QINGKAI SHI, Ph.D. in Computer Science and Engineering (HKUST)

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Education and Employment

Postdoc Research Associate 2021 - Present
Purdue University, USA

Ph.D., Computer Science and Engineering 2015 - 2020
The Hong Kong University of Science and Technology
Thesis: Precise and Scalable Static Bug Finding for Industrial-Sized Code

Co-founder of Sourcebrella Inc., Shenzhen, China 2015 - 2021
Sourcebrella Inc. commercializes my research on static bug finding
Sourcebrella Inc. was acquired by Ant Group in 2020

Research Engineer 2012 - 2015
Nanjing University & Mooctest Inc., Nanjing, China

B.S., Software Engineering 2008 - 2012
Nanjing University, Nanjing, China

Research Statement

My research interest centers around **programming language**, **cybersecurity**, and **software engineering**, focusing on the use of compiler techniques, including both static and dynamic program analysis, for ensuring software reliability.

My research has been commercialized and deployed in many Global 500 companies, helping them hunt deeply-hidden software vulnerabilities. Due to the industrial value, the startup that commercializes my research has been acquired by Ant Group.

My research has won me an ACM SIGSOFT Distinguished Paper Award (2019), three champions in NASAC prototype competitions (2016, 2018a, 2018b), Hong Kong PhD Fellowship (2015), and China National Scholarship (2010, 2015).

Publications

I contributed to seventeen top-tier papers in the area of programming language (PLDI×2, OOPSLA×2), security (S&P×2), and software engineering (ICSE×3, ESEC/FSE×1, ISSTA×5, TSE×1, TRel×1).

* **corresponding author and paper under my supervision**

1. Heqing Huang, Yiyuan Guo, **Qingkai Shi***, Peisen Yao, Rongxin Wu, Charles Zhang. Beacon: Directed Grey-Box Fuzzing with Provable Path Pruning. In **S&P 2022**: the 43rd IEEE Symposium on Security and Privacy.
2. **Qingkai Shi**, Yongchao Wang, Charles Zhang. Indexing Context-Sensitive Reachability. In **OOPSLA 2021**: the 36th ACM SIGPLAN Conference on Object Oriented Programming, Systems, Languages and Applications.
3. Peisen Yao, **Qingkai Shi***, Heqing Huang, Charles Zhang. Program Analysis via Efficient Symbolic Abstraction. In **OOPSLA 2021**: the 36th ACM SIGPLAN Conference on Object Oriented Programming, Systems, Languages and Applications.
4. Peisen Yao, Heqing Huang, Wensheng Tang, **Qingkai Shi**, Rongxin Wu, Charles Zhang. Skeletal Approximation Enumeration for SMT Solver Testing. In **ESEC/FSE 2021**: the 29th ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering.

5. Peisen Yao, Heqing Huang, Wensheng Tang, **Qingkai Shi**, Rongxin Wu, Charles Zhang. Fuzzing SMT Solvers via Two-Dimensional Input Space Exploration. In **ISSTA 2021**: the 30th ACM SIGSOFT International Symposium on Software Testing and Analysis.
6. **Qingkai Shi**, Peisen Yao, Rongxin Wu, Charles Zhang. Path-Sensitive Sparse Analysis without Path Conditions. In **PLDI 2021**: the 42nd annual ACM SIGPLAN conference on Programming Language Design and Implementation.
7. Peisen Yao, **Qingkai Shi***, Heqing Huang, and Charles Zhang. Fast Bit-Vector Satisfiability. In **ISSTA 2020**: the 29th ACM SIGSOFT International Symposium on Software Testing and Analysis.
8. Gang Fan, Chengpeng Wang, Rongxin Wu, Xiao Xiao, **Qingkai Shi**, and Charles Zhang. Escaping Dependency Hell: Finding Build Dependency Errors with the Unified Dependency Graph. In **ISSTA 2020**: the 29th ACM SIGSOFT International Symposium on Software Testing and Analysis.
9. Chunrong Fang, Zixi Liu, Yangyang Shi, Jeff Huang, and **Qingkai Shi**. Functional Code Clone Detection with Syntax and Semantics Fusion Learning. In **ISSTA 2020**: the 29th ACM SIGSOFT International Symposium on Software Testing and Analysis.
10. Yang Feng, **Qingkai Shi***, Xinyu Gao, Jun Wan, Chunrong Fang, and Zhenyu Chen. DeepGini: Prioritizing Massive Tests to Enhance the Robustness of Deep Neural Networks. In **ISSTA 2020**: the 29th ACM SIGSOFT International Symposium on Software Testing and Analysis.
11. **Qingkai Shi**, Charles Zhang. Pipelining Bottom-up Data Flow Analysis. In **ICSE 2020**: the 42nd ACM/IEEE International Conference on Software Engineering.
12. **Qingkai Shi**, Rongxin Wu, Gang Fan, Charles Zhang. Conquering the Extensional Scalability Problem for Value-Flow Analysis Frameworks. In **ICSE 2020**: the 42nd ACM/IEEE International Conference on Software Engineering.
13. Heqing Huang, Peisen Yao, Rongxin Wu, **Qingkai Shi***, Charles Zhang. Pangolin: Incremental Hybrid Fuzzing with Polyhedral Path Abstraction. In **S&P 2020**: the 41st IEEE Symposium on Security and Privacy.
14. Gang Fan, Rongxin Wu, **Qingkai Shi**, Xiao Xiao, Jinguo Zhou, Charles Zhang. SMOKE: Scalable Path-Sensitive Memory Leak Detection for Millions of Lines of Code. In **ICSE 2019**: the 41st ACM/IEEE International Conference on Software Engineering.
ACM SIGSOFT Distinguished Paper Award
15. **Qingkai Shi**, Xiao Xiao, Rongxin Wu, Jinguo Zhou, Gang Fan, Charles Zhang. Pinpoint: Fast and Precise Sparse Value Flow Analysis for Million Lines of Code. In **PLDI 2018**: the 39th annual ACM SIGPLAN Conference on Programming Language Design and Implementation.
16. **Qingkai Shi**, Zhenyu Chen, Chunrong Fang, Yang Feng, Baowen Xu. Measuring the Diversity of a Test Set with Distance Entropy. In **TRel 2016**: IEEE Transactions on Reliability, Vol. 65, No. 1, 2016.
17. **Qingkai Shi**, Jeff Huang, Zhenyu Chen, and Baowen Xu. Verifying Synchronization for Atomicity Violation Fixing. In **TSE 2016**: IEEE Transactions on Software Engineering, Vol. 42, No. 3, 2016.

