

Linhai Song

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RESEARCH INTERESTS

Tool support for improving the reliability, security and efficiency of software systems

EDUCATION

University of Wisconsin–Madison , Madison, WI, USA Ph.D., Computer Science (M.S. along the way) Advisor: Shan Lu	Nov. 2015
Chinese Academy of Sciences , Beijing, China M.S., Computer Science	Jun. 2010
Huazhong University of Science and Technology , Wuhan, Hubei, China B.E., Software Engineering	Jun. 2007

EMPLOYMENT

Pennsylvania State University , State College, PA, USA Assistant Professor at College of Information Sciences and Technology	Aug. 2017 - Present
Kwai Inc. , Seattle, WA, USA Consultant	Jun. 2021 - Aug. 2021
ByteDance Ltd. , Palo Alto, CA, USA Consultant	May 2019 - Aug. 2019
FireEye, Inc. , Milpitas, CA, USA Staff Research Scientist	Nov. 2015 - Jul. 2017
NEC Laboratories America, Inc. , Princeton, NJ, USA Research Intern	May 2013 - Aug. 2013
Microsoft Research Asia , Beijing, China Research Intern	May 2010 - Jul. 2010

HONORS AND AWARDS

- NSF CAREER Award, 2022
- Mozilla Research Award, 2019
- MICRO'2014 Best Paper Runner Up for paper [C5], 2014
- ACM SIGPLAN Research Highlights @ PLDI for paper [C1], 2011

PUBLICATIONS¹

Refereed Journal Articles

[J2] Boqin Qin^S, Tengfei Tu^S, Ziheng Liu^S, Tingting Yu, and **Linhai Song**. “Algorithmic Profiling for Real-World Complexity Problems.” In *Transactions on Software Engineering (TSE)*, 2021. *Accepted as a Journal-First paper by ICSE’2022*

[J1] Dongdong Deng, Guoliang Jin, Marc de Kruijf, Ang Li, Ben Liblit, Shan Lu, Shanxiang Qi, Jinglei Ren, Karthikeyan Sankaralingam, **Linhai Song**, Yongwei Wu, Mingxing Zhang, Wei Zhang, and Weimin Zheng. “Fixing, Preventing, and Recovering from Concurrency Bugs.” In *Science China Information Sciences volume*, vol. 58, pp. 1–18, April 2014.

Refereed Conference Proceedings

[C16] Shuofei Zhu^S, Ziyi Zhang^S, Boqin Qin^S, Aiping Xiong, and **Linhai Song**. “Learning and Programming Challenges of Rust: A Mixed-Methods Study.” In *Proceedings of the 44th International Conference on Software Engineering (ICSE’2022)*, May 2022. (Acceptance Rate: 28.5%, 197 out of 691) (*: co-first authors)

[C15] Ziyi Zhang^S, Shuofei Zhu^S, Jaron Mink, Aiping Xiong, **Linhai Song**, and Gang Wang. “Beyond Bot Detection: Combating Fraudulent Online Survey Takers.” In *Proceedings of the ACM Web Conference 2022 (WWW’2022)*, April 2022. (Acceptance Rate: 17.7%, 323 out of 1822)

[C14] Ziheng Liu^S, Shihao Xia^S, Yu Liang, **Linhai Song**, and Hong Hu. “Who Goes First? Detecting Go Concurrency Bugs via Message Reordering.” In *Proceedings of the 27th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS’2022)*, March 2022. (Acceptance Rate: 20.1%, 80 out of 397) (*: co-first authors)

[C13] Ziheng Liu^S, Shuofei Zhu^S, Boqin Qin^S, Hao Chen, and **Linhai Song**. “Automatically Detecting and Fixing Concurrency Bugs in Go Software Systems.” In *Proceedings of the 26th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS’2021)*, April 2021. (Acceptance Rate: 18.8%, 75 out of 398)

[C12] Boqin Qin^{S*}, Yilun Chen^{*}, Zeming Yu^S, **Linhai Song**, and Yiying Zhang. “Understanding Memory and Thread Safety Practices and Issues in Real-World Rust Programs.” In *Proceedings of the 41st ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI’2020)*, June 2020. (Acceptance Rate: 22.5%, 77 out of 341) (*: co-first authors)

