Soonho Kong

Principal Applied Scientist at Amazon Web Services
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Research Interests

My research focuses on the design and implementation of AI systems with formal reasoning capabilities. In particular, I'm interested in combining LLMs with interactive and automated theorem proving techniques to achieve this goal.

Work Experience

- Amazon Web Services (Sep 2021 – Present)
- Toyota Research Institute (Aug 2016 – Sep 2021)

Education

Carnegie Mellon University
Ph.D. in Computer Science
Advisor: Prof. Edmund M. Clarke

Seoul National University
Master of Science in Computer Science and Engineering
Advisor: Prof. Kwangkeun Yi

Seoul National University
Bachelor of Science in Computer Science and Engineering

Software

dReal: SMT solver for nonlinear theories over the Reals (Lead developer, since 2013)
Drake: Model-based design and verification for robotics (Platform-reviewer, 2017 – 2021)
Lean: Lean theorem prover (Contributor, 2013 – 2016)

Publications

[1] Kevin Lotz, Amit Goel, Bruno Dutertre, Benjamin Kiesl-Reiter, Soonho Kong, and Dirk Nowotka. "Solving string constraints with concatenation using SAT". In: *FMCAD 2024*. 2024.

[2] Kevin Lotz, Amit Goel, Bruno Dutertre, Benjamin Kiesl-Reiter, Soonho Kong, Rupak Majumdar, and Dirk Nowotka. "Solving String Constraints Using SAT". In: *Computer Aided Verification*. Ed. by Constantin Enea and Akash Lal. Cham: Springer Nature Switzerland, 2023, pp. 187–208.

[3] U. Guajardo, A. Bryan, N. Arechiga, S. Campos, J. Chow, D. Jackson, S. Kong, G. Litt, and J. Pollock. "Certified Perception for Autonomous Cars". In: *6th Workshop On Monitoring And Testing Of Cyber-Physical Systems* (2021).

[4] Nikos Arechiga, Jonathan DeCastro, Soonho Kong, and Karen Leung. "Better AI through Logical Scaffolding". In: *FoMLAS 2019: 2nd Workshop on Formal Methods for ML-Enabled Autonomous Systems*. 2019.

[5] Sicun Gao, James Kapinski, Jyotirmoy Deshmukh, Nima Roohi, Armando Solar-Lezama, Nikos Arechiga, and Soonho Kong. "Numerically-Robust Inductive Proof Rules for Continuous Dynamical Systems". In: *Computer Aided Verification*. Ed. by Isil Dillig and Serdar Tasiran. Cham: Springer International Publishing, 2019, pp. 137–154.

[6] Calvin Huang, Soonho Kong, Sicun Gao, and Damien Zufferey. "Evaluating Branching Heuristics in Interval Constraint Propagation for Satisfiability". In: *Numerical Software Verification*. Ed. by Majid Zamani and Damien Zufferey. Cham: Springer International Publishing, 2019, pp. 85–100.

[7] Daniel Jackson, Jonathan DeCastro, Soonho Kong, Dimitrios Koutentakis, Angela Feng Ping Leong, Armando Solar-Lezama, Mike Wang, and Xin Zhang. "Certified Control for Self-Driving Cars". In: *DARS 2019: 4th Workshop On The Design And Analysis Of Robust Systems*. 2019.

[8] Soonho Kong, Armando Solar-Lezama, and Sicun Gao. "Delta-Decision Procedures for Exists-Forall Problems over the Reals". In: *Computer Aided Verification*. Ed. by Hana Chockler and Georg Weissenbacher. CAV'18. Cham: Springer International Publishing, 2018, pp. 219–235.

[9] Kyungmin Bae, Peter Csaba Ölveczky, Soonho Kong, Sicun Gao, and Edmund M. Clarke. "SMT-Based Analysis of Virtually Synchronous Distributed Hybrid Systems". In: *Hybrid Systems: Computation and Control*. HSCC'16. Vienna, Austria: ACM, 2016, pp. 145–154.

