DAVID SOLOVEICHIK

Department of Electrical and Computer Engineering
The University of Texas at Austin
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Academic Positions:

09/21–present *The University of Texas at Austin*, Electrical and Computer Engineering, Associate Professor
08/15–08/21 *The University of Texas at Austin*, Electrical and Computer Engineering, Assistant Professor
09/11–07/15 *University of California, San Francisco*, Center for Systems and Synthetic Biology Fellow
Independent postdoc
10/09–9/11 *University of Washington*, Computing Innovation Postdoctoral Fellow
06/08–10/09 *California Institute of Technology*, Postdoctoral Scholar

Education:

09/02-06/08 *California Institute of Technology*, Computation & Neural Systems, Ph.D.
Thesis advisor: Erik Winfree
Dissertation title: "Molecules computing: self-assembled nanostructures, molecular automata, and chemical reaction networks"
(Milton and Francis Clauser Doctoral Prize for the best Caltech dissertation of 2008)
09/98-06/02 *Harvard University*, Computer Science, M.S.
Harvard University, Computer Science (Mind, Brain and Behavior Track), B.S. with Highest Honors, Magna Cum Laude

Awards and Honors:

- **Schmidt Science Polymaths** (2023)
- Best Student Poster Award in DNA29: International Conference on DNA Computing and Molecular Programming (2023)
- ECE Capstone Project-First Place Team in Student Proposed category (2023)
- Temple Foundation Endowed Faculty Fellowship (2022)
- Best Student Paper in DNA26: International Conference on DNA Computing and Molecular Programming (2020)
- **Sloan Research Fellowship** (2020)
- Best Student Paper in DNA25: International Conference on DNA Computing and Molecular Programming (2019)
- Best Paper in CMSB'18: Computational Methods in Systems Biology (2018)
- ECE Capstone Project-First Place Team in Industry category (2017)
- **NSF CAREER** (2016)
- Best Paper in DISC'14: International Symposium on Distributed Computing (2014)
- **Tulip Award** from the International Society for Nanoscale Science, Computation, and Engineering (ISNSCE) recognizing "the DNA Computer Scientist of the Year" (2014)
- **Feynman Prize in Nanotechnology** (Theory) from the Foresight Institute for "advanc[ing] the achievement of Feynman's goal for nanotechnology" (2012)
- Finalist, Burroughs Wellcome Fund Career Award at the Scientific Interface (2011)
- Computing Innovation Postdoctoral Fellowship (2009)
- **Milton and Francis Clauser Doctoral Prize** for best Caltech PhD thesis of the year (2008)
- Best Student Paper in DNA14: International Conference on DNA Computing and Molecular Programming (2008)
- ARCS Foundation Scholarship (2005)

- Best Student Paper in DNA10: International Conference on DNA Computing and Molecular Programming (2004)

Publications:
(citations: > 5280, h-index: 22 [Google Scholar])
[*α*] = alphabetical author order following the theoretical computer science convention. *= co-corresponding authors.

