CLIFFORD ALAN SHAFFER

(Shortened Vitae, last updated October 4, 2021)

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Date and place of birth: August 15, 1959, Baltimore, Maryland.

Education:

- BS in Computer Science: University of Maryland, College Park, 1980.
- MS in Computer Science: University of Maryland, College Park, 1982.
- PhD in Computer Science: University of Maryland, College Park, 1986.

Dissertation Title: Application of Alternative Quadtree Representations
Advisor: Hanan Samet

Professional positions held:

Professor (9/87 – present) and Associate Department Head for Graduate Studies (7/17 – present)
Department of Computer Science, Virginia Polytechnic Institute & State University.
Interdisciplinary Program in Genetics, Bioinformatics, and Compuational Biology, 7/04 – present.

W.S. "Pete" White Chair for Innovation in Engineering Education (6/16 – 6/18)
Department of Computer Science, Virginia Polytechnic Institute & State University.

Selected Publications

1. M. Mohammed, C.A. Shaffer, and S.H. Rodger, Teaching Formal Languages with Visualizations and Auto-Graded Exercises, accepted for publication in *Proceedings of the 2021 ACM SIGCSE Technical Symposium on Computer Science Education (SIGCSE'21)*, March 2021.

2. A.M. Kazerouni, J.C. Davis, A. Basak, C.A. Shaffer, F. Servant, and S.H. Edwards, Fast and accurate incremental feedback for students' software tests using selective mutation analysis, *Journal of Systems and Software 175*, (May 2021), 110905.

3. H. Manzoor, K. Akhuseyinoglu, J. Wonderly, P. Brusilovsky, and C.A. Shaffer, Crossing the Borders: Re-Use of Smart Learning Objects in Advanced Content Access Systems, *Future Internet 11*, 7(July 2019), 1-15. DOI: https://doi.org/10.3390/fi11070160

4. A.M. Kazerouni, C.A. Shaffer, S.H. Edwards, and F. Servant, Assessing Incremental Testing Practices and Their Impact on Project Outcomes, *Proceedings of the 2019 ACM SIGCSE Technical Symposium on Computer Science Education (SIGCSE'19)*, February 2019. Winner, 2nd place Best Paper for CS Education Research.

5. M. Chen, B. Amos, L.T. Watson, J.J. Tyson, Y. Cao, C.A. Shaffer, M. Trosset, C. Oguz, G. Kakoti, Quasi-Newton Stochastic Optimization Algorithm for Parameter Estimation of a Stochastic Model of the Budding Yeast Cell Cycle, *IEEE/ACM Transactions on Computational Biology and Bioinformatics 16*, 1(January/February 2019), 301–311. DOI: https://doi.org/10.1109/TCBB.2017.2773083

6. Hamouda S, Edwards SH, Elmongui HG, Ernst JV, Shaffer CA. RecurTutor: An Interactive Tutorial for Learning Recursion, *ACM Transactions on Computing Education 19* 1(November 2018), 1:1–1:25.

7. A.C. Bart, J. Tibau, D.G. Kafura, C.A. Shaffer, and E. Tilevich, Design and Evaluation of a Block-based Environment with a Data Science Context, *IEEE Transactions on Emerging Topics in Computing*, July 2017. DOI: `https://doi.org/10.1109/TETC.2017.2729585`.

8. Hamouda S, Edwards SH, Elmongui HG, Ernst JV, Shaffer CA. RecurTutor: An Interactive Tutorial for Learning Recursion, to appear in *ACM Transactions on Computing Education*.

9. A.C. Bart, R. Whitcomb, D. Kafura, C.A. Shaffer, and E. Tilevich, Computing with CORGIS: Diverse, Real-world Datasets for Introductory Computing, in *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education (SIGCSE 2017)*, Seattle, WA, March 2017, 57–62 (Winner, Best Research Paper Award).

10. M.F. Farghally, K.H. Koh, H. Shahin, and C.A. Shaffer, Evaluating the Effectiveness of Algorithm Analysis Visualizations, in *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education (SIGCSE 2017)*, Seattle, WA, March 2017, 201–206 (Designated an Exemplary Research Paper).

11. M.F. Farghally, K.H. Koh, J.V. Ernst, and C.A. Shaffer, Towards a Concept Inventory for Algorithm Analysis Topics in *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education (SIGCSE 2017)*, Seattle, WA, March 2017, 207–212.