[10] Md. Ariful Islam, Greg Byrne, Soonho Kong, Edmund M. Clarke, Rance Cleaveland, Flavio H. Fenton, Radu Grosu, Paul L. Jones, and Scott A. Smolka. "Bifurcation Analysis of Cardiac Alternans Using delta-Decidability". In: *Computational Methods in Systems Biology*. Ed. by Ezio Bartocci, Pietro Lio, and Nicola Paoletti. CMSB'16. Cham: Springer International Publishing, 2016, pp. 132–146.

[11] Seunghak Lee, Soonho Kong, and Eric P. Xing. "A network-driven approach for genome-wide association mapping". In: *Bioinformatics* 32.12 (2016), pp. i164–i173.

[12] Yungbum Jung, Soonho Kong, Cristina David, Bow-Yaw Wang, and Kwangkeun Yi. "Automatically inferring loop invariants via algorithmic learning". In: *Mathematical Structures in Computer Science* 25.4 (2015), pp. 892–915.

[13] Soonho Kong, Sicun Gao, Wei Chen, and Edmund Clarke. "dReach: Delta-Reachability Analysis for Hybrid Systems". In: *Tools and Algorithms for the Construction and Analysis of Systems*. TACAS'15. New York, NY, USA: Springer-Verlag New York, Inc., 2015, pp. 200–205.

[14] Bing Liu, Soonho Kong, Sicun Gao, Paolo Zuliani, and Edmund M. Clarke. "Towards Personalized Prostate Cancer Therapy Using Delta-reachability Analysis". In: *Hybrid Systems: Computation and Control*. HSCC'15. Seattle, Washington: ACM, 2015, pp. 227–232.

[15] Leonardo de Moura, Soonho Kong, Jeremy Avigad, Floris van Doorn, and Jakob von Raumer. "The Lean Theorem Prover (System Description)". In: *Automated Deduction*. Ed. by Amy P. Felty and Aart Middeldorp. CADE'15. Cham: Springer International Publishing, 2015, pp. 378–388.

[16] Qinsi Wang, Paolo Zuliani, Soonho Kong, Sicun Gao, and Edmund M. Clarke. "SReach: A Probabilistic Bounded Delta-Reachability Analyzer for Stochastic Hybrid Systems". In: *Computational Methods in Systems Biology*. Ed. by Olivier Roux and Jérémie Bourdon. CMSB'15. Cham: Springer International Publishing, 2015, pp. 15–27.

[17] Sicun Gao, Soonho Kong, and Edmund M. Clarke. "Proof Generation from Delta-Decisions". In: *Symbolic and Numeric Algorithms for Scientific Computing*. SYNASC'14. Sept. 2014, pp. 156–163.

[18] Bing Liu, Soonho Kong, Sicun Gao, Paolo Zuliani, and Edmund M. Clarke. "Parameter Synthesis for Cardiac Cell Hybrid Models Using δ-Decisions". In: *Computational Methods in Systems Biology*. Ed. by Pedro Mendes, Joseph O. Dada, and Kieran Smallbone. CMSB'14. Cham: Springer International Publishing, 2014, pp. 99–113.

[19] Sagar Chaki, Arie Gurfinkel, Soonho Kong, and Ofer Strichman. "Compositional Sequentialization of Periodic Programs". In: *Verification, Model Checking, and Abstract Interpretation*. VMCAI'13. Rome, Italy: Springer-Verlag New York, Inc., 2013, pp. 536–554.

[20] Sicun Gao, Soonho Kong, and Edmund M. Clarke. "dReal: An SMT Solver for Nonlinear Theories over the Reals". In: *Automated Deduction*. CADE'13. Lake Placid, NY: Springer-Verlag, 2013, pp. 208–214.

[21] Sicun Gao, Soonho Kong, and Edmund M. Clarke. "Satisfiability modulo ODEs". In: *Formal Methods in Computer-Aided Design*. FMCAD'13. 2013, pp. 105–112.

