

# Atharva Aalok

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## EDUCATION

### Stanford University

- Master of Science, Aeronautical and Astronautical Engineering

Graduation Date: June 2026

GPA: 4.07/4.0

### Indian Institute of Technology (IIT), Madras

- Bachelor of Technology, Aerospace Engineering
- Department Rank: 1/58
- Awards: Hindustan Aeronautics Limited (HAL) Prize, Institute Silver Medal

Graduation Date: May 2023

CGPA: 9.38/10

## PUBLICATIONS

**Atharva Aalok**, Juan Alonso, “NIGnets: Neural Injective Geometry Networks for Representing non-self-intersecting Geometry”, **Manuscript in preparation**. [Link](#)

Jiayi Zhou\*, **Atharva Aalok\***, Valentin Duruisseaux, Xinyi Li, Juan Alonso, Anima Anandkumar. “Robust Shape Optimization with Neural Shape Representations and Neural Operators”. **Manuscript in preparation**.

**Atharva Aalok**, Juan Alonso. “Robust Aerodynamic Shape Optimization via Deep Reinforcement Learning with Non-Self-Intersecting Geometry Networks”. **Manuscript in preparation**. [Link](#)

**Atharva Aalok**, Induja Pavithran, R.I. Sujith. “Breaking points of Early Warning Signals: Robustness in Rate-delayed tipping regime”. **Accepted in Conference on Nonlinear Systems and Dynamics**.

## RESEARCH EXPERIENCE

### Robust ML based Shape Optimization

Nov 2024 - Present

*Prof. Juan J. Alonso (Stanford), Collaborator: Prof. Anima Anandkumar (Caltech)*

- Robust shape optimization using Neural Operators (FNOGNO, GINO, BNO) with geometry represented using NIGnets and NeuralODEs to prevent self-intersection and optimization over in-distribution shapes.
- Generated Euler and RANS datasets with ~20,000 simulations each using SU2 for 1500 airfoils at 16 different angles of attack. Trained Neural Operators to 2% accuracy on pressure field and skin-friction predictions.
- Trained a NeuralODE based generative geometry model with hard guarantees on non-self-intersection. Achieved extremely accurate shape reconstruction loss of 1e-8 L2 on the entire shape dataset.
- Manuscript in preparation.

### NIGnets: Neural Injective Geometry Networks

Sept 2024 - Present

*Prof. Juan J. Alonso, Aerospace Design Lab, Stanford University*

- Developed a new neural architecture that gives a hard guarantee on representing only non-self-intersecting geometry.
- Utilized monotonic networks for expressivity, replacing activation functions, while maintaining injectivity.
- Developed the concept of Pre-Auxilliary networks to allow NIGnets to work as generative models, parameterizing non-self-intersecting shapes using latent vectors.
- Manuscript in preparation. [Paper](#), [Github](#), [Website](#), [Presentation](#)

### Shape Optimization using Deep Reinforcement Learning

March 2025 - Present

*Prof. Juan J. Alonso (Stanford), Collaborator: Prof. Elie Hachem (CEMEEF Mines Paris - PSL)*

- Used NIGnets and NICE as our geometry representation to reduce the design space that agents search through by avoiding unphysical (self-intersecting) shapes.
- Trained PPO and AAC based agents to maximize L/D ratio using Xfoil as flow solver. Used Hindsight Experience Replay to improve sample efficiency as well as design for a specified L/D ratio.
- Achieved L/D ratios upto 61.64 and trained policies to design for specified L/D ratios. [Paper](#), [Github](#)

## DATASETS

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### RANS - Subsonic

*Prof. Juan J. Alonso, Stanford University*

June 2025 - Present

- ~250,000 RANS simulations of 1500 UIUC airfoils at 16 different angles of attack from Mach 0.01-0.5.
- CFD using SU2 with meshing done in Gmsh. Computations done on the Stanford HPC cluster.
- Expansion and curation in-progress. Dataset on [Google Cloud](#).

## TEACHING EXPERIENCE

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### AA141 - Atmospheric Flight (Aircraft Conceptual Design)

*Prof. Juan J. Alonso, Stanford University*

April - June 2025

- Held weekly office hours to clarify concepts and assist students with coursework.
- Graded assignments and provided feedback to support student learning.

