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**Efficient threshold dynamics methods for topology optimization for fluids and heat transfer problems**

In this talk, we will introduce an efficient threshold dynamics method for topology optimization for fluids modeled with the Stokes equation. A domain approach is applied to solve the problem in the whole domain and the minimization problem can be solved with an iterative scheme. The total energy decaying property of the iterative algorithm can be obtained. The extensions of the iterative thresholding method will also be introduced for topology optimization for the Navier-Stokes flow and the heat transfer problems.

**A numerical method for elliptic equations based on sample solutions**

A learning based method for elliptic equations is considered. Based on Runge's approximation, it can be proved that when the solution can be continued outside the computational domain, using circularly distributed fundamental solutions as learning samples is sufficient to obtain the solution mapping with generates spectral accuracy. However, for complex geometries such as corners, this approximation may only have logarithmic convergence due to regularity issues, which is computationally impracticable. In this work, we will investigate how to choose learning samples so as to essentially ensure the generalizability of the method. Error analysis and numerical examples Illustrate the flexibility and high-accuracy features.

**O N**

quasi-2D confinement

Ewald

**Numerical analysis of the hemivariational inequalities governed by fluid-fluid coupled flow**

In this work, we explore the well-posedness and conduct numerical analysis of hemivariational inequalities for the coupled stationary Navier-Stokes/Navier-Stokes system. The interface condition involves the Clark subgradient and serves as a generalization of various interface interaction relations, including nonlinear transmission conditions and friction-type conditions. We present an existence and uniqueness result for a solution of the continuous model. We propose a domain decomposition approach to solve the coupled system and examine the convergence of iterations. Moreover, we use the finite element approximation to discretize the hemivariational inequality and derive error estimates. Numerical results are reported to illustrate the theoretical analysis.

**Newton's method and its hybrid with machine learning for Navier-Stokes Darcy Models discretized by mixed element methods**

In this talk, we focus on discussing Newton's method and its hybrid with machine learning for the steady state Navier-Stokes Darcy model discretized by mixed element methods. First, a Newton iterative method is introduced for solving the relative discretized problem. It is proved technically that this method converges quadratically with the convergence rate independent of the mixed element mesh size, under certain standard conditions. Later on, a deep learning algorithm is proposed for solv-

## Optimal transportation for the freeform reflector problem

The inverse reflector problem aims to design a freeform reflecting surface that can direct the light from a specified source to produce the desired illumination in the target area. Mathematically, it can be regarded as an optimization problem, which is exactly the optimal transportation problem if the target is in the far field. A Sobolev gradient descent method is proposed to solve the corresponding optimization problem for both the far-field and the near-field cases under the finite element framework.

## Some AI methods with normalized DNN for stationary and evolutional problems