[C11] Shuofei Zhu^S, Jianjun Shi^S, Limin Yang, Boqin Qin^S, Ziyi Zhang^S, **Linhai Song**, and Gang Wang. “Measuring and Modeling the Label Dynamics of Online Anti-Malware Engines.” In *Proceedings of the 29th USENIX Security Symposium (USENIX Security’2020)*, August 2020. (Acceptance Rate: 17.1%, 44 out of 256)

[C10] Bangwen Deng, Wenfei Wu, and **Linhai Song**. “NFReducer: Redundant Logic Elimination in Network Functions.” In *Proceedings of the 2020 ACM SIGCOMM Symposium on SDN Research (SOSR’2020)*, March 2020. (Acceptance Rate: 28.3%, 17 out of 60)

[C9] Peng Peng, Limin Yang, **Linhai Song**, and Gang Wang. “Opening the Blackbox of VirusTotal: Analyzing Online Phishing Scan Engines.” In *Proceedings of the 2019 ACM Internet Measurement Conference (IMC’2019)*, October 2019. (Acceptance Rate: 19.7%, 39 out of 197)

[C8] Tengfei Tu^S, Xiaoyu Liu, **Linhai Song**, and Yiying Zhang. “Understanding Real-World Concurrency Bugs in Go.” In *Proceedings of the 24th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS’2019)*, April 2019. (Acceptance Rate: 21.1%, 74 out of 350)

¹Students directly under my supervision are denoted by “S”.

The second-most visited URL related to Golang in 2019. Featured on “a morning paper” and “Hacker News”.

[C7] **Linhai Song** and Shan Lu. “Program Analysis for Inefficient Loops.” In *Proceedings of the 39th International Conference on Software Engineering (ICSE’2017)*, May 2017. (Acceptance Rate: 16.4%, 68 out of 415)

[C6] Rui Gu, Guoliang Jin, **Linhai Song**, Linjie Zhu, and Shan Lu. “What Change History Tells Us About Thread Synchronization.” In *Proceedings of the 2015 10th Joint Meeting on Foundations of Software Engineering (FSE’2015)*, August 2015. (Acceptance Rate: 25.4%, 74 out of 291)

[C5] **Linhai Song**, Min Feng, Nishkam Ravi, Yi Yang, and Srimat Chakradhar. “COMP: Compiler Optimizations for Manycore Processors.” In *Proceedings of the 47th Annual IEEE/ACM International Symposium on Microarchitecture (MICRO’2014)*, December 2014. (Acceptance Rate: 19.4%, 53 out of 273)

MICRO’2014 Best Paper Runner Up.

[C4] **Linhai Song** and Shan Lu. “Statistical Debugging for Real-World Performance Problems.” In *Proceedings of the 2014 ACM International Conference on Object Oriented Programming Systems Languages & Applications (OOPSLA’2014)*, October 2014. (Acceptance Rate: 28.4%, 53 out of 186)

[C3] Adrian Nistor, **Linhai Song**, Darko Marinov, and Shan Lu. “Toddler: Detecting Performance Problems via Similar Memory-Access Patterns.” In *Proceedings of the 2013 International Conference on Software Engineering (ICSE’2013)*, May, 2013. (Acceptance Rate: 18.5%, 85 out of 461)

[C2] Guoliang Jin*, **Linhai Song***, Xiaoming Shi, Joel Scherpelz, and Shan Lu. “Understanding and Detecting Real-World Performance Bugs.” In *Proceedings of the 33rd ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI’2012)*, June 2012. (Acceptance Rate: 18.8%, 48 out of 255) (*: co-first authors)

[C1] Guoliang Jin, **Linhai Song**, Wei Zhang, Shan Lu, and Ben Liblit. “Automated Atomicity-Violation Fixing.” In *Proceedings of the 32nd ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI’2011)*, June 2011. (Acceptance Rate: 23.3%, 55 out of 236)

ACM SIGPLAN Research Highlights Award (Top 8 papers selected from all papers in 13 SIGPLAN conferences in 2011 for “high quality and broad appeal”).

