

CHARLES NAUDET

PhD Student at the University of Notre Dame

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EDUCATION

Ph.D. in Computational Mechanics

University of Notre Dame

📅 August 2020– Present

B.Sc. in Mechanical Engineering

University of Notre Dame

📅 August 2016 – May 2020

WORK EXPERIENCE

Aerothermodynamics Engineer (Intern)

NASA Ames Research Center

📅 June 2022 - August 2022

- Actively contributed to research on the application of anisotropic adaptive mesh refinement (AMR) on unstructured meshes to address large-scale problems involving high-speed, shock-dominated flow.
- Played a key role in post-processing Computational Fluid Dynamics (CFD) solutions to compute heat flux, ensuring the accuracy of heat transfer analyses.
- Made substantial contributions to the quantification of CFD's ability to calculate heat flux using unstructured meshes with AMR and benchmarked results against conventional block-structured finite volume methods.

RESEARCH EXPERIENCE

High-order implicit shock tracking

University of Notre Dame

- Made substantial contributions to the design and development of a modular software package in the Julia programming language for solving a wide range of partial differential equations, resulting in improved computational efficiency, accuracy, and generality.
- Developed novel high-order computational fluid dynamics (CFD) methods to simulate unsteady high-speed flows, enhancing the fidelity of simulations.
- Utilized machine learning techniques, including Gaussian processes, for precise function estimation and shock trajectory prediction, improving prediction accuracy and reducing computational cost.
- Engineered meshing operations, such as h -adaptivity, edge flips, and face swaps, to enhance the adaptability and resolution of numerical grids.
- Formulated a novel coupled augmented Lagrangian and Sequential Quadratic programming optimization solver for PDE-constrained optimization, streamlining the solution of complex optimization problems.
- Co-authored two peer-reviewed journal publications and one conference publication, demonstrating the ability to communicate complex research findings effectively.
 - [Arxiv](#) (In-review)
 - [Journal](#)
 - [Conference Journal](#)

Numerical Bifurcation Analysis of MEMS

University of Notre Dame

- Developed a P1-Finite Element solver to model micro-electromechanical systems (MEMS), improving the accuracy and efficiency of simulations.
- Implemented Adaptive Mesh Refinement (AMR) techniques to resolve multi-scale features within the solutions, optimizing the utilization of computational resources.
- Integrated the FEM solver with a pseudo arc length continuation method to explore the bifurcation structure of various PDEs, including symmetry-breaking bifurcations.

- Conducted in-depth analysis of bifurcation structures on diverse domains of interest, leading to a peer-reviewed journal publication.
 - [Arxiv](#) (In-review)

PDE constrained optimization for heart flow reconstruction

University of Notre Dame

- Applied computational fluid dynamics (CFD) to solve the incompressible Navier-Stokes equations for blood flow through vessels, facilitating accurate simulations.
- Devised a PDE-based optimization framework to reconstruct high-resolution CFD solutions from low-resolution, noisy MRI data, enabling the quantification of blood flow characteristics.
- Conducted rigorous uncertainty quantification for optimization results, enhancing the reliability of reconstructed simulations.
- Published research in a peer-reviewed journal, contributing to the field of simulation-based imaging.
 - [Journal](#)

Modeling of Cell Biology

University of Notre Dame

- Developed finite element model to study 2-D pattern formation in coupled membrane-bulk reaction diffusion system
- Conducted linear stability analysis to understand behavior of system

PROGRAMMING SKILLS

Matlab	● ● ● ● ●
Julia	● ● ● ● ●
Python	● ● ● ● ●
SolidWorks	● ● ● ● ●

TECHNICAL SKILLS

Computational Fluid Dynamics (CFD)	
Machine Learning	Reduced Order Models
Adaptive Mesh Refinement (AMR)	
Meshing Operations	Uncertainty Quantification
Numerical Simulation	
Software Development (Julia, MatLab)	

LEADERSHIP AND SERVICE

- **Fall 2020, Spring 2021, Fall 2021, Spring 2022, Spring 2023, Fall 2023** - Teachers Assistant
Design Tools 2, University of Notre Dame
Aided students in coursework for topics including use of CAM in the design process, CAD model preparation, defining the manufacturing plan, Numerically Controlled (NC) part programming, machine tool simulation, post-processing, preparing files for laser machining and 3D printing, and a continuation of finite element analysis.
- **Fall-Winter 2022** - Coach
Youth Basketball, South Bend Youth Basketball League
Head coach for 3-5th grade boys and girls basketball team, training them in the fundamentals of basketball
- **Spring 2022, Fall-Winter 2022** - Tutor
Algebra/Trig, Robinson Community Learning Center
Instructed small group of middle school students and high school students in algebra and trigonometry
- **Fall 2022** - Teachers Assistant
Finite Element Methods, University of Notre Dame
Aided students in coursework in the fundamental concepts of linear and nonlinear finite element methods with applications to structural analysis, heat flow, fluid mechanics, and multiphysics problems