[22] Yungbum Jung, Soonho Kong, Bow-Yaw Wang, and Kwangkeun Yi. "Deriving Invariants by Algorithmic Learning, Decision Procedures, and Predicate Abstraction". In: *Verification, Model Checking, and Abstract Interpretation*. VMCAI'10. Madrid, Spain: Springer-Verlag, 2010, pp. 180–196.

[23] Soonho Kong, Yungbum Jung, Cristina David, Bow-Yaw Wang, and Kwangkeun Yi. "Automatically Inferring Quantified Loop Invariants by Algorithmic Learning from Simple Templates". In: *Asian Conference on Programming Languages and Systems*. APLAS'10. Shanghai, China: Springer-Verlag, 2010, pp. 328–343.

[24] Soonho Kong, Wontae Choi, and Kwangkeun Yi. "Abstract Parsing for Two-staged Languages with Concatenation". In: *Generative Programming and Component Engineering*. GPCE'09. Denver, Colorado, USA: ACM, 2009, pp. 109–116.

[25] Soonho Kong, Wontae Choi, and Kwangkeun Yi. "PCC Framework for Program-Generators". In: *Workshop on Proof-Carrying Code and Software Certification*. 2009.

[26] Soonho Kong, Nikolai Tillmann, and Jonathan de Halleux. "Automated Testing of Environment-Dependent Programs - A Case Study of Modeling the File System for Pex". In: *Information Technology: New Generations*. ITNG'09. Apr. 2009, pp. 758–762.

Patents

[1] "Wearable exoskeleton". Jonathan DeCastro, Soon Ho Kong, Nikos Gonzalez Arechiga, Frank Permenter, and Dennis Park United States Patent #11918535. March 2024.

[2] "Actively adapting to driving environments based on human interactions". Soonho Kong, Jonathan DeCastro, Nikos Arechiga, and Frank Permenter United States Patent #11801852. October 2023.

[3] "Certified control for self-driving cars". Daniel Jackson, Jonathan Decastro, Soon Ho Kong, Nikos Arechiga Gonzalez, Dimitrios Koutentakis, Feng Ping Angela Leong, Mike Meichang Wang, And Xin Zhang United States Patent #11745732. September 2023.

[4] "Predictive impairment monitor system and method". Nikos Gonzalez Arechiga, Soon Ho Kong, Jonathan DeCastro, Frank Permenter, and Dennis Park United States Patent #11518408. December 2022.

[5] "Predictive parking due to weather". Nikos Gonzalez Arechiga, Soon Ho Kong, Jonathan DeCastro, Frank Permenter, and Dennis Park United States Patent #11479239. October 2022.

[6] "Simulation-based Technique to Synthesize Controllers that Satisfy Signal Temporal Logic Specifications". Nikos Arechiga, Karen Y. Leung, Soon Ho Kong, Jonathan Decastro, and Frank Permenter United States Patent #11256611. February 2022.

[7] "System and Method for Detecting Errors and Improving Reliability of Perception Systems Using Logical Scaffolds". Nikos Arechiga, Soonho Kong, Jonathan DeCastro, Sagar Behere, and Dennis Park United States Patent #11157756. October 2021.

[8] "Actively Adapting To Driving Environments Based On Human Interactions". Soonho Kong, Jonathan DeCastro, Nikos Arechiga, and Frank Permenter United States Patent #11072342. July 2021.

[9] "Systems And Methods For Improving Situational Awareness Of A User". Jonathan DeCastro, Frank Permenter, Soonho Kong, and Nikos Arechiga United States Patent #10621858. April 2020.

Professional Activities

Program Committee Member:
ADHS 2021, HSCC 2021, MEMOCODE 2021, MT-CPS 2021, HSCC 2020, MEMOCODE 2020, DARS 2019, HSCC 2019, MEMOCODE 2019, NSV 2019, DARS 2018, WSC 2018

External Reviewer:
IEEE-IV 2021, IEEE-IV 2020, POPL 2020, ATVA 2015, ASE 2014, FoSSaCS 2013, POPL 2013, APLAS 2012, SAS 2012, GPCE 2010, SPLASH 2010, CAV 2010, VMCAI 2010, SAS 2009, DEFECTS 2009, APLAS 2007