Computer-Aided Verification (CAV)*, pages 452–466, August 2006.

3. **Demand-Driven Points-to Analysis for Java.**
   Sridharan, M., Gopan, D., Bodik, R., Shan, L.,
   In *Proceedings of Object-Oriented Programming, Systems, Languages, and Applications (**OOPSLA**)*,
   pages 59–76, October 2005.

4. **Automatic verification of strongly dynamic software systems.**
   Dor, N., Field, J., Gopan, D., Lev-Ami, T., Loginov, A., Manevich, R., Ramalingam, G., Reps, T.,
   Rinetzky, N., Sagiv, M., Wilhelm, R., Yahav, E., Yorsh, G., In *Proceedings of Verified Software:
   Theories, Tools, Experiments (**VSTTE**)*, October 2005.

5. **A relational abstraction for functions.**
   Jeannet, B., Gopan, D., and Reps, T.,
   In *Proceedings of Static Analysis Symposium (**SAS**)*, pages 186–202, September 2005.

6. **A framework for numeric analysis of array operations.**
   Gopan, D., Reps, T., and Sagiv, M.,
   In *Proceedings of Symposium on Principles of Programming Languages (**POPL**)*, pages 338–350,
   January 2005.

7. **A relational abstraction for functions.**
   Jeannet, B., Gopan, D., and Reps, T.,
   In *Workshop on Numerical and Symbolic Abstract Domains (**NSAD**)*, January 2005.

8. **Numeric domains with summarized dimensions.**
   Gopan, D., DiMaio, F., Dor, N., Reps, T., and Sagiv, M.,
   In *Proceedings of Tools and Algorithms for the Construction and Analysis of Systems (**TACAS**)*, pages
   530–545, April 2004.

Publication Submissions

1. **Guided Static Analysis.**
   Gopan, D., Reps, T.,
   Submitted for review to *Static Analysis Symposium (**SAS**)*, 2007.

Technical Reports

1. **Numeric analysis of array operations.**
   Gopan, D., Reps, T., and Sagiv, M.,
   Technical Report 1516, Computer Sciences Department, University of Wisconsin, 2004.

Conference and External Seminar Presentations

- *Lookahead Widening.*
  18th Conf. on Computer-Aided Verification (**CAV**). Seattle, WA, August 2006.

- *Shape Analysis: Dealing with Numbers.*
  Rockwell Collins Advanced Technology Center. Cedar Rapids, IA, July 2005.

- *Numeric domains with summarized dimensions.*
  10th Tools and Algorithms for the Construction and Analysis of Systems (**TACAS**), Barcelona, Spain, April 2004.

Funding-Review Presentations

- *A framework for numeric analysis of array operations.*
  MURI Review. Arlington, VA, February 2005.

- *New approach to abstraction of numeric quantities.*
  MURI Review. Pittsburgh, PA, July 2003.

Professional Activities

External reviewer	Tools and Algorithms for the Construction and Analysis of Systems (**TACAS**), 2007
External reviewer	International Conference on Computer-Aided Verification (**CAV**), 2006
Reviewer	Journal of Higher-Order and Symbolic Computation (**HOSC**), 2006
External reviewer	International Conference on Computer-Aided Verification (**CAV**), 2005
External reviewer	Conference on Parallel Architectures and Compilation Techniques (**PACT**), 2001
External reviewer	Workshop on Optimization of Middleware and Distributed Systems (**OM**), 2001

Honors and Awards

2004–2006	Cisco Systems Distinguished Graduate Fellowship in Computer Science (UW CS Dept.)
2000	Department-sponsored summer research assistantship (UW CS Dept.) *adviser:* Rastislav Bodik
1995–1996	Deans Honor List (UW-Milwaukee CS dept.)

Industrial Experience

- **Software Engineer**   *Johnson Controls, Inc., Milwaukee, WI*   1996–1999
  Advanced Development Team

  Worked on Advanced Development Team designing an interactive development environment for programming distributed networks of controllers. Designed, implemented, and tested a compiler for the development environment. Participated in the design and troubleshooting of the programming language for the firmware. Worked closely with the end-users of the development environment: the control engineers. Provided maintenance for several related utilities, such as an editor and a debugger.