

## Vitae

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### Education:

B.E. (Electronics and Communication Engg.) Indian Institute of Science,  
Bangalore, 1981

M.S. (Computer Science), Indian Institute of Technology, Madras, 1983.

Ph.D. (Computer Science), University of Minnesota, 1987.

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### Recent Professional Activities:

- Invited speaker, *Workshop on Benford Distribution and Applications*, Santa Fe, New Mexico, December 17-18, 2008.
  - *Invited speaker, Workshop on Descriptive Complexity of Formal Systems*, Prince Edwards Island, July 2008.
  - Program Co-chair, *Conference on Implementation and Application of Automata*, San Francisco, July 16 – 19, 2008.
  - Member of Program Committee, *Conference on Implementation and Application of Automata*, Prague, Czech Republic, July 2007.
  - Member of the program committee, *Descriptive Complexity of Formal Systems*, July 2006.
  - Member of the program committee, *Developments in Language Theory, June 2006*, Santa Barbara, 2006.
  - *External reviewer, Tenure committee* of Dr. Mark Daley, University of Western Ontario, CA.
  - *External member of Thesis Committee* of Dr. Nick Santean, University of Western Ontario, CA.
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### Teaching:

#### Recent courses taught:

- [CS 415 Algorithm Analysis](#)
- [CS 454 Theory of Computation](#)
- [CS 480 Artificial Intelligence](#)
- [CS 460 Programming Languages](#)
- [CS 351 Computer Architecture](#)
- [CS 370 Software Design and Development](#)

## Graduate Courses:

- CES 514 Data Mining
  - CES 516 High-Performance Computing
  - CES 512 Theory of Software Systems
  - CES 524 Advanced Computer Architecture
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## Undergraduate Directed Study Projects Supervised

- A graph-theoretic tool for sequence analysis (Bob Thomas)
- A visualization tool for BLAST algorithm (Steve French)
- Game development on a PDA (Mike Heaviside)
- A regular expression synthesis tool

## Graduate Theses supervised:

Some graduate students who recently completed their thesis with me are:

- **Ethan Stone** (Parallel Sorting on a Coarse-grained Parallel Computer)
- **Xiao-ming Lu**, A new DFA minimization algorithm and its application to some counting problems
- **Mari Rajakumari** (A Tablet PC Application)
- **Madhavi Danduluri** (A clustering algorithm and its application to web document processing)
- **Betty Zhang** (Implementation of Periodic Balanced Sorting on a Linux Cluster)
- **Krithika Krishnarajan** (Design and implementation of an automated software testing tool)
- **Kevin Nishinaga** (Real-time recognition of Japanese hand-writing on a tablet PC environment)
- **Renato Vasquez** (An independent protocol suite design for wireless networks)
- **Srilatha Jandhyala** (A fast approximate multiplication algorithm and its implementation)
- **Rama Muthukumaraswamy** (Recognizing hand-written mathematical expressions using a tablet PC).

Current students working on their Masters thesis or project are: **Bruce Beauchamp, Steve Bottarini, Raksha Gundarahalli, Jeba Sanchin and Antonio Navarro** and **Steve Olson**.

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## Recent papers

**A simple multiplication game and its analysis**, accepted for publication in the *International Journal of Combinatorial Number Theory*.

**Benford-Newcomb distribution and unambiguous context-free languages**, accepted for publication in *Journal of Foundations of Computer Science*.

**Decimation of formal languages and state complexity**, (with Kreiger, Shallit, and Ramparsad), accepted for publication in *Theoretical Computer Science*.

**On unique operations and the state complexity of regular languages**, (with Santean, Ramparsad and Shallit), accepted for publication in *Theoretical Computer Science*.

**Quality-Aware Service Delegation in Automated Web Service Composition**, (with Ibarra, Gerede and Su), accepted for publication in *Theoretical Computer Science*.

**Efficient Implementation of algorithms for approximate exponentiation** (with Kooshesh) to appear in *Information Processing Letters*, Feb 2008.

