

Curriculum Vitae

Contact

Sriram Sankaranarayanan
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Employment

Aug 2009 - Present: Assistant Professor, Department of Computer Science,
University of Colorado, Boulder, CO, USA.

Oct. 2005 - Aug 2009: Research Staff Member
NEC Laboratories America, Princeton, NJ 8540, USA.

Education

Aug. 2005: PhD in Computer Science, Stanford University, Stanford, CA.

Dissertation: Mathematical Analysis of Programs.

Advisor: Prof. Zohar Manna.

Awards: Siebel Scholar (2005)

Sep. 2002: M.S. in Computer Science, Stanford University, Stanford, CA.

July 2000: B. Tech (Hons.) in Computer Science and Engg.,

Indian Institute of Technology, Kharagpur.

Ranked #1 (GPA) in graduating class of \sim 650 students.

Research Interests

Programming Languages & Software: Modeling and verification of Hybrid (Cyber-Physical) Systems. Numerical domain static analysis techniques.

Theory of Computation: Logic, optimization and automated constraint solving.

Other Interests: Control Theory. Statistical techniques: rare-event simulations, estimation and machine learning.

Awards and Honours

NSF Career Award Proposal titled “Automatic Analysis of Cyber-Physical Systems” (March 2010 - Feb 2015).

ACM SIGSOFT Distinguished Paper Award. For paper on deadlock analysis for concurrent library that appeared in Proc. of Automated Software Engg. Conference (ASE), November, 2009.

NEC Technology Commercialization Award. Successful technology transfer from research to a commercial product VARVEL, 2007.

Siebel Scholarship. Stanford University, 2004-2005.

President of India Gold Medal. Indian Inst. of Technology, Kharagpur, class of 2000.

Award Papers. RV’02, HSCC’04, VMCAI’05, TIME’05, ASE’09 and TACAS’09.

Ongoing Projects

Scull (2010-present): A programming framework for modeling and verification of numerical properties of control software. Scull integrates analysis at the source code level with reasoning over models of physical sub-systems expressed as switched Ordinary Differential Equations.

Funding: NSF CAREER Award: March 2010 - February 2015 (PI: Sankaranarayanan).

Rare Event Simulations: A framework for testing and predicting extremal properties of control software using *rare-event simulations*. Our foci include the use of Monte-Carlo techniques, importance sampling, cross-entropy method and techniques from extreme value theory for falsification of temporal properties.

Funding: NSF CNS Award #1016994, 8/1/2010-7/31/2013 (PI: Sankaranarayanan and Prof. Fainekos, Arizona State University).

Verifying Human-Computer Interfaces: A theory and framework for analyzing human-machine interactive cyber-physical systems. We are investigating techniques for modeling human interactions and possible failures of these interactions through *operator mistakes*.

Funding: NSF CPS Award #1035845, 9/1/2010-8/31/2013. (PI: Sankaranarayanan, Co-PI: Lewis).

Completed Projects

Verifying Reconfigurable Power Systems: Application of stochastic sampling and rare-event simulations for reconfigurable “smart-grid” power systems.

Funding: Joint Institute for Strategic Energy Analysis (NREL), 9/1/2010-6/30/2011 (PI: Prof. Suryanarayanan, Colorado State Univ., Co-PIs: Chang, Grunwald and Sankaranarayanan.)

F-Soft/Varvel (2005-2009): A static program analysis framework for finding bugs in programs by combining abstract interpretation and model checking. Currently F-Soft tool and the underlying technologies are being productized by NEC Japan under the name VARVEL(tm).

CoBE (2006-2009): CoBE (Concurrency Bug Eliminator) is a visual and interactive static analysis toolkit for debugging, visualization and comprehension of concurrent multi-threaded programs.

TeSSA (2008-2009): Analysis of embedded controller software focussing on automotive control software. Currently developing analyses on *Simulink/Stateflow*(TM) models, especially using symbolic execution and static analysis.

SpecTackle (2007-2009): Property inference using both static analysis and dynamic testing along with statistical techniques such as machine learning. Currently under evaluation as a companion to the VARVEL product.

