KIAH HAN MAO

Infusing Theory with the Flavor of Practice

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TAUGHT

- Algorithm Analysis
- Combinatorics
- Linear Algebra
- Operations Research
- Math in Real-life Applications
- Probability
- Algorithms Design

RESEARCH INTERESTS

- Combinatorial Optimization
- Analytic Combinatorics
- Error-Correcting Codes
- Combinatorial Coding Theory
- Algebraic Coding Theory
- Algorithm Design
- Algorithm Analysis
- Data Storage
- DNA-Based Data Storage
- Low-Bandwidth Repair
- Privacy-Preserving Technology
- Distributed Coded Computation
- Private Information Retrieval

LANGUAGES

Proficient: Python, SageMath,LaTeX

Novice: Javascript, HTML

PUBLICATION LIST

Google Scholar
Research Gate

RESEARCH PHILOSOPHY

The best theory is inspired by **practice** *and the best practice is inspired by* **theory**.

D. E. Knuth, "Theory and Practice"

EXPERIENCE

Assistant Professor | School of Physical and Mathematical Sciences
Nanyang Technological University

May 2015 – present | Singapore

- $\geq$ 50 journal and $\geq$ 80 conference publications in both fields of engineering and applied mathematics. Journal and proceedings include: *IEEE Transactions on Information Theory*, *IEEE Journal on Selected Areas in Information Theory*, *IEEE International Symposium on Information Theory (ISIT)*.
- h-index: 22
- Invited Presentations: *Coding and Information Theory Israel Conference* (2023), *Workshop on Coding Theory and Related Concepts* (2022), *Munich Workshop on Coding and Cryptography* (2022).
- Guest Editors: *IEEE Journal on Selected Areas in Information Theory*, *IEEE Transactions on Molecular, Biological, and Multi-Scale Communications*.

♥ International Symposium on Information Theory and Its Applications 2022 Early Career Researcher Paper Award Winner (Researcher: D. T. Dao)
♥ International Symposium on Information Theory and Its Applications 2020 Best Student Paper Award winner (Student: J. Chrisnata)
♥ 2018 SPMS Young Researcher Award

Postdoctoral Research Associate | Coordinated Science Laboratory
University of Illinois at Urbana-Champaign

Feb 2014 – Feb 2015 | USA

Naval Officer | Republic of Singapore Navy

Jan 2006 – Jun 2010 | Singapore

EDUCATION

PhD in Mathematics | Nanyang Technological University

2010 – 2014 | Singapore

B. Sc. in Mathematics, 1st Class Honours, in Mathematics | National University of Singapore

2002 – 2006 | Singapore

- Singapore Mathematical Society Medal and Prize, 2006
- Singapore National Academy of Science Award, 2006
- Dean's List, National University of Singapore, 2002-2006
- Lim Soo Peng Book Prize, 2004

RESEARCH HIGHLIGHTS

Coding Theory

Focus: Improve reliability and efficiency in various modern data storage and communication scenarios.

Storage of data on synthetic DNA strands

- Sequence reconstruction problem: Leveraging multiple noisy reads to increase information rate [13], [15], [17].
- Constrained coding: Enforcing GC-content and homopolymer runlength constraints while incorporating error-correcting capabilities [1], [14], [16].

Low-bandwidth, verifiable, privacy-preserving schemes for distributed applications

- Repair for distributed data storage: Reducing the cost (bandwidth / latency) of repairing failed nodes [4], [11].
- Distributed coded computation: Reducing bandwidth while incorporating verifiability and privacy in distributing computation across multiple workers [3], [8].
- Private information retrieval: Developing protocols that allow users to retrieve data from databases without revealing identity of data being retrieved [9], [10].

Combinatorial Optimization

- Taught graduate course on operations research.
- Exploited symmetries to solve *large* optimization problems related to coding applications [2], [18].
- Applied network flow techniques to solve the *bee identification problem* [5], [7], [12].

Analytic Combinatorics

- Taught undergraduate and graduate course on combinatorics, algorithm design and algorithm design.
- Performed average running time analysis for algorithms related to coding applications [1], [7].
- Applied techniques from analytic combinatorics in several variables to estimate the Gilbert-Varshamov [6].

Selection Publications

[1] D. T. Dao, **H. M. Kiah**, and T. T. Nguyen, "Efficient encoding of binary constant-weight codes: Variable-length balancing schemes à la Knuth," *IEEE Transactions on Information Theory*, 2024.

