Randal E. Bryant

Education

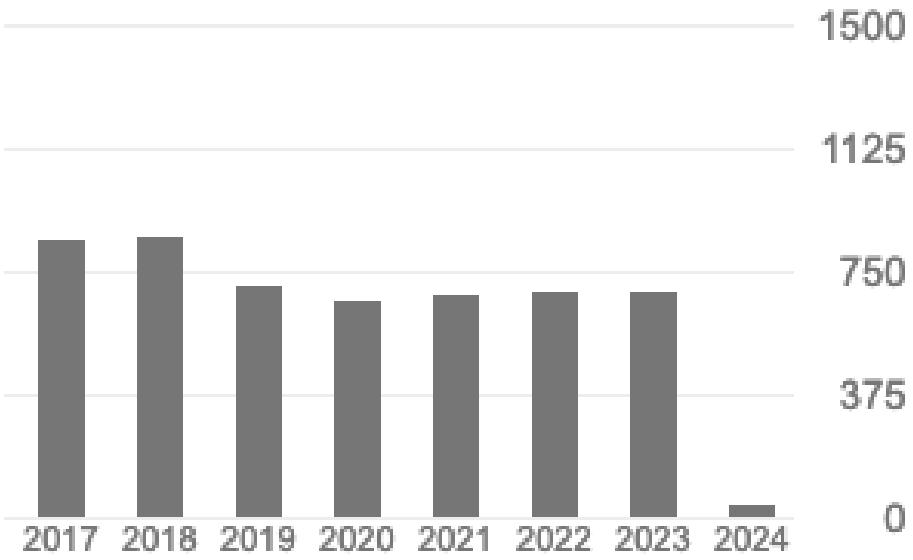
1974–1981	Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, S.M. (1977), E.E. (1978), PhD (1981). Thesis Supervisor: Prof. Jack B. Dennis. MS Thesis Title: "Simulation of Packet Communication Architecture Computer Systems." PhD Thesis Title: "A Switch-Level Simulation Model of Integrated Logic Circuits."
1970–1973	University of Michigan, College of Engineering (Applied Math), B.S. (1973).

Employment

2020–present	Founders University Professor of Computer Science Emeritus, Carnegie Mellon University. Research areas: Boolean satisfiability, formal hardware and software verification.
2004–2020	University Professor of Computer Science, Carnegie Mellon University. Research areas: formal hardware and software verification, system testing, and computer science education. Teaching subjects: computer systems, distributed systems, parallel computing.
2014–2015	Assistant Director for Information Technology Research and Development, White House Office of Science and Technology Policy. Activities in: robotics, machine learning, high-performance computing, semiconductor technology, and cloud computing.
2004–2014	Dean, School of Computer Science, Carnegie Mellon University.
1999–2004	Head, Computer Science Department, Carnegie Mellon University.
1997–2004	Robert Mehrabian Professor of Computer Science, Carnegie Mellon University. Research areas: formal hardware and software verification, computer security. Teaching subjects: computer systems, computer networking, algorithms.
1992–1997	Professor of Computer Science, Carnegie Mellon University. Research areas: VLSI circuit verification, symbolic manipulation, and parallel computation. Teaching subjects: computer architecture
1987–1992	Associate Professor of Computer Science, Carnegie Mellon University. (Tenure granted Sept., 1990.) Research areas: VLSI simulation, VLSI circuit verification, symbolic manipulation, and parallel computation. Teaching subjects: introductory computer science, computer architecture, advanced VLSI design.
1990–1991	Visiting Research Fellow, Fujitsu Laboratories, Ltd., Kawasaki, Japan.
1984–1987	Assistant Professor of Computer Science, Carnegie Mellon University.
1984–present	Courtesy appointment in Electrical and Computer Engineering, Carnegie Mellon University.
1981–1984	Assistant Professor of Computer Science, California Institute of Technology. Research areas: VLSI circuit models, logic simulation, and circuit testing. Teaching subjects: computer architecture, digital systems theory, and computer algorithms.

