The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A strategy to optimal block-incremental singular value decomposition for unsteady high-fidelity simulation data

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Keywords: *Computational Fluid Dynamics, Singular Value Decomposition, Incremental SVD, high-dimensional data*

Singular value decomposition (SVD) has been widely applied to achieve data-based model analyses such as proper orthogonal decomposition (POD) or dynamic mode decomposition (DMD). The increasing amount of data from high-fidelity simulations poses the storage challenge for these modal analyses. The offline SVD approach, which needs to access the entire high-dimensional dataset at once, leads to prohibitive memory cost to process this massive data. The incremental SVD [1] was proposed to overcome this difficulty by splitting the dataset into smaller subsets and accumulating the SVD analysis on the fly. One-column incremental SVD [2] is able to effectively complete the modal analysis online, but this online method is much slower than offline SVD. We herein present a strategy to obtain an optimal updating number for block-incremental SVD with balancing the computing time and memory cost simultaneously. This is demonstrated using 2D randomized matrices. A criterion is defined to find the optimal value, and the effectiveness is validated on an engineering situation where a series of datasets need to be analyzed, implying it would be useful for applications in practice.

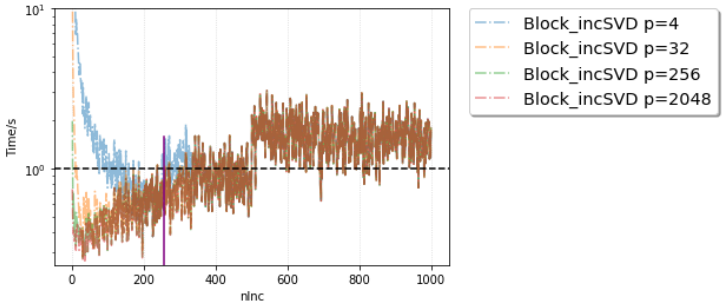

Figure 1: The time ratio between the block-incremental SVD and onfline SVD, with different incremental number (nInc) for the data with 4, 32, 256 and 2048 sets of a 1000-by-1000 matrix.

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