Rekha R

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I am a Research Associate in the Department of Computer Science at Oxford University. My research interest is in Program Analysis for Verification.

Education

- 2009–2017 Ph.D, National Institute of Technology Calicut, Kerala, India.
- 2007–2009 M.Tech in Computer Science and Engineering, National Institute of Technology Calicut, Kerala, India, CGPA: 9.48 (Out of 10).
- 1998–2002 B.Tech in Computer Science and Engineering, Kerala University, Kerala, India, First Class with Distinction.

Research

Area of Program Analysis for Verification

interest

Current work "Verification of CHERI systems"

CHERI (Capability Hardware Enhanced RISC Instructions) extends conventional hardware Instruction-Set Architectures (ISAs) with new architectural features to enable fine-grained memory protection and highly scalable software compartmentalisation. The CHERI memory protection features allow unsafe programming languages such as C and C++ to be adapted to provide protection against many currently widely exploited vulnerabilities. The current work is to verify software systems adapted to run on CHERI hardware.

PhD Thesis "Detection of redundant expressions in SSA"

Elimination of redundant expressions in a program, based on values of expressions, is a compiler optimization done with a view to improve on the runtime efficiency of the program. The problem is complex enough to warrant a separation of the analysis and the optimization phases. The problem studied in detail for my PhD thesis is the detection of redundant expressions. An expression e is *redundant* if its value has already been computed. The problem is well studied but the state-ofart algorithms are either "precise" or polynomial-time computable but not both. The new perspectives on *confluence operation* and *values*, introduced in the thesis, has enabled combining precision with polynomial time computability. I proposed and implemented two algorithms to detect redundant expressions in Static Single Assignment (SSA) form of programs. The algorithms was adopted as an analysis pass in LLVM (v5.0.0) compiler by their principal developer Daniel Berlin.

- Masters "Partial Redundancy Elimination"
 - Thesis Partial Redundancy Elimination is a compiler optimization that eliminates expressions that are redundant on some but not necessarily all paths in a program. I proposed an algorithm to eliminate partially redundant expressions in programs. The algorithm uses only three uni-directional analyses.

Experience

I have over four years of research experience after doctoral study. I also have over 4½ years of experience as full time teacher and 5 years as teaching assistant during graduate studies and post doctoral work.

Research Associate

- Dec 2021 Research Associate with Prof. Tom Melham at Department of Computer Science, current University of Oxford.
- Oct 2018 UGC-Dr. DS Kothari Post Doctoral Fellow with Prof. Deepak D'Souza at Computer Oct 2021 Science and Automation, IISc Bangalore.
- Jul 2017 Research Associate with Prof. Deepak D'Souza at Computer Science and Automation,
 - Oct 2018 IISc Bangalore.

Teaching Assistant

2018–2020 Indian Institute of Science Bangalore

Assisted in the conduct of "Program Synthesis and Machine Learning" course. This course introduces the fundamentals of program synthesis and ML. Various methods to combine the aspects of ML into program synthesis were explored through paper discussions. 2020

Delivered lecture on "Kildall's Algorithm for Data Flow Analysis" for graduate students. Also assisted in the evaluation of course project in the Java based WALA framework. 2018

2009–2013 National Institute of Technology Calicut

Delivered lectures on "Foundations of Data Flow Analysis" for graduate students. The lectures are based on the text book "Compilers: Principles, Techniques, and Tools" by Aho, Lam, Sethi, and Ullman. 2011, 2012 Designed and assisted in Programming Lab for undergraduates. This lab course introduced techniques to control intellectual complexity of programs - in particular, procedural abstraction, data abstraction, and modular design. The course is based on the textbook "Structure and Interpretation of Computer Programs" by Gerald Jay Sussman and Hal Abelson. 2011, 2012 Assisted in Compiler Lab for undergraduates. This lab course involved implementation of a Simple Intermediate Language (SIL) designed in-house for the purpose.

2010, 2013

Designed and assisted in Programming Languages Lab for undergraduates. This lab involved implementation of Untyped and Typed Lambda Calculus and its variants, based on the textbook "Types and Programming Languages" by Benjamin C Pierce. The interpreter for these languages are written in *OCaml* provided along with the book. 2010, 2011, 2012

Lecturer

Sept College of Engineering, Perumon, Kerala, India.

- 2006–July $\,$ Offered the course on Computer Networks and E-commerce for undergraduates. 2007
 - Feb College of Engineering, Vadakara (Formerly Co-operative Institute of Tech-
- 2004–Aug nology Vadakara), Calicut, Kerala, India.
 - 2006 Offered courses on Design and Analysis of Algorithms and Software Engineering for undergraduates.