TimePass (2006-2009): Verification of hybrid control systems using time trajectory approximations for ordinary differential equations through positive invariant computation as well as guaranteed set-valued integration techniques over polyhedra.

StInG/LPInv(2003-2005): Academic toolkit for automatic synthesis of invariants. Based on ideas from my dissertation work at Stanford University.

Invited Talks, Seminars and Colloquia

Invariant Synthesis for Hybrid Systems, Dept. of Computer Science and Mathematics, Colorado School of Mines, Nov. 2011.

Formal Verification of Hybrid Systems, Institute for Mathematical Sciences, National University of Singapore, Sept. 2011.

Model-Based Testing of Human Machine Interfaces, University of Pennsylvania, Precise Seminar, Nov 2010.

Invariant Generation using Constraints, University of Pennsylvania, Architecture and Verification Seminar, Nov 2010.

Formal Verification of Hybrid Systems, CU Boulder, Applied Math Department, Oct. 2010.

Algebraic Techniques for Solving Reachability Problems in Continuous Systems, Computer Science & Engineering Seminar at Indian Institute of Technology, Kharagpur, India, June 2010.

Program Analysis and Geometry, Invited talk at BMAC seminar, Dept. of Computer Science, Colorado State University, Jan 2010.

Mathematical Analysis of Programs,

- Dept. of Electrical Engg. and Computer Science, University of Michigan, Ann Arbor, Apr. 2009.

- Dept. of Computer Science, University of Wisconsin, Madison, Apr. 2009.
- Dept. of Computer Science, University of California, Davis, Mar. 2009.
- Dept. of Computer Science, University of Colorado, Boulder, Mar. 2009.

Abstract Interpretation for Continuous and Hybrid Systems, Dept. of Computer Science, École Polytechnique, Paris, France, Sep. 2008.

Path Sensitive Program Analysis Techniques, Microsoft Research, Redmond, Aug. 2008.

State-Space Exploration Using Monte-Carlo Sampling, Computer Science Seminar, SUNY, Stony Brook, Dec. 2007.

State-Space Exploration Using Monte-Carlo Sampling, North Eastern Verification Seminar (NEVER), Univ. Pennsylvania, Sept. 2007.

LOLA: Runtime Monitoring for Synchronous Systems, Dagstuhl Seminar on Runtime Verification, Schloss Dagstuhl, Germany, Jan 2007.

Polyhedral Analysis of Software, Workshop on Constraints in Verification, Isaac Newton Institute of Mathematical Sciences, Cambridge University, UK, May 2006.

Scalable Analysis of Software using Polyhedra, Analysis of Computer Systems Seminar, Dept. of Computer Science, New York University, Feb. 2006.

Mathematical Analysis of Programs, Microsoft Research, Redmond, April 2005.

Mathematical Analysis of Programs, Departmental Colloquium, Computer Science, New York University, March 2005.

Scalable Analysis of Linear Systems using Mathematical Programming, Max Planck Institut für Informatik, Saarbruecken, Germany, Jan. 2005.

Teaching

Instructor: Courses taught at CU Boulder.

- Discrete Structures (CSCI 2824), Spring 2011, 2012.
- Linear Programming (CSCI 5654), Fall 2009, 2011.
- Complexity of Computations (CSCI 7154), Fall 2010.
- Automata For Cyber-Physical Systems (CSCI 4830/7000), Spring 2010.

Guest Lecturer: Program Analysis, Fall 2007, Univ. Pennsylvania (Instructor: Rajeev Alur). Three guest lectures on *Abstract Interpretation*.

Teaching Assistant: Automata and Complexity Theory, Stanford University, Winter 2001 (Robert Van Glabbeek), Fall 2004 (David Dill).

Logic and Automated Reasoning, Fall 2001, (Zohar Manna),

Formal Methods for Reactive Systems, Winters 2002 and 2004. (Zohar Manna),

Professional Service

Guest Editor: Guest editor for the following special issues:

- ACM Trans. on Embedded Computing Systems Special Issue on Verification of Cyber-Physical Systems (In progress, 2010).
- Formal Methods in Systems Design, special issue on Numerical Software Verification, In press, 2010.

