

Heng Guo

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Academic Positions

- Lecturer in algorithms and complexity, School of Informatics, University of Edinburgh 2017/09 – present
- Visiting Professor, Institute for Theoretical Computer Science, Shanghai University of Finance and Economics 2018/05 – present
- Google research fellow, Simons Institute for the Theory of Computing, University of California, Berkeley 2016/01 – 2016/05
- Postdoctoral researcher, School of Mathematical Sciences, Queen Mary, University of London 2015/10 – 2017/08

Education

- Ph.D. in Computer Science University of Wisconsin-Madison, 2015
Advisor: Jin-Yi Cai
Thesis: Complexity Classification of Exact and Approximate Counting Problems
- M.A. in Mathematics University of Wisconsin-Madison, 2013
- M.S. in Computer Science Peking University, 2010
- B.S. in Mathematics Peking University, 2007

Research Interests

- Theory of computing, with an emphasis on computational counting and sampling.

Honours and Awards

- Best paper award of ICALP 2018 track A, for the paper “A polynomial-time approximation algorithm for all-terminal network reliability” (joint work with Mark Jerrum).
- EATCS distinguished dissertation award. European Association for TCS, 2016.
- Google research fellow. Simons Institute of Computing, UC-Berkeley, 2016 Spring.
- Simons award for graduate students in TCS. The Simons foundation, 2013-2015.
- Kang Zheng fellowship. Peking University, 2008-2009.

Research Articles

- Uniform sampling through the Lovász local lemma
Heng Guo, Mark Jerrum, and Jingcheng Liu
J. ACM, to appear
Preliminary version: **STOC’17**, pp. 342-355
- A polynomial-time approximation algorithm for all-terminal network reliability
Heng Guo and Mark Jerrum
SIAM J. Comput., to appear
Preliminary version: **ICALP’18**, 68:1-12 (Best paper award for track A)

- Approximation via correlation decay when strong spatial mixing fails
Ivona Bezáková, Andreas Galanis, Leslie Ann Goldberg, Heng Guo, and Daniel Štefankovič
SIAM J. Comput., to appear
Preliminary version: **ICALP'16**, 45:1-13
- Zeros of Holant problems: locations and algorithms
Heng Guo, Chao Liao, Pinyan Lu, and Chihao Zhang
SODA'19, pp. 2262-2278
Available at arXiv: 1807.09129
- Uniqueness, spatial mixing, and approximation in ferromagnetic 2-spin systems
Heng Guo and Pinyan Lu
ACM Trans. Comput. Theory, 10(4):17, 2018
Preliminary version: **RANDOM'16**, 31:1-26
- Clifford gates in the Holant framework
Jin-Yi Cai, Heng Guo, and Tyson Williams
Theor. Comput. Sci., 745, 163-171, 2018
- Perfect simulation of the hard disks model by partial rejection sampling
Heng Guo and Mark Jerrum
ICALP'18, 69:1-10
Available at arXiv: 1801.07342
- Counting hypergraph colorings in the local lemma regime
Heng Guo, Chao Liao, Pinyan Lu, and Chihao Zhang
STOC'18, pp. 926-939
Available at arXiv: 1711.03396
- Holographic algorithms beyond matchgates
Jin-Yi Cai, Heng Guo, and Tyson Williams
Inf. Comput., 259(1), 102-129, 2018
Preliminary version: **ICALP'14**, pp. 271-282
- Layerwise systematic scan: deep Boltzmann machines and beyond
Heng Guo, Kaan Kara, and Ce Zhang
AISTATS'18, PMLR 84, 178-187
- Random cluster dynamics for the Ising model is rapidly mixing
Heng Guo and Mark Jerrum
Ann. Appl. Probab., 28(2), 1292-1313, 2018
Preliminary version: **SODA'17**, pp. 1818-1827
- The complexity of approximating complex-valued Ising and Tutte partition functions
Leslie Ann Goldberg and Heng Guo
Comput. Complex., 26(4), 765-833, 2017
- A complete dichotomy rises from the capture of vanishing signatures
Jin-Yi Cai, Heng Guo, and Tyson Williams
SIAM J. Comput., 45(5), 1671-1728, 2016
Preliminary version: **STOC'13**, pp. 635-644

