







# Diego MANZANAS LOPEZ

## Graduate Research Assistant

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## EDUCATION

2017-Present PhD in Electrical Engineering, Vanderbilt University (4.00/4.00)  
2019 Machine Learning specialization, Coursera (*Certificate*)  
2013-2017 Bachelor of Science in Physics with a Math minor, Presbyterian College (3.97/4.00)

## SKILLS

**Prog. Languages** Python, MATLAB, Mathematica, Simulink, Racket  
**Frameworks & Tools** Docker, Git, PyTorch, Tensorflow, Keras, ONNX, Pandas, WebGME, Deep Learning Toolbox, System Identification Toolbox  
**Systems** Linux, Windows 10, AWS, Robotic Operating System (ROS)  
**Research** Machine Learning, Deep Learning, Cyber-Physical Systems (CPS), Formal Methods, Safe AI  
**Languages** Spanish, English

## EXPERIENCE

**Present** **Graduate Research Assistant | Institute for Software Integrated Systems, VANDERBILT UNIVERSITY, Nashville, TN, US**  
**August 2017** Working under the supervision of Taylor T. Johnshon (VeriVITAL)  
    > Collaborating in a DARPA project for assured autonomy of vehicles, where my work focuses on the identification of system dynamics.  
    > Verification and validation of these complex models and their controllers.  
    > Collaborate in various team projects regarding the forward reachability analysis and verification of neural networks.  
    > Developing a verification tool for feedforward neural networks and closed-loop systems with linear and non-linear dynamics with other members of the VeriVital group at Vanderbilt (nnv)  
    > Leading the development of a neural network transformation tool for several feedforward and convolutional neural network verification tools as well as some well-known deep learning frameworks such as TensorFlow.

**December 2016** **Undergraduate Research Assistant | Physics Department, PRESBYTERIAN COLLEGE, Clinton, SC, US**  
**January 2016** Worked under the supervision of Chad Rodekohr  
    > Studying the mathematical analysis of rope braiding  
    > Goal is to develop rope braiding as a science and reduce waste and money on braiding production.  
    > Main contribution is the formulation of the initial angle the yarns make with each other at the braiding formation point.

**May 2017** **Academic Tutor | Athletics Department, PRESBYTERIAN COLLEGE, Clinton, SC, US**  
**February 2016** Physics and Math Individual Sessions  
    > Provided individual academic support and guidance to fellow students in introductory courses.  
    > Developed personalised explanations of material to help improve comprehension where difficulty exists.  
Math Help Sessions  
    > Organized 2-hour sessions to help improve comprehension by doing examples of material covered in class.  
    > One-to-one help after to help students with their individual questions.

Summers '15-'17  
Dec '13-'16

### Tennis Coach, ESTUDIO TENIS COUDER, Spain

Overnight Tennis Camp Counselor and Tennis Coach (Villoria de Orbigo, Leon, Spain).

- > Coordinated junior tournaments around Spain for our top players.
- > Developed group tennis and fitness lessons for 60 to 80 children
- > Organized afternoon and night activities for children ages 7-16

Adult and Kids Tennis Coach (Madrid, Spain)

- > Travelled to tournaments and leagues in Madrid with small groups of junior tennis players (Ages 10-16)
- > Mentored and motivated athletes to work harder towards specific goals on and off the court.
- > Taught individual and group tennis lessons, developing interpersonal and leadership skills

## PROJECTS

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### DARPA ASSURED AUTONOMY

RESEARCH PROJECT

[DARPA AA project](#)

The overall goal of this project is to create technology and techniques for the assurance of learning enabled CPS, meaning any CPS that has any ML/AI components as part of the CPS. The focus of the projects is on the autonomous vehicle space, although the technology and techniques are anticipated to be transferable to other autonomous systems under minimal modifications. Both of the next two projects are funded by DARPA under the Assured Autonomy program.

[CPS](#) [System Identification](#) [Deep Learning](#) [Safe AI](#)

### F1/10 AUTONOMOUS CAR

COMPETITION

[F1tenth](#) [github.com/verivital/F1TenthVanderbilt](https://github.com/verivital/F1TenthVanderbilt)

We built a 1/10 scale autonomous vehicle equipped with a LIDAR, stereo camera, and inertial sensors to compete in the F1/10 Competition at CPSWeek in April 2018 at Montreal for the first time in school's history. Based on the sensors available and the track environment, we designed several algorithms and then chose one to compete the day of the competition. In contrast to other teams, our goal for this project is not to only create fast autonomous cars, but also safe and verified cars are our main concerns.

[ROS](#) [Python](#) [C++](#)

### NNV

SOFTWARE TOOL

[nnv description](#) [github.com/verivital/nnv](https://github.com/verivital/nnv)

NNV is a software verification tool which ultimate goal is to develop several neural network (NN) verification techniques. The first one is the verification of control systems with feedforward NN as controllers at Design Time as well as Run-time verification. Another area is the verification and robustness evaluation of convolutional neural networks (CNN), implemented in the VGG-16 and VGG-19 models, and of Recurrent Neural Networks (RNN).

