Meriel von Stein

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EDUCATION

PhD Candidate of Computer Science (Software Engineering & Robotics) Charlottesville, VA | Ongoing
University of Virginia

BA Honours of Art History (Islamic Art & Architecture) Oberlin, OH | May 2014
Oberlin College

PUBLICATIONS

PHYSCOV: PHYSICAL TEST COVERAGE FOR AUTONOMOUS VEHICLES

Carl Hildebrandt, Meriel von Stein, Sebastian Elbaum
Under Submission.
Python, C++, ROS, Gazebo, automation, stochastic learning

Adequately covering autonomous vehicles' (AV) behavior is fundamental in their validation. However, quantifying such coverage is challenging as the AVs' behavior is influenced by large, complex physical environment(s). Data sensed by the AV provides a unique spatial signature of the environment inputs. Consequently, we introduce a new abstraction, *RSR*, and coverage metric, *PhysCov*. RSR integrates sensor readings with a physical reachability analysis to determine the input region that may affect the AV. It then characterizes that region through a parameterizable geometric approximation that can trade quality for cost. This paper applies *RSR* to generate *PhysCov* for two AV's running on two different simulators, and demonstrates *PhysCov*'s ability to quantify an AV's test suite coverage, and highlights its value in terms of its high-positive correlation with the number of vehicle crashes found.

BEYOND DNN SILO-TESTING: INTEGRATING AUTONOMOUS SYSTEM STATE

Meriel von Stein, David Shriver, Sebastian Elbaum
Under Submission.
Python, Lua, PyTorch, BeamNG, automation, adversarial testing

Adversarial testing tends to focus on DNNs in isolation, to the exclusion of the full system state and system behaviors resulting from sequences of DNN output. We propose a more holistic approach to DNN testing that accounts for the effects of perturbations on the system state. Our approach involves three key elements: 1) integration of simulator into the testing process to update state, 2) optimization of perturbation over time, and 3) fitting perturbations to sequences of inputs consistent over spatio-temporally ordered states. We illustrate the potential of our idea through adversarial perturbation of the physical environment of an autonomous vehicle.

PREPARING SOFTWARE ENGINEERS TO DEVELOP ROBOT SYSTEMS

Carl Hildebrandt, Meriel von Stein, Trey Woodlief, Sebastian Elbaum
ICSE 2022. Pittsburgh, PA, U.S.A.
Python, C++, ROS, STEM education theory, virtualized environments, simulation

Most undergraduates are not equipped to manage the unique challenges in developing software for modern robots, despite rapid expansion of the field. We here introduce a course we have designed and delivered to better prepare students to develop software for robot systems. It emphasizes the distinctive challenges of software development for robots paired with related software engineering techniques, it provides many opportunities for experiential learning across both disciplines, and it lowers the barriers for learning how to build robotic systems.

AUTOMATED ENVIRONMENT REDUCTION FOR DEBUGGING ROBOTIC SYSTEMS

Meriel von Stein, Sebastian Elbaum
ICRA 2021. Xi'an, China.
Python, C++, ROS, Gazebo, automation, stochastic learning

In this work we present the first automated approach for reducing the environment in which a robot failed. Similar to software debugging techniques, our approach systematically performs a partition of the environment space causing a failure, executes the robot in each partition containing a reduced environment, and further partitions reduced environments that still lead to a failure.

PROBABILISTIC CONDITIONAL SYSTEM INVARIANT GENERATION WITH BAYESIAN INFERENCE

Meriel von Stein, Sebastian Elbaum, Lu Feng, Shili Sheng
Available via Arxiv as of December 2020.

Python, Java, ROS, motion capture, automation, probabilistic analysis
Probabilistic invariants can encode a family of conditional patterns, are generated using Bayesian inference to leverage observed trace data against priors gleaned from previous experience and expert knowledge, and are ranked based on their surprise value and information content. Our studies on two semi-autonomous mobile robotic systems show how the proposed approach is able to generate valuable and previously hidden stateful invariants.