A. Refereed Journal Papers

- B Wang*, SS Wang*, C Chalk, AD Ellington, D Soloveichik, “Parallel molecular computation on digital data stored in DNA,” PNAS: Proceedings of the National Academy of Sciences, USA 120 (37) e2217330120 (Sep 2023). doi: 10.1073/pnas.2217330120
- [*α*] HL Chen, D Doty, W Reeves, D Soloveichik, “Rate-independent computation in continuous chemical reaction networks,” Journal of the ACM 70 (3): 1-61 (May 2023). doi: 10.1145/3590776
- B Wang, C Thachuk, D Soloveichik, “Speed and Correctness Guarantees for Programmable Enthalpy-Neutral DNA Reactions,” ACS Synthetic Biology 12(4): 993-1006 (Apr 2023). doi: 10.1021/acssynbio.2c00356
- M Vasić*, C Chalk*, A Luchsinger, S Khurshid, D Soloveichik, “Programming and Training Rate-Independent Chemical Reaction Networks,” PNAS: Proceedings of the National Academy of Sciences, USA 119 (24) e2111552119 (June 2022). doi: 10.1073/pnas.2111552119
- SK Tabatabaei, B Wang, NBM Athreya, B Enghiad, AG Hernandez, CJ Fields, JP Leburton, D Soloveichik, H Zhao, O Milenkovic, “DNA punch cards for storing data on native DNA sequences via enzymatic nicking,” Nature Communications 11: 1742 (Apr 2020). doi: 10.1038/s41467-020-15588-z.
- M Vasic, D Soloveichik, S Khurshid, “CRN++: Molecular Programming Language,” Natural Computing 19: 391-407 (Jan 2020). doi: 10.1007/s11047-019-09775-1
- [*α*] K Breik, C Chalk, D Haley, D Doty and D Soloveichik, "Programming Substrate-Independent Kinetic Barriers with Thermodynamic Binding Networks," IEEE/ACM Transactions on Computational Biology and Bioinformatics (Dec 2019). doi: 10.1109/TCBB.2019.2959310
- [*α*] C Chalk, N Kornerup, W Reeves and D Soloveichik, "Composable Rate-Independent Computation in Continuous Chemical Reaction Networks," IEEE/ACM Transactions on Computational Biology and Bioinformatics (Nov 2019). doi: 10.1109/TCBB.2019.2952836
- K Breik, C Thachuk, M Heule, D Soloveichik, “Computing properties of stable configurations of thermodynamic binding networks,” Theoretical Computer Science 785: 17-29 (Sep 2019). doi: 10.1016/j.tcs.2018.10.027
- B Wang, C Thachuk, AD Ellington, E Winfree, D Soloveichik, “Effective design principles for leakless strand displacement systems,” PNAS: Proceedings of the National Academy of Sciences, USA 115: E12182-E12191 (Dec 2018). doi: 10.1073/pnas.1806859115
- [*α*] D Doty, D Soloveichik, “Stable leader election in population protocols requires linear time,” Distributed Computing 31: 257-271 (Aug 2018). doi: 10.1007/s00446-016-0281-z
- [*α*] R Brijder, D Doty, D Soloveichik, “Democratic, Existential, and Consensus-Based Output Conventions in Stable Computation by Chemical Reaction Networks”, Natural Computing 17: 97-108 (Mar 2018). doi: 10.1007/s11047-017-9648-8
- N Srinivas, J Parkin, G Seelig, E Winfree, D Soloveichik, “Enzyme-free nucleic acid dynamical systems.” Science 358, (Dec 2017). doi: 10.1126/science.aal2052
- [*α*] HL Chen, R Cummings, D Doty, D Soloveichik, “Speed faults in computation by chemical reaction networks”, Distributed Computing 30: 373-390 (Oct 2017). doi: 10.1007/s00446-015-0255-6
- [*α*] R Cummings, D Doty, D Soloveichik, “Probability 1 computation with chemical reaction networks”, Natural Computing 15: 245-261 (Jun 2016). doi: 10.1007/s11047-015-9501-x
- [*α*] HL Chen, D Doty, D Soloveichik, “Deterministic Function Computation with Chemical Reaction Networks”, Natural Computing 13: 517-534 (2014). doi: 10.1007/s11047-013-9393-6

