Josue N. Rivera

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EDUCATION

December 2024 **Doctor of Philosophy** | Purdue University
- **Program:** Aeronautics and Astronautics Engineering
- **Major:** Autonomy and Control | **Minor:** Aerospace Systems Design
- **Dissertation Title:** Multi-Scale Design and Control of Complex Advanced UAV Systems
- **Advisor:** Dr. Dengfeng Sun (Distributed autonomy and unmanned aerial vehicle systems)
- **Honors, Leaderships and Awards:**
  - *Purdue Doctoral Fellow*: Prestigious funded fellowship given for academic merit and inclusion.

2021 **Master of Science** | University of Massachusetts Dartmouth
- **Program:** Computer Science
- **Thesis Title:** Graph Induced Lifelong Learning through Features Similarities and Dissimilarities
- **Advisor:** Dr. Ming Shao (Geometric deep learning and machine learning)
- **Honors, Leaderships and Awards:**
  - *Departmental Service Award*: Award given for dedication to the department as a graduate staff.

2019 **Bachelor** | *Summa Cum Laude* | University of Massachusetts Dartmouth
- **Program:** Computer Science
- **Honors, Leaderships and Awards:**
  - *Endeavor Scholar*: Prestigious scholarship given for academic merit, leadership, and civic engagement.
  - *Newman Fellow*: Nationwide recognition given to change-makers and public problem-solvers.
  - *29 Who Shine Award Recipient*: Award given by the Dept. of Higher Education and state governor.
  - *University Civic Engagement Award Recipient*: Given to a student who made an impact on the campus.
  - *Chancellor's List*: Inducted into a list of students who have earned a GPA of 3.8 or higher.

2016 **Diploma** | *Valedictorian* | Lawrence High School (MST)

WORK EXPERIENCE

August 2021 – December 2024 **Graduate Research Assistant |** Purdue University
- Researching scalable routing algorithms for aerial cargo operations.
- Developing foundational optimal neural controllers and state estimator for dynamical systems.

August 2023 – May 2024 **Graduate Teaching Assistant |** Purdue University
- Graduate teaching assistant on courses covering control theory and optimization.

(a) May 2021 – August 2021
(b) May 2022 – August 2022 **Research Associate (Intern) |** Hewlett Packard Enterprise
- Large Scale Integrated Photonics Lab (LSIP) research associate intern at Hewlett Packard Labs
- Worked on the parallelization and physic-informed reinforcement learning methods for the automated generation of photonics grating coupler designs – nano-scale devices capable of redirecting electromagnetic waves.

- Additionally, developed automated tests and visualization techniques for the model's parameters and performance.

January 2020 – May 2021 **Graduate Teaching Assistant |** University of Massachusetts Dartmouth

- Graduate teaching assistant on a wide range of computer science courses including but not limited to theorical computer science and distributed systems.

May 2019 – August 2019 **Research Fellow |** University of Texas at Dallas

- Worked as a research fellow through the National Science Foundation Research Experiences for Undergraduate (REU) Program and under the supervision of Dr. Eric Wong.
- The team conducted a deep analysis on the reliability of various classical machine learning techniques, deep learning models and radiologists to provide empirical data that can either support or oppose the use of deep learning in critical situation where reliability is a priority.

September 2017 – May 2019 **Research Assistant |** University of Massachusetts Dartmouth

- Research assistant to Dr. Maoyuan Sun (Data visualization and human-centered ML)
- Worked on numerous projects including the NSF-supported research: Visualizing Data Relationships Across Multiple Views. The project investigated methods for displaying relationships in data.

PUBLICATION

Conference | *In Progress* **|** Adaptive Path Planning for Real-Time Restrictive Routing Potential Field (*first author*)

- Dynamic multi-resolution cell decompositions/meshing for real-time path planning in potential field. The method allows graph-based routing to adapt to obstacles changes and the inclusion of other active agents.
- Rivera, J. N., Sun, D. (2025). Adaptive Path Planning for Real-Time Restrictive Routing Potential Field. [Unpublished manuscript].

