

# Jacob Mantooth

SouthBend, IN | [LinkedIn](#) | 1-(405)756-7226 | [jmantoot@nd.edu](mailto:jmantoot@nd.edu)

## EDUCATION

### University of Notre Dame

Aug. 2023 - Dec. 2024

*Master of Science in Applied and Computational Mathematics and Statistics*

*South Bend, IN*

- **Relevant Coursework** : Nonlinear and Stochastic Optimization, Finite Element Analysis, Numerical Analysis I & II, Data Visualization, and Finite Elements in Engineering

### East Central University

Aug. 2019 - May. 2023

*Bachelor of Science in Mathematics and Physics, Minor in Computer Science*

*Ada, OK*

- **Relevant Coursework** : Data Structures and Algorithms, C++ Programming I & II, Thermodynamics, Quantum Mechanics, Real Analysis, Discrete Mathematics and Differential Equations

## EXPERIENCE

### University of Notre Dame

Aug. 2023 – Present

*Graduate Research Assistant in Mathematical Biology and Stochastic Modeling*

*South Bend, IN*

- Contributed to the publication of a comprehensive theory on Mean First Passage Time (MFPT), providing new insight into transport equations and their applications in biological and ecological systems
- Developed and validated stochastic simulation models in MATLAB, achieving 99% accuracy when compared to Finite Element Method (FEM) predictions implemented in Python and FreeFem-++
- Conducted theoretical research on the homogenization of anisotropic transport processes, deriving 1D and 2D homogenized equations for velocity jump processes in crowded domains
- Applied Physics-Informed Neural Networks using TensorFlow to solve MFPT model, achieving an  $L_2$  error of  $10^{-5}$

*Finite Element Modeling and Structural Analysis Researcher*

May. 2023 – Aug. 2023

- Created custom Python code for structural displacement modeling, including defining element geometry, calculating shape functions, performing coordinate transformations, and assembling stiffness matrices
- Focused on enhancing computational efficiency in large-scale structural problems by integrating encoder-decoder models, reducing computation time
- Pioneered novel techniques for reconstructing the original unstressed state of a structure using only stressed-state data, eliminating the need for prior structural knowledge

### NASA

Jun. 2021 – Dec. 2022

*Machine Learning and Optimal Control Researcher*

*Hybrid*

- Developed a highly accurate deep learning model in TensorFlow for handwritten digit classification using the MNIST dataset, achieving 98% accuracy
- Implemented Neural Networks using Tensor Flow to simulate a Two-Burn Orbit Raise System
- Explored methods for solving the Boltzmann equation for monoatomic particles, Investigated the potential of Edgeworth series expansions to surpass traditional Hermite methods in both accuracy and computational efficiency

### Emory University

May. 2022 – Aug. 2022

*Machine Learning and Optimal Control Researcher*

*Atlanta, Georgia*

- Conducted a comparative analysis of three methods for solving the Continuous Mountain Car problem using both PyTorch, evaluating their performance and computational efficiency
- Applied the Hamilton-Jacobi-Bellman (HJB) equation to train a neural network for value function approximation, significantly improving solution accuracy
- Investigated the trade-offs between data-driven reinforcement learning methods and model-driven optimal control methods, providing new insights into their respective strengths and weaknesses

### University of Oklahoma Health Sciences Center

Apr. 2020 – Dec. 2020

*Data Analyst*

*Norman, OK*

- Performed in-depth analysis of Google travel data to identify correlations between regional travel behaviors and Covid-19 transmission rates, offering valuable insights into pandemic spread and control strategies
- Designed, developed, and deployed interactive models to visually track and illustrate the impact of Covid-19 on U.S. travel patterns, enabling real-time data-driven decision-making for public health interventions
- Presented findings to health officials, translating complex data into actionable insights for community-level response planning

## PROJECTS

---

### **Image Detection Using Convolutional Neural Networks | Python**

- Developed a machine learning model using convolutional neural networks (CNNs) that is able to detect and classify sign language gestures
- Optimized the model architecture, reducing inference time, significantly improving real-time gesture recognition capabilities

### **Predator-Prey Non-Linear System | Matlab**

- Developed temporal/spatial discretization methods to solve a non-linear system for governing predator-prey dynamics
- Analyzed the stability and accuracy of the discretization schemes, ensuring reliable predictions of population behaviors under various conditions

### **Machine Learning on Games | Python**

- Developed multiple reinforcement learning models tailored to various game environments, analyzing performance across continuous, single-discrete, and multi-discrete action spaces to assess model robustness and adaptability
- Conceptualized and implemented three unique game simulations to comprehensively evaluate the efficiency and effectiveness of RL algorithms under diverse environmental conditions

### **Operational Efficiency Optimization | Python, R**

- Collaborated with Cantrell Jackson to assess and streamline operational workflows, focusing on maximizing efficiency and resource utilization
- Designed and implemented optimized truck routing and scheduling algorithms, resulting in a 10% increase in company profits through improved logistics management

## LEADERSHIP EXPERIENCE

---

### **Graduate Teaching Assistant**

Aug. 2023 – Dec. 2024

- Provided one-on-one tutoring sessions, addressed students' questions during office hours, and graded assignments to ensure comprehension and course progress
- Collaborated with professors to develop problem sets and exam questions that accurately reflected course material and learning objectives

### **Teaching Assistant**

Aug. 2021 – Jan. 2022

- Guided students through physics experiments, ensuring accurate execution of lab procedures and a deep understanding of experimental techniques
- Provided clear explanations of theoretical concepts, bridging the gap between practical experiments and underlying physics principles
- Assisted in grading lab reports and offered feedback to help students improve their scientific writing and data analysis skills

**Leadership Roles:** President of SIAM (Society for Industrial and Applied Mathematics), President of AMS (American Mathematical Society), McNair Fellow, NASA Fellow, LSAMP Fellow (Louis Stokes Alliances for Minority Participation)

## ADDITIONAL

---

**Programming Languages:** Python, MATLAB, C/C++, HTML/CSS, R, FreeFem++, Excel

**Awards:** 1st Place at Emory Poster Symposium, 2nd Place at MMA Conference, Dean List, President List, Cum laude

**Interest:** Rock Climbing, Cycling, Web Site Design, Baking, Fishing