WORK EXPERIENCE

UNIVERSITY OF VIRGINIA | PhD Candidate — Charlottesville, VA | ongoing

- Research assistant
  - Joined program August 2018, qualified in March 2020.
  - **Project leader; State-aware adversarial testing of system-embedded DNNs.** Adversarial DNN testing does not take into account the spatiotemporal relationships between the system containing the DNN and the environment containing the input space. State can be incorporated into the perturbation process and constrain the direction and magnitude of perturbation according to system state.
  - **Project leader; spatial partitioning and prioritization for debugging robotic systems.** Environment configurations can expose faults in robotic systems, but can also complicate the output complexity. Test environments can be programatically reduced to produce the same failure and cut down on efforts to debug.
  - **Project leader; Bayesian invariants generation for robotics systems.** Robotic systems have many conditional invariants that become live only under certain states. Conditional invariants generated through statistical inference capture these substates for single and swarm robot systems.
- Teaching assistant:
  - Introduced project concepts for robotics-oriented software analysis.
  - Developed course materials: designed, coded, and taught 2 labs and final project, and supported co-TAs' work in **Robotics for Software Engineers**; ICSE education paper forthcoming.
  - Led office hours, graded, discussed syllabus adjustments, and came up with project suggestions for Software Analysis and **Introduction to Embedded Computer Systems**.

NASA GODDARD SPACE FLIGHT CENTER | Pathways Program — Greenbelt, MD | Aug 2017 – Aug 2018

- Develop, update & maintain GMSEC satellite ground system API and component code.
- Reconcile federal infosec requirements with implementation from a top-down/bottom-up approach.
- Support code reviews & evaluate software systems from a security assurance perspective.
- Interview stakeholders on current & projected implementation of NIST and internal security standards.

NASA KENNEDY SPACE CENTER | Software Engineer Intern — Cape Canaveral, FL | Dec 2016 – Aug 2017

- Build & test proof-of-concept Beowulf cluster for granular mechanics and robotics simulations.
- Provide in-house software support for SwampWorks robotics & UAV projects.
- Design & implement in-house lab network and secure teleconferencing platform.
- Develop and debug testing suites for various prototypes.
- Design, develop and debug automated testing software for a future launch control system.
- Write, fix and execute unit tests; participating in and facilitating code inspections.
- Maintain technical points of contact and report project progress from a matrix management environment.

UNIVERSITY OF NEBRASKA - LINCOLN | Cybersecurity Summer Research Fellow — Lincoln, NE | June 2016 – August 2016

- Ran static analysis on malicious Android apps using bash scripting, isolating data flows.
- Wrote C++ module for static analysis tool to handle Java 8 Reflection calls and represent them in Graphviz.
- Wrote colluding Android apps in Eclipse and Android Studio for sample runs of static analysis tool.
- Wrote scripts to analyze tool output via MySQL database & text parsing of application dexcode.
- Presented progress reports to supervising faculty & suggested follow-up courses of action.

PROJECTS

SUPERDEEPBILLBOARD — Python

Reproduce the technique outlined in **DeepBillboard** and improve upon it to leverage the kinematics of the vehicle and state of the test environment.

DDENV Python, Object-Oriented Design, ROS, Robotics, Simulation
End-to-end tool for delta-debugging robotic environments with a semi-known failure distribution.

BAYESIAN INFERENCE ENGINE FOR ROBOTICS HTML, Python, Bash, Java, CSS, Lex
Probabilistic inference engine for time series data traces.

GITHUB REPO SCRAPER FOR ROBOTIC SWARM PROJECTS Python
Scrape github for swarm projects that fit criteria for project maturity and centering around swarm control.

ROSBAG DATA CLEANING AND SPLINE INTERPOLATION Python
Find largest common subinterval among publish rates and interpolate values to populate subintervals by data type.

ACTIVITIES AND HONORS

CSGSG 2022 Mentoring Chair Help new students transition to graduate life through enriching mentoring program, organizing events, and assisting with orientation and prospective visits.
ICSE 2021 Organizing Volunteer Main conference organizing volunteer supporting paper presentation sessions.
FIRST Robotics Software Engineering Mentor Software mentor and software-hardware working group liason.
Million Woman Mentor Project, Software and Electrical Engineering mentor, grades 1 through 4.
Association for Computing Machinery (ACM) member Rowan chapter, App Development working group.
Contributor to An Efficient, Robust, and Scalable Approach for Analyzing Interacting Android Apps at University of Nebraska-Lincoln Paper accepted by 2017 ICSE conference
Panelist, thesis presenter at James A. Rawley Graduate Conference in the Humanities, University of Nebraska-Lincoln placed second overall for best undergraduate paper.
Recipient of Oberlin College Grant, John F. Oberlin Scholarship (2010-2014).

SKILLS

Languages: Java, Python, Bash, C/C++, SQL
Robotics/ML Frameworks: ROS, TensorFlow, PyTorch
Simulation Development: Gazebo, Unity, Blender, FlightGoggles, BeamNG, particle simulation
Spoken/Written Languages: English, Spanish, Turkish, French.
Other: Git/GitHub, MatLab, R, AutoCAD, VirtualBox, Docker, LaTeX, Gimp, JavaScript, TypeScript, HTML/CSS