Program Committees: Member of Technical Program Committee:

- VMCAI 2012, HSCC 2012, CAV 2012, SAS 2012.
- APLAS 2011, CAV 2011, VMCAI 2011.
- Hybrid Systems: Computation and Control, 2009 and 2010.
- Numerical and Symbolic Abstract Domains (NSAD 2010).
- Intl. Conference on Software Engg. (ICSE), New and Emerging Research Track, 2010.
- Numerical Software Verification (NSV 2010), 2010.

Workshop Organizer: Co-Organizer of the following workshops:

- Workshop on Numerical Verification of Cyber-Physical Software (July'2010, Snowbird, UT).
- Workshop on Numerical Verification of Cyber-Physical Software (proposed date March'09 in San Francisco, CA).
- Workshop on Numerical Software Verification (NSV), July 2008, Princeton, NJ.
- Third North Eastern Verification Seminar (NEVER), May 2007.

PhD Students: Advisor to the following PhD students:

- Aleksandar Chakarov, University of Colorado, Boulder.
- Arlen Cox (co-advised with Evan Chang), University of Colorado, Boulder.
- Aditya Zutshi, Dept. of ECEE, University of Colorado, Boulder.

MS Students: Advisor to the following graduate students (MS):

- Huxley Bennett (CSCI, CU Boulder).

BS Students: Advisor to the following undergraduate students:

- Nathan Lapinski (Major: CSCI).

Graduated Students: The following students were advised by me during their studies at CU Boulder.

- Sidartha Sam Flavio Gracias (MS in CSCI, Dec. 2011).
- Hadjar Homaei (MS in CSCI, Aug. 2011).

Thesis Committees: Member of the following thesis committees

- Hyojung Han, University of Colorado, Boulder, PhD, 2011.
- Hyondeuk Kim, University of Colorado, Boulder, PhD, 2011.
- Olivier Boissiou, Ecole Polytechnique (France), PhD, 2008.

Referee: *Automatica*, *Formal Methods in Systems Design*, *J. Theoretical Comp. Sci*, *J. Satisfiability*, *IEEE Trans. on Automatic Control*, *ACM Trans. on Design of Electronic Systems*, *J. Symbolic Computation*, *POPL'05-'07*, *PLDI'07*, *CAV'05-'09*, *TACAS '07-'11*, *LICS'11* and *many others*.

Publications

Note: The DBLP server maintains an up to date index of computer science related publications at <http://www.informatik.uni-trier.de/~ley/db/>.

Journals

- [AFSIG12] Houssam Abbas, Georgios Fainekos, Sriram Sankaranarayanan, Franjo Ivancic, and Aarti Gupta, *Probabilistic temporal logic falsification of cyber-physical systems*, *ACM Transactions on Embedded Computing Systems (TECS)* (2012), (to appear).
- [DES11] Jyotirmoy V. Deshmukh, E. Allen Emerson, and Sriram Sankaranarayanan, *Symbolic modular deadlock analysis*, *Autom. Softw. Eng.* **18** (2011), no. 3-4, 325–362.
- [SSM08] Sriram Sankaranarayanan, Henny Sipma, and Zohar Manna. Constructing invariants for hybrid systems. *Formal Methods in System Design*, 32(1):25–55, 2008.
- [FSS05] Bernd Finkbeiner, Sriram Sankaranarayanan, and Henny Sipma. Collecting statistics over runtime executions. *Formal Methods In System Design*, 27(3):253–274, 2005.
- [DCDS01] Pallab Dasgupta, P.P. Chakrabarti, Jatinder Deka, and Sriram Sankaranarayanan. Min-max computation tree logic. *Artificial Intelligence*, 127(1):137–162, 2001.
- [VPSS00] Pradeep Verma, B.S. Panwar, Arjun Singh, and S. Sriram. Metastability reduction by aperture transformation. *IEE Electronics Letters*, 36(6):501–503, 2000.