Publication and Research Highlights

	All	Since 2019
Citations	32714	3469
h-index	60	21
i10-index	147	40



Google Scholar Citation Count. Downloaded 14-Feb-2024.

Most Cited Publications

1. R. E. Bryant, "Graph-Based Algorithms for Boolean Function Manipulation," *IEEE Transactions on Computers*, Vol. C-35, No. 8 (August, 1986), pp. 677–691.

   Foundational paper describing binary decision diagrams (BDDs) as data structure and algorithms for representing and manipulating Boolean functions in symbolic form. BDDs were described by Donald Knuth in a 2008 lecture as "one of the only really fundamental data structures that came out in the last twenty-five years."

2. R. E. Bryant, "Symbolic Boolean Manipulation with Ordered Binary Decision Diagrams," *ACM Computing Surveys*, Vol. 24, No. 3 (September, 1992), pp. 293–318.

A tutorial and update on BDDs.

3. K. S. Brace, R. L. Rudell, and R. E. Bryant, "Efficient Implementation of a BDD Package," *27th Design Automation Conference*, June, 1990, pp. 40–45.

   Describes a collection of refinements for implementing BDDs. Most BDD packages follow the implementation ideas described in this paper. At the 50th anniversary of the Design Automation Conference, this paper was listed as the one with the sixth highest citation count.

4. M. Christodorescu, S. Jha, S. A. Seshia, D. Song, and R. E. Bryant, "Semantics Aware Malware Detection," *IEEE Symposium on Security and Privacy*, May, 2005, pp. 32–46.

   Shows how to automatically remove the obfuscations generated by polymorphic malware programs to reveal the underlying code.

5. R. E. Bryant, and D. R. O'Hallaron, *Computer Systems: A Programmer's Perspective*, Prentice-Hall. First edition 2003, second edition 2011, third edition 2015.

   A textbook based on a course created at CMU that covers the combination of hardware, networking, and software that comprises a computer system. This book has been translated into Chinese, Russian, Korean, and Macedonian, and is in use at over 325 institutions worldwide.

6. R. E. Bryant, "On the Complexity of VLSI Implementations and Graph Representations of Boolean Functions with Application to Integer Multiplication," *IEEE Transactions on Computers*, Vol. 40, No. 2 (February, 1991), pp. 205–213.

   Describes a method for proving that a particular class of Boolean functions will have exponentially-sized BDD representations. Showed that this case holds for the functions representing integer multiplication. This paper has been the subject of many refinements and extensions.

7. R. E. Bryant, and Y.-A. Chen, "Verification of Arithmetic Circuits with Binary Moment Diagrams," *32nd Design Automation Conference*, June, 1995, pp. 535–541.

   Describes a variant on BDDs that can represent the word-level functionality of arithmetic circuits. Winner of best paper award in category "Verification, Simulation, and Test." An early version of a general approach to verifying arithmetic circuits using polynomial representations.

8. R. E. Bryant, "A Switch-Level Model and Simulator for MOS Digital Systems," *IEEE Transactions on Computers*, (February, 1984), pp. 160–177.

   Describes the algorithmic basis for MOSSIM II, a logic simulator that models transistors as simple switches. This simulator and its successors were widely used in industry and academia in the 1980s. Intel used it to simulate several generations of microprocessor circuits.

9. R. E. Bryant, *Simulation of Packet Communication Architecture Computer Systems*, Technical Report TR-188, MIT Laboratory for Computer Science, November, 1977.

    My masters thesis. Considered the first published work describing fully distributed, discrete-event simulation.

10. C.-J. H. Seger, and R. E. Bryant, "Formal Verification by Symbolic Evaluation of Partially-Ordered Trajectories," *Formal Methods in System Design*, Vol. 6, No. 2 (March, 1995), pp. 147–190.

    Describes symbolic trajectory evaluation, a method for formally verifying digital circuits via symbolic simulation. This approach was heavily used within Intel for many years.

11. R. E. Bryant, R. H. Katz, and E. D. Lazowska, "Bit-data Computing: Creating Revolutionary Breakthroughs in Commerce, Science, and Society," Computing Community Consortium, 2008.

