Deyun Lyu

Research Fellow | National Institute of Informatics

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About Me

I am a Research Fellow at the National Institute of Informatics, working in the Trustworthy & Smart Software Engineering Lab led by Prof. **Fuyuki Ishikawa**. I received my Ph.D. in Information Science and Electrical Engineering from Kyushu University under the supervision of Prof. **Jianjun Zhao**, with co-advisors Prof. **Paolo Arcaini** and Prof. **Zhenya Zhang**. My research interests focus on the quality assurance of AI-enabled cyber-physical systems (AI-CPSs).

Research Interests

- Trustworthy AI-Enabled Cyber-Physical Systems
- Safe and Reliable Autonomous Driving Systems
- Software Engineering for AI Systems (SE4AI)
- Formal Verification and Validation

Education

Kyushu University **Fukuoka, Japan**
Ph.D. in Advanced Information Technology *Oct. 2020 – Mar. 2025*
Supervisor: Prof. Jianjun Zhao, Co-advisors: Prof. Paolo Arcaini, Prof. Zhenya Zhang *Graduated*

Dalian University of Technology **Dalian, China**
M.S. in Software Engineering *Sept. 2018 – June 2020*
Supervisor: Prof. Weiqiang Kong *Graduated*

Dalian University of Technology **Dalian, China**
B.S. in Network Engineering *Sept. 2014 – June 2018*
Supervisor: Prof. Jing Gao *Graduated*

Work Experience

National Institute of Informatics **Tokyo, Japan**
Information Systems Architecture Science Research Division
Research Fellow *Apr. 2025 – Present*

Kyushu University **Fukuoka, Japan**
Graduate School of Information Science and Electrical Engineering
Teaching Assistant *Summer 2024*
Course: *Python Programming Exercises (Python プログラミング演習)* for undergraduate students

National Institute of Informatics **Tokyo, Japan**
Information Systems Architecture Science Research Division

Visiting Researcher *Sept. 2023 – Mar. 2024*

Kyushu University **Fukuoka, Japan**
Graduate School of Information Science and Electrical Engineering
Teaching Assistant *Summer 2023*
Course: *Python Programming Exercises (Python プログラミング演習)* for undergraduate students

Japan Science and Technology Agency **Fukuoka, Japan**
Research Fellow (JST-SPRING) *Oct. 2021 – Sept. 2023*

Kyushu University **Fukuoka, Japan**
Graduate School of Information Science and Electrical Engineering
Research Assistant *Oct. 2020 – Sept. 2021*

Dalian University of Technology **Dalian, China**
School of Software Technology
Teaching Assistant *Fall 2019*
Course: *C++ Programming Exercises* for undergraduate students

Dalian University of Technology **Dalian, China**
School of Software Technology
Teaching Assistant *Spring 2019*
Course: *C Programming Exercises* for undergraduate students

Dalian University of Technology **Dalian, China**
School of Software Technology
Teaching Assistant *Fall 2018*
Course: *Operating Systems Practicum* for undergraduate students

Dalian University of Technology **Dalian, China**
School of Software Technology
Research Assistant *Sept. 2018 – June. 2020*

