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Dynamic reconstruction of sub-sampled data using Optimal Mode Decomposition JAKUB KROL, ANDREW WYNN, Imperial College London — The Nyquist-Shannon criterion indicates the sample rate necessary to identify information with particular frequency content from a dynamical system. However, in experimental applications such as the interrogation of a flow field using Particle Image Velocimetry (PIV), it may be expensive to obtain data at the desired temporal resolution. To address this problem, we propose a new approach to identify temporal information from undersampled data, using ideas from modal decomposition algorithms such as Dynamic Mode Decomposition (DMD) and Optimal Mode Decomposition (OMD). The novel method takes a vector-valued signal sampled at random time instances (but at Sub-Nyquist rate) and projects onto a low-order subspace. Subsequently, dynamical characteristics are approximated by iteratively approximating the flow evolution by a low order model and solving a certain convex optimization problem. Furthermore, it is shown that constraints may be added to the optimization problem to improve spatial resolution of missing data points. The methodology is demonstrated on two dynamical systems, a cylinder flow at $\mathrm{Re} = 60$ and Kuramoto-Sivashinsky equation. In both cases the algorithm correctly identifies the characteristic frequencies and oscillatory structures present in the flow.

Jakub Krol
Imperial College London

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