Linhai Song

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College of Information Sciences and Technology
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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   Nov. 2015
Ph.D., Computer Science (M.S. along the way)
Advisor: Shan Lu

Chinese Academy of Sciences, Beijing, China   Jun. 2010
M.S., Computer Science

Huazhong University of Science and Technology, Wuhan, Hubei, China   Jun. 2007
B.E., Software Engineering

EMPLOYMENT

Pennsylvania State University, State College, PA, USA   Aug. 2017 - Present
Assistant Professor at College of Information Sciences and Technology

Kwai Inc., Seattle, WA, USA   Jun. 2021 - Aug. 2021
Consultant

ByteDance Ltd., Palo Alto, CA, USA   May 2019 - Aug. 2019
Consultant

FireEye, Inc., Milpitas, CA, USA   Nov. 2015 - Jul. 2017
Staff Research Scientist

NEC Laboratories America, Inc., Princeton, NJ, USA   May 2013 - Aug. 2013
Research Intern

Microsoft Research Asia, Beijing, China   May 2010 - Jul. 2010
Research Intern

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

PUBLICATIONS[1]

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)

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[1]Students 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 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 Yiying 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 Yiying 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 Yiying 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 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

- 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 Yiying 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

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 (2019 – 2021): [C13] [C14] → Ph.D. at UCSD

- Li Wang (2021): → Assistant Professor at FontBonne University

Master Students

- Tiffany Amigon (2022 – Present)

Undergraduate Students

- Edward Burke (2022)

- Phil Reeves (2020)

- Tianchen Zhang (2019 – 2020)

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): [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).

- **[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.