- YJ Chen, N Dalchau, N Srinivas, A Phillips, L Cardelli, D Soloveichik*, G Seelig*, “Programmable chemical controllers made from DNA”, Nature Nanotechnology 8: 755-762 (Sep 2013). doi: 10.1038/nnano.2013.189
- D Soloveichik, G Seelig, E Winfree, “DNA as a Universal Substrate for Chemical Kinetics”, Proceedings of the National Academy of Sciences, USA 107: 5393-5398 (Mar 2010). doi: 10.1073/pnas.0909380107
- D Soloveichik, “Robust Stochastic Chemical Reaction Networks and Bounded Tau-Leaping”, The Journal of Computational Biology 16: 501-522 (Mar 2009). doi: 10.1089/cmb.2008.0063
- D Soloveichik, M Cook, E Winfree, J Bruck, “Computation with Finite Stochastic Chemical Reaction Networks”, Natural Computing 7: 615-633 (Feb 2008). doi: 10.1007/s11047-008-9067-y
- D Soloveichik, M Cook, E Winfree, “Combining Self-Healing and Proofreading in Self-Assembly”, Natural Computing 7: 203-218 (2008). doi: 10.1007/s11047-007-9036-x
- D Soloveichik, E Winfree, “Complexity of Self-Assembled Shapes”, SIAM Journal on Computing 36: 1544-1569 (Feb 2007). doi: 10.1137/S0097539704446712
- G Seelig, D Soloveichik, DY Zhang, E Winfree, “Enzyme-Free Nucleic Acid Logic Circuits,” Science 314: 1585-1588 (Dec 2006). doi: 10.1126/science.1132493
- D Soloveichik, E Winfree, “The Computational Power of Benenson Automata”, Theoretical Computer Science, 244: 279-297 (Nov 2005). doi: 10.1016/j.tcs.2005.07.027

B. Refereed Conference Proceedings

- A Luchsinger, D Doty, D Soloveichik, “Optimal Information Encoding in Chemical Reaction Networks,” DNA29: International Conference on DNA Computing and Molecular Programming (Sep 2023). doi: 10.4230/LIPIcs.DNA.29.9
- J Petrack, D Soloveichik, D Doty, “Thermodynamically Driven Signal Amplification,” DNA29: International Conference on DNA Computing and Molecular Programming (Sep 2023). doi: 10.4230/LIPIcs.DNA.29.8
- K Breik, A Luchsinger, D Soloveichik, “Molecular machines from topological linkages,” DNA27: International Conference on DNA Computing and Molecular Programming (Sep 2021). doi: 10.4230/LIPIcs.DNA.27.7
- M Vasic, D Soloveichik, S Khurshid, “CRNs Exposed: A Method for the Systematic Exploration of Chemical Reaction Networks,” International Conference on DNA Computing and Molecular Programming (July 2020).
- M Vasic, C Chalk, S Khurshid, D Soloveichik, “Deep Molecular Programming: A Natural Implementation of Binary-Weight ReLU Neural Networks,” ICML 2020: International Conference on Machine Learning (July 2020).
- B Wang, C Chalk, D Soloveichik, “SIMDIIDNA: Single Instruction, Multiple Data Computation with DNA Strand Displacement Cascades,” International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 11648: 219-235 (July 2019). doi: 10.1007/978-3-030-26807-7_12
- [*a*] K Breik, C Chalk, D Doty, D Haley, D Soloveichik, “Programming Substrate-Independent Kinetic Barriers with Thermodynamic Binding Networks”, CMSB 2018: Computational Methods in Systems Biology, Lecture Notes in Computer Science 11095: 203-219 (Aug 2018). doi: 10.1007/978-3-319-99429-1_12
- [*a*] C Chalk, N Kornerup, W Reeves, D Soloveichik, “Composable Rate-Independent Computation in Continuous Chemical Reaction Networks”, CMSB 2018: Computational Methods in Systems Biology, Lecture Notes in Computer Science 11095: 256-273 (Aug 2018). doi: 10.1007/978-3-319-99429-1_15
- M Vasic, D Soloveichik, S Khurshid, “CRN++: Molecular Programming Language”, International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 11145: 1-18 (Sep 2018). doi: 10.1007/978-3-030-00030-1_1
- [*a*] A Belleville, D Doty, D Soloveichik, “Hardness of Computing and Approximating Predicates and Functions with Leaderless Population Protocols”, ICALP 2017: 44th International Colloquium on Automata, Languages, and Programming 80: 141:1-141:14 (2017). doi: 10.4230/LIPIcs.ICALP.2017.141