    An early whitepaper proclaiming the potential benefits of large-scale, data-intensive computing.

Professional Activities

Affiliations

2018–2023	Chair, Data-Model Convergence Initiative Advisory Committee, Pacific Northwest National Laboratories.
2017–2023	Physical and Computational Sciences Directorate Advisory Committee, Pacific Northwest National Laboratories.
2016–2020	XSEDE Advisory Board (NSF-funded program for access to high performance computing resources.)
2015–2023	Alumni Advisory Board, University of Michigan Computer Science and Engineering Divison.
2011–2014	Infosys Prize jury member, Infosys Science Foundation.
2010	Review Committee for federal Networking and Information Technology Research and Development (NITRD) program on behalf of President's Council of Advisors on Science and Technology (PCAST).
2010–2017	Council member, Computing Community Consortium
2010–present	American Academy of Arts and Sciences
2010–2014	Technical Advisory Board, Reveal Design Automation
2007–2014	Governing Board, Singapore Centre for Quantum Technology
2006–2012	Technical Advisory Board, NextOp Software (acquired by Atrenta, Inc.)
2006–2014	Academic Research Council, Singapore Ministry of Education.
2006–2009	Computer and Information Science and Engineering (CISE) Advisory Board, National Science Foundation.
2005–2011	Information Technology Advisory Board, Federal Bureau of Investigation.
2003–present	National Academy of Engineering. Section 5 (computer science and engineering) Peer Committee 2008–2009, Nominating Committee, 2010. Search committee executive 2010–2012. Vice Chair 2013–2014, Chair 2014–2015.
2003–2009	Technical Advisory Board, Nusym (acquired by Synopsys in 2010)
2000–2006	Board of Directors, Computing Research Assocation.
1999–2003	Technical Advisory Board, Innologic Systems (acquired by Synopsys in 2003).
1998–2000	Technical Advisory Board, Simplex Solutions (acquired by Cadence in 2002).
1993–2005	Technical Advisory Board, Fujitsu Labs of America, San Jose, CA.
1981–1985	Consultant: Hewlett Packard, Litton Data Systems, Digital Equipment Corporation, IBM, and other companies.
1978–present	ACM. Elected Fellow, 1999.
1977–present	IEEE. Elected Fellow, 1990.

Awards

2021	CAV Award. One of 21 recognized for "pioneering contributions to the foundations of the theory and practice of satisfiability modulo theories (SMT)." Award given annually at the Computer Aided Verification Conference.
2013	Design Automation Conference. Recognized as coauthor of one of the 10 most cited

papers, as one of the ten most cited authors, and for having published over 25 papers during the 50 year history of the conference.

2010 Elected to American Academy of Arts and Sciences.

2010 ACM/IEEE A. Richard Newton Technical Impact Award in Electronic Design Automation. Recognizing the impact of the 1986 paper "Graph-based algorithms for Boolean function manipulation."

2009 Phil Kaufman Award, Electronic Design Automation Consortum (EDAC) and IEEE Council for Electronic Design Automation. Citation: "for his seminal breakthroughs in the area of formal verification."

2008 University of Michigan Distinguished Engineering Alumni Award.

2007 IEEE Emanuel R. Piore Award. Citation: "For seminal contributions to the field of computer-aided circuit design and verification, including the development and promulgation of ordered binary decision diagrams."

2003 IEEE CAD Transactions Best Paper Award. For paper coauthored with Ph.D. student Yirng-An Chen.

2003 Elected to National Academy of Engineering. Citation: "For contributions to symbolic simulation and logic verification."

2003 Paper selected for inclusion in *The Best of ICCAD, 20 Years of Excellence in Computer-Aided Design*, a collection of 42 out of over 2,200 papers that have been presented at the International Conference on Computer-Aided Design between 1983 and 2002.

2000 Golden Jubilee Medal. Awarded to 118 members of the IEEE Circuits and Systems Society for professional contributions.

