Patrick **Musau**

Graduate Research Assistant · Institute of Software Integrated Systems

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Education

Vanderbilt University — *Nashville, TN*

Ph.D. in Electrical Engineering — *Currently Enrolled*

Vanderbilt University — *Nashville, TN*

M.S in Electrical Engineering

Furman University — *Greenville, SC*

B.S. in Physics, and Computing and Applied Mathematics

Skills

Programming	Python, C, C++, MATLAB
Frameworks	NumPy, Pandas, OpenCV, Tensorflow, Keras
Web (Basic)	SQL, JQuery, HTML, Bootstrap, Javascript and CSS
Systems	Linux, Docker, Robotics Operating System, AWS (basic knowledge)
Languages	English, Swahili, French
Awards	$ 2300 NSF Microgrant Winner, Winner of 2020 36|86 Student Entrepreneurship Competition, DS4A Two Sigma Distinguished Scholar

Experience

The Verification and Validation for Intelligent and Trustworthy Autonomy Laboratory — *Nashville, TN*

Graduate Research Assistant — *July 2017- PRESENT*

- Research is primarily focused on the verification of artificial neural networks and AI inspired autonomous applications
- Developing a translation tool for neural network models into the Open Neural Network Exchange format (https://onnx.ai/) to assist verification researchers in translating between the various input formats for state of the art neural network verification tools.
- Involved in DARPA's Assured Autonomy project, that seeks to assure Learning enabled components in Autonomous Cyber-physical systems
- Participant in the F1Tenth Autonomous Racing Competition (f1tenth.org). Competed at CPS IOT Week in Montreal, Canada in April of 2019
- Participated twice in the 2018 and 2019 edition of the NSF CPS Challenge focused on autonomous drone applications

Open Robotics — *Remote*

Software Engineering Intern — *May 2021 - Aug 2021*

- Assisted with the ongoing ROS2 Migration and maintenance of ROS Perception pipeline packages.
- Ported Alvar AR Tracking library to ROS2.
- Helped design ROS2 shell architecture demo for the U.S.DOT CARMA Platform ROS2 Migration.

Correlation One, Data Science For All (DS4A) — *Remote*

Data Science Fellow — *October 2020 - Feb 2020*

- DS4A is a competitive, merit-based immersive 13-week program led by Natesh Pillai of Harvard University. The curriculum teaches data skills through real business cases, using actual datasets. The program is defined by a diverse network of professional mentors and highly talented peers.
- Program Partners include Soft Bank Group, Citadel Securities, Point72, Two Sigma, IHS Markit, Gilead, BlackRock, Accenture, and Marshall Wace

Projects

Run-time Assurance for Autonomous Systems

Research Project (github.com/pmusau17/rtreach_f1tenth)

- Created a runtime assurance architecture using real-time reachability techniques and a simplex regime.
- This regime ensures that a system will not collide with objects within its environment whilst utilizing a controller synthesized using AI and Machine Learning techniques
- Funded through the Assured Autonomy(AA) Project, Defense Advanced Research Projects Agency (DARPA)
- Framework's used: Robotic Operating System, Python, MATLAB, C, C++

F1/10 Autonomous Racing Competition

Research Project, (https://github.com/pmusau17/Platooning-F1Tenth)

- Built a 1/10 scale autonomous vehicle testbed equipped with a LIDAR, stereo camera, and inertial sensors
- Implemented numerous driving strategies involving Simultaneous Localization and Mapping, Path Planning, Reinforcement Learning, and End to End Learning
- Competed in five different international competitions over the last two years
- Development timeframe: March 2019-present
- Languages and Framework's used: Robotic Operating System, Python, C++, C
- https://youtu.be/fevOWV0qbu8

National Science Foundation CPS Challenge

Research Project, (github.com/verivital/VandyCPS)

- Goal of this challenge is to use a quadrotor aircraft with downward facing camera, and other sensors, to scan an area for a lost aircraft, and recover it safely back to base
- (https://youtu.be/D0zkDO46w_A)
- Platform used: the Intel® Aero Ready to Fly Drone
- Development timeframe: 2017-Present
- Languages and Framework's used: Robotic Operating System, Python, OpenCV, C++

Neural Network Verification Model Translation Tool

Software Tool, (github.com/verivital/nnvmt)

- Created a neural network model translation tool for interchange between neural network verification tools and related software tools, such as ONNX, PyTorch, Keras, Tensorflow
- Purpose of this tool was to address the lack of neural network model standardization among the various verification research software artifacts
- Written in Python 3

Selected Publications

Journal Articles

[J1] Weiming Xiang, Diego Manzanas Lopez, Patrick Musau, Taylor T. Johnson, "Reachable Set Estimation and Verification for Neural Network Models of Nonlinear Dynamic Systems", In (Huafeng Yu, Xin Li, Richard M. Murray, S. Ramesh, Claire J. Tomlin, eds.), Springer International Publishing, pp. 123–144, 2019

Conference Papers

[C1] Patrick Musau, Nathaniel Hamilton, Diego Manzanas Lopez, Preston Robinette, and Taylor T. Johnson, "Online Safety Assurance for Machine Learning Controllers with Real-Time Reachability", Submitted for Review to the ACM SIGBED International Conference on Embedded Systems (EMSOFT) at ESWeek 2021

[C2] Patrick Musau, Diego Manzanas Lopez, Nathaniel Hamilton, Taylor T Johnson, "Runtime Verification within Autonomous Racing ", Submitted for Review to the IEEE International Conference on Intelligent Robots and Systems 2021

[C3] Nathaniel Hamilton, Patrick Musau, Diego Manzanas Lopez, Taylor T Johnson, "Zero-Shot Policy Transfer in Autonomous Racing: Reinforcement Learning vs Imitation Learning", Submitted for Review to the IEEE International Conference on Intelligent Robots and Systems 2021

[C4] Hoang-Dung Tran, Diego Manzanas Lopez, Patrick Musau, Xiaodong Yang, Luan Viet Nguyen, Weiming Xiang, and Taylor T. Johnson, "Star-Based Reachability Analsysis for Deep Neural Networks", In 23rd International Symposisum on Formal Methods (FM'19) (, ed.), Springer International Publishing, 2019, October

[C5] Hoang-Dung Tran, Luan Viet Nguyen, Patrick Musau, Weiming Xiang, Taylor T. Johnson," Decentralized Real-Time Safety Verification for Distributed Cyber-Physical Systems", In Formal Techniques for Distributed Objects, Components, and Systems (FORTE'19) (Jorge A. Pérez, Nobuko Yoshida, eds.), Springer International Publishing, Cham, pp. 261–277, 2019, June.