**Row completion problem for SUDOKU**, (with Kananaa), accepted for publication in *Utilitas Mathematica*.

**On some variations of probabilistic finite automata**, accepted for presentation at the international conference on *Developments in Language Theory, Santa Barbara, June 2006*.

**On partially blind multihead finite automata** (with O. Ibarra), in *Theoretical Computer Science*. 356(1-2): 190-199 (2006)

**Some connections between the lying oracle problem and Ulam's search problem**, in the proceedings of the *Australasian Workshop on Combinatorial Algorithms*, September 21-24, 2005, University of Ballarat, Victoria, Australia. Revised version submitted for journal publication.

**QoS-aware Delegation in Automated Web Service Composition**, (with O. Ibarra and Gerede), accepted for publication in the *Journal of Automata, Languages and Combinatorics*.

**On-line and ad-hoc minimum cost delegation in e-service composition** (with Gerede, Ibarra and Su, UC Santa Barbara), presented at the *IEEE International Conference on Services Computing*, Orlando, Florida, July 15-18, 2005.

**On the approximation of non-regular languages by regular languages**, (with G.Eisman), accepted for presentation at the *Australian Computer Science Conference*, New Castle, Australia, January 31, 2005 to February 4, 2005. (revised version submitted to *Theoretical Computer Science*.)

**A Fibonacci Search Algorithm for a Two-person Search Game** (with G.Cooper), presented at the Conference on *Foundations of Computer Science*, June 27-29, 2005, Las Vegas, Nevada.

**An efficient algorithm for approximate exponentiation**, (with A.Kooshesh), presented at the Conference on *Foundations of Computer Science*, June 27-29, 2005, Las Vegas, Nevada.

**Implementation of optimized periodic balanced sorting algorithm on a linux cluster**, (with Betty Zhang), submitted to JPDC.

A generating function approach to fast computation of the n-th term of a linear recurrence equation and some applications. Submitted to *Math Magazine*.

**Las Vegas randomized approximation algorithm for approximate exponentiation and some applications** (submitted to *Mathematical Foundations of Computer Science, 2008*).

**Mapping balanced sorting algorithm on a course-grained parallel processor**, (with Ethan Stone) presented in *Hawaii International Conference on Computer Sciences*. (January 15-18, 2004).

**Weak minimization of DFA - an algorithm and applications**. Presented at the Conference on Implementation and Applications of Automata 2003, Santa Barbara, July 16-18, 2003

**Counting simple paths in a restricted grid**. (unpublished manuscript).

**Efficient algorithms for prefix grammars** (with Liang Quan) submitted for publication.

[Application of Halls theorem to a card trick](#) (with D. Innes), *SIAM Conference on Discrete Mathematics 2002, San Diego, August 13, 2002*. (revised version in preparation)

[A Fault-Tolerant Merge Sorting Algorithm](#), presented at the *Eighth International Conference on Computing and Combinatorics*, Singapore, August 15-17, 2002. Springer-Verlag Lecture Notes in Computer Science, pp. 440-447.

[Foveated texture mapping in JPEG 2000 for 3D animation applications](#), presented in *International Conference on Image Processing*, Greece, October 10-14, 2001. Proceedings published by IEEE Computer Society Press.

[A note on maximal prefix codes](#). in *Workshop on Coding Theory*, London, Ontario, August 1 - 3 (2000). (co-author: D. Innes)

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#### **Selected Journal Publications: (prior to 2004)**

**Weak minimization of DFA - an algorithm and applications**. (with G.Eisman), in *Theoretical Computer Science*, Volume 328, Issues 1-2, 29 November 2004, Pages 113-133.)

**Peg-solitaire, string rewriting systems and finite automata**, in *Theoretical Computer Science*, Volume 321, Issues 2-3, 16 August 2004, pages 383-394.

