CHARLES NAUDET

PhD Student at the University of Notre Dame

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QUICK SUMMARY

I am a PhD student at the University of Notre Dame interested in many areas of computational science. I have experience in optimization methods, system analysis, meshing operations, and creating models for many types of physics. I enjoy learning and applying my skillset to new problems.

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

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.

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.

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.

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

AWARDS AND HONORS

- USNCCM17 Travel Award - Albuquerque, New Mexico - July 2023
- USNCCM16 Travel Award - Chicago, Illinois (Virtual) - July 2021

JOURNAL PAPERS

1. C. Naudet, M.J.Zahr, "High-order implicit shock tracking method for simulation of unsteady flows," Journal of Computational Physics. Submitted. 2023. Arxiv
2. C. Naudet, A.E. Lindsay, "Numerical Bifurcation Analysis of mathematical models of Micro-Electromechanical Systems," Mathematics and Computers in Simulation. Submitted. 2023. Arxiv
3. T. Huang, C. Naudet, and M.J. Zahr. "High-order implicit shock tracking boundary conditions for flows with parametrized shocks." Journal of Computational Physics (2023): 112517. Journal
4. C. Naudet, Töger, J., Zahr, M.J. Accurate quantification of blood flow wall shear stress using simulation-based imaging: a synthetic, comparative study. Engineering with Computers 38, 3987–4003 2022. Journal

CONFERENCE PAPERS

1. C. Naudet, M.J. Zahr. "High-Order Implicit Shock Tracking for Finite-Source Spherical Blast Waves." AIAA SCITECH 2023 Forum. 2023. Conference Journal

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

PRESENTATIONS

- Charles Naudet, “High-Order Implicit Shock Tracking for Time-Dependent Flows” in *United States National Congress on Computational Mechanics 2017 (USNCCM17)*, (Albuquerque, New Mexico), 7/26/2023
- Charles Naudet, “High-Order Implicit Shock Tracking for Finite-Source Spherical Blast Waves” in *Proc. of the AIAA Science and Technology Forum and Exposition*, (San Diego, California), 6/15/2023
- Charles Naudet, “High-Order Implicit Shock Tracking for Time-Dependent Flows” in *Computational Fluids Conference (CFC2023)*, (Cannes, France), 4/28/2023

- Charles Naudet, “High-Order Implicit Shock Tracking for Time-Dependent Flows” in *15th World Conference on Computational Mechanics (WCCM15)*, (Yokohama, Japan) (Virtual), 8/3/2022
- Charles Naudet, “Accurate quantification of blood flow wall shear stress using simulation-based imaging,” in *United States National Congress on Computational Mechanics 2016 (USNCCM16)*, (Chicago, Illinois) (Virtual), 4/8/2021