Conference | *In Progress* **|** Taylored Multi-Faceted Approach for Neural ODE & State Estimation (*first author*)

- Architecture for physics-informed neural networks that ensures initial condition when solving ODE and infers future state estimation of a dynamical system given a polynomial control strategy.
- Rivera, J. N. (2025). Taylored Multi-Faceted Approach for Neural ODE & State Estimation. [Unpublished manuscript].

PhD Dissertation | *In Progress* **|** Multi-Scale Design and Control of Complex Advanced Systems

- The problem of designing and operating complex systems at various scale is explored with a focus on Unmanned Aerial Vehicles (UAVs) network. In the first set of chapters, we explore at a large scale the design of infrastructure and algorithms for UAVs in aerial cargo delivery. In the final chapter, we present a novel machine learning model for controlling autonomous systems with customizable transient behavior.
- Rivera, J. N. (2024). *Multi-Scale Design and Control of Complex Advanced Systems*. Purdue University.

Journal | *Ready for Submission* **|** Receding Hamiltonian-Informed Control and State Estimation for Closed-Loop Dynamical Systems (*first author*) [*preprint available*]

- Neural controller trained using physics-informed neural networks and Pontryagin's maximum principle for optimal control. The generative explicit non-linear model predictive controller can infer future states of and optimal control for dynamical systems. It can also guarantee accurate dynamics in the state prediction for a subset of ODEs and adjust the transient characteristic of the system response.
- Rivera, J. N., & Sun, D. (2024). Receding Hamiltonian-Informed Optimal Neural Control and State Estimation for Closed-Loop Dynamical Systems. *arXiv preprint arXiv:2411.01297*. (preprint)

Research Poster | Adaptive Path Planning for UAVs in Real-Time Restrictive Routing Potential Field (*presenter*)

- Presented the results of applying our adaptive routing algorithm at a large scale for cargo delivery UAVs in Austin, TX. Demonstrated how our method can ensure a variable safety distance from restrictions and add or remove obstacles from consideration adaptively.
- Rivera, J. N. (2024). *Adaptive Path Planning for UAVs in Real-Time Restrictive Routing Potential Field* [Poster Presentation]. NASA ULI Annual Meeting 2024, West Lafayette, IN, USA.

Conference | *Ready for Submission* **|** Multi-Scale Cell Decomposition for Path Planning using Restrictive Routing Potential Fields (*first author*) [*preprint available*]

- Meshing algorithm that capitalizes on the format of a potential field-based restriction map. Through a series of multi-scale cell decompositions, optimized graph formations, and dual objective path planning, the framework can efficiently compute routing solutions that ensure variable safe distance from obstacles. Our method was applied to generate aerial routes for UAVs in Austin, TX that demonstrate quantifiable safety from obstacles.
- Rivera, J. N., & Sun, D. (2024). Multi-Scale Cell Decomposition for Path Planning using Restrictive Routing Potential Fields. *arXiv preprint arXiv:2408.02786*. (preprint)

Conference | Air Traffic Management for Collaborative Routing of Unmanned Aerial Vehicles via Potential Fields | ICRAT 2024 (*first author*)

- The research introduces a format for defining routing restrictions for Unmanned Aircraft System Traffic Management (UTM) using the concept of repulsive potential fields. Furthermore, we propose a scalable UTM infrastructure for collaborative routing by independent shareholders and provide a demonstration of how it can be used.
- Rivera, J. N., & Sun, D. (2024). Air Traffic Management for Collaborative Routing of Unmanned Aerial Vehicles via Potential Fields. In *Proceedings of the 11th International Conference on Research in Air Transportation (ICRAT)*, Singapore, Singapore. (link)

Master Thesis | Graph Induced Lifelong Learning through Features Similarities and Dissimilarities