LNCS Chapters & Conference Proceedings (Peer Reviewed)

- [GSC12] Arlen Cox, Sriram Sankaranarayanan, and Bor-Yuh Evan Chang, *A bit too precise? bounded verification of quantized digital filters*, *Tools and Algorithms for the Construction and Analysis of Systems (TACAS)*, *Lecture Notes in Computer Science*, 2012, (to appear).
- [ST11] Sriram Sankaranarayanan and Ashish Tiwari, *Relational abstractions for continuous and hybrid systems*, *CAV*, *Lecture Notes in Computer Science*, vol. 6806, Springer, 2011, pp. 686–702.
- [SHL11] Sriram Sankaranarayanan, Hadjar Homaei, and Clayton Lewis, *Model-based dependability analysis of programmable drug infusion pumps*, *FORMATS*, *Lecture Notes in Computer Science*, vol. 6919, 2011, pp. 317–334.

- [IBGS+11] Franjo Ivancic, Gogul Balakrishnan, Aarti Gupta, Sriram Sankaranarayanan, Naoto Maeda, Hiroki Tokuoka, Takashi Imoto, and Yoshiaki Miyazaki, *Dc2: A framework for scalable, scope-bounded software verification*, ASE, IEEE, 2011, pp. 133–142.
- [BCSS11] Sam Blackshear, Bor-Yuh Evan Chang, Sriram Sankaranarayanan, and Manu Sridharan, *The flow-insensitive precision of andersen’s analysis in practice*, SAS, Lecture Notes in Computer Science, vol. 6887, 2011, pp. 60–76.
- [CSF11] Aleksandar Chakarov, Sriram Sankaranarayanan, and Georgios Fainekos, *Combining time and frequency domain specifications for periodic signals*, Runtime Verification (RV), Lecture Notes in Computer Science, Springer, 2011.
- [BS11] Huxley Bennett and Sriram Sankaranarayanan, *Model Counting Using the Inclusion-Exclusion Principle (Extended Abstract)*, Theory and Applications of Satisfiability Testing (SAT), Volume 6695 of Lecture Notes in Computer Science (LNCS), pp. 362–363, 2011.
- [S11] Sriram Sankaranarayanan, *Automatic Abstraction of Non-Linear Systems using Change of Variables Transformations*, Hybrid Systems: Computation and Control (HSCC), ACM Press, pp. 143 – 152, 2011.
- [ALFS11] Yeshwant Annapureddy, Che Li, Georgios Fainekos and Sriram Sankaranarayanan, *S-Taliro: A Tool for Temporal Logic Falsification of Hybrid Systems*, Tools and Algorithms for Construction and Analysis of Systems (TACAS), volume 6605 of Lecture Notes in Computer Science (LNCS), pp. 254–257, 2011.
- [CS11] Michael A. Colòn and Sriram Sankaranarayanan, *Generalizing the Template Polyhedral Domain*, Eurpoean Symposium on Programming (ESOP), volume 6602 of Lecture Notes in Computer Science (LNCS), pp. 176–195, 2011.
- [FCS11] Robert C. Frohardt, Bor-Yuh Evan Chang and Sriram Sankaranarayanan, *Access-Nets: Modeling Access to Physical Spaces*, Verification, Model-Checking and Abstract Interpretation (VMCAI’11), Volume 6538 of Lecture Notes in Computer Science (LNCS), pp. 184–198, 2011.
- [IGS10] Franjo Ivančić, Malay Ganai, Sriram Sankaranarayanan and Aarti Gupta, *Numerical Stability Analysis of Floating Point Computations using Software Model Checking*, ACM/IEEE Intl. Conference on Formal Methods and Models for Codesign (MEMOCODE), 2010, IEEE Press, pp. 49–58.
- [G+10] Sicun Gao, Malay Ganai, Franjo Ivančić, Aarti Gupta, Sriram Sankaranarayanan and Edmund Clarke, *Integrating Interval Constraint Propagation (ICP) with Linear Real Arithmetic (LRA) for deciding nonlinear real arithmetic*, Formal Methods in Computer-Aided Design (FMCAD), 2010, IEEE Press, pp. 81–89.
- [TS+10] Truong Nghiem, Sriram Sankaranarayanan, Georgios Fainekos, Franjo Ivančić, and Aarti Gupta, *Robust Falsification of Metric Temporal Logic Properties of Hybrid Systems using Monte-Carlo Sampling*, Hybrid Systems: Computation and Control, Apr. 2010, ACM Press, pp. 211–220.