Refereed Workshop Proceedings

[W3] Yongheng Chen^S, **Linhai Song**, Xinyu Xing, Fengyuan Xu, and Wenfei Wu. “Automated Finite State Machine Extraction.” In *Proceedings of the 3rd ACM Workshop on Forming an Ecosystem Around Software Transformation (FEAST’2019)*, November 2019. (Acceptance Rate: 87.5%, 7 out of 8)

[W2] **Linhai Song** and Xinyu Xing. “Fine-Grained Library Customization.” In *Proceedings of the First International Workshop on Software debLoading And Delaying (SALAD’2018)*, July 2018. (Acceptance Rate: 66.7%, 2 out of 3)

[W1] **Linhai Song**, Heqing Huang, Wu Zhou, Wenfei Wu, and Yiyang Zhang. “Learning from Big Malware.” In *Proceedings of the 7th ACM SIGOPS Asia-Pacific Workshop on Systems (APSys’2016)*, August 2016. (Acceptance Rate: 40.8%, 20 out of 49)

Technical Reports

[T4] Zeming Yu^S, **Linhai Song**, and Yiyang Zhang. “Fearless Concurrency? Understanding Concurrent Programming Safety in Real-World Rust Software.” arXiv:1902.01906.

[T3] **Linhai Song** and Xinyu Xing. “Fine-Grained Library Customization.” arXiv:1810.11128.

[T2] **Linhai Song** and Shan Lu. “Program Analysis for Inefficient Loops.” UChicago CS Technical Report TR-2016-06.

[T1] **Linhai Song** and Shan Lu. “Statistical Debugging for Real-World Performance Problems.” UW-Madison CS Technical Report 1803.

Posters

[P3] Ziyi Zhang^S and **Linhai Song**. “Poster: Visualizing Critical Sections in Rust.” In *Student Research Competition at the 27th ACM Symposium on Operating Systems Principles (SOSP’2019)*.

[P2] Tengfei Tu^S, Xiaoyu Liu, **Linhai Song** and Yiyang Zhang. “Poster: Understanding Real-World Concurrency Bugs in Go.” In *the 13rd USENIX Symposium on Operating Systems Design and Implementation (OSDI’2018)*.

[P1] **Linhai Song** and Shan Lu. “Poster: Statistical Debugging for Real-World Performance Problems.” In *the 4th Greater Chicago Area Systems Research Workshop (GCASR’2015)*.

Demonstrations

[D2] Ziyi Zhang^S, Boqin Qin^S, and **Linhai Song**. “Demo: VRLifeTime -- An IDE Tool to Avoid Concurrency and Memory Bugs in Rust.” In *the 27th ACM Conference on Computer and Communications Security (CCS’2020)*.

[D1] Shuofei Zhu^S, Ziyi Zhang^S, Limin Yang, **Linhai Song**, and Gang Wang. “Demo: Benchmarking Label Dynamics of VirusTotal Engines.” In *the 27th ACM Conference on Computer and Communications Security (CCS’2020)*.

Software and Data Release

[S6] A dynamic Go concurrency bug detector, 2022.
<https://github.com/system-pclub/GFuzz>. ([104](#) GitHub stars)

[S5] A static Go concurrency bug detector, 2021.
<https://github.com/system-pclub/GCatch>. ([413](#) GitHub stars)

[S4] A production-run algorithmic profiler, 2021.
<https://github.com/ComAirProject/ComAir>.

[S3] Dataset of the daily snapshots of VirusTotal labels for 14,000 files over a year, 2020.
<https://sfzhu93.github.io/projects/vt/index.html>.

[S2] Dataset of 170 real-world Rust safety issues, 2020.
<https://github.com/system-pclub/rust-study>. ([68](#) GitHub stars)

[S1] Dataset of 171 real-world Go concurrency bugs, 2019.
<https://github.com/system-pclub/go-concurrency-bugs>. ([210](#) GitHub stars)

Patents

[PA1] Min Feng, Srimat Chakradhar, and **Linhai Song**. “Compiler Optimization for Many Integrated Core Processors.” U.S. Patent No. 20150277877, October 1st, 2015.

