

# Li Jiaying

Ph.D., Microsoft

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## Research Interests

### Formal Verification, Software Engineering, Artificial Intelligence

My primary research focuses on the correctness of software systems, including classic computer programs, smart contracts, and artificial intelligence systems such as deep neural networks. I also have a broad interest in both the theoretic and practical aspects of software analysis, testing, debugging and verification. My vision is to furnish new insights and perspectives, as well as to develop prototype tools, in order to help practitioners build trustworthy and high-quality software systems.

## Education

- 2013.09 — **Ph.D. of Computer Science**, *Information Systems Technology and Design*, Singapore University of Technology and Design, Singapore.  
Research Areas: formal verification and program analysis  
Thesis: Facilitating Formal Verification with Invariant Learning  
Advisor: Professor Sun Jun
- 2017.11 — **Visiting Scholar**, *Department of Computer Science*, University of California, Davis, USA.  
2018.03 Research Areas: program verification  
Advisor: Professor Su Zhendong
- 2011.09 — **Master (dropped)**, *Institute of Computing Technology*, Chinese Academy of Sciences, China.  
2013.06 Research Areas: storage systems, operating systems  
Advisors: Professor Xu Lu, Professor Zhan Jianfeng
- 2007.09 — **Bachelor of Engineering**, *College of Software*, Nankai University, China.  
2011.06 GPA: 3.9/4.0 Rank: 1/134  
Thesis: Multi-tasking OS Kernel with a Priority Scheduling Mechanism  
Advisor: Professor Li Yaoguo

## Employment Experiences

- 2021.06 — **Senior SDE**, *Bing Platform*, Microsoft, Beijing, China.  
present
- 2019.10 — **Research Scientist**, *School of Computing and Information Systems*, Singapore Management University, Singapore.  
2021.06  
Advisor: Professor Sun Jun
- 2018.05 — **Research Fellow**, *iTrust Lab.*, *Information Systems Technology and Design*, Singapore University of Technology and Design, Singapore.  
2019.09  
Advisors: Professor Sun Jun, Professor Paweł Szałachowski
- 2013.07 — **Research Assistant**, *Information Systems Technology and Design*, Singapore University of Technology and Design, Singapore.  
2013.09  
Advisor: Professor Sun Jun

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## Publications (Accepted or Conditionally Accepted)

- 2024 **ReLU Hull Approximation**, In the 51st ACM SIGPLAN Symposium on Principles of Programming Languages (POPL), 2024.  
Zhongkui Ma, Jiaying Li, Guangdong Bai
- 2023 **Towards an Effective and Interpretable Refinement Approach for DNN Verification**, In the 23rd IEEE International Conference on Software Quality, Reliability, and Security (QRS), 2023.  
Jiaying Li, Guangdong Bai, Long H. Pham, and Jun Sun
- 2023 **A Comprehensive Study of Real-World Bugs in Machine Learning Model Optimization**, In the 45th IEEE/ACM International Conference on Software Engineering (ICSE), 2023.  
Hao Guan, Ying Xiao, Jiaying Li, Yepang Liu, Guangdong Bai
- 2021 **Verification Assisted Gas Reduction for Smart Contracts**, In the 28th Asia-Pacific Software Engineering Conference (APSEC), 2021 **Best Paper**.  
Bo Gao, Siyuan Shen, Ling Shi, Jiaying Li, Jun Sun, Lei Bu
- 2021 **sVerify: Verifying Smart Contracts through Lazy Annotation and Learning**, In the 10th International Symposium On Leveraging Applications of Formal Methods, Verification and Validation (ISoLA), 2021.  
Bo Gao, Ling Shi, Jiaying Li, Jialiang Chang, Jun Sun and Zijiang Yang
- 2019 **Deep Clustering by Gaussian Mixture Variational Autoencoders with Graph Embedding**, In the International Conference in Computer Vision (ICCV), 2019.  
Linxiao Yang, Ngai-Man Cheung, Jiaying Li, Jun Fang
- 2017 **Classification-based Parameter Synthesis for Parametric Timed Automata**, In the 19th International Conference on Formal Engineering Methods (ICFEM), 2017.  
Jiaying Li, Jun Sun, Bo Gao and Étienne André
- 2017 **Automatic Loop-invariant Generation and Refinement through Selective Sampling**, In the 32nd IEEE/ACM International Conference on Automated Software Engineering (ASE), 2017.  
Jiaying Li, Jun Sun, Li Li, Quang Loc Le and Shang-Wei Lin
- 2016 **Scaling BDD-based Timed Verification with Simulation Reduction**, In the 19th International Conference on Formal Engineering Methods (ICFEM), 2016.  
Truong Khanh Nguyen, Tian Huat Tan, Jun Sun, Jiaying Li, Yang Liu, Manman Chen, Jin Song Dong
- 2015 **An Invariant Inference Framework using Active Learning and SVMs**, In the 20th International Conference on Engineering of Complex Computer Systems (ICECCS), 2015.  
Jiaying Li

