

Kai Zhao

CURRENT POSITION Assistant Professor
Department of Computer Science
Florida State University

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EDUCATION **Ph.D.** in Computer Science 2017–2022
University of California, Riverside Riverside, CA
B.S. in Computer Science 2010–2014
Peking University Beijing, China

RESEARCH INTERESTS High Performance Computing
Scientific Data Management, Analytics, and Visualization
Fault Tolerance and Resilience in Machine Learning and HPC
Large Scale Deep Neural Networks
Parallel and Distributed Systems

PROFESSIONAL EXPERIENCE

- Assistant Professor, Florida State University, Tallahassee, FL 2023-present
- Assistant Professor, University of Alabama at Birmingham, Birmingham, AL 2022-2023
- Research Aide, Argonne National Laboratory, Lemont, IL 2019
- Senior Software Engineer, Wacai Technology Co., Ltd., Hangzhou, China, 2017
- Software Engineer, MicroStrategy, Hangzhou, China 2016
- Software Engineer, Alibaba Group, Hangzhou, China 2014-2016

GRANTS

- Site PI**, Argonne National Laboratory, *Lossy compression for streaming data*, \$78K 2024-2024
- PI**, FSU FYAP, *HLC: a homomorphic lossy compression framework for scientific applications*, \$20K 2024-2024
- Site PI**, NSF CSSI, *Collaborative Research: Frameworks: FZ: A fine-tunable cyberinfrastructure framework to streamline specialized lossy compression development*, \$540K 2023-2027

TEACHING EXPERIENCE

- FSU ISC 5318 High Performance Computing Spring 2025
- FSU CIS4930/5930 Special topics in Computer Science Spring 2024
- FSU CDA4150/5155: Computer Architecture Fall 2023
- UAB CS632/732: Parallel Computing Spring 2023
- UAB CS332/532: Systems Programming Fall 2022

REFEREED CONFERENCE PUBLICATIONS

- [SC'25] Shixun Wu, Jinwen Pan, Jinyang Liu, Jiannan Tian, Ziwei Qiu, Jiajun Huang, **Kai Zhao**, Xin Liang, Sheng Di, Zizhong Chen, Franck Cappello, “Boosting Scientific Error-Bounded Lossy Compression through Optimized Synergistic Lossy-Lossless Orchestration.” *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, St. Louis, MO, USA, Nov 16-21, 2025.
- [SC'25] Daoce Wang, Pascal Grosset, Jesus Pulido, Jiannan Tian, Tushar M. Athawale, Jinda Jia, Baixi Sun, Boyuan Zhang, Sian Jin, **Kai Zhao**, James Ahrens, Fengguang Song, “STZ: A High Quality and High Speed Streaming Lossy Compression Framework for Scientific Data.” *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, St. Louis, MO, USA, Nov 16-21, 2025.
- [SC'25] Franck Cappello, Robert Underwood, Yuri Alexeev, Alison Baker, Ebru Bozdağ, Martin Burtscher, Kyle Chard, Sheng Di, Kyle Gerard Felker, Paul Chrsitopher O’Grady, Hanqi Guo, Yafan Huang, Peng Jiang, Sian Jin, Petter Johansson, Shaomeng Li, Xin Liang, Erik Lindahl, Peter Lindstrom, Zarija Lukić, Magnus Lundborg, Danylo Lykov, Masaru Nagaso, Kento Sato, Amarjit Singh, Seung Woo Son, Shihui Song, William Tang, Dingwen Tao, Jiannan Tian, Kazutomo Yoshii, **Kai Zhao**, “What to Support When You’re Compressing: The State of Practice, Gaps, and Opportunities for Scientific Data Compression.” *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, St. Louis, MO, USA, Nov 16-21, 2025.