- A graph neural network model (LIGN) and technique developed for lifelong learning tasks based on comparing similarities and differences between known and unknown data in extracted features representation. These can be used to recognize known classes and identify new ones.
- Rivera, J. N. (2021). *Graph induced lifelong learning through features similarities and dissimilarities: a thesis in Computer Science*. University of Massachusetts Dartmouth. (link)

Book Chapter & Conference | An Educational Tool for Exploring the Pumping Lemma Property for Regular Languages (*first author*)

- The research introduces an active learning tool (MIPU) that was designed to explore the pumping lemma property for regular languages and build an intuitive understanding for determining irregular languages.
- Rivera, J. N., & Xu, H. (2021). An Educational Tool for Exploring the Pumping Lemma Property for Regular Languages. In: Arabnia, H.R., Deligiannidis, L., Tinetti, F.G., Tran, QN. (eds) Advances in Software Engineering, Education, and e-Learning. Transactions on Computational Science and Computational Intelligence. Springer, Cham.
- Rivera, J. N., & Xu, H. (2020). An Educational Tool for Exploring the Pumping Lemma Property of Regular Languages. In *Proceedings of the 16th International Conference on Frontiers in Education: Computer Science and Computer Engineering (FECS'20)*, Las Vegas, Nevada, USA. (link)

Research Poster | A Comparison of the Reliability between Traditional Machine Learning Techniques and Deep Learning in the Classification of Breast Cancer (*presenter*)

- Presented the research completed during my residency at University of Texas at Dallas, a deep analysis on the reliability of machine learning models and their roles in critical scenarios.
- Rivera, J. N., Richard, J., and Ramirez. R. (2019). *A Comparison of the Reliability between Traditional Machine Learning Techniques and Deep Learning in the Classification of Breast Cancer* [Poster Presentation]. Research Experiences for Undergraduates Symposium (REUS) 2019, Alexandria, VA, USA.

TECHNICAL PROJECT

2023 – Present **Path Planning Package |** Last-Mile Restrictive Path Planning (Larp) (link)
- Larp is an open-source Python package and framework that facilitates path planning in any space represented by a restrictive routing potential field. It allows for the implementation of custom path planning algorithms, cell decomposition or meshing methods, and the extraction of additional information, such as the closest obstacles and the gradient of the field at any given point.

2022 – Present **Neural Controller |** Hamiltonian-Informed Optimal Neural (Hion) Controller
- Hion controllers are a class of deep learning models that learn optimal control strategies for dynamical systems (i.e., driven by ordinary differential equations). Our framework integrates Pontryagin's maximum principles and the control Hamiltonian into a ML model learning process using PyTorch to generate a set of optimal control inputs and estimated future states for a receding horizon.

2022 – 2023 **UTM Platform |** Last-Mile Aerial Routing (LAR) (link)
- LAR is a full stack platform consisting of a NoSQL database (MongoDB), a backend server (Flask/Python), and a frontend website (React). The platform is part of a NASA's sponsored project to provide foundational algorithms for aerial cargo deliveries feasible at scale.

2022 **Flight Controller |** Quadcopter LQG controller
- Developed a linear–quadratic–gaussian (LQG) flight controller for quadcopters. Under simulation, the controller withstood gaussian disturbance on its state and output vectors.

2019 – 2021 **Machine Learning Framework |** Lign (link)
- An extension to PyTorch to aid with geometric deep learning.

2020 **Machine Learning Model |** Predictive Interpolation of Frames (PIF) Model (link)
- Generative Adversarial Neural Network (GAN) to interpolate in-between frames in videos.

2020 **Database System |** SQL Database Engine (link)
- Custom database engine to process common SQL queries and apply optimization techniques.

2020 **Web Development |** Personal Website (link)
- Individually developed personal portfolio website.

2018 – 2019 **Capstone Project |** 3D Geometry Foot
- Classical algorithm for estimating 3D reconstruction of feet for shoemaking.

