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Large-scale Inverse Modeling of Hydraulic Tomography by Physics Informed Neural Network

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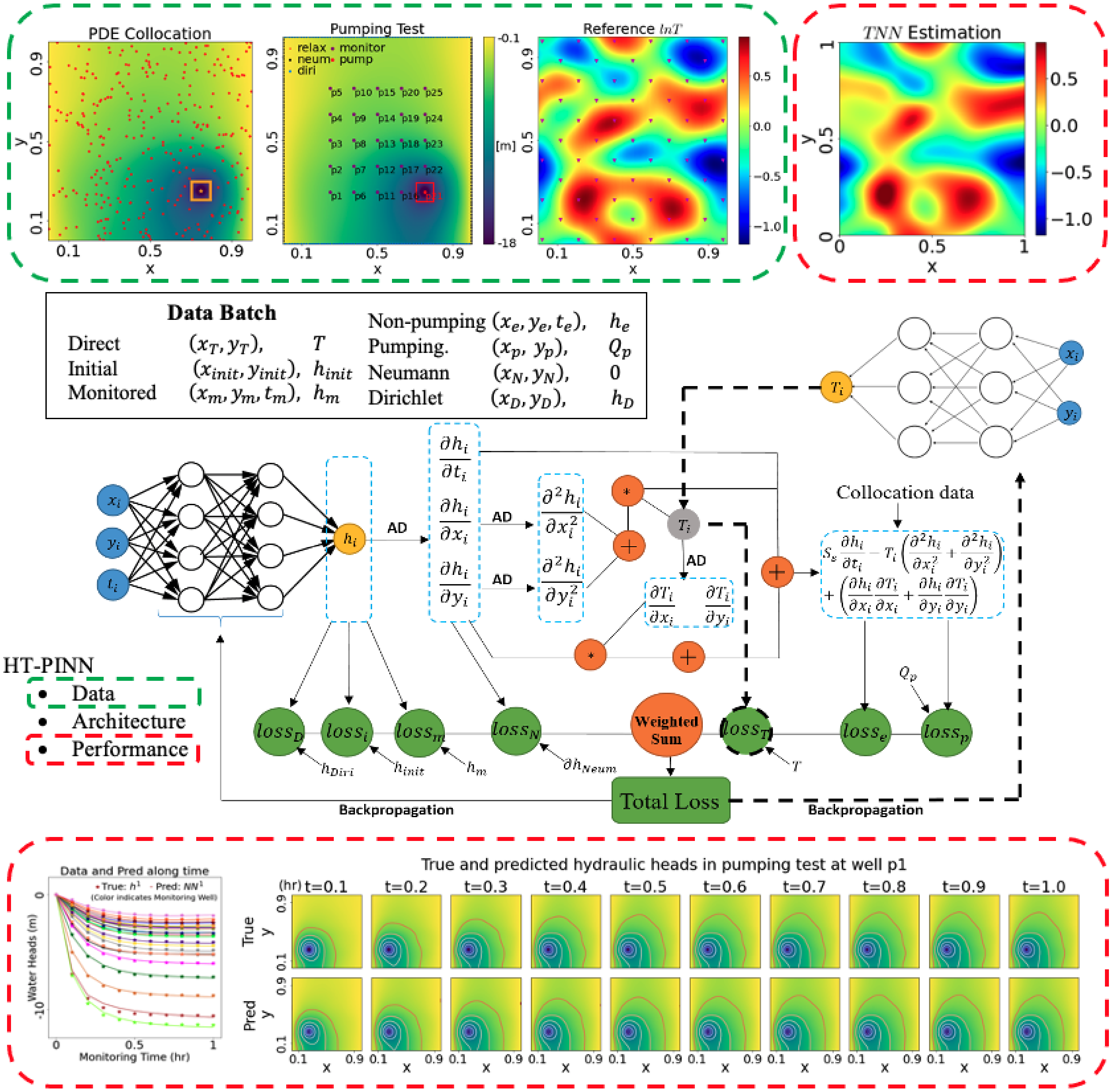
In this study, we develop a hydraulic tomography - physics informed neural network (HT-PINN) for inversion of two-dimensional large-scale spatially distributed transmissivity. HT-PINN involves a neural network model of transmissivity and a series of neural network models to describe transient or steady-state sequential pumping tests. All neural network models are trained by minimizing the total loss function including data fitting errors and PDE constraints. Batch training of collocation points is used to amplify the advantage of mesh-free property of neural networks, thereby limiting the number of collocation points per training iteration and reducing the total training time. The developed HT-PINN successfully simulates transient and steady state hydraulic tomography and accurately and efficiently inverts two-dimensional Gaussian transmissivity fields with more than a million unknowns (10241024 resolution). HT-PINN exhibits great scalability and structural robustness in inverting fields with different resolutions. Specifically, data requirements do not increase with the problem dimensionality, and the computational cost remains almost unchanged due to its mesh-free nature,

while maintaining high inversion accuracy when increasing the field resolution.



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