4. [HPDC'25 (Best Paper Nominee)] Zhuoxun Yang, Sheng Di, Longtao Zhang, Ruoyu Li, Ximiao Li, Jiajun Huang, Jinyang Liu, Franck Cappello, **Kai Zhao**, "IPComp: Interpolation Based Progressive Lossy Compression for Scientific Applications." *Proceedings of the 34th ACM International Symposium on High-Performance Parallel and Distributed Computing*, Notre Dame, IN, USA, July 20-23, 2025.
5. [VLDB'25] Jinyang Liu, Pu Jiao, **Kai Zhao**, Xin Liang, Sheng Di, and Franck Cappello, "QPET: A Versatile and Portable Quantity-of-Interest-preservation Framework for Error-Bounded Lossy Compression." *Proceedings of the 51th International Conference on Very Large Data Bases*, London, UK, Sept 1 - 5, 2025.
6. [SIGMOD'25] Longtao Zhang, Ruoyu Li, Congrong Ren, Sheng Di, Jinyang Liu, Jiajun Huang, Robert Underwood, Pascal Grosset, Dingwen Tao, Xin Liang, Hanqi Guo, Franck Cappello, **Kai Zhao**, "LCP: Enhancing Scientific Data Management with Lossy Compression for Particles." *Proceedings of the ACM SIGMOD International Conference on Management of Data*, Berlin, Germany, June 22-27, 2025.
7. [SC'24] Daoce Wang, Pascal Grosset, Jesus Pulido, Tushar M. Athawale, Jiannan Tian, **Kai Zhao**, Zarija Lukic, Axel Huebl, Zhe Wang, James Ahrens, Dingwen Tao, "A High-Quality Workflow for Multi-Resolution Scientific Data Reduction and Visualization." *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, Atlanta, GA, USA, Nov 17-22, 2024.
8. [SC'24] Jiajun Huang, Sheng Di, Xiaodong Yu, Zhaiyu Jia, Jinyang Liu, Zizhe Jian, Xin Liang, **Kai Zhao**, Xiaoyi Lu, Zizhong Chen, Franck Cappello, Yanfei Guo, Rajeev Thakur, "hZCC: Accelerating Collective Communication with Co-designed Operation-supported Compression." *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, Atlanta, GA, USA, Nov 17-22, 2024.
9. [SC'24] Jinyang Liu, Jiannan Tian, Shixun Wu, Sheng Di, Boyuan Zhang, Robert Underwood, Yafan Huang, Jiajun Huang, **Kai Zhao**, Guanpeng Li, Dingwen Tao, Zizhong Chen, Franck Cappello, "High-ratio Scientific Lossy Compression on GPUs with Optimized Multi-level Interpolation." *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, Atlanta, GA, USA, Nov 17-22, 2024.
10. [ICS'24] Jiajun Huang, Sheng Di, Xiaodong Yu, Zhaiyu Jia, Jinyang Liu, Yafan Huang, Ken Raffanetti, Hui Zhou, **Kai Zhao**, Xiaoyi Lu, Zizhong Chen, Franck Cappello, Yanfei Guo, Rajeev Thakur, "gZCCL: Compression-Accelerated Collective Communication Framework for GPU Clusters." *38th ACM International Conference on Supercomputing (ACM ICS2024)*, 2024.
11. [IPDPS'24] Zizhe Jian, Sheng Di, Jinyang Liu, **Kai Zhao**, Xin Liang, Haiying Xu, Robert Underwood, Jiajun Huang, Shixun Wu, Zizhong Chen, Franck Cappello, "CliZ: Optimizing Lossy Compression for Climate Datasets with Adaptive Fine-tuned Data Prediction." *Proceedings of the 38th IEEE International Parallel and Distributed Processing Symposium*, 2024.
12. [IPDPS'24] Jiajun Huang, Sheng Di, Xiaodong Yu, Yujia Zhai, Zhaorui Zhang, Jinyang Liu, Xiaoyi Lu, Ken Raffanetti, Hui Zhou, **Kai Zhao**, Zizhong Chen, Franck Cappello, Yanfei Guo, Rajeev Thakur, "An Optimized Error-controlled MPI Collective Framework Integrated with Lossy Compression." *Proceedings of the 38th IEEE International Parallel and Distributed Processing Symposium*, 2024.
13. [ICDE'24] Mingze Xia, Sheng Di, Franck Cappello, Pu Jiao, **Kai Zhao**, Jinyang Liu, Xuan Wu, Xin Liang, Hanqi Guo, "Preserving Topological Feature with Sign-of-Determinant Predicates in Lossy Compression: A Case Study of Vector Field Critical Points." *Proceedings of the 40th IEEE International Conference on Data Engineering*, Utrecht, Netherlands, May 13 - 16, 2024.
14. [SIGMOD'24] Jinyang Liu, Sheng Di, **Kai Zhao**, Xin Liang, Sian Jin, Zizhe Jian, Jiajun Huang, Shixun Wu, Zizhong Chen, and Franck Cappello, "High-performance Effective Scientific Error-bounded Lossy Compression with Auto-tuned Multi-component Interpolation." *Proceedings of the 2024 International Conference on Management of Data*, Santiago, Chile, June 9 - 15, 2024.
15. [HiPC'23] Arham Khan, Sheng Di, **Kai Zhao**, Jinyang Liu, Kyle Chaid, Ian Foster, and Franck Cappello, "SECRE: Surrogate-based Error-controlled Lossy Compression Ratio Estimation Framework." *Proceedings of the IEEE 29th International Conference on High Performance Computing, Data, and Analytics*, Goa, India, Dec 18 - 21, 2023.
16. [BigData'23] Jinyang Liu, Sheng Di, Sian Jin, **Kai Zhao**, Xin Liang, Zizhong Chen, and Franck Cappello, "SRN-SZ: Deep Learning-Based Scientific Error-bounded Lossy Compression with Super-resolution Neural Networks." *Proceedings of 2023 IEEE International Conference on Big Data*, Sorrento, Italy, Dec 15 - 17, 2023.