- [S10] Sriram Sankaranarayanan, *Automatic Invariant Generation for Algebraic Hybrid Systems Using Ideal Fixed Points*, Hybrid Systems: Computation and Control, Apr. 2010, ACM Press. pp. 221–230.
- [HSIA10] William R. Harris, Sriram Sankaranarayanan, Franjo Ivančić, and Aarti Gupta, *Satisfiability modulo path programs*, ACM Principles of Programming Languages (POPL’10), ACM Press, Jan 2010. pp. 71–82.
- [FSIA09] Georgios E. Fainekos, Sriram Sankaranarayanan, Franjo Ivančić, and Aarti Gupta, *Robustness of simulink simulations*, Real-Time Systems Symposium, ACM Press, Dec 2009. pp. 345–354.
- [DAS09] Jyotirmoy Deshmukh, E. Allen Emerson, and Sriram Sankaranarayanan, *Symbolic deadlock analysis in concurrent libraries and their clients*, Automated Software Engg. (ASE), ACM Press, Nov 2009. (**Award Paper:** ACM SIGSOFT distinguished paper award). pp. 480–491.
- [BSIG09] Gogul Balakrishnan, Sriram Sankaranarayanan, Franjo Ivancic, and Aarti Gupta, *Refining the control structure of loops using static analysis*, EMSOFT, ACM, 2009, pp. 49–58.
- [KAIR+09] Aditya Kanade, Rajeev Alur, Franjo Ivancic, S. Ramesh, Sriram Sankaranarayanan, and K. C. Shashidhar, *Generating and analyzing symbolic traces of simulink/stateflow models*, CAV, Lecture Notes in Computer Science, vol. 5643, Springer, 2009, pp. 430–445.
- [KSG09] Vineet Kahlon, Sriram Sankaranarayanan, and Aarti Gupta, *Semantic reduction of thread interleavings in concurrent programs*, TACAS, Lecture Notes in Computer Science, vol. 5505, 2009, pp. 124–138. (**Award Paper:** Invited submission to Software Tools for Technology Transfer Journal, 2010).
- [SCIG08] Sriram Sankaranarayanan, Swarat Chaudhuri, Franjo Ivancic, and Aarti Gupta. Dynamic inference of likely data preconditions over predicates by tree learning. In *Intl. Symp. Software Testing & Analysis (ISSTA)*, pages 295–306. ACM, 2008.
- [SIG08] Sriram Sankaranarayanan, Franjo Ivancic, and Aarti Gupta. Mining library specifications using inductive logic programming. In *Intl. Symp. on Software Engg. (ICSE)*, pages 131–140. ACM, 2008.
- [BSI⁺08] Gogul Balakrishnan, Sriram Sankaranarayanan, Franjo Ivancic, Ou Wei, and Aarti Gupta. SLR: Path-sensitive analysis through infeasible-path detection and syntactic language refinement. In *SAS*, volume 5079 of *Lecture Notes in Computer Science*, pages 238–254. Springer, 2008.
- [SDI08a] Sriram Sankaranarayanan, Thao Dang, and Franjo Ivancic. A policy iteration technique for time elapse over template polyhedra. In *HSCC*, volume 4981 of *Lecture Notes in Computer Science*, pages 654–657. Springer, 2008.
- [SDI08b] Sriram Sankaranarayanan, Thao Dang, and Franjo Ivancic. Symbolic model checking of hybrid systems using template polyhedra. In *TACAS*, volume 4963 of *Lecture Notes in Computer Science*, pages 188–202. Springer, 2008.