12. A.C. Bart, J. Tibau, E. Tilevich, C.A. Shaffer, and D.G. Kafura, Implementing an Open-Access, Data Science Programming Environment for Learners, in *Proceedings of the 40th IEEE Annual Computer Software and Applications Conference (COMPSAC 2016)*, Atlanta, GA, June 2016, 728–737.

13. E. Fouh, M.F. Farghally, S. Hamouda, K.H. Koh, and C.A. Shaffer, Investigating Difficult Topics in a Data Structures Course Using Item Response Theory and Logged Data Analysis, in *Proceedings of the 9th International Conference on Educational Data Mining (EDM 2016)*, Raleigh, NC, June 2016, 370–375.

14. V. Karavirta and C.A. Shaffer, Creating Engaging Online Learning Material with the JSAV JavaScript Algorithm Visualization Library, *IEEE Transactions on Learning Technologies 9*, 2(April–June 2016), 171–183.

15. E. Fouh, S. Hamouda, M.F. Farghally, and C.A. Shaffer, Automating Learner Feedback in an eTextbook for Data Structures and Algorithms Courses, in *Challenges in ICT Education: Formative Assessment, Learning Data Analytics and Gamification*, Santi Caballé and Robert Clarisó, eds., Elsevier, 2016, 135–165.

16. A.C. Bart and C.A. Shaffer, Instructional Design is to Teaching as Software Engineering is to Programming, in *Proceedings of the 47th Technical Symposium on Computer Science Education (SIGCSE 2016)*, Memphis, TN, March 2016, 240–241.

17. S. Hamouda and C.A. Shaffer, Crib Sheets and Exam Performance in a Data Structures Course, *Computer Science Education 26*, 1(February 2016), 1–26.

18. J. Martin, S.H. Edwards, and C.A. Shaffer, The Effects of Procrastination Interventions on Programming Project Success, *Proceedings of the eleventh annual International Conference on International Computing Education Research (ICER '15)*, Omaha, Nebraska, September, 2015, 3–11.

19. S.H. Edwards, J. Martin, and C.A. Shaffer, Examining Classroom Interventions to Reduce Procrastination, *Proceedings of the 20th Annual Conference on Innovation and Technology in Computer Science Education (ITiCSE'2015)*, July 2015, Vilnius, Lithuania, 254–259.

20. E. Fouh, V. Karavirta, D.A. Breakiron, S. Hamouda, S. Hall, T.L. Naps, and C.A. Shaffer, Design and Architecture of an Interactive eTextbook – the OpenDSA System, *Science of Computer Programming 88, Special Issue on Software Development Concerns in the e-Learning Domain*, 1(August 2014), 22–40.

21. M.L. Cooper, C.A. Shaffer, S.H. Edwards, and S.P. Ponce, Open source software and the algorithm visualization community, *Science of Computer Programming 88, Special Issue on Software Development Concerns in the e-Learning Domain*, 1(August 2014), 82–91.

22. M. Akbar and C.A. Shaffer, Social Networks in Digital Libraries, in *Digital Libraries Applications: CBIR, Education, Social Networks, eScience/Simulation, and GIS*, E.A. Fox and J.P. Leidig, eds., Morgan & Claypool, 2014, 45–62. DOI: 10.2200/S00565ED1V01Y201401ICR032

23. A.C. Bart, E. Tilevich, S. Hall, T. Allevato, and C.A. Shaffer, Transforming Introductory Computer Science Projects via Real-time Web Data, in *Proceedings of the 45th ACM Technical Symposium on Computer Science Education (SIGCSE '14)*, Atlanta, GA, March 2014, 289–294.

24. A. Verstak, N. Ramakrishnan, L.T. Watson, J. He, C.A. Shaffer, and A.Y. Grama, Using Hierarchical Data Mining to Characterize Performance of Wireless System Configurations, *Advances in Engineering Software 65*, November 2013, 66–77.

25. V. Karavirta and C.A. Shaffer, JSAV: The JavaScript Algorithm Visualization Library, in *Proceedings of the 18th Annual Conference on Innovation and Technology in Computer Science Education (ITiCSE 2013)*, Canterbury, UK, July, 2013, 159–164.

26. E. Fouh, M. Akbar, and C.A. Shaffer, The Role of Visualization in Computer Science Education, *Computers in the Schools 29*, Issue 1-2, 2012, 95–117.

27. Z. Liu, Y. Pu, C.A. Shaffer, S. Hoops, J.J. Tyson, and Y. Cao, Hybrid Modeling and Simulation of Stochastic Effect on Progression through the Eukaryotic Cell Cycle, *Journal of Chemical Physics 136*, 3(January) 2012.

