Vitae for Dan Edward Willard (last updated on November 6, 2021)

Biographical Information and CAREER HIGH-LIGHTS

Emeritus Computer Science Professor of University at Albany who:

1. received the university's "Excellence in Research Award" in 2008,
2. held a Courtesy Appointment with Math Department together with CS position.
3. published many papers about Symbolic Logic and Computerized Search Algorithms, **INCLUDING TWO** significant new results in 2020 and 2021 (see A-1 and B-1),
4. was a "Member of Technical Staff" for AT&T Bell Laboratories (1979-1983) and also for Bell-Core (1984 and 1989) prior to recruitment by University of Albany.

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DEGREES

Ph.D., Mathematics, Harvard University, 1978.

A.M., Mathematics, Harvard University, 1972.

B.S., Mathematics, SUNY at Stony Brook, 1970.

PROFESSIONAL INTERESTS and IMPACTS in NEWS MEDIA

Proof-Theoretic Aspects of Mathematical Logic, Algorithms, Data Structures, Complexity Theory, Computational Geometry, Data Base Theory and special implications of Darwinian Evolution. Various aspects of my research have been reported in national news media outlets. For instance, the Fusion Trees were the first of just six topics mentioned in the "Mathematics and Computer Science" section of the *National Science Foundation 1991 Annual Report*. Also, the Trivers-Willard Hypothesis about mathematical Darwinian Mechanics was the topic of two full-length articles in the *New York Times* in 1981 and 2017. (More details are provided by Part C of the Publication List (i.e. page 8), with Google searching information.)

MOST RECENT RESEARCH about SYMBOLIC LOGIC

Our recent research has focused mostly on developing generalizations of Gödel's Second Incompleteness Theorem and on formalizing boundary-case exceptions where it is not valid. This research has appeared in the papers of A.1 through A.9 and B.1 through B.10. All these articles have been sole-authored, and they include four papers in the *Journal of Symbolic Logic*, two in the *Annals of Pure and Applied Logic.* and a recent 2021 article published by Oxford University's *Journal of Logic and Computation*.

PRIOR INVESTIGATIONS (before Research about Proof Theory):

My earlier research had investigated traditional computer science topics, such as Advanced Data Structures, Computational Geometry, Fusion Trees, and Relational Database Optimization. During 1982-2002, we published four papers in *Journal of ACM*, five papers in *SIAM Journal on Computing* and five papers in *Journal of Computer and System Sciences*. (Ten of these fourteen papers were sole-authored.)

TEACHING EXPERIENCE

Two levels of graduate-student courses about Symbolic Logic, Algorithms (graduate and undergraduate), Highly Advanced Data Structures, Complexity Theory, Computational Geometry, and Data Base Theory.

CAREER SUMMARY :

1. Harvard PH D (1978)
2. Member of Technical Research - Bell Laboratories (1979-1983)
3. SUNY-Albany Computer Science Department 1983-2018
   a. Associate Professor (1983-1988)
   b. Full Professor (1988-2018)
   c. Received University's "Excellence in Research Award" (2008)

SUPPORT FROM THE NATIONAL SCIENCE FOUNDATION:

Approximately $ 685K of support under the five sole-authored NSF grants of DCR8412447, IRI8703430, CCR9060509, CCR9302920 , CCR9902726 & CCF0956405.

WILLARD's PUBLICATION LIST has a SURPRISING Section-C on Page 8

A. Journal Publications

The articles below *are not* listed in chronological order. Instead, they are listed in roughly a sequential order related to my current research interests. Thus, the papers in the papers about Logic are listed first — although *not all of them* are my most recent papers chronologically.

1. "About the Characterization of a Fine Line That Separates Generalizations and Boundary-Case Exceptions for the Second Incompleteness Theorem under Semantic Tableau Deduction", *Journal of Logic and Computation* 31 (2021), pp. 375-392.

2. "Some Specially Formulated Axiomizations for $I\Sigma_0$ Manage to Evade the Herbrandized Version of the Second Incompleteness Theorem", **invited paper** by *Information and Computation* 207 (2009) pp. 1078-1093.

3. "On the Available Partial Respects in which an Axiomizations for Real Valued Arithmetic Can Verify its Own Formal Consistency and Related Topics", *Journal of Symbolic Logic* 71 (2006) pp. 1189–1999.

4. "An Exploration of the Partial Respects in which an Axiom System Recognizing Solely Addition as a Total Function Can Verify Its Own Consistency", *Journal of Symbolic Logic* 70 (2005) pp. 1171-1209.

5. "How to Extend The Semantic Tableaux And Cut–Free Versions of the Second Incompleteness Theorem Almost to Robinson's Arithmetic Q", *Journal of Symbolic Logic* 67 (2002) pp. 465-496.

