

*Department of Mathematics,  
University of California San Diego*

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# Math 278A - Center for Computational Mathematics Seminar

**David Kamensky**  
UCSD

## **Beyond FE with FEniCS: Automating isogeometric and immersed methods for numerical PDEs**

**Abstract:**

The open-source FEniCS Project (<https://fenicsproject.org/>) has proven to be a popular and successful finite element (FE) automation tool, applicable to many problem domains involving partial differential equations (PDEs). (CCoM seminar regulars may recall a 2017 talk by L. Ridgway Scott on FEniCS and its implications for pedagogy.) The present talk discusses recent work extending FEniCS to numerical methods other than traditional FE methods. The library tIGAr (<https://github.com/david-kamensky/tIGAr>) extends FEniCS to isogeometric analysis (IGA), where spline-based geometries from design and graphics replace the meshes of traditional FE analysis. This library retains a similar workflow to traditional FE analysis with FEniCS, while using object-oriented abstractions to separate PDE solution from geometry creation. This design permits analysis of many different PDEs, using a wide variety of existing spline types, and provides an interface to add support for future spline constructions. This talk surveys several example applications of tIGAr, including divergence-conforming IGA of incompressible flow, Kirchhoff–Love shell analysis, and nonlocal contact mechanics. Going further beyond standard FE analysis, we consider immersed-boundary methods, which present more complicated challenges for automation software. Some initial results on combining FEniCS and tIGAr for immersed fluid–structure interaction will be presented, along with recent work coupling tIGAr-based isogeometric shell analysis at intersection curves of separately-parameterized structural components. Lastly, we discuss the ongoing development of general-purpose tools for immersed FE analysis.

**Tuesday, October 19, 2021  
11:00 AM  
Zoom ID 970 1854 2148**

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