Publications

Quality Assurance of AI-Enabled Cyber-Physical Systems

- **[AI-CPS-P7] Deyun Lyu**, Jiayang Song, Zhenya Zhang, Zhijie Wang, Tianyi Zhang, Lei Ma and Jianjun Zhao. “Repair of DNN Control Policies via STL-Guided Patch Synthesis.” IEEE Transactions on Reliability. (TREL 2025, the flagship journal in reliability engineering, **CORE Rank A**, Impact Factor: 5.7, under review)
- **[AI-CPS-P6] Deyun Lyu**, Zhenya Zhang, Paolo Arcaini, Thomas Laurent, Borui Zhang, Fuyuki Ishikawa, and Jianjun Zhao. “ContrRep: Search-Based Repair of DNN Controllers of AI-Enabled CPSs.” Automated Software Engineering. (ASEJ 2025, **CORE Rank B**, Impact Factor: 3.1, under review)
- **[AI-CPS-P5] Deyun Lyu**, Yi Li, Zhenya Zhang, Paolo Arcaini, Xiao-Yi Zhang, Fuyuki Ishikawa and Jianjun Zhao. “Fault Localisation of AI-Enabled Cyber-Physical Systems by Exploiting Temporal Neuron Activation.” Journal of Systems and Software. (JSS 2025, **CORE Rank A**, Impact Factor: 4.1)
- **[AI-CPS-P4] Deyun Lyu**, Zhenya Zhang, Paolo Arcaini, Xiao-Yi Zhang, Fuyuki Ishikawa and Jianjun Zhao. “SpectAcle: Fault Localisation of AI-Enabled CPS by Exploiting Sequences of DNN Controller Inferences.” ACM Transactions on Software Engineering and Methodology. (TOSEM 2025, a top-tier journal in software engineering, **CORE Rank A***, Impact Factor: 6.6, **IPSJ SIG-SE Excellent Research Award**)

- **[AI-CPS-P3] Deyun Lyu**, Zhenya Zhang, Paolo Arcaini, Fuyuki Ishikawa, Thomas Laurent and Jianjun Zhao. “Search-Based Repair of DNN Controllers of AI-Enabled CPS Guided by System-Level Specifications.” Proceedings of the Genetic and Evolutionary Computation Conference. (GECCO 2024, a top-tier conference in computational intelligence, **CORE Rank A**)
- **[AI-CPS-P2]** Zhenya Zhang, **Deyun Lyu**, Paolo Arcaini, Lei Ma, Ichiro Hasuo and Jianjun Zhao. “FalsifAI: Falsification of AI-Enabled Hybrid Control Systems Guided by Time-Aware Coverage Criteria.” IEEE Transactions on Software Engineering. (TSE 2023, the flagship journal in software engineering, **CORE Rank A***, Impact Factor: 6.5)
- **[AI-CPS-P1]** Jiayang Song, **Deyun Lyu***, Zhenya Zhang, Zhijie Wang, Tianyi Zhang and Lei Ma. “When Cyber-Physical Systems Meet AI: A Benchmark, an Evaluation, and a Way Forward.” 44th International Conference on Software Engineering: Software Engineering in Practice. (ICSE 2022, the flagship conference in software engineering, **Co-first author**, **CORE Rank A***)

Quality Assurance of Cyber-Physical Systems

- **[CPS-P4]** Tanmay Khandait, **Deyun Lyu***, (12 other authors). “ARCH-COMP 2025 Category Report: Falsification.“ 12th International Workshop on Applied Verification of Continuous and Hybrid Systems. (**Co-first author**, to appear)
- **[CPS-P3]** Yipei Yan, **Deyun Lyu**, Zhenya Zhang, Paolo Arcaini and Jianjun Zhao. “Automated Generation of Benchmarks for Falsification of STL Specifications.” IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems. (TCAD 2025, the flagship journal in electronic design automation, **CCF A**, Impact Factor: 2.9)
- **[CPS-P2]** Zhenya Zhang, **Deyun Lyu**, Paolo Arcaini, Lei Ma, Ichiro Hasuo and Jianjun Zhao. “Effective Hybrid System Falsification Using Monte Carlo Tree Search Guided by QB-Robustness.” 33rd International Conference on Computer-Aided Verification. (CAV 2021, the flagship conference in formal methods, **CORE Rank A***)
- **[CPS-P1]** Zhenya Zhang, **Deyun Lyu**, Paolo Arcaini, Lei Ma, Ichiro Hasuo and Jianjun Zhao. “On the Effectiveness of Signal Rescaling in Hybrid System Falsification.” 13th NASA Formal Methods Symposium. (NFM 2021)

Quality Assurance of Autonomous Driving Systems

Note: *These works were conducted during my time at Dalian University of Technology. While my official academic name is “Deyun Lyu”, one of them ([ADS-Verf-P1]) lists me as “Deyun Lv” following pinyin conventions.*