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## Research Projects

- 2020 — 2023 **Deep Neural Network Analysis and Verification.**  
DNNs were subject to vulnerabilities. This project aims at building new systems and developing new techniques to analyze and verify DNNs. In particular, we have built a unified platform, named SOCRATES, for DNN analysis, which eases researchers in developing, extending and evaluating different DNN testing and verification techniques. We have also developed a new debugging technique that can refine DNN verification in an interpretable yet effective way. Moreover, we have developed a novel method that can approximate multiple neurons together in a precise, efficient and scalable way, greatly advancing the state-of-the-art approaches.
- 2018 — 2021 **Smart Contract Analysis and Verification.**  
Smart contracts are programs running on blockchain infrastructures and they suffer from vulnerabilities that may lead to huge financial loss. This line of research aims to verify the correctness of smart contracts and optimize their gas usage. We first developed an unbounded verifier for smart contract based on symbolic execution and invariant learning. By leveraging some intermediate verification result, we have also developed an optimization technique that can reduce the gas optimization for smart contract automatically.

## 2015 — 2018 **Program Analysis and Verification.**

Loop invariant generation is a fundamental problem in computer science. This line of work automatically generates loop invariants through machine learning techniques. We first propose a learning-based technique to generate loop invariants for program verification. It leverages classification algorithms and active learning techniques. Then, we consider invariants in disjunctive forms, which are challenging to generate through existing techniques. To tackle the challenges, we use program control flow information to generate these invariants in a compositional way.

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## **Fellowships & Awards**

- 2021 Best Paper Award, APSEC2021, Taiwan
- 2013, 2014, SUTD President's Graduate Fellowship, Ministry of Education, Singapore
- 2015, 2016,
- 2017, 2018
- 2011 First Prize National Fellowship, Ministry of Education, China
- 2010 National Scholarship, Ministry of Education, China
- 2009 National Endeavor Scholarship, Ministry of Education, China
- 2008 Second Prize National Fellowship, Ministry of Education, China

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## **Professional Services**

- Program Committee ICFEM 2023
- Reviewer APSEC2016, ICECCS 2017, SATE18, ICFEM2018, ICFEM2019, TASE 2019, FormaliSE 2019, AST 2020, SETTA 2020, IMLSE 2020, Internetwork 2020, SiMLA 2022
- Teaching Machine learning (undergraduate, ISTD, SUTD, Spring, 2014)
- Assistant Elements of software construction (undergraduate, ISTD, SUTD, Fall, 2014)

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## **Talks**

- 2023 Refining DNN Verification via Debugging, QRS2023@Chiang Mai, Thailand
- 2023 Detecting Memory Bugs in C/C++, 1ES Sharing@Microsoft, Beijing, China
- 2021 Interpretable Refinement for DNN verification, Huawei@Hangzhou, China
- 2018 Facilitating Formal Verification with Invariant Learning, Thesis Defense@SUTD, Singapore
- 2017 Learning Parametric Timed Automata, ICFEM2017@Xi'an, China
- 2017 Generating Loop Invariants via Learning, ASE2017@UIUC, Illinois, USA
- 2016 Better BDD-based Timed Verification, ICFEM2016@Tokyo, Japan
- 2015 Learning-based Loop Invariant Generation, ICECCS2015@Gold Coast, Australia