

國立中央大學數學系

專題演講

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演講題目：CONSERVATIVE PHYSICS-INFORMED
NEURAL NETWORKS FOR GENERALIZED
BUCKLEY-LEVERETT EQUATION NEAR
CRITICAL STATES

演講時間：2023年12月12日(星期二) 10:00 a.m.

演講地點：中央大學鴻經館M107

Abstract：

In this dissertation, a modified version of conservative Physics-informed Neural Networks (cPINN) is provided to approach the solutions of Riemann problem for the hyperbolic scalar conservation laws in non-conservative form. To demonstrate the results, we use the model of generalized Buckley-Leverett equation (GBL equation) with discontinuous porosity in porous media. By inventing a new unknown, the GBL equation is transformed into a two-by-two resonant hyperbolic conservation laws in conservative form. We experiment with our idea by using a cPINN algorithm to solve the GBL equation in both conservative and non-conservative forms, as well as the cases of critical and non-critical states. This method provides a combination of two different neural networks and corresponding loss functions, one is for the two-by-two resonant hyperbolic system, and the other is for the scalar conservation law with a discontinuous perturbation term in the non-convex flux. The technique of re-scaling to the unknowns is adopted to avoid the oscillation or inaccurate speed of the Riemann solutions in the cases of critical Riemann data. The solutions constructed by the modified cPINN match the exact solutions constructed by the theoretical analysis for hyperbolic conservation laws. Finally, we compare the performance of the modified cPINN with numerical method called WENO5. Whereas WENO5 struggles with the approximate solutions for the Riemann problems of GBL equation in non-conservative form, cPINN works admirably. Moreover, the integration of meta-learning into the initialization of cPINN for the re-scaled GBL equation is being explored as an additional step forward. And as an ongoing project, definitive conclusions about the effectiveness of meta-learning integration cannot be drawn at this point due to inconsistencies in performance.

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