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A Deep Learning Based Physics Informed Continuous Spatio Temporal Super-Resolution Framework SOHEIL ESMAEILZADEH, Stanford University, CHIYU MAX JIANG, UC Berkeley, KAMYAR AZIZZADENESHELI, California Institute of Technology, KARTHIK KASHINATH, MUSTAFA MUSTAFA, Lawrence Berkeley National Laboratory, HAMDI A. TCHELEPI, Stanford University, PHILIP MARCUS, UC Berkeley, MR PRABHAT, Lawrence Berkeley National Laboratory, ANIMA ANANDKUMAR, California Institute of Technology and NVIDIA — We propose a novel deep learning based super-resolution framework to generate continuous (grid-free) spatio-temporal solutions from the low-resolution inputs. While being computationally efficient, our proposed framework accurately recovers the fine-scale quantities of interest and allows for: (i) the output to be sampled at all spatio-temporal resolutions, (ii) a set of Partial Differential Equation (PDE) constraints to be imposed, and (iii) training on fixed-size inputs on arbitrarily sized spatio-temporal domains owing to its fully convolutional encoder. We empirically study the performance of our framework on the task of super-resolution of turbulent flows in the Rayleigh-Benard convection problem. Across a diverse set of evaluation metrics, we show that our proposed framework significantly outperforms the existing baselines. Furthermore, we provide a large-scale implementation of our framework and show that it efficiently scales across large clusters, achieving 96.80 percent scaling efficiency on up to 128 GPUs and a training time of less than 4 minutes. We provide an open-source implementation of our method that supports arbitrary combinations of PDE constraints.

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