Lecturer on Ad hoc Basis

- Dec College of Engineering, Perumon, Kerala, India.
- 2002–Feb Offered courses on E-commerce and Software Engineering for undergraduates.
 - 2004

Publications

Suresh, V., Pai, R., D'Souza, D., D'Souza, M., Chakrabarti, S.K. Static Race Detection for Periodic Programs. In: Ilya Sergey. (eds) Programming Languages and Systems. ESOP 2022. Lecture Notes in Computer Science, vol 13240, pp. 290-316, Springer

Pai R., Singh A., D'Souza D., D'Souza M., Prakash P. Static Analysis for Detecting High-Level Races in RTOS Kernels. Formal Methods of Software Design (FMSD) 2021. IF: 0.673

Tulsyan R., Pai R., D'Souza D. Static Race Detection for RTOS Applications. In: Saxena N. and Simon S. (eds) 40th IARCS Foundations of Software Technology and Theoretical Computer Science (FSTTCS) 2020. LIPIcs vol 182, pp. 1–20, Schloss Dagstuhl

Singh A., Pai R., D'Souza D., D'Souza M. Static Analysis for Detecting High-Level Races in RTOS Kernels. In: ter Beek M., McIver A., Oliveira J. (eds) Formal Methods – The Next 30 Years. FM 2019. Lecture Notes in Computer Science, vol 11800, pp. 337–353. Springer, Cham

Chopra N., Pai R., D'Souza D. Data Races and Static Analysis for Interrupt-Driven Kernels. In: Caires L. (eds) Programming Languages and Systems. ESOP 2019. Lecture Notes in Computer Science, vol 11423, pp. 697–723. Springer, Cham

Pai, Rekha R. Detection of Redundant Expressions: A Precise, Efficient, and Pragmatic Algorithm in SSA. Computer Languages, Systems, and Structures, 2016. vol 46, pp. 167–181. IF: 0.5

Pai, Rekha R. Detection of Redundant Expressions: A Complete and Polynomial-time Algorithm in SSA. In the Proceedings of Asian Symposium of Programming Languages and Systems (APLAS) 2015. LNCS 9458, pp. 49–65, Springer International Publishing Switzerland

Workshops/Schools Attended

Workshop on Research Highlights in Programming Languages co-located with 40^{th} IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS) 2020 (online event). December 15 – 17, 2020.

Winter School in Software Engineering, TRDDC Pune, India. December 11 – 16, 2017.

The Second Indian SAT+SMT School, Infosys Campus, Mysore, India. December 6 – 8, 2017.

The First Indian SAT+SMT School, TIFR Mumbai, India. December 4 – 10, 2016.

AVeRTS: Algorithmic Verification of Real-Time Systems (a post FSTTCS Workshop), IISc Bangalore, India. December 19, 2015.

Design and Analysis of Algorithms, IIITM-K, Thiruvananthapuram, India. April 24 – 29, 2015.

Essential Abstractions in GCC '12, IIT Bombay, India. June 30 – July 03, 2012.

Second International Summer School on Trends in Concurrency, TiC'10, IIIT Bangalore, India. May 23 – 29, 2010.

Professional Service

Program Committee member of the 8^{th} Workshop on Advances in Programming Languages, 2-5 September, 2021, online.

Program Committee member of the 7^{th} Workshop on Advances in Programming Languages, 1-4 September, 2019, Leipzig, Germany.

Program Committee member of the 6^{th} Workshop on Advances in Programming Languages, 3-6 September, 2017, Prague, Czech Republic.

Program Committee member of the Programming Languages track at the 32^{nd} ACM Symposium on Applied Computing, 3 - 7 April 2017, Marrakech, Morocco.

Research Affairs Secretary of NIT Calicut ACM Student Chapter, 2013.

Volunteered for Indo-US Workshop on Biocomputing (ISB 2011), jointly organised by NIT Calicut and Indiana University Purdue University Indianapolis held at Calicut, Kerala.

Volunteered for International Symposium on Bio-Computing (ISB 2010), jointly organised by NIT Calicut and Indiana University Purdue University Indianapolis in cooperation with ACM held at Calicut, Kerala.

Faculty-in-charge of Indian Society for Technical Education (ISTE) Student's Chapter at College of Engineering Perumon, 2006 – 2007.

Warden of Ladies Hostel at College of Engineering Vadakara, 2004 – 2006.

Achievements

UGC-Dr. DS Kothari Post Doctoral Fellowship for the period 2018-21 SERB-National Post Doctoral Fellowship for the period 2018-20 National Eligibility Test (NET) qualified for Assistant Professor position ACM-Women Scholarship for attending APLAS'15 held at Pohang, South Korea, 2015 ACM-India/IARCS Travel Grant for attending APLAS'15 held at Pohang, South

Korea, 2015

MHRD Government of India PhD Scholarship 2009-2013

Graduate Aptitude Test in Engineering (GATE) Scholarship 2007-2009

Professional Body Membership

Professional member of Association of Computing Machinery (ACM)

Invited Talks

Delivered a lecture on *Static Race Detection in Embedded Systems* in the Workshop on Research Highlights in Programming Languages co-located with 40th IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS) 2020.

Delivered a lecture in the Faculty Development Programme on *Syntax Directed Translation* sponsored by *TeQIP* Phase-II at College of Engineering Perumon on April 2016.

Delivered a lecture in the Faculty Development Programme on *Program Analysis and Transformation* sponsored by *TeQIP* Phase-II at College of Engineering Thalassery on December 2015.

Delivered a lecture in the Faculty Development Programme on *Compiler Design and Optimization Techniques* sponsored by *TeQIP* Phase-II at LBS Institute of Technology for Women Trivandrum on January 2014.

Delivered a lecture on *Compiler Construction: An Overview* as part of TeQIP Phase-II funded one day workshop at College of Engineering Vadakara. March 2013.

References

Deepak D'Souza, Professor, Department of Computer Science and Automation Indian Institute of Science Bangalore, India. deepakd@iisc.ac.in

Vineeth Paleri, Professor, Department of Computer Science and Engineering National Institute of Technology Calicut. Kerala, India. vpaleri@nitc.ac.in