A simplified NP-complete MAXSAT problem. *Information Processing Letters*, 65(1):1-6, 15, January 1998. (co-authors: Venkatesh Raman, S. Srinivasa Rao.)

Minimal NFA problems are hard. *SIAM Journal on Computing*, 22 (1): 1117-1141 (1993). (co-author: T. Jiang)

A note on the space complexity of some decision problems for finite automata. *Information Processing Letters*, 40(1):25-31, 11 October 1991. (co-author: T. Jiang)

Structure and complexity of minimal NFA over a unary alphabet. *International Journal of Foundations of Computer Science*. 2(2), 163-182 (1991). (co-authors: T. Jiang and E. McDowell).

Coping with errors while sorting. *IEEE Transactions on Computers*. 40 (9), 1081-1084 (1991). (co-authors: K.B. Lakshmanan and K. Ganesan)

Some languages in NC, *Information and Computation*. 90 (1991), 86-106. (co-authors: J. Chang, O. Ibarra and T. Jiang.)

Bounds on the size of test sets for sorting and other related networks. *Discrete Mathematics* 81 (1990), 1 - 9. (co-author: M. J. Chung).

Relating the degree of ambiguity of finite automata to the succinctness of their representation. *SIAM Journal on Computing*. 18 (6), 1263-1282 (1989). (co-author: O. Ibarra)

Strong non-deterministic Turing reduction - A technique for proving intractability. (Invited paper) *Journal of Computer and System Sciences*. 39 (1), 2-20 (1989). (co-author: M. J. Chung)

Some subclasses of context-free languages in NC<sup>1</sup>. *Information Processing Letters*, 29(3):111-117, 26 October 1988. (co-authors: O. H. Ibarra, T. Jiang)

Sublogarithmic space Turing machines, non-uniform space complexity and closure properties. *Mathematical System Theory*. 21 (1988), 1-17. (co-author: O. Ibarra).

Some observations concerning alternating Turing machines using small space. *Information Processing Letters*, 25(1):1-9, 20 April 1987. (co-authors: J. H. Chang, O. Ibarra, and L. Berman.)

On pebble automata. *Theoretical Computer Science* 44 (1986), 111-121. (co-authors: M. Palis and O. Ibarra).

Coping with known patterns of errors in a binary search game. *Theoretical Computer Science* 33 (1984), 85-94. (co-author: K. B. Lakshmanan).

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## Selected Refereed Conference Publications (prior to 2003)

*Weak minimization of automata - An algorithm and its applications*, Presented at the Conference on Implementation and Applications of Automata, Santa Barbara, July 2003.

*A fault-tolerant merge sorting algorithm*, presented at the Eighth Annual International Conference on Computing and Combinatorics, Singapore, August 2002.

*Foveated texture mapping in JPEG 2000 for 3D animation applications*, presented at the **International Conference on Image Processing**, Greece, October 10-14, 2001.

*A note on maximal prefix codes*. in **Workshop on Coding Theory**, London, Ontario, August 1 - 3 (2000). (co-author: D. Innes).

*Parallel algorithms for finite automata problems*. (invited presentation), **Workshop on Randomized Parallel Algorithms, IPPS**, March 1998, Orlando, Florida.

*Peg-solitaire, string rewriting systems and finite automata*. Talk presented at the **Symposium on Algorithms and Computation**, December 1997, Singapore. Proceedings published by Springer-Verlag in the series: Lecture Notes in Computer Science.

*Implementing sequential and parallel programs for homing sequence problem* Talk presented at the **Workshop on Implementation of Finite Automata**, London, Ontario, August 1996. Proceedings published as lecture notes in computer science by Springer-Verlag. (co-author: X. Xiong)

Randomized parallel algorithm for the homing sequence problem. Talk presented at the **Twenty-fifth annual IEEE Conference on Parallel Processing**, Chicago, 1996. Proceedings published by IEEE Computer Society Press. Vol 3, pp. 82-89. (co-author: X. Xiong)

Parallel algorithm for minimization of finite automata. Talk presented at the **Tenth Annual IEEE International Parallel Processing Symposium**, Honolulu, Hawaii, April 1996. (co-author: X. Xiong)

A deterministic parallel algorithm for the homing sequence problem. Talk presented at the Ninth **Annual IEEE Symposium on Parallel and Distributed Processing**, New Orleans, LA, October 1996.

