

# Josue N. Rivera

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## INTERESTS

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Machine learning; control theory; autonomy; geometric deep learning; optimization; physics-informed neural networks; theoretical computing; applied and computational engineering; robotics; embedded systems; photonics.

## EDUCATION

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- Doctor of Philosophy** | Purdue University 2025
- **Program:** Aeronautics and Astronautics Engineering
  - **Major:** Autonomy and Control | **Minor:** Aerospace 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
- Master of Science** | University of Massachusetts Dartmouth 2021
- **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 computer science department as a staff
- Bachelor** | *Summa Cum Laude* | University of Massachusetts Dartmouth 2019
- **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
- Diploma** | Lawrence High School (MST) 2016
- **Honors, Leaderships and Awards:** *Valedictorian; L' Pin Award Recipient*

## PROFESSIONAL EXPERIENCE

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- Graduate Research Assistant** | Purdue University August 2021 – Present
- Research assistant to Dr. Dengfeng Sun
  - Researching machine learning-based optimal controller and scalable aerial cargo operations with Dr. Sun
  - Developing a data-free Hamiltonian-informed optimal neural controller for non-linear dynamical systems
- Research Associate (Intern)** | Hewlett Packard Enterprise May 2022 – August 2022
- Summer Large Scale Integrated Photonics Lab research associate intern at Hewlett Packard Labs
  - Worked on the parallelization and reinforcement learning methods for the automated generation of photonics grating coupler designs – nano-scale devices capable of redirecting electromagnetic waves.
  - Developed automated tests and visualization techniques for the model's parameters and performance.
- Graduate Teaching Assistant** | University of Massachusetts Dartmouth January 2020 – May 2021
- Former TA & grader for the courses: Data Structures and Fundamental Algorithms, Theoretical Computer Science, Object-Oriented Programming I, Parallel and Distributed Software Systems, and Advance Computer Systems.
- Research Fellow** | University of Texas at Dallas May 2019 – August 2019
- Worked as a research fellow at the University of Texas at Dallas 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.

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

- 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 across multiple visualizations.

## PUBLICATION

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**Conference** | *Draft* | Rapid Physics-Informed Model Predictive Control Approximation via Deep Learning for Stable Quadcopter Descent

- A physics-informed surrogate model for MPC quadcopter landing controllers capable of producing responses to a non-linear system roughly twice as often as an MPC. It also presents a novel integration of Lyapunov's second method into the surrogate neural network learning process to encourage asymptotic stability for in- and out-of-distribution system states.

**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.

**Book Chapter & Conference** | An Educational Tool for Exploring the Pumping Lemma Property for Regular Languages | FECS 2020 (*first author*)

- The research paper 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.

**Research Poster** | A Comparison of the Reliability between Traditional Machine Learning Techniques and Deep Learning in the Classification of Breast Cancer | REUS 2019

- 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.

## TECHNICAL EXPERIENCE\*

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**Optimal Neural Network Controller** | Hion August 2022 – Present

- Hamiltonian-Informed optimal neural (Hion) controller is a deep learning model that learns an optimal control strategy for a data-free system described by an ODE. The method seeks to integrate the necessary conditions of Pontryagin's maximum principle and the control Hamiltonian into the model learning process to generate a set of optimal control inputs and estimated future states for a moving horizon.

**Deep Learning Framework** | Lign August 2019 – May 2021

- An extension to PyTorch to aid with graph neural network construction, geometric deep learning, and other graph-based machine learning algorithms.

**Neural Network Model** | Predictive Frame Interpolation (PIF) Model January 2020 – May 2020

- Designed an autoencoder convolutional neural network that can generate in-between frames of a given video thus increasing the frame rate. During the research, a high definition 25 fps video was increased to 50 fps without loss in resolution, reduced length of video or noticeable distortions.

**Database System** | SQL Database Engine January 2020 – May 2020

- Developed a custom database engine that can process common SQL queries and apply standard optimization techniques like projection pushdown, selection pushdown & cross product to join conversion.

**Capstone Project** | 3D Geometry Foot September 2018 – May 2019

- Prototyped a classical machine learning algorithm for a start-up that can reconstruct 3D models of human feet from images and find their measurements for footwear designs.
- The project *3D Geometry Foot* consisted of a smartphone application that can scan and send data (images, phone rotation, etc.) to a server where the algorithm tries to reconstruct a model of the individual's feet.

**Video Game Development** | Runner-Z January 2018 – May 2018

- Designed a video game for the Intellivision console of 1979.

For more information, visit <https://josuenrivera.site>

- The game incorporated modern game design concepts while working with the limitation of the hardware.
- The game was completely written in BASIC with some Assembly for data management efficiency.

## TECHNICAL SKILL

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### Programming Languages, Libraries and Others:

- Fluent: *Python*; C; Java; HTML; CSS; JavaScript; React; Node.js; R; MATLAB; BASIC; SQL; Git; JSON; XML; OpenCV; *PyTorch*; *PyTorch Geometric*; *TensorFlow*; *Keras*; Unix; Linux; REST API.
- Familiar: C++; Julia; JAX; PHP; jQuery; Bootstrap; Docker.

### Software and Tools:

- Fluent: Github; VSCode; Blender 3D; Arduino; ESP-32; Raspberry PI; Godot; Adobe; FreeCAD; CAD; 3D Printing.
- Familiar: Android Studio; Tizen Studio; Unity 3D; Resolve; SolidWorks.

### Software Development Frameworks:

- Fluent: Scrum; Agile Development; UML; Unit Testing.
- Familiar: Integration Testing.

### Languages:

- Fluent: Spanish; English.

## CIVIC ENGAGEMENT EXPERIENCE

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**Mentor** | Purdue Engineering GradTrack – Purdue University August 2022 – Present

- Mentored prospective students wishing to start graduate school or research opportunities after undergraduate school

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

- Volunteered to mentor/tutor undergraduate students in a wide range of computer science courses.

**Leduc Leader** | Leduc Center for Civic Engagement September 2016 – May 2020

- Conducted and led community service events that got students involved civically in their community.
- Involved in community service activities weekly during the 2018-2019 academic year.
- Spoke on the importance of community service and the benefits of volunteerism to college and high school students

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

- Helped provide food to students, staff, faculty, and community members in need at the university.

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

- Taught the STEM class that involved computer programming, physics, engineering, and robotics.
- One of the main projects consisted of a car that uses the energy stored in a mouse trap to move itself.

## HOBBIES

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### Pool/Billiards

- Amateur billiards player
- Winner of the 2018 Pool Tournament at UMass Dartmouth

### Robotics/Electronics

- Former member and programming leader of FIRST Robotic Team 1289.
- Former referee for FIRST Lego Robotic Competition.
- Taught classes on electronics, robotics, and Arduino to high and middle schoolers.
- Build PCs, robots, and automated systems on my spare time.
- Currently developing an automated indoor garden with Wi-Fi connectivity and monitoring system.

### Web Design

- Developed various website using technology such as WebGL, HTML 5, CSS3, Bootstrap, etc.
- Designed the former website for FIRST Robotic Team 1289, my personal site, and various other pages.

### Painting/Drawing

- Amateur artist
- Background in acrylic painting.
- Mostly work with digital art.

## **Game Design**

- Created RunnerZ for the Intellivision console, a web based interactive version of the popular math game Nim, Space invader inspired web game and several others in my spare time.
- Some experience with game engines such as Unity3D, Godot, Roblox Studio and WebGL.