## UNDERGRADUATE RESEARCH EXPERIENCE

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### Design of Jet Based UAVs with Thrust Vectoring

*Prof. S. Sundaram, Artificial Intelligence and Robotics Lab, IISc Bangalore*

May 2022 - Jan 2023

- Designing a high altitude (5000m+) jet based UAV with 50kg payload capacity and STOL capabilities.

#### Phase 2

- Worked towards building a prototype vehicle as proof of concept of a novel 2-DOF thrust vectoring mechanism.
- Design: [Prototype](#).

#### Phase 1

- Modelled a 3-DOF thrust stand and fabricated through laser cutting, CNC machining, milling and 3D printing. Chose and calibrated temperature, pressure and force sensors and set up data acquisition. Handled purchase worth over 10 Lakh (\$12k).

### Robustness of Early Warning Signals

*Prof. R.I. Sujith, Sujith's Lab, IIT Madras*

June 2021 - November 2022

- Rigorously studied the behavior of Early Warning Signals (EWSs) for a 3<sup>rd</sup> order non-autonomous power system model. Discovered emergence of rate-induced tipping in our system. Studied EWS for predicting rate-delayed and rate-induced tipping.
- Accepted in Conference on Nonlinear Systems and Dynamics.

### Analytical Investigations in Rate-Induced Tipping – Bachelor's Thesis

*Prof. R.I. Sujith, Sujith's Lab, IIT Madras*

August 2022 - June 2023

- Derived a theoretical result governing the relative motion between the system state and its fixed points in phase space for a general non-autonomous  $n^{th}$  order dynamical system and showed that it can be analyzed from a control system perspective.

## OTHER PROJECTS

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### DeepFusion

- Built a deep learning framework from scratch! MLPs, CNNs, RNNs etc.

2024

### NIGnets

- Library for new neural architecture we built for hard guarantees on non-self-intersecting geometry.

2025

### GeoDiff

- A differentiable geometry representation library. (Work in progress)

2025

### GeoSimilarity

- A differentiable geometric loss function library.

2025

### Moving Window Statistics

- Matlab toolbox to compute moving window statistics fast! Speed-up 50-760x.

2023

### Professional Plots

- Matlab toolbox for creating publication quality plots quickly. Over 4200 downloads!

2023

### Search and Rescue UAV Design

- Designed a 10.47kg, 1.95m wingspan UAV design with Payload capacity: 1.3kg, Range: 115km, Endurance: 90 min and Cruise Speed: 20m/s.

2022

## **TECHNICAL SKILLS**

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<b>Programming Languages :</b>	Python, MATLAB, C/C++
<b>CFD</b>	SU2, Luminary Cloud, Gmsh
<b>Machine Learning</b>	PyTorch, JAX, Stable Baselines3
<b>Hardware</b>	Raspberry Pi, Arduino, Thermocouples, Pitot tubes, Load Cells
<b>3D Modelling</b>	SolidWorks, Fusion 360, OnShape

## **AWARDS AND RECOGNITION**

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- HAL Prize (Institute Silver Medal), IIT Madras (best academic performance in Aerospace Engineering). 2023
- Recipient of the prestigious KVPY Fellowship by Dept. of Science and Technology, Govt. of India. 2019
- Awarded the coveted National Talent Search Examination (NTSE) fellowship by NCERT, Govt. of India 2018
- Amongst the top 2% Open-source contributor on MathWorks (MATLAB Community). Present

## **EXTRA-CURRICULAR ACTIVITIES**

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- Department Academic Legislator, Elected representative, Department of Aerospace Engineering, IIT Madras 2022-2023.
- Member, Aerospace Engineering Association, IIT Madras 2022-2023.
- Freshman Mentor, SAATHI - IITM Mental Health and Wellness Community, IIT Madras 2021-2022.
- Acted in the opening scene of the film *History of Yoga* which has been screened in 6 different continents.
- Long distance events, running: half marathons and cycling: Gran Fondo (100km+) rides with participation in marathons in multiple cities.