- [*α*] D Doty, T A Rogers, D Soloveichik, C Thachuk, D Woods, “Thermodynamic binding networks”, International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 10467: 249-266 (Aug 2017). doi: 10.1007/978-3-319-66799-7_16
- [*α*] D Alistarh, B Dudek, A Kosowski, D Soloveichik, P Uznański, “Robust detection in leak-prone population protocols”, International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 10467: 155-171 (Aug 2017). doi: 10.1007/978-3-319-66799-7_11
- B Wang, C Thachuk, A D Ellington, D Soloveichik, “The design space of strand displacement cascades with toehold-size clamps”, International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 10467: 64-81 (Aug 2017). doi: 10.1007/978-3-319-66799-7_5
- [*α*] D Doty, D Soloveichik, “Stable leader election in population protocols requires linear time”, DISC 2015: Proceedings of the 29th International Symposium on Distributed Computing 9363: 602–616 (Oct 2015). doi: 10.1007/978-3-662-48653-5_40
- C Thachuk, E Winfree, D Soloveichik, “Leakless DNA strand displacement systems", International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 9211: 133-152 (July 2015). doi: 10.1007/978-3-319-21999-8_9
- [*α*] R Cummings, D Doty, D Soloveichik, “Probability 1 computation with chemical reaction networks”, International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 8727: 37-52 (2014). doi: 10.1007/978-3-319-11295-4_3
- [*α*] HL Chen, R Cummings, D Doty, D Soloveichik, “Speed faults in computation by chemical reaction networks”, DISC’14: International Symposium on Distributed Computing 8784: 16-32 (2014). doi: 10.1007/978-3-662-45174-8_2
- [*α*] HL Chen, D Doty, D Soloveichik, “Rate-independent computation in continuous chemical reaction networks”, ITCS’14: Proceedings of the 5th Conference on Innovations in Theoretical Computer Science, 313-326 (Jan 2014). doi: 10.1145/2554797.2554827
- L Qian, D Soloveichik, E Winfree, “Efficient Turing-universal computation with DNA polymers”, International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 6518: 123-140 (2011). doi: 10.1007/978-3-642-18305-8_12
- D Soloveichik, G Seelig, E Winfree, “DNA as a Universal Substrate for Chemical Kinetics”, International Conference on DNA Computing and Molecular Programming, Lecture Notes in Computer Science 5347: 57-69 (2009). doi: 10.1007/978-3-642-03076-5_6
- G Seelig, D Soloveichik, “Time-Complexity of Multilayered DNA Strand Displacement Circuits”, International Workshop on DNA-Based Computers, Lecture Notes in Computer Science 5877: 144-153 (2009). doi: 10.1007/978-3-642-10604-0_15
- D Soloveichik, E Winfree, “Complexity of Compact Proofreading for Self-Assembled Patterns”, International Workshop on DNA-Based Computers, Lecture Notes in Computer Science 3892: 305-324 (2006). doi: 10.1007/11753681_24
- D Soloveichik, E Winfree, “Complexity of Self-Assembled Shapes”, International Workshop on DNA-Based Computers, Lecture Notes in Computer Science 3384: 344-354 (2005). doi: 10.1007/11493785_30

C. Other Publications

- D Doty, N Kornerup, A Luchsinger, L Orshansky, D Soloveichik, D Woods, “Harvesting Brownian Motion: Zero Energy Computational Sampling,” arXiv preprint arxiv:2309.06957 (Aug 2023). https://arxiv.org/abs/2309.06957
- N Kornerup, J Sadun, D Soloveichik, “The Spooky Pebble Game (in Quantum Computing)”, arXiv preprint arXiv:2110.08973 (Oct 2021). https://arxiv.org/pdf/2110.08973
- D Soloveichik, “Statistical Learning of Arbitrary Computable Classifiers”, arXiv preprint cs.LG/0806.3537 (Jul 2008).