17. [SC'23] Daoce Wang, Jesus Pulido, Jesus Pulido, Jiannan Tian, Sian Jin, Houjun Tang, Jean Sexton, Sheng Di, **Kai Zhao**, Bo Fang, Zarija Lukic, Franck Cappello, James Ahrens, and Dingwen Tao, "AMRIC: A Novel In Situ Lossy Compression Framework for Efficient I/O in Adaptive Mesh Refinement Applications." *Proceedings of the 35rd ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis*, Denver, CO, USA, Nov 12 - 17, 2023.
18. [VLDB'23] Pu Jiao, Sheng Di, Hanqi Guo, **Kai Zhao**, Jiannan Tian, Dingwen Tao, Xin Liang, and Franck Cappello, "Toward Quantity-of-Interest Preserving Lossy Compression for Scientific Data." *Proceedings of the 49th International Conference on Very Large Data Bases*, Vancour, Canada, Aug 28 - Sep 1, 2023.
19. [ICS'23 (Best Paper Nominee)] Jinyang Liu, Sheng Di, **Kai Zhao**, Xin Liang, Zizhong Chen, and Franck Cappello, "FAZ: A flexible auto-tuned modular error-bounded compression framework for scientific data." *Proceedings of the 37th ACM International Conference on Supercomputing*, Orlando, FL, June 21 - 23, 2023.
20. [CCGrid'23] Yafan Huang, **Kai Zhao**, Sheng Di, Guanpeng Li, Maxim Dmitriev, Thierry-Laurent D. Tonellot and Franck Cappello, "Towards Improving Reverse Time Migration Performance by High-speed High-fidelity Lossy Compression." *Proceedings of the 23rd IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing*, Bangalore, India, May 1 - May 4, 2023.
21. [ICDE'23] Md Hasanur Rahman, Sheng Di, **Kai Zhao**, Robert Underwood, Guanpeng Li, and Franck Cappello, "A Feature-Driven Fixed-Ratio Lossy Compression Framework for Real-World Scientific Datasets." *Proceedings of the 39th IEEE International Conference on Data Engineering*, Anaheim, CA, USA, April 3 - 7, 2023.
22. [PPoPP'23] Jieyang Chen, Xin Liang, **Kai Zhao**, Hadi Zamani Sabzi, Laxmi Bhuyan, and Zizhong Chen, "Improving Energy Saving of One-sided Matrix Decompositions on CPU-GPU Heterogeneous Systems." *Proceedings of the 28th ACM SIGPLAN Annual Symposium on Principles and Practice of Parallel Programming*, Montreal, Canada. Feb 25 - Mar 1, 2023.
23. [HiPC'22] Yuanjian Liu, Sheng Di, **Kai Zhao**, Sian Jin, Cheng Wang, Kyle Chard, Dingwen Tao, Ian Foster, and Franck Cappello, "Optimizing Multi-Range based Error-Bounded Lossy Compression for Scientific Datasets." *Proceedings of the IEEE 28th International Conference on High Performance Computing, Data, and Analytics*, Bengaluru, India, Dec 17-20, 2022.
24. [SC'22] Jinyang Liu, Sheng Di, **Kai Zhao**, Xin Liang, Zizhong Chen, and Franck Cappello, "Dynamic Quality Metric Oriented Error Bounded Lossy Compression for Scientific Datasets." *Proceedings of the 34rd ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis*, Dallas, TX, USA, Nov 13 - 18, 2022. Acceptance Rate: 25.3% (81/320)
25. [HPDC'22] Xiaodong Yu, Sheng Di, **Kai Zhao**, Jiannan Tian, Dingwen Tao, Xin Liang, and Franck Cappello, "Ultra-fast Error-bounded Lossy Compression for Scientific Dataset." *Proceedings of the 31th International Symposium on High-Performance Parallel and Distributed Computing*, Minneapolis, USA, June 27 - July 1, 2022. Acceptance Rate: 19% (21/108)
26. [ICDE'22] **Kai Zhao**, Sheng Di, Danny Perez, Zizhong Chen, and Franck Cappello, "MDZ: An Efficient Error-bounded Lossy Compressor for Molecular Dynamics Simulations." *Proceedings of the 38th IEEE International Conference on Data Engineering*, Online, May 9 - 12, 2022.
27. [SC'21] Sihuan Li, Sheng Di, **Kai Zhao**, Xin Liang, Zizhong Chen, Franck Cappello, "Resilient Error-bounded Lossy Compressor for Data Transfer." *Proceedings of the 33rd ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis*, St. Louis, MO, Nov 14 - 19, 2021. Acceptance Rate: 23.6% (86/365)
28. [Cluster'21] Jinyang Liu, Sheng Di, **Kai Zhao**, Sian Jin, Dingwen Tao, Xin Liang, Zizhong Chen, Franck Cappello, "Exploring Autoencoder-Based Error-Bounded Compression for Scientific Data." *Proceedings of the 23rd IEEE International Conference on Cluster Computing*, Online, Sep 7 - 10, 2021. Acceptance Rate: 29% (48/163)
29. [Cluster'21] Jiannan Tian, Sheng Di, Xiaodong Yu, Cody Rivera, **Kai Zhao**, Sian Jin, Yunhe Feng, Xin Liang, Dingwen Tao, Franck Cappello, "CuSZ+: Optimizing Error-Bounded Lossy Compression for Scientific Data on GPUs." *Proceedings of the 23rd IEEE International Conference on Cluster Computing*, Online, Sep 7 - 10, 2021. Acceptance Rate: 29% (48/163)
30. [ICS'21] Yujia Zhai, Elisabeth Giem, Quan Fan, **Kai Zhao**, Jinyang Liu, and Zizhong Chen, "FT-BLAS: A High Performance BLAS Implementation With Online Fault Tolerance." *Proceedings of the 35th ACM International Conference on Supercomputing*, Online, June 14 - 17, 2021. Acceptance Rate: 24% (38/157)