[2] K. Goyal and **H. M. Kiah**, "Evaluating the Gilbert-Varshamov bound for constrained systems," *Entropy*, vol. 26, no. 4, p. 346, 2024.

[3] **H. M. Kiah**, W. Kim, S. Kruglik, S. Ling, and H. Wang, "Explicit low-bandwidth evaluation schemes for weighted sums of reed-solomon-coded symbols," *IEEE Transactions on Information Theory*, 2024.

[4] W. Zhang, Y. M. Chee, S. H. Dau, T. Etzion, **H. M. Kiah**, and Y. Luo, "Repairing with zero skip cost," *arXiv preprint arXiv:2405.03614, accepted for 2024 IEEE International Symposium on Information Theory (ISIT)*, 2024.

[5] J. Chrisnata, **H. M. Kiah**, A. Vardy, and E. Yaakobi, "Bee identification problem for DNA strands," *IEEE Journal on Selected Areas in Information Theory*, 2023.

[6] K. Goyal, D. T. Dao, **H. M. Kiah**, and M. Kovačević, "Evaluation of the Gilbert-Varshamov bound using multivariate analytic combinatorics," in *2023 IEEE International Symposium on Information Theory (ISIT)*, IEEE, 2023, pp. 2458–2463.

[7] **H. M. Kiah**, A. Vardy, and H. Yao, "Efficient algorithms for the bee-identification problem," *IEEE Journal on Selected Areas in Information Theory*, 2023.

[8] W. Kim, S. Kruglik, and **H. M. Kiah**, "Coded computation of multiple functions," in *2023 IEEE Information Theory Workshop (ITW)*, IEEE, 2023, pp. 468–473.

[9] S. Kruglik, S. H. Dau, **H. M. Kiah**, and H. Wang, "K-server byzantine-resistant pir scheme with optimal download rate and optimal file size," in *2023 IEEE International Symposium on Information Theory (ISIT)*, IEEE, 2023, pp. 1532–1537.

[10] S. Kruglik, S. H. Dau, **H. M. Kiah**, and H. Wang, "Two-server private information retrieval with optimized download rate and result verification," in *2023 IEEE International Symposium on Information Theory (ISIT)*, IEEE, 2023, pp. 1354–1359.

[11] S. Kruglik, G. Luo, W. Kim, *et al.*, "Repair of reed-solomon codes in the presence of erroneous nodes," in *2023 IEEE International Symposium on Information Theory (ISIT)*, IEEE, 2023, pp. 1003–1008.

[12] S. Singhvi, A. Boruchovsky, **H. M. Kiah**, and E. Yaakobi, "Data-driven bee identification for DNA strands," in *2023 IEEE International Symposium on Information Theory (ISIT)*, IEEE, 2023, pp. 797–802.

[13] J. Chrisnata, **H. M. Kiah**, and E. Yaakobi, "Correcting deletions with multiple reads," *IEEE Transactions on Information Theory*, vol. 68, no. 11, pp. 7141–7158, 2022.

[14] K. Cai, Y. M. Chee, R. Gabrys, **H. M. Kiah**, and T. T. Nguyen, "Correcting a single indel/edit for DNA-based data storage: Linear-time encoders and order-optimality," *IEEE Transactions on Information Theory*, vol. 67, no. 6, pp. 3438–3451, 2021.

[15] K. Cai, **H. M. Kiah**, T. T. Nguyen, and E. Yaakobi, "Coding for sequence reconstruction for single edits," *IEEE Transactions on Information Theory*, vol. 68, no. 1, pp. 66–79, 2021.

[16] T. T. Nguyen, K. Cai, K. A. S. Immink, and **H. M. Kiah**, "Capacity-approaching constrained codes with error correction for DNA-based data storage," *IEEE Transactions on Information Theory*, vol. 67, no. 8, pp. 5602–5613, 2021.

[17] V. L. P. Pham, K. Goyal, and **H. M. Kiah**, "Sequence reconstruction problem for deletion channels: A complete asymptotic solution," *arXiv preprint arXiv:2111.04255, accepted for 2023 IEEE International Symposium on Information Theory (ISIT)*, 2021.

[18] **H. M. Kiah**, A. Tandon, and M. Motani, "Generalized sphere-packing bound for subblock-constrained codes," *IEEE Transactions on Information Theory*, vol. 67, no. 1, pp. 187–199, 2020.