- **[ADS-Verf-P2]** Huihui Wu, **Deyun Lyu**, Y. Zhang, Gang Hou, Masahiko Watanabe, Jie Wang and Weiqiang Kong. “A Verification Framework for Behavioural Safety of Self-Driving Cars.” IET Intelligent Transport Systems. (**CCF C**, Impact Factor: 2.3)
- **[ADS-Verf-P1]** Huihui Wu, **Deyun Lyu**, TengXiang Cui, Gang Hou, Masahiko Watanabe and Weiqiang Kong. “SDLV: Verification of Steering Angle Safety for Self-Driving Cars.” Formal Aspects of Computing. (FAC 2021, **CCF B**, Impact Factor: 1.8)

Invited Talks, Presentations, and Posters

Invited Talks

- **[IT3]** “Quality Assurance of AI-Enabled Cyber-Physical Systems.” The 220th IPSJ/SIGSE Software Engineering Workshop (第 221 回 ソフトウェア工学研究発表会), 東大寺総合文化センター, Nara, Japan. (*Scheduled, Nov. 2025*)
- **[IT2]** “SpectAcle: Fault Localisation of AI-Enabled CPS by Exploiting Sequences of DNN Controller

Inferences." IPSJ/SIGSE Software Engineering Symposium (ソフトウェアエンジニアリングシンポジウム 2025), Waseda University, Tokyo, Japan. (*Sept. 2025*)

- **[IT1]** "Search-Based Repair of DNN Controllers of AI-Enabled Cyber-Physical Systems Guided by System-Level Specifications." Top Conference/Journal Special Talk (トップカンファレンス・トップ論文誌特別講演), 41st Annual Conference of the Japan Society for Software Science and Technology (日本ソフトウェア科学会第 41 回大会), Ritsumeikan University, Osaka, Japan. (*Sept. 2024*)

Presentations

- **[Pres4]** "SpectAcle: Fault Localisation of AI-Enabled CPS by Exploiting Sequences of DNN Controller Inferences." Journal-First Track, 40th IEEE/ACM International Conference on Automated Software Engineering (ASE 2025), Seoul, South Korea. (*Scheduled, Nov. 2025*)
- **[Pres3]** "Fault Localisation of AI-Enabled Cyber-Physical Systems by Exploiting Temporal Neuron Activation." Journal-First Track, 40th IEEE/ACM International Conference on Automated Software Engineering (ASE 2025), Seoul, South Korea. (*Scheduled, Nov. 2025*)
- **[Pres2]** "Search-Based Repair of DNN Controllers of AI-Enabled CPS Guided by System-Level Specifications." Journal-First Track, Proceedings of the Genetic and Evolutionary Computation Conference (GECCO 2024), Melbourne, Australia. (*July 2025*)
- **[Pres1]** "Towards Building Reliable AI-Enabled Cyber-Physical Systems." Doctoral Symposium, 26th International Symposium on Formal Methods (FM 2023), Lübeck, Germany. (*Mar. 2023, Accepted, but not presented due to COVID-19 travel restrictions.*)

Posters

- **[Poster1]** "FalsifAI: Falsification of AI-Enabled Hybrid Control Systems Guided by Time-Aware Coverage Criteria." Demo/Poster Session (デモ・ポスターセッション), 39th Annual Conference of the Japan Society for Software Science and Technology (日本ソフトウェア科学会第 39 回大会), Nanzan University, Nagoya, Japan.