- The complexity of counting edge colorings and a dichotomy for some higher domain Holant problems
Jin-Yi Cai, Heng Guo, and Tyson Williams
Res. Math. Sci., 3:18, 2016
Preliminary version: **FOCS'14**, pp. 601-610
- #BIS-hardness for 2-spin systems on bipartite bounded degree graphs in the tree nonuniqueness region
Jin-Yi Cai, Andreas Galanis, Leslie Ann Goldberg, Heng Guo, Mark Jerrum, Daniel Štefankovič, and Eric Vigoda
J. Comput. Syst. Sci., 82(5), 690-711, 2016
Preliminary version: **RANDOM'14**, pp. 582-595
- A Holant dichotomy: Is the FKT algorithm universal?
Jin-Yi Cai, Zhiguo Fu, Heng Guo, and Tyson Williams
FOCS'15, pp. 1259-1276
Available at arXiv: 1505.02993
- The complexity of symmetric Boolean parity Holant problems
Heng Guo, Pinyan Lu, and Leslie G. Valiant
SIAM J. Comput., 42(1), 324-356, 2013
Preliminary version: **ICALP'11**, pp. 712-723
- The complexity of planar Boolean #CSP with complex weights
Heng Guo and Tyson Williams
ICALP'13, pp. 516-527
Available at arXiv: 1212.2284
- Inapproximability after uniqueness phase transition in two-spin systems
Jin-Yi Cai, Xi Chen, Heng Guo, and Pinyan Lu
COCOA'12, pp. 336-347
Available at arXiv: 1205.2934
- The complexity of weighted Boolean #CSP modulo k
Heng Guo, Sangxia Huang, Pinyan Lu, and Mingji Xia
STACS'11, pp. 249-260
- On model checking Boolean BI
Heng Guo, Hanpin Wang, Zhongyuan Xu and Yongzhi Cao
CSL'09, pp. 302-316

Preprints

- Approximately counting bases of bicircular matroids
Heng Guo and Mark Jerrum
Submitted. arXiv: 1808.09548
- Tight bounds for popping algorithms
Heng Guo and Kun He
Submitted. arXiv: 1807.01680

**Book Chapters,
Surveys,
Other Writings**

- On the complexity of Holant problems
Heng Guo and Pinyan Lu
The Constraint Satisfaction Problem, Dagstuhl Follow-Ups 7, 159-177, 2017
- Mapping the complexity of counting problems
Heng Guo
Bulletin of EATCS, No 120: October 2016
- Holant problems
Jin-Yi Cai, Heng Guo, and Tyson Williams
Encyclopedia of Algorithms 2016: 918-921

Talks

- Counting hypergraph colorings in the local lemma regime
 - 2019 Jan, Combinatorics Seminar, University of Birmingham, UK
 - 2018 Oct, LFCS lab lunch, University of Edinburgh, UK
 - 2017 Dec, Tensor workshop, China Academy of Science, China
- A polynomial-time approximation algorithm for all-terminal network reliability
 - 2018 Aug, Partition functions workshop, Universiteit van Amsterdam, NL
 - 2018 Jul, Queen Mary Algorithms Day, London, UK
 - 2018 Jul, ICALP, Prague, Czech
 - 2018 Jun, Applied math seminar, Zhejiang University, China
 - 2018 Jun, ITCS seminar, Shanghai University of Finance and Economics, China
 - 2018 May, FATA seminar, University of Glasgow, UK
 - 2018 May, TADS seminar, Alan Turing Institute, London, UK
 - 2018 Apr, Scottish Combinatorics Meeting, Edinburgh, UK
- A simple FPRAS for bi-directed reachability
 - 2017 Dec, TCS seminar, Peking University, China
- Uniform sampling through the Lovász Local Lemma
 - 2017 Nov, Probability seminar, Heriot-Watt University, UK
 - 2017 Nov, ACiD seminar, University of Durham, UK
 - 2017 Aug, Dagstuhl Seminar 17341: Computational Counting, Germany
 - 2017 Jun, STOC, Montreal, Canada
 - 2017 Jun, Reunion workshop, Simons Institute, UC-Berkeley, CA
 - 2017 May, Nanjing Theory Day 2017, Nanjing, China
 - 2016 Dec, TCS seminar, Nanjing University, China
 - 2016 Dec, ITCS Workshop I, Shanghai University of Finance and Economics, China
- Random cluster dynamics for the Ising model is rapidly mixing
 - 2017 Dec, Probability seminar, Peking University, China

