

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:

- 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: >2300, h-index: 16 [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.

- N Srinivas, J Parkin, G Seelig, E Winfree, D Soloveichik, "Enzyme-free nucleic acid dynamical systems." Preprint: bioRxiv: doi.org/10.1101/138420 (2017).

- K Breik, L Prakash, C Thachuk, M Heule, D Soloveichik, “Computing properties of stable configurations of thermodynamic binding networks.” Preprint: arXiv:1709.08731 (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] R Brijder, D Doty, D Soloveichik, “Democratic, Existential, and Consensus-Based Output Conventions in Stable Computation by Chemical Reaction Networks”, *accepted to Natural Computing* (2017).
- [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, D Soloveichik*, 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”.)
- [α] HL Chen, D Doty, D Soloveichik, “Deterministic Function Computation with Chemical Reaction Networks”, *Natural Computing* 13: 517-534 (2014).
- L Qian, D Soloveichik, 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).
- 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 (2010).
- G Seelig, D Soloveichik, “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, D Soloveichik, E Winfree, J Bruck, “Programmability of Chemical Reaction Networks”, in *Algorithmic Bioprocesses*, (Eds. Condon, Harel, Kok, Salomaa, Winfree), Springer, pp. 543-584 (2009).
- D Soloveichik, “Robust Stochastic Chemical Reaction Networks and Bounded Tau-Leaping”, *The Journal of Computational Biology* 16: 501-522 (2009).
- D Soloveichik, M Cook, E Winfree, J Bruck, “Computation with Finite Stochastic Chemical Reaction Networks”, *Natural Computing* 7: 615-633 (2008).
- D Soloveichik, M Cook, E Winfree, “Combining Self-Healing and Proofreading in Self-Assembly”, *Natural Computing* 7: 203-218 (2008).
- D Soloveichik, E Winfree, “Complexity of Self-Assembled Shapes”, *SIAM Journal on Computing* 36: 1544-1569 (2007).

- G Seelig, D Soloveichik, 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*.)
- D Soloveichik, 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).
- D Soloveichik, E Winfree, “The Computational Power of Benenson Automata”, *Theoretical Computer Science*, 244: 279-297 (2005).

Other Publications:

- D Soloveichik, “Statistical Learning of Arbitrary Computable Classifiers”, arXiv preprint cs.LG/0806.3537v2.

Edited Proceedings Volumes:

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

Conference and Invited Talks:

- Invited Talk, Microsoft Research Faculty Summit (July 2016).
- Invited Talk, CanaDAM 2015, Invited Minisymposium on Algorithmic chemical reaction networks (June 2015).
- Invited Tutorial Talk, 28th International Symposium on Distributed Computing, Austin (Oct 2014).
- Invited Tutorial Talk, Workshop on Programming Chemical Reaction Networks, Banff, Canada (Jun 2014).
- Invited Talk, “Molecules Computing”, Santa Fe Institute and University of New Mexico (Sep 2013).
- Invited Talk, Workshop on Advances in Molecular Programming and Computing: Toward Chemistry as a New Information Technology, Stockholm, Denmark (May 2013).
- “An Artificial ‘Biochemistry’ with DNA.” Foresight Institute Feynman Prize talk (Jan 2013).
- “Exposing Chemical Algorithms.” National Centers For Systems Biology Annual Meeting, University of Chicago (July 2012).
- “The Programming Language of Chemical Kinetics.” EECS Seminar, University of California, Berkeley (May 2012).
- “The Programming Language of Chemical Kinetics, and How To Discipline Your DNA Molecules using Strand Displacement Cascades.” Invited Tutorial Talk, 17th International Meeting on DNA Computing and Molecular Programming, Pasadena, California (Sep 2011).
- “Programmable Chemical Reactions: DNA Strand Displacement Cascades.” Invited Talk, 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).
- “Computer-Theoretic Abstractions for Molecular Programming.” Invited talk, CS Colloquium, University of Washington (Jan 2010).
- “Computability Properties of Chemical Reaction Networks.” Invited talk, 2nd Banff Workshop on Stochasticity in Biochemical Reaction Networks, Canada (Sep 2009).
- “Signal Propagation and Propagation Delays in Molecular Circuits.” 15th International Meeting on DNA Computing and Molecular Programming, Fayetteville, Arkansas (June 2009).
- “Programmable Chemical Kinetics.” Invited talk, 6th Annual Conference on the Foundations of Nanoscience, Snowbird, Utah (Apr 2009).

- “Algorithmic Behavior in Well-Mixed Chemical Kinetics.” Invited talk, CS Colloquium, Yale (Nov 2008); also invited talk at Caltech Information Science and Technology Seminar (Nov 2008); also invited talk at the AMS Sectional Meeting, Raleigh (Apr 2009).
- “DNA as a Universal Substrate for Chemical Kinetics.” 14th International Meeting on DNA Computing, Czech Republic (2008).
- “Fast Simulation of Robust Stochastic Chemical Reaction Networks.” Invited talk, Banff Workshop on Stochasticity in Biochemical Reaction Networks, Canada (2007).
- “Complexity of Compact Proofreading for Self-Assembled Patterns.” 12th International Meeting on DNA Computing, South Korea (2006).
- “Complexity of Self-Assembled Shapes.” 10th International Meeting on DNA Computing, Italy (2004).

Patents:

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

Research Support:

- 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, \$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, \$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 2016): 80 students
- (New graduate course) EE381V: Programming with Molecules (Spring 2016): 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: STOC (ACM Symposium on Theory of Computing), DNA (International Meeting on DNA Computing and Molecular Programming), SODA (ACM-SIAM Symposium on Discrete Algorithms), PODC (ACM Symposium on Principles of Distributed Computing), CACOON (International Computing and Combinatorics Conference), FOCS (Symposium on Foundations of Computer Science).
- 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).