D. Chapters of Books; Editor of Books

- D Soloveichik, B Yurke (editors), DNA Computing and Molecular Programming, Proceedings of the 19th International Conference, Lecture Notes in Computer Science 8141 (Sep 2013). doi: 10.1007/978-3-319-01928-4
- M Cook, D Soloveichik, E Winfree, J Bruck (chapter authors), "Programmability of Chemical Reaction Networks", in Algorithmic Bioprocesses, (Eds. Condon, Harel, Kok, Salomaa, Winfree), Springer, pp. 543-584 (Aug 2009). doi: 10.1007/978-3-540-88869-7_27

Oral Presentations:

- Invited talk, Hamilton Institute Seminar, Maynooth University, Ireland (Dec 2022)
- Invited talk, "All You Need is DNA: Dynamical Systems and Chemical Computers," Foresight Institute, Molecular Machines Seminar Series (April 2022)
- Invited talk, "Computing with Chemical Reaction Networks," Department of Energy, Advanced Scientific Computing Research Briefing (Feb 2022)
- "Engineering Chemical Brains," Center for Theoretical and Computation Neuroscience, UT Austin (Feb 2022)
- Invited talk, "SIMD||DNA: Single Instruction, Multiple Data Computation with DNA Strand Displacement Cascades," Workshop on Computing with Unconventional Technologies (Oct 2021)
- "Know Your Professor Outside the Lab," IEEE Graduate Student Chapter Faculty Talk Series, UT Austin (Apr 2021)
- "Thermodynamic Binding Networks," Portland State University, Portland, Oregon (Nov 2019)
- MPP2-Finale Workshop, California Institute of Technology, Pasadena, California (June 2019)
- D Doty, T A Rogers, D Soloveichik, C Thachuk, D Woods, "Thermodynamic binding networks", 23rd International Meeting on DNA Computing and Molecular Programming, Austin, Texas (Sep 2017)
- Tutorial talk, 23rd International Meeting on DNA Computing and Molecular Programming, Austin, Texas (Sep 2017)
- "Agents and Reagents: Distributed Computing in a Test Tube", Microsoft Research Faculty Summit (July 2016)
- CanaDAM 2015, Invited Minisymposium on Algorithmic chemical reaction networks, Canada (June 2015)
- HL Chen, R Cummings, D Doty, D Soloveichik, "Speed faults in computation by chemical reaction networks", DISC'14: 28th International Symposium on Distributed Computing, Austin, Texas (Oct 2014)
- Tutorial Talk, DISC'14: 28th International Symposium on Distributed Computing, Austin, Texas (Oct 2014)
- Tutorial Talk, Workshop on Programming Chemical Reaction Networks, Banff, Canada (Jun 2014)
- Santa Fe Institute and University of New Mexico, Santa Fe, New Mexico (Sep 2013)
- Workshop on Advances in Molecular Programming and Computing: Toward Chemistry as a New Information Technology, Stockholm, Denmark (May 2013)
- Foresight Institute Feynman Prize talk (Jan 2013)
- National Centers for Systems Biology Annual Meeting, University of Chicago (July 2012)
- EECS Seminar, University of California, Berkeley (May 2012)
- Tutorial Talk, 17th International Meeting on DNA Computing and Molecular Programming, Pasadena, California (Sep 2011)
- Workshop on Statistical Mechanics and Computation of DNA self-assembly, Mariehamn, Finland (May 2011)
- Plenary Talk, 16th International Meeting on DNA Computing and Molecular Programming, Hong Kong, China (June 2010)
- CS Colloquium, University of Washington (Jan 2010)
- 2nd Banff Workshop on Stochasticity in Biochemical Reaction Networks, Canada (Sep 2009)
- 6th Annual Conference on the Foundations of Nanoscience, Snowbird, Utah (Apr 2009)
- CS Colloquium, Yale (Nov 2008)
- Caltech Information Science and Technology Seminar (Nov 2008)