1999 Elected Fellow, ACM.

1998 Allen Newell Research Excellence Medal, Computer Science Department, Carnegie Mellon University.

1998 ACM Kanellakis Theory and Practice Award. Shared with Ken McMillan, Edmund M. Clarke, and Allen Emerson for the development of symbolic model checking

1996 Technical Excellence Award, Semiconductor Research Corporation. Shared with Ken McMillan and Edmund M. Clarke for the development of symbolic model checking.

1995 Litton Fellow, Carnegie Mellon Computer Science Department.

1995 Best Paper Award, Simulation, Verification, and Test Category, 32nd Design Automation Conference, for paper coauthored with Ph.D. student Yirng-An Chen.

1990 Elected Fellow, IEEE. Citation: "for contributions to switch-level simulation of very large scale integrated circuits."

1990 Inventor Recognition Award, Semiconductor Research Corporation, for the BDD symbolic Boolean manipulation software library.

1989 Inventor Recognition Award, Semiconductor Research Corporation. for the COSMOS switch-level simulator.

1989 IEEE W. R. G. Baker Award for "The most outstanding paper reporting original work in any of the IEEE *Transactions*, *Proceedings of the IEEE*, journals, or magazines issued during the previous year."

1988 Best Paper Award, Design, Simulation and Test Category, 25th Design Automation Conference. For paper coauthored with Ph.D. student Derek Beatty.

1988 Two papers selected for inclusion in *Twenty Five Years of Electronic Design Automa-*

tion, a collection of 77 of the over 1600 papers presented at the Design Automation Conferences for the years 1964–1987.

1987 IEEE CAD Transactions Best Paper Award.

1983, 1984 IBM Faculty Development Award (One of 100 recipients of special grant for junior faculty.)

1974–1978 National Science Foundation Graduate Fellow.

Academic Review Committees

2022 University of California, Santa Barbara, Computer Science Department.

2017 Stanford University, Computer Science Department.

2015 Iowa State University, Electrical and Computer Engineering Department.

2012 University of Michigan, Computer Science and Engineering Division.

2011 University of California, San Francisco, Bioinformatics Advisory Panel.

2010 Washington University St. Louis, School of Engineering and Applied Science.

2009 University of Tokyo, Graduate School of Information Science and Technology.

2009 University of Utah, School of Computing.

2009 Princeton University, Computer Science Department.

2009 University of Virginia, Computer Science Department.

2009–2013 Massachusetts Institute of Technology, Department of EECS.

2009 University of Washington, Computer Science Department.

2007 Georgia Institute of Technology, College of Computing.

2007 Stanford University, Computer Science Department.

2005 University of Virginia, Computer Science Department.

2004 Kuwait University, Graduate program in computer science.

2004 Information Technology University of Copenhagen, Denmark.

2003 University of Pittsburgh, Computer Science Department.

2003 University of Utah, School of Computing.

2002 University of Texas, Computer Science Department.

2001 Stanford University, Electrical Engineering Department.

2000 Technion, Haifa, Israel, Faculty of Computer Science.

Conference Committees

2018 Organizing Committee, NITRD Big Data and High End Computing Interagency Working Groups Joint Workshop.

2015 Co-organizer, White House Workshop on the National Strategic Computing Initiative

2011, 2012 Program Committee, International Conference on Theory and Applications of Satisfiability Testing.

2008 Co-organizer, Hadoop Summit and Symposium on Data-Intensive Computing, Sunnyvale, CA.

2002–2004 Program Committee, Design and Test in Europe.

1996, 1998, 2000, 2002, 2004 Program Committee, International Conference on Formal Methods in Computer-Aided Design.

1990, 1994, 2000–2001, 2004, 2006 Program Committee, International Conference on Computer-Aided Verification.

1994–2000 Executive Committee, Design Automation Conference (tutorial chair 1994–1995, program co-chair 1998–1999).

1990, 1992 Program Committee, TAU International Workshop on Timing Issues in the Specification and Synthesis of Digital Systems.

1991, 1993 Program Committee, International Workshop on Logic Synthesis.