Patents

Note: *These patents were filed during my time at Dalian University of Technology. In U.S. patents, my name appears as "Deyun Lv", following pinyin conventions. In Chinese patents, my name appears as "吕德运". My official academic name is "Deyun Lyu".*

U.S. Patents

- **[US-Pt3]** Weiqiang Kong, **Deyun Lyu**, Zhong Wei, Risheng Liu, Xin Fan and Zhongxuan Luo. "Method For Infrared Small Target Detection Based On Depth Map In Complex Scene." US Patent, No. 12,108,022, Oct. 2024. (Granted, Serve as the primary contributor)
- **[US-Pt2]** Weiqiang Kong, **Deyun Lyu**, Zhong Wei, Risheng Liu, Xin Fan and Zhongxuan Luo. "Method for Fully Automatically Detecting Chessboard Corner Points." US Patent, No. 12,094,152, Sept. 2024. (Granted, Serve as the primary contributor)
- **[US-Pt1]** Zhong Wei, **Deyun Lyu**, Weiqiang Kong, Risheng Liu, Xin Fan, Zhongxuan Luo and Shengquan Li. "Method for Adaptively Detecting Chessboard Sub-Pixel Level Corner Points." US Patent, No. 11,900,634, Feb. 2024. (Granted, Serve as the primary contributor)

Chinese Patents

- **[CN-Pt6]** Weiqiang Kong, **Deyun Lyu**, Wei Zhong, Risheng Liu, Xin Fan, Zhongxuan Luo. "A Fully Automatic Checkerboard Corner Detection Method", CN Patent, No. CN111243032B, May 2023. (Granted, Serve as the primary contributor)

- **[CN-Pt5]** Weiqiang Kong, **Deyun Lyu**, Wei Zhong, Risheng Liu, Xin Fan, Zhongxuan Luo. “An Infrared Small Target Detection Method Based on Depth Map in Complex Scenes”, CN Patent, No. CN111209877B, May 2023. (Granted, Serve as the primary contributor)
- **[CN-Pt4]** Wei Zhong, **Deyun Lyu**, Weiqiang Kong, Risheng Liu, Xin Fan, Zhongxuan Luo, Shengquan Li. “A Checkerboard Sub-pixel Level Corner Adaptive Detection Method”, CN Patent, No. CN111260731B, May 2023. (Granted, Serve as the primary contributor)
- **[CN-Pt3]** Wei Zhong, **Deyun Lyu**, Weiqiang Kong, Risheng Liu, Xin Fan, Zhongxuan Luo, Shengquan Li. “A Color Small Target Detection Method Based on Depth Map in Complex Scenes”, CN Patent, No. CN111291747B, June 2023. (Granted, Serve as the primary contributor)
- **[CN-Pt2] Deyun Lyu**, Wei Zhong, Weiqiang Kong, Risheng Liu, Xin Fan, Zhongxuan Luo. “Method for Quickly Registering Visible Light and Infrared Camera”, CN Patent, No. CN111242991B, Sept 2022. (Granted)
- **[CN-Pt1]** Wei Zhong, **Deyun Lyu**, Weiqiang Kong, Risheng Liu, Xin Fan, Zhongxuan Luo, Shengquan Li. “Method for Optimizing External Parameters of Binocular Camera”, CN Patent, No. CN111243033B, Sept 2022. (Granted, Serve as the primary contributor)

Professional Memberships and Services

Academic Memberships

- Member, IEEE (Institute of Electrical and Electronics Engineers)
- Member, IPSJ (Information Processing Society of Japan)
- Member, IPSJ SIG-SE (Special Interest Group on Software Engineering)

Professional Services

Journal Paper

- Reviewer, ACM Transactions on Software Engineering and Methodology (TOSEM)
- Reviewer, Empirical Software Engineering (EMSE)
- Reviewer, IEEE Transactions on Reliability (TRel)
- Reviewer, Research Directions: Cyber-Physical Systems

Conference Paper

- Web Chair, International Symposium on Formal Methods (FM 2026)
- PC Member, International Symposium on Automated Technology for Verification and Analysis (ATVA 2025) – Artifact Evaluation Track
- PC Member, Association for the Advancement of Artificial Intelligence (AAAI 2023, 2024, 2025)
- Reviewer, International Conference on Software Engineering (ICSE)
- Reviewer, IEEE/ACM International Conference on Automated Software Engineering (ASE)
- Reviewer, ACM SIGSOFT Symposium on the Foundations of Software Engineering (FSE)
- Reviewer, International Symposium on Software Testing and Analysis (ISSTA)
- Reviewer, International Conference on Machine Learning (ICML)
- Reviewer, International Conference on Embedded Software (EMSOFT)