- American Mathematical Society (AMS) Sectional Meeting, Raleigh (Apr 2009)
- D Soloveichik, G Seelig, E Winfree, “DNA as a Universal Substrate for Chemical Kinetics”, International Meeting on DNA Computing and Molecular Programming, Arkansas (2009)
- G Seelig, D Soloveichik, “Time-Complexity of Multilayered DNA Strand Displacement Circuits”, International Meeting on DNA Computing and Molecular Programming, Prague (2008).
- Banff Workshop on Stochasticity in Biochemical Reaction Networks, Canada (2007)
- D Soloveichik, E Winfree, “Complexity of Compact Proofreading for Self-Assembled Patterns”, International Meeting on DNA Computing and Molecular Programming, Seoul (2006)
- D Soloveichik, E Winfree, “Complexity of Self-Assembled Shapes”, International Meeting on DNA Computing and Molecular Programming, Italy (2004).

Patents:

- G Seelig, D Soloveichik, E Winfree, DY Zhang, “Nucleic acid-based logic circuits”, US Patent 7,745,594

Teaching:

- (New graduate course) EE381V / CS395T: Unconventional Computing (Spring 2020–2024): 18–31 students
- (Undergraduate course) EE360C Algorithms (Fall 2016–2019, 2021–2023): 40-189 students
- (New graduate course) EE381V: Programming with Molecules (Spring 2016–2018): 7–23 students
- Mentoring undergraduate student teams for ECE Capstone Project (2016–present)
- Instructor for mini-course “Cellular Cognition”, IPQB program, UCSF (2014)
- Instructor for new mini-course “Distributed Algorithms in Biology”, IPQB program, UCSF (2012)
- Teaching Assistant, CS/CNS 129: Information and Complexity, Caltech (2003, 2007); series of lectures on “NP-Completeness” and “Chaitin’s Algorithmic Information Theory”
- Teaching Assistant, CS/CNS 191: Biomolecular Computation, Caltech (2007)
- Teaching Assistant, CS 151: Computational Complexity Theory, Caltech (2004)

Professional Memberships:

- ISNSCE (International Society for Nanoscale Science, Computation and Engineering)

Selected Professional and Community Activities:

- Member, Disabled Faculty Equity Council at UT Austin (2022–present)
- Program Committee, SAND: Symposium on Algorithmic Foundations of Dynamic Networks (2022)
- Faculty Mentor, ECE Partner Program (2021–present)
- Chair, ECE Colloquium Committee (2021–present)
- Faculty Advisory Board, “Art of Molecular Programming” textbook initiative (2021–present)
- Steering Committee, DNA: International Conference on DNA Computing and Molecular Programming (2019–present)
- Graduate Advisor and Coordinator for bioECE track in ECE (2019–present)
- Organizing Committee co-Chair, DNA23: International Conference on DNA Computing and Molecular Programming (2017)
- Program Committee, DISC: International Symposium on Distributed Computing (2017)
- Program Committee, DNA: International Conference on DNA Computing and Molecular Programming (2015–2021)
- Milken Community High School (Los Angeles), Board of Trustees (2006–2011).

Vita:

David Soloveichik received his B.S. and M.S. degrees from Harvard University in Computer Science in 2002.

He completed his Ph.D. degree in Computation and Neural Systems at the California Institute of Technology in 2008, where his dissertation was awarded the Milton and Francis Clauser Doctoral Prize for the best doctoral thesis. Subsequently, David was a Computing Innovations Fellow and a Fellow at the Center for Systems and Synthetic Biology at the University of California, San Francisco. He joined The University of Texas at Austin as an Assistant Professor at the Department of Electrical and Computer Engineering in 2015.

David was the recipient of the Feynman Prize in Nanotechnology (Theory) from the Foresight Institute in 2012, and the Tulip Award from the International Society for Nanoscale Science, Computation and Engineering in 2014 which recognizes “the DNA Computer Scientist of the Year.” He received the National Science Foundation CAREER Award in 2016, the Sloan Research Fellowship in 2020, and the Schmidt Futures Foundation Polymath Award in 2023. His scientific area of interest is the engineering of complex molecular systems for nanotechnology and synthetic biology using bottom-up computer science and electrical engineering principles, as well as using formal models of computing to discover the potential and limits of chemical information processing.