DAVID SOLOVEICHIK

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Research Interests:

Natural computing: the study of computation inspired by nature. Molecular programming: engineering of functional molecular systems using the principles of electrical engineering and computer science.

Academic Positions:

08/15-present   *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
                  Principle investigator: Georg Seelig

06/08-10/09   *California Institute of Technology*, Postdoctoral Scholar
                  Principle investigator: Erik Winfree

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:

- Best Student Paper Award in DNA25 (2019)
- Best Paper Award in CMSB (2018)
- NSF CAREER (2016)
- Best Paper Award in DISC'14 (2014)
- Tulip Award from the International Society for Nanoscale Science, Computation, and Engineering (ISNSCE) (2014)
- Feynman Prize in Nanotechnology (Theory) from the Foresight Institute (2012)
- Finalist, Burroughs Wellcome Fund Career Award at the Scientific Interface (2011)
- Computing Innovation Postdoctoral Fellowship (2009–2010)
- Milton and Francis Clauser Doctoral Prize (best Caltech PhD thesis)
- Best Student Paper Awards in DNA Computing and Molecular Programming Conference (2004, 2008)
- ARCS Foundation Scholarship (2005)

Refereed Publications:

(citations: >3100, h-index: 18 [Google Scholar])

[*α*] = alphabetical author order following the theoretical computer science convention. *= co-corresponding authors. For publications with both conference and journal versions, only the journal version is listed.

- B Wang, C Chalk, D Soloveichik, "SIMDǀǀDNA: Single Instruction, Multiple Data Computation with DNA Strand Displacement Cascades." *Proceedings of DNA Computing and Molecular Programming 25 (DNA25)* (2019).
  (Best Student Paper award.)
- K Breik, C Thachuk, M Heule, D Soloveichik, "Computing properties of stable configurations of thermodynamic binding networks." *Theoretical Computer Science* 785: 17-29 (2019).
- B Wang, C Thachuk, AD Ellington, E Winfree, D Soloveichik, "Effective design principles for leakless strand displacement systems", *Proceedings of the National Academy of Sciences*, *USA* 115 (52): E12182-E12191 (2018).
- [*α*] K Breik, C Chalk, D Doty, D Haley, D Soloveichik, "Programming Substrate-Independent Kinetic Barriers with Thermodynamic Binding Networks", *Proceedings of the 16th International Conference on Computational Methods in Systems Biology (CMSB)* (2018).
  (Top 3 paper at CMSB.)
- [*α*] C Chalk, N Kornerup, W Reeves, D Soloveichik, "Composable Rate-Independent Computation in Continuous Chemical Reaction Networks", *Proceedings of the 16th International Conference on Computational Methods in Systems Biology (CMSB)* (2018).
  (Best paper award at CMSB.)
- M Vasic, D Soloveichik, S Khurshid, "CRN++: Molecular Programming Language", *Proceedings of DNA Computing and Molecular Programming 24 (DNA24)* (2018).
- N Srinivas, J Parkin, G Seelig, E Winfree, D Soloveichik, "Enzyme-free nucleic acid dynamical systems." *Science* 358 (6369), (2017).
- [*α*] D Doty, T A Rogers, D Soloveichik, C Thachuk, D Woods, "Thermodynamic binding networks", *Proceedings of DNA Computing and Molecular Programming 23 (DNA23)* (2017).
- [*α*] D Alistarh, B Dudek, A Kosowski, D Soloveichik, P Uznański, "Robust detection in leak-prone population protocols", *Proceedings of DNA Computing and Molecular Programming 23 (DNA23)* (2017).
- B Wang, C Thachuk, A D Ellington, D Soloveichik, "The design space of strand displacement cascades with toehold-size clamps", *Proceedings of DNA Computing and Molecular Programming 23 (DNA23)* (2017).
- [*α*] A Belleville, D Doty, D Soloveichik, "Hardness of Computing and Approximating Predicates and Functions with Leaderless Population Protocols", *Proceedings of the 44th International Colloquium on Automata, Languages and Programming (ICALP)* (2017).
- [*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 (2018).
- [*α*] R Cummings, D Doty, D Soloveichik, "Probability 1 computation with chemical reaction networks", *Natural Computing* 15: 245-261 (2016).
- [*α*] D Doty, D Soloveichik, "Stable leader election in population protocols requires linear time", *Proceedings of the 29th International Symposium on Distributed Computing (DISC'15)* (2015).
- C Thachuk, E Winfree, D Soloveichik, "Leakless DNA strand displacement systems", *Proceedings of DNA Computing and Molecular Programming 21 (DNA21)* (2015).
- [*α*] HL Chen, R Cummings, D Doty, D Soloveichik, "Speed faults in computation by chemical reaction networks", *Proceedings of the 28th International Symposium on Distributed Computing (DISC'14)*, 16-32 (2014).
  (Best paper award at DISC'14.)
- [*α*] HL Chen, D Doty, D Soloveichik, "Rate-independent computation in continuous chemical reaction networks", *Proceedings of the 5th Conference on Innovations in Theoretical Computer Science (ITCS'14), 313-326* (2014).