31. **[ICDE'21] Kai Zhao**, Sheng Di, Maxim Dmitriev, Thierry-Laurent D. Tonellot, Zizhong Chen, and Franck Cappello, "Optimizing Error-Bounded Lossy Compression for Scientific Data by Dynamic Spline Interpolation." *Proceedings of the 37th IEEE International Conference on Data Engineering*, Chania, Crete, Greece, Apr 19 - 22, 2021. Acceptance Rate: 27% (151/549)
32. **[PACT'20] Jiannan Tian**, Sheng Di, **Kai Zhao**, Cody Rivera, Megan Hickman, Robert Underwood, Sian Jin, Xin Liang, Jon Calhoun, Dingwen Tao, and Franck Cappello, "cuSZ: An Efficient GPU Based Error-Bounded Lossy Compression Framework for Scientific Data." *Proceedings of the 29th International Conference on Parallel Architectures and Compilation Techniques*, Atlanta, GA, USA, Oct 3 - 7, 2020. Acceptance Rate: 25% (35/137)
33. **[Cluster'20] Sihuan Li**, Sheng Di, **Kai Zhao**, Xin Liang, Zizhong Chen, and Franck Cappello, "Towards End-to-end SDC Detection for HPC Applications Equipped with Lossy Compression." *Proceedings of the 22nd IEEE International Conference on Cluster Computing*, Kobe, Japan, Sep 14 - 17, 2020. Acceptance Rate: 24% (32/132)
34. **[HPDC'20] Kai Zhao**, Sheng Di, Xin Liang, Sihuan Li, Dingwen Tao, Zizhong Chen, and Franck Cappello, "Significantly Improving Lossy Compression for HPC Datasets with Second-Order Prediction and Parameter Optimization." *Proceedings of the 29th International Symposium on High-Performance Parallel and Distributed Computing*, Stockholm, Sweden, June 23 - 26, 2020. Acceptance Rate: 22% (16/71)
35. **[SC'19] Sihuan Li**, Hongbo Li, Xin Liang, Jieyang Chen, Elisabeth Giem, Kaiming Ouyang, **Kai Zhao**, Sheng Di, Franck Cappello, and Zizhong Chen, "FT-iSort: Efficient Fault Tolerance for Introsort." *Proceedings of the 31st ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis*, Denver, Colorado, USA, Nov 17 - 22, 2019. Acceptance Rate: 20% (72/344)
36. **[ICS'19] Jieyang Chen**, Nan Xiong, Xin Liang, Dingwen Tao, Sihuan Li, Kaiming Ouyang, **Kai Zhao**, Nathan DeBardeleben, Qiang Guan, and Zizhong Chen, "TSM2: Optimizing Tall-and-Skinny Matrix-Matrix Multiplication on GPUs." *Proceedings of the 33rd ACM International Conference on Supercomputing*, Phoenix, AZ, USA, June 26 - 28, 2019. Acceptance Rate: 23% (45/193)
37. **[SC'18] Jieyang Chen**, Hongbo Li, Sihuan Li, Xin Liang, Panruo Wu, Dingwen Tao, Kaiming Ouyang, Yuanlai Liu, **Kai Zhao**, Qiang Guan, and Zizhong Chen, "Fault Tolerant One-sided Matrix Decompositions on Heterogeneous Systems with GPUs." *Proceedings of the 30th ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis*, Dallas, Texas, USA, Nov 11 - 16, 2018. Acceptance Rate: 19% (55/288)