PROFESSIONAL ACTIVITIES

Conference Program Committee Service

- International Conference on Architectural Support for Programming Languages and Operating Systems (**ASPLOS**): 2022
- Workshop on Programming Languages and Operating Systems (**PLOS**): 2021
- Poster and Demonstration Session at ACM Conference on Computer and Communications Security (**CCS**): 2020

- Poster Session at International Conference on Software Engineering (**ICSE**): 2020
- Software Engineering in Practice at International Conference on Software Engineering (**ICSE**): 2019
- ACM SIGOPS Asia-Pacific Workshop on Systems (**APSys**): 2018, 2019, 2022
- Student Research Competition (**SRC**) at ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (**FSE**): 2018
- Student Research Competition (**SRC**) at International Conference on Architectural Support for Programming Languages and Operating Systems (**ASPLOS**): 2018
- Artifact Evaluation at ACM SIGPLAN Conference on Programming Language Design and Implementation (**PLDI**): 2015
- Artifact Evaluation at ACM SIGSOFT International Symposium on Software Testing and Analysis (**ISSTA**): 2014

Conference Reviewer

- ACM SIGSOFT International Symposium on Software Testing and Analysis (**ISSTA**): 2018
- International Conference on Architectural Support for Programming Languages and Operating Systems (**ASPLOS**): 2019, 2020, 2021
- ACM Conference on Computer and Communications Security (**CCS**): 2017, 2018
- USENIX Annual Technical Conference (**USENIX ATC**): 2017

Journal Reviewer

- ACM Computing Surveys
- ACM Transactions on Computer Systems
- Empirical Software Engineering Journal
- IEEE Computer Architecture Letters
- Transactions on Software Engineering
- Journal of Computer Science and Technology

Journal Editor

- EAI Transactions on Security and Safety

Conference & Workshop Organization Service

- Chair for Student Research Competition (**SRC**) at International Conference on Architectural Support for Programming Languages and Operating Systems (**ASPLOS**): 2019

Other Services

- National Science Foundation (**NSF**) ad-hoc reviewer: 2021
- National Science Foundation (**NSF**) Review Panel: 2018

TALKS

- Detecting Concurrency Bugs in Go Software Systems
 - University of Virginia, May 2022
 - Google, April 2022
 - University of Illinois Urbana-Champaign, April 2022

- University of California Merced, April 2022
 - Northwestern University, April 2022
 - Peking University, April 2022
- Who Goes First? Detecting Go Concurrency Bugs via Message Reordering
 - ASPLOS'2022, March 2022
- Combating Real-World Concurrency Bugs in Go
 - Bytedance, August 2021
 - Kwai, June 2021
 - Tsinghua University, May 2021
 - North Carolina State University, April 2021
- Measuring and Modeling the Label Dynamics of Online Anti-Malware Engines
 - Southern University of Science and Technology, January 2020
 - University of Science and Technology of China, December 2020
- Understanding Real-World Concurrency Bugs in Go
 - ASPLOS'2019, April 2019
- Understanding Real-World Concurrency Bugs in New Programming Languages
 - Carnegie Mellon University, October 2019
 - ByteDance, December 2018
 - Baidu X-lab, December 2018
- Protocol Subsetting and Dialect Generation
 - Salad'2018, July 2018
- Protocol Subsetting and Dialect Generation
 - Baidu X-lab, December 2017
- Performance Diagnosis for Inefficient Loops
 - ICSE'2017, May 2016
- Improve Software Security and Performance through Data Analytics
 - Pennsylvania State University, March 2016
- Learning from Big Malware
 - APSys'2016, August 2016
- Understanding, Detecting, and Diagnosing Real-World Performance Bugs
 - National University of Singapore, March 2016
 - Microsoft Research Asia, December 2015
 - Peking University, June 2015
 - Pivotal Labs, May 2015
- Statistical Debugging for Real-World Performance Problems
 - OOPSLA'2014, October 2014
 - WISDOM Workshop II, May 2014
- Optimizing Memory Performance on Many Integrated Core Coprocessors
 - NEC Labs America, August 2013
- Understanding and Detecting Real-World Performance Bugs
 - PLDI'2012, June 2012
 - Programming Languages Seminar, University of Wisconsin-Madison, May 2012

