THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Mathematics Colloquium

October 12, 2023
3:30 - 4:30 p.m.
PH 332

Shape-morphing modes for solving PDEs with conserved quantities

Mohammad Farazmand (NCSU)

Abstract. I introduce shape-morphing modes for efficient and scalable approximation of solutions to time-dependent PDEs. Numerical methods typically assume the solution of a PDE as the linear combination of static modes, such as Fourier modes or finite elements. This is quite inefficient for PDEs whose solutions are localized and/or dominated by advection. In contrast, in our framework, the modes depend nonlinearly on time-varying parameters, thus allowing the modes to change shape and adapt to the solution of the PDE over time. I will show that the shape parameters can be evolved optimally by solving a system of ODEs. I will also discuss the interpretation of this idea as a neural network whose weights and biases are time-dependent. In contrast to conventional neural nets, no training is required to determine the network parameters; instead, they are evolved by solving a known system of ODEs. Finally, I'll show that, in our framework, one can easily ensure that the approximate solution preserves the conserved quantities of the PDE.