28. C.A. Shaffer, *Data Structures and Algorithm Analysis in Java: Third Edition*, Dover Publications, Mineola, NY, 2011.

29. C.A. Shaffer, M.L. Cooper, A.J.D. Alon, M. Akbar, M. Stewart, S. Ponce, and S.H. Edwards, Algorithm Visualization: The State of the Field, *ACM Transactions on Computing Education 10*, 3(August 2010), 1–22.

30. R. Randhawa, C.A. Shaffer, and J.J.Tyson, Model Composition for Macromolecular Regulatory Networks, *IEEE/ACM Transactions on Computational Biology and Bioinformatics 7*, 2(April-June 2010), 278–287.

31. R. Randhawa, C.A. Shaffer, and J.J.Tyson, Model Aggregation: a building-block approach to creating large macromolecular regulatory networks, *Bioinformatics 25*, 24(2009), 3289–3295.

32. M. Vass, C.A. Shaffer, N. Ramakrishnan, L.T. Watson, and J.J. Tyson, The JigCell Model Builder: A Spreadsheet Interface for Creating Biochemical Reaction Network Models, *IEEE/ACM Transactions on Computational Biology and Bioinformatics 3*, 2(Apr–Jun 2006), 155–164.

33. N.A. Allen, K.C. Chen, C.A. Shaffer, J.J. Tyson, and L.T. Watson, Computer Evaluation of Network Dynamics Models with Application to Cell Cycle Control in Budding Yeast, *IEE Proceedings – Systems Biology 153*, 1(Jan 2006), 13–21.

34. J.M.A. Begole, R.L. Smith, C.A. Struble, and C.A. Shaffer Resource Sharing for Replicated Synchronous Groupware, *IEEE Transactions on Networking 9*, 6(Dec 2001) 833–843.

35. A. Goel, C.A. Baker, C.A. Shaffer, B. Grossman, W.H. Mason, and L.T. Watson VizCraft: A Problem Solving Environment for Configuration Design of a High Speed Civil Transport, *Computing in Science and Engineering 3*, 1(Jan/Feb 2001), 56–66.

36. Clifford A. Shaffer, Jason W. Zwolak, Ranjit Randhawa, and John J. Tyson Modeling Molecular Regulatory Networks with JigCell and PET, in *Systems Biology 500*, Ivan Maly, ed., Humana Press, 2009, 81-111.

Research Grants (Since 2000):

2017-2020 C.A. Shaffer, S.H. Edwards, P. Brusilovsky (UPitt), K. Koedinger (CMU) "BCC-EHR: Collaborative Research: Community-building and Infrastructure Design for Data-Intensive Research in Computer Science Education", National Science Foundation DLR-1740765, $268,941 (Virginia Tech share).

2016-2018 C.A. Shaffer, "Pete White Professorship", Virginia Tech, $52,000.

2016-2019 D.G. Kafura, C.A. Shaffer, E. Tilevich, K.S. Cennamo, and J.V. Ernst, "IUSE: A Scaffolded Data-Centric Approach to Improved Learning of Introductory Computing Concepts", National Science Foundation DUE-1624320, $594,314.

2015-2017 C.A. Shaffer, J.V. Ernst, S.Rodger (Duke), T.L. Naps (U. Wisconsin–Oshkosh) "Collaborative Research: Assessing and Expanding the Impact of OpenDSA, an Open Source, Interactive eTextbook for Data Structures and Algorithms", National Science Foundation DUE-1432008, $998,402 ($716,000 Virginia Tech share).

2014-2015 D.G. Kafura, E. Tilevich, and C.A. Shaffer, "TUES: EAGER: Scaffolding Big Data for Authentic Learning of Computing", National Science Foundation DUE-1444094, $97,658.

2013-2015 S.H. Edwards and C.A. Shaffer, "Classroom Interventions to Reduce Procrastination", National Science Foundation DUE-1245334, $199,986.

2013-2014 S. Puntambekar (U. Wisconsin–Madison), N. Narayanan (Auburn U.), and C.A. Shaffer, "EAGER: SAVI: Dynamic Digital Text: An Innovation in STEM Education", National Science Foundation IIS-1258471, $247,933 ($67,208 VT share).

2012-2014 C.A. Shaffer, T.S. Hall, T.L. Naps (U. Wisconsin–Oshkosh), and R. Baraniuk (Rice U.), "Integrating the eTextbook: Truly Interactive Textbooks for Computer Science Education", National Science Foundation DUE-1139861, $200,000 ($125,000 VT share).

