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DeepCosmo: A New Method of Neural Network Trained with Tetrad-Based Riemann Curvature Tensor Calculation for Solving Einstein Field Equations in AdS/CFT Duality

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Traditional numerical methods face unprecedented challenges when solving complex gravitational problems, especially in the computation of black hole metric in AdS/CFT duality. This paper proposes an innovative approach — DeepCosmo, which combines the method of computing curvature tensors using orthonormal rigid tetrad to train neural networks, exploring a new path for efficiently obtaining accurate solutions to highly nonlinear Einstein's field equations through machine learning. Compared to existing research that is limited in computing Christoffel symbols, DeepCosmo utilizes Ricci rotation coefficients, connection 1-forms, and Cartan's second structural equation to obtain the Riemann tensor. This not only reduces computational complexity of AdS/CFT duality but also significantly improves training and operational efficiency while offering better physical intuition, accelerating research in the field of AdS/CFT duality. This paper presents multiple variants of DeepCosmo based on deep neural networks, exploring the fitting effects of different DeepCosmo variants. By employing various solutions of Einstein's field equations, such as the Schwarzschild vacuum solution, and the Reissner-Nordstrom solution, the effectiveness of the DeepCosmo method is verified from multiple perspectives.

Presenter(s) : HUANG, Chenqingshui (Central China Normal University Wollongong Joint Institute)

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