6. "Self–Verifying Systems, the Incompleteness Theorem and the Tangibility Reflection Principle", *Journal of Symbolic Logic* 66 (2001) pp. 536–596.

7. "A Generalization of the Second Incompleteness Theorem and Some Exceptions to It", **invited paper** in the *Annals of Pure and Applied Logic* 141 (2006) pp. 472-496.

8. "Passive Induction and a Solution to a Paris-Wilkie Open Question", *Annals of Pure and Applied Logic* 146 (2007) pp. 124-149.

9. "A Version of the Second Incompleteness Theorem For Axiom Systems that Recognize Addition But Not Multiplication as a Total Function", in *First Order Logic Revisited*, edited by V. Hendricks et al. and published by Logos Verlag (Berlin) 2004, pp. 337–368.

10. "An Algorithm for Handling Many Relational Calculus Queries Efficiently", *Journal of Computer and System Sciences* 65 (2002) pp. 295-331.

11. "Examining Computational Geometry, Van Emde Boas Trees and Hashing From the Perspective of the Fusion Tree", *SIAM Journal on Computing* 29 (2000) pp. 1030–1049.

12. "Self-Reflection Principles and NP-Hardness", invited paper in *The Dimacs Series in Discrete Mathematics and Theoretical Computer Science (published by the American Mathematics Society),* Volume 39 (January 1998), pp. 297-320.

13. "Applications of Range Query Theory to Relational Database Selection and Join Operations", *Journal of Computer and Systems Sciences* 52 (1996) pp 157-169.

14. "Transdichotomous Algorithms for Minimum Spanning Trees and Shortest Paths" (with M. L. Fredman), invited paper in *The Journal of Computer and Systems Sciences* 48 (1994) pp. 533-551.

15. "Surpassing the Information Theoretic Barrier with Fusion Trees", (with M. L. Fredman), invited paper in *The Journal of Computer and Systems Sciences* 47 (1993) pp. 424-433.

16. "Optimal Sampling Residues for Differentiable Data Base Query Problems", *Journal of ACM*, 38 (1991), pp 104-119.

17. "Multi-Dimensional Search Trees that Provide New Types of Memory Reduction," *Journal of ACM* 34 (1987), pp. 846-858.

18. "A Transformation for Adding Range Restriction Capability to Data Structures," (with G.S. Lueker); *Journal of ACM,* 32 (1985), pp. 597-618.

19. "Algorithms for Resolving Conflicts in Dynamic Storage Allocation," (with B.S. Baker and E.G. Coffman, Jr.), *Journal of ACM,* 32 (1985) pp. 327-343.

20. "Log-logarithmic Selection Resolution Protocols in a Multiple Access Channel," in *SIAM Journal on Computing,* 15 (1986), pp. 468-477.

21. "New Data Structures for Orthogonal Range Queries," *SIAM Journal on Computing,* 14(1985), pp. 232-253.

22. "Searching Unindexed and Non-uniformly Generated Files in Log Log N Time," *SIAM Journal on Computing,* 14 (1985), pp. 1013-1029.

23. "Polygon Retrieval," *SIAM Journal on Computing,* 11 (1982), pp. 149-166.

24. "New Fast Trie Data Structures Which Support Very Fast Search Operations," *Journal of Computer and Systems Sciences* 28 (1984), pp. 379-395.

25. "Lower Bounds for the Addition-Subtraction Operations in Orthogonal Range Queries and Related Problems," *Information and Computation.* 82 (1989) pp. 45-64

26. "A Density Control Algorithm for Doing Insertions and Deletions in a Sequentially Ordered File in Good-Worst Case Time," *Information and Computation* 97 (1992) pp. 150-204.

27. "The Very Unusual Behavior of Parallel Interpolation Search," (with J. Reif), *Information and Computation.* 81 (1989) pp. 364-379.

28. "Log-Logarithmic Worst-Case Range Queries are Possible in Space O(N)," *Information Processing Letters* 17 (1983), pp. 81-84.

29. "A Data Structure for Dynamic Range Queries," (with G.S. Lueker), *Information Processing Letters* 15 (1982), pp. 209-213.

30. "On the Angle Restricted Nearest Neighbor Problem," (with Y.C. Wee and S. Chaiken), *Information Processing Letters,* 34 (1990) pp. 71-76.

31. "Natural Selection of Parental Ability to Vary Sex Ratio of Offspring", (with R.L. Trivers), *Science,* (Jan. 5, 1973), pp. 90-92.

32. Dissertation has been published in the Garland Company's Series of *Outstanding Dissertations in Computer Science.*

B. Publications in Refereed Conference Proceedings

The list below includes *only* papers published in "refereed" conference proceedings. It does not include 30+ additional talks I gave at ASL conferences during 1995-2200, whose 300-word abstracts were published in the *Bulletin of Symbolic Logic,* but which were not formally refereed articles.