Existence of synchronizing sequence in regular DFA's - A probabilistic proof. Talk presented at the **Sixth Annual Conference on Random Structures and Algorithms**, Atlanta, Georgia, March 1995. (co-author: D. Innes)

A linear time algorithm for peg-solitaire on  $k$  by  $n$  board and other generalizations. Talk presented at *Twenty-fifth Annual South Eastern Conference on Graph Theory, Combinatorics and Computing*, Boca Raton, Florida, March 1994.

Median finding using unary predicates. Talk presented at the *Sixth Annual SIAM Conference on Discrete Mathematics*. Van Couver, BC, Canada, June 1992.

A note on checking matrix products. Talk presented at the *ACM Symposium on Applied Computing*, Kansas City, MO, March 1992. Proceedings published by ACM Press, pp. 937-943.

Some observations on 2-way probabilistic finite automata. Talk presented at the *Twelfth Conference on Foundations of Software Technology and Theoretical Computer Science*, New Delhi, India, December 1991. Proceedings published by Springer-Verlag, pp. 392-403.

The structure and complexity of minimal NFA over a unary alphabet. Talk presented at the *Eleventh Annual Conference on Foundations of Software Technology and Theoretical Computer Science*, New Delhi, India, December 1990. Proceedings published by Springer-Verlag, pp. 151-171. (co-authors: T. Jiang and E. McDowell)

Minimal NFA problems are hard. In Javier Leach Albert and Burkhard Monien and Mario Rodríguez-Artalejo, editors, *Automata, Languages and Programming, 18th International Colloquium*, volume 510 of Lecture Notes in Computer Science, pages 629-640, Madrid, Spain, 8-12 July 1991. Springer-Verlag. (co-author: T. Jiang)

On some languages in  $NC^1$ . Talk presented at the *First Aegean Workshop on Computing*, Corfu Islands, Greece, June 1988. Proceedings published by Springer-Verlag, pp. 86-106. (co-authors: J. Chang, T. Jiang and O. Ibarra)

Relating the degree of ambiguity of finite automata to the succinctness of their representations. Talk presented at the *Seventh Annual Conference on the Foundations of Software Technology and Theoretical Computer Science*, Bangalore, India, December 1987. (co-author: O. Ibarra)

Bounds on the size of test sets for sorting and related networks. Talk presented at the *International Conference on Parallel Processing*, Chicago, 1987. Proceedings published by IEEE Computer Society Press.

Coping with errors in selection. Talk presented at the *Fourth Annual Symposium on Theoretical Aspects of Computer Science*, Germany, 1987. (co-authors: K.B. Lakshmanan and K.Ganesan). Proceedings published as Lecture Notes in Computer Science.

On pebble automata. Talk presented at the *Twentieth Annual Conference on Information Sciences and systems*, Princeton, NJ, 1986. (co-authors: M. Palis, O. Ibarra and J. Chang).

On sparseness, ambiguity and other decision problems for acceptors and transducers. Talk presented at the *Third Annual Symposium on Theoretical Aspects of Computer Science*, Orsay, France, 1986. (co-author: O. Ibarra) Proceedings published by Springer-verlag as a volume of Lecture Notes in Computer Science series.