- YJ Chen, N Dalchau, N Srinivas, A Phillips, L Cardelli, <u>D Soloveichik</u>*, G Seelig*, "Programmable chemical controllers made from DNA", *Nature Nanotechnology* 8: 755-762 (2013).
  (Associated News and Views article: E Shapiro and T Ran, "Molecules reach consensus".)
- [*a*] HL Chen, D Doty, <u>D Soloveichik</u>, "Deterministic Function Computation with Chemical Reaction Networks", *Natural Computing* 13: 517-534 (2014).
- L Qian, <u>D Soloveichik</u>, E Winfree, "Efficient Turing-universal computation with DNA polymers", *Proceedings of DNA Computing and Molecular Programming 16 (DNA16), Lecture Notes in Computer Science* 6518: 123-140 (2011).
- <u>D Soloveichik</u>, G Seelig, E Winfree, "DNA as a Universal Substrate for Chemical Kinetics", *Proceedings of the National Academy of Sciences, USA* 107: 5393-5398 (2010).
- G Seelig, <u>D Soloveichik</u>, "Time-Complexity of Multilayered DNA Strand Displacement Circuits", *Proceedings of DNA Computing and Molecular Programming 15 (DNA15), Lecture Notes in Computer Science* 5877: 144-153 (2009).
- M Cook, <u>D Soloveichik</u>, E Winfree, J Bruck, "Programmability of Chemical Reaction Networks", in *Algorithmic Bioprocesses*, (Eds. Condon, Harel, Kok, Salomaa, Winfree), Springer, pp. 543-584 (2009).
- <u>D Soloveichik</u>, "Robust Stochastic Chemical Reaction Networks and Bounded Tau-Leaping", *The Journal of Computational Biology* 16: 501-522 (2009).
- <u>D Soloveichik</u>, M Cook, E Winfree, J Bruck, "Computation with Finite Stochastic Chemical Reaction Networks", *Natural Computing* 7: 615-633 (2008).
- <u>D Soloveichik</u>, M Cook, E Winfree, "Combining Self-Healing and Proofreading in Self-Assembly", *Natural Computing* 7: 203-218 (2008).
- <u>D Soloveichik</u>, E Winfree, "Complexity of Self-Assembled Shapes", *SIAM Journal on Computing* 36: 1544-1569 (2007).
- G Seelig, <u>D Soloveichik</u>, DY Zhang, E Winfree, "Enzyme-Free Nucleic Acid Logic Circuits," *Science* 314: 1585-1588 (2006).
  (Associated Perspectives article: W Fontana, "Pulling Strings". Work was discussed in the mainstream media, including *Scientific American* and *The Economist*.)
- <u>D Soloveichik</u>, E Winfree, "Complexity of Compact Proofreading for Self-Assembled Patterns", *Proceedings of DNA Computing 11 (DNA11), Lecture Notes in Computer Science*, 3892: 305-324 (2006).
- <u>D Soloveichik</u>, E Winfree, "The Computational Power of Benenson Automata", *Theoretical Computer Science*, 244: 279-297 (2005).