2012-2014 E. Tilevich and C.A. Shaffer, "Transforming Introductory Computer Science Projects via Real-TimeWeb Data", National Science Foundation DUE-1140318, $199,987.

2011-2013 D.G. Tatar, S. Harrison, D.G. Kafura, M.A. Perez-Quinonez, and C.A. Shaffer, "Planning Grant: Integrating Computational Thinking into Middle School Curriculum", National Science Foundation, CNS-1132227, $199,998.

2010-2014 J.J. Tyson, W. Baumann, J. Peccoud, S. Hoops, Y. Cao, and C.A. Shaffer, "Stochastic Models of Cell Cycle Regulation in Eukaryotes," National Institutes of Health, 2-R01-GM078989-05, $1,986,688.

2010-2011 C.A. Shaffer and S.H. Edwards, "The AlgoViz Portal: Lowering the Barriers for Entry into an Online Educational Community" National Science Foundation NSDL program, DUE-0937863, $149,999.

2009–2010 C.A. Shaffer and S.H. Edwards, "Building a Community and Establishing Best Practices in Algorithm Visualization through the AlgoViz Wiki," National Science Foundation CCLI program, DUE-0836940, $149,206.

2009–2010 C.A. Shaffer and S.H. Edwards, "AlgoViz Project Steering Committee" National Science Foundation, DUE-0946644, $8,500.

2009 C.A. Shaffer, "TCNP Driving Biological Problem: Year 4 Renewal: Using Composition to Integrate a Cell Cycle Model with Morphological Checkpoints," University of Connecticut, $20,925.

2008–2009 C.A. Shaffer and S.H. Edwards, "Steering Committee Workshop to Build a Community for Algorithm Visualization" National Science Foundation, DUE-0839837, $8,500.

2008 C.A. Shaffer, "TCNP Driving Biological Problems: Using Composition to Integrate a Cell Cycle Model with Morphological Checkpoints," University of Connecticut, $17,738.

2006–2010 J.J. Tyson, W.T. Baumann, Y. Cao, M.R. Paul, A. Sandu, C.A. Shaffer, and L.T. Watson, "Stochastic Models of Cell Cycle Regulation in Eukaryotes," National Institute of General Medical Sciences, 1-R01-GM078989-01, $1,437,504.

2006–2007 C.A. Shaffer, "Refinement and Analysis of Log Surface Defect Detection Methods Using High-Resolution Laser Scanning," Wood Education and Resource Center, USDA Forest Service, $50,000.

2001–2006 J.J. Tyson, B. Novak, F.R. Cross, M.D. Mendenhall, J.C. Sible, K.C. Chen, C.A. Shaffer, L.T. Watson, and N. Ramakrishnan, "The Eukaryotic Cell Cycle as a Test Case for Modeling Cellular Regulation in a Collaborative PSE," Defense Advanced Research Projects Agency: $2,442,399.

2001–2003 J.J. Tyson, L.T. Watson, J. Sible, K. Chen, C.A. Shaffer, N. Ramakrishnan, and P. Mendes, "Problem Solving Environment for Modeling the Cell Cycle," National Institute of General Medical Sciences, R01-GM64339-01, $211,038.

2001–2002 J.J. Tyson, C.A. Shaffer, J.C. Sible, N. Ramakrishnan, L.T. Watson, and D.G. Kafura, "Biocomplexity Incubation Activity: A Collaborative PSE for Computational Modeling of Eukaryotic Cell Cycle Controls," NSF: $99,965, MCB-0083315.

2001–2005 C.A. Shaffer and R. Ehrich, "Detection of Surface Defects on Barked Hardwood Stems and Logs," USDA Forest Service, $54,378.

2000–2001 C.A. Shaffer, "Virginia Tech Computer Science Department Support for ADOPTECH STTR Phase II Proposal," ADOPTECH Corp: $53,374.

1999–2002 T.S. Rappaport, C.A. Shaffer, W. Tranter, L.T. Watson, N. Ramakrishnan, and D.G. Kafura, "A Collaborative Problem Solving Environment for Modeling of Broadband Wireless Communications Systems": NSF, $1,000,000.

Major research projects:

2017-present: Co-principle Investigator for SPLICE: Standards, Protocols, and Learning Infrastructure for Computing Education. See `https://cssplice.org`.

2011-present: Principle Investigator for the OpenDSA project to develop a creative-commons, open-source active eTextbook for algorithms and data structures courses. See `https://opendsa.org`.

2006–present: Principle Investigator for the AlgoViz project to develop a community of users and developers of algorithm visualization in computer science education. This includes development of the AlgoViz Portal.