2018 **Intellivision (1979) Game |** Runner-Z (link)
- Designed and developed a portable working video game for the Intellivision console of 1979.
- Published in intellivisionrevolution.com.

TEACHING EXPERIENCE

2024 **Graduate Teaching Assistant**, AAE 364: Control System Analysis, Purdue University, West Lafayette, IN.

2023 **Graduate Teaching Assistant**, AAE 550: Multidisciplinary Design Optimization, Purdue University, West Lafayette, IN.

2021 **Graduate Teaching Assistant**, CIS 481: Parallel and Distributed Software Systems, University of Massachusetts Dartmouth, North Dartmouth, MA.

2021 **Graduate Teaching Assistant**, CIS 180: Object-Oriented Programming I, University of Massachusetts Dartmouth, North Dartmouth, MA.

2020 **Graduate Teaching Assistant**, CIS 570: Advanced Computer Systems, University of Massachusetts Dartmouth, North Dartmouth, MA.

2020 **Graduate Teaching Assistant**, CIS 560: Theoretical Computer Science, University of Massachusetts Dartmouth, North Dartmouth, MA.

TECHINICAL SKILL

Mathematics:

- Linear algebra; Differential equations; Probability; Discrete mathematics; Vector calculus.

Control Theory and Optimization:

- Kalman filters; Proportional–integral–derivative (PID) controller; Linear–quadratic regulator (LQR); Model predictive control.
- Convex optimization; Gradient-based optimization; Generic algorithm; Linear programming.

Machine Learning:

- Physics-informed neural network; Generative adversarial network (GAN); deep learning.
- PyTorch; JAX; Keras; Scikit-learn; PyTorch Geometric.

Programming Languages and Framework:

- Python; MATLAB; Java; C; HTML; CSS; JavaScript; React; R; BASIC; SQL; NoSQL.
- **Familiar:** C++; Julia; PHP; jQuery; Bootstrap.

Operating and Embedded Systems:

- Multi-threading; Multi-processing; Distributed processing; HTTPS; SSH.
- Linux; Ubuntu; Arduino; ESP-32; Raspberry PI.

Software and Tools:

- Git; VSCode; Blender 3D; Godot; FreeCAD; Eclipse; OpenCV.
- **Familiar:** Android Studio; Unity 3D; Resolve; SolidWorks.

Languages:

- Spanish; English.
- **Familiar:** Portuguese.

Other skills:

- Photography; 3D printing; Vector art; Scrum.

LEADERSHIP EXPERIENCE

Present **Reviewer** | ACC, T-ITS, CDC, JAIR
- Reviewer for papers on the topics of machine learning, air transportation, and deep learning

2023 – 2024 **Senator** | Purdue Graduate Student Government (PGSG)
- Senator for the School of Aeronautics and Astronautics Engineering.
- Member of the community committee.

2023 – 2024 **Representative** | AeroAssist: Department Student Organization
- Represented the School of Aeronautics and Astronautics Engineering's graduate student body at the university scale, including PGSG.

2018 – 2020 **Treasurer** | UMass Dartmouth Big Data Club

2017 – 2020 **President** | UMass Dartmouth Animation Club

2017 – 2020 **Delegate** | UMass Dartmouth Model United Nations

2017 – 2020 **Representative** | Leduc Center for Civic Engagement

2017 – 2019 **Senator** | UMass Dartmouth Student Government Association

COMMUNITY SERVICE EXPERIENCE

2023 **Mentor |** PACE
- Mentored student working on machine learning project to detect Arrhythmia from ECG.

2019 – 2020 **Computer Science Mentor** | CIS Department - UMass Dartmouth

2016 – 2020 **Volunteer Leader |** Leduc Center for Civic Engagement

2016 – 2020 **Volunteer** | Food Pantry: Arnie's Cupboard

2016 – 2019 **STEM Teacher Volunteer** | Fall River YMCA