Miguel A. Arroyo

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Education

Columbia University — *New York, NY*

PH.D IN COMPUTER SCIENCE — *PRESENT*

M.PHIL IN COMPUTER SCIENCE — *2016-2018*

M.S. IN COMPUTER ENGINEERING — *2014-2015*

B.S. IN COMPUTER ENGINEERING — *2009-2013*

Skills

SOFTWARE DEVELOPMENT

C/C++ · Python · Assembly (x86,ARM) · Java · Lua · Lisp · LaTeX | PIN · Clang+LLVM · Docker · Git · CMake/Make · GDB

FOREIGN LANGUAGES

Spanish (Native) · French (Advanced) · Japanese (Intermediate)

Publications

Stateless Permutation of Application Memory

ARXIV PRE-PRINT — *2020*

M. Tarek Ibn Ziad & *Miguel A. Arroyo*, Simha Sethumadhavan

Using Name Confusion to Enhance Security

ARXIV PRE-PRINT — *2020*

M. Tarek Ibn Ziad, *Miguel A. Arroyo*, Evgeny Manzhosov, Vasileios P. Kemerlis, Simha Sethumadhavan

Practical Byte-Granular Memory Blacklisting using Califorms — *Columbus, OH*

IEEE/ACM INTERNATIONAL SYMPOSIUM ON MICROARCHITECTURE (MICRO) - **IEEE MICRO TOP PICKS HONORABLE MENTION** — *2019*

Hiroshi Sasaki, *Miguel A. Arroyo*, M. Tarek Ibn Ziad, Koustubha Bhat, Kanad Sinha, Simha Sethumadhavan

YOLO: Frequently Resetting Cyber-Physical Systems for Security — *Baltimore, MD*

SPIE DEFENSE AND COMMERCIAL SENSING — *2019*

Miguel A. Arroyo, M. Tarek Ibn Ziad, Hidenori Kobayashi, Junfeng Yang, Simha Sethumadhavan

Experience

Columbia Computer Architecture and Security Technology Lab (CASTL) — *New York, NY*

RESEARCH ASSISTANT — *Aug. 2015 - PRESENT*

- Designed & implemented a comprehensive memory corruption defense as a LLVM/Clang compiler pass and runtime library that permutes program data by instrumenting loads and stores.
- Proposed a new architectural primitive implemented in gem5 and supported by a custom LLVM toolchain, which provides N-variant execution at near zero cost.
- Explored program behavior using the LLVM compiler framework and binary instrumentation tools to guide the design of a cache formatting scheme called *Califorms* to enhance security.
- Designed & implemented *YOLO*, a novel security defense leveraging inertia, using a combination of C/C++ and assembly at the real-time operating system (RTOS) level to provide resilient operation for CPS microcontrollers (eg. ARM Cortex-M series).

Intel — *Santa Clara, CA*

GRADUATE INTERN — *May 2019 - Aug. 2019*

- Performed headroom studies to aid the design of experimental hardware optimizations targeting multiple JIT engines (eg. Javascript V8, Java HotSpot) by instrumenting JIT engine source code to collect dynamic profile data using PIN.
- Investigated performance tradeoffs of various GPGPU programming languages (eg. OpenCL, SYCL, CUDA, CM) on Intel iGPUs to compare benefits of explicit vs implicit SIMD programming paradigms.

Ardupilot (Google Summer of Code) — *New York, NY*

DEVELOPER — *May 2017 - Aug. 2017*

- Worked with Ardupilot, an autonomous vehicle autopilot firmware, on designing & implementing an efficient low-latency (in the order of a few microseconds) protocol to manage transport of sensor data for various vehicle types.
- Extended low-level drivers and OS internals (in C++) for an ARM Cortex-M series microcontroller to integrate and process sensor data for load-balancing tasks in coordination with the main flight controller (ARM Cortex-A) improving battery usage and overall compute performance.

Amazon
Seattle, WA

Software Developer Engineer — *Jul. 2013 - Jan. 2015*

- Developed market specific features for the *checkout* and *detail* pages for India (amazon.in) marketplace.
- Architected and implemented Amazon Business Wholesale India (amazonbusiness.in) business management backend systems using Java & Spring involving the design of appropriate DB schemas (in Amazon RDS) & infrastructure organization (in AWS) to accomodate for large traffic volume.
- Designed infrastructure routing framework and migration for Quidsi platform using Java, Spring, & AWS.

Software Developer Engineer Intern — *Jun. 2012 - Aug. 2012*

- Implemented a performance metric monitoring system on FireOS (Kindle Android variant) using Java & Hadoop that allowed for development of key performance enhancements for Kindle FreeTime within FireOS.

Columbia Intrusion Detection Systems Lab
New York, NY

Research Assistant — *Aug. 2012 - May 2013*

- Found vulnerabilities in embedded system firmware from devices such as Cisco routers, VoIP phones, and firewalls using reverse engineering tools such as IDA Pro.
- Built database for processing and vetting firmware images for vulnerabilities using Python & MongoDB.

International Physics Olympiad (IPhO)
Hanoi, Vietnam

Team Leader — *Jul. 2008*

- Selected after a series of examinations to represent Puerto Rico at the International Physics Olympiad 2008, a competition that tests general physics knowledge.
- Attended one month training at Recinto Universitario de Mayaguez to prepare for competition.
- Competed at IPhO 2008 in Vietnam.

U.S. Department of Energy National Science Bowl
Washington, D.C.

Co-Captain — *Apr. 2008 - May 2008*

- Represented Saint John's School in Condado, PR at regional and statewide rounds.
- Acted as the team's spokesperson and solved issues in the event of disputes over questions during the competition.
- Trained in solving Physics and Chemistry questions of the competition.
- Won regional & statewide rounds and competed in National rounds in Washington D.C.

Awards

2017 **Scholar,** RSAC Security Scholar — *San Francisco, CA*

A nomination-based program for cybersecurity students to present their research to leading-experts at the RSA Conference.

2017 **Fellow,** Columbia SEAS Translational Fellowship — *New York, NY*

A competitive program that provides funding and mentorship to pursue commercialization of a technology originating from research.

Talks

A Look at Memory Safety
Santa Clara, CA

Silicon Valley Cyber Security Meetup — *May 2020*

YOLO: Frequently Reseting Cyber-Physical Systems for Security
New York, NY

Workshop on the Design and Analysis of Robust Systems (DARS) — *Jul. 2019*

Go Go Gadget! An Introduction to Return Oriented Programming
Santa Clara, CA

Silicon Valley Cyber Security Meetup — *Apr. 2019*

WACI: How To Make Driving Awesome
Williamsburg, VA

ACM Architectural Support for Programming Languages and Operating Systems (ASPLOS) — *Mar. 2018*

Writing

A Computer Architecture Solution to Fake News and Autonomous Car Accidents

ACM SIGGARCH — *Jun. 2018*

Patents

Stateless Permutation of Application Memory

Pending — *2020*

M. Tarek Ibn Ziad & Miguel A. Arroyo, Simha Sethumadhavan

Cache Line Formats for Fine-Grained Memory Safety

Pending — *2019*

Hiroshi Sasaki, Miguel A. Arroyo, M. Tarek Ibn Ziad, Simha Sethumadhavan

Secured Cyber-Physical Systems

US10417425 — *2016*

Miguel A. Arroyo, Simha Sethumadhavan, Jonathan Weisz