- Reviewer, IEEE International Conference on Software Testing, Verification and Validation (ICST)
- Reviewer, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- Reviewer, International Conference on Engineering of Complex Computer Systems (ICECCS)
- Reviewer, International Symposium on Theoretical Aspects of Software Engineering (TASE)
- Reviewer, International Conference on AI Engineering – Software Engineering for AI (CAIN)

Other Research Experience

Quality Assurance of End-to-End Autonomous Driving Systems

National Institute of Informatics **Tokyo, Japan**
Researcher *July 2025 – Present*
Collaboration with Toyota, JARI and GAIO.

- Demonstrated the potential of my prior research on end-to-end ADS.
- Developing new fault localisation and repair techniques for large-scale end-to-end controllers.

Testing of Multimodal Social Robots

National Institute of Informatics **Tokyo, Japan**
Researcher *June 2025 – Present*
Collaboration with University of Turin.

- Ongoing development of a multimodal-aware metamorphic testing method of social robots (with Pepper robot as a case study).

eBPF-assisted Falsification of Temporal Logic Specifications under Noisy Environments

National Institute of Informatics **Tokyo, Japan**
Researcher *Apr. 2025 – Present*
Collaboration with Kyushu University and University of Bergamo.

- Ongoing development of an eBPF-assisted falsification framework under noisy environments.

Benchmark Contribution to the 2025 ARCH Falsification Competition

National Institute of Informatics **Tokyo, Japan**
Researcher *Apr. 2025 – June. 2025*
ARCH-COMP is a well-established, internationally recognized competition in CPS community.

- Developed a novel benchmark generation method for falsification[CPS-P3] and contributed five benchmarks to the 2025 ARCH Falsification Competition.
- Participated in the competition with our falsification tool *ForeSee*[CPS-P2].

Engineerable AI Project

National Institute of Informatics **Tokyo, Japan**
Visiting Researcher *Sept. 2023 – Mar. 2024*
University research project funding by JST Mirai project (Grant No. JPMJMI20B8).

- Developed a fault localisation approach to localise faulty weights in DNN controllers.
- Proposed the first search-based repair approach for DNN controllers of AI-CPSs.

Testing, Analysis, and Repair of AI-Enabled Cyber-Physical Systems

Kyushu University **Fukuoka, Japan**
Research assistant *Apr. 2023 – Mar. 2025*

University research project funded by JSPS (Grant No. 23H03372).

- Designed an approach to localise faulty neurons in DNN controllers of AI-CPSs.
- Developed a data-driven method for automatically generating synthetic benchmarks for falsification.

機械がバグを修正する時代—擬似オラクル生成・適用と自動バグ修正技術の深化

Kyushu University **Fukuoka, Japan**
Research assistant *Jan. 2021 – Aug. 2022*
University research project funded by JSPS (Grant No. 21H04877).

- Proposed eight time-aware coverage criteria and developed FalsifAI, the first coverage-guided falsification framework for AI-CPSs.

Comprehensive Analysis and Repairing Techniques for Stateful Deep Learning Systems

Kyushu University **Fukuoka, Japan**
Research assistant *May 2021 – Jan. 2022*
University research project funded by JSPS (Grant No. 20H04168).

- Established the first public benchmarks for AI-enabled CPSs, enabling systematic evaluation and guiding testing research.

Traffic Accident Scene Reconstruction and Preprocessing Using TLS Point Clouds

Dalian University of Technology **Dalian, China**
Research Assistant *Sept. 2019 – June. 2020*
Collaboration with Guangzhou Traffic Police Department.

- Developed a 3D point cloud-based system for traffic accident scene investigation and preprocessing.
- Implemented the system as a practical tool and deployed it in practice.