2004–2006: Principal Investigator for an investigation of log surface defect detection methods using high-resolution laser scanning.

2001–present: Co-Principal Investigator for the JigCell project, a problem-solving environment for biochemical pathway analysis. With support from DARPA, NSF, and NIH, this is a major multi-disciplinary project involving faculty from Biology and Computer Science. My major role is as system architect, primarily for developing user interfaces and visualizations for the system, and overseeing general software development and system integration.

1996–1999: Principal Investigator for FIPSE-supported "Integrating Statistics and Models across the Social Sciences Curricula." This project integrates statistical processing with large databases and tutorials to teach Social Sciences students basic statistics and data visualization.

1990–1996: Project director for Project GeoSim, a series of software modules that apply geographic information systems and simulation to introductory geography education. This software simulates of various geographic and economic processes, such as migration and population dynamics.

PhD Students Graduated:

Ayaan Kazerouni, *Measuring the Software Development Process to Enable Formative Feedback*, April 20202.

Austin Cory Bart, *Motivating Introductory Computing Students with Pedagogical Datasets*, May 2017.

Mohammed F. Farghally, *Visualizing Algorithm Analysis Topics*, November 2016.

Sally Hamouda, *Enhancing Learning of Recursion*, December, 2015.

Eric Fouh, *Building and Evaluating a Learning Environment for Algorithm and Data Structure Courses*, May, 2015.

Monika Akbar, *Integrating Community with Collections in Educational Digital Libraries*, December, 2013.

Ranjit Randhawa, *Composition and Aggregation in Modeling Macromolecular Regulatory Networks*, April, 2008.

Liya Thomas, *Automated Detection of Surface Defects on Barked Hardwood Logs and Stems Using 3-D Laser Scanned Data*, September, 2006.

Nicholas A. Allen, *Computational Software for Building Biochemical Reaction Network Models with Differential Equations*, November, 2005.

James M.A. Begole, *Flexible Collaboration Transparancy: Supporting Worker Independence in Replicated Application-Sharing Systems*, December, 1998.

MS Students Graduated: Mark Lattanzi (1989), Dave B. Boldery (1990), Gregory M. Herb (1990), Matt Zukoski (1990), Sheryl Kriss (1991), Vincent Miranda (1991), Mahesh Ursekar (1991), Timothy Ryan (1992), Patrick R. Brown (1992), Tungsheng Yu (1992), Colin Klipsh (1993), Nirupama Thiruvengadam (1993), James M.A. "Bo" Begole (1994), Jun Yang (1995), David Hines (1996) John Raley (1996), Philip L. Isenhour (1998), Amit Goel (1999), Ali Ashgar Zafer (2001), Purvi Saraiya (2002), Dhananjay Mishra (2004), Matthew L. Cooper (2007), A.J. Alon (2010), U.J. Mobassera (2011), Gayathri Subramanian (2012), Daniel A. Breakiron (2013), Ann M. Paul (2013), Nabanita Maji (2015), Hosam Shahin (2017), Ehsan Elgendi (2019), Hamza Manzoor (2019), Jieun Chon (2019), Jackson Wonderley (2019).

Recent Awards:

April 2021 – Dean's Award for Excellence in Service.

June 2020 – Winner of Virginia Tech's Excellence in Access & Inclusion Award

June 2017 – Winner of Virginia Tech 2017 Scholarship of Teaching and Learning Award.

April 2017 – Winner of Virginia Tech XCalibur Award for integrating technology in teaching and learning.

June 2016 to June 2018 – W.S. "Pete" White Chair for Innovation in Engineering Education.

December 2015 – ACM Distinguished Educator.

April 2015 – Dean's Award for Excellence in Teaching.

Selected Recent Professional service:

2017-present: Associate Department Head for Graduate Studies, Department of Computer Science, Virginia Tech.

2014-present: Specialty Chief Editor for Digital Education, *Frontiers in ICT*.

2006–present: Member, Editorial Review Board, AACE Journal of Computers in Mathematics and Science Teaching (JCMST).

2010 to 2012 – Chair, Department of Computer Science Personnel Committee

1998 to 2006 – Chair, Department of Computer Science Graduate Program Committee

Professional Societies: Senior Member of IEEE, IEEE Computer Society. Distinguished Educator of ACM, SIGCSE. Member of ASEE.

Current research interests: Digital Education, Algorithm Visualization, Computational Biology and Bioinformatics, Algorithm Design and Analysis, Data Structures.