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Reliable Lower Eigenvalue Bounds for Beam Buckling Problem

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Abstract: In the stability analysis of elastic structures, accurately estimating the critical buckling load is essential for safe and efficient design. This problem is commonly formulated as an eigenvalue problem, where the smallest eigenvalue corresponds to the critical load. However, standard numerical methods often provide upper bounds on these eigenvalues, but not lower bounds. This limits the reliability and practical applicability of such estimates. This contribution presents a framework for deriving guaranteed and computable lower bounds for eigenvalues associated with buckling problem for both linear Euler-Bernoulli model and nonlinear Gao beam model. We demonstrate how these lower bounds can be computed alongside standard numerical approximations, particularly those based on finite element discretization, resulting in two-sided estimates for the critical buckling load. We illustrate the approach with numerical examples and discuss its potential extensions.