1989 Program Committee, IFIP Workshop on Applied Formal Methods for Correct VLSI Design.

1986–1992 Program Committee, Design Automation Conference.

1989–1990 Program Committee, Microelectronic System Education Conference.

1989 Program Committee, International Conference on Compuer-Aided Design.

1988 Program Committee, IFIP Conference on Design Methodologies for VLSI and Computer Architecture.

1987 Program Committee, IEEE VLSI Workshop, Clearwater Beach, Florida.

1985–1991, 1997 Program Committee, Conference on Advanced Research in VLSI (held at MIT, Caltech, UNC, Brown, and Michigan).

1983 Chairman, Third Caltech Conference on Very Large Scale Integration.

1979 Organizer, MIT Workshop on Self-Timed Systems.

Review Committees

2019 NSF CISE Committee of Visitors

2001 Texas Advanced Research/Advanced Technology Programs Reviewer.

2001 National Science Foundation CAREER Program Proposal Panel.

2001 National Science Foundation ITR Program Preproposal Panel.

1990 National Science Foundation Graduate Fellowship evaluation panel.

Editorships and Reviewing

1995–1997 Editor-in-Chief, *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*.

1991–2000 Editorial Board, *Formal Methods in System Design*

1989–1995 Associate Editor, *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*.

1976–present Reviewer for papers submitted to *IEEE Transactions on Computers*, *IEEE Computer*, *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, *IEEE Transactions on Software Engineering*, *IEEE Transactions on Circuits and Systems*, *ACM Transactions on Computing Systems*, *Journal of the ACM*, *International Journal of Parallel Programming*, *Communications of the ACM*, *Theoretical Computer Science*, *Information Processing Letters*, and numerous conferences.

1983–1988 Reviewer for ACM Distinguished Dissertation Award

University Service

2020–2021	Academic Freedom Commission, reviewing CMU's policies on academic freedom and freedom of expression
2020–2021	Faculty Senate Chair Emeritus.
2019–2020	Faculty Senate Chair.
2019–2020	Member of review committee for Dean of Dietrich College of Humanities and Social Science.
2017–2019	Faculty Senate Vice Chair.
2017	Chair of search committee for Dean of Carnegie Mellon University, Qatar.
2015–2016	Member of review committee for Dean of Carnegie Mellon University, Qatar.
2007	Member of Search Committee for Dean of Mellon College of Science
2004	Member of Search Committee for Director of Robotics Institute.
2000	Member of Provost Search Committee
1998–1999	Co-Chair of School of Computer Science Dean Search Committee
1993–1999	In charge of faculty reappointments and promotions, Computer Science Department.
1991–1993	School of Computer Science Graduate Council. Chairman-Elect 1991–1992, Chairman 1992–1993.
1991–1993	Member, CMU Faculty Development Awards Committee
1992	Member of School of Computer Science Dean Search Committee
1988–1989	Presidential appointee to CMU Faculty Senate.
1988–1990	Graduate Admissions Committee, CMU Computer Science (Chairman, 1989).
1985–1987	Qualifier Review Committee, CMU Computer Science Dept. (Chairman, 1986–1987).
1986–1987	University Research Council, CMU.
1986–1988	Facilities Advisory Committee, CMU Computer Science Dept.
1981-1984	Organized Computer Science Seminar series, Caltech.
1982-1984	In charge of Computer Science Library, Caltech.
1982	Computer Science Graduate Admissions Committee, Caltech.

Community Service

2020–present	Board of Directors, Bach Choir of Pittsburgh
2015–present	Member of Bass Section, Bach Choir of Pittsburgh
2011–2014	Member of Bass Section, Pittsburgh Gospel Choir
2001–2014	Board of Directors, Steel City Rowing Club, Pittsburgh, PA. Board president 2005–2014.
1998–2000, 2003–2006, 2017–2023	Board of Session, Bellefield Presbyterian Church, Pittsburgh, PA.
1986–1990	Board of Trustees, Bellefield Presbyterian Church, Pittsburgh, PA.