Other Publications:

- <u>D Soloveichik</u>, "Statistical Learning of Arbitrary Computable Classifiers", arXiv preprint cs.LG/0806.3537v2.

Edited Proceedings Volumes:

- <u>D Soloveichik</u>, B Yurke (eds), *Proceedings of DNA Computing and Molecular Programming 19 (DNA19), Lecture Notes in Computer Science* 8141 (2013).

Invited Talks:

- Tutorial talk, 23rd International Meeting on DNA Computing and Molecular Programming, Austin, Texas (Sep 2017).
- Microsoft Research Faculty Summit (July 2016).
- CanaDAM 2015, Invited Minisymposium on Algorithmic chemical reaction networks (June 2015).
- Tutorial Talk, 28th International Symposium on Distributed Computing, Austin (Oct 2014).

- Tutorial Talk, Workshop on Programming Chemical Reaction Networks, Banff, Canada (Jun 2014).
- Santa Fe Institute and University of 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)
- AMS Sectional Meeting, Raleigh (Apr 2009).
- Banff Workshop on Stochasticity in Biochemical Reaction Networks, Canada (2007).

Patents:

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

Support:

- DARPA: Native DNA-based Data Storage and Computing. PI: Olgica Milenkovic, co-PIs: Alvaro Hernandez, Mark Riedel, David Soloveichik, Huimin Zhao. My share: $400,000 (2017-2020).
- NSF CCF: 23rd International Conference on DNA Computing and Molecular Programming. PI: Andrew Ellington, co-PI: David Soloveichik. $12,000 (2017).
- NSF CAREER: Robust Molecular Computation: Error-Correcting Reaction Networks and Leakless DNA Circuits, CCF-1652824. PI: David Soloveichik. $460,786 (2017-present).
- NSF AF: Small: Collaborative Research: Kinetics and Thermodynamics of Chemical Computation, CCF-1618895. PI: David Soloveichik. My share: $249,928 (2016-present).
- NSF CCF: SHF: Small: Programming Networks of Molecular Interactions Using DNA Strand-Displacement Cascades, CCF-1117143. PI: Georg Seelig, co-PI: David Soloveichik. Total: $430,000 (2011-2016).
- NIGMS P50: Exploring design principles of cellular control circuits. PI: Wendell A. Lim. Personal annual allocation: 12 mo. salary, $15,000 (2011-2015).

Teaching Experience:

- (Undergraduate course) EE360C Algorithms (Fall 2018): 189 students
- (Undergraduate course) EE360C Algorithms (Fall 2016, 2017): 40-80 students
- (New graduate course) EE381V: Programming with Molecules (Spring 2016, 2017, 2018): 7-23 students
- 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)

Professional and Community Activities:

- Organizing Committee co-Chair, DNA 23 (International Meeting on DNA Computing and Molecular Programming) (2017).
- Program Committee, DISC (International Symposium on Distributed Computing) (2017).
- Program Committee, VEMDP (Verification of Engineered Molecular Devices and Programs) (2014).
- Guest Editor, *Natural Computing* (2013).
- Program Committee co-Chair, DNA 19 (International Meeting on DNA Computing and Molecular Programming) (2012-2013).
- Program Committee, DNA (International Meeting on DNA Computing and Molecular Programming) (2007-2012, 2014-2017).
- Conference reviewer: DNA (International Meeting on DNA Computing and Molecular Programming), STOC (ACM Symposium on Theory of Computing), FOCS (Symposium on Foundations of Computer Science), DISC (International Symposium on Distributed Computing), SODA (ACM-SIAM Symposium on Discrete Algorithms), PODC (ACM Symposium on Principles of Distributed Computing), CACOON (International Computing and Combinatorics Conference).
- Journal reviewer: Algorithmica, Natural Computing, ToCT (ACM Transactions on Computation Theory), Journal of the Royal Society Interface, Nature Reviews Genetics, ACS Synthetic Biology, Artificial Life, Nature Chemistry.
- Milken Community High School (Los Angeles), Board of Trustees (2006-2011).