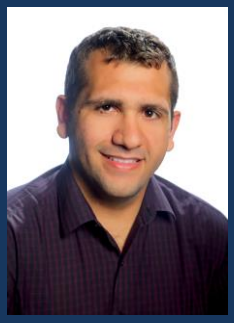
# Department of Applied and Computational Mathematics and Statistics




## Matthew Zahr

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### *Integrating computational physics and numerical optimization to address challenges in science, engineering, and medicine*


Optimization problems governed by partial differential equations are ubiquitous in modern science, engineering, and mathematics. They play a central role in optimal design and control of multiphysics systems, data assimilation, and inverse problems. However, as the complexity of the underlying PDE increases, efficient and robust methods to accurately compute the objective function and its gradient become paramount. To this end, I will present a high-order framework for PDE-constrained optimization and novel model reduction techniques to accelerate the time and resources required to obtain the optimal solution. The framework is applied to solve several of optimization problems including the design of energetically optimal flapping motions, the design of energy harvesting mechanisms, and data assimilation to enhance the resolution of magnetic resonance images. In addition, I will demonstrate that the role of optimization in computational physics extends well beyond these traditional design and control problems. I will introduce a new method for high-order accurate resolution of shock waves in compressible flows using PDE-constrained optimization techniques. The key feature of this method is an optimization formulation that aligns discontinuous features of the solution basis with discontinuities in the solution. The method is demonstrated on a number of two- and three-dimensional compressible flows; in all cases, discontinuities in the flow are fit to high-order accuracy with curved mesh elements, which leads to accurate solutions on extremely coarse meshes.


Monday, April 5, 2021
4:30 PM

Zoom Link:
https://notredame.zoom.us/j/92814033379?pwd=aE1PaUpla0ZkaVFRQkVQRFBuWFBmZz09
Meeting ID: 928 1403 3379
Passcode: 326476