1. "On the Tender Line Separating Generalizations and Boundary-Case Exceptions for the Second Incompleteness Theorem under Semantic Tableaux Deduction", a talk given at the LFCS 2020 conference. Published on pp. 268-286 of Volume 11972 of Springer's LNCS series.

2. "On the Broader Epistemological Significance of Self-Justifying Axiom Systems", *Springer Verlag LNCS* 8652, pp.221-236. (Proceedings of Wollics 2014 conference.)

3. "The Axiom System $I\Sigma_0$ Manages to Simultaneously Obey and Evade the Herbrandized Version of the Second Incompleteness Theorem", *Electronic Notes in Theoretical Computer Science* 165 (November 2006) pp. 213–226 (This is the Proceedings of Wollics 2006 conference.)

4. "On the Results of a 14-Year Effort to Generalize Gödel's Second Incompleteness Theorem and Explore Its Partial Exceptions", *Collegium Logicum* IX (2007) pp. 81-86.

5. "On the Partial Respects in Which an Axiomization for Real Valued Arithmetic Can Verify its Tableaux Consistency", *Automated Reasoning with Analytic Tableaux and Related Methods* (2005 Proceedings), Springer–Verlag LNCS # 3702, pp. 292-306.

6. "Some New Exceptions for the Semantic Tableaux Version of the Second Incompleteness Theorem", *Automated Reasoning with Analytic Tableaux and Related Methods* (2002 Proceedings), Springer–Verlag LNCS # 2381, pp. 281-297.

7. "The Semantic Tableaux Version of the Second Incompleteness Theorem Extends Almost to Robinson's Arithmetic Q", in *Automated Reasoning with Semantic Tableaux and Related Methods*, Springer–Verlag LNCS # 1847, 2000, pp. 415–430.

8. "Tangibility Reflection Principle for Self-Verifying Axiom System", in *Computational Logic and Proof Theory: The 5-th Kurt Gödel Colloquium*, Springer-Verlag LNCS # 1289 (1997), pp. 319-334.

9. "Self-Verifying Axiom Systems", in *Computational Logic and Proof Theory: The 3-rd Kurt Gödel Colloquium*, Springer-Verlag LNCS # 713 (1993), pp. 325-336.

10. "A New Form of the Semantic Tableaux Version of the Second Incompleteness Theorem", a position paper at the Rome (Italy) Semantic Tableaux 2003 conference, disseminated in University of Rome Technical Report RT-DIA-80-2003, pp. 68-72 (September 2003).

11. "Applications of the Fusion Tree Methodology to Computational Geometry and Searching", in *The Proceedings of the Third Annual SIAM Symposium of Discrete Algorithms,* (1992) pp. 286-295.

12. "Blasting Through The Information Theoretic Barrier with Fusion Trees" (with M. Fredman), in *ACM Proceedings of the 22nd Symposium on Theory of Computing*, (1990), pp 1-7.

13. "Transdichotomous Algorithms for Minimum Spanning Trees and Shortest Paths" (with M. Fredman), in *The Proceedings of the 31st IEEE Symposium on the Foundations of Computer Science.* (1990), pages 719-725.

14. "Quasi-linear Algorithms for Processing Relational Calculus Expressions", in *The Proceedings of PODS -1990 Conference,* pp. 243-257.

15. "Computing Geographic Nearest Neighbors Using Monotone Matrix Searching", *Proceedings of the 18th ACM CSI Conference,* 1990 (with Y.C. Wee and S. Chaiken)

16. "General Metrics and Angle Restricted Voronoi Diagrams", in *Proceedings of First Canadian Conference on Computational Geometry, Montreal,* 1989 (with Y.C. Wee and S. Chaiken)

17. "Quasi-Valid Range Querying and Its Implications for Nearest Neighbor Problems" (with Y.C. Wee), published in the *Proceedings of the 1988 ACM Computational Geometry Conference,* pp. 34-43.

18. "Good Worst-Case Algorithms for Inserting and Deleting Records in Dense Sequential Files", in the *Proceedings of 1986 SIGMOD Conf.,* pp. 251-260.

19. "On the Application of Sheared Retrieval to Orthogonal Range Queries," in *The Proceedings of the 1986 ACM Conference on Computational Geometry,* June 1986, pp. 80-89.

20. "Lower Bounds for Dynamic Range Queries that Permit Subtraction", published in *The Proceedings of the 1986 International Conference on Automata, Languages and Programming* pp. 444-455.