- [SIG07] Sriram Sankaranarayanan, Franjo Ivancic, and Aarti Gupta. Program analysis using symbolic ranges. In *SAS*, volume 4634 of *Lecture Notes in Computer Science*, pages 366–383, 2007.
- [KYSG07] Vineet Kahlon, Yu Yang, Sriram Sankaranarayanan, and Aarti Gupta. Fast and accurate static data-race detection for concurrent programs. In *CAV*, volume 4590 of *Lecture Notes in Computer Science*, pages 226–239, 2007.
- [SCJI07] Sriram Sankaranarayanan, Richard M. Chang, Guofei Jiang, and Franjo Ivancic. State space exploration using feedback constraint generation and monte-carlo sampling. In *ESEC/SIGSOFT FSE*, pages 321–330. ACM, 2007.
- [SCSM06] Sriram Sankaranarayanan, Michael Colón, Henny B. Sipma, and Zphar Manna. Efficient strongly relational polyhedral analysis. In *VMCAI*, volume 3855 of *Lecture Notes in Computer Science*, pages 111–125, 2006.
- [SISG06] Sriram Sankaranarayanan, Franjo Ivancic, Ilya Shlyakhter, and Aarti Gupta. Static analysis in disjunctive numerical domains. In *SAS*, volume 4134 of *Lecture Notes in Computer Science*, pages 3–17, 2006.
- [SSM06] Sriram Sankaranarayanan, Henny Sipma, and Zohar Manna. Fixed point iteration for computing the time elapse operator. In *HSCC*, volume 3927 of *Lecture Notes in Computer Science*, pages 537–551, 2006.
- [DSSO05] Ben D’Angelo, Sriram Sankaranarayanan, César Sánchez, and Others. LOLA: runtime monitoring of synchronous systems. In *Proc. TIME’05*, pages 166–174. IEEE computer society, 2005. **Award Paper:** Invited to Information and Computation Journal.
- [SSM05] Sriram Sankaranarayanan, Henny B. Sipma, and Zohar Manna. Scalable analysis of linear systems using mathematical programming. In *Verification, Model-Checking and Abstract-Interpretation (VMCAI 2005)*, volume 3385 of *Lecture Notes in Computer Science*, 2005. **Award Paper:** Invited to Special Issue in J. Theoretical Computer Science.
- [SSM04c] Sriram Sankaranarayanan, Henny B. Sipma, and Zohar Manna. Non linear invariant generation using Gröbner bases. In *ACM Principles of Prog. Lang. (POPL 2004)*, pp.318–329, ACM Press, Jan. 2004.
- [SSM04b] Sriram Sankaranarayanan, Henny B. Sipma, and Zohar Manna. Constructing invariants for hybrid systems. In *Hybrid Systems: Computation and Control (HSCC 2004)*, volume 2993 of *Lecture Notes in Computer Science*, pages 539–555. Springer-Verlag, march 2004. **Award Paper:** Invited to appear in special issue of formal methods in systems design.
- [SSM04a] Sriram Sankaranarayanan, Henny B. Sipma, and Zohar Manna. Constraint-based linear-relations analysis. In *Static Analysis Symposium (SAS 2004)*, volume 3148 of *Lecture Notes in Computer Science*, pages 53–69. Springer-Verlag, August 2004.
- [CSS03] Michael Colón, Sriram Sankaranarayanan, and Henny Sipma. Linear invariant generation using non-linear constraint solving. In *Computer Aided Verification*, volume 2725 of *Lecture Notes in Computer Science*, pages 420–433. Springer-Verlag, July 2003.

- [SSS⁺03] César Sánchez, Sriram Sankaranarayanan, Henny Sipma, Ting Zhang, and David Dill. Event correlation: Language and semantics. In *EMSOFT*, volume 2855 of *Lecture Notes in Computer Science*, pages 323–339, 2003.
- [SSM03] Sriram Sankaranarayanan, Henny B. Sipma, and Zohar Manna. Petri net analysis using invariant generation. In *Verification: Theory and Practice*, volume 2772 of *Lecture Notes in Computer Science*, pages 682–701. Springer–Verlag, 2003. **Invited Paper.**
- [FSS02] Bernd Finkbeiner, Sriram Sankaranarayanan, and Henny Sipma. Collecting statistics over runtime executions. In *Runtime Verification (RV 2002)*, volume 70 of *Elec. Notes Theor. Comp. Sci*, 2002. **Award Paper:** Invited to appear in special issue in J. Formal Methods in Systems Design.

Other Information

Citizenship: India (Permanent Resident of USA).

Hobbies: Indian classical vocals and *veena* player.