REFEREED
JOURNAL
PUBLICATIONS

1. **[CSUR'25] Sheng Di**, Jinyang Liu, **Kai Zhao**, Xin Liang, Robert Underwood, Zhaorui Zhang, Milan Shah, Yafan Huang, Jiajun Huang, Xiaodong Yu, Congrong Ren, Hanqi Guo, Grant Wilkins, Dingwen Tao, Jiannan Tian, Sian Jin, Zizhe Jian, Daoce Wang, Md Hasanur Rahman, Boyuan Zhang, Shihui Song, Jon C. Calhoun, Guanpeng Li, Kazutomo Yoshii, Khalid Ayed Alharthi, and Franck Cappello, "A Survey on Error-Bounded Lossy Compression for Scientific Datasets" *ACM Computing Surveys*, 2025.
2. **[TPDS'25] Zhaorui Zhang**, Sheng Di, **Kai Zhao**, Sian Jin, Dingwen Tao, Zhuoran Ji, Benben Liu, Khalid Alharthi, Jiannong Cao, and Franck Cappello, "FedCSpc: A Cross-Silo Federated Learning System with Error-Bounded Lossy Parameter Compression" *IEEE Transactions on Parallel and Distributed Systems*, 2025.
3. **[TPDS'23] Yujia Zhai**, Elisabeth Giem, **Kai Zhao**, Jinyang Liu, Jiajun Huang, Bryan Wong, Christian Shelton, and Zizhong Chen, "FT-BLAS: A Fault Tolerant High Performance BLAS Implementation on x86 CPUs" *IEEE Transactions on Parallel and Distributed Systems*, 2023.
4. **[TBD'22] Xin Liang***, **Kai Zhao***, Sheng Di, Sihuan Li, Robert Underwood, li M. Gok, Jiannan Tian, Junjing Deng, Jon C. Calhoun, Dingwen Tao, Zizhong Chen, and Franck Cappello, "SZ3: A Modular Framework for Composing Prediction-Based Error-Bounded Lossy Compressors." *IEEE Transactions on Big Data*. August 2022. *Authors contributed equally.
5. **[TPDS'22] Yuanjian Liu**, Sheng Di, **Kai Zhao**, Sian Jin, Cheng Wang, Kyle Chard, Dingwen Tao, Ian Foster, and Franck Cappello, "Optimizing Error-Bounded Lossy Compression for Scientific Data With Diverse Constraints" *IEEE Transactions on Parallel and Distributed Systems*, July 2022.
6. **[TPDS'21] Kai Zhao**, Sheng Di, Sihuan Li, Xin Liang, Yujia Zhai, Jieyang Chen, Kaiming Ouyang, Franck Cappello and Zizhong Chen, "FT-CNN: Algorithm-Based Fault Tolerance for Convolutional Neural Networks." *IEEE Transactions on Parallel and Distributed Systems*, Volume 32, Issue 7, July 2021.