CVE

As a security researcher, I contributed to revealing the following CVE-identified software vulnerabilities:

1. CVE-2017-14739: ImageMagick 7.0.7–4 mishandles failed memory allocation, which allows remote attackers to cause a denial of service.
2. CVE-2017-14952: International Components for Unicode (ICU) for C/C++ through 59.1 contains a double free that allows remote attackers to execute arbitrary code.
3. CVE-2017-15096: GlusterFS in versions prior to 3.10 contains a null pointer dereference that may cause denial of service.

4. CVE-2017-16892: Bftpd 4.6 contains a memory leak which occurs if a mal-crafted sequence of FTP requests are received.
5. CVE-2017-1000445: ImageMagick 7.0.7–1 and older version are vulnerable to null pointer dereference in the MagickCore component and might lead to denial of service.
6. CVE-2018-20786: libvterm through 0+bzr726, as used in Vim and other products, mishandles certain out-of-memory conditions, leading to a denial of service (application crash), related to screen.c, etc.
7. CVE-2019-13238: An issue was discovered in Bento4 1.5.1.0. A memory allocation failure is unhandled in Core/Ap4SdpAtom.cpp and leads to crashes. When parsing input video, the program allocates a new buffer to parse an atom in the stream. The unhandled memory allocation failure causes a direct copy to a NULL pointer.
8. CVE-2019-13959: In Bento4 1.5.1-627, AP4_DataBuffer::SetDataSize does not handle reallocation failures, leading to a memory copy into a NULL pointer.
9. CVE-2019-13960: In libjpeg-turbo 2.0.2, a large amount of memory can be used during processing of an invalid progressive JPEG image containing incorrect width and height values in the image header.
10. CVE-2020-19715: An integer overflow vulnerability in the getUShort function of Exiv2 0.27.1 results in segmentation faults within the application, leading to a denial of service (DOS).
11. CVE-2020-19716: A buffer overflow vulnerability in the Databuf function in types.cpp of Exiv2 v0.27.1 leads to a denial of service (DOS).
12. CVE-2020-19717: An unhandled memory allocation failure in Core/Ap48bdlAtom.cpp of Bento 1.5.1-628 causes a NULL pointer dereference, leading to a denial of service (DOS).
13. CVE-2020-19718: An unhandled memory allocation failure in Core/Ap4Atom.cpp of Bento 1.5.1-628 causes a NULL pointer dereference, leading to a denial of service (DOS).
14. CVE-2020-19719: A buffer overflow vulnerability in Ap4ElstAtom.cpp of Bento 1.5.1-628 leads to a denial of service (DOS).
15. CVE-2020-19720: An unhandled memory allocation failure in Core/AP4IkmsAtom.cpp of Bento 1.5.1-628 causes a NULL pointer dereference, leading to a denial of service (DOS).
16. CVE-2020-19721: A heap buffer overflow vulnerability in Ap4TrunAtom.cpp of Bento 1.5.1-628 may lead to an out-of-bounds write while running mp42aac, leading to system crashes and a denial of service (DOS).
17. CVE-2020-19722: An unhandled memory allocation failure in Core/Ap4Atom.cpp of Bento 1.5.1-628 causes a direct copy to NULL pointer dereference, leading to a denial of service (DOS).

Patents

I contributed to the following US and China patents.

- Defect detection method, device. system, and computer readable medium. (US Patent No. 20190108003, China Patent No. 201811013103.6).
- Use-after-free detection method, device, system, and computer readable medium. (China Patent No. 201811013000.X).
- SQL-injection detection method, device, system, and computer readable medium. (China Patent No. 201811015751.5).
- Inter-procedural null dereference detection method, device, system, and computer readable medium. (China Patent No. 2018110146864).
- A method of controlling computer with mobile phone's inner sensors. (China Patent No. 2011104124584).
- A method of randomly selecting co-diversified test cases. (China Patent No. 2012100526910).

- A method of verifying synchronization for atomicity violation fixing. (China Patent No. 2014107099836).
- A method of obtaining the feedback on the teaching of Java unit testing. (China Patent No. 2016102941812).

Professional Services

- Artifact Evaluation Committee: POPL'22.
- Student Volunteer: PLDI'16, QSIC'13, and PLDI'12.

Teaching Experience

- Teaching Assistant for COMP3111/3111H: Software Engineering (Fall 2018)
- Teaching Assistant for COMP4111: Software Engineering Practices (Spring 2018)
- Teaching Assistant for COMP4111: Software Engineering Practices (Fall 2016)

August 1, 2021