- 2017 Jul, LMS - EPSRC Durham Symposium, Durham, UK
- 2017 Jan, SODA, Barcelona, Spain
- 2016 Nov, A&C seminar, Oxford University, UK
- 2016 Oct, CSG, Queen Mary, University of London, UK
- 2016 Jun, ITCS seminar, Shanghai University of Finance and Economics, China
- 2016 May, ToC seminar, Harvard University, MA
- 2016 Apr, Simons Institute, UC-Berkeley, CA
- Computational counting and sampling
 - 2017 Mar, University of Edinburgh, UK
 - 2017 Mar, CS Colloquium, University of Chicago, IL
- Uniqueness, spatial mixing, and approximate counting
 - 2016 Sep, RANDOM, Paris, France
 - 2016 Mar, Classification workshop, Simons Institute, UC-Berkeley, CA
 - 2015 Oct, ToC seminar, Columbia University, NY
- Approximation via correlation decay when strong spatial mixing Fails
 - 2016 Jul, ICALP, Rome, Italy
- Planar dichotomy theorems
 - 2016 Jan, Counting program bootcamp, Simons Institute, UC-Berkeley, CA
 - 2015 Oct, FOCS, Berkeley, CA
- The complexity of Ising models with complex weights
 - 2014 Dec, Midwest Theory Day, University of Michigan, MI
- Dichotomy theorems in computational complexity
 - 2014 Sep, Nanjing University, China
 - 2014 Feb, ACiD seminar, Durham University, UK
- Edge coloring, Siegel's theorem, and a Holant dichotomy
 - 2014 Sep, China Theory Week, Tsinghua University, China
- #BIS-hardness for 2-spin systems on bipartite bounded degree graphs in the tree nonuniqueness region
 - 2014 Sep, RANDOM, Barcelona, Spain
- Holographic algorithms beyond matchgates
 - 2014 Jul, ICALP, Copenhagen, Denmark
- Phase transition and computational transition
 - 2014 May, A&C seminar, Oxford University, UK
- The complexity of planar Boolean #CSP with complex weights

- 2013 Jul, ICALP, Riga, Latvia
- A complete dichotomy rises from the capture of vanishing signatures
 - 2013 Jun, STOC, Palo Alto, CA
 - 2013 Jan, Dagstuhl Seminar 13031: Computational Counting, Germany

Teaching

In the University of Edinburgh:

- 2018 Fall Computational Complexity (INFR11102)
- 2018 Spring Computational Complexity (INFR11102)

In Queen Mary, University of London:

- 2016 Fall Advanced Combinatorics (MTH742P)

Services and activities

- Program committee: FAW 2019, NCTCS 2018, FAW 2018.
- LFCS (Edinburgh) seminar organiser from Jan 2018.
- Seminar organiser of the 2016 spring program “Counting Complexity and Phase Transitions” in the Simons institute of UC-Berkeley.
- Journal Referees for: ACM Transactions on Algorithms,
ACM Transactions on Computation Theory,
Computational Complexity,
Information and Computation,
Journal of Combinatorics,
Journal of Computer and System Sciences,
Journal of Discrete Algorithms,
Journal of Statistical Physics,
Proceedings of the National Academy of Sciences of the USA,
Random Structures and Algorithms,
SIAM Journal on Computing,
Theoretical Computer Science,
Theory of Computing,
Theory of Computing Systems.
- Conference Reviews: COLT, ESA, FAW, FOCS, ICALP, ISAAC, MFCS, QIP, RANDOM, SODA, STACS, STOC, TAMC, WAOA.
- Other Reviews: MathSciNet, Handbook of the Tutte Polynomial.