REFEREED
WORKSHOP
PUBLICATIONS

1. **[IWBD-2]** Jinyang Liu, Sihuan Li, Sheng Di, Xin Liang, **Kai Zhao**, Dingwen Tao, Zizhong Chen, and Franck Cappello, “Improving Lossy Compression for SZ by Exploring the Best-Fit Lossless Compression Techniques” *Proceedings of the 2st International Workshop on Big Data Reduction @BigData’21*, Orlando, FL, USA, Dec 15 - 18, 2021.
2. **[IWBD-1]** **Kai Zhao**, Sheng Di, Xin Liang, Sihuan Li, Dingwen Tao, Julie Bessac, Zizhong Chen, and Franck Cappello, “SDRBench: Scientific Data Reduction Benchmark for Lossy Compressors” *Proceedings of the 1st International Workshop on Big Data Reduction @BigData’20*, Online, Dec 10 - 13, 2020.
3. **[DRBSD-7]** Yuanjian Liu, Sheng Di, **Kai Zhao**, Kyle Chard, Wentao Ding, Sian Jin, Cheng Wang, Ian Foster, and Frank Cappello, “Understanding Effectiveness of Multi-error-bounded Lossy Compression for Preserving Ranges of Interest in Scientific Analysis” *Proceedings of the 7th International Workshop on Data Analysis and Reduction for Big Scientific Data*, St. Louis, MO, USA, Nov 14th, 2021.

STUDENTS
MENTORING

- **PhD:** Longtao Zhang (2023 - present), Ruoyu Li (2024 - present),
- **MS:** Zhuoxun Yang (2024 - present), Nicholas Simmons (2024)

SERVICE

- **Organizing Committee:** IWBD (co-chair)
- **Programs Committee:** HPCC, IWBD
- **Reviewer:** SC, ICS, HPDC, IPDPS, ICPP, CCGrid, BigData, TPDS, TPAMI, ICMLA, ICSNC, SELSE, UAAI

INVITED TALKS

- “Data Reduction and Error Resilience for Exascale Applications”, College of Information Sciences and Technology, Penn State University 03/2022
- “Data Reduction and Error Resilience for Exascale Applications”, Department of Computational and Data Sciences, George Mason University 03/2022

HONORS AND
AWARDS

- First Year Assistant Professor Award, Florida State University 2024
- R&D 100 Award (SZ compression framework) 2021
- Laxmi N. Bhuyan Fellowship, University of California, Riverside 2021
- Dissertation Year Program Fellowship, University of California, Riverside 2021
- Dean’s Distinguished Fellowship, University of California, Riverside 2017
- Second Prize in Microsoft Student Challenge, Microsoft Research Asia 2012
- First Prize of National Olympiad in Informatics in Henan Provinces, China 2009