Coping with known patterns of lies in a search game. Talk presented at the *Third Annual Conference on the Foundations of Software Technology and Theoretical Computer Science*, Bangalore, India (1983). (co-author: K.B. Lakshmanan)

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#### **Grants and Awards:**

- National Science Foundation Grant. \$ 36000 for the period 1991-1994 for a proposal titled "New Directions in the Study of Finite Automata".
- Champlin Foundation Grant. \$ 65000 for the academic year 1999-2000. Proposal: "Advanced Graphics and Multimedia Laboratory" (offered to Computer Science Department).
- URI Foundation Research Grant \$ 6000 for the summer of 1989 for proposal titled "New Techniques for proving Hardness of Combinatorial problems".
- Feinstein Foundation Grant (state of Rhode Island) \$ 5000 for the period Summer 1999 and Fall 1999 for a proposal titled "Interactive Graphics Enhancement to the courseware Math 108".
- Two research grants from URI Research office for \$ 3700 in Fall 1999 to acquire head-mounted display (HMD) and other peripherals (data-glove) for a graphics workstation.
- Award of \$ 1400 by URI Foundation for a proposal to upgrade computer science department library.
- Travel grant of \$ 1500 from the Provost's office at the University of Rhode Island during Summer 1991 to attend a conference and a workshop.

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#### **Professional Activities (prior to 2004):**

Session Chair, Conference on Implementation and Applications of Automata, July 2003, Santa Barbara.

Member of program Committee: 17<sup>th</sup> Annual Conference on Foundations of Software Technology and Theoretical Computer Science, Kharagpur, India, December 1997.

Member of Program Committee, Second Workshop on Implementation of finite automata, London, Ontario, September 1997.

Session chair, Sixth Annual Parallel and Distributed Processing, New Orleans, 1996.

Member of program committee, North-Atlantic Workshop on Testing, 1995-97.



Referee for numerous journals including: Theoretical Computer Science, Mathematical System theory, SIAM Journal on Computing, SIAM Journal on Discrete Mathematics, Discrete Applied Mathematics, Discrete Mathematics, Journal of Parallel and Distributed computing, IEEE Transactions on Computers, Information Processing Letters, Information and Computation, International Journal of the Foundations of Computer Science and several others.  
Refereed papers for numerous conferences including: FOCS, ICALP, FST & TCS, FCT, MFCS, International Conference on Algorithms and Computation, COCOON, Conference on Implementation of Automata, ISAAC, Developments in Language Theory etc.

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### **Book Chapters**

Formal Models and Computability, Chapter 1 in *Handbook of Computer Science and Engineering*, *CRC Press*, A. Tucker, Editor. (co-authors: M. Li and T. Jiang) 1998

Basic Notions of Computational Complexity, Chapter 30 in *Handbook of Algorithms and Computation*, *CRC Press*, M. Attalah, Editor. (co-authors: M. Li and T. Jiang) 1999

Formal Languages and Grammars. Chapter 31 in *Handbook of Algorithms and Theory of Computation*, *CRC Press*, M. Attalah, Editor. (co-authors: M. Li, T. Jiang and K. Reagan) 1999.

Computability, Chapter 32 in *Handbook of Algorithms and Theory of Computation*, *CRC Press*, M. Attalah, Editor. (co-authors: M. Li, T. Jiang and K. Reagan) 1999

Parallel algorithms for finite automata problems, Chapter 10 in *Advances in Randomized Parallel Computing*, P. Pardalos and S. Rajasekaran, Editors. Kluwer Academic Publishers.

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### **List of Ph.D. students Supervised (at the University of Rhode Island)**

- Timothy Henry (completed 2001) Foveated Texture Mapping from Wavelet Compressed Images. Current position: Lecturer, Department of Computer Science, University of Rhode Island, Kingston, RI 02881.
- Shlomo Neeman (completed, October 2000) *Application of Wavelets in Image Query and Mammography*. Current position: Assistant Professor, Division of Engineering, Johnson-Wales University, Providence, Rhode Island.
- Xuefeng Xiong (completed 1996) *Parallel algorithms for finite automata problems*. Current position: Member of Technical Staff, Parallel system design group, Compaq-DEC, Massachusetts.

- Duncan Innes (ABD) *Synchronization sequence for automata and prefix codes.*
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