21. "Lower Bounds for Randomized Algorithms and an Open Question," in *The Proceedings of the Twentieth Annual Conference on Information Sciences and Systems,* March 1986, pp. 333-335.

22. "Reduced Memory Space for Multi-Dimensional Search Trees," in the *Proceedings of the Symposium on Theoretical Aspects of Computer Science, 1985,* Springer-Verlag LNCS Volume 182, pp. 363-374.

23. "Parallel Interpolation Search," (with J. Reif), *23-rd Allerton Conf. on Comm. Contr. and Comput,* 1985, pp. 821-829.

24. "Log-logarithmic Selection Protocols for Resolving Ethernet and Semaphore Conflicts", in the *16-th ACM Symp. on Theory of Computing* (May 1984) pp. 512-521.

25. "Efficient Processing of Relational Calculus Expressions Using Range Query Theory", *Proceedings of 1984 ACM SIGMOD Conference,* pp.164-175.

26. "Sampling Algorithms for Differentiable Batch Retrieval Problems," *1984 International Conference on Automata, Languages and Programming* (ICALP), pp. 514-526, and *The 1984 SIAM Conference on the Statistics-Computer Science Interface* invited a second oral presentation of this result.

27. "Predicate Retrieval Theory", *21st Allerton Conf. on Comm., Cont., and Comp.* (1983), pp. 663-674.

28. "Surprisingly Efficient Search Algorithms for Non uniformly Generated Files", *21-st Allerton Conf. on Comm., Contr., and Comp.,* (1983), pp. 656-662.

29. "A New Time Complexity for Orthogonal Range Queries," *20-th Allerton Conf. on Comm., Contr. and Comp.,* (1982), pp. 462-471.

30. "Maintaining a Dense Sequential Files in a Dynamic Environment," at the *14th ACM Symp on Theory of Computing,* 1982, pp. 114-122.

31. "Two Very Fast Trie Data Structures", *19-th Allerton Conf. on Comm., Contr., and Comp.,* (1981), pp. 355-363.

32. "A Log Log N Search Algorithm for Nonuniform Distributions," invited paper in *Proceedings of ORSA-TIMS Conf. on Applied Probability Computer Science Interface,* vol. II, pp. 3-14, 1981.

33. There have also been six additional Cornell ArXiv technical reports produced by Willard during 2013-2020 (that can be accessed via Google Searches).

C. Several News Media Citations of Trivers-Willard Hypothesis, Fredman-Willard Fusion Trees, Willard's Logic Framework etc.

1. *New York Times,* 21 January 2017, article in Sunday Week-in-Review Section by Nancy L Segal and Satoshi Kanazawa, mentioning Trivers-Willard on *five* separate occasions during 14 paragraphs in an article entitled *"Does Breast Milk Have a Sex Bias"*.
2. *New York Times,* 17 February 1981, front page of Science Section article by Walter Sullivan entitled *"Survival of Species Linked to Lopsided Sex Ratios"*. (Both Items 1 & 2 can be found via a Google-search.)
3. More than 4,250 citations to Trivers-Willard mathematical sex-ratio theory (journal article 31) listed by Google Scholar on November 1, 2021
4. Over 1,100 recent citations in Google Scholar to the main three Fredman-Willard papers about Searching with Fusion Trees. Also, please see below:
5. National Science Foundation 1991 Annual Report (page 12). The Fredman-Willard research was the first of only six topics mentioned in the section entitled *"Mathematics and Computer Science Research (during 1991)".* (Again available by doing a Google search.)
6. NSF Press Release 91-32, 29 April 1991 about Fredman-Willard algorithm.
7. Science News (article by Ivars Peterson) 29 June 1991 (p. 406) about Fredman-Willard algorithm.
8. Computer World, 27 May 1991 (p. 18) about Fredman-Willard algorithm.
9. Byte Magazine, August 1991, p. 25 about Fredman-Willard algorithm.
10. Information Week, 21 October 1991 (p. 60) about Fredman-Willard algorithm.
11. The MacArthur-award winning MIT professor of Erik DeMaine has recorded video lectures summarizing the properties of Fusion Trees and Willard's Y-Fast Tries.
12. The Wikipedia contains a nicely simplified description of journal articles 14 and 15 under the heading of "Fusion Trees".
13. Journal Article A-28 has received over 400 citations in Google Scholar. Also, Wikipedia summarizes 28's content under the headings of "X-fast Tries" and "Y-fast Tries"
14. The Wikipedia contains a description of journal articles 5 and 6 under the heading of "Self-Verifying Theories". (Although Willard's logic research has currently received less publicity than some of his other projects, Willard has predicted that by the year 2030, it will be remembered as his most important achievement. See journal article 1 for a nicely compact year-2021 expansion of this topic, published by Oxford University's *Journal of Logic and Computation.*)