Contribution ID: **39** Type: **Talk**

Low-synchronization variants of reorthogonalized block classical Gram-Schmidt

Monday 17 February 2025 17:00 (30 minutes)

Interest in communication-avoiding orthogonalization schemes for high-performance computing has been growing recently. In this talk, we discuss some open questions about the numerical stability of various block classical Gram-Schmidt variants that have been proposed in the past few years. We introduce an abstract framework, the flexibility of which allows for new rigorous bounds on the loss of orthogonality in these variants. With this framework, we first analyze a generalization of (reorthogonalized) block classical Gram-Schmidt, and then, using this variant, which has four synchronization points per block column, we remove the synchronization points one at a time and analyze how each alteration affects the stability of the resulting method. Our analysis shows that the variant requiring only one synchronization per block column cannot be guaranteed to be stable in practice, as stability begins to degrade with the first reduction of synchronization points.

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Session Classification: Contibuted Talk