TALK VIDEOS

- “Algorithmic Profiling for Real-World Complexity Problems” presented by Boqin Qin
 - <https://www.youtube.com/watch?v=M1hfaHPB868> (10 views)
 - <https://www.bilibili.com/video/BV15Y4y187VQ> (48 views)
- “Learning and Programming Challenges of Rust: A Mixed-Methods Study” presented by Shuofei Zhu
 - <https://www.youtube.com/watch?v=STjQxTu3tS8> (715 views)
 - <https://www.bilibili.com/video/BV1RS4y1h7Nf> (925 views)
- “Who Goes First? Detecting Go Concurrency Bugs via Message Reordering” presented by Shihao Xia
 - <https://www.youtube.com/watch?v=sQbnzYPOcz4> (79 views)
 - <https://www.bilibili.com/video/BV1TF411b7nN> (4032 views)
 - <https://www.bilibili.com/video/BV1om4y1d7Jn> (lightning talk) (1392 views)
- “Automatically Detecting and Fixing Concurrency Bugs in Go Software Systems” presented by Ziheng Liu
 - <https://www.youtube.com/watch?v=qsjptcAWTWM> (61 views)
 - <https://www.bilibili.com/video/BV1Gb4y1D7QH> (123 views)
- “Measuring and Modeling the Label Dynamics of Online Anti-Malware Engines” presented by Shuofei Zhu
 - <https://www.youtube.com/watch?v=dhbcWx3HC64> (128 views)
 - <https://www.bilibili.com/video/BV1Rk4y127cQ> (401 views)
- “Understanding Memory and Thread Safety Practices and Issues in Real-World Rust Programs” presented by Yilun Chen
 - <https://www.youtube.com/watch?v=s5UqjOEaZ.8> (325 views)
 - <https://www.bilibili.com/video/BV17i4y1x7CM> (1478 views)
 - <https://www.bilibili.com/video/BV1zA411t7ze> (lightning talk) (126 views)
- “Understanding Real-World Concurrency Bugs in Go” presented by Xiaoyu Liu
 - <https://www.youtube.com/watch?v=ClVrJcTM-lA> (311 views)
 - <https://www.bilibili.com/video/BV12b411b7Gt> (313 views)

GRANTS

*(Total project funding: **\$1.39 million**, total project funding from external sources: **\$1.24 million**, personal share from external sources: **\$1.01 million**)*

- CAREER: Rethinking Toolchain Design for Rust
 - Role: PI;
 - Total: \$550,193;
 - National Science Foundation (NSF);
 - 01/15/2022 to 01/14/2027.
- Avoiding Rust Deadlocks via Lifetime Visualization
 - Role: PI; with Yiyang Zhang from UC San Diego as Co-PI;
 - Total: \$60,000; Personal Share: \$30,000 (50%);

- Web3 Foundation;
 - 09/01/2021 to 08/30/2022.
- GCatch++: Automatically Detecting Concurrency Bugs in Software Systems implemented in Go
 - Role: PI;
 - Total: \$30,000;
 - Ethereum Foundation;
 - 09/01/2021 to 08/30/2022.
- Learning and Programming Challenges of Rust: An Interdisciplinary Investigation
 - Role: PI; with Aiping Xiong from Penn State as Co-PI;
 - Total: \$55,000; Personal Share: \$27,500 (50%);
 - IST@PSU Seed Grant;
 - 09/01/2021 to 08/30/2022.
- SaTC: CORE: Small: Understanding and Detecting Memory Bugs in Rust
 - Role: PI; with Hao Chen from UC Davis as Co-PI;
 - Total: \$497,340; Personal Share: \$298,404 (60%);
 - National Science Foundation (NSF);
 - 07/01/2020 to 06/30/2023.
- Measuring and Modeling the Label Dynamics of Online Anti-Malware Engines
 - Role: Sole PI;
 - Total: \$9,966; Personal Share: \$9,966 (100%);
 - ICDS@PSU Seed Grant;
 - 05/01/2020 to 04/30/2021.
- Statically Detecting Memory Bugs in Rust Applications
 - Role: Sole PI;
 - Total: \$80,100; Personal Share: \$80,100 (100%);
 - Open Tech Fund;
 - 01/01/2020 to 06/30/2021.
- Benchmarking Generic Functions in Rust
 - Role: Sole PI;
 - Total: \$25,000; Personal Share: \$25,000 (100%);
 - Mozilla Research Award;
 - 09/01/2019 to 09/01/2020.
- Benchmarking, Detecting, and Diagnosing Real-World Performance Problems
 - Role: Sole PI;
 - Total: \$85,500; Personal Share: \$85,500 (100%);
 - IST@PSU Seed Grant;
 - 09/01/2018 to 09/01/2019.

