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Unstructured fluid flow data recovery using machine learning and Voronoi diagrams KAI FUKAMI, Keio University, ROMIT MAULIK, NESAR RAMACHANDRA, Argonne National Laboratory, KUNIHIKO TAIRA, University of California, Los Angeles, KOJI FUKAGATA, Keio University — Recent studies have demonstrated the strengths of convolutional neural networks (CNNs) in a range of applications in fluid dynamics. However, most studies have been performed on structured grids since traditional convolutional operations in CNNs are founded on image processing. We here introduce the use of a Voronoi diagram, as a simple data preprocessing step, to interface the structured grid-based convolutional methods and unstructured data arising from sparse sensor placements or unstructured grids widely used in numerical simulations. The Voronoi diagram provides a structured-grid approximation of low-dimensional measurements based on Euclidean distance from the unstructured data. The present idea serves as a proof of concept for spatial fluid flow reconstruction on unstructured grids or from randomly placed sensors. To demonstrate the overall CNN approach with the Voronoi diagram inputs, we consider (1) two-dimensional cylinder wake, (2) NOAA sea surface temperature, and (3) turbulent channel flow. We show that the present CNN with the Voronoi idea can reconstruct the high-resolution flow field from coarse information. Our results reveal that the unstructured fluid data sets can be handled by CNNs without considering complex machine learning algorithms.

Kai Fukami
Keio University

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