Vehicle-Mounted Visible – Infrared Stereo Vision Perception Unit

Dalian University of Technology **Dalian, China**
Research Assistant *June 2018 – Sept. 2019*
University – Industry Collaboration Project, resulting in multiple US and CN patents (See Section Patents).

- Designed automated sub-pixel chessboard corner detection methods and implemented them as practical calibration tools.
- Developed efficient external parameter optimization and r registration approaches for visible – infrared stereo vision perception systems.
- Proposed a depth map-based method for detecting small infrared/colour targets in complex scenes.

Teaching Assistantships

- **Python Programming Exercises**, Summer 2024, Kyushu University, Fukuoka, Japan (approx. 60 undergraduate students)
- **Python Programming Exercises**, Summer 2023, Kyushu University, Fukuoka, Japan (approx. 30 undergraduate students)
- **C++ Programming Exercises**, Fall 2019, Dalian University of Technology, Dalian, China (approx. 100 undergraduate students)
- **C Programming Exercises**, Spring 2019, Dalian University of Technology, Dalian, China (approx. 100 undergraduate students)
- **Operating Systems Practicum**, Fall 2018, Dalian University of Technology, Dalian, China (approx. 100 undergraduate students)

Mentoring Experience

- **Chenchang Wang**, Expected to graduate in March 2027, Kyushu University, Fukuoka, Japan
  Master's thesis: *eBPF-assisted Falsification of Temporal Logic Specifications under Noisy Environments*
- **Borui Zhang**, Expected to graduate in March 2026, Kyushu University, Fukuoka, Japan
  Master's thesis: *ContrRep: Search-Based Repair of DNN Controllers of AI-Enabled CPSs*
- **Yipei Yan**, Graduated in March 2025, Kyushu University, Fukuoka, Japan
  Master's thesis: *STL* 公式に基づく *CPS* テスト用ベンチマークの自動生成技術
- **Yi Li**, Graduated in March 2025, Kyushu University, Fukuoka, Japan
  Master's thesis: *Tactical: Fault Localization of AI-Enabled Cyber-Physical Systems by Exploiting Temporal Neuron Activation*
- **Ruinan Zhang**, Graduated in June 2022, Dalian University of Technology, Dalian, China
  Master's thesis: *Research on Test Prioritization Technique for Deep Neural Networks*

Research Grants and Funding

- Principal Investigator, Support for Pioneering Research Initiated by the Next Generation (次世代研究者挑戦的研究プログラム), Japan Science and Technology Agency (JST), Oct. 2021 – Sept. 2023. Grant No. JPMJSP2136. Amount: JPY 500,000 annually (total JPY 1,000,000).

Awards

2025 IPSJ SIG-SE Excellent Research Award (情報処理学会 ソフトウェア工学研究会 2025 年度卓越研究賞) *Aug. 2025*
Information Processing Society of Japan, Special Interest Group on Software Engineering (IPSJ SIG-SE)
For our TOSEM 2025 paper entitled "SpectAcle: Fault Localisation of AI-Enabled CPS by Exploiting Sequences of DNN Controller Inferences."

2025 IPSJ SIG-SE Recommended Doctoral Dissertation（情報処理学会 ソフトウェア工学研究会 2025 年度推薦博士論文） *June 2025*
Information Processing Society of Japan, Special Interest Group on Software Engineering (IPSJ SIG-SE)

GECCO 2024 Student Travel Grant *May 2024*
ACM Special Interest Group on Genetic and Evolutionary Computation (ACM SIGEVO)
(Amount: $600 USD)

Support for Pioneering Research Initiated by the Next Generation (JST SPRING, 次世代研究者挑戦的研究プログラム) *Oct. 2021 – Sept. 2023*
Japan Science and Technology Agency (JST)
(Grant No. JPMJSP2136; Amount: JPY 2,400,000 per year)

Graduate School Research Support Scholarship *Sept. 2021*
Kyushu University
(Amount: JPY 250,000)

First-Class Scholarship of the Graduate School *Sept. 2018 – June 2020*
Dalian University of Technology
(Amount: RMB 19,600 per year)