[MATLAB](#) [Deep Learning Toolbox](#)

### NNVMT

SOFTWARE TOOL

[github.com/verivital/nnvmt](https://github.com/verivital/nnvmt)

NNVMT is a software tool built in Python which main goal is to translate neural networks (FNN and CNN) across multiple formats and frameworks such as MATLAB and Keras. With a special emphasis on neural network verification tools, we also support input formats of other research software such as Marabou, Sherlock, and more. As an ongoing project, we would like to include size reduction techniques of neural networks which goal is the deployment in physical devices for faster computation while preserving the accuracy of the model.

[Python](#) [TensorFlow](#) [PyTorch](#) [ONNX](#) [Keras](#)

### NSF CYBER-PHYSICAL SYSTEMS CHALLENGE

COMPETITION

[CPS Challenge](#) [github.com/verivital/VandyCPS](https://github.com/verivital/VandyCPS)

This is a competition funded by the NSF whose goal is to promote research in the area of autonomous drones. Specifically, the goal of this competition is to *autonomously* find a "lost" object in the desert of Tucson, AZ, pick the object up, drop it at the desired destination and land at the starting point. In this project, we used a commercial platform: Intel Aero Ready to Fly Drone, finishing in 3<sup>rd</sup> place.

[ROS](#) [Python](#) [C++](#) [OpenCV](#)

## PUBLICATIONS

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### REFEREED JOURNAL PAPERS

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

## REFEREED CONFERENCE PROCEEDINGS PAPERS

- FM '19** Hoang-Dung Tran, Patrick Musau, **Diego Manzanas Lopez**, Xiaodong Yang, Luan Viet Nguyen, Weiming Xiang, Taylor T. Johnson, "Star-Based Reachability Analysis for Deep Neural Networks", In 23rd International Symposium on Formal Methods (FM'19) (, ed.), Springer International Publishing, 2019, October. [\[pdf\]](#)
- EMSOFT '19** Hoang-Dung Tran, Feiyang Cei, **Diego Manzanas Lopez**, Taylor T. Johnson, Xenofon Koutsoukos, "Safety Verification of Cyber-Physical Systems with Reinforcement Learning Control", In ACM SIGBED International Conference on Embedded Software (EMSOFT'19), ACM, 2019, October. [\[pdf\]](#)

## REFEREED WORKSHOP PROCEEDINGS PAPERS

- FormaliSE '19** Hoang-Dung Tran, Patrick Musau, **Diego Manzanas Lopez**, Xiaodong Yang, Luan Viet Nguyen, Weiming Xiang, Taylor T. Johnson, "Parallelizable Reachability Analysis Algorithms for Feed-forward Neural Networks", In Proceedings of the 7th International Workshop on Formal Methods in Software Engineering (FormaliSE'19), IEEE Press, Piscataway, NJ, USA, pp. 31–40, 2019, May. [\[pdf\]](#)
- ARCH '19** **Diego Manzanas Lopez**, Patrick Musau, Hoang-Dung Tran, Taylor T. Johnson, "Verification of Closed-loop Systems with Neural Network Controllers", In ARCH19. 6th International Workshop on Applied Verification of Continuous and Hybrid Systems (Goran Frehse, Matthias Althoff, eds.), EasyChair, vol. 61, pp. 201–210, 2019, April. [\[pdf\]](#)
- ARCH '19** **Diego Manzanas Lopez**, Patrick Musau, Hoang-Dung Tran, Souradeep Dutta, Taylor J. Carpenter, Radoslav Ivanov, Taylor T. Johnson, "ARCH-COMP19 Category Report: Artificial Intelligence and Neural Network Control Systems (AINNCS) for Continuous and Hybrid Systems Plants", In ARCH19. 6th International Workshop on Applied Verification of Continuous and Hybrid Systems (Goran Frehse, Matthias Althoff, eds.), EasyChair, vol. 61, pp. 103–119, 2019, April. [\[pdf\]](#)
- ARCH '18** Patrick Musau, **Diego Manzanas Lopez**, Hoang-Dung Tran, Taylor T. Johnson, "Differential Algebraic Equations (DAEs) with Varying Index (Benchmark Proposal)", In 5th Applied Verification for Continuous and Hybrid Systems Workshop (ARCH), Oxford, UK, 2018, July. [\[pdf\]](#)

## ● HONORS, AWARDS AND AFFILIATIONS

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- 2019 Wond'ry Prelaunch Entrepreneur Program - \$2300 Microgrant Winner
- 2019 *International Conference on Computer-Aided Verification Week Travel Award*, Loris D'Antoni, New York, NY
- 2017 *Pi Mu Epsilon* (Mathematics), Presbyterian College, Clinton, SC
- 2017 *Society of Physics Students*, Presbyterian College, Clinton, SC
- 2016, 2017 *Scholar Athlete of the Year*, Big South Conference, Clinton, SC
- 2014 *Freshman of the Year*, Big South Conference, Clinton, SC
- 2012 *America International Student Scholarship*, America International, Madrid, Spain

## “ REFERENCES

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### Dr. Taylor T. Johnson

Advisor, VANDERBILT UNIVERSITY

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### Dr. Joel A. Rosenfield

Mentor, U. OF SOUTH FLORIDA

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### Dr. Chad L. Rodekohr

Advisor, PRESBYTERIAN COLLEGE

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