

# 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

- Zeros of Holant problems: locations and algorithms  
Heng Guo, Chao Liao, Pinyan, Lu, and Chihao Zhang  
**SODA’19**, to appear  
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
- A polynomial-time approximation algorithm for all-terminal network reliability  
Heng Guo and Mark Jerrum  
**ICALP'18**, 68:1-12 (Best paper award for track A)
- Counting hypergraph colorings in the local lemma regime  
Heng Guo, Chao Liao, Pinyan, Lu, and Chihao Zhang  
**STOC'18**, pp. 926-939
- 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
- Uniform sampling through the Lovász local lemma  
Heng Guo, Mark Jerrum, and Jingcheng Liu  
**STOC'17**, pp. 342-355
- Approximation via correlation decay when strong spatial mixing fails  
Ivona Bezáková, Andreas Galanis, Leslie Ann Goldberg, Heng Guo, and Daniel Štefankovič  
**ICALP'16**, 45:1-13
- 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
- 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
- Inapproximability after uniqueness phase transition in two-spin systems  
Jin-Yi Cai, Xi Chen, Heng Guo, and Pinyan Lu  
**COCOA'12**, pp. 336-347
- 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

- 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
- Counting hypergraph colorings in the local lemma regime
  - 2018 Oct, LFCS lab lunch, University of Edinburgh, UK
  - 2017 Dec, Tensor workshop, China Academy of Science, 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 2018.
- Seminar organiser of the 2016 spring program “Counting Complexity and Phase Transitions” in the Simons institute of UC-Berkeley.
- Journal Reviews: ACM Transactions on Algorithms,  
ACM Transactions on Computation Theory,  
Computational Complexity,  
Information and Computation,  
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.