SELECTED PRESS

- [Software Engineering Daily] Rust and Go Research with Linhai Song, 01/2021
- [A Journey With Go] Go: Concurrency Bugs in Go, 09/2019
- [GTech Booster] Is Rust the low-level-ish, 02/2019

TEACHING

Term	Course	Enrollment	Course Quality	Instructor Quality
Spring 2022	IST 597 Special Topics	5	7/7	7/7
FALL 2021	SRA 221 Information Security (1)	59	6/7	6/7
Spring 2021	SRA 221 Information Security (1)	60	6.5/7	6.5/7
Fall 2020	SRA 221 Information Security (1)	68	6/7	6/7
Fall 2019	IST 451 Network Security (1)	72	4.78/7	5.03/7
Fall 2019	IST 451 Network Security (2)	66	5.23/7	5.57/7
Fall 2018	IST 451 Network Security (1)	71	5.69/7	5.66/7
Fall 2018	IST 451 Network Security (2)	45	5.59/7	5.59/7
Spring 2018	IST 451 Network Security (1)	48	5.68/7	5.8/7
Fall 2017	IST 451 Network Security (1)	71	5.16/7	5.19/7

INTERNAL SERVICES

- Qualifying Exam Committee, Penn State, 2019, 2021, 2022
- Faculty Annual Review Committee, Penn State, 2022
- Faculty Search Committee, Penn State, 2020–2021
- Faculty Council, Penn State, 2019–2021
- Graduate Advisory Committee (GAC), Penn State, 2018–2019
- Graduate Recruiting Committee (GRC), Penn State, 2018–2020

ADVISING

Ph.D. Students

- Shuofei Zhu (2018 – Present): [C11] [C13] [C15] [C16]
- Shihao Xia (co-advised with Hong Hu) (2020 – Present): [C14]
- Mengting He (2022 – Present)
- Ziheng Liu (2018 – 2021): [C13] [C14] [J2] → Ph.D. at UCSD
- Li Wang (2021): → Assistant Professor at Fontbonne University

Master Students

- Tiffany Amigon (2022 – Present)
- Shiqin Chen (2018 – 2021)

Undergraduate Students

- Edward Burke (2021)
- Erin Flannery (2020)
- Phil Reeves (2020)
- Tianchen Zhang (2019)

Visiting Students

- Boqin Qin (Ph.D. student from BUPT) (2018 – 2020): [C11] [C12] [C13] [C16] [J2] → China Telecom Cloud Computing

- Ziyi Zhang (Undergraduate from USTC) (2019 – 2021): [C11] [C15] [C16] → Ph.D. at Wisconsin-Madison
- Jianjun Shi (Ph.D. student from BIT) (2018 – 2019): [C11]
- Zeming Yu (2018 – 2019): [C12]
- Yongheng Chen (Undergraduate from NJU) (2019): [W3] → Ph.D. at Gatech
- Tengfei Tu (Ph.D. student from BUPT) (2017 – 2018): [C8] [J2] → faculty at BUPT

Thesis Committee at Penn State

- [Current] Lexiang Huang (PhD), Shuofei Zhu (PhD).
- [2021] Li Wang (PhD), Minli Liao (PhD), Zhenpeng Lin (MS), Xian Wu (MS).

Qualification Committee at Penn State

- [2022] Zhimeng Guo, Geng Xiao, Junjie Xu, Huaisheng Zhu.
- [2021] Quan Li, Haizhou Wang, Tianrou Xia, Zhaohan Xi.
- [2019] Neisarg Dave, Ankur Mali, Shaurya Rohatgi, Rui Yu.

Student Mentoring Programs at Top-Tier Conferences

- [ASPLOS'2022] Xiang Cheng, Yuheng Yang.
- [SOSP'2021] Yuhan Liu, Hannah Atmer.
- [ASPLOS'2021] Shijia Wei , Jules Drean.