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Divide and conquer algorithms and software for large Hermitian eigenvalue problems

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Divide-and-conquer paradigms can lead to efficient and flexible techniques for solving large Hermitian eigenvalue problems. This talk will discuss how these techniques can be put to work to implement 'spectrum slicing' strategies, i.e., strategies that extract slices of the spectrum independently. The presentation will begin with an overview of polynomial filtering, a general approach that can be quite efficient in the situation where the matrix-vector product operation is inexpensive and when a large number of eigenvalues is sought. We will present a few techniques based on the Lanczos algorithm with and without restarts, as well as subspace iteration. An alternative to polynomial filtering that is generating a growing interest is a class of methods that rely on rational functions. Good representatives of this general approach are the FEAST eigensolver and the Sakurai-Sugiura algorithm. We will argue that the standard Cauchy integral–based approach can be substantially improved upon – especially when iterative solvers are involved. Finally, the talk will discuss our recently released code named EVSL (for eigenvalues slicing library) that implements these ideas.

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