

# Linhai Song

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## RESEARCH INTERESTS

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

## EDUCATION

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

## EMPLOYMENT

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

## HONORS AND AWARDS

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

## PUBLICATIONS<sup>1</sup>

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<sup>1</sup>Students directly under my supervision are denoted by “S”.

## Refereed Journal Articles

- [J3] Boqin Qin<sup>S</sup>, Yilun Chen, **Linhai Song**, and Yiying Zhang. “Understanding and Detecting Real-World Safety Issues in Rust.” Under Preparation.
- [J2] Boqin Qin<sup>S</sup>, Tengfei Tu<sup>S</sup>, Ziheng Liu<sup>S</sup>, Tingting Yu, and **Linhai Song**. “Algorithmic Profiling for Real-World Complexity Problems.” In *Transactions on Software Engineering (TSE)*, 2021.
- [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] Ziyi Zhang<sup>S</sup>, Shuofei Zhu<sup>S</sup>, Jaron Mink, Aiping Xiong, **Linhai Song**, and Gang Wang. “Beyond Bot Detection: Combating Fraudulent Online Survey Takers.” Submitted to *Proceedings of the ACM Web Conference 2022 (WWW’2022)*.
- [C15] Shuofei Zhu<sup>S</sup>, Ziyi Zhang<sup>S</sup>, Boqin Qin<sup>S</sup>, Aiping Xiong, and **Linhai Song**. “Learning and Programming Challenges of Rust: A Mixed-Methods Study.” Submitted to *Proceedings of the 44th International Conference on Software Engineering (ICSE’2022)*.
- [C14] Ziheng Liu<sup>S</sup>, Yu Liang, Shihao Xia<sup>S</sup>, **Linhai Song**, and Hong Hu. “Who Goes First? Detecting Go Concurrency Bugs via Message Reordering.” Submitted to *Proceedings of the 27th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS’2022)*.
- [C13] Ziheng Liu<sup>S</sup>, Shuofei Zhu<sup>S</sup>, Boqin Qin<sup>S</sup>, 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)*. (Acceptance Rate: 18.8%, 75 out of 398)
- [C12] Boqin Qin<sup>S\*</sup>, Yilun Chen<sup>\*</sup>, Zeming Yu<sup>S</sup>, **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)*, pp. 763–779, June 2020. (Acceptance Rate: 22.5%, 77 out of 341) (\*: co-first authors)
- [C11] Shuofei Zhu<sup>S</sup>, Jianjun Shi<sup>S</sup>, Limin Yang, Boqin Qin<sup>S</sup>, Ziyi Zhang<sup>S</sup>, **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)*, pp. 34–40, 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)*, pp. 478–485, October 2019. (Acceptance Rate: 19.7%, 39 out of 197)
- [C8] Tengfei Tu<sup>S</sup>, 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)*, pp. 865–878, April 2019. (Acceptance Rate: 21.1%, 74 out of 350)
- [C7] **Linhai Song** and Shan Lu. “Program Analysis for Inefficient Loops.” In *Proceedings of the 39th International Conference on Software Engineering (ICSE’2017)*, pp. 370–380, 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)*, pp. 426–438, 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)*, pp. 659–671, 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)*, pp. 561–578, 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)*, pp. 562–571, 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)*, pp. 77–88, 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)*, pp. 389–400, 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<sup>S</sup>, **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)*, pp. 9–15, 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 debLoating And Delayering (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)*, pp. 1–8, August 2016. (Acceptance Rate: 40.8%, 20 out of 49)

## Technical Reports

[T4] Zeming Yu<sup>S</sup>, **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<sup>S</sup> 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<sup>S</sup>, 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<sup>S</sup>, Boqin Qin<sup>S</sup>, 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<sup>S</sup>, Ziyi Zhang<sup>S</sup>, 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

[S5] A static Go concurrency bug detector.  
<https://github.com/system-pclub/GCatch>

[S4] A production-run algorithmic profiler.  
<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>

[D1] Dataset of 171 real-world Go concurrency bugs, 2019.  
<https://github.com/system-pclub/go-concurrency-bugs>

## 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
- 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: 2019, 2020, 2021

#### **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**

- Combating Real-World Concurrency Bugs in Go
  - Bytedance, August 2021
  - Kwai, June 2021
  - Tsinghua University, May 2021
- 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

## GRANTS

- 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%);
  - Ethereum 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.

## TEACHING

Term	Course	Enrollment	Course Quality	Instructor Quality
Spring 2021	SRA 221 Overview of Information Security (1)	60	6.5/7	6.5/7
Fall 2020	SRA 221 Overview of 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

## ADVISING

### Ph.D. Students

- Shuofei Zhu (2018 – Present): [C11] [C13] [C15] [C16] [D1] [S3] [S5]
- Shihao Xia (co-advised with Hong Hu) (2020 – Present) [C14]
- Ziheng Liu (2019 – 2021): [C13] [C14] [J2] [S4] [S5] → Ph.D. at UCSD

### Visiting Students

- Boqin Qin (Ph.D. student from BUPT) (2018 – 2020): [C11] [C12] [C13] [J2] [J3] [D2] [S2] [S4] [S5]

- Ziyi Zhang (Undergraduate from USTC) (2019): [C11] [C15] [C16] [P3] [D1] [D2] [S3] → Ph.D. at Wisconsin-Madison
- Jianjun Shi (Ph.D. student from BIT) (2018 – 2019): [C11]
- Zeming Yu (2018 – 2019): [C12] [T4]
- Yongheng Chen (Undergraduate from NJU) (2019): [W3] → Ph.D. at Gatech
- Tengfei Tu (Ph.D. student from BUPT) (2017 – 2018): [C8] [J2] [P2] → faculty at BUPT