Review of Reasearch paper

Shubham A. Sutar
Indian Institute of Science,Bangaluru
Computational and Data Science
shubhamas@iisc.ac.in

1 Major Strength and Weakness of presented work in research paper

1.1 Strengths of Research Papers

There are several methods used for Reduced Order model and Galerkin-POD is one of the method. Galerkin ROM's are unstable for long time interval.Least-Square Petrov Galerkin ROM's(LSPG) are more accurate than Galerkin ROM's over small time window where Galerkin is stable.The most important finding is that decreasing the time step does not necessarily decrease the error for the LSPG's ROM's. LSPG's ROM's are most accurate for an intermediate time step.This highlights the critical importance of time step selection.There are several new findings demonstrated that have important practical implementation,including condition under which the LSPG ROM has a time continuous representation,condition under which both techniques are equivalent,and time-discrete error bounds for the two approaches.[1]

Many data driven approaches such as eigen value decomposition,PCA,SVD are used for dimensionality reduction of system.The POD gives an orthogonal set of basis vector with the minimal distortion.This property is useful in reduced-order model of the flow-field.For high dimensional spatial datasets,snapshot method is used because it is to easy to calculate POD modes.Incoherent noise in the data generally appears as a high-order POD modes,provided that noise level is lower than signal level.So,POD analysis can be used to practically remove the incoherent noise from the dataset by removing high-order modes from the expansion.[2]

1.2 Weakness of Research paper

LSPG ROM's are used for linear multistep method scheme such as Euler method and Runge-Kutta Method.There is no mention of number 'k' (number of dimension) which is very much less than original dimension of model 'n' which gives johnson-Lindenstrauss type result i.e plus or minus epsilon closer to the original solution.LSPG ROMs are only unstable for small time steps.Adding modes to the POD basis has little effect on LSPG ROM accuracy for large time steps.It is not developed for non-linear method.[1]

As the proper orthogonal decomposition is based on second-order correlation,higher-order correlation are ignored.POD is generally computationally expensive.The temporal coefficients of spatial POD modes generally contain a mix of frequencies. The spectral POD discussed previously addresses this issue.The POD arranges modes in the order of energy contents and not in the order of the dynamical importance. This point is addressed by balanced POD and DMD(Dynamic Mode Decomposition) analyses.It is not always clear how many POD modes should be kept,and there are many different truncation criteria.[2]

References

[1] Kevin Carlberg, Matthew Barone, and Harbir Antil. Galerkin v. least-squares Petrov–Galerkin projection in nonlinear model reduction. *arXiv:1504.03749 [cs, math]*, August 2016.

[2] Kunihiko Taira, Steven L. Brunton, Scott T. M. Dawson, Clarence W. Rowley, Tim Colonius, Beverley J. McKeon, Oliver T. Schmidt, Stanislav Gordeyev, Vassilios Theofilis, and Lawrence S. Ukeiley. Modal Analysis of Fluid Flows: An Overview. *AIAA Journal*, 55(12):4013–4041, December 2017.